HARMFUL ALGAL BLOOMS
Potential Water Quality Challenges
Harmful Algal Bloom Research

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Ramsey County
Monday, March 18, 2019 | 4:00 p.m. - 6:00 p.m.
Acknowledgements:

State Agencies: MPCA, MDH

Local Government, Counties, Cities,

Researchers, colleges, universities

Educators

Home owners

……

YOU!

http://HAB.umn.edu
WATER WARNING

AVOID CONTACT WITH THE WATER

This water contains a blue-green algal bloom that can be harmful to humans and pets.

For your safety:
• Do not swim, waterski, or tube in the water
• Avoid swallowing water
• Stay away from areas of scum when boating

Photo: Prairie Lake algae3
TOPIC: HARMFUL ALGAL BLOOM RESEARCH

1. Algae - a quick look
2. Why do we care? Urgency, problem
3. Research:
4. Next
Lake system: Who eats who?

Algae is not a type, group, domain, or kingdom of living things, but rather a collection of various organisms represented from different aquatic groups that can make their own food and are autotrophs.

→ Any shape or form in almost anywhere in the world
Algae
many shapes, forms, and places

Suspended in water

Attached to other things

Attached to sediment

Bottom sediment

Phytoplankton

Periphyton

Photo courtesy of J. Pearson
Algae
many shapes, forms, and places

Algae are
good!

Architects of earth's atmosphere
3.5 billion years old

Movement of Chlamydomonas reinhardtii studied by Dr. Veikko Goyer at Max Planck researchers in Dresden, Germany.
Algae
many shapes, forms, and places

Muskgrass (Chara) – Filamentous algae also:
Spirogyra, Anabaena, Oscillatoria, Lyngbya

Forming mats! (maybe Lyngbya (bluegreen))

Free floating colonies or single cells
THE PROBLEM: THEY CAN GROW!

300bluegrealgaeLittle Rock Lake-impaired - MPCA - 11/06
The **problem**: they can grow!
Clear water

Visible algae

Nuisance

Harmful

The problem: they can grow!

Number of Microcystis cells per milliliter of water

0  10,000  100,000  > 1,000,000
Are all algae HABs?

Put the jar in the refrigerator and leave it undisturbed overnight (MPCA-wq-swm1-04)
Harmful Algal Blooms (HABs)

Microcystis
**Harmful Algal Blooms (HABs)**

**Drinking Water Health Advisories**

**ADVISORY LEVEL**

- Cyanotoxins detected in tap water at levels of concern.
- Cyanotoxins detected in tap water at levels of concern for young children and vulnerable populations.*
- Cyanotoxins not detected in tap water at levels of concern.

**ACTION**

- Do not drink tap water.
- Do not let children or vulnerable populations drink tap water.
- Drink tap water.
Why does it matter?

20% of MN rely on surface water as a source of drinking water
Blue-green algae in Minnesota lakes

Understanding and predicting harmful algal blooms

Algae blooms can turn water green and smelly, contribute to fish kills, and at times produce toxins that pose a health risk to people and animals. These types of algae blooms are referred to as Harmful Algal Blooms, or HABs, and their occurrence is on the rise in Minnesota lakes, streams and wetlands.

Algae occur naturally in almost all surface waters. They are an essential source of food for many aquatic organisms and come in many shapes and forms.

Under the right temperature and water conditions, blue-green algae (cyanobacteria) can grow very rapidly and form extremely high-density populations or “blooms.” These colonies can then float to the water surface and form a dense layer of scum.

More frequent HABs may be triggered by a number of factors, including urban and agricultural runoff and climate change.
Research areas

- Detection
- Tracking
- Monitoring
- Mitigation
- Education, outreach, training,...
Research areas
Detection & Tracking

TRACKING HARMFUL ALGAL BLOOMS (HABS) IN MINNESOTA LAKES
Sediment cores
To see changes through time!
Research areas
Detection & Monitoring

Meteorological & physical-chemical-biological conditions

Normal lake conditions with few algae

Rapid & excessive algal growth

Harmful Algal Bloom

Or

Toxic
Why the research?

- Detection
- Tracking
- Monitoring
- Mitigation
- Education, outreach, training, ...

Forecasting & Predication

Meteorological & physical-chemical-biological conditions

Rapid & excessive algal growth

Harmful Algal Bloom

Normal lake conditions with few algae

Or

Toxic

HAB
Prediction of Algal Blooms

Lake St. Croix and Madison Lake: Two Different Scales, Same Problem Cyanobacteria

Pool 4, Net Tow Sept 2013
Pearl Lake Algal Biomass

- Very good correlation to different classifications
- Dominant classification: cyanobacteria
- (measured data: mostly *Microcystis aeruginosa*)
- Cryptophyta / haptophyta late in year
Why the research?

- Detection
- Tracking
- Monitoring
- Mitigation
- Education, outreach, training...

