

A nautical chart of Lake Superior, showing the lake's outline, depth contours, and surrounding landmasses. The chart is titled 'LAKE SUPERIOR' and 'CHART NO. 9' in the top left corner. The text 'O N T A R I O' is visible at the top, and 'W I S C O N S I N' is visible at the bottom.

The Lake Superior Algal Bloom Subgroup: Partnering for Nearshore Cyanobacterial Bloom Monitoring, Research, and Public Health Outreach

Gina LaLiberte

Wisconsin Department of Natural Resources



US EPA GREAT PLAINS AND MIDWEST HARMFUL ALGAL BLOOMS WORKSHOP
February 4-5, 2020



Environment and
Climate Change Canada
Environnement et
Changement climatique Canada



NORTHLAND
COLLEGE

UMD
UNIVERSITY OF MINNESOTA DULUTH
Driven to Discover

UNIVERSITY of WISCONSIN
UWMILWAUKEE

Lakehead
UNIVERSITY

UNIVERSITY of WISCONSIN
Superior

WISCONSIN
UNIVERSITY OF WISCONSIN-MADISON



CSTE

Cooperative Institute for
Great Lakes Research
CIGLR
Great Lakes Science for Society

Extension
UNIVERSITY OF WISCONSIN-MADISON

mi MINNESOTA POLLUTION
CONTROL AGENCY

BATTELLE





CORPS OF ENGINEERS
U. S. ARMY
U. S. LAKE SURVEY
LAKE SUPERIOR
CHART NO. 9
1964
POLYCONIC PROJECTION
SCALE 1:50,000

MEMORANDUM IN PENCIL FROM TECHNICAL STAFF AND IN PASTORAL BLUE INK

NOTE
PLANE OF REFERENCE OF THIS CHART (Low Water Datum) ... 800.0 ft. referred to mean water level at Father Point, Quebec, International Great Lakes Datum (IGLD).

BLUE TINT Areas with depths to 50 feet are tinted blue.

CONTINUITY OF SOUNDING Soundings in the lake water were made by continuous sounding with a straight line and measuring the angle of the intersection with a constant line at a near the middle of the sounding.

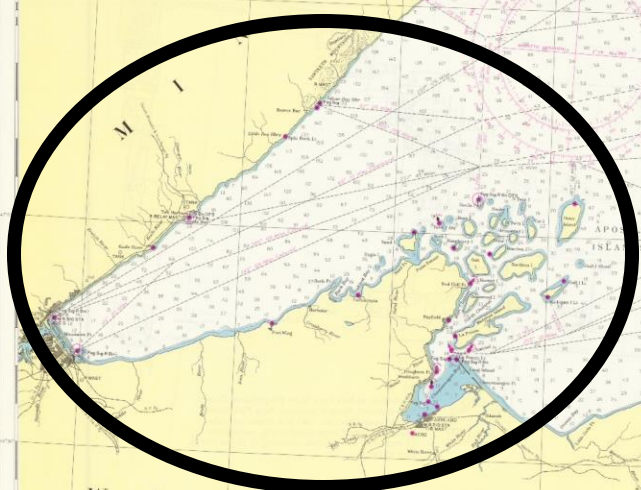
SYMBOLS AND ABBREVIATIONS For complete list of symbols and abbreviations see Chart No. 1.

GREAT LAKES PILOT For latest information as to sounding depths in uncharted waters, consult latest edition of the Great Lakes Pilot, containing description of routes, harbors, channels, dry docks, canals, bridge clearances, cable and telephone, etc. Copies may be purchased from the U. S. Army Engineer District, Lake Survey.

REPRODUCTION RESTRICTION This chart may not be reproduced in whole or in part without the written permission of the District Engineer, U. S. Army Engineer District, Lake Survey.

CAUTION
Areas shown that are under construction on the lake are indicated with a red symbol.

ADRO
Areas shown that are under construction on the lake are indicated with a red symbol.



LAKE SUPERIOR

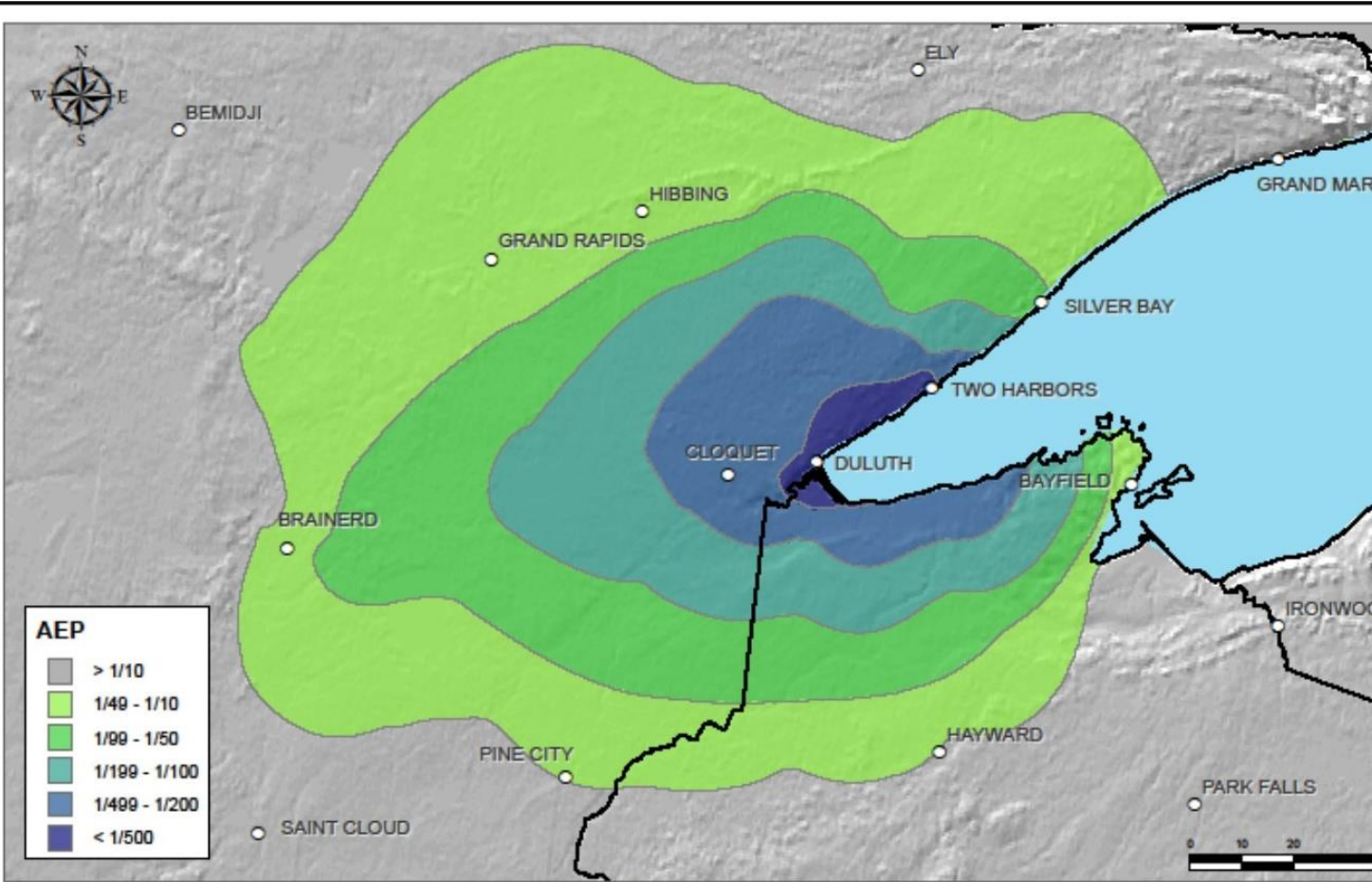
| DEPTH | CONTOUR |
|-------|---------|
| 10 | 10 |
| 20 | 20 |
| 30 | 30 |
| 40 | 40 |
| 50 | 50 |
| 60 | 60 |
| 70 | 70 |
| 80 | 80 |
| 90 | 90 |
| 100 | 100 |
| 110 | 110 |
| 120 | 120 |
| 130 | 130 |
| 140 | 140 |
| 150 | 150 |
| 160 | 160 |
| 170 | 170 |
| 180 | 180 |
| 190 | 190 |
| 200 | 200 |

