Cable Lakes Lake Management Report

Cable Lakes
Cable, Wisconsin

Prepared for:

Cable Lakes Association
Cable, Wisconsin

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Executive Summary

Cable Lakes Association retained Ayres Associates to conduct a lake study on Cable Lakes located in Cable, Wisconsin. The tasks involved in the lake study are as follows:

Task I: Coordination with Cable Lakes Association - At the beginning of the project a kickoff meeting with members of Cable Lakes Association and students from Sigurd Olson Environmental Institute at Northland College to discuss the project.

Task II: Water Quality Testing - The water quality testing consisted of taking samples from locations on Wiley and Cable Lakes at spring and fall turnovers and throughout the summer months. An assessment of the shoreland development was also conducted by Ayres in conjunction with the water quality testing.

Task III: Watershed Evaluation – For this evaluation the watershed boundary of Cable Lakes was delineated and the land uses in the watershed were mapped. The existing ordinances of Bayfield County shoreland and wetland zoning was reviewed to determine the protection it offered the lakes. A water quality model was used to create a hydrologic and morphometric module that evaluated flows to and through the lake and a non-point and point source modules evaluated phosphorus loading.

Task IV: Sensitive Area Study/ Reclassification Information – Several people at DNR were contacted to conduct a sensitive area study as part of this lake study. Information was also collected on the northern portion of Cable Lake locally known as Mud Lake.

Task V: Lakeshore Resident Survey - A survey of the lakeshore residents was taken to assess the views they have of the lake.

Task VI: Aquatic Plant Survey/Shoreland Assessment - A survey of the aquatic plants in the lake was conducted to determine variety and density of species

Task VII: Listed Threatened, Rare, or Endangered Species - Bald eagles currently nest on the shoreline of the lake. The location of the nesting areas is shown on the map so residents are aware of the area and can avoid it so as not to disturb the nesting eagles.

Task VIII: Canoe Recreational Trail - The lake association is in the process of developing a canoe recreational trail through the lake system. The information gathered in this study such as the sensitive areas and different plant communities in the lake will be used for the trail creation.

These tasks were conducted during the summer of 2004. The information gathered is presented in the following report.

Introduction

Cable Lake Association retained Ayres Associates to conduct a lake study on Cable Lakes. The purpose of the lake study was to determine the water quality of the lake, collect data to assist the association in reclassification of unique areas of the lakes, assess the watershed and shoreline of the lake and survey the aquatic plants in the lake. The lake study consisted of the following tasks: coordination with Cable Lakes Association, water quality testing, watershed evaluation, sensitive area/reclassification information collection, lakeshore resident survey, aquatic plant survey, endangered species assessment and canoe recreation trail information gathering.

Cable Lakes are located in Bayfield County west of Cable Wisconsin. The lakes consist of Cable and Wiley Lakes. The northern basin of Cable Lake is locally known as Mud Lake, for this study it will also be referred to as Mud Lake. They cover approximately 224 acres of land with a maximum depth of 43 feet. The lakes have low development density and support a variety of fish and aquatic plants.

The purpose of this study is to collect water quality information on the lakes. This data was used to determine the current water quality of the lake, identify any lake management needs and set goals to achieve these, and establish background data for future studies. The analytical data collected from the lake will be used in conjunction with an inventory of the watershed to develop a lake water quality model using the Wisconsin Lake Modeling Suite (WiLMS). Additional information was collected to assist the lake association in reclassifying Wiley Lake and the "Narrows" and classifying "Mud Lake" as a separate lake instead of a portion of Cable Lake.

Information was collected on the watershed and shoreline to aid the lake association in their quest to protect the lake and establish stricter controls in the sensitive areas on the lakes. The members of the Lake Association would also like to see more recreational and educational uses of the lake. An example of this is establishing a canoe trail on the lake marking interesting areas such as the sensitive areas. To increase awareness and education on the lake, a presentation was given at the Cable Community Center explaining the lake study and presenting the findings. The study was completed as outlined in the following tasks.

Task I: Coordination with Cable Lakes Association - At the beginning of the project a kickoff meeting with members of Cable Lakes Association and students from Sigurd Olson Environmental Institute at Northland College was held. At this meeting project issues were discussed, students were trained on water sampling techniques and the first set of samples were collected.

Task II: Water Quality Testing - The water quality testing consisted of taking samples from locations on Wiley and Cable Lakes at spring and fall turnovers and throughout the summer months. Two sample points were chosen on Cable Lake and one on Wiley. Samples were collected five times throughout the summer and tested for a number of parameters to determine the quality of the water in the lakes. An assessment of the shoreland development was also conducted by Ayres in conjunction with the water quality testing. A rating scheme was used to determine the amount of shoreland development on the lake and the number of structures on the lakeshore. The information gathered will aid in the reclassification process.

Task III: Watershed Evaluation – For this evaluation the watershed boundary of Cable Lakes was delineated and the land uses in the watershed were mapped. Using this information the amount of runoff and the pollutant load it carried into the lakes was estimated. The existing

ordinances of Bayfield County shoreland and wetland zoning was reviewed to determine the protection it offered the lakes. Using the results of the water quality testing and flow estimates for the watershed a water quality model for the lake was developed. The model developed the hydrologic and morphometric module that evaluated flows to and through the lake, the non-point and point source modules evaluated phosphorus loading.

Task IV: Sensitive Area Study/ Reclassification Information – There are at least two areas on the lakes that are of special concern and may be deemed "Sensitive Areas" by DNR. Several people at DNR were contacted to conduct a sensitive area study as part of this lake study. Information on the vegetation and shoreline were collected to assist in the sensitive area study. Information was also collected on the northern portion of Cable Lake locally known as Mud Lake. The members of the Association would like to see this classified as a separate lake. The Association members would also like to see Wiley Lake and the Narrows change from Class II to Class III to afford additional protection to these sensitive areas. The information needed to apply for a change of classification with county zoning was collected during this study.

Task V: Lakeshore Resident Survey - A survey of the lakeshore residents was taken to assess the views they have of the lake. A survey was created that had questions specific to the Cable Lakes. The survey was mailed to lakeshore residents and lake users. The survey was tallied by Cable Lakes association and the results will be presented in this report.

Task VI: Aquatic Plant Survey/Shoreland Assessment - A survey of the aquatic plants in the lake was conducted to determine variety and density of species. Students from the Sigurd Olson Institute conducted the survey on several visits to the lakes. A series of transects was set up for each lake and points were sampled along them. A variety of vegetation was found throughout all three lakes.

