MAPLE LAKE CITIZEN MONITORING PROJECT

MAPLE LAKE ASSESSMENT REPORT--1991

Final report submitted - December 1992
Prepared by Wayne R. Goeken

Cooperative Project involving:
Citizen Monitors
Maple Lake Improvement District
Union Lake Sarah Improvement Association
East Polk Soil & Water Conservation District
Minnesota Pollution Control Agency
Minnesota Extension Service
University of Minnesota-Crookston
Red Lake Watershed District
Sand Hill River Watershed District

This project was completed with grant funds received through the Minnesota Board on Water and Soil Resource's Challenge Grant Program.

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Note:

Understanding of this report will be enhanced if the reader is familiar with basic water quality terminology as used in the Citizens' Guide to Lake Protection. This report is available from your regional office of the Minnesota Pollution Control Agency or it may also be available from your local Soil and Water Conservation District Office.

Commonly used abbreviations in this report include:
ug/l = micrograms per liter = parts per billion (ppb)
mg/l = milligrams per liter = parts per million (ppm)
1 meter = 3.2803 feet
1 foot = .3048 meters
1 hectare = 2.4711 acres

Appreciation is expressed to all parties involved throughout this project and in the development of this report. Special thanks to the citizen lake monitors--Bob Bohm and Doug Thorson on Maple Lake and Rosie Canniff and Jack Bailey on Union Lake and Lake Sarah. Their involvement and assistance was essential and very much appreciated throughout the project. Also thanks to Gary Lee of the East Polk County Soil and Water Conservation District who provided overall coordination of the project and finally thanks to Willis Mattison of the Minnesota Pollution Control Agency's Detroit Lakes regional office who provided invaluable assistance in the sampling phase of the project and also in interpretation of the data.

It is hoped that this is the first step in development of a working management plan for Maple Lake that will provide for stewardship of Maple Lake and its contributing watershed. It is also hoped that this project will result in citizens taking a more active role in managing "their lakes" and improved communication between citizens and the various resource agencies that are available to assist local management efforts.

MAPLE LAKE ASSESSMENT REPORT-1991

INTRODUCTION/PROJECT OVERVIEW

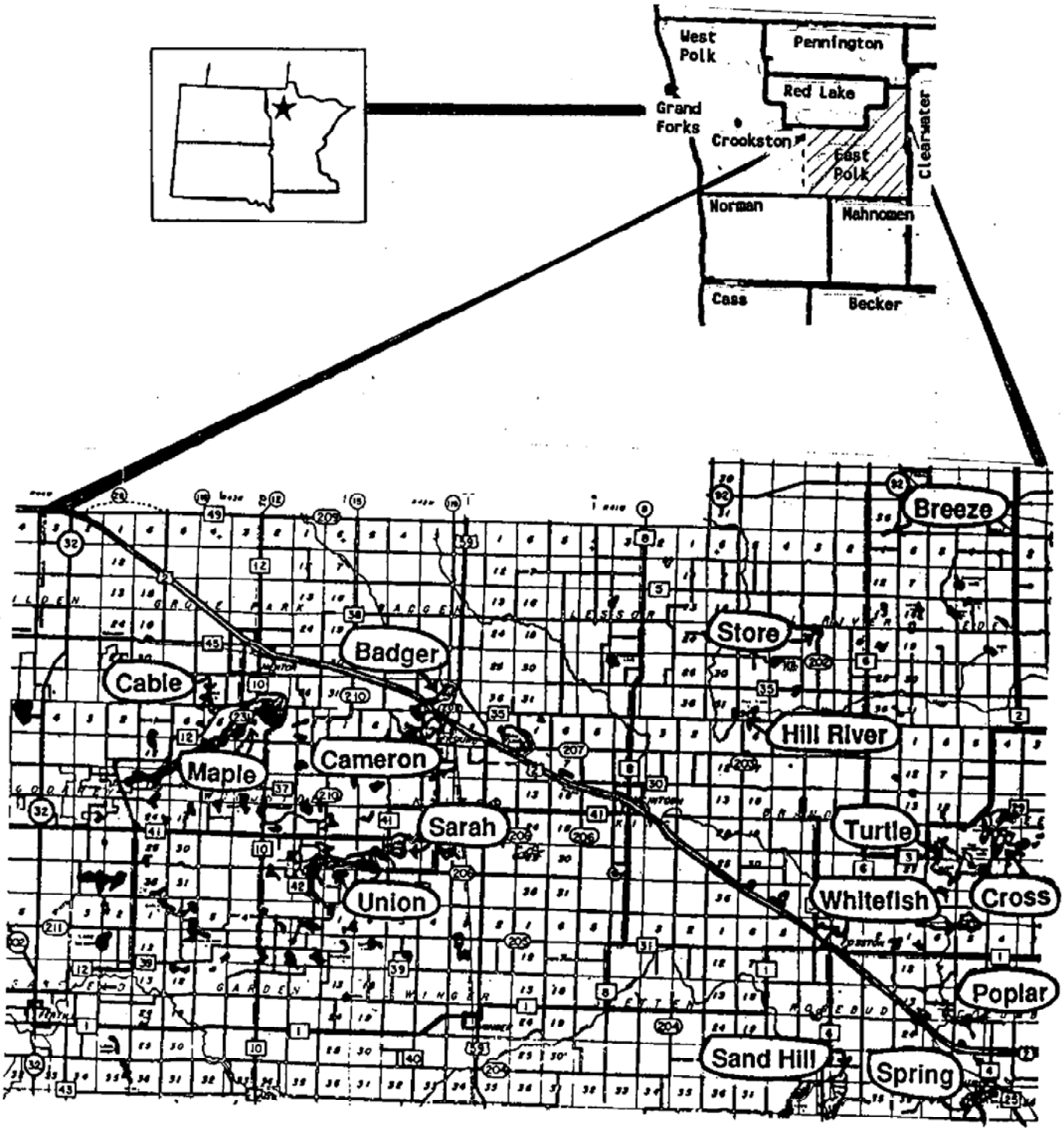
Maple Lake was one of 15 lakes involved in a Citizen Lake Monitoring Program in central and east Polk County in 1991 (See Figure 1). Maple Lake is located in northwestern Minnesota about 2 miles south of the community of Mentor, Minnesota which is located on U.S. Highway 2 in Polk County. It is about 25 miles east of Crookston and 50 miles east of Grand Forks, North Dakota. It is one of the first large lakes that is encountered when coming from the rich Red River Valley farmlands to the west, thus it has a large proportion of residents from North Dakota. Polk County has about 300 lakes, with Maple Lake being the largest in terms of surface area with 1,445 acres.

As part of the Citizen Monitoring Program citizens did volunteer monitoring throughout the summer including secchi disc, water temperature, rainfall, pH, and lake levels. In addition, local volunteers were trained to collect water samples from Maple, Sarah and Union Lakes that were shipped to state certified labs for analysis of nutrient levels and other variables. Documenting this baseline data was one of the objectives of the project. Data collection methods and results are reported later in this report. Another major objective was to increase public awareness and understanding of our lake resources and how they can be locally managed. This was achieved by involving citizens in collecting and analyzing information about their lakes and providing information to citizens via project newsletters and public meetings. The project has provided the basis for further local involvement in setting lake management goals and implementing local management plans to protect area lakes.

Primary funding for the project was provided by a grant received from the Minnesota Board of Water and Soil Resources. Local cash support was generated from several sources including the Maple Lake Improvement District, Union Lake Sarah Improvement Association, Sand Hill River Watershed District, and the East Polk Soil and Water Conservation District. In-kind support was provided by these sources also in addition to in-kind support from the MN Pollution Control Agency, MN Extension Service, Red Lake Watershed District, University of Minnesota-Crookston and local citizen volunteers. The MN Pollution Control Agency covered the costs of one month of testing and provided primary support for training citizen volunteers to take lake water samples and in interpretation of sampling data and modeling results.

Bob Bohm and Doug Thorson of the Maple Lake Improvement District led local monitoring efforts for weekly collection of rainfall data, lake level, surface water temperature, secchi disc reading and pH level. Mike Weick collected weekly data on Cable Lake. Monthly water samples were taken to determine total and ortho phosphorus, total kjeldahl nitrogen, chlorophyll a and dissolved oxygen. Other parameters such as total suspended solids, total volatile solids and color were also tested for on a limited basis. Five monthly samples were taken between June and mid-October. The June sample was sent to the Minnesota State Health Department lab with the samples from the following four months sent to ERA Labs in Duluth (a state certified lab). Split samples were taken in August and sent to the State Health Department, ERA Labs and U of M-Crookston as part of the projects quality assurance/quality control program. Willis Mattison-MnPCA, Barb Liukkonen-Mn Extension, Gary Lee-East Polk SWCD and Wayne Goeken assisted with the monthly sampling.

Figure 1. Polk County Lakes in 1991
Citizen Lakes Monitoring Program



MAPLE LAKE CHARACTERISTICS

Lake Development and History

Early development on Maple Lake began before the turn of the 20th Century with the first settlements occurring on the north end of the lake in the 1890's. By the 1930's cabins were only found between the present day fire numbers of 1100 to about 1800 (See Figures 2 and 3). Currently there are an estimated 604 residences around Maple Lake with 481 of these (80%) being seasonal and 123 (20%) being year-round residences. The number of residences converting to year-round occupancy has been increasing at a faster pace in recent years and is expected to continue to do so. There are an additional 38 mobile home sites located at three resorts around Maple Lake. These are located at Ulland's Resort, Oak Cove Resort and Lakeview Resort. These resorts and the Maple Lake Park Campground operated by Polk County, through its Highway Department, also offer campground accommodations ranging from tent sites to full mobile home hook-ups. Some seasonal housing is also provided at Breezy Point Resort. A variety of services are offered at these resorts from bait and tackle to laundry and restaurant.