FACTORS AND FEET TO METERS

| FEET | METERS |
|------|---------|
| 1 | 0.3048 |
| 2 | 0.6096 |
| 3 | 0.9144 |
| 4 | 1.2192 |
| 5 | 1.5240 |
| 6 | 1.8288 |
| 7 | 2.1336 |
| 8 | 2.4384 |
| 9 | 2.7432 |
| 10 | 3.0480 |
| 11 | 3.3528 |
| 12 | 3.6576 |
| 13 | 3.9624 |
| 14 | 4.2672 |
| 15 | 4.5720 |
| 16 | 4.8768 |
| 17 | 5.1816 |
| 18 | 5.4864 |
| 19 | 5.7912 |
| 20 | 6.0960 |
| 21 | 6.4008 |
| 22 | 6.7056 |
| 23 | 7.0104 |
| 24 | 7.3152 |
| 25 | 7.6200 |
| 26 | 7.9248 |
| 27 | 8.2296 |
| 28 | 8.5344 |
| 29 | 8.8392 |
| 30 | 9.1440 |
| 31 | 9.4488 |
| 32 | 9.7536 |
| 33 | 10.0584 |
| 34 | 10.3632 |
| 35 | 10.6680 |
| 36 | 10.9728 |
| 37 | 11.2776 |
| 38 | 11.5824 |
| 39 | 11.8872 |
| 40 | 12.1920 |
| 41 | 12.4968 |
| 42 | 12.8016 |
| 43 | 13.1064 |
| 44 | 13.4112 |
| 45 | 13.7160 |
| 46 | 14.0208 |
| 47 | 14.3256 |
| 48 | 14.6304 |
| 49 | 14.9352 |
| 50 | 15.2400 |
| 51 | 15.5448 |
| 52 | 15.8496 |
| 53 | 16.1544 |
| 54 | 16.4592 |
| 55 | 16.7640 |
| 56 | 17.0688 |
| 57 | 17.3736 |
| 58 | 17.6784 |
| 59 | 17.9832 |
| 60 | 18.2880 |
| 61 | 18.5928 |
| 62 | 18.8976 |
| 63 | 19.2024 |
| 64 | 19.5072 |
| 65 | 19.8120 |
| 66 | 20.1168 |
| 67 | 20.4216 |
| 68 | 20.7264 |
| 69 | 21.0312 |
| 70 | 21.3360 |
| 71 | 21.6408 |
| 72 | 21.9456 |
| 73 | 22.2504 |
| 74 | 22.5552 |
| 75 | 22.8600 |
| 76 | 23.1648 |
| 77 | 23.4696 |
| 78 | 23.7744 |
| 79 | 24.0792 |
| 80 | 24.3840 |
| 81 | 24.6888 |
| 82 | 24.9936 |
| 83 | 25.2984 |
| 84 | 25.6032 |
| 85 | 25.9080 |
| 86 | 26.2128 |
| 87 | 26.5176 |
| 88 | 26.8224 |
| 89 | 27.1272 |
| 90 | 27.4320 |
| 91 | 27.7368 |
| 92 | 28.0416 |
| 93 | 28.3464 |
| 94 | 28.6512 |
| 95 | 28.9560 |
| 96 | 29.2608 |
| 97 | 29.5656 |
| 98 | 29.8704 |
| 99 | 30.1752 |
| 100 | 30.4800 |

Duluth-Superior flooding June 19-20, 2012

7-10 inches of rain & 500-year storm event



Duluth, MN Event, 19-20 June 2012

Annual Exceedance Probabilities (AEPs) for Worst Case 24-hour Rainfall

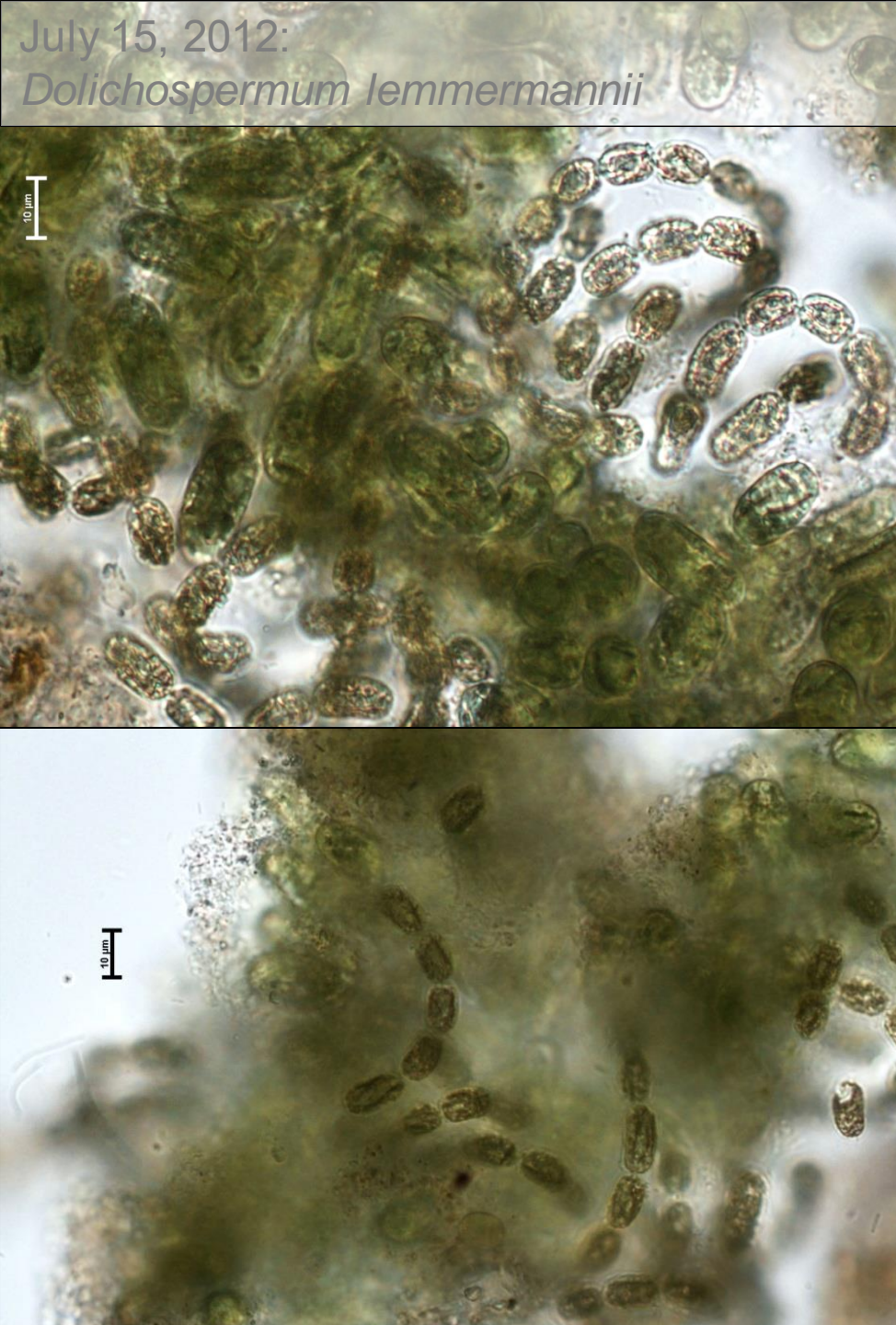
Hydrometeorological Design Studies Center
Office of Hydrologic Development, National Weather Service
National Oceanic and Atmospheric Administration

<http://www.nws.noaa.gov/oh/hdsc/>

Map created on 12 July 2012.

