Milfoil Advisory Group Agenda

WEDNESDAY NOVEMBER 25, 2020 – 4:00 P.M.

This meeting will be held using Zoom video/audio conference technology due to the COVID-19 restrictions currently in place.

Join online by visiting:
https://us02web.zoom.us/j/2698572603

Join by phone by dialing:
(312) 626-6799 -or-
(646) 518-9805

Then enter "Meeting ID":
2698572603

1. CALL TO ORDER
2. PUBLIC COMMENT
3. PANEL DISCUSSION/Q&A
    - Melissa DeSimone, Michigan Lakes and Streams Association
    - Zach Berry and Ryan Schauland, Aquatic Doctors Lake Management
    - Jason Broekstra and Andy Tomaszewski, PLM Lake & Land Management
    - Mike Smith, Mtt DASH Divers
    - Kim Arter – Laketon Township Supervisor/Bear Lake Association
    - Tentative: Mike Bauer – Huron Lakes Weed Control
4. COMMITTEE MEMBER COMMENTS
5. NEXT STEP
6. ADJOURN

Milfoil Advisory Group Meeting Minutes
November 11, 2020 4 p.m.
Remote/Zoom

Ken Trester called the meeting to order.

Present: Ken Trester, Garnet Lewis, Bob Shuchman, Patrick Burroughs, Tim Straker,
Staff Present: Karen Doyle Homan, Erin Wilkinson
Also Present: Scott Dean, Dan Callum

Introductions:

- Ken Trester, City Council, resident on harbor
- Pat Burroughs, resident on harbor, member of Harbor Authority, practiced Environmental Law, Civil Engineering degree from Michigan Technological University
- Bob Shuchman: Resident, boater, co-director of Michigan Technological Research Institute, working on DNR grant researching environmental & water quality contaminated sediments of entire harbor area
- Garnet Lewis: City Council Mayor Pro-Tem, resident on harbor
- Tim Straker: Resident, Chairman of Historic District Commission, boater, passionate about the health of the harbor and its role in vitality of the community
- Scott Dean: City Council, resident, boater, paddle boater, executive with Michigan Department of Environment, Great Lakes and Energy
- Dan Callum, Greenway Manager, Outdoor Discovery Center

First Task: Evaluate best approach

Herbicide: The Kaiser & Associates study, completed two years ago, recommend proceeding with herbicide treatment. There was negative reaction from Outdoor Discovery Center and others regarding the effectiveness and consequences of using herbicides in the lake. Using algaecide with flow may be an issue.

Cutting or harvesting will send fragments to root elsewhere. Perhaps the flow of the water will take fragments to deeper water where it can't take root.

Diver Assisted Suction Harvesting (DASH) reduces the problem of drifting milfoil. It is labor intensive and costlier.

Weevils eat the milfoil but the company that provided weevils no longer offers the service.

Dredging. Eurasian milfoil likes 5' or shallower water but it has been found in 7' of water. Transparency of the water is an issue in that if light gets further down milfoil can take root in deeper water. If dredging is possible would need to dredge to 10' depth.

Discussion

Duckweed and Milfoil-are they connected? Duckweed floats, milfoil grows from the bottom. Milfoil is acting as a collection device; duckweed gets caught up in the milfoil. Some of the floating milfoil/duckweed pods are a result of milfoil getting cut upstream—usually from boaters. It is coming from Blue Star and then hooking a right into the harbor but is not seen further up river. If we had better circulation if would float out to the big lake as it used to do. The docks sitting on high water are also acting as surface barriers decreasing the natural cleaning out that would normally occur with lower water levels.

Silting is occurring and will continue to be an issue. When the water goes down more of the harbor will be subject to the milfoil. Even with the high water there are a lot of areas under 10' of depth.

Pat Burroughs shared his experience with the milfoil problem while living on Lake Columbia. They tried harvesting; it was just an expensive problem every year. The Homeowners Association went to chemical treatment and it is keeping the weeds under control. They're not having problems with the riparian owners objecting. The treatment lasts three years before it has to be treated again. Pat will get the details of the algaecide used and the company that treated it.

The smell? It is duckweed.

Next Step

Find out what our neighbors have done. Learn from them so as to not repeat a costly mistake. For example, Port Sheldon. The difference between last year and this year is remarkable. They conquered their Eurasian Milfoil problem.

Interim City Manager will contact Grand Haven, South Haven, Whitehall and other communities.

Our timeline is ambitious. We must decide on our approach, do cost benefit analysis, get riparian owners to agree, and decide how to pay for it.

The next meeting will be November 25, 2020 at 4 pm.

Advisory group adjourned at 5:48

City Manager

From: Harbor Master <HarborMaster@cityofharborsprings.com>
Sent: Thursday, November 19, 2020 3:57 PM
To: City Manager
Subject: RE: Looking for Advice Invasive Species

Follow Up Flag: Flag for follow up
Flag Status: Flagged

Karen- At least 8 years ago we had quite the "bloom" of EWM in slips located on the east side of our marina. At that time our main floating dock was essentially sitting on the bottom so our suspicion was that with the lack of water movement caused by the dock acting as a breakwater the milfoil had a chance to propagate. We had a company come in and surface spray all of our east dock slips which seemed to work fairly well. The next year we dredged the entire marina to an average depth of 10 feet which essentially removed any leftover EWM.

Since then we have not experienced a recurrence of EWM in our slips and with the increase in high water levels our main east dock is now off the bottom again allowing water to move around the dock.

Good luck with your project!!

Michael Johnson
Harbormaster
City of Harbor Springs

From: City Manager [mailto:citymanager@saugatuckcity.com]
Sent: Wednesday, November 18, 2020 12:15 PM
To: Harbor Master
Subject: Looking for Advice Invasive Species

The City of Saugatuck's Kalamazoo Lake Harbor has had an issue with the invasive species Eurasian Water Milfoil (EWM). Last year Council was not able to make a decision on the best way to treat it, herbicide or less invasive means, so nothing at all was done. This year, hoping to avoid that, we've formed an advisory group that has been tasked to recommend the treatment by the end of January.

I am looking for other Lake Michigan cities who have had experience with the invasive plant. Has Harbor Springs had EWM?

Karen Doyle Homan
Interim City Manager
City of Saugatuck
O: 269-857-2603 Ext 104
C: 616-520-5131

City Manager

From: Howard Baumann <howard@portsheldontwp.org>
Sent: Wednesday, November 11, 2020 6:12 PM
To: Dan Callam
Cc: David Nyitray; City Manager
Subject: RE: Harbor Navigation At Port Sheldon

Follow Up Flag: Flag for follow up
Flag Status: Flagged

Hello Dan,

Five to six years ago Pigeon Lake was experiencing the same problem with the invasive Eurasian Watermilfoil (EWM) as you mentioned Saugatuck is currently facing. Property owners including a homeowners Association (Port Sheldon Beach) adjacent to the lake petitioned our Township Board in early 2017 to establish a Special Assessment District (SAD) for the treatment of the lake. The Board went through the proceedings to establish the SAD.

We contract with PLM Lake and Land Management Corp. on a year to year basis for the treatment of the lake. The SAD was established for 5 years, 2017-2021. Very good results were evident after the first year of treatment. The fourth year has been completed this past summer also proving good results.

If you have further questions please feel free to contact me by phone or email.

Thank you,

Howard

Howard Baumann, Jr.
Port Sheldon Township, Supervisor
Ph.- 616-399-6121
Fax- 616-399-7173

From: Dan Callam [mailto:danc@outdoordiscovery.org]
Sent: Wednesday, November 11, 2020 4:53 PM
To: Howard Baumann <howard@portsheldontwp.org>
Cc: David Nyitray <david@outdoordiscovery.org>; City Manager <citymanager@saugatuckcity.com>
Subject: Harbor Navigation At Port Sheldon

Hi Howard,

I hope things are well up in Port Sheldon Township. I was just in a meeting with some folks in the City of Saugatuck, who are looking at a treatment for invasive water millfoil that is clogging their harbor. One of the members of the committee noted that in travelling to Pigeon Lake that there were significantly fewer weeds in the lake this year compared to years past. Do you happen to know if there was any sort of dredging or treatment in the lake that has cleared things out? If you or a contact you have can help us understand your problem, that

might go a long way to helping Saugatuck deal with their problem. Any help you can provide would be greatly appreciated. Thanks!

Dan

--
Dan Callam
Greenway Manager
ODC Network
Main: 616-393-9453 Direct: 616-368-7005
www.outdoordiscovery.org

Lake Leelanau
LAKE ASSOCIATION

Fall 2019

News & Views from the Watershed

Late Summer Sunset
Photo Credit: Cathy Fisher

In this issue

LAKE LEELANAU LAKE ASSOCIATION · FRIENDS OF THE LAKE ·

Board Directory

OFFICERS

Tom Hiatt, President
317-590-7376 tom@thomashiatt.com
Kathy Birney, Vice President / Treasurer
248-930-5231 kbirney@leelanauconservancy.org
Cindy Kacin, Secretary
231-256-8873 cakacin@charter.net
George Prewitt, Past President
231-499-4470 geoprewittjr@charter.net

TOWNSHIP REPRESENTATIVES

John Popa, Bingham
231-947-1088 jjpopa@charter.net
Jamie Damm, Centerville
231-228-2409 jamiedamm@gmail.com
Robert Bosch, Elmwood
231-421-1676 rbosch10@yahoo.com
Wayne Wunderlich, Leland
231-256-9294 cedarhavencot@hotmail.com
Jeff Green, Leland
231-866-1105 green@indiana.edu

COMMITTEE CHAIRS

Lonnie Rademacher, Fish
517-303-9616 radema43@gmail.com
Hugh Farber, Water Quality
231-256-7187 hughnbetty@gmail.com
Brian Price, Lake Biologist
231-409-9080 brprice11@gmail.com
Bonnie Gotshall, Water Safety
231-929-2177 gotshall2002@hotmail.com
Barb Kobberstad, Membership
231-218-1033 bkobberstad@gmail.com
Patrice Korson, Newsletter
231-994-2000 korsoncreative@gmail.com
Steve Lindo, Marketing & Fundraising
612-865-6647 steve.lindo@gmail.com
David Baty, Website & Social Media
david@lakeleelanau.org

A Letter from the President *by Tom Hiatt, President*

Dear Friends of Lake Leelanau,

After a late wet spring, it was a beautiful summer on Lake Leelanau. As you reflect on your summer, I hope that it was filled with many pleasant memories of time on a boat or on your deck, watching cloud formations or the sun rise over the water, swimming, picnicking or perhaps sitting in the shade listening to the birds. Our family did all of these things, and the time we spent together in and around Leland brought us all closer together.

Although I have served as the Association's President only a few months, this past season has been particularly momentous for your Association.

As you know, the primary focus of our Association is to protect and to preserve the beauty and water quality of Lake Leelanau and its surrounding watershed. As a small research-based nonprofit, we are concerned about organisms, large and small, which can upend the delicate biology of our lake's ecosystem, or which interfere with our members' ability to enjoy the lake.

As we report extensively in this issue of our newsletter, we have recently identified a new and very serious threat to the health and to our collective enjoyment of Lake Leelanau: Eurasian Water Milfoil (EWM), the most invasive and troublesome aquatic plant in North America. Left unchecked, this weed will almost certainly grow rapidly and irreversibly change our lake's ecosystem. It will make swimming unpleasant, boating problematic and likely lead to a reduction of property values.

The weed has created all of these problems and more in lakes throughout the United States and Canada, particularly in those where its growth has not been checked.

Continued on page 11

Eurasian Water Milfoil

North America's Most Invasive Aquatic Plant Found in Lake Leelanau

by Brian Price, Lake/Watershed Biologist

This past summer Eurasian Water Milfoil (EWM) was found in significant amounts in South Lake Leelanau. According to MSU Extension's guide, this invasive plant is known for its ability to "take over a lake, crowding out native species and creating a recreational nightmare."

Fragments of EWM were found near the south end of Lake Leelanau in the summer of 2018, leading the LLLA to conduct a search in the summer of 2019 to locate the sources of EWM and to formulate a plan to control its spread. In early July, EWM was found in three locations in South Lake Leelanau.

Why Eurasian Water Milfoil is a Major Problem

EWM was accidentally introduced to North America in the 1940s. Since then the weed has spread to nearly every state, becoming the most important and widely managed aquatic nuisance weed in the country.

Some of the reasons that this plant is "public enemy number 1" include:

• EWM grows in extremely dense beds, crowding out native species. It grows so densely that birds are occasionally seen walking on the emergent plant stalks, swimmers become entangled, and boat props are fouled with weeds.

• The plant produces viable seeds, plus it spreads rapidly when fragments break off and then re-root in new areas. Boats traveling through beds of EWM typically break off fragments which are then transported and deposited in a new area.

• EWM grows well in sandy and soft sediments, typically in waters from 7-12 feet deep.

• EWM has the potential, if left unchecked, to "take over" a lake. For example, in Lake George in New York, EWM increased from 15% to 95% of the lake's rooted plant community in just two years.

• EWM is capable of hybridizing with native watermilfoil (which is also present in Lake Leelanau). The hybrids can be very aggressive and highly invasive, and extremely resistant to traditional biological and chemical control methods.

• Because it is such a dense and widespread nuisance weed, EWM has the potential to severely affect boating and other recreational activities.

• When unchecked, EWM can and has become the dominant rooted aquatic plant in many lakes in North America. In such instances, it has caused significant disruptions to the ecological balance of a lake, adversely affecting both fish populations and property values.

After finding EWM in three locations in Lake Leelanau early in July, an initial survey of the entire perimeter of South Lake Leelanau was conducted in waters ranging from 5-20 feet deep. An additional eight infestations were documented, bringing the total number of known beds of EWM to 11. Most of these beds of EWM are compact and dense and easily identified from a boat on calm days in late summer, when the strands of milfoil reach nearly to the surface of the lake.

Based on this preliminary survey, we estimate that EWM covers an area of approximately ten acres in Lake Leelanau, with by far the largest concentration along the east side of the south lake about 2-3.5 miles north of the Bingham Boat Launch. (See map) No Eurasian Water Milfoil has been found in North Lake Leelanau….yet.

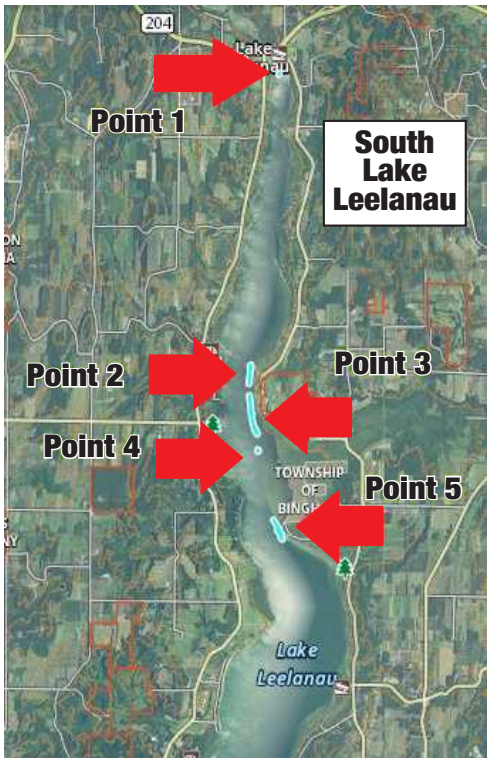
Tackling EWM in Lake Leelanau

Drone videos taken from 2017 through 2019 show that EWM has expanded rapidly in the past two years. We believe that EWM, if left unchecked, will become a major nuisance in Lake Leelanau. This conviction is based on the experience of other lakes in northern Michigan (Higgins, Houghton, and Long Lake, among many others), on the amount of available habitat in the 5-15 foot water depth range, and on the experience of homeowners and scientists attempt-

Tackling the Newest & Most Dangerous Threat to Lake Leelanau

ing to control the weed in many other states and in Canada. Indeed, EWM is already a problem in most states with freshwater lakes. Certain areas, such as the south end of Lake Leelanau and areas within several miles of the Narrows, have extensive areas of shallow water, which provide a suitable habitat for EWM.

Because EWM is the most noxious and widely distributed aquatic weed in North America, many different methods of control have been tested to control and manage it. Each of these methods has drawbacks. Where EWM is widely established and covers a significant percentage of surface area in a lake, control efforts usually center on either mechanical harvesting or chemical treatment. Mechanical harvesting is not being seriously considered for Lake Leelanau, as it can create loose fragments that re-root in new locations. It is also costly and generally does not remove the root, so plants grow back over the course of the summer. Chemical treatment has been used with mixed success on many Michigan lakes: according to available reports, EWM beds die back for several years, then usually reappear, necessitating further treatment. Biological controls have also been tried, but the results have been disappointing.



Over the past ten years, a system of harvesting Eurasian Water Milfoil plants, in their entirety and by hand has been employed by an increasing number of lakes in northern states. The system, dubbed DASH (Diver Assisted Suction Harvesting), deploys divers operating from a barge. The diver feeds the milfoil stems into a large suction hose which transports the plants to the barge where the milfoil is trapped in mesh bags and transported to shore for composting. The process is costly and time-consuming, but has the advantage of removing whole plants. Lakes which have employed this system report about 95% success in preventing re-sprouts. Follow-up control is necessary for at least two years, but the volume of EWM harvested drastically declines over time.

Above: This map shows the locations of identified EWM infestations in the South Lake.

Left: Boats traveling through mats of EWM can get hung up on the thick strands.

Below: Swimming in areas of EWM is unpleasant and can be dangerous.

The DASH system has several advantages to a lake in the early stages of an infestation. Among them:

- Only the targeted species is removed, leaving native rooted plants to provide competition to the invasive plant
- Fragments are captured by the use of turbidity screens (much like a construction site fence)
- No toxic chemicals are introduced into the lake
- Once control is achieved, management costs usually decline significantly in succeeding years.

The DASH system works best in the early stages of an EWM infestation. Once established, it may not be possible for the harvest rate to exceed the rate of expansion. On Lake Leelanau we believe we are catching the problem early enough to effectively use the DASH removal method, and based on our current analysis, it seems to be the most appropriate remediation strategy.

The LLLA entered into a contract with Mike Smith of MTT Dash Divers, an experienced Michigan-based

contractor. Mike and his crew began work in early October to remove EWM in the highest traffic areas of the lake (see photos at right and on page six). While they expected to work for a week, gusty winds and cold water temps allowed just five days on the lake, but in that time they were able to harvest over 500 lbs of plants.

Mike is happy with the results, and has stated that working on the project this fall has given him a good orientation, and he has ideas of how to move the project along very efficiently next spring. He anticipates employing two boats and four divers when the project commences in June.

Lake Association's Action Plan for Tackling EWM in 2019 and 2020

by Tom Hiatt, LLLA President

Shortly after the discovery of EWM in South Lake Leelanau, the leadership of LLLA mobilized quickly to address what the Association considers to be the most important existential threat to Lake Leelanau's ecosystem.

The Association has taken the following steps:

1. Brian Price, LLLA's biologist, conducted an initial survey of South and North Lake Leelanau, seeking to locate and document the locations and size of the beds of EWM.
2. The Association leadership briefed LLLA members on the discovery of EWM at the Association's Annual Meeting in late July and at the Association's Legacy event for major donors in mid-August.
3. In addition, the Association's leadership prepared background information and briefed a reporter for an article about the discovery of EWM which appeared in the September 5, 2019 edition of the Leelanau Enterprise.
4. After researching control alternatives, LLLA identified a professional contractor, experienced in using the hand removal method to begin work in Lake Leelanau, once the required permits were received.
5. In early October, The State of Michigan issued LLLA a permit to begin removal operations on a limited scale.
6. The team got to work in early October and successfully removed over 500 lbs of EWM from the high traffic area near the Narrows (South LL).

DASH boat arrives at the site of the large infestation near the Narrows to begin work.

DASH boat releases a turbidity screen, which will contain any plant fragments and prevent further spreading of EWM

Removing EWM. Diver is in water near the orange float. Turbidity curtain can be seen in the distance.

The Association will apply for another permit to undertake the larger scale operation planned for next summer.

7. The State requires that written permission must be obtained from owners of adjacent properties in advance of weed removal operations. These permissions were obtained from 11 owners of properties adjacent to those areas the Association expects to treat first.

8. The Association also plans to engage an experienced professional researcher to complete a comprehensive survey of all the aquatic vegetation in the entire lake during the summer of 2020. We want to make sure that we not only find and document the location of all EWM beds, but we also want to identify and document the presence of any other invasive plants as well as the location of major beds of beneficial native plants so that we will have a comprehensive audit and record of the lake's aquatic plant population.

9. These efforts—to remove as much EWM from Lake Leelanau as possible (total eradication is unlikely) and to establish an ongoing monitoring and maintenance program so that the plant never gains an upper hand in future years—will be expensive. Based on our current incomplete understanding of the extent of the problem, the Association tentatively estimates the cost for remediation, management, education and communication will be approximately $150,000-$200,000 during 2019-2020.

10. Recognizing the urgency and importance of this threat, as well as the need to take immediate action, the leadership of the Association has initiated a fundraising campaign to cover the costs of this work. To date, we are pleased to report that we have raised approximately $50,000—enough funds to begin work but certainly not yet enough to cover the removal costs of the known beds of EWM in Lake Leelanau.

11. The Association urgently needs your help supporting this critical initiative. This threat is, without exaggeration, the single most important threat to the quality of Lake Leelanau that we may face in our lifetimes.

12. The Association is a registered nonprofit organization. Contributions to the Association are tax-deductible as allowable by law. Contributions designated for the EWM program may be mailed to Ms. Kathy Birney, Treasurer, Lake Leelanau Lake Association, PO Box 123, Leland, MI 49654-0123. Or additionally, contributions can be made via a "Go Fund Me" account which has been established to receive contributions online: *https://www.gofundme.com/f/6jjtng*

Plants are received from the suction hose onto the barge, where they are bagged up for composting.

Turbidity curtain is retrieved with any plant fragments or disturbed sediment, for disposal.

Diver, Mike Smith warms up on the barge, after much time spent on the floor of South Lake Leelanau.

What You Can Do to Address the EWM Challenge

by Barb Kobberstad, Membership Chair

Everyone who lives on Lake Leelanau can and must work together to address the threat Eurasian Water Milfoil presents to the Lake's ecosystem. While this is a significant problem, the Association believes it is a manageable one—if we all pitch in and help. Quite frankly, if we don't, this aggressive and noxious invasive weed can take over Lake Leelanau, as it has infested many other lakes in North America. We simply cannot let that happen.

Here's What You Can Do To Help

Contribute. The initiative to combat Eurasian Water Milfoil on Lake Leelanau will be the costliest project ever undertaken by the Lake Leelanau Lake Association. As Tom Hiatt, the Association's President, mentions in his article on the previous two pages, we are currently expecting to raise and spend between $150,000-$200,000 over the course of the next 18 months. In subsequent years, we believe remediation costs may be less, but we will be operating a continual maintenance program for the indefinite future, finding EWM and removing it promptly to seek to prevent it from getting out of control any time in the future.

Join. Of the approximately 1400 property owners on North and South Lake Leelanau, currently 370 are active members. I would hope each current member would contact their neighbors and friends and encourage them to join this fight against EWM. Explain to them the threat this invasive plant poses. Ask them to join LLLA as members. The financial burden to control this problem belongs to all who live on our beautiful lake. In addition, if you are financially able to increase your membership level, please do so. This can be accomplished by visiting www.lakeLeelanau.org or by mailing checks to P.O. Box 123, Leland, MI 49654.

EWM has 4 'leaves' in each whorl with about 16 leaflets on each side of the stem as shown here

Learn to Identify and Report EWM. Eurasian Water Milfoil is easily identified but can be confused with native milfoil or even native coontail. (See photo below). If you find this plant in the southern half of South Lake Leelanau or anywhere in North Lake Leelanau (areas currently not believed to be infested) please report your findings to Brian Price at brprice11@gmail.com.

Don't Spread Aquatic Weeds. If you pick up aquatic weeds on your boat or prop, remove the weeds immediately. Put them in your boat for disposal on land. Never throw them back in the lake!

Wash Your Boat if Coming from Another Watershed. EWM is just one of the aquatic invaders that have reached Lake Leelanau by hitching a ride on a boat or trailer. Other noxious aquatic plants may be on their way, including curly pondweed and starry stonewort, two other troublesome invaders not yet found in our lake. The State of Michigan requires you to wash your boat after leaving one watershed before placing it in another.

Support Efforts to Establish Permanent Boat Washing Facilities. There are nine public boat launches on Lake Leelanau. None have boat washing stations. Everyone who lives on or near Lake Leelanau, or who uses the Lake for recreational purposes, should speak with any local public officials they know and advocate for the installation of boat washing stations to make it easier for boat owners to clean their boats before entering the Lake.

Volunteer. The Association needs volunteers to help mobilize the community to tackle this threat. In order to treat larger infestations in the Lake, volunteers will be needed to help secure written permission for treatment from owners of properties adjacent to areas to be treated. Grant writers are also needed, as are individuals skilled in the use of social media and communications. Thank You!

Who Will Pay for Repairs Needed on the Dam?
by John J. Popa, PE

Lake Association members and property owners on Lake Leelanau need to be aware that the dam between Lake Leelanau and Lake Michigan needs to be repaired. County officials and members of the Dam Authority are currently discussing the best way to finance these repairs. Your voice will help determine the outcome of these deliberations.

The dam between Lake Leelanau and Lake Michigan is owned by Leelanau County and is managed by the Dam Authority, a six-member panel consisting of the five members of the County Board of Public Works and the elected County Drain Commissioner. Current members of the Authority are James Calhoun, Bob Joyce, Greg Mikowski, Tom Eckerle, Steve Christensen and me- John Popa.

A court order requires the County to maintain and operate the dam and also to maintain the water levels in Lake Leelanau within specific parameters. In addition, the dam's operations are subject to regulatory requirements relating to dam safety and periodic inspections.

The dam was last rebuilt approximately 15 years ago to withstand a 200-year flood. Since then the dam has been operating fairly smoothly, but is now beginning to show signs of age.

Although the Authority has commissioned outside experts to inspect the dam and provide estimates on the scope and cost of repairs required, we do not yet have the final report or cost estimate. The Authority has noted the following major concerns, however, which need to be addressed:

- When the water level in Lake Michigan is high, the dam's control room floods.
- To improve worker safety and address OSHA concerns, a mechanism to physically lock the dam while individuals work on it needs to be installed.
- Remote greasing capabilities are needed.
- Leaks in the control room roof require repair.
- A manual de-watering barrier needs to be installed.
- Possible overhaul of all hydraulic components

Over the past few decades, improvements to the dam have been financed jointly by the County and by owners of property on Lake Leelanau (riparians). In the past two instances, the County Government paid 50% of the cost of repairs and riparians paid, through a special assessment, the remaining 50%.

The composition of the County Commission has changed since the last assessment, however, and there seems to be some inclination on the part of the County to consider asking riparians to bear some or all of the cost of the improvements to the dam.

At its meeting on September 26, 2019, the board of the Lake Leelanau Lake Association passed a resolution outlining its position that the riparians should pay no more than 50% of the planned repairs and that the County should, in keeping with historic precedent, pay the remaining 50%. Unlike other lakes in Leelanau County, the County owns the dam on Leland River and is responsible for its operation.

Although it is still unclear what the total cost of the repairs to the dam will be, I estimate that the total bill for repairs and maintenance will be in the neighborhood of $1 million. Depending upon the funding formula the Authority and the County establish, I would estimate the cost to each riparian to be between $1.25 to $2.50/per linear foot of shoreline.

The Lake Association encourages all interested parties, especially riparians, to send emails and letters to the County Commissioners expressing their views on this issue. Their contact info is in the blue box to the right of this column.

In addition, I would encourage all members and interested individuals to attend meetings of the Commissioners and Dam Authority, and speak during public comment sessions….whether the subject is on the agenda or not.
Regular meetings of the Leelanau County Board of Commissioners are held each third Tuesday of the month, unless otherwise indicated, in the Commissioners Meeting Room at the Leelanau County Government Center, 8527 E. Government Center Drive, Suttons Bay. For information on meeting dates and times, go to *https://www.leelanau.cc/downloads/2019_regular_session_meeting_notice.pdf*. The last two meetings of this year will be held at 7 PM on Tuesday, November 19, 2019 and Tuesday, December 17, 2019.

Take Action Now!

Call, write or email the members of the County Board of Commissioners to let them know you **support a 50/50 split for the costs of the Leland Dam repair!**

Tony Ansorge / 231-941-1078
10101 E. Carter Rd., Traverse City MI 49684
tansorge@co.leelanau.mi.us

Debra L. Rushton / 231-941-8286
10243 E. Cherry Bend Rd., Traverse City MI 49684
drushton@co.leelanau.mi.us

William J. Bunek / 231-256-7124
3161 S. Maple Valley Rd., Suttons Bay MI 49682
wbunek@co.leelanau.mi.us

Ty Wessell / 231-386-9054
452 Vincer Way, Northport MI 49670
twessell@co.leelanau.mi.us

Patricia Soutas-Little / 231-218-8496
PO Box 1143, Leland MI 49654
psoutaslittle@co.leelanau.mi.us

Carolyn (Peachy) Rentenbach / 231-334-3728
4480 W. Empire Hwy, Empire MI 49630
crentenbach@co.leelanau.mi.us

Melinda C. Lautner / 231-947-2509
12708 S. Solon Rd., Cedar MI 49621
mlautner@co.leelanau.mi.us

The Latest on Lake Levels, Recordings & Dredging
by John J. Popa, PE

FEMA…Flooding…Flood Insurance?
The following is information about possible flooding and flood insurance, and how it may affect you, as a riparian.

- FEMA (Federal Emergency Management Agency) was tasked to improve flood hazard data around the nation.
- Around eight years ago FEMA mapped the Great Lakes region. The maps included Lake Leelanau because of its proximity to Lake Michigan.
- Various meetings were held with local and county governments to explain and receive comments. Preliminary maps were handed out.
- The flood criteria was a 1% chance of a major flood…or "hundred year flood".
- We appealed the inclusion of Lake Leelanau in the FEMA maps because the dam is designed to accept and pass a 200-year flood.
- The appeal was denied because of some clause that states that 'dams do not count'.
- FEMA ran out of mapping money and final maps were not issued for a few years.
- Maps are now available…they show that the water level in Lake Leelanau may rise 1 foot during a 100-year event.
- These maps are available on line or should be in your local Township office.
- Aerial views should show your house and if it is high enough above the flood line shown on the map.

So how does this affect Riparians?
... quite a bit if you want flood insurance.
- If you need insurance because of a mortgage, your lender may ask for more information or proof.
- Your property will show up in FEMA's Flood Hazard Mapping.
- Many owners had (or have) to hire an authority that provides proof and/or a statement that flooding is not a concern, which can cost big money.
- It is up to the owner to provide proof to the insurance carrier. Some accept the maps…but many do not.
- Doing it yourself may be cheaper, but if you are in the position of selling your property, or obtaining insurance, than it may be prudent to have some proof already in hand to avoid delays.

You can try the website for more information. www.floodmaps.fema.gov/fhm/fmx_main.html. Contact me if you have further questions. I may be able to help. John Popa / 231-384-5364

Newsletter Update

by Patrice Korson, Newsletter

It has been 3 years that I have been working with the LLLA on these newsletters and other print publications. While we customarily focus on spreading awareness about swimmers itch and other lake issues, this is the first time that I've been asked to dedicate almost an entire issue to ONE problem area. As you've read by now, the impact Eurasian Watermilfoil could have on our lake is catastrophic. It can make swimming dangerous and unpleasant, and cause all kinds of trouble for boaters and fishermen. The good news... efforts are underway to get it under control.

If you are able, please support these efforts. Donations are appreciated. Also, please encourage your friends and neighbors to become members of the LLLA. Membership makes a difference!

Lastly... PLEASE wash your boat before transferring it between lakes. It is YOUR responsibility to help prevent further spread of this noxious weed, and is frankly against the law in Michigan.

Don't forget, I'm always accepting photos of life on the lake, from any season, for publication in these newsletters. Please send them to my email... KorsonCreative@gmail.com. Happy Leelanau Fall, y'all!

Water Quality Bulletin

by Hugh Farber, Water Quality

Eurasian Water Milfoil (EWM) has been found growing in the South Lake. Efforts are being made by our Board to handle this threat. Please read the special section of this newsletter on pages 3-7, if you haven't already.

The septic issue remains of concern, as enteric bacterial has been found in the lake. The LLLA Board supports the effort to pursue realistic regulations for testing current systems.

Please follow area water efforts at the Leelanau Clean Water website **www.leelanau.cc/lcw.asp**

Photo Credit: Kelly Greenman Switzer

YOU CAN HELP PREVENT THE SPREAD OF INVASIVE SPECIES

1. Inspect your boat and trailer for any water weeds or other biological materials.
2. Powerwash or carefully wash down any boat that is coming from outside the watershed, unless it has been out of the water for several weeks.
3. Never dump bait or bait buckets in the lake.

Michigan Law states:
It is illegal to place a boat, boating equipment, or boat trailer in the water in Michigan if the boat, equipment or trailer has any aquatic organism attached, including plants.
Before transporting any watercraft, you are required to:
Remove all drain plugs from bilges, ballast tanks and live wells.
Drain all water from live wells and bilges.
Ensure the watercraft, trailer and all conveyances are free of aquatic organisms, including plants. ***It's The Law!***

MEMORIAL GIFTS

Lake Leelanau Lake Association accepts monetary gifts made in someone's honor or memory. If you or a loved one names the LLLA as the recipient of donations, we will gladly provide envelopes for the memorial services at your request.
Thanks for your consideration.

Letter from the President cont.

While your Association remains engaged in research on swimmer's itch, this problem pales in comparison to the potential havoc EWM, if left unaddressed, may cause. I urge you to read Brian Price's article on the nature of this infestation, Barb Kobberstadt's piece on steps you can take to help us address it as well as my report on what your Association is doing to tackle it.

Please understand, however, that our ability to deal with this threat is entirely a function of our ability to raise funds to finance its removal. We expect the cost of removal in 2019 and 2020 to be between $150,000 to $200,000—more money than the Association has ever raised for any purpose before. I am pleased to report since we identified this threat and began publicizing it in late summer, we have raised contributions totaling approximately $50,000. These funds will enable us to begin limited control work in high traffic areas next spring, but are insufficient to mount the full-scale removal and management program we undoubtedly need to initiate before the weed gains an upper hand.

Please help by sending us a contribution to wage war on EWM. The Association is a registered nonprofit organization. Contributions are tax deductible as allowable by law and mail be mailed to Kathy Birney, Treasurer, LLLA, PO Box 123, Leland, MI 49654.

If you know of a private foundation, a donor advised fund or a government program that we should approach for financial support, please contact me directly and alert me to any possible leads. My email address is tom@thomashiatt.com.

Please accept my gratitude for your past and future support. I am confident that, working together, we can successfully tackle this existential threat to our beloved lake.

Thank you, Cindy!

Cindy Kacin has volunteered her time and talents to the Lake Leelanau Lake Association for many years, and we have all been the beneficiaries of her skills and dedication. She and her husband Jim have invested countless hours in the community, organizing events and dedicating themselves to making Leelanau County a better place to live.

Cindy has elected to step down as the Association's Secretary effective December 31, 2019. We would like to recognize and thank Cindy for her service to the Association and our community.

Thank You!

We salute the following businesses who show their love of the lake through membership

- **Amber Sands Resort**
- **Bluebird of Leland**
- **Boathouse Vineyards**
- **Break'n Waves Boat Rentals**
- **Cedar Haven Cottages**
- **DeWeese Hardware**
- **First Choice Industrial**
- **Hansen Foods**
- **Korson Creative**
- **Lake Leelanau Narrows Yacht Club**
- **Lake Leelanau RV Park**
- **Leelanau Conservancy**
- **Leelanau Enterprise**
- **Riverside Inn**
- **Stander Marine**
- **Timberlee Property Owners**
- **Whaleback Inn**

If you are a member of the LLLA and your business isn't listed here, please let us know so we can give you the recognition you deserve!

If you're NOT a member but would like to be, visit **lakeleelanau.org** or contact Barb at **bkobberstad@gmail.com**

Lake Leelanau Lake Association
P.O. Box 123
Leland, MI 49654-0123

Follow us on Facebook!

MISSION STATEMENT

The Lake Leelanau Lake Association is dedicated to protecting and enhancing the quality and beauty of Lake Leelanau and its surrounding watershed for current and future generations.

Photo Credit: Cathy Fisher

2019 Fall Edition

Lee Lake News

LEE LAKE ASSOCIATION

Our Mission:

The Lee Lake Association is a group of volunteers that pledges to work together to protect and enhance the quality of the water, the aquatic environment, the fishery and the wildlife of Lee Lake and its surrounding watershed. We are a community committed to preserving the health of our lake for present and future generations.

We pledge to keep our neighbors informed of developments that will impact our lake community. To promote activities within our lake community that will offer the opportunity for all neighbors to get involved.

The Board Report

We did it!

With your support, we completed the first round of controlling the spread of non-native Eurasian Milfoil using chemical-free diver suction harvesting. It's been a long journey, with a lot of hard work, from a dedicated LLA Board of Directors to all of the Lake Association members. Our Lake Association should be proud that we completed this first step in preserving the health of our lake for present and future generations.

From September 3rd through September 11th MTT Dash Divers LLC began working on Diver Suction Harvesting in Lee Lake targeting Eurasian Milfoil.

MTT performed suction harvesting primarily in the site identified as Site 1. Site 1 is located at the Northeast corner of Lee Lake.

The divers concentrated on the shallower areas in the location of Section 1. These areas are most impacted by boat traffic. Boat props cause fragmentation of the Milfoil, these fragments can float away from the original colony and reseed, causing new colonies.

Divers observed a stretch of native plants mixed in with Milfoil approximately 65 feet from shore. The divers did remove some of the Milfoil from the area but chose to utilize the time removing the milfoil from areas where saturation was near 100%.

MTT Dash Divers covered approximately .3 acres of section 1 during the listed time frame, removing 256, 30 to 45-pound bags of Eurasian Milfoil.

The bags were placed onshore for removal by a team of volunteers.

Photos:

Mike Kile helped dispose of the bags of Milfoil.

MTT Dash Divers standing on a pile of milfoil

MMT Dash Divers with some of the volunteers

Mike having some fun spreading Milfoil

MTT Dash Divers recommend continued efforts to diminish the areas of Milfoil. MTT Dash Divers also recommend allocating time to remove milfoil in the areas where milfoil is intermingled with native plants, with the understanding the volume of milfoil removed will be decreased. This, however, will allow the native plants to thrive and reseed. Without action the milfoil will overtake the native plants, starving them of sunlight.

What's the next step?

We need to start preparing for the 2020 treatment season. Permits have already been approved and we need to contract MTT divers for next summer's work. The Board would also like to ask the Lake Association to approve a Lake Survey for 2020. We feel this is essential to track the health and progress of the LLA efforts.

In 2018, with the communication and help of volunteers around the lake, our residents donated $12,855.00. The approved payment schedule was $200 lakefront lots, $100 lake access lots and use of the lake, back lots $50.

We need your support to continue!

So far we have collected $5,837.00 in 2019. Maybe some residents are hesitant to contribute because of the problems getting the required permits last year and wanted to wait until we started DASH. Now that we have everything in place to continue, we need you to contribute. Our Lake Association is only as strong as its members who are willing to be involved.

Please fill out the form below and mail your check to:
Janie Evans (Lake Association treasurer)
861 Clark Rd.
Ceresco, MI 49033

You can also pay online at: https://leelakemi.com/voluntary-treatment-program.html

LEE LAKE VOLUNTARY DONATION FOR 2019

DATE _____

PROPERTY OWNER _____

ADDRESS _____

EMAIL ADDRESS _____

PAYMENT LAKEFRONT **$200** _____ LAKE ACCESS **$100** _____

ACROSS STREET **$50** _____ OTHER AMOUNT _____
(PLEASE CHECK ONE)

METHOD OF PAYMENT CHECK _____ PAYPAL _____
(Lee Lake Website)

www.leelakemi.com

*** THIS IS A VOLUTARY TREATMENT PROGRAM. OUR GOAL IS TO NOT CREATE A HARDSHIP FOR ANYONE WHO CAN'T AFFORD THE APPROVED AMOUNT.**

EGLE

Management of Aquatic Plants

Prepared By:
State of Michigan
Department of Environment, Great Lakes and Energy
Water Resources Division
www.Michigan.gov/EGLE

MANAGEMENT OF AQUATIC PLANTS

Introduction

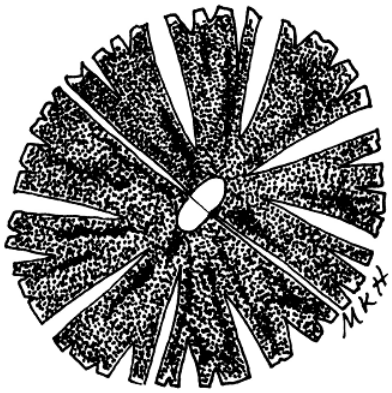
Aquatic plants are a vital part of any lake or pond. They convert sunlight and chemical elements into living plant tissue. Fish, waterfowl, insects, mammals, and microscopic animals use the plants for food. Plants also replenish the aquatic environment with oxygen, which is essential to aquatic animals. Additionally, rooted plants create a varied aquatic environment in which fish food organisms reside. They also provide cover for spawning fish, nesting waterfowl, shoreline mammals, and their young.

