EURASIAN WATER MILFOIL MANAGEMENT PLAN

(2018-2020)

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EXECUTIVE SUMMARY

Malcolm and Ardoch Lakes are located in North Frontenac Township, Frontenac County. Ardoch Lake is directly upstream of Malcolm Lake, which drains northwest into the Mississippi River. **(See chart 1.0 in Appendix for Characteristics of the Lakes)**

In 2015 the Stewardship Committee (LSC) began to track the growth of aquatic invasive species. The predominant invasive species found was Eurasian Water-Milfoil which has the potential to ***destroy all lakes in the area.*** Malcolm Lake has a public boat launch which is the most critical feature for the introduction and or spread of EWM. There are no boat wash stations in the vicinity, any boat users can easily transport fragments to other lakes. The concern is not the **native milfoil species** which has been in our lakes for years. **(See Appendix 2.0 Watersheds Canada Report on EWM)**

In 2016 EWM was first noted off a dock in Ardoch Lake. Property owners' hand-harvested individual plants throughout the summer and had some success in keeping it under control in that area. At the June AGM, the newly developed Lake Plan was introduced. The membership selected three top priorities for first year focus: water quality, fisheries management and land use & development. These three priorities will all be affected by the presence of EWM invasive species.

In August 2017 the Stewardship Chair contacted the program supervisor of the Granite Ridge Education Centre (GREC) to request drone service for the EWM project; a partnership was formed with Above & Beyond and planning began. **(See Appendix 3.0 Aquatic Invasive Species Drone Project 2017)**

In 2017 EWM patches were discovered in Malcolm Lake west of the boat launch. Property owners along the shore began hand-harvesting individual plants throughout the summer. Stewardship Committee conducted a Boating Survey to determine such factors as types of boats used on each lake, the amount of usage, recreational priorities AND travel between the two lakes. In July the Stewardship Committee members toured the lakes to determine affected areas and found several new colonies in depths usually about 3 metres. An Invasive Species Education session, led by Brook Schryer of the Invading Species Awareness Program, was hosted by MALLA with funding from FOCA (Federation of Ontario Cottagers' Association). It was attended by interested lake users from many local lakes, conservation authorities and as far away as Ottawa. MALLA designed an Aquatic Invasive Species sign for the boat launch and provided all MALLA members with an identification card to become more serious "Weed Watchers". (**See Appendix 4.0 Aquatic Invasive Species sign, 4.1 Invading Species Boat sign and 4.2 Alert sign for Township boat launches)**

Throughout the winter of 2017-18 the students from GREC analyzed photos and videos and prepared orthomosaic maps of the two lakes. In the spring of 2018, more flights of the same areas were conducted to provide comparable data.

In June 2018 a permit application was delivered to MNRF seeking approval for the placement of burlap in a pilot project. At the June AGM a student rep from the Above & Beyond program, Ryleigh Rioux, led the presentation to the membership to demonstrate the need for monitoring of the rapid EWM growth. By the end of the summer the flight information was incorporated into a more comprehensive report. **(See Appendix 5.0 Above & Beyond Student Report)**. In July and August, the Stewardship Committee mapped the predominant patches of EWM with GPS co-ordinates, prepared a site map and requested a

presentation at North Frontenac's Council meeting. **(See Appendix 6.0, 6.1 and 6.2 for site map and GPS data)**. Additional supporting data were sent to MNRF as it became available. At each MALLA event in the summer, education sessions were included for identification of the EWM and demonstrations about its removal. Hand tools purchased with the FOCA grant were made available to members as needed. On August 24, 2018 MALLA made a presentation to North Frontenac Township which resulted in support at several levels. Two fact sheets used by MALLA were provided through www.ontario.ca/invasivespecies and www.invadingspecies.com/eurasian-water-milfoil.

The Mayor approached the Minister of the Environment & Climate Change seeking support for the project. A Letter of Approval was received from MNRF(Bancroft) in late September 2018. The first placement of burlap was on the September 23, 2018.The Above & Beyond flew most of the area in October; the imagery clearly showed the burlap placement and the extent of summer EWM growth. Grant writing began for funding of materials, resources and personnel. A submission was made to MNRF in December for a continuation of the permits in 2019. **A Letter of Authority for the continuation of the pilot project was received from MNRF on the January 17th 2019. (See Appendix 7.0 EWM report 2018)**

MALLA strategies are meant to slow the spread of until a broader approach can be taken. The Stewardship Committee believes that intervention funding must come from all three levels of government Municipal, Provincial and Federal. MALLA identified funded programs in Michigan and Quebec. The following paragraphs are taken from the Quebec link.

"The highly invasive and prodigious Eurasian Watermilfoil grows and spreads rapidly, choking out native water plant species and lowering oxygen levels so that certain species of fish are driven away. Within a relatively short period, the weed beds create tangled, oxygen starved mats that are inhospitable to marine life and that impede use by boats and swimmers. When the thick weed beds die each fall, the dead refuse drifts to the lake bottom causing premature aging of the lake.

The depreciation of land values is another detrimental effect of the "zombie" plant that directly affects the riparian (shoreline) owners. In some Quebec municipalities, the value of a property with milfoil on its property can be reduced by as much as $100,000 in the real estate market.

Studies by aquatic biologists associated with the Lac Saint Pierre Lake Association and Federation of Lakes have determined that there are at least two methods to rid the lake of weeds. The least expensive is to smother the weed beds by covering them with biodegradable burlap (jute) and weighing the corners down with biodegradable sandbags. The more expensive —but most effective—method is to hire certified divers to pull out each plant by the roots."

Our research has determined that the most effective, feasible and affordable strategy is to use an integrated multi-year management approach. Strategies to be included: education, plant monitoring and mapping with the drone technology, hand-harvesting where appropriate, burlap (jute) placement as a pilot project, partner with the team organized by Professor Jesse Vermaire (EWM specialist at Carleton University) and to investigate aquaponic production of milfoil weevils. Based on information provided by Farlain Lake Community Association, we will research the Diver Assisted Suction Harvesting system to determine if it is feasible as a management method for MALLA.

The ultimate result in ignoring this invasive species will be the slow decline in tourism in cottage country as this invasive species takes over Ontario lakes and rivers.

BACKGROUND INFORMATION

The Lakes Stewardship Committee has attempted to address the aquatic invasive species topic in general since 2016 and the Eurasian Water Milfoil in particular since July 2017. Much research has been read, contacts made with experts, discussion, planning and some aspects acted upon, BUT to no avail. This aggressive species has overcome native species in both Ardoch and Malcolm Lakes and we will face a crisis if we do nothing. The problem is too big for your Lakes Stewardship Committee and thus we enlisted Township support.

The presenters were Glen Fowler, Dr. Bud Griswold, Mary Gessner, Cathy Owen and Brenda Martin with several MALLA members in the audience to show their support. A display was setup in the Council chambers showing a present-day sample taken from the lake that week and a massive ten- foot sample representing year three growth. Education materials and a poster board helped to visualize our concerns. The session began with our purpose – the immediate need of intervention by Council to preserve not only our two lakes but all North Frontenac lakes. We sought a partnership with Council to find the resources needed to slow down the spread of EWM.

A two- page description of EWM was distributed. After an accurate description of EWM, Dr. Griswold clearly outlined the impact that the species will have on recreational activities, fishing and property values. Mary described one of our best sources of research, the Big Cedar Lake study from the Kawartha which is in year 8. Glen summarized the information collected from the North Frontenac Lakes Alliance Association. It was obvious that most other lakes have not identified the species or are in denial of the potential for crisis. Cathy answered questions about identification, growth and getting a start on shoreline control. Our Action Plan was outlined in detail. In summary, MALLA asked for five specific items of support. These were: 1) Apply political pressure to allow MALLA to conduct a pilot/demonstration project starting with the mouth of Ardoch River this summer; 2) Provide funding of $10 000 to partner with Watersheds Canada for a intern program to conduct intensive research and develop a plan to address the issue and $1500 to assist with the project at the mouth of Ardoch Lake; 3) Consider boat wash stations (at least one for each Ward); 4) Educate lake users through signage, and communications on Township website and an insert in the 2019 tax bill; 5) Apply for federal and provincial funding to address the issue before it becomes a crisis.

The presentation was extremely well received; and a motion passed to give immediate assistance and support to all requests. By afternoon, the Mayor had contacted MNRF with favourable results. Before the end of September, a Letter of Authority gave permission for MALLA to undertake the pilot project in the designated area. By next spring, we expect some data to determine the impact of “smothering” the EWM. The Frontenac News covered the meeting and wrote an excellent article for the public.

A partnership with the Above & Beyond Drone program has been instrumental in the data collection. In the fall, MALLA secured a partnership with Carleton University under the direction of Professor Jesse Vermaire. A graduate student, Patrick Beaupre, has been assigned as the lead on the project thus saving the Township $10 000 that would be required for an intern. In return, the Township will provide the wages of a summer student to work directly with MALLA on this EWM plan. **(See Appendix 8.0 MALLA Project_Carleton; See Appendix 9.0 Summer Student Technology Profile for North Frontenac Township)**

WATER QUALITY INFORMATION

Water quality monitoring first took place on Malcolm and Ardoch Lakes in the 1970's through the Ministry of Environment and Climate Change (MOECC) Recreational Lakes Program, which ran from 1971 to 1987. More recent measurements were obtained through two separate programs: the MOECC's Lake Partner Program, through which volunteers sample the lake once each year; and the MVCA Watershed Watch program, through which sampling and analysis are undertaken three times per year on a 5-year rotation. For this program, Ardoch Lake and Malcolm Lake both have one Watershed Watch sampling station situated at the deepest point on each lake.

Ardoch Lake

In addition, because of a proposed residential development on the southern lakefront of Ardoch Lake, MVCA also undertook sampling in 2012 and 2013, ahead of the 2014-scheduled sampling, in order to acquire more data for assessing studies related to the proposed development.

The Lake Partner Program sampling is done by volunteers once a year in May in order to determine the internal load of total phosphorus concentrations before the lake has "turned over". Lake turnover is a process where layers of water with noted temperature differences begin to mix together and the water and debris that has been sitting at the bottom of the lake begins to mix with the layers of water above.

In 2004, the Mississippi Valley Conservation Authority (MVCA) Watershed Watch Program also started sampling on Ardoch Lake. The Watershed Watch program monitors lakes on a five- year rotation, sampling Ardoch Lake in 2004, 2009 and 2014. The Watershed Watch Program samples three times per sampling year to represent the lake conditions prior to spring turnover (May), in the summer (July or August) and lastly before fall turnover (end of August or early September) when the lake would be at its most productive.

Overall Ardoch Lake showed phosphorus levels that have generally stayed within the oligotrophic and low mesotrophic range. The bottom Total Phosphorus levels exhibited the expected increase in the fall, following the build-up of nutrients that have settled on the lake bottom throughout the summer season. Malcolm Lake also showed phosphorus levels that have generally stayed within the oligotrophic and low mesotrophic range. The bottom Total Phosphorus levels are less consistent which is likely due to the shallowness of the lake preventing usual stratification and lake turnover.

The average pH levels of both lakes are either equal to or greater than 7.3 – the minimum threshold for zebra mussel colonization. Zebra mussels are an invasive species that require calcium in order to form their shells, and a higher pH means there is more calcium available for them to thrive. Zebra mussels can be detrimental to the lake environment because they alter the food web by over-filtering the water and removing essential food sources such as plankton. Also, by removing these organisms, light is able to penetrate deeper increasing the growth of aquatic vegetation as well as the occurrence of toxic algal blooms.

Ardoch Lake was sampled for invasive species by the Watershed Watch monitoring team in 2004, 2009 and 2012. In 2009, zebra mussel veliger (larvae) and rusty crayfish were present in the samples collected. Malcolm Lake was sampled in 2004 and 2009. In 2009, as with Ardoch, zebra mussel veliger and rusty crayfish were found to be present. It is important to note that if something was not caught in the plankton haul net, we cannot conclude that the invasive species was not in the lake; it just means that they were not there at the time the sampling took place.

Dissolved oxygen is vital for all aquatic plants and animals to survive. Adequate dissolved oxygen is an indicator of good water quality and is necessary for all life forms. Poor or depleted oxygen levels cause stress on organisms such as fish and may result in fish kills, where mass death of a species occurs in one season. Warm water fish species are better adapted to low oxygen levels than cold water fish species. As water temperature increases, the amount of dissolved oxygen in the water decreases. Aquatic vegetation also affects dissolved oxygen as it is consumed in the decomposition process.

Ardoch Lake -Summary of Water Quality Trophic Status Ratings

Total Phosphorus (µg/L)		Chlorophyll-*a* (µg/L)	Clarity/Secchi Disc Depth (m)
Spring (Euphotic Zone)	***Annual Average (Euphotic Zone)***		
Oligotrophic	High Oligotrophic/Low Mesotrophic	Oligotrophic	Oligotrophic

Malcolm Lake

The earliest record for total phosphorus (TP) levels on Malcolm Lake dates back to 1976 when the MOECC undertook sampling through their Recreational Lakes Program. The average TP in 1976 was 10 µg/L placing it at the top of oligotrophic range. MOECC sampling for total phosphorus in Malcolm Lake did not take place again until 2004 after the Recreational Lakes Program was reformatted to the Lake Partners Program. After that Malcolm Lake was sampled again in 2008, 2010 and 2011.

In 2004, the Mississippi Valley Conservation Authority (MVCA) Watershed Watch Program also started sampling on Malcolm Lake under its five- year rotation, sampling the lake in 2004, 2009 and 2014. The lake is sampled three times per sampling year to represent the lake conditions prior to spring turnover (May), summer (July or August) and lastly before fall turn over (end of August or early September) when the lake would be at its most productive.

Due to the shallowness of Malcolm Lake, there is no true stratification of the lake water. Instead, the entire water column is considered the Epilimnion. The profiles demonstrate clearly how temperature remains near constant for the entire depth of the lake. Also owing to the shallow nature of the lake, there was almost always sufficient dissolved oxygen to provide suitable fish habitat.

Water quality data for Malcolm Lake show that the trophic status ranges between high oligotrophic to low mesotrophic, meaning that it has low to moderate nutrient levels, providing for some biological productivity in terms of the growth of aquatic vegetation and algae.

Malcolm Lake -Summary of Water Quality Trophic Status Ratings

Total Phosphorus (µg/L)		Chlorophyll-*a* (µg/L)	Clarity/Secchi Disc Depth (m)
Spring (Euphotic Zone)	***Annual Average (Euphotic Zone)***		
Oligotrophic	High Oligotrophic	High Oligotrophic/Low Mesotrophic	Mesotrophic*

* influenced by the shallowness of the lake

Due to the recent establishment of EWM, there were concerns that dissolved oxygen might become depleted in future years. Also, the ice-in date for Malcolm Lake set a new record November 23, 2018. The Stewardship Chair collected baseline data concerning dissolved oxygen and pH levels in the winter of 2018-2019.

GOALS OF THE INTEGRATED MANAGEMENT PLAN

The goals of the plan aim for long-term management and control of the EWM growth. Research indicates that once EWM becomes established in an ecosystem, eradication becomes nearly impossible. Preventing new introductions is the most economical approach for this aquatic invasive species. A prevention strategy that identifies and targets areas that are most at risk to invasion (e.g., high boater traffic at the entrance to Ardoch Lake and the area close to the public boat launch on Malcolm Lake) will be considered as priorities.

