Eurasian Watermilfoil in Lake Leelanau
Report on Field Activities in 2020

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Executive Summary

Approximately 4.3 acres of Eurasian Watermilfoil (EWM) were targeted and eradicated on Lake Leelanau using a combination of control techniques. Benthic barriers were used over the largest and most dense EWM beds using innovative deployment techniques which ensured efficient, accurate and secure placement. Monitoring of benthic barriers throughout the field season by scuba divers confirmed that the anchoring and weighting methods used were effective in securing barriers. Diver-assisted suction harvest (DASH) and hand pulling were highly effective for controlling smaller infestations and for "clean-up" around the edges of the barriers used and were major components of the EWM control strategies used in Lake Leelanau. Although further evaluations are needed, the multi-pronged approach of using benthic barriers in conjunction with other strategies was a highly efficient and effective means to control the spread of EWM in Lake Leelanau.

Introduction

Eurasian Watermilfoil (EWM) was confirmed in Lake Leelanau in the summer of 2019. During 2019, eleven discrete infestation sites were discovered and described. Collections of EWM were taken at each of the sites for genetic analysis. This analysis determined that there was at the time, no *hybrid* EWM (e.g. Eurasian watermilfoil which had cross bred with native milfoil) in Lake Leelanau.

During the fall and winter months prior to the 2020 field season the Lake Leelanau Lake Association (LLLA) took steps to bring the newly discovered infestation under control using an integrated approach that employed non-chemical techniques. More specifically, the following actions were undertaken:

- The LLLA and the Grand Traverse Band of Ottawa and Chippewa Indians (GTB) entered into a partnership to develop and fund a plan to bring EWM under control, restore native vegetation to EWM sites and conduct research.

- Restorative Lake Sciences (RLS) was hired to conduct a baseline survey of the entirety of Lake Leelanau, and to locate and map EWM and other invasive plants.
- GTB and LLLA developed and adopted a Management Plan that outlined an integrated approach to bring EWM under control using benthic barriers, DASH diving, and hand-pulling under the direction of GTB's Inland Policy Biologist Dan Mays and LLLA Lake Biologist Brian Price.
- The partners applied for grants and ultimately received funding to implement the Management Plan over a three-year period.

The adopted Management Plan describes the nature of the threat and lays out a comprehensive long-term strategy to achieve the following goals:

1. **Bring EWM under control in South Lake Leelanau and maintain that control indefinitely;**
2. **Prevent introduction and spread of EWM to North Lake Leelanau;**
3. **Employ a combination of physical control techniques that can be carefully evaluated and documented to help guide future**

control effort and assist other lakes in their implementation of control measures for EWM;

4. **Determine the ecological impacts to native plant and animal communities from the control techniques employed over several years; and**
5. **Explore the re-establishment of native plant communities during and after control measures.**

This report describes what the partners learned from EWM control and research during the 2020 field season and prescribes activities for continued control efforts in 2021 and beyond.

Discussion of Control Techniques

The Management Plan adopted by LLLA and GTB calls for each known site to be treated over three years. The largest sites were to be treated by benthic barrier and subsequently followed up with Diver Assisted Suction Harvesting (DASH). Medium-sized sites or those with extensive native vegetation mixed in with EWM were to be treated by DASH only. Sites that were small and isolated, or that consisted of occasional individual EWM plants, were addressed by hand-pulling by a hired diver.

Adapting control procedures that were employed by Shaw et al. (2016) on Lake Tahoe, each site is considered and treated as a separate infestation. The partners made a 3-year commitment to intensively treat each site in a first year (whether in 2020 or 2021), followed by two more years of maintenance treatment. Assuming that first-year intensive treatment was successful, each of the follow-up treatment years would allow maintenance to occur employing less intensive methods. For example, large sites with intensive EWM beds would require barrier deployment and DASH treatment in the first year, followed by

DASH only treatment in the second year, and if all goes well hand-pulling by a diver in the third year. Careful monitoring and assessment year-to-year is a key component. (A more thorough discussion of treatment undertaken at each site is included in Appendix A.)

2020 presented some unanticipated challenges. First, spring arrived late and new growth of EWM was delayed by several weeks. Visual observations of EWM at most sites, even by divers, made determinations of where barriers would be set and DASH treatment difficult in mid-May. Accordingly, a decision was made to shut down for two weeks, postponing the start of most treatment until the week of June 6. In addition, a shelter-in-place order in response to the Covid 19 pandemic prevented Restorative Lake Sciences from conducting fieldwork to map EWM sites until the week of June 20, and so we were dependent on visual observations from the surface and underwater, along with rake tosses to confirm sites during much of the initial treatment period.

Benthic Barriers

Benthic barriers are basically large opaque tarps that lie on the bottom of a lake. These barriers kill aquatic plants, both target species and any non-target species that may be present, by depriving them of sunlight. Accordingly, they should be used on pure or nearly-pure beds of EWM and it is critical that barriers be deployed with precision.

Two different types of benthic barriers were used on Lake Leelanau. **Manufactured Lake Bottom Blankets** (LBB's) are made of synthetic material, and thus are reusable. Standard sizes are 10ft x 40 ft, held down by 10 ft long pieces of re-rod located in sleeves every 5 feet along the length of the material. They are designed to be easily deployed in shallow water by wading, in deeper water from small boats, or by divers where placement needs to be precise. We ordered 40 LBB's and assembled them prior to the summer field season. **Burlap Barriers** were custom ordered from Dayton Bag and Burlap. Panels of 10oz burlap five feet wide were sewn together to construct barriers that were 40 feet wide and 400 feet long. Each barrier weighed just over 1,100 lbs and was transported by a semi-truck on pallets which were unloaded with a fork lift and stored in a barn until needed. Barrier sizes were chosen based on several factors: (i) the length and width of the larger beds of EWM observed on Lake Leelanau in 2019, (ii) the weight that the boat and a pick-up truck could handle, and (iii) the width that could be deployed from a pontoon workboat with a working deck 20 feet long. Made of biodegradable material, burlap barriers will break down over a period of up to a year. (For more information on costs and sources see Appendix B.)

A standard recreational pontoon boat was stripped down, re-decked, and outfitted in order to be able to create an unobstructed deck space that was a large as possible. (Appendix C)

Lake Bottom Blankets

Lake Bottom Blankets were deployed early in the summer over high-priority known infestations beginning with seven LBB's placed on a medium sized EWM bed just south of the Lake Leelanau Narrows. This site, due to its proximity to the boating channel to North Lake Leelanau, and its protected location on windy days, was chosen for initial treatments with

LBB's. At least four different methods of deployment were used. All of them are workable depending on the setting and substrate.

