

# 2020 Paw Paw Lake Improvement Plan

Coloma and Watervliet Township  
Berrien County, Michigan

**Submitted to:**  
Paw Paw Lake  
Improvement Board

**Submitted by:**  
Spicer Group  
1400 Zeeb Drive  
St. Johns, MI 48879

GEI Consultants of Michigan, Inc.  
806 Hastings Street, Suite M, Box 14  
Traverse City, MI 49686

June 17, 2020

---

## Table of Contents

---

<b>Executive Summary</b>	<b>4</b>
<b>Introduction</b>	<b>6</b>
<b>2015 – 2019 Success</b>	<b>8</b>
<i>Manage and control invasive and nuisance species</i>	8
<i>Improve overall water quality and clarity</i>	9
<i>Improve fisheries, wildlife, recreational, and aesthetic values of the lake</i>	11
<b>Improvement Goals</b>	<b>12</b>
<i>Goal 1 – Manage and Control Invasive and Nuisance Species</i>	12
Task 1 – Reduce Percent Cover of Invasive and Nuisance Species	13
Task 2 – Increase Percent Cover and Diversity of Native Vegetation	15
<i>Goal 2 – Improve Overall Water Quality and Water Clarity</i>	17
Task 1 – Reduce Total Phosphorous in the Water Column	17
<i>Goal 3 – Improve Fisheries, Wildlife, Recreation, and Aesthetic Values of the Lake</i>	20
Task 1 – Reduce Algal Blooms	20
Task 2 – Evaluate Existing Resources and Resource Improvements	23
<i>Goal 4 – Provide Educational Outreach</i>	24
<i>Goal 5 – Measure Success</i>	25
Task 1 – Refine metrics to quantify the progress of plan’s tasks and actions	27
<b>Literature Cited and Reference Materials</b>	<b>28</b>

## **Executive Summary**

---

The 2020 Lake Improvement Plan includes the continuation of work implemented in the 2012 and 2016 plans and adds several new projects to further address sediment and nutrient input into the lake. These will be important to continue to improve the overall quality of the water the lake receives and the environment of the lake.

### **2020 GOALS**

The goals of the 2020 Plan are the same as the goals of the 2016 Plan, which are to:

- Manage and control invasive and nuisance species
- Improve overall water quality and water clarity – halt/reverse lake degradation
- Improve fisheries, wildlife, recreational and aesthetic values of the lake

Additional Plan goals include:

- Provide educational outreach
- Measure success of Plan

### **2020 – 2025 ACTION PLANS**

The Action Plans related to these goals will be expanded to focus on further reducing sediment and nutrient input into the lake and to maintain the lake in its current state. The action items are ambitious, long-term and costly in total. However, they are critical for taking the next steps toward overall lake quality improvement

- Continue the weed management, water quality monitoring, algae monitoring and control, identification and response to new invasive species and monitoring on the Branch & Derby Drain.

In addition, the following are new actions to be initiated:

- Re-examine the Branch & Derby Drain to find sources of discharge of sediment into the lake.
- Restoring existing wetlands and floodplains to trap and reduce discharge.
- Divert water through a wetland adjacent to the Green Drain to provide sediment and nutrient filtration.
- Reconnect the lower Branch & Derby Drain to its original channel and wetland system immediately upstream of the Paw Paw Lake Road crossing.
- Install buffer strips at locations along the Branch & Derby Drain

- Locate and examine all storm sewers in the lake watershed and develop a maintenance program to keep them clean (timely removal of their accumulated sediment and pollutants before they are flushed into the lake).
- Install swirl concentrators, grit chambers and other devices at key locations of the stormwater system.

The result of these actions should result in the quality of the lake continuing to improve for the benefit of us and future generations of lake residents and guests.



Figure 1- Paw Paw Lake Aerial Image. Source: Coldwell Banker, Flickr

## Introduction

---

Spicer Group, Inc (Spicer) and GEI Consultants of Michigan (GEI) were retained by the Paw Paw Lake Improvement Board (PPLIB) to assist in updating the 2016 lake improvement plan. The plan lays out a framework for better understanding, assessing and selecting methods for improving the natural resources and water quality of the lake. In 2012, a 5-year lake management plan was adopted and implemented to address concerns with the invasion of Eurasian milfoil (*Myriophyllum spicatum*) across the lake coupled with the apparent high concentration of phosphorous being released from bottom sediments into the water column exacerbating nuisance growths of aquatic weeds and algal blooms.



Figure 2- Eurasian watermilfoil. Sources: R - Lake Bottom Blanket, L - Lake George Association.

Implementation of this plan provided for the lake-wide herbicide treatment of Eurasian milfoil in 2012 with Sonar (Fluridone) treatment. Coupled with subsequent spot treatments in 2013 – 2015, these treatments have proven effective in stopping and controlling the spread of this non-native nuisance plant species across the lake. The plan also included implementation of a pilot aeration project in the northern lobe of the lake to reduce the release of phosphorous from bottom sediments into the water column and to reduce the accumulation of bottom sediments. Water quality monitoring took place before, during, and after the pilot project in the order to evaluate the effectiveness of this treatment method and provide insight on future treatment options.

This lake improvement plan evaluates the effectiveness of the actions taken under the previous watershed and lake management plans<sup>1</sup> for Paw Paw Lake and look for ways

---

<sup>1</sup> Paw Paw Lakes and Watershed Study (Feb 2008) and Paw Paw Lake Restoration Plan (May 2010), 2012 Lake Management Plan, 2015, 2016, 2017, 2018, and 2019 Water Quality Monitoring Reports.

of improving upon their successes and shortfalls. The financial projections for this plan are based on a five-year cycle, 2020 – 2024. This plan is intended to be a working document that can be utilized beyond the five-year timeframe. The plan also contains a framework for public education and outreach, which include providing informational brochures, workshops, and meetings along the lakeshore. Public education and outreach are intended to assist both riparian property owners and lake visitors in understanding what actions are being taken by PPLIB and what actions they can take to do their part in making Paw Paw Lake a place for people to enjoy for generations to come.

## 2015 – 2019 Success

---

Within the last five years, 2015 – 2019, the PPLIB has taken action on the previous lake improvement plan's goals and objectives. The goals and objectives from the previous plan are nearly the same as the current plan's, which include:

- Management and control of invasive and nuisance species,
- Improvement of overall water clarity and quality, and
- Improvement of fisheries, wildlife, recreational, and aesthetic values of the lake.

The following items are the result of the PPLIB's work towards improving and enhancing Paw Paw Lake for each goal.

### ***Manage and control invasive and nuisance species***

Completed actions include:

- Aquatic invasive species have been well-managed and new invasive species, such as starry stonewort, have been kept at bay
- Aquatic vegetative species within the lake have been identified and quantified over time
- Boat wash educational events have taken place at the State of Michigan boat launch on the east side of the lake
- Educational outreach and sharing of AVS data at public meetings
- Analysis of the likelihood of a massive zebra mussel infestation based on water quality parameters measured in the monitoring program
- Educational outreach on zebra mussels

Aquatic invasive species in Paw Paw Lake had previously been managed via spot treatments for target species. However, in recent years, treatment methods have been updated to a lake-wide Sonar® (active ingredient of fluridone) treatment and follow up spot treatments in years that follow. This method has proven to be more effective at eliminating invasive and nuisance species while also being more cost effective.