Forecasting & Predication

Rapid & excessive algal growth

Meteorological & physical-chemical-biological conditions

Harmful Algal Bloom

Normal lake conditions with few algae

HAB

Toxic
**PHYLUM**

**GENUS**

**SPECIES**

CYANOBACTERIA

MICROCYSTIS

AERUGINOSA

---

**Cells**

3-8 µm

**Colony, mucilage, and bacteria**

**Large Colonies**

Missaghi 2012
MICROCYSTIS - HARMFUL ALGAL BLOOM

Rapid growth ➔ blooms ➔ scums ➔ issues

Surface water

~ > 3 ms\(^{-1}\)

~ < 2-3 ms\(^{-1}\)

bloom

scums

Die-off

Decomposition depleting DO

Toxin

339-774 µg g\(^{-1}\)
Lake Physical Lake Conditions

- The temperature is maximum in the surface layer during mid July and into August
- Madison Lake is warmer and the thermocline is less stable

We observe lake turnover in Madison Lake in mid August

Researchers: Anne Wilkinson & Jackie Taylor at SAFL
Solutions
Solutions
Examples of Algae Control Methods

- Copper Sulfate (Blue Crystals)
- Peroxide (Sodium Percarbonate Crystals)
- Pond Dyes For Shading
- Herbicides (Endothall)
- Alum or Aluminum Sulfate (Precipitate Phosphates)
- Ultraviolet (smaller ponds)
- barley straw,
  
  .......

Solutions
Solutions

WETLAND CONSERVATION

Protecting wetlands from development and agriculture can maintain a healthy environment for fish, wildlife & plants, and make it harder for toxic algae to take hold.

AQUATIC BUFFERS

Creating and maintaining natural buffers - using trees, shrubs and other plants - between farmland, development and waterways can help filter out excess nitrogen and phosphorus before they reach the water.

COVER CROPS

By planting farmland with cover crops instead of leaving the land bare between cash crops, farmers can protect soil from erosion and absorb excess fertilizer, helping to keep nutrients out of nearby waterways.
Ultimately: to be ready for (prediction) HABs

Then we can measure associated health & economical costs
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Potential Water Quality Challenges
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THANK YOU

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Ramsey County
Monday, March 18, 2019 | 4:00 p.m. - 6:00 p.m.
Algae bloom toxin linked to Alzheimer's, other diseases

In the late 1990s, Paul Alan Cox, Ph.D., an ethnobotanist currently at the Institute for Ethnomedicine in Jackson Hole, Wyo. and colleagues, began traveling to the Pacific island of Guam to interview Chamorro villagers who were suffering from a disease that was similar to Parkinson's, ALS (Lou Gehrig's disease) and Alzheimer's disease. The mysterious illness was first noticed by the U.S. military in the 1950s. Yet 20 years of research didn't turn up any clues.
During that time period, there were over 450 possible cases of illness associated with HABs. Of those, over 200 were identified as suspect/probable cases of illness associated with HABs, most related to ciguatera fish poisoning. From the original possible cases, over 170 (36%) were associated with a freshwater cHAB exposure. However, as with most cases of cHABs, very few were confirmed with positive findings for cyanobacteria/cyanotoxins and were classified as probable or suspect.
Why does it matter?

Motivation: Mobilizing MN communities to fight HABs & become resilient

20% of MN rely on surface water as a source of drinking water.
“Annie, Fannie, and Mike”

Blue Greens

- Unicellular, (non-N₂ fixing)
  *Microcystis*, *Gomphosphaeria*
  Mike

- Filamentous, non-heterocystous
  (mostly non-N₂ fixing)
  *Lyngbya*, *Oscillatoria*  
  Annie

- Filamentous, heterocystous (N₂ fixing) *Anabaena*, *Aphanizomenon*
  *Cylindrospermopsis*, Fannie
  *Nodularia*
  * Contains Toxic strains

Hans Paerl, UNC
Examples of Algae Control Methods

- Copper Sulfate (Blue Crystals)
- Peroxide (Sodium Percarbonate Crystals)
- Pond Dyes For Shading
- Herbicides (Endothall)
- Alum or Aluminum Sulfate (Precipitate Phosphates)
- Ultraviolet (smaller ponds)
- Barley straw,
What we know:
The problem

**Toxins produced by freshwater planktonic cyanobacteria**

<table>
<thead>
<tr>
<th>Toxin type</th>
<th>Primary organ affected</th>
<th>Produced</th>
</tr>
</thead>
<tbody>
<tr>
<td>microcystins</td>
<td>liver</td>
<td><em>Microcystis</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Anabaena</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Oscillatoria</em></td>
</tr>
<tr>
<td>anatoxins</td>
<td>nervous</td>
<td><em>Anabaena</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Aphanizomenon</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Oscillatoria</em></td>
</tr>
<tr>
<td>saxitoxins</td>
<td>nervous system</td>
<td><em>Anabaena</em></td>
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</tr>
<tr>
<td></td>
<td></td>
<td><em>Cylindrospermopsis</em></td>
</tr>
<tr>
<td>cylindrospermopsins</td>
<td>liver</td>
<td><em>Cylindrospermopsis</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Aphanizomenon</em></td>
</tr>
<tr>
<td>LPS</td>
<td>skin irritant</td>
<td></td>
</tr>
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</table>
Plankton (floating)

Zoo Plankton (heterotroph)

Phyto Plankton
Planktonic algae (autotroph; primary producers)

