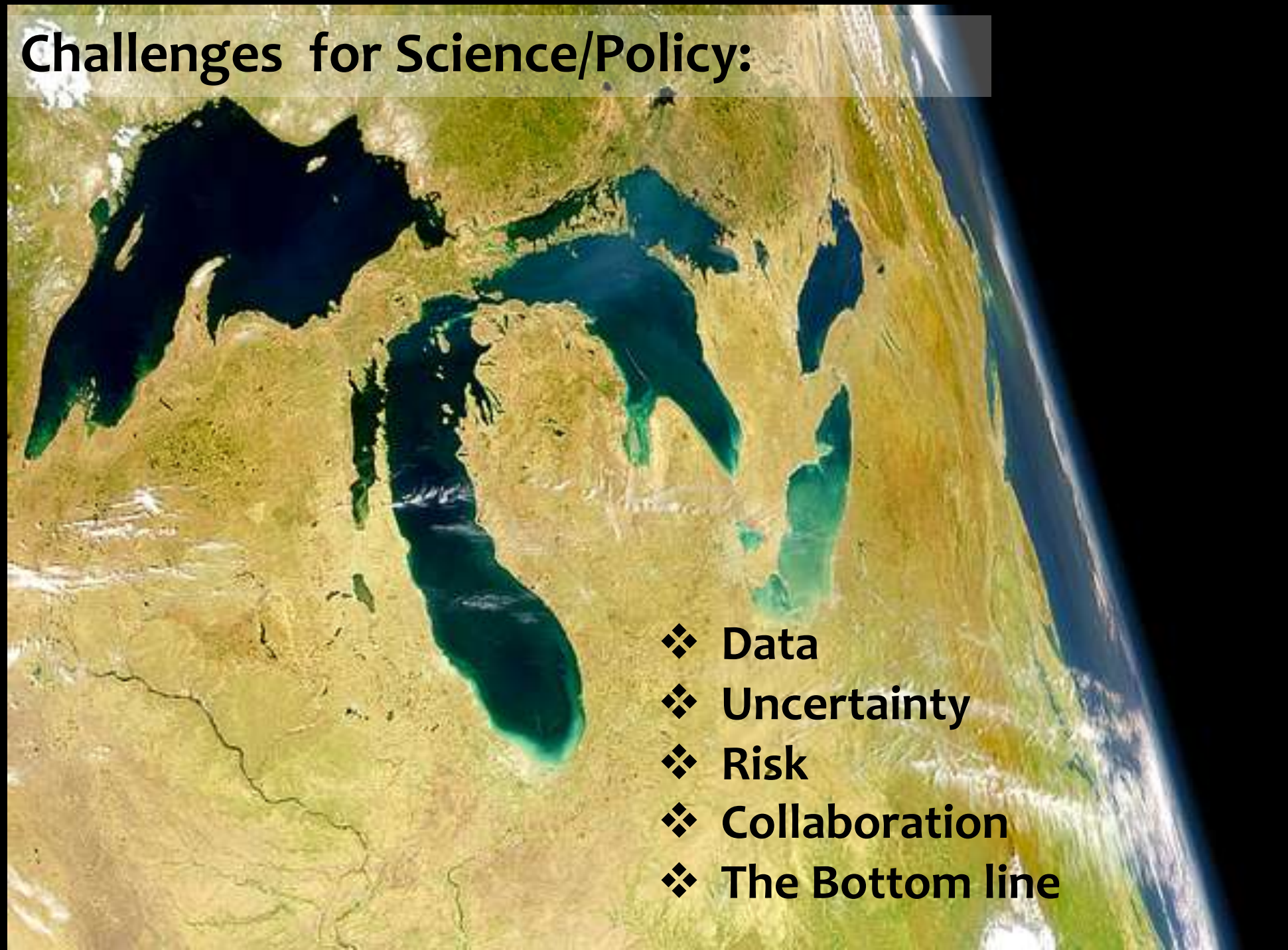
Spotlight on Lake Michigan

Dr. J. Val Klump

Great Lakes Legislative Caucus Annual Meeting 16 July 2016

Challenges for Science/Policy:



- Data
- Uncertainty
- Risk
- Collaboration
- The Bottom line

$4 billion sports fishery industry.

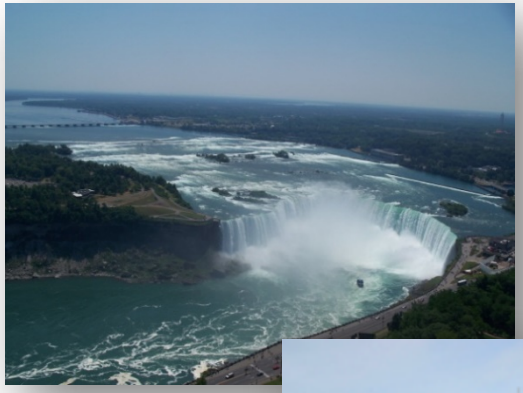
100 million Lake Trout in L. Superior

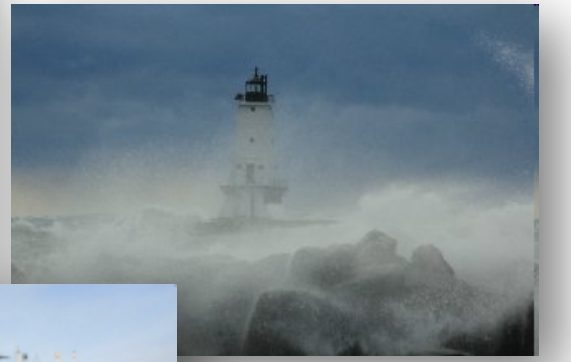
drinking water for 40 million people

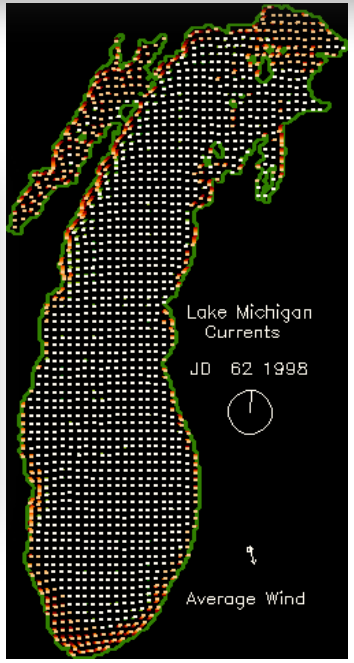
Regional economy = **4th largest** in the world

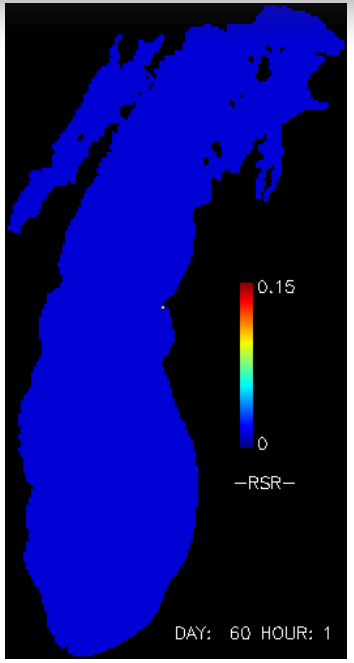
"priceless"

Inland Seas – *not* mere “lakes”:





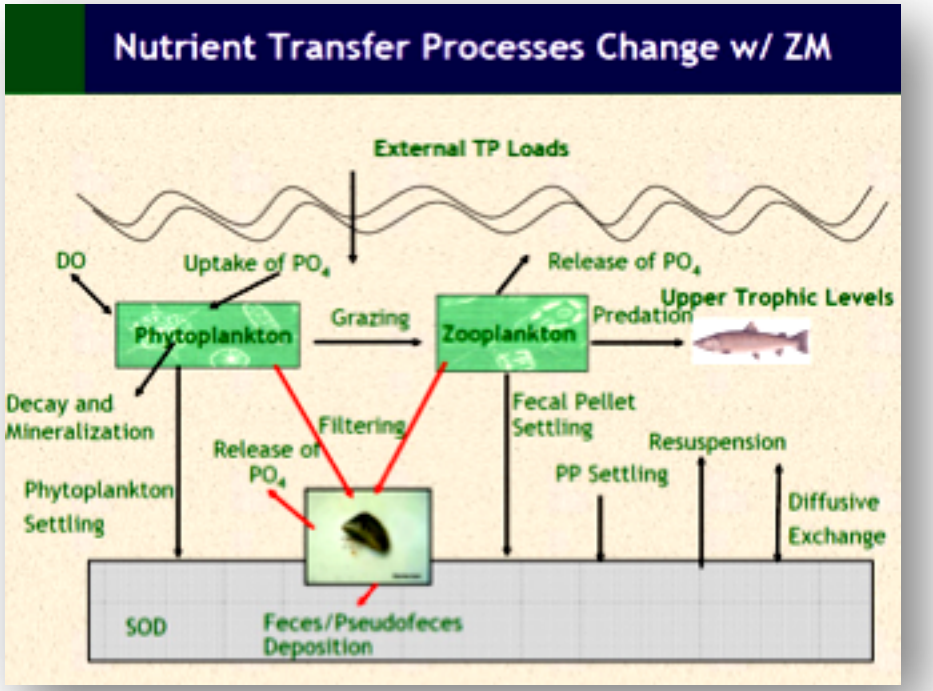


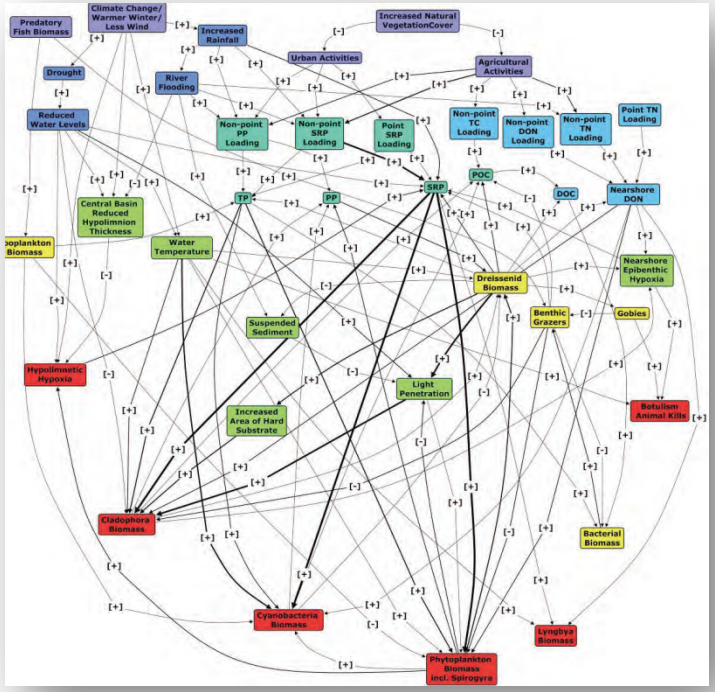


Yet, despite their size these systems are **surprisingly fragile**

- Evolutionarily “young” - Simple food webs

∴ highly susceptible to non-native spp.

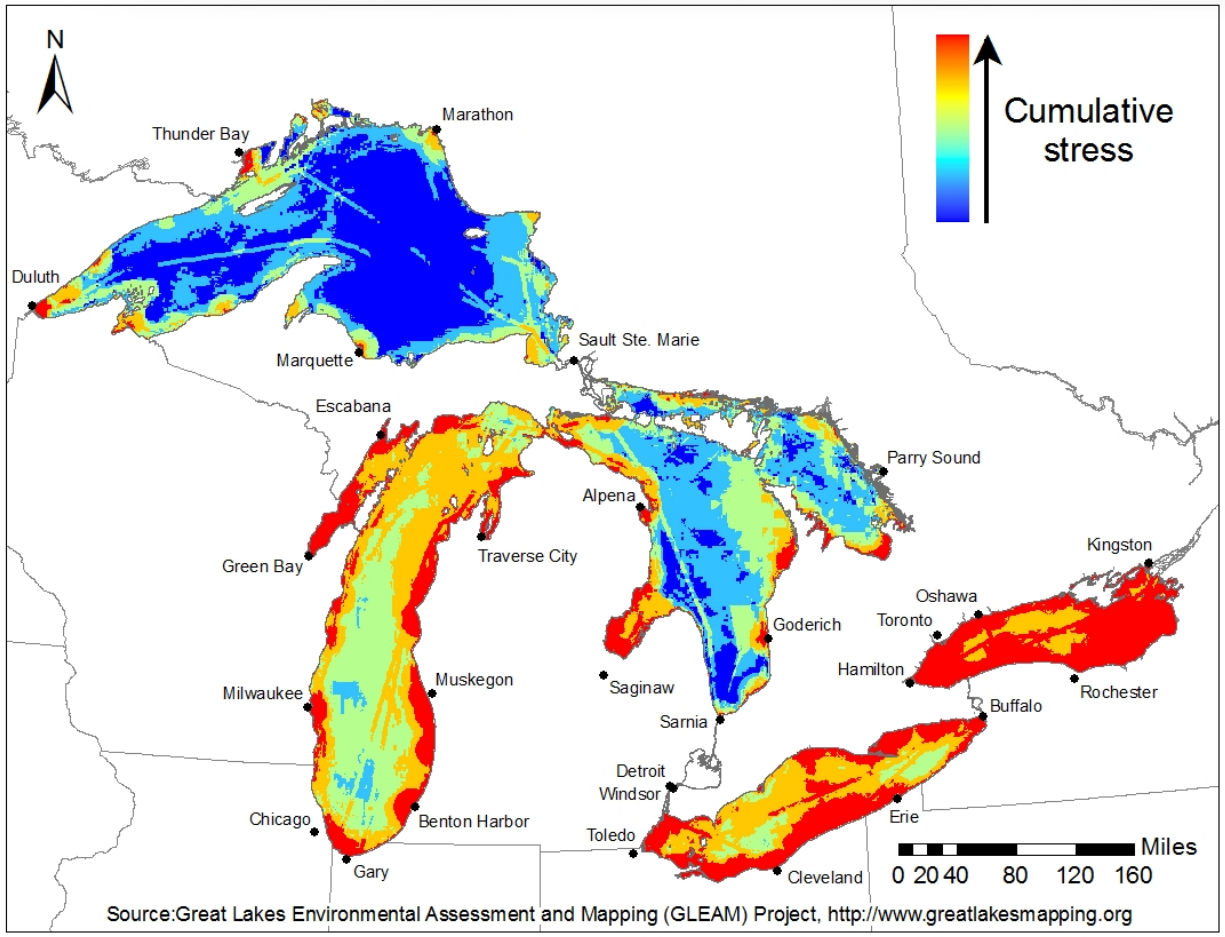




2 ports of call away
from 99% of the world

Global system

⇒ cumulative environmental stresses



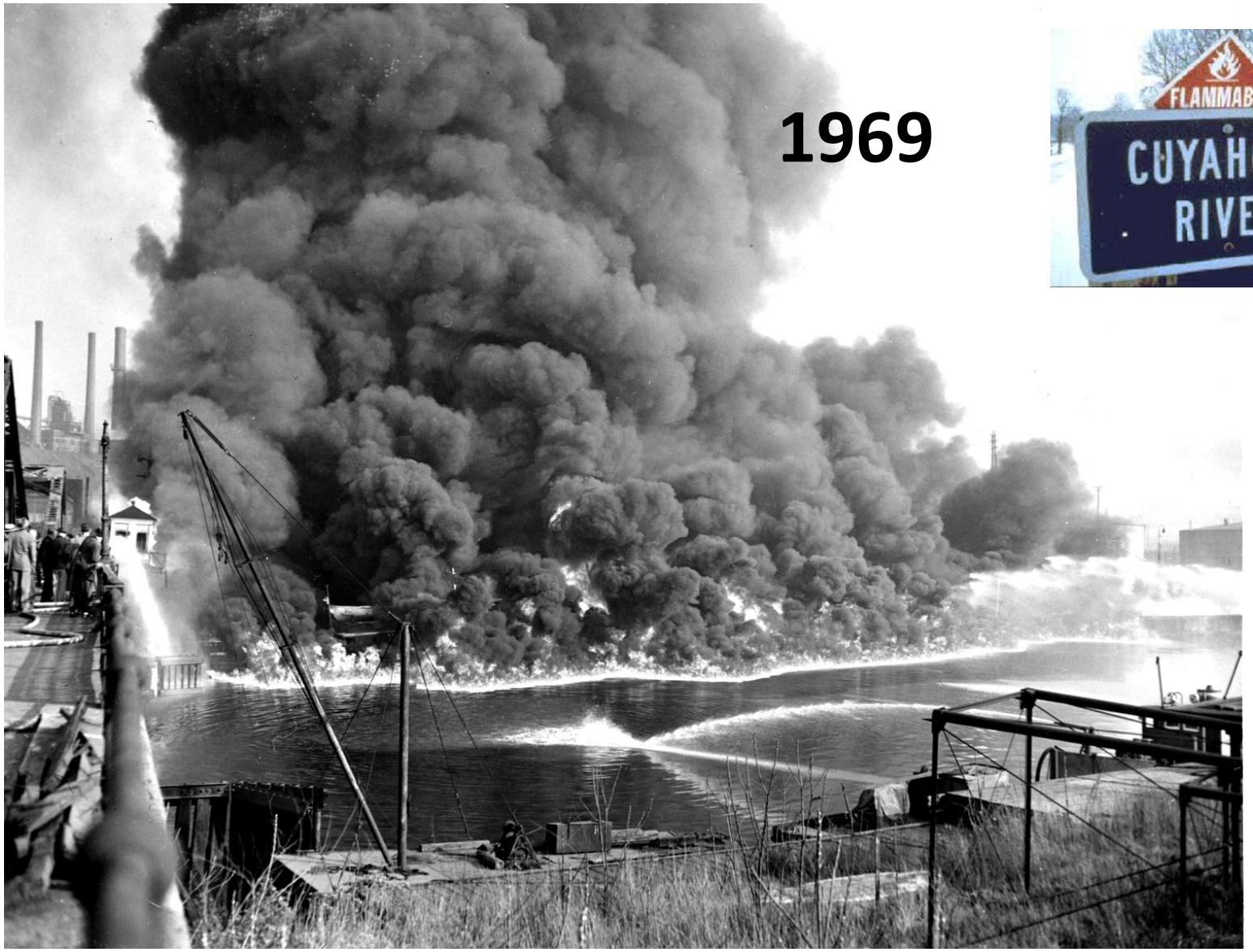
U. Michigan GLEAM project

- 34 different threats

- ❖ Habitat alterations
- ❖ **Climate change**
- ❖ Coastal Development
- ❖ Fisheries management
- ❖ **Invasive species**
- ❖ **NPS runoff**
- ❖ Toxic substances