An aquatic invasive plant new to the lake was starry stonewort. Starry stonewort is a macroalgae that is very effective in nutrient uptake, however it tends to have cycles of population booms and crashes in mesotrophic to eutrophic inland lakes in Michigan and the Midwest. The extreme fluctuation of starry stonewort population leads to lack of vegetative diversity in lakes and ultimately poor water quality, as when the algae dies off and decomposes, substantial dissolved oxygen from the water is utilized in the

decomposition process. Less dissolved oxygen in the water column may suffocate fish and other aquatic organisms. Fortunately, only a small patch of starry stonewort was observed, treated and eradicated before it became a larger issue.

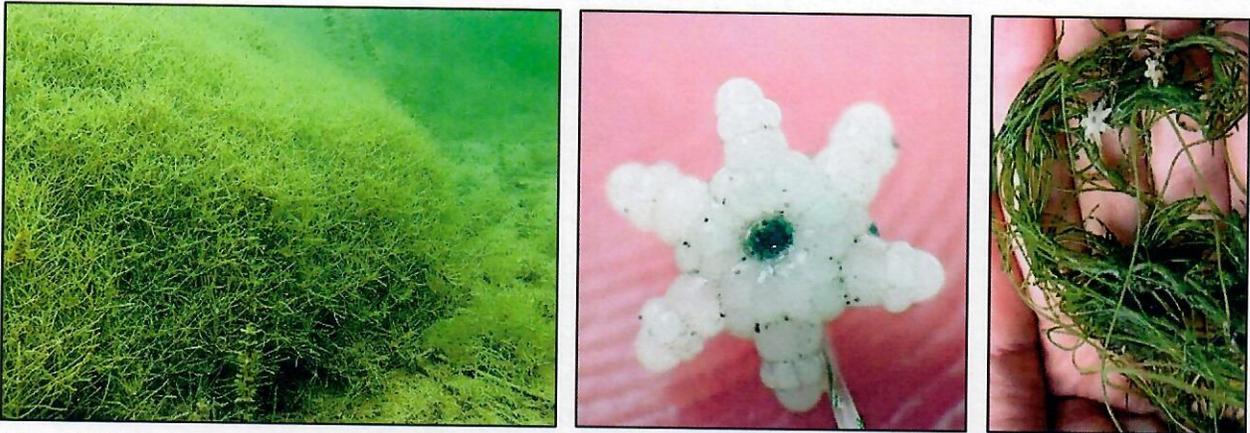


Figure 3- Starry Stonewort. From L to R: Starry stonewort growing in clumps underwater, bulbils structure of plant, starry stonewort out of water. Sources L to R: North Fork Crow River Watershed District, Paul Skawinski, Lake Miliona Association.

An increase in zebra mussel population was also observed within the last 5 years. The increase in zebra mussels likely lead to the observed increase in water clarity and decrease in surface total phosphorus and chlorophyll-a concentrations. Paw Paw Lake has the water quality conditions that provide a moderate potential for nuisance zebra mussel infestation (USACE Zebra Mussel Resource Document). Zebra mussel control methods were reviewed during the 2018 monitoring season, however, they were not necessary in the 2019 season, as the population appeared to stabilized itself.

Management and control of invasive and nuisance species continues to be a primary goal of the 2020 – 2024 Paw Paw Lake Improvement Plan.

### ***Improve overall water quality and clarity***

Actions completed include:

- Aeration units were installed to help reduce internal nutrient loading
- Consistent lake water quality monitoring plans were executed, providing insight on success of projects or areas where projects could improve
- Continuous water quality monitoring in the Branch & Derby Intercounty Drain with automated sampling during wet weather events
- Algal analysis with identification and enumeration of algal species during blooms and normal conditions

- Microcystins analysis conducted in order to ensure safety on the lake during a blue-green algae bloom
- Educational outreach for riparian landowners and general public with annual water quality reports for Paw Paw Lake and the Branch & Derby Intercounty Drain as well as presentations made during public meetings.

Improving upon water quality within Paw Paw Lake not only accomplishes the goal of improving water quality, but also improves fisheries, wildlife, recreational, and aesthetic value of the lake, and creates conditions that are less conducive to an outbreak of invasive species.

Within the last five years, a pilot aeration project was implemented in the northern lobe of the lake. The diffusers circulated water from the bottom of the lake to the lake's surface in order to oxygenate the entire water column. The aeration system was effective in increasing dissolved oxygen at greater depths; however, the concentrations were below 5 mg/L, MDNR's warmwater fishery standard. Additionally, dissolved oxygen tended to be lower in surface waters compared to previous years, and nutrient-rich water from the bottom of the lake were brought to the surface. Higher concentrations of nutrients within the photic zone could lead to more algal blooms and growth of aquatic vegetative species. Therefore, after reviewing the water quality data and anecdotal evidence, it was decided to cease the pilot aeration program.

A comprehensive and consistent water quality monitoring protocol has been established for the lake and allows for simple year to year comparison of data. Algal analysis was added to the protocol in 2016 as there were concerns about what kind of algae was blooming and if it could produce harmful toxins called microcystins. Fortunately results show that there is not concern for microcystins in Paw Paw Lake. The most common algae observed during blooms and normal conditions is blue-green algae.

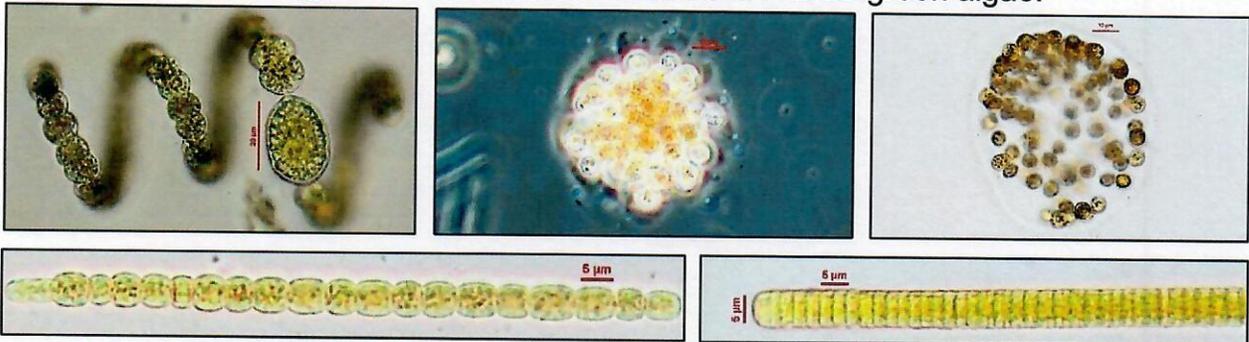


Figure 4- Species of algae found in Paw Paw Lake. Species names from left to right, top to bottom are the following: *Dolichospermum crassum*, *microcystis botrys*, *microcystis wesenbergii*, *nostoclean filament sp.*, *planktothrix isothrix*. Source: GreenWater Labs.

Monitoring and water quality improvement are a key part to the 2020 – 2024 Paw Paw Lake Improvement Plan as well.

***Improve fisheries, wildlife, recreational, and aesthetic values of the lake***

Actions completed include:

- Consistent water quality monitoring program
- Management of aquatic invasive and nuisance species
- Provide guidance on the installation of fish habitat structures around the lake; coordination with regulatory agencies on permitting process (EGLE currently reviewing)

Fisheries, wildlife, recreational and aesthetic values of the lake have been indirectly improved upon by pursuing the goals of water quality improvement and invasive species management.

