Antler Lake Management Plan

Phase I: Water Quality Study of Antler Lake

Prepared for
Antler Lake Association

Prepared by Barr Engineering Co.
with Assistance from:
Antler Lake Association
Polk County Land Conservation Department
Wisconsin Department of Natural Resources

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Introduction

Antler Lake in Polk County, Wisconsin is located in a part of the State known as the Balsam Branch of the Apple River Watershed. Because of the importance of the area as a State resource, the Balsam Branch has been designated as a Priority Watershed by the Wisconsin Department of Natural Resources (WDNR). The lake currently has very good water quality and a high quality fisheries.

Antler Lake has a surface area of approximately 101 acres and a shoreline length of approximately three miles. The lake has a maximum depth of 27 feet, an average depth of 9 feet, and a volume of 932 acre-feet. The lake's fishery consists of northern pike, bass, panfish, and walleye. A winter aeration system protects the lake's fishery from winterkill. The lake has a public access. Its high water quality makes it desirable for boating, fishing, swimming, and aesthetic viewing.

Antler Lake is a landlocked, nondrainage lake, referred to as a seepage lake. Therefore, its current water quality is determined by runoff to the lake from its relatively undeveloped watershed. Consequently, the water quality of the lake is high. However, development of its tributary watershed could increase nutrient loads, thereby reducing its water quality. Because the lake is a seepage lake, nutrients entering the lake remain in the lake, causing the lake to be particularly sensitive to development impacts.

Due to concerns that future development could adversely affect the lake's water quality, the Antler Lake Association initiated a Wisconsin Lake Management Planning Grant Project to investigate the current water quality of the lake and develop a Lake Management Plan. Development of the Lake Management Plan is comprised of three phases:

- **Phase I** Collection of data (i.e., water quality, lake level, and land use).
- **Phase II** Preparation of hydrologic and phosphorus budgets for existing watershed land use conditions.
- **Phase III** Preparation of the Lake Management Plan.

This report discusses the methodology, results, and conclusions from the Phase I study. The study was primarily a data collection project to evaluate the water quality of Antler Lake and assemble requisite data for the Phase II project. Consequently, water quality data, lake level data, and watershed land use data were collected.

Methods

The methods used for the Phase I portion of the Lake Management Plan are discussed in the following sections of this report. Included in the discussion are:

- Water Quality Survey of Antler Lake
- Biological Parameters
- Macrophyte Survey of Antler Lake
- Collection of Lake Level Data
- Evaluation of the Tributary Watershed

Water Quality Survey of Antler Lake

The 1995 water quality survey of Antler Lake was designed to provide an understanding of the interacting physical, chemical, and biological processes controlling the water quality of Antler Lake. The 1995 sampling program involved measurements and/or collection of samples from Antler Lake at spring overturn (within two weeks of ice-out) and approximately biweekly from mid-June through mid-September. Barr Engineering Company provided training for the Antler Lake Association volunteers, who collected the water quality data.

Antler Lake is comprised of one basin. Samples were collected from the deepest portion of the basin, because this location best represented the limnological properties of the basin. The sample location is shown on Figure 1.

Water temperature, specific conductance, and dissolved oxygen concentrations were determined at spring overturn and on a biweekly basis during mid-June through mid-September. Measurements were made along a profile at depth intervals of 1 meter. The limits of Secchi disc visibility were measured on each sampling date to ascertain water transparency.

Water samples were collected from Antler Lake following ice-out and on five occasions during June through September. Samples collected on each sample date are shown in Table 1. Samples were collected from 0-2 meters (i.e., integrated composite samples) and analyzed for all parameters shown in Table 1. In addition, total phosphorus samples were collected from the 3.5 and 5.0 meter depths and near the bottom (i.e., one-half meter above the lake bottom).

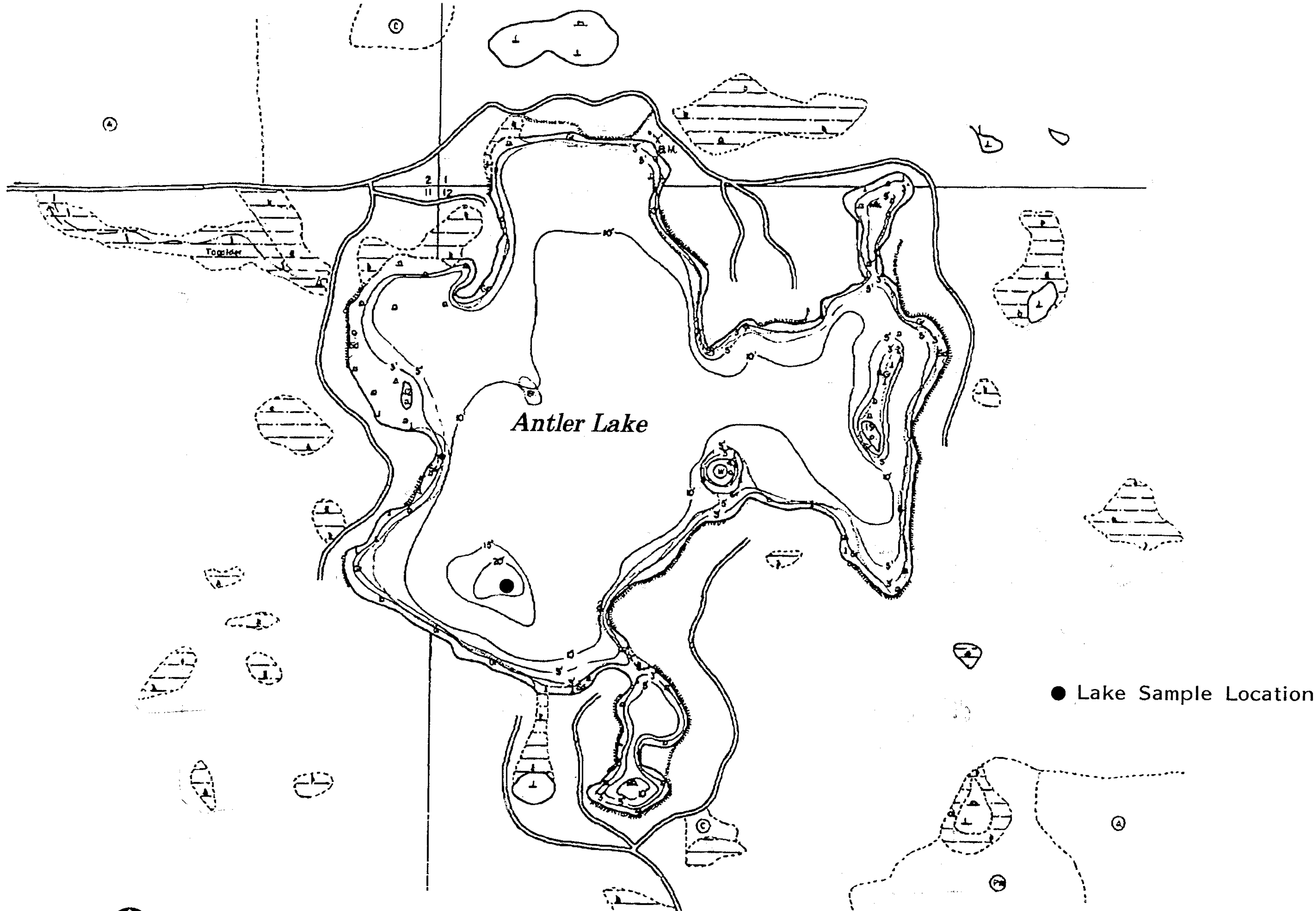


Figure 1
ANTLER LAKE
SAMPLE LOCATION MAP

Table 1

Antler Lake Water Quality Parameters

Parameter	Depth (meters)	Spring	June	July	Early August	Late August	September
Total Phosphorus		X	X	X	X	X	X
Soluble Reactive Phosphorus	0-2	X	X	X	X	X	X
Total Kjeldahl Nitrogen	0-2	X	X	X	X	X	X
Ammonia Nitrogen	0-2	X	X	X	X	X	X
Nitrate + Nitrite Nitrogen	0-2	X	X	X	X	X	X
Alkalinity	0-2	X	X	X		X	
pH	0-2	X	X	X		X	
Chlorophyll *a*	0-2	X	X	X	X	X	X
Phytoplankton	0-2		X	X	X	X	X
Zooplankton	Bottom to Surface Tow			X		X	X

4949007\38171-1/YMH

Biological Parameters

Phytoplanktonic algae contained in summer, epilimnetic samples were identified to their lowest practical taxonomic level, and cell density counts were made. Zooplankton were sampled by vertical net haul (lake bottom to surface) on summer sampling dates. Zooplankton taxa were later identified and enumerated in the laboratory.

Antler Lake Macrophyte Survey

A macrophyte (i.e., aquatic weed) survey was completed during late June and again during late August. The surveys were completed by Barr Engineering Company, with assistance from the Antler Lake Association. The purpose of the surveys was to determine species composition, abundance, and locations of growth within Antler Lake. The surveys were based upon Jessen and Lound (1962) methodology, but was modified to be qualitative. Details of the survey are as follows:

While motoring at idling speed in the littoral zone, a grappling hook was thrown overboard periodically to retrieve aquatic plants and determine species density. All plants retrieved by the grappling hook were identified. Species density was determined by the number of tines containing each species retrieved by the hook. The following criteria were used for species density determination:

1. **Light density rating** = species found on 1-2 tines
2. **Moderate density rating** = species found on 3-4 tines
3. **Heavy density rating** = species found on 5-6 tines

Collection of Lake Level Data

Two staff gages were installed on April 24 and read approximately on a daily basis during the period April 24 through October 31. The staff gage measurements are indicative of lake level changes. During the Phase II portion of the project, the staff gage readings will be used to complete the hydrologic budget.

Evaluation of the Tributary Watershed

Evaluation of the Antler Lake tributary watershed was completed by the Polk County Land Conservation Department. The evaluation consisted of a determination of watershed land use and a preliminary estimate of phosphorus loading based upon phosphorus export coefficients.

Results and Discussion

The results of the water quality study are presented in the appendices. The following discussion:

- Presents general concepts used in assessing lake water quality
- Assesses the existing water quality of Antler Lake
- Assesses the Antler Lake macrophyte community
- Assesses the tributary watershed
- Presents preliminary phosphorus loading estimates

For the purposes of this report, total phosphorus, chlorophyll *a*, and Secchi disc transparency have been used as the key water quality indicators.

Water Quality Concepts

Before dealing with the specifics of the water quality in Antler Lake, it is useful to consider some general concepts involved in assessing lake water quality. Presented in the sections that follow are brief discussions of topics involved in the study of lakes, including:

- Eutrophication
- Trophic states
- Limiting nutrients
- Structure of lakes and ponds and nutrient recycling

Eutrophication

The water quality problems caused by sediment and nutrients from a lake's watershed are described by the word eutrophication. Eutrophication, or lake degradation, is the process whereby lakes accumulate sediments and nutrients from their watersheds. Over time, a lake naturally becomes fertile. It is converted from oligotrophic (nutrient poor) to eutrophic (nutrient rich) status as it is progressively enriched by nutrients from its watershed. Nutrients serve as a catalyst for algae and weed growth in a lake. Biological production, aided by sediment inflow from the lake's watershed, eventually fills the lake's basin. Over a period of many years, the lake successively becomes a pond, a marsh and, ultimately, a terrestrial site.

The process of eutrophication is natural and results from the normal environmental forces that influence a lake. Natural eutrophication occurs very slowly. Cultural eutrophication, however, is an acceleration of the natural process caused by human activities. This acceleration may result from point-source nutrient loadings, such as septic tanks. It may also be caused by diffuse (i.e., non-point) sources of nutrients and sediments, such as stormwater runoff. Nutrients and sediments may be added to the lake via runoff from an agricultural watershed. 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) and/or the proliferation of rooted aquatic weeds (macrophytes).

The root cause of cultural eutrophication is uncontrolled development within a lake's watershed and/or development without the use of Best Management Practices (BMPs). Either scenario results in water quality degradation in the receiving water body. Development of a lake management plan prior to the development of a lake's watershed may prevent or minimize impacts from cultural eutrophication. It is for this reason that the Antler Lake management plan is being completed to protect the lake's current water quality and prevent or minimize impacts by cultural eutrophication. The Phase I data collection program defines the existing trophic state of the lake, so that its current stage of eutrophication may be known.

Trophic States

Because of varying nutrient status, not all lakes are in the same stage of eutrophication. Therefore, criteria have been established to evaluate lakes, such as Antler Lake, to denote their nutrient "status". Four "trophic" descriptions are frequently used to describe the effects of the nutrients on the general water quality and/or trophic conditions of a water body. They are:

1. **Oligotrophic**
2. **Mesotrophic**
3. **Eutrophic**
4. **Hypereutrophic**

Oligotrophic (Greek for "food poor") describes a clear, low productivity lake. **Mesotrophic** describes an intermediate productivity lake which has relatively good water quality. **Eutrophic** (Greek for "food-rich") describes a lake rich in nutrients and having a high productivity. **Hypereutrophic** lakes are extremely high in nutrients and are extremely productive. An oligotrophic or mesotrophic condition in a lake is considered desirable, while a eutrophic or hypereutrophic condition is considered problematic.

The North American Lake Management Society (NALMS, 1988) has used Carlson's Trophic State Index to relate the trophic state of a water body to total phosphorus concentrations, chlorophyll *a* concentrations, and Secchi disc transparency. Therefore, Carlson's Trophic State Index of a water body may be used to indicate its stage of eutrophication (i.e., degradation). The four trophic status designations used for lakes are listed below with corresponding TSI value ranges.

1. **Oligotrophic—[TSI ≤ 38]**
2. **Mesotrophic—[38 < TSI ≤ 50]**
3. **Eutrophic—[50 < TSI ≤ 62]**
4. **Hypereutrophic—[62 < TSI]**

During 1995, the average Antler Lake TSI value was 47. Therefore, the lake has a trophic status designation of mesotrophic.

The Limiting Nutrient

The determination of the eutrophication stage of a lake (i.e., its stage of degradation) is an important aspect of assessing its current condition. Eutrophication indicates the level of algal growth and whether or not this level of growth interferes with its recreational goals. However, it does not indicate the cause of algal growth, or a means of reducing such growth if it is considered problematic.

The quantity or biomass of algae in a lake or pond is usually limited by the water's concentration of an essential element or nutrient—the "limiting nutrient". (Rooted aquatic plants, in contrast, 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 idea that, in considering all of the substances needed for biological growth, only one will be present in limited quantity. The availability of this limiting nutrient will, therefore, control the rate of algal growth. It follows then, that the identification of a lake's limiting nutrient will point the way toward a management strategy to control algal growth.

Nitrogen (N) and phosphorus (P) are generally the two growth-limiting nutrients for algae in most natural waters. Analysis of the nutrient content of lake water and algae provides ratios of N:P that can indicate whether one or the other of these elements is growth-limiting. By comparing the tissue concentrations of important nutrients in algae to the concentrations of the same nutrients in the ambient waters, one can estimate whether a particular nutrient may be limiting.

Algal growth is generally phosphorus-limited in waters with N:P ratios greater than 12. During 1995, Antler Lake had an average summer N:P ratio of 36. Therefore, phosphorus was the limiting nutrient in Antler Lake. A reduction in the phosphorus concentration in Antler Lake is, therefore, necessary in order to reduce algal abundance. Increases in the lake's phosphorus concentration will result in increased algal abundance and reduced water transparency. Therefore, prevention of additional phosphorus loading to the lake will be necessary to protect its current water quality.

Structure of Lakes and Ponds and Nutrient Recycling

The determination of a lake's limiting nutrient is but the first step in the process of formulating a lake management strategy. Because phosphorus enters lakes and ponds from internal and/or external sources, it is necessary to determine the source of the current load. Once the source of phosphorus loading is determined, management efforts to avoid increases may be formulated. An understanding of the depth-temperature patterns, or "structure" of a lake helps one determine whether the source of phosphorus loading is primarily from external sources, internal sources, or a combination of both. Nutrient recycling from bottom sediments results in internal loading, while runoff from the tributary watershed results in external loading. Details regarding lake structure and nutrient recycling follow.

In any water body, certain physical phenomena occur that can profoundly influence its chemistry and biology. Probably the most important of these phenomena is "thermal stratification". Because the density of water decreases as it warms, warmer water tends to rise to the surface. As a result, lakes and ponds in temperate regions tend to form temperature layers, or "stratify", when they are exposed to the heat of the sun.

When the ice melts in the spring, the water temperature in a lake is usually around 4 degrees Celsius (~39 degrees Fahrenheit) from top to bottom. At this temperature, water is most dense (heaviest). During the spring and summer months, the sun warms the surface layer of the lake causing it to become warmer and less dense (lighter). The warm surface layer of the lake is called the epilimnion. In shallow portions of a lake, the sun's rays are often able to reach the lake's bottom in most places. During the summer, the water temperature in these portions (which are usually near the shore, or in the "littoral zone") may be warm throughout.

The deeper portion of lakes typically have a thermal/density structure that differs from the shallow regions. Because sunlight does not reach the bottom of the deeper portions of the lake, these waters remain cool and more dense. Therefore, the warmer, lighter water lays near the surface and the cooler, heavier water stays at the bottom of the lake.

The cooler, deeper water layer of the lake is called the **hypolimnion**, and the warm surface zone is known as the **epilimnion**. Between the warm epilimnion and the cool hypolimnion is a transitional layer of water known as the **metalimnion**. This layer of the lake is characterized by a rapidly-declining temperature.

The significance of thermal stratification in lakes is that the density change in the metalimnion provides a physical barrier to mixing between the epilimnion and the hypolimnion. While water above the metalimnion may circulate as a result of wind action, hypolimnetic waters at the bottom generally remain isolated. Consequently, very little transfer of oxygen occurs from the atmosphere to the hypolimnion during the summer.

If the lake or pond sediments are rich in organic matter, microbial decomposition and respiration can deplete hypolimnetic waters of their dissolved oxygen. Phosphorus contained in the sediment may then be released into the water column as a result of changes in the oxidation-reduction (REDOX) potential of the system caused by oxygen depletion. Later, this phosphorus will contribute to the growth of algae in surface waters when the thermal stratification of the lake breaks down and the lake or pond mixes.

Shallow water bodies (generally less than 10 feet in depth) may circulate many times during the summer as a result of wind mixing. In contrast, the deeper parts of lakes generally become well-mixed only twice each year. This usually occurs in the spring and fall. During these periods, the lack of strong temperature/density differences allow wind-driven circulation to mix the water column throughout. During these mixing events, oxygen may be transported to the deeper portions of the lake, while dissolved phosphorus is brought up to the surface.

Recycling of nutrients from anoxic (devoid of oxygen) sediments to the surface waters of a lake or pond is most often a problem in highly-fertile water bodies. These eutrophic lakes are subject to hypolimnetic oxygen depletion during periods of stratification, with consequent recycling of phosphorus from the lake's sediments during mixing.

Temperature and dissolved oxygen data from Antler Lake provide information relative to thermal stratification and the role of nutrient recycling in the lake's phosphorus load. The information indicates whether lake management efforts should focus exclusively on the tributary watershed, or should include control of internal loading.

Having this background material on the study of lakes, one is better able to consider the results of the 1995 study of Antler Lake.