Task VII: Listed Threatened, Rare, or Endangered Species - Bald eagles currently nest on the shoreline of the lake. The location of the nesting area is shown on the map so residents are aware of the area and can avoid it so as not to disturb the nesting eagles.

Task VIII: Canoe Recreational Trail - The lake association is in the process of developing a canoe recreational trail through the lake system. The information gathered in this study such as the sensitive areas and different plant communities in the lake will be used for the trail creation.

Methods

Water Quality Testing

The water quality testing consisted of taking samples from locations on Cable, Wiley, and Mud lakes at spring and fall turnovers and throughout the summer months. At spring/fall turnover samples were collected at locations on all three lakes. Cable Lake contains two basins that are at least 30 feet deep. The basin just south of Mud Lake was chosen for sampling at the turnover events only. Mud Lake and Wiley Lake were sampled at the turnover events and throughout the summer. Mud Lake was monitored throughout the summer because it is located near the outlet. It was assumed that the water entering Cable Lake from the watershed will eventually flow to this area creating a sampling point that is the most representative of the whole lake. Wiley Lake is relatively shallow so we assumed it did not stratify during the summer months. For this reason one sample point was chosen and all samples were taken from this area.

Samples were collected at spring and fall turnovers and once a month June through August. Table 1 lists the parameters the collected samples were tested for during the lake turnover events:

Table 1

Lake Parameters
Dissolved Reactive Phosphorous
Total Phosphorous
Total Kjeldahl Nitrogen
Nitrate Plus Nitrite
Ammonia
Alkalinity
Chloride
Chlorophyll a
Color
Hardness
Suspended Solids
Total Dissolved Solids
Turbidity
Conductivity
Temperature
pH
Dissolved Oxygen
Secchi Disk Reading

Table 2 lists the parameters that were tested for in the monthly lake samples.

Table 2

Lake Parameters
Total Phosphorous
Total Kjeldahl Nitrogen
Nitrate Plus Nitrite
Ammonia
Chlorophyll a
Conductivity
Temperature
pH
Dissolved Oxygen
Secchi Disk Reading

Three water samples were collected at each location in Cable and Mud Lakes, one each from the top, bottom and thermocline. This was done to assess the loading of phosphorous in the lake and its effects on the water quality. In Wiley Lake, samples were taken from the top and bottom only. The water samples were collected by students from the Sigurd Olson Institute under supervision of Mike Gardner. The students were trained in sampling techniques by Ayres Associates.

All of the samples were sent to the State Laboratory of Hygiene for analysis. Sample bottles were provided by WDNR. Meters to measure dissolved oxygen, conductivity, pH, and temperature as well as water sampling equipment were provided by Ayres. The meters and equipment were shipped to the Association for a one-week period during each sampling month. When sampling is complete for that round, the Association returned the meters and equipment.

An assessment of the shoreland development was conducted by Ayres in conjunction with the water quality sampling. A rating scheme was used to determine the amount of shoreland development on the lake and the number of structures on the lakeshore. The development was rated from 1 to 5 according to the following criteria.

1. Development with any of the following: riprap, seawall, cleared shoreline, no or little setback on structures, boathouses, and vegetation cleared from lake bottom.

2. Development with shoreline clearing and no buffer.

3. Development with some shoreline clearing, some buffer, docks, swimming rafts.

4. Light development with shoreline buffer, little clearing and no docks or rafts.

5. No development, natural shoreline.

Photos were taken to document the rating scale. A map was created showing the development on the lake. The information gathered will aid in the reclassification process.

Watershed Evaluation

The watershed boundary for Cable lakes was delineated and land uses within the watershed were mapped. The watershed boundary was delineated using a USGS topographic map. The WDNR Web View website was used for the land use in the watershed. This map was checked against the county's mapping and aerial photos. Areas of land use were determined from an aerial photo and the land use maps. These areas were used in the Natural Resource Conservation Service TR-55 model to estimate runoff amounts. An EPA program called STEPL was used to estimate pollutant loads based on land uses. The areas of each land use were entered along with information on septic systems from the lake lots. The program determined the amounts of nitrogen, phosphorous, biological oxygen demand (BOD) and sediment that is reaching the lake from the watershed. Estimates were made for lot sizes and the number of people residing at each lot. It was assumed each lot was 1 acre and 2 people were at the residence year round. Surface drainage patterns were determined using the topographic maps and visual assessment of the watershed. Management recommendations have been made based on the information collected.

The current zoning ordinances were reviewed to determine what protection they afford to the lakes. Copies of the shoreland and wetland zoning for Bayfield County were obtained online and reviewed. The information was summarized for this report.

Using the results of the water quality testing and flow estimates for the watershed a water quality model was developed for the lake. The WiLMS model was used to develop the hydrologic and morphometric module, which evaluated flows to and through the lake, the non-point and point source modules evaluated phosphorus loading in the lake. The estimates used in the STEPL program for lot size and septic systems were also used in this model. The results of the model are presented in this report.

The value of watershed modeling is to help identify potential nutrient supplies to the lake system. Modeling in this study is limited to the existing land use condition. Future modeling to be considered would include projections of development within the watershed and the resultant impacts on lake water quality. The analysis also could consider land management practices that would minimize most or nearly all of the impacts due to development. This level of analysis is beyond the scope of this study, but should b e considered in future studies.

Sensitive Area Study

Cable Lakes Association indicated there are at least two areas on the lakes that are of special concern and may be deemed "Sensitive Areas" by DNR. We contacted Dan Ryan and Frank Koshere of DNR and neither one believed that there have been specific studies carried out on these lakes pertaining to Sensitive Area classification. Mr. Koshere did express interest in conducting a study to determine if any Sensitive Areas do exist on the lake. However, DNR had neither time nor funding to conduct a study concurrent with ours. The Association may wish to contact Mr. Koshere again to see if their DNR would be able to conduct a study another year.

The Association also expressed concern regarding the classification of Wiley Lake and the Narrows and the designation of Mud Lake. Additionally, the members expressed concerns on the classification of Headquarters Lake. The members of the Association would like to see Wiley Lake and the Narrows change from Class II to Class III to afford additional protection to

these sensitive areas. They would also like to see Mud Lake as a separate lake from Cable Lake and classified as Class III. Similarly, Headquarters Lake, connected to Cable Lake via a narrow channel, should be classified as Class 3. Below is the description of lake classifications from the Bayfield County Zoning Ordinance (Sec. 13-1-32 Inland Lake Classification and Shoreland Lot Development Requirements.)