GOAL (1) Prevention of further spreading of EWM

Objectives:

a) Use effective education through group sessions, shoreline talks, conferences, media and networking to raise awareness of the importance of preventing EWM from spread by removing plants and soil from boats, trailers, and gear prior to leaving or entering a water body (e.g., Clean, Drain, Dry or Boats).
b) Remove EWM from shoreline areas; scoop fragments spotted in the water
c) Install signage at the public boat launch and encourage the Township to post other lakes
d) Coordinate and collaborate among multiple partners at local and regional levels.

GOAL (2) Detect, map and monitor

Objectives:

a) Increase monitoring and reporting of existing populations to inform prevention efforts.
b) Recruit volunteers for Watch Program.
c) Use drone flights for mapping and orthomosaic map production
d) Encourage research and development of new techniques for monitoring and preventing the spread of EWM.

GOAL (3) Implement Management/Control of EWM

Objectives:

a) Implement control methods with consideration to the features of our two lakes, resources available and success rates in other projects. Preferred methods were identified as hand-harvesting, laying of jute mats, and biological controls used appropriately, which minimize the negative impacts to native plant species and aquatic life. These include:
i) investigate ways to increase native plant growth. Native plants compete directly with EWM for space, nutrients, and light, thereby helping to slow the establishment, growth, and spread of EWM within a lake. ii) The native milfoil weevil (Euhrychiopsis lecontei) has shown preference for EWM as food compared to the native Northern watermilfoil, so nontarget impacts are uncommon. Research has shown weevils can control EWM with long-term and continual efforts. but further study is required to determine if success is density-dependent (for both weevils and EWM). iii) Natural vegetation zones along the shoreline may also slow EWM growth. Inputs of sediment and nutrients, in particular phosphorus, results in

increased aquatic plant growth, including EWM. Natural shoreline buffers around a lake can intercept human activities. Native vegetation provides shoreline stabilization, thereby preventing or limiting erosion.

b) Evaluate success/failure of plan and its components to determine management effectiveness, guide future control efforts, and implement best management practices with i) annual assessment ii) three- year summary assessment.

GOAL (4) Develop partnerships having expertise and experience to address components of the plan

Objectives:

a) Partner with Carleton University team headed by Professor Jesse Vermaire to i) collect and analyze data to determine factors which promote EWM growth ii) collect and analyze data to help determine aspects that will reduce EWM spread.

b) Partner with Above & Beyond Drone Program to: i) map both lakes bi-annually ii) produce orthomosaic maps (stitched photographs) to determine growth of EWM colonies ii) produce videos and related material to share with environmental organizations.

c) Partner with North Frontenac Township for: i) initial funding support iii) political contact with government agencies iii) hiring a summer student with technology background iv) grant writing applications v) implementation of a pilot project.

d) Seek advice and resources from environmental organizations such as Mississippi Valley Conservation Authority, Watersheds Canada, Ontario Invading Species Awareness program.

GOAL (5) Obtain government funding for long term maintenance of our lakes

Objectives:

a) Lobby political representatives starting with Municipal Council

b) Seek funding support through grant submissions, private sponsorships, donations and in-kind donations (eg. TD Bank, OFAH, FOCA, DFO,..)

MALLA EURASIAN WATER MILFOIL MANAGEMENT PLAN -MANAGEMENT METHODS

CONTROL OPTIONS	*No Action*	*Hand Harvesting*	*Aeration*	*Bethnic Barriers*	*Diver Dredging*	*Hydraulic Dredging*
FACTORS						
Volunteers		Some training	some	Lots	Some	Some
Experts		Deep water -divers	For installation	Planners/divers	Yes	Yes
Permits		No	No	Yes	Yes	Yes
Equipment		Limited	specialized	Jute/stone	Specialized	Specialized
Safe Environment	degradation	Little disturbance	Detrimental to aquatic wildlife	Little disturbance	Disturbance	Much disturbance
Depth		Shallow	Unknown	Limited	Shallow	Deep
Fragments	lots	Need to scoop	Limited	If cut first	Yes	Yes
Labour		Intensive	Installation& maintenance	Intensive	Intensive	machine
Cost		Limited	High	Medium	High	Prohibitive
Success Rate	zero	effective	unknown	effective	unknown	For water channels

CONTROL OPTIONS	Milfoil Weevils	Aquatic Herbicide	Mechanical Harvesting	Dispersal Barriers	D.A.S.H.	Rotovation
FACTORS						
Volunteers	Some	Some	Some	Lots	Some	Some
Experts	Growers/divers	Divers	Trained	Trained	Divers	Operators
Permits	No	Yes	No	Possibly	Not usually	Yes
Equipment	Lab/quarry	Limited	Special cutters	Specialized	Specialized	Specialized
Safe Environment	Yes	Toxic to water life	Cuts all plants	Navigational hazard	Largely	turbidity
Depth	Varies	Shallow	3-4’ down	Surface	Any	Limited
Fragments	Limited	Low	Lots	Contains much	Reduced	Lots
Labour	Intensive	yearly/several years	2/season	Installation	Intensive	Machine
Cost	High	Reasonable	Share equipment	High	High	High
Success Rate	Variable	Shallow water	Regrowth	Effective	For small areas	Large patches

PREFERRED MANAGEMENT METHODS

A number of EWM control options were considered for the three-year integrated management plan. Based upon our research, these were the top three considered: Hand Harvesting, Benthic Barriers (Jute) and Indirect Management. Two others will be investigated in 2019 as possible methods applicable to our lakes in future: Milfoil Weevils and Diver Assisted Suction Harvesting (DASH).

The first method chosen was **hand harvesting** as it was identified as the primary control method in the studies and has proven to be effective for low density infestations in shallow water. This method provides the opportunity for the lake volunteers to contribute in a meaningful, inexpensive way. Small tools are available as needed. Individuals can undertake hand-pulling appropriate to their time and ability. The area around their shoreline and docks was suggested; in this way no one was encouraged to enter deeper water. It was stressed that only qualified divers should consider hand harvesting in greater depths. Education/demonstration sessions were shared at MALLA summer events in 2018 for the identification of EWM and proper pulling. Scoops were recommended to capture any fragments that floated. It was also recommended that property owners check each week for fragments or plants that have washed ashore. Stewardship members demonstrated the root growth on a sample EWM that had been in the water container for only a few days.

NOTE: In March 2019 a contact with Farlain Lake Community Association has prompted discussion/consideration to include the DASH system (Diver Assisted Suction Harvesting) for deeper but small infestations. The feasibility of this method will be examined early in 2019 and consultation begin with FLCA who developed the prototype. Page 34 from the FLCA EWM Integrated Management Plan describes this option, its pros and cons. The chart has been provided courtesy of FLCA**. (See Appendix 10.0 for Background Paper DASH)**

Control Options

Options	Pros	Cons
Diver Assisted Suction Harvesting (DASH)	DASH provides site-specific and species selective control. Can be used in situations where aquatic herbicide is not an option. Results in reduced dispersal of plant fragmentation. Effective in large areas with light plant growth. Low possibility for fish to be affected or harmed as they will vacate the area being hand harvested. More efficient delivery system for transporting hand harvested EWM biomass to the surface. Since DASH is a transportation system and not a sediment dredging system, permits may not require approval from DFO and/or MNRF.	Labour intensive and costly. Not appropriate for large, densely infested areas. Entire plant removal difficult in rocky/gravel substrate. Potential short-term increased turbidity. Ongoing costs (e.g. maintenance, repairs, insurance, storage, etc.) for a mobile DASH pontoon boat and equipment. The highest expense of hand harvesting invasive aquatic plants is the cost of contracting commercial divers. 'In water work' covered by the Ministry of Labour requires a minimum of three certified commercial divers for each project.

The second method selected by MALLA as a control strategy was **Benthic Barriers**. Our research investigated "lake blankets" which would cover an area about the size of a blanket. It is a chemical free, sun light barrier that controls aquatic weeds that have detrimental effects on water quality and the recreational use of lakes. For plants to grow they require sunlight; when sunlight is reduced the photosynthetic process is prevented and plants die. That is the goal of the blanket and to do so in weeks. It shades only the areas that need to be cleared and therefore it can target EWM. This method had been used by Big Clear Lake Association. In our discussion with members of Big Clear Lake they indicated that the mats were very heavy after they were in the water for months and difficult to move to the next targeted area. In consultation with MNRF, they indicated they would require the mats to be removed after a specific period of time. With this new information, we transferred our efforts to investigate biodegradable jute bottom barriers.

Numerous studies from New Zealand, Unites States and Quebec Studies showed effectiveness- up to 95% success rate within 2-3 months with the Lac Pemichangan, Outaouais, Quebec experimental project. The weave of the jute material also allowed native flora and fauna to grow through the mesh. Jute allowed gases from the decaying vegetation to escape. No extraction of the jute was required after installation as it decomposes within 2-3 years. MALLA had some concerns about the composition of the lake blankets having a chemical that might be hazardous to the lake. These were determining factors for MALLA to select the bottom barrier method.

Selecting appropriate sites for the laying of the burlap, a technique to ensure that it remained in place and a designing an apparatus that would dispense the jute efficiently became the new foci. The Stewardship Committee believed there were willing and capable volunteers who could solve these issues. In order to have MNRF permission all aspects of the "pilot project" would be included as part of the application, so detailed planning was necessary.

After modifications to the application for a permit, a Letter of Authority was issued in September 2018.

A third management method selected was **Biological** as this has been an integral component of The Lake Plan implementation since 2016. Native plants compete directly with EWM for space, nutrients, and light, thereby helping to slow the establishment, growth, and spread of EWM within a lake. Natural vegetation zones along the shoreline may also slow EWM growth. Inputs of sediment and nutrients, in particular phosphorus, results in increased aquatic plant growth, including EWM. Natural shoreline buffers around a lake can intercept human activities. Native vegetation provides shoreline stabilization, thereby preventing or limiting erosion.

The Stewardship Committee initiated several activities and programs to increase native plant growth. In May 2016 all property owners on Ardoch and Malcolm Lakes experienced "The Love-Your-Lake" program. Shoreline assessment gave useful information to property owners, with a summary document made available to the Stewardship Committee by Watersheds Canada. The Natural Edge Rehabilitation program was offered to property owners on both lakes; several landowners took advantage of the native plants and shrub planted to help prevent erosion. For the 150th anniversary celebration of Canada, Mississippi Valley Authority offered free plants and shrubs. These were pre-ordered and distributed at the AGM. The 2016 fundraiser was a Wildflower calendar of local/lake photos provided by MALLA members. An education session entitled "Aquatic Plants" was offered the following summer-led by LSC member Cathy Owen. Participants toured the shorelines and lakes to better identify local native plants.

In 2017 MALLA was investigating the possibility of implementing **Milfoil Weevils**. Our contact at Big Cedar Lake in the Kawartha region described their 8- year effort dealing with EWM. They had some success with benthic mats and weevils. Their experiences influenced our decisions for both of these management methods. Big Cedar Lake had a partnership with Prof. Peter Sager at Trent University who shared the results of their study with MALLA. The use of the weevils was discontinued as EnvironScience no longer supplied weevils to Ontario. There had been considerable success in the first three years with a combined use of blanket mats and the weevils. Biological controls used appropriately, tended to minimize the negative impacts to native plant species and aquatic life. The native milfoil weevil (Euhrychiopsis lecontei) has shown preference for EWM as food compared to the native Northern watermilfoil, so nontarget impacts are uncommon. Research has shown weevils can control EWM with long-term and continual efforts, but further study is required to determine if success is density-dependent (for both weevils and EWM).

The partnership with Above & Beyond has sparked a renewed interest in Milfoil Weevils as a management tool. The lead teacher of the secondary program has a background in aquaponics and has been able to reproduce most any aquatic species. Further investigation will determine the feasiblity of weevil stocking for our lakes.

THE EURASIAN WATER MILFOIL CONTROL PLAN 2018

Action	Lead Personnel	Timeline	Goal/Objective Targeted	Notes
Drone Deploy program for baseline data collection	Teacher-Wade Leonard; MALLA-Brenda Martin	Fall 2017; spring 2018	Monitoring 2(c)	Sept.2017; May 2018
Funding application to FOCA; report	Brenda Martin	Spring Fall	Funding 5(b)	June1/2018 Nov. /2018
Permit application to MNRF	Brenda, Glen, Bud	Before AGM	Pilot project request 3 (a)	June 9/2018
Posted alerts on MALLA website re: Eurasian Water Milfoil identification	LSC; webmaster	June	Prevention 1 (a) (c) monitoring	June
Installation of Aquatic Invasive Species Awareness sign at boat launch	LSC; Don Martin	June	Prevention; Monitoring 1(c)	June 8/2018
Invasive Species Education/Drone Deploy Awareness session with MALLA members; identi-card distribution	LSC; Ryleigh Rioux	For AGM	Prevention 1 (a); partnership with Above & Beyond 4 (b)	June 16/2108
Research of control strategies	LSC	May-July 2018 ongoing	Management methods; best practices 2(d)	
Development of action plan	Steering Comte; consultation with Brook Schryer OISA; Barb King Watersheds Canada	June	Goal/objective setting (1-5)	July 1/2018
Equipment items to purchase for hand harvesting; order burlap, rebar	LSC input; Brenda Martin	July 2018	Management methods 3(a)	
Alert Notices; demos for identi. and hand harvesting	Cathy O., Brenda, Glen F.	July 14, 2018	Prevention 1(a)	July 14/2018

Hand harvesting training for landowners	Cathy & Mary	MALLA summer events	Education 1(b)	Fish derby, Corn Roast
GPS mapping of EWM in both lakes; identify priority sites	Don, Bud, Brenda	Summer	Data collection 2(a-c)	July
Modifications to permit request	Brenda	Summer/fall	Pilot project request 3(a)	July & Aug.28; first Letter of Authority Sept20/19
Request to present at North Frontenac Council	Brenda	July 27/2018	Pilot project planning 4 ©	July 27/2018
Research management methods/draft presentation	Brenda; Glen, Bud, Mary, Cathy	July-August	Pilot project planning 4 (a-d)	August 8/2018
Presentation to Township Council	Glen, Bud, Mary, Cathy, Brenda	August	Education; 1 (a) (c) partnership; (d) funding 4(d)	August 23/2018
Steering Committee meeting	Steering Committee	August	Pilot project planning (1-5)	August 28/2018
Prepare grant appln for OFA&H	Bud & Brenda	August	Funding 4(d)	Submitted Aug.26/2018
Drone deploy prep	Brenda, Ryleigh, Wade	First 2 weeks Sept.	Monitoring 2 (c)	Weather conditions & class scheduling factors
Burlap laying plan; practice; order stone	Fishing Cmte; Steering Committee	Early Sept	Pilot project planning 3 (a)	Sept.4 &20/2018
Burlap pilot project	Fish Cmte; Cathy, Bud, Mary & volunteers	Sept.23/2018	Pilot project implementation 3 (a)	Laid only 1/5 rolls
Design EWM sign for Township boat launches	Ruth, Brenda	Fall	Prevention 1 (c)	October 5/2018
Research internships for grad students	Brenda, Barb King,	Sept.-Nov.	Partnership 2 (d) 4 (a)	Not suitable