Individual LBB's were deployed initially by simply dumping them in the lake over location, allowing a diver to unfold and place the barrier. At the Narrows site, a combination of very soft substrate and heavy currents made this method generally unworkable. A second method, anchoring one end of the LBB with a 50 ft line tied to a small trap net anchor, then backing away allowing the LBB to run out over the bow of the boat, was more workable, provided that the anchor was set with precision. A third method, setting the un-anchored LBB over the bow of the boat, simply beginning the set at the moment when the edge of the weed bed passed under the boat, proved most generally successful. In all instances, the key ingredients for success were being able to clearly see EWM beds from the surface, marking their dimensions with small floats ("poolies") that were temporarily deployed, and having nearly dead-calm weather. Any wind at all would get under the edge of the LBB, turning it into a sail, causing us to abandon the effort to set LBB's. In good conditions and good weather, setting a LBB took only 15 minutes. Generally, no additional weight or anchoring was needed, and we did not experience any problems with secure placement over the course of the summer.

Sets of multiple LBBs proved successful over larger beds of EWM. Up to 12 LBBs were tied together in a double wide "gang." Nylon cord

and/or zip ties were used to attach the LBB's together. Such a gang could be up to 240 feet long and 20 feet wide. The size again was limited by the weight our boat could handle. Similar to setting individual LBB's, we first carefully marked the location of the EWM bed, but when setting larger gangs, a "head-line" was set directly over the area we intended to cover, anchored on each end by 50 lb trap net anchors. Once the "head-line" was set, the boat returned to end of the EWM bed, pulled up the head-line, and replaced the line with the "gang" of LBBs. In one instance we loaded and set a 12 LBB gang in the morning, tied onto it, and set an additional 10 LBB gang in the afternoon. In that instance, our crew was able to deploy barriers that eradicated an area of 0.2 acres of EWM in a day's work.

Wider infestations (more than 20ft) proved difficult to cover with Lake Bottom Blankets. We experimented with different ways to orient multiple blankets without overlap or gaps but were not able to develop an efficient solution.

Lake Bottom Blankets were left in for at least 8 weeks, which according to the literature is sufficient to kill weed growth underneath. The LBB's set earliest in the summer were removed in mid-July and re-used on another significant infestation near Otto Road. In all, 17 LBB's were used twice, so in total 57 LBB's were deployed in the course of the summer. The total surface area covered by LBB's thus amounted to approximately 0.5 acres.

Burlap Barriers

Burlap Barriers were much larger that the Lake Bottom Blankets and are biodegradable. To our knowledge no one had ever set such large barriers underwater for the purpose of killing aquatic invasive plants, so we had to invent techniques to deploy the barriers. Methods to hold the barriers in place using anchors and sandbags were adapted based on work by Chadderton and Tucker (2017) in southern Michigan lakes.

Sites for burlap barriers were scouted and marked using multiple small buoys (poolies) a day or two prior to deployment. Since barriers were 400 feet long, we were looking for infestations of EWM that were at least 40 feet wide and running in a relatively straight line along a bank for at least 400 feet. There were two such locations in Lake Leelanau about a mile apart.

Barriers on pallets were loaded onto a truck, transported to a road-end site (Hohnke Road), where a crew of at least four individuals were able to pull the burlap off the truck and unfold it. The boat was brought in as close as possible parallel to the shore. Plywood "grommets" about 5x5" were screwed onto the corners and ends of the burlap barriers to provide a secure spot for attaching corner anchors and the "head-line" anchors. The burlap was loaded onto the boat by 3 volunteers pulling the tarp up onto the boat, and up to 3 other individuals on shore moving the tarp into position for loading. Once loading started, it took no more than 20 minutes to complete.

Burlap Barriers were set using the same modified commercial fishing technique that had been employed for setting "gangs" of LBB's tied together. The head line was set over the middle of the EWM bed, running parallel to the bank, with about 100 feet left over at each end. Once the head-line was set and in position, the boat returned to the approximate location where the barrier set would begin, pulling the line up and across the boat using a buoy that had been attached for that purpose. The beginning location of the barrier set can be

adjusted by simply moving the boat forward or backward along the head-line.

The actual set begins when the center grommet on the end of the burlap is tied on to the head-line, then the boat backs off about 20 feet or so, getting the corners of the barrier out and clear of the boat. At this point a small skiff with an outboard engine is used to pull out trap net anchors in a direction that is about 30 degrees from perpendicular to the head-line. This sets the corners, spreading the tarp to its full width, and anchoring one end. At this point the head-line is cut so it can be replaced by the tarp, and the boat winches itself along the remaining head-line, again replacing the head-line with the barrier.

We had some concern that the burlap would either sink too fast, making it difficult to see how effectively the barrier was being deployed, or worse, it would stay on the surface too long. In our experience the burlap stayed up for only a minute or so before soaking up and sinking to the bottom. Every 80 – 100 feet, we stopped to set side anchors that would hold the barrier laterally in position. Again, these anchors were 20 lb trap net anchors set with a small boat perpendicular to the direction of the head line. On the deep side (12-20 feet) the anchors lines were about 50 ft long. On the shallow side (usually less than 7 feet) they were only about 20 feet long. All lines were nylon so that they would sink and stay out of the way of boaters.

The burlap barrier set ended when all the material was off the boat. The corners were again anchored, and the head line anchors stayed in place to keep considerable tension on the barrier along the length of the set. In good weather a barrier could be set in about 90 minutes. We were able, on two occasions, to return, reload, and set a second barrier in a single day. Altogether, 5 burlap barriers were placed in the lake, covering about 1.8 acres.

Burlap barriers, unlike the LBB's, needed to be weighed down. Because we had extra anchors, we left them in for at least a month or so to provide extra assurance that the barrier would not shift under water. Based on suggestions of Nature Conservancy researchers Lindsay Chadderton and Andrew Tucker, within a few days we bombarded the burlap barriers with sand bags also made of burlap. Because visibility was generally good, we tried to pin down every corner, along with sandbags every 30 or 40 feet along the edges. Occasional sandbags were added to the middle of the barrier. Each barrier, when set, was kept in place with 14 anchors and about 30 sandbags. After a month or so, the anchors were removed for use elsewhere.

Since EWM is killed *in situ* by this method, there is no way to calculate a cost per pound for EWM eliminated. LBB's cost approximately $250 each, while each burlap barrier cost about $1,200. Additional costs include the cost of sandbags, lines, and anchors.

Diver Assisted Suction Harvesting (DASH)

DASH has been employed in multiple lakes to increase the efficiency of hand-pulling of EWM by divers. One or more divers feed EWM into a large suction tube that delivers the plants to a pontoon boat where the water and plants flow into "onion bags." The water runs through the bag mesh, leaving plant material behind. Divers generally are provided with air via a tube rather than free diving with tanks.

