Lake Mallalieu Management Plan

March, 2014

Words of Thanks

This document was prepared by volunteers of the Lake Mallalieu Lake Association, staff members of St. Croix County's Community Development Department, Wisconsin Department of Natural Resources personnel, and other interested individuals who are working to preserve and enhance Lake Mallalieu's beauty and health for future generations. The printing and preparation of this report was supported by the Lake Association.

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LAKE MALLALIEU ASSOCIATION

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Purpose and Scope

Implementing Lake Mallalieu's Lake Association Lake Management Plan will protect and enhance what we value most for current and future generations of lake users. An important purpose of the plan is to educate and motivate the lake's residents and users. Moreover, this plan serves as a tool that can be utilized to achieve better water quality within the lake.

The lake management plan attempts to improve water quality in Lake Mallalieu by preventing the occurrence of nuisance algae blooms, reducing nutrient loading from runoff to the lake, and increasing water clarity. In addition, it recognizes the importance of protecting and restoring shoreland habitats.

The plan highlights efforts to sustain a self-supporting fishery and diverse aquatic plant community, while also preventing the expansion of new infestations of native species.

Furthermore, this plan recognizes the value of multifaceted recreational opportunities on and around the lake. It highlights the importance of courteous and safe boating behavior for all users of the lake.

This plan recognizes Lake Mallalieu and the Willow River as federally designated 303(d) listed waters. In 2004, the Environmental Protection Agency listed Lake Mallalieu as impaired due to excessive phosphorus and chlorophyll levels during the summer months. In 1998 a portion of the Willow River was designated as impaired due to low dissolved oxygen levels. EPA's designation has directed WDNR to develop and Implement a TMDL Project. Lake Mallalieu's Lake Association will make efforts to partner with WDNR, and other stakeholders in an effort to improve Lake Mallalieu's water quality.

Restoring the water quality in Lake Mallalieu will require a grassroots effort of local stakeholders to include citizens, municipalities, resource agencies, and the agricultural community.

As an Association, we value Lake Mallalieu and the Willow River Watershed, particularly for recreation, fishing, and for the aesthetic qualities these water resources offer. Boating,

swimming, and simply enjoying the natural beauty of the lake are all valuable activities.

Improving lake quality will help Lake Mallalieu continue to support a high quality warm water bass sport fishery. Good water quality will also maintain adequate numbers of panfish and northern pike, and continue to maintain healthy aquatic communities.

Portions of the Willow River's mainstem and the North and South Forks of the Willow are Class II and Class III trout waters. Much like Lake Mallalieu, the lower river supports a warm water sport fishery. Willow River State Park is located on lands along the Willow mainstem in the lower watershed and includes the Willow River gorge, waterfalls, and Little Falls Lake.

The Lake Management Plan will continue to recognize the importance of providing safe, multifaceted recreational opportunities for lake users. Lake Mallalieu's recreational uses and needs will continue to grow as population increases and development continues throughout St. Croix County. Going forward, it will be important to provide safe recreational opportunities for all lake users while protecting critical lake habitats and water quality.

A History of Lake Mallalieu

Lake Mallalieu was first impounded in 1848. The impoundment was initially referred to as Willow Pond, but in 1887 the lake was renamed and became "Lake Mallalieu". The lake was named by Dr. Irving Wiltrout. Dr. Wiltrout is credited with building Hudson's first hospital. According to records, Dr. Wiltrout stated, "I have named this lake in honor of Rev. William F. Mallalieu, D.D., L.L.D., Bishop of the Methodist Church and a resident of New Orleans" (Lake Mallalieu Lake Association, 2001).

The 1850's brought rapid settlement to Hudson and in 1854, a second dam was built on the river, a short distance above Willow Pond.

Through the years Hudson continued to grow and in 1871, the single most formative event in Hudson history took place – the railroad arrived. With the railroad came shipyards, which concentrated on manufacturing and repairing both freight and passenger rail cars. The shipyards were Hudson's principal engine of growth for many years, until production dwindled after WWII. The businesses were closed by 1957.

Fishing activity on Lake Mallalieu became popular in the early years and by 1941, the lake supported a commercial fishery. A fisheries report noted that commercial fishermen netted 56,400 lbs. of carp. During 1941-54 there was an attempt to establish walleye by stocking. This was not effective however, and it was recognized that Lake Mallalieu was best suited for northern pike, bass and panfish.

During the 1950's, Lake Mallalieu started to be recognized as a prime residential location. Much building took place in the 1960's as larger parcels around the lake were divided into smaller lots. Building has continued to the present. For the most part, virtually all buildable sites around Lake Mallalieu are now occupied. Water quality issues have come to the forefront as the number of lakeshore homeowners has increased over time.

Nuisance aquatic plants in Lake Mallalieu have been a recurring concern. A 1951 fisheries report noted "abundant vegetation", perhaps caused by removing carp which were present and fed on aquatic plants. Between 1961 and 1966, permits were issued to residents, allowing large amounts of herbicides to be used for aquatic plant control. It is believed some arsenic compounds remain in the Lake's bottom sediments from those applications.

By the 1970's vegetation in the lake was scarce, water conditions were murky, and carp populations were large. In 1975, there was a partial drawdown of the lake in an attempt to control the carp by disrupting their spawning period.

Over the years, three dams were built on the river above Hudson. In 1967, the State of Wisconsin purchased the three from NSP and

formed Willow River State Park. The middle dam (Willow Falls) and upper one (Mounds Dam) were removed in the 1990's. Willow Falls and its gorge have reverted back to their beautiful, natural state, and Mounds Dam has been a scenic attraction in its own right.

In the early 1980's, the Lake Mallalieu Lake Association was formed. This group arose out of concerns for the Lake. The group had three primary concerns. First, the dam would eventually need repairs. Who would pay? Ultimately, in the fall of 1983 an agreement was reached, the lake level was drawn down, and repairs were made. The second problem had to do with the potential development of a hatchery property. The property was believed to be unsuitable for building. The property was eventually purchased by a St. Paul individual and he has kept the property in its natural state since. The third concern was a proposed condominium on the southeast corner of the lake. Objections to the development included concerns over wet soils, installation of utilities, and negative visual impacts. After much discussion and outcry, the proposed condominium project was abandoned.

In 1989, another very serious lake issue presented itself. Extremely high levels of fecal coliform were measured when some children became sick after swimming. LAKE CLOSED signs went up around the shore. Sampling confirmed that parts of Lake Mallalieu were dangerously polluted. Association members spent many hours taking weekly water samples from the lake for analysis, with frequent newsletters giving the latest updates and speculating at the cause. Over time, local government inspections revealed sewage violations around the lake. The problem sites were immediately capped and the year ended without a conclusive resolution to the problem.

By the next year municipal engineers dominated the dialogue and local governments were persuaded to install full sewer and water services to all lakeshore homes. Full utilities were installed in 1991 (Brasch, R. 2008).

Shortly after the installation of utilities around Lake Mallalieu in 1991, the Association applied for, and obtained a Lake Planning Grant from WDNR. The grant award allowed the Association to hire an engineering firm to conduct a lake study. The study's primary finding concluded that the lake was receiving excessive nutrients. Shortly after having completed the Lake study, the Lake Association became inactive. It was not until 1997 when the Association was reactivated in response to increasing problems with abundant nuisance aquatic plants, especially in the shallow north basin.

After considering chemical controls, an aquatic plant survey was undertaken with expert help from WDNR (1998). The greatest problem identified was the presence of Eurasian Water Milfoil. The prescribed treatment was winter freezing by lowering the lake level. During the fall and winter residents endured a deep drainage of the lake for an extended period of time while dams were being repaired. Freezing did control the milfoil and the two succeeding summers (1999 and 2000) were virtually free of non-native and nuisance *aquatic plants.*

In 1997 and 1998 the Lake Association obtained WDNR grants to support the reactivation of the Lake Mallalieu Lake Association. The Association was charged with studying the source of excessive nutrient loading to the lake, in addition to developing a Lake Management Plan. The Association published their lake management plan in January of 2001.

