BEECHER & UPPER LAKES

MANAGEMENT PLAN

AUGUST, 1997

LPL-261

Beecher & Upper Lakes
Management Plan

August, 1997

Primary Author
Charles Druckrey, Water Resource Specialist, Marinette County LWCD

Contributors
William Kowalski, County Conservationist, Marinette County LWCD
Tim Rasman, Limnologist, WDNR Northeast Region

Beecher Lake Management Planning Grant Study Committee
Randy Johnson
Pat Holst
Chuck Holst
Joe Siudzinski

Beecher Lake Association Board
Randy Johnson, President
Lynn Johnson, Secretary
Pat Holst, Treasurer

Marinette County Land & Water Conservation Committee
Mark Anderson, Chairperson
David Setunsky, Vice Chairperson
Ervin Sengstock, Secretary
Adolph Staidl
Carl Baker
Russell Bousley
Stanley Lewandowski, USDA Farm Services Agency Representative

This plan was prepared by the Marinette County Land & Water Conservation Department for the Beecher Lake Association. Funding was provided by the Wisconsin Lake Management Planning Grant Program through the Wisconsin Department of Natural Resources. Local matching dollars were provided by the Beecher Lake Association and the Marinette County Land & Water Conservation Committee.

TABLE OF CONTENTS

LIST OF FIGURES

Beecher Lake
Management Plan

Beecher Lake is a 56 acre lake located in northern Marinette County. The lake is made up of two separate lake basins, Beecher Lake (35 acres) and Upper Lake (21 acres) joined by a narrow channel. For all essential purposes the two lake basins can be treated as one lake and for this report all references to Beecher Lake can be taken to mean both Beecher and Upper lakes.

Beecher Lake is heavily developed with 62 cottages and homes located on the shoreline. The property owners of Beecher Lake have a long history of working to protect and improve their lake, including the formation of the Beecher Lake Association. The Association contracted with the Marinette County Land & Water Conservation Department (LWCD) in 1995 to produce a comprehensive Lake Management Plan. The purpose of this plan is to explore lake management options and assist the Beecher Lake Association in future management decisions.

Setting

Beecher Lake is classified as a drainage lake, which means it receives most of its water from overland drainage. The area draining to the lake, known as the watershed, is approximately 2,830 acres in size. Most runoff enters the lake through Beecher Creek which empties into the lake on the north shore of Upper Lake next to the public boat landing. The outlet of Beecher Lake drains to the Pike River, a class I trout stream.

A dam located at the outlet of Beecher Lake maintains a head of approximately 4 feet. The structure connects the Beecher and Upper Lake Basins to create a single lake. The Beecher Lake dam has a level spillway with no provision for adjusting the water level.

The Beecher Lake watershed is primarily forested land (1,450 acres) and wetland (1,320 acres). Approximately 60 acres of residential development and roads drain to the lake.

Beecher Lake has a maximum depth of 47 feet, while the Upper Lake basin is 18 feet deep. Both lake basins stratify during the winter and summer months. The stratification, or separation of water into distinct layers, is an important process which effects the chemistry and hydrology of the lake. Beecher and Upper Lakes have a volume of approximately 566 acre feet, or 184 million gallons of water. Approximately 38% of the lake is greater than 10 feet deep (see figure 1).

Past Management Efforts

Past organized management efforts undertaken by the Beecher Lake Association have included weed cutting and removal with a Hockney weed cutter, and adopting unofficial rules regulating the use of personal watercraft "Jet-Skis", etc. The Wisconsin Department of Natural Resources (WDNR) has also conducted several fisheries surveys and stocking programs on Beecher Lake. These management efforts will be discussed in detail throughout the report.

Beecher Lake User Survey

On August 19, 1995, a meeting was held to introduce Association members to the lake planning grant process. The LWCD also

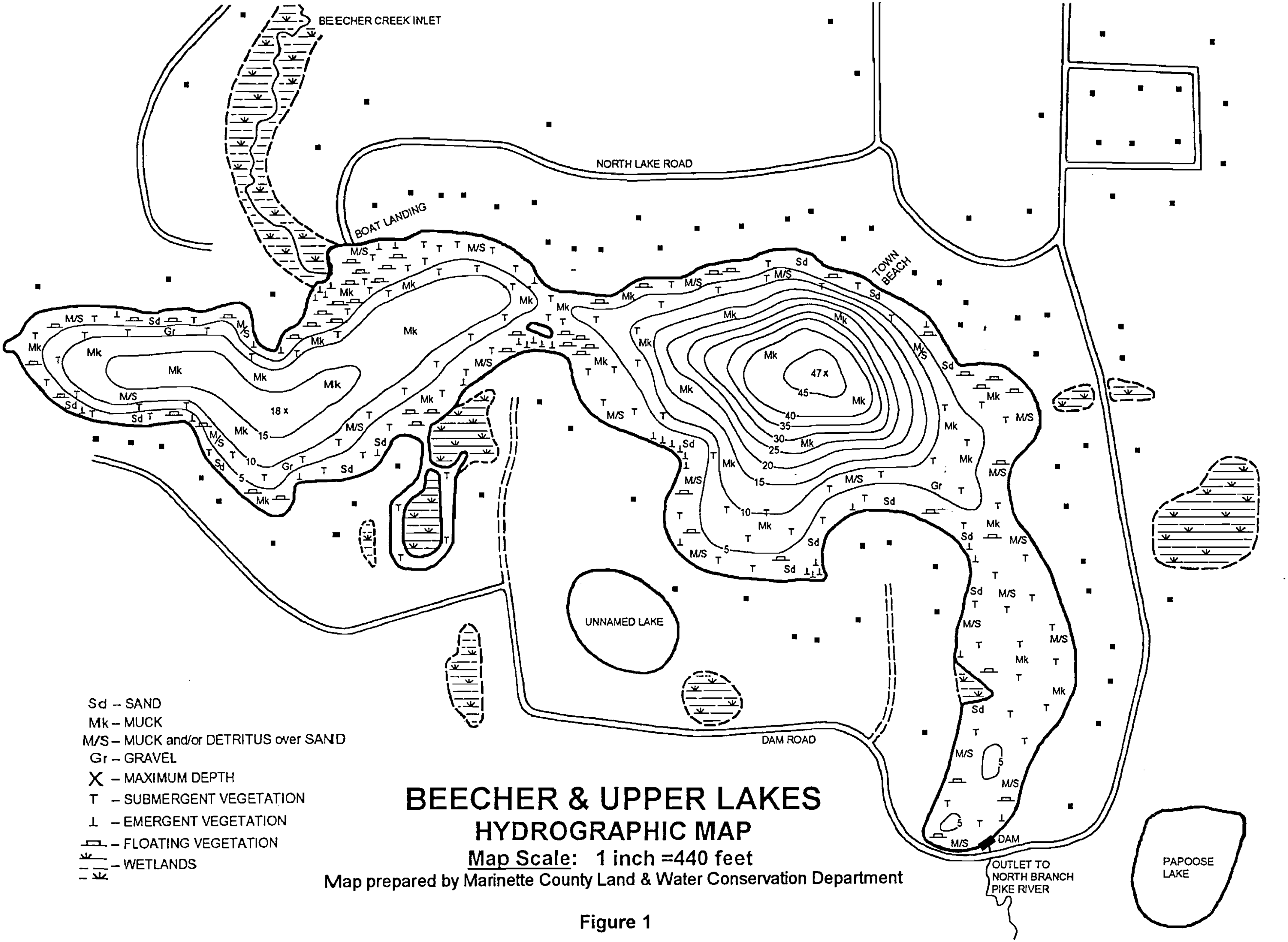

BEECHER CREEK INLET
NORTH LAKE ROAD
BOAT LANDING
TOWN BEACH
UNNAMED LAKE
DAM ROAD
DAM
OUTLET TO NORTH BRANCH PIKE RIVER
PAPOOSE LAKE
47 x
18 x
Sd – SAND
Mk – MUCK
M/S – MUCK and/or DETRITUS over SAND
Gr – GRAVEL
X – MAXIMUM DEPTH
T – SUBMERGENT VEGETATION
⊥ – EMERGENT VEGETATION
– FLOATING VEGETATION
– WETLANDS
BEECHER & UPPER LAKES
HYDROGRAPHIC MAP
Map Scale: 1 inch =440 feet
Map prepared by Marinette County Land & Water Conservation Department

Figure 1

conducted a "nominal group process" meeting to rank-order the major concerns of lakefront property owners. Major concerns voiced at this meeting are listed below.

- Too much muck
- Problems with weed harvesting program
- Declining fishery
- Unatractive shoreline development
- Excessive shoreline development

These concerns and others were included in a questionnaire which was mailed in February of 1996. Thirty-four of the forty-four surveys mailed out were completed and returned. Figures 2 - 4 detail some interesting survey results. Approximately 68% of the respondents are weekend visitors to Beecher Lake, while only 17% are permanent residents. It is clear from the survey that most residents come to Beecher Lake to enjoy the lake's natural beauty and for peace and quiet (82% of residents listed these as their primary reasons for coming to the lake) .

Top concerns of Association members are excessive aquatic weed growth, excessive muck and poor fishing. More than 79% of the respondents described weed growth as heavy or choked, and 67% thought the problem has been getting worse. Water quality was rated as fair to good by 94% of the respondents, and 18% thought the water quality has decreased over the years. Details of the survey are listed in appendix A.

Water Quality

Water quality is actually a very subjective term as the survey of Association members shows (see figure 4). Water "quality" as perceived by lake residents is affected by many factors which have little to do with the actual physical properties of the water. These include the depth and shape of the lake, recreational pressure, shoreline development and quality of the fishery.

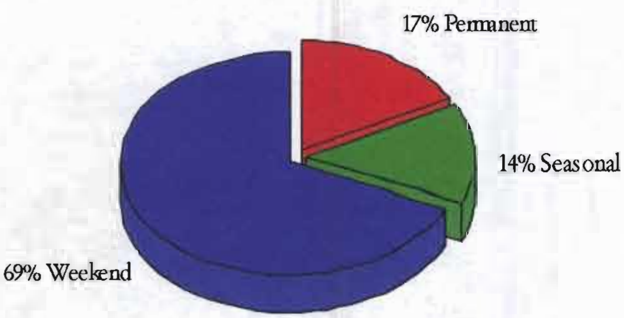
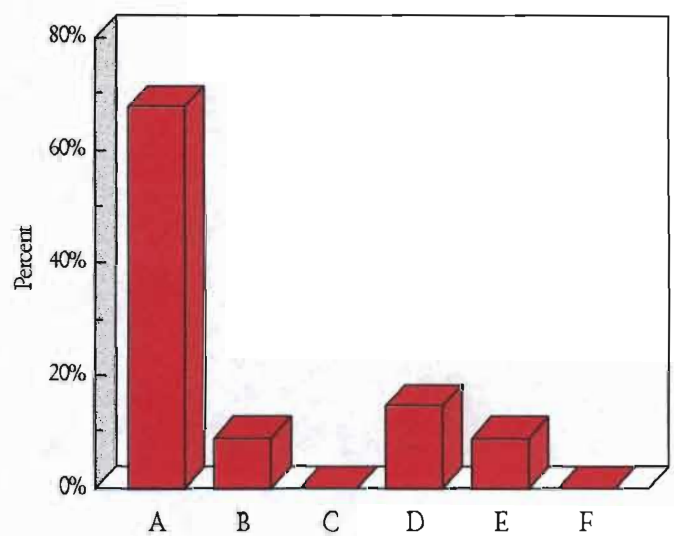


Figure 2. Residency status of Association members.



A. Peace and quiet
B. Fishing/ Hunting
C. Motorized recreation
D. Natural Beauty
E. Non-motorized recreation
F. Other

Figure 3. Why residents enjoy Beecher Lake.

For this lake study we investigated many physical and chemical properties of Beecher Lake and the Upper Lake basin. The results were interpreted and compared to values found on similar lakes throughout the state. A summary of these results and a discussion concerning each parameter is presented in this section. A detailed listing of water quality results is found in Appendix B.

Dissolved Oxygen and Temperature From a biological point of view, dissolved oxygen is one of the most important water quality parameters. Dissolved oxygen is required by all fish and most other aquatic life. A lake's oxygen content is determined by a number of factors, including lake basin shape (morphometry), water temperature, weather patterns, nutrient inputs, and biological activity within the lake. The water quality standard for dissolved oxygen is 5 mg/l (milligrams per liter or parts per million). Below this level many fish become stressed and reproduction may be impaired.

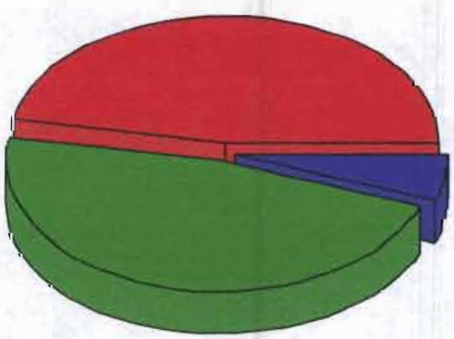


Figure 4. How residents see the water quality of Beecher Lake.

The solubility of oxygen in water varies with temperature. Water at 32^{0}F (0°C) can contain 14.6 mg/l of oxygen when 100% saturated. At 70^{0}F (21^{0}C) the same water can hold only 8.8 mg/l of oxygen. The primary source of oxygen in water is gas exchange with the atmosphere. Ice cover, thermal stratification and windless periods all reduce mixing and can lead to oxygen depletion in a lake.

Stratification is the divison of the lake water into distinct layers which do not mix. Summer stratification occurs when the surface of the lake warms quickly and forms a layer of less dense warm water (epilimnion) above a cold deep layer (hypolimnion). The thin layer of water separating the epilimnion and hypolimnion is called the metalimnion. In both lake basins this layer is usually found between seven and thirteen feet (2-4 meters) deep (figures 5 & 6). Once stratified, the epilimnion and hypolimnion resist mixing until the surface water cools in the fall and becomes as dense as the water below.

Winter stratification occurs when water near the surface approaches the freezing point and becomes less dense than the water below. There is only a slight temperature difference in the winter, and the layers are only weakly stratified. However, ice cover shields the lake from the mixing effect of wind. The lake turns over again immediately after ice-out when spring winds mix the lake from top to bottom.

Aquatic plants add oxygen to the water column through photosynthesis and consume oxygen through respiration. On calm sunny days plants and algae in the upper waters of the lake can experience high rates of photosynthesis and oxygen production leading to oxygen super-saturation. During nightime hours plant respiration can lead to localized oxygen depletion.

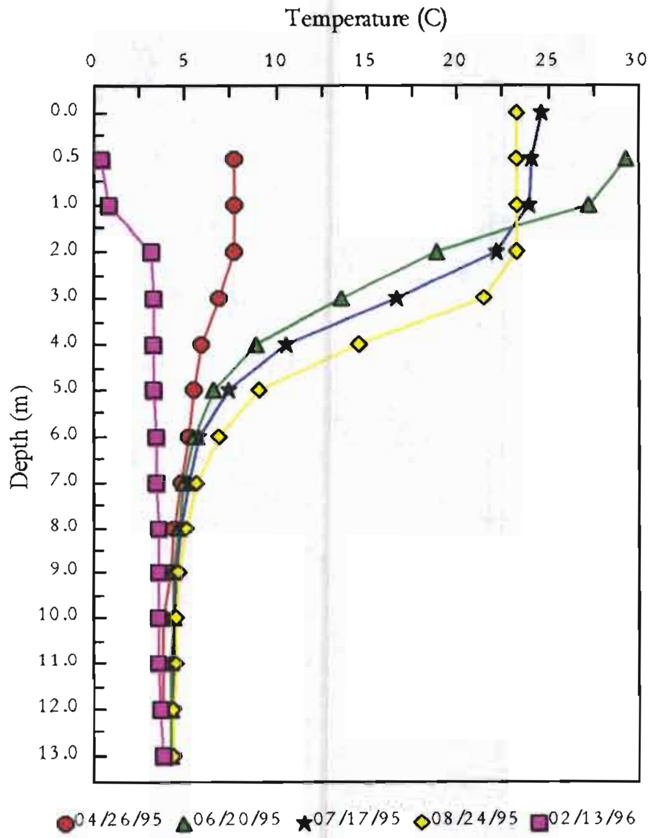


Figure 5. Temperature profiles of Beecher Lake.

