Mitigation Strategies and Policy Guidance for Harmful Algal Blooms in Ohio's Drinking Water Sources

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Division of Drinking and Ground Waters
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Overview

- Background information on HABs
- Types of in-lake management controls
  - Physical
  - Chemical
  - Biological
- Guidance documents
- Regulatory requirements and updates
- Satellite imagery for inland lakes

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Defining HABs

- **Harmful –** posing threat to ecosystem, animal and human health; *cyanotoxins* are a primary concern for drinking water and recreation
- **Algae –** photosynthetic aquatic organisms lacking true roots and stems; *cyanobacteria* are primary concern in freshwater systems
- **Bloom –** excessive biomass, occurs when conditions (e.g., nutrients, light, temperature) support high growth rates



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Adverse Impacts

- **Cyanotoxin production** - dermal toxins, neurotoxins, and hepatotoxins
  - Symptoms of exposure include nausea, skin rashes, gastrointestinal distress, disorientation, numbness, and fatigue.
  - Ohio has received reports of human illness and dog deaths associated with recreational exposure to cyanotoxins.
- **Taste and odor problems**
  - Methylisoborneol (MIB) & Geosmin (earthy/musty odor)
- **Dissolved oxygen dips**
- **Nuisance** - visual and olfactory effects can be significant
- **Costs to communities**
  - Economic impacts from loss of recreation based tourism
  - Increased costs for production of drinking water

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Benefits from Reducing HABs

- Protect human health and appealing lake
- Cost saving to water system
  - Reduced cyanotoxins and HAB monitoring
  - Reduced taste & odor compounds
  - Reduced turbidity
  - Reduce filter clogging
  - Reduced organic carbon, reduced THMs
  - Reduce treatment chemical requirements

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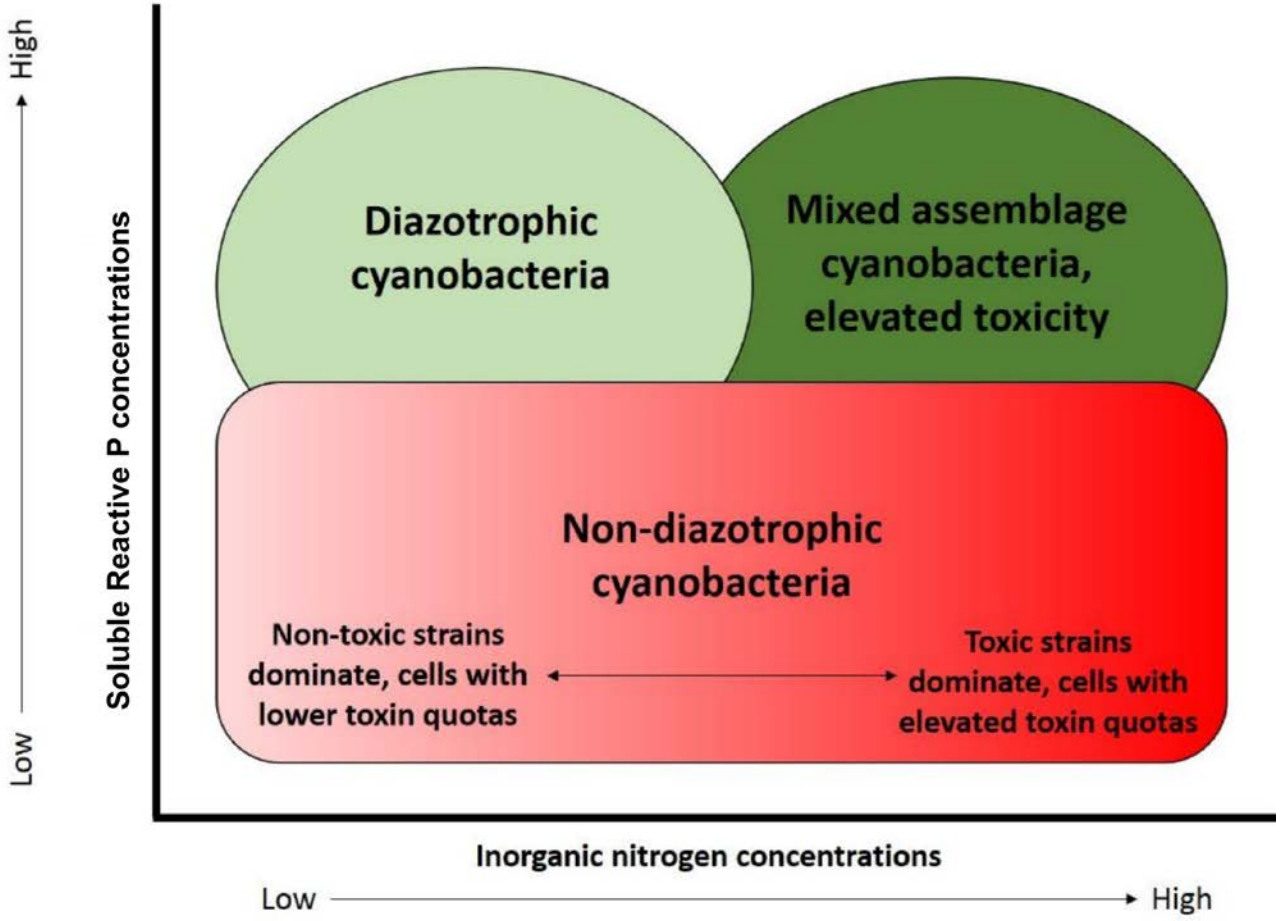
Factors Affecting (Promoting) HABs

