

Forecasting Harmful Algal Blooms to Help Lake Erie Stakeholders

03.06.18

Devin Gill, University of Michigan
Cooperative Institute for Great Lakes Research



Cooperative Institute for Great Lakes Research

Conduct research to support NOAA's goals & expand scientific expertise

Research Areas

Invasive species &
food web ecology



Protection & restoration
of resources

Hydro-meteorological &
ecosystem forecasting



Observing systems &
advanced technology

CIGLR: Science for Society

- **What does a stakeholder engagement specialist do?**
Foster public participation in Great Lakes science!



Case Study: Lake Erie Anglers & HAB Tracker

- Harmful algal blooms
 - What are they?
 - Why are they a problem?
- Lake Erie Anglers & HABs
 - How are they impacted?
 - Can the HAB Tracker help?



Peter Essick (photographer) National Geographic 2011

An aerial photograph showing a large body of water. On the right side, there is a massive, textured green algal bloom that extends from the foreground towards the background. On the left side, there is a landmass with various fields and structures. The water in the center is dark blue, contrasting with the green bloom and the land. The text "Harmful Algal Blooms" is overlaid in white in the center of the image.

Harmful Algal Blooms

Photo Credit: Aerial Associates Photography, Inc. by Zachary Haslick

Harmful Algal Blooms (HABs)



Microcystis

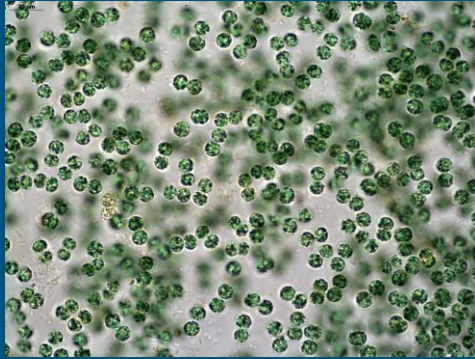
- Plant-like, small organisms
- Algae are part of a natural lake system!
- NOT all algae produce toxins
- *Microcystis*: most common HAB in western lake Erie

HABs: Know Your Algae!

Which photo is of *Microcystis*? Can you identify the other algae?

(A)

Microcystis



(B)

Lemnoideae
(Duckweed)



(C)

Cladophora
(Saginaw Bay
Muck)

(D)

Lyngbya



HABs: Impacts of HABs in Lake Erie

- Health risks

People

Pets

- Impact to fish?

- Impact to drinking water

2014 Toledo Water Crisis

Toledo Water Quality

Water Quality

Toledo tests raw and treated water regularly for the presence of toxins, including microcystin created by algae blooms. See scale below for the current status of drinking water quality according to Ohio EPA guidelines.



- CLEAR:** Less than 5 ppb in the intake crib & non-detect in tap water.
- WATCH:** Greater than or equal to 5 ppb in the intake crib & non-detect in tap water.
- CAUTION:** Microcystin has been detected in tap water, but test results do not indicate the need to issue an advisory. Additional testing and sampling is under way and water treatment has been accelerated.
- PRE-SCHOOL ADVISORY:** DO NOT DRINK for children 5 and younger. Tap Water tests greater than 0.3 and not exceeding 1.6 ppb.
- DO NOT DRINK:** DO NOT DRINK. Tap water tests greater than 1.6 ppb.

Last updated: 9/19/2017



Photo credit: NOAA GLERL



Photo credit: Lauren Highleyman

HABs: Managing Phosphorus Loads

- HABs management in the 60s/70s vs. today
- Goal: 40% phosphorus load reduction under the US-Canada Great Lakes Water Quality Agreement
- A draft US Action Plan for Lake Erie describes plans to achieve the goal

An aerial photograph of Lake Erie. In the foreground, a large, textured area of bright green water indicates a harmful algal bloom (HAB). The water transitions from a dark blue in the center to a lighter blue near the shore. In the background, a large peninsula with a mix of green fields and brown patches is visible. The sky is a clear, pale blue.

Lake Erie Anglers & HABs

Photo Credit: Aerial Associates Photography, Inc. by Zachary Haslick

Lake Erie Anglers & HABs

Will Lake Erie anglers find HAB forecasts to be useful?
Should we target anglers as research partners?



