LAKE ASSESSMENT PROGRAM
1993
MINK AND SOMERS LAKES
(I.D. #86-0229, #86-0230)
Wright County, Minnesota

Minnesota Pollution Control Agency
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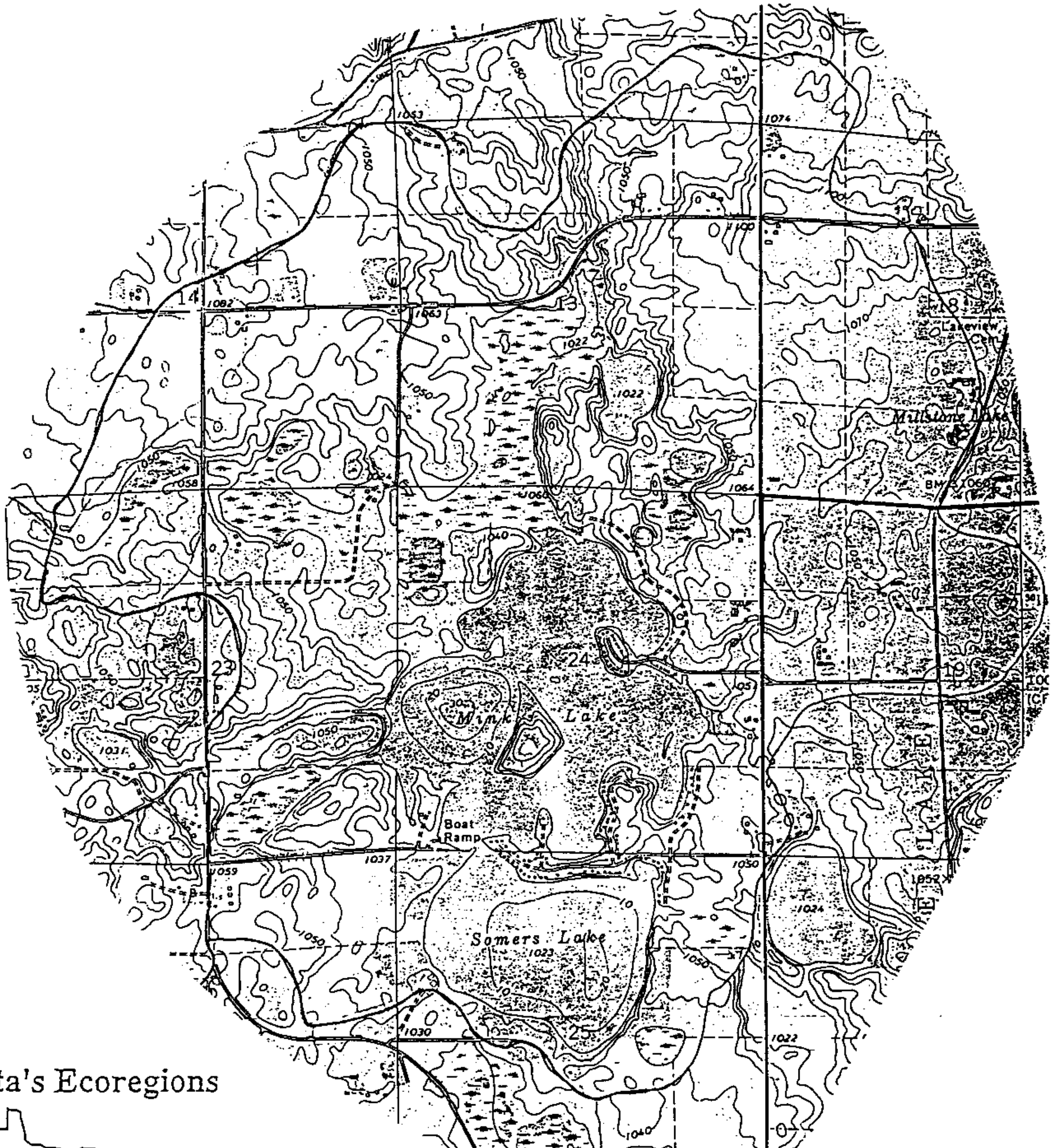
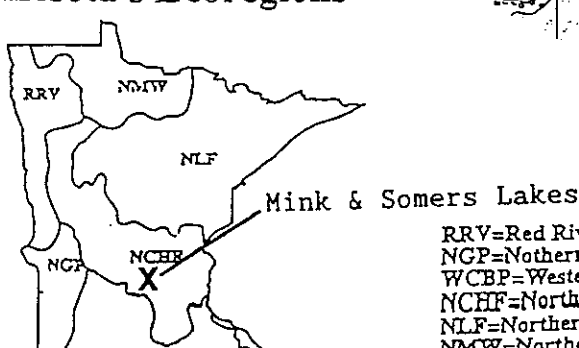
Figure 1. MINK AND SOMERS LAKES LOCATION AND WATERSHED MAP