Rainfall frequency estimates are from NOAA Atlas 14, Volume 8 Version 1 (to be published in 2013).
Observations come from COOP, CoCoRAHS, and ASOS datasets. Not all data have been verified.





July 15, 2012:
Dolichospermum lemmermannii

Sediment plumes from June 19-20 storms.
Arrow is bloom sample location on July 15.

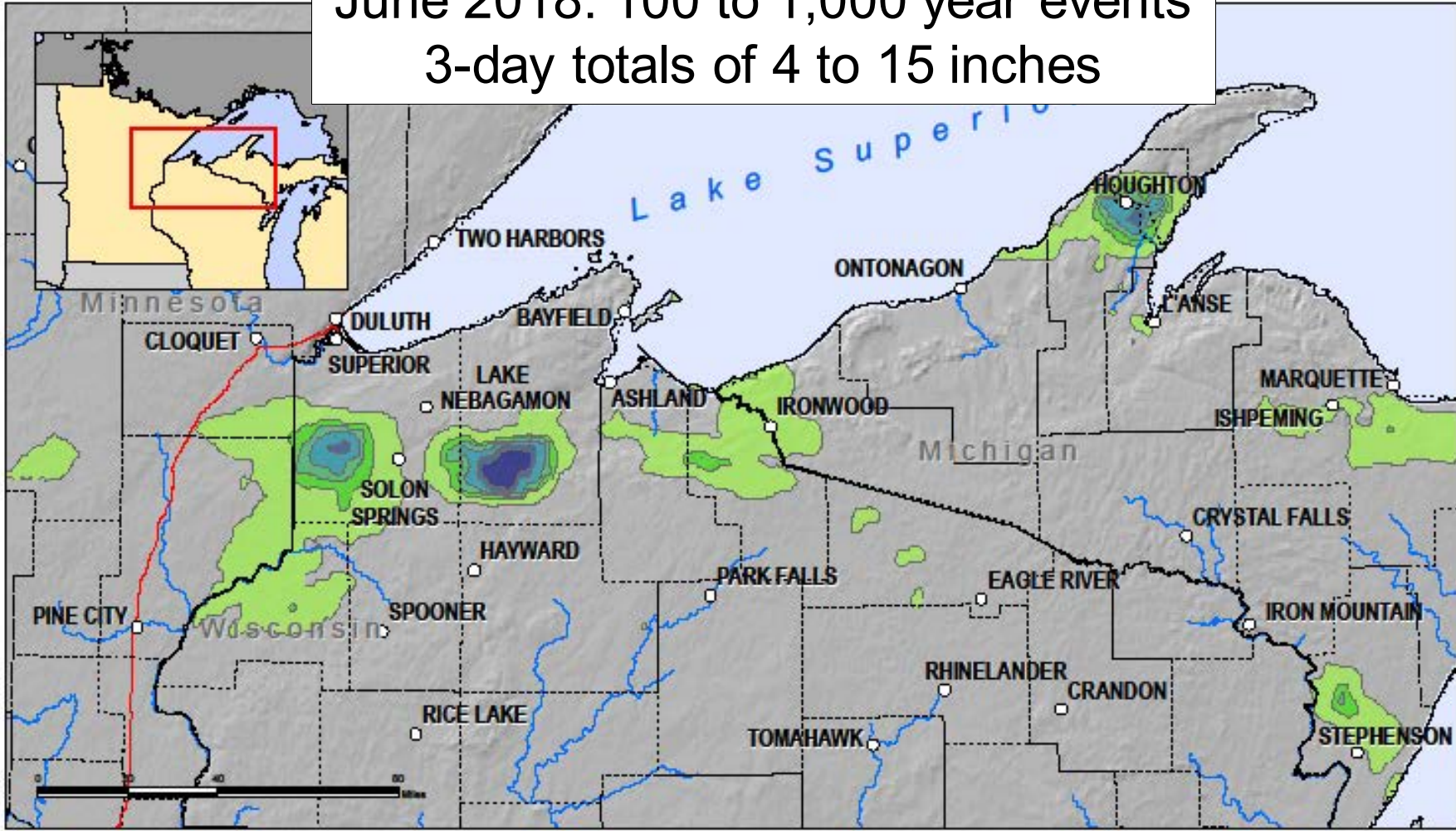
NOAA MODIS July 1, 2012

Known algal blooms in Lake Superior



- Anecdotal Historical Observations
- 2012 Observations
- 2015 Observations
- 2016 Observations
- 2017 Observations
- 2018 Observations

June 2018: 100 to 1,000 year events
3-day totals of 4 to 15 inches



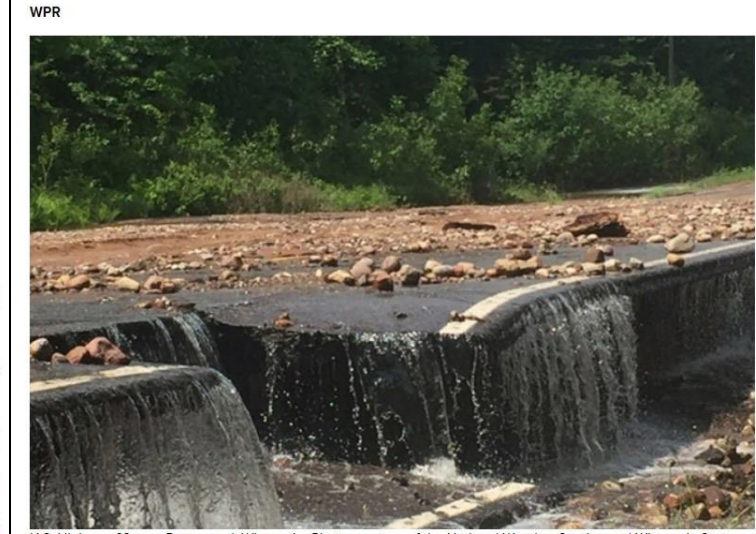
Michigan and Wisconsin 14 - 18 June 2018
Annual Exceedance Probabilities (AEPs) for the Worst Case 6-hour Rainfall

Hydrometeorological Design Studies Center
Office of Water Prediction, National Weather Service
National Oceanic and Atmospheric Administration

<http://www.nws.noaa.gov/ohd/hdsc/>

Created 19 June 2018
Rainfall frequency estimates are from NOAA Atlas 14
Rainfall values come from 1-hour Stage IV data.

- 1/50 - 1/10
- 1/100 - 1/50
- 1/200 - 1/100
- 1/500 - 1/200
- 1/1000 - 1/500
- < 1/1000



U.S. Highway 63 near Drummond, Wisconsin. Photo courtesy of the National Weather Service and Wisconsin State Patrol

Once-In-A-Lifetime Rains Falling Frequently On Northern Wisconsin

Northwestern Wisconsin Has Seen 100-Year Rains Several Times In Last Decade

By Danielle Kaeding
Published: Wednesday, June 20, 2018, 2:00pm

SHARE:

Listen Download

In the last decade, areas of northern Wisconsin have experienced several storms with heavy rains that are only projected to occur once in a lifetime, according to precipitation archives from the National Oceanic and Atmospheric Administration.

An official analysis of the weekend's storms in northern Wisconsin by NOAA confirms that 100 to 1,000-year rainfall events occurred in some areas of the state.



Bob Sterner
@bobsterner

Perhaps unprecedented surface algal bloom at @LakeSuperior shore at Cornucopia, WI yesterday. We are coordinating with Apostle Islands NPS to sample today. Photo by Brenda Lafrancois. Nutrients, warming, wind, what have you done?