Although they are important to the aquatic environment, plants frequently conflict with recreational and economic interests. A need, therefore, exists for proper aquatic plant management to ensure that the natural environment and human interests are mutually protected. The Department of Environment, Great Lakes, and Energy (EGLE), Aquatic Nuisance Control (ANC) Program has developed this bulletin as a primer for those seeking information on aquatic plant management.

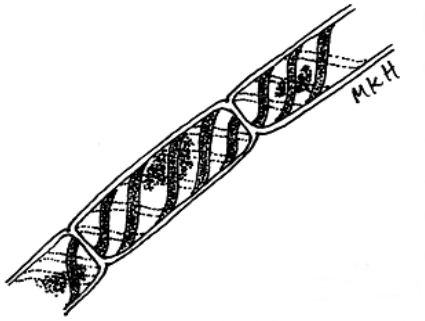
Aquatic Plant Types

The first step in any lake or pond management program should be to identify the aquatic plants present in that particular waterbody. The proper management of aquatic vegetation requires knowledge of the various plants that grow in lakes and ponds and their importance to the aquatic ecosystem. Although aquatic plants may be divided into many categories, a simple classification according to life forms and growth patterns divided them into only two categories: the algae and the macrophytes (rooted aquatic plants).

ALGAE



Algae are divided basically into planktonic, filamentous and macroalgae forms. Planktonic forms are microscopic, free floating plants often referred to as “water bloom”. In large numbers, these algae can cause water to appear green, brown, yellow or even red, depending upon the species present.



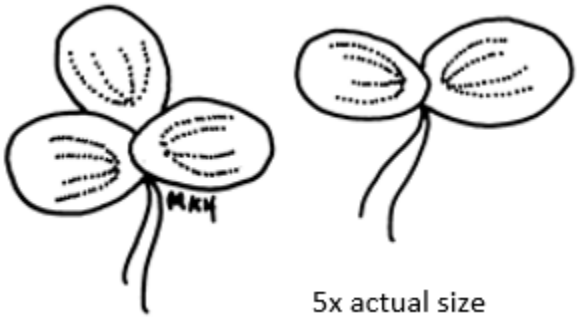
Filamentous algae, commonly called “pond scum”, can form raft-like masses over the water surface, but since they are vulnerable to winds and currents, they are generally restricted to bays, bayous and sheltered shorelines. Filamentous algae can also grow attached to the lake bottom, the macrophytes, or piers and docks. The filamentous algae will frequently detach from the substrate and form floating mats.

The macroalgae include two groups of native species, referred to as Chara and Nitella, and one non-native species, Nitellopsis obtusa (starry stonewort). These macroalgae are large and can resemble macrophytes.

MACROPHYTES

The macrophytes are the rooted plants found in a lake or pond. They are usually large, easily seen plants; however, some are small enough that dozens of plants can be held in an individual's hand. The macrophytes may be divided into three basic forms: submergent, emergent, and free-floating. Submergent macrophytes usually grow rooted to the bottom with stems and leaves below the water surface, except for some plants which may produce a few small floating or aerial leaves. Submergent plants provide food and cover for fish, waterfowl, and other aquatic life.

Emergent plants grow in shallow water, with most of the plant protruding above the water surface. Cattails, waterlilies, arrowhead, rushes, and reeds are examples of emergent plants and, like the submerged plants, are important as food and cover for fish, waterfowl and other shoreline animals.



The free-floating macrophytes in Michigan are the duckweeds. These tiny plants are not attached to any substrate but float freely upon the water. They are subject to current and wind action which will concentrate them in certain portions of a lake. Some waterfowl utilize duckweed as food.

For additional help in identification of plants refer to the bulletin “Common Aquatic Plants of Michigan.” County extension agents, chemical companies dealing in aquatic herbicides, universities, and EGLE district offices may also provide assistance.

What Makes Aquatic Plants Grow?

The distribution and abundance of aquatic plants in a lake is dependent upon the lake’s chemical and physical properties including:

1. the amount of light available,
2. water levels,
3. water temperatures,

4. type of lake bottom sediments,
5. current or wave action, and
6. the concentration of dissolved gases and nutrients.

In lakes, nutrients and light availability are most often the factors which limit plant growth. Nutrients are the chemicals such as nitrogen, phosphorus, carbon, potassium, etc., which plants require for their growth. These nutrients originate in the rocks and soils surrounding the lake. Natural processes at work within the lake's watershed continually carry some of these nutrients into the lake. A lake's watershed is the land around the lake from which water drains to the lake (Figure 1). Lake watersheds vary greatly in size, topographic relief and the means by which water moves through the watershed (stream flow, groundwater movement, surface runoff, etc.). The natural movement of nutrients to lakes is, therefore, dependent upon the characteristics of the watershed.

Figure 1. This diagram represents a lake and its watershed. The broken line represents the drainage divide of the watershed. The arrows depict the pattern of overland flow.

As nutrients enter lakes from the watersheds, lakes respond by producing aquatic plants and algae. Limnologists (lake scientists) have for many years grouped lakes by a classification system based upon their productivity or ability to produce plants. Lakes that are low in productivity are called oligotrophic, while lakes high in productivity are called eutrophic.

Oligotrophic lakes usually:

1. are deep
2. have high oxygen concentrations in the deeper water
3. are very clear
4. have sparse populations of aquatic plants
5. are populated with cold water fishes such as trout and whitefish

Eutrophic lakes usually:

1. are shallow
2. have little oxygen in waters deeper than 30 feet
3. have murky water
4. have substantial growths of aquatic plants
5. are populated with warm water fishes such as bass, pike and bluegills

The term mesotrophic is often used to describe a lake with characteristics between oligotrophic and eutrophic.

All lakes will become more productive or “age” with time. This aging process, commonly referred to as “eutrophication” is dependent upon the lake’s physical characteristics and upon the quantity of sediments and nutrients washed into the lake from its watershed. Without human influence, the natural aging process is extremely slow often taking thousands of years to result in any noticeable changes in lakes. Human activity on the watershed, however, may greatly accelerate the aging process by increasing the quantity of sediments and nutrients entering the lake. This fact emphasized the importance of proper watershed management, especially at the shoreline of lakes and streams. Figure 2 illustrates a preferred watershed management plan vs. poor management of the watershed.

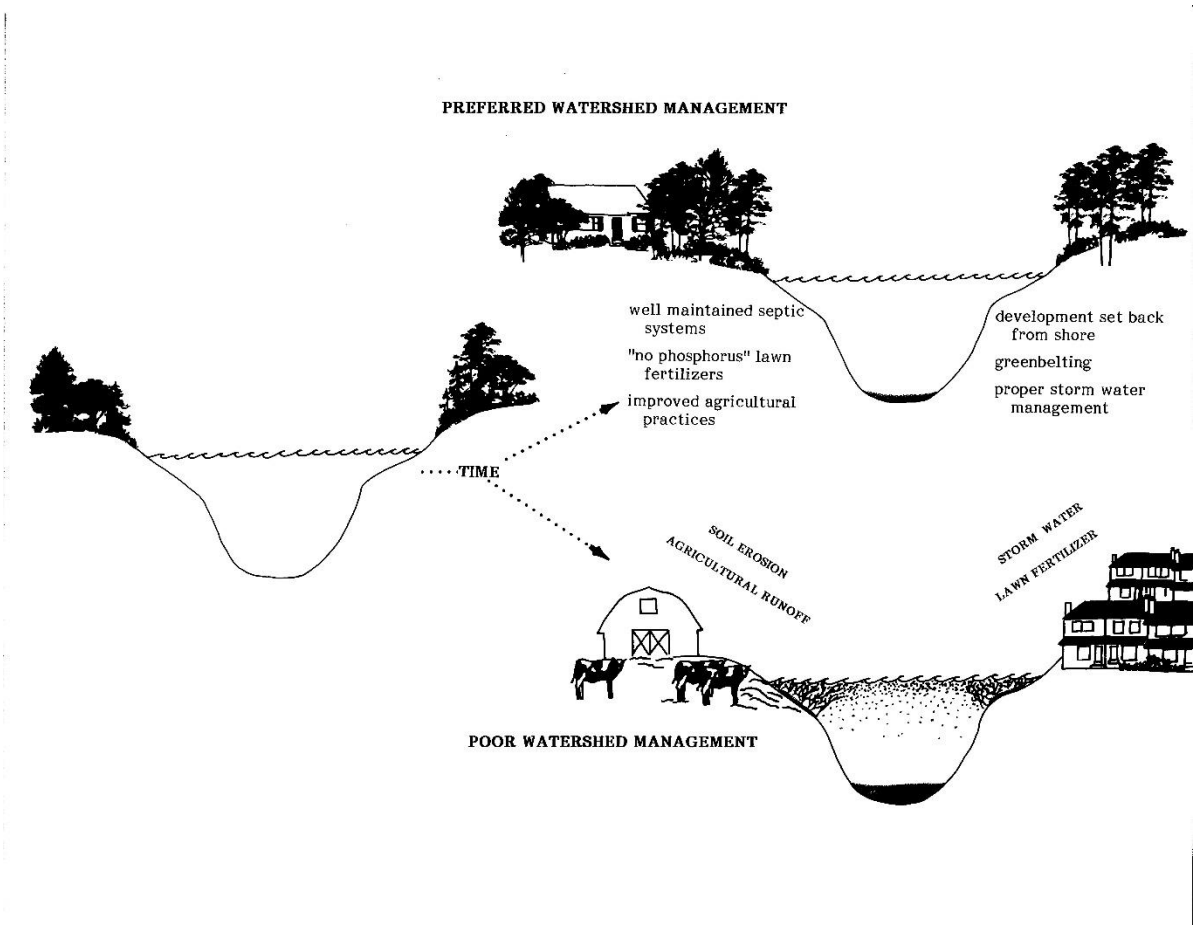


Figure 2. Preferred Watershed Management vs. Poor Watershed Management

The Aquatic Plant Management Program

The goal of any plant management program should be to maintain a proper balance of plants within a lake. Ideally, every aquatic plant management program will have two phases: (1) long-term management (nutrient control) and (2) short-term management (direct manipulation of macrophyte and algae populations). Short-term management is relatively easy to implement, but long-term

management is more complicated. It requires considerable community involvement and cooperation, and results take years rather than days to develop.

The remainder of this bulletin will consider the principles and techniques of long-term and short-term aquatic plant management. Not every principle or technique presented will be applicable to every lake and even those that are should be evaluated carefully before using them. While economics must, of course, be considered, ecological values should receive prime consideration before any management technique is employed. Attention to ecological values may result in a program that is less costly over the period of a decade or two.

Long Term Management (Nutrient Control)

Aquatic plants require nutrients for growth and reproduction. The nutrients most often considered in shortest supply, and therefore limiting plant growth, are phosphorus and nitrogen. Since aquatic plant growth is directly dependent upon the amount of nutrients available, nuisance growth is a general symptom of high nutrient levels. This is important, as all too often aquatic plant control programs are directed only at the aquatic plants, and not at what causes the excessive growth (nutrients).

An effective aquatic plant management program must give proper consideration to the amount of nutrients entering the lake. Aquatic plant management techniques designed only to “kill weeds” must be considered temporary cosmetic measures to reduce the symptoms of high nutrient levels. Furthermore, this technique continues the cycle of nutrient addition, from the decaying plants, for future, excessive, plant growth.

It is more sensible to control the movement of nutrients from the watershed than to attempt remedial action after nutrients have entered the lake. Limiting the movement of nutrients into waterbodies requires management of nutrient sources. Natural sources of nutrients are those which would enter a lake, usually in small amounts, without human influence. However, cultural sources of nutrients are usually large in volumes as well as concentrations, and greatly accelerate the rate of eutrophication. Some nutrient sources, both natural and cultural, are listed in Table 1 below.

Table 1. Natural and cultural sources of plant nutrients to the aquatic environment.

Natural	Cultural
wetland runoff	domestic and industrial wastewater
meadow land runoff	agricultural runoff (cropland, feedlots, & pasture)
forest runoff	agricultural wetland drainage
precipitation on the lake surface	managed forest runoff
Non-human related soil erosion	urban stormwater runoff
aquatic bird and animal wastes	septic system discharges
leaf, pollen and dust deposition	landfill drainage
groundwater influxes	construction site runoff

nitrogen fixation by plants	lake shore lawn runoff
sediment recycling	atmospheric fall-out of wind-borne fertilizers

(Modified from Shannon and Brezonik, 1972. Relationship between lake trophic state and nitrogen and phosphorus loading rates. Environmental Science Tech. 6:719-725)

All nutrient sources will have different levels of manageability. Some may be uncontrollable, while others may be controlled with little effort or cost. Ideally, it is desirable to know which sources are contributing nutrients to a lake and in what quantities. It is then possible to adjust funds and activities to control nutrient sources to most effectively reduce the amount of nutrients entering the lake.

For lakefront property owners, and/or other concerned citizens, who are interested in monitoring a lake may be interested in the Cooperative Lakes Monitoring Program (CLMP) through the Michigan Lake and Stream Associations and the Michigan Clean Water Corps. The primary purpose of the CLMP is to help citizen volunteers monitor indicators of water quality in their lake and to document changes in lake quality over time. The CLMP is a cost-effective process for EGLE to increase the baseline data available for Michigan's inland lakes as well as to establish a continuous data record for determining water quality trends in lakes. More information on the CLMP can be found at http://www.micorps.net/lakeoverview.html.

The best time to begin a nutrient control program is before aquatic plants have attained nuisance levels. The management of nutrient sources is an on-going responsibility, which must be intensified as development of the watershed continues. Methods of nutrient source management include:

1. proper land use planning and zoning,
2. wise consumer use of commercial products,
3. treatment of inflowing waters high in nutrients,
4. diversion of water high in nutrients, and
5. municipal and industrial wastewater treatment.

Proper Land Use Planning and Zoning

Planning and zoning (P&Z) are public policies and laws used to regulate the use of land by local units of government. There are many objectives to P&Z, but primarily it is used to avoid land use conflicts, ensure compatibility with community characteristics, and protect public health, safety, and welfare. Over the years P&Z has evolved to include other objectives such as environmental protection. In order to meet the objectives through P&Z, local ordinances are established to include specific land use practices and should include compliance with state regulations where applicable.

In Michigan, the State Legislature enacted the Soil Erosion and Sedimentation Control Act of 1972 (Act No. 347 of Public Acts of 1972) to limit the movement of sediments and associated nutrients into surface waters during earth moving activities (except agricultural tillage).

Considerable resources regarding land use regulations can be found at the Michigan State University's Planning and Zoning Center website at www.pzcenter.msu.edu/natural.php. Some of the resources include Filling the Gaps: Environmental Protection Options for Local Governments, and Michigan Soil Erosion and Sedimentation Control Guidebook. In addition, there are other pages within the website that include other categories such as landscaping for environmental purposes.

Here are some examples of wise land use practices which reduce polluted runoff from land to waterbodies:

- Ensure the Soil Erosion and Sedimentation Control Act of 1972 (Act No. 347 of Public Acts of 1972) is properly implemented and advocate sediment control from logging and agricultural activities as well.
- Preserve wetlands through Purchase of Development Rights and/or publicly owned green space.
- Require or encourage native vegetation buffers and/or setbacks along lake and stream banks.
- Promote proper collection and land application of farm and feedlot wastes through the Right to Farm (RTF) program implemented through the Michigan Department of Agriculture
- Encourage sound farm fertilization practices, also through the RTF program
- Encourage proper collection and composting/disposal of leaves especially in the more urban areas.
- Require routine inspection and maintenance of catch basins in private developments. Limit or restrict the use of fertilizers on lawns adjacent to lakes and streams.
- Prevent stormwater drainage from directly discharging to a waterbody, by requiring subdivision designs to maximize infiltration and groundwater recharge.
- Regulate the size and use of lake and stream front lots and back lots to prevent over-development of the environment and its associated high nutrient loading.
- Prevent development in areas where the seasonal groundwater is higher than 3 feet below the bottom of the septic system. In addition, include a minimum setback of 200 feet or more from the shoreline for both structures and the septic system where seasonal high water tables are acceptable.
- If not already being done as part of the Michigan Municipal Separate Storm Sewer System program, ensure the community is educated in these various topics through community wide education efforts (such as Public Service Announcements, billboards, brochures in tax mailings, etc.).

Wise Consumer Use of Commercial Products

By now it is well known that detergents and fertilizers can contribute significant amounts of nutrients to our waterbodies. However, proper use and management of these products, as well as alternative choices in detergents, would substantially reduce the loading of these nutrient sources. Specifically, waterfront property owners should take special care in the use of detergents and fertilizers.

To reduce phosphorus loading into waterways, high phosphate detergents have been banned in Michigan and several surrounding states. In addition, a phosphorous restriction law was passed in Michigan regarding fertilizers.

Many waterfront property owners prefer a nice mowed green lawn all the way to the edge of the water. However, a maintained lawn is also one of the primary causes of excessive nutrients to Michigan's waterbodies due to fertilizer runoff and the erosion of properties at the water's edge. A mowed lawn does not filter runoff or hold soil in place the way a well vegetated buffer of native plants will.

If lawns must be fertilized, soils should be tested to determine which chemical nutrients are needed. If the soil does not require phosphorus, a fertilizer with little or no phosphorus should be used. County cooperative extension agents can provide information on soil testing procedures and the best methods for applying fertilizers.

Of course, the most natural fertilizer, as well as easiest and cheapest, is simply leaving the grass clippings in place. This provides the necessary nitrogen for new growth through natural breakdown.

Better yet, native landscaping could be incorporated into one's yard. Along the water's edge, this contributes not only to nutrient treatment and soil stability (further discussed below), but is beneficial to native pollinators, native birds, and other wildlife and fish. Native landscaping is almost maintenance free once it is well established and can be as simple as a 10 foot wide buffer to an elaborate beautiful garden setting.

One excellent resource is the Michigan Natural Shoreline Partnership program, information about natural shoreline management can be found at http://www.mishorelinepartnership.org.

A great source for waterfront property owners is Landscaping for Water Quality: Garden Designs for Homeowners 3rd Edition, The Environmental Protection Agency also has an extensive resource on natural landscaping at https://www.epa.gov/watersense/landscaping-tips.

Treatment of Inflowing Waters

An inflowing stream, drain, or overland runoff may carry substantial amounts of nutrients and other pollutants collected from sources such as agricultural activities, urban stormwater drainage, industrial stormwater, and construction stormwater. While it is always easiest, cheapest, and best to prevent pollution from discharging to a waterbody, in some situations it is possible to treat polluted waters.

While there are regulatory programs in place for industrial, municipal, and construction wastes and stormwater, other programs are voluntary, or incentive based. In regard to these regulatory programs, the EGLE Stormwater Program's website can be consulted. Here you will find information, permitting, and guidance for all three storm water regulations. Keep in mind, the municipal storm

water program only applies to urban areas, but the guidance on this subject can still be used for more rural areas.

While most polluted agricultural runoff is not regulated, Michigan does have a Right to Farm program that includes guidance on following the Generally Accepted Agricultural Management Practices (GAAMPs). This program is implemented through the Department of Agriculture and Rural Development (MDARD). The MDARD Right to Farm webpage not only includes the information, but also includes multiple environmental programs for agriculture.

Treatment of nutrient-laden water, outside the realm the regulatory programs mentioned above can include: 1) reviving and/or expanding existing wetlands, 2) establishing new wetlands, infiltration ponds, and/or rain gardens, 3) modifying drainage areas, and 4) establishing filter strips along waterbodies and drainage ditches. In addition, there are multiple other resources for treatment and/or management of nonpoint source pollution at the EGLE website mentioned in the previous section.

Short Term Management of Aquatic Plants

Although the initial and continuing phase of aquatic plant management should be the control of nutrient sources, many lakes have such serious plant problems that short-term management techniques may be needed to maintain the recreational and economic interests in the lake. Also, in cases where nutrient control is impractical, such as shallow reservoirs on major, agricultural or urbanized river systems, short-term management practices may have to be conducted annually. Even in such cases, however, under no circumstances should the complete eradication of aquatic plants be considered. This practice is environmentally unsound and could have very undesirable consequences. In some lakes it may be necessary to alter recreational activities somewhat to suit the lake's state of eutrophication, rather than attempt to change the lake to meet recreational demands. In situations where nutrient control is possible, short-term management techniques should be considered only as temporary measures, designed to replace nuisance plant species with plant species that conflict less with recreational and economic interests.

The short-term methods of managing aquatic plants include:

1. biological control,
2. mechanical harvesting,
3. environmental manipulation, and
4. use of herbicides.

These methods are directed primarily at the results (aquatic plants) of nutrients entering the lake and not at reducing the flow of nutrients. In some cases, however, nutrient levels with the water system may be reduced incidentally with certain techniques.

Biological Control

Biological control of aquatic vegetation is presently the least understood and utilized of the four short-term management techniques. Biological control normally includes the introduction of an organism that competes with, preys upon, inhibits the growth of, causes disease in, or parasitizes a plant species which has created a problem.

The introduction and release of exotic, foreign or non-native insects, fish or other animals into Michigan without specific authorization is strictly forbidden by state laws (Act No. 286 of the Public Acts of 1929; Act No. 196 of the Public Acts of 1958). At the present time, there are two biological control techniques being applied in Michigan waters. These methods are not regulated by state agencies, therefore, if you are interested in these programs, please contact the program directly.

The Purple Loosestrife Program was initiated by Michigan State University and Michigan Sea Grant College Program as an ecologically-sound approach to the biological control of purple loosestrife, an exotic plant species native to Europe and Asia that inhabits wetland areas. This program introduces natural insect enemies, or biological control agents, to existing purple loosestrife populations. The biological control agents feed on the leaves, and stem and root tissue, causing defoliation and eventually plant death.

Previous attempts have been made to control Eurasian watermilfoil using specific weevil species. However, the efficacy of those attempts is undetermined and currently no entity is pursuing this method as a means of invasive milfoil management.

Mechanical Harvesting

Mechanical harvesting involves the pulling or cutting and removal of macrophytes from selected areas of a lake. It may employ hand tools or highly sophisticated motorized cutting or rotovating devices. The harvesting of algae from lakes appears presently to be economically infeasible primarily due to very high energy costs to remove the microscopic plants from water.

When large areas of aquatic plants are harvested, the cut material should be removed from the lake. If left in the lake, the cut plant parts will decompose, sometimes only partially, and contribute nutrients and organic material to the lake bottom. This, in turn, helps to nourish new plant growth. In addition, during biological decomposition of the cut plant material, dissolved oxygen levels may be lowered. This can affect the delicate balance between the water and sediment chemistry. Low oxygen levels also affect fish and fish-food organisms. Removing cut material from a lake may even improve water quality somewhat if the amount of nutrients removed (in plant material) is greater than the amount of nutrients entering the lake from the watershed.

Mechanical harvesting also has drawbacks which must be considered. It has a high initial investment if a specially manufactured harvester is purchased. Many of these machines are large, heavy, and can be damaged by obstructions (logs, boulders, and debris) hidden below the lake surface. Additionally, harvesting could aid the spread of a plant problem, since fragments of certain plants could drift into unaffected areas, take root and grow.

Environmental Manipulation

The objective of environmental manipulation is to alter one or more physical or chemical factors (listed in “What Makes Aquatic Plants Grow?”) critical to plant reproduction and growth thus making the environment less suitable to the plant. Several techniques have been used with varying degrees of success. These methods may not be economically or environmentally practical in every lake. Even in practical situations, a technique should be employed only after the particular plant problem, and social and economic factors have been carefully considered. Environmental manipulation can provide some control of aquatic plants, but without reduction of nutrient inputs, any results achieved will be only temporary. Since most of these methods are somewhat technical, only a brief discussion of each is given below. Most of these activities require a permit from the Department of Environment, Great Lakes, and Energy.

Dredging reduces nuisance aquatic macrophytes by deepening the lake bottom below the depth of light penetration. Reduction of the size of the well-lighted zone around the shore will reduce the total amount of macrophytes. The disadvantages of dredging include a temporary increase in silt suspended in the water, which on settling in non-dredged areas can smother bottom living animals. Additionally, a suitable upland site must be available for the disposal of dredge spoils.

Aeration is the introduction of air into the waters of a lake for the purpose of increasing the dissolved oxygen concentration of the water. Aeration is most effective in lakes which are devoid of oxygen in the deep water. Keeping oxygen in the bottom waters will prevent the release of nutrients from sediments. As long as nutrients remain chemically bound to the sediments in the deeper parts of the lake, they are less available for aquatic plant growth. Decreases in nuisance algal populations and a shift to more favorable species have been reported following aeration, but this result is not always observed. Control of aquatic plants by aeration has not been demonstrated. A possible disadvantage of aeration is that it can be detrimental to cold water fishes (trout) if warm surface waters are mixed with cool bottom waters making the total lake environment unsuitable for these fish species. There are methods of aerating only the deeper waters, however. The use of an aerator may also cause the re-suspension of bottom muds which may increase turbidity ("cloudiness" of the water).

Nutrient Inactivation is the application of a chemical to a lake that binds with and otherwise immobilizes nutrients necessary for plant growth. Once immobilized, the nutrients settle to the lake bottom. This method is appropriate for algae control but has little effect on the growth of aquatic plants. The chemical substance used to immobilize and settle out the nutrients is usually a metal ion (iron, aluminum, calcium). The settling process may also reduce suspended solids and decrease turbidity and color, in addition to inactivating nutrients. This technique is expensive and may adversely affect the small animals that serve as fish food.

Drawdown or water level manipulation is a potential mechanism for controlling certain types of aquatic vegetation. In this technique, water levels are lowered for a period of time to expose shallow water areas. This dries out the exposed plants and kills them. Many submerged macrophytes are susceptible to this procedure, but certain emergent macrophytes benefit from it. In addition, this method does not control algae. A drawdown period of approximately two months is necessary for drying and freezing to be effective during winter drawdown.

Dilution or Displacement of low-quality water with water of higher quality may lessen algae problems but may not affect plant growth. A supply of higher quality replacement water must be available as well as an acceptable means of disposing of lower quality lake water.

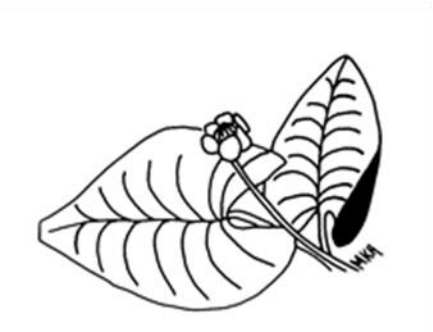
Shading for prolonged periods (4 weeks or longer) has been effective in reducing certain submerged macrophytes by light limitation. Light reduction using water dyes has been tried with some success in

ponds. In Michigan, usage of these products is limited to waterbodies smaller than 10 acres. Black plastic sheeting has been used as a floating shade. Its success on small areas (swimming beaches) is good for certain submerged macrophytes and of limited control value for emergent vegetation. However, problems with wave action and currents limit the usefulness of a floating plastic shade primarily to small ponds. The plastic sheeting should be removed after five to six weeks of shading in the spring. This method does not effectively control the growth of algae.

Covering of bottom sediments with sheeting material (such as black plastic) and/or particulate material (sand, clay) can perform two functions in controlling aquatic plants. It can prevent the exchange of nutrients from the sediments to the overlying water and it can retard the establishment of rooted aquatic macrophytes. Disadvantages of this technique are that bottom dwelling animals are usually killed when the sediment is covered and often gas is produced under the plastic sheeting causing it to float to the surface. Sheeting is now available that has pores which allow gases to escape. Experience with this technique so far has resulted in good temporary control. However, macrophytes will gradually recolonize the area unless the sheeting is removed periodically and cleared of any growth.

Intensive Use and Periodic Manual Clearing of shoreline areas will in many instances prove to be an effective means of aquatic plant control in small beach areas. The rooted plants must produce sufficient food in their leaves to maintain their root systems. Frequent cutting of the leaves or their destruction by wading and swimming will eventually lead to death of the root system. This technique is particularly effective with emergent vegetation such as water lilies. Like weeding the garden, it is necessary to watch for the early development of potential problems and remove the plants as they become established and before they spread over large areas.

Use of Herbicides



Chemical control is another means of temporarily controlling aquatic plants and algae. There are a number of chemicals available which offer varying degrees of action time, persistence, cost, selectivity and safety to humans, other mammals and aquatic animal life.

When herbicides are part of an aquatic plant management program, special care must be taken to protect both the environment and individuals involved, since herbicides are potentially dangerous to both. To promote the proper use of aquatic herbicides Part 33, Aquatic Nuisance Control, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, has granted regulating authority over the application of these compounds to EGLE. A permit is required from EGLE prior to any chemical treatment of a waterbody. The only exemption from this permit requirement is treatment of a pond which is less than ten (10) acres, does not have an outlet, and which is owned by only one person or corporation. Even in situations where a permit is not required, only herbicides registered for use in lakes and ponds may be used. A current list of these herbicides, and permit applications, are available from EGLE, Water Resources Division, Aquatic Nuisance Control, P.O. Box 30458, Lansing, MI 48909-7958, e-mail egle-wrd-anc@michigan.gov, telephone 517-284-5593, or on the web at: www.michigan.gov/anc.

It is important that herbicides be used with extreme care. Herbicides require special handling such as protective clothing for application and posting of treated water so that innocent swimmers or fishermen are not exposed to potentially harmful chemicals. Before applying any chemical always read the product label completely and follow all instructions. Take special note of all warnings on the label to avoid any personal injury and dispose of all empty chemical containers as directed. The product label will also explain the best methods for using the product, as well as rate of application and a list of plants which may be controlled by the product.

If you do not have the proper training or equipment to apply herbicides, you may wish to contact a licensed aquatic herbicide applicator. A list of commercial applicators licensed by the Michigan Department of Agriculture and Rural Development (MDARD) to apply herbicides to the aquatic environment is available from the MDARD Pesticide Section. Additionally, the ANC Program is available to answer questions which may arise concerning chemical control of aquatic plants or other aspects of inland lake management.

It is important to point out that the use of herbicides to control aquatic plants has certain drawbacks. Most herbicides control all forms of plant life to some extent. Beneficial aquatic plants may be killed along with the nuisance plants. It is also difficult to control the drift of herbicides under certain conditions. Consequently, plants may be killed over a much wider area than intended. Additionally, herbicides give only temporary control. In lakes where herbicides are used repeatedly on a large scale, dramatic shifts in plant populations can occur which may seriously alter the lake's ecology.

In calculating the proper amount of herbicide to use, the first step is to determine the surface area to be treated. In the case of small ponds, this can be done by direct measurement with a tape. For waterbodies of unusual shape, divide the surface into distinct areas, each of which is a shape with which you can deal. The surface area of each section can be calculated, and the areas added together to give the total area of the waterbody. In the case of man-made ponds, the engineer or surveyor who designed the pond may already have the surface area calculated. If the area has been calculated in square feet, divide the number by 43,560 square feet/acre to obtain the number of acres. Example: treatment area of 100 feet x 200 feet = 20,000 sq. ft.; 20,000 sq. ft. ÷ 43,560 sq. ft./acre = .459 acre, or about one-half acre.

For some herbicides, the application rate is expressed as gallons or pounds per acre-foot. To calculate the acre-feet of a treatment area, multiply the surface area (in acres) by the average depth (in feet). If a depth contour map of the lake or pond is available, the average depth can be calculated from it. If not, the average depth can be measured through the use of a pole or sounding line (a calibrated cord with a weight at one end). Generally, in an area used for swimming or docking of boats, an average depth of 3-5 feet can be used.

If there are questions that you would like to ask, or if you simply need more information, contact:

Aquatic Nuisance Control Program
Water Resources Division
Michigan Department of Environment, Great Lakes, and Energy
PO Box 30458
Lansing, MI 48909-7958
e-mail: EGLE-WRD-ANC@michigan.gov

Additional References:

Introduction to Freshwater Vegetation by Donald N. Riemer, Krieger Publishing Company, Melbourne, Florida, 1993 reprint (hardcover 218 pp.) 1-800-724-0025

A Manual of Aquatic Plants by N.C. Fassett, revision appendix by E.C. Ogden, University of Wisconsin Press, Madison, Wisconsin, 1969 (hardcover, 405 pp.)

Illustrations by Maureen Kay Houghton, Michigan Department of Environmental Quality, Environmental Science and Services Division.

Detection and Classification of Eurasian watermilfoil with Multispectral Drone-Enabled Sensing

Colin Brooks

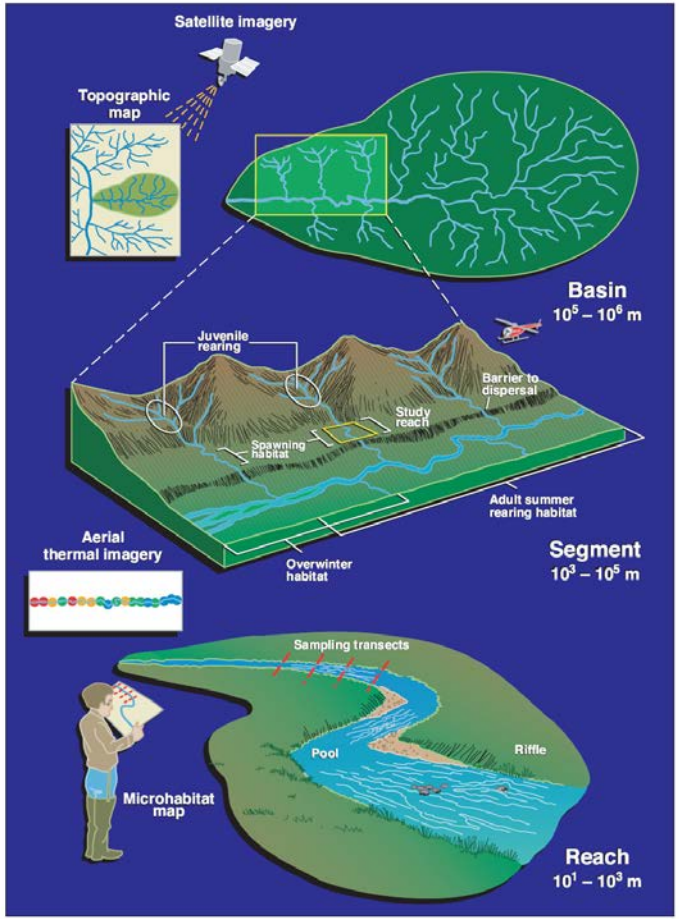
Dissertation Presentation, 22nd July, 2020

Biological Sciences

The US Environmental Protection Agency under assistance agreement 00E01928 and the Michigan Department of Natural Resources under project number IS14-2005 provided grant funding that supported this research. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency nor does the EPA endorse trade names or recommend the use of commercial products mentioned in this document. Support was provided by the Michigan Tech Research Institute, and the Great Lakes Research Center & Biological Sciences Department of Michigan Technological University.

Need for remote sensing

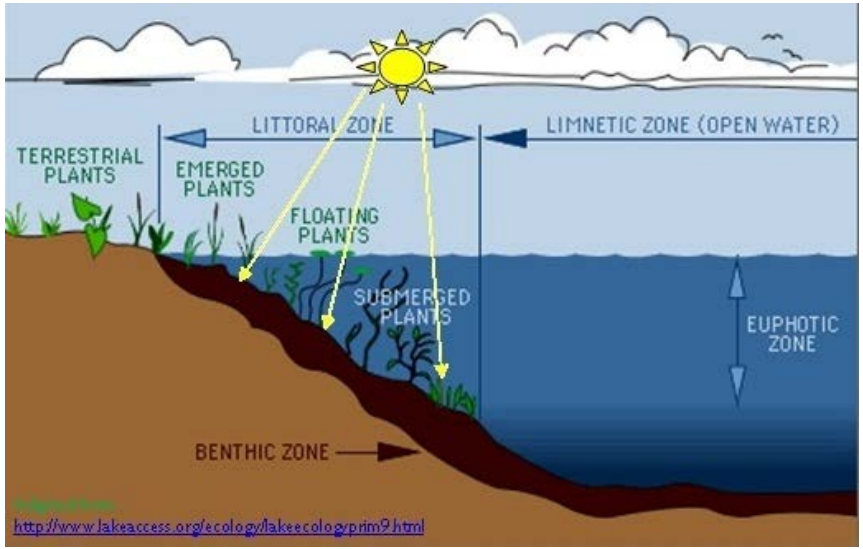
- Remote sensing data can address important ecological questions
- Satellite RS covers large areas at coarser resolution; field methods provide detailed data but at limited spatial scales & frequency
- Unmanned aerial systems / vehicle (UAS, UAV, or 'drones') - can provide data at a scale in between satellite & field methods
- Ecological understanding is improved by integrating information at intermediate scales (Fausch et al. 2002)



Fausch et al. 2002

Remote sensing of littoral zones

- Satellite imagery poorly matched for lake littoral zones
- Mostly applied to floating & emergent plants
  - Limited previous successful use for SAV
- Need to address issues of light attenuation in the water column, more challenging than terrestrial plant remote sensing
  - Inherent optical properties - dissolved & suspended materials
  - Apparent optical properties - external factors (weather, sun angle)



Eurasian watermilfoil

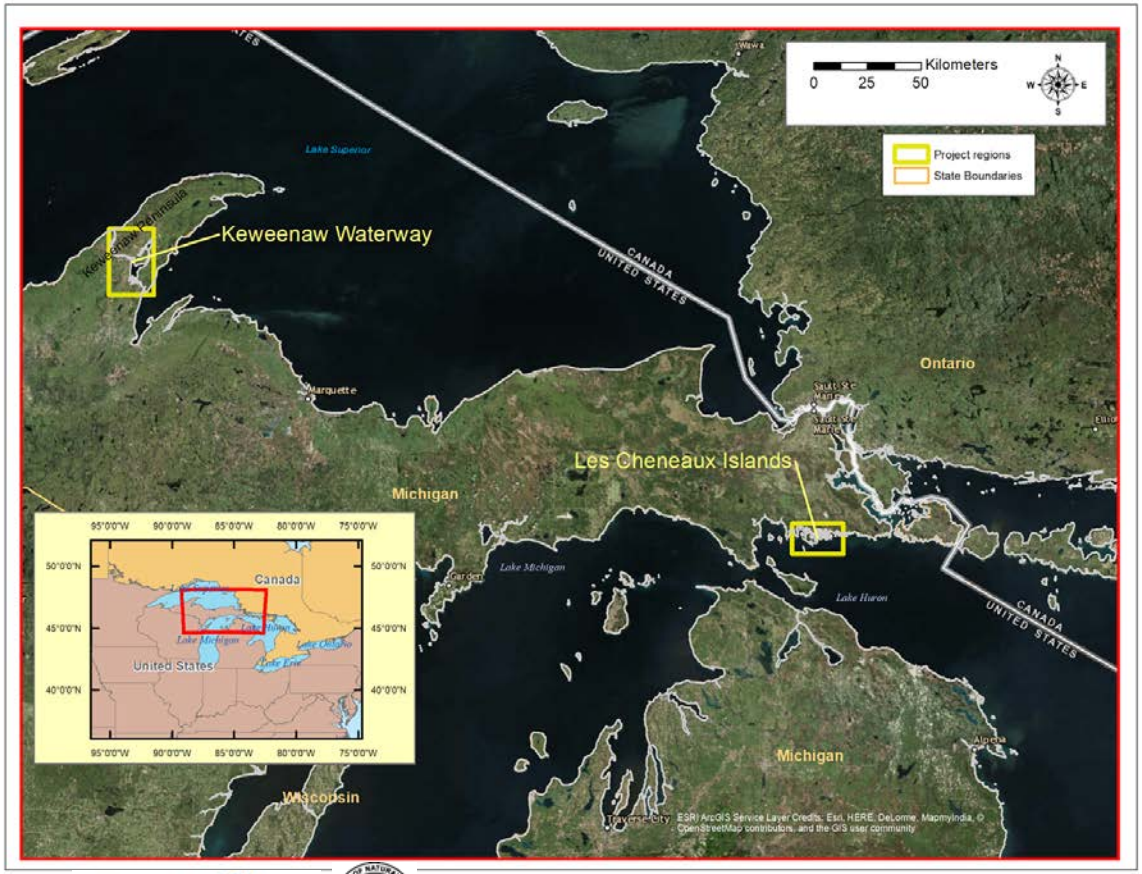
- Species of interest: Eurasian watermilfoil, *Myriophyllum spicatum* L. ("EWM")
  - Found in U.S. in 1942, in Great Lakes region in 1952
  - Hybridizes with native milfoil species
- Impacts:
  - Crowds out native plants
  - Interferes with recreation
  - Reduces diversity & abundance of native plants
  - Reduces dissolved oxygen
  - Increases nutrient cycling
  - Changes fish community dynamics

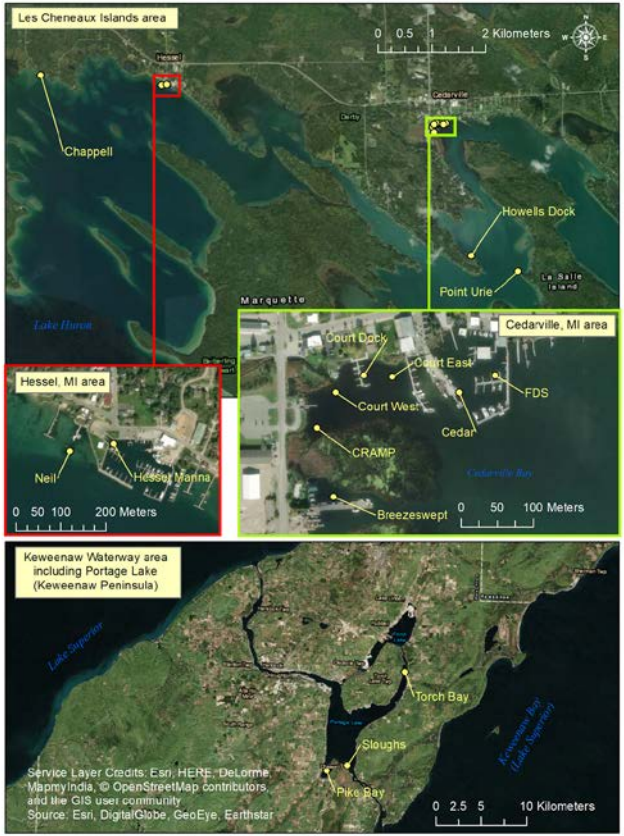




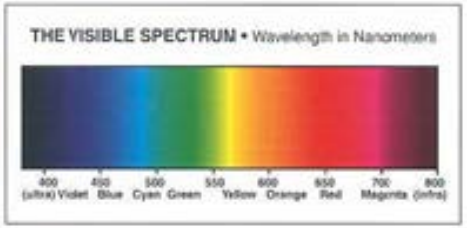
Three main points of investigation:

1. Can spectral profile data be collected at three different scales that enable evaluation of whether EWM can be differentiated from other species of submerged aquatic vegetation (SAV)?
2. Can object-based image analysis of multispectral UAS imagery matched with detailed field data be used to produce SAV maps with useful accuracy?
3. Can methods developed for points 1 & 2 enable quantitative documentation of changes in EWM extent after different types of treatment?