(bacteria) Blue-green algae (not very tasty to Zoos - HAB)

other algae .....
### What we know:
The problem

<table>
<thead>
<tr>
<th>Relative Probability of Acute Health Effects</th>
<th>Cyanobacteria (cells/mL)</th>
<th>Microcystin-LR (µg/L)</th>
<th>Chlorophyll-a (µg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>&lt; 20,000</td>
<td>&lt;10</td>
<td>&lt;10</td>
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<tr>
<td>Moderate</td>
<td>20,000-100,000</td>
<td>10-20</td>
<td>10-50</td>
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<tr>
<td>High</td>
<td>100,000-10,000,000</td>
<td>20-2,000</td>
<td>50-5,000</td>
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<tr>
<td>Very High</td>
<td>&gt; 10,000,000</td>
<td>&gt;2,000</td>
<td>&gt;5,000</td>
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</table>

https://www.epa.gov/nutrient-policy-data/guidelines-and-recommendations#what3
<table>
<thead>
<tr>
<th>TOXIN</th>
<th>ACUTE EFFECT</th>
<th>SYMPTOMS</th>
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<tbody>
<tr>
<td>Anatoxin-a</td>
<td>Neurotoxicity</td>
<td>Not documented</td>
</tr>
<tr>
<td>Anatoxin-a (s)</td>
<td>Neurotoxicity</td>
<td>Not documented</td>
</tr>
<tr>
<td>Cylindrospermopsin</td>
<td>Hepatotoxicity, renal toxicity, chromosome breakage, aneuploidy</td>
<td>Enlarged liver, malaise, anorexia, vomiting, headache.</td>
</tr>
<tr>
<td>Microcystin</td>
<td>Hepatotoxicity</td>
<td>Paresthesia and numbness of lips and mouth within ½ to 3 hours after exposure, extending to face, neck, extremities; motor weakness; incoordination; respiratory and muscular paralysis.</td>
</tr>
</tbody>
</table>
Altering the Microbial loop
WATER QUALITY IN RAMSEY COUNTY

John Manske
Environmental Services, Lake Management
RAMSEY COUNTY LAKE MANAGEMENT
SUMMER MONITORING PROGRAM

- 30 lakes sampled at deepest point
- Sampled 8 times between May 1st – September 30th
- Depth profile taken with sonde (DO, Temp, Cond, pH)
- Samples taken for in-house laboratory analysis
- 17 total parameters measured
- Aquatic vegetation monitoring
- AIS monitoring
- HAB risk assessment
HARMFUL ALGAL BLOOM RISK ASSESSMENT

• Based on the research of Steve Heiskary Et al. from the MPCA (5)
• pH >9.0
• Secchi <0.5 m
• Cyanobacteria Concentration >100,000 cells/mL
• Chl A Concentration >50mg/m³
RAMSEY COUNTY LAKE MANAGEMENT LABORATORY

Phosphorus (All forms)  Total Hardness
Nitrogen (All forms)    Total Alkalinity
Chloride               Total Nonfilterable Residue
Chlorophyll A          Volatile Nonfilterable Residue
Turbidity              E. coli
Phytoplankton          eDNA
Zooplankton
Zebra Mussel Veliger
<table>
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<td>C</td>
<td>C</td>
<td>D</td>
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<td>C</td>
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<td>WHITE BEAR</td>
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</table>
April 16, 2018

By the Numbers at MSP

0
Number of days that have been above normal so far this April

15.8
Storm total snowfall at MSP

15.9
Monthly temperature departure below normal

26.1
April monthly snowfall at MSP, new record (21.8” 1983)

37.0
Today’s forecast high temperature

58.0
Today’s normal high temperature

78.3
Inches of snow so far this season

Created by NWS Twin Cities – April 16, 2018
Records set in May 2018

• Warmest Mean Temperature in USA
• 6 days above 90°F in the Twin Cities
• Earliest 100°F day in the Twin Cities (May 28th)

Twin Cities were 8.7°F above average
Average Temperature in the epilimnion of all Ramsey County lakes monitored May-Sept

Average Chlorophyll A in the epilimnion of all RC lakes May-Sept
BALD EAGLE ALUMINUM SULFATE TREATMENT

Project Engineer:

Contractor:

Treatment 1: 2014
Treatment 2: 2016

The largest alum treatment in MN
Bald Eagle ChlA

Bald Eagle TP

Bald Eagle Secchi

Note: 2014 + 2016 Alum treatments

Link to Alum Treatment Project Page
Note: 2014 Zebra Mussel infestation confirmed
RAMSEY COUNTY LAKE MANAGEMENT WINTER MONITORING PROGRAM

- Dissolved oxygen monitoring/aerating
  - Como, Owasso, Island, Otter, Silver East, Beaver
- Chloride monitoring
  - Worked with MPCA to establish a state water quality standard for chloride. TCMA Chloride Project Link
  - A large number of lakes were categorized as impaired for aquatic life, or at high risk of becoming impaired.
WHERE DOES CHLORIDE COME FROM?