Shortly after 2002, the Lake Association became increasingly inactive, but interest in the Association was rekindled in 2010. Working with WDNR and St. Croix County staff members, the Lake Association put it upon themselves to update their management plan. In addition, members made a further commitment to update and re-tool the Lake Association's web site. It was felt that each of these efforts could incorporate valuable water quality information; information that has come to the attention of both lake residents and local resource managers.

Since 2004, Lake Mallalieu has been included on the Environmental Protection Agency's (EPA's) 303D impaired waters list, at high priority for eutrophication and pH impairments due to excess phosphorus. As a result of this designation, The Clean Water Act requires WDNR to prepare a phosphorus TMDL (Total Maximum Daily Load) for Lake Mallalieu and its upstream contributing area. The TMDL plan will have a goal of reducing nutrient loading to Lake Mallalieu, in addition to increasing public awareness of the upstream implementation efforts needed throughout the watershed. Specifics of the TMDL plan will guide nutrient reduction efforts for Lake Mallalieu and the Willow River Watershed well into their futures.

Surveying Lake Residents

Results of the 2011 Lake Residents Survey

On behalf of the St. Croix County Community Development Department and the Lake Mallalieu Lake Association, the Environmental Resources Center of UW Madison designed and conducted a survey of owners of properties bordering Lake Mallalieu.

In the spring of 2011, the University of Wisconsin Extension's Environmental Resources Center completed a survey of lake residents. Ninety four surveys were returned of the one hundred and sixteen sent—an exceptional 81% return rate. UW Extension staff members Jake Blasczyk and Andrew Meyers compiled the results (Blasczyk & Meyers, 2011).

The most significant responses are listed below (percentages are of total respondents). These responses helped determine the major issues addressed in this Lake Management Plan.

1. What types of activities do you "often" do on or around the lake? Wildlife viewing (83%), Relaxing with family and friends (76%), Pleasure boating (57%), Swimming (30%), kayaking/canoeing (17%) and open water fishing (19%).

2. What moved you to purchase Lake Property? Scenic Beauty (73%), boating/watersport activities (34%), place for family and friends (33%), and investment potential (14%).

3. What potential pollution sources do you believe to be contributing to the lake (high to very high likelihood)? Ag fertilizers (59%), storm water runoff (52%), manure from farm animals (50%), fertilizing of lawns along lake (48%), Use of pesticides by lake property owners (41%), and soil from agricultural fields (39%).

4. How has the lake changed since owning your property? Amount of algae has increased (54%), amount of aquatic plants has increased (54%), shoreline erosion on your lot has stayed the same (44%), water clarity has decreased (44%), and the quality of fishing has stayed about the same (33%).

5. Do you have a strong willingness to change and support several strategies on your property to improve water quality? I am willing to change some things (41%), I favor improved government regulations as a means to better water quality (14%), efforts to improve water quality must be strictly voluntary (12%), I would financially support a group that worked to improve water quality (12%), I would favor forming a lake district that could levy taxes (7%).

The survey report concludes with a final section discussing the following twelve conclusions about respondents and their attitudes and opinions regarding aspects of Lake Mallalieu.

1. Almost all are long term permanent residents who value Lake Mallalieu, with many belonging to the Lake Association, but are uninvolved.

2. Many respondents have water frontage under 200 ft. and with a buffer.

3. Many value a well-kept lawn but not necessarily the well-manicured suburban type.

4. Many had some awareness of Wisconsin's fertilizer law which was reflected in opinions and behaviors regarding fertilizing.

5. Most respondents mow their lawns and some hire a service to apply fertilizer or weed killers. Few had soil tests taken.

6. Some respondents were indecisive about buffers while noting their potential benefits.
7. Many noted changes to the lake since owning their property.
8. A majority viewed agricultural sources as being major contributors to pollution of Lake Mallalieu, but also recognized that to a certain extent, lake residents also contribute.

9. Large majorities utilized some form of conservation practice on their property, with few numbers installing rain gardens or rain barrels.

10. A majority are not in favor of becoming a taxing lake district, but respondents do support broad strategies to improve local water quality.

11. Many respondents agreed they are willing to change how they manage their property to improve local water quality.

12. A minority burned yard waste or leaves and a minority would volunteer for fall and spring boulevard leaf pickup.

You can view the complete 2011 Lake Mallalieu survey on the Association's web site (Blasczyk & Meyers, 2011)..

Encouraging Courteous and Safe Boating Behavior

Introduction

The Lake Mallalieu Association charter for encouraging courteous and safe boating behavior is:

"To encourage courteous and safe boating behavior as guided, in part by the Lake Mallalieu resident/visitor surveys and Wisconsin boating laws. The Lake Mallalieu Association will define and implement a range of options and specific steps to encourage and enforce more courteous boating behavior to support a harmonious and satisfying lake environment for all users of Lake Mallalieu."

The Lake Mallalieu Association Plan for Encouraging Courteous and Safe Boating Behavior has five elements:

- Boating Committee
- Lake Safety
- Education
- Enforcement
- Organizational Interfaces

Boating Committee Recommendations

The Lake Association has the authority to form committees from time to time. The following language will guide the composition and responsibilities of the Boating Committee if and when the Association determines it should be established. The Boating Committee is not active at the time of this writing.

1. The Boating Safety and Behavior Committee shall consist of three lake residents approved by the Board of Directors.
2. The Board of Directors will strive to select and approve Boating Safety and Behavior Committee members who reside by both the lake's east main body and the western narrower portion of the lake.
3. The Boating Safety and Behavior Committee member term of office is one (1) year in length.
4. The Boating Safety and Behavior Committee is responsible for communicating issues relating to boating safety and behavior to residents and lake users.
5. The Boating Safety and Behavior Committee is responsible for bringing to the Board of Directors and/or the general membership information and proposals associated with boating safety and behavior.

Lake Safety

1. The Boating Safety and Behavior Committee will monitor the safety of the lake as related to reduction in lake depth, shore objects (fallen trees, docks, floats, boats stored at anchor, etc.). The Committee will support efforts to increase "structure" for improved fishing near shore.
2. The Boating Safety and Behavior Committee may coordinate the removal of known "dead heads" and other surface, semi-floating or submerged objects away from shore which are not normal, legal and appropriate to the lake that may pose a hazard to boaters and skiers. Spring runoff debris is a major focus.

3. The Boating Safety and Behavior Committee shall report to the Board of Directors any shore object (as defined above) which may require Association action or communication to rectify in the interests of safety.

Boater Education

1. The Boating Safety and Behavior Committee is responsible for the definition, construction, installation, maintenance and renewal of the Lake Mallalieu boat launch sign. The Lake Mallalieu boat launch sign shall be located in an appropriate site at the lake public access off of Wisconsin Highway 35 in Hudson, Wisconsin.

2. The boat launch sign will contain a graphic outline of the lake which identifies shallow danger areas for boaters and skiers as well as narrow areas where state law restrictions on boating distance applies.

3. The boat launch sign will contain selected Wisconsin Boating Law statements as determined by the Boating Safety and Behavior Committee. The boat launch sign statements will be short, simplified, accurate condensations of Wisconsin Boating Law and will be selected based on lake resident and user observations of boating behavior and safety problems.

4. The boat launch sign design, placement, and content shall be reviewed and approved by the Board of Directors.

5. The Boating Safety and Behavior Committee is responsible for the content of educational pamphlets or cards which are to be made available to the public in a protective box, attached to the lake boat launch sign.

6. The educational pamphlets shall list Wisconsin Boating Law and the Lake Mallalieu Association position on boating behavior and safety.

7. The Boating Safety and Behavior Committee supports the education of boaters who are in violation of Wisconsin State Boating law by approaching them on the water, without confrontation, and politely informing them of the law and DNR enforcement. The Boating Safety and Behavior Committee recommends that a minimum of two people perform this action. This topic is also listed under Enforcement below. The Committee will sponsor a boating safety course if there is sufficient interest.

