Mead Lake Management Plan

The Mead Lake and Watershed PARTNERSHIP

March 2010

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Acknowledgements

The Mead Lake Management Plan is a cooperative effort of the members of the Mead Lake and Watershed Partnership:

Citizens of the Mead Lake Watershed

Mead Lake District

Clark County Land Conservation Department

Natural Resources Conservation Service

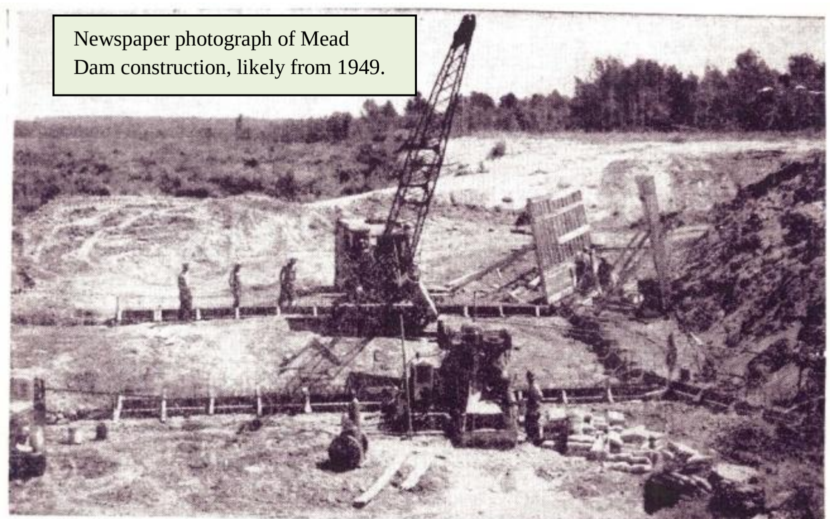
Wisconsin Department of Natural Resources

University of Wisconsin – Extension

Thanks go to the Stakeholder Leadership Team members who helped write this plan and participated in the meetings leading up to its completion. Thanks also to the Town of Mead, the US Army Corps of Engineers, and the University of Wisconsin-Stevens Point.

Introduction

Since the Mead Dam was completed in 1951, Mead Lake has been used by residents and visitors for fishing, swimming, boating, camping, family events, and many other recreational activities. Even before Mead Lake existed, enthusiasm for the lake was present in the local population. In 1948, a year before construction on the dam was scheduled to begin, twenty-six people had already applied for leases for lake property and had put down deposits. The location of Mead Lake, far from most metropolitan areas and surrounded by mostly forest, makes it an idyllic location to relax, experience nature, and get together with family and friends. Cabins and residences around the lake have been built over the years, and now number around 130. For more than fifty years, residents of the lake and outside visitors have been enjoying the pleasures Mead Lake has to offer.



Newspaper photograph of Mead Dam construction, likely from 1949.

WORK ON DAM PROGRESSES—Workmen pour concrete into forms beginning construction of the Mead Dam in western Clark County. The first concrete for the Mead project was poured last Friday and is expected to continue until about Oct. 15. By Nov. 1 the dam should be completed, according to a member of the Gottschalk Construction Company, Edgar, which has the contract. Mead Dam, located about 9 miles west of Greenwood on the Eau Claire River, will have an 18-foot head and will form close to a 400-acre flowage backing the water up more than 3 miles. The artificial lake will be stocked for fishing, and cottage sites will be available through leasing from the county.

Managing and improving Mead Lake has been an ongoing process since its creation. Dam repairs have been made several times over the years. A campground was added in the 1960s, with new boat docks following in years after. In 1959 the Mead Lake Club was organized, and during the course of their existence, promoted many improvements at the lake. In the 1990s, the Club became the Mead Lake Association, eventually becoming the Mead Lake District in 2001. Many interesting details about the creation of the lake can be found in the document "A Collection of Mead Lake Nostalgia", available from the Mead Lake District and included in Appendix A.

Nuisance algae blooms have been an issue for much of Mead Lake's existence. Records show that as early as 1971 attempts were made to control such blooms using chemical treatment and lake draw-downs. In November 2008, water quality issues in the lake brought concerned stakeholders together in Greenwood, WI, just east of Mead Lake. At this meeting, people brought up several dozen issues of concern regarding the lake and also heard from experts on some of the science behind the algae problems. At the conclusion of the meeting, people were asked to sign up to be part of an organized partnership effort to address these concerns. The minutes for this meeting are included in Appendix A. The group came to be known as the Mead Lake and Watershed Partnership (the Partnership). A Stakeholder Leadership Team formed within the Partnership and began meeting monthly. The Partnership includes landowners from Mead Lake and its watershed, the Mead Lake District, Clark County Land

Conservation Department, Natural Resources Conservation Service, Wisconsin Department of Natural Resources (WDNR), and University of Wisconsin-Extension.

"The Mead Lake & Watershed Partnership's mission is to create and implement strategies to raise awareness of the interdependent link between people, land and water, and to protect and restore Mead Lake and its watershed in order to preserve the ecological, recreational and aesthetic value of these resources for future generations."

Many studies on Mead Lake in recent years have looked at aquatic plants, invasive species, shore land habitat and erosion, fisheries, and sanitary sewer systems. These studies demonstrated the need for an organized effort to address water quality and other concerns at Mead Lake. As the Partnership began to discuss these concerns, it became clear that a Lake Management Plan was a necessary first step towards addressing them. A list of studies that were conducted is included in Appendix A.

This plan will be reviewed and updated by the Partnership on an annual basis.

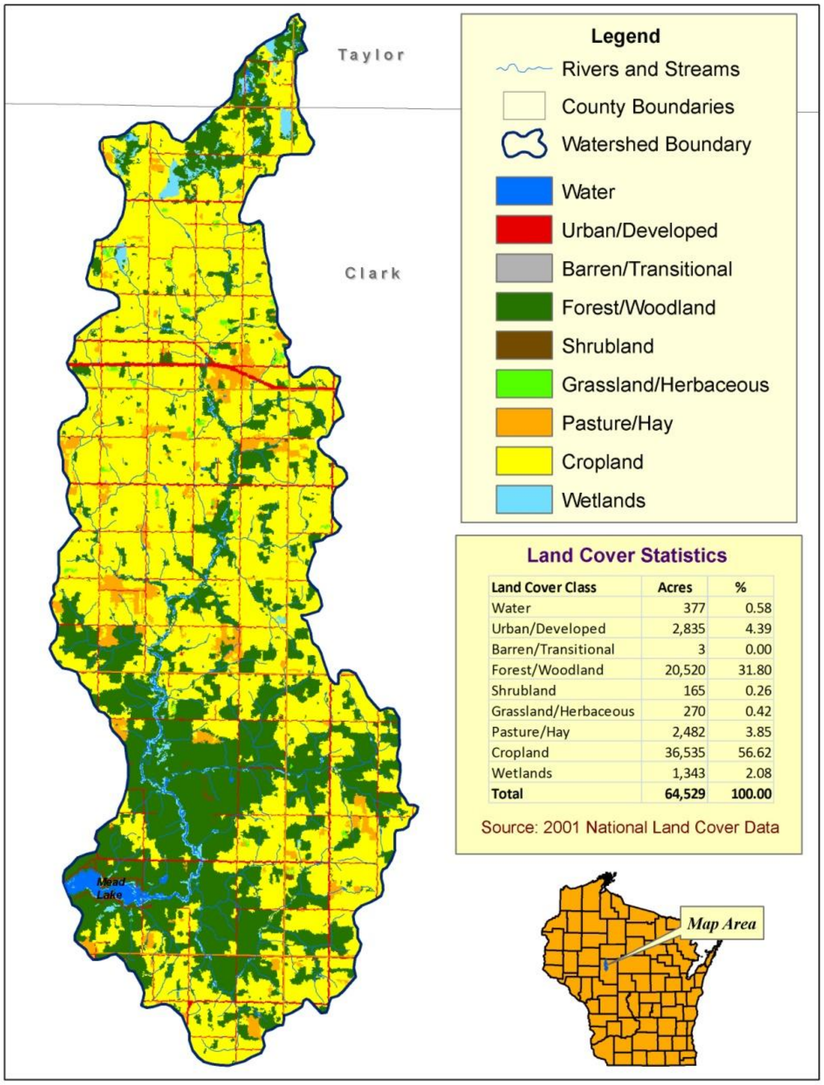
Background

One of the earliest references found regarding the creation of Mead Lake dates to March of 1948, when Clark County applied to the Public Service Commission of Wisconsin in Madison for a permit to construct a dam on the South Fork Eau Claire River for recreational purposes. The Clark County Board "Resolution on the Town of Mead Dam" supporting the application is located in Appendix A. The dam was completed in 1951, forming what is now the 320 acre Mead Lake in the Town of Mead, west of Greenwood. The lake has a mean depth of about five feet and maximum depths of around sixteen feet. The watershed draining to Mead Lake is approximately 64,000 acres, or about 100 square miles in size. The majority of the land use in the watershed is cropland (see land cover map, page 4). There are no incorporated municipalities in the watershed, and a good portion of the agricultural population is made up of Amish and Mennonite communities, some only arriving in the area in the last twenty to thirty years. The main tributary to Mead Lake is the South Fork Eau Claire River, with other smaller tributaries such as Rocky Run.

The dam at Mead Lake in summer 2009

Mead Lake is considered highly eutrophic (nutrient-rich), and the lake has been listed on Wisconsin's 303d list of impaired waters in 1998 due to sediment and phosphorus. From 2002 to 2003, the US Army Corps of Engineers did a study of Mead Lake's water quality. Results from this study were used to develop the Total Maximum Daily Load (TMDL) written by WDNR and approved by the US Environmental

Protection Agency in 2008. The TMDL document defines prescriptive goals for phosphorus load reductions to the lake. Since phosphorus is the principle nutrient contributing to the growth of algae and cyanobacteria, lower phosphorus levels would lead to reductions in the frequency and extent of unwanted algae blooms. Cyanobacteria, sometimes called "blue-green algae", release dangerous toxins into the water that can cause illness and even death in pets and people if ingested in high enough quantities. Surveys conducted in 2009 indicate that people avoid recreational activities such as swimming and fishing when algal blooms are present.



An improvement in water quality will increase the recreational and aesthetic benefits of Mead Lake, as well as the aquatic life found in the lake and its tributaries. Furthermore, any efforts to control phosphorus in the lake's watershed will likely decrease the amount of sediment flowing into the lake, thus increasing the lake's lifespan. Controlling the amount of phosphorus and sediment flowing into the lake will take a coordinated effort between those living at the lake and those living farther up in the watershed. Pollution control efforts implemented now will reduce the need for pollution control later; therefore, society's cost for clean-up will be less. Erosion from fields and shorelines, barnyard runoff, manure management, and septic systems are just some of the issues that need to be addressed.

2009 Mead Lake Sociological Surveys

During summer 2009, the Partnership worked with staff at the Environmental Resources Center at the University of Wisconsin-Madison and staff at WDNR to develop sociological surveys designed to survey people living at the lake and those visiting the lake. Survey questions focused on how people used the lake and how they perceived the water quality. They were asked their opinions regarding the causes of poor water quality, how water quality could be improved, and their willingness to participate in such efforts. Lake property owners were also asked how they managed their property to help minimize any negative impacts on the lake.

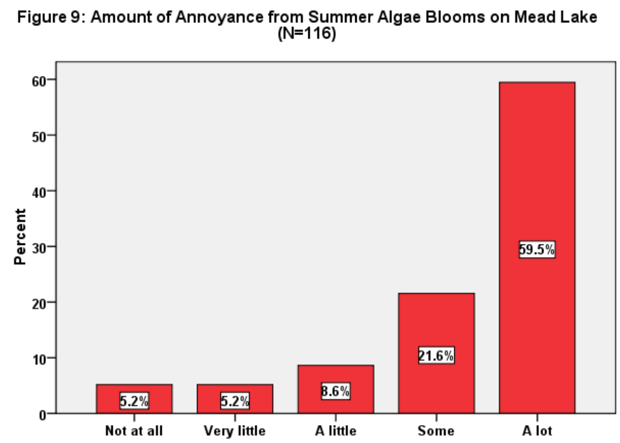
Lakefront Property Owner Survey

The mail survey of lake residents was conducted from late August through September 2009. The survey questions and results can be found in Appendix A. Of 132 surveys mailed out to all lakefront property owners, 116 were returned, for a response rate of 88%, suggesting that a large portion of Mead Lake residents are interested in the health of the lake.

According to the survey, the top four recreational activities in which lake residents participated in the previous twelve months were; scenic viewing (70%), motorized boating (61%), fishing (53%) and wildlife viewing (53%).

Among lake residents there was a widely held view that water quality was poor for swimming and other recreational activities during much of the summer due to the presence of algal blooms. It was also apparent that a majority of lake residents (72%) said they'd be willing to change how they manage their property if it would improve the water quality of the lake. However, the majority of respondents held negative views toward installing vegetated buffers between their property and the shore. Only 31% of respondents had some type of vegetated buffer on their property. Nearly 60% of those who had a lawn on their property did not use fertilizer, and another 28% were already using a low- or no-phosphorus type of fertilizer.

The typical respondent to the survey was a seasonal lake resident who spent weekends, especially during the summer, at Mead Lake, rather than a permanent, year-round resident. The average number of years that a respondent owned their property was 18 years.



Graph showing that a large majority of Mead Lake residents are concerned about summer algal blooms. (Blasczyk and Summers)

Additionally, a majority of respondents had some knowledge of improvement efforts focused on water quality at the lake. Twenty-four of the 116 respondents had attended at least one of the monthly meetings of the Partnership's Stakeholder Leadership Team.

Lake Visitors Intercept Survey

During the last three weeks of summer in 2009, leading up to and including Labor Day weekend, volunteers (mostly from the Mead Lake District) conducted face-to-face surveys with visitors to the lake. During this time, 99 interviews were completed. The survey questions and results can be found in Appendix A.

The largest percentage of visitors (41%), were from Clark County. There were many other visitors from other nearby counties including Eau Claire, Marathon and Wood. People also came from places much farther away. Distances traveled ranged from 1 to 625 miles, with the median distance being 35 miles. Most of those surveyed visited Mead Lake many times during the previous 12 months.

The activities that most people participated in over the previous 12 months were scenic viewing and open-water fishing, followed by motorized boating and wildlife viewing. The two major reasons for their visit on the day of the survey were fishing and camping.

An overwhelming majority (91%) of survey respondents were either very concerned or somewhat concerned about the water quality of the lake. About 40% of those interviewed said they had avoided certain recreational activities during past visits because of poor water quality. Swimming was the most common activity avoided. When survey participants were asked to explain why they avoided such activities, the most common answers were poor water quality in general, or "green water."

Further survey work is being conducted in the watershed during spring and summer of 2010 to determine the interests/needs/concerns of producers in the watershed. Since farmers will play a key role in phosphorus and sediment reduction strategies it's important to understand their concerns so that any type of reduction programs maximize producer cooperation.

Total Maximum Daily Load (TMDL)

In 2008, WDNR completed a Total Maximum Daily Load, or TMDL, for Mead Lake (included in Appendix A). A TMDL is a document that specifies the maximum amount of a particular pollutant a water body can receive and still meet water quality standards. The results of this TMDL were based on surface water monitoring conducted in the watershed, as well as hydrologic modeling of how land use affects the watershed. Although the main issue with Mead Lake is phosphorus and sediment inputs, the State of Wisconsin currently does not have numeric water quality criteria for phosphorus or sediment. However, the State does have a water quality standard for pH. The pH of a lake is closely correlated to the presence of *chlorophyll a*, which is influenced by the amount of phosphorus entering a body of water. A water body with high levels of *chlorophyll a* (a basic indicator of algal biomass) will have a correspondingly high pH. Therefore, if Mead Lake can achieve the water quality standard for pH, it will have fewer and less intense algal blooms.

For the Mead Lake TMDL, water monitoring was conducted in the lake and in the South Fork Eau Claire River in 2002-2003. The study focused on external pollutant loading (suspended sediments and nutrients) from the South Fork Eau Claire River, internal movement of phosphorus from lake sediments into the water column, and general in-lake water quality. The study found that on average, 83% of phosphorus loading to the lake came from direct drainage from the lake's tributaries. Internal loading from phosphorus already present in the bottom sediments in the lake averaged only 17%. A Soil and Water Analysis Tool (SWAT) model was used to determine possible sources of the loading from tributaries, how such loading affects the lake, and how decreasing these loads will positively affect water quality.

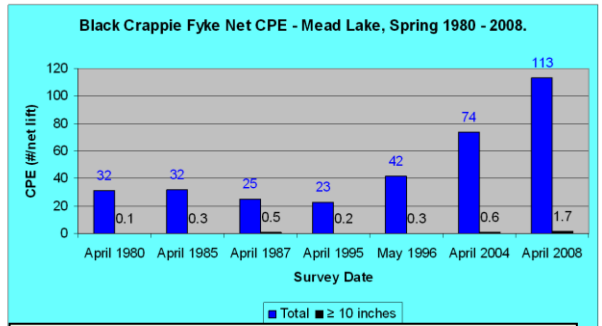
A TMDL usually calls for reductions of the pollutant of concern from both point sources (such as an effluent pipe from a waste water treatment plant) and non-point sources (such as agricultural fields or residential lawns). Since there are no municipalities or large industries in the Mead Lake watershed, there are no point sources of pollution. Therefore, reductions of phosphorus and sediment will have to come from non-point sources. The recommended seasonal (growing season) reduction written into the TMDL for Mead Lake, and based on the monitoring and modeling work, is a 30% reduction of sediment and a 30% reduction of phosphorus inputs to Mead Lake. Such reductions should decrease the frequency and intensity of algal blooms, and improve the water quality of Mead Lake.

Once phosphorus contributions from the Lake's tributaries are significantly decreased, then the in-lake phosphorus contributions from lake sediments can be addressed. The most common method for this would be treating the sediment with alum, sealing the phosphorus beneath the alum layer and making it unavailable to the water column.

Fishery

Spring collection of fish data has taken place on Mead Lake often in the last few decades; 1980, '85, '87, '95, '96, 2004, and '08. Pan fish, game fish, and carp have all been surveyed. Summaries of fishery survey data are included in Appendix A.

Generally, the condition of the fishery is good. In the 2008 survey, crappies were numerous and of good size. Bluegills showed good size structure but were fewer in number compared to years past. Perch showed a high density but poor size. Walleye density was typical compared to years past, which is to be expected since walleye are stocked annually in the lake. Musky showed nice sizes, and are being stocked every other year. The WDNR recommends checking recruitment of largemouth bass, as numbers are low. Carp showed a low density in the 2008 survey, and are not considered a major problem. Carp have been denser in the lake in years past, and many area lakes currently have challenges with carp. However, a few carp is good for both fish diversity and the aquatic plant community in the lake.



Black crappie survey history at Mead Lake over the past 30 years. (Courtesy of Dan Hatleli – WDNR)

The WDNR recommends continued stocking of walleye and musky, along with winter monitoring of dissolved oxygen. Current fishing regulations appear adequate. The fishery at Mead Lake will be surveyed again in 2012.

Aquatic Plant Community

The most recent complete study of the aquatic plant community in Mead Lake, for which complete analysis is available, was done in 1998. From this study, seventeen separate aquatic plants were present in the lake, and a "moderate" rating of diversity was given. Of the seventeen plants, only one was a non-native and considered invasive; *P. crispus*, or curly leaf pondweed.

Another assessment of the aquatic plant community was completed during the summer of 2009. However, an analysis of the results of this study is not yet complete. One important finding that can be reported is that no additional invasive plants, beyond curly leaf pondweed, were identified in the lake. It is significant that no specimens of the invasive species *M. spicatum*, or Eurasian water milfoil, were identified. This is important because many other lakes in the region report the presence of this aggressive invasive plant, and keeping it from entering Mead Lake will benefit the lake's ecological community and help maintain a diverse native plant community beneficial for aquatic habitat.

Curly leaf pondweed (Photo by Vic Ramey, University of Florida/IFAS Center for Aquatic and Invasive Plants. Used with permission.)

Septic Systems

In 1996, Clark Co. applied for and received a WDNR grant to survey all private on-site wastewater treatment systems at the lake. In 1997 the survey was done by Ayres Associates in cooperation with the Clark Co. Planning and Zoning Department. The study showed that many of these systems were considered failing, or in some way not up to code. The results of the study are located in Appendix A.

Although the recommendation by Ayres was for a cluster treatment system at the lake, the residents instead chose to individually upgrade their systems. All failing systems at the lake were brought up to code after the study. However, a similar study has not been conducted for other septic systems within the watershed.

Typical septic system being installed

Management Goals and Objectives

Based on scientific research, sociological surveys, meetings with stakeholders, and other information about Mead Lake and its history, the following goals and objectives for the Mead Lake Management Plan will guide efforts in the future to insure a beautiful and healthy natural resource for years to come.

Goal 1: Improve water quality and decrease the frequency and intensity of algae blooms, by decreasing sediment and phosphorus inputs to the lake.

The TMDL for Mead Lake suggests that a 30% reduction in phosphorus and sediment loads delivered to the lake via runoff and tributaries is necessary to minimize algal blooms, increase the desirability of the water for full-body-contact recreation, such as swimming and water skiing, and to achieve compliance with water quality standards. This equates to a mean summer phosphorus concentration of 93µg/l (micrograms per liter). This would be a significant decrease from concentrations measured in 2002 and 2003 of approximately 130µg/l. Since phosphorus is the limiting factor for algae growth, a reduction of sediment and phosphorus inputs to the lake should lead to a decrease in the number, intensity and duration of algal blooms. Both the survey of lake residents and the intercept survey of lake users suggest that algal blooms and the poor water quality that results from these blooms is a concern for people who live and/or recreate at the lake.

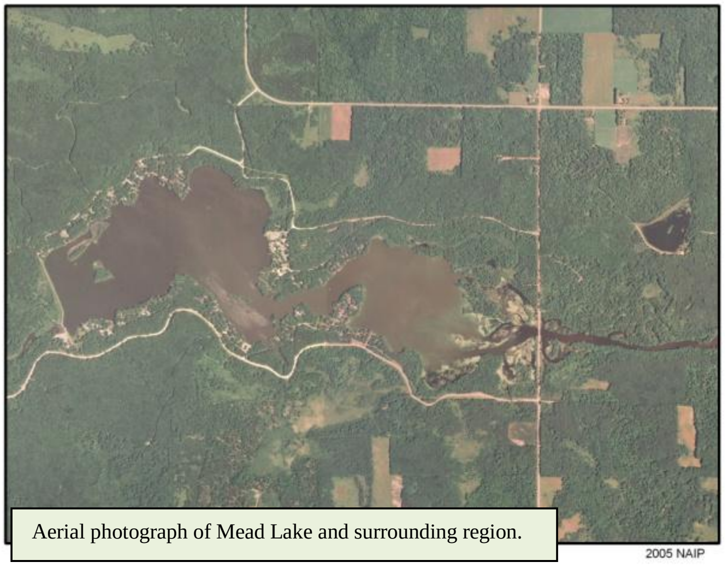
Severe algal bloom at Mead Lake

The Mead Lake TMDL also states that the majority of phosphorus and sediment entering the lake and its tributaries originates from agricultural land, which comprises the largest percentage of land use in the watershed**.** Agricultural landowners will play a key role in the improvement of water quality at Mead Lake.

Objective 1) Watershed Restoration and Protection Strategy. Phosphorus and sediment have many sources in the lake's watershed. A comprehensive watershed management plan will be developed that will address phosphorus and sediment sources. The management plan will include a targeted approach that focuses efforts on those lands that have the greatest need for conservation practice implementation and will respond most efficiently to practice implementation. This "needs-based response" analysis will help target limited staff and funding in those areas of the watershed that will provide the greatest conservation return for the time and money invested. Mead Lake is listed on the 303(d) list for impaired waters, therefore a watershed restoration and protection strategy will be designed and written to address not only the methods by which phosphorus and sediment loads will be reduced, but will also address the state and federal requirements related to the water quality impairments in Mead Lake.

Much of the specific design of the strategy will hinge on the results of further survey work being done in spring and summer 2010 to determine the needs and concerns of producers in the watershed. Once this data is gathered, the watershed restoration and protection strategy will be completed, likely by early 2011. The strategy will: define sources of funding for specific implementation projects/programs; identify agencies or entities responsible for different phases of implementation; provide estimates of load reductions achievable through various approaches, and; include a timeline for when the various phases of implementation will be achieved. Implementation of this strategy will be carried out by the Partnership and cooperating entities.

Objective 2) Apply for Lake Protection Grants. Much of the work necessary to implement the watershed management of phosphorus and sediment will take additional staff resources above and beyond what is currently available and require cost-share funds to assist farmers living in the watershed with conservation practice implementation. Therefore, once this Lake Management Plan is approved, the Partnership will seek Lake Protection Grants to provide cost-share funds for targeted sources of phosphorus and sediment within the watershed.



Aerial photograph of Mead Lake and surrounding region.

Objective 3) Groundwater Testing. There is a lack of data regarding the quality of groundwater within the watershed and a lack of knowledge by lake residents about the quality of groundwater in their wells. The state does not perform regular testing of private wells within the watershed. Therefore a concerted effort to test groundwater within the watershed will be pursued by the Partnership with help from Clark County. Groundwater conditions may help determine if any phosphorus load might be moving to the lake due to soil saturation of phosphorus near the lake or stream tributaries.

Objective 4) Education. According to the sociological surveys conducted by the Partnership, there are many areas where knowledge regarding the sources of phosphorus and sediment is lacking. Furthermore, there is less knowledge regarding management techniques that can be used to reduce nutrient and sediment loads, such as shore land riparian buffers or the planting of cover crops on agricultural fields. Therefore more work in educating those living at the lake and in the watershed, as well as those visiting the lake, will be undertaken. Much of this work is underway by the Partnership through their monthly meetings, press releases to local media, and word of mouth through the fairly small lake community. Kiosks will also be installed at the lake in 2010 for display of educational materials.

Goal 2: Increase natural vegetation to produce biologically productive shore land that minimizes erosion and enhances natural aesthetics.

In the most recently available shoreline land use survey (Konkel, 1998) the type of shoreline land cover with the highest percentage of occurrence was cultivated lawn. Additionally, the information gathered from the survey of lake residents showed that most residents held a negative opinion toward shoreline riparian buffers. This information indicates that the lake may benefit from increasing the amount of natural vegetated cover along shorelines.

However, it is necessary to educate lake property owners about how these buffers are beneficial, how to install them, and how they can be made more aesthetically pleasing.

Objective 1) Survey Current Lakeshore Riparian Conditions. Since no official inventory has been conducted in over a decade, the amount of natural vegetative cover on the lake's shoreline most likely has changed since the most recent 1997 survey. Newer data would be beneficial to help understand the contribution of shoreline erosion and/or runoff from lakefront properties to the lake's phosphorus and sediment levels. The inventory could also provide valuable information that would assist with preventing the loss of lake front property due to erosion. The Partnership will work with Clark County and the DNR to assess the lake's shoreline. This inventory may be completed by staff, through volunteer work or via a contracted service. A Lake Planning Grant will be necessary to fund this activity and will be applied for in 2010.

Objective 2) Installation of Vegetated Shore Land Buffers. In order to increase the number of installed riparian buffers and the percentage of shoreline covered by natural vegetation, education of lake residents will be an important first step. As identified in the lakefront property owner survey, there are obstacles to overcome, especially regarding the view of lake residents toward riparian buffers. The Partnership will work with natural resource professionals to inform and educate lake residents about the benefits of riparian buffers and how to properly install and maintain them. A workshop for lake residents will be conducted in 2010.

Goal 3: Maintain healthy fishery with desirable species, and a diverse native aquatic plant community.

Biological surveys of the Mead Lake fishery over the last twenty years show that the current condition of the fishery is fairly good. While there are a few desirable species that showed some decline in size or number (e.g. bluegills, perch), the fishery is quite productive. Carp, an undesirable species that is troublesome in other lakes, show a fairly low occurrence. The aquatic plant community also appears to be quite diverse with only one invasive species occurring (curly leaf pondweed). However, many survey respondents indicated they thought the lake had too many "weeds" that interfered with recreational activities and lake aesthetics.

Objective 1) New Lake Map. The Partnership discussed the possibility of creating a new lake map showing bathymetric data, lake bed characteristics, and physical habitat locations and characteristics. The geography department at University of Wisconsin – Eau Claire has produced such maps for other area lakes in the past. The Partnership will pursue creating a map for Mead Lake at the earliest date available. A Lake Planning Grant from the state and/or possible funding from the Mead Lake District will be necessary to pay for this work. Discussions are currently underway with UW-Eau Claire to determine how soon such a map can be produced.

Objective 2) Promote A More Self Sustaining Fishery. The most recent survey inventoried bluegill at a lower density in recent years, and demonstrated that stocking is still necessary for walleye and musky. The promotion and development of spawning habitat would help in maintaining these populations on a more self-sustaining scale. A bathymetric map would provide data on the current location/condition of spawning habitat. Fish cribs and other near shore woody debris may also assist in increasing spawning habitat. The Partnership will work with local natural resource professionals to pursue the knowledge and resources necessary to determine if this is a viable alternative for the lake.

Black Crappie (painting by Virgil Beck)

Objective 3) Education. It's important for those who recreate at the lake to understand the condition of the lake's resources, including fish and aquatic plants. The Partnership will work to educate those living on and using the lake regarding the current state of the fishery and what can be done to help maintain it. As fish surveys are completed by WDNR, this information will be made available to lake residents and visitors. Additionally, there is a need to educate lake users and residents on the value of a diverse aquatic plant community that provides habitat, cycles nutrients, and outcompetes invasive species.

Goal 4: Prevent expansion and new infestation of invasive and exotic species.

Currently the only invasive species known to be present in Mead Lake is curly leaf pondweed (*P. crispus*). Although it has not grown to a nuisance condition, curly leaf pondweed has likely been present in the lake for at least twelve years. Work must be undertaken to keep this species from spreading to more areas within the lake, and also to keep other invasive species, such as Eurasian water milfoil (*M. spicatum*), a species that is present in many other area lakes, from entering Mead Lake.

Objective 1) Monitoring. It's important to know the extent of any invasive population/infestation that enters or is already present in the lake. For that reason, continuous monitoring for invasive species must take place. The partnership will work with the WDNR, lake monitoring volunteers, and others to continually monitor the lake for the occurrence or spread of invasive species.

Objective 2) Education. It is important to keep curly leaf pondweed from moving to other parts of Mead Lake or to other lakes in the region and also to prevent the spread of other invasives into Mead Lake. The Partnership will work with the WDNR, Clark County, the Clean Boats Clean Waters program, and other educational outlets to educate boaters and fishing enthusiasts regarding the cleaning of their boats before entering into or exiting Mead Lake. Instructional workshops for Clean Boats Clean Waters are being conducted in the region many times during 2010, and members of the partnership will attend these workshops to receive instruction.

In addition to plants, species such as zebra mussel (*D. polymorpha*) and rusty crayfish (*O. rusticus*) also need to be kept out of the lake, and any education program will address these and other aquatic and terrestrial invasive species as well. The educational kiosks, once installed, will be an excellent way to post such information for those visiting the lake.

Goal 5: Provide safe, diverse recreational opportunities for all.

In addition to those folks living on the lake, people come from many places, near and far, to recreate on Mead Lake. Many survey respondents indicated that at one time or another they avoided certain activities on the lake due to poor water quality. Many respondents expressed a concern with contacting the water when it is covered with a thick algal bloom. In order to increase the amount of body-contact recreation days, the water quality must be improved by decreasing the phosphorus and sediment load entering into Mead Lake. Additionally, there are other recreational challenges that the Partnership may address in the future.

Objective 1) Beach. Currently the lake has no user-friendly beach area. A quality beach with sand would provide better opportunities for swimming and shore land recreation. The Partnership will investigate the possibility of adding such a public beach at the lake. The Clark County Forestry and Parks Department has expressed an interest in improving the existing recreational areas, including the small beach area located at the campground. Current discussions indicate this task could be accomplished in 2010.

Objective 2) Boating Regulations. The Partnership will assess the need for any additional boating regulations focusing on protecting erodible shore land, or re-suspension of bottom sediments that contain phosphorus and contribute to algae blooms. Boating safety is also an issue on many area lakes, and the Partnership will explore how to get some of its members certified as boating safety instructors.

The golden age of water skiing at Mead Lake.

References

Blasczyk, J. and David J. Summers. 2009. The Mead Lake Property Owners: Their Views on Water Quality of the Watershed and Their Management Practices. Environmental Resources Center, University of Wisconsin, Madison, WI.

Blasczyk, J. and Rachel Ford. 2009. Mead Lake Intercept Survey Results. Environmental Resources Center, University of Wisconsin, Madison, WI.

Friehofer, Adam. 2006. Mead Lake Watershed SWAT Model Setup. Center for Watershed Science and Education, University of Wisconsin - Stevens Point, Stevens Point, WI.

Hatleli, D. 2009. Presentation to Mead Lake and Watershed Partnership on Fish Population Data, Mead Lake, WI. Presentation prepared by Wisconsin Department of Natural Resources.

Konkel, D. 1998. The Aquatic Plant Community of Mead Lake, Clark Co, WI. Prepared by Wisconsin Department of Natural Resources.

Lovelace, B. and J. Lovelace-Voigt. 2002. A Collection of Mead Lake Nostalgia. Prepared by a committee of Mead Lake Residents.

Mead Lake Sanitary Septic Survey. 1997. Report prepared by Ayres Associates. Eau Claire, WI.

Schmidt, S. 2009. Raw data for Summer 2009 Mead Lake Aquatic Plant Study. Data made available by Wisconsin Department of Natural Resources.

Schreiber, K. and N. Richmond. 2008. Total Maximum Daily Load: Mead Lake, Clark Co, WI. Prepared by the Wisconsin Department of Natural Resources.

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Matt Zoschke: page 9
National Agricultural Imagery Program: page 10
Peggy Compton: page 8
Vic Ramey: page 8

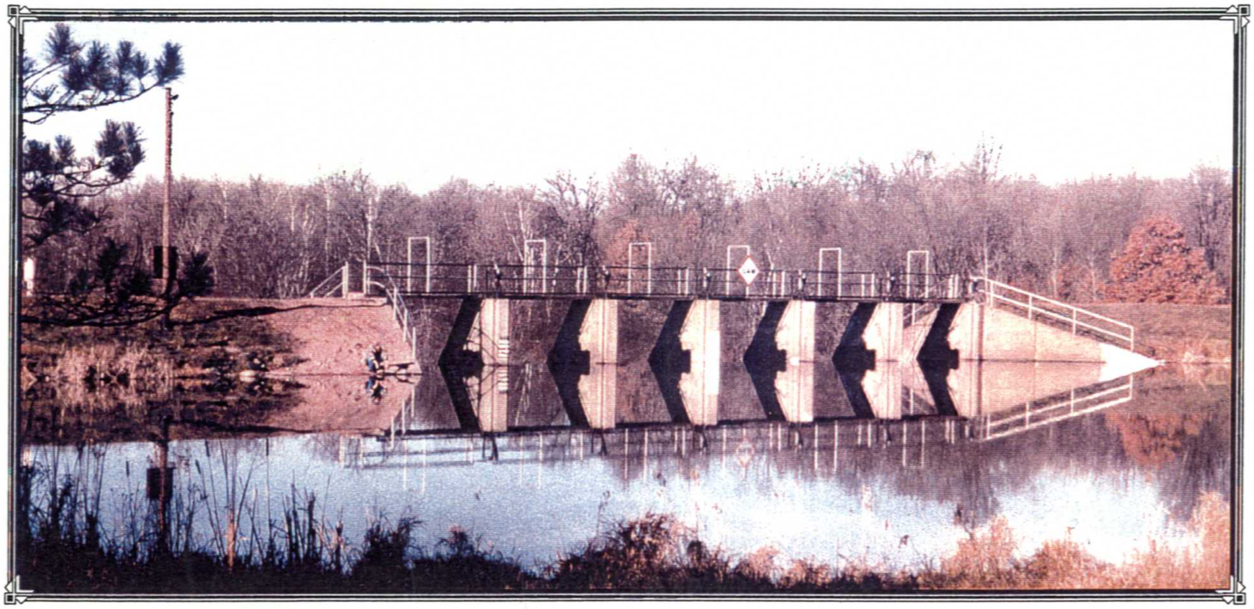
Land Cover Map, page 4, created by University of Wisconsin-Extension

Appendix A

Reference and Historical Documents

A Collection of

Mead Lake Nostalgia



Our Lake is 50 years old
1952-2002

Acknowledgments:

This is a collective work of a committee and is made possible through the generosity of the Trierweiler Family.

Bradford C. Lovelace, historian
Jennifer Lovelace-Voigt, writer
Darlene Schultz, artistic layout
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Pat Braun, Greenwood Library
Ray Hoffman
Jennie Hoffman
Glenn Struss
Eula Luzovek
Pattie Denk

This publication is a gift to the home owners and friends of Mead lake in the memory of

Harold Trierweiler

Harold was one of the original cabin owners on Mead Lake. Throughout his many years of weekends spent on the lake, his love of it was apparent to all who knew him. His favorite lake activity was muskie fishing.

1922-1998

Origins of the Name "Mead Lake"

It appears that the Town of Mead and later Mead Lake were named for farmer, lumberman and former county board supervisor, William H. (Harrison / "Harry") Mead. [1]

William H. Mead was born in Pawlings, NY on November 19, 1833. He, along with his wife and children, arrived in Clark County in 1865. He farmed for a while, but later saw the huge potential for logging in the area. He became one of the leading loggers in this area and at one time he and his partners owned 10,000 acres of forest. [2] He had held several political offices and in 1891 was defeated by four votes in his bid for state assemblyman. [3]

MR. AND MRS. WILLIAM H. MEAD

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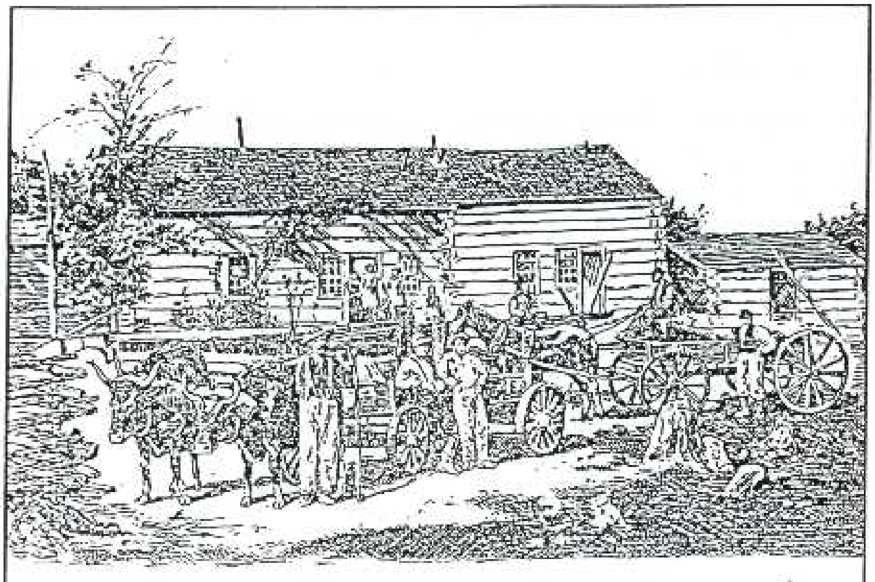
[1] R. J. MacBride, History of Clark County, Clippings from the Thorp Courrier, 1900's, 1909

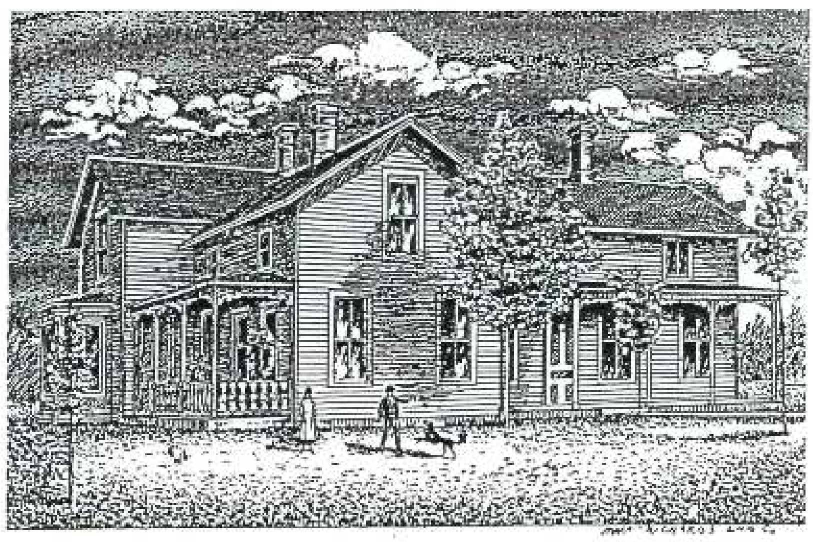
[2] Franklyn Curtiss-Wedge, History of Clark County (Chicago: H.C. Cooper, Jr., &Co, 1918), 424-425

[3] MacBride.

Mr. Mead settled with his family first in what is now Greenwood. When they first arrived, there were only three farms between Greenwood and Neillsville. He took a homestead of 160 acres of wild and heavily timbered land about 6 miles north of Greenwood which he cleared and farmed in what is now Warner Township. He later owned a farm two and a half miles south of Withee.



Pioneer Home of Harry Mead.



Farm Residence of William Mead.

The Evolution of a Lake

The Town of Mead was created on November 16, 1865 and consisted of what is now Mead and Butler. The first town meeting was held at the home of William Volrath. In 1916 the town was reorganized to its present boundaries.[4]

Map 1: Clark County 1873

- The future Mead Lake to be located in sections 28 and 29, what was then known as the Town of Warner.

Map 2: Clark County 1893

- Existence of flood or log dam in section 28
- Most land owned by lumber companies and land companies; very little privately owned land.

Map 3: Clark County 1906

- Note: Most land still owned by lumber companies and land companies

Map 4: Clark County Circa 1930

- Note: All land in Mead privately owned

Map 5: Clark County Circa 1940 (after the Great Depression)

- Note: Clark County now owns one-fourth of Town of Mead

Map 6: Clark County 2002

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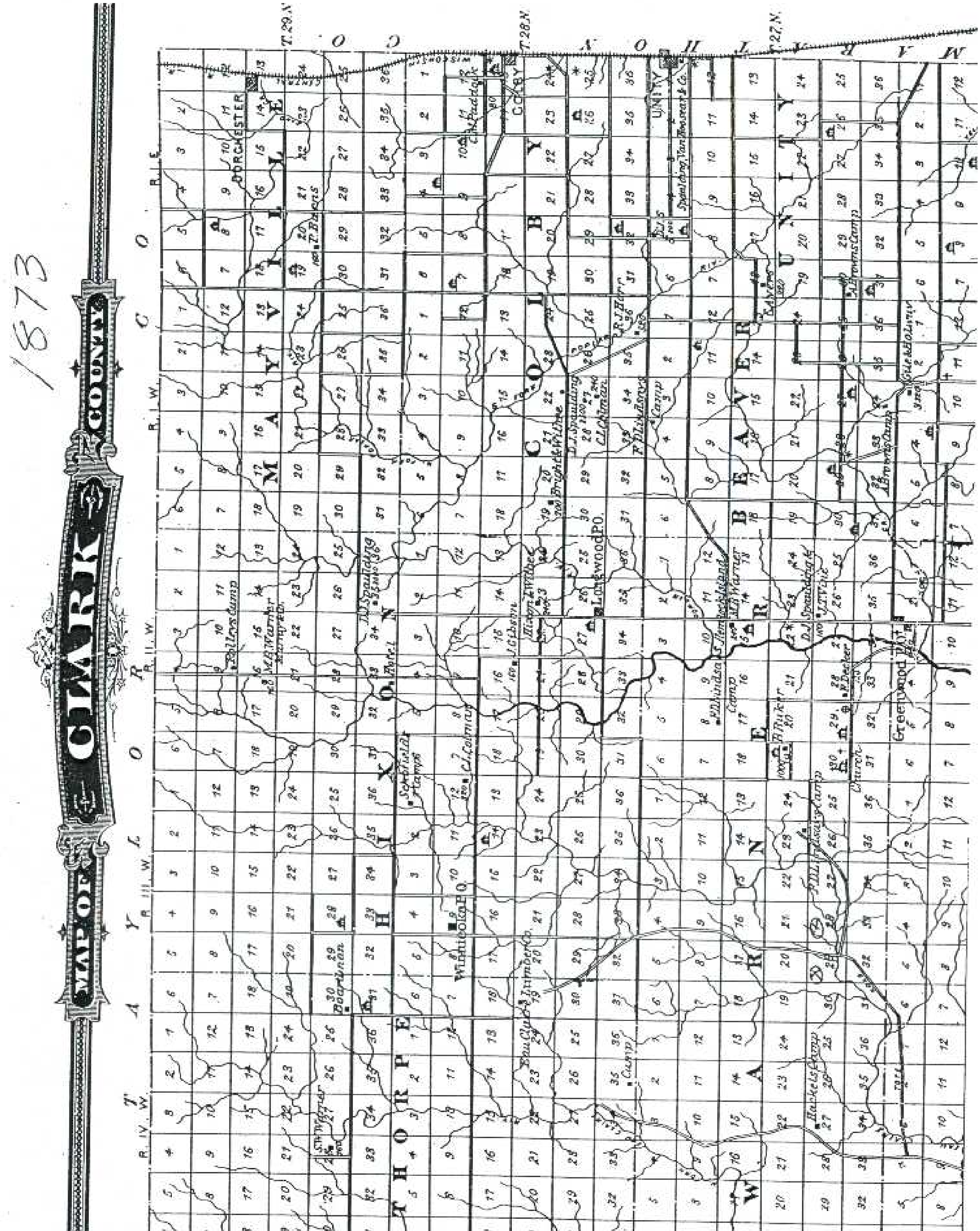
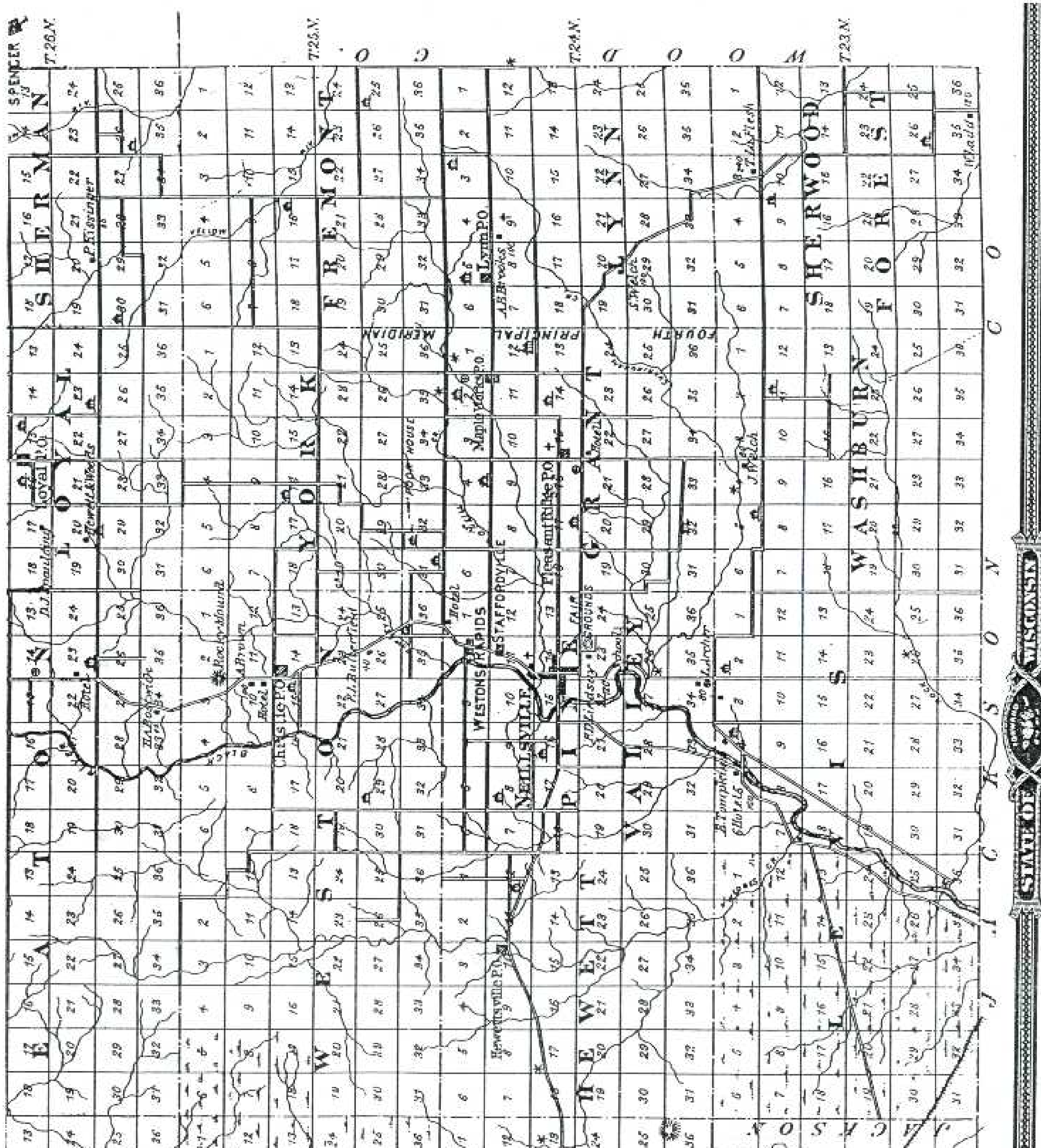
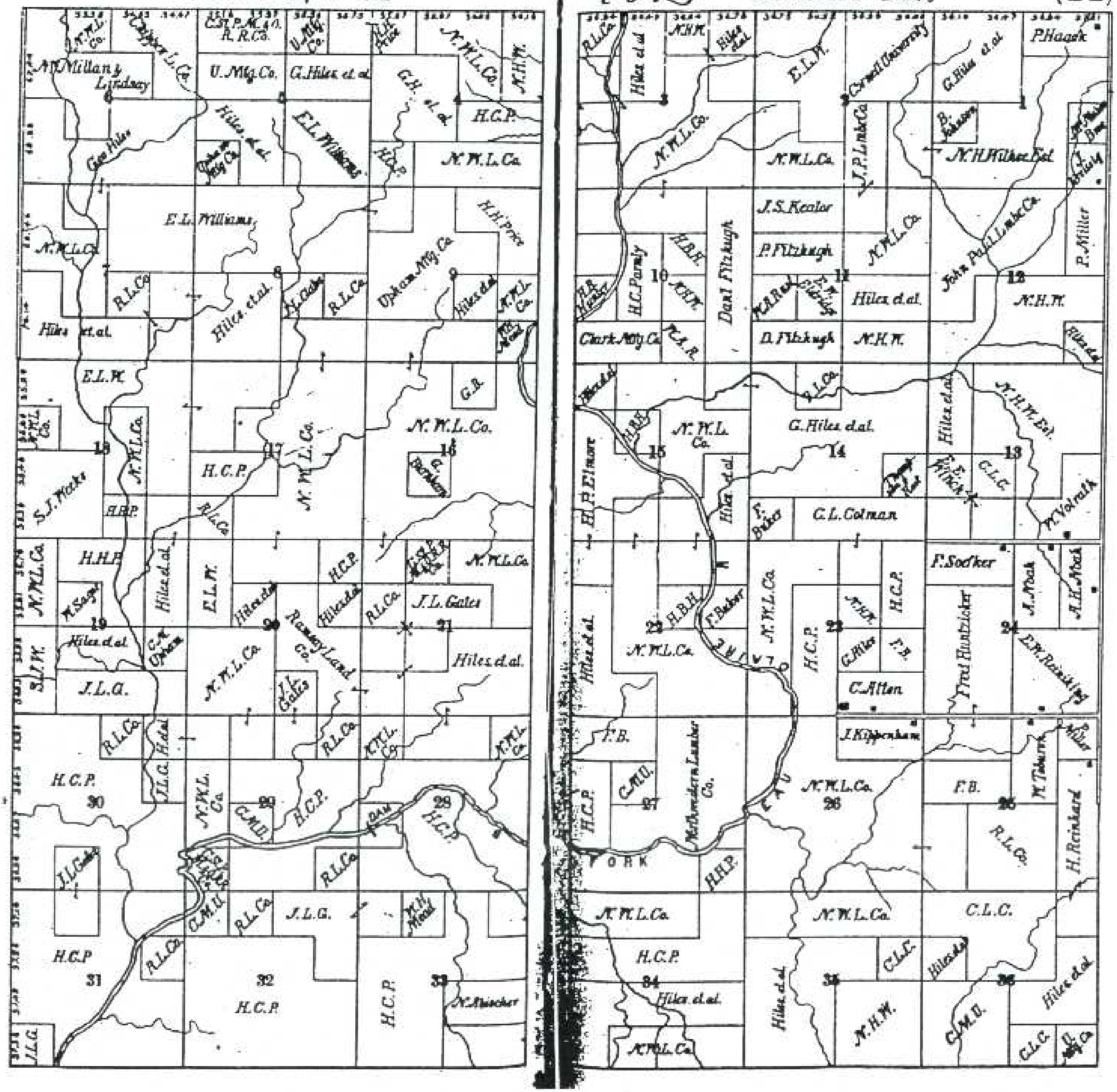
[4]Franklyn Curtiss-Wedge, History of Clark County (Chicago: H.C. Cooper, Jr., &Co, 1918), 424-425.


1873
MAP OF CLARK COUNTY
DORCHESTER
COLBY
UNITY
MAYVILLE
COLBY
BEAVER
UNITY
THORPE
HIXON
LONGWOOD
WARNER
Longwood P.O.
Withee P.O.
Greenwood
CHIPPEWA CO.

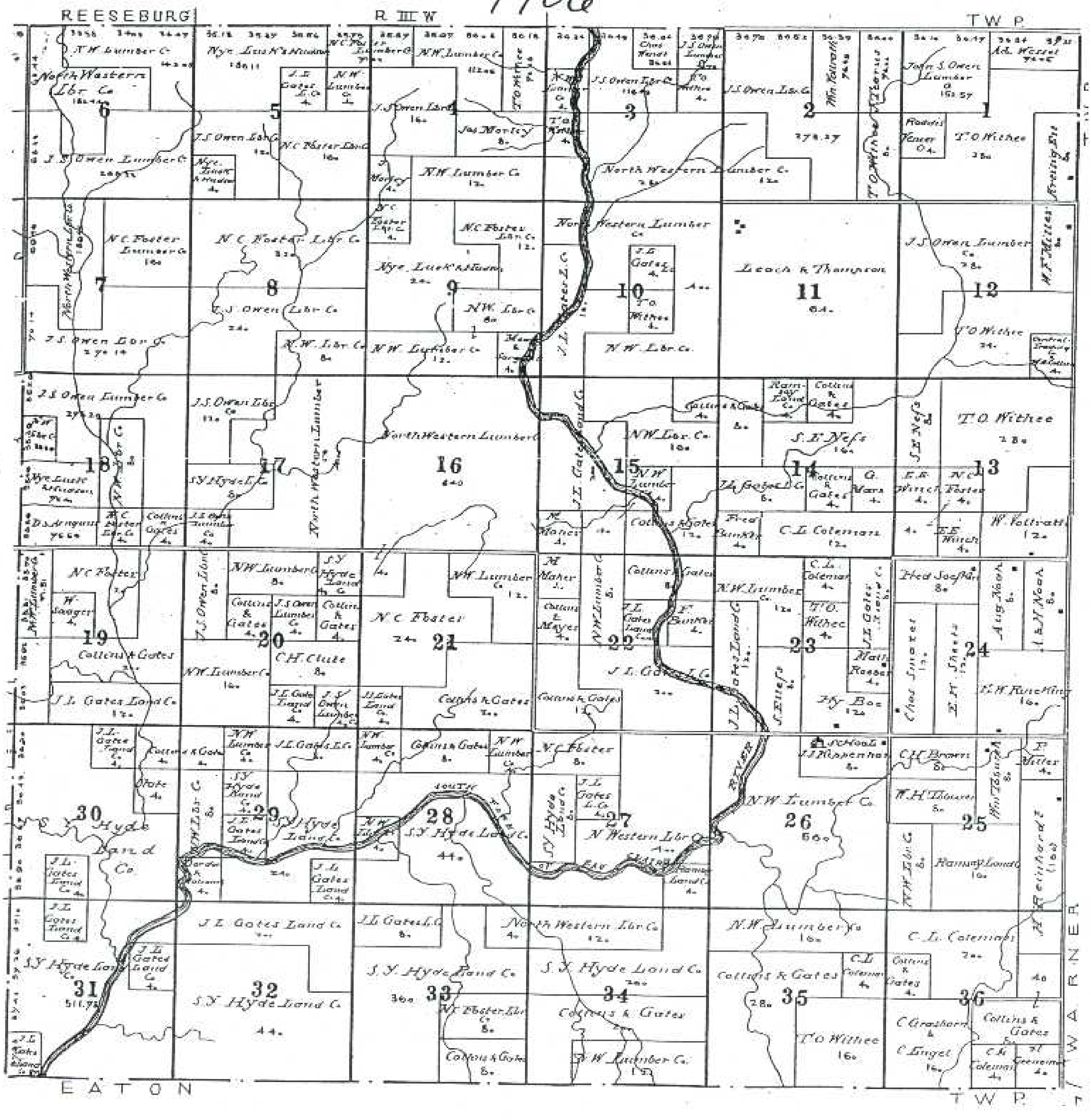

STATE OF WISCONSIN
SHERMAN
LOYAL
YORK
FREMONT
LYNN
GRANT
SHERWOOD
FOREST
WASHBURN
PINE VALLEY
WESTON
HEWETT
LEVIS
NEILLSVILLE
WESTONS RAPIDS
HUMBIRD
MERRILLAN
ALMA CENTRE
SPENCER
LYNN P.O.
EAU CLAIRE
WOOD
JACKSON

Town 27, 3 W

1893 NOW MEAD Warner M⅓ (23)



1906


REESEBURG
R. III W.
TWP.
EATON
TWP.
WARNER
N.W. Lumber Co.
North Western Lbr Co
J.S. Owen Lumber Co.
N.C. Foster Lumber Co.
N.C. Foster Lbr Co.
Nye, Luck & Hudson
T.O. Withee
North Western Lumber Co.
Leach & Thompson
J.L. Gates Land Co.
Collins & Gates
S.Y. Hyde Land Co.
C.L. Coleman
C.H. Clute
S.E. Ness
N.W. Lumber Co.
North Western Lbr Co.
SCHOOL
RIVER
SOUTH
1
2
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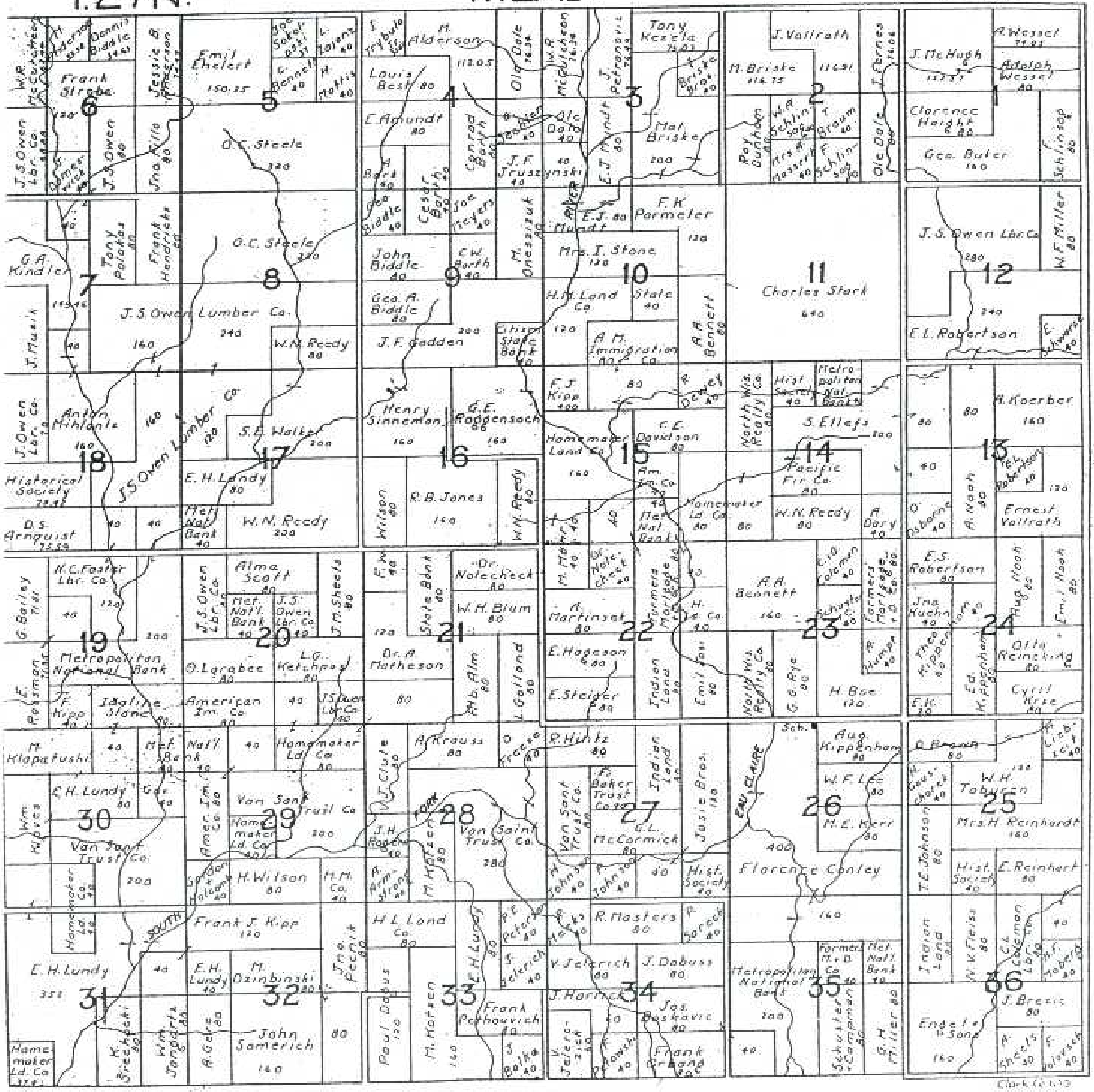
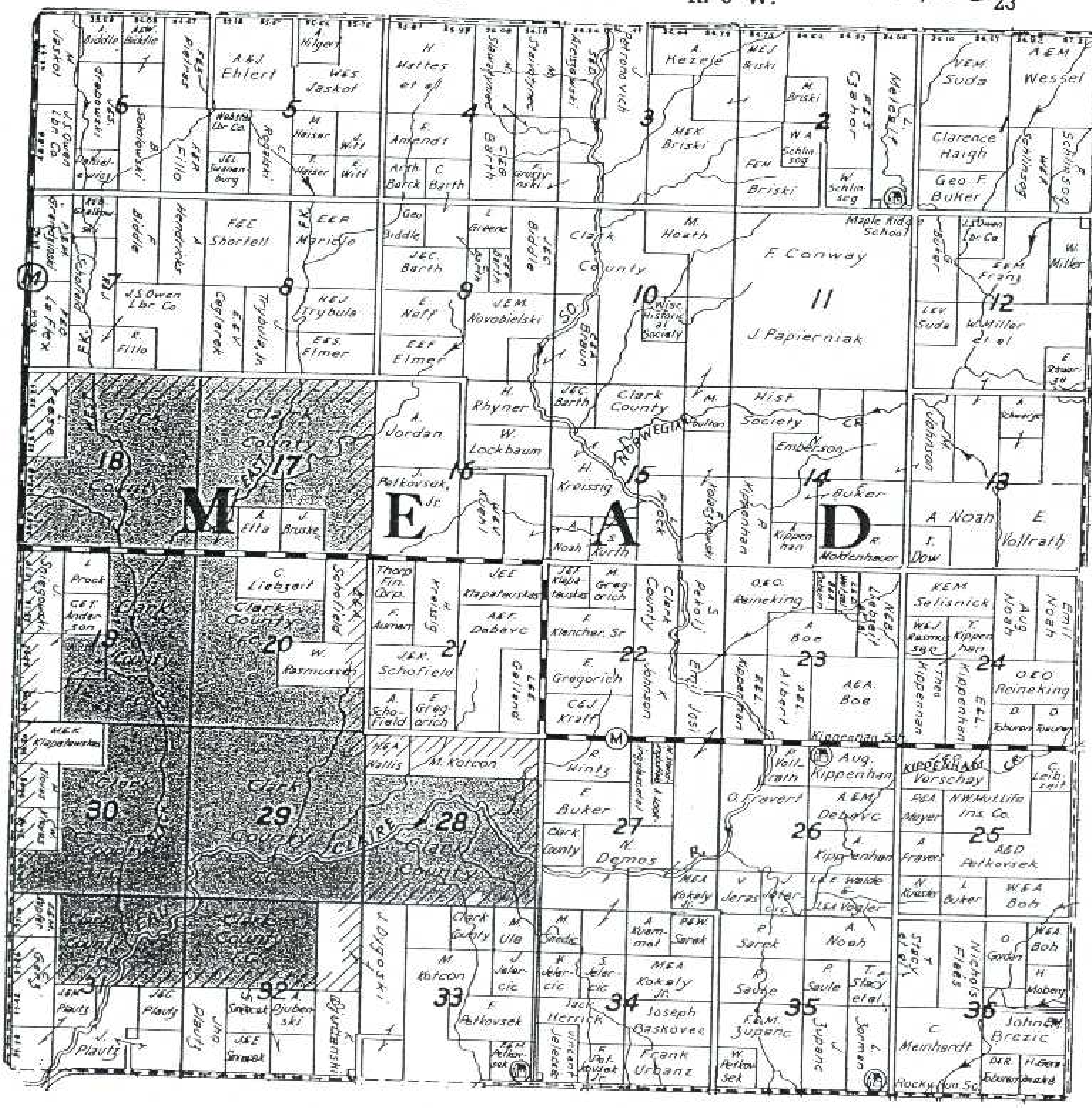
T.27N. MEAD 1930's R.3W.

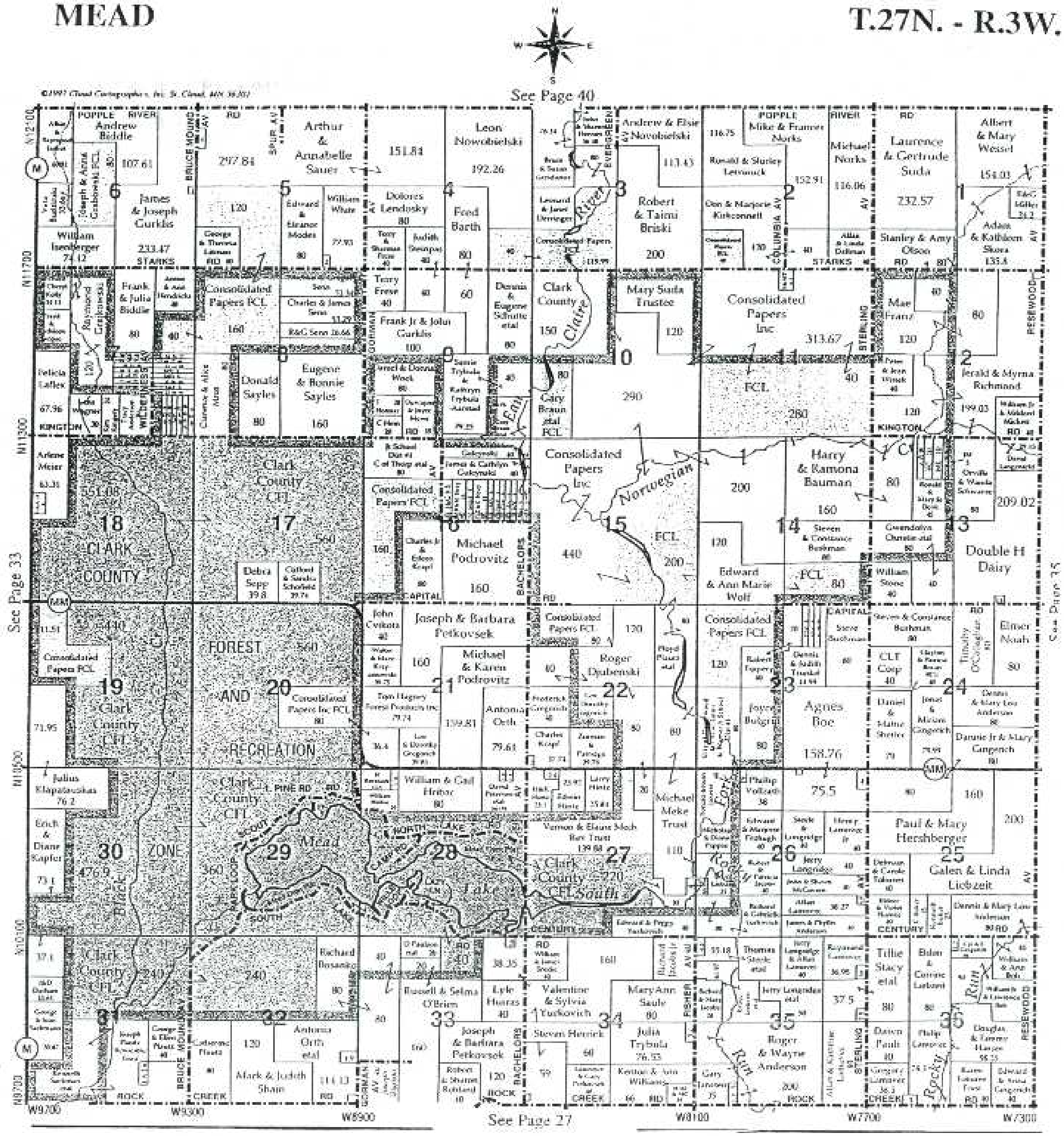


Twp. 27 N. Mead R. 3 W. 1940's



MEAD

T.27N. - R.3W.



That Damn Dam

The very first reference found regarding the damming of the river was in March 1948. An application of Clark County for a permit to "construct, operate and maintain a dam in the South Branch of the Eau Claire River" for recreational purposes was put before the Public Service Commission of Wisconsin in Madison on March 12, 1948.[5]

In the early stages, it was thought that the state Conservation Commission would foot the entire bill. However, it became apparent early on that the state intended for the lake to be used for conservation and sport only with no provisions for cottages or resort use. It would have been much smaller and not as deep. The county fathers chose to pass on the state's plan and continue the project locally. They expected that the lake would turn a profit from the $15.00 a year it planned to charge for leasing cabin sites.[6]

That being decided, the board voted to appropriate $30,000 for the project. Interestingly enough, only one company even made a bid on it. The Nelson Construction Company of Black River Falls made a bid of $28,000 to complete the project. Although three other construction firms had inspected the site and made plans, they did not choose to make a bid.[7]

Later that year in September, The *Clark County Press* reported that a contract of $28,000 for the construction of the dam had been signed by the chairman of the Clark County Park Commission and the chairman of the Clark County Board of Supervisors. The newspaper commented that this was "the first step in the creation of a 400-acre lake and county-owned recreation area...[and would] maintain the area as a recreation spot for residents." Approximately 200 cottage

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[5]Notice of Hearing and Order of Publication, Public Service Commission of Wisconsin. 12 March 1948.

[6]"New Lake in the Town of Mead is Acquired by County in Year 1951", *Clark County Press*, 1 January 1952: 1+

[7]"Contract is Let for Construction at the Mead Dam," *Clark County Press* 2 September 1949: 1.

sites were to be released to individuals near the edge of the 400 acre lake. County Clerk Mike Krultz, Jr. (who was later a cabin owner himself) said that 26 people had already applied for leases and put down deposits before the project had even started. Construction was expected to start by March 1, 1949 after the dam construction starting in the fall of 1948.[8]

Oh, Dam!

Quickly it became apparent that $30,000 would not be nearly enough to build a dam. In December 1948 another article in the *Clark County Press* reported that the construction of the new dam would cost closer to $63,000 to $85,000 according to an estimate made by engineers employed to make a survey of the site by the county public property committee. The engineers, Mead and Hunt of Madison, found that the lake conditions were appropriate to permit construction of the 18 foot dam. The engineers estimated that an annual income of $5,400 for each leased lot for 20 years would be sufficient to raise the extra money needed if the interest rate were 4% annually. (Or only $4,860 at 2%APR)[9] A *Marshfield News Herald* article from January 1949 stated that the County authorized the engineers of Mead and Hunt to complete the survey of the area.[10] In April of that same year, the county board of supervisors appropriated $40,000 more for the construction of Mead dam after two and a quarter hours of discussion.[11] In July, a $60,000 bid for the project by E. & B. Gottschalk of Edgar, Wisconsin was approved by the Clark County Public Property Committee. They were to start the preliminary work immediately. [12]

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[8] "Contract is Let for Construction at the Mead Dam," *Clark County Press* 2 September 1949: 1.

[9] "Report on Mead Dam is Received," *Clark County Press* 16 December 1948: 1.

[10] "County Group Approves Work on Mead Dam," *Marshfield News Herald* 20 January 1949: 13

[11] "Vote $40,000 for Mead Dam," *Clark County Press* 21 April 1949: 1.

[12] "Mead Dam Work Opens Next Week," *Clark County Press* 28 July 1949: 1.

Adventures in Dam Building:

Notes from the construction site

On July 17 work started at Mead Dam. Equipment on the job were mixer, grader, two scrapers, one bulldozer and one pusher. Two men operated a scraper, bulldozer and pusher. On July 17 and 18. Rain fell the entire day on July 19. On July 20, rock excavated with difficulty near north abutment. At 5:00 P.M. work stopped because of break on bulldozer, rewelding of same completed at 2:00 P.M. on July 21. On July 22 difficult rock excavation at north abutment was completed and approximatëly the north half of the spillway. A pump was in operation dewatering at south abutment. At 3:30 P.M. a broken part put the bulldozer out of operation. Work scheduled for July 23 was canceled because the 20 " wide buckwt had not been assembled on the excavating hoe.

On July 24, the hoe excavated the upstream trench at the north abutment to a depth of less than 2 feet. Some solid rock in the trench cannot be removed. A flat tire on a trailer, enroute from Stetsonville, blew out so that a second bulldozer was abandoned 7 miles north of Greenwood. A part on a second trailer broke enroute to move the 2nd bulldozer. A new part from Minneapolis was installed on bulldozer #1 on July 25 and excavation continued with scraper and and bulldozer #1 between 11:00 A.M. and 7:00 P.M. with a one hour breakdown requiring welding. Engineer acquainted carpenter with plans and helped prepare detailed lumber list required before a first pour of trenches, apron, and portion of abutment.

