Aquatic Plant Management Plan for Upper and Lower Herring Lakes

Benzie County, Michigan

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I. Introduction

The Importance of Aquatic Plants

Aquatic plants form the foundation of healthy and flourishing lake ecosystems - both within lakes and rivers and on the shores around them. They not only protect water quality, but they also produce life-giving oxygen. Aquatic plants are a lake's filtering system, clarifying the water and helping to absorb nutrients like phosphorus and nitrogen that could stimulate algal blooms. Aquatic plant beds stabilize soft lake and river bottoms and reduce shoreline erosion by reducing the effect of waves and current. Healthy native aquatic plant communities help prevent the establishment of invasive non-native plants such as Eurasian watermilfoil.

The best fishing spots are typically near aquatic plant beds. Aquatic plants provide important reproductive, food, and cover habitat for fish, invertebrates, and wildlife. In order to maintain healthy lakes and rivers, we must maintain healthy native aquatic plant communities. Because aquatic plants are an integral part of the lake's ecosystem, their indiscriminate removal through poorly designed management programs can severely affect the natural balance in the system. The abundance and distribution of aquatic plants and algae in a lake depends on light, temperature, water clarity and depth, nutrient availability, type of substrate (bottom material) and the amount of disturbance of this substrate. Human activities in and around the lake and its natural physical characteristics (e.g., shape and size) influence these factors.

Excessive Aquatic Plant Growth

Although native aquatic vegetation is generally beneficial, excessive growth can not only be a nuisance, but also drastically alters the use and ecology of a lake. The following are some of the problems that can occur as a result of excess plant growth:

- Accelerated nutrient enrichment (eutrophication), leading to dramatic and detrimental biological and physical changes.
- Impaired recreational activities.
- Accumulation of sediments as plants die, thus reducing water depth.
- Recycling of nutrients into the water column.
- Reduced water speed, thus increased siltation and flooding in drainage ditches.
- Domination of the aquatic plant community (1) by invasive species (e.g., Eurasian water milfoil, curlyleaf pondweed, purple loosestrife, and reed canary grass) when native species are eradicated, and (2) by bluegreen algae when rooted plants are destroyed, causing algae to form unsightly scum, produce undesirable taste and odors, and decrease water clarity.
- Increased levels of toxic phytoplankton, which can affect drinking water supplies for wildlife, domestic animals, and humans.
- Increased numbers of nuisance insects (e.g., mosquitoes) due to reduction in water circulation and loss of insect predators.
- Decreased property values due to impaired aesthetic quality and recreational use of a lake.

Why Aquatic Plant Managements Plans are Useful

A lakewide, long-term integrated aquatic plant management plan (APMP) provides a valuable tool for lake protection. The process of developing an APMP helps to identify and to prioritize problems for the lake, and to provide guidance for addressing these problems. The APMP also provides a mechanism for evaluating the success of the plan and for updating and reevaluating the goals and objectives that have been identified. Inherent in the development of an APMP, however, is controversy over what constitutes a “problem” and what appropriate actions are. Conflict occurs because different individuals or different management agencies place different values on the various attributes that attract people to lakes. Some individuals value water clarity whereas others may be focusing on fish or aquatic birds. More importantly, it is common that each individual or group of individuals believes there is a "right way" and a "wrong way."

Conflicts or differences of opinion regarding what makes a quality lake can be dealt with more effectively if every waterbody has an aquatic plant management plan. The plan for an individual waterbody, however, should reflect not only the desires of the user-groups, but how lakes actually function. Because lakes are complex systems and users often have different desires, putting exactly the right plan into action is a process of negotiation and compromise.

The Approach for Developing the Herring Lakes Aquatic Plant Management Plan

APMP Development. The proposed APMP for Upper and Lower Herring Lakes was developed based on the available information on the Lake's nutrient dynamics as determined by comprehensive monitoring, a survey of the aquatic plants present in the lake, and the relative abundance and distribution of these plants. This plan has been developed by the Great Lakes Environmental Center (GLEC) as a starting point for discussion and use by the stakeholders on the Herring Lakes. ***It is strongly suggested that a group of stakeholders in conjunction with the lake association come together to form a working group or steering committee to review the data, assess the problems as discussed in this initial APMP, and evaluate the overall management goals and objectives to determine whether the suggested approaches for lake management are valid.*** The process of managing the lakes is continual, and it is critical for the steering committee to reach out to the community to share information, and allow for participation of all interested individuals in the current and future planning process of the APMP.

Critical Elements of an Aquatic Plant Management Plan. A successful aquatic plant management plan is built on six main principles:

1) **Characterize the waterbody –** understand the lake ecology and the aquatic plant community. Although plant and lake ecology can be complex subjects,

it is important to gather as much information as possible. This information would include an aquatic plant map that shows what types of plants are present, the distribution of these plants and their relative density. Also included in this inventory would be any rare or sensitive plants, as well as any invasive, non-native plants that are present. GLEC conducted an aquatic plant survey of Upper and Lower Herring Lake in 2002 and developed a comprehensive report which identified the variety of aquatic plants present, relative densities of plants around the lake, and any invasive species of concern. In conjunction with this report, maps were generated which allowed for a visual interpretation of areas of concern relative to critical spots on each lake, such as lake inlets or outlets, public access sites (boat launches), and areas of high and low development.

2) **Identify the uses and problems present in the waterbody** - determine if any of these uses are impaired or benefited by aquatic vegetation. It is important to reach a consensus regarding impairment of uses on the lake. This process requires stakeholders to be broadly represented so that all perceived problems are addressed. Once a complete list of problems has been elicited, the problems can be grouped into common elements (e.g. fishing, boating, swimming, visual enjoyment, wildlife habitat) and the problems can be refined as much as possible. This process of refining perceived problems is critical for building consensus among stakeholders, and will allow for the development of appropriate management goals and objectives.
3) **Set Management Goals –** Once uses, impairment of uses and the underlying ecology are understood, the next step is to come up with specific management goals. Management goals define what the community wants to achieve in response to the aquatic plant problem(s). Defining goals helps in selecting the best management methods, which form the heart of the Plan. It is important to understand the difference between management goals and management methods. The goals are conditions in the water body that the community wants to achieve, and the methods are the means of attaining those conditions. A goal, for example, might be to reduce aquatic plant growth near a

swimming beach so that it is no longer a safety hazard. Mechanical harvesting of the plants, or the use or herbicides are methods that can be used to achieve the goal. But, the method cannot be chosen before the community establishes its goals and examines other critical aspects (for example, legal, political, or financial limitations) of the problem. In setting the management goals, there is one option that should always be considered: the "**do nothing option"**. When a problem(s) arises, solutions are sought. The community must know that the "doing nothing" option was considered and that the consequences were indeed worse than the course of action chosen. If this option is not carefully considered, lingering doubts among groups of individuals may adversely affect the ultimate adoption of an integrated aquatic plant management plan or any future modifications of the plan.