1995 Antler Lake Water Quality

Data collected from Antler Lake during 1995 indicate its water quality is excellent. The water quality data are presented in Appendix A and are discussed in the following sections:

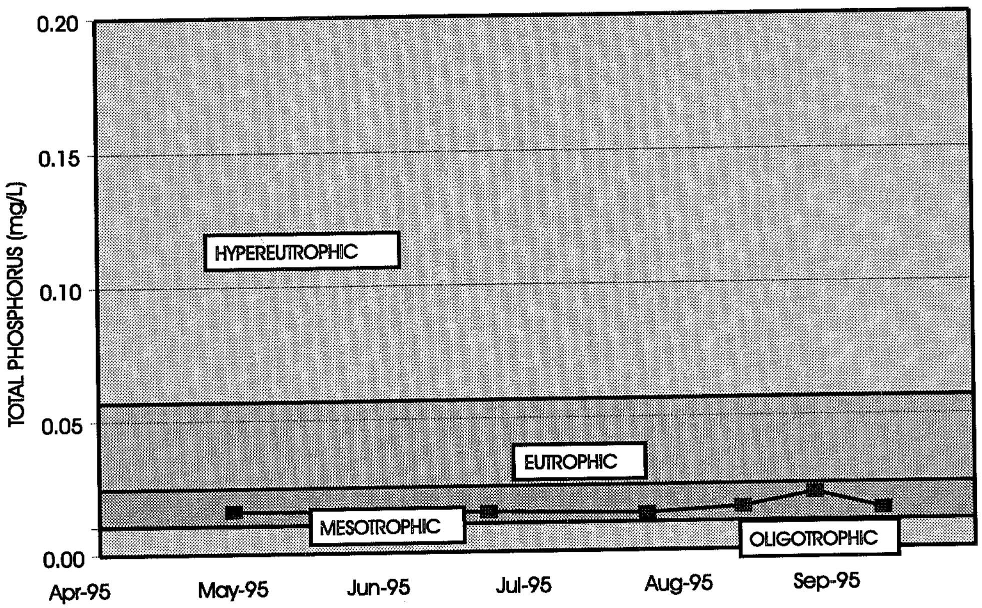
- Total Phosphorus
- Chlorophyll *a*
- Secchi Disc Transparency
- Temperature and Dissolved Oxygen Isopleths
- Phytoplankton
- Zooplankton
- Macrophyte (Aquatic Weed) Survey

Total Phosphorus

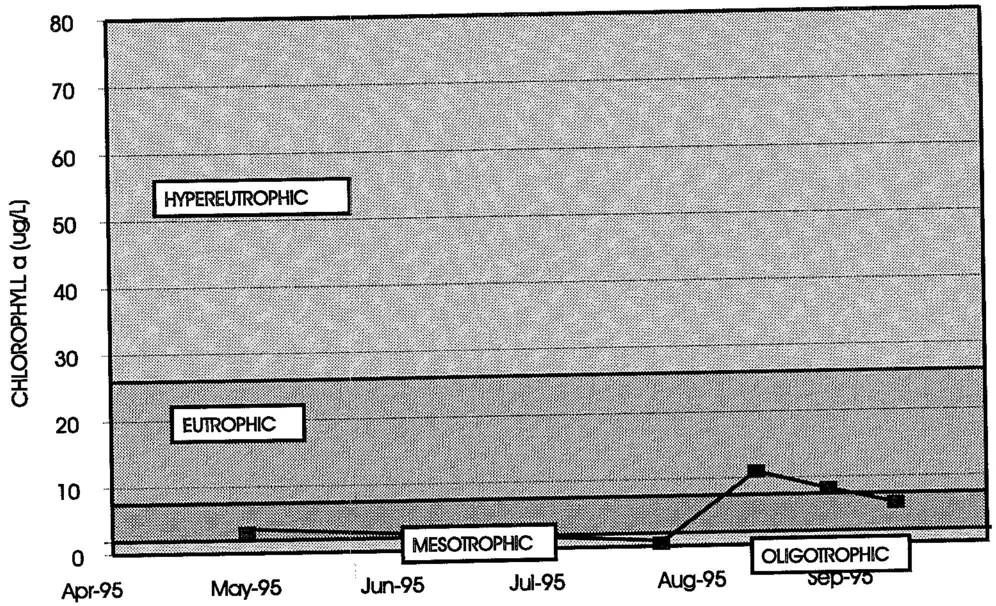
As discussed previously, total phosphorus is the nutrient limiting algal growth within Antler Lake. As such, it indicates the lake's potential for algal growth, and is a good indication of the lake's level of eutrophication. Total phosphorus data collected from Antler Lake during 1995 indicate the lake would have a designated trophic status of mesotrophic (See Figure 2). This means the lake is receiving a moderate level of phosphorus loading and its water quality is excellent. Phosphorus concentrations were relatively stable throughout the monitoring period, except for an increase during late August. These data indicate that judicious management of the lake's watershed is essential to preserving the lake's current mesotrophic trophic status.

Antler Lake total phosphorus data collected at depths indicate phosphorus recycling from bottom sediments occurs during the summer months. These data, however, suggest that thermal stratification retains the recycled nutrients in the bottom waters until the fall overturn. Therefore, these nutrients are prevented from mixing with epilimnetic surface waters during the summer period. Thus, Antler Lake management efforts should focus on control of external phosphorus loading (i.e., from the watershed) rather than internal loading.

ANTLER LAKE: 1995 SUMMER EPILIMNETIC TOTAL PHOSPHORUS CONCENTRATIONS



ANTLER LAKE: 1995 SUMMER EPILIMNETIC CHLOROPHYLL CONCENTRATIONS



ANTLER LAKE: 1995 SECCHI DISC TRANSPARENCIES

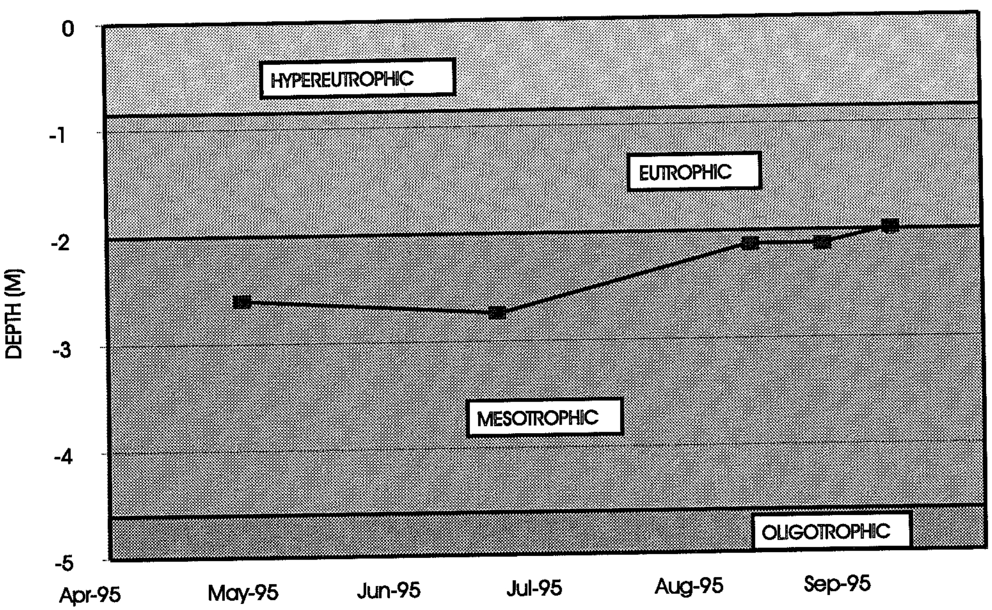


Figure 2

CHANGES IN CONCENTRATION OF TOTAL PHOSPHORUS AND CHLOROPHYLL a AND SECCHI DISC TRANSPARENCIES FOR ANTLER LAKE, 1995

Chlorophyll *a*

Chlorophyll *a* is a pigment found within algae. Its measurement indicates the quantity of algae found within a lake, and provides a measure of a lake's level of eutrophication. The average summer chlorophyll *a* value from Antler Lake was within the mesotrophic category, indicating the lake generally noted a moderate algal population. However, individual values indicated the lake's trophic status ranged from mesotrophic to mildly eutrophic during the summer period (see Figure 2). These data indicate algal yield from the lake's phosphorus concentration is slightly higher than expected. As indicated previously, average phosphorus concentrations were entirely within the mesotrophic category. The data further indicate that algal populations increased throughout the summer.

Chlorophyll *a* data corroborate the phosphorus data and support the need for a management plan to prevent additional increases in the lake's algal population. The lake's current chlorophyll *a* concentrations are not considered problematic. However, the mildly eutrophic trophic status indicates that additional increases would likely result in problematic conditions during the summer period.

Secchi Disc Transparency

Secchi disc transparency provides a measure of a lake's water clarity. Because increasing eutrophication is associated with decreasing water clarity, Secchi disc measurements can provide an indication of a lake's level of eutrophication. The 1995 Antler Lake average summer Secchi disc transparency value was within the mesotrophic category. Individual values were within the mesotrophic category, although a borderline mesotrophic/eutrophic value was noted in September (see Figure 2). The data indicate the lake noted excellent water transparency throughout the 1995 summer period. However, the data corroborate the chlorophyll *a* and phosphorus data and support the need for a management plan. Judicious management will prevent additional increases in the lake's algal population and consequential decreases in the lake's water transparency.

User perceptions and user expectations relative to lake water quality are generally correlated with water clarity. Therefore, water transparency has been correlated with a lake's suitability for recreational use. Increasing algal blooms and decreasing water transparency have been associated with recreational use impairment because of user perceptions that the lake is unsuitable for some types of recreational activities. The Metropolitan Council completed a survey to determine recreational use impairment over a range of Secchi disc measurements. Survey results indicate that minimal recreational use impairment occurs over a Secchi disc range of 2 to 4 meters, which includes the range of values measured in Antler Lake during 1995 (i.e., 2.0-2.7 meters) (Osgood, 1989). Therefore, the current water quality of Antler Lake makes it suitable for all types of recreational activities throughout the summer period.

Temperature, Dissolved Oxygen, and Conductivity Isopleths

Depth/time relationships or isopleths were used to determine the:

- Stratification (mixing) pattern (i.e., temperature isopleths)
- Loss of oxygen near the lake bottom (i.e., oxygen isopleths)
- Quantity of dissolved solids in the lake (i.e., conductivity isopleths)

Temperature isopleths indicate Antler Lake became thermally stratified following spring overturn and remained stratified throughout the summer period (Figure 3). Stratification caused the hypolimnion (bottom waters) to be separated from the epilimnion (surface waters) during the summer period.

The density difference between the warm surface waters and the cold bottom waters caused the bottom waters to be "sealed-off" from the atmosphere by the surface waters. The oxygen in the bottom waters was not replenished by wind and wave action as occurred in the surface waters throughout the summer. Instead, it was depleted by decomposition of organic matter. The dissolved oxygen isopleths indicated that extremely low dissolved oxygen concentrations were noted in the bottom waters during the summer period (Figure 4).

Oxygen depletions in the bottom waters of Antler Lake affect its fishery. The lake's walleye, largemouth bass, northern pike, and panfish population are unable to inhabit the lake's cold bottom waters because of the low oxygen concentrations. The fish are, instead, restricted to the upper half of the lake, which contains sufficient oxygen to meet their needs. Walleye is a cold water species and is best suited for colder waters. Inhabiting the warmer waters of Antler Lake is less than ideal for this species.

Conductivity is a measurement of dissolved solids, and therefore, is an indicator of overall water quality. Conductivity measurements in Antler Lake were low throughout the monitoring period (see Figure 5) and indicate the lake's water quality was excellent. Measurements of the bottom waters were somewhat higher than surface water measurements. The higher bottom water measurements are indicative of the higher phosphorus concentrations near the lake's bottom, which were caused by the release of phosphorus from the lake's sediments.

ANTLER LAKE
TEMPERATURE ISOPLETHS (C)

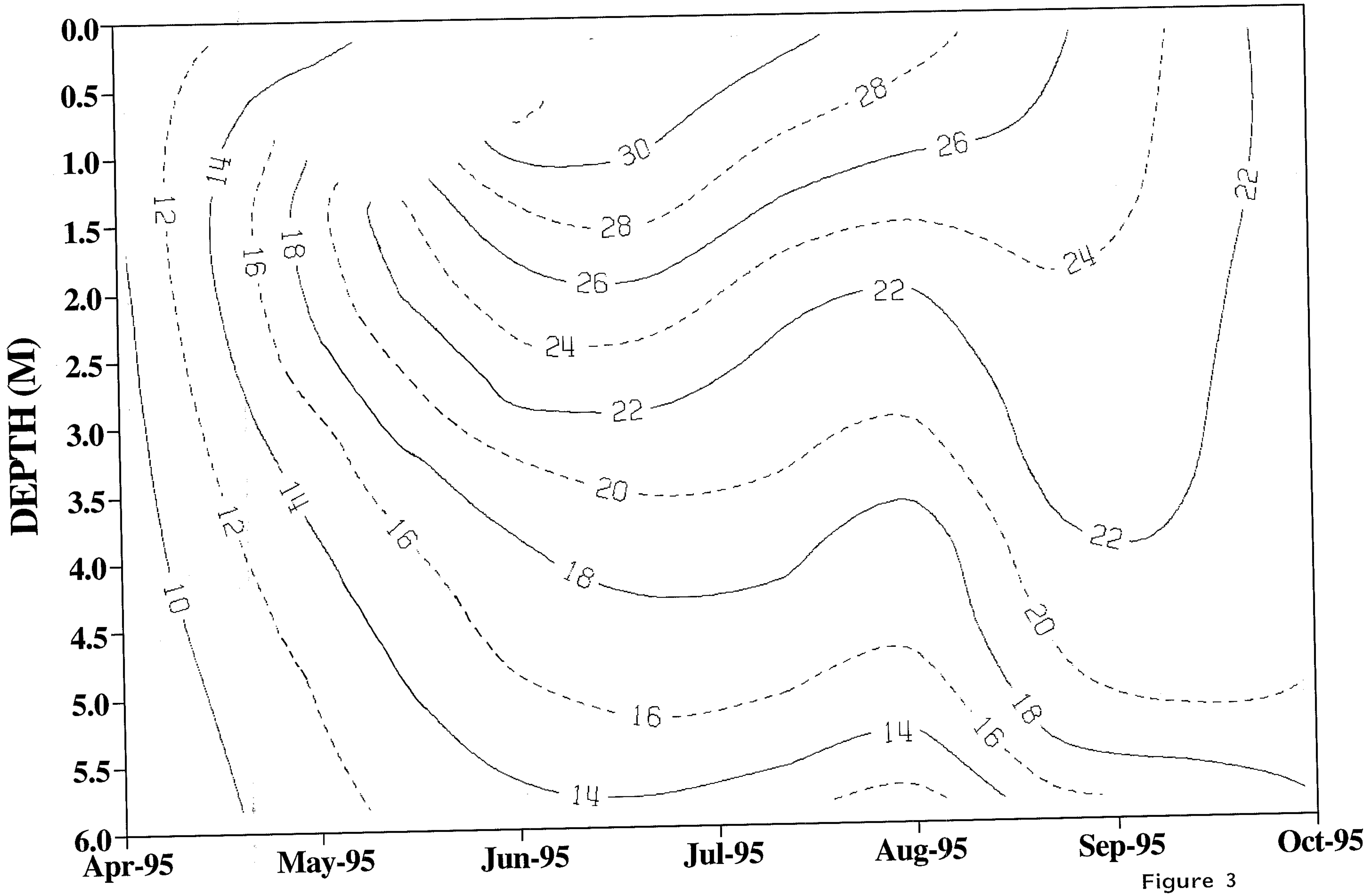


Figure 3

1995 ANTLER LAKE
TEMPERATURE ISOPLETHS

ANTLER LAKE
DISSOLVED OXYGEN ISOPLETHS (mg/L)

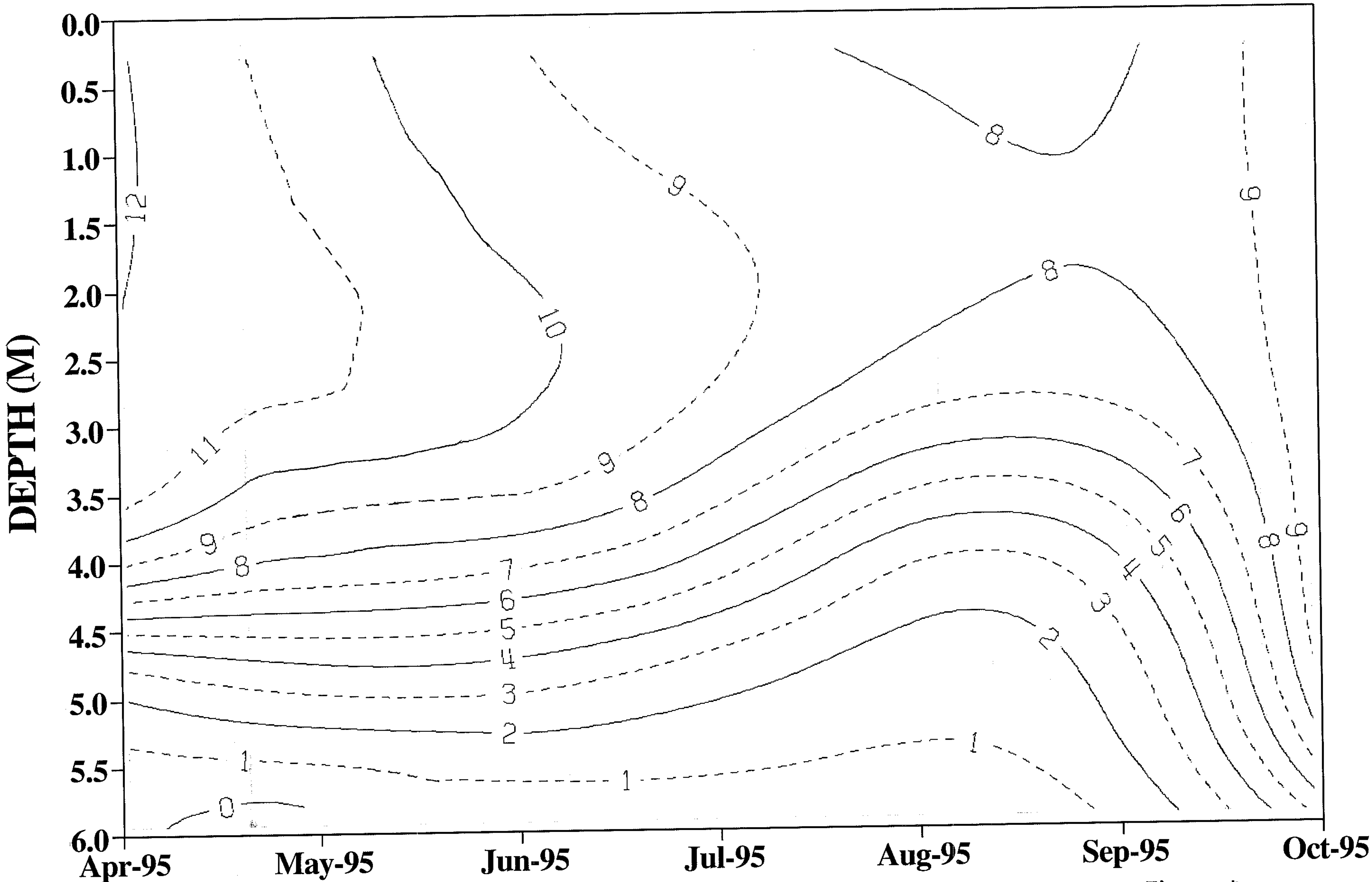


Figure 4

1995 ANTLER LAKE
DISSOLVED OXYGEN ISOPLETHS

ANTLER LAKE
CONDUCTIVITY ISOPLETHS (UMHOS/CM @ 25C)

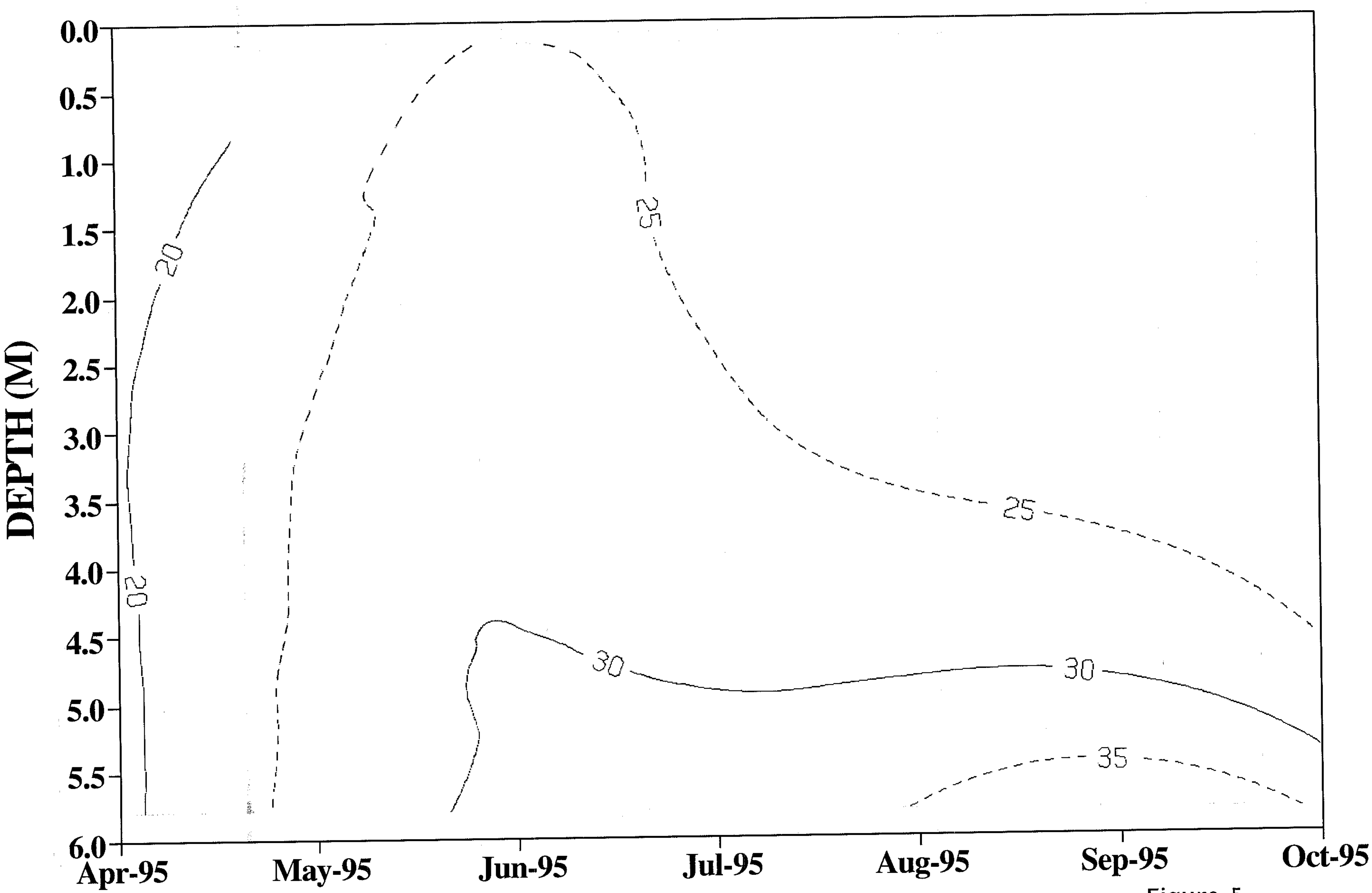


Figure 5

1995 ANTLER LAKE
CONDUCTIVITY ISOPLETHS

Phytoplankton (Algae)

The phytoplankton species in Antler Lake form the base of the lake's food web and directly impact the lake's fish production. Phytoplankton, also called algae, are small aquatic plants naturally present in all lakes. They derive energy from sunlight (through photosynthesis) and from dissolved nutrients found in lake water. They provide food for several types of animals, including zooplankton, which are in turn eaten by fish. A phytoplankton population in balance with the lake's zooplankton population is ideal for fish production. An inadequate phytoplankton population reduces the lake's zooplankton population and adversely impacts the lake's fishery. Excess phytoplankton, however, can interfere with the recreational usage of a lake and is considered problematic.