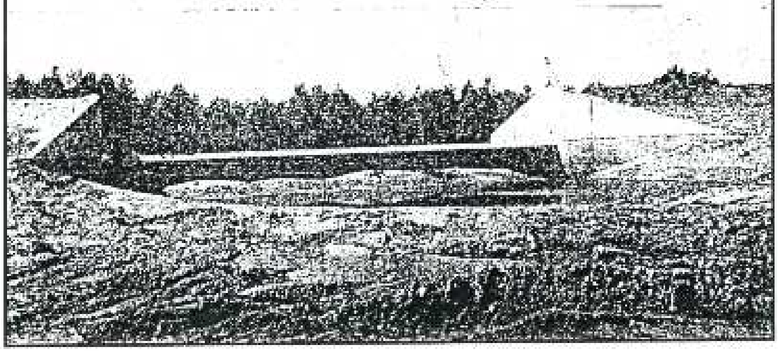
On July 26, a bulldozer prepared site for batching bin and hoe excavated trench for south abutment. On July 27, road was repaired and second bulldozer brought to job. On july 27, trench at upper end of spillway was dug. Final grading for sloping apron completed. All necessary stakes and instructions were given so work can be completed for trenches. Engineer left Thursday at 5:00 P.M. and will return for concrete pour of trenches.

Date	Men	Equipment	Remarks
July 17	2	Scraper, Bulldozer, and pusher	
July 18	3	" " "	
July 19	-Rain		
July 20	3	Bulldozer	
July 21	2	Bulldozer	Repaired bulldozer by 2:00 P.M.
July 22	2	Bulldozer	
July 23	-Rain		Lack bulldozer
July 24	3	Excavating Hoe	Lack bulldozer
July 25	5	Scraper, bulldozer & Pusher	Bulldozer repaired by 11:00 A.M.
July 26	5	1 bulldozer, Hoe	
July 27	5	2 bulldozers, hoe	

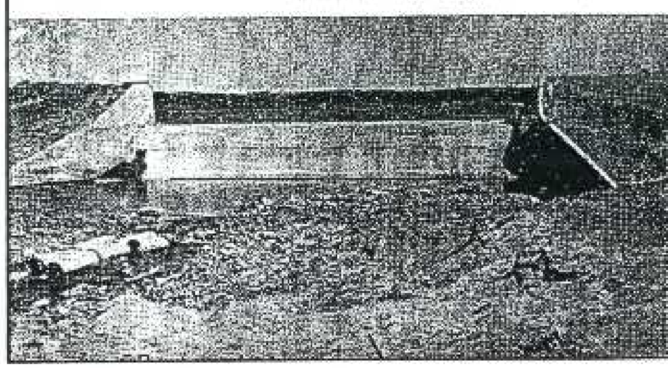
The Best Laid Plans of Mice and Men and Dam Builders Oft Go Awry.

The original plans for the dam had to be extensively revised due to the unanticipated soil and rock conditions. Originally it was predicted through boring that the ground was composed of solid granite which would have been perfect for supporting a dam. However, they quickly realized that the ground was merely shale and disintegrated granite. The removal of this rock and subsequent replacement with concrete would have raised the cost of the project. They tried two other sites further downstream with no luck. Finally they decided to go with the third site and alter the manner of construction to meet the actual conditions and keep within their budget.[13] At this point the Gottschalks predicted that the work would start in the Spring of 1951 and would be completed in the fall of 1952, just in time for the fall rains to help fill the lake. It would be equivalent to one mile long and a half a mile wide.[14]

Completed Mead Dam as it Looks from Upstream



Rear View of Dam Before Lake was Filled



pictures courtesy *The Clark County Press*

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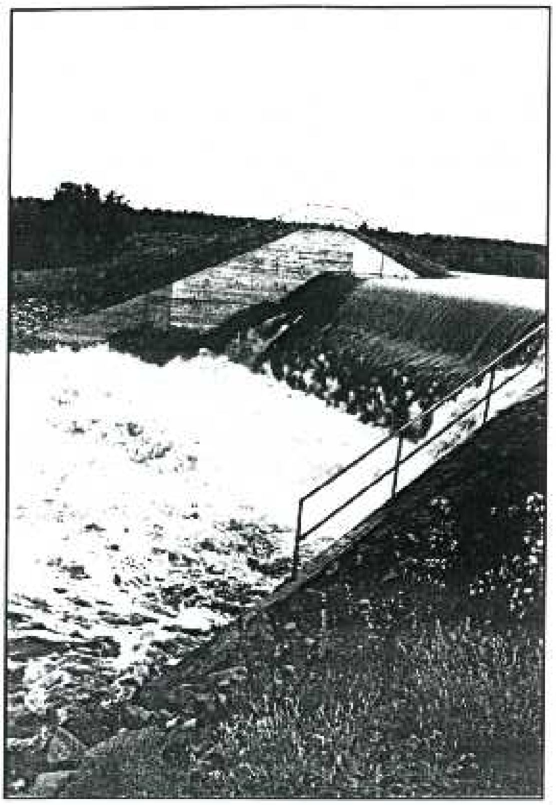
[13] "Completion of the Mead Dam is Now Set for Early Fall," *Clark County Press* 13 April 1950: 1.

[14] "Completion of the Mead Dam is Now Set for Early Fall," 1.



Dam before new gates were installed

Finally...

The *Clark County Press* reported on August 30, 1951 that the Mead Dam was completed and the lake was starting to fill up. It seems that although the new lake had many supporters, it also had its share of dissenters including County Board Supervisor Joe Tobola who dubbed the entire project, "Operation Rathole."[15]

Much to the amazement of proponents and naysayers alike, the New Year's Day edition of the *Clark County Press* heralded the completion of the county's newest lake. The project was finally finished with an estimated price tag of $80,000. The thirty four people who had put their deposits down for a lake shore lot were finally going to be able to start choosing. The applicants would be allowed to select their lots in the order in which they put their deposit down. The first and third choices went to S. J. Glankoski of Thorp and the second choice went to Calvin Mills of Owen.
All together, there would be 192 lots available.[16] There is much question to who actually built the first cottage. There are several that went up about the same time, but no record as to the actual first one.

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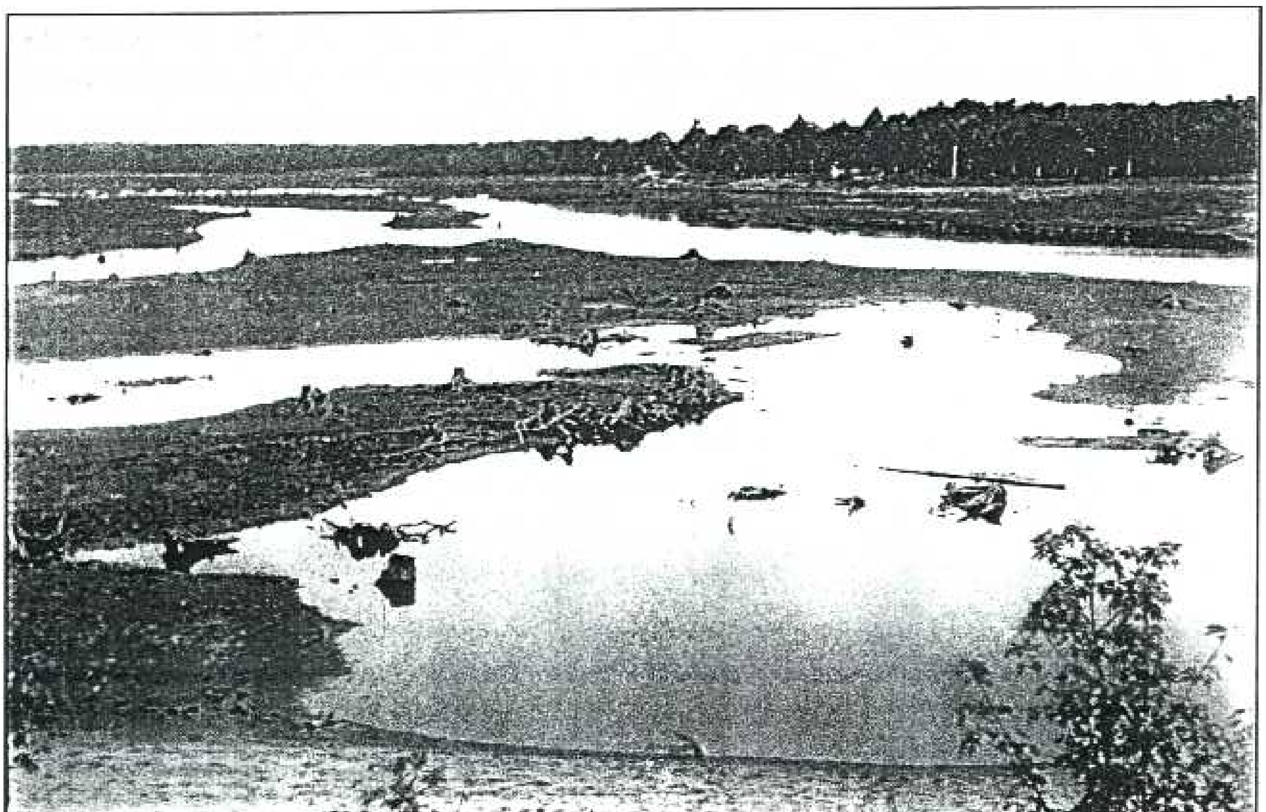
[15] "Mead Dam Now Backs up Waters of Eau Claire River to Create new Lake," *Clark County Press* 30 August 1951: 1

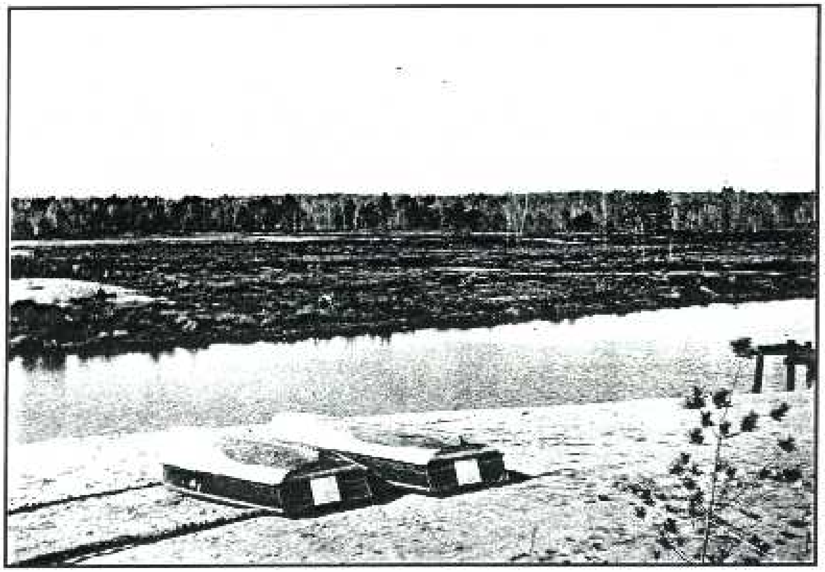
[16] "New Lake in the Town of Mead is Acquired by County in Year 1951" *Clark County Press* 1 January 1952: 1+

More Dam Fun!

In June 1954 *The Clark County Press* reported that 80 sites had been leased but some were no longer lakefront property. During the previous spring, heavy rains had flooded the lake and the rising water threatened the structure of the dam itself. Fortunately the flash boards broke in time to save the dam. However, this caused the water level to drop significantly leaving some sites without the lake right out in front.



Picture courtesy the Hoffman Family

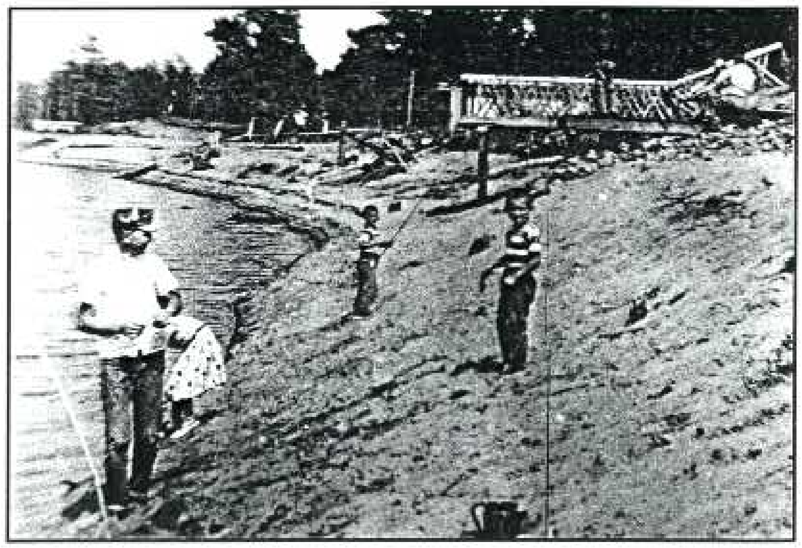


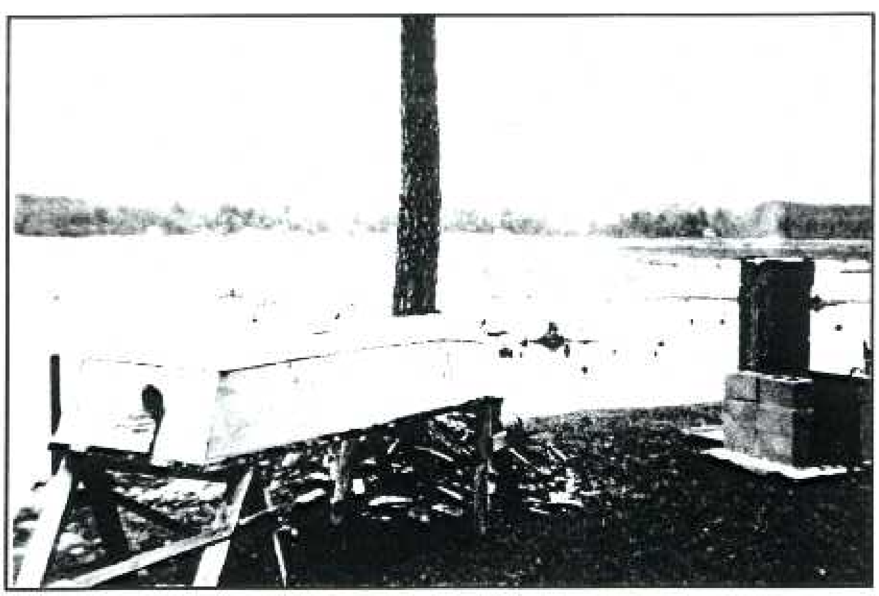
Lake drained for dam work in front of Hoffman's (next to dam)

picture courtesy Hoffman Family

Lake drained for fish eradication and to compact the lake bottom. Picture taken in front of Staut's dock.
(south side of lake)

picture courtesy Stout Family





pictures courtesy Trierweiler Family

Drained lake in front of Trierweiler cabin looking toward north side of lake.

The County Board was once again faced with the dilemma of what to do with the lake. Some supervisors wanted to just abandon the entire project whereas others grudgingly admitted that they couldn't just walk away from it since they had so much invested already. Another felt that they couldn't break their promise to the cottage owners on the lake. They decided to hire an engineer to advise them.[17] In August the engineer came back with a proposal to improve the system of flash boards and to build another spillway. The suggestion was tabled until the fall session.[18] In November the board voted to allocate $25,000-$30,000 for an auxiliary spillway on the north of the dam.[19]

More dam problems

The County learns in April of the following year that the cost of fixing the dam will be even more than first thought: $39,945. This would make the total expenditures for the dam total a whopping $141, 393.39, significantly more than the original $30,000 apportioned eight years prior. According to the April 21, 1955 *Clark County Press*, the resolution to approve the repair of the dam, "was rejected by the county board of supervisors at 3 p.m. Wednesday. The vote was 36 for, 25 against." A two thirds vote (41 votes) would have been needed to approve it. [20]

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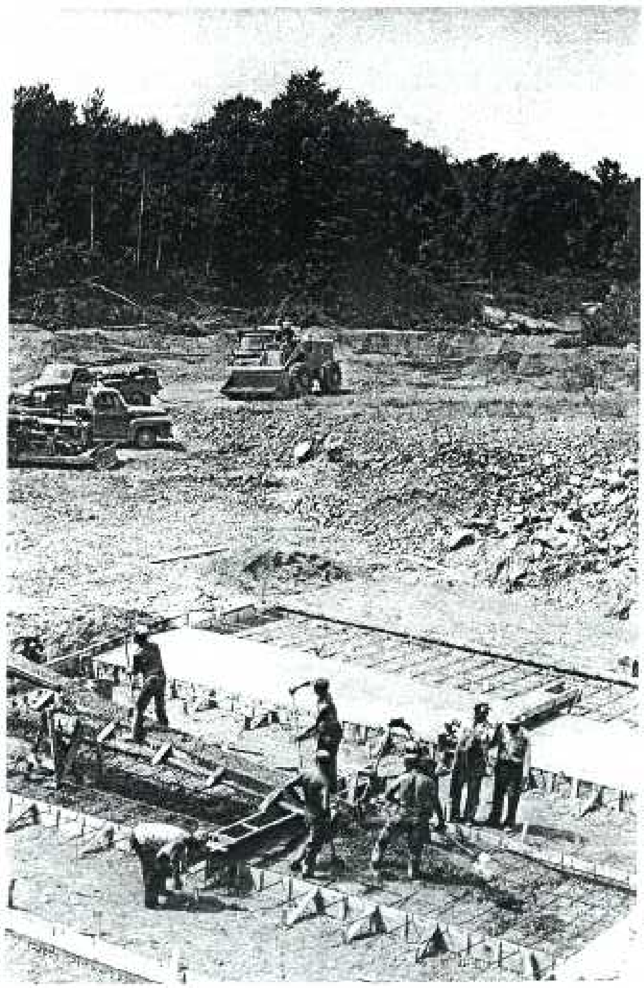
[17] "More Worries for Clark County on the Mead Project," *Clark County Press* 10 June 1954: 1-2.

[18] "Mead Dam Slapped Down at Tuesday's Session of County Board," *Clark County Press* 12 August 1954: 1

[19] "New Spillway for Mead Dam Likely," *Clark County Press* 18 November 1954: 1.

[20] "Mead Dam Project Would Cost $39,945, the County Board Learns," *Clark County Press* 21 April 1955: 1.

It appears that there was more public support for the lake than the County Board originally thought. By this time, a considerable number of cottages had been built with many more anticipated. The hope was that the lake would become a "substantial resort."[21]



Work begins on Mead Dam-1954
Picture courtesy Hoffman Family

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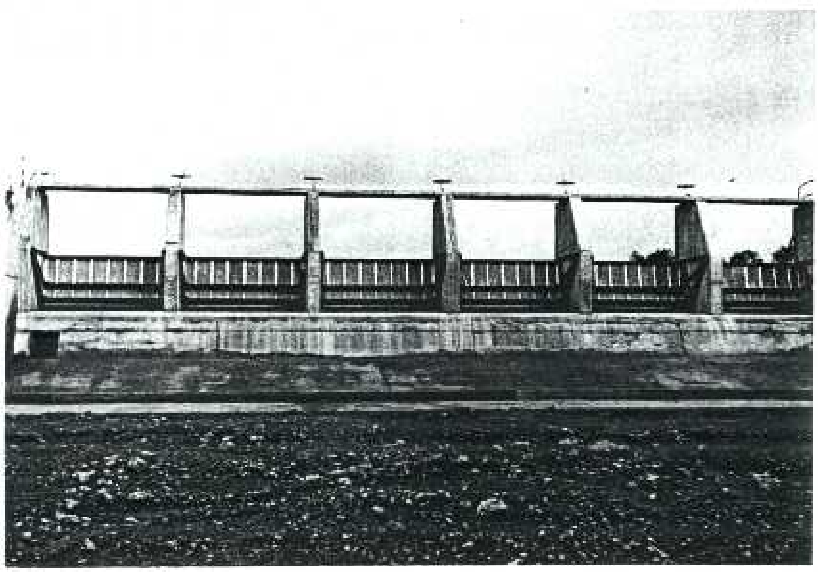
[21] "New Spillway of Mead Dam is Completed and Goes into Service," *Clark County Press* 13 October 1955: 1+.

On October 13, 1955, the front page of *The Clark County Press* was blazoned with the headline, "New Spillway of Mead Dam is Completed and Goes into Service." The old spillway wall was cut away to make room for six gates that could be raised or lowered with cables according to the desired water level. The potential pitfall of this system was that it required a responsible person to take charge of raising or lowering the gates year round or the result could be the disaster of a washed out dam which had actually occurred in several places including Greenwood.[22] Ray Hoffman was one of the original gate tenders, a job he greatly loved and diligently performed. He had to crank all the gates open and shut by hand . Later Leo Olson was responsible for this job.

One of the last single operators to perform this task was Gerald Schwenn. This job is very difficult for one person because he must monitor the water level of the lake constantly and be on-call all day, everyday, rain (especially rain) or shine.

When he retired in 2001, it took three men to replace him. Today, Terry Schultz, Doug Larson and Brad Lovelace all take turns monitoring the dam and water levels.



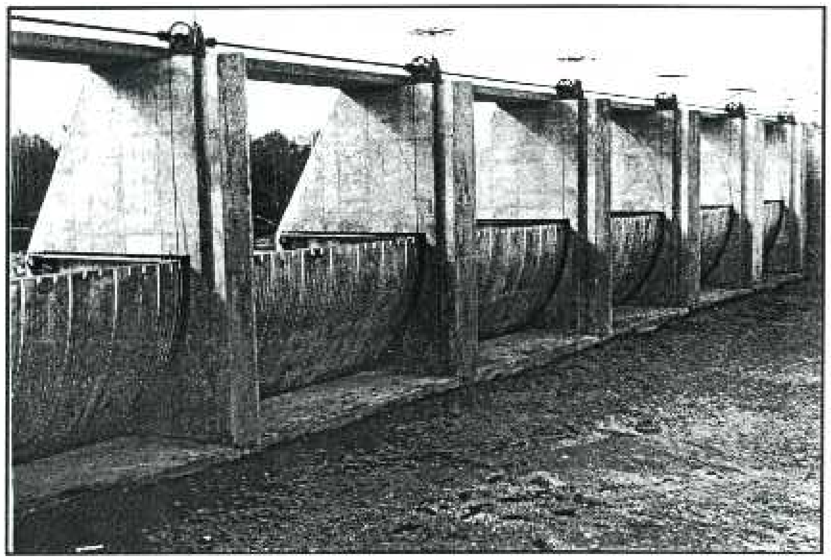
View of new gates from the front

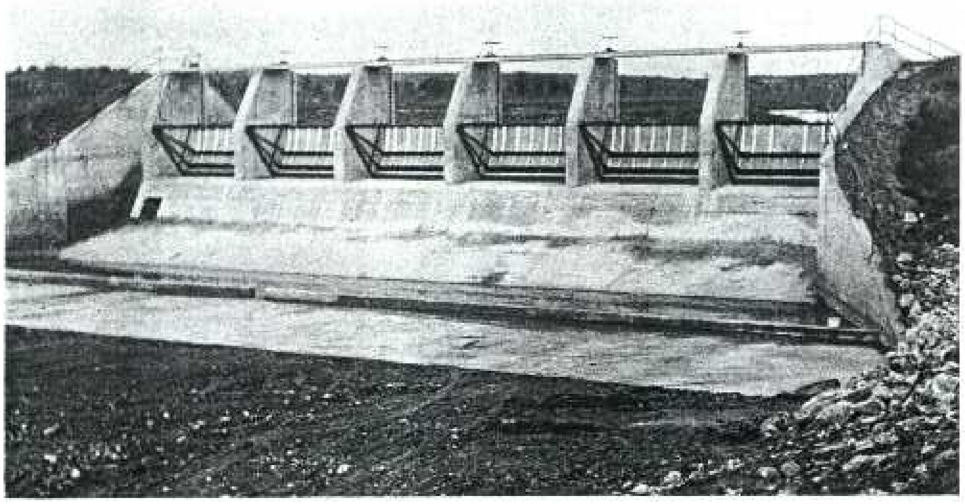
Picture courtesy the Hoffman Family

[22] "New Spillway of Mead Dam is Completed and Goes into Service," *Clark County Press* 13 October 1955: 1+.

The Much Anticipated New Dam Gates 1954

View of new gates from the lake side.





New Dam Gates in Use

Pictures courtesy Hoffman family

Since 1955 there have been various repairs made to the dam. The following is a chronology taken from notes submitted by the Forestry and Park Committee regarding the Mead Lake dam, lake, and parks.

1961: Lake and some 25 miles of the Eau Claire and its tributaries were treated with toxicants to remove rough fish this summer.
-Lake was stocked with walleye and bass fingerlings.
-Carp seining areas were made for future rough fish controls.
-Dam gates were repaired.
-A 25 unit campground, toilets, a shelter, boat landing and beach will be added.

1962: -A break on one of the gates at the dam forced emergency repairs at the dam. Next year all gates will be strengthened as a precautionary measure.
-A plan for a campground and beach on the north side of the lake has been prepared and partially laid out. Work will be done next year to complete the 35 unit campground. This will include one-quarter mile of new town road, one-half mile of new camp road, one toilet and one well.
-The boat landing on the south side of the lake will also be improved.

1963: -The 35 unit campground on the north park has been completed and will be ready for use next year. A beach area and picnic area will be completed next year. This will include a shelter, parking lot and changing booth.

1964: -The Mead Lake is growing in popularity. In time it is hoped that it will rival Russell Park.
-A new beach and picnic area has been completed on the north park.
-These facilities, along with the 33 unit campground that was completed last year, make a fine addition to the park system. The facilities included a 30 X 60 foot shelter, a set of changing stalls, a new toilet, and a parking lot. The Wisconsin Conservation Department contributed $9,350 toward the development of this park.

1966 -A new toilet was installed at the dam
-Cement steps were constructed along the abutments of the dam.
-Fishing has been good this past season with muskies up to 41 inches long being caught. These fish were all stocked in the flowage since the summer of 1961 when all the fish were eradicated.
-Boating and waterskiing was very popular this year
-Camping about the same as last year
-Considerable duck hunting this year

-Forestry and Park Committee suggested that hard surfaced roads leading to dam would attract more people.

1968: -Boat landing was constructed at Mead, near the north park. This added convenience for the campers and public using the large picnic area there. The Green Thumb crew helped with this project.

1969: Electricity was installed at some of the campsites at Mead Dam this summer and the road through the camping area was repaired.

1970: -Extensive repairs to the dam gates and river channel due to erosion.

1971: -Parking lot constructed in the Mead Dam area for fishermen.

-More camping sites were provided due to the increase in the number of campers.

-Chemical control for algae was used on the lake this past summer. This along with the draw down of the lake (approximately 2 feet this winter) is thought to control the algae problem.

1973: -Mechanically operated gates were installed at dam.

-New shelter building, barbeque grill, and playground equipment added at campground along with a blacktopped parking lot and road entrance.

1974: Improvements this year:

A new boat landing and ramp were constructed, parking lot area blacktopped, new well drilled, car curbing was installed

1976: Construction of a sanitary dump station to enhance the camping facilities. This type of facility is important to the camper who has a self-contained unit. A charge of 50 cents per dump helps supplement the operating costs of this facility. This project also was cost-shared by ORAP local park aids program.

1984: Clark County had the opportunity to receive 50% cost sharing for the development of a new park by Mead Dam. The Forest and Park Dept. constructed a new shelter building, barbeque grill and play ground equipment.

-blacktopped parking lot and roadway entrance.

-approximately three acres of camping area was brushed, stumps and rocks removed, landscaped and seeded into grass. This enhanced the environment of the area in promoting greater camper usage. Many favorable comments in regard to this project.

1988: -Repaired cement on dam and replaced two gates. This project was very time-consuming because the department is not equipped nor do they have the experience in repairing dams. Also limited amount of manpower within the department. Many times other priorities arose causing them to stop work on the dam and do other jobs.

-The state DNR inspected the dam in September. This inspection was to cost $2500.00.

Past Presidents of the Mead Lake Club

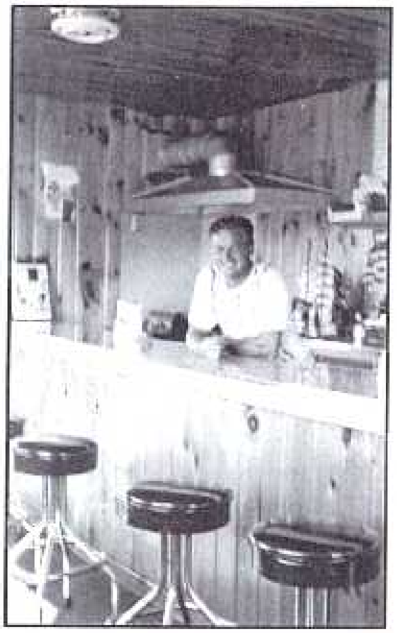
1959 Harry Liebzeit
1960 Lowell Dorn
1961 Dr. Smith
1962 Robert Stewart
1963 Walter Krultz
1964 Dr. Koepp
1965 Dr. Koepp
1966 Dr. Koepp
1967 Dr. Koepp
1968 Dr. Koepp
1969 Dr. Koepp
1870 Dr. Koepp
1971 Roger Sutherland
1972 Roger Sutherland
1973 Roger Sutherland
1974 Harold Trierweiler
1975 Harold Trierweiler
1976 Bob Beck
1977 Bob Beck
1978 Bob Beck
1979 Louis Gerhard
1980 Arnold Rasmussen
1981 Arnold Rasmussen
1982 Arnold Rasmussen resigns
1982 Bob Brom finished term
1983 Bob Brom
1984 Bob Brom
1985 Bob Brom
1986 Foster Will
1987 Foster Will
1988 Foster Will
1989 Foster Will
1990 Foster Will
1991 Foster Will
1992 Foster Will
1993 Foster Will
1994 Foster Will
1995 Dale Thomas
1996 Dale Thomas
1997 Dale Thomas
1998 Dale Thomas

Past Presidents of Lake Association

1999 Dale Thomas
1999 Charles Bena (Fall of '99)
2000 Charles Bena
2001 Charles Bena until district formed
2001 Dave Petersen-Chairman of Mead Lake Lake District

Hoffman's Resort

Anybody who was around Mead Lake during the 1950's, 60's and early 70's remembers Hoffman's. Hoffman's Resort, which opened in May 1953, was located next to the dam on the south side of the lake. It was a small, white building with a small swimming beach in front, a dock and a raft. They rented boats and sold bait to fishermen. The proprietors, Ray and Jennie Hoffman, sold lake patrons great food, soda pop, shakes, sundaes and candy. Hoffman's was home to the world famous chocolate covered frozen banana. Hoffman's closed its doors for good in September 1972.



Ray Hoffman 1954

Janet and Susan Hoffman

Pictures courtesy Hoffman family

Dale's North Mound Tavern

Another icon of the area for the past 65 years has been the North Mound Tavern, located two miles from the lake. The current proprietor, Dale Petkovsek, wrote the following history of the tavern:

Where **DALE'S NORTH MOUND TAVERN** now stands, there once was a greater school of knowledge!! The **NORTH MOUND SCHOOL**, originally located a mile east of the current site, was built in the fall of 1919. The acre of land needed was purchased for $30 from Vincent Jelercic. For an additional $1616.61 the entire school was constructed, including the well, materials and labor. An additional $602.56 bought furniture, books, and supplies.

Valentine Jeras constructed the foundation, plastered the interior, and erected the chimney. He recieved $7/day for his labor. Anton Gerc, the head carpenter, recieved $4/day for his services.

On March 6, 1920, a motion was made that every child must speak "in American" while in school! Most of whom were descendants of non-english speaking immigrants.

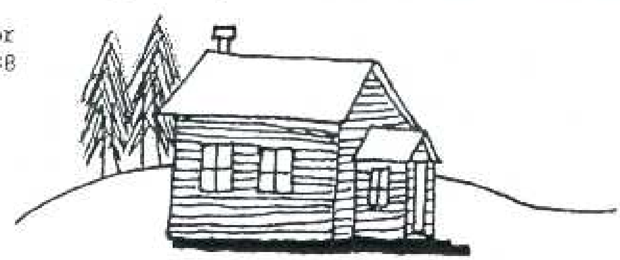
At a special meeting on August 6, 1924, it was decided to move the building to a more central part of the district. Another acre of land was again purchased for $30, this time from Mike Djubenski, and with teams of horses and using logs as rollers the school was moved to Djubenski's corner. This process wasn't completed until October, so classes were held six days a week for that year to catch up. The total cost of moving the building was $1032.50, which most likely included the foundation, etc.

The decision to wire the building for electricity was made at the July 11, 1938 meeting.

Most of the teachers were of the Clark County area, and boarded at neighboring homes for a cost of about $10/month. The classes averaged between 15-60 students, and the teachers salaries ran between $65-$110/month. The teachers were responsible for the janitor's duties; sweeping, dusting, tending the fire, etc. One teacher, Mable Gray, was only 17 1/2 when she taught in 1921. A student, Charlie Herrick, would arrive 90 minutes early to make a fire and warm up the building for the arriving students, for this he would receive 50 cents/month. The teachers would sometimes pay a dollar or two to a upper grade girl to do the sweeping after school. The students would take turns carrying water, the wood, and putting up the Flag.

Due to lack of students, the end of the school year in 1942 was the end of classes at the **NORTH MOUND SCHOOL**! In 1943 the school was officially closed. In 1947 the building was bought by the Benjamin School District and again moved, to the intersection of Cty. Hwy. O and Capital Road were it stands today being used as a family home.

John & Joe Plautz purchased the land on October 15, 1946, which was later sold to Frank & Frances Luzovec on October 15, 1947. There they built a tavern with a grocery store attached and living quarters upstairs, know as the **NORTH MOUND TAVERN!!**



Fanny & Shortie Luzovec - October 15, 1947 - May 15, 1964
Gladys Trost/Martin Matkovich - May 15, 1964 - May 19, 1967
   Leased to: Charlie & Millie Herrick, then later Vic Harder
Betty Kotcon - May 19, 1967 - January 13, 1969
   Leased to: Harvey Tuchalski
Bob Matkovich - January 13, 1969 - July 7, 1969
Helen & Swede Neuman - July 7, 1969 - November 12, 1970
Jim & Lila Olehaphen - November 12, 1970 - July 31, 1973
Edna Sandregger - July 31, 1973 - January 24, 1978
   Leased to : Bob Brom
Bob Brom - Janurary 24, 1978 - January 31, 1978
John Kramer (managed by John & Chris Regalia) - January 31, 1978 - June 30, 1983
Dale Petkovsek - June 30, 1983 - ????

From Mead Lake Club to Mead Lake Association:

Minutes taken from meetings-1959-2002

1959: November 10-Mead Lake Club formed
Harry Liebzeit-President
Otto Stock-Vice President
Lowell Dorn-Secretary
Clarence Gorsenger-Treasurer

1960: January 12-Discussion whether to name the club, "Mead Lake Club" or "Greenwood Conservation Club". Club dues: $1.00.

1961: July 5-Meeting held in the office of Dr. Smith in Greenwood. Discussion about the possibility of telephone service at or near the Hoffman resort.

1962: September 29-Two meetings a year approved. Motion to attempt to eliminate trailer parks on lake.

1964: May 30-Recommend signs, "Danger! No skiing in East Bay".

1966: September 3-$50.00 reward for vandalism. Information approved.

1968: June 1-Club to pay for pop, milk and coffee at meetings
August 31-Attendance prize of $10.00. Must be present to win.

1970: September 5-Discussed a beauty pageant with boat parade.

1971: May 29-Petition is to be made up to have blacktop roads to the lake and around it. Members to check to see about group insurance for owners. Concern about what can be done about cabin break ins.

1973: September-Lake draw down to compact lake bottom; DNR says lake district can be formed even if county owns land.

1974: May 25--Cost problems in getting a sanitary district

1976: May 28-Interested members to meet at "The Stump" on July 4th and try to remove it.
September 5-A committee looks into possibility of buying lake lots.

1977: May 28-Motion made to have the Club fabricate and install a boating safety and traffic danger sign at the boat landings.
September 4-Dues raised to $5.00 a year.

1978: May 27-Look into automatic gate openers for dam. County to look into long term leases instead of purchase of land.

1982: July 3-Ken Speich, Forest and Park Representative, feels lake district is feasible and is in favor of it.

1984: July 7: Club dues raised to $10.00 a year. Recommendation to try to form a lake district.

1985: May 26-Establish lake district and apply for funds. Use soil conservation

department for funding . Start at the county level.
September 1- Steve Denk chairs committee on lake district.

1986: May 25-Wayne Trimberger talked about the legalities involved in a district. Bob Brom talked about advantages. Vote was in favor of pursuing a lake district.
August 31-Motion made to table the lake district formation

1987: September 6-Commercial fishermen that were netting carp in Mead Lake were not coming back that fall; they did not get many carp last time. Club offered to help with $50.00 for expenses. Fishermen not interested. DNR is in contact with Don Kirn regarding repair procedures on the dam.

1988: Mead Lake Club promoting electric gate openers to be installed to make it more convenient for the gate tenders.

1989:County hired Struensee Construction to replace two dam gates; two others to be replaced later

1991: May 26-Mead Lake residents to get street signs and fire numbers; north and south roads will be avenues whereas east and west roads will be roads.

1992: September 6-Mead Dam leaking-more work to be done on it.
-Luchterhand to check sewers for leakage; he never did it.

1993: -Daryl Braatz made up new bylaws for Mead Lake Club.
-DNR says walleyes that are 18+ inches have an excess of mercury

1994: September 4-Eleven units in boat parade.
-Foster Will was given $20.00 gift certificate for outstanding job.
-Look into differences between a "Lake District" and a "Lake Association."

1995: September 3-Board voted to change bylaws to conform to the rules of the Wisconsin Lake Association.
-Question regarding the increase of dues from $20.00 to $25.00.
-Jennie Hoffman commented that when lots were first being leased on the lake in the 1950's, the first 6 lots on the south side next to the dam were designated as business sites. Hoffmans bought the first two and ran a small shop.
-Kenny Miller suggested a carp shoot in the spring.

1996: May 25-Dues to be raised to $25.00.
-Carp shoot cancelled due to liability.
-Clark County to check septic systems
-In case the Club needed to raise money for the watershed, a lake district could be formed.
July 15-Mead Lake was made a priority for the watershed project.
$2.6 million would be allocated.
September 1-No watershed dollars; the state has pushed everything back until December because it ran out of money.

1997: Mead Lake did not get priority watershed program due to $18 million expenditure shortfalls by the state.

1988: September: Gregg Stangl applied for a new watershed program for Mead.
Price: $150 million.
-Petitions for additional lot sales. 51 members did not want any sales; 9 were for
it if members could pick lots.

1999: October-Special meeeting regarding becoming a lake district. Being a lake district
would help with problems such as the watershed and obtaining grants.
Forest and Park Notes: New ADA and CPSC compliant play equipment and
landscaping installed by dam and at campground.

2000: DNR and Clark County fully responsible for dam.
-Vote to change from alke asociation to lake district: of 223 possible voters, 164 voted "yes", 15 voted "no", 49 did not respond. Cocktail party on October 21-30 people participated.

2001: -Last meeting of lake Association
-$10,000 grant for field study
-Lake Association dissolved and all equipment, assets and liabilities transferred
to new Lake Disctict.

2002: New vault style toilets installed at the dam
Anticipated 2002: All the gates and opening mechanisms are scheduled to be replaced in the early fall. They will be much sturdier and more efficient. The cost of this project is estimated to be $375,000+.

Long gone...

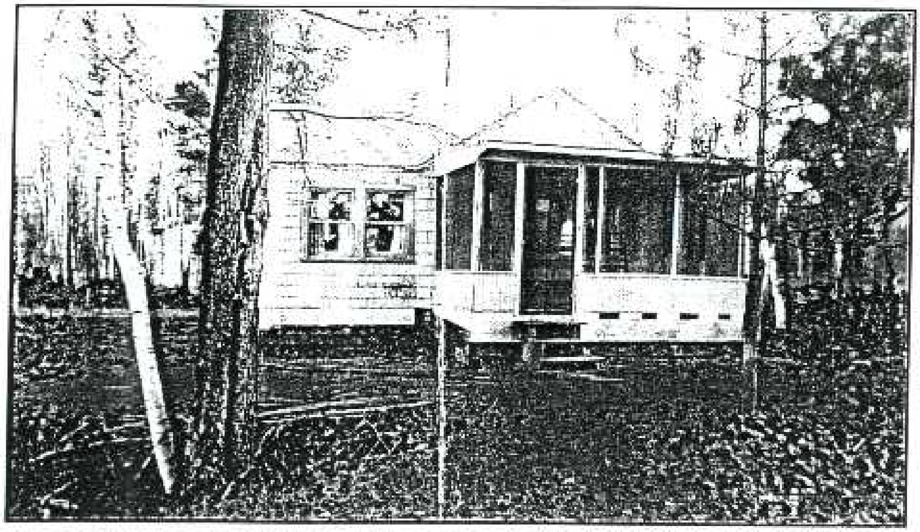
The Old Bridge

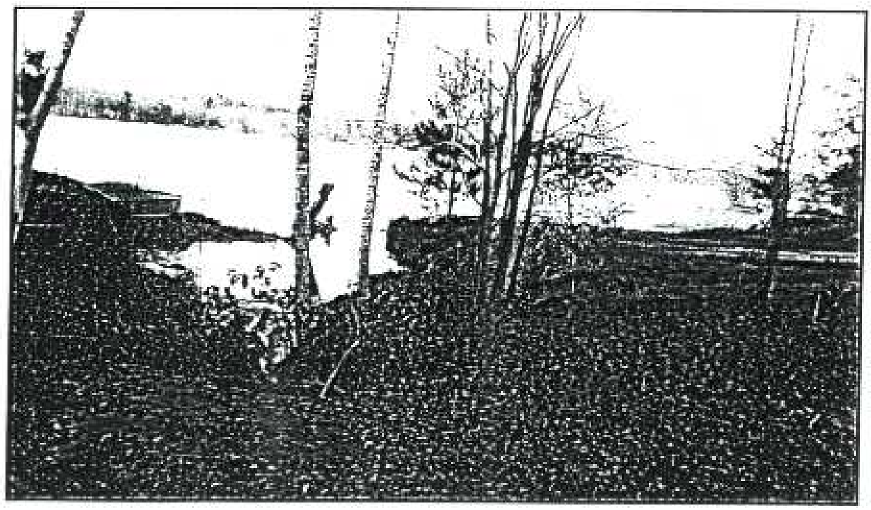
The old bridge that spanned the river that feeds Mead Lake was replaced in 1992. This bridge connects the main artery of travel for the people on the north side of the lake who were extremely inconvenienced when the new bridge was being built. When the new bridge was finished, cabin owners were all invited to a party hosted by George Bahr at Dale's North Mound in celebration.

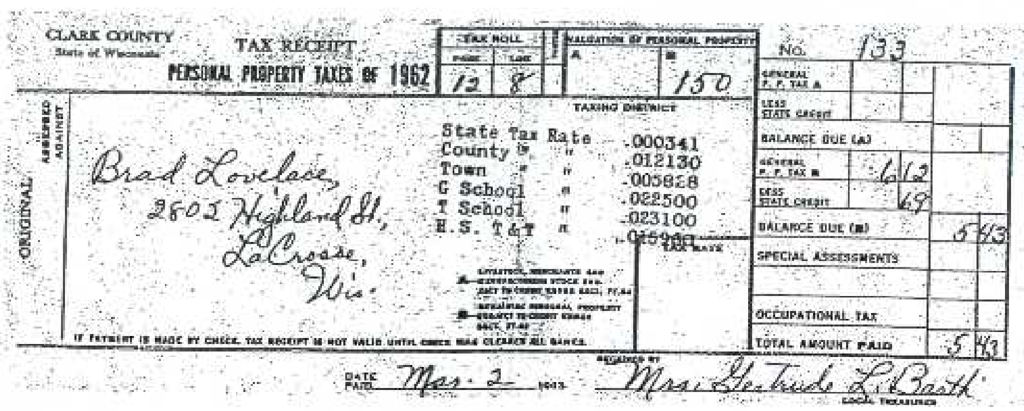
The Town Dump

The town dump officially closed in the fall of 1988. This ended the Saturday morning get-togethers and the opportunity to search for valuable treasures. The truck pictured was not part of the discards.

Old Lovelace Cabin circa 1961. (south side)






CLARK COUNTY
State of Wisconsin
TAX RECEIPT
PERSONAL PROPERTY TAXES OF 1962

Tax Roll: Page 12, Line 8
Valuation of Personal Property: B 150

No. 133

ORIGINAL — ASSESSED AGAINST

Brad Lovelace,
2803 Highland St.,
LaCrosse,
Wis.

TAXING DISTRICT

State Tax Rate	.000341
County " "	.012130
Town " "	.005828
G School "	.022500
T School "	.023100
H.S. T&T "	.015900

TAX RATE

GENERAL P. P. TAX A	
LESS STATE CREDIT	
BALANCE DUE (A)	
GENERAL P. P. TAX B	6.12
LESS STATE CREDIT	.69
BALANCE DUE (B)	5.43
SPECIAL ASSESSMENTS	
OCCUPATIONAL TAX	
TOTAL AMOUNT PAID	5.43

IF PAYMENT IS MADE BY CHECK, TAX RECEIPT IS NOT VALID UNTIL CHECK HAS CLEARED ALL BANKS.

DATE PAID Mar. 2 1963

RECEIVED BY Mrs. Gertrude L. Barth
LOCAL TREASURER

1962 Property Tax Receipt for cabin on Mead lake.

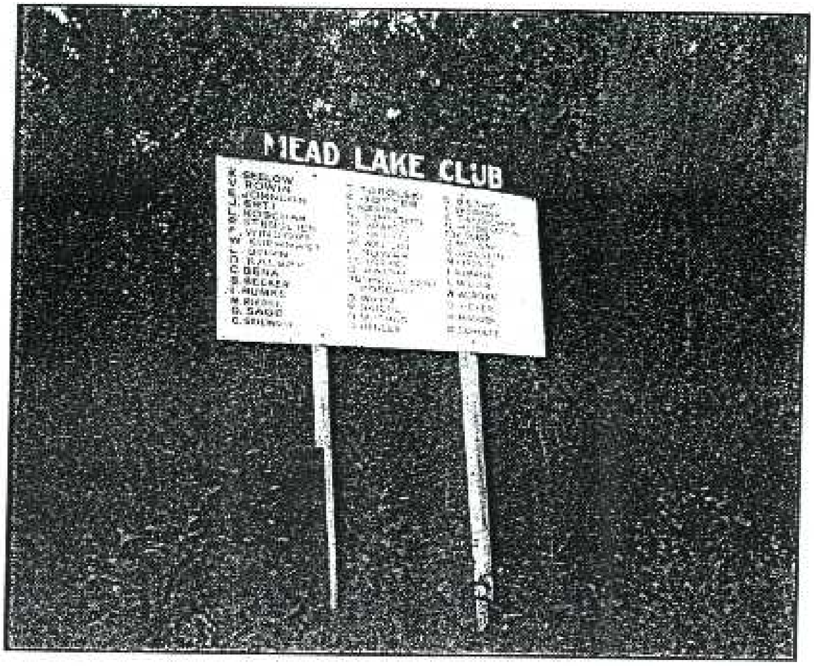
YES! You are reading that correctly - only five dollars and forty-three cents!

Bridge to cross inlet
between Larson's and
Schwenn's cabins. 1952.
(south side, near dam)

Old Hibbard cabin
1952.
(south side of lake)

Old Ayers cabin
(South side of lake)

Mead Lake Club Signs
circa 1980



Sign for north side of lake

Sign for south side of lake

MEAD LAKE

by Dale Thomas June 10, 1993

In1957, Jerry Sowieja, Billy Stabnow and I, Dale Thomas, leased some of the last lots left on Mead Lake. There wasn't't any road into our lots. We cut the road in, that you now call Wills Loop. We cleared the trees and brush off the lots and took a tractor and quack digger to clean up the land. Our children were small and we used to leave the trunk open on the car with baby blankets and the smallest ones sleeping in the trunk while we worked evenings cleaning up the lots. We had the lots a few years before we could afford to build a cabin on them. When I built mine, I could only afford a shell. We put the plumbing in but didn't have a pressure system. We carried water from our diven point for a few years before we could afford to have a well drilled. As the years went by, we added on and finished the inside. I hauled in rocks and lined the shoreline to keep from loosing any more shoreline. I had several loads of black dirt hauled in to spread on my lawn, which I did all with a wheelbarrow. I hauled many loads of gravel and spread on our road and smoothed it with a tracktor and blade as that was a private road for many years before we managed to get the township to call it a town road so they would grade it. We had some large oak trees blow over, which we cut up and dug the stumps out by hand with a pick and shovel.

When they drained the lake and killed all of the fish, we helped clean up the dead fish.

I planted all of the pine trees on my lot. I got full of poison ivy transplanting some wild roses from my folks farm to my lot.

For several years, we used to catch fish below the dam and carry them up and turn them loose above the dam. We only took the walleyes and muskies up above the dam.

As far as I know, I think the mead lake citizen association was the beginning of the Mead Lake Club. I may be wrong, but it seems to be that that is what it was called at first.

No one had much money so we all tried to improve our lot as best we could with whatever means we could.

the county and township had layed out a few rules that we all had to follow. Some that I remember was that you couldn't install a trailer house. We had a few years to build a permanent struckture and if you didn't get it built, county would cancel your lease. Even back then we had to get permission to install rip-rap on the shoreline. the lots was 75 ft. wide and the length was determined by how far it was to the road. I furnished all of the mental stakes that was put in when they surveyed the lake. the county brought them from me. Buckwheat Jolivette made the arrangements for me to cut the stakes to length and furnish the material for them. He worked for the county at that time. I would guess this was sometime in 1957. I think the club started about that same time.. In 1957 or 58. I went to milwaukee in 1959 and it seems like the club was already going then but I may be wrong. this is just guessing. I have been in it ever since it started. I think Ray Hoffman was the first president.

That's about all I can think of for now.

Dale Thomas

Kippenhan School on County Road MM first shown on 1906 Map. Used as Mead Town Hall until 1989. Currently a hunting camp.

The "Good Times"

And

The "Not So Good Times"

GOOD TIMES ON MEAD LAKE

THERE HAVE BEEN MANY ACTIVITIES ON MEAD LAKE THAT CAN BE CONSIDERED "GOOD TIMES". THEY INCLUDE STEAK FRIES, BRAT FEEDS, DALES ANNUAL GET-TOGETHER, BOAT PARADES (HELD ON THE 4TH OF JULY) AND THIS YEAR CARP DAYS. SO ENJOY SOME OF THE PICTURES OF THE "GOOD TIMES" GET TOGETHERS.

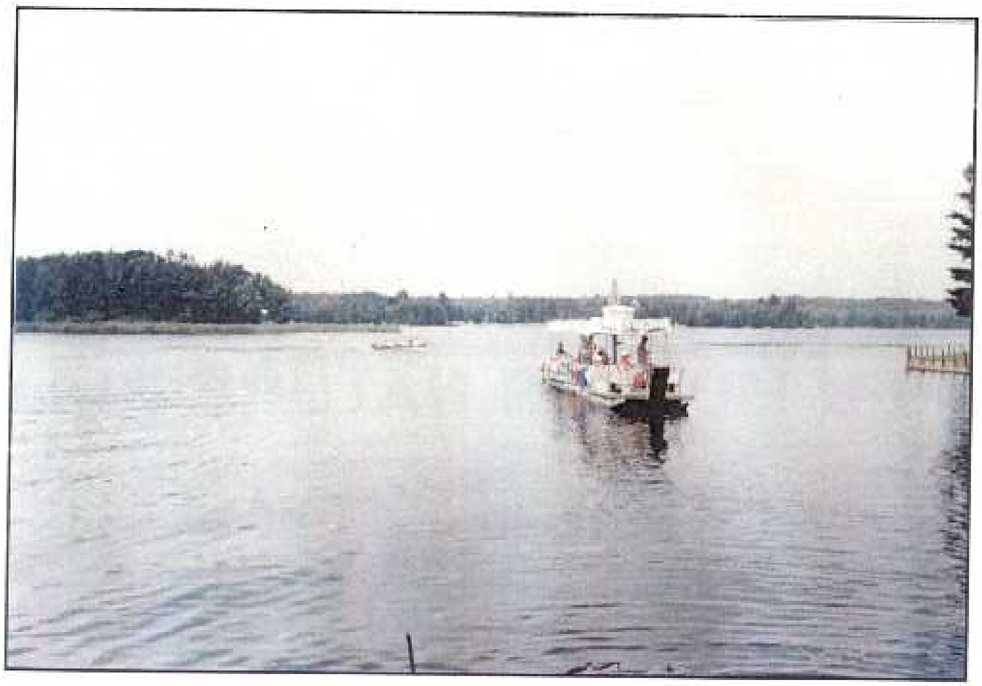

July


Mead Lake Queen


MEAD LAKE


3
3
JuLy


USA DAIRYLAND



**Once the work was done, the fun began.
You usually toured the whole lake as a group and then would meet at the South Side Park. Sometimes just to laugh & talk, other times to enjoy brats & beer. These definitely were the "good times".**

WHEN MOTHER NATURE RULES

IF YOU HAVE BEEN AROUND ON MEAD LAKE FOR A FEW YEARS, YOU REMEMBER WHEN SHE "RULED" OUR LAKE. THIS IS A PICTURE OF THE DAMN WHEN ALL OF THE GATES ARE OPENED TO TRY AND CONTROL THE RUSH OF WATER THAT WE USUALLY SEE 8 - 12 HOURS AFTER IT HAS RAINED NORTH OF US. THE TWO MOST MEMORABLE FLOODS WERE IN 1982 AND 1993 --- LOOK OUT FOR 2003 (it seems to happen every 10 years).

1982

Some of the cabins had over 36" of water inside. Clean up was a "huge" job.

1982

Most of the roads and driveways were impassable.

1982

South Lake Road washout

After a flood - the debris left behind creates a "mess" that is not easy to clean up.

1993

1993

"How high is the water ma ma?"
"2 feet high and rising."

1993

Once again, all roads became impassable. This is South Lake Road in '93.

1993

If you lived on South Lake Road, there was no way to leave. There was major road damage no matter if you went East or West.

1993

Hopefully, this will be the last picture taken of a flood on Mead Lake.

MEAD LAKE'S FIRST ANNUAL CARP DAYS

2002

Seeing this was our "First" Carp Days and that Mother Nature did not cooperate (the carp were not as active as hoped) the weekend turned out to be a success. There were 32 carp taken out of the lake.

On Sunday, we had a chicken feed. By the end of the day, when we were all very tired and all the chicken was gone, then and there, we decided to call it a "SUCCESS".

There are too many people and businesses to list who donated their time and products, so we will just give each and everyone one of you a hugh "THANK YOU".

One of the boats used during "Carp Days" on Mead Lake. The best time to shoot carp is the "wee early" morning. Instead of fishing with poles, the carp are shot with bows.

Some of the "Carp Shooters" and their "catch of the day".

Some of the carp were picked up and taken home for smoking. The rest was handled by "Barrs" animal food business.

The chicken feed was held on Sunday, June 2, 2002 at the park by the dam. The "Feast" consisted of chicken, baked beans, chips and buns.

We hope that you enjoy this book.

We want to "Thank"
The Trierweiler Family
for donating the money that
made this book possible.

The first 50 years definitely had
its "ups and downs" but the lake
is still here and hopefully
will be here to celebrate its 100th.

Supervisor Rasmussen moved the County Board of Supervisors go on record as favoring the construction of a dam on the Eau Claire river in the town of Mead.

Supervisor Brinkmeier moved an amendment that such construction be done only after the dams already built are repaired.

Supervisor Schultz moved to adjourn to 1:00 P. M. Thursday, April 17, 1947.

Neillsville, Wisconsin
April 17, 1947
Thursday P. M.

Meeting called to order by Chairman Stadler.

Roll call taken by Clerk. 47 present, 5 absent.

Minutes of previous meeting read and approved as read.

Supervisor Brinkmeier moved to withdraw his amendment to the motion on the town of Mead dam, that such work be commenced only after the dams already constructed are repaired. Motion carried.

Supervisor Rasmussen moved to withdraw his original motion that the County Board of Supervisors go on record as favoring the construction of a dam on the Eau Claire river in the Town of Mead.

Resolution on the town of Mead dam read.

RESOLUTION ON THE TOWN OF MEAD DAM

WHEREAS, it is a known fact that all conservation minded citizens and various other groups in Clark County are desirous of creating lakes within the county for the purpose of fishing, recreation and cottage building sites and,

WHEREAS the Eau Claire river in the town of Mead would provide all of these facilities if a dam were constructed

NOW THEREFORE BE IT RESOLVED THAT the Clark County Board of Supervisors petition the State Conservation Commission to construct a dam on the Eau Claire river in said town of Mead, the same to be financed out of the State Public Hunting and Fishing Fund.

BE IT FURTHER RESOLVED THAT Clark County donate the land in forest crop to the Public Hunting Grounds Division of the Conservation Commission that will be flooded, reserving all shore line rights.

A. E. Stadler	Edward Murphy
Arthur Baures	Peter A. Hemmy
Frank Hoffman	Charles Seif
Walter W. Bratz	Arnold Rasmussen
Chet Daines	Arthur Wegner
W. F. Nolecheck	Oscar Brinkmeier

Supervisor Christianson moved the adoption of the resolution. Motion carried.

Mr. Fradette appeared before the Board.

Mr. Wuethrich appeared before the Board.

Resolution on purchase of excess roll read.

RESOLUTION ON PURCHASE OF EXCESS ROLLS

WHEREAS, the County Board is authorized by a two-thirds (2/3) vote, to direct the County Treasurer to purchase and assume such delinquent taxes and tax certificated and interest thereon from any town, city or village pursuant to section 59.08 (27) of the Wisconsin Statutes,

NOW THEREFORE BE IT RESOLVED, that the Clark County Treasurer is hereby directed not to purchase the excess rolls for the 1946 Real Estate taxes and that remain unpaid on July 31, 1947.

FINANCE COMMITTEE
O. E. Parkinson
O. W. Lewerenz
Emil Welzien

Supervisor Parkinson moved the adoption of the resolution. 27 ayes, 24 noes, 1 absent. Motion carried.

List of 1947 Dance Hall Inspectors read.

DANCE HALL INSPECTORS — 1947

Town of Dewhurst
Anthony Mack, Neillsville
Town of Foster
Clarence Butler, Thorp
Town of Fremont
Vic. Montag, Chili
C. A. Nevins, Chili
Town of Seif
Lyle Humboldt, Willard
Town of Sherman
Herb Adler, Spencer
Town of Sherwood
Walter Hansen, R3 Granton

April 1947 Clark County Board Proceedings

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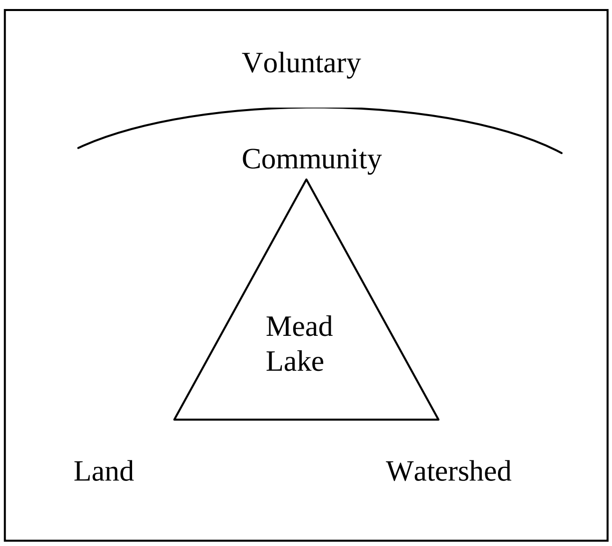
Summary of Mead Lake Restoration Strategy Meeting
Greenwood American Legion, Greenwood, WI
7:00 – 9:30 PM Thursday, November 13, 2008

Staff present: Karen Voss, Mark Hazuga, Ken Schreiber (DNR); Matt Zoschke (LCD); Dan Zerr (UW-EX)

Attendees:

Self-Identified Category	**Approximate Number**
Local government (County or Town Boards)	12
Resident near Mead Lake	20
Farmer	20
Retired	2
Farm Bureau	2
Citizen	2
Fisherman	2
UW-Extension	1
Volunteer Stream Monitor	2
Land Conservation staff	2
Business (owner?)	1
Law Enforcement	2
Total	**65-70**

Matt Zoschke gave a brief welcome to attendees, emphasizing key elements of a process to develop Mead Lake improvement strategy, using a diagram to illustrate:



Matt's key points were that the discussion tonight was focused in voluntary efforts that the community as a whole could choose to do on the land and in the watershed to benefit Mead Lake, and that community support and involvement is key to improving Mead Lake for everyone's benefit.

Dan Zerr gave a brief introduction and invited attendees to introduce themselves (see attendees list, above).

Citizen-Led Mead Lake Watershed Restoration Strategy – Power Point Presentation by Dan Zerr

- Summarized key components of a citizen led strategy
- Identified general 4-step process: Coming Together, Assessment (gathering information), Designing the Strategy (goals and actions) and Implementation (gather & administer resources, execute).
- Emphasized this as a citizen-let effort, not a top-down approach. Key to success depends on citizen/stakeholder involvement; agencies (also stakeholders) are there to provide assistance.
- Identified anyone who benefits from Mead Lake as a stakeholder.

Watershed Basics and Mead Lake Water Quality and Watershed Monitoring and Modeling Summary – Power Point presentation by Ken Schreiber

- Explained the basics of a watershed, and factors (soils, slope, land use) that affect runoff water quality
- Illustrated Mead Lake's watershed & general land uses
- Summarized Mead Lake phosphorus loading sources, amounts and impacts
- Described SWAT modeling and future "what-if" land use scenarios to predict changes in P loading
- Identified the 30% P load reduction goal and associated predicted water quality improvement.

Attendee Issues Identification – Dan Zerr led the group in identifying and recording key issues they consider important for Mead Lake. He clarified that this was an opportunity to identify with a word or phrase an issues of concern related to Mead Lake, but not a detailed discussion or critique of the issue, or an attempt to identify solutions. Thirty-one issues were offered:

1. Phosphorus
2. Clear cutting
3. Money – funding
4. Educating people (who aren't here tonight)
5. Cattails
6. Fertilizer on lawns
7. Septic systems
8. Residential runoff
9. Sediment
10. Manure runoff
11. Wildlife populations
12. Motor boats (stirring up sediment)
13. Leaf Litter
14. Water depth/shallowness
15. Swimming
16. Fishing
17. Too many carp
18. Cost sharing programs-farmers & landowners
19. Manure management (daily haul vs. storage)
20. Cows in streams
21. Is P the only cause of algae blooms?
22. P in feed – feed type to reduce P in manure
23. Aesthetic value of the lake
24. Planting natural buffers/barriers
25. Lake oxygen levels –winter & summer
26. Economic impacts

27. Dredging
28. Road dust control
29. Looking at other examples of lake management
30. Buffers for more sensitive areas
31. Put land in CRP

This was followed by an opportunity for attendees to ask questions or make observations. Dan Zerr moderated this discussion. Questions and responses were as follows:

1. How can you tell the source of the phosphorus – which is worse, P from fertilizer, or P from manure?
   Matt Z; P is P, no matter where it comes from, and it is everywhere. The goal is to identify where it can most effectively be reduced in P loads to Mead Lake.
   Ken: Where P can be reduced would need to be identified on a farm-by-farm basis. Each farm is unique, and analyzing and planning for each farm would need to be individual.

2. Are some soils naturally high in P?
   Matt: Yes. In field sampling, they found some forest soils at 17-18 ppm. Most ag fields are higher than forest soils, but it is highly variable. Land closest to barnyards tends to be highest in P. The importance of nutrient management is to look at manure as a resource, and identify how most cost-effectively to put it to use.

3. What is a TRM grant? (Requested farmer in the audience with a TRM grant to describe his operation and what he is doing with the grant.)
   Matt: Briefly described the Targeted Runoff Management Grant program, and how Clark and Taylor counties worked together and with the farmer (Mike) to apply for funding.
   Mike (farmer): He bought the farm two years ago. On previous farming operations, he has always looked at manure as an asset. This farm does not have manure storage, and as a result they are not able to effectively use manure nutrients. Therefore, he sought cost sharing to install manure storage. He and Matt Z. worked together to come up with the best plan for his farm.

4. One long-time resident's comments and observations:
   a. Complimented Matt Z. on a recent TRG (?) news article as being very good and accurate.
   b. He has known Mead Lake since the dam was built, and observed that water quality problems have existed since the first decade after the dam was built.
   c. Expressed some frustration that data on the lake and watershed has been collected for years, but they seem to have been "spinning their wheels" on getting implementation underway.
   d. Ongoing education is crucial – Mead Lake needs to stay in the public eye and in the media.
   e. Soil testing is the foundation of nutrient management, and needs to be promoted.
   f. His first-hand experience with using a sediment probe convinces him of the extent and complexity of sediment deposition throughout Mead Lake.

5. Please discuss the use of barley bales to control algae.
   Ken: As it decomposes, barley releases an algae toxin. However, it is only really effective on small ponds, as it is not possible to get this approach to work effectively on a large waterbody.

6. How long will Matt Z. be Clark Co. Land Conservationist? We need his leadership!
   Matt: He has no plans to leave, though recognizes his term depends on the County Board.

7. Comment: "Algae blooms are a part of nature, and they shade and protect aquatic vegetation."
   Ken: What Mead Lake has are excessive algae blooms, which are detrimental.

8. Comment from long-time resident: "These same discussions about Mead Lake water quality have been happening since the 1970's, but we have not seen any implementation of practices to change things. It's very frustrating."
   Dan Z: Now is the opportunity, but this is not an "easy" process. Things can be accomplished, but it will require stakeholder commitment to the effort.

9. Comment from attendee: Noted that this evening's meeting was attended by a good diverse group, and that this is important.

10. Comment from young farmer regarding opportunities to make changes now, compared to in the past: He observed that soil testing and nutrient management planning have become the "normal" thing to do now, and this is a big change from the past. He sees this as really making a long-term difference in the ability to improve Mead Lake water quality.

Solicitation of local citizen/stakeholders to continue the Lake Restoration Strategy Process
Dan Zerr encouraged attendees to sign up to be on the Stakeholder Leadership Team (SLT). He emphasized that this is not a "closed" process. Anyone can attend meetings, and SLT members may come and go. However, it is important to have individuals who will commit to working through the strategy development process. Meetings will likely be scheduled approximately once per month. (Dan Zerr has the sign up sheet – approximately 20 people signed up.)

Wrap-up:
Informal discussion continued for about 30 minutes over pies and refreshments. The meeting ended at approximately 9:30 pm.

Summary prepared by Karen Voss 11/17/08

The Mead Lake Property Owners: Their Views on Water Quality of the Watershed And Their Management Practices

Prepared for the Mead Lake and Watershed Partnership
Dan Zerr, UW-Extension Basin Educator
Matt Zoschke, Clark County Conservationist

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November, 2009

Introduction

On behalf of the Mead Lake and Watershed Partnership, the Environmental Resources Center, designed and conducted a survey of owners of properties bordering Mead Lake. After this introduction, seven sections present findings according to categories of survey questions:

- The Respondents and Their Property, (Questions 1, 2, 29 through 32, 17 through 23)
- Management practices and Decision Making Factors (Questions 24 through 28),
- Recreational use of the Watershed and Perceptions of Water Quality (Questions 3, 4, and 5),
- Problems and Conditions (Questions 7, 8, 10 through 12)
- Contributors to Water Quality Problems (Question 9 and four statements from question 6)
- Willingness to Change, Voluntary Efforts Versus Regulations and Dredging (Question 6)
- Current Involvement in Improvement Efforts and Concerns (Question 13 through 16).

The report ends with conclusions followed by appendices. Methods and procedures will now be covered.

Census, Survey Administration and Response Rate

All owners with parcels on Mead Lake received a survey, making it a census. Appendix A has a map showing locations. The Clark County Conservation Department determined that there were 132 owners with shorelines and provided addresses for legal residences. A survey was prepared after the Mead Lake Partnership Leadership Team identified topics. The Team reviewed all drafts. Jordon Petchenik from the Wisconsin Department of Natural Resources Bureau of Science Services critiqued and approved the survey. See Appendix B for survey.

The survey was conducted from August 13, 2009 to October 15, 2009 following research based methods[1]. Surveys were mailed first class and involved four contacts. Individuals received advance letters addressed to them on stationary with the Partnership logo and signed by Daniel Zerr, UW Extension Basin Educator, Matt Zoschke, Clark County Conservationist and Allen Hemann, former Mead Town Chair and a farmer from the Watershed.

Within one week after mailing the advance letters, all households received a survey packet that had a questionnaire, a pre-addressed postage-paid envelope, and another letter describing the survey. Surveys were returned to Dan Zerr. All respondents were assured of confidentiality. Those not responding after seven days received a follow up letter. Households that did not respond within 10 days of the follow up letter received another complete survey packet.

When the survey was closed on October 15, 2009 there were 116 returned and completed surveys. This meant a robust response rate of 88%. There were no bad addresses.

Data Analysis Procedures

Survey responses were coded and those representing numbers were entered into SPSS, a statistical software package. Responses to open-ended questions were inputted into a word processing file. Patterns, trends and/or relationships within, among and between numbers data were identified using percentages and means. These were studied using inductive and deductive reasoning and eventually resulted in findings. Data from opened ended questions were also studied using inductive and deductive reasoning to first identify patterns or commonalities, which were then further studied and culminated with findings.

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[1] Dillman, D. (2007). *Mail and internet surveys, the tailored design method.* Hoboken, NJ: John Wiley.

Graphs and tables have a notation of *N*=. This refers to the actual number of respondents who completed the question or its sub-parts. This varies because of skipped questions.

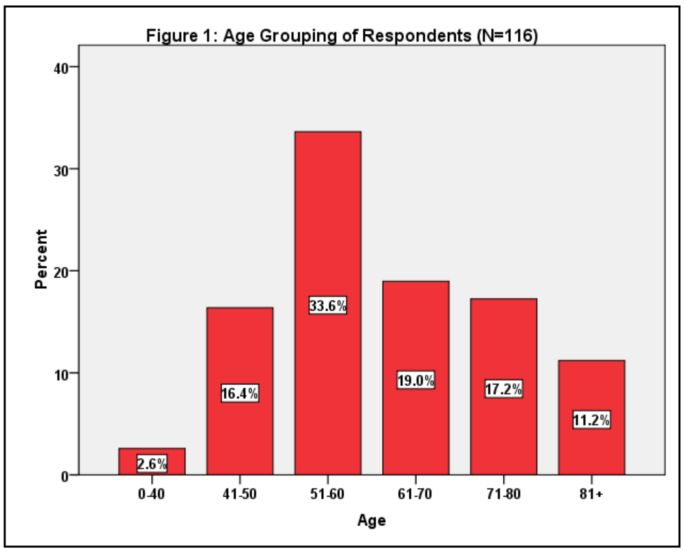
Respondents and Their Property

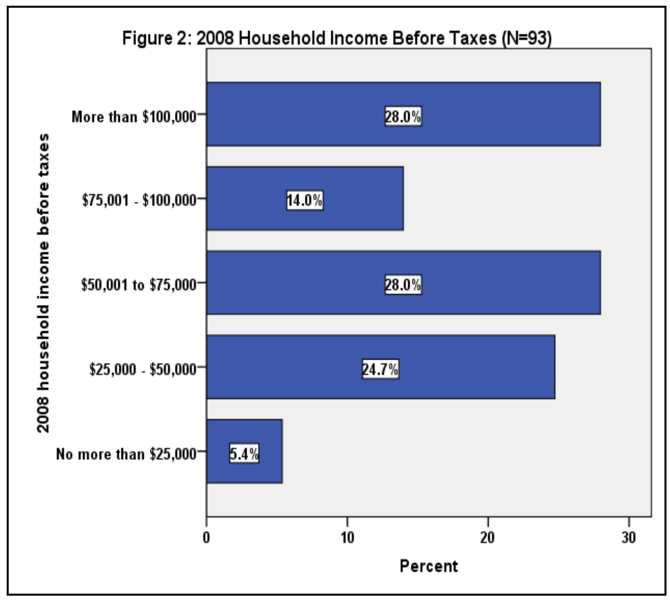
Findings about respondents (i.e., those who completed the survey) and their lake property are now presented. Just over half (50.5% or 56) completed the survey alone, while the remainder did so with another household member. Of the 113 respondents, 95.6% or 108 knew they lived in the Mead Lake Watershed before receiving the survey.

Demographics

Gender, Age and Income: Seventy-nine percent (79% or 88) of the 111 respondents were male. The average age was 60 and ranged from 35 to 88. Figure 1 shows the distribution.

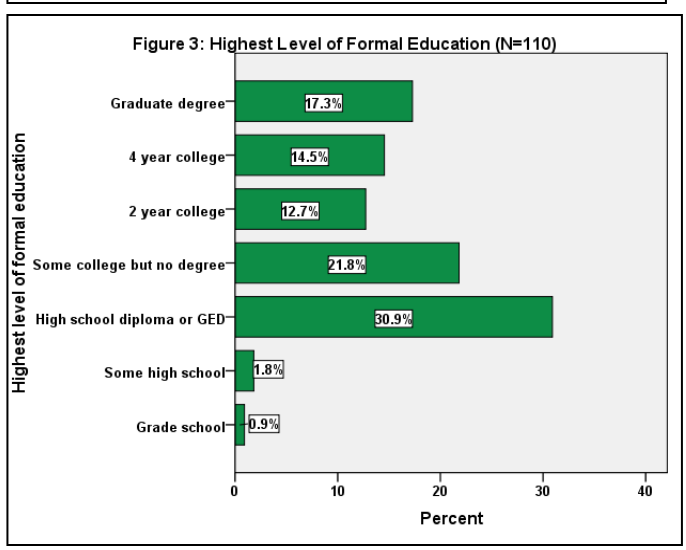
As Figure 2 shows, nearly 25% of the 93 respondents had 2008 household income (before taxes) between $25,000 and $50,000 and 28% had incomes between $50,001 and $75,000; equaling 53% of all respondents. Those with above $75,000 equaled 42% of the respondents.





