Aquatic Plant Management Goals & Objectives

The goal of the Lake Noquebay Rehabilitation District is to: **Develop and implement a sustainable aquatic plant management program for Lake Noquebay to reduce variable-leaf milfoil dominance and maintain the navigational potential of the lake while protecting fish and wildlife habitat.** To achieve this goal specific management objectives have been identified and targets have been set to gauge success and guide selection of management options.

Goal: Develop a sustainable aquatic plant management program for Lake Noquebay.

A sustainable aquatic plant management program will be cost-effective, socially acceptable and should, as much as possible, be relatively easy to repeat as needed. In determining cost effectiveness the District needs to consider annual management cost, duration of control and permitting requirements.

Objective: Increase efficiency and effectiveness of the current aquatic plant harvesting program.

Since the District has already invested heavily in a successful aquatic plant harvesting program emphasis should be placed on increasing the effectiveness of the program and looking for efficiencies to reduce cost and/or better meet the needs of LNRD members. Annual evaluation of the harvesting program will be easier if adequate records are kept and presented in a clear manner.

Target – Collect detailed records of annual harvesting efforts and areas harvested.

Keeping the harvesters in good repair and replacing equipment at the optimal times to reduce maintenance costs can minimize the cost of the harvesting program.

Target – Implement a routine maintenance program to reduce harvester downtime.

The Wisconsin Waterways Commission harvester grant program cedes any interest in cost-shared equipment after 10 years. Assuming additional grant funding is available it makes sense to replace harvesters after 10 years when their re-sale value is greatest.

Target – Continue replacing harvesters on a 10-year cycle as state grant funds allow.

While aquatic plant harvesting is the primary aquatic plant management tool employed by the District, other alternatives should be explored.

Objective: Explore other aquatic plant management options for potential effectiveness, cost and public acceptability.

A review of common aquatic plant management alternatives is explored on page 44. The alternatives should be reviewed and updated as conditions on the lake change or new management alternatives become available.

Target - Provide District members with copies of the management plan to educate them about various management alternatives.

An aquatic plant management program that is sustainable over the long-term also needs to adapt as environmental conditions and aquatic plant populations change. To make the required adjustments

those responsible for making management decisions need current information upon which to base their decisions.

Objective: Track changes in the aquatic plant population so to evaluate management efforts.
The recommended frequency of plant surveys depends on the frequency of changes in management methods. When new management methods are adopted surveys should be completed to track changes and determine management effectiveness. If, however management is routine the amount of time between plant surveys can be lengthened.

Target - Conduct pre and post management aquatic plant surveys to evaluate effectiveness of new management tools.

Target - Conduct a full point/intercept survey of the lake every 10 years unless management conditions call for more frequent surveys.

Even in the absence of formal point/intercept surveys landowners and the aquatic plant harvesting crew should be routinely monitoring the lake for early detection of new invasive species.

Target – Train volunteers and aquatic plant harvesting crew in aquatic plant identification and aquatic invasive species monitoring methods.

Target - Conduct annual surveys of the lake for new aquatic invasive species according to DNR AIS monitoring protocol.

For any management program to be sustainable LNRD members need to understand and take ownership of the program. Good communication is essential so members are realistic about the expected outcomes and understand what they as landowners can do to help.

Objective: Increase efforts to effectively communicate with LNRD members.
Annual meeting reports, while important, do not reach a significant portion of the membership. To increase the scope of its communication and education efforts the District Board should use other avenues to reach LNRD members. This could include assisting with the formation of a Lake Association that could help with education and communication efforts.

Target - Publish a regular newsletter to keep members informed about management practices and outcomes, and to share success stories.

Target – Develop a website to help disseminate information.

Target - Provide aquatic invasive species educational materials to members.

Goal: Prevent variable-leaf watermilfoil (VWM) dominance in Lake Noquebay.

The impetus for forming the LNRD and managing aquatic plants was the rapid expansion of VWM, which, at one time rendered hundreds of acres of Lake Noquebay unnavigable. Currently VWM can be found in abundance in most waters between 3 and 10 feet deep in an area that covers approximately 1,000 acres, or 40% of the lake. Throughout the Lake VWM is still the species primarily responsible for nuisance conditions.

There are no management tools currently available that will allow for the eradication of VWM from the lake. Also, most aquatic plants are opportunistic and any areas that can support plant growth will

be colonized in short order if plants are removed. Invasive species and certain aggressive natives such as VWM are especially good at colonizing available habitats. For this reason it is unrealistic to try and eradicate milfoil or any other aquatic plants from areas that will support them. The only realistic objective is to reduce the abundance of nuisance species.

Objective: Choose management practices that allow selective control of variable-leaf watermilfoil whenever possible.

A plant can be "controlled" by reducing its frequency (where it is found in the lake) and/or by reducing its abundance (the amount, or density of plants at a location). Various management strategies differ in method of control and in the potential to selectivity control milfoil. These differences can be found in the review of aquatic plant management alternatives on page 44. The current harvesting program works primarily by reducing milfoil abundance and creating room for native plants to grow. Many of these native plants, including bushy pondweed and stonewort are low growing plants that seldom cause nuisance conditions. Increasing the frequency and density of these good aquatic plants will alleviate nuisance conditions while preserving habitat.

Target - Decrease variable-leaf watermilfoil abundance in the lake.

Target - Increase the frequency and abundance of stonewort, bushy pondweed and other species where experience shows them to be beneficial (or at least less of a nuisance).

There are still areas in the lake where native species dominate and VWM is rare. Extra care should be taken in these areas to prevent radical disturbances that will open areas and invite milfoil expansion.

Target – Prevent spread of variable-leaf watermilfoil in areas that are currently dominated by native pondweeds and other high quality native plant communities.

Goal: Maintain the navigational potential of Lake Noquebay.

Although variable-leaf watermilfoil is the species primarily responsible for nuisance conditions in Lake Noquebay, it is not the only species capable of obstruction navigation. Many of the larger pondweeds, coontail, and other species have the potential to grow to the surface and become a problem. To maintain navigation on the lake areas with dense vegetation at the surface should be managed even when dominated by otherwise "good" aquatic plants.