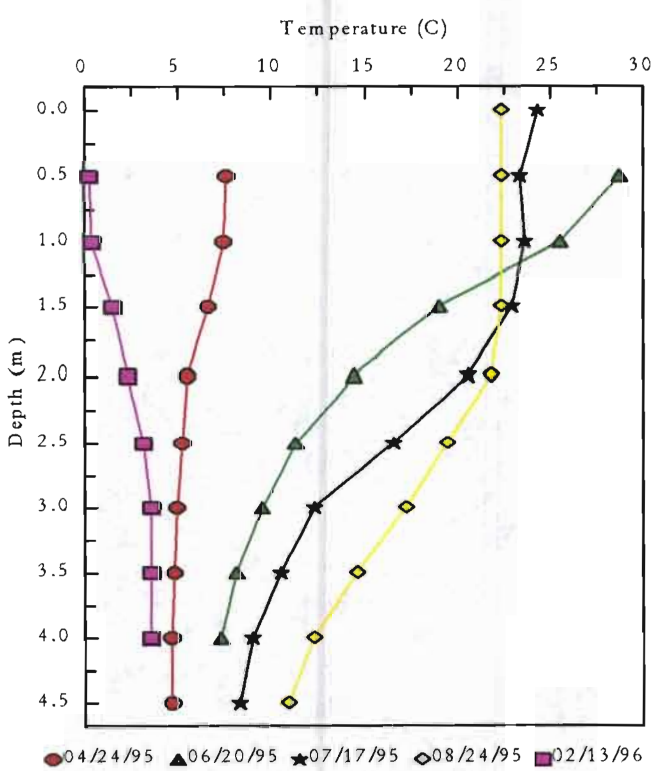


Figure 6. Temperature profiles of Upper Lake.

Decomposition of dead plants and algae also effects oxygen concentration. In Beecher Lake, dead and dying algae sink into the hypolimnion where their decomposition consumes oxygen. Since the hypolimnion is isolated from the atmosphere by stratification, this oxygen is not replenished and continues to decrease until the lake turns over.

Winter can be a critical time for oxygen stress in lakes. Ice cover prevents oxygen exchange with the atmosphere while heavy snow cover reduces photosynthetic oxygen production and plants begin to die. The decomposition of these plants can reduce oxygen to critical levels, resulting in the death of fish (winter kill).

Dissolved oxygen monitoring shows that Beecher Lake experiences strong thermal stratification (figure 5). This stratification leads to near total oxygen depletion (anoxia) in the hypolimnion by summers end (see figure 7). Winter oxygen depletion is less severe, making winter kill unlikely.

Monitoring of the Upper Lake basin showed much weaker thermal stratification (figure 6). This is due in part to the relatively shallow depth of the basin (18 feet or 5.5 meters). Oxygen depletion during summer and winter stratification is also much less severe (figure 8).

Phosphorus Phosphorus is an essential nutrient required for the growth of all plants. In natural waters phosphorus is generally found in very low concentrations in relation to other major plant nutrients and is usually the limiting factor controlling aquatic plant growth. As a growth limiting factor, small inputs of phosphorus can cause significant increases in the growth of algae and aquatic plants.

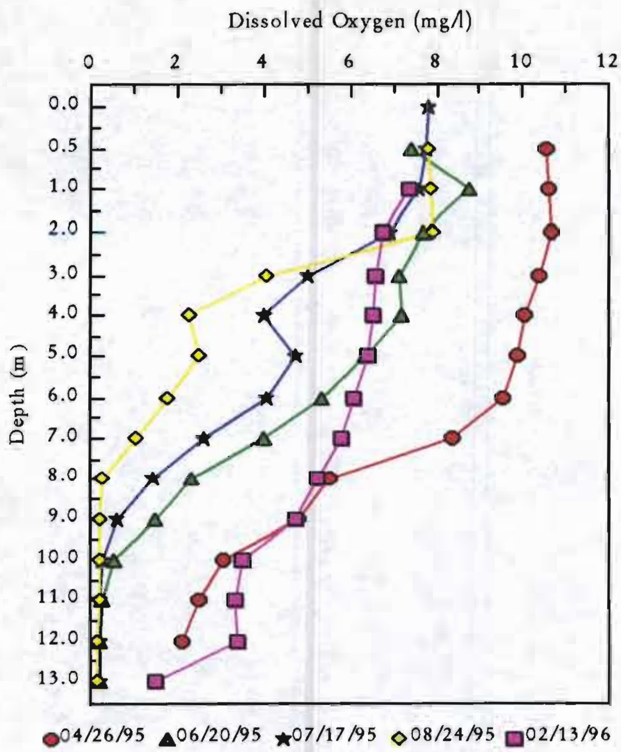


Figure 7. Dissolved oxygen profiles of Beecher Lake.

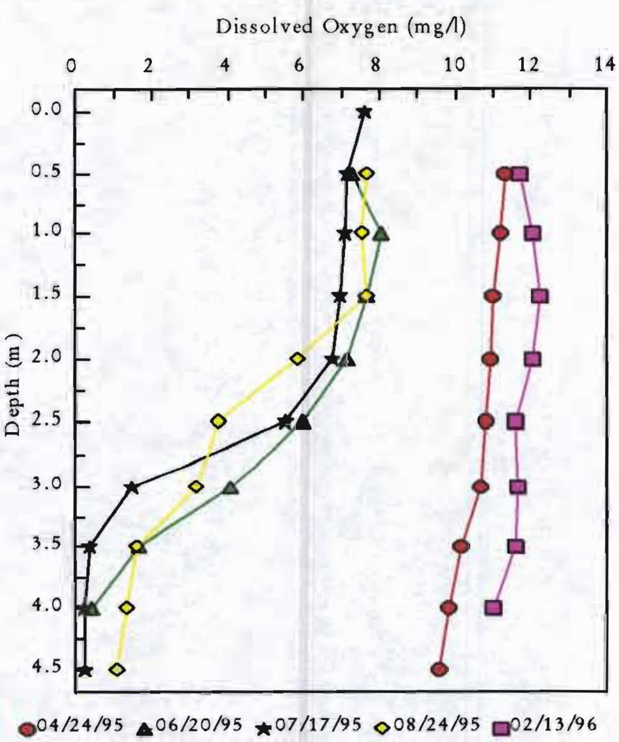


Figure 8. Dissolved oxygen profiles of Upper Lake.

Phosphorus comes from many natural sources including soil particles, decaying vegetation, and rainfall. Many sources of phosphorus are also generated by people. These include detergents, fertilizers and septic system discharge. Many of the land use changes we make to a lake's watershed also lead to increased phosphorus delivery. Disturbance of natural vegetation, cultivation, and shoreline alteration can all increase runoff and the amount of phosphorus delivered to the lake.

Phosphorus is measured in two basic forms in the lake, total phosphorus and ortho-phosphorus. Total phosphorus is a measure of all forms of phosphorus. Ortho-phosphorus is a biologically available form which is quickly taken up by plants and algae.

Phosphorus entering a lake can undergo many transformations and be recycled within the lake for many years. Incoming phosphorus attached to sediment particles quickly settles to the lake bottom where it becomes available to rooted macrophytes. Dissolved or ortho-phosphorus is biologically available and most is taken up by aquatic plants or algae. As plants and algae die and decompose much of the phosphorus contained within them is released to the overlying waters. A fraction also falls to the bottom of the lake where it is trapped in the sediment.

In the presence of oxygen, phosphorus forms relatively stable compounds with iron in the sediment and is unavailable for use by plants and algae. However, when water overlying the sediment becomes anoxic (oxygen depleted), this phosphorus is released into the overlying water.

The internal cycling of phosphorus in a lake can perpetuate itself and lead to steadily decreasing water quality. The process starts when external inputs of phosphorus to the lake lead to increased algae growth. When these larger algae populations die and sink into the hypolimnion, oxygen is consumed. This oxygen depletion leads to accelerated phosphorus release from the sediment and even greater algae production following spring turnover. Further adding to this decreasing spiral of water quality is the shading effect algae has on rooted aquatic macrophytes. As water becomes clouded with algae, aquatic plants are shaded out and die. Without the stabilizing effect of aquatic plants, sediment is easily resuspended and phosphorus that would often be used by rooted plants is made available to algae.

Phosphorus concentration is commonly reported in micrograms per liter of water (ug/l) which is equal to parts per billion (ppb). Lakes with total phosphorus concentrations below 20 ug/l typically do not experience nuisance algae blooms. The average annual surface total phosphorus concentration for Beecher Lake was 10.7 ug/l. This level should not be sufficient to produce nuisance algae blooms. This level is also considerably less than the 40 ug/l average for Wisconsin stratified drainage lakes (Shaw, 1994).

Ortho-phosphorus was also found in low concentrations. This indicates that most of the biologically available phosphorus is tied up in the aquatic plants and unavailable for algae production

Beecher Lake does experience oxygen depletion in the hypolimnion during stratification. During these periods phosphorus is released from the sediment and builds up in the hypolimnion. Monitoring during the summer of 1995 showed that hypolimnetic phosphorus increased from 21 ug/l in April to 217 ug/l in August, a ten-fold increase. Spring and fall turnover mixes this phosphorus throughout the lake making it available for algae and plant growth

Sediment disturbance by motorboats and wave action can also cause increased phosphorus release from sediments. Studies have shown that motorboat activity can cause sediment disturbance in as much as 15 feet of water (Boreman, 1996). Large scale removal or destruction of aquatic plant beds can also lead to increased sediment resuspension and phosphorus release.

Chlorophyll-a All green plants contain the pigment chlorophyll-a which is used in photosynthesis. The chlorophyll-a concentration in a water sample is used as a measure of the amount of algae in water. Low levels of chlorophyll-a indicate low levels of algae production and usually correspond to clear water. Chlorophyll-a concentrations greater than 10 ug/l indicate a eutrophic or nutrient rich condition in the lake.

The average chlorophyll-a concentration in Beecher Lake was 1.9 ug/l. This is less than would be expected based on the phosphorus concentration, and is an indicator that much of the phosphorus is tied up by rooted plants and is unavailable for algae production.

Secchi Disk Depth Secchi disk depth is a measure of water clarity. A black and white disk measuring 20 cm in diameter is lowered into the water until it is no longer visible. This measurement, the Secchi depth, is affected by a number of factors including the amount of algae in the water column, the amount of suspended solids in the water and natural staining of the water by organic compounds such as tannins.

The average Secchi disk depth in Beecher Lake was 9.3 feet (2.8 meters). The water clarity is less than would be expected based on the chlorophyll-a level in the lake. This is due to the naturally stained water in Beecher Lake. The dark staining is due to the presence of tannins and lignins which are organic compounds released from decaying vegetation. These compounds are washed into the lake from the large wetland areas surrounding Beecher Creek.

According to the Beecher Lake users survey, 65% of property owners view the lake as stained while 32% consider the water to be clear. Also, a majority (85%) believed that the water clarity of Beecher Lake has, in their experience, stayed the same over the years.

Trophic State Index Trophic state indices (TSI's) are popular water quality indicators used to classify lakes based on phosphorus concentration, chlorophyll-a concentration and secchi disk depth. Lakes classified as oligotrophic are nutrient poor and have clear unproductive water. Mesotrophic lakes have moderate nutrient levels, are productive and have occasional algae blooms. Lakes classified as eutrophic are nutrient rich and commonly exhibit water quality problems such as frequent algae blooms, severe oxygen depletion and poor water clarity.

The phosphorus and Secchi disk TSI values for Beecher Lake were consistently in the mesotrophic range (40-50) , while the chlorophyll TSI was in the oligotrophic range (<40) during June and July (See figure 9).

This discrepancy in TSI values is due to the stained water in Beecher Lake. Even when algae concentrations were low, water clarity is only moderate due to the normal stained color of the water.

Nitrogen Nitrogen is another important nutrient required for plant growth. However, due to its relative abundance, nitrogen does not typically limit algae growth. In most cases the nitrate level in lake water corresponds to local land use. Surface runoff and groundwater high in nitrogen may come from a variety of sources including agricultural land, fertilized lawns, and septic systems. Nitrogen levels in Beecher Lake averaged 625 ug/l. This level is typical for Wisconsin drainage lakes.

Although nitrogen in the water column seldom limits algae production, recent research shows that aquatic macrophytes increase in response to elevated sediment nitrogen levels (Rasman pers. com.). A likely source of excessive nitrogen in lake sediment is shallow groundwater contaminated by poorly functioning septic systems and nitrogen rich runoff from developed lots.

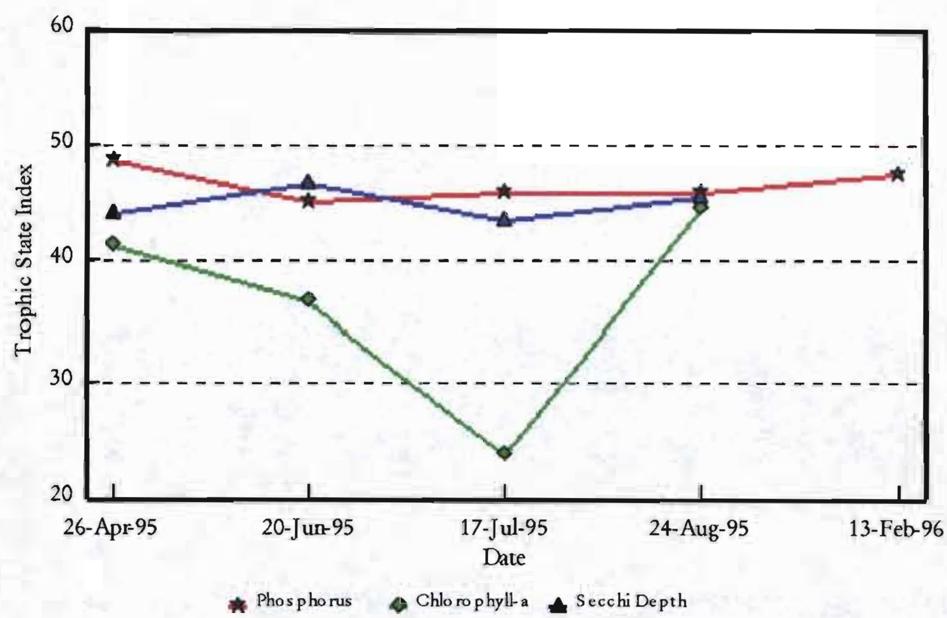
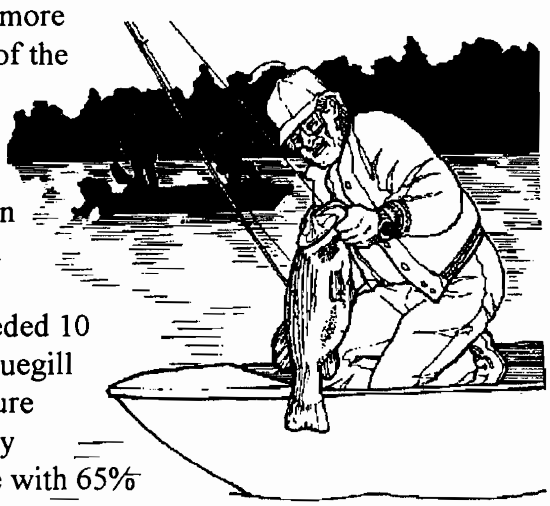


Figure 9. Beecher Lake trophic state indices.