Education: More respondents have college degrees than do the population of Clark County. According to 2002 Census data 7.4% of the County's population had Bachelors, 2.9% had a graduate degree, and 22.4% had some college. Within the county, 42.6% were high school graduates.[2]

As Figure 3 shows, nearly 31% of the respondents had a high school degree or GED and 22% completed some college. 4-year College degrees equaled 14.5% and 12.7% completed 2 years of college. About 17% had a graduate degree.



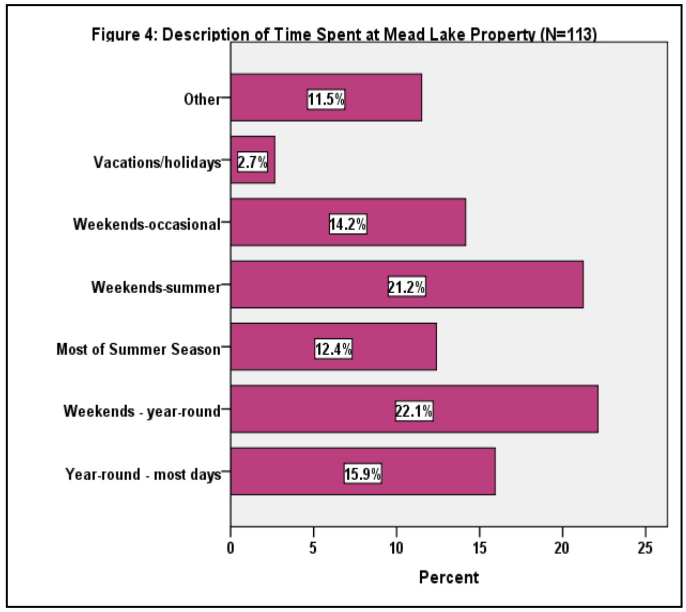
[2] Accessed on November 4, 2009
http://www.epodunk.com/cgi-bin/educLevel.php?locIndex=23112

Lake Property Characteristics

Years Owned: Respondents were long term Mead Lake property owners. Specifically, lake property was owned for an average of 21 years with a median of 18 years and a range from 1 year to 75 years (family owned).

Summer Time Non-residents: For 82% or 93 of the 113 respondents Mead Lake property was not their primary residence. Their legal residence was elsewhere.

As Figure 4 shows, most respondents spent at least summer weekends at their property with 22% or 25 spending weekends year round at their property.

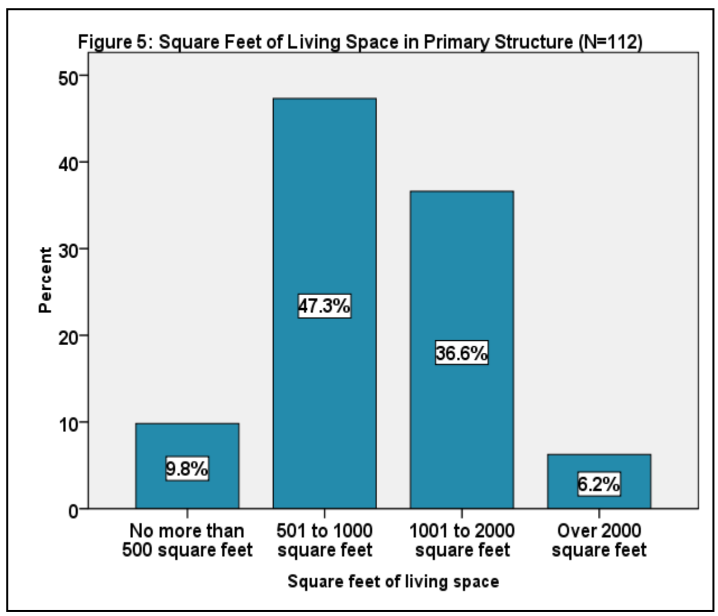


Dwelling: The living space of the primary structure on the property is relatively modest for nearly a majority of the respondents. As Figure 5 shows, close to half (47%) of the primary structures were between 501 and 1,000 square feet.

Another almost 37% had a primary structure between 1,001 and 2,000 feet. About 6% had living space over 2,000 feet.

Water Frontage: Reported number of feet of water frontage would put most in the classification of being mid-size, with 84% or 94 of the 112 respondents having 50 to 100 feet of water frontage on their property.

Another 12% or 13 had 101 to 200 feet of water frontage. Only 3% had less than 50 feet and 2% had more than 200 feet of water frontage.



Banks: Heights of banks at shorelines are low for almost all respondents. Ninety-five percent (95% or 106) of the 112 respondents classified their shoreline as a “low bank” (10 feet or less) and the remaining (5% or 6) had a “high bank” (greater than 10 feet).

Shoreline Features: Riprap (rock) was on close to 80% of respondents' shorelines. Slightly more than a third had sheet piling seawalls.

Considerably fewer respondents had other possible shoreline features, as shown in Table 1. For example, about 15% had a beach and 19% had wetland/marsh.

Table 1: Features of Respondents' Shoreline		
Types	**Yes**	**No**
Riprap (rock) (N=108)	79.6%	20.4%
Sheet Piling Seawall (N=116)	34.5%	65.5%
Wetlands, Marsh (N=79)	19.0%	81.0%
Beach (sand/gravel) (N=78)	15.4%	84.6%
Wooden Seawall (N=80)	7.5%	82.5%
Concrete Seawall (N=77)	5.2%	94.8%

Management Practices and Decision Making Factors

A considerable portion of the survey focused on what land management practices were being used, including factors related to how respondents made decisions about their lake properties.

Factors Affecting Decision Making

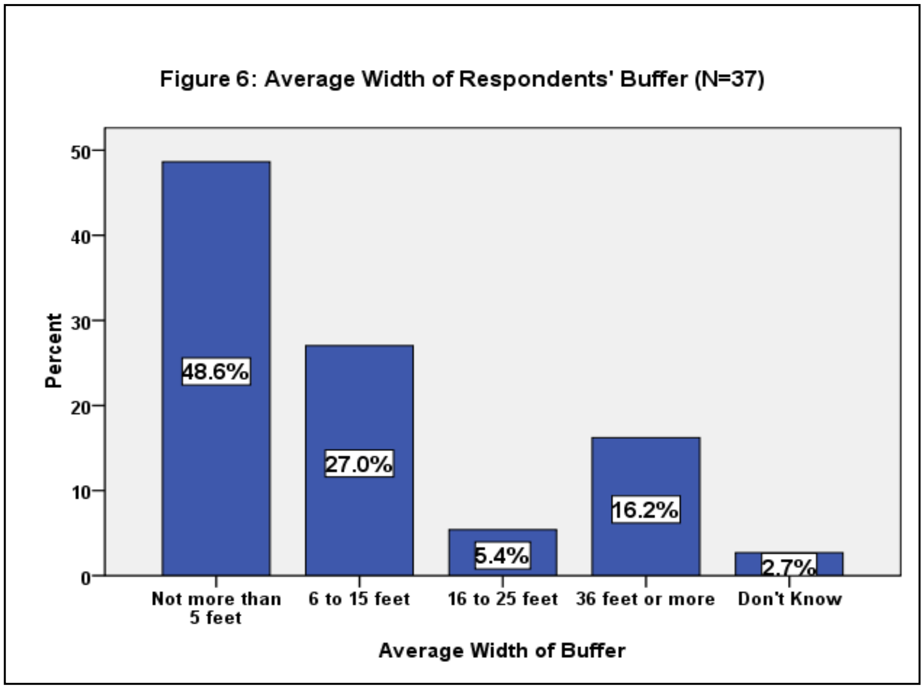
Respondents were asked how important five factors were when they made decisions about changing, improving, or maintaining their lake property. As Table 2 shows, large percentages considered all of the five factors to be either somewhat or very important. Nearly all (98.2%) respondents rated *the effects on water quality of Mead Lake* as being either *very* or *somewhat important* when they made decisions about their lake property. Likewise, nearly all respondents rated *effects on local fish and wildlife* as being somewhat or very important.

Percentages that considered effects on lake views from home and effects on property values as being either somewhat or very important decreased slightly. Neighbors' attitudes/views were also to some extent important to 65.4%, when they made lake property related decisions.

Table 2: The Importance of Five Factors To Making Decisions About Changing, Improving or Maintaining Mead Lake Property					
Effect	**N**	**Not at All Important**	**Not Too Important**	**Somewhat Important**	**Very Important**
Effects on water quality of Mead Lake	113	1.8%	0.0%	33.6%	64.6%
Effects on local fish and wildlife	113	1.8%	0.9%	35.4%	61.9%
Effects on lake views from home	113	4.4%	5.3%	41.6%	48.7%
Effects on property values	113	5.3%	8.0%	42.5%	44.2%
Neighbors' attitudes/views	113	13.3%	21.2%	43.4%	22.1%

Buffers and Attitudes Towards Them

Buffers are often cited as contributing to lake water quality because they prevent sediments and nutrients from entering a lake. Thirty-two percent (32% or 36) of the 110 respondents had a buffer to some extent along their shorelines.



Nearly 50% of the buffers were no more than five feet wide (see Figure 6); with 55.6% reporting that most of their waterfront had one.

The buffers of 22.2% covered all of the waterfront length. This compared to 19.4% with a buffer that extended along *some* of the waterfront and 2.8% covering *a small amount* of the length.

Those with buffers rated the importance of six factors explaining why buffers are installed. As Table 3 shows, *improved fish or wildlife habitat* was an important reason. Specifically, nearly 42% *selected improved fish or wildlife habit* as *very important* while another 33.3% rated it as *somewhat important*; together equaling 81% of those with buffers*. Good for water quality* was another important factor in deciding to have and maintain a buffer, with about 83% regarding this factor as either *somewhat* or *very important*. In contrast, nearly 83% rated *Funds from a cost share program* as either *Not at all important* or *not too important*. Having a buffer to increase privacy was also unimportant to many owners.

Table 3: Explanatory Factors For Installing and Maintaining a Buffer

Practice	Not at All Important	Not Too Important	Somewhat Important	Very Important
Improved fish or wildlife habitat(N=36)	13.9%	11.1%	33.3%	41.7%
Good for water quality (N=36)	5.6%	11.1%	47.2%	36.1%
Improved appearance of property (N=35)	28.6%	20.0%	28.6%	22.9%
Reduced area to mow (N=35)	40.0%	34.3%	17.1%	8.6%
Funds from a cost share program (N=35)	74.3%	8.6%	11.4%	5.7%
Increased privacy (N=35)	48.6%	28.6%	20.0%	2.9%

To understand attitudes towards buffers, all respondents were asked the extent they agreed or disagreed with a set of statements and these tended to be negative about buffers. At least half of respondents were somewhat negative about buffers. As Table 4 shows, majorities of respondents strongly agreed or agreed that a buffer increased mosquitoes and ticks, buffers obstructed lake views, and that buffers are messy and look unkempt. The majority neither agreed nor disagreed with the two statements about costs. Nearly 43% also selected the neither agree-disagree response for *buffers may reduce property values.* On *buffers do little to protect water quality,* 37.5% chec*ked* neither agreed nor disagreed while 25.9% agreed to some extent.

Table 4: Percentages Agreeing/Disagreeing With Statements Regarding Buffers

Statement	Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree
Buffers increase mosquitoes and ticks (N=112)	12.5%	44.6%	24.1%	16.1%	2.7%
Buffers obstruct lake views (N=112)	11.6%	44.6%	30.4%	11.6%	1.8%
Buffers make lake access difficult (N=112)	8.9%	41.1%	30.4%	17.9%	1.8%
Buffers are messy and look unkempt (N=111)	9.0%	39.6%	27.0%	20.7%	3.6%
Buffers may reduce property values (N=112)	8.9%	25.0%	42.9%	19.6%	3.6%
Buffers attract unwanted wildlife (N=111)	9.0%	24.3%	36.0%	26.1%	4.5%
Buffers do little to protect water quality (N=112)	7.1%	18.8%	37.5%	31.2%	5.4%
Installing a buffer is too expensive (N=112)	1.8%	15.2%	55.4%	22.3%	5.4%
Maintaining buffer is too expensive (N=112)	1.8%	10.7%	53.6%	28.6%	5.4%

Seven Practices

Respondents indicated if they were doing any of seven practices listed in Table 5, which help reduce effects of stormwater runoff on lakes. Slightly more than 50% used a mulching lawnmower. Nearly 47% of those who considered the practice applicable were cleaning up and disposing of their pet waste. Nearly 37% were redirecting rain downspouts and about 22% had a compost pile for grass clippings and leaves. In comparison, fewer respondents were doing the last three practices listed below the table's dark line

Table 5: Percentage of Respondents Doing Seven Practices

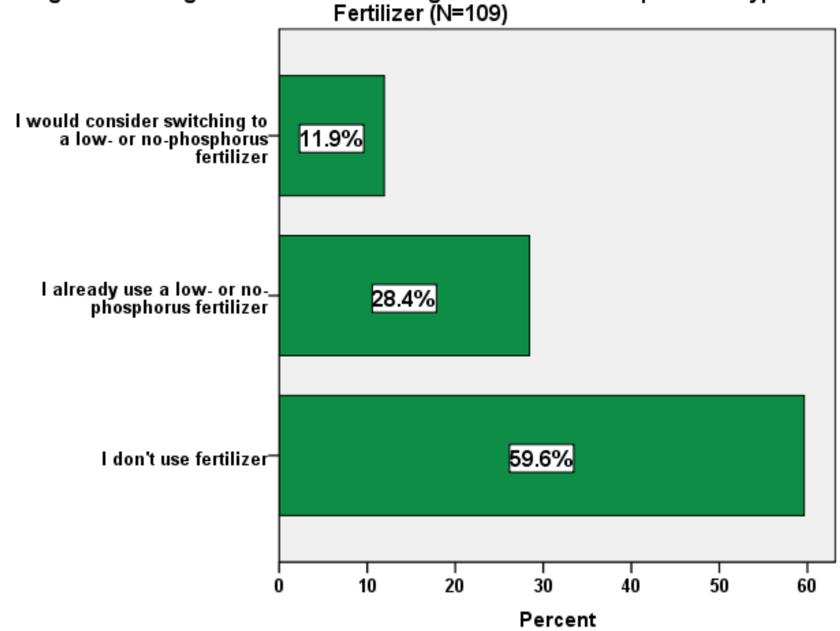
Practice	Yes	No	Does Not Apply
Use a mulching lawnmower (N=109)	51.4%	40.4%	8.3%
Clean up and dispose of pet waste (outdoor waste) (N=111)	46.8%	9.0%	44.1%
Rain downspouts directed away from driveway and from areas sloping toward lake (N=111)	36.9%	43.2%	19.8%
Have a compost pile for grass clippings & leaves in your yard (N=111)	21.6%	69.4%	9.0%
Have a rain garden to infiltrate roof runoff (N=111)	11.7%	77.5%	10.8%
Conduct soil tests on lawn to determine fertilizer application rates (N=111)	7.2%	73.9%	18.9%
Use rain barrels to capture roof runoff (N=111)	1.8%	90.1%	8.1%

Lawns and Lawn Care

Almost all respondents (95%) maintained a lawn somewhere on their property. As already reported, nearly half used a mulching mower. In addition, as Figure 7 shows, 59.6% of those with lawns did not use fertilizer.

Furthermore 28.4% already used a low or no-phosphorus type of fertilize. The remainder (11.9%) would consider switching.

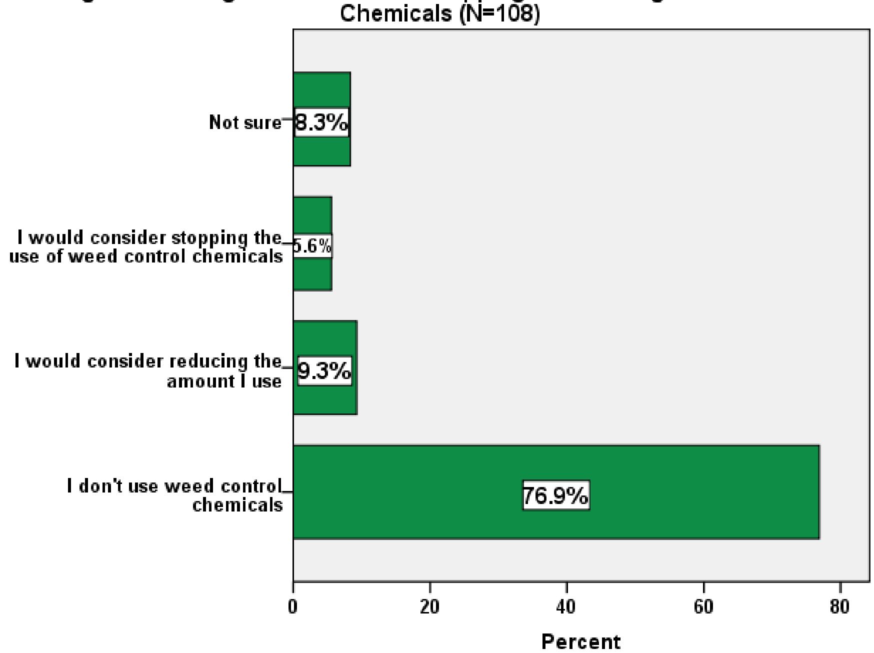
Figure 7: Willingness to Consider Using a Low- or No-Phosphorous Type of Fertilizer (N=109)



High numbers did not use weed control chemicals. As Figure 8 shows nearly 77% did not use them.

Ten percent (10%), who used weed control chemicals, would consider reducing the amount they use. Another 6% would consider stopping the use of weed control chemicals and about 8% were not sure.

Figure 8: Willingness to Consider Stopping or Reducing Weed Control Chemicals (N=108)



Recreational Use of the Watershed and Perceptions of Water Quality

So far information about the characteristic of respondents, information about their lake properties and information about their land management practices have been presented. Now the report shifts to the third category of survey questions: watershed recreational activities done by respondents and their perceptions of water quality.

Recreational Use

Respondents reported how often in the last 12 months they had used the Mead Lake Watershed for nine activities listed in Table 6. The top four activities being done *many times* were scenic viewing, motorized boating, fishing, and wildlife viewing. Considerably fewer respondents were doing the remaining five activities.

Table 6: Percentage of Respondents Doing Nine Recreational Activities

Activities	Not at All	Once	A Few Times	Many Times
Scenic viewing (N=115)	7.0%	1.7%	21.7%	69.9%
Motorized boating (N=114)	14.9%	0.9%	22.8%	61.4%
Fishing, open water (N=113)	10.6%	2.7%	33.6%	53.1%
Wildlife viewing include bird watching (N=115)	13.0%	2.6%	31.3%	53.0%
Swimming (N=112)	31.2%	6.2%	33.0%	29.5%
Non-motorized boating: canoe, kayak, sailing, rowing (N=113)	39.8%	2.7%	34.5%	23.0%
Waterskiing/knee boarding (N=113)	46.9%	2.7%	29.2%	21.2%
Fishing, ice (N=110)	49.1%	5.5%	26.4%	19.1%
Hunting (N=109)	62.4%	2.8%	20.2%	14.7%

Perceptions of Water Quality of Mead Lake

Besides revealing how respondents recreationally used the Mead Lake Watershed, the survey showed how they rated the water quality of Mead Lake for five activities. As Table 7 shows, water quality of Mead Lake for swimming received a poor rating by nearly 64% of the respondents with another 28.4% assigning a rating of fair.

In contrast, ratings of water quality for the remaining four activities were better, with the majority of respondents assigning a rating of fair or good on each one. Percentages assigning a fair or good rating ranged from a high of 76.6% for boating to a low of 55.9% who rated water quality for wildlife habit as being either fair or good.

Table 7: Respondents' Rating of Mead Lake's Water Quality for Five Activities

	Poor	Fair	Good	Fair + Good	Excellent	Don't Know
For swimming (N=116)	63.8%	28.4%	4.3%	32.7%	0.0%	3.4%
For boating (N=116)	17.2%	38.8%	38.8%	76.6%	2.6%	2.6%
For fish habitat (N=116)	20.7%	39.7%	29.3%	69%	3.4%	6.9%
For scenic beauty (N=116)	21.6%	25.9%	37.9%	63.8%	13.8%	0.9%
For wildlife habitat (N=116)	10.6%	29.2%	45.1%	55.9%	8.8%	6.2%

Perceptions of Water Quality At the Watershed Level

Respondents also rated the quality of most rivers and streams within the Watershed. Thirty percent (30%) of the 116 respondents gave a rating of *fair*, 22% a *poor*, 12% a *good*, and 1% a rating of *excellent*. Thirty-five percent (35%) checked the response of *don't know*.

Problems and Conditions

Survey questions provided information about how respondents perceived problems and conditions involving Mead Lake and its watershed.

Problems Affecting Mead Lake

Respondents were presented with seven potential problems for lakes in general (as listed in Table 8) and were asked the extent they agreed or disagreed that each was a problem affecting Mead Lake. On six of the seven potential problems, large majorities (varying from 79.8% to 52.6%) either strongly agreed or agreed that each problem affected Mead Lake; with polluted swimming areas having the highest percentage. Those feeling that contaminated fish were affecting Mead Lake were almost a majority (49.1%) but with about 26% checking "Don't Know".

Table 8: Percentage of Respondents Agreeing/Disagreeing That Seven Lake Problems Were Affecting Mead Lake

	Strongly Agree	**Agree**	**Neither Agree Nor Disagree**	**Disagree**	**Strongly Disagree**	**Don't Know**
Polluted swimming areas (N=114)	37.7%	42.1%	7.0%	4.4%	0.0%	8.8%
Overabundant weeds affecting recreational activities, beauty, of the lake, or fish habitat (N=114)	37.7%	23.7%	14.9%	12.3%	4.4%	7.0%
Poor water quality affecting the enjoyment of water recreation activities (N=116)	34.2%	49.1%	8.8%	3.5%	0.0%	4.4%
Health risks to people from algae blooms (N=11$)	28.9%	36.0%	12.3%	3.5%	0.9%	18.4%
Health risks to pets from algae blooms (N=114)	27.2%	33.3%	13.2%	5.3%	0.9%	20.2%
Loss of desirable fish species (N=114)	19.3%	33.3%	12.3%	8.8%	1.8%	24.6%
Contaminated fish (N=114)	12.3%	36.8%	10.5%	14.0%	0.0%	26.3%

Watershed Conditions

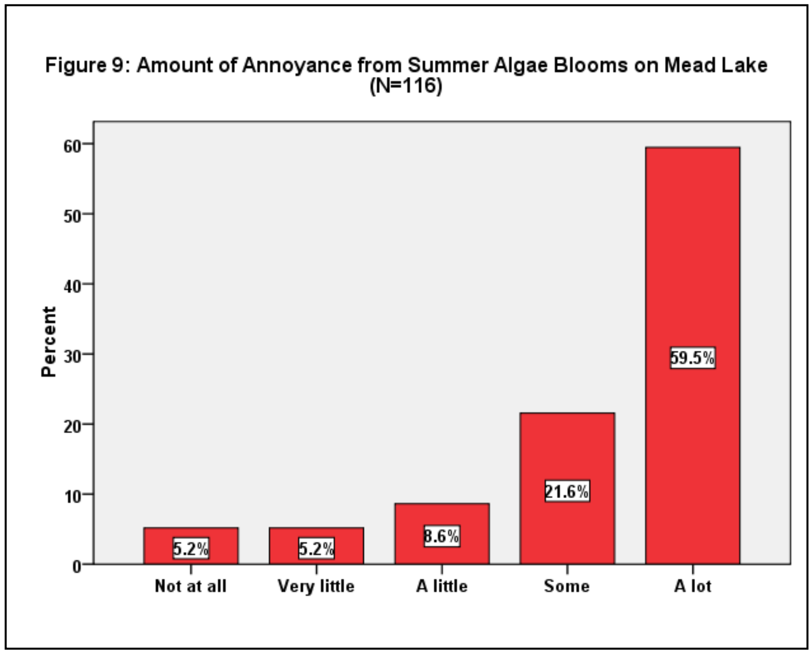
Respondents also reported the degree they thought two conditions were present in the Watershed. As Table 9 shows, most were unsure if *areas of contaminated ground water* (64.9% unsure) and *contaminated private well water* (77% unsure) were present.

Table 9: Percentage of Respondents Who Thought that Two Conditions Were Present in the Watershed

	Far Too Many	**Some**	**A Little**	**None**	**Don't Know**
Areas of contaminated ground water (N=114)	8.8%	11.4%	7.9%	7.0%	64.9%
Contaminated private wells (N=113)	0.9%	9.7%	4.4%	8.0%	77.0%

Features of Mead Lake and Algae Blooms

Respondents indicated the extent five features of Mead Lake had *Increased, Decreased*, or were *About the same* compared to five years ago. They also revealed how much Mead Lake's summer algae blooms bothered or annoyed them.



Most respondents were annoyed by the summer algae blooms. As Figure 9 shows, 59.5% were bothered *a lot* by the blooms and to another 21.6%, the algae blooms were of *some* annoyance*.*

Table 10 shows the extent respondents viewed the status of five other Mead Lake features compared to five years ago. Please note that the table only shows how respondents viewed changes in the features and not how they attributed changes to decreased or improved water quality of Mead Lake.

To 47.4% of the respondents, the quality of Mead Lake fishing had decreased in the last five years. Just over a third (35.1%) thought that shoreline erosion had increased, while 28.1% reported that water clarity of Mead Lake had decreased, with another 51.8% feeling that water clarity has remained the same. More felt that the amount of algae was about the same, compared to those feeling it had increased or decreased. The same is true for the amount of aquatic plants – more said about the same compared to those noting increases or decreases.

Table 10: Status of Mead Lake Features Compared to Five Years Ago (N=114)

	Increased	Decreased	About the Same	Not Sure
Shoreline erosion	35.1%	9.6%	38.6%	16.7%
Amount of algae	25.4%	23.7%	42.1%	8.8%
Amount of aquatic plants	23.7%	17.5%	38.6%	20.2%
Water clarity	12.3%	28.1%	51.8%	7.9%
Quality of fishing	4.4%	47.4%	31.6%	16.7%

Knowledge of Invasive Species

Respondents were asked how much they know about four invasives that can affect lake water quality. As Table 11 shows, overall knowledge of three invasives was relatively low: Curly-leaf pondweed, Rusty crayfish and Eurasian water milfoil. Substantial percentages of respondents never heard of these three invasives or knew nothing but heard of them.

In comparison, more respondents knew something about Zebra mussels. Nearly 44% checked *some* or *A lot,* while nearly 24% knew *A little.* Those who were at the other two opposite knowledge levels (never heard of it or nothing, but heard of it) equaled nearly 33%.

Table 11: Knowledge About Invasive Species					
	Never Heard of It	**Nothing, But Heard of It**	**A Little**	**Some**	**A Lot**
Curly-leaf pondweed (N=112)	56.2%	18.8%	11.6%	8.9%	4.5%
Rusty crayfish (N=113)	49.6%	22.1%	13.3%	10.6%	4.4%
Eurasian water milfoil (N=113)	39.8%	22.1%	8.8%	17.7%	11.5%
Zebra mussels (N=114)	8.8%	23.7%	23.7%	24.6%	19.3%

Contributors to Water Quality Problems

The survey provided ample information about how respondents viewed sources contributing to water quality problems. Of all sources, farms were viewed as major contributors. As Table 12 shows, substantial numbers viewed runoff of fertilizers and pesticides from fields and runoff from applying manure as contributing *A Lot*. Substantial numbers also tagged soil erosion from farm fields and runoff from barnyards or animal feedlots as major contributors.

Table 12: Percentage of Respondents According to Sources Contributing to Possible Mead Lake Water Quality Problems

	Not at All	**A Little**	**Some**	**A Lot**	**Don't Know**
Runoff of fertilizers and pesticides from farm fields (N=114)	0.9%	4.4%	14.0%	78.1%	2.6%
Runoff from applying manure on farm fields (N=114)	0.9%	6.1%	19.3%	69.3%	4.4%
Soil erosion from farm fields (N=114)	1.8%	7.0%	28.1%	57.9%	5.3%
Runoff from barnyards or animal feedlots (N=114)	3.5%	2.6%	28.9%	56.1%	8.8%
Tiling and draining of farm fields (N=114)	1.8%	6.1%	31.6%	42.1%	18.4%
Soil erosion from shorelines and/or stream banks (N=114)	0.9%	15.8%	47.4%	26.3%	9.6%
Tiling and draining of wetlands (N=114)	3.5%	12.4%	23.0%	24.8%	36.3%
Poorly maintained septic systems on farms (N=114)	2.6%	10.5%	34.2%	23.7%	28.9%
Runoff of fertilizer and pesticides from lawns of homes around Mead Lake (N=114)	3.5%	21.9%	50.0%	14.9%	9.6%
Milk house waste (N=113)	4.4%	10.6%	23.9%	13.3%	47.8%
Storm water runoff from roads and streets	6.1%	26.3%	39.5%	10.5%	17.5%
Poorly maintained septic systems around Mead Lake (N=113)	35.4%	23.0%	16.8%	8.8%	15.9%
Erosion from gravel roads (N=113)	10.6%	28.3%	33.6%	8.0%	19.5%
Grass clippings and leaves (N=114)	15.8%	43.0%	21.9%	6.1%	13.2%
Burning yard waste or leaves near shore (N=116)	24.6%	28.1%	18.4%	1.8%	27.2%
Storm water runoff from Mead Lake homes (N=113)	11.5%	35.4%	35.4%	0.0%	17.7%

Table 12 also shows that sources related to lake property were viewed as contributing less to Mead Lake water quality problems compared to farms. These are shaded and below the dark line in Table 12. Fifty percent (50%) regarded runoff of fertilizers and pesticides from lawns of Mead Lake as contributing "some". Just over a third regarded poorly maintained septic systems around Mead Lake as *not at all* contributing to water quality problems. This probably reflects how, according to a written comment, lake residents had to install holding tanks to comply with DNR regulations and actions of the Mead Lake District.

The overwhelming majority of respondents did not consider burning yard waste or leaves near the shoreline and stormwater runoff from Mead Lake homes as major sources for water quality problems. To about a third, stormwater contributed *some* to water quality problems and about 18% assigned *some* to describe the contribution of burning waste and leaves.

Additional data showed that respondents viewed farms as major contributors to water quality problems at the watershed level, as well as how neighborhood use of fertilizer contributes to problems in the watershed. As Table 13 shows nearly 96% either strongly agreed or agreed that what farmers do on their land affects water quality in the watershed. Another nearly 87% also strongly agreed or agreed that time of year farmers apply manure affect water quality.

Large percentages (87.8%) also agreed that how much fertilizer used in their neighborhoods affects the water quality of the Watershed. This suggests that large numbers of respondents, while viewing farms as major sources contributing to watershed water problems, were also willing to consider how actions in their neighborhoods were affecting water quality.

Table 13: Percentage Agreeing/disagreeing With Three Statements (N=114 for All Statements)

Statement	Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree
What farmers do on their land affects the water quality in the Mead Lake Watershed	73.7%	20.2%	3.5%	2.6%	0.0%
The time of year farmers apply animal manure to fields affects the water quality in the Mead Lake Watershed	51.8%	35.1%	10.5%	2.6%	0.0%
How much fertilizer is used in my neighborhood affects the water quality in the Mead Lake Watershed	40.4%	47.4%	7.9%	2.6%	1.8%

Willingness to Change, Voluntary Efforts versus Regulations and Dredging

Survey data helped understand the extent respondents were willing to change how they managed their lake property to improve water quality of the watershed. In addition, analysis revealed attitudes about how improvement efforts required new governmental regulations and if they had to be voluntary. Sentiments about dredging Mead Lake as the best way to improve its water quality were also revealed.

As Table 14 shows, 72% strongly agreed or agreed that they were willing to change how they managed their Mead Lake property to improve the water quality in the Watershed. Responses to a statement about expenses of improvement actions suggested some caution in interpreting the extent respondents were really willing to change management practices. Nearly 41% neither agreed nor disagreed that *Taking action to improve the water quality in my local area is too expensive for me*, while nearly 38% disagreed or strongly disagreed with the statement. The unknown is how many of the 41% group were neutral as opposed to feeling that costs of specific practices would effect their willingness to change how they mange their property.

Respondents seemed to be split on if efforts to improve water quality in the Mead Lake Watershed must include new governmental regulations. About 39% agreed with the statement and about 31% disagreed and nearly 30% neither agreed nor disagreed.

Respondents seem to be less split on the need for watershed improvement efforts to be voluntary. About 47% disagreed with a statement stating that efforts to improve water quality in the Watershed must be voluntary. Another 36% agreed with the statement calling for voluntary efforts, indicating a preference for voluntary efforts.

On dredging Mead Lake as the best way to improve its water quality, 39% agreed compared to about 25% who disagreed. Nearly 35% neither agreed nor disagreed.

Table 14: Agree/Disagree with Statements

Statement	Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree
I am willing to change how I manage my Mead Lake property to improve the water quality in the Watershed (N=114)	36.0%	36.0%	22.8%	4.4%	0.9%
Taking Action to improve the water quality in my local area is too expensive for me (N=111)	9.0%	12.6%	40.5%	25.2%	12.6%
Efforts to improve water quality in the Mead Lake Watershed must include new governmental regulations (N=112)	15.2%	24.1%	29.5%	20.5%	10.7%
Efforts to improve water quality in the Mead Lake Watershed must be voluntary (N=114)	7.9%	28.1%	16.7%	39.5%	7.9%
Dredging Mead Lake is the best way to improve its water quality (N=113)	14.2%	24.8%	34.5%	18.6%	8.0%

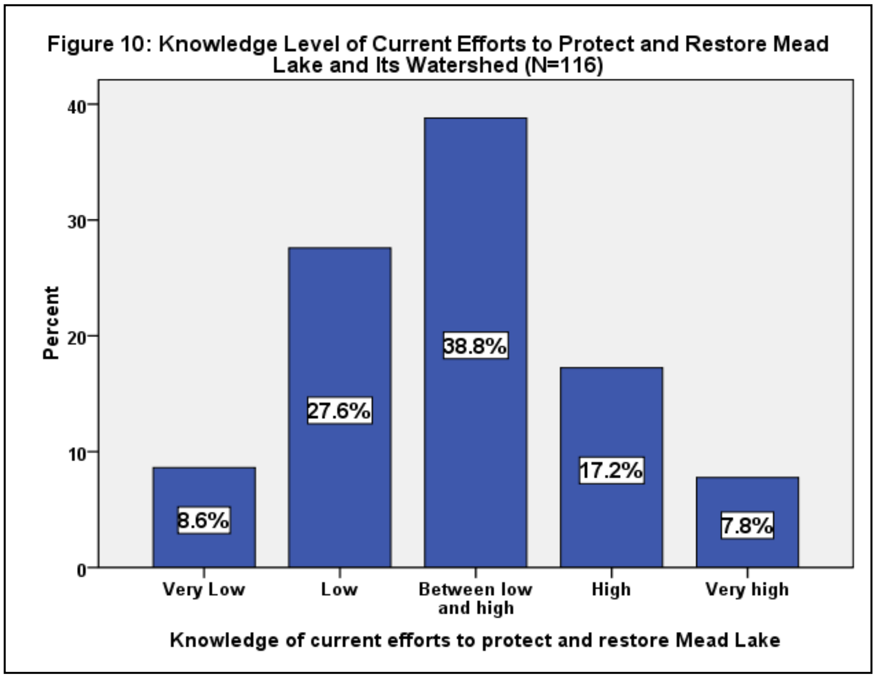
Current Involvement and Concerns

The final focus of the survey was on knowledge of current efforts to improve water quality in the area as well as awareness of the Partnership. In addition, respondents could relay one or two of their most important concerns about water quality in the Watershed to the Partnership's Leadership Team.

Knowledge of Current Efforts

Respondents rated their knowledge level of current efforts to protect and restore Mead Lake and its watershed, before receiving the survey. As Figure 10 shows, 26% rated their knowledge as being high or very high.

This compares to 36.4% who checked very low or low. In the middle of the question's five point response scale (between low and high) were nearly 39% of the respondents.



Attendance at Partnership's Meetings

Eighty-four percent (84% or 97) of the 116 respondents did not attend the first public meeting of the Partnership held at the Legion Hall in Greenwood in November 2008. The remaining either attended the meeting (14.7% or 17) or could not remember (1.7% or 2).

Most (79% or 92) of the 116 respondents had not attended any of the monthly meetings at Mead Town Hall conducted by Partnership's Leadership Team. The remaining (21% or 24) had attended at least one monthly meeting.

Concerns Relayed to Leadership Team

Seventy-one percent (71% or 72) of the 102 respondents expressed their most important concerns regarding the health and quality of Mead Lake and its watershed that the Stakeholder Leadership Team should give attention to. Eighteen referred to poor water quality. Other categories of concerns along with number of respondents were:

- Algae bloom growth (11)
- Farm field runoffs (7)
- Cat tails (7)
- Shoreline erosion (5)
- Fishing quality (5)
- Water depth (4)
- Dredging (4)
- Weed growth (4)
- Septic systems (3)
- Boating – too powerful (2)
- Fish habitat (2)
- Increased taxes (1)

Some respondents provided more information about their concerns by writing additional comments in the space provided. See Appendix C for categorized comments.

Conclusions

This report based on 116 completed surveys from a possible 132 was done on behalf of the Mead Lake and Watershed Partnership. The high response rate of 88% suggests that Mead Lake residents are interested in the health of their lake. Twenty-three other conclusions, grouped into six categories, are now presented. The categories are:

- Recreation and Perceptions of Water Quality
- Contributors to Poor Water Quality
- Practices and Making Decisions
- Willingness to Change, Views About Improvement Efforts, and Dredging
- Knowledge of Current Improvement Efforts and Concerns
- Characteristics of Respondents and Their Lake Properties

Recreation and Perceptions of Water Quality

Six conclusions were made about how respondents recreationally used Mead Lake and the rivers and stream of the watershed, as well as their perceptions of the quality of these waters.

1. Four primary recreational activities within the watershed.

The top four recreational activities done within the watershed during the last twelve months were scenic viewing (69.9%), motorized boating (61.4%), fishing (53.1%) and wildlife viewing (53%). Considerably fewer respondents were doing the remaining five survey listed activities (swimming, non-motorized boating: canoe, kayak, sailing, rowing, waterskiing/knee boarding, ice fishing and hunting).

2. Widely held view that water quality of Mead Lake is poor for swimming.

Water quality of Mead Lake for swimming received a poor rating by nearly 64% of the respondents with another 28.4% assigning a rating of fair. In contrast, ratings of Mead Lake's water quality for four other activities were better, with the majority of respondents assigning a rating of fair or good on each one. The four were boating, fish habitat, scenic beauty, and for wildlife habitat.

3. Many feel water quality of Mead Lake affected by seven lake problems.

On six of seven problems lakes may have, large majorities (varying from 79.8% to 52.6%) either strongly agreed or agreed that each affected Mead Lake; with polluted swimming areas having the highest percentage. The other five were:

- Overabundant weeds affecting recreational activities, beauty of the lake, or fish habitat
- Poor water quality affecting the enjoyment of water recreation activities
- Health risks to people from algae blooms
- Health risks to pets from algae blooms
- Loss of desirable fish species

To almost a majority (49.1%), contaminated fish affected Mead Lake but about 26% didn't know.

4. A majority rated water quality of the Watershed as being either fair or poor.

Respondents also rated the overall water quality of most rivers and streams within the Mead Lake Watershed. Thirty percent (30%) gave a rating of fair, 22% a poor, 12% a good, and only 1% a rating of excellent. Thirty-five percent (35%) checked the response of *don't know*.

5. Unsure if contaminated ground water and contaminated wells existed in the Watershed.

Respondents reported the degree they thought two situations were present in the Watershed. Most were unsure if *areas of contaminated ground water* (64.9% unsure) and *contaminated private well water* (77% unsure) were present.

6. Perceptions varied about how Mead Lake features changed in the last five years, while many were bothered by summer algae blooms.

Respondents indicated the extent five features of Mead Lake had *Increased, Decreased*, or were *About the same* compared to five years ago and how much the summer algae bothered them. For 88% of the respondents, the summer algae blooms bothered them to a relatively high degree.

Nearly a majority (47.4%) of the respondents felt that the quality of fishing had decreased in the last five years. Just over a third (35.1%) thought that shoreline erosion had increased while 28.1% reported that water quality of Mead Lake had decreased, with another 51.8% feeling that water quality has remained the same. More felt that the amount of algae and the amount of aquatic plants were about the same compared to those feeling it had increased or decreased.

Contributors to Poor Water Quality

Two conclusions were made about how respondents viewed sources contributing to poor water quality and resulting conditions, in addition to one about their knowledge of invasive plants and species.

1. Farms widely viewed as the major source affecting water quality of Mead Lake and its Watershed.

Respondents indicated to what extent each of 16 sources contributed to possible Mead Lake water quality problems. Farms were considered major contributors to Mead Lake water quality. Substantial numbers viewed runoff of fertilizers and pesticides from field and runoff from applying manure as contributing *A Lot*. Substantial numbers also tagged soil erosion from farm fields and runoff from barnyards or animal feedlots as major contributors.

Sources related to lake property were viewed as contributing less to Mead Lake water quality problems. Fifty-percent (50%) regarded runoff of fertilizers and pesticides from lawns of Mead Lake as contributing “some”. Just over a third regarded poorly maintained septic systems around Mead Lake as *not at all* contributing to water quality problem. The overwhelming majority did not consider burning yard waste or leaves near the shoreline and stormwater runoff from Mead Lake homes as major sources for water quality problems.

Furthermore, large percentages of respondents viewed the behaviors of farmers as affecting water quality in the Mead Lake Watershed. Nearly 96% either strongly agreed or agreed that what farmers do on their land affects water quality. Another nearly 87% also strongly agreed or agreed that time of year farmers apply manure affects water quality.

2. Neighborhood use of fertilizer affects water quality of the Watershed.

Large percentages (87.8%) agreed that how much fertilizer used in their neighborhoods affects the water quality of the Mead Lake Watershed. This suggests that large numbers of respondents, while viewing farmers as the major source contributing to watershed water problems, were also willing to consider how actions in their neighborhoods affected water quality.

3. Very little knowledge (if any) of three invasives.

Knowledge of Curly-leaf Pondweed, Rusty Crayfish and Eurasian Water Milfoil was relatively low. Substantial percentages of respondents never heard of the three invasives or knew nothing but heard of them. Percentage who checked *never heard of* or *nothing, but heard about it* varied from a high of 75% for Curly-leaf Pondweed to 62% for Eurasian Water Milfoil.

In comparison, more respondents knew something about Zebra Mussels. Nearly 44% checked *some* or *A lot,* while nearly 24% knew *A little.* Those who were at the other two opposite knowledge levels (*never heard of it* or *nothing, but heard of it*) equaled nearly 33%.

Practices and Making Decisions

Findings resulted in four conclusions about practices used by respondents on their lake property and factors taken into account when making property related decisions.

1. Taking into account environmental effects.

When making decisions to improve, change or maintain their lake property an overwhelming majority of respondents take into consideration environmental effects. Specifically, 98% of the respondents rated *the effects on water quality of Mead Lake* as being either *very* or *somewhat important* when they make decisions. Likewise, nearly all respondents (97%) rated *effects on local fish and wildlife* as being somewhat or very important to their decision making.

Furthermore, for some of the 36 respondents with buffers, installing and maintaining them appeared to be motivated by environmental concerns. Those with buffers rated the importance of six factors explaining why buffers are installed. Nearly 42% *selected improved fish or wildlife habitat* as *very important* while another third rated it as *somewhat important*; together equaling 81% of those with buffers. *Good for water quality* was another important factor in deciding to have and maintain a buffer, with about 83% regarding this factor as either *somewhat* or *very important*. In contrast, nearly 83% rated *Funds from a cost share program* as either *Not at all important* or *not to important*. Increased privacy was also an unimportant reason to many buffer owners.

2. Some buffers while most respondents generally being negative about them.

About a third or 36 respondents had a buffer. As a group, at least half of the respondents were somewhat negative about buffers. Majorities of respondents agreed that a buffer increased mosquitoes and ticks, buffers obstructed lake views, and that buffers are messy and look unkempt. On *buffers do little to protect water quality,* 37.5% che*cked* neither agreed nor disagreed while 25.9% agreed.

3. Little use of practices to lessen stormwater effects except for mulching lawnmower.

Numbers of respondents doing any of seven practices for mitigating effects of stormwater runoff on lake water quality varied. Slightly more than 50% used a mulching lawnmower. Nearly 47% of those who considered the practice applicable were cleaning up and disposing of their pet waste. Nearly 37% were redirecting rain downspouts and about 22% had a compost pile for grass clippings and leaves. Few respondents had a rain garden, conducted soil tests on lawn to determine fertilizer application rates, or used rain barrels to capture roof runoff.

4. Most maintained lawns but many not using fertilizers or weed killers.

Almost all respondents maintained a lawn somewhere on their lake property. Nearly 60% of those with lawns did not use fertilizer. Furthermore, 28% already used a low- or no-phosphorus type of fertilize. The remainder would consider switching.

High numbers (77%) did not use weed control chemicals and 10% who used weed control chemicals would consider reducing the amount they use. Another 6% would consider stopping the use of weed control chemicals.

Willingness to Change, Views About Improvement Efforts, and Dredging

Four conclusions are warranted about respondents' willingness to change their land management practices, about their views regarding the need for new regulations versus improvement efforts being voluntary and support for dredging Mead Lake.

1. Some evidence of willingness to change management practices.

A large majority (72%) of respondents were willing to change how they managed their Mead Lake property to improve the water quality in the Watershed. Responses to a statement about expenses of improvement actions suggested some caution in interpreting the extent respondents were really willing to change management practices. Nearly 41% neither agreed nor disagreed that *Taking action to improve the water quality in my local area is too expensive for me*, while nearly 38% disagreed with the statement. The unknown is how many of the 41% group were neutral, as opposed to feeling that costs of specific practices would effect their willingness to change how they mange their property. Nevertheless, there was some evidence that respondents were willing to change management practices.

2. Split on need for new governmental regulations.

Respondents seemed split on if efforts to improve water quality in the Mead Lake Watershed must include new governmental regulations. About 39% agreed with the statement and about 31% disagreed and nearly 30% neither agreed nor disagreed.

3. Less of a split on improvement efforts being voluntary.

Respondents seem to be less split on the need for watershed improvement efforts to be voluntary. About 47% disagreed with a statement stating that efforts to improve water quality in the Watershed must be voluntary. Another 36% agreed with the statement calling for voluntary efforts, indicating a preference for voluntary efforts.

4. Split on dredging Mead Lake.

On dredging Mead Lake as the best way to improve its water quality, 39% agreed compared to about 25% who disagreed. Nearly 35% neither agreed nor disagreed. This suggests that as a group, respondents were split on the merits of dredging Mead Lake.

Knowledge of Current Improvement Efforts and Concerns

Four conclusions focused on respondents' knowledge (before receiving the survey) of efforts to protect and restore Mead Lake and its watershed and concerns they wanted addressed.

1. A majority had some knowledge of current efforts to protect and restore Mead Lake and its Watershed.

About a quarter of the respondents felt that their knowledge of current improvement efforts was high or very high and those who rated their knowledge as being between low and high were nearly 39% of the respondents. Thus, a majority felt they had some knowledge of current improvement efforts. This compares to about 36% who felt this knowledge was very low or low.

2. Attendance at Partnership monthly meetings higher than attendance at first meeting.

Seventeen of the 116 respondents attended the first public meeting of the Partnership held at the Legion Hall in Greenwood in November 2008. Twenty-four have attended at least one of the Partnership's monthly meetings.

3. Poor water quality of Mead Lake a primary concern.

Respondents listed their concerns that the Stakeholder Leadership Team should pay attention to. Poor water quality of Mead Lake was the most stated concern, followed by algae bloom growth, farm field runoff, and overabundance of cat tails.

Characteristics of Respondents and Their Lake Properties

Three conclusions were made about the characteristics of respondents and their lake properties.

1. More respondents had college degrees compared to the county's population.

Educational levels indicated that proportionally there were more respondents with four year and graduate degrees than in the general population of Clark County. 2002 Census data shows that 7.4% of the population had a Bachelors degree and 2.9% had a graduate degree. In contrast, 14.5% of the respondents had a Bachelors degree and about 17% had a graduate degree.

2. Long term ownership, weekend and seasonal residents with a variety of dwellings.

The typical respondent was a seasonal lake resident who spent weekends, especially during the summer at Mead Lake, rather than a permanent year-round resident. Tenure or the numbers of years owned averaged 18, which is relatively long.

The primary structures or dwellings of nearly half of the respondents were relatively modest, having 500 to a 1000 square feet of living space. Some could be the "cabins" referred to by one of the respondents. Yet another third had primary structures from 10001 and 2000 square feet of living space and about 6% had living space over 2,000 feet.

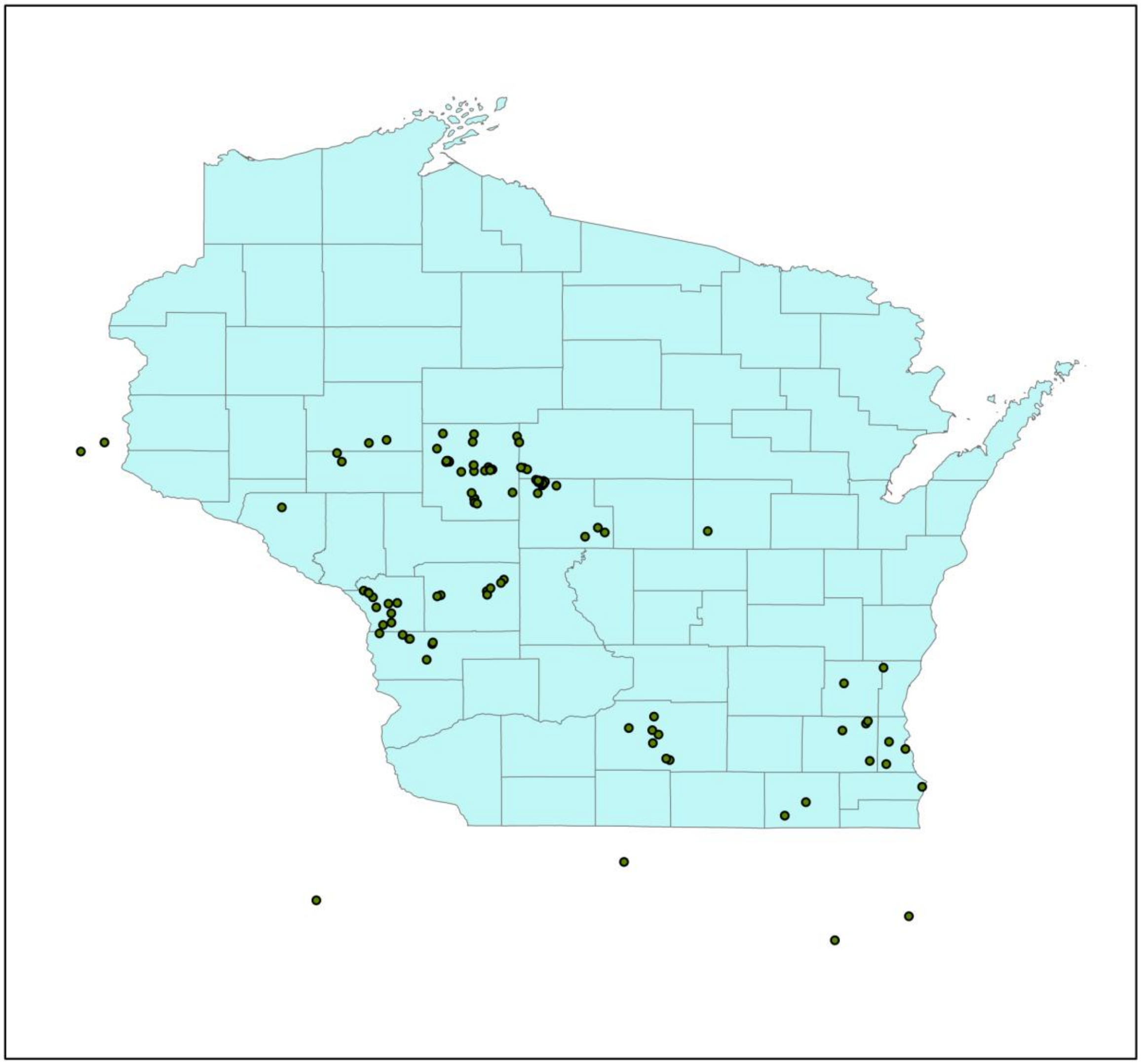
3. Water frontage in the mid-range, low banks and a lot of riprap.

Eight four percent (84%) or 94 respondents had 50 to 100 feet of water frontage on their property. Another 12% or 13 had 101 to 200 feet of water frontage. Only 3% had less than 50 feet and 2% had more than 200 feet of water frontage.

Heights of banks at shorelines were 10 feet or less for 95% of the respondents and 84% of all respondents had 50 to 100 feet of water frontage. Riprap (rock) was on close to 80% of respondents' shorelines.

Appendix A

Mead Lake Survey Mailing List



County Counts

Clark	44	Chippewa	2
Wood	17	Eau Claire	2
La Crosse	10	Walworth	2
Monroe	8	Waupaca	1
Vernon	7	Buffalo	1
Dane	7	Ozaukee	1
Marathon	4	Washington	1
Waukesha	4	Racine	1
Milwaukee	3	Out of State	7

Your Views on Water Quality of the Mead Lake Watershed: Lake Residents

Thank you for completing this survey. The survey should be completed by a household adult who makes most of the decisions about your Mead Lake property. If more than one person makes decisions all can jointly complete the survey. Unless otherwise instructed, please fill in the circle that best matches your response.

USINGTHE WATERSHED AND PERCEPTIONS OF WATER QUALITY

The Mead Lake Watershed is made up of Mead Lake and the rivers and streams that drain into it. See map insert. The Watershed covers 103 square miles and the Lake (320 acres) is the largest water body.

1. **Are you completing this survey alone or with another household member?**

   ❍ Alone   ❍ With another household member

2. **Before receiving this survey did you know that you live in the Mead Lake Watershed?**

   ❍ Yes   ❍ No

3. **How often in the last 12 months have you or any household member used the Mead Lake Watershed for the following activities?**

Activity	Not at All	Once	A Few Times	Many Times
Swimming	○	○	○	○
Fishing, open water	○	○	○	○
Fishing, ice	○	○	○	○
Motorized boating	○	○	○	○
Non-motorized boating: canoe, kayak, sailing, rowing	○	○	○	○
Waterskiing/knee boarding	○	○	○	○
Hunting	○	○	○	○
Wildlife viewing including bird watching	○	○	○	○
Scenic viewing	○	○	○	○
Other activities that you do or have done at least once. Please identify:				

4. **How would you rate the water quality of Mead Lake on each of the following?**

	Poor	Fair	Good	Excellent	Don't Know
For wildlife habitat	○	○	○	○	○
For swimming	○	○	○	○	○
For boating	○	○	○	○	○
For fish habitat	○	○	○	○	○
For scenic beauty	○	○	○	○	○

5. **How would you rate the water quality of most rivers and streams within the Mead Lake Watershed?**

Poor	Fair	Good	Excellent	Don't Know
○	○	○	○	○

6. **How much do you agree or disagree with the statements below?**

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
What farmers do on their land affects the water quality in the Mead Lake Watershed.	○	○	○	○	○
Taking action to improve the water quality in my local area is too expensive for me.	○	○	○	○	○
How much fertilizer is used in my neighborhood affects the water quality in the Mead Lake Watershed.	○	○	○	○	○
The time of year farmers apply animal manure to fields affects the water quality in the Mead Lake Watershed.	○	○	○	○	○
I am willing to change how I manage my Mead Lake property to improve the water quality in the Watershed.	○	○	○	○	○
Efforts to improve water quality in the Mead Lake Watershed must be voluntary.	○	○	○	○	○
Efforts to improve water quality in the Mead Lake Watershed must include new governmental regulations.	○	○	○	○	○
Dredging Mead Lake is the best way to improve its water quality.	○	○	○	○	○

7. **Below are potential problems for lakes in general. How much do you agree or disagree that each is a problem affecting Mead Lake? If you don't know please check the last column.**

	Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree	Don't Know
Polluted swimming areas	○	○	○	○	○	○
Contaminated fish	○	○	○	○	○	○
Loss of desirable fish species	○	○	○	○	○	○
Poor water quality affecting the enjoyment of water recreation activities	○	○	○	○	○	○
Overabundant weeds affecting recreational activities, beauty of the lake, or fish habitat	○	○	○	○	○	○
Health risks to pets from algae blooms	○	○	○	○	○	○
Health risks to people from algae blooms	○	○	○	○	○	○

8. **To what degree do you think each of the following are present in the <u>Mead Lake Watershed</u>? If you don't know please check the last column.**

	Far Too Many	Some	A Little	None	Don't Know
Areas of contaminated ground water	○	○	○	○	○
Contaminated private well water	○	○	○	○	○

9. **Regarding <u>Mead Lake</u>, how much, if at all, do you think each of following contributes to possible problems with its water quality?**

	Not at All	A Little	Some	A Lot	Don't Know
Soil erosion from farm fields	○	○	○	○	○
Soil erosion from shorelines and/or stream banks	○	○	○	○	○
Tiling and draining of farm fields	○	○	○	○	○
Tiling and draining of wetlands	○	○	○	○	○
Runoff of fertilizers and pesticides from farm fields	○	○	○	○	○
Runoff from applying manure on farm fields	○	○	○	○	○
Runoff of fertilizer and pesticides from lawns of homes around Mead Lake	○	○	○	○	○
Erosion from gravel roads	○	○	○	○	○
Poorly maintained septic systems on farms	○	○	○	○	○
Poorly maintained septic systems around Mead Lake	○	○	○	○	○
Runoff from barnyards or animal feedlots	○	○	○	○	○
Milk house waste	○	○	○	○	○
Storm water runoff from roads and streets	○	○	○	○	○
Storm water runoff from Mead Lake homes	○	○	○	○	○
Grass clippings and leaves	○	○	○	○	○
Burning yard waste or leaves near shore	○	○	○	○	○

10. **Compared to five years ago, would you say each of the following features of <u>Mead Lake</u> has "increased," "decreased," or stayed "about the same"? Or are you "not sure"?**

	Increased	Decreased	About the Same	Not Sure
Amount of algae	○	○	○	○
Water clarity	○	○	○	○
Amount of aquatic plants	○	○	○	○
Quality of fishing	○	○	○	○
Shoreline erosion	○	○	○	○

11. How much do the summer algae blooms on Mead Lake bother or annoy you?

- ❍ Not at all
- ❍ Very little
- ❍ A little
- ❍ Some
- ❍ A lot

12. How much do you know about the following invasive species that can affect lake water quality?

	Never Heard of It	Nothing, But Heard of It	A Little	Some	A Lot
Curly-leaf pondweed	○	○	○	○	○
Eurasian water milfoil	○	○	○	○	○
Zebra mussels	○	○	○	○	○
Rusty crayfish	○	○	○	○	○

LOCAL WATER QUALITY PROTECTION EFFORTS

13. Before receiving this survey, how would you rate your knowledge level of current efforts to protect and restore Mead Lake and its watershed?

- ❍ Very Low
- ❍ Low
- ❍ Between low and high
- ❍ High
- ❍ Very high

14. Did you attend the first public meeting about a citizen-led process to protect and restore Mead Lake and its watershed held at the Legion Hall in Greenwood in November 2008?

- ❍ Yes
- ❍ No
- ❍ Cannot remember

15. Have you attended any of the monthly meetings at Mead Town Hall conducted by the Stakeholder Leadership Team of the Mead Lake and Watershed Partnership?

- ❍ Yes
- ❍ No

16. Do you have any concerns regarding the health and quality of Mead Lead and its watershed that you feel the Stakeholder Leadership Team should pay attention to? If yes, please list one or two of your most important concerns.

- ❍ No
- ❍ Yes. Please list below

A.

B.

YOUR LAKE PROPERTY AND YOUR MANAGEMENT PRACTICES

17. How many years have you owned your lake property? If less than 1 year enter "1". _____ years

18. Is your Mead Lake property your primary residence?

- ❍ Yes
- ❍ No

19. Which one best describes how often you are at your Mead Lake property?

- ❍ Year-round – most days
- ❍ Weekends—year-round
- ❍ Most of Summer Season
- ❍ Weekends—summer
- ❍ Weekends—occasional
- ❍ Vacations/holidays
- ❍ Other (Please identify when)____________________

20. About how many square feet of living space is in your primary structure (home, cottage, cabin, mobile home)?

- ❍ No primary structure on property
- ❍ Not more than 500 square feet
- ❍ 501 to 1000 square feet
- ❍ 1001 to 2000 square feet
- ❍ Over 2000 square feet

21. How much water frontage do you have?

- ❍ Less than 50 feet
- ❍ 50 – 100 feet
- ❍ 101 – 200 feet
- ❍ Over 200 feet

22. How would you classify the height of the bank at the shoreline?

- ❍ High bank (Greater than10 feet)
- ❍ Low bank (10 feet or less)

Definition: *Shoreline* refers to the area where the water and land meet.

23. Are any of these types of shore features part of your shoreline?

Types	Yes	No
Riprap (rock)	○	○
Concrete seawall	○	○
Wooden seawall	○	○
Sheet piling seawall	○	○
Beach (sand/gravel)	○	○
Wetlands, marsh	○	○

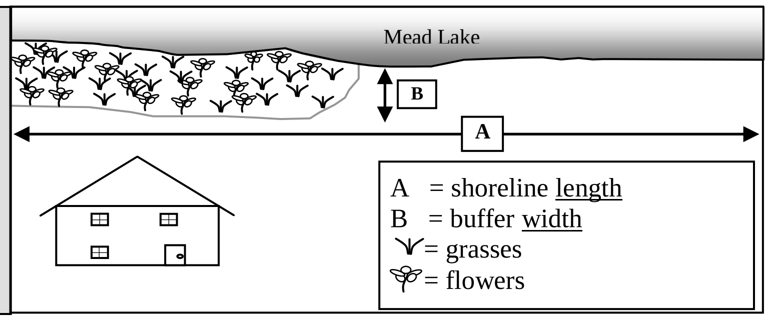
Definition: *Seawall* refers to an artificial erosion control measure placed at the shoreline.

24. Are you now doing any of the following practices? If a practice is impossible to do because of your situation check “Does not apply.” For example, “no lawn” so can’t use mulching lawnmower.

Practice	Yes	No	Does Not Apply
Conduct soil tests on lawn to determine fertilizer application rates	○	○	○
Have a compost pile for grass clippings & leaves in your yard	○	○	○
Use a mulching lawnmower	○	○	○
Rain downspouts directed away from driveway and from areas sloping toward the lake	○	○	○
Clean up and dispose of pet waste (outdoor waste)	○	○	○
Have a rain garden to infiltrate roof runoff	○	○	○
Use rain barrels to capture roof runoff	○	○	○

What is a buffer?

Definition: A buffer is vegetation, such as flowers, tall grasses, shrubs, or trees, along the edge of the lake, just above the shoreline. A kept lawn is NOT a buffer.



25. Do you have a buffer along your waterfront? (Check “no” if you have lawn all the way to the shore)

- ❍ No (Skip to Question 26)
- ❍ Yes (Please answer 25a-25c)

25a: How important was each of the following in your decision to install/maintain a buffer?

	Not at All Important	Not Too Important	Somewhat Important	Very Important
Improved appearance of property	○	○	○	○
Increased privacy	○	○	○	○
Good for water quality	○	○	○	○
Reduced area to mow	○	○	○	○
Funds from a cost share program	○	○	○	○
Improved fish or wildlife habitat	○	○	○	○

25b: About how much of your total waterfront length has a buffer?

- ❍ All
- ❍ Most
- ❍ Some
- ❍ Small Amount

25c: What is the average <u>width</u> of your buffer?

- ❍ Not more than 5 feet
- ❍ 6 to 15 feet
- ❍ 16 to 25 feet
- ❍ 26 to 35 feet
- ❍ 36 feet or more
- ❍ Don't know

26. How much do you agree/disagree with these statements about buffers?

	Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree
Buffers do little to protect water quality	○	○	○	○	○
Installing a buffer is too expensive	○	○	○	○	○
Maintaining a buffer is too expensive	○	○	○	○	○
Buffers may reduce property values	○	○	○	○	○
Buffers are messy and look unkempt	○	○	○	○	○
Buffers make lake access difficult	○	○	○	○	○
Buffers increase mosquitoes and ticks	○	○	○	○	○
Buffers attract unwanted wildlife	○	○	○	○	○
Buffers obstruct lake views	○	○	○	○	○

27. Do you maintain a lawn anywhere on your property?

- ❍ No (Skip to Question 28)
- ❍ Yes (Please answer 27a and 27b)

27a. If you apply fertilizer would you be willing to consider using a low- or no-phosphorus type?

- ❍ I don't use any fertilizer
- ❍ I already use a low- or no-phosphorus fertilizer
- ❍ I would consider switching to a low- or no-phosphorus fertilizer
- ❍ I would not consider switching to a low- or no-phosphorus fertilizer
- ❍ Not sure

27b. If you use weed control chemicals would you consider stopping or reducing their use?

- ❍ I don't use weed control chemicals
- ❍ I would consider reducing the amount I use
- ❍ I would consider stopping the use of weed control chemicals
- ❍ Not sure

28. How important is each of the following when you make decisions about changing, improving or maintaining your lake property?

	Not at All Important	Not Too Important	Somewhat Important	Very Important
Neighbors' attitudes/views	○	○	○	○
Effects on property values	○	○	○	○
Effects on lake views from home	○	○	○	○
Effects on water quality of Mead Lake	○	○	○	○
Effects on local fish and wildlife	○	○	○	○

BACKGROUND INFORMATION

29. What is your gender?

- ❍ Male
- ❍ Female

30. What is your age as of today? Write a number________

31. Which <u>one</u> of the following best describes your total 2008 household income before taxes?

- ❍ No more than $25,000
- ❍ $25,000 - $50,000
- ❍ $50,001 - $75,000
- ❍ $75,001 - $100,000
- ❍ More than $100,000

32. What is your highest level of formal education?

- ❍ Grade school
- ❍ Some high school
- ❍ High school diploma or GED
- ❍ Some college but no degree
- ❍ 2 year college degree
- ❍ 4 year college degree
- ❍ Graduate degree

Thank you for providing this valuable information. Please return your completed survey in the postage-paid envelope provided. Please use the space below for any additional comments about topics covered in this survey.

<u>Additional Comments:</u>

Appendix C

Additional Volunteered Comments Of Respondents: Nine Categories

1. Farms Major Contributors To Poor Water Quality of Mead Lake

Comment 1: I've actually been coming to Mead Lake for 42 years. Having owned my lake home for 25 of those years, I've seen many efforts come and go when it comes to improving the poor water quality of the lake. At one point a $10,000 study was done which indicated 7% of the problem was due to lake residents and 93% by farmers upstream. As a result of the study, almost every lake residence was required to get a holding tank. However, no farmer was forced to do anything—even though their run-off caused most of the problem! I've done what I needed to do at my residence to keep this lake clean at my own expense. Now it's time to force the farmers to do the same at their expense. I'm not going to pay to fix what they created. No lake resident should be forced to do so. If anyone or any group tries to force us to pay, instead money should come from fees at the boat landings or weekends for non-residents and a large portion of the money generated from the campground. To me, the solution to this problem is obvious; go after the source of the problem—the farmers. Throughout the survey, there is mention of algae blooms. In reality, much of what's coming from upstream are fertilizing foods. I know this because when my neighbors' dog died from ingesting these turquoise fertilizer foods, an autopsy and subsequent water test confirmed them to be the cause of it's death. If you do not regulate the farmers and make them pay for improvements, what few frogs and turtles we have will be gone—there used to be an abundance of them! Also, more and more fish will develop unsightly, unhealthy growths on their bodies or just die. When what happens to the animals that eat them? Even though I truly do applaud your efforts, please forgive my skepticism at a green, dying lake for 42 years.

Comment Two: We have made the necessary changes through the years – i.e. septic, building codes, water well quality. What changes the farmers (all of them) made to stop impacting the watershed?

Comment Three: The farms up the river are the big problem

Comment Four: Over 99% of the cabins/homes were forced to comply with the DNR and Mead Lake association to change their septic systems 12 years ago. That was to control 15% of the pollution going in Mead Lake. Now it's time for all the farms to step up. Some of us landowners struggled a lot to comply. I don't want to hear about the plight of the farmer, step up or get out.

Comment 5: The farms up the river are the big problem

Comment 6: Farming practices are outdated in this area and they have to be made to clean up this act.

2. Effects of Not Acting

Comment 1: It is unfortunate these efforts to improve the lake quality weren't initiated 25 years ago when it was first proposed. However, the majority of the cabin/home owners at the time refused to deal with the issue in any meaningful way. As a result, we have a more polluted lake, and the fertilants are still coming into the lake. Hopefully these new efforts will make a difference to the current landowners. Good luck with the undertaking

3. Suggestions for Improvements

Comment 1: One of the easiest and simplest ways to start cleaning up Mead Lake is to control pet and animal feces on and around Mead Lake, maybe an ordinance and clean up after animals

Comment 2: I would like to see reduced horse power on boats. No wake zone east of the camp ground, on the narrow channel. A deeper lake with good fishing and boating. Please, these 90-110 HP boats go too fast for this lake, thanks

Comment 3: Consider protected wildlife/fishing areas. Boating has contributed to reduction of healthy weed areas.

4. Cat Tails and Weeds

Comment 1: Would like to see some cat tails come down, love Mead Lake

Comment 2: We are very concerned about the water quality and very happy improvements are being worked on. Also the cat tails by the Boy Scout camp—why are they not taken out? The cabins are hidden and very low access

Comment 3: We feel it is highly important that something be done to destroy the cattails taking over on the north side of the lake . They can't even access the lake anymore, but boat, by canoe, etc. Why should that be? We feel water quality by us has improved over the years. We are able to swim almost any day during the summer months

Comment 4: Weeds – overabundance of cattails in the dam area. Many weed beds have disappeared due to boat traffic

5. Favor Dredging Mead Lake

Comment 1:Dredging would accomplish cleaner water and more boating area, from what I have heard not every cabin owner was compliant in getting septic systems up to code, why not?

Comment 2: It has taken over 50 years of doing everything wrong to silt the lake in. I think dredging and education is the ticket to a healthy lake.

Comment 3: There is not enough water to eliminate lake problems – dredging would not make a long term difference. Water coming in is dirty.

6. Algae Problem and Poor Water Quality

Comment 1: I hope the results of this survey will improve the serious algae problem in the lake 98: Having a usable lake is very important

Comment 2: The algae bloom along the river is disgusting, smells and harmful to health. Usually poor swimming conditions on the lake during July and August. Lake is always green by July 4th 5:

Comment 3: Water quality in the lake is so poor that it should not be used for fishing or recreation.

Comment 4: We have children ages 5-15 and we use Mead a lot (each weekend) and we love it out there but the water quality is very bad

Comment 5: Most of the algae bloom we have is caused by phosphorous.

7. Erosion

Comment 1: Shoreline erosion – increased due to heavier boat traffic.

Comment 2: Our shoreline erosion has increased dramatically, we would like to be able to improve the shoreline, but not to the detriment of water quality. Our understanding is that we are unable to build up the shoreline with rock, etc.

Comment 3: Good survey! An important problem here (and elsewhere) is high speed boating creating huge wakes and soil erosion. I believe I have lost a large amount of shoreline. This should be a no-wake area in the channel

Comment 4: In the 40+ years our family has been on Mead Lake we have lost over 10 ft. of shoreline. Would like to see some assistance on shoreline maintenance

8. Put in Septic Tanks and Still Have Problems

Comment 1: Also, the quality of our groundwater and well water is very poor. I am frustrated that after spending the money to install a septic system, the water has high levels of iron and minerals. The quality of the water is worse than when we had a simple sand point

Comment 2: Lake property owners put in holding tanks but water is still green

9. Miscellaneous

Comment 1: Keep in mind lake owners pay a high property tax, but many who use the lake do not pay for the privilege

Comment 2: Is there a cost/share program?

Comment 3: The silting caused by the township on roads around the lake when rebuilt really upset me. They didn't have the funds for proper erosion control they said. They shouldn't have started the project without the funds

Mead Lake Intercept Survey Results

Prepared for The Mead Lake and Watershed Partnership:
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November 2009

Volunteers representing the Mead Lake and Watershed Partnership conducted structured interviews of users of Mead Lake during late August and early September 2009. The interviews, referred to as an “intercept survey”, focused on how interviewees used Mead Lake as a recreational resource and about perceptions of the water quality of Mead Lake.

Interviewers followed a protocol and were trained prior to conducting intercept surveys. As the term “intercept” suggests, interviewees were approached as they were preparing to participate in recreational activities on or near Mead Lake or while actually doing so. As each question was answered, responses were written on the paper survey. There were 99 completed surveys.

The intercept survey is part of the Partnership’s efforts to collect information from the residents of the Mead Lake Watershed and others who use/recreate at the lake. The information will be used to: (a) understand how people view conditions potentially affecting the water quality of the watershed and particularly Mead Lake, (b) develop programs that inform the public, and (c) to develop plans for protecting, restoring, and preserving Mead Lake and its streams.

Staff of the Environmental Resources Center inputted data into SPSS. Analysis involved developing inferences based on tendencies, trends, and patterns within the data. Further reflection and study resulted in findings.

This report presents findings according to three categories: Characteristics of Interviewees, Recreational Use, and Perceptions of Mead Lake and Quality of Its Water. Each section starts with a summary, which is followed by more details according to each interview question.