Objective: Manage vegetation in all areas where navigation and recreation are restricted due to dense plant growth.

When managing areas of excessive plant growth efforts should be made to prevent unnecessarily opening the areas to invasion by VWM. Methods should be chosen that address the nuisance conditions but do not remove all plants.

Target – Outside of Critical Habitat Areas, eliminate areas where navigation is seriously hindered due to canopy forming plants.

Target – Where pondweeds and other desirable vegetation are dominant prevent shifting the population to VWM.

Goal: Protect fish and wildlife habitat on Lake Noquebay.

Lake Noquebay is a locally and regionally important resource for anglers and hunters alike. Its know widely for its abundant bass and bluegill populations as well as northern pike, walleye and Musky

fishing. The lake and the 1,300-acre Lake Noquebay Wildlife Area to the east are also popular with waterfowl hunters.

Since aquatic vegetation is such an important habitat component on Lake Noquebay, aquatic plant management options should be evaluated for their potential effects on fish and wildlife populations. Extra care should be taken when managing uncommon habitat types and/or habitat known to be critically important.

Objective: Protect critical habitat on Lake Noquebay.

Sine the inception of the harvesting program the Department of Natural Resources has prohibited the harvesting of emergent and floating-leaf vegetation on the lake. These habitat types are relatively uncommon and provide spawning and nursery habitat for fish as well as absorbing wave energy and reducing shoreline erosion. The DNR has also restricted harvesting in Finnegan's Bay as it is home to a high quality submersed plant community that has resisted VWM invasion.

In 2006 the DNR delineated critical habitat areas on Lake Noquebay. The final results were published in 2009 in the Lake Noquebay Critical Habitat Designation Report. The result was the designation of 11 distinct critical habitat, or "sensitive areas" as shown in figure 16. Restrictions on aquatic plant management within the designated areas include:

- (LN1) No aquatic plant harvesting;
- (LN2) Protect emergent vegetation; and
- (LN3 – LN11) Aquatic vegetation removal limited to maintaining a 30-foot navigation channel to docks with a Wisconsin DNR permit.

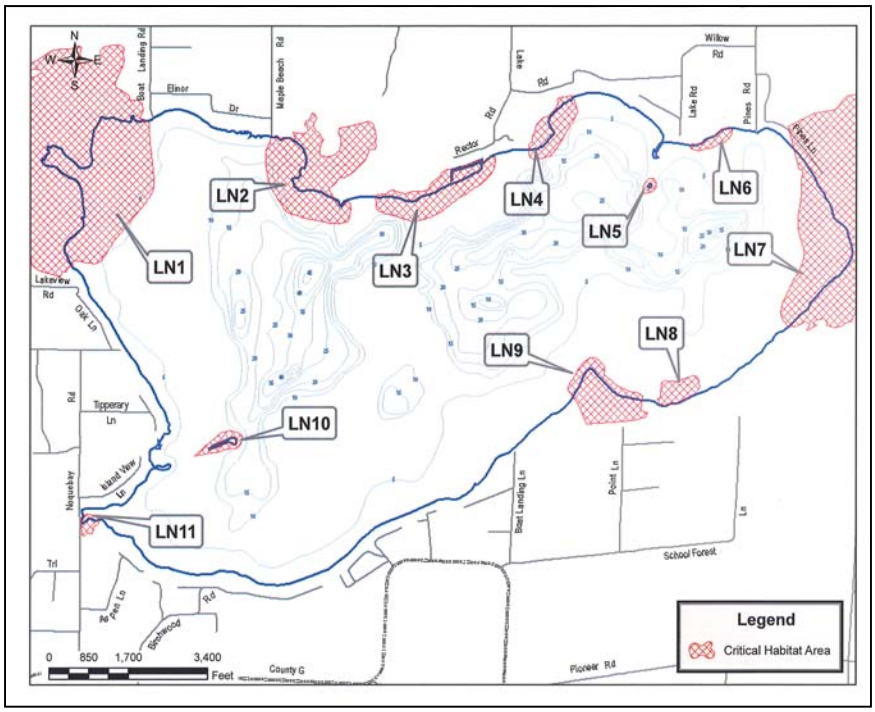

Figure 16. WDNR designated Critical Habitat Areas.

Target – Incorporate critical habitat recommendations into harvesting plan and any future aquatic plant control strategies.

Scattered emergent vegetation outside of designated critical habitat areas also provide important spawning habitat for centrarchid fish (bass, bluegill & sunfish) and should be protected. These areas also provide spawning habitat for yellow perch, nursery areas for juvenile fish, feeding areas for gamefish, and waterfowl habitat.

Target – Protect Emergent vegetation where it occurs outside of officially designated critical habitat areas.

Aquatic Plant Management Alternatives

A successful aquatic plant management strategy must be tailored to the plants and water body in question and will typically utilize multiple control methods as appropriate. A comprehensive review of aquatic plant management alternatives follows. While each of the alternatives may be beneficial in certain situations, not all are applicable to managing aquatic plants in Lake Noquebay.

Do Nothing

Doing nothing is inexpensive, easy to do, and relatively uncontroversial. In rare cases it can also be effective. Lakes are complicated ecosystems and aquatic plant populations fluctuate within them due to a variety of factors. Large-scale climactic conditions and local weather cycles can impact water levels, temperature, and clarity, all of which effect aquatic plant growth. Plant populations also vary because of disease, species introduction, competition and other internal processes. Left to its own devices the plant community in Lake Noquebay will continue to change over time.

However, In the case of variable-leaf watermilfoil, history shows that doing nothing will likely lead to milfoil domination of the aquatic plant community. There is no reason to believe that a hands-off approach will lead to natural declines in the variable-leaf watermilfoil population.

Chemical Control

When properly planned and executed, chemical control of aquatic plants can be effective. However, if care is not taken in the selection, timing, and application of aquatic herbicides the results can be less than desirable, or worse, have unintended negative consequences.