Inlet Chemistries Phosphorus loading to Beecher Lake comes from the watershed through Beecher Creek, and from direct runoff from the near shore area. Inlet water samples were analyzed monthly for phosphorus concentration. The average total phosphorus concentration in Beecher Creek was 16 ug/l. The lowest nutrient readings occurred in May when runoff is the greatest, indicating dilution from spring rains and snowmelt. The highest reading of 23 ug/l occurred during June and most likely reflects internal loading from the wetlands drained by the inlet. On balance, nutrient loading from the Beecher Lake watershed appears to be normal and representative of a watershed in a natural forested condition.

Fish Community A fisheries survey was not conducted as part of this lake management planning grant. However, previous fisheries evaluations and WDNR stocking reports were reviewed. Several fisheries surveys of Beecher Lake have been conducted, including 1963, 1978 and most recently in 1989.

The 1989 fisheries survey was conducted by WDNR Fisheries Technician Greg Kornely. The survey showed a healthy fishery with excellent size structure for largemouth bass, bluegill and black crappie (Kornely, 1997). The survey report noted that more than 58% of the black crappie were greater than 8 inches in length and 24% exceeded 10 inches. Bluegill size structure was equally impressive with 65% of the fish more than 6 inches long and 24% more than 8 inches long. Several trophy size largemouth bass were also captured during the survey. Northern pike numbers were good, however only 10% of the fish captured were larger than 20 inches in length. The survey report concluded that Beecher Lake has a naturally sustaining fishery with excellent number and size structure of both panfish and gamefish. No specific stocking or management recommendations were made.



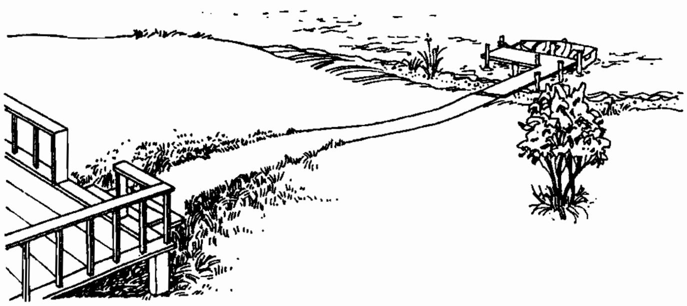
WDNR stocking records indicate that largemouth bass, bluegill and perch were stocked extensively during the 1940's, and musky were introduced with limited success in 1964. The most recent permitted stocking occurred in 1982 when 1,500 largemouth bass were stocked by private purchase.

According to the Beecher Lake users survey, poor fishing is a major concern of association members. Discussions with property owners also point to a fishery in decline. Complaints center around the lack of large bluegills and declining numbers of largemouth bass.

Future fish management efforts in Beecher Lake should be designed to maximize the potential of the lake. According to WDNR Fisheries Technician Greg Kornelly, Beecher Lake would be best managed as a bass/bluegill lake. Specific fishery improvement suggestions are discussed in the section on management alternatives.

Riparian Development It is clear from the results of the survey and talking to Association members that most people come to Beecher Lake to relax and enjoy the natural scenic beauty of the lake. However the natural beauty of the lake is severely threatened by activities which detract from the natural shoreline setting.

As is the case across northern Wisconsin, people have trouble leaving behind the habits and trappings of urban life. The desire to modify the environment has led to urban style lawns, conspicuous houses, and all manner of decks, patios, docks and unnatural lighting. Many of these modifications do not fit into the natural setting and add to the shoreline clutter. Of greater concern is the effect these changes can have on the delivery of nutrients to the lake and the loss of important natural habitat.

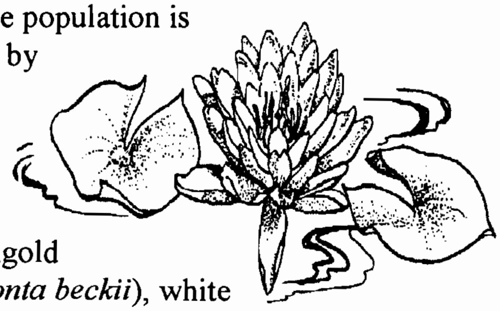


A recent study has shown that riparian development has an effect on the adjacent aquatic plant community (Weber, 1994). Septic system discharge, and increased runoff of nutrients and sediment from developed lots are believed to be responsible for a change in species assemblages. Low growing native species can be replaced by less desirable canopy forming varieties such as Eurasian water milfoil (*Myriophyllum spicatum*) and coontail (*Ceratophyllum demersum*). Destruction of shoreline habitat also reduces fish feeding activity in the shallow near-shore area (Nicholas, 1996). Aquatic insects, amphibians and many species of birds and small mammals are also harmed when deprived of this important shoreline habitat during critical stages of their lives.

An unofficial survey of waterfront properties on Beecher Lake shows that 79% do not conform to current Marinette County or State of Wisconsin shoreland zoning standards. The most common reason is excessive shoreline vegetation cutting (74%) followed by non-conforming boathouses, decks, sea walls or other structures in the shoreline zone (18%). Also, almost 13% of the cottages on the lake appear to be located less than 75 feet from the shoreline. Although some of these "violations" precede the shoreland zoning standards and are "grandfathered" in, many have occurred since ordinance were enacted.

Aquatic Plant Communities An aquatic macrophyte (plant) survey of Beecher Lake was completed on August 9, 1995. Nine transects across the lake were surveyed using SCUBA gear. Species observations and relative density were recorded and specimens were collected for positive identification (See Appendix D). Many aquatic plant specimens were laminated for future reference.

The aquatic plant community of Beecher Lake is healthy and quite diverse. Twenty-three different species of submerged aquatic plants were recorded during the survey. The macrophyte population is dominated by bushy pondweed (*Najas flexilis*), water marigold (*Megalodonta beckii*), white and yellow water lilies (*Nymphaea sp. & Nuphar sp.*), muskgrass (*Chara sp.*) and pondweeds (*Potamogeton sp.*).



Shallow areas with loose flocculent sediment such as the boat landing area are dominated by coontail (*Ceratophyyllum demersum*) which does not require roots to grow and white and yellow water lilies which form large tuberous roots to anchor in the soft sediment. Shallow areas with sandy or firm substrate are dominated by bushy pondweed, muskgrass and a variety of pondweeds.

Waters between three and five feet deep are dominated by yellow pond lilies and a wide variety of pondweeds which grow to the surface. An understory of low growing species such as bushy pondweed and muskgrass are often found under these plants.

In depths greater than five feet there are no plants which dominate the population. The aquatic community in this area is characterized by sparse stands of muskgrass and bushy pondweed with yellow water lilies, coontail and pondweeds.

Low water transparency limits the maximum depth of vegetation growth to approximately eight feet. At this depth, the amount of light available is not sufficient to support plant growth. Due to this limitation, aquatic plants are restricted to approximately 25 surface acres of Beecher Lake.

Although many people see aquatic plants as a nuisance, they play a vital role in maintaining good water quality in Beecher Lake. Aquatic plants bind loose organic sediments together to prevent resuspension by wave action. They also protect shorelines from erosion and tie up nutrients in the lake that would otherwise be available for algae growth. Aquatic plants are also necessary for a healthy fishery as they provide food, cover and spawning habitat.

Exotic Species No exotic species were identified during the aquatic plant survey or monthly lake monitoring visits. The absence of exotic species is not due to a lack of suitable habitat. In fact the lake seems well suited to eurasian watermilfoil. This species of milfoil is one of the most troublesome aquatic plants found in Wisconsin. Transferring boats between lakes and improperly disposing of bait bucket or live-well contents are common avenues for invasion by exotic species. These practices should be avoided to preserve the biotic integrity of the lake.

Land Use Survey & Watershed Analysis

The water quality of a lake is directly related to land cover types found in the lake's watershed. This is especially true of drainage lakes such as Beecher which receive much of their water from runoff of snowmelt and rainfall. As a rule, the amount of nutrients in this runoff increases as the natural forested landscape is converted to agricultural or urban land. A watershed land use map (figure 10) was developed for Beecher Lake based on the UW-Extension publication *Land Use Survey - A Protocol for Lake Management Planning Purposes* (Klessig, 1990).

Forest land comprises 1,450 acres (51%) of Beecher Lake's 2,830 acre watershed. All of the forested acreage in the watershed is privately owned and held primarily for hunting and recreation. Forested land in its natural state is very stable and delivers very little phosphorus. However, poor timber harvesting practices can lead to increased erosion, phosphorus delivery and stream habitat destruction. The most common sources of phosphorus from timber harvest areas are eroded logging roads, skid trails and poorly designed stream crossings. Failure to leave adequate buffer areas near streams during timber harvesting also results in increased phosphorus loading and destruction of vital riparian habitat.

Approximately half (1,320 acres or 47%) of the Beecher Lake watershed is wetlands. Most of this acreage is the large wetland complex surrounding Beecher Creek and extending north to Wiggins Lake. Wetlands can act as both a sink and a source for phosphorus. During periods of active wetland plant growth phosphorus is taken up by the plants. During the winter and spring, decomposing wetland plants can release phosphorus.

The balance of the watershed area (approximately 60 acres) is developed land surrounding the lake. This area has the greatest concentration of roads, driveways and homes in the watershed. All of these structures increase the volume of runoff and decrease the infiltration of surface water. This increased volume of water also carries five to ten times more phosphorus than the surrounding woodlands. Manicured lawns also increase the amount of phosphorus and sediment delivery to the lake. Additional threats to water quality come from septic discharge and hazardous home and lawn care products which can enter the lake in runoff.

Water Quality Modeling

Land cover information from the land use survey was used to model phosphorus loading to Beecher Lake and predict changes in water quality due to land use conversion and disturbance. Phosphorus loading was predicted using the Wisconsin Lake Model Spreadsheet (WILMS) developed by the Wisconsin DNR. The WILMS model is calibrated against measured water chemistry data from Beecher Lake.

Approximately 7% of the phosphorus loading to Beecher Lake comes directly from the atmosphere as dry fall and with precipitation that falls directly on the lake. This is a natural background source of phosphorus and is not controllable.

Approximately 33% of the annual phosphorus load to Beecher Lake is from wetlands which represent 47% of the total watershed area. Wetlands deliver an average of 0.09 pound of phosphorus per acre annually.

Phosphorus export from the 1,450 acres of forested land is approximately .08 lbs of phosphorus per acre annually, or 36% of the total phosphorus load to Beecher Lake. This level may be higher if poor timber management practices are used during timber harvesting operations.

Nutrient loading from septic systems is estimated at 13.8 lbs of phosphorus to the lake every year, or 7% of the total. The loading from septic systems is very difficult to estimate. The efficiency of a system at removing nutrients is dependent upon the age of the system, the amount of use and the type of soils in which it is installed. Soils surrounding Beecher Lake are excessively drained and classified as poorly suited to septic systems due to inadequate filtering of septic effluent. Many of the systems around Beecher Lake are also quite old and likely were not constructed to meet current standards, further increasing the probability that they are not functioning properly. For the purposes of the model it was estimated that the soils were retaining approximately 70% of the phosphorus.

Although the narrow band of development surrounding Beecher lake is only 2% of the watershed area, it represents the largest "controllable" source of phosphorus to the lake. This developed area delivers an estimated (20% of the total phosphorus load to the lake. When the septic phosphorus load is factored in, the impact from the riparian area around Beecher lake is conservatively estimated at 27% of the total phosphorus load.

Model Outcome The WILMS model can be used to predict changes in lake water quality due to changes in land use or the addition of point sources of phosphorus. As discussed above, the largest controllable source of phosphorus to Beecher Lake is riparian development. According to the water quality model, reducing by half the amount of phosphorus from riparian development will lead to a 13% reduction in the spring turnover phosphorus level of the lake. Doubling the amount of development around the lake would result in a corresponding 17% increase in the spring turnover phosphorus level, increasing the chance of algae blooms.

Management Alternatives

This report has detailed the current state of Beecher Lake, trends in water quality and other related issues. However, the future of Beecher Lake lies with the Beecher Lake Association and the actions of each and every landowner on the lake.

It is obvious that most Association residents care deeply about the quality of Beecher Lake and want to maintain the resource for the future enjoyment of their families. It is also clear that many residents have serious concerns about the present state of the lake. Major concerns include the level of aquatic macrophyte growth, excessive sediment, and a declining fishery. The following management options were developed in response to these concerns.

Do Nothing This is the easiest management alternative to implement. It does not require personal or financial sacrifice, cooperation, or effort. In the short term it allows everyone to enjoy the lake rather than worry about the future. However, this option is clearly short sighted and will only lead to declining water quality and further degradation of the riparian environment.

Implement Forestry Best Management Practices The Wisconsin DNR recommends that forestry best management practices (BMP's) be followed when harvesting timber. These practices are aimed at preventing erosion and the destruction of stream, lake and wetland habitat during timber harvest. The implementation of forestry BMP's by private landowners will ensure that phosphorus loading from forested lands is kept to a minimum.

a. *Lake Association members should be aware of forestry activities in the watershed and ensure that forestry practices are not causing excessive erosion or habitat destruction.*

Implement Lakefront BMP's The riparian zone of Beecher Lake represents the largest "controllable" source of phosphorus to the lake. Although an individual home, road or lawn may not appear to be a problem, the cumulative impact of this development on the chemistry and ecology of the lake is significant. To protect Beecher Lake from the effects of current and future development the following management actions should be implemented:

a. *Reduce the use of lawn fertilizers. Runoff from fertilized lawns can transport phosphorus to the lake which feeds weed and algae growth.*

b. *Maintain septic systems with regular pumping. Inspect septic systems regularly and replace those that are not functioning properly.*

c. *Restore natural buffer areas around the lake to reduce the amount of runoff from developed areas and to filter nutrients and other pollutants from the runoff.*

d. *Maintain natural buffer areas where they already exist. Contact new landowners to educate them concerning the importance of natural buffers.*

Implement "Lake Friendly" Home and Garden Practices Many of the household cleaning products we use every day contain hazardous and/or persistent toxic substances which can be harmful to the environment. Often these products are not broken down by on-site septic systems and can contaminate groundwater. Also, many automotive products such as oil, grease and radiator fluid are hazardous to the environment.

Extra care should be taken when using and disposing of toxic substances near the lakeshore. Proximity to the lake combined with the sensitive nature of riparian systems increases the risk of environmental contamination. To reduce this risk the following practices should be implemented.

a. *Reduce dependence on harmful household products by reading labels and choosing environmentally friendly alternatives. Non-toxic alternatives to many cleaning products are commercially available or can be made at home from common ingredients.*

b. *Dispose of used or unwanted household chemicals properly. Take advantage of household "clean sweeps". Clean sweeps are locally sponsored events where residents can take hazardous substances to be properly disposed of for no charge.*

c. *Take automotive products such as oil, radiator fluid and batteries to garages or local collection centers. Never dispose of these products in septic systems or on the ground.*

Improve Lake Aesthetics and Quality of Life on the Lake Most Association members come to Beecher Lake primarily to relax and enjoy the natural beauty. However, most of the natural view has already been replaced by suburban style development. If recent history is an accurate guide, this trend will continue as landowners retire to live at the lake. Cottages will be replaced with larger year round homes, more and larger outbuildings will be built and lawns will expand.

It is the responsibility of current landowners to ensure that future generations can enjoy a relatively natural and unspoiled lake. To accomplish this, people have to resist the urge to further "improve" their property with unnecessary structures and landscapes that are more at home in the suburbs than in the northwoods. The following recommendations

are designed to ensure that future development does not take away from the aesthetics of Beecher Lake and the ability of all lake residents to enjoy this resource.

a. *All lake residents must make an effort to consider how their actions effect the aesthetics of the lake and the ability of their neighbors to enjoy the lake.*

b. *The Association should adopt a "courtesy code" to help avoid conflicts between lake residents. This code can address such things as outdoor lighting, noise, boat usage, etc. A complaint process should be developed utilizing officers of the board to relay concerns and maintain anonymity.*

c. *The Beecher Lake Association should support stronger enforcement of current zoning regulations which are designed to protect the beauty and water quality of lakes. By acting as a group the Association can influence local political decisions.*

d. *The Association should set voluntary standards for development and communicate the need for these standards to Association members. A policy to remove nonconforming decks and boat houses from the shoreline should be adopted.*

Strengthen the Beecher Lake Association

The Beecher Lake Association has undertaken several projects to improve their lake the most prominent of which is the weed cutting operation. Although this program was started with all the best intentions for the lake, it has divided Association members and kept some property owners from participating in Association activities. This is unfortunate, because a strong Lake Association with concerned and committed members can greatly influence lake development, conservation and lake management efforts. An active Association will also foster teamwork and friendship among members.