Characteristics of Interviewees

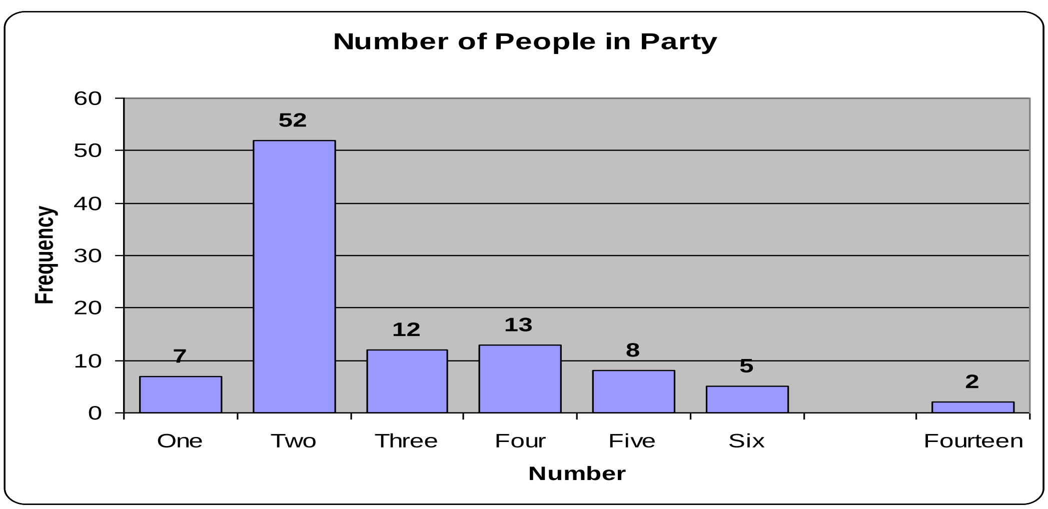
Summary: About two-thirds of the 99 interviewees were male and the others female. The largest number (41%) resided in Clark County with the remainder being residents from twenty other Wisconsin counties and five states. They traveled an average of 85 miles (one way) to Mead Lake and there was an average of two people per party. The average age was 46.

Question 1: Gender

Males made up 66.3% of the total number of interviewees with the remainder (33.7%) female.

Question 2: Number in the Party

Numbers in each party ranged from 1 to 14, with a mean of 3 and a median of 2.

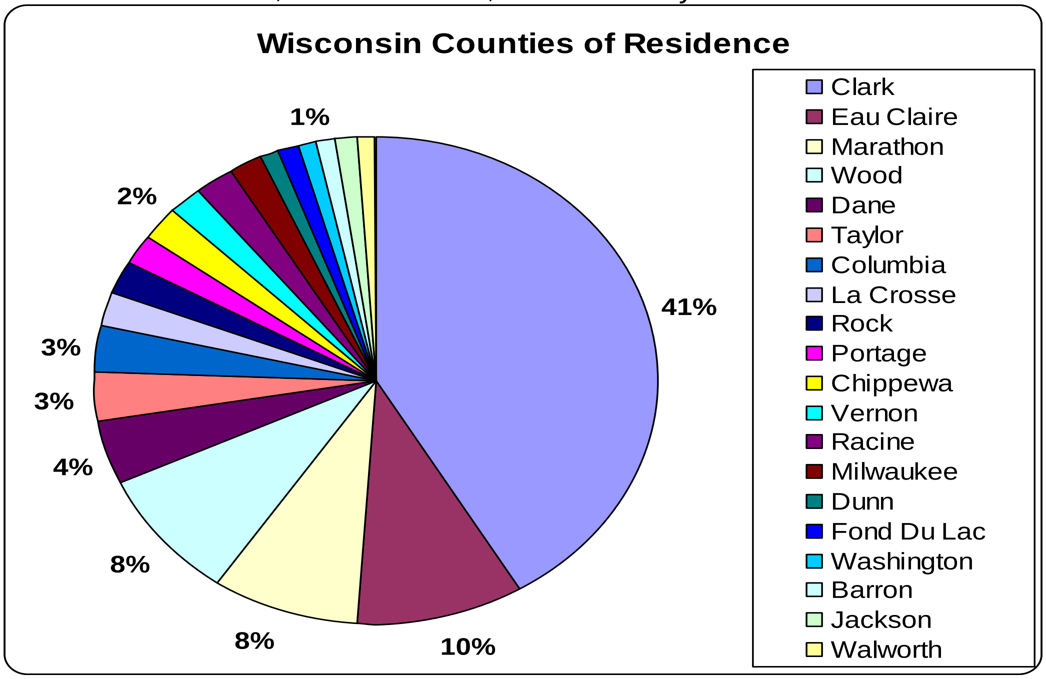


Question 3: Residence

All but six of the 99 interviewees resided in Wisconsin counties with 39 or 41% living in Clark County. Fifty-five (55) were from other Wisconsin counties. These included nine from Eau Claire, eight from Marathon as well as Wood, four from Dane, three from Taylor and three from Columbia County.

Other Wisconsin counties represented were LaCrosse, Dunn, Fond Du Lac, Rock, Washington, Portage, Barron, Jackson, Chippewa, Vernon, Racine, Walworth, and Milwaukee.

There was one interviewee each from Missouri, Florida, Kentucky, Minnesota, and Iowa.

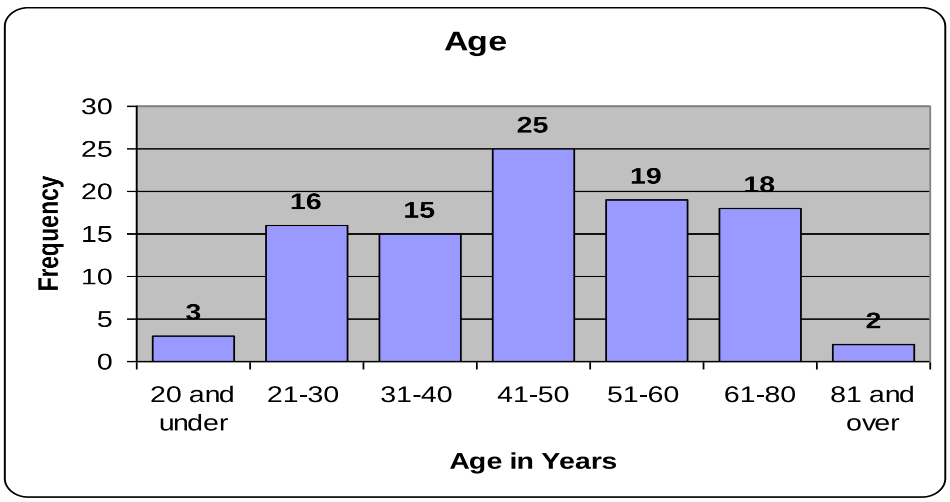


Question 4: Distance Traveled

Respondents were asked how far they had traveled (one way) to arrive at Mead Lake. Distance ranged from 1 to 625 miles, with a mean of 87.8 miles and a median of 35 miles. One traveled 1,500 miles and was not included in the calculations.

Question 5: Age

The average age was 46, with a range of 19 to 85. A majority were between 31 and 60 years old.



Recreational Use of Mead Lake

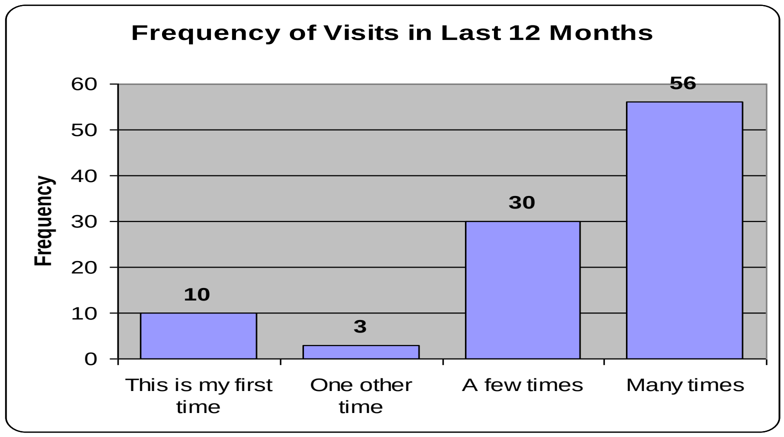
Summary: Most interviewees visited Mead Lake *many times* in the past 12 months, with the average being five times. About 86% said they would visit again some time this year, and estimated they would visit one to six more times in the coming 12 months. As far as activities done in the past 12 months, scenic viewing and open water fishing were the two most frequently selected. The most frequently identified activity for interviewees' trips to Mead Lake on the day of the intercept survey was fishing, closely followed by camping.

About 40% said they had avoided recreational activities involving Mead Lake at some point due to poor water quality. Swimming was the most avoided activity.

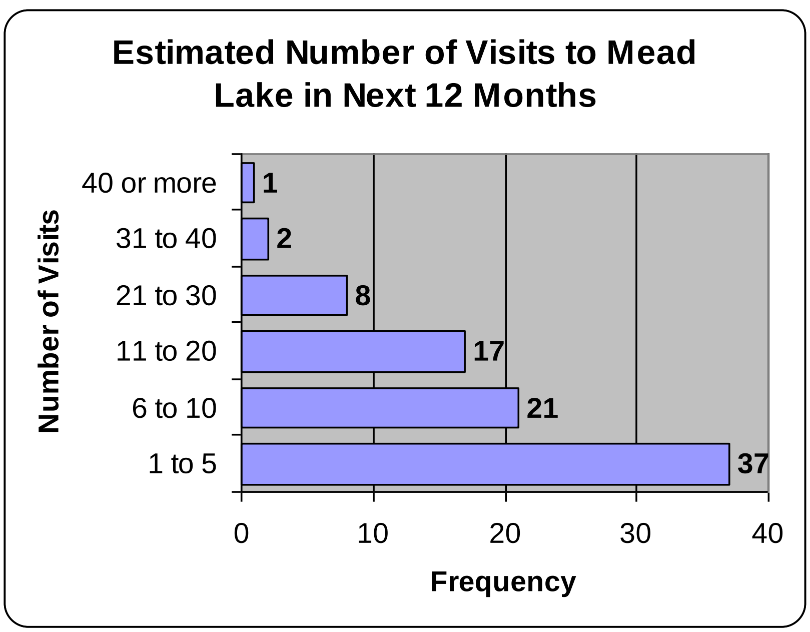
Question 6a and 6b: Number of Visit in the Last 12 Months

Interviewees were first asked to choose, from four options, how many times they would say they had visited Mead Lake in the last 12 months. Of the four options, 56 chose *many times*, followed by 30 who said *a few other times*.

Ten (10) interviewees were visiting for the first time and three (3) had visited Mead Lake one other time.

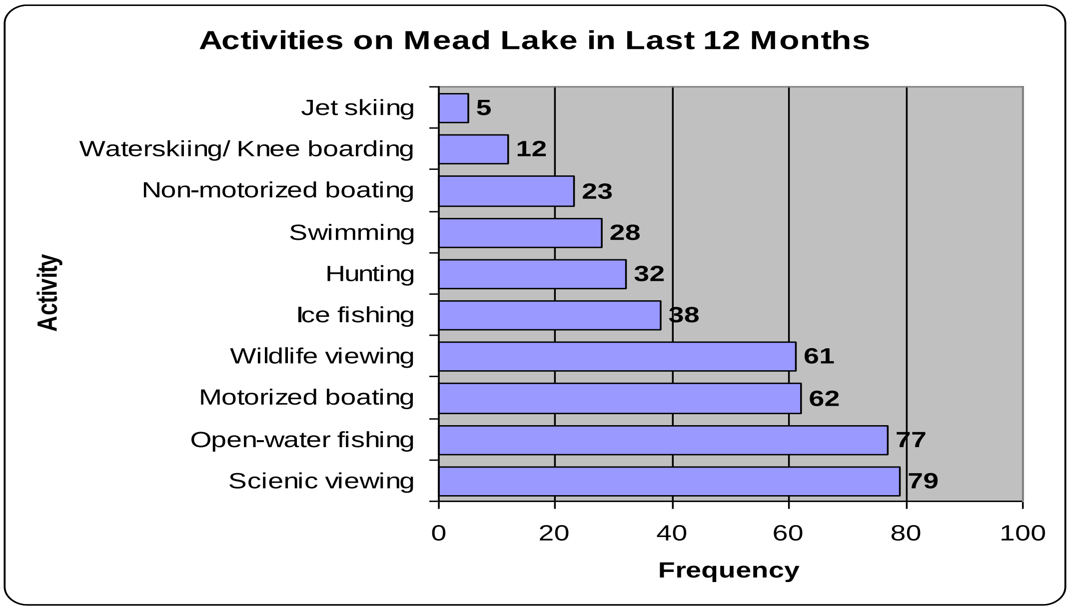


To gain more specific information, those answering "a few times" or "many times" were asked approximately how many times they visited Mead Lake in the last 12 months. Answers ranged from 1 to 62 times, with a mean of 10 visits and a median of 6.0 visits.



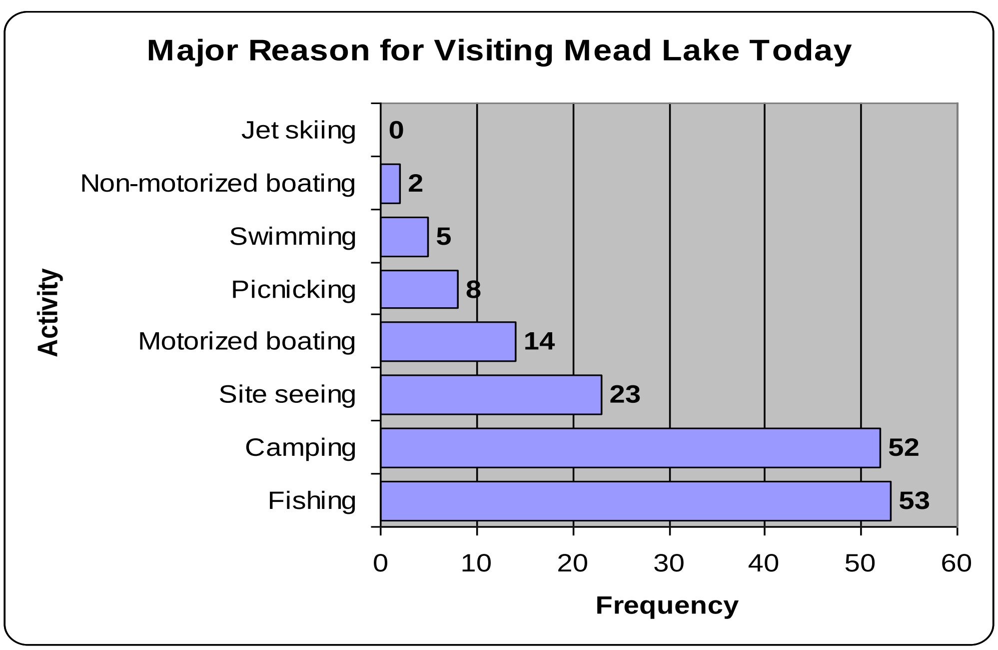
Question 7: Lake Related Activities in the Last Twelve Months

Respondents indicated what activities they had participated in at Mead Lake during visits over the past 12 months. Scenic viewing and open-water fishing were the two most frequently identified activities followed by motorized boating, wildlife viewing, ice fishing, hunting, swimming, non-motorized boating, waterskiing/knee-boarding, and jet skiing.



Question 8: Major Reasons for the Day's Visit

Fishing was the most frequently selected reason for visiting the lake on the day the intercept survey was completed, followed by camping, site seeing, motorized boating, picnicking, non-motorized boating, and jet skiing. Of the 18 people who said other, 13 were visiting friends or family; one was bird watching and another one was camping. Another worked for Clark Co. Forestry and Parks managing Mead Lake.



Question 9a and 9b: Avoiding Recreational Activities Because of Poor Water Quality

Recreational activities involving Mead Lake were avoided because of poor water quality by 40.4% of the interviewees.

Avoided Recreation Due to Poor Water Quality		
	Frequency	Percentage
No	59	59.6%
Yes	40	40.4%

Those who indicated they have avoided recreational activities in Mead Lake due to poor water quality were asked to tell more about when and why they avoided recreational activities. In response to the open-ended question, some talked about the reasons for avoiding the Lake while other talked about the activities they gave up due to the poor water quality of Mead Lake. The table below provides specifics under each type of response and the percentage of all interviewees who were classified in that category. Poor water quality, its green color plus algae and other weeds were often selected reasons. Activities given up were swimming and fishing.

Avoiding Recreation in Mead Lake (N = 40)	
Reasons	**Examples**
Poor water quality in general (25.0%)	• "dirty water" • "mucky water" • "you can't even see the bottom"
Green color (22.5%)	• "green water" • "in the fall water gets green"
Algae and other weeds (20.0%)	• "too much algae" • "duck weed and algae in upper lake"
Health concerns (7.5%)	• "water looked unhealthy" • "dog gets a rash when he swims'
Activities Given Up	**Examples**
Swimming (35.0%)	• "avoided swimming" • "try to avoid swimming"
Fishing (17.5%)	• "fishing sucks" • "hard to fish with children due to getting weeds and scum just about every cast"

** Percentages will not equal 100 as some answers fit more than one category.

Question 10: Plans to Visit Again This Year

Nearly 86% of the interviewees plan on visiting Mead Lake again this year. Of those who said yes, the average number of times they planned on visiting again this year was 6, with a range of 1 to 62.

Plan on Visiting Mead Lake Again This Year		
	Frequency	Percentage
Yes	84	85.7%
No	14	14.3%

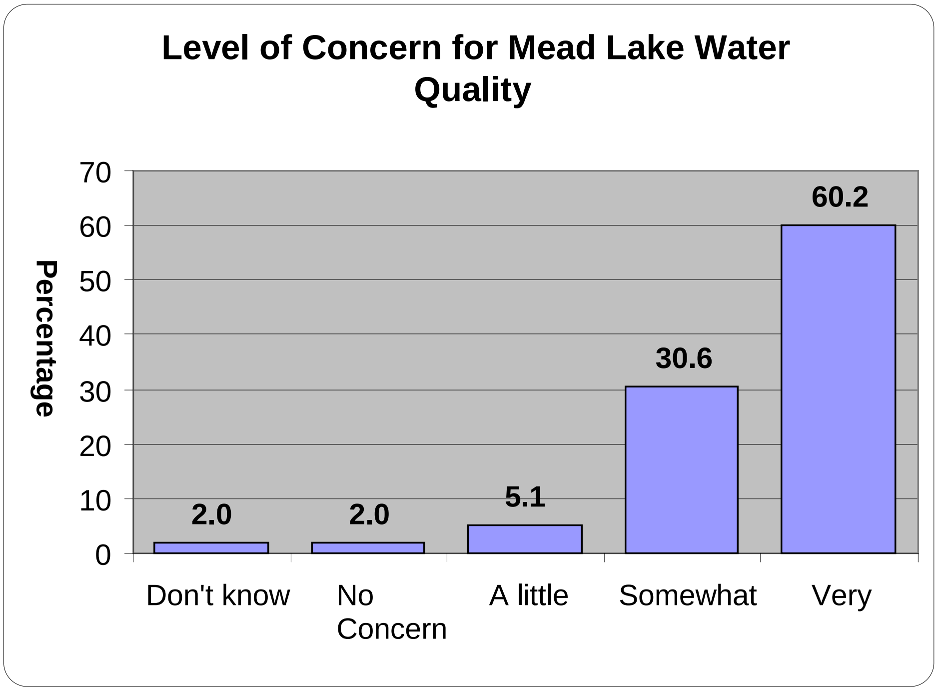
Perceptions of Mead Lake and Quality of Its Water

Summary: An overwhelming majority (nearly 91%) were either *Very concerned* or *Somewhat concerned* about the water quality of Mead Lake. They were concerned about algae and other weeds, green color, poor water quality in general, poor quality of fish/fishing environment, health concerns, unsanitary conditions for swimming, and a bad smell.

Toward the end of the interview, individuals were asked if they wanted to tell the interviewer anything else about the water quality of Mead Lake. Twenty-nine of the 31 individuals who responded discussed further their concerns. Most had already been expressed. The two exceptions felt that overall the water quality of Mead Lake was good.

Question 11 and 11a: Extent Concerned About Mead Lake's Water Quality

Interviewees were asked the extent they were, if at all, concerned about the water quality of Mead Lake and could pick one of five responses; *No concern, A little concerned, Somewhat concerned, Very concerned, and Don't know/can't make a judgment*. Nearly 91% were either *Very concerned* or *Somewhat concerned,* compared to 5.1% who were *A little concerned*. The remainder either had no concerns or didn't know.



In a follow-up question those who were concerned to any extent revealed specific concerns. There were seven categories with nearly 48% talking about algae and other weeds.

Particular Concerns Regarding the Water Quality of Mead Lake (N = 83)	
Concerns	**Examples**
Algae and other weeds (47.2%)	• "algae and duck weed is bad in a big lake" • "algae bloom"
Green color (26.5%)	• "how green it gets later in the year" • "green water is slimy"
Poor water quality in general (25.3%)	• "poor water clarity" • "dirty water" • "water quality and safety"
Poor quality of fish/fishing environment (19.3%)	• "size and health of fish" • "weeds and water are stunting the fish"
Health concerns (12.0%)	• "the health of the fish and wildlife" • "when kids are in water, not wanting them to get sick"
Unsanitary for swimming (3.6%)	• "kids can't swim here" • "cannot swim in water sometimes"
Bad smell (3.6%)	• "smelly"/"the smell of the lake"
Other: Single individuals	• Fear of it getting worst, closing lake, farm runoff

** Percentages will not equal 100 as some answers fit more than one category.

Those who said that they didn't know or were not concerned about the water quality of Mead Lake reasoned that they did not have enough knowledge of the lake and that they 'haven't been [t]here long enough'.

Question 12: Respondents' Additional Comments

Towards the end of the interview, participants were asked if there was anything else they would like to tell the interviewer about the water quality of Mead Lake. Two individuals felt less concerned about the overall water quality of Mead Lake while indicating water quality was generally good. Twenty-nine others felt differently, mentioning concerns such as decreased fish populations because of poor water quality, algae or "the green", concerns that children can not swim, use of personal water crafts and "fast boats", the need to control runoff from farms and wanting "more done to protect and improve the water quality".

Mead Lake Watershed SWAT Model Setup

Photo: South Fork of Eau Claire River

A Report by the Center for Watershed Science and Education
University of Wisconsin – Stevens Point

August 2006

Table of Contents

I. Introduction

A. *Importance*

The U.S. Environmental Protection Agency (USEPA) lists eutrophication as the main cause of impaired waters in the United States (EPA 1996). Eutrophication is nutrient enrichment and subsequent excessive biological productivity in lakes and streams. While they grow, biota reduce water clarity and impair water use. When the biota die and decompose, dissolved oxygen levels are reduced impairing aquatic community composition within the lake. Although nitrogen also affects water quality, phosphorus is usually the limiting nutrient for eutrophication of inland lakes (Correll 1998). The effects of eutrophication in Midwestern lakes are often observed when concentrations of total phosphorus reach 0.02 mg/L (Shaw *et al.* 2000).

Phosphorus concentrations in lakes are controlled by both internal and external phosphorus loading. Internal phosphorus loading occurs when phosphorus already in the lake system becomes available for use by biota. In eutrophic lakes, reduced dissolved oxygen creates an anoxic environment favorable for the release of phosphorus that was previously buried in lake sediment. External phosphorus loading is phosphorus transported into the lakes from the watershed or the atmosphere. External loading can be increased by land management that increases the movement or availability of phosphorus. There is little argument that the phosphorus delivered externally to a reservoir system is a principle cause of eutrophication. Slowing or reversing eutrophication requires that the external and/or internal loads be reduced. Because internal loads are already in the lake, it is critically important to understand and reduce, if possible, the external loading. To efficiently address external loads, it is important to locate and manage the critical areas within the watershed which are the largest phosphorus contributors.

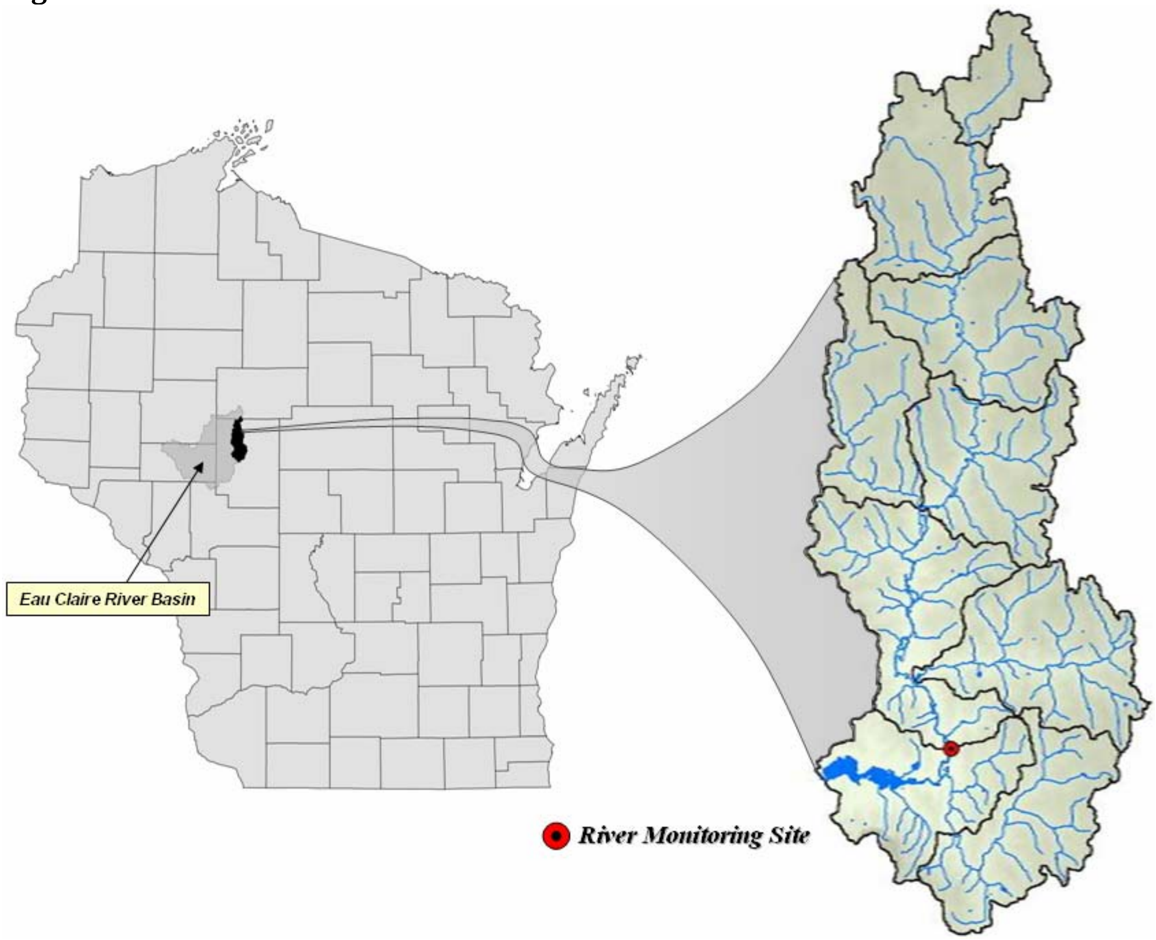
Mead Lake is listed as a high priority on the Wisconsin Department of Natural Resource’s (WDNR) 303d impaired waterway list (WDNR 2006). Impaired waters, as defined by Section 303(d) of the federal Clean Water Act, are those waters that are not meeting the state's water quality standards or use designations. The pollutants of concern are phosphorus and sediment from non-point sources entering the lake by external loading.

A two year study in 2002-2003 of Mead Lake's water quality was conducted by the Army Corps of Engineers (ACOE) (James 2005). The study focused on external loading (suspended sediments and nutrients from the South Fork of the Eau Claire River), internal P fluxes from aquatic sediment, and in-lake water quality measurements. The study found that on average 83% of the P load came from tributaries of Mead Lake. The study concluded that "*because Mead Lake impounds a large portion of the agriculturally-dominated South Fork of the Eau Claire River watershed, it receives substantial P loads that overwhelmingly contribute to poor water quality conditions*." The study went on to recommend that "*the management of internal P loading from the sediment should not be attempted in Mead Lake until significant tributary P loading reduction has been achieved through Best Management Practices (BMP)* " (James 2005).

B. *Location*

The Mead Lake Watershed (MLW), a subbasin of the Eau Claire River Watershed, drains 248 km^2 (61,282 acres) of West-Central Wisconsin (Figure 1). The watershed empties into Mead Lake, a 1.3 km^2 impoundment west of Greenwood, Wisconsin. Mead Lake has a volume of 1.9 hm^3 and mean and maximum depths of 1.5m and 5m, respectively (James 2005). The South Fork of the Eau Claire River (43.8 km channel length) is the primary tributary contributing to Mead Lake.

Figure 1: Location of Mead Lake Watershed within Wisconsin



C. *Purpose and Scope*

In order to understand phosphorus loading from nonpoint sources within the watershed, the SWAT model will be used to simulate the influence of land management on phosphorus transfer to Mead Lake. The SWAT model is a physically based, continuous time, geographic information system (GIS) model developed by the U.S. Department of Agriculture – Agriculture Research Service (USDA-ARS) for the prediction and simulation of flow, sediment, and nutrient yields. The SWAT model incorporates the effects of climate, surface runoff, evapotranspiration, crop growth, groundwater flow, nutrient loading, and water routing for different land uses to predict hydrologic response. SWAT was designed for large, ungaged watersheds and has successfully been used as a nutrient management tool in several Wisconsin watersheds.

II. Model Data Inputs

A. ***Topography***

The topography within the MLW is an important factor influencing nutrient transport. The SWAT model uses topography to delineate the boundaries of the subwatersheds and define subwatershed parameters such as average slope, slope length, and the accumulation of flow for the definition of stream networks. The Mead Lake Watershed was topographically subdivided into 9 subwatersheds based on the stream network and sampling site location.

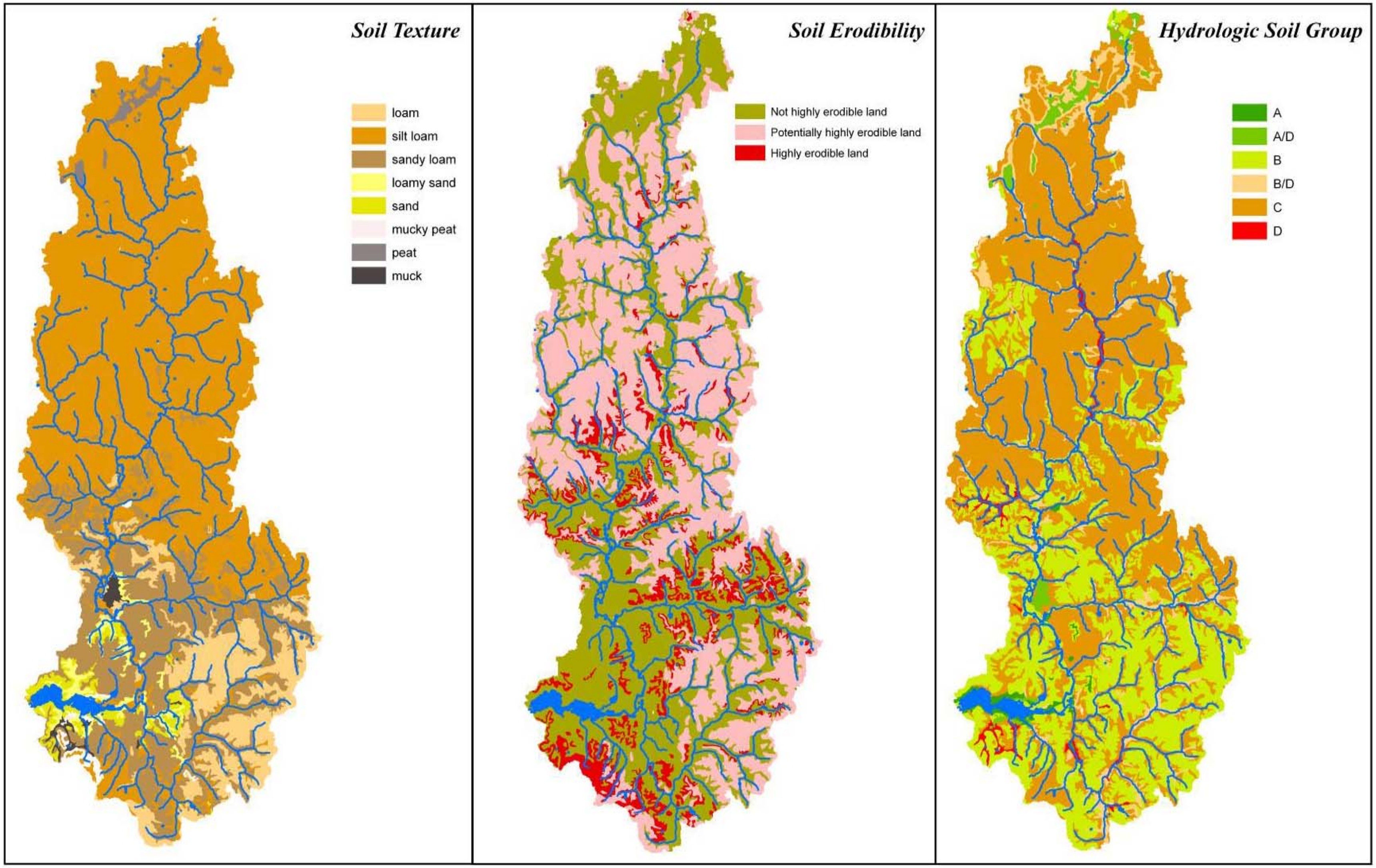
*Datas*et: The statewide 7.5 minute (or 1:24,000 scale) 30-meter grid based DEM obtained from the WDNR will be used for the entire watershed. The 10-meter resolution DEM is not currently available for this watershed.

B. ***Soils***

Soil characteristics, coupled with other landscape factors, are used to determine soil moisture properties and erodibility potential within SWAT. Silt loam, located predominantly in the upper half of the MLW, is the dominant soil texture. SWAT uses the hydrologic soil group to determine the runoff potential of an area (A has the greatest infiltration potential and D is the greatest runoff potential). The MLW is a mixture of the B and C hydrologic soil group (Figure 2).

*Datas*et: The STATSGO soils database created by the USDA Soil Conservation Service will define soil attributes in SWAT. STATSGO provides a general classification within the Mead Lake

Figure 2: Soil Texture, Erodibility, and Hydrologic Soil Group Classifications of the Mead Lake Watershed



C. ***Hydrology***

The stream network is the primary means of surface water and sediment routing. The SWAT model requires a user defined hydrology data set to determine preferred flow paths within the watershed. Prior to being received by Mead Lake, two larger tributaries flow into the South Fork of the Eau Claire (Norwegian Creek and Rocky Run) as well as several unnamed creeks.

*Datas*et: The WIDNR 24K hydrography database will be used as the hydrology input layer for SWAT. The 24K Hydro layer was processed at double precision to accuracy consistent with national map accuracy standards for 1:24000 scale geographic data.

D. ***Measured Water Quality and Discharge***

Subwatersheds one through nine (192 km^2) contribute to the gauged discharge and water quality at Hwy MM on the South Fork of the Eau Claire River. A daily stage elevation (averaged from 15-minute interval stage readings) was converted to volumetric flow using a rating curve. Flow readings were collected between April 2002 and October 2003 (Table 1, Figure 3). Water quality samples were collected biweekly (James 2005) at Hwy MM as well as the outlet of Mead Lake (Appendix A).

Table 1 – Monitoring Stations within Mead Lake Watershed

Flow Location	Time Period	Group	Type of Flow Measurement
South Fork of Eau Claire River at County Rd MM	04/24/2002 to 1/05/2002; 04/11/2003 to 10/07/2003	USACE	Avg. Daily Flow

Figure 3: Mead Lake Watershed Stream Network and Monitoring Location

E. *Climate*

SWAT can use observed weather data or simulate it using a database of weather statistics from specific weather stations. The use of measured climatological data greatly improves SWAT's ability to reproduce stream hydrographs. Observed daily precipitation and min/max temperature data will be utilized from two weather stations within the Eau Claire River Watershed (Table 2). Other weather parameters such as solar radiation and wind speed will be simulated from a SWAT weather generator database using the closest weather station within the SWAT model's internal database (Neillsville, WI).

*Datas*et: Historic climate data for 2 monitoring stations was obtained from the National Climatic Data Center (NCDC). Multiple stations are used for improved spatial climatological definition. Each subwatershed uses the individual climatological station closest to the subwatershed.

Table 2 – Mead Lake Watershed Climatological Collection Stations and Durations

Station Identification	Climatological Collection Time Period
Stanley, Wisconsin	09/1903 to 11/2005
Owen, Wisconsin	07/1946 to 12/2005

F. ***Land Coverage***

The MLW land cover is predominately cropped agricultural land (41%), with higher concentrations (68%) of cropped land in the northern half (subwatersheds 1 through 5) of the watershed (Table 3, Figures 4 & 5). A 2001 land coverage developed by Clark County shows a decrease in agriculture and increase in forested land compared to the 1992 WISCLAND land coverage. This change may be a result of conversion of agricultural to private / recreational land, or it may be due to the differences in coverage production. The 1992 WISCLAND coverage used LANDSAT imagery and the 2001 Clark County coverage was hand digitized from a 1997 aerial photography and verified during a 2001 windshield verification. Refer to Appendix B for land coverage percentages per subwatershed.

Table 3 – Mead Lake Watershed Landuse Comparison between 1992 and 2001

Land Cover	1992 Landuse Area (Acres)	1992 Landuse Percent of Basin	2001 Landuse Area (Acres)	2001 Landuse Percent of Basin
Cropped Farmland	29,467	48.13	25,656	41.38
Farmsteads	---	---	599	0.97
Forest	14,549	23.76	19,660	31.71
Grassland / Pasture	7,105	11.60	6,666	10.75
Urban / Impervious	---	---	3,001	4.84
Water	337	0.55	426	0.69
Wetland	5,988	9.78	5,988	9.66
Barren	3,781	6.18	---	---

*Datas*et: The land coverage dataset for the SWAT model was developed by Clark County through the digitizing a 1997 aerial coverage and windshield verification in 2001. The Clark County landuse was categorized with cropped farmland, forested areas, roads, urbanized areas (residential, commercial, etc), and a category for other resource land (ORL). The ORL is land under private ownership including grassland, pasture, wetlands, and upland. The 1992 WISCLAND wetlands layer was merged into the 2001 Clark County land coverage since wetland boundaries where not delineated with the 2001 coverage and the assumption was made that the wetland boundaries did not change considerably between 1992 and 2001. Once the wetland landuse was merged into the 2001 coverage, all remaining ORL was reclassified as grassland / pasture or forest.

Figure 4: Mead Lake Watershed Land Cover Classification

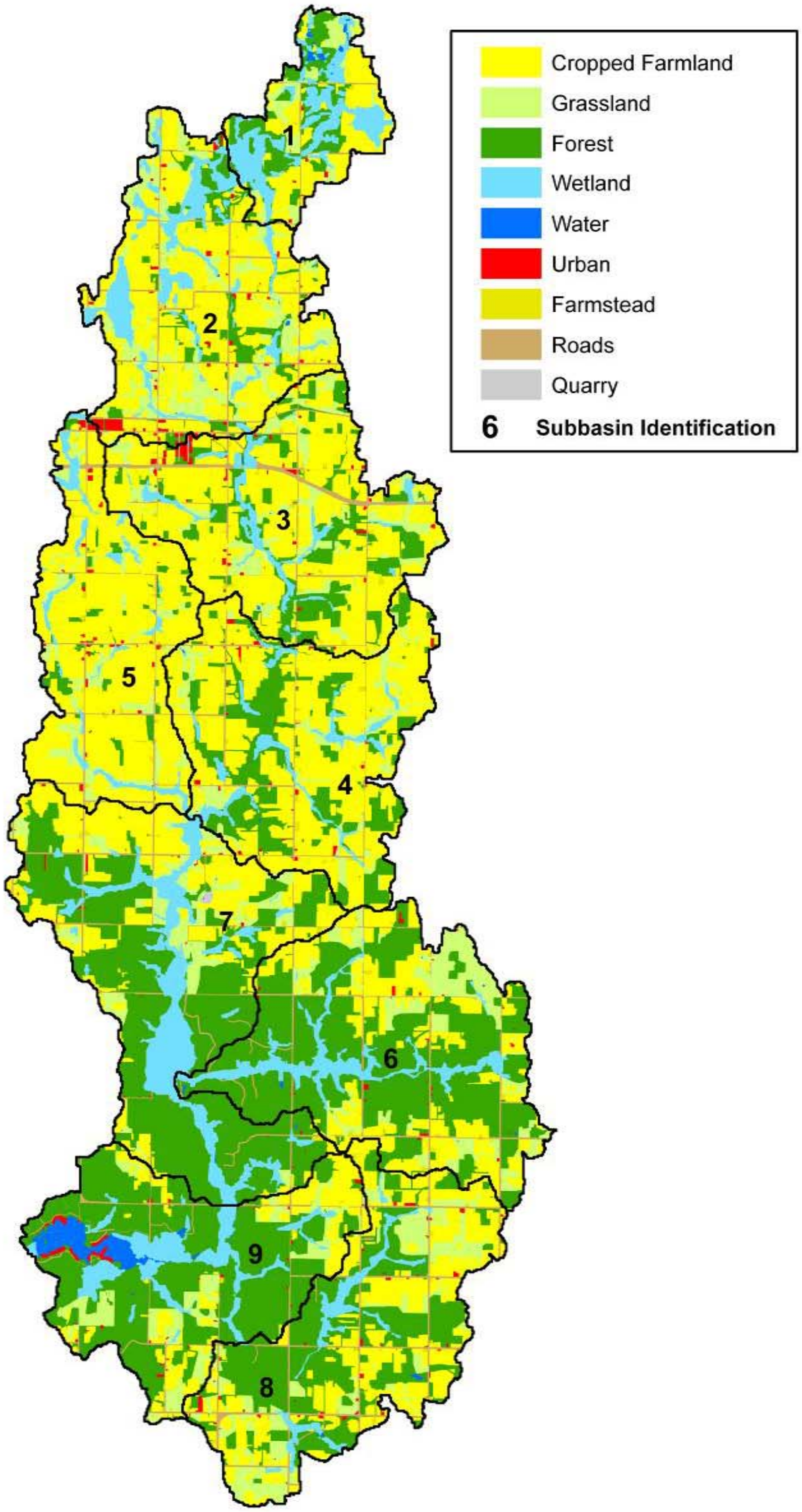
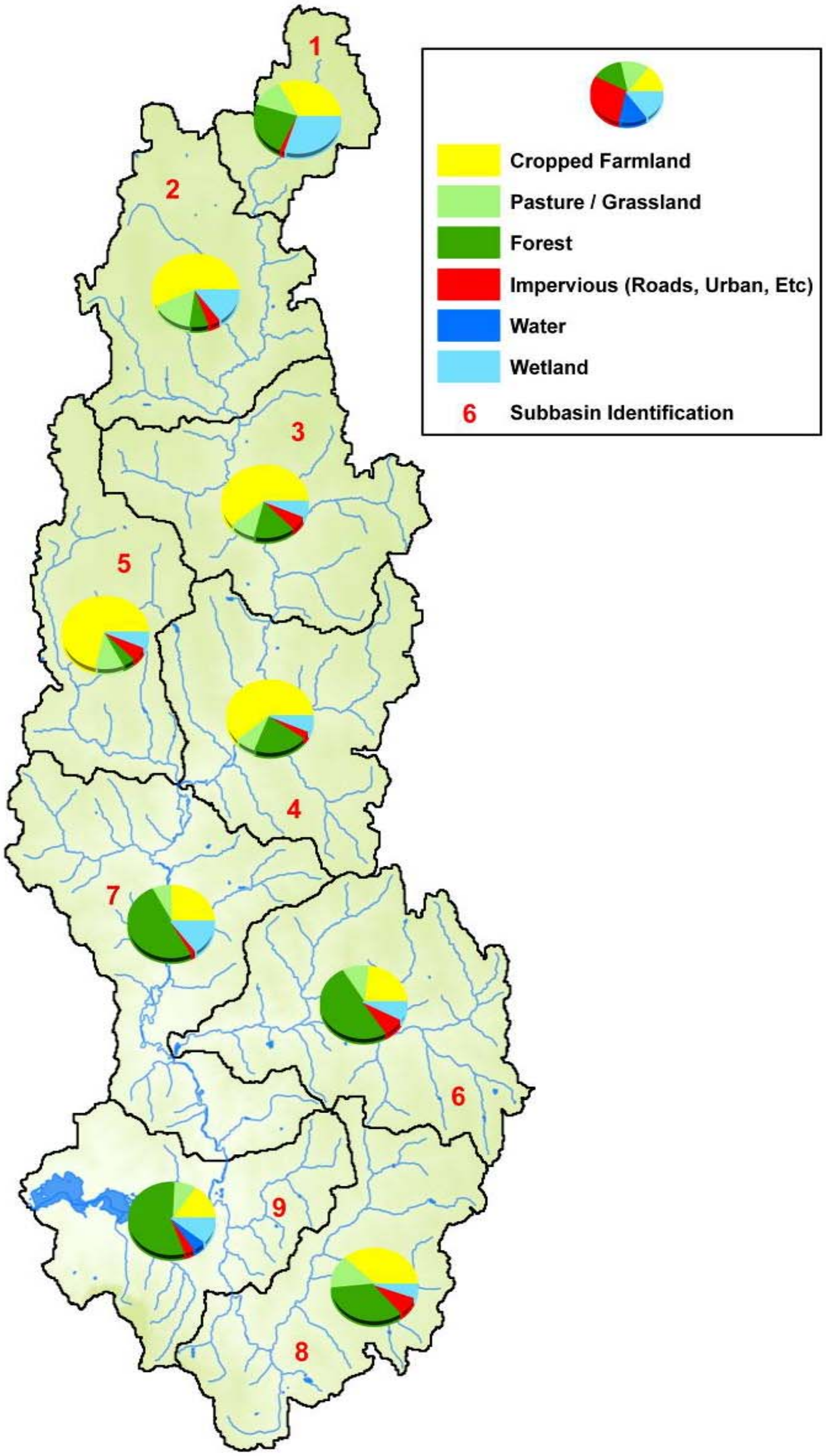


Figure 5: Mead Lake Land Coverage Percentages per Subwatershed



G. *Land Management*

The land management of the MLW was assessed using a 2002 farm survey, a land evaluation completed by the Clark and Taylor County Land Conservation departments, and a 1999 transect survey conducted by the Clark County Land Conservation department. The use of the National Agriculture Statistics Service (NASS) crop yields and cattle counts were not used because the statistics are not spatially defined within each county. The MLW consists of 7.88% of Clark County; therefore the use of county wide statistics might not be accurate.

The 2002 farm survey included 82 farms within the watershed, although some farmers chose not to participate or did not have knowledge of the land practices due to land rental. Of the 82 farmers, 74 gave information regarding herd size, manure management, and crop rotation. The majority of the farmers had some type of dairy rotation which usually consisted of two years of corn, one year of oats and alfalfa, followed by three years of alfalfa (Appendix C). Some farms rotated corn for more then two years and included soybeans, peas, or clover into the rotation. Farmers reported approximately 4,169 head of cattle within the watershed. Assuming each cow produces 52.16 kg manure/day, the watershed manages approximately 217,468 kg of manure daily (Turnquist *et al.* 2005). At the time of the survey 68% of the watershed's farmers reported storing manure (Figure 6). The survey indicated several types of tillage occurring throughout the growing season. Typically the soil was disked prior to planting of corn, oats, and soybeans. During the growing season springtooth harrow, harrow tines, or row cultivator tillage will be used for corn. Fall tillage includes disking and paraplow.

The Clark and Taylor County Land Conservation Departments were each given a landuse map for their portion of the watershed. Dominant management practices were indicated on the map and then entered into GIS for spatial analysis. Of the cropped agriculture within the MLW, conservationists indicated approximately 53% is dairy rotated (one year corn, one year corn or soybean, one year oats and alfalfa, three 3 years alfalfa) with stored manure (Appendix B). The stored manure dairy rotation was the dominant management practice in five of the nine subwatersheds (Figure 7, Table 4). Another approximately 30% of the watershed is in cash grain with no storage and no manure.

A 1999 transect survey conducted by the Clark County Land Conservation Department indicated the crops for 1998 and 1999. The transect route consisted of approximately 18 sites within subwatershed six, eight, and nine. The transect survey points correctly corresponded to the management practice GIS layer created from the Land Conservation Departments.

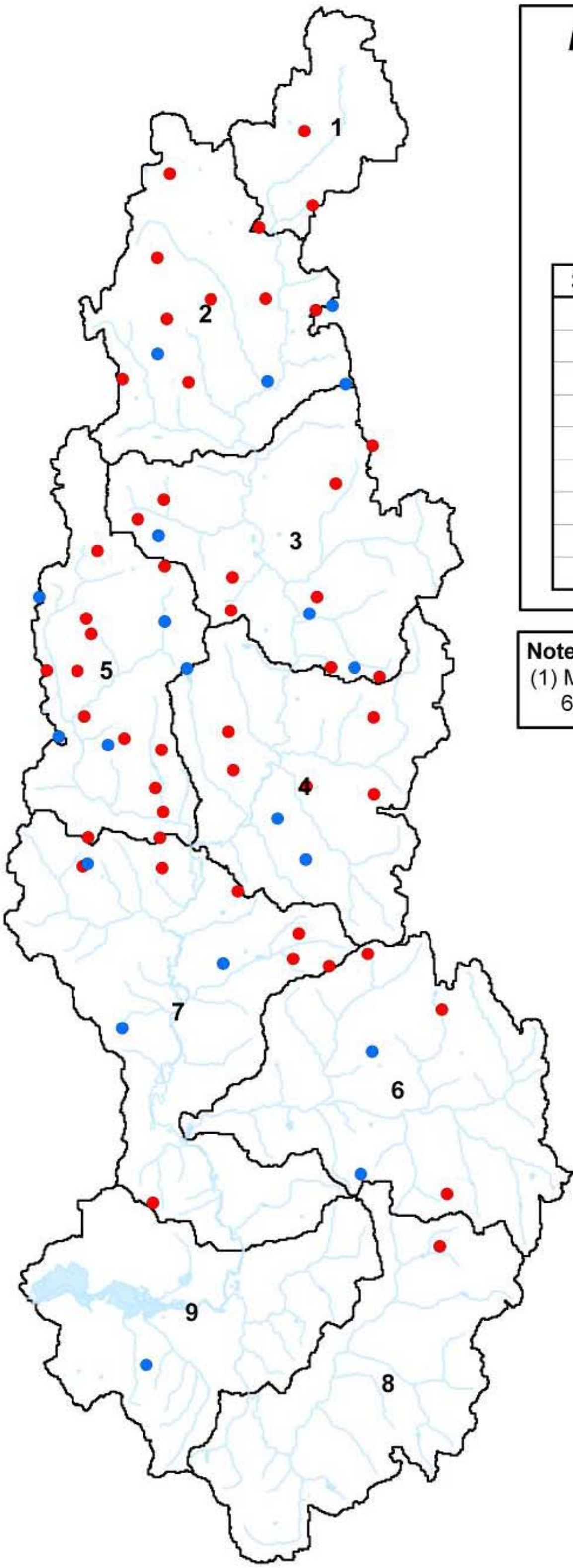
Both the farm survey and the land evaluation concluded similar land management trends. Management scenarios developed in the SWAT model will be based on information from both sources and linked into SWAT using the GIS rotation layer. Refer to Appendix D for detailed management scenarios per rotation type.

Table 4 – Percentage of Management Practices per Subbasin

	Subwatershed Percentage								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Dairy Rotation (C-C/S-O-A-A-A) (Manure Storage)	10.9	80.1	64.6	53.9	61	37.6	52.2	12.4	27
Dairy Rotation (C-C/S-O-A-A-A) (No Storage / No Manure)	64.4	16.2	29.3	33	23	45.1	39.9	19	23.5
Dairy Rotation (C-O-A-A-A) (No Manure Storage)	0	0.6	0.6	6.6	0	3.2	1.6	59.8	26.3
C-C-O-A-A (No Manure Storage)	5.9	1.3	0	0	0	3.8	0	0	4.7
C-C-C-C-O-A-A-A (Manure Storage)	0	0	1.7	0	14.9	0	0	0	0
Continuous Hay / Pasture	0	0	3	0	0	0	0.3	5.2	6.3
Corn – Soybean	2.9	1.8	0.8	6.6	0.9	10.4	6.1	3.6	12.2

*Datas*et: Land management practices will be the 2001 Clark County land coverage attributes. The 2001 Clark County land coverage defines all agricultural land as cropped farmland (WISCLAND grid code 110); however, the land coverage has been modified so that each cropped farmland polygon has a related management rotation (Table 4) assigned to it. The grid code, a numerical value assigned to a landuse in the WIDNR 1992 WISCLAND layer, was modified so that each rotation had a unique grid code value. The dominant rotations (rotations summing greater than 75%) of the watershed will be used for model simulations.

Figure 6: Manure Management and Herd Size Per Subwatershed



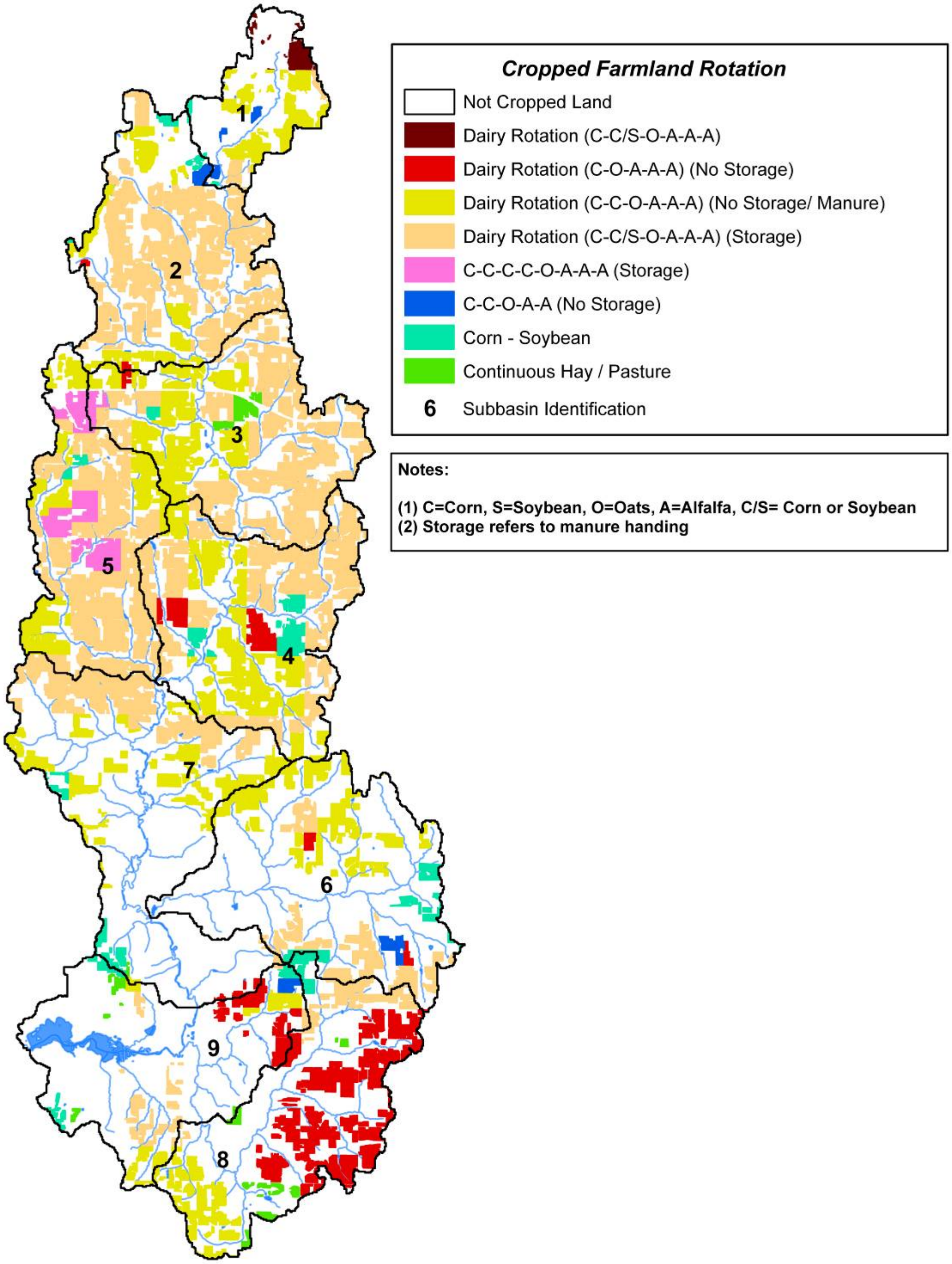
Manure Management

- Haul
- Stored Manure

Subbasin	# of Cattle
1	70
2	445
3	554
4	519
5	1410
6	409
7	487
8	275
9	0

Notes:
(1) Manure Management spatial information includes 69 of the 74 farms involved in the 2002 survey

Figure 7: Dominant Crop Rotations within the Mead Lake Watershed



References

Correl, D. (1998). The Role of Phosphorus in the Eutrophication of Receiving Waters: A Review. *Journal of Environmental Quality* 27, 261-265.

James, W. (2005). Phosphorus Budget and Loading Reduction Analysis of Mead Lake, West-Central Wisconsin. Eau Galle Aquatic Ecology Laboratory of the Environmental Processes and Effects Division of the U.S. Army Corps of Engineers.

Shaw, B., C.Mechenich, L. Klessing (2000). Understanding Lake Data. UW – Stevens Point. University of Wisconsin Extension.

Turnquist, A., J.Foltz, C.Roth (2005). Manure Management on Wisconsin Dairy Farms. Program on Agricultural Technology Studies. University of Wisconsin – Madison and University of Wisconsin – Cooperative Extension. Fact Sheet No. 23.

U.S. Environmental Protection Agency (1996). Environmental Indicators of Water Quality in the United States. EPA 841-R-96-002.

Wisconsin Department of Natural Resources (2006). List of Impaired Waterways. http://dnr.wi.gov/org/water/wm/wqs/303d/303d.html

Appendix A

Table 1
Average Daily Discharge of
South Fork of the Eau Claire River at County Highway MM

Table 2
Water Quality Analysis of
South Fork of the Eau Claire River at County Highway MM

Table 3
Water Quality Analysis of
Mead Lake Water Quality below Mead Lake Dam

Appendix A
Table 1
Average Daily Discharge of
South Fork of the Eau Claire River at County Highway MM

Date	Flow (cfs)	Flow (cms)
4/9/2002	495.332	14.026
4/23/2002	181.609	5.143
4/24/2002	78.639	2.227
4/25/2002	72.734	2.060
4/26/2002	49.78	1.410
4/27/2002	38.501	1.090
4/28/2002	132.923	3.764
4/29/2002	240.647	6.814
4/30/2002	108.909	3.084
5/1/2002	56.499	1.600
5/2/2002	40.463	1.146
5/3/2002	30.618	0.867
5/4/2002	25.231	0.714
5/5/2002	23.057	0.653
5/6/2002	572.801	16.220
5/7/2002	187.542	5.311
5/8/2002	89.466	2.533
5/9/2002	523.803	14.832
5/10/2002	101.119	2.863
5/11/2002	58.013	1.643
5/12/2002	143.65	4.068
5/13/2002	113.87	3.224
5/14/2002	68.661	1.944
5/15/2002	49.154	1.392
5/16/2002	41.713	1.181
5/17/2002	34.126	0.966
5/18/2002	27.038	0.766
5/19/2002	22.481	0.637
5/20/2002	19.293	0.546
5/21/2002	17.483	0.495
5/22/2002	16.17	0.458
5/23/2002	15.627	0.443
5/24/2002	13.79	0.390
5/25/2002	12.537	0.355
5/26/2002	18.563	0.526
5/27/2002	157.707	4.466
5/28/2002	98.583	2.792
5/29/2002	51.614	1.462
5/30/2002	33.684	0.954
5/31/2002	21.432	0.607
6/1/2002	15.158	0.429
6/2/2002	12.368	0.350
6/3/2002	526.405	14.906
6/4/2002	268.158	7.593
6/5/2002	476.84	13.503
6/6/2002	123.362	3.493
6/7/2002	57.281	1.622
6/8/2002	35.95	1.018
6/9/2002	27.539	0.780
6/10/2002	21.632	0.613
6/11/2002	23.682	0.671
6/12/2002	22.69	0.643
6/13/2002	18.292	0.518

Appendix A
Table 1
Average Daily Discharge of
South Fork of the Eau Claire River at County Highway MM

Date	Flow (cfs)	Flow (cms)
6/14/2002	116.247	3.292
6/15/2002	107.355	3.040
6/16/2002	47.468	1.344
6/17/2002	27.872	0.789
6/18/2002	20.902	0.592
6/19/2002	18.435	0.522
6/20/2002	18.059	0.511
6/21/2002	22.775	0.645
6/22/2002	565.189	16.004
6/23/2002	859.526	24.339
6/24/2002	219.391	6.212
6/25/2002	76.714	2.172
6/26/2002	77.421	2.192
6/27/2002	57.683	1.633
6/28/2002	33.212	0.940
6/29/2002	24.245	0.687
6/30/2002	19.24	0.545
7/1/2002	15.346	0.435
7/2/2002	12.732	0.361
7/3/2002	11.407	0.323
7/4/2002	10.433	0.295
7/5/2002	9.422	0.267
7/6/2002	8.722	0.247
7/7/2002	8.095	0.229
7/8/2002	13.883	0.393
7/9/2002	34.691	0.982
7/10/2002	17.186	0.487
7/11/2002	13.503	0.382
7/12/2002	11.772	0.333
7/13/2002	13.079	0.370
7/14/2002	12.965	0.367
7/15/2002	12.799	0.362
7/16/2002	12.688	0.359
7/17/2002	12.485	0.354
7/18/2002	12.807	0.363
7/19/2002	12.77	0.362
7/20/2002	12.9	0.365
7/21/2002	13.085	0.371
7/22/2002	32.339	0.916
7/23/2002	26.531	0.751
7/24/2002	18.71	0.530
7/25/2002	13.642	0.386
7/26/2002	11.828	0.335
7/27/2002	12.656	0.358
7/28/2002	12.601	0.357
7/29/2002	14.328	0.406
7/30/2002	17.094	0.484
7/31/2002	25.22	0.714
8/1/2002	62.512	1.770
8/2/2002	28.813	0.816
8/3/2002	18.016	0.510
8/4/2002	56.24	1.593
8/5/2002	59.274	1.678

Appendix A
Table 1
Average Daily Discharge of
South Fork of the Eau Claire River at County Highway MM

Date	Flow (cfs)	Flow (cms)
8/6/2002	29.292	0.829
8/7/2002	18.374	0.520
8/8/2002	14.278	0.404
8/9/2002	12.004	0.340
8/10/2002	12.736	0.361
8/11/2002	12.891	0.365
8/12/2002	46.608	1.320
8/13/2002	137.306	3.888
8/14/2002	80.35	2.275
8/15/2002	45.395	1.285
8/16/2002	27.002	0.765
8/17/2002	61.54	1.743
8/18/2002	89.228	2.527
8/19/2002	40.549	1.148
8/20/2002	24.115	0.683
8/21/2002	54.773	1.551
8/22/2002	1058.887	29.984
8/23/2002	274.585	7.775
8/24/2002	93.611	2.651
8/25/2002	48.276	1.367
8/26/2002	31.498	0.892
8/27/2002	23.998	0.680
8/28/2002	19.649	0.556
8/29/2002	17.144	0.485
8/30/2002	15.555	0.440
8/31/2002	14.283	0.404
9/1/2002	13.334	0.378
9/2/2002	360.892	10.219
9/3/2002	255.218	7.227
9/4/2002	106.794	3.024
9/5/2002	47.303	1.339
9/6/2002	42.537	1.205
9/7/2002	110.997	3.143
9/8/2002	63.01	1.784
9/9/2002	35.34	1.001
9/10/2002	25.504	0.722
9/11/2002	21.465	0.608
9/12/2002	18.486	0.523
9/13/2002	16.417	0.465
9/14/2002	17.442	0.494
9/15/2002	20.572	0.583
9/16/2002	18.357	0.520
9/17/2002	16.381	0.464
9/18/2002	14.869	0.421
9/19/2002	26.385	0.747
9/20/2002	50.593	1.433
9/21/2002	74.306	2.104
9/22/2002	41.893	1.186
9/23/2002	26.882	0.761
9/24/2002	21.933	0.621
9/25/2002	21.188	0.600
9/26/2002	30.349	0.859
9/27/2002	49.444	1.400

Appendix A
Table 1
Average Daily Discharge of
South Fork of the Eau Claire River at County Highway MM

Date	Flow (cfs)	Flow (cms)
9/28/2002	35.509	1.006
9/29/2002	28.56	0.809
9/30/2002	65.925	1.867
10/1/2002	143.367	4.060
10/2/2002	85.961	2.434
10/3/2002	51.325	1.453
10/4/2002	402.536	11.399
10/5/2002	442.585	12.533
10/6/2002	290.504	8.226
10/7/2002	389.794	11.038
10/8/2002	196.305	5.559
10/9/2002	133.769	3.788
10/10/2002	144.898	4.103
10/11/2002	156.516	4.432
10/12/2002	88.871	2.517
10/13/2002	117.073	3.315
10/14/2002	63.024	1.785
10/15/2002	44.412	1.258
10/16/2002	34.287	0.971
10/17/2002	29.574	0.837
10/18/2002	30.82	0.873
10/19/2002	38.829	1.100
10/20/2002	31.918	0.904
10/21/2002	32.271	0.914
10/22/2002	47.151	1.335
10/23/2002	86.928	2.462
10/24/2002	88.141	2.496
10/25/2002	116.559	3.301
10/26/2002	252.189	7.141
10/27/2002	123.969	3.510
10/28/2002	71.652	2.029
10/29/2002	52.512	1.487
10/30/2002	42.33	1.199
10/31/2002	35.164	0.996
11/1/2002	28.781	0.815
11/2/2002	25.721	0.728
11/3/2002	24.552	0.695
11/4/2002	23.811	0.674
11/5/2002	22.554	0.639
4/11/2003	57.656	1.633
4/12/2003	58.076	1.645
4/13/2003	55.89	1.583
4/14/2003	60.025	1.700
4/15/2003	81.227	2.300
4/16/2003	1168.892	33.099
4/17/2003	1091.561	30.910
4/18/2003	587.112	16.625
4/19/2003	277.493	7.858
4/20/2003	844.613	23.917
4/21/2003	501.268	14.194
4/22/2003	230.482	6.527
4/23/2003	128.849	3.649
4/24/2003	96.043	2.720

Appendix A
Table 1
Average Daily Discharge of
South Fork of the Eau Claire River at County Highway MM

Date	Flow (cfs)	Flow (cms)
4/25/2003	80.276	2.273
4/26/2003	69.455	1.967
4/27/2003	61.788	1.750
4/28/2003	56.26	1.593
4/29/2003	49.84	1.411
4/30/2003	45.33	1.284
5/1/2003	43.489	1.231
5/2/2003	39.375	1.115
5/3/2003	35.332	1.000
5/4/2003	32.997	0.934
5/5/2003	127.449	3.609
5/6/2003	198.422	5.619
5/7/2003	98.267	2.783
5/8/2003	79.423	2.249
5/9/2003	302.38	8.562
5/10/2003	231.779	6.563
5/11/2003	699.948	19.820
5/12/2003	782.774	22.166
5/13/2003	211.225	5.981
5/14/2003	107.142	3.034
5/15/2003	78.137	2.213
5/16/2003	60.362	1.709
5/17/2003	49.046	1.389
5/18/2003	42.301	1.198
5/19/2003	39.454	1.117
5/20/2003	79.414	2.249
5/21/2003	56.705	1.606
5/22/2003	42.713	1.209
5/23/2003	39.254	1.112
5/24/2003	34.958	0.990
5/25/2003	30.144	0.854
5/26/2003	26.901	0.762
5/27/2003	24.59	0.696
5/28/2003	25.101	0.711
5/29/2003	33.571	0.951
5/30/2003	36.591	1.036
5/31/2003	36.086	1.022
6/1/2003	34.51	0.977
6/2/2003	33.718	0.955
6/3/2003	33.586	0.951
6/4/2003	31.845	0.902
6/5/2003	30.678	0.869
6/6/2003	30.625	0.867
6/7/2003	49.773	1.409
6/8/2003	130.037	3.682
6/9/2003	98.119	2.778
6/10/2003	136.958	3.878
6/11/2003	167.341	4.739
6/12/2003	82.84	2.346
6/13/2003	53.725	1.521
6/14/2003	37.699	1.068
6/15/2003	33.936	0.961
6/16/2003	27.761	0.786

Appendix A
Table 1
Average Daily Discharge of
South Fork of the Eau Claire River at County Highway MM

Date	Flow (cfs)	Flow (cms)
6/17/2003	25.935	0.734
6/18/2003	24.536	0.695
6/19/2003	19.583	0.555
6/20/2003	17.402	0.493
6/21/2003	16.183	0.458
6/22/2003	15.848	0.449
6/23/2003	16.275	0.461
6/24/2003	21.268	0.602
6/25/2003	29.358	0.831
6/26/2003	22.168	0.628
6/27/2003	18.996	0.538
6/28/2003	19.746	0.559
6/29/2003	27.04	0.766
6/30/2003	26.911	0.762
7/1/2003	24.171	0.684
7/2/2003	20.446	0.579
7/3/2003	22.682	0.642
7/4/2003	29.997	0.849
7/5/2003	38.535	1.091
7/6/2003	25.067	0.710
7/7/2003	25.269	0.716
7/8/2003	28.069	0.795
7/9/2003	34.566	0.979
7/10/2003	33.745	0.956
7/11/2003	36.956	1.046
7/12/2003	33.735	0.955
7/13/2003	22.144	0.627
7/14/2003	22.061	0.625
7/15/2003	40.404	1.144
7/16/2003	34.185	0.968
7/17/2003	25.972	0.735
7/18/2003	23.206	0.657
7/19/2003	22.705	0.643
7/20/2003	22.679	0.642
7/21/2003	22.206	0.629
7/22/2003	20.412	0.578
7/23/2003	14.443	0.409
7/24/2003	13.483	0.382
7/25/2003	13.463	0.381
7/26/2003	13.361	0.378
7/27/2003	14.3	0.405
7/28/2003	12.537	0.355
7/29/2003	11.255	0.319
7/30/2003	11.691	0.331
7/31/2003	11.224	0.318
8/1/2003	22.739	0.644
8/2/2003	32.978	0.934
8/3/2003	69.077	1.956
8/4/2003	52.895	1.498
8/5/2003	40.259	1.140
8/6/2003	27.688	0.784
8/7/2003	19.087	0.540
8/8/2003	15.565	0.441

Appendix A
Table 1
Average Daily Discharge of
South Fork of the Eau Claire River at County Highway MM

Date	Flow (cfs)	Flow (cms)
8/9/2003	13.151	0.372
8/10/2003	10.658	0.302
8/11/2003	9.554	0.271
8/12/2003	7.718	0.219
8/13/2003	6.965	0.197
8/14/2003	7.101	0.201
8/15/2003	7.566	0.214
8/16/2003	11.057	0.313
8/17/2003	12.097	0.343
8/18/2003	12.44	0.352
8/19/2003	8.081	0.229
8/20/2003	10.799	0.306
8/21/2003	10.925	0.309
8/22/2003	10.906	0.309
8/23/2003	11.06	0.313
8/24/2003	11.5	0.326
8/25/2003	11.322	0.321
8/26/2003	10.78	0.305
8/27/2003	9.609	0.272
8/28/2003	9.43	0.267
8/29/2003	8.519	0.241
8/30/2003	7.831	0.222
8/31/2003	8.106	0.230
9/1/2003	8.32	0.236
9/2/2003	8.684	0.246
9/3/2003	11.063	0.313
9/4/2003	9.386	0.266
9/5/2003	8.075	0.229
9/6/2003	7.824	0.222
9/7/2003	6.561	0.186
9/8/2003	6.602	0.187
9/9/2003	7.091	0.201
9/10/2003	7.422	0.210
9/11/2003	8.152	0.231
9/12/2003	10.622	0.301
9/13/2003	18.796	0.532
9/14/2003	23.213	0.657
9/15/2003	21.854	0.619
9/16/2003	18.939	0.536
9/17/2003	17.348	0.491
9/18/2003	16.006	0.453
9/19/2003	19.651	0.556
9/20/2003	22.448	0.636
9/21/2003	19.566	0.554
9/22/2003	17.124	0.485
9/23/2003	14.547	0.412
9/24/2003	14.463	0.410
9/25/2003	11.631	0.329
9/26/2003	12.166	0.345
9/27/2003	12.528	0.355
9/28/2003	14.339	0.406
9/29/2003	14.617	0.414
9/30/2003	13.223	0.374

Appendix A
Table 1
Average Daily Discharge of
South Fork of the Eau Claire River at County Highway MM

Date	Flow (cfs)	Flow (cms)
10/1/2003	12.157	0.344
10/2/2003	11.95	0.338
10/3/2003	16.1	0.456
10/4/2003	14.779	0.418
10/5/2003	14.503	0.411
10/6/2003	14.716	0.417
10/7/2003	13.825	0.391

Appendix A
Table 2
Water Quality Analysis of
South Fork of the Eau Claire River at County Highway MM

DATE	Flow	TN	TP	SRP	TSS
4/9/2002	495.33	2.236	0.145	0.049	17.5
4/23/2002	181.61	1.192	0.055	0.029	4.8
5/7/2002	187.54	1.683	0.121	0.09	18.2
5/23/2002	15.63	0.682	0.009	0.005	3.6
6/5/2002	476.84	3.261	0.177	0.136	23
6/19/2002	18.44	1.523	0.08	0.06	4.6
7/3/2002	11.41	1.431	0.099	0.078	3.6
7/17/2002	12.49	0.874	0.064	0.064	2
7/31/2002	25.22	1.139	0.085	0.086	2.3
8/28/2002	19.65	1.436	0.083	0.082	3.6
9/11/2002	21.47	1.448	0.151	0.109	4.2
9/28/2002	35.51	1.559	0.061	0.049	3.1
10/15/2002	44.41	1.28	0.076	0.071	4
10/23/2002	86.93			0.065	6.2
4/17/2003	1091.56	3.506	0.265	0.073	57.5
4/22/2003	230.48	2.222	0.1	0.048	8.9
5/6/2003	198.42	1.407	0.077	0.025	6.9
5/21/2003	56.71	1.047	0.057	0.022	3.8
6/18/2003	24.54	1.213	0.124	0.047	3.5
7/2/2003	20.45	0.89	0.071	0.045	2.8
7/16/2003	34.19	0.862	0.123	0.049	3.9
7/30/2003	11.69	0.6	0.115	0.062	2.5
8/12/2003	7.72	0.784	0.153	0.086	2.4
8/27/2003	9.61	0.599	0.114	0.074	
9/10/2003	7.42	0.501	0.076	0.053	2.5
9/24/2003	14.46	0.405	0.077	0.026	1.7
10/7/2003	13.83	0.467	0.041	0.026	1.4

