Big Wood Lake Planning Grant Report
Burnett County, Wisconsin

Prepared for
Big Wood Lake Association

In Cooperation with
Burnett County Land Conservation Department
Wisconsin Department of Natural Resources

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BIG WOOD LAKE PLANNING GRANT REPORT

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1.0 EXECUTIVE SUMMARY

The water quality data collected on Big Wood Lake indicates that it is eutrophic, and experiences water quality typical of lakes with similar trophic status. The hydrologic data suggests that the watershed of the lake contains significant water storage. Therefore, lake levels do not fluctuate greatly with rainfall events. Water quality modeling indicates that the lake's large, extended watershed is well buffered by upstream lakes. Therefore, the direct rural watershed, shoreline cabins and internal nutrient loading have the most significant water quality impact on the lake. Lake macrophyte (weed) problems are most likely caused by curlyleaf pondweed. Curlyleaf is an exotic (non-native) weed which blooms early in the year and dies off rapidly in early July causing odor and shoreline problems.

The report recommends that the Big Wood Lake Association continue to work toward protecting/improving the quality of the lake. A series of long-term educational/public participation efforts are recommended along with a work plan to collect additional information of the urban and rural component of the lake's direct watershed.

2.0 INTRODUCTION

Big Wood Lake (Wood Lake) is located in Burnett County, Wisconsin. The lake discharges to the Wood River, which is ultimately tributary to the St. Croix River. Water quality data from the Wisconsin Self Help Lake Monitoring Program, which is collected by volunteers of the Big Wood Lake Improvement Association, has shown that the lake is eutrophic in nature. Lakes within this classification often experience degraded water quality which is exhibited by algal blooms and decreased water clarity.

The Big Wood Lake Improvement Association recognized the importance of maintaining Big Wood Lake's water quality and preventing its degradation. Therefore, the Association initiated an application to the Wisconsin Lake

Planning Grant Program to receive a $10,000 grant to study the lake and its watershed.

The ultimate goal of the Big Wood Lake Planning Grant Study was to develop a long range planning strategy which would aid the Association and local units of government in managing the lake and its watershed. The specific tasks carried out as part of the study include:

1. Assessment of Big Wood Lake water quality.

2. Collection of hydrologic data in order to determine the general hydrologic conditions of the Big Wood Lake Watershed.

3. Collection of biological data on Big Wood Lake, focussing primarily on aquatic macrophytes.

4. Assessment of general land use patterns within the direct Big Wood Lake watershed.

5. Distribution and analysis of a property owners survey.

2.1 Lake and Watershed Description

The physical morphometry of Big Wood Lake is outlined in Table 1 and is shown on Figure 1. The lake consists of two basins; the south basin is slightly more shallow than the north basin, the lake has a maximum depth of 35 feet. The lake basin has an irregular shoreline with several large bays and peninsulas; also, several picturesque islands are located within the lake. Two main tributary streams discharge into Big Wood Lake; the Wood River enters the lake at the northeast end, and Spirit Creek enters the lake at the south end. The lake outlet is the Wood River, which exits the lake on the west side. The lake shore is fairly well developed, mainly with seasonal dwellings, including a summer church camp. Two public access points are located on the lake, on the east and west shores.

The Big Wood Lake tributary watershed areas are listed in Table 2. The term "watershed" refers to the land area which ultimately drains to a lake or river. A lake's watershed typically contains two basic components, a direct watershed and an extended watershed. A lake's direct watershed refers to the land area directly adjacent to the lake. A lake's extended watershed includes land areas which must first drain through other water bodies before reaching Big Wood Lake. The watersheds of Rice Lake, Spirit Lake, Little Wood Lake, Dunham Lake, Fern Lake, and Hawthorn Lake ultimately drain to Big Wood Lake, and they are included in the lake's extended watershed. Land use in the direct watershed is discussed in Sections 3.2 and 4.4.

3.0 METHODS

The following sections describe the methods used during the course of this investigation.

3.1 Water Quality Survey of Big Wood Lake

As part of the Lake Planning Grant Study, Big Wood Lake volunteers collected lake water samples during May through October, 1993. 0-2 meter surface water composite samples were collected from both the north and south basins; samples were also collected from a depth of 1 meter above the lake bottom. Transparency was measured with a 20 cm white Secchi disc weekly throughout the summer.

Water quality samples were submitted to the Wisconsin Department of Hygiene Laboratory for analysis. Concentrations of total and dissolved phosphorus, chlorophyll a, nitrate, ammonia, and total Kjeldahl nitrogen were determined for surface water samples, along with physical parameters such as color, pH, conductivity, and alkalinity. The near-bottom samples were analyzed for total phosphorus only. These data are presented in Tables 3 and 4, and will be discussed in subsequent sections.

Historical water quality data for Big Wood Lake was taken from data files stored on the Wisconsin Lake Bulletin Board System, or from the Wisconsin Self-Help Lake Monitoring Program report (WDNR, 1990).

3.2 Watershed Evaluation

The Big Wood Lake watershed was evaluated to estimate its influence on the lake water quality and water quantity. Several techniques were used to evaluate the watershed, including evaluation of the water and phosphorus budgets using a lake eutrophication analysis procedure, determination of the direct watershed land use, and collection of precipitation and lake level data.

A complete description of the modeling is listed in Appendix A of the report. In brief, the model uses ecoregion and lake morphometry data to estimate a hydrologic and phosphorus budget for a lake. It was developed as a screening tool to identify lakes with degraded water quality and to pinpoint watersheds with the potential to produce large phosphorus loads. The model also predicts in-lake phosphorus and chlorophyll a concentrations, and secchi disc transparencies for a lake in its natural state, i.e., with no human impacts. The predicted data can be compared to actual data in order to assess if the lake has been impacted by human activities.

The land use in the direct watershed of Big Wood Lake was determined from 1990 aerial photography provided by the Burnett County Land Conservation Department. Certain types of land use, such as animal pastures or erodible lands, have been found to export higher levels of phosphorus than what would be normally found. From the aerial photography, areas which may be causing high loads of phosphorus to Big Wood Lake were noted, and will be discussed in subsequent sections.

In order to determine the effect of precipitation and runoff on the lake's water level, three precipitation gauges were installed in the Big Wood Lake Direct watershed, and read daily by volunteers. To monitor lake levels, a staff gauge was installed and was also read by volunteers.

3.3 Macrophyte Survey of Big Wood Lake

The aquatic macrophyte (weed) growth is of great concern for some Big Wood Lake property owners. Currently, the macrophytes around some dock and swimming areas are controlled through the application of various aquatic herbicides.

Proper control and management is dependent on the areal extent, variety, and species distribution of macrophytes found in the lake; this information can be determined by a macrophyte survey. Because the macrophyte density and distribution may vary throughout the summer, both June and August surveys were performed. The complete methodology used in the macrophyte surveys is presented in Appendix B.

3.4 Property Owners Survey

As part of the Big Wood Lake Improvement Association's effort to develop a management plan for Big Wood Lake and its watershed, a survey was distributed to lake shore residents and association members. The survey, similar to one developed by the University of Wisconsin - Stevens Point, was designed to collect information on topics such as lake use, user conflicts, and other related data. A copy of the survey results is included in Appendix C of this report.

4.0 RESULTS AND DISCUSSION

The following sections present and discuss the data collected during the study.

4.1 Water Quality Overview

Within a lake system, water quality problems and accelerated biological activity are often caused by sediments and nutrients deposited into the lake by tributary streams which drain the lake's watershed. The process of nutrient enrichment and resulting biological activity is termed eutrophication. During the process of eutrophication, a lake accumulates sediments and nutrients from its watershed. The biology and chemistry of the lake may change, as well. Increased macrophyte and algal growth may occur as part of the eutrophication process; the dissolved oxygen in the lake may be affected as the plant matter dies and decomposes. As the process progresses, a lake is converted from oligotrophic (nutrient poor) to eutrophic (nutrient rich) status.

It is important to note that the process of eutrophication is natural and results from normal environmental forces, and usually occurs slowly over many years. However, in many lakes "cultural eutrophication", the accelerated degradation resulting from human activity, is the process that actually takes place. This accelerated degradation may result from point-source nutrient loadings, such as effluent from wastewater treatment plants and septic tanks. It may also be caused by diffuse (i.e., non-point) sources of nutrients and sediments, such as stormwater runoff from urban and agricultural areas. The accelerated rate of water quality degradation caused by these pollutants results in unpleasant consequences. These include profuse and unsightly growths of algae (algal blooms).

Individual lakes will respond differently to the process of cultural eutrophication. Therefore, criteria have been established to evaluate lakes, such as Big Wood Lake, to denote their nutrient status. Four "trophic" descriptions are frequently used to describe the effects of the nutrients on the general water quality water body. They are:

1. Oligotrophic
2. Mesotrophic
3. Eutrophic
4. Hypertrophic

Oligotrophic (Greek for "food-poor") describes a water body with few nutrients, and a clear or pristine appearance. **Mesotrophic** describes a water body that is moderately nourished, and has an appearance midway between an oligotrophic and eutrophic lake. **Eutrophic** (Greek for "food-rich") describes a water body that is rich in nutrients. Significant weed growth and green and/or murky colored water from algal blooms and suspended sediment are generally found in eutrophic water bodies. **Hypereutrophic** describes a water body extremely rich in nutrients. Such water bodies experience heavy algal blooms and/or very dense weed growths all summer.

The determination of the trophic status (stage of eutrophication/ degradation) of Big Wood Lake is an important aspect of the diagnosis of its problem. The trophic status indicates the severity of a lake's algal problems and the degree of change needed to meet its recreational goals. However, it does not indicate the cause of the algal growth, or the means of reducing such growth.

The trophic states of a lake or pond is usually determined by the concentration of an essential element or dissolved nutrient, which is referred to as the "limiting nutrient". This nutrient will generally control the amount of algae a particular lake can produce. Aquatic weeds, on the other hand, derive most of their nutrients from lake or pond sediments. The limiting nutrient concept is a widely applied principle in the study of eutrophication. It is based on the concept that, in considering all of the substances needed for biological growth, one will be present in limited quantity. The availability of this limiting nutrient will, therefore, control the rate of algal growth. The identification of a lake's limiting nutrient may point the way toward possible solutions for its algal problems.

Algal growth is generally phosphorus-limited in most waters similar to Big Wood Lake. It has been amply demonstrated, in experiments ranging from laboratory bioassays to fertilization of in-situ enclosures to whole-lake experiments, that most often phosphorus is the nutrient that limits algal growth. Algal abundance is nearly always phosphorus-dependent. A reduction in the phosphorus concentration in a lake is, therefore, necessary in order to reduce algal abundance and improve water transparency. Failure to reduce phosphorus concentrations will allow the process of eutrophication to continue at an accelerated rate.

Nitrogen is also a naturally occurring nutrient important for aquatic plant growth. While phosphorus typically stimulates excess algal growth, in some cases nitrogen may play a part as well. Also, several forms of nitrogen will be present in runoff. These include: ammonia nitrogen, nitrate + nitrite nitrogen, and total Kjeldahl nitrogen. These nutrients were all measured as a part of this study. A complex biological nitrogen cycle determines the form of nitrogen present in natural waters. For example, microbial decomposition of organic nitrogen waste will produce ammonia; however, over time another type of microbe may convert the ammonia to nitrate and nitrite. Possible sources of nitrogen include fertilizers, malfunctioning septic systems, and animal wastes.

4.2 Water Quality Survey of Big Wood Lake

Lake water samples were collected from Big Wood Lake and analyzed at the Wisconsin State Laboratory of Hygiene. The role phosphorus plays in the water quality of Big Wood Lake has been stressed in this report; all samples taken from the lake were analyzed for phosphorus. However, other parameters such as temperature, dissolved oxygen, pH, alkalinity, and color are also important, and provide information about the general physical and chemical environment present in the lake. While the phosphorus dynamics of Big Wood Lake will be discussed in detail below, the other parameters will be covered as well.

4.2.1 General Chemical Characteristics

4.2.1.1 Temperature and Dissolved Oxygen

Determination of a lake's temperature and dissolved oxygen dynamics is crucial in understanding the in-lake biological and chemical cycles. The degree of thermal stratification that takes place in a lake can be determined from temperature data collected from various depths. Stratification occurs when the surface water is warmed during the late spring and through the summer. A layer of warm, less dense water (called the "epilimnion") is formed at the surface of the lake, while a layer of cool, more dense water (called the "hypolimnon") is formed near the lake bottom. The epilimnion is exposed to the atmosphere, and the effect of the wind ensures that the lake surface is constantly mixed and replenished with oxygen. However, the hypolimnion is isolated from the lake surface by the epilimnion, which forms a barrier preventing the replenishment of oxygen. As stated previously, dead algae, weeds, and other organic matter will sink to the lake bottom and decompose, using much of the available oxygen.

As a lake becomes more productive, the amount of algae and weeds reaching the hypolimnion increases, and all the oxygen may be used up by decomposition. The lack of oxygen will change the chemical environment of the lake bottom, catalyzing the release of phosphorus and other nutrients from the sediments to the water. In a strongly stratified lake, this phosphorus will remain trapped in the hypolimnion, unavailable for algal growth near the lake surface. However, if the lake is not strongly destratified, the epilimnion and hypolimnion would mix together. Phosphorus previously isolated in the bottom waters would be transported to the lake surface, where it would be available for algal growth.

Dissolved oxygen and temperature isopleths for the north and south basins of Big Wood Lake are displayed on Figures 2 through 5. The temperature isopleths indicate that both the north and south basins weakly stratify. While it appears that epilimnetic and hypolimnetic layers do form, the temperature difference between the two may not be sufficient to prevent lake mixing during windy periods.

The dissolved oxygen isopleths indicate that the surface waters were well-oxygenated in the north and south basins during the summer months. However, the oxygen in the near-bottom waters was depleted throughout the summer. During both July and August, the dissolved oxygen concentration in the near-bottom water of both the north and south basins were less than 1 mg/L, low enough to change the chemical nature of the sediments and activate phosphorus release.

4.2.1.2 Conductivity

Conductivity is a measure of a water sample's ability to conduct an electrical current. Electrical currents are transported by ions (dissolved, charged particles) in solution; therefore, conductivity is an indirect measure of the concentration of ions in a lake water sample. The concentration of ions in a lake is dependent on several factors -- the geology and chemistry of weathered rocks and soils in the watershed, point source and non-point source pollution to the lake, and in-lake chemical cycles. The conductivity of natural waters may vary from 50 - 1,500 umhos/cm. The 1993 conductivity measurements taken in Big Wood Lake are shown on Figure 6. The 1993 growing season mean conductivity was 229 umhos/cm in the north basin, and 230 umhos/cm in the south. These values are typical for lakes located geographic regions similar to Big Wood Lake.

4.2.1.3 pH

pH is a measure of the concentration of hydrogen ions in a lake water sample; it is most commonly used as a measure of the acidity of a sample. A pH value of 0 is highly acidic, a pH value of 14 is highly basic, and a pH value of 7 is considered neutral. The pH balance of a lake is crucial, as most aquatic organisms can survive in only a narrow range of pH values. Most natural water bodies have a pH in the range of 4 to 9. The 1993 pH measurements taken in Big Wood Lake are shown on Figure 7. The growing season mean pH value was 8.4 for both the north and south basins. These values are within the normal range expected for Big Wood Lake. The pH is slightly higher in July and August due to the effects of algal metabolism.

4.2.1.4 Alkalinity

The alkalinity of a lake water sample is a measure of its ability to buffer the pH of the water; that is, the ability of the water to neutralize the effects of acids or bases added to the system, thereby keeping the pH in a safe range for aquatic life. Most alkalinity in a lake is present as ions called carbonates and bicarbonates. These ions are mainly the result of geologic weathering of rocks, however the concentration is somewhat regulated by respiration and photosynthesis. The alkalinity of a lake water also provides an estimate of the hardness of the water. The 1993 alkalinity measurements for Big Wood Lake are shown on Figure 8. The growing season mean alkalinity values were 114 mg/L as $CaCO_3$ for the north basin, and 115 mg/L as $CaCO_3$ for the south basin. These values are within the normal range expected for lakes similar to Big Wood Lake, and show that the water of Big Wood Lake is of moderate hardness.

4.2.1.5 Color

The water color of a lake sample can give an indication of the amount and type of dissolved organic matter present. Decomposition of organic matter in wetlands and bogs results in the release of "tea-colored" organic acids, which may be transported to a lake through overland runoff or through tributary streams and rivers. These organic acids are not harmful to the lake or aquatic organisms, however they can affect the transparency of the lake water.

Therefore, the secchi disc transparency of a highly colored lake may be less than would be otherwise expected. The water color measurement scale used in this study can be interpreted as follows: a measurement of 0 would be expected for extremely clear, colorless waters, while a measurement of 300 would result from highly colored bog waters. The 1993 water color measurements taken from Big Wood Lake are shown on Figure 9. The growing season mean was 22 pt-co units in both the north and south basins. A further discussion and analysis of the effect of water color on lake transparency is found in the next section.

4.2.2 Trophic Status

In this section phosphorus concentration, chlorophyll a concentration, and secchi disc transparency will be discussed. These three parameters are used to determine a lake's trophic state. The trophic state of the lake (e.g., oligotrophic, eutrophic, mesotrophic, etc.) were determined from work completed by Carlson, 1977 and will be discussed later in this section.

In-lake phosphorus dynamics have been discussed in detail throughout this report. Phosphorus enrichment of a lake is the most common cause of lake degradation in Wisconsin; and in most lakes of this region, phosphorus is the limiting nutrient. As discussed previously, the limiting nutrient is that compound present in the lake in least amount relative to what is needed for biological growth. However, in a few cases, nitrogen may be the limiting nutrient; therefore control of phosphorus inputs would not improve the lake. The ratio of total nitrogen to total phosphorus concentration provides a simple tool to determine which nutrient is limiting - if the ratio is less than 10, then nitrogen limits, if the ratio is greater than 10, phosphorus limits. The analysis of the Big Wood Lake data is presented on Figure 10. From the data, it appears that phosphorus was the limiting nutrient during 1993. The concentration of dissolved phosphorus, that form of phosphorus readily available to algae as a nutrient, was below the detection limit during the monitoring period. This corroborates that the lake is probably phosphorus limited.

While stormwater runoff from the watershed can import much of the phosphorus load to a lake, in-lake sediment release of phosphorus can provide a significant amount of the total load. Sediment release of phosphorus occurs when the lake hypolimnion (lake bottom) is devoid of oxygen; if the lake mixes that phosphorus is transported to the lake surface where it can stimulate algal growth. Since the oxygen concentrations in both the north and south basins were extremely low during July and August, one would expect that sediment release of phosphorus would occur. Figures 11 and 12 show the phosphorus concentration in the near-surface and near-bottom waters for the north and south basins. In both basins, it is clear that phosphorus release from the sediments is taking place. The near-surface concentrations are also slightly elevated during that time, indicating that some of the near-bottom phosphorus may be transported to the lake surface. The lake appears to be only weakly stratified, and transport of phosphorus from the lake bottom to the lake surface seems likely. Barr personnel noted that a large population of carp were spawning in the Wood River immediately upstream of Big Wood Lake. Carp can live in low-oxygen bottom water environments that may be too harsh for other fish species. Research has shown that the digestive system of the carp may accelerate the transfer of phosphorus from the sediments to the water column.

The trophic status analysis of phosphorus is displayed on Figure 13. During 1993, Big Wood Lake appeared to be mesotrophic/eutrophic during May through July. However, the lake was borderline hypereutrophic during August and September. This corresponds to the period when the bottom waters were devoid of oxygen and high in phosphorus; the water quality appears to be degraded from internal phosphorus load.

The trophic status analysis of chlorophyll a concentration is displayed on Figure 14. Chlorophyll a concentration is used to estimate the amount of algae present in the lake. During June and July, the lake was borderline eutrophic/hypereutrophic. The lake trophic status was hypereutrophic during August and September, indicating severe algal blooms and water quality degradation may have been occurring during that period.

The trophic status analysis of secchi disc transparency is displayed on Figure 15. According to the lake transparencies, the lake was eutrophic/mesotrophic during May, and was borderline eutrophic/hypereutrophic during mid-July through September; the transparency decreased approximately one foot over the course of the summer. In some lakes, the water transparency may be reduced by the natural water color as well as by the presence of nuisance algal blooms. Figure 16 shows the 1993 Big Wood Lake transparency data, the transparency expected based on the chlorophyll concentrations found in the lake (MPCA, 1990), and the transparency expected based on the chlorophyll concentrations and color found in Big Wood Lake (Brezonik, 1978). As can be seen from the graph, the transparency measured in the lake is higher than either prediction. This may be due to the type of algae found in Big Wood Lake, or to the fact that the Wisconsin Department of Hygiene Lab had some difficulties analyzing the chlorophyll samples, and the results reported may overestimate the actual chlorophyll concentrations in the lake. In any event, it does not appear that the natural water color of Big Wood Lake has a measurable effect on the water clarity.

4.2.3 Historical Water Quality

Historical data available for Big Wood Lake is limited to secchi disc transparency measurements taken during 1986 to 1993 as part of the Wisconsin Self-Help Lake Monitoring Program. The historical data for the north and south basins of the lake are shown on Figures 17 and 18, respectively. The figures illustrate clearly the natural variation in water clarity that occurs throughout the summer season as algae blooms intensify and subside. As was seen in 1993, the water clarity is significantly higher during the early summer, and decreases to a minimum by July and August. The water transparency appears to slightly higher in the south basin during the early summer months. This may be due to the total suspended solids and phosphorus carried into the north basin from the Wood River. Visual inspection of the graph indicates that there does not appear to be any significant changes in the water transparency of Big Wood Lake over the past seven years.

4.3 Watershed Overview

The water and nutrient budgets were estimated for Big Wood Lake using MINLEAP (MPCA, 1990); the complete methodology for the modeling is listed in Appendix A. The intent of this modeling was to provide a general overview of the water and phosphorus loads to the lake. The modeling have not been calibrated to any watershed specific data and it was not the intent of the study to collect this data.

4.3.1 Water Budget

The water budget estimated for Big Wood Lake is shown on Figure 19. According to the model, about 63 percent of the water entering Big Wood Lake is from the Wood River, while about 13 percent is from the direct watershed, and the remainder is from either Spirit Lake via Spirit Creek, or from Rice Lake. Groundwater effects are assumed to be negligible and precipitation was assumed to equal evaporation. The total water load to the lake calculated by the model is 15,300 acre-feet per year (approximately 5 billion gallons per year).

The overall flow rate from the Big Wood Lake watershed was calculated to be 0.38 cfs per square mile of watershed area. Data published by the U.S. Geological Survey (Young and Hindall, 1973) lists flow rates for the Wood River watershed calculated from long term measurements. While the headwaters of the Wood River had a flow rate of 0.02 cfs per square mile, the main portion of the watershed had a flow rate of 0.42 cfs per square mile, which correlates well with the results of the MINLEAP modeling.

4.3.2 Nutrient Budget

The phosphorus budget estimated for Big Wood Lake is shown on Figure 20. According to the model, approximately 43 percent of the phosphorus load to the lake originates in the direct watershed (the land area which drains directly to the lake). Even though the Wood River contributes 63 percent of the water to the lake, it contributes only 38 percent of the phosphorus. The Wood River flows through several lakes, such as Little Wood Lake, Dunham Lake, Hawthorn Lake, and Fern Lake, before it reaches Big Wood Lake. These upstream lakes will remove much of the phosphorus from the river flow by algal uptake and sedimentation.

The in-lake phosphorus concentration predicted by MINLEAP modeling for Big Wood Lake is 28 μg/L; the observed concentration during the 1993 growing season was 39 μg/L. The MINLEAP predicted phosphorus concentration is intended to correspond to the lake in a minimally impacted state and does not include such phosphorus sources as septic tanks and internal phosphorus recycling. Since the observed concentration is higher than the predicted, the actual phosphorus load to the lake is probably higher than what would be expected from the natural environment alone. Several factors may contribute to this additional phosphorus load. Internal phosphorus load may be occurring, either from wind mixing of the lake or from carp stirring up the bottom waters. Lawn or agricultural fertilizer, leaky septic systems, animal feed lots, atmospheric deposition and decaying vegetation may all contribute phosphorus to the lake.

4.3.3 Extended Watershed and Lake Levels

As mentioned previously, the extended watershed of Big Wood Lake can be broken into two basic components. The extended watershed which must first discharge through upstream lakes prior to reaching Big Wood Lake and the direct watershed which is immediately adjacent to the lake. In many lake systems, the relative proportion of extended to direct watershed area can play an important role in the water quality of the lake. One way to evaluate relative significance of each of these watershed components is to perform the water quality modeling as described in Section 4.3.2. A second, more general approach was also utilized during this study.