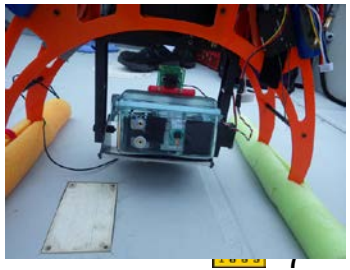

Kilometers
0 25 50
Project regions
State Boundaries
Keweenaw Waterway
Lake Superior
CANADA
UNITED STATES
Ontario
Marquette
Les Cheneaux Islands
Michigan
Lake Michigan
Lake Huron
Michigan
Wisconsin
Canada
United States
ESRI ArcGIS Service Layer Credits: Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community


Les Cheneaux Islands area
0 0.5 1 2 Kilometers
Chappell
Howells Dock
Point Urie
Marquette
Lake Huron
Hessel, MI area
Neil
Hessel Marina
0 50 100 200 Meters
Cedarville, MI area
Court Dock
Court East
Court West
FDS
Cedar
CRAMP
Breezeswept
0 50 100 Meters
Keweenaw Waterway area including Portage Lake (Keweenaw Peninsula)
Lake Superior
Torch Bay
Sloughs
Pike Bay
Service Layer Credits: Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community
Source: Esri, DigitalGlobe, GeoEye, Earthstar
0 2.5 5 10 Kilometers

1) Detecting EWM using SAV spectral profiles



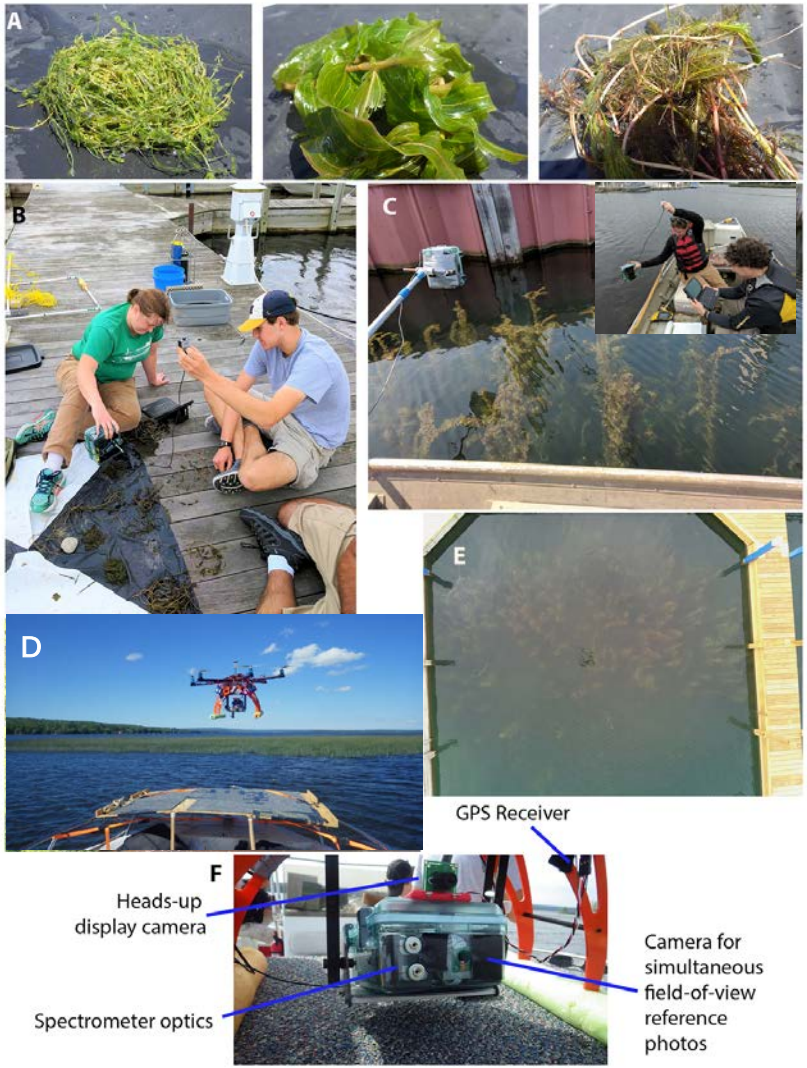
- Colors of plants species are based on pigments, & can look significantly different
- The way that plants absorb & reflect light based on their pigments can be captured using spectroradiometers
- 2 central questions:
  - 1) Can spectral profiles of EWM be differentiated from other SAV species?
  - 2) Are spectral profiles collected at 3 different scales similar?
- Using a spectroradiometer - measures light wavelength and light output/amplitude, usually in the visible to near-infrared (NIR); calculated Remote sensing reflectance (Rrs), calibrated



3 scales of spectral data collection with spectroradiometers

- Out-of-water (OOW) - A, B
  - With ASD FieldSpec 3
- Boatside (C)
  - With Lightweight Portable Radiometer (LPR) or FieldSpec 3
- From UAS (D, E, F)
  - With LPR

Depended on availability, comparable outputs



Are spectral profiles different using all 651 bands?

- OOW spectral bands:
  - a) 8 macrophyes, June 2015
  - b) 9 macrophytes + reference tap, June 2017
- 2015 EWM sample different than all other vegetation type (p<0.001) using K-S test
- Both 2017 EWM spectral samples sig. diff. (p<0.01) using K-S test

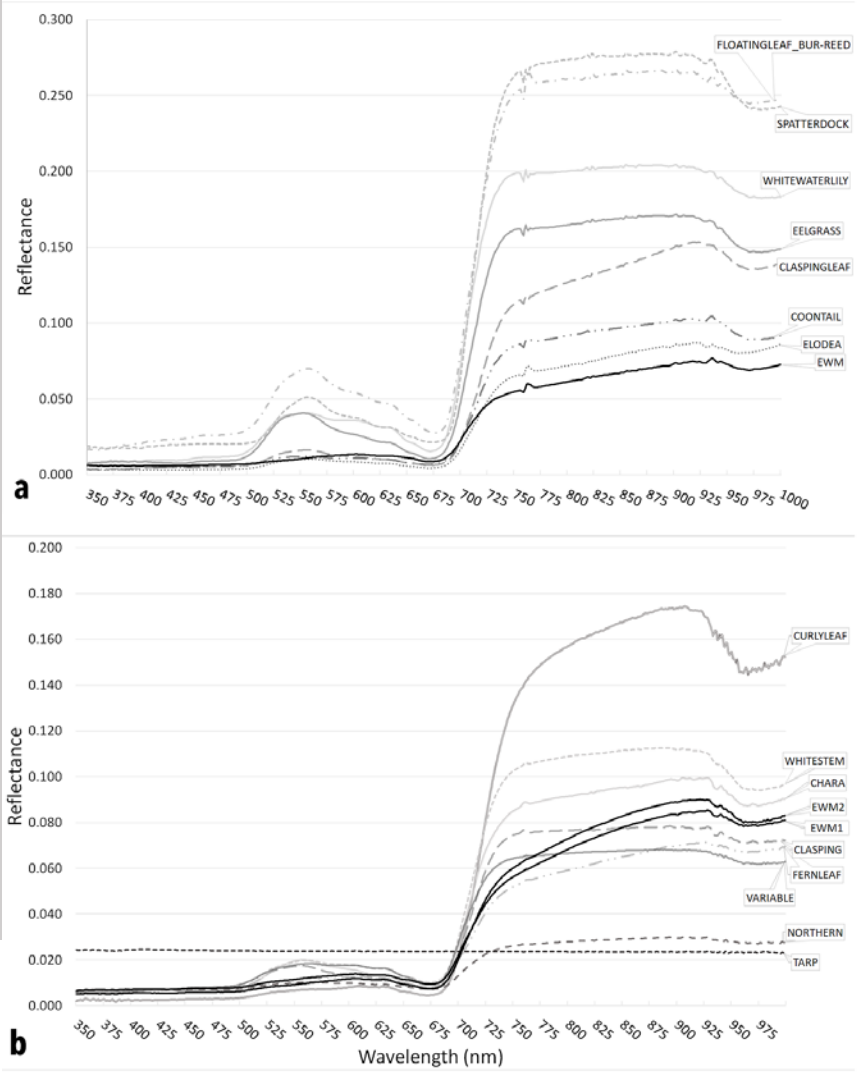


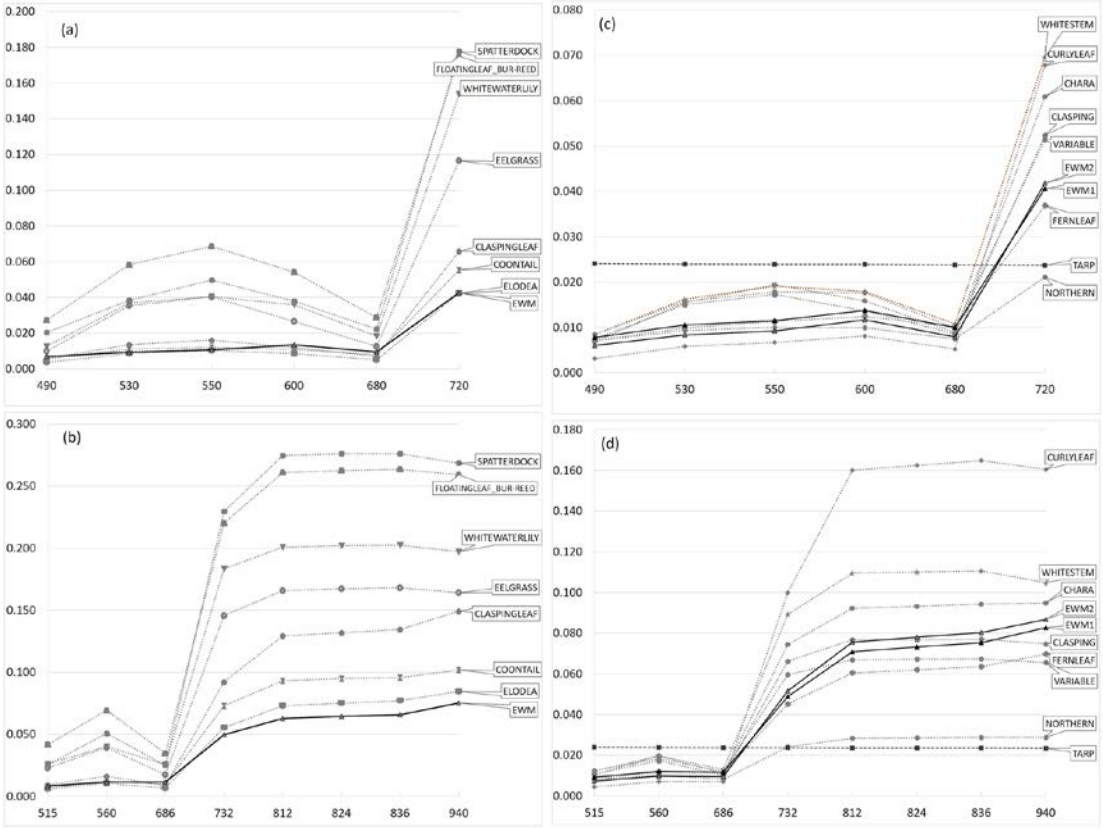
Table 2.2. K-S test of June 2017 OOW spectral data averaged to 65 10-nm-wide bands.

Tested profile	Species profile	*p*-Value	*D*		Tested profile	Species profile	*p*-Value	*D*	
EWM1 vs	CURLYLEAF	0.0000209	0.4	***	EWM2 vs	CURLYLEAF	0.0000209	0.4	***
	FERNLEAF	0.00746	0.3	**		FERNLEAF	0.00211	0.3	**
	EWM2	0.03858	0.2	*		EWM1	0.03858	0.2	*
	CLASPING	0.0625	0.20			CLASPING	0.0133	0.3	*
	CHARA	0.0001122	0.45	***		CHARA	0.0133	0.3	*
	NORTHERN	0.00000336	0.4	*		NORTHERN	0.00000336	0.4	***
	WHITESTEM	0.0000209	0.4	***		WHITESTEM	0.0000209	0.4	***
	VARIABLE	0.004037	0.3	**		VARIABLE	0.00107	0.3	**
	TARP	<0.0000001	0.5	***		TARP	<0.0000001	0.5	***

*Significant at $p < 0.05$. **Significant at $p < 0.01$. ***Significant at $p < 0.001$.

Are OOW spectral profiles different using 6 Tetracam & 8 Becker bands?

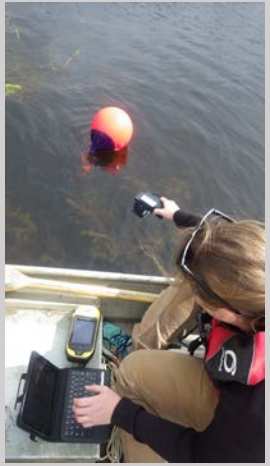
- (a) June 2015 Tetracam bands - EWM different 2 of 7
- (b) June 2015 Becker bands - EWM different 0 of 7
- (c) June 2017 Tetracam bands - EWM different only from tarp (0 of 7 veg.)
- (d) June 2017 Becker bands - EWM different only from tarp (0 of 7 veg.)

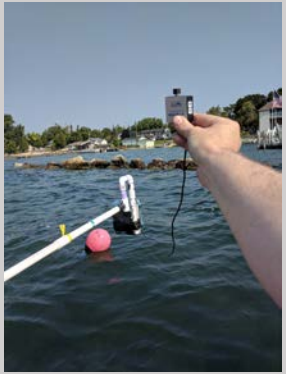


Tetracam - same 6 bands as collected for Tetracam multispectral camera imagery
Becker 2005, 2007 - optimal spectral bands for Great Lakes wetlands (not SAV focused)

Compared spectral characteristics among sites with differing SAV cover

- 62 boatside spectral profiles, 3 sites, 2 years
- Dominant vegetation type for each profile
- 6 Tetracam bands (490, 530, 550, 600, 680, 720 nm)
  - 720nm = red edge with greater penetration than traditional NIR
- Red edge / blue ratio
- 3 indices using red edge instead of NIR, with potential to capture underwater biomass differences:
  - Modified NDVI (mNDVI)
  - Modified NDAVI (mNDAVI)
  - Modified WAVI (mWAVI)

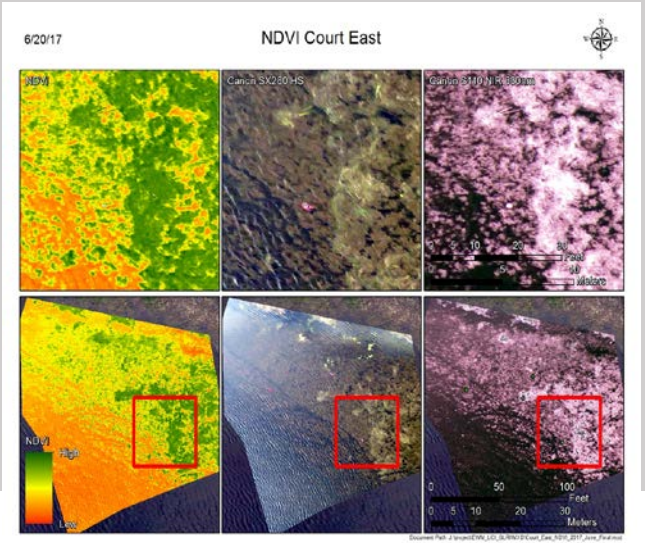


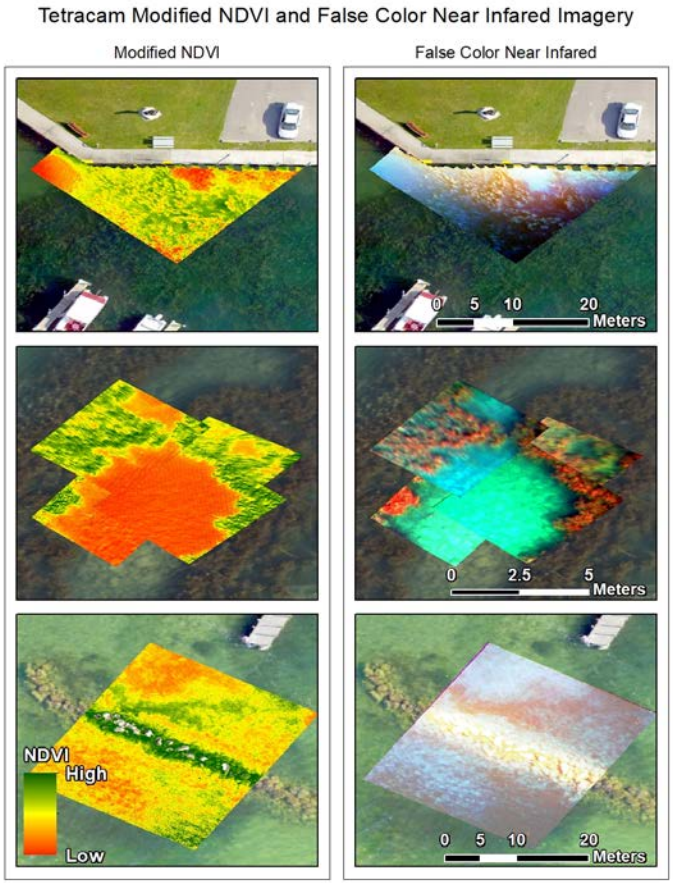


$$mNDVI = \frac{(\rho RedEdge - \rho Red)}{(\rho RedEdge + \rho Red)}$$

$$mNDAVI = \frac{\rho_{RedEdge} - \rho_{BLUE}}{\rho_{RedEdge} + \rho_{BLUE}}$$

$$mWAVI = (1 + L)\frac{\rho_{RedEdge} - \rho_{BLUE}}{\rho_{RedEdge} + \rho_{BLUE+L}}$$





EWM 1-2m below surface

EWM at surface

EWM 1.5 - 1.75m below surface

Analyzing spectral characteristics among sites & month

- **mNDVI significantly different** among dominant vegetation group ($F_{4,17.5} = 3.16$, $p = 0.04$)
  - No difference among months & no significant interaction between month & dominant vegetation group
- RE/BLUE, mNDAVI, mWAVI, & individual bands not significantly different among dominant vegetation groups
- Month effect for bands 490-680

OOW

Boatside

UAS

Comparison (average)	490	530	550	600	680	720	RE_BLUE	mNDVI	mNDAVI	mWAVI	Average all	Average 6 Tetracam bands	Average RE_BLUE, mNDVI, mNDAVI, mWAVI
UAS average versus BOATSIDE	13.7%	14.1%	14.2%	13.2%	13.0%	11.4%	77.8%	43.9%	23.0%	9.6%	23.4%	13.3%	38.6%
UAS average versus OOW	39.0%	32.3%	31.0%	24.1%	28.5%	9.3%	22.9%	14.6%	7.0%	3.6%	21.2%	27.4%	12.0%
BOATSIDE versus OOW	283.4%	228.9%	217.8%	182.3%	219.4%	81.8%	29.4%	33.1%	30.3%	37.9%	134.4%	02.2%	32.7%

- UAS average reflectance lower than boatside or OOW - average of 13.3% of boatside reflectance & 27.4% of OOW values
- Boatside & OOW more similar across scales; boatside reflectance about 2x OOW reflectance
- mNDVI useful across scales

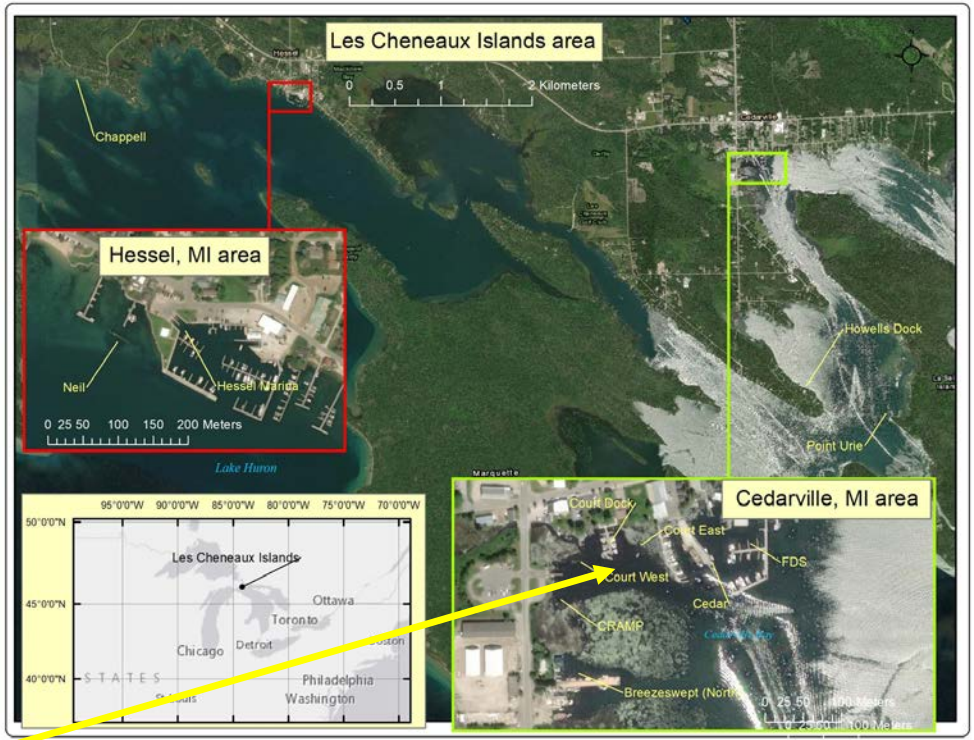
Summary of Point 1 (spectral profiles)

- Hyperspectral numbers of bands (65 10-nm wide bands from 350-1000nm) reliably identified EWM using spectral profile data
- Modified NDVI (using red edge instead of NIR) provided significant difference for EWM vs. other dominant vegetation groups
  - Most likely differentiating based on higher biomass for EWM vs. most other SAV species
  - Red edge & NIR values highly correlated; reasonable substitute & with potential for greater penetration
- UAS LPR signal could capture spectral profiles, but with reduced signal strength vs. OOW & boatside; optimize data collections
  - OOW & boatside similar spectral data

2) EWM classifications using multispectral drone imagery

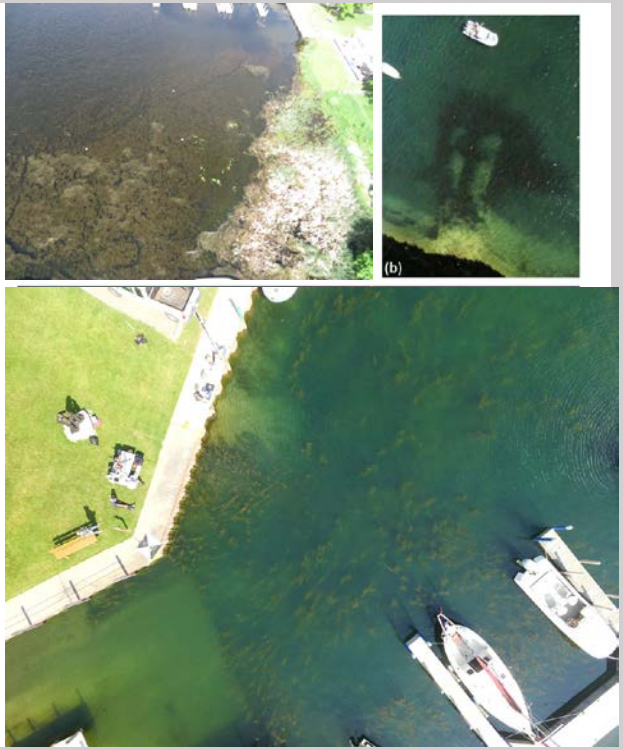
Challenges of SAV identification with remote sensing:

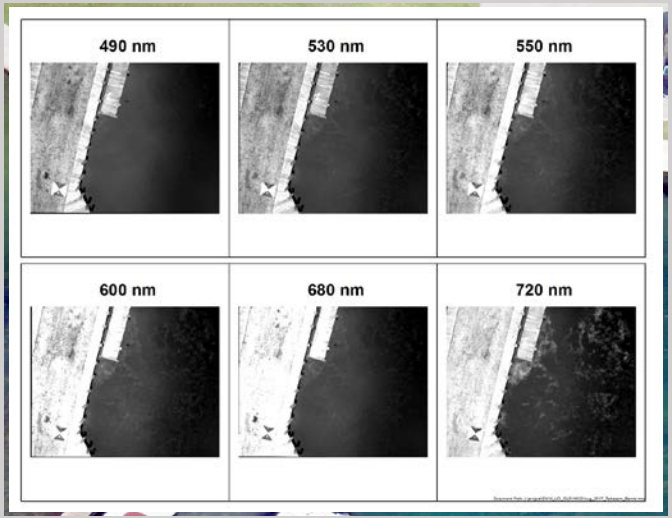
- Light penetration in littoral zone is a controlling factor for vegetation species
- Extinction coefficient of light in water affected by 3 color producing agents (CPA):
  - Chlorophyll (CHL)
  - Suspended Minerals (SM)
  - Colored Dissolved Organic Matter (CDOM) component of dissolved organic carbon (DOC)
- Field observations in LCI areas indicated possible darker & clearer water sites
  - Darker sites near stream mouth

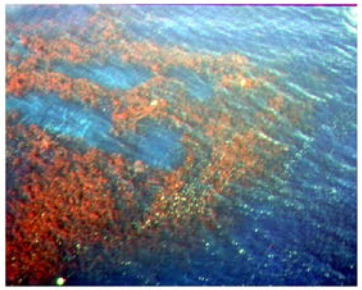


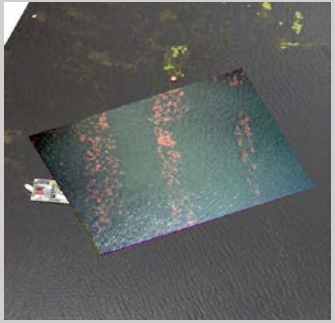
Sensors, & platforms for EWM classification data

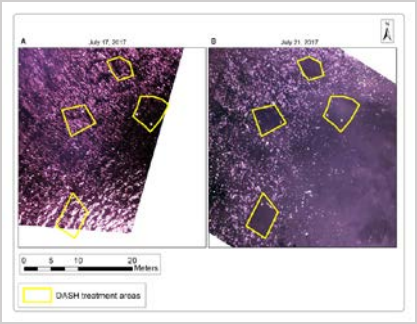
- Deployed:
  - 3 RGB-only cameras for basemaps
  - Tetracam 6-band multispectral camera
  - VISNIR M-5000 4-band dual camera system
  - 3 types of drones (two small DJI, larger Bergen hexacopter for heavier lifting)











RGB (natural color)

Tetracam 6-band multispectral
Bands: 490 (blue), 530 (green 1), 550 (green 2), 600 (Yellow/Orange), 680 (red), 720nm (red edge)

VISNIR 4-band multispectral
RGB + wide NIR (830-1100nm)

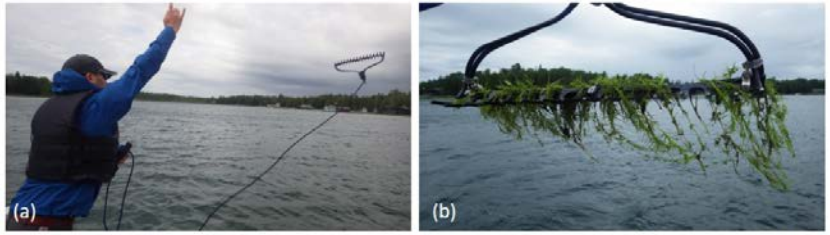


Figure 3.6. Rake toss in action and example results from an area with less dense SAV

Visual estimation of species type, density

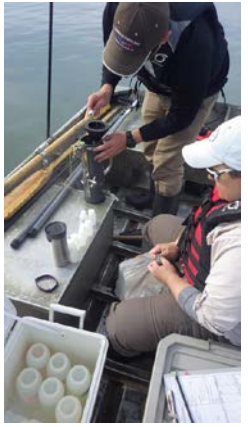
Figure 3.7. Rake twist sample immediately after retrieval from the water from an a with dense SAV, undergoing visual estimation of density.

Field vegetation sampling, recorded:

1) Visual estimation, 2) rake tosses, & 3) rake twists

Tosses & twists Identified to species, with density/fullness

- **Collected water chemistry & light data:**
  - TSS (g/L) (filtered water, heated, weighed)
  - Chl-a (mg/m3) (filtered water, APHA spectrophotometry)
  - DOC (mC/L) (filtered water, TOC analyzer)
  - Light extinction coefficient, k
    - of photosynthetically active radiation - Kd(PAR), with Li-Cor sensor at 0.5m depths to bottom



Cluster analysis by water chemistry

- Five group dendogram analysis
- 1st branch - “clearer water” sites (not near a stream source)
- 2nd branch - “darker water” sites - all close to Pearson Creek near Cedarville (DOC source)

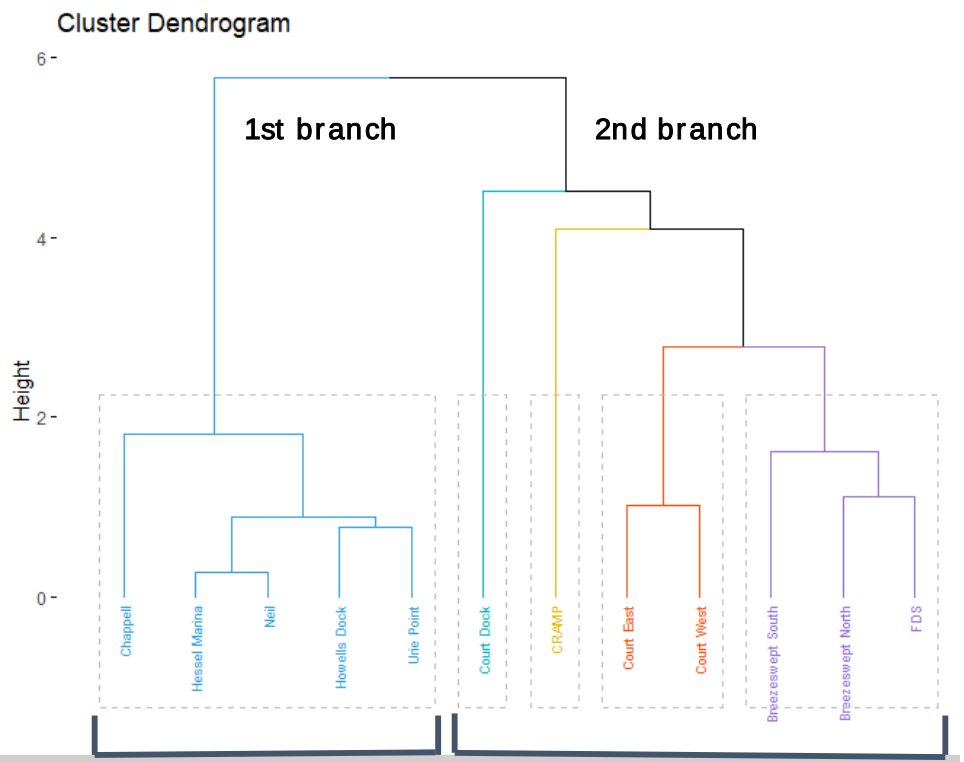


Image classification

- Object-based image analysis (OBIA) using Trimble eCognition Developer v9
  - Vegetation ground truth
- Multiresolution segmentation
  - 3 RGB bands
  - 6 Tetracam bands + mNDVI
  - 4 VISNIR bands
- Two scale parameters: 25 & 50
  - Smaller scale parameter (25) better for clearer water sites?
  - Larger scale parameter (50) better for darker water sites?
- Accuracy assessment - following Congalton & Green, 3rd edition (error matrices), ~50 points per site

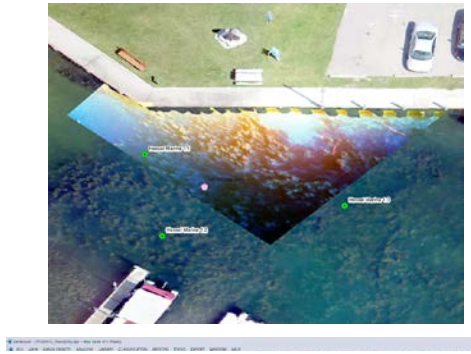
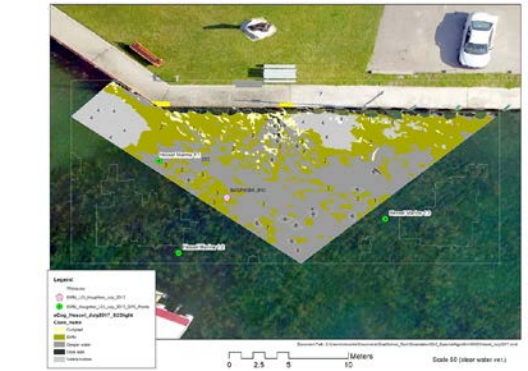
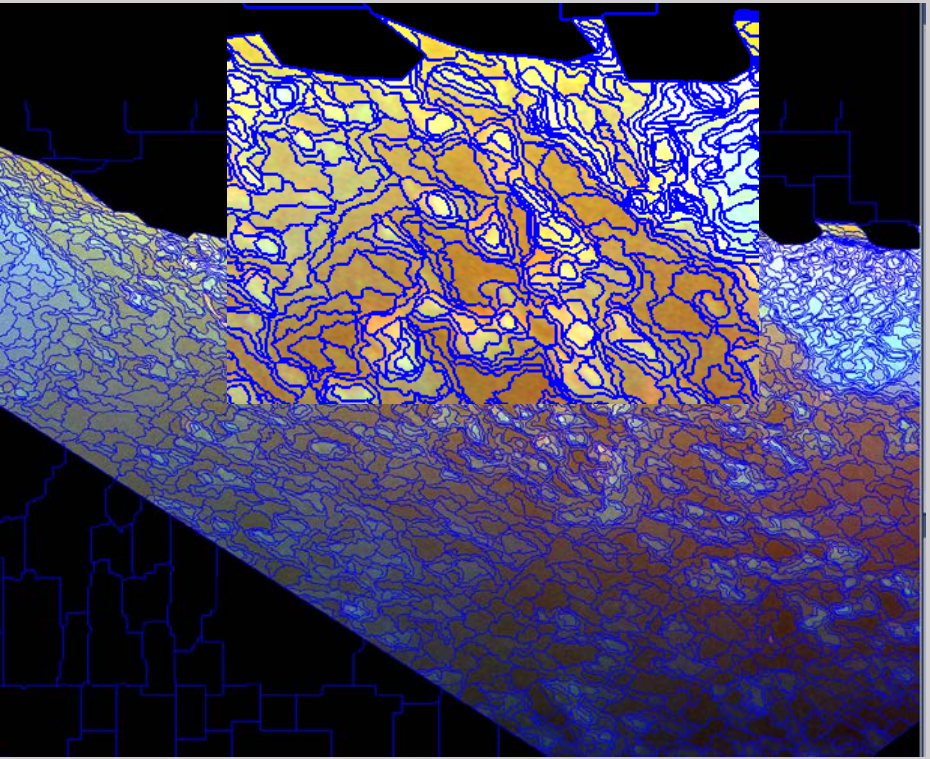


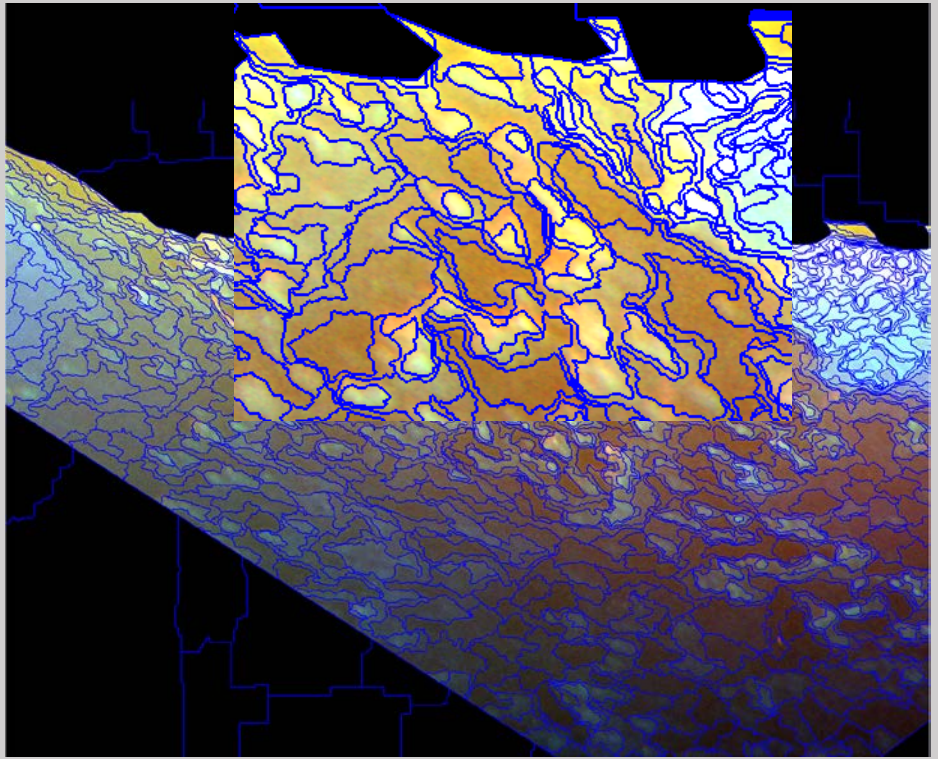
Table 3.1. Diagram of hypothesis prediction if H_o is rejected and the clear and dark water algorithms produce higher accuracies for their own water types.

		Classification type	
		Clear	Dark
Water type	Clear	Higher	Lower
	Dark	Lower	Higher
		(Accuracy results)	





Scale parameter = 25 (smaller objects)
Intended to work better in clearer waters (underwater features more distinct, need smaller objects to identify them)



Scale parameter = 50 (larger objects)
Intended to work better in darker waters (underwater features less distinct, need larger objects to identify them)

Aug. 2016

Figure 3.25. Example of eelgrass peduncles visible at the water's surface near one of the sampling buoys in August 2017 at Howells Dock, with a Trimble GPS unit encircling the location in the foreground.