Minnesota's Ecoregions



RRV=Red River Valley
NGP=Nothern Glaciated Plains
WCBP=Western Corn Belt Plains
NCHF=North Central Hardwood Forests
NLF=Northern Lakes and Forests
NMW=Northern Minnesota Wetlands
DA=Driftless Area

MINNESOTA POLLUTION
CONTROL AGENCY
DIVISION OF WATER QUALITY
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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

SUMMARY AND RECOMMENDATIONS

Mink and Somers are connected lakes located in Wright County. Combined they make up a fairly large lake (430 acres). Land use in the watershed is characterized by cultivated uses (60 percent) and water and marsh (26 percent). This land use composition is fairly typical for lakes in this region of the state - North Central Hardwood Forests ecoregion.

Mink and Somers Lakes were sampled during the summer of 1993 by the Minnesota Pollution Control Agency (MPCA) staff and citizens from the Association of Mink and Somers (Association). Water quality data collected during the study reveal a summer mean (mean of both Mink/Somers lakes) total phosphorus concentration of 124 µg/L, mean chlorophyll a of 84 µg/L and Secchi transparency of two feet. These values are not within the range of values exhibited by reference lakes in this ecoregion. Total phosphorus, chlorophyll a and Secchi transparency help to characterize the trophic status of a lake. For Mink/Somers Lakes, these measures indicate hypereutrophic conditions.

Mink/Somers Lakes are ecologically classified as rough fish-gamefish lakes. The lakes are mostly shallow, turbid due to algae, and experience water level fluctuations. The lakes tend toward winterkill and fishing was often boom or bust. Future plans include reclamation, aeration and a creel survey.

Two lake water quality models were used to estimate the water quality of Mink/Somers Lake based on its morphometry and watershed characteristics. These models provide a means to compare the measured water quality of the lake relative to the predicted water quality.

The first model, MINLEAP, predicts a summer-mean phosphorus concentration of 42 µg/L compared to the observed summer mean of 124 µg/L. The MINLEAP model predicted a significantly lower phosphorus concentration than was observed in 1993. Based on the surface area, depth, size of the watershed and ecoregion they are located in, Mink/Somers lakes would be expected to exhibit a lower phosphorus concentration than observed in 1993.

The second model, Reckhow and Simpson, using high P export coefficients predicts in-lake P concentrations of 83 µg/L. The majority of the P loading to Mink/Somers Lakes comes from the watershed (approximately 80 percent). Feedlots and/or animals pastured in the watershed can potentially be a large source of P to the lakes. Septic systems may potentially be a significant source of P to the lakes. Based on estimated loadings for 1993 septic system concentrations could be on the order of 9-13 percent of the loading.

Based on this study, it appears that the quality of Mink/Somers lakes will vary from year to year as a function of changes in the amount of precipitation and runoff (precipitation during May-August 1993 was about 150 percent of normal). Mink/Somers lakes water quality in 1993 was much worse than expected. It will be important to reduce the amount of nutrients which come from the watershed if conditions observed during 1993 are to improve.

The following recommendations are based on the 1993 Lake Assessment Program (LAP) study of Mink/Somers Lakes:

1. Mink/Somers Lakes have high phosphorus and chlorophyll concentrations compared to other lakes in the North Central Hardwood Forest ecoregion. This is a result of P loadings from the watershed, shallowness of the lakes, and recycling of P from the lake sediments. Cattle and hog operations in the watershed represent a large "potential" source of P for the lakes. Reductions in phosphorus loadings to the lakes will be required to improve the quality of the lakes. It is essential, therefore, that the lake protection efforts be conveyed by all local government groups with land use/zoning authorities for Mink/Somers Lakes.

   The Association should be commended for their efforts to date, which include interacting with the Wright County Soil and Water Conservation District (SWCD), conducting a septic system survey, and participating in the MPCA secchi transparency program (CLMP) and the MDNR lake level programs. To complement these efforts, the Association should develop a plan for protecting the water quality of the lake. This plan, referred to as a lake management plan, should incorporate a series of activities in a prioritized fashion which will aid in the long-term protection and improvement of the lake. The plan should be developed cooperatively by a Committee consisting of representatives from State Agencies (e.g., MDNR, MPCA, BWSR), local units of government, and lake association members. The following activities could be included in the plan:

   a. The Association should continue to participate in the CLMP. Data from this program provides an excellent basis for assessing long-term and year-to-year variations in algal productivity, i.e., trophic status of the lakes. At a minimum, measurements should be taken weekly during the summer at consistent sites. Site 201 in each lake is probably the most valuable for long-term characterization of the transparency of each lake basin.