8. The Boating Safety and Behavior Committee supports and encourages the placement of dock-end instructional signs for boaters. The sign size, style and content shall be approved by the Boating Safety and Behavior Committee to assure appropriateness, uniformity, clarity and durability. Signs are to be simple statements of Wisconsin State Boating Law or appropriate warnings (shallow area, child swim area, etc.).

9. The Boating Safety and Behavior Committee supports and encouraged educational communication with local fishing and water skiing associations with the purpose of soliciting their assistance in the education and enforcement of Wisconsin State Boating Laws.

10. The Boating Safety and Behavior Committee is authorized by the Association to work with local governmental bodies and lake residents to obtain their approval for the placement of appropriate signs advising boaters of restrictions that apply to the immediate area.

Enforcement

1. The Lake Mallalieu Association and the Boating Safety and Behavior Committee encourages

residents and lake users to call Wisconsin DNR when boating violations occur. A WDNR field warden is the preferred contact. In emergencies (immediate risk of health and safety), the St. Croix County Sheriff is to be called at 911.

2. Residents and lake users communicating with offending boaters: See comments in EDUCATION.

3. Boat, boating and launch restriction are supported by the Lake Mallalieu Association and the Boating Safety and Behavior Committee to the extent that they comply with applicable State and local laws and are supported by the abutting municipal governments.

4. The Boating Safety and Behavior Committee and the Board of Directors of the Lake Mallalieu Association shall agree, by unanimous vote, on any supportive actions the Association will take in response to the special interests of any individual or group of individuals associated with boating behavior and boating safety. In all cases, all appropriate local, state and federal ordinances and laws will be considered and complied with.

Organizational Interfaces

1. The Boating Safety and Behavior Committee has the authority to contact and work with municipal governments on issues relating to boating behavior, boating safety and potential ordinances after approval by the Board of Directors.

2. The Boating Safety and Behavior Committee has the authority to contact and work with local fishing and water ski organizations on issues relating to boating behavior, boating safety and potential ordinances after approval by the Board of Directors.

Monitoring and Controlling Invasive Aquatic Plants

Background

The first recorded complaints of algae blooms in Lake Mallalieu were in 1946. The first recorded complaints concerning excess plant growth were in 1949. Letters were sent to the DNR at that time requesting help in "destroying the weeds." The first permit approved by the DNR for chemical treatment using arsenic compounds was issued in 1961, which led to a series of arsenic treatments totaling 7,240 pounds. Other chemicals used included Endothall, Diquat, 2, 4-D and Silvex.

Eurasian water milfoil
(Myriophyllum spicatum)

Arsenic and Silvex were subsequently found harmful and are no longer allowed. The other chemical (Endothall, Diquat and 2, 4-D) are still approved for aquatic plant control if a signed permit is obtained from the DNR.

A plant study had been conducted by Barr Engineering of Minneapolis in 1991 as part of a DNR Lake Planning Grant. No actions were taken as a result of the findings and recommendations in the Barr report.

During the summer of 1997, nuisance aquatic plants became abundant on Lake Mallalieu. It was enough of a problem that sufficient interest was

shown to reactivate the Lake Mallalieu Association. After much review and discussion, it was agreed that some outside assistance would be required. During the summer of 1998, the DNR completed a survey of the lake's aquatic plants and determined that Eurasian water milfoil had become the dominant species in the lake. A limited program of selective use of approved chemicals was implemented with mixed success. Chemical treatment was seen as a short-term, temporary solution. Based on the Association's cooperation with WDNR, it was agreed upon to maintain our participation with WDNR's Aquatic Invasive Species monitoring of the Lake.

White Water Lily
(Nymphaea odorata)

Provides excellent habitat for fish and produces seeds that are eaten by waterfowl.

The most effective nuisance and non-native aquatic plant control action on the lake was a six foot drawdown in the fall of 1998 in order to repair the St. Croix River dams. The drawdown, which was originally approved for three feet, was sufficiently deep to freeze the sediments which contained nearly all the Eurasian water milfoil roots. A follow-up plant study conducted by the DNR confirmed the absence of milfoil and a lake almost totally free of nuisance and non-native aquatic plants during the summer of 1999. Because the drawdown was twice the depth as would normally have been approved by the DNR (due to the dam repair), it was difficult to judge the impact on the plant community had the shallower three foot drawdown occurred (*The Aquatic Plant Community of Lake Mallalieu, St. Croix County, Wisconsin).*

There was a concern for the fish population during the extended drawdown. The DNR conducted a study and found no significant change. A comprehensive fish survey was scheduled and completed by WDNR in 2001 (WDNR Lake Mallalieu Comprehensive Lake Survey Report – St. Croix County, WI 2001).

The lake experienced another drawdown in the winter months of 2004-2005. This measure was again targeted toward the control of non-native aquatic plants. The lake was drawn down 3 ft. from October 2004 to early May of 2005 and the lower water conditions successfully controlled Eurasian water milfoil by freezing the sediments which contained milfoil root structures. The drawdown did not present problems for fish communities and seemed to serve as an effective measure for controlling non-native plants.

In 1998, Lake Mallalieu, with a DNR permit, applied 50 oz. of Rodeo to the shoreline to help control the purple loosestrife found during the aquatic plant study of 1998. To date (2013) purple loosestrife is still present, to a limited extent along the shoreline.

Plant Watch Committee Recommendations

The Lake Association has the authority to form committees from time to time. The following language will guide the composition and

Purple loosestrife
(Lythrum salicaria)

responsibilities of the Plant Watch Committee if and when the Association determines it should be established. The Plant Watch Committee is not active at the time of this writing.

1. The Board may establish a Plant Watch Committee composed of three Lake Association members that will report any significant aquatic plant problems to the Lake Association Board of Directors. The Board would recommend an appropriate course of action. All lakeshore residents are urged to report any significant aquatic plant problems to the Lake Association.

2. The Plant Watch Committee will request a DNR site assessment if a significant nuisance or non-native plant infestation is discovered. This action would be approved by the Board of Directors.

3. The Plant Watch Committee will watch for purple loosestrife and report infestations to the committee members.

4. The Association will continue to encourage residents to employ "low tech" and "non-chemical" means of aquatic plant control by their shores and docks, realizing that a diverse community of aquatic plants is essential to the health of the lake, its fish, and its wildlife. When aquatic plant control is necessary, the Association recommends hand harvesting, hand cutting, raking, and laying plant control mats. The Association is not recommending herbicide treatments for aquatic plant control, since herbicides provide only short-term, symptomatic control.

Curly-leaf pondweed
(Potamogeton crispus)

5. The Lake Association will continue their involvement in the Citizen Lake Monitoring Network. Through this network, goals of the Association include the collection of high quality data for Lake Mallalieu, sharing data with residents and WDNR Regional staff, and empowering volunteers to become active in Citizen Lake Monitoring data collection.

6. Through the Citizen Lake Monitoring Network, working with Beaver Creek Reserve to implement Aquatic Invasive species management (AIS Program) and the "Clean Boats Clean Waters" program and its associated monitoring component, efforts will be made to establish a baseline for the rate at which aquatic invasive species spread. This effort will be in cooperation with WDNR and other partners. Lake Association committee members will develop a schedule for AIS implementation.

Changes in the Aquatic Plant Community of Lake Mallalieu: 1991 to 2005

Studies of aquatic plants in Lake Mallalieu were conducted in 1998, 1999, 2001, and 2005 (Changes in the Aquatic Plant Community and The Long-term Impact of Winter Drawdown on Eurasian water milfoil and the Native Plant Community – Lake Mallalieu, St. Croix County 1991-2005 WDNR). These studies were conducted by WDNR Water Resources staff. Studies were done to assess the long term impacts to the native plant community and to Eurasian water milfoil of the 2004 3 ft. drawdown and to compare this drawdown with impacts of a more severe 6 ft. winter drawdown in 1998-99. The study of diversity, density, and distribution of aquatic plants in Lake Mallalieu is a important component of understanding the lake due to the role aquatic vegetation plays in characterizing water quality. Aquatic plants serve as indicators of water quality because of their sensitivity to various water quality parameters, such as water clarity and nutrients.