Appendix A
Table 3
Water Quality Analysis of
Mead Lake Water Quality below Mead Lake Dam

DATE	Flow	TP	TN	SRP	TSS
5/7/2002		0.044	1.621	0.062	24.4
5/23/2002		0.073	1.114	0.011	9.3
6/5/2002		0.104	2.169	0.107	20.3
6/19/2002		0.049	1.457	0.008	15.2
7/3/2002		0.163	1.718	0.071	8.5
7/17/2002		0.089	1.369	0.053	10.1
7/31/2002		0.13	1.838	0.044	9.6
8/14/2002		0.116	1.97	0.08	14
8/28/2002		0.1	1.475	0.087	7.6
9/11/2002		0.237	1.225	0.14	3.5
9/28/2002		0.056	1.364	0.014	16.2
10/15/2002		0.098	1.42	0.068	12.5
5/8/2003		0.086	1.106	0.005	12.5
5/21/2003		0.062	1.566	0.012	6.2
6/18/2003		0.065	1.038	0.016	5
7/2/2003		0.13	1.375	0.017	5.1
7/16/2003		0.143	1.433	0.021	9.6
7/30/2003		0.123	1.179	0.014	8.8
8/12/2003		0.131	1.471	0.042	5.4
8/27/2003		0.189	1.742	0.073	.
9/10/2003		0.148	1.935	0.04	12.8
9/24/2003		0.133	1.713	0.018	23.2
10/7/2003		0.118	1.967	0.018	11.8

Appendix B

Table 1
Land Coverage of Mead Lake Watershed per Subwatershed &
Management Practices of Mead Lake Watershed per Subwatershed

MEAD LAKE WATERSHED LANDUSE CHARACTERIZATION

	Cropped Farmland (Acres)	Farmsteads (Acres)	Forest (Acres)	Grassland (Acres)	Impervious (Roads, Urban) (Acres)	Water (Acres)	Wetland (Acres)	Totals (Acres)
Subbasin 1	890.59	11.87	581.16	327.19	48.88	29.09	800.6	*2689.38*
Subbasin 2	3837.52	81.69	534.67	1140.02	362.92	12.11	939.08	*6908.01*
Subbasin 3	4233.16	98.02	1199.58	686.81	427.75	10.39	444.47	*7100.17*
Subbasin 4	4346.25	94.46	1582.72	542.63	202.63	22.42	401.73	*7192.84*
Subbasin 5	4118.33	83.36	285.31	676.13	235.48	2.07	341.54	*5742.22*
Subbasin 6	2001.74	71.78	4367.72	985.37	652.83	12.55	639.34	*8731.33*
Subbasin 7	2408.03	64.14	4719.95	723.82	219.21	9.91	1328.94	*9474.01*
Subbasin 8	2760.81	62.57	2532.50	965.86	572.69	12.14	377.37	*7283.94*
Subbasin 9	1059.45	30.91	3856.21	618.47	278.49	315.56	715.36	*6874.45*
Totals (Acres)	25655.89	598.80	19659.82	6666.31	3000.86	426.23	5988.43	**61996.34**
Total %	*41.38*	*0.97*	*31.71*	*10.75*	*4.84*	*0.69*	*9.66*	

	Cropped Farmland (%)	Farmsteads (%)	Forest (%)	Grassland (%)	Impervious (Roads, Urban) (%)	Water (%)	Wetland (%)
Subbasin 1	33.1	0.4	21.6	12.2	1.8	1.1	29.8
Subbasin 2	55.6	1.2	7.7	16.5	5.3	0.2	13.6
Subbasin 3	59.6	1.4	16.9	9.7	6.0	0.1	6.3
Subbasin 4	60.4	1.3	22.0	7.5	2.8	0.3	5.6
Subbasin 5	71.7	1.5	5.0	11.8	4.1	0.0	5.9
Subbasin 6	22.9	0.8	50.0	11.3	7.5	0.1	7.3
Subbasin 7	25.4	0.7	49.8	7.6	2.3	0.1	14.0
Subbasin 8	37.9	0.9	34.8	13.3	7.9	0.2	5.2
Subbasin 9	15.4	0.4	56.1	9.0	4.1	4.6	10.4

MEAD LAKE WATERSHED MANAGEMENT CHARACTERIZATION

	Dairy Rotation (C-C/S-O-A-A-A) (Storage) (Acres)	Dairy Rotation (C-C-O-A-A-A) (No Storage / Manure) (Acres)	Corn - Soybean (Acres)	Dairy Rotation (C-O-A-A-A) (No Storage) (Acres)	C-C-C-C-O-A-A-A (Storage) (Acres)	Continous Hay / Pasture (Acres)	C-C-O-A-A (No Storage) (Acres)	Totals (Acres)
Subbasin 1	97.33	573.88	25.8				52.8	749.81
Subbasin 2	3073.13	621.49	69.86	23.13			49.92	3837.52
Subbasin 3	2736.34	1242.17	32.28	23.18	71.93	127.24		4233.15
Subbasin 4	2340.40	1433.45	286.27	286.14				4346.25
Subbasin 5	2510.85	955.94	36.91		614.64			4118.33
Subbasin 6	752.09	902.09	207.30	64.40			75.87	2001.74
Subbasin 7	1256.17	961.00	146.15	38.52		6.2		2408.03
Subbasin 8	342.88	523.85	99.38	1650.82		143.37	0.52	2760.81
Subbasin 9	286.10	248.85	129.36	278.87		66.86	49.41	1059.45
Totals (Acres)	13395.28	7462.72	1033.29	2365.06	686.57	343.67	228.52	**25515.11**
Total %	52.50	29.25	4.05	9.27	2.69	1.35	0.90	

	Dairy Rotation (C-C/S-O-A-A-A) (Storage) (%)	Dairy Rotation (C-C-O-A-A-A) (No Storage / Manure) (%)	Corn - Soybean (%)	Dairy Rotation (C-O-A-A-A) (No Storage) (%)	C-C-C-C-O-A-A-A (Storage) (%)	Continous Hay / Pasture (%)	C-C-O-A-A (No Storage) (%)
Subbasin 1	10.93	64.44	2.90	0.00	0.00	0.00	5.93
Subbasin 2	80.08	16.19	1.82	0.60	0.00	0.00	1.30
Subbasin 3	64.64	29.34	0.76	0.55	1.70	3.01	0.00
Subbasin 4	53.85	32.98	6.59	6.58	0.00	0.00	0.00
Subbasin 5	60.97	23.21	0.90	0.00	14.92	0.00	0.00
Subbasin 6	37.57	45.07	10.36	3.22	0.00	0.00	3.79
Subbasin 7	52.17	39.91	6.07	1.60	0.00	0.26	0.00
Subbasin 8	12.42	18.97	3.60	59.79	0.00	5.19	0.02
Subbasin 9	27.00	23.49	12.21	26.32	0.00	6.31	4.66

Appendix C

Table 1
Mead Lake Watershed Farm Survey Results

Mead Lake Watershed Farm Survey Results

Subbasin	Name	Address	Acres	Manure	DNR SWAT ID	Cattle #	Rotation	GIS (Y/N)
1	Vernon Shirk	N16162 Sterling Avenue	124	Stored Manure	108	70	C-C-O-A-A	Y
1	Charles Boehlke	W7980 County Road O	200	Stored Manure	104		C-C-O-A-A	Y
1	Lawrence Nolt	N16667 Sterling Avenue	340	Stored Manure	103		C-C-O-A-A	Y
2	Glen Zeifest	W7950 Center Road	160	Stored Manure	107		C-C-O-A-A	Y
2	Les Wriedt	N15153 Bachelors Avenue	115	Stored Manure	106	80	C-C-C-O-A-A	Y
2	Clarence Mroz	N16418 Bachelors Avenue	197	Stored Manure	105		C-C-S-A-A-A-A-A	Y
2	Robert Kroll	W7486 Center Road	199	Haul		75		Y
2	Henry Zeifest	W8248 Center Road	387	Stored Manure	102		C-C-O-A-A	Y
2	Dennis Mnichowiz	N15427 Bachelors Avenue	100	Haul	210	75	C-C-O-A-A-A-A	Y
2	Allen Marek	W7495 Pine Road	199	Haul	211	75	C-C-O-A-A-A	Y
2	Ernst Shirk	W8480 Center Road	220	Stored Manure	212	100	C-C-C-P-A-A-A	Y
2	Jerrold Kobylarczk	W8359 Pine Road	238	Stored Manure	213	40	C-A-A-A-A-A	Y
2	Alvin Zimmerman	W8731 Pine Road	220	Stored Manure	214		C-C-C-P-A-A-A	Y
2	Randy Algar	W7917 Pine Road	120	Haul	218		C-C-O-A-A-A	Y
2	Alvin Martin	W7663 Center Road	199	Stored Manure	135, 235, 535		C-C-O-A-A-A	Y
2	Francis Andruszkiew	N16244 Gorman Avenue	118	Haul				N
3	David Baehr	N14931 County Road O	120	Stored Manure	501	95	C-C-A-A-A-A	Y
3	Mervin Nolt	W7330 County Road X	142	Stored Manure	217		C-S-C-P-A-A-A	Y
3	James Baures	N14035 Fisher Avenue	195	Stored Manure	323	115	C-C-O-A-A-A	Y
3	Isaac Burkholder	N13569 Fisher Avenue	121	Stored Manure	443		C-C-O-A-A	Y
3	Rodney Martens	W8616 Hixwood Road	99	Stored Manure	544		C-C-O-A-A	Y
3	Curvin Brubaker	N14622 Bachelors Avenue	131	Stored Manure	545	50	C-C-O-A	Y
3	John Brubaker	W7634 Oak Road	386	Stored Manure	546		C-C-O-A-A	Y
3	Glenn Sauder	W7436 County Road N	238	Haul	548		C-S-C-O-A-A	Y
3	John Sauder	W7556 County Road N	397	Stored Manure	549	72	C-C-O-A-A-A	Y
3	Richard Broda	N14423 Bachelors Ave	173	Haul	551	72	C-C-O-CLR-CLR-CLR	Y
3	Ammon Sauder	N13680 Resewood Avenue	200	Stored Manure	552	80	C-C-C-O-A-A	Y
3	David Buss	N14008 Sterling Avenue	159	Haul	553	70	C-C-C-O-A-A	Y
4	Marvin Sauder	N13367 Fisher Avenue	240	Stored Manure	433	55	C-O-A-A-A-A	Y
4	Larry Paskert	N12654 Sterling Avenue	159	Haul	434	85	Pasture	Y
4	Noah Zimmerman	N13439 Resewood Ave	160	Stored Manure	436	74	C-O-A-A-A	Y
4	Ivan Brubaker	Fisher Avenue	147	Stored Manure	440	55	C-O-A-A-A	Y
4	Donald Palmer	W7841 Colby Factory Road	239	Haul	438	110	C-C-O-A-A	Y
4	Landis Sauder	N13080 Sterling Avenue	79	Stored Manure	437	30	C-P-A-A-A-A	Y
4	Warren Sauder	N13015 Resewood Ave.		Stored Manure	442	110	C-C-O-A-A	Y
5	James Gulcynski	W9144 County Road N	159	Stored Manure	319	140	C-C-C-S-O-A-A	Y
5	Paul Burkholder	W8692 Broek Road	199	Stored Manure	320	60	S-C-C-O-A-A-A	Y
5	Bruce Gulcynski	W8953 Country Road N	118	Stored Manure	321		C-O-A-A-A-A-A	Y
5	Matthew Grajkowski	W9167 Oak Road	79	Haul	322	65	C-C-C-O-A-A-A-A	Y
5	Joseph Borowski	W8060 Broek Road	239	Haul	324	80	C-O-A-A	Y
5	Joseph Neisius	W8791 Broek Road	199	Haul	325	120	C-C-O-A-A	Y
5	Ann Grajkowski	W8218 County Road N	134	Haul	327, 427, 527	120	C-O-A-A-A	Y
5	Thomas Lipinski	N13967 Gorman Road	353	Stored Manure	328	130	C-C-C-A-A-A	Y
5	Jerome Benzschawel	N13894 Gorman Road	309	Stored Manure	330		C-C-S-O-A	Y
5	Elam Zimmerman	N13053 Bachelors Avenue	193	Stored Manure	441	110	C-C-O-A-A	Y
5	Martin Zeiset Jr	N13264 Bachelors Avenue	201	Stored Manure	439	135	C-C-C-O-A-A-A	Y
5	Martin Zeiset	N14352 Gorman Avenue	120	Stored Manure	547	100	C-S-C-C-O-A-A-A	Y
5	Lamar Shirk	N14270 Bachelors Ave	118	Stored Manure	550	70	C-C-O-A-A-A	Y
5	James Nowobielski	N13964 Bachelors Avenue	201	Haul	333, 554	145	C-C-O-A-A-A	Y
5	Donald Baures	N12776 Bachelors Avenue	200	Stored Manure	662	50	C-C-O-A-A-A-A-A	Y
5	Paul Zimmerman	N12770 Gorman Avenue	81	Stored Manure	668	85	C-C-O-A-A	Y
5	David Jacque	W13439 Gorman Avenue	119	Stored Manure	670		C-O-A-A-A	Y
5	Henry Klopotowski	W8476 Colby Factory Rd		Stored Manure	329		C-C-O-A-A-A	Y
5	Benard Jacque	N13981 Bachelors Avenue		Haul	331		C-O-A-A-A	N

Mead Lake Watershed Farm Survey Results

Subbasin	Name	Address	Acres	Manure	DNR SWAT ID	Cattle #	Rotation	GIS (Y/N)
6	Edwin Henry	W7330 Popple River Road	221	Stored Manure	663		Pasture	Y
6	Double H Dairy	W7364 Capital Road	205	Haul	707		C-C-S-O-A-A-A	Y
6	Chris Baker	N11847 County Road O		Stored Manure	701	125	C-C-O-CLR-CLR-CLR	Y
6	Joe Stephen	N11611 Resewood Avenue		Haul	702	80	C-C-C-O-A-A	Y
6	Jerome Briski	N11885 Sidney Avenue		Stored Manure	706	103	3yr Pasture-C-C-O-A-A-A-A	N
6	James Reiff	N10828 County Road O		Stored Manure	703	101	C-C-S-O-A-A-A	Y
7	Leroy Zeiset	N12610 Bachelors Avenue	157	Stored Manure	661	65	C-O-A-A	Y
7	John Klopptowski	W8057 Cloverdale Road	161	Stored Manure	664	110	C-C-O-A-A-A	Y
7	Ed Zimmerman	N12615 Gorman Avenue	160	Stored Manure	666	95	C-C-O-A-A-A	Y
7	Mike Norks	W7748 Popple River	323	Stored Manure	667	36	C-S-O-A-A-A	Y
7	Lawerence Suda	W7537 Popple River Road	231	Stored Manure	671		C-C-S-A-A-A	Y
7	Michael Podrovitz	N10755 Bachelors Avenue	150	Stored Manure	656, 957		C-S-C-O-A-A-A	Y
7	Mike Norks	N12269 Sterling Avenue	200	Stored Manure	660	50	C-S-O-A-A-A	Y
7	Paul Nova	W8139 Popple River Road		Haul	658	40	A-A-A	Y
7	Ed Kodtis	N12630 Gorman Avenue		Haul	665	65	C-C-O-A-A-A	Y
7	Fred Barth	W8690 Starks Road		Haul	659	26	C-O-A-A-A	Y
8	John Volenec	N10557 County Road O		Stored Manure	700	80	C-C-O-A-A-A	Y
8	Jonas Weaver	W7288 Co Hwy MM		Haul	705	95		N
8	Luke Reiff	County Road O		Stored Manure	704	100	C-C-S-O-A-A-A	N
9	Joe Petkovsek	N9861 Bachelors Avenue	120	Haul	900		C-C-O-CLR-CLR-CLR	Y

Appendix D

Table 1
SWAT Management Scenarios

SWAT Management Scenarios for the Mead Lake Watershed

Dairy Rotation (C-C/S-O-A-A-A) (Storage)					
Year	**Date**	**Operation**	**Crop / Type**	**Rate**	**Units**
1	15-Apr	Manure			
1	1-May	Tillage	Disk		
1	7-May	Starter Fertilizer	9-23-30	112 kg/ha	
1	8-May	Plant	Corn		
1	15-Jun	Tillage	Cultivate		
1	10-Oct	Harvest / Kill	Corn		
1	10-Oct	Tillage	Disk		
1	15-Oct	Manure			
2	15-Apr	Manure			
2	1-May	Tillage	Disk		
2	7-May	Starter Fertilizer	9-23-30	112 kg/ha	
2	8-May	Plant	Corn Silage		
2	15-Jun	Tillage	Cultivate		
2	10-Oct	Harvest / Kill	Corn Silage		
2	10-Oct	Tillage	Disk		
2	15-Oct	Manure			
3	29-Apr	Tillage	Chisel		
3	1-May	Tillage	Disk		
3	3-May	Plant	Oats		
3	18-Jul	Harvest / Kill	Oats		
3	18-Jul	Plant	Alfalfa		
3	10-Sep	Harvest / Kill	Alfalfa		
4	15-Oct	Manure			
4	5-May	Plant	Alfalfa		
4	9-Jun	Harvest	Alfalfa		
4	16-Jul	Harvest	Alfalfa		
4	19-Sep	Harvest/Kill	Alfalfa		
4	15-Oct	Manure			
5	5-May	Plant	Alfalfa		
5	9-Jun	Harvest	Alfalfa		
5	16-Jul	Harvest	Alfalfa		
5	19-Sep	Harvest/Kill	Alfalfa		
5	15-Oct	Manure			
6	5-May	Plant	Alfalfa		
6	9-Jun	Harvest	Alfalfa		
6	16-Jul	Harvest	Alfalfa		
6	19-Sep	Harvest/Kill	Alfalfa		
6	20-Sep	Tillage	Plow		
6	15-Oct	Manure			

SWAT Management Scenarios for the Mead Lake Watershed

Dairy Rotation (C-O-A-A-A) (No Storage)					
Year	Date	Operation	Crop / Type	Rate	Units
1	1-Jan	Manure	DFM		
1	1-Feb	Manure	DFM		
1	1-Mar	Manure	DFM		
1	1-Apr	Manure	DFM		
1	1-May	Tillage	Disk		
1	7-May	Starter Fertilizer	9-23-30	112 kg/ha	
1	8-May	Plant	Corn		
1	15-Jun	Tillage	Cultivate		
1	10-Oct	Harvest / Kill	Corn		
1	10-Oct	Tillage	Disk		
1	15-Oct	Manure	DFM		
1	15-Nov	Manure	DFM		
2	1-Jan	Manure	DFM		
2	1-Feb	Manure	DFM		
2	1-Mar	Manure	DFM		
2	1-Apr	Manure	DFM		
2	29-Apr	Tillage	Chisel		
2	1-May	Tillage	Disk		
2	3-May	Plant	Oats		
2	18-Jul	Harvest / Kill	Oats		
2	18-Jul	Manure	DFM		
2	18-Jul	Plant	Alfalfa		
2	10-Sep	Harvest / Kill	Alfalfa		
2	15-Oct	Manure	DFM		
2	15-Nov	Manure	DFM		
3	5-May	Plant	Alfalfa		
3	9-Jun	Harvest	Alfalfa		
3	9-Jun	Manure	DFM		
3	16-Jul	Harvest	Alfalfa		
3	16-Jul	Manure	DFM		
3	19-Sep	Harvest/Kill	Alfalfa		
3	19-Sep	Manure	DFM		
3	19-Oct	Manure	DFM		
4	1-Jan	Manure	DFM		
4	1-Mar	Manure	DFM		
4	5-May	Plant	Alfalfa		
4	9-Jun	Harvest	Alfalfa		
4	9-Jun	Manure	DFM		
4	16-Jul	Harvest	Alfalfa		
4	16-Jul	Manure	DFM		
4	19-Sep	Harvest/Kill	Alfalfa		
4	19-Sep	Manure	DFM		
4	19-Oct	Manure	DFM		
5	1-Jan	Manure	DFM		
5	1-Mar	Manure	DFM		
5	5-May	Plant	Alfalfa		
5	9-Jun	Harvest	Alfalfa		
5	9-Jun	Manure	DFM		
5	16-Jul	Harvest	Alfalfa		
5	16-Jul	Manure	DFM		
5	19-Sep	Harvest/Kill	Alfalfa		
5	20-Sep	Tillage	Plow		
5	20-Sep	Manure			

SWAT Management Scenarios for the Mead Lake Watershed

Dairy Rotation (C-C-O-A-A-A) (No Storage / Manure)					
Year	Date	Operation	Crop / Type	Rate	Units
1	1-May	Tillage	Disk		
1	7-May	Starter Fertilizer	9-23-30	112 kg/ha	
1	8-May	Plant	Corn		
1	15-Jun	Tillage	Cultivate		
1	16-Jun	Fertilizer			
1	10-Oct	Harvest / Kill	Corn		
1	10-Oct	Tillage	Disk		
2	1-May	Tillage	Disk		
2	7-May	Starter Fertilizer	9-23-30	112 kg/ha	
2	8-May	Plant	Corn Silage		
2	15-Jun	Tillage	Cultivate		
2	16-Jun	Fertilizer			
2	10-Oct	Harvest / Kill	Corn Silage		
2	10-Oct	Tillage	Disk		
3	29-Apr	Tillage	Chisel		
3	1-May	Tillage	Disk		
3	3-May	Plant	Oats		
3	18-Jul	Harvest / Kill	Oats		
3	18-Jul	Plant	Alfalfa		
3	10-Sep	Harvest / Kill	Alfalfa		
4	5-May	Plant	Alfalfa		
4	9-Jun	Harvest	Alfalfa		
4	16-Jul	Harvest	Alfalfa		
4	19-Sep	Harvest/Kill	Alfalfa		
5	5-May	Plant	Alfalfa		
5	9-Jun	Harvest	Alfalfa		
5	16-Jul	Harvest	Alfalfa		
5	19-Sep	Harvest/Kill	Alfalfa		
6	5-May	Plant	Alfalfa		
6	9-Jun	Harvest	Alfalfa		
6	16-Jul	Harvest	Alfalfa		
6	19-Sep	Harvest/Kill	Alfalfa		
6	20-Sep	Tillage	Plow		

Corn - Soybean					
Year	Date	Operation	Crop / Type	Rate	Units
1	29-Apr	Tillage	Chisel		
1	30-Apr	Fertilizer			
1	1-May	Tillage	Disk		
1	8-May	Plant	Corn		
1	8-May	Starter Fertilizer	9-23-30	112 kg/ha	
1	15-Jun	Tillage	Cultivate		
1	10-Oct	Harvest / Kill	Corn		
1	10-Oct	Tillage	Disk		
2	29-Apr	Tillage	Chisel		
2	30-Apr	Fertilizer			
2	1-May	Tillage	Disk		
2	23-May	Plant	Soybean		
2	30-Sep	Harvest / Kill	Soybean		
2	10-Oct	Tillage	Disk		

SWAT Management Scenarios for the Mead Lake Watershed

C-C-C-C-O-A-A-A (Storage)					
Year	**Date**	**Operation**	**Crop / Type**	**Rate**	**Units**
1	15-Apr	Manure			
1	1-May	Tillage	Disk		
1	7-May	Starter Fertilizer	9-23-30	112 kg/ha	
1	8-May	Plant	Corn		
1	15-Jun	Tillage	Cultivate		
1	10-Oct	Harvest / Kill	Corn		
1	10-Oct	Tillage	Disk		
1	15-Oct	Manure			
2	15-Apr	Manure			
2	1-May	Tillage	Disk		
2	7-May	Starter Fertilizer	9-23-30	112 kg/ha	
2	8-May	Plant	Corn Silage		
2	15-Jun	Tillage	Cultivate		
2	10-Oct	Harvest / Kill	Corn Silage		
2	10-Oct	Tillage	Disk		
2	15-Oct	Manure			
3	15-Apr	Manure			
3	1-May	Tillage	Disk		
3	7-May	Starter Fertilizer	9-23-30	112 kg/ha	
3	8-May	Plant	Corn		
3	15-Jun	Tillage	Cultivate		
3	10-Oct	Harvest / Kill	Corn		
3	10-Oct	Tillage	Disk		
3	15-Oct	Manure			
4	29-Apr	Tillage	Chisel		
4	1-May	Tillage	Disk		
4	3-May	Plant	Oats		
4	18-Jul	Harvest / Kill	Oats		
4	18-Jul	Plant	Alfalfa		
4	10-Sep	Harvest / Kill	Alfalfa		
5	15-Oct	Manure			
5	5-May	Plant	Alfalfa		
5	9-Jun	Harvest	Alfalfa		
5	16-Jul	Harvest	Alfalfa		
5	19-Sep	Harvest/Kill	Alfalfa		
5	15-Oct	Manure			
6	5-May	Plant	Alfalfa		
6	9-Jun	Harvest	Alfalfa		
6	16-Jul	Harvest	Alfalfa		
6	19-Sep	Harvest/Kill	Alfalfa		
6	15-Oct	Manure			
7	5-May	Plant	Alfalfa		
7	9-Jun	Harvest	Alfalfa		
7	16-Jul	Harvest	Alfalfa		
7	19-Sep	Harvest/Kill	Alfalfa		
7	20-Sep	Tillage	Plow		
7	15-Oct	Manure			

SWAT Management Scenarios for the Mead Lake Watershed

Continous Hay / Pasture (Acres)					
Year	Date	Operation	Crop / Type	Rate	Units
1	1-May	Graze Start	Dairy Manure		
1	1-Nov	Graze End	Dairy		

C-C-O-A-A (No Storage)					
Year	Date	Operation	Crop / Type	Rate	Units
1	1-Jan	Manure	DFM		
1	1-Feb	Manure	DFM		
1	1-Mar	Manure	DFM		
1	1-Apr	Manure	DFM		
1	1-May	Tillage	Disk		
1	7-May	Starter Fertilizer	9-23-30	112 kg/ha	
1	8-May	Plant	Corn		
1	15-Jun	Tillage	Cultivate		
1	10-Oct	Harvest / Kill	Corn		
1	10-Oct	Tillage	Disk		
1	15-Oct	Manure	DFM		
1	15-Nov	Manure	DFM		
2	1-Jan	Manure	DFM		
2	1-Feb	Manure	DFM		
2	1-Mar	Manure	DFM		
2	1-Apr	Manure	DFM		
2	1-May	Tillage	Disk		
2	7-May	Starter Fertilizer	9-23-30	112 kg/ha	
2	8-May	Plant	Corn Silage		
2	15-Jun	Tillage	Cultivate		
2	10-Oct	Harvest / Kill	Corn Silage		
2	10-Oct	Tillage	Disk		
2	15-Oct	Manure	DFM		
2	15-Nov	Manure	DFM		
3	1-Jan	Manure	DFM		
3	1-Feb	Manure	DFM		
3	1-Mar	Manure	DFM		
3	1-Apr	Manure	DFM		
3	29-Apr	Tillage	Chisel		
3	1-May	Tillage	Disk		
3	3-May	Plant	Oats		
3	18-Jul	Harvest / Kill	Oats		
3	18-Jul	Manure	DFM		
3	18-Jul	Plant	Alfalfa		
3	10-Sep	Harvest / Kill	Alfalfa		
3	15-Oct	Manure	DFM		
3	15-Nov	Manure	DFM		
4	5-May	Plant	Alfalfa		
4	9-Jun	Harvest	Alfalfa		
4	9-Jun	Manure	DFM		
4	16-Jul	Harvest	Alfalfa		
4	16-Jul	Manure	DFM		
4	19-Sep	Harvest/Kill	Alfalfa		
4	19-Sep	Manure	DFM		
4	19-Oct	Manure	DFM		
5	1-Jan	Manure	DFM		
5	1-Mar	Manure	DFM		
5	5-May	Plant	Alfalfa		
5	9-Jun	Harvest	Alfalfa		
5	9-Jun	Manure	DFM		
5	16-Jul	Harvest	Alfalfa		
5	16-Jul	Manure	DFM		
5	19-Sep	Harvest/Kill	Alfalfa		
5	19-Sep	Manure	DFM		
5	20-Sep	Tillage	Plow		
5	19-Oct	Manure	DFM		

Total Maximum Daily Load:
Mead Lake
Clark County, WI

Mead Lake, Clark County, WI
Report prepared by Ken Schreiber & Nicole Richmond
Final August 13, 2008

Phosphorus and Sediment Total Maximum Daily Load (TMDL) for Mead Lake, Clark County, Wisconsin

Wisconsin Department of Natural Resources
West Central Region

August 13, 2008 Final

INTRODUCTION

Mead Lake is a shallow, eutrophic impoundment of the South Fork Eau Claire River (Hydrologic Unit Code 07050006, Wisconsin Waterbody Identification Code 2137000). The Mead Lake watershed drains 248 km^2 (61,282 acres) of west central Wisconsin (Figure 1). Approximately 99 percent of the watershed is within Clark County, with the remaining one percent in Taylor County. The South Fork Eau Claire River is the primary source of surface water inflow to Mead Lake. The lake was placed on the Wisconsin 303(d) impaired waters list in 1998 due to sediment and phosphorus. In 2008, the 303(d) list was updated to reflect that the pollutants of sediment and phosphorus are leading to impairments of degraded habitat, pH criteria exceedances, and excess algal growth in summer which result in limited body contact recreational use (Table 1). The goal of this TMDL is to reduce phosphorus and sediment loadings to Mead Lake to address, pH criteria exceedances, decrease algal blooms in summer, and address degraded habitat so Mead Lake can be improved for recreational purposes.

Figure 1. *Location of Mead Lake watershed in west central Wisconsin.*

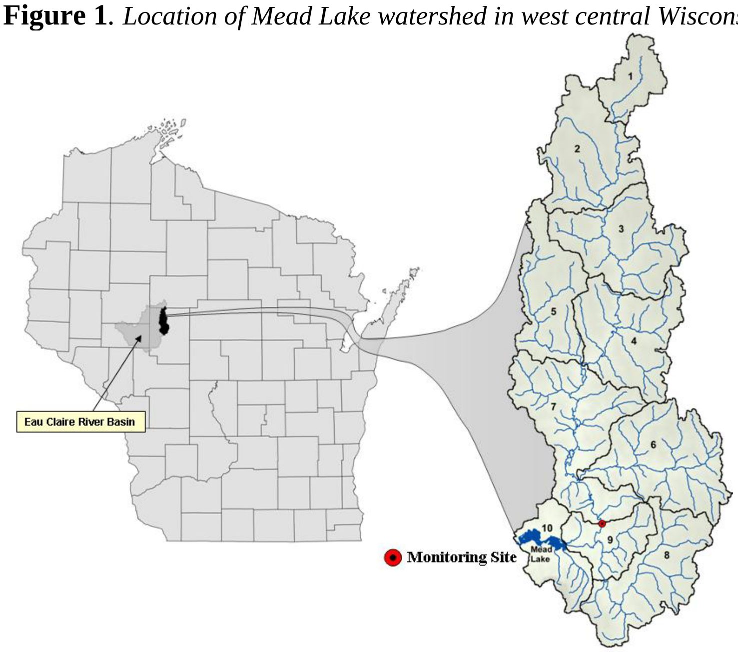


Table 1. Mead Lake Impaired Waters Listing

Waterbody Name	WBIC	TMDL ID	Pollutant	Impairment	Priority
Mead Lake	2143900	277	Total Phosphorus, Sediment	Degraded habitat, excess algal growth, pH	High

PROBLEM STATEMENT

Mead Lake is highly eutrophic and exhibits excessive concentrations of phosphorus and chlorophyll (a measure of algal densities) in its surface waters during the summer months (USACE 2005). Sediment and phosphorus enters the lake via the South Fork Eau Claire River, from nonpoint sources of pollution. Phosphorus is bound to the sediment particles, and once in the system, sediment has the capacity to transfer phosphorus to the lake bottom. The lake's shallow depth, phosphorus-laden sediments and excessive water column phosphorus levels, cause the lake to experience severe algal blooms during the "growing" season (May-October). These eutrophic conditions have significantly impaired body contact recreational activities. In addition, algal blooms in Mead Lake are often accompanied by exceedances of the Wisconsin water quality criterion for pH. The elevated lake pH levels are due to removal of carbon dioxide from water during photosynthesis (by algae). The reduction in carbon dioxide levels during daylight causes an increase in pH. A reduction in sediment loading would reduce phosphorus levels and the corresponding reduction in phosphorus levels would result in a decrease in chlorophyll levels (a measure of productivity) and a reduction in maximum pH levels.

WATER QUALITY STANDARDS

Currently, Wisconsin does not have numeric water quality criteria for phosphorus or sediment. Mead Lake is not currently meeting the applicable narrative *water quality criterion* as defined in NR 102.04 (1); Wis. Admin. Code:

"To preserve and enhance the quality of waters, standards are established to govern water management decisions. Practices attributable to municipal, industrial, commercial, domestic, agricultural, land development or other activities shall be controlled so that all waters including the mixing zone and the effluent channel meet the following conditions at all times and under all flow conditions: (a) Substances that will cause objectionable deposits on the shore or in the bed of a body of water, shall not be present in such amounts as to interfere with public rights in waters of the state, (b) Floating or submerged debris, oil, scum or other material shall not be present in such amounts as to interfere with public rights in waters of the states, (c) Materials producing color, odor, taste or unsightliness shall not be present in such amounts as to interfere with public rights in waters of the state."

This criterion describes acceptable water quality conditions and guides the WDNR in setting numeric target pollutant concentrations. The application of a narrative criterion for Mead Lake necessitates the development of a site-specific in-lake pollutant value for the purpose of this TMDL. For purposes of this TMDL, sediment is considered an objectionable deposit.

The designated use of Mead Lake is described in S. NR 102.04(3) intro., and (b), Wis. Adm. Code as:

"FISH AND OTHER AQUATIC LIFE USES. The department shall classify all surface waters into one of the fish and other aquatic life subcategories described in this subsection. Only those use subcategories identified in pars. (a) to (c) shall be considered suitable for the protection and propagation of a balanced fish and other aquatic life community as provided in federal water pollution control act amendments of 1972, PL 92-500; 33 USC 1251 et.seq.

"(b) Warm water sport fish communities. This subcategory includes surface waters capable of supporting a community of warm water sport fish or serving as a spawning area for warm water sport fish."

The applicable water quality standard for this TMDL is listed in S. NR 102.04(4) intro, and (c), Wis. Adm. Code as follows:

"Standards for Fish and Aquatic Life. Except for natural conditions, all waters, classified for fish and aquatic life shall meet the following criteria:

"(c) pH. The pH shall be within the range of 6.0 to 9.0, with no change greater than 0.5 units outside the estimated natural seasonal maximum and minimum."

Mead Lake has been listed as impaired due to documented water quality standard pH violations. The pH exceedances are most likely related to algal productivity, however, the relationship between pH and chlorophyll and/or phosphorus in Mead Lake is very complex. For this reason, goals established by this TMDL were not based on the pH criterion, but rather external phosphorus and sediment loads to the lake. Generally, reductions in phosphorus would lead to reductions in the frequency and extent of algal blooms, and decreased pH levels.

The water quality target for phosphorus for Mead Lake is based on a site-specific goal of 93 ppb P concentration. This target will reduce algal blooms, and reduce pH exceedances to meet TMDL goals. Since there are no numeric water quality standards for sediment in Wisconsin, the TMDL is derived from load reductions to meet in lake phosphorus and chlorophyll goals.

BACKGROUND

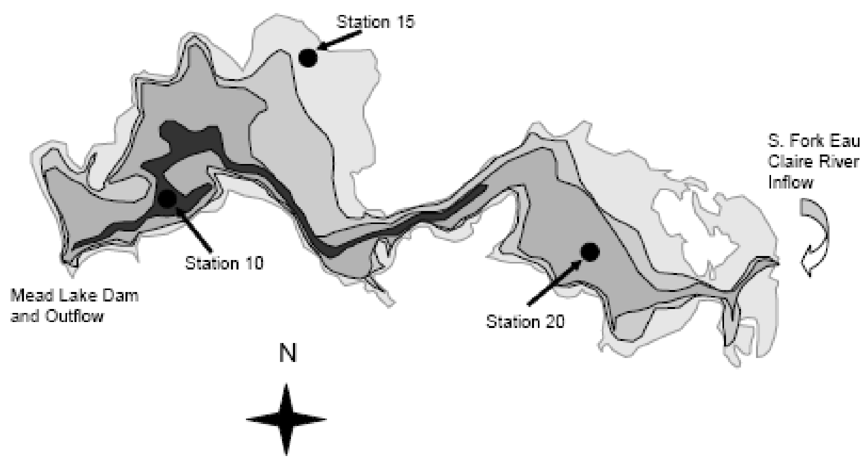
Mead Lake has a surface area of 1.3 km^2, a volume of 1.9 hm^3, and mean and maximum depths of 1.5 m and 5 m, respectively. The Mead Lake watershed is located in the Central Wisconsin Undulating Till Plain Ecoregion (Omernik and Gallant, 1988). This EPA ecoregion is characterized by nearly level to rolling glacial till plains. Lakes in the ecoregion have summer total phosphorus concentrations greater than 50 ppb; lakes over 20 ppb are indicative of eutrophic conditions. The most significant land use in this area is agriculture (Table 2).

A two year study (2002-2003) of water quality in Mead Lake and the South Fork Eau Claire River was conducted by the U.S. Army Corps of Engineers (USACE 2005). The study focused on external loading (suspended sediments and nutrients from the South Fork Eau Claire River), internal P fluxes from lake sediments and in-lake water quality. This study included continuous flow monitoring and bi-weekly and storm event water quality sampling of the South Fork Eau Claire River. Samples were analyzed for total suspended solids, total nitrogen, total phosphorus, and soluble reactive phosphorus. Sampling in Mead Lake was conducted bi-weekly at three locations from May through September of both years (Figure 2). *In situ* profiles of temperature, dissolved oxygen, pH, and conductivity were collected at 1-m intervals at each station. Water samples were collected at 1-m depth intervals for analysis of total nitrogen and phosphorus, soluble reactive phosphorus and chlorophyll. Water samples were collected and analyzed by USACE staff from the Eau Galle Aquatic Ecology Laboratory in Spring Valley, Wisconsin.

Table 2. Summary of land cover in the Mead Lake watershed in 2001(Freihoefer and McGinley 2007).

Land Cover		Area (hectares)	Area (%)
Cropped Farmland		10,383	41.38
Forest		7,964	31.47
Grassland/Pasture		2,690	10.72
Wetland		2,423	9.66
Urban/ Impervious		1,214	4.84
Farmsteads		242	0.97
Water		172	0.69
	Totals:	10,383	99.73

Figure 2. Monitoring stations in Mead Lake, Clark County, Wisconsin (USACE 2005).



Mean total P concentrations of the South Fork Eau Claire River ranged between 0.115 and 0.123 mg/L and accounted for 54% of the total P load to Mead Lake. Laboratory-derived internal P loading rates from sediments were very high under anoxic conditions (range = 16 to 38 mg m^{-2} d^{-1}) suggesting the potential for substantial P flux from bottom sediments. Total P concentrations in the bottom waters increased markedly in 2003 in conjunction with a higher residence time, anoxia in the hypolimnion and reduced flushing rates, compared to 2002 which was a wetter year. Summer chlorophyll concentrations averaged 51 μg/L and 76 μg/L in 2002 and 2003, respectively (USACE 2005).

The USACE study found that on average 83% of the P load originated from direct drainage and tributaries to Mead Lake. Tributary P loading accounted for 87% and 78% of the measured P load in 2002 and 2003, respectively. In contrast, internal P loading from sediment accounted for about 12% and 21%, respectively, of the 2002 and 2003 measured P inputs.

The Wisconsin Trophic State Index (TSI) (Lillie et al. 1993) was estimated for the lake using the mean Secchi transparency values and surface concentrations of total P and chlorophyll estimated over the period May through September of both years. The boundary between mesotrophic and eutrophic lakes for TSI is 50; this study found the lake is highly eutrophic with mean summer TSI values greater than 60 during both years (Table 3).

Exceedances of the state water quality criteria for pH occurred on 16 of 39 (40%) of the sampling events considering all locations and sampling dates. These pH exceedances (>9) generally correspond to chlorophyll levels greater than 70 μg/L.

The seasonal (May – September) suspended sediment load to Mead Lake was estimated at 428 and 189 tons in 2002 and 2003, respectively. The annual sediment load was estimated at 774 and 609 tons in 2002 and 2003, respectively. Sediments deposited in Mead Lake contribute P to the water column via recycling under anoxia or high pH conditions (both which exist in Mead Lake during summer). Laboratory derived internal P loading rates were very high under anoxic conditions (16-38 mg m^{-2} d^{-1}) suggesting a high potential for P flux from bottom sediments (USACE 2005).

Table 3. Summer (May-Sept.) mean values for Secchi depth (SD), viable chlorophyll (CHLA) and total phosphorus (TP) and trophic state index (TSI) values for the surface waters of Mead Lake.

				Trophic State Index		
Year	**Secchi (m)**	**Chla (ug/l)**	**TP (mg/l)**	**TSI_{SD}**	**TSI_{CHLA}**	**TSI_{TP}**
2002	0.52	50.8	0.130	69.2	64.5	65.8
2003	0.70	76.2	0.125	65.0	67.6	65.5

Land Use Modeling

Modeling was conducted to a) determine current loading in the watershed through identification and quantification of current sources, and to b) assess the effectiveness of reducing phosphorus and sediment loads to Mead Lake. Modeling was completed using the Soil and Water Assessment Tool (SWAT version 4/18/2001). SWAT is a distributed parameter, daily time step model that was developed by the USDA-ARS to assess non-point source pollution from watersheds and subwatersheds. SWAT simulates hydrologic and related processes to predict the impact of land use management on water, sediment, nutrient and pesticide export. Crop and management components within the model permit reasonable representation of the actual cropping, tillage and nutrient management practices typically used in this area of the state. Major processes simulated within the SWAT model include: surface and groundwater hydrology, weather, soil water percolation, crop growth, evapotranspiration, agricultural management, urban and rural management, sedimentation, nutrient cycling and fate, pesticide fate, and water and constituent routing. The SWAT model was calibrated to simulate runoff, sediment and phosphorus loading in the Mead Lake watershed using detailed land management information developed from the Clark County Land Conservation Department (LCD), a 2002 farm survey and a 1999 land use transect survey. Seventy-four farms provided information on herd size, manure management, and crop rotations.

Appropriate crop rotations for the model were chosen with assistance from the Clark County LCD. The agricultural scenarios chosen for use in the SWAT model, are reasonable and feasible to implement in this region of the state. Three crop rotations were used to simulate farming practices in the watershed. A dairy rotation consisting of one year of corn grain, one year of corn silage, followed by three years of alfalfa. The first year of the alfalfa rotation was simulated with oats as a nurse crop and harvested as oat hay. Two cash crop rotations were simulated; a two year rotation consisting of corn grain and soybeans and a three year rotation consisting of corn grain, corn grain, and soybeans (Freihoefer and McGinley 2007).

The model was first calibrated for hydrology by balancing surface water, groundwater, and evapotranspiration for calendar year 2002. Once the simulated average annual water export was within ten percent of the monitored flows, simulations were run with daily output for comparison to monitored daily flows. Once surface runoff to base flow contributions were calibrated, sediment and phosphorus contributions from the sub basins were calibrated to 2002 monitored data on a monthly basis. Simulated results were then compared to values estimated based on monitored data. The long-term (25 year) average phosphorus export from the watershed to the lake during the May through September growing season is estimated at approximately 3,743 pounds per year (see Appendix 1).

The scenarios in Table 4 are modifications to the existing (baseline) model simulation to explore the impact of changes in phosphorus export due to different management and land use changes. The summary shows the simulated management scenarios and their impact on long term average growing season (May-September) phosphorus export from the watershed. The SWAT model was used to estimate suspended sediment export from the watershed on an annual and seasonal basis. The model was calibrated using sediment loads and flow from 2002 and 2003 (Appendix 2). Long-term sediment export modeling results are presented in Table 5.

Lake Modeling
The USACE BATHTUB lake model was used to predict changes in total P, chlorophyll, and Secchi transparency in Mead Lake under various P loading scenarios. Model coefficients were developed and calibrated using data collected during the summer of 2002 and used to predict lake responses to measured P loading and in-lake water quality in 2003 (Appendix 3). All model runs were based on a growing season (May – September) due to the relatively short hydraulic residence time of Mead Lake.

Simulated decreases in external P loading from the South Fork Eau Claire River resulted in predicted decreases in the average summer total P and chlorophyll concentration of lake surface waters and increases in Secchi transparency. For example, a 30% reduction in the modeled summer external P loading resulted in a predicted 24% decrease in total P and a 34% decrease in chlorophyll concentrations in the lake (Appendix 3).

Table 4. SWAT model simulated phosphorus export during May – September under different management scenarios in the Mead Lake watershed (Source: Freihoefer and McGinley 2007).

Scenario	Seasonal Total P Load (lbs.)	P Load Reduction (%)
Reducing soil P (25 ppm)	3,231	14%
Reducing Soil Erosion (50% reduction in USLE)	3,220	14%
Reduce manure P by 38% (animal dietary changes)	3,591	4%
Combination: reducing soil P, soil erosion control and manure management	2,723	27%
Winter Rye	Little change	5%
Rotational grazing	2,960	21%

Table 5. Model simulated long term suspended sediment export from the Mead Lake watershed (McGinley and Freihoefer, 2008).

SWAT simulated suspended sediment export from Mead Lake Watershed			
Growing Season (May - September)		Annual (January - December)	
Range (tons)	Average (tons)	Range (tons)	Average (tons)
236 - 431	151	427 - 1,416	535

BATHTUB modeling was also used to examine changes in the bloom frequency of algal densities in the lake under conditions of simulated reduction or increase in external P loading during both summers. The model results suggest that frequency of nuisance blooms with chlorophyll a concentrations of 30 mg/m^3 or greater (i.e., visible to the eye and considered an aesthetic problem) would be reduced by about 29% with a 30% reduction in the external P load.

LINKAGE ANALYSIS

Establishing a link between watershed characteristics and resulting water quality is a crucial step in TMDL development.

Sedimentation often acts as a transport mechanism for other pollutants, such as phosphorus, that will impact the water chemistry. The primary concern of sediment loading to Mead Lake is the capacity to transfer phosphorus from the watershed to the lake bottom. These phosphorus-laden sediments greatly contribute to summer algal blooms, especially under anoxic conditions. The sediment TMDL is derived from load reductions needed to meet in lake phosphorus and chlorophyll goals. As measures are taken to reduce sedimentation, phosphorus transport to the stream will decrease and phosphorus values in Mead Lake will decrease.

As stated above, phosphorus enters the waterbody bound to sediment particles typically during rainfall and runoff events. Phosphorus loading in water bodies can cause eutrophication of lakes, characterized by excessive plant (macrophyte) growth and dense algal growth. Algal blooms result in pH increases due to removal of carbon dioxide from water during photosynthesis (by macrophytes and algae). In lakes with minimal buffering capacity (like Mead Lake), this reduction in carbon dioxide levels during daylight causes a significant increase in pH. A reduction in phosphorus levels would result in a decrease in chlorophyll levels (a measure of productivity) and a reduction in maximum pH levels.

Mead Lake frequently exhibits pH values above the water quality criterion of 9.0 in its surface waters during summer Although the water quality criterion for pH in Mead Lake was not a primary water quality target for the TMDL, the loading reductions for phosphorus and sediment identified in this TMDL will reduce pH exceedances in Mead Lake.

WATER QUALITY GOALS

The goal of this TMDL is to reduce external loadings of phosphorus and sediment to Mead Lake. As mentioned earlier, since Wisconsin does not have numeric water quality standards for phosphorus and sediment, site specific targets were chosen based on existing data and modeling results. In order to achieve a measurable improvement in lake water quality, a summer epilimnetic mean phosphorus goal of 93 ppb has been established. The goal is based on achievable P load reductions in the watershed based on feasible restoration scenarios using the SWAT model, consensus of a local stakeholder group, and best professional judgment of WDNR staff. This site-specific target represents an approximate 24% decrease in mean growing season P and a 34% decrease in mean chlorophyll levels. The BATHTUB model simulations indicate that this phosphorus goal corresponds to a summer mean epilimnetic chlorophyll concentration of 39 μg/L and Secchi depth of 1.1 meters (Appendix 2). The phosphorus goal also corresponds to a 29 percent reduction in the amount of time the lake experiences summer algal bloom conditions in excess of 30 μg/L chlorophyll. By meeting the TMDL goal concentration of 93 ppb in Mead Lake, narrative water criteria stated in NR 102.04 (1); Wis. Admin. Code will be met. This in turn, will decrease algal blooms which impair recreational uses and decrease pH exceedances in Mead Lake.

After the phosphorus goal was identified for this TMDL, the SWAT model was used to determine the corresponding amount of sediment reduction needed to meet the phosphorus goal. A seasonal sediment reduction goal of 30% was set for the TMDL based on this method.

LOADING CAPACITY

The total loading capacity is the sum of the wasteload allocations for permitted point sources, the load allocations for non-point sources, and a margin of safety, as generally expressed in the following equation:

TMDL Load Capacity = WLA + LA + MOS

WLA = Wasteload Allocation
LA = Load Allocation
MOS = Margin of Safety

The loading capacity provides a reference for calculating the amount of pollutant reduction needed to bring a waterbody into compliance with water quality criteria or designated uses. The total phosphorus loading capacity of Mead Lake is a function of an identified mean summer epilimnetic in-lake phosphorus concentration goal of 93 ppb. Nutrient concentrations above this capacity cause designated use impairments and water quality criteria exceedances as discussed earlier in this report.

In order to achieve the identified phosphorus goal, the mean summer phosphorus load to Mead Lake needs to be reduced by 30% to 3,850 pounds and the annual P load needs to be reduced by 35% to 8,600 pounds. At this total phosphorus loading level, we expect that the occurrence of severe algae blooms and exceedances of the 9.0 pH criteria will be significantly reduced. This TMDL only addresses the external load to Mead Lake as a “first step” to meeting water quality goals. Once the external sources of phosphorus and sediment loads are controlled, the TMDL will be re-evaluated to see if decreasing the internal P load is needed.

The loading capacity for sediment is primarily based on the corresponding load reductions required for phosphorus. In order to achieve the summer in-lake phosphorus goal, SWAT modeling determined that the mean summer sediment load needs to be reduced by 30% to 233 tons and the annual sediment load needs to be reduced to 826 tons.

WASTELOAD ALLOCATION

Since there no point sources discharging in the Mead Lake watershed, the wasteload allocation is zero. If a point source discharge were proposed, one of the following would need to occur:

- A re-allocation of the phosphorus and sediment loads would need to be developed and approved by WDNR and EPA.
- Effluent limits of zero phosphorus and zero sediment would be included in the WPDES permit.
- An offset would need to be created through some means, such as pollutant trading.

LOAD ALLOCATION

A watershed calibrated SWAT model was used to develop load allocations for Mead Lake. The SWAT land use model was developed and calibrated using the 2002-2003 monitoring data. The baseline phosphorus and sediment loads to Mead Lake are based on estimated long long-term (25 year) SWAT simulations. The SWAT model loads developed by Freihoefer and McGinley (2007) were modified to more accurately account for long term flow conditions (Appendix 2). The load reduction and in-lake water quality goals for the Mead Lake TMDL are based on SWAT model simulations and input from local stakeholders.

Phosphorus
Tables 5 and 6 provide a summary of estimated mean long term May-September and annual phosphorus loads from nonpoint sources. The SWAT model predicts that implementation of BMPs in the watershed will achieve a higher percentage P load reduction on an annual basis than during May-September. Consequently, we established a 30% P load reduction goal for the May-September period and a 35% annual P load reduction goal. A basin-wide phosphorus reduction goal of 30% results in a seasonal (May – September) nonpoint source load allocation of 3,850 pounds and a daily load allocation of 25 pounds. Seasonal loads are important to determine for this TMDL since the “growing” season occurs May-September when algal blooms occur. A 35% reduction in the annual P load results in an annual P load allocation of 8,600 pounds and daily load allocation of 24 pounds.

Sediment
As previously mentioned, the sediment loading capacity is primarily based upon the amount of sediment reduction needed to achieve the phosphorus goal. A sediment loading reduction goal of 30% results in a seasonal load allocation of 233 tons and an annual load allocation of 826 tons (Tables 7 and 8).

MARGIN OF SAFETY

A margin of safety (MOS) is a required component of the TMDL to account for uncertainty in the relationship between pollutant loads and quality of the receiving waterbody. The MOS accounts for potential uncertainty in data and analysis, or in the actual effect management controls will have on loading reductions and receiving water quality.

The MOS may be either implicitly accounted for by choosing conservative assumptions about loading estimates or water quality response, or is explicitly accounted for during the allocation of loads. The Mead Lake TMDL incorporates an explicit MOS because the actual load reduction goals are more stringent than the loads needed to meet the in-lake water quality goal. Our modeling suggests that a 30% reduction in the P load will actually result in slightly better water quality than the in-lake goal of 93 ppb. The Bathtub model suggests that a seasonal P load allocation of 4,050 pounds would achieve the in-lake goal of 93 ppb, however, the TMDL allocation was set at 3,850 pounds, providing an MOS of 200 pounds P. The annual P load allocation of 8,600 pounds provides an MOS of 480 pounds. Because the sediment load reductions were determined based on load allocations needed for phosphorus reductions in Mead Lake (3,850 pounds P), the MOS for sediment is implicit. Consequently, if the proposed loading reductions are achieved, water quality in Mead Lake will exceed the in-lake target goal.

Another means of providing a margin of safety is through implementation of other ongoing nonpoint source control programs that were not incorporated into in the SWAT land use model simulations. An example is implementation of the Conservation Reserve Program (CRP) in the basin. Conservation gains through this federal program are not accounted for in estimating potential phosphorus loading reductions. In addition, direct barnyard runoff was not incorporated into the land use model, thus implementing barnyard BMPs would provide additional P load reductions.

SEASONAL VARIATION

As the term implies, TMDLs are often expressed as maximum daily loads. However, TMDLs may be expressed in other terms when appropriate. In this case, the TMDL is expressed in terms of allowable daily, seasonal, and annual phosphorus and sediment loads.

During spring, the combination of short residence times, cold temperatures and high runoff flows cause much of the P laden water to flush through the lake with minimal impact on algae blooms. However, runoff that occurs during October – April does contribute phosphorus laden sediments that release phosphorus to the water column during summer, especially under anoxic conditions. During summer, warm temperatures, increased residence time and anoxia in the hypolimnion increases internal recycling of phosphorus, contributing to blue green algae blooms.

Increased TP loading is dependant on flow conditions rather than seasonality. The spectrum of flow conditions that would be expected during the entire year are used in the SWAT modeling for this TMDL. Growing season (May –September) loading as predicted by the SWAT modeling scenarios were used in conjunction with the BATHTUB model to predict the impact of management practices on growing season in-lake water quality. It is important to note, that the summer seasonal P load has a more direct impact on algal growth than that which occurs during other time periods, but by implementing BMPs to control runoff of phosphorus and sediment in the watershed all time periods will be addressed.

REASONABLE ASSURANCE

The Clean Water Act requires that states provide a “reasonable assurance” that the TMDL will be implemented. Reasonable assurance will be provided through a variety of voluntary and/or regulatory means in the Mead Lake watershed. The TMDL will be implemented through enforcement of existing regulations, financial incentives and various local, state and federal water pollution control programs. Following are some activities, programs, requirements and institutional arrangements that will provide a reasonable assurance that the Mead Lake TMDL is implemented and the water quality goal will be achieved.

In general, Wisconsin’s Section 319 Management Plan (approved by EPA) describes a variety of financial, technical and educational programs in the state. The primary state program described in the 319 Management Plan is the Wisconsin Nonpoint Source Water Pollution Abatement Program (s. 281.65 Wis. Stats. and ch. NR 120 Wis. Admin. Code). This TMDL and the implementation plan (when completed) will be incorporated as an amendment to the area wide water quality management plan under ch. NR 121(Wis. Admin. Code).

Wisconsin Administrative Code NR151 identifies performance standards and prohibitions to control polluted nonpoint source runoff. The rule also sets urban performance standards to control construction site erosion and manage runoff from urban development.

The WDNR and Clark County Land Conservation Department (LCD) will implement agricultural and non-agricultural performance standards and manure management prohibitions (Wis. Admin. Code NR 153) to address sediment and nutrient loadings in the Mead Lake watershed. Many landowners voluntarily install Best Management Practices (BMPs) to help improve water quality and comply with the performance standards. Cost sharing may be available for many of these BMPs. In most cases, farmers will not be required to comply with the agricultural performance standards and prohibitions unless they are offered at least 70% cost sharing funds. If cost-share money is offered, those in violation of the standards are obligated to comply with the rule.

The Clark County LCD may apply for Targeted Runoff Management (TRM) grants through WDNR. TRM grants are competitive financial awards to support small-scale, short term projects (24 months) completed locally to reduce runoff pollution. Both urban and agricultural projects can be funded through TRM grants which require a local contribution to the project. The state cost share is capped at $150,000 per grant. Projects that correct violations of the performance standards and prohibitions and reduce runoff pollution to impaired waters are a high priority for this grant program.

Lake Protection grants are available to assist lake users, lake communities and local governments to undertake projects that protect and restore lakes and their ecosystems. This program is administered under Wisconsin Administrative Code NR 191, and typically provides up to 75% state cost sharing assistance up to $200,000 per project. These projects may include watershed management projects, lake restoration, shoreland and wetland restoration, or any other projects that will protect or improve lakes.

The Environmental Quality Incentive Program (EQIP) is another option available to farmers. EQIP is a federal cost-share program administered by the Natural Resources Conservation Service (NRCS) that provides farmers with technical and financial assistance. Farmers receive flat rate payments for installing and implementing runoff management practices. Projects include terraces, waterways, diversions, and contour strips to manage agricultural waste, promote stream buffers, and control erosion on agricultural lands.

USDA Farm Service Agency's (FSA) Conservation Reserve Program (CRP) is a voluntary program available to agricultural producers to help them safeguard environmentally sensitive land. Producers enrolled in CRP plant long term, resource conserving covers to improve the quality of water, control soil erosion, and enhance wildlife habitat. In return, FSA provides participants with rental payments and cost share assistance.

Table 5. Seasonal (May – September) P load allocations for the Mead Lake watershed

Category	Baseline Phosphorus Load (pounds)	Percent Reduction	Reduction in Phosphorus Load (pounds)	Phosphorus Load Allocation (pounds)	Daily Phosphorus Load Allocation (pounds/day)
Nonpoint Sources	5,500	30	1,650	3,850	25
Point Sources	0	0	0	0	0
Margin of Safety				200	
Totals:	5,500	30	1,650	4,050	25

Table 6. Annual P load allocations for the Mead Lake watershed

Category	Baseline Phosphorus Load (pounds/yr)	Percent Reduction	Reduction in Phosphorus Load (pounds/yr)	Phosphorus Load Allocation (pounds/yr)	Daily Phosphorus Load Allocation (pounds/day)
Nonpoint Sources	13,230	35	4,630	8,600	24
Point Sources	0	0	0	0	0
Margin of Safety				480	
Totals:	13,230	35	4,630	8,600	24

Table 7. Seasonal (May – September) sediment load allocations for the Mead Lake watershed

Category	Baseline Seasonal Sediment Load (tons)	Percent Reduction	Reduction in Sediment Load (tons)	Sediment Load Allocation (tons)	Daily Sediment Load Allocation (tons/day)
Nonpoint Sources	333	30	100	233	1.5
Point Sources	0	0	0	0	0
Totals:	333	30	100	233	1.5

Table 8. Annual sediment load allocations for the Mead Lake watershed

Category	Baseline Annual Sediment Load (tons/yr)	Percent Reduction	Reduction in Sediment Load (tons/yr)	Sediment Load Allocation (tons/yr)	Daily Sediment Load Allocation (tons/day)
Nonpoint Sources	1,180	30	354	826	2.3
Point Sources	0	0	0	0	0
Totals:	1,180	30	354	826	2.3

PUBLIC PARTICIPATION

A local advisory group was formed in September 2007 to provide input in developing the Mead Lake TMDL. The advisory group consisted of WDNR staff, Clark County Land Conservation Department staff, town officials, farmers, lake district members and other private individuals. Public informational meetings on the draft TMDL were held on May 24, 2008 and June 14, 2008.

The Mead Lake TMDL was subject to public review from May 22, 2008 to June 30, 2008. On May 15th, 2008, a news release was sent to local newspapers, television stations, radio stations, interest groups, and interested individuals in the west central region portion of the state. The news release indicated the public comment period and how to obtain copies of the public notice and draft TMDL. The news release, public notice, and draft TMDL were also placed on the DNR's website: http://dnr.wi.gov/org/water/wm/wqs/303d/Draft_TMDLs.html

WDNR received three letters of support regarding the Mead Lake TMDL with no specific technical comments. In addition, EPA Region 5 submitted comments during the public comment period. All comments were documented, considered, and addressed, with many incorporated into the final report. Comments and responses can be found in Appendix 4 of this report.

IMPLEMENTATION

The Mead Lake TMDL identifies water quality goals and wasteload allocations. The next step following approval of the TMDL is to develop an implementation plan that specifically describes how the goals will be achieved. The implementation planning process is expected to be completed following approval of the TMDL.

The implementation planning process will develop strategies to most effectively utilize existing federal, state, and county based programs to achieve nonpoint source load allocations outlined in the TMDL. Generally, funding sources are available to install BMPs, but most of these sources do not include funds to hire local staff.

The implementation plan will address various management issues including:

- Funding priorities for implementing BMPs based on cost effectiveness
- Funding for local land conservation staff to implement the project
- Develop or identify an existing organizations or agencies to implement the project
- Develop targeted performance standards (if needed)
- Determine how to implement agricultural performance standards

Developing an implementation plan will require a collaborative effort that utilizes the funding and expertise of various agencies and private organizations. Participating partners will likely include the Clark County Land Conservation Department, WDNR, Mead Lake District, TMDL Advisory Group and possibly other interested parties. An inter-agency cooperative agreement can be used to define contributing roles and responsibilities of each respective partner. Details of the implementation plan will include project goals, actions, costs, timelines, reporting requirements, and evaluation criteria.

Internal P Load Control

While a 30% reduction in the external P load to Mead Lake will result in a noticeable improvement in water quality, further improvement would occur from measures to reduce the internal P load during summer. Several possible methods that could be employed to reduce the internal P load include;

- Alum treatment: This requires treatment of areas of the lake bottom that typically go anoxic and therefore release P. This could not be done cost effectively until external sediment and P loading is controlled, because new P-laden sediment will cover the alum layer and render it ineffective.
- Aeration: Air bubble lines could be placed in the deep holes, and be used to prevent stratification and anoxic release of bottom sediment P. The costs of operation and maintenance may be prohibitive, as electricity is needed to run the pumps.
- Siphoning: This involves siphoning off water continuously from the bottom of the lake, before it can become anoxic. This would prevent the bottom water from becoming anoxic. However, in dry years, there may not be enough flow through the lake to allow this approach.

After considerable control of external P sources has been achieved and financing to reduce internal loading become available, internal loading control efforts will be pursued if feasible.

MONITORING

Water quality monitoring will be conducted by the WDNR on Mead Lake and in its watershed beginning 5 years after initiation of the TMDL implementation plan. This monitoring will provide an interim evaluation of project effectiveness and goals. The monitoring approach will generally replicate monitoring conducted in 2002-2003 as outlined in USACE (2005).

Pollutant loads will be measured for two years at a station located on the South Fork Eau Claire River where it enters Mead Lake. Streamflow will be measured continuously and water chemistry samples will be collected bi-weekly for two years. Lake water quality will be monitored at three sites in Mead Lake, following the protocol outlined in USACE (2005). Land use data will be updated, which in conjunction with the monitoring data, will be used to develop an updated watershed SWAT loading model for Mead Lake. The watershed model and an updated lake response model will be used to re-evaluate project goals for Mead Lake.

Volunteer monitoring

An ongoing monitoring effort sponsored by the Wisconsin Self-Help Citizen Lake Monitoring program provides basic water quality data that is collected by local volunteers. Self-help volunteers have been collecting Secchi depth data five times per summer in Mead Lake since 1996. In order to more effectively measure implementation effectiveness, this effort will be increased to capture summer monthly Secchi depth, total P and chlorophyll data at two sites in Mead Lake on an annual basis.

REFERENCES

Freihoefer, A. and P. McGinley. 2007. Mead Lake watershed sediment and nutrient export modeling. Center for Watershed Science and Education, University of Wisconsin – Stevens Point.

Lillie, R. A., S. Graham and P. Rasmussen. 1993. Trophic state index equations and regional predictive equations for Wisconsin lakes. Research Management Findings, No.35. Wis. Dept. of Natural Resources. Madison, WI.

McGinley, P and A. Freihoefer. 2008. SWAT model simulations of suspended sediment loading to Mead Lake. Feb. 18, 2008 memo to K. Schreiber and P. Oldenburg (WDNR). UW-Stevens Point, Stevens Point, WI.

Omernik, J.M. and A.L. Gallant. 1988. Ecoregions of the Upper Midwest States. U.S. Environ. Prot. Agency. Report No. EPA/600/3-88/037, Corvallis, OR. 56pp.

U.S. Army Corps of Engineers. 2005. Phosphorus budget and loading reduction analysis of Mead Lake, West-Central Wisconsin. Waterways Experiment Station, Environmental Laboratory, Spring Valley, Wisconsin. 44pp.

Walker, W.W., 1996. Simplified procedures for eutrophication assessment and prediction: User manual. Instruction Report W-96-2. U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

Appendix 1. Simulating Mead Lake water quality from land management changes (McGinley, P. and A Freihoefer, 2008).

MEMORANDUM

To: Ken Schreiber and Pat Oldenburg
From: Paul McGinley and Adam Freihoefer

Simulating Mead Lake Water Quality
from Land Management Changes
Revised January 15, 2008

The impact of land management changes on Mead Lake water quality was projected using SWAT simulations linked with BATHTUB simulations. The SWAT model was used to generate monthly flow and phosphorus export to the lake. This was converted to a growing season total flow and flow-weighted concentration for input to BATHTUB. The BATHTUB model was used to estimate growing season water quality. The BATHTUB modeling used an average of the calibration coefficients from the James et al. (2005) study.

Comparison to 2002/2003 Conditions

The SWAT/BATHTUB simulations were first used to demonstrate how the results of the combined models match the measurements from 2002-2003. Table 1 compares the SWAT/BATHTUB simulation results with the measured range and average for 2002 and 2003. The SWAT/BATHTUB results are shown both as "average" and "maximum" from simulations based on six different simulation starting dates. This starting date affect is largely due to year-to-year variations in cropping assignments. The SWAT modeling used a staggered assignment of crop rotation starting points to approximate a uniform distribution of crops on different soils, but because the distribution is not exact, it leads to variations for a specific year depending on the starting point in the simulation. The model was calibrated using a single starting year, but the staggered starting dates might provide some measure of how variations in land management influence the variation in lake response. In the discussion that follows, the SWAT/BATHTUB simulation results were evaluated as both annual averages of the multiple year simulations or as the average of annual maximums from the multiple year simulations. Table 1 summarizes the averages of the different starting dates for those two analysis methods for the two monitored years.

The results in Table 1 show general agreement between the measured and simulated lake response. The measured average results fall between the SWAT/BATHTUB modeling for 2002 and exceed the simulated maximum for 2003. In all cases, the range in measured lake concentration is much larger than the simulated averages and maximums. It appears reasonable to use the average and maximum rotation averages to bracket the likely lake response to management changes.

Influence of Land Management Changes on Mead Lake

Combined SWAT/BATHTUB modeling was also used to examine the impact of management changes on Mead Lake water quality. To provide year-to-year comparisons, the modeling was similar to that described above, where results from staggered starting dates were modeled using SWAT/BATHTUB and then the results shown as averages or maximums for each year.

Table 1. Comparison Between Measured and SWAT/BATHTUB Simulated using 88-93 Start Dates and Averaged BATHTUB Model

	2002			2003		
	TP (ug/l)	**Chlorophyll a (ug/l)**	**Secchi (m)**	**TP (ug/l)**	**Chlorophyll a (ug/l)**	**Secchi (m)**
Measured Average (Range)	112 (44-237)	51	0.5	125 (62-189)	76	0.7
Simulated Average	101	46	0.7	99	44	0.7
Simulated Maximum (Max P/Chla & Min Secchi)	123	61	0.6	112	53	0.6

Notes: Simulation staring dates from 1988-1993 to provide six to eleven year warm-up periods prior to evaluation period from 1999 to 2004.

Figures 1 and 2 show the baseline and phosphorus reduction scenarios. The phosphorus concentrations in the lake are lower under the different management scenarios. As would be expected, the concentration in the lake is a little different from year-to-year, primarily reflecting the variations in rainfall timing and quantities.

Table 2 summarizes the average of the different staggered-start-date simulations for both the baseline and phosphorus management conditions. Similar to results that were shown in previous project memoranda, they lead to phosphorus reduction scenarios with changes of approximately 15% for the soil P and soil erosion scenarios, and almost 30% for the combination scenario (soil P, erosion, and dietary P). The total phosphorus export is shown for both annual and the May through September growing season. The annual export is much greater than the growing season and reflects the very high export simulated for February, March and April. In general, those months were simulated without the benefit of field data for calibration, so the annual export totals are more uncertain than those for the growing season. The phosphorus export for the baseline and reduction scenarios is larger than that reported in the November 27, 2007 project memorandum. The simulations presented here are shorter term simulations to reduce the impact of changes in watershed phosphorus storage, and they combine the results of multiple starting years, both of which lead to a larger overall phosphorus export. Comparison of these results with those shown previously demonstrates that the percentage reductions are relatively robust regardless of simulation approach (long-term average with a single starting date or shorter-term average with multiple starting dates).

Table 3 summarizes the results from averaging the maximum for each year in the staggered-start-date simulations. This leads to a higher phosphorus export and lake phosphorus concentration, and a larger percentage reduction in phosphorus in the management scenarios. These values represent a more extreme combination of management practices that would result in higher phosphorus export for all years in the rotation. The increased phosphorus reduction percentage for the different management scenarios than those in Table 2 is consistent with a greater percentage of the phosphorus coming from agricultural land management that is impacted by the land management change simulated.

Consistent with the modeling shown in James et al. (2005), the percentage reduction in the lake total phosphorus response is relatively similar to (as a percentage), although slightly lower than

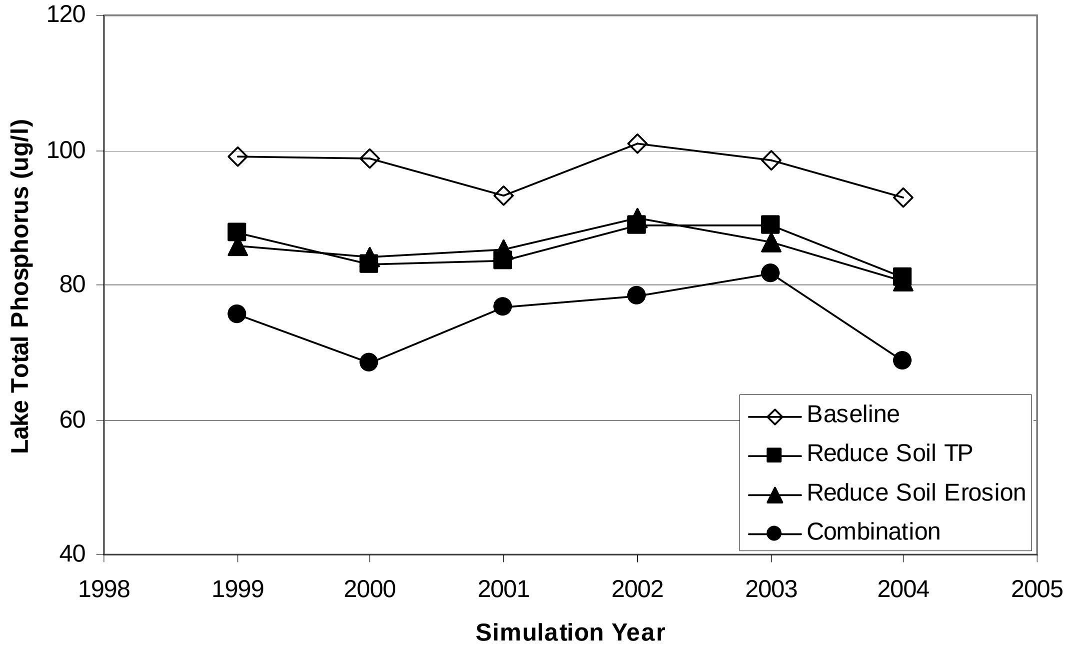


Figure 1. Predicted lake phosphorus concentration for the baseline and reduction scenarios 1, 2 and 8. Phosphorus concentrations are the mean of the six BATHTUB simulations for each year using the different SWAT starting dates.

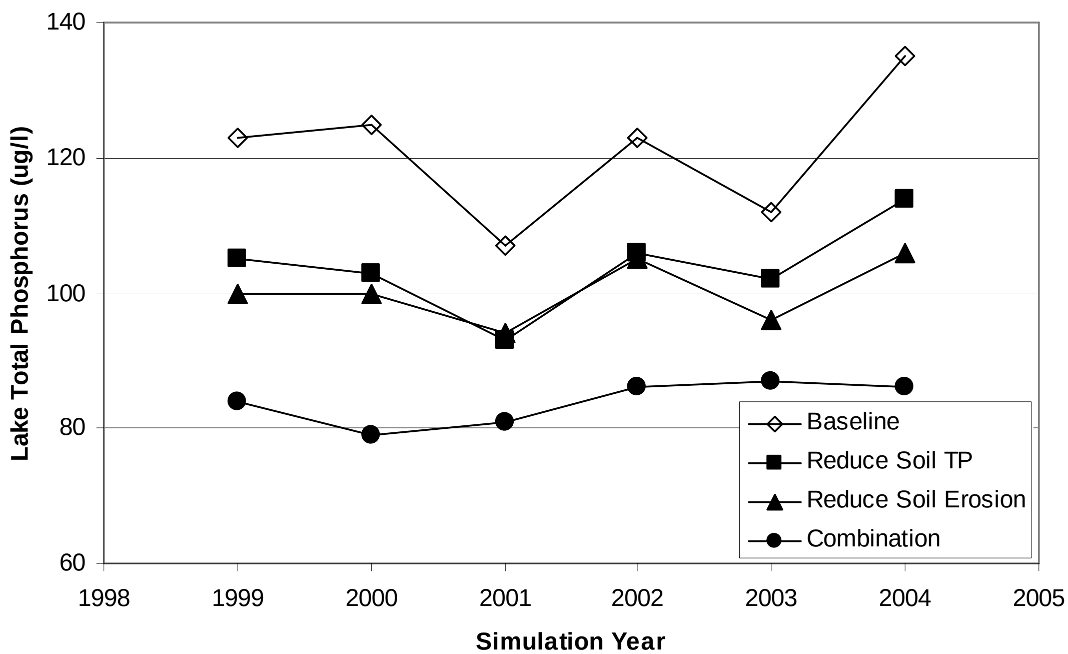


Figure 2. Predicted lake phosphorus concentrations for the baseline and reduction scenarios 1, 2 and 8. Concentrations are the maximum for each year based on six BATHTUB simulations using different starting dates in the SWAT simulations.