   b. The Association should follow-up on the evaluation of all on-site septic systems around the lake. The survey which was conducted had a 49 percent response rate. Of these, 38 percent either did not respond to the question on pumping, pump infrequently (five years or longer) or do not pump their systems. Based on these results, the Association should focus more attention on this issue. Steps should be taken to educate all lakeshore property owners and any systems out of compliance with county/state codes should be brought into compliance. These steps may require assistance from Wright County. Education of homeowners around the lake, with respect to septic systems, lawn maintenance and shoreline protection may be beneficial. Staff from the MPCA and the Minnesota Department of Natural Resources (MDNR), along with the county officials, such as staff from Minnesota Extension Service, and the Wright County Soil and Water Conservation District and County Planning and Zoning Department could provide assistance in this area. The booklet, A Citizens' Guide to Lake Protection may also be a useful education tool for the Association.

c. Further development in the immediate watershed of the lake should occur in a manner that minimizes water quality impacts on the lake. Considerations such as setback provisions and septic tank regulations should be strictly followed. MDNR's and county shoreland regulations will be important in this regard. Also, activities in the total watershed that change drainage patterns, such as wetland removal or major alterations in lake use, should be discouraged unless they are carefully planned and adequately controlled. The Association should continue to seek representation on boards or commissions, e.g., watershed management organizations, that address land management activities so that their impact can be minimized.

   The booklet, Protecting Minnesota's Waters: The Land-Use Connection, may be a useful educational tool in this area.

d. A more detailed examination of the possible nutrient sources such as wetland runoff, agricultural runoff, septic systems, lawn fertilizer, and the effects of ditching and draining of wetlands, etc., may aid the Association in determining areas where improvement is needed. Some of the county offices mentioned above may be of help in this regard.

2. The 1993 water quality of Mink and Somers lakes is poor relative to other lakes in the NCHF ecoregion. The lakes could, however, exhibit a decline in transparency, increases in the amount of algae, and possibly increases in the amount of rooted vegetation with an increase in in-lake total phosphorus. Changing land use practices, poor management of shorelands, or draining of wetlands in the watershed provide the greatest likelihood for changes in phosphorus loading.

   Conversely, a reduction of the amount of nutrients that enter the lake should result in improved transparency and a reduction in algal concentrations. One means of reducing nutrient input is by implementing best management practices (BMPs) in the watershed (land management activities used to control nonpoint source pollution). Technical assistance in BMP implementation may be available through local resources management agencies. The Association should continue to work with Wright SWCD to examine land use practices in the watershed and develop strategies for reducing the transport of nutrients to the lake. It may be wise to first focus efforts on the watershed near the lake, in particular.

   Restoring or improving wetlands in the watershed may also be beneficial for reducing the amount of nutrients or sediments which reach Mink/Somers Lake. The U.S. Fish and Wildlife Service at Fort Snelling may be able to provide technical and financial assistance for these activities.

   MPCA's Clean Water Partnership Program (CWP) is also an option for further assessing and dealing with nonpoint sources of nutrients in the watershed. However, since there is extensive competition for CWP funding, it may be in the best interest of the Association and Mink/Somers Lakes to continue to work with the Wright SWCD, and the local townships to do as much as possible to protect the condition of the lake by means of local ordinances and education of shoreland residents. If these steps prove to be inadequate or lake condition worsens (as evidenced by declines in Secchi transparency), application to CWP may then be appropriate.

3. Should a CWP application be deemed necessary, this LAP report serves as a foundation upon which further studies and assessments may be based. The water nutrient income-outgo summaries were estimated based on limited amounts of monitoring data and should be considered best approximations. The next step would be to define water and nutrient sources to the lake in a much more detailed fashion. These detailed studies would allow the estimation of reasonably accurate total phosphorus (and ortho-phosphorus), a total nitrogen (and inorganic nitrogen) and water income-outgo summaries. This should be accomplished prior to implementation of any extensive in-lake restoration techniques.

LAKE ASSESSMENT PROGRAM: 1993

Mink/Somers Lakes
(I.D. #86-0229 and 86-0230)

INTRODUCTION

Mink and Somers Lake was sampled by the Minnesota Pollution Control Agency (MPCA) during the summer of 1993 as a part of the Lake Assessment Program (LAP). This program is designed to assist lake associations or municipalities in the collection and analysis of baseline water quality data in order to assess the trophic status of their lakes. The general work plan for LAP includes Association participation in the Citizen Lake-Monitoring Program (CLMP), cooperative examination of land use and drainage patterns in the watershed of the lake, and an assessment of the data collected by MPCA staff.