The phytoplankton data corroborate the total phosphorus, chlorophyll *a*, and Secchi disc data and suggest the lake currently has excellent water quality. The lake's 1995 phytoplankton population consisted of a diverse assemblage representing green algae, blue-green algae, golden-brown algae, diatoms, cryptomonads, euglenoids, and dinoflagellates. The numbers of algal cells increased throughout the summer period, except for a decline during late July (see Figure 6). More than half of the lake's algal population during 1995 were edible by zooplankton and are considered desirable food for the aquatic animals within the lake's ecosystem (see Figure 7).

Protection of the current water quality of Antler Lake will also protect the current phytoplankton community from changes which would adversely impact the lake's ecosystem. Increased phosphorus loading to a lake is generally correlated with increased dominance by blue-green algae. Because blue-greens are generally inedible to fish, waterfowl, and most zooplankters, such a change adversely impacts the lake's ecosystem. The dominance by blue-green algae in Antler Lake during late July and early August of 1995 point to the importance of judicious management to prevent phosphorus load increases to the lake.

Zooplankton

Zooplankton are the second step in the Antler Lake food web, and are considered vital to its fishery. They are microscopic aquatic animals which feed on particulate matter, including algae, and are in turn eaten by fish. Protection of the lake's zooplankton community through judicious management practices affords protection to the lake's fishery.

Figure 6

ANTLER LAKE EPILIMNETIC PHYTOPLANKTON COUNT DATA SUMMARY BY MAJOR ALGAL GROUP

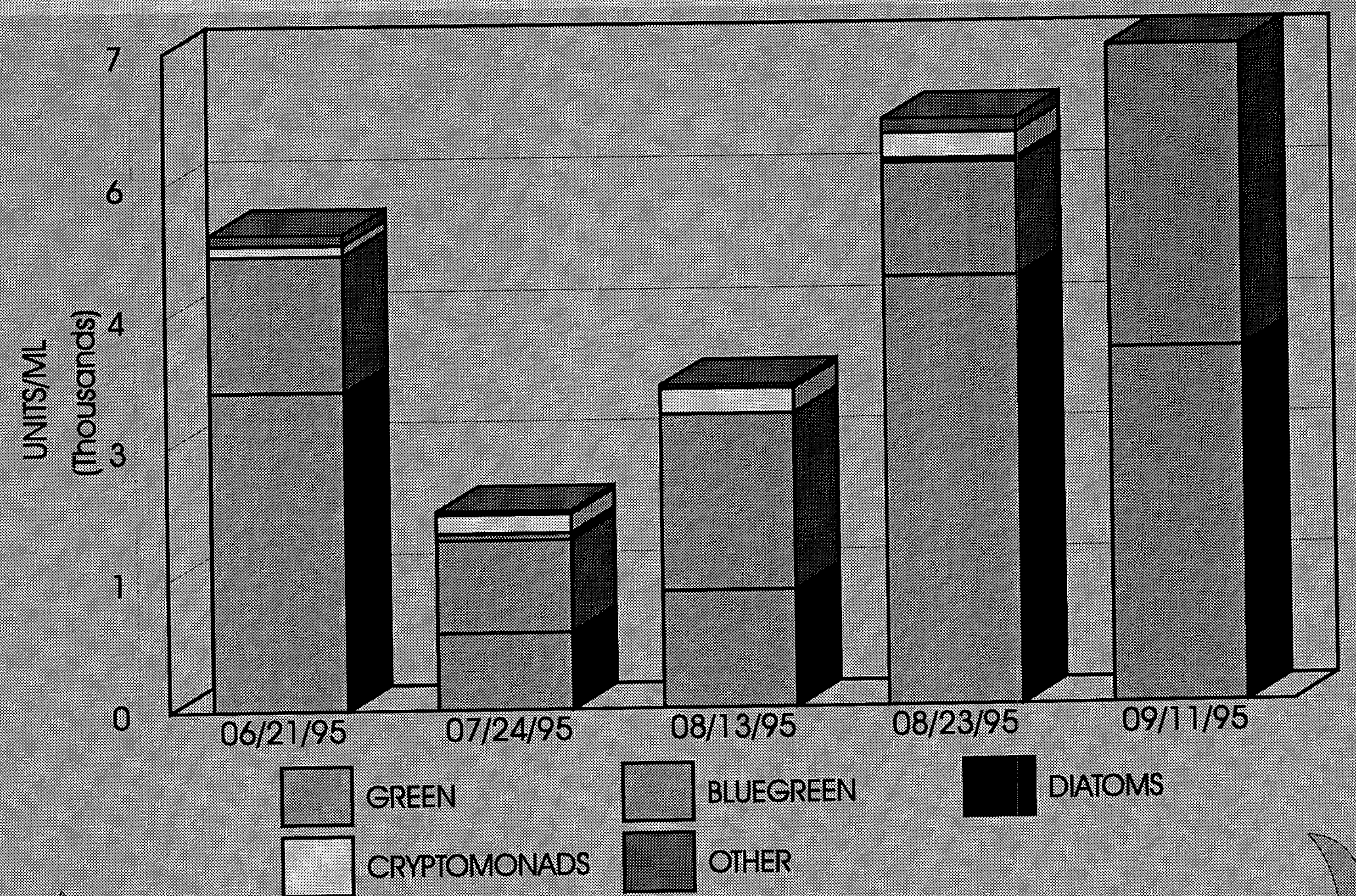
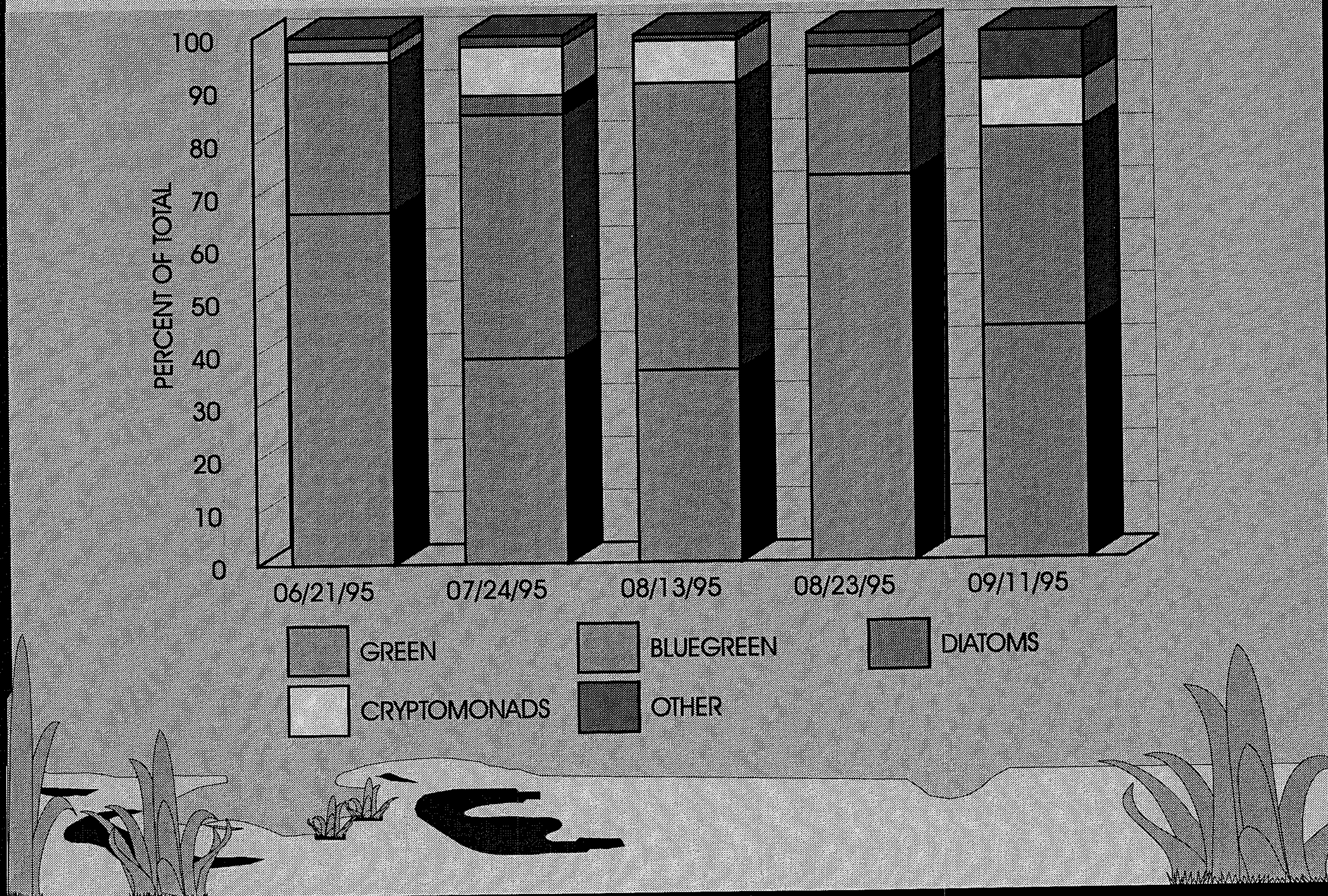


Figure 7

ANTLER LAKE EPILIMNETIC PHYTOPLANKTON DATA SUMMARY BY MAJOR ALGAL GROUP



Three types of zooplankton were found in Antler Lake: rotifers, cladocera, and copepods. The population, however, was generally dominated by rotifers (see Figure 8). The zooplankton community in Antler Lake provides food for the lake's fishery. In fact, the reduced numbers of cladocera and copepods in Antler Lake indicate fish are preying upon these groups. However, the current zooplankton community has little predatory impact upon the lake's algal community. Grazing by zooplankton during the summer of 1995 was estimated to be negligible based upon the species and numbers noted (see Figure 9). The rotifers and copepods in Antler Lake graze primarily on extremely small particles of plant matter and do not significantly affect the lake's water quality. The cladocera graze primarily on algae. If present in abundance, large cladocera can decrease the number of algae and improve water transparency within a lake. The low grazing rate during 1995 was mainly due to the absence of large bodied cladocera. The lake's cladocera group consistently was comprised of small-bodied species with a negligible grazing impact on the lake.

The assessment of the lake's zooplankton community suggests prevention of nuisance algal blooms in Antler Lake must be accomplished through the management of nonpoint source discharges. Zooplankton predation does not control algal growth in Antler Lake, and therefore, algal growth must be controlled through control of phosphorus loading from the lake's tributary watershed.

The primary function of the zooplankton community appears to be a food source for the lake's fish community. Therefore, preservation of the zooplankton community is requisite to preserving the lake's fishery.

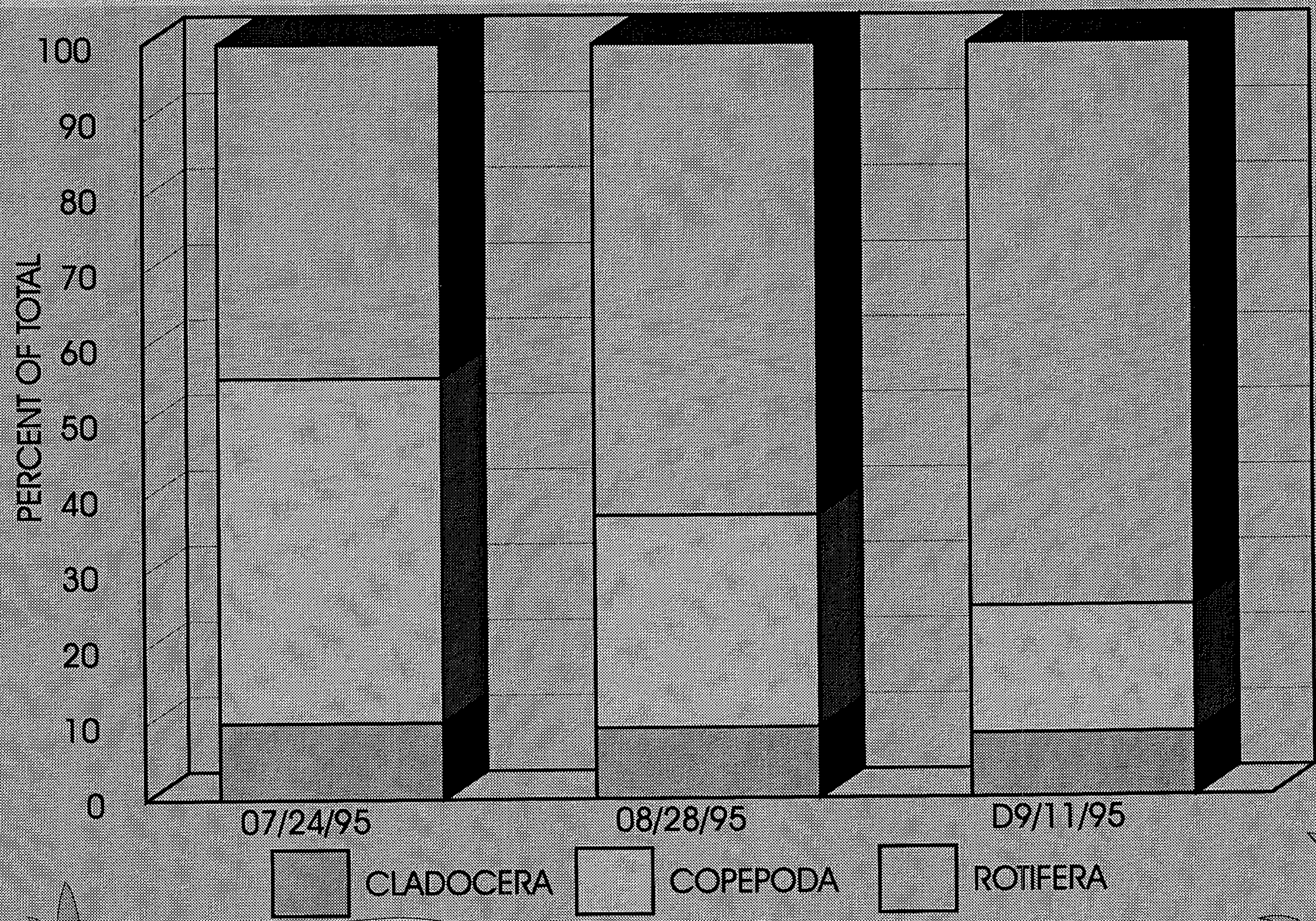
Macrophytes

Aquatic plants are a natural part of most lake communities and provide many benefits to fish, wildlife, and people. In lakes, life depends--directly or indirectly--on water plants. They are the primary producers in the aquatic food chain, converting the basic chemical nutrients in the water and soil into plant matter, which becomes food for all other aquatic life.

Within a lake, pond, or impoundment, aquatic plants grow in the area known as the littoral zone--the shallow transition zone between dry land and the open water area of the lake. The littoral zone extends from the shore to a depth of about 15 feet, depending on the depth of light penetration. Turbid or colored water, which limits light penetration, may restrict plant growth. In lakes where water clarity is low all summer, aquatic plants will not grow throughout the littoral zone, but will be restricted to the shallow areas near shore.

Figure 8

ANTLER LAKE ZOOPLANKTON DATA SUMMARY
% COMPOSITION BY MAJOR GROUP



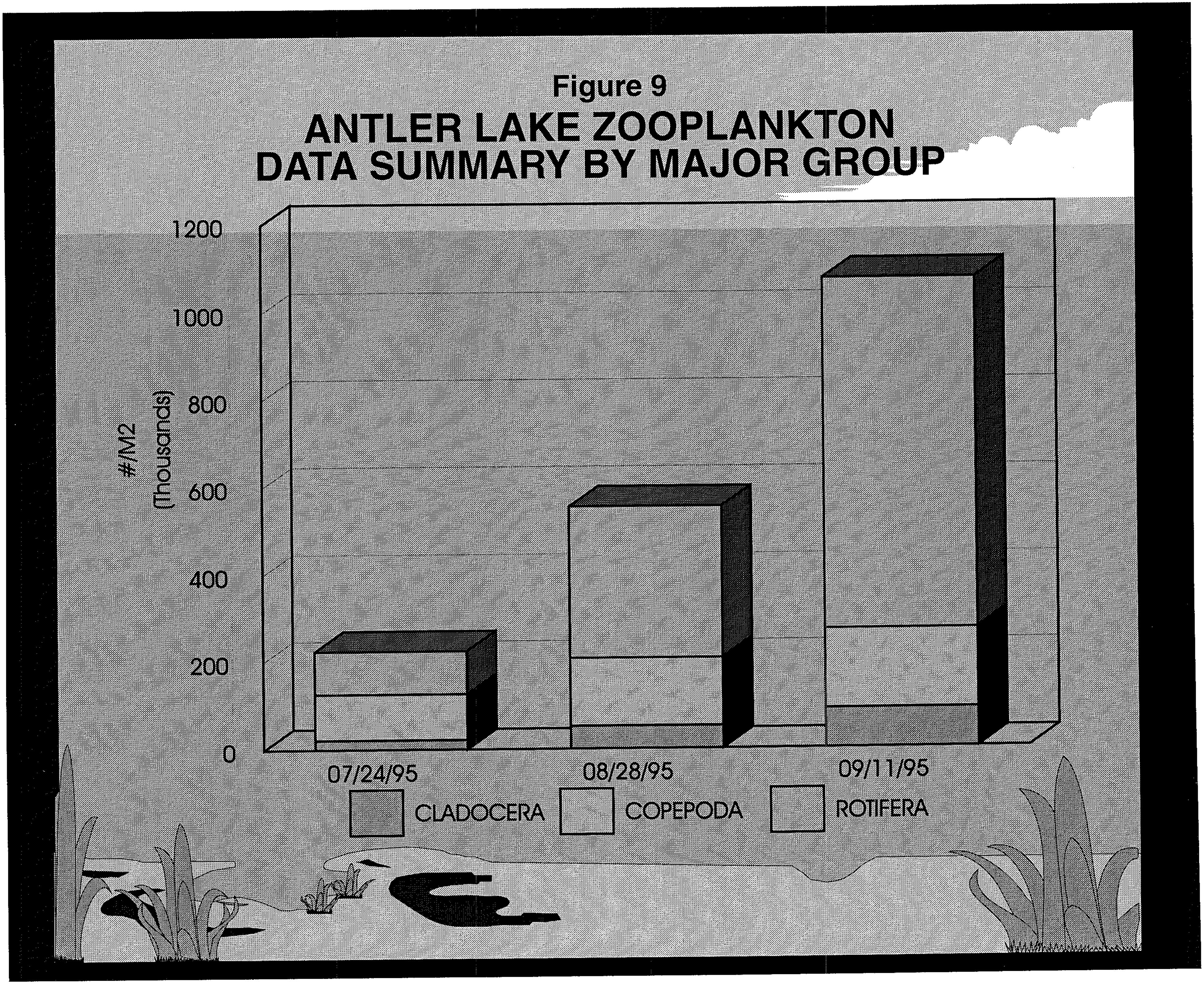


Figure 9
ANTLER LAKE ZOOPLANKTON
DATA SUMMARY BY MAJOR GROUP
#/M2
(Thousands)
1200
1000
800
600
400
200
0
07/24/95
08/28/95
09/11/95
CLADOCERA
COPEPODA
ROTIFERA

Other physical factors also influence the distribution of plants within a lake or pond. For example, aquatic plants generally thrive in shallow, calm water protected from heavy wind, wave, or ice action. However, if the littoral area is exposed to the frequent pounding of waves, plants may be scarce. In a windy location, the bottom may be sand, gravel, or large boulders--none of which provides a good place for plants to take root. In areas where a stream or river enters a lake, plant growth can be variable. Nutrients carried by the stream may enrich the sediments and promote plant growth; or suspended sediments may cloud the water and inhibit growth.

