LAKE EAU CLAIRE MANAGEMENT PLAN 2010

Submitted for Consideration to Wisconsin Department of Natural Resources

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I. Introduction

Lake Eau Claire has been a valued recreational resource in Eau Claire County since the lake was created in the mid-1930's. Few natural lakes existed in Eau Claire County before this time and this lake along with Lake Altoona, Coon Fork, Rock Dam and other lakes became part of a chain of man-made impoundment lakes that are all interconnected via the Eau Claire River and its tributaries. Hence these lakes and the stream system that supports them are linked through their fisheries, water quality, aquatic habitat, and all other resources that make them important recreational components of Eau Claire County and the region. Local community members and tourists use the lake and surrounding area for a wide variety of outdoor recreational activities which include: fishing, boating, hunting, picnicking, golf, snow mobiling and camping. These activities provide a major economic base for local businesses and surrounding communities. Because of escalating development and the resulting increasing tax base the lake region has become central to the economy of the surrounding area.

In recent years, there has been a perceived notion by many people in the Lake Eau Claire region that there has seen a noticeable decline in the lake resources. These declines have largely been associated with the fisheries, water quality (e.g. excessive eutrophication), and erosion and sedimentation. Excessive runoff of nutrients from agricultural lands, forested areas and urban development along shorelines has probably contributed significantly to poor water quality. Increased sedimentation has created navigational problems and even significantly limited access to the lake for property owners and visitors. The fisheries is in decline because of major loss of natural habitat for fish reproduction and sustainability at a time when fishing pressure is higher than it has ever been. Another pressing issue is the ever increasing threat of algae blooms, caused by nutrient loading, which are dominated by blue-green algae which are known to be deleterious to the fish, other beneficial aquatic plants and animals, and humans. These massive algal blooms also have a pronounced negative effect on the environmental aesthetics and water quality (Fig 1).

These concerns have grown in recent years to the point where the Lake Eau Claire Association has taken a proactive stance in attempting to correct and reverse the these negative environmental trends. To this end a Lake Eau Claire Management Plan has been developed as a partnership with community residents, Lake Eau Claire Association, Wisconsin Department of Natural Resources, Eau Claire County Land Conservation, Eau Claire County Parks and Forests, Beaver Creek Reserve, Army Corps of Engineers, faculty from UW Stevens Point and Eau Claire and University of Maimi/RSMAS, local township and city government, and various consultants. This Lake Eau Claire Management Plan has

been developed by the LEC Restoration Steering Committee working in partnership with the various agents mentioned above This plan outlines a framework of lake stewardship activities which will provide improved motorized and non-motorized recreational opportunities, fish and aquatic life habitats and water quality and clarity. This lake management plan includes clearly defined goals and objectives that
will be the road map to improve the attributes of Lake Eau Claire that are valued by all who enjoy the this valuable resource.

Figure 1: July 2009 Blue-Green Bloom

II. Background

A. Historical Transformation Lake Eau Claire:

Lake Eau Claire is an impoundment lake formed by the flooding in 1936 of what was previously a river bed and some surrounding area which became the lake basin. The Lake Eau Claire basin was previously mostly forest land and much of the main lake body area was clear cut although many tree stumps were not removed before flooding. And in some flooded areas the trees were never cut and large areas of flooded forest existed in the lake until well into the 1960’s. In shallow regions of the lake large stumps and fallen trees existed for 40-50 years after the lake was flooded. This coarse woody habitat could be found in nearly all regions of the lake and it provided excellent cover to support a very productive fisheries which largely consisted of walleyes, muskellunge, crappies, and some large and small mouth bass and a large population of carp, red horse suckers, and bullheads. In the mid 1950's, in attempt to control the rough fish population and enhance the boating areas within the lake, the lake was partially drained and much of the shallow western portion of the lake was excavated, and the coarse woody habitat was removed so that it was easier to net and remove rough fish. The resulting deposits from the excavation (mostly sand) were used to build the central islands in the lake. As a result much of the shoreline for years to come existed as steep slopes that were largely composed of sand and that were unstable and ended up slumping over the next 30-40 years. Today most of these steep shorelines have slumped and shallowed and the original abundant coarse woody habitat has all but disappeared and there has been virtually no replacement of it. Some of this fish habitat was recovered in the form of benthic plant community development in the 1990 and early 2000's, but for unknown reasons in recent years most of these new communities have nearly disappeared from many areas in the lake. Two theories are that this is the result of light attenuation due to excessive blue-green productivity or is the result of increased boat traffic turbulence throughout the lake.

One of the obvious changes to the lake environment is shallowing of certain parts of the lake. This is certainly noted along the formerly steep shorelines and in those instances is probably mainly due to unstable sediment slumping and wind and wave induced erosion. The shallowing in mouths of tributaries is largely the result of stream sediment transport and is a significant problem for the areas immediately in front of the tributary input to the lake. After year 2000 the LEC Association in cooperation with the county and state begin addressing these problems by first removing much of the deposits by pump-dredging filled areas, then installing sand traps, and finally scheduling regular cleaning of those traps. Four such areas are now being handling in this way and two more need to be dealt with. One of these is a small tributary in the northwest corner of the lake and the other is the Eau Claire River itself.

According to most people who reside near the lake or who use the lake's resources regularly one of the most pressing issues is water quality. In this case water quality is mostly attributed to eutrophication that typically each summer leads to an overwhelming abundance of blue-green algae. During summer and fall these organisms become quite prolific and major blooms can result at any time during this period. Conditions such as rainfall and weather are believed to be implicated in setting off and sustaining these blooms. Therefore every year can be different depending on controlling conditions. This is not a new problem, but the perception is that it is a growing problem. One thing that is certain, abundances of nutrients and particularly the limiting nutrients like phosphate are essential to kick-off and sustain algal blooms. This is a common problem that many lakes share, but impoundments are different in that nutrient sources can be distant and come from anywhere in the watershed supply area (for LEC this is about 625 Square miles) or from local ground water or riparian runoff. For LEC there is another significant source and that is mobilization of phosphate and nitrogen from anoxic bottom water in the lake. In an impoundment lake like LEC there is probably an increasing tendency for internal loading of phosphate and reduced nitrogen because sediment concentration of nitrogen and phosphorus are increasing with time and so is the tendency for anoxia to develop because of increasing total organic matter levels in the sediments. On the scale of lake development LEC is a relatively young lake (74 years) and internal loading of nutrients will probably increase for some time before reaching a steady state condition. Hence blooms will probably get worse before they get better.

B: Evolution of Lake Eau Claire Management Plan:

Over the past 20 years a growing concern has developed among the Lake Eau Claire (LEC) community that some of the valued environmental characteristics of the lake have declined. In general, concerns have been raised about declining water quality, dramatic sedimentation increases in some areas of the lake and river system, and declining fisheries habitat and the fishery itself. These concerns led the LEC Association to seek guidance from Eau Claire County Government and the WI Department of Natural Resources. Interactions between these three organizations have led to a series of scientific and engineering studies on LEC that have provided valuable insight on details on the perceived existing problems and potential solutions to their resolution. The perceived problems were further validated by conducting a public sociological survey in the Spring of 2009 which helped to establish the priorities for developing a strategic management for LEC. Using the results of the public survey and the preceding 15 or so years of scientific and engineering results a steering committee was convened to assess this information and develop a list of goals and objectives for the management plan. The steering committee was made up of the LEC Broad members, officials from Eau Claire County government and WI DNR, and representatives from local government, sportsman's clubs, local businesses, and other near-by lake associations. This board met five times between July 2009 and January 2010 and at each meeting addressed different management plan subject areas (i.e. water quality, fisheries, habitat, erosion and sedimentation, invasive species control, and recreation). The culmination of this overall effort led to the **Lake Claire Management Plan** which lays out a long term plan for addressing the identified and prioritized problems. The following documents provide information on the various studies and the reports that have resulted in the course of developing this comprehensive management plan for LEC.

Supporting information that was presented to the LEC Restoration Steering Committee and used to develop the following Goals and Objectives in Section III and lake management proposal in Section IV below. All of these resources can be found as links on the Lake Eau Claire Website at http://www.lakeeauclaire.org/LakeRehab.html.

1. ACOE 1998 Report on LEC Water Quality Study

2. 2004 and 2006 LEC Board and Beaver Citizen Science Center Oxygen and Temperature Profiling Studies.

3. Freihoefer, A. and P. McGinley. 2009. Phosphorus Loading Model for Lake Eau Claire and Lake Altoona. Center for Watershed Science and Education Report.

4. 1997 Ayres Sediment Reduction Plan, Ayres Associates, Eau Claire, WI

5. 2007 LEC Preliminary Management Plan as presented to Eau Claire County Dept of Land Management.

