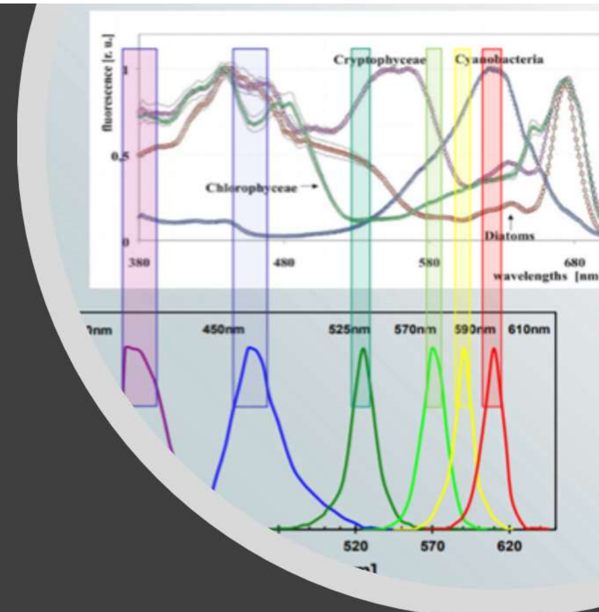
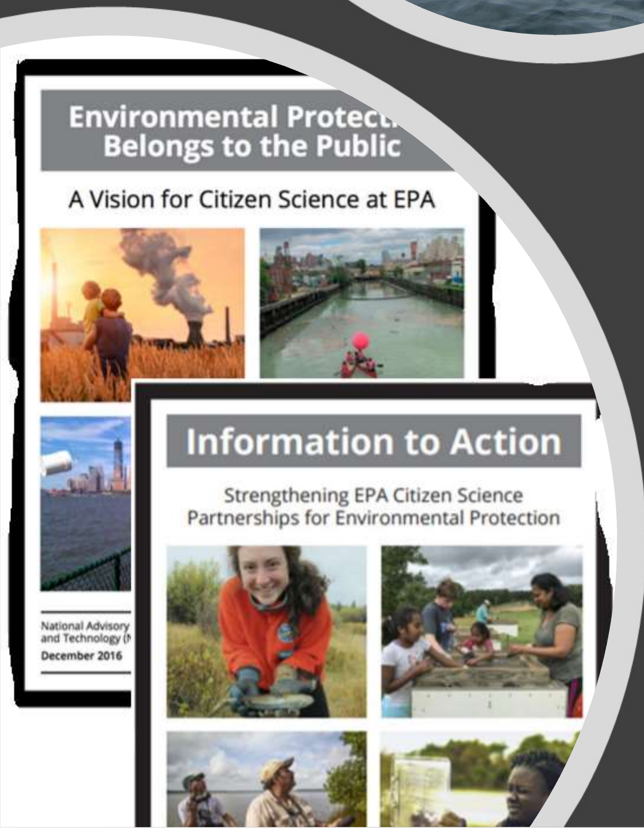
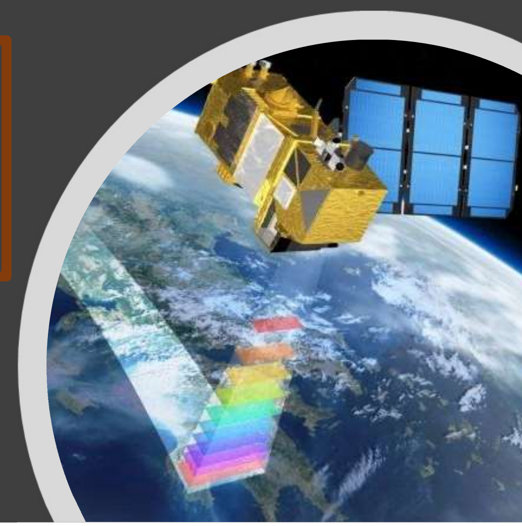




Great Lakes Monitoring
The Next Generation..

Robots, Sensors, Satellites and You!



But first let’s look back…

Don't know your past,
don't know your future….
(Ziggy Marley – “Tomorrow’s People”)

Early Studies of Lake Superior Nutrients, Productivity and Currents 1956-1961

Lake Superior investigations 1950s

In 1956 the Minnesota Department of Health asked the School of Public Health of the University of Minnesota to conduct a limnological study of Lake Superior.

The original planning of the project was conducted in conference with individuals now widely recognized as early leaders in the fields Limnology, Oceanography and Environmental Health. These included:

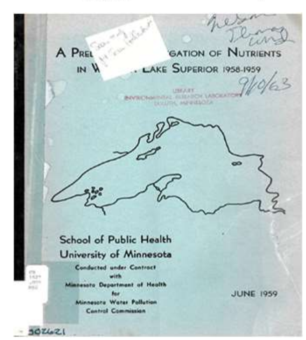
Dr. Athelstan Spilhaus, founder of SeaGrant,
Dr. Gaylord W. Anderson, the first dean of the UMN Scool of Public Health, and
Dr. Alfred C. Redfield, of Woods Hole Oceanographic Institute and the discoverer of the Redfield ratio (which describes the ratio between nutrients in plankton and ocean water).

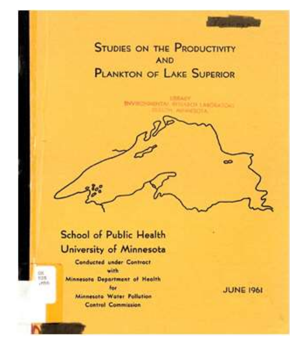
Dr. Redfield acted as a consultant to the project and provided a detailed memorandum regarding the development of a limnological institution for the continuous long-term study of Lake Superior.

Dr. Theron O. Odlaug, founding member of the Unversity of MN Department of Biology also prepared a bibliography and abstracts of Great Lakes literature extending as far back as 1829.

Athelstan Spilhaus in his office at the University of Minnesota (photo courtesy of Sharon Moen)


Plate 1. Dr. A. C. Redfield who has acted as the consultant since the beginning of the project.





For release on receipt

UMD NEWS SERVICE
July 28, 1960
RA 4-8801 Ext 210

DULUTH--The sketchy personality of Lake Superior is coming to light as a result of research by University of Minnesota scientists and their associates.

Working out of UMD's (University of Minnesota, Duluth) Lake Superior Research Station -- a converted fish hatchery on the Duluth shoreline -- they study the western portion of the lake right on its doorstep.

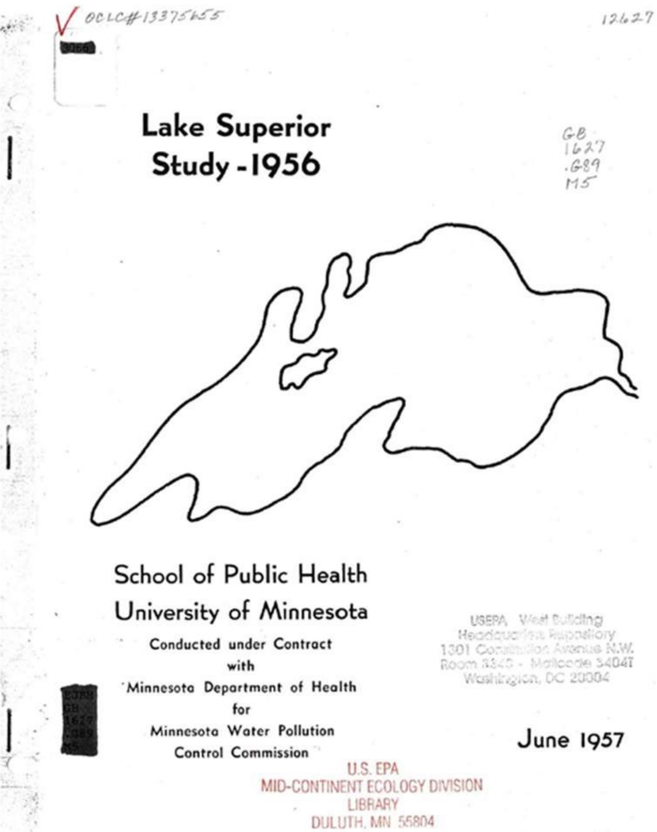
In the group are Dr. Theron O. Odlaug, head of biology at UMD and two UMD students from Duluth, John Odell and James Marshall.

Heading project work this fifth summer of the study is Hugh D. Putnam, research fellow in the University's School of Public Health, Minneapolis. Orlando R. Ruschmeyer, instructor in the School, has completed two years as chief and is again working with the group.

Limnological (fresh water) research was begun in 1956 by the School of Public Health, under contract with the Minnesota Department of Health for the state Water Pollution Control Commission.

First years of the project were spent studying surface currents and water temperatures of Lake Superior. Thousands of soda-like bottles

Other properties of the lake were charted with oceanographic instruments -- some of them resembling torpedos and other military equipment. In 1958, a preliminary investigation of nutrients or chemical content of the water was begun.



Lake Superior
Study - 1956

School of Public Health
University of Minnesota
Conducted under Contract
with
Minnesota Department of Health
for
Minnesota Water Pollution
Control Commission

June 1957

Lake Superior Studies - (est. 1956)

- Released 1,000 bottle drifters (32% returned)
- Collected hundreds of bathythermograph profiles in July, August and Sept. along transects from Duluth to Grand Marais.
- Remodeled former fisheries building into Lake Superior Research Station

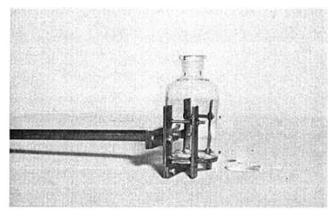
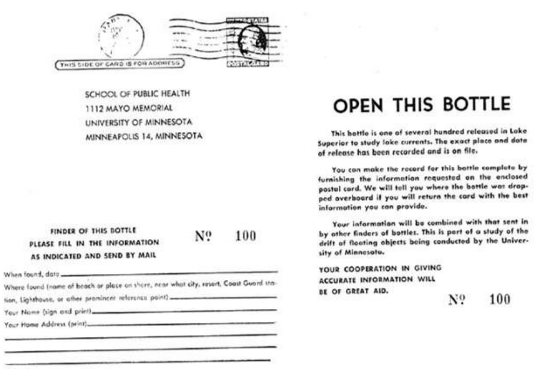


Figure 8 Sampling Device Used for Collection of Surface Water.

Water Movement and Temperatures of Western Lake Superior - 1957

- Released 5,000 more bottle drifters over several months (27% returned).
- Acquired additional equipment including 7 bathythermographs (used to collect more than 300 temperature profiles along cross lake transects).
- Integrated bottle drifter data and temperature profiles for Dynamic Height calculations for surface currents



THIS SIDE OF CARD IS FOR ADDRESS

SCHOOL OF PUBLIC HEALTH
1112 MAYO MEMORIAL
UNIVERSITY OF MINNESOTA
MINNEAPOLIS 14, MINNESOTA

FINDER OF THIS BOTTLE
PLEASE FILL IN THE INFORMATION
AS INDICATED AND SEND BY MAIL

№ 100

When found, date ______
Where found (name of beach or place on shore, near what city, resort, Coast Guard station, Lighthouse, or other prominent reference point) ______
Your Name (sign and print) ______
Your Home Address (print) ______

OPEN THIS BOTTLE

This bottle is one of several hundred released in Lake Superior to study lake currents. The exact place and date of release has been recorded and is on file.

You can make the record for this bottle complete by furnishing the information requested on the enclosed postal card. We will tell you where the bottle was dropped overboard if you will return the card with the best information you can provide.

Your information will be combined with that sent in by other finders of bottles. This is part of a study of the drift of floating objects being conducted by the University of Minnesota.

YOUR COOPERATION IN GIVING ACCURATE INFORMATION WILL BE OF GREAT AID.

№ 100

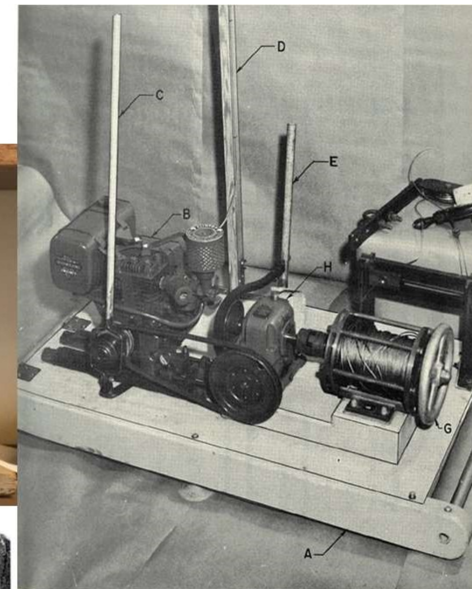


Plate 4. Portable power winch for small boat operation. Designed by T. A. Olson and T. O. Odlaug (manuscript in preparation). A. Wooden base. B. Three h.p., aluminum alloy, gasoline engine. C. V-belt assembly. D. Engine throttle. E. Brake on differential. H. Gear reduction box. G. Winch clutch and brake. F. Manual "level-wind."