> ***Class 1 (Most Developed Lakes). Objectives:*** Preserve and enhance water quality to provide conditions for recreational use and aesthetics; retain existing natural shorelines and encourage restoration; acknowledge a mix of natural and developed shorelines; protect or restore a self-sustaining local ecosystem capable of supporting diverse native flora and fauna; promote peace and quiet; balance public and riparian interests in recreational uses.
>
> ***Class 2 (Moderately Sensitive Lakes and Moderately Developed). Objectives:*** Preserve and enhance water quality to provide conditions for recreational use and aesthetics; balance the current level of development with the sensitivity of these lakes to maintain and protect water quality; maintain and restore natural shoreline aesthetics and encourage restoration; identify and protect current natural and undeveloped areas; promote peace and quiet; protect or restore a self-sustaining local ecosystem capable of supporting diverse native flora and fauna; balance public and riparian interests in recreational uses.
>
> ***Class 3 (Most Sensitive Developed and Undeveloped Lakes). Objectives:*** Maintain and protect water quality; protect or restore the natural/wild appearance of shorelines and lands visible from the water; promote a quiet and peaceful experience; protect or restore a self-sustaining local ecosystem capable of supporting diverse native flora and fauna; discourage commercial use.

For this study, information was collected on the sensitive areas in the lake, on the shoreline and throughout the watershed to aid the association in their quest to achieve these goals. In these areas the information required for classification was collected such as surface area, lake type, maximum depth, shoreline development, watershed area, current development level and drainage patterns. The surface area lake type, maximum depth was gathered form DNR mapping. The shoreline development was determined during the shoreline assessment that was conducted on the lake. The watershed area was determined from USGS topographic mapping. Drainage patterns on the lakes were determined from topographic mapping and field observation.

Lakeshore Resident Survey

A survey of the lakeshore residents was taken to assess the views they have of the lake. The survey was sent to the residents via mail and they returned them to the Association. The survey assessed the problems residents foresee with the lake, their activities and use of the lake, management practices that have been implemented, etc.

Ayres Associates provided several sample surveys to the Association. The Association chose the questions that most pertained to their lakes. The survey was edited by Ayres and mailed to the residents. The residents completed the survey and mailed them to the Association President for recording. The Association tabulated the results and supplied a copy for this report. A summary of the results was made and included in the Tables section of this report.

Aquatic Plant Survey

A survey of the aquatic plants in the lake was conducted to determine variety and density of species. The survey was conducted by students from the Sigurd Olson Institute under the supervision of Mike Gardner. Following is the procedure that was provided by the students.

The macrophyte surveys for Mud, Wiley and Cable Lakes were performed on three separate occasions (August 19, 26 and September 1, 2004, respectively). Prior to sampling, digital GIS maps were created for each lake based on topographic maps. Using a measurement tool in ArcGIS, the length of each shoreline was measured in meters. The shoreline was then divided into transect points every 125 meters for Mud and Wiley Lakes, and every 200 meters for Cable Lake (a transect interval of 125 meters on Cable Lake would result in 52 sampling points, which was simply not feasible given the time constraints). This translated into 32 survey points for Cable Lake, 24 points for Wiley Lake, and 16 points for Mud Lake. A list of UTM coordinates for each transect was recorded in an Excel file.

Surveying was conducted in a canoe as it was necessary to access shallow water. At each transect point, species were recorded beginning from the water's edge and traveling perpendicular from the shoreline to a depth of 6 feet.

A data sheet was prepared in advance using a list of common aquatic species, with spaces provided to record additional species. Species were divided in to emergent and submergent plants. Species found in the first 0-3 feet were labeled with a '1' on the data sheet, plants found from 3-6 feet were labeled with a '2' and plants found at both depths were labeled with a '3'. Plants that could not be identified on the water were collected an later identified using the Wisconsin Herbarium website an the USDA-NRCS Plants Database (online resource). This prdecure was used on all there lakes. Exceptions occurred when there were not two distinct depth zones (extremely shallow or steep drops on shoreline). These exceptions have been noted on the data sheets.

Results

Water Quality Testing

The results of the water quality testing are listed in Table 1, 2 and 3 for Cable, Wiley and Mud Lakes respectively in the Tables section of this report.

Watershed Evaluation

The entire watershed of Cable Lakes covers approximately 736 acres of land. Of this, lake surface area makes up approximately 243 acres, conifer forest 60 acres, mixed deciduous forest 348 acres and wetlands 65 acres. Table 4 in the Tables section includes detailed acreages of the land uses in the entire watershed and a breakdown of each lake's watershed.

The rate of runoff was calculated for the entire watershed using TR-55. According to TR-55 the peak discharge for the 100-year storm is 115 cfs. Table 5 indicates the peak discharge for the 2, 5, 10, 25, 50 and 100-year storm event.

The nutrient loading from the watershed to the lakes was calculated using STEPL. This program calculated the amount of nitrogen, phosphorous, biological oxygen demand and sediment load into the lakes from the watershed. Table 6 gives these loads in lb/year and tons/year.

Water quality models for the lakes were created using WiLMS. The model determines the amount of phosphorous loading to the lake from point sources, non-point sources and areal loading. Table 7 shows the results of the WiLMS modeling. WiLMS was also used to determine the TSI (trophic status index) for each lake. These results are presented in Table 8.

Sensitive Area Study

Information was collected to aid in the reclassification of Wiley Lake and the Narrows. Information was also collected to aid in the classification of the northern basin of Cable Lake to a separate lake known as Mud Lake. The information needed to apply for reclassification has been provided in Table 9.

Lakeshore Resident Survey

The results of the lakeshore resident survey are provided in Table 10. A copy of the survey along with tabulated results is included in the Appendix A.

Aquatic Plant Survey

The aquatic plant survey was completed by students of Sigurd Olson Institute. From the data they provided maps were created for each lake indicating the location of the emergent vegetation and a mix of emergent and submergent vegetation. The maps are included in the Figures section labeled Figures 1, 2 & 3 for Cable, Wiley and Mud lakes respectively. The report provided by Sigurd Olson listing the plant species found in each transect and the transect locations is included in Appendix B.

Discussion

Water Quality Testing

Water samples were collected from the lakes at turnover events in May and September and each month between. The samples were taken from the top and bottom on the stratified lakes (Cable and Mud) and from the surface on Wiley. The water samples were sent to the State Lab of Hygiene for analysis. An explanation of the results is included below.

Dissolved Oxygen (D.O.)