All other life within the lake depends on plant life. Plants provide food and shelter for fish, wildlife, and the invertebrates that serve as food for larger fish and animals. Plants protect shorelines from erosion, add to the aesthetics of the lake, and often impact recreation.

Based upon WDNR's study, the aquatic plant community in Lake Mallalieu has been characterized by low quality and very poor species diversity, with a high tolerance to disturbance. The existing plant community indicates Lake Mallalieu is farther away from an undisturbed condition than the average lake in the North Central part of the state. Furthermore, WDNR's has concluded that there has been a significant change in the lake's aquatic plant community during the years 1998-2005. There are indications the change may have come, in part, from prior winter drawdowns of the lake.

As a result of the 1991-2005 WDNR survey, several long term management recommendations for the lake were made.

Long Term Plan

1. WDNR has designated sensitive areas on Lake Mallalieu to provide protections for preserving habitat and water quality (completed in March of 2006 – "Designation of Sensitive Areas" – Lake Mallalieu, St. Croix County).

2. In cooperation with the Lake Mallalieu Lake Association, WDNR has conducted an aquatic plants survey in early July of 2013. This report is expected to be complete and available to the public in May of 2014.

3. Chemical control of nuisance vegetation will only be permitted by the WDNR as a last resort. Association Plant Watch will conduct continuing education through newsletters, meetings, guest speakers, WDNR publications, and providing a lake homeowners guide to residents along and near the lake.

4. Aquatic plant control will only be conducted if the vegetation is truly at a nuisance level.

5. Mechanical plant harvesting is not a viable control measure due to its high cost.

6. The Association's Board of Directors will seek approval from WDNR for a 3-5 ft. drawdown as needed. A potential drawdown could be used as a control measure for Eurasion Water Milfoil.

7. The Plant Watch Committee will stay in communication with WDNR to evaluate biological developments, as they relate to the use of insects and fish to control nuisance vegetation.

Summary

By following these short- and long-term plans,

aquatic plant control measures will enhance the overall quality of Lake Mallalieu. Implementation costs should be minimal because the plans rest heavily on volunteer efforts and grants, rather than capital expenditures. Future aquatic plant control (if necessary) should rely heavily on manual harvesting, periodic draw downs, and limited chemical herbicide applications.

Fisheries

A comprehensive fisheries investigation was conducted on Lake Mallalieu during a sampling period of April 4, 2001 to September 11, 2001 by WDNR Fisheries Management Staff (Lake Mallalieu – Comprehensive Lake Survey Report, St. Croix County, Wisconsin 2001). This study provided baseline data to assess the current status and long term trends in the lake's fish community. The survey documented species composition and relative abundance of fishes. In addition, it looked at composition, age, growth rate, and the reproductive status of fish species. Data generated will be used to make management decisions and to evaluate the cost effectiveness of management strategies in the years to come.

The first recorded fish survey of the lake was conducted in 1957 and was an inventory investigation to set management goals and objectives. Every survey management recommendation since 1957 promoted largemouth bass and bluegills and discouraged management of walleyes and northern pike. It was felt that walleye and northern pike would move into the much cooler Willow River. As a result, it would be difficult for the lake to support healthy populations of walleye and pike. Populations of carp have been a concern in Lake Mallalieu over the years. An attempt to control them involved lowering of the lake level during their spawning season. This proved futile, as did issuing contracts to commercial fisherman for the harvest of these rough fish. Such activities are no longer suggested as a management strategy.

WDNR utilized 5 methods of sampling for their 2001 survey. These methods included electrofishing, spring fyke netting, fish assemblage, index electrofishing, and forage abundance assessments. Species length was recorded and scale samples were taken for the purpose of aging the fish and determining growth rates.

A total of 39 species of fish were observed during the survey. Walleye populations were virtually nonexistent, Northern Pike populations were low, Smallmouth Bass were second most common and self-sustaining, and largemouth Bass were the most common and self-sustaining. Muskellunge are present but have extremely low densities and Yellow Perch are considered to be common. Black Crappie and Bluegill are common and abundant in the lake. The most common roughfish in the lake include the White Sucker, Gizzard Shad, Carp, Silver Redhorse, and Smallmouth Buffalo (Michalek Jr., W.J., and Engel, M.P. 2001).

The 2001 survey concluded that Lake Mallalieu provides an abundant and diverse sport fish community. Bass fishing is excellent with many trophy size fish present. Northern Pike are found in low densities but their average size is well above average. Panfish populations are good but their growth rates are lower than expected for small, fertile flowages. The drawdowns conducted on Lake Mallalieu do not appear to have impacted fish populations.

Future management goals include:

1. Protecting the density and quality of submergent and emergent plant beds for the benefit of fish and aquatic life.

2. Maintain stable water levels if possible, to protect fish and desirable plant species.

3. Work with landowners to protect and improve riparian areas and shallow and deep water habitat.

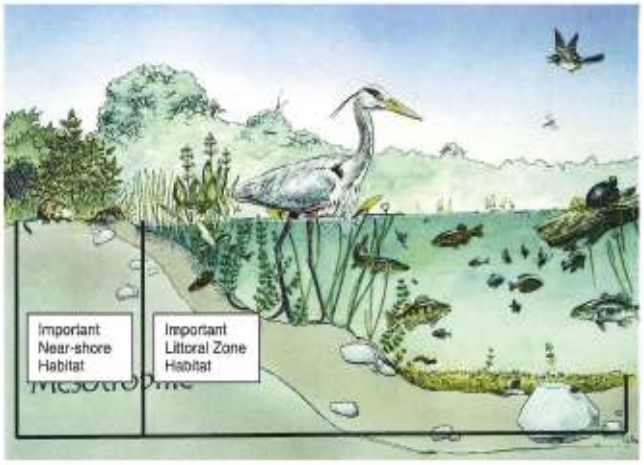


Figure 1. Location of important near-shore and littoral zone habitat.

4. Allow only limited numbers of rip rap permits for shoreline stabilization.

5. Promote watershed management practices to reduce nutrient and sediment delivery.

6. Seek public input and support of WDNR management recommendations.

7. WDNR Fisheries staff will conduct an abbreviated fish survey in the Spring of 2013 using a "funnel net" procedure, targeting different species of fish at different temperature levels. Results in the form of a 2 page report will be made available on WDNR's web site.

8. WDNR will place Lake Mallalieu on a 12 year rotation for fish surveys, provided funding for this work is continued to be made available.

9. Provide public fishing opportunities, provided adequate locations are available.

Sensitive Area Designation for Lake Mallalieu (WDNR March 2006)

Designation of sensitive areas within lakes provide for a comprehensive approach to ecosystem protection. Sites designated as sensitive are fragile areas that support wildlife and fish habitat and provide mechanisms for the protection of water quality (Dresen & Korth, 1998).

Protecting the terrestrial plant community on shore provides a buffer that absorbs nutrient runoff, prevents erosion, and helps to maintain water temperature. Protection of the littoral zone is critical for fish, wildlife, and the invertebrates that both feed upon. WDNRs sensitive area designations for Lake Mallalieu will serve as guide for management decisions that impact the lake's ecosystem.
Based upon WDNRs sensitive area study (conducted September 12, 2005) 5 sensitive areas were identified (WDNR, 2006):

Area #1 was the shallow water inlet to Lake Mallalieu. This was selected for its high quality of fish and wildlife habitat and diverse aquatic vegetation. The following recommendations were made for site #1:

1. Maintain snag and cavity trees along the shore.

2. Promote the eradication of Purple loosestrife through biological means.

3. Protect emergent vegetation.

4. Designate slow no-wake in upper lake.

5. Minimize removal of any shoreline vegetation.

Area #2 was defined as the south shore. This site was selected for the diverse aquatic vegetation and the natural terrestrial vegetation found. This area comprises about 3400 feet of shoreline, out to a maximum rooting depth of 4 feet. The following management recommendations were given:

1. Maintain current wildlife habitat.

2. Maintain snag and perch trees on shore.

3. Restore natural shorelines when possible.

4. Create fish cover via cribs and tree crops

5. Do not remove fallen trees

6. No dredging or lake bed removal.

Area #3 is the rock cliff that encompasses approximately 600 feet along the southern shore, just east of the boat landing. The shoreline at this site is composed mostly of a steep rock wall with wooded cover on top. This area provides habitat for fish cover and wildlife resting areas. Recommendations for this site are:

1. Minimize removal of shoreline.

2. Minimize, if not eliminate, lawn fertilizers.

Lake Mallalieu Sensitive Areas

Figure 2. Location of Designated Sensitive Areas on Lake Mallalieu.