- Nutrients: Phosphorus (bloom) and Nitrogen (toxicity, microcystins)



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Gobler et al. 2016, Harmful Algae

Factors Affecting (Promoting) HABs

- Nutrients: Phosphorus and Nitrogen
- Light
- Temperature
- Water movement (stratification) and residence time
- Micronutrients
- Algal seasonal dynamics and history

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Source Water Management Strategies

Watershed Management

- Control external loading of nutrients
  - Reduce sources or nutrient trapping
- Component of successful long-term management plan to reduce HABs
- High cost per area to achieve goal

Avoidance Strategies

- Multiple source waters (isolate and treat)
- Multiple intake depths

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In-Lake Management Strategies

Physical control

- Dredging to remove nutrient laden sediment or benthic mats
- Harvest/skim scums or mats
- Hydrologic manipulation (flushing, selective withdrawl)
- Aeration, hypolimnetic oxygenation (nanobubbles)
- Artificial mixing
- Sonication, ultrasound

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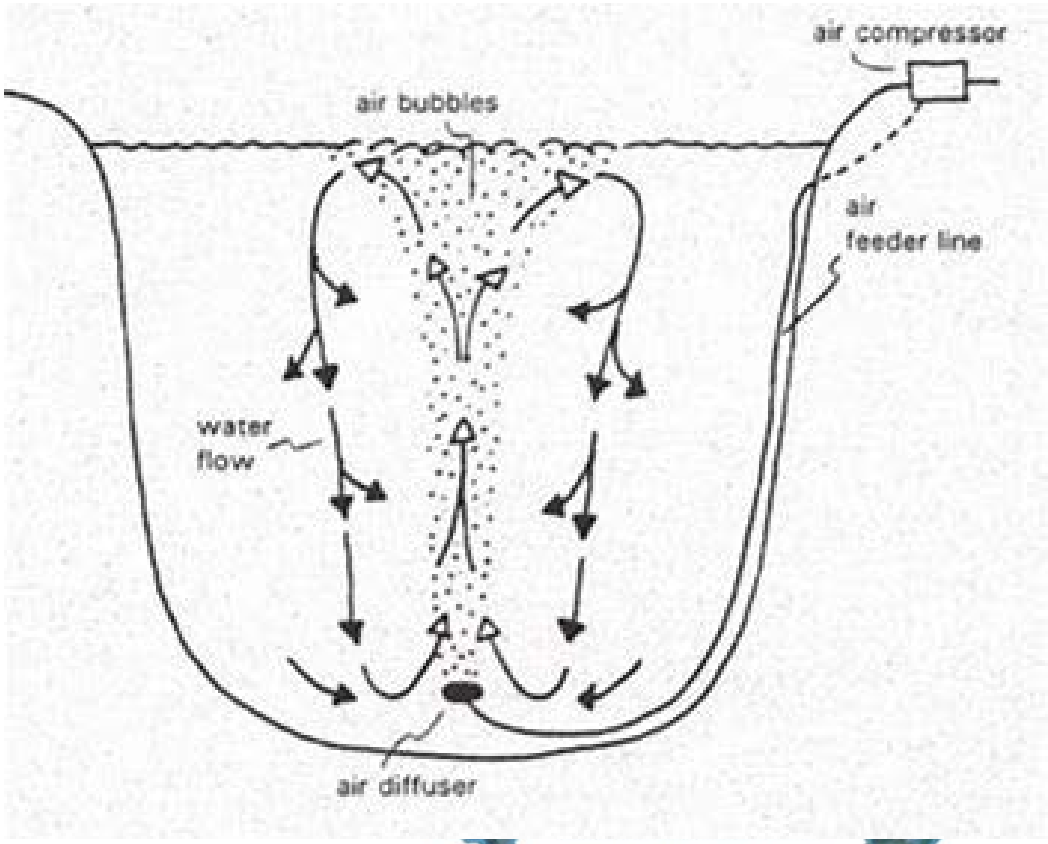
Case Study Examples