Aquatic plants are grouped into four major categories:

- **Algae**—These plants have no true roots, stems, or leaves and range in size from tiny, one-celled organisms to large, multi-celled plant-like organisms, such as *Chara*. Phytoplankton (planktonic algae), which consist of free-floating microscopic plants, grow throughout both the littoral zone and the well-lit surface waters of an entire lake. Other forms of algae, including *Chara* and some stringy filamentous types (such as *Cladophora*) are common only in the littoral area.

- **Submersed**—These plants have stems and leaves that grow entirely underwater, although some may also have floating leaves. Flowers and seeds on short stems that extend above the water may also be present. Submersed plants grow from near shore to the deepest part of the littoral zone and display a wide range of plant shapes. Depending on the species, they may form a low-growing "meadow" near the lake bottom, grow with lots of open space between plant stems, or form dense stands or surface mats.

- **Floating-Leaf**—These plants are often rooted in the lake bottom, but their leaves and flowers float on the water surface. Water lilies are a well-known example. Floating-leaf plants typically grow in protected areas where there is little wave action.

- **Emergent**—These plants are rooted in the lake bottom, but their leaves and stems extend out of the water. Cattails, bulrushes, and other emergent plants typically grow in wetlands and along the shore, where the water is less than 4 feet deep.

Antler Lake contains a diverse assemblage of macrophytes (see Figures 10 and 11). Twenty-two species were noted during the 1995 surveys. Diversity, rather than dominance by any one species, characterizes the lake's macrophyte community. In general, macrophyte growth did not occur at depths greater than 13 feet during August and 15 feet during June. Growth generally occurred at a moderate density. No protected species or endangered species were noted in Antler Lake. However, *Myriophyllum farwellii*, a WDNR species of concern, was noted in Antler Lake.

Figure 10

ANTLER LAKE MACROPHYTE SURVEY
JUNE 23, 1995

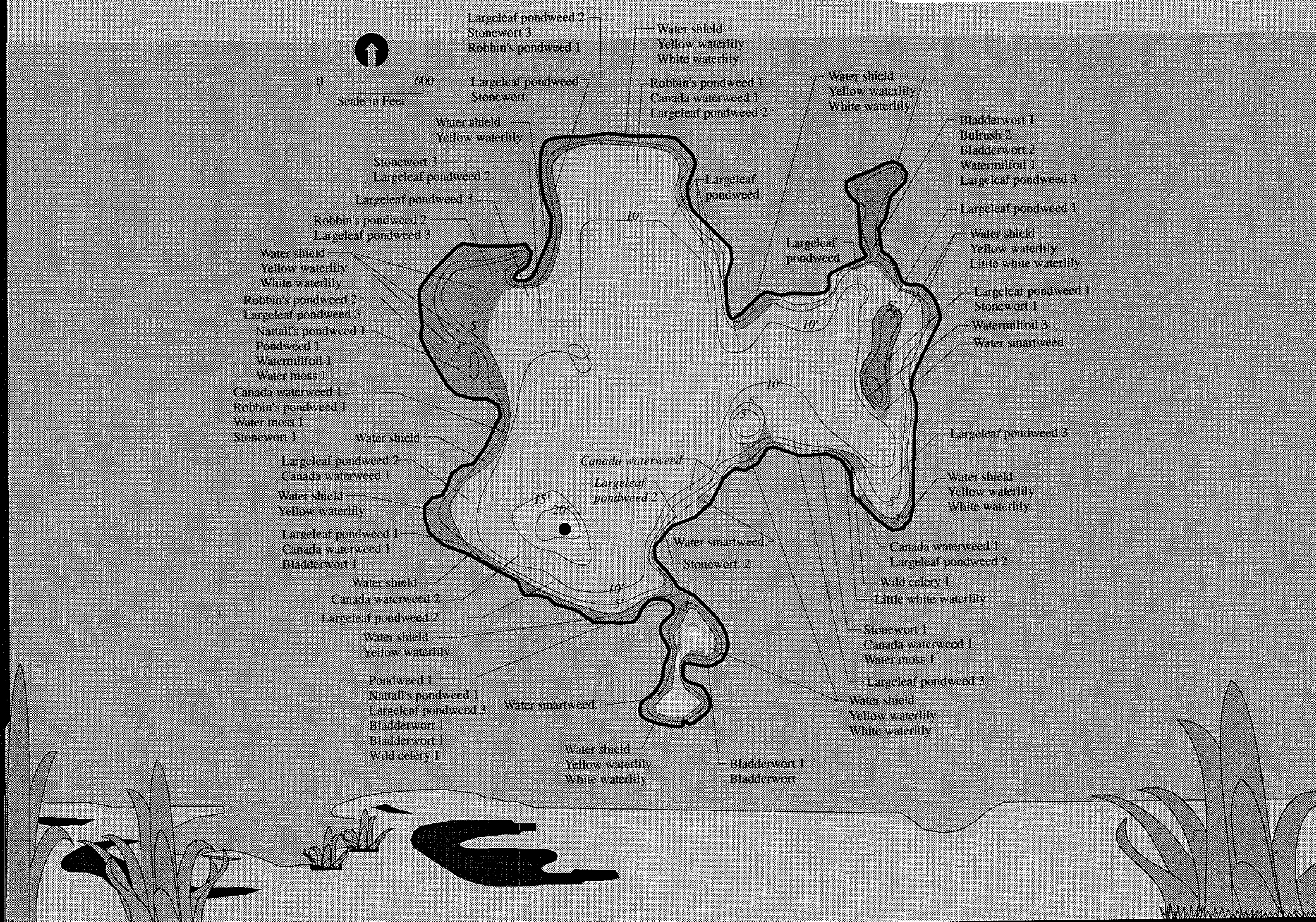
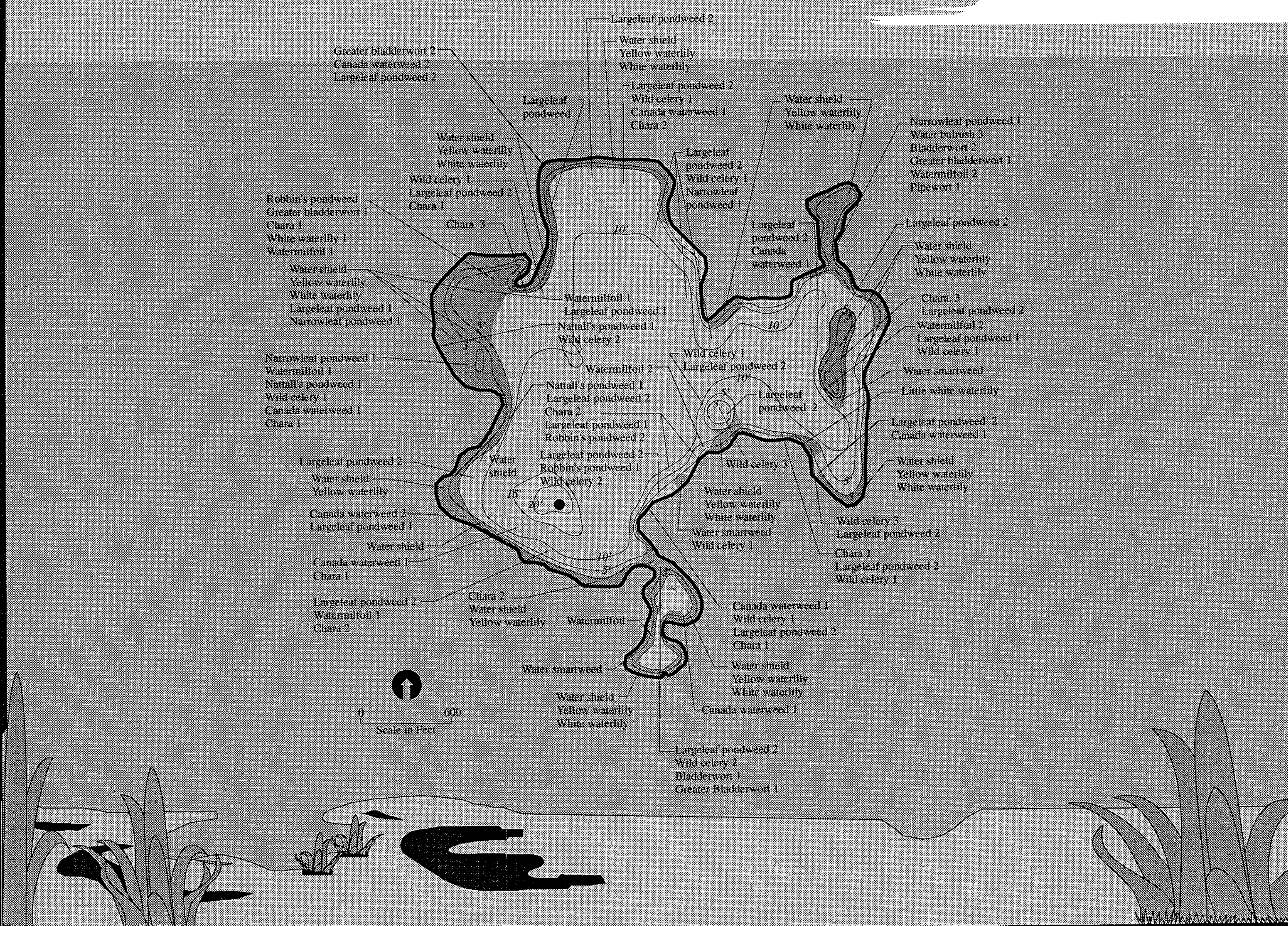


Figure 11

ANTLER LAKE MACROPHYTE SURVEY
AUGUST 25, 1995



The Antler Lake macrophyte community performs a number of valuable functions. Table 2 summarizes the functions performed by individual species noted in the lake. These include providing:

- Habitat for fish, insects, and small invertebrates
- Food for waterfowl, fish, and wildlife
- Oxygen producers
- Spawning areas for fish in early spring
- Help to stabilize marshy borders of the lake; help protect shorelines from wave erosion
- Nesting sites for waterfowl and marsh birds

Macrophytes in Antler Lake consisted exclusively of native species. No exotic (i.e., nonnative) species were sited. During 1995, the most frequently occurring species was *Potamogeton amplifolius* (Largeleaf Pondweed). Largeleaf pondweeds provide excellent habitat for panfish, largemouth bass, muskellunge, and northern pike; bluegills nest near these plants and eat insects and other small animals found on the leaves; walleyes use these pondweeds for cover.

Watershed Land Use Evaluation

The Antler Lake watershed is shown on Figure 12. A watershed land-use evaluation was completed by the Polk County Land Conservation Department (see Figure 13). The evaluation indicates the lake's watershed is primarily comprised of undeveloped forest land and lake shore residences. Small quantities of agricultural land use and wetlands were also noted.

Phosphorus Loading Estimate

The Polk County Land Conservation Department has estimated the annual phosphorus load to Antler Lake from its watershed. Based on this estimate, the lake's annual phosphorus load is approximately 44 kilograms. The annual phosphorus load by watershed land use is shown in Figure 14. A more precise estimate of the lake's annual phosphorus load will be completed during the Phase II portion of the Lake Management Plan project.

Table 2

Functions of Aquatic Plant Species Found in Antler Lake.

Scientific Name (Common Name)	Plant Type	Plant Functions
Elodea canadensis (Canada Waterweed)	Submersed	Provides habitat for many small aquatic animals, which fish and wildlife eat.
Potamogeton epihydrus (Nattall's pondweed) *Potamogeton robbinsii* (Robbin's pondweed) *Potamogeton strictifolius* (Narrowleaf pondweed) *Potamogeton pusillus* (Pondweed)	Submersed	Provide some cover for bluegills, perch, and northern pike, though these fish prefer broad-leaf pondweeds; good cover for walleye; provide food for waterfowl; support aquatic insects and many other small animals that fish and ducklings eat.
Potamogeton amplifolius (Large-leaf Pondweed)	Submersed	Broad-leaf pondweeds provide excellent habitat for panfish, largemouth bass, and northern pike; bluegills nest near these plants and eat insects and other small animals found on the leaves; walleyes use these pondweeds for cover.
Vallisneria americana (Wild Celery)	Submersed	Provides shade and shelter for bluegills, young perch, and largemouth bass; choice food of waterfowl, particularly diving ducks; attracts muskrats, marsh birds, and shore birds.
Myriophyllum tenelum (Milfoil) *Myriophyllum farwelli* (Milfoil)	Submersed	Provides cover for fish and invertebrates; supports insects and other small animals eaten by fish; waterfowl occasionally eat the fruit and foliage.
Chara (Muskgrass)	Algae	Stabilizes bottom sediments; provides food for waterfowl and cover for fish. It also supports insects and other small aquatic animals, which are important foods for trout, bluegills, smallmouth bass, and largemouth bass.

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Table 2 (Continued)

Functions of Aquatic Plant Species Found in Antler Lake.

Scientific Name (Common Name)	Plant Type	Plant Functions
Nuphar variegatum (Yellow water lily)	Floating-leaf	Fruits are eaten by waterfowl and muskrats; the underwater roots contain starch and are edible.
Nymphaea tuberosa (White Water lily) *Nymphaea tetragona* (Little White Water lily)	Floating-leaf	Provides excellent habitat for largemouth bass and sunfish; seeds are eaten by waterfowl; highly decorative--often planted in water gardens.
Brasenia schreberi (Watershield)	Floating-leaf	Provides shade and cover for panfish, largemouth bass, and northern pike; is eaten by waterfowl.