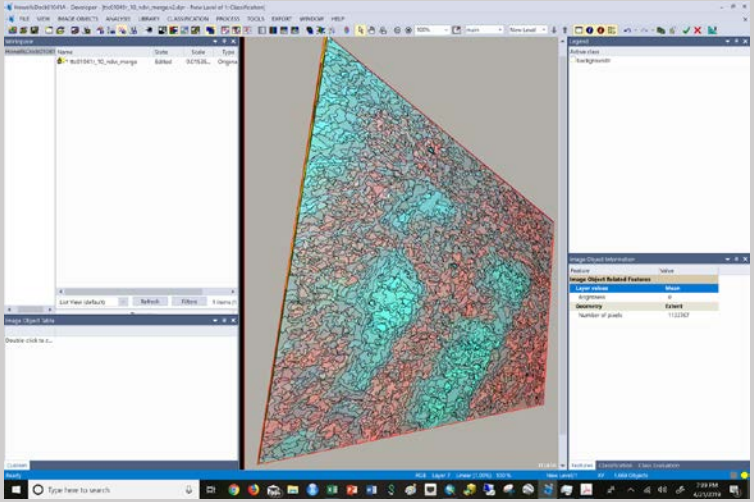
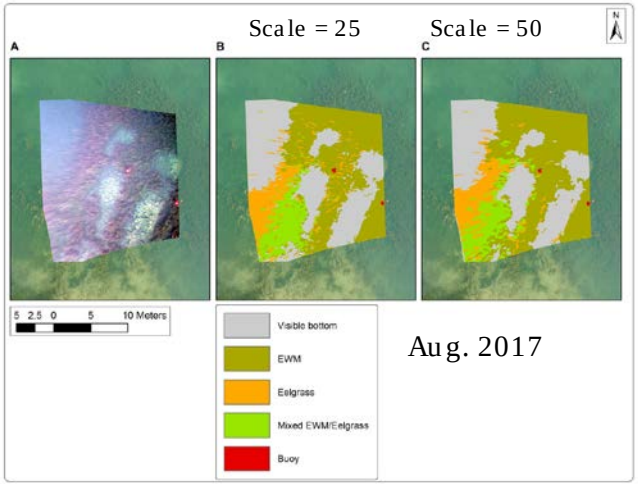
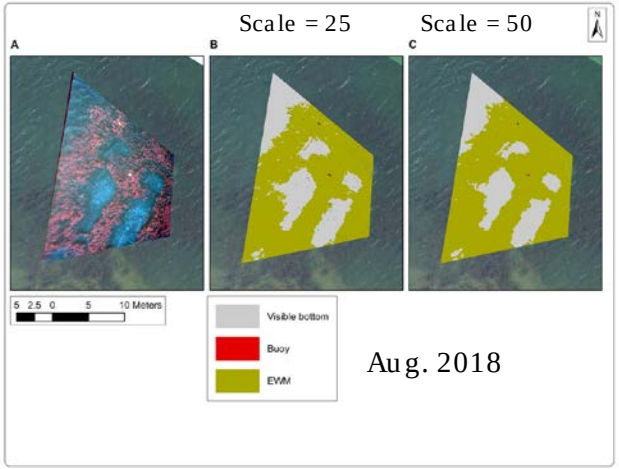


Figure 3.24. The bright green vegetation is northern watermilfoil that was visible in the August 2016 Tetracam imagery for Howells Dock, while the darker green/brown vegetation is Eurasian watermilfoil.

GPS location tagged fied photos for reference

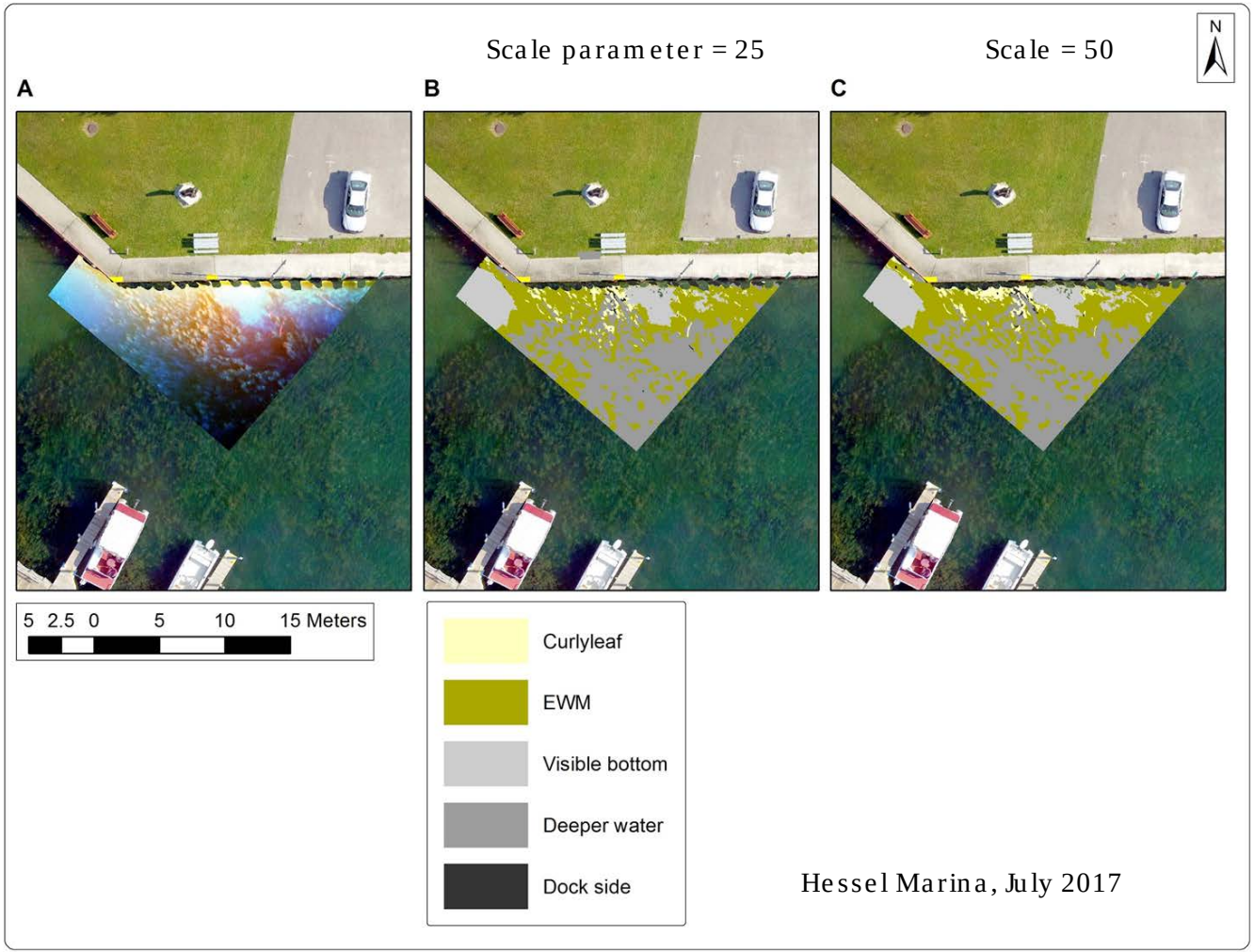


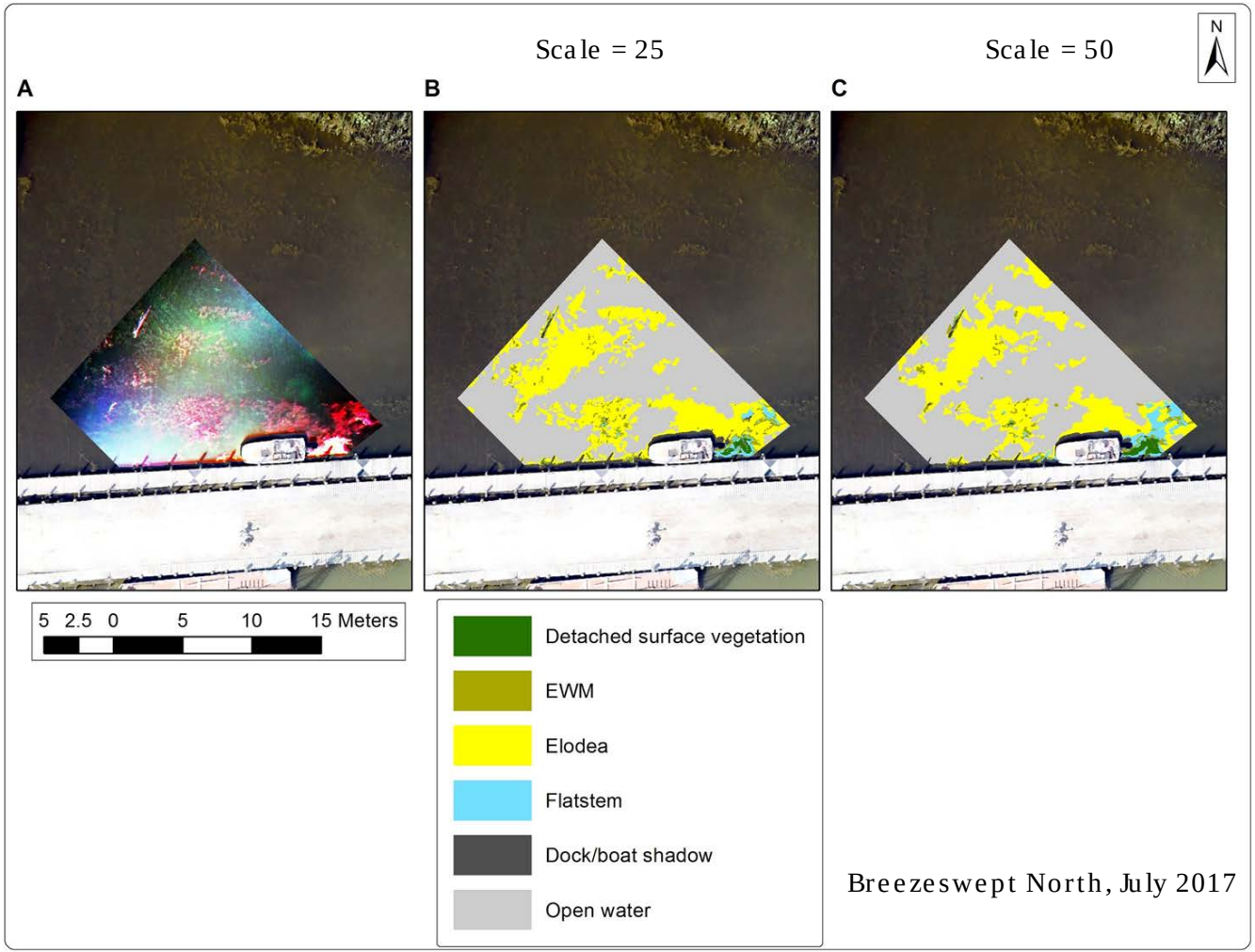
Aug. 2017

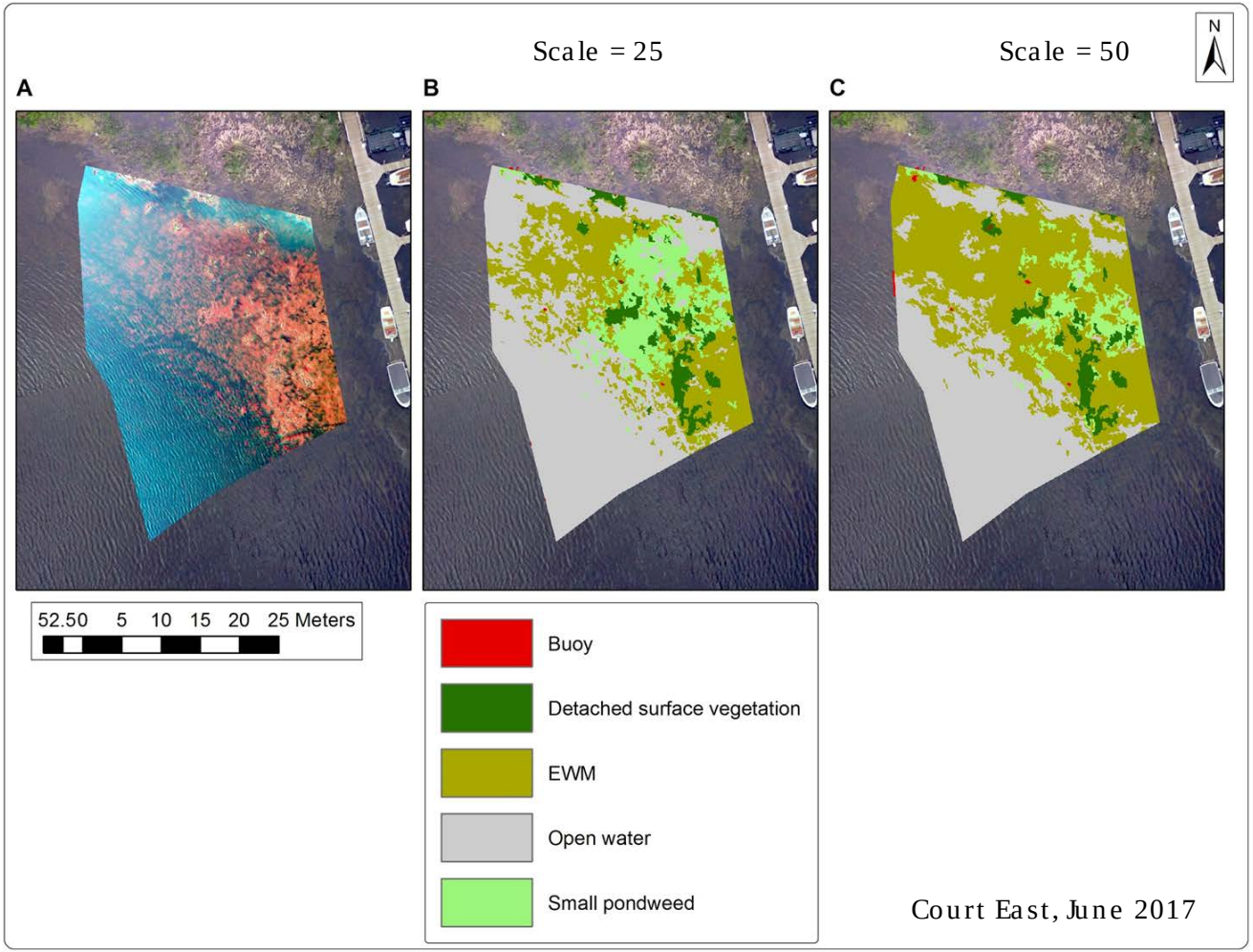


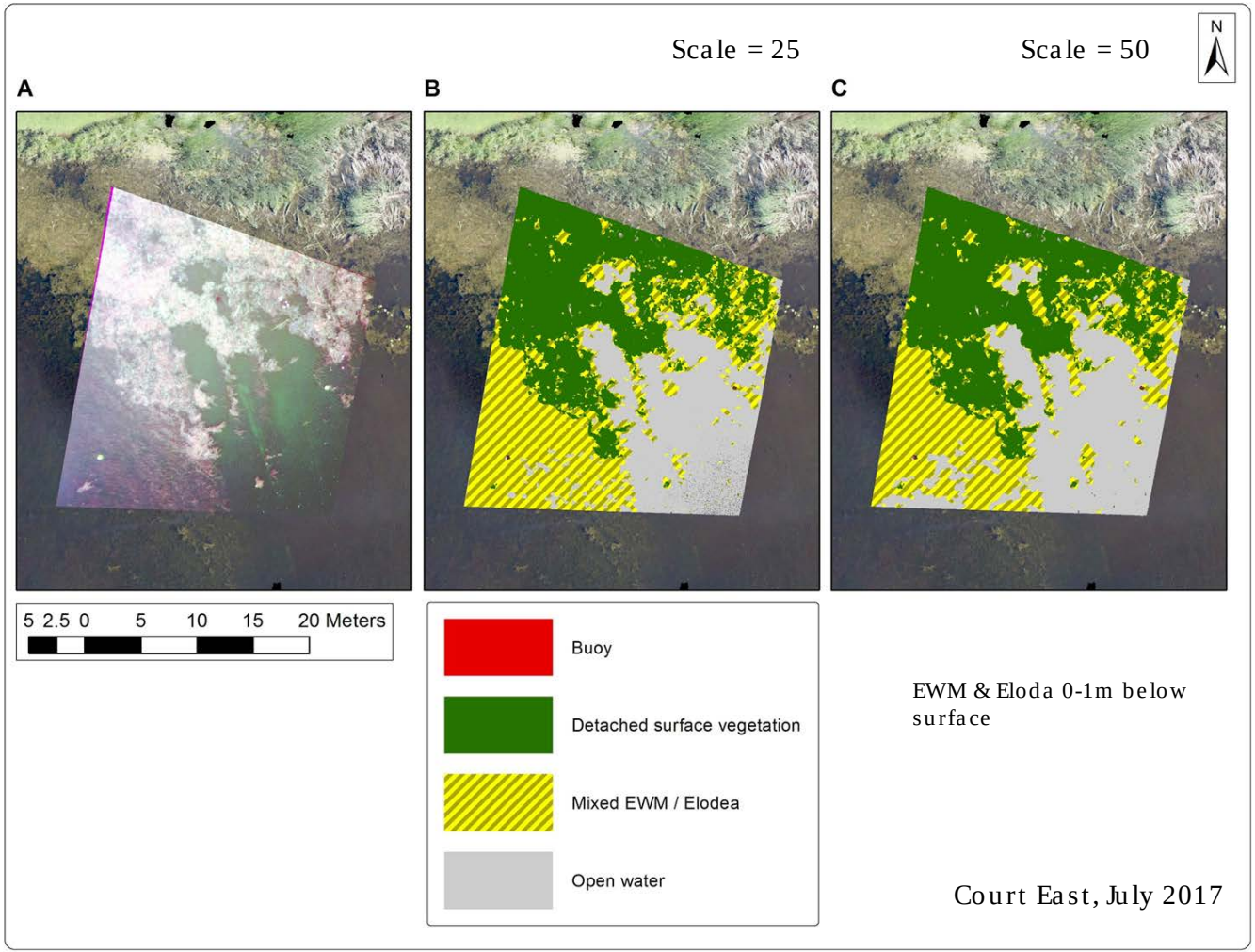
Aug. 2018

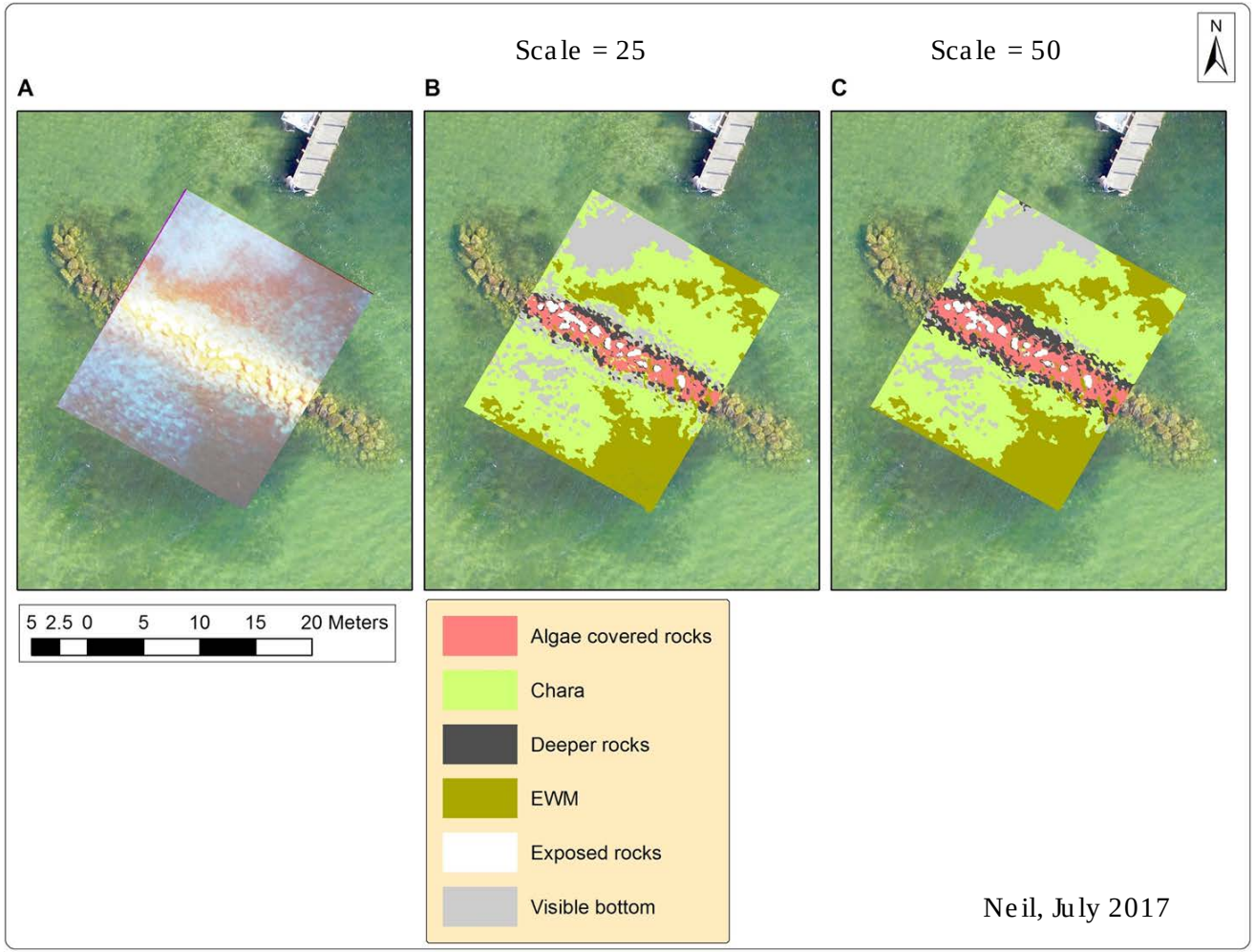
Court East - 3 dates


Scale parameter = 25
Scale = 50
N
A
B
C
5 2.5 0 5 10 15 Meters
Curlyleaf
EWM
Visible bottom
Deeper water
Dock side
Hessel Marina, July 2017


Scale = 25
Scale = 50
N
A
B
C
5 2.5 0 5 10 15 Meters
Detached surface vegetation
EWM
Elodea
Flatstem
Dock/boat shadow
Open water
Breezeswept North, July 2017


Scale = 25
Scale = 50
N
A
B
C
52.50 5 10 15 20 25 Meters
Buoy
Detached surface vegetation
EWM
Open water
Small pondweed
Court East, June 2017


Scale = 25
Scale = 50
N
A
B
C
5 2.5 0 5 10 15 20 Meters
Buoy
Detached surface vegetation
Mixed EWM / Elodea
Open water
EWM & Eloda 0-1m below surface
Court East, July 2017


Scale = 25
Scale = 50
N
A
B
C
5 2.5 0 5 10 15 20 Meters
Algae covered rocks
Chara
Deeper rocks
EWM
Exposed rocks
Visible bottom
Neil, July 2017

Error matrix example

Howells Dock August 2017

Tetracam Scale 25 Image 916		Reference Data: Visible Bottom	EWM	Eelgrass	Mixed Vegetation	Row Total	User's Accuracy
Classified Data	Visible Bottom	11	8	0	0	19	57.9%
	EWM	1	19	0	0	20	95.0%
	Eelgrass	0	2	2	2	6	33.3%
	Mixed Vegetation	1	0	0	5	6	83.3%
	Column Total	13	29	2	7	51	
	Producer's Accuracy	84.6%	65.5%	100.0%	71.4%		OVERALL ACCURACY= 37/51=72.5%

Howells Dock August 2017

Tetracam Scale 50 Image 916		Reference Data: Visible Bottom	EWM	Eelgrass	Mixed Vegetation	Row Total	User's Accuracy
Classified Data	Visible Bottom	16	2	0	1	19	84.2%
	EWM	2	19	0	0	21	90.5%
	Eelgrass	0	2	4	0	6	66.7%
	Mixed Vegetation	0	1	0	5	6	83.3%
	Column Total	18	24	4	6	52	
	Producer's Accuracy	88.9%	79.2%	100.0%	83.3%		OVERALL ACCURACY= 44/52=84.6%

Accuracy summary by site & classification types

Table 3.5. Summary of accuracy results by site (water) type and classification type (small scale factor = light or large scale factor = dark).

		Classification type Clear	Dark
Water type	Clear	76.7% (+/-10.5%)	78.3% (+/-9.2%)
	Dark	80.9% (+/-11.2%)	77.4% (+/-8.2%)

(+/- one standard deviation)

Accuracy Results

- Accuracies slightly higher for opposite classification type
  - opposite of expectations
  - not significant at p=0.05 (two-way ANOVA mixed model)
  - **Neither scale factor or site type have a significant effect on overall accuracy**
- **Average overall accuracy = 76.7%**
  - **Average producer's accuracy for EWM = 78.7%**
  - **Average user's accuracy for EWM = 77.6%**
  - Higher accuracies than other remote sensing SAV studies

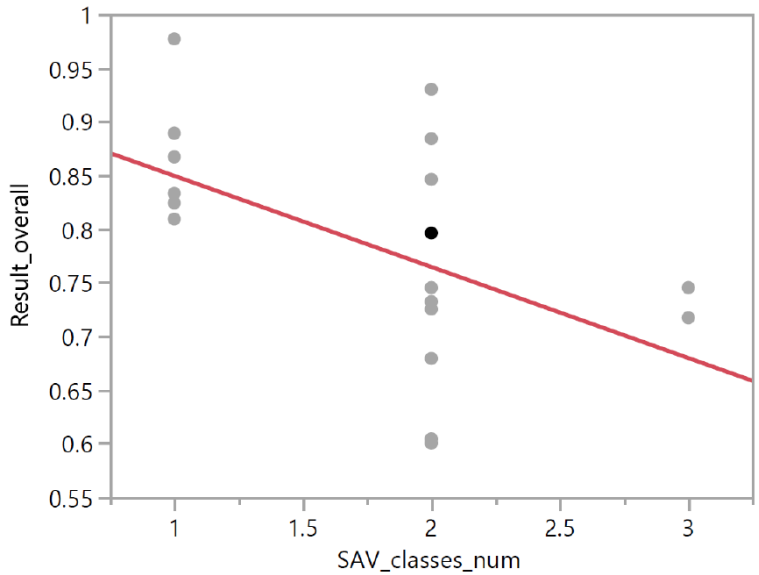


Figure 3.29. Regression equation for overall accuracy vs. number of SAV classes.

Effect of number of SAV classes

- Significant regression equation for producer's accuracy
  - $F_{(1,18)} = 34.8510$, $p<0.0001$
- No significant regression equation for user's accuracy
  - $F_{(1,18)} = 1.5128$, $p=0.2345$
- The more SAV classes attempted to map, the lower the producer's accuracy
  - *Producer's accuracy = 1.346 - 0.334 x (number of SAV classes)*
  - $R^2 = 0.6594$

Summary of Point 2 (EWM classification)

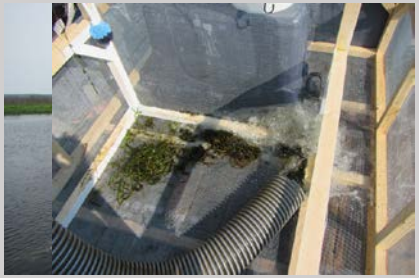
- Demonstrated higher accuracies in identifying EWM vs. other species than previous remote sensing of SAV studies
  - 78.7% avg. producer's accuracy, 76.7% avg. user's accuracy for EWM
- Different scale factors for image segmentation did not significantly affect accuracy results
- Fewer SAV classes increases mapping accuracy

Point 3: Measuring change in EWM extent due to treatment using multispectral UAS imagery

Remote sensing for aquatic plant management

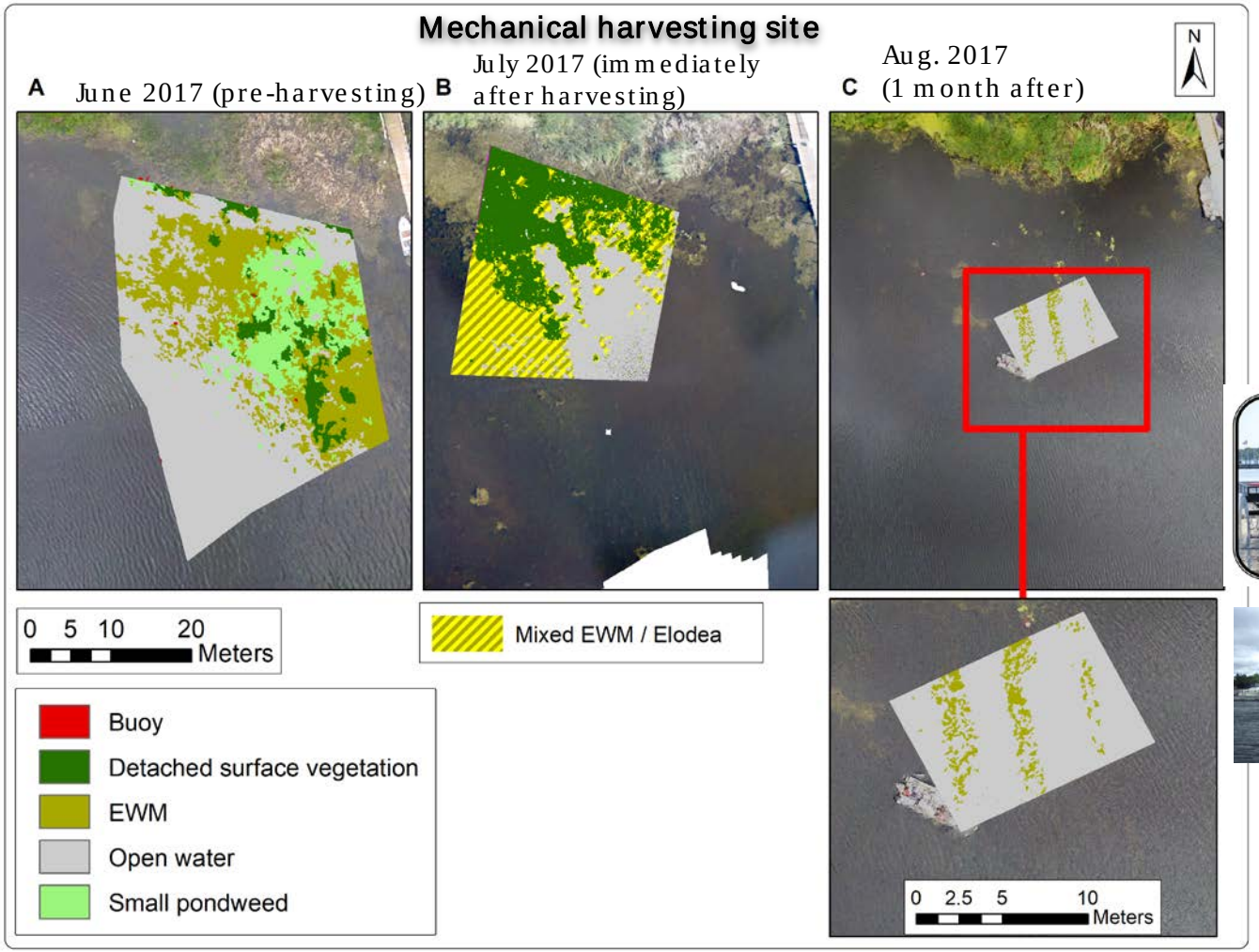
- There are extensive, ongoing efforts to control invasive aquatic plant species
- If remote sensing for plant identification & monitoring of change are both successful, potentially less costly to identify aquatic vegetation types & extent than field sampling alone
  - Goals:
    - Produce quantitative data of species extent
    - Monitor changes in extent due to treatment
- Previous studies show accuracies up to 61% or lower, but were not species-specific
- Potential to apply to many different species of invasive aquatic plants present in Midwest & elsewhere



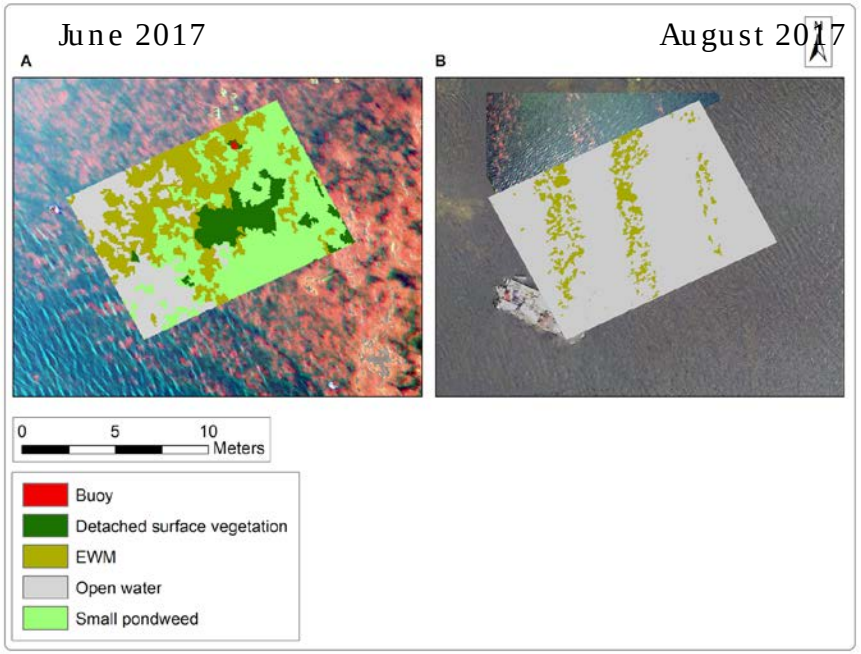




3 types of treatment quantified:

- Mechanical harvesting
  - Significant fragmentation issues
- Diver-assisted suction harvesting (DASH)
  - Designed to reduce negative impacts of traditional harvesting methods
- Biological treatment with native Mt fungus
  - *Mycoleptodiscus terrestris* (Gerd.)
  - Documented since 1970s for controlling EWM growth; fermented before application
  - Some studies have shown significant reduction


Mechanical harvesting site
A June 2017 (pre-harvesting)
B July 2017 (immediately after harvesting)
C Aug. 2017 (1 month after)
N
0 5 10 20 Meters
Mixed EWM / Elodea
Buoy
Detached surface vegetation
EWM
Open water
Small pondweed
0 2.5 5 10 Meters

Mechanical harvesting site change analysis



Identical extents for the June 2017 pre-harvesting classification (A) and the August 2017 post-harvesting classification (B) to enable change comparison

Table 4.2. Change in class areas from June 2017 to August 2017 at the Court East site, before and after mechanical harvesting treatment.

June 2017		
Class	Area (m^2)	Percent
Buoy	0.1	0.1%
Detached surface vegetation	11.0	10.1%
EWM	31.5	29.0%
Open water	21.9	20.2%
Small pondweed	44.0	40.5%
	108.6	
August 2017		
Class	Area (m^2)	Percent
EWM	11.5	10.6%
Open water	112.6	89.4%
	108.6	

EWM reduced from 31.5 m^2 to 11.5 m^2 (63% reduction)

Significant surface fragmented vegetation visible immediately after harvest:

Figure 4.6. Hessel Marina natural color imagery from A) July 2017 at the start of Mt treatment and from B) August 2018 one year after treatment.

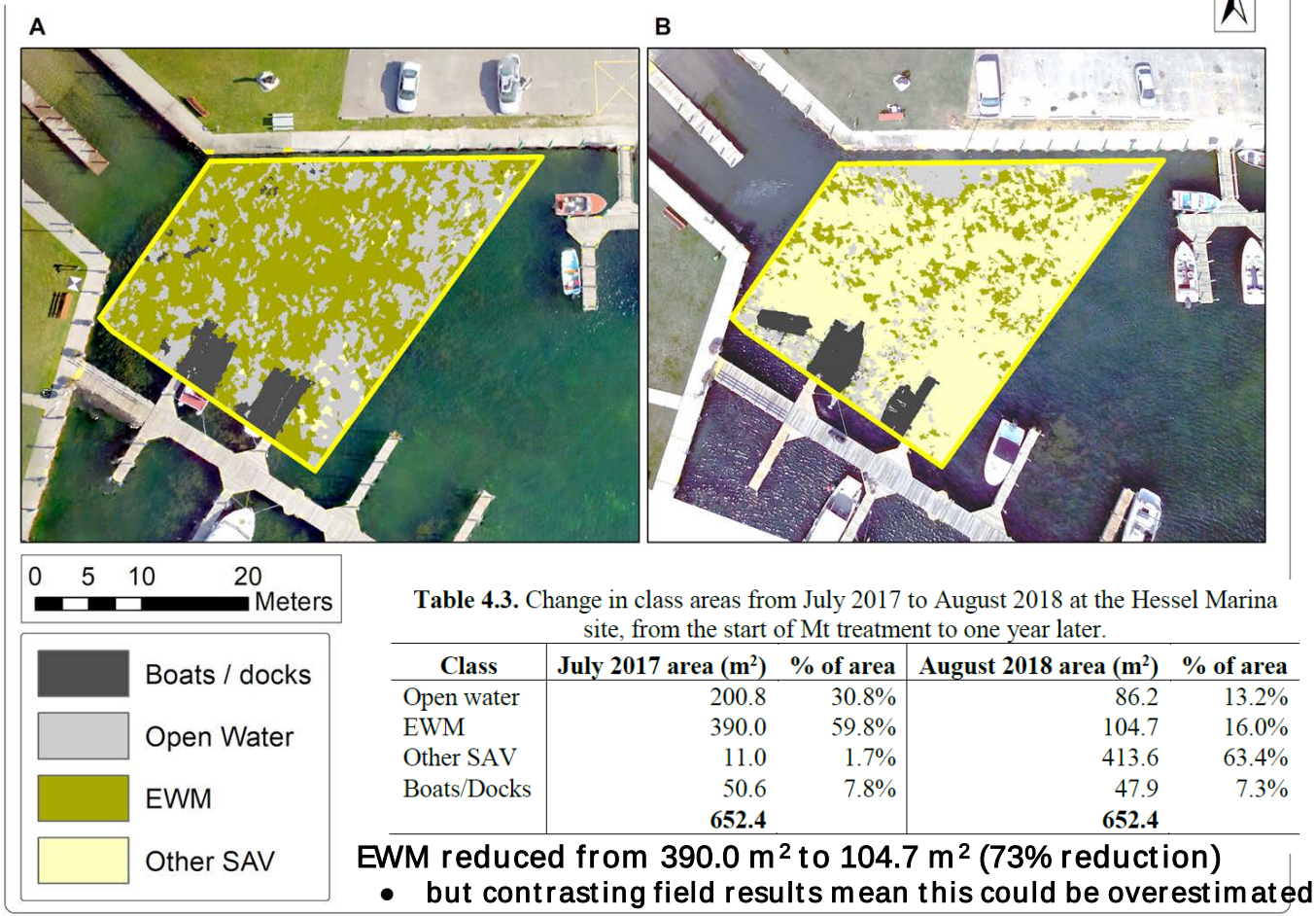


Table 4.3. Change in class areas from July 2017 to August 2018 at the Hessel Marina site, from the start of Mt treatment to one year later.