4) **Consider all Management Techniques –** select those techniques that are most appropriate for the defined problems. Choosing a management approach can be difficult. Each technique's mode of action, effectiveness, length of control, advantages and any potential short-term or long-term environmental drawbacks all must be carefully considered. A component of choosing a management technique is also determining the intensity of control that is needed. For example, is low-level control desired to allow some intermediate level of plant growth, or does the problem warrant intensive control, with the intent of keeping the minimum amount of nuisance plants as possible.
5) **Develop an Action Plan** - The final task is to take all the information and formulate a written, long-term action program (Plan) for aquatic plant management. The Plan should be flexible and evolving. There should be short-term and long-term program elements. This Plan provides the community with guidance and direction for aquatic plant management. A written Plan also provides continuity as time moves on and active steering committee participants change. The Plan should also provide for regular checking of how well the actions are working and allow for modification as conditions change. Lake monitoring programs are especially important for evaluating any lake management activities, including integrated aquatic plant

management. Without monitoring a lake there is no way of determining if the management activities are achieving the determined goals set in any lake management plan.

6) **Education and Public Outreach** - A successful aquatic plant management plan requires a long-term commitment to education. Once a problem is "solved" people often tend to forget it and move on to something else. Once the plant problem is removed, it is generally only a matter of a few years before users begin to question why activities such as the maintenance control of aquatic plants is still being done. Continuing education and public outreach programs should be conducted annually explaining the management plan to the community. Educational meetings can be used to tell the community of users that the Plan is not carved in stone and that changes can be made.

Aquatic Plant Management Techniques

In general, there are four ways to control or remove aquatic plants:

1. Chemical: includes herbicides and some dyes. Only those chemicals registered with the U.S. EPA and Michigan Department of Environmental Quality (MDEQ) may be used. When controlling aquatic plants with chemicals, it is important to correctly identify the plants and the appropriate chemical beforehand and to be certain that treatment occurs at the proper timing and dosage. Chemical control of aquatic plants always requires a permit from the DEQ. It is important to point out that the use of herbicides to control aquatic plants has certain drawbacks. Most herbicides control all forms of plant life to some extent. Beneficial aquatic plants may be killed along with the nuisance plants. It is also difficult to control the drift of herbicides under certain conditions. Consequently, plants may be killed over a much wider area than intended. Additionally, herbicides give only temporary control. In lakes where herbicides are used repeatedly on a large scale, dramatic shifts in plant populations can occur which may seriously alter the lake's ecology.

2. Manual/Mechanical: includes hand-pulling and raking or mechanically harvesting plants. This may employ hand tools or motorized equipment. When large areas of aquatic plants are harvested, the cut material should be removed from the lake. If left in the lake, the cut material will decompose and contribute nutrients and organic material to the lake, which may encourage further plant growth.

3. Physical/ Environmental Manipulation: includes dredging, aeration, nutrient inactivation (by chemical additions), drawdown (water level manipulation), shading, and intensive manual clearing. The objective of environmental manipulation is to alter one or more physical or chemical factors which are critical to plant growth and development. Some of these approaches have been used with varying degrees of success, but these methods are often not economical or practical. Most of these activities require a permit from the DEQ.

4. Biological: includes the introduction of organisms which competes with, preys upon, inhibits the growth of, causes disease in or parasitizes a plant species which has created a problem. An example is the MiddFoil® program, a biological control program for Eurasian watermilfoil. MiddFoil® supplements exisiting lake populations of a native insect (weevil) that feeds on watermilfoil tissue, causing damage to the plant and reducing its viability over time. It should be noted that most, if not all, biological control programs do not result in eradication of the plant species, but essentially control their abundance to a level which is acceptable for lake users.

II. Management of Upper Herring Lake

1. Characteristics of Upper Herring Lake

Upper Herring Lake is a shallow, clear 572 acre lake located in Blaine Township in southwestern Benzie County, Michigan. The shoreline is composed mainly of forests, with residential and agricultural developments around the shore. The forested area between Upper and Lower Herring Lakes is comprised of 2,500 acres of wetlands which include a 123 acre Grand Traverse Regional Land Conservancy preserve on the west side of Upper Herring Lake. Two inlets are noted on county maps, one on the east side and one on the south side (Figure 1). During the 2002 field survey conducted by GLEC, the inlet on the east side of the lake was visible and easy to locate. The inlet on the south side was not located. Upper Herring Lake is located east of Lower Herring Lake with an outlet at the north end of the lake which flows directly to Lower Herring Lake. The only public access site is a Michigan Department of Natural Resources (MDNR) boat launch off Herron Road on the north end of the lake. The deepest part of the lake is less than 30 feet deep, with the majority of the lake less than 25 feet deep, and characterized by gravel, marl, organic and sandy sediments.

Twenty-three aquatic plant species were identified during the summer 2002 survey including 20 different species of submersed aquatic plants (the majority of the plant grows beneath the water surface), which is indicative of a diverse plant community (Table 1). There were no exotic (non native), threatened or endangered plant species identified in Upper Herring Lake during the survey. *Myriophyllum heterophyllum* (native milfoil) was the most common submerged vascular plant species observed in Upper Herring Lake. Although *M. heterophyllum* is not an exotic species, it is known to grow in dense colonies. *M. heterophyllum* was present at 43 percent of the sampling sites and at 34 out of a total of 36 transects. Dense growth (greater than 70 percent coverage) of *M. heterophyllum* was observed at 31 percent of the transects. *Chara*, a macroscopic algae was the next most commonly observed species followed by *Potamogeton zosterformis* (flat-stemmed pondweed). Chara was found throughout the lake at 50 sampling sites and at 31 transects; densities ranged from sparse to heavy growth. Flat-stemmed pondweed was observed at 51 sampling sites with sparse to moderate growth. Illinois pondweed (*Potamogeton illinoensis*), elodea (*Elodea candensis*) and water celery (*Vallisneria americana*) were observed with sparse to moderate growth at 35, 29 and 19 sampling sites, respectively. A list of all of the plant species identified in Upper Herring Lake, the number of sampling sites and transects where each species was identified was provided in the final report of the Aquatic Macrophyte Survey submitted to the Benzie Conservation District in 2003.