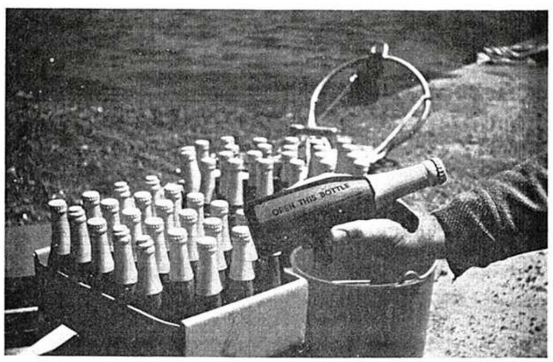


Figure 2 Completed Drift Bottles as Used for Lake Superior Studies.

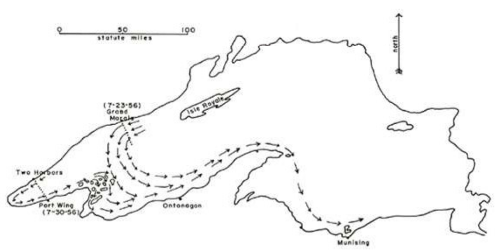


FIGURE I SURFACE CURRENTS IN WESTERN LAKE SUPERIOR AS SUGGESTED BY BATHYTHERMOGRAPH AND DRIFT BOTTLE STUDIES

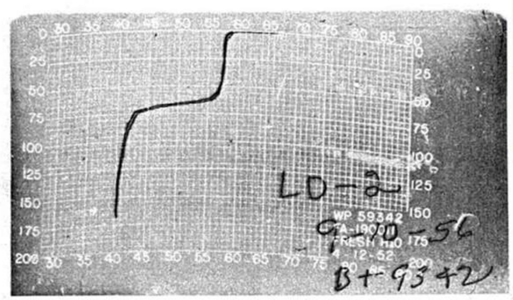


Figure 16. Bathythermograph record in the deeper water off Lakewood Water Station indicates a well defined thermocline on September 10, 1956.

An Investigation of Nutrients in Western Lake Superior - 1960

- Sampled 11 tributaries for nutrients and WQ
- Sampled along transects from Duluth to Grand Marais
- Also sampled for turbidity, chlorophyll, bacteria and radioactivity.

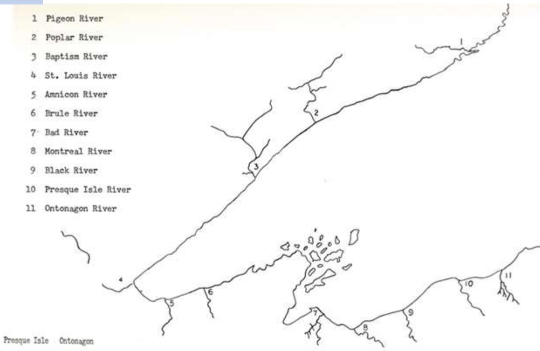


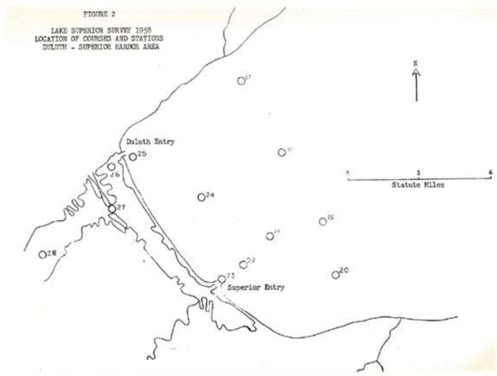
FIGURE 3 TRIBUTARY STREAMS UNDER INVESTIGATION IN 1958

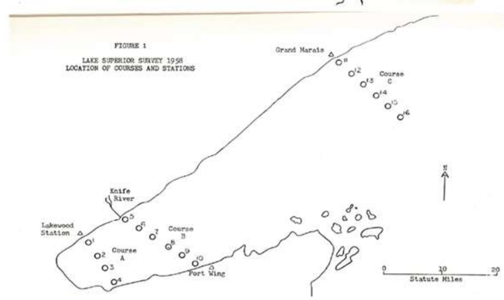
Table XVI

...nt Input to Lake Superior

...ns for August and September 1958

	Mo.	Pigeon	Poplar	Baptism	St. Louis	Brule	Bad	Montreal	Black	Presque Isle	Ontonagon
Nitrate	8	0.7	0.5	2	43	1	10	8	2	3	6
	9	7.8	2	4	88	0.6	8	9	2	1	9
Total Nitrogen	8	1	0.5	7	123	2	20	13	8	9	16
	9	20	2	13	206	6	40	35	15	7	39
Silica	8	22	7	62	686	115	199	102	48	92	270
	9	113	24	116	2,111	143	507	315	98	84	429
Phosphorus	8	0.2	0.4	0.4	3	0.6	1	0.7	0.2	0.6	1
	9	0.9	0.4	0.4	15	1	0.2	0.4	1	3	0.5
Sulfate	8	9.0	2	12	485	16	47	40	13	17	60
	9	95	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]



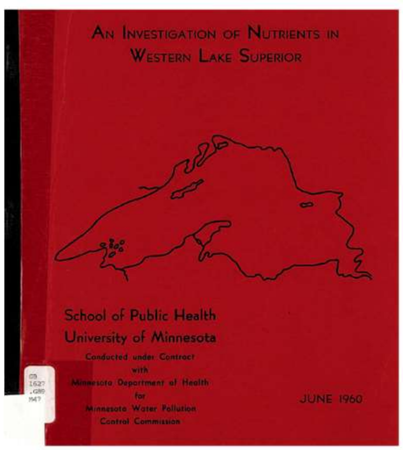


Mean Monthly Discharge Rates of

Tributary Streams Sampled in 1958

Stream	Mean	1	2	3	4	5	6	7	8	9	10	11	12
Pigeon	9 yr mean	142	133	139	1120	1858	844	412	316	281	339	268	180
	1958 mean	91	89	93	422	222	130	78	65	327	111	165	105
Poplar	6 yr mean	35	32	35	224	323	178	88	48	49	49	59	46
	1958 mean	37	27	28	97	55	64	40	17	56	56	78	47
Baptism	9 yr mean	29	24	29	559	598	260	122	87	125	147	99	48
	1958 mean	21	16	22	191	95	152	126	114	214	53	116	37
St. Louis	8 yr mean	421	419	696	8947	5150	3466	3606	2505	2387	1530	1291	685
	1958 mean	278	410	641	2243	1105	3648	5338	1207	3900	935	1410	405
Brule	9 yr mean	138	140	148	300	268	230	225	167	169	157	165	152
	1958 mean	142	138	140	193	140	151	266	151	210	141	171	148
Bad	9 yr mean	182	166	401	2453	1459	948	808	438	350	333	468	323
	1958 mean	181	163	310	1324	268	176	1225	378	834	131	354	268
Montreal	9 yr mean	197	182	244	1052	639	355	355	254	258	202	237	211
	1958 mean	193	161	190	824	176	164	299	219	590	100	211	166
Black	4 yr mean	75	61	91	1078	282	118	142	154	149	197	200	118
	1958 mean	68	74	120	951	110	73	286	124	220	59	199	102
Presque Isle	9 yr mean	163	165	243	1261	676	467	429	200	154	242	314	222
	1958 mean	678	776	938	3576	966	1025	1513	200	154	531	1114	751
Ontonagon	9 yr mean	800	817	1185	4640	2352	1791	1475	1103	973	1048	1115	923
	1958 mean	699	792	1032	3443	931	990	1551	554	761	551	1143	783

(discharge rates are in cubic feet per second)

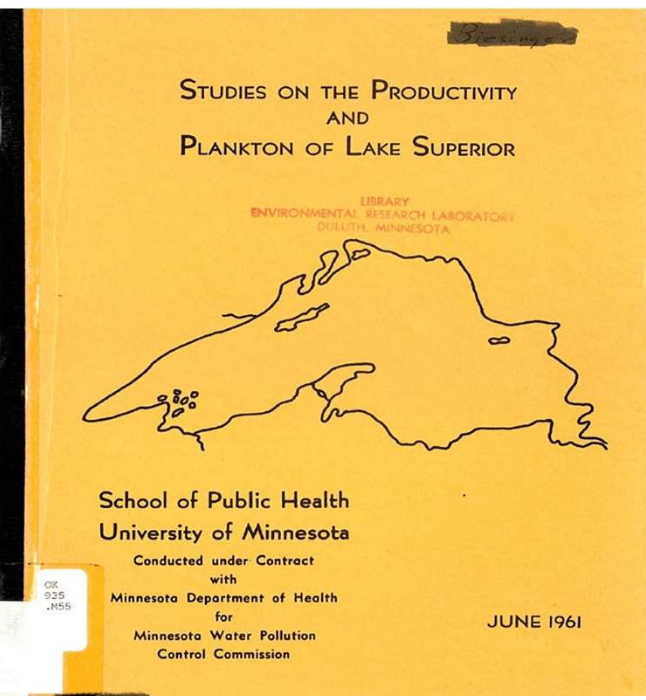


Studies on the Productivity and Plankton of Lake Superior 1961

- Primary objectives of the program involved a preliminary investigation of the standing crop of plankton organisms
- An attempt to evaluate the primary production of the lake.
- Measurements pertaining to the chlorophyll content and photosynthetic activity of the phytoplankton community.

Secondary objectives included investigations of phenomena of concern:

- Fish net slime (diatom algae communities)
- Green Water near Silver Bay (possibly associated with taconite waste).



The university's 1103 electronic computer was used for calculating dynamic heights from the bathythermograph data

1955 ERA 1103 Computer
Master Console
by
"Engineering Research Associates"

later marketed by Remington Rand
as the
UNIVAC 1103 Scientific Computer

Memorandum on the Limnology of Minnesota by Alfred C. Redfield

- Alfred C. Redfield, senior oceanographer of the Woods Hole Oceanographic Institute, acted as a consultant and adviser for the length of the project and provided a detailed memo regarding the development of an institute at the University.

The staff of a first class institute of limnology should contain leaders with support for effective work in the following departments:

1. Hydrography - which deals with the physical movement of water and which include the general circulation, the action of waves as erosive agents, etc.

2. Climatology and Meteorology - which deal with the principal agencies responsible for supplying the natural water initially and modifying from time to time its behavior.

3. Chemistry - which provides the techniques of examining the qualities of water and tracing the sources of the components on which these qualities depend.

4. Geology - which deals with the sedimentary deposits, their origin and behavior.

5. Biology - which is concerned equally with the production and control of fish and other life, both desirable and undesirable, and including particularly the microbiology involved in contamination by sewage.

Plate 1. Dr. A. C. Redfield who has acted as the consultant since the beginning of the project.

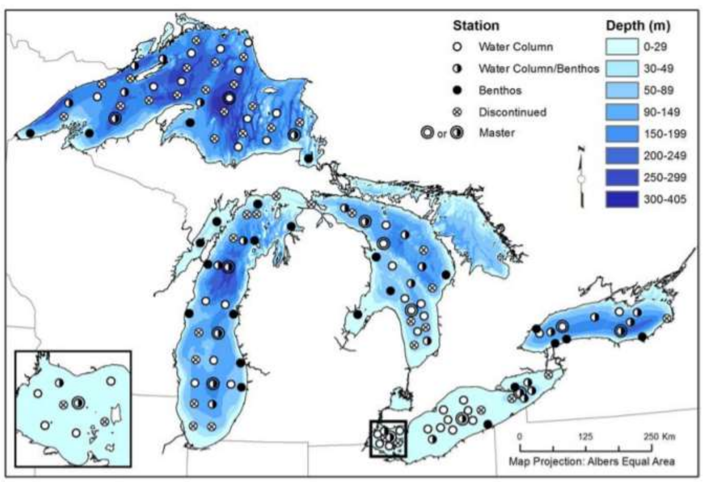


Fig. 2. Map of GLNPO water quality survey long-term monitoring stations from 1983–present. Inset shows stations in the western basin of Lake E

Journal of Great Lakes Research 44 (2018) 539–546

Contents lists available at ScienceDirect

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journal homepage: www.elsevier.com/locate/jglr

Commentary

A brief history of the U.S. EPA Great Lakes National Program Office's water quality survey

Richard P. Barbiero[a,*], Barry M. Lesht[b], Elizabeth K. Hinchey[c], Todd G. Nettesheim[c]

[a] GDIT, 1359 W. Elmdale Ave. Suite 2, Chicago, IL 60660, USA
[b] GDIT and Department of Earth and Environmental Sciences, University of Illinois at Chicago, 845 W. Taylor St., Chicago, IL 60607, USA
[c] U.S. EPA Great Lakes National Program Office, 77 W. Jackson Boulevard, Chicago, IL 60604, USA

- “The U.S. Environmental Protection Agency Great Lakes National Program Office (GLNPO) water quality survey (WQS) constitutes the longest-running, most extensive monitoring of water quality and the lower trophic level biota of the Laurentian Great Lakes and has been instrumental in tracking shifts in nutrients and the lower food web over the past several decades.“

- “The initial impetus for regular monitoring of the Great Lakes was provided by the 1972 Great Lakes Water Quality Agreement (GLWQA) which asked the parties to develop monitoring and surveillance programs to ensure compliance with the goals of the agreement.”