Mink and Somers Lake was sampled on five occasions during the spring and summer of 1993. Participants in the sampling effort include Willis Munson from the MPCA and members of The Association of Mink and Somers (TAMS). Association participants in the sampling include Dan Hinrichs, Dick Edlund and Bob Baumann during the summer of 1993. Precipitation and lake water levels measurements were taken by Dan Hinrichs. Paul Diedrich, area fisheries supervisor, Minnesota Department of Natural Resources (MDNR) Montrose Area Fisheries Headquarters provided the fisheries evaluation. Land-use information for the lakes watershed was assembled by Kerry Saxton and Greg Bengston from the Wright Soil and Water Conservation District (SWCD). Water level evaluation and figures were provided by Chuck Revak from the MDNR, Division of Waters, Surface Water Unit. Precipitation information was provided by Greg Spoden from the MDNR, Division of Waters, State Climatology Office.

This study was conducted at the request of the Association, whose members are interested in identifying sources of pollution to the lake, characterizing the quality of the lake, and developing a program to assist in lake management. Some data was available for Mink/Somers Lakes from previous MPCA surveys and CLMP. Very little historical data is available for assessing year-to-year fluctuations in the quality of Mink/Somers Lakes. The Association conducted a septic system survey (Appendix) and compiled a history of events that pertain to the lake and watershed.

BACKGROUND

Mink/Somers Lakes are located northwest of Maple Lake, Minnesota in Wright County. With a combined surface area of about 430 acres and a maximum depth of 32 feet, they are in the upper fifteenth percent of the lakes in the state, in terms of area. Mink Lake is the larger (283 acres) and has the deeper maximum depth (32 feet) but has a smaller mean depth (8.7 feet).

Glacial till from the superior lobe was deposited across the majority of Wright County and then capped by glacial till from the Grantsburg sub-lobe of the DesMoines lobe, the most recent lobe during the Wisconsin Glaciation (Wright County comprehensive water plan). The watershed consists primarily of Lester-Hayden-Peat associations. They are deep, medium, textured and moderately fine textured soils on rolling uplands. Erosion and drainage are the major problem.

Mink/Somers Lakes have a small watershed (4.7 square miles) relative to its surface areas (7:1 watershed to surface area ratio). Eighty four percent of the watershed drains to Mink Lake before it goes to Somers Lake. Mink Lake acts as a settling basin for Somers Lake.

Since land use affects water quality, it has proven helpful to divide the state into regions where land use and water resources are similar. Minnesota is divided into 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. Mink/Somers Lake is located in the North Central Hardwood Forest ecoregion (Figure 1).

The land uses observed in the watershed of Mink/Somers Lakes are fairly comparable to the typical range for this ecoregion (Table 1). Cultivated and pastured uses account for about 64 percent of the land use in this watershed. A number of lakes and wetlands are present in the watershed (26%). They will allow pollutants in runoff to settle out and serve to slow the flows which enter Mink/Somers Lakes during periods of high precipitation and runoff. Forest uses are less than expected (4 percent).

Precipitation in the Wright County area was about 36 inches, which is about 4-8 inches above normal (Appendix) for the 1993 water year (October 1992 - September 1993). According to rainfall records kept by one member of the Association, 8.6 inches of precipitation was recorded near Mink/Somers Lakes from May 15 through June 30 of 1993. The normal precipitation for the period from May to September is on the order of 18-19 inches and the annual normal is on the order of 28-29 inches for this part of the state. Precipitation in the Wright County area was about 22 inches for the period May - August 1993 and was about 125-150 percent of normal precipitation (Appendix). Many areas of the state experienced a wetter than normal summer during 1993 (State Climatology Office). Evaporation typically exceeds precipitation in this part of the state and averages about 36 inches per year. Runoff averages about 5 inches with 1 in 10 year low and high values of 1 inch and 7.8 inches respectively for this area (Gunard, 1985).

Water Residence Time and Lake Levels

Mink/Somers Lakes water levels and residence time (time it would take to fill the lake if it was empty) will vary as a function of inflow from the watershed. Based on runoff estimates for this part of the state (Wilson 1989), water residence time averages about three years. During periods of low precipitation, residence time may be greater and during periods of high runoff (e.g., 1993) residence time will be shorter.

The Minnesota Department of Natural Resources, Division of Waters has monitored Somers Lake levels in cooperation with volunteer readers since 1991. The water level has fluctuated 3.7 feet since 1991, from a high of 1023.71 on August 28, 1993, to a low of 1020.05 in May of 1991 (Appendix). Water levels fluctuated over the summer of 1993 and remained at a high level during the months of August - September. Mink/Somers Lakes are classified as separate basins, but the water levels are equal as they fluctuate as one lake. The lakes outlet via a loose rock dam at elevation 1022.2 that eventually leads to Silver Creek.

TABLE 1. MINK/SOMERS LAKES: MORPHOMETRIC, WATERSHED AND FISHERY CHARACTERISTICS.