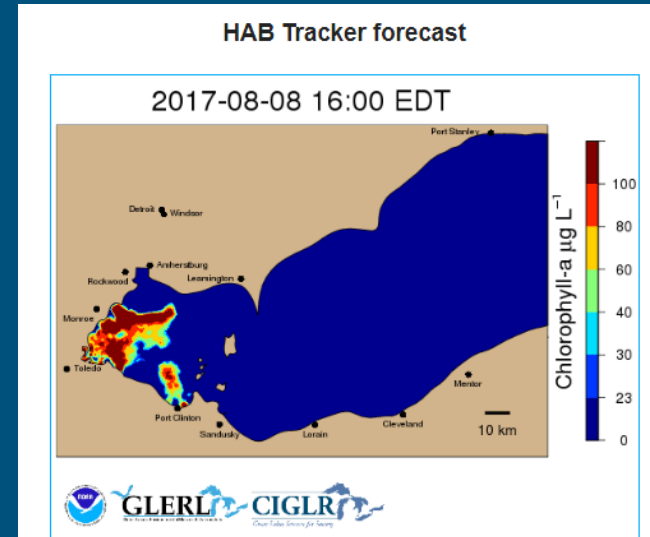
Experimental Lake Erie HAB Tracker

Purpose:

Daily Forecast of harmful algal blooms (HABs)

- ✓ Where are blooms?
- ✓ How big are they?
- ✓ Where are they likely headed?

Model Developer Contact:
Mark Rowe, mdrowe@umich.edu



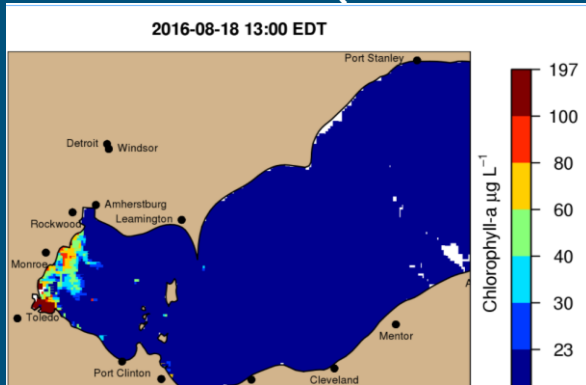
Lake Erie HAB Tracker



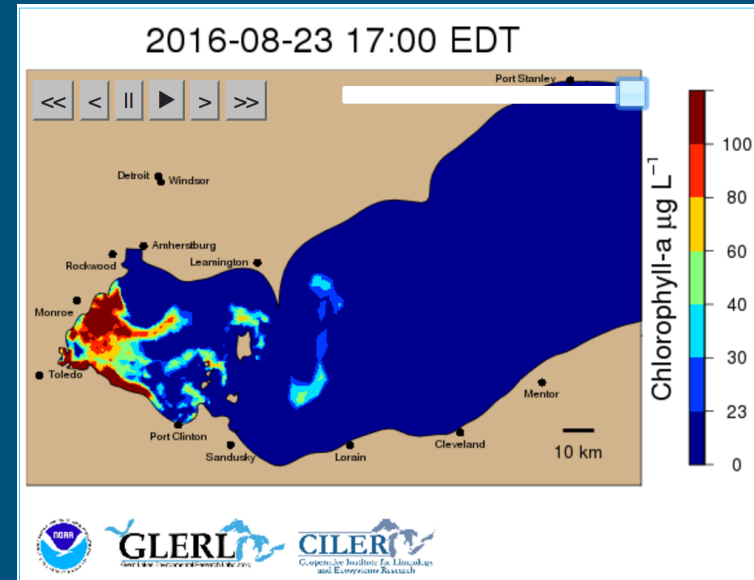
MODIS Satellite Image



Satellite Derived Cyanobacterial Chlorophyll Concentration (NOAA NCCOS)