Dissolved oxygen is one of the most important parameters in a lake. The DO is necessary for the survival of fish and the concentration of DO determines the form and concentration of the other chemical parameters in the lake water. The minimum water quality standard for DO in warm water lakes and streams is 5 mg/l. This is the minimum amount of oxygen fish and invertebrates require for survival and healthy growth. If the concentrations dip below this level, fish kills may occur. Low dissolved oxygen typically occurs happens in the winter in shallow lakes, and is more severe during winters with thick ice and heavy snow cover. At the bottom of the lake, the oxygen levels decrease due to decomposition of plants. At these low levels of oxygen, nutrients and other compounds are released from the sediment. The low levels of oxygen may also occur during the summer months in stratified lakes where the water at the bottom becomes anoxic because it can not mix with surface water and replenish the oxygen supply. In stratified lakes such as Cable and Mud, turnover in the spring and fall completely mix the lake spreading the nutrients and oxygen throughout the water column.

Turnover can be detected in the DO and temperature graphs shown in the Figures section of this report. At turnover the temperature and DO readings are nearly the same throughout the water column. When stratification occurs, the temperature decreases with depth and a rather large jump in temperature occurs at the thermocline. This is the layer of water that separates the top of the lake from the bottom and prevents mixing of these waters.

DO concentrations are also affected by temperature; colder water can hold more oxygen than warmer water. At 32°F water can hold 15 mg/l of oxygen and only 8 mg/l when the temperature reaches 77°F. Oxygen enters the water through the surface and is produced by the plants through photosynthesis. Oxygen is also used by the plants through respiration and by decaying plant material. The DO level is constantly changing due to the ways it is produced and consumed. The DO and temperature data collected for this study can be found in Tables 1, 2 & 3 and in the graphs in the Figures section. In Cable and Mud lakes the DO drops below the 5 mg/l threshold during the summer months. This is due to the stratification. The same results can be seen in the temperature readings. A definite drop is seen near the bottom of the lake in the summer months and the temperature stays level at the turnover events. Wiley Lake also showed a drop in DO in June and July meaning it was probably stratified at those times. From the data it appears the thermocline is at about 20 feet in Cable, 15 feet in Wiley, and 20 feet in Mud. In the areas where the DO drops below 5 mg/l fish will not be found, they move to other areas of the lake that have an adequate oxygen supply.

Nutrients

The nutrients that have the greatest impact on vegetation in a lake are phosphorus and nitrogen. Total phosphorus is used to measure the lakes nutrient status. Phosphorus promotes plant growth and is the key nutrient affecting the amount of algae and weed growth. Sources of

phosphorus include human and animal wastes, fertilizers, septic systems and decaying plants. Phosphorus is measured in two forms in lake water: Total phosphorus (TP) and dissolved reactive phosphorus (DRP). TP includes DRP and the phosphorus in plants and animals in the water. DRP is the soluble form that is readily taken up by plants. Both were measured for this study. TP is a better indicator of the lakes nutrient status because it remains more stable than DRP. DRP is measured in the spring to determine if there are sufficient nutrients for the algae to create the nuisance blooms in the summer months. DRP concentrations vary greatly over short periods of time due to its uptake by plants.

Nitrogen is the second most important nutrient in a lake for plant and algae growth. Sources of nitrogen include fertilizer, human and animal waste and groundwater. Nitrogen exists in several forms in lakes. The analysis for this study included total Kjeldahl N, nitrate plus nitrite N and ammonium N. The forms of nitrogen are constantly interchanging in the lake water through the nitrogen cycle. Inorganic nitrogen (nitrate, nitrite, ammonium) can be used by aquatic plants. If these levels are greater than 0.3 mg/l in the spring there is enough nitrogen present to create summer algae blooms. When the plants die and decay, ammonium is released into the water. This can then be taken up by plants again and cycled through the system or it can undergo the conversions of the nitrogen cycle. If oxygen levels are depleted, the ammonium is converted to nitrate then to nitrite then to nitrogen gas, which is lost to the air.

The ratio of the amount of total nitrogen to total phosphorus is important information for lake managers. This number indicates if a lake is nitrogen limited or phosphorus limited; if there is not an ample supply of the limiting nutrient, algae blooms will not occur and plant growth will decrease. If the ratio is less than 10:1 the lake is nitrogen limited (this occurs in 10% of Wisconsin's lakes). Lakes with values between 10:1 and 15:1 are considered transitional, and lakes with values greater that 15:1 are phosphorus limited.

Total Phosphorus (TP)

The summer average TP measured in theses lakes for this study was below 0.02 MG/L at the surface and ranged from 0.05 to 0.13 MG/L at the bottom. The concentrations of phosphorous was always greater in the bottom samples. This indicates that during stratification when the oxygen levels are low at the bottom of the lake there may be a release of phosphorous from the sediments. It doesn't appear to be a great amount because there isn't a spike in concentrations at turnover events. The only sample that contained DRP was taken in Mud Lake at fall turnover. The concentration was 0.002 mg/l, levels below .010 mg/l are needed to avoid nuisance algae blooms.

The phosphorous concentrations in these lakes is rated as good for Wisconsin lakes. The average for natural lakes is .025 mg/l. A concentration of 0.015 is very good and some of the readings in the summer months for all three lakes were in this range.

Nitrogen

The lakes in the ecoregion range from 0.6 to 1.2 MG/L for total Kjeldahl N and <0.01 MG/L for nitrate plus nitrite for summer averages. Cable lakes had concentrations below this range for most of the summer readings. In most samples nitrate plus nitrite was not detected. The highest concentrations of nitrogen were found in the turnover samples. During the summer when the lake is stratified and there is little or no oxygen at the bottom, ammonia is released from the sediments. At turnover the lake mixes and stirs the ammonia throughout the water column. When the ammonia comes into contact with oxygen it converts to nitrate. The total

Kjeldahl nitrogen is a measure of the ammonium plus organic nitrogen. When ammonia is added to the column it increases this reading.

Total Nitrogen (TN) to Total Phosphorus (TP) Ratio

In the case of Cable lakes, the mean ratio of TN to TP ranged from 13:1 to 45:1. Cable and Mud lakes had values closer to the 45:1 for most of the samples. This means the lakes are phosphorous limited and the amount of weed and algae growth will depend on the amount of phosphorus in the lake and not nitrogen. Wiley Lake had values near 13:1, which means it is a transitional. It is still phosphorous limited but lakes with ratios under 10:1 are nitrogen limited. Only about 10% of Wisconsin lakes are nitrogen limited. If the plant growth is to be controlled, the amount of phosphorus in the water needs to be controlled.

Water Clarity

Water clarity is a measure of water quality related to the chemical and physical properties of water. Water clarity has two main components: true color and turbidity. Both of these components were measured directly and indirectly in this study. The dissolved materials determine the color of the water and the suspended solids in the water determine the turbidity. To establish values for these parameters the following tests were conducted: true color, total dissolved solids, turbidity, suspended solids, chlorophyll a and secchi disk readings.

