Lake Superior Cooperative Science and Monitoring Initiative (CSMI)

Cyanobacterial boom studies update

Presented by Anna Baker, Tom Hollenhorst, and Kaitlin Reinl

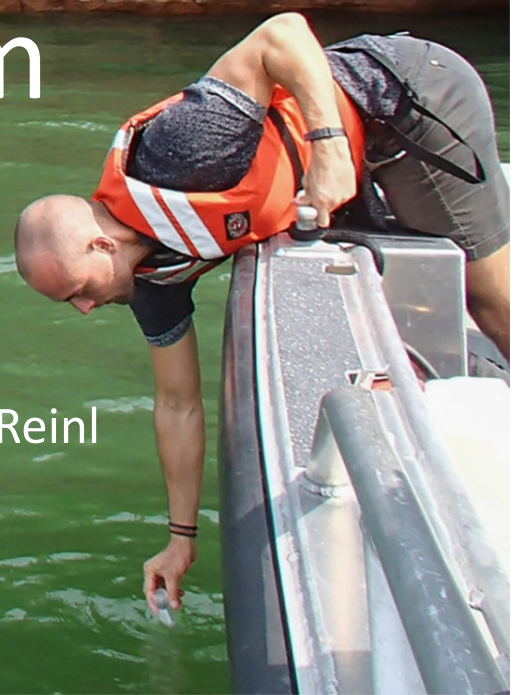


Photo by Brenda Lafrancois, NPS

Cooperative Science and Monitoring Initiative (CSMI)

- Initiative of the Science Annex of Great Lakes Restoration Initiative
- Focuses on one of the Great Lakes each year
- Priorities set under LAMPs (Lake-wide Action Management Plans) for each lake
- Intensive sampling year

What work goes on in one year across the lakes during the 5-year CSMI cycle? Using 2020 as an example:

- Lake Michigan – Field year underway
- Lake Erie – Data analysis from 2019 field year
- Lake Ontario – Reporting out from 2018 field year
- Lake Huron – Identifying priorities for 2022 field year
- Lake Superior – Planning for 2021 field year

Funded Projects

- LAMP Priority – Nutrients and Bacterial Pollution
  - Tributary Monitoring and Phosphorus Cycling(USGS)
  - Near shore monitoring
  - Mechanistic studies addressing bloom drivers
  - Historical Analysis
- LAMP Priority – Habitat and Species
  - Multi-Trophic Level Assessment (USGS, EPA)
  - Groundwater study (USGS)
  - Food web dynamics and Coaster Brook Trout (MI DNR)
  - Lake Sturgeon Index Survey (USFWS)
  - Coastal wetlands – study of effects of water level fluctuations (USFWS)

LAMP Priority: Nutrients and Bacterial Pollution

- Cyanobacterial bloom studies

Interagency Team

- NPS
- UMD (LLO and NRRI)
- EPA (ORD, GLTED, GLNPO)
- Northland College Burke Center
- WI- DNR
- USGS (UMid and UMESC)
- Lakehead University
- UW-Madison
- Purdue University Ohio Sea Grant

First meeting

- ~30 attendees, at least 9 institutions represented
  - UMD (LLO and NRRI),
  - EPA (ORD, GLTED, and GLNPO);
  - Northland College Burke Center,
  - NPS,
  - WI-DNR,
  - USGS (UMid and UMESC),
  - Purdue University and Illinois Sea Grant,
  - Lakehead University, UW-Madison

Background on Lake Superior Cyanobacterial Blooms

(Slides from Brenda Lafrancois, National Parks Service Apostle Island National Lakeshore)

Overview of Lake Superior HABs findings to date

Co-authors and Contributors:

Brenda Lafrancois, David VanderMeulen, Julie Van Stappen (NPS)

Robert Sterner, Kaitlin Reinl, Sandra Brovold (UMD)

Todd Miller (UWM)