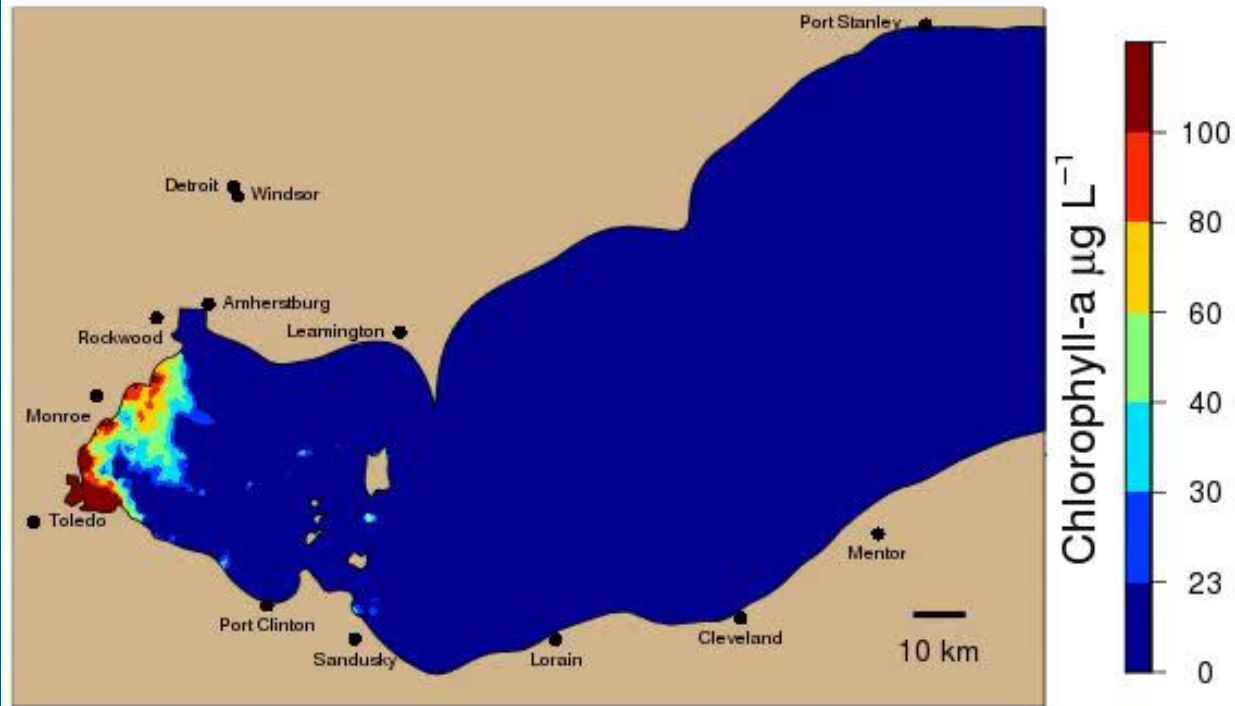


HAB Tracker Model

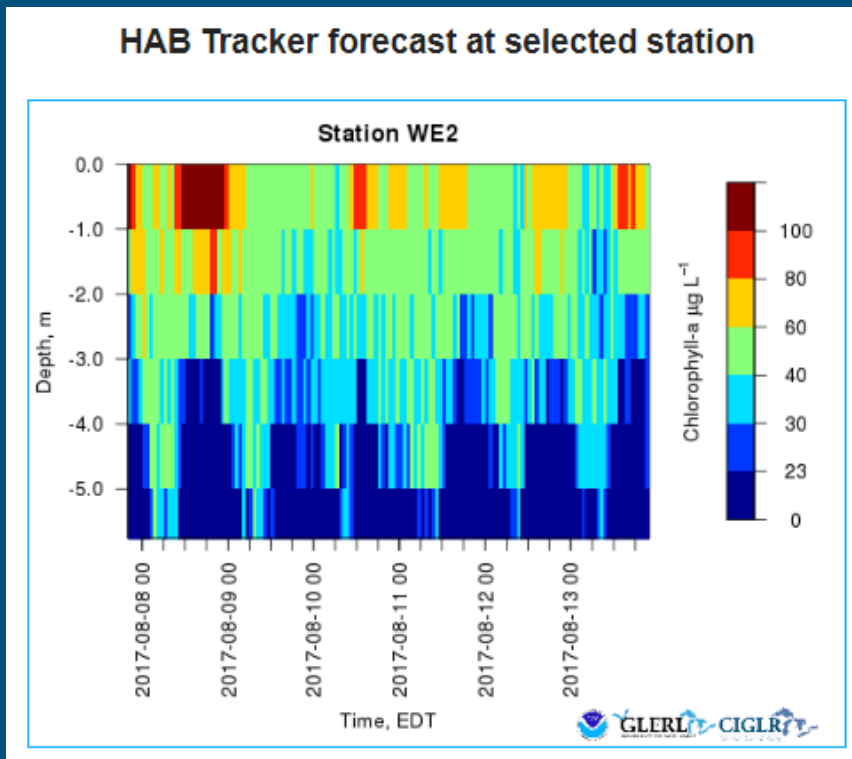


Model Developer Contact:
Mark Rowe, mdrowe@umich.edu

2016-08-18 13:00 EDT



Vertical distribution



Model Developer Contact: Mark Rowe, mdrowe@umich.edu

Lake Erie Anglers & HABs

Will Lake Erie anglers find HAB forecasts to be useful?