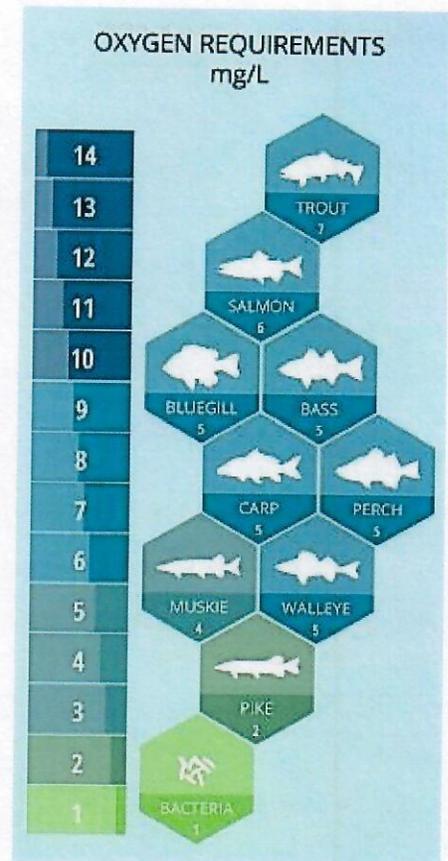


Figure 5- Oxygen requirements for fish in freshwater environments. Source: Fondriest Environmental.

## Improvement Goals

---

The previous Lake Improvement Plan extended 5 years: 2012 – 2016. The plan allowed for a lake-wide treatment of Eurasian water milfoil, the installation of pilot aeration project in the northern lobe of lake, water quality monitoring, and many other improvement and monitoring activities. The current plan will continue the success and momentum of the previous plan for the next five years, 2020 – 2024. The 2012 – 2016 and 2020 – 2024 Lake Improvement Plans have similar core goals that have been developed by the PPLIB and its consultants. Each goal is broken down into tasks, and each task is broken down into actions to be completed that will help to obtain each goal. The primary improvement goals for both plans are to:

1. Manage and control invasive and nuisance species
2. Assess and manage pollutant (e.g. sediment, total phosphorus) discharges into the lake from various sources (e.g. Branch & Derby Drain)
3. Maintain, and where possible, improve overall lake water quality
4. Improve fisheries, wildlife, recreational, and aesthetic values of the lake
5. Provide educational outreach
6. Measure success

### ***Goal 1 – Manage and Control Invasive and Nuisance Species***

---

One of the greatest threats to Michigan’s inland lakes and its associated aquatic resources is the uncontrolled spread of invasive and nuisance species, including non-native and exotic species. These organisms can compete with native species for food and space, affect the natural balance of aquatic ecosystems, and significantly impact resource use (MDEQ et al., 2013; Michigan Sea Grant, 2012).

There are numerous cases in the Great Lakes region where invasive species such as zebra mussels (*Dreissena polymorpha*), round goby (*Neogobius melanostomus*), and Eurasian milfoil have upset the natural balance of the aquatic communities resulting in poorer fishing opportunities, decreased abundance of fish prey (e.g., invertebrates) and spawning habitat, decreased recreational opportunities, and decreased waterfront property values, among other impacts (Lovell, 2005; Rosaen et al., 2012; MDEQ et al., 2013).

As of September 2015, an additional 10 aquatic plant and 7 fish/aquatic animal species are listed on MDNR's invasive species "watch list" (MDNR, 2015), indicating the potential for colonization by other species in the future.

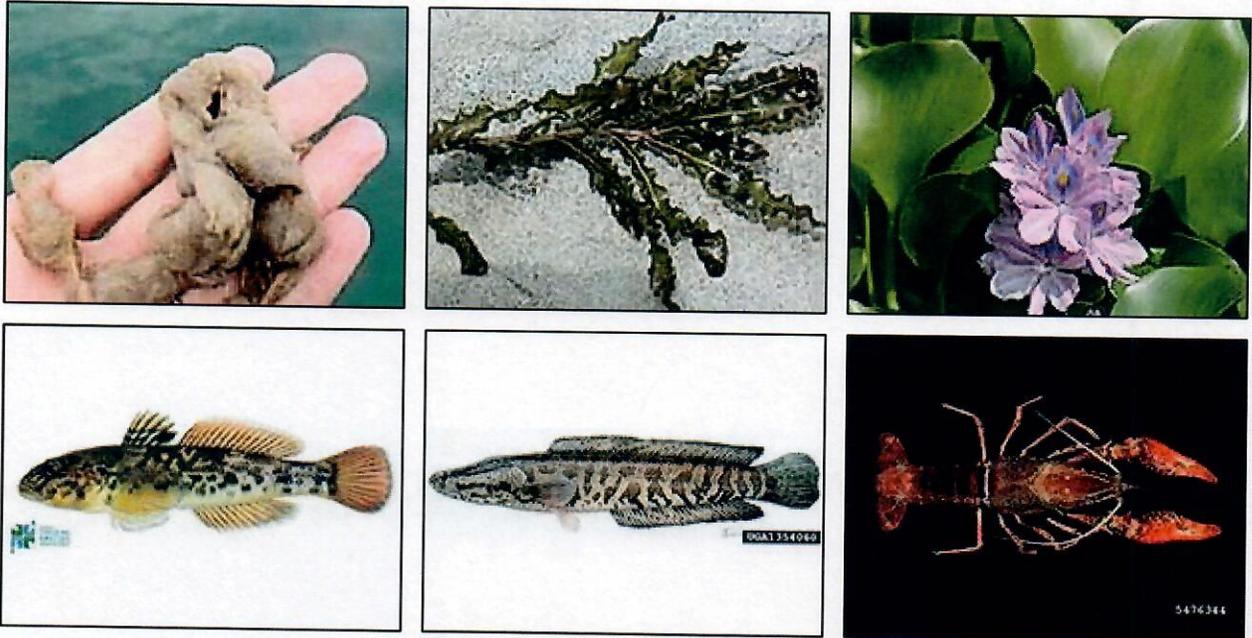


Figure 6- Examples of invasive species found in aquatic ecosystems. Species from left to right, top to bottom are: Didymo (Rock Snot), Curly-Leaf Pondweed, Water Hyacinth, Round Goby, Northern Snakehead, Red Swamp Crayfish. Source: Michigan Invasive Species.

The PPLIB has received numerous complaints pertaining to invasive and nuisance species. They recognize the importance of managing and controlling invasive and nuisance species, whether plant or animal, in order to sustain and improve species composition and recreational value in the lake.

Management and control of invasive and nuisance species may be broken down into smaller tasks and actions. These smaller steps are outline in the paragraphs below.

### **Task 1 – Reduce Percent Cover of Invasive and Nuisance Species**

This task relates most directly with the goal of “Managing and Controlling Invasive and Nuisance Species.” However, it also contributes to other goals by reducing threats to native plant and animal communities, which provides a greater array of wetland functions and values, and habitats for aquatic and terrestrial biota (as compared to invasive species). If left unchecked, invasive species can outcompete native species and reduce plant and animal diversity. This in turn reduces fish and wildlife resources and ultimately reduces recreational, economic, and aesthetic values to the lake.

