



# **Perch and Crystal Lakes Aquatic Vegetation Management Plan with Professional Management Recommendations Hillsdale County, Michigan**



**Provided for the: Perch and Crystal Lakes Association**

**Prepared by: Restorative Lake Sciences  
Jennifer L. Jermalowicz-Jones, PhD, CLP, CLM  
[www.restorativelakesciences.com](http://www.restorativelakesciences.com)**

©The information, format, and ideas in this report are proprietary property of Restorative Lake Sciences (RLS) and cannot be used without permission by RLS. July, 2025.

## TABLE OF CONTENTS

| SECTION  | PAGE |
|--|------|
| LIST OF FIGURES .....  | 3    |
| LIST OF TABLES .....   | 4    |
| 1.0 EXECUTIVE SUMMARY .....  | 5    |
| 2.0 PERCH AND CRYSTAL LAKES AQUATIC VEGETATION COMMUNITIES.....                  | 7    |
| 2.1 Overview of Aquatic Vegetation and the Role for Lake Health .....            | 7    |
| 2.2 Perch & Crystal Lakes Native Aquatic Plants (2025).....                      | 10   |
| 2.3 Perch & Crystal Lakes Invasive Aquatic Plants (2025) .....                   | 16   |
| 3.0 PERCH AND CRYSTAL LAKES AQUATIC VEGETATION MANAGEMENT METHODS .....          | 22   |
| 3.1 Perch and Crystal Lakes Aquatic Plant Management Methods .....               | 22   |
| 3.1.1 Aquatic Herbicides and Applications .....                                  | 22   |
| 3.1.2 Mechanical Harvesting.....   | 23   |
| 3.1.3 Diver Assisted Suction Harvesting.....                                     | 24   |
| 3.1.4 Benthic Barriers and Nearshore Management Methods .....                    | 25   |
| 3.1.5 Boat Washing Stations .....  | 26   |
| 4.0 PERCH AND CRYSTAL LAKES IMPROVEMENT CONCLUSIONS AND RECOMMENDATIONS .....    | 28   |
| 4.1 Perch and Crystal Lakes Aquatic Plant Management Proposed Annual Costs ..... | 29   |
| 5.0 LITERATURE CITED.....  | 31   |

## LIST OF FIGURES

| FIGURE  | PAGE |
|---|------|
| 1. Perch and Crystal Lakes Aquatic Vegetation Biovolume Map (June 25, 2025).....        | 8    |
| 2. Perch and Crystal Lakes Aquatic Vegetation Biovolume Map (June 25, 2025).....        | 9    |
| 9. Photo of EWM and its Components .....  | 13   |
| 3. Photo of Chara.....  | 13   |
| 4. Photo of Illinois Pondweed.....  | 13   |
| 5. Photo of Large-leaf Pondweed .....   | 13   |
| 6. Photo of Fern-leaf Pondweed .....  | 13   |
| 7. Photo of White-stem Pondweed .....   | 13   |
| 8. Photo of Bladderwort.....  | 13   |
| 9. Photo of Coontail.....   | 14   |
| 10. Photo of Variable Watermilfoil.....   | 14   |
| 11. Photo of Whorled Watermilfoil.....  | 14   |
| 12. Photo of Wild Celery.....   | 14   |
| 13. Photo of Watershield .....  | 14   |
| 14. Photo of White Waterlily.....   | 14   |
| 15. Photo of Yellow Waterlily.....  | 15   |
| 16. Photo of Cattails .....   | 15   |
| 17. Photo of Swamp Loosestrife.....   | 15   |
| 18. Photo of Bulrushes .....  | 15   |
| 19. Photo of Pickerelweed .....   | 15   |
| 20. Photo of Iris .....   | 15   |
| 21. Photo of EWM .....  | 16   |
| 22. Photo of EWM Canopy .....   | 17   |
| 23. Distribution of Whorled Watermilfoil in Crystal Lake (May 13, 2025).....            | 18   |
| 24. Distribution of EWM and CLP in Crystal Lake (May 13, 2025).....                     | 18   |
| 25. Photo of CLP .....  | 19   |
| 26. Distribution of invasive Starry Stonewort and CLP in Perch Lake (May 13, 2025)..... | 20   |
| 27. Photo of Starry Stonewort.....  | 21   |
| 28. An Aquatic Herbicide Application Boat .....   | 23   |
| 29. A Mechanical Harvester .....  | 24   |
| 30. Photo of a DASH Boat.....   | 25   |
| 31. Diagram of a Benthic Barrier .....  | 26   |
| 32. Photo of a Weed Roller .....  | 26   |
| 33. Photo of a Boat Washing Station on an Inland Lake .....                             | 27   |

## LIST OF TABLES

| <b>TABLE</b>  | <b>PAGE</b> |
|---|-------------|
| 1. Perch Lake Aquatic Vegetation Biovolume Data (June 25, 2025) .....                         | 10          |
| 2. Crystal Lake Aquatic Vegetation Biovolume Data (June 25, 2025) .....                       | 10          |
| 3. Perch Lake Native Aquatic Plant Relative Abundance & Frequency Data (May 13, 2025) .....   | 11          |
| 4. Crystal Lake Native Aquatic Plant Relative Abundance & Frequency Data (May 13, 2025) ..... | 12          |
| 5. Perch Lake Native Invasive Relative Abundance & Frequency Data (May 13, 2025).....         | 21          |
| 6. Crystal Lake Invasive Relative Abundance & Frequency Data (May 13, 2025) .....             | 21          |
| 7. Perch and Crystal Lakes Aquatic Vegetation Management Goals & Locations.....               | 29          |
| 8. Perch and Crystal Lakes Improvement Annual Estimated Costs .....                           | 30          |

# Perch and Crystal Lakes Aquatic Vegetation Management Plan with Professional Management Recommendations

July, 2025

---

## 1.0 EXECUTIVE SUMMARY

Perch and Crystal Lake are both located in Somerset Township in Hillsdale County, Michigan (T.5S, R.1W, Section 3). The Perch Lake basin is comprised of 45 acres, and the Crystal Lake basin consists of 129 acres (RLS, 2023). The Perch Lake basin has nearly 1.3 miles of shoreline and the Crystal Lake basin has nearly 3.7 miles of shoreline. The mean depth of the Perch Lake basin is approximately 5.9 feet, and the mean depth of the Crystal Lake basin is approximately 13.6 feet. The maximum depth of the Perch Lake basin is approximately 9.7 feet, and the maximum depth of the Crystal Lake basin is approximately 62.4 feet (RLS, 2023 bathymetric scan data).