- “The resulting monitoring plan, eventually known as the Great Lakes International Surveillance Plan (GLISP), envisioned a nine-year rotation of intensive surveys of the five lakes. A broadening of the scope of the GLWQA in 1978 and the completion of the first nine-year cycle of sampling, prompted reappraisals of the GLISP. During this pause, and using knowledge gained from GLISP, GLNPO initiated an annual WQS with the narrower focus of tracking water quality changes and plankton communities in the offshore waters of the lakes. Beginning in 1983 with lakes [illegible] Huron, and Michigan, the WQS added Lake Ontario in 1986 and Lake Superi[illegible] into its current form in which all five lakes are sampled twice [illegible]

- “The WQS is unique in that all five lakes are sampled by one [illegible] and one principal laboratory for each parameter group, and represen[illegible] resource for managing and understanding the Great Lakes.”

“Winter surveys were also conducted, by helicopter, to enable parameter estimates relatively free from influences of biological activity and tributary loadings.”

Other Great Lakes Monitoring

https://www.epa.gov/national-aquatic-resource-surveys

- EPA OW National Aquatic Resource Surveys
  - National Coastal Condition Assessment (Great Lakes)
  - National Wetland Condition Assessment (Midwest), National Rivers and Streams Assessment (NRSA), National Lakes Assessment
- University efforts, and more..

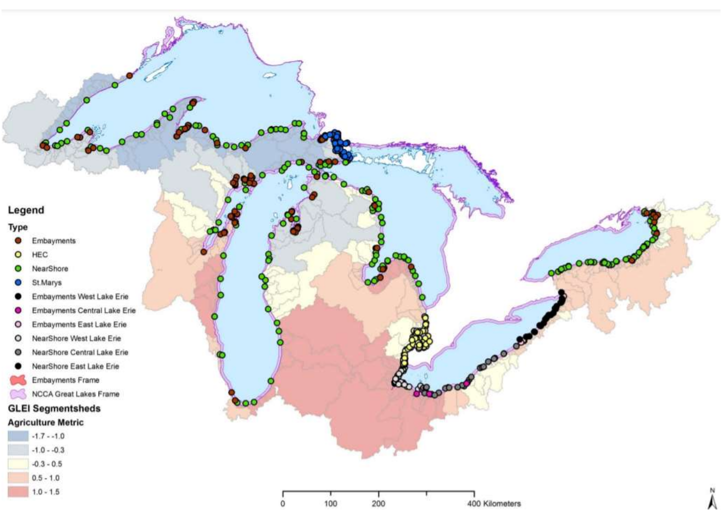
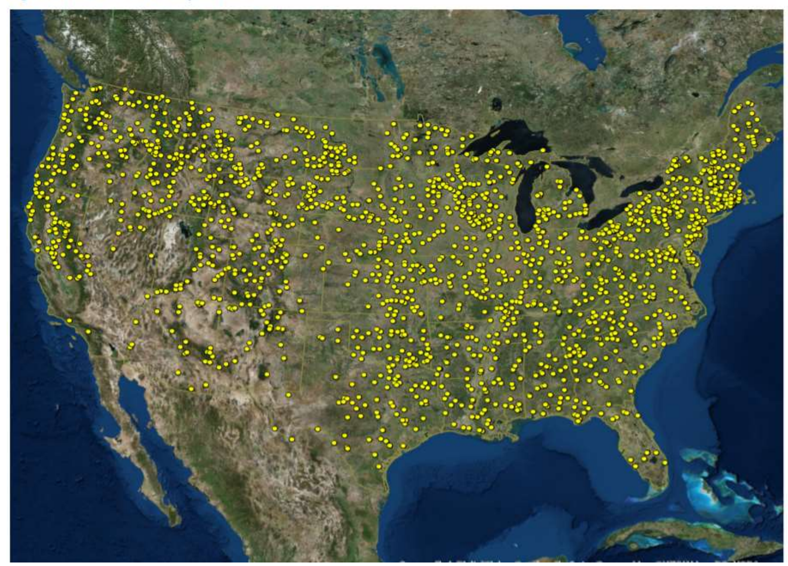
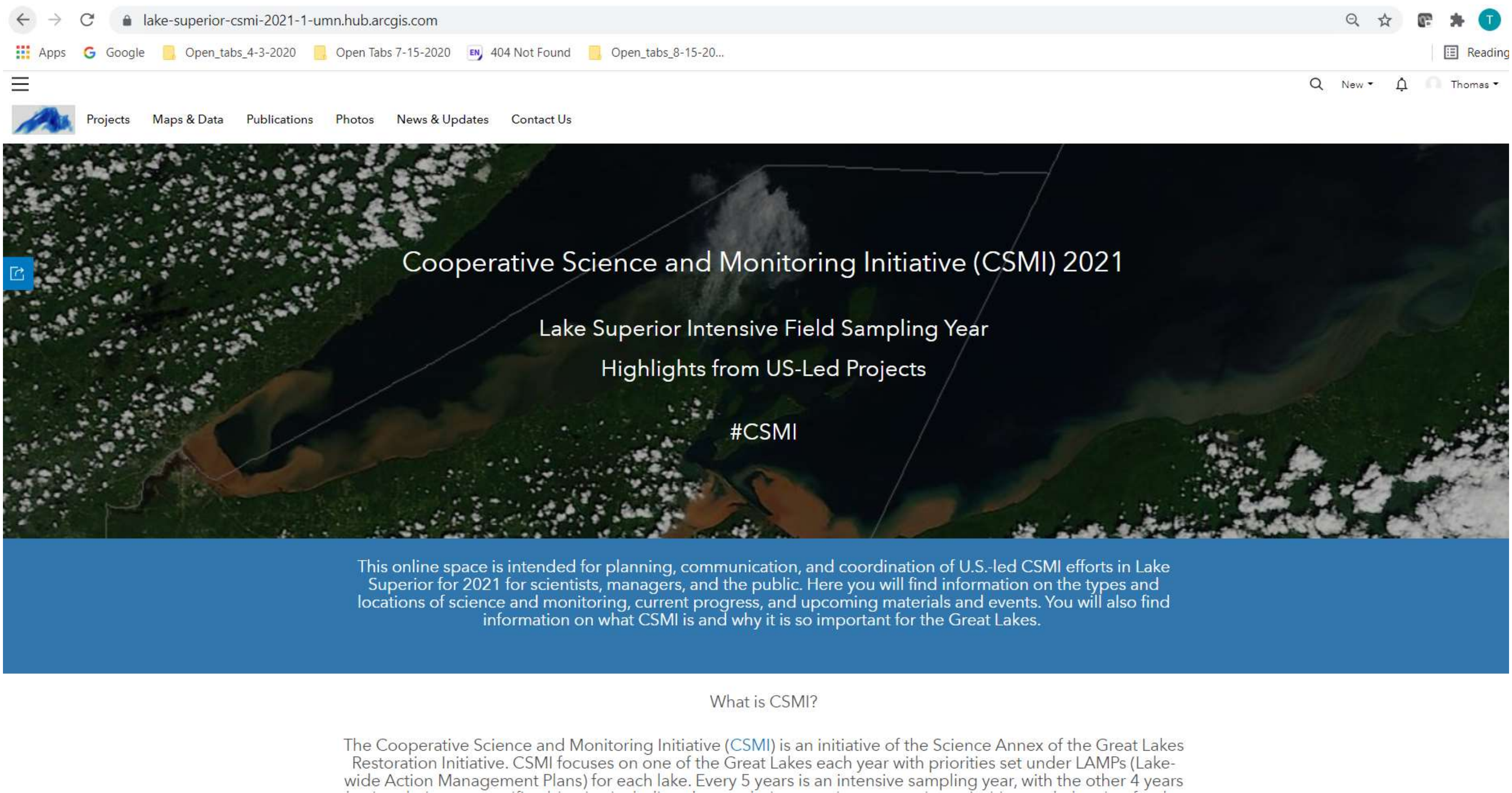


Figure 2.1 NRSA 2013–14 Sampled Sites



Other Great Lakes Monitoring (cont.)



Interagency Team

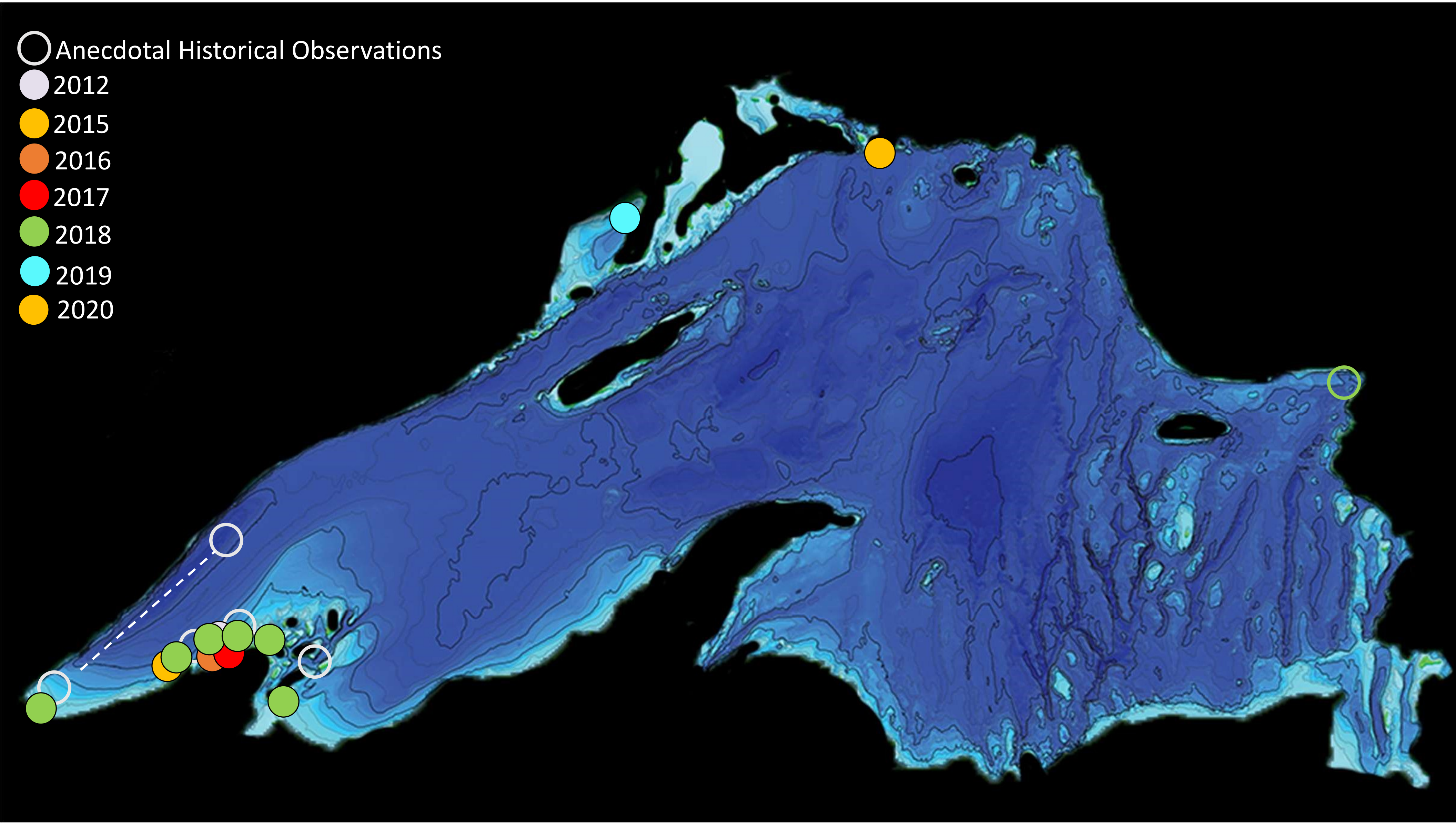
- NPS
- UMD (LLO and NRRI)
- EPA (ORD, GLTED, GLNPO)
- Northland College Burke Center
- WI- DNR
- USGS (UMid and UMESC)
- Lakehead University
- UW-Madison
- Purdue University Ohio Sea Grant

Highlights from US-Led Lake Superior CSMI 2021 Projects

- Lake Superior Multi-Trophic Level Assessment
  - Lake-wide surveys for water quality including chemistry, benthos, and phytoplankton are a staple of CSMI and help understand the current health of Lake Superior and provide a longer-term record to observe changes over time.
- Food web Assessment
  - Describe the status and trend of major species across multiple trophic levels
- Lake Superior CSMI Lake-wide Benthos Survey
- Habitat Assessments
  - of species and their habitats both in Lake Superior and in the surrounding watershed.
- Estimating groundwater contributions to Lake Superior: Data assimilation and evaluation of baseflow patterns
- Effects of Water Level Fluctuations on Protecting Lake Superior's Coastal Wetlands
- Cyanobacterial Blooms and Monitoring
- Autonomous Underwater Glider Transects
- Autonomous Drifter Experiments
- South Shore (near shore)Water Quality Survey – Continuous sensor tows
- Metabarcoding of Planktonic Microbes - Characterize the microbial community through time via DNA metabarcoding
- Tributary Water Quality Sampling
- Phosphorus Cycling
- Wateshed Modeling - Landscape management affecting South Shore stream function
- Remote Sensing - Develop and calibrate algorithms and techniques for classifying HABs using *in situ* data from gliders, towed arrays, and sampling
- Citizen Science - Employ citizen science for outreach, education and possibly early warnings of blooms