6. 2008 LEC DNR Shocking and Netting Fish Survey Report

7. 2010 LEC DNR and Beaver Creek Aquatic Plant Survey Report (still in progress)

8. 2010 LEC DNR Shoreline Assessment Survey and Report

6. 2009 ACOE Water Quality Siphoning Model Final Report

7. Summation of results of the 2009 Community Sociological Survey of local residents and users of the LEC resources.

III. Goals and Objectives from 2009-2010 Steering Committee Meetings

A. Water Quality

Goal:

Protect and restore water quality, reduce phosphorus loading (both internal and external), and reduce the occurrence and intensity of blue-green algae blooms

Objectives For Improving Water Quality:

a. *Reduce internal phosphorus loading into Lake Eau Claire through installation of a pipeline aeration system to destabilize the western area of the lake that falls below the 12 foot depths. The Eau Claire County Land Conservation Division (ECC-LCD) and Lake Eau Claire Association (LECA) will apply for a WDNR Lake Restoration/Protection grant to assist with implementation costs. The grant application will be submitted in May 2010. (WDNR, ECC-LCD, LECA)*

b. *The ECC-LCD will work with Eau Claire County farms in the Lake Eau Claire contributing watershed to ensure cost share dollars are made available to bring the farms into compliance with NR151 non-point runoff standards and ATCP 50 nutrient management regulations.*

c. *Develop partnerships with other lake districts/lake associations and bordering County Land Conservation Departments within the Eau Claire River watershed in order to take a more watershed approach to dealing with nutrient and sedimentation issues within the watershed. In addition, form partnerships with Rivers Alliance and other NGO's that could assist us in this effort. (ECC-LCD, LECA)*

d. *Utilize the UW-Stevens Point SWAT Model to address implementation of best management practices in land uses, such as agriculture and forestry* *practices, that have been identified as potential sources of nutrients and sediment to Lake Eau Claire. (WDNR, ECC-LCD, LECA)*

e. *Educate riparian landowners of the importance of managing stormwater runoff from their properties and provide education and technical assistance in the installation of rain barrels and rain gardens to reduce stormwater runoff from impervious surfaces along shoreland properties. (ECC-LCD, LECA)*

f. *Educate riparian landowners of the importance of regular maintenance of private onsite wastewater systems (septic systems) (ECC-CCHD)*

B. Fisheries

Goal:

Protect and improve the aquatic life of Lake Eau Claire, including a self-sustaining fishery and diverse aquatic plant community. (Objectives for this goal could be established that pertain to studies and management of all aspects of aquatic life.)

Objectives For Improving Lake Fisheries:

a. *Monitor the lake's fish population every four years to assess trends in the fish community. Under WDNR's lake monitoring program, the next scheduled survey would take place in 2012. However under WDNR's treaty assessment program, a fisheries survey is planned for 2013. In conjunction with this survey, an angler creel survey also will be conducted. Data from this fish survey will be compared to the 2008 survey, and information gathered from the creel survey will be used to evaluate the desires and perspectives of anglers on Lake Eau Claire as well as the angler's impact on the fish community. (WDNR)*

b. *Adopt an annual voluntary creel/fishing experience survey that will be combined with current invasive species surveillance program at the main boat landings. The creel survey will assist by providing more data on fishing experiences of angler's and may assist in overcoming some of the current negative public perception about the lake. (LECA and BCR/CCS oversight by WDNR)*

c. *Continue stocking muskellunge in Lake Eau Claire on a biennial basis (odd-numbered years) at a rate of one large fingerling per acre.*

d. *Within the confines of natural variations, maintain fish populations at densities and size structure that are desirable for anglers. Using 2008 and 2013 survey data, evaluate population density, size structure, growth and mortality rates of the dominant gamefish and panfish species in Lake Eau Claire to determine whether or not regulation changes are needed to improve the quantity and/or quality of these populations.*

e. Explore the possibility of establishing slow-no-wake areas around mid-lake plant beds to protect them from boat and jet ski activity. Develop a boating traffic study that will assess the impact of boating activity on these and other critical plant beds in the lake that may be negatively affected by boating traffic. (LECA, Ludington and Bridge Creek Townships)

C. Habitat

Goal:

Protect and improve in-lake and shoreline habitat to promote a healthy and diverse community of aquatic life in Lake Eau Claire. (WDNR, ECC-LCD, LECA)

Objectives For Habitat Protection and Improvement:

a. Educate riparian landowners of the importance of coarse woody habitat (CWH) and aquatic plants in the lake to the community health of fish and other aquatic life in the lake. (ECC-LCD, LECA)

b. Develop a plan to increase CWH in the lake. LECA will send letters out to lakeshore property owners about the plan to improve CWH and solicit participation in a voluntary tree drop campaign. The Habitat Committee of LECA conducted a visual survey of the lakeshore and identified trees that are likely to fall into the lake within the next few years. To prevent shoreline erosion problems, these trees could be dropped into the lake to enhance littoral zone habitat. Utilize these structures to stabilize aquatic plant habitat. (LECA, WDNR)

c. Conduct tree drops along the shoreline to increase the amount of CWH in the littoral zone. Along developed shorelines, it is desirable to have a minimum of 1-2 pieces of CWH per 100 ft. of shoreline. Along undeveloped shorelines, it is desirable to have a minimum of 3-6 pieces of CWH per 100 feet of shoreline. Tree drops should not be used in lake areas with moderate to high density aquatic plant populations. (LECA, WDNR)

d. Install log fish cribs in deeper portions of the lake to increase the amount of deep water habitat available to fish. Fish cribs must have a minimum clearance of five feet of water over the top of the structure. Note this will be a long range objective to be implemented once water clarity improvements have been seen. (LECA, WDNR).

e. Install half-log structures in the littoral zone to increase spawning habitat for smallmouth bass. These structures must be placed in water less than five feet deep, and will provide spawning habitat along shorelines where tree drops may not be possible or desirable (LECA, WDNR).

f. Conduct a critical habitat designation survey of Lake Eau Claire in 2010. WDNR will utilize aquatic plant surveys conducted in 2003 and 2009 and a *team of biologists and regulatory staff to determine the type and amount of habitat in the lake that is critical for protecting water quality, wildlife, fish and other aquatic life as well as aesthetics. Once a critical habitat designation has been completed, it can be used as a tool by the lake association, Eau Claire County, WDNR and others to protect these important lake features. (WDNR, ECC-LCD, LECA)*

g. *Educate riparian landowners of the importance of restoring shoreland areas to reduce the amount of sediment and erosion occurring to the lake. Educate landowners as to the importance of a healthy self-sustaining benthic plant community and it's influence on improving water quality. The ECC-LCD will provide technical assistance to landowners on installation of proper shoreland buffers and educate the lake community on the importance of restoring and protecting the shoreland. (ECC-LCD, LECA)*

h. *Develop shoreland restoration demonstration projects on at least two different shoreland properties on Lake Eau Claire and conduct a public education effort to educate the riparian landowners on the importance and benefits of shoreland restoration and use of native plants in restoration efforts.*

D: Erosion and Sedimentation

Goal:

Reduce overall erosion and sedimentation occurring in Lake Eau Claire, restore areas within the lake that have been adversely affected by excess sedimentation and assess the amount of sedimentation coming into lake Eau Claire from watershed impacts.

Objectives For Reversing and Preventing Adverse Sedimentation Trends:

a. *Educate riparian landowners of the importance establishing healthy vegetative buffers along the shoreland to reduce erosion of shoreline areas. Provide technical assistance on slowing the flow of stormwater runoff that may accelerate this erosion. (ECC-LCD, LECA)*

b. *Maintain the current sediment traps installed along the north shore of the lake by regular dredging every 1-3 years depending on sediment build-up. (ECC-LCD, LECA)*

c. *Install additional sediment trap on NW corner of lake to control sediments entering lake from that tributary. (ECC-LCD, LECA)*

d. *Work with UWEC Geography Dept to assess streambank erosion along select sections of the Eau Claire River upstream of Lake Eau Claire. (UWEC-Geog, WDNR, ECC-LCD, LECA)*

e. *Work with USGS to quantify the bedload for the Eau Claire River from up-stream land uses. (UWEC-Geog/USGS?, WDNR, ECC-LCD, LECA)*

f. *Dredge out meander loop area upstream of Skid Row Boat landing to avoid future loading threat to lake. (ACOE Ecosystem Restoration Project?,, ECC-LCD, LECA)*

g. *Develop sediment traps at 1-2 sites upstream of Skid Row Boat Landing. The trap should have enough capacity to handle 4,500 cubic yards of se-diment, which is the estimated load in the river expected over a 1-3 year period. First trap will be installed under WDNR Lake Protection Grant at Skid Row, second would be near original gravel pit. (WDNR, ECC-LCD, LECA)*

h. *Work with County, state and private forestry departments to ensure proper implementation of BMPs in forestry practices in Lake Eau Claire wa-tershed (WDNR, ECC-LCD, LECA)*

i. *Collect sediment cores in the lake to assess sediment accumulation and sources. (WDNR, ECC-LCD, LECA)*

j. *Stabilize island margins in heavy boating areas to minimize future slump-ing of sediments. (WDNR, ECC-P&F, ECC-LCD, LECA)*

k. *Conduct a boating impacts study in areas where there is likely sediment mobilization to determine if boating restrictions should be instituted in the future. (WDNR, ECC-LCD, LECA)*