Class	July 2017 area (m^2)	% of area	August 2018 area (m^2)	% of area
Open water	200.8	30.8%	86.2	13.2%
EWM	390.0	59.8%	104.7	16.0%
Other SAV	11.0	1.7%	413.6	63.4%
Boats/Docks	50.6	7.8%	47.9	7.3%
	652.4		**652.4**	

EWM reduced from 390.0 m^2 to 104.7 m^2 (73% reduction)

- but contrasting field results mean this could be overestimated

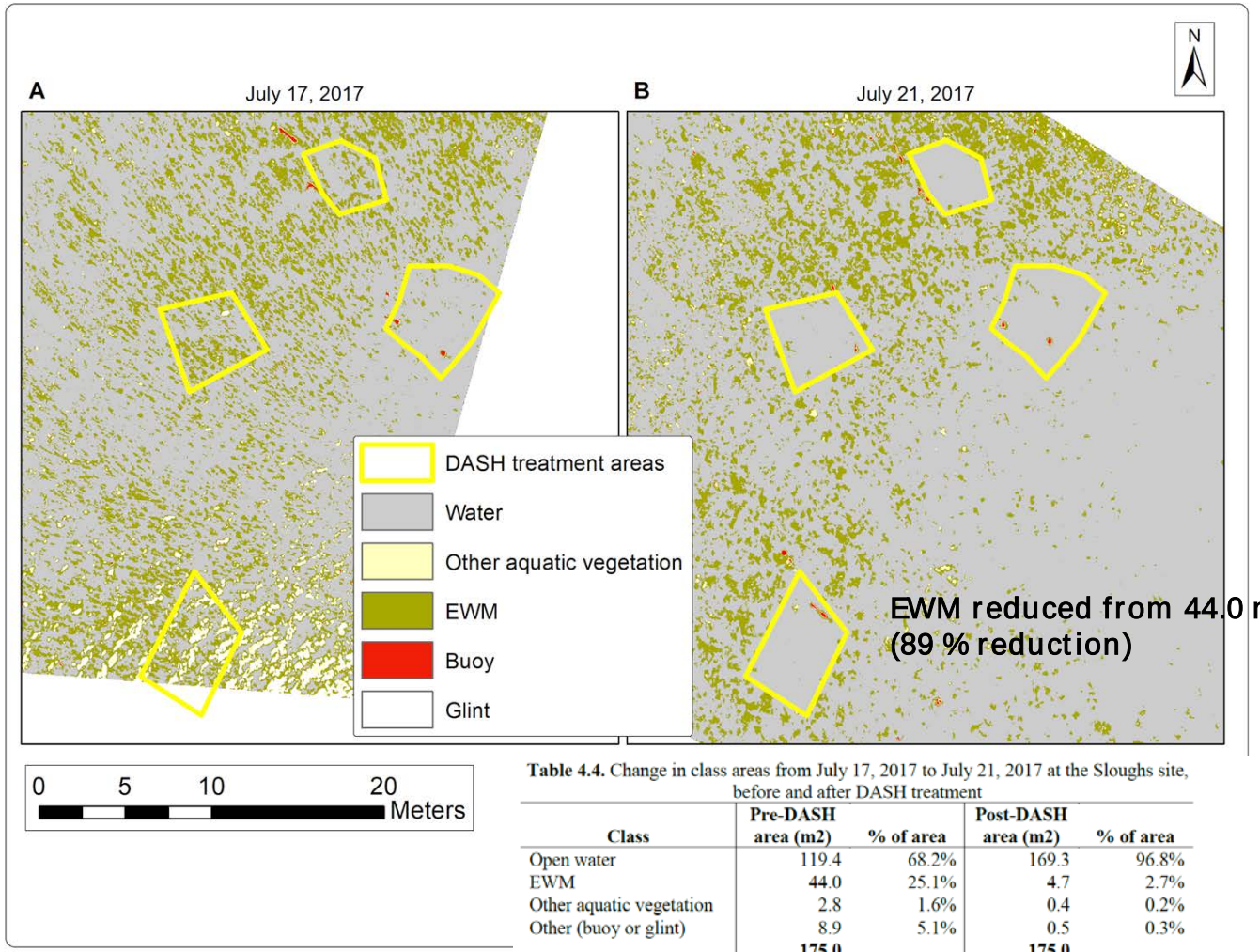
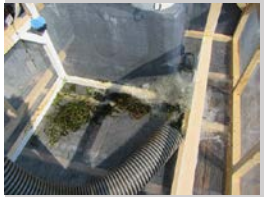


Table 4.4. Change in class areas from July 17, 2017 to July 21, 2017 at the Sloughs site, before and after DASH treatment

Class	Pre-DASH area (m2)	% of area	Post-DASH area (m2)	% of area
Open water	119.4	68.2%	169.3	96.8%
EWM	44.0	25.1%	4.7	2.7%
Other aquatic vegetation	2.8	1.6%	0.4	0.2%
Other (buoy or glint)	8.9	5.1%	0.5	0.3%
	175.0		**175.0**	



Point 3 summary (measuring change)

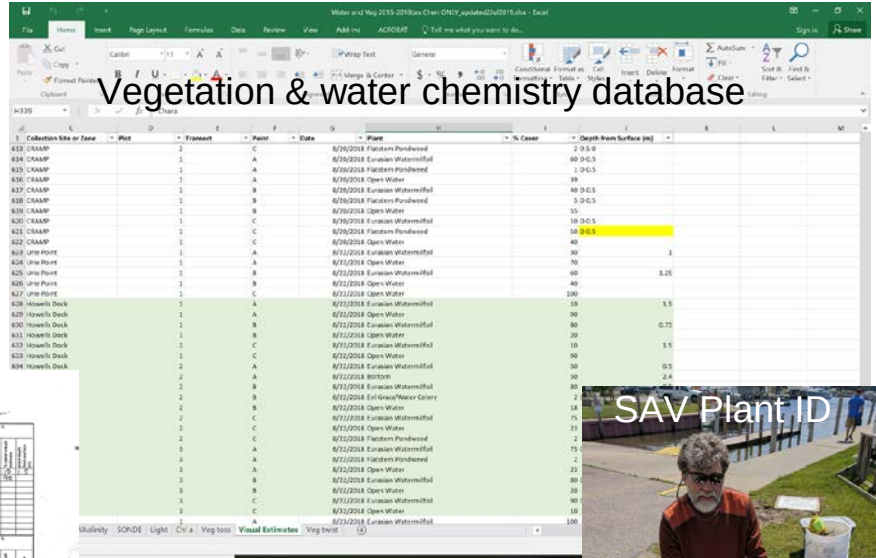
- Able to quantify reduction in EWM extent of 63-89% due to three different treatment methods
  - mechanical harvesting - 63%
  - Mt fungus biological treatment - 73%
  - DASH - 89%
- UAS-enabled multispectral sensing can produce useful quantitative data on presence & extent of SAV species of interest
  - Provides a tool for monitoring treatment effects & improving understanding of aquatic ecology

Summary of major findings & lessons learned (1)

- Larger numbers of wavelengths better for species-specific SAV identification
  - But mNDVI can be very useful if species of interest has high biomass vs. other SAV species
    - Useful for terrestrial RS **&** aquatic remote sensing (with sufficient light penetration up to ~2m)
- Research need to deploy hyperspectral sensors & compare to multispectral sensor at most useful bands
- littoral zone remote sensing of SAV is practical & more useful than previously demonstrated
- Possible to identify particular SAV species of interest
  - More accurate with fewer species
  - Can measure change in SAV extent (due to treatment methods)

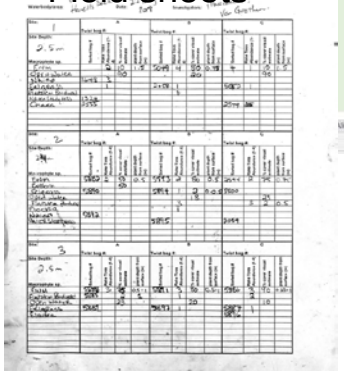
Summary of major findings & lessons learned (2)

- **Need high-quality ground truth data** - tied to identifiable locations; more challenging for aquatic systems



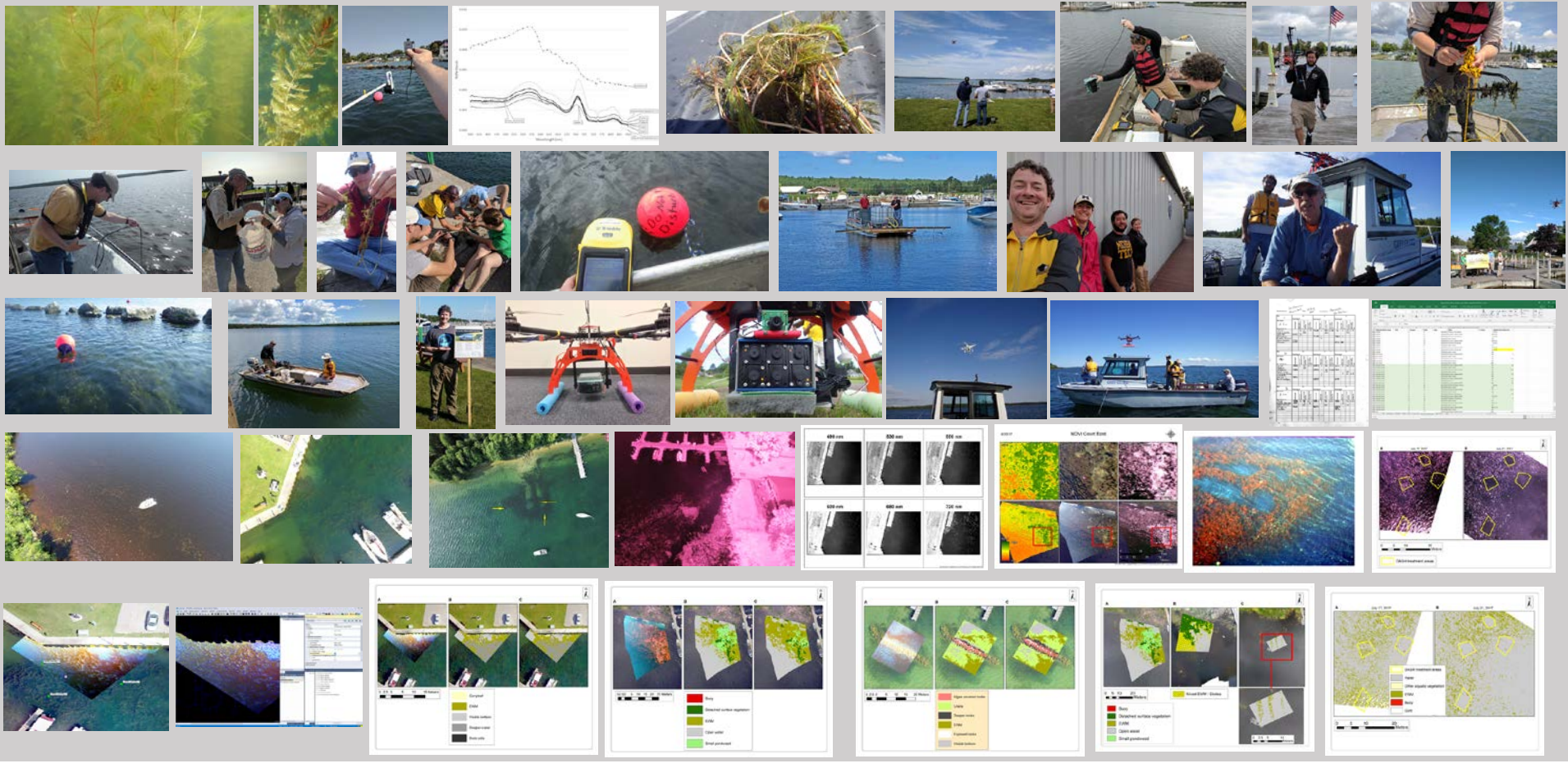
SAV sampling

Field sheets



Thank you!

Dr. Amy Marcarelli, Margaret Weiss, Isaac Brooks, Lillia Brooks, Eileen Brooks, Tony Brooks, Dr. Alasdair Brooks, Dr. Robert Shuchman, Dr. Casey Huckins, Dr. Marty Auer, Dr. Evan Kane, Dr. Charlie Kerfoot, Dr. Guy Meadows, Dr. Joe Wagenbrenner, Dr. Tess Ahlborn, Dr. Noel Urban, Amanda Grimm, Rick Dobson, Nick Marion, Mike Sayers, Michelle Wienert, Ryan Van Goethem, Chris Adams, Kevin Nevorski, Erin Eberhard, Jamey Anderson, Lucy Buller, Mark Clymer, Bob Smith, Dorothy Allard, Cindy Aulbach, Curtis Hutto, Doug Muchoney, Christi Lambert, Michelle Davalos, Rick Chubb, Harry Park, Tom Lloyd, Rose Summeral, Dr. Adina Merenlender, Kerry Heise, Monsieur Charles, Mrs. Beizer, Mr. Potoschnik, Mr. Sandy, Mr. Laws, Dr. Karen McDougal, Dr. Dan Richter, Dr. Stephen Walsh, Dr. Steve Francouer, Sir David Attenborough… & the novel coronavirus for the unexpected time to complete this endeavor. *And other friends, colleagues, teachers, mentors, and family members not otherwise mentioned here!*



Michigan Technological University

Thank you to everyone that helped me on this journey!

Michigan Tech Research Institute

LES CHENEAUX WATERSHED COUNCIL

EPA/GLRI Assistance Agreement: GL-00E00809

Funding Opportunity: EPA-R5-GL-2011

FINAL TECHNICAL REPORT

For the

Eurasian Watermilfoil Strategic Biological Control Program

2011—2013

Prepared by

Mark Clymer, Project Manager

March 31, 2014

TABLE OF CONTENTS

INTRODUCTION

In order to reduce overhead and focus on quantifiable objectives, this Final Technical Report will endeavor to stay within the narrowly defined scope of the GLRI Grant Project: researching "the potential for milfoil weevils to provide sustainable and low maintenance control of Eurasian watermilfoil (EWM)". It is noted here, however, that this project and it's impact are part of a functional and ecosystem level effort in the Les Cheneaux Islands (LCI) watershed to balance native and invasive species by facilitating the natural diversity still present.

Biological control of EWM growth is part of an comprehensive and strategic weed management approach being implemented by the Les Cheneaux Watershed Council (LCWC) to improve the ecology and the economy of the Les Cheneaux Islands (LCI), through the revitalization of native vegetation and hydrological restoration. This project has also given an opportunity to demonstrate the viability of biological control of Aquatic Invasive Species (AIS) in Great Lakes waters.

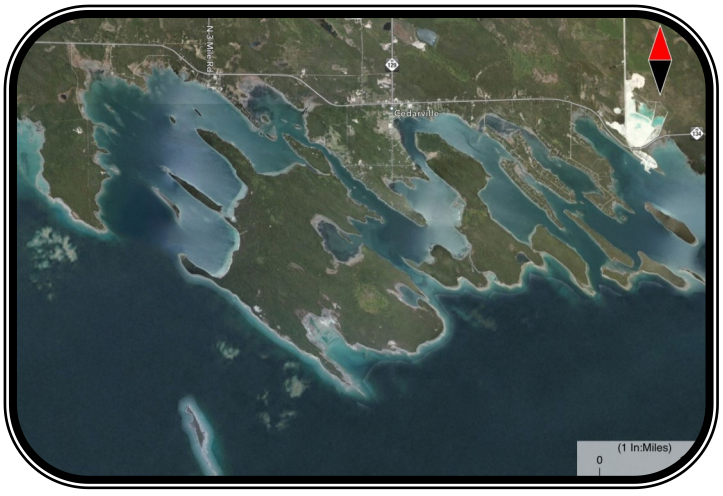
The utilization of aquatic weevils as a biological control method is both proven in documented studies, and regarded as a logical approach to EWM control. The weevils used are native to the Les Cheneaux Islands and have been shown to preferentially feed on EWM over their natural food source, Northern watermilfoil (*M. sibericum*). Aquatic weevils have been commercially produced by EnviroScience for fourteen years and many successful EWM control programs have been conducted.

Results of this project indicate that some macrophytes appear able to compete with EWM, and that EWM does not appear to be as severe an ecological threat in LCI as suggested by some in 2011-2013. This statement does not mean there is no problem, only that under favorable conditions the Pondweed Family, Chara, and Eel Grass for instance, are able to successfully cohabitate with EWM, as demonstrated in the 2013 Aquatic Vegetation Assessment Site (AVAS) survey and a Point Intercept (PI) survey findings. Favorable factors include cooler water temperatures, less available sunlight, and the presence of EWM pathogens & predators.

The presence of Milfoil Weevils decreased EWM stem density in all three project areas, but most markedly in John Smith Bay and Cedarville Bay. The exception was Sheppard Bay during the summer of 2012, an especially favorable growing year for EWM, as was reported across the entire Midwestern US.

Project Goals and Objectives have now been met and the Les Cheneaux Watershed Council wishes to express their sincere appreciation for the funding provided by the EPA's GLRI grant in 2011.

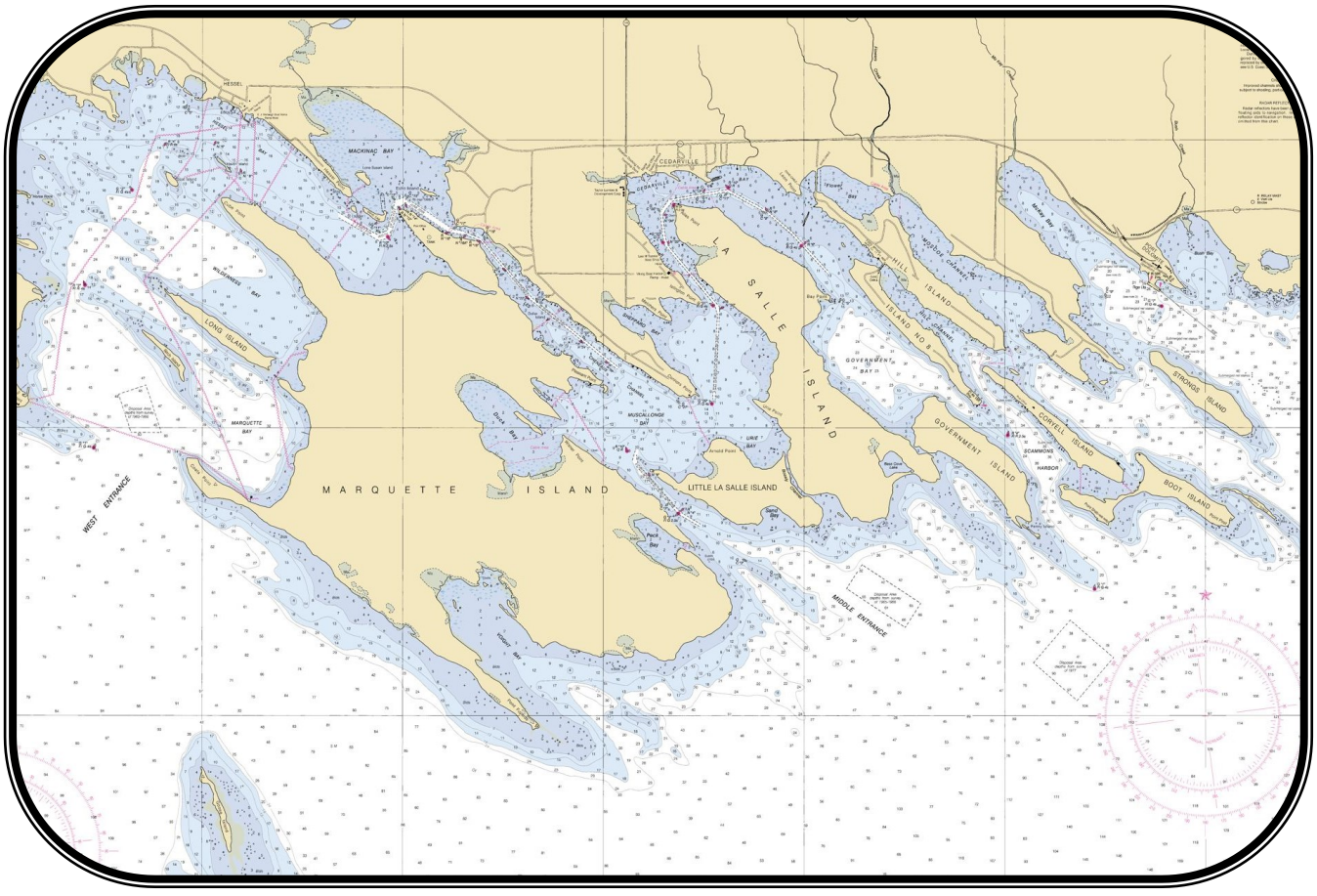
Osprey providing oversight to AVAS Project



Les Cheneaux Islands

Companion projects funded locally and being concurrently carried out by LCWC include:

- Annual Water Quality Study Project, in cooperation with Les Cheneaux Islands Association (LCIA) is in it's 13th year
- Beach Raking and Composting Project is an outreach and educational project that is promoting the cleaning up of EWM fragments from prop cuts along lake shores
- Benthic Tarping Project is providing shoreline stakeholders with a means to limit EWM in near shore areas, beaches, and around docks
- Boat Wash Project is still in the planning stage, as the local boat launches are currently limited in their ability to offer electricity, water delivery, and a way to dispose of EWM upland
- Cormorant Depredation Project, in cooperation with Islands Wildlife and LC Sportsman's Club has succeeded in reducing the local invasive cormorant population on five local rookeries
- *Dispose of your Milfoil Divots* is a Project to raise awareness on the impact of prop cuttings
- Dredge/Drag Project, in cooperation with MDNR and Islands Wildlife, is studying methodologies to uproot EWM with in the seven mile Federal Navigation Channel
- Late Season Harvesting Project is collecting evidence of weakening EWM before energy can be moved to the root system for over-wintering
- Microbial Control Agent Project in cooperation with USDA has completed first year site tests



Les Cheneaux Islands (Sheppard Bay Project Site - Lat: 45.97931 Long: -84.36195)

EPA GRANT: FINAL TECHNICAL REPORT

PROJECT OUTPUTS

1. **Resolve the problem of EWM (along with other aquatic nuisance species)**
2. **Demonstrate the potential for Weevils to control EWM and restore native plant dominance**
3. **Develop appropriate invasive species control methods**
4. **Conduct surveys to assess invasive species infestation & spread**
5. **Reduce Perch habitat impacts from invasive species and restore Perch spawning grounds**
6. **Provide local job creation for 3 part-time individuals**
7. **Public Outreach and Education**

AVAS Crew: "Lake Girls" & Walker

Les Cheneaux: "The Channels"

One of many Ospreys track field work

Summarize Nature & Extent of Project (Scope of Work - SOW)

1. Resolve the problem of EWM (along with other aquatic nuisance species)

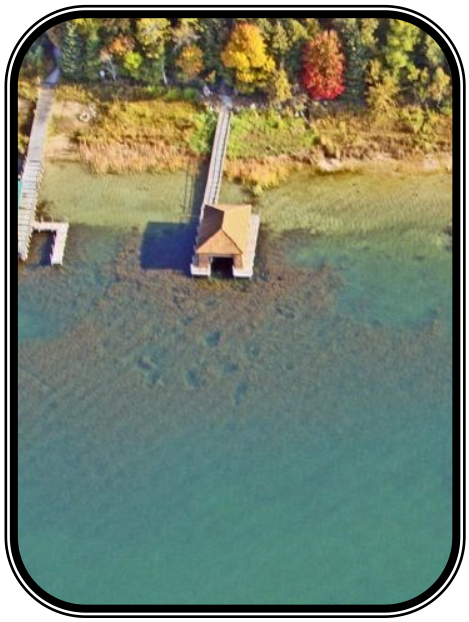
EWM is successful in many aquatic plant communities because it out-competes desirable native vegetation and tends to form dense monocultures which may contain several hundred stems per square meter. This is primarily due to its fast growth rate and canopy-forming growth habit, which allows it to shade out more desirable native vegetation. EWM does well in a wide variety of sediment conditions, can tolerate low light, and also low temperatures. Dense colonies of the plants and its ability to form thick floating mats interfere with all types of recreation - even to the extent of stopping and incapacitating motors boats with V-8 engines! Clogging water intakes has led to dozens of engine failures locally, and propellers clogged with nuisance vegetation has led to many boaters being left stranded. Dense EWM monocultures provide poor fish habitat, cause degraded water quality, and weaken ice cover - which led to the death of one very experienced local resident.

The Les Cheneaux Watershed Council has been exploring a number of ways to meet the challenge of aquatic nuisance species. The use of Weevils (I) as a biological control method is the main focus of the *Eurasian Watermilfoil Strategic Biological Control Program* and will be discussed at length in this report. Other methodologies employed by the Les Cheneaux Watershed Council are discussed in their *Aquatic Adaptive Management Plan*, and as they are not funded by this GLRI Grant, will only be touched on here. They do however constitute elements of an overall application of synergist methods that collectively are achieving the stated purpose of resolving the problem of EWM and other nuisance species.

Environmental justice is being served by supporting, both this important ecosystem, and the implications for the project methodology across the entire Great Lakes Watershed.

So we are weed-free and life without prop fouling or new weed growth is good, right? Wrong.

Whereas the milfoil did not grow as robustly this year, a number of nuisance aquatic cousins have had a very good year. Specifically, Northern watermilfoil, Richardson's Pondweed, Narrow-leaf pond weed and Elodea.



EWM infestation from prop cuttings

Pristine Island Ecosystem before EWM

EWM prop cuts around Weevil planting

2. Demonstrate the potential for Weevils to control EWM and restore native plant dominance

The Les Cheneaux Watershed Council (LCWC) retained EnviroScience Inc. (ES) to provide biological control of Eurasian Watermilfoil (hereafter referred to as EWM) in three highly infested areas within the Les Cheneaux Islands. As a subcontractor for the LCWC, ES assumed primary responsibility for supplying the biological control agent *Euhrychiopsis lecontei*, commonly known as the Milfoil Weevil. ES biologists stocked populations of the insect into the infested areas, collected baseline condition data and monitored both the weevil and aquatic plant populations after stocking. A combination Aquatic Vegetation Assessment Site Survey (AVAS) and Point Intercept Survey (PI) was added to the contracted for activities in year three, with funding provided by the Les Cheneaux Lion's Club and LCWC.

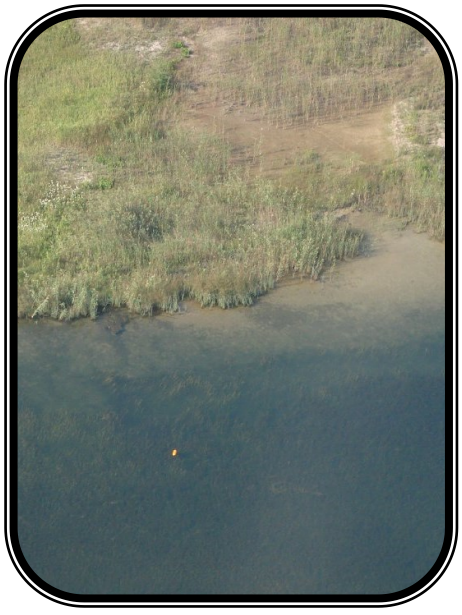
In 2007-2008, a project initiated by the Les Cheneaux Watershed Council in Cedarville Bay, Lake Huron, demonstrated the first successful implementation of Milfoil Solution® in one of the Great Lakes. Two weevil stocking sites, S1 and S2, were established on opposite ends of one long bed of EWM on the west side of the bay. Monitoring site, M1, was established along the north shore, east of the Cedarville marina. In June 2007, 13,550 weevils were planted in S1 and 2,000 in S2. The follow-up survey that year showed a decrease in EWM density by 14% in S1 and 45% in S2 and increase of 74% in M1.

By the final survey in August 2008, EWM density had reduced dramatically from June 2007 in both stocking sites by 96% in S1 and 87% in S2. A decrease in EWM was also noted in M1 along with an increase in the weevil density. As the percent EWM decreased, all sites experienced an increase in native plants, as well as the presence of bare substrate where EWM once grew. These dramatic changes in one year demonstrated that faster results can be achieved when a large number of weevils are targeted to a discrete bed of EWM in the first year of a program.

Beginning in July of 2011, a total of 85,000 aquatic weevils (*E. lecontei*) were stocked in the three project bays over a two-year period. In 2013, a follow-up monitoring survey of all program sites was completed to document the extent to which the weevils have controlled the EWM in the project areas. It was expected that EWM would transition from a dominant species to a relatively small part of the overall plant community.

EWM growing near surface

Milfoil Weevil collected from EWM



EWM Buoy at Mouth of J Smith Bay

3. Develop appropriate invasive species control methods

In order to maintain the pristine character and long term ecologic viability of the of the Les Cheneaux Islands & it's watershed, LCWC takes a "Dynamic Adaptive Management" approach, where resource stewardship policies balance management decisions with the complexity of ecosystem demands. In this way the extremes of hands off "tree-hugging" vs. large scale "silver-bullet" interventions are reconciled.

Identifying the causes allows for more preventative measures to be taken, rather than the reactionary "symptom chasing" too often witnessed when political-science is applied to systemic issues like invasive species. With at least 36 native aquatic plant species identified so far locally, LCI is a long way from requiring the "petri-dish" management techniques applied postmortem in many urban areas.

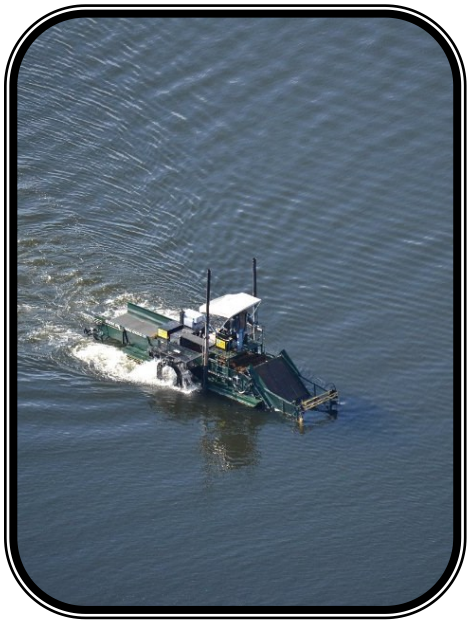
In addition to the rich local ecosystem diversity, there is also variability across the watershed. Water depths range up to 60 feet, bottom makeup spans from silt to bedrock, and the 200 linear miles of shoreline reach from large limestone rock outcroppings to wetland marshes.

There are a variety of man made stressors from both recreational and commercial usage. Climatic variability, as seen in the 6-1/2 foot water level drop between 1986 & 2012 — and this is on top of the 21" net water level drop from dredging and gravel mining in the St. Clair River between 1852 and 1962, also impacts systemic viability.

In other words, there is not a single management tool that can be applied in every instance, consequently the LCWC has been working with a number of management tools that can be applied in synergistic or additive combinations across the watershed. These intervention tools are continually being optimized for the changing conditions that are faced each season.

In the spring and early summer, Project surveys have been conducted both aerially and on the water to assess impacts from the previous year's efforts, and modified accordingly to adjust for the current year's work plan.

EWM burned by herbicide application



Harvester at work cutting EWM

Planting Milfoil Weevils

Dredge/Drag Project, in cooperation with MDNR and Islands Wildlife to Uproot EWM in the seven mile Federal Navigation Channel through the Les Cheneaux Islands

The Les Cheneaux Watershed Council (LCWC) is currently researching and developing a bottom dredging device that will remove EWM, along with dredge material, and collect milfoil for upland composting. This process aims to minimize bottom disturbance to the upper six inches of soil and is initially going to be utilized within the seven mile Federal Navigation Channel, that has been dredged multiple times over the last 100 years. Previous attempts at hand pulling EWM have demonstrated that the soil composition is such that merely pulling on plant stems results in breaking them off. This will impact the 85 acres of this channel area now threatened by EWM and other aquatic nuisance species.

The USACE undertook a maintenance dredging project in the Les Cheneaux Channels during 2009-10, sponsored in part by the LCWC. The areas dredged within the seven mile Federal Navigation Channel have remained free of EWM. The literature indicates dredged areas remain EWM free for five years or longer.

Locally, 2 heavy equipment vehicles have gone through the ice in recent years. Five years afterward, the trail they left after being drug across the bottom through EWM beds to shore is still visible from the air and has not refilled with EWM.

Unfortunately, the water level of Lake Huron has declined by approximately two feet since the USACE dredging in 2010, and some areas that met the seven foot depth requirement were not dredged at that time. Sheppard Bay is one such area and the one mile Federal Navigation Channel there is now indistinguishable from the adjacent waters and filled with Eurasian watermilfoil. Boating is hazardous and has resulted in numerous boat engines overheating from clogged water intakes and props becoming entangled. A typical inboard or inboard-outboard will cut and accumulate around 1 cubic yard of EWM in the propeller, that then will re-root where ever the EWM cutting are cleared from the propeller. Many boats were immobilized during 2012 and had to be towed into marine repair facilities.

As there is no longer any identifiable channel or clear path to get across Sheppard Bay, and other infested areas, boaters are inadvertently spreading EWM cuttings throughout the Les Cheneaux Islands, where they re-root and start new EWM beds. The Sheppard Bay stretch of the Federal navigation Channel constitutes phase I of this study.

EWM Drag Device

EWM Drag Device in Tow

LCWC Drag/Dredge Project

LCWC PROJECT NAME (Objective/How)

ACTION STRATEGY (Means): ***Navigation Channel Drag/Dredge Demonstration***

ASSOCIATED MISSION (Outcome) : *1. Limit Adverse Impact of Nuisance Aquatic Weeds*

ASSOCIATED GOAL (What): *3. Control/Manage/Restore* **Or** Enter Goal.

NEED: This project will remove nuisance weeds from the roots in primary navigation channels, limiting the growth of nuisance weeds and allowing boaters clear passage.

Priority: 5 - High **Success Probability:** 3 - Medium

Cost: 2 - Moderate **Time Required:** 3 - Weeks Score (High >11): **13**

ACTION STRATEGY ELEMENTS:

Budget: $7800 **Funding Source:** private donations & grants

Who: Jonas Carpenter, LCWC crew, & Islands Wildlife crew **Project Lead:** Lakeside Bob

Partners: Breezeswept, Bob Dunn

Resources: Barge, drag device, GPS

Where: 7. Sheppard Bay **Sub-Zone:** Federal Navigation Channel

When: 5/26/2014 10/31/2014 **Duration:** 2 days, weather dependent

CONTEXT: ☐ **Is this Project dependent on another project?**

☒ **Does this Project require land owner &/or regulatory permission/s?**

Owner/Agency: MDEQ

☒ **Does the Project provide community connections/connectivity?**

☒ **Is this Project visible to the community?**

NOTES: *This project is part of a larger research effort on weakening nuisance plants.

PROJECT IMPACT: ☒ **Ecosystem/Habitat** ☐**Pollution/Runoff** ☒ **Water Quality**

☒ **Ed./Stewardship** ☒ **Recreation** ☐ **Other:** Enter Impact.

* Extracted Project Form from LCWC's Dynamic Aquatic Adaptive Management Plan—Draft of 031814

Late Season Harvesting Project is collecting evidence of weakening EWM before energy can be moved to the root system for over-wintering

A EWM harvester was acquired by Flotation Docking Systems a few years ago, with encouragement from LCWC, and is available to harvest EWM from the seven and one half miles of local secondary navigation lanes to provide access for boaters and fish to go through EWM beds.

A critical annual stage for EWM is the shift of moving energy to the meristem for flowering, followed by shifting energies to the stem and root system for winter survival. Late season cutting weakens EWM at this critical juncture, and many of these still rooted stems will fall over (as happens when weevils chew through EWM stems). "Pruning" earlier in the season can give EWM a chance to regrow if these cuttings are not collected and composted or disposed of at an upland location. This mechanical approach will leave weevils planted in the three project areas undisturbed.

Benthic Tarping Project is providing shoreline stakeholders with a means to limit EWM in near shore areas, beaches, and around docks

Bottom barriers are sheets of synthetic material, anchored to the bottom in shallow areas to obstruct sunlight, which controls the growth of aquatic plants. The concept is comparable to using landscape fabric to control weed growth around ornamental bushes and plants in residential yards. Bottom-barrier treatments are intended for small areas, and are most commonly installed in high use areas such as near beaches, docks, and boat ramps.

These barriers can also be installed to create edge habitat for fish such as perch, pike, & bass, and may increase angler success. There is a variety of bottom barrier or screen products available that aim to suppress aquatic plant growth by reducing or blocking light. Ideally, bottom barriers should be heavier than water but porous enough to allow gas bubbles produced by bottom sediments and decomposing plant material to pass through the barrier without ballooning the material off the bottom. Geotextile fabric products are superior to burlap or plastic sheet liners as they are rot-, tear-, and puncture-resistant, but not always permeable enough to allow gas evacuation, which can lead to ballooning.

LCWC is initiated a testing program in 2012 with the help of the Higgins Lake Association, followed by an educational program on Benthic Tarping in 2014, and plans are in motion to make the purchase Benthic Tarps available to local shoreline residents and stakeholders.

EWM Harvester in Action, cutting & collecting

EWM Harvest Project in front of Boathouse

LCWC Harvester Project

LCWC PROJECT NAME (Objective/How)

ACTION STRATEGY (Means): ***Cut Secondary Navigation Lanes***

ASSOCIATED MISSION (Outcome) : ***1. Limit Adverse Impact of Nuisance Aquatic Weeds***

ASSOCIATED GOAL (What): ***3. Control/Manage/Restore*** **Or** Enter Goal.

NEED: This project will remove nuisance weeds from the path of boaters, limiting the spread of nuisance weeds and allowing boaters greater access to their cottages and recreational pursuits.

Priority: 3 - Medium **Success Probability:** 5 - High

Cost: 2 - Moderate **Time Required:** 3 - Weeks Score (High >11): **13**

ACTION STRATEGY ELEMENTS:

Budget: $11,000 **Funding Source:** grant from Mackinac County

Who: Boat Captain **Project Lead:** Lakeside Bob

Partners: FDS, Joni Burger

Resources: harvester, GPS, buoys

Where: 7. Sheppard Bay **Sub-Zone:** north & west of weevil plantings

When: 6/23/2014 8/9/2014 **Duration:** 2 days, weather dependent

CONTEXT: ☐ **Is this Project dependent on another project?**

☒ **Does this Project require land owner &/or regulatory permission/s?**

Owner/Agency: MDEQ

☒ **Does the Project provide community connections/connectivity?**

☒ **Is this Project visible to the community?**

NOTES: *This project is part of a larger research project on both weakening nuisance plants, and utilizing biological treatments after plants have been weakened by cutting. (Budget figure includes all 2014 activity)

PROJECT IMPACT: ☒ **Ecosystem/Habitat** ☐**Pollution/Runoff** ☒ **Water Quality**

☒ **Ed./Stewardship** ☒ **Recreation** ☐ **Other:** Enter Impact.

* Extracted Project Form from LCWC's Dynamic Aquatic Adaptive Management Plan—Draft of 031814

LCWC Benthic Tarping Project

LCWC PROJECT NAME (Objective/How)

ACTION STRATEGY (Means): ***Make Benthic Tarps Available to Residents***

ASSOCIATED MISSION (Outcome) : *1. Limit Adverse Impact of Nuisance Aquatic Weeds*

ASSOCIATED GOAL (What): *3. Control/Manage/Restore* **Or** Enter Goal.

NEED: This project will stop nuisance weeds from growing in shallow littoral areas, limiting the spread of nuisance weeds and allowing greater recreational opportunities. The goal is to have residents purchase benthic tarps from a link on our website, and the supplier will then make donations on a per purchase basis to LCWC.

Priority: 5 - High **Success Probability:** 5 - High

Cost: 3 - Bargain **Time Required:** 3 - Weeks Score (High >11): **16**

ACTION STRATEGY ELEMENTS:

Budget: $0 **Funding Source:** private purchases

Who: Mark Clymer **Project Lead:** Lakeside Bob

Partners: Benthic Tarp wholesalers

Resources: website link

Where: 0. Entire LC Watershed **Sub-Zone:** near shore areas

When: 5/1/2014 9/30/2014 **Duration:** 30-45 days

CONTEXT: ☐ **Is this Project dependent on another project?**

☐ **Does this Project require land owner &/or regulatory permission/s?**

Owner/Agency: Enter Name of Owner or Agency.

☒ **Does the Project provide community connections/connectivity?**

☒ **Is this Project visible to the community?**

NOTES:

PROJECT IMPACT: ☒ **Ecosystem/Habitat** ☐**Pollution/Runoff** ☒ **Water Quality**

☒ **Ed./Stewardship** ☒ **Recreation** ☐ **Other:** Enter Impact.

* Extracted Project Form from LCWC's Dynamic Aquatic Adaptive Management Plan—Draft of 031814

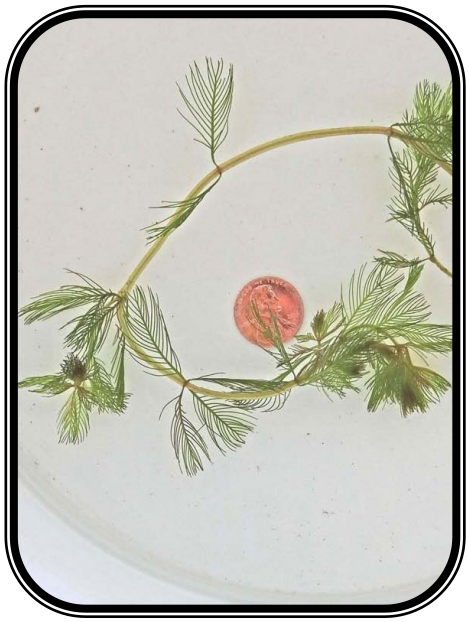
Microbial Control Agent Project in cooperation with USDA after year one site tests

Initial testing of a water-borne fungus showed lethal infectivity against Eurasian watermilfoil in Les Cheneaux waters. Although a positive outcome, significantly more testing needs to be conducted before this organism will be considered appropriate for large scale use in Les Cheneaux.

The first experiment was to inoculated with four concentrations of *Mycoleptodiscus terrestris (*Mt) based on a nominal concentration that was successfully used against EWM and Hydrilla in southern waters. Ranges were used based on the volume of Mt provided and the desire to test a concentration span that would provide unequivocal results. An untreated control (UTC) block was also used as previously described in our plot layout. Follow-up monitoring was conducted 28 days later, and EWM in the entire treated area was obviously impacted by Mt introduction. The level of plant attack appeared more severe as a function of Mt concentration applied.

Both the EWM density and macrophyte mix were different during 2013. In 2012 the entire area in which our treatment block was located appeared as a monoculture of EWM. At the time this trial was inoculated it also appeared that EWM was the primary plant growing. However, 28 DAT a considerable distance between EMW plants was obvious, where plants could be found. At areas of 6x and 9x the nominal level almost no EWM was visible. Moreover, a mixture of macrophytes was observed, to include: *Vallisneria americana* (Eelgrass or Wild Celery) was in bloom, *Elodea canadensis* (Elodea) and *Potamogeton richardsonii* (Richardson's pondweed) were all present with Vallisneria being predominant among the three. EWM remained about 16" below the surface at this time.

The experiment demonstrated the efficacy of *Mycoleptodiscus terrestris* against *Myriophyllum spicatum* (Eurasian watermilfoil). Further tests are planned for the 2014 season.



EWM from untreated area

Preparing to Apply Microbial

EWM 28 Days After Treatment

LCWC Microbiological Project

LCWC PROJECT NAME (Objective/How)

ACTION STRATEGY (Means): ***Mt Demonstration Test in Sheppard Bay***

ASSOCIATED MISSION (Outcome) : *1. Limit Adverse Impact of Nuisance Aquatic Weeds*

ASSOCIATED GOAL (What): *3. Control/Manage/Restore* **Or** Enter Goal.

NEED: This project will test the efficacy of a microbiological control agent on Eurasian watermilfoil (Myriophyllum spicatum) .