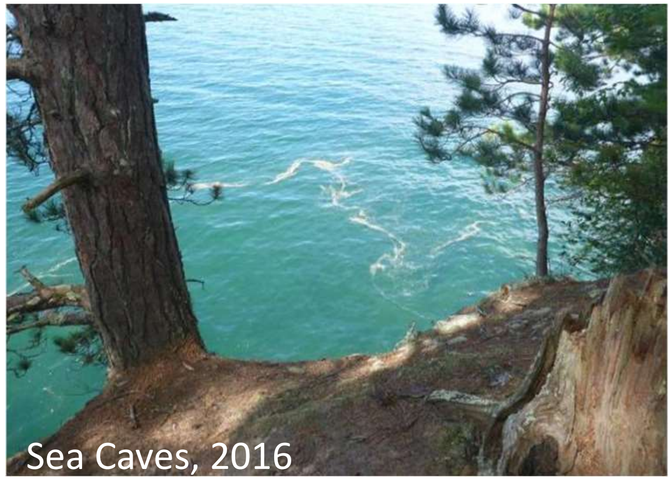
Overview of Lake Superior cyanobacterial bloom findings to date

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

Lake Superior Blooms – South Shore Observations


Sea Caves, 2017


Sea Caves, 2016


Little Sand Bay, 2018 (NPS photo)


Meyers Beach, 2016

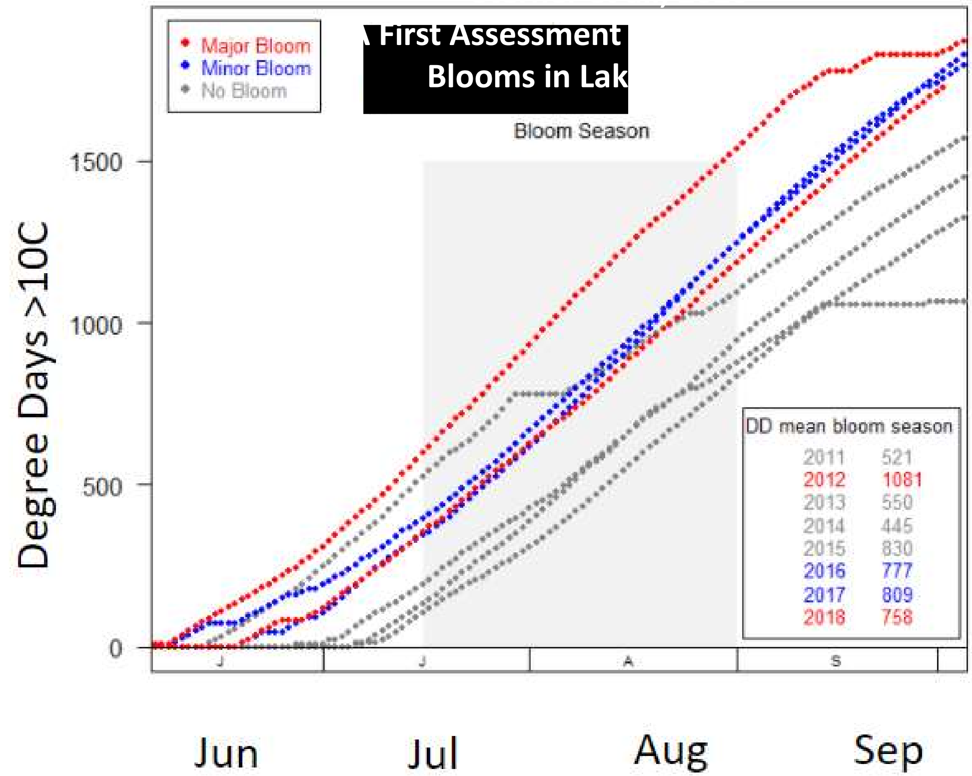

Corny Beach, 2018


Barkers Island, 2018 (Kait Reinl)

Brenda Lafrancois, NPS

Lake Superior HABs Research – Bloom Drivers

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



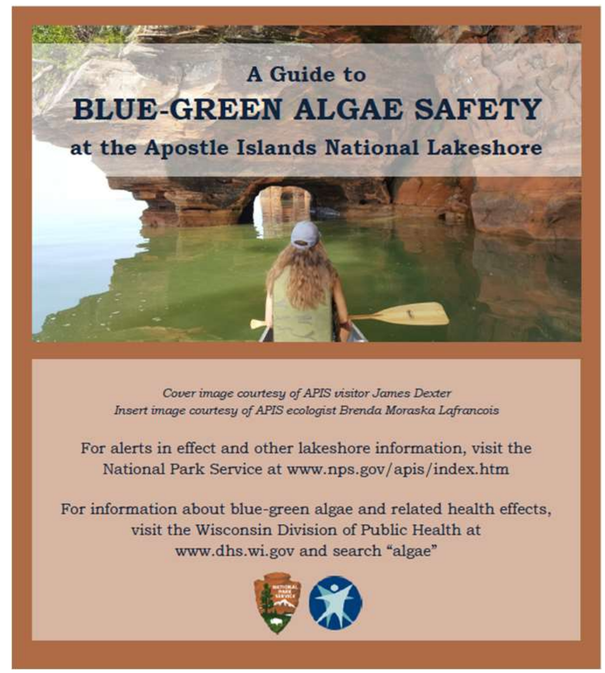
Brenda Lafrancois, NPS

Bloom Monitoring and Response

Lake Superior Partnership "Algal Bloom Subgroup" developed after 2018 State of Lake Superior

Focal areas

- Monitoring and research coordination
- Rapid response coordination, including points-of-contact lists and sampling kits
- Outreach/ed and citizen engagement



Brenda Lafrancois, NPS

Tributary Monitoring – locations and parameters

Richard Keisling, Faith Fitzpatrick, Eric Dantoin, Anna Baker (USGS Upper Midwest Water Science Center)
Becky Kreiling (USGS Upper Midwest Environmental Sciences Center)

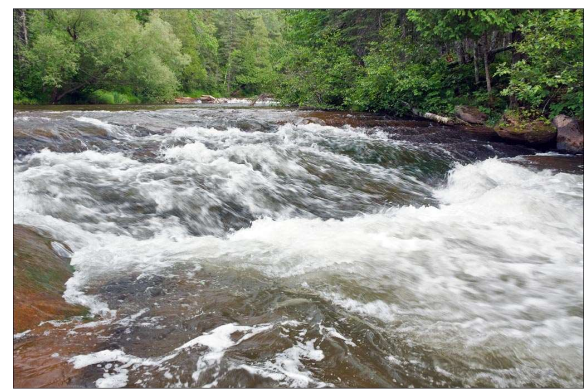
- Loads and Algal/cyanobacterial biomass monitoring
  - Streamflow
  - Total and Dissolved Phosphorus (TP, TDP, SRP)
  - NO3, NH3, TKN, dissolved TNK,
  - Suspended sediment concentration
  - Chlorophyll-a

- Sediment nutrient cycling
  - P sorption potential (EPC0)
  - Sediment Total Phosphorus, Total Nitrogen, and Total Carbon
  - Sediment denitrification and nitrification
  - Sediment exchangeable nutrients

Siskiwit River

Photos from Eric Dantoin, USGS

Bois Brule River

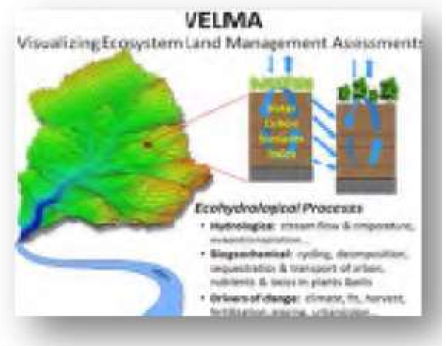


Photos from Wisconsin Trail Guide

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

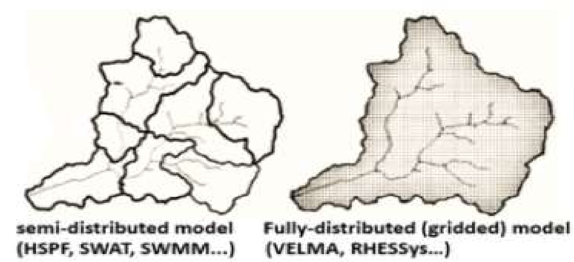
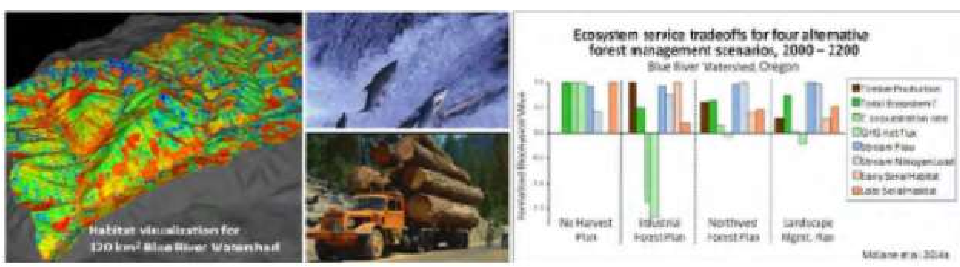


Image:



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

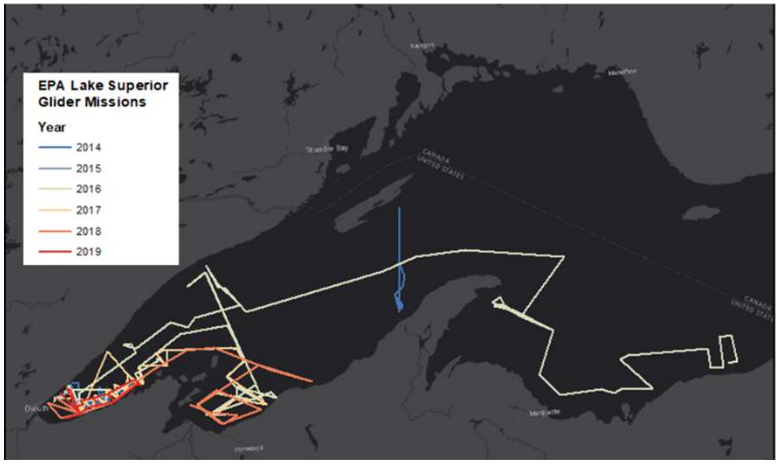
Autonomous underwater glider work

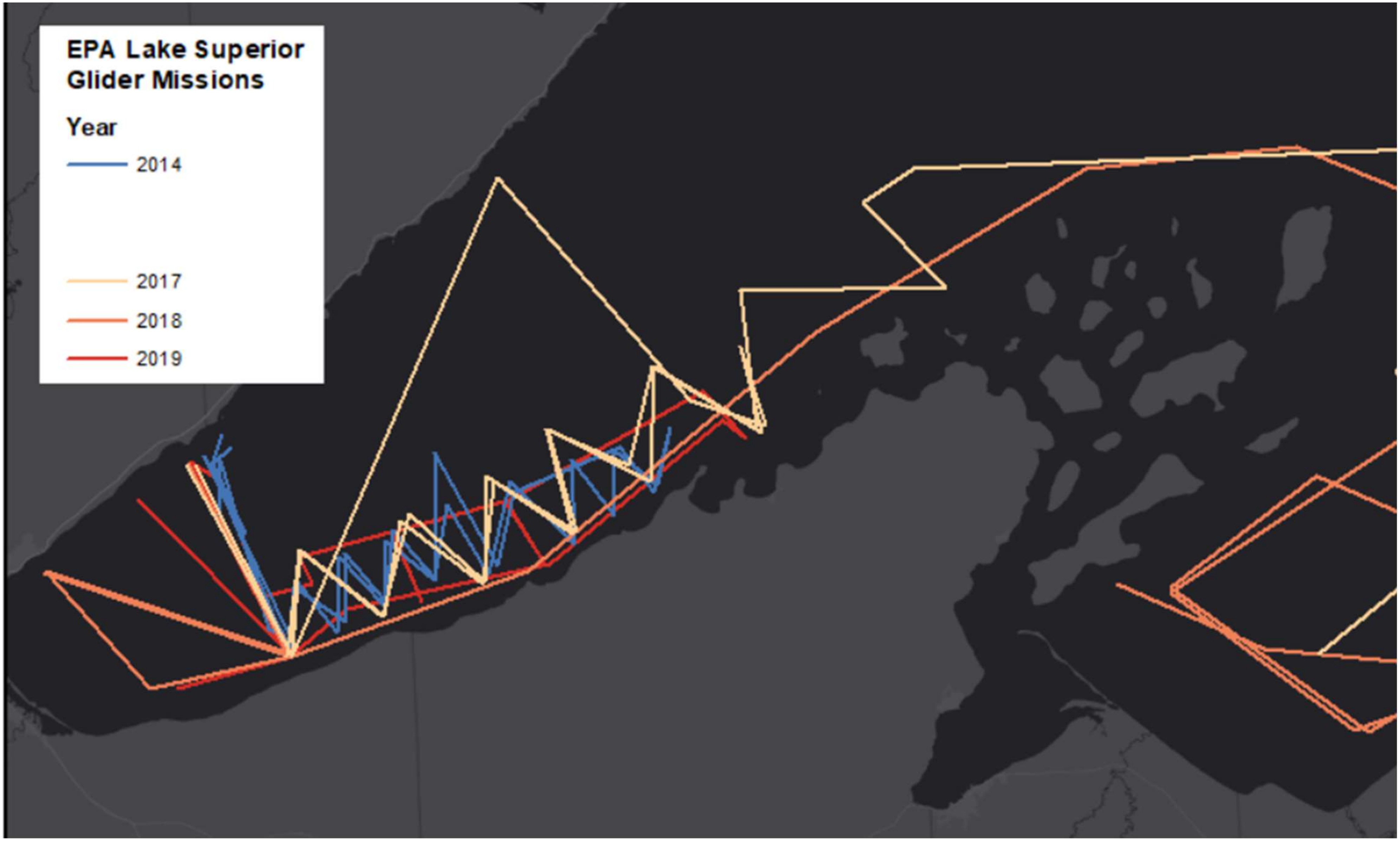
Chasing plumes and blooms…. and storms

Participants: Paul Mckinney, Tom Hollenhorst, Aabir Banerji, Joel Hoffman & others