Although state and local government have certain responsibilities for lake and watershed management, the future of the lake ultimately lies in the hands of the Beecher Lake Association and its members. The Association must become stronger and continue to participate in projects and speak up on issues which effect Beecher Lake. Members and lake residents should adopt the following recommendations to strengthen the Beecher Lake Association.

a. *All lake management projects and cooperative efforts require a committed and unified membership to be successful. Beecher Lake residents must "bury the hatchet" so to speak and put the weed harvester issue behind them. If these types of issues continue to divide the group, consensus can not be reached and Beecher Lake will suffer as a result.*

b. *The Beecher Lake Association should become a member of the Wisconsin Association of Lakes (WAL). WAL lobbies for laws and programs which protect and benefit lakes in Wisconsin.*

c. *Every year a few different members should attend the annual Wisconsin Lakes Convention sponsored by WAL. The annual convention features workshops and presentations to educate and assist lake residents in managing their lakes. The convention is also a great place to meet people from other lakes and discuss problems and solutions they are experiencing.*

d. *Plan ahead for future lake management efforts. A fund should be established to ensure that local matching dollars are available for future grants or lake management efforts.*

e. *Invite local Wisconsin DNR, Zoning and UW-Extension lake experts to annual meetings to educate residents about lake ecosystems and management.*

f. *Introduce new landowners to the Beecher Lake Association as soon as possible. Educating new members about the lake and the work being done to protect it will give them a sense of ownership and responsibility.*

g. *After the Beecher Lake Association has been strengthened the membership should consider becoming a lake district. A district is similar to an association but has the power to levy a tax on its members for the purpose of lake management efforts. This would assure the steady revenue required for long term protection and improvement projects.*

Protect Sensitive Areas From Development
Beecher lake was once surrounded by undisturbed forests and wetlands. In fact, as recently as 1960 much of the lake remained undeveloped. However the lake now has little undeveloped shoreline and few riparian wetlands remain. As these undisturbed areas shrink in size the remaining natural areas become even more important for fish and wildlife habitat and lake aesthetics.

a. *The Association should encourage long term protection of undeveloped shoreline areas. Easements, deed restrictions, donations and direct purchase are some of the tools that can be used to preserve these areas should the opportunity presents itself. Wisconsin Lake Protection Grant cost-share dollars are available for purchase of sensitive areas.*

b. *Natural areas and wetlands on presently developed properties should be protected. Further disturbance near the shoreline of these properties should be discouraged by the Association.*

Participate in County Association of Lakes
The Marinette County LWCD supports the formation of a Marinette County Association of Lakes. The purpose of this group will be to support lake management activities and programs in Marinette County and represent lake users at the local level. This new group would have a member assigned to the Land & Water Conservation Committee, a standing committee of County Board which sets policy for the Land & Water Conservation Department.

The County Association of Lakes could provide many beneficial services to its members including financial and technical assistance, education, support and assistance for grant programs. Other possibilities include coordinating services such as weed harvesting and water quality monitoring programs.

a. *The Beecher Lake Association should support the formation of a Marinette County Association of Lakes and become a member.*

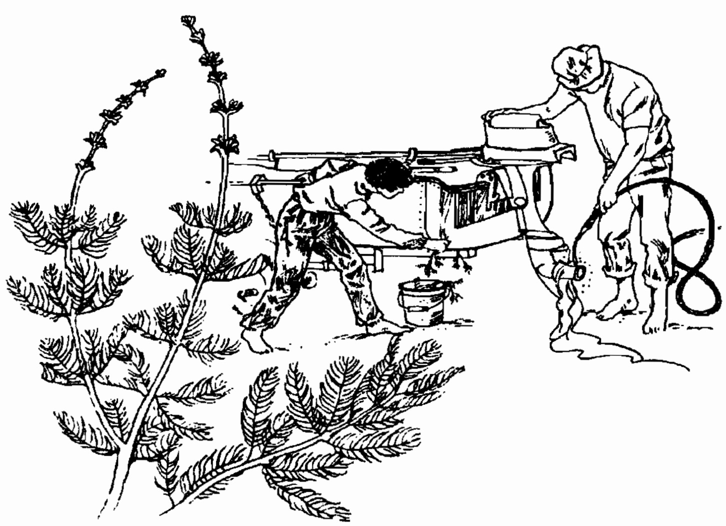
Prevent Introduction of Exotic Species The introduction of exotic plants and animals to a lake can have a devastating effect on the aquatic ecosystem. Many exotic plant species out-compete native vegetation and have little or no wildlife value. Many exotic macrophytes have growth forms which interfere with boating and fishing. An example is eurasian watermilfoil which forms dense floating mats that shade out native vegetation. Eurasian watermilfoil prefers shallow waters and soft organic sediment.

The exotic purple loostrife a wetland plant with tall purple flower spikes was seen growing near the boat landing. These plants crowd out native wetland plants and provide little benefit to wildlife.

Most exotic species are introduced to lakes on boats, trailers or in live-wells and bait buckets. The public access on Beecher Lake is a likely avenue for the unintentional introduction of exotics. Lake Association members can help by adopting the following recommendations.

a. *Purple loostrife should be removed from the shoreline of Beecher Lake whenever it is found. The plants should be pulled and destroyed before they set seed.*

b. *Boats which are used on other waters should be checked carefully before use in Beecher Lake. Any plant material from other lakes should be removed from boats and trailers. Water and fish from live-wells and bait buckets should never be transferred to another lake. Many exotic species are introduced in this way.*



c. *The Association or the town should erect a sign at the boat landing educating boaters about the danger of transferring exotics and reminding them to clean their boat trailers.*

d. *A healthy aquatic plant species structure should be maintained in the lake. A healthy community will help prevent invasion by exotic plants.*

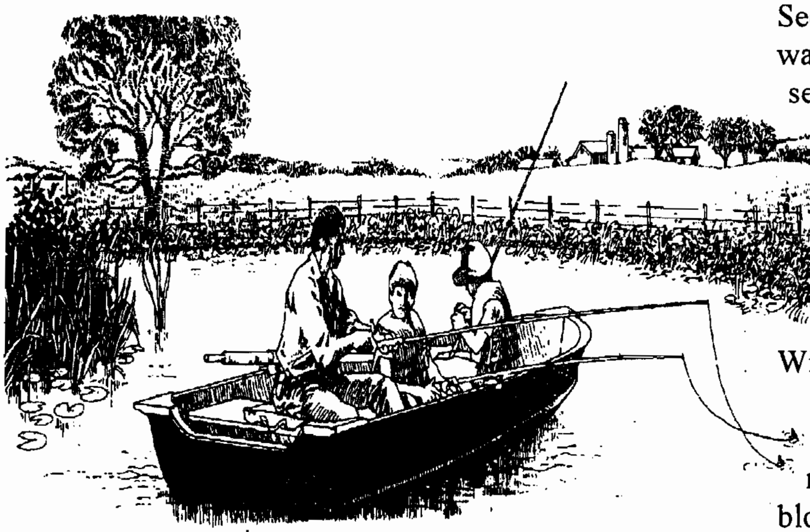
Fisheries Enhancement The results of the landowner survey showed that many lake residents are concerned with the quality of the fishery in Beecher Lake. Previous fisheries surveys conducted by the Wisconsin DNR showed that Beecher Lake had an outstanding bluegill/bass fishery as recently as 1989. Since that time fishing has apparently declined.

When attempting to manipulate the fish population, it is important to recognize the lake's potential and accept its limitations. In the past, WDNR fisheries management policy was very aggressive with regular fish stocking and new species introduction to many lakes including Beecher. However, the stocking of fish is expensive and often ineffective. According to WDNR Fisheries Technician Greg Kornely, current policy focuses on improving populations through habitat improvement and harvest control. Stocking is usually done only to reestablish a fishery.

The introduction of new species into the lake to provide "improved" fishing opportunities can have many unintended consequences. For instance, walleye stocked in an established bass lake often severely exploit the bass population by preying on juvenile bass (Kornely, 1997). The walleye are also difficult to catch and usually fail to reproduce. WDNR fish managers recommend managing Beecher Lake to maximize the bass/bluegill fishery. A variety of projects can be undertaken to improve in-lake habitat for the fish population, including:

a. *Stop destruction of the near-shore littoral zone habitat. Beecher Lake currently has little undisturbed shoreline. The key to maintaining a healthy fishery is protecting valuable fish habitat.*

b. *Leave trees and shrubs which are leaning over the water or have fallen in. This provides shade and cover for predator fish and a feeding area for many young fish. Also, according to WDNR Fisheries Technicians, large fallen woody debris is important spawning habitat for perch as it suspends their eggs above the silty sediment.*



c. *Consider the fishery in any harvesting plan. Limit heavy aquatic plant harvesting to areas in front of docks and in swimming areas. Cutting lanes through dense aquatic plant beds can benefit predator fish which use these lanes to reach smaller prey hidden in the weed beds. Extensive removal of weed beds for purely aesthetic reasons only damages the fishery.*

d. *Protect spawning habitat in the lake. The best spawning substrate for bass and bluegill is firm sand and gravel. These areas are especially valuable when located adjacent to natural shorelines.*

e. *Work with WDNR Fish Managers to improve the fishery. The WDNR has a limited budget available for large scale fish population surveys. However, if sufficient concern is expressed by the Association, a limited fish survey might be scheduled.*

f. *Invite WDNR Fish Managers to an annual meeting to discuss the fishery and additional management options.*

Sediment Deactivation of Phosphorus

Sediment loading of phosphorus to the overlying water of a lake can be reduced by treating the sediment with alum. Alum is an aluminum salt which combines with phosphorus to form an insoluble precipitate. It is most often used in deep lakes where oxygen depletion in the hypolimnion leads to increased phosphorus cycling. Alum treatment has been used successfully in several nutrient rich lakes in Wisconsin.

Sediment deactivation of phosphorus would not greatly benefit Beecher Lake. Algae blooms are not a problem and macrophytes derive most of their nutrients from the sediment, not the overlying water. If continued nutrient inputs lead to algae blooms, an alum treatment could be necessary in the future.

Alum treatments require a lot of planning and are best done by lake management consultants who specialize in these applications. A planned alum treatment of Bass Lake in Marinette County will cost an estimated 13,700 dollars or more than $370.00 per surface acre.

a. *An alum treatment of Beecher Lake would be of little benefit at this time. However, it is a tool that is available if needed in the future. This is another reason for the Association to establish a fund for future management efforts.*

Sediment Removal Excessive sediment in Beecher Lake was the second biggest concern with lake residents according to the landowner survey. The soft organic sediment (muck) is unpleasant for swimmers and provides a good growth substrate for aquatic plants.

Dredging is the only proven way to remove large amounts of sediment. There are two primary methods of dredging, mechanical and hydraulic. Mechanical dredging is accomplished with the use of a dragline, clamshell bucket or backhoe which scoops sediment from the lake bottom. Hydraulic dredging employs a cutter head to suck up a sediment and water slurry through a hose. Both methods of dredging require a dewatering area where dredged material is deposited to settle and dry. Typically, water which drains from the dredged material is pumped back to the lake.

Mechanical dredging removes far less water than hydraulic dredging and requires a smaller dewatering area. This method is best suited to removing well consolidated sediment.

Hydraulic dredging is best suited to removing soft organic sediment. This type of sediment is readily mixed up and easy on the pumping equipment. Hydraulic dredging is generally less costly than mechanical methods. Small portable hydraulic dredges are also available for purchase or hire. The main drawback to hydraulic dredging is the need for a large dewatering area to handle the dredge spoils. Also, temporary lake level drawdowns are possible if water from the dewatering site is not returned to the lake.

Large scale dredging to deepen Beecher Lake is not necessary or desirable. The maximum depth of aquatic plant growth in Beecher Lake is approximately eight feet, with generally sparse growth in depths greater than five feet. Given these conditions, approximately 31 acres or 55% of the lake is open water.

Large scale dredging is a very expensive management tool. Three dredging companies were contacted for cost estimates. The price range estimated by the contractors ranged from $3.00 to $6.00 per cubic yard. For illustrative purposes, a project to dredge two feet of sediment from a ten acre area would remove in excess of 32,000 cubic yards of material. At $3.00 per cubic yard this hypothetical project would cost more than $96,000.

The heaviest accumulation of muck and aquatic vegetation is near the boat landing and in the shallow bay near the dam. In these areas localized dredging near docks to remove silt and muck accumulations to create small swimming areas is a much more realistic goal. However, people must realize that if the area is not used often by swimmers, sediment will move back in quickly and plants will re-colonize the area.

Dumping sand in the lake to create a beach area is not recommended. The practice usually does not last as the sand becomes mixed with soft sediment and plants soon re-colonize the area. Dumping sand on the lake bed without a permit is also a violation of state law. Dumping sand on steep shorelines is a violation of Marinette County zoning ordinances.

According to Robert Rosenberger WDNR Water Management Specialist, Any amount of dredging will require a WDNR and possibly a U.S. Army Corps of Engineers permit. Dredging projects which remove more than 3,000 cubic yards of sediment may require contaminant testing of the dredged material and an environmental impact statement

a. *Large scale dredging of Beecher Lake is not recommended.*

b. *Landowners who wish to create a better swimming areas should keep it small to limit habitat disturbance. The local WDNR Water Management Specialist must be contacted for permits.*

Drawdown Water level drawdowns are commonly used as a management tool on reservoirs and lakes with water level control structures. The benefits of controlled drawdowns can include reduction of some species of aquatic vegetation, reduction of ice damage and compaction of loose flocculent sediment.

Drawdowns to reduce aquatic vegetation have met with varying success. Some species common in Beecher Lake are readily controlled by drawdown, including white and yellow water lily and watershield (*Bresenia aquatica*) . However, many species found in the lake reportedly increase in response to drawdown such as megalodanta, coontail and water celery (*Vallisneria americana*). Many other species are variable in their response.

The consolidation of soft sediment due to drawdown is a possibility. According to some longtime lake residents the five year drawdown which occurred when the dam failed in 1970 resulted in a firm bottom when the lake was re-filled. A five year drawdown would not be permitted or desired today. However, a more limited one year drawdown beginning in summer and lasting through one complete winter may provide many of the same benefits. A drawdown would require a WDNR permit. A public hearing would likely be needed to obtain the permit.

Although the Beecher Lake dam has no provisions to adjust the water level, a drawdown might be possible using some combination of pumps and a siphon. An engineering firm familiar with quarry dewatering operations should be able to provide advice on feasibility and cost.

a. *If the Association wishes to pursue a drawdown of Beecher Lake for sediment consolidation, WDNR water management personnel should be contacted regarding the possibility of a permit.*

Aquatic Plant Management The two most popular methods of aquatic plant management are chemical treatment and harvesting. Each method has its good and bad points, and each method has many secondary effects on the fish and plant community of the lake.

Chemical treatment is fast and efficient, however a WDNR permit is required and any liquid herbicide application must be performed by a licenced applicator. Chemical treatment also kills the entire plant. This opens up the bottom to increased wave action and leaves openings for invasion by less desirable species. Plants killed through chemical treatment also stay in the lake where they decompose. The nutrients released from the decomposing plants can stimulate algae blooms and cause increased plant growth. Although aquatic plants vary in their susceptibility to different herbicides, it is still difficult to accurately target certain species or areas with chemical treatment.

Harvesting removes the upper portions of the plant, leaving the roots to bind the sediment and allow for plant regrowth. Harvesting also removes the nutrients tied up in the plant material from the lake. In addition, harvesting allows for more precise management of species and areas to be conserved.