Percent cover of invasive and nuisance species is a routine measurement obtained by a field biologist. Percent cover consists of estimating the amount of vegetative cover, native or non-native species (i.e. invasive and nuisance species) within a given area. Data is collected during the Aquatic Vegetation Survey (AVS) of the lake. From this survey a numeric value of percent cover of the entire lake or portions of the lake can be derived.

AVS are typically required to be included in EGLE aquatic nuisance control permit applications and are strongly recommended to be completed in both early and late summer coinciding with both pre- and post-herbicide treatments. The surveys are used to obtain a complete understanding of what plant species are growing in the lake, note some species are not fully represented until later in the growing season, and to analyze the effectiveness of your herbicide or other weed control measures that were implemented. To help complete the task reducing percent coverage of invasive and nuisance species the following actions have been outlined for the Lake Improvement Plan:

- A. Continue to implement, monitor, assess, and improve upon current aquatic nuisance weed management plan
  - Utilize qualified consultants, experienced with the identification, assessment, treatment, and monitoring of aquatic nuisance plant species to provide the services required by the ANWMP
  - The Aquatic Vegetation Surveys (AVS) will be conducted using botanist/aquatic biologist experienced with nuisance and native plant identification and conducting AVS, one from the selected herbicide/chemical application contractor (PLM) and the other from the Spicer/GEI team.
  - PLM will prepare herbicide/application recommendations for Spicer/GEI to review, provide recommendations, and submit to PPLA for approval prior to implementation.
  - PLM will complete the herbicide/chemical applications
  - Post survey evaluations of the effectiveness of the applications will be conducted using the same two-person team used for the AVS.
  - PLM, Spicer, and GEI will evaluate the effectiveness of the implemented components of the ANWMPs
  - Recommend additions or changes to the plan to decrease percent cover of invasive and nuisance species
  - the results scientifically and without bias

- B.** Re-examine tributaries (e.g. Branch & Derby Drain) and other point and non-points sources of discharge into the lake as it has been several years since this watercourse was last inspected and new areas of concern may have developed. Specific items to identify, document, and assess include, but are not limited to, the following:
- Point and non-point sources of pollutants (e.g. areas of erosion, agricultural and road runoff)
  - Restoration of wetlands and floodplains to trap and reduce the downstream discharge of pollutants
  - Estimate of cost/benefit from addressing these issues within the various watercourse, drains, or areas of non-point source discharge to the lake
- C.** Research, evaluate and implement existing and other technologies for assessing and controlling non-native, invasive, nuisance, and exotic species.
- Boat washing station(s) – identify success rate and use of these systems, as well as cost and funding through grant money
  - Surveys for early detection of invasive vegetative species
  - Biocontrol of invasive species
  - Zequanox for zebra and quagga mussel treatment
  - Use of other chemicals or products to remove nutrients from the water column (e.g. Alum)
- D.** Develop and provide educational brochures, materials and workshops for the general public. Partner with Southwest by Southwest Cooperative Invasive Species Management Area (SW x SW CISMA) on the development of these materials and for joint training opportunities, outreach events, invasive species reporting and treatment. These efforts look to focus on educating the public and riparian landowners about the benefits and values of identifying and controlling invasive, exotic and non-native species, importance of and how to reduce point and non-point source discharges to the lake, and what they can do themselves, on their own property, to help.

### ***Task 2 – Increase Percent Cover and Diversity of Native Vegetation***

This task relates most directly with the goal of “*Managing and Controlling Invasive and Nuisance Species*”. However, it also contributes to the other two goals by sequestering nutrients in plant tissue, thus reversing lake degradation. An increase in native vegetation

also increases fish, wildlife, recreational and aesthetic values of the lake. As previously stated in Task 1, Reduce Cover of Invasive and Nuisance Species, invasive species have the capability to become dominant, outcompete native species, and reduce plant and animal diversity. Reduction in diversity decreases the quality of the fishery and ultimately recreational, economic, and aesthetic values to the lake.

Percent cover of native species is a routine measurement conducted by a field biologist and consists of estimating the amount of vegetative native and non-native cover within a given area. Native species cover data is collected at the same time as invasive and nuisance species cover data previously identified in Section 1.1. Data is collected during an Aquatic Vegetation Survey (AVS). From this survey, a numeric value of percent cover of the entire lake or portions of the lake is derived. Again, AVS are typically required by EGLE for numerous permit applications, including aquatic nuisance weed management. They are also recommended to be completed in both the early and late summer, coinciding with both pre- and post-herbicide treatments. This allows for a full understanding of what plant species are in the lake, note that some species are not fully represented until later in the growing season. This method also allows for understanding how effective implemented herbicide and other weed control measures were. The following actions have been developed in order to promote an increase in percent cover and diversity of native vegetation:

- A.** Continue to implement, monitor, assess, and improve upon current aquatic nuisance weed management plan (ANWMP).
  - Continue to utilize qualified consultants to provide the services required by the ANWMP.
  - Utilize a consultant and/or aquatic biologist to annually conduct Aquatic Vegetation Surveys (AVS).
    - AVS will help determine how effective ANWMP is and will provide insight on recommendations for improving the management plan.
    - Third party consultants may also provide a scientific non-biased review of aquatic vegetation surveys or other contracted work, as well as provide recommendations that allow for a more efficient approach to increasing percent cover of native species.
  
- B.** Research, evaluate and consider reintroduction of native vegetation in strategic locations around the lake (township sites, access points).
  - Provide educational materials to the public and riparian landowners on:

- Benefits of incorporating native plantings on private lands both on the shoreline and within the watershed
  - Reduction of mowing to the shoreline and fertilizer use
  - Identification, control and management of invasive plant and animal species
  - Other activities landowners can do to improve the lake and its watershed
- Research the cost effectiveness, permitting requirements, and likelihood of re-introducing native species back into areas eradicated of non-native species (i.e. invasive and nuisance species).

## ***Goal 2 – Improve Overall Water Quality and Water Clarity***

---

Water quality and clarity is important for a lake to maintain its health, which in turn supports a healthy fishery and provides recreational opportunities. Additionally, high water quality tends to be correlated with higher property values. This goal stems from years of complaints and concerns brought to the PPLIB regarding algal blooms, decreased visibility, and nuisance smells across the lake. During the years 2012 – 2016, these conditions had increased in number, frequency, duration, and occurrence in the summer months when lake use is at its highest. However, these conditions began to lessen starting in 2017. This is likely due to the reduction in phosphorus and chlorophyll-a, which may have been attributed to an increase in zebra mussel population. Tasks and actions to measure and address these issues and to meet this goal are of primary importance to the PPLIB.

### ***Task 1 – Reduce Total Phosphorous in the Water Column***

This task relates most directly with the goal of *“Improving Overall Water Quality and Water Clarity – Halt/Reverse Lake Degradation”*. However, it also contributes to *“Managing and Controlling Invasive and Nuisance Species”* by reducing the amount of available nutrients in the water column for these overly aggressive and high nutrient tolerant species to utilize (which outcompete native species). Reducing total phosphorous in the water column will limit the available nutrients for adverse growth of algae and nuisance plants which will in turn provide clearer water.