Priority: 5 - High **Success Probability:** 5 - High

Cost: 2 - Moderate **Time Required:** 3 - Weeks Score (High >11): **15**

ACTION STRATEGY ELEMENTS:

Budget: $25,930 **Funding Source:** private donations

Who: Bob & LCWC Crew **Project Lead:** Lakeside Bob

Partners: USDA

Resources: Mt from USDA, GPS, buoys, boat, sprayer

Where: 7. Sheppard Bay **Sub-Zone:** north end of bay

When: 7/7/2014 9/30/2014 **Duration:** 1 day, weather dependent

CONTEXT: ☐ **Is this Project dependent on another project?**

☒ **Does this Project require land owner &/or regulatory permission/s?**

Owner/Agency: APHIS

☒ **Does the Project provide community connections/connectivity?**

☒ **Is this Project visible to the community?**

NOTES: *This project is part of a larger research effort on weakening nuisance plants. (Budget figure includes all 2014 activity).

PROJECT IMPACT: ☒ **Ecosystem/Habitat** ☐**Pollution/Runoff** ☒ **Water Quality**

☒ **Ed./Stewardship** ☒ **Recreation** ☐ **Other:** Enter Impact.

* Extracted Project Form from LCWC's Dynamic Aquatic Adaptive Management Plan—Draft of 031814

4. Conduct surveys to assess invasive species infestation & spread

A vegetation survey was conducted throughout 24 bays of the Les Cheneaux Chain of Islands (LCI) from July 31 to August 6, 2013 (Enviroscience report included in section E, Compilation and Analysis of Data Collected). Two vegetation survey methods were implemented throughout these twenty-four areas: an Aquatic Vegetation Assessment Site (AVAS) survey and a Point Intercept (PI) survey.

The purpose of this survey was to compile an inventory of all aquatic vegetation species, identify locations of Eurasian watermilfoil (*Myriophyllum spicatum*) (EWM) infestation, and identify additional invasive/nuisance species to provide a baseline for future management practices.

A milfoil weevil (*Euhrychiopsis lecontei*) population survey was also conducted in the three Project Bays of Cedarville, Sheppard's, and John Smith's Bays to document the extent to which the weevils have controlled the EWM in the project areas, per the 2013 requirements of the stocking contract provided for in the EPA/GLRI Grant Work Plan.

A total of 43 species were identified in all survey areas. EWM was identified to varying extent in 22 of the 24 survey areas. Milfoil distribution maps and plant species tables are included in the Enviroscience report.

Both survey methods were implemented in areas of Cedarville Bay to accommodate the large area. The point intercept survey was conducted at 146 points within Cedarville Bay. Twenty-five species were identified in these points, of which EWM was found in 51% of the points (73 of 146) at varying densities.

Low growing native species found to occur in high abundance included Chara (59%), Naiad (30%) and Robbins' Pondweed (25%). Eelgrass was also relatively high at 52% occurrence. This native species is not often considered problematic, but in shallow areas it can grow to the surface and foul boat propellers. The native sedge (Juncus spp.) was observed on shore. Three invasive shoreline species were observed: Phragmites, reed canary grass, and purple loosestrife at the Cedarville boat launch.

EWM Sampling

EWM Rake Toss

EWM Rake Toss Skipped Here

A Point Intercept survey at Sheppard Bay was implemented at 147 grid points. EWM was identified in 75% of the points (111 of 147). It was most dense near the center of both major basins. The remaining 36 points or rake tows only contained native species. Twenty-two species were identified, including reed canary grass on shore.

Of the 21 species identified in John Smith Bay, EWM was most dominant at 41%. It was primarily recorded at densities of C and D, but further in to the bay, where milfoil weevils were planted in 2011 and 2012, it was sparse and distributed with dense eelgrass. A weevil population survey was conducted in the inner (eastern) end of this bay. Invasive Phragmites and reed canary grass were seen on shore.

During the GLRI Project period, it was hoped at the start of the 2011 weevil pilot study that the weevils would gain control of the milfoil as quickly as was observed during the initial 2007 program in Cedarville Bay (sponsored by the Les Cheneaux Watershed Council with local funding). Unfortunately, grant constraints pushed the first stocking event to early August, much later than the preferred stocking time of early June to mid-July. By September, milfoil densities at both Cedarville Bay and Sheppard Bay, had more than doubled over a five week period.

Additionally, a very early spring and unusually warm temperatures during the first half of 2012 resulted in EWM flowering very early and heavily throughout the Midwest. Once milfoil flowers, it is generally unsuitable for egg laying by female weevils. As a result, dramatic declines in weevil populations were noted across the region during the summer, and this trend also held true for the Les Cheneaux Islands region.

More typical weather patterns returned in 2013, weevil populations rebounded, and a more typical EWM-weevil relationship was observed, particularly in the original Cedarville sites and in the John Smith Bay stocking location. One of the largest changes noted was the decrease in density and size of milfoil beds in Sheppard Bay. Additionally, a more desirable native plant community continues to increase and thrive in all the project areas.

The presence of a healthy and diverse native plant community has been shown to be an important factor in maintaining long-term control of Eurasian watermilfoil, as natives are often able to outcompete EWM for light and space under favorable conditions.

When working with a biocontrol agent such as the milfoil weevil, it is important to remember that the rate in which “control” is achieved can vary greatly from bay to bay. Many factors play an important role including the size of the bay, shoreline habitat, amount and health of the EWM, amount of weevils stocked, and how much recreation occurs near the EWM beds planted with Milfoil Weevils. Most EWM control programs entail stocking weevils over multiple years (3-5) to gain effective control.

Augmenting the indigenous weevil population in Cedarville Bay in 2007 yielded abnormally quick results within one season. Although the same results were not achieved during this Project, positive attributes were still observed including: reduction of milfoil at the stocking locations, increase in desirable native plant community and finding weevils in various locations proving they are surviving, successfully overwintering and returning to the lake.

Despite variation in weevil numbers and milfoil density, overall the Les Cheneaux Islands weevil stocking program made steady, positive progress given the two years of stocking.

5. Reduce perch habitat impacts from invasive species and restore Perch spawning grounds

By reducing the biomass and range of EWM utilizing Milfoil Weevils, in conjunction with previous & ongoing synergistic measures, this project is designed to create a mix of open areas, less aquatic vegetative density, and an increase in native plant diversity in the three project areas once dominated by EWM.

Starting with a trophic state that has been classified by limnologists as excellent, with only limited potential of nutrients to support algal or plankton biomass, has made the introduction of Eurasian watermilfoil (EWM) a very visible invasive species in the Les Cheneaux Islands (LCI). Shifts in EWM density during the 3 Project years (2011-2013) were noteworthy, as a combination of factors both challenged and assisted the sustainability of the Weevil population in the 3 Project Bays, along with EWM beds in other areas of the LCI.

During the 2013 summer season, local native submerged plant species were able to compete more affectively and the impact of weevils in the project areas was more in keeping with predicted outcomes. Perch data from MDNR Fisheries will not be presented until April, 2014, but early indications are that 2013 produced a very good year class of perch and other local fish species.

The Les Cheneaux Watershed Council (LCWC) is also participating in the US Fish and Wildlife Double -Crested Cormorant Control Program in the Les Cheneaux Islands. This program has been instrumental in several recent successful spawning years for Yellow Perch (*Perca flavescens*) and a rebound in recreational sport fishing. Cormorant populations have now stabilized at US Fish & Wildlife Service targeted levels. Large flocks of these non-native birds, of often over 1000 birds, once disrupted the spring spawning cycle of Yellow Perch, and resulted poor year classes from 1985 through 2000. They also each consume an average of 2.2 pounds of fish per day, reducing the biomass of the local fishery by many tons in each of those years.

Fish spawning within these bays is adversely affected and is resulting in reduced year classes. In the case of Yellow Perch (*Perca flavescens*), their eggs must be loosely suspended off the bottom and available for male spawning to fertilize them. With the density of EWM approaching 200 stems/meter (Enviroscience, 2012 Progress Report), the fish can barley swim, and are often unable to reach their historic spawning beds, and if accessed, have a poor chance of completing an effective reproduction cycle.

Predators now feast on fish again

Eagle nest on shoreline

Immature Bald Eagle watching AVAS

6. Provide local job creation for 3 part-time individuals

This project has directly effected the high local rate of unemployment by the hiring of 3 part time personnel and the local services used to implement the project. Indirectly, hundreds of recreational boaters, fishermen, tourists, and businesses have benefited from the EWM control efforts and the resulting sustainability, restoration, and protection of the local fishery.

The Les Cheneaux Community benefited from service offerings such as lodging, boat rental, restaurants, and plane rental, along with opportunities provided to interact with visiting Enviroscience biologists, and state fisheries biologists and both state and federal AIS experts.

Project Assistance from Islands Wildlife

EWM Field Work

EWM Fearless Leader

7. Public Outreach and Education

Awareness that the Les Cheneaux waters are being adversely affected by the invasive aquatic species Eurasian water milfoil is now widespread. Efforts to control the spread of aquatic nuisance species have been undertaken by the Les Cheneaux Watershed Council since 2006.

A public forum was held on 5/23/13 though which the Les Cheneaux Watershed Council (LCWC) demonstrated that a more concerted effort is required to protect our waterways resource. During the course of that meeting there was interest expressed in sending a survey out to the entire community to get feedback on both the importance and methods that the community felt should be used in managing Eurasian water milfoil.

The survey results indicated a continuing strong interest both in maintaining the pristine nature of the Les Cheneaux islands and limiting the impact of nuisance aquatic species, such as EWM.
(The results are presented in the following pages)

Outreach events were created to share project activities, such as taking local biology students out to Milfoil Weevil planting sites by kayak, and taking both Senate and Congressional Representatives, and their staff members, to view the project areas by boat.

EWM display booths were setup and provided information on the project at public meetings, Annual FrogFest event, and the Antique Wooden Boat Show in each of the project years 2011-13.

Presentations were created and brought to local organizations such as Islands Wildlife, Les Cheneaux Community Foundation, Les Cheneaux Islands Association, and the Les Cheneaux Lions Club. The Power Point presentation to the Lion's Club is representative of these, and is included in the Appendix.

Public meetings have also been held with the both the Clark Township Board and Mackinac County Board with Power Point Presentations, that were often followed by in depth discussions.

A selection of newspaper articles on the *Eurasian Watermilfoil Strategic Biological Control Program* is provided in the Appendix.

Lion's Club Presentation on EWM, March 2013

Community Forum on EWM, May 2013

Clark Twp. & Les Cheneaux Watershed Council Milfoil Management Plan Survey	**YES**	**NO**	**???**
1. Are you or your family waterfront property owners?	**313**	66	9
2. Do you lease or own bottom lands?	101	**238**	33
3a. Do you use a lake water intake system?	116	**254**	1
3b. If yes, is this a source of your potable water?	59	**124**	0
4. What water based recreational or commercial activities do you participate in?			
_Fishing - all types, winter or summer	**278**	56	2
_Boating (motorized)	**328**	29	2
_Boating (non-motorized)	**250**	79	3
_Skiing, boarding, or skating - all types, winter or summer	**176**	129	3
_Sailing, windsurfing, ice boating - all types, winter or summer	**147**	**148**	3
_Scenic enjoyment	**352**	15	1
_Snowmobile, air sleigh, ATV	141	**156**	1
_Swimming	**296**	43	1
5. Is milfoil adjacent to your property, or where you stay, & limiting your water based activities?	**176**	170	21
6. Have you undertaken measures to manage milfoil near your property, or where you stay?	60	**268**	5
_Benthic Tarping (Mechanical)	15	**146**	3
_Dredging (Mechanical)	19	**138**	2
_Milfoil fragment disposal from anchors, cutting, prop cuts, raking, etc.	64	**113**	1
_Herbicides (Chemical)	15	**150**	2
_Harvesting (Mechanical)	35	**129**	3
7. What is your preferred source of information on this topic?			
_Social Networking, Facebook, Google + conversations, etc.	**106**	91	11
_Internet search	**126**	66	6
_Les Cheneaux Watershed Council (LCWC) Website	**228**	57	6
_Newspaper	**246**	39	4
_Scholarly articles, fact sheets, brochures	**199**	50	4
_Word of Mouth	**197**	49	5

Clark Twp. & Les Cheneaux Watershed Council Milfoil Management Plan Survey	YES	NO	???
8. Concerned about the impact of milfoil on native ecosystem, fishery & fish food web?	**348**	20	3
9. Are you concerned about ecological impacts of milfoil management efforts?	**297**	49	13
10. Are you concerned about low lake levels and it's impact on milfoil growth?	**352**	20	4
11. Are you concerned about LCI water quality?	**335**	22	5
_Runoff from fertilizers, herbicides, pesticides, & pet waste?	**284**	47	9
_Septic systems	**314**	47	6
_Twp. sewer system	**279**	46	7
12. How do you think management efforts to inhibit growth of milfoil should be paid for?			
_Donations	**222**	38	12
_Government Grants or Emergency Funds	**323**	19	9
_Property Tax Millage	110	**145**	15
_Special Assessment District (like the Clark Twp. Sewer)	**133**	**132**	17
13. Are you concerned about the economic impacts of milfoil in the LCI?	**309**	29	5
_Erosion of the local Clark Twp. tax base, and the services they can provide?	**259**	50	10
_Loss of your property's resale value?	**265**	60	7
_Loss of employment opportunities?	36	4	13
_Lost business revenue?	**246**	46	15
14. Are you willing to participate in community efforts to solve the problem?	**200**	31	29
_Financial donation/pledge, or "in-kind" (like hours of labor, or a boat, or property) donation?	**192**	58	23
_Organizational involvement	**149**	89	27
_Practice management techniques on own property	**235**	34	15

Clark Twp. & Les Cheneaux Watershed Council Milfoil Management Plan Survey	YES	NO	???
15. Which management methods would you like to know more about to make informed choices?			
_Benthic Tarping (Mechanical)	**149**	35	25
_Boat washing stations (Mechanical)	**125**	53	20
_Dredging (Mechanical)	**181**	27	16
_EWM fragment disposal from anchors, cutting, prop cuts, raking, etc.	**158**	38	16
_Fungi (Biological)	**194**	31	19
_Herbicides (Chemical)	**133**	41	4
_Harvesting (Mechanical)	**197**	24	12
_Prop cut minimizing (Mechanical)	**159**	35	16
_Weevils (Biological)	**197**	27	14
16. What topics surrounding milfoil management would you like to know more about?			
_Elements required for an LCI Comprehensive Lake Management Plan?	**249**	11	9
_Impacts of management efforts on humans, pets, fish, gardens, or wildlife?	**150**	13	5
_Potable water, wells, & lake water intakes?	**214**	26	6
_Restrictions on activities, or the use of water & waterways?	**216**	27	7
_Shoreline buffers & low impact yard care?	**194**	32	7
_Other concern:_____			

Notes (Not Linked to Questions)

1. … behind idea of weevils
2. favor any: reasonable cost, that minimizes environmental & water quality impact
3. very interested in find a solution… I would like this area to stay as it has always been
4. we don't know anything about milfoil
5. bigger problem than we can correct ourselves…need big government help…will lose tourism, prop values
6. if we lose the lake, we have lost everything we love about our land
7. exploited all funding sources; organized & effective action...before unsanctioned & potential harmful meas.
8. consider all methods, with chemical options being a last resort. Adverse effects not worth risk; consensus
9. concerned with oxygen levels & effect on fish

Notes (Not Linked to Questions)

10. used some herbicide at my dock with limited success

11. use herbicides only if a safe product is found. …don't feel we have been shown a safe herbicide yet

12. concerned about any proposed chemical use

13. I support all methods to control invasives except chemicals; (chem.) will destroy our environ. & economy

14. most concerned with loss of upper lake's water; …pressure Fed to take remedial action on St Clair River

15. If herbicides can not be proved safe to those opposed to them…buy harvesters & mow, mow, mow

16. consideration of herbicides must be entertained, e.g., Houghton Lake… need to know how much danger...

17. NO HERBICIDES! …Completely against their use!!... How is survey going to offer a preferred choice?

18. concerned with quality of life, & dropping water levels… public lacks the will to address causes…

19. I am against applying any herbicides in the Les Cheneaux Waterways.

20. serious issue that needs to be addressed by DNR, EPA, Dept of Interior; GL's are a vital natural resource

21. Already feel very informed. Reluctantly pro use of herbicide as deemed effective/safe.

22. My property is plagued by phragmites. I would like that to go away & be managed.

23. contact other communities that have succeeded in eliminating this problem… consider similar treatment

24. I'm afraid non-waterfront owners don't realize how seriousness… they get the vote & it's not a concern

25. concerned with expansion of invaded areas. … need milfoil mapping to determine the extent

26. I am not an expert. I do think herbicides should be used along with other methods.

27. What about the problem with micro-fine plastic that is suspended in the Great Lakes water?

28. Much prefer the mechanical approach… The real problem with invasives is nutrient overload.

29. Info important… all methods of milfoil control will be needed based on geography… water level control

30. species specific herbicides combined with mechanical cutting/clearing methods will be …beneficial

31. Good to present management plan… understanding & voluntary participation will show results good/bad

32. better permit process -taken for granted that chemicals are safe… education on dangers of herbicides

33. Our overriding concern is low water & weed growth… unable to get even a small boat to our dock

34. Why has problem evolved to this point? … State should be main source of funding to manage plant.

35. Very much against chemical (herbicides) treatment of milfoil.

36. other concern: The ignorance of the local population about treatment.

Notes (Not Linked to Questions)

37. Use whatever management method is not lethal to us.

38. There seems to be little action taken.

39. water quality, poor septic installations, and sloppy & incompetent home builders. Economic impact…

40. problem is bigger than Twp/resident/property owners can handle. Bring in the experts.

41. Although milfoil may be a problems for boaters, it has no effect on us at all.

42. believes sewer was not done right, lagoons are not lined & leaking. Leave it to the experts… experiment…

43. Ecologically balanced solutions, dredging, harvesting, composting, sellable product. Biological solution…

44. I can't imagine how we can solve this without some use of herbicides…learn to make this happen safely

45. …chemical solution ok so long as: no impact on recreational water use, native vegetation, drinking water.

46. Help is needed on massive scale; taxed out already; local $ & private donations can't address problem

47. I believe the problem should be addressed by the states bordering the great lakes and not just LCI

48. Impact on Waterways Harbor Grant; Lake Management Plan needed; Native American role/input?

49. no shoreline buffers - didn't buy lakefront to see forest; USACE caused problem, let them pay for fixing

50. I'm opposed to the use of herbicides.

51. Where does (the State of) Michigan stand on this problem?

52. Chemicals are too dangerous for children, potable water, fish, & wildlife.

53. talk to others with this problem; work together with this problem.

54. Swimming safety vs Milfoil accumulation

55. Overall the Twp has the most to lose & tax base; gov't at all levels needs to take an active role

56. What is role of sewer? What is causing it?

57. Every town in the nation has problems… but we can't all be asked to help.

58. low water & phragmites are 2 other problems that need to be focused on.

59. we are against chemical intervention

60. Gov't agencies imposing waterfront restrictions should pay for the milfoil problem

61. Would like to know what milfoil management works?

62. Ships that brought this in should be paying for milfoil control. Tax or special assessment - HELL NO!

Notes (Not Linked to Questions)

63. Communication: info, educational links, & progress reports pasted on web page.

64. Concerned about discharge from sewer system & algae growth from "rich" discharge

65. Do not want to see the use of chemicals.

66. Both gov't & waterfront property owners need to pay, not non-waterfront land owners.

67. Please no additional taxes. Find ways to reduce property taxes.

68. If the proper tool was sold locally, property owners would clean up their own waterfront

69. Used 24D on inland lake in the 70's. Worked well for many years.

70. concerned with a "cocktail" of herbicides being used over 1 product, & about current/tidal effect

71. Sheppard Bay so bad can barely get boat in or out of bay; Kayaking is a gross, disgusting experience

72. Sort of ironic how we all become ecologically minded too late!

73. I have great concern about using a chemical method of control, as with any run off of chemicals or toxins

74. I don't trust seeking a quick chemical fix, that may cause long term effects to humans or environment

75. Need greater federal/international involvement, ...have equal resources dedicated to water levels

76. Suggest keeping all options open to control milfoil

77. Already subsidize sewer; don't want to subscribe to anything else; let those with direct benefit pay

Reading and assimilating these comments offers evidence of the diverse stakeholder interests that the Les Cheneaux Watershed Council is integrating with the systemic needs of the natural ecosystem of Les Cheneaux.

Especially spirited was the debate on the use of herbicides to combat EWM. While spot use of Glyphosate have been applied to patches of Phragmites locally, the majority consensus on wide spread aquatic use of herbicides is not to utilize this management tool at this time. A small book on this chapter of local EWM management efforts alone could easily be written. The debate on herbicide use is an ongoing one, and may never be resolved under the current process of petrochemical oversight. The complexity and long term effects from 1000's of combinations of petrochemicals in open natural systems is well beyond the current technologies of modeling and simulation available, so there may always be unknown risks in their use. A well known example is DDT. Once thought to be safe, it's use now is limited to treating areas of malaria infestation under the assumption that malaria is a greater stressor than DDT.

SIGNIFICANT EVENTS AND EXPERIENCES

The *Eurasian Watermilfoil Strategic Biological Control Program* has marked a very significant milestone in the Les Cheneaux Watershed Council's (LCWC) history. Among the Project's many positive impacts, the opportunity for a small rural Township to leverage community resources with local, state, and federal agencies in a systemic *and* successful undertaking is very noteworthy.

Data gathered from the three year project continues to produce new insights and will be utilized to update the LCWC's *Dynamic Aquatic Adaptive Management Plan* in 2014. An excerpt from a draft version is included in the Appendix.

Future Watershed management efforts will certainly rely on Project data sets, aerial photos, and a new comprehension of ecosystem viability and stressors. One example currently being implemented is the Dredge/Drag Project. Two of the photographs at the bottom of this page are aerial shots taken during the Project that captured the impact of dragging heavy equipment along the bottom after having fallen through the ice. In both of these examples, at least five years has elapsed and the adjacent EWM beds have not succeeded in re-infesting these tracks where the bottom was disturbed and compacted.

The photo at the left on the bottom of this page shows one of the samples collected in the Sheppard Bay Project site in 2012 after an unknown person or persons applied a chemical to the EWM bed from shore. Very few dead plants were found, but the chemical burns on the plants observed in the EWM bed worsened close to shore and extended at least half way across the bay, on a diminishing capacity. As this type under-application of petrochemicals (probably the herbicide 2-4D) in an unauthorized and unpermitted application commonly triggers hybridization in EWM, samples were sent in for genetic testing.

Although genetic tests did not show signs of hybridization, the thousands of EWM plants witnessed by the Project field team and characterized by this photograph, clearly show the plants were only "inconvenienced" by this vigilante applicator.

EWM with Chemical Burns

Sheppard Bay Equipment Drag Trail

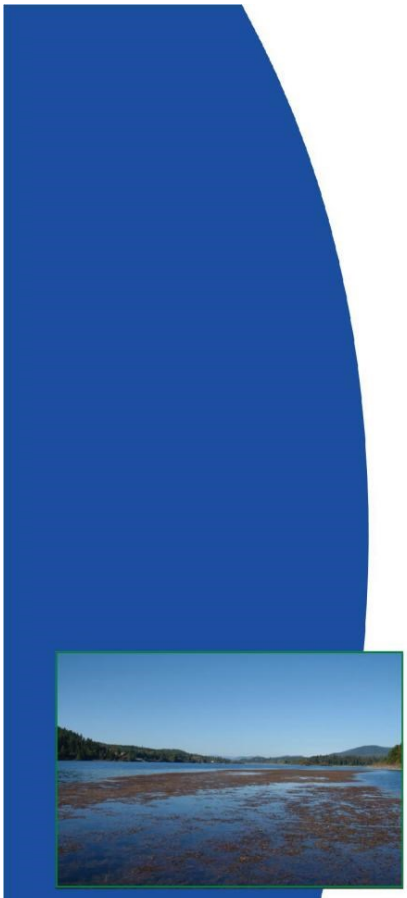
Cedarville Bay Equipment Drag Trail

METHODOLOGIES, COMPILATION OF DATA COLLECTED, AND ANALYSIS OF DATA

(This section is covered by the work of Enviroscience, and followed the approved Work Plan & QAPP)

The Appendix contains:

- 2013 Vegetation Survey and Eurasian watermilfoil Strategic Biological Control Program
  - AVAS and Point Intercept Maps and Tables
  - Aquatic Plant Guide
  - Weevil Stocking and Survey Maps



2013 Vegetation Survey and *Eurasian Watermilfoil Strategic Biological Control Program* at Les Cheneaux Islands, Lake Huron, Michigan

Prepared for:

The Les Cheneaux Watershed Council

Prepared by:

EnviroScience
Excellence In Any Environment

5070 Stow Rd.
Stow, OH 44224
800-940-4025
www.EnviroScienceInc.com

Project No. 978-4903

Date: January 2, 2014

CONCLUSIONS

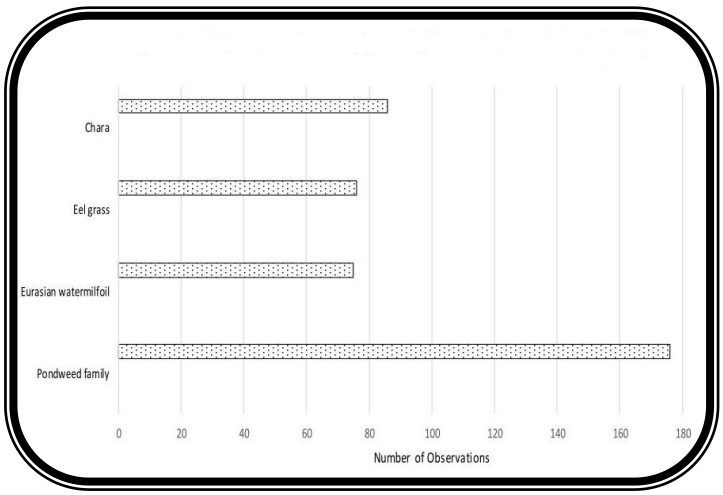
Native aquatic plants may be able to compete with Eurasian watermilfoil in LCI under favorable environmental conditions, and the presence of Milfoil Weevils is advantageous .

The perception of how an invasive aquatic weed such as Eurasian watermilfoil (Myriophyllum spicatum or EWM) impacts submerged aquatic weeds in LCI has changed since the intense, aggressive growth experienced in 2012. Data from 2013 and past records suggest that temperature is a primary factor in the ability of native aquatic plants to compete with EWM in a given season. That is to say, an early, warm spring will enable EWM to out-compete native plants whereas a longer, cool spring favors native plants being able to compete with EWM. Water level is important too, in that higher water decreases the amount of light available to plants and, therefore, growth of all plants is slower.

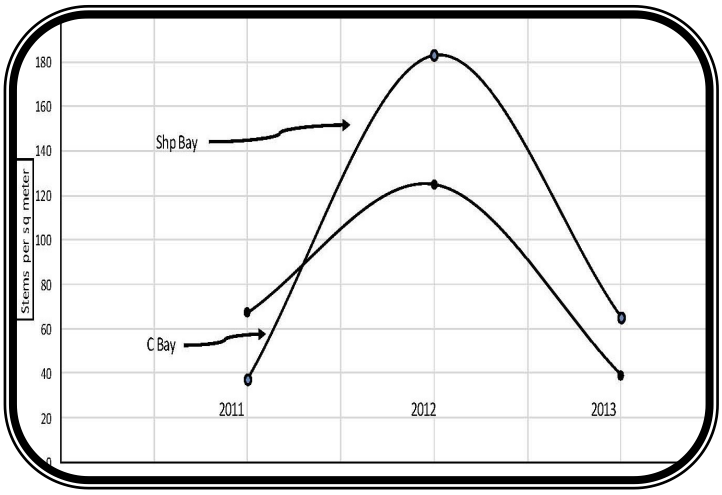
Based upon the aggressive EWM growth experienced in 2012 the expectation of many was that EWM density would be as bad, if not worse, in 2013. Such was not the case. The figure on the left below shows that Chara, an alga, and Eel grass (Wild celery) were as common as EWM in Cedarville Bay in 2013. It also shows that the Pondweed family was significantly more common than EWM suggesting that under the cooler conditions experienced in 2013 the native plants of LCI were able to compete with EWM growth. A generalization here is that some native aquatic plants appear able to compete with EWM in a given season and that EWM is less of an ecological threat than was suggested by some in 2012. The water level was approximately eight inches higher and three degrees cooler in 2013 than in 2012.

The Figure below, on the right, shows averaged EWM stem density in areas of Cedarville Bay and in Sheppard Bay where weevils were not planted. Elevated stem density in both bays during 2012 is attributed to higher average seasonal temperature with water depth as a contributing factor. It is probable that EWM began a growth spurt in 2011 in the warmer waters compared to 2010.

Data from both figures suggest that the EWM growth pattern experienced in hundreds of inland lakes may not apply to the waters of LCI that are more of an open flow than the restricted, contained waters of inland lakes.



2013 Cedarville Bay EWM Balance with other Aquatic Plants



EWM Growth Spike as a Function of Temperature (2011/60°; 2012/63°; 2013/59°) CBay- ●; Shp-○

RECOMMENDATIONS (From Enviroscience)

Two of the major concerns for the Les Cheneaux Islands are decreasing water level due to activities in the St. Clair River and the spread of the nuisance aquatic weeds, such as Eurasian watermilfoil (EWM). EWM has been increasing and spreading rapidly throughout the Les Cheneaux Watershed for more than twenty years. An example of this rapid spread can be seen in a small stand of milfoil that was found in Sheppard Bay in 2008. This stand comprised of a relatively few acres increased dramatically over the next few years to cover much of the bay by 2012, the LCWC estimated that EWM infested at least 1,400 total surface acres across the chain of islands (2012 Aerial Survey).

The worsening infestation has become more evident with the decreasing water level over the last several years, and abnormal growing seasons like the one in 2012 contribute to optimal conditions for milfoil growth and resulting nuisance conditions. Prior to the LCWC designing and implementing an Aquatic Action Plan and best management practices (BMPs), it is suggested to perform a detailed survey to document plant distribution and abundance of emergent, floating-leaved and submersed species. Although the survey methods used in the 2013 plant survey are common practice in the state of Michigan, they are somewhat limited in that they do not calculate total acreage occupied by each species. With the underlying goal of this survey in mind, these methods did successfully in identify the primary locations of the EWM infestation and other species present. They were also the most accurate and practical methods to inventory the extensive aquatic plant community throughout the Les Cheneaux Islands given the scope and budget of the project.

For future years, annual or biannual vegetation surveys are recommended to monitor the spread of invasive species and plant community changes over time. In addition to monitoring the spread of existing exotic species in Les Cheneaux islands, these surveys provide an early warning system by detecting new exotic species. Several invasive species have the potential to grow in the LCI. One invasive species common in the state is Curly-leaf pondweed (*Potamogeton crispus*) which occurs early in the growing season. Invasive Hydrilla (*Hydrilla verticillata*) has been identified in the Ohio River, Indiana and New York. A similar species, Brazilian Elodea (*Egeria densa*), has been found in southern Indiana and West Virginia. Early detection of Hydrilla and Brazilian Elodea is often difficult as they both resemble the commonly found native species elodea.

Duck Bay, Marquette Island

Cedarville Bay

RECOMMENDATIONS (From the Project Manager)

Milfoil management is a complex problem that will not be solved by following a single established routine solution. 50 plus years of attempts to control milfoil infestations across the country have clearly demonstrated this.

After the visionary work of "Lakeside Bob" Smith of introducing weevils to Cedarville Bay in 2007, with clear demonstrated success, he directed me to find a funding source to take that weevil project to the next level. A broader scope was proposed and this grant was obtained from the EPA, from Great Lakes Restoration Initiative funds, for a 3 year demonstration project across 3 diverse & environmentally unique bay systems using more weevils.

Continuing to accomplish future successes will require ingenuity on the scale of Thomas Edison (who happened to visit LCI a few times as a guest of Frank Seiberling on Long Island), rather than the "way we've always done it" robotic approach of R2D2.

Developing a broader approach, while maintaining our strategic focus on long term viable solutions, is going to require regular review and updating of the LCWC's *Dynamic Aquatic Adaptive Management Plan* that encompasses both known and presently unknown milfoil control alternatives This methodology will concurrently set the stage for both public and private funding opportunities.

Milfoil management is going to require us to discover and integrate new control methods using the best science available. Depending on funding availability, we may be challenged to prioritize certain high value areas or focus on "winnable battles" at these priority sites. In addition to the current partners we have utilized, the next phase now includes collaboration with Government laboratories and Universities to discover and implement the innovative solutions we are currently testing.

One common denominator among all plants is the need for a rich source of nutrients. Fewer available nutrients will yield slower plant growth. It is, therefore, strongly suggested that nutrient limitation be included in our area-wide weed management plans. It is also obvious that nuisance weed management plans need to address plants other than milfoil.

Continuing to carry out annual AVAS and PI surveys, and perhaps even more detailed monitoring, will be of unquestionable importance. From this ongoing work data models can be created and simulations run to test new opportunities as they unfold in near real time.

The 1st line of defense, and most viable critical path in our management approach, Prevention, has already passed us by in many ways. The option to "quarantine" infected areas and eliminate pathways of spread is going to be very difficult to carry out, as boat traffic through infested areas would have to be re-routed both day and night. Addressing entry points by installing boat cleaning stations and educating both boaters and shoreline property owners on how to properly "*Dispose of your Milfoil Divots"* is crucial to minimizing additional EWM introductions, as boat propellers are now the single biggest cause of milfoil spreading, and far outweigh lost fragments from the local harvester.

The 2nd line of defense of Early Detection and Rapid Response was instituted in 2007 with our first Weevil plantings, and followed up in 2011 & 2012 with additional plantings provided by this EPA/GLRI grant. We need to continue monitoring these sites in future years for signs of measurable success, both in weevil density and the balance of aquatic plant species present.

We are now primarily focused on the 3rd line of defense, Control, Management, and Restoration. Research is now being carried out to further develop our manual of control practices, and we plan to implement both field testing and ongoing control methods in the spring of 2014.

Our study was focused on detecting change in EWM following treatment using a novel remote sensing approach, not to evaluate the appropriateness or efficacy of various treatment techniques. The entity choosing to treat EWM must consider what treatment methods make the most sense for location conditions, including available funding, willingness to deploy newer treatment methods, and tolerance for effects of treatment such as EWM fragmentation, as discussed below.

It must be noted that mechanical harvesting comes with significant problems as a management tool. EWM reproduces primarily by vegetative fragments (Grace and Wetzel 1978). EWM management guides note that there is a high risk of spread due to stem fragments created by mechanical harvesting (Jacobs and Mangold 2009), and repeated harvesting efforts may actually increase EWM extent (Smith and Barko 1990). It is likely that the 63% reduction in EWM extent we saw in imagery covering the same area resulted in significant fragmentation of EWM and its potential re-establishment in existing areas and spread to nearby areas.

The DASH technique was developed in part to help address the negative effects of mechanical harvesting. Eichler et al. (1993) describe an early application of suction harvesting on Lake George, New York, USA where herbicides and mechanical cutting were considered unacceptable due to water quality and fragmentation concerns. Their DASH technique used a vacuum pump mounted on a pontoon boat, with a diver pulling the EWM (including the roots) and feeding it into two vacuum hoses. A 2,828 m^2 area was suction harvested with 28 person-days of effort. A year after DASH, only 7% of the pre-harvest biomass was present during a revisit. Tucker (2017) reported on application of DASH for another invasive milfoil, *Myriophyllum heterophyllum* (variable milfoil) in New Hampshire, USA, that also spreads primarily by fragmentation. DASH is described as efficient, and providing significant advantages over just hand-pulling and useful for management of dense milfoil stands. Our results showing an 89% decrease in EWM extent appear to support that DASH treatment is effective at rapid reductions in EWM presence, at least within the depth that our imagery can penetrate.

The Mt fungus treatment technique has been reported on for a number of decades as a method of biological control for EWM (Smith and Winfield 1991) based on promising results from greenhouse cylinders. More recently, Nelson and Shearer (2005) reported up to 79% reduction in EWM biomass with Mt alone and up to 90% when combined with herbicide. It has been deployed twice in the open nearshore waters of the Les Cheneaux Islands in 2014 and 2017 by the Les Cheneaux Watershed Council (Smith et al. 2018). The fungus must be grown in a fermenter and transported to the field site, and then applied from a boat, such as the gravity fed mix tank setup used at the Les Cheneaux Islands, (Figure 4.10), making practical deployment currently expensive. In the 2017 demonstration at the Les Cheneaux Islands, a 70% reduction in EWM biomass was reported at 70 days after treatment while a nearby control site had an increase in its EWM biomass (Smith et al. 2018).

Figure 4.10. Deployment of the Mt fungus from a customized treatment vessel in the Les Cheneaux Islands in 2017 by the Les Cheneaux Watershed Council.

4.5 Conclusions

We have demonstrated that UAS-enabled sensing can provide quantitative data documenting changes in visible extent of EWM most obviously due to three types of treatment. For three areas in the Upper Peninsula of Michigan each undergoing different types of treatment (mechanical harvesting, biological treatment, and DASH), we measured the reduction in EWM extent in area and percentage terms. At a mechanical harvesting site, we measured a 63% reduction in the extent of EWM one month after treatment, using multispectral UAS imagery. At a Mt fungus biological treatment site, we measured a 73% reduction in EWM extent one year after treatment using natural color imagery, although differing field results may indicate this reduction was not as large as measured. At a DASH treatment site, we measured an 89% reduction in EWM extent using multispectral UAS imagery within three days of the treatment being completed. UAS-enabled sensing also has the potential to scale to mapping larger areas while still providing high-resolution data that could help track site-specific effects. If entities engaging in treatment efforts want to have a method to quantify the effects of different management methods, then the research described here would indicate that UAS-enabled remote sensing is an important tool to consider.

4.6 Acknowledgements

This project has been funded in part through the United States Environmental Protection Agency (US EPA) under assistance agreement 00E01928 to Michigan Technological University, as part of the Great Lakes Restoration Initiative, and in part through Michigan Department of Natural Resources (MDNR) under project number IS14-2005. The

Considerations When Applying for Permits for Diver-Assisted Suction Harvesting

Eric Calabro and Anne Garwood
MDEQ – Water Resources Division

What is DASH and Why Do it?

Diver-Assisted Suction Harvesting

- Control of submerged aquatic invasive plants - EWM
- ID and hand pull intact plants
- Immediately fed into a suction hose and transported to surface

Diver-Assisted Suction Harvesting

- Plants are bagged
- Disposed in an approved location

Is DASH a method my lake should consider? How and Why?

- Benefits:
  - non-chemical,
  - selective for target species,
  - removes roots not just above ground biomass
- Potential harm:
  - spreading of plant fragments,
  - misidentification of species,
  - Turbidity
  - Loss of habitat
  - Disturbance of sediment
- Other Factors:
  - labor intensive,
  - requires highly trained crew

Ok, we want to pursue DASH. Now What?