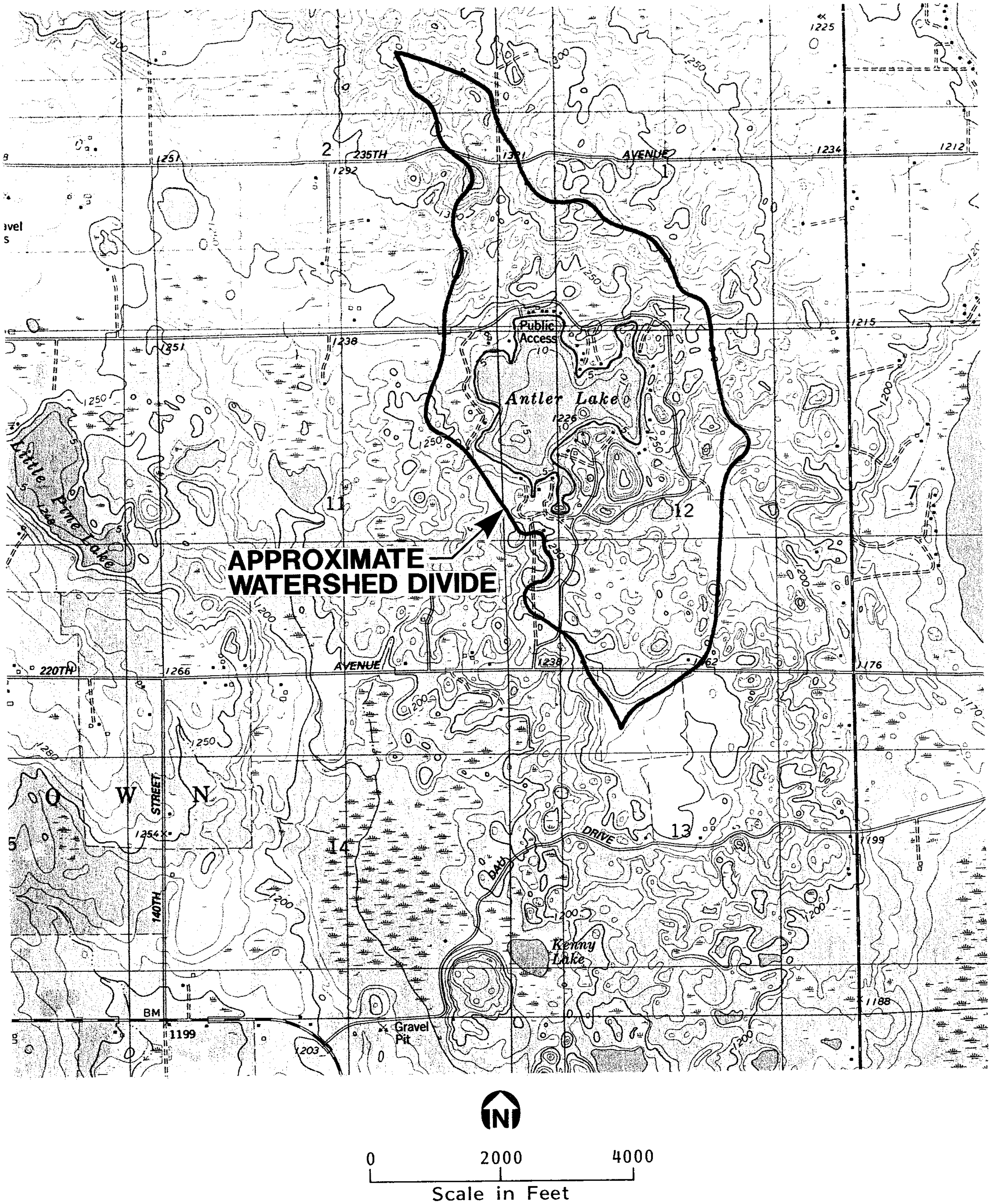


Figure 12

ANTLER LAKE WATERSHED

Fig 12

Figure 13

ANTLER LAKE WATERSHED LAND USE

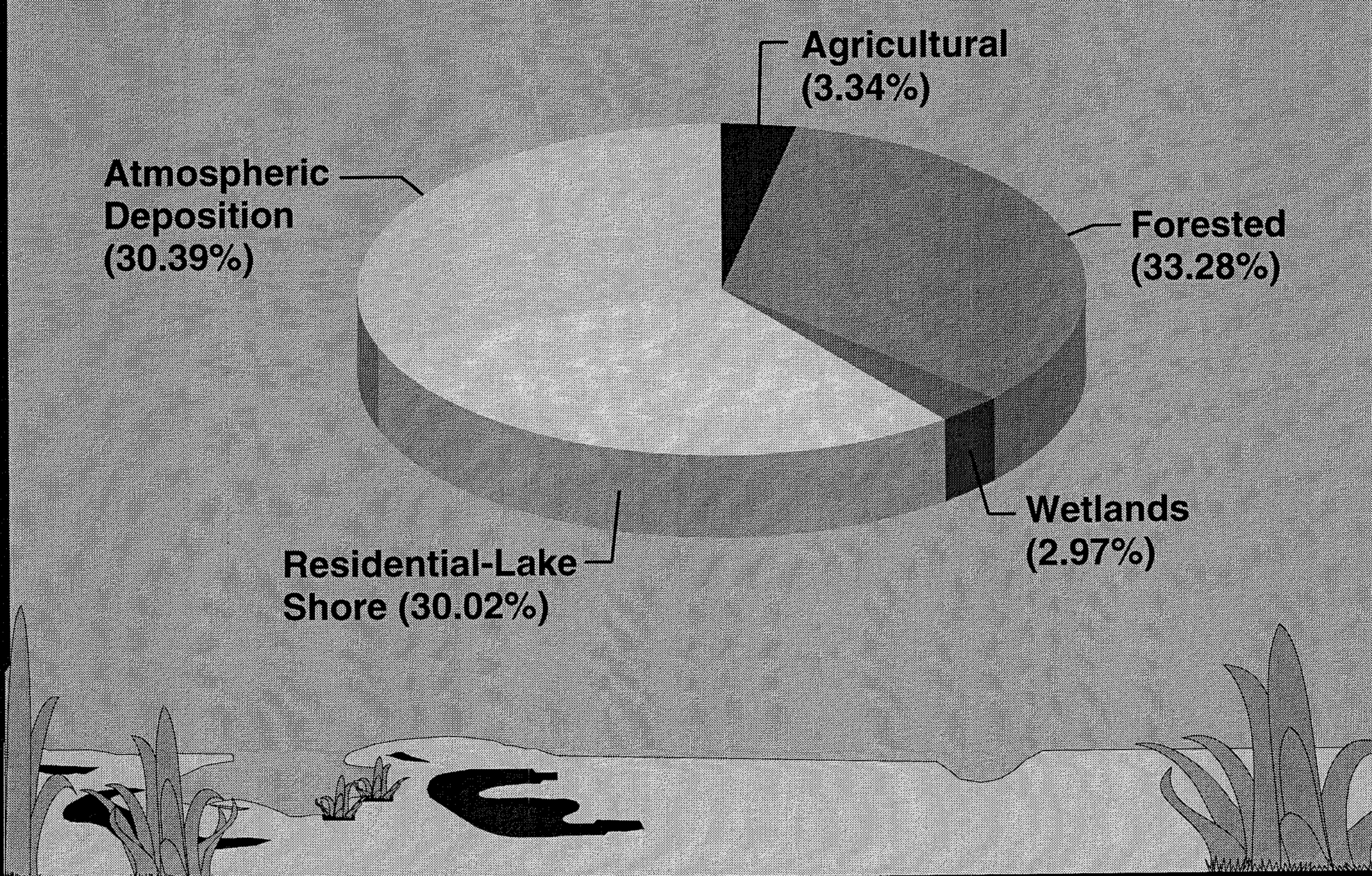
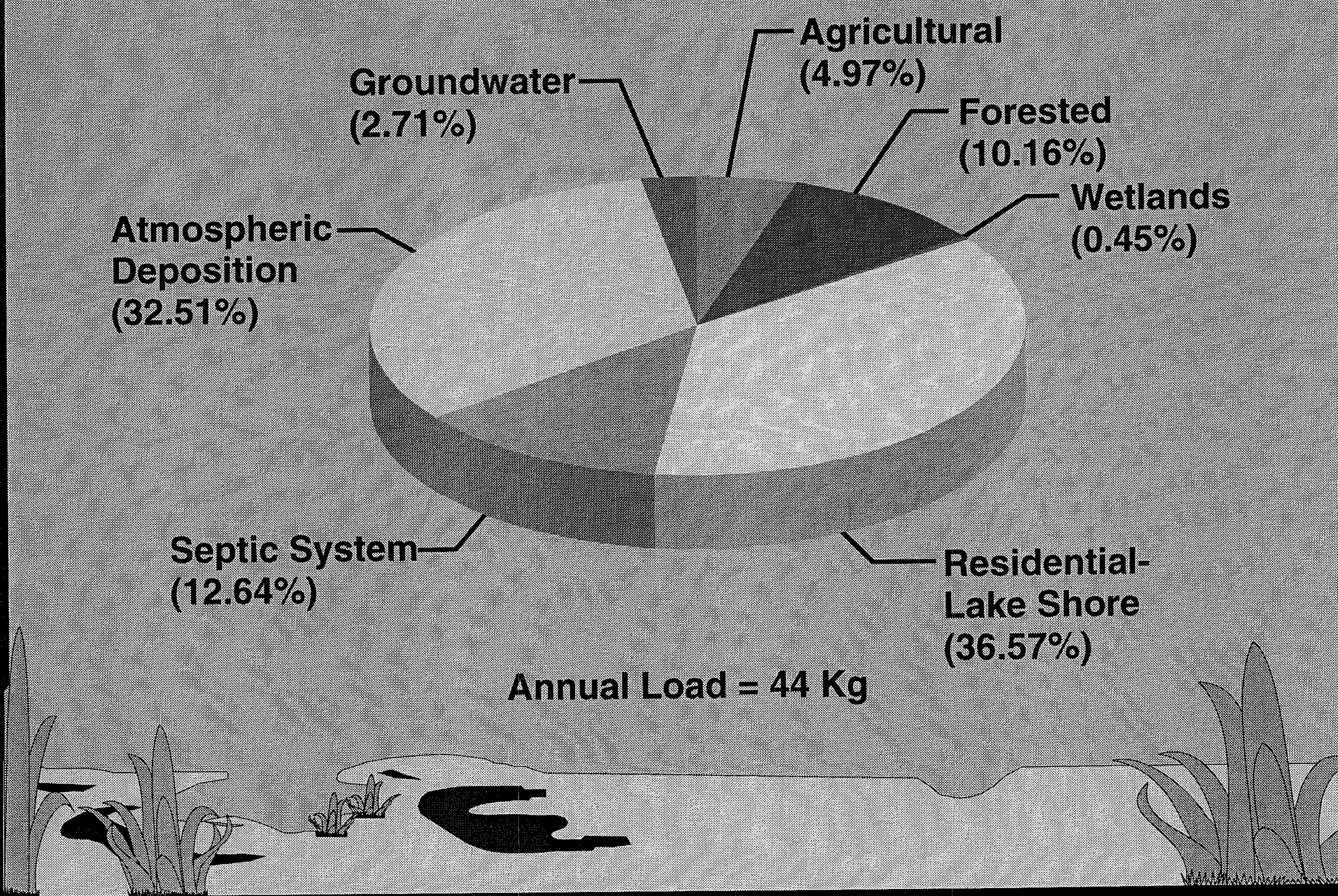


Figure 14

ANTLER LAKE ANNUAL PHOSPHORUS LOAD: % OF ANNUAL LOAD BY WATERSHED LAND USE



Lake Level Data

A summary of daily lake level measurements is found in Appendix B. The measurements will be used to determine the lake's hydrologic budget during the Phase II portion of the Lake Management Plan project.

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Appendix A

Antler Lake Water Quality Data

1995 Antler Lake Water Quality Data

Date	Max. Depth (meters)	Secchi Disc (meters)	Depth (meters)	Chl. a (ug/L)	D.O. (mg/L)	Temp. (C)	Cond. (Umho @ 25 C)	Total P (mg P/L)	Sol. React. P (mg P/L)	NH3 (mg N/L)	N03 + N02 (mg N/L)	TKN (mg N/L)	pH (S.U.)	Alk. (mg/L)
04/29/95		2.6	0-2	3.13*	--	--	--	0.016	<0.002*	<0.027	<0.01	0.6	7.31	14
			0	--	12.1	10.5	16	--	--	--	--	--	--	--
			1	--	12.2	10	16	--	--	--	--	--	--	--
			2	--	12.0	9.5	17	--	--	--	--	--	--	--
			3	--	11.9	9	21	--	--	--	--	--	--	--
			3.5	--	--	--	--	0.018	--	--	--	--	--	--
			4	--	12.0	9	17	--	--	--	--	--	--	--
			5	--	0.3	8	17	0.014	--	--	--	--	--	--
			6	--	0.3	8	17	--	--	--	--	--	--	--
			Bottom	--	--	--	--	0.013	--	--	--	--	--	--
06/21/95		2.7	0-2	--	--	--	--	0.015	<0.002	<0.027	<0.01	0.6	7.53	14
			1	--	8.8	31	32	--	--	--	--	--	--	--
			2	--	10	27	30	--	--	--	--	--	--	--
			3	--	10.2	20.5	33	--	--	--	--	--	--	--
			3.5	--	--	--	--	0.014	--	--	--	--	--	--
			4	--	10	18.5	33	--	--	--	--	--	--	--
			5	--	2.4	16	35	0.027	--	--	--	--	--	--
			6	--	1.2	14	36	--	--	--	--	--	--	--
			Bottom	--	--	--	--	0.035	--	--	--	--	--	--
07/10/95			1	--	9	24	18	--	--	--	--	--	--	--
			2	--	9.2	22	19	--	--	--	--	--	--	--
			3	--	9.4	21	19	--	--	--	--	--	--	--
			4	--	7	20	20	--	--	--	--	--	--	--
			5	--	1.5	16	23	--	--	--	--	--	--	--
			6	--	1	13	27	--	--	--	--	--	--	--
			7	--	--	--	--	--	--	--	--	--	--	--

1995 Antler Lake Water Quality Data

Date	Max. Depth (meters)	Secchi Disc (meters)	Depth (meters)	Chl. a (ug/L)	D.O. (mg/L)	Temp. (C)	Cond. (Umho @ 25 C)	Total P (mg P/L)	Sol. React. P (mg P/L)	NH3 (mg N/L)	N03 + N02 (mg N/L)	TKN (mg N/L)	pH (S.U.)	Alk. (mg/L)
07/24/95			0-2	0.49	--	--	--	0.014	<0.002	<0.027	<0.01	0.5	7.45	14
			1	--	8.5	23	21	--	--	--	--	--	--	--
			2	--	8.5	20	22	--	--	--	--	--	--	--
			3	--	8	16	24	--	--	--	--	--	--	--
			3.5	--	--	--	--	0.092	--	--	--	--	--	--
			4	--	2.0	13	25	--	--	--	--	--	--	--
			5	--	1.0	11	40	0.053	--	--	--	--	--	--
			6	--	--	9	--	--	--	--	--	--	--	--
			Bottom	--	--	--	--	0.056	--	--	--	--	--	--
08/13/95		2.1	0-2	11.00	--	--	--	0.016	<0.002	<0.027	0.010	0.6	--	--
			1	--	8	26	20	--	--	--	--	--	--	--
			2	--	8	25	21	--	--	--	--	--	--	--
			3	--	7.9	25	23	--	--	--	--	--	--	--
			3.5	--	--	--	--	0.025	--	--	--	--	--	--
			4	--	1.5	24	30	--	--	--	--	--	--	--
			5	--	1.0	21	32	0.032	--	--	--	--	--	--
			6	--	0.8	17	41	--	--	--	--	--	--	--
			Bottom	--	--	--	--	0.378	--	--	--	--	--	--
08/28/95		2.1	0-2	8.31	--	--	--	0.021	<0.002	<0.027	0.078	0.5	7.44	15
			0	--	7.45	23.8	21	--	--	--	--	--	--	--
			1	--	7.15	23.6	22	--	--	--	--	--	--	--
			2	--	7.10	23.2	22	--	--	--	--	--	--	--
			3	--	6.80	22.5	22	--	--	--	--	--	--	--
			3.5	--	--	--	--	--	--	--	--	--	--	--
			4	--	5.60	22.2	22	--	--	--	--	--	--	--
			5	--	0.80	20.5	32	0.021	--	--	--	--	--	--
			6	--	0.85	15.5	61	--	--	--	--	--	--	--
			Bottom	--	0.84	--	--	0.044	--	--	--	--	--	--

1995 Antler Lake Water Quality Data

Date	Max. Depth (meters)	Secchi Disc (meters)	Depth (meters)	Chl. a (ug/L)	D.O. (mg/L)	Temp. (C)	Cond. (Umho @ 25 C)	Total P (mg P/L)	Sol. React. P (mg P/L)	NH3 (mg N/L)	N03 + N02 (mg N/L)	TKN (mg N/L)	pH (S.U.)	Alk. (mg/L)
09/11/95		2.0	0-2	6.02	--	--	--	0.015	<0.002	0.027	0.01	0.6	--	--
			0	--	10	20.5	23	--	--	--	--	--	--	--
			1	--	10	20.5	23	--	--	--	--	--	--	--
			2	--	9.8	20	23	--	--	--	--	--	--	--
			3	--	9.8	20	23	--	--	--	--	--	--	--
			3.5	--	--	--	--	0.012	--	--	--	--	--	--
			4	--	9.8	20	23	--	--	--	--	--	--	--
			5	--	9.9	19.5	23	0.010	--	--	--	--	--	--
			6	--	8.8	18	34	--	--	--	--	--	--	--
			Bottom	--	--	--	--	0.013	--	--	--	--	--	--

*Collected on 5/1/95

PHYTOPLANKTON UNIT (CLUMP) COUNT

PROJECT: ANTLER LAKE

LAKE: ANTLER

SAMPLE DEPTH: 0-2 METERS

SAMPLE DATE: 06/21/95

DIVISION	TAXON	UNITS/ML
CHLOROPHYTA (GREEN)	*Chlamydomonas globosa*	1,757
	Selenastrum minutum	468
	Ankistrodesmus Brauni	351
	Ankistrodesmus falcatus	195
	Sphaerocystis Schroeteri	195
	Oocystis parva	156
	Tetraedron sp.	117
	Scenedesmus sp.	117
	Botryococcus sudeticus	39
CHRYSOPHYTA (YELLOW BROWN)	*Dinobryon sociale*	117
CYANOPHYTA (BLUE-GREEN)	*Aphanocapsa delicatissima*	1,210
	Anabaena flos-aquae	78
	Aphanizomenon flos-aquae	78
	Merismopedia tenuissima	39
	Oscillatoria limnetica	39
CRYPTOPHYTA (CRYPTOMONADS)	*Cryptomonas erosa*	117
	TOTAL	5,075

PHYTOPLANKTON UNIT (CLUMP) COUNT

PROJECT: ANTLER LAKE

LAKE: ANTLER

SAMPLE DEPTH: 0-2 METERS

SAMPLE DATE: 07/24/95

DIVISION	TAXON	UNITS/ML
CHLOROPHYTA (GREEN ALGAE)	*Chlamydomonas globosa*	312
	Sphaerocystis Schroeteri	195
	Ankistrodesmus Brauni	78
	Rhizoclonium hieroglyphicum	78
	Scenedesmus sp.	78
	Oocystis parva	39
	Tetraedron sp.	39
CYANOPHYTA (BLUE-GREEN)	*Anabaena affinis*	312
	Aphanocapsa delicatissima	312
	Aphanizomenon flos-aquae	156
	Microcystis incerta	117
	Merismopedia tenuissima	78
BACILLARIOPHYTA (DIATOMS)	*Asterionella formosa*	78
CRYPTOPHYTA (CRYPTOMONADS)	*Cryptomonas erosa*	195
PYRROPHYTA (DINOFLAGELLATES)	*Peridinium cinctum*	39
	TOTAL	2,108

PHYTOPLANKTON UNIT (CLUMP) COUNT

PROJECT: ANTLER LAKE

LAKE: ANTLER

SAMPLE DEPTH: 0-2 METERS

SAMPLE DATE: 08/13/95

DIVISION	TAXON	UNITS/ML
CHLOROPHYTA (GREEN ALGAE)	*Chlamydomonas globosa*	586
	Sphaerocystis Schroeteri	195
	Ankistrodesmus Brauni	156
	Dictyosphaerium Ehrenbergianum	78
	Rhizoclonium hieroglyphicum	78
	Scenedesmus sp.	78
	Oocystis parva	39
	Selenastrum sp.	39
CHRYSOPHYTA (YELLOW BROWN)	*Dinobryon sociale*	39
CYANOPHYTA (BLUE-GREEN)	*Aphanizomenon flos-aquae*	1,093
	Anabaena affinis	429
	Aphanocapsa delicatissima	156
	Anabaena flos-aquae	78
	Microcystis incerta	78
	Merismopedia tenuissima	39
CRYPTOPHYTA (CRYPTOMONADS)	*Cryptomonas erosa*	273
	TOTAL	3,436

PHYTOPLANKTON UNIT (CLUMP) COUNT

PROJECT: ANTLER LAKE

LAKE: ANTLER

SAMPLE DEPTH: 0-2 METERS

SAMPLE DATE: 08/23/95

DIVISION	TAXON	UNITS/ML
CHLOROPHYTA (GREEN ALGAE)	*Chlamydomonas globosa*	3,748
	Sphaerocystis Schroeteri	273
	Ankistrodesmus Brauni	117
	Crucigenia quadrata	117
	Schroederia Judayi	78
	Ankistrodesmus falcatus	39
	Coelastrum microporum	39
	Cosmarium sp.	39
	Pediastrum duplex	39
	Quadrigula sp.	39
	Staurastrum sp.	39
CHRYSOPHYTA (YELLOW BROWN)	*Dinobryon sociale*	156
CYANOPHYTA (BLUE-GREEN)	*Aphanizomenon flos-aquae*	429
	Anabaena affinis	234
	Oscillatoria limnetica	195
	Aphanocapsa delicatissima	156
	Merismopedia tenuissima	78
	Phormidium mucicola	78
	Anabaena flos-aquae	39
BACILLARIOPHYTA (DIATOMS)	*Tabellaria fenestrata*	39
CRYPTOPHYTA (CRYPTOMONADS)	*Cryptomonas erosa*	273
EUGLENOPHYTA (EUGLENOIDS)	*Euglena sp.*	39
	TOTAL	6,246

PHYTOPLANKTON UNIT (CLUMP) COUNT

PROJECT: ANTLER LAKE

LAKE: ANTLER

SAMPLE DEPTH: 0-2 METERS

SAMPLE DATE: 09/11/95

DIVISION	TAXON	UNITS/ML
CHLOROPHYTA (GREEN ALGAE)	*Chlamydomonas globosa*	2,889
	Ankistrodesmus Brauni	195
	Scenedesmus sp.	195
	Tetraedron sp.	156
	Ankistrodesmus falcatus	117
	Sphaerocystis Schroeteri	78
	Cosmarium sp.	39
	Crucigenia quadrata	39
	Quadrigula sp.	39
	Scenedesmus quadricauda	39
CHRYSOPHYTA (YELLOW BROWN)	*Dinobryon sociale*	742
CYANOPHYTA (BLUE-GREEN)	*Aphanocapsa delicatissima*	1,484
	Aphanizomenon flos-aquae	508
	Oscillatoria limnetica	508
	Anabaena flos-aquae	156
	Merismopedia tenuissima	156
	Anabaena affinis	117
	Microcystis incerta	117
	Gomphosphaeria Naegelianum	78
	Rhabdoderma sp.	78
	Phormidium mucicola	39
CRYPTOPHYTA (CRYPTOMONADS)	*Cryptomonas erosa*	781
EUGLENOPHYTA (EUGLENOIDS)	*Euglena sp.*	39
	TOTAL	8,589

ZOOPLANKTON COUNT

PROJECT: ANTLER LAKE

LAKE: ANTLER

VERTICAL TOW (BOTTOM TO SURFACE)

SAMPLE DATE: 07/24/95

DIVISION	TAXON	#/M2
CLADOCERA	*Bosmina longirostris*	11,406
	Chydorus sphaericus	3,802
	Daphnia parvula	3,802
	Diaphanosoma leuchtenbergianum	3,802
COPEPODA	Nauplii	64,635
	Cyclops sp.	38,020
ROTIFERA	*Keratella cochlearis*	34,218
	Kellicottia bostoniensis	22,812
	Polyarthra vulgaris	19,010
	Trichocerca cylindrica	15,208
	Asplanchna priodonta	3,802
	Keratella quadrata	3,802
	TOTAL	224,320

ZOOPLANKTON COUNT

PROJECT: ANTLER LAKE

LAKE: ANTLER

VERTICAL TOW (BOTTOM TO SURFACE)

SAMPLE DATE: 08/28/95

DIVISION	TAXON	#/M2
CLADOCERA	*Ceriodaphnia sp.*	25,995
	Bosmina longirostris	8,665
	Chydorus sphaericus	8,665
	Diaphanosoma leuchtenbergianum	8,665
COPEPODA	Nauplii	95,316
	Cyclops sp.	60,656
ROTIFERA	*Polyarthra vulgaris*	147,307
	Keratella cochlearis	138,642
	Kellicottia bostoniensis	34,660
	Trichocerca cylindrica	25,995
	TOTAL	554,567

ZOOPLANKTON COUNT

PROJECT: ANTLER LAKE

LAKE: ANTLER

VERTICAL TOW (BOTTOM TO SURFACE)

SAMPLE DATE: 09/11/95

DIVISION	TAXON	#/M2
CLADOCERA	*Chydorus sphaericus*	56,588
	Bosmina longirostris	11,318
	Daphnia parvula	11,318
	Diaphanosoma leuchtenbergianum	11,318
COPEPODA	Nauplii	113,177
	Cyclops sp.	45,271
	Diaptomus sp.	22,635
ROTIFERA	*Keratella cochlearis*	486,660
	Polyarthra vulgaris	181,083
	Kellicottia bostoniensis	113,177
	Asplanchna priodonta	22,635
	TOTAL	1,075,180

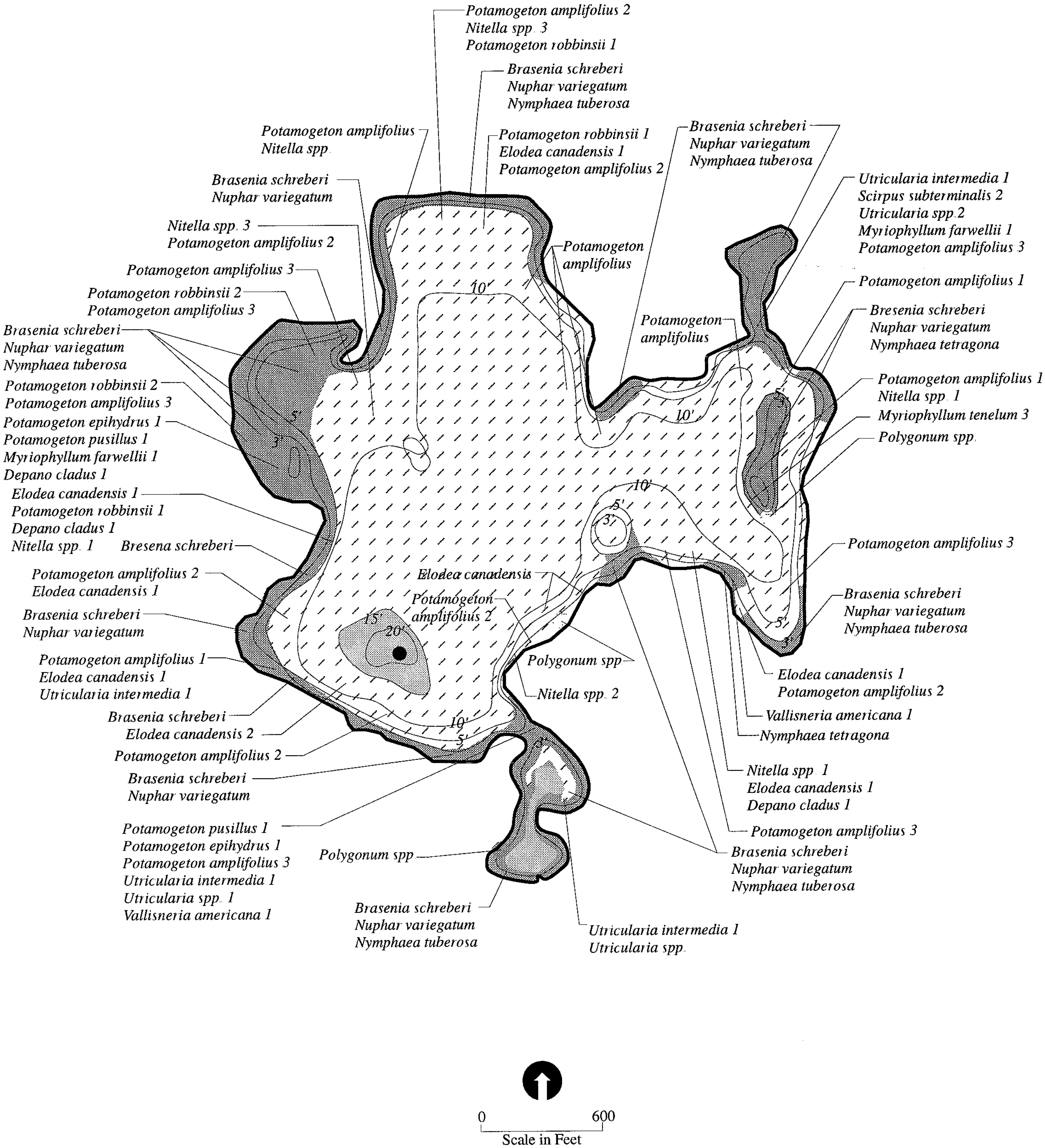
ANTLER LAKE MACROPHYTE SURVEY
JUNE 23, 1995

. No Macrophytes Found In Water > 15.0'.