Polk County also maintains a day-use picnic area in the vicinity of the recently located fishing pier and a swimming beach/picnic area just north of the public access and inlet. Another "non-residential" operation on Maple Lake is the Maple Lake Pavillion which is primarily a roller skating rink that operates during the summer tourism season. It is also the site of the annual Maple Lake Arts and Craft Festival and is used for other special meetings and gatherings including the Maple Lake Improvement District summer annual meeting during the past few years. There are plans to renovate the abandoned Buhn Motel into a Bed and Breakfast operation scheduled to be operational by 1994. There are also two church operated camps on Maple Lake--Shalom and Trinity Point.

Electric service first became available to the Maple Lake area in 1948 with service available all around the lake by 1952. Hard surfacing of local roads to the Maple Lake area began around 1960. Polk County 41 which lies just south of Maple Lake and travels in an east-west direction was hard surfaced from Minnesota Highway 102 to Polk County 12 in 1959 with the pavement extending past Polk County 10 and east to Polk County 42 north of Union Lake in 1961. Polk Co. 12 which goes along the west side of Maple Lake and connects Mentor and Fertile was paved in 1960. Polk County #10 which goes around the east side of Maple Lake was paved from Mentor to Polk County 41 in 1968. The County access roads from the Pavillion south to the Buhn Hotel and from the Pavillion east to Polk County 10 were paved in 1974.

Residents around Maple Lake formed a lake association prior to 1940. In 1987, after several years of discussion, lake landowners petitioned the Polk County Board to become a lake improvement district. This status was approved and the present day Maple Lake Improvement District was established on March 23, 1987. By changing to a District, the cost of lake improvement projects, (aeration, street lights, cleanup, annual meetings, directory, water quality projects, newsletter,fisheries, etc.) are now shared by all of the property owners through an assessment on the real estate tax, rather than depending on voluntary payment of dues. Although the District was created by the County Board, it is essentially controlled by the property owners. The District holds an annual meeting and the seven member Board of Directors meets monthly.

Additional development history of the Maple Lake area should be recorded while residents are still available to recall such histories. This could include development of the Maple Bay area, adjoining bays and lakes such as Ulland's Bay and Cable Lake, association with townships, garbage handling, lighting and signs and a variety of other related topics.

Figure 2. Maple Lake Features

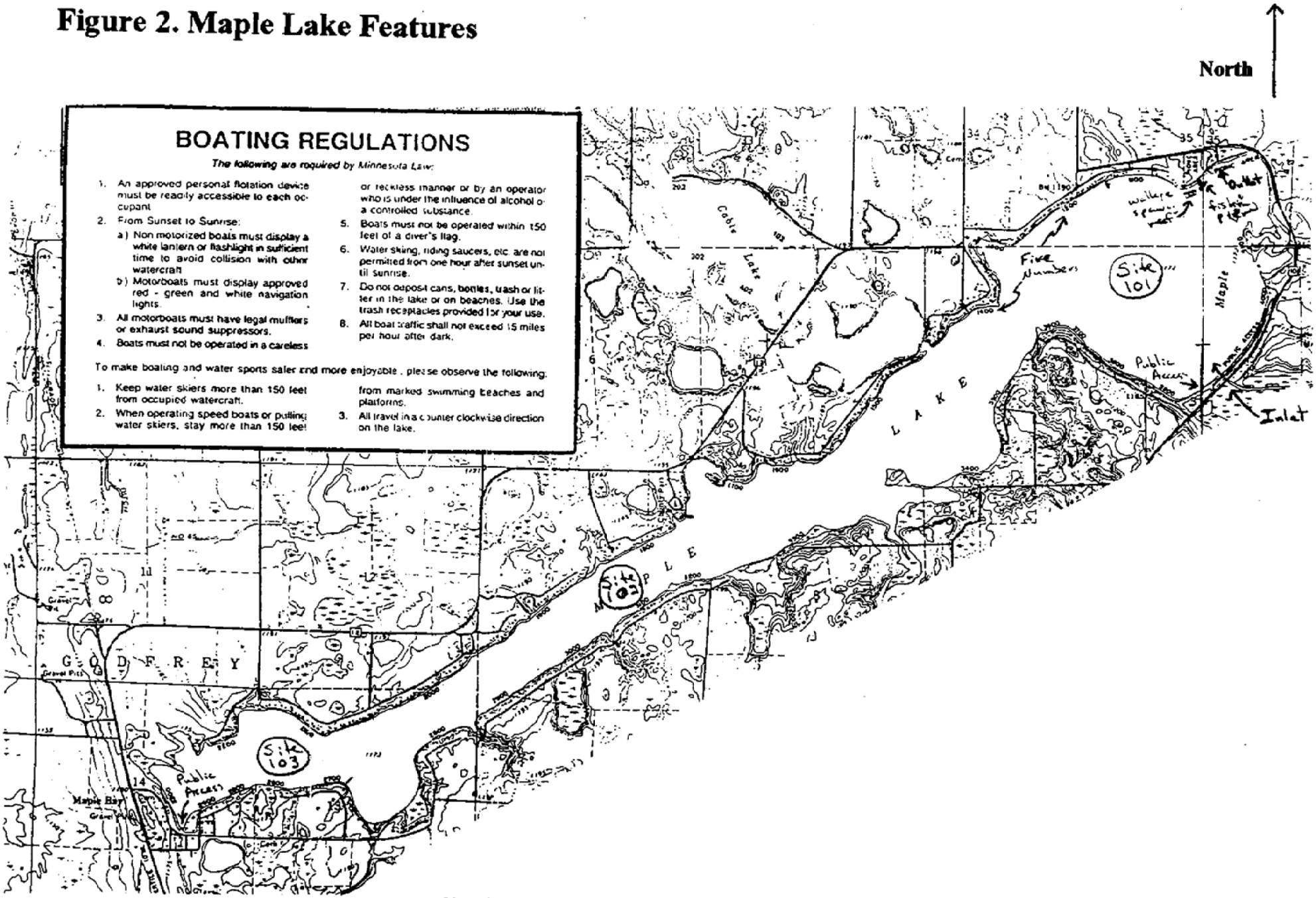
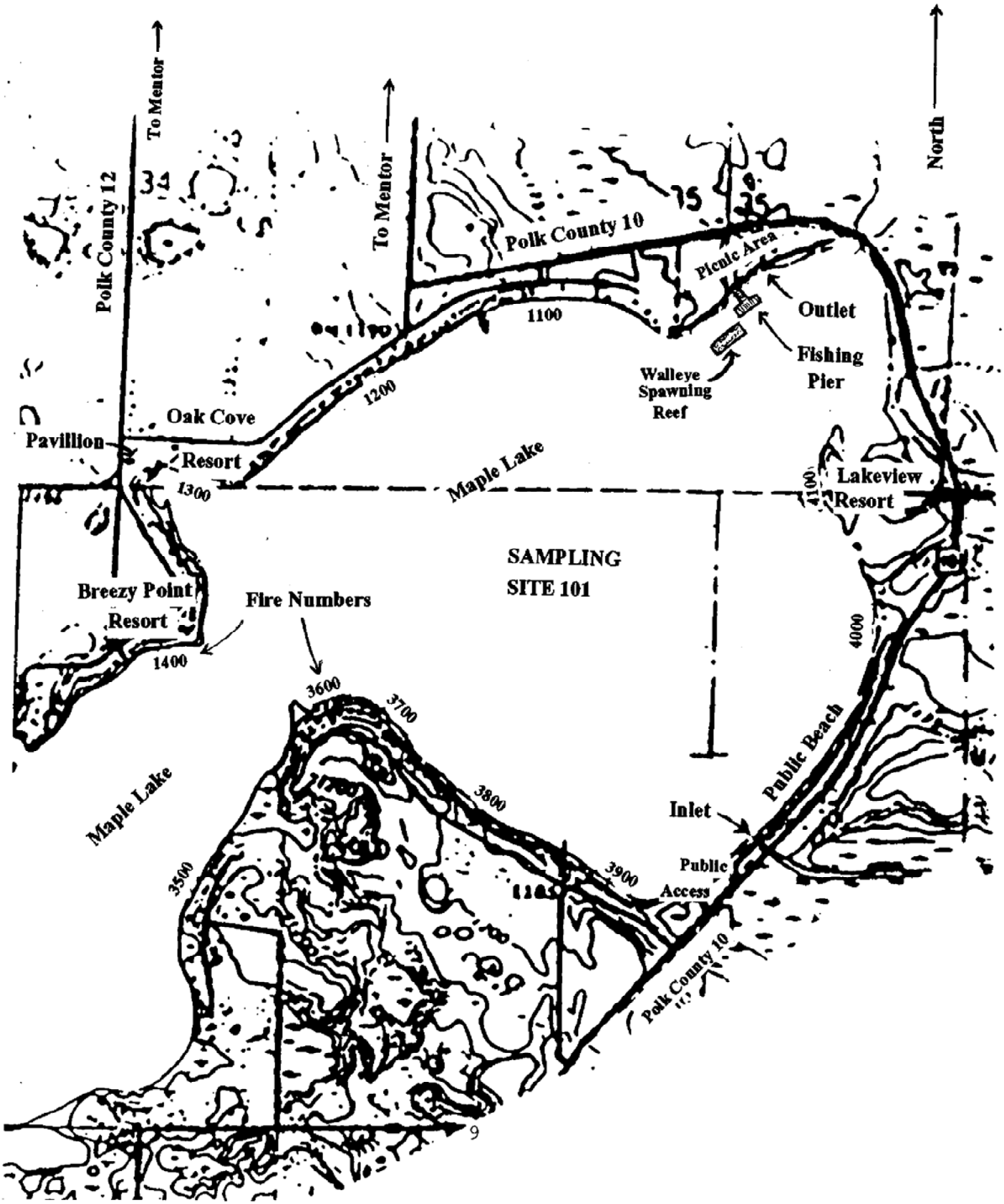