True Color

True color is a result of the type and amount of dissolved organic chemicals the water contains. The water picks up the color from the terrain it flows through or from the materials in the water. The vegetation in the lake may add color to the water during decomposition. The color of Cable Lake was 10 standard units (SU), Wiley was 5 SU and Mud was 15 SU. The color is categorized as Low according to DNR scale. The lower reading may be a result of less dissolved solids.

The color of the water is determined by the terrain the water flows through as is the amount and type of dissolved solids. The main ions that are measured for the dissolved solids test are carbonate, bicarbonate, chloride, sulfate, nitrate, sodium, potassium, calcium, and magnesium. The average concentration for total dissolved solids for lakes are Cable – 82 mg/l, Wiley – 111 mg/l, Mud – 73 mg/l.

Turbidity

Turbidity is the measure of the amount of particles in the water such as suspended solids and algae. The average turbidity reading are as follows: Cable – 2.1 NTU (Nephelometric Turbidity Unit), Wiley – 1.6 NTU, and Mud – 1.4 NTU. This reading is average when compared to other lakes in the ecoregion which have values of 1-2 NTU. A measurement of suspended solids indicates an average concentration as follows: Cable – 3.3 mg/l, Wiley – 3.2 mg/l, Mud – not detected. The amount of algae present is measured indirectly by finding the concentration of chlorophyll a in the water. The chlorophyll a is the green pigment that the algae contain. The average chlorophyll a concentration is as follows: Cable – 1.89 ug/l, Wiley – 7.7 ug/l, Mud – 2.9 ug/l. These readings are rather low and indicate a trophic status of oligotrophic for Cable and Mud and mesotrophic for Wiely. The trophic status is a measure of a lakes productivity. This is further explained in the "Watershed" section below.

An indirect measure of turbidity is done with the Secchi disk. The average readings from this study are as follows: Cable – 17ft, Wiley – 9 ft, Mud – 9 ft. These indicate that all three lakes are oligotrophic according to Secchi disk readings.

Buffering Capacity

A lakes buffering capacity is measured by the alkalinity of the water. Alkalinity is measured by the concentration of calcium carbonate in the water, the carbonate is the buffering agent. The values for this study indicate the water has a high buffering capacity, which makes it insensitive to acid rain. Alkalinity of water also determines its pH. The alkalinity for the lakes is as follows: Cable – 60 mg/l, Wiley – 75 mg/l, Mud – 55 mg/l. These values are above 25 mg/l which means they have great buffering capacity and are not sensitive to acid rain.

Hardness is also measured by the amount of calcium carbonate in the water. The calcium and magnesium ions cause hardness in water. Hard water is beneficial to health but can cause problems with scaling in pipes. Since hardness and alkalinity are a measure of the same compound, the values should be close. If the alkalinity value is high the sodium concentrations in the water may be high. If the alkalinity is much lower than the hardness the chloride, nitrate or sulfate concentrations may be high. The following are the values found in the lakes: Cable – 60 mg/l, 75 mg/l, 57 mg/l.

Another parameter that is measured relative to hardness is conductivity. The conductivity is a measure of the water's ability to conduct an electrical current and it gives an indication of the amount of dissolved substances in the water. The conductivity in an uncontaminated lake should be about twice the hardness. If it is much higher it may indicate the presence of contaminants such as chloride, sodium, nitrate or sulfate. The values of conductivity were determined to be: Cable – 123 umhos/cm, Wiley – 153 umhos/cm, Mud – 114 umhos/cm. Conductivity in uncontaminated lakes is twice the hardness which indicates that the lakes are not contaminated.

Pollution Indicators

Chloride is an indicator of water pollution, or lack of pollution; water samples obtained from the lakes in this study were tested for chloride. The presence of chloride in lake water, where it does not naturally occur, may be an indication of pollution. The natural chloride level in lake water in the northern section of the state is less than 3 mg/l. The concentration found in the lakes are: Cable – 1.4 mg/l, Wiley – 1.4 mg/l, Mud – 1.3 mg/l. This low observed level of chloride indicates that the lakes are relatively pristine, and have not been significantly impacted from potential pollution sources such as leaking septic systems, fertilizers, animal waste or road salt. Chloride concentrations tend to vary naturally in lakes, for this reason it is important to have background data to draw accurate conclusions. The values obtained in this survey may be used as background data for future studies since these are the first chloride measurements taken in the lakes.

Watershed Evaluation

The watershed evaluation consisted of delineating the watershed boundary, mapping land uses, estimating runoff and pollutant loading, identifying sensitive areas and drainage patterns, review of existing ordinances and modeling water quality of the lakes. The watershed was found to be quite healthy and does a good job of protecting the lakes. Following is detailed information of each task that was completed.

The watershed of the lakes covers approximately 736 acres. This is a relatively small watershed for the surface areas of the lakes. There are a total of five lakes in this watershed, Cable, Wiley, Mud, Lake 1 and Lake 2. Lakes 1 & 2 are small unnamed lakes that contribute flow to the lakes through channels or wetlands. The total surface areas of the lakes are 243 acres. The watershed contributing to the lakes is small due to the undulating geography of the area. The majority of the watershed is mixed deciduous forest with stands of conifers. There area approximately 65 acres of wetland that contribute to the lakes. The amount of residential land was estimated to be approximately 43 acres.

Since the watershed is mainly forested the runoff volume and pollutant loading is relatively low for these lakes. The ground cover of the forests and the wetlands in the watershed retain and slow the flow of water to the lakes. The storm that would be expected to occur every 2 years would result in 2 cfs (cubic feet per second) of discharge. If the watershed was urban or highly developed this number would be much higher. Because the runoff is low the pollutant loading from the watershed is also low. The majority of the pollutants are coming from the residential areas according to our modeling. 62% of nitrogen, 44 % of phosphorous and 73% of BOD (biological oxygen demand) is coming from the residential land use and the septic systems on the lake. The forested areas and the wetlands contribute the majority of the sediment flowing in to the lake. The model was set up to look at BMPs (best management practices) in the watershed also. The most feasible BMP would be vegetative buffers along the developed shoreline. If buffers were maintained on each property on the lake the loads of nitrogen, phosphorus, BOD and sediment could be reduced by 6.5%, 4.5%, 10.9% and 5% respectibley. There could be further reductions by using infiltration practices and diversion techniques.