E: Invasive Species Control

Goal:

Prevent the expansion and new infestations of invasive species

Objectives For Prevention of Invasive Species Problems:

a. *Utilize the current Clean Boats/Clean Waters program to educate riparian shoreland owners and lake users about the risk of spreading aquatic inva-sive species from lake to lake and the practices that should be utilized to minimize the spread of invasive species between lakes. (BCR/CCS, ECC-LCD, LECA)*

b. *Continue to recruit volunteers to work in the Clean Boats/Clean Waters program for Lake Eau Claire. (BCR/CCS, LECA)*

c. *Educate riparian landowners of the importance of maintaining a healthy plant community and encourage them to leave aquatic vegetation along their shorelines. (BCR/CCS, ECC-LCD, LECA)*

d. *Recruit volunteers to work with the Beaver Creek Reserve to monitor for all invasive species. Beaver Creek/Citizen's Science Center will train volunteers to detect invasive species and establish a routine monitoring program (BCR/CCS, LECA)*

e. *WDNR will conduct aquatic plant surveys utilizing techniques used in 2009 at least every 3 years. WDNR will analyze the data collected from the 2009 survey and present it to the Lake Association. (WDNR, BCR/CCS, ECC-LCD, LECA)*

<u>F: Recreation</u>

Goal:

Provide safe and multifaceted recreational opportunities

Objectives For Improvement of Recreational Opprotunities:

a. *Provide appropriate and safe public access though proper maintenance and assessment of beach and boat ramps/docks. (WDNR, ECC-P&F)*

b. *Add signage to islands of where bathroom and garbage facilities are located to minimize the usage of islands for waste disposal sites. (LECA)*

c. *Conduct a boating traffic/usage study to determine if any potential boating impacts may exist to public safety, recreational usage/enjoyment, and/or damage aquatic plant communities in critical habitat areas or cause resuspension of sediments in shallow areas. (LECA)*

d. *Propose improvements to public restroom facilities and piers for better access at public boat landing and County Park. (LECA, ECC-P&F)*

e. *Educate lake users and riparian land owners on revised shoreland rules NR115 and revised recreational boating rules and how it could change boating activities near shoreland and islands.*

IV. Proposal Objectives for Lake Eau Claire Management

Many of the objectives shown in Section III above are in fact future recommendations or continuations of programs or projects already underway. Most of these are funded under some existing county or state program or can be achieved through the cooperative and volunteer efforts of local lake residents and lake resource users, and various organizations such as environmental non-profit and sportman's clubs. For the most part the funds to carry out these objectives are minimal and therefore are not dealt with in this section on the proposal.

Therefore discussion here will primarily be limited to achieving objectives related to water quality, fisheries and habitat, and sedimentation. These are also the areas where the Lake Eau Claire Association is seeking financial and in-kind assistance.

A. Water Quality

1. Background

Over the past 20 years a number of overlapping studies have helped to provide a fairly comprehensive idea of nutrient loading, physical mixing and the ramifications of these properties as they relate to the microbiology of Lake Eau Claire. Most of this information can be found in the reports, presentations and papers listed in Section II B above and can be viewed or downloaded from the LEC Association website http://www.lakeeauclaire.org/LakeRehab.html The bottom line of these studies is that Lake Eau Claire is seriously eutrophic for much of the warmer months of the year. Not surprisingly the prevailing conditions during these months result in high levels of planktonic biomass with nearly 90 % being blue-green algae during the months from April to October in 1998 (Fig. 2). The consequences of high blue-green abundances are well documented and characteristics such as greatly reduced water clarity, surface mats of plankton, toxins associated with blue-greens and rapid oxygen depletion in sub-surface waters.

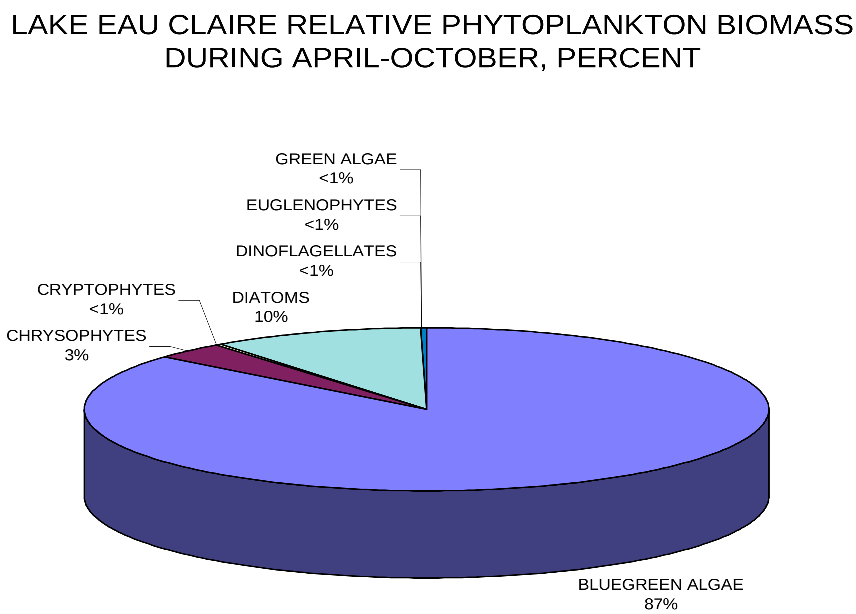


Figure 2: Relative Average Phytoplankton Biomass in 1998

Each year's conditions tend to vary somewhat however in the three years (1998, 2004 and 2006) in during which twice weekly temperature and oxygen profiles were measured the lake's deeper water overturned several times during the summer and into the early fall. Each time one of these overturns occurs a significant amount of phosphate and ammonia are injected into the lake's shallow photic zone and it is believed that these high pluses of nutrients and particularly phosphate induce blooms. On the average from spring to fall the amount of internal phosphorus vs. external from the lake's tributaries are approximately equal (James, W., 1999 ACOE Report) (Fig. 3). However if one takes into account the low summer tributary flow rates particularly in recent years and the fact that the internal loading is episodic the internal source of nutrients may play a dominant role in causing the episodic blooms. If this is indeed the case a large reduction in internal phosphorus loading may produce a significant benefit in the reduction of blue-green populations. To achieve this ultimate goal a number of possible scenarios were considered of which two appeared to fit best for impoundment lake with large sources of internal and external nutrient loading.

