PELICAN RIVER WATERSHED DISTRICT

Ryan M. Wersal, Ph.D.
Minnesota State University, Mankato
Department of Biological Sciences

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Readiness Response Plan for Aquatic Invasive Plants – Eurasian and Hybrid Watermilfoil, Starry Stonewort and Hydrilla

Pelican River Watershed District
Readiness Response Plan for Aquatic Invasive Plants

An "aquatic invasive species" or AIS, is a non-indigenous species whose introduction causes or is likely to cause harm to the economy, environment or human health. This document provides a framework to assist managers in responding thoroughly and professionally to the many challenges which result from new invasions. The value of a readiness response plan is realized only if populations are identified when they are small and manageable.

Each response must be guided by case-specific facts. How a species invades (i.e., their number, density and distribution, proximity to other known invasions, the time of year, water use, and numerous other facts) determines what actions are possible and useful. Instead of pre-determined plans, stakeholders should rely upon an established process to guide decision-making and response actions for each invasion.

The following procedure will guide the response of Pelican River Watershed District (PRWD) and other partners for all newly detected AIS in PRWD Main Lakes (Figures 1-7). This framework outlines the actions required to contain, and if possible, eradicate newly introduced AIS.

Essential Steps

1. **Verification -** An accurate identification of a new invasive species is the important first step. The Minnesota Department of Natural Resources (MN DNR) will have an AIS Specialist verify the species and document location, may be followed by a formal press release from the MN DNR Commissioner's office.
2. **Notification** – After MN DNR official confirmation, communicate to stakeholders (i.e. City of Detroit Lakes, Becker County, Becker COLA, lake association, etc.) a possible infestation has been identified.
3. **Readiness Assessment** - Monitor or hire a contractor to monitor the extent of the infestation. Once the extent is known, collaborate with MN DNR, Aquatic Plant Management Expert, and stakeholders to determine best course of action including: containment, eradication, partial or temporary suppression to control harmful impacts and reduce nuisance, continue to actively monitor and evaluate, or no action.
4. **Planning -** Once a course of action has been determined, secure the needed permits from the MN DNR and perform pre-treatment monitoring if required by the permit. Hire a contractor to perform treatment, either chemical or manual removal, as specified in the permit. And finally, determine how the treatment will be funded.
5. **Readiness Response** -The rapid response is the action or actions taken to quickly contain, and if possible, control newly discovered invaders. Control options include physical, mechanical, chemical and biological methods to remove, destroy and/or suppress invasive species.
6. **Monitoring & Evaluation** - Perform, or hire a contractor to perform, post-treatment monitoring to determine effectiveness. At a minimum, monitoring efforts should focus on treated waters, but should also include adjacent high risk waters when possible.
7. **Communicate & Educate** - Communicate information regarding the AIS treatment/removal and results to all stakeholders. Disseminate the results of the treatment in the region to assist other agencies in the event of an infestation nearby. Distribute educational materials to help prevent future AIS infestations.

Successful implementation of this plan requires resource managers who are willing to aggressively respond to the particular circumstances of a new infestation. Ideally, this guidance will prompt improvements in response timing, organizational development, permitting efficiencies, funding mechanisms, outreach strategies, and other tools that in turn will allow this document to evolve over time.

When evaluating management plans and techniques, the assumption is erroneously made that doing nothing is environmentally neutral. In dealing with nonnative aquatic species, the environmental consequences of doing nothing may be high, possibly even greater than any of the effects of management techniques. Unmanaged, these species can have severe negative effects on water quality, native plant distribution, abundance and diversity, and the abundance and diversity of aquatic insects and fish (Madsen 1997).

Overall Framework

Project Management

The Readiness Response Plan (Plan) will be developed, reviewed, amended, and implemented by PRWD. PRWD will convene and work with stakeholder groups (Table 1) during the implementation phase of the Plan and will be the point of contact with respect to management permits with the MN DNR.

In order for any program to be successful it has to have a clear definition of its goals and objectives. Project management should align with the program goals outlined by PRWD and stakeholder groups listed in Table 1, as it relates to aquatic invasive plant species. As part of the planning process for Aquatic Plant Management (APM) activities, there needs to be a clear definition of what "aquatic plant control" will mean as it relates to the Plan.

The Aquatic Plant Management Society defines aquatic plant control as techniques used alone or in combination which result in a timely, consistent, and substantial reduction of a target plant population to levels that alleviate an existing or potential impairment to the uses or functions of the water body. In addition to the aforementioned definition, prevention and eradication should be precedents prior to maintenance management activities.

Program Goals

Goal 1: Prevention. Prevention should focus on keeping new aquatic invasive plant species from entering the waterbodies covered by this Plan. It is generally less costly to prevent plants from invading than managing them once they have established in a given waterbody. The elements of a prevention program are education and quarantine combined with proactive management of new infestations (early detection and rapid response; Madsen 2014). The most likely point of entry into a waterbody will be boat launches and therefore signage at boat launches and marinas will target this vector of spread and bring awareness to potential problematic species. Collaborating with the MN DNR, county aquatic invasive species prevention programs, and utilizing their network and educational media will enhance the reach of the prevention program. Additionally, training

homeowners and other stakeholders, such as anglers, on the target lakes on how to properly identify key aquatic invasive plants will increase the probability of early detection and rapid response.

Goal 2: Eradication. An early detection and readiness response program should be employed in conjunction with prevention efforts to control new infestations at an early stage. Proactively controlling new infestations before they develop into large populations of exotic plants is both technically easier and less expensive (Madsen 2014). An eradication program is characterized by the following (Netherland and Schardt 2014):

- sustained and multi-year efforts to ensure elimination of the plant population
- small-scale efforts to control relatively few plants
- control costs on a per acre basis may be quite high
- the overall impact of repeated control efforts on the infested water body is continually weighed against the regional threat posed by the invasive plant
- control efforts may eventually be reduced; however, ***vigilant monitoring remains a key to success; especially for species with long lived propagules.***

Goal 3: Adaptive Maintenance Management. In the event an aquatic invasive plant becomes established, and eradication is no longer feasible, then a maintenance management program will be implemented. A maintenance management approach will reduce the abundance of the target plant below a predetermined threshold based on the major uses of the water resource. Thresholds will vary spatially (i.e. lake to lake) and temporally based on the success or failure of the overall management program and longevity of propagules. However, maintenance management is a conscious decision to actively control an aquatic plant problem with the added understanding a long-term commitment to management rather than eradication is the goal (Netherland and Schardt 2014). This approach will involve routine, recurring control efforts to suppress a problem aquatic plant population to an acceptable level (Netherland and Schardt 2014). Maintenance control encompasses a continuum of control objectives. On one extreme, the goal of maintenance control may be to reduce and sustain a plant population at the lowest feasible level that technology, finances, and conditions will allow.

Current Management Techniques for Eurasian and hybrid milfoils, Starry stonewort, and Hydrilla

Biological. Biological agents exist for Eurasian watermilfoil and hydrilla; however the milfoil weevil (*Euhrychiopsis lecontei*) is unpredictable as to its efficacy, and the hydrilla agents are not cold tolerant. Currently, there are no biological agents for use on starry stonewort.

Mechanical. A number of mechanical devices have been used to manage invasive aquatic plants including harvesters, cutters, hand pulling, mechanical pulling, rotovating, grinding, weed rollers, and diver-operated suction dredging. Of these techniques mechanical pulling, hand pulling of small infestations, and diver-operated suction dredging could be of use in an integrated management plan for the target species to remove as much plant biomass as possible. Effectiveness will be dependent upon the size of the infestation and presence of propagules in the sediment **(*as well as the skill and degree of implementation*).**

Physical. Physical management techniques include dredging, drawdown, benthic barriers, shading, and nutrient inactivation. In the PRWD benthic barriers could be used on small (< 1000 ft^2) insipient

populations, or in areas around boat launches. However, the use of benthic barriers is prohibited and dredging is not normally allowed for aquatic plant control and any proposed use of benthic barriers or dredging will require a special permit from the MN DNR.