The Beecher Lake Association currently cuts aquatic plants with a Hockney weed cutter. As many Association members know, one of the drawbacks of the Hockney type cutter is its inability to collect or "harvest" the cut vegetation. Wisconsin law requires that cut vegetation be removed from the water. Without removing the cut vegetation, much of the benefit is lost as the cut plants will remain in the water and decay or wash up on the shoreline. The main drawback to the current Beecher Lake weed cutting program is the feelings of ill will it has created between some lake residents.

The main obstacle to harvesting is the capital cost of the equipment. A 5 foot wide harvester, conveyor and transport trailer will cost upwards of $50,000. However there are Wisconsin Waterways Commission grants available to help defray the cost of purchasing a harvester. The grant pays 50% of the cost of the equipment. Grant recipients must have an approved aquatic plant management plan for the waters to be harvested and at least 40 acres of harvestable area.

The small number of landowners and the requirement for 40 acres of harvestable area limits the ability of many lake groups such as the Beecher Lake Association to obtain a Wisconsin Waterways Commission grant. However, if several area lakes cooperated and pooled resources a grant could be received and a harvester purchased. The operation of a successful harvester sharing agreement would require a paid crew, an operating/maintenance budget and a mutually agreeable plan of operation. The operation of a shared harvesting operation could also be coordinated by the proposed Marinette County Association of Lakes.

Aquatic plant harvesting for hire is also available through several private contractors. The Lake List, an annual publication of the UW-Extension Lakes Program lists harvesting contractors. One contractor that harvests in northeast Wisconsin was contacted. The contractor charges $120.00 per hour for harvesting and has a 20 hour minimum. At the average stated harvesting rate of ½ acres per hour, it would cost $2,400 to harvest 10 acres.

a. *The Beecher Lake Association should form a Harvesting Committee to explore a cooperative agreement with other area lakes to apply for a Wisconsin Waterways Commission harvester grant, and support such efforts through a County Association of Lakes.*

b. *Prior to application for a harvester grant, the Lake Association should work closely with the Marinette County LWCD and WDNR to develop an aquatic plant harvesting plan.*

c. *As soon as it is feasible, the current weed cutting program should be abandoned and the weed cutter sold.*

d. *The Harvesting Committee should explore contracting aquatic plant harvesting to private contractors.*

ACTIVITY	YEAR COMPLETED OR CONTINUING								
	1997	1998	1999	2000	2001	2002	2003	2004	2005
1. Monitor forestry BMP's									
2. Restore natural buffer areas									
3. Implement "lake friendly" home practices									
4. Set voluntary standards for development									
5. Develop a "courtesy code" to avoid conflicts between lake users.									
6. Join Wisconsin Association of Lakes									
7. Strengthen Beecher Lake Association									
8. Establish lake management fund									
9. Invite local water quality and fisheries experts to annual meetings									
10. Participate in Marinette County Association of Lakes									
11. Develop fish management plan									
12. Form dredging committee to solicit cost estimates from dredging contractors									
13. Form a harvesting committee to explore harvester purchase or rental									

REFERENCES

Borman, Susan. 1995. "The benefits of trend monitoring for macrophyte management: a case study," *15th International Symposium on Lake, Reservoir and Watershed Management.* November 6-11, 1995. North American Lake Management Society, Toronto, Ontario.

Cooke, G. Dennis, Welch, E.B., Peterson, S.A., and Newroth, P.R. 1993. "Restoration and Management of Lakes and Reservoirs: Second Edition CRC Press, Inc., Boca Raton, Florida

Kornelly, Greg. 1997. Fisheries Technician, Wisconsin Department of Natural Resources, Personal communication.

Panuska, John., and Sorge, B. 1996. "Measuring the Impacts of Development: Lake Water Quality and Watershed Disturbance." at *An Uncertain inheritance: The History and Implications of Humans on Wisconsin's Lakes, a Pre-Conference Technical Session of the 1997 Wisconsin Lakes Convention*, April 3, 1996. Wisconsin Association of Lakes, Stevens Point, Wisconsin.

Shaw, Byron., Mechenich, C., and Klessig, L. 1994. "Understanding Lake Data" University of Wisconsin Extension Publication No. G3582.

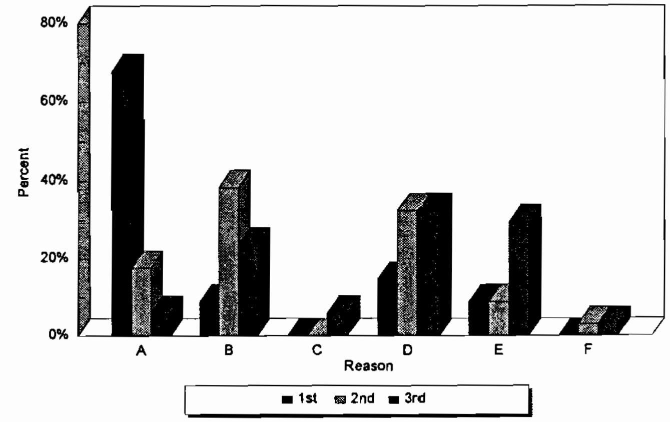
Weber, Steven. 1994. "The influence of groundwater and sediment characteristics on the aquatic macrophyte community of Legend Lake, Wisconsin." Masters Thesis, University of Wisconsin - Stevens Point.

APPENDIX A

Water Resources Questionnaire

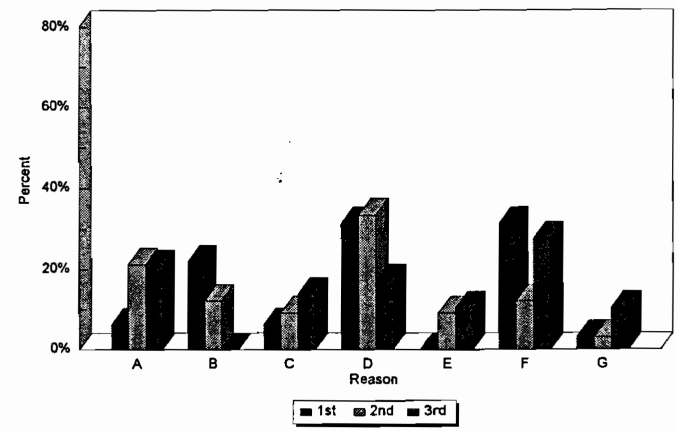
#1. Why do you enjoy Beecher Lake?

REASON		CHOICE 1st	CHOICE 2nd	CHOICE 3rd	PERCENT 1st	PERCENT 2nd	PERCENT 3rd
A	Peace and quite	23	6	2	68%	18%	6%
B	Fishing/hunting	3	13	8	9%	38%	24%
C	Motorized recreation: boating/skiing/etc.	0	0	2	0%	0%	6%
D	Natural beauty	5	11	11	15%	32%	32%
E	Non-motorized recreation: swimming/canoeing/etc.	3	3	10	9%	9%	29%
F	Other	0	1	1	0%	3%	3%
	respondents	34	34	34			



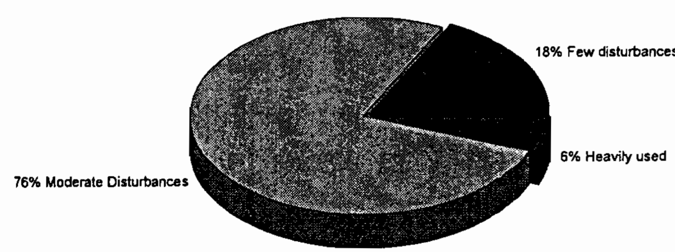
#2. Why did you choose property on Beecher Lake?

REASON		CHOICE 1st	CHOICE 2nd	CHOICE 3rd	PERCENT 1st	PERCENT 2nd	PERCENT 3rd
A	Distance from home	2	7	6	6%	21%	21%
B	Family tradition	7	4		22%	12%	0%
C	Investment	2	3	4	6%	9%	14%
D	Privacy of Lake	10	11	5	31%	33%	17%
E	Because of Neighbors		3	3	0%	9%	10%
F	Ability to meet the needs from Question #1	10	4	8	31%	12%	28%
G	Other	1	1	3	3%	3%	10%
	respondents	32	33	29			



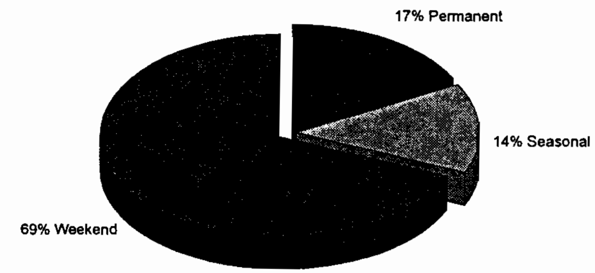
#3. Which statement best describes the peace and tranquility at Beecher Lake

REASON		NUMBER	PERCENT
A	Few disturbances	6	18%
B	Moderate Disturbances	26	76%
C	Heavily used	2	6%
D	Over used	0	0%
E	Unusable	0	0%
	respondents	34	



#4. How often is your lakefront residence used?

REASON	NUMBER	PERCENT
A Permanent	6	17%
B Seasonal	5	14%
C Weekend	24	69%
respondents	35	

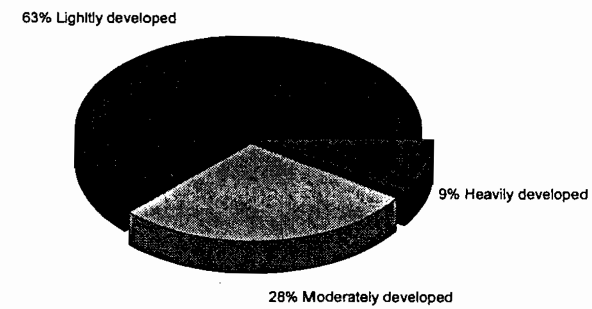


#5. How long have you been coming to Beecher Lake? Average = 23.3

#6. How many people use your lake residence on a regular basis? Average = 4.5

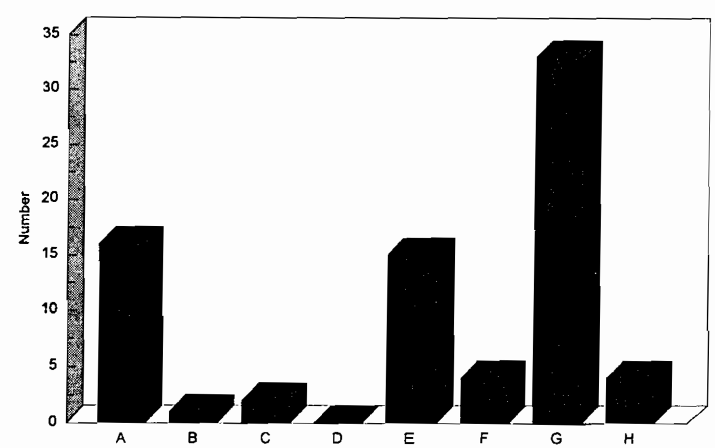
#7. Which statement do you feel best describes the shoreline of Beecher Lake Lake?

REASON	NUMBER	PERCENT
A Lighltly developed	20	63%
B Moderately developed	9	28%
C Heavily developed	3	9%
D Over developed		0%
respondents	32	



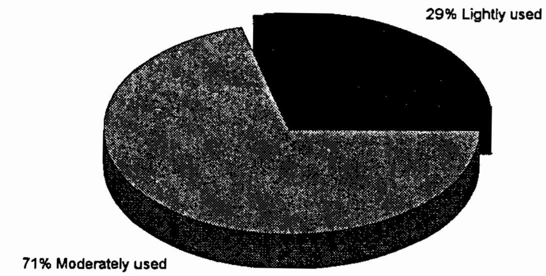
#8 How many of the following watercraft are kept at your property?

REASON	NUMBER
A Canoe	16
B Jet Ski	1
C Raft	2
D Power boat over 25hp	0
E Power boat under 25 hp	15
F Sail boat	4
G Row boat	33
H Paddle boat	4



#9 Which statement best describes the boat traffic on Beecher Lake?

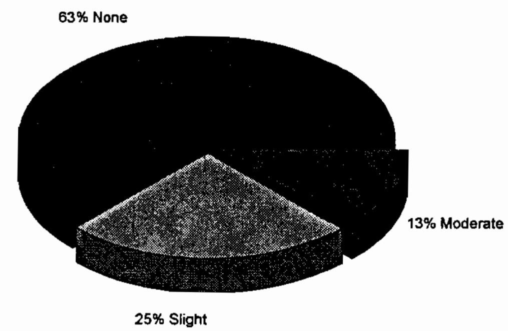
REASON	NUMBER	PERCENT
A Lightly used	7	29%
B Moderately used	17	71%
C Heavily used	0	0%
D Over used	0	0%
respondents	24	



#10. Approsimately how many feet of lake frontage do you own? Average = 137'

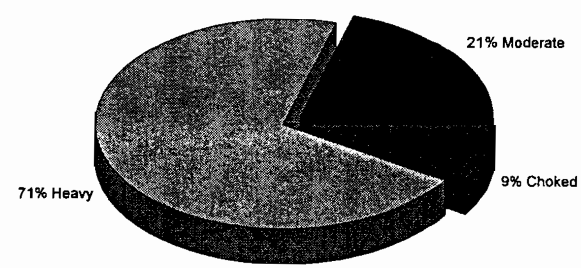
#11. How whould you describe the severity of shoreline erosion or loss on your lake frontage?

REASON	NUMBER	PERCENT
A None	20	63%
B Slight	8	25%
C Moderate	4	13%
D Heavy	0	0%
E Severe	0	0%
respondents	32	



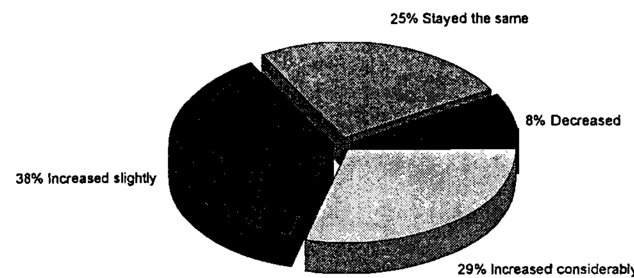
#12. Which statement best describes the level of aquatic plant (weed) growth in the lake?

REASON	NUMBER	PERCENT
A Light	0	0%
B Moderate	7	21%
C Heavy	24	71%
D Choked	3	9%
respondents	34	



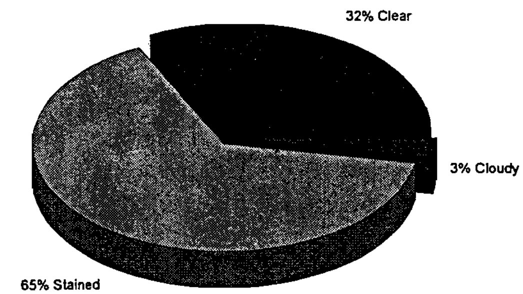
#13. In your experience, how has the level of aquatic plant (weed) growth changed over the years?

REASON	NUMBER	PERCENT
A Decreased	2	8%
B Stayed the same	6	25%
C Increased slightly	9	38%
D Increased considerably	7	29%
respondents	24	



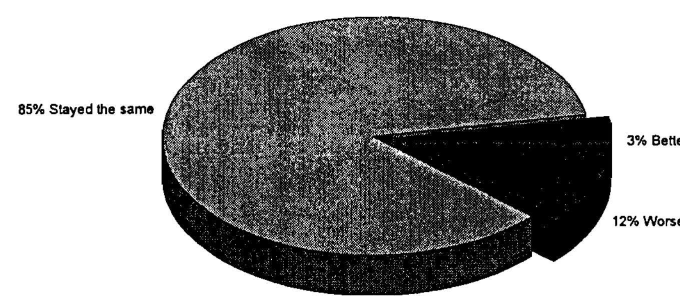
#14. Which term best defines what you consider the water "clarity" of Beecher Lake to be?