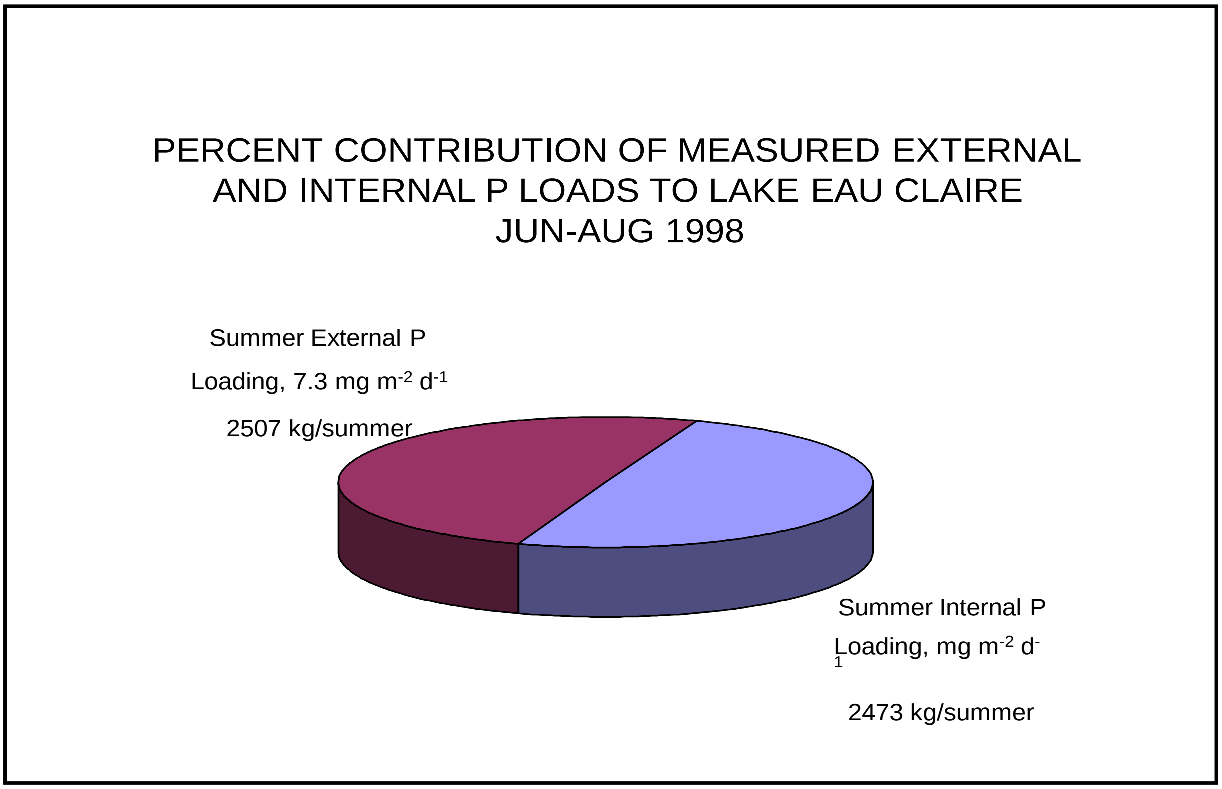


Figure 3: Internal vs. External Phosphorus Loading in 1998

2. Scenario One: Siphoning Deep Anoxic Water

A CE-QUAL-W2 water quality model was developed by the Army Corps of Engineers for Lake Eau Claire to help predict the effectiveness of a proposed bottom withdrawal pipe on reducing internal phosphorus loading. In theory, this pipe-scenario would promote mixing throughout the summer and keep water overlaying the profundal sediments' oxic, which limits P flux into the water column. Predicted reductions of anoxic sediment surface area from the model runs varied with the rate of outflow from the pipe. In a 140-acre study area surrounding the withdrawal zone, the maximum "run of river" discharge pipe showed more than a 90 percent reduction from the existing modeled condition during 1998 and 2006 summer time periods. A fixed withdrawal pipe set at 70.8 cfs (2 cms) showed reductions around 87 percent for both summers. A fixed withdrawal pipe set at 35.4 cfs (1 cms) and a 35.4 cfs pipe with 2 intakes spaced 100 meters apart showed nearly the same reductions of about 63 percent and 48 percent for 1998 and 2006, respectively. Although the model predicts a reduction in anoxic build-up in the hypolimnion using a siphon, this study suggests that it is not a practical option for several reasons: the reduction appears to be localized to the pipe's inlet, periods of anoxia still existed under the maximum discharge scenario.

3. Scenario Two: Compressed Air Injection Destratification

To reduce the internal phosphorus loading we are proposing to install and operate during the open water period of the year a air stream induced destratification system to cover roughly a 200 acre area of the deeper western portion of the lake (Fig. 4). To develop the plan for such a system the Lake Eau Claire Association hired Richard Wedepohl (formerly with WDNR and now Lake Management Consultants, Inc.) as a consultant and have also consulted with several corporations with expertise in aeration systems and compressor and blower technology. The destratification system described below takes into account all of the consultant advice plus experience gained from operational systems already used in other lakes in the Wisconsin (Garrison, P. J. 2009 andSommerfeldt, S. K.

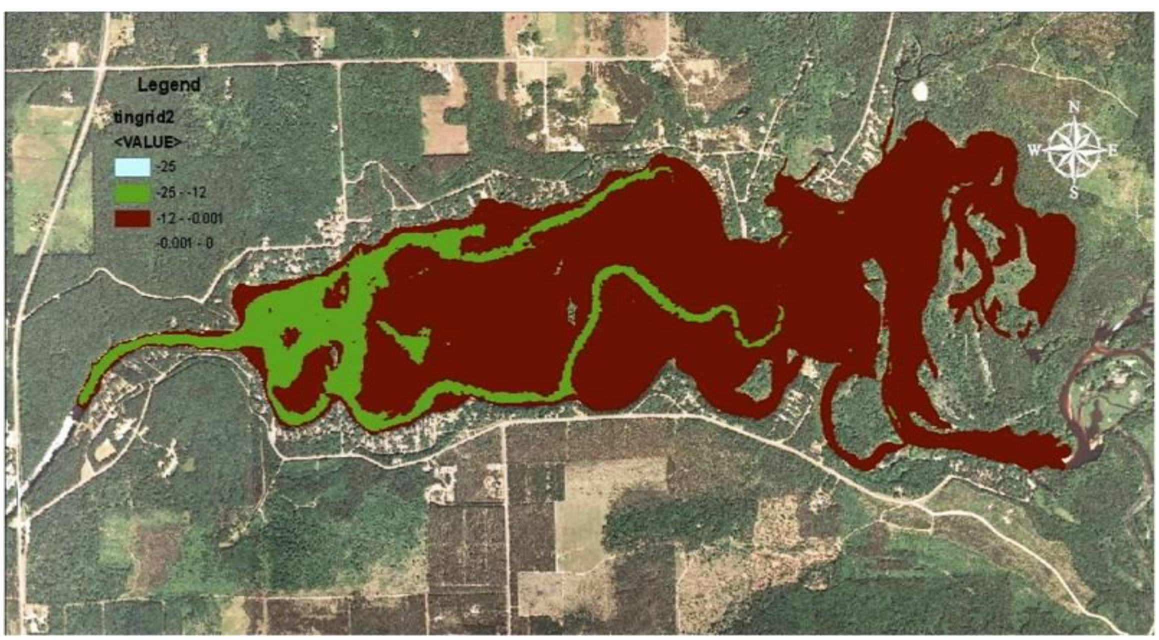


Figure 4: Green Areas Indicate Depths Greater than 12 Feet from 2007 Survey

4. Proposed Objective: Destratification System Design

The preliminary design plan is to provide sufficient mixing to the lower 200 acres on the western end of the lake and the Eau Claire River outlet channel (Figure 5). This will require an estimated 300 to 400 cfm (cubic feet per minute) of air to prevent stratification from occurring in the lower 200 acres of the lake, an area where most of the internal recycling of nutrients appears to be occurring. This estimate is based on experience in other lakes and may need to be further refined. Unlike most of the other lakes where destratification systems have been successfully employed Lake Eau has some features which may help facilitate vertical mixing and sediment phosphate release. First the lake is an impoundment with a flooded river channel meandering down the length of the lake. This channel provides a continual supply of cold oxygen-rich-water which because of density should be subducted and follow the deeper connected old river channel on the east end of the lake. The deep water residence time is therefore shortened on the east end of the lake and the development of anoxia is limited or non-existent at most times. This was verified by the vertical profiling studies for oxygen and temperature in 2004 and 2006 and by absence of elevated phosphate in this region during 1998 summer study. Field data suggests that the major source of phosphate is coming from the deep water on the west end of the lake and this is consistent with evidence for where the plankton blooms begin and appear to be most intense.

Another unique feature of the lake is its long axis orientation from east to west. Prevailing winds on the lake surface are often easterly or westerly. The long fetch for easterly winds down the lake should enhance destratification measures and in fact even without such measures the lake naturally overturns several times from spring to fall as was seen in the studies in 1998, 2004, and 2006. Although the westerly winds have a shorter fetch they should also aid in destratification. Because of the narrow east-west orientation of the lake basin and the relatively high surrounding shorelines one would also expect that seiches are a common feature in the lake and through pressure gradient fluctuations may induce deep water pumping from the river outlet channel back into lake. Since this channel is the deepest part of the lake and the most anoxic and probably never overturns until the fall density overturn it could represent a significant flux of phosphate into the deep water basin on the east end of the lake.

a. Destratification System Option 1

Based on these considerations the design for the destratification system should cover the areas shown in Figure 5. Given the long lengths of piping needed to distribute air over the entire 200 acre area of the lake from a single point, a preliminary design was considered that used two locations for the blowers or compressors sources. The feasibility and cost effectiveness of having two independent pump houses makes this an unlikely scenario. Nevertheless because of significant depth differences between the two destratification areas two separate air supply sources may be required. It is important to keep in mind that smaller size pipes ease installation and shorter pipe runs are more efficient in preventing excessive head losses. Also efficient blowers, as opposed to compressors, could be used to reduce energy requirements. Obviously the ability to find suitable locations for a blower housing and the availability of power are important considerations as well. So balancing these considerations led to the choice of three potential locations for the pump houses which are shown in Figure 6. For the sake of the discussion here we are using the location in the Eau Claire Lake's County Park as one site and a location (yet to be determined) in the NW corner of the lake as the other.