Drone flights	Above & Beyond class; Brenda, Don, Roy, Dan, Trever, Glen	Fall	Monitoring 2 (c)	Oct.12/18
LSC Chair meet with NFT Community Manager Re: Twsp resolutions	Brenda, Corey	Fall	Funding-TD Bank, signage, request for JR. Rangers in 2019; grad student intern ? 1(d) 4 (c) 5 (b)	Oct.1 & 26/2018
Request to MNRF for permit continuance 2019	Brenda & Glen	Submit early December	Pilot project 3 (a)	Nov.16/2019
Meet with Prof. Jesse Vermaire re: partnership	Glen, Brenda, Wade, Ryleigh, Principal James McDonald	December	Partnership-grad student as lead instead of intern 4 (a)	Dec.17/2018
Revise requests to Township-prepare profile for summer student with technology background	Brenda	December	Funding for summer student 4 (c) 5 (b)	

THE EURASIAN WATER MILFOIL CONTROL PLAN 2019

Action	Lead Personnel	Timeline	Goal/Objective Targeted	Evaluation/Notes
Grant writing	Brenda with Corey at Township for TD Bank; summer school tech student appln	January 15/2019	Funding 4 (c) 5 (b)	Completed grant proposals Jan.8/2019; submitted Jan. 10/2019 Rec'd denial from OFA&H
EWM Management document revisions and develop 2019 and 2020	Editor-Brenda; input Steering Committee and partners	Winter 2019	Goal setting and develop objectives (1-5)	Draft March 12/2019
Nutrient monitoring in lakes eg.dissolved oxygen, pH	Brenda & Don, Kelly Stiles (MCVA) for equipment & training	January, February, March (April depending upon lake conditions)	Monitoring 2 (a) (d)	Chart in Appendix
MNRF Letter of Authority permit request	Brenda	Spring 2019	Permits 3 (a)	Recd Jan. 17/2019
Research of management methods	Steering Committee & Wade Leonard	Winter 2019	1 (d) 4 (d)	Contacts from Farlain Lake Community Association shared- March 2019
Detection/monitoring/ mapping plan	Wade & class; Brenda for logistics, volunteers for crew support	Early June & fall; as reqd in summer	Assessment of EWM growth 2 (a-c)	Planning meeting Mar.22/2019
Burlap laying project	LSC, Fishing CMTE, volunteers	May-June 2019	Management method 3(1)	
Seek additional funding	Steering Cmte;partners	June-August	5 (a)	
Implement management/control strategies	SteeringCmte; partners; Weed Watch volunteers	May-September	3 (a)	

Detect/monitor/map	Above & Beyond partner; summer student	May-September	2 (a,b,c) 1 (b) 3(d)	
EWM Sampling	Prof. Vermaire	May-September	Assessment of benthic barriers as control & examine impacts on aquatic habitat 2(d) 4 (c)	
Evaluate components of plan; prepare report(s); revise plan as needed	Steering Cmte; researchers; Weed Watchers; partners	Oct-end of Nov.	3 (b) i	
Lobby for government funding	MALLA and partners	Dec.	5 (a)	

THE EURASIAN WATER MILFOIL CONTROL PLAN 2020

Action	Lead Personnel	Timeline	Goal/Objective Targeted	Evaluation/Notes
Grant writing	Brenda in consultation with Corey at Township	Mid-January 2020	Funding 4 (c) 5 (b)	
EWM Management document revisions and adjust 2020 plan	Editor-Brenda; input Steering Committee and partners	Winter 2020	Goal setting and develop objectives (1-5)	
Nutrient monitoring in lakes eg.dissolved oxygen, pH	MALLA reps; Kelly Stiles (MCVA) for equipment & training	January, February, March (possibly April depending upon conditions)	Monitoring 2 (a) (d)	See Appendix 11
MNRF Letter of Authority permit request	MALLA President & LSC Chair	Early January	Permits 3 (a)	
Research of management methods	Steering Committee & Wade Leonard;	Winter 2020	1 (d) 4 (d)	
Detection/monitoring/ mapping plan	Wade & class; Brenda for logistics, volunteers for crew support	March 2020	Assessment of EWM growth 2 (a-c)	
Seek additional funding as needed	Steering Cmte; partners	June-August	5 (a)	
Burlap laying	LSC; Fishing Cmte; volunteers	May-June 2020	Management methods 3(1)	
Implement management/control strategies	SteeringCmtte; partners; Weed Watch volunteers	May-September	3 (a)	

Detect/monitor/map	Above & Beyond partner; summer student	May-September	2 (a,b,c) 1 (b) 3(d)	
EWM Sampling	Prof. Vermaire	May-September	Assessment of benthic barriers as control & examine impacts on aquatic habitat 2(d) 4 (c)	
Evaluate components of plan; prepare report(s); revise plan as needed	Steering Cmte; researchers; Weed Watchers; partners	Oct-end of Nov.	3 (b) i	
Lobby for government funding As needed	MALLA and partners	May-September	5 (a)	

FUNDING

The estimates provided are dependent upon the ability of MALLA, its partners and the lake community to provide labour required to implement management controls of hand-harvesting and burlap laying in priority areas AND the approval of grants being submitted. The hiring of a summer student in 2019 and 2020 is the major cost reflected in the monitoring and mapping budget. If the D.A.S.H. method is undertaken, equipment and divers would be required necessitating insurance costs must be added.

Year	EWM Management	Monitoring Mapping	Education	Evaluation	Total
2018	$2385	$500	$227	$100	$3212
2019	$11500	$7350	$150	$100	$19100
2020	$6000	$7400	$150	$250	$13800
Contingency	$500	$500	0	$100	$1100
Total	$20385	$15750	$527	$550	$37212

APPENDIX:

1.0 Physical Characteristics of the Lakes

Characteristics	Ardoch Lake	Malcolm Lake	
Shoreline (Perimeter)	5.8km	14.6 km	Large % natural shoreline
Surface Area	0.9 km^2	2.1 km^2	
Drainage Area	6.7 km^2	18.7 km	Flow from Ardoch to Malcolm- east to west- the only lake in the district to do so; drains into Mississippi River system to Ottawa area
Elevation	282m a.s.l.	253m a.s.l.	
Assessed Lakefront Properties (2018)	23 (0 permanent residences)	115 (12 permanent residences)	
Length	1.9 km	3.1 km	
Common Fish	Northern Pike, Bass, Walleye, Yellow Perch	Northern Pike, Bass, Walleye, Yellow Perch	*established and improved walleye beds in both lakes since 2016
Flushing Rate	Low	N/A	
Average depth	7.6 m	2.2 m	
Water quality testing	1971-1987 MoE; 2016 Lake Partners program and Watershed Watch program 3 times a year, every 5 years through Mississippi Valley Conservation Authority	1971-1987 MoE; 2016 Lake Partners program and Watershed Watch every 5 years through Mississippi Valley Conservation Authority	*This winter I have monitored both lakes for dissolved oxygen levels and pH with monthly tests in 3 sites on each lake. Our concern is for our fish population.

2.0 WATERSHEDS CANADA REPORT

Wondering about the ***"Zombie Plant"***?

The province of Quebec has recently committed 8 million dollars to combat it, and this news is making waves in the environmental sector.

As it was first discovered in Ontario in 1961, chances are you've probably encountered this invasive aquatic plant at some point in your lifetime. The "Zombie Plant", more often known as Eurasian Water Milfoil, has gained the zombie moniker due to its ability to regenerate and spread even from small clippings that have been separated from the root system.

Like all invasive species, it spreads easily and has the ability to choke out native aquatic plants, thus creating a lack of biodiversity that can affect fish and wildlife habitat, as well as water quality.

Recently, Watersheds Canada's Executive Director, Barb King, spoke with Stu Mills of the CBC about the effects of Eurasian Water Milfoil on Ontario's freshwater: 'Zombie plant' threatening Ontario's lakes | CBC News. Barb also offered some instruction on how to identify the plant, which you can check out in this video.

Photo by Stu Mills/CBC

As the article mentions, Fisheries and Oceans Canada has also set up hotlines across Canada to report any aquatic invasive species.

To Donate to Watersheds Canada to help create plant biodiversity and restore fish and wildlife habitat, visit our page.

3.0 AQUATIC INVASIVE SPECIES DRONE PROJECT (2017) FOR MALLA

Ardoch Lake looking to the west, Malcolm Lake is in the distance.

Preparing for Flight Operations

There are many preparations for a drone flight. All property owners need to be notified. Public lake users were notified through a posting at the boat launch. A crew with boats and walkie-talkies were put in place on both lakes for safety reasons. The drone must be in-sight at all times. Permission from property owners for launch and recovery sites is required.

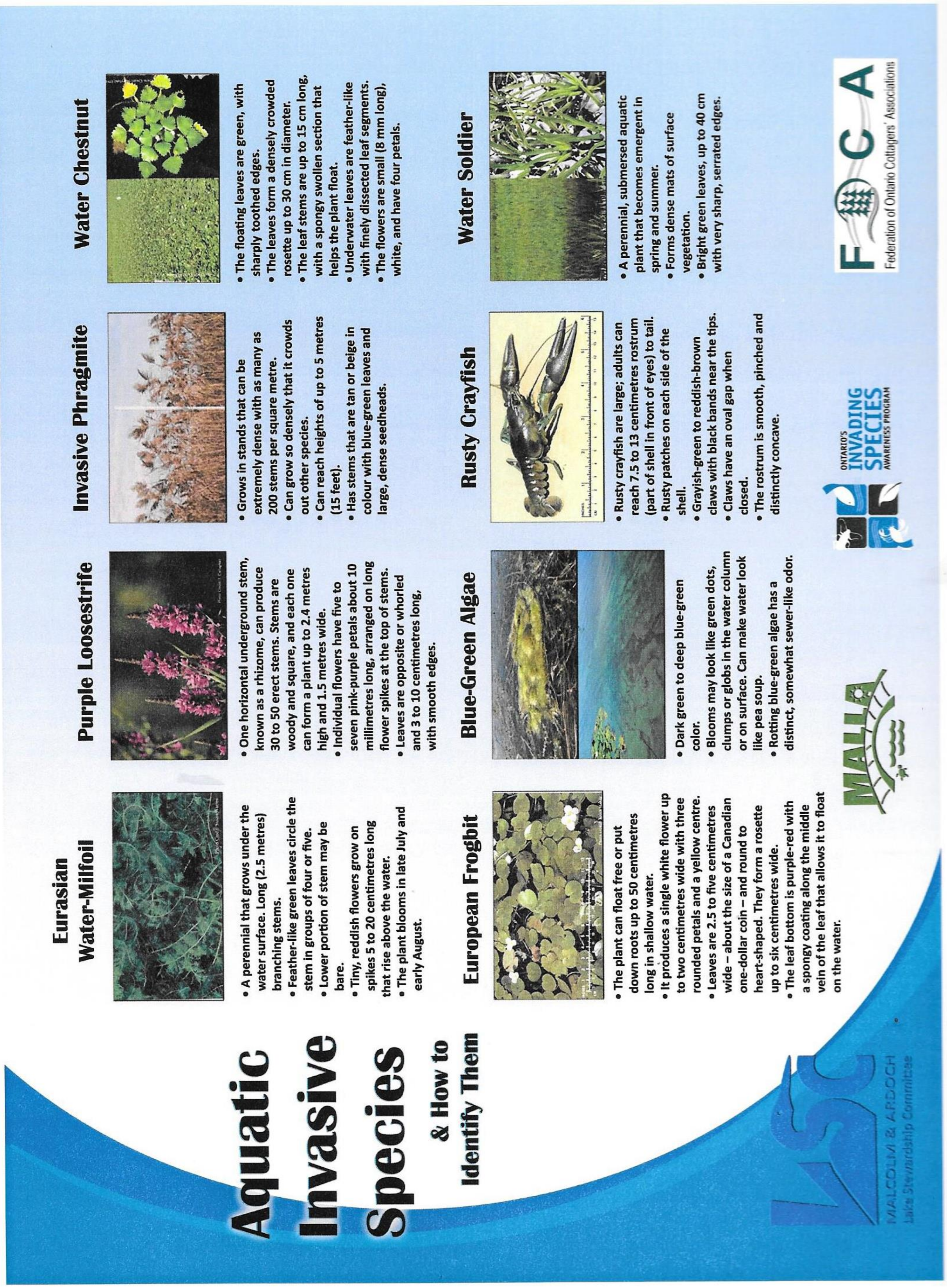
The LSC continued to implement Lake Plan activities aimed to monitor, protect and improve our lakes through recommendations and actions. Aquatic Plant mapping began in 2015 to help monitor plant growth with the intention of identifying invasive species. In 2015 the Stewardship Committee participated in an aquatic plant mapping echo-sounder program through Carleton University using boats and GPS equipment. Although we were registered for the program in 2016, it was cancelled. As a result, we had only one year of data for Malcolm Lake and insufficient data for Ardoch Lake. A heat map and grid chart of Malcolm Lake are shown herein to give an example of the potential of the project. Finding an alternative program was costly. We heard about the new drone program that the local school (Granite Ridge Education Centre) would be initiating and felt that a real-life environmental need could make a great local partnership. Through discussions with teacher, Wade Leonard, the project co-ordinator, it seemed to be an excellent match for our first priority- monitoring plant growth. It had the potential for grid mapping each season for plant growth; in addition, fisheries' spawning beds, shoreline mapping and the heron rookery could be recorded.

In September 2017 we tested the possibilities. Given it was new software, new terrain, and a new program with no previous training of students, there were many variables to be considered. In the school year 2017-18 Wade Leonard and his class solved many of the issues and felt that they were ready to address LSC needs. In addition to the drone mapping, they would provide grid maps similar to the ones below. MALLA made an agreement for the year with the

Drone Program to gather data for our invasive species monitoring.

Near ideal conditions on Malcolm Lake September 27, 2017

4.0 AQUATIC INVASIVE SPECIES IDENTIFICATION SIGN (MALLA 2018)



4.1 INVADING SPECIES BOAT LAUNCH SIGN

CLEAN + DRAIN + DRY YOUR BOAT

Motors, boats, and Ontario's ecosystems can be ruined by zebra mussels and other aquatic invasive species. Take a few simple steps to preserve our lakes and fisheries: **CLEAN** off any plants or debris, **DRAIN** bilges and ballast water, and **DRY** any wet areas of your boat.

DON'T LET THEM CATCH A RIDE

STOP AQUATIC HITCHHIKERS

TO REPORT INVASIVE SPECIES:
1-800-563-7711
www.EDDMapS.org/Ontario

ONTARIO'S INVADING SPECIES AWARENESS PROGRAM
FOCA Federation of Ontario Cottagers' Associations
Ontario

4.2 ALERT of EWM (MALLA 2018) prepared for Township of North Frontenac boat launches

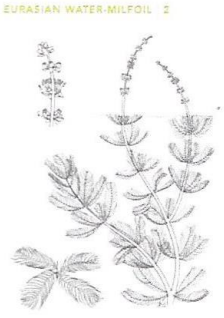
EURASIAN WATER-MILFOIL ALERT

The Township of North Frontenac is asking for the public's help to slow down the spread of this invasive species that is threatening many of our lakes.

EWM has is an invasive, very aggressive aquatic plant that can totally infest shallow lakes with dense growth in the water and on the surface; tangles in rudders, props and fishing gear; kills native vegetation and depletes oxygen levels for fish and other aquatic animals.

WHAT YOU CAN DO:

- Clean your boat, propeller and trailer at home before launching in a different lake.
- Avoid disturbing establishes EWM patches while boating or fishing. Even small broken pieces re-root in days.
- If you own lakeshore property, hand-pull plants along your shoreline and dispose of them away from the water.