8:11 AM · Aug 10, 2018 · Twitter for iPhone

84 Retweets 102 Likes

@bobsterner
August 10, 2018

Algae Bloom in Lake Superior Raises Worries on Climate Change and Tourism



New York Times
August 29, 2018

Scientists collecting samples of the algae. Lake Superior is one of several major bodies of water where algae blooms have drawn scientific scrutiny. Brenda Moraska Lafrancois

By Christine Hauser

Aug. 29, 2018



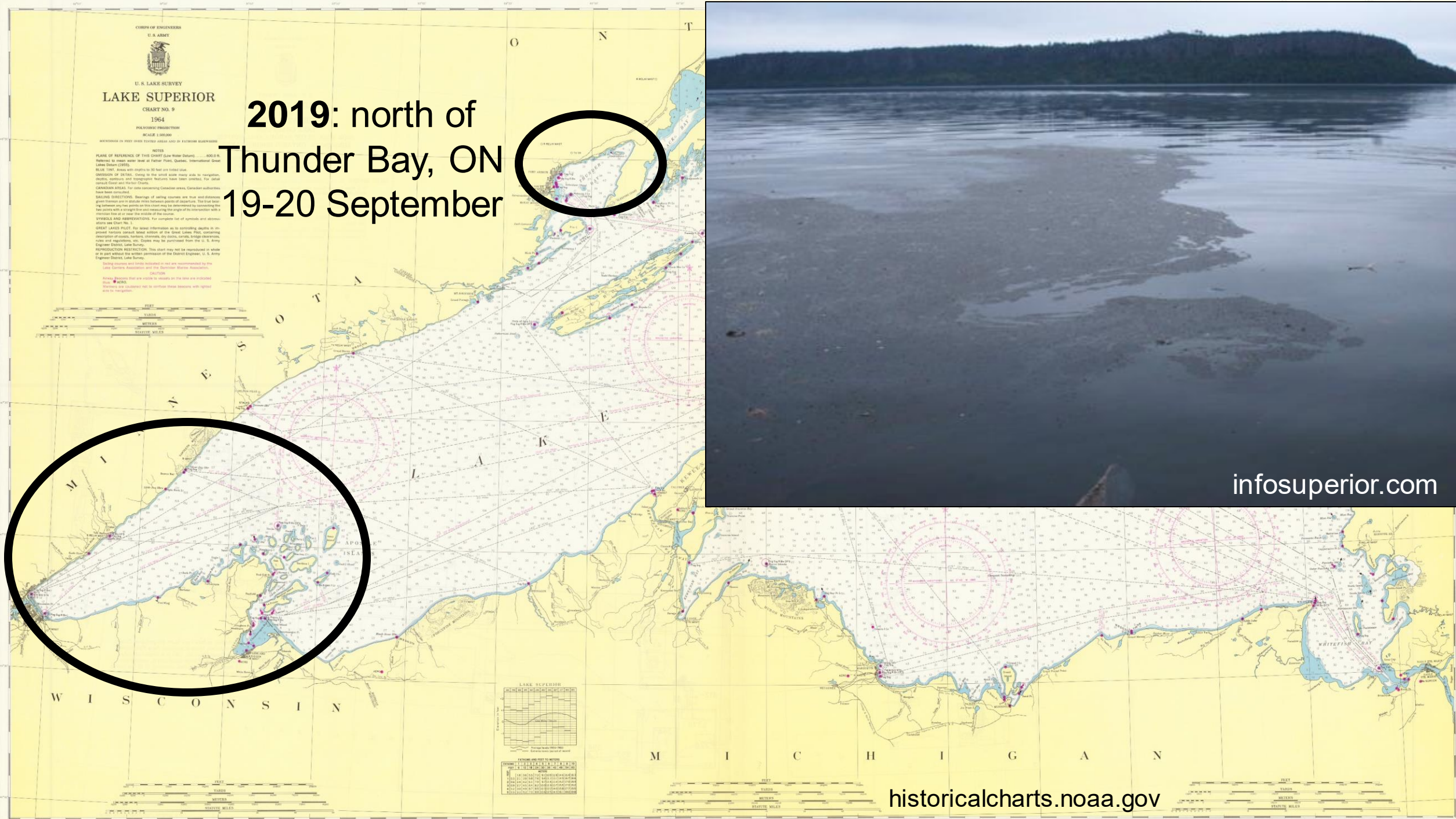
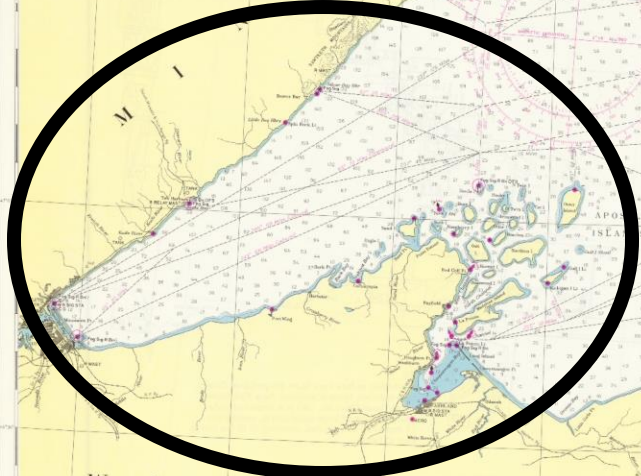
In 19 years of piloting his boat around Lake Superior, Jody Estain had never observed the water change as it has this summer. The lake has been unusually balmy and cloudy, with thick mats of algae blanketing the shoreline.