Lake Leelanau Lake Association entered into a contract with MTT Dash Divers to conduct 25 days of suction harvesting beginning in October of 2019, with the bulk of this work being done in June of 2020. The Grand Traverse Band contracted with MTT to provide an additional 15 days of suction harvesting work in the late summer of 2020.

Conditions from site to site on Lake Leelanau varied greatly, effecting the efficiency of suction harvesting. Some sites (eg. Site 1, Lake Leelanau Narrows S), had dense concentrations of EWM over a soft, silty, substrate. In these conditions plants pull out easily, but visibility rapidly declines as silt clouds the water. Other sites (eg. Site 14 Otto Road N) had a firm sand or cobble bottom. In such conditions visibility is generally better, but plants are harder to pull. Most sites were somewhere between these two extremes.

DASH is time consuming, laborious, and expensive. But given the goal of eradicating EWM from each treated site in an intensive initial treatment, DASH or hand-pulling by divers is an essential component of treatment. When used in combination with barriers, DASH is used to "clean up" along the margins of benthic barriers. Where barriers are used to quickly cover the most intense and pure stands of EWM, divers must be employed to pull the remaining plants that are "missed." Also, it is typical for large and intense stands of EWM to grade into stands of native plants on the margins, becoming mixed. Hand-pulling by divers in these situations is the only way to remove invasive plants while leaving native plant communities relatively intact.

Over the course of the summer it became evident that a single DASH treatment would not be able to eradicate all plants from any particular site, and multiple visits would be required. For instance, at the Lake Leelanau Narrows S site, seven Lake Bottom Blankets were deployed in May over the most intense

EWM areas. Follow up DASH treatment around the edges of these barriers occurred in late May and mid-June until all visible EWM was removed. By late summer, EWM plants that had escaped detection earlier in the summer had again grown back and were easily visible from the surface. In September, a combination of further DASH diving and hand-pulling again eliminated visible EWM from the site. We can expect that in 2021 and subsequent years we will continually revisit this site, but in each treatment the amount of effort required should diminish.

Medium-sized EWM infestations were addressed by DASH only, including infestations where EWM occurred amongst beds of native plants. In such situations, barriers were not judged appropriate as they kill all plants.

In total, we estimate that DASH diving removed EWM from nearly 2 acres of Lake Leelanau. Large areas could be treated rapidly if EWM was either less dense or scattered amongst native vegetation. In areas of poor visibility or dense stands of EWM, progress was much slower. At four large sites, DASH followed up around deployed barriers, while four additional sites were treated by DASH only. Due to time constraints, two larger sites where barriers were deployed had no DASH follow-up in 2020, and those sites should be very high priority for DASH treatment in 2021.

EWM removed from the lake was composted on farm property distant from water. Each "onion bag" was estimated to weigh about 40 lbs. Most full workdays between 4-8 such bags

could be harvested by the DASH crew. Set-up time at each new site (moving and anchoring boats, transporting and setting the barrier that is required to catch EWM fragments), down time due to equipment malfunctions, and the inevitable weather problems decreased efficiency. In all, approximately 3,500 lbs of EWM was removed from Lake Leelanau via DASH in 2020. Total costs for this service were nearly $46,000, for cost of about $11/lb of EWM harvested.

Hand Pulling by Diver

LLLA employed an experienced certified diver to assist with research work over barriers, to scout sites where EWM was reported by the Restorative Lake Sciences report, and to hand-pull small and scattered sites of EWM.

Annalise Povolo assisted with research work and observations over benthic barriers beginning in mid-July then began to work an average of 4 days each week beginning early in August. Most days she was accompanied either by the lake biologist or by a volunteer.

Efforts were made early on to increase the efficiency of hand-pulling operations by rigging a receptacle for the diver to stuff EWM into, but these efforts were abandoned as Annalise found it easier to simply stuff EWM into an onion bag, periodically bringing the bag back to the boat for disposal.

Hand-pulling has some of the same difficulties that were experienced by DASH crews. Visibility at some sites was poor, causing the diver to try to move frequently to allow time for the water to clear. At other sites, hard bottom made it more difficult to pull entire plants including the roots. Fragments often rose to the surface, where they were collected by the volunteer in the boat. Anchoring the boat so that it was directly downwind of the diver's worksite allowed for capture of the large majority of fragments that were created.

Advantages of hand-pulling include virtually non-existent set-up time. Locations for daily work were often chosen to avoid problems with wind and weather. The diver and/or volunteers would choose to pass up larger sites (documenting location via GPS) if it was judged to take more than a day or so to hand-pull. This method can be highly effective on small infestations.

Hand-pulling was carried out on all or parts of 27 days between July 27 and September 25. EWM was removed in 5-gallon buckets and composted. In all, about 112 buckets of EWM were removed, with an estimated weight of 15lb per bucket, for a total weight of 1680 lbs. The estimated cost per pound of EWM removed by this method was $4/lb.

Discussion of Results

Our fieldwork in 2020 determined that large barriers can be deployed in combination with hand harvesting to kill Eurasian Watermilfoil in Lake Leelanau. Our key observations:

Benthic Barriers

1) Setting barriers requires some specialized equipment, in the form of a modified work pontoon boat and trap net anchors. Professionals or volunteers with boat-handling skills can set barriers with some training.
2) We did not experience any problems with barriers shifting position, rising to the surface with gas build-up, or otherwise causing any problems for boaters or riparian property owners. We did not get any complaints. There were less than a

dozen or so fishing lures that were found while removing Lake Bottom Blankets or viewed in burlap barriers while inspecting the barriers by underwater drone or diver.

3) Use of barriers is dependent on careful scouting and marking of EWM locations. We were able to set barriers with precision once locations were carefully marked by buoys ("poolies"). There is some very limited ability to "wiggle" long barriers to follow an EWM bed that is not quite straight, but in general, deviating more than 10 or 20 feet from the course of the headline was very unlikely.
4) Barriers cannot be used effectively as a stand-alone treatment method. After removal of synthetic barrier material (LBB's) or as biodegradable material breaks down, we are confident that any remaining EWM plants along the margins will re-invade the space covered by the barrier.
5) LBB's appeared to be nearly 100% effective in killing all vegetation they covered. Initial observations would suggest that burlap barriers, by contrast, were not as completely effective. Within a month or so, some small plants, both EWM and pondweeds, were seen growing up through the weave of the burlap, especially near the edges. These new volunteers were sparse, seldom more than a plant or so per square meter. So far, we believe that hand-pulling by divers will be able to remove the occasional EWM plants that grow up through the barrier.
6) Long-term impacts to non-target species are not known at this time (see discussion under Research Priorities.)

DASH Diving

1) DASH diving can be effective, but multiple follow-up treatments will be necessary at any given site.