There are several high quality wetlands in the Cable lakes watershed. The wetlands are classified as shrub/scrub, forested and aquatic beds. These wetlands are shown in Figure 4. The wetlands are protected under the shoreland zoning and by state laws but care should be taken by the residents to protect them also. Wetlands are very beneficial to a lake system by providing cover for fish and wildlife, removing pollutants such as nitrogen, phosphorous and sediment and by retaining flood flows and providing flow from groundwater. Wetlands can be protected by the residents by not mowing or disturbing the vegetation, not dumping anything including yard waste into them, protect them from sediment from construction or from roads and driveways. The drainage patterns in this wetland are varied due to the topography. There are many ridges and swales in the watershed that direct water in all directions. Many of the areas are internally drained, meaning that they do not flow any other surface waters; the water just seeps into the ground.

There are several areas along the lakeshore that have very steep slopes that need protection. These slopes should not be disturbed by clearing the vegetation or building on them. If the vegetation is disturbed on these slopes it could lead to massive erosion which would contribute a lot of sediment into the lakes. Specific examples of steep slopes warranting protection include those along the narrows and at the north end of Wiley Lake. Sensitive areas that should be protected are shown in Figure 4.

The shoreland and wetland ordinances for Bayfield County were reviewed to determine the amount of protection they offer to the lakes and surrounding wetlands. The ordinances appear to offer quite a bit of protection to these areas in Bayfield County. Wetlands are protected from filling and other adverse impacts and structures can not be built within 25 feet of the wetland boundary. The wetlands can not be rezoned if adverse impacts will occur upon any of the following:

1. Storm and floodwater storage capacity.
2. Maintenance of dry season stream flow or discharge of groundwater.
3. Filtering or storage of sediments, nutrients or other pollutants.
4. Shoreline protection against erosion
5. Fish spawning, breeding, nursery or feeding grounds.
6. Wildlife habitat.
7. Areas of special recreation or scenic interest.

The ordinance regulates structures in the shoreland area and requires setbacks, minimum lot size and vegetative buffers for these lots. The specifics can be seen in Table 11. The ordinance restricts improvements on non-conforming structures and requires mitigation for allowed expansion or improvement to these structures. The lot requirements and restrictions are based on the classification of the lakes. There are three classifications in Bayfield County. Class I is the most developed class, Class II is moderately developed and moderately sensitive lakes, Class III is the most sensitive and least developed or undeveloped lakes. Cable and Wiley are both Class II lakes.

The water quality modeling that was done for this study indicates a moderately low level of phosphorous in the lakes. Table 7 lists the loading to the lakes from areal sources, point sources and non-point sources. There are no point sources on the lakes. The majority of the phosphorous loading on the lakes comes from non-point sources such as residential areas and septic systems. The model suggests a range of phosphorous that is contributed to the lake from on-land activities. Based on the limited land development and lack of intense use, the phosphorus contributions are low. Because there is a higher level of development on Cable Lake, the model projects a higher contribution of phosphorous than is projected for Wiley or Mud Lakes. Mud Lake has the lowest projected values due to the fact that there is no development on the lake. The amount of phosphorous entering Mud Lake is projected by the model to be 65% less than that entering Cable Lake. This shows how much effect development can have on a lake.

The model also calculated the trophic status index (TSI) for each lake. This is a measure of the productively of the lake. It is determined by the amounts of phosphorous and "*chlorophyll a*" and Secchi disk readings throughout the summer months. The lakes are then classified as eutrophic, mesotrophic or oligotrophic. Eutrophic lakes are highly productive and have high concentrations of phosphorous and chlorophyll and low Secchi disk readings; they have many, dense stands of aquatic vegetation. Oligotrophic lakes are low in production and have low levels of the indicators, high Secchi disk readings and have few plants. Mesotrophic are in between and have moderate levels of the indicators, moderate clarity and moderate plant production. Table 8 lists the TSI for each indicator and the average TSI for each lake. Cable Lake is classified as oligotrophic, Wiley and Mud Lakes are mesotrophic.

Comparison to Area Lakes

To provide a better level of understanding of the quality and condition of Cable and Wiley Lakes, a comparison of chemical indicators for area lakes and discussion is presented below.

Continued pressure for development of lakeshore in northern Wisconsin presents a threat to the quality of all of our lakes. For comparative purposes, Cable and Wiley Lakes (including Mud Lake) water chemistry and quality were compared to the following lakes. These lakes were chosen for comparison because they have water quality data readily available in the Wisconsin DNR database and the Gaylord Nelson Institute for Environmental Studies at the University of Wisconsin – Madison.

- Takodah Lake
- Lake Namakagon
- Upper Eau Claire Lake
- Middle Eau Claire Lake

Data for comparison is for 2004, the period in which data was collected for this study. Total Phosphorus, Chlorophyll-a, and secchi disk comparative data is shown in the following table and charts.

Phosphorus - Phosphorus is a nutrient natural to lakes and is used by plants and algae for growth. It is the limiting nutrient for plant and algae growth. Phosphorus levels for Cable and Cable (Mud) Lakes were consistently below the average of the area lakes. This is consistent with the comparatively low level of development around the lakes and the nature of the lake itself. Wiley Lake, on the other hand, because of its trophic state, shows higher levels of phosphorus than Cable Lake. This is likely a result of its natural makeup; being a shallower lake and having less volume, it is more prone to have higher levels of phosphorus than the deeper Cable Lake. Phosphorus levels, however, are low compared to a statewide levels, and indicative of good water quality.

Chlorophyll-a - Chlorophyll-a is the green pigment that is responsible for a plant's ability to convert sunlight into the chemical energy needed to fix $C0_2$ into carbohydrates. Both chlorophyll-a and secchi depth are long-accepted methods for estimating the amount of algae in lakes. Chlorophyll levels for Cable and Cable (Mud) Lakes, like phosphorus levels, were measured in 2004 to be consistently below the Bayfield area lakes chlorophyll levels. Wiley Lake Chlorophyll levels, similar to phosphorus levels, were higher than in Cable Lake. Again, this is consistent with the nature of Wiley Lake, however the level of chlorophyll observed is well below state averages. The observed level of chlorophyll indicates that water quality is very good, and algae production in the lake is low.

Secchi Disk - Secchi disk readings are simply a measure of water clarity. A black and white disk is lowered into the water column until it cannot be viewed any longer and this depth is recorded as the secchi disk reading. Secchi disk readings in Cable lakes ranged from 8 feet to 20 feet. Cable Lake's readings are consistently somewhat higher than Wiley Lake readings, but values for both lakes indicate very good water quality.