Figure 3. Detail of Maple Lake Northeast Bay



Watershed Characteristics

Maple Lake is a shallow lake with a maximum depth of 16 feet. Maple Lake is a long narrow lake oriented in a northeast to southwest direction. The lake is approximately six miles long and a half mile wide with a surface area of 1,445 acres. The inlet and outlet are both situated in the northeast bay of the lake (See Figure 2). Maple Lake is also connected to Cable Lake to the west via a connection channel which passes under Polk County 12. Cable Lake has no other inlets or outlets and no official public access. The main public access on Maple Lake is near the inlet at the east end of the lake. A public access is also at the south end of the lake. Several private businesses and a county park also provide boat launching access for a fee.

Maple Lake was formed by glacial activity. It is on the edge of the Red River Valley, just south and east of the former Glacial Lake Agassiz lake basin. The area was originally prairie, which was later invaded by hardwoods. The Maple Lake area is within the Fosston Till Plain geomorphic region which is characterized by gently rolling topography with depressions, potholes and small bogs being common. The majority of the soils are loam to clay loam and have good drainage. A lake's watershed includes the lake and all the land that drains into it. Figure 4 illustrates the watershed area of Maple Lake, including the type of land cover in the watershed. Table 1 identifies the acreages of Maple Lake's watershed according to the type of land cover. Data for Union Lake and Lake Sarah are also included for comparison purposes.

As land use affects water quality, it is useful to divide the state into regions where the land use and water resources are similar. For Minnesota, this results in seven regions, referred to as "ecoregions," as defined by soils, land surface form, natural vegetation and current land use. Data gathered from representative, minimally-impacted (reference) lakes within each ecoregion serve as a basis for comparing the water quality and characteristics of other lakes within that ecoregion. Maple Lake is located in the extreme northwestern corner of the North Central Hardwood Forests (NCHF) ecoregion, nearly on the border of the Red River Valley ecoregion (see Figure 5). A "typical" range of land use of lakes' watersheds within the North Central Hardwood Forest ecoregion is presented in Table 1. This is the "interquartile range" which are the values of the watersheds within the 25-75th percentile range of all watersheds in the ecoregion, thus disregarding the high and low watershed values within the ecoregion.

Table 1. 1989 Watershed Land Use-Maple Lake, Lake Sarah, Union Lake and North Central Hardwood Forest Interquartile (25-75th percentile) Range

	Maple Lake		Lake Sarah		Union Lake		NCHF
Land Use	Acres	%	Acres	%	Acres	%	Range
Cropland	20,012	52	3,883	61	1,515	26	22-50 %
Forest	5,562	14	652	10	1,435	25	6-25 %
Grassland(Pasture)	5,407	14	701	11	752	13	11-25 %
Water	4,488	12	664	10	1,233	22	14-30 %*
Wetlands	2,033	5	289	5	452	8	*
Urban/Residential	1,196	3	166	3	366	6	2-9 %
Total Watershed Area	38,698	100	6,356	100	5,752	100	11,540 acres
Lake Surface Area(acres)	1,445		318		734		899 acres
Watershed:Lake Surface	26.3:1		20.0:1		7.8:1		12.8:1
Mean Depth (ft.)	8 ft.		7.9 ft.		20 ft.		22 ft.

*Water and wetlands were grouped together in the data available for the NCHF Ecoregion.

Figure 4. Maple Lake Watershed Land Cover 1989

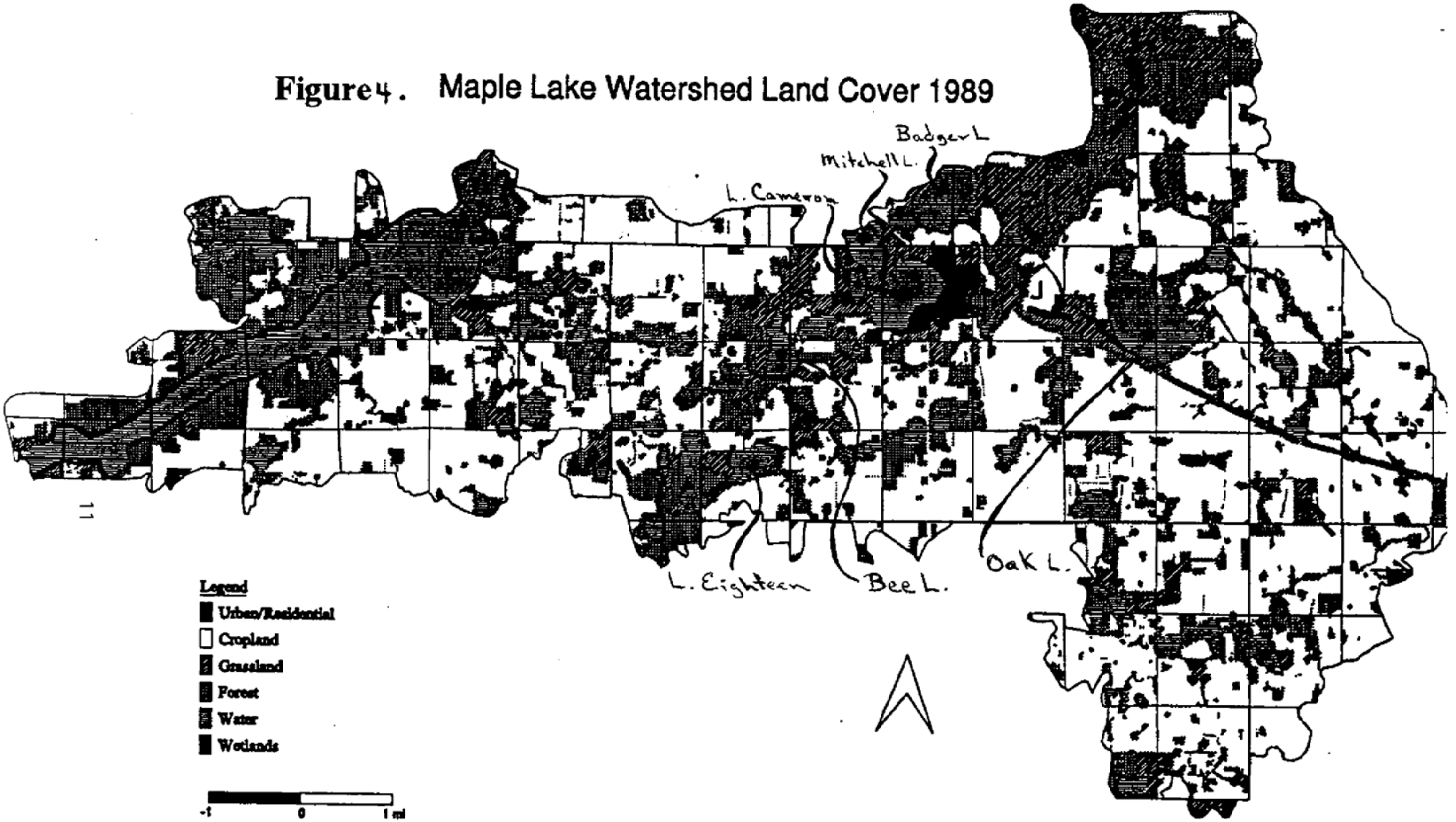
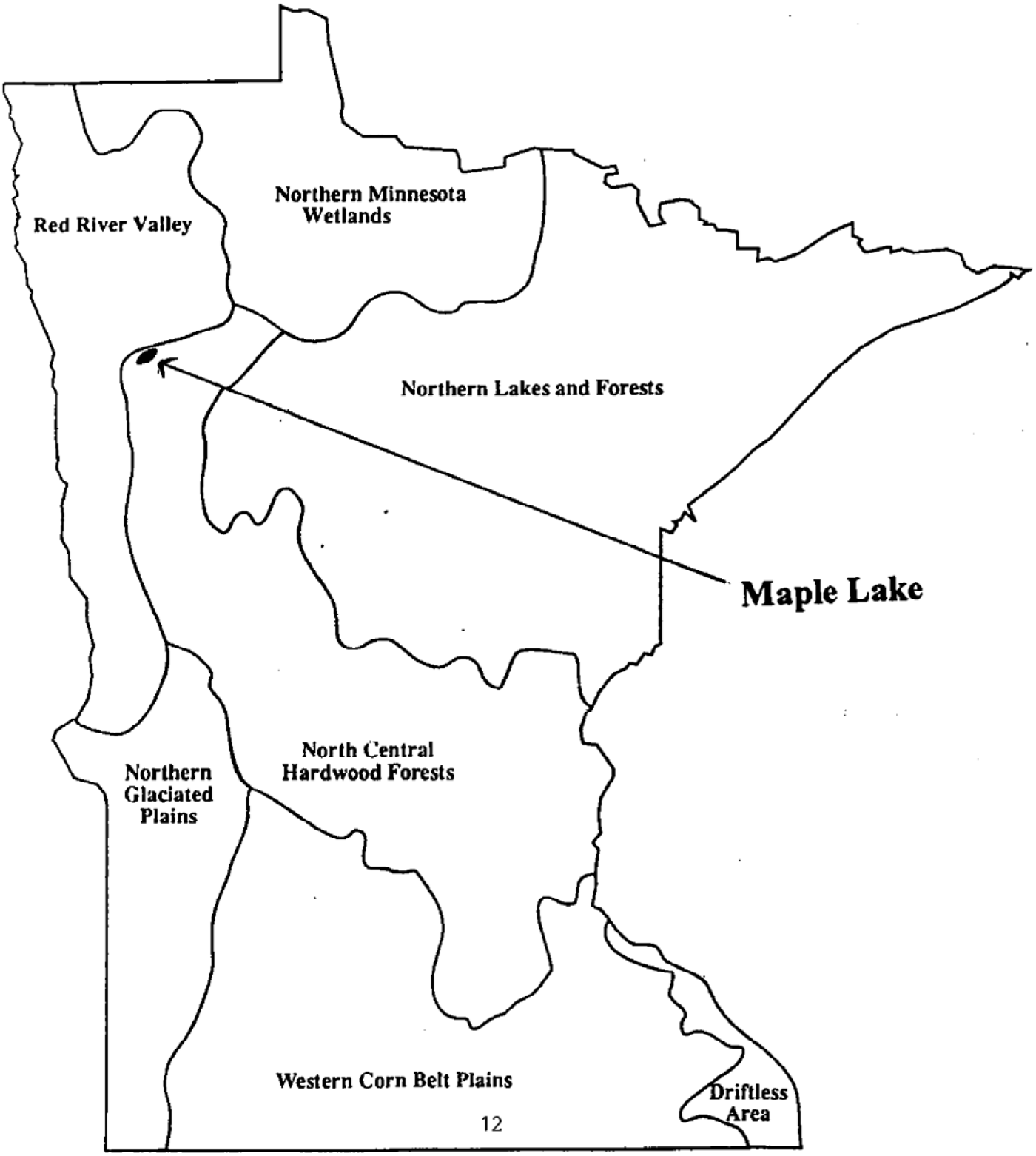