2) DASH diving or hand pulling will be essential as a complement to the use of barriers in killing larger EWM infestations.
3) The effectiveness of DASH diving and its cost viability would be much improved if methods can be developed to make it more mobile. Set-up times and the complexity of the equipment deployed make this method add significantly to the costs of this method.
4) Impacts to non-target species are very dependent on the expertise of the diver and the visibility in which he or she is working. Based on our observations, DASH can be quite selective if practiced with care and precision.

Hand-Pulling

1) Using skilled divers and volunteers to remove EWM by hand can be a highly mobile, very cost-effective method of control.
2) Because the movement of divers underwater raises clouds of sediment which lead to reduced visibility, engaging multiple divers to work in close proximity is not likely to be very effective.
3) Skilled divers are critical. Cold water, visibility issues and the general spookiness in diving, in addition to the challenges of spending long periods of time in dense weed beds, will probably eliminate most average recreational divers from this work.
4) There is no way to completely prevent generating fragments. More effort to devise and employ volunteers to collect

fragments, or to design a small-scale containment and capture system, could be very worthwhile.

5) The impact to non-target species can be minimal with good training and attention of the diver. Native milfoil species can be difficult to distinguish from EWM in low light and poor visibility. While we did find some small amounts of native milfoil and other native plants amongst the plants removed, the vast majority of the harvested plants were EWM.

Assessment of the results from this work will not be possible for at least several years. Ultimately the effectiveness of this integrated management approach will depend on our ability to follow-up, sometimes over multiple years, until individual infestations are completely eradicated. We believe that great progress was made in 2020, but ultimate success at bringing EWM under control in Lake Leelanau will depend on maintaining a high level of effort, continued flexibility and adaptation of control techniques, and that the rate of spread will not exceed our ability to remove EWM from the lake.

As an additional note for future work, some fairly large infestations went untreated in 2020. Two large sites on the west side of the lake (Site 16 - Billman's beach and Site 17 – Dunklow Farm S) include EWM amongst a rich mix of native plants. Judging these sites inappropriate for barrier deployment, some combination of DASH and hand-pulling may be the only way to remove EWM and enable native plants to repopulate the area. One key may be careful timing of treatment. Rapid growth of EWM as the water warms up in the spring may allow harvest of EWM plants while sparing natives.

Research Priorities

Prior to deployment of barriers, personnel from GTB collected plant and sediment samples at

at locations where we expected to set barriers. Some of those locations ended up receiving barriers, while others ultimately did not. Regardless, these samples, when analyzed will help to establish a baseline for benthic communities in Lake Leelanau. Additional samples near areas where barriers were deployed should be taken in 2021 as well. Sediment and plant samples were also taken after Lake Bottom Blankets were removed at three different locations. No live plants were found at these locations, as expected. Beginning on July 22 (3 weeks after the last burlap barrier was set) and continuing on 8/5, 8/19, and 9/24 sampling was conducted below the burlap barriers in two locations near Gordon's Point. On each sample location a 1-meter square was cut from the burlap, and photos along with vegetation and sediment samples were taken. This sampling should be repeated at appropriate intervals in 2021.

As burlap barriers degrade, plants will re-invade from the edges and as dormant seeds sprout. Carefully documenting this process, and whether it favors EWM and/or what types of native plants should be a research priority. Since controlling EWM and gauging the effectiveness of various barriers is our major thrust, harvesting EWM while setting aside smaller "control" sites would seem appropriate. All such decisions will be made by the Grand Traverse Band biologists along with academic partners, in consultation with EGLE invasive species program managers.

There may be considerable natural variability, year to year, in EWM beds in Lake Leelanau and elsewhere. In Long Lake, careful observation over many years has documented the disappearance of EWM beds without treatment in some locations, along with the sudden re-appearance after some degree of control has been achieved (Dennis Wiand, personal communication). In Lake Leelanau, in an area mid-way between Gordon's Point and Grant's Point, a large bed of EWM observed in 2019 seemed to decline, becoming separated into smaller EWM infestations along with sporadic and occasional strands of EWM. Hand-pulling of these small and scattered infestations was conducted in 2020, but we don't know whether EWM will return in greater amounts in 2021 or subsequent years.

Only visual observations augmented by aerial drone photography exist to document any natural fluctuations in EWM beds. Since these "natural fluctuations" should be intensely interesting to any control program, a major effort should be established to quantify EWM through the use of aerial and underwater drones, and other sensory equipment if possible.

A major goal of the EWM control program is to re-establish native species, especially in areas where barriers were used to kill virtually all plants because of the dominance of EWM. The large areas where barriers were deployed in 2020 provide opportunities to harvest plugs of native plants from elsewhere in Lake Leelanau, relocating them to barrier sites. If burlap barriers have not completely deteriorated over the winter, some transplants could be made through the barrier material. Again, this research should be conducted primarily by GTB, EGLE, and academic partners.

Major questions remain unanswered:

1) Can we establish the long-term effectiveness of an integrated approach to control EWM using barriers, DASH, and hand-pulling? Can we get EWM under control and maintain that control indefinitely, and at what cost?
2) How quickly will plant communities re-invade barrier sites, and what species will be advantaged or disadvantaged?
3) When barriers are deployed, what are the impacts to benthic organisms, and how fast do these communities recover from being impacted by barriers?
4) Can we develop a method of removing EWM from "aquatic gardens," sites where diverse communities of native plants are being invaded by EWM?
5) Can we assist in the re-establishment of desirable native plant communities as a defense against re-establishment of EWM?
6) What are the most effective ways to monitor the lake for new infestations and to document and control any reinvasions? Can aerial and underwater drone technology be employed to make monitoring much cheaper and more effective?
7) Can we prevent re-invasion of EWM and other aquatic invasives through education and the provision of boat cleaning facilities at public boat launches?

Summary

The Lake Leelanau Lake Association and the Grand Traverse Band made great progress in this first year of fieldwork to control EWM in Lake Leelanau by non-chemical means. In all, about 2.3 acres of EWM was treated by barriers, about 2 acres were treated by DASH diving, and an area of less that 0.5 acres was treated by hand-pulling.

We learned that use of both synthetic and biodegradable barriers over dense beds of EWM holds great promise as a potential tool in controlling this invasive plant. Barriers can be deployed at a reasonable cost, by both professionals and trained volunteers, and if correctly deployed they should not pose any major hazard to boaters or other recreational users.

DASH and hand-pulling are essential tools to combine with any use of barriers. Without commitment to comprehensive follow-up with these techniques, barrier deployment with its inevitable impacts to benthic communities, would be inappropriate and not meet the overarching goal of protecting the biological integrity of Lake Leelanau.