. . . and constantly changing

anthropogenic Drivers

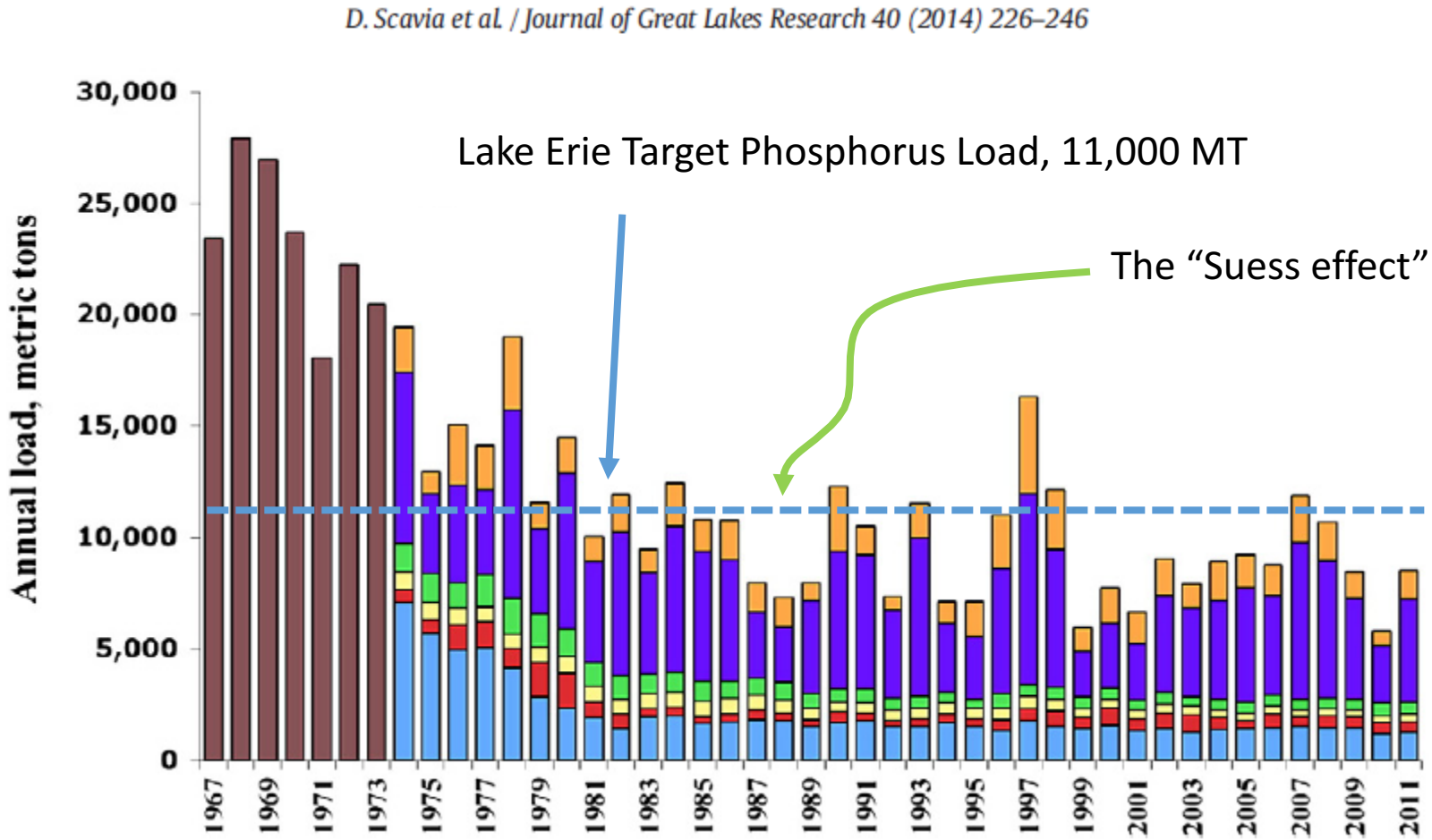


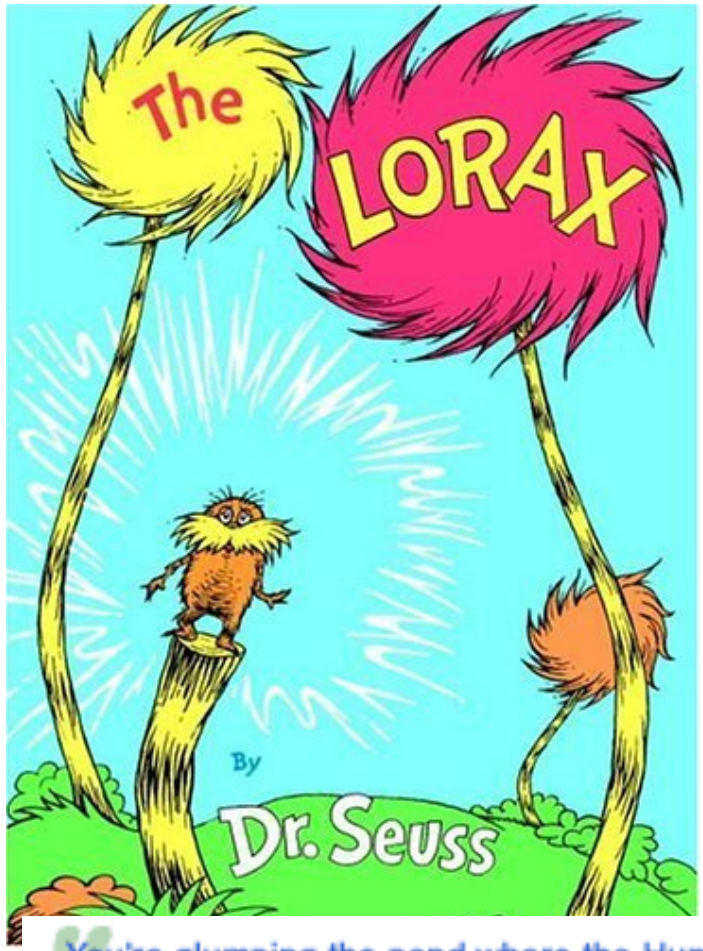
1969

triggered passage of
CWA in 1972

Lake Erie declared **“dead”**

→ phosphorus abatement ~ 60% reduction





"You're glumping the pond where the Humming-Fish hummed!
No more can they hum, for their gills are all gummed.
So I'm sending them off. Oh, their future is dreary.
They'll walk on their fins and get woefully weary
in search of some water that isn't so smeary.
I hear things are just as bad up in Lake Erie."

— *The Lorax, by Dr. Seuss*

Dr. Seuss
7301 Encelia Drive
La Jolla, California 92037

January 27, 1986

Dear Claudia Melear and Margie Pless:

You must think me terribly rude for not answering your very pleasant letter of December 6. The fault, however, is not mine. It just arrived this morning, having been somewhat circuitously forwarded from New York via pony express.

Although I will be unable to accept your kind invitation to come to Cleveland, I do agree with you that my 1971 statement in the Lorax about the condition of Lake Erie needs a bit of revision. I should no longer be saying bad things about a body of water that is now, due to great civic and scientific effort, the happy home of smiling fish.

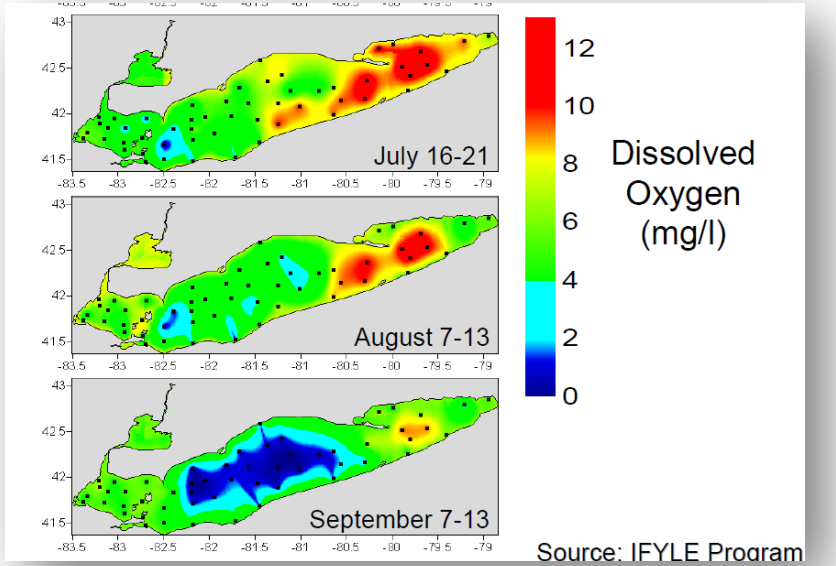
I can assure you the process of purifying my text will commence immediately. Unfortunately, the purification of texts, like that of lakes, cannot be accomplished over night. The objectionable line will be removed from future editions. But it could possibly take more than a year before the existing stock of books has moved out of the book stores.

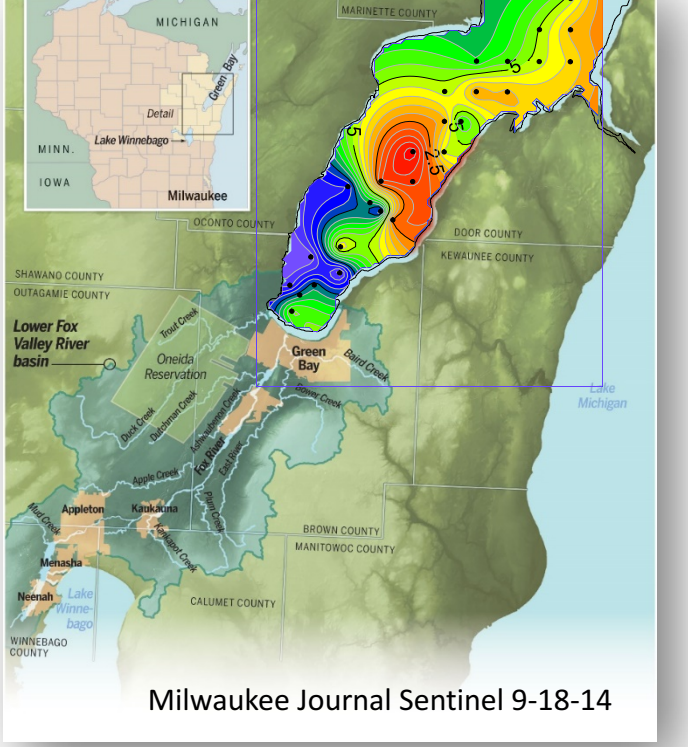
In the meantime, thank you for your letter and for all the great Loraxian work you have been doing.

Dr. Seuss

Theodor S. Geisel

Lake Erie: 9 October 2011

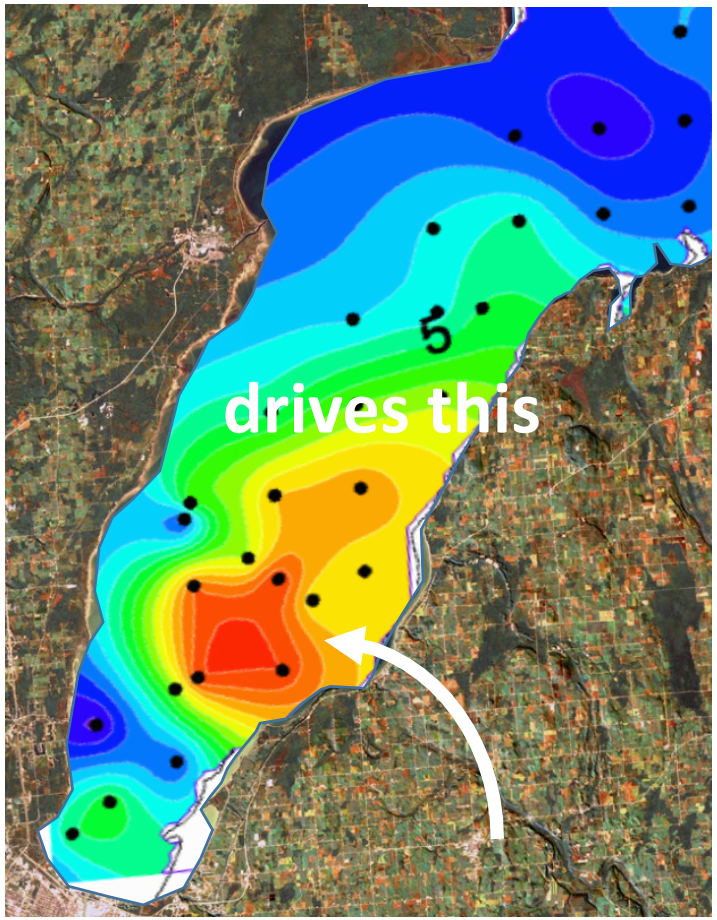




Milwaukee Journal Sentinel 9-18-14

❖ Expanding **Dead Zones**

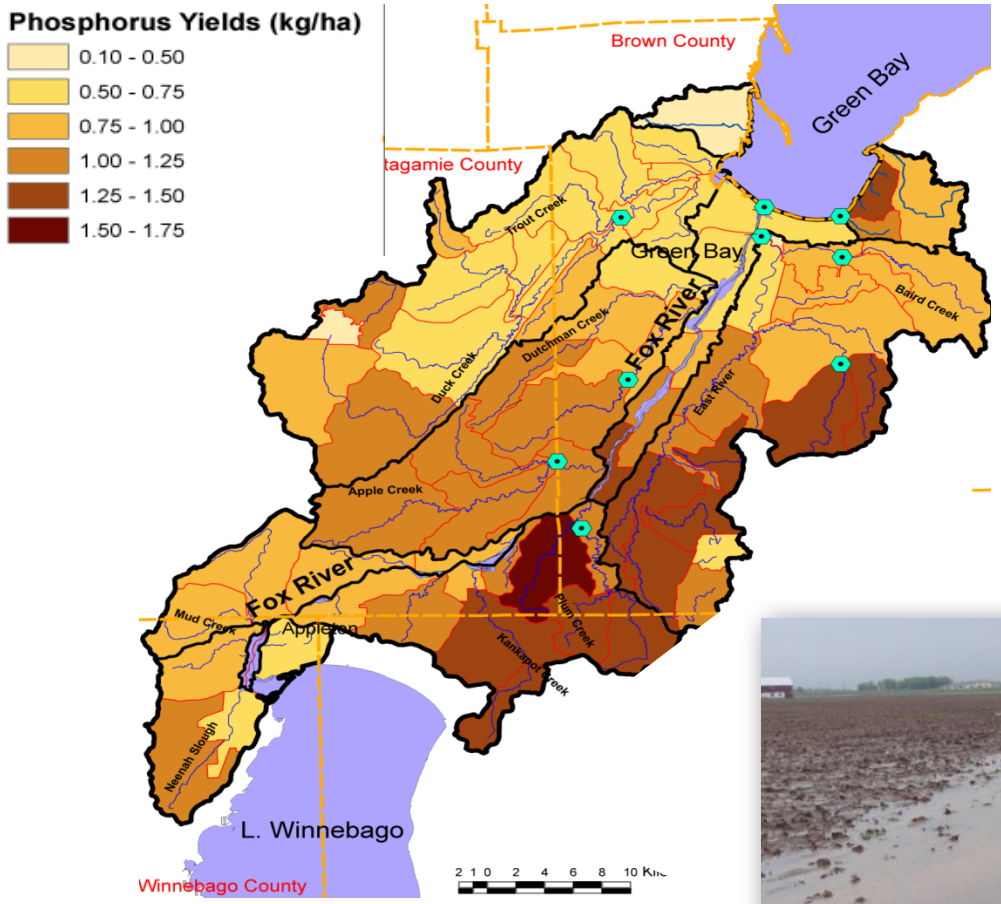
processes resulting in hypoxia in Green Bay



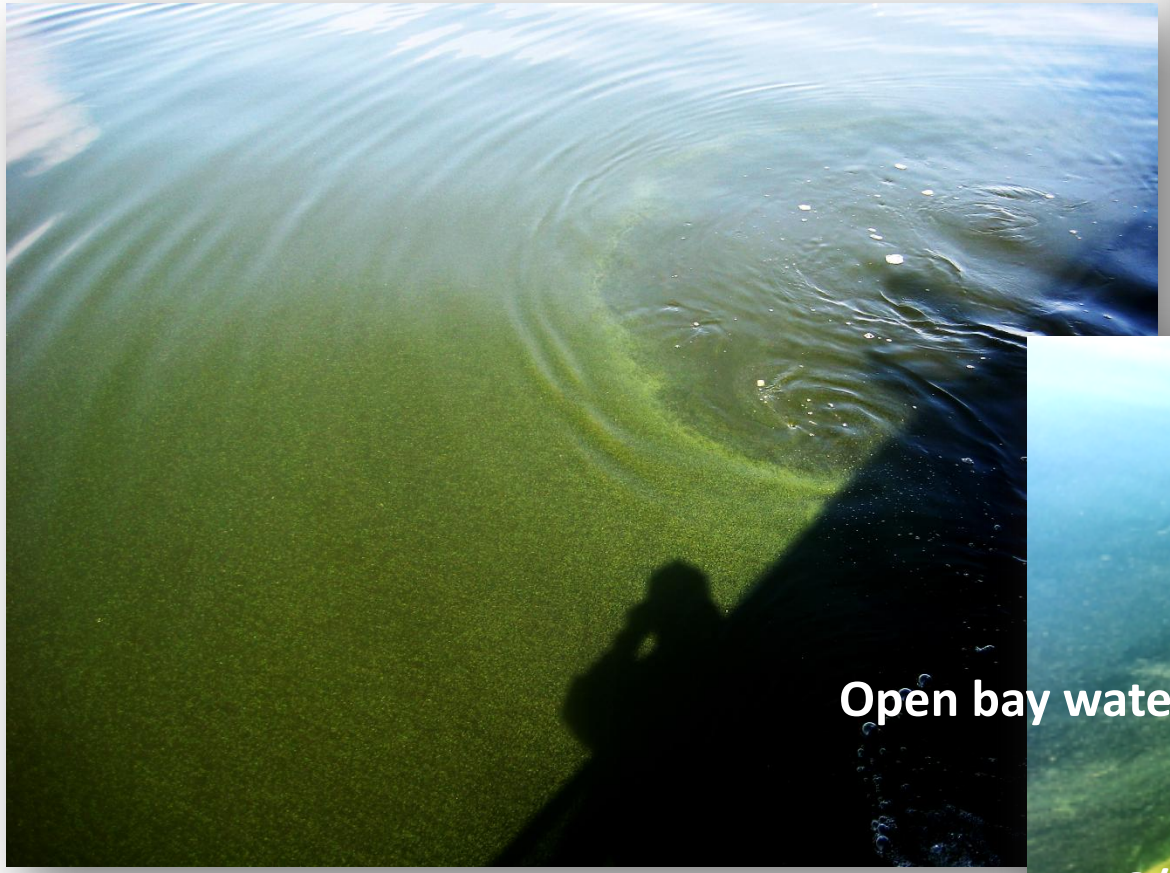
The Green Bay Dead Zone

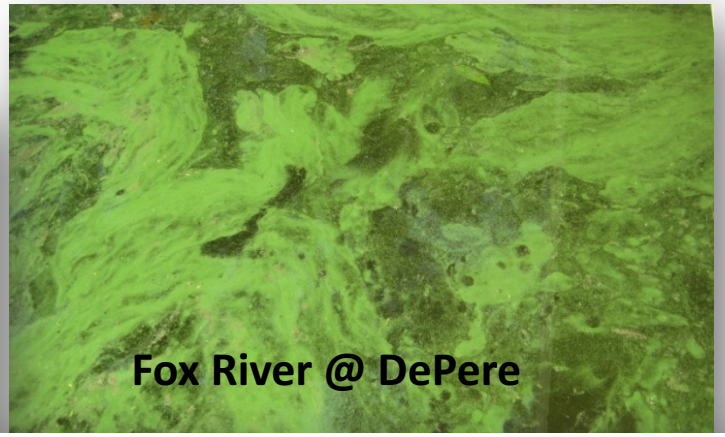
concurrence of several conditions:

✓ ***Over "fertilization"*** = Excessive loading of nutrients – usu. from the watershed

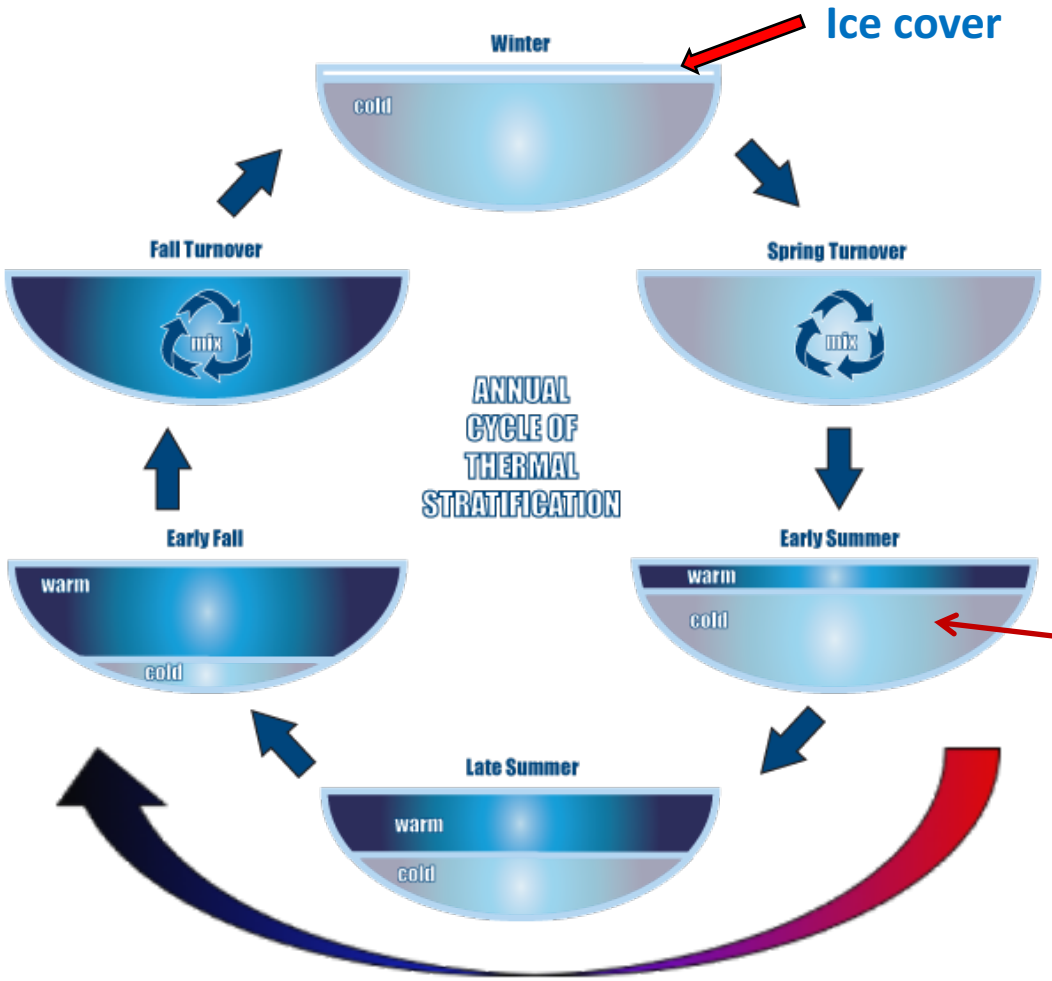


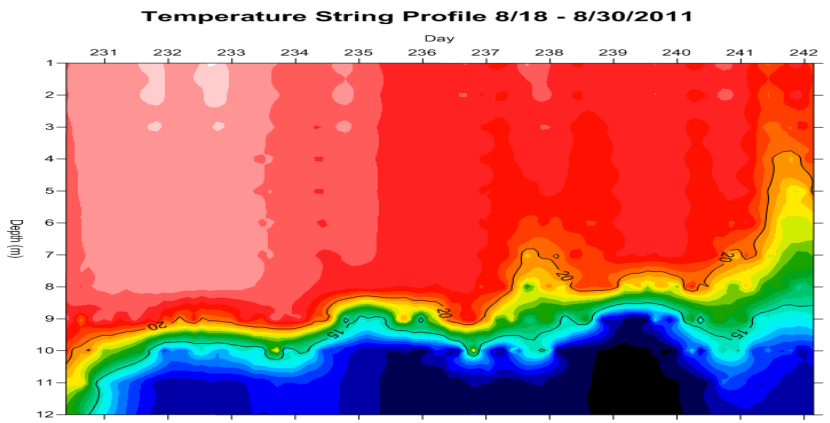
✓ ***Highly productive*** – nutrient loading stimulates excessive algal blooms





✓ SEQUESTRATION - seasonal stratification

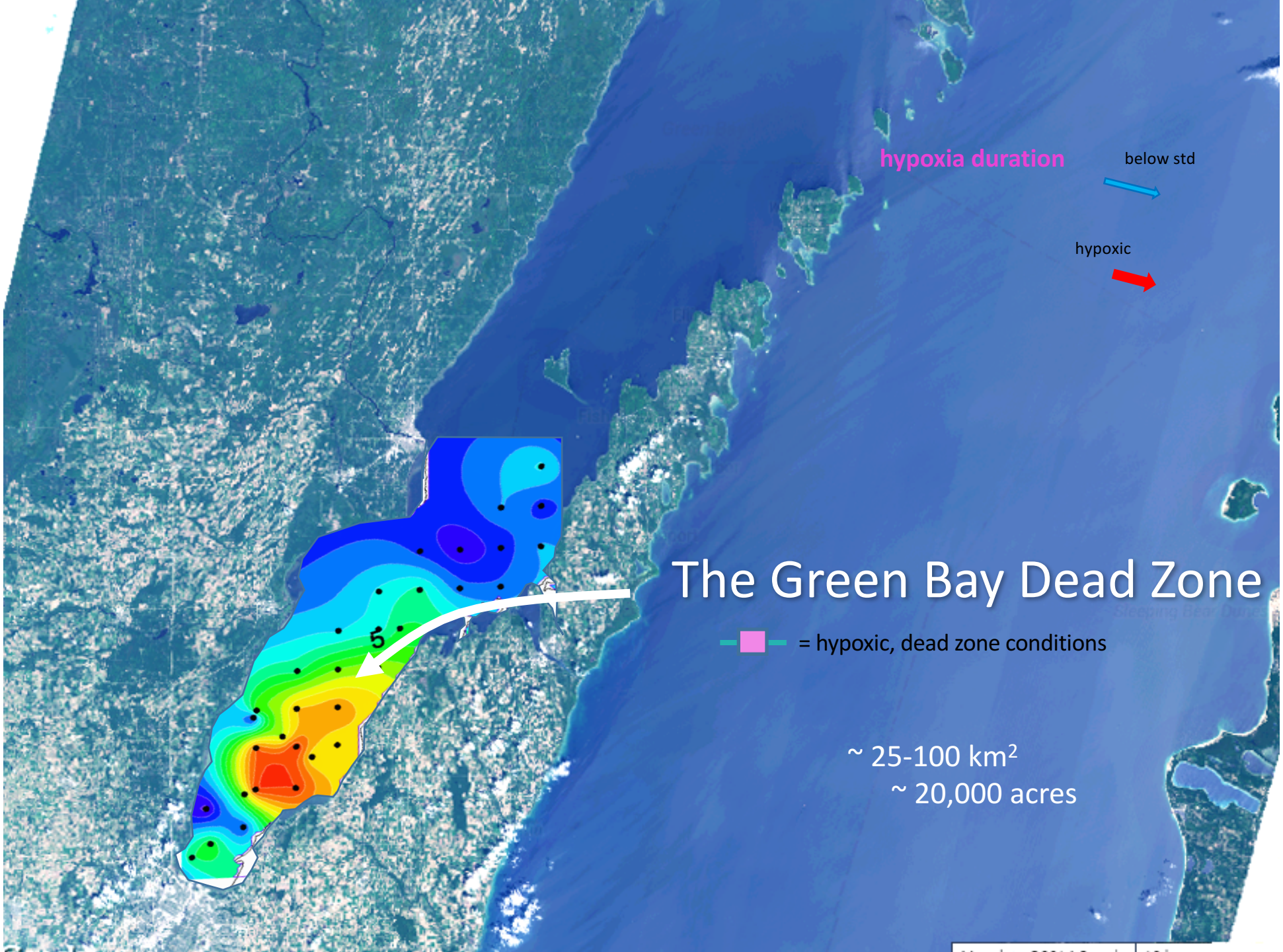




O_2 is 'sequestered'
- must last the summer

Future climate??

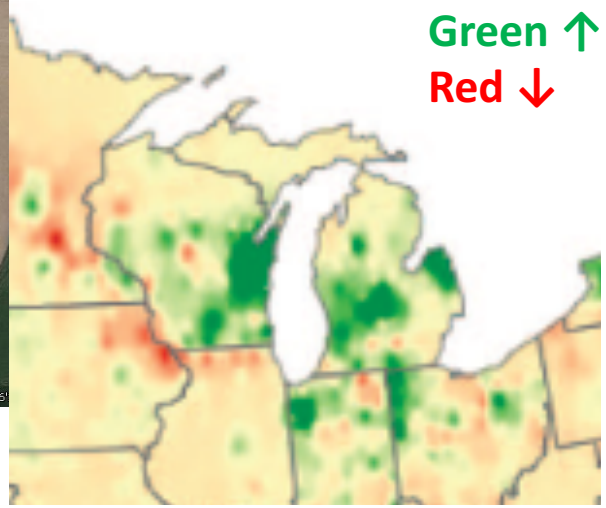
❖ dissolved oxygen availability is limited by thermal stratification


hypoxia duration
below std
hypoxic
The Green Bay Dead Zone
= hypoxic, dead zone conditions
~ 25-100 km²
~ 20,000 acres
5

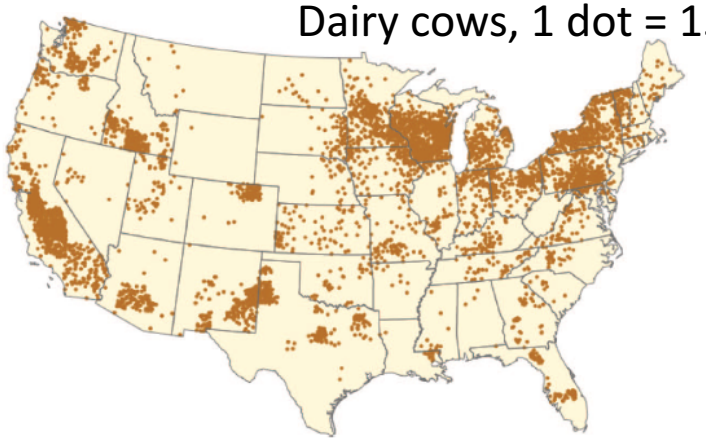
Changes in milk density 2001-11

Green ↑

Red ↓



Dairy cows, 1 dot = 1500



60-80% of P and N fed is excreted
+ soil P maybe 2-3x higher than needed

J. Dairy Sci. 96:5405–5425
http://dx.doi.org/10.3168/jds.2012-6354

Invited review: **Sustainability of the US dairy industry**

M. A. G. von Keyserlingk,*[1] N. P. Martin,† E. Kebreab,‡ K. F. Knowlton,§ R. J. Grant,# M. Stephenson
C. J. Sniffen,¶ J. P. Harner III,** A. D. Wright,†† and S. I. Smith‡‡


THE WALL STREET JOURNAL.

U.S. EDITION · Thursday, August 15, 2013 As of 4:13 PM EDT

$1 A WEEK for 12 W

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2 of 12 — Poll Shows de Blasio Surge in New York City's Mayoral Primary

3 of 12 — City Opera in Most Dramatic Struggle

August 15, 2013, 4:13 p.m. ET

Scientists: 'Dead zone' showing up in Green Bay


WISCONSIN STATE FARMER

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HEADLINES

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One of Green Bay's biggest problem is the large phosphorous load carried by Plum Creek that snakes its way through miles of farmland. Photo By Kevin Fermanich

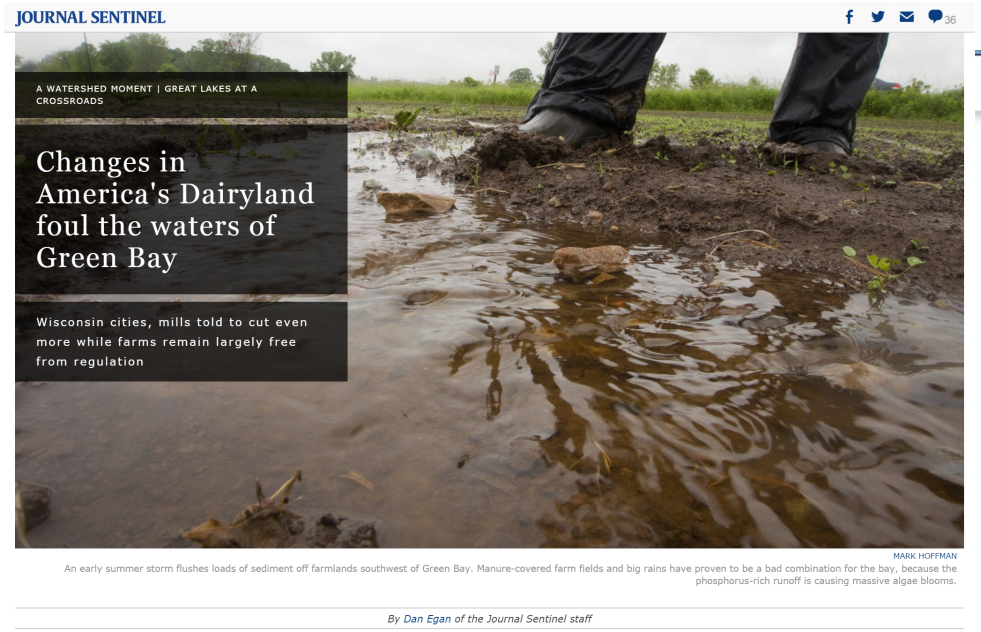
Ribble entreats stakeholders to "Save the Bay"

By Colleen Kottke Associate Editor

June 29, 2015 | 0 comments

GREEN BAY

❖ Encouraging signs


JOURNAL SENTINEL

A WATERSHED MOMENT | GREAT LAKES AT A CROSSROADS

Changes in America's Dairyland foul the waters of Green Bay

Wisconsin cities, mills told to cut even more while farms remain largely free from regulation

MARK HOFFMAN

An early summer storm flushes loads of sediment off farmlands southwest of Green Bay. Manure-covered farm fields and big rains have proven to be a bad combination for the bay, because the phosphorus-rich runoff is causing massive algae blooms.

By Dan Egan of the Journal Sentinel staff


WisconsinWatch.org Donate

NUTRIENT POLLUTION

April 1, 2015

Farmers vow to reduce phosphorus, bane of Green Bay

'I'm part of the problem … But I'm also part of the solution,' dairy farmer says at summit led by U.S. Rep. Reid Ribble

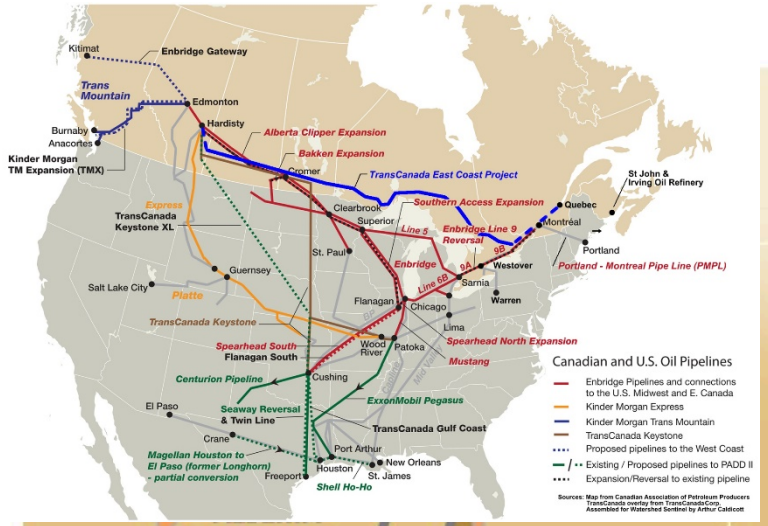
By **Kate Golden**

❖ Target = 40-50% reduction

other non-conventional pollution threats

- spills – highly vulnerable

- emerging contaminants



THE OIL INDUSTRY AND THE GREAT LAKES

Two separate oil transportation projects are in the works that would greatly expand the amount of oil shipped near — and on — the Great Lakes.

Pipelines
Enbridge Line 67 | Other Enbridge lines | Pumping stations

Edmonton
SASKATCHEWAN
Hardisty
Metiskow
Kerrobert
Milden
Regina
Craik
White City
Odessa
Rowatt
CANADA
U.S.
MANITOBA
Gretna
Viking
Clearbrook
NORTH DAKOTA
Deer River
MINN.
Superior
Proposed oil barge dock
ONTARIO
Lake Superior
Sault Ste. Marie
Lake Huron
Lake Erie
WIS.
MICH.
Detroit
Cleveland
Toledo
OHIO
IND.
ILL.
Delavan
Chicago
Flanagan

BY LAND ...

Enbridge is seeking to nearly double the capacity of oil shipped on its Line 67, or Alberta Clipper, pipeline to 880,000 barrels per day. That's more capacity than the controversial Keystone XL pipeline proposed from Canada to Texas.