Lake Carmi, VT

- Large, shallow with high internal P
- Impaired for nutrients (TMDL) and history of recreational HABs
- Evaluation aeration versus circulation system to address internal P



https://dec.vermont.gov/sites/dec/files/wsm/lakes/docs/Encroachment/AerationReport_FINAL.pdf

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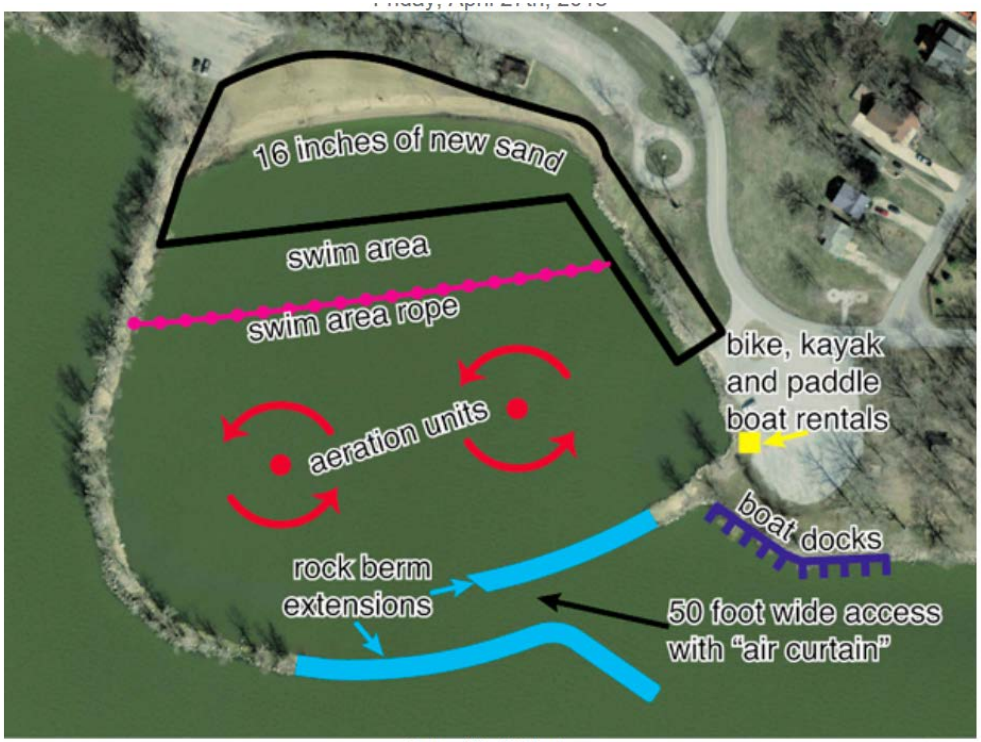
Case Study Examples

Grand Lake St. Marys Beach

- Isolate beach embayment
- Aeration units and “air curtain”



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In-Lake Management Strategies

Chemical control

- Algaecides
- Phosphorus inactivation (Alum, Phoslock)
- Flocculation agents
- Oxidizing agents (permanganate, ozone; potentially with nanobubbles)

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Alum Lake Treatment

Alum used as a phosphorus control Since 1960's

- Phosphorus becomes biologically unavailable through inactivation by binding P to Al
- Aluminum phosphate is very insoluble and stable under low oxygen and wide range of pH
- Treatments may be very effective for mixed systems by reducing internal cycling/loading of P
- Treatment longevity largely depended on new, external P inputs

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Alum Treatment Strategies

- Sediment phosphorus inactivation
- Phosphorus water column stripping
- Phosphorus interception (external lake loading)
- Combination of strategies!

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Alum Treatment: Factors to Consider

- More effective for lake with high internal P load
  - Lakes with high lake surface to watershed area ratio increases longevity (lower flushing rate)
- Accurate dosing increases effectiveness, longevity of treatment
- Type of lake system
  - Stable system with infrequent mixing
  - Deep versus shallow (more P load per volume)
- Effectiveness in shallow systems may need to implement additional strategies

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In-Lake Management Strategies

Biological control

- Predators (not successful)
- Barley straw (allelopathic effect)
- Viral controls (lab-scale only)
- Bacterial additives (potential off-label use, in combination)

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Roll Call for Algal Control

- Watershed management (where external load is high)
- Phosphorus inactivation (for internal load or inflow)
- Circulation/mixing (deep versus shallow systems)
- Oxygenation (deep lakes, internal load dominant)
- Dredging (where feasible, benthic mats)
- Algaecides (with proper timing, limited usage, no nutrient control)
- Sonication (for susceptible algae, no control for nutrients)
- Biological controls (moderate P, variable)
- Multi-faceted approach (toolbox)

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Monitoring Program

Data needs to determine triggers for response and evaluate effectiveness of treatment