- Ramsey County uses 16,000,000 lbs/year to deice roads
- 700,000,000 lbs/year used in the Twin Cities Metro Area (1)
- 78% of this chloride is transported to surface or ground water in the TCMA

Table 1. Summary of annual road salt application amounts

<table>
<thead>
<tr>
<th>User</th>
<th>Use (Tons)</th>
<th>Use %</th>
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</thead>
<tbody>
<tr>
<td>MNDOT</td>
<td>80,797</td>
<td>23%</td>
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<tr>
<td>Counties</td>
<td>70,284</td>
<td>20%</td>
</tr>
<tr>
<td>Cities</td>
<td>114,314</td>
<td>33%</td>
</tr>
<tr>
<td>Commercial Bulk</td>
<td>66,349</td>
<td>19%</td>
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<tr>
<td>Packaged</td>
<td>17,460</td>
<td>5%</td>
</tr>
<tr>
<td>Total</td>
<td>349,204</td>
<td>100%</td>
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</table>
WHY IS CHLORIDE SO BAD?

- It takes only one teaspoon of salt to permanently pollute five gallons of water.
- There’s no easy way to remove salt from water.
- Causes osmotic stress to organisms
- Decreases the biodiversity of sediment organisms and plants(2)
- Increases the release and transport of heavy metals(3)
- 30% of wells in TCMA had chloride concentrations above the chronic water quality standard.
- Corrosive to most surfaces
<table>
<thead>
<tr>
<th>Location</th>
<th>n</th>
<th>Chloride Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring Lake</td>
<td>32</td>
<td>964</td>
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<tr>
<td>Little Johanna Lake</td>
<td>9</td>
<td>853</td>
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<tr>
<td>Brownie Lake</td>
<td>21</td>
<td>780</td>
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<tr>
<td>Kasota Pond North</td>
<td>70</td>
<td>533</td>
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<td>Battle Creek Lake</td>
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<td>Como Lake</td>
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<td>Silver Lake</td>
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Table 2: TCMA Chloride Management Plan - MPCA 2015
LAKES WITH A HIGH RISK OF CHLORIDE IMPAIRMENT

- Beaver
- Bennett
- Crosby
- Gervais
- Johanna
- Keller
- McCarrons
- Wabasso
- Wakefield
WHAT IS RAMSEY COUNTY DOING

- Set goals to decrease salt usage
- Track usage of salt with calibrated dispensers
- Prevent ice buildup by shoveling and plowing more often, or with better equipment.
  - Ramsey County recently purchased tungsten carbide plow blades for our trucks to improve ice and snow removal ($145,000)
- **MPCA Smart Salt Applicating Training and Tools**
- Use Salt brine when conditions allow
- Sweep up excess salt and reuse
Great Online Resources

**Improved Winter Maintenance: Good Choices for Clean Water**

**MN Key Water Info List**
http://es.metc.state.mn.us/KeyWaterList/#SurfaceWater

**Surface Water Data - MPCA**
http://cf.pca.state.mn.us/water/watershedweb/wdip/index.cfm

**Road Salt and Water Quality - MPCA**
https://www.pca.state.mn.us/water/chloride-salts
https://www.pca.state.mn.us/water/salt-applicators
REFERENCES


Salt pollutes.

When snow and ice melts, the salt goes with it, washing into our lakes, streams, wetlands, and groundwater. Once in the water, there is no way to remove the chloride, and it takes only one teaspoon of road salt to permanently pollute five gallons of water. Less is more when it comes to applying salt because at high concentrations, chloride can harm the fish and plant life in our waters.
Thank You Plow Drivers!

Ramsey County plow truck drivers work tirelessly to not only keep us mobile in the worst weather, but also focus on smart salt use using innovative equipment, technology, and know how to reduce chloride use on the roads.
Preventing New Infestations and Their Effect on Water Quality
March 2019 Forum

Justin Townsend
Aquatic Invasive Species Coordinator
Ramsey County
Parks and Recreation-Soil and Water Division
1425 Paul Kirkwold Drive
Arden Hills, MN 55117
651-266-7277
Justin.Townsend@co.Ramsey.MN.US
Friendly public service announcement: Not all aquatic plants or animals are bad. They require care like any landscape. Please take care of them.
What are we looking for?

Photos 1 & 2: Juvenile zebra mussel found on a settlement plate by a lake resident on August 18, 2018 in Bald Eagle Lake, Ramsey County.

Figure 1. Zebra mussels found in Lake Johanna, collected in 2018. Two distinct year classes were found (top numbers on ruler are in mm).
Why Should I Care?

- Zebra mussel shells are extremely sharp
- At scale they foul equipment (clogged engine intakes)
- Eat the base of the food chain fish species rely on
- Change water clarity increasing nuisance plants

https://bugwoodcloud.org/mura/mipn/assets/File/UMISC-2016/Tuesday/2/Fieldseth_McComas_ZebraMusselsWaterQualLakeMinnetonkaMN.pdf
Why Should I Care?

- Eurasian Milfoil, Starry Stonewort, Brittle Niad, Phragmites, and Flowering Rush are aggressive plants.
- They diminish the recreational value of lakes.
- Decrease or interrupt spawning habitat for fish.
- May have allelopathic (kills other plants) tendencies.

**Mission**
Prevent the Spread of Aquatic Invasive Species (AIS) and Protect Water Resources, Critical Aquatic Habitats and the Ecosystem Services Dependent on Them in Ramsey county.