3. Maintain current natural vegetation buffer.

4. Maintain aquatic vegetation in an undisturbed condition.

Area #4 is the West Basin which encompasses about 15 acres, near the Highway 35 bridge. This site includes shoreline habitat and shallow water habitat. Large woody debris from fallen trees provides valuable habitat for fish and wildlife. The following management recommendations have been made:

1. Maintain current habitat.

2. Protect emergent vegetation.

3. Restore natural shoreline in areas that have more than 30 ft. of cleared access.
4. Leave fallen trees in water.

5. No dredging or lake bed removal.
6. No permit approval for pea gravel beds or sand blankets.

Area #5 is the North Point that includes approximately 1500 feet of shoreline 0n the north point and its west side. This area has been identified as being important for near-shore terrestrial habitat, and shoreline habitat. Large woody debris in this area provides valuable habitat and cover for fish and wildlife. WDNR has suggested the following management recommendations:

1. Maintain current habitat.

2. Limit, if not eliminate, lawn fertilizer applications.

3. Lakeshore property owners work with County Resource Division and WDNR staff in efforts to re-establish native vegetation on and along eroded shorelines.

4. No bank grading.

5. No dredging or removal of lake bed.

Selection of each of the 5 sensitive areas around Lake Mallalieu is important. They were selected based on their natural buffering for terrestrial vegetation, which protects large portions of the lake. In addition, each site serves to protect water quality, habitat, and offers buffering against the invasion of exotic species.

Enhancing and Protecting the Lake's Wildlife, Tranquility and Beauty

Summary

In review of the lake resident's survey, the largest number of respondents identified the beauty of Lake Mallalieu as a primary reason for choosing to live on the lake. The following measures are therefore recommended to protect, preserve and

Lakeshore Restoration

enhance Lake Mallalieu's wildlife and fish habitat in both the lake and along the surrounding shoreline.

The Lake Mallalieu Association will establish a permanent Wildlife Committee to conduct wildlife education and wildlife enhancement projects. The Committee will be responsible for the following projects:

Fish and Waterfowl Habitat

1. Help lake users understand the beneficial aspects of aquatic plants, woody debris, and wild shorelines for Lake Mallalieu's fish and wildlife. Publicize the results of Marty Engel's 2001 comprehensive fish survey by posting it on the Lake Association website. Help residents understand the interdependent

Raingarden

relationship between aquatic plants, shoreline plants, fish and wildlife (Craven & Ellarson, 1997).
2. Encourage lake residents to leave fallen trees and other "structure" in the lake to provide fish habitat.

3. Educate lake residents on ways to increase waterfowl habitat.

4. Explore the possibility of installing 'fish cribs" in deep water areas of the lake for the purpose of enhancing deep habitat for fish.

Shoreline Habitat Protection and Improvement

1. Educate lake residents on measures to improve habitat for animals, fish, and birds, consistent with St. Croix County's Shoreland Zoning Ordinance (St. Croix County Land Use Ordinance Chapter 17-17.30 Zoning; Subchapter III Shoreland).

2. Continue to provide information and examples on shoreline cover enhancement and methods of maintaining and increasing natural shoreline.

3. Work with lake residents to reduce impacts of storm water runoff from their properties by incentivizing clean water diversions and rain gardens.

4. Educate residents about eliminating fertilizer runoff from their properties and conduct periodic soil testing to evaluate soil test phosphorus and nitrogen levels.

5. Educate residents on state and municipal laws relating to lake shore development or modification and educate residents on the roles played by state and municipal agencies.

6. Advise and assist home owners on the proper plants, trees, and buffers to establish in lakeshore areas (refer to USDA Natural Resouce Conservation Service Technical Note 1: Shoreland Habitat Standard).

7. Conduct voluntary shoreline habitat assessments in 2014, in cooperation with St. Croix County Resource Management staff.

8. Work with St. Croix County's Resource Management Division to provide seminars and workshops for residents. Workshops may cover rain garden design and installation,

lakeshore restoration options, and possibly other surface water runoff control measures.

Resident Education

1. Use the Association newsletter to distribute information on a regular basis to lake owners and surrounding communities.

2. Work with St. Croix County's Resource Management Division and WDNR in 2014 to set up "New Homeowner Packet" to be distributed to all new home owners on the lake containing brochures on lake law, shoreline vegetation, aquatic vegetation, and smart lawn care for lake property owners, etc.

3. Stress the importance to near lake residents of becoming active in the Lake Mallalieu Lake Association and encourage them to attend Lake Association meetings and functions.

4. Review and amend the Lake Mallalieu Lake Association Lake Management Plan every 5 years.

Wisconsin DNR, UW Extension, and St. Croix County

1. Consult with WDNR specialists for their direction on wildlife enhancement projects.

2. Consult with WDNR for the purpose of acquiring permits, as they relate to shoreline restoration and enhancements, future lake drawdowns, and invasive and nuisance aquatic plant control.

3. Promote WDNR website as a source for information and education.

4. Work with WDNR staff in an effort to implement the Lake Mallalieu/Willow River TMDL Implementation Plan.

5. Consult with UW Extension and St. Croix County Resource Management staff to implement information and educational activities.

www.dnr.wi.gov

Lake Association Website and Newsletter

1. Promote the usage of the Lake Association Website (www.lakemallalieu.org) to establish wildlife viewing "posts".

2. Compile and publish water quality data periodically, both in the Association Newsletter but also on the Association website.

3. Promote resident involvement by maintaining a dynamic and informative website.

4. Provide a quarterly newsletter to Association members and provide a link to them on the website.

Historic (1999) Load (metric tons/year)	Baseline (2006) Load (metric tons/year)	TMDL Goal (kg/day)	TMDL Goal (metric tons/year)	WLA	LA	MOS	RC	Reduction from Baseline
24.3	20.5	25.2	9.2	1.2	8	Implicit	0	55%

WLA = wasteload allocation (CULT-PS)
LA = load allocation (CULT-NPS)
MOS = margin of safety
RC = reserve capacity

Table 9 of "Phosphorus Total Maximum Daily Load: Lake Mallalieu St. Croix and Polk Counties, Wisconsin, January 2013

Enhancing and Protecting Water Quality

Background

Lake Mallalieu is a flowage located within the channel of the Willow River. The impoundment is approximately 270 acres and has a drainage area of 300 square miles. Lake Mallalieu has a maximum water depth of 17 feet with a mean depth of 5 feet. The lake's residence time is short, 5-6 days. Lake Mallalieu supports a high quality bass sport fishery.

Since 2004, Lake Mallalieu has been included on EPA's 303(d) impaired waters list. It's listed as having significant impairments due to excess phosphorus.