Objective(s):

- Fly gliders along near shore to collect WQ info before, during and after blooms, also intersecting blooms to capture gradients of bloom intensity.
- Integrate with USGS continuous tow data, EPA Fluoroprobe data, and other WQ sampling efforts.
- Integrate with Remotely Sensed data also use satellite data to guide gliders to plumes and blooms for adaptive sampling.
- Incorporate past glider mission data collected along south shore




EPA Lake Superior
Glider Missions
Year
2014
2017
2018
2019

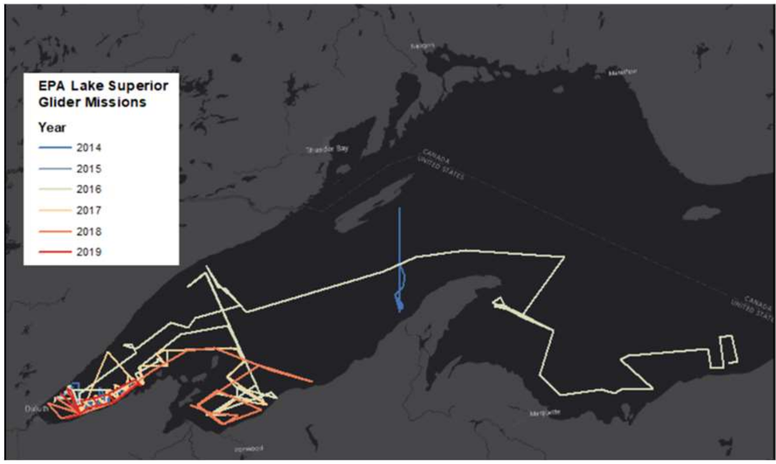
Autonomous underwater glider work

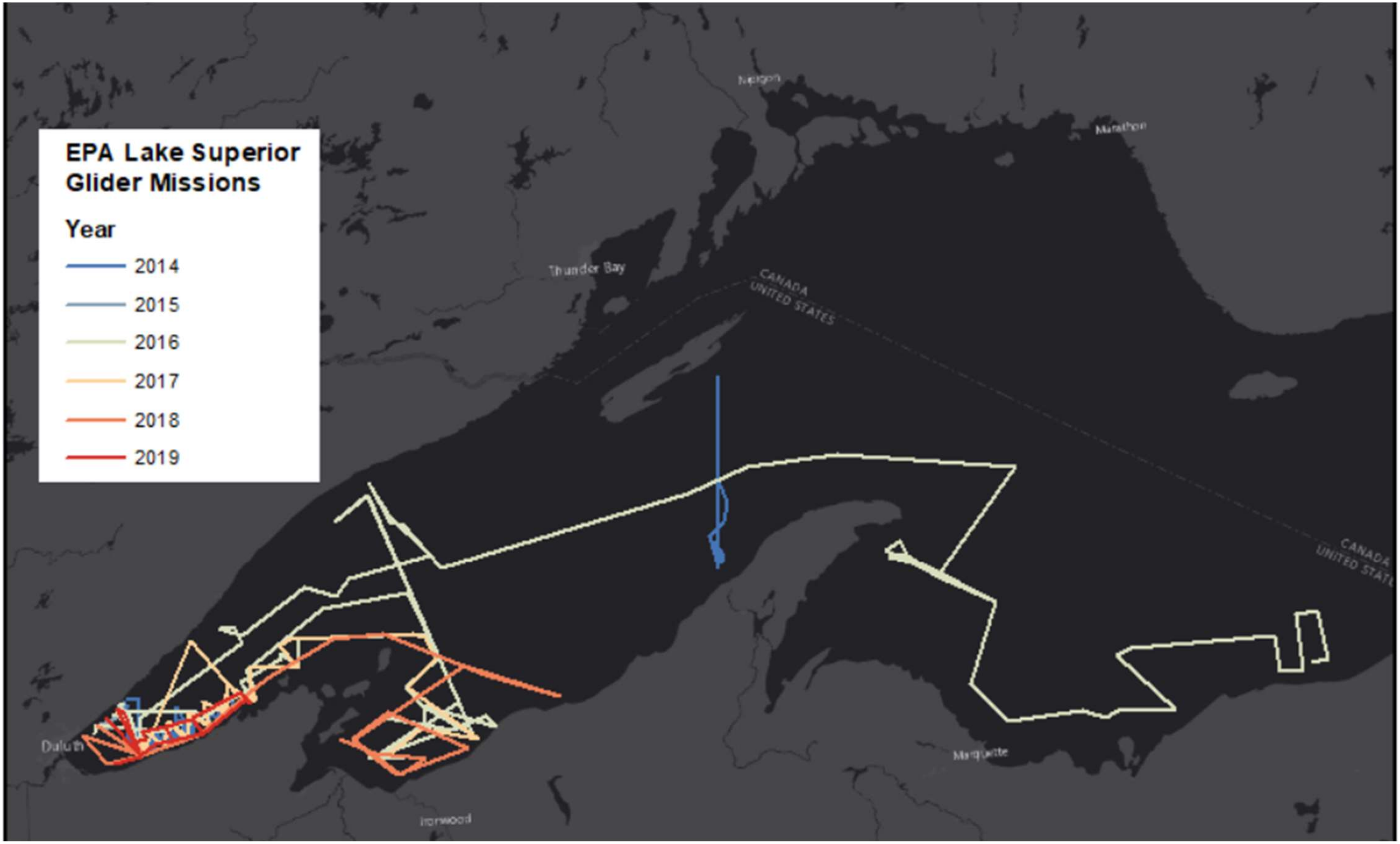
Chasing plumes and blooms…. and storms

Participants: Paul Mckinney, Tom Hollenhorst, Aabir Banerji, Joel Hoffman & others

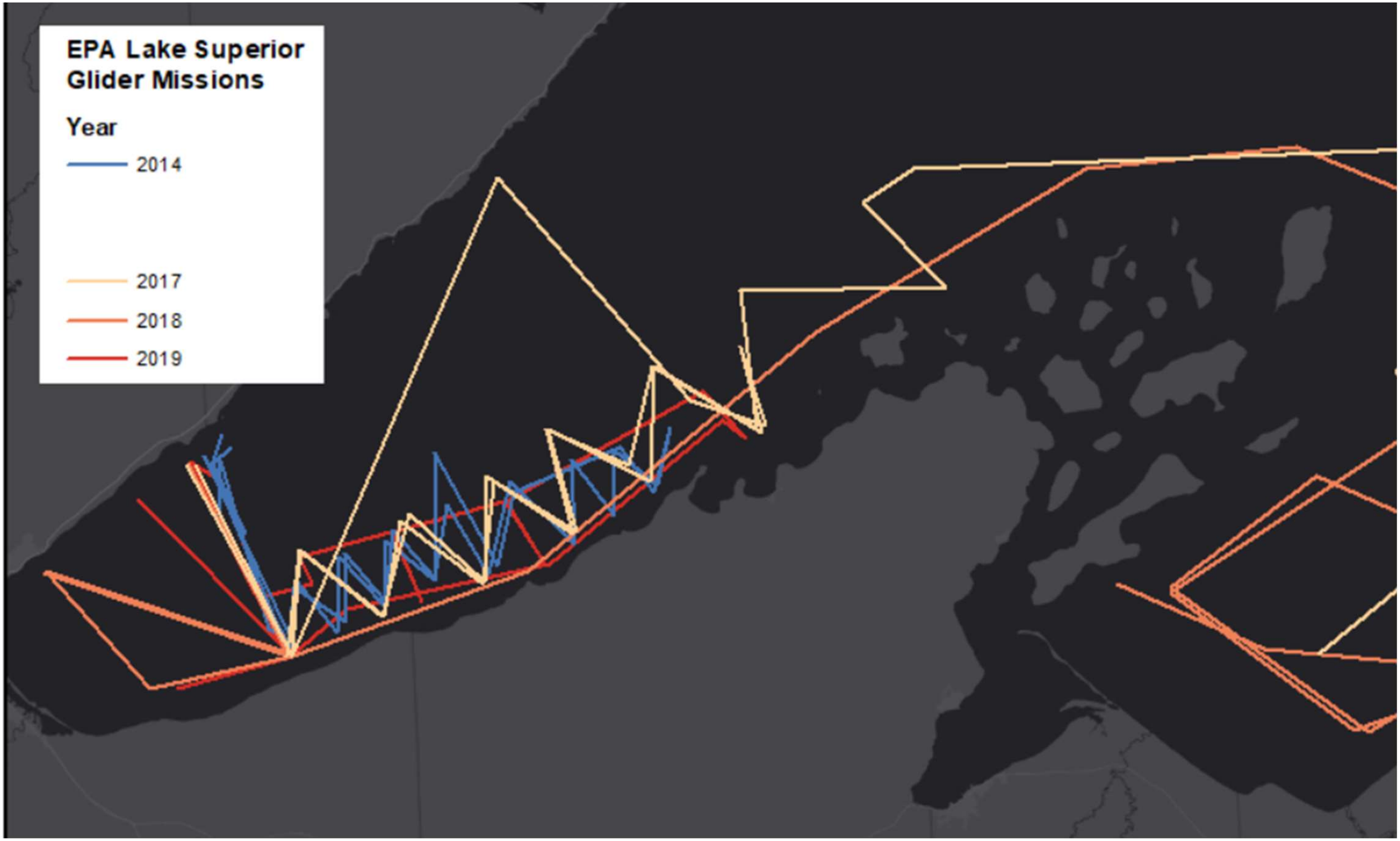
Objective(s):

- Fly gliders along near shore to collect WQ info before, during and after blooms, also intersecting blooms to capture gradients of bloom intensity.
- Integrate with USGS continuous tow data, EPA Fluoroprobe data, and other WQ sampling efforts.
- Integrate with Remotely Sensed data also use satellite data to guide gliders to plumes and blooms for adaptive sampling.
- Incorporate past glider mission data collected along south shore





EPA Lake Superior
Glider Missions
Year
2014
2015
2016
2017
2018
2019
Nipigon
Marathon
Thunder Bay
CANADA
UNITED STATES
CANADA
UNITED STATES
Duluth
Marquette
Ironwood



EPA Lake Superior
Glider Missions
Year
2014
2017
2018
2019

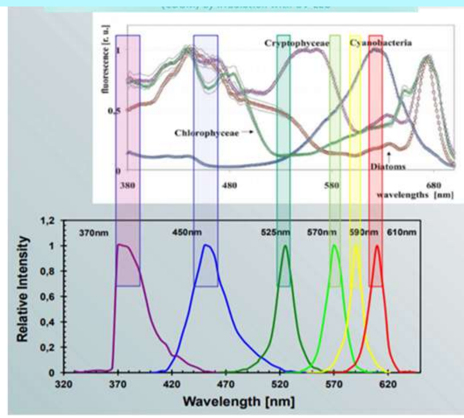
Resources

What we have:

Slocum G2 Glider

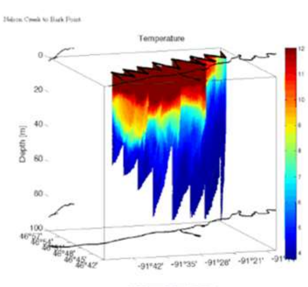
- CTD (Conductivity, Temp, Depth)
- Dissolved Oxygen
- CDOM
- Fluorescence

Submersible Spectrofluorometer with Automatic Algae Class And Chlorophyll Analysis



New Glider (Slocum G3)