There are several herbicides approved for aquatic use in Wisconsin, each with differing modes of action and species it controls. Contact herbicides kill exposed plant material but can leave the root system intact. Plant re-growth can be problem with these types of herbicides. Systemic herbicides are transported to the roots and kill the entire plant. Systemic herbicides provide longer-term control but may act slower than contact herbicides. Herbicides can also be grouped into two general groups, "broad-spectrum" and "selective". Broad-spectrum herbicides control a broad range of plants. Selective herbicides, as the name implies, are more-or-less selective and control fewer species while leaving many others unharmed. Often selectivity is a function of timing or concentration of the herbicide.

Variable-leaf watermilfoil (VWM) is susceptible to several common aquatic herbicides. The plant is especially susceptible to formulations of 2,4-D. Since most pondweeds and many other native aquatic plants are resistant or only slightly susceptible to 2,4-D the chemical can be used to selectively control milfoil while protecting many native species (Parsons, 2001). Cost depends primarily on the chemical formulation and application rate. In 2009 the actual cost to treat Eurasian milfoil in three Marinette County Lakes with 2,4-D at a rate of 150 lbs/ac was $700 per acre. In water over 10 feet deep the rate was increased to 200 lbs/ac at a cost of $900 per acre.

Fluridone has proven effective for the selective control of VWM when used at concentrations of 10 ppb or higher. However, due to its mode of action it is only appropriate for whole lake treatments. Fluridone is very slow acting and needs to be maintained at the proper concentration for 60 to 120 days to achieve effective control (ENSR, 2005). It is reported that fluridone application costs range from $500 to $2,000 per acre depending on the form of fluridone used and any necessary re-treatment needed to maintain the required concentration. At the concentration required for VWM control negative impacts on non-target species can be expected.

Triclopyr is a fast acting systemic herbicide that also shows promise for selective control of VWM. While milfoil control is excellent, pondweeds and other monocotyledonous species are minimally affected at label doses (ENSR, 2005). Costs for Triclopyr treatments range from $600 to $800 per acre.

With the use of selective herbicides it is possible to get multi-year control of VWM. This is most likely to be achieved when the native community is relatively vigorous and can resist VWM reestablishment. Eventually VWM will return so even selective management will have to be repeated on a regular basis.

Improper or excessive use of aquatic herbicides can have unintended consequences. Widespread use of broad-spectrum herbicides can leave large areas of suitable habitat exposed to colonization by nuisance species. Many of the more common nuisance plants, such as VWM, are aggressive pioneer species that can quickly invade disturbed areas. The decomposition of tons of aquatic plants also releases large amounts of nutrients to the water column. These nutrients can trigger algae blooms and fuel additional aquatic plant growth

Chemical treatment of aquatic plants in Wisconsin always requires a permit from the Wisconsin DNR. This is to ensure that the proposed chemical treatment will use appropriate chemical(s), at the correct concentration and at the proper time of the year. In almost all situations the chemical must be applied by a Wisconsin Department of Agriculture Trade and Consumer Protection licensed applicator.

The LNRD does not currently use chemical treatment as a management tool. Individual landowners can apply for permits from the DNR. Currently there are no State cost-share programs that will provide funding for the chemical treatment of VWM

Benthic Barriers

Benthic, or sediment barriers cover the sediment and prevent the growth of aquatic plants. The barriers work by physically disrupting plant growth or eliminating light at the sediment surface. When installed properly benthic barriers are very effective at eliminating all plant growth. However the difficulty of installing and maintaining these barriers prevent their widespread use.

Benthic barriers can be made of naturally occurring materials (sand and gravel) or artificial (synthetic plastic sheeting). Sand or pea gravel is commonly used to create weed free swim areas. However, there are several common problems with sand and gravel benthic barriers. If deposited on soft sediment it can sink in and mix with the native sediment. Also, over time new sediment is deposited on top of the barrier. All of these factors will lead to failure of the barrier.

Artificial barriers typically consist of sheets of polypropylene, polyethylene, fiberglass or nylon (Wagner 2004). All must be weighted to hold them in place against water currents, waves, and boat wake. If constructed of non-porous material benthic barriers will be subject to billowing and may float free of the sediment as gasses from decomposition build up beneath them. Porous barriers are less subject to billowing but plant fragments that settle on top are better able to root through them. Both types of barriers require annual maintenance since sediment accumulation on top of the barriers will build up and support new aquatic plant growth. Artificial benthic barriers are difficult to install and maintain. Maintenance consists primarily of annually removing accumulated sediment, which typically requires removal and replacement of the barrier. The use of any type of benthic barrier requires a DNR permit.

Dyes and Floating Covers
Dyes are liquid chemicals that are applied to change the color of the water. Covers physically cover the water surface. Both control aquatic plants by reducing the amount of light reaching the sediment.

Dyes typically color the water a deep blue or even black. For small ponds they are relatively inexpensive, long lasting, and effective. Effectiveness is limited in shallow water (2 feet or less) where the light reduction is seldom enough to prevent plant growth. Dyes must stay in the water throughout much of the growing season. Because of their dark color, dyes increase light absorption and can result in higher water temperatures. The increase water temperature can in-turn result in stronger stratification, increased algae growth, lower dissolved oxygen and widespread changes in the aquatic community (Wagner 2004). Dyes are not an option in larger lakes and those with significant outflow.

Floating covers disrupt plant growth by reducing light levels at the sediment surface. However, unlike dyes the floating covers prevent virtually all water use while they are in place. Floating covers can be difficult to install and effectively anchor and are not practical for use in large areas.

Both dyes and floating covers require DNR permits. The main permitting issue with floating covers is the disruption of public water rights (fishing and navigation) that they cause while installed.

Harvesting
Aquatic plant harvesting is a widely accepted aquatic plant management alternative that can be effective on a large or small scale. Individual landowners often manually clear small areas around their dock or swim area. Typically this is accomplished by using one of several specially designed aquatic plant rakes and/or hand-held cutting implements. Under current Wisconsin Law landowners can manually harvest plants without a permit if the plant removal is not in a DNR designated sensitive area and is limited to a 30-foot wide area (measured parallel to shore). There is no limit on how far out into the lake a landowner can harvest by hand if they stay within the 30-foot wide corridor. The control area must be around existing piers, boat lifts, and swim rafts and the cut plants must be removed from the water.