Each leaf of EWM has at least 12 thread-like segments.

If removing EWM from a motor while on the water, take fragments to shore for disposal.

5.0 ABOVE & BEYOND STUDENT REPORT

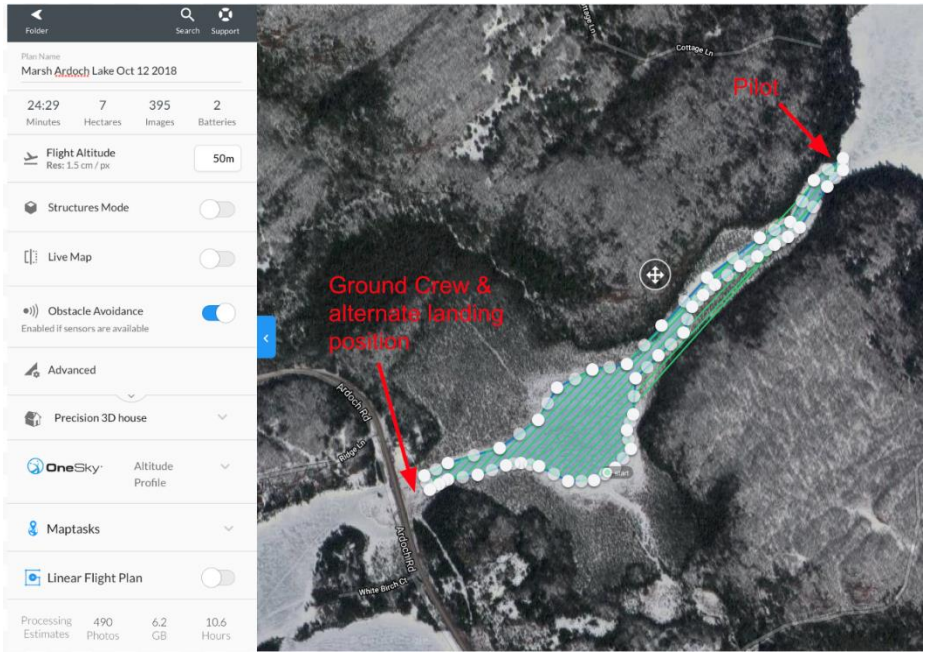
This report reflects findings from the Above & Beyond perspective. Recommendations will be evaluated by MALLA and not necessarily become components of the EWM Control Plan.

Malcolm and Ardoch Lake Proposal

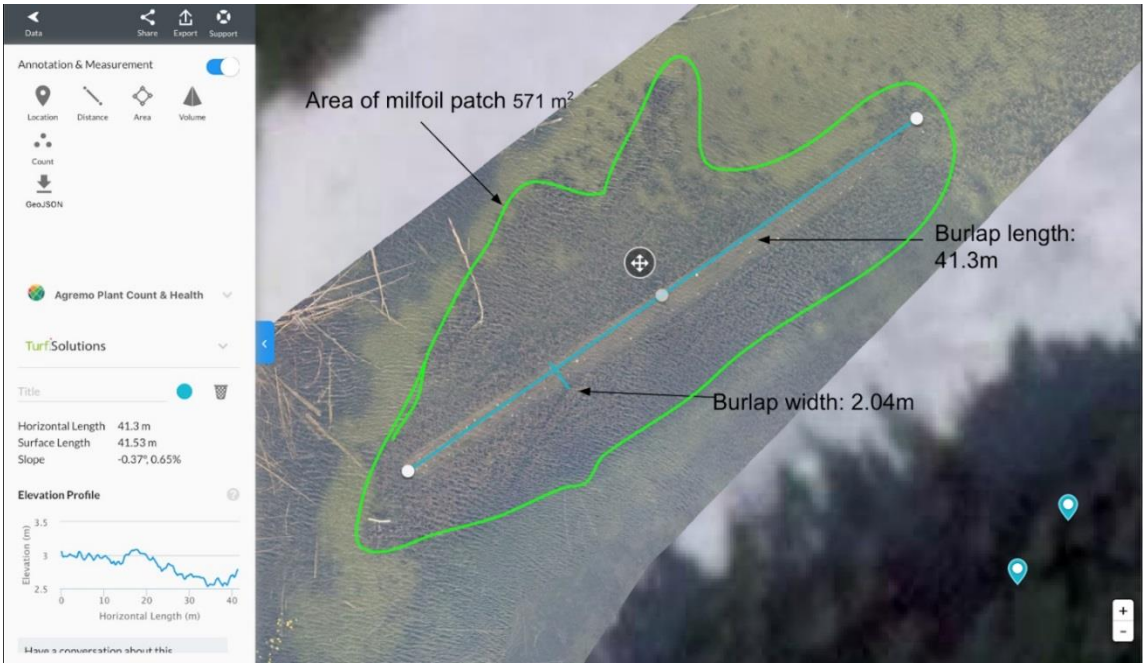
I am a member of the Above and Beyond Class at Granite Ridge Education Center. Our program is located in Central Frontenac and we offer UAV Services including; videography, photography, mapping and GIS analysis in Frontenac County and surrounding areas. We are working with The Malcolm Ardoch Lakes Landowners' Association (MALLA) to use aerial imagery to map the spreading of EMW over the last two years. The Malcolm and Ardoch Lake Association sought the help of the Above and Beyond class at GREC to collect aerial imagery of a recent Eurasian Water Milfoil infestation in their lakes. The MALLA have had many concerns regarding the spreading of EWM for multiple years now. The concern is with how quickly this EWM is spreading throughout the lake. The goal of this year's flight is to determine how much the EMW has spread since the prior year and identify which areas of the lake are overrun by this milfoil. The MALLA is seeking out multiple grants to raise money for prevention services but needed baseline data to determine what needs to be done to control the EMW population. As MALLA is a small association with limited resources they felt the aerial imagery Above and Beyond could provide, would be a beneficial way to collect this data. This is the second year of working with the MALLA and the goal for this year was to pinpoint new areas of interest with high levels of EWM.

Operations for this mission included multiple flights which were to take place an October 12 on both Malcolm and Ardoch Lake. click here for preflight

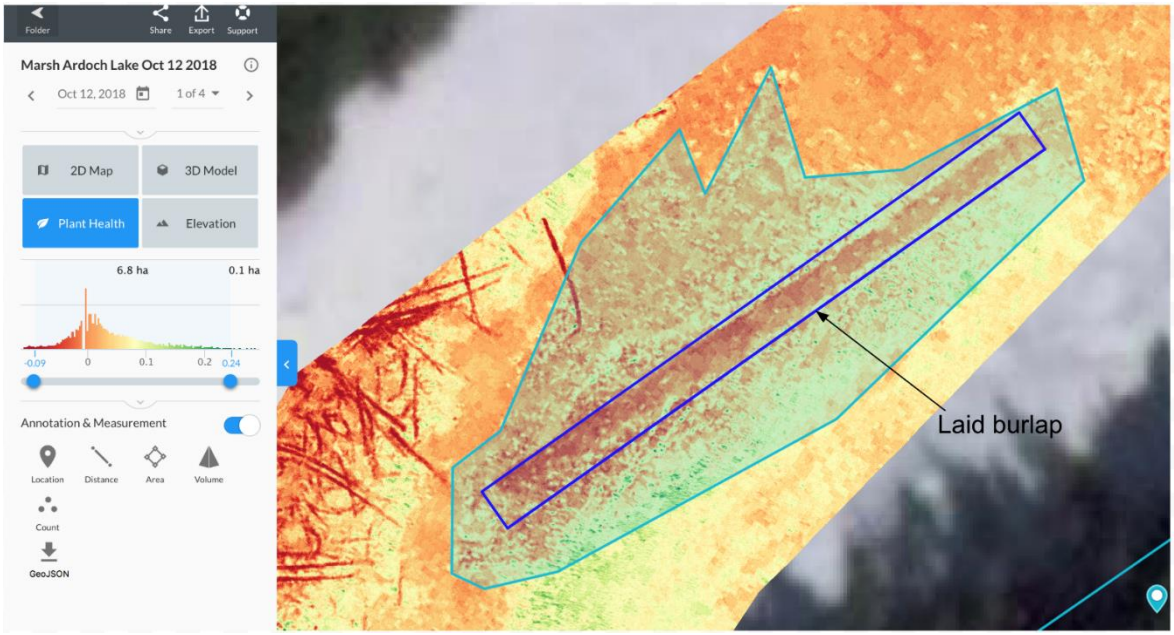
Marsh Ardoch Lake (click here for Marsh Ardoch Lake accuracy report)
The purpose of this mission was to determine the milfoil infestation in the marsh area between the two lakes. Burlap was also laid in the marsh and the MALLA wanted to have aerial imagery of the burlap to see its location and its effectiveness. This mapped area was 7 acres and flown at 50 metres AGL with a runtime of 24:29 minutes. The mission required two batteries and the drone took 395 photos. The drone took off from a boat at one end of the marsh and visual observers were located on land on the opposite side of the marsh.



The orthomosaic for Marsh Ardoch Lake turned out quite well with clear imagery and minimal reflection of light off the water. The main issue occurred while the orthomosaic was being stitched together, a gap was left in the middle of the main marsh area.

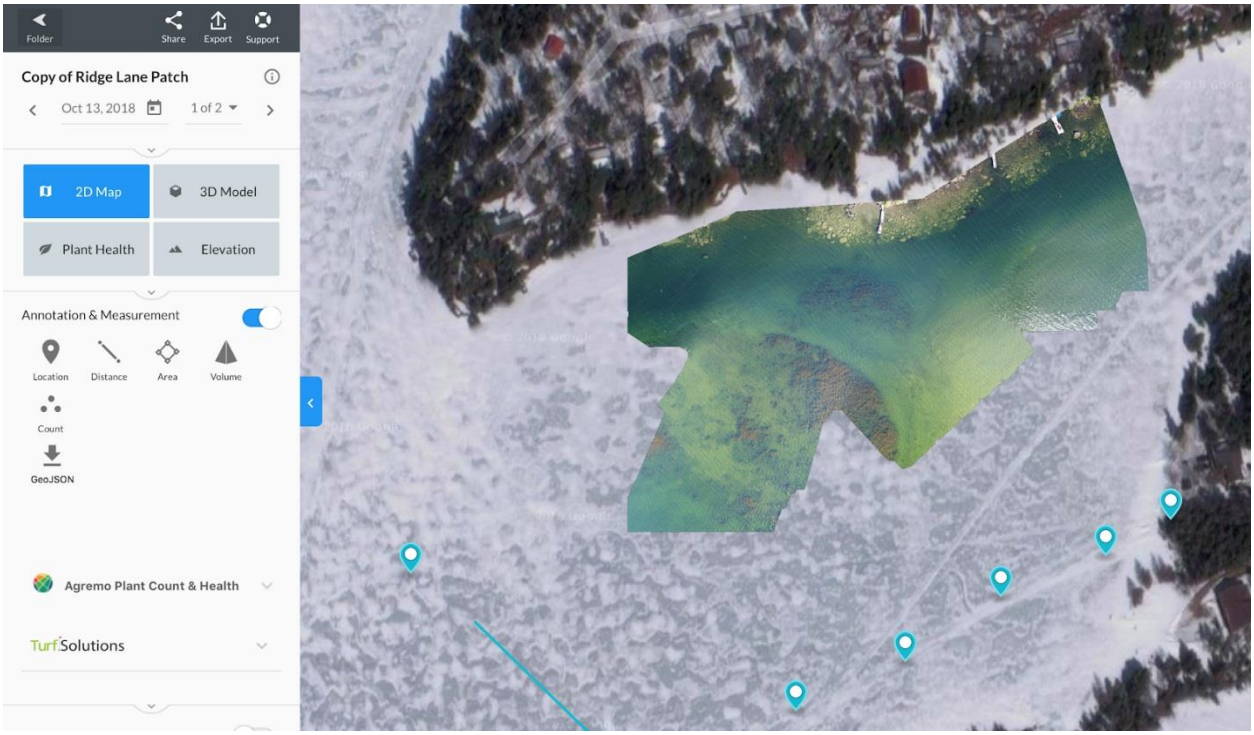


The area of most importance was where the burlap was laid which is presented in the image above. The green line shows the approximate edge of the most extensive EWM patch in this area of the lake. The blue lines show the approximate length and width of the burlap with approximate area of the burlap about 84.25m^2.



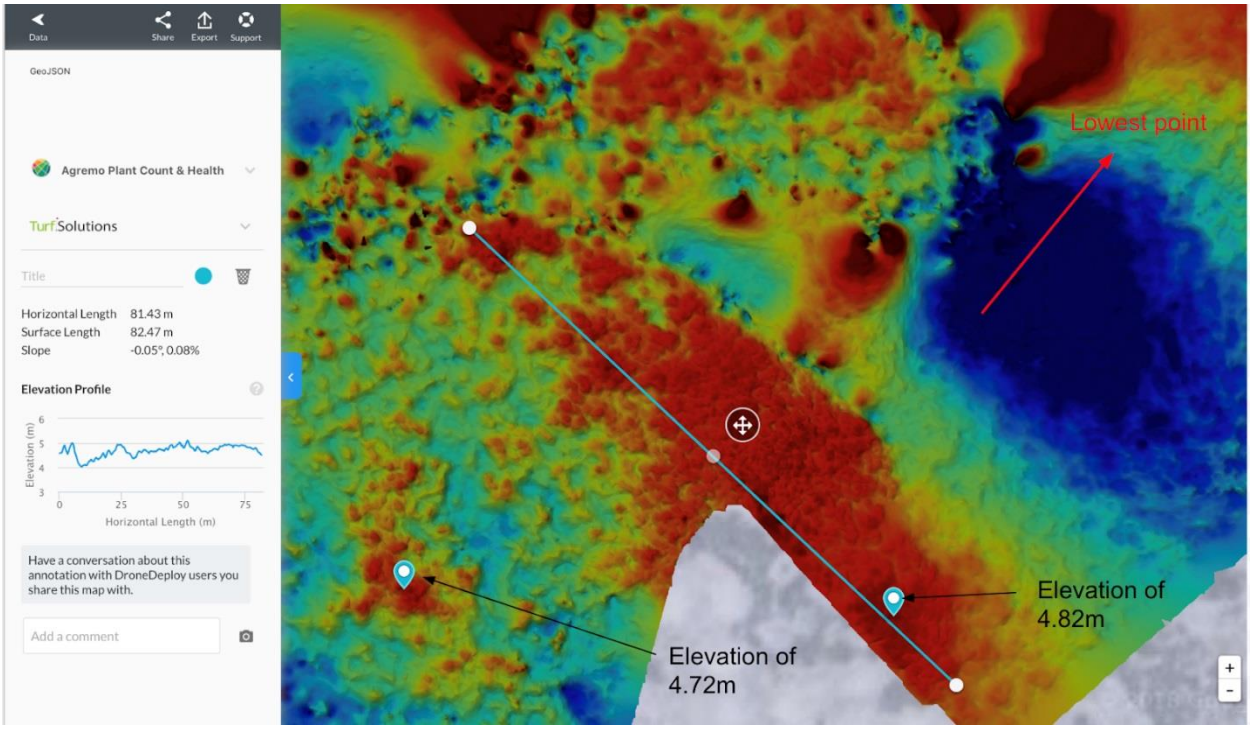
The orthomosaic above is showing the plant health on the floor of the marsh. As you can see the area outlined by the blue rectangle is the area with the burlap. This area is reflecting red which means it is more- dead than the surrounding milfoil. A suggestion for the future is to increase the width of the burlap, because of the extreme height of the milfoil it may not stay situated under a piece of burlap with a small width making its way out the sides causing the burlap to not be overly affective.