The Perch Lake basin also has a fetch (longest distance across the lake) of around 0.5 miles, and the Crystal Lake basin has a fetch of around 0.7 miles (RLS, 2023). The Perch Lake basin has an approximate water volume of 242.2 acre-feet, and the Crystal Lake basin has an approximate water volume of 1,980.9 acre-feet (RLS, 2023 bathymetric data). The immediate watershed (which is the area directly draining into the lakes) differs for each basin with Perch Lake being approximately 113.7 acres and Crystal Lake being approximately 365.5 acres. This is about 7.6 times the size of the lake, which is moderately large. Both lakes are considered closed-basin systems, but Crystal Lake does drain into a wetland at the west end of the lake.

Based on the current study, Perch Lake contains 1 invasive aquatic plant species which includes the submersed Starry Stonewort and Crystal Lake contains hybrid Eurasian Watermilfoil (EWM), and Curly-leaf Pondweed (CLP). Continued surveys and vigilance are needed to assure that additional invasives do not enter both lakes. Recommendations for prevention of invasives are offered later in this management plan report. Extensive whole-lake aquatic vegetation surveys and biovolume scans were conducted on both lakes on June 13, 2023 and again on May 13, 2025 (survey) and June 25, 2025 (scan). Perch Lake contained 5 native submersed, 3 floating-leaved, and 4 emergent aquatic plant species, for a total of 12 native aquatic macrophyte species. Crystal Lake contained 10 native submersed, 3 floating-leaved, and 5 emergent aquatic plant species, for a total of 18 native aquatic macrophyte species as in 2023. This represents a fair to good biodiversity that could be enhanced with continued control of the submersed invasives. Aquatic herbicide treatments are recommended on a spot-treatment basis to effectively reduce the invasives over time.

Only systemic herbicides should be used on the invasive milfoil for root control. In addition, Curly-leaf Pondweed naturally declines in mid-summer but contact herbicides can also be used. Algaecides should be used sparingly on only dense, green, filamentous algal blooms since many favorable algae are present in both lakes and are critical food for the zooplankton.

Both lakes have multiple land uses such as wetlands, beaches, and riparian properties. Aquatic vegetation management should include nearshore methods such as the use of benthic barriers or Weed Rollers near beach and dock areas and the use of only systemic herbicides on watermilfoil. For the invasive macro alga Starry Stonewort, the use of chelated copper algaecides may be recommended. For the control of invasive Curly-leaf Pondweed, contact herbicides such as diquat or hydrothol. Additionally, the use of mechanical harvesting may be used for Curly-leaf Pondweed as well as for dense nuisance native pondweeds.

RLS also recommends an aquatic invasive species (AIS) educational signage and/or a boat washing station at the access sites. This is to prevent the transfer of invasive species into or out of the lakes. Regular whole-lake aquatic vegetation surveys are critical in the early detection of all invasives and for determining the efficacy of herbicide treatments.

Restorative Lake Sciences recommends an annual whole-lake GPS species inventory and survey, follow-up surveys, and a comprehensive scan to determine the relative abundance of all native and invasive aquatic plant species, their relative abundance, and the percent cover of the lake surface area as well as follow up surveys in key areas. This data will be used each year to make management decisions about where to treat and what method(s) to use as these may change with time and results. Survey data can also be used to determine treatment efficacy.

## 2.0 PERCH AND CRYSTAL LAKES AQUATIC VEGETATION COMMUNITIES

### 2.1 Overview of Aquatic Vegetation and the Role for Lake Health

Aquatic plants (macrophytes) are an essential component in the littoral zones of most lakes in that they serve as suitable habitat and food for macroinvertebrates, contribute oxygen to the surrounding waters through photosynthesis, stabilize bottom sediments (if in the rooted growth form), and contribute to the cycling of nutrients such as phosphorus and nitrogen upon decay. In addition, decaying aquatic plants contribute organic matter to lake sediments which further supports healthy growth of successive aquatic plant communities that are necessary for a balanced aquatic ecosystem. An overabundance of aquatic vegetation may cause organic matter to accumulate on the lake bottom faster than it can break down. Aquatic plants generally consist of rooted submersed, free-floating submersed, floating-leaved, and emergent growth forms. The emergent growth form (i.e., Cattails, Native Loosestrife) is critical for the diversity of insects onshore and for the health of nearby wetlands. Submersed aquatic plants can be rooted in the lake sediment (i.e., Milfoils, Pondweeds), or free-floating in the water column (i.e., Coontail). Nonetheless, there is evidence that the diversity of submersed aquatic macrophytes can greatly influence the diversity of macroinvertebrates associated with aquatic plants of different structural morphologies (Parsons and Matthews, 1995). Therefore, it is possible that declines in the biodiversity and abundance of submersed aquatic plant species and associated macroinvertebrates, could negatively impact the fisheries of inland lakes.

Alternatively, the overabundance of aquatic vegetation can compromise recreational activities, aesthetics, and property values. Perch Lake currently has a moderately high quantity of submersed aquatic vegetation which can lead to recreational and navigational issues. Over-management of the native aquatic vegetation is not advised, however, as it will only encourage excess growth by algae since the latter competes with the vegetation for vital water column nutrients. Crystal Lake has an ideal quantity of aquatic vegetation which is limited by its greater depth.