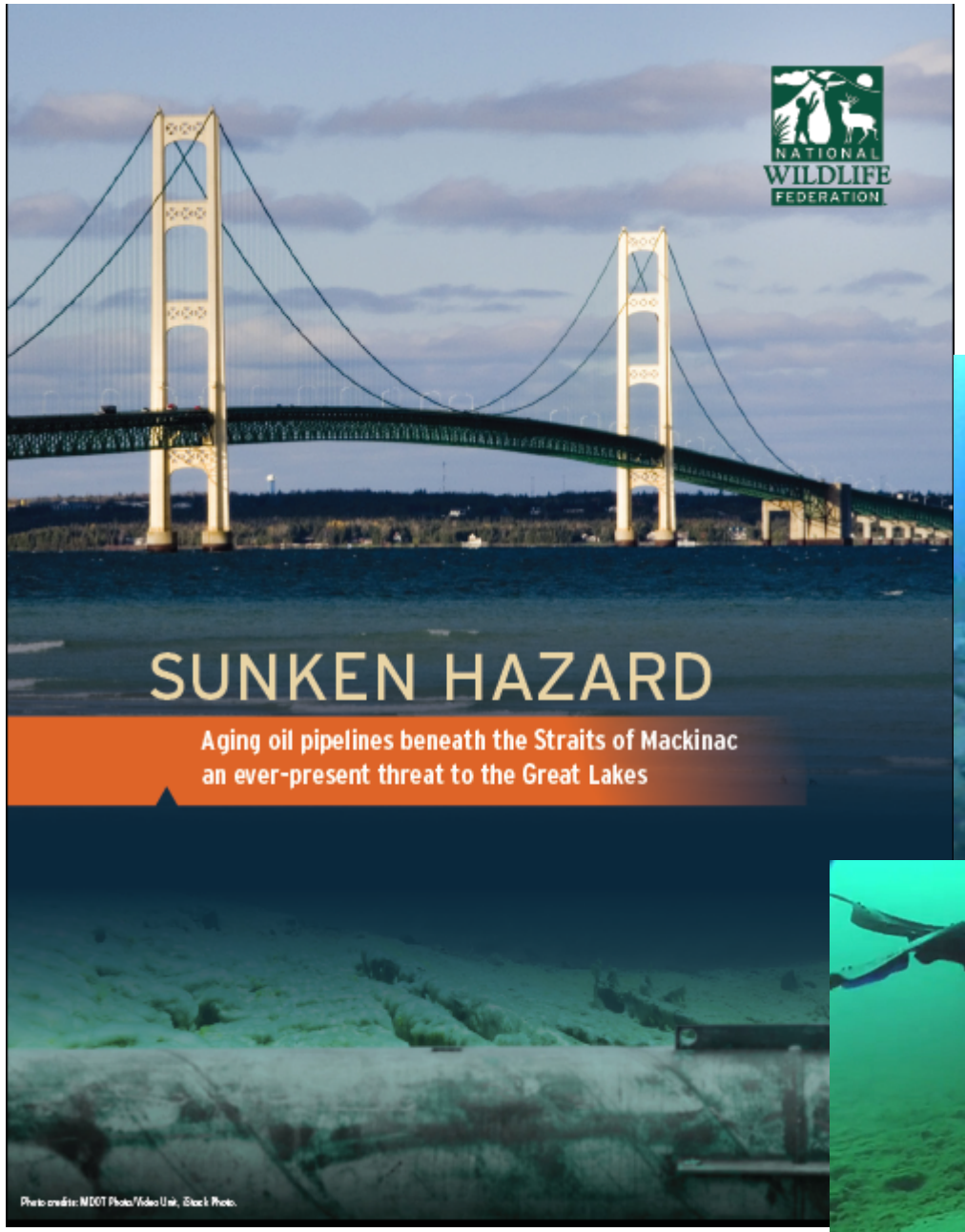
... AND SEA

Calumet Specialty Products Partners, a Superior, Wis., refinery operator, is considering construction of a crude oil loading dock, where oil barges would take up to 13 million barrels of oil per year for shipment via the Great Lakes. Company officials say the project could be operational by 2015.

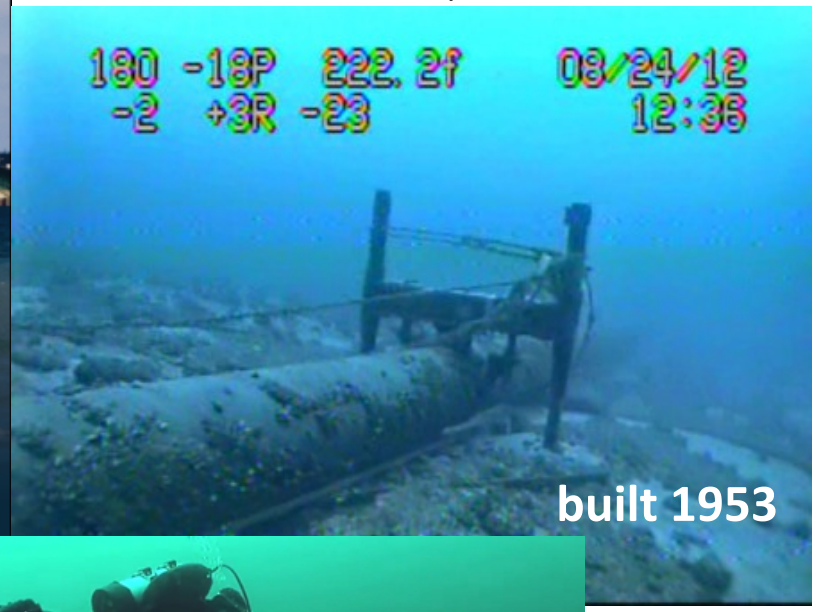
From Enbridge Line 67, oil is shipped on a pipeline network to refineries throughout the Midwest and other parts of the U.S., including to the Marathon oil refinery in Detroit.

SOURCE: Enbridge

DAVID PIERCE and MARTHA THIERRY/DETROIT FREE PRESS



two pipelines, called Line 5, carry a total of 20 million gallons of crude oil and natural gas
fluids each day from Superior, Wisconsin to Sarnia, Ontario.



Eric Anderson & David Schwab
J. Great Lakes Res (2013)

Simulated spill trajectories – St. Mackinac – up to 20 days post spill

What's the risk?

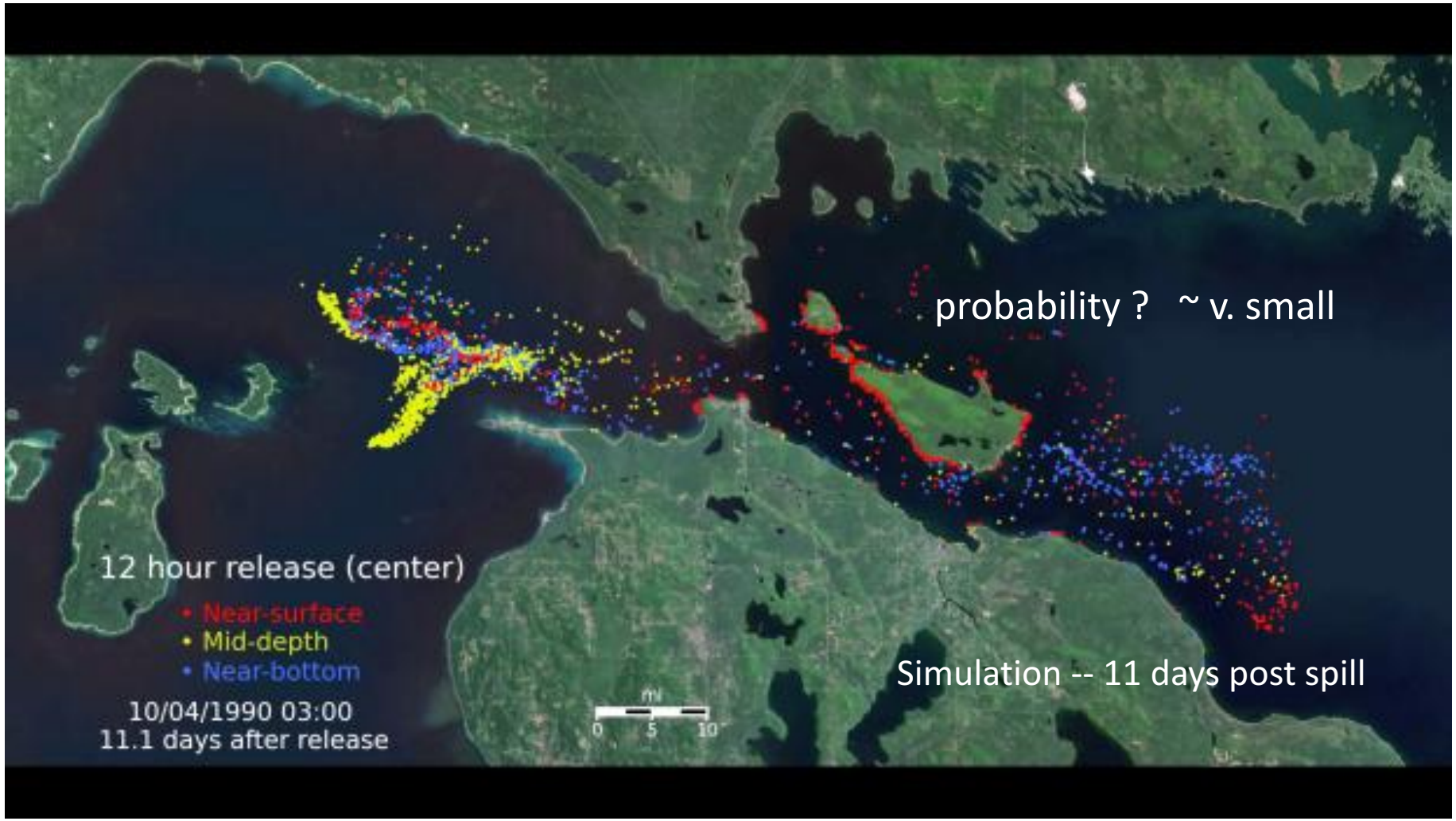
Talmadge Creek, tributary to the Kalamazoo River, is overcome with toxic tar sands oil during the 2010 Enbridge oil spill on Line 6B. Photo credit: MIDEQ.

~$1 B clean up ~ 6 years

2010 Kalamazoo River – 1,000,000 gal tar sands oil

Enbridge Energy pipeline

The 2010 Kalamazoo River tar sands oil spill, by Enbridge Energy, was the largest and most costly inland oil spill in U.S. history due to 17 hours passing before Enbridge reported the spill and inadequate response plans. Photo credit: MIDEQ.

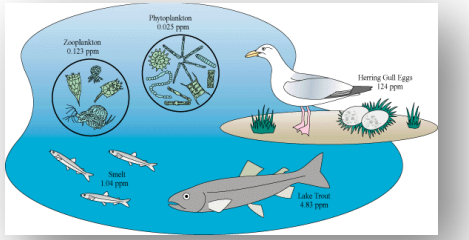


Risk ? → potential damage in the multiple billions + remediation ~ decades (if ever)

Eric Anderson & Dave Schwab, GLERL & MWC

Legacy & traditional contaminants: Pathogens, PCBs, DDT, Hg, etc

– **43 Areas of Concern**, Fish consumption advisories, beach closings



Emerging classes of contaminants: pharmaceuticals, caffeine, personal care products, pesticides, flame retardants, plasticizers, nanomaterials

ENVIRONMENTAL Science & Technology

VIEWPOINT

pubs.acs.org/est

On the Need for a National (U.S.) Research Program to Elucidate the Potential Risks to Human Health and the Environment Posed by Contaminants of Emerging Concern

P. J. Novak,[*,†] W. A. Arnold,[†] V. S. Blazer,[‡] R. U. Halden,[§] R. D. Klaper,[⊥] D. W. Kolpin,[∥] D. Kriebel,[#] N. G. Love,[▽] D. Martinović-Weigelt,[%] H. B. Patisaul,[@] S. A. Snyder,[††] F. S. vom Saal,[‡‡] A. V. Weisbrod,[§§] and D. L. Swackhamer[⊥⊥]

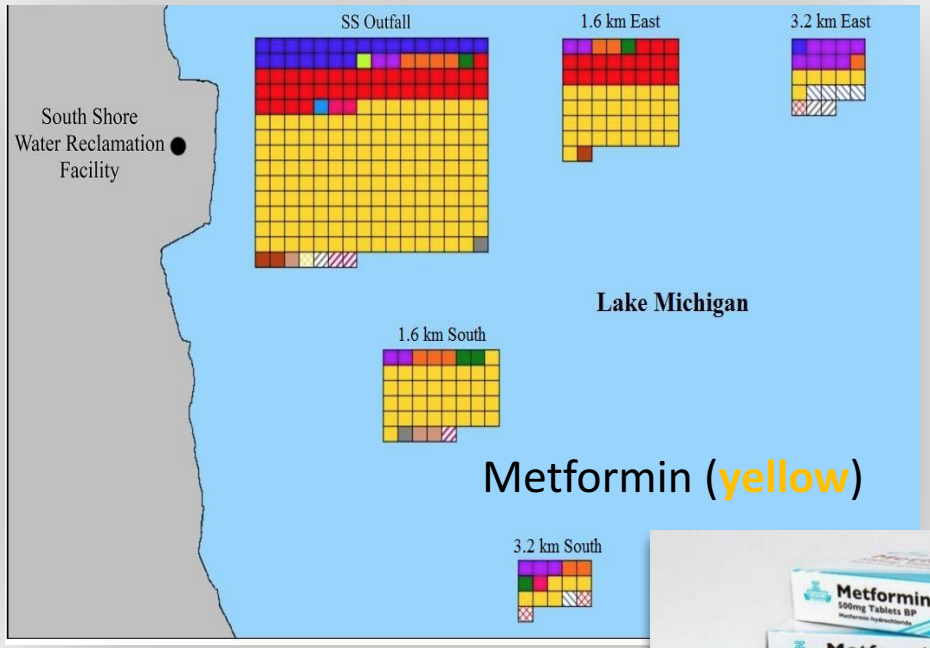
Major unknowns:

- what's there ? = detection (not routine)
- where do they go? = source, distribution & fate
- do they have an impact?

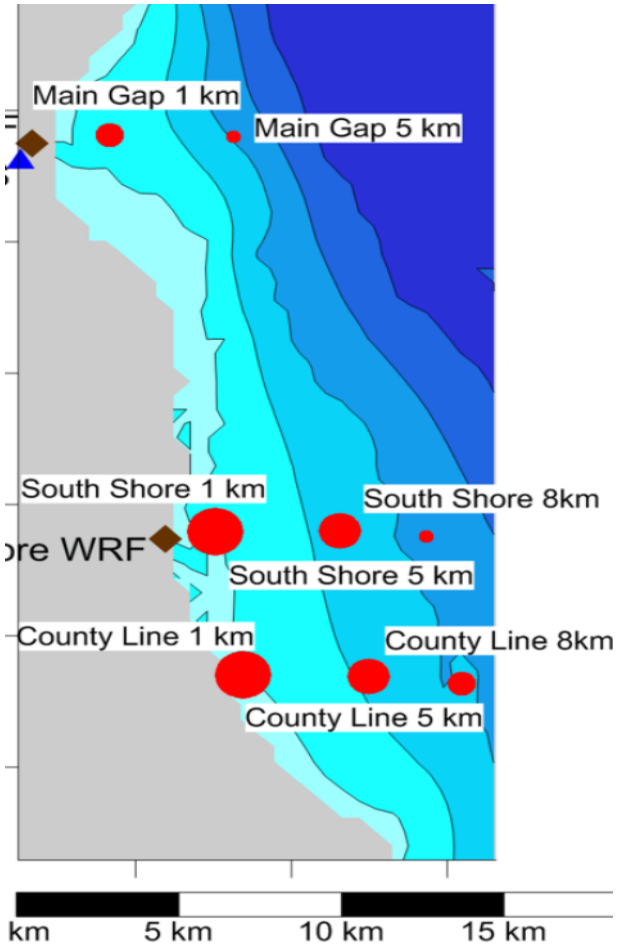
	Discharge (kg/year)
Metformin	6400
Caffeine	1700
Acetaminophen	450
Paraxanthine	450
Naproxen	200
Sulfamethoxazole	120
Sulfanilamide	120
Ofloxacin	100
Trimethoprim	90
Triclosan	90
Diltiazem	80
Ampicillin	70

(Blair, Klaper et al. 2013)

e.g. presence ⇒ input/persistence



- 7th most prescribed drug in US
- Highest input of any drug to environment



Iodine – 131

Short lived, Radioactive

~ 8 day half life

Sea Grant New York

New York Sea Grant

229 Jarvis Hall
SUNY at Buffalo
Buffalo, NY 14260-4400
Phone: 716.645.3610
Fax: 716.645.3612
E-mail: hmd4@cornell.edu

Web: www.nyseagrant.org

Plastic Microbeads in the Great Lakes

By Helen M. Domske

Photo: 5Gyres.org

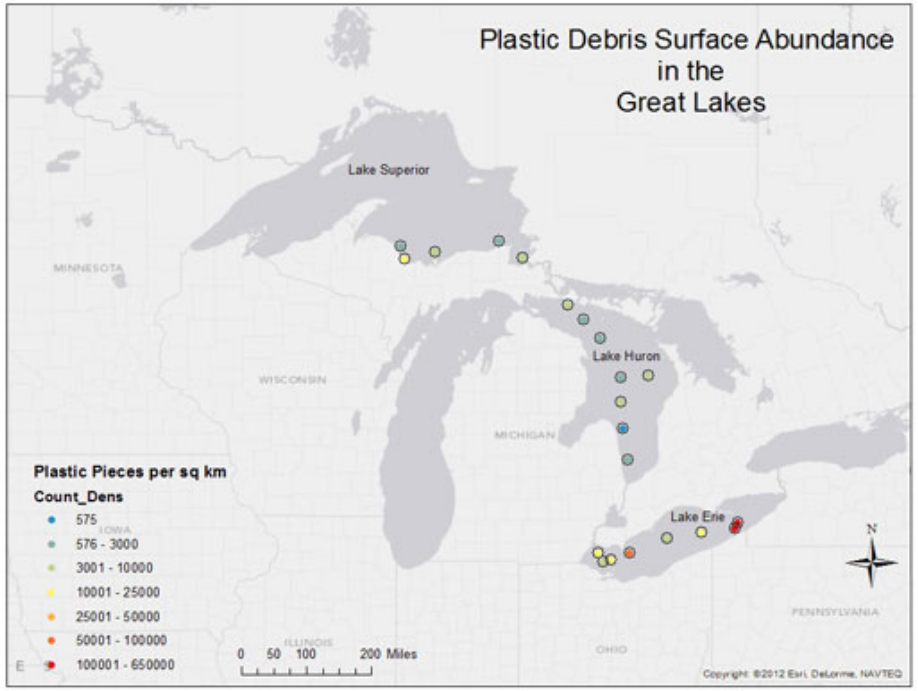
Microplastics

#2050

For years people have worried about the environmental impacts from plastics left behind in the oceans and Great Lakes. Pictures of birds tangled in six-pack rings or turtles choking on plastic bags have documented the danger of discarded plastics that linger in the environment. Recently, attention has turned to the Great Lakes and small plastic particles and microbeads that have been found there. Some plastic particles result from the breakdown of larger plastic items, but others are small plastic spheres known as microbeads.

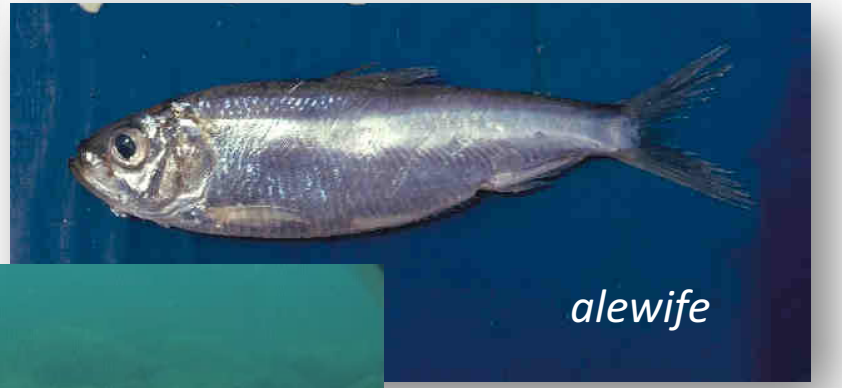
These minute plastic beads are typically used as scrubbing agents or exfoliants in personal care products. They are often brightly colored and can been seen suspended in the body washes, facial scrubs and toothpastes that contain them. As these products are used by consumers, microbeads are rinsed off and go directly down the drain with water that eventually makes its way to waste water treatment plants. Although some of the particles are captured through treatment, many are not and sewage treatment overflows can also dump these microbeads directly into the ecosystem.

Although harmless in appearance, microbeads have the potential to cause environmental damage. Some of the microbeads are about the size of certain fish eggs, so these small plastic particles can be ingested by Great Lakes fish and other aquatic organisms. Once eaten the plastic material could deprive these organisms of nutrients supplied by food or possibly get lodged in their stomachs or digestive systems. Additionally, plastics can absorb toxins, such as polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs), making these harmful substances more readily available within the food web. These toxins remain in fish where they can move up the food chain, as smaller fish are eaten by larger predators.