Ridge Lane Patch (click here for ridge lane patch accuracy report)
The purpose of this mission was to collect aerial imagery of the most prominent Milfoil patch on the lake which is located in the flight boundaries of this mission. This aerial imagery would be used as baseline data so in the future we can flight the mission again and track the growth of the patch.

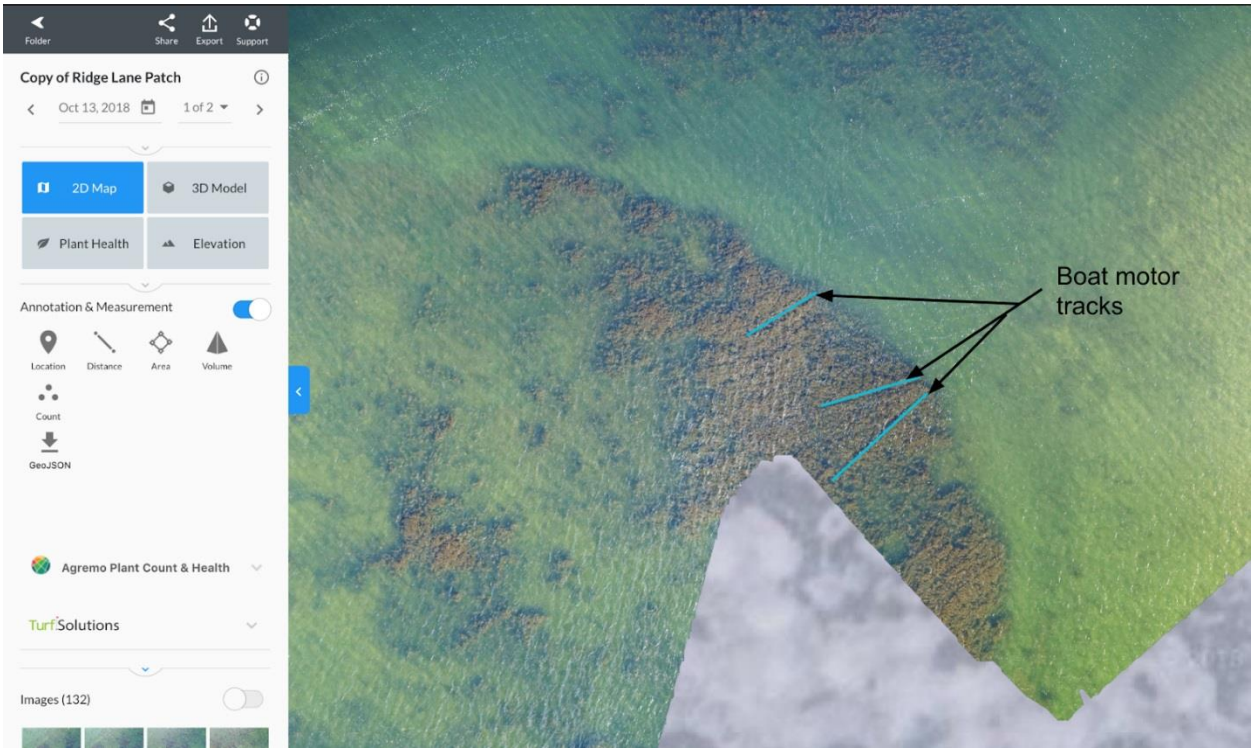


The orthomosaic shown above was produced from the Ridge Lane flight. Its colouring was beautiful with very minimal reflection off the water. While being stitched together portions of the flight did not make it into the final orthomosaic but the portions of the orthomosaic which were produced turned out quite well.

The image above shows the major milfoil patches in the lake located on the North-East end of Malcolm Lake at the inflow area between Ardoch and Malcolm Lake. The most prominent and large patches are found in the area highlighted by the map above. The largest patch in the lake is outlined in the above picture in purple and has an area of 1,657m^2. This patch is made up of multiple dense areas of milfoil- the middle of the patch being most dense to the edge where the density of milfoil slightly decreases. The image above also shows multiple smaller less dense patches in the lake's main infested area. More in depth information and analysis of this map is available at ArcGIS Online

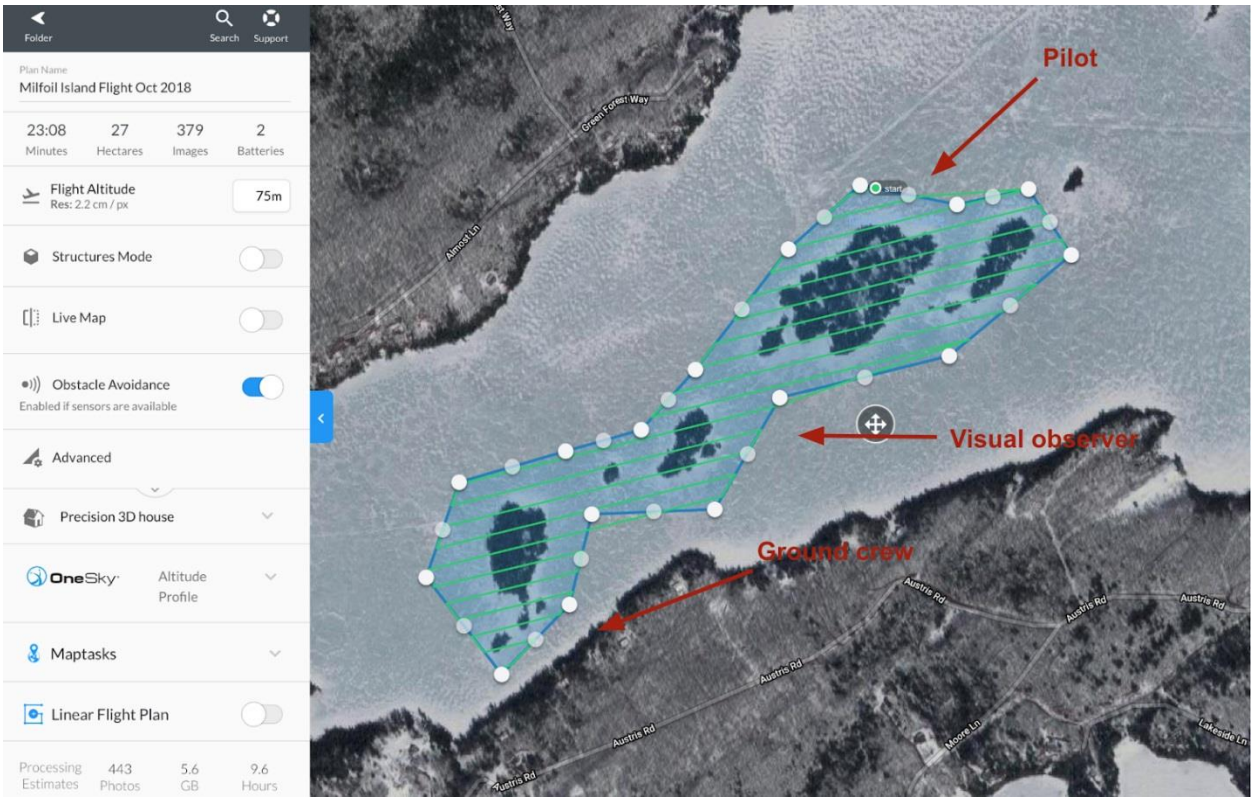


This image clearly shows the elevation differences in the milfoil patches to the surrounding areas. The milfoil which is highlighted in red stands much taller than the other vegetation in the water which are represented by the yellows, greens, and blues. The blue pins represent the highest elevations within the milfoil patches; the main patches highest elevation is 4.82m. The annotated photo above, also highlights the elevation differences throughout one patch which is shown on the graph on the left- hand side of the image above. In this case, we are looking at the elevation differences from one side of the main patch to the other; this is represented by the blue line across the patch. The elevation map to the left of the orthomosaic is not consistent and reached a height of almost 5m. The blue line also tells us that the patch is approximately 81 meters in length.

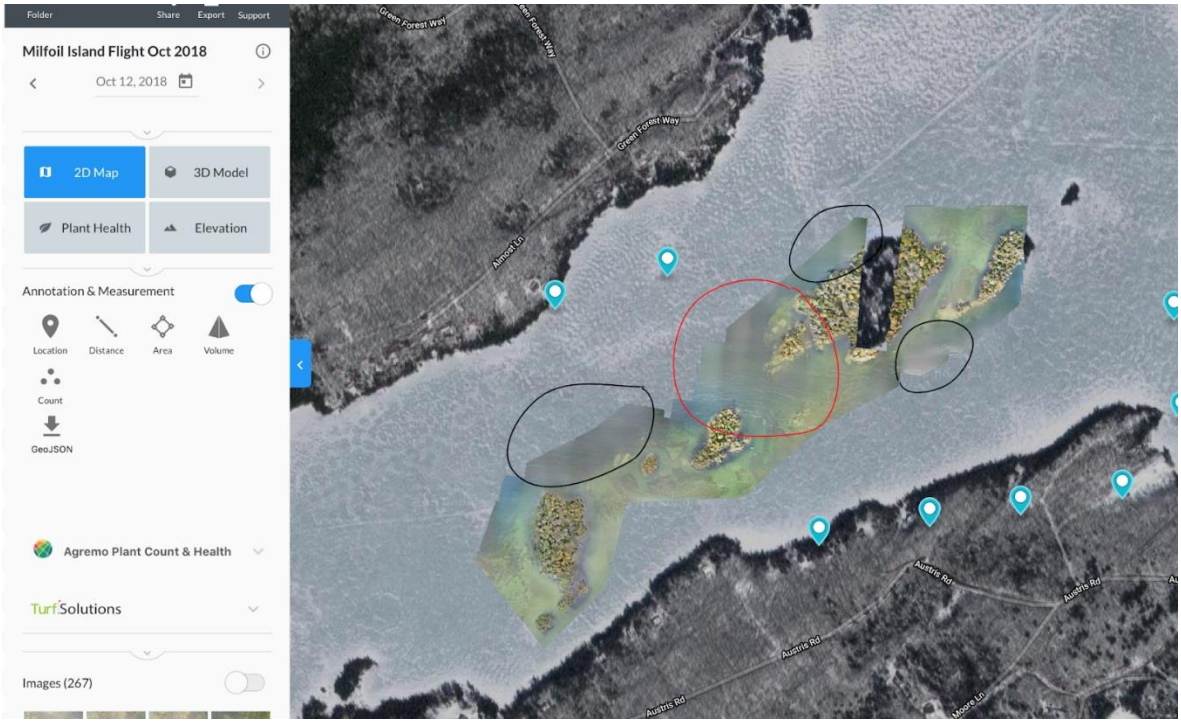


The blue lines in the picture above, are boat motor tracks in the milfoil. This shows how high the milfoil plant can grow if the boats on the top of the water are coming in contact with them. This is a huge issue with the spreading of the milfoil throughout the lake. When the boats come in contact with the milfoil it causes the plant to fragment and attach to boat propellers. The EMW is then transferred throughout the lake by the boat and has the ability to replant itself in other areas of the lake. To keep the milfoil from spreading, boaters need to avoid the areas of the lake with major milfoil patches as well as make sure to remove any milfoil segments from their boats if they travelled through a patch. The benefits of collecting data using a UAV are: 1) you are not disturbing the lake's ecosystem; 2) you also eliminate the risk related to the spreading of milfoil due to boats; 3) this method of surveying is more precise and less time-consuming than other methods including ground surveying.

MIlfoil Island flight (click here for Milfoil island accuracy report)
The purpose of this flight was to determine the locations of smaller milfoil patches surrounding the islands at the south west end of Malcolm Lake. The mission should take 23 minutes, cover 27 acres, take 379 images and produce a beautiful orthomosaic yet that was not the reality. While flying this mission we faced very high winds causing the drone to sway off track. The wind also produced lots of white caps in the water making it difficult for the drone deploy system to develop a clear orthomosaic as a result of the excessive movement of the water.



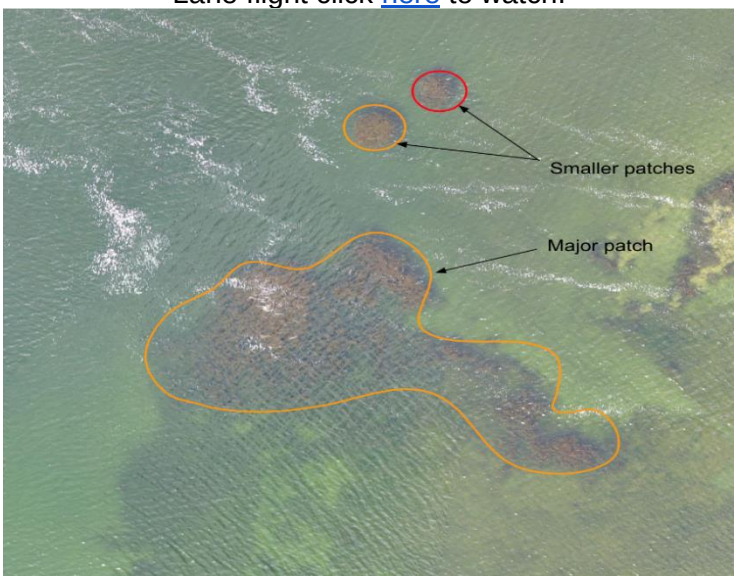
In the orthomosaic below, the white caps on the water are evident, as well as the sun's reflection off the water. This is due to the orientation of the drone changing throughout the course of the mission. This caused one pass to be facing away from the sun producing clear reflection free imagery and the next pass to be oriented into the sun (an example of light reflection is outlined in black). This causes light to reflect off the water and caused ample glare on the water restricting your sight to the lake floor. In addition to the light reflection, the changing orientation of the drone also caused for colour differences between passes. In the area circled in red there are clearly defined lines of different coloured areas right beside each other.



The blue location pins in the orthomosaic below, are showing the locations of the multiple small milfoil patches in the area of the lake surrounding the islands. The most prominent milfoil patch which we located during this mission was located in the center of the orthomosaic and is circled in red.

The image below, is the aerial imagery collected of the major patch surrounding the islands on Malcolm Lake. The major patch has an area of 573 m^2 with medium to low density areas. There are also two smaller dense patches in close vicinity to the major patch. For a more in-depth look at the other less prominent patches found on the island flight as well as the multiple other flights refer to ArcGIS map .