Q1. How do HABs impact angler decision-making?

Q2. Can the HAB Tracker support this decision-making?

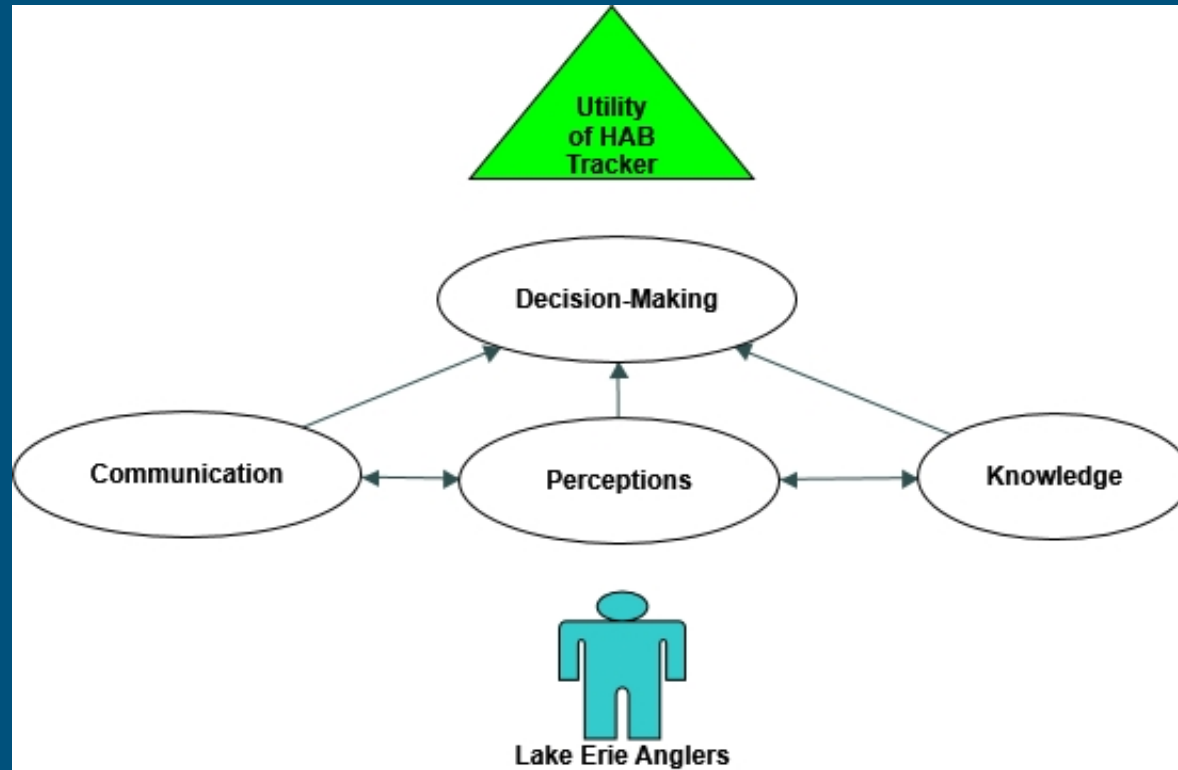
Focus groups

Focus Group Participants

Offshore Recreational Anglers	Charter Boat Captains
Wyandotte: 7	La Salle: 5
Sandusky: 6	Oregon: 5
Oregon: 6	Oregon: 10
*Cleveland: 2	