Based on what we learned about the use of barriers, it seems apparent that the size, extent, composition, and spatial dimensions of EWM in any lake are key elements in assessing whether barriers might be useful as a control technique. In Lake Leelanau, barriers are most effective where EWM grows abundantly on long straight banks.

While a promising start, it will be several years before we know if we ultimately will be able to bring EWM under control in Lake Leelanau through the use of non-chemical means.

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This work would not have been possible without the steadfast support of the board of directors of the **Lake Leelanau Lake Association**, and especially Tom Hiatt (Board President) and Kathy Birney (Treasurer).

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Lindsay Chadderton and Andrew Tucker, of the Nature Conservancy's Aquatic Invasive Species program made many observations and suggestions that set us off on productive lines of inquiry.

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Volunteers and Staff made important contributions to our work throughout the summer. Some of the volunteers include:

- **Jim Wysor**: always seemed to be available for help in setting barriers and especially in working with our diver
- **Dan Harkness**: especially for help in scouting EWM infestations in both 2019 and 2020 and working with our diver

- **Dennis Wiand**: Dennis volunteered his equipment and expertise with both aerial and underwater drones
- **Josh Jackiewicz and Nate Campbell**: GTB staff members, Josh and Nate were part of the field crew and greatly assisted with data collection, boat operations and benthic barrier deployments.

We could not have accomplished this work without three essential **contractors**:

- **Restorative Lake Sciences**: Dr. Jennifer Jones and crew documented in the size and extent of EWM beds and conducted a full vegetation survey that helped confirm over a dozen new locations of EWM in 2020.
- **MTT DASH Divers**: Mike Smith and his crew not only used their equipment and expertise in DASH, but cheerfully helped scout sites for barrier placement and deployed barriers during late spring and early summer.
- **Annalise Povolo**: Annalise had the "right stuff" to work in difficult conditions and was highly effective in assisting research over barriers and hand-pulling EWM from smaller sites.

Appendix A – Descriptions of EWM Sites in Lake Leelanau

Sites discovered in 2019

Site 1 – Narrows South
First observed: 7-8-19
Location: 44 58.40 N, 85 42.36W
Waypoints: 16, 54 and 55
Robust stand EWM, 5-10 ft depth, about 50yd SW of channel entry. Original estimated extent: 30ft x 70 ft. Highest priority site because of boat traffic on the edge of the Narrows channel.
2019 Treatment: DASH divers on site for 3 days October 8-10. About 500 lbs removed. Diver estimate 50% of total site treated. Visibility good, sand hard-packed so removal slowed.
2020 Treatment: 5 Lake Bottom Blankets were installed on May 20, and 2 more were added on June 9 on the most dense areas. Inspected by MTT divers on 5/21 to check LBB configuration and make sure barriers stayed in location. (See Appendix B.)
The DASH crew returned to the site to pull EWM from near the edges of the blankets in mid-June, finishing when all observed EWM had been harvested. About 300# removed.
In September EWM was observed, probably from low plants that had been missed in the early summer treatment and grew rapidly by late summer. This was addressed by hand pulling and then again with follow-up in September 2020 by the DASH crew until all visible EWM was again eliminated.
Prescription: Follow-up maintenance in 2021 by DASH. Time Estimate: 1 day

Site 2 – DNR Launch North (AKA Laskey)
First Observed: 8-12-19
Location: 44 55.079N, 85 43.431 W about ¼ mile south Hohnke Road
Waypoint: 53
Notes: Small stand EWM, est 100sq ft., 11 ft depth
2020 Treatment: Visited 5/5 by MTT and BP. On 6/9 visited again and decision to DASH only. DASH June 25. No fall follow-up.
Prescription: Follow-up maintenance in 2021 by DASH or hand-pulling

Site 3 – DNR Launch South
First Observed: 8-12-19
Location: 44 5.28N, 85 43.04W About ¼ south of DNR boat launch
Waypoint: LLLA 49
2019 Notes: 9ft water, about 150sq ft.
2020 Treatment: Visited 5/21 but little EWM visible, even with diver in the water. DASH diving as part of treatment for Site 4 in June 2020 (see below)
Prescription: Follow-up by DASH. Time Estimate: 1 day

Site 4 – Willow Point South
First Observed: 8-9-19
Location: 44 54.28N, 85 43.04W Just south of point with large willow, about ½ mile south boat launch
Waypoints: 36,38,52, LLLA 17-19
2019 Notes: Robust stand EWM, about 200sq ft. (In fact stand extends into deeper water, and expands north and south)
2020 Treatment: This site first visited on 5/21 when EWM had not progressed far in spring growth. By June growth was more visible, but mixed with natives, and decision to DASH only.
RLS veg survey indicated additional EWM in rake tosses between Sites 3 and 4. DASH diving started in late June at Site 4, then continued northward for about ¼ mile to Site 3 until visible EWM was removed. Also, from Site 4 eastward into water to 15 ft deep, EWM was discovered and pulled by the DASH crew.
Prescription: Follow up by DASH. Time Estimate: 2 days

Site 5 – Kozelko
First Observed: 8-12-19
Location: 44 53.56N, 85 42.50W. Off Rice Creek
Waypoints: 49,50
Notes: Limited number of individual plants observed mixed with natives, in shallow water (less than 5ft.)
2020 Treatment: Hand-pulled by AP on 8/10. Very limited amount found in original location and scouting revealed a few more strands about 100 ft south. All pulled.
Prescription: Hand pull in 2021

Site 6 – Kelenske Pt
First Observed: 8-12-19
Location: 44 53.25N, 85 42.36 W 100 yd north of Kelenske Pt
Waypoints: 47,48, 56, 91
Notes: Robust stand EWM, 8.5 ft water, 150 sq ft. Sporadic to SW for 50 yds.
2020 Treatment: Marked for MTT and DASHed late June 2020. Many natives in and around infestation, including northern milfoil. Followed up by hand pulling on 8/25 and 8/26 until no more visible EWM.
Prescription: DASH or hand pull in 2021.

Site 7 – Cedar River mouth
First Observed: 8-10-19
Location: around 44 50.49N, 85 45.01W off river mouth
Waypoints: 15, 42

Notes: Individual plants scattered widely between natives and also northern milfoil. Extent not well known. About 7 ft depth
2020 Treatment: BP visited site July 27 but found no EWM plants. Did not spend much time there but assume similar to 2019. No treatment in 2020.
Prescription for 2021: Survey by drone in late spring to gauge extent. Hand pulling of EWM among extensive "aquatic garden" if time permits. Observation only if necessary.