. Macrophyte Densities Estimated As Follows: 1=light; 2=moderate; 3=heavy

Aquatic Vegetation:

	Common Name	Scientific Name
Submerged Aquatic Plants:	Bladderwort	*Utricularia intermedia*
	Bladderwort	*Utricularia spp.*
	Canada waterweed	*Elodea canadensis*
	Water moss	*Depano cladus*
	Wild celery	*Vallisneria americana*
	Largeleaf pondweed	*Potamogeton amplifolius*
	Nattall's pondweed	*Potamogeton epihydrus*
	Pondweed	*Potamogeton pusillus*
	Stonewort	*Nitella spp.*
	Robbin's pondweed	*Potamogeton robbinsii*
	Bulrush	*Scirpus subterminalis*
	Watermilfoil	*Myriophyllum tenelum*
	Watermilfoil	*Myriophyllum farwellii*
Floating Leaf Plants:	Water shield	*Brasenia schreberi*
	Yellow waterlily	*Nuphar variegatum*
	White waterlily	*Nymphaea tuberosa*
	Little white waterlily	*Nymphaea tetragona*
Emergent Plants:	Water smartweed	*Polygonum spp.*
No Aquatic Vegetation Found:		



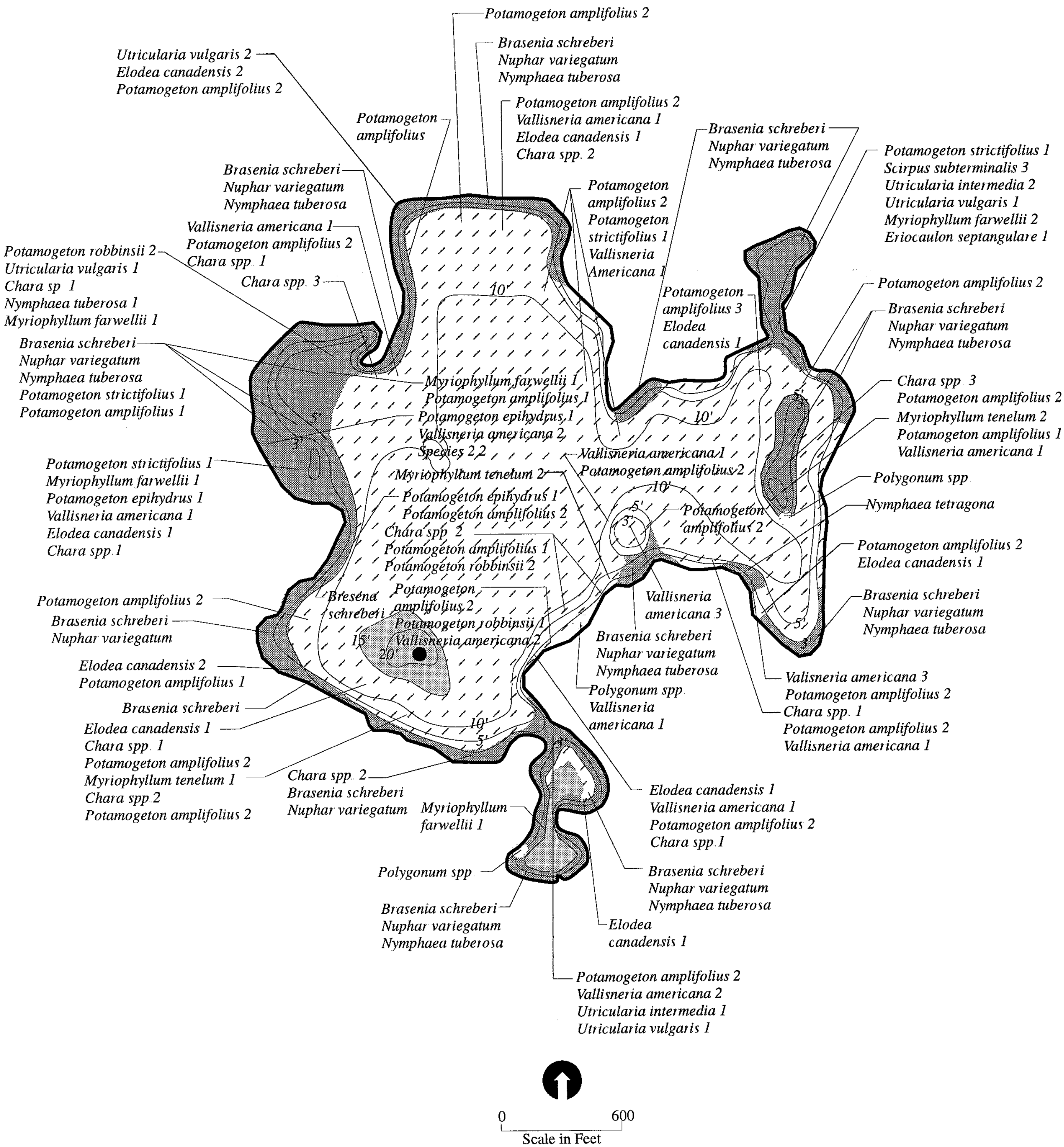
ANTLER LAKE MACROPHYTE SURVEY
JUNE 23, 1995

ANTLER LAKE MACROPHYTE SURVEY
AUGUST 25, 1995

- No Macrophytes Found In Water > 13.0'.
- Macrophyte Densities Estimated As Follows: 1=light; 2=moderate; 3=heavy

Aquatic Vegetation:

	Common Name	Scientific Name
Submerged Aquatic Plants:	Bladderwort	*Utricularia intermedia*
	Greater Bladderwort	*Utricularia vulgaris*
	Canada waterweed	*Elodea canadensis*
	Chara	*Chara spp.*
	Wild celery	*Vallisneria americana*
	Largeleaf pondweed	*Potamogeton amplifolius*
	Nattall's pondweed	*Potamogeton epihydrus*
	Robbin's pondweed	*Potamogeton robbinsii*
	Narrowleaf pondweed	*Potamogeton strictifolius*
	Water bulrush	*Scirpus subterminalis*
	Watermilfoil	*Myriophyllum tenelum*
	Watermilfoil	*Myriophyllum farwellii*
Floating Leaf Plants:	Water shield	*Brasenia schreberi*
	Yellow waterlily	*Nuphar variegatum*
	White waterlily	*Nymphaea tuberosa*
	Little white waterlily	*Nymphaea tetragona*
	Pipewort	*Eriocaulon septangulare*
Emergent Plants:	Water smartweed	*Polygonum spp.*
No Aquatic Vegetation Found:		



ANTLER LAKE MACROPHYTE SURVEY
AUGUST 25, 1995

Appendix B

Antler Lake Water Level Data

1995 LAKE LEVEL READINGS
ANTLER LAKE WISCONSIN LAKE MANAGEMENT PROJECT

GAGE # 1

MONTH: April	
Day	Lake Level (Ft.)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	2.55
25	2.56
26	2.57
27	2.55
28	2.55
29	2.53
30	2.52

MONTH: May	
Day	Lake Level (Ft.)
1	2.50
2	2.50
3	2.50
4	2.52
5	2.50
6	
7	2.49
8	2.50
9	2.50
10	2.50
11	
12	2.47
13	2.49
14	2.50
15	2.50
16	2.50
17	2.51
18	2.51
19	2.50
20	2.45
21	2.46
22	2.40
23	2.45
24	2.45
25	2.42
26	2.42
27	2.43
28	2.44
29	2.59
30	2.55
31	2.56

MONTH: June	
Day	Lake Level (Ft.)
1	2.54
2	2.52
3	2.52
4	2.54
5	2.55
6	2.60
7	
8	2.60
9	2.57
10	
11	2.60
12	2.60
13	2.60
14	2.60
15	2.60
16	2.60
17	2.50
18	2.50
19	2.50
20	
21	2.48
22	2.46
23	
24	2.40
25	2.41
26	2.42
27	2.40
28	
29	2.90
30	2.40

1995 LAKE LEVEL READINGS
ANTLER LAKE WISCONSIN LAKE MANAGEMENT PROJECT

GAGE # 1

MONTH: July	
Day	Lake Level (Ft.)
1	2.39
2	2.38
3	2.35
4	2.33
5	2.35
6	2.38
7	
8	
9	2.35
10	2.35
11	2.35
12	2.35
13	2.35
14	2.33
15	2.33
16	2.37
17	2.35
18	
19	2.32
20	2.30
21	2.30
22	2.30
23	2.30
24	2.30
25	2.28
26	2.26
27	
28	2.28
29	2.25
30	2.23
31	2.22

MONTH: August	
Day	Lake Level (Ft.)
1	2.20
2	2.00
3	
4	2.22
5	2.22
6	2.25
7	2.36
8	2.35
9	2.35
10	
11	
12	2.40
13	2.48
14	
15	2.60
16	2.59
17	2.58
18	2.58
19	2.58
20	
21	2.50
22	2.49
23	2.49
24	2.49
25	
26	2.60
27	2.60
28	2.60
29	2.60
30	2.60
31	2.59

MONTH: September	
Day	Lake Level (Ft.)
1	2.58
2	
3	2.55
4	2.52
5	2.50
6	2.49
7	
8	2.45
9	2.43
10	2.42
11	2.40
12	2.39
13	2.39
14	
15	2.35
16	2.35
17	2.35
18	2.35
19	2.35
20	2.35
21	
22	2.30
23	2.30
24	2.29
25	2.29
26	2.29
27	2.27
28	2.26
29	2.25
30	2.34

1995 LAKE LEVEL READINGS--
ANTLER LAKE WISCONSIN LAKE MANAGEMENT PROJECT

GAGE # 1

MONTH: October	
Day	Lake Level (Ft.)
1	2.36
2	2.39
3	2.40
4	2.40
5	2.42
6	2.43
7	2.45
8	2.47
9	2.50
10	2.50
11	2.49
12	2.47
13	2.47
14	2.45
15	
16	
17	2.40
18	2.40
19	2.40
20	2.40
21	2.40
22	2.39
23	2.42
24	2.50
25	2.55
26	
27	
28	
29	
30	
31	2.60

MONTH: November	
Day	Lake Level (Ft.)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
30	

MONTH: December	
Day	Lake Level (Ft.)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
30	
31	

1995 LAKE LEVEL READINGS
ANTLER LAKE WISCONSIN LAKE MANAGEMENT PROJECT

GAGE # 2

MONTH: April	
Day	Lake Level (Ft.)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	2.79
25	2.70
26	2.80
27	2.80
28	2.80
29	2.77
30	2.75

MONTH: May	
Day	Lake Level (Ft.)
1	2.75
2	2.75
3	2.73
4	2.75
5	2.73
6	
7	2.71
8	2.71
9	2.72
10	2.71
11	
12	2.70
13	2.70
14	2.71
15	2.73
16	2.75
17	2.75
18	2.75
19	2.73
20	2.70
21	2.69
22	2.65
23	2.65
24	2.65
25	2.65
26	2.66
27	2.65
28	2.67
29	2.85
30	2.80
31	2.80

MONTH: June	
Day	Lake Level (Ft.)
1	2.78
2	2.75
3	2.75
4	2.78
5	2.80
6	2.90
7	
8	2.80
9	2.80
10	
11	2.83
12	2.80
13	2.81
14	2.80
15	2.82
16	2.81
17	2.81
18	2.80
19	2.80
20	
21	2.79
22	2.78
23	
24	2.70
25	2.70
26	2.72
27	2.68
28	
29	2.65
30	2.65

ANTLER LAKE WISCONSIN LAKE MANAGEMENT PROJECT

GAGE # 2

MONTH: July	
Day	Lake Level (Ft.)
1	2.60
2	2.60
3	2.60
4	2.58
5	2.60
6	2.60
7	
8	
9	2.60
10	2.60
11	2.60
12	2.60
13	2.60
14	2.60
15	2.60
16	2.60
17	2.60
18	
19	2.59
20	2.58
21	2.55
22	2.52
23	2.55
24	2.55
25	2.53
26	2.52
27	2.52
28	2.50
29	2.49
30	
31	2.46

MONTH: August	
Day	Lake Level (Ft.)
1	2.45
2	2.42
3	
4	2.40
5	2.40
6	2.45
7	2.60
8	2.59
9	2.60
10	
11	
12	2.68
13	2.78
14	
15	2.85
16	2.83
17	2.82
18	2.82
19	2.82
20	
21	2.80
22	2.77
23	2.77
24	2.77
25	
26	2.75
27	2.77
28	2.87
29	2.87
30	2.86
31	2.85

MONTH: September	
Day	Lake Level (Ft.)
1	2.85
2	
3	2.84
4	2.80
5	2.75
6	2.75
7	
8	2.70
9	2.68
10	2.67
11	2.66
12	2.65
13	2.65
14	
15	2.60
16	2.60
17	2.60
18	2.60
19	2.60
20	2.60
21	
22	2.55
23	2.55
24	2.54
25	2.53
26	2.53
27	2.50
28	2.50
29	2.50
30	2.59

1995 LAKE LEVEL READINGS--
ANTLER LAKE WISCONSIN LAKE MANAGEMENT PROJECT

GAGE # 2

MONTH: October	
Day	Lake Level (Ft.)
1	2.60
2	2.63
3	2.63
4	2.63
5	2.63
6	2.69
7	2.70
8	2.72
9	2.75
10	2.74
11	2.73
12	2.72
13	2.72
14	2.70
15	
16	
17	2.65
18	2.65
19	2.65
20	2.64
21	2.63
22	2.62
23	2.65
24	2.74
25	2.80
26	
27	
28	
29	
30	
31	2.85

MONTH: November	
Day	Lake Level (Ft.)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
30	

MONTH: December	
Day	Lake Level (Ft.)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
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19	
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23	
24	
25	
26	
27	
28	
29	
30	
31	

PX PAPERWORX JOB SHEET

JOB # 0109

NORMANDALE LAKE 893-9233 NORTHLAND 897-5080

BUSINESS INFORMATION

CUSTOMER G. Monson

COMPANY Ball

ADDRESS

CITY

STATE | ZIP | PHONE

PAYMENT TERMS:

☐ CASH ☐ CHECK ☐ 30 DAY CREDIT (MUST BE APPROVED IN ADVANCE)

☐ PAYMENT IN ADVANCE FOR:

DESCRIPTION OF SERVICE

RECEIVED 8 10 12-1 3 5

DATE 5/24 Initials

mon tues wed thurs fri

COMPLETED 8 10 12-1 3 5

DATE 5/24 Initials

mon tues wed thurs fri

CUST P.O. OR JOB IDENT 6005

DESCRIPTION

13/10 Color collate

PREPARATION-LAYOUT, DESIGN, DTP, GRAPHICS, TYPESETTING

QUALITY CLEAN-UP ____ Min-Hrs ____

WORD PROCESSING ____ Min-Hrs ____

DESK TOP PUBLISHING ____ Min-Hrs ____

LAYOUT AND DESIGN ____ Min-Hrs ____

OTHER:

PRODUCTION PRINTING OR COPYING

#ORIG ____ X SETS ____ = TOTAL IMP ____

☐ 2-SIDED ☐ 3-HOLE DRILL ☐ COLORED ____

SIZE: ☐ LETTER ☐ LEGAL ☐ 11X17 ☐ OTHER

SPECS: ☐ 20# ☐ 60# ☐ OTHER ____

☐ COLOR COPIES ☐ HAND COLLATE

FINISHING

☐ GBC ☐ VELO ☐ STAPLE ☐ SLIP SHEET

☐ PLASTIC ☐ CARDSTOCK

☐ FOLD ☐ PAD ☐ CUT ☐ LAM ☐ DRILL

☐ SHRINK WRAP ☐ OTHER

PRICING

SUPPLIES:	SERVICE:

COPYING		
COLOR COPIES		
SUPPLIES		
PRINTING/BLUEPRINTING		
CLERICAL		
WORD PROCESSING		
GRAPHICS		
POSTAGE		
OTHER		
SUBTOTAL		
SALES TAX		
TOTAL		