Interview & survey design



Research results

Key Decisions When Fishing in HABs



Egan, D'Arcy (Photographer). (October 2011). www.cleveland.com



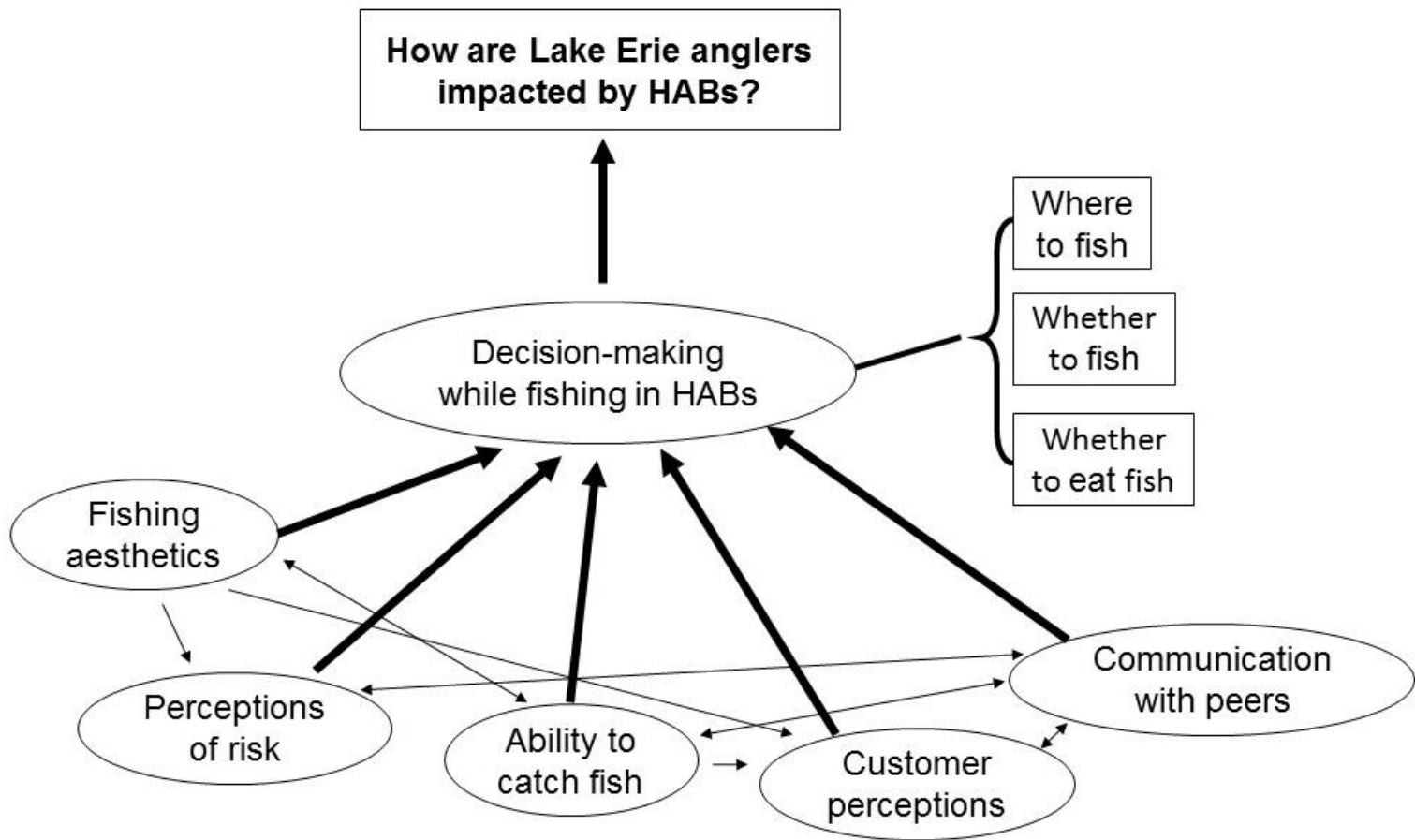
- Whether to fish
- Where to fish
- Whether to eat the fish

Research results

Main Factors that Influence Decision-Making

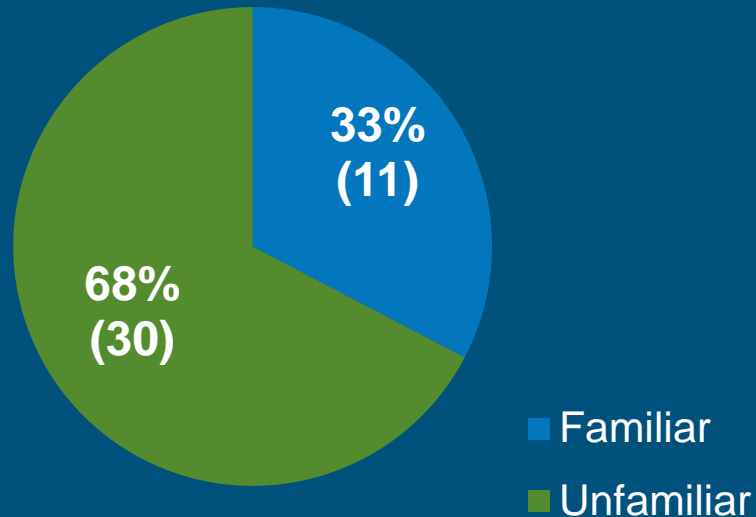
- Will I enjoy my fishing trip? (looks bad, smells bad)
- Will I put my health at risk?
- Will I be able to catch anything?
- Are customers still willing to go fishing?
- What are other anglers saying about HABs?