In Lake Noquebay, large scale harvesting is done with three specially designed aquatic plant harvesters. These machines are capable of cutting plants in a 10-foot wide swath up to 6-feet deep. Plants are cut and collected in one operation and each machine can hold more than 16,000 lbs of vegetation.

Like most aquatic plant management alternatives harvesting seldom eliminates plants. Much like cutting your lawn, harvesting leaves the root system intact and plants will re-grow. In some cases repeated harvesting close to the sediment surface can stress plants enough to cause mortality. Species that depend on seed production for their spread may be partially controlled by harvesting if seeds are repeatedly removed. Plants that spread by fragmentation such as VWM and coontail can actually be spread through harvesting when cut fragments escape the harvester and drift to other areas of the lake.

As a management tool harvesting is only minimally selective and most appropriate where nuisance species are dominant and widespread. Harvester operators can control where they cut but it is impossible to target individual species that grow in mixed assemblages.

Plant re-growth depends on the species present, timing of harvest, and cutting depth. Studies have shown that very deep cutting with specialized harvesters can even have multiple year effects on milfoil and other aquatic plants.

Repeated harvesting can also have impacts on the aquatic plant community that go beyond the initial cutting. In Lake Noquebay repeated harvesting has led to measurable shifts in the aquatic plant community. When harvesting began in 1978 the lake was dominated by VWM. After 28 years of harvesting the plant community has changed noticeably. Harvesting tonnage has gone down and many areas of the lake are dominated by muskgrass and bushy pondweed, low growing natives that typically stay below the maximum cutter depth. Many pondweeds and other native species can also be found growing with the VWM. Repeated harvesting of the VWM prevents it from forming a canopy and shading out other vegetation.

Large Scale mechanical harvesting is an expensive proposition. The LNRD currently spends more than $96,000 per year (2009) to operate its harvesting program. This includes operation & maintenance costs for three 10-foot harvesters as well as funds to replace aging equipment. Capital equipment costs are also quite high. A new harvester can range from $50,000 to $100,000 depending on the size of machine and options. Other necessary equipment includes a truck to transport plants to a disposal site and a shoreline conveyor to transfer cut plants from the harvester to the truck. Wisconsin does provide financial assistance for harvester and related equipment purchases through the Wisconsin Waterways Commission. Grants are awarded on a competitive basis and cover 50% of equipment purchase price. The LNRD has received grant funding for all of the harvesters and shoreline conveyors currently in use.

Mechanical harvesting requires a Wisconsin DNR approved aquatic plant management plan and permit. The approved management plan is also a requirement for receiving a Waterways Commission grant for equipment purchase.

Dredging

Typically a practice known for increasing depth to aid in navigation, dredging can also be an effective, and expensive, aquatic plant control technique. As a plant control measure dredging has two primary modes of action: changing sediment type, and increasing the depth to sediment.

Where a layer of nutrient rich organic sediment overlies a nutrient poor layer of mineral soil the organic layer can be removed to expose the sand or gravel layer that is less capable of supporting plant growth. Typically such removal will change the plant community structure, not eliminate all plant growth. Removing the upper layers of sediment also eliminates plant roots and most viable seeds. Unfortunately, the result of organic sediment removal is seldom long lived since many plants will colonize mineral soil where they quickly begin the process of building new organic matter. Very little organic matter is needed to support dense plant growth.

Eliminating all submersed aquatic plants requires dredging the lake to a depth where light availability limits plant growth. In Lake Noquebay the lower limit of aquatic plant growth is about 14 feet with sparse plant growth beyond the 12-foot depth.

There are two major types of dredging, hydraulic and mechanical. Hydraulic dredging is accomplished by pumping a sediment/water slurry out of the lake to a disposal/dewatering area. Hydraulic dredging is best suited to loose organic sediment. Mechanical dredging employs heavy equipment deployed on barge or shore to dig out the sediment and transfer it to trucks for removal.
It should come as no surprise that dredging is typically a very expensive alternative. Rough estimates for mechanical dredging range from $8.00 to $25.00 per cubic yard (Wagner 2004) depending on the type of sediment, accessibility and disposal costs.

As a practical matter, large scale dredging to reduce VWM growth on Lake Noquebay would not be feasible. While VWM grows best in muck it can grow in any firm sediment. As a management tool in very limited areas it may be of some benefit but, as mentioned, in shallow areas the benefit is not long lasting.

Any type of dredging requires, at a minimum, a Wisconsin DNR and US Army Cops of Engineers permit. Permits must describe in detail the scope of the proposed dredging, dewatering and disposal of spoils, and the effects the project will have on fish, wildlife, and public water rights.

Drawdown

Temporarily lowering water levels (drawdown) can be a valuable aquatic plant management tool. Its effectiveness depends on the season and duration of the drawdown. Currently the water level in Lake Noquebay is drawn down each winter by 1.5 feet (19 inches). The drawdown was first implemented in an effort to help control milfoil. It was thought milfoil at the surface would freeze in the ice and could be uprooted when the water was raised in the spring. While it never worked as intended the drawdown was continued because it significantly reduces the amount of shoreline damage from ice heaving. The winter drawdown does help control aquatic plants in very shallow water (less than three feet deep).

Winter drawdown controls plants by exposing their root systems to freezing conditions. In winter the duration of the drawdown is less important than the timing. It is important that frost penetrates to the root zone before snow insulates the lakebed. Summer drawdown, on the other hand, kills some species through desiccation of the root system. This is often difficult in organic sediments since they retain moisture. Also, many plants are stimulated by changing water levels and can increase with summer drawdown.

The response of aquatic plants to drawdown is well known for some species but not for others. To complicate matters, accounts in the scientific literature do not always agree. Table 1 lists the species found in Lake Noquebay and their reported susceptibility to winter drawdown according to Nichols (1991). While its susceptibility to winter drawdown is listed as variable, the lack of VWM in shallow waters of Lake Noquebay suggests it is adequately controlled by repeated winter drawdown.