The littoral zone, or the zone of plant growth, for Upper Herring Lake stretches from the shore to depths up to 23 feet (Figure 3). Moderate to dense plant growth was commonly observed at depths between 5-16 feet deep, while sparse to moderate growth was observed in deeper or shallower areas. Dense growth areas were common in the south and western portions of the lake. An estimate of the size (in acres) of the littoral zone of Upper Herring Lake was calculated using mapping software which utilizes data from GPS coordinates, information collected at each of the transects and aerial photographs of the lake. The littoral zone of Upper Herring Lake is estimated to be 208 acres, which is approximately 36 percent of the total lake area.

2. Identified Uses and Impairments/Problems

Identified Uses**.** In general, it appears from observations that the primary use of Upper Herring Lake is for fishing, small boats, kayaks and canoes. Although there may be some powerboat and personal watercraft use on Upper Herring Lake, this is much more limited than on Lower Herring Lake. The availability of only a single launch on the lake may contribute to this relatively low level of motorboat activity.

All of the plants identified during this survey of Upper Herring Lake are generally considered to be highly beneficial to lake ecosystems and with no associated negative characteristics (MSU, 2000). The most frequently observed species in Upper Herring Lake were *Myriophyllum heterophyllum*, chara, and flat-stemmed pondweed. Upper Herring Lake has abundant and healthy populations of aquatic plants, which are essential for healthy fish and other animal populations. Twenty-three different aquatic plant species were identified during the summer 2002 survey including 20 different species of submersed aquatic plants. This is indicative of a diverse plant community. Another indicator of healthy lake ecosystems is the absence of exotic species. No exotic species were observed in Upper Herring Lake during the survey. Healthy populations of native plants help to exclude exotic species and promote water clarity.

Noted Problems. *M. heterophyllum* was the dominant species found in Upper Herring Lake and was observed at 34 out of 36 transects. Although *M. heterophyllum* is not an exotic species, it is one of the native plants that under certain circumstances can form dense colonies. This plant can grow to the lake surface even at depths of 12 feet or more. Greater than 50 percent of the sampling transects (19 out of 36 transects) of Upper Herring Lake had sampling locations with heavy to dense plant growth, with *M. heterophyllum* the dominant species. In addition, dense growth areas where 70 percent or more of the sediment is covered with aquatic plant growth were observed near the south and western shores (Figure 3) that are likely impacted by inputs from Herring Creek. This dense growth is likely indicative of high nutrient levels in the surface water and/or sediments. Therefore, it is likely that Upper Herring Lake is receiving, or has in the past received, high nutrient inputs from the watershed. These nutrient inputs may be contributing to overall plant growth, particularly growth of *M. heterophyllum*.

3. Management Goals

Although Upper Herring Lake has a diverse plant community with no apparent invasive plant species and few problems, the presence of dense aquatic plant growth in the southern and western portions of the lake suggest that inputs from the watershed may be contributing nutrients which may be detrimental to lake water quality and recreational activities in the long run. The following long-term and short-term management goals are suggested for evaluation and implementation.

Long Term Management Goals

Goal 1. Reduce nutrient/sediment loading to Upper Herring Lake from the watershed to minimize impairments to lake quality and recreational uses.

Because sources of nutrients may be contributing to aquatic plant growth, potential algal blooms and degraded water quality, control of these watershed sources of nutrients and sediments should be addressed. The followed specific objectives may be relevant for this management goal

> **Objective 1:** Implement soil erosion Best Management Practices at identified sites within the watershed, and specifically Herring Creek, which may act as point sources of nutrients.
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> **Objective 2:** Reduce nutrient loading to Upper Herring Lake by decreasing or eliminating residential fertilizer use by riparian owners and by controlling agricultural runoff.
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> **Objective 3:** Discourage excessive landscape watering practices, which can lead to surface water transport of nutrients to the lake. The use of lake water for near shore irrigation/fertilization requirements should be encouraged.

Short-Term Management Goals

Goal 1. Continue monitoring of Upper Herring Lake, Herring Creek and its tributaries for sources of nutrients.

> **Objective 1:** Monitor lake nutrient concentrations every two to three years
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> **Objective 2:** Perform an aquatic macrophyte survey every three years. This survey need not be extensive but merely monitor plant density and note any problem areas, as well as examining the lake for the occurrence of any invasive species.
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> **Objective 3:** Place informational signs at the public access point to educate recreational users about invasive species in order to limit the introduction of unwanted aquatic organisms.

4. Management Techniques

Because of the quality of Upper Herring Lake, there are no specific short-term goals that involve direct lake intervention and so there are no management techniques to be currently considered. The long-term objectives involve management of the greater watershed and non-point source pollution that must be addressed through a combination of landowner cooperation and educational outreach, working through relevant organizations such as the Benzie Conservation District. As such, the do nothing alternative for direct management of Upper Herring Lake is the appropriate option at this time.

5. Action Plan

The action plan, which is relevant to Upper Herring Lake, as well as Lower Herring Lake, is discussed in Section 5 (Action Plan) of the Lower Herring Lake Management Plan (see below).

6. Education/Public Outreach

The education/public outreach component of the Upper Herring Lake Management Plan will be discussed as a combined component with Section 6 of the Lower Herring Lake Management Plan (see below).

III. Management of Lower Herring Lake

1. Characteristics of Lower Herring Lake

Lower Herring Lake is a 450-acre, 60 foot deep, natural, very hard water lake located in Blaine Township in Benzie County, Michigan. The shoreline is relatively undeveloped compared to many lakes in Michigan. Three public boat launches allow access on the eastern shore, a resort is located on the southern shore, a summer camp is located on the western shore and dense residential developments are located on the northeast side of the lake. Much of the shoreline is vegetated with native forests. An inlet, which receives water from Upper Herring Lake, is located just south of the public boat launch on the northeast side of the lake. An outlet with a dam, which maintains the water level at 10 feet above the elevation of Lake Michigan, is located near the south west corner of the lake. Gravel and organic sands characterize the lake sediments.

Fourteen species of emergent/submerged plants were identified during the summer survey (Figure 2). Chara was found in all but two of the transects in Lower Herring Lake and at 58 percent of the sampling sites with sparse to heavy growth. *Myriophyllum spicatum* (Eurasian milfoil), was the next most common species observed. Eurasian milfoil is a non-native aggressive submersed aquatic plant that was found throughout Lower Herring Lake. Sparse to moderate growth of Eurasian milfoil was frequently observed, while several areas were observed with heavy or dense growth (Figure 4). Eurasian milfoil was present at 18 of the 26 transects (62 percent). The third most frequently observed species on Lower Herring Lake was Sago pondweed (*Potamogeton pectinatus*) which was found at 50 percent of the transects with sparse to moderate densities. Other species observed included: water celery (*Vallisneria americana*) and Illinois pondweed (*Potamogeton illinoensis*). Aquatic plants were present in most of the littoral zone from depths of 1-20 feet, with the majority of the plant growth at depths less than 15 feet in Lower Herring Lake.