Civic standards are the foundation achieving goals:
- All those impacted by the problem are stakeholders and help define the problem in light of civic principles and the realities of their situation.
- All stakeholders are accountable for contributing resources (leadership/time, knowledge, constituencies & dollars) to solve the problem.
- All stakeholders are engaged in decision-making and policy-making that contributes to the common good.
- All stakeholders implement policies grounded in civic principles in the places where they have the authority to act.

**Objective 1:** Prevent New Infestations

**Strategy 1:** Leverage science & data to optimize treatments and prioritize most critical points of intervention.

**Strategy 2:** Identify & Promote behaviors that can prevent AIS spread

**Objective 2:** Detect Infestations Early and New Infestation Response

**Strategy 1:** Support early detection best practices and research novel early detection methods

**Strategy 2:** Refine the new infestation response plan (NIRP) to optimize reach & impact

**Objective 3:** Minimize Existing Infestations

**Strategy 1:** Refine best practices to minimize Prohibited AIS

**Strategy 2:** Seek partnerships to fund management
Mission

Prevention

Strategy 1: Leverage science & data to optimize treatments and prioritize most critical points of intervention.

Tactic 1: Partner with US Forest Service (USFS) to develop formula to inform decision on inspector placement

Tactic 2: Recruit MNDNR trained AIS Ambassadors or volunteers

Tactic 3: Collect boat launch use and AIS law compliance data

Tactic 4: Fund county staff and/or contract for WIP inspectors

Strategy 2: Identify & Promote behaviors that can prevent AIS spread

Tactic 1: Reinforce good behavior for preventing AIS Spread

Tactic 2: Raise awareness of AIS

Tactic 3: Create an action plan to penalize behaviors that spread AIS

Tactic 4: Develop a grant opportunity for innovative projects in prevention

Early Detection and Response

Strategy 1: Support early detection best practices and novel detection methods

Tactic 1: Support Volunteer detectors to inspect each launch every month

Tactic 2: Professional services to inspect each launch and perform Point intercept surveys

Tactic 3: Train inspectors to complete boat launch AIS inspection each shift

Tactic 4: Support eDNA detection research by Ramsey County

Strategy 2: Refine the NIRP to optimize reach & impact

Tactic 1: Ensure $50,000 reserve

Tactic 2: Create a budget/criteria for spending NIRP fund

Tactic 3: Complete bottom hardness maps for all lakes with existing data

Minimize Infestations

Strategy 1: Refine best practices to minimize prohibited AIS

Tactic 1: Complete bioassays on zebra mussels

Tactic 2: Support completion of genotyping EWM in all lakes

Tactic 3: Complete bottom hardness maps for all lakes with existing data

Tactic 4: Develop a cooperative weed management program

Strategy 2: Seek partnerships to fund management

Tactic 1: Secure partners that have not funded treatments

Tactic 2: Present a model for cities to fund AIS treatment

Tactic 3: Develop funding mechanism and grant opportunity for innovative projects in management
What are we doing to address this?

We Inspect to:
• Raise awareness
• Gather data
• Educate

We analyze to:
• Refine inspections
• Reach more people
• Reduce the risk

We reduce the barriers to clean boats
• Provide the Knowledge
• Provide the tools
• Increase the social pressure to clean, drain, dispose

\[
\max_{x_{ik}, y_{jk}} Z = \sum_{j \in J} \sum_{l \in I} \sum_{k \in K} n_{ijk} (a_{ijk} + b_{ijk}) \\
\text{Subject to:}
\begin{align*}
a_{ijk} &\leq x_{ik} \quad \forall i,j,k \\
b_{ijk} &\leq y_{jk} \quad \forall i,j,k \\
a_{ijk} + b_{ijk} &\leq 1 \quad \forall i,j,k
\end{align*}
\]

Stop Here

Clean off aquatic plants and animals
Drain water and remove drain plugs
Dispose of unwanted bait in trash

Thank you for protecting Minnesota waters!
Early Detection

- Inspectors search daily
- Volunteer detectors search monthly
- Veliger Tows
- Contracted diver searches at each boat launch
- Cutting edge eDNA detection
Response

- Planning-developed the new infestation response plan
- Funding- contingency dollars via county prevention aid
- Collaborating-working proactively with lake associations, cities, and all stakeholders
- Bioassays to study chemical efficacy for zebra mussel treatment
- Working with the Minnesota Aquatic Invasive Species Research Center (MAISRC) on Eurasian Milfoil genotyping
New Infestation Response Plan

Jurisdiction

Primary Contact

DNR AIS Specialist, AIS Coordinator, County, City, and Watershed Districts/WMO will coordinate See Teams

Field Verification

New Infestation Verified

DNR Virtual Verification

Not a species of concern

Field Verification

See Survey for submission assistance

Submit to EDDMapS

See Teams

See Survey for services

Create map See Survey

Budget

Budgeted funds and actual expenses influence decisions

Choose Treatment and/or containment options

MPARS: Invasive Aquatic Plant Management Permit

Contact Proper Authority for Barrier Approval

Complete post-treat report. End response plan. Begin monitoring

Early Detection

Confirm Species

Survey see teams

Treatment see teams

See teams

See teams

Last Modified 5/17/2018

Please follow the Communication Plan throughout this process
**Bottom Line**

Invasions are hard to predict.
Watch your boats and lifts! Report new sightings.