Chemical. There are currently 17 pesticides (includes herbicides, algaecides, peroxides, and colorants) registered with the United States Environmental Protection Agency for use in aquatic habitats, though not all of them will be applicable for use in the PRWD. Pesticide selection will be based on the target species, association of non-target species, site-specific characteristics, and state regulations.

Problem Assessment (Aquatic Plant Species of Concern)
Eurasian (*Myriophyllum spicatum*) and hybrid (*Myriophyllum spicatum* X *Myriophyllum sibiricum)* watermilfoil

Eurasian watermilfoil is a submersed aquatic plant native to Europe and Asia. It is an evergreen perennial meaning it remains green all year. Eurasian watermilfoil grows in a diverse range of aquatic habitats, including rivers, reservoirs, and natural lakes, freshwater and brackish estuaries. In freshwater, it tolerates environments ranging from soft water, low alkalinity systems to hard water lakes, and trophic states from oligotrophic to eutrophic. Eurasian watermilfoil was first found in the United States in the 1940's, with almost simultaneous introductions to California, Arizona, Ohio, and the Chesapeake Bay. By the 1960's, it was found in a number of northeastern, midwestern, southwestern, and southeastern states. By the 1980's, numerous sites occurred throughout the United States with the apparent exception of the northern plains states. Currently, it is one of the most widespread invasive aquatic plants.

In Minnesota, it typically grows in water depths from 1 to 15 feet; however if water clarity is high it can grow in deeper water. Eurasian watermilfoil forms a dense root crown, which is its main overwintering structure and the source of new shoots each year. As it grows to the surface, it branches repeatedly to form a very dense canopy with a profusion of leaves. The leaves are pinnately compound, with 14 to 24 pairs of thin tubular leaflets. These leaves typically occur in groups of four whorled at each node on the stem. Stems and apical tips of Eurasian watermilfoil tend to be reddish, but variation in this color also occurs. Eurasian watermilfoil forms a short flowering spike above the water surface. Since Eurasian watermilfoil looks like some of the native milfoil species, confusion in the identification of this nuisance invader frequently occurs.

Eurasian watermilfoil reproduces almost entirely by vegetative means, either by stolons or fragments. Plants auto-fragment as part of their life history and these fragments act as dispersal units within waterbodies, or between waterbodies if the distance from lake to lake is short and fragments do not dry out. While seeds are produced, they are not considered an important source of new colonies. Seeds do resist desiccation; so one possible mechanism of reproduction by seed is after drawdown.

Eurasian watermilfoil can hybridize with the native northern watermilfoil (*M. sibiricum*) (Moody and Les 2007), and in many lakes, hybrid milfoil grows faster than Eurasian watermilfoil (LaRue et al. 2013). Hybrid watermilfoil is becoming more and more dominant in Midwestern lakes given the effective management of Eurasian watermilfoil (*Myriophyllum spicatum*). It has been shown under laboratory and field conditions some hybrid milfoil biotypes are more tolerant to 2,4-D and fluridone than the parental Eurasian watermilfoil species (Berger et al. 2012, Thum et al. 2012, LaRue 2013,

Berger et al. 2015). However, not all hybrid genotypes have been tested and their response to herbicides is unknown. The problem of managing hybrid watermilfoil is exacerbated by 1) difficulty identifying whether the target plant is Eurasian or hybrid; 2) there are many genotypes of hybrid watermilfoil with different life history characteristics; and 3) there may be differential tolerance to select herbicides between different genotypes of hybrid watermilfoil.

Eurasian watermilfoil and its hybrids are a widespread nuisance-forming weed though it is not on the USDA Federal Noxious Weed List, and as such, not regulated by the federal government. In general, the Federal Noxious Weed List is reserved for plant species, terrestrial and aquatic, that are not widespread in the United States. However, Eurasian watermilfoil and its hybrids are a prohibited invasive species in Minnesota, which means it is unlawful (a misdemeanor) to possess, import, purchase, transport or introduce these species except under a permit for disposal, control, research or education.

Readiness Response Plan for Eurasian and hybrid watermilfoil (Table 2)

Prevention/Early Detection and Readiness Response

1. Use educational signage, pamphlets, or web material on what milfoils look like and the dangers they pose.
2. Establish boat check stations at popular boat launches in the area.
3. Conduct directed surveys in and around all boat launch areas at least two times per year (late spring to early summer and late summer to early fall).
4. Conduct a meandering boat search of the littoral area in each waterbody at least once per year to look for watermilfoils. As part of this effort, partner with the University of Minnesota Extension Aquatic Invasive Species Detectors Program to train volunteers who are on the lakes in aquatic invasive species identification. As a result this should improve detection ability as more people are looking for target species.
5. If a suspected invasive watermilfoil is located, PRWD staff will be notified, who in turn will notify the MN DNR to facilitate proper identification. Samples will be sent to Dr. Ryan Thum at Montana State University for genotype determination.
6. Point intercept surveys will be conducted in the area of suspected infestation to determine the extent of the population and to serve as a pretreatment threshold for the assessment of management techniques.
7. PRWD will obtain the necessary permits from the MN DNR in the event the genetic screening provides a positive result.

Eradication

1. If the infestation is a few scattered plants in shallow water (≤ 3 ft.) then both aboveground and belowground biomass should be removed immediately.
2. If the incipient infestation is small enough, a temporary enclosure of the population would be beneficial in keeping boat traffic out of the area which could help increase and maintain contact time for a chemical treatment.
3. If the infestation is larger (1,000 ft^2) and in shallow water then benthic barriers, or diver operated suction dredging could be utilized to control the growth and spread, especially in areas such as boat ramps.

4. If the infestation is larger (1 acre or more), or in deeper water, then herbicides should be applied to reduce the abundance and spread of the infestation. PRWD will work with aquatic herbicide applicators, university personnel, and other experienced individuals to design and implement a herbicide application program. Herbicide selection will depend upon site characteristics, water exchange patterns, size of the infestation, and the target plant (whether there has been documented tolerance to specific herbicides). Applying a short exposure contact herbicide as soon as possible after confirmation will slow the spread of watermilfoil and provide more time to determine if systemic herbicides, or herbicide combinations would be more efficacious.
5. Post-treatment surveys will be conducted utilizing the same points as the pre-treatment survey. This survey should be done 6 to 8 weeks after the implementation of management techniques and then again during spring of the following year. The spring survey will determine annual recruitment and serve as the new pre-treatment threshold for the coming growing season.
6. This process will be repeated until the target plant is no longer observed in the waterbody.
7. Following eradication, regular surveys (directed surveys and meandering boat searches) will resume on an annual basis to ensure the target plant is in fact gone, and to monitor for a new introduction.

Maintenance Management

1. If eradication is not feasible for small limited areas or patches, where the population is below 15% of the littoral area, then adaptive management efforts will be implemented to reduce the occurrence or abundance of the target watermilfoil to ≤ 1% of the littoral zone.
2. Maintenance management should be adaptable, and methods chosen to match the uses of the waterbody, size of the infestation, and location of the infestation. In many cases the approach will be integrated whereby several types of methods will be used.
3. For larger infestations, applications of herbicides will be used to reduce the population to below threshold levels.
4. Annual pre-treatment and post-treatment surveys, either point intercept or biomass, will be conducted to quantitatively assess the management program so informed decisions can be made on a particular method based on data collected from a particular waterbody.

Starry stonewort (*Nitellopsis obtusa*)

Starry stonewort is a non-native, invasive macro-algae from Europe and western Asia (Blindow 1994; Kato et al. 2005). It was introduced into the United States via ballast water into the Great Lakes (Sleith et al. 2015). Since its introduction it has spread to New York, Vermont, Pennsylvania, Michigan, Minnesota, Wisconsin, and Indiana (Kipp et al. 2017). Unlike many of the native green macro-algae, starry stonewort can elongate into the water column, and in some cases reach plant lengths of 2 meters. It is bright green to dark green and forms branchlets (4-8) in whorls around the main thallus (Steudle and Zimmermann 1977). Starry stonewort is anchored to bottom sediments by rhizoids. These rhizoids are important as they often contain bulbils, or are the point of bulbil production. Bulbils (4-5 mm in size) are star-shaped, which is a unique identifying characteristic for this species. Bulbils are starch-containing tissues used for overwintering and perennation. When conditions are conducive for growth, bulbils will sprout and grow a new thallus.