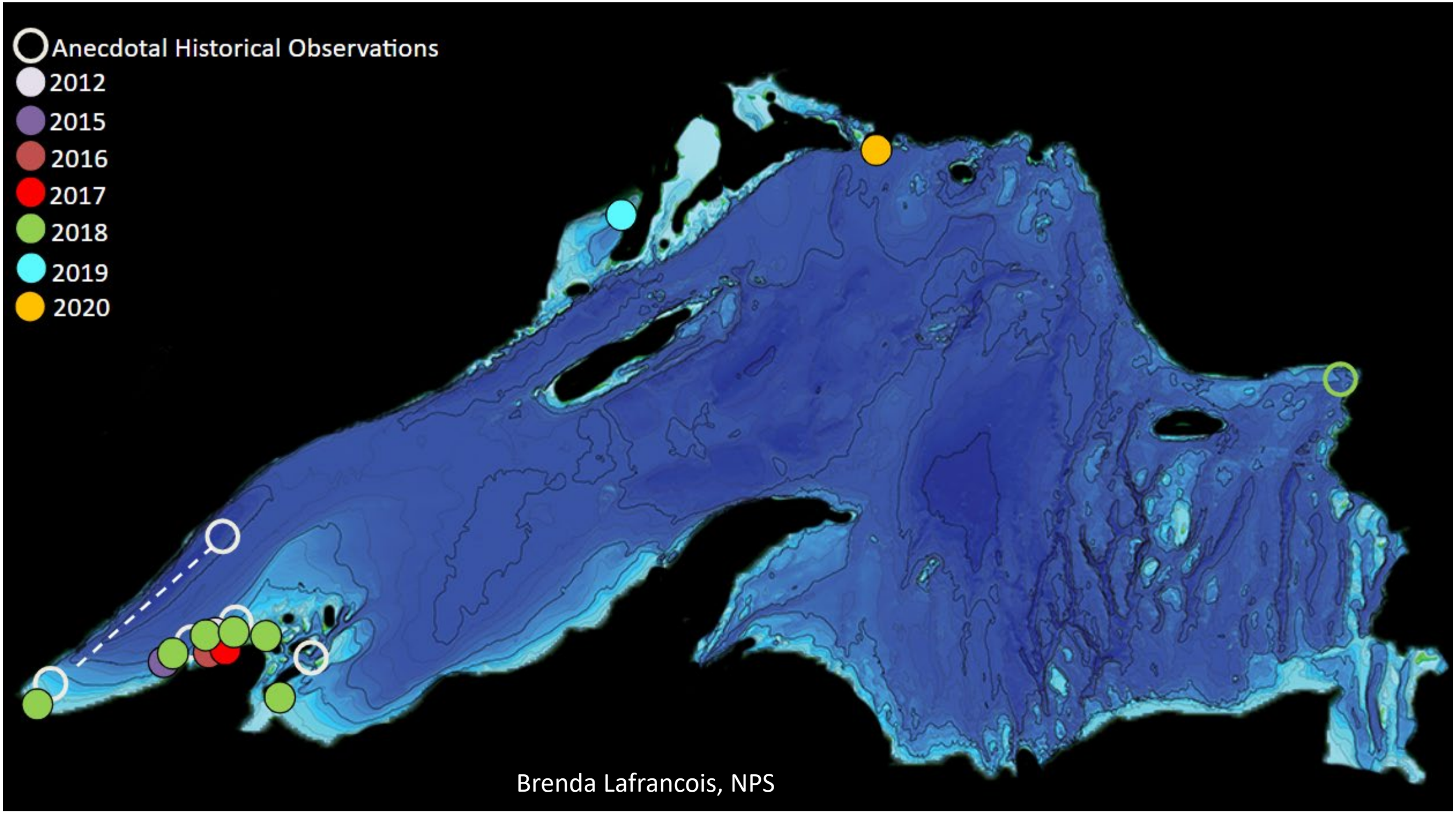
Michele Wheeler, Madeline Magee, Gina LaLiberte (WDNR)

Dawn Perkins (WSLH), Amanda Koch (WDHS)

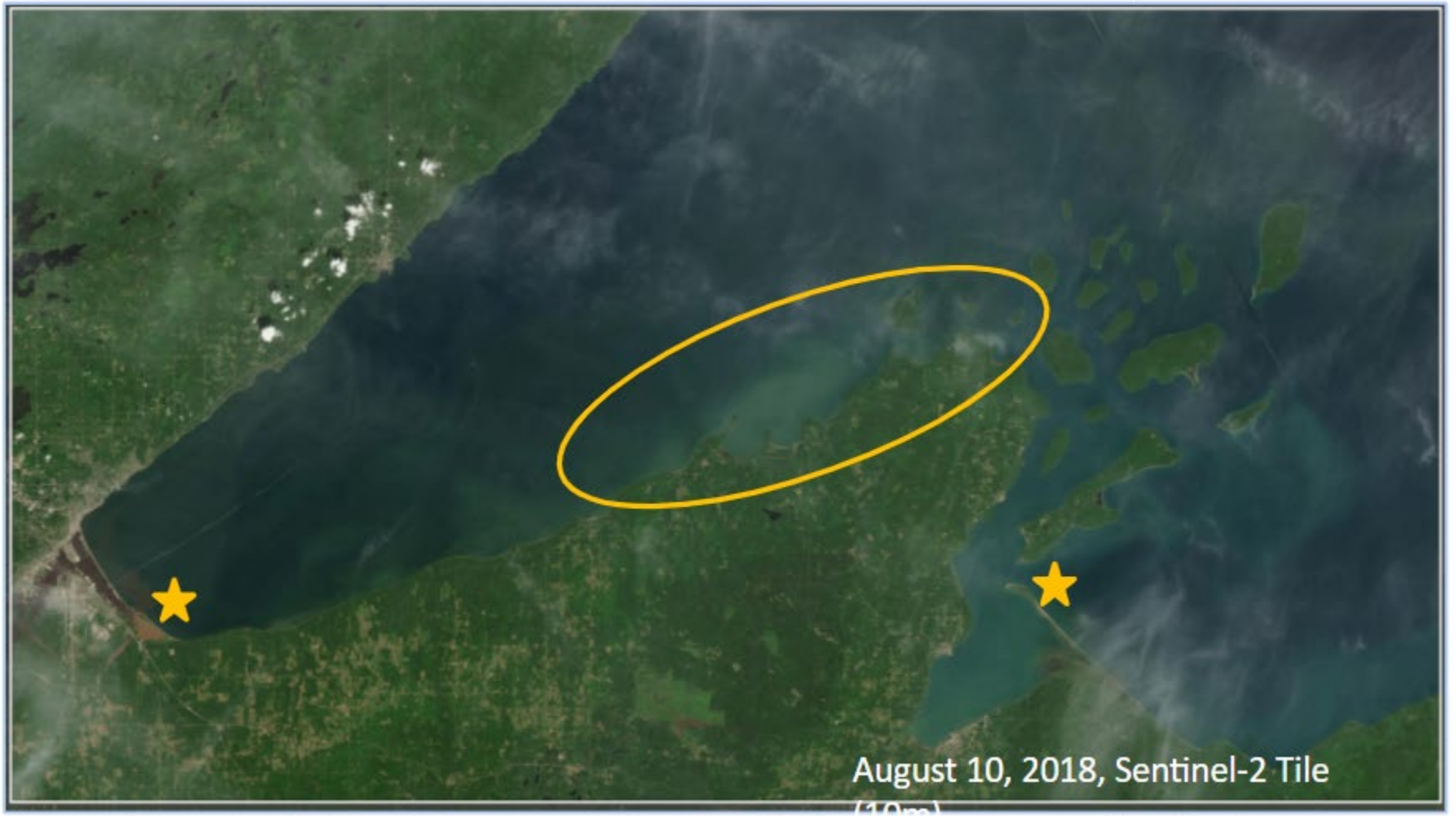
Matt Hudson, Matt Cooper (Northland College)