The effects of precipitation and corresponding stormwater runoff often have significant impacts on lake water quality. This is because the runoff often contains pollutants and nutrients which end up in the lake system. In lake systems with a large direct watershed, runoff often reaches the lake very quickly and generally will result in a significant increase in lake level following the storm event. Lakes with large extended watersheds, such as Big Wood Lake, often do not experience these rapid water level changes because stormwater runoff is stored in upstream lakes and wetlands.

In order to evaluate the general response of Big Wood Lake and its watershed to storm events, rainfall and lake level information was collected by Big Wood Lake volunteers. This data is presented in Figure 21. As Figure 21 indicates, Big Wood Lake's water levels do not fluctuate greatly. During the month of May through June at least 11 inches of rain occurred over the direct watershed of Big Wood Lake. Lake levels, however, only increased 1.0 foot over that period and decreased rapidly when the rain stopped. This indicates that two things are occurring. First, there is significant storage in the numerous lakes and wetlands in Big Wood Lake's extended watershed. Second, the outlet characteristics of the Wood River when it leaves Big Wood Lake do not restrict flows significantly. Therefore, the lake does not experience significant water level flocculations.

4.3.4 Direct Watershed Land Use

As shown by MINLEAP modeling, the Big Wood Lake direct watershed is potentially a major source of phosphorus to the lake. With the exception of the homes and cabins surrounding the lake, the land in the Big Wood Lake direct watershed is generally used for agriculture. Land use in the watershed can greatly influence the amount of phosphorus reaching a lake. For example, animal feed lots may produce large amounts of phosphorus. Soil runoff from highly erodible lands may not only result in elevated phosphorus concentrations, but elevated suspended solids as well. Properly maintained crop fields, woods, and open land will have less of an impact on the lake.

The land use in the Big Wood Lake direct watershed is shown on Figure 22. Land areas with the highest potential for impacting the lake are indicated by the Symbols F (Fields) and HEL (Highly Erodible Land). There are stretches of highly erodible land bordering both the Wood River and Spirit Creek; eroded soil from these areas would be directly transported to the lake.

4.4 Macrophyte Survey

Two macrophyte surveys were completed on Big Wood Lake -- on June 14 and August 16, 1993. Appendix B lists the survey methodology. A brief overview of macrophyte ecology is included below, followed by a discussion of the macrophyte survey results.

Macrophytes (aquatic plants) are naturally present to some extent in all northern lakes, and are an important part of the aquatic environment. Macrophytes form fish "nurseries", providing tangled shelters which protect eggs and fry from predators. Macrophytes also provide food and cover for waterfowl and adult fish. Insects, snails, algae, and microcrustaceans are all supported by macrophytes, which are also important food for both waterfowl and fish. Macrophytes also supply oxygen to the water column through the process of photosynthesis.

Four general types of macrophytes are typically found in northern lakes. "Emergents" are plants which are rooted in the lake bottom, but the stems grow above the lake surface. Examples of emergents are cattails (*Typha* spp.) and bulrush (*Scripus* spp.). Emergents generally grow in the shallow waters found near the lake shore. While emergents may sometimes form problems for boat access, they provide shoreline protection from the action of waves and waterfowl nesting habitat. "Free-floating" macrophytes, such as duckweed (*Lemna* spp.), are not rooted in the lake bottom but have an extensive root system which hangs beneath the free-floating leaves. These plants are often quite small, and may completely cover the water surface in small, stagnant water bodies. In larger lakes, they are generally not a nuisance. Duckweed, as the name implies, provides food for waterfowl. "Floating-leaved" macrophytes have leaves which float on the lake surface, with a long rooted stem; an example is the water lily (*Nuphar* spp.). The leaves of these plants are quite fragile and are easily torn by wave action; therefore, they are typically found only in quiet bays. The "submergents" grow entirely underwater. Some submergents, such as the naiads (*Najas* spp.) generally grow close to the lake sediments, while others, such curlyleaf pondweed (*Potamogeton crispus*) may grow to the lake surface and form a thick mat. Submergent macrophytes may form a barrier to wave action and water currents. They also accelerate the removal of suspended solids from turbid water by trapping the particles on leaf and stem surfaces.

In some instances, macrophytes can become overabundant, causing detrimental effects to the lake ecosystem and decreasing the enjoyment of lake users. Dense macrophyte growth can interfere with boat navigation, overwhelm swimming beaches, and diminish the amount of oxygen available to aquatic life when they die and decompose. Contrary to popular opinion, nuisance macrophyte growth is <u>not</u> directly caused by increased phosphorus loads to a lake. Macrophytes generally extract nutrients from the lake bottom sediments, and do not use the dissolved nutrients which cause nuisance algae blooms. The process of eutrophication does tend to increase the amount of phosphorus found in lake sediments, and this may accelerate macrophyte growth. More likely, nuisance macrophyte growth occurs from the invasion of exotic (non-native) species, such as eurasian water milfoil and curlyleaf pondweed. The aquatic ecosystem depends on a macrophyte community formed of many plant species. Since exotic species have few natural predators, they tend to crowd out the native species, forming large single-species colonies. Unfortunately, the exotic plant species also tend to form dense, troublesome surface mats.

To properly manage nuisance macrophytes, it is important to understand their growth patterns, and understanding these patterns can lead to possible management strategies for controlling nuisance colonies. In general, the most common techniques for macrophyte control are herbicide application, mechanical harvesting, manual harvesting, and installation of benthic barriers. Common herbicides include Diquat, Aquathol-K, 2,4-D, and Sonar; the application rate and type of herbicide used must be closely monitored and controlled to eliminate negative impacts on the lake. Aquatic herbicides should only be applied by a trained technician. One drawback of herbicide use is that unless they are removed, the treated macrophytes will sink to the lake bottom and decompose, decreasing the concentration of oxygen in the water column and releasing nutrients into the water column which can promote algal growth.

Mechanical harvesting provides immediate results, and can be used to selectively treat only nuisance colonies. Drawbacks of mechanical harvesting are that the process is expensive and time consuming, and small fish may inadvertently be killed during harvesting. The harvested macrophytes must be removed from the lake, and disposed of on shore. Manual harvesting with a rake or scythe can be used to remove macrophytes from around small beaches or dock areas, with little adverse affects.

Benthic barriers are structures placed on the lake bottom to block macrophyte growth. Advantages of benthic barriers include: no toxic substances are released, their use is confined to small, specific areas, they can be removed, and they are effective on all species of macrophytes. Disadvantages include: they are expensive, they may be difficult to install on steep slopes, they must be cleaned off each year to prevent macrophyte rooting, and they may float to the surface if gases are trapped beneath them (Cooke et. al., 1993). Aquascreen, a commercially available fiberglass screen coated with polyvinyl chloride, has been proved effective in controlling macrophyte growth. Burlap has also been used, but it typically rots within one to three years.

It is important to note that any macrophyte control carried out in a lake should be undertaken as a scientific, coordinated effort. Indiscriminate macrophyte treatment can actually exacerbate the problem. A macrophyte control plan formulated for the lake is usually the best management practice.

The Wisconsin Department of Natural Resources estimates that 25 of the 150 different macrophytes that are found in Wisconsin lakes can form nuisance colonies (WDNR, 1989). The following lists the common nuisance plants found in Wisconsin (adapted from WDNR, 1989):

Common Name	Scientific Name
*coontail	*Ceratophyllum demersum*
*native water milfoil	*Myriophyllum spp.*
Eurasian Water Milfoil	*M. spicatum*
* Canada waterweed or elodea	*Elodea canadensis*
* sago pondweed	*Potamogeton pectinatus*
*flatstem pondweed	*P. zosteriformis*
*curlyleaf pondweed	*P. crispus*

*Present in Big Wood Lake during 1993.

Curlyleaf pondweed is an exotic (non-native) macrophyte which became established in northern lakes in the early 1900s. It tends to emerge early each spring, and collapses by the first week of July (Pullman, 1992). Curlyleaf pondweed tends to form dense surface mats over expansive meadows. <u>It grows especially well in areas where mechanical harvesting or herbicides are used without careful planning</u>. Pullman (1992) recommends early seasonal control of curlyleaf pondweed, so it can be removed before it interferes with summer recreation, and before the July die-off causes lake water oxygen depletion. Research has shown selective control can be achieved through early season application of fluridone (Sonar) or endothall (Aquathol-K, at low concentrations).

Eurasian water milfoil is also an exotic macrophyte species. It is extremely aggressive, and capable of displacing most native species. Like curlyleaf pondweed, it forms dense surface mats, and spreads rapidly. It is spread by fragmentation of plant parts, and is usually introduced to a lake via boats and boat trailers. Once it is established in a lake, it is usually controlled only by use of aquatic herbicides, especially 2,4-D and fluridone (Sonar).

The other nuisance macrophytes on the list, which were found in Big Wood Lake, such as native water milfoil, Canada waterweed, sago pondweed, flatstem pondweed, and coontail, are native species and typically grow in patchy distributions of low growing meadows (Pullman, 1992). Occasionally, these species will cover more expansive areas, or will form surface mats; only at these times should these plants be managed as nuisance macrophytes.

Tables 5 and 6 present summaries of the results of the two macrophyte surveys completed on Big Wood Lake. The frequency of occurrences, as shown in the table, is a measure of how often a particular weed species was found after a sampling event. For example, assume the sampling instrument was in the lake 100 times and 60 times the particular weed species was found. The species would then have a frequency of occurrence of 60 percent. The density rating is a measure of how "dense" a particular weed species grows in a particular area. A density rating of 5 indicates an extremely dense growth and a density ratio of 1 indicates a relatively small amount of growth. The complete results of the surveys are included in Appendix B. During the time of the June survey, coontail, native water milfoil, and curlyleaf pondweed were present in greatest numbers. During the August survey, coontail, water milfoil, flatstem pondweed, naiad, and canada waterweed were present in greatest numbers. No Eurasian water milfoil was found in Big Wood Lake during either survey. Curlyleaf pondweed, an exotic species, was found during the June survey, but had died out by the time of the August survey.

As mentioned previously, curlyleaf pondweed is an exotic (non-native) macrophyte. It is unique among most weeds because it grows rapidly in the spring and dies off quickly during the first week of July. After die off, large mats of rotting vegetation often wash up on shore causing odor and aesthetic problems. Curlyleaf pondweed is likely causing the majority of the nuisance problems.

Figure 23 shows the general distribution of curlyleaf pondweed along the shoreline of Big Wood Lake. As Figure 23 indicates, curlyleaf tends to favor the shallow shoreline areas most frequently used for swimming and boat docks. It is, therefore, likely that curlyleaf pondweed is the cause of nuisances weed problems on Big Wood Lake.

4.5 Property Owners Survey

The intent of the survey was to collect information which would assist the Big Wood Lake Association in short and long range planning. The Association compiled the results, and ranked the top three responses to each question. Complete results of the survey are listed in Appendix C. 167 surveys were distributed; 72 were returned (43 percent response). The following issues were addressed in the survey, and are pertinent to this report:

- Why did you buy property on Big Wood Lake
- Water quality and water clarity
- Aquatic plant growth
- Lake Shore Frontage and Shoreline Structures

Why Did You Buy Property on Big Wood Lake

The response to this question centered on enjoying the peace and tranquility of the lake, the view of the lake, and the recreational opportunities for family and friends. The majority of respondents report that there are few to moderate disturbances on Big Wood Lake, and that the view from their properties is generally not impacted by lake shore development. The respondents noted that the boat traffic on the lake is moderate to heavy at times, with moderate conflict occurring due to discourteous boaters.

26 respondents use their properties as year-round residences, while the remainder tend to use their properties on the weekends and during the summers. If summer homes are converted to permanent residences or if changes in public use occur, the boat traffic may increase. The Big Wood Lake Association may need to address this issue in the future.

Water Clarity and Water Quality

The survey responses on water clarity in Big Wood Lake are split between classifying the water as clear or cloudy. Similarly, the responses on water quality are split between good and fair. The responses indicate that there is some dissatisfaction with the water quality in Big Wood Lake; this issue is currently being addressed by the Big Wood Lake Association through its lake planning grant study and through this report.

Aquatic Plant Growth

The majority of respondents indicated that there was heavy plant growth in Big Wood Lake which limits the use of some parts of the lake and diminishes the attractiveness of the lake. This issue is currently being addressed by the lake association through the macrophyte surveys completed as a part of the lake planning grant study. However, the responses were split on the issue of chemical treatment for macrophyte control. This issue will need to be addressed as the lake association formulates a macrophyte management plan. Currently, the best treatment for the exotics present in the lake, especially curlyleaf pondweed, is some form of controlled, carefully applied chemical treatment. Eurasian water milfoil has not been found in Big Wood Lake to date. The lake association should take preventative measures, such as boat inspections and public education, to ensure that the lake is not infested.

Lake Shore Frontage and Shoreline Structures

The proper management of lake shore property is crucial to lake water quality. As shown previously in this report, watershed modeling predicts that the majority of phosphorus entering Big Wood Lake is from the direct watershed. However, the model also indicate that there is an additional phosphorus load which is impacting the lake. Leaky septic systems and over-fertilization of lawns are two likely sources of these additional phosphorus loads. According to the survey responses, most lake frontages consist of stabilizing structures, such as rocks or walls, and lawns. Most respondents felt that the enforcement of current shoreland zoning and sanitary/septic ordinances has been adequate. However, the data indicate that additional measures may be needed. The Big Wood Lake Association should focus on educating property owners on proper lawn fertilization, the benefits of native shoreline vegetation, and septic system upkeep in their long-range management of the lake.

5.0 RECOMMENDATIONS AND MANAGEMENT ACTIONS

The recommendations and management actions presented in this report are based on the evaluation of the Self Help Lake Monitoring Data and the Big Wood Lake Planning Grant Study.

The management recommendations are broken down into four main categories. These include:

1. Urban Lake Shore Recommendations
2. Agricultural Watershed Recommendations
3. In-Lake Recommendations
4. Additional Work Tasks

5.1 Urban Lake Shore Recommendations

The immediate ring of cabins and roads surrounding the shoreline of Big Wood Lake is very typical of low to moderate density residential land use observed in many urban situations. This type of land use generally exports 2 to 5 times the phosphorus into a lake than does land in its natural state. The increase in pollutant load is primarily attributable to increases in impervious (paved) surfaces. The surfaces increase the amount of stormwater runoff. Additionally, land use practices such as fertilizing near the shoreline, grass clippings placed into the lake, and failing septic systems all result in increased pollutant loads.

The results of the hydrologic and phosphorus budget estimates indicate that watershed phosphorus loads into Big Wood Lake are relatively important in comparison to other sources. It is important for Big Wood Lake property owners to recognize that their property represents a significant potential source of pollutants into Big Wood Lake. Therefore, in order to protect Big Wood Lake's water quality, the Big Wood Lake Association and other local units of government should adopt, as its management goal, a no-net increase in phosphorus load from the urban lake shore areas surrounding Big Wood Lake and potentially a decrease. It is, therefore, recommended that the Big Wood Lake Association implement the following actions:

1. Regularly educate Association members regarding their role in protecting Big Wood Lake's water quality. Activities such as using low phosphate fertilizers, regularly maintaining septic systems, and creation of shoreline buffer strips should be encouraged. Lake shore property owners should consider the regular maintenance and update of their septic systems as the "costs" associated with owning lake shore property.

2. Comprehensive land use planning should be considered in the watershed of Big Wood Lake. Specifically, any new residential, commercial, or institutional development which will increases the amount of storm water runoff and hence pollutant loadings into Big Wood Lake should be directed to discharge stormwater through an appropriate treatment device. These devices can include grassed swales, wetlands or constructed wet detention ponds. This practice will assist in mitigating the eutrophication effects of the development.

3. The Big Wood Lake Association should begin a program to regularly update property owners regarding the most current regulations affecting zoning, boater safety, and sanitary ordinances. These ordinances, if enforced and followed, offer significant protection to Big Wood Lake's water quality.

5.2 Agricultural Watershed Recommendations

The hydrologic and nutrient budgets indicate that watershed and agricultural loadings of nutrients into Big Wood Lake are significant. The potential to decrease the nutrient loadings from the agricultural watershed into Big Wood Lake would be the single biggest benefit to the long term health of Big Wood Lake. It is therefore important for the Big Wood Lake Improvement Association to actively work with the local agriculture community in a cooperative manner. Specifically, the Big Wood Lake Improvement Association should focus its attention on the following issues related to the agricultural watershed of Big Wood Lake.

1. Promote the retention/detention of stormwater runoff within Big Wood Lake's direct watershed. This activity includes protection of any existing depressions and wetlands, and creation of new detention areas, especially within the direct watershed of the lake.

2. Promote the stabilization and restoration of stream beds and adjacent lands within Big Wood Lake's watershed. Analysis of aerial photography of the Big Wood Lake watershed revealed several highly erodible areas in the vicinity of both the Wood River and Spirit Creek. Stabilization of these areas may prevent phosphorus and suspended solids inflows to the lake.

3. Work closely with the agricultural community to identify cost effective management practices which lead to increased profitability for the farm operators and improved water quality in Big Wood Lake's tributary streams.

5.3 In-Lake Recommendations

The water quality analysis of Big Wood Lake focussed on two issues: the nuisance macrophyte growth, and degradation of water clarity.

1. Nuisance Macrophyte Growth

The weed issue is significant because a significant number of Big Wood Lake property owners identified weeds as a problem within the lake. It must be understood by the public that aquatic weeds generally do not derive their nourishment from phosphorus in the water column. Their nourishment typically comes from the lake's sediments, which have a large supply of nutrients. Generally, very little can be done to control weed growth other than harvesting and chemical treatment.

The data indicate that curlyleaf pondweed is likely causing the nuisance problems. Therefore, it is recommended that the mechanical/chemical treatment of macrophytes in Big Wood Lake focus on control of curlyleaf pondweed. Curlyleaf pondweed is most effectively controlled during the early spring, either by mechanical removal (raking) or select chemical applications to areas of known curlyleaf pondweed infestation. The property owners should work closely with WDNR to develop a weed control program which protects the native plant community while effectively minimizing water quality conflicts caused by the weed. A random or uncontrolled treatment of aquatic weeds can result in detrimental consequences for the lake and its aquatic community.

A second option for conflict avoidance is for the property owners to develop common areas for boat docking and swimming. This option would limit the amount of areas which would require treatment for weed removal.

Additionally, the Big Wood Lake Association should actively work to prevent the introduction of Eurasian water milfoil (EWM) into the lake. Select Association members should be trained to identify the weed. Periodic surveys of public access areas should be conducted. Typically, EWM is found first in these areas. If found in its early stages, the weed is much easier to control.

2. Degradation of Water Clarity and Water Quality

The results of the general chemistry analysis show that Big Wood Lake has typical values for conductivity, pH, alkalinity, and water color. The temperature and oxygen data show that the lake only weakly stratifies, and that by late July the bottom water is anoxic (devoid of oxygen).

Trophic state analysis of the phosphorus, chlorophyll a, and transparency data reveals that the lake is currently eutrophic in status, with the corresponding occurrence of algal blooms and degraded water transparency. The water quality degrades throughout the summer, and is lowest during August. Data indicates that internal phosphorus loading may be occurring at that time, due to the high bottom water concentrations of phosphorus, and the weakly stratified water column. The presence of large numbers of carp in the lake may be exacerbating the problem; carp may increase internal phosphorus load from the sediments to the water column through their digestive systems, or by stirring up the sediment-water interface.

The control of internal phosphorus load would likely require the application of a chemical precipitate such as alum (aluminum sulfate), which effectively prevents the release of phosphorus from anoxic sediments. Aeration is another technique which has been suggested as a means to reduce the internal load of phosphorus in lakes. However recent studies (Beduhn et al., 1993) have found that destratifying aeration systems can actually increase the internal loading of phosphorus from lake sediments and typically result in degraded late summer water quality if the systems are not designed properly.

However, the control of internal loading is not typically recommended unless the external load is first controlled. Therefore, the use of alum or aeration, is not advised without further study and implementation of watershed controls. The control of carp and other rough fish is a practical alternative. These fish do have commercial value and are harvested regularly for that purpose. Often it is necessary for an organization, such as the Big Wood Lake Association, to subsidize the commercial removal of these fish. The Association should consider pursuing this management option.

5.4 Additional Work Tasks

To determine which steps would be appropriate to protect/improve the quality of Big Wood Lake, conversations were held with Mr. Dan Ryan of the Wisconsin Department of Natural Resources and Mr. Dave Ferris of the Burnett County Land Conservation Department. These government officials both indicated that the members of the Big Wood Lake Association should understand that there will not be a single "fix" to protecting the water quality of Big Wood Lake due to the potential multiple source of pollutants. Therefore, additional work tasks (if so desired by the Association), should focus on collecting data on both the urban and direct rural agricultural watershed. The following summarizes a work plan outline which could be incorporated into a August, 1994 Lake Planning Grant Application. Also, a summary of Federal and State lake and land management programs which may be of interest to members of the Lake Association are listed in Table 7.

Urban (Lake Shore Area)

The urban, immediate lake shore line area typically has an impact on lake water quality. Septic systems, shoreland erosion and stormwater runoff can add to water quality problems. The Burnett LCD, the WDNR and Barr all conclude that any further lake planning grant work towards improving Big Wood Lake should include some formal assessment/educational effort toward improving the shoreland area of Big Wood Lake. This should include:

1. Septic system inventory and survey.

2. Lake shore erosion survey and inventory.

3. Educational efforts or demonstration projects.

The Burnett LCD indicated they would be willing to assist the Association and Barr in developing a specific work plan should a grant application be desired.

Direct Rural/Agricultural Watershed

The water quality modeling indicates that the direct watershed of Big Wood Lake contributes a significant portion of the annual phosphorus load to the lake. The Burnett LCD, WDNR and Barr all concurred that additional testing/study of the direct watershed to Big Wood Lake would be appropriate. A study of the watershed should include:

1. A ground truthing survey of the direct watershed to confirm aerial survey mapping and identify occurrence of tile inlets and other surface inflows. This work would likely be done by Burnett LCD employees.

2. Upon completion of the truthing survey, conduct an intensive water quality/flow monitoring survey of the direct watershed of Big Wood Lake. Preferably, during a 2 to 3 day period following a significant rainfall event.

3. Conduct periodic/routine water quality monitoring of the Wood River and Spirit Creek.

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Tables

Table 1. Big Wood Lake Physical Morphometry

Surface Area @ Normal Elevation*	530 acres
Maximum Depth - North Basin	35 feet
- South Basin	30 feet
Volume @ Normal Elevation*	10,500 acre-feet
Mean Depth (Volume/Surface Area)	19.8 feet
Watershed Area to Lake Area Ratio	70:1

*Water surface elevation based on 1983 Trade Lake USGS quadrangle map.