Site 8 – Sanborn
First Observed: 7-3-19
By: Jeff Sanborn and Brian Price
Location: 44 50 03N, 85 43.12W just north of former Sanborn house N of Birch Pt.
Waypoints: 39,40,43,44
Notes: Individual plants, perhaps 20-40, in about 5-7 ft depth, mixed native veg present
2020 treatment: Visited in June by BP and determined to be about same as observed in 2019. Hand pulled by AP on 7/27. About 5 #
Prescription for 2021: Hand pull

Site 9 – Gordon Point and Site 10 – Reed Bed
First Observed: 7-8-19
Location: From 44 54.07N northward for about 2000 feet. About 85 42.34W
Waypoints: 27,28,75,59. LLLA 9-14 and 27, 28 (locations of sampling sites)
Notes: Extensive EWM from 500 ft south of Gordon Pt extending northward for about 2000 feet. 7-12 ft depth. No EWM south of blue-topped boat lift, about 5 houses south of point. Site 9 and Site 10 appeared to be separate in observations from the boat and rake tosses in 2019, but by 2020 they had either filled in to form a continuous stand of EWM or the growth between the two sites was just not easily visible in 2019.
2020 Treatment: EWM was clearly visible mid-May only at northern end of the area, the Reed Bed Site. In May, decision to begin treatment only on this part of site. When visited on June 8 EWM extended from 5th house south of the Gordon Point (same as previous year) to Site 10 (Reed Bed). From Gordon Point southward EWM was mixed with natives, but dominant from Gordon Pt north extending for an estimated 1,200 feet. Estimated 40-70 ft wide at Gordon Point, narrowing to the north. Thickest density in 7-12 feet. Decision to place burlap barriers to south of Reed Bed.

- 10 LBB's in a double wide gang were set on Reed Bed site on 5/22. Growth of EWM in this area was clearly visible by mid-May. The LBB's were removed on 7/14.
- 22 LBB's were place in a double wide gang on 6/8/20 in a nearly straight line with S end off end of Basye Dock. Inner edge in about 7ft, with nearby shoal easily visible. All 22 LBB's were removed on 8/11.

As June progressed, EWM was clearly visible extending well north of the 22 LBB set almost to the location of the 100 LBB set at the Reed bed.

- On 6/15 two large burlap barriers (40' by 400') were set from the north end of the 22 LBB northward to about 100 ft south of the previous 10LBB Reed Bed set.

By late June EWM was easily observed west and adjacent to the 22 LBB set in deeper water.

- On June 30 another burlap barrier was set alongside and immediately west of the LBB's, with a gap of about 0 to 4 feet between the barriers. Care was taken to not set over the LBB's since they would need to be removed, but not the burlap.

Over the course of the summer these barriers were repeatedly checked and sampled. Time did not allow for extensive DASH follow-up. MTT did DASH around the 10LBB (Reed Bed) site in early July, and along the shoal (east) side of the 400' northern burlap barrier, and between the ends of the two large burlap barriers. (See Appendix B.)

Treatment in 2021: This is the largest single infestation of EWM in the lake. Much progress was made in reducing the biomass of EWM at this site. The inability to follow-up with DASH work in 2020 makes this the top priority site for extensive DASH work in 2021. Personal communication from Mike Smith indicates that EWM is fairly continuous off the deep side of barriers, but not extremely dense. Gaps between the parallel LBB's and between the LBB's and burlap near the south end should be addressed in June and again late summer. Mixed EWM and mixed natives extending south from barrier locations should also be addressed.
Time Estimate: 30 days DASH

Site 11 – Grant's Point
First Observed: 7-8-19
Location: From 44 55.40N to 44 55.87N, at approximately 85 42W (from 1st house N Mebert NA to Grants Pt.
Waypoints: 60-64, 57, 101. LLLA 05,06,30,33
Notes: Large and robust bed of EWM, in summer of 2019 appeared nearly continuous with some breaks, stretching about 4000 ft south of Grants point in water ranging from 6-12 ft. Width varied, but up to 50 ft. In 2020, only the northernmost extent of this area was solid EWM, becoming much more sporadic in smaller but intense infestations to the south.
2020 Treatment: Unlike Gordon's Point, where EWM seemingly expanded greatly between 2019 and 2020 (or at least became more visible), the Grant's Point area presented a less continuous EWM infestation in 2020 than seemed to be evident in 2019. Accordingly, decisions were made to only place barriers on the most obvious and continuous EWM that was observed.
Two burlap barriers were set from about 100 feet N of the large white mooring buoy northward on June 19 (Between waypoints LLLA 05 and 06). EWM was thick and contiguous, with a fairly steep bank becoming steeper to the north. With about 700' of barrier set and only 100' still on the boat, native plants became predominant, so a decision was made to cut the barrier off at about 700'. About 50 feet north of the burlap barrier, a fairly narrow but intense EWM infestation was located. The densest part of this was covered with a single LBB on 6/28 and a single additional LBB on 7/14 (Waypoints LLLA 30,33).

The area was DASHed in late September over a 4 day period. MTT cleared EWM from the area extending about 200 yards north from the burlap, which included fairly dense areas interspersed with native plants and sparse EWM. They also worked along most of the shoal edge of the burlap, and around the deeper edge at the north end. MTT also DASHed to about 100 yards south of the burlap barrier, where EWM became more mixed with natives and sporadic.
Prescription: Follow-up treatment by DASH around all of the areas addressed in 2020 and initial DASH treatment in the broken patches of EWM that extend for about ½ mile south. Given the inconsistent observations of EWM extent between 2019 and 2020, allowances should be made for the possibility greater EWM in 2021. Spot deployment of LBB's if practical over dense stands might be beneficial.
Time Estimate: 20 Days DASH, possible hand pulling to south in addition. This southern extension, stretching for more than ½ mile, contained many pockets of EWM. Careful observation and treatment will be necessary.

2020 New Sites

Site 12 - Mebert Shoal
First observed: 6/14/20 Also observed by RLS survey
Location: 44 54.58N 85 42.54W
Waypoints 58, 70-73. LLLA 08
Notes: Intense EWM stand appears nearly pure, about 50 wide and 100 ft long on a line between Hohnke Rd and Gauthier trailer site, off edge of shoal.
Treatment in 2020: Set Burlap fragment, about 40 x 80 ft, on core of area on 6/29. Only anchored on corners, sandbagged. DASHed in September until no visible EWM remaining.
Prescription: Repeat DASH in 2021. Estimated Time: 1 day

Site 13 - Otto Road
First Observed: RLS crew mapped as single larger site during fieldwork in late June 2020. Confirmed by BP and DH as medium size, dense, about 50 x 100 feet solid EWM. 6ft of water. Source of many floating fragments
Location: 44 56.18N 85 42.40W
Waypoints: LLLA 24-26
Treatment in 2020: Since a new site, and major source of spread, decision was made to relocate LBB's from Site 1 (7 on 7/10) and Site 10 (Reed Bed on 7/14). 16 total LBB's did not cover the site, as there were many gaps in coverage and EWM around the edges. No DASH in 2020.
Prescription: DASH in 2021. High priority. Estimated Time: 8 days

Site 14 – Otto Road North Sites
First Observed by RLS. Follow up by BP and Dan Harkness on July 6, 2020.
Location: 44 56.25N to 44 56.44N at approximately 85 42.38W.
Waypoints: 82-89 and 94, 95. LLLA 21-23 and 51
Notes: a number of small sites clustered about 100 yards to 500 yards north of the larger Site 13 above. Waypoints were marked on visible infestations, and buoys marked larger sites. Most infestations were nearly pure EWM over cobbles crusted with marl.
Treatment in 2020: Hard substate made for decent visibility but harder pulling. Largest site at Waypoint LLLA 21 was DASHed in September 2020 over two days.
Other smaller sites were hand pulled by diver.
Prescription: Hand pull in 2021, DASH if necessary.