The estimated acreage of the littoral zone of Lower Herring Lake was calculated using GPS coordinates, transect data and aerial photographs utilizing the same procedure used to calculate the littoral zone of Upper Herring Lake. The littoral zone is calculated to be 116 acres which is approximately 26 percent of the total lake area.

2. Identified Uses and Impairments/Problems

Identified Uses. As was noted above, three public boat launches allow access on the eastern shore, a resort is located on the southern shore, a summer camp is located on the western shore and dense residential developments are located on the northeast side of Lower Herring Lake. Because of this increased access and the presence of the resort, Lower Herring Lake appears to be more heavily used for recreational boating, personal watercraft and waterskiing. Fishing, kayaking, canoeing and swimming are also common uses on the lake.

Noted Problems. Fourteen species of aquatic plants were identified during the macrophyte survey of Lower Herring Lake, which is indicative of a moderately diverse plant community. The littoral zone of Lower Herring Lake was largely vegetated with sparse to moderate plant densities with 12 percent of sampling transect sites with heavy to dense growth areas. While many of the dense growth areas were dominated by chara, a very low growing plant with many beneficial attributes, some of the dense growth areas were dominated by the exotic species Eurasian milfoil (*Myriophyllum spicatum*), which is known to be an aggressive invader in some lakes. Sago pondweed (*Potamogeton pectinatus*) was observed at 50 percent of the transects and like many of the pondweed species provides exceptional habitat for small aquatic invertebrates and fish and is also an excellent waterfowl food source. This particular species of *Potamogeton* can form dense colonies especially if excess nutrients, sediment disturbance or other weed control projects have occurred. However, there were no areas of heavy or dense sago pondweed growth observed during the survey in Lower Herring Lake.

Two species of non-native plants were identified in Lower Herring Lake: Eurasian milfoil and giant reed grass (*Phragmites australis*). Eurasian milfoil is a submersed aquatic plant that was commonly found at depths of 5-15 feet in Lower Herring Lake. Eurasian milfoil was the second most frequently observed species in Lower Herring Lake. Several areas with dense monotypic (single species) colonies were observed, including the outlet area and an area in the northwest section of the lake. Eurasian milfoil is different from many native plants because it does not rely exclusively on seeds for reproduction. Eurasian milfoil seeds germinate poorly under natural conditions, but it reproduces very effectively by fragmentation. These fragments, which can be carried by currents or can be inadvertently picked up by boaters and transported in bilges, live wells or bait buckets, and can stay alive for weeks if kept moist. Once a population of Eurasian milfoil has become established in a lake, it reproduces from stolons (stems that grow horizontally on the sediment surface). The stolons, stems and roots persist over winter, and store the carbohydrates that help milfoil take advantage of the available habitat earlier in the spring than many native plants. The rapid and effective dispersal of Eurasian milfoil, and its ability to displace other macrophyte species through competition are major factors contributing to Eurasian milfoil=s ability to dominate certain lakes. Eurasian milfoil is not, however, invasive in every lake where this species is found (Grace, 1978). Eurasian milfoil does not spread rapidly into undisturbed areas where native plants are well established. It does, however, tend to invade disturbed areas where native plants cannot adapt as quickly to an alteration. Alterations to a lake bottom can include dredging, motor boating in shallow water (or any similar activity that disturbs the sediment), pesticide/herbicide application, siltation and excessive nutrients (Engel 1990).

Giant reed grass is an aggressive, emergent species that inhabits the shoreline area to depths of several feet. Emergent species typically grow in saturated sediments to depths of several feet with a large portion of the plant remaining above the water; cattails and rushes are examples of common emergent species. Giant reed grass can become established when shoreline habitats are disturbed. Disturbances, which have been found to encourage the growth of giant reed grass, include: water level changes, sediment disturbance (boating, dredging) and high nutrient levels in water and sediments. The distribution of these species is provided in Figure 4.

GLEC conducted a brief survey of Lower Herring Lake in 1998 to help address some concerns of the Lower Herring Lake Association members who had noticed changes in the lake. Since 1998 the populations of both the Eurasian milfoil and the giant reed grass have expanded; the dense growth areas of Eurasian milfoil observed in 2002 were not noted in the 1998; the giant reed grass population observed in the bay on the south west corner of the lake in 1998, is now dominating a larger part of the shoreline. In addition, four newly established smaller populations of giant reed grass that were not evident in 1998, have become established along the western shore (Figure 4).

Both of these exotic species are of concern because they are known to be aggressive invading species which can out-compete native plants and reduce the diversity and overall quality of lakes. There are a variety of factors that could contribute to the exotic species invasions observed on Lower Herring Lake. It is interesting that no specimens of Eurasian milfoil were observed or collected on Upper Herring Lake while it was found at the majority of transects on Lower Herring Lake. Upper and Lower Herring Lakes have many differences including size, water depth and their relative placement in the watershed. Another important difference between these lakes is how recreationists use the lakes. The bay area on the south west side of Lower Herring Lake, where giant reed grass began infesting 1990's, was an area where water ski boats were observed turning around and causing waves to hit the shoreline. This activity could be significant because disturbance of sediments by motor boat activity is thought to be a cause of exotic species establishment in some lakes (Lakeline, 1999). Other areas with dense growth of invasive species included the lake outlet, as mentioned previously, and off the shore north of the outlet area. There were also a number of motor boaters in the outlet area the day the aquatic macrophyte study was conducted by GLEC. In addition to bottom disturbances, changes in water levels in lakes (higher or lower) can also encourage invasive plant species to grow. Lower Herring Lake is higher than it was in 1998, for example. The outlet to Lake Michigan did not have any water flowing over the dam in 1998; at least a foot of water was flowing over the dam during the summer of 2002.