*Ramsey County will work with you to be a county of excellence in AIS prevention*
Save The Date: May 17th 2019
Soil and Water Conservation Division Forum

Composting
Get Active. Become an AIS Detector.
Contact Justin if interested
Justin.Townsend@co.ramsey.mn.us
More Questions? Contact Us

Harmful Algal Blooms
• Shahram Missaghi
  – miss0035@umn.edu
  – 952-221-1333

Salt
• John Manske
  – John.manske@co.ramsey.mn.us
  – 651-266-7277

Aquatic Invasive Species
• Justin Townsend
  – Justin.townsend@co.ramsey.mn.us
  – 651-266-7277
Please Let us Know What is Working
Please take 3 minutes on Wednesday March 20th for a survey

https://www.surveymonkey.com/r/DCDN2NH

• How did you like this forum?
• Was the venue comfortable?
• What would you like to see at the next forum?

Don’t like computers? Contact Justin Townsend
justin.townsend@co.ramsey.mn.us or 651-266-7277 to take the survey
via phone or email.
WATER QUALITY IN RAMSEY COUNTY

John Manske
Environmental Services, Lake Management
RAMSEY COUNTY LAKE MANAGEMENT SUMMER MONITORING PROGRAM

- 30 lakes sampled at deepest point
- Sampled 8 times between May 1st – September 30th
- Depth profile taken with sonde (DO, Temp, Cond, pH)
- Samples taken for in-house laboratory analysis
- 17 total parameters measured
- Aquatic vegetation monitoring
- AIS monitoring
- HAB risk assessment
HARMFUL ALGAL BLOOM RISK ASSESSMENT

- Based on the research of Steve Heiskary Et al. from the MPCA (5)
- pH > 9.0
- Secchi < 0.5 m
- Cyanobacteria Concentration > 100,000 cells/mL
- Chl A Concentration > 50mg/m³
Phosphorus (All forms)  Total Hardness
Nitrogen (All forms)  Total Alkalinity
Chloride  Total Nonfilterable Residue
Chlorophyll A  Volatile Nonfilterable Residue
Turbidity  E. coli
Phytoplankton  eDNA
Zooplankton
Zebra Mussel Veliger
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<td>15.8</td>
<td>Storm total snowfall at MSP</td>
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<td>15.9</td>
<td>Monthly temperature departure below normal</td>
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<td>26.1</td>
<td>April monthly snowfall at MSP, new record (21.8” 1983)</td>
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<td>37.0</td>
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<td>58.0</td>
<td>Today’s normal high temperature</td>
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<tr>
<td>78.3</td>
<td>Inches of snow so far this season</td>
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</tr>
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</table>
Records set in May 2018

- Warmest Mean Temperature in USA
- 6 days above 90°F in the Twin Cities
- Earliest 100°F day in the Twin Cities (May 28th)

Twin Cities were 8.7°F above average
BALD EAGLE ALUMINUM SULFATE TREATMENT

Project Engineer:

Contractor:

Treatment 1: 2014
Treatment 2: 2016

The largest alum treatment in MN
Bald Eagle ChlA

Kendall's tau p=0.01 decreasing

Bald Eagle TP

Kendall's tau p<0.025 decreasing

Bald Eagle Secchi

Kendall's tau p=0.025 increasing

Note: 2014 + 2016 Alum treatments

Link to Alum Treatment Project Page
Note: 2014 Zebra Mussel infestation confirmed
RAMSEY COUNTY LAKE MANAGEMENT
WINTER MONITORING PROGRAM

- Dissolved oxygen monitoring/aerating
  - Como, Owasso, Island, Otter, Silver East, Beaver
- Chloride monitoring
  - Worked with MPCA to establish a state water quality standard for chloride. [TCMA Chloride Project Link](#)
  - A large number of lakes were categorized as impaired for aquatic life, or at high risk of becoming impaired.
WHERE DOES CHLORIDE COME FROM?

- Ramsey County uses 16,000,000 lbs/year to deice roads
- 700,000,000 lbs/year used in the Twin Cities Metro Area (1)
- 78% of this chloride is transported to surface or ground water in the TCMA

Table 1. Summary of annual road salt application amounts

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<th>User</th>
<th>Use (Tons)</th>
<th>Use %</th>
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<td>80,797</td>
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<tr>
<td>Counties</td>
<td>70,284</td>
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<tr>
<td>Cities</td>
<td>114,314</td>
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<tr>
<td>Commercial Bulk</td>
<td>66,349</td>
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<td>Packaged</td>
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</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>349,204</strong></td>
<td><strong>100%</strong></td>
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</table>
WHY IS CHLORIDE SO BAD?