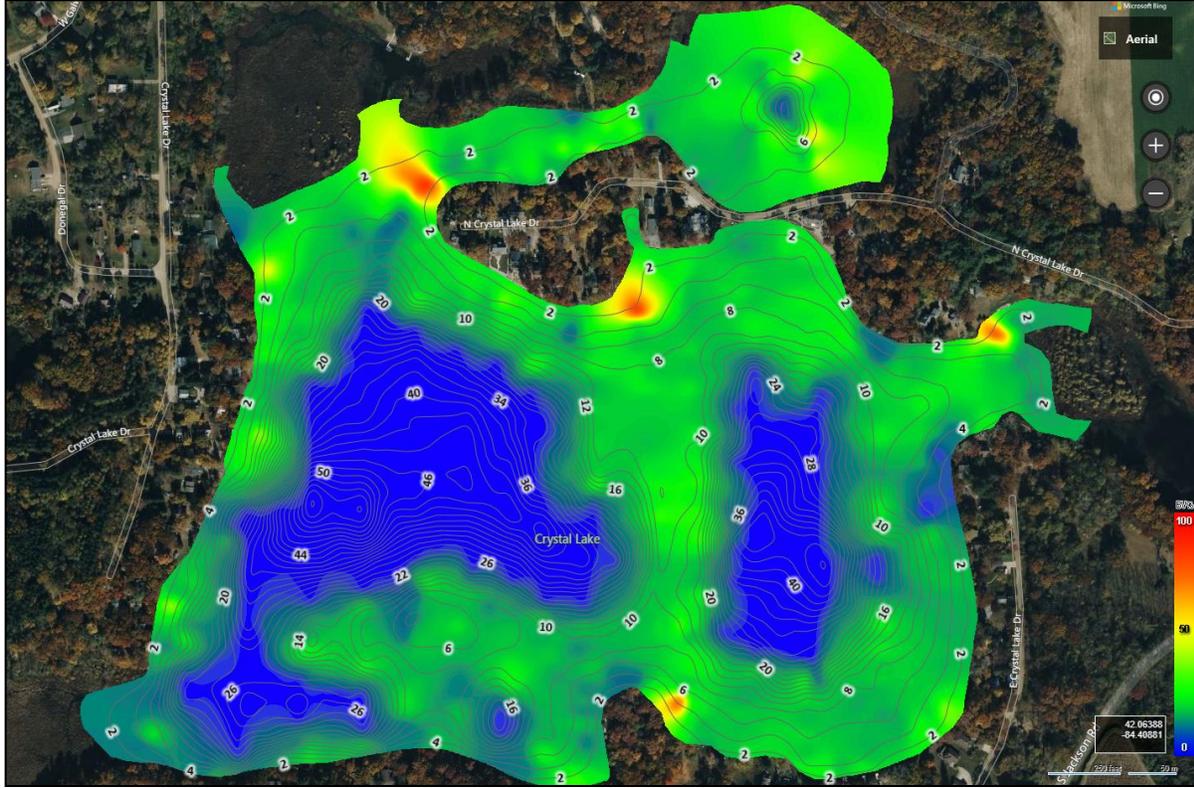
A whole-lake scan of the aquatic vegetation biovolume in both lakes was conducted on June 25, 2025 with a WAAS-enabled Lowrance HDS 9 GPS with variable frequency transducer. This data included 12,817 data points on Perch Lake and 4,068 data points on Crystal Lake. There were more points on the smaller Perch Lake due to its shallow depths and hence more vegetation cover. Points were then uploaded into a cloud software program to reveal maps that displayed depth contours, sediment hardness, and aquatic vegetation biovolume (Figures 1-2). On these maps, the color blue refers to areas that lack vegetation. The color green refers to low-lying vegetation. The colors red/orange refer to tall-growing vegetation. There are many areas around the littoral (shallow) zone of the lake that contain low-growing plants like Chara or Coontail. In addition, any emergent canopies or lily pads will show as red color on the map. For this reason, the scans are conducted in conjunction with a whole lake GPS survey to account for individual species identification of all aquatic plants in the lake. Tables 1-2 show the biovolume categories by plant cover during the June 25, 2025 scan and survey.

The Point-Intercept Survey method was conducted on May 13, 2025 and is used to assess the presence and percent cumulative cover of submersed, floating-leaved, and emergent aquatic vegetation within and around the littoral zones of inland lakes. With this survey method, sampling locations are geo-referenced (via GPS waypoints) and assessed throughout the entire lake to determine the species of aquatic macrophytes present and density of each macrophyte which are recorded onto a data sheet. Each separate plant species found in each sampling location is recorded along with an estimate of each plant density. Each macrophyte species corresponds to an assigned number. There are designated density codes for the aquatic vegetation surveys, where a = found (occupying < 2% of the surface area of the lake), b = sparse (occupying 2-20% of the surface area of the lake), c = common, (occupying 21-60% of the surface area of the lake), and d = dense (occupying > 60% of the surface area of the lake).

The survey of Perch Lake consisted of 280 sampling locations around the littoral zone and the survey of Crystal Lake consisted of 204 sampling locations. More sampling stations were required in Perch Lake due to the larger littoral zone (shallow area). Data were placed in a table showing the relative abundance of each aquatic plant species found and a resultant calculation showing the frequency of each plant, and cumulative cover.



**Figure 1. Aquatic plant biovolume of all aquatic plants in Perch Lake, Hillsdale County, Michigan (June 25, 2025). Note: Red denotes high-growing aquatic plants, green color denotes low-growing aquatic plants, and blue represents a lack of aquatic vegetation.**



**Figure 2. Aquatic plant biovolume of all aquatic plants in Crystal Lake, Hillsdale County, Michigan (June 25, 2025). Note: Red denotes high-growing aquatic plants, green color denotes low-growing aquatic plants, and blue represents a lack of aquatic vegetation.**

**Table 1. Perch Lake aquatic vegetation biovolume by category percent over of each category (relative cover on June 25, 2025).**

| <b>Biovolume Cover Category</b> | <b>% Relative Cover of Bottom by Category</b> |
|---------------------------------|---|
| <b>0-20%</b>                    | 44.9  |
| <b>20-40%</b>                   | 29.2  |
| <b>40-60%</b>                   | 8.5   |
| <b>60-80%</b>                   | 1.8   |
| <b>80-100%</b>                  | 15.7  |

**Table 2. Crystal Lake aquatic vegetation biovolume by category percent over of each category (relative cover on June 25, 2025).**

| <b>Biovolume Cover Category</b> | <b>% Relative Cover of Bottom by Category</b> |
|---------------------------------|---|
| <b>0-20%</b>                    | 61.5  |
| <b>20-40%</b>                   | 26.5  |
| <b>40-60%</b>                   | 7.5   |
| <b>60-80%</b>                   | 0.6   |
| <b>80-100%</b>                  | 3.8   |

## **2.2 Perch and Crystal Lakes Native Aquatic Macrophytes**

There are hundreds of native aquatic plant species in the waters of the United States. The most diverse native genera include the Potamogetonaceae (Pondweeds) and the Haloragaceae (Milfoils). Native aquatic plants may grow to nuisance levels in lakes with abundant nutrients (both water column and sediment) such as phosphorus, and in sites with high water transparency. The diversity of native aquatic plants is essential for the balance of aquatic ecosystems, because each plant harbors different macroinvertebrate communities and varies in fish habitat structure. Figures 18-19 show unique native aquatic vegetation present in Perch and Crystal lakes with respect to waterlilies Perch Lake and variable native watermilfoil in Crystal Lake.

Perch Lake contained 5 native submersed, 3 floating-leaved, and 4 emergent aquatic plant species, for a total of 12 native aquatic macrophyte species (Table 3). Crystal Lake contained 10 native submersed, 3 floating-leaved, and 5 emergent aquatic plant species, for a total of 18 native aquatic macrophyte species (Table 4). Photos of all native aquatic plants are shown below in Figures 3-20. The majority of the emergent macrophytes may be found along the shoreline of the lake and are critical for reducing shoreline erosion and for wildlife habitat along the lakeshore. Additionally, the majority of the floating-leaved macrophyte species can be found near the shoreline and wetland areas.

Both lakes contained an ample population of floating-leaved aquatic plants including white and yellow waterlilies and Watershield. These plants are critical snail habitat and also keep shallow areas cooler during the summer months which can allow for successful fish spawning in those areas. These plants should be preserved. Floating-leaved aquatic vegetation also serves to reduce waver energy in the water along with emergent aquatic plants such as the cattails, swamp loosestrife, bulrushes, and pickerelweed.