- Algae, cyanobacteria types and abundance (phycocyanin, genetics, cyanotoxins)
- Water quality (nutrients, pH, temperature, oxygen; spatial and temporal)
- Lake bathymetry
- Inflow and outflow sources
- Other biological communities

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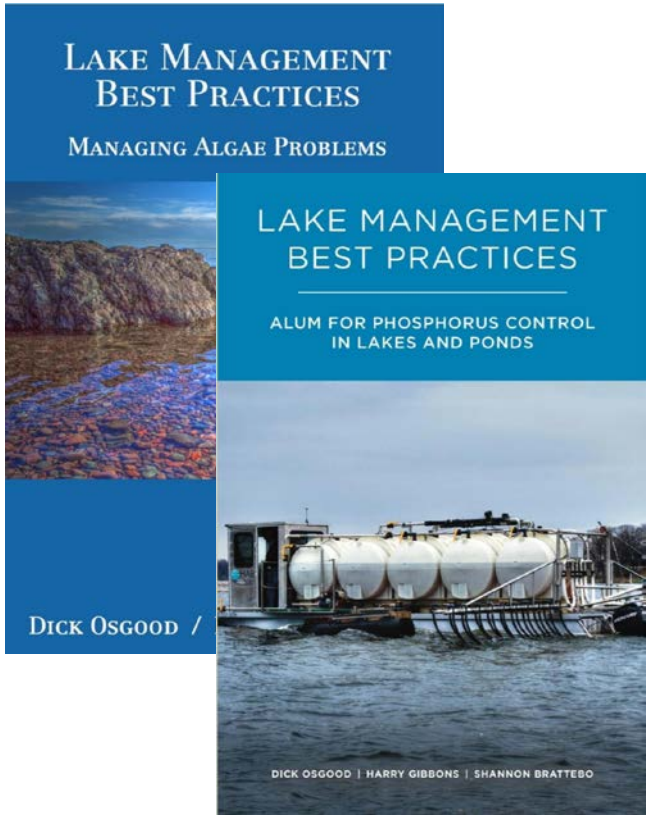
Reservoir Management Guidance

Workshops in lake management with North American Lake Management Society (NALMS)



http://www.lulu.com/shop/dick-osgood-and-harry-gibbons-and-shannon-brattebo/lake-management-best-practices-alum-for-phosphorus-control-in-lakes-and-ponds/paperback/product-23393687.html

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HAB Guidance, In Development

- ITRC – Harmful Cyanobacterial Bloom Project
- Produce a web document (portal), strategy section tools, training curricula, and fact sheets
- Finalize documents and tools, develop training materials in 2020
- Training should be underway in 2021!
- *Join the team at itrcweb.org*