Dense growth of starry stonewort can alter the community structure of aquatic habitats by extirpating native vegetation, thereby changing macro-invertebrate assemblages and ultimately fish assemblages. Starry stonewort interferes with boating and other recreational activities. Aquatic invasive species like starry stonewort have also resulted in declines in property values (Horsch and Lewis 2009). The USDA Federal Noxious Weed List does not regulate starry stonewort; and therefore interstate transport is still occurring from infested states. In Minnesota, it is a state prohibited aquatic invasive species, therefore it is unlawful (a misdemeanor) to possess, import, purchase, transport, or introduce these species.

Readiness Response Plan for Starry stonewort (Table 2)

Prevention/Early Detection and Readiness Response

1. Use educational signage, pamphlets, or web material on how to identify starry stonewort in comparison to native macro-algae such as *Chara* spp. or *Nitella* spp.
2. Establish boat check stations at popular boat launches in the area to look for branchlets and bulbils on boats, trailers, and equipment.
3. Pursue the development of a decontamination protocol and/or stations at key areas in order decontaminate equipment after leaving an infested lake.
4. Conduct directed surveys in and around all boat launch areas at least two times per year (early summer and late summer to early fall).
5. Conduct a meandering boat search of the littoral area in each waterbody at least once per year to look for starry stonewort. As part of this effort, partner with the University of Minnesota Extension Aquatic Invasive Species Detectors Program to train volunteers who are on the lakes in aquatic invasive species identification. As a result, this should improve detection ability as more people are looking for target species.
6. If starry stonewort is located, PRWD staff will be notified, who in turn will notify the MN DNR to facilitate identification, verification, and public notification.
7. Point intercept surveys will be conducted in the area of suspected infestation to determine the extent of the population and to serve as a pre-treatment threshold for the assessment of management techniques. In addition to point intercept surveys, sediment core samples will be collected in the area of the infestation to estimate bulbil density. Bulbil data will give insights as to the length of time the population may have been there and the recruitment potential after management has been initiated.
8. PRWD will obtain the necessary permits from the MN DNR to initiate pesticide applications.

Eradication

1. A copper based algaecide should be applied to reduce the abundance and spread of the infestation; and to prevent bulbil formation. PRWD will work with aquatic herbicide applicators, university personnel, and other experienced individuals to design and implement a pesticide application program. Pesticide selection will depend upon site characteristics, water exchange patterns, and size of the infestation, and the target plant. Applying a copper-based algaecide (copper-ethanolamine complex or emulsified ethanolamine complex) as soon as possible after confirmation will slow the spread and provide more time to determine if other chemistries or approaches are more efficacious. Copper efficacy is density dependent, meaning

if there is a high density of algae cells in the water (i.e. high starry stonewort biomass) then more copper will be needed to control the infestation. If starry stonewort is allowed to grow to high densities (canopy formation) prior to treatment, then reduced efficacy from copper treatments can be expected, as use rates will be limited by the pesticide label (i.e. a maximum of 1 mg/L of copper). It is recommended to treat starry stonewort early when plants are small and before bulbil production occurs.

2. Diver operated suction dredging could be utilized in small infested areas to remove any bulbils in the sediment.
3. Post-treatment surveys will be conducted utilizing the same points as the pre-treatment survey. This survey should be done every 4 weeks during the growing season to assess the efficacy of management techniques, and to determine if another pesticide application is needed. A similar survey will be conducted during spring of the following year. The spring survey will determine annual recruitment and serve as the new pre-treatment threshold for the coming growing season. Sediment core samples will be collected during the post-treatment survey times to assess bulbil densities in the sediment.
4. This process will be repeated until the target plant is no longer observed in the waterbody.
5. Following eradication, regular surveys (directed surveys and meandering boat searches) will resume on an annual basis to ensure the target plant is in fact gone, and to monitor for a new introduction.
6. Prevention of bulbil production and depletion of the sediment bulbil bank will be critical if eradication is to be successful. This will require a dedicated effort with respect to management techniques, and to survey and monitoring. Monitoring should continue for a minimum of 3 years after the last positive observation of starry stonewort. If starry stonewort is observed again, the treatment cycle is re-initiated.

<u>Maintenance Management</u>

1. If eradication is not feasible for small limited areas or patches where the population is below 15% of the littoral area, then adaptive management efforts will be implemented to reduce the occurrence or abundance of starry stonewort to ≤ 1% of the littoral zone.
2. Maintenance management should be adaptable and methods chosen to match the uses of the waterbody, size of the infestation, and location of the infestation. In many cases the approach will be integrated whereby several types of methods will be used.
3. For larger infestations, applications of algaecides will be used to reduce the population to below threshold levels. Additionally, mechanical weed pullers in combination with algaecides have been successful at maintaining starry stonewort levels in other Minnesota lakes.
4. Annual pre-treatment and post-treatment surveys, either point intercept or biomass, will be conducted to quantitatively assess the management program so informed decisions can be made on a particular method based on data collected from a particular waterbody.

Hydrilla (*Hydrilla verticillata*)

Hydrilla (*Hydrilla verticillata* (L.F.) Royle) is an invasive aquatic macrophyte introduced into the United States by tropical fish and plant dealers. Its first appearance was on the west coast of Florida in 1960 and was confused with the common native species *Elodea canadensis*. The confusion and delay in identification allowed hydrilla to spread rapidly throughout Florida. Therefore, it is imperative for any program or plan directed at managing invasive species to rapidly and accurately identify problem species. Hydrilla decreases the use and quality of any water body it invades by impeding waterways, disrupting recreation, changes nutrient cycles, and altering community structure.

Invaded habits include ponds, canals, ditches, lakes and rivers. Hydrilla is a submersed plant with erect stems rooted in bottom sediments. Hydrilla often grows to a depth of 15', but may grow in even deeper water if water is very clear. Its lance-shaped leaves are about 0.1" (2-4 mm) wide and 0.25"-1.0" (6-20 mm) long arranged in whorls of 5 to 7 leaves. Hydrilla has small teeth on the leaf margins and small spines on the leaf midrib on the underside of the leaf. The number of leaves in the whorl, serrated leaf margins, and spines on the midrib are important identification characteristics, as the native elodea does not possess these morphological characteristics. Elodea has leaves in whorls of 3 or 4, entire leaf margins (i.e. no teeth), and no spines on the underside of the leaves.

Hydrilla has been termed the perfect aquatic weed because of the adaptive attributes it possesses for colonization and perennation in invaded habitats (Langeland 1996). It reproduces vegetatively through the production of turions in leaf axils, and in the formation of subterranean turions in the sediment. The axial turion is a dormant spiny green bud 0.1"-0.5" (3-12 mm) in length. Subterranean turions are often white to black, 0.2-0.6" (4-15 mm) in length and found growing at the terminal end of rhizomes. It is important to note hydrilla is the only species in this family found in the United States which forms turions. In addition to turion formation, hydrilla can also reproduce from fragments. These fragments can serve as a long-distance dispersal mechanism in and among lakes.