Another confounding environmental issue facing many northern Michigan Lakes is that the water temperatures have been slowly rising over the last five years (coupled with warmer winters), causing many lakes not to freeze over for the same length of time as was common in years past. The warmer water temperatures could also be a factor contributing to increases in plant growth. Finally, the introduction of zebra mussels, which were found in both Upper and Lower Herring Lakes, to inland lakes have also been correlated with an increase in Aweed growth@ in lakes by increasing water clarity and increasing the depth that light will penetrate. This increase in the "photic zone" will slightly expand the effective plant growth zone (littoral zone) in the lakes. Therefore, zebra mussels could be influencing on the growth of macrophytes in these lakes.

3. Management Goals

Generally, Lower Herring Lake has a healthy plant community; the littoral zone accounts for approximately 26 percent of the lake area, and provides good habitat for fish and other aquatic organisms. However, as with Upper Herring Lake there are some indications that the lake could be receiving excess nutrients or other disturbances resulting from human activities. The following long-term and short-term management goals are suggested for evaluation and implementation.

Long Term Management Goals

Goal 1. Reduce nutrient/sediment loading to Lower Herring Lake from the watershed to minimize impairments to lake quality and recreational uses.

The watershed or the surrounding land that drains surface water and run-off towards Upper Herring and Lower Herring Lakes includes 16,210 acres. Nutrients from a large portion of the watershed could enter these lakes from streams and surface water run-off because the elevation of land toward the east side of the watershed is higher and decreases west towards Upper and Lower Herring Lakes to Lake Michigan. Activities in the watershed which include timber harvesting, agriculture, industrial or residential developments and road building can influence the quantity and quality of the run-off that will enter these lakes. As was the case for Upper Herring Lake, nutrients from the watershed may be contributing to aquatic plant growth, potential algal blooms and degraded water quality. It is important to control watershed sources of nutrients and sediments as much as possible. The followed specific objectives may be relevant for this management goal.

Objective 1: Implement surface water runoff Best Management Practices, including establishing shoreline vegetation buffer zones.

Objective 2: Reduce nutrient loading to Lower Herring Lake by decreasing or eliminating residential fertilizer use by riparian owners and control agricultural runoff

Objective 3: Discourage excessive landscape watering practices, which can lead to surface water transport of nutrients to the lake. The use of lake water for near shore irrigation/fertilization requirements should be encouraged.

Goal 2. Control or reduce current exotic invasive plant species (Eurasian milfoil, Giant reed grass) to maintain lake and recreational quality.

The occurrence of invasive plant species on Lower Herring Lake poses a concern at this point and warrants monitoring over the next few years for new species or expanding growth of existing species.

> **Objective 1:** Investigate appropriate long-range control strategies, such a
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> **Objective 2:** Implement long-term monitoring of distribution and density of invasive plant species.
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> **Objective 3:** Utilize public education and public outreach to enable recreational users and riparian owners to minimize the impact of their activities on spread of invasive species.

Short-Term Management Goals

Goal 1. ***Implement specific control methods for short-term management of invasive species in Lower Herring Lake.***

> **Objective 1:** Continue to monitor lake nutrient concentrations every two to three years as an indicator of nutrient enrichment in Lower Herring Lake.
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> **Objective 2:** Determine the most appropriate management method for controlling invasive species in Lower Herring Lake, based on the distribution and severity of the infestation.
>
> **Objective 3:** Monitor the effectiveness of the control method(s) on a yearly basis and make appropriate adjustments or changes in the control strategies.
>
> **Objective 4:** Place informational signs at the public access point to educate recreational users about invasive species in order to limit the introduction of unwanted aquatic organisms.

In determining the most appropriate course of action for the control of invasive species, one management approach would designate that all growths of this species should be managed. Another approach might specify that the population does not pose a long-term threat to the water body and no action is necessary. However, each management strategy must consider the reasons these species are present. For example, if you kill or remove Eurasian milfoil from an area and the environmental conditions still exist (high nutrients and bottom disturbance) that allowed for the original infestation that plant species will likely return. Therefore, a determination of the extent of the control of these invasive species is critical and should be thoroughly discussed by the riparian stakeholders prior to initiating a control methodology.

There are various methodologies available for control of invasive aquatic plants. These methods are sometimes specific for individual species, but some are broader spectrum in their effectiveness. These methodologies will be discussed in Section 4 (Management Techniques) below.

4. Management Techniques

Eurasian milfoil

Typically, prevention of invasion of lakes, streams, and rivers is the best method of avoiding the development of uncontrolled monocultures of this aquatic weed. Chemical and mechanical methods are well developed, but provide short- to medium-term control, and often must be used every 1 to 3 years to provide nuisance control. Research on long-term biological control of Eurasian watermilfoil is continuing in North America and throughout the world. The effectiveness of these insects for long-term suppression is currently being analyzed

Chemical Control. Since Eurasian watermilfoil is a dicot it is amenable to selective control using herbicides that specifically target this group, such as 2,4-D. Effective broad spectrum chemicals such as Diquat and Fluridone are also available for this species, but these chemicals would impact all aquatic plants, including beneficial native species and are not usually recommended. Chemical control can provide short- to medium-term control (1 to 3 years), and is often appropriate for immediate use on small initial infestations, with additional potential for use on larger scale or whole-lake infestations where deemed necessary. Because of potential impacts to native vegetation and general environmental concerns, GLEC does not typically encourage the use of herbicides in lakes. Application of chemicals in inland lakes always requires a permit from the DEQ.

<u>Mechanical/Physical Control</u>. Mechanical control of Eurasian watermilfoil is a short- to medium-term strategy that can be deployed for initial control of small to moderate infestations. One disadvantage of some mechanical control methods is the fragmentation of stems that can create vegetative propagules, and potentially cause further spread. Physical control options provide medium to long-term control of this invasive aquatic weed. The more successful mechanical and physical control practices include the following options:

Hand cutting tools have been used to control all submersed aquatic weeds and are effective on Eurasian watermilfoil. Harvesting of Eurasian watermilfoil also is an effective option for short-term clearance of the vegetation from the upper portions of the water column. Since aquatic weeds such as Eurasian watermilfoil can grow up to one foot per week, harvesting may need to be performed several times in a growing season to maintain usability of the water. Following harvesting, Eurasian watermilfoil should be collected and disposed of in a manner that does not contaminate other water bodies. Hand removal by divers has been especially effective against Eurasian watermilfoil. Both the plant and root crown are dislodged, and these structures may then be removed from the lake system. Diver harvesting is best utilized against small, pioneering infestations of Eurasian watermilfoil. Where new colonies are discovered interspersed with native plants this technology can selectively remove only the Eurasian watermilfoil, and with careful planning and implementation diver dredging has minimal impact on the native flora. This treatment has been successful against well-established communities, but the high cost of operations for extensive infestations limits the application of this technology.