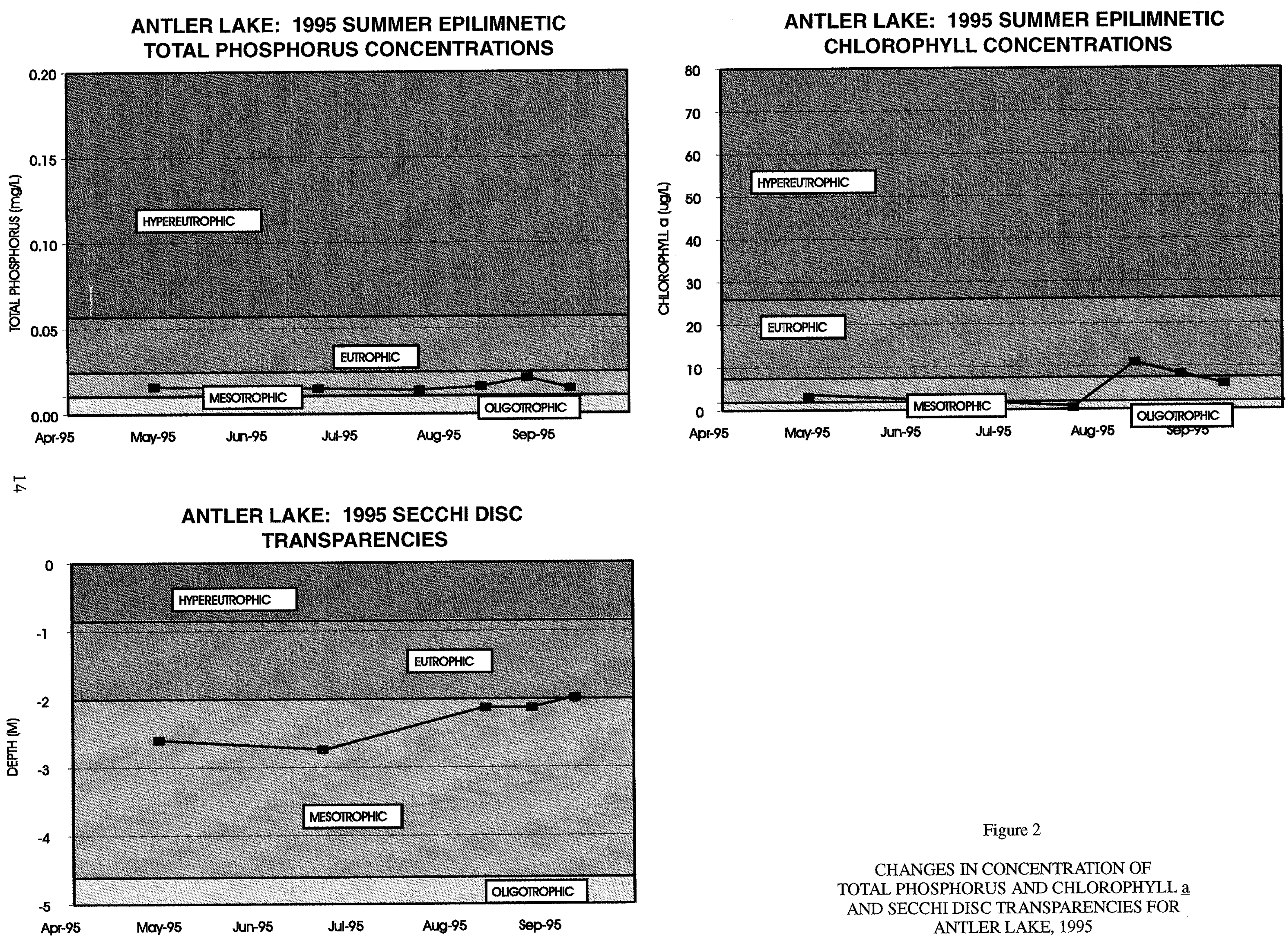


Figure 2

CHANGES IN CONCENTRATION OF
TOTAL PHOSPHORUS AND CHLOROPHYLL a
AND SECCHI DISC TRANSPARENCIES FOR
ANTLER LAKE, 1995

Figure 6

ANTLER LAKE EPILIMNETIC PHYTOPLANKTON COUNT DATA SUMMARY BY MAJOR ALGAL GROUP

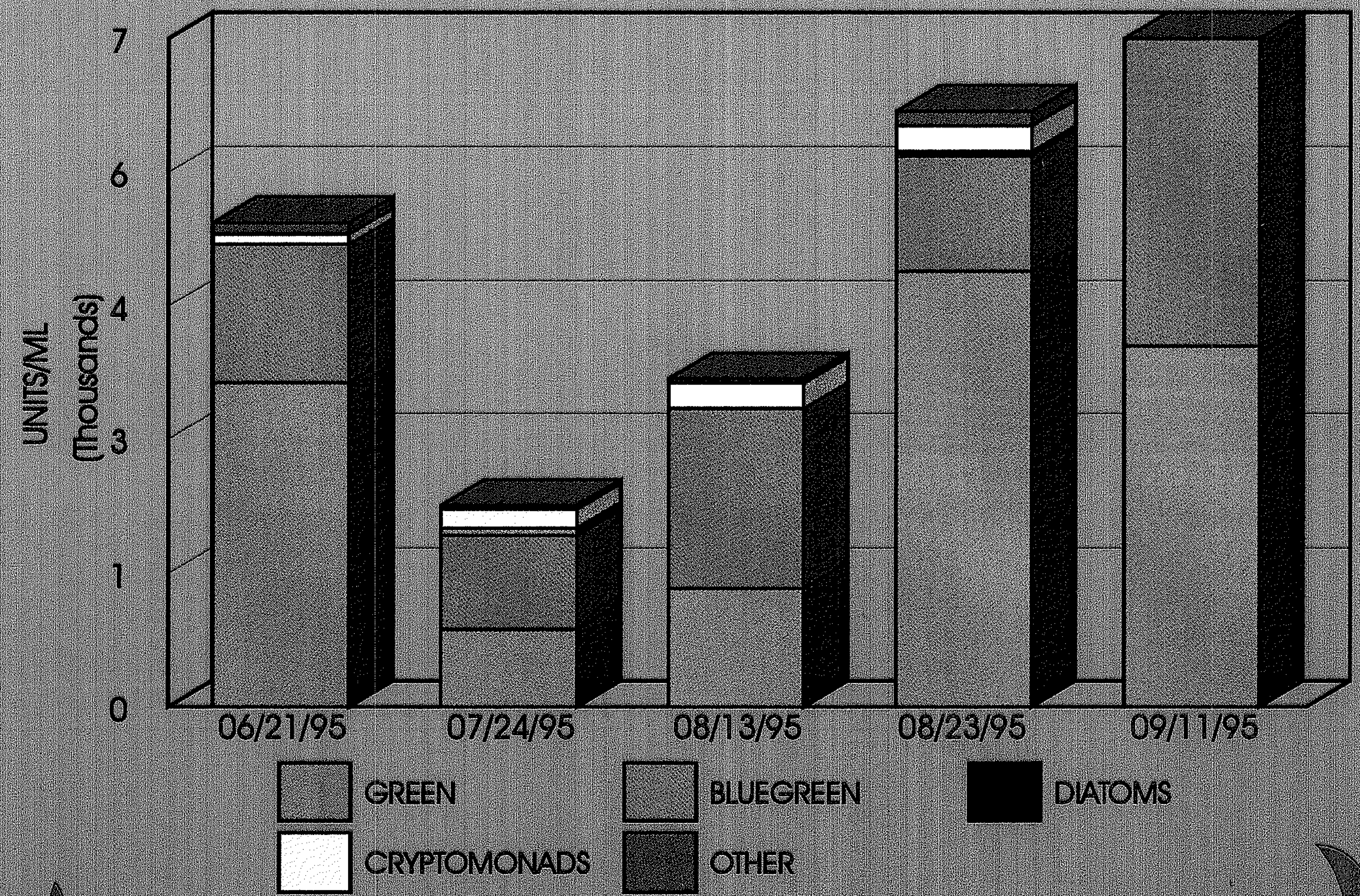


Figure 7

ANTLER LAKE EPILIMNETIC PHYTOPLANKTON DATA SUMMARY BY MAJOR ALGAL GROUP

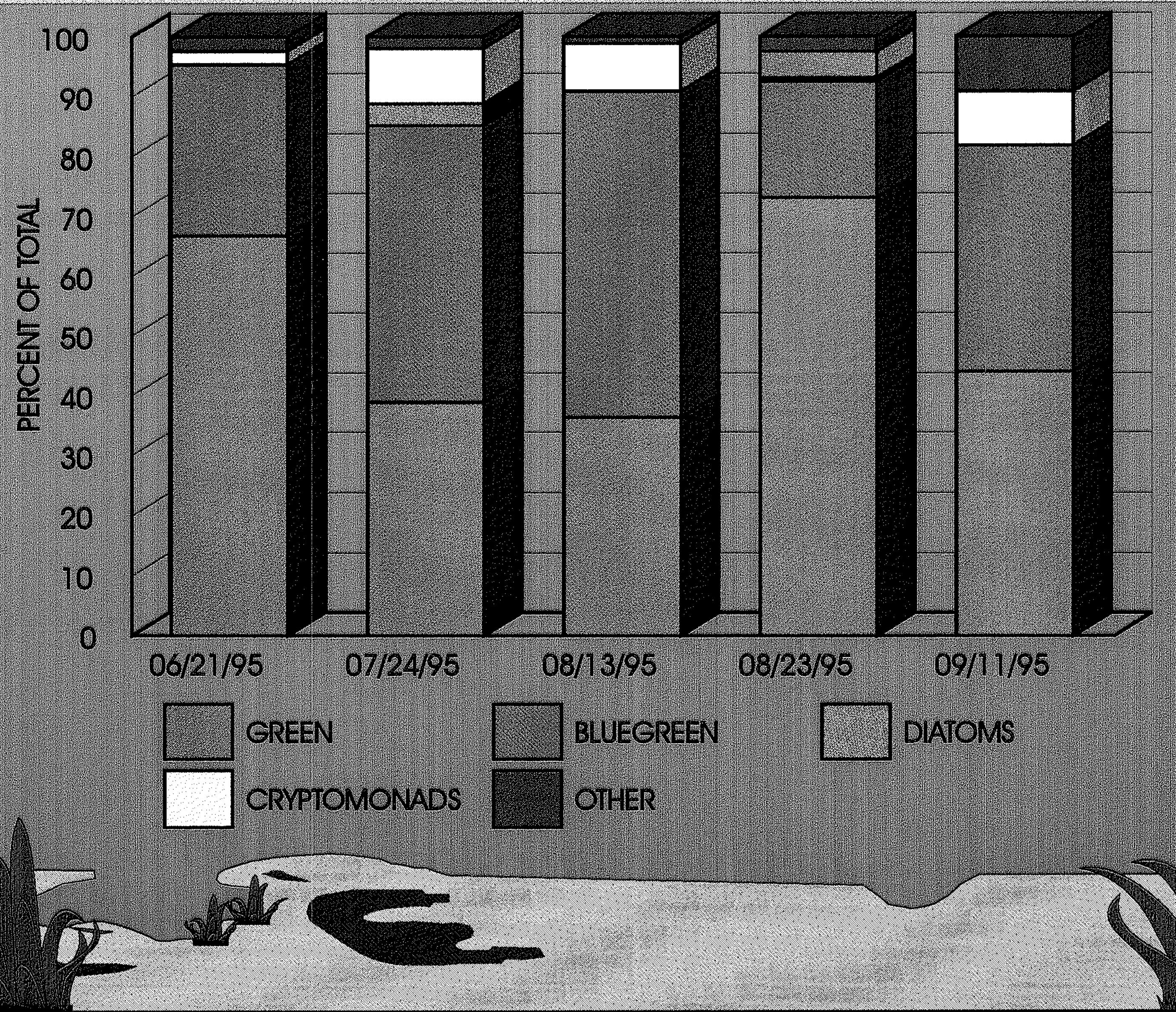


Figure 8

ANTLER LAKE ZOOPLANKTON DATA SUMMARY
% COMPOSITION BY MAJOR GROUP

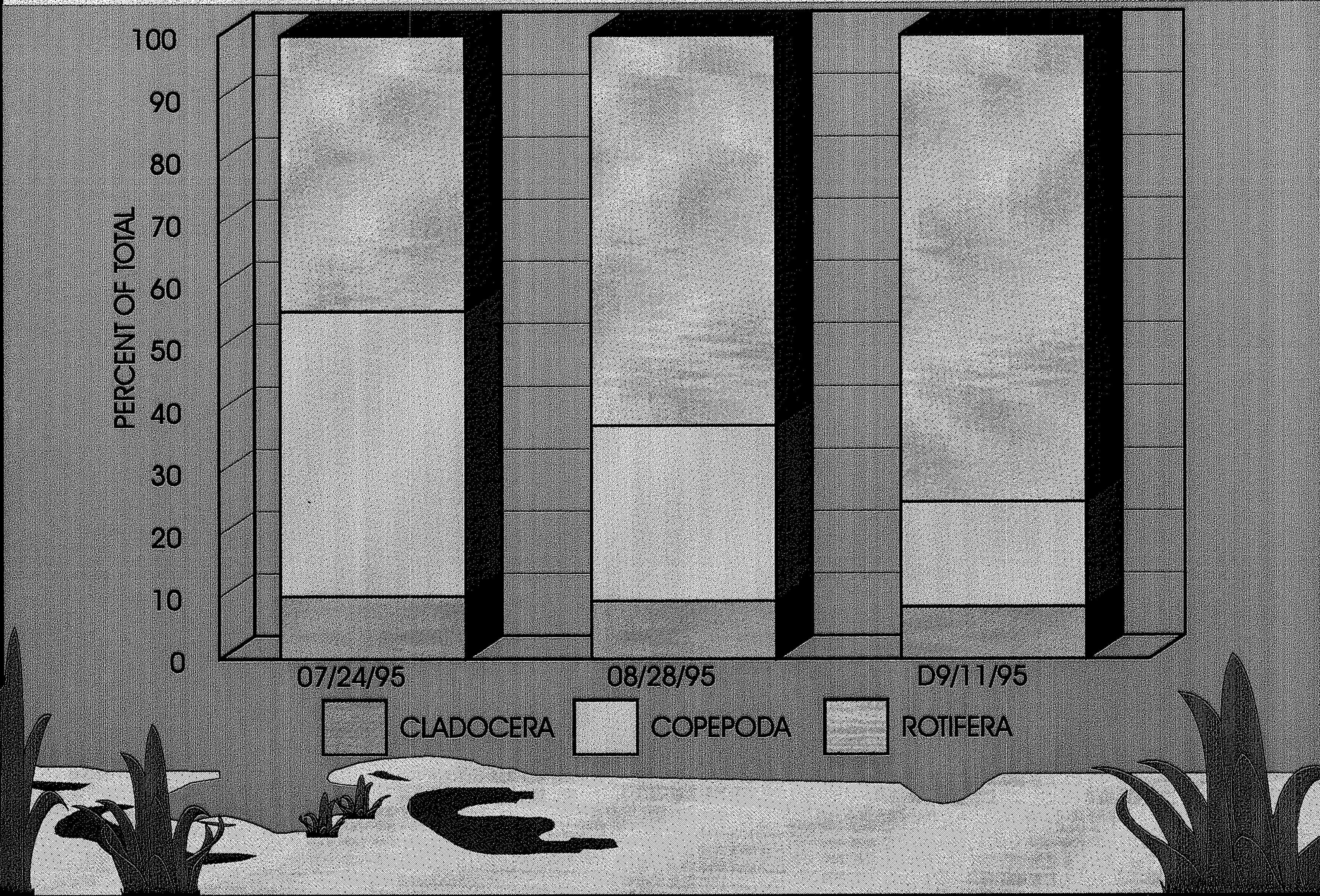


Figure 9

ANTLER LAKE ZOOPLANKTON DATA SUMMARY BY MAJOR GROUP

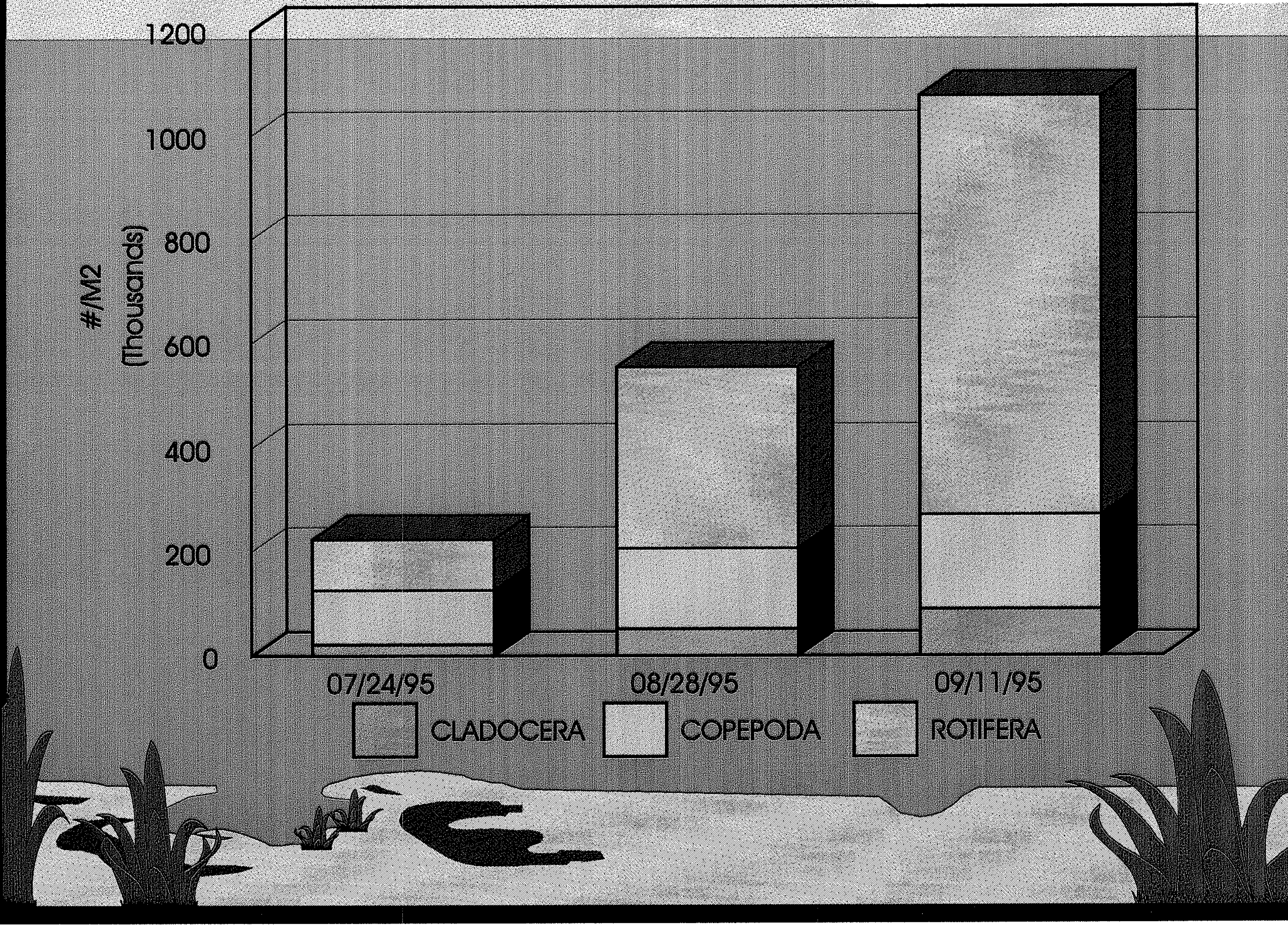


Figure 10
ANTLER LAKE MACROPHYTE SURVEY
JUNE 23, 1995

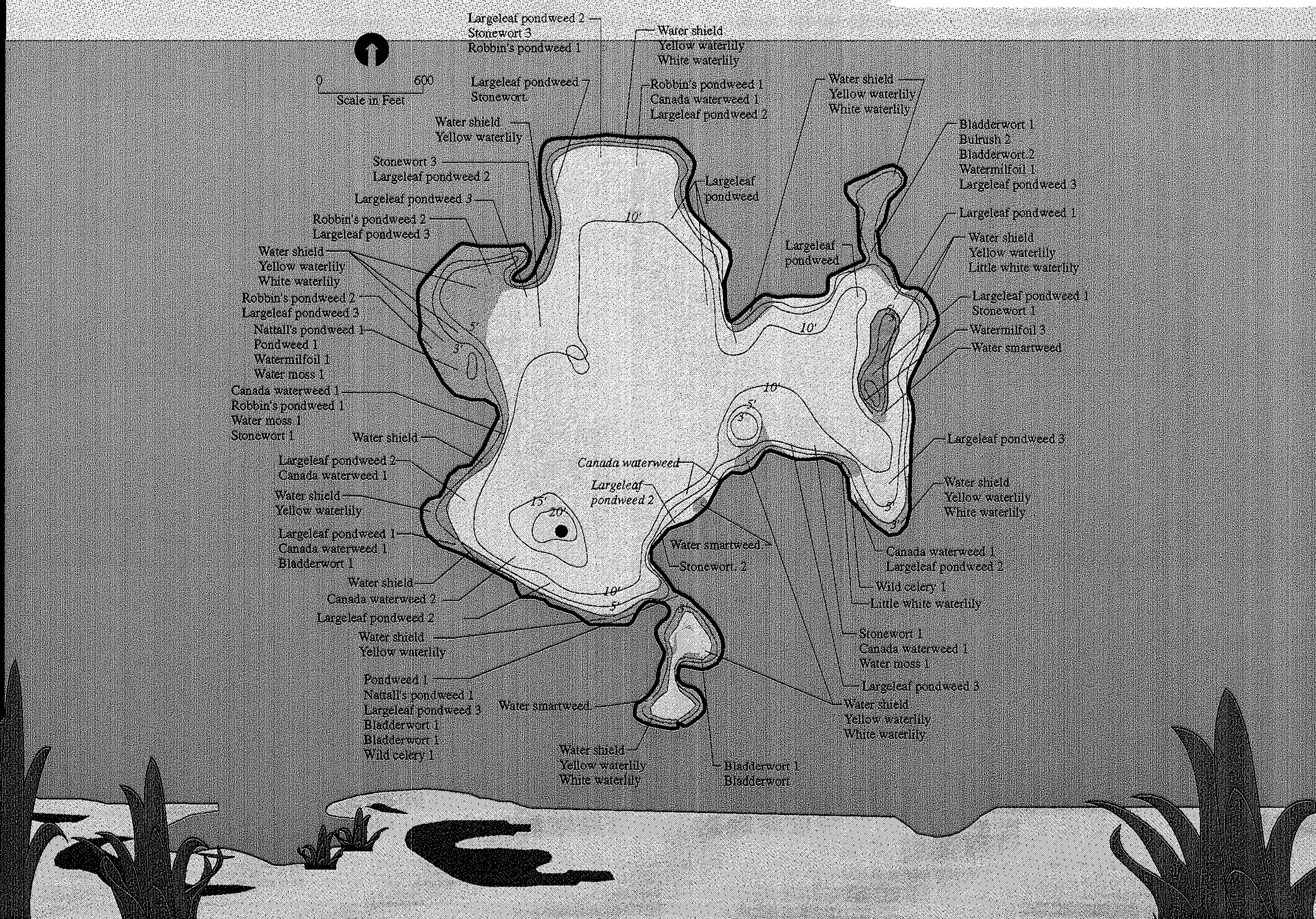


Figure 11
ANTLER LAKE MACROPHYTE SURVEY
AUGUST 25, 1995

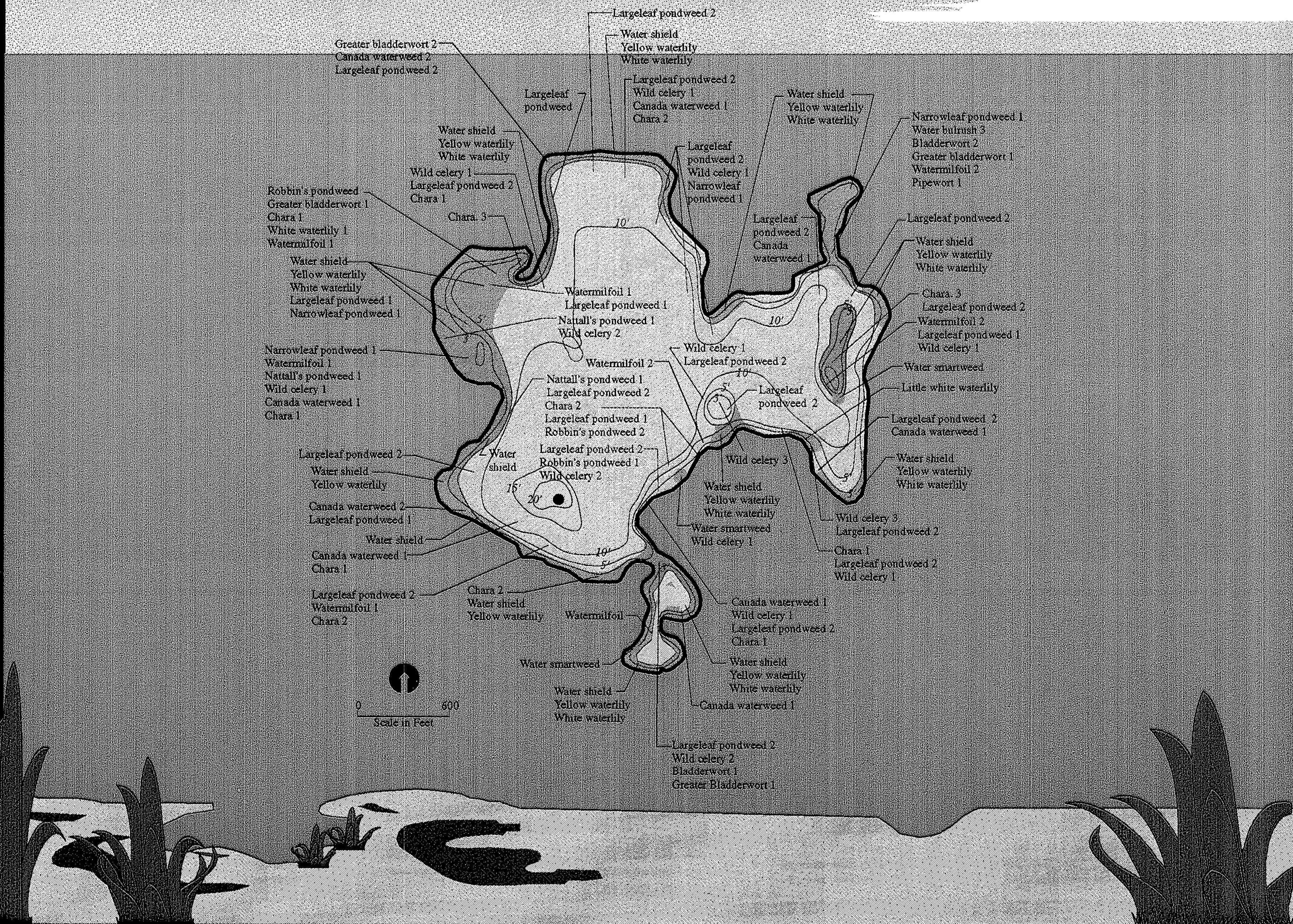


Figure 13

ANTLER LAKE WATERSHED LAND USE

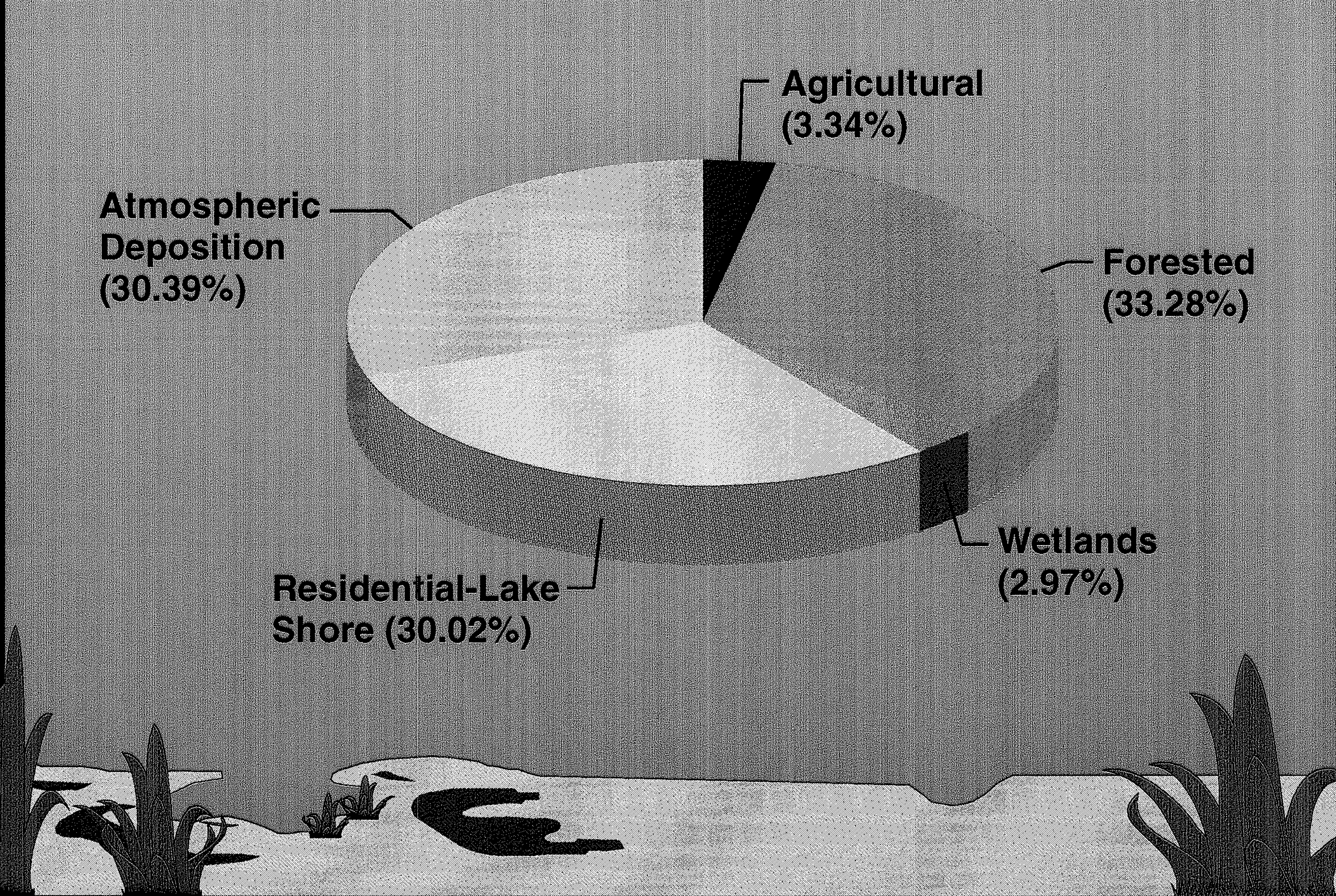
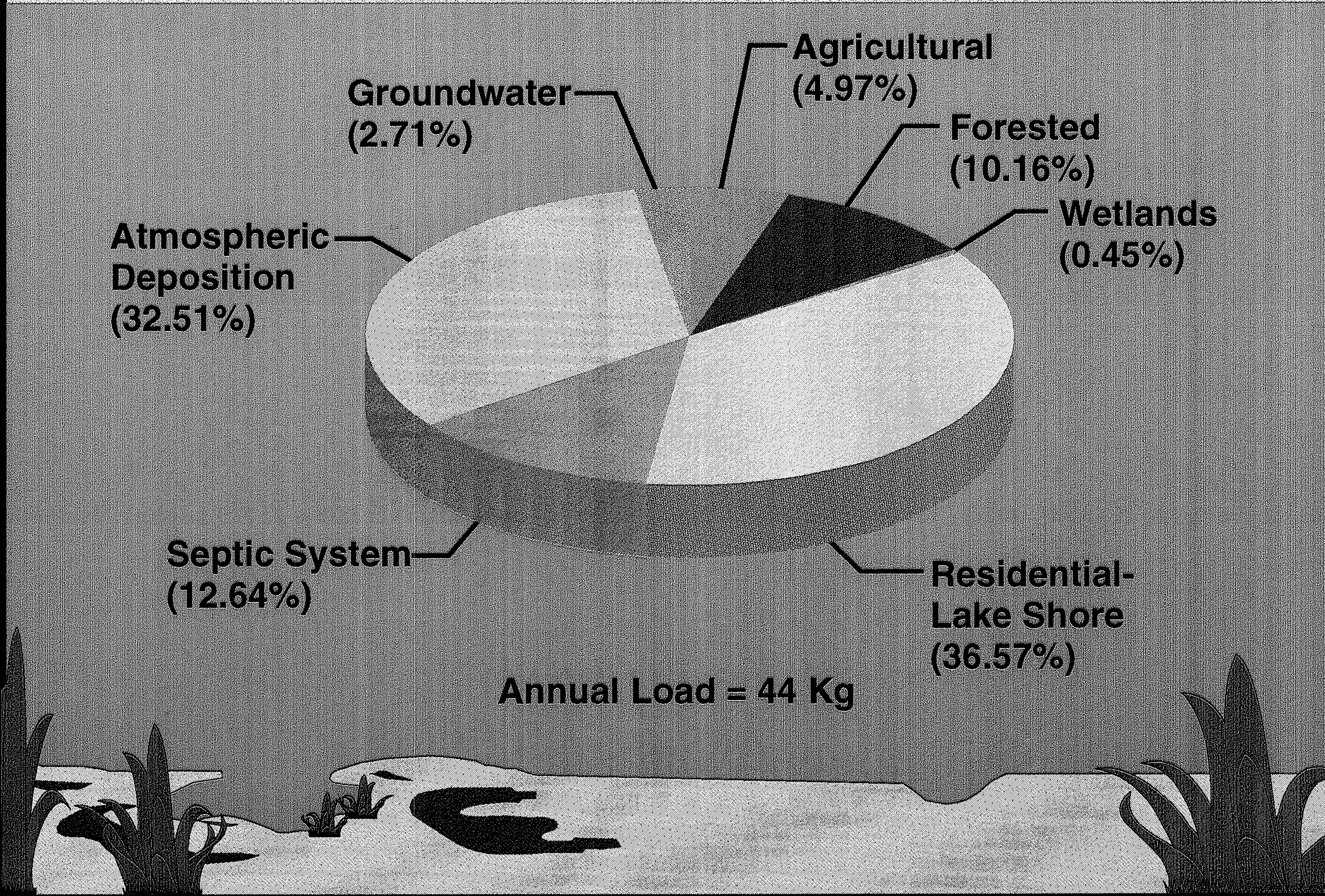


Figure 14

ANTLER LAKE ANNUAL PHOSPHORUS LOAD: % OF ANNUAL LOAD BY WATERSHED LAND USE



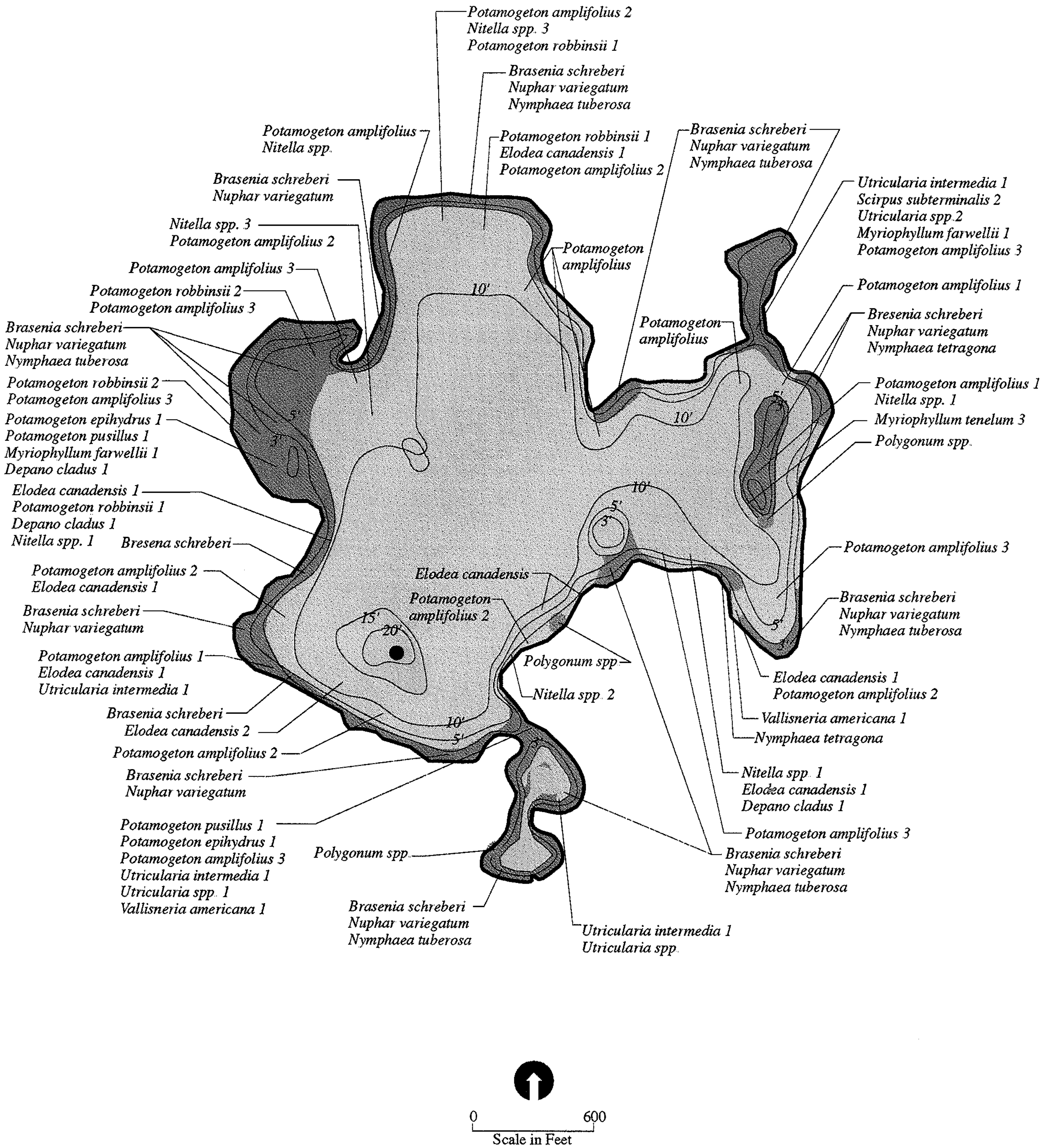
ANTLER LAKE MACROPHYTE SURVEY
JUNE 23, 1995

. No Macrophytes Found In Water > 15.0'.

. Macrophyte Densities Estimated As Follows: 1=light; 2=moderate; 3=heavy

Aquatic Vegetation:

	Common Name	Scientific Name
Submerged Aquatic Plants:	Bladderwort	*Utricularia intermedia*
	Bladderwort	*Utricularia spp.*
	Canada waterweed	*Elodea canadensis*
	Water moss	*Depano cladus*
	Wild celery	*Vallisneria americana*
	Largeleaf pondweed	*Potamogeton amplifolius*
	Nattall's pondweed	*Potamogeton epihydrus*