Two biotypes of hydrilla occur in the U.S., dioecious and monoecious. The dioecious biotype has the staminate (pollen-forming) and pistillate (ovule or seed forming) flowers on different plants, currently only pistillate forming plants are in the United States. The monoecious biotype has both flower types on the same plant. Distinguishing between the two biotypes is difficult as they look identical, and growing conditions can have a significant effect on the appearance of the plant (True-Meadows et al. 2016). Therefore, there is no way, visually, to distinguish between biotypes without flowers (True-Meadows et al. 2016). However, monoecious hydrilla tends to be less robust with smaller and a more lateral (prostrate) growth form early in its growth cycle (Van 1989); whereas dioecious hydrilla sprouts and grows vertically toward the surface. Monoecious hydrilla produces more subterranean turions than dioecious hydrilla; though the tubers are smaller and weigh less (Van 1989, Sutton et al. 1992, Owens et al. 2012). Sprouting of subterranean turions occurs at lower temperatures in monoecious plants, which was indicative of a lower temperature tolerance (Steward and Van 1987). This latter attribute suggests if hydrilla were to invade Minnesota it would likely be the monoecious biotype. Hydrilla was found and eradicated in Spies Lake, WI on two separated occasions (2005 and 2007), indicating it can grow in Midwestern waters.

Hydrilla is on the USDA Federal Noxious Weed List, which carries federal fines for anyone in possession or transporting this species in the United States without proper permits. In Minnesota, it is

a state prohibited invasive species and an Aquatic Plant Early Detection target https://www.dnr.state.mn.us/invasives/aquaticplants/earlydetection.html, which means it is non-native, invasive, has limited or no distribution in Minnesota, and is considered a high-risk species to natural resources.

Readiness Response Plan for Hydrilla (Table 2)

Prevention/Early Detection and Readiness Response

1. Use educational signage, pamphlets, or web material on how to identify hydrilla as opposed to *Elodea canadensis* or *Egeria densa*. This would include key characteristics such as leaf whorl arrangement, serrated edges on leaves, spine on leaf midrib, and turion identification compared to native plant tubers.
2. Establish boat check stations at popular boat launches in the area.
3. Conduct directed surveys in and around all boat launch areas at least two times per year (mid-summer and early fall).
4. Conduct a meandering boat search of the littoral area in each waterbody at least once per year to look for hydrilla. As part of this effort, partner with the University of Minnesota Extension Aquatic Invasive Species Detectors Program to train volunteers who are on the lakes in aquatic invasive species identification. As a result, this should improve detection ability as more people are looking for target species.
5. If hydrilla is located, PRWD staff should be notified, who in turn will notify the MN DNR to facilitate identification, verification, and public notification.
6. Point intercept surveys should be conducted in the area of suspected infestation to determine the extent of the population and to serve as a pretreatment threshold for the assessment of management techniques. In addition to point intercept surveys, sediment core samples will be collected in the area of the infestation to estimate turion density. Turion data will give insights as to the length of time the population may have been there and the recruitment potential after management has been initiated.
7. PRWD will obtain the necessary permits from the MN DNR to initiate herbicide applications.

Eradication

1. Herbicides should be applied to reduce the abundance and spread of the infestation; and to prevent turion formation. Subterranean turions can remain viable in the sediment for as long as 4 years. PRWD will work with aquatic herbicide applicators, university personnel, and other experienced individuals to design and implement an herbicide application program. Herbicide selection will depend upon site characteristics, water exchange patterns, and size of the infestation, and the target plant. Applying a short exposure contact herbicide as soon as possible after confirmation will slow the vegetative spread and provide more time to determine if systemic herbicides, or herbicide combinations would be more efficacious.
2. Diver operated suction dredging could be utilized in the infested area to remove any turions in the sediment.
3. Post-treatment surveys will be conducted utilizing the same points as the pre-treatment survey. This survey should be done 6 to 8 weeks after the implementation of management techniques and then again during spring of the following year. The spring survey will determine annual

recruitment and serve as the new pre-treatment threshold for the coming growing season. Sediment core samples will be collected during the post-treatment survey times to assess the turion bank in the sediment.

4. This process will be repeated until the target plant is no longer observed in the waterbody.
5. Following eradication, regular surveys (directed surveys and meandering boat searches) will resume on an annual basis to ensure the target plant is in fact gone, and to monitor for a new introduction.
6. Prevention of turion formation and depletion of the sediment turion bank will be critical if eradication is to be successful. This will require a dedicated effort with respect to management techniques, and to survey and monitoring. Monitoring should continue for a minimum of 4+ years after the last positive observation of hydrilla. If hydrilla is observed again, the treatment cycle is re-initiated.

Maintenance Management

1. If eradication is not feasible for small limited areas or patches where the population is below 15% of the littoral area, then adaptive management efforts will be implemented to reduce the occurrence or abundance of hydrilla to ≤ 1% of the littoral zone.
2. Maintenance management should be adaptable, and methods chosen to match the uses of the waterbody, size of the infestation, and location of the infestation. In many cases the approach will be integrated whereby several types of methods will be used.
3. For larger infestations, applications of herbicides should be used to reduce the population to below threshold levels.
4. Annual pre-treatment and post-treatment surveys, either point intercept or biomass, will be conducted to quantitatively assess the management program so informed decisions can be made on a particular method based on data collected from a particular waterbody.

AIS Education Plan

PRWD will conduct an AIS education program in partnership with local stakeholder groups, MN DNR AIS personnel, University of Minnesota Extension, University of Minnesota Sea Grant, and other knowledgeable individuals or groups. The program should include targeted mailings on AIS species and management activities. A specific webpage should be developed and devoted to the Readiness Response Plan so individuals can obtain up to date information on their lake. An annual meeting open to the public should be held to discuss activities pertaining to AIS management in the system. Local education of property owners and resource users will be conducted by lake association groups to their respective members.

Readiness Response Plan Evaluation

The Plan should be evaluated annually by PRWD and all stakeholder groups. During the evaluation process the Plan will be adapted and amended based on successes and failures, or the needs of stakeholder groups.

Literature Cited

Berger, S.T., M.D. Netherland, and G.E MacDonald. 2012. Evaluating fluridone sensitivity of multiple hybrid and Eurasian watermilfoil accessions under mesocosm conditions. Journal of Aquatic Plant Management 50:135-140.

Berger S.T., M.D. Netherland, and G.E. MacDonald. 2015. Laboratory documentation of multipleherbicide tolerance to fluridone, norflurazon, and topramazone in a hybrid watermilfoil (*Myriophyllum spicatum* x *M. sibiricum*) population. Weed Science 63:235– 241.

Blindow I. 1994. Rare and threatened charophytes in Sweden. *Svensk Botanisk Tidskrift* 8: 65-73.

Horsch, E.J. and D.J. Lewis. 2009. The effects of aquatic invasive species on property values: evidence from a quasi-experiment. Land Economics 85:391-409.

Kato S, S. Higuchi, Y. Kondo, S. Kitano, H. Nozaki, J. Tanaka. 2005. Rediscovery of the wild-extinct species *Nitellopsis obtusa* (Charales) in Lake Kawaguchi, Japan. *Journal of Japanese Botany* 80: 84-91.

Kipp R.M., M. McCarthy, A. Fusaro, and I.A. Pfingsten. 2017. *Nitellopsis obtusa*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL.
Retrieved from https://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=1688 Revision Date: 5/02/2019

Langeland, K.A. 1996. *Hydrilla verticillata* (L.f.) Royle (Hydrocharitaceae), the perfect aquatic weed. Castanea 61:293–304.

LaRue E.A., M.P. Zuellig, M.D. Netherland, M.A. Heilman, and R.A. Thum. 2013. Hybrid watermilfoil lineages are more invasive and less sensitive to a commonly used herbicide than their exotic parent (Eurasian watermilfoil). Evolutionary Applications 6:462-471.

Madsen, J.D. 1997. Methods for management of nonindigenous aquatic plants. In: J.O. Luken and J.W. Thieret, (*eds*). Assessment and Management of Plant Invasions. Springer, NY. Pp. 145-171.

Madsen, J.D. 2014. Developing a lake management plan. Appendix D In: Gettys et al. (*eds*). Biology and Control of Aquatic Plants: A Best Management Practices Handbook 3rd edition. Aquatic Ecosystem Restoration Foundation, Marietta, GA.

Moody, M.L. and D.H. Les. 2007. Geographic distribution and genotypic composition of invasive hybrid watermilfoil (Myriophyllum spicatum · M. sibiricum) populations in North America. Biological Invasions 9:559-570.