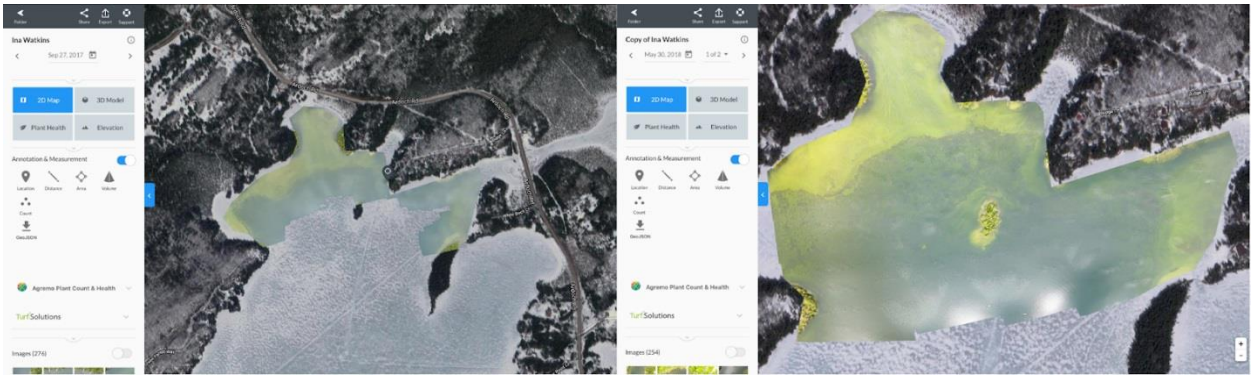
In addition to the ArcGIS map, I also produced an informative video of the Island and Ridge Lane flight click here to watch.



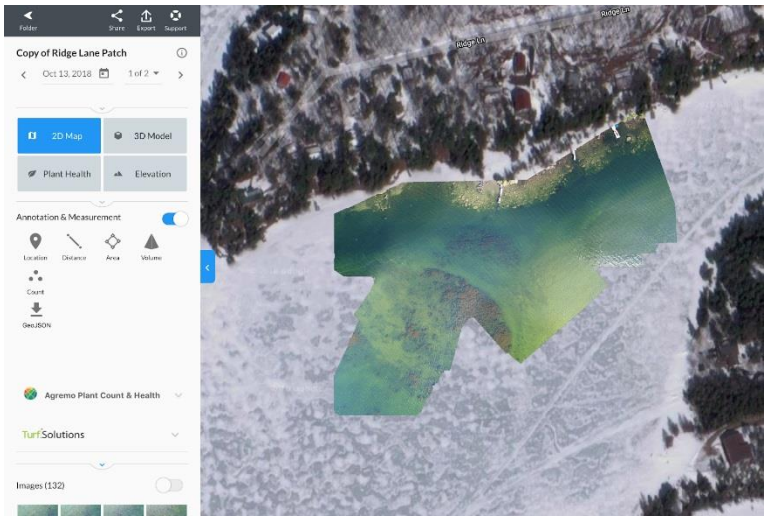
Compare and contrast

We have been working with the MALLA for the last two years and throughout this partnership our program has experienced considerable improvements. An example of this improvement is noted in the comparison our first year of imagery to our second year of imagery. The following images compare all three flights which took place along Ridge Lane where the most prominent milfoil patch is located.

Sept. 27, 2017 May 30, 2018



Oct, 12, 2018



Clearly, the clarity of our imagery has greatly increased from the first time we conducted a mission at Malcolm Lake. The first mission flown on September 27, 2017 gave us no data regarding the milfoil due to the extreme amount of glare present in the orthomosaic. This was our first mission ever- let alone the first time flying over a large body of water. Numerous issues arose.

Our second flight conducted on May 30th, 2018 was an improvement from our first flight but still did not capture the imagery we were looking for as the major milfoil patch was still not visible. The orthomosaic produced, still had a high concentration of glare making it extremely difficult to analyse.

Our most recent mission, which was conducted on October 12, 2018 captured our best imagery yet. There is very little to no glare present on the orthomosaic and a clear view of the major patch which was not present in the orthomosaics produced in the prior years. Because of the clarity of the imagery, I could clearly analyse the collected data and provided the MALLA with new, useful information. For the last mission conducted we introduced the use of polarization filters which filter out unwanted light removing heavy glare and producing a beautifully coloured orthomosaic with crisp defined features. Though this mission did go better than the prior mission, there is still room for improvement. For example, the orthomosaic is only a small portion of the planned flight, and due to high winds and uncontrollable weather conditions not all aspects of the flight were conducted.

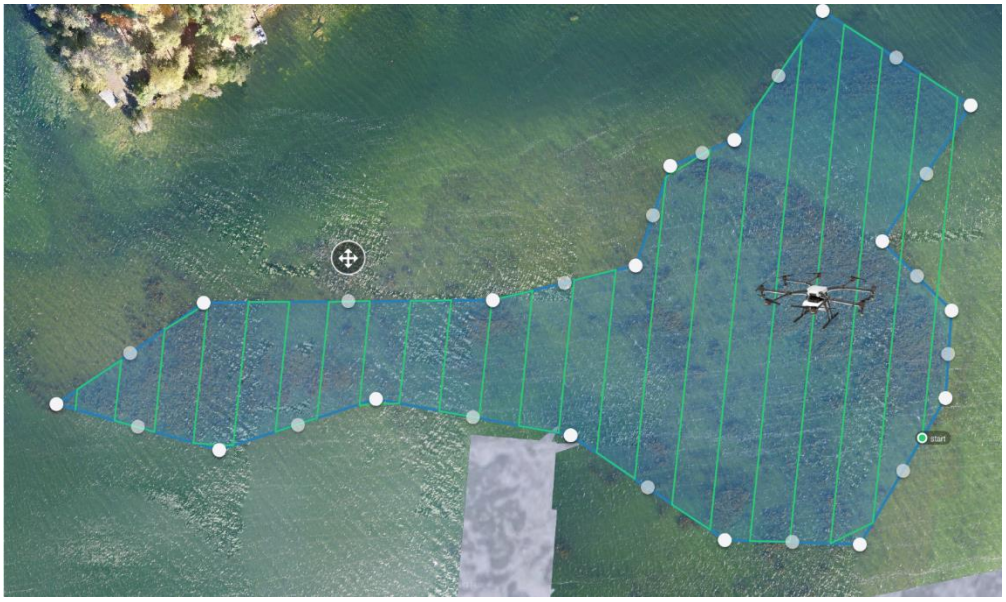
Recommendations for the future

Recommendations for the future include at least bi-yearly flights to determine expansion rates of milfoil patches and planned flights surrounding specific areas of the lake where milfoil infestation seems to be a more prominent issue. Regulated flights will allow us to monitor the long- term changes occurring within the lake regarding the milfoil. This could be monitoring the growth rate of the milfoil or determining the success rates of removal techniques such as burlap or Milfoil weevils. With these bi-yearly flights, we can easily determine the health of the milfoil plants, to determine where removal operations have been successful or unsuccessful as well as where more operations should occur. This technology will allow you to easily track your progress compared to taking a boat where there is a higher risk of fragmentation, and the risk of spreading the milfoil. The drone will give you a clear perspective which will not have any negative effects on the milfoil patches being surveyed.

There are multiple removal options; the use of milfoil weevils stands out as it controls the EMW without causing drastic damage to the surrounding aquatic vegetation and environment. The Weevil feeds on the stem of the EMW overall controlling its population and keeps it from over throwing the lake. It is suggested that you have an average of 3000 weevils per acre of EMW. Though the patches do take up a large area of the lake, the major patches we have mapped thus far have only an approximate area of 8000 m^2 or 2 acres of milfoil patches. This means the average cost of the weevils will be about $6,600 as a single weevil costs approximately $1.10. Weevils are very cost efficient as well as sustainable due to their ability to survive cold conditions throughout the winter months. During the winter the weevils make their way 1 to 6 meters from shore and burrow themselves under about 5 centimeters of duff, soil, and leaves. They must avoid the rising water throughout the winter months and have a 60 percent winter survival rate which can be increased with the help of the lake residents. To increase

survival rates avoid raking away debris from your shorelines during periods when they are present; this will help to insure the weevils have a safer environment to sustain themselves. The weevils will return to the milfoil areas when it has reached a temperature of around 10 to 15 degrees Celsius.

Another EWM control option, is the use of an agricultural drone which is commonly used to spray crops. With a few minor adjustments you may be able to introduce the weevils to the lake in an extremely beneficial manner. If you were to use an agricultural drone and pinpoint the exact locations of the EWM patches, the weevils could be dropped with precision at exact locations in a timely fashion. This would also decrease the chance of milfoil spreading with the use of a boat to introduce the weevils. If you had to drive over patches with a boat, the EWM would fragment off due to the motor of the boat leading to the spreading of the milfoil as it would detach from the boat motor and re-root elsewhere.



Summary

The multiple missions conducted at both Malcolm and Ardoch Lake allowed us to capture second year imagery of the milfoil infestation on both lakes in a way which did not disturb the ecosystem. This imagery increased our knowledge of the locations, sizes, and densities of the major milfoil patches infesting the lakes. With this better understanding we were able to develop methods of removal as well as determine next steps for our partnership.

This partnership provided the MALLA with aerial imagery of the major milfoil patches infesting their lake as well as detailed analysis of each patch. This data can be used in developing removal methods or applying for grants in the future.

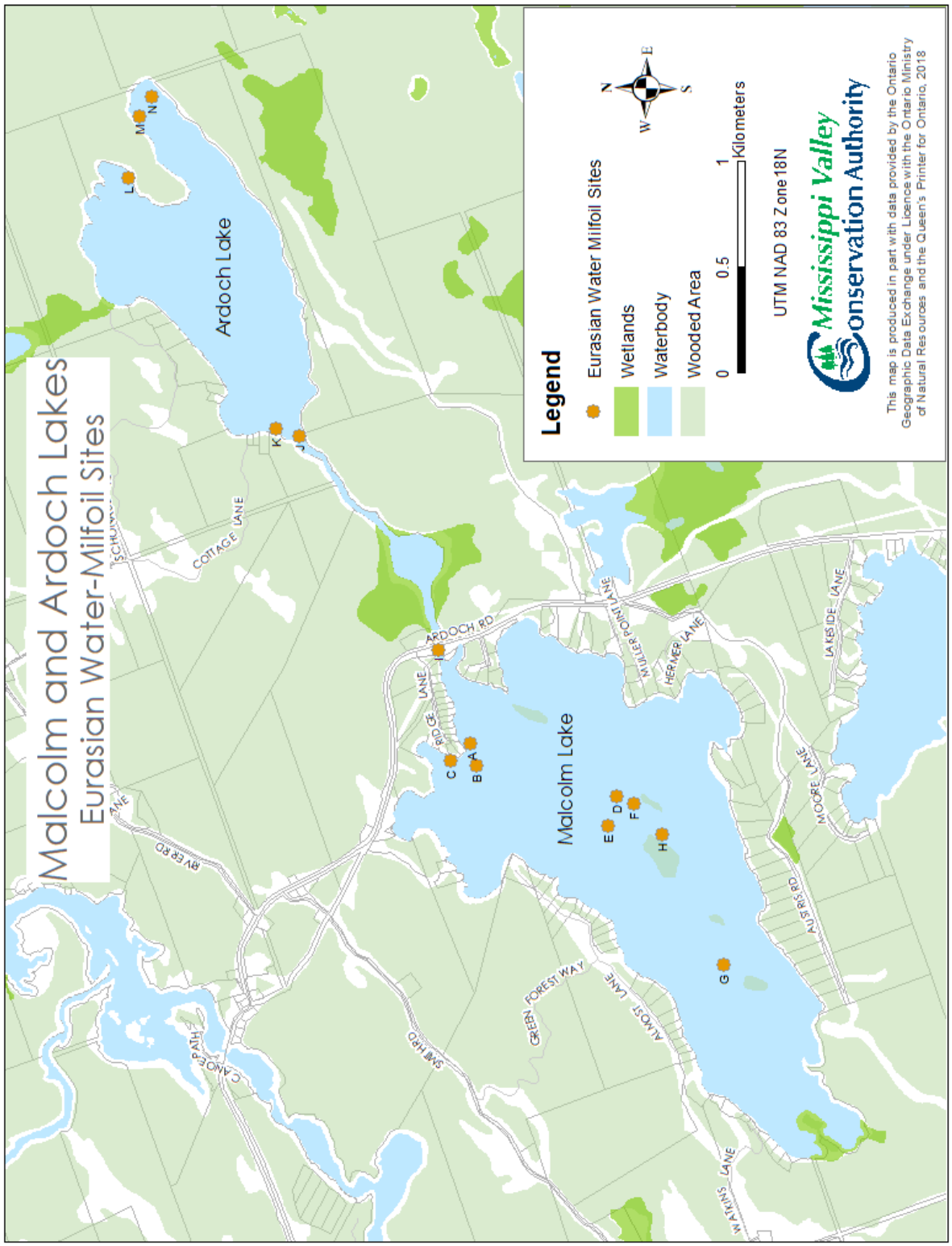
This partnership has allowed the Above and Beyond class at GREC to greatly improve our program as the Malcolm and Ardoch Lake missions have been some of the most challenging. This has allowed us to improve our problem- solving skills taking into account adaptations for flights over large bodies of water. Our program as a whole has benefited from this partnership. Personally, it has been beneficial as I was allowed to take a leadership role on the missions. I have gained many skills by working through stages in the project- from start to finish (though I am aware it is not finished yet). I know this partnership has not only improved the program but myself as well.

I hope that the data provided in this report provides the information MALLA requires to move forward with the EWM control project. I look forward to your comments and further answers that I may provide.

Sincerely,
Ryleigh Rioux

Above and Beyond
Granite Ridge Education Centre
Sharbot Lake
Ontario
K0H 2P0

6.0 EURASIAN WATER MILFOIL SITES on MALCOLM AND ARDOCH LAKES (2018)



MALCOLM LAKE

Site	Location Description	GPS Coordinate	GPS Coordinate	Longitude	Latitude	Depth (finder is registering to the top	Size Comments
A	North shore parallel to Ridge Lane	N4454.534	W07653.329	44.9089	-76.88882	4.7'-6.9'	1500'longX50' wide
B	Towards first island	N4555.187	W07653.472	44.91978	-76.8912	6.7'-7.2'	20'X20'
C	Along shoreline at Reed's and around into bay	Close to shore	Close to shore			3'-6'	3'X12' potentially can be pulled
D	West of E	N4454.828	W07653.569	44.9138	-76.89282	5'-9'	50'X30'- dense
E	Middle of the lake- north of two islands	N4435.112	W0765.318	44.5852		6'-7'	300'longX 60' wide, very dense
F	Near edge of island	N4454.784	W07653.595	44.91307	-76.89325	6'-7'	Scattered 4 sections each 10'X 20'
G	West end of lake near the last island	N4454.541	W07654.169	44.90902	-76.90282	6'-7'	3 clumps, scattered
H	South side of big island	N4454.708	W07653.703	44.9118	-76.89505	Mostly 4'	10'X10' * good potential for mat placement
I	Boat launch	N4455.291	W07653.059	44.92152	-76.88432	3'	A few single stocks as you approach launch, then intermixed with native

6.2 EWM DATA 2018 ARDOCH LAKE

ARDOCH LAKE

Site	Location Description	GPS Coordinate	GPS Coordinate	Longitude	Latitude	Depth	Size Comments
J	Mouth of river	N4455.658	W07652.298	44.92763	-76.87163	4'-5'	Starts in river, then 600'X90'- dense
K	North side in front of Schonauers	N4455.719	W07652.276	44.92865	-76.87127	10'-15'	Clumps spread 200'X20'
L	Near Lindeggers, east end of lake on north side	N4456.112	W07651.385	44.9352	-76.85642	7'-8'	Starts near exposed log, 225'X120' close to the bottom
M	East end of lake approaching sand beach-north side	N4456.087	W07651.159	44.93478	-76.85265	6'-10'	Some scattered, then dense mass 450'X 40'
N	East end of lake near sand beach, south	N4456.055	W07651.089	44.93425	-76.85148	6'-8'	Dense mass 180'X90'

7.0 EWM Report 2018

MALLA REPORTS ON EURASIAN WATER MILFOIL (2018)

The Lakes Stewardship Committee has experienced an overwhelming year of challenges. Some aspects of the Lake Plan implementation will be on hold until we find some control to the EWM crisis. At our MALLA events (starting with June AGM, July Bass Derby and our August Corn Roast) members of the Stewardship Committee made presentations and gave demonstrations about the removal of EWM. We have some rakes, cultivators, sample scoops and mesh bags for safe removal of EWM when members tackle their own dock and beach areas. Support from the membership has been heart-warming! LSC recognized that the control issue is far beyond our lakes capabilities and the Township needed to join the action plan.