Nathan Wilson (Lakehead University)

Elizabeth LaPlante (EPA), Amy Thomas (Battelle)


Anecdotal Historical Observations
2012
2015
2016
2017
2018
2019
2020
Brenda Lafrancois, NPS

Largest Lake Superior Bloom – 2018 Spatial Extent



Imagery: Planet Team (2017). Planet Application Program Interface: In Space for Life on Earth. San Francisco, CA. https://api.planet.com

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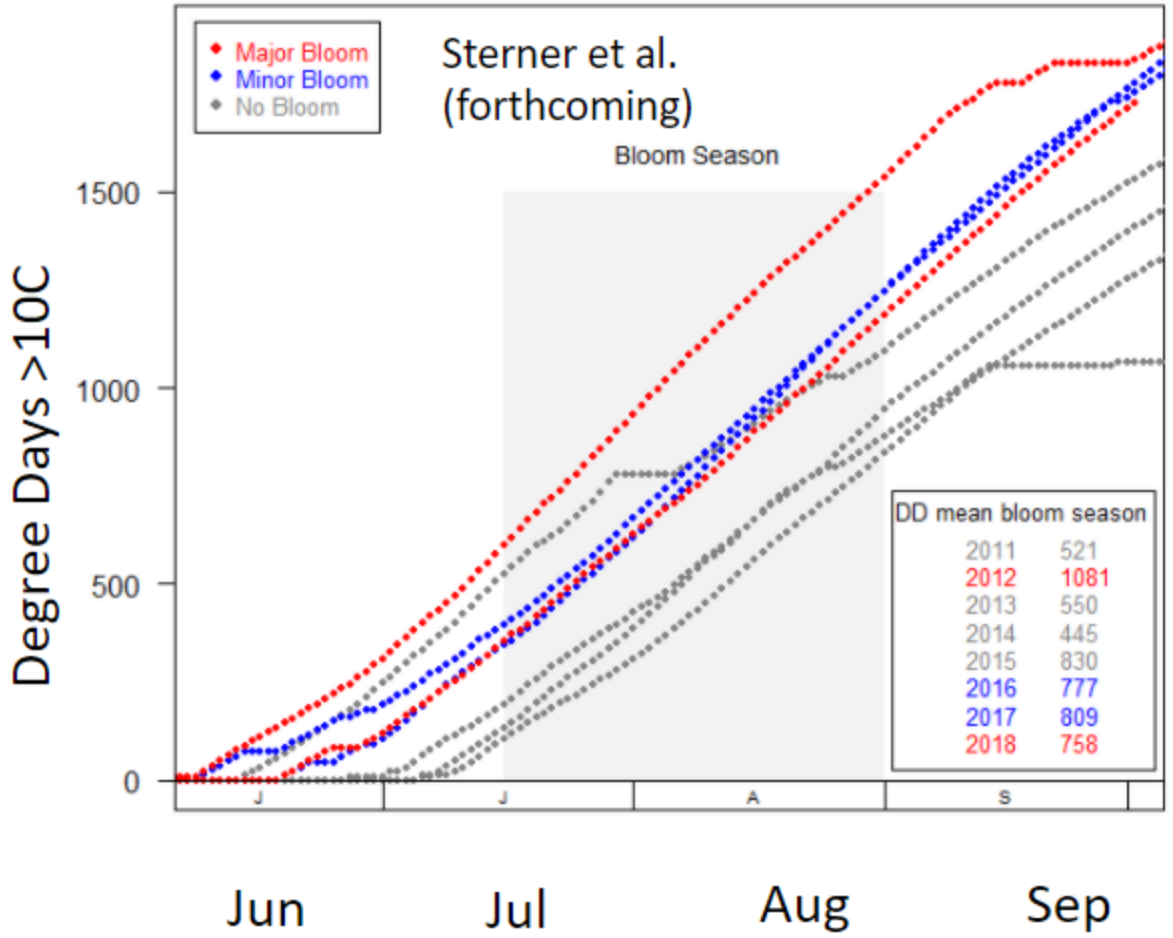
Lake Superior HABs Research – Bloom Drivers