Site 15 – Kelenske Point South
Observed: RLS survey June 2020, confirmed by BP on July 6.
Location: 44 53.15N 85 42.36W
Waypoint: LLLA 16
Notes: From surface appeared small and dense, but turned out to be bigger.
Treatment in 2020: hand-pulled by diver over a 3 day period in August 2020
Prescription: follow up by hand-pulling

Site 16 - Billman's Beach
Observed: RLS survey, confirmed by BP and DH on July 6.
Location: 44 52.18N 85 43.23W
Waypoint: 78. LLLA 15

Notes: Appeared as fairly dense EWM site among "aquatic garden" of pondweeds, valisneria, and native plants. Visited on 8/10/20 by AP. BP, snf Ron Reimink also to assess and determine best treatment. Divers found EWM very difficult to pull among very heavy native vegetation of many species. Decision to defer treatment until 2021, developing a strategy least disruptive to natives.
2020 Treatment: none
Prescription: high priority as most southward site on W side, but needs careful plan. Perhaps hand pull or DASH in early summer as EWM out-grows adjacent natives? Repeat monthly?

Site 17 - Dunklow Farm SE
Observed: RLS Survey June 2020, confirmed by BP and DH on July 6.
Location: 44 56.17N 85 43.16W
Waypoint: LLLA 20
Notes: Similar to Site 16 as EWM among native plants. Fairly dense near shore, running eastward into deeper water and becoming more mixed with natives.
Treatment in 2020: None
Prescription: Assess and DASH or hand-pull in 2021. Very similar to Site 16 above.

Site 18– Mebert Creek Natural Area
Observed: On October 6 by BP, following up on suspicious weed bed in 2017 shoreline drone survey. A check of 2017 drone survey shows that infestation was well established in 2017.
Location: 44 54.45N 85 42.30W about 200 yds south of Gauthier camp
Waypoints: 103 (s end) and 104 (n end)
Notes: This stand is near shore at Mebert Creek Natural Area, in very shallow water among old stumps, set apart from the larger lake by extensive shoal area north of Reed Bed. Quite dense at southern edge and becoming more sparse to the north over about 100 yards.
Prescription: Observe? Use as study site for barriers or other research? Many obstructions make difficult for barriers. Shallow water makes difficult for DASH.

Site 19 – DNR Boat Launch
Observed: August of 2020
Location: 44 54.50N 85 43.26W
Notes: Not observed until late summer when a few strands of EWM were evident just south of launch ramp in about 3-4 ft of water.
No Treatment in 2020
Prescription: Hand pull in 2021

<u>Sites Not Confirmed in 2020</u>

A site just NE of Rocky Point was observed in 2019 but not found again in 2020

Two small sites along the east side of the basin between Fountain Point and the Narrows were checked by diver in 2020. They were reported by RLS. Northern site had only a couple of strands EWM and was pulled. Southern site not confirmed. Keeping EWM out of this entire basin is a very high priority to keep EWM from moving into and through the Narrows.

Two sites, one just south of the beach at Leelanau RV Park, and one just north of the RV Park, were reported by RLS but not found in several visits in 2020.

A series of sites along the west side of the lake opposite the Otto Road North area was reported by RLS. The area was scouted by diver and only a few strands of EWM were found and pulled at the south end.

RLS also reported EWM from a site near the north end of Glaziers beach. Several visits, including two dives, did not confirm EWM at this site.

All of these sites should be carefully scouted by aerial and underwater drone, and treated if necessary in 2021.