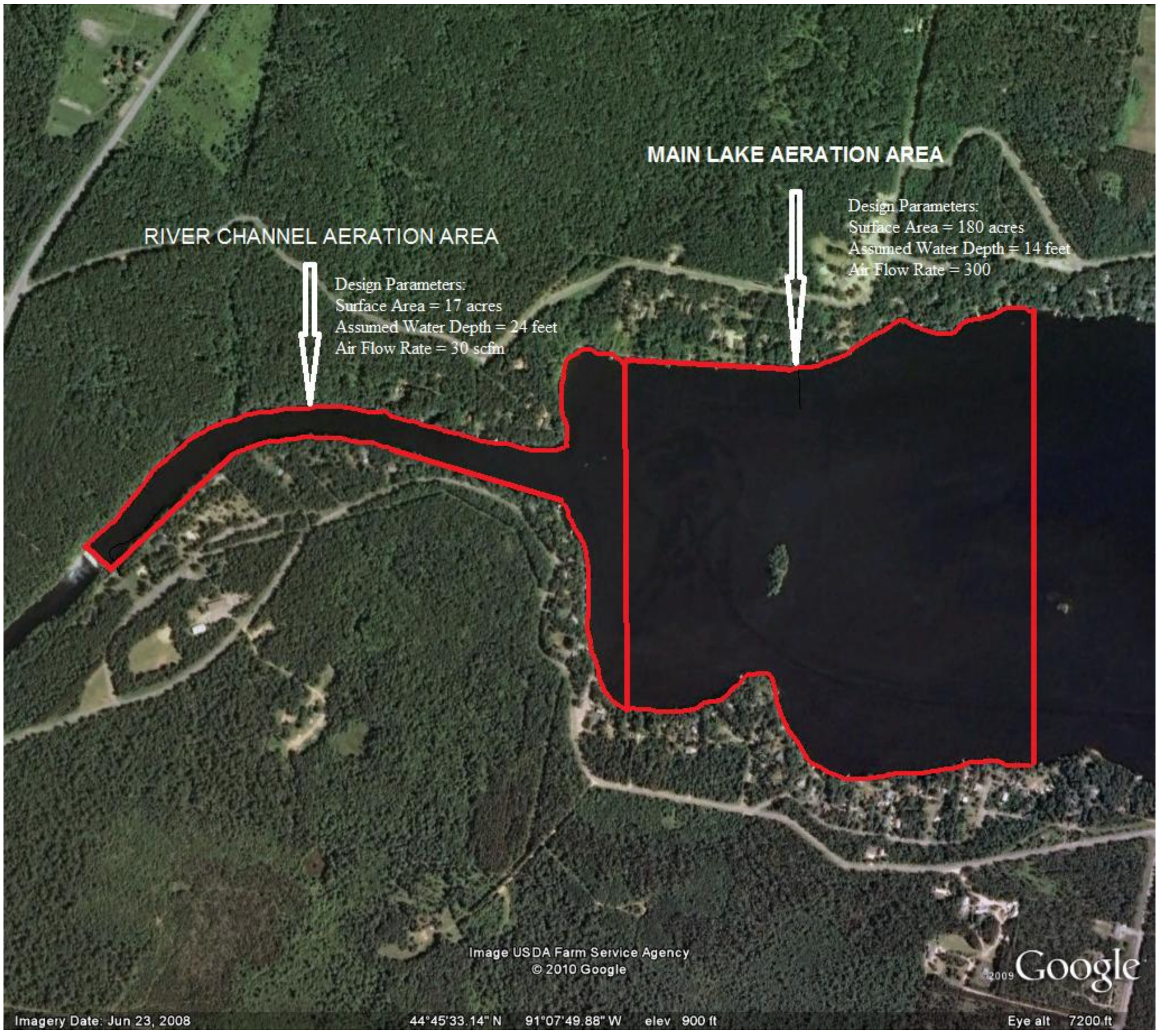
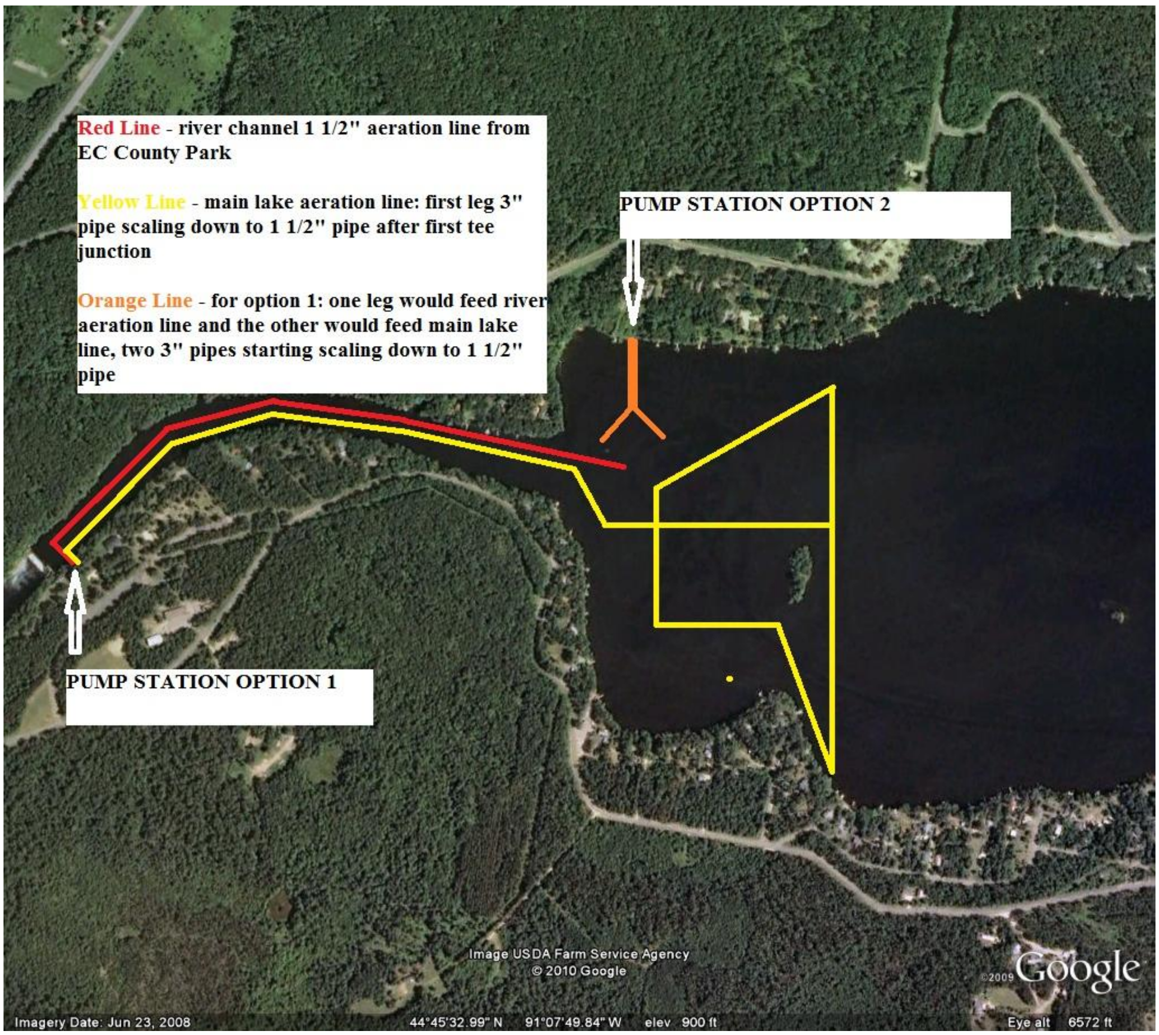


Figure 5: Destratification Areas and Design Parameters

<u>Air Volume Requirements and Discharge Location:</u> Research on lake destratification systems has shown that between 1 and 2 scfm (standard cubic feet) of air, per acre of lake, will provide the energy needed to maintain a destratified system. Air release points are preferably located in the deepest part of the lake to maintain an oxygenated area immediately above the lake sediments. Studies have also shown that lake mixing will not occur in areas deeper than 1 to 2 feet below the point of air release (deeper areas will go anoxic), therefore system piping should generally be located in the deepest possible parts of the lake.

Basic System Components: The basic components of an air distribution system start with a shore based blower or compressor that is housed in a small shelter. The blower or compressor discharges to shore based piping that then connects to polyethylene distribution pipes. Pipes can be weighted in a variety of ways but experience has shown that use of steel reinforcement rod, running the continuous length of the pipe is preferable. This design provides both weight and strength to the line, to the point where even if the lines are accidentally hooked with an anchor and pulled to the surface, they can be released and will simply sink back to the bottom undamaged.



Air is released from several points along the pipes through drilled holes. Size of the holes can vary and are not critical but use of 1/8” to 3/16” diameter holes is common. Although more complex designs are available that incorporate ceramic stones, micro-diffusers, etc. these systems have been shown to be no more, and even less, effective than the simple drilled hole.