The dominant native aquatic plants in Perch Lake included Large-leaf Pondweed (19.6% of the sampling sites and reduced from 2023), and White Waterlily (15.0% of the sampling sites and increased from 2023). The dominant native aquatic plants in Crystal Lake included Chara (45.0% of the sampling sites, an increase from 2023), and Large-leaf Pondweed (38.7% of the sampling sites, an increase from 2023). The Pondweeds grow tall in the water column and serve as excellent fish cover. In dense quantities, they can be a nuisance for swimming and boating and can be controlled with selective herbicide management or with mechanical harvesting.

The relative abundance of rooted aquatic plants (relative to non-rooted plants) in the lake suggests that the sediments are the primary source of nutrients (relative to the water column), since these plants obtain most of their nutrition from the sediments.

**Table 3. Perch Lake native aquatic plants (May 13, 2025).**

| <b>Aquatic Plant<br/>Common Name</b> | <b>Aquatic Plant Latin<br/>Name</b>   | <b>A<br/>level</b> | <b>B<br/>level</b> | <b>C<br/>level</b> | <b>D<br/>level</b> | <b># Sites<br/>Found<br/>(%)</b> |
|--------------------------------------|---------------------------------------|--------------------|--------------------|--------------------|--------------------|----------------------------------|
| Muskgrass                            | <i>Chara vulgaris</i>                 | 8                  | 6                  | 5                  | 0                  | 6.8                              |
| Illinois Pondweed                    | <i>Potamogeton<br/>illinoensis</i>    | 19                 | 5                  | 4                  | 6                  | 12.1                             |
| Large-leaf Pondweed                  | <i>Potamogeton<br/>amplifolius</i>    | 1                  | 30                 | 18                 | 6                  | 19.6                             |
| Bladderwort                          | <i>Utricularia vulgaris</i>           | 3                  | 3                  | 1                  | 0                  | 2.5                              |
| Variable<br>Watermilfoil             | <i>Myriophyllum<br/>heterophyllum</i> | 9                  | 2                  | 7                  | 1                  | 6.8                              |
| Watershield                          | <i>Brasenia schreberi</i>             | 1                  | 5                  | 4                  | 0                  | 3.6                              |
| White Waterlily                      | <i>Nymphaea odorata</i>               | 8                  | 33                 | 1                  | 0                  | 15.0                             |
| Yellow Waterlily                     | <i>Nuphar variegata</i>               | 6                  | 4                  | 1                  | 0                  | 3.9                              |
| Cattails                             | <i>Typha latifolia</i>                | 2                  | 2                  | 0                  | 0                  | 1.4                              |
| Swamp Loosestrife                    | <i>Decodon verticillata</i>           | 2                  | 8                  | 0                  | 0                  | 3.6                              |
| Bulrushes                            | <i>Schoenoplectus sp.</i>             | 2                  | 1                  | 0                  | 0                  | 1.1                              |
| Pickerelweed                         | <i>Pontedaria cordata</i>             | 7                  | 2                  | 0                  | 0                  | 3.2                              |

**Table 4. Crytal Lake native aquatic plants (May 13, 2025).**

| <b>Aquatic Plant<br/>Common Name</b> | <b>Aquatic Plant Latin<br/>Name</b>   | <b>A<br/>level</b> | <b>B<br/>level</b> | <b>C<br/>level</b> | <b>D<br/>level</b> | <b># Sites<br/>Found<br/>(%)</b> |
|--------------------------------------|---------------------------------------|--------------------|--------------------|--------------------|--------------------|----------------------------------|
| Muskgrass                            | <i>Chara vulgaris</i>                 | 23                 | 68                 | 1                  | 0                  | 45.0                             |
| Illinois Pondweed                    | <i>Potamogeton<br/>illinoensis</i>    | 19                 | 24                 | 1                  | 0                  | 21.6                             |
| Large-leaf Pondweed                  | <i>Potamogeton<br/>amplifolius</i>    | 21                 | 58                 | 0                  | 0                  | 38.7                             |
| Fern-leaf Pondweed                   | <i>Potamogeton robbinsii</i>          | 2                  | 2                  | 0                  | 0                  | 2.0                              |
| White-stem<br>Pondweed               | <i>Potamogeton<br/>praelongus</i>     | 4                  | 1                  | 1                  | 0                  | 2.9                              |
| Bladderwort                          | <i>Utricularia vulgaris</i>           | 6                  | 5                  | 1                  | 0                  | 5.9                              |
| Coontail                             | <i>Ceratophyllum<br/>demersum</i>     | 0                  | 1                  | 0                  | 0                  | 0.5                              |
| Variable<br>Watermilfoil             | <i>Myriophyllum<br/>heterophyllum</i> | 9                  | 13                 | 4                  | 0                  | 12.7                             |
| Whorled<br>Watermilfoil              | <i>Myriophyllum<br/>verticillatum</i> | 4                  | 1                  | 0                  | 0                  | 2.5                              |
| Wild Celery                          | <i>Vallisneria americana</i>          | 5                  | 4                  | 1                  | 0                  | 4.9                              |
| Watershield                          | <i>Brasenia schreberi</i>             | 15                 | 26                 | 3                  | 0                  | 21.6                             |
| White Waterlily                      | <i>Nymphaea odorata</i>               | 16                 | 28                 | 4                  | 0                  | 23.5                             |
| Yellow Waterlily                     | <i>Nuphar variegata</i>               | 5                  | 29                 | 1                  | 0                  | 17.2                             |
| Cattails                             | <i>Typha latifolia</i>                | 2                  | 1                  | 1                  | 0                  | 2.0                              |
| Swamp Loosestrife                    | <i>Decodon verticillata</i>           | 2                  | 1                  | 1                  | 0                  | 2.0                              |
| Bulrushes                            | <i>Schoenoplectus sp.</i>             | 1                  | 4                  | 0                  | 0                  | 2.5                              |
| Pickerelweed                         | <i>Pontedaria cordata</i>             | 3                  | 7                  | 0                  | 0                  | 4.9                              |
| Iris                                 | <i>Iris sp.</i>                       | 5                  | 6                  | 0                  | 0                  | 5.4                              |



**Figure 3. Chara  
(Muskgrass) ©RLS**



**Figure 4. Illinois  
Pondweed ©RLS**



**Figure 5. Large-leaf  
Pondweed ©RLS**



**Figure 6. Fern-leaf  
Pondweed ©RLS**



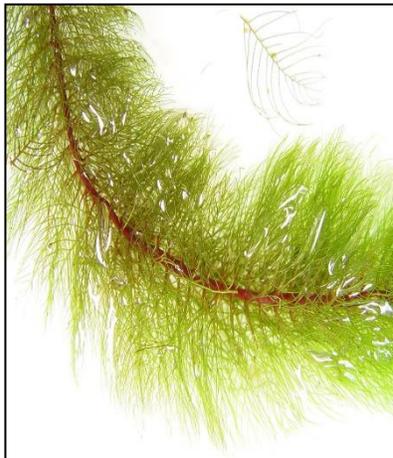
**Figure 7. White-stem  
Pondweed ©RLS**