Figure 5. Maple Lake Location Within Minnesota Ecoregions



As shown in Table 1, with 1,445 surface acres and 38,698 acres of watershed drainage, Maple Lake is 1.6 times larger than the typical lake in the NCHF ecoregion in terms of surface area and its watershed is 3.4 times larger than the average watershed in the ecoregion. It is useful to compare the ratio of watershed area to lake surface area to get a feel for the relative importance of management practices immediately around the lake as compared to the watershed as a whole. The ratio of watershed area to lake surface area for Maple Lake is 26.3:1--twice the ecoregion average. Inferences from this comparison alone suggests that while it is important for residents on Maple Lake to use best management practices, the impact from land use in the entire watershed is proportionately greater than a situation such as Union Lake where the contributing watershed area is much smaller relative to the lake area.

A review of the data in Table 1 shows that 52 percent of land use within Maple Lake's watershed is considered cultivated putting it past the upper end of the ecoregion range of 22-50 percent.This is a significant variation especially when combined with the large watershed to lake surface area noted above. Water and wetlands within the Maple Lake watershed is towards the lower end of the ecoregion range. At three percent, land classified as urban and residential in the Maple Lake watershed is also at the low end of the ecoregion range of 2-9 percent. Although residential development is very intense immediately around Maple Lake and in the community of Erskine, the majority of the watershed has quite limited residential development.

Lake Level Fluctuations and Precipitation

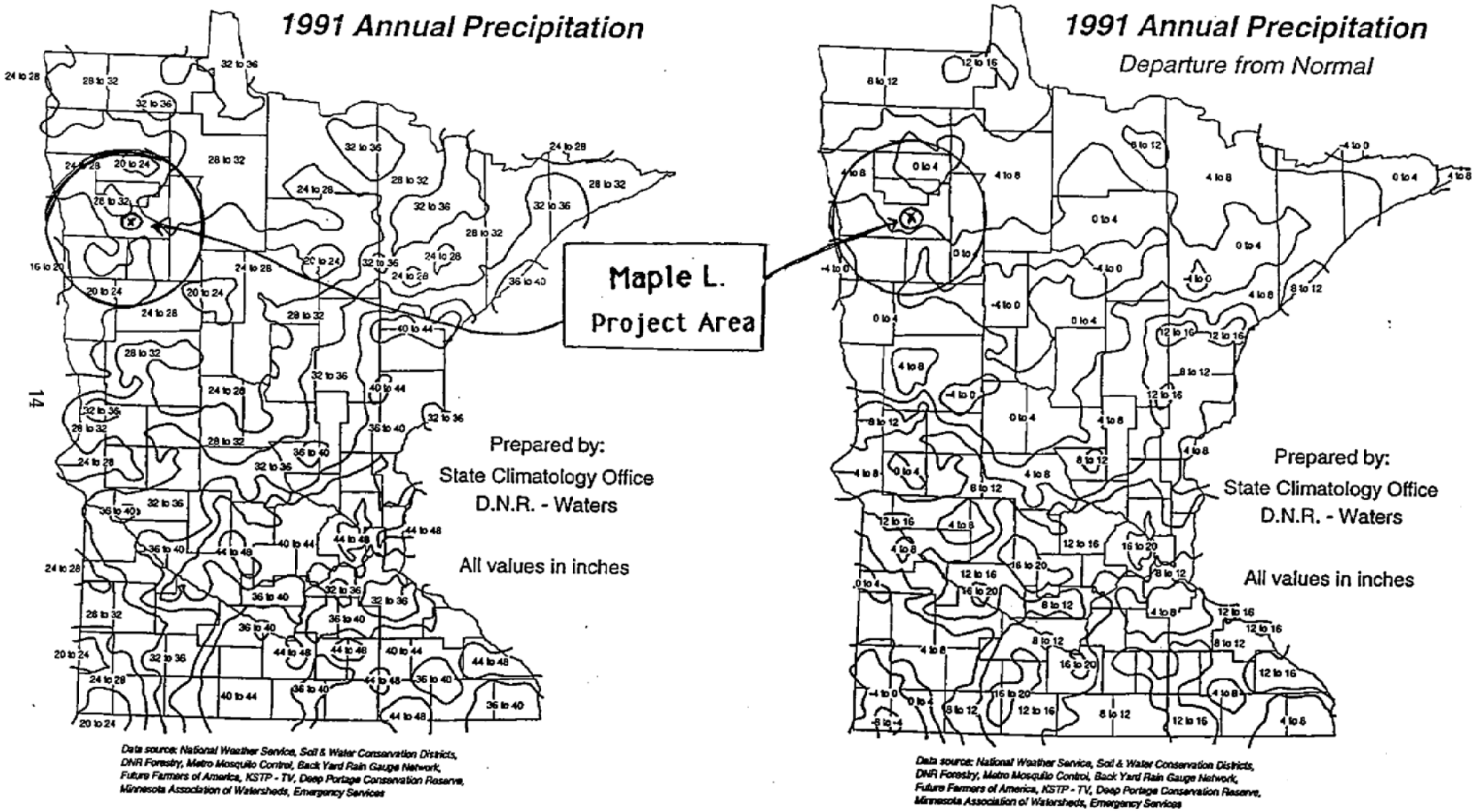
With the drought of the 30's Maple Lake receded to the point where it only had water in the big bay at the northeast end of the lake by the early 40's. There are many recollections of the lake bottom being plowed for farming during those years. There has been unconfirmed speculation that a contributing factor to Maple Lake drying up was due to dynamiting for road construction near Maple Bay in the 1930's which broke a "dam" that blocked flow to the southwest. No specific accounts have been found to verify this speculation.

As shown in Figure 3 Maple Lake has an inlet on the east end of the lake with its outlet across the bay at the north end of the bay. The inlet is connected to Judicial Ditch #73 which was built in the late 1920's to provide flood control for lands adjacent to Badger Creek and Badger Lake and to supply water to Maple Lake for water level control. There is a control structure at the outlet with a metal bar welded in place at a point that allows water to flow out when the lake elevation reaches its ordinary high water level of 1172 feet above sea level.

There is also a channel and culvert under Polk County Road #12 which connects Maple Lake to Cable Lake to the west. There is a control structure in place at this location. Operation of the structure is controlled by the Polk County Commission with agreement that the structure be opened to allow water from Maple Lake to enter Cable Lake whenever water levels on Maple Lake are such that water is flowing over the Maple Lake outlet at the 1172 elevation. There are no other inlets and no outlets on Cable Lake. It is speculated that much of Cable Lake's water supply is derived from underground aquifers which are also connected to Maple Lake.

Precipitation for this area of Polk County ranged from 4 to 8 inches above the normal average annual precipitation of 22 inches (See Figure 6) for the 1991 calendar year. On average, 70 percent of the annual precipitation total falls as rain during the months of May to September for this part of the country. This would be approximately 15.4 inches for the Maple Lake area. Lake levels and ground water recharge are generally not significantly impacted by snowfall amounts. Evaporation generally exceeds precipitation in this part of the state and averages about 26 inches per year. Average annual runoff is 3.6 inches for the region.