A key requirement of ensuring even airflow distribution along the length of pipe is to ensure air holes are as close as possible to the same depth. Quite simply, more air will be discharged from a hole that is closer to the surface than one that is deeper because of the differential water pressure against the air pressure at the point of release. Typical installations attempt to maintain no more than a 2 foot difference in water depth. As an example, 50% more air will flow out of a 1/8" diameter hole than from one located at a water depth 2 feet lower, possibly resulting in uneven mixing. Although discharge systems can be designed with different sized pipes and orifices to compensate for different over pressures, this level of design detail can usually be avoided by carefully locating the pipe along the same depth contour, again as close to the deepest part of the lake as possible.

In this example a blower/compressor house would be located in the park area preferably near the dam. Two pipes would be run, one down the channel towards the lake and the other down the channel towards and into the main lake. The 1½" weighted polyethylene line would supply approximately 30 scfm over the 17 acres of water area. Another option would be to increase airflow and extend a discharge pipe further into the lake along the current river channel. With the pipes laid at the 24 foot contour, pressure required to overcome 24 feet of water would be approximately 10.4 psi and additional piping and outlet losses would put blower pressure requirements close to 15psi. Although this pressure begins to push the capabilities of blowers, there are certain types of modified blower units which could meet requirements of as much as 18 psi. Blowers, as opposed to compressors, are more reliable and efficient at moving high amounts of air. If higher pressures are required then a compressor design would be needed.

b. Destratification System Option 2

Another option would be to locate the pump station in the NW corner of the lake or at the boat landing (see Fig. 6). Either site would provide shorter distance pipe runs to the destratification zones. This would be the most desirable approach however costs of land acquisition and site development may make this option prohibitive. And the issue of long-term ownership also must be addressed.

In this option a blower/compressor house would be located on the north shore (Fig. 8). Three pipes, each approximately 1900 feet long, would be placed on the bottom at the 14 foot water depth. Three inch (3") diameter polyethylene lines would each carry 100 scfm of air for a total of 300 scfm, mixing approximately 180 acres of water area. With the pipes laid at the 14 foot contour, pressure required to overcome 14 feet of water would be approximately 6.1 psi plus pipe losses and outlet losses, totaling about 11 psi requirement. Again it would be possible to use an air blower rather than a compressor.

A larger number of smaller diameter pipes, as many as 9, 1 ½" could also have been used. Advantages would include more complete mixing (although the aerial extent of mixing provided by 3 pipes would probably be adequate) and ease of handling and installation. Disadvantages would likely relate to higher costs and having more areas of the lake where pipes could be disturbed by anchors, etc.)

c. Typical Blower Requirements:

Outlet Channel: 30 scfm @ 15 psi to 17 psi Gardner Denver CycloBlower, 10 to 15HP

Main Lake: 300 scfm @ 11 psi, Gardner Denver IQ package approx 25HP

Three phase power will probably be required for this pumps. Three phase power is available from supply lines on highway 27. Since getting three phase power to designated pump station sites on the lake may could cost $15-20,000 it could prove more economical to use 3-phase converters at the pump station.

B. Fisheries and Habitat

This was one of the most important areas for improvement in the sociological survey and probably the most debated during the steering committee meetings. The goals are clear and many of the objectives (see Sections III B&C above) are increased efforts in existing activities or future volunteer activities in the planning and yet to be implemented stages. One additional objective that was not included in the steering committee recommendations, but is being pursued by the local community and is endorsed by the Lake Eau Claire Association is changes to existing bag and size limit regulations that would be more consistent with other area lakes.

The following are the changes that are being proposed: the new bag limits for Panfish would be reduced from 25 to 10; Walleye limit would be reduced to 3 fish with no keep slot size between 14 and 18 inches, however you can keep 1 Walleye over 18 inches and 2 under 14 inches or 3 under 14 inches. The goal of these changes is to rebuild the fish population.

Although these regulation changes may take some pressure off the fisheries the most gain will probably come from restoring fisheries habitat. This can be facilitated in a number of ways. One of the most immediately productive ways is to increase the amount of coarse woody debris (CWD) in the lake and particularly along the shorelines. The abundance of CWD that once existed in and around the edges of the lake has all but disappeared. In a shoreline survey in 2009 less than 10 tree falls were counted. Certainly with over 40 miles of largely wooded shoreline many more tree falls must take place, but apparently removal by lake property owners and by ice flows during the spring eliminates most of the tree falls quickly and before they offer much benefit to the fisheries and other wildlife.

1. Proposed Long-Term Objectives:

The objectives under IIIC above will be organized and overseen by the LEC Association and appointed committee of local appropriate agencies and organizations. Lake wide plans developed and implemented and permits sought by this committee. This will be a long term ongoing activity since replacement of habitat will be a continuous issue. The LEC Association will set some annual funds aside for this process, but local and state support will be required particularly during the initial phases of the habitat restoration effort. It is expected that most of the labor will be voluntary and come from local invested individuals and organizations like sportsman and fishing clubs. Therefore most of the cost will be for materials and transportation of materials.

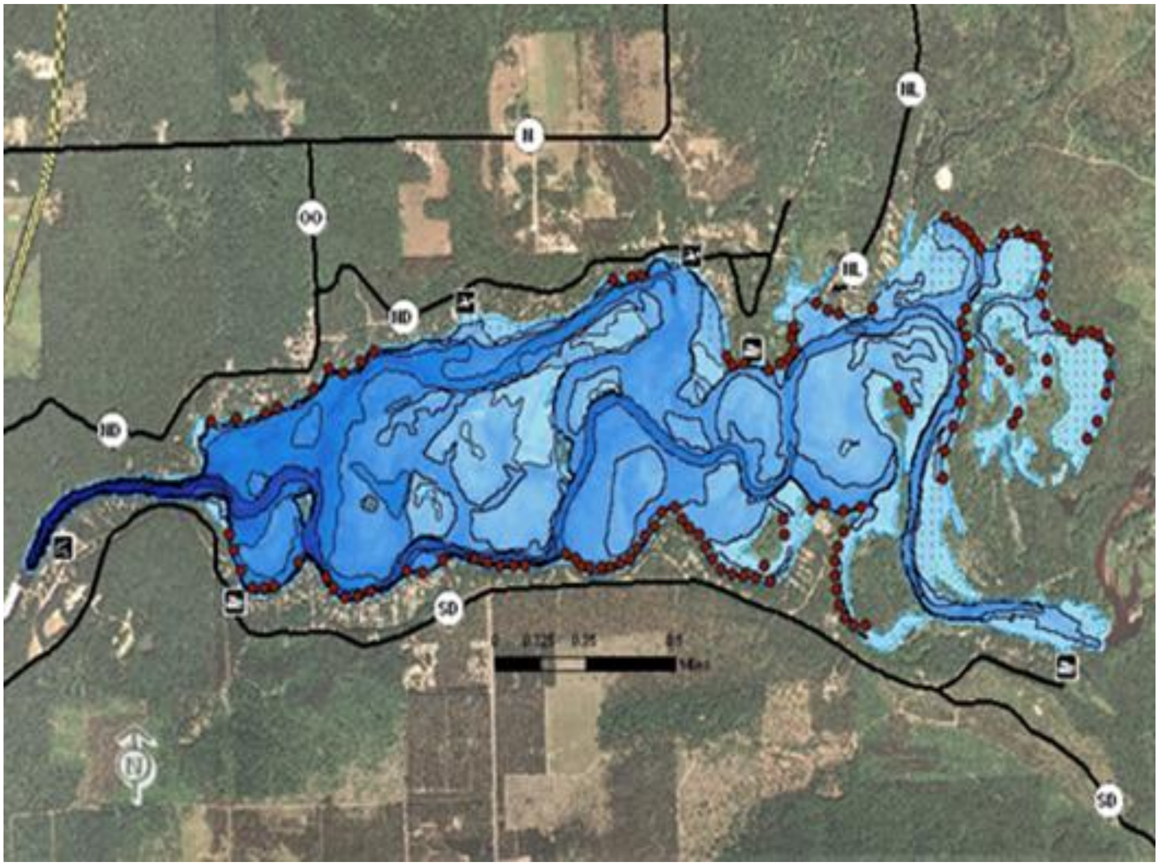


Figure 7: Red Dots Shown 2009 Locations for Potential Tree Falls for CWD

2. Near-term objectives:

1) Develop and get approval of a blanket permit to begin to add CWD to areas around the lake.
2) During the 2009 shoreline survey roughly 75 trees that met the approved criteria for CWD (see LECA website). These are indicated by red dots along the shoreline on the map in Figure 7. These trees are all close to falling and before this happens we propose to fall them and anchor them to the shoreline and plant a replacement tree in their place at the site. Only trees that are in locations were ice removal is unlikely will be used for this purpose.
3) Where CWD structure placements are susceptible ice or high water removal we will use anchored subsurface structures which are referred to as half-log structures and these will only be located in shallow water in the littoral zone.
4) Although in the past log cribs were installed throughout the lake in the deeper water they had little beneficial effect because of low oxygen levels at depths greater than 8 feet. This condition was not understood at the time these cribs were installed. Side scanning sonar images taken last year indicate many of these deeper cribs appearing in groups of

three are still intact even after 20-40 years. The addition of the destratification system should make these cribs viable and improve the fisheries on the west end of the lake. Experience in all lakes shows that more concentrated groupings of cribs are more beneficial. Hence we propose that the existing cribs be supplemented with additional cribs after the destratification is operational.