Appendix B - Mapped EWM Sites in Lake Leelanau

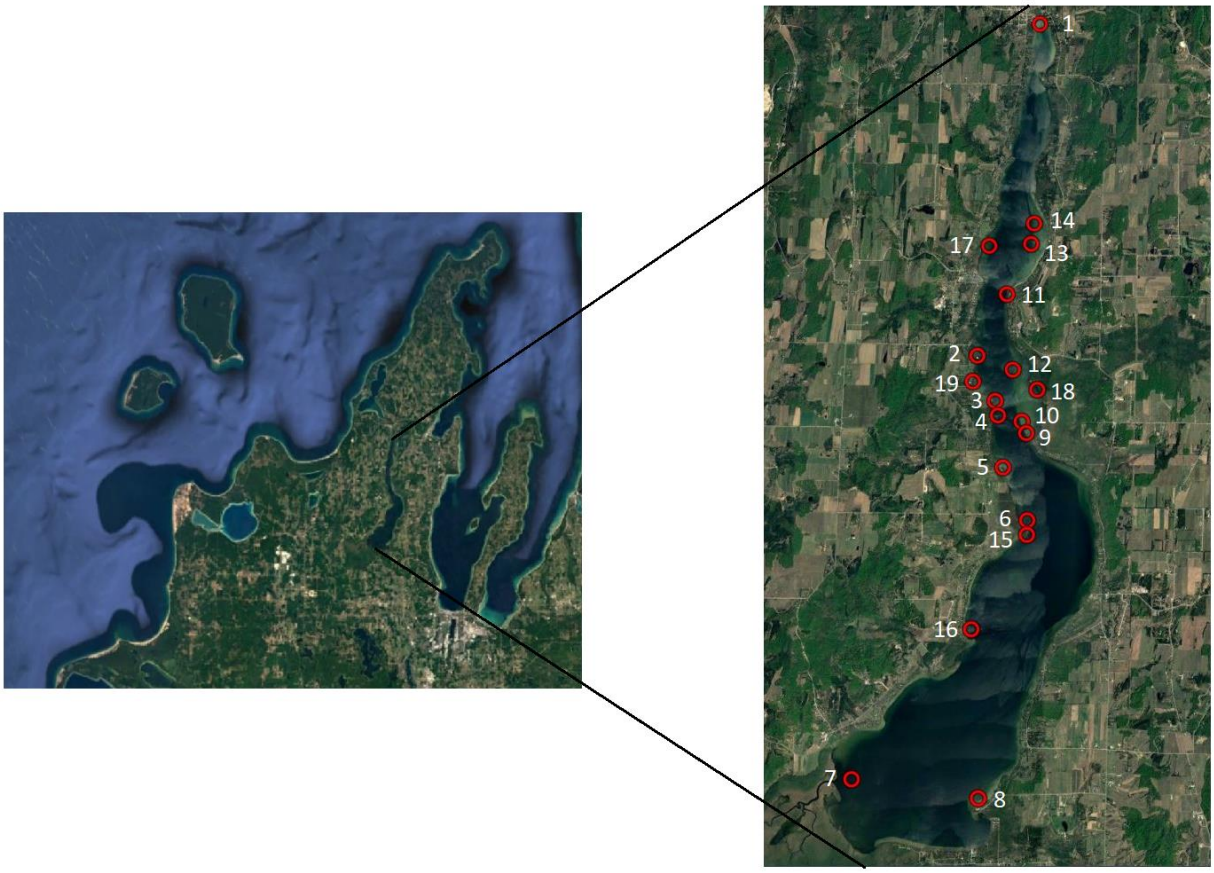
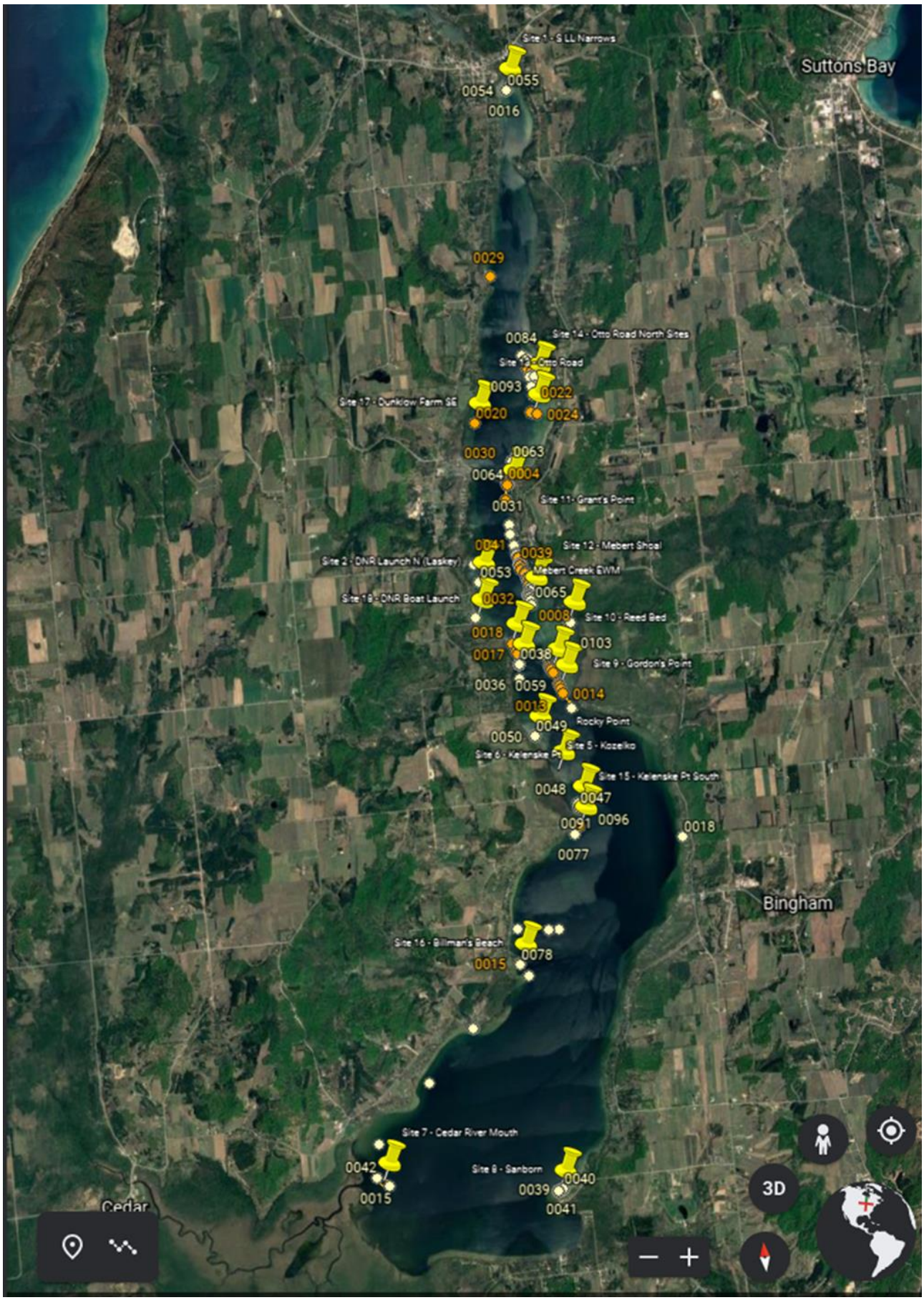


Figure 1. Site locations of EWM detected in Lake Leelanau. Locations correspond to site descriptions in Appendix A.


Site 1 - S LL Narrows
Suttons Bay
0055
0054
0016
0029
0084
Site 14 - Otto Road North Sites
Site 13 - Otto Road
0093
0022
Site 17 - Dunklow Farm S6
0020
0024
0030
0063
0064
0004
0031
Site 11 - Grant's Point
0041
Site 12 - Mebert Shoal
0039
Site 2 - DNR Launch N (Laskey)
0053
Mebert Creek EWM
0065
Site 18 - DNR Boat Launch
0032
0008
Site 10 - Reed Bed
0018
0103
0017
0038
Site 9 - Gordon's Point
0036
0059
0014
0013
Rocky Point
0049
0050
Site 5 - Kozelko
Site 6 - Kelenske Pt
Site 15 - Kelenske Pt South
0048
0047
0091
0096
0018
0077
Bingham
Site 16 - Billman's Beach
0078
0015
Site 7 - Cedar River Mouth
0042
Site 8 - Sanborn
0040
0039
0015
0041
Cedar
3D

Appendix C – Literature cited

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Appendix D – Photos

Photo 1. Dense Eurasian Watermilfoil bed captured via scuba diver with attached GoPro.

Photo 2. Scuba divers marking Eurasian Watermilfoil beds for benthic barrier deployment.

Photo 3. Lake Bottom Blankets (deployed to the right of the boat).

Photo 4. Burlap Barriers.

Photo 5. GTB biologist collecting macroinvertebrate samples.