Clean Water Act regulations require that Total Maximum Daily Load (TMDL) goals be developed

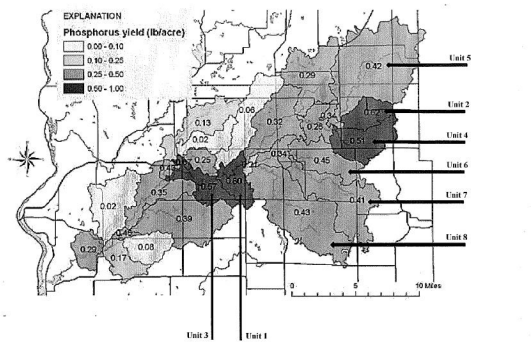
for each waterbody on the Impaired Waters List. As a result, WDNR is required to prepare a "Phosphorus TMDL" for Lake Mallalieu and its upstream contributing area.

Development of the TMDL goal for Lake Mallalieu required monitoring of annual phosphorus loading upstream of the lake and of in-lake conditions. Monitoring was conducted in the years 1991, 1999, 2003, and 2006. Upon completion, a land use model (Soil and Water Assessment Tool – SWAT) was used to evaluate the effect of land management changes on the quality of water entering Lake Mallalieu. The monitoring and modeling information gathered from SWAT has been used to develop water quality targets and loading reduction goals for the TMDL. Ultimately, the TMDL report has identified allocations and management actions that will help restore good water quality to the lake.

Parameter	Historic (1999)	Baseline (2006)	TMDL Goals
Total phosphorus (ug/L)	111	65.5	45
Chlorophyll-a (ug/L)	70	50.9	25
Percent of summer days with algal bloom condition (chlorophyll-a > 30 ug/L)	>78	71	15
Total Phosphrous loading (metric tons/year)	24.3	20.5	9.2

Table 5 of "Phosphorus Total Maximum Daily Load: Lake Mallalieu St. Croix and Polk Counties, Wisconsin, January 2013

Willow River Watershed Priority Areas 1-8



SWAT model phosphorus yields (lb/acre) for subbasins in the Willow River watershed, 2006

Setting

Upper and Lower Willow River Watersheds comprise over 200,000 acres. Many of these acres are in agricultural use. This area ultimately drains its surface waters into the Willow River and Lake Mallalieu. Surface waters carrying sediment and phosphorus influence the water quality within Lake Mallalieu.

Based on sampling data, Lake Mallalieu is considered to be a hypereutrophic lake with poor water quality. This is due to high nutrient levels, high algal concentrations, and poor water clarity. Persistent algal blooms in the lake hinder light penetration for other aquatic plants and result in impaired recreational use and have the potential for algal toxicity. This condition has a negative effect on humans, pets, and wildlife. The more days of algal blooms during the summer months, the more impaired the water.

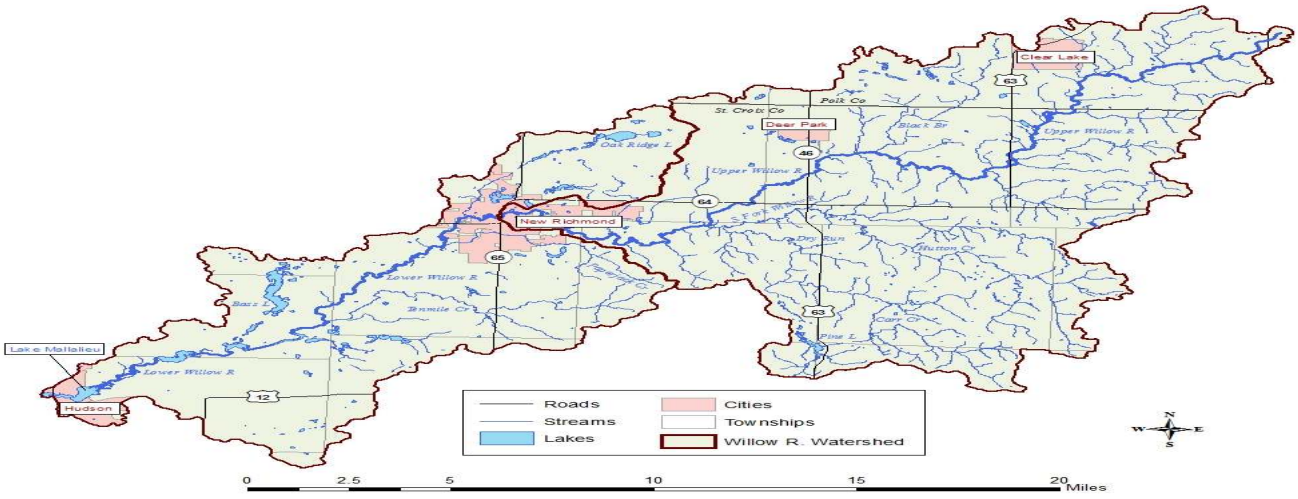
Lake Mallalieu/Willow River TMDL

Water samples taken from Lake Mallalieu during the summer of 1999 indicated phosphorous concentrations of 98 parts per billion (ppb which is equivalent to 98 micrograms/liter). This phosphorous level is high for lakes in this eco-region (western Wisconsin prairie habitat) and is typical of impoundments fed by large watersheds.

Phosphorous originates from a variety of sources, many of which are related to human activities. Major sources include human and animal wastes, municipal waste water treatment plants, soil erosion, detergents, septic systems, lawn fertilizer, and municipal runoff (Bartilson & Magdalene, 2013).

At present, the Willow River Watershed has five waste treatment facilities upstream of Lake Mallalieu permitted under Wisconsin's Pollutant Discharge Elimination System. There are two small dischargers (Deer Park and Lakeside foods), two larger ones (the cities of New Richmond and Clear Lake), and Emerald Dairy, a Concentrated Animal Feeding Operation (CAFO). Emerald Dairy has a permitted outfall to surface water, although it is not currently discharging (Bartilson & Magdalene, 2013).

Other CAFOs in the watershed include Arcand Poultry Inc., Jenni-O Turkey Store, and Minglewood Inc.



Land use data collected for SWAT modeling revealed an approximate 75,000 acres of cropland in the watershed, 17,100 acres of developed land (700 urban and 16,400 rural residential), 73,000 acres of undeveloped land (grassland, forest, and wetland/water) and 12,400 acres of grazed lands (Almendinger, J., 2008).

Land use values for SWAT modeling are averages of 15 years of model runs (weather data from 1992 -2006) with land cover representative of 2005-2006 (Almendinger, J., 2008).

The SWAT model was used to calculate the expected range of nutrient and sediment loading to the Willow River and Lake Mallalieu under dry-average-wet climate conditions. In addition, it projects how changes in cropping practices and other land uses affect the nutrient and sediment loading to the Willow.
TMDL nutrient and sediment load reduction goals for Lake Mallalieu and the Willow River were established by using the Soil and Water Assessment Tool (SWAT). The tool was developed to evaluate the effects of land management changes on the quality of water that that enters the lake. Ultimately, the TMDL Plan was developed to identify allocations and management actions that will help restore the biological integrity of the lake.

Lake Mallalieu is among several riverine lakes in the Midwest that are undergoing eutrophication. The phosphorus TMDL for Lake Mallalieu is nested within two similar TMDLs for eutrophication:first, Lake St. Croix of the St. Croix River Basin and second, Lake Pepin of the Upper Mississippi River Basin (St. Croix County LWCD, 2009).

The Mallalieu Impoundment and the Willow River Watershed

The Lake Mallalieu impoundment drains a large area and is typical of similar river impoundments throughout the Midwest. These impoundments are characterized by:

a. Very poor water clarity with a Secchi depth of about 3 ft.;

b. A retention time of less than 2 weeks (time for water to flush from lake);

c. Mean total phosphorous levels on the order of 94 parts per billion.

d. A ratio of watershed basin area to lake area of approximately 1000 to 1.

Research indicates that agriculture is the largest contributor of phosphorus. According to the Upper and Lower Willow River Water Quality Management Plan (WDNR 2010), approximately 75% of the phosphorus in the watershed is due to non-point agricultural sources. However, during periods of low rainfall, municipal sources may exceed agricultural sources of pollution in the watershed. Also, as smaller dairy farms have been replaced by operations with 3,000 cows or more, the potential phosphorous danger has increased.