CORPS OF ENGINEERS
U. S. ARMY
U. S. LAKE SURVEY
LAKE SUPERIOR
CHART NO. 9
1964
POLYCONIC PROJECTION
SCALE 1:50,000

**2019: north of
Thunder Bay, ON
19-20 September**

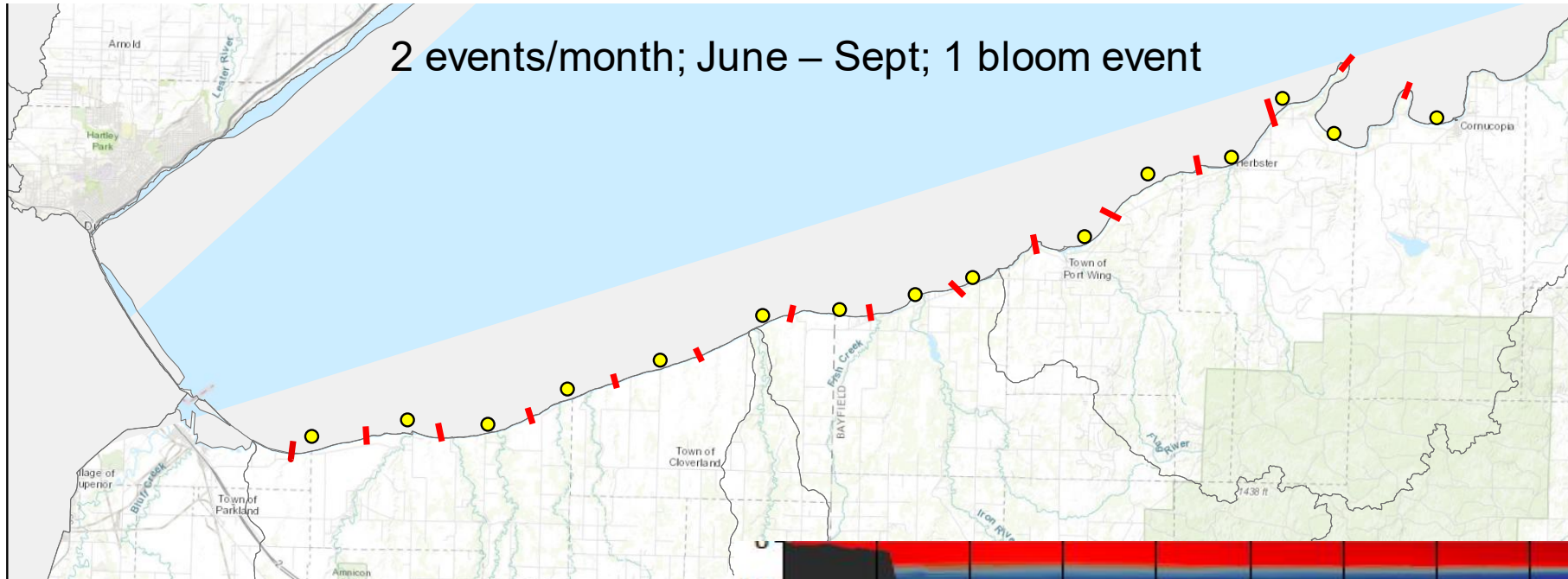


infosuperior.com



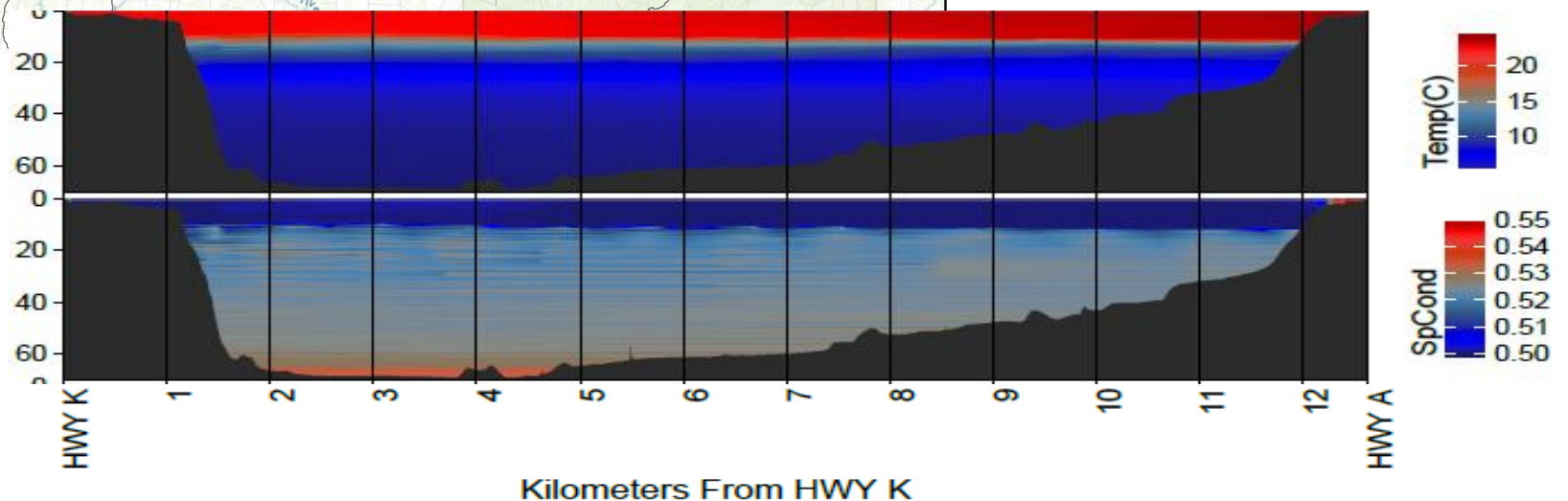
historicalcharts.noaa.gov

WDNR 2019 Nearshore Monitoring



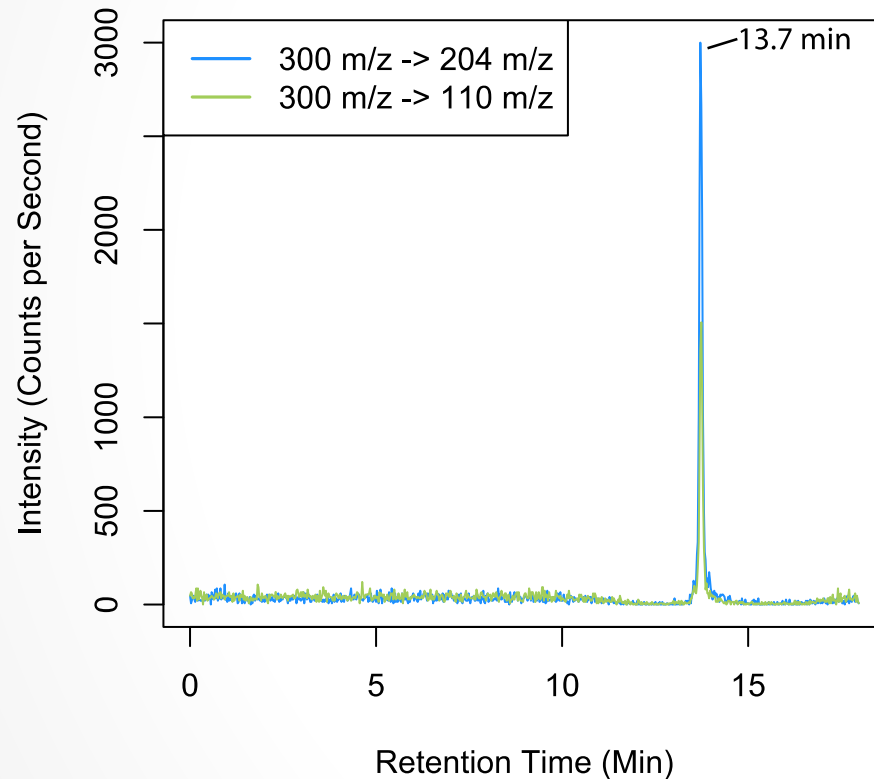
- ❖ Distribution of blooms?
- ❖ Water quality conditions leading up to and during blooms?

- ❖ How do grab samples represent nearshore conditions?