Table 2. Big Wood Lake Watershed Areas

Lake	Lake Surface Area	Direct Watershed Area
Big Wood Lake	530 acres	4,431 acres
Rice Lake	87 acres	680 acres
Spirit Lake	596 acres	7,737 acres
Little Wood Lake	205 acres	4,086 acres
Dunham Lake	233 acres	15,176 acres
Fern Lake	23 acres	2,307 acres
Hawthorn Lake	11 acres	1,001 acres
Total Big Wood Lake Watershed Area		35,418 acres

Table 3
Big Wood Lake Water Quality Data

Date	Basin	Sample Depth (meters)	Temp. (C)	D.O. (mg/L)	Secchi (meters)	Total P (mg/L)	Dissolved P (mg/L)	Chlorophyl a (ug/L)	Color (pt-co units)	Conductivity (umhos/cm)	pH (su)	Alkalinity (mg/L as CaCO3)	Ammonia (mg/L as N)	Nitrate + Nitrite (mg/L as N)	Total Kjeldahl N (mg/L)
05/17/93	North	0-2			On	0.032	<0.002		15	244	8.3	121	0.009	<0.007	0.4
05/17/93	North	0.0	15.0	9.0	Separate										
05/17/93	North	1.0	15.0	9.1	Table										
05/17/93	North	2.0	15.0	9.1											
05/17/93	North	3.0	15.0	9.0											
05/17/93	North	4.0	15.0	9.1											
05/17/93	North	5.0	15.0	9.1											
05/17/93	North	6.0	14.5	7.9											
05/17/93	North	7.0	12.0	2.2											
05/17/93	North	8.0	11.0	0.6											
05/17/93	North	9.0	11.0	0.5											
05/17/93	North	9.2	11.0	0.4		0.042									
06/14/93	North	0-2				0.024	<0.002	31.2	15	233	8.5	116	0.025	<0.007	0.7
06/14/93	North	0.0	20.5	10.2											
06/14/93	North	1.0	20.5	10.3											
06/14/93	North	2.0	20.5	10.2											
06/14/93	North	3.0	20.5	10.2											
06/14/93	North	4.0	17.0	8.0											
06/14/93	North	5.0	15.9	7.0											
06/14/93	North	6.0	15.5	5.6											
06/14/93	North	7.0	14.0	3.8											
06/14/93	North	8.0	13.8	3.2											
06/14/93	North	9.0	13.5	2.1		0.059									
06/14/93	North	9.5	14.0	2.5											
07/19/93	North	0-2				0.033	<0.002	39.2	30	218	8.6	109	0.008	<0.007	0.9
07/19/93	North	0.0	24.5	11.6											
07/19/93	North	1.0	24.0	12.0											
07/19/93	North	2.0	24.0	12.0											
07/19/93	North	3.0	21.5	6.6											
07/19/93	North	4.0	20.0	5.8											
07/19/93	North	5.0	18.5	2.2											
07/19/93	North	6.0	17.0	0.5											
07/19/93	North	7.0	15.0	0.5											
07/19/93	North	8.0	14.0	0.5											
07/19/93	North	8.6	14.0	0.5		0.152									

Table 3
Big Wood Lake Water Quality Data

Date	Basin	Sample Depth (meters)	Temp. (C)	D.O. (mg/L)	Secchi (meters)	Total P (mg/L)	Dissolved P (mg/L)	Chlorophyl a (ug/L)	Color (pt-co units)	Conductivity (umhos/cm)	pH (su)	Alkalinity (mg/L as CaCO3)	Ammonia (mg/L as N)	Nitrate + Nitrite (mg/L as N)	Total Kjeldahl N (mg/L)
08/16/93	North	0-2			On	0.056	<0.002	61.8	30	216	8.7	108	0.01	<0.007	1.1
08/16/93	North	0.0	24.0	10.0	Separate										
08/16/93	North	1.0	24.0	9.5	Table										
08/16/93	North	2.0	23.0	6.6											
08/16/93	North	3.0	21.0	1.7											
08/16/93	North	4.0	20.0	0.7											
08/16/93	North	5.0	20.0	0.6											
08/16/93	North	6.0	18.0	0.6											
08/16/93	North	7.0	16.0	0.6											
08/16/93	North	8.0	15.0	0.6											
08/16/93	North	8.6	15.0	0.6		0.33									
09/13/93	North	0-2				0.054	<0.002	45.0	20	236	8.1	117	0.095	<0.007	1.0
09/13/93	North	0.0	17.0	8.8											
09/13/93	North	1.0	17.0	8.8											
09/13/93	North	2.0	17.0	7.8											
09/13/93	North	3.0	17.0	7.4											
09/13/93	North	4.0	17.0	7.4											
09/13/93	North	5.0	17.0	7.2											
09/13/93	North	6.0	16.5	7.0											
09/13/93	North	7.0	16.5	6.7											
09/13/93	North	8.0	16.5	5.9		0.063									
05/17/93	South	0-2				0.025	<0.005		15	245	8.3	121	0.014	<0.007	0.5
05/17/93	South	0.0	15.5	9.5											
05/17/93	South	1.0	15.5	9.5											
05/17/93	South	2.0	15.5	9.4											
05/17/93	South	3.0	15.0	9.3											
05/17/93	South	4.0	15.0	9.2											
05/17/93	South	5.0	15.0	9.1											
05/17/93	South	6.0	15.0	8.6											
05/17/93	South	7.0	11.0	1.2											
05/17/93	South	8.0	10.0	0.3											
05/17/93	South	8.4	10.0	0.3		0.04									

Table 3
Big Wood Lake Water Quality Data

Date	Basin	Sample Depth (meters)	Temp. (C)	D.O. (mg/L)	Secchi (meters)	Total P (mg/L)	Dissolved P (mg/L)	Chlorophyl a (ug/L)	Color (pt-co units)	Conductivity (umhos/cm)	pH (su)	Alkalinity (mg/L as CaCO3)	Ammonia (mg/L as N)	Nitrate + Nitrite (mg/L as N)	Total Kjeldahl N (mg/L)
06/14/93	South	0-2			On	0.03	<0.005	24.0	15	235	8.4	117	0.024	<0.007	0.6
06/14/93	South	0.0	20.0	10.2	Separate										
06/14/93	South	1.0	20.0	10.2	Table										
06/14/93	South	2.0	20.0	10.2											
06/14/93	South	3.0	20.0	10.1											
06/14/93	South	4.0	17.0	9.0											
06/14/93	South	5.0	15.9	7.8											
06/14/93	South	6.0	14.9	5.7											
06/14/93	South	7.0	14.0	4.1											
06/14/93	South	8.0	13.0	3.6											
06/14/93	South	8.4	12.6	0.8		0.052									
07/19/93	South	0-2				0.037	<0.002	32.3	30	218	8.6	109	0.011	<0.007	0.9
07/19/93	South	0.0	24.0	11.0											
07/19/93	South	1.0	24.0	11.2											
07/19/93	South	2.0	23.5	10.6											
07/19/93	South	3.0	21.0	5.6											
07/19/93	South	4.0	20.0	2.2											
07/19/93	South	5.0	19.0	1.4											
07/19/93	South	6.0	17.0	0.5											
07/19/93	South	7.0	15.0	0.5											
07/19/93	South	8.0	13.0	0.5		0.149									
08/17/93	South	0-2				0.046	<0.002	73.0	30	218	8.7	109	0.012	<0.007	1.1
08/17/93	South	0.0	24.0	8.8											
08/17/93	South	1.0	24.0	8.8											
08/17/93	South	2.0	24.0	8.8											
08/17/93	South	3.0	22.0	3.0											
08/17/93	South	4.0	21.0	1.2											
08/17/93	South	5.0	19.5	0.3											
08/17/93	South	6.0	17.0	0.3											
08/17/93	South	7.0	15.0	0.3											
08/17/93	South	7.7	13.0	0.3		0.27									

Table 3
Big Wood Lake Water Quality Data

Date	Basin	Sample Depth (meters)	Temp. (C)	D.O. (mg/L)	Secchi (meters)	Total P (mg/L)	Dissolved P (mg/L)	Chlorophyl a (ug/L)	Color (pt-co units)	Conductivity (umhos/cm)	pH (su)	Alkalinity (mg/L as CaCO3)	Ammonia (mg/L as N)	Nitrate + Nitrite (mg/L as N)	Total Kjeldahl N (mg/L)
09/13/93	South	0-2			On	0.052	<0.002	42.7	20	236	8	117	0.105	<0.007	1.0
09/13/93	South	0.0	17.0	8.7	Separate										
09/13/93	South	1.0	17.0	8.5	Table										
09/13/93	South	2.0	17.0	8.4											
09/13/93	South	3.0	17.0	8.0											
09/13/93	South	4.0	17.0	7.8											
09/13/93	South	5.0	17.0	7.4											
09/13/93	South	6.0	16.5	6.5											
09/13/93	South	7.0	16.5	6.4											
09/13/93	South	8.0	16.0	5.1		0.056									

Table 4
Big Wood Lake Water Quality Data -- Secchi Disc Transparency

Date	North Basin (feet)	North Basin (meters)	South Basin (feet)	South Basin (meters)
05/23/93	6.5	2.0	6.0	1.8
06/03/93	7.5	2.3	9.5	2.9
06/21/93	5.0	1.5	5.8	1.8
06/26/93	4.0	1.2	4.0	1.2
07/02/93	3.8	1.1	3.8	1.1
07/10/93	2.8	0.8	3.3	1.0
07/19/93	3.3	1.0	2.8	0.8
07/29/93	2.8	0.8	3.0	0.9
08/07/93	2.8	0.8	2.8	0.8
08/12/93	2.8	0.8	2.8	0.8
08/23/93	3.0	0.9	3.0	0.9
09/02/93	3.0	0.9	2.5	0.8
09/12/93	2.8	0.8	2.8	0.8
09/18/93	4.5	1.4	3.3	1.0

TABLE 5

BIG WOOD LAKE

MACROPHPYTE SURVEY

June 14, 1993

PLANT SPECIES SCIENTIFIC NAME	PLANT SPECIES COMMON NAME	FREQUENCY OF OCCURRENCE* (%)	SPECIES MEAN DENSITY RATING (1-5)**
Ceratophyllum demersum	Coontail	63.3	3.4
Chara sp.	Muskgrass	11.7	2.3
Elodea canadensis	Canada waterweed	23.3	2.1
Myrrophyllum exalbescens	Native water milfoil	33.3	2.5
Potamogeton amplifolius	Largeleaf pondweed	5.0	2.0
Potamogeton crispus	Curlyleaf pondweed	30.0	2.1
Potamogeton natans	Floatingleaf pondweed	1.7	1.0
Potamogeton nodosus	River pondweed	3.3	1.5
Potamogeton richardsonii	Claspingleaf pondweed	11.7	1.6
Rununculus sp.	Water buttercup	5.0	1.0

* The percentage of all sample points where a species has occurred.

** An average of the density ratings from the sample points where each species was found.

TABLE 6

BIG WOOD LAKE

MACROPHPYTE SURVEY

August 16, 1993

PLANT SPECIES SCIENTIFIC NAME	PLANT SPECIES COMMON NAME	FREQUENCY OF OCCURRENCE* (%)	SPECIES MEAN DENSITY RATING (1-5)**
Ceratophyllum demersum	Coontail	70.0	3.7
Chara sp.	Muskgrass	21.7	2.9
Elodea canadensis	Canada waterweed	31.7	2.2
Heterathera dubia	Mud Plantain	8.3	2.2
Myrrophyllum exalbescens	Water milfoil	53.3	2.5
Najas sp.	Naiad/Pondweed	31.7	2.7
Potamogaton amplifolius	Largeleaf Pondweed	1.7	2.0
Potamogeton natans	Floatingleaf Pondweed	11.7	1.9
Potamogeton pectinatus	Sago Pondweed	15.0	1.4
Potamogeton richardsonii	Claspingleaf Pondweed	18.3	1.7
Potamogeton zosteriformis	Flatstem pondweed	40.0	1.9
Ranunculus sp.	Water buttercup	10.0	1.0
Vallisneria americana	Wild celery	31.7	2.5

* The percentage of all sample points where a species has occurred.

** An average of the density ratings from the sample points where each species was found.

TABLE 7

SUMMARY OF FEDERAL/STATE LAKE AND LAND MANAGEMENT PROGRAMS

PROGRAM	AVAILABLE FUNDING	DESCRIPTION	CONTACT
Lake Management Planning Grant Program	Maximum State Share is $10,000 25 Percent Local Share Required	Provides funds for conducting lake and watershed studies with the ultimate goal of lake protection or rehabilitation	Dan Ryan DNR Northwest District Box 309 Spooner, WI 54801 (715)635-4073
Lake Management Protection Grant Program	Maximum State Share is $100,000 50 Percent Local Share Required	Provides funds to carry out lake protection through: 1. the purchase of property which may contribute to the protection of the lake. 2. the restoration of a wetland which will prevent degradation of the lake. 3. the development of local regulations which will prevent degradation of the lake.	Dan Ryan DNR Northwest District Box 309 Spooner, WI 54801 (715)635-4073
Recreational Boating Facilities Program	50 Percent Cost Share	Provides funds for development of recreational boating facilities and includes the acquisition of capital equipment necessary to cut and remove nuisance aquatic plants.	Phil Wallace DNR Northwest District Box 309 Spooner, WI 54801 (715) 635-4159
Forest Stewardship Incentive Program	25 Percent Local Share Maximum Grant is $10,000	Provides funds to owners of 10 contiguous acres of land for enhancement of wildlife habitats, soil and water protection, and reforestation efforts.	Phil Stromberg or Dan Bailey DNR Bureau of Forestry PO Box 51 Webster, WI 54893 (715) 866-8201 (715) 349-2158

TABLE 7 (Continued)

SUMMARY OF FEDERAL/STATE LAKE AND LAND MANAGEMENT PROGRAMS

PROGRAM	AVAILABLE FUNDING	DESCRIPTION	CONTACT
Water Bank Program	Variable	Ten year lease to protect wetlands and adjacent upland acres	Burnett USDA Agricultural Stabilization & Conservation Service (ASCS) 7410 County Road K #108 Siren, WI 54872 (715) 349-2161 (715) 349-2162
Agricultural Conservation Program (ACP)	Variable	Cost share program for protection of agricultural lands and waters. Cost share practices include sediment retention structures, stream protection, animal waste control.	Burnett USDA Agricultural Stabilization & Conservation Service (ASCS) 7410 County Road K #108 Siren, WI 54872 (715) 349-2161 (715) 349-2162
Wetlands Reserve Program	Variable	Ten year least to preserve wetlands; cost sharing is available for wetland restoration.	Burnett USDA Agricultural Stabilization & Conservation Service (ASCS) 7410 County Road K #108 Siren, WI 54872 (715) 349-2161 (715) 349-2162
Small Watershed Program	Variable	Cost sharing and technical help for fish and wildlife habitat improvement and wetland conservation	Burnett USDA Agricultural Stabilization & Conservation Service (ASCS) 7410 County Road K #108 Siren, WI 54872 (715) 349-2161 (715) 349-2162