The primary drawbacks to drawdown include loss of recreational use during the low water period (minimal with a winter drawdown) and potentially lowering water levels in shallow wells adjacent to the lake. Other impacts may include unintended effects on fish and aquatic life. Since Lake Noquebay has ample deep water a limited drawdown has little direct impact on fish.

The maximum drawdown is controlled by the height of the dam and the downstream water elevation. The sill of the Noquebay dam is 3.6 feet below the normal pool elevation and 2 feet below the currently permitted winter drawdown level. Since there is approximately a foot of backwater even at low flows the water level in Noquebay could only be reduced by another foot during the winter months. Not enough to have a significant effect on VWM distribution.

Decreases	Variable response / Unknown	Increases
White water lily	Variable-leaf watermilfoil (V)	Coontail
Spatterdock Lily	Muskgrass (V)	Bushy pondweed
Common bladderwort	Variable leaf pondweed (V)	Floating-leaf pondweed
Robbins pondweed	Small pondweed (V)	Water celery
	Large-leaf pondweed (V)	Hard-stem bulrush
	White-stem pondweed (U)	
	Common waterweed (V)	
	Flat-stem pondweed (V)	
	Northern watermilfoil (V)	
	Illinois pondweed (U)	
	Stonewort (U)	
	Sago pondweed (V)	
	Richardson's pondweed (V)	

Table 1. Response of common aquatic plants to winter drawdown.

Automated Mechanical Bottom Disturbance

Several automated systems exist that control plants by physically disrupting them throughout the growing season. Modes of action include physically raking, rolling, or spraying the sediment with jets of water. The Weed Roller™ is one of the more common devises. It has a central motor that attaches to a dock, boatlift or other fixed point. The motor drives a series of cylindrical rollers back and forth across the bottom of the lake in an arc of up to 270 degrees. Fins on the rollers disturb the sediment and plants, removing existing plants and preventing the establishment of new ones.

In two studies weed rollers were found to cause a significant reduction in fine sediment and a nearly complete elimination of aquatic plants (James 2004, James 2006). Sediment removed from the site was often fond to be deposited immediately outside of the impacted area.

These devices are only appropriate for small areas in shallow water to maintain swimming areas etc. Negative environmental impacts include sediment disturbance, which may lead to local increases in turbidity and suspended phosphorus. This may lead to major nutrient increases if the practice is widespread. While studies have not been conducted on the impact these devices have on aquatic organisms, the periodic bottom disturbance likely reduces or eliminates many aquatic insects and would surely prevent successful fish spawning in the impacted area.

Cost for the Weed Roller™ starts at approximately $3,000 for motor, mounting hardware, and a 21-foot roller. Other comparable devises have similar price tags. This and other automated mechanical bottom disturbing devises require a Wisconsin DNR permit.

Control/Reduce Nutrient Inputs

Aquatic plant response to nutrient input varies by species and source of nutrients. For the most part, rooted aquatic plants absorb their nutrients through the root system so nutrient additions to the sediment are more important than dissolved nutrients in the water column. Dissolved nutrients however can become sediment bound nutrients when they fuel algae growth that dies and sinks to the bottom.

Studies have shown that many aquatic plants are particularly stimulated by nitrogen additions to the sediment. Rogers (1995) reported that nitrogen additions to sediment significantly increased wild celery growth. Nitrogen is a water-soluble nutrient. Septic systems intensive irrigation and excessive

nitrogen fertilizer use have all been shown to cause increased nitrogen concentrations in groundwater. Reducing these sources of nutrients will help control aquatic plant growth and expansion in the lake.

Biological Plant Control

Biological control (biocontrol) typically utilizes bacteria, fungi, or insects to control an unwanted plant. Biocontrol of exotic species often involves finding the natural control mechanism in the exotic plants country of origin and importing it to the US. Since there is always a risk that introducing a new organism may lead to unintended impacts to non-target species a lot of study is required to approve the use of new biocontrol agents. Currently there are no known biocontrol agents that target VWM specifically.

The use of grass carp, an exotic fish species that feeds on vegetation, has also been used to control unwanted vegetation in lakes. However, grass carp typically prefer native pondweeds to milfoil so they can increase milfoil dominance in a lake. Grass carp also uproot vegetation and stir up the bottom, greatly increasing turbidity and dissolved nutrients in the overlying water. In many lakes the introduction of grass carp for vegetation control has lead to massive algae blooms and a near complete destruction of the plant community. For this and other reasons the Wisconsin DNR prohibits the introduction of grass carp into Wisconsin waters.

Exotic Species Monitoring and Prevention

As is often the case, an ounce of prevention is worth a pound of cure. With exotic species this is doubly true. In most lakes, and for most exotic species the primary mode of introduction is by boat, boat trailer, or bait bucket.

Once established in a water body it is extremely difficult to eradicate an exotic species. In the few cases where eradication has been successful the introduction was detected early. For this reason routine monitoring to detect new invasive species is an important step in any aquatic plant management effort. The Wisconsin DNR and University of Wisconsin Extension have many good publications and websites to help the layperson identify exotic species. Periodically these agencies also offer exotic species identification and control training to landowners.

The DNR also provides grants and training to conduct watercraft inspections and provide educational materials at boat landings. The "Clean Boats, Clean Waters" program utilizes volunteers and/or paid staff to hand out educational materials at boat landings that educate boaters about practices they can use to reduce the likelihood of spreading aquatic invasive species between lakes. As a locally and regionally important resource, Lake Noquebay is at high risk of additional AIS invasions from nearby Green Bay and is a likely source for the spread of zebra mussels to other inland lakes.

Aquatic Plant Management Recommendations

Since the District has already invested a great deal of time and money in a successful aquatic plant harvesting program the plan should focus on increasing the efficiency of aquatic plant harvesting. At the same time, the District needs to explore all available options to maintain navigation and control variable-leaf watermilfoil.

Recommendation #1 – Continue harvesting to maintain the navigational and recreational potential of the lake.
The current harvesting program has proven effective at reducing excessive aquatic plant growth on Lake Noquebay and remains more economical than other large-scale aquatic plant management options, including repeated chemical control. The LNRD should continue to implement the harvesting program outlined in Figure 17, and described in table 2, to prevent aquatic plants from impeding navigation on the lake.