Bottom barriers have been successfully used to manage Eurasian watermilfoil in certain circumstances. They have effectively covered pioneering infestations of this weed and prevented spread of the plant. They have also been used in a maintenance role, keeping water around docks or swimming areas open for use. However, this approach would likely require a permit from the DEQ.

Biological Control. Biological control is a Best Management Strategy that should be considered wherever possible. Biocontrol agents are preferred, as they do not require physical alteration of the lakes or the use of agrichemcials. An indigenous weevil, *Euhrychiopsis lecontei,* appears to be the most promising agent for long-term biological suppression of Eurasian watermilfoil. It has been associated with documented watermilfoil declines in Michigan, Wisconsin, Minnesota, New England and elsewhere. The weevil appears widespread across northern North America. Recent surveys in Wisconsin indicate that the weevil likely occurs in most lakes with northern or Eurasian watermilfoil.

Once exposed to the exotic Eurasian watermilfoil, the weevil prefers Eurasian to its native host northern watermilfoil *(M. sibiricum)*. Adult weevils live underwater and lay eggs on watermilfoil meristems. The larvae eat the meristem and bore down through the stem. The consumption of meristem and stem mining by larvae are the two main effects of weevils on the plant, and this damage can suppress plant growth, reduce root biomass and carbohydrate stores, and cause the plant to sink from the top of the water column. Watermilfoil declines often occur over winter, in early summer, or persist over several years. Therefore, it is likely that long-term effects, such as reduced overwinter survival or reduced competitive abilities, are important to sustained control of Eurasian watermilfoil.

The effectiveness of this weevil has been mixed, with good results at some sites and poor results at others. Factors associated with predictability of suppression by the milfoil weevil are currently being investigated, as well as factors limiting weevil populations. Currently, weevils are available through a commercial supplier (EnviroScience, Inc., Stow, OH; http://www.envirosciencein.com) and have been used on several area lakes, including Long Lake in Grand Traverse County and Manistee Lake in Antrim County. Currently, there is some evidence that the weevils have produced some measure of control in Long Lake, but additional yearly monitoring is necessary for confirmation.

Giant Reed Grass

Current information on managing this species is available from a variety of sources, including the Michigan Invasive Species Council website http://forestry.msu.edu/mipc/. The primary control methodologies include chemical and mechanical controls, similar to those outlined for Eurasian milfoil (above). However, control of Giant reed grass has been extremely difficult and it is important to research management techniques because many traditional methods of plant control which include digging, mowing, herbicides and burning can cause the infestation to worsen. In some cases, the do nothing option may be the best solution if the extent and density of Giant reed grass is limited, does not appear to be spreading or does not interfere with recreational uses in Lower Herring Lake. Again, as for Eurasian milfoil, the riparian stakeholders must agree on the severity of the problem and whether it interferes with designated uses of the lake prior to implementing any type of control strategy.

5. Action Plan

The action plan for management of aquatic plants on Lower Herring Lake consists of a series of tasks which should be implemented over the next one to five years. These tasks include:

Task 1) **Establish a Herring Lakes management committee.** This committee will consist of representatives of riparian owners, local government officials and other interested parties with the charge of revising and implementing the aquatic plant management plan (APMP) for both Upper and Lower Herring Lakes. This task should be completed prior to implementing any management strategies.

Task 2**) Determine the severity of identified problems on Upper and Lower Herring Lakes and the desired management options for control or remediation of these problems.** As noted above, the identified problems for Upper Herring Lake center on long-term management of nutrients entering the lake from the watershed. No invasive species were identified on Upper Herring Lake. For Lower Herring Lake, in addition to managing nutrient enrichment from the watershed, two invasive species were identified in the aquatic plant survey in 2002: Eurasian milfoil and giant reed grass.

Task 3) **Implement short-term management strategies where appropriate**. This task also includes determining the relative costs, benefits and advantages of the available management techniques, such as biological, physical or chemical control procedures.

Task 4) **Develop an approach for managing the long-term nutrient enrichment from the watershed.** This is a difficult task, and may require assistance from the state and local agencies, in addition to cooperation from watershed residents. This will be the most effective long-term management tool to reduce impacts on both Upper and Lower Herring Lakes and to maintain lake water quality, while simultaneously limiting aquatic plant density. This task would include determining an appropriate schedule for continued nutrient monitoring as well as updating the status of the aquatic vegetation.

Task 5) **Develop a comprehensive education/public outreach program to inform watershed residents and riparian stakeholders of management activities on Upper and Lower Herring Lakes.** This education program should include the explanation of and rationale for all management decisions, information for stakeholders to help them protect and improve the water quality and resources on the Herring Lakes, and provide opportunities for public meetings and input on future management decisions.

6. Education and Public Outreach

A successful aquatic plant management plan requires a long-term commitment to education. Continuing education and public outreach programs should be conducted annually explaining the management plan for both Upper and Lower Herring Lakes to the community. Educational meetings can be used to tell the community of users that the Plan is not carved in stone and that changes can be made.

Targeted periodic mailings to riparian owners can be used to help continue to present current information and critical concepts. These concepts could include topics such as fertilizer management, development of vegetative buffer strips, stormwater retention, septic system maintenance and any other relevant information regarding protection of water resources. Although not everyone will read or adopt these practices, a continued effort may slowly increase the participation of lakeside individuals who are proactive and who care about the quality of Upper and Lower Herring Lakes. In addition, several Landowner's Handbooks have been developed for Lake Leelanau, Long Lake and the Grand Traverse Bay. Copies of these or an edited version relevant to the Herring Lakes should be made available to residents of the watershed. Periodic announcements, through mailings or at township meetings, can be used to remind residents that this information source is available.

Evaluation is an important part of watershed management. A well planned evaluation process can assess which efforts are successful, and can be used to provide valuable feedback for refining implementation strategies. Several evaluation strategies include:

Watershed Monitoring. Monitoring of specific aspects of the watershed, including lake water quality and macrophyte abundance and distribution, will provide an measure of whether a reduction of nutrient and sediment input to Upper and Lower Herring Lakes is having a measurable effect. This evaluation process should be ongoing, performed at intervals of every two years.

Stakeholder Assessment Surveys. A relatively moderate-cost method of assessing attitudes, beliefs and behaviors of watershed residents is by a mail survey. The information obtained by such surveys could provide an idea of whether education and outreach materials are providing any benefit to the watershed. Specific areas that may be addressed could focus on land use priorities, attitudes towards conservation, riparian practices towards reductions in fertilizer usage and stormwater retention (probably an anonymous survey) and determining interest in actively participating in Lake

Associations or other watershed related activities. It would be useful to complete a survey at the beginning of implementing watershed management, followed by an additional survey 2-3 years later, with an analysis of any changes in response by those who completed the initial survey.