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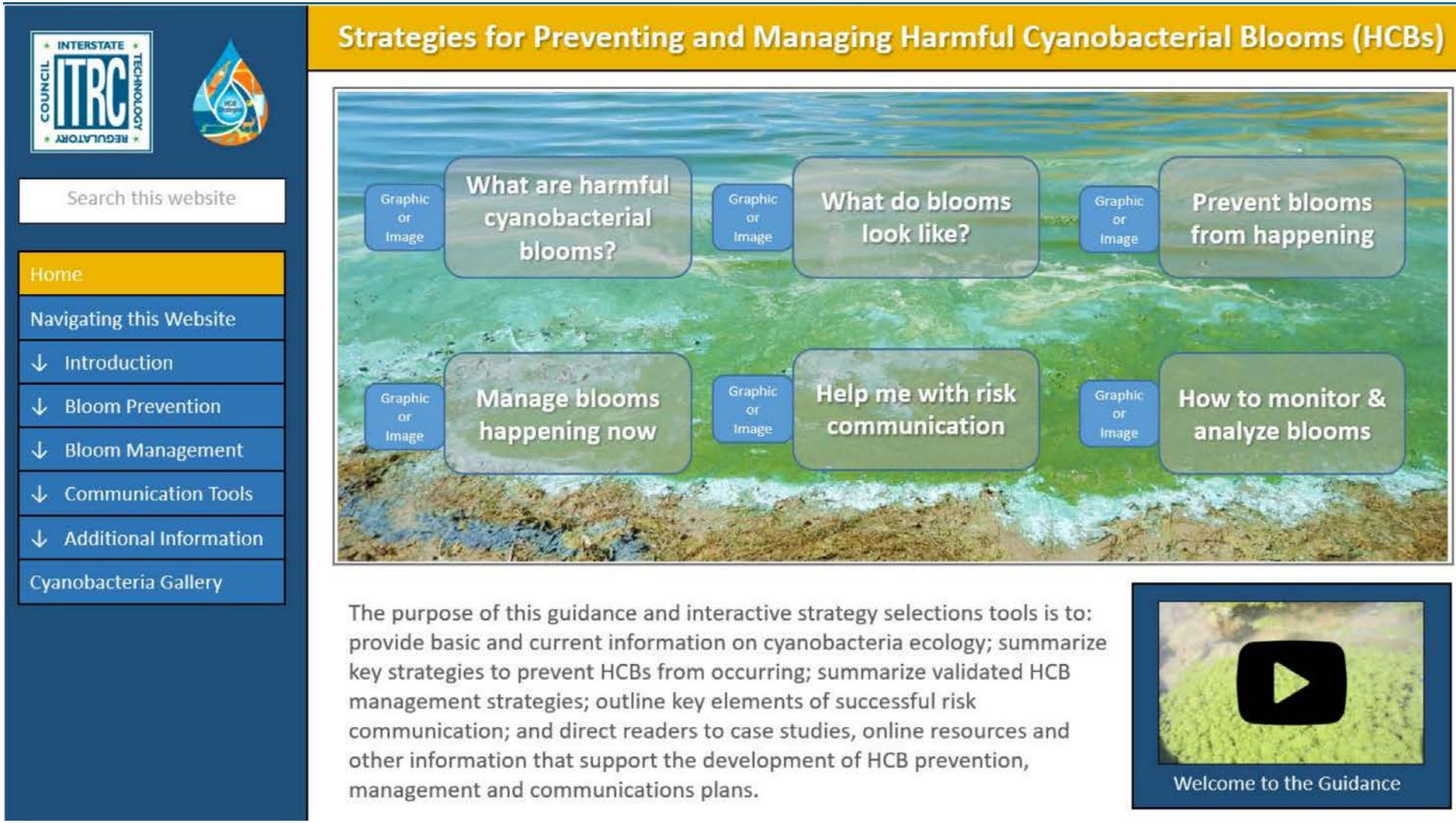
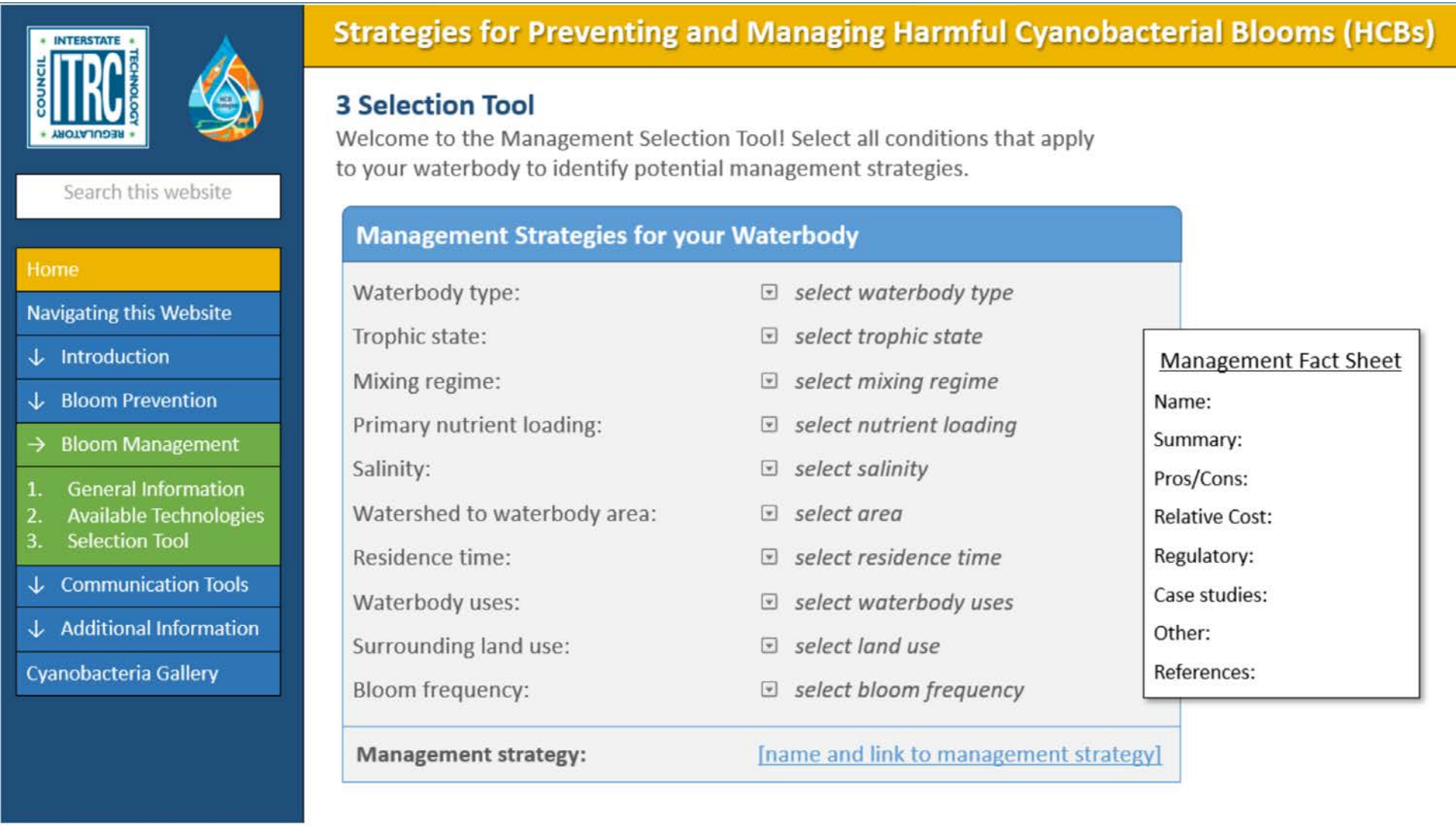
HCB Project Overview