Comparison of Selected Bayfield County Lakes

Total Phosphorus 2004 (ug/l)

Lake	Spring	Early Summer	Late Summer	Fall	Summer Average	MAX	MIN	Turnover Average
Cable	15			15				
Cable (Mud)	18		11	16	11	18	11	17
Wiley	32	14	19	28	16.5	32	14	30
Takodah	17	11	14	19	12.5	19	11	18
Namakagon	18	17	25	88	21	88	17	53
Upper Eau Claire		61	19	20	40	61	19	20
Middle Eau Claire	16	16	17	30	16.5	30	16	23
Average	19.3	23.8	17.5	30.9	19.6	41.3	14.7	26.8

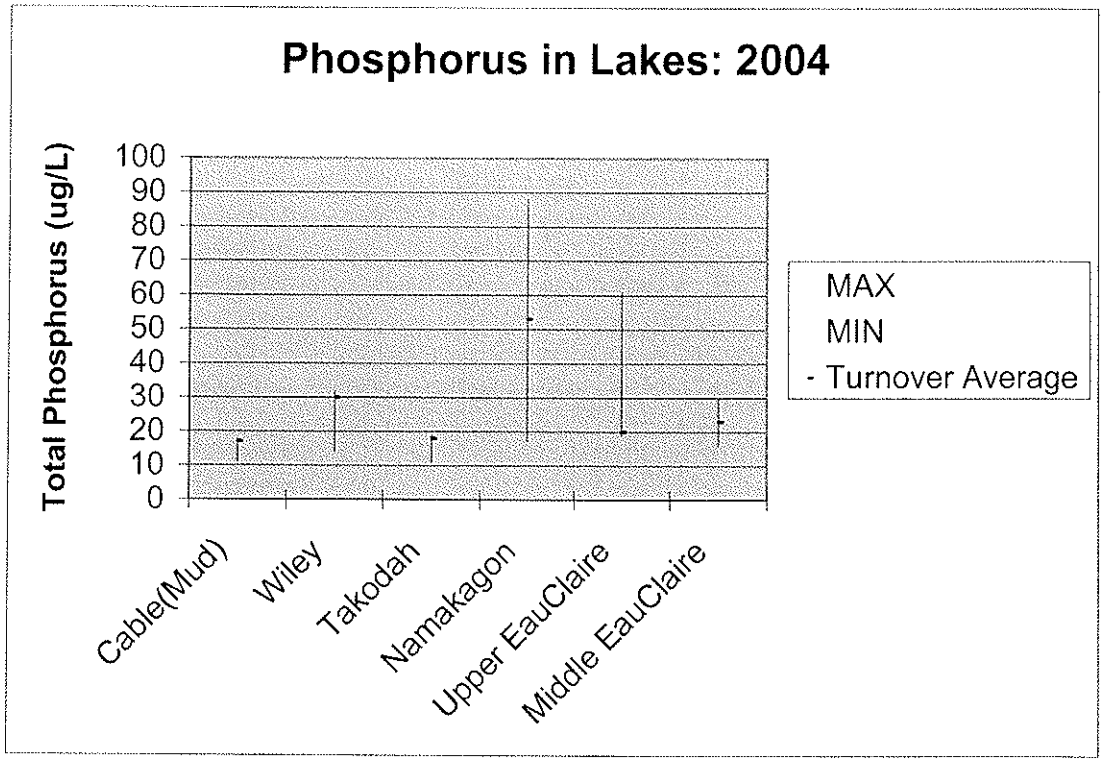
Chlorophyll-a 2004 (ug/l)

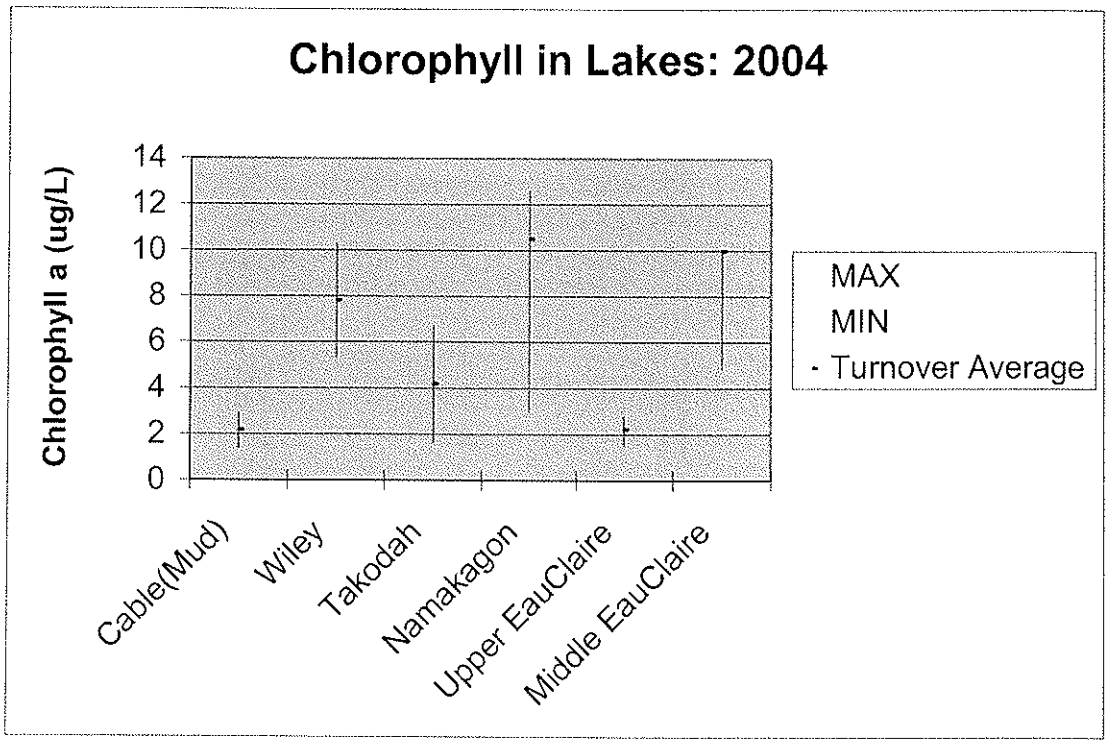
Lake	Spring	Early Summer	Late Summer	Fall	Summer Average	MAX	MIN	Turnover Average
Cable	2.2			1.6				
Cable (Mud)	3.0		2.9	1.4	2.9	3.0	1.4	2.2
Wiley	10.3		7.7	5.3	7.7	10.3	5.3	7.8
Takodah		6.7	1.6	4.2	4.2	6.7	1.6	4.2
Namakagon		3.0	12.6	10.5	7.8	12.6	3.0	10.5
Upper Eau Claire		1.6	2.8	2.2	2.2	2.8	1.6	2.2
Middle Eau Claire		4.9	5.3	10.0	5.1	10.0	4.9	10.0
Average	5.1	4.1	5.5	5.0	5.0	7.6	3.0	6.1