REASON	NUMBER	PERCENT
A Crystal clear	0	0%
B Clear	11	32%
C Stained	22	65%
D Cloudy	1	3%
E Murky	0	0%
respondents	34	



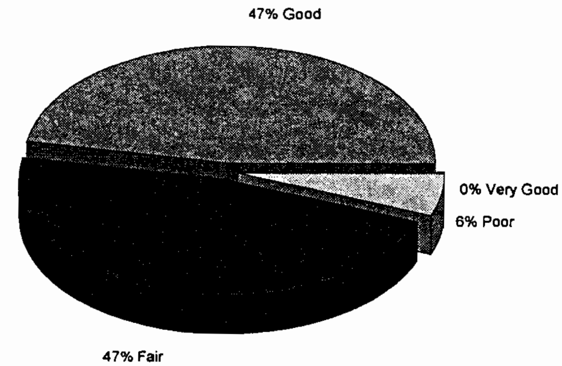
#15. In your experience, how has the water clarity changed over the years?

REASON	NUMBER	PERCENT
A Better	1	3%
B Stayed the same	29	85%
C Worse	4	12%
respondents	34	



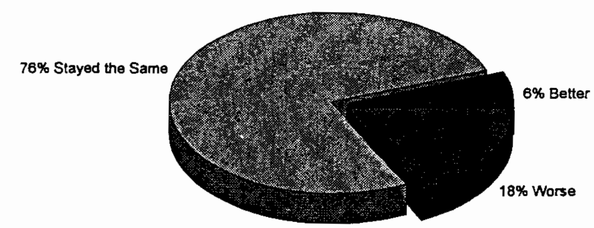
#16. Which term best describes what you consider the water "quality " of Beecher Lake to be?

REASON		NUMBER	PERCENT
A	Very Good	0	0%
B	Good	16	47%
C	Fair	16	47%
D	Poor	2	6%
E	Seriously polluted	0	0%
	respondents	34	



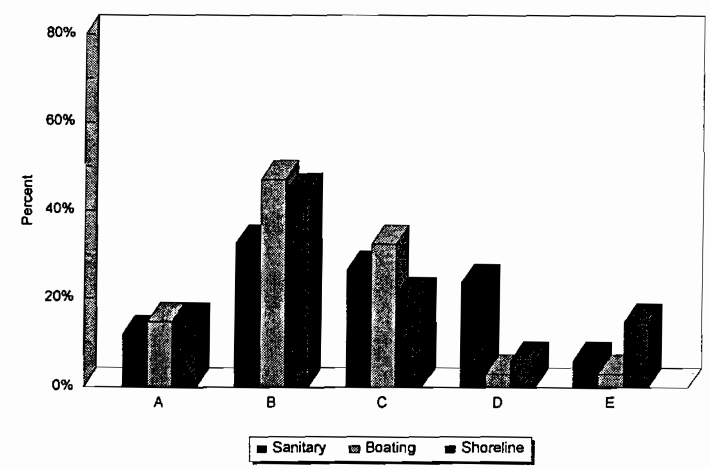
#17. In your experience, how has the water quality changed over the years?

REASON		NUMBER	PERCENT
A	Better	2	6%
B	Stayed the Same	26	76%
C	Worse	6	18%
	respondents	34	



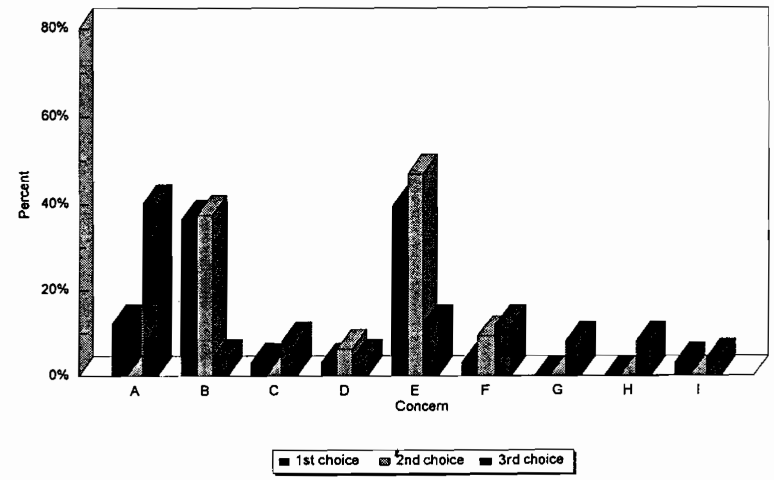
#18. How would you rate the enforcement of the following esisting regulations?

REASON		NUMBER 1st	2nd	3rd	PERCENT San.	Boat	Shore
A	Excellent	4	5	5	12%	15%	15%
B	Good	11	16	15	32%	47%	44%
C	Fair	9	11	7	26%	32%	21%
D	Poor	8	1	2	24%	3%	6%
E	Not familiar with regulations	2	1	5	6%	3%	15%
	respondents	34	34	34			



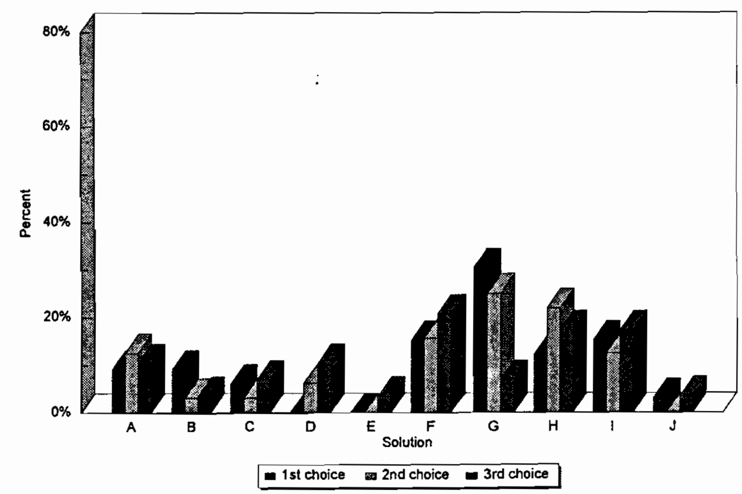
#19. The most serious problems or concerns regarding Beecher Lake are?

REASON		NUMBER 1st	2nd	3rd	PERCENT 1st choi	d choi	rd choice
A	Poor Fishing	4	0	10	12%	0%	40%
B	Excessive sediment on the lake bottom	12	12	1	36%	38%	4%
C	Over development of the shoreline	1	0	2	3%	0%	8%
D	Crowding/over use	1	2	1	3%	6%	4%
E	Excessive aquatic plant growth	13	15	3	39%	47%	12%
F	Excessive algae blooms	1	3	3	3%	9%	12%
G	poor water quality	0	0	2	0%	0%	8%
H	Unattractive shoreline development	0	0	2	0%	0%	8%
I	Other	1	0	1	3%	0%	4%
	respondents	33	32	25			



#20. What sollutions do you favor to deal with the issues facing Beecher Lake?

REASON		NUMBER 1st	2nd	3rd	PERCENT 1st choi	d choi	rd choice
A	Strengthen the Beecher Lake Association	3	4	3	9%	13%	10%
B	Stronger regulation of shorline development	3	1	1	9%	3%	3%
C	Education about environmentally friendly lake living an	2	1	2	6%	3%	7%
D	Increase environmentally sound management of the la	0	2	3	0%	6%	10%
E	Continue current management practices	0	0	1	0%	0%	3%
F	Stock lake and manage fish population	5	5	6	15%	16%	21%
G	Manage (remove) aquatic plants	10	8	2	30%	25%	7%
H	Update septic systems to reduce pollution	4	7	5	12%	22%	17%
I	Remove excessive sediment deposits	5	4	5	15%	13%	17%
J	Other	1	0	1	3%	0%	3%
	respondents	33	32	29			



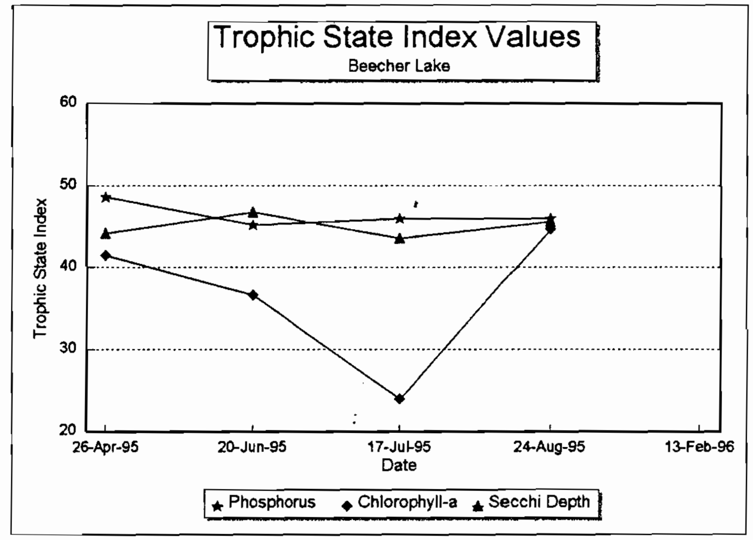
APPENDIX B

Water Quality Monitoring Data

BEECHER LAKE
MARINETTE COUNTY, WI

SURFACE WATER QUALITY SAMPLES

Date	Total P (ug/l)	Ortho P (ug/l)	TKN (ug/l)	No2-No3	NH3	Chlor-a (UG/L)	Secchi (ft)	Phosporus TSI	Chlor-a TSI	Secchi TSI
26-Apr-95	14	2	600	53	17	2.41	9.8	48.6	41.5	44.2
20-Jun-95	9	ND	700	ND	ND	1.28	8.2	45.2	36.7	46.8
17-Jul-95	10	ND	600	ND	ND	0.24	10.2	46.0	24.0	43.6
24-Aug-95	10	3	600	ND	ND	3.68	8.9	46.0	44.7	45.6
13-Feb-96	12	8								



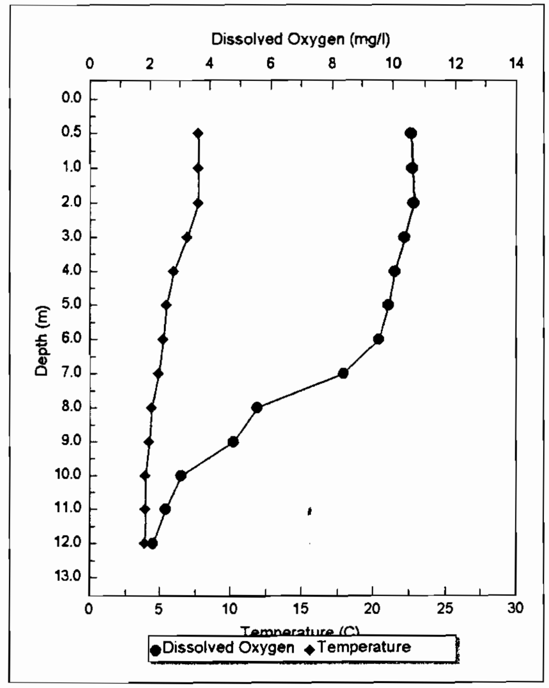
BOTTOM SAMPLES (0.5 m from bottom)

Date	Total P (ug/l)	Ortho P (ug/l)	TKN (ug/l)	No2-No3	NH3
26-Apr-95	21	9	600	169	59
20-Jun-95	59	28	700	107	117
17-Jul-95	105	45	800	31	150
24-Aug-95	217	129	217	ND	301
13-Feb-96	20	13			

Hydrolab Monitoring Results

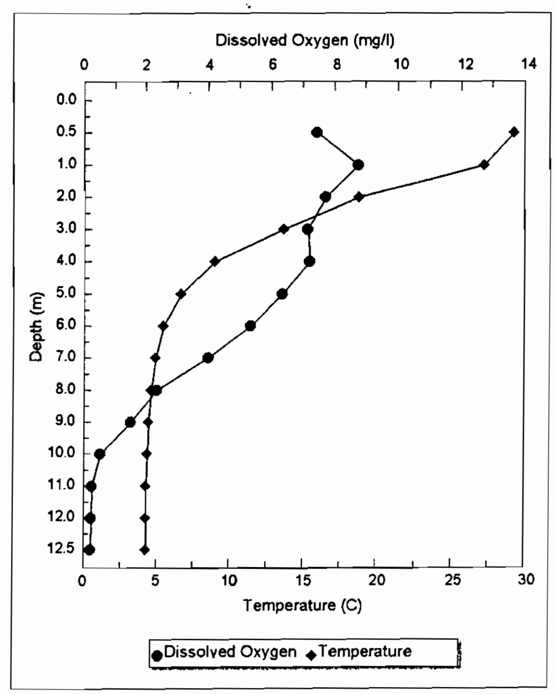
Beecher Lake
04/26/95

Depth (m)	Temp (C)	D.O. (mg/l)	Cond. (mS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0						
0.5	7.69	10.55	0.186	7.52	0.119	88.6
1.0	7.70	10.58	0.186	7.51	0.119	88.8
2.0	7.69	10.63	0.186	7.46	0.119	89.0
3.0	6.90	10.36	0.185	7.41	0.121	85.0
4.0	5.98	10.05	0.191	7.36	0.122	80.1
5.0	5.45	9.86	0.191	7.35	0.122	78.0
6.0	5.23	9.53	0.193	7.33	0.123	75.0
7.0	4.90	8.37	0.202	7.25	0.129	64.1
8.0	4.38	5.53	0.223	7.12	0.143	42.4
9.0	4.22	4.76	0.228	7.08	0.146	36.1
10.0	3.92	3.04	0.240	7.03	0.154	23.0
11.0	3.92	2.52	0.243	7.02	0.155	18.9
12.0	3.91	2.10	0.244	7.01	0.156	16.0
13.0						



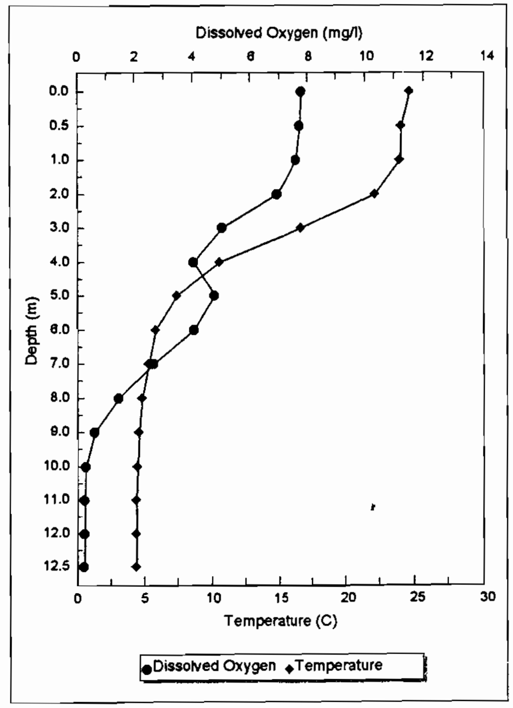
Beecher Lake
06/20/95

Depth (m)	Temp (C)	D.O. (mg/l)	Cond. (mS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0						
0.5	29.26	7.42	0.160	7.94	0.103	96.1
1.0	27.20	8.74	0.155	7.99	0.099	109.8
2.0	18.80	7.69	0.149	7.38	0.096	82.3
3.0	13.67	7.12	0.150	7.1	0.095	67.1
4.0	8.99	7.18	0.179	6.91	0.115	63.5
5.0	6.65	6.33	0.183	6.9	0.117	51.7
6.0	5.48	5.32	0.190	6.86	0.122	41.7
7.0	4.92	3.98	0.200	6.79	0.128	30.2
8.0	4.64	2.35	0.211	6.74	0.135	17.9
9.0	4.44	1.49	0.219	6.71	0.140	10.2
10.0	4.37	0.52	0.223	6.69	0.143	3.6
11.0	4.28	0.26	0.227	6.69	0.145	2.0
12.0	4.27	0.23	0.229	6.69	0.146	1.8
12.5	4.27	0.22	0.231	6.7	0.147	1.7