IV. References

Engel, S. 1990. Ecosystem responses to growth and control of submerged macrophytes. Wis. Dep.Nat. Resour., Tech. Bull. No.170. 20 pp.

Grace, J.B. and R.G. Wetzel 1978. The Production Biology of Eurasian Milfoil (*Myriophyllum spicatum* L.): A Review, J.Aquat. Plant Manage. 16: 1-11.

Lakeline, *Can no-wake zones effectively protect littoral zone habitat from boating disturbance?*, Vol.19, No.1 March 1999

MDEQ, 1999. *Management of Aquatic Plants* - Land and Water Management Division Michigan Department of Environmental Quality EQC 2762 (Revised March 1999).

MSU, 2000. *A Citizen=s Guide for the Identification, Mapping and Management of the Common Rooted Aquatic Plants of Michigan Lakes*, Department of Fish and Wildlife, Michigan State University, April 2000

Figure 1. Transect Locations with Sampling Point Densities - Upper Herring Lake, Benzie County, Michigan - July, 2002.

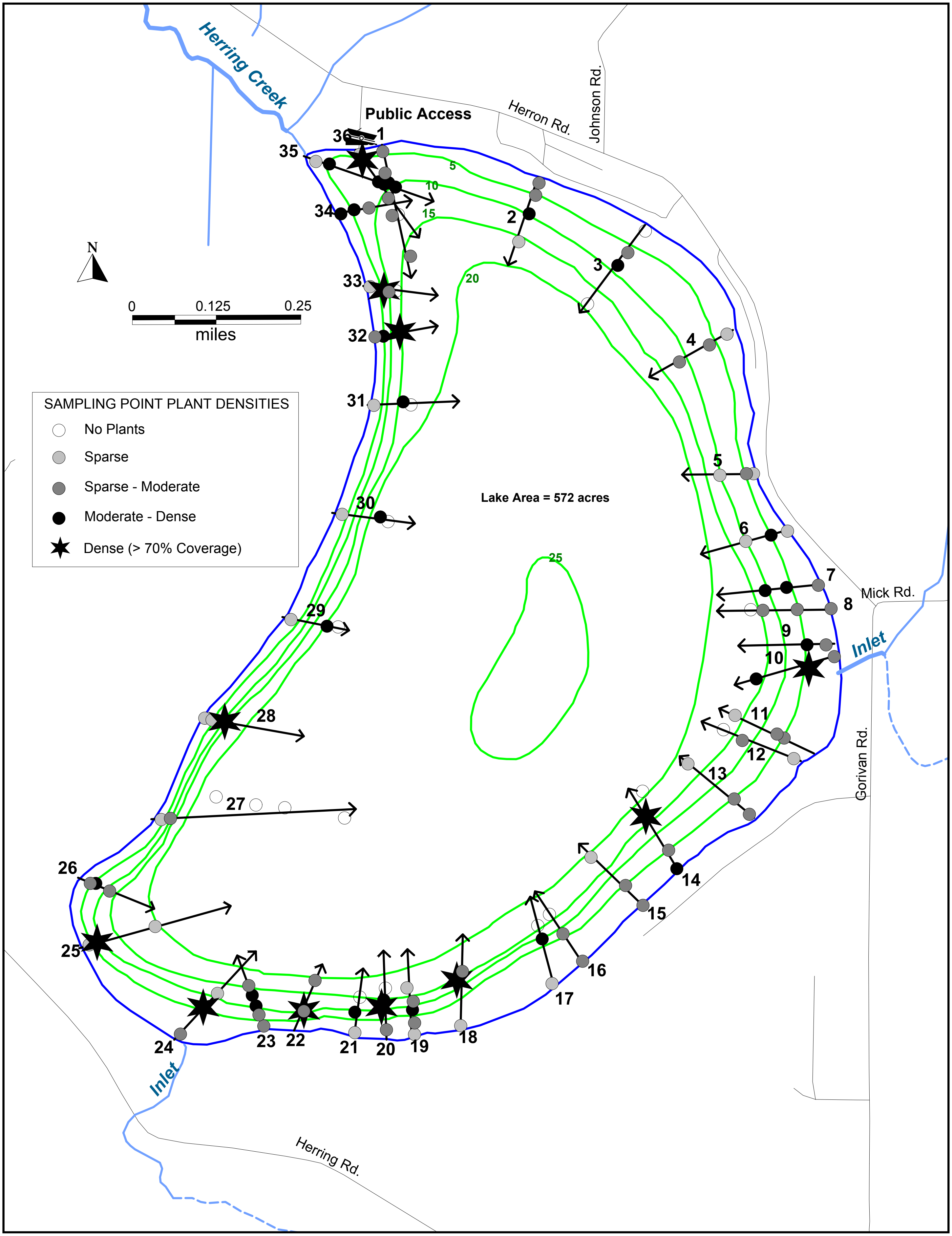

Figure 2. Transect Locations with Sampling Point Densities - Lower Herring Lake, Benzie County, Michigan - July, 2002.