**Figure 8. Bladderwort  
©RLS**



**Figure 9. Coontail  
Pondweed ©RLS**



**Figure 10. Variable  
Watermilfoil ©RLS**



**Figure 11. Whorled  
watermilfoil ©RLS**



**Figure 12. Wild Celery  
©RLS**



**Figure 13. Watershield  
©RLS**



**Figure 14. White  
Waterlily ©RLS**



**Figure 15. Yellow Waterlily ©RLS**



**Figure 16. Cattails ©RLS**



**Figure 17. Swamp Loosestrife ©RLS**



**Figure 19. Pickerelweed ©RLS**



**Figure 18. Bulrushes ©RLS**



**Figure 20. Iris ©RLS**

### 2.3 Perch and Crystal Lakes Exotic Aquatic Macrophytes

Exotic aquatic plants (macrophytes) are not native to a particular site, but are introduced by some biotic (living) or abiotic (non-living) vector. Such vectors include the transfer of aquatic plant seeds and fragments by boats and trailers (especially if the lake has public access sites), waterfowl, or by wind dispersal. In addition, exotic species may be introduced into aquatic systems through the release of aquarium or water garden plants into a water body. An aquatic exotic species may have profound impacts on the aquatic ecosystem. Eurasian Watermilfoil (*Myriophyllum spicatum*; Figure 21) is an exotic aquatic macrophyte first documented in the United States in the 1880's (Reed 1997), although other reports (Couch and Nelson 1985) suggest it was first found in the 1940's. In recent years, this species has hybridized with native milfoil species to form hybrid species. Eurasian Watermilfoil has since spread to thousands of inland lakes in various states through the use of boats and trailers, waterfowl, seed dispersal, and intentional introduction for fish habitat. Eurasian Watermilfoil is a major threat to the ecological balance of an aquatic ecosystem through causation of significant declines in favorable native vegetation within lakes (Madsen et al. 1991), in that it forms dense canopies (Figure 22) and may limit light from reaching native aquatic plant species (Newroth 1985; Aiken et al. 1979). Additionally, Eurasian Watermilfoil can alter the macroinvertebrate populations associated with particular native plants of certain structural architecture (Newroth 1985).

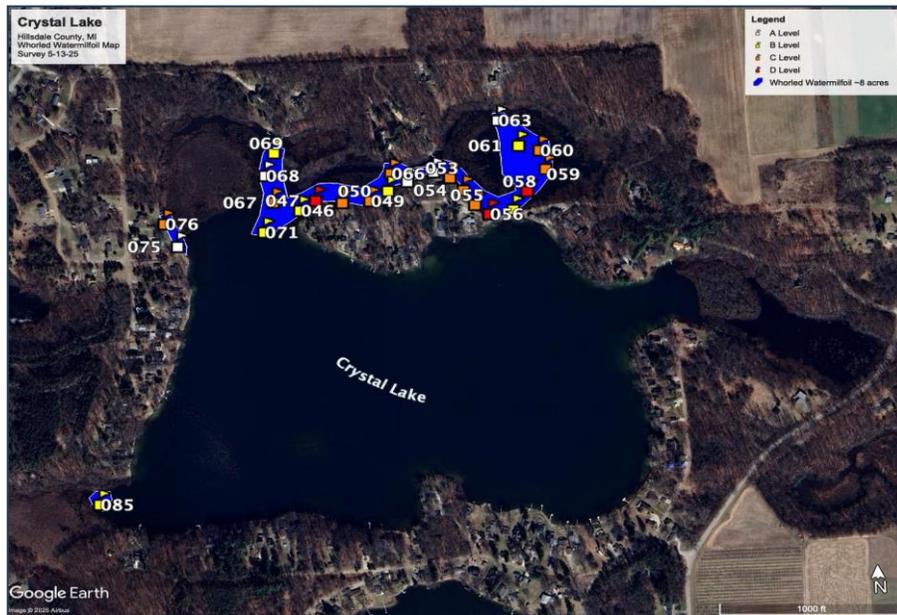
Eurasian Watermilfoil growth in Crystal Lake is capable of producing dense surface canopies, even despite the deeper waters as most of the littoral zone could be infested if not controlled. Figure 23 shows the distribution of the native Whorled Watermilfoil which can grow to nuisance levels and may require treatment in recreational areas. Figure 24 shows the distribution of milfoil within Crystal Lake (1.75 acres). At the time of the survey, Perch Lake did not have any milfoil present as in 2023. Tables 5-6 show the various invasives found and their relative abundance in both lakes.



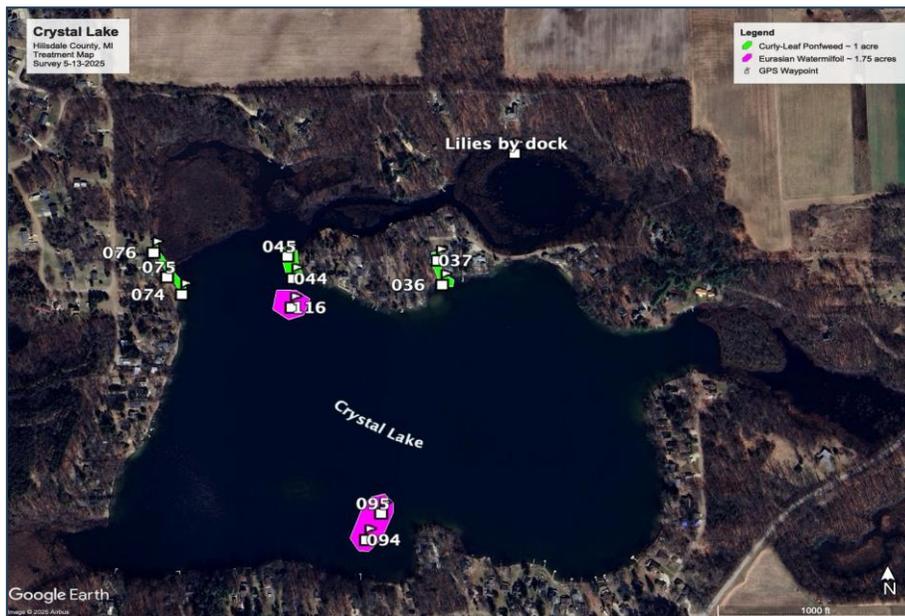
**Figure 21. Hybrid Eurasian Watermilfoil plant with seed head and fragments (©RLS).**