Netherland, M.D and J. Schardt. 2014. A manager's definition of aquatic plant control. Appendix E In: Gettys et al. (*eds*). Biology and Control of Aquatic Plants: A Best Management Practices Handbook 3rd edition. Aquatic Ecosystem Restoration Foundation, Marietta, GA.

Owens, C.S., R.M. Smart, and G.O. Dick. 2012. Tuber and turion dynamics in monoecious and dioecious hydrilla (*Hydrilla verticillata*). Journal of Aquatic Plant Management 50:58–62

Sleith, R.S., A.J. Havens, R.A. Stewart, and K.G. Karol. 2015. Distribution of *Nitellopsis obtusa* (Characeae) in New York, U.S.A. *Brittonia* 67:166-172.

Steudle, E. and U. Zimmermann. 1977. Effect of turgor pressure and cell size on the wall elasticity of plant cells. *Plant Physiology* 59:285-289.

Steward, K.K. and T.K. Van. 1987. Comparative studies of monoecious and dioecious hydrilla (*Hydrilla verticillata*) biotypes. Weed Science 35:204–210.

Sutton, D.L., T.K. Van, and K.M. Portier. 1992. Growth of dioecious and monoecious hydrilla from single tubers. Journal of Aquatic Plant Management 30:15–20.

Thum, R.A., D.J. Wcisel, M.P. Zuellig, M. Heilman, P. Hausler, P. Tyning, L. Huberty, and M.D. Netherland. 2012. Field documentation of decreased herbicide response by a hybrid watermilfoil population. Journal of Aquatic Plant Management 50:141–146.

True-Meadows, S., E.J. Haug, and R.J. Richardson. 2016. Monoecious hydrilla - A review of the literature. Journal of Aquatic Plant Management 54:1-11.

Van, T.K. 1989. Differential responses to photoperiods in monoecious and dioecious Hydrilla verticillata. Weed Science 37:552–556.

Table 1. Stakeholder Contact information. (June 2020)

Main Lake	**Contact**	Phone	Email
Lake Detroiters	Brad Wimmer	701-730-0524	brad@wimmersdiamonds.com
	Dick Hecock	218-849-2965	rhecock@arvig.net
Long Lake Association	Tom Anderson	701-361-3549	Tr.bank@yahoo.net
	Loxley Koshnick	218-849-2488	loxbobkoshnick@arvig.net
Sallie/Melissa Association	Mike Becraft	571-213-0420	mikebecraft@verizon.net
	Wanda Roden	701-388-0821	wrnodak@outlook.com
Fox Lake Association	John Flatt	218-849-3216	Jaflatt52@gmail.com
Pearl Lake Association	Ron Schmit	701-306-1962	rsmschmit@cableone.net
Floyd Shore Lake Association	Larry Anderson	218-289-0381	Landerson1056@gmail.com
	Jennifer Mastrud	701-200-9144	mastruj@gmail.com
Pelican River Watershed District	Tera Guetter	218-846-0436	Tera.guetter@arvig.net
Becker County	Mike Brethorst	218-846-7201	m.brethorst@co.becker.mn.us
	John Okeson	218-847-6244	jokeson@co.becker.mn.us
	Karl Koenig	218-846-7360	kikoeni@co.becker.mn.us
City of Detroit Lakes	Kelcey Klemm	218-846-7123	kklemm@cityofdetroitlakes.com
	Shawn King	218-846-7145	sking@cityofdetroitlakes.com
MN DNR	Mark Ranweiler	218-739-7576 ext 254	Mark.ranweiler@state.mn.us
	Nicole Kovar	218-732-8960	Nicole.kovar@state.mn.us
	Wendy Crowell	651-728-0051	Wendy.crowell@state.mn.us
MAISRC	Nick Phelps	612-624-7450	Phelps083@umn.edu
	Cori Mattke	612-624-7785	cmattke@umn.edu
Aquatic Plant Management Experts	Ryan Wersal	507-389-5728	ryan.wersal@mnsu.edu
	Gray Turnage	662-325-7527	gturnage@gri.msstate.edu
	John Madsen	530-752-7870	jmadsen@ucdavis.edu

Table 2: Readiness Response Plan Outline Activity	PRWD	City of Detroit Lakes	Becker County	Lake Association	MN DNR	Aquatic Plant Management Expert
Notify MN DNR of AIS infestation.	Notify MN DNR				Verifies infestation	
Communicates the infestation to all Stakeholders.	Immediately following press release, distribute information to all stakeholders.	Disseminates Information from PRWD	Disseminates information from PRWD	Disseminates information from PRWD	MN DNR issues press release.	
Perform, or hire contractor to perform, monitoring to determine the extent of the AIS Infestation.	Collaborate with MN DNR and Aquatic Plant Management Expert regarding the monitoring design.				Collaborate with PRWD and MAISRC	Collaborates with PRWD and MN DNR regarding monitoring design and recommendations for a contractor. Pre-treatment and post-treatment surveys.
Determine whether isolation of the infestation is needed, and if so isolate the infestation.	Collaborate with MN DNR and Aquatic Plant Management Expert				Collaborate with PRWD and MAISRC.	Collaborate with PRWD and MN DNR.
Collaborate with MN DNR, Aquatic Plant Management Expert and stakeholders to determine appropriate readiness response treatment/removal and associated costs.	Implements the readiness response effort, Collaborates with MN DNR and Aquatic Plant Management Expert.	Collaborates with MN DNR, MAISRC and PRWD.	Collaborates with MN DNR, MAISRC and PRWD.	Collaborates with MN DNR, MAISRC and PRWD.	Collaborates with MN DNR, City of Detroit Lakes and Becker County.	Collaborates with MN DNR, PRWD, City of Detroit Lakes, Becker County.
Obtain MN DNR Treatment/Removal Permits.	Obtains treatment/removal permit from MN DNR.	Receives copies of all permits and communication.	Receives copies of all permits and communication.	Receives copies of all permits and communication.	Works with PRWD to issue the permit.	Collaborates with PRWD and MN DNR as needed to provide technical information.
Perform additional pre-treatment monitoring if required by MN DNR permit.	Performs plant surveys or hires a contractor to perform plant surveys.				Collaborates with PRWD regarding monitoring requirements of permit.	Collaborates with PRWD regarding monitoring design and recommendations for a contractor.
Hire contractor to perform AIS readiness response treatment/removal (e.g. chemical treatment or manual removal of AIS).	Hires contractor					
Fund the AIS treatment/removal.	Funds a percentage of the services provided for the project.	Considers funding support.	Considers awarding Readiness Response Grant.	Considers funding support.		
Perform, or hire contractor to perform post treatment monitoring to determine treatment/removal effectiveness.	Performs plant surveys.				Collaborates with PRWD, and City of DL regarding monitoring requirements of permit.	Collaborates with PRWD, City of DL, regarding monitoring design and recommendations for a contractor.
Communicate information about the AIS treatment/removal and results of AIS treatment/removal efforts to stakeholders and the general public	Provides information to the City of DL, Becker County and lake association	Disseminates information provided by PRWD	Disseminates information provided by PRWD	Disseminates information provided by PRWD		
Design and implement education program to help prevent future infestation.	Takes the lead on education activities.	Disseminates educational materials.	Disseminates educational materials.	Disseminates educational materials.		