The presentation by student Ryleigh Rioux at the AGM clearly indicated the ability of monitoring the EWM through the drone program "Above & Beyond". The baseline data from 2017 will allow comparison with re-mapping in the fall. The amount and quality of the data far exceeds what we could have achieved with previous methods. Our preliminary mapping to provide GPS co-ordinates was a positive step in the plan. These maps are available on the website. Mapping in October produced videos that clearly show the rapid expansion of EWM in both lakes. Further examination of the maps will happen this fall and winter. We have the ability to isolate sections of the mapping and produce photos as needed, but it is a time-consuming process as there are approximately 800 photos in any mapping grid.

MALLA's presentation at the August 24th Council meeting received immediate attention with resolutions to support the requests. (Copies of the Resolutions area available on the website). Many follow-up aspects are underway, with many more yet to be completed.

1) As a result of our education session with the Township, we are applying for grants to obtain materials. The Township will decide in their 2019 budget deliberations if they will donate $10000 toward the hiring of an intern who will specifically research EWM for the Township. A grant would be submitted with Watersheds Canada as the lead organization to host the intern. If Watersheds Canada becomes a partner, there will be the opportunity to receive a charitable receipt for donations made by individuals. MALLA members are anxious to help financially if they cannot be a labourer.

2) MALLA has been asked to identify signage that would be appropriate for each of the public boat launches in the township. The Stewardship Chair requested signage from FOCA to match the “Clean, Drain, Dry Your Boat” sign that we have at our boat launch. FOCA responded positively and forwarded signs for each of the Township boat launches. A more specific sign has been designed and forwarded to the printers to determine production costs. The Township will consider this additional sign during their budget deliberations.

3) MALLA was asked to determine the location and feasibility of installing boat wash stations in each Ward of the Township. At this time, it is MALLA’s opinion, there are not suitable water or hydro systems in place to be able to recommend sites. Cost will be prohibitive.

4) MALLA has begun the planning for work permit application(s) to address other areas of our lakes in the spring of 2019. Property owners are still encouraged to hand-pull any EWM that you can from your shoreline and beach areas as you do not need a permit to remove EWM in this manner.

5) Mississippi Valley Conservation Authority will be providing tools to measure throughout the year, the dissolved oxygen levels on Malcolm Lake and when feasible on Ardoch Lake. Fish species may be in jeopardy this winter which would be a shame when the walleye reproduction with the new spawning beds has proven to be successful.

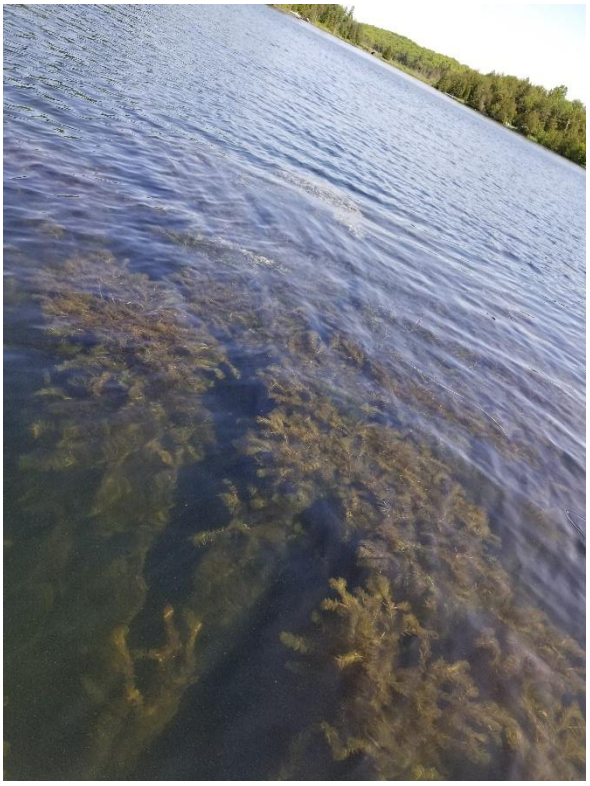
6) LSC is working closely with the drone deploy program “Above & Beyond” to improve resolution of vegetation mapping photos. This fall, polarized filters were added to the camera lens. We are looking for ways to make the EWM vegetation distinct; it is easily identifiable in the recent videos.

7) The Stewardship Chair is working with the township staff on a grant application to TD Bank “Friends of the Environment”. We hope to have the submission ready in November.

The FOCA grant component for our pilot project at the mouth of Ardoch Lake happened on September 23rd. A trial demonstration was undertaken the week before at Martin’s beach area. This pre-planning strategy proved to be a wise move as we discovered how the burlap handled when wet, what apparatus we would need to design in order to dispense it from the roll, how much stone would hold it down, how to fasten the rebar so we could recover it and who would do each of the tasks. We had planned to have this burlap laid in June, however, MNRF did not give a work permit. What we did receive on Sept.20th was a Letter of Authority granting MALLA permission to do a restricted project. Thanks to 12 volunteers a small section was covered with burlap and held with riverwash stones. It will be spring before we can examine the burlap area and make our recommendations. Since we are hopeful of positive results, MALLA will proceed with another work permit application for 2019.

EWM SAMPLES

Ardoch Lake



Malcolm Lake

Sept. as it grows out of the water

PLANNING SESSION FOR BURLAP LAYING

Preparing the burlap (49 lbs. per roll) ground crew

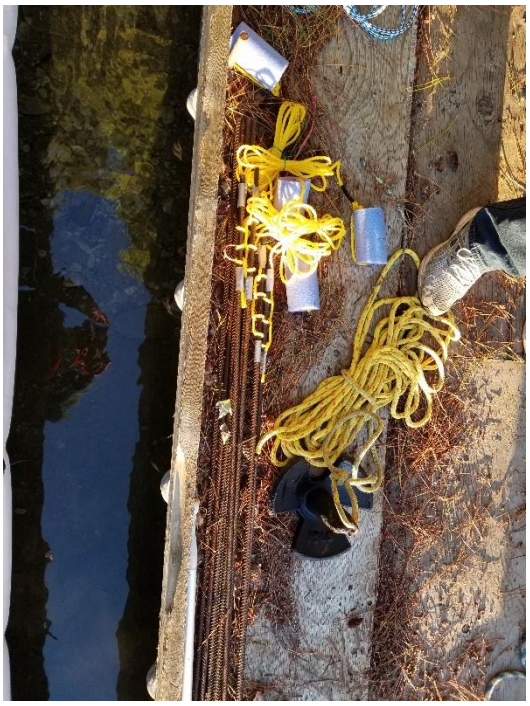
Glen Fowler and Don Martin relaying info to

Discussion of how to dispense from a barge

Apparatus made by Don M to dispense burlap

ARDOCH LAKE PILOT PROJECT Sept 23/2018

Early morning planning huddle



Plan B – new strategy to remove the rebar

Preparing materials and reviewing jobs

All systems go!

Barge is anchored and boat ready to unroll burlap

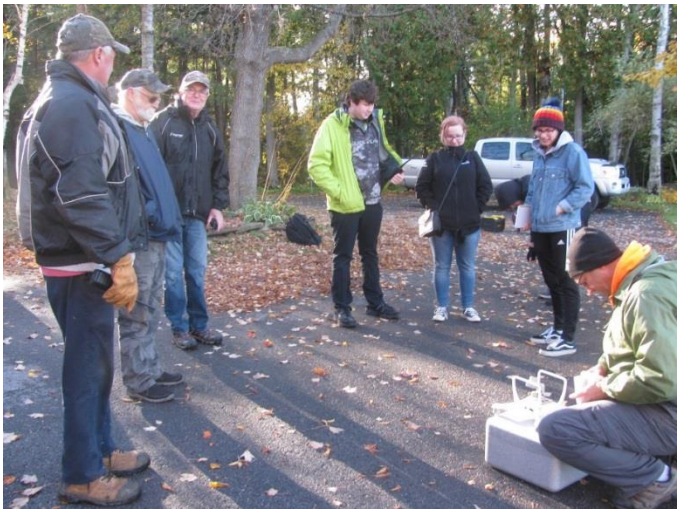
Unrolling the burlap

Keeping the burlap stretched

Rope and float to keep track of the rebar for easy pick up

DRONE MAPPING IN OCTOBER 2018

Prior to the drone deploy day, styrofoam buoys were placed in both lakes for drone mapping. It allows you to recognize the target areas on the base camera as the drone flies. Announcements were provided to lake users and property owners two weeks prior to flight. Extra boats were posted on the lakes to ensure no interference and for safety reasons.



The drone team arrives by 9 a.m. Weather looked promising.

Members of the program have specific jobs. Ryleigh is helping to get the drone ready for a test flight to assess conditions before the mapping begins.

Test flight by Wade Leonard

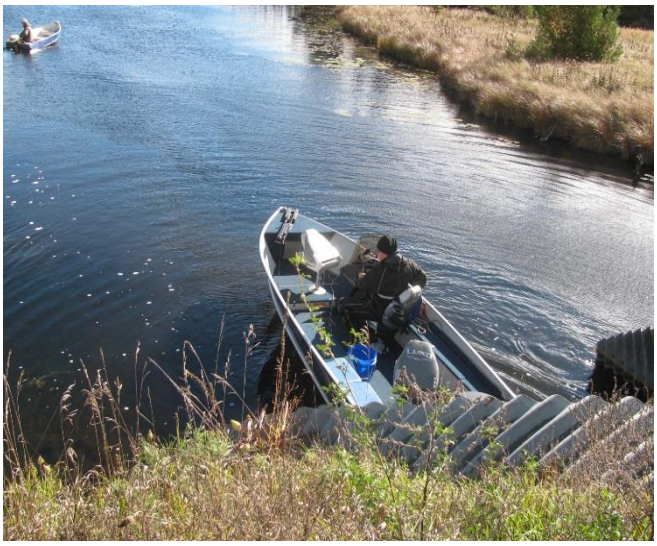
Drone returning to launch site

Wind and sun conditions to be checked

Indoors to check the footage and make decisions about settings for resolution and wind factor. Ryleigh making notes to share. Phil discussing changes with Riley#2 about wind and wave factors. Hannah in the background is on a teaching placement at GREC. Above & Beyond is new to her.

As we go to Ardoch Lake, there is a rain shower and we have to abort for 20 minutes. Back in business and boats are heading to Ardoch Lake for the first flight.

Boat used for launching



Two boats used for observations/monitoring

Ground crew waiting at culvert between the lakes. Ryleigh and Phil have communication radios. Riley#2 has test drone and gathering amazing footage of river and Mud Lake…until his drone loses communication and goes on its own along the river to Ardoch Lake. It was spotted by the launch crew, but they were in the middle of flight recovery and unable to chase it down. It passed by them within reach!

Returning to Malcolm Lake for shoreline mapping

Checking the boat motors you will find EWM attached

Boats in place for mapping on Malcolm. Wind has increased significantly. Sunshine is affecting photos on return passes. Settings have to be adjusted on the drone. A “fail” message shows on the monitor but Mr. Leonard can see great imagery on the screen. When he checks that evening, he finds that the mapping would not upload. He returns to Malcolm Lake on the Saturday morning to re-do a segment with video. After examining it indoors, the video was downloaded to a USB stick for MALLA to use. Fall mapping is complete!

8.0 MALLA PROJECT_CARLETON

Summary of Carleton participation in MALLA project

Background:

The near-shore littoral zone of lakes is the most biodiverse and productive region of a lake, providing important habitat for numerous fish species and other animals. It is also the region most used by people (e.g. swimming, fishing). *Myriophyllum spicatum* is an invasive aquatic plant that forms very dense beds that reduce littoral habitat quality and can become a nuisance to lake users by hindering recreational activities (e.g. swimming, fishing, boating). In an effort to maintain the quality of near-shore habitat and the recreational value of lakes, controlling *M. spicatum* has become a goal of a number of conservation authorities and lake associations. One possibility for controlling dense *M. spicatum* beds is the use of a biodegradable benthic barrier (i.e. burlap) to prevent *M. spicatum* growth and establishment. However, few studies have examined what impact these benthic barriers have on overall littoral habitat quality and whether the use of these barriers could have undesirable negative effects on fish habitat or the littoral community. **The objectives of this project are to assess the use of a biodegradable benthic barrier as a control of dense *M. spicatum* beds and examine what impact(s), if any, the use of these benthic barriers have on aquatic habitat.** Specifically, our role in the Malcolm and Ardoch Lakes Landowners' Association (MALLA) project will be to quantify how benthic barriers alter the physical (light, temperature), chemical (dissolved organic carbon, phosphorus) and biological (algae, invertebrates) structure of Malcolm and Ardoch Lakes.

Methodology:

Dense beds of *M. spicatum* will be controlled with an experimental burlap sheet that will be acquired and applied to the lake bottom by MALLA. An equal sized region of the lake with similar aquatic plant composition will be marked off as a control site for comparison to the treated region of the lake. To examine the effectiveness of this benthic barrier in controlling dense *M. spicatum* beds before the experimental mat is applied, macrophyte biovolume and community composition will be quantified in both the experimental and control regions of the lake. These observations will be coordinated and compared with remotely sensed drone data acquired by students at Granite Ridge Education Centre.

At both the control and experimental sites, light and water temperature changes will be quantified using data loggers, and dissolved organic carbon and total phosphorus will be measured in triplicate on a monthly basis over the Spring to early Fall (May-September; total of 5 sampling visits). Algal biomass, zooplankton abundance, and benthic invertebrate communities will be quantified during the summer, before and following treatment with the benthic barrier using appropriate field methodologies.

Expected results:

Results of this proposed field study will provide some of the first empirical evidence for the effectiveness of large scale biodegradable barriers in controlling the highly invasive aquatic plant *M. spicatum*. Furthermore, this study will also examine what impact, if any, these benthic barriers are having on other important components of aquatic habitat, including light and temperature, nutrient concentrations, algal biomass, zooplankton abundance, and benthic invertebrates. These data will help lake users and managers across much of Canada better develop management plans for this invasive species and where appropriate take management actions to ensure healthy and functional lake ecosystems.

Project Schedule:

Sampling will commence in May 2019 with monthly site visits to establish background conditions in the lake. The burlap mat will be deployed by MALLA according to their own schedule. Following ice-out in the spring of 2020, sampling will resume as the aquatic plants begin to grow, providing an initial measure of inter-annual effectiveness of the mats. The project will be completed in September 2020.