Recommendation #2 – Intensively harvest areas dominated by variable-leaf watermilfoil.
Areas dominated by VWM (more than 50% coverage as seen from the surface) should be targeted for the most intensive harvesting as described in table 2. Where possible, the harvesters cutting bar should be lowered to its maximum depth when harvesting these areas. Figure 17 shows areas dominated by VWM during the 2007 survey.

Recommendation #3 – Maintain areas dominated by large pondweeds by reducing harvesting pressure in these areas.
When areas dominated by native pondweeds and other beneficial aquatic plants are impeding navigation they should be harvested at a lesser depth to prevent opening the area to VWM invasion. Past experience has shown that cutting to a depth of 3 feet or less in deep water (> 5 feet) will provide relief from nuisance conditions while preserving the existing plant community. The downside to reduced cutting depth is increased cutting frequency, but the payoff is a healthier aquatic ecosystem. Figure 17 shows areas that were dominated by native pondweeds and had good plant diversity during the 2007 survey.

Recommendation #4 – Take advantage of state cost-share dollars and replace equipment on a routine basis.
The Wisconsin Waterways Commission continues to provide 50% cost-share assistance for the purchase of aquatic plant harvesting equipment. The Commission retains an interest in the equipment for 10 years after which time the grant recipient has full ownership of the equipment. The LNRD should continue to replace its harvesting equipment on a 10-year schedule to receive maximum benefit from the grant program while getting the best price when selling the used equipment.

Recommendation #5 – Continue winter drawdown on Lake Noquebay.
The winter drawdown is at least partially responsible for the sparse vegetation in shallow water (less than 2 feet) and reduces shoreline damage from ice heaving. It should be continued as practiced.

Recommendation #6 – Protect critical fish spawning and nursery areas on Lake Noquebay.
Do not harvest aquatic plants in Wisconsin DNR designated sensitive areas except to maintain a 30-foot wide corridor between open water and docks as recommended in the Lake Noquebay Critical Habitat Designation Report (Appendix B). Mechanical and manual harvesting of plants within designated critical habitat areas requires a WDNR permit. A detailed map of critical habitat areas should be kept on the harvesters at all times for reference.

Recommendation #7 – Explore alternative management options as they become available.
While harvesting is currently the most cost effective method of controlling aquatic plant growth in the lake, changes in the plant community and new developments in aquatic plant management may call for new approaches. The LNRD board should keep and open mind and evaluate alternatives as conditions change and new management options become available.