- Biggest blooms happened in warm years
- Biggest blooms followed historic rainfall events (but lagged several weeks)



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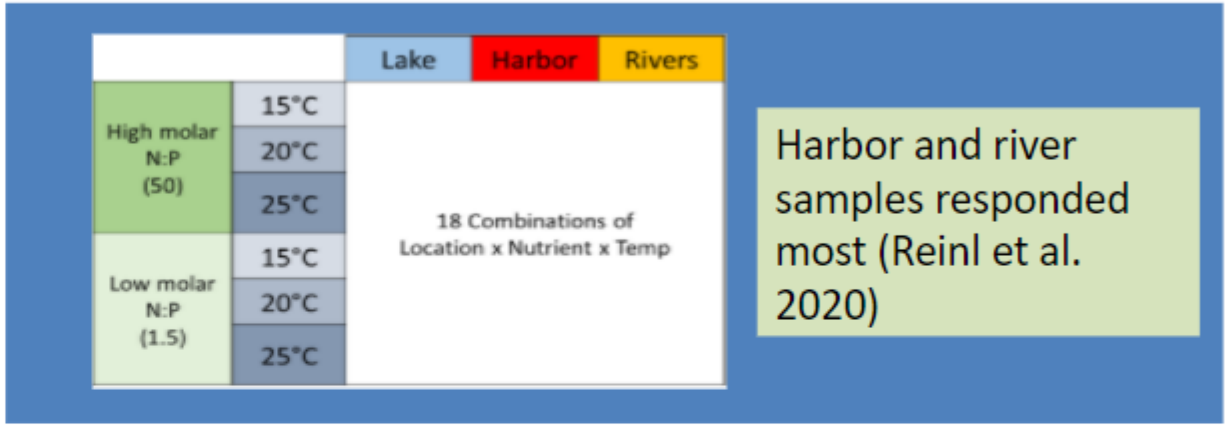
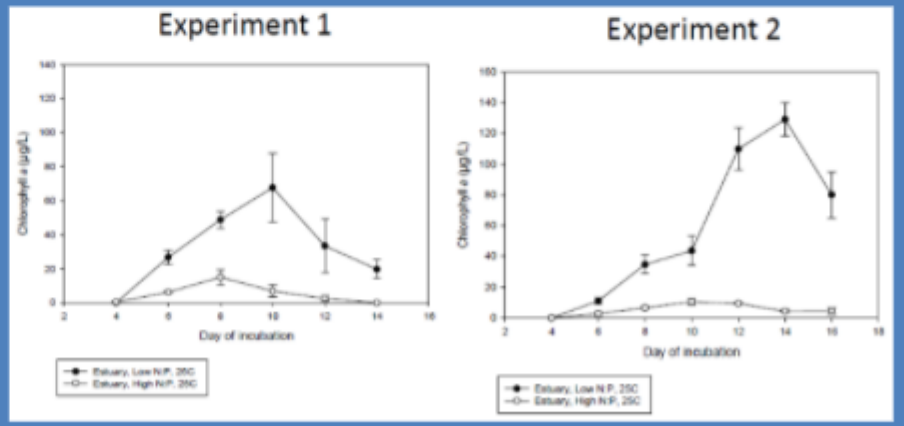
Lake Superior HABs Research – Bloom Drivers

- Experiments by UMD-LLO and Northland College suggest **upland sources**
- Conditions promoting growth include **warm temps and enhanced phosphorus** (low N:P)



Harbor and river samples responded most (Reinl et al. 2020)



Estuary samples responded most (Cooper et al. in prep)