9.0 SUMMER STUDENT TECHNOLOGY PROFILE FOR NORTH FRONTENAC TOWNSHIP

SKILLS:

- Experience or familiarity with all stages of data collection via drone
- Planning drone mapping missions over water (including mission pre-flight documents)
- Recovering data
- Uploading data and analyzing orthomosaics
- Production of plant health and choropleth elevation maps
- Experience working with drone in proximity of airports
- Demonstrated knowledge of Transport Canada drone regulations
- Experience or familiarity with data collection and measurement tools in online subscription software (specifically the Drone Deploy Program)
- Experience or familiarity with integrating map tiles into ArcGIS online
- Experience or familiarity with Microsoft Excel and data sets
- Interpersonal skills with ability to work as part of team
- Effective oral and written communication skills (public speaking skills are an asset)
- Ability to follow directions from supervisor(s)
- Effective time management skills

The successful candidate will be required to:

- To plan and execute drone missions over water
- Recover data and analyze the data via Drone Deploy Program
- Manage data sets and communicate frequently with community and academic partners
- Work as a highly motivated, academic team member
- Meet timelines

10.0 BACKGROUND PAPER- DIVER ASSISTED SUCTION HARVESTING

Diver Assisted Suction Harvesting (DASH)

The DASH system is an emerging and evolving method to efficiently transport hand harvested aquatic plants to the surface. For the past several decades, DASH systems have been used successfully in New Hampshire, Maine, Vermont, Connecticut, New York State, Michigan, and Wisconsin. There are no known DASH systems in Ontario.

DASH is not bottom dredging. Dredging is the physical removal of sediment from the bottom of the lake; it is rarely used for aquatic plant control as it is costly and has a high environmental impact. As practiced as per government directions, suction harvesting is not considered dredging as the aquatic plants are removed by hand and sediment removal is incidental (sediment attached to roots) to plant harvesting.

"DASH utilizes a similar suction device such as suction dredging, but the device (suction hose) is solely used to transport hand-picked target species by a diver to the surface, without the diver surfacing with the target species." *Waterway protection Mechanized aquatic plant management. Wisconsin Department of Natural Resources.*

DASH is not used to directly harvest aquatic plants directly from the sediment. "Diver assisted suction harvesting means a control activity where aquatic plants are pulled and removed from the sediment by hand and fed into a suction nozzle. The suction nozzle must not be used to directly move vegetation from the benthic sediments." *Aquatic Nuisance Control General Permit, Vermont Agency of Natural Resources, Department of Environment Conservation.*

The DASH system is an evolving method to efficiently transport hand harvested targeted aquatic plants to the surface. Instead of divers repeatedly swimming to the surface to dispose of collection bags filled with harvested plants, hand harvested vegetation is directed by the diver into a suction hose which rapidly conveys the plant material to a surface work platform such as a barge or a pontoon boat.

Once harvested plants are transported by suction hose to the surface work platform, the plant biomass is discharged onto a sorting table, into mesh bags or screened bins where the water is separated from the plant biomass. EWM plant biomass and sediments imbedded in the plant's root ball and runners are trapped in a filtration screen; the water is returned to the waterbody. The separated plant biomass is transferred to shore for disposal inland in a compost pile.

The DASH system is a more efficient delivery system to transport harvested material to the surface. The most significant expense of hand harvesting invasive aquatic plants is the cost of contracting commercial divers in Ontario. Current Ministry of Labour regulations require a minimum of three certified divers for each project. With the DASH system, divers spend less time on the surface and more time at the bottom harvesting targeted plants. Plant removal rates vary from approximately 0.25 acres per day to one acre per day depending on plant density, sediment type, and diver proficiency.

With the DASH hand harvesting system, targeted plants (e.g. EWM) are accurately removed while leaving native species untouched.

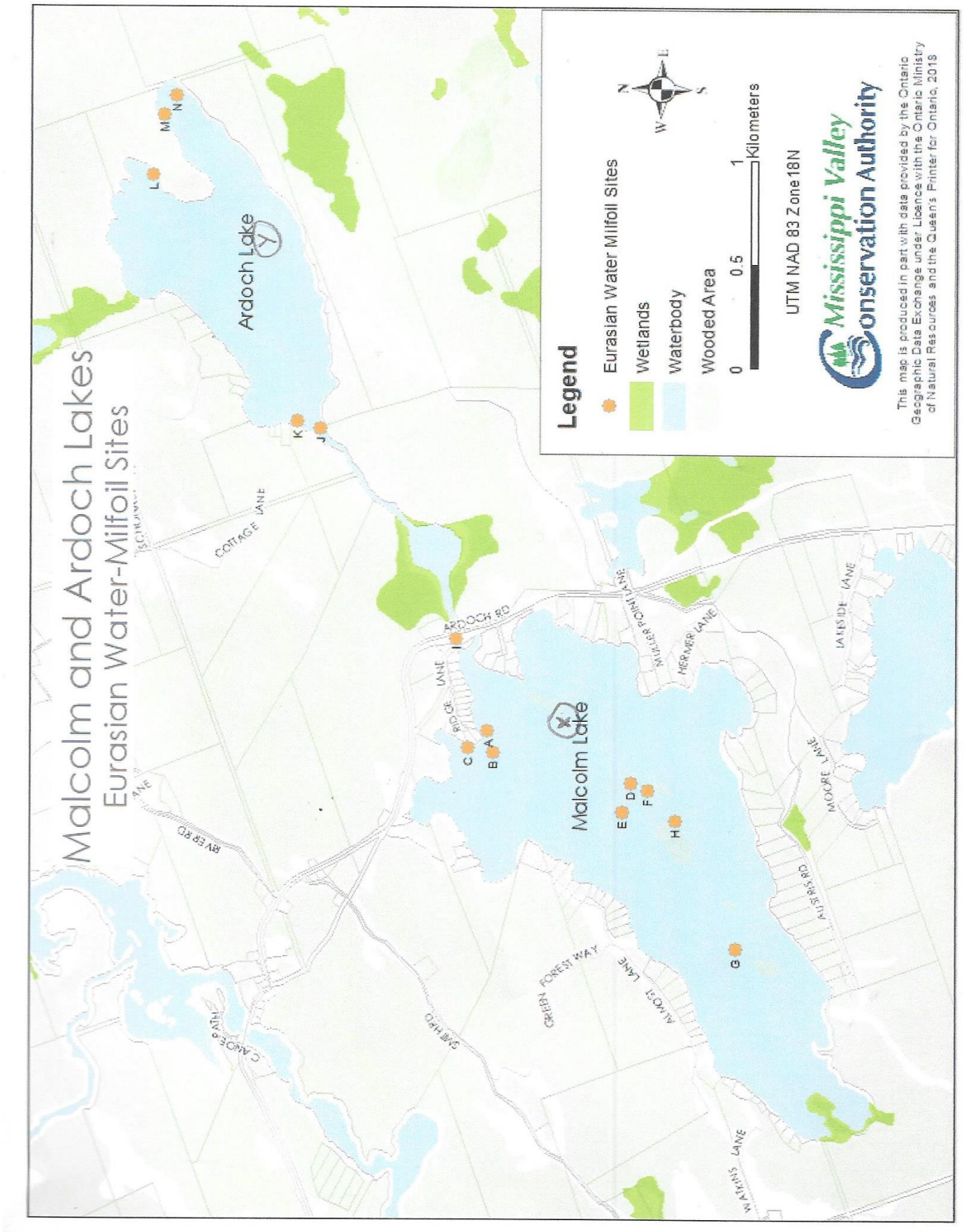
Diver Assisted Suction Harvesting (DASH) (continued)

EWM has been reported through the Early Detection and Distribution Mapping System in 54 locations in Ontario including the regions of Sault Ste. Marie, Parry Sound, Wiarton, Lake Couchiching, Prince Edward County, St. Lawrence River, and the Kawartha Lakes. Hybrid milfoil is wide-spread in Lake Scugog. Local regional EWM infestations exist in Glouchester Pool, Six Mile Lake, and Penetanguishene Harbour. These sites could possibly make use of the DASH system particularly in marinas, resorts, species at risk habitat, and municipal infrastructure (e.g. water intakes, etc.), parks, and boat launches as an alternative to mechanical harvesting, aquatic herbicide treatment, and other control methods.

(Courtesy of Farlain Lake Community Association p.42-43 of

Farlain Lake Integrated EWM Management Plan 2019-2021)

11.0 DISSOLVED OXYGEN TEST SITES (2019)



Dissolved Oxygen Test Sites on Malcolm Lake: B, X, F on Ardoch Lake: M,Y,J*pilot site

YSI SUMMARY OF DATA PROVIDED BY KELLY STILES, AQUATIC BIOLOGIST, MISSISSIPPI VALLEY CONSERVATION AUTHORITY

Site Name	Depth (m)	Date	Time	°C	mmHg	DO %	DO mg/L	SPC-uS/cm	TDS mg/L	pH	TNTC FNU	TSD
B	3m	01/26/2019	3:23:04 PM	3.9	741.0	77.8	10.19	317.8	206.590		223.5	0
B	3m	11/02/2019	6:09:18 PM	4.1	748.7	50.0	6.53	292.1	189.866		30.5	0
B	0.1	09/03/2019	5:43:35 PM	1.9	745.8	49.6	6.86	232.6	151.177	8.04	1.7	0
B	1	09/03/2019	5:45:43 PM	3.7	745.6	31.1	4.11	244.0	158.577	8.07	2.3	0
B	2	09/03/2019	5:54:54 PM	3.0	745.5	62.0	8.35	229.3	149.070	7.58	1.9	0
B	0.1	26/03/2019	3:59:18 PM	3.8	746.7	53.0	6.97	230.7	149.984	8.08	1.6	0
B	1	26/03/2019	4:00:45 PM	4.5	746.7	46.5	6.02	247.6	160.931	8.08	3.6	0
							Average	256.3	166.6	8.0		
							Max	317.8	206.6	8.1		
							Min	229.3	149.1	7.6		
							Count	7	7	5		

DO concentration and % saturation were lower on March 9 than March 26.

Concentration and % saturation numbers do look low but still reasonable.
Not sure why concentration is so low at March 9 at 1m and then goes back up at 2m depth.

Site Name	Depth (m)	Date	Time	°C	mmHg	DO %	DO mg/L	SPC-uS/cm	TDS mg/L	pH	NN(FNU	TSS mg/L
F	2.5m	#########	6:22:22 PM	5.2	749.0	17.9	2.27	272.4	177.057		1.1	0
F	0.1	#########	6:10:06 PM	3.2	745.3	71.1	9.52	230.1	149.577	7.48	2.0	0
F	1	#########	6:11:49 PM	4.0	745.2	43.9	5.75	242.0	157.330	7.73	1.6	0
F	0.1	#########	4:23:50 PM	4.0	746.6	51.9	6.80	239.0	155.331	7.48	1.6	0
F	1	#########	4:26:56 PM	4.7	746.6	27.1	3.48	251.4	163.416	7.84	1.5	0

Average	247.0	160.5	7.6
Max	272.4	177.1	7.8
Min	230.1	149.6	7.5
Count	5	5	4

Can see that DO concentration and % saturation decreased from March 9 to March 26

The deeper readings do look lower than a prefered 6mg/l. What is different about this site?

Site Name	Depth (m)	Date	Time	°C	mmHg	DO %	DO mg/L	SPC-uS/cm	TDS mg/L	pH	NTU FNU	TSS mg/L
X	3m	######	6:15:31 PM	5.2	749.0	24.2	3.06	299.4	194.627		2.0	0
X	0.1	######	5:59:48 PM	4.5	745.3	17.2	2.22	250.8	162.991	8.15	2.3	0
X	1	######	6:01:42 PM	4.9	745.3	5.3	0.67	263.5	171.300	8.16	2.4	0
X	2	######	6:03:07 PM	5.2	745.4	3.7	0.47	347.9	226.159	7.88	313.9	0
X	0.1	######	4:09:07 PM	3.9	746.8	55.5	7.30	238.5	155.032	7.99	1.6	0
X	1	######	4:10:25 PM	4.3	746.8	46.4	6.03	243.6	158.330	8.08	1.8	0
X	1	######	4:10:26 PM	4.3	746.8	46.4	6.03	243.6	158.320	8.08	1.8	0
X	2	######	4:13:18 PM	4.8	746.6	18.3	2.34	257.3	167.267	8.18	2.5	0
X	3	######	4:16:13 PM	5.4	746.8	4.2	0.52	378.0	245.668	7.57	697.5	0

Average	280.3	182.2	8.0
Max	378.0	245.7	8.2
Min	238.5	155.0	7.6
Count	9	9	8

Concentrations and % saturation look low when compared to other sites in the lake.
It looks like there was some improvement from early March to later March.

Site Name	Depth (m)	Date	Time	°C	mmHg	DO %	DO mg/L	SPC-uS/cm	TDS mg/L	pH	FNU	TSS mg/L
J	1.5m	#########	12:42:32 PM	2.4	739.3	78.0	10.67	216.5	140.700		1.7	0
J	0.1	#########	5:32:26 PM	1.7	745.9	76.5	10.67	218.1	141.767	8.43	1.7	0
J	0.1	#########	3:47:42 PM	2.4	746.8	80.7	11.02	207.7	134.980	8.68	1.8	0

Average	214.1	139.1	8.6
Max	218.1	141.8	8.7
Min	207.7	135.0	8.4
Count	3	3	2

DO concentration and % saturation fairly high and consistent between visits.
Only a surface reading was done at this site each time in March as the probe would not go lower

Site Name	Depth (m)	Date	Time	°C	mmHg	DO %	DO mg/L	SPC-uS/cm	TDS mg/L	pH	NTC FNU	TSS DEP m
Y	4m	#####	12:33:36 PM	3.5	739.5	75.3	10.00	212.9	138.377		1.4	0
Y	0.1	#####	5:18:36 PM	1.7	745.8	82.0	11.43	208.1	135.253	8.81	1.6	0
Y	1	#####	5:19:56 PM	3.2	745.7	77.5	10.38	211.2	137.282	8.49	1.5	0
Y	2	#####	5:21:07 PM	3.3	745.7	74.1	9.88	213.6	138.824	8.67	1.4	0
Y	3	#####	5:22:04 PM	3.5	745.7	71.3	9.46	215.0	139.722	8.79	1.4	0
Y	4	#####	5:23:06 PM	3.5	745.8	69.0	9.15	216.5	140.703	8.88	1.4	0
Y	4.5	#####	5:24:24 PM	3.7	745.9	64.8	8.56	218.9	142.288	8.93	2.0	0
Y	0.1	#####	3:25:30 PM	2.3	746.8	79.9	10.96	185.9	120.850	8.95	1.6	0
Y	1	#####	3:26:50 PM	3.3	746.8	76.7	10.24	211.0	137.172	8.68	1.5	0
Y	2	#####	3:28:02 PM	3.7	746.7	71.6	9.45	214.6	139.463	8.81	1.5	0
Y	3	#####	3:29:15 PM	3.7	746.7	68.8	9.09	217.1	141.094	8.97	1.4	0
y	4	#####	3:30:25 PM	3.6	746.8	66.8	8.84	218.8	142.201	9.06	1.4	0
Y	4	#####	3:30:26 PM	3.6	746.8	66.8	8.84	218.8	142.203	9.06	1.4	0
Y	5	#####	3:31:33 PM	3.7	746.8	60.9	8.05	220.7	143.475	9.06	1.4	0
Y	6	#####	3:32:57 PM	3.7	746.8	56.8	7.49	222.3	144.479	9.06	1.5	0

Average	213.7	138.9	8.9
Max	222.3	144.5	9.1
Min	185.9	120.9	8.5
Count	15	15	14

Concentrations and % saturation look good and fairly consistent across the samples.

THE END