• It takes only one teaspoon of salt to permanently pollute five gallons of water.
• There’s no easy way to remove salt from water.
• Causes osmotic stress to organisms
• Decreases the biodiversity of sediment organisms and plants(2)
• Increases the release and transport of heavy metals(3)
• 30% of wells in TCMA had chloride concentrations above the chronic water quality standard.
• Corrosive to most surfaces
<table>
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<tr>
<th>Location</th>
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<th>Average Chloride Concentration</th>
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<td>Kasota Pond North</td>
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<td>Parkers Lake</td>
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<td>418</td>
</tr>
<tr>
<td>Thompson Lake</td>
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<td>395</td>
</tr>
<tr>
<td>Kasota Pond West</td>
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<td>393</td>
</tr>
<tr>
<td>Wirth Lake</td>
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</tr>
<tr>
<td>Kohlman Lake</td>
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<td>387</td>
</tr>
<tr>
<td>Carver Lake</td>
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<td>373</td>
</tr>
<tr>
<td>Powderhorn Lake</td>
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<td>366</td>
</tr>
<tr>
<td>Battle Creek Lake</td>
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</tr>
<tr>
<td>Diamond Lake</td>
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<td>340</td>
</tr>
<tr>
<td>Tanners Lake</td>
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<td>308</td>
</tr>
<tr>
<td>Valentine Lake</td>
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<td>301</td>
</tr>
<tr>
<td>Sweeney Lake</td>
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</tr>
<tr>
<td>Peavely Lake</td>
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<td>259</td>
</tr>
<tr>
<td>Long Lake</td>
<td>5</td>
<td>256</td>
</tr>
<tr>
<td>Como Lake</td>
<td>8</td>
<td>250</td>
</tr>
<tr>
<td>Silver Lake</td>
<td>11</td>
<td>241</td>
</tr>
</tbody>
</table>

Table 2 TCMA Chloride Management Plan - MPCA 2015

Average chloride concentration when exceeding 230 mg/L
Lakes with a high risk of chloride impairment:

- Beaver
- Bennett
- Crosby
- Gervais
- Johanna
- Keller
- McCarrons
- Wabasso
- Wakefield
WHAT IS RAMSEY COUNTY DOING

• Set goals to decrease salt usage
• Track usage of salt with calibrated dispensers
• Prevent ice buildup by shoveling and plowing more often, or with better equipment.
  • Ramsey County recently purchased tungsten carbide plow blades for our trucks to improve ice and snow removal ($145,000)
• MPCA Smart Salt Applicating Training and Tools
• Use Salt brine when conditions allow
• Sweep up excess salt and reuse
Great Online Resources

Improved Winter Maintenance: Good Choices for Clean Water
MN Key Water Info List
http://es.metc.state.mn.us/KeyWaterList/ #SurfaceWater
Surface Water Data – MPCA
http://cf.pca.state.mn.us/water/watershedweb/wdip/index.cfm
Road Salt and Water Quality - MPCA
https://www.pca.state.mn.us/water/chloride-salts
https://www.pca.state.mn.us/water/salt-applicators
REFERENCES


Salt pollutes.

When snow and ice melts, the salt goes with it, washing into our lakes, streams, wetlands, and groundwater. Once in the water, there is no way to remove the chloride, and it takes only one teaspoon of road salt to permanently pollute five gallons of water. Less is more when it comes to applying salt because at high concentrations, chloride can harm the fish and plant life in our waters.
Thank You Plow Drivers!

Ramsey County plow truck drivers work tirelessly to not only keep us mobile in the worst weather, but also focus on smart salt use using innovative equipment, technology, and know how to reduce chloride use on the roads.
Preventing New Infestations and Their Effect on Water Quality

March 2019 Forum

Justin Townsend
Aquatic Invasive Species Coordinator
Ramsey County
Parks and Recreation-Soil and Water Division
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Arden Hills, MN 55117
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Justin.Townsend@co.Ramsey.MN.US
Friendly public service announcement: Not all aquatic plants or animals are bad. They require care like any landscape. Please take care of them.
What are we looking for?

Photos 1 & 2: Juvenile zebra mussel found on a settlement plate by a lake resident on August 18, 2018 in Bald Eagle Lake, Ramsey County.

Figure 1. Zebra mussels found in Lake Johanna, collected in 2018. Two distinct year classes were found (top numbers on ruler are in mm).

Photo Courtesy of Steve McComas or Bluewater Science

Photo Courtesy of MNDNR

Photo Courtesy of St. Cloud Times
Why Should I Care?

• Zebra mussel shells are extremely sharp
• At scale they foul equipment (clogged engine intakes)
• Eat the base of the food chain fish species rely on
• Change water clarity increasing nuisance plants

https://bugwoodcloud.org/mura/mipn/assets/File/UMISC-2016/Tuesday/2/Fieldseth_McComas_ZebraMusselsWaterQualLakeMinnetonkaMN.pdf

PHOTO BY BRAD HENLEY
Why Should I Care?

- Eurasian Milfoil, Starry Stonewort, Brittle Niad, Phragmites, and Flowering Rush are aggressive plants
- They diminish the recreational value of lakes
- Decrease or interrupt spawning habitat for fish
- May have allelopathic (kills other plants) tendencies

Mission
Prevent the Spread of Aquatic Invasive Species (AIS) and Protect Water Resources, Critical Aquatic Habitats and the Ecosystem Services Dependent on Them in Ramsey county.