Figure 6. 1991 Annual Precipitation and Departure From Normal-Minnesota



Rainfall recorded by a citizen monitor at the northeast end of Maple Lake totalled 21.45 inches for the period May 11 through September 28, 1991. The highest rainfall came during the month of June with 8.67 inches received. The September total of 6.67 inches was above average for this time of year. In 1992, for the period of April through September a citizen monitor located five miles south of Maple Lake recorded a rainfall total of 18.39 inches, approximately 3.5 inches below the normal annual precipitation. As shown in Table 2 lake levels remained fairly stable throughout 1991 with the highest level recorded in June and July, primarily due to the June rainfall. Figure 7 shows the variation in rainfall and lake levels over the past several years.

Table 2. Maple Lake Rainfall, Lake Levels, Surface Water Temperature and Secchi Disk Data-1991

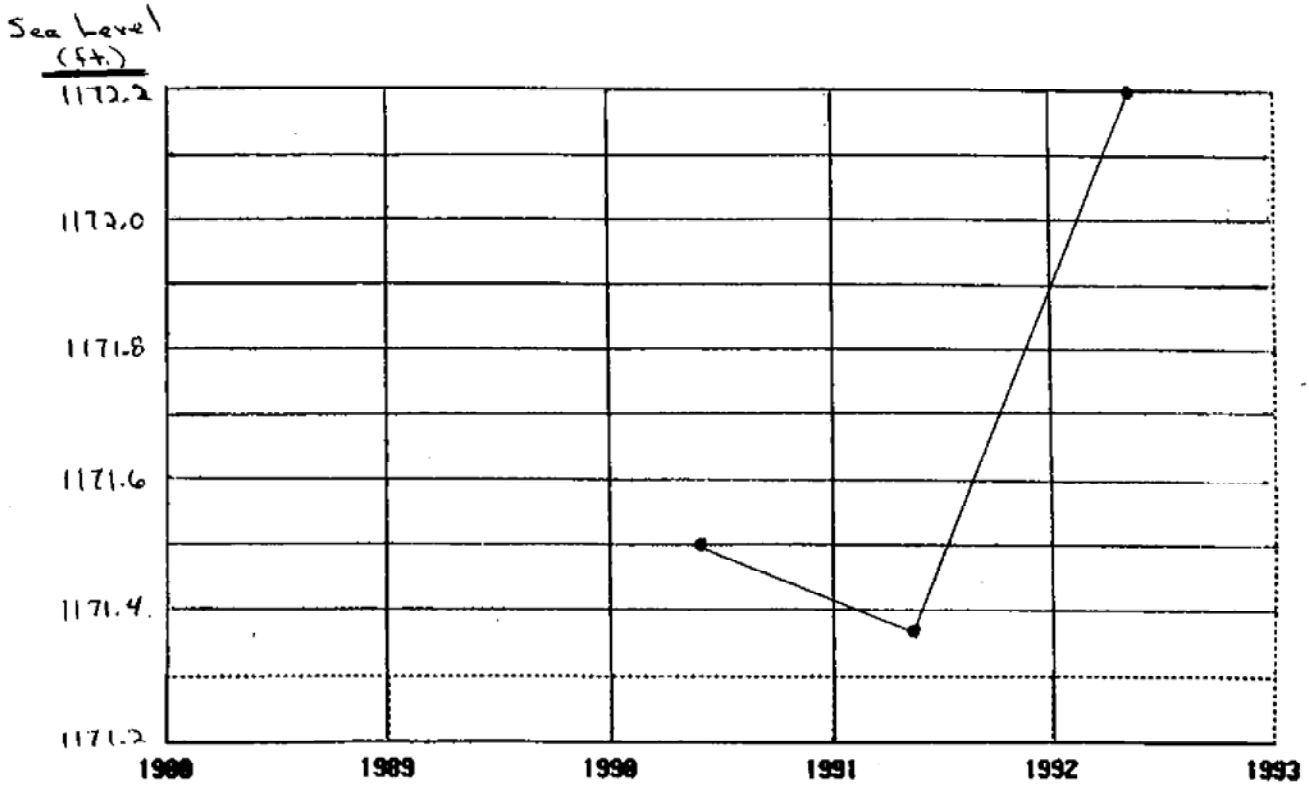
Sampling period	Monthly Rainfall(inches)	Lake Level(ft)	Water Temp (°F)	Secchi disk (ft)
May	1.68	71.5	65.0	6.1
June	8.67	71.7	73.2	3.1
July	1.90	71.8	74.3	3.0
August	2.53	71.6	72.3	3.0
September	6.67	71.4	70.5	2.75

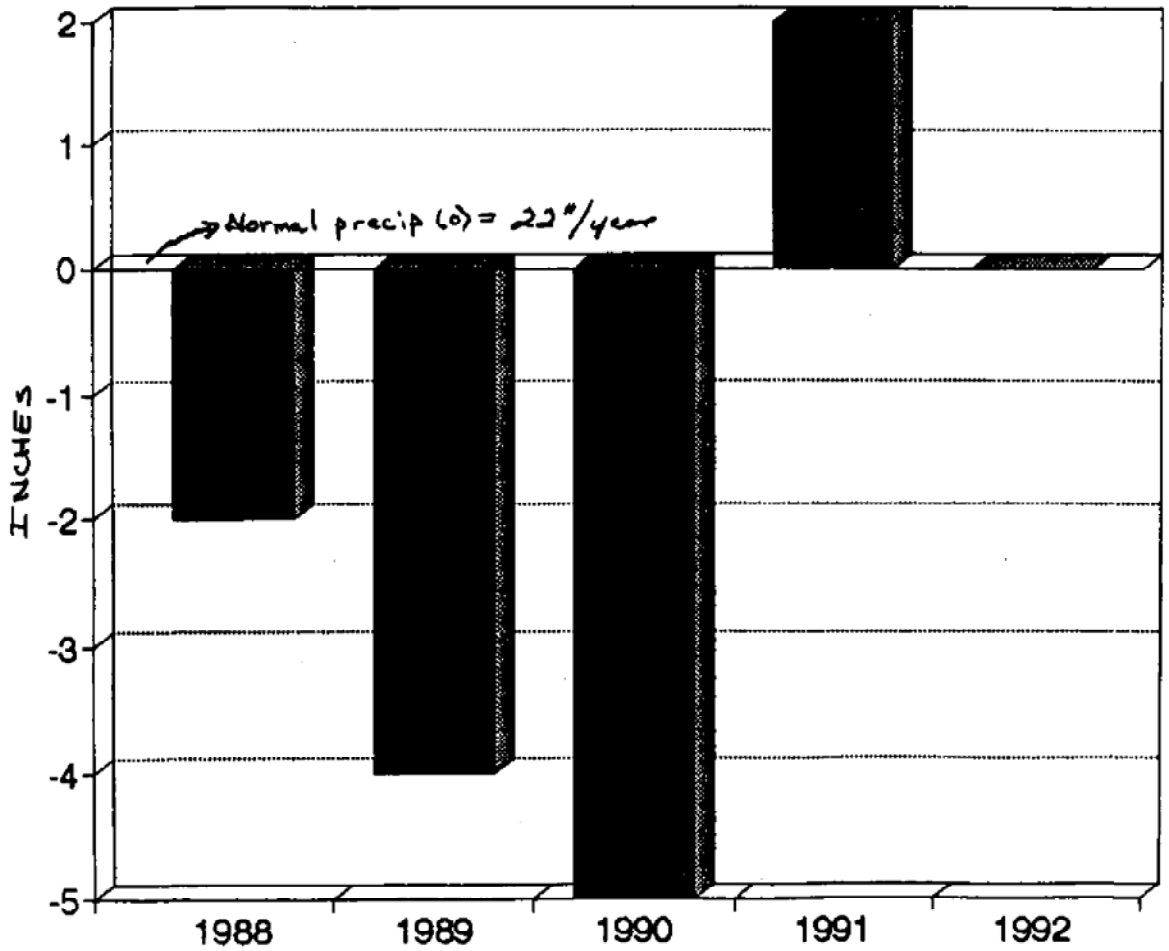
The data in the above table represent monthly totals and averages. The complete weekly data summaries are included as Appendix Table B-1.

It is unknown to what extent lake levels are maintained via surface water runoff or by groundwater and underground springs feeding Maple Lake. At 1172 feet above sea level, Maple Lake is 36 feet below the elevation of Union Lake which lies approximately 7 miles southeast of Maple Lake. The Maple Lake Improvement District initiated a water signaturing study in 1992 to better understand the water dynamics of Maple Lake. The study was carried out by Joe Magner of the MN Pollution Control Agency. Details of the study are included in a separate report issued by Magner--a brief report of his findings follows.

"Maple Lake appears to be comprised of several different source waters--direct precipitation, inflow from Tamarack Lake and shallow ground water. The inflow and outflow of Maple Lake likely precludes a complete mix of all water source types throughout the lake. Maple Lake lies downgradient of both infiltration and lake water recharge sources, yet upgradient of ground water discharge zones in the glacial Lake Agassiz beach ridge sediments. Shallow ground water, derived from a shallow till, high total dissolved solids infiltration derived flow system is likely discharging into Maple Lake along the southern shore. While Maple Lake is not receiving water directly from Union Lake, it was determined that the semi-regional flow of ground water moves along a southeast to northwest axis. Thus, Union Lake water likely does move towards the northwest following a moderately deep flow path (See Figure 8). More rigorous monitoring and modeling is needed to further understand Maple Lake's hydrology."