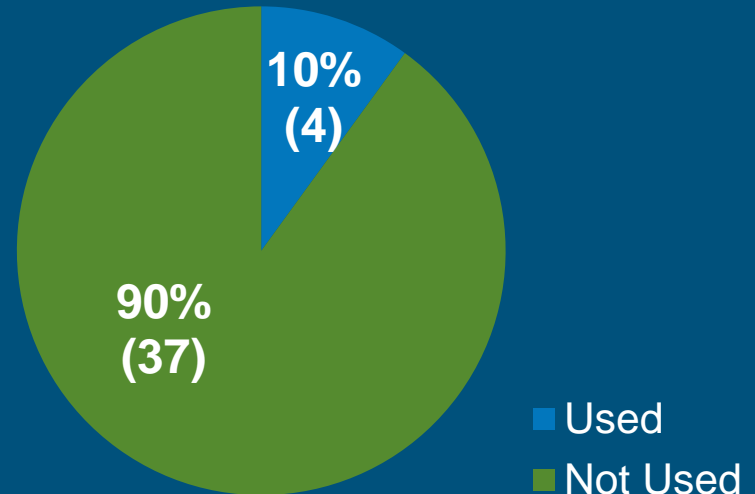


HAB Tracker survey

Participants Familiar with
the HAB Tracker
(n = 41)



Participants Who Used
the HAB Tracker
(n = 41)



Social science theory: diffusion of innovations

1. Compatibility

Compliments my understanding of the lake?

2. Relative Advantage

Better than MODIS?
Experiential knowledge?

3. Complexity

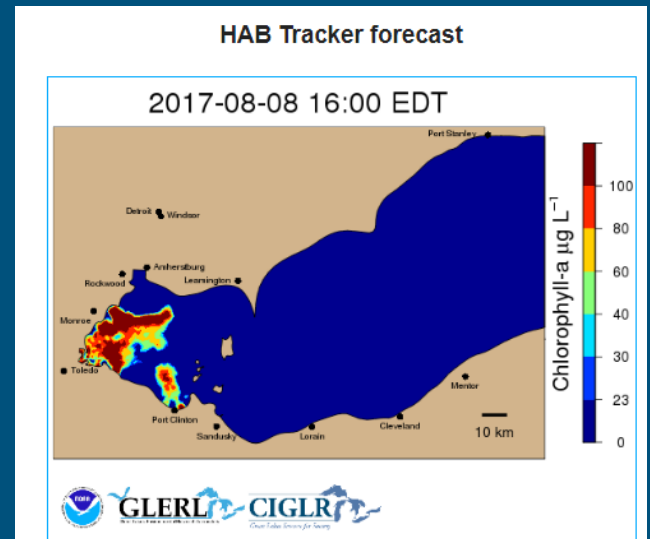
What's a "HAB"?
What's a red vs. yellow bloom?

4. Observability

Reliably accurate?

5. Trialability

What's at stake?



Improving the HAB Tracker

1. Compatability

- Link HAB Tracker to MODIS Coastwatch webpage
- Improve explanation of reliability and accuracy of models