Although the Upper Willow River Watershed was designated a “priority watershed” in the early 80’s, many of the pollution management measures installed by farmers have been abandoned. Also, dairying, increases in the price of agricultural commodities, and general population growth are increasing the pressure on the Willow and Lake Mallalieu.

If Lake Mallalieu continues to receive large inflows of phosphorous, the ageing of the lake will be accelerated. This means more muck from decaying plants and algae, less oxygen for fish respiration, declining water clarity, and more rough fish.

TMDL Water Quality Recommendations:

The lake classification system for Wisconsin lakes uses ranges in water clarity data to define categories of lake condition, or trophic status index (TSI). Lakes in our ecoregion are typically trophic and have summer total phosphorus concentrations of greater than 50 ppb.

Water quality monitoring of Lake Mallalieu has been conducted by WDNR during summer months since the 1970's, and most consistently in this past decade (measured total phosphorus, chlorophyll, and clarity). This data has been used to calculate the trophic status index or "TSI" (indicates the degree of nutrient enrichment in a lake) of Lake Mallalieu.

Based on the data collected by WDNR, the average of the mean annual TSI is just over 60. TSI values of 60 have helped lead WDNR to establish specific TMDL water quality goals for Lake Mallalieu and the Willow River Watershed in general.

As specified in DNR code, ph standards for Wisconsin waters need to be maintained between 6.0 and 9.0 standard units to protect life. EPA has listed Lake Mallalieu as impaired due in part to frequent summer exceedances of this standard, with ph values over 9.0. High ph values are due to algal photosynthesis (removal of carbon dioxide from the water). A reduction in sediment loading to Lake Mallalieu would reduce phosphorus levels in the Lake, and the corresponding reduction in phosphorus levels would result in a decrease of chlorophyll levels (chlorophyll is a measure of productivity) and a reduction in maximum ph levels.

Wisconsin promulgated phosphorus standards for lakes in 2010. Under the new rules, the standard for impoundments such as Lake Mallalieu is 75 ug/L (micrograms per liter). Very few, if any, measured phosphorus concentrations have exceeded this standard, but the lake is still prone to excessive algae growth. The lake experiences algal blooms over 78% of the summer season. As a result, a more stringent goal of 45 ug/L is needed and established in the Lake Mallalieu/Willow River TMDL Plan. In addition, the TMDL Plan has set a "Percent of summer days with algal bloom condition" at a goal of 15 days.

Trophic Status	TSI	Quality Index	TP (ug/L)	Chl-a (ug/L)	SD (ft)
Oligotrophic	0-40	Excellent	<1	<1	>19
		Very good	1-10	1-5	8-19
Mesotrophic	40-50	Good	10-30	5-10	6-8
		Fair	30-50	10-15	5-6
Eutrophic	50-70	Poor	50-150	15-30	3-4
Hypereutrophic	70-100	Very Poor	>150	>30	<3

Table 4 of "Phosphorus Total Maximum Daily Load: Lake Mallalieu St. Croix and Polk Counties, Wisconsin, January 2013

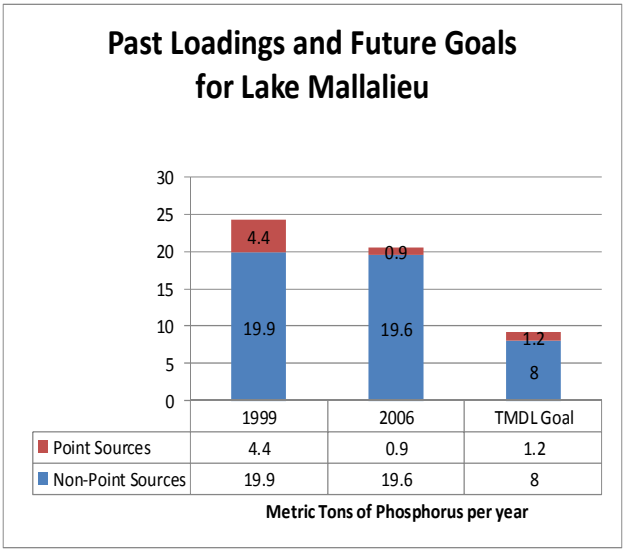


Figure 10 from "Phosphorus Total Maximum Daily Load": Lake Mallalieu St. Croix and Polk Counties, Wisconsin January 2013

Agriculture dominates the land use throughout the Willow River watershed. To meet TMDL water quality goals for Lake Mallalieu, sediment and nutrient runoff from agricultural sources need to be reduced. The TMDL reduction goal for phosphorus in the Willow River Watershed from Ag sources is approximately 12 metric tons of "P" (or an approximate 26,400 lbs.).

Heavy Metals in Lake Mallalieu

Arsenic was used as an aquatic herbicide in Lake Mallalieu in the 1960's in a series of applications approved by the DNR. Although arsenic has been found to be harmful to all organisms, it poses little threat if it remains undisturbed or chemically bound in the bottom, sediments of the lake.

The percentage of silt and clay in lake sediments is important in assessing the stability of heavy metals found in lake sediments. When there is a high percentage of clay and silt, and when these sediments are not disturbed, then heavy metals are more stable and will remain bound up as long as the lake sediments are not disturbed.

The heavy metal concentrations found in Lake Mallalieu sediment are within the ranges seen in this part of the state in similar impoundments. Since the data on heavy metals in Lake Mallalieu is from only one core sample, it is difficult to draw any more generalized conclusions from it.

As long as heavy metals are stabilized in lake bottom sediments and are not disturbed, their presence is generally not a concern. However, the makeup of lake bottom sediments in particular portions of the lake could be a future concern if activities on or in Lake Mallalieu were likely to result in disturbing the lake bottom sediments.

Recommendation:

1. Make sure that any future sediment sampling in Lake Mallalieu includes heavy metal testing.

Sedimentation and Dredging

Approximately 60% of Lake Mallalieu has a depth less than 5 feet. Much of the shallow bottom is covered by a thick layer of muck formed by the decomposition of plant matter in a nutrient-rich environment. Were it not for the constant supply of fresh water from the Willow River, the decomposing plant matter at the lake bottom would consume much of the lake's oxygen and create a harmful environment for fish (WDNR, 2010).

Maps of the lake made 30 years ago, as well as aerial photos dating back to the 1930's, suggest that there has been no large change in lake depth over the intervening period. Sediment does not appear to be entering the lake from the Willow River except during extreme rainfall events or major floods.