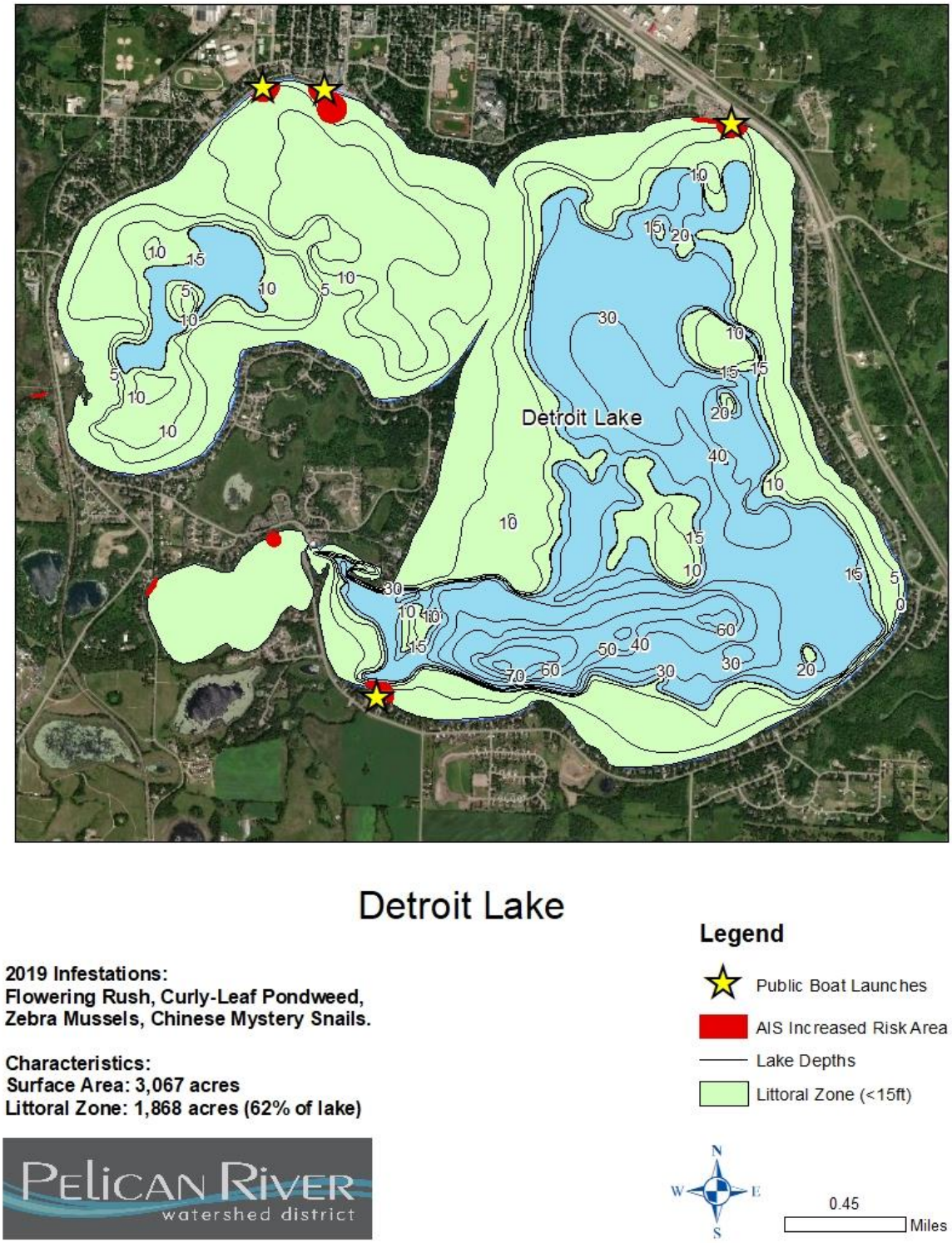


Figure 1. Littoral Zone and Increased Risk areas on Detroit Lake. Littoral zone (vegetative growth area) is susceptible to invasion from vegetative AIS. AIS increased risk areas include public boat launches or private access/marinas.

Figure 2. Littoral Zone and Increased Risk areas on Long Lake. Littoral zone (vegetative growth area) is susceptible to invasion from vegetative AIS. AIS increased risk areas include public boat launches or private access/marinas.

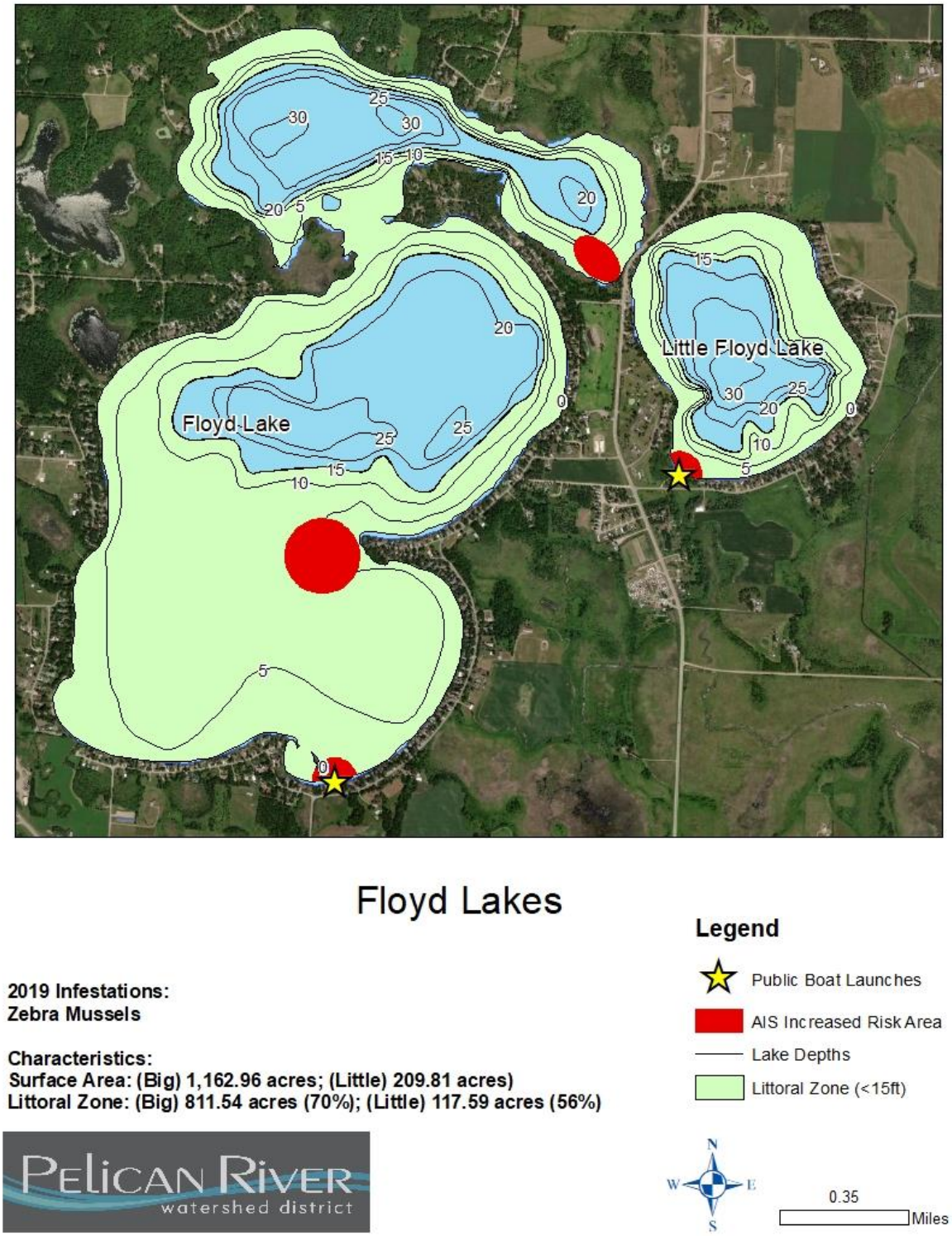
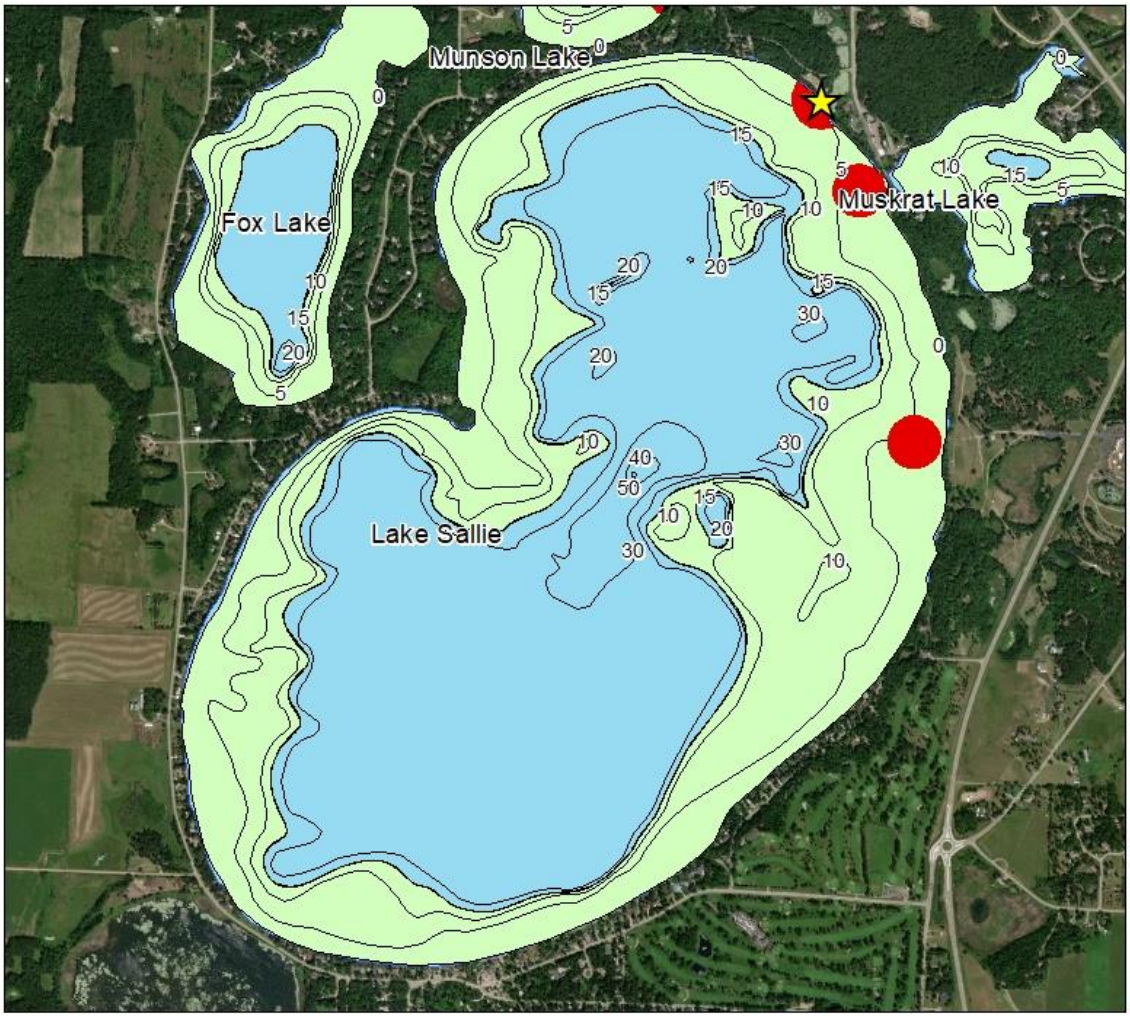