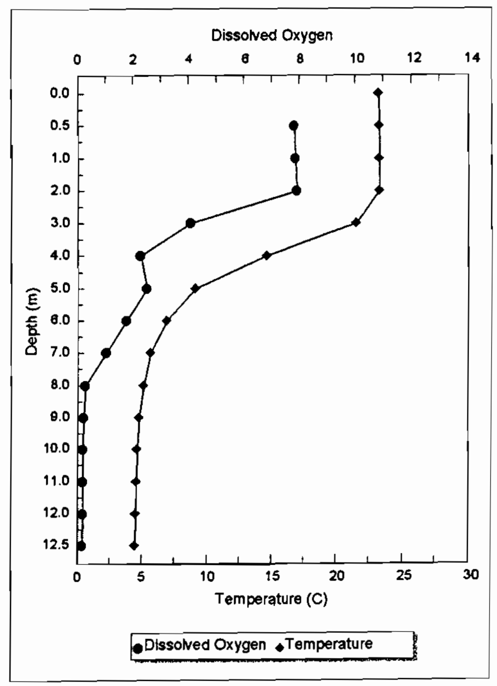
Beecher Lake
07/17/95

Depth (m)	Temp (C)	D.O. (mg/l)	Cond. (mS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0	24.67	7.78	0.159	7.99	0.102	93.0
0.5	24.07	7.72	0.159	8.13	0.102	92.2
1.0	23.97	7.58	0.159	8.11	0.101	90.7
2.0	22.13	6.92	0.160	7.75	0.102	81.9
3.0	16.64	5.02	0.159	7.22	0.097	50.4
4.0	10.54	4.02	0.179	7.01	0.113	35.4
5.0	7.39	4.75	0.186	7.01	0.119	40.2
6.0	5.83	4.05	0.193	6.94	0.123	31.1
7.0	5.26	2.63	0.202	6.91	0.129	17.5
8.0	4.78	1.43	0.211	6.87	0.135	9.3
9.0	4.56	0.58	0.220	6.84	0.140	2.6
10.0	4.46	0.27	0.225	6.84	0.144	1.8
11.0	4.38	0.22	0.235	6.85	0.148	1.7
12.0	4.36	0.22	0.243	6.93	0.156	1.7
12.5	4.35	0.20	0.245	6.96	0.157	1.6



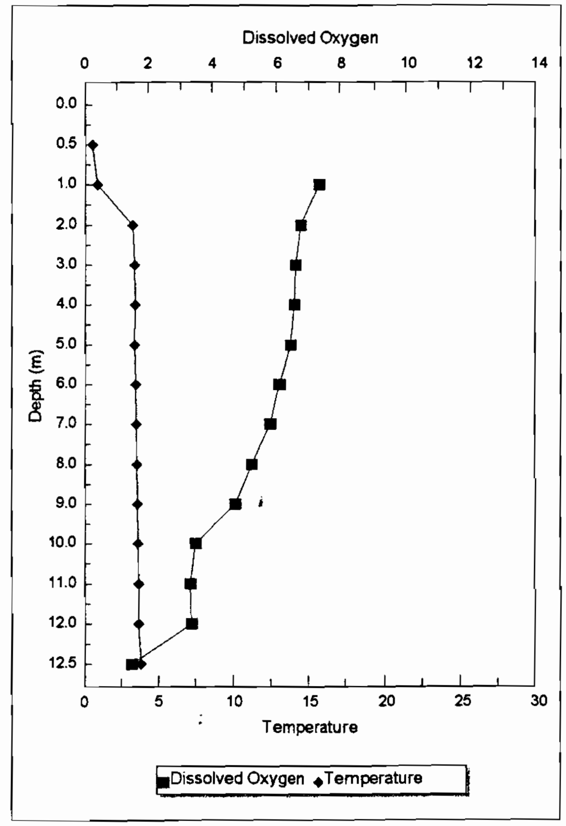
Beecher Lake
08/24/95

Depth (m)	Temp (C)	D.O. (mg/l)	Cond. (mS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0	23.25					
0.5	23.27	7.81	0.169	8.39	0.108	93.0
1.0	23.27	7.85	0.169	8.38	0.108	93.4
2.0	23.27	7.90	0.169	8.37	0.108	91.8
3.0	21.50	4.08	0.158	7.5	0.101	41.5
4.0	14.60	2.27	0.176	7.21	0.113	20.3
5.0	9.13	2.49	0.187	7.19	0.119	21.7
6.0	6.90	1.78	0.196	7.17	0.125	11.8
7.0	5.64	1.03	0.204	7.13	0.131	6.6
8.0	5.10	0.27	0.212	7.1	0.135	1.9
9.0	4.73	0.19	0.219	7.1	0.140	1.5
10.0	4.58	0.18	0.228	7.1	0.145	1.4
11.0	4.55	0.18	0.236	7.11	0.151	1.3
12.0	4.47	0.17	0.245	7.18	0.157	1.4
12.5	4.46	0.16	0.249	7.22	0.159	1.2



Beecher Lake
02/13/96

Depth (m)	Temp (C)	D.O. (mg/l)	Cond. (mS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0						
0.5	0.50					
1.0	0.83	7.33	0.197	7.09	0.127	49.5
2.0	3.22	6.74	0.193	7.01	0.123	49.5
3.0	3.38	6.57	0.193	7	0.123	49.1
4.0	3.39	6.54	0.194	6.98	0.124	48.9
5.0	3.38	6.41	0.194	6.97	0.124	48.2
6.0	3.46	6.07	0.194	6.95	0.124	45.0
7.0	3.52	5.81	0.194	6.94	0.124	42.0
8.0	3.56	5.24	0.196	6.92	0.125	37.9
9.0	3.60	4.74	0.198	6.91	0.127	33.9
10.0	3.64	3.50	0.199	6.88	0.127	24.6
11.0	3.65	3.34	0.203	6.87	0.129	24.7
12.0	3.68	3.37	0.208	6.87	0.133	25.4
12.5	3.83	1.50	0.222	6.9	0.147	10.5



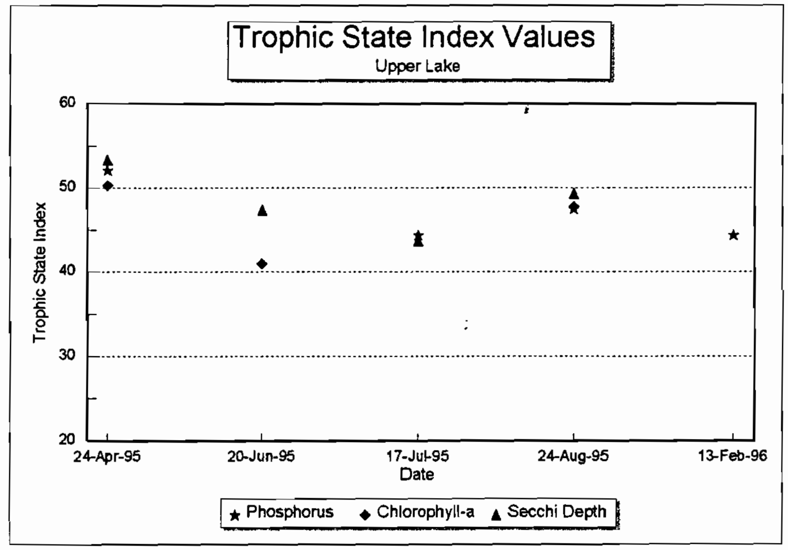
Upper Lake
MARINETTE COUNTY, WI

SURFACE WATER QUALITY SAMPLES

Date	Total P (ug/l)	Ortho P (ug/l)	TKN (ug/l)	No2-No3 (ug/l)	NH3 (ug/l)	Chlor-a (UG/L)	Secchi (ft)	Phosporus TSI	Chlor-a TSI	Secchi TSI
24-Apr-95	22	ND	600	38	ND	7.76	5.2	52.1	50.3	53.4
20-Jun-95	ND	ND	600	ND	ND	2.24	7.9	ERR	40.9	47.3
17-Jul-95	8	ND	600	ND	ND	(0.04 approx.)	10.16	44.3	ERR	43.7
24-Aug-95	12	4	600	ND	ND	5.55	6.9	47.5	47.8	49.3
13-Feb-96	8	5						44.3	ERR	ERR
								ERR	ERR	ERR
								ERR	ERR	ERR
								ERR	ERR	ERR
								ERR	ERR	ERR

BOTTOM SAMPLES (0.5 m from bottom)

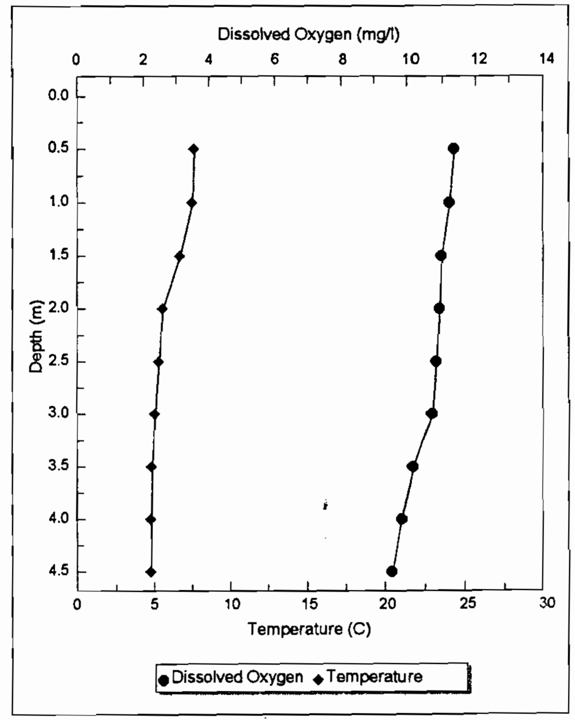
Date	Total P (ug/l)	Ortho P (ug/l)	TKN (ug/l)	No2-No3	NH3
24-Apr-95	20	ND	500	48	42
20-Jun-95	18	3	700	17	153
17-Jul-95	22	2	600	25	59
24-Aug-95	46	4	700	ND	ND
13-Feb-96	9	5			



Hydrolab Monitoring Results

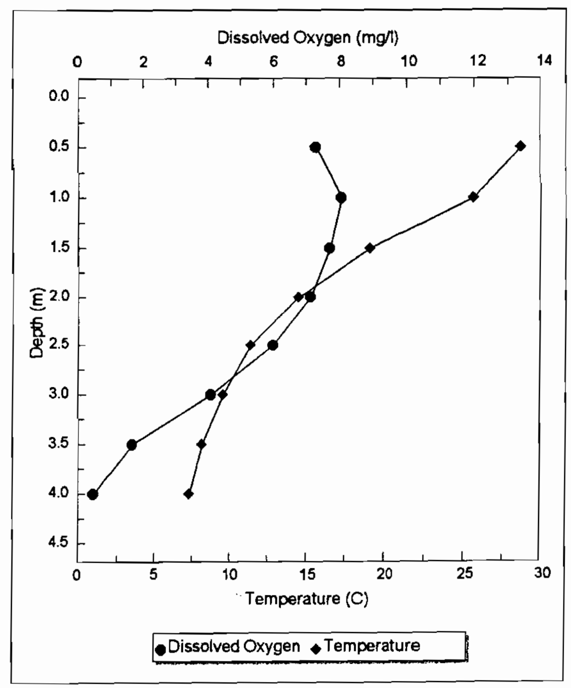
Upper Lake
04/24/95

Depth (m)	Temp (C)	D.O. (mg/l)	Cond. (mS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0						
0.5	7.57	11.34	0.174	7.62	0.112	95.5
1.0	7.44	11.19	0.175	7.59	0.112	93.1
1.5	6.67	10.97	0.170	7.5	0.108	90.5
2.0	5.52	10.90	0.161	7.42	0.106	86.2
2.5	5.28	10.80	0.171	7.39	0.109	85.2
3.0	5.01	10.68	0.172	7.38	0.110	83.7
3.5	4.80	10.15	0.179	7.34	0.114	79.2
4.0	4.76	9.82	0.182	7.32	0.116	75.9
4.5	4.76	9.53	0.182	7.3	0.117	74.2



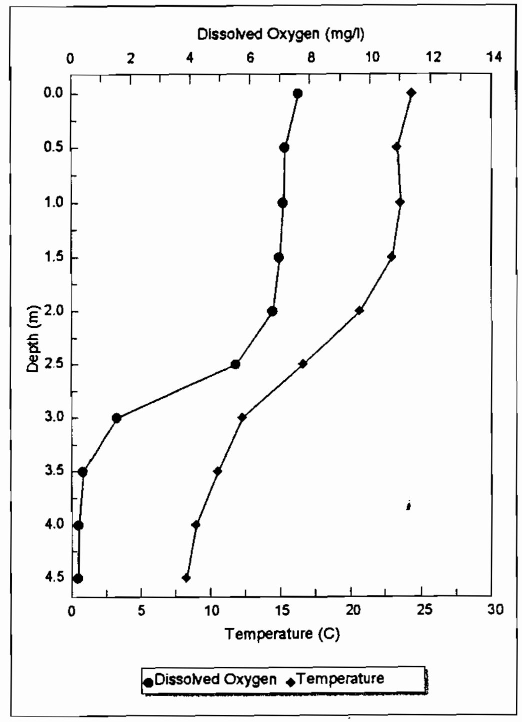
Upper Lake
06/20/95

Depth (m)	Temp (C)	D.O. (mg/l)	Cond. (mS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0						
0.5	28.68	7.26	0.170	7.83	0.109	93.5
1.0	25.62	8.04	0.165	7.69	0.106	97.6
1.5	19.10	7.69	0.171	7.31	0.110	83.5
2.0	14.50	7.12	0.145	7.07	0.093	70.8
2.5	11.35	5.99	0.144	6.84	0.093	54.3
3.0	9.54	4.07	0.155	6.74	0.098	28.4
3.5	8.13	1.65	0.163	6.64	0.104	7.5
4.0	7.28	0.44	0.170	6.64	0.111	2.7
4.5						



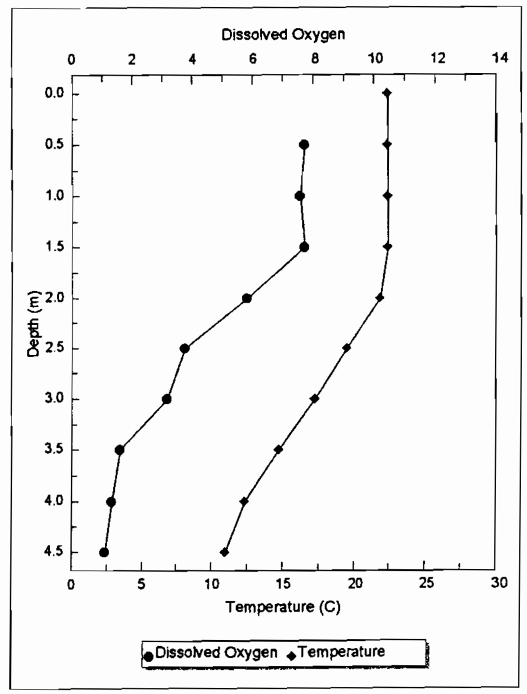
Upper lake
07/17/95

Depth (m)	Temp (C)	D.O. (mg/l)	Cond. (mS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0	24.35	7.60	0.175	7.97	0.112	92.1
0.5	23.38	7.16	0.176	7.96	0.112	84.5
1.0	23.61	7.08	0.173	8	0.110	84.5
1.5	23.00	6.97	0.185	7.71	0.117	82.4
2.0	20.64	6.74	0.182	7.56	0.116	74.9
2.5	16.63	5.51	0.150	7.09	0.095	54.8
3.0	12.29	1.50	0.159	6.86	0.102	9.1
3.5	10.50	0.37	0.165	6.8	0.106	2.7
4.0	8.96	0.21	0.180	6.83	0.115	1.8
4.5	8.26	0.20	0.193	6.87	0.123	1.8