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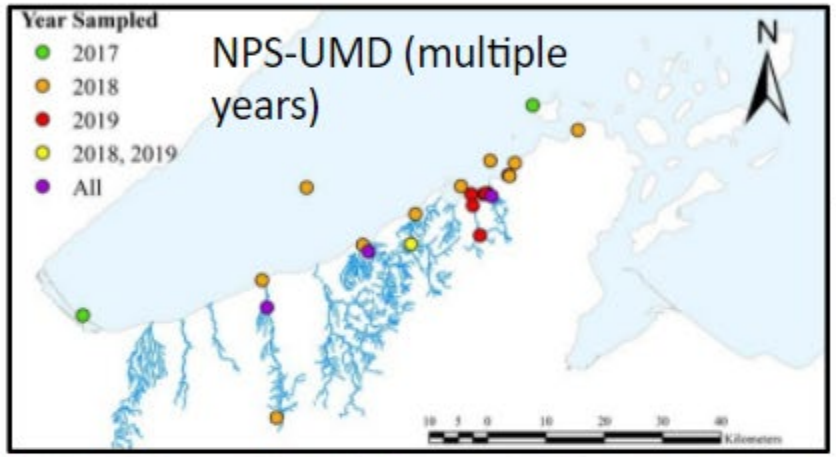
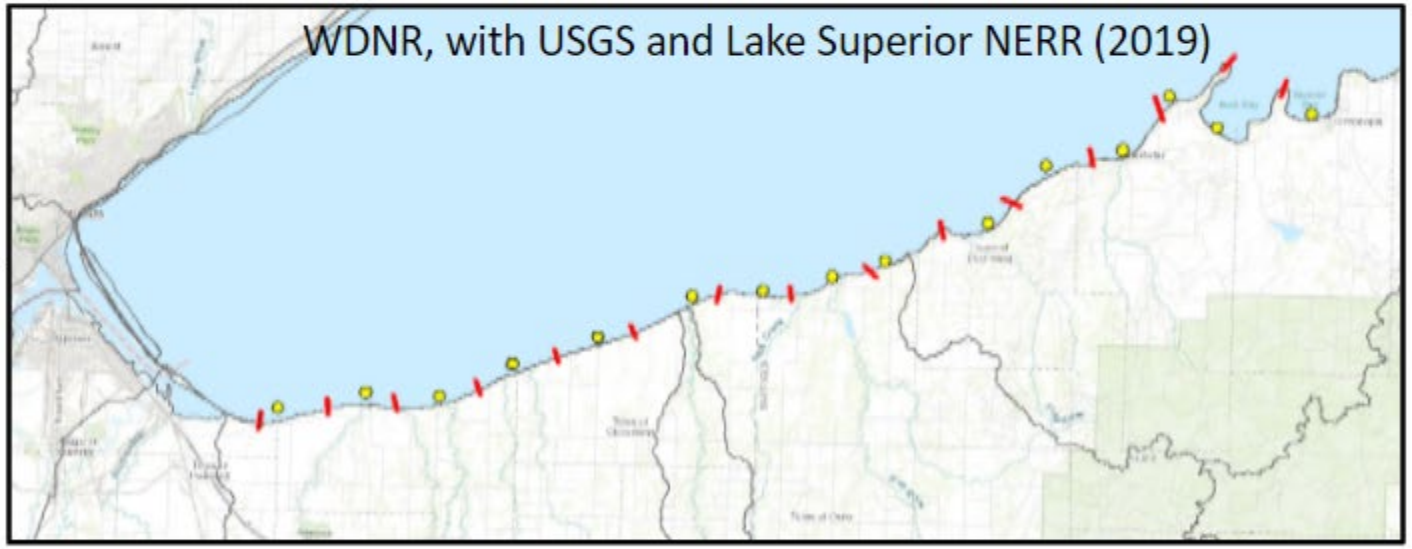
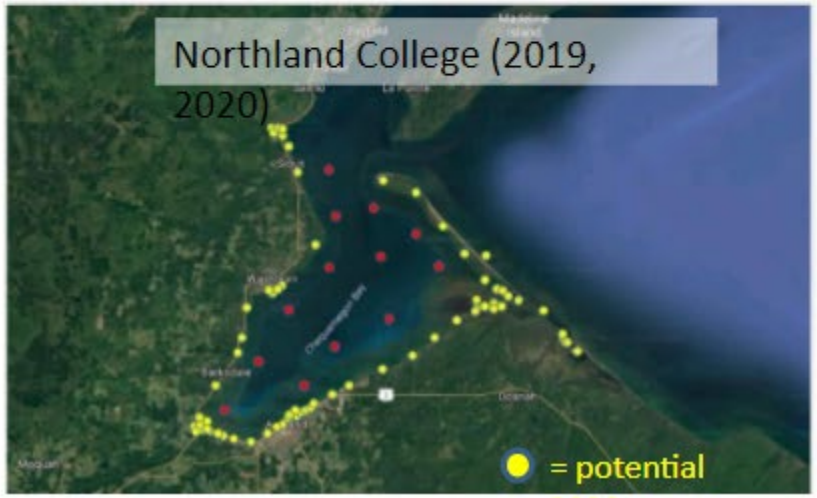
Bloom Monitoring and Response