Measuring total phosphorous in the water column has been a component of historic monitoring protocols on Paw Paw Lake and is required by EGLE for various permits. Therefore, it is recommended that total phosphorus monitoring continues to be

incorporated into the lake's water quality monitoring program. Total phosphorus concentrations are measured by collecting water samples at various depths within the lake's water column and sending those samples to a laboratory for analysis. Lab results are sent to the consultants where results from other samples taken at various depths, locations and years are compared. Actions developed to help complete the task of total phosphorus reduction in the water column are as follows:

- A.** Evaluate the potential use of the following, at various locations within the watershed, for reducing nutrient inputs into the lake:
- Restoration or creation of wetlands
  - Off-line detention systems
  - In-line detention systems and sediment traps Retention basins to control overland runoff or other discharges
  - Treatment trains
  - Level control structures
  - Drain maintenance projects and cleanouts
- B.** Evaluate other practices that have been reported to sequester phosphorus. Practices include:
- Floating treatment wetlands
  - Planting of native aquatic vegetation in areas where it is absent or could be denser
  - Alum
- C.** Continue to collect and compare trends in water quality data. Parameters to be monitored include:
- Dissolved oxygen,
  - Total phosphorous,
  - Soluble reactive phosphorus,
  - Nitrate,
  - Ammonia,
  - Specific conductivity,
  - pH,
  - Secchi Depth (visibility),
  - Total suspended solids,
  - Temperature and
  - Chlorophyll-a.

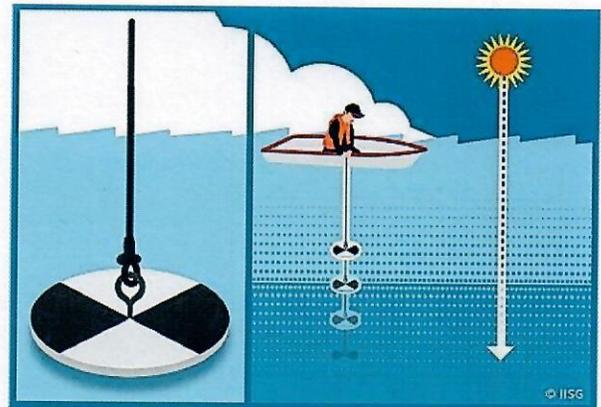


Figure 7- Secchi disk used for measuring water clarity.  
Source: Limno Loan.

- D. Continue to shape the monitoring plan so that it effectively evaluates improvement actions implemented
- E. Understand nutrient loading and inputs from Paw Paw Lake's watershed and sub-watersheds.
- Coordination with the Berrien County and Van Buren County Drain Commissioner Offices for inspection and evaluation of drains tributary to Paw Paw Lake
  - Coordinate with Little Paw Paw Lake SAD on their water quality findings and improvement methods
  - Coordination with the Department of Public Health on potential faulty septic systems and illicit discharges to the lake
  - Coordination with United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) on programs for controlling agricultural runoff and other potential point and non-point sources of discharge to the lake
  - Update Paw Paw Lake 2008 watershed model to understand nutrient inputs to the lake based on land use, rainfall, and watershed data.
  - Use existing water quality and gauge data collected within the watershed reducing phosphorous inputs into the lake
  - Methods for phosphorous reduction and removal include, but are not limited to:
    - Aeration – at key locations and depths
    - Alum
    - Drawdowns
    - Dredging
    - Filtering, extraction or removal of nutrients from water
    - Watershed management practices



Figure 8- Autosamples installed at the Branch & Derby Intercounty Drain. Source: E. Short.



Figure 9- Branch & Derby Intercounty Drain post-rain event, May 2020. Source: S. Kogge, L. Protasiewicz.

### ***Goal 3 – Improve Fisheries, Wildlife, Recreation, and Aesthetic Values of the Lake***

---

Taking action on the two aforementioned goals of improving water quality and reducing aquatic invasive species, will assist in achieving this goal. Fisheries, wildlife, and recreational improvement was identified as a separate goal to draw attention to the lake’s natural resources and the recreational opportunities they provide to both riparian landowners and visitors of the lake. People value the lake slightly different from one another. For example, one person may value the fishing opportunities of the lake, while their neighbor, who may never fish, enjoys the serenity of seeing the clear blue waters daily. The PPLIB decided that all individuals who utilize the lake need to have their interests understood and addressed in a comprehensive lake management or improvement plan.

#### ***Task 1 – Reduce Algal Blooms***

This task relates to two goals – one being the goal of “*Improving Overall Water Quality and Water Clarity – Halt/Reverse Lake Degradation*” and the other to “*Improve....Aesthetic Values of the Lake*”. The “pea soup” appearance of algal blooms occurring within inland lakes throughout Michigan and the Midwest is well documented. Reducing the amount of available nutrients in the water column, especially during heavy recreation in the summertime, is key to reducing the number and intensity of algal blooms. (Sea Grant 2012b, USEPA 2016)

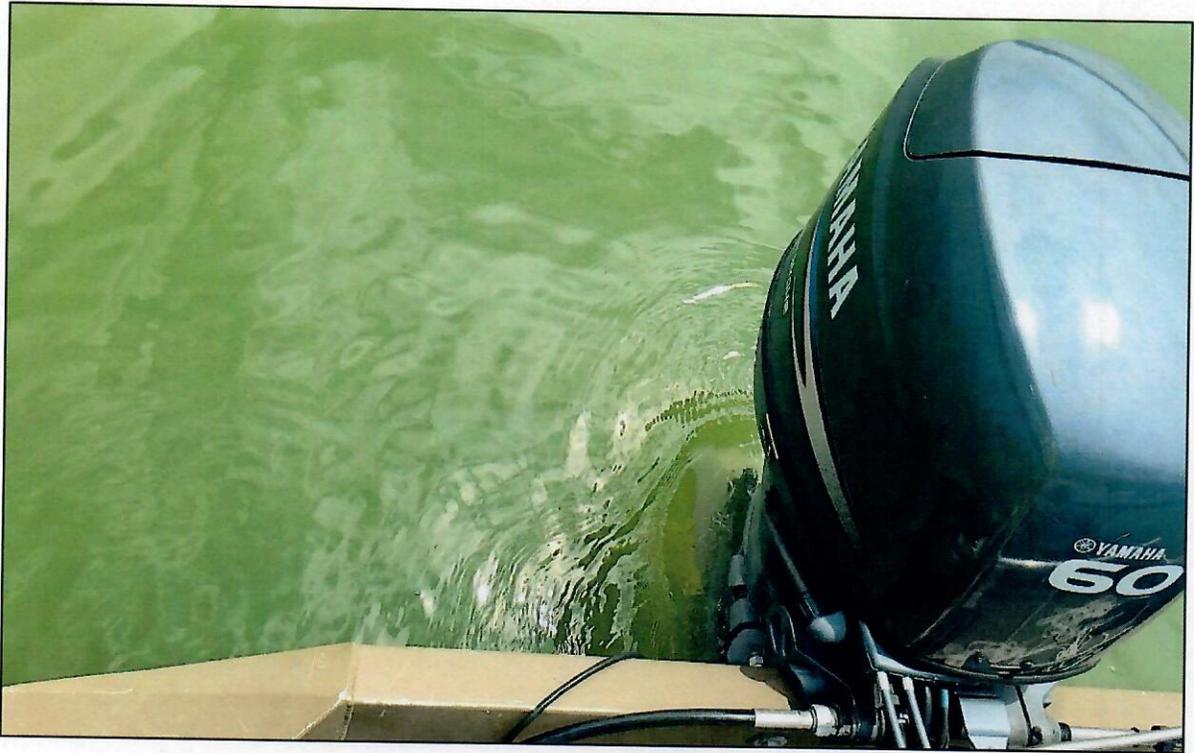


Figure 10- Bluegreen algae bloom observed in Paw Paw Lake on August 9, 2016. Source: R. Holem.