Secchi Disk (feet)

Lake	Spring	Early Summer	Late Summer	Fall	Summer Average	MAX	MIN	Turnover Average
Cable				17.0				
Cable (Mud)		12.3	8.0	20.0	10.2	20.0	8.0	20.0
Wiley		10.0	8.2	15.0	9.1	15.0	8.2	15.0
Takodah	15.0	15.0	9.5	11.0	12.3	15.0	9.5	13.0
Namakagon	14.0	13.0	6.5	10.5	9.8	14.0	6.5	12.3
Upper Eau Claire		21.0	19.0	12.0	20.0	21.0	12.0	12.0
Middle Eau Claire	35.3	16.0	16.3	12.0	16.1	35.3	12.0	23.6
Average	21.4	14.6	11.2	13.9	12.9	20.0	9.4	16.0

Comparison of Selected Bayfield County Lakes





Sensitive Area Study

The Cable Lake Association expressed concern regarding two areas that are of special concern and may be deemed "Sensitive Areas" by DNR. DNR was contacted regarding the lakes and they did not believe that a sensitive area study had been conducted on the lakes. They expressed an interest in conducting a study. When they were contacted to conduct a study they did not have the budget or the time to conduct it concurrent with our study. They may be able to schedule it in the future and should be contacted again regarding this.

Concern was also expressed regarding the classification of Wiley Lake and the Narrows and the designation of Mud Lake as a separate lake. The members of the Association would like to see Wiley Lake and the Narrows change from Class II to Class III to afford additional protection to these sensitive areas. The Narrows shoreline, because of its steep shoreland and narrow bays, is prone to rapid degradation from development that would disturb the naturally protected slopes. Hence, the Narrows is deserving of a class III designation, offering a higher level of protection than it currently has. Additionally, future modeling of Mud Lake, and the Narrows, is recommended to further investigate the potential for environmental damage if the steep slopes in these areas are developed.

Members of the Association suggested that in future activities, the possibility of constructing and maintaining a permanent outflow system at the outlet of Mud Lake, pending approval of the landowner and the Department of Natural Resources. Stabilization of the lake levels would eliminate significant fluctuations that might interfere with aquatic plant growth, shoreline ecology, and nuisance to dock owners.

The Association members would also like to see Mud Lake designated as a lake, separate from Cable Lake. In conducting this study, information was collected on the shoreline and throughout the lake and watershed that supports these changes. Table 9 includes the information for Wiley and Mud lakes that will be useful in their reclassification. According to Bayfield County Zoning there are factors that must be met to reclassify a lake. Wiley and Mud Lake meet the following:

Water Quality

- Water quality is good to excellent based on average summer readings
  The Secchi disk readings range from 8 to 15 feet for Wiley and 6 to 20 feet for Mud. A reading greater than 10 is considered good by DNR.

- Dense stands of aquatic macrophytes or algal blooms that impair ecological or recreational values are absent from the waterway.

- There are no invasive or problem causing species that were found in the macrophyte survey. The vegetation is present in the shallow areas for fish habitat and there is open water for recreation in the deeper areas of the lake.

- Significant impacts of point or nonpoint source pollution are absent from the watershed. The water quality model indicates there are no point sources and the contribution from nonpoint sources are minimal due to the fact that there are few developed sites on Wiley Lake and none on Mud Lake.

Environmental Significance

- The watershed is largely natural or undisturbed.
- The maps indicate the watershed is mainly forested with areas of wetland and light development around the shoreline.

Wildlife and Recreational Significance

- The waterway provides high quality, multiple use or unique recreational experiences. The lakes provide great scenic beauty because Wiley has little development and Mud has none, they provide fishing opportunities and areas for boating and canoeing or kayaking.

Lakeshore Resident Survey

A survey of the lakeshore residents and lake users was taken to assess the views they have of the lake. A total of 39 completed surveys were returned. According to the survey, the majority of the people believe the lakes are in good to excellent condition. The lake users think the fishing has decreased over the years but the quality of the water and the shoreland had remained the same. The respondents also think the development on the lake has increased over the years and has had an impact on the water quality of the lake by way of shoreline clearing and through soil erosion during construction. Many of the people support stricter regulations on development to protect the shoreline and the lake. The majority of the respondents do not apply fertilizer to their lawns and have natural landscaping or a shoreland buffer. A summary of the most popular responses to each question is included in Table 10. The original survey and a tally of the results are included in Appendix A.

Aquatic Plant Survey

The aquatic plant survey was conducted by students from Sigurd Olson Institute. A copy of the methods and data sheets are included in Appendix B. The survey found a healthy diverse population of aquatic plants throughout all three lakes. A total of 21 plant species where found in the lakes. A mix of emergent and submergent plants were found. There were not any invasive plants or species that are known to cause problems. Table 12 includes the scientific and common names of the plants and the importance of each plant.

Aquatic plants play a very important role in a lakes ecosystem. Plants have a number of characteristics that make them important to fish. They provide water purification, nutrient cycling, provide shelter from temperature, sunlight and predators and provide cover for invertebrates (fish food). Plants also stabilize sediments and shorelines, increase sedimentation and reduce turbidity. The aquatic plants also provide habitat, food and nesting sites and material for wildlife and birds.

Shoreland Assessment

The shoreland of the lakes has little development, most of the shoreline is natural in Wiley Lake and all of it is natural in Mud Lake. There are a few structures that are built closer to the waters edge than current zoning allows and a few places have shorelines that are completely cleared. Many of the lots have natural vegetation and shoreline buffers. Most of the lots have docks also. A map indicating the shoreland rating is included in the Figures section of this report.

Listed Threatened, Rare or Endangered Species

There is one known endangered species the uses the lake. A bald eagle nest is located on one of the islands in Cable Lake and has been nesting there for some years. The location of the nest is shown on Figure 4. The nest area should be avoided during active nesting. Eagles lay their eggs in March or April and they hatch approximately one month later. Human disturbance can have an impact on the bald eagle, as most of them need some privacy and quiet to breed. People wanting to observe or photograph the eagles can disturb them enough to cause them to abandon a nest. Use binoculars and spotting scopes for viewing, and keep at a reasonable distance. This area should be protected from development and the tree itself should be protected from being cut down.