2020

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Planned work under CSMI

CSMI Monitoring - Big Picture

- Tributary Monitoring
  - Discharge and Water Quality (USGS – Umid)
  - Phosphorus Cycling (USGS – UMESC)
- Nearshore Monitoring
  - Water quality boat-based survey with towable probes (USGS – Paul Reneau)
    - + Sampling + sondes deployed (WI-DNR, Northland College Burke Center)
  - Glider and drifter surveys (EPA)
  - Remote Sensing (EPA)
  - Citizen Science (EPA)
- Microbial Genetics in Open Lake (LLO and EPA)
- Landscape Mgmt Model (VELMA) (EPA, UMD)
- Mechanistic Drivers – Experimental Work (UMD, LLO, NECASC)

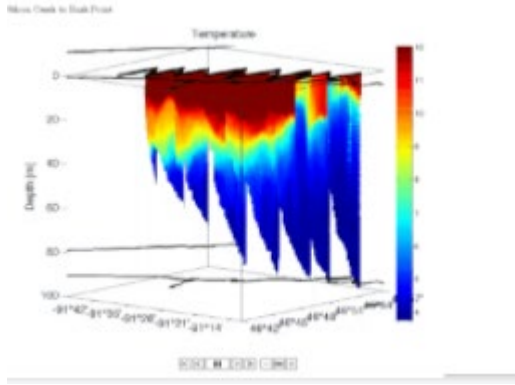
- Data Integration and Synthesis (All)

Tributary Monitoring

- Participants – Richard Keisling, Faith Fitzpatrick, Becky Kreiling, Eric Dantoin, Anna Baker
- Objectives:
  - Event based and baseflow nutrients, sediment and algal monitoring
    - Develop loads, tie in to nearshore bloom response
  - Phosphorus cycling in sediment
    - Look at potential for streambed to store and exchange nutrients
- Locations

Location	What we're adding
Bois Brule at highway 2	Monthly grab sampling, event grab sampling when possible
Bois Brule at highway 13	Fully telemetered gage, ISCO sampler for events, monthly grab sampling, event grab or EWI sampling
Bois Brule at Weir Riffles or Harvey Rd	Monthly grab sampling, event grab sampling when possible
Siskiwit River at Falls Road	Fully telemetered gage, ISCO sampler for events, monthly grab or EWI sampling
Siskiwit River at Siskiwit Lake Rd	Syphon samplers, stage sensor. Monthly grab sampling, event grab sampling when possible

Nearshore Monitoring – Water Quality Surveys

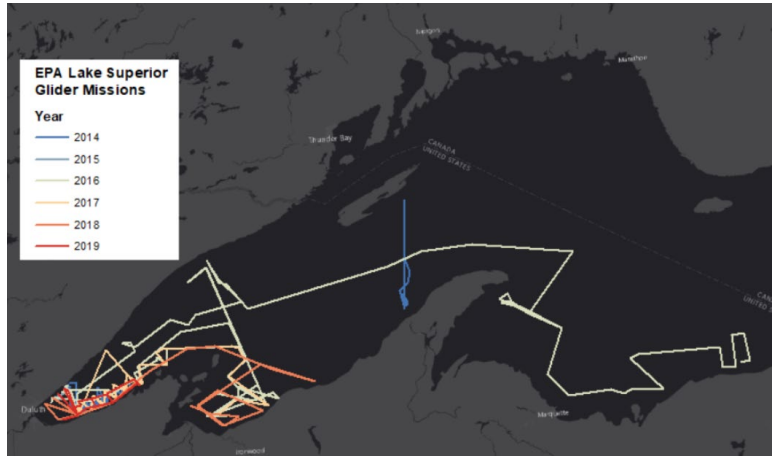


Participants: USGS: Paul Reneau, EPA: Paul Mckinney, Tom Hollenhorst, Aabir Banerji, Joel Hoffman, Terry Brown, Jim Berrill, WDNR: Gina La Liberty, Ellen Cooney

Objectives:

- Water Quality Surveys - Event driven water quality/hydrodynamic survey along south shore, mapping plumes coming from tributaries where possible
    - Parameters: BGA, Chl-a, C-DOM DO, Turbidity, pH, Sp. Cond, Temp, Peak Temp, Water Velocity, Water Direction, and Acoustic Backscatter.

- Gliders – WQ before, during, and after blooms, intersecting blooms to capture gradients of bloom intensity



- Drifters – drift along nearshore to better understand nutrient movements, tributary inputs. Drift with blooms. Explore outreach opportunities "follow the drifter"