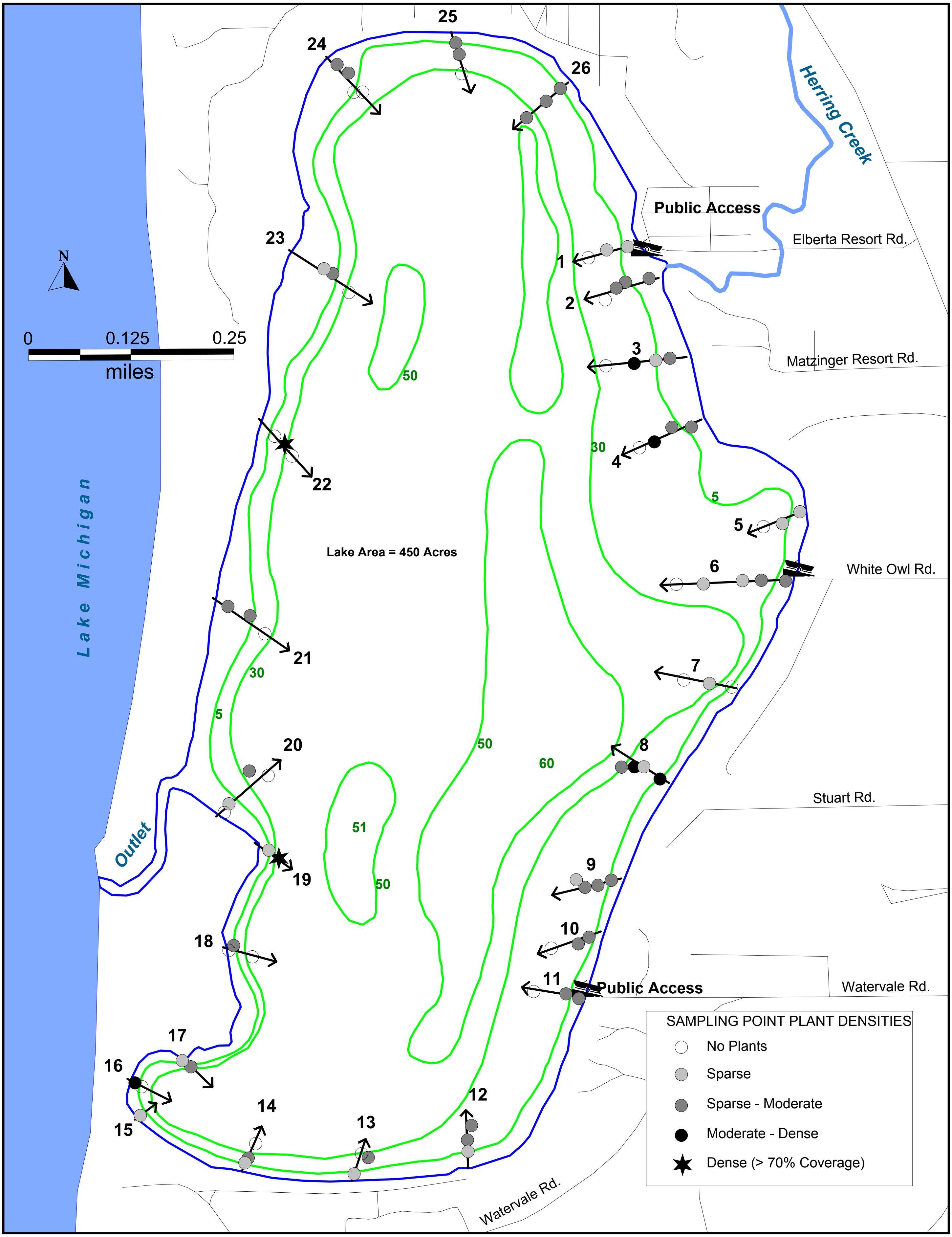

Figure 3. Estimated Littoral Zone Area of Upper Herring Lake with Locations of Dense (>70% Coverage) Plant Growth.

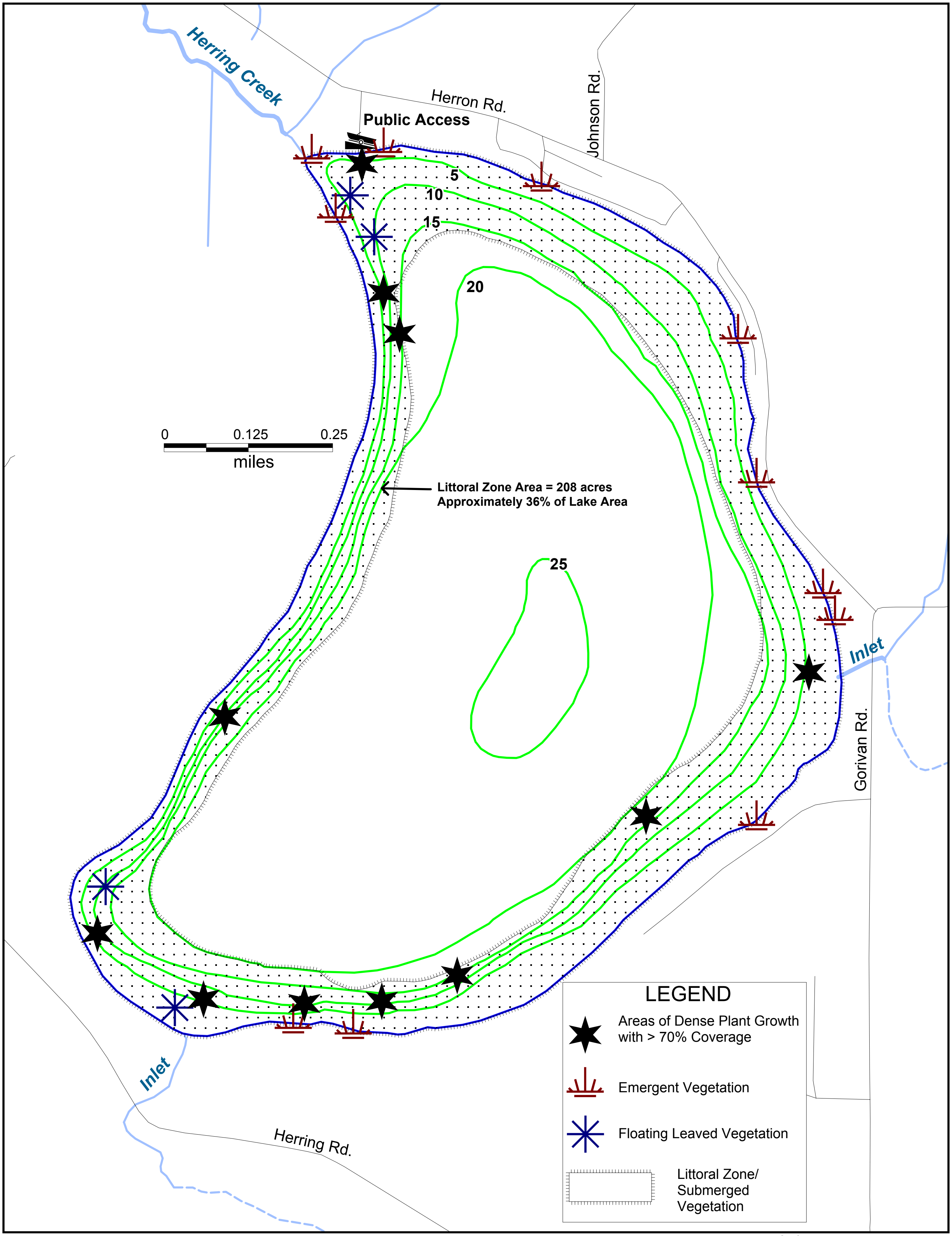

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Figure 4. Estimated Littoral Zone Area of Lower Herring Lake with Locations of Exotic Species.