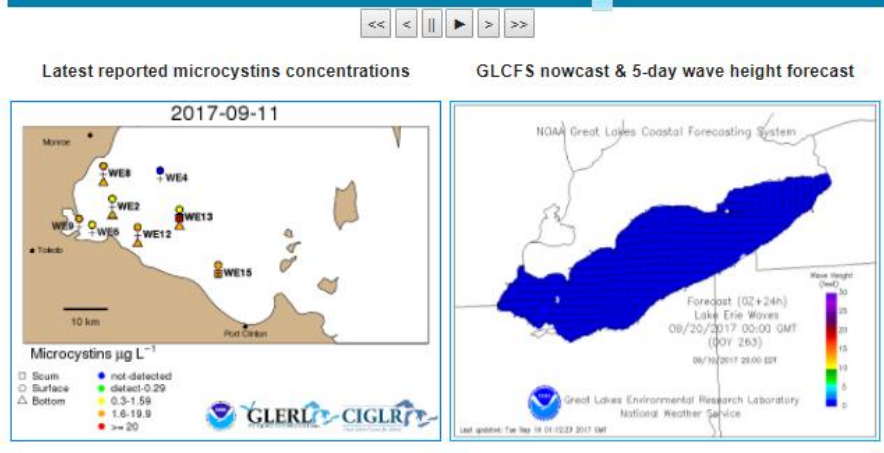
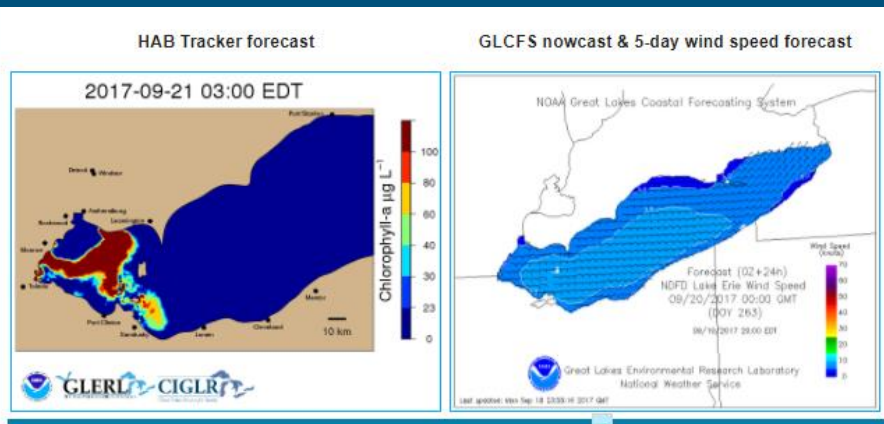
2. Relative Advantage

- Include wave height, wind direction, wind velocity data on Tracker webpage

3. Complexity

- Explain how to interpret color scale (what does yellow mean for anglers???)

HAB Tracker: www.glerl.noaa.gov



Home / Algal Blooms & Hypoxia

Experimental Lake Erie Harmful Algal Bloom (HAB) Tracker

The upper left panel shows the HAB Tracker view surface forecast. The other panels provide additional information on wave conditions. See panel descriptions below. For more information on the HAB Tracker, visit the [About the Lake Erie HAB Tracker](#) page. For the latest images, when your browser is not clear is open.

HAB Tracker forecast

2017-09-20 22:00 EDT

GLCFS's nowcast & 5-day wind speed forecast

2017-09-20 22:00 EDT

Latest reported microcystins concentrations

2017-09-11

GLCFS's nowcast & 5-day wave height forecast

2017-09-11

Panel descriptions:

HAB Tracker forecast - This panel depicts the HAB Tracker 5-day forecast. The color scale indicates surface HAB concentration in terms of cyanobacteria ([Chlorophyll-a](#)).

GLCFS's nowcast & 5-day wind speed forecast - The [Great Lakes Coastal Forecasting System \(GLCFS\)](#) nowcast view is derived solely from observations transmitted to the web, while the forecast uses the National Weather Service's Database generated by the National Weather Service.

Latest reported microcystins concentrations - The HAB Tracker doesn't predict toxin concentrations, so the latest measurements are given here to provide context. Microcystins are the toxin compounds most commonly associated with lake Erie HABs. The symbol shape indicates the depth at which [cyanobacteria](#) occurred at each monitoring station. "Surface" is approximately 0.75 m deep in the water column. Symbols color correspond with thresholds identified by the [Ohio Environmental Protection Agency](#). Microcystins concentrations exceeding the Cleveland Metropolitan Health Authority are indicated in red. Note that the HAB Tracker uses a different color scale - the HAB Tracker does not indicate toxin concentrations.

GLCFS's nowcast & 5-day wave height forecast - The wave height forecast is produced by the [Great Lakes Coastal Forecasting System \(GLCFS\)](#).

For more information on how the HAB Tracker works, who uses it, and what's next in research and operations, visit our [About the Lake Erie HAB Tracker](#) page. Note: NOAA also provides an operational twice weekly HAB nowcast and publishes it in the [Lake Erie HAB Bulletin](#).

(Please view the laboratory's [Disclaimer and Intellectual Property Notice](#). If you would like to provide feedback on the HAB Tracker, access the [user survey](#) developed by the Cooperative Institute for Great Lakes Research (CIGLR). (This is not a NOAA survey).)

Latest satellite-derived data used by the HAB Tracker

Sensors attached to satellites gather data, which is processed into the cyanobacterial index, an indicator of the abundance, or density, of cyanobacteria associated with HABs. Processed satellite imagery is provided by the [NOAA's HAB Operational Observations System](#). The cyanobacterial index scale is converted to a concentration. Chlorophyll scale for use in the HAB Tracker, is similar indicator of cyanobacterial abundance.