Figures

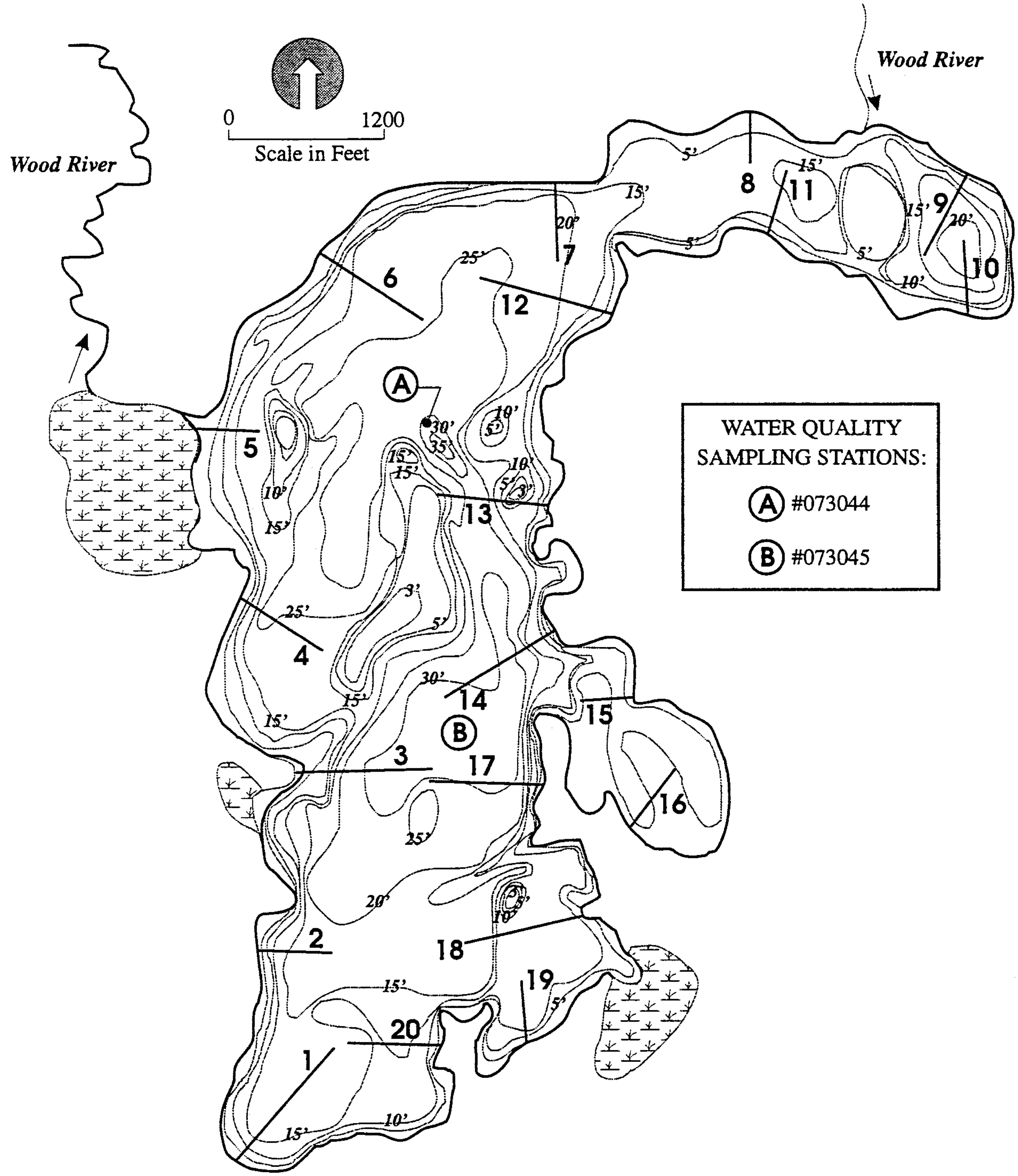


Figure 1

BIG WOOD LAKE
1993 MACROPHYTE SURVEY TRANSECT LOCATIONS
AND
WATER QUALITY SAMPLING STATION LOCATIONS

Big Wood Lake - North Basin
1993 Temperature (C) Isopleth

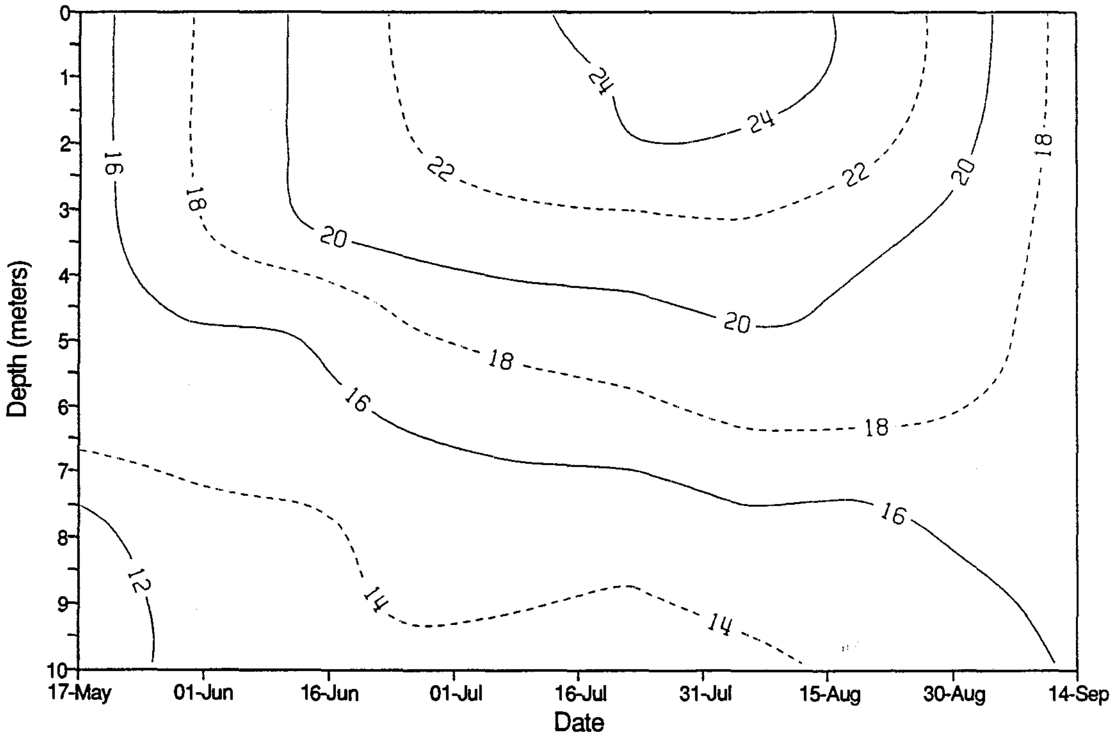


Figure 2

Big Wood Lake - South Basin
1993 Temperature (C) Isopleth

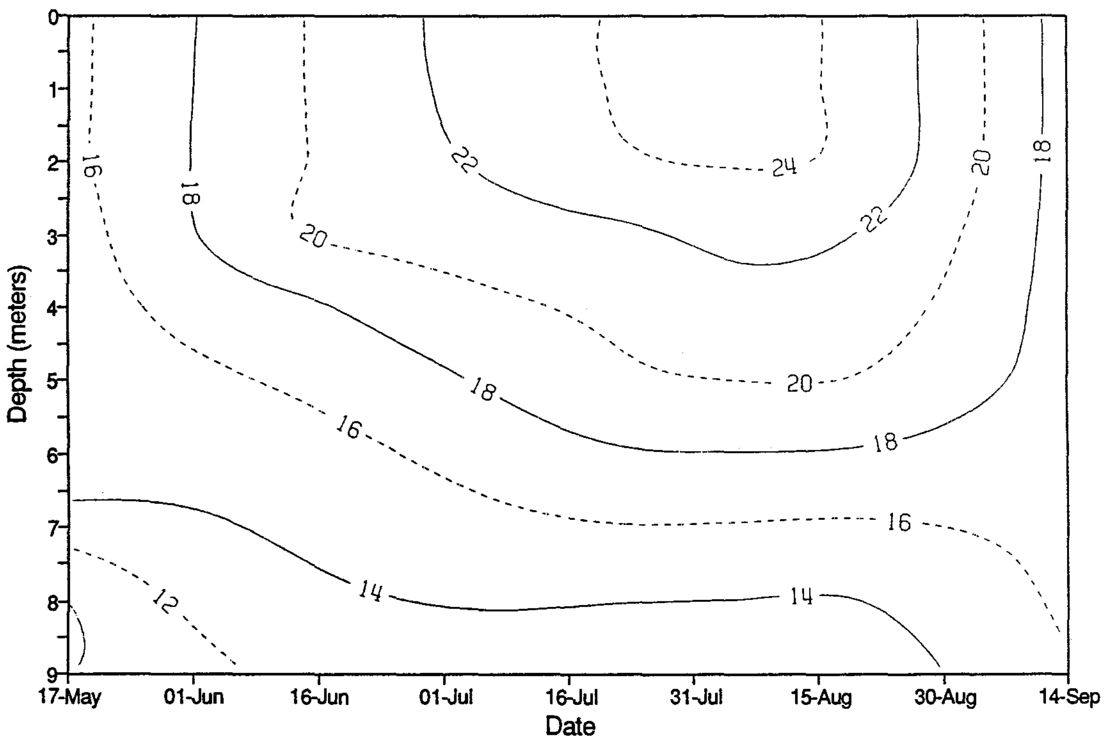


Figure 3

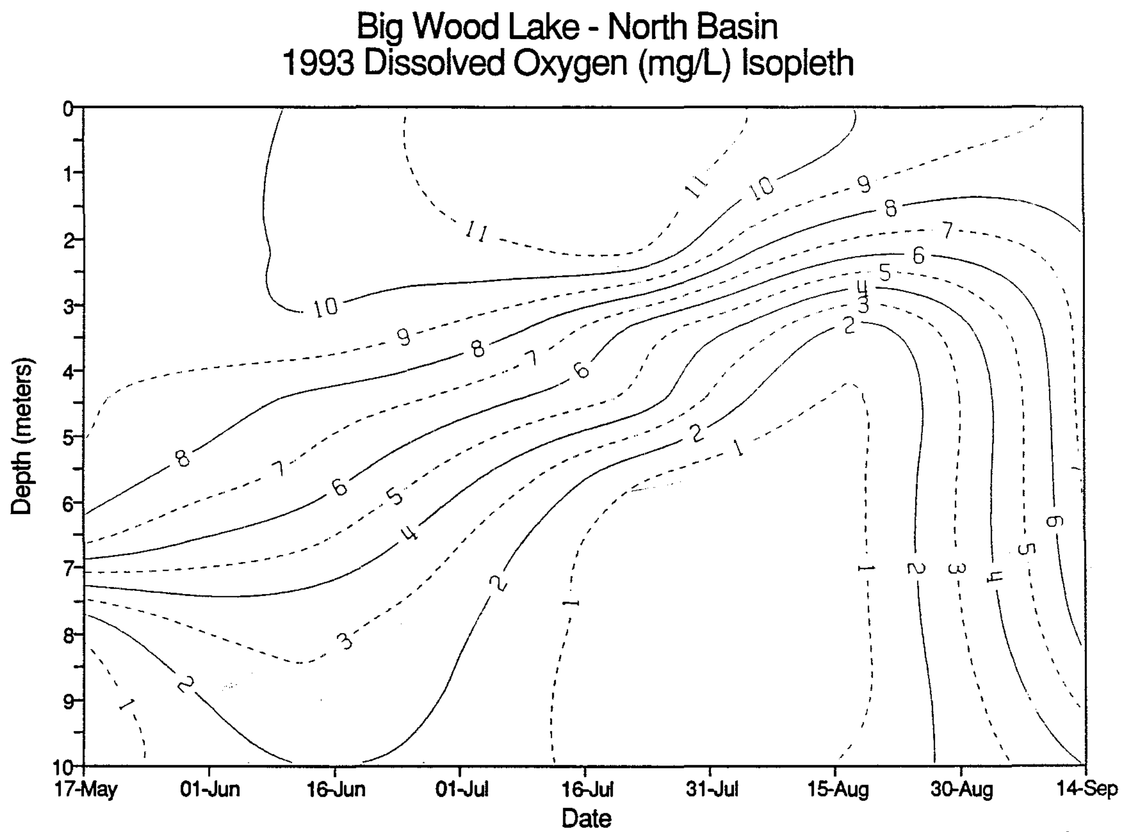


Figure 4

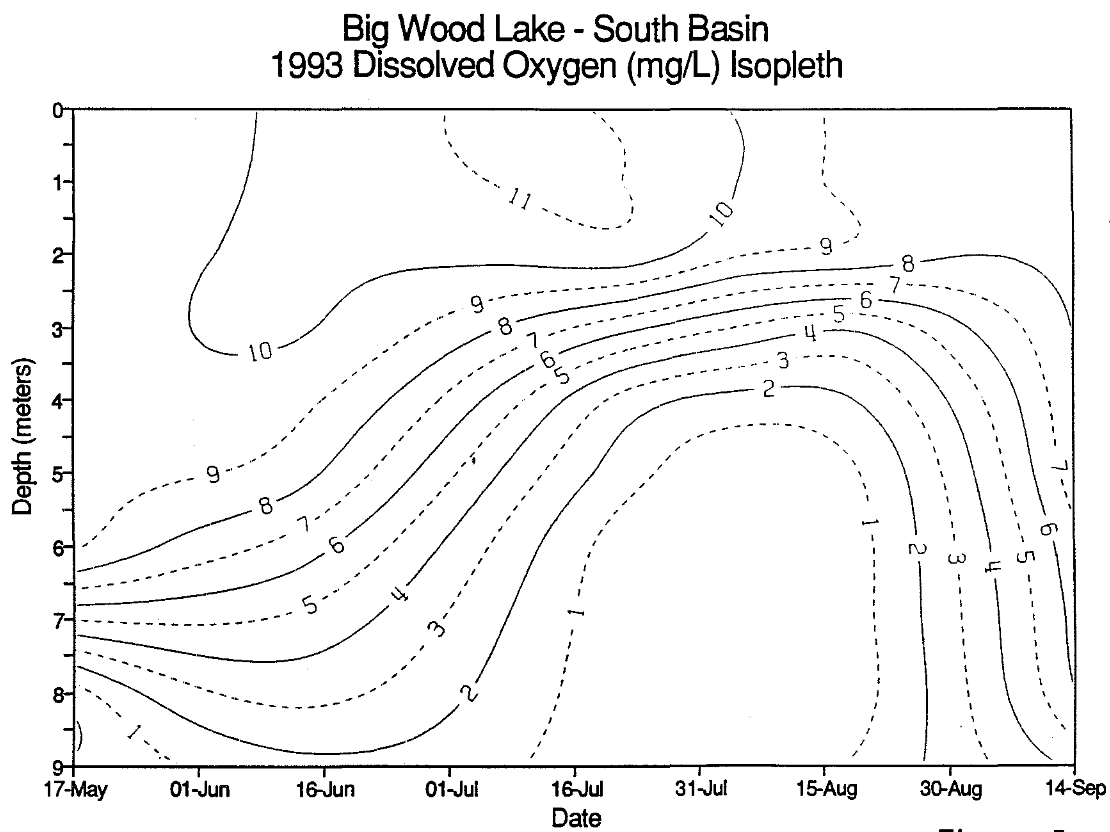


Figure 5

Big Wood Lake - 1993 Conditions
Conductivity

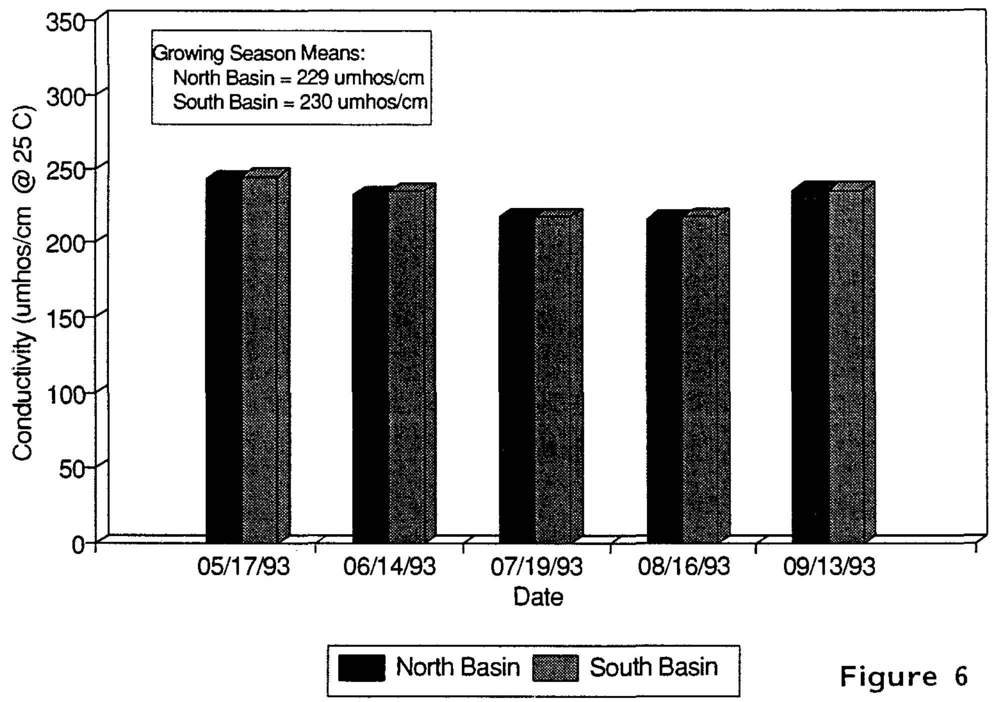


Figure 6

Big Wood Lake - 1993 Conditions
pH

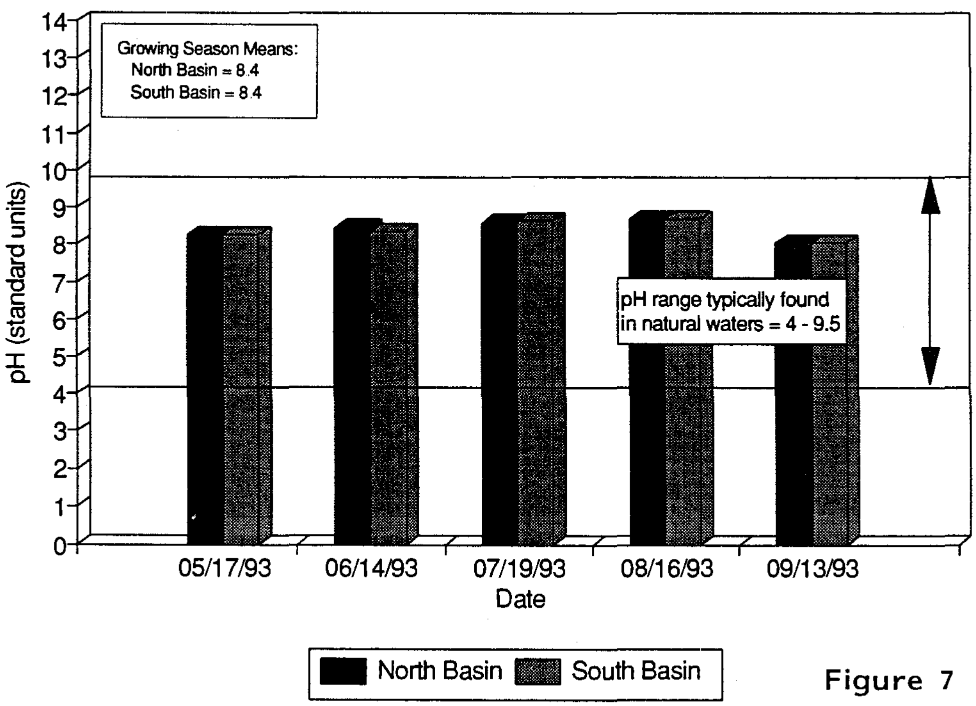


Figure 7

Big Wood Lake - 1993 Conditions
Alkalinity

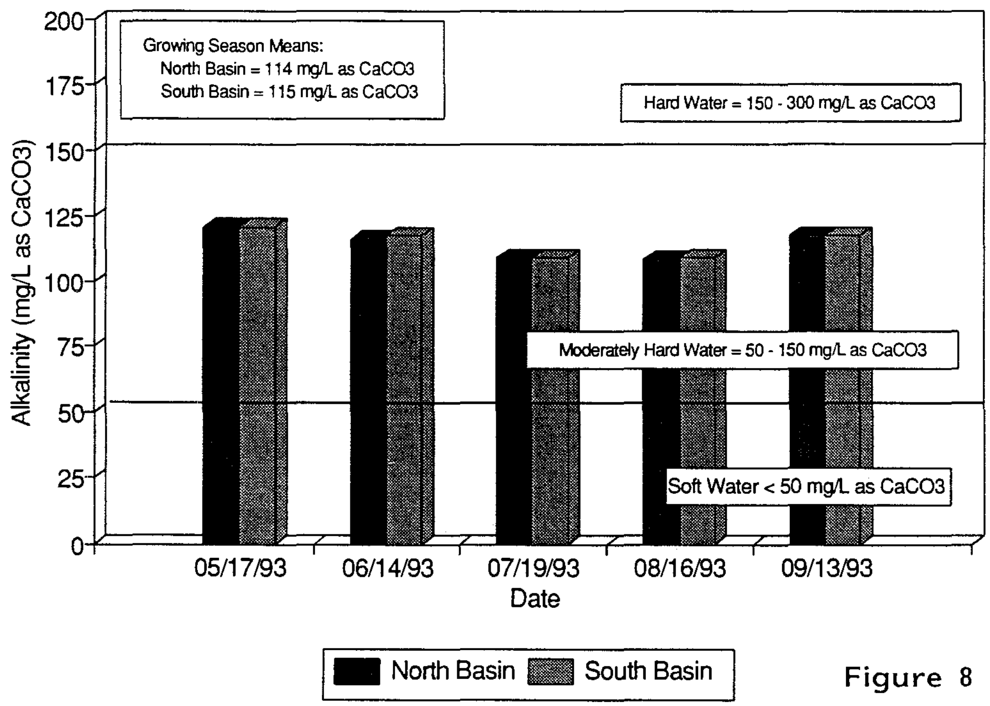


Figure 8

Big Wood Lake - 1993 Conditions
Water Color

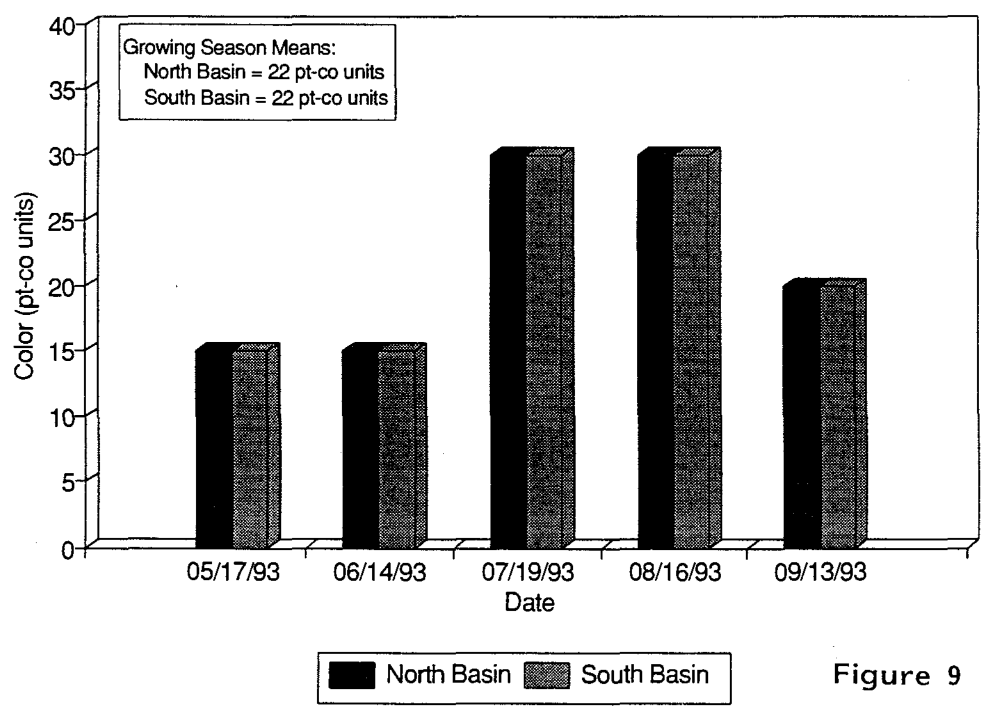


Figure 9

Big Wood Lake - 1993 Conditions
Total Nitrogen : Total Phosphorus

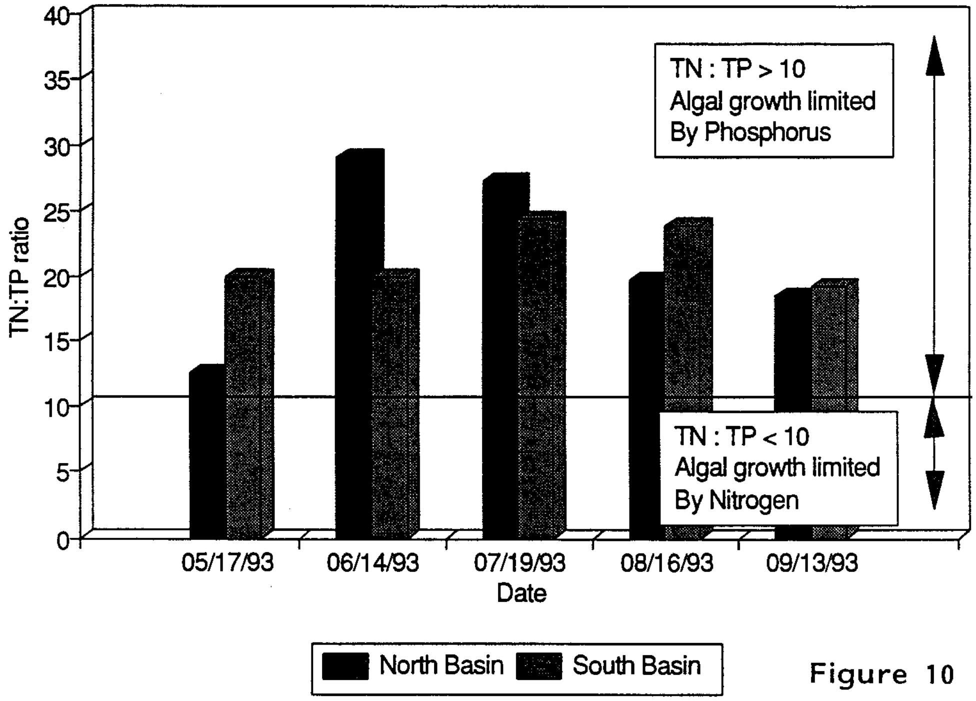


Figure 10

Big Wood Lake - 1993 Conditions
North Basin Total Phosphorus

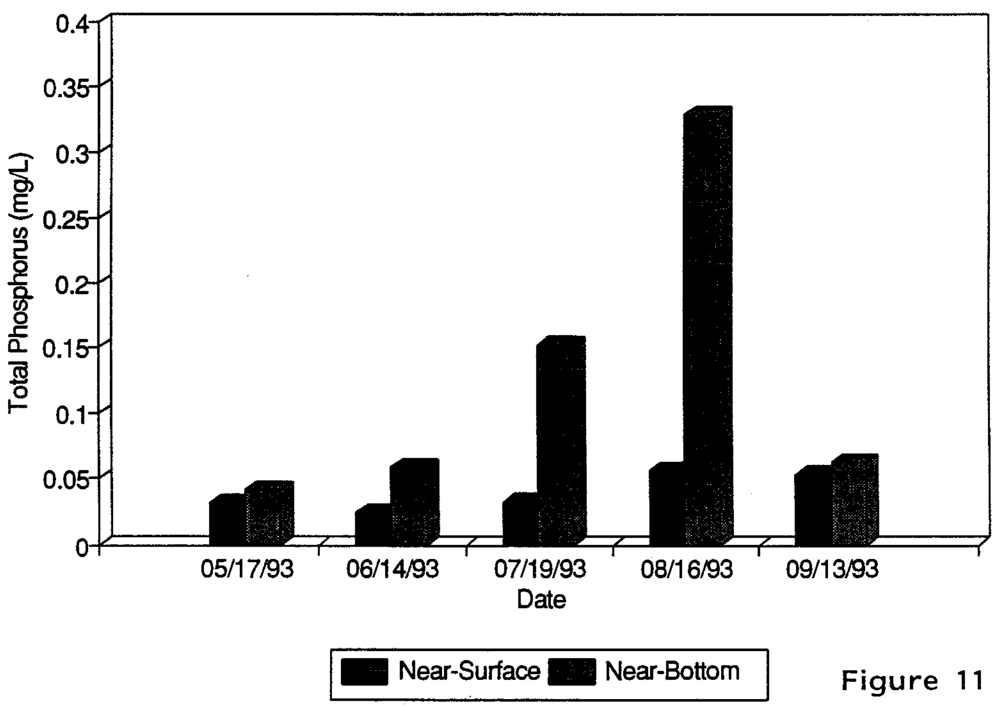


Figure 11

Big Wood Lake - 1993 Conditions
South Basin Total Phosphorus

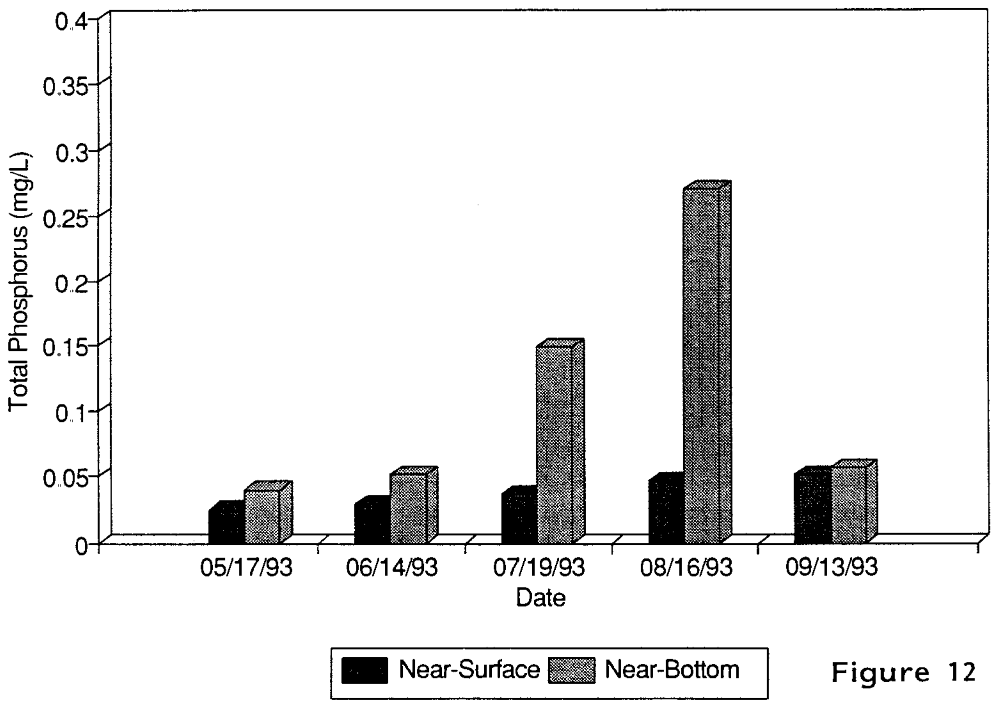


Figure 12

Big Wood Lake - 1993 Conditions
Total Phosphorus

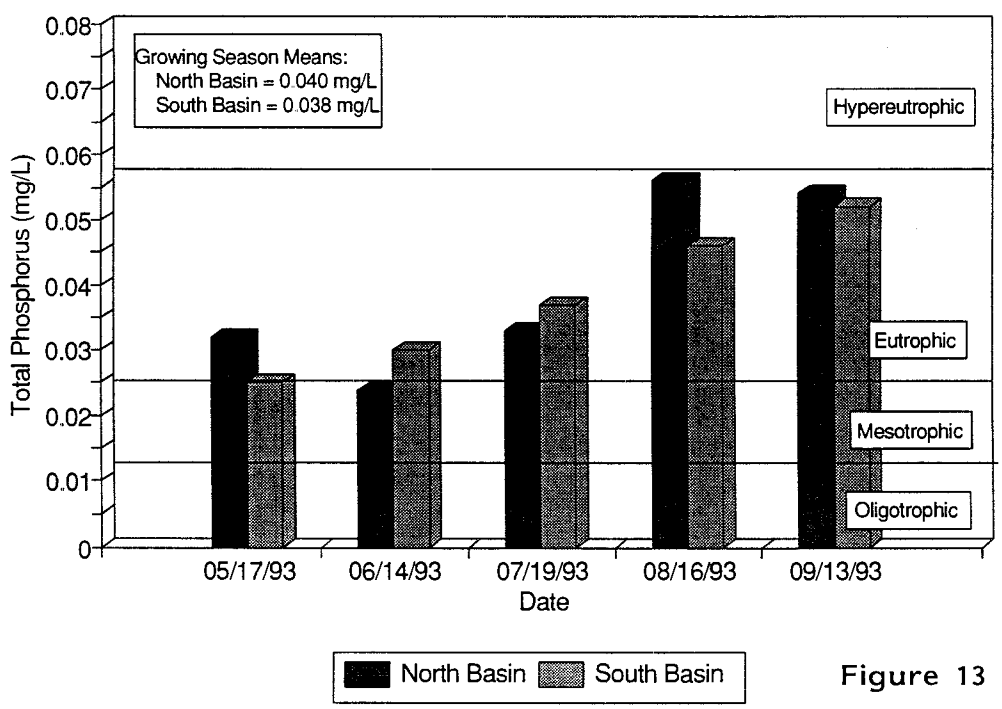


Figure 13

Big Wood Lake - 1993 Conditions
Chlorophyll a

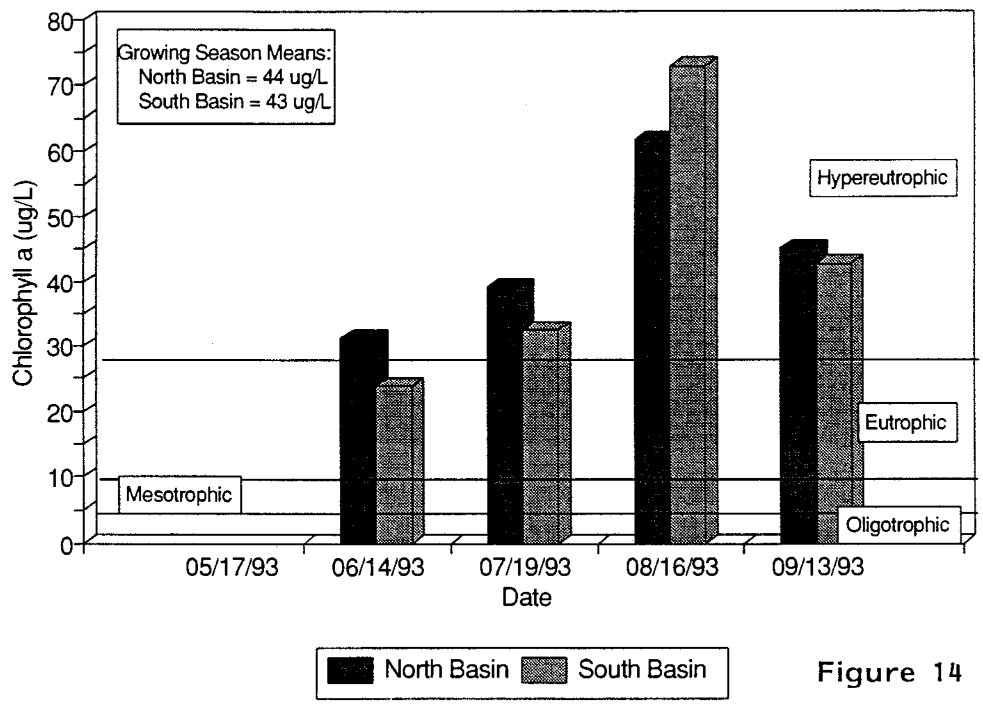


Figure 14

Big Wood Lake - 1993 Conditions
Secchi Disc Transparency

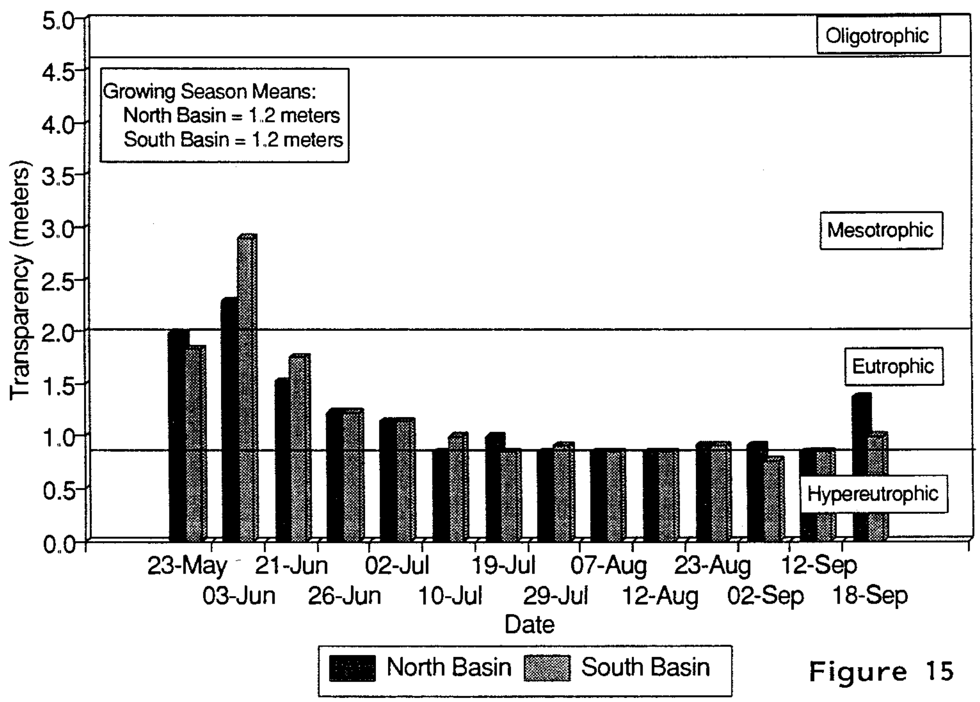


Figure 15

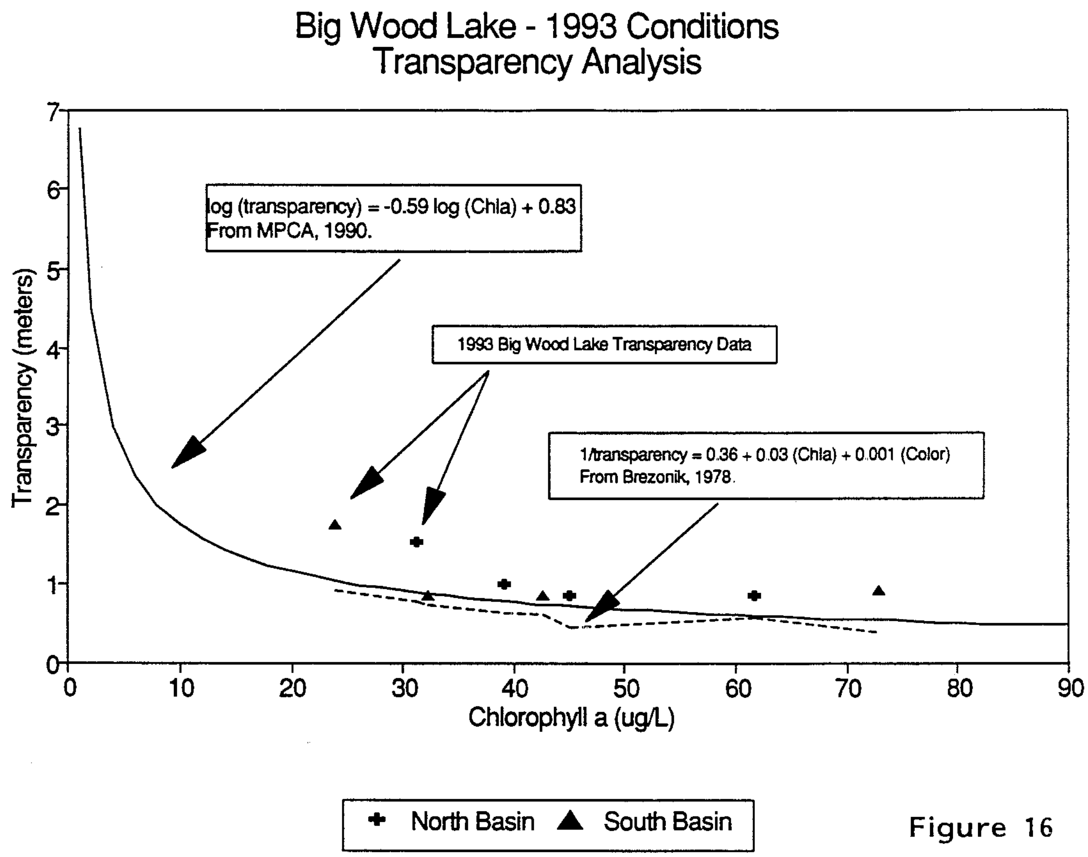


Figure 16

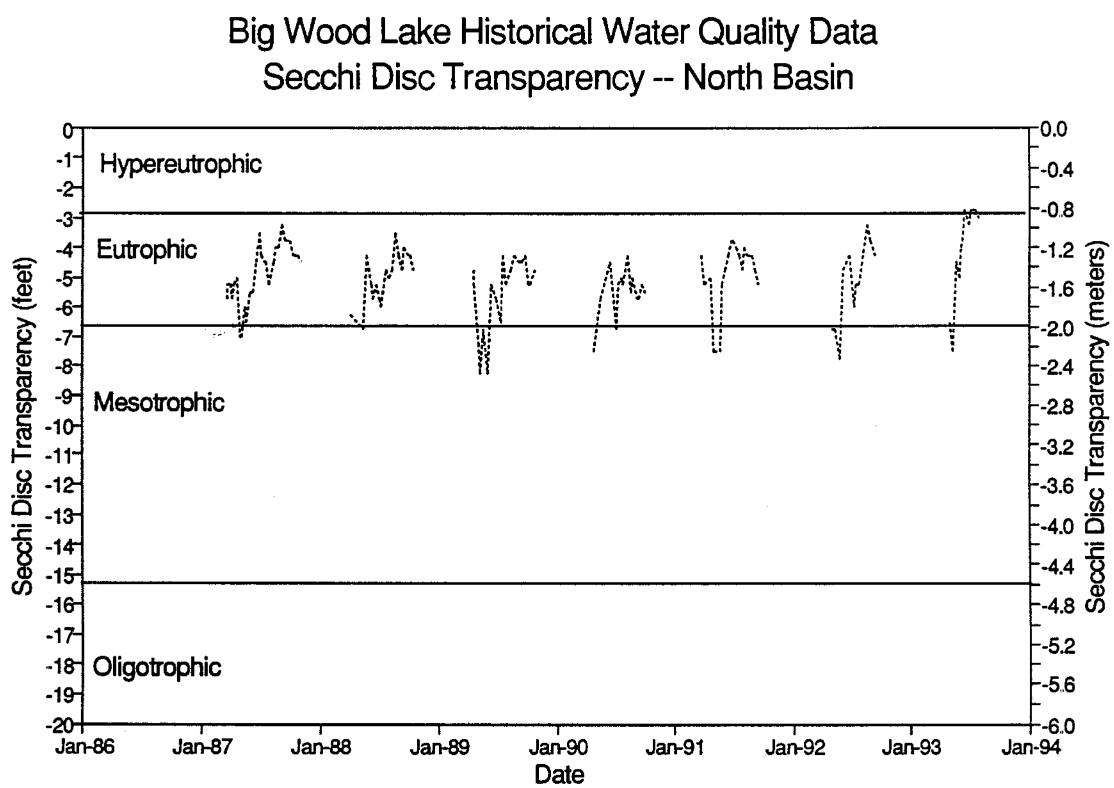


Figure 17

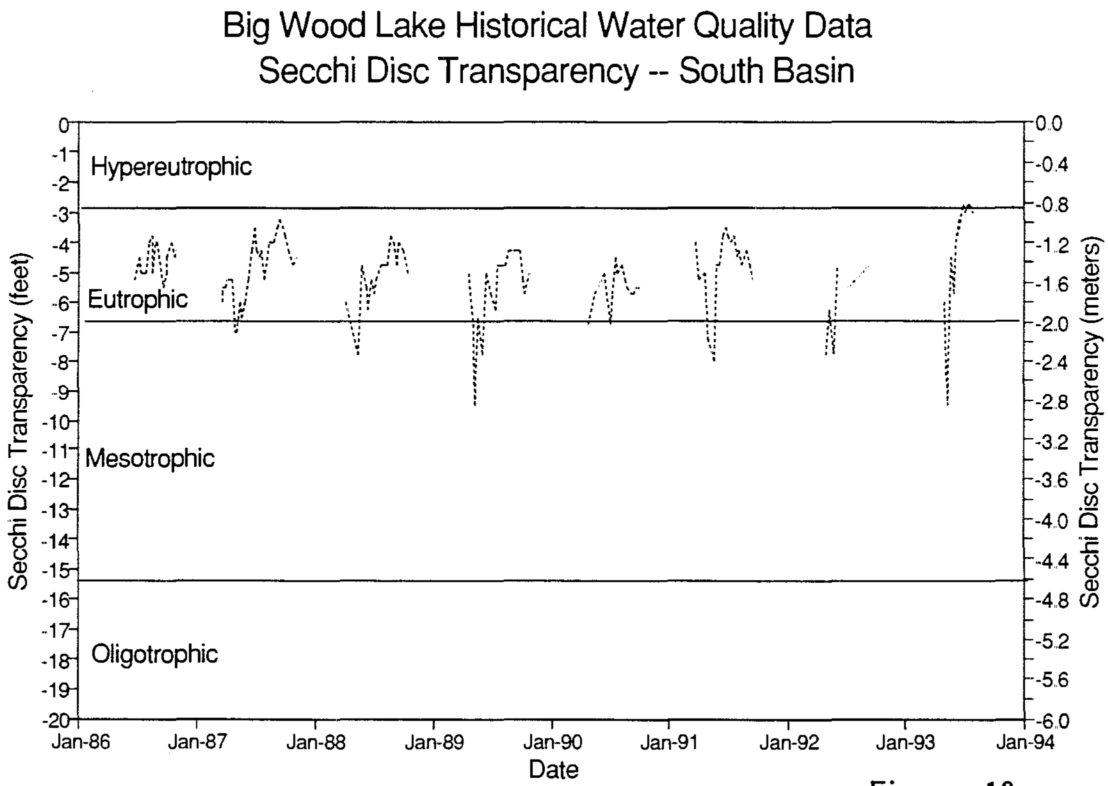
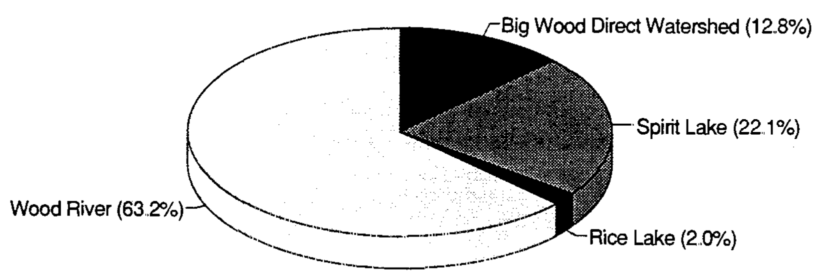


Figure 18

Big Wood Lake -- Results of MINLEAP Modelling
Calculated Water Loads

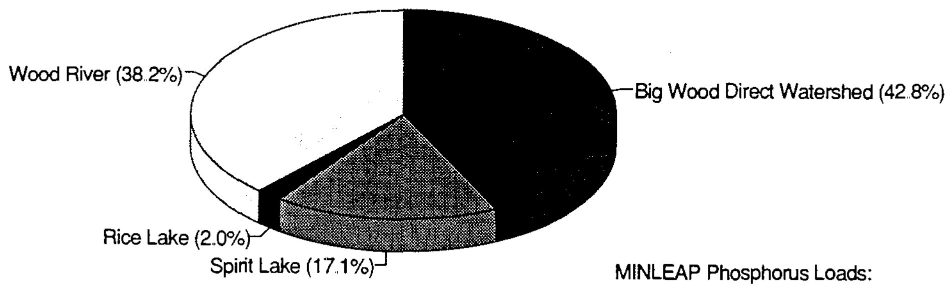