Watershed Data	Mink Lake	Somers Lake	Both Lakes
MDNR I.D.	86-0229	86-0230	
Lake Area[1]:	283 acres (115 ha)	147 acres (60 ha)	430 acres (174 ha)
Mean Depth[1]:	7 ft (2.1 m)	10.2 ft. (3.1 m)	8.1 ft (2.5 m)
Maximum Depth[1]:	32 ft. (9.8 m)	19 ft (5.8 m)	32 ft (9.8 m)
Volume[1]:	1,990 acre ft. (2.5 hm^3)	1,503 acre ft. (1.9 hm^3)	3,493 ACRE FT. (4.3 hm^3)
Littoral Area[1]:	256 (91%)	117 acres (79%)	373 acres (87%)
Watershed Area[2]	Approx. 2,520 (85%)	---	3,000 acres (1,215 ha)
Watershed Area: Lake Surface Ratio:	Approx. 9:1	---	7:1
Estimated Average Water Residence Time (years)	---	---	3
MDNR Use Classification[3]			
- Ecological	Roughfish-Gamefish	Roughfish-Gamefish	
- Management	Warmwater Gamefish	Warmwater Gamefish	
Shoreland Zoning Development	Recreational Development	Recreational Development	
Shore Length	6 mi	2.1 mi	8.1 mi

DEVELOPMENT (homes)		Seasonal	Permanent	Total
Mink	1967[3]	56	11	67
	1982[3]	47	36	83
Somers	1967[3]	16	3	19
	1982[3]	15	18	33
Mink/Somers	1993[4]	53*	76	129

* additional use-summer camp on island.

TABLE 1 (continued)

LAND USE (Percentage)	Forest	Water & Marsh	Pasture	Cultivated	Urban
North Central Hardwood Forest Ecoregion[5]	6-25%	14-30%	11-25%	22-50%	2-9%
Mink/Somers Watershed[2]	4%	26%	4%	60%	7%

<u>INLETS</u>: None
<u>OUTLETS</u>: 1
<u>PUBLIC BOAT ACCESS</u>: Mink Lake 1

[1] MDNR bathymetric map, calculations.
[2] Information from Wright County Soil and Water Conservation District
[3] Swim data base, State Planning Agency, Information Center, St. Paul, Minnesota
[4] Information provided by The Association of Mink and Somers
[5] Derived from descriptive characteristics of the seven ecoregions in Minnesota (Fandrei 1988)

Fishery Management

The fisheries of Mink and Somers Lakes, located in Wright County, are managed by the DNR Fisheries Office at Montrose. Because of the fact that the lakes tended toward winterkill and fishing was often of the boom or bust variety, the lakes were managed by stocking walleye fry and winter rescue northern pike. Growth rates of both species were fast as forage was abundant; but neither species had sufficient natural reproduction to support more than a limited fishery. The

long range fisheries goal for the lakes was to provide a northern pike population at 3-5/gill net with the average size of two plus pounds; and to establish a walleye population of 4-5/gill net.

The operational plan portion of the fisheries lake management plan included such details as:

1) Stocking walleye fry at a rate of 1000/littoral acre three years running and/or after occasional winterkills; and stock winter rescue northern pike at a rate of one pound per littoral acre every other year;
2) Monitor oxygen levels during severe winters;
3) Conduct annual fish house counts;
4) Issue Class B permit for commercial species utilization;
5) Resurvey every five years to assess fish populations and evaluate stocking;
6) Testnetting to determine extent of winterkill.

The potential plan included reclamation, aeration and creel survey. Reclamation was proposed because during the drought years of 1987-1988 water levels declined and the lakes sustained a series of partial winterkills. An active lake association supported, even suggested the reclamation, but as the years passed, it did not seem like the project would receive funding.

In 1993, the reclamation project was funded, but then postponed as water levels increased to a level above the high water mark (OHW 1023.1). The reclamation is scheduled to proceed during the fall of 1994 and will be followed by annual assessments to evaluate the restored fishery and the lakes' response. The primary management species will be walleye, largemouth bass, yellow perch and bluegill. Northern pike and black crappie may be subsequently introduced. Preliminary, experimental angling regulations will be proposed for walleye, largemouth bass and bluegill. We are certain that excellent fisheries will develop after the reclamation and the experimental rules should prolong the fishing excellence.

Following reclamation, aeration will be used to reduce any threat of winterkill. an aeration system is envisioned for both lakes and should eliminate the partial winterkills which have occurred in the past. Eliminating carp and bullheads should eliminate phosphorous loading caused by those species and improve water clarity.