True-color satellite image of Lake Erie

2017-09-17 18:00 EDT

HAB index satellite analysis

2017-09-17 18:00 EDT

Latest relatively cloud-free MODIS satellite image of Lake Erie. For additional satellite imagery of Lake Erie, visit the [satellite](#) in the HAB Tracker menu. HAB index satellite analysis.

Latest HAB index satellite analysis used to update the bloom line. For additional satellite imagery of Lake Erie, visit the [satellite](#) in the HAB Tracker menu. HAB index satellite analysis.

Benefits of engaging stakeholders in research?

- Builds trust
- Incorporates new knowledge
- Grounded in reality

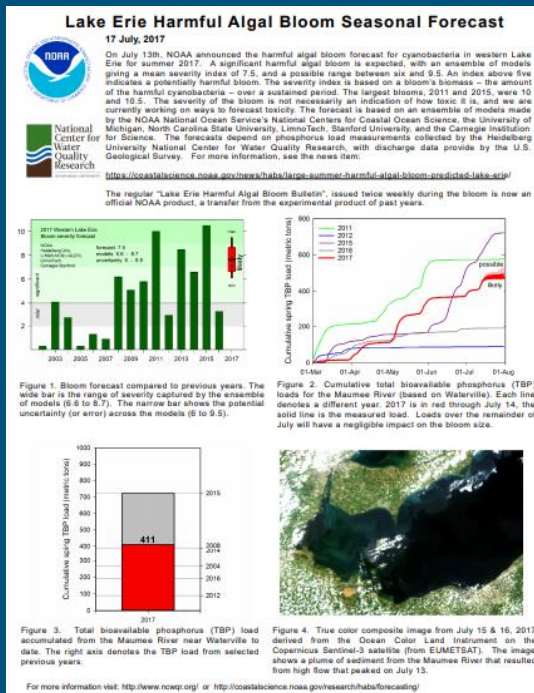


Harmful Algal Bloom Forecasts

- HAB Bulletin
- Seasonal Forecast
- Pre-Season Forecast

Seasonal/HAB Bulletin Contact:
Rick Stumpf, richard.stumpf@noaa.gov

HAB Tracker Contact:
Mark Rowe, mdrowe@umich.edu



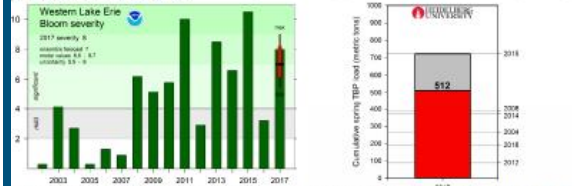
Experimental Lake Erie Harmful Algal Bloom Bulletin 7 November 2017, Bulletin 36, Seasonal Assessment

2017 Bloom Analysis. The *Microcystis* cyanobacteria bloom in 2017 had a severity index (SI) of 8, which is a severe bloom. This is roughly equivalent to 2013 (SI = 8.5) which was the third worst bloom observed this century, after 2012 (SI = 10) and 2015 (SI = 10.5). The severity index captures the amount of bloom biomass over 30 days. While the severity in 2017 was slightly less than that for 2013 using this metric, because of variability through this season, the peak bloom size in mid-September, 2017 was greater than the peak in 2013. The severity was consistent with the forecast of 7 and within the range from the ensemble of models of a likely severity between 6.6 and 8.

During the week following September 20th, the bloom covered a maximum area of 1000 square miles from Toledo to the Ontario coast, reaching the mouth of the Detroit River. During that week, scum covered up to 280 square miles of the western basin. For comparison, the 2015 bloom covered over 4000 square miles of the lake at its maximum extent, yet had similar scum coverage at any one time to 2017. In the western Lake Erie basin, the bloom biomass was less toxic than several of the recent bloom years.

Like 2016, this bloom had a "double peak", one in August followed by a decrease in biomass, then a strong reappearance in mid-September. The densest bloom in August was mostly in the center of the western basin, while the bloom impacted more shorelines in September. Isolated pockets of the *Microcystis* bloom persisted into late October along the Michigan shoreline.

The forecast models are based primarily on the load of bioavailable phosphorus from the Maumee River. Heavy rains in May and late June resulted in high discharge from the Maumee River. The high concentration of phosphorus in the river, combined with the high discharge produced conditions favorable for the bloom.



Devin Gill

Stakeholder Engagement Specialist
University of Michigan

(734) 741-2283

deving@umich.edu