	Pondweed	*Potamogeton pusillus*
	Stonewort	*Nitella spp.*
	Robbin's pondweed	*Potamogeton robbinsii*
	Bulrush	*Scirpus subterminalis*
	Watermilfoil	*Myriophyllum tenelum*
	Watermilfoil	*Myriophyllum farwellii*
Floating Leaf Plants:	Water shield	*Brasenia schreberi*
	Yellow waterlily	*Nuphar variegatum*
	White waterlily	*Nymphaea tuberosa*
	Little white waterlily	*Nymphaea tetragona*
Emergent Plants:	Water smartweed	*Polygonum spp.*
No Aquatic Vegetation Found:		



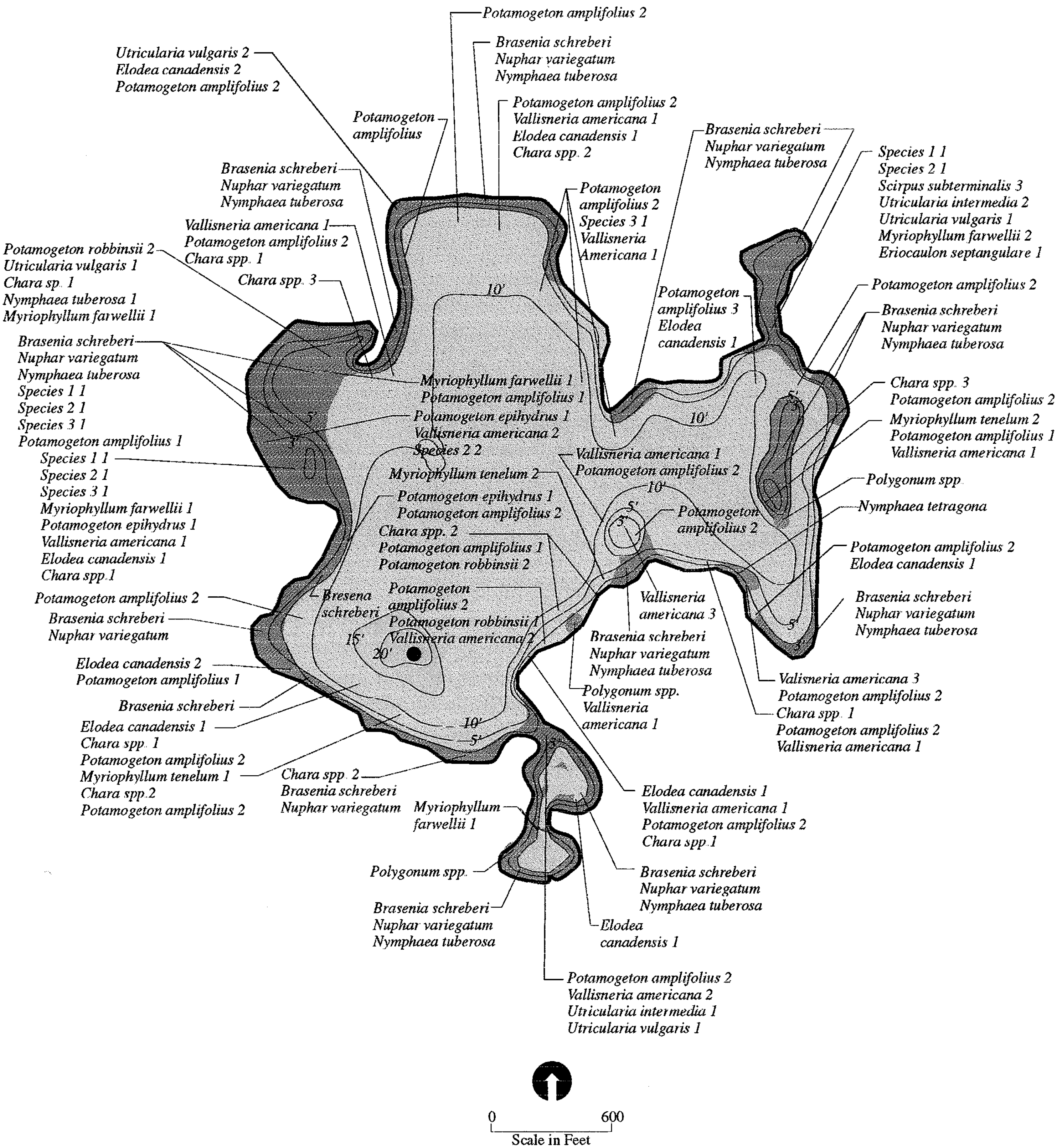
ANTLER LAKE MACROPHYTE SURVEY
JUNE 23, 1995

ANTLER LAKE MACROPHYTE SURVEY
AUGUST 25, 1995

- No Macrophytes Found In Water > 13.0'.
- Macrophyte Densities Estimated As Follows: 1=light; 2=moderate; 3=heavy

Aquatic Vegetation:

	Common Name	Scientific Name
Submerged Aquatic Plants:	Bladderwort	*Utricularia intermedia*
	Greater Bladderwort	*Utricularia vulgaris*
	Canada waterweed	*Elodea canadensis*
	Chara	*Chara spp.*
	Wild celery	*Vallisneria americana*
	Largeleaf pondweed	*Potamogeton amplifolius*
	Nattall's pondweed	*Potamogeton epihydrus*
	Robbin's pondweed	*Potamogeton robbinsii*
	Narrowleaf pondweed	*Potamogeton strictifolius*
	Water bulrush	*Scirpus subterminalis*
	Watermilfoil	*Myriophyllum tenelum*
	Watermilfoil	*Myriophyllum farwellii*
Floating Leaf Plants:	Water shield	*Brasenia schreberi*
	Yellow waterlily	*Nuphar variegatum*
	White waterlily	*Nymphaea tuberosa*
	Little white waterlily	*Nymphaea tetragona*
	Pipewort	*Eriocaulon septangulare*
Emergent Plants:	Water smartweed	*Polygonum spp.*
No Aquatic Vegetation Found:		



ANTLER LAKE MACROPHYTE SURVEY

AUGUST 25, 1995