A fish barrier was constructed (in 1991 by the fisheries construction crew) on the outlet at the first downstream road crossing from Somers Lake. The barrier consists of a smooth bore, concrete culvert placed at sufficient grade to make upstream fish passage impossible through the high water velocity created. The barrier has been in place for two seasons during which the water outflow was relatively high. The barrier has effectively stopped the upward migration of all fish, but especially carp from downstream waters. On several occasions during spring, hundreds of carp could be seen staging below the culvert outflow. None could swim through the culvert.

Historical Perspectives: There has been a history of periodic winterkill and restocking. Winterkill events might be expected to occur once in five years and are usually partial in nature. The most recent kills occurred in 1986, 1988 and 1991-1992. Winterkill severity was exacerbated by low water conditions which occurred during the drought of 1988-1989. Mink and Somers Lakes drain a relatively small watershed, and, since they have been isolated, provide an excellent opportunity for fisheries management.

Surveys: Initial lake surveys were conducted in 1971 though the data for both lakes was lumped together. Resurveys were conducted in 1984 and population assessments in 1989 (Somers Lake only), 1992 and 1993. Mink Lake was not assessed in 1989 because droughty conditions prevented access. Annual aerial fish house counts have been made since 1975.

Limiting Factors: A shallow basin and high water fertility foster periodic winterkill, high populations of carp and bullheads, low water clarity, and heavy blue-green algal blooms. Curled pondweed grows in nuisance proportions in spring and causes recreational use problems and low submerged plant species diversity.

Historical net catches of some important species at Mink Lake (median is for lake class 38):

	1971*	1984**	1992	Median
northern pike	2.00	3.50	---	6.58
carp***	---	0.50	31.33	1.00
bl. bullhead***	2.00	193.75	48.67	32.50
bluegill	0.67	136.88	0.25	21.75
black crappie	1.50	80.75	5.63	6.31
yellow perch	---	1.50	0.33	12.50
walleye	4.00	---	1.00	2.67

* Only one gill net was set
** Data was combined with Somers Lake
***The net catch refers to gill nets

During 1992, catches of yellow perch, walleye, bluegill and northern pike were below the first quartile value for lake class 38. Catches of black bullhead and black crappie were within the range of expected values; and the catch of carp was above the third quartile value.

Historical net catches of some important species at Somers Lake (median is for lake class 34):

	1971*	1984	1989	1992	Median
northern pike	2.00	2.50	2.00	0.00	4.00
carp (gillnet)	---	1.25	72.75	29.00	1.33
bl. bullhead	7.50	6.50	250.67	10.80	8.67
bluegill	0.67	154.17	17.17	9.40	19.73
black crappie	1.50	116.67	54.83	20.40	8.60
yellow perch	---	30.00	---	1.00	10.50
walleye	4.00	---	.83	0.00	3.00

*data was combined for Mink and Somers Lakes, one gill net was set

During 1992, the catch of carp was above the third quartile value for the lake class. Catches of black crappie, bluegill and black bullhead were within the range of expected values; and yellow perch, walleye and northern pike were below the first quartile value for lake class 34.

Commercial Fishery: During the latter 1980's black bullhead carp populations were large, but of marginal size and commercial value. We encouraged commercial fishermen to remove carp and bullheads to utilize this resource.

Stocking Plans: After the lakes are reclaimed, walleye will be re-established by fry stockings and fingerlings if necessary. Largemouth bass brood adults will be stocked and their progeny will populate the lake. Bluegill of a single sex may be stocked in order to limit natural reproduction and keep populations from becoming superabundant. Some mistakes will be made during the sex determination so that both genders will be represented and some natural reproduction will take place. Yellow perch and fathead minnows will be stocked primarily as forage for the predator species. However, the yellow perch may play a significant role in keeping bluegill large.

Evaluation Plans: Experimental regulations are designed to protect walleye and maximize the fast growth which is characteristic of the early years. With largemouth bass, protection of the intermediate sizes is desired so they can fulfill a predator type role to keep the fish populations in balance. The bluegill goal will be to reduce the harvest of large fish. Early survey work has shown that anglers are interested in catching larger fish even if they can only harvest 3-5/trip. No creel surveys have ever been conducted. Creel and recreational use surveys are part of the potential plan to estimate angling pressure and harvest and evaluate the economic benefits of reclamation. Continue annual aerial fish house counts as an indirect way of monitoring winter angling pressure.

<u>Lake and Watershed History</u>

A history of the lakes and their watersheds was prepared by Dan Hinrichs of the association and is summarized as follows:

"1962-1963 A group of four cabin owners first organized with their main goal to work with Corinna Township in road maintenance. The township offered to match dollar for dollar their contribution to the purchase of gravel. The four cabin owners each contributed $10 each.

1964 More cabins had been built around the lakes and more problems arose. The original four held a meeting where more cabin owners attended and elected officers and selected a name for the organization TAMS (the Association of Mink and Somers) was formed.