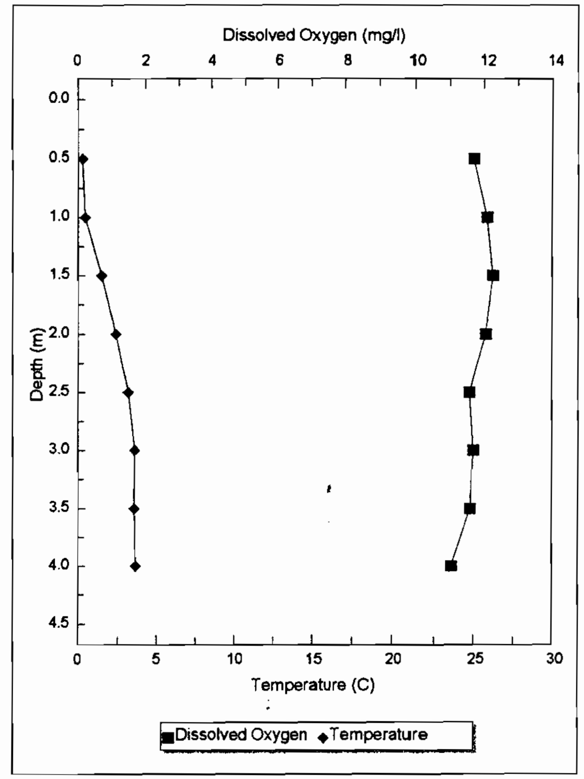
Upper Lake
08/24/95

Depth (m)	Temp (C)	D.O. (mg/l)	Cond. (mS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0	22.39					
0.5	22.40	7.69	0.191	8.03	0.122	89.2
1.0	22.40	7.55	0.191	8.03	0.122-	88.4
1.5	22.40	7.69	0.191	8.02	0.122	87.4
2.0	21.85	5.82	0.194	7.78	0.122	71.6
2.5	19.48	3.78	0.187	7.37	0.119	43.5
3.0	17.23	3.17	0.164	7.15	0.105	30.4
3.5	14.70	1.60	0.169	7.06	0.108	15.1
4.0	12.35	1.31	0.188	7.12	0.121	11.5
4.5	10.96	1.08	0.198	7.17	0.127	9.4



Upper Lake
02/13/96

Depth (m)	Temp (C)	D.O. (mg/l)	Cond. (mS/cm)	pH	TDS (g/l)	Oxygen (%sat.)
0.0						
0.5	0.30	11.68	0.216	6.96	0.138	79.3
1.0	0.44	12.06	0.213	6.93	0.137	83.1
1.5	1.47	12.25	0.211	6.87	0.136	88.5
2.0	2.37	12.03	0.211	6.85	0.134	91.0
2.5	3.15	11.55	0.212	6.85	0.136	86.4
3.0	3.57	11.67	0.216	6.86	0.140	89.7
3.5	3.56	11.57	0.218	6.88	0.140	84.7
4.0	3.61	11.02	0.222	6.88	0.143	83.1
4.5						



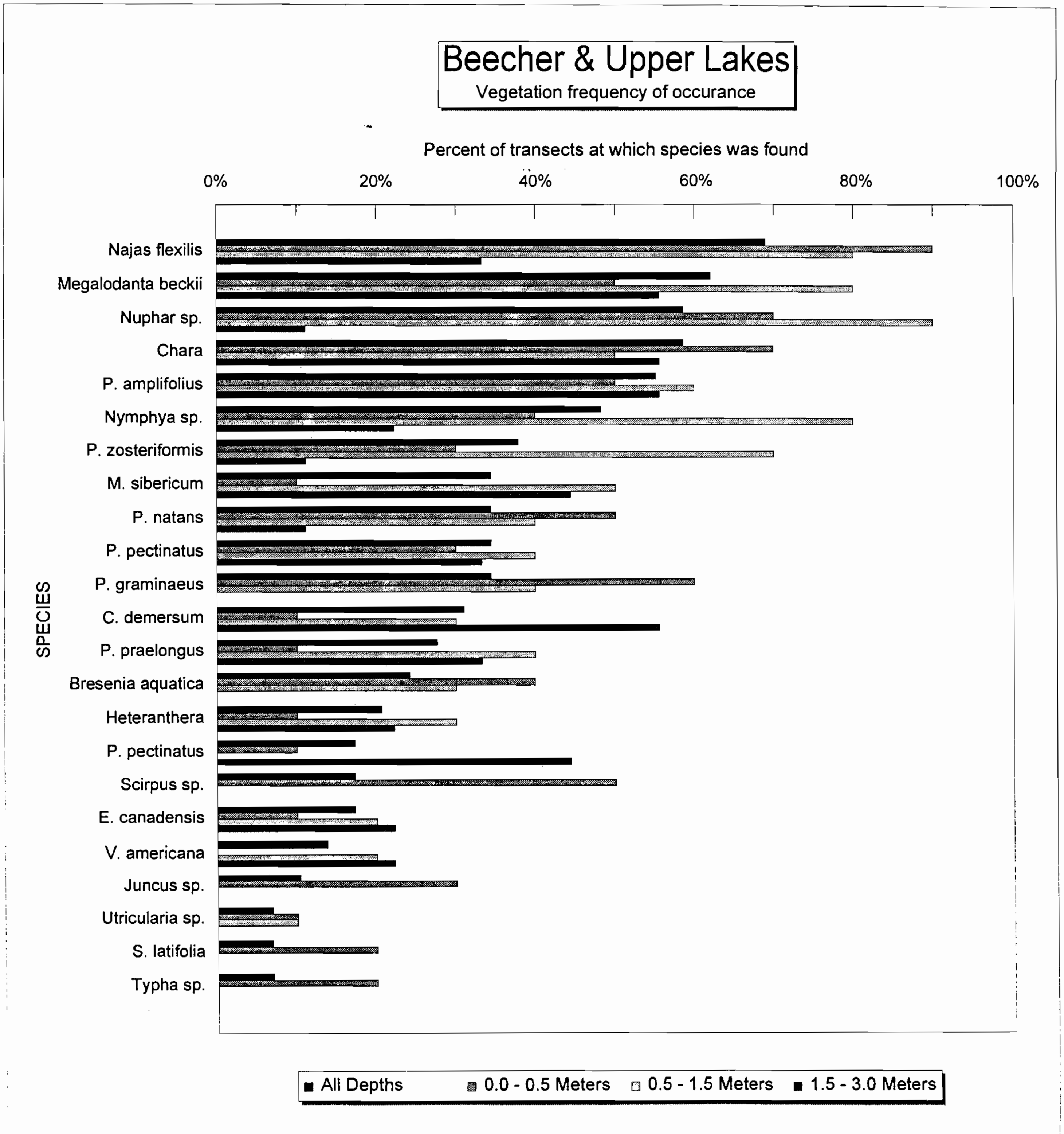
APPENDIX C

Aquatic Macrophyte Survey Data

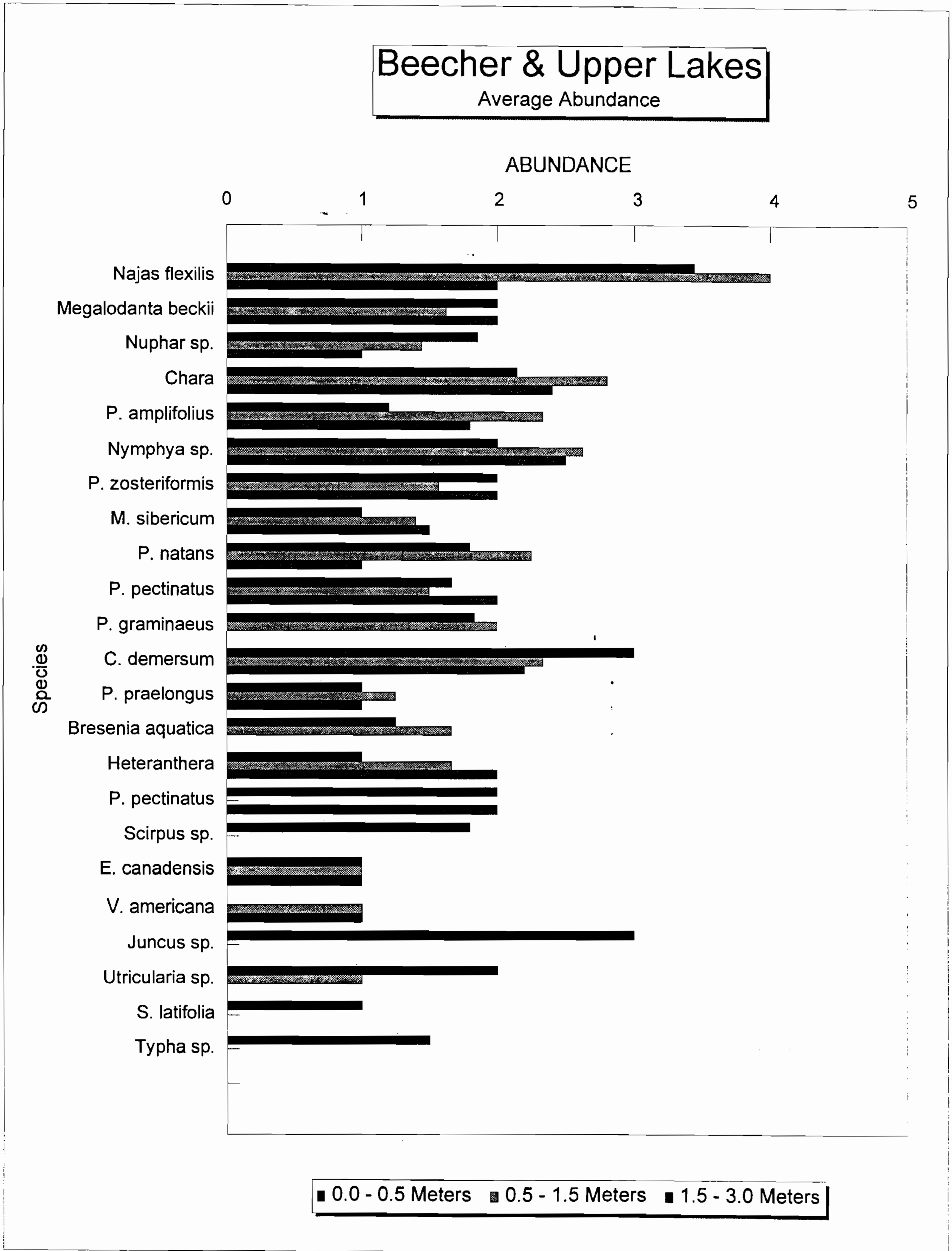
Lake Name: Beecher & Uppper Lakes
Survey Date: August 9, 1995
Surveyors: C. Druckrey, B. Kowalski, T. Rasman

	A			A'			B			D			E			F			G			H		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Najas flexilis	5	2		1	5		4	3	3	2	4		5			4	4	1	3	5	2	2	3	
Megalodanta beckii	2	1	1			2		2					1	3		2	3	2		1			1	
Nuphar sp.	3	2			1		1				1		2	1			1		1	2	1	1	1	
Chara				2			2		2	4	3	2	1	3	1	1	2	5	3			2	2	
P. amplifolius						1		1	1		1	1	1	1		1	3	2	1	4				
Nymphya sp.	2	3		3	3			4			1		2				1			4	1		1	
P. zosteriformis					1			1					2	3		1	1			1				
M. sibericum							1	2	2					1	1					1				
P. natans	2			1				2					1			2	2							
P. pectinatus													2	3	2					1			1	
P. graminaeus	2	2		3	2		2				1			1					1			2		
C. demersum									1					1	2			1						
P. praelongus							1	2	1					1	1					1	1		1	
Bresenia aquatica							1			2						1	1		1	3			1	
Heteranthera					1									2	3	1	2	1						
P. pectinatus				2		3			3			1						1						
Scirpus sp.	1						1			3									2					
E. canadensis																				1	1			
V. americana																	1	1			1			
Juncus sp.	3																					3		
Utricularia sp.	2	1																						
S. latifolia																						1		
Typha sp.																						2		

	I			J									PERCENT OCURANCE				AVERAGE DENSITY RATING		
	1	2	3	1	2	3	1	2	3	1	2	3	TOTAL	0 - 0.5 M	0.5 - 1.5 M	1.5 - 3.0 M	0 - 0.5 M	0.5 - 1.5 M	1.5 - 3.0 M
Najas flexilis	5	4											69%	90%	80%	33%	3.4	4.0	2.0
Megalodanta beckii	2	1	2	3	1	3							62%	50%	80%	56%	2.0	1.6	2.0
Nuphar sp.	4	1		1	2								59%	70%	90%	11%	1.9	1.4	1.0
Chara		2	2										59%	70%	50%	56%	2.1	2.8	2.4
P. amplifolius	2			1	4	4							55%	50%	60%	56%	1.2	2.3	1.8
Nymphya sp.				1	4	4							48%	40%	80%	22%	2.0	2.6	2.5
P. zosteriformis	3	3			1	2							38%	30%	70%	11%	2.0	1.6	2.0
M. sibericum		2	1		1	2							34%	10%	50%	44%	1.0	1.4	1.5
P. natans	3	3	1		2								34%	50%	40%	11%	1.8	2.3	1.0
P. pectinatus	1		3	2	1	1							34%	30%	40%	33%	1.7	1.5	2.0
P. graminaeus				1									34%	60%	40%		1.8	2.0	ERR
C. demersum		1	2	3	5	5							31%	10%	30%	56%	3.0	2.3	2.2
P. praelongus													28%	10%	40%	33%	1.0	1.3	1.0
Bresenia aquatica													24%	40%	30%		1.3	1.7	ERR
Heteranthera													21%	10%	30%	22%	1.0	1.7	2.0
P. pectinatus													17%	10%		44%	2.0	ERR	2.0
Scirpus sp.				2									17%	50%			1.8	ERR	ERR
E. canadensis	1	1	1										17%	10%	20%	22%	1.0	1.0	1.0
V. americana					1								14%		20%	22%	ERR	1.0	1.0
Juncus sp.				3									10%	30%			3.0	ERR	ERR
Utricularia sp.													7%	10%	10%		2.0	1.0	ERR
S. latifolia				1									7%	20%			1.0	ERR	ERR
Typha sp.				1									7%	20%			1.5	ERR	ERR
																	ERR	ERR	ERR



Beecher & Upper Lakes
Vegetation frequency of occurance
Percent of transects at which species was found
0%
20%
40%
60%
80%
100%
SPECIES
Najas flexilis
Megalodanta beckii
Nuphar sp.
Chara
P. amplifolius
Nymphya sp.
P. zosteriformis
M. sibericum
P. natans
P. pectinatus
P. graminaeus
C. demersum
P. praelongus
Bresenia aquatica
Heteranthera
P. pectinatus
Scirpus sp.
E. canadensis
V. americana
Juncus sp.
Utricularia sp.
S. latifolia
Typha sp.
All Depths
0.0 - 0.5 Meters
0.5 - 1.5 Meters
1.5 - 3.0 Meters


Beecher & Upper Lakes
Average Abundance
ABUNDANCE
0
1
2
3
4
5
Species
Najas flexilis
Megalodanta beckii
Nuphar sp.
Chara
P. amplifolius
Nymphya sp.
P. zosteriformis
M. sibericum
P. natans
P. pectinatus
P. graminaeus
C. demersum
P. praelongus
Bresenia aquatica
Heteranthera
P. pectinatus
Scirpus sp.
E. canadensis
V. americana
Juncus sp.
Utricularia sp.
S. latifolia
Typha sp.
0.0 - 0.5 Meters
0.5 - 1.5 Meters
1.5 - 3.0 Meters