C. Sedimentation and Erosion

1. Background

Addressing sedimentation and erosion concerns were another top priority in both the sociological survey and the steering committee meetings and one that people expressed an urgency about. Over the last 10 years three dredging projects have already been tackled: Muskrat and Hay Creek tributaries on the north side of the lake and the area in front of and adjacent to the Skid Row boat landing. The plans for these projects and for a more extensive dredging projects for the whole lake and for the area upstream of the Skid Row boat landing were developed by Ayres Engineering (Ayres 1997). The larger projects were not acted upon because of the estimated high costs involved; as much as $33,000,000 for the whole lake dredging project.

The common wisdom today is that much of river and main body of the lake have been filled in by sedimentation since the lake was flooded in 1937. In their analysis Ayres used maps from the early 1960's and 1990's to examine this trend and concluded that a major amount of sediment had filled in much of the lake. I n preparing for the 2009 steering committee meeting a problem was discovered with the earlier maps that Ayres used in their analysis. First the geographic coordinates were seriously in error on one of the maps and resolution inferior to a more recent map from 2007. One of the earlier maps was apparently used by Navionics, Inc. to produce their commercial GPS fishing map for Lake Eau Claire it was not close to matching the actual lake bathymetry. In addition if the lake had filled in to the extend believed and suggested in the Ayres report the river channels would no longer be distinguishable and yet they are clearly defined throughout the lake. As are other distinct features such as logs and stumps that are not buried in the sediments.

Much of what is believed to be sediment filling is due to shoreline erosion and slumping of steep sand drop-offs along the shorelines and islands that were created in the 1950's excavation project. Today the primary threats to the lake come from the 5 small tributary streams along the north shoreline. In these cases the problem can be dealt with by installing sand traps that are cleaned out regularly. This has been done for four of these tributaries and one remains to be completed in the NW corner of the lake.

2. Proposed Objectives

a. Skid Row Sediment Trap

Add a sediment trap just above the Skid Row boat landing to stop further intrusion of sand into the upper region of the lake. The location of the trap is shown in Figure 8. The Skid Row Trap (SRT) should be elongated as shown to prevent breakthrough of sand anywhere between the ends of the trap as shown on the map. These points define the high ground limits that are above the flood plain. If break through during flood events occurs and a new channel forms it has to be between these two points. This trap as long as it is cleaned out when necessary should stop any further shallowing of the lake head-waters beyond the trap.

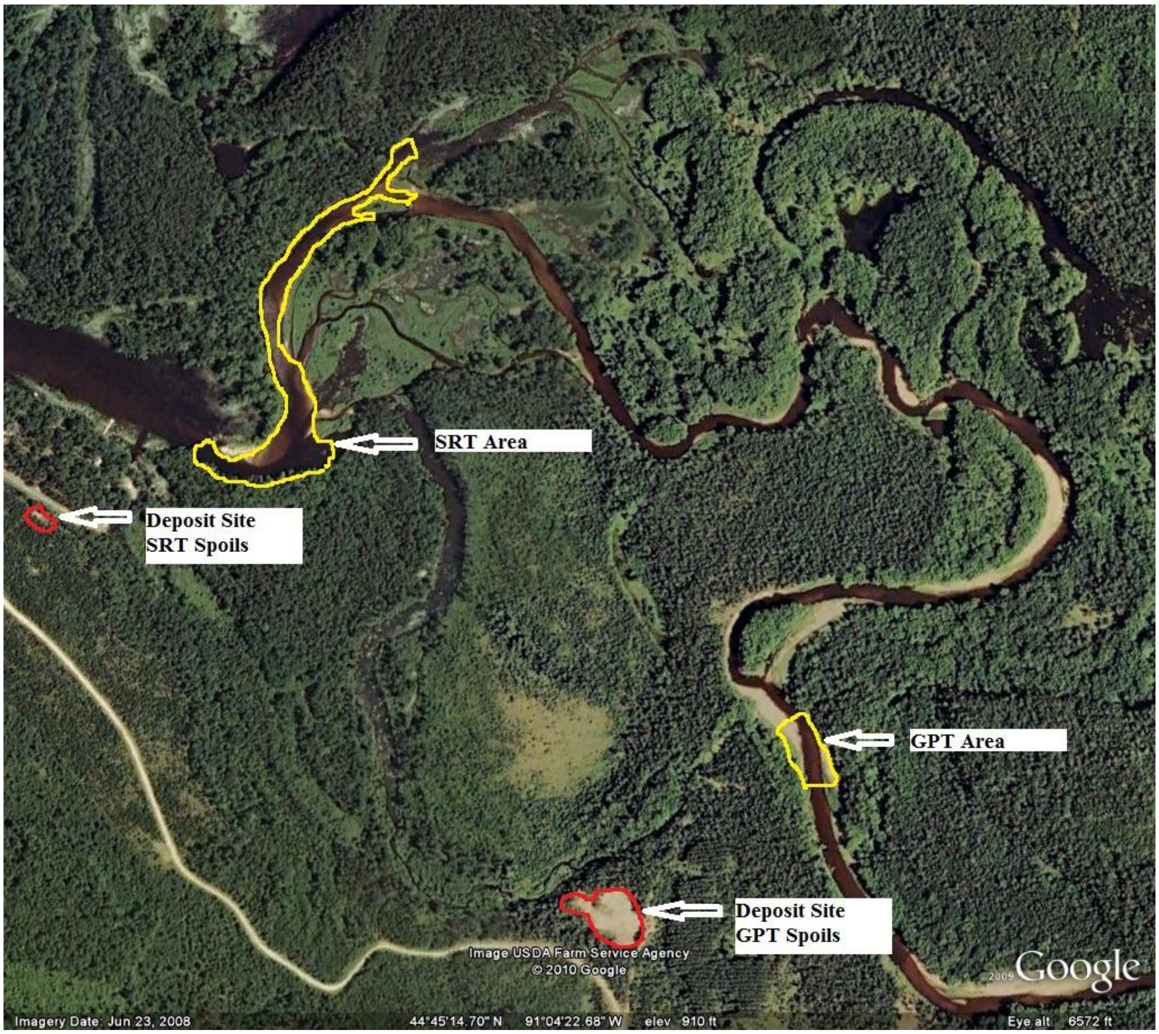


Figure 8: Sediment Removal for River Fisheries Habitat Recovery

b. Gravel Pit Sediment Trap

It is proposed that another sediment trap will be added in the main river channel up-stream from the Skid Row site at a location near an abandoned gravel pit. It is proposed that the gravel pit is used as the deposit site for the river sediments. This site is close enough to the proposed river sand trap so that sediments can easily be hydraulically transported through a pipe line to the gravel pit. Since there is also an existing road to the gravel pit and to the river at this location access to the river will be fairly straight forward. The Gravel Pit Trap (GPT) will be used to stop additional sand from further up the river from entering into the lake headwaters. Removing sand from this trap on a regular basis should gradually deepen the river channel between the GPT and the SRT sites by natural river bed-load transport.

To estimate the amount of sediment that needs to be removed to restore conditions to 1960 the total fill volume was estimated and summed for different areas using satellite and aerial imagery as follows. The following assumptions and calculations were performed:

1) The total area filled above the Skid Row Boat Landing was estimated by summing all the individual areas that have been filled since 1960 = A+B+C+……….. = 229,223 yd3
2) Assume that this is the amount deposited since 1960
3) Therefore 229,223 yd3/50 years = 4584yd3/year assuming 5 foot average depth for total area.
4) As an upper limit an 8 foot average depth gave 458,446 yd3/ 50 years = 9169 yd3
5) Upstream sediment traps should therefore have a capacity of 10,000 yd3 to safely accommodate the annual bed load flux of 4584 yd3

If the assumptions are correct and most of the sediment is coming from bed load than roughly 4600 yd3 on average per year will need to be removed from the traps. More than likely the sediment transport is variable from year to year and episodic with much higher levels being transported during flood events and high precipitation years. Therefore required trap clean out times could vary from a year to multiple years depending largely on precipitation in the river water shed area above the lake. Also from observations it appears that changes in the river bed have occurred over the years and that these changes correlate to large tree jams that force the river to change course, particularly during high volume flows. If this is the case removing these jams as quickly as possible would be beneficial in stabilizing the main river channel and recovering much of valuable wetlands and fish spawning areas which have been isolated from the main river system over the last 50 years.

If sedimentation levels remain as they have over the last fifty years this would amount to a 4000-10,000 yd3/year reduction in bed load between the Gravel Pit Trap and Skid Row Boat Trap. This would amount to roughly an average annual deepening of the entire width of the river channel of 2 to 3 inches between these end members. This should also help to restore some of the valuable fisheries wildlife habitat in the headwaters area of the lake, since the deepening of the main channel could make these areas accessible again.