Key Concepts: In-lake Treatments



OEPA HAB Guidance Documents

Treatment Optimization Protocol (short term options)

https://epa.ohio.gov/Portals/28/documents/habs/TreatmentOptimizationProcotol.pdf

Cyanotoxin General Plan (long term planning)

https://epa.ohio.gov/Portals/28/documents/habs/HABGeneralPlanGuidance.pdf

Sections specific to source water management!

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Treatment in Source Waters

- OAC 3745-83-01(d) Operational requirements
  - ANSI/NSF Standard 60 Drinking Water Treatment ***Chemicals***
    - Includes algaecides
  - ANSI/NSF Standard 61 Drinking Water System ***Components***

- ***Encourage new reservoir management technologies to comply!***

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Permitting Process for Algaecide

- Ohio General NPDES permit (OHG870002):
  - Effective January 1, 2017
  - Expiration December 31, 2021
  - Fee required for renewal
  - Submit to Division of Surface Water
- Applications “in, over or near” surface water
- Notice of Intent (NOI) are required for direct application to drinking water reservoirs

http://www.epa.ohio.gov/dsw/permits/GP_Pesticide.aspx

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Restrictions for Algaecide in Drinking Water Source

- Due to the potential release of cyanotoxins, algaecide use is restricted in drinking water sources during a severe bloom (scum or >100,000 cells/mL cyanobacteria) or if cyanotoxin concentrations at PWS intake exceed drinking water thresholds
- Exemptions:
  - Bloom is not producing cyanotoxins
  - Source water is isolated
  - Treatment capacity for extracellular cyanotoxins
  - Cyanotoxins
- *Updated factsheet May 2020*

https://www.epa.ohio.gov/Portals/28/documents/HABs/Publications/AlgaecideApplicationFactSheet.pdf

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Algaecide Application Notes

- Follow label instructions and be aware of environmental impact and practical considerations
- Apply algaecide during early stages of bloom, before cyanotoxins are detected in raw water, and only to areas where cyanobacteria are present

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2020 PWS HAB Strategy Updates

- Drinking water thresholds
  - Updated values for anatoxin-a (child: 0.3 µg/L, adult: 1.6 µg/L)
  - Removed 'Do Not Use' tier
- Adjust monitoring schedules for bi-weekly cyanobacteria screening (all schedule 1 and 2 systems samples same week)
- Modify response sampling for saxitoxins and cylindrospermopsin

https://epa.ohio.gov/ddagw/HAB

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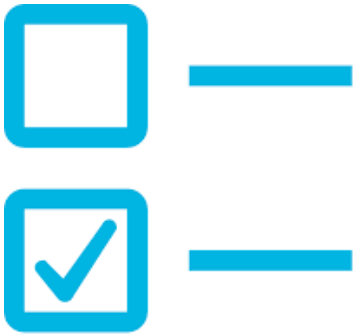
HAB Rule Review and Survey

- HAB Rules, OAC 3745-90 are currently undergoing five-year rule
  - Early Stakeholder Outreach, comments by 7/6/2020

    https://epa.ohio.gov/Portals/28/documents/rules/ESO_HABs_Final.pdf
- Survey on HAB impacts to PWS
  - Request surveys submitted by 8/1/2020



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Treatment in Source Waters

- OAC 3745-91 Plans Approval
  - Required for any new source or alteration in source
  - Specifies substantial change to water quality
  - Five-Year Review in 2020; Early Stakeholder Outreach, comments by 6/26/2020