Success will be measured by qualitative evidence. Tracking the number, frequency and density of algal blooms that occur throughout the year as observed and reported by lake residents and visitors will be documented. The actions listed below will strive to reduce the number, frequency, intensity, and duration of those blooms as well as understand why blooms are occurring at various times of the year, what species are present and flourishing, and which algicides or methods may be used to reduce their occurrence. Actions include:

- A.** Continue to identify algal species, their densities, and microcystin concentrations during periods of algal blooms and normal conditions.
- B.** Compare algal data to historic algal data and understand how the population is changing or not changing over time.
- C.** Create and provide educational programs, workshops, social media posts, flyers, and brochures for the general public and riparian landowners on the following topics:

- Identification and elimination of point source and non-point source pollution and runoff
  - Sources of excess nutrients and how an individual can help prevent the introduction of these nutrients into the lake within the watershed or at the shoreline.
  - Native and natural shorelines
- D.** Continue to collect and compare trends in water quality data. Parameters to be monitored include:
- Dissolved oxygen,
  - Total phosphorous,
  - Soluble reactive phosphorus,
  - Nitrate,
  - Ammonia,
  - Specific conductivity,
  - pH,
  - Secchi Depth (visibility),
  - Total suspended solids,
  - Temperature and
  - Chlorophyll-a.
- E.** Continue to shape the monitoring plan so that it effectively evaluates improvement actions implemented.
- F.** Research, evaluate and implement new technologies to reduce algal blooms and other mechanisms that contribute to periodic booms in algal population
- Evaluation of methods to control algal blooms may include but is not limited to the following:
    - Alum treatments
    - Algaecides
    - Aeration at key locations and depths
    - Watershed management practices
    - Filtering, extraction or removal of nutrients and/or algal cells from the water surface and water column using various technologies

## Task 2 – Evaluate Existing Resources and Resource Improvements

This task relates most directly with the goal of “Improving Fisheries, Wildlife, Recreational and Aesthetic Values of the Lake”. However, it also contributes to “Managing and Controlling Invasive and Nuisance Species” Resources include fish and wildlife habitat, recreation, and aesthetics.

Documentation and assessment of existing resources including fish, wildlife, and their habitats may be obtained in multiple way:

- Visual surveys around the perimeter of the lake and any adjacent wetland complexes.
- Data review of past reports including monitoring, fisheries population, stocking, wetland delineation, and other reports.

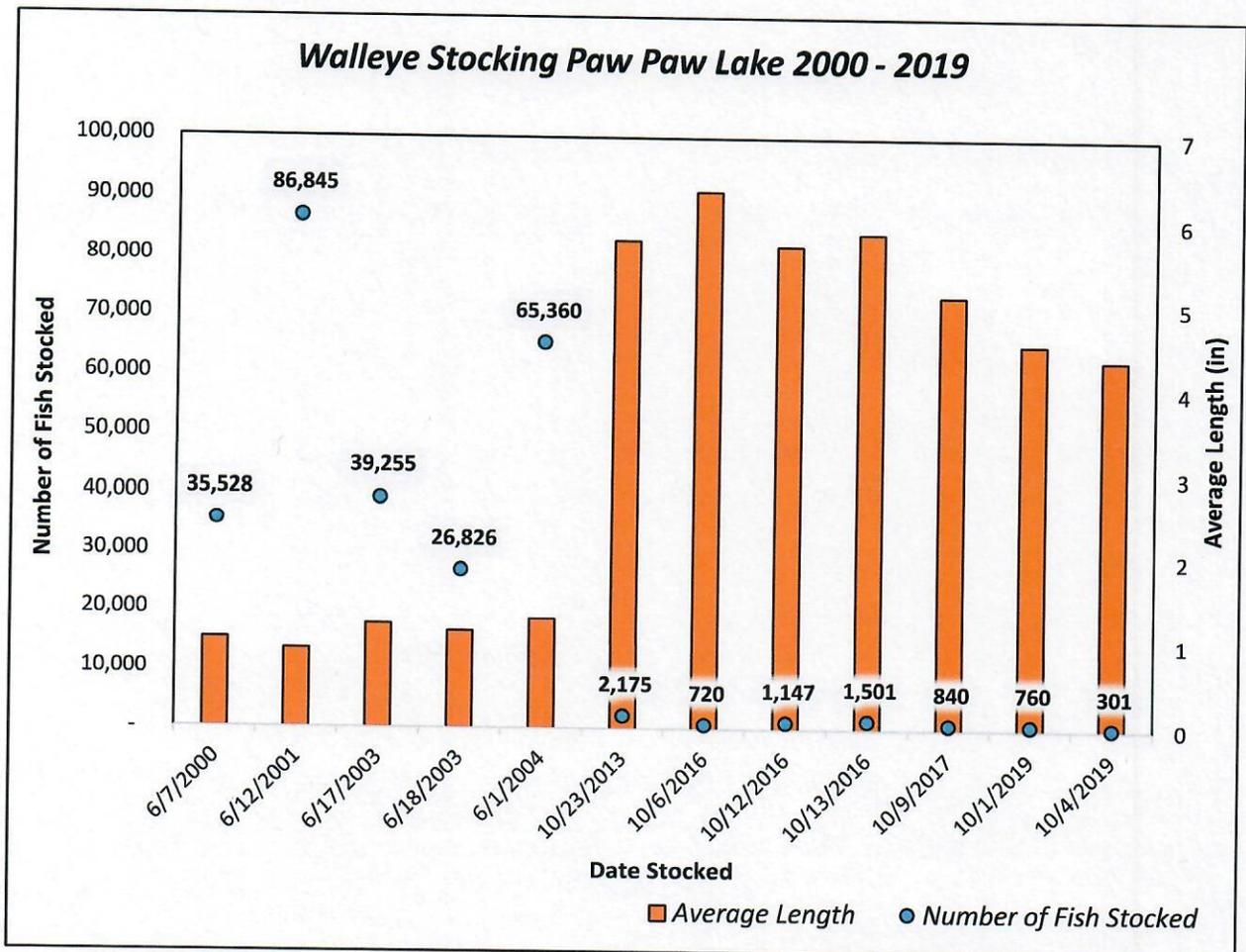


Figure 11- Walleye stocked in Paw Paw Lake from 2000 - 2019. Source: Michigan DNR Fish Stocking Database.

In order to complete this task, the following actions have been developed:

- A. Review of existing documents and reports related to fish and wildlife habitat, recreation, and aesthetic resources.
- B. Reconnect existing wetlands to lakes in order to improving fisheries resources. Improvements including increased spawning, nursery, rearing, and feeding habitats for fish which may have once been connected but have been lost due to roadways and developments.
- C. Research and install fish and wildlife habitat structures:
  - o Evaluate existing fish communities and habitats within the lake and outline locations and methods for improving habitat or access to wetland systems that may be obstructed by culverts, road crossings, etc.
  - o Coordinate with MDNR Fisheries Division on habitat and locations for selected species to ensure improvement actions are in agreeance with the agencies.
- D. Delineate watershed wetlands or review existing GIS datasets.