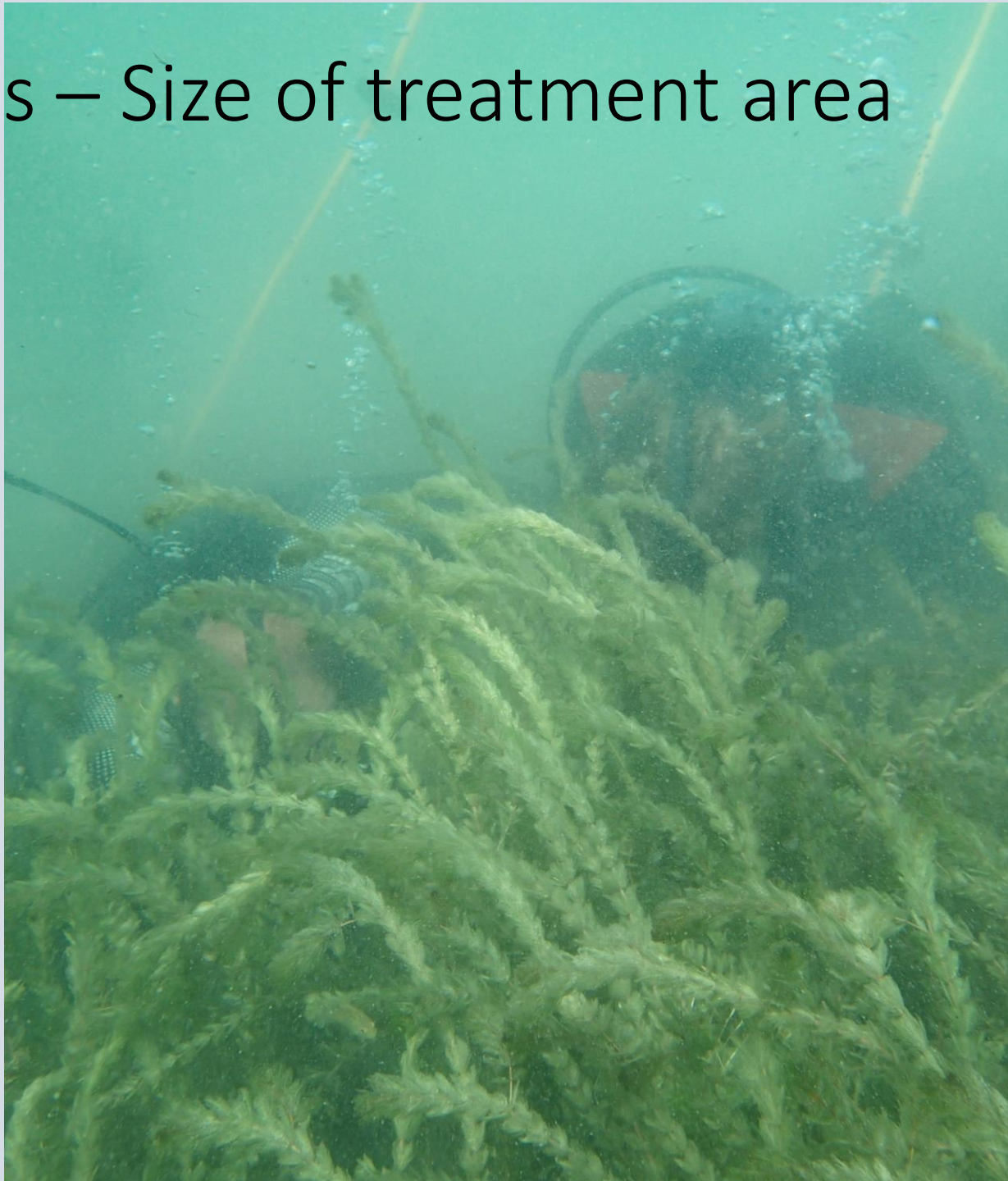
- Consider initially using DASH in conjunction with other management methods

- Pilot DASH project vs. Long-term maintenance

Considerations – Size of treatment area

- Most effective in small geographic areas
- DASH will not eliminate AIS in a single season

- DASH works well as part of a multi-faceted AIS management plan
  - Compliments other techniques well
  - Prevent re-infestation

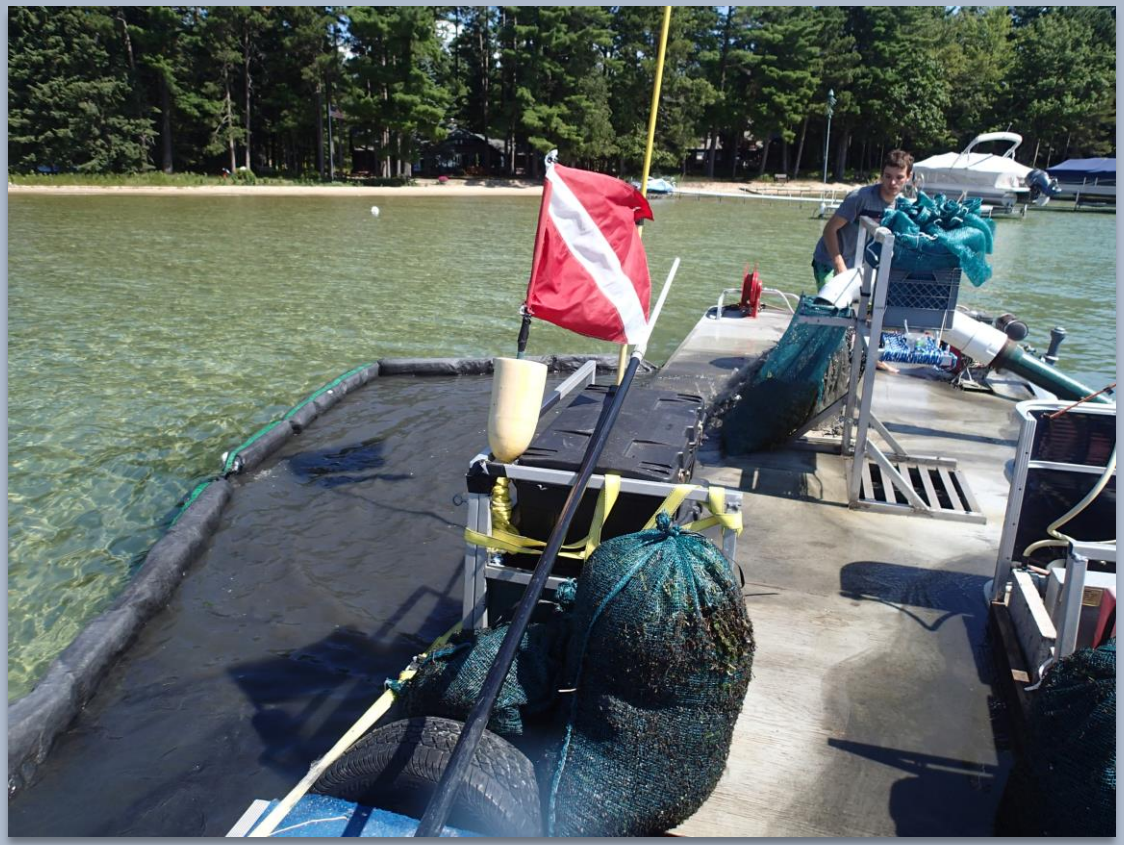


Planning

- Plant Survey
- Lake characteristics – ease of conducting DASH, or likelihood of success
  - E.g. substrate, native vegetation community and density, woody or other debris on the lakebed, depth, etc.
- Prioritize sites for pilot effort or long-term maintenance
- Identify qualified crew or plan for appropriate training, equipment purchases, etc.

Considerations – Sediment

- Soft, flocculent sediment – not ideal
- Sediment disturbance and suspension
  - Reduced visibility
  - Negative effects on aquatic organisms
  - Reduce water quality
  - Sediments can contain heavy metals and contaminants



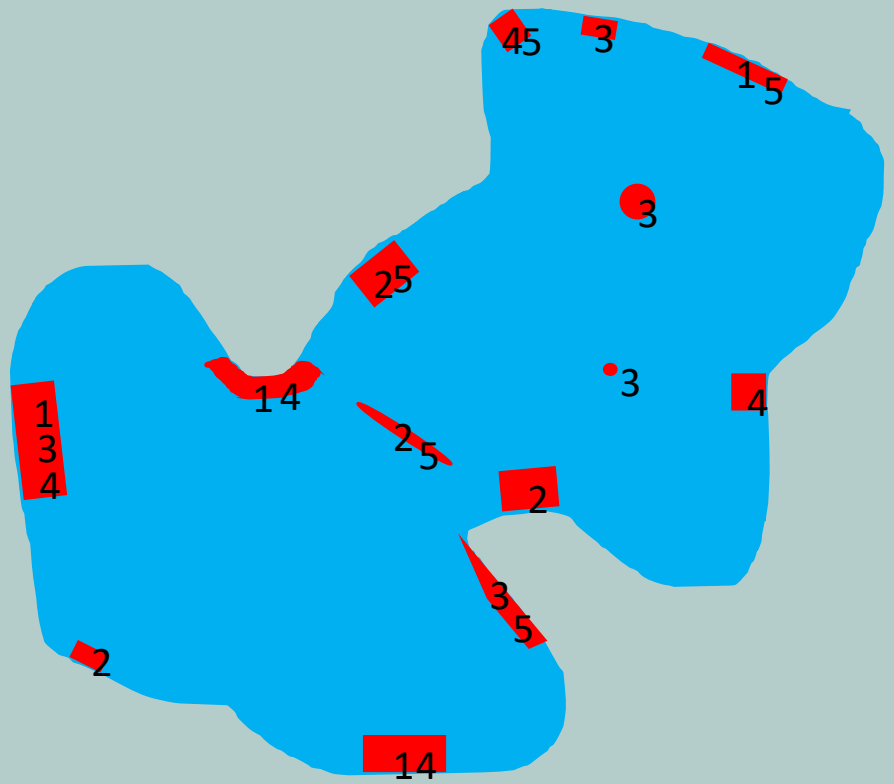
Considerations – Care in plant removal

- Many species spread through rhizomes and runners
  - Essential to remove all to prevent re-infestation
- EWM and others reproduce through fragmentation
  - Potential for spread
- If DASH divers pull plants too fast or move through an area too quickly
  - Misidentification
  - Incomplete removal
  - Plant fragmentation and dispersal

Considerations – Time commitment

- DASH takes time!
- Divers need to move slowly and deliberately
  - Misidentification
  - Incomplete removal
  - Plant fragmentation and dispersal
- Multiple years of removal, maintenance, and future management are required

Site planning

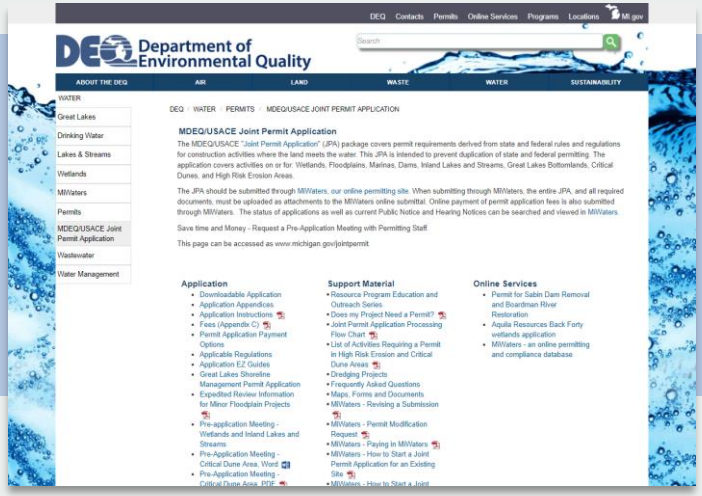


- Often includes some particularly large or dense sites being visited multiple time per year, for several years
- Other smaller sites may only require visits once or one year
- Needs to incorporate consideration of how much a crew is capable of implementing DASH in while using BMPs

Michigan DEQ Application Process

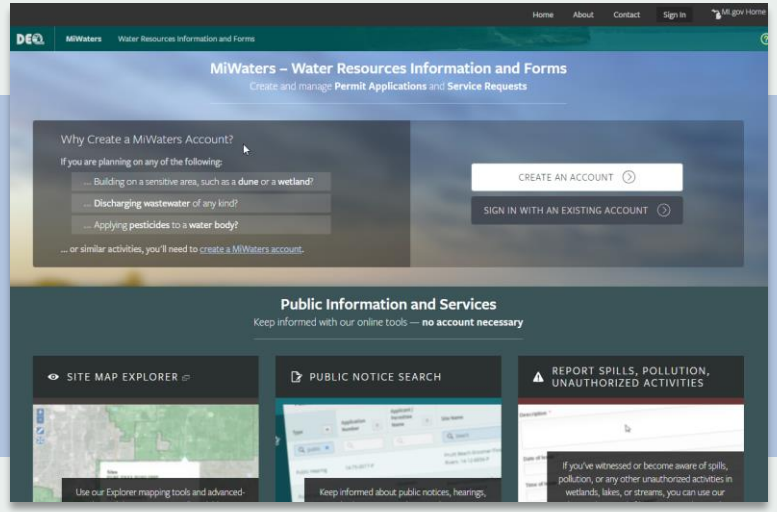
Michigan DEQ Water Resources Division

Joint Permit Application
www.Michigan.gov/jointpermit



MiWATERS

https://miwaters.deq.state.mi.us



Part 301, Inland Lakes and Streams

Protects inland waters by regulating work in inland lakes and streams.

Michigan has over 36,000 miles of streams, and more than 11,000 lakes and ponds, providing fish and wildlife habitat, and recreational opportunities.

DASH Application – What to submit

- Site Location Map
- Table of Proposed Treatment Locations
- Site Plan and Property List
- Cross-section drawings
- Vegetation photograph

Site Location Map

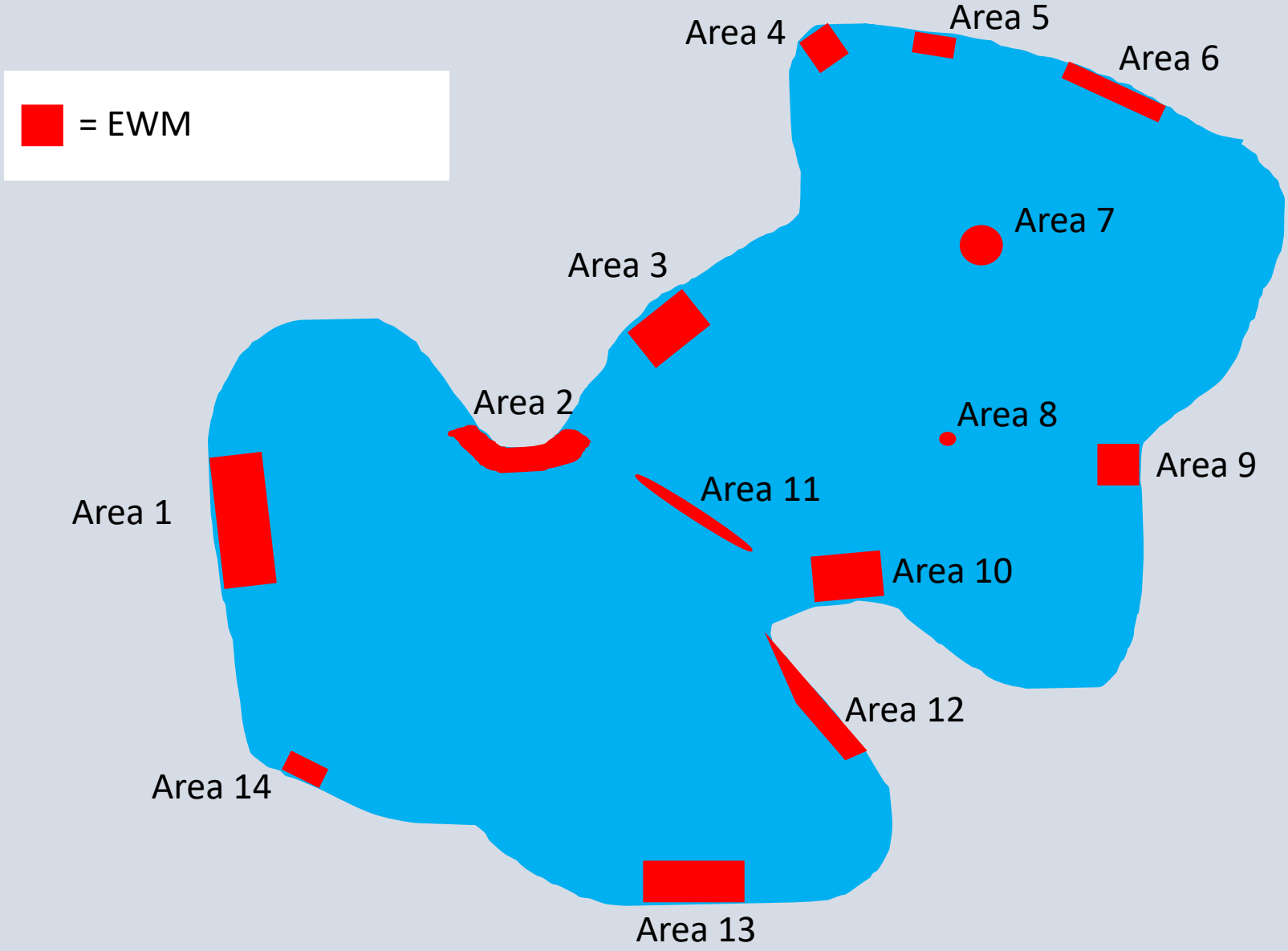
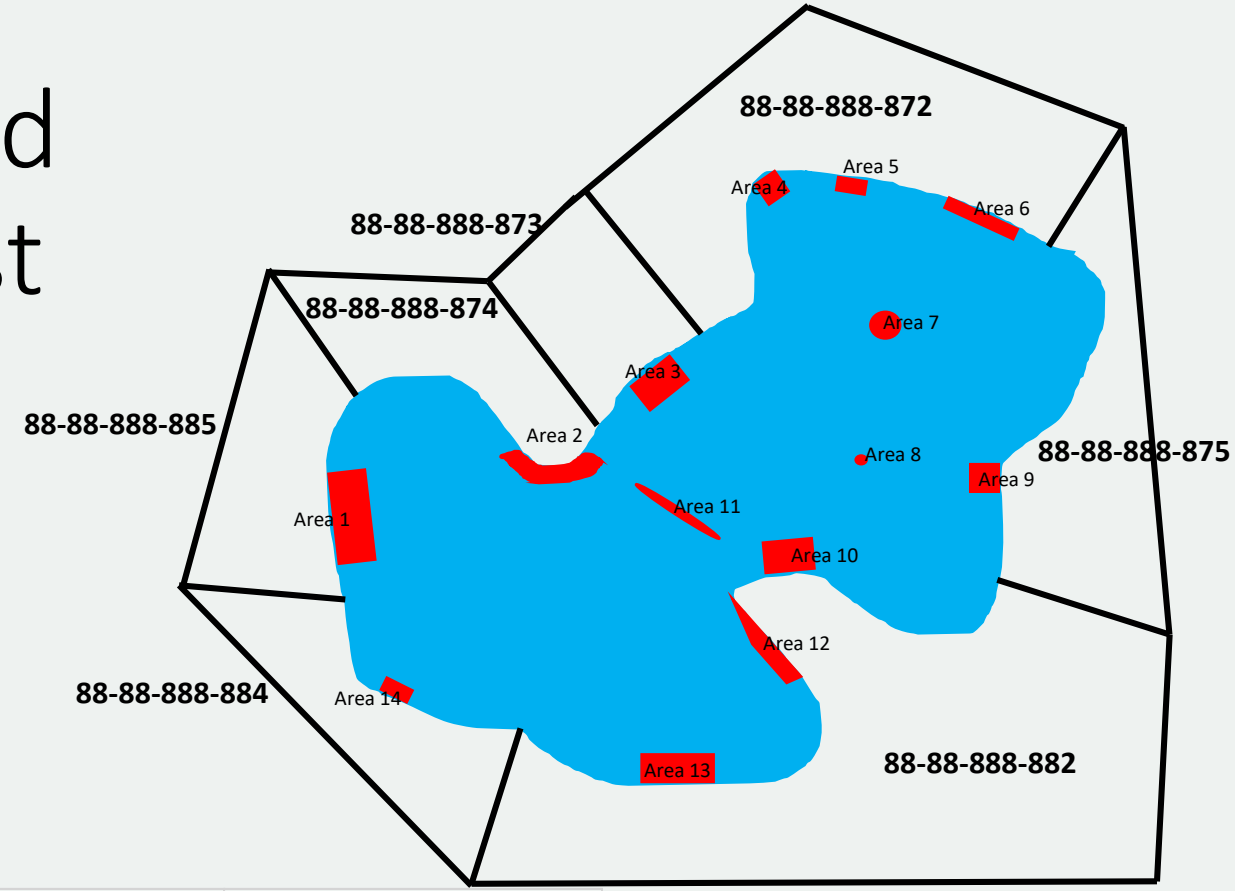


Table of Proposed Treatment Locations

Site Number	Length (ft)	Width (ft)	Area (sq.ft.)	Water Depth (ft)	Latitude	Longitude	Plant Community
1	38.729833	38.729833	1500	6-8	44.4637	-84.681	90% EWM
2	14.142136	14.142136	200	3-6	44.4677	-84.6946	80% EWM
3	70.710678	70.710678	5000	6-8	44.4673	-84.6938	95% EWM
4	83.666003	83.666003	7000	10-15	44.4676	-84.6888	100% EWM
5	17.320508	17.320508	300	6-8	44.4676	-84.6903	90% EWM
6	30	30	900	6-10	44.4673	-84.691	80% EWM
7	122.47449	122.47449	15000	3-10	44.511	-84.7607	95% EWM
8	44.72136	44.72136	2000	6-10	44.4795	-84.7776	100% EWM
9	59.160798	59.160798	3500	3-6	44.4484	-84.704	90% EWM
10	130.38405	130.38405	17000	3-10	44.4482	-84.6759	80% EWM
11	54.772256	54.772256	3000	3-6	44.4482	-84.6758	95% EWM
12	43.588989	43.588989	1900	3-6	44.4711	-84.7059	100% EWM
13	114.01754	114.01754	13000	3-10	44.4718	-84.7044	90% EWM
14	89.442719	89.442719	8000	10-15	44.4723	-84.7044	80% EWM
TOTAL			78300				

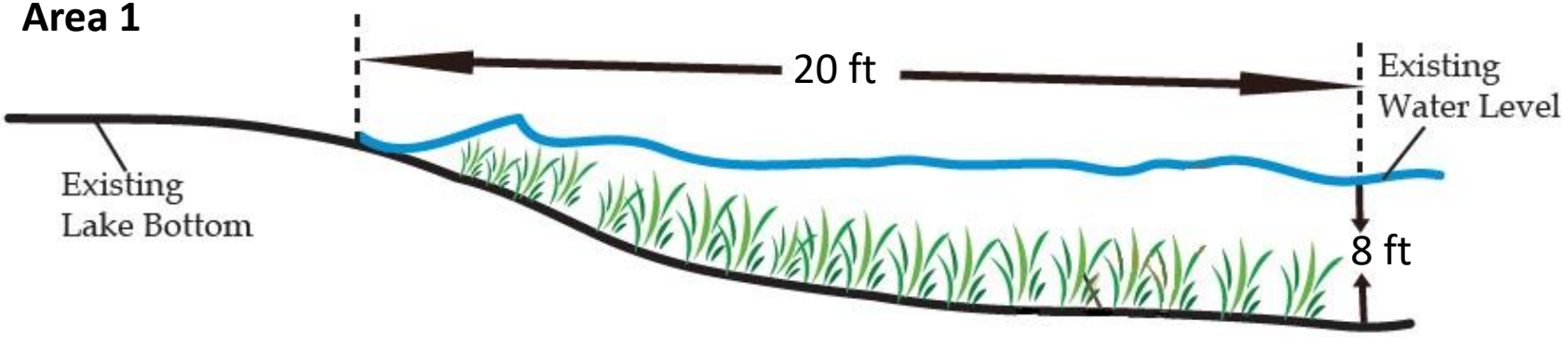
Site Plan and Property List



Pacel Number	Owner	Pacel Number	Owner
88-88-888-882	John Smith 801 Lake Ln. Village, MI 88888	88-88-888-872	Luke Lane 701 Lake Ln. Village, MI 88888
88-88-888-884	Joan Smith 802 Lake Ln. Village, MI 88888	88-88-888-873	Leslie Lexington 702 Lake Ln. Village, MI 88888
88-88-888-885	Julie Jones 803 Lake Ln. Village, MI 88888	88-88-888-874	Robert Robertson 703 Lake Ln. Village, MI 88888
		88-88-888-875	Fred Francis 704 Lake Ln. Village, MI 88888

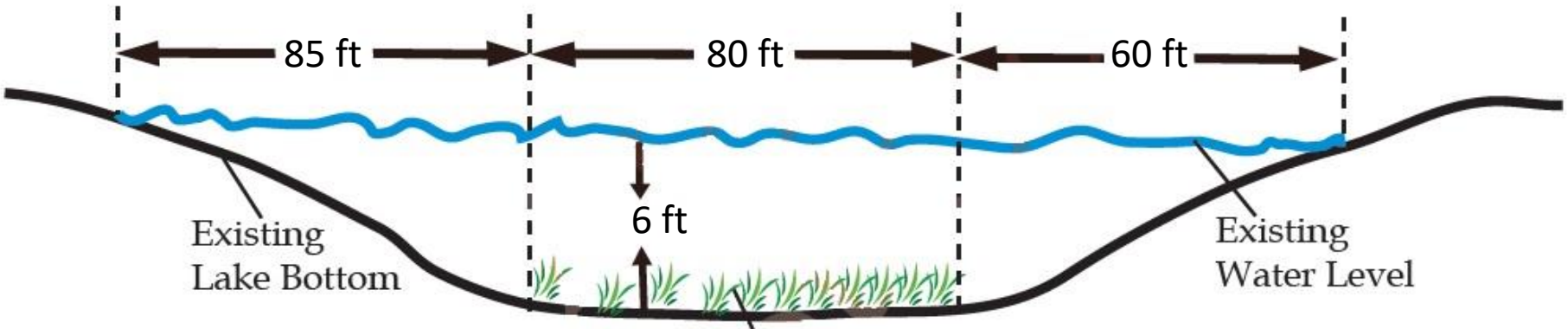
Cross-section Drawings

Area 1



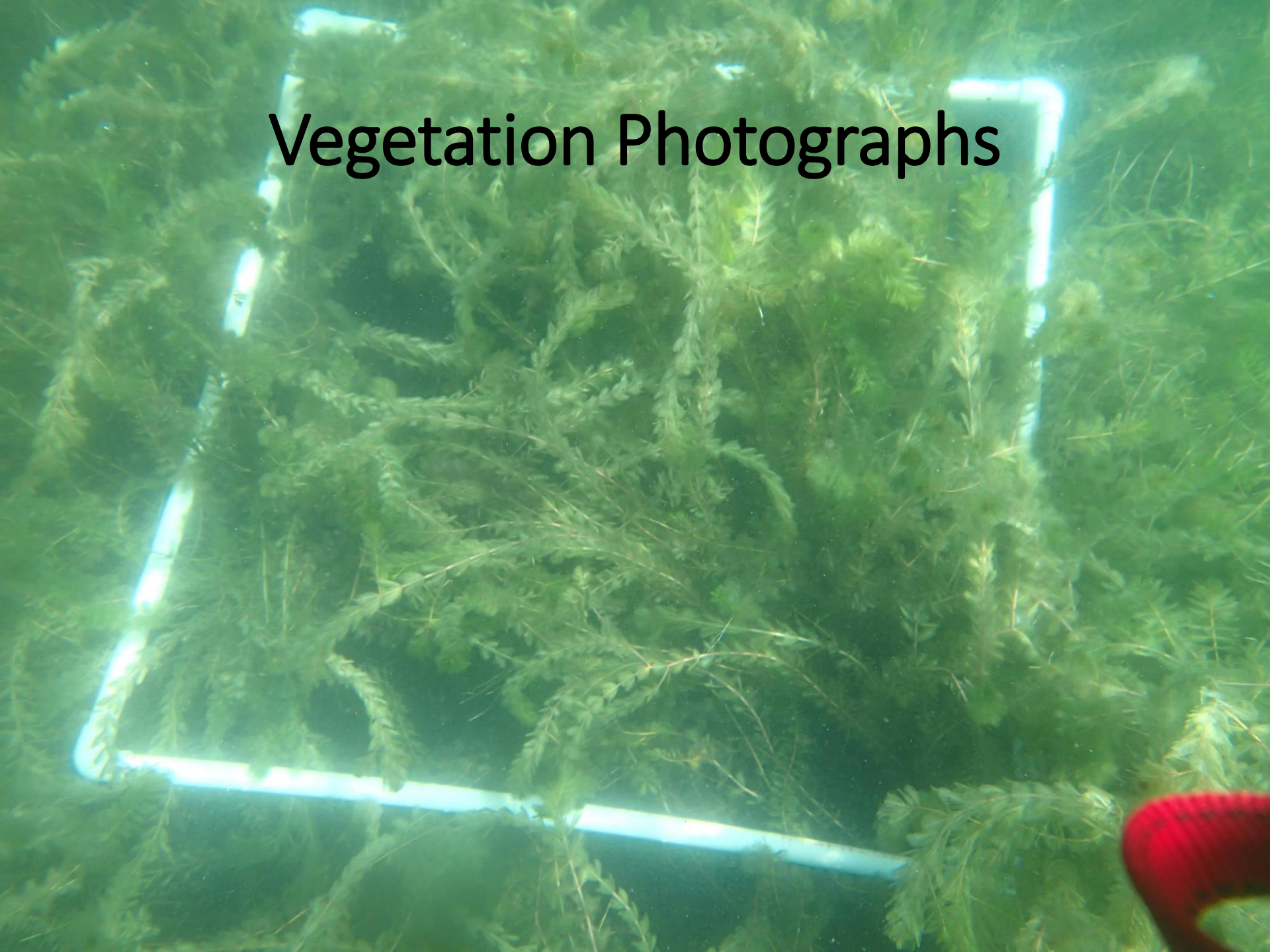
Vegetation disturbance
area 1,600 sq.ft.

Area 11



Vegetation disturbance
area 7,600 sq.ft.

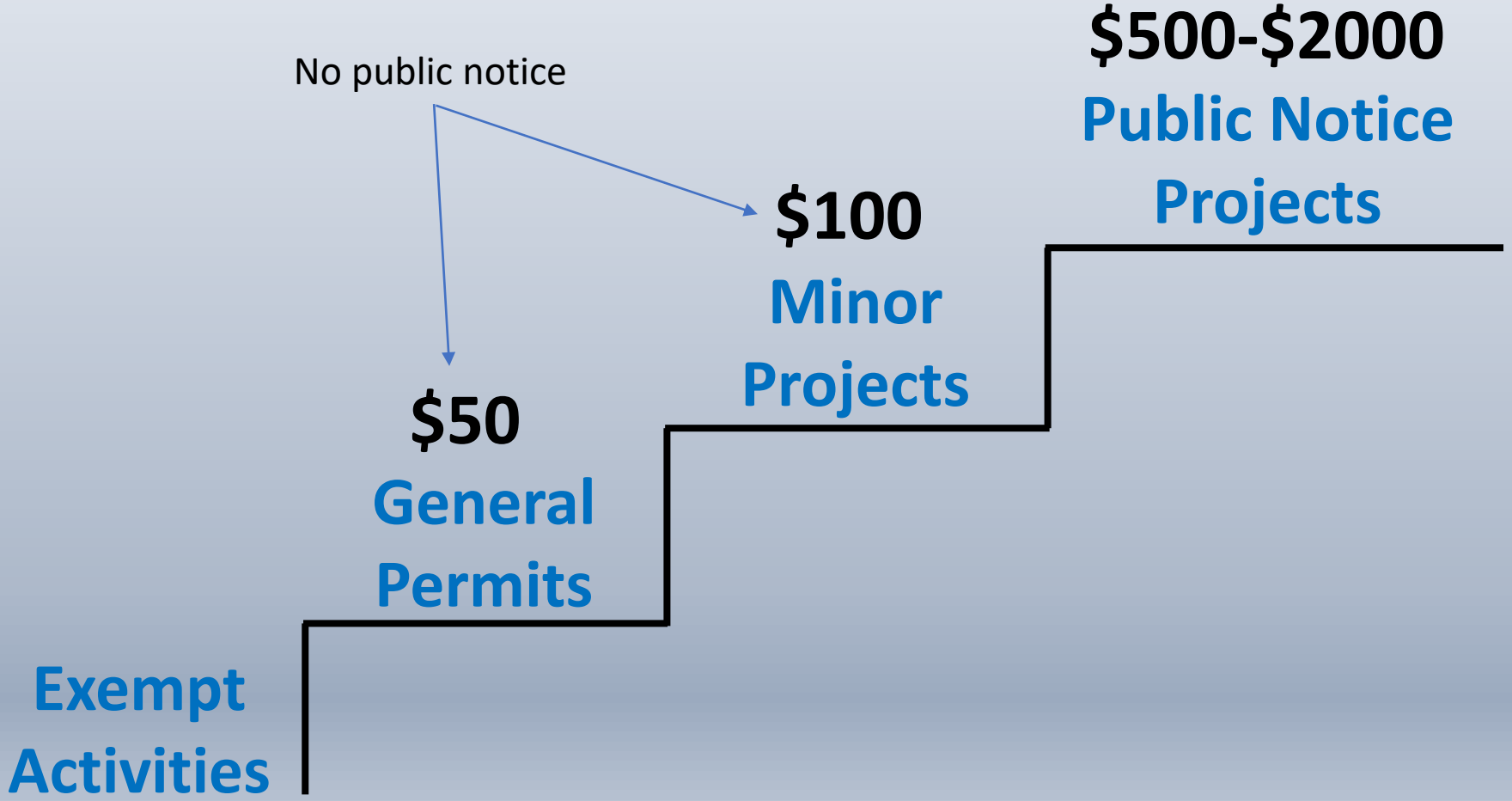
Vegetation Photographs



Michigan DEQ Application Process and Permit Requirements for DASH

- Site Planning – identify highest priority, and greatest likelihood of success
  - Plan to implement DASH prior to plant reproduction
  - Plan to revisit difficult sites in same season or future years
- BMPs
  - Trained crew – proper plant ID
  - Turbidity curtains
  - Appropriate bags

3 Tiered Permitting System



DASH Permit Options

- General Permit U - $50
  - Total area ≤800 square feet per year per single family residence
- Minor Permit 47 - $100
  - Total area ≤2 acres per lake per year
- Public Notice Permit - $500
  - Total area >2 acres

Michigan DEQ Application Process for all Wetlands, Lakes and Streams Permits

A permit applicant must follow these regulatory principles:

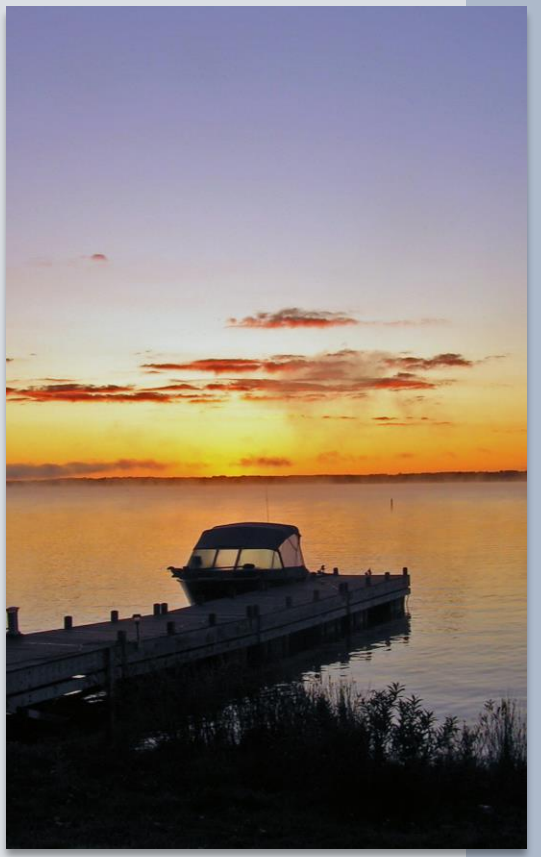
1. Avoidance
   - Do feasible and prudent alternatives exist?
   - Different location, configuration, size, or method.

2. Minimization
   - Minimize impacts.
   - Different location, configuration, size, or method.

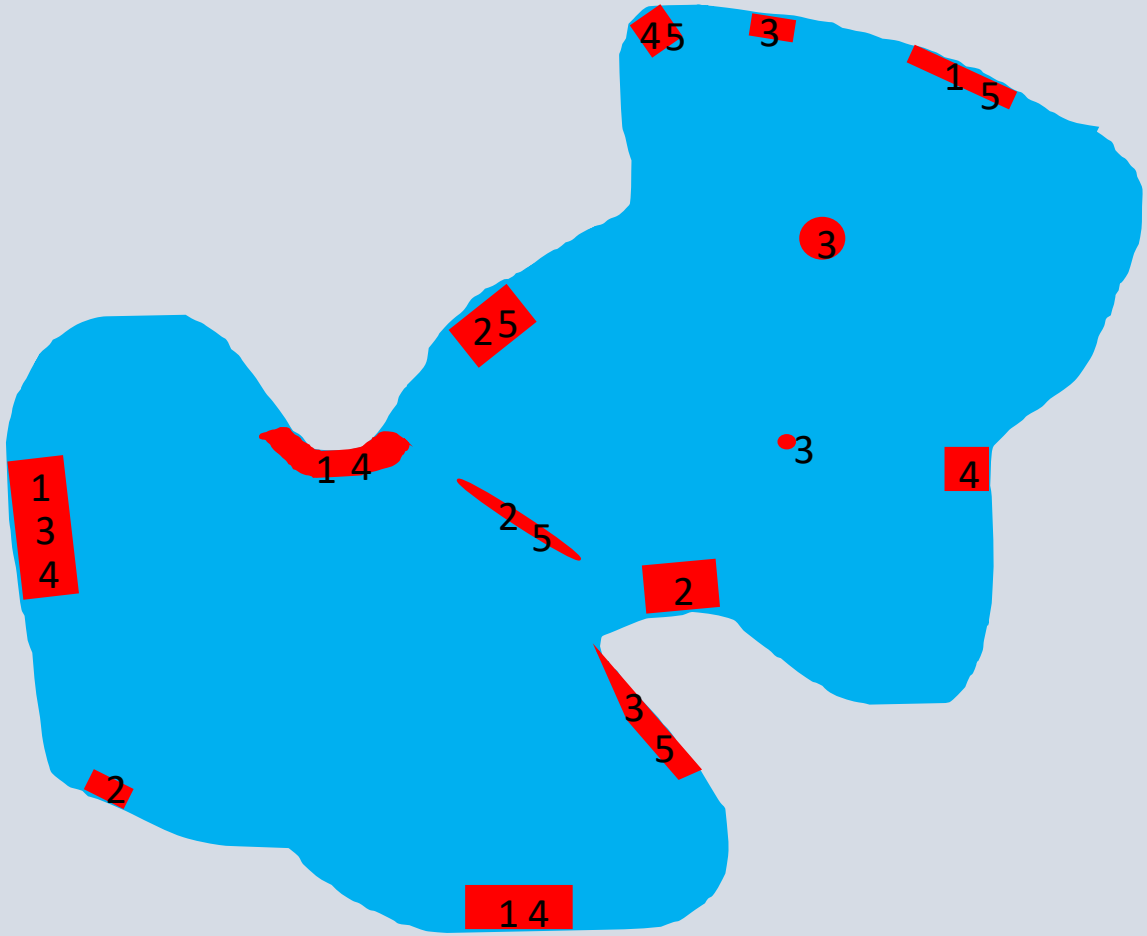
3. Mitigation
   - Replace unavoidably lost resources.
   - Ensure no net loss of functions and values.

DASH Application Considerations

- Avoidance and minimization of impacts
  - Spreading of fragments
  - Turbidity
  - Pulling of non-target native species
  - Qualifications of crew
  - Ability of the crew to cover the area being requested using BMPS (curtains, proper plant id, working around debris, substrate settling, etc.)



Best Management Practices – Site planning



Site planning over 5 year permit period

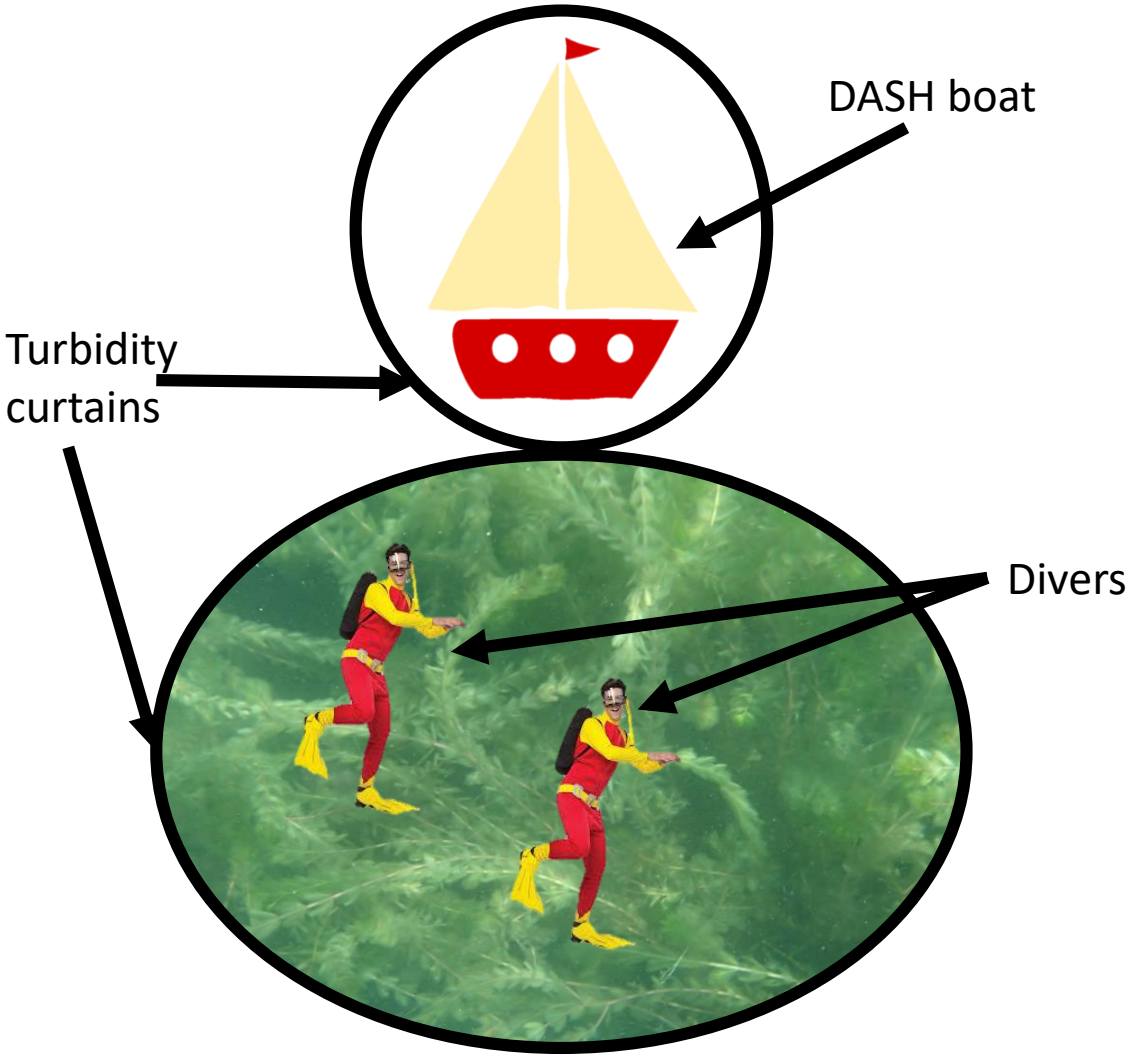
Best Management Practices – Skimming fragments

Skimming fragments

Best Management Practices – Turbidity curtains

Turbidity curtains around both the boat and work area

Leaving turbidity curtains in until sediment has settled



Best Management Practices – Aquatic plant identification

- MISIN AIS identification tutorials
  - https://www.misin.msu.edu/species-training/
  - 19 species modules
- Michigan Wetlands Association
  - Aquatic Plant Identification class
- Michigan State University Extension

MISIN Midwest Invasive Species Information Network

MWA Michigan Wetlands ASSOCIATION

Decontamination

- Visually inspect and remove any plants from:
  - Wetsuits, footwear, clothing
  - Equipment
- Drain all water from vehicles and equipment before:
  - Leaving site
  - Entering a new waterbody
- Disinfect equipment between sites (when possible)
  - Bleach solution
  - Heated pressure washer

DASH Permit Conditions

- Nonnative invasive submergent plants shall be pulled by hand. A small hand tool may be used to assist in pulling out the plant and roots.