MINLEAP Water Loads:
Big Wood Lake Direct = 1,960 acre-feet
Wood River = 9,700 acre-feet
Rice Lake = 300 acre-feet
Spirit Lake = 3,380 acre-feet

Total = 15,300 acre-feet

Figure 19

Big Wood Lake -- Results of MINLEAP Modelling
Calculated Phosphorus Loads



MINLEAP Phosphorus Loads:
Big Wood Lake Direct = 410 kg
Wood River = 370 kg
Rice Lake = 20 kg
Spirit Lake = 160 kg

Total = 960 kg

Figure 20

Big Wood Lake -- Watershed Evaluation
Comparison of Lake Level and Precipitation

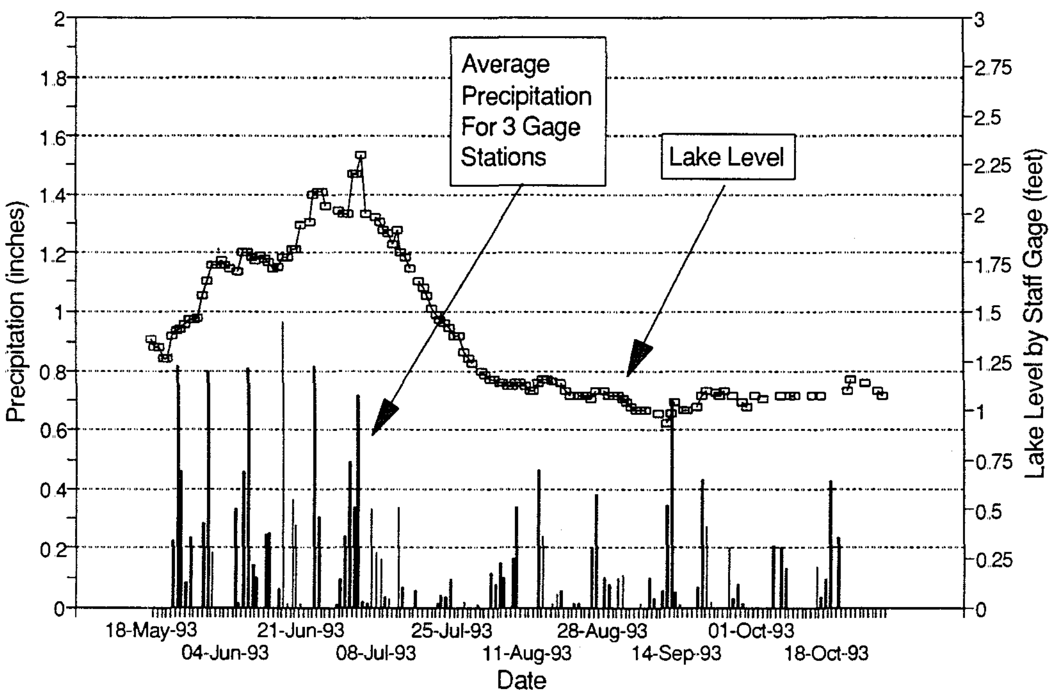
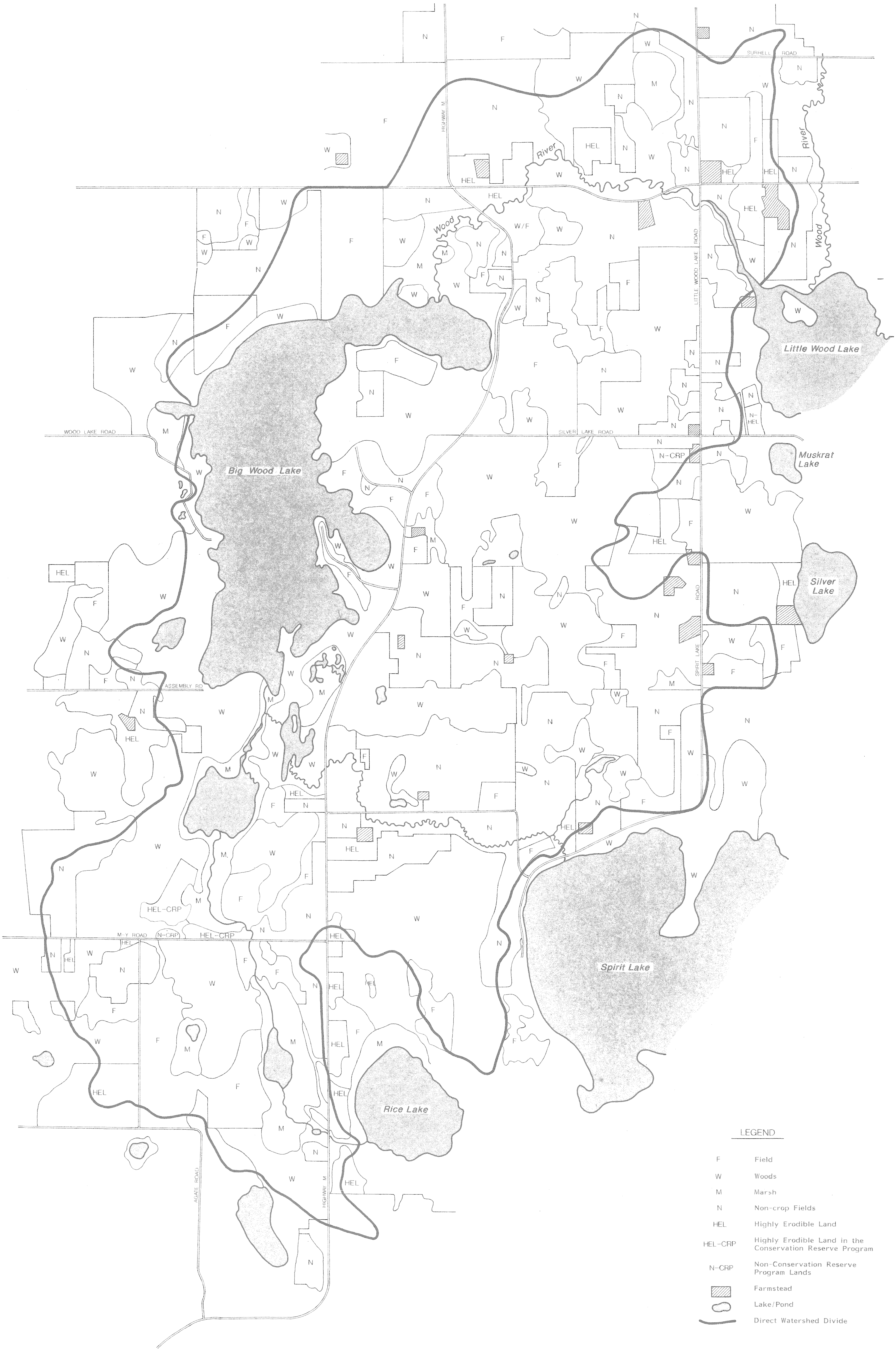


Figure 21



SOURCE: 1990 Aerial Photography
Burnett County Land Conservation Department

0 1000 2000
Scale in Feet

FIGURE 22

BIG WOOD LAKE

DIRECT WATERSHED LAND USE MAP

WISCONSIN LAKE PLANNING GRANT PROGRAM

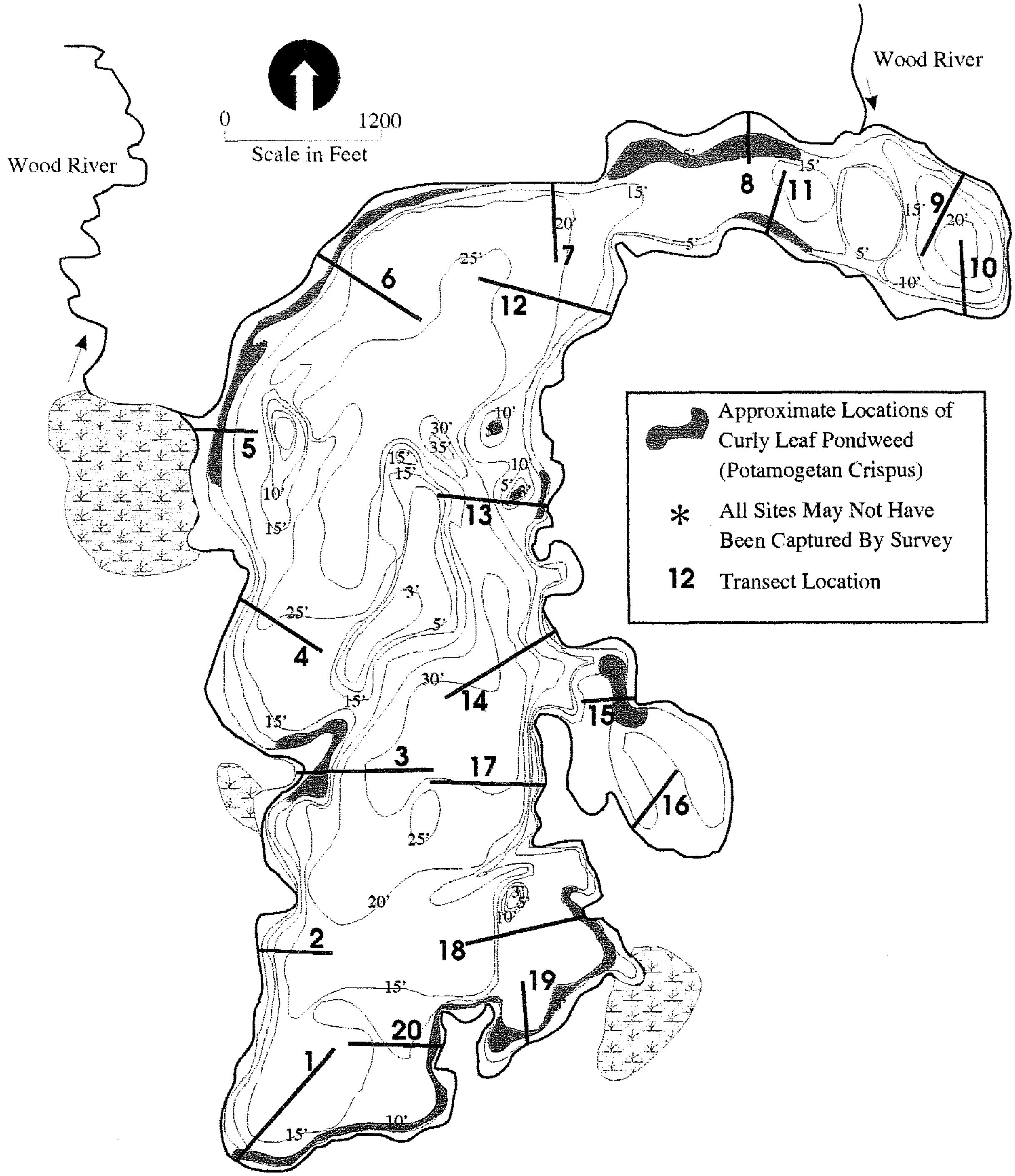


Figure 23

BIG WOOD LAKE
JUNE 1993 MACROPHYTE SURVEY TRANSECT LOCATIONS
AND
CURLY LEAF PONDWEED LOCATIONS

Appendices

Appendix A

APPENDIX A

WATER QUALITY MODELING METHODOLOGY

The water and nutrient budgets for Big Wood Lake were estimated using MINLEAP (Minnesota Lake Eutrophication Analysis Procedure), developed by the Minnesota Pollution Control Agency (MPCA, 1990). Using lake morphometry and ecoregion location information, MINLEAP predicts the water quality of a lake in its "natural" state using a phosphorus mass balance model developed by Canfield and Bachmann (1981). The water quality predicted by MINLEAP is compared with the observed water quality, and an assessment can be made as to whether the lake has suffered from negative impacts. MINLEAP is intended to be used as a first level assessment of lakes when little or no field measurements have been taken within the watershed. The intent of the modeling effort was to provide an estimate of the relative distribution of phosphorus and water loading into the lake.