Highly perturbed ecologies

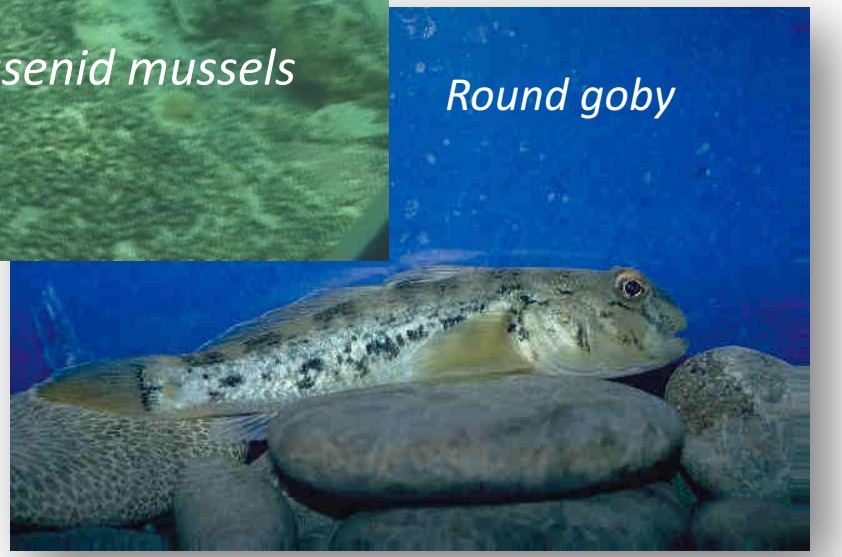
Sea lamprey



alewife

Dreissenid mussels

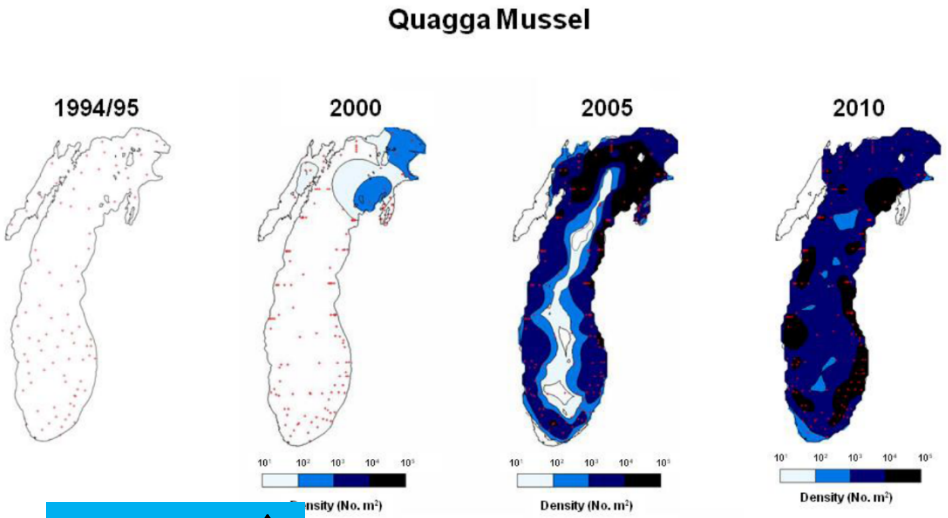
Spiny water flea



Round goby

> 180 spp

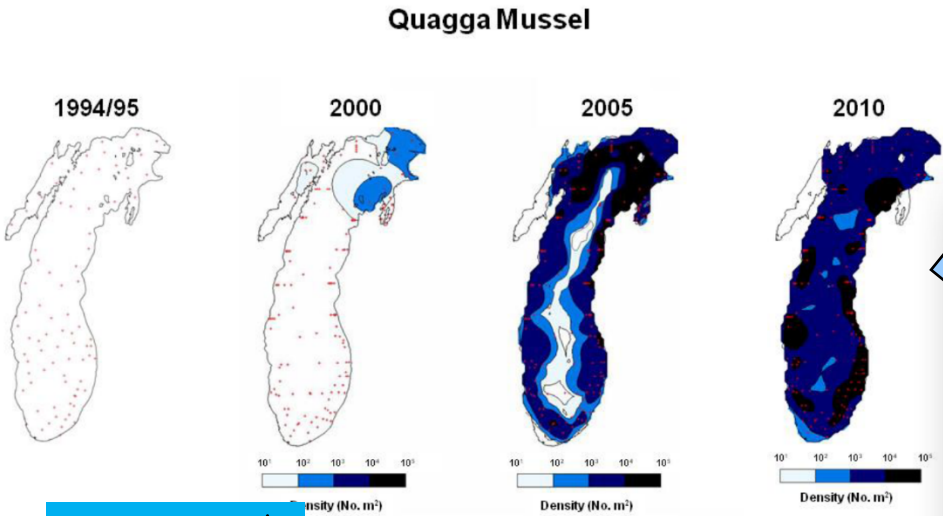
Dreissenid mussel invasion: zebra (1990's) → quagga (2000's)



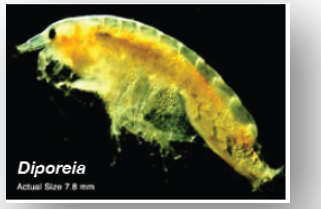
mussels ↑

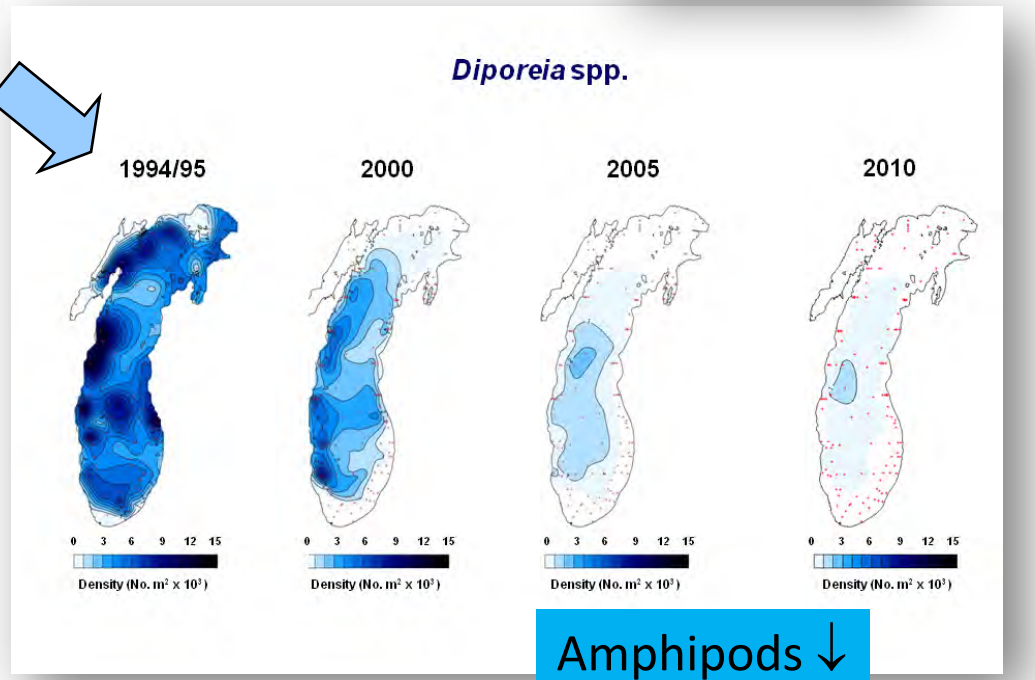
Quaggas replaced zebras in ~ 2 generations – **4 years**

Dreissenid mussel invasion: zebra (1990's) → quagga (2000's)



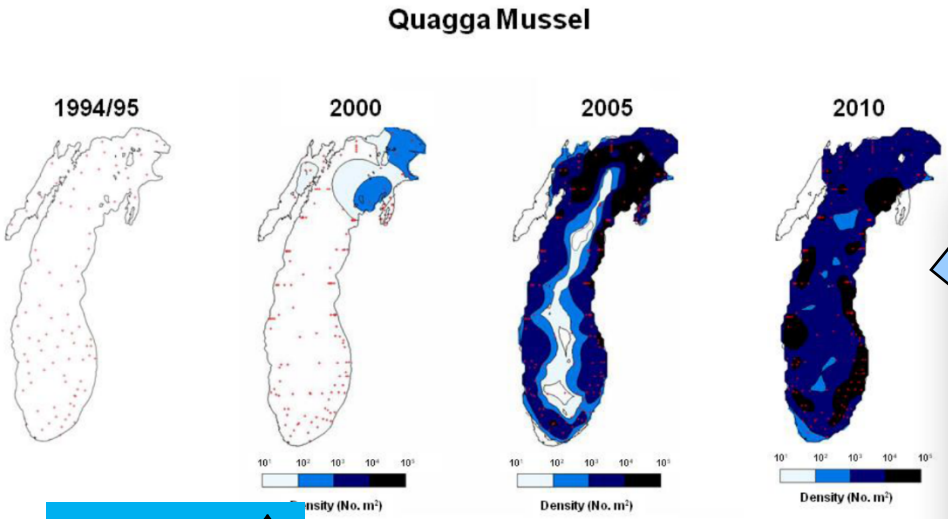
mussels ↑



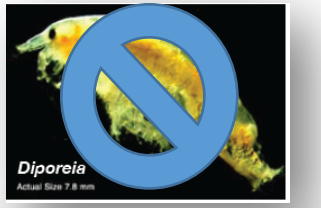


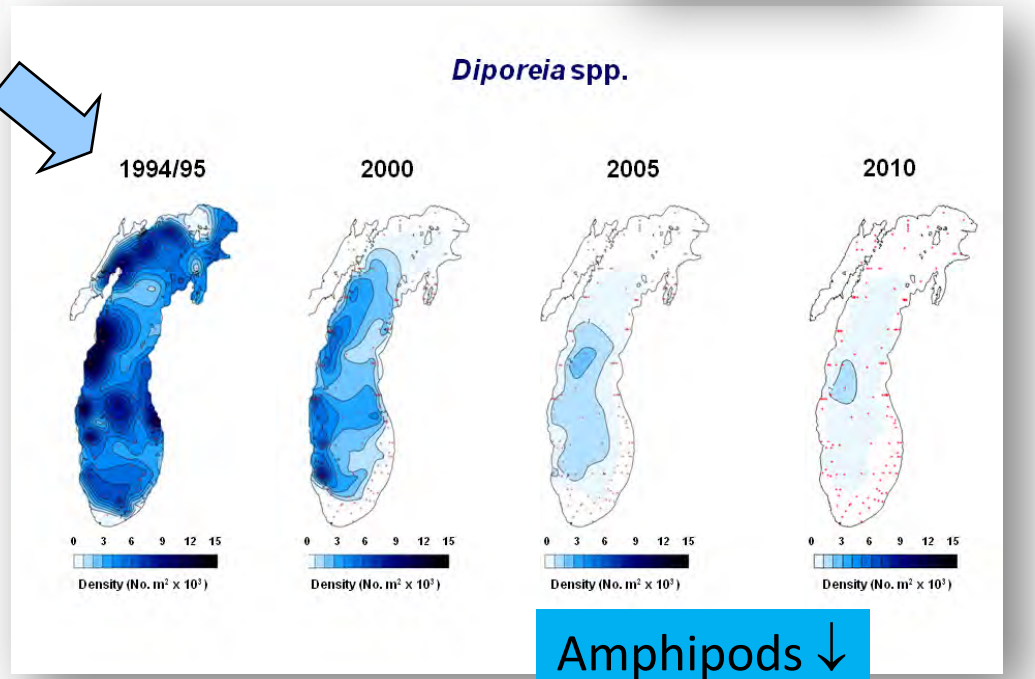
Amphipods ↓

Dreissenid mussel invasion: zebra (1990's) → quagga (2000's)



mussels ↑

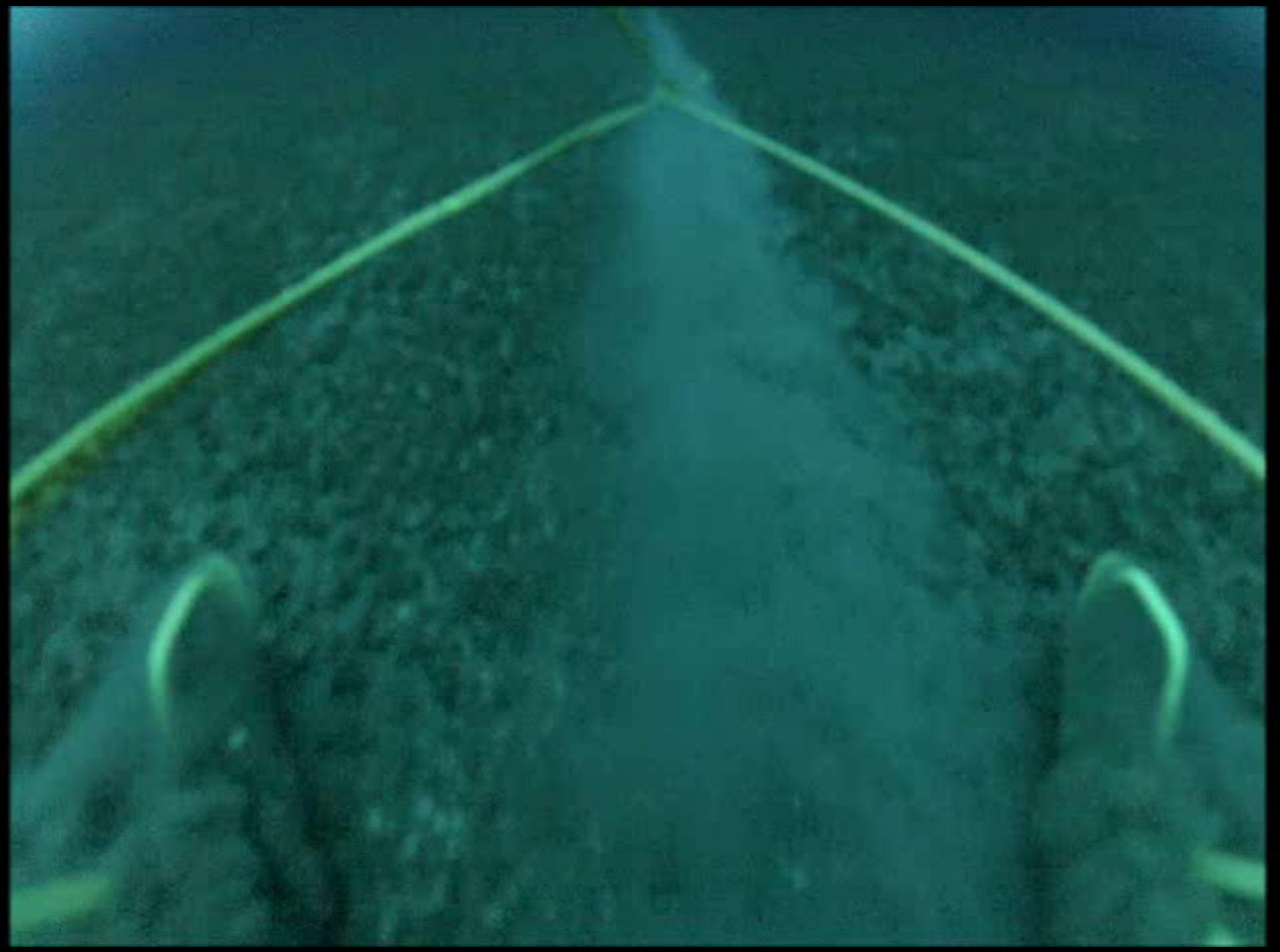




Amphipods ↓

Collapse of the food chain in < 10 years

3-4 minute trawl off Fox Point @ 45 meters, 2011



Bottom trawl Lake Michigan offshore

a **re-engineered** ecosystem

Quagga mussels: 950 trillion tiny time bombs in our lakes?

By Jeff Alexander | Muskegon Chronicle
on April 15, 2011 at 8:00 AM, updated April 15, 2011 at 9:26 AM

Print

A crew of government scientists was measuring water clarity recently in Lake Michigan, several miles offshore of Frankfort, when they saw something none had thought possible.

"The water was gin clear ... you could see 90 feet down," said Gary Fahnenstiel, a senior ecologist at the National Oceanic and Atmospheric Administration's Great Lakes field station in Muskegon.

Howard Meyerson | The Grand Rapids Press

Green is not always good: Smelly, slimy blooms like this on the tip of South Fox Island in Lake Michigan are directly related to the explosion of quagga mussels.