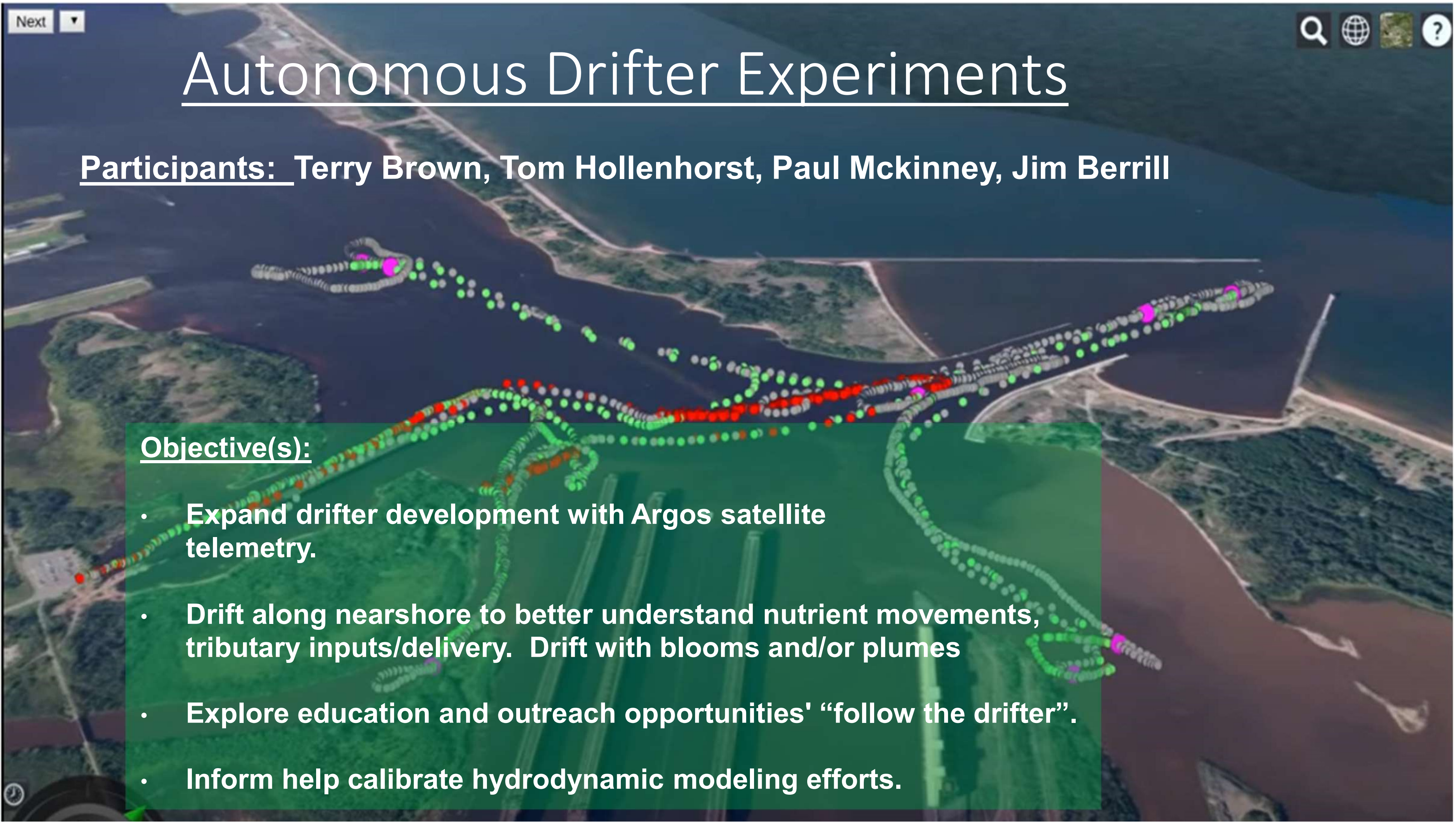
- Additional sensors: Phycocyanin & LISST sensor (Particle size, concentration)
- Hybrid propulsion
- Hope to “push” into and out from shallow nearshore
- Rechargeable batteries!



What we need

- Clear skies for cloud free satellite imagery during missions
- Storm events during missions
- A little luck and synchronicity intercepting blooms and plumes
- Other coincident in situ data (WQ, CTD and Fluorometer profiles, tow data etc.
- Integrated & innovative data analyses…

Autonomous Drifter Experiments



Participants: **Terry Brown, Tom Hollenhorst, Paul Mckinney, Jim Berrill**

Objective(s):

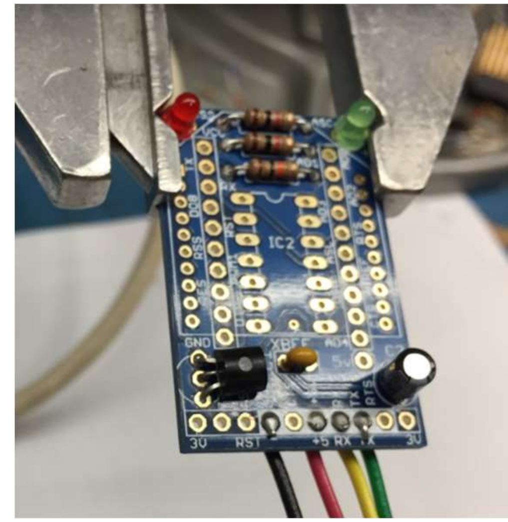
- **Expand drifter development with Argos satellite telemetry.**
- **Drift along nearshore to better understand nutrient movements, tributary inputs/delivery. Drift with blooms and/or plumes**
- **Explore education and outreach opportunities' "follow the drifter".**
- **Inform help calibrate hydrodynamic modeling efforts.**

Logistics

Sampling Location(s): Yet to be determined…

Parameter(s): Conductivity, temperature, current velocity & direction

- Hopefully, new drifters can be deployed for multiple days & weeks at a time.



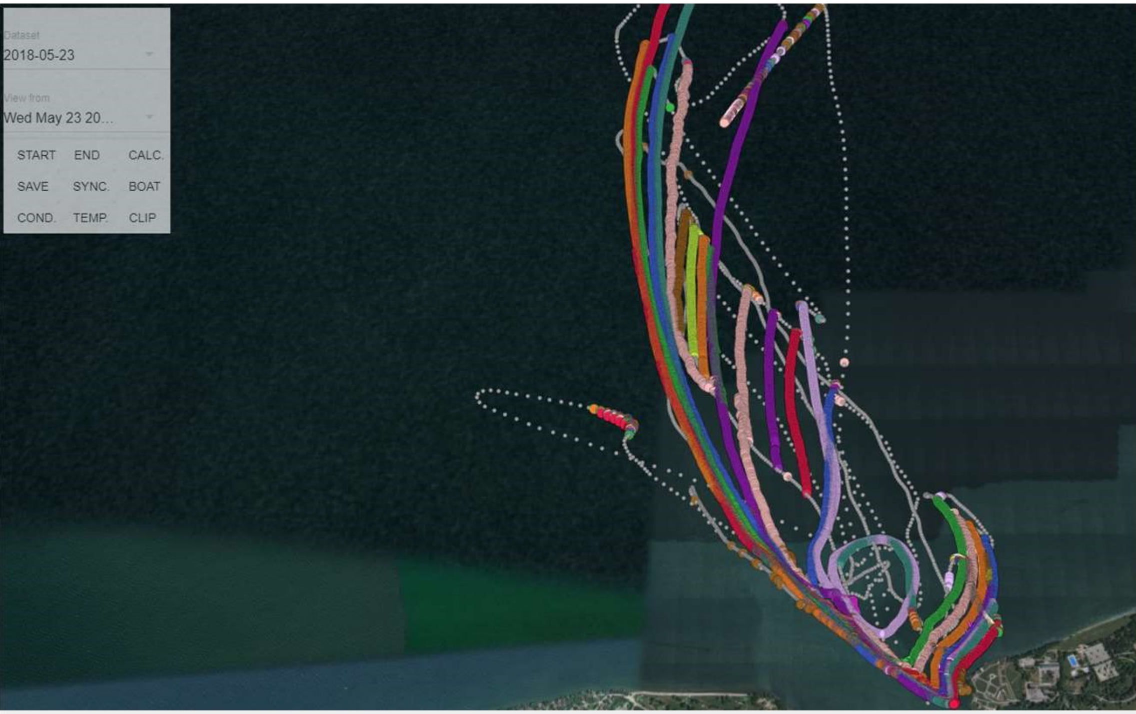
Resources

- Currently 10 drifters with radio transmitters, for short deployments (6-12 hours)
  - Base station software interface
- Working with Woods Hole group to acquire components for 10 with Argos satellite telemetry
  - Need to design assemble and calibrate sensors. Longer deployments (days – weeks)

Needs

- Young sharp eyes for drifter assembly soldering
- Interested teachers, educators

Other Possibilities….



PLOS ONE

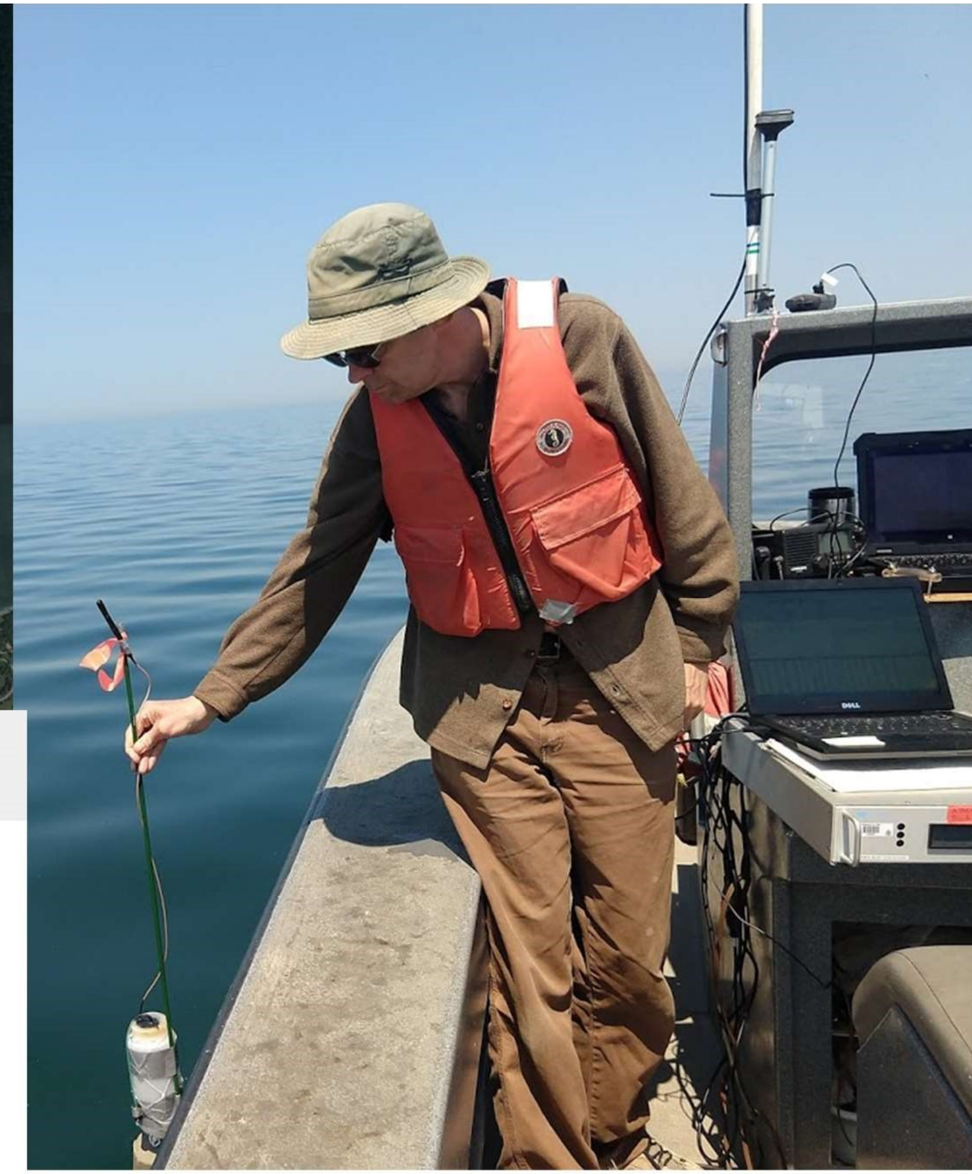
OPEN ACCESS PEER-REVIEWED

RESEARCH ARTICLE

Message in a bottle: Open source technology to track the movement of plastic pollution

Emily M. Duncan, Alasdair Davies, Amy Brooks, Gawsia Wahidunnessa Chowdhury, Brendan J. Godley, Jenna Jambeck, Taylor Maddalene, Imogen Napper, Sarah E. Nelms, Craig Rackstraw, Heather Koldewey