1967 25 cabin owners attended a meeting on July 2. The task of 'cleaning up' Mink and Somers was the most imminent project of the initial meeting. One member from Van's Island worked with the MN Conservation Department to get enough manpower and boats to cover both lakes. Jody Terrace was cleared of trees and had gravel brought in so that it could be turned over to the township. Annual dues were used to install a directory listing names and location of each resident on Mink & Somers Lakes.

1968 MN Department of Conservation removed 17,600 pounds of bullheads from Mink lake and 4,125 pounds from Somers in the fall with hoop nets.

1969 The Post Office began mail delivery to Van's Island, Jody Terrace and the east side of Mink Lake. TAMS helped Camp Courage with Humphrey Island. By-laws were drafted for TAMS. Van's Island was invited to join TAMS. Annual pot luck community picnic on Humphrey Island tradition started. Dialog with the MPCA begun to correct Corinna Township dump problems on north end of Mink Lake.

1970 Copper sulfate application to control algae (lake cleaning). Area fisheries manager says in a letter to TAMS 'Lakes of this type are primarily rough fish lakes and the only way they could be controlled is to isolate them and chemically treat them. This is not possible with Mink and Somers as there are two inlets and an outlet which is connected to Silver Creek which flows into the Mississippi River .... If we have a hard winter kill, this will take care of the rough fish problem.'

1971 Area fisheries manager says in June 1 letter to TAMS 'the winter kill last winter took care of more rough fish in Mink and Somers than we could have taken out with all of our nets and traps. Since the winter kill, we have already stocked 11,250 northern pike fingerlings and 300,000 walleye fry. We intend to stock adult pan fish in the next week or two.' Report of a cesspool or septic tank that was overflowing. The township remade the road at the intersection of the property and installed a culvert close to the property so the overflow is directly into the lake.

1972 Jody Terrace road improvement completed. Street signs ordered and installed. Directory boards installed.

1973 'Lake cleaning' June 24 (copper sulfate application). Lake level was high, TAMS was checking with Conservation Department on lowering lake. Conservation Department contacted again about carp problem.

1974 'Lake cleaning' again. Efforts under way to install culvert to Van's Island to eliminate stagnant water from bays. TAMS members were told by township that a culvert would do no good and the township does not have any funds for it.

1975 In May, $40.00 was paid for dead fish removal, 3½ manure spreaders full of the 3-5 pound carp. Copper sulfate ordered again for 'lake cleaning.' Van's Island culvert discussed again. Permission to install a carp barrier in the ditch on Francis Bruns property was obtained. Sunfish were stocked. Township approved installation of culvert at TAMS expense. $450 by TAMS and $450 by Vans Island residents.

1976 500 crappies stocked. Culvert to Horseshoe Island to be cleaned at TAMS expense. Mink Lake Terrace turn-around agreed upon if it could be made acceptable for the township for $300. Also, TAMS was not to be involved in roads after September 1, 1977. 2000 pounds of copper sulfate applied. Members only to be on TAMS signboards.

1977 2020 pounds of copper sulfate applied.

1978 2295 pounds of copper sulfate used. Dutch Elm disease started around lakes.

1979 Copper sulfate again. President of lake must be a year around resident and have lived year around for at least 1 year. This motion was made and seconded.

1980 Weeds (curly leaf pond weed) now the biggest issue. Copper sulfate again. Culvert on van's Island cleaned. Septic systems also surface as an issue. Copper sulfate again 2295 pounds. People known to have applied chemical for weeds without permit.

1981 Mink and Somers named lake of the week in Outdoor News January 30, 1981. Fishing for panfish was excellent. Curley leaf weeds were thick.

1982 DNR recommended cutting weeds rather than using chemicals. Water levels high. Lots of shoreline being eroded. Rock riprap installed by many seemed to help. Weeds thick, fishing for panfish exceptional.

1983 400 northern pike total weight of 572 pounds were stocked. Cars traveling too fast on roads around lakes. It was recognized that copper sulfate treatment for algae doesn't work. Dues reduced from $25 to $12. Weeds thick this year again.

1984 TAMS purchased a weed cutter that cut 4 feet wide and up to 4 feet deep. It was mounted on a jon boat; total cost for 15 hp motor, 14 foot jon boat, and weed cutter $1,050. Cutting of channels was done so people could get to open water. Numbering system for cabins around lakes undertaken.

1985 330,000 walleye fry stocked. Weed cutting done again. Weeds very thick, too thick to even cut. Lack of volunteers to cut weeds. Fishing very good for panfish.

1986 Fish kill was significant. Many of the panfish died. Weeds too extensive to handle with little weed cutter and lack of manpower. Chemical treatment with Diquat, Citrine Plus by R&J Aquatic from Brainerd. Good results. Task force worked with several contractors to look at methods to improve lakes. Suggestions were to analyze lake via lab analysis etc. Water clarity project solicited donations for project.