**Figure 22. Hybrid Eurasian Watermilfoil Canopy on an inland lake (©RLS).**



**Figure 23. Distribution of native whorled watermilfoil in Crystal Lake (May 13, 2025).**



**Figure 24. Distribution of invasive watermilfoil and Curly-leaf Pondweed in Crystal Lake (May 13, 2025).**

Curly-leaf Pondweed (*Potamogeton crispus*; Figure 25) is an exotic, submersed, rooted aquatic plant that was introduced into the United States in 1807 but was abundant by the early 1900's. It is easily distinguished from other native pondweeds by its wavy leaf margins. It grows early in the spring and as a result may prevent other favorable native aquatic species from germinating. The plant reproduces by the formation of fruiting structures called turions. It does not reproduce by fragmentation as invasive watermilfoil does; however, the turions may be deposited in the lake sediment and germinate in following seasons. Curly-leaf Pondweed is a pioneering aquatic plant species and specializes in colonizing disturbed habitats. It is highly invasive in aquatic ecosystems with low biodiversity and unique sediment characteristics. Curly-leaf pondweed was found in Crystal Lake (Figure 26) and Perch Lake but in low abundance (1.0 acre and 2.8 acres, respectively). It will naturally decay by late July so it could be left alone but there is a risk since turions can fall into the sediment and re-germinate the following season and mechanical harvesting may reduce that risk.



**Figure 25. Curly-leaf Pondweed (©RLS).**



**Figure 26. Distribution of invasive Starry Stonewort and Curly-leaf Pondweed in Perch Lake (May 13, 2025).**

Starry Stonewort (*Nitellopsis obtusa*; Figure 27) is an invasive macro alga that has invaded many inland lakes and was originally discovered in the St. Lawrence River. The “leaves” appear as long, smooth, angular branches of differing lengths. The alga has been observed in dense beds at depths beyond several meters in clear inland lakes and can grow to heights in excess of a few meters. It prefers clear alkaline waters and has been shown to cause significant declines in water quality and fishery spawning habitat. Individual fragments can be transported to the lake via waterfowl or boats. It was found in approximately 2.0 acres of Perch Lake in 2025 which was an increase from recent years (Figure 26 above).



Figure 27. A fragment of Starry Stonewort (©RLS).

Table 5. Perch Lake invasive aquatic plants (May 13, 2025).

| Aquatic Plant Common Name | Aquatic Plant Latin Name   | A level | B level | C level | D level | # Sites Found (% of total) |
|---------------------------|----------------------------|---------|---------|---------|---------|----------------------------|
| Curly-leaf Pondweed       | <i>Potamogeton crispus</i> | 5       | 8       | 9       | 4       | 9.2                        |
| Starry Stonewort          | <i>Nitellopsis obtusa</i>  | 5       | 1       | 11      | 4       | 7.5                        |

Table 6. Crystal Lake invasive aquatic plants (May 13, 2025).

| Aquatic Plant Common Name    | Aquatic Plant Latin Name                           | A level | B level | C level | D level | # Sites Found (% of total) |
|------------------------------|--|---------|---------|---------|---------|----------------------------|
| Hybrid Eurasian Watermilfoil | <i>Myriophyllum spicatum</i> var. <i>sibiricum</i> | 2       | 9       | 8       | 2       | 12.7                       |
| Curly-leaf Pondweed          | <i>Potamogeton crispus</i>                         | 2       | 3       | 1       | 6       | 10.2                       |

## 3.0 PERCH AND CRYSTAL LAKES MANAGEMENT IMPROVEMENT METHODS

---

### 3.1 Perch and Crystal Lakes Aquatic Plant Management Methods

Improvement strategies, including the management of only invasive aquatic plants, control of land and shoreline erosion, and further nutrient loading from external sources, are available for the various problematic issues facing Perch and Crystal Lakes. Long-term lake management components involve both within-lake (basin) and around-lake (watershed) solutions to protect and restore complex aquatic ecosystems. **The goals of a lake improvement program are to improve aquatic vegetation biodiversity, improve water quality and wildlife habitat, protect recreational use of a water resource and protect waterfront property values.** Regardless of the management goals, all management decisions must be site-specific and should consider the socio-economic, scientific, and environmental components of the lake management plan.

**The management of nuisance level exotic aquatic plants is necessary in Perch and Crystal Lakes due to accelerated growth and distribution. Management options should be environmentally and ecologically sound and financially feasible.** Options for control of aquatic plants are limited yet some are capable of achieving strong results when used properly. Exotic aquatic plant species should be managed with solutions that will yield long-term results. The sections below discuss the individual lake management methods (tools) and then ultimately lead to a section with specific recommendations using those methods.

#### 3.1.1 *Aquatic Herbicides and Applications*

The use of aquatic chemical herbicides is regulated by the Michigan Department of Environment, Great Lakes, and Energy (EGLE) and requires a permit. Aquatic herbicides are generally applied via an airboat or skiff equipped with mixing tanks and drop hoses (Figure 28). The permit contains a list of approved herbicides for a particular body of water, as well as dosage rates, treatment areas, and water use restrictions. **Contact and systemic aquatic herbicides are the two primary categories used in aquatic systems.**

Contact herbicides such as diquat, flumioxazin, and hydrothol cause damage to leaf and stem structures; whereas systemic herbicides are assimilated by the plant roots and are lethal to the entire plant. **Wherever possible, it is preferred to use a systemic herbicide for longer-lasting aquatic plant control of invasives. In Perch and Crystal Lakes, the use of contact herbicides (such as diquat and flumioxazin) would be highly discouraged since those offer short-term control of plants and are most commonly used on nuisance native aquatic plant species. The native aquatic plants within Perch and Crystal Lakes are critical for the lake fishery and should all be protected. They also assist with preventing further infestations from invasives. Contact herbicides could be used for the Starry Stonewort, however, but they are often used in combination with chelated copper.**

Algaecides such as copper sulfate should also be avoided on Perch and Crystal Lakes. **Copper accumulates in lake sediments and bio-persists over time. It is harmful to sediment biota and can be released into the water column with sediment perturbations.**

Systemic herbicides such as 2, 4-D and triclopyr are the two primary systemic herbicides used to treat milfoil that occurs in a scattered distribution. Fluridone (trade name, SONAR<sup>®</sup>) is a systemic whole-lake herbicide treatment that is applied to the entire lake volume in the spring and is used for extensive infestations. The objective of a fluridone treatment is to selectively control the growth of milfoil in order to allow other native aquatic plants to germinate and create a more diverse aquatic plant community. **Due to the cost and potential impacts of fluridone on native aquatic plants in Perch and Crystal Lakes, the use of fluridone is not recommended.**

Systemic herbicides such as 2, 4-D, triclopyr, and ProcellaCOR<sup>®</sup> are the primary systemic herbicides used to treat Eurasian Watermilfoil, but 2,4-D has shallow well restrictions and ProcellaCOR<sup>®</sup> is cost-prohibitive given the current EWM quantity in Perch and Crystal Lakes. Thus, the use of liquid triclopyr with adjuvant (a sinking agent) is recommended. This approach was very successful in 2024, with minimal growth remaining at the end of the 2024 season. The 2025 survey revealed the presence of milfoil only in Crystal Lake which was treated with systemic herbicide.