Figure 12- Fish habitat structure examples. Source: L - The Daily News, Huntingdon County, PA, R - Effingham Radio, Effingham, IL.

#### **Goal 4 – Provide Educational Outreach**

---

Public education and outreach is intended to assist riparian property owners, watershed property owners, and visitors to the lake in understanding what actions are being taken by the PPLIB and what actions they can take to do their part in making Paw Paw Lake a place for people to enjoy for generations to come.

---

Educational outreach may be approached in a variety of ways, including presentations, field visits, hands-on work activities, and informational social media or website posts. Educational topics may include:

**Invasive Species Topics:**

- How to use the Midwest Invasive Species Information Network (MISIN) app for invasive species reporting.
- Identification, control and management of invasive plant and animal species

**Nutrient and Contaminant Control:**

- Agricultural and land management best practices
- What can be done on an individual basis to reduce nutrient input into the lake.
- Identification and elimination of point source and non-point source pollution into the lake
- Identification of nutrient sources and how to manage them
- Use of buffer strips and raising the height in which a lawn is mowed (nearest the lake). Ideally, lawns near the water's edge or the seawall edge will not be mowed or maintained.
- Use of low nutrient fertilizers, pesticides, and herbicides on lake frontages.
- Shoreline management, including use of buffer strips, natural waterfronts, and native vegetation planting

**Fisheries and Natural Resources Topics:**

- Paw Paw Lake's fishery and natural resources in their current state, what species the lake and its watershed can support, and how these resources may be enhanced
- Fish structures and habitats that may be incorporated in private bottomlands and under docks
- Stocked fish and success rates within Paw Paw Lake
- Native and natural shorelines and their benefits
- Algal blooms, algae species and how algae can be managed

***Goal 5 – Measure Success***

---

The last goal of the lake improvement plan is to determine if project goals are being met. It is important to reflect on project success and shortfalls and ask the question: "Is what we're doing really protecting, managing, and improving the natural resources and water

quality of the lake?" By doing so, adjustments may be made to the project for it to be run most efficiently. Key factors for measuring success are the following:

- Reduce Percent Cover of Invasive and Nuisance Species
- Reduce Total Phosphorus in the Water Column
- Reduce Algal Blooms
- Decrease Nutrient Inputs into the Lake
- Increase Percent Cover and Diversity of Native Vegetation
- Document and assess existing resources and fish and wildlife habitat, along with recreational and aesthetic values associated with the lake
- Identify areas of potential recreational and wildlife improvement, enhancement or restoration
- Conduct a resident survey to understand what people value around the lake
- Consider fish stocking in the lake if appropriate and desired by residents

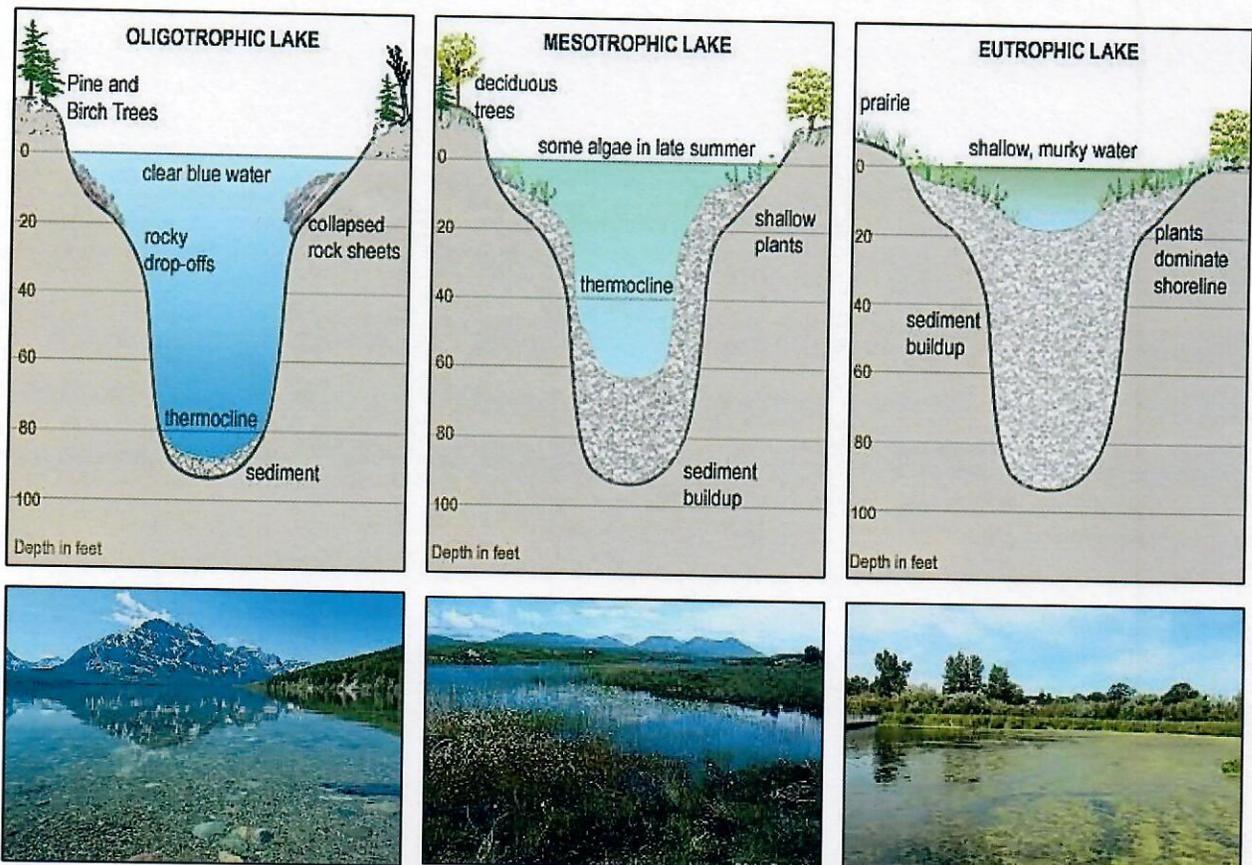


Figure 13- Trophic statuses of lakes. Trophic status measures the biological productivity of a water body. An oligotrophic lake is the least productive, where a eutrophic lake is the most productive.

### ***Task 1 – Refine metrics to quantify the progress of plan’s tasks and actions***

It is imperative that Lake Improvement Plan goals and tasks progress and are ultimately achieved. Measuring the success of the actions outline for each task need to be evaluated and modified where appropriate. Though various methods have been used to monitor success currently and, in the past, the methods may become outdated due to evolving goals, new goals, or changes in regulatory requirements.

- A.** Currently, data collected from water quality monitoring, fisheries studies, shoreline inspections, Aquatic Vegetation Surveys, and other reports provide insight on if actions, tasks, and finally project goals are being met. If there are other economical or more valuable methods of project evaluation, the options will be considered, and the plan will be updated accordingly.
- B.** Compare annual water quality data to goals and success factors of the lake.
- C.** Additionally, data, results, discussions, recommendations, successes and shortfalls of the actions implemented on an annual basis will be presented to the PPLIB. The board will then provide the information to the general public via public meetings, the PPLIB webpage, Facebook, flyers, brochures, and any other method that may be appropriate.