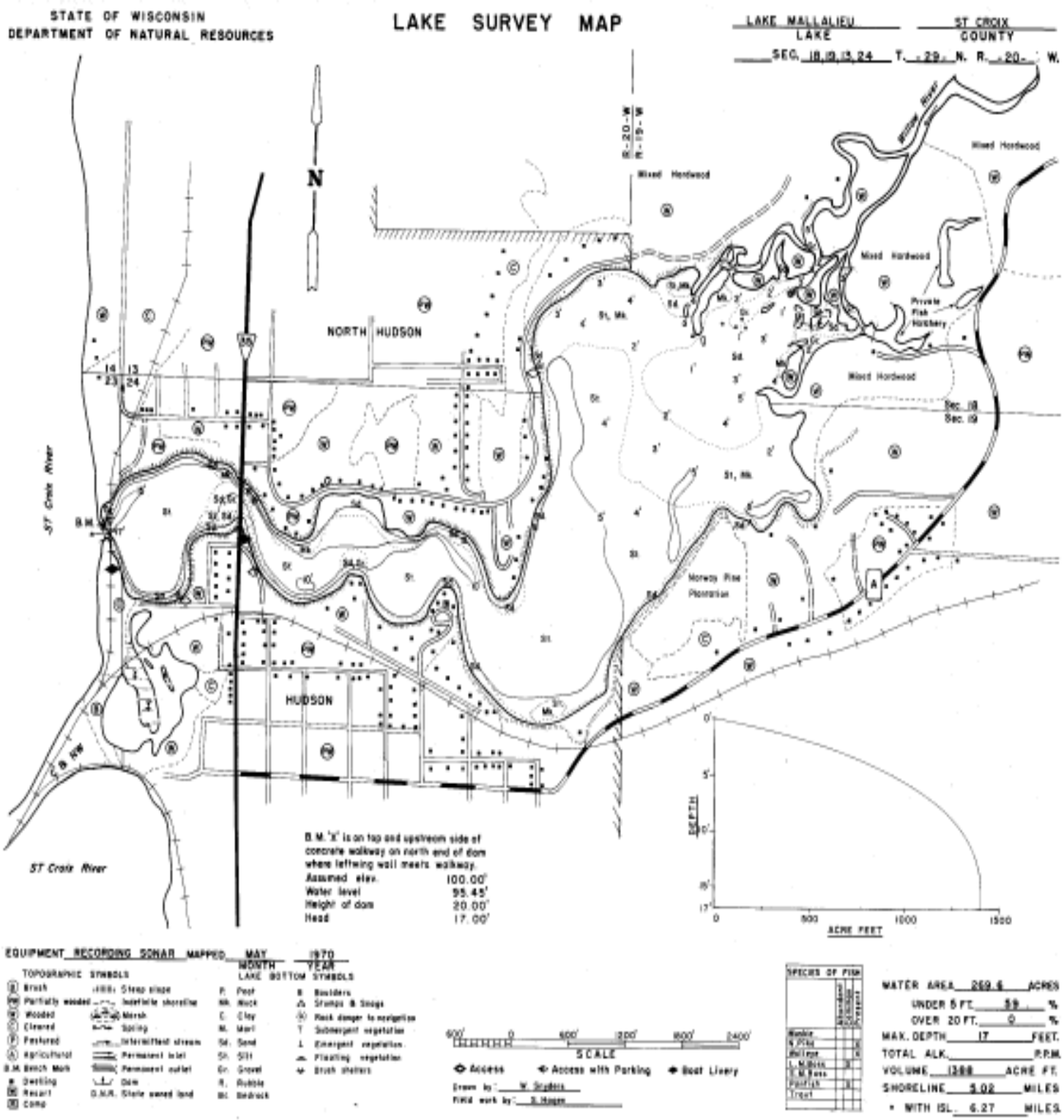
Nevertheless, the shallow depth of much of the lake as led some Association members to suggest that dredging might be a practical means of removing sedimentary muck and increasing the depth of the lake.

Extrapolating from data prepared for Eagle Spring Lake in Waukesha County, Wisconsin, dredging about one-third of Lake Mallalieu in order to increase the depth of two feet would cost about $4,500,000 *(A Lake Management Plan for Eagle Spring Lake,* Southeastern Wisconsin Regional Planning Commission, 1996). Amortized over 30 years at 80% interest, this would cost about $400,000 annually; or, based on 100 residents, $4,000 per resident per year for 30 years. Even if the cost could be reduced to one-half of this figure, it is unlikely that voluntary Association contributions would be sufficient to defray the costs of the project.

Pursuit of a dredging project would require a thorough feasibility study, followed by the creation of a lake district with the power to levy a special assessment on lake residents to retire the debt incurred by the project. Also, it is extremely unlikely that the DNR would permit significant disruption of the lake's aquatic plant community as part of any dredging project.

Recommendation:

1. Continue to gather information on dredging costs and benefits in similar lakes and present information to Association members in newsletter.



Source: Wisconsin Department of Natural Resources 608-266-2621
Lake Mallalieu – St. Croix County, Wisconsin DNR Lake Map
Date – May 1970 - Historical Lake Map - Not for Navigation
A Public Document - Please Identify the Source when using it.

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Glossary:

ALGAE
One celled or multicellular plants suspended in the water or attached to rocks and other substrates. Algae are an essential part of the lake ecosystem.

ARSENIC
A highly poisonous metallic element that can form a number of poisonous compounds. It can be found in nature at low levels.

BASIN
Large drainage area, that is a central collector of many individual watersheds.

BEST MANAGEMENT PRACTICE (BMP)
The most effective, practical measure to control a non-point source pollutant that runs off from land surfaces.

BUFFER STRIP
Strips of grass, shrubs, trees, or other vegetation between disturbed areas and a stream, lake, or wetland.

CHLOROPHYLL
The green coloring matter of leaves and plants, essential to the production of carbohydrates by photosynthesis.

CITIZEN LAKE MONITORING NETWORK
Voluntary participation of citizens residing on or near lakes, who take weekly water quality measurements.

COST EFFECTIVE
A level of treatment or management with the greatest incremental benefit for the money spent.

ECOSYSTEM
A biological community interacting with its nonliving surroundings.

ELECTROFISHING
Common scientific survey method used to sample fish populations. The method uses a direct electric current to attract and temporarily immobilize fish for easy capture.

EROSION
Wearing away of the land surface by wind or water.

EUTROPHICATION
The process of nutrient enrichment of a lake leading to increased overall production of aquatic organisms. Eutrophication can be accelerated by human activity such as agriculture and improper waste disposal.

FECAL COLIFORM
A group of bacteria used to indicate the presence of other bacteria that cause disease. The number of coliform is particularly important when water is used for drinking and swimming.
FISH CRIB:

FLOWAGE
A body of water, such as a lake or reservoir, formed by usually deliberate flooding.

FUNNEL NET
A fish trapping technique used to evaluate fish populations.

HABITAT
The place or type of site where a plant or animal naturally lives and grows.

HOLDING POND
A small basin or pond designed to hold sediment laden or contaminated water until it can be treated to meet water quality standards.

IMPOUNDMENT
A body of water confined within an enclosure, as a reservoir.

INVASIVE SPECIE
An organism that is not native and has negative effects on our economy, environment, or our health.

INVERTABRATES
An animal lacking a backbone. Invertebrates account for more than 97% of all species.

LITTORAL ZONE
The near shore area where sunlight penetrates all the way to the sediment and allows aquatic plants to grow.

MACROPHYTE
An aquatic plant, large enough to be seen by the naked eye.

NON POINT SOURCE
Pollution whose sources cannot be traced to a single point, such as a municipal or industrial wastewater treatment plant discharge pipe. Non point sources include eroding farmland and construction sites, urban streets, and barnyards. Pollutants from these sources reach water bodies in runoff, which can best be controlled by proper land management.

NUTRIENT
A food or other substance that provides energy or building material for the survival and growth of a living organism.

PHOSPHORUS
A nutrient that when reaching lakes in excess, can lead to over fertile conditions and algae blooms.

POINT SOURCE
Source of pollution that have discrete discharges, usually from a pipe or outfall.

PURPLE LOOSTRIFE
An old world plant widely naturalized in North America, growing in wet places and having spikes of reddish purple flowers.

RAIN GARDEN
A strategically located low area planted with native vegetation that intercepts runoff.

RETENTION TIME
The overall mean time that water spends in a lake.

RIPARIAN
Belonging or relating to the bank of a lake, river, or stream.

RIPRAP
Broken rock, cobbles, or boulders placed on the bank of a stream or lake to protect against erosion.

RUNOFF
Water from rain, snowmelt, or irrigation that flows over the ground surface and returns to streams and lakes. Runoff can collect pollutants from air or land and carry them to receiving waters.

SECCHI DISK
A black and white disk that is lowered into a water column and used to measure water transparency or clarity.

SEDIMENT
Soil particles suspended in and carried by water as a result of erosion.

STAKEHOLDER
A person, group, or organization that has interest or concern in an organization.

TERRESTRIAL
A habitat which is defined by the plant structure, types of leaves, plant spacing, and climate. It includes forests, grasslands, deserts , and rainforests. A habitat where plants and animals reside.

TMDL
Total Maximum daily Load: the maximum amount of a pollutant that can be discharged into a stream or lake without causing a violation of water quality standards.

TROPHIC STATUS
The level of growth or productivity of a lake measured by phosphorus content, algae abundance, and depth of light penetration.

WATERSHED
The land area that drains to a river, lake, or wetland.