"The water is gin clear, you can see 90 feet down – parts are now clearer than Lake Superior"

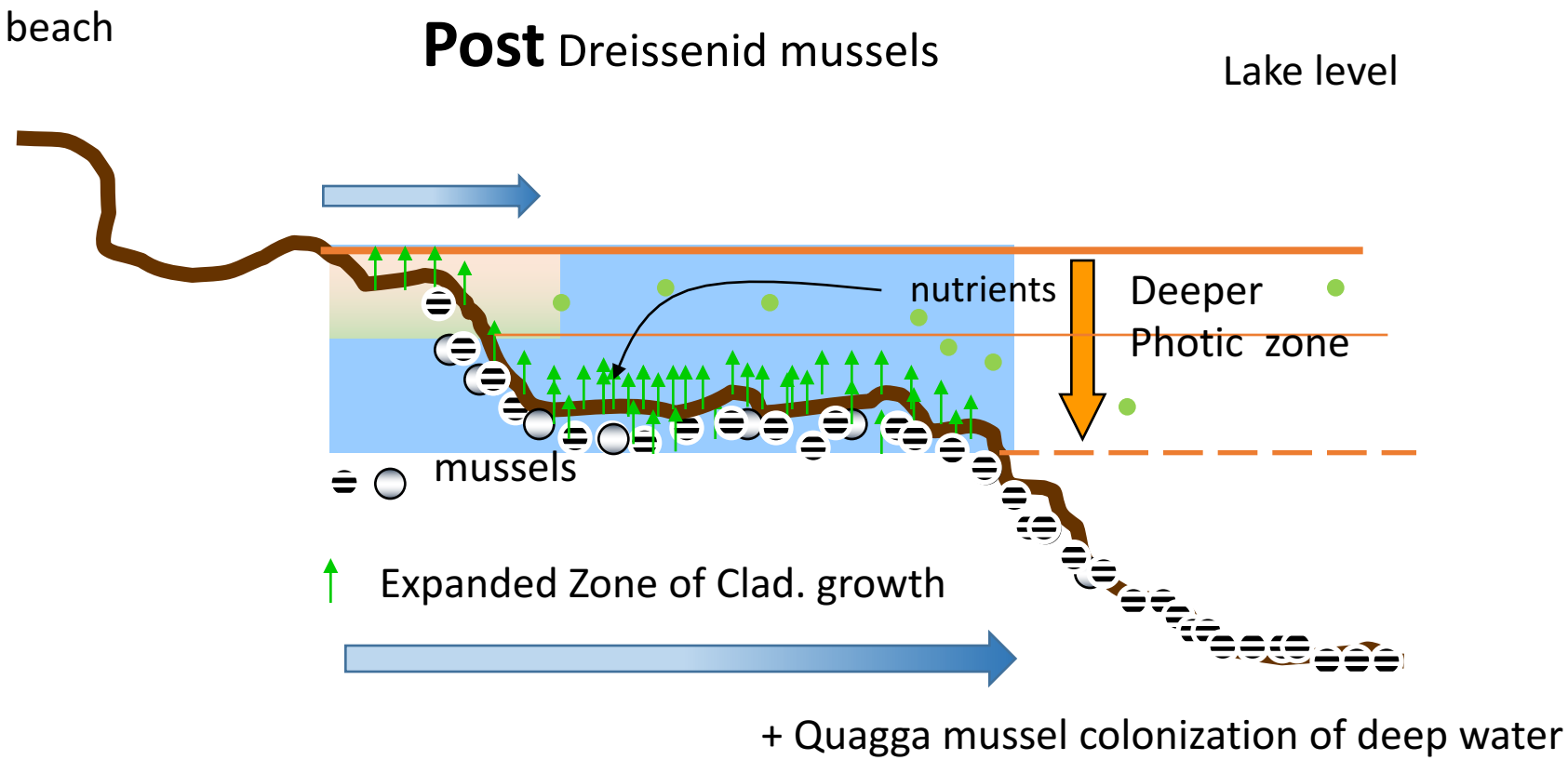
500 million pounds of quagga mussels
= 4 x weight of all prey fish species

Lake Superior is now the **3rd clearest** in the Great Lakes

1995-98 → 2007-08

87% decline in phytoplankton **biomass**
70% decline in phytoplankton **primary production**

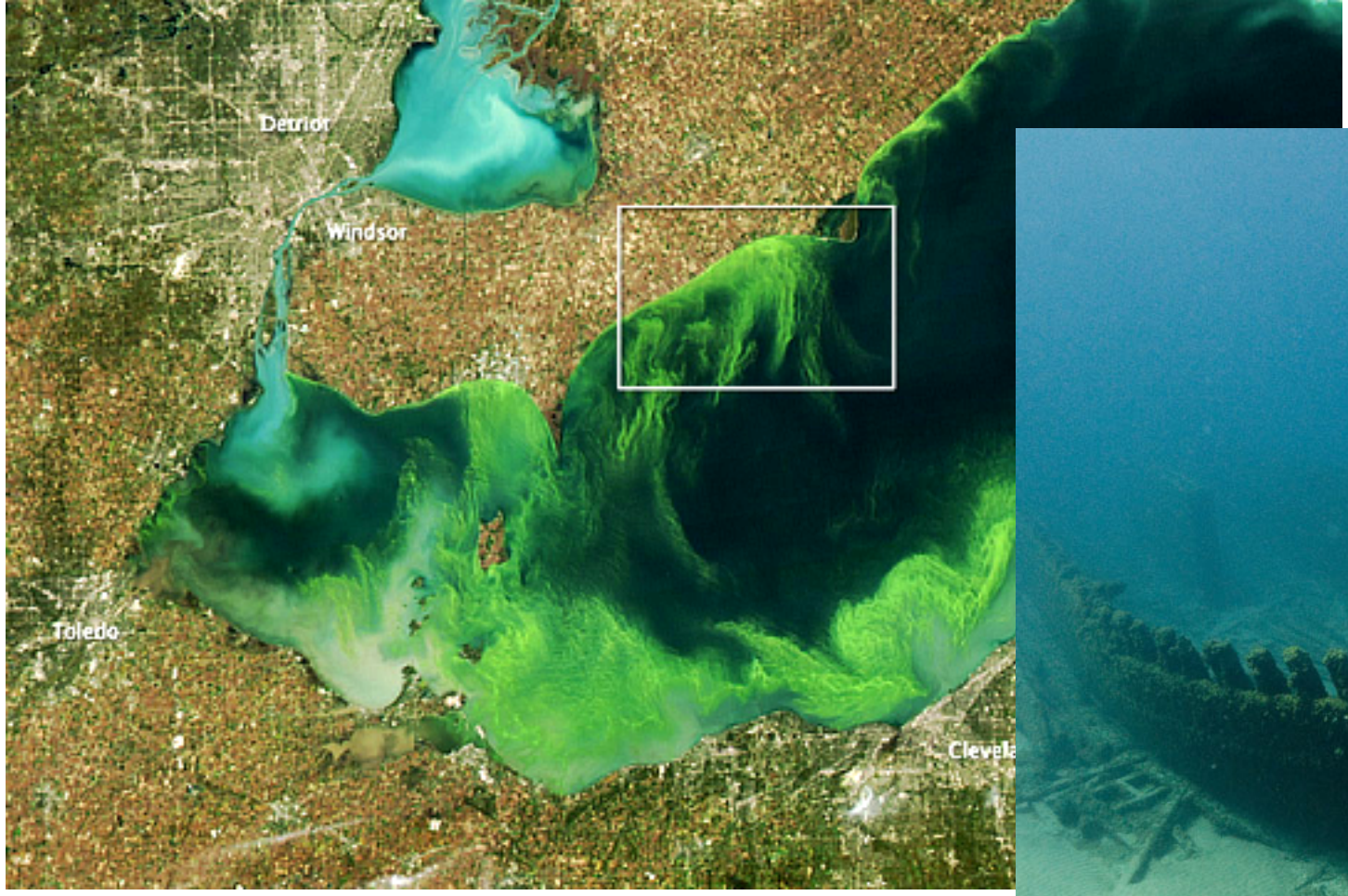
Ancillary (unforeseen?) impacts of Increased water clarity




Today's nearshore, formerly exposed cobble

Nearshore Lake Michigan: Round gobies feeding on mussels

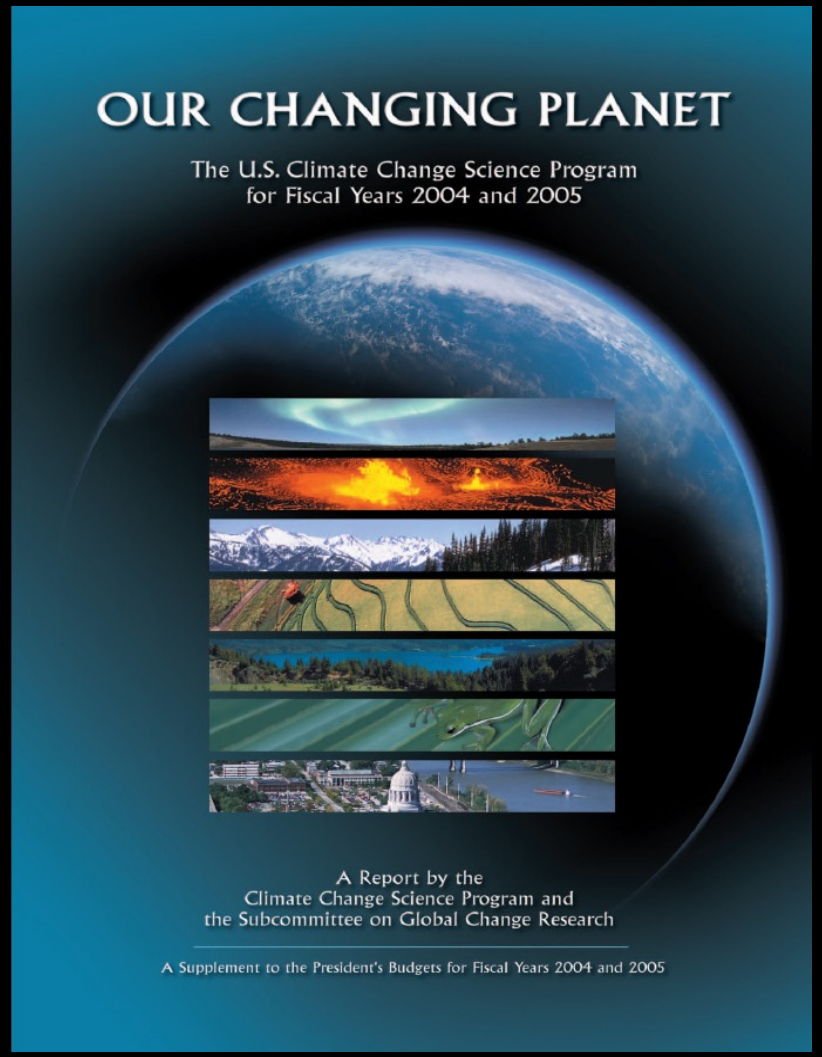
Ancillary impacts cont.



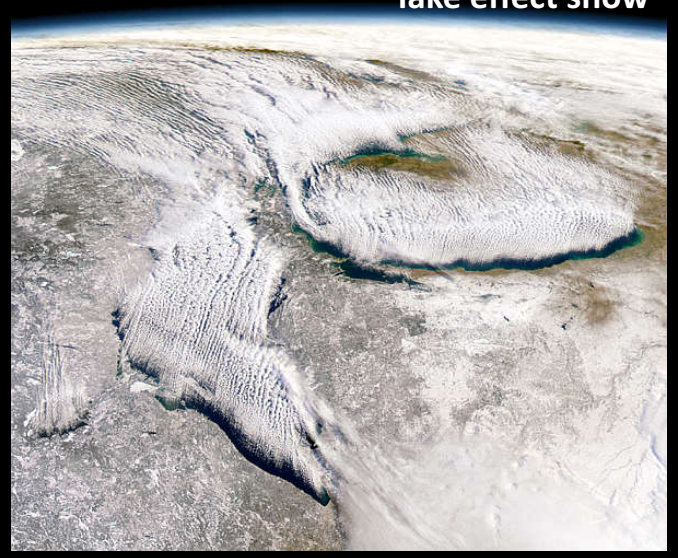
Unprecedented nearshore HABs,

unprecedented offshore clarity

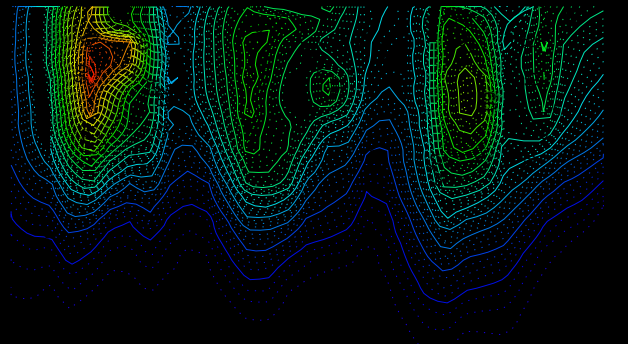
Climate change

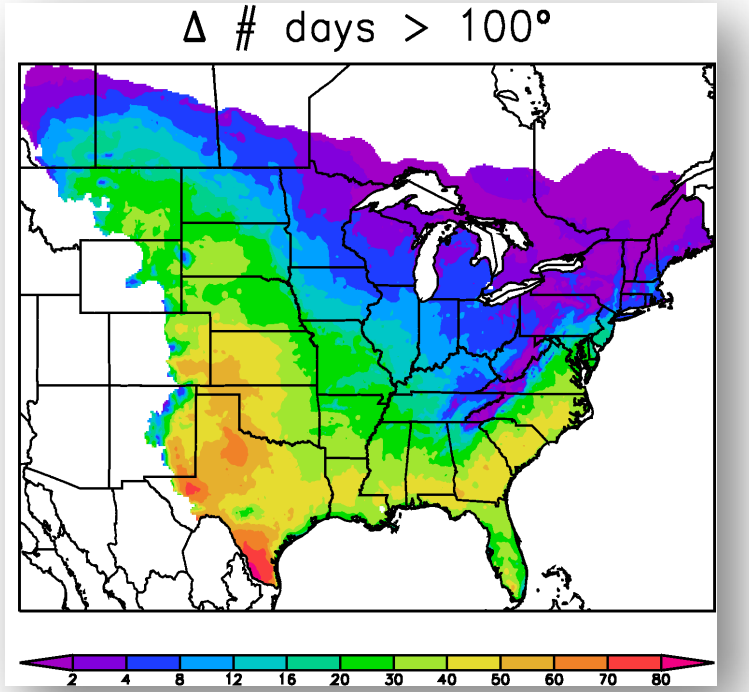


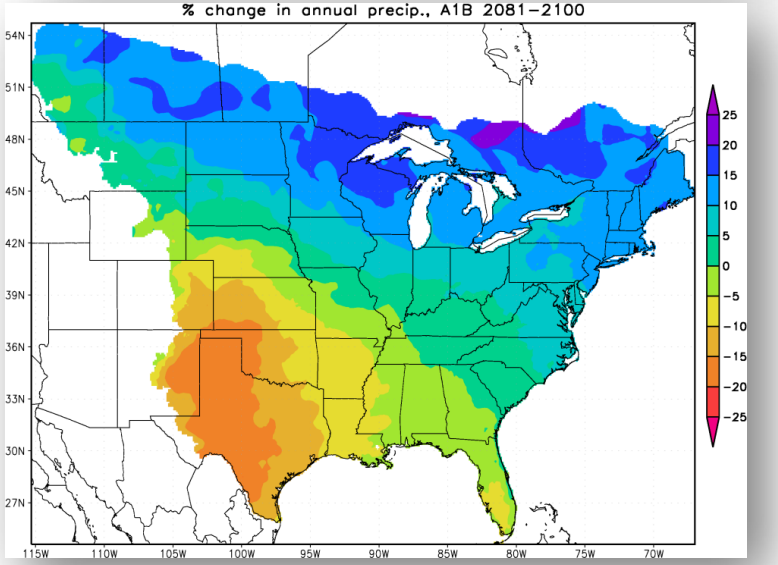
lake effect snow



'98 El Nino







D. Lorenz UW-Madison

A warmer region

nearly 2 months over 90°

nearly 2 weeks over 100°

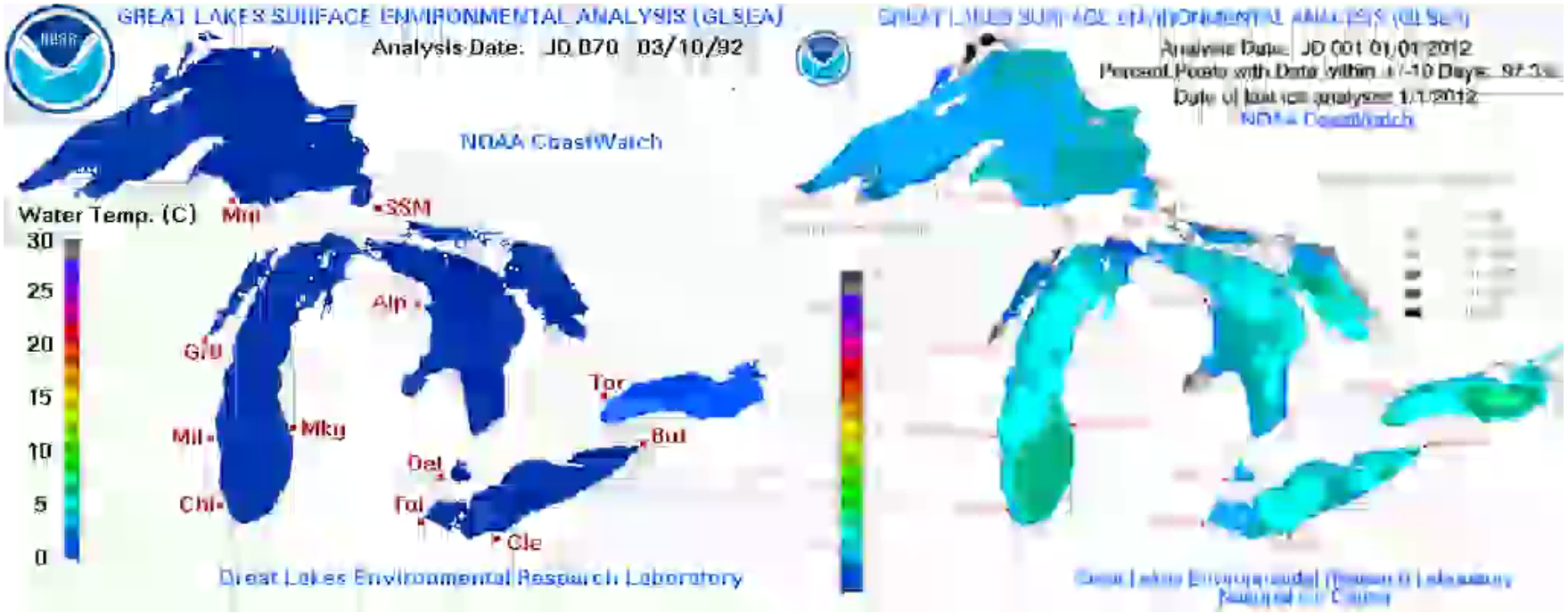
- ✓ + 4-9 F. hotter by 2090
- ✓ Reduced ice cover
- ✓ Prolonged stratified period ~ 6 weeks

also wetter

- ✓ 10-20% increase in ppt
- ✓ 50-100% increased freq intense events

& changing climatology ?