Civic standards are the foundation achieving goals
- All those impacted by the problem are stakeholders and help define the problem in light of civic principles and the realities of their situation.
- All stakeholders are accountable for contributing resources (leadership/time, knowledge, constituencies & dollars) to solve the problem.
- All stakeholders are engaged in decision-making and policy-making that contributes to the common good.
- All stakeholders implement policies grounded in civic principles in the places where they have the authority to act.

Objective 1: Prevent New Infestations
- Strategy 1: Leverage science & data to optimize treatments and prioritize most critical points of intervention.
- Strategy 2: Identify & Promote behaviors that can prevent AIS spread

Objective 2: Detect Infestations Early and New Infestation Response
- Strategy 1: Support early detection best practices and research novel early detection methods
- Strategy 2: Refine the new infestation response plan (NIRP) to optimize reach & impact

Objective 3: Minimize Existing Infestations
- Strategy 1: Refine best practices to minimize Prohibited AIS
- Strategy 2: Seek partnerships to fund management
Mission

Prevention

Strategy 1: Leverage science & data to optimize treatments and prioritize most critical points of intervention.
  - Tactic 1: Partner with US Forest Service (USFS) to develop formula to inform decision on inspector placement
  - Tactic 2: Recruit MNDNR trained AIS Ambassadors or volunteers
  - Tactic 3: Collect boat launch use and AIS law compliance data
  - Tactic 4: Fund county staff and/or contract for WIP inspectors

Strategy 2: Identify & Promote behaviors that can prevent AIS spread
  - Tactic 1: Reinforce good behavior for preventing AIS Spread
  - Tactic 2: Raise awareness of AIS
  - Tactic 3: Create an action plan to penalize behaviors that spread AIS
  - Tactic 4: Develop a grant opportunity for innovative projects in prevention

Early Detection and Response

Strategy 1: Support early detection best practices and novel detection methods
  - Tactic 1: Support Volunteer detectors to inspect each launch every month
  - Tactic 2: Professional services to inspect each launch and perform Point intercept surveys
  - Tactic 3: Train inspectors to complete boat launch AIS inspection each shift

Strategy 2: Refine the NIRP to optimize reach & impact
  - Tactic 1: Ensure $50,000 reserve
  - Tactic 2: Create a budget/criteria for spending NIRP fund
  - Tactic 3: Complete bottom hardness maps for all lakes with existing data
  - Tactic 4: Support eDNA detection research by Ramsey County

Minimize Infestations

Strategy 1: Refine best practices to minimize prohibited AIS
  - Tactic 1: Complete bioassays on zebra mussels
  - Tactic 2: Support completion of genotyping EWM in all lakes
  - Tactic 3: Create a cooperative weed management program
  - Tactic 4: Support development of innovative projects in management

Strategy 2: Seek partnerships to fund management
  - Tactic 1: Secure partners that have not funded treatments
  - Tactic 2: Present a model for cities to fund AIS treatment
  - Tactic 3: Develop funding mechanism and grant opportunity for innovative projects in management
We Inspect to:
• Raise awareness
• Gather data
• Educate

We analyze to:
• Refine inspections
• Reach more people
• Reduce the risk

We reduce the barriers to clean boats
• Provide the Knowledge
• Provide the tools
• Increase the social pressure to clean, drain, dispose

\[
\begin{align*}
\max_{x_{ik}, y_{jk}} \quad & Z = \sum_{j \in J} \sum_{i \in I} \sum_{k \in K} n_{ijk}(a_{ijk} + b_{ijk}) \\
\text{Subject to:} \quad & a_{ijk} \leq x_{ik} \quad \forall i, j, k \\
& b_{ijk} \leq y_{jk} \quad \forall i, j, k \\
& a_{ijk} + b_{ijk} \leq 1 \quad \forall i, j, k
\end{align*}
\]
Early Detection

- Inspectors search daily
- Volunteer detectors search monthly
- Veliger Tows
- Contracted diver searches at each boat launch
- Cutting edge eDNA detection
Response

• Planning-developed the new infestation response plan
• Funding- contingency dollars via county prevention aid
• Collaborating-working proactively with lake associations, cities, and all stakeholders
• Bioassays to study chemical efficacy for zebra mussel treatment
• Working with the Minnesota Aquatic Invasive Species Research Center (MAISRC) on Eurasian Milfoil genotyping
New Infestation Response Plan

Jurisdiction

Primary Contact

- DNR AIS Specialist, AIS Coordinator, County, City, and Watershed Districts/WMO will coordinate [See Teams]
- Field Verification
- New Infestation [Verified]
- Not a species of concern
- DNR Virtual Verification

Early Detection

Confirm Species

Submit to EDDMapS

[See Teams] for submission assistance

Survey

[see teams]

See Survey

for services

Create map

[See Survey]

Treatement

[see teams]

Choose Treatment

and/or containment options

[MPARS: Invasive Aquatic Plant Management Permit]

Contact Proper Authority for Barrier Approval

Complete post-treat report.
End response plan. Begin monitoring

Budget

Budgeted funds and actual expenses influence decisions

Please follow the Communication Plan throughout this process

Last Modified 5/17/2018
Bottom Line

Invasions are hard to predict
Watch your boats and lifts! Report new sightings

Ramsey County will work with you to be a county of excellence in AIS prevention