Figure 7. Maple Lake Annual Rainfall and Lake Levels



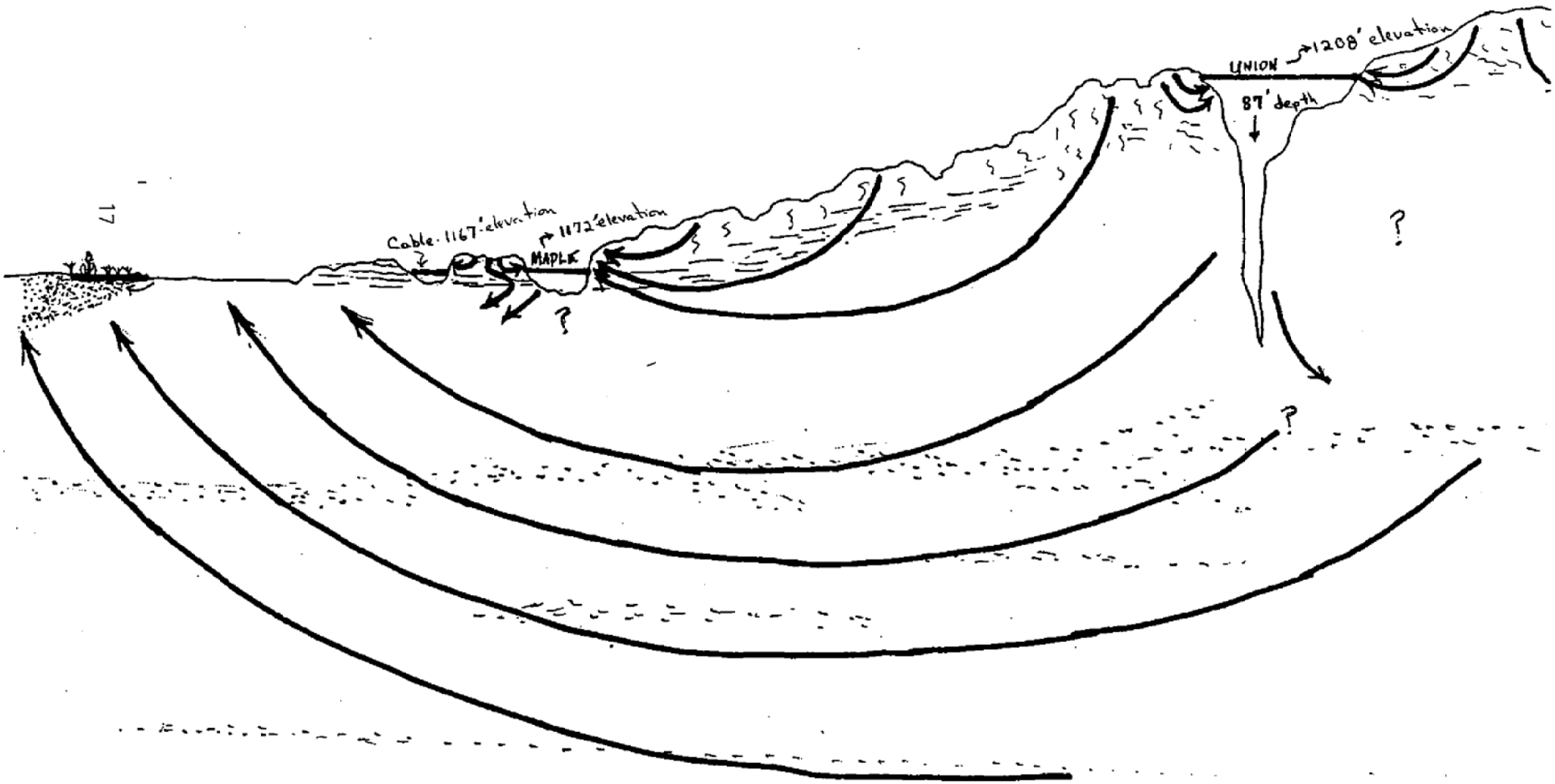


Source: Minnesota Department of Natural Resources--Division of Waters, 1992

PRECIPITATION

(Departure From Normal; 22"/year)

Figure 8. Lake Elevations and Conceptual Flow Model



Fisheries

Maple Lake is the nearest fishing lake to areas north and west including the larger communities of Crookston, Thief River Falls, East Grand Forks and Grand Forks. Fishing pressure has increased over the past decade as walleye and black crappie catches continue to be good. Maple Lake is not necessarily known for giving up a large number of walleye but there does seem to be a disproportionately large number of trophy size walleyes caught. The best fishing times are at night and during the week when competition with other water recreation users is minimal.

Maple Lake is known for its spring crappie run when the crappies enter the shallower bays for spawning. Anglers line the shores of these bays during this annual ritual with limits easily being caught although the size of the individual crappies is generally not very big. Larger crappies are more often caught by ice fishing which is a very popular fishing method on Maple Lake.

According to MN DNR lake management plans that date back to 1984, Maple Lake has been and continues to be managed as a walleye lake. Fish stocking records that date back to 1971 also indicate walleye to be the predominant fish that has historically been stocked. According to the current DNR management plan (See Appendix A), Maple Lake will be stocked with walleye fingerlings at the rate of one pound per littoral acre on a biennial basis. No stocking of any other species is recommended. A littoral acre is defined as the lake area that has a water depth of 15 feet or less. The entire 1,477 surface acres of Maple Lake is considered to be in this category, thus 1,477 pounds of walleye fingerlings are to be stocked in Maple Lake every two years.

Some northern and sunfish have been stocked in Maple Lake in the past (Appendix Table A-1). Over 9 million walleye have been stocked since 1971 with nearly 90 percent of these being walleye fry which typically have a low survival rate in natural waters. Many of the walleye stocked over this period were from a rearing pond which is located near Maple Lake's outlet. The rearing pond yielded 582,304 walleye totalling 9,368 pounds over the 14-year period when records are available (Appendix Table A-2). Nearly all of these walleye were stocked in Maple Lake. The rearing pond was last used in 1982.

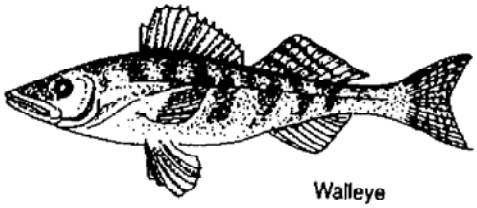
A summary of gill and trap net surveys taken since 1971 are shown in Appendix Table A-3. Walleye and northern pike populations are below the goals established in DNR's Maple Lake Management Plan. Black bullheads show up as the most prevalent fish species in Maple Lake. Rough fish removal has been done on occasion by commercial netting. Fish removed included bullheads, yellow perch, white suckers, carp and turtles. Further attempts will be made to remove bullheads from the lake, however there are no commercial harvesters in this area and the bullheads in Maple Lake tend to be of a smaller size that do not generally provide an attractive enough economic return to commercial harvesters.

Natural walleye spawning areas are lacking primarily due to siltation. Winter kill was also a factor limiting game fish populations and enhancing rough fish numbers. A three unit pump and baffle aeration system was provided to Maple Lake through the DNR C.O.R.E. program and is now operated by the Maple Lake Improvement District when oxygen levels become low in the winter. The DNR monitors the oxygen levels and notifies the Maple Lake Improvement District and the Mentor Sportsmens Club when to operate the pumps. Generally, when dissolved oxygen levels fall to 4 parts per million or less, the pumps will be activiated. It has not been necessary to operate the pumps for the past several years. When the pumps are operated throughout the season, it costs approximately $3,000 for electricty--averaging about $1,000 per pump. Operation of these pumps when necessary has eliminated winter kill as a limiting factor in Maple Lake.

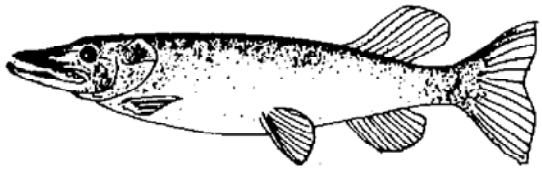
In an effort to provide walleye spawning habitat, a rock reef walleye spawning area was installed in February of 1992. The rock reef is located southwest of the outlet in the area of the Polk County

day-use park. The reef consists of 14 piles of rock arranged in a series of mounds which covers approximately one-quarter acre (see Figure 9). The multiple pile arrangement was used versus one long reef to increase the surface area for spawning. The rock were collected from the local area, washed, and stockpiled on shore until the ice was thick enough to work on. Holes were then cut in the ice with chainsaws and the rocks dumped by loader through the holes to make the piles. The top of the reef is at least four feet under the water surface to avoid any boat propellers being hit. The DNR will monitor use of the reef for at least the next two years by placing egg baskets on the reef to allow collection and counting of walleye eggs and other aquatic invertebrates.

Another fisheries development involved installation of a fishing pier in June of 1991. The pier was installed through the DNR C.O.R.E. program with assistance from the Mentor Sportsmens Club, the Maple Lake Improvement District and Polk County. This handicapped accessible "T" shaped pier is located in the large eastern bay near the outlet and is accessed through the Polk County day-use park. The pier is in a good location for anglers to catch a variety of fish species with the pier receiving heavy use since being installed. The Mentor Sportsmens Club detaches the pier from its land base in the fall and floats it a short distance to a protected bay near Lakeview Resort for the winter and then reinstalls it in the spring after ice-out.