Slide content from Paul Reneau and Tom Hollenhorst

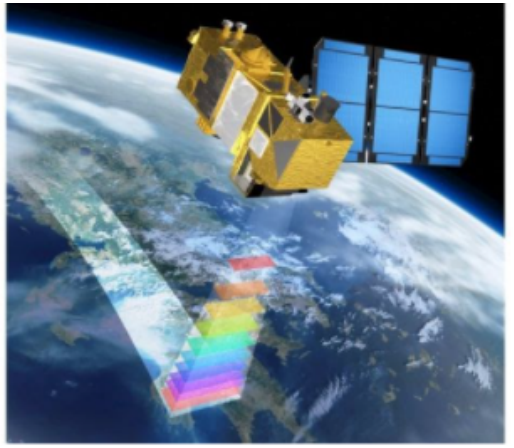
Nearshore Monitoring – Remote Sensing

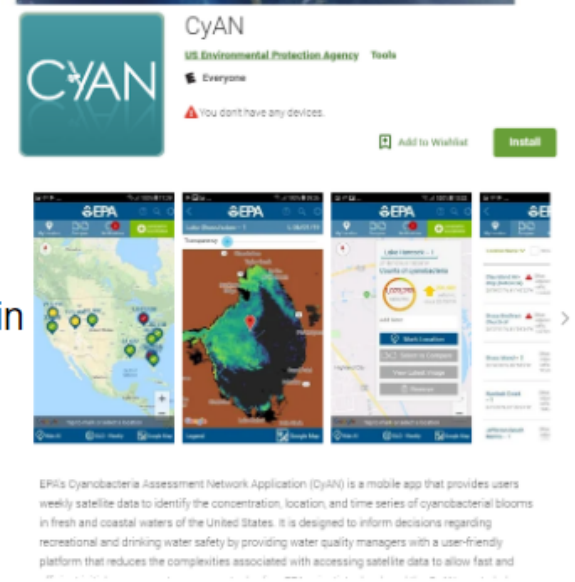
Remote sensing

Participants:
Yet to be determined…. (but I'm interested, as are some other EPA ORD researchers)

Objective(s):

- Employ remotely sensed data to identify past and current algal bloom occurrences
- Also identify and characterize tributary plumes and sediment movements along the shore
- Synchronize in situ sampling with satellite orbits/schedules
- Develop and calibrate algorithms and techniques for classifying HABs using in situ data from gliders, towed arrays, and sampling (EPA ORD scientist).
- Employ remotely sensed data from satellites for adaptive in situ sampling & HABs tracking
  - New imagery
  - CyAN App for Early Detection
  - https://www.epa.gov/water-research/cyanobacteria-assessment-network-cyan





Slide content from Tom Hollenhorst

Nearshore Monitoring – Citizen Science

Citizen Science – CyanoScope Kits, Bloomwatch

Participants: Tom Hollenhorst, Paul Mckinney, Aabir Banerji, Nathan Wilson (LakeHead University), Hilary Snook, others…

Objective(s):

- Employ citizen science for outreach, education and possibly early warnings of blooms
- Deploy ~ 4 CyanoScope kits along the south shore with interested citizen scientist
  Provide training via 1-2 workshops and various demos
- Also engage citizen scientist with new updated bloomwatch app and other notification mechanisms.

bloomWatch
Welcome to bloomWatch!
Crowdsourcing to find and report potential cyanobacteria blooms

cyanoScope
MAPPING CYANOBACTERIA ONE SLIDE AT A TIME

ADD OBSERVATIONS

cyanoScope

iNaturalist

Mapping cyanobacteria one slide at a Time

Genetic Studies – Nearshore and Open Lake

Metabarcoding of Planktonic Microbes

Participants: Aabir Banerji, US EPA GLTED; Carlie LaLone, US EPA GLTED; Erik Pilgrim, US EPA WECD; Sara Okum, US EPA WECD {plus an ORISE person}.

Objective(s):

1. Characterize the microbial community through time via DNA metabarcoding (including cyanobacteria, other bacteria, eukaryotic algae, protozoa, and tiny arthropods).

2. Identify toxic cyanobacteria, algae, or mixotrophic protozoa that form HABs, as well as organisms that promote, inhibit, dissipate, or perpetuate HABs and organisms that benefit or suffer from them.

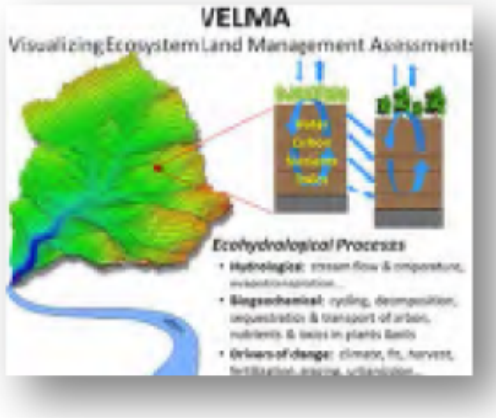
3. Collaborate with this group – how could microbial community data be of use to you?