Table 3. Simulated Phosphorus Export, Stream Concentration and Lake Concentration Using Rotation Annual Average SWAT / BATHTUB Simulation Results

	Annual Phosphorus Export (Pounds)	Growing Season Phosphorus Export Pounds (% Reduction)	Mead Lake Growing Season TP ug/l (% Reduction)	Growing Season Chlorophyll a ug/l (% Reduction)	Growing Season Secchi Depth (ft) (% Increase)
Baseline	15,873	4,896	97	43.1	2.4
Reduce Soil P (Scenario 1)	13,386	4,173 (15%)	86 (11%)	35.9 (17%)	2.6 (9%)
Reduce Soil Erosion (Scenario 2)	12,831	4,156 (15%)	85 (12%)	35.8 (17%)	2.6 (8%)
Combination (Scenario 8)	10,871	3,518 (28%)	75 (22%)	29.4 (32%)	2.9 (21%)

Notes: Values calculated from annual and growing season (May-Sept) monthly export using 1999-2004 results with six different simulations with starting dates 1988-1993. These represent the average values from thirty six different year-simulations (six different years in the six simulations).

Table 4. Simulated Phosphorus Export, Stream Concentration and Lake Concentration Using Rotation Average of Annual Maximum SWAT / BATHTUB Simulation Results

	Annual Phosphorus Export (Pounds)	Phosphorus Export Pounds (% Reduction)	Mead Lake Growing Season TP ug/l (% Reduction)	Growing Season Chlorophyll a ug/l (% Reduction)	Growing Season Secchi Depth (ft) (% Increase)
Baseline	20,536	6,717	121	59.3	2.0
Reduce Soil P (Scenario 1)	16,808	5,509 (18%)	104 (14%)	47.5 (20%)	2.2 (9%)
Reduce Soil Erosion (Scenario 2)	15,622	5,265 (22%)	100 (17%)	45.0 (24%)	2.3 (17%)
Combination (Scenario 8)	12,639	4,235 (37%)	84 (31%)	34.8 (41%)	2.6 (33%)

Notes: Values calculated from growing season (May-Sept) using 1999-2004 results with six different simulations with starting dates 1988-1993. These represent the average of the annual maximum values for each year (average of the six annual maximums).

the watershed phosphorus reduction. For example, a fifteen percent reduction in growing season watershed export in Table 2 leads to an eleven to twelve percent reduction in growing season lake phosphorus concentration.

The relationship between reductions in phosphorous export from the watershed and improvement in water quality in Mead Lake was also examined for the different SWAT/BATHTUB simulations. While the lake response to loading reductions will be influenced by the flow and concentration that year, the results of different annual SWAT/BATHTUB simulations in Figures 3 and 4 show that for the Mead Lake watershed, they generally adhere to a similar relationship. This relatively linear response simplifies evaluating other reduction scenarios or permits an evaluation using a baseline lake concentration that differs from those used in Tables 2 and 3 above.

Summary and Recommendations

1. Results from the linked SWAT/BATHTUB simulations were similar to the measured Mead Lake water quality. To minimize the influence of staggered agricultural management in rotations, results are shown as both average and maximum for each year in the simulation using multiple starting years. The average measured values appear to generally fall between these values.

2. Expressing the impact of management changes on phosphorus reduction as a percentage reduction from the average baseline is relatively robust regardless of simulation approach (long-term, short-term, multiple start dates). Therefore, when possible, express the phosphorus reductions as a percentage from the baseline. The percentage reductions are greater when examining the maximum years in a combination of different starting years, reflecting the higher percentage of phosphorus export attributable to agricultural activities in those simulations.

3. The range of phosphorus export that is simulated in the model for rotation average and rotation maximum suggests a growing season phosphorus export of 4,896 to 6,717 pounds for the Mead Lake watershed. This range accommodates uncertainty in the different cropping practices from year to year in the watershed. The anticipated reduction in phosphorus export from year-to-year will also vary depending on the combination of management practices, but the average scenario condition estimates in Table 3 would be the recommended percentage growing season reductions associated with the implementation of the management strategies to reduce phosphorus export.

4. The impact of phosphorus reductions on lake response using SWAT/BATHTUB can be done as either a percentage or as a projected value (eg., TP concentration). Projected values for the lake total phosphorus concentration in the baseline simulation range from ~100 to 120 ug/l depending whether it is based on the rotation average or maximum, respectively. The response of the lake phosphorus or chlorophyll a is relatively linear with respect to changes in watershed phosphorus export over the likely reduction range and it may be useful to use a graphical approach (Figures 3 and 4) based on any baseline assumptions to show the impact of percentage reductions on water quality.

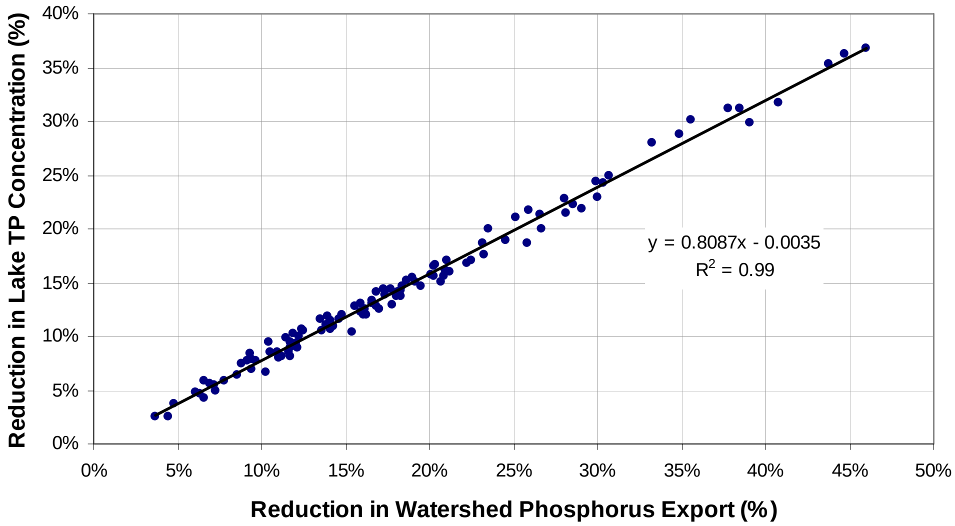


Figure 3. Relationship between reductions in watershed phosphorus export and predicted lake total phosphorus concentration using the results from the six years of the six different starting date SWAT/BATHTUB simulations and three reduction scenarios.

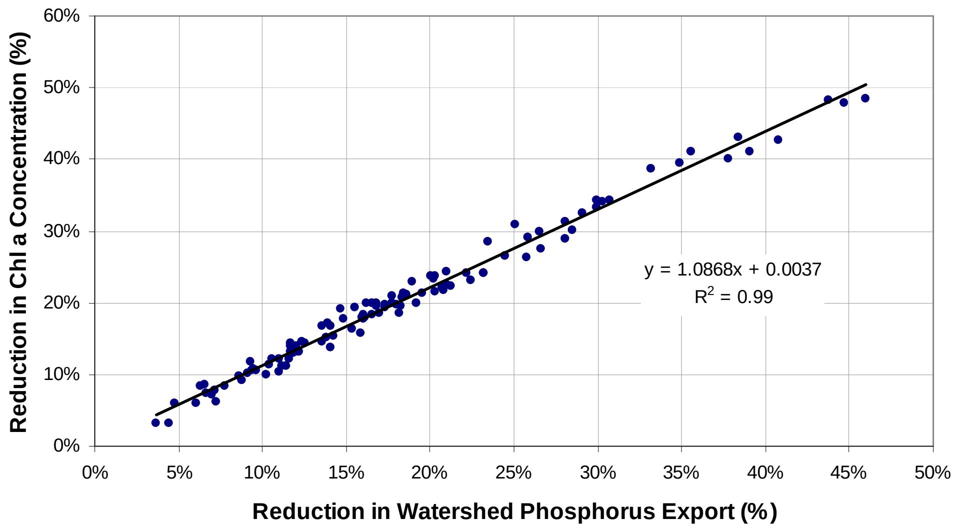


Figure 4. Relationship between reductions in watershed phosphorus export and predicted lake chlorophyll a concentration using the results from the six years of the six different starting date SWAT/BATHTUB simulations and three reduction scenarios.

Appendix 2. BATHTUB Modeling of Mead Lake, Clark County, Wisconsin

The following analysis was developed by P. Oldenburg (WDNR) and drawn from two main sources, SWAT modeling work done by Paul McGinley and Adam Freihoefer (2007) and the monitoring work of Bill James (USACE 2005).

The UWSP modeling results presented a range of possible loading rates as the "baseline scenario". This approach was the result of the impact of starting dates on model output results. This starting date affect was largely due to year-to-year variations in cropping assignments. The SWAT modeling used a staggered assignment of crop rotation starting points to approximate a uniform distribution of crops on different soils, but because the distribution was not exact, it lead to variations for a specific year depending on the starting point in the simulation. The results of this exercise predicted mean summer (May – September) external phosphorus loading to Mead Lake of 4,896 lbs. and an annual load of 15,873 lbs. However, by using the same calibrated model and different start date, the model predicted average external summer phosphorus loading to Mead Lake of as high as 6,717 lbs. and an annual load of 20,536 lbs. (See January 15, 2008 memo from Paul McGinley and Adam Freihoefer).

The USACE monitoring results were from 2002 and 2003. The seasonal phosphorus loading estimates were 3,704 kg (8,165 lbs.) for summer 2002 and 2,062 kg (4,546 lbs.) for summer 2003. Since the tributary loading was only monitored for two years, data from a nearby gage was used to estimate longer term loading. The Neillsville gage on the Black River (USGS #05381000) has been operated from 1905-09, 1913-2000 and 2001 to present. Using 1974 to 2005 as a long term estimate of flow, 2002 was in the 90^{th} percentile of annual flow and 93^{rd} percentile for the summer flow. By contrast 2003 was in the 31^{st} percentile of annual flow and 40^{th} percentile for summer flow. The long term loading to Mead Lake can be estimated by using the ratio of 1974 to 2005 median to the 2002 and 2003 flows flow at the Black River gage. This results in a long term estimate of loading to Mead Lake of 2,625 kg/summer (5,787 lbs.) and 6,021 kg/yr (13,274 lbs.).

Based on these two approaches, 2,500 kg/summer (5,510 lbs) and 6,000 kg/yr (13,230 lbs) should be used as baseline P loads for the TMDL. The 2,500 kg/summer load was used because it matched up well with a long term estimate arrived at by using the loading data and subsequent discussions with Paul McGinley about the SWAT model results in which he was concerned that the 2,221 kg figure may be an underestimate of loading. The annual load of 6,000 kg/yr was based on the loading data and review of SWAT modeling data which show a tendency to over-predict winter base flows and runoff.

Since a percentage reduction goal has already been identified by the stakeholder group at 30% for the growing season, a May – September load goal of 1,750 kg/yr (3,860 lbs/yr.) is recommended. Since SWAT modeling predicts that use of many agricultural best management practices will achieve a higher percentage reduction in annual loading than the May - September load, I recommend that the annual load goal be set at 35% of 6,000 kg/yr (13,227 lbs/yr), or 3,900 kg/yr (8,600 lbs/yr).

In order to estimate the effect of this load reduction on Mead Lake water quality, I ran a BATHTUB May – September baseline scenario with a external load of 2,625 kg (5,790 lbs), a 30% external load reduction (i.e. external load = 1,837 kg) and a 30% external load reduction with a 70% internal load control. The results are shown in Table 1.

Table 1. Mead Lake BATHTUB model loading reduction scenarios.

Parameter	Baseline (5,790 lbs/summer)	30% Reduction (4,050 lbs /summer)	30% Reduction w/internal load control
Total Phosphorus (μg/L)	122	93	76
Chlorophyll-a (μg/L)	59	39	30
30 μg/L Chlorophyll-a bloom frequency (%)	78	55	37
Secchi Depth (m)	0.7	1.1	1.4

An in-lake goal of 93 μg/L growing season mean total phosphorus is recommended for the TMDL. The BATHUB model indicates that this goal could be met with an external loading rate higher than the recommended TMDL goal, therefore choosing this in-lake goal in conjunction with the TMDL load goal will provide a margin of safety in the TMDL.

Note that this BATHTUB model is different that that used in the James study, but analysis of the response curves show that the models behave nearly identically over the range of expected reductions for the TMDL, indicating a fair amount of model robustness. The modeling conditions for both model calibration based on the 2002 and 2003 monitoring data and modeling for the long term analysis are listed in Table 2.

Table 2. Estimation of Long Term P Loading to Mead Lake.

Long term annual and season loadings were developed for the South Fork Eau Claire River at CTH MM using a ratio method based on flow data from the from Black River at Neillsville. First the long term average of the annual and seasonal flows was determined at the Black River site:

Summary of Data from Black River at Neillsville:
POR: 1974-1998, 2001-2005. n=30
30 yr annual mean = 648.4 cfs
2002 mean annual flow = 990.6 cfs
2003 mean annual flow = 483.7 cfs

30 yr May – Sept mean flow = 554.0 cfs
2002 mean May – Sept flow = 1162.5 cfs
2003 mean May – Sept flow = 394.9 cfs

Then the ratio between the Black River flows of an individual year vs. the long term average was determined as:

$$\text{Ratio} = \frac{\text{30 Year Mean}}{\text{Individual Year Mean}}$$

2002 Annual Ratio = 0.655
2003 Annual Ratio = 1.341
2002 May-Sept Ratio = 0.477
2003 May-Sept Ratio = 1.403

Summary of Data from South Fork Eau Claire River at CTH MM:

2002 mean annual flow = 62.2 cfs
2003 mean annual flow = 45.9 cfs
2002 mean May – Sept flow = 73.8 cfs
2003 mean May – Sept flow = 43.8 cfs
2002 estimated annual TP Load = 6682 kg (14,731 lbs)
2003 estimated annual TP Load = 4931 kg (10,871 lbs)
2002 estimated May – Sept TP Load = 3397 kg (7,489 lbs)
2003 estimated May – Sept TP Load = 1872 kg (4,127 lbs)

To estimate the long term flow/load the ratio developed from the Black River data was applied to the South Fork Eau Claire River to estimate the long term flow and load.

Appendix 3. SWAT model simulations of suspended sediment loading to Mead Lake (McGinley and Freihoefer, 2008).

MEMORANDUM
To: Ken Schreiber and Pat Oldenburg
From: Paul McGinley and Adam Freihoefer

The results of the SWAT modeling were used to estimate the suspended sediment export from the watershed on both an annual (Jan-Dec) and growing season (May-Sept) basis. The SWAT model was calibrated using growing season loads and flows from 2002 and 2003. The longer-term SWAT simulation results are presented in Figure 1 as the average and range in sediment load for each year based on simulations with six different simulation starting dates. Similar to the phosphorus results, the starting date affect is largely due to year-to-year variations in cropping assignments. The SWAT results are presented in Table 1 as the average of the different starting-year simulations or as the average of annual maximums from the different starting-year simulations. Similar averages are obtained for the annual sediment load when looking at a twelve year time period that starts with 1993. Therefore, an average annual sediment load of approximately one million kilograms is estimated for the watershed and the unit area suspended sediment export for the entire watershed is approximately 43 kg/ha or 4300 kg/km^2.

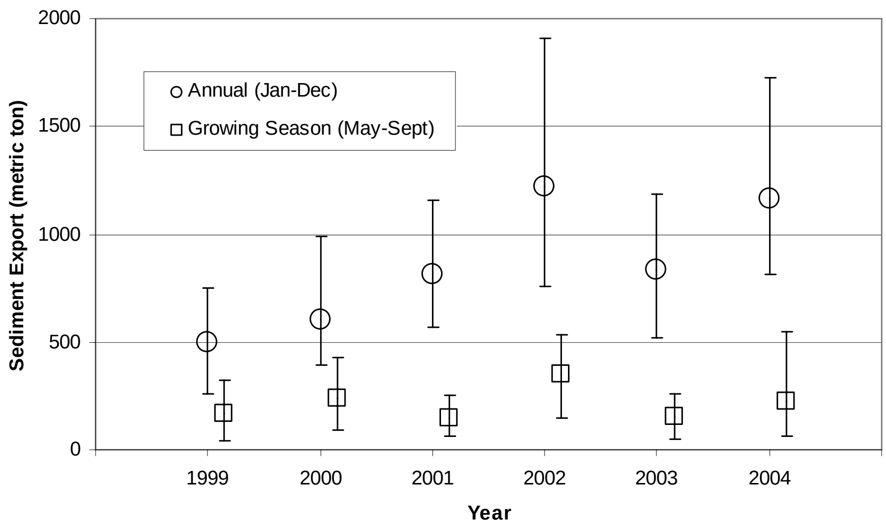


Figure 3. Simulated suspended sediment export across evaluation period shown as average and range for the different simulation starting dates.

Table 1. SWAT Simulated Suspended Sediment Export for Mead Lake Watershed

Growing Season (May-September)		Annual (January-December)	
Range (kg/year)	**Average (kg/year)**	**Range (kg/year)**	**Average (kg/year)**
214,000-391,000	302,000	854,000-1,285,000	1,070,000

Notes: The range is from the mean of the averages to the mean of the maximums for each year using the different starting point simulations across the evaluation period. The average is the mean of average annual and average maximum. Simulation staring dates from 1988-1993 to provide six to eleven year warm-up periods prior to evaluation period from 1999 to 2004.

Appendix 4. Comment and Response Log

Comments received from US EPA on 08/02/2008
Addressed by Ken Schreiber and Nicole Richmond

NOTE: Comments were summarized and this TMDL report was re-formatted to be more readable and answer many of the comments and questions below. Page numbers have changed due to formatting.

1. The USACE 2005 report provides support for eutrophication impairment, correct?
   WDNR: Yes, the USACE report provides supports that the lake is highly eutrophic.

2. The primary goal of the TMDL is to address the eutrophication impairment by reducing levels of P in the Lake. What about the other impairments?
   WDNR: The text has been changed in the document to emphasize that this TMDL is addressing both phosphorus and sediment and their corresponding impairments.

3. Is this table consistent with the 2006 list? The 2008 list?
   WDNR: This table has been updated to reflect changes to the 2008 303(d) list (pending US EPA approval as of 08/01/08). Total phosphorus is incorrectly listed as an impairment on the 2008 list (this is only a pollutant for this impaired water body and is being corrected).

4. What is the significance of having P levels greater than 50ppb?
   WDNR: Lakes are generally considered eutrophic when P concentrations are measured at over 20 ppb. This was addressed in the text.

5. This section includes very good information about previous studies and their conclusions, however, a clear linkage is needed to the impairments and pollutants for which loads are being established.
   WDNR: This was addressed by adding a “Problem Statement” section in the TMDL report and also additional text in the “Water Quality Standards section.”

6. What are acceptable TSI values?
   WDNR: 50 is the boundary between eutrophic and mesotrophic conditions in the lake. Any TSI over 50 is considered eutrophic. This was addressed in the text as well.

7. Include a statement why SWAT is a reasonable model to use for this TMDL.
   WDNR: Text was added to explain why SWAT was used for this TMDL.

8. Include a statement explaining why these were simulated and why these are reasonable scenarios for this TMDL.
   WDNR: The scenarios for this TMDL were chosen with assistance from the Clark County Land Conservation Department. These are reasonable and feasible scenarios that are linked to agriculture and may be implemented in this region of the state. This was addressed in the text.

9. What is the basis of the estimated values?
   WDNR: The term estimated values has been changed with “monitored loads” since the model was developed based on what was actually measured in the watershed.

10. What is the basis for saying they were simulated correctly?
    WDNR: This was addressed in the text. After the model was calibrated with 2002 monitored loads, the model was verified by predicting the 2003 measured load. Good agreement between the calibrated and verified loads is an indication the model was predicting accurately.

11. (Multiple comments) Please address the impairments, pollutants and the linkage of how they were selected to meet water quality standards in the report.
    WDNR: This was addressed by adding a "Problem Statement" section in the TMDL report and also additional text in the "Water Quality Standards section."

12. The TMDL is only addressing external loadings of P to Mead Lake, correct? Will these external load reductions, without any internal load reductions, achieve the applicable water quality standards?
    WDNR: The goals set for phosphorus and sediment for this TMDL will meet the identified water quality standards. Further improvements could be made to the lake in the future if more water quality improvements, including internal load reductions,, are pursued. This was addressed in the text.

13. Explain how you determined that the mean summer sediment load needs to be reduced by 30% to 233 tons and the annual load needs to be reduced to 826 tons.
    WDNR: Text was added to explain that the SWAT model used P as a surrogate to reach a sediment reduction target for Mead Lake.

14. In the WLA sections, something should be said about the other two impairments, i.e. sedimentation and pH and how the WLA addresses these.
    WDNR: Comment addressed in the text.

15. Explain why seasonal and annual daily load allocations are necessary to achieve water quality standards.
    WDNR: This was addressed in the text.

16. If you want to use the 30% as a MOS, what is the reduction needed to achieve the 93 ppb so it is obvious that the TMDL and associated load allocations are indeed more conservative than needed.
    WDNR: This was addressed in text – p. 11

17. The seasonal variation section explains the impact of seasonality on phosphorus but how was seasonal variation taken into account specifically in the model runs that led to the % reductions used to calculate the allocations and how was seasonal variation taken into account in calculating the loading capacity?
    WDNR: This was addressed in text – p.7 and 11

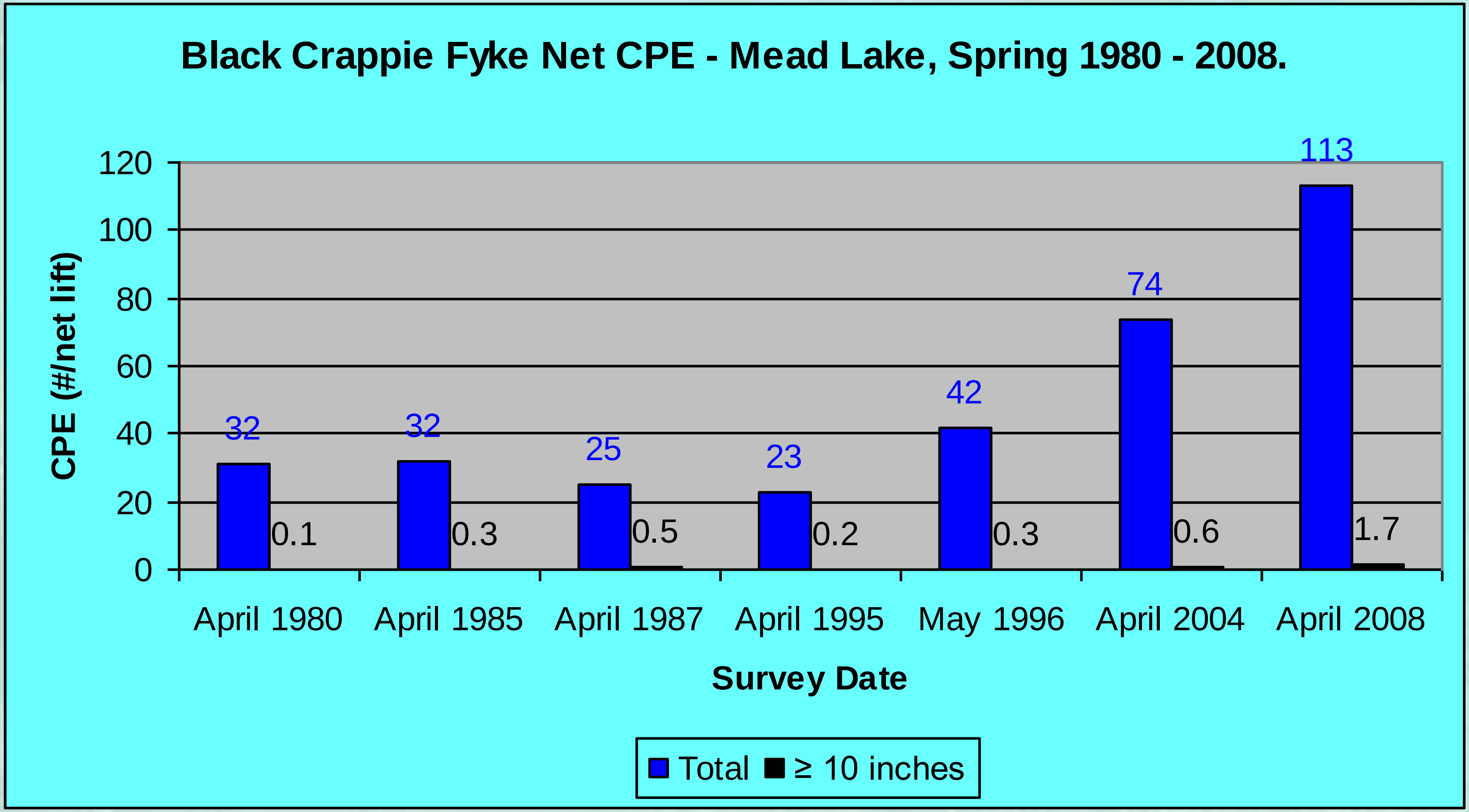
18. Please indicate in Tables 5-8 that you are assigning the load allocation to nonpoint sources.
    WDNR: In tables 5-8 the load allocation is assigned to nonpoint sources only since the Mead Lake Watershed contains no point sources.

Fish Population Data
Mead Lake, Wi

Outline

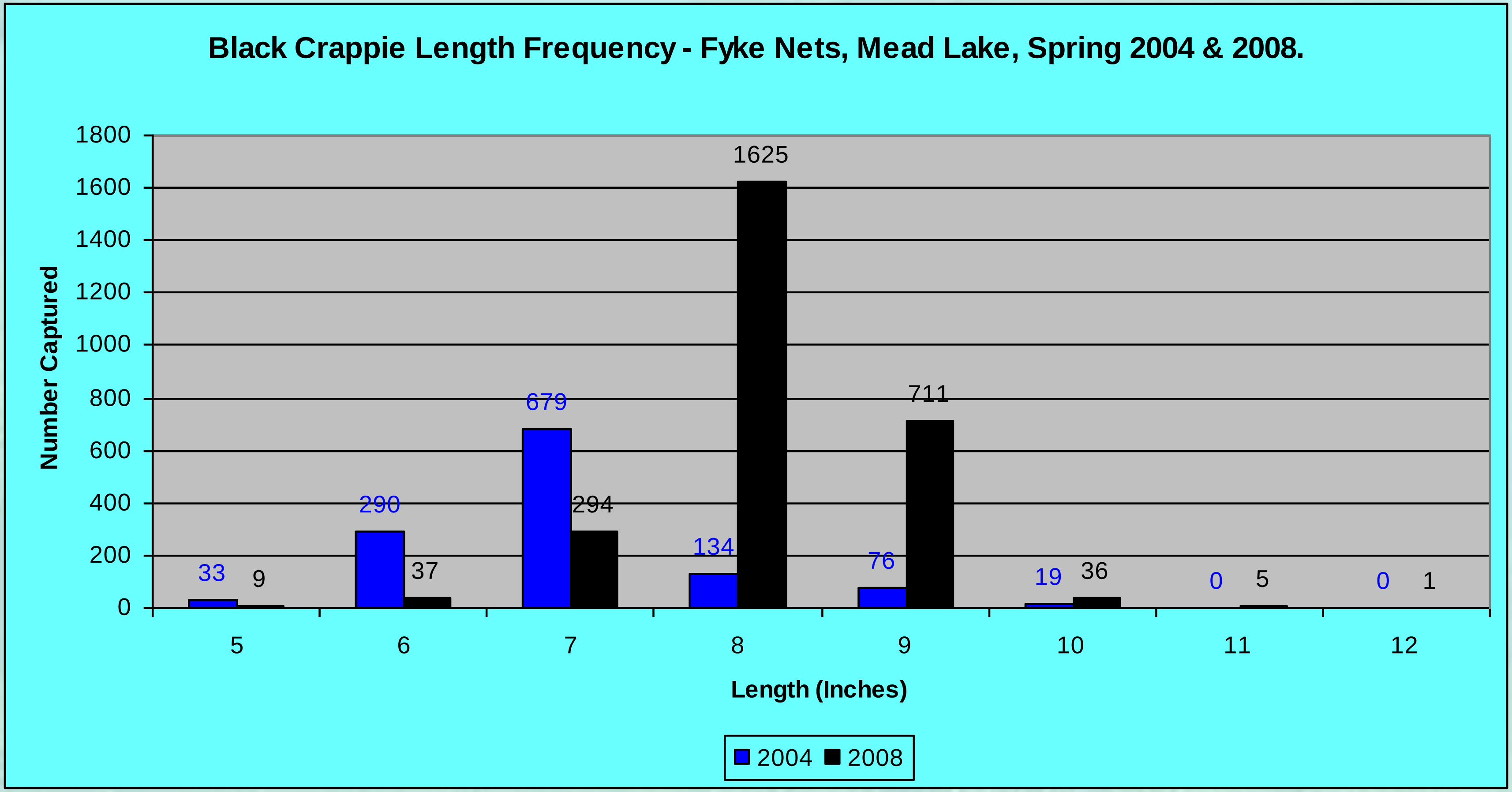
- Panfish
- Gamefish
- Carp
- Stocking
- Management
- Questions

Crappies



Black Crappie Fyke Net CPE - Mead Lake, Spring 1980 - 2008.
CPE (#/net lift)
120
100
80
60
40
20
0
32
0.1
32
0.3
25
0.5
23
0.2
42
0.3
74
0.6
113
1.7
April 1980
April 1985
April 1987
April 1995
May 1996
April 2004
April 2008
Survey Date
Total
≥ 10 inches

Crappies



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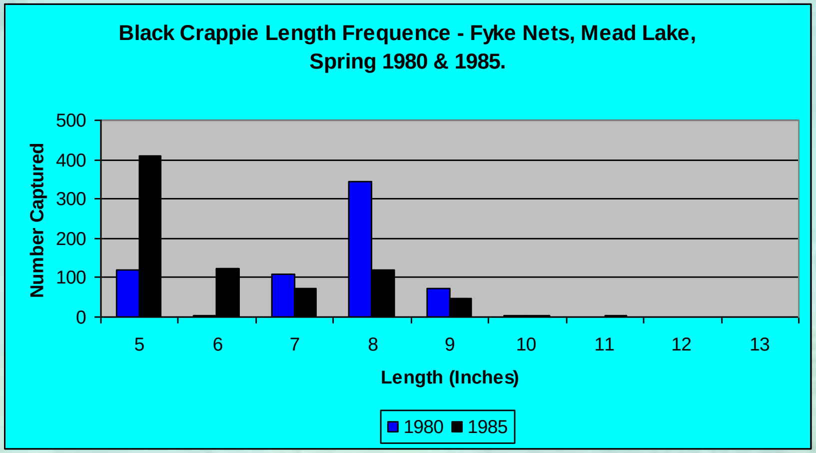
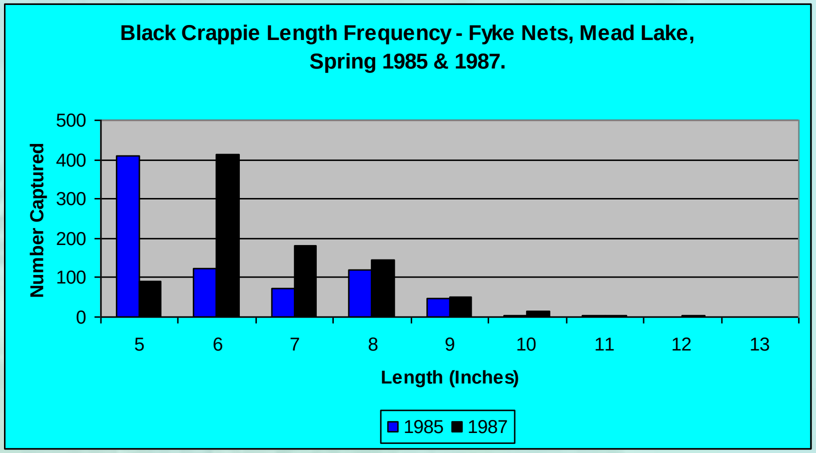
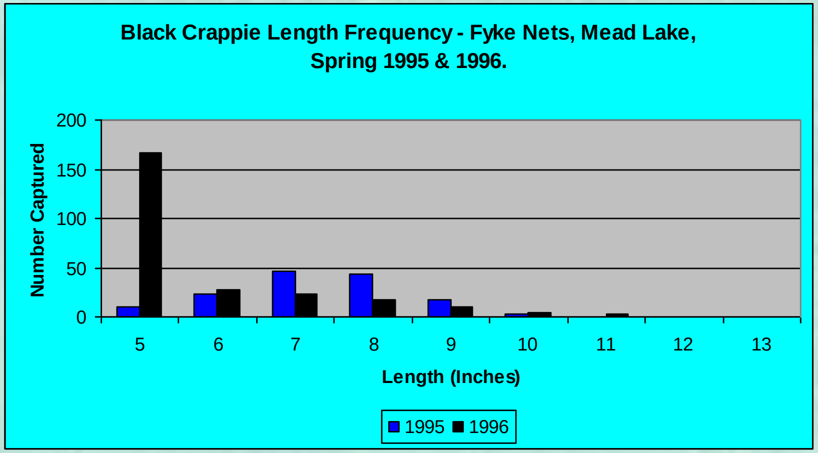
Crappies



Black Crappie Length Frequence - Fyke Nets, Mead Lake, Spring 1980 & 1985.
Number Captured
Length (Inches)
1980
1985

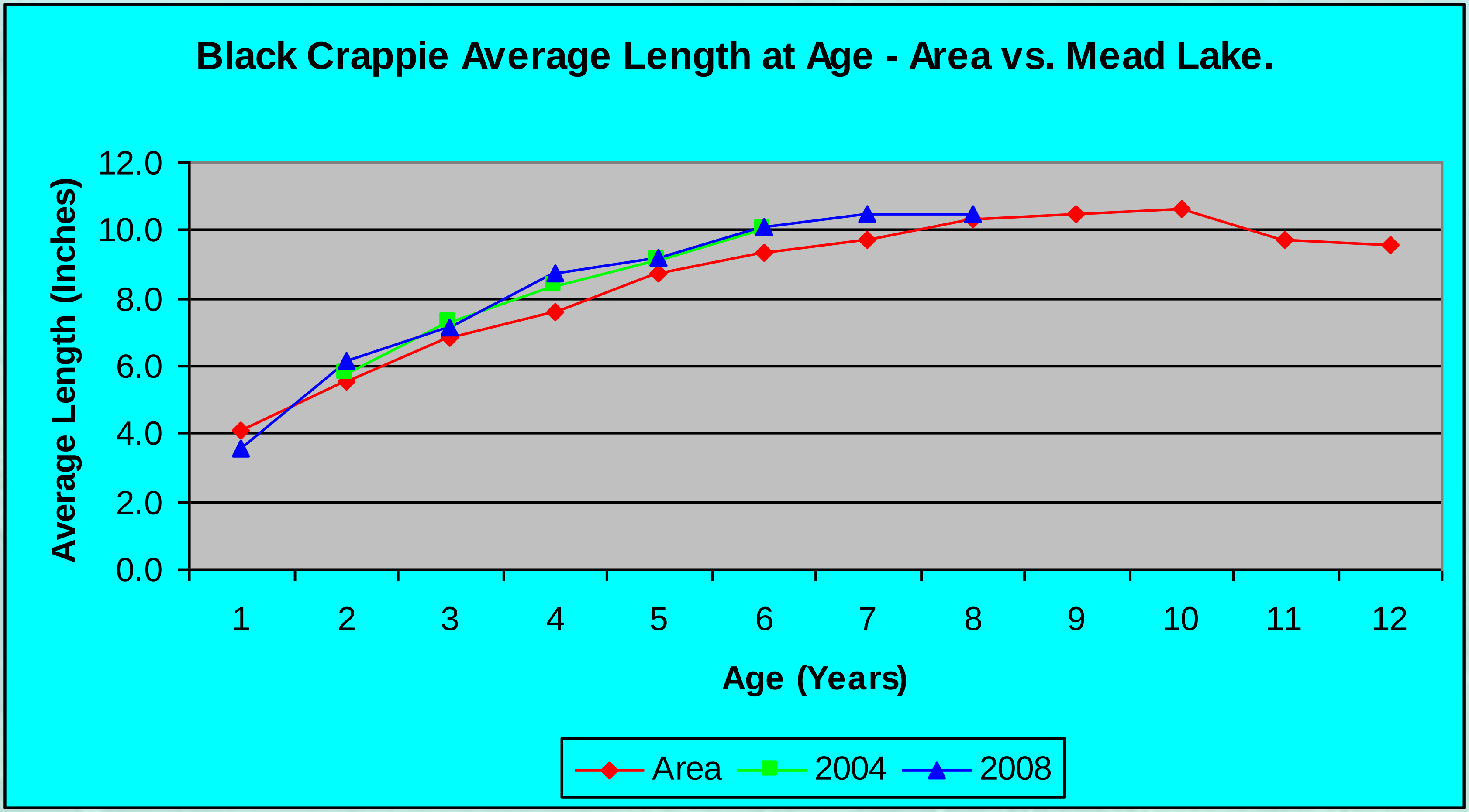


Black Crappie Length Frequency - Fyke Nets, Mead Lake, Spring 1985 & 1987.
Number Captured
Length (Inches)
1985
1987



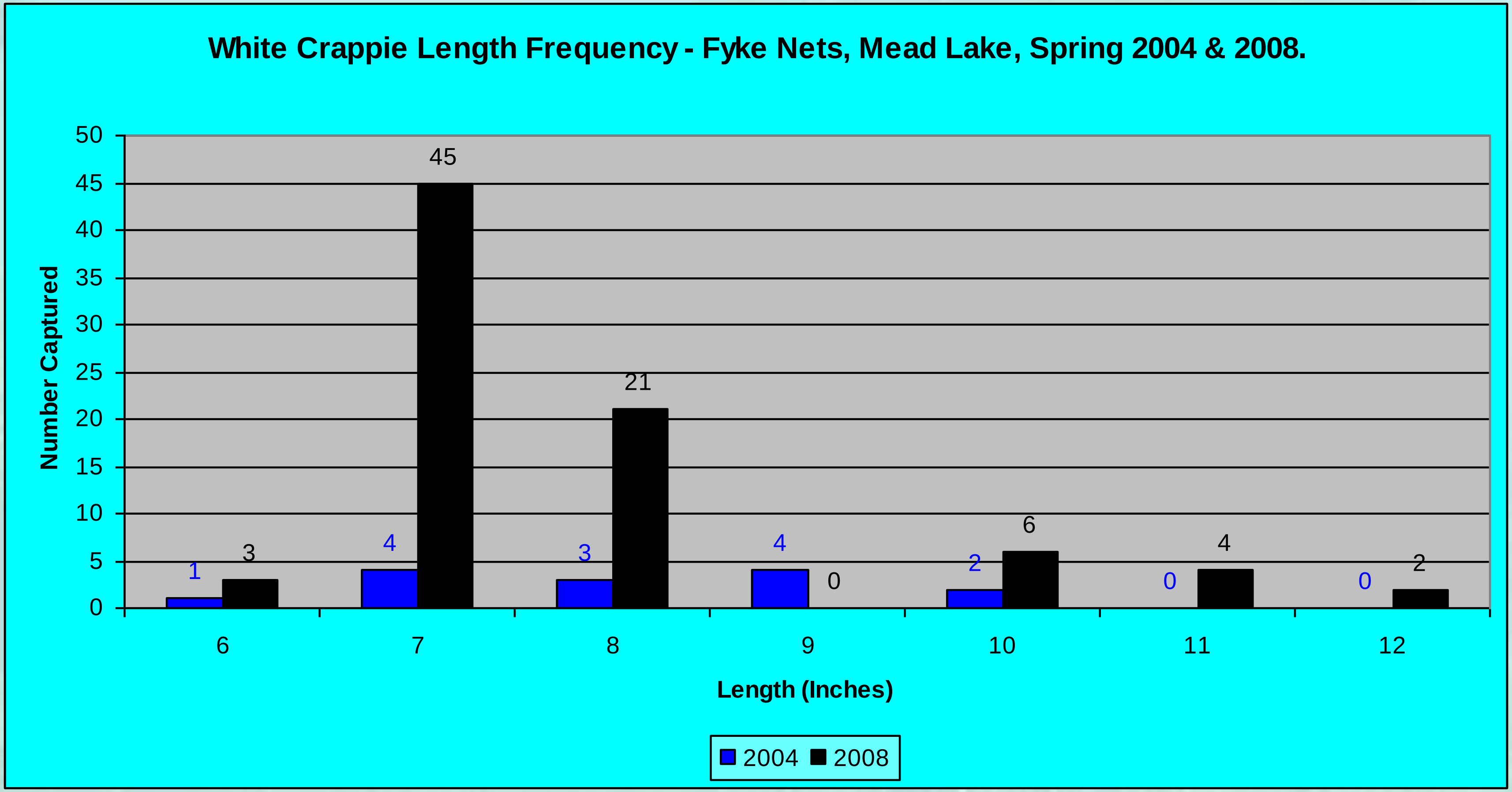
Black Crappie Length Frequency - Fyke Nets, Mead Lake, Spring 1995 & 1996.
Number Captured
Length (Inches)
1995
1996

Crappies



Black Crappie Average Length at Age - Area vs. Mead Lake.
Average Length (Inches)
12.0
10.0
8.0
6.0
4.0
2.0
0.0
1
2
3
4
5
6
7
8
9
10
11
12
Age (Years)
Area
2004
2008

Crappies



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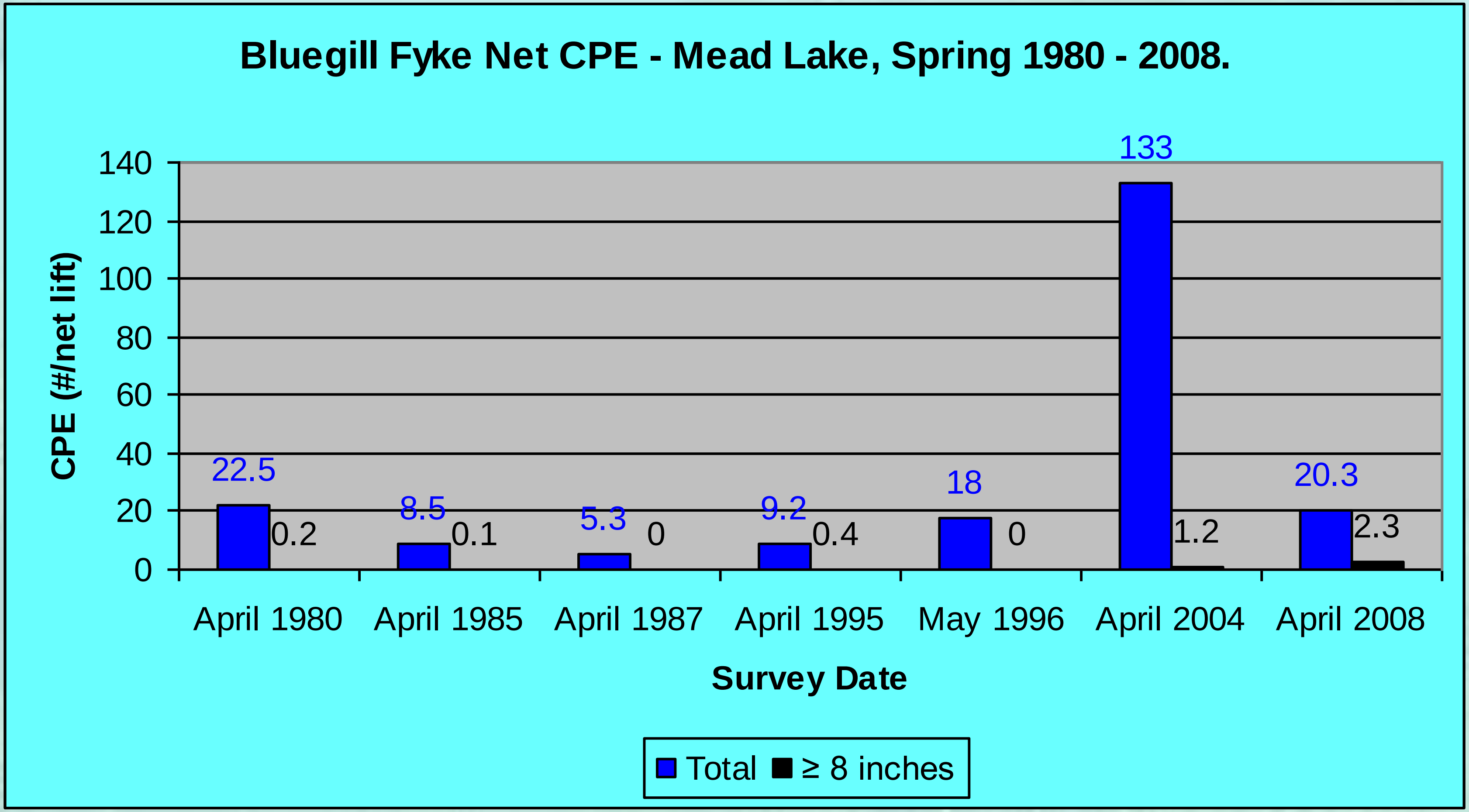
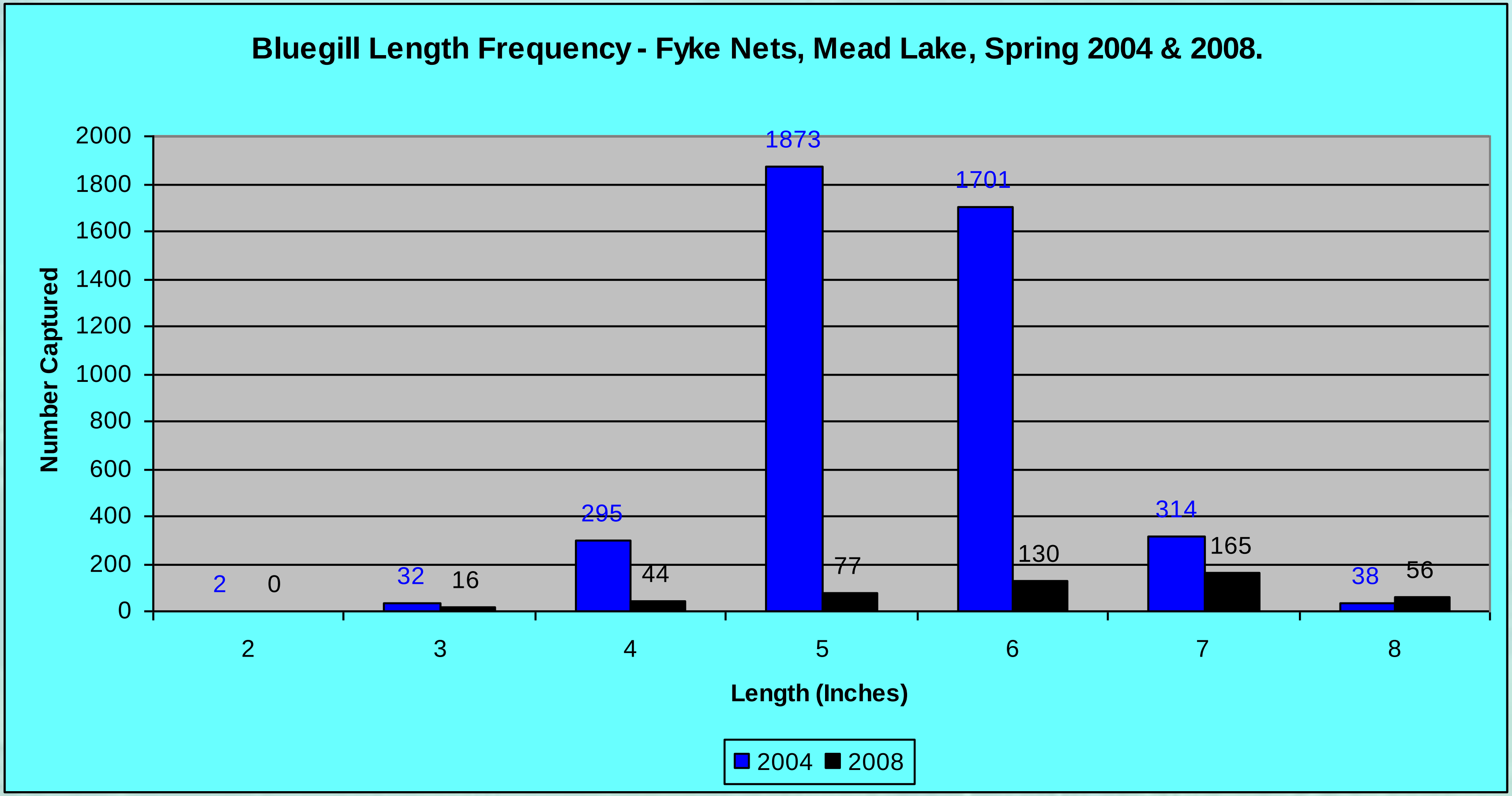
Bluegills



Bluegill Fyke Net CPE - Mead Lake, Spring 1980 - 2008.
CPE (#/net lift)
140
120
100
80
60
40
20
0
133
22.5
8.5
5.3
9.2
18
20.3
0.2
0.1
0
0.4
0
1.2
2.3
April 1980
April 1985
April 1987
April 1995
May 1996
April 2004
April 2008
Survey Date
Total
≥ 8 inches

Bluegills



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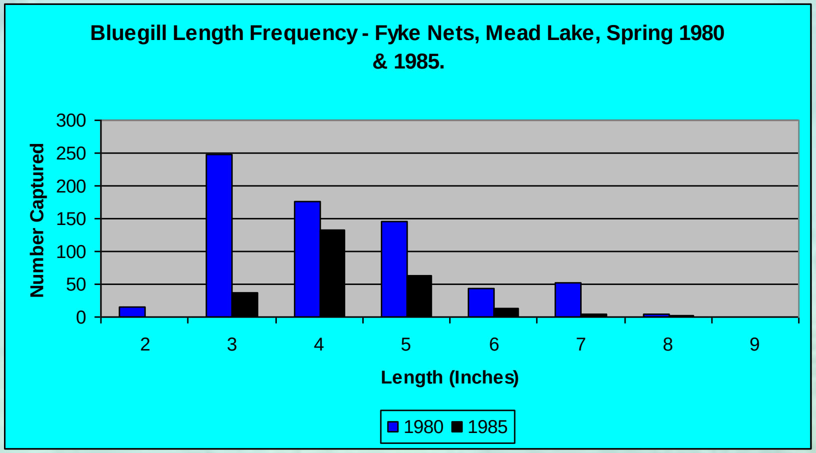
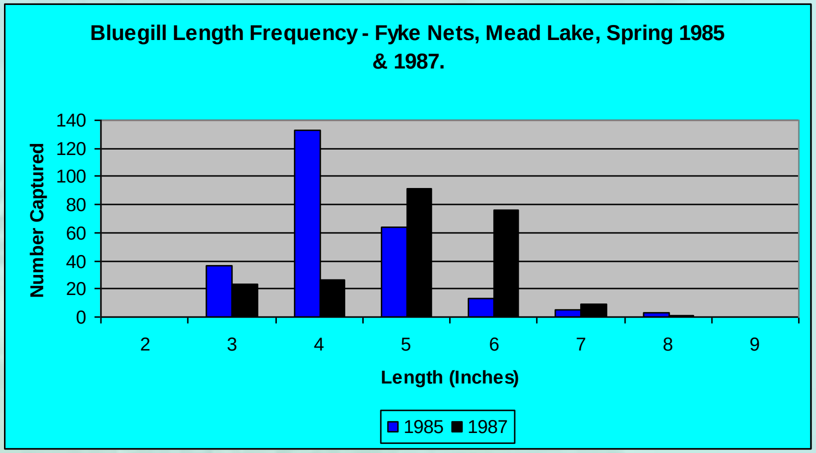
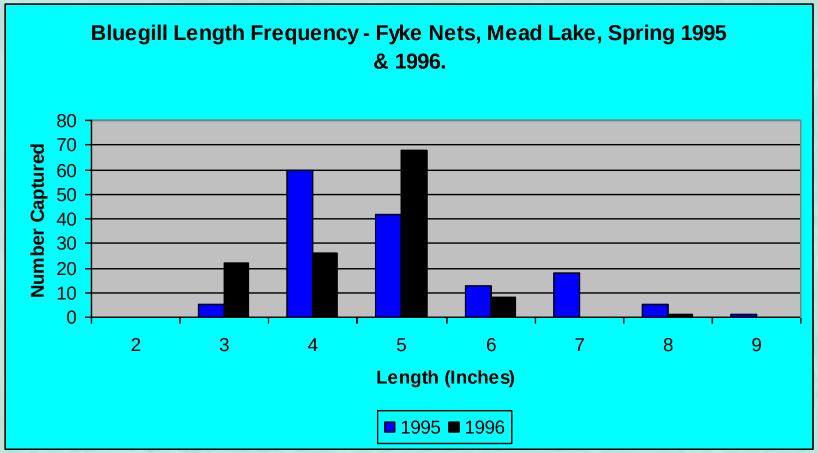
Bluegills



Bluegill Length Frequency - Fyke Nets, Mead Lake, Spring 1980 & 1985.
Number Captured
300
250
200
150
100
50
0
2
3
4
5
6
7
8
9
Length (Inches)
1980
1985

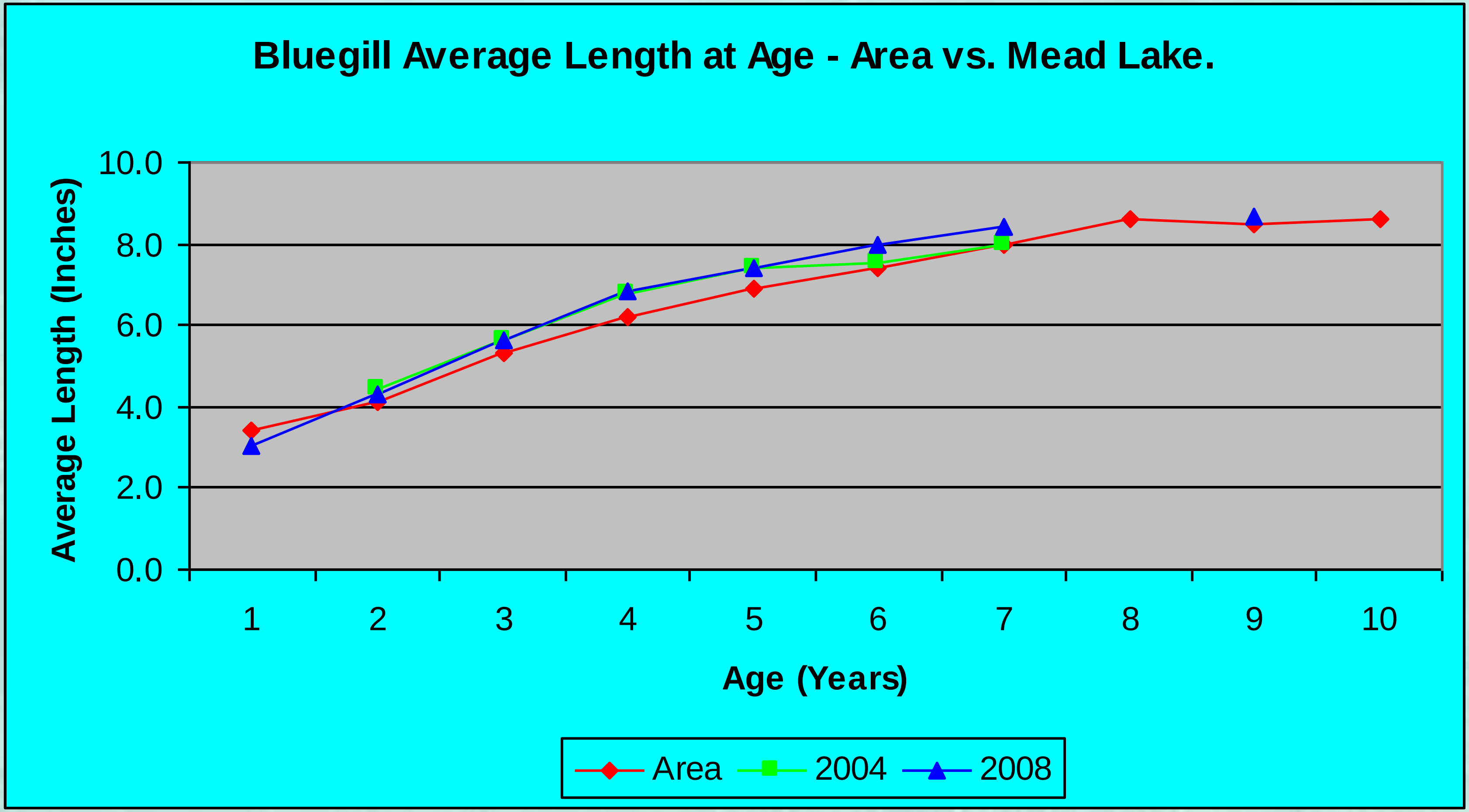


Bluegill Length Frequency - Fyke Nets, Mead Lake, Spring 1985 & 1987.
Number Captured
140
120
100
80
60
40
20
0
2
3
4
5
6
7
8
9
Length (Inches)
1985
1987

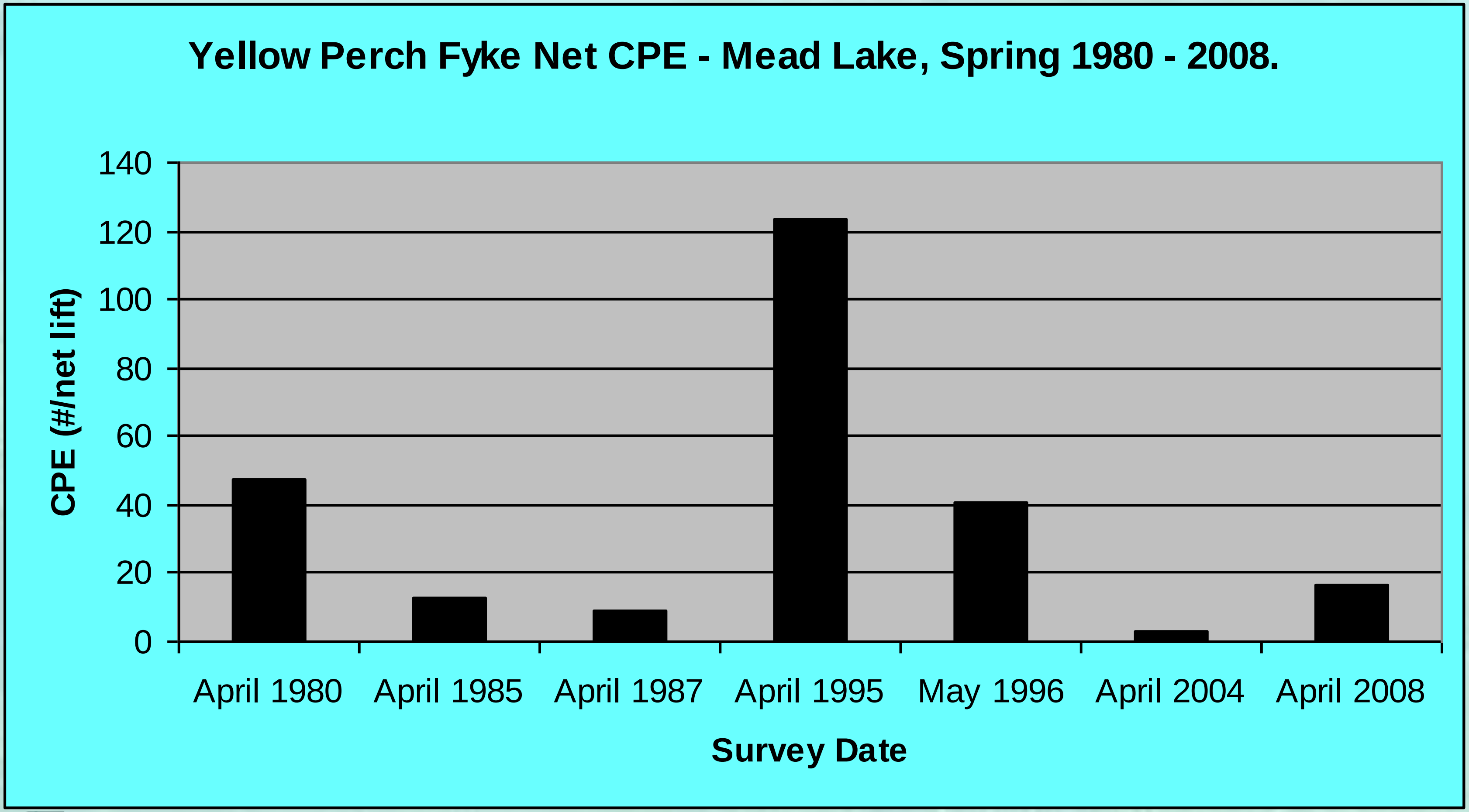


Bluegill Length Frequency - Fyke Nets, Mead Lake, Spring 1995 & 1996.
Number Captured
80
70
60
50
40
30
20
10
0
2
3
4
5
6
7
8
9
Length (Inches)
1995
1996

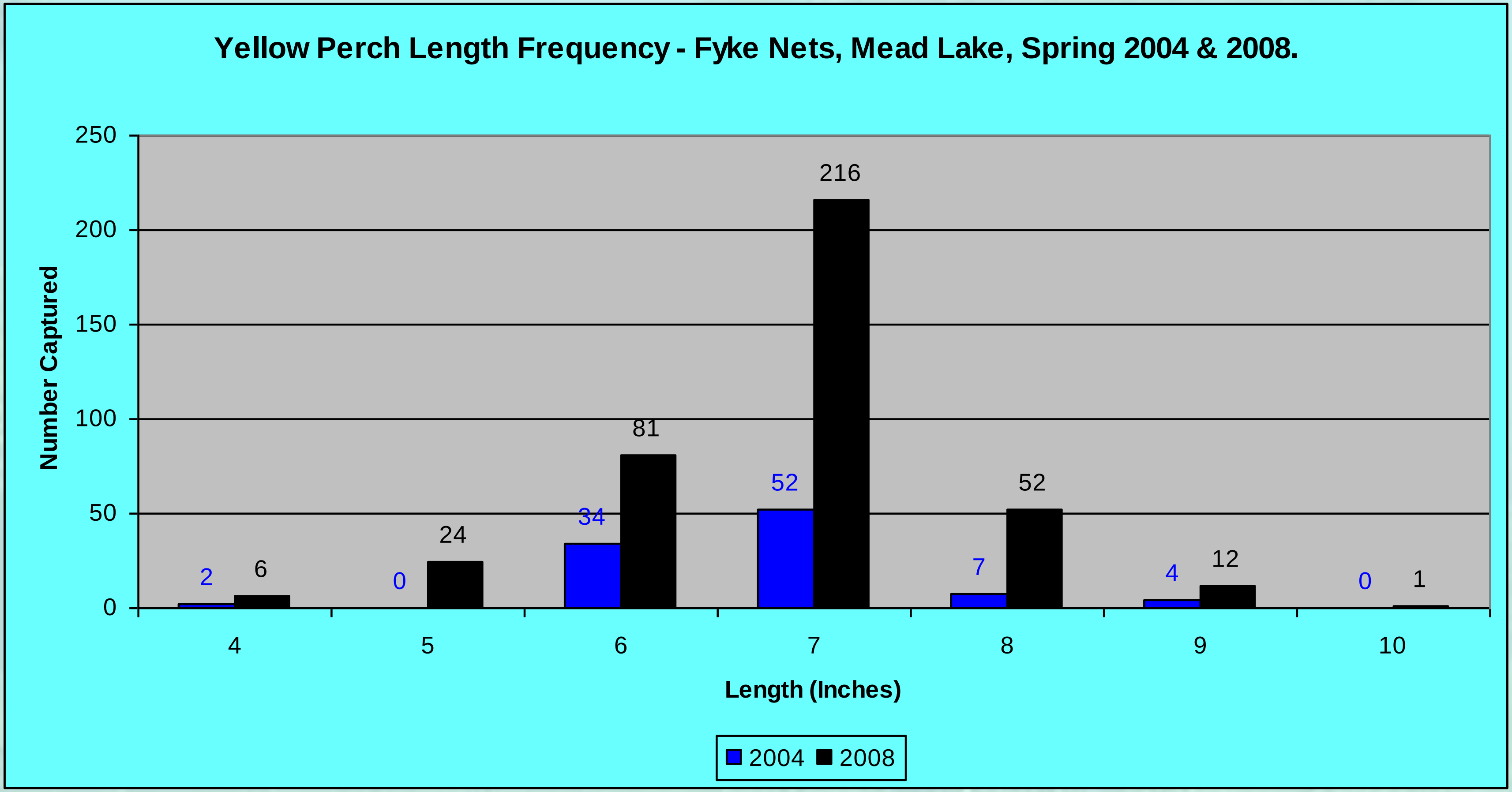
Bluegills


Bluegill Average Length at Age - Area vs. Mead Lake.
Average Length (Inches)
10.0
8.0
6.0
4.0
2.0
0.0
1
2
3
4
5
6
7
8
9
10
Age (Years)
Area
2004
2008

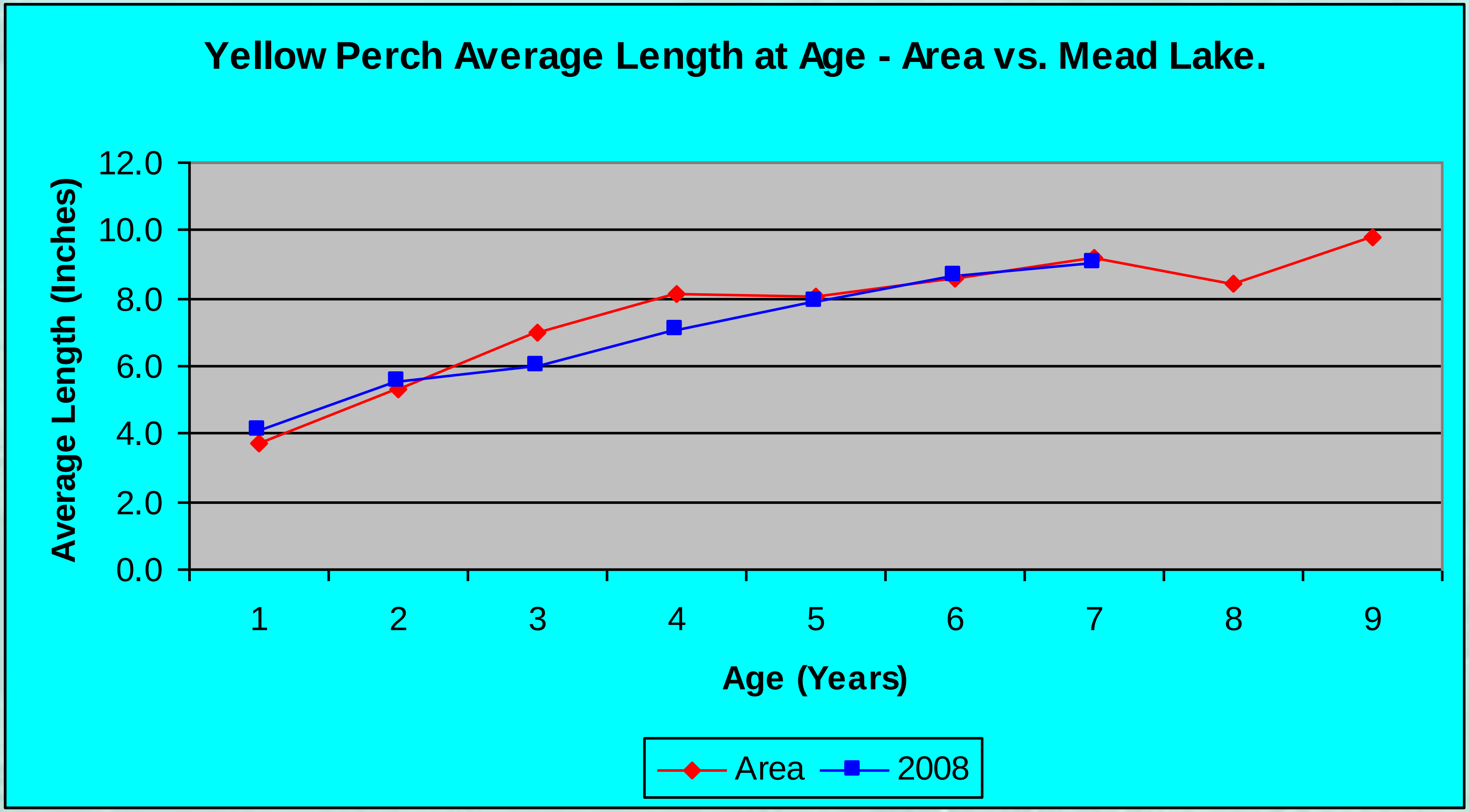
Perch


Yellow Perch Fyke Net CPE - Mead Lake, Spring 1980 - 2008.
140
120
100
80
60
40
20
0
CPE (#/net lift)
April 1980
April 1985
April 1987
April 1995
May 1996
April 2004
April 2008
Survey Date

Perch

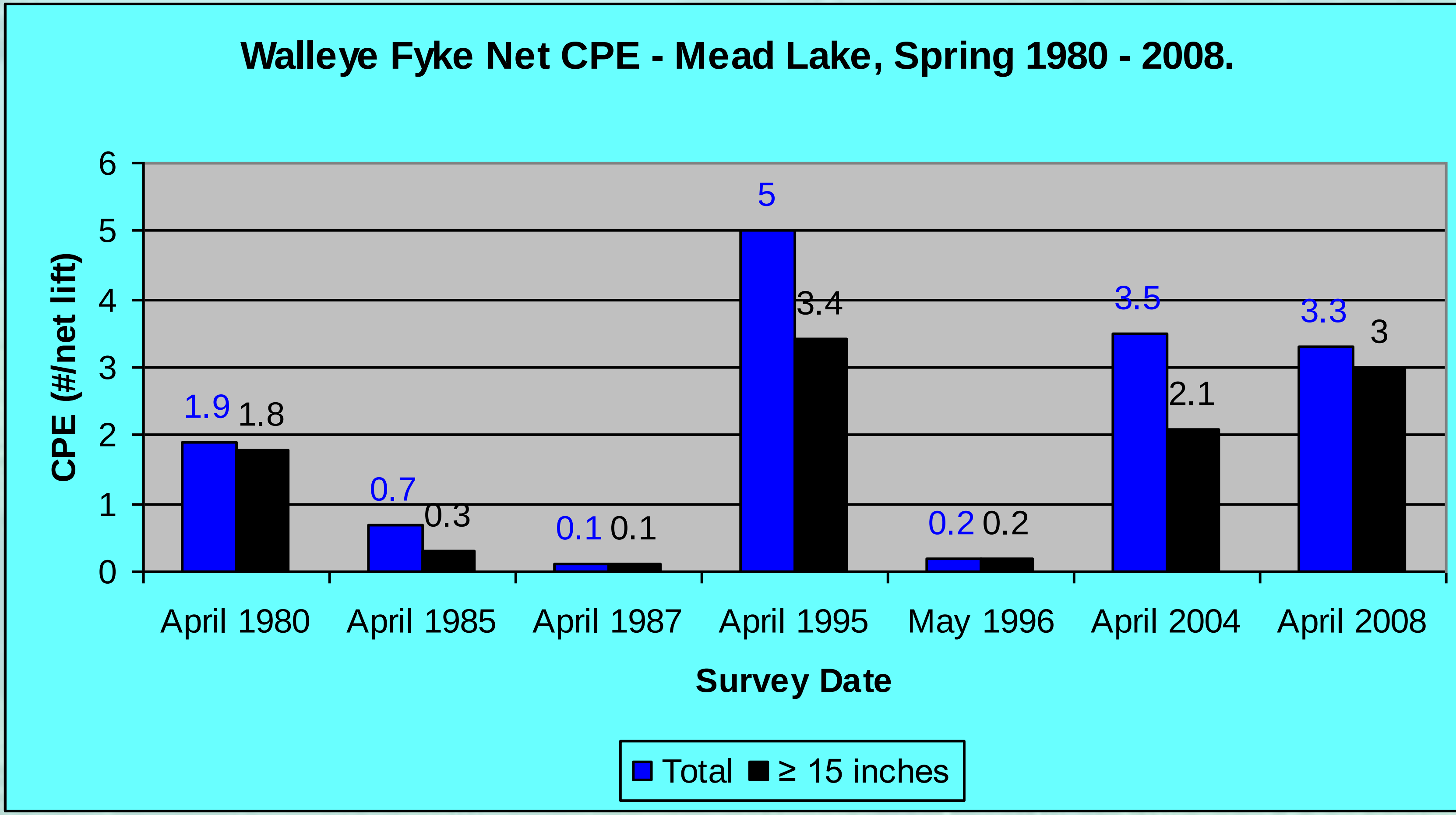

Yellow Perch Length Frequency - Fyke Nets, Mead Lake, Spring 2004 & 2008.
Number Captured
0
50
100
150
200
250
Length (Inches)
4
5
6
7
8
9
10
2
6
0
24
34
81
52
216
7
52
4
12
0
1
2004
2008