Figure 3. Littoral Zone and Increased Risk areas on Big and Little Floyd Lakes. Littoral zone (vegetative growth area) is susceptil from vegetative AIS. AIS increased risk areas include public boat launches or private access/marinas.



Lake Sallie

2019 Infestations:
Flowering Rush, Curly-Leaf Pondweed, Zebra Mussels, Chinese Mystery Snails.

Characteristics:
Surface Area: 1,272.88 acres
Littoral Zone: 576.81 acres (45% of lake)

Legend

- Public Boat Launches
- AIS Increased Risk Area
- Lake Depths
- Littoral Zone (<15ft)

N W E S

0.3 Miles

Figure 4. Littoral Zone and Increased Risk areas on Lake Sallie. Littoral zone (vegetative growth area) is susceptible to invasion from vegetative AIS. AIS increased risk areas include public boat launches or private access/marinas.

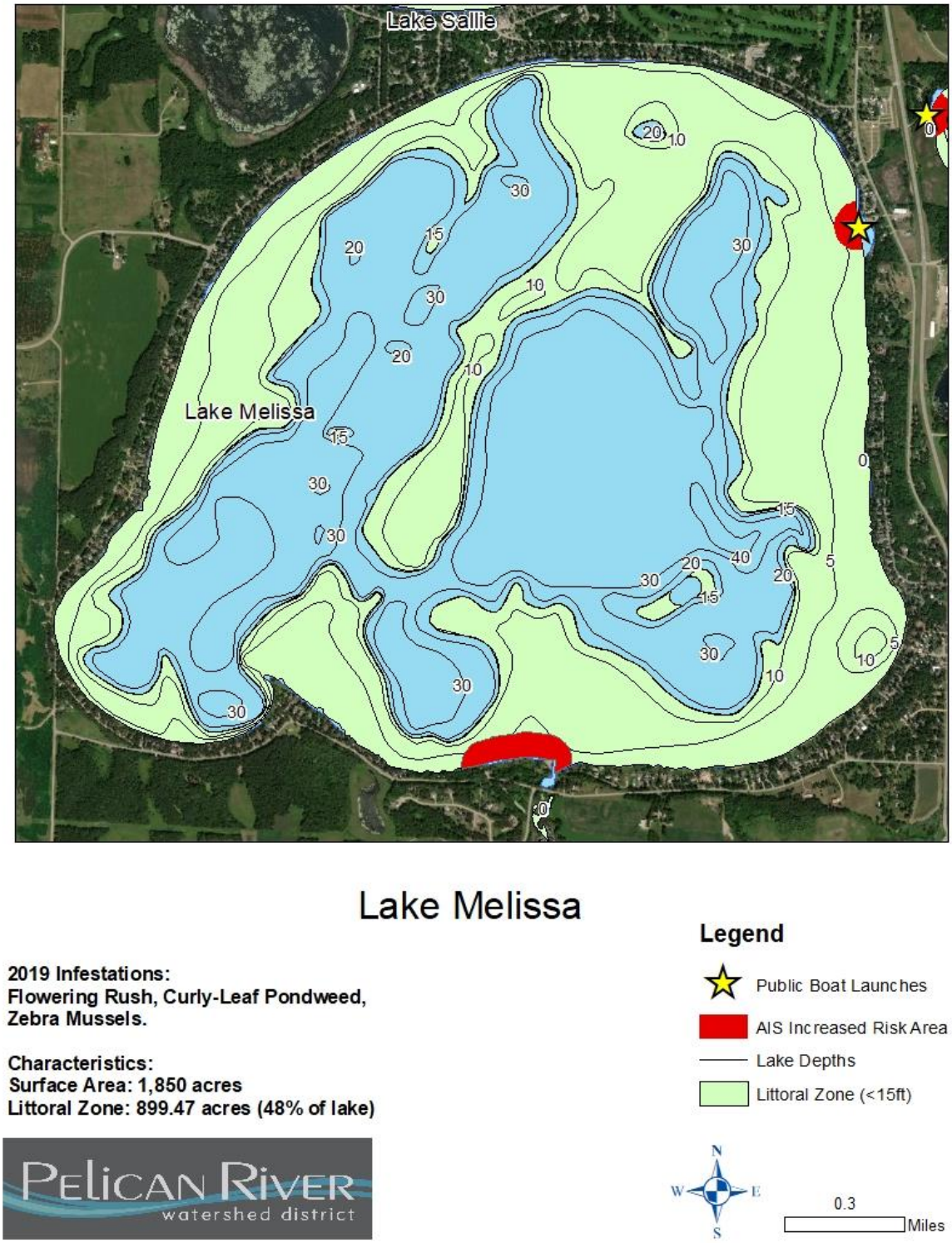


Figure 5. Littoral Zone and Increased Risk areas on Lake Melissa. Littoral zone (vegetative growth area) is susceptible to invasion from vegetative AIS. AIS increased risk areas include public boat launches or private access/marinas.