Plan goals, tasks and actions for the next five years are outlined in the goals and tasks table. Within this table, each action has milestones, a timeline, and cost estimate associated with it. The table is intended to provide a quick reference and structure for goals, tasks, and actions outlined in this Lake Improvement Plan. While the table provides an outline of the plan, it is intended to be flexible and allows room for expansion or reduction of any of the actions, tasks or goals outlined.

## **Literature Cited and Reference Materials**

---

- Lovell, et al. 2005. The Economic Impacts of Aquatic Invasive Species: A Review of the Literature. *Agricultural and Resource Economics Review* 35 (1):195-208.
- Michigan Department of Environmental Quality. 2013. Michigan's Aquatic Invasive Species State Management Plan 2013 Update.
- Michigan Department of Natural Resources. 2015. Invasive Species Watch List. Updated 9/15/15: [http://www.michigan.gov/documents/dnr/InvasiveSpecies-WatchList\\_498319\\_7.pdf](http://www.michigan.gov/documents/dnr/InvasiveSpecies-WatchList_498319_7.pdf)
- Michigan Sea Grant. 2012a. Aquatic Invasive Species in Michigan, Fact Sheet.
- Michigan Sea Grant. 2012b. Harmful Algal Blooms – The Beach Manager's Manual. MICHU-12-502. 8 pages.
- Paw Paw Lake Foundation (PPLF). 2008. Paw Paw Lakes and Watershed Study. Prepared by Spicer Group, Inc. Feb 2008.
- PPLF. 2010. Paw Paw Lake Restoration Plan. Prepared by Spicer Group, Inc. and JFNew, May 2010.
- PPLF. 2011. Water Quality Assessment. Prepared by Cardno JFNew. October 2011
- Rosaen, et al. 2021. The Costs of Aquatic Invasive Species to the Great Lakes States. Anderson Economic Group LLC. East Lansing, MI 48823
- USEPA. 2016. Nutrient Pollution Policy and Data - Control and Treatment of Algal Blooms. Website accessed on February 18, 2016. <http://www.epa.gov/nutrient-policy-data/control-and-treatment>

**Appendix A**  
**Paw Paw Lake Improvement Plan**  
**Tasks and Actions Table**

**2020 - 2024 Paw Paw Lake Improvement Plan Tasks and Actio**

Actions	Priority (L,M,H)	Milestone	Notes	Meets Project Go			
				1 - Invasive Species	2 - Water Quality	3 - Fisheries and Wildlife	4 - Education
Continue to implement, monitor, assess, and improve upon current aquatic nuisance weed management plan.	H	Monitor annually.	Refer to aquatic nuisance weed management plan.	X			
Third party review of aquatic vegetation management plan <b>prior to and after</b> implementation.	H	Review annually.	GEI to review PLM's plan prior to implementation. Work completed in conjunction with monitoring events on Paw Paw Lake.	X			
Research, evaluate and implement new and existing methods for controlling native, non-native, invasive, nuisance, and exotic species	M	Revisit annually.	Methods may include boat washing stations, surveys for early detection of invasive vegetative species, biocontrol of invasive species, Zequanox for zebra and quagga mussel treatment and use of other chemicals or products to remove nutrients from the water column.	X			
Research, evaluate and consider reintroduction of native vegetation in strategic locations around the lake (township sites, access points).	H	Revisit annually.	Samples will be analyzed for Algal ID and enumeration and microcystins	X		X	
Install native vegetation within and around Paw Paw Lake in key locations for maximum benefit.		Begin plan and implementation in 2022.	Species may be scrub shrub, emergent/wet meadow, deep emergent, or subemergent vegetation.	X		X	
Evaluate large-scale improvement projects that, when implemented, will reduce phosphorus and other nutrient inputs to Paw Paw Lake.	H	Evaluate in year one, select project(s) by the end of year one, implement project(s) in years 2-5.	Projects may include one of or a combination of the following: Restoration or creation of wetlands, off-line detention system(s), in-line detention system(s) and sediment trap(s), retention basin(s), overland runoff control, treatment train(s), level control structure(s), drain maintenance projects and cleanouts. Specifically six projects have been identified as feasible and impactful for Paw Paw Lake. These projects are outlined in the line items below. The total for all 6 projects' costs and annual maintenance cost is on the far right of this line item.	X	X	X	X
			Watershed Runoff Management	X	X	X	X
			M140 Treatment	X	X	X	X
			Green Drain Treatment	X	X	X	X

Identify watershed wetlands using GIS database.	H	Identify in the first year.	Existing wetlands may be identified for improvement projects, including, but not limited to, reconnection of wetlands to tributary waterways or Paw Paw Lake, or enhancement of the existing wetland.	X	X	X
Field check areas of concern, areas of improvement, or potential project locations identified in the technological review.	H	Evaluate every 5 years.	Field checking may include inspections, photologs, sampling, or other activities.	X	X	X
Develop project and preliminary estimate of cost.	H	Develop project plan and cost estimate in year one.	Based on project goals, feasible project location, and other factors, an estimate of cost will be developed.	X	X	X
Continue to collect and compare trends in water quality data, including phosphorus.	H	Monitor and evaluate annually.	Monitoring parameters include, but are not limited to: Total phosphorus, orthophosphate (soluble reactive phosphorus), nitrate, ammonia, total suspended solids, chlorophyll-a, Secchi depth, dissolved oxygen, temperature, specific conductivity, and pH.	X		
Compare annual water quality data to goals and success factors of the lake.	H	Compare monthly during the monitoring season and once at the end of the season.	Key success factors of the lake include reduction of nutrients, increase in clarity, and maintaining its trophic status as a mesotrophic to eutrophic lake. Mesotrophic lakes tend to have the following water quality characteristics: chlorophyll-a concentrations of 0.0026 - 0.0073 mg/L, Secchi Depth of 7 - 13 feet, and total phosphorus concentrations of 0.012 - 0.024 mg/L.	X	X	
Monitor the Paw Paw Lake Watershed and Tributaries for Nutrients	H	Monitor annually.	Monitoring may be carried out on any of the drains and creeks tributary to Paw Paw Lake. Typical monitoring parameters include, but are not limited to: Total phosphorus, orthophosphate, nitrate, ammonia, total suspended solids, and level.	X	X	
Identify algal species, their densities, and microcystin concentrations during periods of algal blooms and normal conditions in Paw Paw Lake.	H	Monitor annually.	Algal sample events will take place in tandem with water quality sample events, or opportunistically as blooms occur. Annually there are three water quality sample events; algal samples will be collected during two of the three events. Expenses will be lessened if algal monitoring work is consolidated with water quality monitoring or other fieldwork being conducted.	X	X	X
Compare algal data to historic data and outline changes in population overtime.	H	Compare and analyze annually.	Samples will be analyzed for Algal ID and enumeration and microcystins.	X	X	X
Research, evaluate and implement new technologies to reduce algal blooms and			Utilize existing resources produced by NOAA, Great Lakes Environmental			

Install fish and wildlife habitat structures.	M	Obtain permit in year 1.	Research and install in year 1 and 2, monitor in years 3-5.		
Present the data, results, discussions, recommendations, successes and shortfalls of the actions implemented on an annual basis to the Paw Paw Lake Improvement Board (PPLIB).	M	Present annually.	Data may be presented at an end of the year meeting annually, via email, other methods, or a combination of all three.		X