Perch

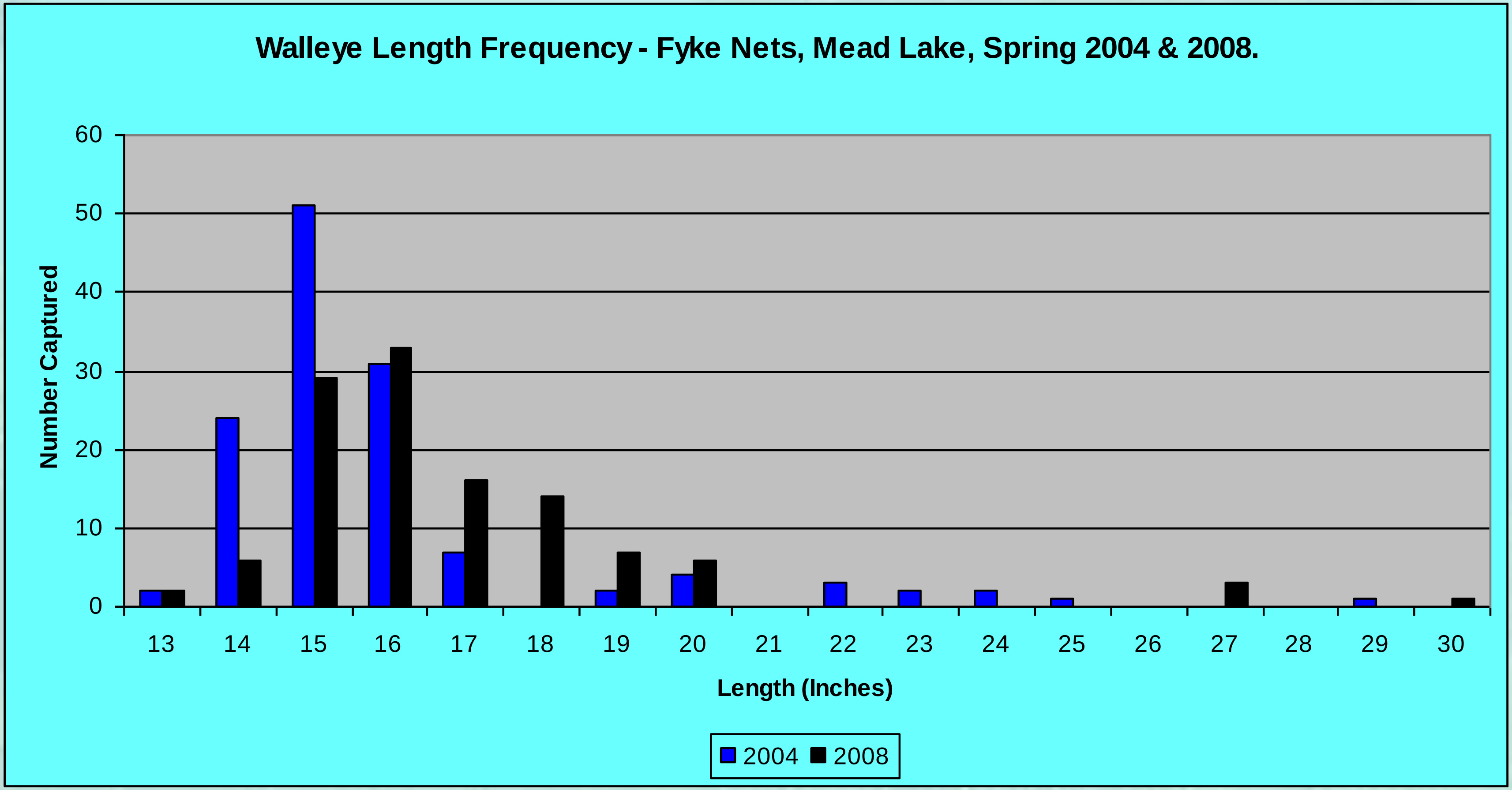


Yellow Perch Average Length at Age - Area vs. Mead Lake.
Average Length (Inches)
12.0
10.0
8.0
6.0
4.0
2.0
0.0
1
2
3
4
5
6
7
8
9
Age (Years)
Area
2008

Walleye

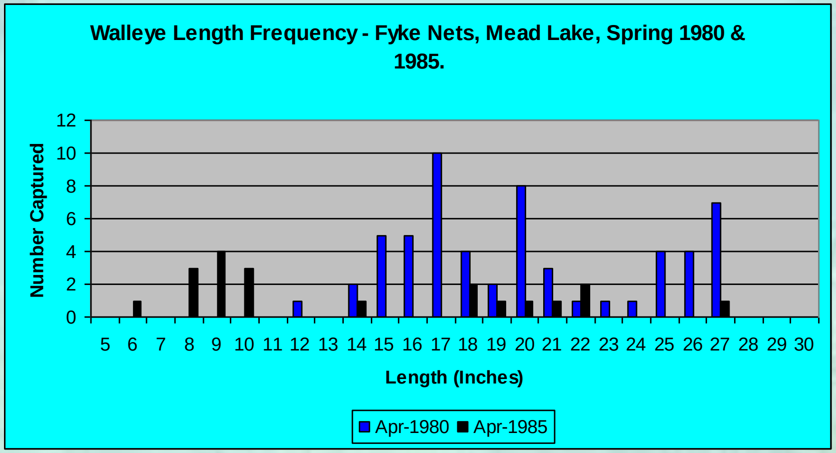

Walleye Fyke Net CPE - Mead Lake, Spring 1980 - 2008.
CPE (#/net lift)
6
5
4
3
2
1
0
1.9 1.8
0.7 0.3
0.1 0.1
5 3.4
0.2 0.2
3.5 2.1
3.3 3
April 1980
April 1985
April 1987
April 1995
May 1996
April 2004
April 2008
Survey Date
Total
≥ 15 inches

Walleye

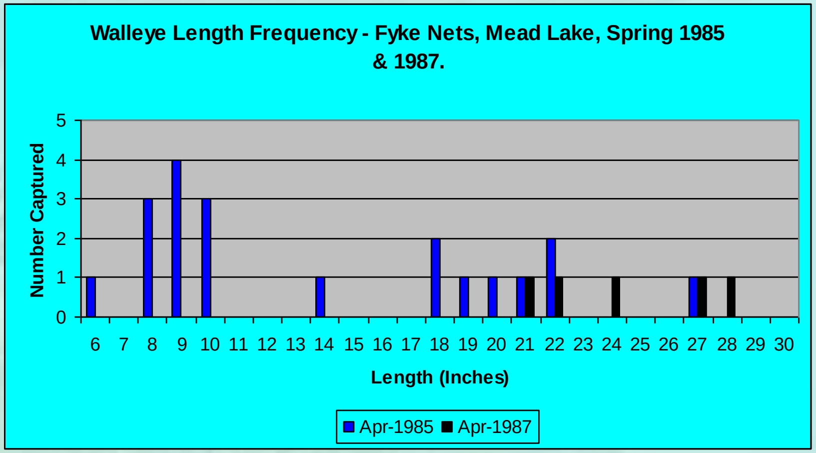


Walleye Length Frequency - Fyke Nets, Mead Lake, Spring 2004 & 2008.
Number Captured
0
10
20
30
40
50
60
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
Length (Inches)
2004
2008

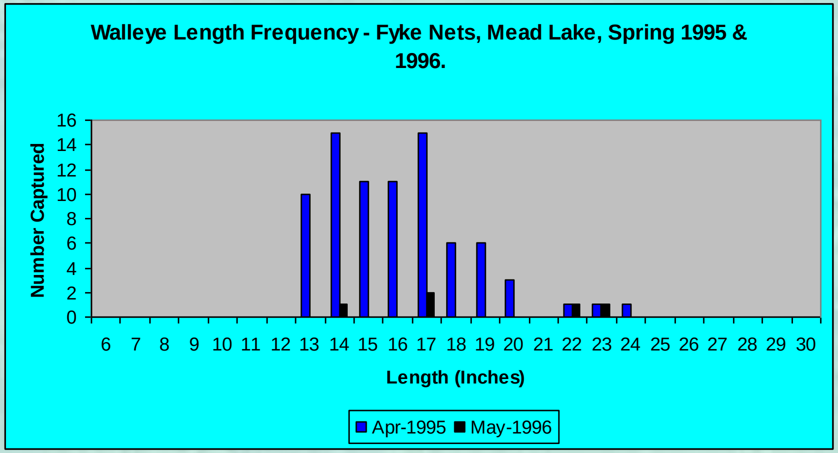
Walleye



Walleye Length Frequency - Fyke Nets, Mead Lake, Spring 1980 & 1985.
Number Captured
Length (Inches)
Apr-1980
Apr-1985

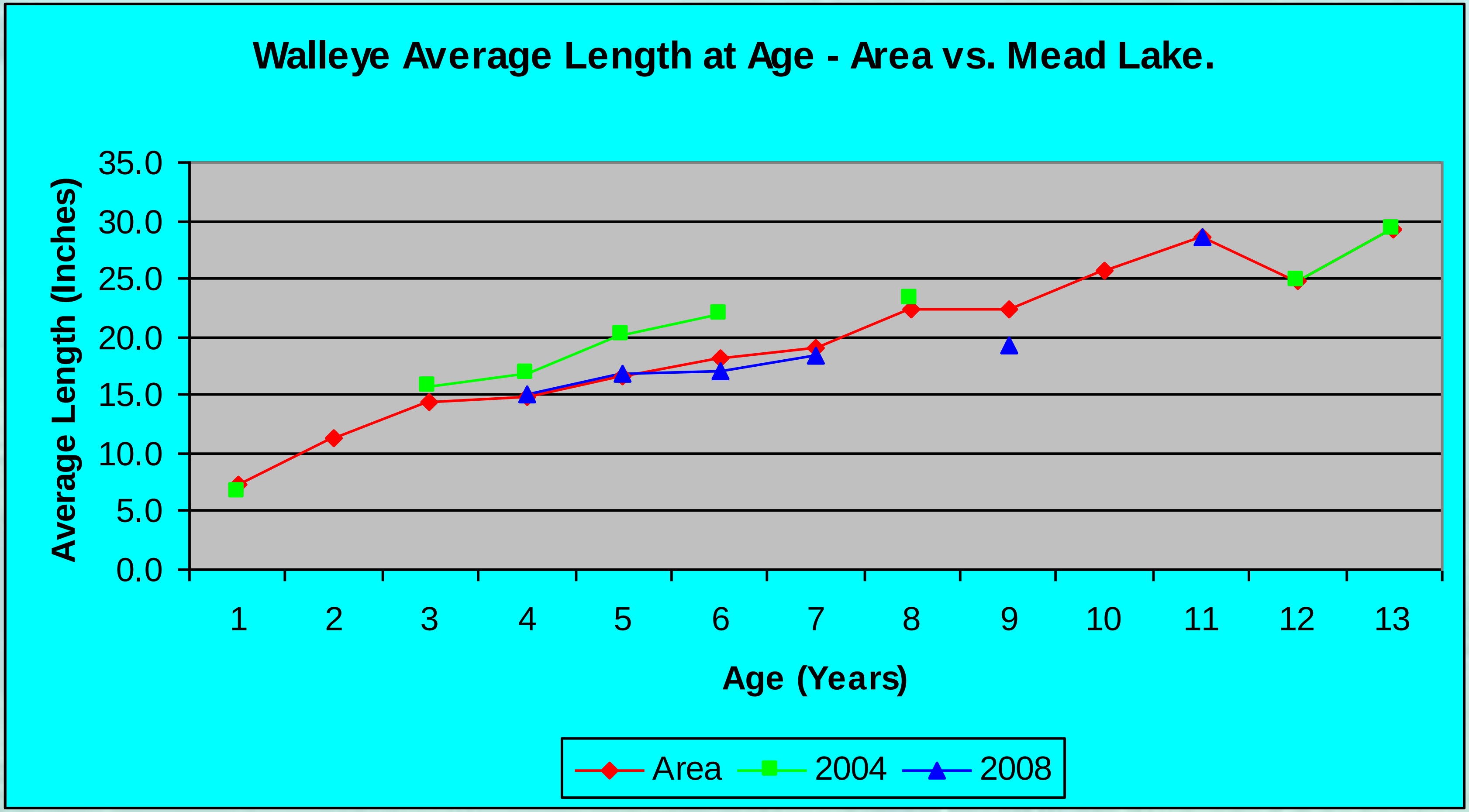


Walleye Length Frequency - Fyke Nets, Mead Lake, Spring 1985 & 1987.
Number Captured
Length (Inches)
Apr-1985
Apr-1987

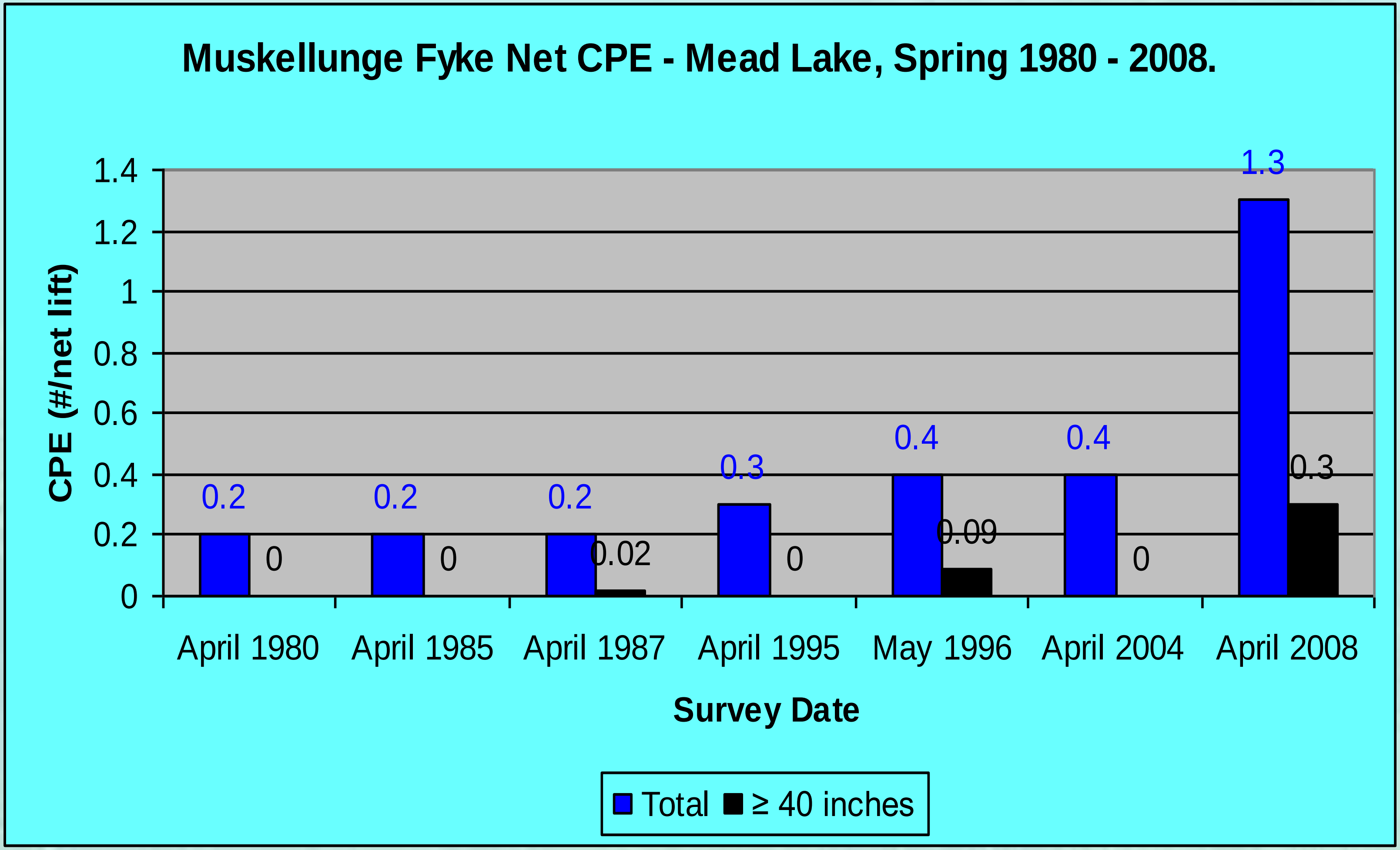


Walleye Length Frequency - Fyke Nets, Mead Lake, Spring 1995 & 1996.
Number Captured
Length (Inches)
Apr-1995
May-1996

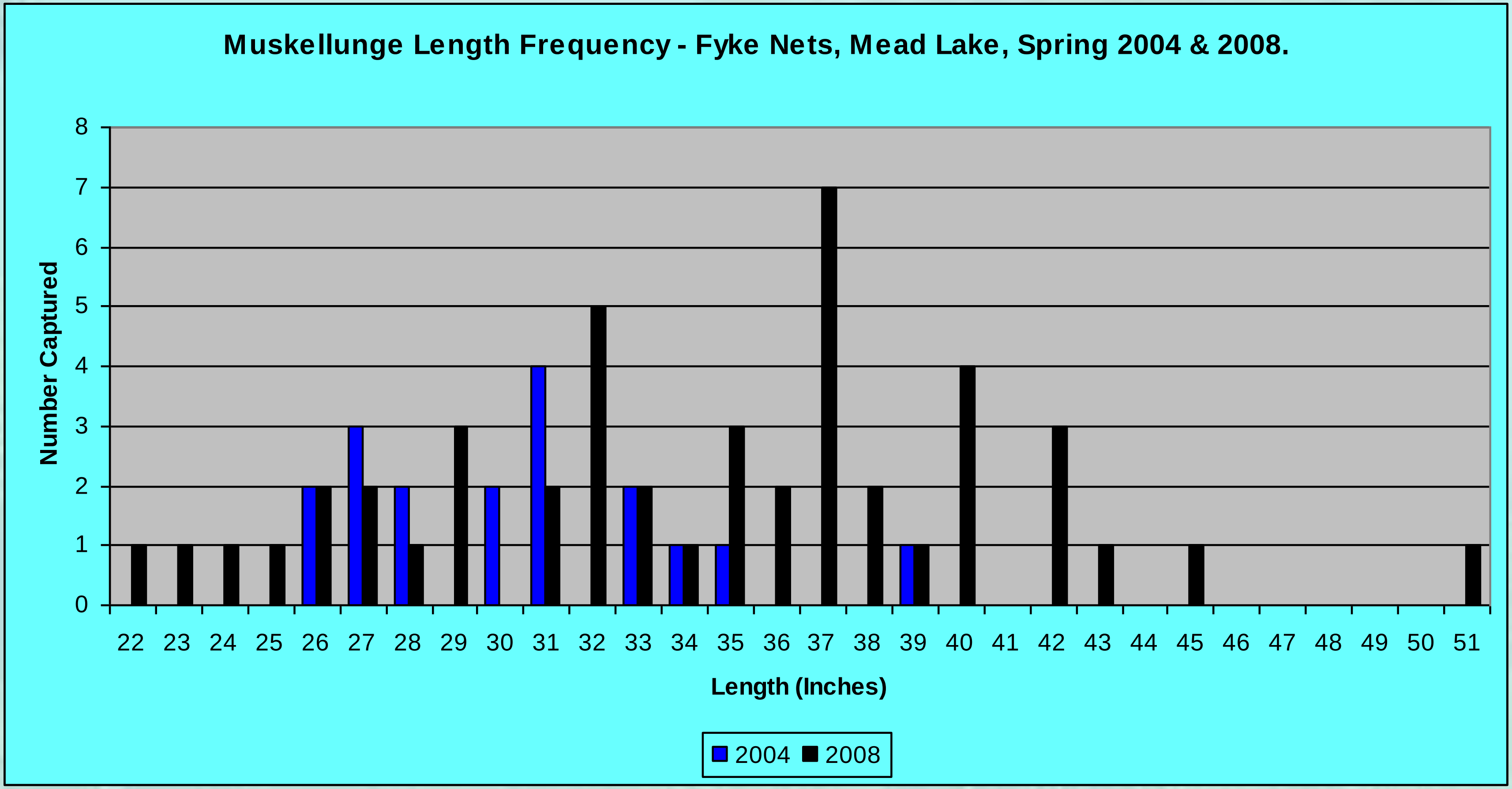
Walleye


Walleye Average Length at Age - Area vs. Mead Lake.
Average Length (Inches)
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
1
2
3
4
5
6
7
8
9
10
11
12
13
Age (Years)
Area
2004
2008

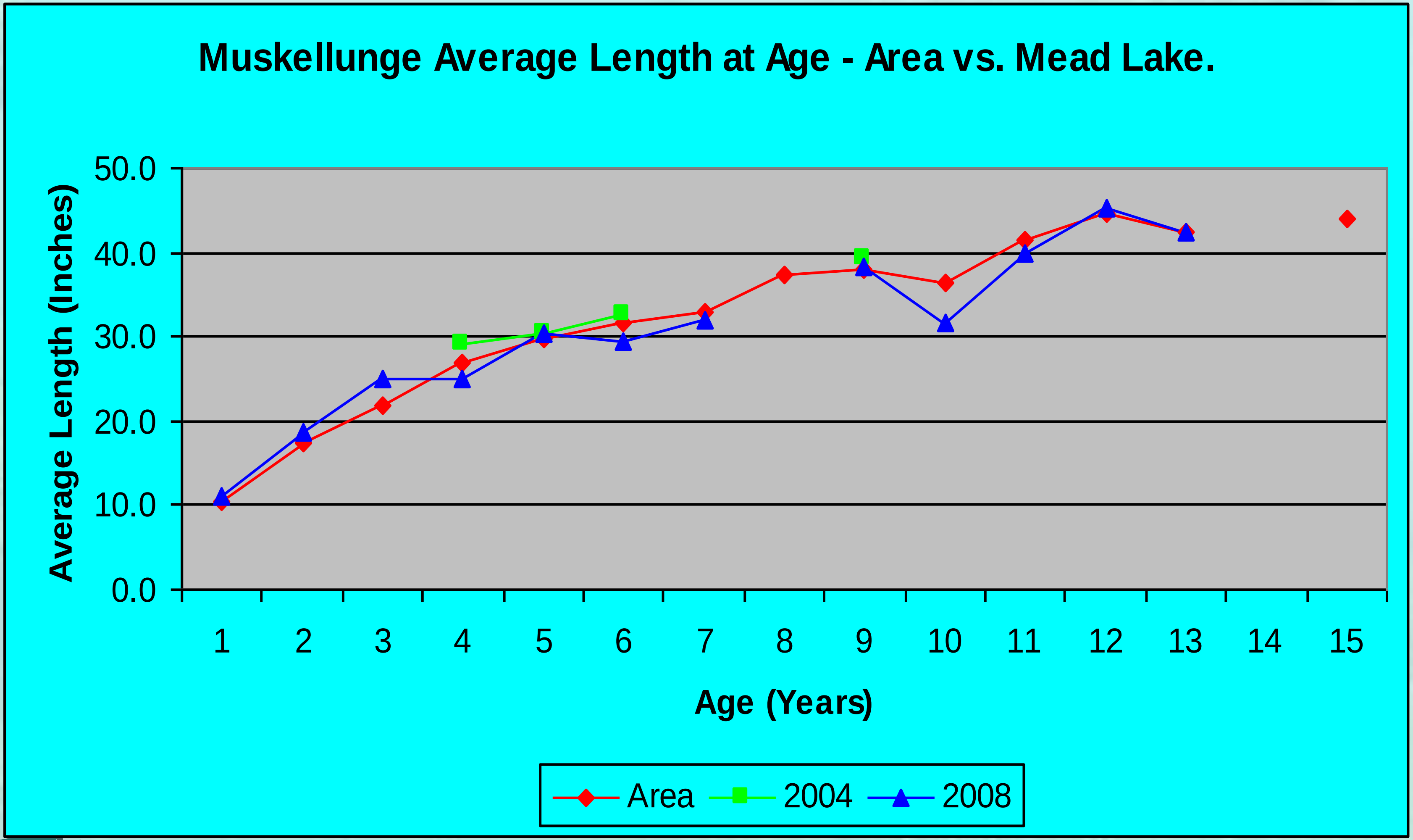
Muskellunge



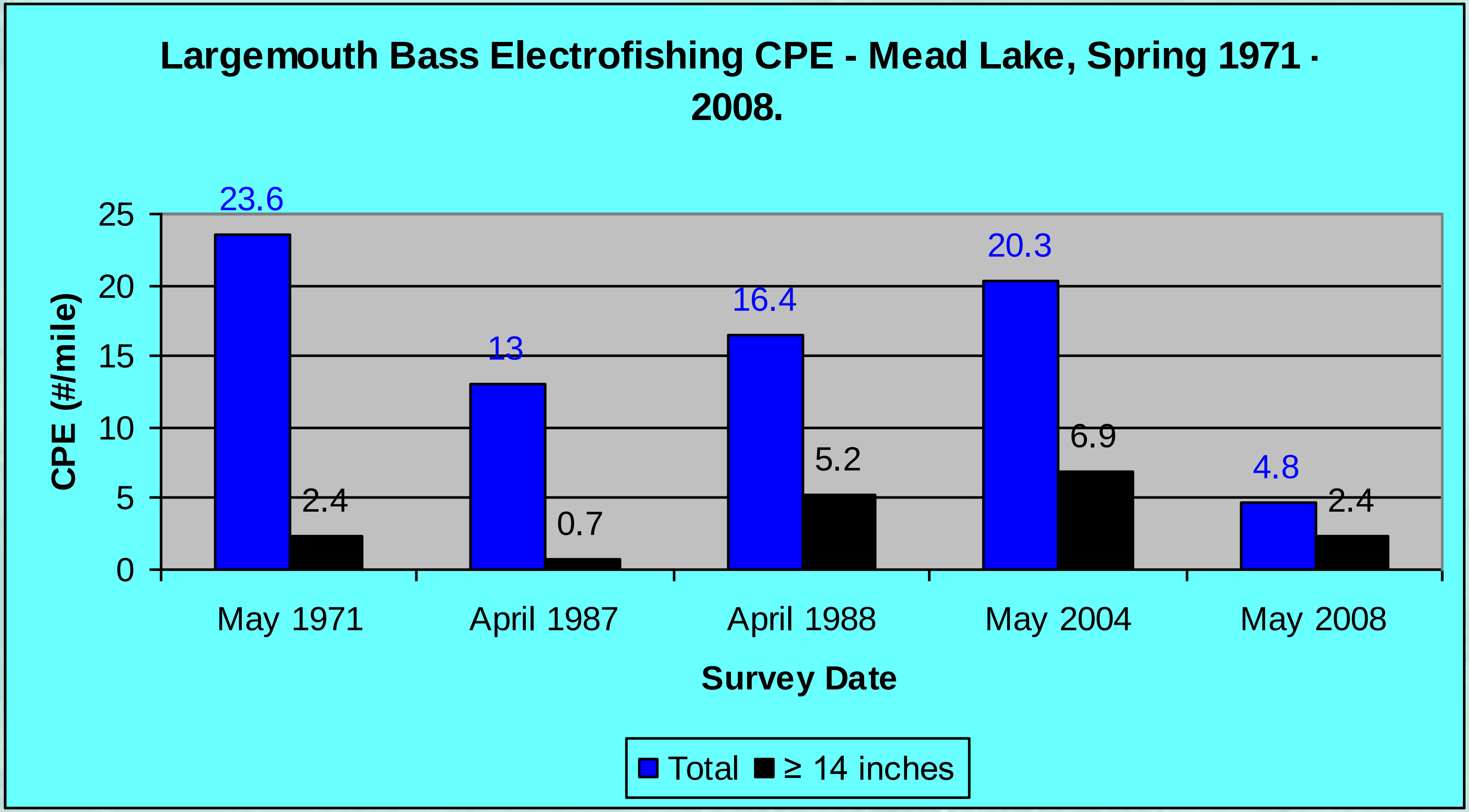
Muskellunge



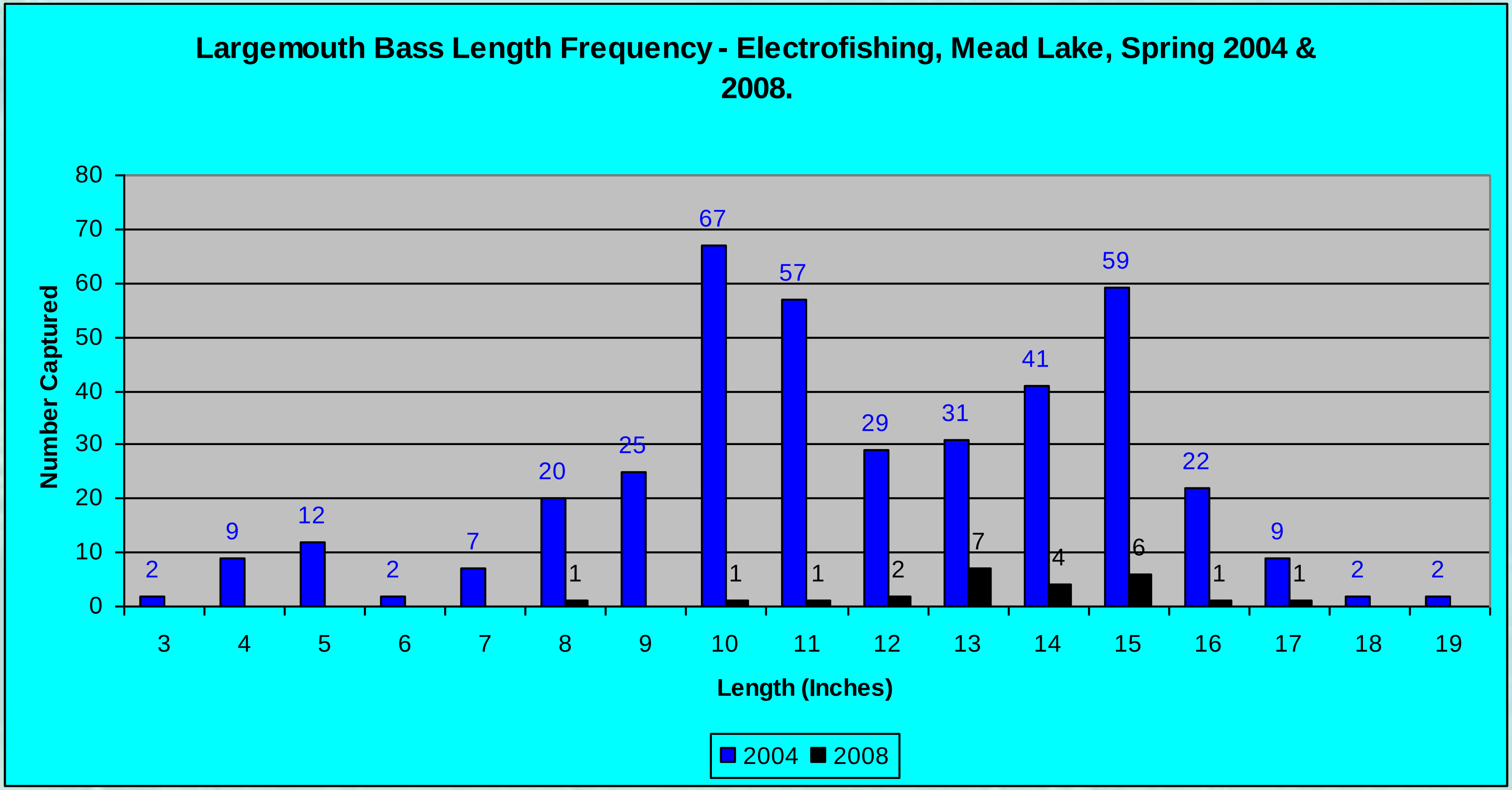
Muskellunge



Largemouth Bass



Largemouth Bass



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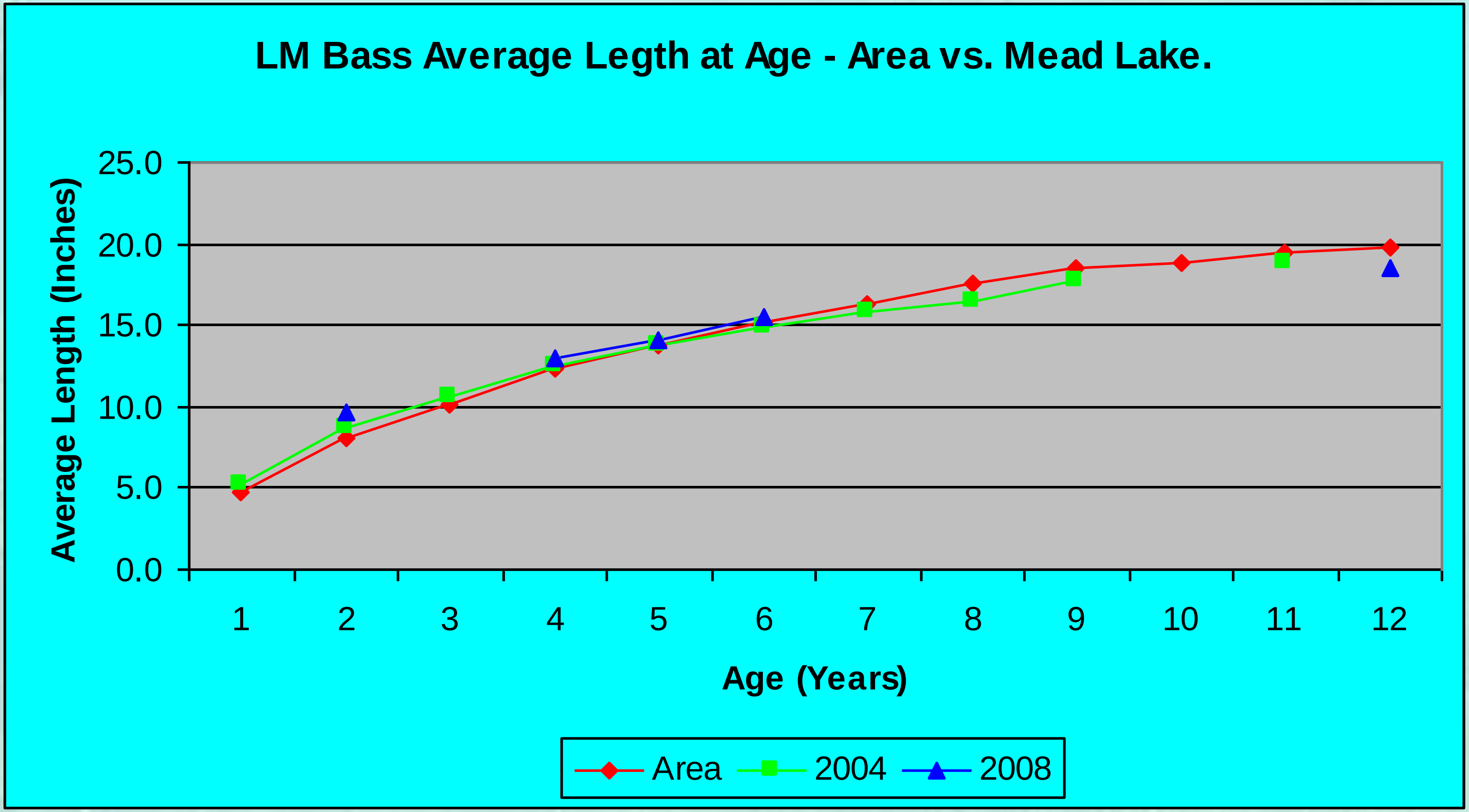
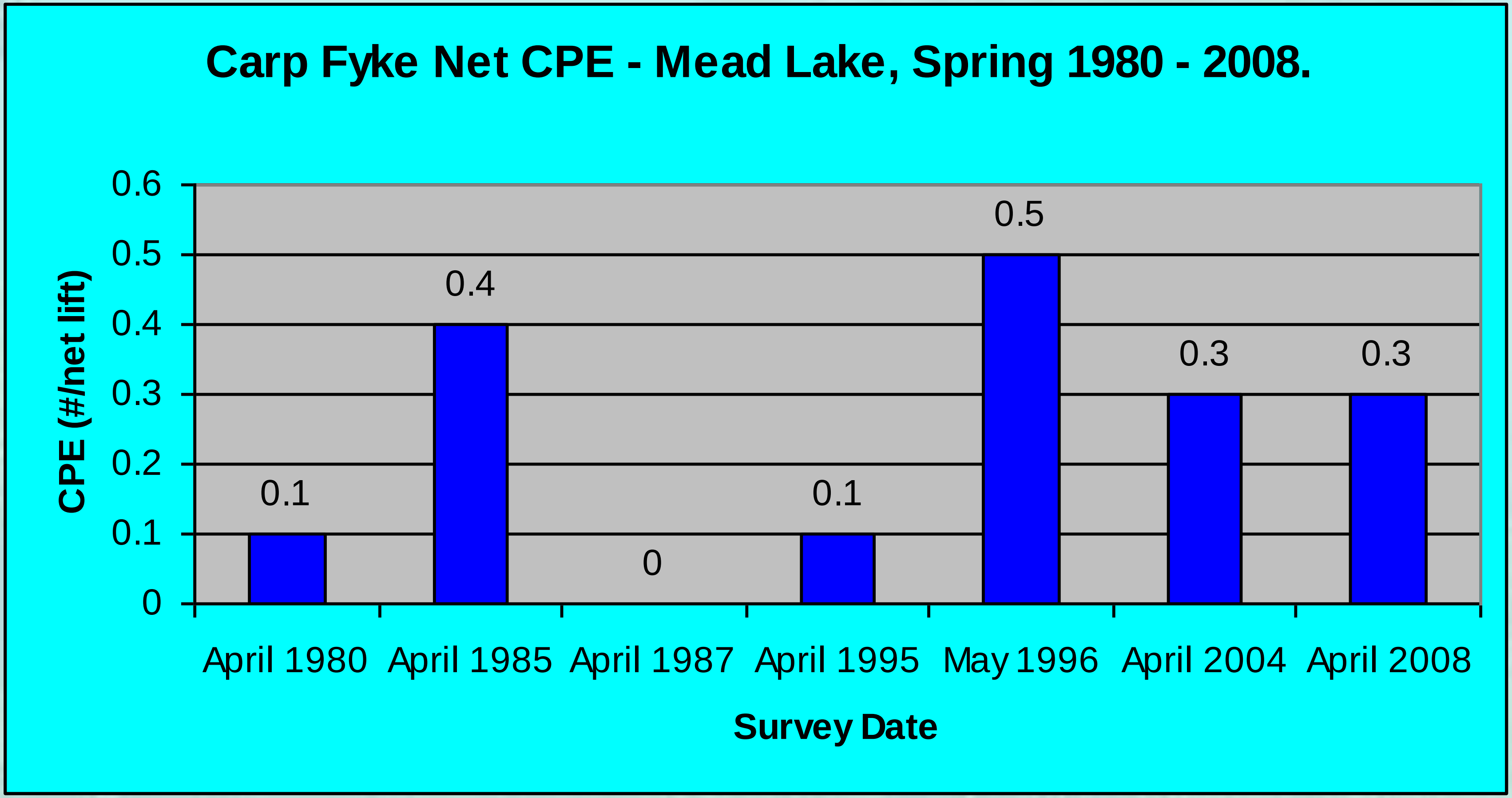
WISCONSIN DEPT. OF NATURAL RESOURCES

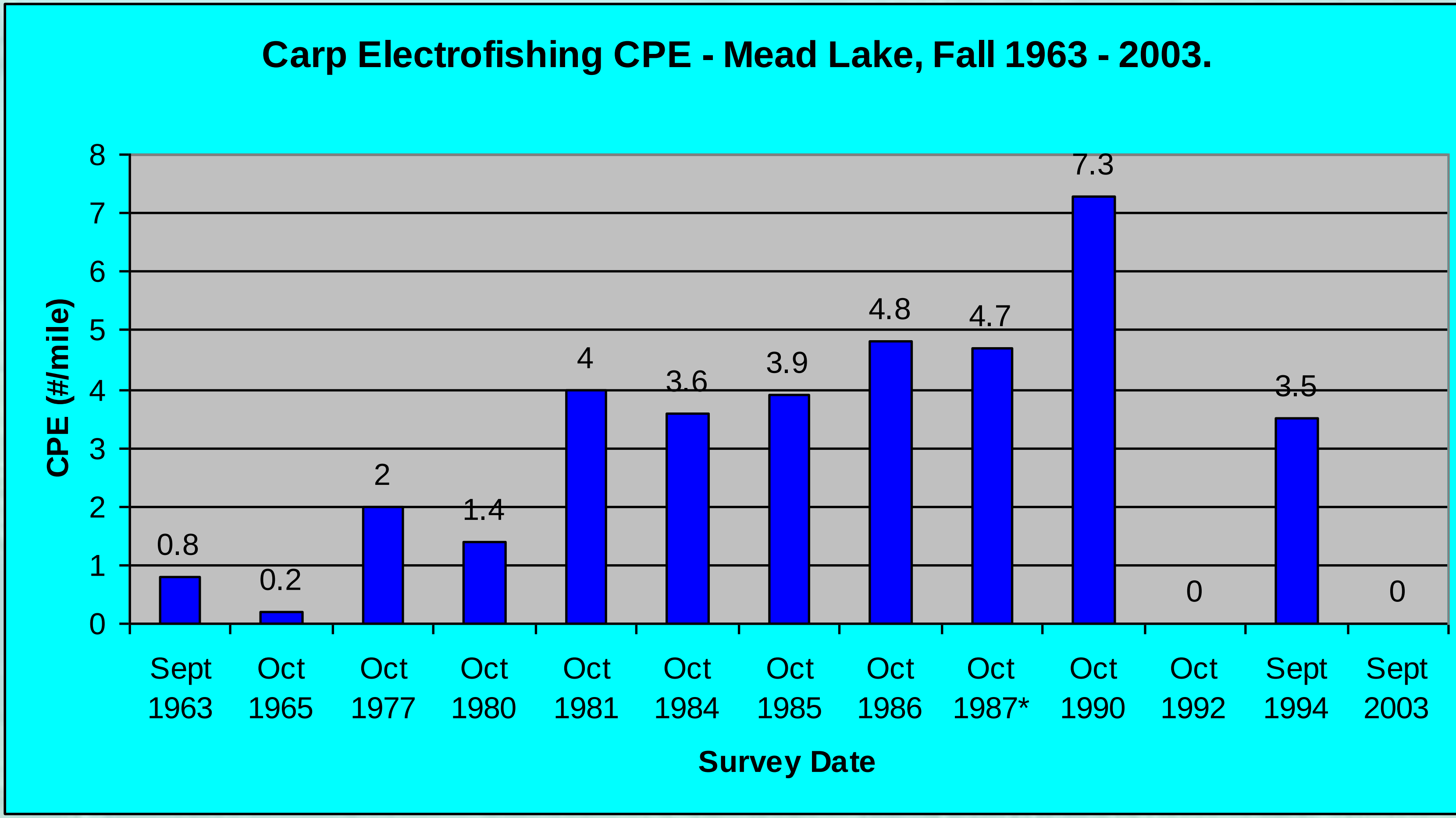
Largemouth Bass



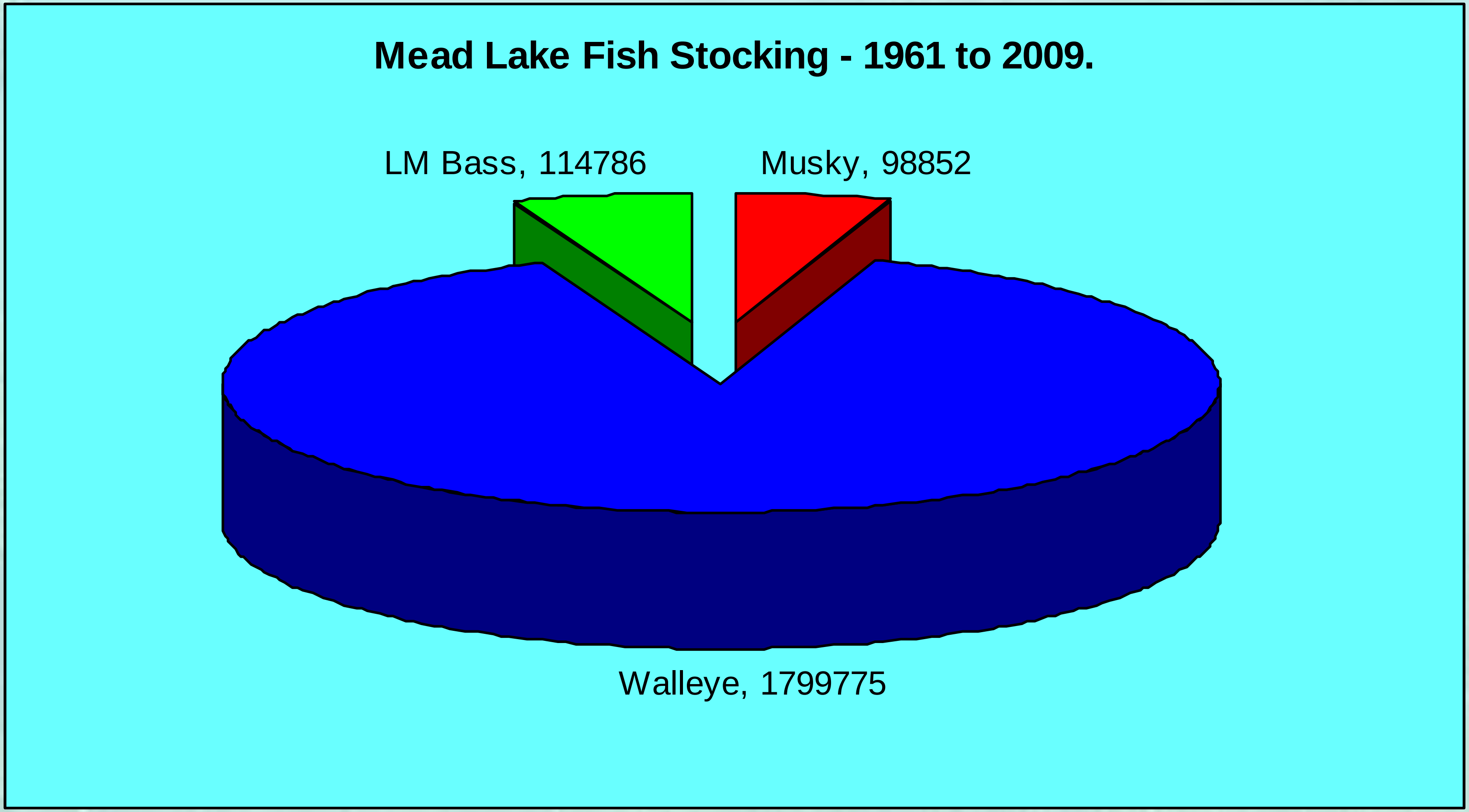
Carp


Carp Fyke Net CPE - Mead Lake, Spring 1980 - 2008.
CPE (#/net lift)
0.6
0.5
0.4
0.3
0.2
0.1
0
0.1
0.4
0
0.1
0.5
0.3
0.3
April 1980
April 1985
April 1987
April 1995
May 1996
April 2004
April 2008
Survey Date

Carp


Carp Electrofishing CPE - Mead Lake, Fall 1963 - 2003.
CPE (#/mile)
0
1
2
3
4
5
6
7
8
0.8
0.2
2
1.4
4
3.6
3.9
4.8
4.7
7.3
0
3.5
0
Sept 1963
Oct 1965
Oct 1977
Oct 1980
Oct 1981
Oct 1984
Oct 1985
Oct 1986
Oct 1987*
Oct 1990
Oct 1992
Sept 1994
Sept 2003
Survey Date

Stocking



FISHERIES MANAGEMENT................................ we make fishing better

WISCONSIN DEPT. OF NATURAL RESOURCES

Summary

- Crappies – better size structure, plenty
- Bluegills – better size structure, low density than previous years
- Perch – higher density, size poor
- Walleyes – typical density, annual stocking
- Musky – nice sizes, alt. year stocking
- Bass – possible problem, check recruitment
- Carp – low density, not a problem
- Overall – GO FISHING!!! – and take a kid.

Management

- Surveys – every 4 years (next 2012)
- Current regulations – OK
- Check on LM Bass recruitment
- Later net surveys (panfish)
- Maintain WAE and MSK stocking
- Winter DO monitoring
- New Panfish Statewide Committee

Questions???

The Aquatic Plant Community

of

Mead Lake

Clark County, Wisconsin

1997

submitted by

Deborah Konkel

March 1998

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The Aquatic Plant Community in Mead Lake

I. INTRODUCTION

A study of the aquatic macrophytes (plants) in Mead Lake was conducted during July and August 1997 by Water Resources staff of the West Central Region - Department of Natural Resources (DNR). This was the first quantitative vegetation study of Mead Lake by the DNR. Qualitative assessments of vegetation have been made in the past by DNR personnel for the purpose of plant management recommendations.

A study of the diversity, density, and distribution of aquatic plants is an essential component of understanding a lake due to the important ecological role of aquatic vegetation and the ability of the vegetation to characterize the water quality (Dennison et al. 1993).

Ecological Role: All other life in the lake depends on the plant life (including algae) - the beginning of the food chain. Aquatic plants provide food and shelter for fish, wildlife, and the invertebrates that in turn provide food for other organisms. Plants improve water quality, protect shorelines and lake bottoms, add to the aesthetic quality of the lake, impact recreation, and serve as indicators of water quality.

Characterize Water Quality: Aquatic plants serve as indicators of water quality because of their sensitivity to water quality parameters, such as water clarity and nutrient levels (Dennison et. al. 1993).

The present study will provide information that is important for effective management of the lake including fish habitat improvement, protection of sensitive wildlife areas, aquatic plant management, and water resource regulations. The baseline data that it provides will be compared to future plant inventories and offer insight into any changes occurring in the lake.

Background and History: Mead Lake is a 320-acre impoundment on the South Fork of the Eau Claire River in Clark County, Wisconsin. The Mead Lake watershed had been selected as a Priority Watershed, until all new projects were terminated that year. The maximum depth of Mead Lake is 16 feet (Figure 1).

Mead Lake is the second largest of the six lakes in Clark County, so it is an important recreational resource in the local area. There are two public boat landings and three separate units of county park along the lakeshore.

For several years there has been concern about the algae blooms, high bacterial counts and heavy sedimentation at the inlet. The watershed of Mead Lake includes approximately 64,000 acres. This gives a drainage area/lakes size ratio of 200:1. Lakes with drainage area/lake size ratios greater than 10:1 tend to have water quality problems (Field 1994).

The lake was created in 1951; in 1952 the lakeshore of Mead Lake was platted into 191 small lots. Presently, 129 lots have been developed, about 30 of these are permanent year-round homes. Only 32 of the lots have sanitary systems installed after 1980. Based on soil tests, the sanitary systems installed after 1980 were required to have holding tanks. The rest of the sanitary systems are older and may be of the conventional type, possibly on seasonally saturated soils or at the groundwater level. If this is the case, the sanitary systems could be failing and leaking into the lake. These systems could be a large contribution to the nutrient levels. As a Priority Watershed, farms in the watershed and lakefront property will be surveyed for nutrient contribution to the lake. Sanitary systems will be surveyed to determine which are failing.

Fish surveys in the past have raised concerns about declining largemouth bass and walleye numbers, slow growth rate of largemouth bass and panfish, and minimal walleye reproduction (Babros 1986). Reasons proposed for the declining fishery are fluctuating water levels and temperature in the spring and siltation on spawning beds. The lake is considered to be important for waterfowl habitat.

Control of aquatic plants have been attempted in the past. During the winter of 1971-72, the lake level was lowered two feet to control aquatic macrophytes by exposing the sediments and macrophyte reproductive structures to freezing temperatures. Chemical control of plants and algae was attempted during 1971-74 (Table 1).

Table 1. Chemical treatments for Aquatic Plants

	Copper Sulfate (lbs.)	Aquathol (lbs.)	Diquat (gal.)	Algimycin (gal.)
1971	200	40		
1972	50	50	1.5	3.5
1973	100			
1974	100			
Totals	450	90	1.5	3.5

This macrophyte survey will hopefully provide insight into the concerns that have been raised about Mead Lake and aid in formulating future management of the lake.

II.METHODS

Field Methods

The study design was based primarily on the rake-sampling method developed by Jessen and Lound (1962), using stratified random placement of the transect lines.

The shoreline was divided into 21 equal segments and a transect, perpendicular to the shoreline, was randomly placed within each segment, using a random numbers table. One transect had to be eliminated due to siltation in the upper end of the lake.

One sampling site was randomly located in each depth zone (0-1.5ft., 1.5-5ft., 5-10ft., and 10-20ft.) along each transect. Using a long-handled steel thatching rake, four rake samples were taken at each sampling site. The four samples were taken from each quarter of a 6-foot square quadrat. The aquatic plant species that were present on each rake sample were recorded. Each species was given a density rating (0-5) based on the number of rake samples on which it was present at each sampling site. (A rating of 1 indicates that a species was present on one rake sample...a rating of 4 indicates that it was present on all four rake samples and a rating of 5 indicates that it was abundantly present on all rake samples at that sampling site.) The sediment type at each sampling site was also recorded.

The type of shoreline cover was recorded at each transect. A section of shoreline, 50 feet on either side of the transect intercept with the shore and 30 feet back from the shore, was evaluated. The percentage of each cover type within this 100' x 30' rectangle was visually estimated.

Visual inspection and periodic samples were taken between transect lines in order to record the presence of any species that did not occur at the sampling sites. Specimens of all plant species present were collected and saved in a cooler for later preparation of voucher specimens. Nomenclature was according to Gleason and Cronquist (1991).

Data Analysis

The percent frequency of each species was calculated (number of sampling sites at which it occurred / total number of sampling sites) (Appendix I). Relative frequency was calculated based on the number of occurrences of a species relative to total occurrence of all species (Appendix I). The mean density was calculated for each species (sum of a species' density ratings / number of sampling sites) (Appendix II). Relative density was calculated based on a species density average density relative to total plant densities. A "mean density where present" was calculated for each species (sum of a species' density ratings / number of sampling sites at which the species occurred) (Appendix II). The relative frequency and relative density was summed to obtain an importance value (Appendix III). Simpson's Diversity Index was calculated (Appendix I).

III. RESULTS

PHYSICAL DATA

WATER QUALITY - The trophic state of a lake is an indicator of its water quality. Phosphorus concentration, chlorophyll concentration, and water clarity data are collected and combined to determine the trophic state. Eutrophic lakes are high in nutrients and therefore support a large biomass. Oligotrophic lakes are low in nutrients and support limited plant growth and smaller fish populations. Mesotrophic lakes have intermediate levels of nutrients and biomass.

Water quality testing was conducted on Mead Lake monthly during April through August, from 1991-1995 by the U. S. Geological Service. Samples were taken from two locations in the lake: one in the west basin and one in the east basin. The west basin of the lake is the downstream part of the impoundment, closer to the dam and the deepest portion of the lake. The east basin is the upstream portion, near the inflow and shallower (average depth of 4 feet).

Phosphorus is a limiting nutrient in many Wisconsin lakes. So, increases in phosphorus in a lake can feed algal blooms and excess plant growth.
1991-95 mean summer phosphorus in Mead Lake was 158 ug/l.
The level of phosphorus in Mead Lake was indicative of a hypereutrophic lake (Table 2.

Table 2 Trophic Status

	Quality Index	Phosphorus ug/l	Chlorophyll ug/l	Secchi Disc ft.
Oligotrophic	Excellent	<1	<1	> 19
	Very Good	1-10	1-5	8-19
Mesotrophic	Good	10-30	5-10	6-8
	Fair	30-50	10-15	5-6
Eutrophic	Poor	50-150	15-30	3-4
Hypereutrophic	Very Poor	>150	>30	>3
Mead Lake 1991-95	Very Poor	158	63	2.7

After Lillie & Mason (1983)
Shaw et. al. (1993)

Measuring the level of chlorophyll in the water gives an indication of algal levels. Algae is natural and essential in lakes, but high algal levels can cause problems, increasing the turbidity and reducing the light available for plant growth.
1991-95 mean summer chlorophyll in Mead Lake was 63 ug/l.
The chlorophyll concentration in Mead Lake indicates that it was a hypereutrophic lake (Table 2).

There were variations in the phosphorus and chlorophyll levels from year-to-year and during the year. The phosphorus levels appear to increase steadily during the summer (Figure 2). Chlorophyll also increases during the summer, but on average, drops slightly in July before increasing in August (Figure 2).

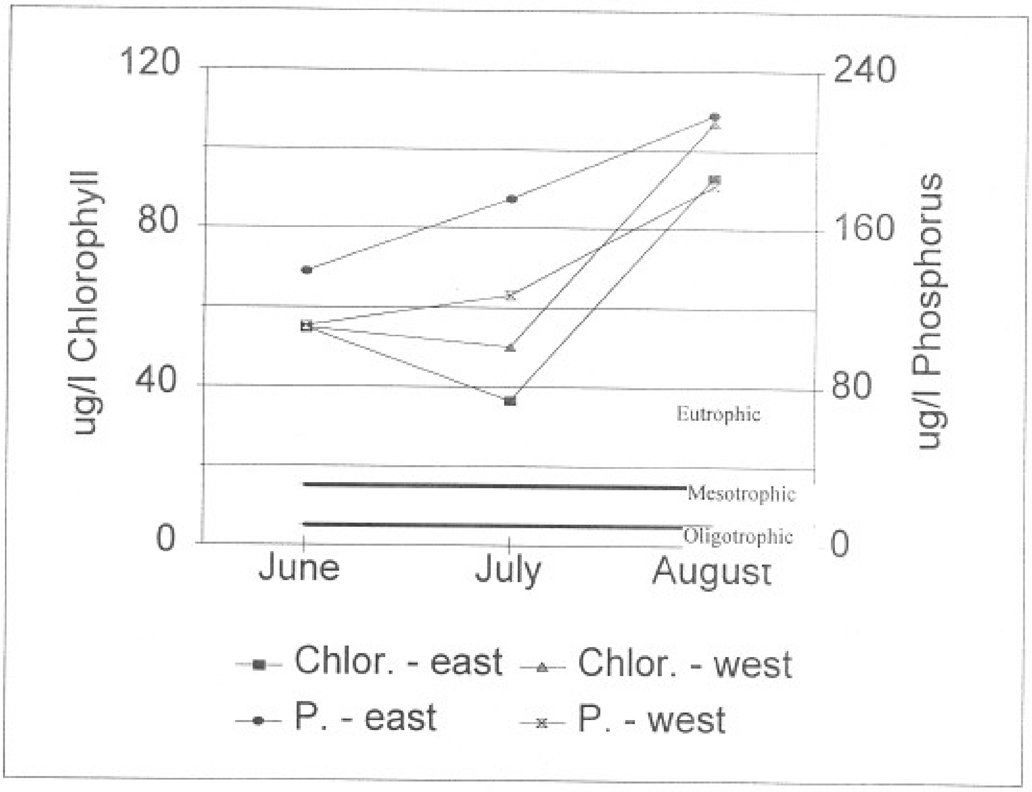

Figure 2. Change in phosphorus and chlorophyll levels during the summer.

The mean levels of phosphorus have increased since 1991 (Figure 3) but the chlorophyll levels have not shown a trend, varying wildly over the years (Figure 3). The variation in algae (chlorophyll) levels may be caused by other factors such as nitrogen input, summer temperatures or rainfall.

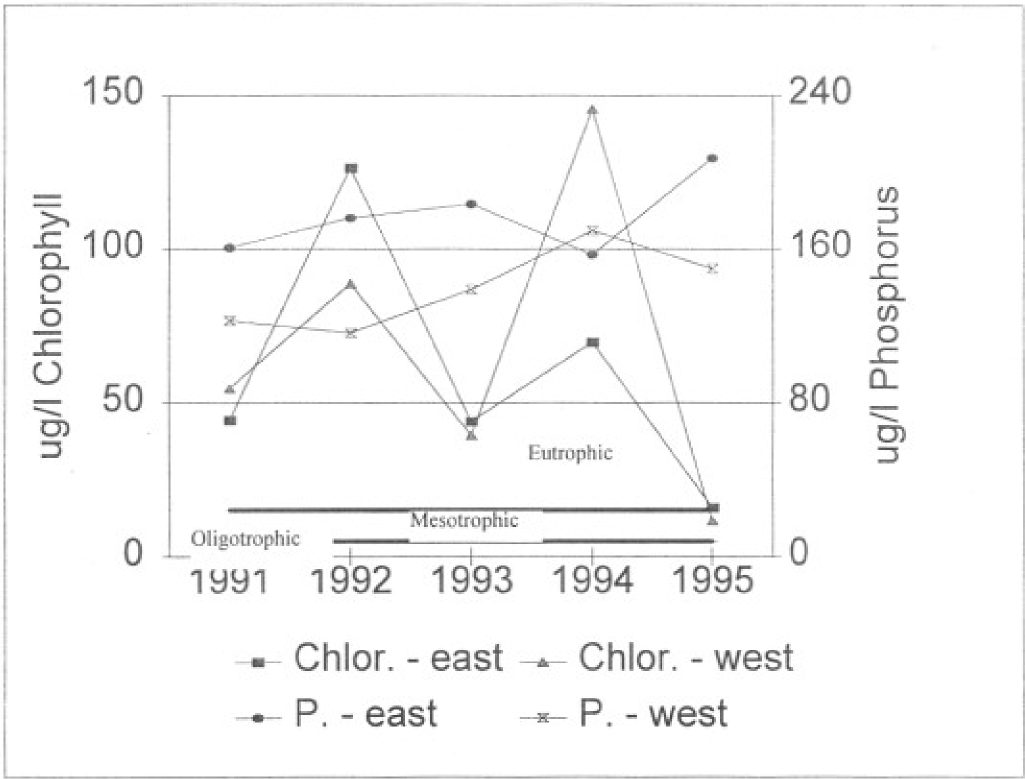

Figure 3. Change in phosphorus and chlorophyll levels 1991-1995

Water quality testing in 1991 to 1995 also indicated that during summer stratification, dissolved oxygen disappears in the bottom portion. This not only makes the bottom portion unable to support fish, but large amounts of phosphorus (a nutrient) can be released from the sediments during this anoxic period (Field 1994).

Although phosphorus is the nutrient of most concern in the majority of Wisconsin lakes, lakes that have a nitrogen:phosphorus ratio less than 10:1 are considered nitrogen limited. This means that an increase in nitrogen has more of an impact on plant and algae growth than phosphorus. Based on water quality data collected 1991 to 1995, the nitrogen:phosphorus ratio in Mead Lake was 9:1. Nitrogen inputs to Mead Lake may be as important or more important for determining potential algal growth than phosphorus (Field 1994). Phosphorus levels are still valuable as an indicator of overall nutrient availability.

Water clarity is a critical factor for plants. When plants receive less than 1 - 2% of the surface illumination, they can not survive. Water clarity is reduced by turbidity (suspended materials such as algae and silt) and dissolved organic chemicals that color the water. Water clarity can be measured with a Secchi disc that shows the combined effect of turbidity and color. Secchi disc readings can be used to calculate a predicted maximum rooting depth for plants in the lake (Dunst 1982).

1991-95 Mean summer Secchi Disc Clarity was 2.7 Ft.
Based on the Mean 1991-95 Secchi Disc Clarity, the predicted maximum rooting depth was 6 ft. in the lake.
The Secchi disc depth also indicates that Mead Lake was a hypereutrophic lake that had poor clarity in 1995 (Table 2).

The water clarity also varied from year-to-year and during the year. Water clarity increased in 1993 and increased slightly in 1995 (Figure 4). These variations in clarity may be related to the level of algae growth. The noticeable increase in water clarity in 1993 corresponds with a substantial decrease in algae levels in 1993.

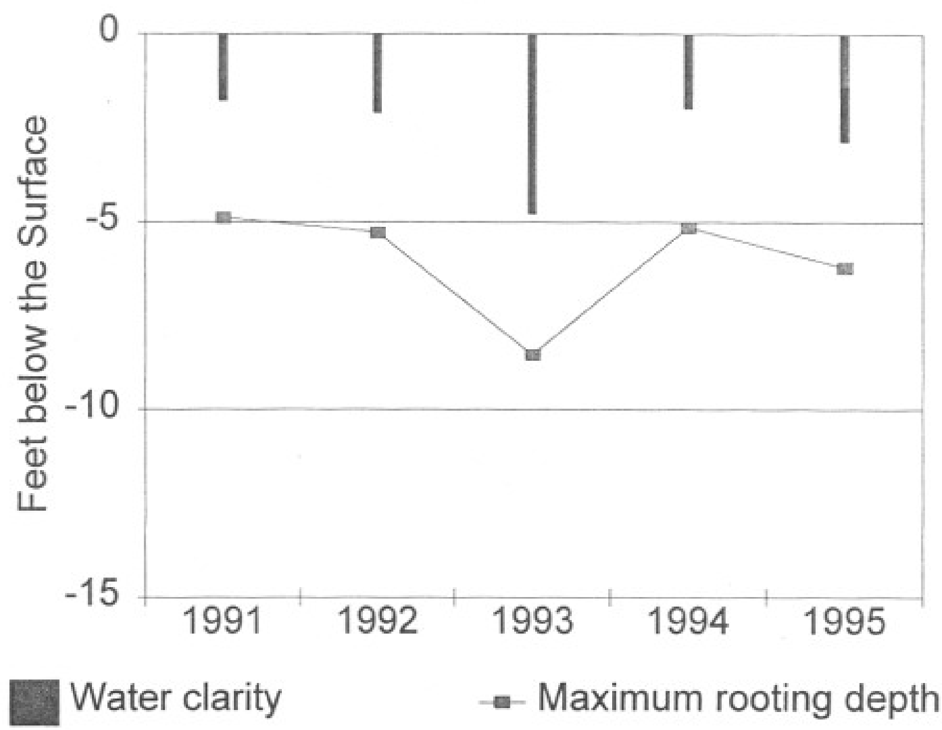

Figure 4. Water clarity in Mead Lake 1991-1995

Water clarity is also slightly greater in June before most algae blooms begin (Figure 5).

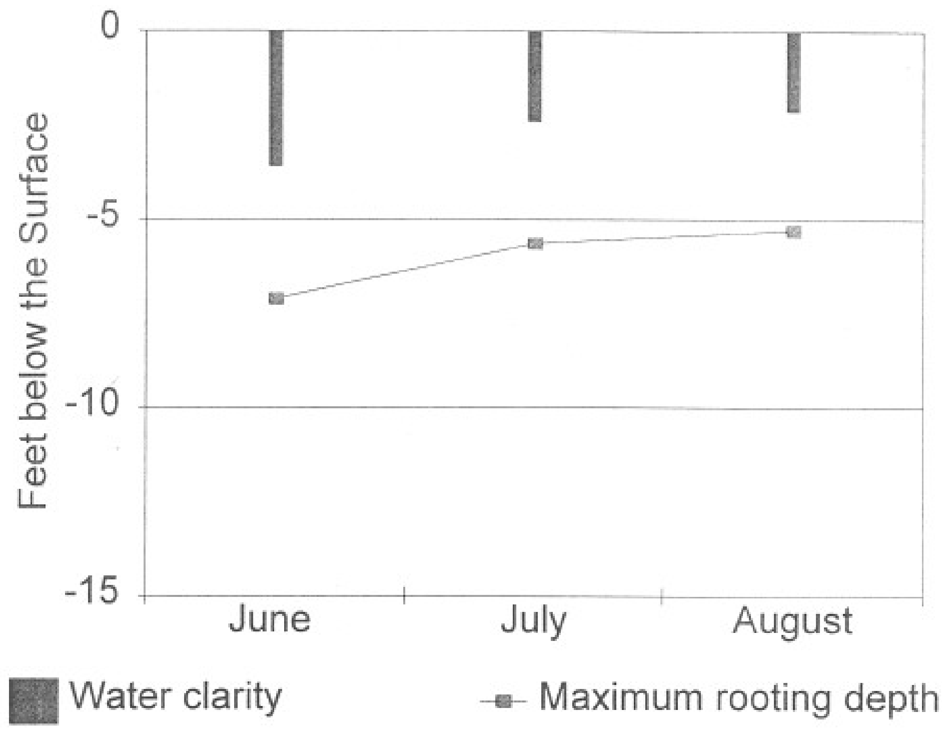

Figure 5. Water clarity in Mead Lake during the summer

Water clarity data has also been collected by Foster Will since 1987 as part of the Self-Help Volunteer Monitoring Program. In 1996, John Pernsteiner continued the water clarity data collection when Foster Will retired after several years of very active data collection. The data gathered in this volunteer program spans a greater number of years (1987-1996), a longer time period during the year (May - October) and includes more frequent data collection (at least bi-monthly) than the water clarity data gathered by the U. S. Geological Service. The volunteer data also shows variations in water clarity from year-to-year (Figure 6) and during the year (Figure 7) with greater water clarity in the spring and fall when the water temperatures are cooler and less ideal for algae growth.

The combination of the phosphorus levels, chlorophyll levels, and clarity values indicates the trophic status of the lake. These values for Mead Lake indicate that it was a hypereutrophic lake. This trophic state favors high levels of plant or algae growth with periods of turbidity common.

The pH of a lake indicates the acidity or alkalinity of the water.
The 1991-95 mean summer pH of the surface water in Mead Lake was 8.1.
This would favor plants adapted to slightly alkaline conditions.

The alkalinity as measured by mg. of $CaCO_3$/l indicates the hardness of the water.
The 1991-95 mean $CaCO_3$/l in Mead Lake was 32.
Hardness levels less than 60mg$CaCO_3$/l are considered soft water. Soft water lakes tend to have lower levels of plant growth.

LAKE MORPHOMETRY - The morphometry of a lake is an important factor in determining the distribution of aquatic plants. Duarte and Kalff (1986) found that the slope of the littoral zone could explain 72% of the observed variability in the growth of submerged plants. Gentle slopes support more plant growth than steep slopes (Engel 1985). Mead Lake has an irregular shape (Figure 1). The lake consists of two basins connected by a narrow strait. The presence of a few islands further restrict the strait. The west basin is deeper (16 ft.), but still shallow with a gradually sloped littoral zone on the north shore and a steeper littoral zone on the south shore. The east basin is shallow (maximum depth of 8 ft.) with a gradually sloped littoral zone. The shallow depth and gradual sloped shoreline over half the lake should favor plant growth in that area.

SEDIMENT COMPOSITION - Hard (high density) sediments were the predominant (48% frequency of occurrence) sediments at the sample sites and, of these, sand was the most frequently found hard sediment (Table 3). Sand was found throughout the lake, at depths less than 10ft.

Mixed sediments were found at 33% of the sample sites and sand sediments mixed with silt were common throughout the lake, especially as the water depth increased.

Soft sediments, silt and muck were found along the gradually sloped littoral zone along the north shore and at the east end of the lake were the river enters. The soft sediments (silt and muck) were more common at depths of 1.5-5ft.

Table 3. Sediment Composition

		0-1.5' Depth	1.5-5' Depth	5-10' Depth	10-20' Depth	Percent of all Sample Sites
Hard Sediments	Sand	30%	32%	23%		28%
	Sand/Rock	10%	21%	8%		12%
	Rock	20%	5%			8%
Mixed Sediments	Sand/Silt	10%	16%	62%	50%	28%
	Sand/Muck	15%				5%
Soft Sediments	Silt	10%	26%	8%	33%	17%
	Muck	5%				2%

SHORELINE LAND USE - There has been an increasing awareness that land use practices strongly impact the aquatic plant community. Practices on shore can directly impact the plant community through increased sedimentation from erosion, increased nutrient levels from fertilizer run-off and soil erosion and increased toxics from farmland and urban run-off.

Wooded cover was the most frequently encountered shoreline cover found at the transects, but cultivated lawn had a higher mean coverage. Native herbaceous growth was also found at half of the transects. Shrub growth, hard structures and rip-rap were also commonly encountered (Table 4).

Natural shoreline (wooded, shrub, native herbaceous) was found at 80% of the sites and had a mean coverage of 52%. Disturbed shoreline (cultivated lawn, rip-rap, hard surface or structures) was found at 65% of the sites and had a mean coverage of 48%.

Table 4. Shoreline Land Use

Cover Type	Frequency of Occurrences at Transects	Mean % Coverage
Cultivated lawn	50%	38.8%
Wooded	55%	30.8%
Native Herbaceous	50%	14.5%
Shrub	30%	6.8%
Hard Surface	10%	5.0%
Hard Structures	20%	2.2%
Rip-rap	20%	2.0%

MACROPHYTE DATA

SPECIES PRESENT

A total of 22 species was found in Mead Lake. Of the 22 species, 10 were emergent species, 3 were a floating-leaf species, and 9 were submergent species (Table 5). No endangered or threatened species were found. One non-native species was found: *Potamogeton crispus*.

Table 5. Mead Lake Aquatic Plant Species

Scientific Name	Common Name	I. D. Code
Emergent Species		
1) *Calla palustris* L.	water arum	calpa
2) *Carex aquatilis* Wahlenb.	sedge	caraq
3) *Carex diandra* Schrank	sedge	cardi
4) *Carex tuckermannii* F. Boott.	sedge	cartu
5) *Phalaris arundinacea* L.	reed canary grass	phaar
6) *Sagittaria* sp.	arrowhead	sagsp
7) *Scirpus cyperinus* (L.) Kunth.	wool-grass	scicy
8) *Scirpus validus* Vahl.	softstem bulrush	sciva
9) *Sparganium americanum* Nutt.	burreed	spaam
10) *Typha latifolia* L.	common cattail	typla
Floating-leaf Species		
11) *Lemna minor* L.	lesser duckweed	lemmi
12) *Spirodela polyrhiza* (L.) Schleiden.	greater duckweed	spipo
13) *Wolffia columbiana* Karsten.	watermeal	wolco
Submergent Species		
14) *Ceratophyllum demersum* L.	coontail	cerde
15) *Chara* sp.	muskgrass	chasp
16) *Elodea canadensis* Michx.	common water-weed	eloca
17) *Najas flexilis* (Willd) Rostkov & Schmidt.	northern water-nymph	najfl
18) *Potamogeton crispus* L.	curly-leaf pondweed	potcr
19) *Potamogeton foliosus* Raf.	leafy pondweed	potfo
20) *Potamogeton nodosus* Poiret.	longleaf pondweed	potno
21) *Potamogeton richardsonii* (Ar. Bennett) Rydb.	Richard's pondweed	potri
22) *Potamogeton zosteriformis* Fern.	flat-stem pondweed	potzo

FREQUENCY OF OCCURRENCE

Of the 22 species found in Mead Lake, 17 occurred at sampling sites. The species with the highest frequency of occurrence was *Ceratophyllum demersum* (32.8%) (Figure 8). Other commonly occurring species were *Lemna minor* (27.6%), *Wolffia columbiana* (22.4%) and *Spirodela polyrhiza* (20.7%).