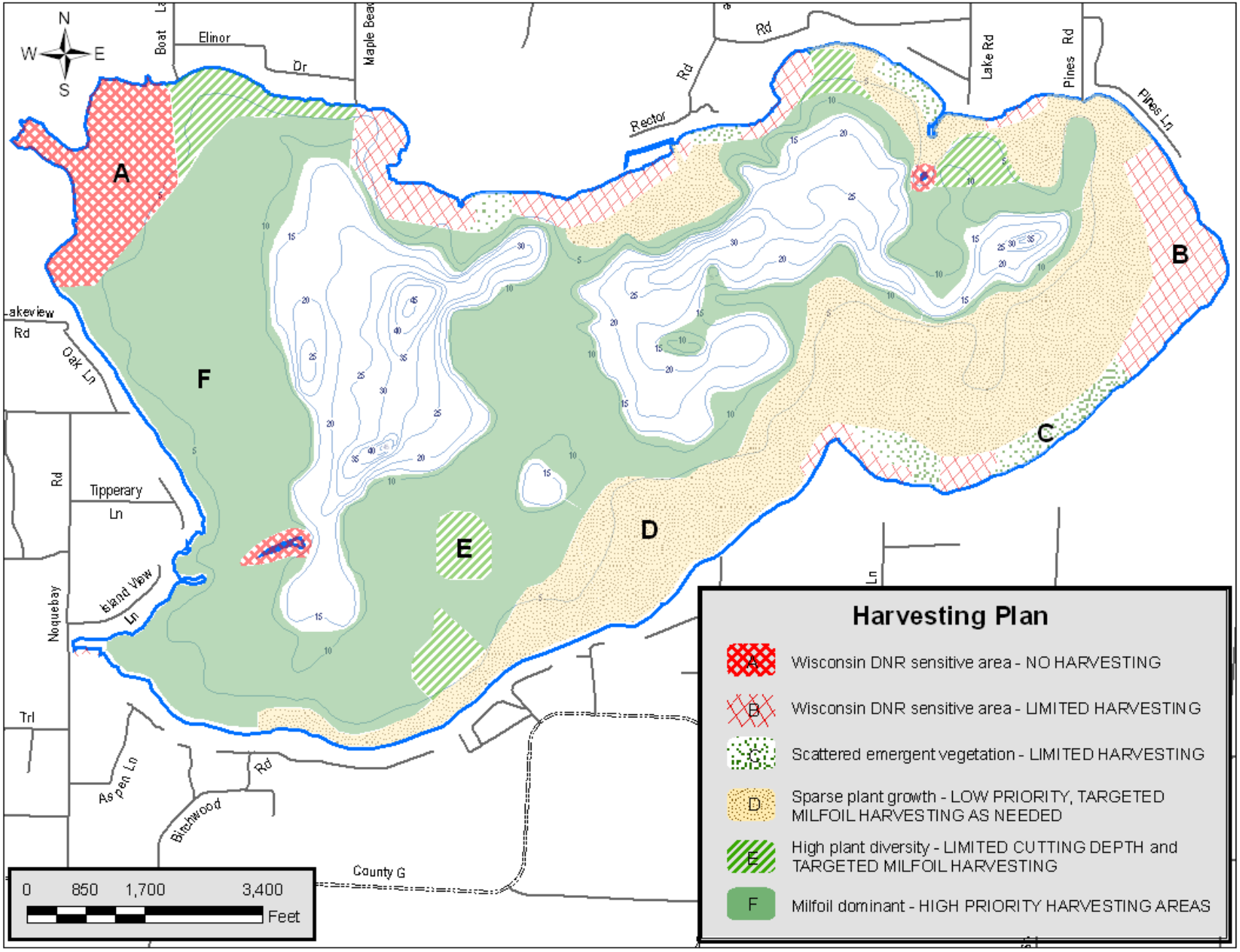

Figure 17. Recommended harvesting plan map for Lake Noquebay

Area	Zone	Acres	Description & Management Measures
A	Wisconsin DNR identified sensitive areas	96	Selected areas of the lake that contain significant stands of emergent plants (rushes, wild rice etc.) and/or floating-leaf plants (water lilies) that provide important fish & wildlife habitat, or contain other important fish spawning habitat. These areas do not front on developed properties and should be preserved.
			No harvesting of aquatic plants in these areas.
B	Wisconsin DNR identified sensitive areas	152	Selected areas of the lake that contain significant stands of emergent plants (rushes, wild rice etc.) and/or floating-leaf plants (water lilies) that provide important fish and wildlife habitat, or contain uncommon fish habitat. These areas should be preserved.
			Mechanical harvesting of emergent and floating-leaf plants is limited to a 30-foot wide corridor to allow boat access to docks. Boating corridors should be sited and/or combined as needed to minimize the impact on emergent and floating-leaf aquatic plants.
			LNRD shoreline cleanup of dead and dislodged plant material around docks is allowed where practical and the plants can be accessed without destroying emergent and floating-leaf plants.
C	Scattered emergent plants	48	Areas that contain scattered stands of emergent plants providing important fish and wildlife habitat. Submersed aquatic plants are typically sparse in these areas. Emergent vegetation should be preserved.
			No harvesting of emergent aquatic plants.
D	Sparse aquatic plant growth	509	Sandy areas that typically contain sparse aquatic plant growth. Most submersed plants are low growing native varieties.
			Target harvesting efforts on scattered VWM clones as needed.
E	High plant diversity	95	Areas with abundant aquatic plants that also have excellent plant diversity, including both low growing species and native pondweeds. Dense stands of VWM can also be found growing in these areas.
			Reduce harvesting depth to three feet in mixed plant beds.
			Where found, harvest dense stands of VWM at full depth of cut.
F	Milfoil dominant	921	Areas where submersed aquatic plant growth is typically dense and VWM is the dominant species.
			Harvest as needed to maintain navigation and open the plant canopy.

Table 2. Recommended aquatic plant management measures for Lake Noquebay.

Monitoring and Evaluation Plan

In order to evaluate and make changes to the management program the District needs to keep detailed management records and track changes in the aquatic plant community. The aquatic plant management program for Lake Noquebay needs to be evaluated on a regular basis and changed to meet shifting needs and address new challenges.

Recommendation #4 – Improve record keeping to better evaluate the harvesting program.
Improving record keeping is a quick and inexpensive way to collect important data that will allow the LNRD to evaluate the harvesting program and make necessary changes. The Harvesting Foreman should collect the following information on a daily/weekly basis:

- Size and location of all areas harvested. A GPS should be used to accurately record harvest buoy locations.
- Hours spent harvesting each area
- Number of harvester loads taken from each area.
- Location of the offloading site used.

The previous information should also be collected for shoreline cleanup activities. A sample harvest record sheet is included in appendix E.

Recommendation #2 – Conduct periodic aquatic plant surveys to track changes in the lakes aquatic plant community and evaluate management practices.
Aquatic plant surveys are valuable tools, essential in evaluating new and ongoing aquatic plant management practices. The frequency at which aquatic plant surveys should be conducted depends on changes in management and changes in the plant community.

Survey frequency should be dictated by changes in management practices and the aquatic plant community. Previous aquatic plant surveys of Lake Noquebay were completed in 1982, 1992, 2000, and 2007. Assuming no new invasive aquatic species introductions or obvious changes to the aquatic plant community a complete survey of the lake should be conducted in 2015 and every 8 to 10 years after that. If new aquatic invasive species are discovered, or if unexplained changes in the plant community are noticed a new survey should be conducted immediately. Likewise changes in management practices should be accompanied by aquatic plant surveys to evaluate practice effectiveness. Often these surveys can be conducted on a few representative areas where management changes are implemented.

Future lake surveys should be conducted according to Wisconsin DNR aquatic plant management protocol. Lake-wide surveys should utilize the same sample locations used in 2007. Surveys designed to evaluate new management tools should be conducted before and after treatment and should be scaled appropriately to accurately describe the plant community. DNR or County Land & Water Conservation Department staff should be consulted when designing survey methods.

Recommendation #3 – Continue evaluating the harvesting program and new aquatic plant management practices on an annual basis.
The LNRD Board currently evaluates harvesting activities on a monthly basis. The Board or designated committee should continue to review harvesting data and the plant community and recommend changes to the aquatic plant management program as needed.

Information & Education Plan

A strong information and education effort is an important part of any AIS prevention program. It is also important to effectively communicate with district members when trying to implement a flexible aquatic plant management plan.

Recommendation #1 – Maintain signage at the boat landings and provide educational materials to visitors to Lake Noquebay.
Maintain educational signage at the public boat landings to inform visitors to Lake Noquebay about the danger of AIS and how they can help prevent the spread. Signage should be clear and uncluttered. Handouts should be provided through the "Clean Boats, Clean Waters" program during busy periods. Signage and educational materials can be obtained from the Peshtigo DNR office or on line at Wisconsin Lakes Partnership or UW Extension Lakes Program websites.

Recommendation #2 – Form a Lake Association to assist in educational efforts and other lake and AIS management efforts.
The District should support/assist in the formation of a separate Lake Association to conduct AIS and lake management education. A separate association would free up the District Board to focus on aquatic plant management efforts. While a standing committee of the LNRD could fill the need, a separate association would be eligible for grants to implement AIS education efforts and undertake lake studies.