Published: December 2, 2020 • https://doi.org/10.1371/journal.pone.0242459

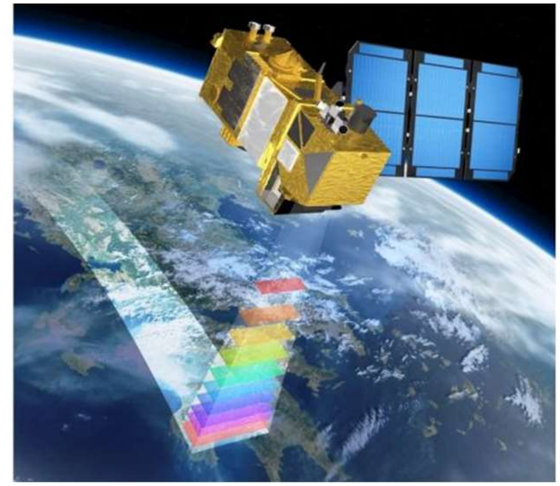


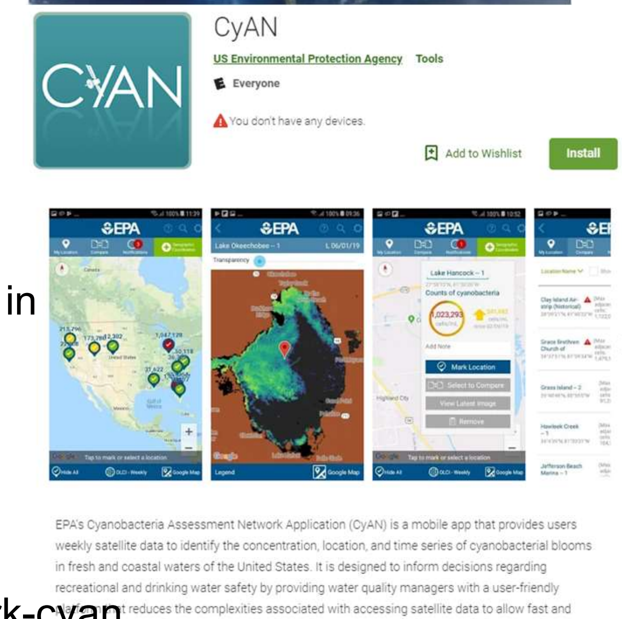
Remote sensing

Participants:
Tom Hollenhorst, Darryl Keith and others

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



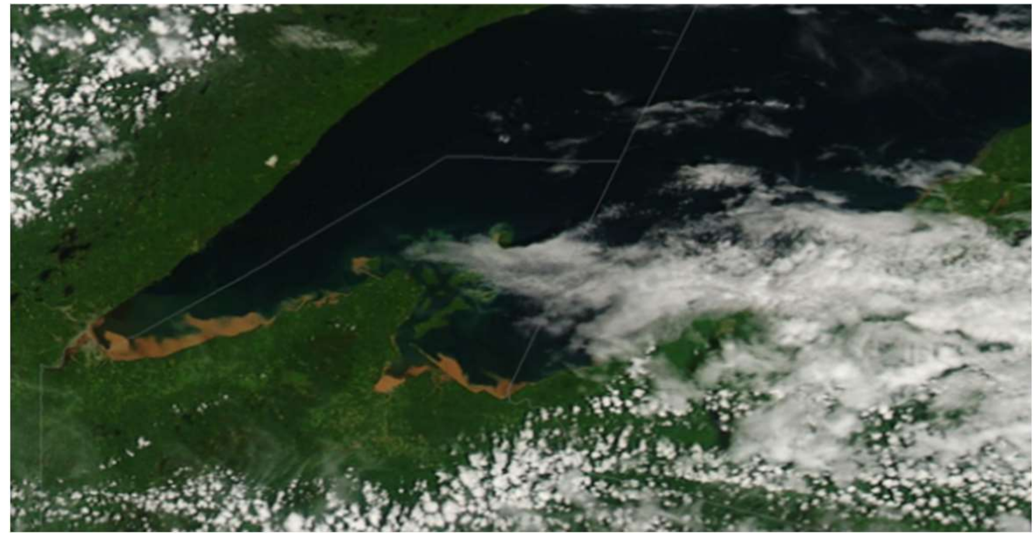


Logistics

Sampling Location(s): Across the area…

Parameter(s):

- Various satellite imagery available for the area (Landsat, Sentinel, MODIS, Digital Globe, etc.)



MODIS on 19 June 2018 – UW Madison CIMSS

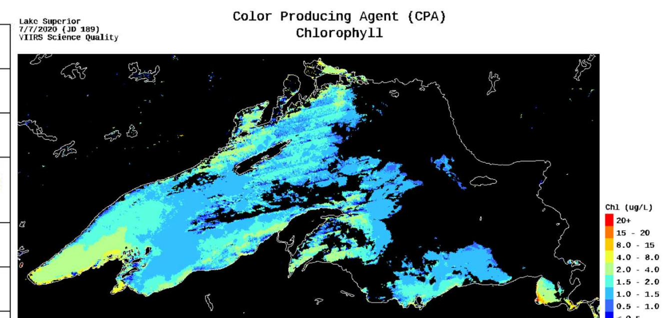
NOAA CoastWatch Great Lakes · Home · GLSEA · MODIS · Ocean Color · In-Situ · Statistics ·

n Color

Color Producing Agents (CPAs) and Harmful Algal Blooms (HABs)

icing Agents (Experimental)

Superior	Michigan	Huron	Erie	Ontario
Chlorophyll	Chlorophyll	Chlorophyll	Chlorophyll	Chlorophyll
Dissolved Organic Carbon	Dissolved Organic Carbon	Dissolved Organic Carbon	Dissolved Organic Carbon	Dissolved Organic Carbon
Colored Dissolved Organic Matter absorption	Colored Dissolved Organic Matter absorption	Colored Dissolved Organic Matter absorption	Colored Dissolved Organic Matter absorption	Colored Dissolved Organic Matter absorption
Suspended Minerals	Suspended Minerals	Suspended Minerals	Suspended Minerals	Suspended Minerals
KD490	KD490	KD490	KD490	KD490
KDpar	KDpar	KDpar	KDpar	KDpar
Photic Zone Depth	Photic Zone Depth	Photic Zone Depth	Photic Zone Depth	Photic Zone Depth



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.

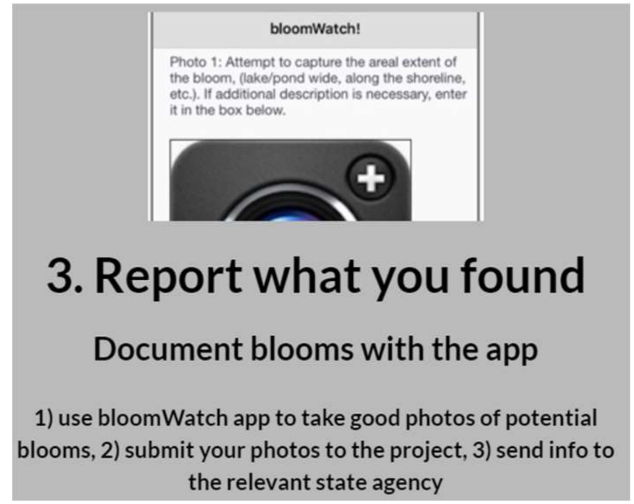
Mapping cyanobacteria one slide at a Time

Logistics

Sampling Location(s): Yet to be determined…

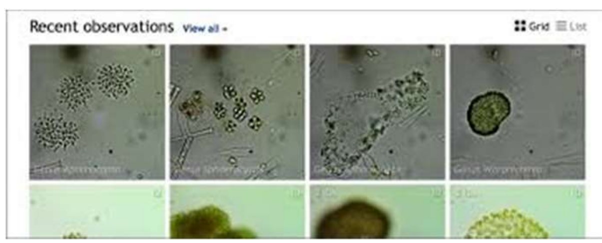
Parameter(s):

- images of algae collected along the shore uploaded to iNaturalist, Bloomwatch



Resources

- ~ four CyanoScope algae monitoring kits
- Interested teachers & educators



Needs

- More interested teachers & educators, citizen scientist

Genetic Studies – Nearshore and Open Lake

Metabarcoding of Planktonic Microbes

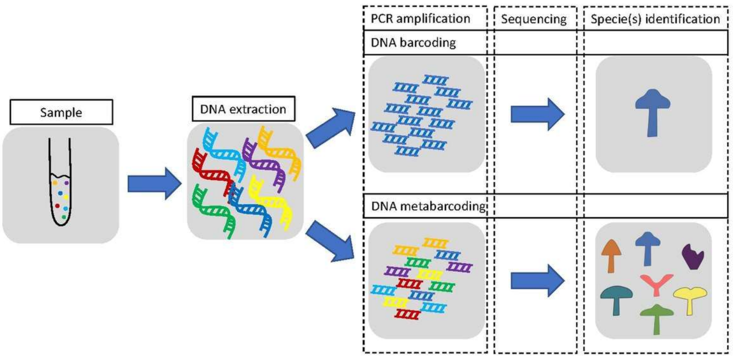
Participants: Aabir Banerji, US EPA GLTED; Carlie LaLone, US EPA GLTED; Erik Pilgrim, US EPA WECD; Sara Okum, US EPA WECD {plus an ORISE person}.

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 suffer from them.

3. Collaborate [redacted] – how could microbial community data be of use to you? [redacted]

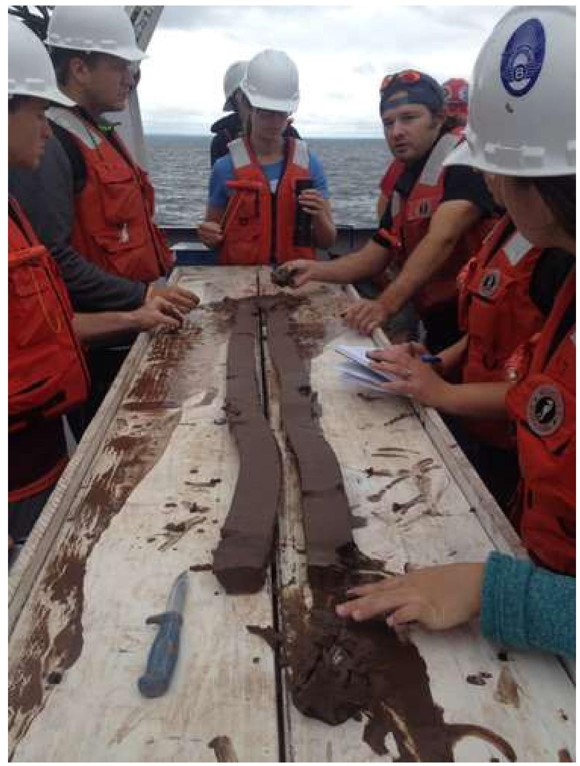


Related ongoing work by Cody Sheik (LLO) and Euan Reavie (NRRI)
- Seasonal and spatial distribution of microbial phytoplankton
- Functional diversity of microbial communities and individual genomes
- Expression patterns of key metabolic genes

Slide content from Aabir Banerji and Cody Sheik

Historical Analysis

- Participants – Bob Sterner (UMD/LLO), Hillary Dougan (NECASC), Rob Mooney (UW-Madison) and others



- Paleo-limnological Historical Analysis
  - Sediment cores for historical nutrient and sediment loading and cyanobacterial history
  - Lake Superior and inland headwaters lake
- Remote Sensing Study
  - Looking at recent changes in water clarity, trophic status, and bloom occurrence

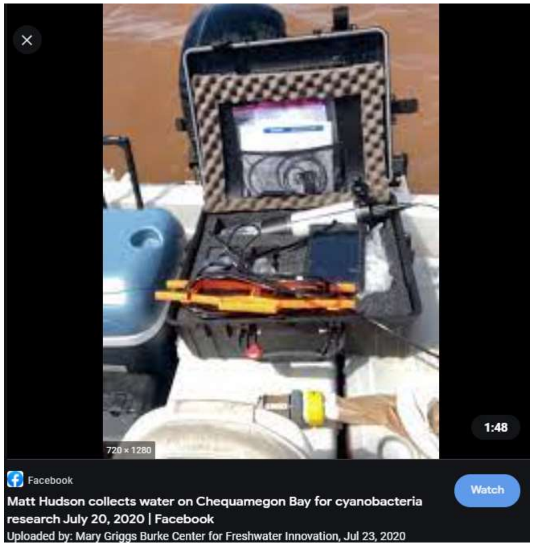
Nearshore Monitoring and Experimental work

- Participants: Matt Hudson, Northland College Burke Center, and others

- Near shore water quality and sonde profiles
  - Collaborating with UMD on 5 trips at 15 locations
  - Extending CSMI nearshore monitoring to entire WI Lake Superior coast

- Chequamegon Bay water quality monitoring and experimental work
  - Exploring the risk of blooms in Chequamegon Bay
    - Based on experimental approach used by Kate Reinl and the Sterner Lab

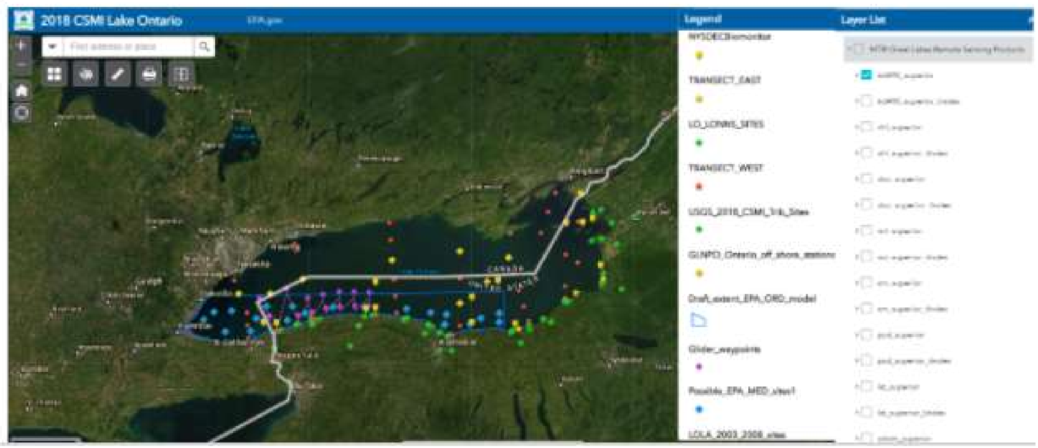
Mary Griggs Burke Center for Freshwater ...
northland.edu