Due to the inflows of the Wood River and Spirit Creek, Big Wood Lake has a large, extended watershed. The water quality of the upstream lakes in the watershed will have an influence on that of Big Wood Lake, and were, therefore, included in the model. The watershed flow chart used in the MINLEAP modeling is displayed on Figure A1. The summary of the lake water quality calculations used in the modeling are displayed in Tables A1 and A2.

Table A1. Results of Phosphorus Mass Balance Analyses and Lake Water Quality Calculations Compared to Current Water Quality in Big Wood Lake Watershed

Lake	Current Conditions			Best Land Management Conditions*		
	[P] (mg/L)	[Chl a] (μg/L)	Secchi Disc Transparency (m)	[P] (mg/L)	[Chl a] (μg/L)	Secchi Disc Transparency (m)
Big Wood Lake	0.039	44	1.2	0.028	10	2.00
Spirit Lake	--	--	1.7	0.048	19	1.38
Rice Lake	--	--	--	0.052	21	1.28
Little Wood Lake	--	--	1.5	0.031	10	2.00
Dunham Lake	--	--	2.1	0.056	24	1.20
Hawthorn Lake	--	--	--	0.094	51	0.77
Fern Lake	--	--	--	0.097	53	0.75

[P] = Phosphorus concentration (mg/L), observed or predicted by mass balance modeling techniques (MPCA, 1990).

[Chl a] = Chlorophyll a concentration (μg/L), observed or predicted from MPCA, 1990.

Transparency = Secchi disc transparency (m), observed or predicted from MPCA, 1990.

(--) = Insufficient data

* Minimally impacted North Central Hardwood Forest Lake (per MINLEAP; MPCA, 1990).

Table A2. Summary of Lake Water Quality Calculations

	Lake Dimensions (units)		Water Quality Model Parameters (Units)					
Lake	V (ac-ft)	A (acres)	L ($g/m^2/yr$)	q_s (m/yr)	R_p	$\bar{z}$ (m)	θ (yr)	[P] (mg/L)
Big Wood Lake	10,496[1]	529.5	0.45	8.8	0.45	6.0	1.5	0.028[4]
Spirit Lake	6,700[1]	596.4	0.23	1.7	0.71	3.4	0.5	0.039[5]
Rice Lake	520[2]	86.8	0.18	1.1	0.69	1.8[3]	0.6	0.052[4]
Little Wood Lake	2,400[1]	205.0	0.62	14.4	0.30	3.6	4.0	0.031[5]
Dunham Lake	7,400[1]	232.7	0.48	10.4	0.60	9.8	1.1	0.018[5]
Hawthorn Lake	68[2]	11.4	1.7	11.5	0.37	1.8[3]	6.4	0.094[4]
Fern Lake	137[2]	22.8	2.0	13.2	0.35	1.8[3]	7.3	0.097[4]

V = Lake volume (acre-feet)
A = Lake surface area (acres)
L = Areal phosphorus loading rate ($g/m^2/yr$)
q_s = Lake overflow rate (m/yr)
R_p = Phosphorus retention coefficient (dimensionless)
$\bar{z}$ = Average lake depth (m)
θ = Mean hydraulic residence time (years)
[P] = Phosphorus concentration

[1] Determined by planimetry of bathymetric map.
[2] Calculated from surface area and assumed mean depth.
[3] Assumed
[4] MINLEAP output (MPCA, 1990).
[5] Estimated from Secchi disc field measurements.

Appendix B

APPENDIX B

MACROPHYTE SURVEY METHODOLOGY AND RESULTS

The methodology for the macrophyte survey was developed from the grid sampling method of Jessen and Lound (1962). The survey transect locations were tentatively determined on a base map of Big Wood Lake prior to the June survey. Approximately 20 transects were established by dividing the shoreline distance by 20 to determine the unit distance between transects. Each of the 20 transects were drawn on the map, equidistant from one another and perpendicular to the shoreline. Using the tentative survey transects, final transects were determined in the field by establishing a landmark or reference point for each transect. The compass bearing for each transect was recorded on field data sheets, and a photograph was taken of each landmark or reference point (see Figure B1). The final transect selection was made based on information provided by the Big Wood Lake Association to avoid locations treated with aquatic herbicides. The length of each transect was then determined. Sampling personnel proceeded perpendicular to the shoreline along the transect until macrophyte growth stopped - the end of the transect corresponds to the maximum depth of macrophyte growth. Once the transect length was determined, sampling points along the transect were chosen randomly, using the following criteria:

- One location between 0 and 0.5 meters deep
- One location between 0.5 and 1.5 meters deep
- One location between 1.5 and 3.0 meters deep
- One location between 3.0 and 6.0 meters deep
- One location greater than 6.0 meters if plants are present

Sampling began near the shoreline, and proceeded to the end of the transect. Each sampling point consisted of a 6 foot diameter circle, divided into four quadrants. Each quadrant was sampled using a garden rake with an extended handle, which was cast and retrieved four times in each quadrant. The following information was recorded on field sheets for each plant species retrieved:

- The transect
- Depth class

- Sampling depth
- Species name
- Species density rating

The species density rating was based on the presence of macrophytes on the rake tines using the following criteria:

Rake Recovery of Species	Density Rating
Rake teeth full during all four casts	5
Rake teeth partly full during all four cast	4
Found on rake teeth 3 of 4 casts	3
Found on rake teeth 2 of 4 casts	2
Found on rake teeth 1 of 4 casts	1

At the conclusion of the two surveys, a map was prepared indicating the locations of each transect; the species of plants found along each transect, and the abundance of each plant species based on the above rankings were tabulated and are listed in Tables B1 and B2. The map is presented on Figure 1. Other miscellaneous field notes and compass directions are included in this appendix, in Tables B3 through B7. Photographs of the transects are presented in Figure B-1.

TABLE B1
LONG-TERM TREND LAKE MACROPHYTE DATA
SAMPLE POINT DATA

LAKE NAME: Big Wood Lake

COUNTY NAME: Burnett

DATE: June 14, 1993

NOTE TAKER: MRH

FIELD CREW: MRH, Roger Reid

TRANSECT	DEPTH CODE	DEPTH (FT.)	SUBSTRATE	SPECIES/DENSITY RATING (COMMON NAME)
1	3	8	Sand/mud	*Ceratophyllum demersum*/4 (Coontail)
				Potamogeton zosteriformis/2 (Flatstem pondweed)
				Elodea canadensis/2 (Canada waterweed)
	2	4	Sand/mud	*Elodea canadensis*/2 (Canada waterweed)
				Potamogeton zosteriformis/2 (Flatstem pondweed)
				Ceratophyllum demersum/4 (Coontail)
				Potamogeton crispus/3 (Curlyleaf pondweed)
				Myrrophyllum exalbescens/3 (Native water milfoil)
	1	1.5	Sand/mud	*Myrrophyllum exalbescens*/1 (Native water milfoil)
				Potamogeton crispus/2 (Curlyleaf pondweed)
				Potamogeton richardsonii/1 (Claspingleaf pondweed)
2	3	8	Sand	*Elodea canadensis*/1 (Canada waterweed)
				Ceratophyllum demersum/4 (Coontail)
				Potamogeton zostoniformis/1 (Flatstem pondweed)
				Myrrophyllum exalbescens/2 (Native water milfoil)
	2	4	Sand	*Ceratophyllum demersum*/1 (Coontail)
				Potamogeton zostoniformis/1 (Flatstem pondweed)
	1	1	Sand	No macrophytes found
3	3	8	Sand	*Ceratophyllum demersum*/4 (Coontail)
				Potamogeton zostoniformis/2 (Flatstem pondweed)
				Potamogeton crispus/2 (Curlyleaf pondweed)
				Myrrophyllum exalbescens/1 (Native water milfoil)
	2	4	Sand	*Potamogeton zostoniformis*/2 (Flatstem pondweed)
				Potamogeton richardsonii/3 (Claspingleaf pondweed)
				Potamogeton crispus/1 (Curlyleaf pondweed)
				Chara sp./3 (Muskgrass)
	1	1	Sand/rock	No macrophytes found

TABLE B1 (cont.)
LONG-TERM TREND LAKE MACROPHYTE DATA
SAMPLE POINT DATA

LAKE NAME: Big Wood Lake

COUNTY NAME: Burnett

DATE: 6/14/93

NOTE TAKER: MRH

FIELD CREW: MRH, Roger Reid

TRANSECT	DEPTH CODE	DEPTH (FT.)	SUBSTRATE	SPECIES/DENSITY RATING (COMMON NAME)
4	3	9	Sand/rock	*Ceratophyllum demersum*/3 (Coontail)
	2	4	Sand/rock	*Ceratophyllum demersum*/3 (Coontail)
				Chara sp./2 (Muskgrass)
				Myrrophyllum exalbescens/1 (Native water milfoil)
	1	1.5	Sand	*Potamogeton zostoniformis*/1 (Flatstem pondweed)
				Potamogeton richardsonii/1 (Claspingleaf pondweed)
5	3	9	Sand	*Ceratophyllum demersum*/2 (Coontail)
				Potamogeton crispus/2 (Curlyleaf pondweed)
	2	4	Sand	*Potamogeton richardsonii*/1 (Claspingleaf pondweed)
				Ceratophyllum demersum/4 (Coontail)
				Potamogeton amplifolius/2 (Largeleaf pondweed)
	1	1	Sand	*Ceratophyllum demersum*/1 (Coontail)
6	3	8	Sand/mud	*Potamogeton crispus*/4 (Curlyleaf pondweed)
				Ceratophyllum demersum/5 (Coontail)
	2	4	Sand	*Chara sp.*/2 (Muskgrass)
				Ceratophyllum demersum/2 (Coontail)
				Elodea canadensis/1 (Canada waterweed)
				Myrrophyllum exalbescens/1 (Native water milfoil)
	1	1.5	Sand	No macrophytes found
7	3	9	Sand	*Ceratophyllum demersum*/4 (Coontail)
				Potamogeton crispus/3 (Curlyleaf pondweed)
				Myrrophyllum exalbescens/4 (Native water milfoil)
				Potamogeton zostoniformis/1 (Flatstem pondweed)
				Chara sp./1 (Muskgrass)
	2	4	Sand	*Chara sp.*/4 (Muskgrass)
	1	1.5	Sand	*Chara sp.*/1 (Muskgrass)
8	3	9	Mud	*Ceratophyllum demersum*/5 (Coontail)

TABLE B1 (cont.)
LONG-TERM TREND LAKE MACROPHYTE DATA
SAMPLE POINT DATA

LAKE NAME: Big Wood Lake

COUNTY NAME: Burnett

DATE: 6/14/93

NOTE TAKER: MRH

FIELD CREW: MRH, Roger Reid

TRANSECT	DEPTH CODE	DEPTH (FT.)	SUBSTRATE	SPECIES/DENSITY RATING (COMMON NAME)
				Potamogeton crispus/3 (Curlyleaf pondweed)
				Ranunculus sp./1 (Water buttercup)
				Potamogeton zostoniformis/1 (Flatstem pondweed)
				Elodea canadensis/1 (Canada waterweed)
	2	4	Mud	*Elodea canadensis*/4 (Canada waterweed)
				Ceratophyllum demersum/5 (Coontail)
	1	1.5	Mud	*Ceratophyllum demersum*/5 (Coontail)
				Potamogeton zostoniformis/5 (Flatstem pondweed)
9	3	8	Mud	*Ceratophyllum demersum*/5 (Coontail)
				Myrrophyllum exalbescens/2 (Native water milfoil)
				Potamogeton zostoniformis/2 (Flatstem pondweed)
	2	4	Mud	*Elodea canadensis*/3 (Canada waterweed)
				Potamogeton zostoniformis/4 (Flatstem pondweed)
				Potamogeton amplifolius/2 (Largeleaf pondweed)
				Ceratophyllum demersum/4 (Coontail)
				Myrrophyllum exalbescens/3 (Native water milfoil)
	1	1	Sand	*Ceratophyllum demersum*/1 (Coontail)
10	3	8	Mud	*Ceratophyllum demersum*/4 (Coontail)
				Myrrophyllum exalbescens/4 (Native water milfoil)
				Potamogeton zostoniformis/1 (Flatstem pondweed)
	2	3	Mud	*Elodea canadensis*/3 (Canada waterweed)
				Potamogeton nodosus/2 (River pondweed)
	1	1	Sand/mud	No macrophytes found
11	3	9	Mud	*Ceratophyllum demersum*/4 (Coontail)
				Myrrophyllum exalbescens/3 (Native water milfoil)
				Potamogeton crispus/2 (Curlyleaf pondweed)
	2	4	Mud	*Myrrophyllum exalbescens*/4 (Native water milfoil)

TABLE B1 (cont.)
LONG-TERM TREND LAKE MACROPHYTE DATA
SAMPLE POINT DATA

LAKE NAME: Big Wood Lake COUNTY NAME: Burnett

DATE: 6/14/93

NOTE TAKER: MRH FIELD CREW: MRH, Roger Reid

TRANSECT	DEPTH CODE	DEPTH (FT.)	SUBSTRATE	SPECIES/DENSITY RATING (COMMON NAME)
				Potamogeton crispus/2 (Curlyleaf pondweed)
				Elodea canadensis/2 (Canada waterweed)
				Ranunculus sp./1 (Water buttercup)
	1	1.5	Sand/mud	*Potamogeton crispus*/1 (Curlyleaf pondweed)
12	3	8	Sand/mud	*Ceratophyllum demersum*/4 (Coontail)
				Myrrophyllum exalbescens/1 (Native water milfoil)
	2	4	Sand/mud	*Ceratophyllum demersum*/2 (Coontail)
				Myrrophyllum exalbescens/4 (Native water milfoil)
				Potamogeton zostoniformis/1 (Flatstem pondweed)
	1	1	Sand/mud	No macrophytes found
13	3	8	Sand/rock	*Ceratophyllum demersum*/3 (Coontail)
	2	3	Sand	*Elodea canadensis*/2 (Canada waterweed)
				Myrrophyllum exalbescens/4 (Native water milfoil)
				Potamogeton zostoniformis/1 (Flatstem pondweed)
				Potamogeton crispus/1 (Curlyleaf pondweed)
				Chara sp./3 (Muskgrass)
	1	1	Sand/rock	*Potamogeton crispus*/1 (Curlyleaf pondweed)
14	3	8	Sand/rock	*Ceratophyllum demersum*/3 (Coontail)
	2	4	Sand/rock	*Ceratophyllum demersum*/3 (Coontail)
				Myrrophyllum exalbescens/3 (Native water milfoil)
				Potamogeton nodosus/1 (River pondweed)
				Potamogeton zostoniformis/2 (Flatstem pondweed)
				Elodea canadensis/2 (Canada waterweed)
	1	1	Sand	No macrophytes found
15	3	7	Mud	*Ceratophyllum demersum*/5 (Coontail)
				Potamogeton crispus/2 (Curlyleaf pondweed)
	2	4	Mud	*Elodea canadensis*/3 (Canada waterweed)

TABLE B1 (cont.)
LONG-TERM TREND LAKE MACROPHYTE DATA
SAMPLE POINT DATA

LAKE NAME: Big Wood Lake

COUNTY NAME: Burnett

DATE: 6/14/93

NOTE TAKER: MRH

FIELD CREW: MRH, Roger Reid

TRANSECT	DEPTH CODE	DEPTH (FT.)	SUBSTRATE	SPECIES/DENSITY RATING (COMMON NAME)
				Potamogeton crispus/1 (Curlyleaf pondweed)
	1	1.5	Mud	*Elodea canadensis*/2 (Canada waterweed)
				Ceratophyllum demersum/2 (Coontail)
16	3	6	Mud	*Ceratophyllum demersum*/5 (Coontail)
	2	4	Mud	*Potamogeton natans*/1 (Floatingleaf pondweed)
				Ceratophyllum demersum/4 (Coontail)
				Potamogeton zostoniformis/4 (Flatstem pondweed)
				Myrrophyllum exalbescens/2 (Native water milfoil)
	1	1.5	Mud	*Ceratophyllum demersum*/3 (Coontail)
17	3	9	Sand/rock	*Ceratophyllum demersum*/5 (Coontail)
	2	4	Sand/rock	*Ceratophyllum demersum*/2 (Coontail)
				Myrrophyllum exalbescens/2 (Native water milfoil)
	1	1.5	Sand	*Potamogeton richardsonii*/1 (Claspingleaf pondweed)
18	3	9	Rocky	*Ceratophyllum demersum*/4 (Coontail)
				Potamogeton crispus/2 (Curlyleaf pondweed)
	2	4	Rocky	*Potamogeton amplifolius*/2 (Largeleaf pondweed)
				Myrrophyllum exalbescens/2 (Native water milfoil)
				Potamogeton zostoniformis/3 (Flatstem pondweed)
	1	1	Rocky	No macrophytes found
19	3	9	Mud	*Ceratophyllum demersum*/4 (Coontail)
				Potamogeton crispus/2 (Curlyleaf pondweed)
	2	4	Sand/Mud	*Ceratophyllum demersum*/4 (Coontail)
				Potamogeton zostoniformis/3 (Flatstem pondweed)
				Ranunculus sp./1 (Water buttercup)
				Elodea canadensis/2 (Canada waterweed)
	1	1	Sand	*Ceratophyllum demersum*/1 (Coontail)
20	3	9	Sand	*Potamogeton crispus*/4 (Curlyleaf pondweed)

TABLE B1 (cont.)
LONG-TERM TREND LAKE MACROPHYTE DATA
SAMPLE POINT DATA

LAKE NAME: Big Wood Lake

COUNTY NAME: Burnett

DATE: 6/14/93

NOTE TAKER: MRH

FIELD CREW: MRH, Roger Reid

TRANSECT	DEPTH CODE	DEPTH (FT.)	SUBSTRATE	SPECIES/DENSITY RATING (COMMON NAME)
				Ceratophyllum demersum/4 (Coontail)
				Potamogeton zostoniformis/2 (Flatstem pondweed)
	2	5	Sand	*Myrrophyllum exalbescens*/3 (Native water milfoil)
				Potamogeton richardsonii/3 (Claspingleaf pondweed)
				Ceratophyllum demersum/1 (Coontail)
	1	1	Sand	*Potamogeton richardsonii*/1 (Claspingleaf pondweed)

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TABLE B2
LONG-TERM TREND LAKE MACROPHYTE DATA
SAMPLE POINT DATA

LAKE NAME: Big Wood Lake

COUNTY NAME: Burnett

DATE: August 16, 1993

NOTE TAKER: MRH

FIELD CREW: Tom Gizwald
MRH

TRANSECT	DEPTH CODE	DEPTH (FT.)	SUBSTRATE	SPECIES/DENSITY RATING (COMMON NAME)
1	3	7	Sand/mud	*Ceratophyllum demersum*/4 (Coontail)
				Potamogeton zostoniformis/2 (Flatstem pondweed)
				Myrrophyllum exalbescens/2 (Native water milfoil)
	2	3	Sand/mud	*Myrrophyllum exalbescens*/4 (Native water milfoil)
				Ranunculus sp./1 (Water buttercup)
				Ceratophyllum demersum/4 (Coontail)
				Potamogeton zostoniformis/2 (Flatstem pondweed)
	1	1	Sand/mud	*Heterathera dubia*/3 (Mud plantain)
				Najas sp./2 (Naiad/Pondweed)
				Myrrophyllum exalbescens/2 (Native water milfoil)
2	3	7	Sand	*Ceratophyllum demersum*/3 (Coontail)
				Myrrophyllum exalbescens/2 (Native water milfoil)
				Vallisneria americana/1 (Wild celery)
				Najas sp./1 (Naiad/Pondweed)
	2	3	Sand	*Najas sp.*/3 (Naiad/Pondweed)
				Chara sp./4 (Muskgrass)
				Ranunculus sp./1 (Water buttercup)
				Vallisneria americana/2 (Wild celery)
	1	1	Sand	*Najas sp.*/3 (Naiad/Pondweed)
3	3	7	Sand/mud	*Ceratophyllum demersum*/4 (Coontail)
				Myrrophyllum exalbescens/3 (Native water milfoil)
				Potamogeton zostoniformis/3 (Flatstem pondweed)
	2	3	Sand/mud	*Vallisneria americana*/3 (Wild celery)
				Myrrophyllum exalbescens/3 (Native water milfoil)
				Potamogeton zostoniformis/3 (Flatstem pondweed)
				Ceratophyllum demersum/3 (Coontail)
				Potamogeton richardsonii/1 (Claspingleaf pondweed)

TABLE B2 (cont.)
LONG-TERM TREND LAKE MACROPHYTE DATA
SAMPLE POINT DATA

LAKE NAME: Big Wood Lake

COUNTY NAME: Burnett

DATE: 8/16/93

NOTE TAKER: MRH

FIELD CREW: Tom Gizwald
MRH

TRANSECT	DEPTH CODE	DEPTH (FT.)	SUBSTRATE	SPECIES/DENSITY RATING (COMMON NAME)
				Ranunculus sp./1 (Water buttercup)
				Chara sp./2 (Muskgrass)
	1	1	Sand/rock	*Chara sp.*/3 (Muskgrass)
				Najas sp./3 (Naiad/Pondweed)
4	3	7	Sand/rock	*Myrrophyllum exalbescens*/3 (Native water milfoil)
				Vallisneria americana/1 (Wild celery)
				Potamogeton zostoniformis/1 (Flatstem pondweed)
				Ceratophyllum demersum/1 (Coontail)
	2	4	Sand/rock	*Ceratophyllum demersum*/1 (Coontail)
				Vallisneria americana/3 (Wild celery)
				Chara sp./2 (Muskgrass)
				Najas sp./3 (Naiad/Pondweed)
	1	1	Sand	*Potamogeton richardsonii*/2 (Claspingleaf pondweed)
				Ceratophyllum demersum/1 (Coontail)
				Chara sp./2 (Muskgrass)
				Potamogeton pectinatus/1 (Sago pondweed)
				Najas sp./3 (Naiad/Pondweed)
5	3	8	Sand	*Ceratophyllum demersum*/4 (Coontail)
				Myrrophyllum exalbescens/3 (Native water milfoil)
				Vallisneria americana/2 (Wild celery)
				Potamogeton zostoniformis/2 (Flatstem pondweed)
	2	3	Sand	*Chara sp.*/1 (Muskgrass)
				Vallisneria americana/2 (Wild celery)
				Potamogeton richardsonii/2 (Claspingleaf pondweed)
				Ceratophyllum demersum/4 (Coontail)
				Myrrophyllum exalbescens/3 (Native water milfoil)
				Ranunculus sp./1 (Water buttercup)