Surface water temperatures

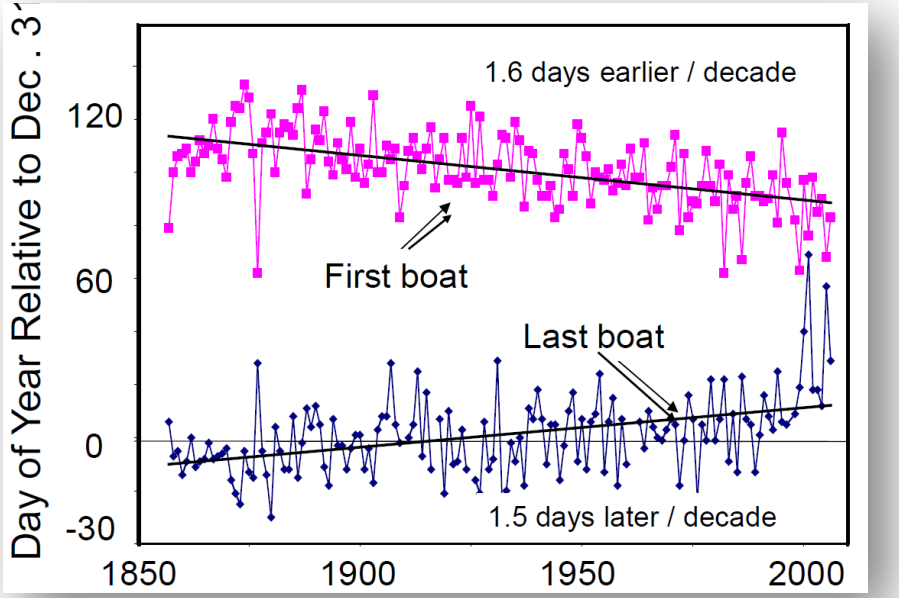


1992

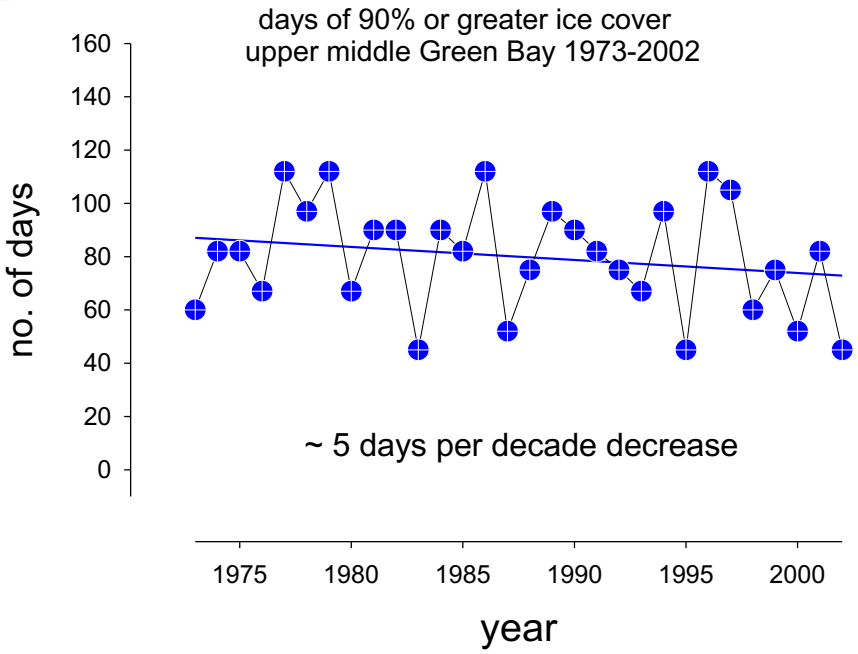
2012

Summertime water temperatures have increased over **8°F since 1980**

Bayfield Harbor**, L Superior:**
Last boat in fall, 1st boat in spring

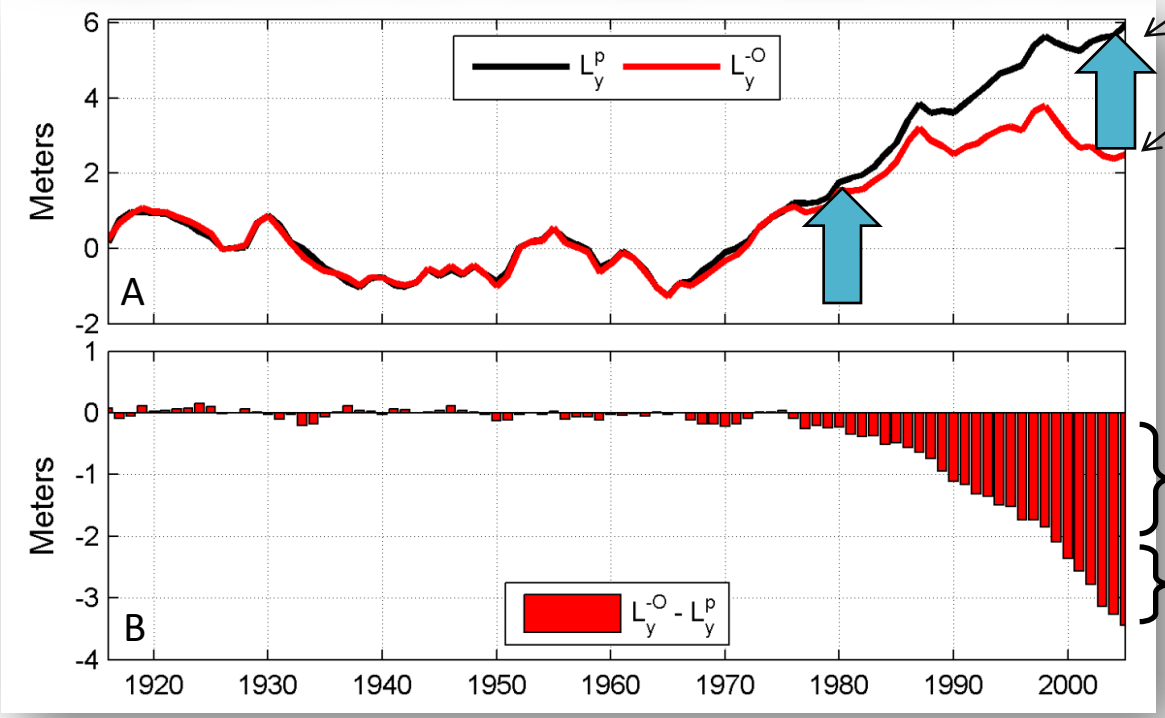


Green Bay – ice cover



Decreasing ice cover → rising water temps 2x > air

Evaporation has increased about 25% since 1980



Precipitation-driven

Outflow-removed

Summer evaporation

Fall evaporation?

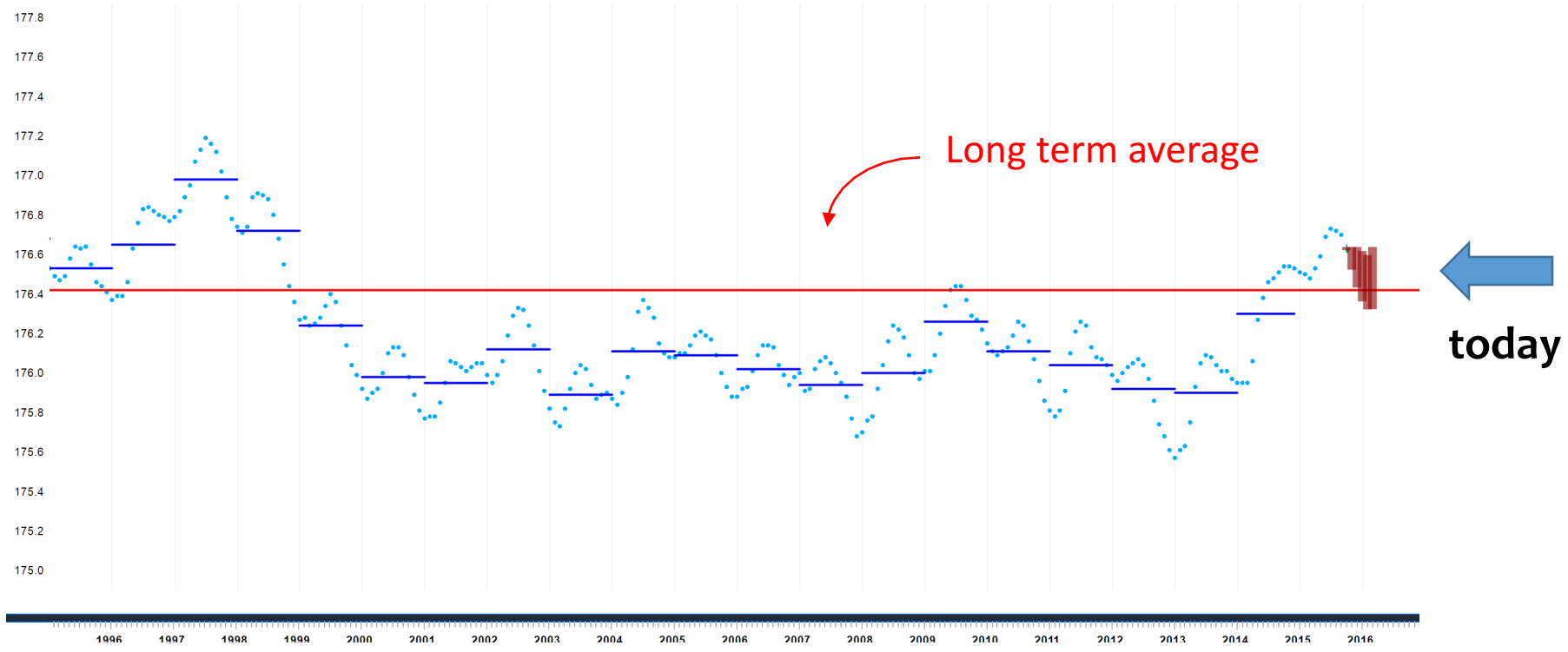
Fig. 19 (a) Outflow-removed lake level (red), precipitation-driven lake level (black), (b) difference between the curves.

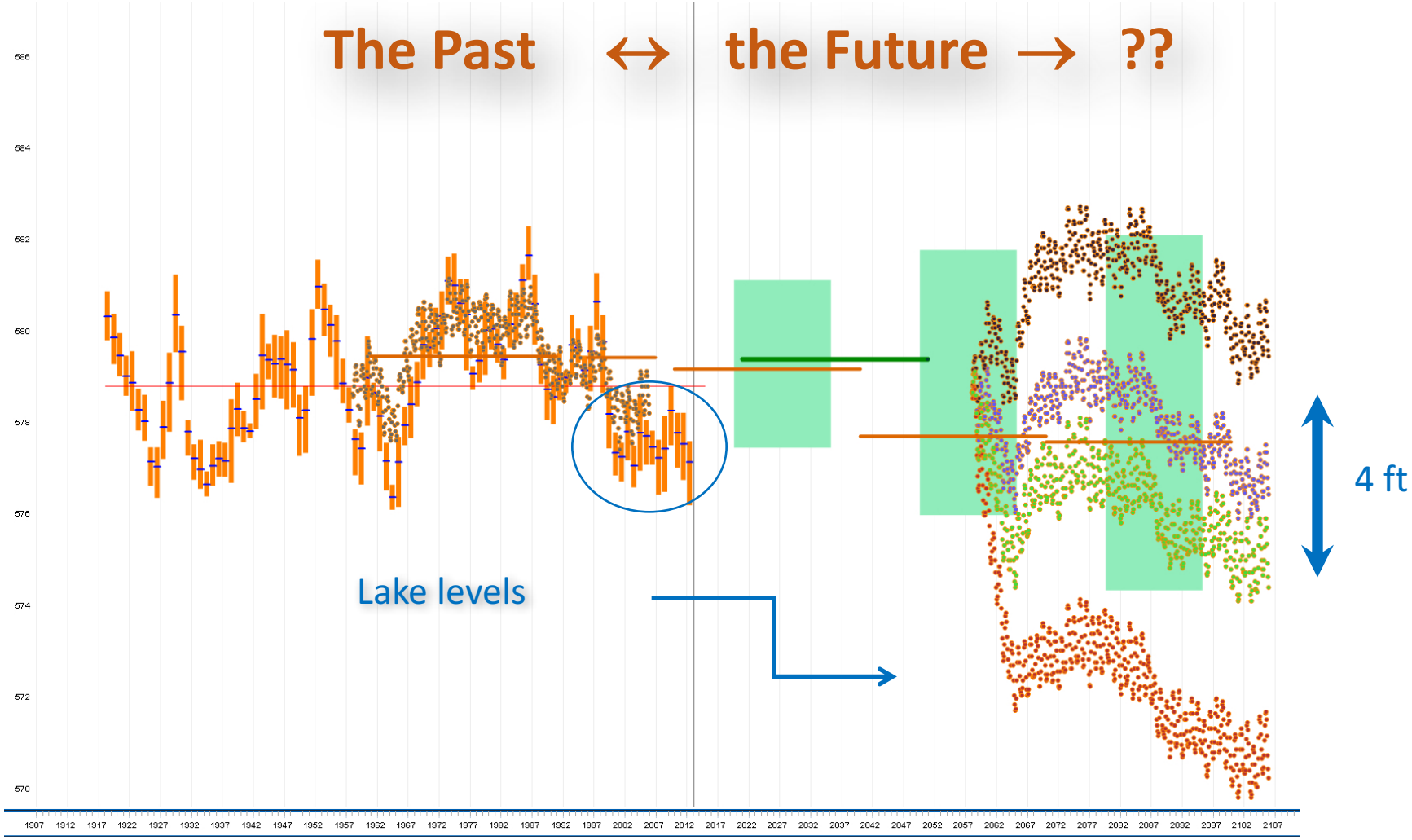
- ½ of increase is during summer months alone
- Air temperatures have remained near constant

Hanrahan & Roebber 2011

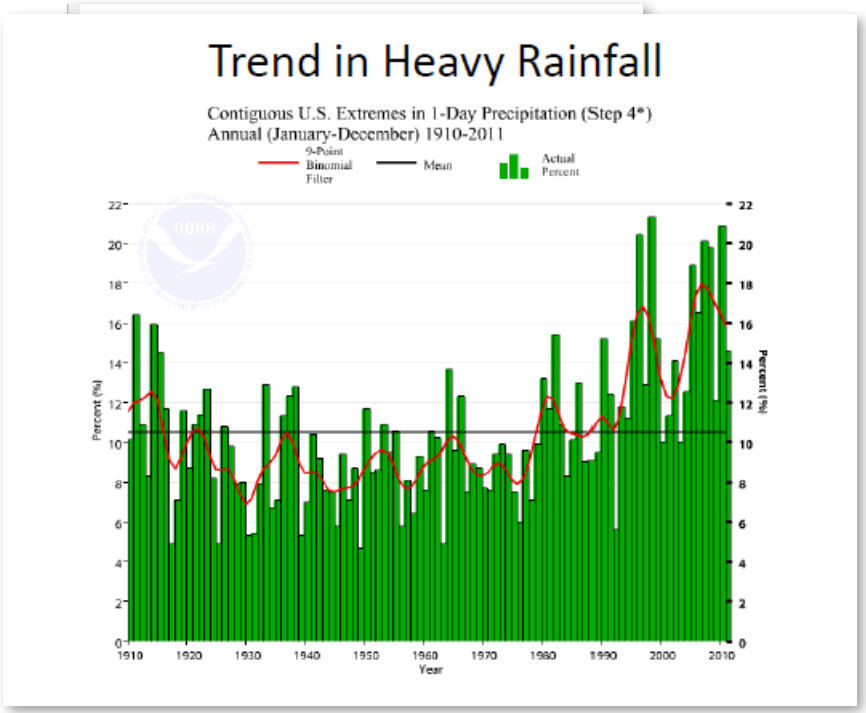
Falling levels – not rising

Lake **Michigan-Huron levels** last 20 years

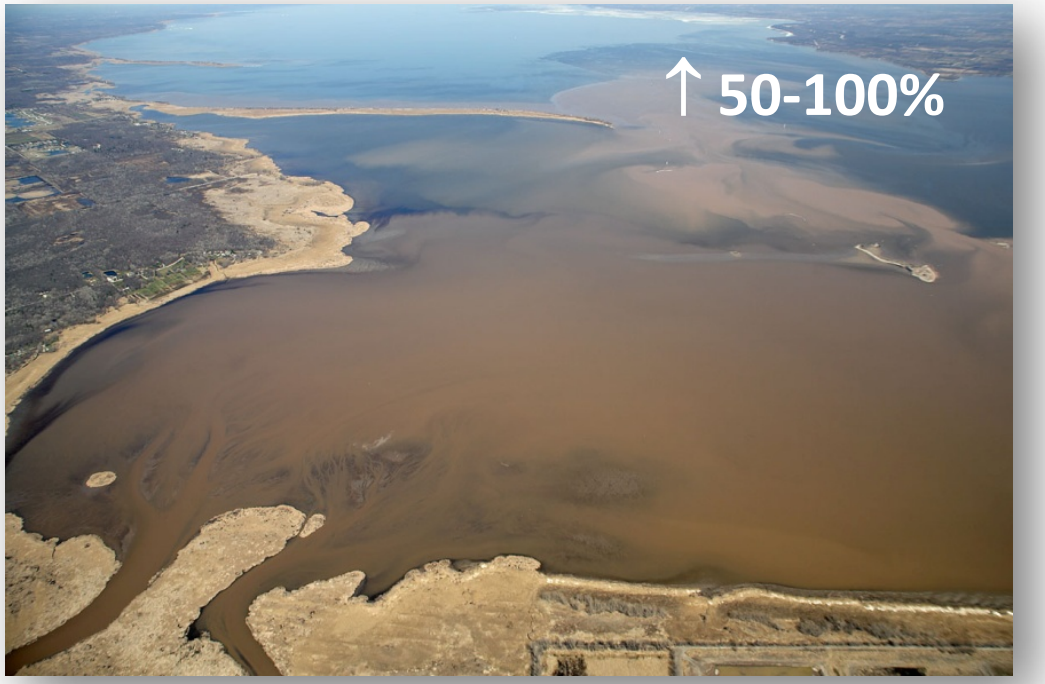


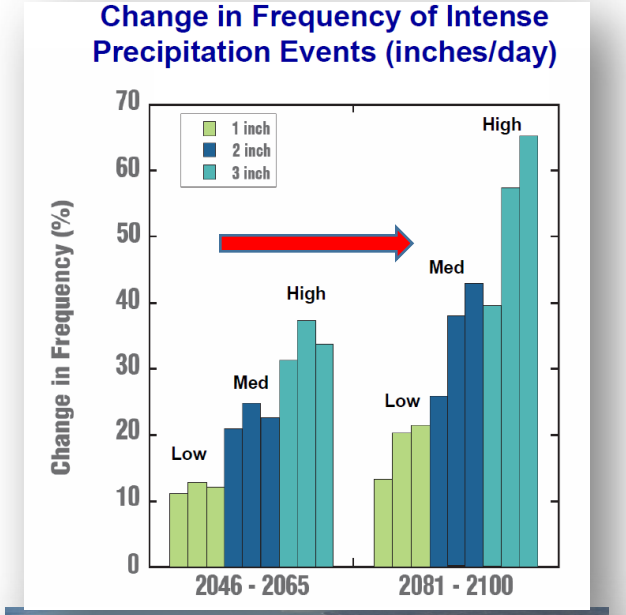

The Past ↔ the Future → ??
586
584
582
580
578
576
574
572
570
1907 1912 1917 1922 1927 1932 1937 1942 1947 1952 1957 1962 1967 1972 1977 1982 1987 1992 1997 2002 2007 2012 2017 2022 2027 2032 2037 2042 2047 2052 2057 2062 2067 2072 2077 2082 2087 2092 2097 2102 2107
Lake levels
4 ft
1910
1960
2010
2060

50-100% increase in **intense** rain **events**



Aging infrastructure





#1 runoff → highly event driven

~ 70-80% of loading in 10 days

-- Timing can be critical

the major challenge of the 21st century:

- *to reconcile the inherent conflict between human activity and environmental sustainability and to preserve this asset for future generations*

our challenge & a major opportunity for us to demonstrate how it is done

Science → ***Policy*** → ***Law***

SEARCH

The New York Times

EDITORIAL
Standing With Brussels Against...

ROGER COHEN
In Brussels, Europe Is Struck at Its Heart

THOMAS L. FRIEDMAN
Does Obama Have This Right?

The Opinion Pages | OP-ED CONTRIBUTOR

Water Is Broken. Data Can Fix It.