Recommendation #3 – Publish a regular newsletter, provide educational materials, and update lake residents about AIS management efforts.
A regular newsletter is a good way to distribute educational materials and keep members abreast of lake management issues. With the abundance of home computers in use many members cold receive an e-newsletter, reducing printing and distribution costs. Every member of the District should also be signed up to receive the Lake Tides newsletter, a free quarterly publication by the Wisconsin Lakes Partnership.

Recommendation #4 – Continue as a member of the Wisconsin Association of Lakes and take advantage of their resources.
The Wisconsin Association of Lakes (WAL) is a statewide lake organization that promotes sound lake policy and provides training opportunities for lake groups throughout the state. The District should send a few members each year to the annul lakes convention, a three day event featuring numerous speakers, workshops and presentations concerning lake management, operating effective lake organizations, and current issues of concern to Wisconsin lake residents.

Aquatic Invasive Species Prevention, Monitoring and Rapid Response Plan

Locally, Marinette County is at the front lines of a rapid expansion of Eurasian watermilfoil (*Myriophyllum spicatum*) and curly-leaf pondweed (*Potamogeton crispus*). Even more concerning is the fact that Lake Noquebay is less than 25 miles from the Bay of Green Bay, which is home to almost every invasive aquatic species in the Midwest! The best way to deal with these invaders is to be proactive and prevent their introduction. The LNRD should also adopt an exotic species monitoring plan to detect early invasions and a rapid response plan to deal with new invasive species if they are found.

Prevention

An effective AIS prevention plan should focus on the most common routes of AIS invasion, boats, and water gardens. Boats traveling between lakes can carry plant fragments or exotic mussels attached to the boat or trailer. Water in the boat or bait buckets can carry plants, snails, mussels, zooplankton, algae, and disease causing organisms. While the information and education program can provide valuable information regarding the spread of AIS a more effective case can be made when delivering the message face-to-face.

Recommendation #1 – Participate in the "Clean Boats, Clean Waters" watercraft inspection and information program.

Volunteers should be trained to conduct watercraft inspections at Lake Noquebay public landings and talk to boaters about the danger of spreading invasive species. State grant funding is available to conducting "CBCW" watercraft inspections. Many lake organizations partner with local scout or other youth organization to conduct watercraft inspection and education programs.

Recommendation #2 – Promote/support watercraft inspection and AIS education at nearby source waters.

Studies show it is more efficient to target AIS efforts at the source waters than at the receiving water. In Marinette County the most likely source waters are Green Bay, High Falls Flowage, Cauldron Falls Flowage, and the Menominee River Flowages. The LNRD should promote and support AIS education and watercraft inspection efforts at these waters.

Recommendation #3 – Focus education efforts on the most common modes of AIS introduction.

The most important pathway for introduction of AIS is through the movement of watercraft between waterbodies. Increasingly, however, intentional and unintentional introductions have been traced to private water gardens. A recent investigation of the water garden industry found that plants known to be invasive are available and routinely shipped around the country. Contamination of orders with other species, including invasive species, is also rampant (Maki, 2004). AIS education efforts aimed at lake residents and visitors should focus on these modes of infestation.

Monitoring

Effective management of AIS is much easier when the invader is detected early. In some cases it may even be possible to eradicate an invasive species if it is discovered early enough.

Recommendation #1 – LNRD weed harvesting staff and additional volunteers should be trained to conduct aquatic invasive species monitoring.

All LNRD harvesting staff should be trained to identify aquatic invasive species. Also, while the While the information & education program should equip many District members with a basic knowledge of invasive species, interested volunteers should receive detailed training in AIS monitoring protocols.

The Marinette County LWCD in cooperation with the Citizen Lake Monitoring Network holds workshops to train volunteers in AIS monitoring protocols. Workshop participants receive instructions and materials needed to monitor for the presence of several aquatic invasive species including plants, snails, minnows, mollusks, and zooplankton.

Recommendation #2 – Volunteer AIS monitors should conduct annual AIS surveys of the lake.
Aquatic plant surveys, although very beneficial, are not designed to find many types of aquatic invaders and may even miss pioneer plant invasions. A better method is to look specifically for different invasive species at the optimal time of year and in the most likely habitats. The ideal monitoring time varies by species but can typically be covered with one early season inspection and one late season inspection.

Trained volunteers should conduct annual invasive species surveys. Findings should be reported to the District and the Citizen Lake Monitoring Network. The harvesting crew should carry AIS identification material on the harvesters and marker buoys that can be quickly deployed to mark suspicious plants.

Recommendation #3 – Report any suspected aquatic invasive species to local resource professionals. If any suspected exotic species are found report it immediately to the Peshtigo DNR office or the County LWCD. Collect a sample of the invasive species for positive identification. And mark or record the location of suspect plants.

Rapid Response

When a new invasive species is positively identified the District needs to act quickly. Depending on the species found, length of time since invasion, and where the pioneer colony is found, there may be a possibility for eradication. The following steps should be followed:

Step #1 – Notify LNRD Board and local resource agencies and explore grant funding opportunities. The District Board should immediately arrange a meeting with the Wisconsin DNR to explore control measures and determine if obtaining an AIS Rapid Response grants is appropriate. These grants were designed to deal with pioneer AIS infestations. The typical grant application process is bypassed so grant funds can be made available within weeks in hopes of eradication.

Step #2 – Notify membership of the discovery and what the Board plans to do about it. Notify Lake District members of the discovery and advise them of any measures they can take to prevent its further spread within the lake or to other waters. Let them know how the Board plans on dealing with the invasion.

Step #3 – Conduct a thorough survey of the lake to determine the extent of the AIS infestation. Working with County LWCD or DNR staff, conduct a thorough survey of the lake. Map location of the invasive species and record its density as well as any other physical data that may be important such as water depth, sediment type etc.

Step #4 – Determine if eradication is a possibility or if management is the only option. Work with local resource agencies and outside experts where necessary to determine if eradication is possible. Where eradication is not feasible begin revising the lake management plan to deal with the new species.

Step #5 – Develop an action plan based on species and extent of invasion. Work closely with the experts to develop a customized plan aimed at eradication or control. If outside consultants are needed for things like herbicide treatment or scuba diving bring them into the process. Many consultants can also help with things like mapping and planning.

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