**Figure 28. An herbicide treatment airboat and crew preparing for a lake treatment.**

### **3.1.2 Mechanical Harvesting**

Mechanical harvesting involves the physical removal of nuisance aquatic vegetation with the use of a mechanical harvesting machine (Figure 29). The mechanical harvester collects numerous loads of aquatic plants as they are cut near the lake bottom. The plants are off-loaded onto a conveyor and then into a dump truck.

Harvested plants are then taken to an offsite landfill or farm where they can be used as fertilizer. Mechanical harvesting is preferred over chemical herbicides when native aquatic plants exist, or when excessive amounts of plant biomass need to be removed. **Mechanical harvesting is usually not recommended for the removal of watermilfoil since the plant may fragment when cut and re-grow on the lake bottom. This technology would have the most efficacy on very large weed beds and was recently used in 2025 to reduce nuisance pondweeds. It must be used to reduce dense areas of pondweed only once all of the EWM is reduced and only if the pondweeds prohibit recreation and navigation on the lake.**



**Figure 29. A mechanical harvester.**

### ***3.1.3 Diver Assisted Suction Harvesting (DASH)***

Suction harvesting via a Diver-Assisted Suction Harvesting (DASH) boat (Figure 30) involves hand removal of individual plants by a SCUBA diver in selected areas of lake bottom with the use of a hand-operated suction hose. Samples are dewatered on land or removed via fabric bags to an offsite location. **This method is generally recommended for small (less than 10 acres) spot removal of vegetation since it is usually cost-prohibitive on a larger scale.** The advantage it has is that it can be selective in what species it removes since a diver is guiding the suction hose to targeted plants. This process may remove either plant material or sediments and may require a USACE bottomlands permit. Furthermore, this activity may cause re-suspension of sediments (Nayar et *al.*, 2007) which may lead to increased turbidity and reduced clarity of the water.



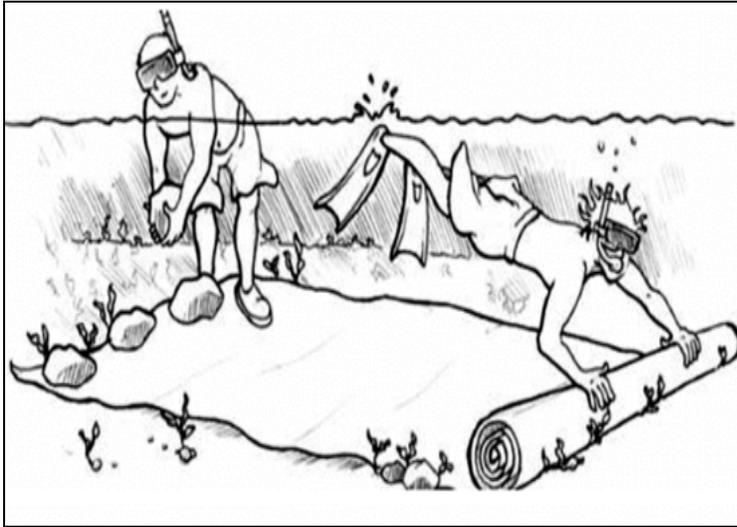
**Figure 30. A DASH boat for hand-removal of watermilfoil or other nuisance vegetation.**  
©Restorative Lake Sciences, LLC

### ***3.1.4 Benthic Barriers and Nearshore Management Methods***

The use of benthic barrier mats (Figure 31) or Weed Rollers (Figure 32) have been used to reduce weed growth in small areas such as in beach areas and around docks. The benthic mats are placed on the lake bottom in early spring prior to the germination of aquatic vegetation. They act to reduce germination of all aquatic plants and lead to a local area free of most aquatic vegetation. Benthic barriers may come in various sizes between 100-400 feet in length. They are anchored to the lake bottom to avoid becoming a navigation hazard. The cost of the barriers varies among vendors but can range from \$100-\$1,000 per mat. Benthic barrier mats can be purchased online at: [www.lakemat.com](http://www.lakemat.com) or [www.lakebottomblanket.com](http://www.lakebottomblanket.com). The efficacy of benthic barrier mats has been studied by Laitala et al. (2012) who report a minimum of 75% reduction in invasive milfoil in the treatment areas. Lastly, benthic barrier mats should not be placed in areas where fishery spawning habitat is present and/or spawning activity is occurring.

Weed Rollers are electrical devices which utilize a rolling arm that rolls along the lake bottom in small areas (usually not more than 50 feet) and pulverizes the lake bottom to reduce germination of any aquatic vegetation in that area. They can be purchased online at: [www.crary.com/marine](http://www.crary.com/marine) or at: [www.lakegroomer.net](http://www.lakegroomer.net).

**Both methods are useful in shallow lakes such as Perch and Crystal Lakes and work best in beach areas and near docks to reduce nuisance aquatic vegetation growth. These technologies could be used in beach areas on the lake if the bottom substrate is consolidated (firm).**



**Figure 31. A Benthic Barrier.** Photo courtesy of Cornell Cooperative Extension.



**Figure 32. A Weed Roller.**

### ***3.1.5 Boat Washing Stations***

In 2019, the Michigan Natural Resources Environmental Protection Act (PA 451 of 1993, Part 413) was amended with new boating and fishing laws that aim to prevent the introduction and spread of invasive aquatic species. Due to this amendment, technologies such as boat washing stations are becoming prevalent and necessary.

With over 13 million registered boaters in the U.S. alone, the need for reducing transfer of aquatic invasive species (AIS) has never been greater. The Minnesota Sea Grant program identifies five major boat wash scenarios which include: 1) permanent washing stations at launch sites, 2) Portable drive-through or transient systems, 3) Commercial car washes, 4) Home washing, and 5) Mandatory vs. volunteer washing. Boat washing stations are voluntary for incoming and exiting boaters. Boat washing stations promote the Clean Waters Clean Boats volunteer education program by educating boaters to wash boating equipment (including trailers and bait buckets) before entry into every lake. Critical elements of this education include: 1) how to approach boaters, 2) demonstration of effective boat and trailer inspections and cleaning techniques, 3) the recording of important information, 4) identification of high-priority invasive species, and 5) sharing findings with others. **Once a boat washing station is located on Perch and Crystal Lakes, the Association should work together to educate the public and lake users on proper cleaning techniques and other invasive species information. A “Landing Blitz” can be held once the station is in place and the public can be invited to a field demonstration of how to use the washing station.** Figure 33 displays a typical CD3 boat washing station that is solar-lowered.