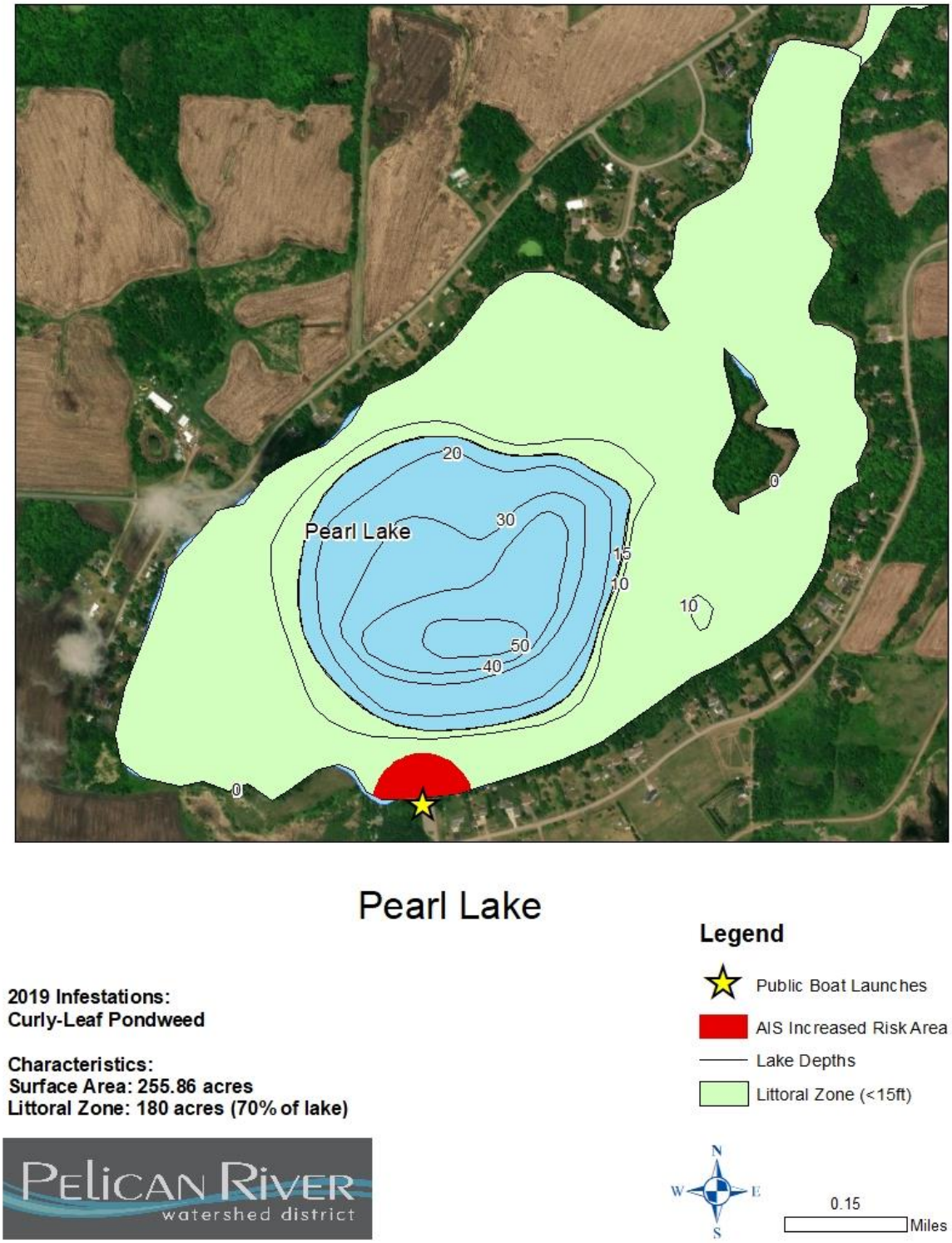
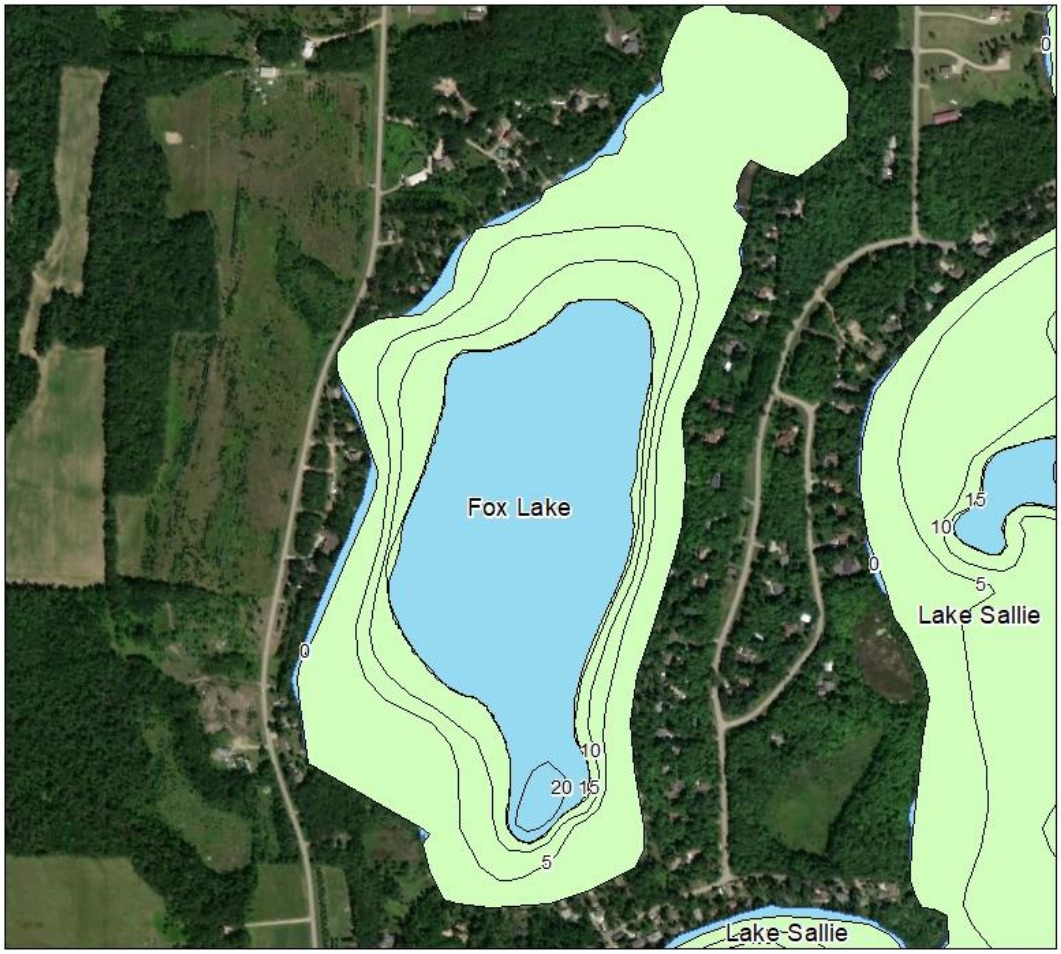


Figure 6. Littoral Zone and Increased Risk areas on Pearl Lake. Littoral zone (vegetative growth area) is susceptible to invasion from vegetative AIS. AIS increased risk areas include public boat launches or private access/marinas.



Fox Lake

2019 Infestations:
None

Characteristics:
Surface Area: 143 acres
Littoral Zone: 93.25 acres (65% of lake)

Legend

Public Boat Launches
AIS Increased Risk Area
Lake Depths
Littoral Zone (<15ft)

N
W
E
S
0.1
Miles

Figure 7. Littoral Zone and Increased Risk areas on Fox Lake. Littoral zone (vegetative growth area) is susceptible to invasion from vegetative AIS. AIS increased risk areas include public boat launches or private access/marinas.