Data Synthesis and Integration

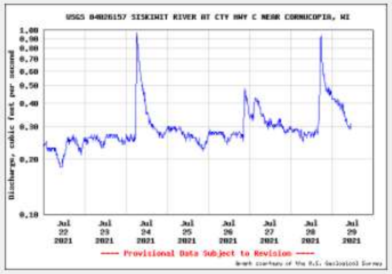
Objective(s):

- 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

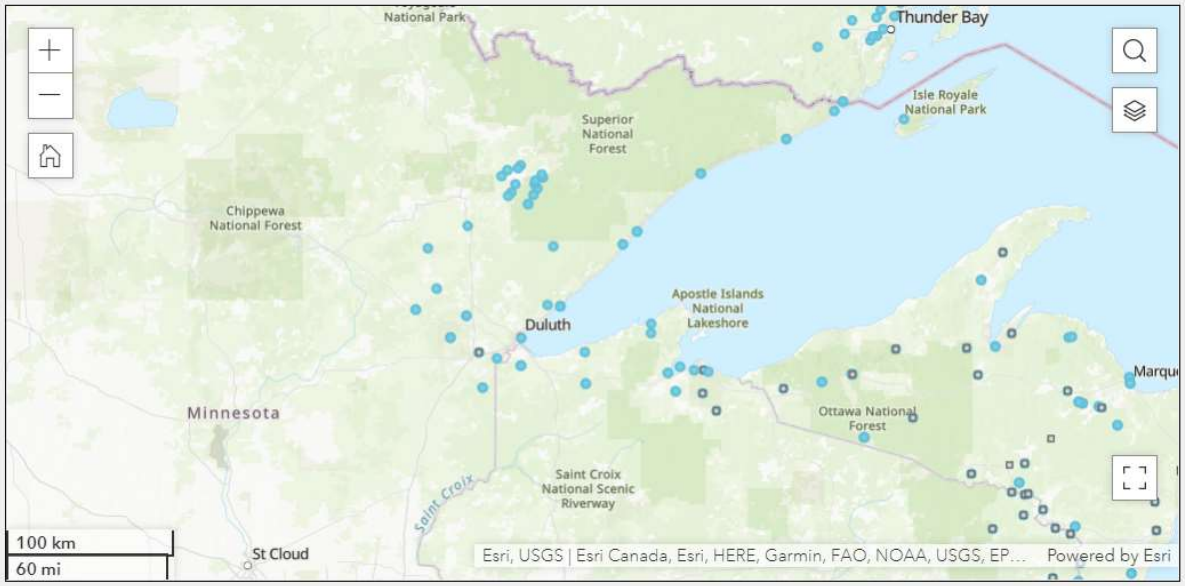


- Entire team will be involved –

Welcome | History | Siskiwit Bay Story Map | Siskiwit River Live Stream Gauges | Satellite Imagery Static | Satellite Imagery - test | Environmental Justice



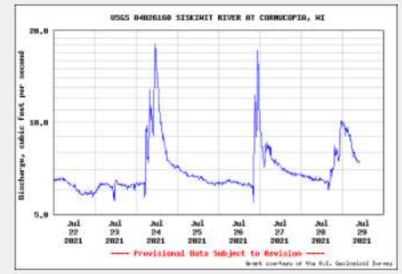
See data from previous dates

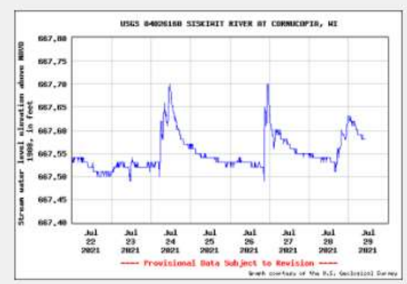


LiveStreamGaugesGreatLakesWatershed_CopyFeatures

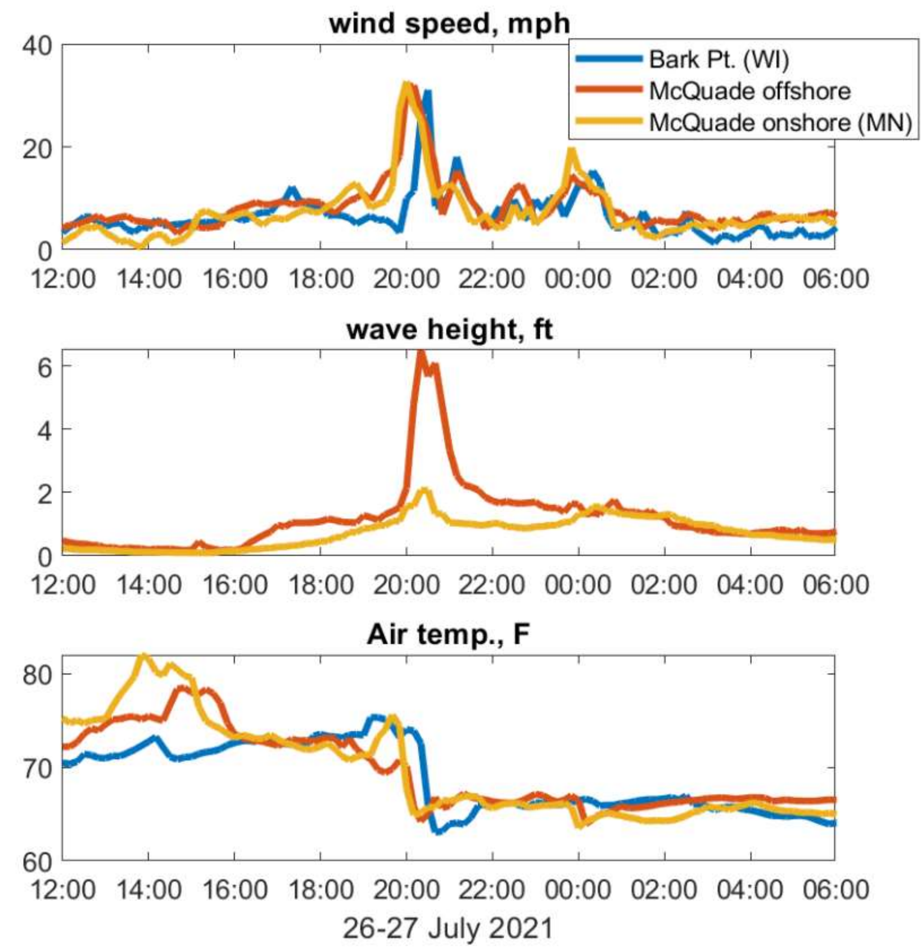
Status

- Major Flood
- Moderate Flood
- Minor Flood
- Action Stage





See data from previous dates



UMD Buoys

July 27 at 10:46 AM ·

Quite a storm last night- what did it look like on the lake? Let's check the buoys!
In the attached plot, we show wind speed, wave height, and air temperature at three buoy sites- One near McQuade Harbor on the north shore on Minnesota, a mid-lake buoy, and the Bark Point buoy, on the Wisconsin shoreline. All three recorded winds in excess of 30 mph, a bit later at the WI site which is further east than the other two. Waves were large in the middle of the lake, exceeding 6 feet, but relatively small on the MN shore, due to the direction of the wind (Bark Point wave sensor is offline right now). Finally, all three show a significant drop in air temperature, resulting in today's comfortable conditions! **See Less**

https://www.d.umn.edu/buoys/

32 5 Comments 30 Shares

Like Comment Share

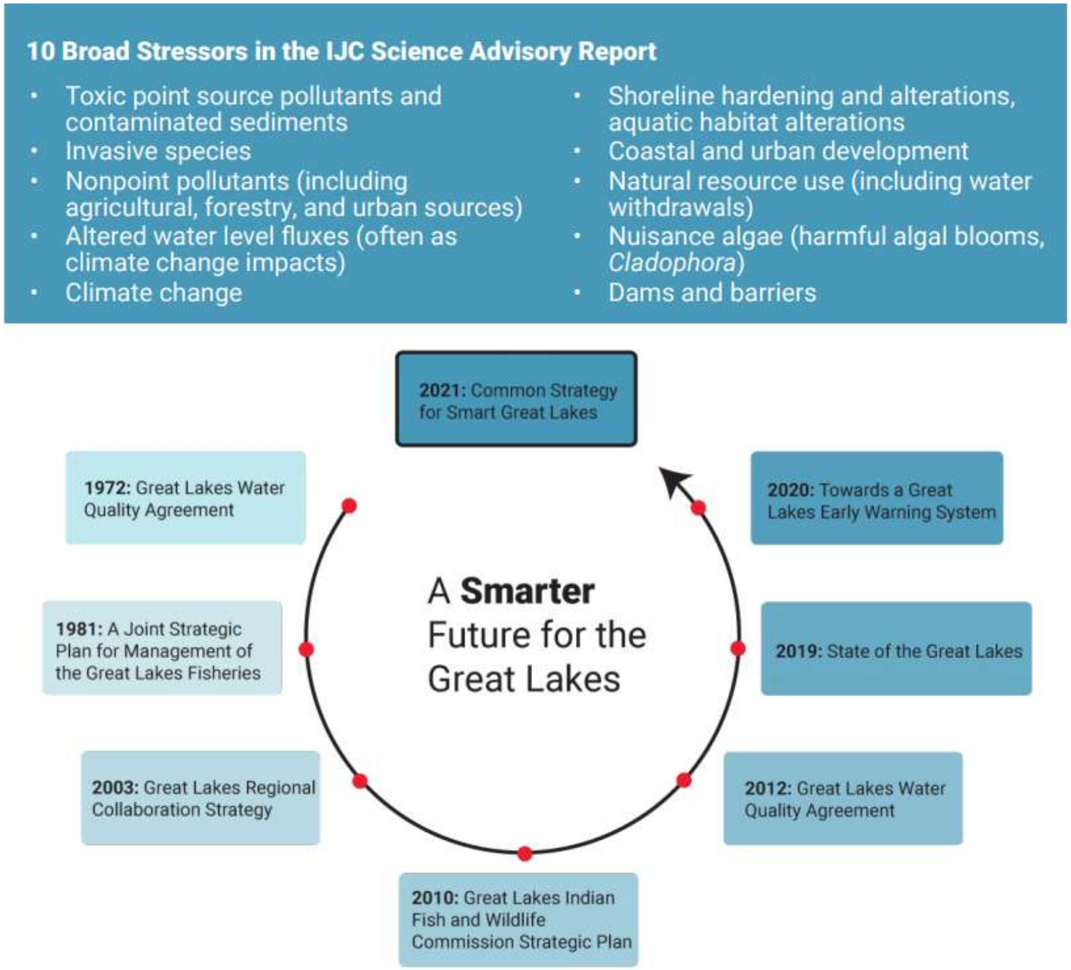


Figure 1: Over the past five decades, several key documents have been published to articulate solutions to emerging Great Lakes challenges, from natural resource management to economic development to climate change.

www.glos.us/smartgreatlakes

Common Strategy for Smart Great Lakes

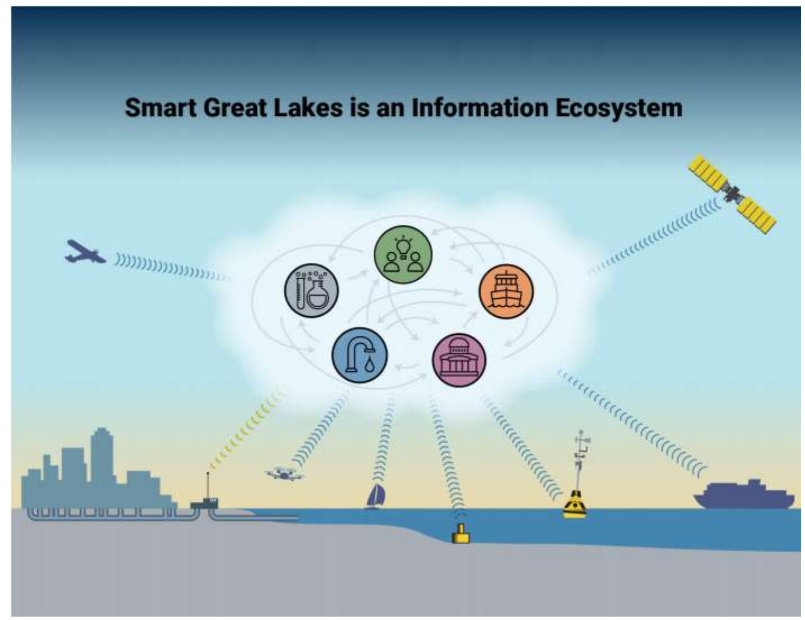


Figure 2: The Smart Great Lakes information ecosystem includes many components. Science, research, water treatment facilities, observation instruments, all levels of government, industry, innovative ideas and people are only the beginning of what is possible.


Questions?