**Figure 33. A boat washing station on an inland lake.**

#### 4.0 PERCH AND CRYSTAL LAKES CONCLUSIONS & RECOMMENDATIONS

---

The information given in the aforementioned sections for the long-term management of Perch and Crystal Lakes should be considered for effective management and balance of native aquatic plants, and the reduction of invasive aquatic plant species. **The overall goals of this proposed aquatic vegetation management program are listed in Table 5 along with where the proposed improvements should be implemented in and around the lake. The proposed aquatic vegetation management program conclusions and recommendations include the following:**

1. Protect the robust and healthy native aquatic plant biodiversity
2. Reduce invasive species such as Eurasian Watermilfoil and Curly-leaf Pondweed and Starry Stonewort. Although Curly-leaf Pondweed is an invasive aquatic plant, it will not likely take over the lake as there are so many other native pondweeds that are successfully outcompeting the Curly-leaf Pondweed. It may be treated with contact herbicides or mechanically harvested.
3. Reduction of nuisance natives such as native pondweeds and whorled watermilfoil may be desired if there are impairments to navigation and recreation. Both types of vegetation may be mechanically harvested or the latter treated with systemic herbicides similar to invasive milfoil.
4. As in 2024-5, the licensed aquatic herbicide applicator (PLM) should be retained for treatments that may be needed in future years. To avoid any conflicts of interest, an independent consulting limnologist (Restorative Lake Sciences) should oversee all lake treatments and make objective treatment recommendations as in 2026 and future years.
5. In nearshore areas, especially beaches, the use of benthic mats and weed rollers can reduce aquatic plant germination and growth without the use of chemicals.
6. Consider future purchase of a boat washing station when the invasives are reduced. The systems are costly (usually around \$30,000 per unit) but are worth the investment. Periodic grants are available.

**If the improvement methods described above are implemented, the aquatic plant communities of the Perch and Crystal Lakes ecosystem will improve over time. Such improvements will take considerable time and financial investment. RLS has prepared the optimum herbicide options for cost and responsibility to the ecosystem below in Table 7.**

**Table 7. Proposed aquatic vegetation program improvement methods for Perch and Crystal Lakes’s Improvement plan. Note: Water quality and other services are excluded based on the scope of work the Association requested from RLS.**

| <b>Lake Management Activity</b>                                   | <b>Primary Goal</b>                                     | <b>Secondary Goal</b>   | <b>Best Locations to Use</b>   |
|---|---|---|--|
| <b>Systemic aquatic herbicides for Eurasian Watermilfoil</b>      | To reduce % cover of EWM throughout lake                | To protect native aquatic plant biodiversity                    | ONLY where EWM is located and/or where nuisance Whorled milfoil is present |
| <b>Contact herbicides/algaecides for Starry Stonewort control</b> | To stop it from spreading to other areas of the lake    | To protect native aquatic plant biodiversity                    | ONLY where SS is located   |
| <b>Mechanical Harvesting</b>                                      | To reduce nuisance native plants                        | To allow for enhanced recreation and navigation                 | ONLY where nuisance natives are dense                                      |
| <b>Benthic Barriers/Weed Rollers</b>                              | To prevent germination of nuisance weeds in beach areas | To reduce dependency on chemicals in nearshore areas            | Beach areas only   |
| <b>Lake Vegetation Surveys/Scans</b>                              | To determine % cover by invasives and use as data tool  | To compare year to year reductions in nuisance vegetation areas | Entire lake, annually and follow-ups as needed                             |

#### **4.1 Cost Estimates for Perch and Crystal Lakes Aquatic Vegetation Management:**

The proposed lake improvement and management program for Perch and Crystal Lakes is recommended to begin as soon as possible. **Since aquatic herbicide treatments at this scale are likely to be the costliest improvement, it may be conducted over a period of 3-5 years or more to reduce annual cost and reduce cover of invasives over time.** A breakdown of estimated costs associated with the various proposed treatments in Perch and Crystal Lakes is presented in Table 8. It should be noted that proposed costs are estimates and may change in response to changes in environmental conditions (i.e., increases in aquatic plant growth or distribution, or changes in herbicide costs). Note that this table is adaptive and is likely to change.

**Table 7. Perch and Crystal Lakes proposed aquatic vegetation management program costs (2026-2028).**

| <b>Proposed Perch and Crystal Lakes Improvement Item</b>  | <b>2026 Costs</b> | <b>Years 2027-2028 Annual Costs</b> |
|---|-------------------|-------------------------------------|
| Professional services (limnologist management of lake recommendations, reporting, education) <sup>1</sup> | \$5,800           | \$6,000                             |
| EWM treatment using systemic herbicides (up to 4 acres)   | \$3,200           | \$3,200                             |
| Starry Stonewort Treatment (using chelated copper and hydrothol)  | \$1,500           | \$1,500                             |
| Mechanical harvesting of dense nuisance native pondweeds and/or Whorled watermilfoil                      | \$6,000           | \$6,500                             |
| Contingency <sup>3</sup>  | \$1,650           | \$1,720                             |
| <b>Total Annual Estimated Cost</b>  | <b>\$18,150</b>   | <b>\$18,920</b>                     |

<sup>1</sup> Professional services includes comprehensive management of the lake with an annual GPS-guided, aquatic vegetation survey, lake scans and aquatic vegetation treatment maps, and professional objective recommendations for successful aquatic plant management.

<sup>2</sup> Herbicide treatment scope may change annually due to changes in the distribution and/or abundance of aquatic plants.

<sup>3</sup> Contingency is 10% of the total project cost, to assure that extra funds are available for unexpected expenses. Note: Contingency may be advised and/or needed for future treatment years.

## 5.0 SCIENTIFIC LITERATURE CITED

---

- Anderson, E. 1948. Hybridization of the habitat. *Evolution* 2:1-9.
- Parsons, J.K., and R.A. Matthews. 1995. Analysis of the camps between macroinvertebrates and macrophytes in a freshwater pond. *Northwest Science*, 69: 265-275.
- Madsen, J.D., J.A. Bloomfield, J.W. Sutherland, L.W. Eichler, and C.W. Boylen. 1996. The aquatic plant community of Onondaga Lake: Field survey and plant growth bioassays of lake sediments, *Lake and Reservoir Management* 12:73-79.
- Madsen, J.D. G.O. Dick, D. Honnell, J. Schearer, and R.M. Smart. 1994. Ecological assessment of Kirk Pond, Miscellaneous Paper A-94-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.
- Nayar, S., DJ Miller, A. Hunt, BP Goh, and LM Chou. 2007. Environmental effects of dredging on sediment nutrients, carbon, and granulometry in a tropical estuary. *Environmental Monitoring and Assessment*, 127(1-3):1-13.
- Wetzel, R. G. 2001. *Limnology: Lake and River Ecosystems*. Third Edition. Academic Press, 1006 pgs.