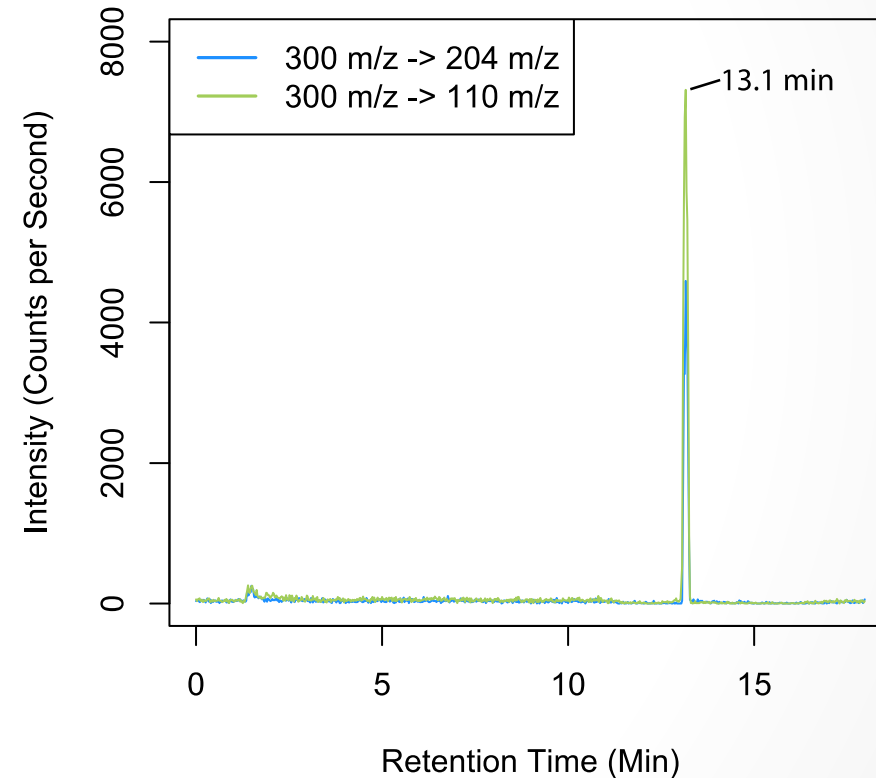


Possible Detection of Saxitoxin in Lake Superior Blooms

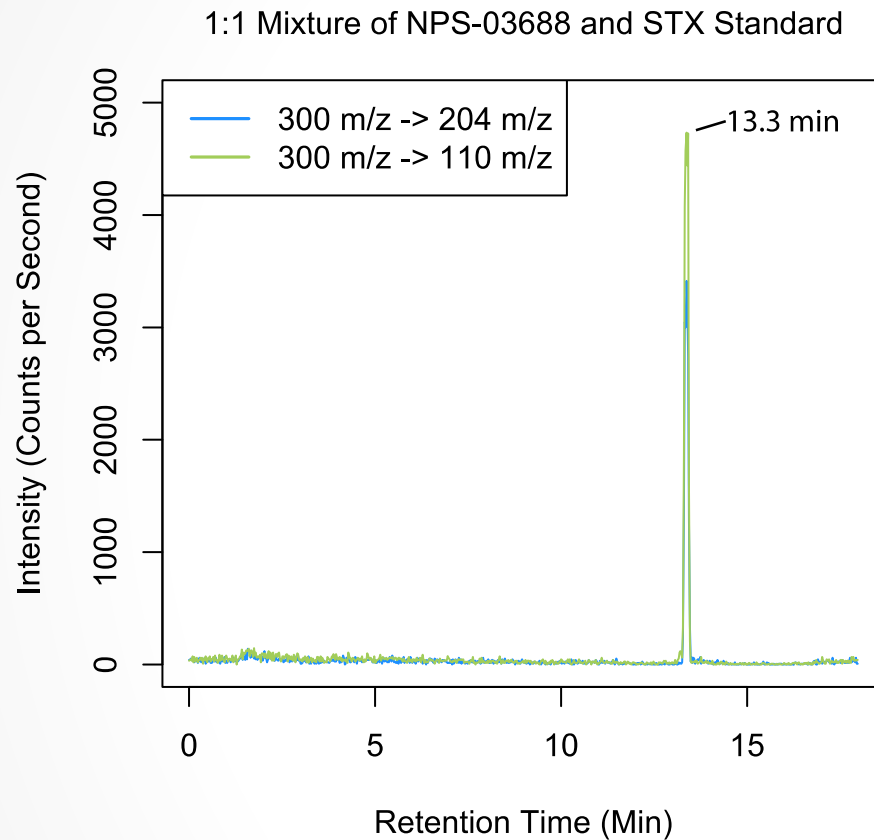
50 $\mu\text{g/L}$ Saxitoxin Standard



Sample# NPS-03688



Mixture of Standard and Sample Gives One Peak



The New York Times

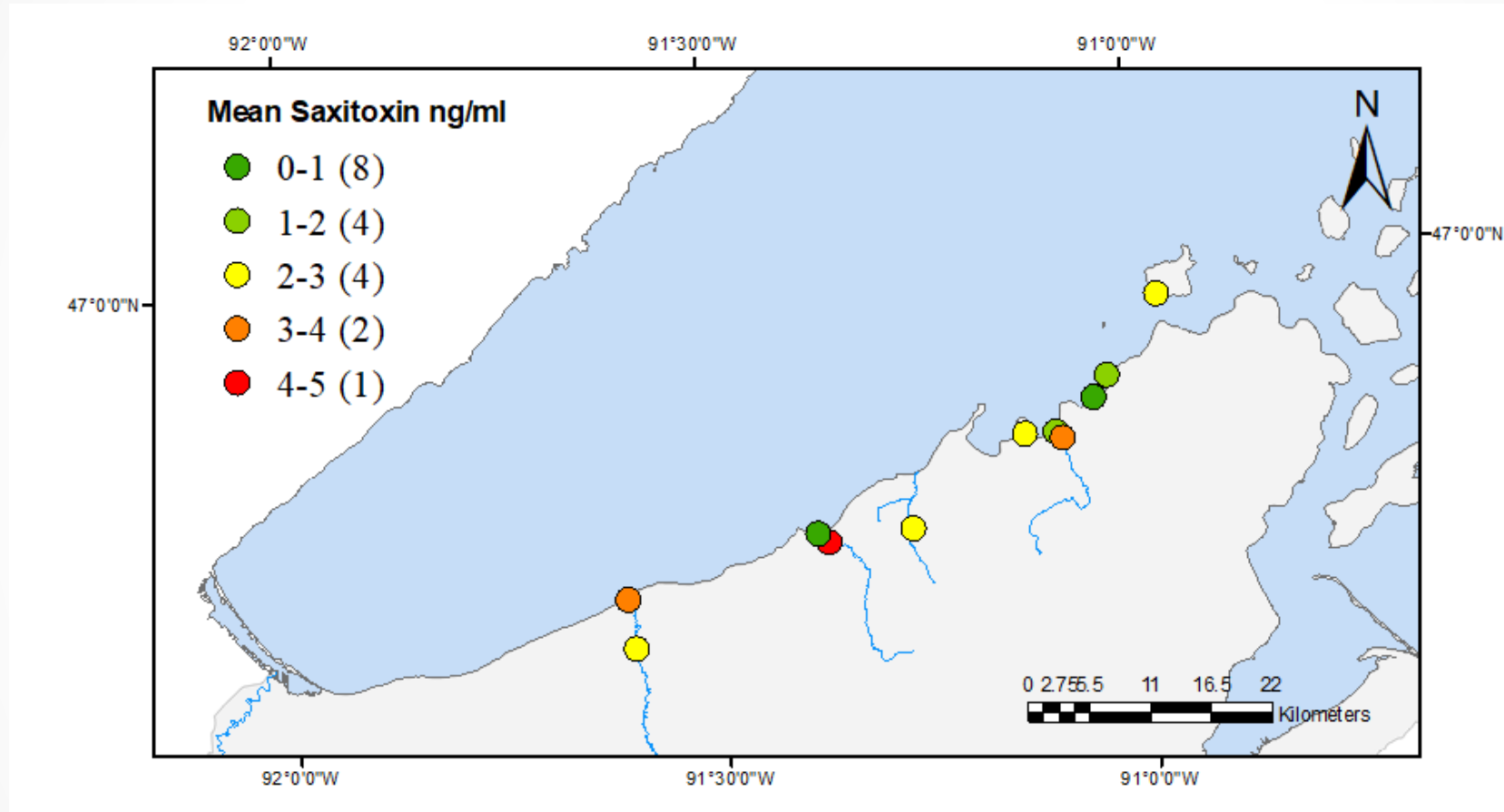
Algae Bloom in Lake Superior Raises Worries on Climate Change and Tourism



“...tests showed that none of its commonly occurring toxins were found in hazardous concentrations”

-New York Times Aug. 29, 2018

Presumptive Saxitoxin Concentrations



Where do the blooms originate from?

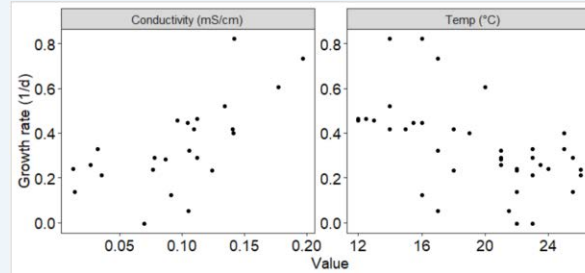
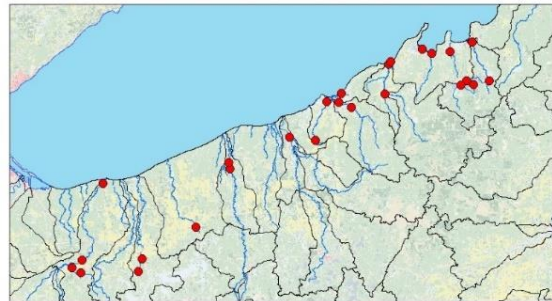
Incubation studies by PhD student Kaitlin Reinl, work ongoing.

| | | Lake | Harbor | Rivers |
|---------------------------|------|--|--------|--------|
| High molar N:P (50) | 15°C | 18 Combinations of Location x Nutrient x Temp | | |
| | 20°C | | | |
| | 25°C | | | |
| Low molar N:P (1.5) | 15°C | | | |
| | 20°C | | | |
| | 25°C | | | |

Incubated samples from three locations in different chemical and temperature conditions.