- Removal of emergent or native vegetation is not included. Removal must occur during the growing season when the nonnative invasive species can be properly identified.

DASH Permit Conditions

- Once removed by hand, a hose attached to a suction dredge may be used to transport the plants to the water surface for immediate collection. The suction hose shall not be used to remove plants or roots from the bottom sediments or to suction bottom sediments. Dragging of the suction hose on the bottom shall be minimized.

- All plant fragments must be contained and collected. Plants must be disposed of at an upland location. A turbidity curtain may be required by the DEQ.

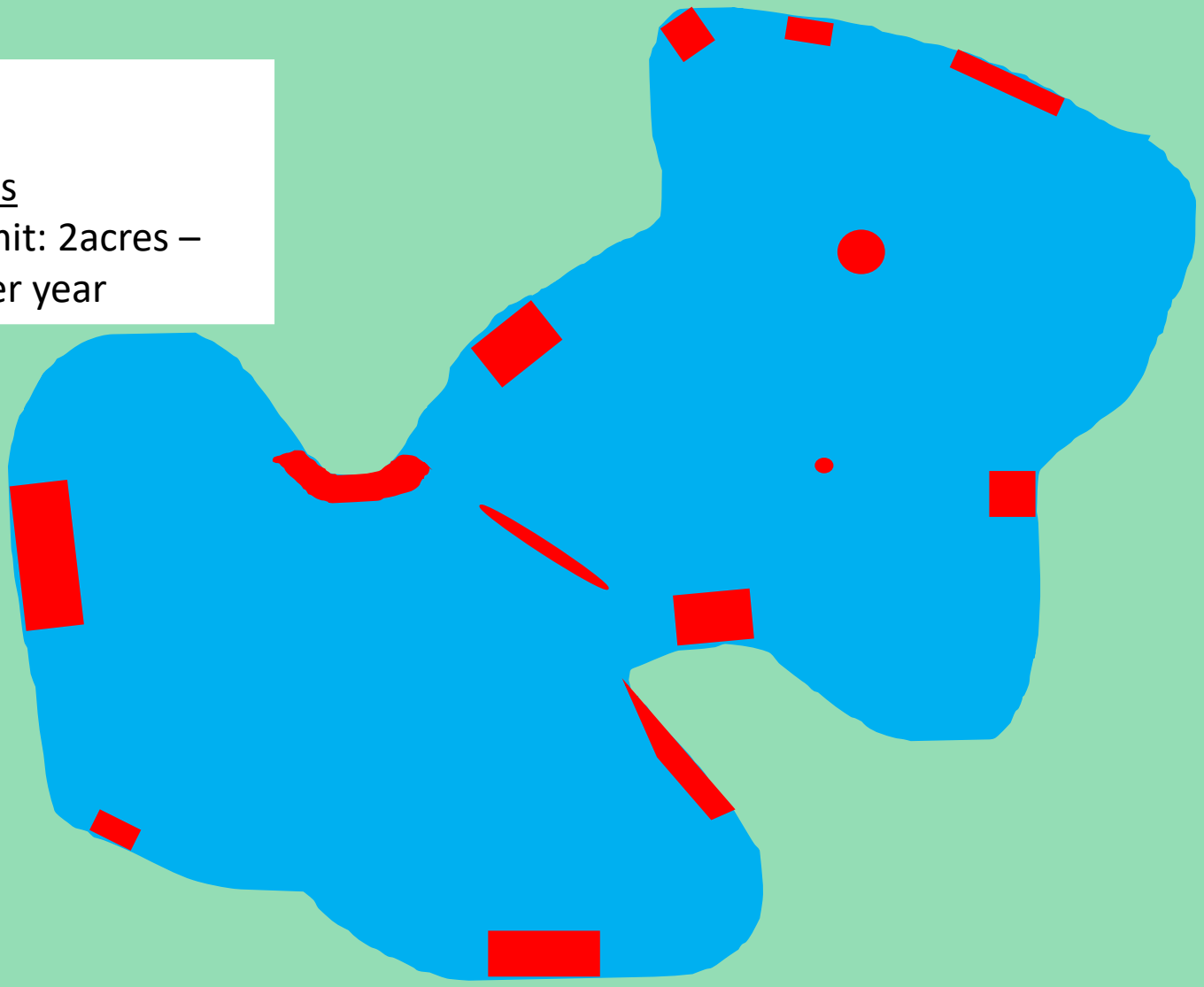
- Permittee shall document vegetation removal actions using the Diver-Assisted Suction harvesting Monitoring Form

Minor Permit Example

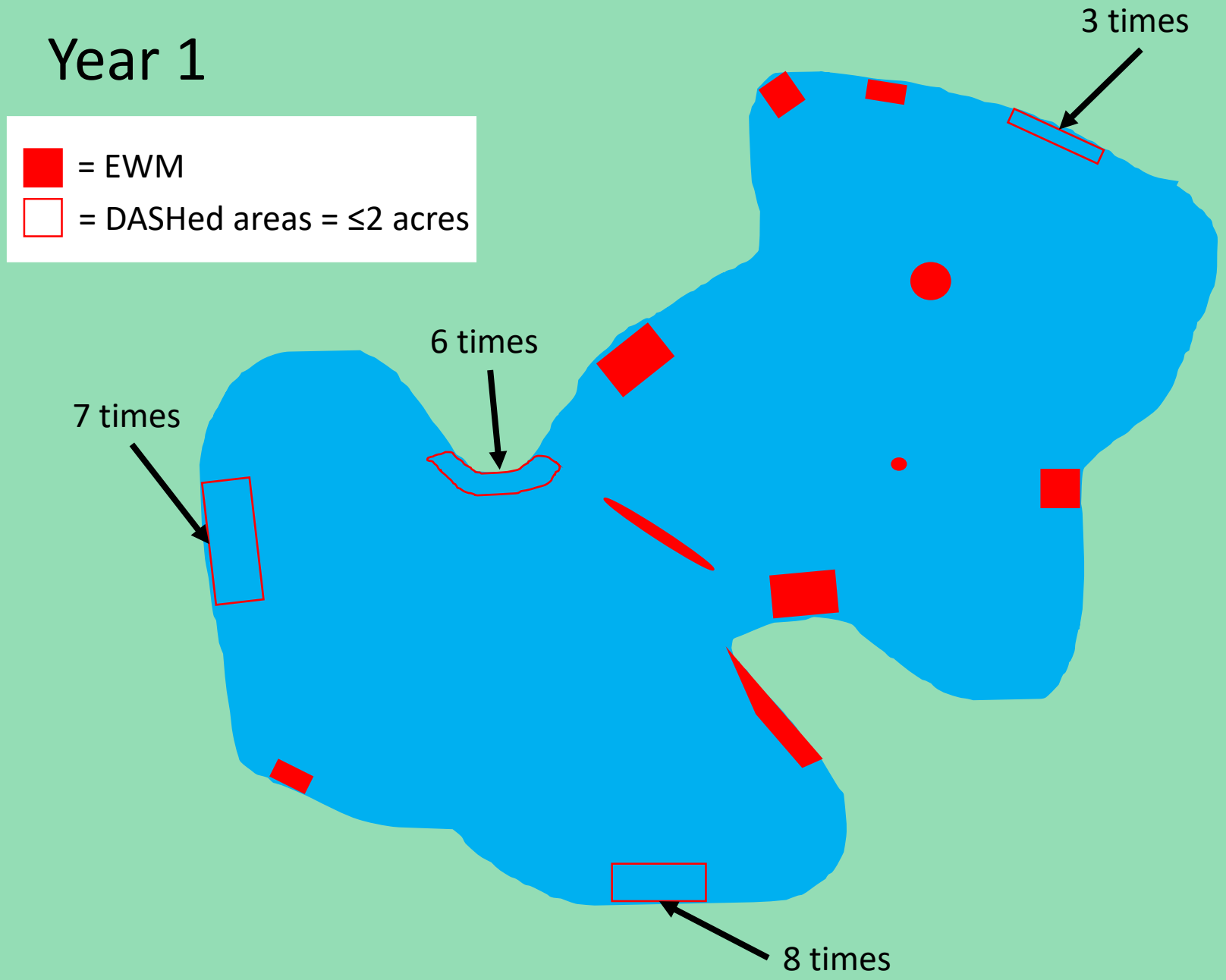
= EWM

<u>8 total acres</u>

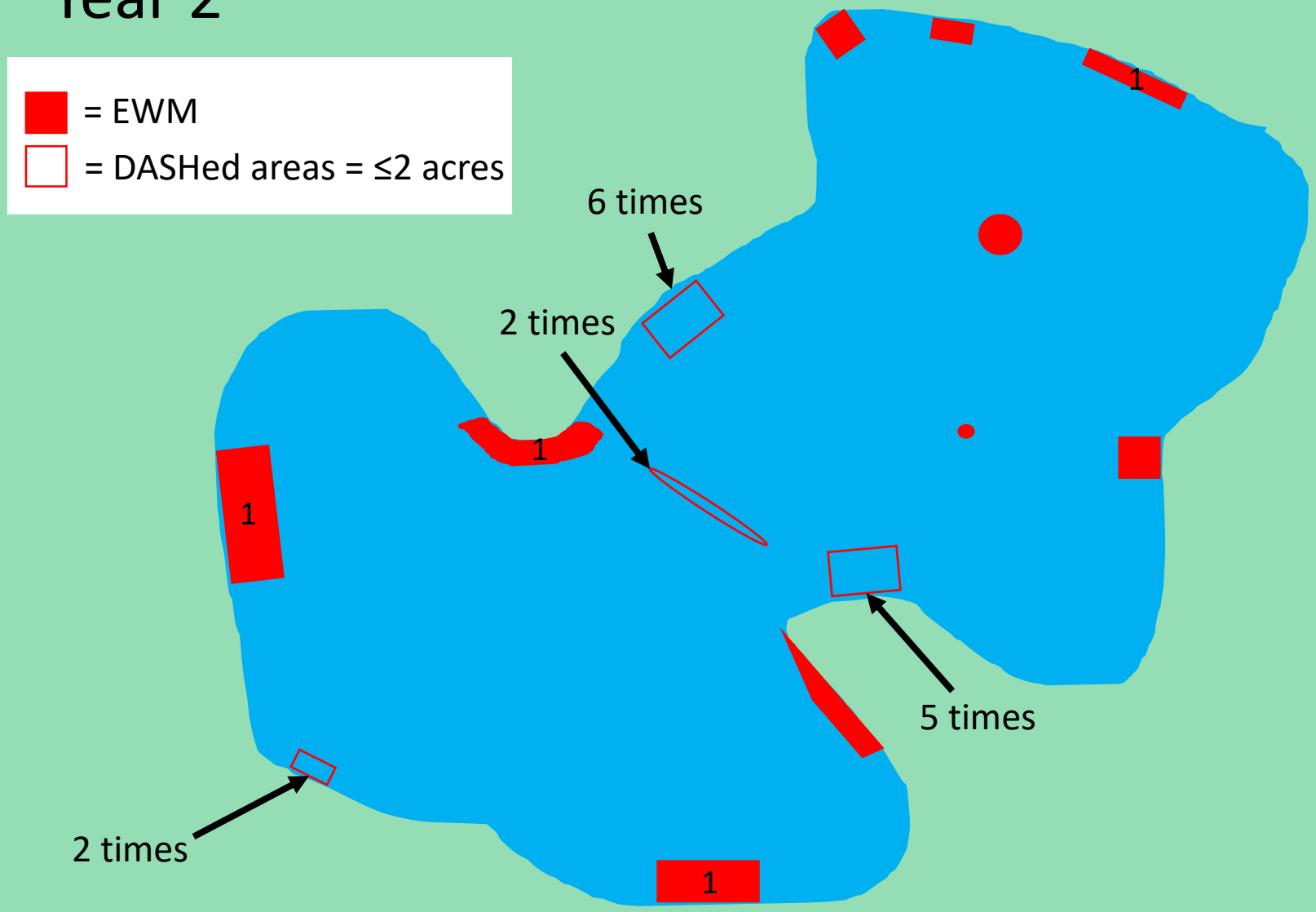
Minor Permit: 2acres – per lake, per year



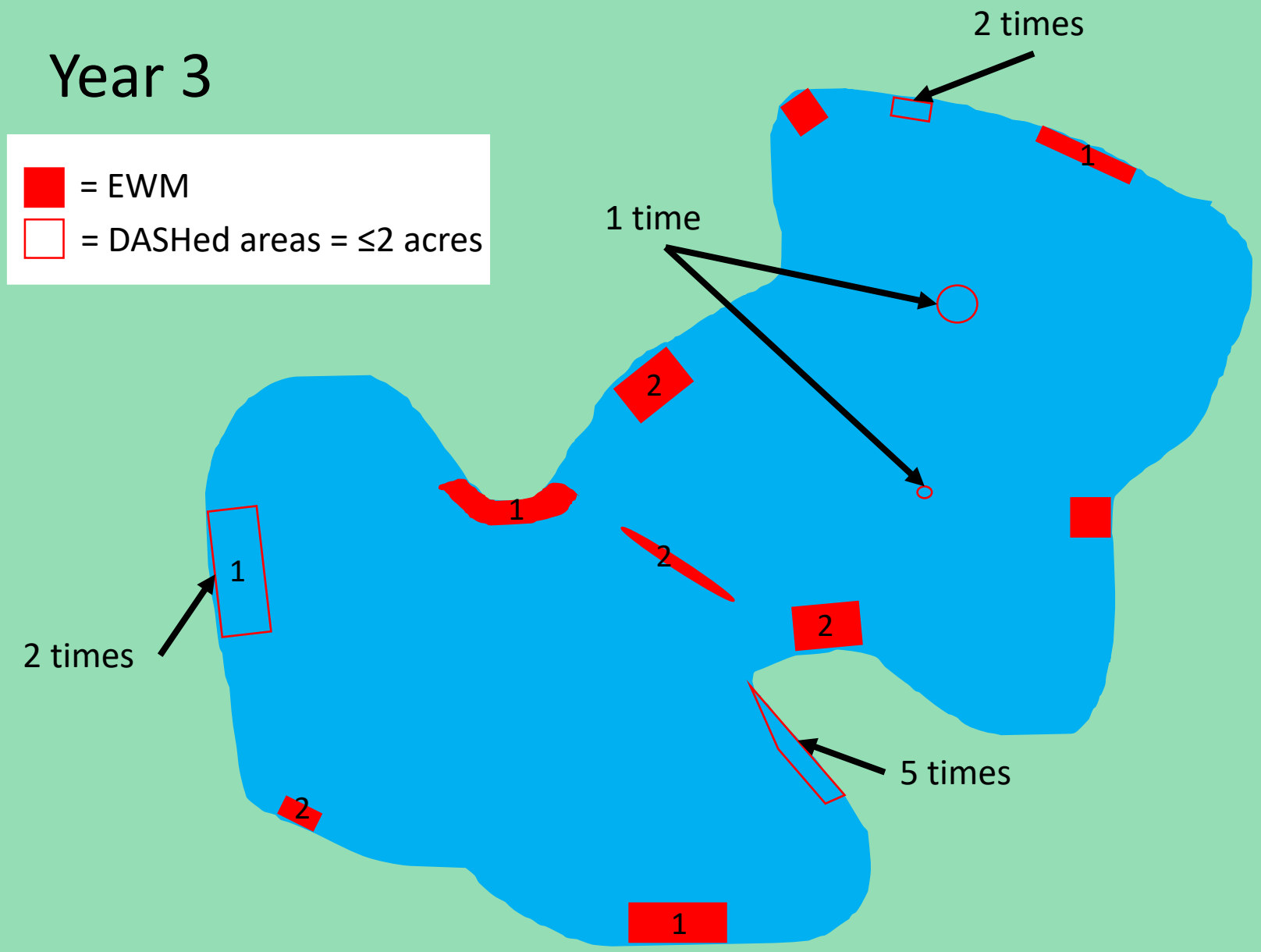
Year 1

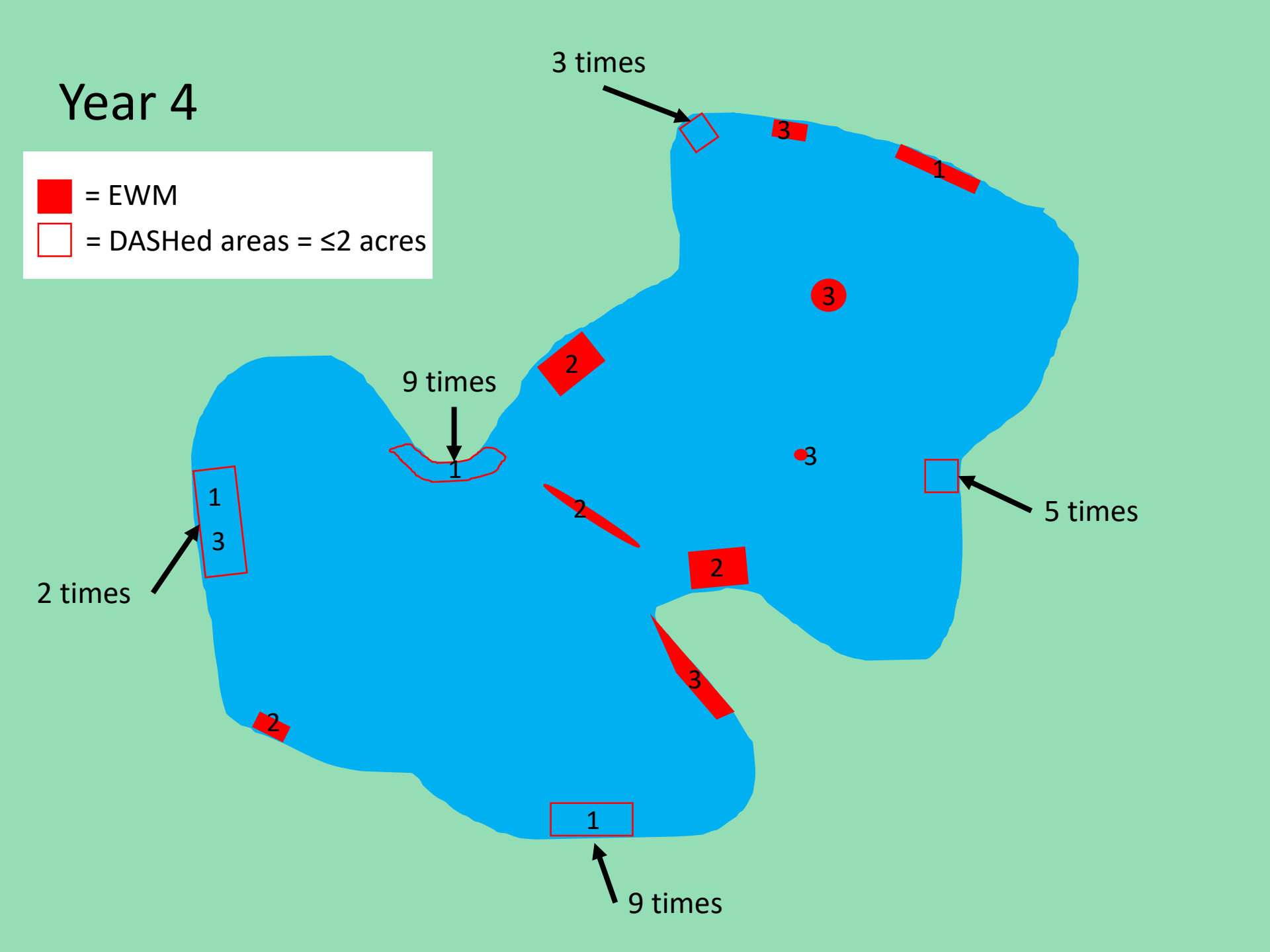


Year 2

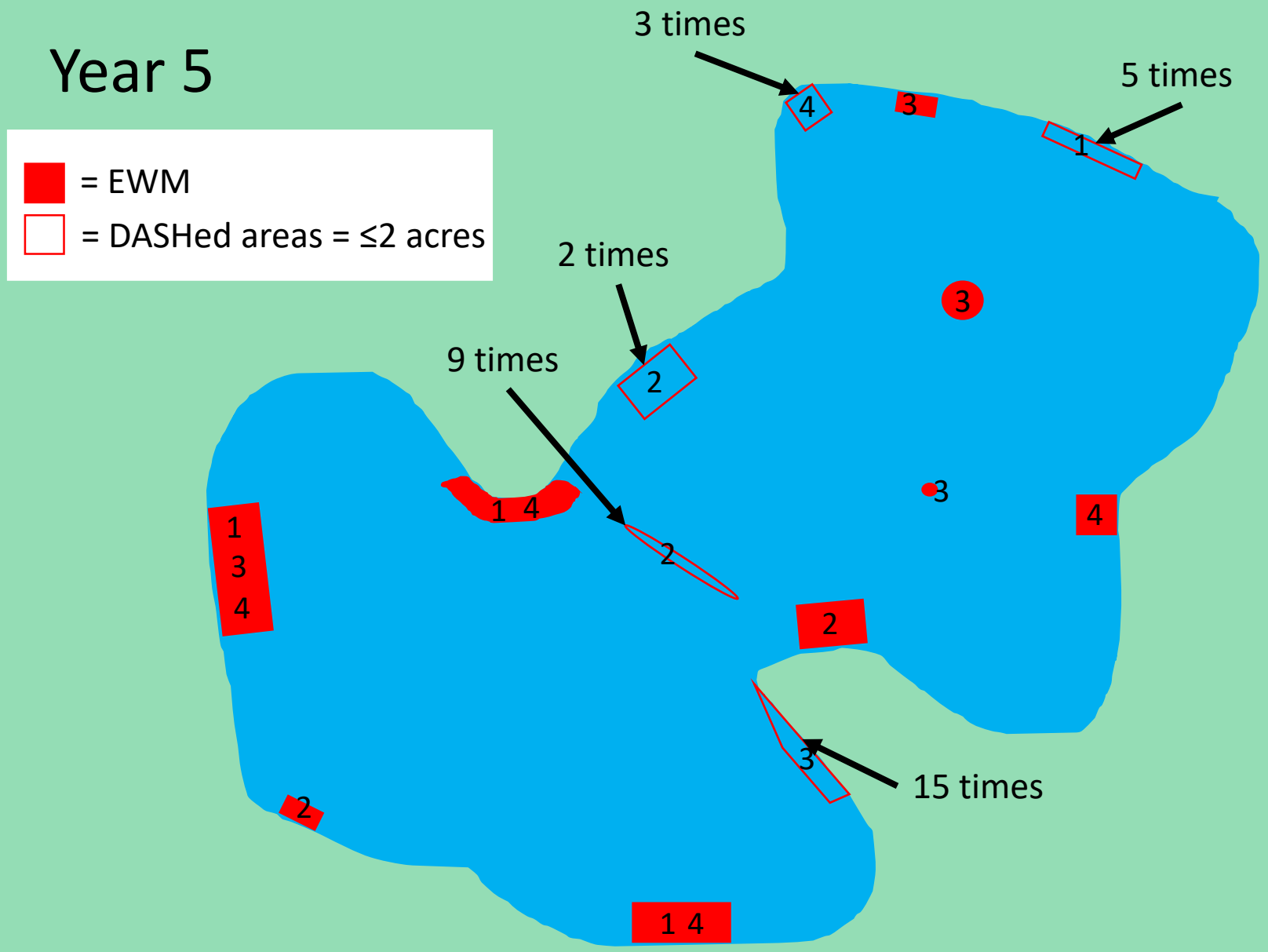


Year 3


= EWM
= DASHed areas = ≤2 acres
2 times
1
1 time
2
1
2
1
2 times
2
2
5 times
2
1

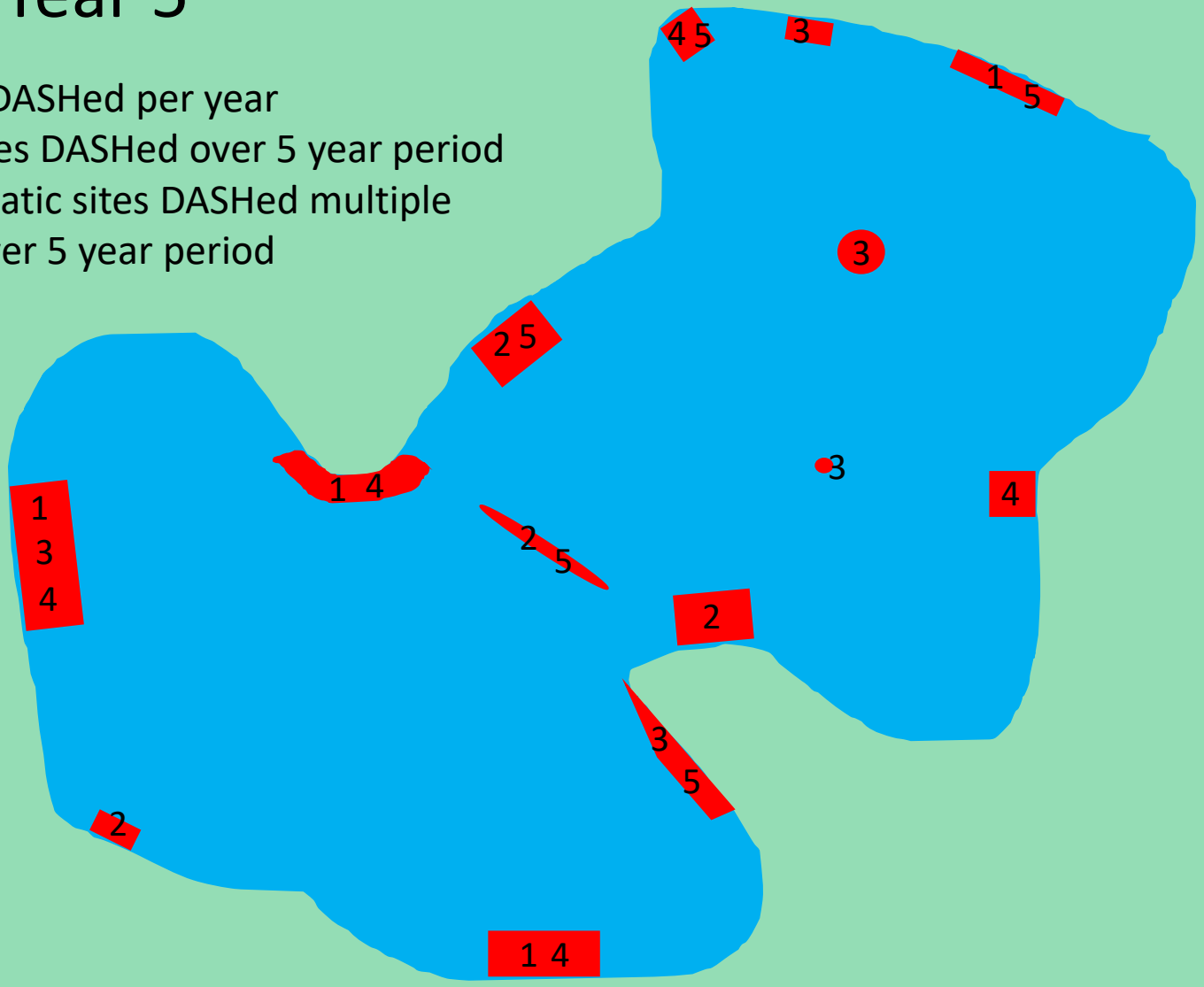

Year 4
= EWM
= DASHed areas = ≤2 acres
3 times
3
1
3
2
9 times
1
3
2
5 times
1
3
2 times
2
2
3
2
1
9 times

Year 5


= EWM
= DASHed areas = ≤2 acres
3 times
5 times
2 times
9 times
15 times
4
3
1
2
3
1 4
1
3
4
4
2
2
3
2
1 4

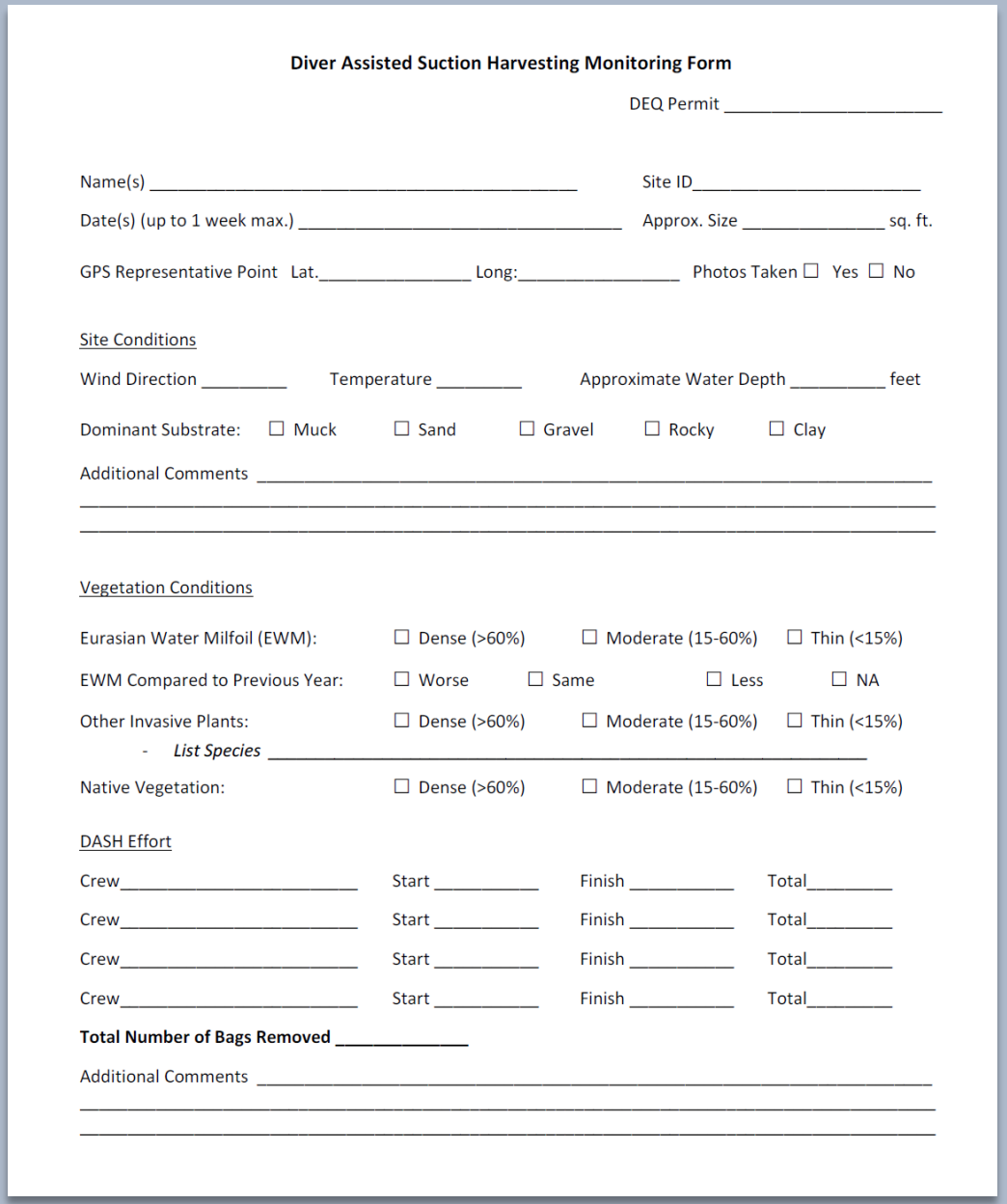
After Year 5

- 2 acres DASHed per year
- All 8 acres DASHed over 5 year period
- Problematic sites DASHed multiple times over 5 year period



Monitoring Form

- Completed for each treatment event and site
- Can be used for multiple consecutive days at a site up to one week
- Annual Report



Diver Assisted Suction Harvesting Monitoring Form

DEQ Permit _____

Name(s) _____ Site ID_____

Date(s) (up to 1 week max.) _____ Approx. Size _____ sq. ft.

GPS Representative Point Lat._____ Long:_____ Photos Taken ☐ Yes ☐ No

Site Conditions

Wind Direction _____ Temperature _____ Approximate Water Depth _____ feet

Dominant Substrate: ☐ Muck ☐ Sand ☐ Gravel ☐ Rocky ☐ Clay

Additional Comments _____

_____

_____

Vegetation Conditions

Eurasian Water Milfoil (EWM): ☐ Dense (>60%) ☐ Moderate (15-60%) ☐ Thin (<15%)

EWM Compared to Previous Year: ☐ Worse ☐ Same ☐ Less ☐ NA

Other Invasive Plants: ☐ Dense (>60%) ☐ Moderate (15-60%) ☐ Thin (<15%)

- *List Species* _____

Native Vegetation: ☐ Dense (>60%) ☐ Moderate (15-60%) ☐ Thin (<15%)

DASH Effort

Crew_____ Start _____ Finish _____ Total_____

Crew_____ Start _____ Finish _____ Total_____

Crew_____ Start _____ Finish _____ Total_____

Crew_____ Start _____ Finish _____ Total_____

Total Number of Bags Removed _____

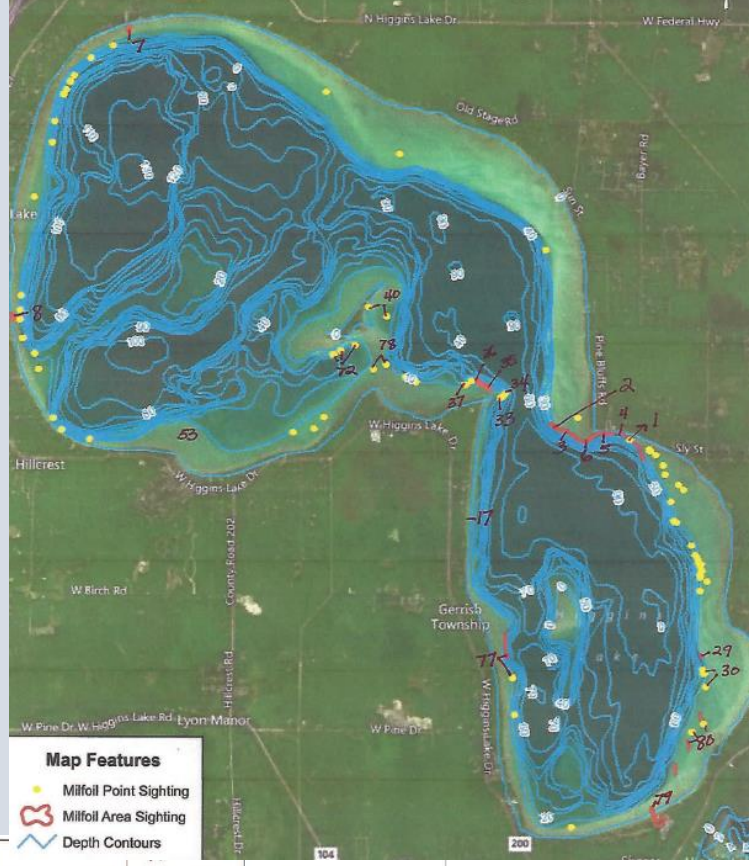
Additional Comments _____

_____

_____

Annual Report

- Table
- Map
- All monitoring forms
- Photos of project sites, vegetation, bags, turbidity curtain, etc.



Site Number	G.P.S (Latitude)	(Longitude)	Bags Collected	Sq. Feet	Problem Area *	
1	44.4637	-84.681	83	1500	Kelley Beach*	
2	44.4677	-84.6946	90	400	Flag Point*	The Flag Point area seems to come back the strongest each year.
3	44.4673	-84.6938	29	400	Flag Point*	
4	44.4676	-84.6888	62	4000	Flag Point*	
5	44.4676	-84.6903	49	4000	Flag Point*	
6	44.4673	-84.691	53	3000	Flag Point*	
7	44.511	-84.7607	62	1000	North State Park	
8	44.4795	-84.7776	67	12000	DNR West Launch	
17	44.4481	-84.704	50	1800	Lakeview	
29	44.44822	-84.6759	13	3200	Highland Park	
30	44.4482	-84.6758	12	3200	Highland Park	
33	44.4711	-84.7059	15	4500	Detroit Point*	The Detroit Point area is very dense.
34	44.4718	-84.7044	48	3000	Detroit Point*	
35	44.4723	-84.7044	28	10000	Detroit Point*	
36	44.4724	-84.7057	18	8000	Detroit Point*	
37	44.4727	-84.713	22	25000	Detroit Point*	
40	44.4784	-84.7225	14	7500	East Side of Treasure Island	
53	44.469	-84.753	24	4800	Hillcrest	
72	44.4744	-84.7252	121	2400	Between Old Point & Island*	Milfoil is spread throughout broad area between Treasure Island and Old Point
78	44.4755	-84.7247	47	3600	Between Old Point & Island*	
*77	44.464	-84.7018	10	3000	Clear View/Oak Bluffs	New site
*79	44.4265	-84.6807	14	1200	South State Park Lagoon	New site
*80	44.4377	-84.6752	19	2000	Near the Cut River	New Site
			950	109500		

Eric Calabro
CalabroE@Michigan.gov

Anne Garwood
GarwoodA@Michigan.gov

VEGETATION REMOVAL

IN INLAND LAKES AND STREAMS

Michigan law requires that a permit be applied for and received from the Department of Environmental Quality (DEQ) before conducting certain activities in inland lakes and streams. These activities include dredging, filling, constructing or placing a structure on bottomlands, constructing or reconfiguring a marina, interfering with the natural flow of water, or connecting a ditch or similar waterway to an inland lake or stream. Vegetation removal (i.e., pulling vegetation out by its roots and disturbing bottom sediments) in inland lakes and streams is also regulated, and needs a permit in many cases.

Because shoreline vegetation provides protection against erosion and pollution and provides habitat for fish and wildlife, vegetation removal should be avoided and minimized as much as possible. The DEQ permitting process ensures that potential negative impacts are avoided and minimized, and that the project will not adversely affect the public trust, riparian rights, or the environment.

This Fact Sheet answers the following questions:

Do I need a permit to pull or remove vegetation?

Do I need a permit for raking?

Do I need a permit to remove fallen trees?

How do I apply for a permit?

Michigan Department of Environmental Quality

Water Resources Division

www.mi.gov/wrd

Do I need a permit to pull or remove vegetation?

A permit is not required for vegetation removal by the riparian owner in inland lakes and streams if:

- The plants are an aquatic nuisance as defined in state law,
- The removal is accomplished by hand-pulling without using a powered or mechanized tool, and
- All of the plant fragments are removed from the water and disposed of on upland.

The DEQ recommends that vegetation removal be minimized, as shoreline vegetation provides protection against erosion and pollution. Vegetation removal also negatively impacts recreational fishing, reptiles and amphibians, and other wildlife.

A permit is required for larger-scale removal of plants, removal using powered or mechanized tools, placing materials on the lake bottom for vegetation control, or removing vegetation in wetlands. Removal of vegetation assisted by a suction tool (Diver Assisted Suction Harvesting) requires a permit. Chemical control of aquatic plants requires an Aquatic Nuisance Control permit from the DEQ.

Do I need a permit for raking?

A permit is not required to rake lake bottom by a riparian owner as long as the raked areas are predominately composed of sand or pebbles and are unvegetated before raking, and the raking is performed without a powered or mechanized tool.

Do I need a permit to remove fallen trees?

If the tree is embedded in the lake or stream such that bottom sediments or the banks of the inland lake or stream will be disturbed during the removal of a fallen tree, a permit is required. Because fallen trees provide important fish and wildlife habitat, the DEQ recommends that as much of the tree remain in place as possible and that the embedded pieces of the tree be cut off to avoid disturbing the lake or river bottom and banks.

How do I apply for a permit?

Applicants should use the DEQ Joint Permit Application:

- Permit applications should be submitted through the MiWaters online permit application system.
- Information on the permit application process and how to submit an application in MiWaters is available at **www.mi.gov/jointpermit**.