Walleye



Northern Pike

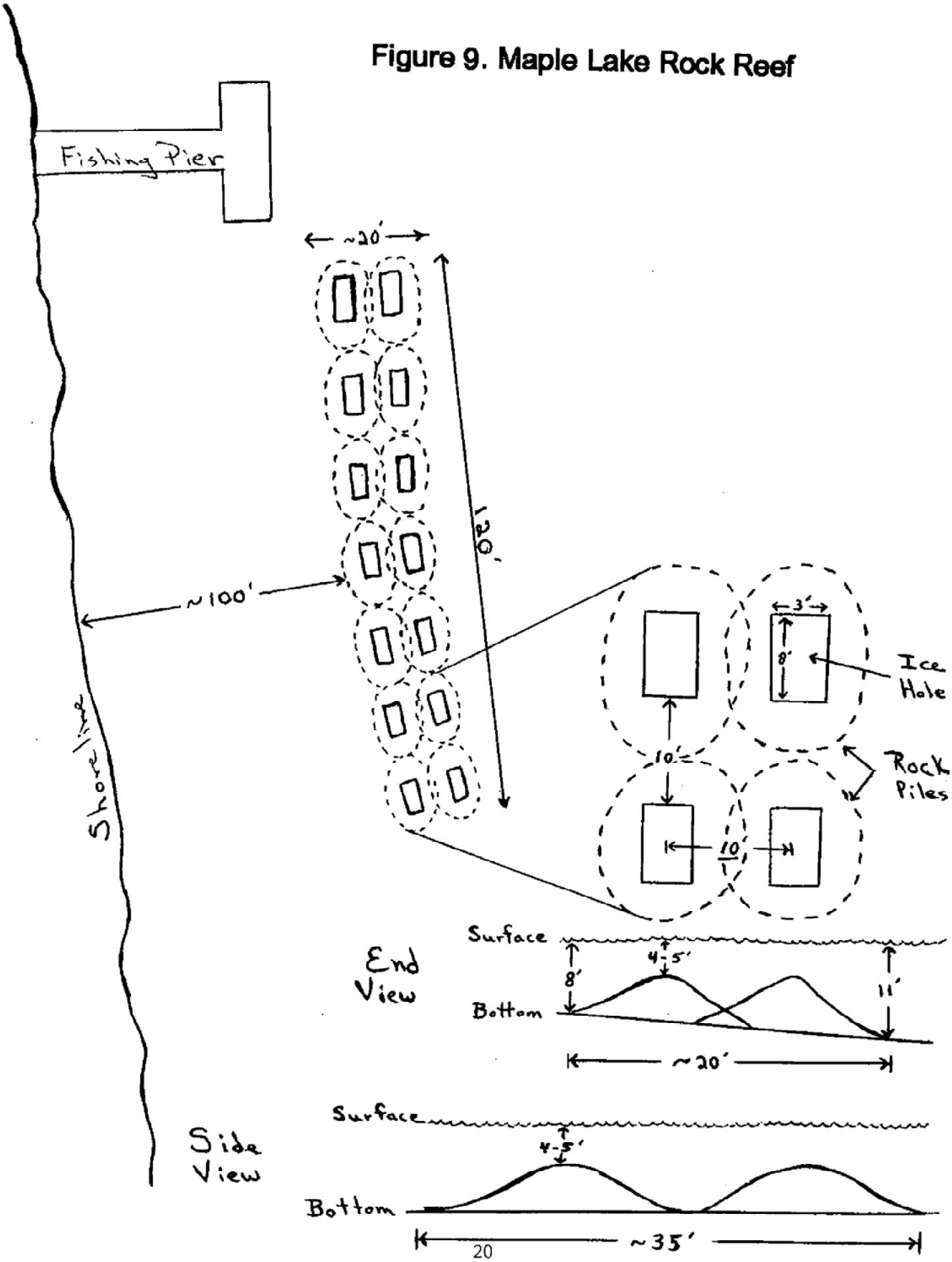
Aquatic Plants

Native aquatic plants have many values to man, fish, and wildlife. They are the primary producers in the aquatic food chain, they assimilate sunlight to generate oxygen and new plant tissue. They provide food and shelter for fish. Plants in shallow areas can increase water clarity by reducing the turbidity caused by particles resuspended by wave action. Emergent aquatic plants, such as cattails and bulrushes, protect the shoreline from erosion. Aquatic plants provide food and shelter for waterfowl. They also purify water by absorbing phosphates, nitrates, and other nutrients. Lakes with a high nutrient load that lack an abundant growth of emergent vegetation often develop heavy filamentous or blue-green algae growths. Many of our aquatic plants are also aesthetically pleasing, such as waterlillies and pickerelweed.

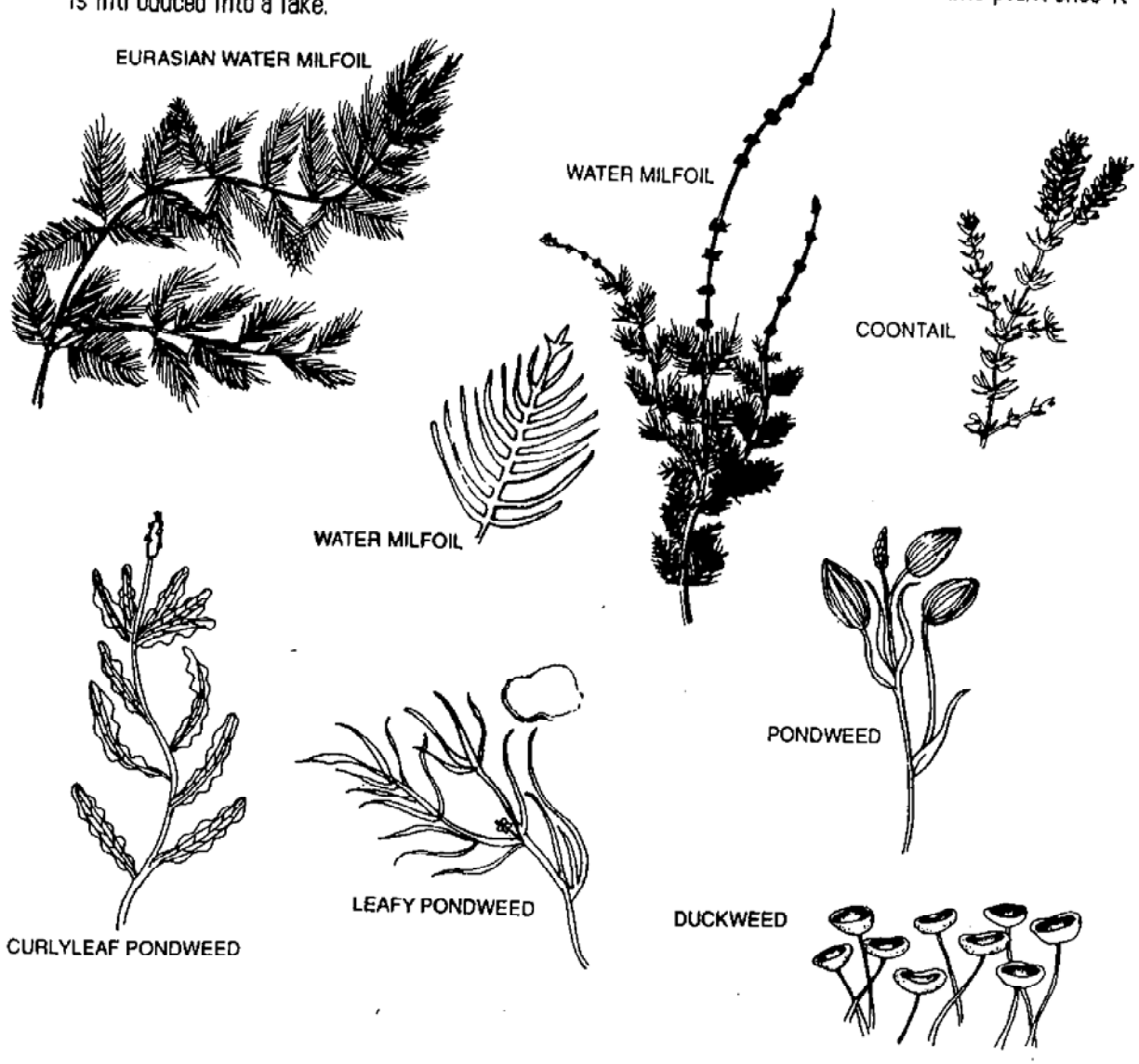
No large scale aquatic plant harvesting has been done in Maple Lake. Individual homeowners on the lake rake aquatic plants from in front of their properties to provide recreation and boating opportunities. Differences of opinion exist regarding the extent of plant removal that should occur. Those that want extensive plant removal are primarily interested in short-term aesthetic benefits related to recreation suitability. Arguments for keeping plants in place relate to providing fish habitat and nutrient uptake by plants which helps control algae growth. While plants do take up nutrients which in turn keeps these nutrients from being available for algae growth, these plants also annually die off and release these nutrients as bottom sediment which can be mixed in the lake via wind action and power boat disturbances. The net effect of taking up and releasing of these nutrients or of extensive plant harvesting is uncertain although it is believed that as part of the natural ecosytem these plants should as much as possible be left in place.