Subscribe to rules emailing list at https://epa.ohio.gov/ddagw/rules

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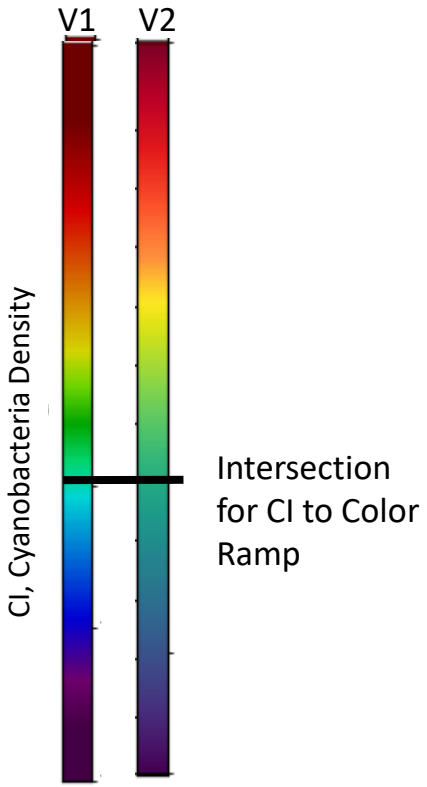
Satellite Imagery for Inland Lakes

- Ocean and Land Color Instrument (OLCI) on two ESA satellites: Sentinel-3, A and B
  - Pixel resolution 300m, near-daily imagery
- NOAA provides Cyanobacteria Index (CI) products for larger inland lakes and rivers
  - CIcyano maps shared 2017-2019
  - Updates for 2020, Version 2 (V2):
    - New processing with adjustments to land mask and “no data” (grey) pixels
    - Extended CI scale to higher maximum concentration
    - New color ramp, consistent saturation



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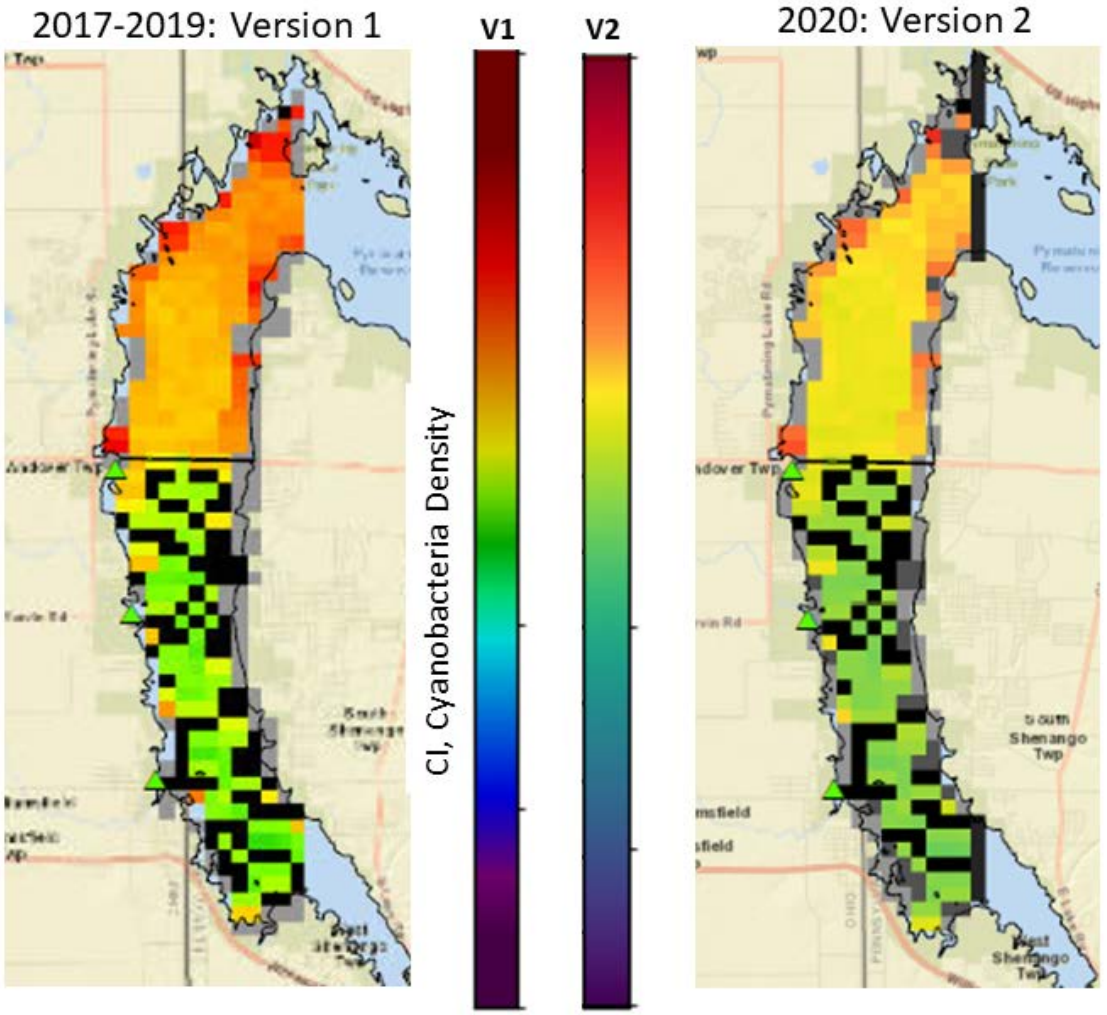
Comparison V1 and V2 Processing