1. Dolichospermum grew from Harbor and River but not from Lake.



Growth = Temp. X Cond.
 $R^2=0.57$, $p=0.00015$

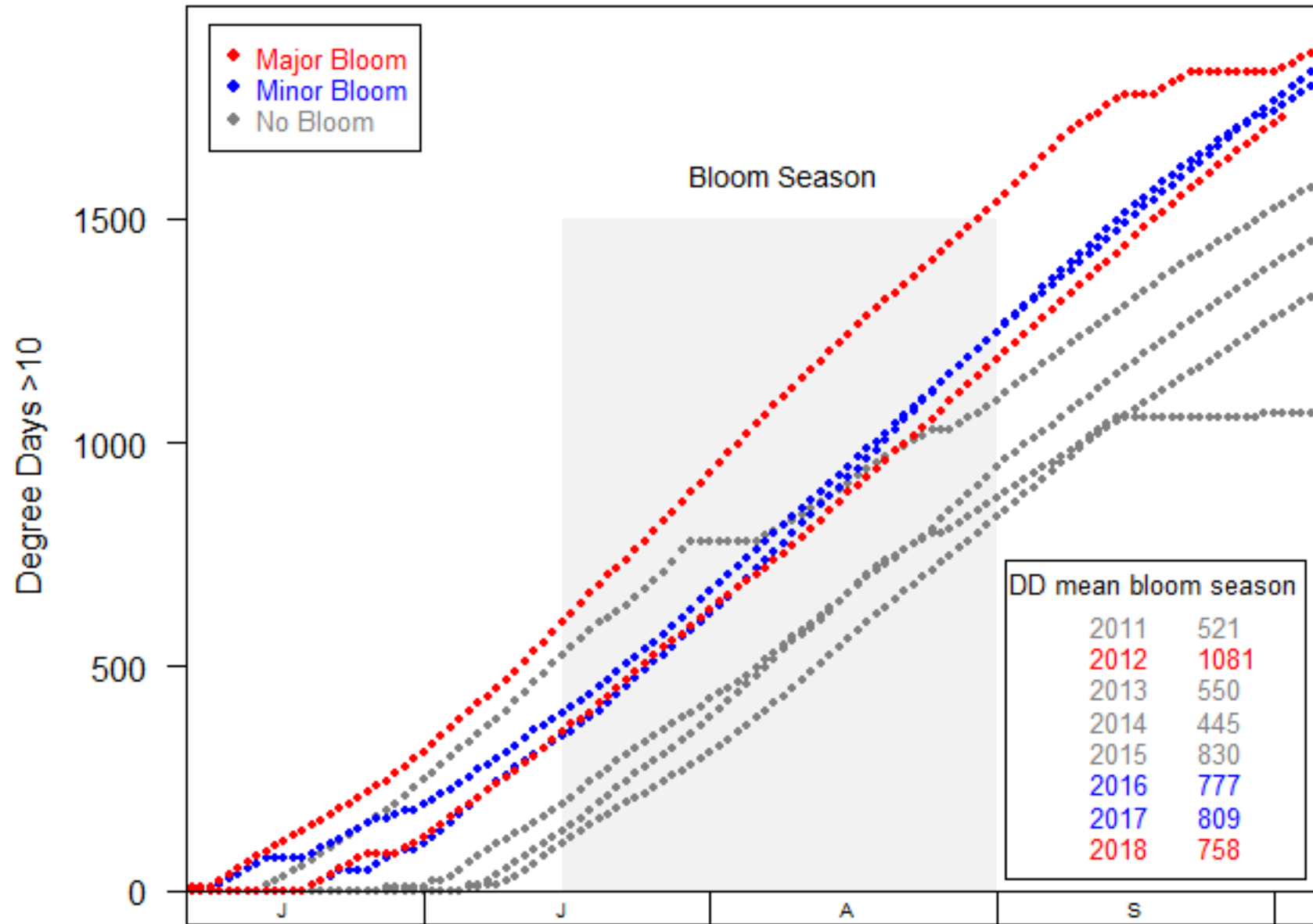
2. High conductivity and low temperatures were associated with increased potential for cyanobacteria growth



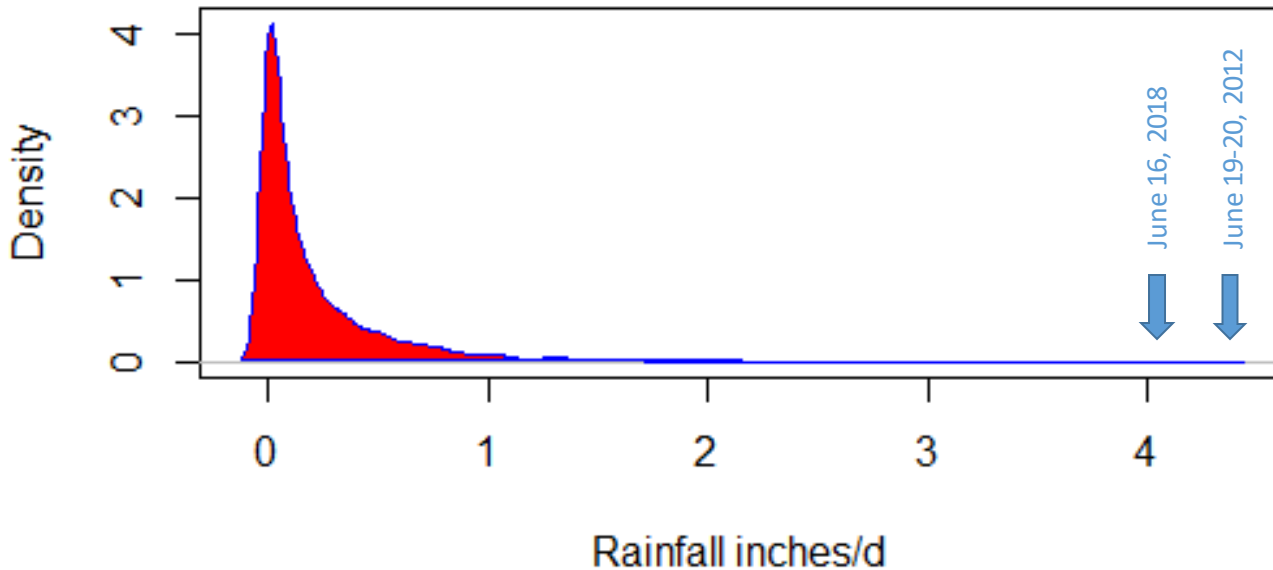
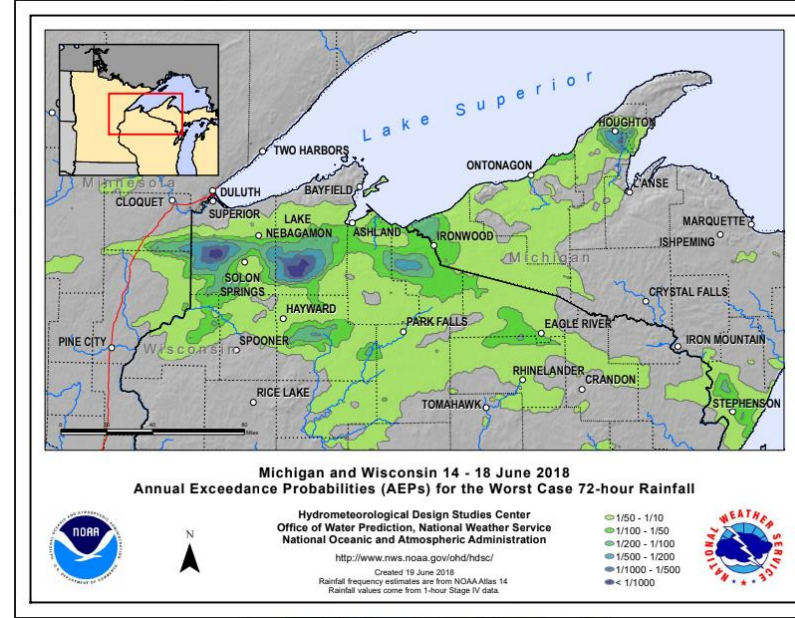
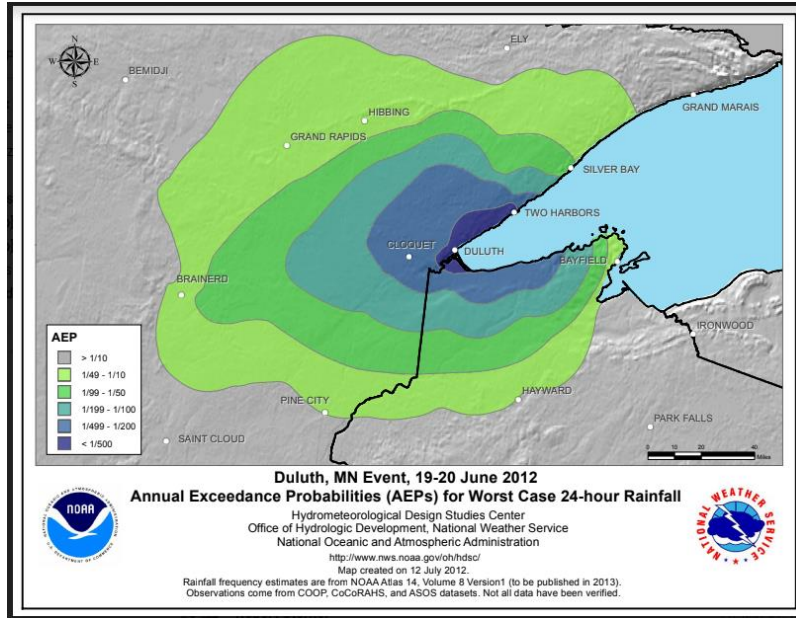
LARGE LAKES OBSERVATORY
UNIVERSITY OF MINNESOTA DULUTH
Driven to Discover