However, utmost attention should be placed on preventing introduction and spreading of exotic aquatic plants into the Maple Lake watershed. The two primary plants of concern at this time are purple loosestrife and eurasian water milfoil. These species are very competitive and once

Figure 9. Maple Lake Rock Reef



established will overtake other plants and reduce the diversity of aquatic plants in the lake and hence the diversity and health of the entire lake ecosystem. Eurasian water milfoil has not spread to this part of the state yet. The Maple Lake Improvement District has placed signs at boat landings warning of this plant and requesting that all boaters thoroughly check their boat trailers, propellers and other places where fragments of this plant could be located and thereby introduced into Maple Lake. There have been no effective methods developed to date to control this plant once it is introduced into a lake.



Wildlife

Maple Lake provides the necessary ingredients of food, water and shelter for a variety of wildlife. The greatest diversity is found in the watershed east of Maple Lake due to the less intense development. Deer and moose are the most common larger mammals. A variety of waterfowl are found in the potholes and sloughs east of Maple Lake. Canada geese numbers have risen significantly in recent years and trumpeter swans have been re-introduced to the area at the Rydell National Wildlife Refuge just east of Maple Lake. A pair of bald eagles are also known to have been nesting over the past couple years near Badger Lake by Erskine. The area is excellent for birdwatchers as a large number and variety of songbirds migrate through the area.

Citizen Concerns

A survey was included in two editions of the Lake Leader newsletter that went out to all lake property owners. Concerns expressed by residents around Maple Lake primarily related to issues of water quality and aesthetic enjoyment of "lake life". Many comments were made about too much development and destruction of natural habitat. A peaceful lake experience was also valued as many noted too many and too large of boats and jet skis being noisy and reckless. There was concern over nutrients entering the lake from improper septic systems and overfertilizing lawns, however the overall impression from the surveys was that water quality has improved since the 1950's. Generally, fishing was viewed as being poorer today than in the past with a need to control rough fish populations and stock more desirable species. Following are some of the survey responses received from Maple Lake residents.

- Too much clearing and filling in of drainage areas and wetlands.
- Help area wildlife by leaving nearby wetland alone.
- Too much clearing of land. Also concern with expansion of trailer park near Pavillion.
- Too high of population density around lake. Should be a program to retire lakeshore property when it comes up for sale until number of cottages is reduced.
- Too much emphasis on fancy lawns which are probably overfertilized which then enters lake.
- Walleye and crappie fishing has declined and more sunfish are being taken.
- Large mouth bass are rare. Perch are scarce. Large carp and bullheads predominate.
- Used to catch large northerns. Too many weeds removed--need to save weeds as fish habitat.
- Best walleye fishing in 1950's and 80's--poor in 60's and 70's.
- Too many big power boats--need to limit size or speed somehow.
- Cars are required to have mufflers so this should also be required of boats & those pesky jet skis.
- Boat traffic has declined recently--maybe they're too expensive.
- Due to Maple Lake being shallow the big power boats keep churning up the bottom. Big boats with loud motors and hydroplanes have destroyed peacefulness of the lake--not to mention the "jet skis" with their irritating sound.
- Jet skis are too noisy and drive recklessly.
- Boat traffic increased greatly since mid 60's. Jet skis are so noisy and can ruin a day at the lake.
- Have observed more algae blooms in some areas of lake, especially west end.
- Water quality has decreased with more frequent algae bloom problems.
- Notice of decrease in water clarity over past 20 years.
- As year-round resident on Maple Lake for 45 years, I think water quality has improved--much less algae bloom. Main water quality problem is from large boats stirring up bottom on weekends.
- Water quality was worse in 1955--very green. Credit ditches for improvements over the years.
- Sewage systems are not monitored and many are illegal. There are some sewage systems that only use a 50 gallon drum--this should be corrected.
- Septic tanks are not polluting the lake at all. Farm runoff is our main source of pollutants.
- Unfair taxes. If you get a building permit your taxes are raised while others build or change without a permit and then there is no change in their taxes.
- Too many instances of illegal use of boathouses, i.e. for habitation.
- Not fair when we follow rules in replacing our dock and then others build new, large docks closer to waterline.
- Everyone needs to take responsibility for the environment of the lake--stop fertilizing their yards, quit shampooing hair and washing with body soap in the lake.
- Too many public accesses on the lake.
- I would like to see all the money spent on street lights used for lake quality.
- Weekend boaters often ignore safety rules. Lake residents also often boat too close to docks.
- Need to address boat safety and littering, including ice house littering.
- New houses are too large for the size of the lots, also too many buildings on each lot.

- Run off from lawn fertilizing is a major problem, especially from recently constructed lake homes with their big lawns.
- Provide more education about what lake property owners can do re: fertilizers, not burning, etc.
- Could a "back yard clean-up" deal be offered annually to get rid of old appliances, docks, etc.?

Similar comments were heard when visiting with Maple Lake residents and others related to Maple Lake. Comments were made that Maple Lake experiences algae blooms throughout the year with excess algae and weeds reaching nuisance levels which detract from recreation uses of the lake. Over the years there has been mention of developing an outlet at the southwest end of the lake to try to get more of a flushing action of water going through the entire lake in hopes that this would flush out more of the nutrients that contribute to the algae problems. Ensuring an adequate supply of water to keep the lake level stabilized at its normal level has also been a concern as long-time residents recall when the majority of the lake was dry in the late 1930's and early 40's.

WATER QUALITY MONITORING

Sampling Program and Procedures

As mentioned, objectives of this project included establishing baseline data and involving citizens in lake monitoring and management. Data was collected over the summer of 1991 which was used to evaluate how Maple Lake is behaving relative to other typical lakes in its ecoregion. The data will also be useful as benchmark data to compare to monitoring results in future years. Water quality data was collected on five dates during the summer of 1991 at three sampling sites within the lake--Site 101 in the middle of the large bay at the northeast end of the lake, Site 102 at the midpoint of the lake and Site 103 in the middle of the bay at the southwest end of the lake (See Figure 2). The sampling dates were June 3, July 2, August 7, September 12, and October 9.

Lake surface samples were collected with an integrated sampler, which is a PVC tube 6.6 feet (2 meters) in length with an inside diameter of 1.25 inches (3.2 centimeters). This sampler collects a column of water from the lake surface straight down to a depth of two meters. The sample was poured into a clean plastic bucket to ensure complete mixing of the water column from which subsamples for water quality and biological analysis were taken. The integrated sampler and bucket were rinsed with distilled water before using. Near bottom samples were taken with a Kemmerer sampler. The samples were placed in laboratory provided containers and kept in a cooler until delivery to the laboratory which was within 24 hours to allow for immediate analysis of unstable parameters such as chlorophyll a. Temperature and dissolved oxygen profiles and secchi disk transparency measurements were also taken on each sampling occurrence. All data was stored in STORET, U.S. Environmental Protection Agency's (EPA) national water quality data bank.

The June water samples were sent to the MN Department of Health lab with the remainder of the samples being sent to ERA Labs in Duluth for analysis. As part of the project's quality assurance/quality control program a split sample was taken in August whereby identical samples taken from the same collection container were sent to seperate labs to check on consistency of results. The split samples were sent to both ERA Labs and the MN Dept. of Health Lab. A replicate sample was also taken at one site each month whereby identical samples would be taken from the same site, but would be labeled as being from seperate sites. The Red Lake Watershed District also often collected water samples at the same time which were analyzed at the water quality laboratory at the University of Minnesota-Crookston. Equipment problems were encountered at the U of M-Crookston lab, thus these results are not available. Willis Mattison of the MPCA and Barb Liukkonen, MN Extension Water Quality Specialist, trained citizen volunteers in sampling procedures necessary to assure quality control. A summary of the average summer water quality indicators for Maple Lake are shown in Table 3 along with additional data that will be discussed below. The complete list of parameters tested for and results from each sampling date are included in Appendix Table B-2. The reader may find more explanation of water quality terminology and concepts used in the following discussion by referring to the Citizens' Guide to Lake Protection.

Table 3. Lake Characteristics and Average Summer Water Quality Indicators-Union Lake, Lake Sarah, Maple Lake-1991				
Parameter	**Union Lake**	**Lake Sarah**	**Maple Lake**	**NCHF Ecoregion Value or Range**
Total Acreage in Watershed	5,752	6,356	38,698	11,540
Lake Surface Area (acres)	734	296	1,445	899
Watershed: Lake Surface	7.8:1	21.5	26.3:1	12.8
Land Use of Watershed-1991 (%)				
Cropland	26	61	52	22-50
Forest	25	10	14	6-25
Grassland(pasture)	13	11	14	11-25
Water	22	10	12	14-30
Wetlands	8	5	5	NA
Urban/Residential	6	3	3	2-9
Mean Depth (feet)	20	7.9	8	21.6
Maximum Depth	83	28	14	NA
% Littoral (depth < 15 ft.)	36	39	100	NA
Total Phosphorus (ug/L)	26.0	23.8	46.9	23-50
Chlorophyll a (ug/L)				
Mean	6.82	7.8	16.4	5-22
Maximum	13	11	25.6	7-37
Secchi Disk (feet)	9.54	7.09	3.1	4.9-10.5
Total Kjeldahl Nitrogen (mg/L)	.79	1.05	1.3	<0.6-1.2
Nitrite + Nitrate-N (mg/L)	<0.01	<0.01	<0.01	<0.01
Alkalinity (mg/L)	160	NA	200	75-150
Color (Pt-Co Units)	10	12	13	10-20
pH (SU)	9.2	10.1	9.1	8.6-8.8
Chloride (mg/L)				