V. Educational and Community Involvement

The Lake Eau Claire Association has strived over many years to involve local educators and their students other members of the community in environmental studies and various environmental programs related to the Eau Claire Lake and River. Much of the scientific evidence that has been used in the preparation of the Lake Management Plan was provided through studies that involved high school and college students and local lay people. Studies include water profiling for light attenuation, oxygen and nutrient, and sediment profiling. These kind of studies will once again be invaluable in this Lake Management Plan for evaluating and adjusting the operation parameters for the proposed aeration system. Since one of the primary goals of this Management Plan is to improve the fisheries by improving water quality and habitat, studies on the success of these efforts will be conducted by using ongoing creel surveys and tagging larger fish with transponders to determine survival rates and fishing pressure. These studies will be conducted in conjunction with Beaver Creek Reserve and the Wildland School.

The Lake Association also plays a strong rule in empowering local lay people to be actively involved in environmental matters such as shoreline restoration and assisting in establishing and preserving habitat. An active education system is provided through mechanisms such as Spring and Fall seminars on various topics such as the use of native vegetation, shore land restoration, erosion prevention through landscaping, rain gardens, creating fish habitat, creating bird and wildlife friendly lake buffers, and vegetation to attract butterflies.

The Association also provides literature and works closely with county in providing advice on a wide variety of lake relative topics such as the following.

Pesticide free Gardening (Audubon)
Lake Tides (WAL)
Invasive Species Identification cards
Owning Lake Front Property
Clean Boats – Clean Waters Guide
Life on the Edge
Sensible Shore land Lighting
Maintain your Septic System

The Lake Association is also very active in other state and county environmental organizations such as WAL and the River Alliance. Members of the Lake Association Board Participate in Wisconsin Association of Lakes meetings, the Wisconsin Lakes Convention, and Lake Leaders Program. The Lake Association also hosts various meetings and events during the year which are directed at public awareness of environmental issues and raising funds specifically for environmental causes.

News and information on most of these activities are available through a quarterly newsletter and the Association's website at http://www.lakeeauclaire.org

VI. References

Ayres, 1997. Ayres Sediment Reduction Plan, Ayres Associates, Eau Claire, WI

Garrison, Paul J. Fall 2009. Destratifying Moderately Shallow Lakes. Lakeline

Sommerfeldt, Skip (Thomas). Fall 2009. Wisconsin: Overcoming Winterkill. Lakline.

VII. Project Budgets

A. Water Quality – Aeration System for Destratification

	Project Costs		
Items	**Requested Funds**	**Cost-Share Value**	**Total Costs**
1. Salaries and benefits[1]		$10,000	$10,000
2. Consulting Services[2]	$4000	$4,000	$8,000
3. Purchased services[3]		$400	$400
4. Other purchased services[4]	$6,000	$6,000	$12000
5. Plant material			
6. Supplies[5]	$70,000		$70,000
7. Depreciation			
8. Hourly equipment charges			
9. State Lab of Hygiene Costs			
10.Non-SLOH Lab costs[6]	$2,000	$9,000	$11,000
11.Land or easement acquisition value			
12.Associated acquisition costs			
13.Other[7]		$850	$850
TOTALS	$82,000	$30,250	$112,250

B. Fisheries and Habitat

	Project Costs		
Items	**Requested Funds**	**Cost-Share Value**	**Total Costs**
1. Salaries and benefits[1]		$6,000	$6,000
2. Consulting Services			
3. Purchased services[3]		$200	$200
4. Other purchased services			
5. Plant material[8]	$2,500	$3,000	$3,000
6. Supplies[9]	$3,000	$2,000	$5,000
7. Depreciation			
8. Hourly equipment charges[10]	$2,475		$2,475
9. State Lab of Hygiene Costs			
10.Non-SLOH Lab costs			
11.Land or easement acquisition value			
12.Associated acquisition costs			
13.Other[7]		$850	$850
SUBTOTALS	$7,975	$12,050	$20,025

C. Sedimentation and Erosion

	Project Costs		
Items	**Requested Funds**	**Cost-Share Value**	**Total Costs**
1. Salaries and benefits[1]		**$4,000**	**$4,000**
2. Consulting Services			
3. Purchased services[3]		**$400**	**$400**
4. Other purchased services[11]	**$110,000**	**$20,000**	**$130,000**
5. Plant material			
6. Supplies			
7. Depreciation			
8. Hourly equipment charges			
9. State Lab of Hygiene Costs			
10.Non-SLOH Lab costs			
11.Land or easement acquisition value			
12.Associated acquisition costs			
13.Other			
TOTALS	**$110,000**	**$24,400**	**$134,400**

GRAND TOTAL FOR A, B, and C $199,975 $ 66,700 $266,675

D. Budget Justification for Footnotes in Budgets A, B, and C Above

1. Salary and Benefits: This is cost sharing for Dr. Zika's time in overseeing this project. As a professional consultant for industry and government agencies such as the EPA he normally receives daily consulting fees of $500-$1000 plus expenses. Therefore at $500/day for the duration of this project he is committed to 40 days. He is currently a professor at the University of Miami and this amount of time consulting is legally provided under contract terms of employment with the University. This consulting time will be subdivided between the separate projects.

2. Consulting services: This is for having an engineering consultant familiar with installation of lake aeration systems provide oversite in the design and construction of aeration system for the lake. The LEC Association has already employed Mr. James Wedepohl (formally with DNR) as a consultant in the design of the lake aeration system. He has agreed to continue in a consultant capacity during the construction and startup phases.

3. Purchased services: Mainly for office related costs, communications, and shipping costs.

4. Other purchased services: These are costs for work boats and personnel for installation of aeration pipe line and for diver expenses. The work boat costs with two operators is $75/day. So two weeks have been scheduled for the installation time.

5. Supplies: This includes all the material costs for the aeration system (i.e blowers, 3-phase power converters and other electrical hardware, valves, piping, iron ballast, strapping, etc.)

6. Non-SLOH Lab costs: To determine the operating parameters and establish the effectiveness of the aeration system pre-installation and post-installtion monitoring will be conducted. This will be done as it has been in the pass with members from the Beaver Creek Reserve and Wildland School in Eau Claire County. Dr. Zika will supply some of necessary equipment and supplies fro his lab at the University of Miami. Among the measured parameters oxygen, phopshate, light penetration, and phytoplankton speciation will be evaluated.

7. Other: These funds will be used to cover insurance costs for liability exposure to the Lake Association. So of the activites the Association is promoting through the management plan have obvious increased liability risks associated with them.

8. Plant material: As discussed in the objectives section tree falls will be widely used around the lake to increase CWD. Where existing shoreline trees are used for CWD they will be replaced with newly planted shoreline trees. In addition in certain location selected shoreline or aquatic plants such as bull rushes will be established as shoreline habitat and for shoreline erosion protection.

9. Supplies: These funds are to be used for installation of tree falls and half log structures for fish habitat. Included in the list of supplies are strapping , concrete block, etc.

10. Hourly equipment charges: Some funds will be require for move and installing trees for tree falls. Some of these trees will be moved and installed during the winter months to take advantage of ice cover.

11. Other purchased services: With particular service is the for paying for dredging company for sediment removal in the two traps in the river above the lake. The lowest price we have been quoted by one company is \$4.00/yd^3.   A price of \$4 to \$5 was used to determine the size and cost of the upstream sediment traps at SRT and GPT sites (see Figure 8).

LAKE EAU CLAIRE MANAGEMENT PLAN 2010 TIMELINE

Number	Task	Resource	Start	End	Duration Days
1	Boat Landing Invasive Species Creel Reporting Surveys & Education	Beaver Creek & LEC Volunteers	5/23/2010	5/10/2013	758
2	Aeration Detail Design	Engineering Consultants	10/4/2010	1/3/2011	63
3	Aeration Construction Phase-Pipe line Installation	TBD & Volunteers	1/4/2011	3/1/2011	39
4	Pump House Construction	TBD & Volunteers	4/4/2011	6/2/2011	42
5	Aeration System Startup & Testing Phase	LEC Assoc. & Beaver Creek Reserve & Wildland School	6/23/2011	11/3/2012	349
6	Install Tree Falls and Half-Log Structures - Ongoing Program	LEC Assoc. & Local Volunteers	7/26/2010	5/3/2012	453
7	Sediment Removal Engineering Completion Design Phase & Contract Development	TBD & LEC . Assoc.	11/17/2010	6/1/2011	138
8	Sediment Removal	TBD & LEC Assoc.	7/7/2011	11/17/2011	94
9	First SRT & GPT Sediment Deposition Rate Survey	DNR & LEC Assoc.	7/31/2012	8/15/2012	11