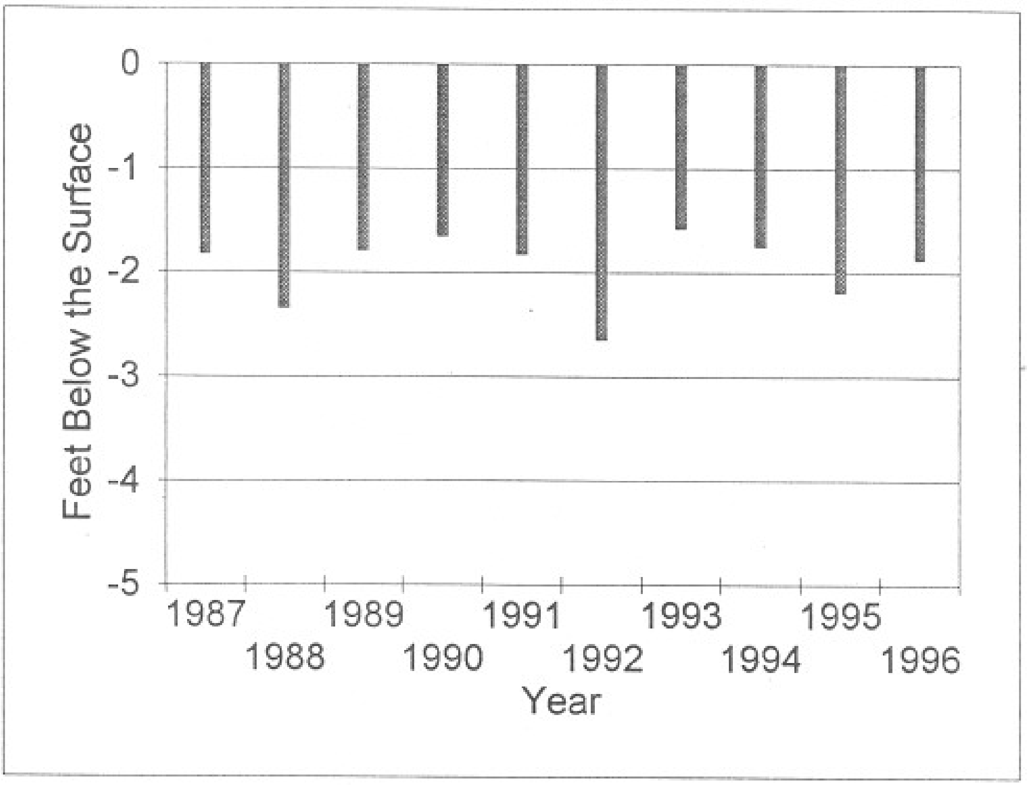

Figure 6. Water clarity data collected by Self-Help Volunteers 1987-present.

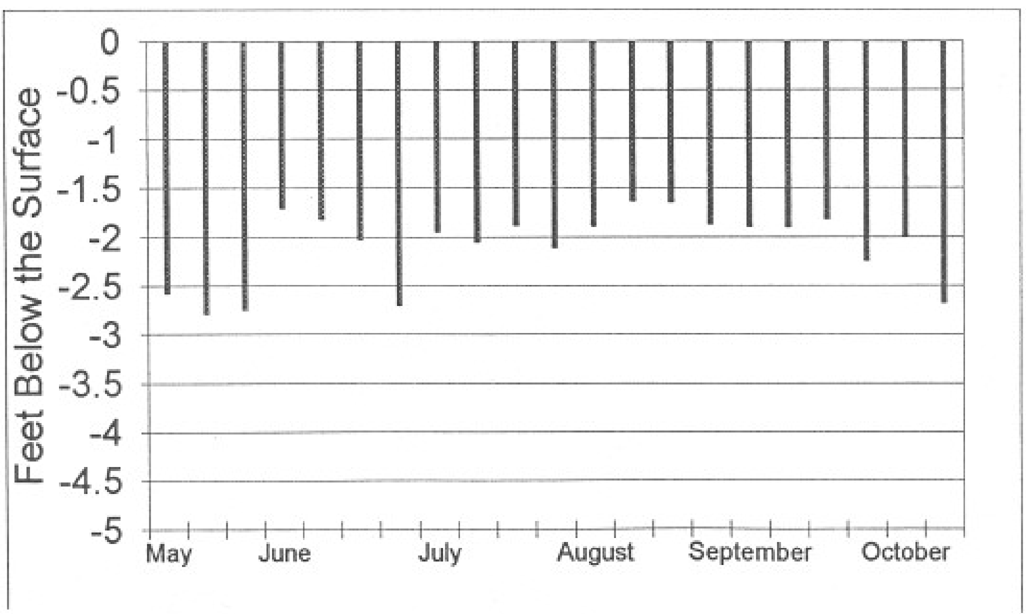

Figure 7. Volunteer collected water clarity data over the growing season.

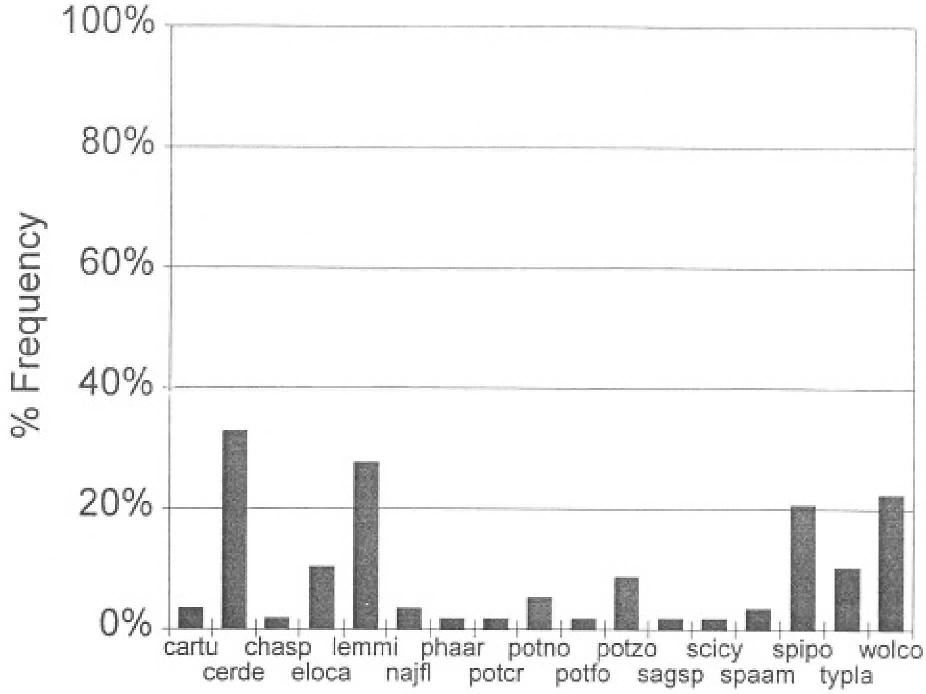

Figure 8. Macrophyte Frequencies in Mead Lake

Filamentous algae had a higher occurrence than any macrophyte; it occurred at 48% of the sample sites.

75% of the 0-1.5ft. depth zone had filamentous algae.
52% of the 1.5-5ft. depth zone had filamentous algae.
23% of the 5-10ft. depth zone had filamentous algae.
0% of the 10-20ft. depth zone had filamentous algae.

DENSITY

Ceratophyllum demersum had the highest mean density (0.98) on a density scale of 1-4) (Figure 9). *C. demersum* and *Lemna minor* had the highest mean densities at sites at which they were present (both 3.0). A high density at sites at which it was present indicates that these species had dense growth form in Mead Lake (Figure 9).

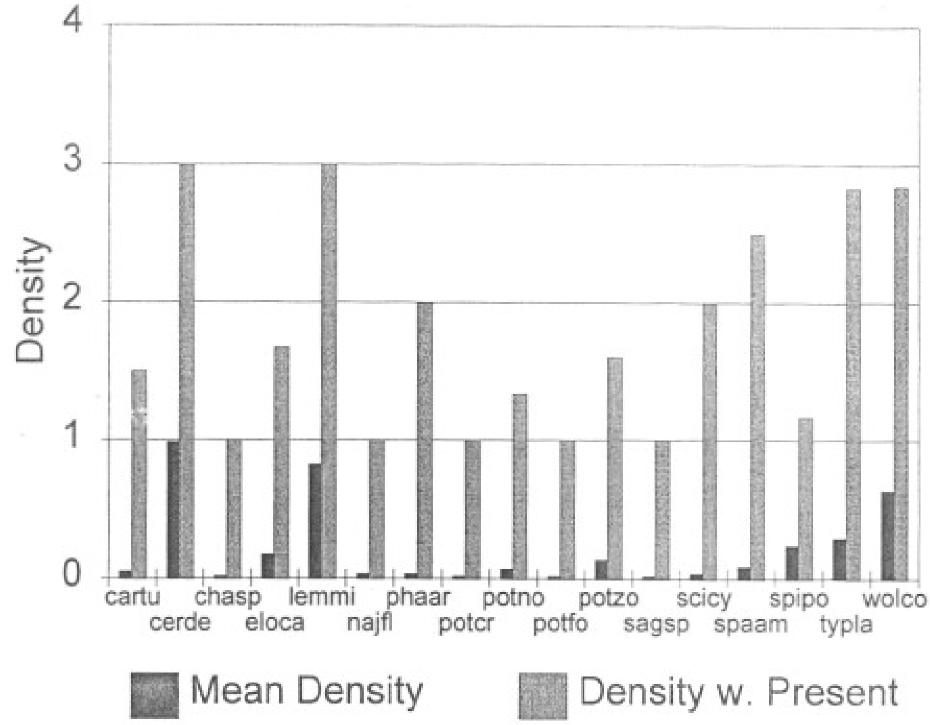

Figure 9. Densities of Macrophytes in Mead Lake.

DOMINANCE

Combining relative frequency and relative density into an importance value indicates the relative dominance of species within the macrophyte community (Appendix III). Based on the importance value, *Ceratophyllum demersum* was the dominant species in the lake (Figure 10). *Lemna minor* was sub-dominant.

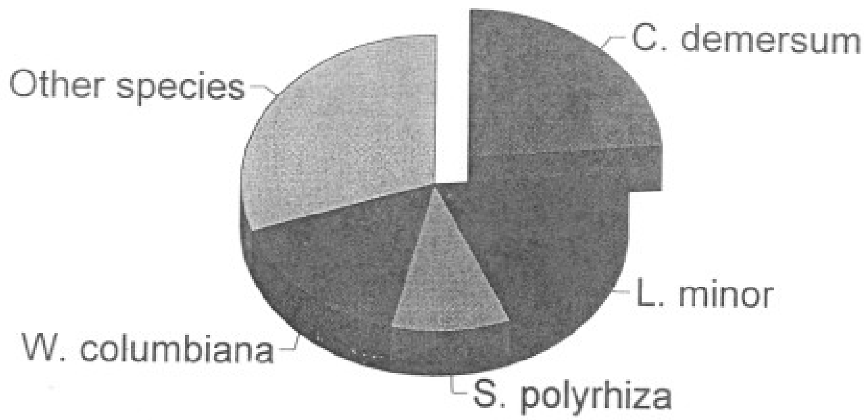

Figure 10. Dominance within the Macrophyte Community, of the Most Prevalent Macrophytes, based on Importance Value.

DISTRIBUTION

The most common species (*Ceratophyllum demersum, Lemna minor, Spirodela polyrhiza, Wolffia columbiana)* were distributed mainly in the east basin and along the north shore of the west basin.

Aquatic plants were found growing at 45% of all sampling sites. Rooted vegetation was found at 26% of the sampling sites. The maximum rooting depth was 9 ft. *Chara* sp., a macrophytic algae was found at the maximum depth.

85% of the sites in the 0-1.5 ft. depth zones were vegetated.
37% of the sites in the 1.5-5 ft. depth zone were vegetated.
15% of the sites in the 5-10 ft. depth zone were vegetated.
None of the sites in the 10-20 ft. depth zone were vegetated.

The mean number of species found at each sampling site was 1.6.
In the 0-1.5' depth zone, the mean number of species per sample site was 3.6.
In the 1.5-5' depth zone, the mean number of species per site was 0.9.
In the 5-10' depth zone, the mean number of species per site was 0.2.
In the 10-20' depth zone, the mean number of species per site was 0.

32 sites had 0 species
7 sites had 1 species
5 sites had 2 species
2 sites had 3 species
4 sites had 4 species
2 sites had 5 species
3 sites had 6 species
2 sites had 7 species
1 site had 11 species

The 0-1.5 ft. depth zone had the highest total occurrence and total density of macrophytes (Figure 11). The occurrence and density of macrophyte growth decreased with increasing depth zones. Plant growth was not found in the 10-20ft. depth zone.

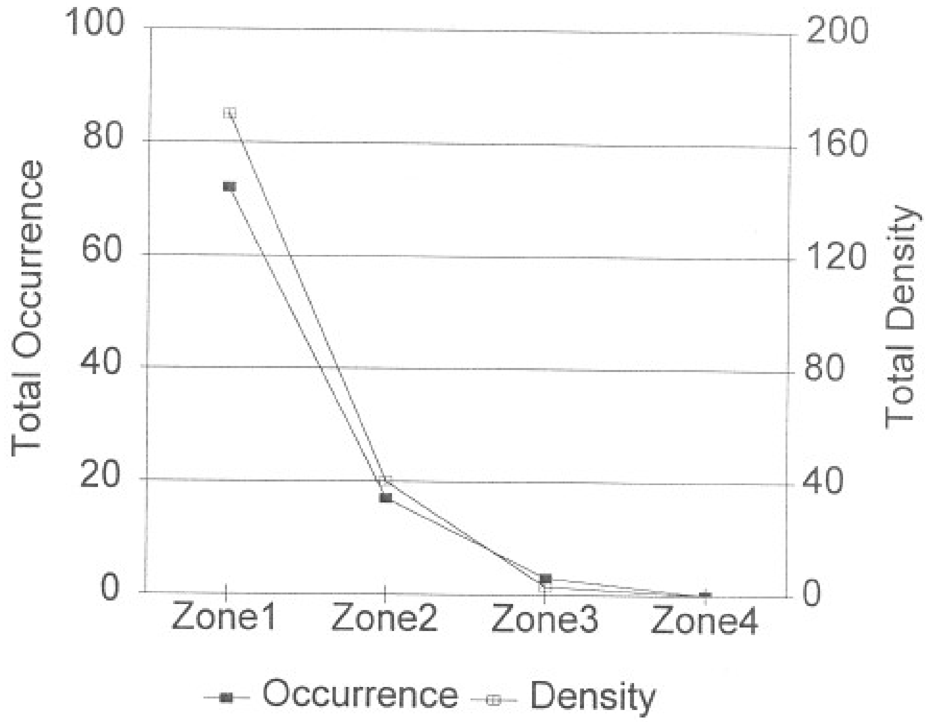

Figure 11. Total Occurrence and Density of Macrophytes by Depth Zone.

The frequencies and densities of individual species varied with depth zone. Each depth zone had a different dominant species. *Lemna minor* was the most frequent and most dense species in the 0-1.5 ft. depth zone (Figure 12) and occurred at its highest frequency and density in this depth zone (Figure 13).

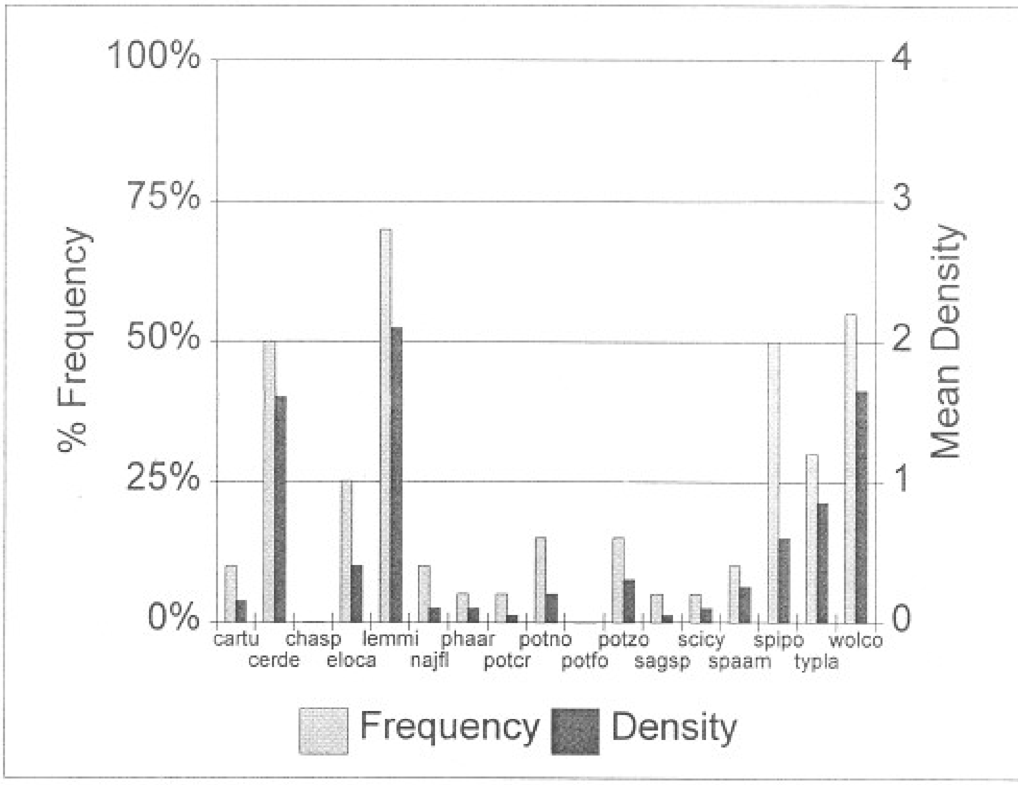

Figure 12. Macrophyte Frequencies in the 0-1.5 Foot Depth Zone.

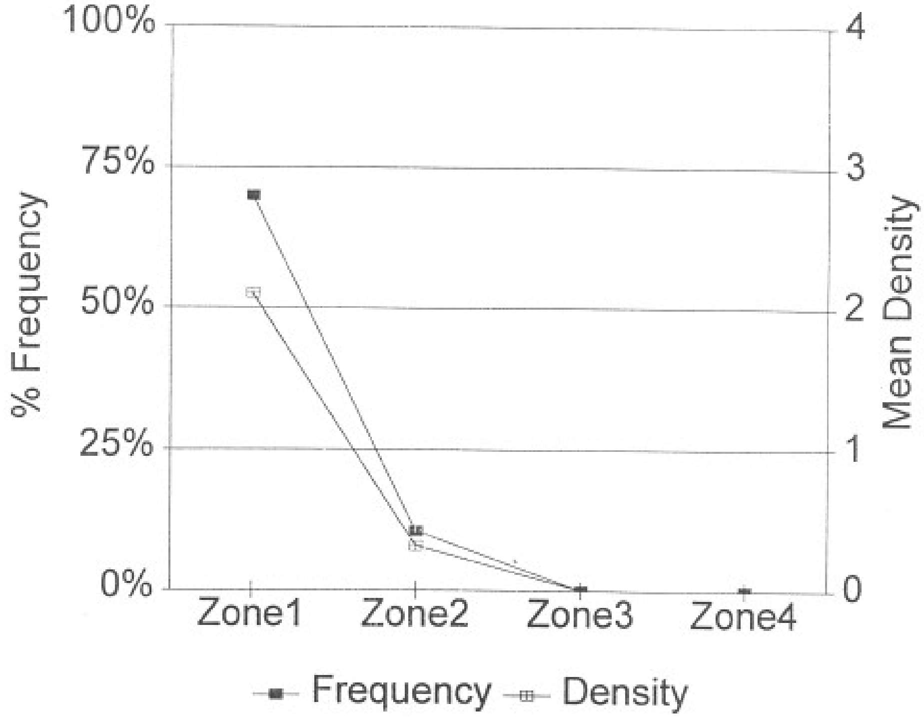

Figure 13. Frequency and density of *Lemna minor* by depth zone.

Ceratophyllum demersum was the most frequent and most dense species in the 1.5-10 ft. depth zones (Figure 14). But *C. demersum* occurred at its highest frequency and density in the 0-1.5 ft. depth zone (Figure 15). Its presence decreased with increasing depth.

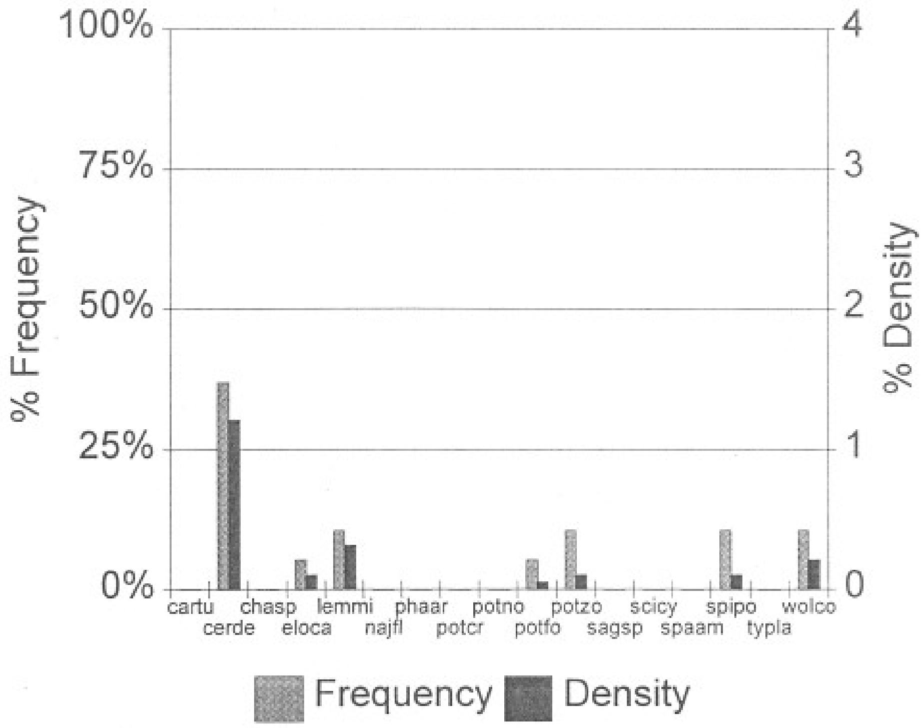

Figure 14. Macrophyte Frequencies in the 1.5-5 Foot Depth Zone.

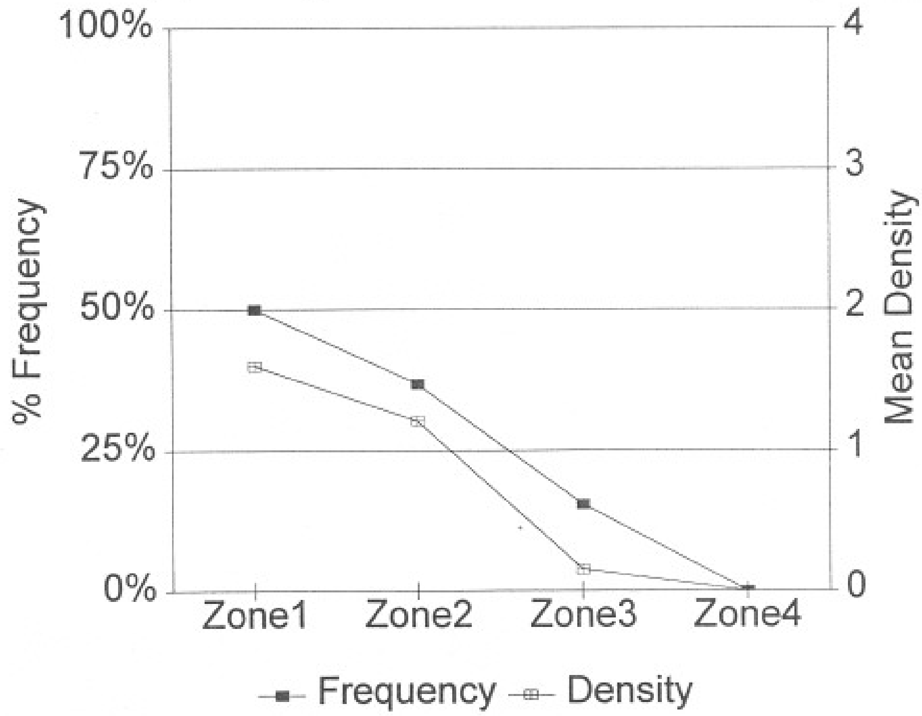

Figure 15. Frequency and density of *Ceratophyllum demersum* by depth.

SEDIMENT COMPOSITION - Some plants depend on the sediment for their nutrients. The richness of sterility of the sediment will determine the type and abundance of macrophyte species that can survive in a location.

The availability of mineral nutrients for growth is highest in sediments of intermediate density, such as silt (Barko and Smart 1986). Highly organic muck sediments are low density; sand, gravel and rock are high density sediments.

Sand sediments and sand/silt mixtures were the predominant sediments found in Mead Lake. Sand mixed with rock were also commonly found. Sand and sand/rock sediments may limit plant growth because of the high density. Silt/muck and pure muck sediments had a low occurrence in the lake but had a high level of vegetation because of the high nutrient level of organic muck and the intermediate density of silt (Table 6). Hard, high density sediments were found at 48% of the sites and would limit plant growth, but more favorable sediments were found at 52% of the sites.

Table 6. Sediment Influence

		Percent of all sample sites	Percent vegetated
Hard Sediments	Sand	28%	19%
	Sand/Rock	12%	14%
	Rock	8%	20%
Mixed Sediments	Sand/Silt	28%	25%
	Sand/Muck	5%	100%
Soft Sediments	Silt	17%	20%
	Muck	2%	100%

THE COMMUNITY

Simpson's Diversity Index was 0.88, indicating a moderate diversity. A rating of 1.0 would mean that each species in the lake would be a different species (the most diversity achievable).

The Aquatic Macrophyte Community Index (AMCI) developed by Weber et. al. (1995) was applied to Mead Lake (Table 7). Values between 0 and 10 are given for each of six categories: maximum rooting depth, % of littoral zone vegetated, Simpson's Diversity Index, relative frequency of submersed vegetation, relative frequency of sensitive species, and ratio of native to non-native species. The highest value for this index is 60. AMCI for Mead Lake is 31. This is below average (40) for lakes in Wisconsin.

Table 7. Aquatic Macrophyte Community Index

Category		Value
Maximum Rooting Depth	2.7 meters	4
% Littoral Zone Vegetated	44.8%	8
Simpson's Diversity	0.88	9
# of Species	17 (one non-native)	5
% Submersed Species	20% Rel. Freq.	3
% Sensitive Species	6% Relative Freq.	2
Totals		31

V. DISCUSSION

Based on the clarity, chlorophyll and phosphorus levels in 1991-1995, Mead Lake is a hypereutrophic lake with poor water quality. The trophic status, the gradual-sloped littoral zone and shallow depths over much of the lake would favor macrophyte growth. The soft water and poor clarity could limit macrophyte growth. Lake sediments would have a mixed impact; about half of the sites had sediments favorable to plant growth and half had sediments that could limit plant growth.

The mean coverage of natural shoreline (wooded, shrub and native herbaceous growth) and disturbed shoreline (mowed lawn, bare soil, hard surface and structures) around Mead Lake was nearly equal. Cultivated lawn had the highest mean coverage of all the shoreline use types and wooded sites had the highest occurrence. Preserving a buffer of natural vegetation along the shore could protect the water quality of the lake from excess nutrient and chemical run-off that could feed algal blooms and from erosion that could increase sedimentation.

Mead Lake may be a nitrogen-limited lake which would mean that nitrogen inputs could be having more impact on plant and algae growth than phosphorus. There are three likely sources of nutrient enrichment that are the cause of the water quality problems in Mead Lake.

1) Run-off from the very large watershed area:lake area ratio is likely a major source of nutrients.
2) Failing septic systems could be contributing additional nutrients to the lake.
3) Stratification of the lake in the summer and loss of oxygen in the deepest layer of water sets up the chemical conditions necessary for the recycling of phosphorus from the bottom sediments. This is indicated by the continuous increase in phosphorus levels during the summer.

Simpson's Diversity Index indicates that the macrophyte community had a moderate diversity. The Aquatic Macrophyte Community Index (AMCI) indicates that the macrophyte community in Mead Lake is below average for Wisconsin lakes. The low AMCI is due to the shallow maximum rooting depth, the low occurrence of submersed species and the lack of sensitive species.

Filamentous algae, although not considered a macrophyte, could be considered the most abundant species: it occurred at 48% of the sites. *Ceratophyllum demersum* was the dominant macrophyte species in Mead Lake, based on its higher frequency of occurrence and higher mean density as compared with other species. *Lemna minor, Spirodela polyrhiza,* and *Wolffia columbiana* were also common species. The dominant and most common species are all floating species: *C. demersum* floats just under the surface of the water and the others float on the water surface. This adaptation favors these species in turbid waters.

The highest occurrence and density of macrophytes, the highest percentage of vegetated sites and the highest mean number of species at each sample site was found in the 0-1.5 foot depth zone, the shallowest depth zone. Macrophyte occurrence, macrophyte density, percent of vegetated sites and mean number of species decreased with increasing water depth.

The results of the macrophyte survey indicate that poor water clarity may be determining the structure and distribution of the macrophyte community in the lake. The poor clarity is limiting the light availability for a diverse macrophyte community. The dominance of floating species indicates that water clarity may be too poor for the growth of a healthy submersed macrophyte community. In addition, the macrophyte growth is concentrated in the shallowest zone, in which light penetration to the sediments is adequate. There is no macrophyte growth in the 10-20ft. zone. This results in a very narrow band of vegetation in the littoral zone.

Many of the species in Mead Lake (*Ceratophyllum demersum, Chara, Elodea canadensis, Lemna minor, Najas flexilis, Potamogeton crispus, P. foliosus, P. nodosus, Spirodela polyrhiza, Typla latifolia*) tolerate turbid water and have been known to grow to over-abundance when there is an excess of nutrients in the lake (Nichols and Vennie 1991). All of the dominant and common species in Mead Lake are included in this group of species. One of these species, *P. crispus*, is not native and has grown to nuisance conditions in many lakes.

Comparison with the Previous Surveys

In August 1971, plant growth was assessed for aquatic plant control. Nuisance growth was found at the east end of the lake and along the park property on the north shore. A heavy algae bloom was found on the entire lake.

In August 1982, a qualitative survey for aquatic plant control was conducted by Jim Talley (DNR Area Fish Manager) and Jack Eslien (DNR Water Pollution Biologist). Algae growth was evident (both planktonic and filamentous). Heavy submerged plant growth was found at the east end of the lake at the mouth of the Eau Claire River. Sparse plant growth was found along most lakeshore properties and park areas.

Plant growth was still abundant in some areas in 1997, but, except in the bays at the east end of the lake, the growth was not rooted growth.

The 1971 and 1982 macrophyte surveys were different types of surveys than the survey conducted in 1997, so the direct comparison of data is not appropriate, but trends can be interpreted. The species have showed some changes (Table 8). *Ceratophyllum demersum* is now dominant; *Najas flexilis* is no longer abundant; *Nymphaea, Polygonum, Potamogeton gramineus, P. richardsonii* were not found in 1997.

Table 8. Difference in Species Present in Macrophyte Assessments

August 23, 1971	August 24, 1982
♦*Ceratophyllum* sp.	*Ceratophyllum demersum*
★*Elodea* sp.	*Elodea* sp.
★*Lemna* sp.	
♦*Najas* sp.	
Nymphaea sp.	
Polygonum sp.	
■*Potamogeton gramineus*	
■*Potamogeton richardsonii*	*Potamogeton* sp.
Scirpus sp.	
■*Spirodela polyrhiza*	
Typha sp.	*Typha* sp.
■Filamentous algae	Filamentous & planktonic algae

■ - nuisance level
♦ - abundant in the lake
★ - common species in the lake

Chemical treatments and winter drawdowns were used during 1971-1974 to control plant growth in the lake.

The species that have disappeared or have been reduced appear to have disappeared between 1971 and 1982 (Table 8). They may have been eliminated by the aquatic plant control measures. *N. flexilis* is no longer abundant and is sensitive to the chemical diquat, which was used. As an annual, *N. flexilis* could have been reduced greatly if it was treated for a couple consecutive years before setting seed. *P. gramineus* and *P. richardsonii* are sensitive to the endothall products such as aquathol and could have been eliminated or greatly reduced by the treatments. *N. odorata* was not found in 1997 and is sensitive to winter drawdowns.

VI. CONCLUSIONS

Mead Lake is a hypereutrophic lake with abundant algae growth and a limited macrophyte community, below average for Wisconsin lakes. The aquatic macrophyte community has moderate diversity, but dominated by turbidity tolerant species. The macrophyte community is restricted to the shallow depth zones, declining rapidly as the depth increases above 1.5 feet. This too is an indication that poor water clarity is impacting the macrophyte community. *Ceratophyllum demersum* is the dominant species within the plant community and the dukweed species are sub-dominant. Filamentous algae has a higher occurrence than any macrophyte and planktonic algae is abundant.

The macrophyte community appeared to be slightly more diverse in 1971, but chemical treatments and winter drawdowns may have eliminated or greatly reduced some species. The subsequent decay of plant material treated with herbicides and the loss of plant mass to take up some of the nutrients may have compounded the algae problem. The plant species that were abundant and common in 1997 are all floating species that are favored by turbid conditions. The turbidity in the lake is due to algal growth fed by high levels of nutrients.

A healthy aquatic plant community plays a vital role within the lake community. This is due to the role plants provide play in 1) improving water quality 2) providing valuable resources for fish and wildlife 3) resisting invasions of non-native species and 4) checking excessive growth of tolerant species that could crowd out the more sensitive species, therefore reducing the diversity.

1) Macrophyte communities improve water quality in many ways: they trap nutrients, debris, and pollutants entering a water body; they may absorb and break down the pollutants; they reduce erosion by damping wave action and stabilizing shorelines and lake bottoms; they remove nutrients that would otherwise be available for algae blooms (Engel 1985).

2) Aquatic plant communities provide important fishery and wildlife resources. Plants (including algae) start the food chain that supports many levels of wildlife, and at the same time produce oxygen needed by animals. Plants are used as food, cover and nesting/spawning sites by a variety of wildlife and fish. Cover within the littoral zone should be about 25-85% to support a healthy fishery.

Compared to non-vegetated lake bottoms, macrophyte beds support larger, more diverse invertebrate populations that in turn will support larger and more diverse fish and wildlife populations (Engel 1985). Additionally, mixed stands of macrophytes support 3-8 times as many invertebrates and fish as monocultural stands (Engel 1990). Diversity in the plant community creates more microhabitats for the preferences of more species. Macrophyte beds of moderate density support adequate numbers of small fish without restricting the movement of predatory fish (Engel 1990).

The macrophytes in Mead Lake provides 36% cover within the littoral zone and woody structure for fish habitat was limited to the 0-1.5ft. depth zone, providing structure at 20% of those sites. The plants in Mead Lake provide many other benefits to wildlife and fish (Table 9)

Table 9. **Wildlife Uses of Aquatic Plants in Mead Lake**

Aquatic Plants	Fish	Water Fowl	Shore Birds	Upland Birds	Muskrat	Beaver	Deer
Submergent Plants							
Ceratophyllum demersum	F,I, C, S	F, I, C			F		
Chara sp.	F*, S	F*, I*					
Elodea canadensis	C, I	F, I					
Najas flexilis	F, C	F*	F				
Potamogeton crispus	F, C, S	F					
Potamogeton foliosus	F, C	F*					
Potamogeton nodosus	C	F*					
Potamogeton richardsonii	F, C, I	F					
Potamogeton zosteriformis	F, C	F					
Floating-leaf Plants							
Lemna minor	F	F*, I	F	F	F	F	
Spirodela polyrhiza	F	F		F			
Wolffia columbiana		F			F		
Emergent Plants							
Carex aquatilis		F	F				
Carex tuckermannii		F		F	F*		
Scirpus cyperinus	F, S, C	F, C	F, C	F	F		
Scirpus validus	F, C, I	F*	F	F	F		
Typha latifolia	F, I	F, C	F, C		F*, C*	F	

F=Food, I= Shelters Invertbrates, a valuble food source C=Cover, S=Spawning
***=Valuable Resource in this category**

*Current knowledge as to plant use. Other plants may have uses that have not been determined.
After Fassett, N. C. 1957. A Manual of Aquatic Plants. University of Wisconsin Press. Madison, WI
Nichols, S. A. 1991. Attributes of Wisconsin Lake Plants. Wisconsin Geological and Natural History Survey. Info. Circ. #73

and the lake is considered to be an important resource for waterfowl. Fish Management of the Department of Natural Resources has identified areas of the lake that are especially important for fish spawning and rearing and waterfowl habitat (Figure 16).

It is important to improve protect the resources and water quality in Mead Lake. Important measures to protecting water quality would be to

1) reduce nutrients entering the lake from the watershed
2) conduct a sanitary survey and replace older, failing sanitary systems
3) explore the possible benefits of preventing dissolved oxygen loss during summer stratification thus improving the fishery resource and preventing phosphorus recycling from the sediments
4) preserve and expand natural buffer zones of native vegetation along the shore. Leaving a strip of shoreline unmowed and allowing native vegetation to grow would reduce and filter the run-off into the lake.

These practices will protect the water quality and wildlife habitat in Mead Lake, an important public recreation resource in Clark County.

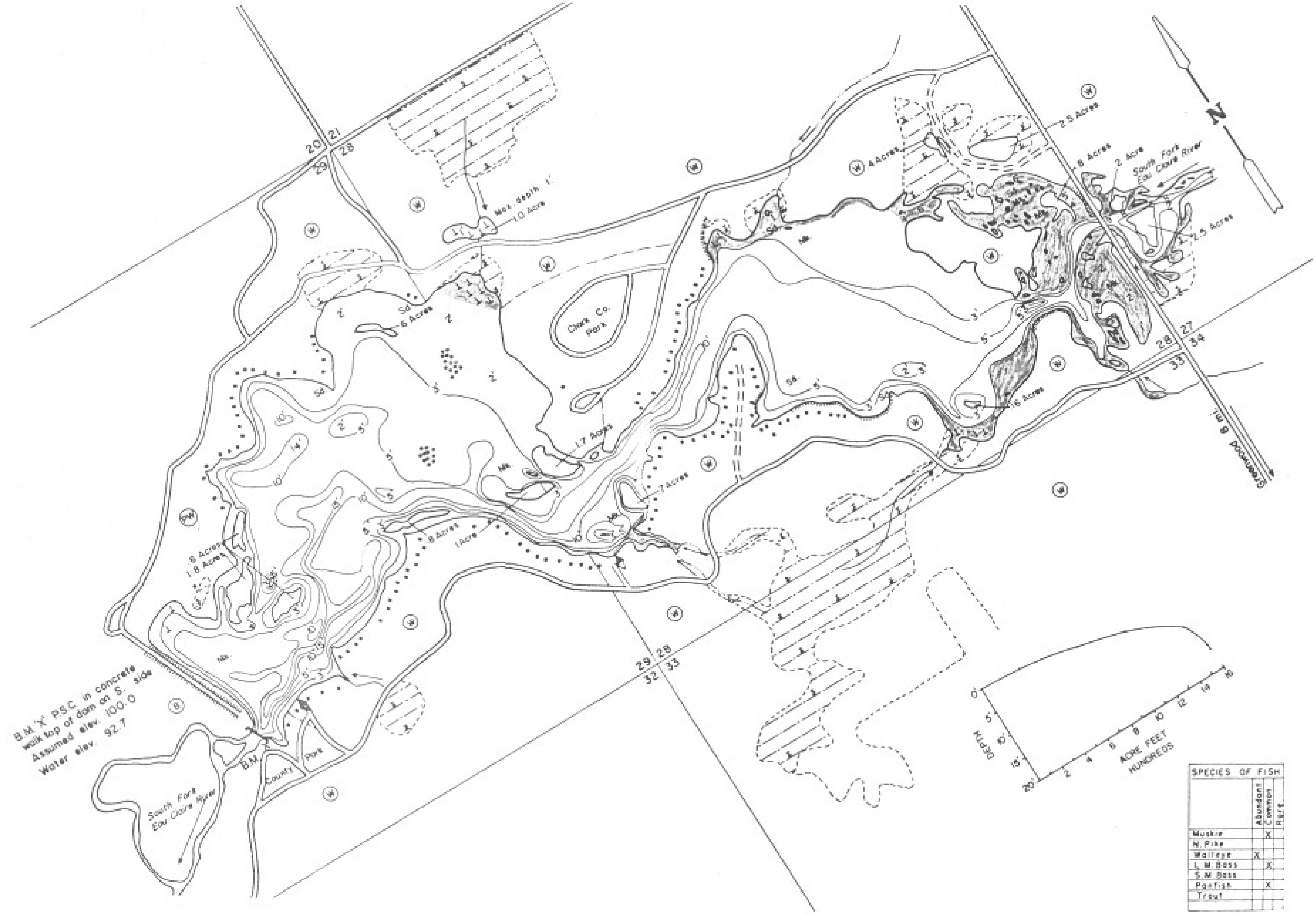

Figure 16. Location of important wildlife habitat in Mead Lake.

LITERATURE CITED

Babros, Timothy. 1986. Lake Survey of Mead Lake, Clark County. Wisconsin Department of Natural Resources. Eau Claire, WI.

Barko, J. and R. Smart. 1986. Sediment-related mechanisms of growth limitation in submersed macrophytes. Ecology 61:1328-1340.

Duarte, Carlos M. and Jacob Kalff. 1986. Littoral slope as a predictor of the maximum biomass of submerged macrophyte communities. Limnol. Oceanogr. 31(5):1072-1080.

Dennison, W., R. Orth, K. Moore, J. Stevenson, V. Carter, S.Kollar, P. Bergstrom, and R. Batuik. 1993. Assessing water quality with submersed vegetation. BioScience 43(2):86-94.

Dunst, R. C. 1982. Sediment problems and lake restoration in Wisconsin. Environment International 7:87-92.

Engel, Sandy. 1990. Ecosystem Response to Growth and Control of Submerged Macrophytes: A Literature Review. Technical Bulletin #170. Wisconsin Department of Natural Resources. Madison, WI.

Engel, Sandy. 1985. Aquatic Community Interactions of Submerged Macrophytes. Wisconsin Department of Natural Resources. Technical Bulletin No. 156. Madison, WI

Fassett, Norman C. 1957. A Manual of Aquatic Plants. University of Wisconsin Press. Madison, WI.

Field, Stephen. 1994. United States Deaprtment of the Interior: U. S. Geological Survey Correspondance. June 13, 1994. Madison, WI.

Gleason, H. and A. Cronquist. 1991. Manual of Vascular Plants of Northeastern United States and Adjacent Canada (Second Edition). New York Botanical Gardens, NY.

Jessen, Robert and Richard Lound. 1962. An evaluation of a survey technique for submerged aquatic plants. Minnesota Department of Conservation. Game Investigational Report No. 6.

Lillie, R. A. and J. W. Mason. 1983. Limnological Characteristics of Wisoconsin Lakes. Wisconsin Department of Natural Resources Tech. Bull. 138. Madiosn, WI

Nichols, Stanley A. and James G. Vennie. 1991. Attributes of Wisconsin Lake Plants. Wisconsin Geological and Natural History Survey. Information Circular 73.

Shaw, S., C. Mechenich and L. Klessig. 1993. Understanding Lake Data. University of Wiscosnin-Extension. Madison, WI

Weber, S., B. Shaw and S. Nichols. 1995. The Aquatic Plant Community of Eight Northern Wisconsin Flowages. University of Wisconsin-Stevens Point. Stevens Point, WI.

APPENDICES

Aquatic Plant Frequency Spreadsheet

Species	Total Occur.	Occurrence DepthZone1	Occurrence DepthZone2	Occurrence DepthZone3	Occurrence DepthZone4	%Freq.	%Freq. w.veg.	Relative Freq.	Freq. Zone1	Freq. Zone2	Freq. Zone3
Carex tuckermanii	2.00	2.00				3.45%	7.69%	0.02	10.00%		
Ceratophyllum demersu	19.00	10.00	7.00	2.00		32.76%	73.08%	0.21	50.00%	36.84%	15.38%
Chara sp.	1.00			1.00		1.72%	3.85%	0.01			7.69%
Elodea canadensis	6.00	5.00	1.00			10.34%	23.08%	0.07	25.00%	5.26%	
Lemna minor	16.00	14.00	2.00			27.59%	61.54%	0.17	70.00%	10.53%	
Najas flexilis	2.00	2.00				3.45%	7.69%	0.02	10.00%		
Phalaris arundinacea	1.00	1.00				1.72%	3.85%	0.01	5.00%		
Potamogeton crispus	1.00	1.00				1.72%	3.85%	0.01	5.00%		
Potamogeton nodosus	3.00	3.00				5.17%	11.54%	0.03	15.00%		
Potamogeton foliosus	1.00		1.00			1.72%	3.85%	0.01		5.26%	
Potamogeton zosteriformi	5.00	3.00	2.00			8.62%	19.23%	0.05	15.00%	10.53%	
Sagittaria sp.	1.00	1.00				1.72%	3.85%	0.01	5.00%		
Scirpus cyperinus	1.00	1.00				1.72%	3.85%	0.01	5.00%		
Sparganium americanum	2.00	2.00				3.45%	7.69%	0.02	10.00%		
Spirodela polyrhiza	12.00	10.00	2.00			20.69%	46.15%	0.13	50.00%	10.53%	
Typha latifolia	6.00	6.00				10.34%	23.08%	0.07	30.00%		
Wolffia columbiana	13.00	11.00	2.00			22.41%	50.00%	0.14	55.00%	10.53%	
Totals	92.00	72.00	17.00	3.00		*********		1.00			

Number sample sites	58.00
Sample sites/veg	26.00
Number open sites	32.00
%Open	0.55

Simpson's Diversity	0.88	8.64	0.12	0.88

Zone1 sites	20.00
Zone2 sites	19.00
Zone3 sites	13.00
Zone4 sites	6.00

Aquatic Plant Density Spreadsheet

Species	Total Density	Density DepthZone1	Density DepthZone2	Density DepthZone3	Density DepthZone4	Mean Density	MeanDens w.pres.	Relative Density	Density Zone1	Density Zone2	Density Zone3
Carex tuckermanii	3.00	3.00				0.05	1.50	0.01	0.15		
Ceratophyllum demersu	57.00	32.00	23.00	2.00		0.98	3.00	0.27	1.60	1.21	0.15
Chara sp.	1.00			1.00		0.02	1.00	0.00			0.08
Elodea canadensis	10.00	8.00	2.00			0.17	1.67	0.05	0.40	0.11	
Lemna minor	48.00	42.00	6.00			0.83	3.00	0.23	2.10	0.32	
Najas flexilis	2.00	2.00				0.03	1.00	0.01	0.10		
Phalaris arundinacea	2.00	2.00				0.03	2.00	0.01	0.10		
Potamogeton crispus	1.00	1.00				0.02	1.00	0.00	0.05		
Potamogeton nodosus	4.00	4.00				0.07	1.33	0.02	0.20		
Potamogeton foliosus	1.00		1.00			0.02	1.00	0.00		0.05	
Potamogeton zosteriform	8.00	6.00	2.00			0.14	1.60	0.04	0.30	0.11	
Sagittaria sp.	1.00	1.00				0.02	1.00	0.00	0.05		
Scirpus cyperinus	2.00	2.00				0.03	2.00	0.01	0.10		
Sparganium americanum	5.00	5.00				0.09	2.50	0.02	0.25		
Spirodela polyrhiza	14.00	12.00	2.00			0.24	1.17	0.07	0.60	0.11	
Typha latifolia	17.00	17.00				0.29	2.83	0.08	0.85		
Wolffia columbiana	37.00	33.00	4.00			0.64	2.85	0.17	1.65	0.21	
Totals	213.00	170.00	40.00	3.00		3.67		1.00			

Appendix III. Mead Lake - 1997

Aquatic Plant Importance

Species	Importance Value
Carex tuckermanii	0.04
Ceratophyllum demersu	0.47
Chara sp.	0.02
Elodea canadensis	0.11
Lemna minor	0.40
Najas flexilis	0.03
Phalaris arundinacea	0.02
Potamogeton crispus	0.02
Potamogeton nodosus	0.05
Potamogeton foliosus	0.02
Potamogeton zosteriformi	0.09
Sagittaria sp.	0.02
Scirpus cyperinus	0.02
Sparganium americanum	0.05
Spirodela polyrhiza	0.20
Typha latifolia	0.15
Wolffia columbiana	0.32
Total	2.00

Appendix IV. MEAD LAKE Macrophyte Data - July 31, August 3, 1997
Species Found at Transects and Density Ratings
(Density rating range: 1=sparse; 5=over abundant)

Transect	Species Density Depth: 0-1.5'	Species Density Depth: 1.5-5'	Species Density Depth: 5-10'	Species Density Depth: 10-20'
1	**0.5' sand/gravel** najfl1 (fa)	**4' sand/gravel** (fa)	**9' sand/silt** no vegetation	**11' sand/silt** no vegetation
2	**1' gravel** (fa)	**2' sand/gravel** no vegetation	**8.5' sand/silt** no vegetation	no depth > 10'
3	**0.5' rock** lemmi1 typla1 (fa)	**3' rock** (fa)	**8' sand** no vegetation	**13' silt** no vegetation
4	**1' sand/silt** cerde4 eloca1 lemmi4 spipo1 typla3 wolco3 (fa)	**2'sand** cerde4 lemmi4 spipo1 wolco3 (fa)	**6.5' silt** no vegetation	no depth > 10'
5	**1' sand/silt** cerde2 lemmi4 potno1 spipo1 wolco4 (fa)	**2' silt** cerde1 lemmi2 spipo1 wolco1	**9' sand/silt** cerde1 chasp1 (fa)	**14' silt** no vegetation
6	**0.5' gravel** lemmi spipo1 wolco1 (fa)	**3' sand** (fa)	**9.5' sand/silt** (fa)	**10' sand** no vegetation
7	**1' silt** lemmi5 wolco4 (fa)	**4.5' sand/silt** (fa)	no depth > 5ft.	no depth > 5'
8	**0.5' sand** cartu1 lemmi3 potcr1 spipo1 typla4 wolco2 (fa)	**3.5' silt** (fa)	no depth > 5ft.	no depth > 5'
9	**0.5' muck** cartu2 cerde1 lemmi3 najfl1 phaar2 sagsp1 scicy2 spaam3 spipo1 typla1 wolco2 (fa)	**2.5' sand/gravel** no vegetation	**7.5' sand/silt** no vegetation	no depth > 10'
10	**1.5' rock** lemmi1 (fa)	**4' sand** no vegetation	**7.5' sand** (fa)	no depth > 10'
11	**1' sand** (fa)	**4.5' silt** no vegetation	**7' sand/silt** no vegetation	no depth > 10'
12	site eliminated due to silting in			
13	**1' sand** cerde3 eloca2 (fa)	**3' sand/silt** cerde4 eloca2 potfo1 potzo1	no depth > 5'	no depth > 5'
14	**0.5' sand/muck** cerde4 eloca1 lemmi5 potno2 potzo3 typla3 wolco5	no depth > 1.5'	no depth > 1.5'	no depth > 1.5'

Transect	Species Density Depth: 0-1.5'	Species Density Depth: 1.5-5'	Species Density Depth: 5-10'	Species Density Depth: 10-20'
15	**1' sand/muck** cerde4 eloca3 lemmi4 spipo2 typla5 wolco4	**2.5' sand/silt** cerde4 (fa)	no depth > 5'	no depth > 5'
16	**1' silt** cerde5 lemmi4 spaam2 spipo 1wolco4	**3.5' silt** cerde5 potzo1 (fa)	no depth > 5'	no depth > 5'
17	**1' sand** cerde4 lemmi3 spipo1 (fa)	**3' silt** cerde4 (fa)	no depth > 5'	no depth > 5'
18	**1' sand/muck** cerde4 eloca1 lemmi3 potno1 potzo2 spipo2 wolco4 (fa)	**4' sand** no vegetation	**7' sand/silt** no vegetation	no depth > 10'
19	**0.5' sand** lemmi1 potzo1 spipo1 wolco3	**2.5' sand** cerde1 (fa)	**6.5' sand/gravel** no vegetation	no depth > 10'
20	**0.5' sand/concrete** no vegetation	**3.5' sand** no vegetation	**6' sand/silt** cerde1	**13' sand/silt** no vegetation
21	**0.5' sand/gravel** cerde1 (fa)	**3' sand/gravel** no vegetation	**8' sand** no vegetation	**12.5' sand/silt** no vegetation

EXECUTIVE SUMMARY

Mead Lake was formed in 1949 when the South Fork of the Eau Claire River was dammed. The resulting impoundment covers 320 acres at an average depth of 5 feet. Development began around the lake in the early 1950's following the creation of 191 platted lots by Clark County. The lots are presently in both private and public ownership. The lake is used by permanent and seasonal homeowners as well as the general public via county campgrounds, parks, and boat landings along the lake.

The lake currently suffers from high levels of algae growth in the summer months which reduces water quality and fish populations, and creates odors and aesthetically unpleasant views. A primary factor in excessive algae growth is the eutrophic condition of the lake caused by high nutrient levels. A potential source of contributing nutrients is failing septic tank systems on lakeshore lots. Septic tank systems are considered in failure when effluent is introduced into the soil at a distance of less than 3 feet from groundwater, seasonally saturated soil, or bedrock, or surface discharge of effluent occurs. The Clark County Planning and Zoning Department deemed a sanitary survey necessary to determine the functional status and code compliance of septic tank systems located on lots surrounding Mead Lake.

The Mead Lake sanitary survey was conducted in September and October, 1997, by Ayres Associates in cooperation with the Clark County Planning and Zoning Department. The survey was conducted as part of a WDNR Lake Management Planning grant administered by the county. Results were based on existing county records, a homeowner questionnaire, and field work conducted by Ayres Associates. The field work consisted of determining system type and location, surveying relative horizontal elevations for infiltration systems, soil borings, lake, bedrock, groundwater, and mottled soil. Treatment system tanks and infiltration system setbacks were measured from wells, lakeshore, habitable buildings, and property lines. Treatment system status and setback compliance were determined from these observations and based on current Wisconsin statutes and Department of Commerce code.

Survey results indicate 133 private and 59 county owned lots. Of the 133 private lots, 127 are developed and 6 are undeveloped or owned as double lots. There are presently 54 holding tanks, 11 privies, 8 lots with no system and 60 soil-based treatment systems. Of these 60 systems, 40 were determined to be failed systems, 12 sites yielded inconclusive results, and 8 meet current code requirements for separation and surface discharge. Setback distances from wells, lake, property line and habitable buildings were measured for septic, holding and pump tanks, and infiltration areas. 90 systems met all setback requirements, 9 were inconclusive, 8 had no system, and 27 were non-compliant in at least one distance.

It is expected that the number of permanent residents along the lake will increase in future years. The frequency of failed systems will increase without modification or replacement of most existing soil-based treatment systems. While at-grade or mound systems are feasible alternatives, small lot sizes and locations of wells and buildings limit or exclude placement of these systems because of setback restrictions. Other possible treatment options include sewering to the city of Greenwood, pump and haul from individual holding tanks to municipal treatment, cluster treatment systems, or an onsite treatment plant. The excessive construction costs associated with sewering to Greenwood or building an onsite treatment plant make them unrealistic options. Cluster systems are well suited for use at Mead Lake. Effluent from individual septic tanks serving groups or clusters of homes flows through small diameter sewers to a central lift station where it is pumped to a central subsurface wastewater infiltration system. Holding tanks are considered a "last resort" treatment option by the state and are less desirable for permanent residency because of frequent service requirement and increased pumping and tipping fees.

PROJECT OBJECTIVE

The purpose of this sanitary survey was to inventory and to assess hydraulic performance and code compliance of onsite wastewater treatment systems serving properties adjacent to Mead Lake.

PROJECT BACKGROUND

Mead Lake History

Mead Lake is a man-made impoundment located in the Town of Mead, Clark County, Wisconsin. The South Fork of the Eau Claire River was dammed in the late 1940's creating Mead Lake. The dam consists of an earthen embankment and a concrete dam holding a series of manually operated bottom - draw gates used to control lake levels. The lake is approximately 320 acres in size with a maximum depth of 16 ft and a mean depth of 5 ft.

Current Use

The Mead Dam Plat was approved in 1952 creating 191 small lots (typical size = 75 feet by 200 feet). Additional lots were added to the plat after 1952 bringing the present total to 193 lots. Clark County retains ownership of 59 lots; some are used for parks, campgrounds and boat ramps for public lake access and others unsuitable for development. There are 128 improved and 6 unimproved lots in private ownership. The 128 improved lots contain 103 seasonal homes or cabins and 25 permanent residences. The lake provides recreational activities such as fishing, watercraft sports, snowmobiling, camping, picnicking and hiking for both the general public and the permanent and seasonal cabin/home owners. Map 1 illustrates lot ownership and residency status.

Reason For Sanitary Survey

Development began around Mead Lake in the 1950s, with resultant onsite sewage systems installed under various sanitary codes. Since 1980, Clark County Zoning and Planning Department records indicate sanitary permits issued for 32 of 128 developed lots. Pre-1980 records provide limited information about system components or design. Current records indicate soil conditions around the lake are predominately suitable for at-grade or mound systems, and in many cases, only holding tanks. This implies that many of the installed treatment systems have their infiltrative surface in groundwater or in soils which are seasonally saturated.

The poor water quality and abundance of algae blooms in Mead Lake prompted a search for the nutrient sources causing these problems. One potential source of increased nutrients, phosphorous in particular, could be from partially or untreated septic tank effluent entering the lake via surface runoff or groundwater. A sanitary survey of Mead Lake would provide information about treatment system performance and compliance.

SITE CONDITIONS

Location

Mead Lake is located in Sections 28 and 29, T.27N., R.3W, Mead Township, Clark County, Wisconsin. The lake is 9 miles west of Greenwood, Wisconsin, and 13 miles south of Thorp, Wisconsin.

Landscape Position

Mead Lake occupies an alluvial valley in an area consisting of glacial till. The topography surrounding the lake varies from wetlands to undulating hills and low sandstone mounds.

Surface Waters

The surface area of Mead Lake covers 320 acres with an average depth of 5 feet. The lake is fed by the South Branch of the Eau Claire River and Rocky Run Creek which joins the South Branch approximately 1 mile above the headwaters of the lake. The watershed feeding Mead Lake encompasses over 100 square miles of forest and farmland and is part of the Chippewa River watershed which eventually enters the Mississippi River below the town of Pepin, Wisconsin.

The lake, whose water quality is considered as poor to very poor by the USGS, can be classified as eutrophic. The poor water quality results from high levels of seasonal algae growth which directly reduce water clarity and increase water temperature, and indirectly reduce the concentration of dissolved oxygen and cause offensive odors. In Mead Lake, as in many lakes, the availability of phosphorous limits the amount of plant and weed growth. When phosphorous concentrations are elevated, excessive algae growth can result. These elevated phosphorous levels can be impacted by leaking and failing septic tank systems, but more typically result from urban and/or agricultural runoff.

Vegetation

Vegetation types associated with Mead Lake includes mixed maple/oak/pine forest on higher landscape positions tending to birch and aspen in wetter areas and cattail/sedge in ponded or wet areas. Several large expanses of undeveloped land are found along the lake typically in the wetter areas unsuitable for development. These areas are predominately vegetated by facultative or obligate wetland species.

SURVEY PROCEDURE

The survey was conducted using homeowner questionnaires, existing county records, owner interviews, and field investigations completed during the fall of 1997.

A sanitary survey questionnaire was prepared by Ayres Associates in cooperation with Clark County Planning and Zoning departmental staff. They were mailed to property owners of the 133 private lots in August, 1997. The questionnaire elicited data about ownership, residency, sewage system information, system maintenance and performance history, and general comments. A site sketch was requested detailing locations of system components, buildings, and wells. At the start of the field work over 90% of the questionnaires had been completed and returned to the Zoning Department. This very high rate of questionnaire return suggests landowners consider this project a high priority. A copy of the questionnaire is found in Appendix A.

The field work was conducted by Ayres Associates personnel. Jay Shambeau, Clark County Zoning Administrator, provided access to county plats, records, maps, and historical information on the lake. Kent Langfoss, Clark County Land Technician, provided assistance in the field and with record searches. Leroy Jansky, Wisconsin Department of Commerce, provided procedural and code guidelines relative to sanitary survey procedures.

Survey procedures involved locating and identifying wastewater treatment system components for all privately-owned lots. System components were located using landowner supplied lot information, physical measurements and metal probes. Probes were also used to determine subsurface infiltrative surface depths. Where obvious, the physical condition of system components was noted. A hand augered soil boring was completed in the vicinity of each system to determine soil characteristics and depth to limiting conditions such as mottling, bedrock and groundwater. Described soil characteristics include texture, color, mottling, rooting and horizon depth. Descriptions utilized standard Natural Resource Conservation Service (NRCS) nomenclature. Setbacks from wells, lake, property boundaries, and buildings were measured from septic, dose and holding tanks, privies, and infiltration areas. Relative elevations were surveyed for soil borings, lake, bedrock, groundwater, mottles, and infiltrative surface. Elevations were tied to a benchmark set at the dam and correlated to the lake elevation. Lake elevation was checked each morning before field work began. Collected information was recorded on field data sheets and in a survey notebook. A copy of the survey data sheet, the survey data, and survey metadata are provided in Appendix A.

SOILS INFORMATION

While the current soil survey for Clark County has been completed, the results have not yet been published. Available county soil data compiled by the NRCS was provided by the Clark County Zoning Department to the survey team. Map 2 details the soil types associated with Mead Lake.

Soils in the Mead lake area were formed in silty to sandy glacial till and alluvial deposits. These deposits overlay Cambrian sandstone at depths ranging from 3 to 20 feet. The bedrock at the soil/bedrock interface is typically eroded and weakly structured. Mottled conditions, resulting from the oxidation/reduction reactions of iron in the soil, are an indicator of zones of seasonally saturated soils. Typically, these conditions are found just above bedrock, the permanent water table, a perched water table or in very slowly permeable soils.

A typical soil profile for the Mead Lake lots consists of 4 inches of loam or sandy loam overlaying 30-50 inches of sand or fine sand with mottles appearing within 20 inches of the water table. The sands are typified by striking colors ranging from medium chroma and value yellow reds to medium value/high chroma reds. The lower, wetter areas containing organic soils within lot boundaries along the lake have typically been filled. Dredgings from lake construction was used extensively for fill along the south shore of the lake yielding a varied mixture of fine-textured surface horizons overlaying buried organic and mineral soils.
As illustrated by the the soil map there are four soil mapping units (NRCS nomenclature) found in the survey area. The Eauclaire loamy sand (EaB) and Rockdam sand (RkA) are both

moderately well-drained, non-hydric, sandy textured soils. Bedrock is found at depths greater than 60 inches. The Ludington-Fairchild sands complex (LxB) contain two series of sandy/loamy sand soils 20 to 40 inches over soft bedrock. The Ludington series is moderately well drained while the Fairchild is somewhat poorly drained; neither is a hydric soil. The Fairchild-Elm Lake complex (FeA) is composed of the Fairchild (see description above) and Elm Lake soils. The Elm Lake series is poorly to very poorly drained sandy/loamy sand found 20 to 40 inches over soft bedrock. Ponding frequently occurs on this hydric soil. Detailed NRCS descriptions of these soils are included in Appendix B.

RESULTS AND FINDINGS

The type of onsite treatment system for each private lot was determined using owner records, questionnaire results and onsite inspections. Existing onsite treatment system types are illustrated by map 3 and summarized in table 1 below.

TABLE 1. PRIVATE LOTS - TREATMENT SYSTEM TYPES

SYSTEM TYPE	NUMBER	% TOTAL
UNKNOWN	2	0.8
NONE	8	6.0
PRIVY	11	8.2
HOLDING TANK	54	40.6
SEEPAGE PIT	6	4.5
DRYWELL	12	9.0
AT-GRADE	1	0.8
MOUND	2	1.5
SEEPAGE TRENCH/BED	38	28.6
TOTALS	134	100 %

System failures were identified by calculating the separation between the absorption area surface and limiting condition using survey data and also determining if surface discharge of sewage was occurring. The determination of failure is based on the definition of sewage system failure found in Section 145.245 (4), Wisconsin Statutes, which reads as follows:

> "FAILING PRIVATE SEWAGE SYSTEMS. The department shall establish criteria for determining if a private sewage system is a failing private sewage system. A failing private sewage system is one which causes or results in any of the following conditions:
>
> (a) The discharge of sewage into the surface water or groundwater.
>
> (b) The introduction of sewage into zones of saturation which adversely affects the operation of a private sewage system.
>
> (c) The discharge of sewage to a drain tile or into zones of bedrock.
>
> (d) The discharge of sewage to the surface of the ground.

(e) The failure to accept sewage discharges and back up of sewage into the structure served by the private sewage system."

Note that (a), (b), and (c) above are currently interpreted as requiring the 3 foot vertical separation above groundwater and bedrock that is used in the above Failure - High Groundwater/Seasonally high groundwater/Bedrock categories.

It was not possible to determine or identify the number of systems that failed by back up of sewage during peak flow nor was it possible to determine number of systems that would fail from conversion of seasonal to permanent residency. These conversions can result in significant and rapid increases in hydraulic loading yielding failures resulting in surface discharge of sewage or back ups into the structure.

The onsite sewage system status for all lots is illustrated by map 4 and summarized below in table 2.

TABLE 2. ONSITE SEWAGE SYSTEM STATUS

SYSTEM STATUS	NUMBER SYSTEMS	% TOTAL
NO SYSTEM	8	4.1
PRIVIES	11	5.7
FAILURE - HIGH GROUNDWATER	21	10.9
FAILURE - BEDROCK	3	1.6
FAILURE - SURFACE DISCHARGE	1	0.5
FAILURE - SEASONALLY HIGH GROUNDWATER	15	7.8
INCONCLUSIVE	13	6.7
NO FAILURE	8	4.1
HOLDING TANKS	54	28.0
N/A - COUNTY LAND	59	30.6
TOTALS	193	100%

The system status conditions are grouped into the following categories:

1. No System. This category covers all private parcels which have no onsite sewage system on the premises. This includes all parcels which are vacant, owned as part of a double lot, and a few which have been improved.

2. Privies. This category covers all lots that have no treatment system but utilize a privy for waste disposal.

3. Failure: High Groundwater. Systems in this category are considered to be a serious health and environmental hazard due to pollution of groundwater. In general, the bottom of the system in or within three feet of the existing groundwater table.

4. Failure: Bedrock. The bottom of the absorption system is less than three feet above a bedrock condition. Systems installed in or too close to bedrock pose a serious threat to groundwater and public health due to groundwater pollution.

5. Failure: Surface Discharge or Backup. The operation of the system is considered to be a health hazard because untreated sewage is directly accessible to humans, animals, and insects which could spread disease or contaminants.

6. Failure: Seasonally High Groundwater. The existing system is considered to be a health hazard due to pollution of periodically high groundwater. This system lacks the minimum of 3 feet of separation from the system bottom to estimated high groundwater. Estimated high groundwater is based on soil mottles which indicate that soil saturation occurs periodically.

7. Inconclusive. Inconclusive evidence to determine condition of the existing system due to inability to determine infiltrative system type, location, or elevation.

8. No Failure. The existing soil absorption system has at least a 3 foot separation above soil mottling, observed groundwater and bedrock and shows no indication of surface discharge. This soil absorption system and/or septic tank may be undersized, but are otherwise compliant.

9. Holding Tank. Soil and site conditions have dictated the use of holding tanks as a treatment option.

10. N/A - County Land. Land owned by Clark County.

Map 5 illustrates compliance with setback distances by holding tanks, septic tanks, and infiltration systems from lakes, wells, inhabited buildings and property lines. The setback distances for septic and holding tanks are based on Wisconsin Department of Commerce ILHR 83.15 (Table 12m) code and appears as follows:

MINIMUM SETBACK DISTANCES FOR TREATMENT TANKS, PUMP AND SIPHON TANKS, SERVICING SUCTION LINES AND PUMP DISCHARGE LINES	
Setback Element	Horizontal distance (feet)
All Structures, Swimming Pools	5
Lot or Property Line	2
Underground water supply System and Cistern	10
Well, High Water mark of Lake, Stream, Pond, Flowage or Reservoir	25

The setback distances for infiltration systems are based on Wisconsin Department of Commerce ILHR 83.10 (1) and reads as follows:

> “Site Requirements. (1).........(T)he soil absorption system shall be located not less than 5 feet from any lot line; 10 feet from a water service, or an uninhabited slab constructed building; 15 feet....from a habitable slab constructed building measured from the slab; 25 feet from the below grade foundation of any occupied or habitable building or dwelling, public water main or cistern; 50 feet from any water well , reservoir or from the high water mark of any lake, stream or other watercourse.....”

The following tables summarize the survey results regarding setbacks.

TABLE 3A. SETBACK COMPLIANCE STATUS - SEPTIC TANK

ELEMENT	# COMPLIANT	# NON-COMPLIANT	# UNKNOWN
WELL	43	8	9*
LAKE	59	0	1
PROPERTY LINE	57	1	2
BUILDING	55	3	2

* The high number of well setback unknowns is due to well location inside building.

TABLE 3B. SETBACK COMPLIANCE STATUS - INFILTRATION SYSTEM

ELEMENT	# COMPLIANT	# NON-COMPLIANT	# UNKNOWN
WELL	34	15	11*
LAKE	50	7	3
PROPERTY LINE	53	4	3
BUILDING	48	9	3**

* The high number of well setback unknowns is due to well location inside building.
** Setback from building is based on 15 foot distance.

TABLE 3C. SETBACK COMPLIANCE STATUS - HOLDING TANKS

ELEMENT	# COMPLIANT	# NON-COMPLIANT	# UNKNOWN
WELL	47	4	3*
LAKE	54	0	0
PROPERTY LINE	54	0	0
BUILDING	52	2	0

* The high number of well setback unknowns is due to well location inside building.

The parcel ID number, residency status, owner's name and address, and status and compliance for each system are listed in Appendix C of this report.

CONCLUSIONS

Of the 134 private lots surveyed, 2 sewage treatment systems meet all code requirements for setbacks, separation and surface discharge; 8 systems meet code criteria for separation and discharge but not setbacks. There was one system failure due to surface discharge and evidence that several other systems had experienced surface discharge though they were not in failure at the time of the survey. 39 infiltration systems were determined to be in failure due to insufficient separation distance from a limiting factor. Based on the age of many of the systems, it can be assumed there are deteriorating and leaking septic and holding tanks and undersized infiltration areas. Many of the failed systems were installed using methods and components not acceptable by present code. The two systems meeting all code requirements are mound systems installed after 1995.

Soil and site conditions at Mead Lake do not exclude the use of new or replacement onsite treatment systems. Numerous lots appear to have adequate soil for installation of onsite systems meeting all code requirements. A detailed soil evaluation would be required to determine site potential for replacement onsite treatment systems. Map 6 illustrates the depth to limiting factors from ground surface for all private lots.

Two points of concern relative to failed systems are phosphorous and health hazards associated with untreated wastewater reaching groundwater or the ground surface. As described previously, excess phosphorous introduced to a phosphorous limited lake can cause elevated levels of algae growth. While it can be assumed there is some contribution by failed septic tank systems to this increase, it is minuscule compared to the phosphorous loading resulting from agricultural runoff and delivered by the lake's inflow. It is unlikely a noticeable difference in algae growth or water quality would result under a scenario whereby all septic tank systems were brought to code. Of greater concern is the possibility of fecal contamination of groundwater or lake water from improperly treated wastewater. The three foot separation rule was designed to provide adequate treatment of pathogens in wastewater by the soil. While systems located within three feet of limiting factors can provide satisfactory hydraulic treatment due to the high permeability of the sandy soils associated with Mead Lake, adequate biologic treatment is not taking place.

There are only 25 permanent residents along Mead Lake at this time. As evidenced elsewhere in similar scenarios, seasonal use is often replaced by permanent residency as owners retire or sell. Increased use will generate higher wastewater flows taxing already failed and inadequate systems. Higher flows increase the risk of environmental hazards or groundwater contamination in at least three ways: 1) elevated use of failed systems results in more untreated wastewater and associated pathogens reaching groundwater, 2) increased use of failed or undersized systems results in backups or surface discharge of sewage, and 3) the high percentage of shallow wells utilized by homeowners are more susceptible to contamination.

ALTERNATIVES

Treatment Options

Alternatives for treating wastewater generated by homes and cottages at Mead Lake include:

- No Action
- Upgrade Existing Onsites
- Holding Tanks
- Clusters
- Regional
- Construct Onsite Treatment Plant

<u>No Action</u>. This option would allow existing systems to continue at current treatment levels with no change in design or requirements. This option is unacceptable as many systems are in failure and posing serious health and environmental threats from untreated wastewater entering the groundwater or discharging to the surface; additionally, there is the potential, however small, of phosphorous contribution to the lake.

<u>Upgrade Existing Onsites</u>. This option would require all treatment systems be upgraded to meet current code requirements. In most cases the installation of at-grade or mound systems would be required due to shallow depths to groundwater, mottles, or bedrock. Providing infiltration sites that meet all separation and setback requirements could be difficult due to small lot sizes and central locations of structures and wells. While this would not be an equitable solution for all lot owners, it would greatly diminish potential for both fecal contamination of groundwater and phosphorous contribution to the lake.

Holding Tanks. At present, the most common form of treatment at Mead Lake. While holding tanks work well for low impact seasonal users, as permanent residency increases at Mead Lake, holding tanks become a poor option because higher costs resulting from increased service requirement and escalating tipping fees. Based strictly on code, holding tanks can be used only if no other onsite treatment system is feasible on the property.

Cluster Systems. Cluster systems use a single infiltration area for groups or clusters of homes connected by a common collection system. The cluster system concept would be well suited for Mead Lake because of the natural grouping of improved lots. Based on existing soil mapping and topographic information there appears to be suitable soil available in the Mead Lake vicinity to provide treatment sites for clusters.

Regional. Regional treatment would entail constructing a sewer line from Mead Lake to Greenwood for final treatment. This option would be very expensive and is not considered a viable option.

Construct On Site Wastewater Treatment Plant. This option would require construction of a collection sewer and central onsite treatment plant at Mead Lake. Sewage would be treated and discharged to the South Fork of the Eau Claire River below the Mead Lake dam. This would be very expensive to construct and maintain and is not considered a viable choice for Mead Lake property owners.

Recommendation:

Ayres Associates recommends that a cluster treatment system be considered at Mead Lake. There appears to be suitable soil for central infiltration areas, the lots are amenable to groupings, small diameter sewer would install easily, and costs could be shared equitably among all owners.