Pymatuning Reservoir, 8/11/2019

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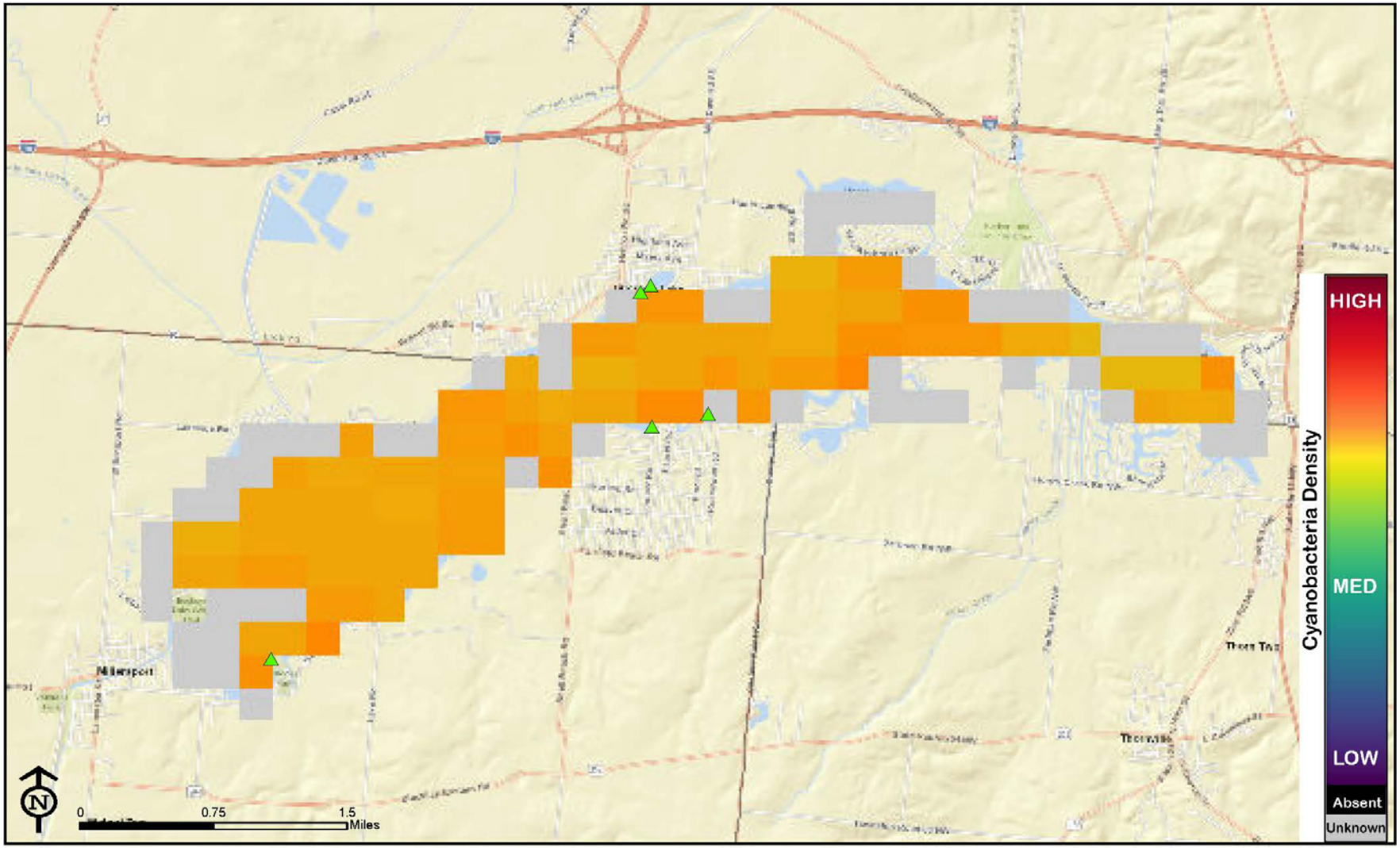

Harmful Algal Bloom (HAB) Satellite Imagery
NOAA - NOS, Copernicus Sentinel-3

This data product is experimental. Cyanobacteria detections should be confirmed and may not indicate presence of cyanotoxins.
Learn more about HABs at ohioalgaeinfo.com
Find beach advisories and sampling data at http://publicapps.odh.ohio.gov/beachguardpublic

Buckeye Lake

FAIRFIELD; LICKING; PERRY COUNTY

Satellite Image Taken: 4/20/20
NEW (V2) PROCESSING & COLOR RAMP

PWS Active Intakes
ODNR Sample Sites

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Report Date: 4/21/2020

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