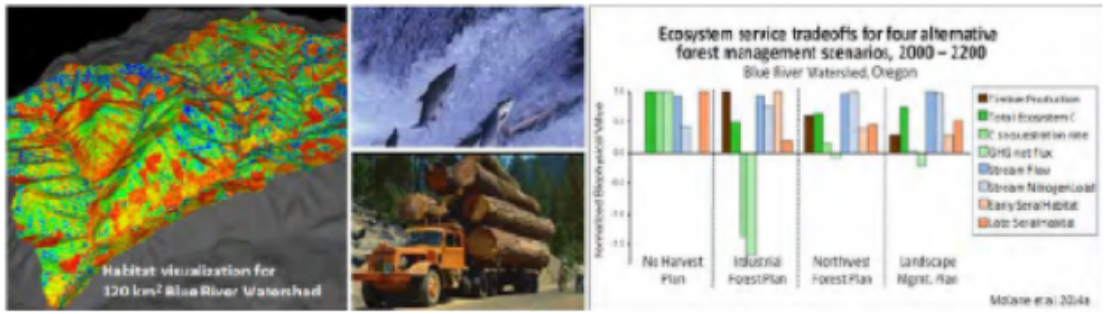
Slide content from Aabir Banerji

Landscape Management Model

What is VELMA?

VELMA predicts the effectiveness of alternative land use and land cover scenarios for protecting stream water quality, and also estimates potential ecosystem services co-benefits and tradeoffs.





Grid size is important

Image:

https://www.epa.gov/water-research/visualizing-ecosystem-land-management-assessments-velma-model-20

Participants: Chris Filstrup, Joel Hoffman, U-M grad student, Bob McKane, Jonathan Halama

Slide content from Joel Hoffman

Mechanistic Drivers

- Participants – UMD/LLO: Bob Sterner, Kait Reinl, NECASC: Hillary Dougan and others

Experimental study on Akinetes

Participants: Kait Reinl (UMD) in collaboration with EPA

Objective(s): Akinetes are typically present in L.Superior blooms. These experiments will be used to to determine conditions for germination of akinetes to better understand how this life cycle stage contributes to blooms.

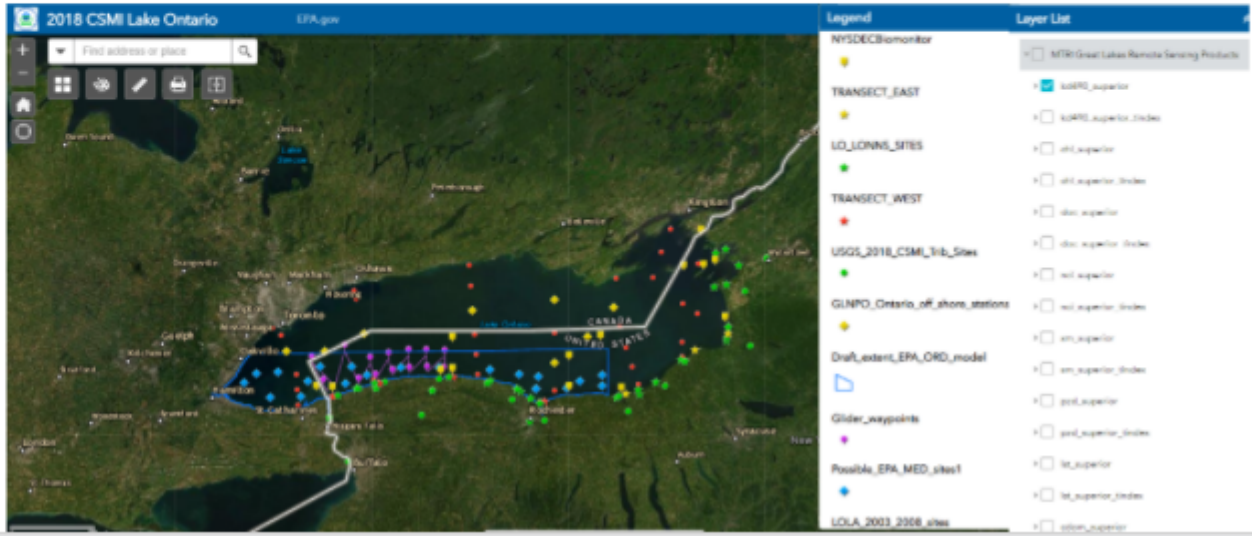
- NECASC/LLO collaboration – sediment cores for age and algal history in Lake Superior and inland headwaters lake in bloom area

Slide content from Kait Reinl

Data Synthesis and Integration

Objective(s):

- Develop a platform for data integration, synthesis and sharing (across agencies & institutions)
- From the above also incorporate other additional relevant information
  - Weather, wind, waves (real time buoy data)
  - Surface water temp (from satellites)
  - Accumulated growing degree days
- Use for planning & adaptive sampling
- Data visualization



- Entire team will be involved – but also talked about needing a steward/champion for data synthesis

Slide content from Tom Hollenhorst

Subgroups

- Nearshore - Paul Reneau, USGS
  - Water Quality Monitoring – Ellen Cooney, WI DNR
  - Remote Sensing – Tom Hollenhorst, EPA
  - Hydrodynamics – Chin Wu, UW-Madison
  - Microbes – Aabir Banerji, EPA
- Data Management and Integration – Kait Reinl, UMD-LLO
- Tributary Monitoring and Modeling – Anna Baker, USGS