TABLE B2 (cont.)
LONG-TERM TREND LAKE MACROPHYTE DATA
SAMPLE POINT DATA

LAKE NAME: Big Wood Lake

COUNTY NAME: Burnett

DATE: 8/16/93

NOTE TAKER: MRH

FIELD CREW: Tom Gizwald
MRH

TRANSECT	DEPTH CODE	DEPTH (FT.)	SUBSTRATE	SPECIES/DENSITY RATING (COMMON NAME)
				Heterathera dubia/2 (Mud plantain)
				Potamogeton zostoniformis/2 (Flatstem pondweed)
	1	1	Sand	No macryphytic found
6	3	6	Sand/mud	*Ceratophyllum demersum*/5 (Coontail)
				Myrrophyllum exalbescens/4 (Native water milfoil)
				Potamogeton zostoniformis/1 (Flatstem pondweed)
				Vallisneria americana/2 (Wild celery)
	2	3	Sand	*Ceratophyllum demersum*/2 (Coontail)
				Vallisneria americana/2 (Wild celery)
				Elodea canadensis/1 (Canada waterweed)
				Chara sp./4 (Muskgrass)
				Potamogeton zostoniformis/1 (Flatstem pondweed)
	1	1	Sand	*Chara sp.*/4 (Muskgrass)
				Ceratophyllum demersum/4 (Coontail)
				Najas sp./4 (Naiad/Pondweed)
7	3	8	Sand	*Myrrophyllum exalbescens*/3 (Native water milfoil)
				Elodea canadensis/2 (Canada waterweed)
				Vallisneria americana/3 (Wild celery)
				Chara sp./4 (Muskgrass)
				Potamogeton natans/1 (Floatingleaf pondweed)
				Potamogeton richardsonii/2 (Claspingleaf pondweed)
				Potamogeton zostoniformis/1 (Flatstem pondweed)
	2	3	Sand	*Najas sp.*/4 (Naiad/Pondweed)
				Elodea canadensis/3 (Canada waterweed)
				Ceratophyllum demersum/4 (Coontail)
				Vallisneria americana/2 (Wild celery)
	1	1	Sand	*Najas sp.*/4 (Naiad/Pondweed)

TABLE B2 (cont.)
LONG-TERM TREND LAKE MACROPHYTE DATA
SAMPLE POINT DATA

LAKE NAME: Big Wood Lake

COUNTY NAME: Burnett

DATE: 8/16/93

NOTE TAKER: MRH

FIELD CREW: Tom Gizwald
MRH

TRANSECT	DEPTH CODE	DEPTH (FT.)	SUBSTRATE	SPECIES/DENSITY RATING (COMMON NAME)
				Chara sp./4 (Muskgrass)
				Potamogeton richardsonii/2 (Claspingleaf pondweed)
8	3	7	Mud	*Ceratophyllum demersum*/5 (Coontail)
				Potamogeton zostoniformis/1 (Flatstem pondweed)
	2	4	Mud	*Ceratophyllum demersum*/5 (Coontail)
				Elodea canadensis/3 (Canada waterweed)
				Potamogeton zostoniformis/1 (Flatstem pondweed)
				Potamogeton pectinatus/2 (Sago pondweed)
				Myrrophyllum exalbescens/1 (Native water milfoil)
	1	1	Mud	*Ceratophyllum demersum*/5 (Coontail)
				Elodea canadensis/1 (Canada waterweed)
				Potamogeton zostoniformis/2 (Flatstem pondweed)
9	3	8	Mud	*Elodea canadensis*/1 (Canada waterweed)
				Myrrophyllum exalbescens/1 (Native water milfoil)
				Potamogeton zostoniformis/2 (Flatstem pondweed)
				Ceratophyllum demersum/5 (Coontail)
	2	4	Mud	*Ceratophyllum demersum*/5 (Coontail)
				Potamogeton zostoniformis/2 (Flatstem pondweed)
				Elodea canadensis/1 (Canada waterweed)
				Potamogeton natans/2 (Floatingleaf pondweed)
				Potamogeton pectinatus/2 (Sago pondweed)
	1	1	Sand/mud	*Vallisneria americana*/4 (Wild celery)
				Myrrophyllum exalbescens/3 (Native water milfoil)
				Ceratophyllum demersum/3 (Coontail)
10	3	7	Mud	*Ceratophyllum demersum*/5 (Coontail)
	2	3	Mud	*Elodea canadensis*/3 (Canada waterweed)
				Potamogeton zostoniformis/2 (Flatstem pondweed)

TABLE B2 (cont.)
LONG-TERM TREND LAKE MACROPHYTE DATA
SAMPLE POINT DATA

LAKE NAME: Big Wood Lake

COUNTY NAME: Burnett

DATE: 8/16/93

NOTE TAKER: MRH

FIELD CREW: Tom Gizwald
MRH

TRANSECT	DEPTH CODE	DEPTH (FT.)	SUBSTRATE	SPECIES/DENSITY RATING (COMMON NAME)
				Ceratophyllum demersum/4 (Coontail)
				Myrrophyllum exalbescens/3 (Native water milfoil)
				Potamogeton natans/2 (Floatingleaf pondweed)
				Najas sp./2 (Naiad/Pondweed)
				Vallisneria americana/3 (Wild celery)
				Potamogeton pectinatus/2 (Sago pondweed)
				Heterathera dubia/2 (Mud plantain)
	1	1	Mud	*Potamogeton natans*/4 (Floatingleaf pondweed)
				Ceratophyllum demersum/3 (Coontail)
				Ranunculus sp./1 (Water buttercup)
				Myrrophyllum exalbescens/2 (Native water milfoil)
11	3	8	Mud	*Ceratophyllum demersum*/3 (Coontail)
				Myrrophyllum exalbescens/2 (Native water milfoil)
	2	4	Mud	*Elodea canadensis*/2 (Canada waterweed)
				Myrrophyllum exalbescens/4 (Native water milfoil)
				Potamogeton pectinatus/1 (Sago pondweed)
				Potamogeton natans/1 (Floatingleaf pondweed)
	1	1	Mud	*Ceratophyllum demersum*/1 (Coontail)
				Elodea canadensis/1 (Canada waterweed)
				Chara sp./2 (Muskgrass)
12	3	8	Mud	*Ceratophyllum demersum*/5 (Coontail)
				Myrrophyllum exalbescens/3 (Native water milfoil)
				Potamogeton zostoniformis/2 (Flatstem pondweed)
	2	3	Mud	*Myrrophyllum exalbescens*/3 (Native water milfoil)
				Vallisneria americana/5 (Wild celery)
				Potamogeton natans/1 (Floatingleaf pondweed)
				Potamogeton zostoniformis/2 (Flatstem pondweed)

TABLE B2 (cont.)
LONG-TERM TREND LAKE MACROPHYTE DATA
SAMPLE POINT DATA

LAKE NAME: Big Wood Lake

COUNTY NAME: Burnett

DATE: 8/16/93

NOTE TAKER: MRH

FIELD CREW: Tom Gizwald
MRH

TRANSECT	DEPTH CODE	DEPTH (FT.)	SUBSTRATE	SPECIES/DENSITY RATING (COMMON NAME)
				Ceratophyllum demersum/2 (Coontail)
				Elodea canadensis/3 (Canada waterweed)
				Potamogeton richardsonii/2 (Claspingleaf pondweed)
	1	1	Mud	*Najas sp.*/1 (Naiad/Pondweed)
				Vallisneria americana/1 (Wild celery)
				Potamogeton richardsonii/1 (Claspingleaf pondweed)
13	3	7	Rocky	*Ceratophyllum demersum*/5 (Coontail)
				Myrrophyllum exalbescens/1 (Native water milfoil)
	2	4	Sand/rocky	*Ceratophyllum demersum*/4 (Coontail)
				Myrrophyllum exalbescens/4 (Native water milfoil)
				Chara sp./3 (Muskgrass)
				Elodea canadensis/1 (Canada waterweed)
				Potamogeton zostoniformis/1 (Flatstem pondweed)
				Potamogeton richardsonii/1 (Claspingleaf pondweed)
	1	1	Sand/rock	*Najas sp.*/3 (Naiad/Pondweed)
				Potamogeton pectinatus/1 (Sago pondweed)
14	3	8	Rocky	*Ceratophyllum demersum*/4 (Coontail)
				Myrrophyllum exalbescens/1 (Native water milfoil)
	2	3	Sand/rock	*Chara sp.*/3 (Muskgrass)
				Elodea canadensis/1 (Canada waterweed)
				Potamogeton zostoniformis/2 (Flatstem pondweed)
				Heterathera dubia/2 (Mud plantain)
				Potamogeton richardsonii/2 (Claspingleaf pondweed)
				Vallisneria americana/1 (Wild celery)
	1	1	Sand	*Najas sp.*/3 (Naiad/Pondweed)
				Myrrophyllum exalbescens/1 (Native water milfoil)
15	3	6	Mud	*Elodea canadensis*/3 (Canada waterweed)

TABLE B2 (cont.)
LONG-TERM TREND LAKE MACROPHYTE DATA
SAMPLE POINT DATA

LAKE NAME: Big Wood Lake

COUNTY NAME: Burnett

DATE: 8/16/93

NOTE TAKER: MRH

FIELD CREW: Tom Gizwald
MRH

TRANSECT	DEPTH CODE	DEPTH (FT.)	SUBSTRATE	SPECIES/DENSITY RATING (COMMON NAME)
				Ceratophyllum demersum/4 (Coontail)
				Myrrophyllum exalbescens/1 (Native water milfoil)
	2	3		*Ceratophyllum demersum*/4 (Coontail)
	1	1		*Najas sp.*/3 (Naiad/Pondweed)
16	3	7	Mud	*Ceratophyllum demersum*/4 (Coontail)
	2	3	Mud	*Ceratophyllum demersum*/4 (Coontail)
				Elodea canadensis/4 (Canada waterweed)
	1	1	Mud	*Ceratophyllum demersum*/5 (Coontail)
				Elodea canadensis/3 (Canada waterweed)
				Potamogeton zostoniformis/2 (Flatstem pondweed)
				Myrrophyllum exalbescens/2 (Native water milfoil)
17	3	8	Sand	*Ceratophyllum demersum*/5 (Coontail)
				Potamogeton zostoniformis/1 (Flatstem pondweed)
	2	4	Sand/rock	*Vallisneria americana*/4 (Wild celery)
				Potamogeton richardsonii/2 (Claspingleaf pondweed)
				Myrrophyllum exalbescens/3 (Native water milfoil)
				Potamogeton pectinatus/1 (Sago pondweed)
				Elodea canadensis/3 (Canada waterweed)
				Ceratophyllum demersum/2 (Coontail)
	1	1	Sand/rock	*Najas sp.*/4 (Naiad/Pondweed)
				Myrrophyllum exalbescens/1 (Native water milfoil)
18	3	7	Rock	*Ceratophyllum demersum*/4 (Coontail)
				Myrrophyllum exalbescens/4 (Native water milfoil)
	2	4	Rock	*Myrrophyllum exalbescens*/3 (Native water milfoil)
				Potamogeton natans/2 (Floatingleaf pondweed)
				Potamogeton amplifolius/2 (Largeleaf pondweed)
				Elodea canadensis/3 (Canada waterweed)

TABLE B2 (cont.)
LONG-TERM TREND LAKE MACROPHYTE DATA
SAMPLE POINT DATA

LAKE NAME: Big Wood Lake

COUNTY NAME: Burnett

DATE: 8/16/93

NOTE TAKER: MRH

FIELD CREW: Tom Gizwald
MRH

TRANSECT	DEPTH CODE	DEPTH (FT.)	SUBSTRATE	SPECIES/DENSITY RATING (COMMON NAME)
				Ceratophyllum demersum/2 (Coontail)
	1	1	Rock	*Najas sp.*/1 (Naiad/Pondweed)
19	3	7	Mud	*Ceratophyllum demersum*/5 (Coontail)
				Potamogeton zostoniformis/3 (Flatstem pondweed)
	2	3	Sand/mud	*Ceratophyllum demersum*/3 (Coontail)
				Vallisneria americana/4 (Wild celery)
				Ranunculus sp./1 (Water buttercup)
				Elodea canadensis/3 (Canada waterweed)
				Myrrophyllum exalbescens/1 (Native water milfoil)
	1	1	Sand	*Vallisneria americana*/2 (Wild celery)
				Potamogeton pectinatus/1 (Sago pondweed)
20	3	7	Sand	*Ceratophyllum demersum*/4 (Coontail)
				Potamogeton zostoniformis/4 (Flatstem pondweed)
	2	3	Sand	*Potamogeton richardsonii*/2 (Claspingleaf pondweed)
				Najas sp./2 (Naiad/Pondweed)
				Myrrophyllum exalbescens/4 (Native water milfoil)
				Heterathera dubia/2 (Mud plantain)
	1	1	Sand	*Najas sp.*/3 (Naiad/Pondweed)
				Potamogeton pectinatus/2 (Sago pondweed)

TABLE B3
LONG-TERM TREND LAKE MACROPHYTE DATA
FIELD NOTES ON FLOATING LEAF PLANTS, EMERGENT PLANTS,
AND FLOATING ALGAE MATS.

LAKE NAME: Big Wood Lake

COUNTY NAME: Burnett

DATE: June 14, 1993

NOTE TAKER: MRH

FIELD CREW: Roger Reid
MRH

TRANSECT	DEPTH CODE	SPECIES/COMMON NAME
1	1	*Rhizodonium hieroglyphicum*/algae mat.
		Scirpus sp./bulrush
		Nuphar variegatum/yellow waterlily
3	1	*Scirpus sp.*/bulrush
5	1	*Scirpus sp.*/bulrush
		Eleocharis acicularis/needlerash
7	2	*Rhizodonium hieroglyphicum*/algae mat.
	1	*Rhizodonium hieroglyphicum*/algae mat.
10	2	*Nymphae tuberosa*/white waterlily
11	2	*Nuphar variegatum*/yellow waterlily
		Scirpus sp./bulrush
	1	*Nuphar variegatum*/yellow waterlily
		Scirpus sp./bulrush
12	1	*Scirpus sp.*/bulrush
13	2	*Rhizodonium hieroglyphicum*/algae mat.
14	2	*Scirpus sp.*/bulrush
	1	*Scirpus sp.*/bulrush
15	2	*Rhizodonium hieroglyphicum*/algae mat.
		Nymphae tuberosa/white waterlily
	1	*Rhizodonium hieroglyphicum*/algae mat.
		Lemna trisulca/star duckweed
16	2	*Rhizodonium hieroglyphicum*/algae mat.
		Nymphae tuberosa/white waterlily
	1	*Rhizodonium hieroglyphicum*/algae mat.
		Nymphae tuberosa/white waterlily
		Lemna trisulca/star duckweed

TABLE B3
LONG-TERM TREND LAKE MACROPHYTE DATA (Continued)
FIELD NOTES ON FLOATING LEAF PLANTS, EMERGENT PLANTS,
AND FLOATING ALGAE MATS.

LAKE NAME: Big Wood Lake

COUNTY NAME: Burnett

DATE: June 14, 1993

NOTE TAKER: MRH

FIELD CREW: Roger Reid
MRH

TRANSECT	DEPTH CODE	SPECIES/COMMON NAME
18	2	*Rhizodonium hieroglyphicum*/algae mat.
	1	*Scirpus sp.*/bulrush
20	1	*Scirpus sp.*/bulrush

TABLE B4
LONG-TERM TREND LAKE MACROPHYTE DATA
FIELD NOTES ON FLOATING LEAF PLANTS, EMERGENT PLANTS,
AND FLOATING ALGAE MATS.

LAKE NAME: Big Wood Lake

COUNTY NAME: Burnett

DATE: August 16, 1993

NOTE TAKER: MRH

FIELD CREW: Tom Gizwald
MRH

TRANSECT	DEPTH CODE	SPECIES/COMMON NAME
1	1	*Scirpus sp.*/bulrush
		Nuphar variegatum/yellow waterlily
3	1	*scirpus sp.*/bulrush
5	1	*scirpus sp.*/bulrush
8	2	*Nymphae tuberosa*/white waterlily
		Nuphar variegatum/yellow waterlily
		Lemna minor/lesser duckweed
10	2	*Nymphae tuberosa*/white waterlily
	1	*Nymphae tuberosa*/white waterlily
		Scirpus sp./bulrush
11	2	*Nuphar variegatum*/yellow waterlily
		Scirpus sp/bulrush
		Nuphar variegatum/yellow waterlily
		Scirpus sp/bulrush
12	2	*Scirpus sp*/bulrush
	1	*Scirpus sp.*/bulrush
14	2	*Scirpus sp.*/bulrush
	1	*Scirpus sp.*/bulrush
15	2	*Nymphae tuberosa*/white waterlily
16	2	*Nymphae tuberosa*/white waterlily
		Brasenia schreberi/watershield
	1	*Nymphae tuberosa*/white waterlily
		Lemna minor/lesser duckweed
		Rhizodonium hieroglyphicum/algae mat.
18	1	*Scirpus sp.*/bulrush

TABLE B4
LONG-TERM TREND LAKE MACROPHYTE DATA (Continued)
FIELD NOTES ON FLOATING LEAF PLANTS, EMERGENT PLANTS,
AND FLOATING ALGAE MATS.

LAKE NAME: Big Wood Lake

COUNTY NAME: Burnett

DATE: August 16, 1993

NOTE TAKER: MRH

FIELD CREW: Tom Gizwald
MRH

TRANSECT	DEPTH CODE	SPECIES/COMMON NAME
20	2	*Scirpus sp.*/bulrush
	1	*Scirpus sp.*/bulrush

TABLE B5

BIG WOOD LAKE MACROPHYTE SURVEY

June 14, 1993 and August 16, 1993

Descriptions of Reference Points for Each Transect

Transect #	Description*
1	Between the two ash trees
2	Willow tree
3	Tree on Hanson's Point
4	Tree in front of the Glen Johnson cabin
5	Tree with tire swing
6	Bell in front of the Roskop cabin
7	Birch tree
8	Between tree tops of two tall trees
9	Tree on lakeshore
10	Tree stump
11	Birch tree
12	Small tree in front and left of pine tree
13	Window of brown boat house
14	Tree in front and right of brown cabin
15	Tree in front of house
16	Tall wooden pole
17	Large pine tree
18	Old birch tree on point
19	Tree in front of cabin
20	Large dead tree

*Reference photographs for further identification of landmark.

TABLE B6
LONG-TERM TREND LAKE MACROPHYTE DATA
TRANSECT DATA

LAKE NAME: Big Wood Lake

COUNTY NAME: Burnett

DATE: June 14, 1993

NOTE TAKER: MRH

FIELD CREW: Roger Reid
MRH

TRANSECT	COMPASS BEARING	MAX. ROOTING DEPTH (FT)
1	225°	10
2	270°	10
3	270°	10
4	276°	10
5	284°	9
6	315°	10
7	355°	10
8	010°	10
9	040°	9
10	195°	10
11	130°	10
12	120°	10
13	120°	9
14	060°	10
15	060°	*
16	215°	*
17	090°	10
18	095°	10
19	150°	10
20	105°	10

* Entire bay impacted by macrophyte growth.

TABLE B7
LONG-TERM TREND LAKE MACROPHYTE DATA
TRANSECT DATA

LAKE NAME: Big Wood Lake

COUNTY NAME: Burnett

DATE: August 16, 1993

NOTE TAKER: MRH

FIELD CREW: Tom Gizwald
MRH

TRANSECT	COMPASS BEARING	MAX. ROOTING DEPTH (FT)
1	225°	8
2	270°	8
3	270°	8
4	276°	8
5	284°	8
6	315°	8
7	355°	8
8	010°	8
9	040°	8
10	195°	8
11	130°	8
12	120°	8
13	120°	8
14	060°	8
15	060°	8
16	215°	8
17	090°	8
18	095°	8
19	150°	8
20	105°	8

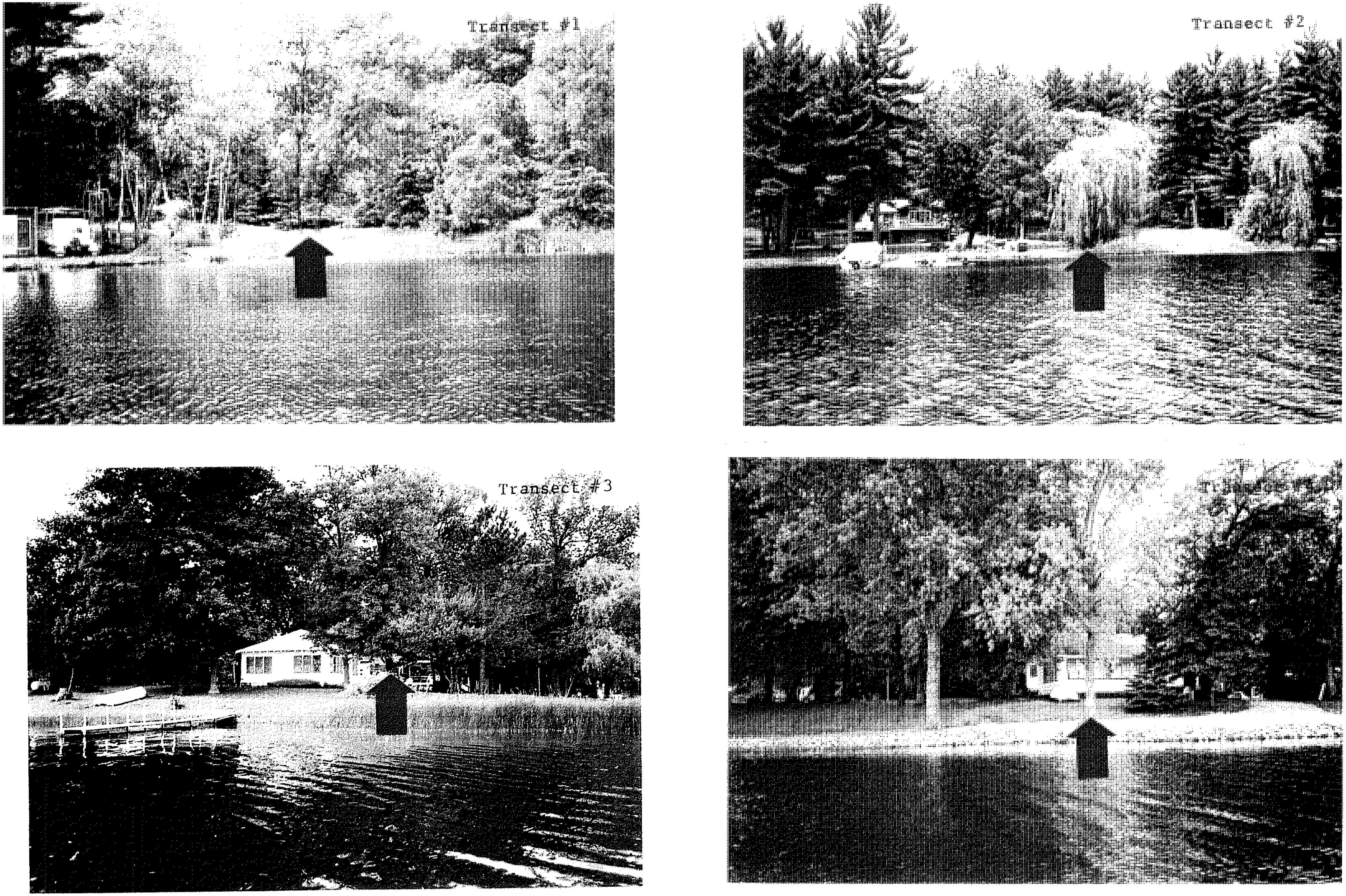
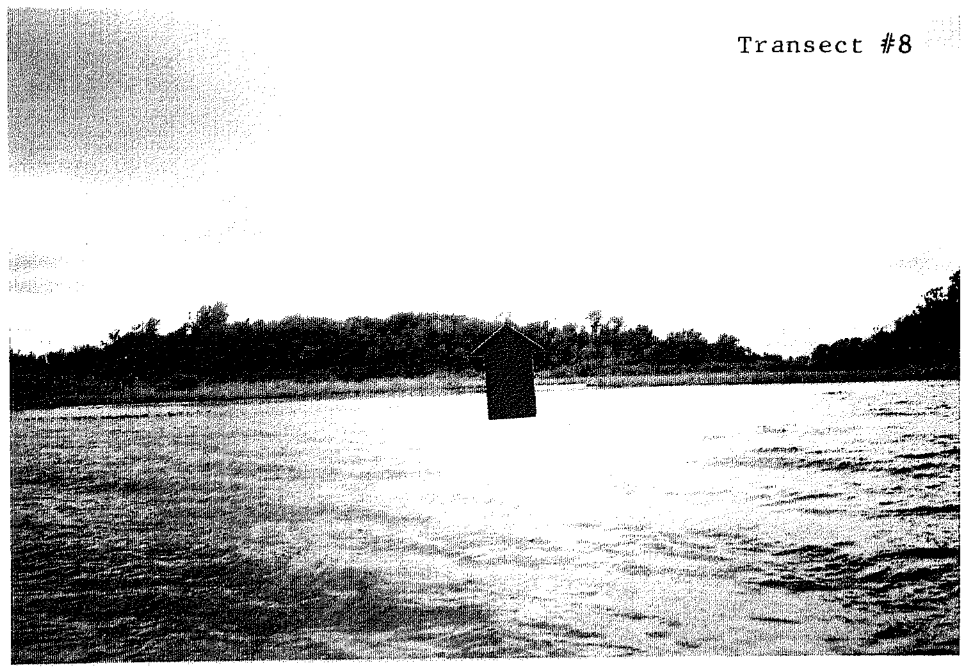