Bob Sterner

Degree days (> 10 C) shows clearly how blooms occurred in warm years.



The 2012 and 2018 storms were truly historic



Blooms occurred 25 (2012) and 53 (2018) days after the storms.

Coincidence?

Public Health Outreach

Ad hoc group for bloom notification to tribal & local public health agencies & other interested parties

April 29, 2019 “Blooms and the Big Lake” workshop with Wisconsin Division of Public Health and Lake Superior National Estuarine Research Reserve

DPH Staff Funding



Amanda Koch - DPH



Amanda Koch - DPH

Signs for tribal & local public health and other agencies

IS IT BLUE-GREEN ALGAE ...OR SOMETHING ELSE?

Blue-green algae are bacteria known as *cyanobacteria* and are a natural part of water bodies. With enough sunlight and nutrients, cyanobacteria can grow quickly and form a blue-green algae bloom.

- Blooms often look like spilled paint or pea soup and can change the color of the water to green, blue, turquoise, purple, tan, or white.
- Blue-green algae can produce toxins that can make people and animals sick.*
- In Wisconsin, blooms are most common in the summer, or May to September.
- Blooms have look-alikes, so use your best judgment when choosing a spot to swim. Do not swim in discolored water or where you see foam, scum, or algal mats.

HARMFUL

NOT HARMFUL



Green water that looks like pea soup



Long, hair-like filamentous green algae



Surface scum that looks like spilled paint



Yellow plant pollen



Floating globs or mats



Tiny, green floating plants (duckweed)

To learn more about blue-green algae and their health effects, visit www.dhs.wi.gov and search "algae"

Wisconsin Department of Health Services
Division of Public Health
Bureau of Environmental and Occupational Health
P-02421B (05/2019)

SCAN before you SWIM

A blue-green algae bloom may be present. Blue-green algae can produce toxins that can make people and animals sick.

Be alert! Avoid water that:



Is discolored or streaky



Looks like spilled paint or pea soup



Has floating scum, globs, or mats



Has small green dots floating in it

- ✓ Do not swallow lake water or touch foam, scum, or algal mats.
- ✓ Do not let pets swim in scummy water or lick algae off their fur.
- ✓ Rinse fish with fresh, clean water and throw away guts before cooking and eating.
- ✓ Do not swim in areas where you cannot see your feet in knee-deep water.

For questions, call _____

To learn more about blue-green algae, visit www.dhs.wi.gov and search "algae"

Wisconsin Department of Health Services | Division of Public Health
Bureau of Environmental and Occupational Health | P-02421C (05/2019)

CAUTION



BLUE-GREEN ALGAE (CYANOBACTERIA) BLOOM MAY BE PRESENT IN THE WATER

Blue-green algae can produce toxins that can make people and animals sick.

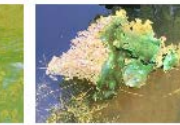
Be alert! Avoid water that:



Is discolored or streaky



Looks like spilled paint or pea soup



Has floating scum, globs, or mats



Has small green dots floating in it

- ✓ Do not swallow lake water or touch foam, scum, or algal mats.
- ✓ Do not let pets swim in scummy water or lick algae off their fur.
- ✓ Rinse fish with fresh, clean water and throw away guts before cooking and eating.
- ✓ Do not swim in areas where you cannot see your feet in knee-deep water.

Call your doctor, the Wisconsin Poison Center, or your veterinarian if you or your animals have sudden sickness or signs of poisoning.

Wisconsin Poison Center: 800-222-1222

For questions or to report a blue-green algae-related illness, call: _____

To learn more about blue-green algae and their health effects, visit www.dhs.wi.gov and search "algae"

WISCONSIN DEPARTMENT OF ENVIRONMENTAL AND OCCUPATIONAL HEALTH

BEACH CLOSED

BLUE-GREEN ALGAE (CYANOBACTERIA) BLOOM PRESENT

Blue-green algae can produce toxins that can make people and animals sick.



KEEP YOURSELF AND YOUR PETS OUT OF DISCOLORED WATER AND DO NOT TOUCH FOAM, SCUM, OR ALGAL MATS

Call your doctor, the Wisconsin Poison Center, or your veterinarian if you or your animals have sudden sickness or signs of poisoning.

Wisconsin Poison Center: 800-222-1222

For questions or to report a blue-green algae-related illness, call: _____

To learn more about blue-green algae and their health effects, visit www.dhs.wi.gov and search "algae"

Wisconsin Department of Health Services
Division of Public Health
Bureau of Environmental and Occupational Health
P-02421LR (05/2019)

Also available as bookmarks

<https://www.dhs.wisconsin.gov/water/bg-algae/health-pros.htm>

Thank you!



Environment and
Climate Change Canada
Environnement et
Changement climatique Canada



NORTHLAND
COLLEGE

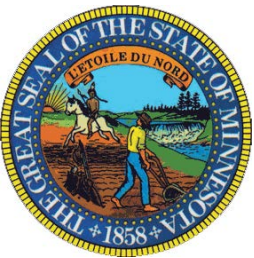
UMD
UNIVERSITY OF MINNESOTA DULUTH
Driven to Discover

UNIVERSITY of WISCONSIN
UWMILWAUKEE

Lakehead
UNIVERSITY

UNIVERSITY of WISCONSIN
Superior

WISCONSIN
UNIVERSITY OF WISCONSIN-MADISON



CSTE

Cooperative Institute for
Great Lakes Research
CIGLR
Great Lakes Science for Society

Extension
UNIVERSITY OF WISCONSIN-MADISON

mi MINNESOTA POLLUTION
CONTROL AGENCY

BATTELLE