By CHARLES FISHMAN MARCH 17, 2016

Sprinklers in an agricultural field in California. Max Whittaker for The New York Times

COMMITMENTS TO ACTION ON BUILDING A SUSTAINABLE WATER FUTURE

The Executive Office of the President

THE WHITE HOUSE
WASHINGTON

March 22, 2016

Cannot manage *something if you do not know* ***how it works***

ecosystem management

Data driven

Assessing progress

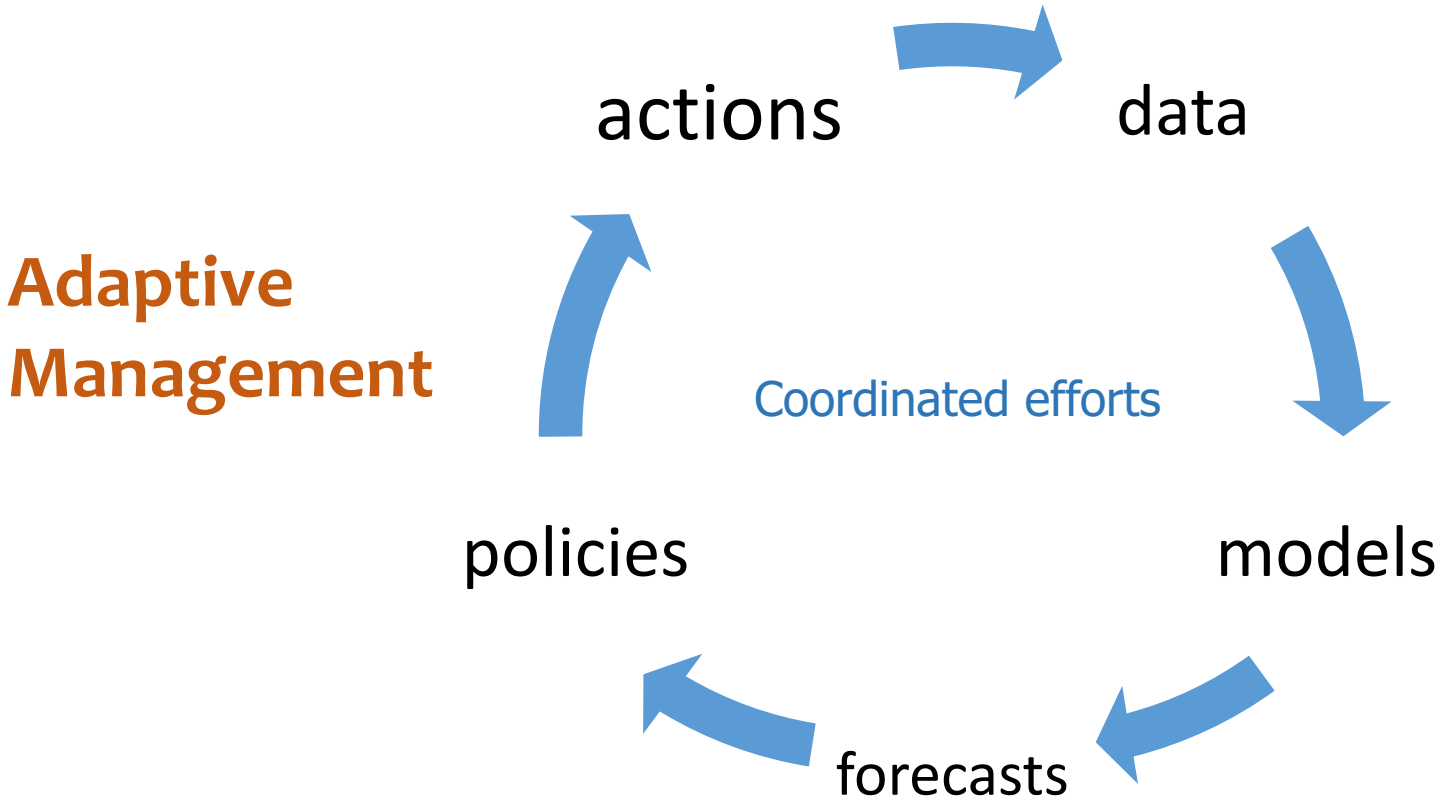
Indicators & vital signs

Models

Forecasting the future

"the 20 year question"

Data → models → forecasts → policies → action (remediation, mitigation, protection)



http://glos.us

Monitoring is essential

the **bottom line**

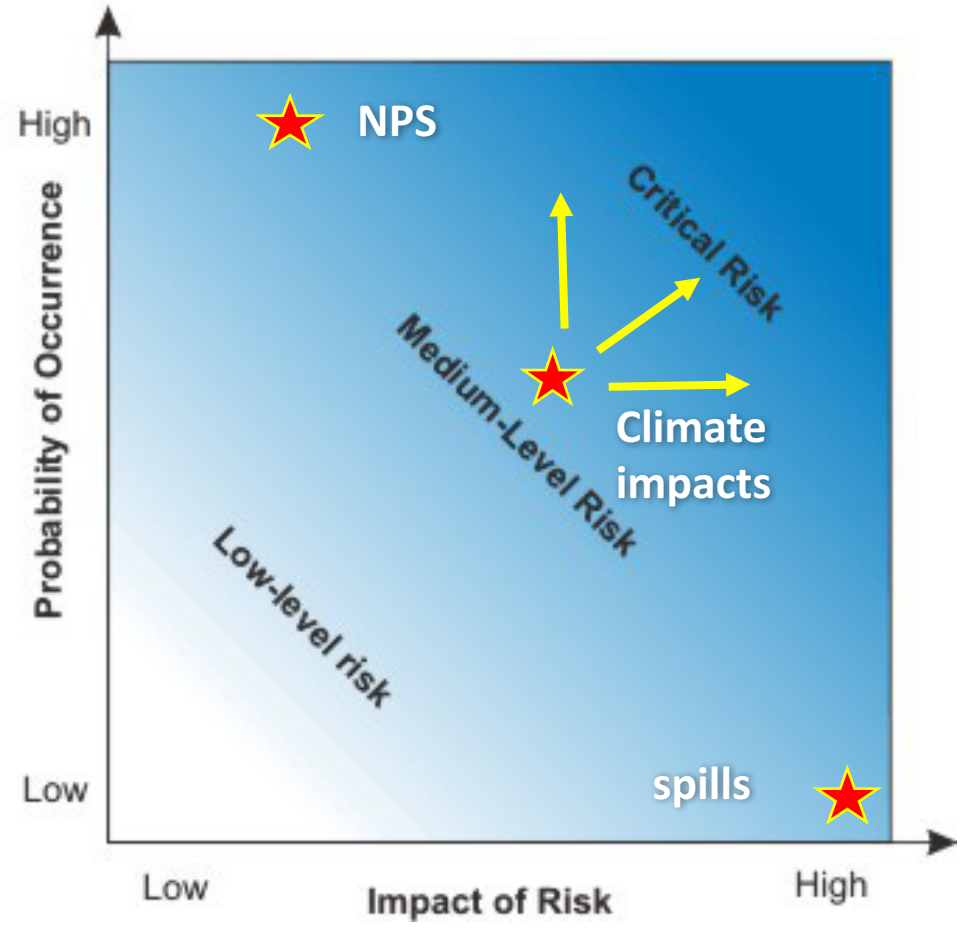
Needed investment ~$100-300M/yr
just for the data challenge

< 0.003% annual value GL

assessing *RISK*

combines uncertainty + magnitude of harm

probability x
potential harm



"Water: the next ***oil****" -* but no substitute at any price

- **not a free good** – costs include treatment & distribution but also include '***ecological costs***' – almost completely ignored
  - > $1 trillion invested in US infrastructure
  - EPA est. $350B over next 20 years in US to rehabiliate
  - more public works $$ than any other single item

- The most **essential**, yet **cheapest** commodity we use
  - pay more for cable than water ~ $1/day
  - < 1% of the water that enters your home is ingested

≡ little incentive to conserve, or use water at its true value, e.g. the 2 fastest growing states in the U.S., Arizona and Nevada – are also the driest

"water bill" – is a misnomer – b/c the water itself is treated as **free**

Source: Jud Hill, Summit Global, Milwaukee Water Summit III

❖ Oh – and one other big problem

Water – for Free !! . . . *not!*

Opinion

Home » News » Opinion

A cost at both ends of the pipe

By J. Val Klump

Posted: Sept. 19, 2009

The issue of our "water bill" has been headline news. What gets lost in this discussion is the fact that while we pay for pumping, filtering, treating and disposing of the water we use, the water itself costs us nothing. This is wrong, because a readily available, abundant supply of fresh water is not free.

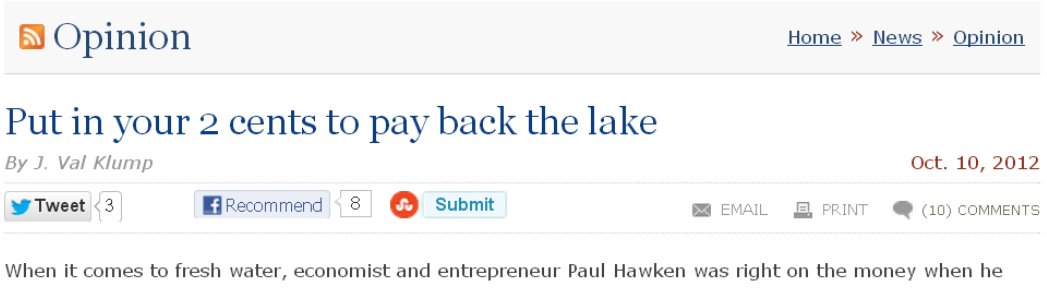
One suggestion:

2¢ per 100 gal. "to pay back the lakes"

~1 ¢ per person per day < 10 cents a week

< $12/yr ave. household --- Milwaukee → $4-5M per year

- basin wide → $200M/yr



Opinion

Home » News » Opinion

Put in your 2 cents to pay back the lake

By J. Val Klump

Oct. 10, 2012

Tweet 3 Recommend 8 Submit EMAIL PRINT (10) COMMENTS

When it comes to fresh water, economist and entrepreneur Paul Hawken was right on the money when he

Good news!

One Region * One Future * Growing Southeastern Wisconsin

Regional Report

Volume Three - Number Two
February 2006

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Dan Stoffel, *dairy farmer*

Full report available at www.publicpolicyforum.org

Public Policy Forum
moving the region forward

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Phone (414) 276-8240

Clean Water, Healthy Future

Asset Management for Regional Prosperity

Clean and abundant water is a strategic asset -- central to the Milwaukee area's history and its future, and to the region's quality of life and global competitiveness. Unlike counties and villages, however, water knows no boundaries, making management of this asset extremely complex. Early in 2005, the Public Policy Forum assembled a panel of leaders with various backgrounds from across southeastern Wisconsin in an effort to reach a consensus on this difficult problem. This is the water advisory panel's consensus:

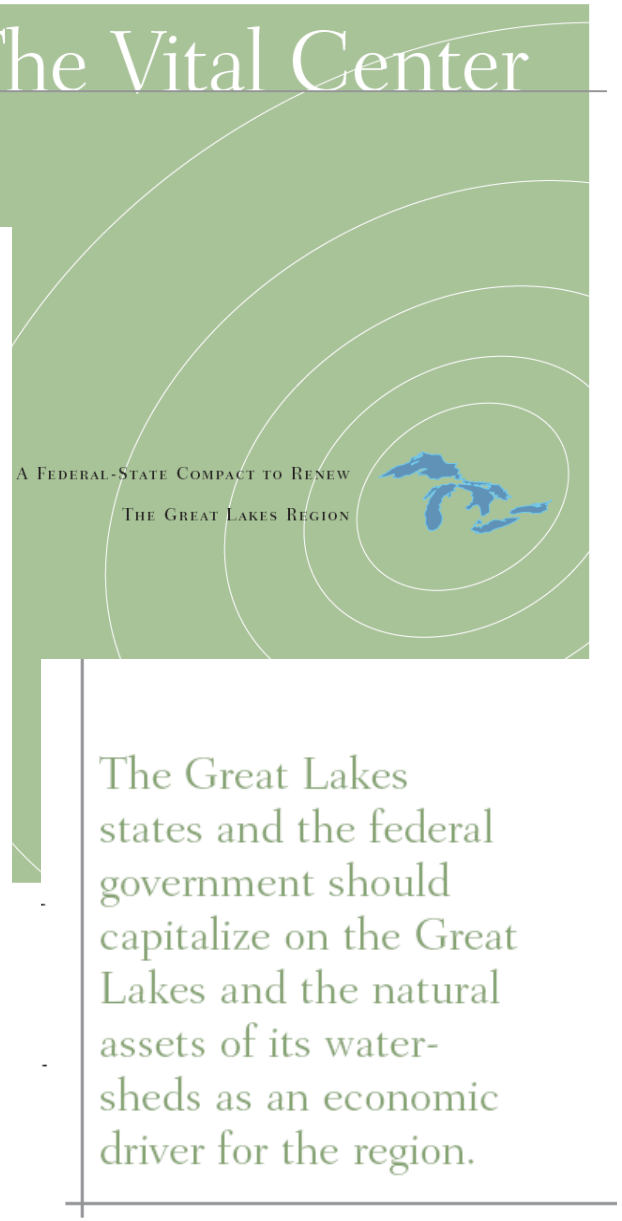
- We face urgent problems, like dropping water tables and declining quality.
- Jurisdictional overlaps, policy gaps, and lack of data hamper solutions.
- Leaders must think strategically and regionally about water resources.

Recommendations

The advisory panel calls on state legislators to adopt a goal of achieving integrated water resource management and to request the Joint Legislative Council convene a study committee to address the panel's policy options:

1. *Vision and goals* - We need an integrated water strategy recognizing the relationship between surface waters and groundwater. It must address quality and quantity, link to other types of planning and be grounded in scientific data, ultimately leading to a "no-net loss" concept of replenishing the water we use.
2. *Science-based solutions* - There is no one-size-fits-all answer to complex water issues. Many options are available to help communities manage the region's water resources in an integrated fashion.
3. *Regional water management models* - Integrated management options:
   - Regional Water Resource Commission - Cooperative council of water managers appointed by municipalities/counties to create and implement plans.
   - Compact among Local Governments - Contract that specifies goals, actions to be performed, and funding mechanism.
   - Wisconsin Department of Natural Resources - State provides guidelines for local governments, which adopt plans and options to meet objectives.
   - Regional Water Resource Authority - Appointed body with professional staff to plan, set priorities, and implement and enforce policies.
4. *Policy and law* - To achieve the regional vision and goals and implement policies, programs, and governance models, it will be necessary to clarify certain laws, change others and create new state water laws as needed.

1



The Vital Center

A Federal-State Compact to Renew The Great Lakes Region

The Great Lakes states and the federal government should capitalize on the Great Lakes and the natural assets of its watersheds as an economic driver for the region.

"The Great Lakes and its waterways offer a tremendous opportunity for reinvigorating the economy of the region, and boosting the competitiveness of the nation as a whole."

Metropolitan Policy Program
The Brookings Institution

Healthy Waters, Strong Economy:
The Benefits of Restoring the Great Lakes Ecosystem

By John C. Austin, Soren Anderson, Paul N. Courant, Robert E. Litan[1]

The Great Lakes are one of America's most important—and often-overlooked—natural features. Together, they account for 90 percent of the United States' and 20 percent of the world's surface fresh water. The Great Lakes also directly impact the lives of the roughly 35 million people who live in the cities, states, and Canadian provinces surrounding them, providing drinking water and recreation, commercial transportation, and both tangible and intangible quality of life benefits.

However, the Great Lakes and surrounding areas face numerous threats to their health and utility. This report summarizes the major findings of a more in-depth study—Developing America's North Coast: A Benefit Cost Analysis of a Great Lakes Infrastructure Program—of the benefits and costs of the federal-state Great Lakes Regional Collaboration (GLRC) Strategy by the same authors. It begins by outlining the major elements of the restoration strategy, and the costs of cleaning and preserving the Great Lakes ecosystem. It then describes the results of a rigorous analysis of the GLRC Strategy, highlighting the economic benefits of its implementation. The report concludes by discussing the policy implications of this analysis, arguing that, because the restoration plan outlined in the GLRC Strategy is likely to produce economic benefits well in excess of its costs, federal and state policy makers should act on its recommendations.

Introduction

The Midwestern states that surround the Great Lakes are in a time of economic transition—from an agricultural and industrial era that relied on the Great Lakes and its waterways for transportation and industrial production, to a global knowledge economy in which the lakes are both an increasingly valuable resource, and an important amenity. Outside the region, the United States and other nations around the world are increasingly looking for ways to move beyond economic growth patterns that diminish natural resources to those that support long-term sustainable development.

The Great Lakes and their abundant fresh water offer a doorway to this new economy.

In 2005, the Brookings Institution joined with academic, public policy, business, education, environmental, and civic organizations to launch the Great Lakes Economic Initiative—a multi-year research and policy development effort focused on supporting economic growth and change in the Great Lakes region.[2] A pillar of the initiative's agenda is to leverage the region's

$50-80B return

*our future depends upon **freshwater***

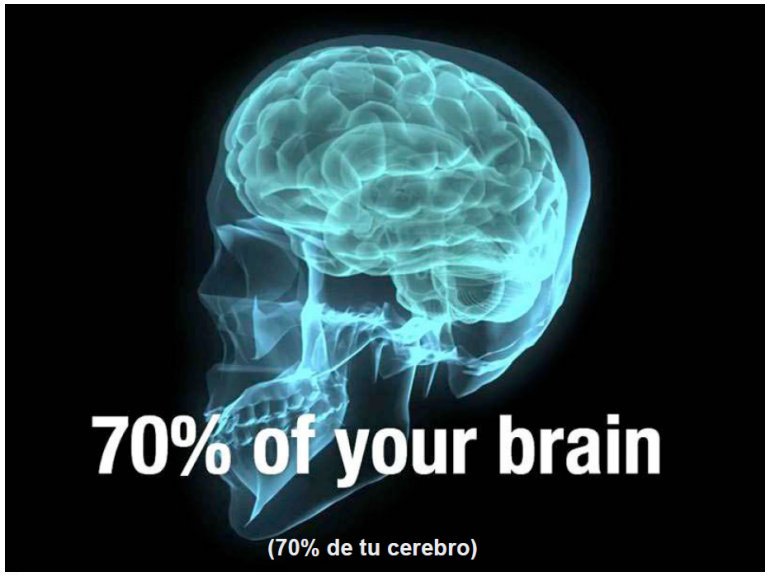
final thought

Fundamental Fact:

- Great Lakes are **CLOSED** Systems

- ✓ if you dump it in today – you will ***drink it tomorrow***

Water is:



60% of your body

and ∴ if you live around here

YOU ARE Lake Michigan !

?

- the ultimate bottom line:

the future is our responsibility


Thank you
UNIVERSITY of WISCONSIN
UWMILWAUKEE

August 2, 2014

City of Toledo
8 hours ago

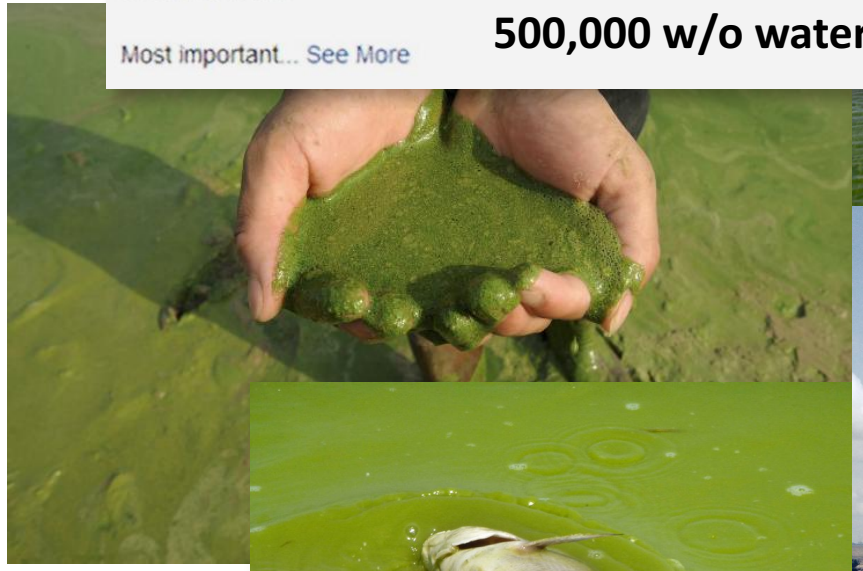
URGENT NOTICE TO RESIDENTS OF TOLEDO & LUCAS COUNTY WHO RECEIVE WATER FROM THE CITY OF TOLEDO

DO NOT DRINK THE WATER
DO NOT BOIL THE WATER

Chemists testing water at Toledo's Collins Park Water Treatment Plant had two sample readings for microcystin in excess of the recommended "DO NOT DRINK" 1 micro-gram per liter standard. This notice applies to ALL customers of Toledo water.

Most important... See More

500,000 w/o water



a "CUYAHOGA moment"