Figure B-1

Transect #7

Transect #8



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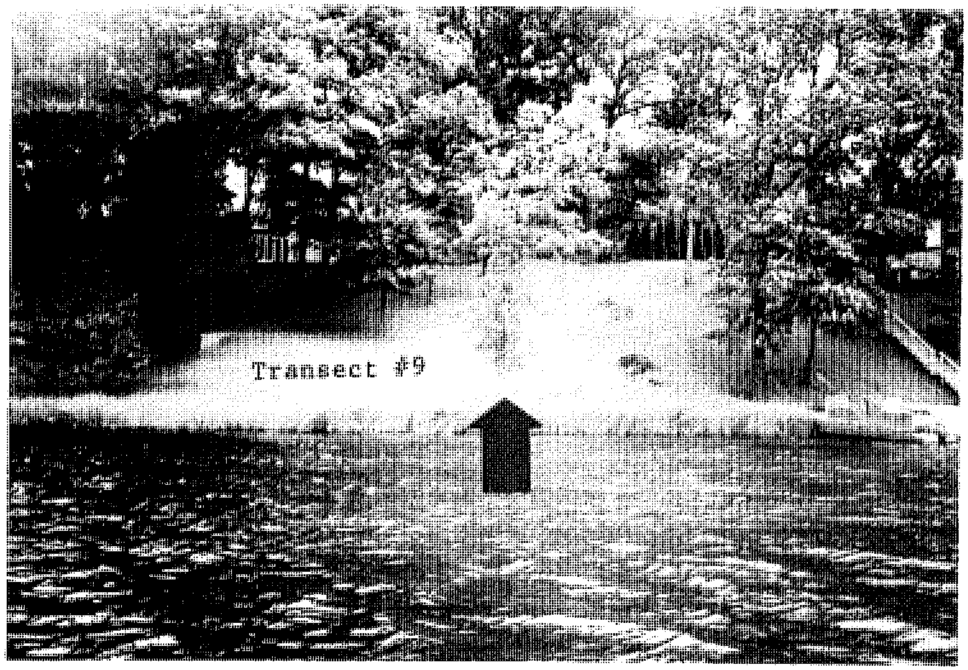

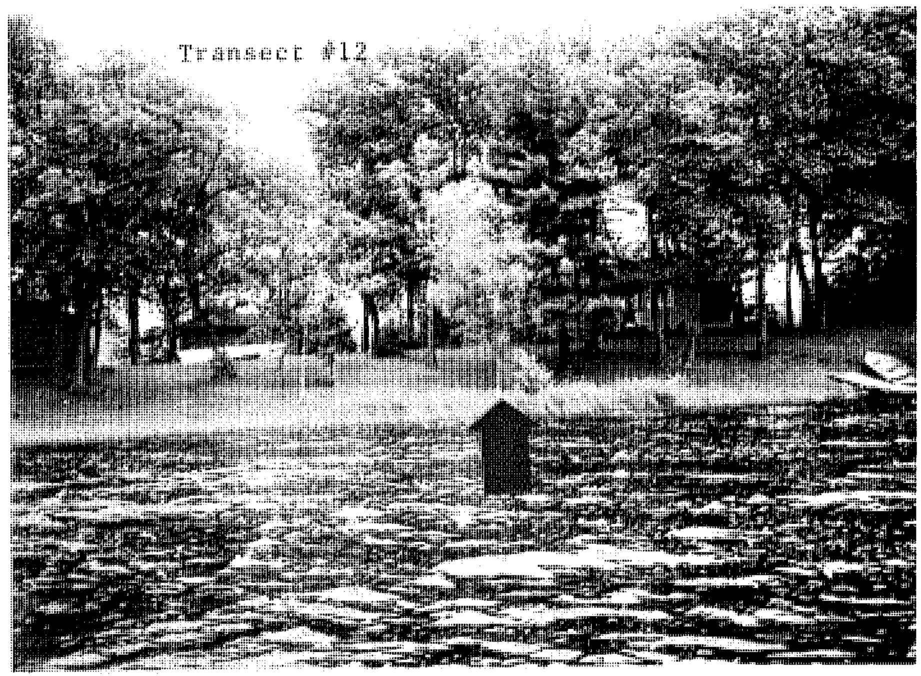

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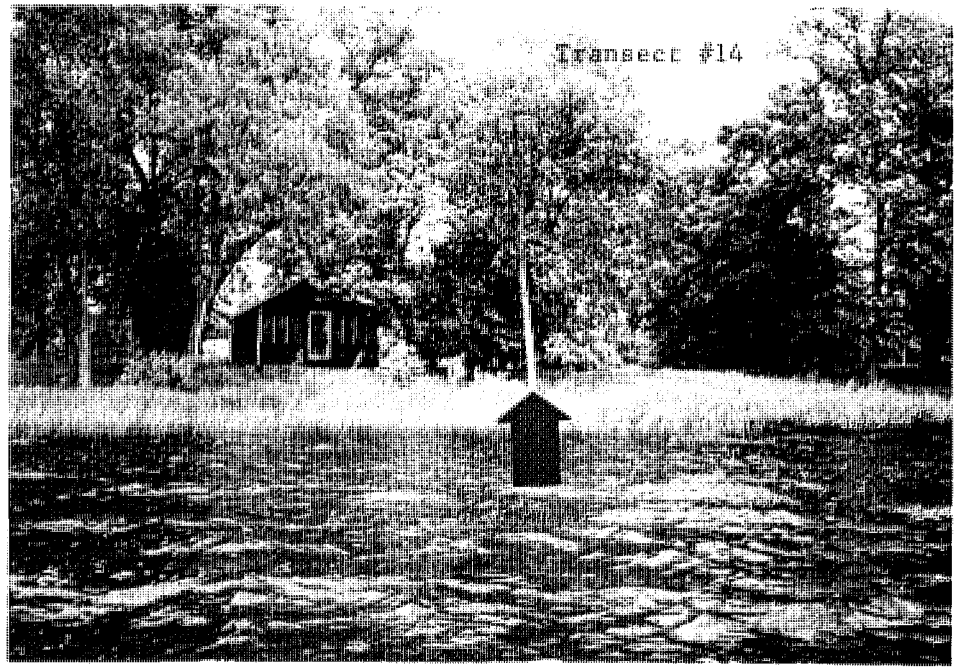
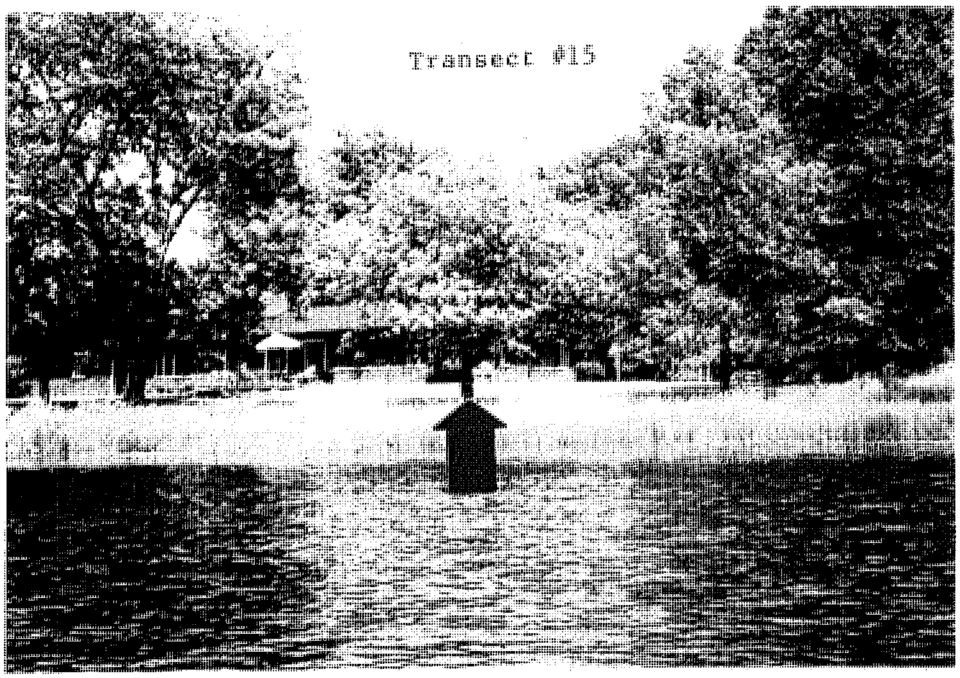
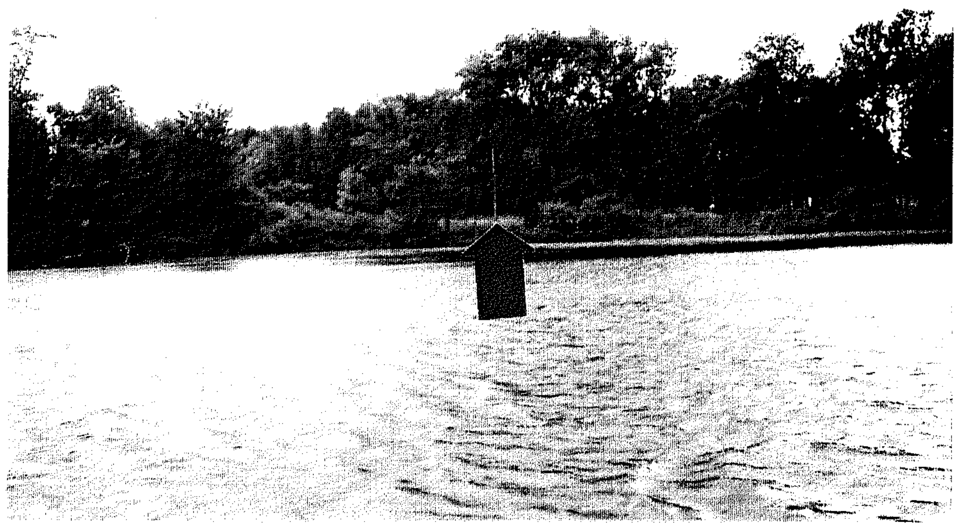




Transect #16



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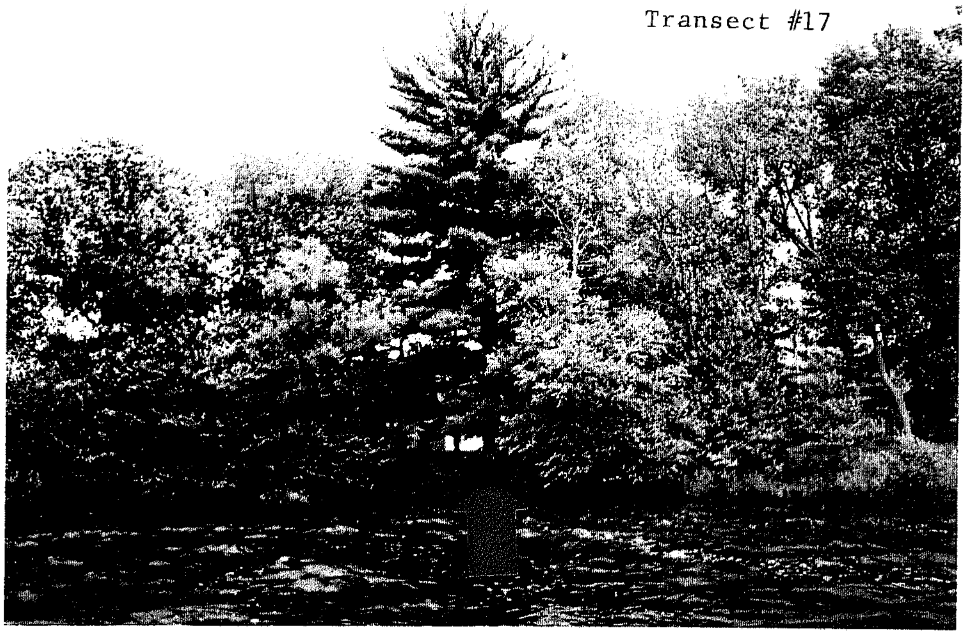

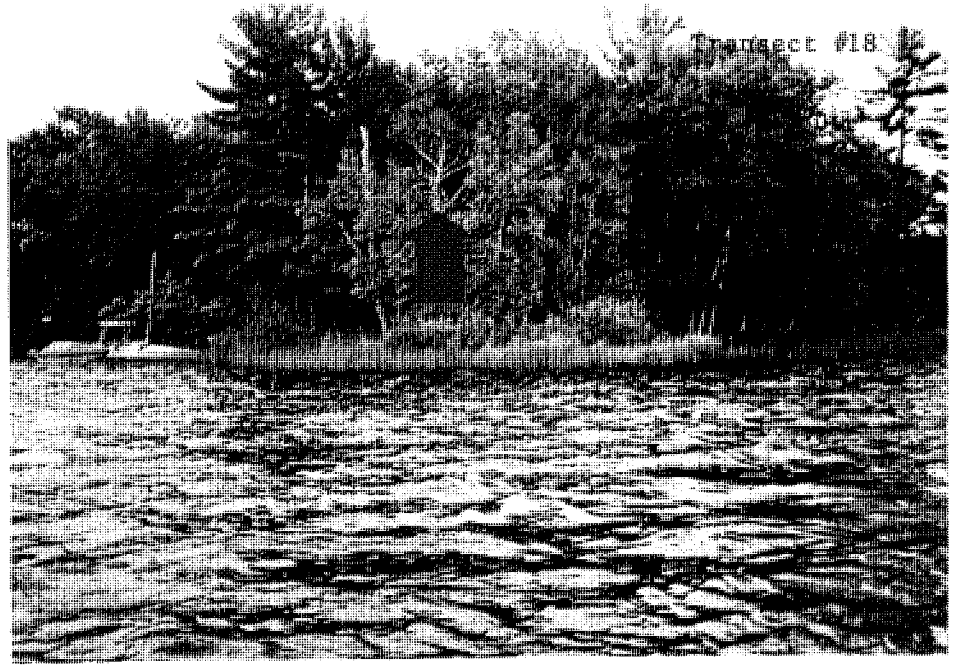

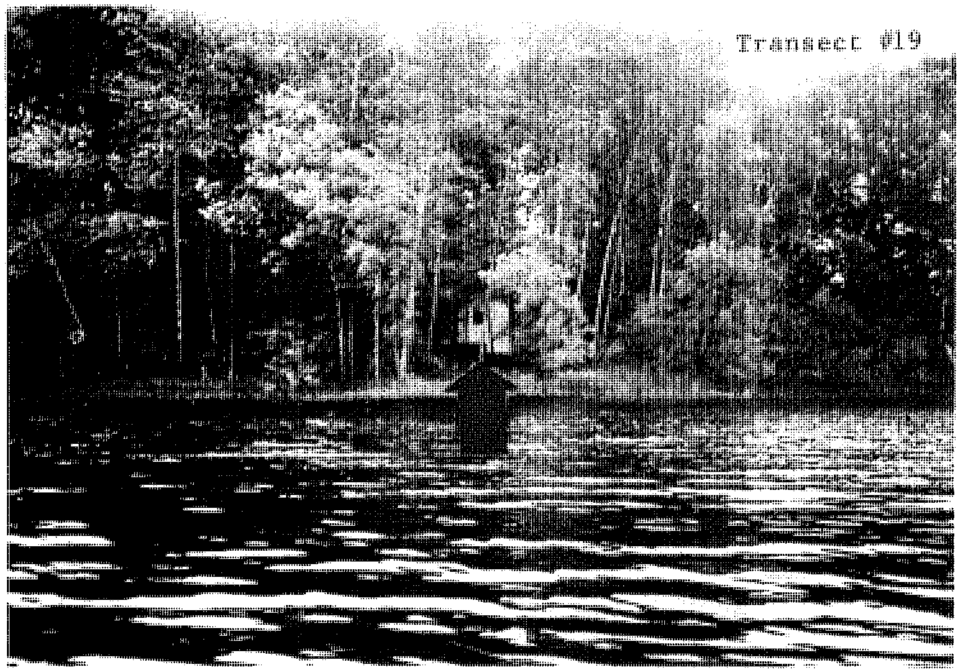

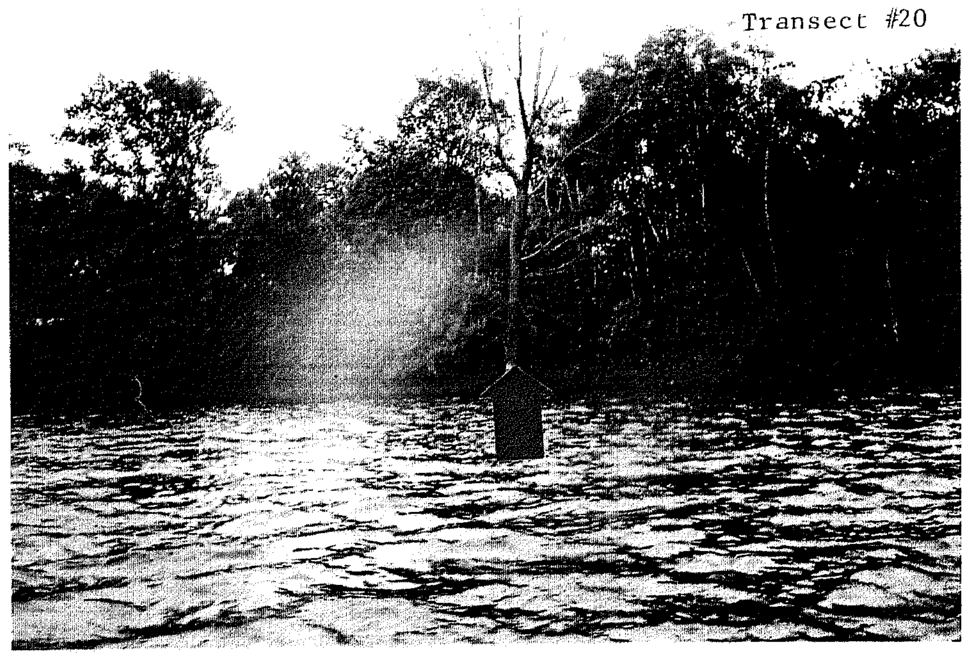

Figure B-1 (continued)

Appendix C

APPENDIX C

PROPERTY OWNERS SURVEY RESULTS

MEMBERSHIP SURVEY FOR BIG WOOD LAKE ASSOCIATION INC.

RESULTS

Below you will find indicated the responses to our recent survey conducted as part of our Wisconsin Lake Planning Grant. A total of 72 responses were returned out of 167 surveys distributed. This represents a 43% response which, sadly to say, falls within the norm for surveys of this nature. A sincere thank you goes out to those of you who took the time to respond. For 1st, 2nd and 3rd type responses, the top vote getters are indicated in the response positions and each possible choice has its numerical responses listed in the following format 1st/2nd/3rd. The remainder of the questions have the numerical or verbal responses as indicated.

1. Why did you buy property on a lake? (list your top three reasons in order of importance:) 1st G 2nd B 3rd H

18/2/1 A. Primary residence
14/18/10 B. Entertaining friends & family
4/3/2 C. Investment
5/17/8 D. Fishing
1/5/9 E. Observing wildlife
-/1/2 F. Swimming, diving, scuba
22/10/11 G. Appreciating peace & tranquility
H. Enjoying the view -/10/17
I. Water skiing -/-/3
J. Jet skiing -/-/-
K. Motorized boating -/1/4
L. Canoeing, rowing -/-/-
M. Sailing -/-/-
N. Other ____ 6/2/3

2. Why did you choose property on this lake? (list your top three reasons in order of importance:) 1st B 2nd A 3rd F

23/20/9 A. Distance from home
30/4/1 B. Family tradition
4/17/11 C. Cost of property
1/10/14 D. Low number of people using lake
E. For the neighbors 2/4/6
F. Needs from # 1 4/11/16
G. Other ____ 6/3/6

3. Approximately how many feet of lake frontage do you own? (VARIOUS)

4. Which of the following best describes your lake frontage? (check one)

3 Masonry retaining wall
4 Wood retaining wall
28 Rocks for stabilization
22 Lawn
13 Vegetation
2 Trees & Shrubs

5. How many of the following watercraft are kept at your property?

33 canoes 14 sailboats 39 rowboats 2 jet skis 42 pontoon
19 paddle-boats 21 motor boat under 25 HP 33 motor boat 25 HP and over
4 Other ____

- __ Over developed – Shoreline structures are detracting from the natural beauty of most of the shoreline.
- __ Unusable – Shoreline structures have replaced the natural beauty of the shoreline.

14. Which statement best describes the boat traffic the lake receives? (Please check one)

- – Lightly used – Rarely see another boat.
- 49 Moderately used – Not enough to bother my use.
- 23 Heavily used – On occasion I have to modify my plans because of boat traffic.
- – Over used – I have to regularly change my plans because of the boat traffic on the lake.
- – Unusable – There is so much boat traffic that I don't use the lake much any more.

15. Which best describes your experience with other boaters while on the water? (Please check one)

- 33 Little conflict – Boaters have been courteous and law abiding.
- 38 Moderate conflict – A few boaters have been discourteous and broken rules.
- – Heavy conflict – Significant number of boaters have been discourteous and broken rules.
- – Overt conflict – Some boaters intimidate and harass other boaters.
- – Displacement – I have generally quit boating because of the behaviour of other boaters.

16. Which statement best describes the level of aquatic plant growth in the lake? (Please check one)

- – Light growth – Very little, less than optimum for fish and wildlife.
- 25 Moderate growth – Just the right amount for fish and wildlife.
- 41 Heavy growth – The plants limit my use of some parts of the lake and diminish attractiveness.
- 3 Dense growth – The plants limit my use of much of the lake and are unattractive.
- 2 Choked with growth – The plants ruin my ability to enjoy the lake.

17. How would you rate the enforcement of the following existing regulations? (Please check one for each regulation)

	Excellent	Good	Fair	Poor	Not familiar with the regulation
Shoreland zoning	7	40	8	1	15
Sanitary/septic ordinances	8	25	16	6	16
Boating regulations	5	35	14	9	7

18. Which statement best describes current public access to the lake? (Please check one)

24. Have you attended an annual or special meeting of the Big Wood Lake Association, Inc. in the past two years?

56 Yes   16 No

25. Have you ever served as an officer of the organization?

10 Yes   62 No

26. What is the best way for the organization to communicate with the members? (Please check one)

32 Meetings   37 Newsletters
2 Articles in local paper   – Informal discussion

27. What do you like about the current policies and activities of the lake association?

NEWSLETTER,* INCORPORATION, LAKE GRANT,* PIG ROAST,* MARKERS,* WEED CONTROL, FELLOWSHIP, LEADERSHIP, ALL VIEWS HEARD,* MEETINGS,* GOOD OFFICERS,* MORE VOLUNTEERS, DEMOCRATIC, SINCERE, NOT RESTRICTIVE, NON-REGULATORY, WHAT ARE THEY, REPRESENTATION TO DNR AND LOCAL OFFICIALS

* MULTIPLE RESPONSES

28. What would you like to see changed?

STOP "COLLECTORS", INSPECTION OF VISITING LAKE VEHICLES, MORE INVOLVEMENT,* TAXES TOO HIGH, WINTER FUNDRAISER, WILDLIFE POLLUTION, H.P. LIMITS ON BOATS, N. SHORE DR. SPEED LIMIT, WEED CONTROL, ECOLOGY EDUCATION, REGULATE WATER SKI TIMES,* SEPTIC REGULATION, MORE POLITICAL CLOUT, STOCK FISH,* BOAT SPEED LIMITS,* NO CHEMICALS,* REMOVE CARP, STUDY LAKE CLARITY, GET OUT MORE INFO

* MULTIPLE RESPONSES

-------------------------DUES ARE DUE 6/5/93---------------------

For those of you who have responded to our previous mailing we sincerely THANK YOU, and we encourage those of you who have not to join in the continued stewardship of BIG WOOD LAKE.

Tax deductible contribution: ___ $20 ___ $50 ___ $100

Pre-payment of '93 dues (non-deductible): ___ $15

I am interested in doing volunteer work: ___ Yes ___ No

Make checks payable to Big Wood Lake Association, Inc., 22656 Hanson Pt. Rd., Grantsburg, WI 54840.