1987 Weed cutter sold. Chemical application again by R&J with very good results. Directory prepared for TAMS. Township was presented a petition to upgrade the roads.

1988 Drought. Lakes at lowest level in years. Raffle... lots of prizes. Guest speaker at meeting from soil and waters. Due to low water, nothing was done with weeds.

1989 33,000 pounds of carp seined in February/March. Drought continued. Hot, dry summer. Property owners seeing more shore than ever before. Suggestion and study done to pump water into lake. Narrows between Mink/Somers channeled.

1990 Drought at peak. Lake levels reached near record low. Carp were becoming very observable. There were three separate bodies of water. Water level approximately 5 feet below normal. Property owners mowing, tilling, disking and cleaning expansive beaches. Public access upgraded with concrete planks. CORE project for reclamation of lakes submitted. Many large walleye and northern taken from Mink's deep spot between Christmas and New Years.

1991 Lake levels begin to rise. This surprised everyone as they come back fast. CORE project at state level. We are told that we need to have outlet changed into a carp barrier. Culvert replaced with smooth barrel culvert. Secchi monitoring through Freshwater Foundation. No weeds, with the exception of some bullrush stands, and lots of cattails. Crimewatch signs erected at all entrances to lakes.

1992 Funds for roetenone not available and roetenone use put on hold. Secchi readings done. Lake levels become almost too high. Fishery very poor. Lots of carp visible. No weeds. Bullrush and cattail. Marker Bouys in place on either side of narrows between Mink/Somers. Blacktopping of roads into Jody Terrace and surrounding areas not approved by township board.

1993 Mink/Somers accepted for LAP. Monthly monitoring from May - October. DNR got funding and purchased roetenone for lakes, water levels were too high for proposed application in late October. Culvert appears to be keeping carp from lake beautifully. Roetenone application assured for application in fall of 1994 (if lake levels are low enough). Septic system survey done as part of LAP with over half of residents responding. All parcels of land riparian to lakes now on computer data base. WCSWCD completed a mapping of the watershed for Mink and Somers lakes. New street signs installed by county, now we have street addresses."

Septic System Survey

A septic system survey form was sent out to about 140 property owners around Mink/Somers Lakes by the Association. A summary of the results is included in the Appendix. The purpose of this survey is to provide the Association with some basic information regarding the type of systems on the lake, age of the systems, type of dwelling and the frequency of pumping. This information should assist the Association in determining whether more education is needed with respect to design and maintenance of on-site systems and whether assistance from Wright County is needed, e.g., education, inspections, etc.

Of the 140 surveys distributed, 68 (49 percent) were returned. This is an average percentage for this type of survey. Based on the returned surveys, the following types of systems are noted: septic tank & drainfield - 56 percent, holding tank - 18 percent; septic tank - drywell - 3 percent; shared septic & drainfield - 0 percent; cesspool - 9 percent; and other or do not know - 9 percent. The majority of the systems (49 percent) are 15 year old or less, while 34 percent are greater than 25 years of age or unknown. About 39 percent of the respondents pump their systems at least once per year. Another 18 percent pump every two to three years. About 34 percent did not respond, do not pump, or only pump their systems every ten years. Minnesota Extension Service recommends pumping every one to three years for a 1,000 gallon tank serving a three-bedroom house and four occupants (assumes year-round use). Based on the results of the survey, it appears that more work on septic tank maintenance (education and inspection) may be appropriate.

RESULTS AND DISCUSSION

Water quality data was collected on May 1, June 3, July 1, July 29 and September 1, 1993. Two sites were used primarily: Site 101 over the point of maximum depth and site 102 (Figure 2) in each lake. 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 1.24 inches (3.2 centimeters). Near-bottom samples were collected with either a two-liter PVC Kemmerer or Van Dorn sampler. In addition, phytoplankton (algae) samples were taken at Somers Lake, site 101, with an integrated sampler. One site in each lake had Secchi disk monitoring through the CLMP (sites 202 in Somers Lake and 203 in Mink Lake).

Sampling procedures were employed as described in the MPCA Quality Control Manual. Laboratory analyses were performed by the laboratory of the Minnesota Department of Health using U.S. Environmental Protection Agency (EPA)-approved methods. Samples were analyzed for nutrients, color, solids, pH, alkalinity, turbidity, conductivity, chloride and chlorophyll (Table 2). Temperature and dissolved oxygen profiles and Secchi disk transparency measurements were also taken. CLMP Secchi disk measurements from previous years were available for comparison. All data was stored in STORET, the EPA's national water quality data bank. The following discussion assumes that the reader is familiar with basic water quality terminology as used in the Citizens' Guide to Lake Protection.

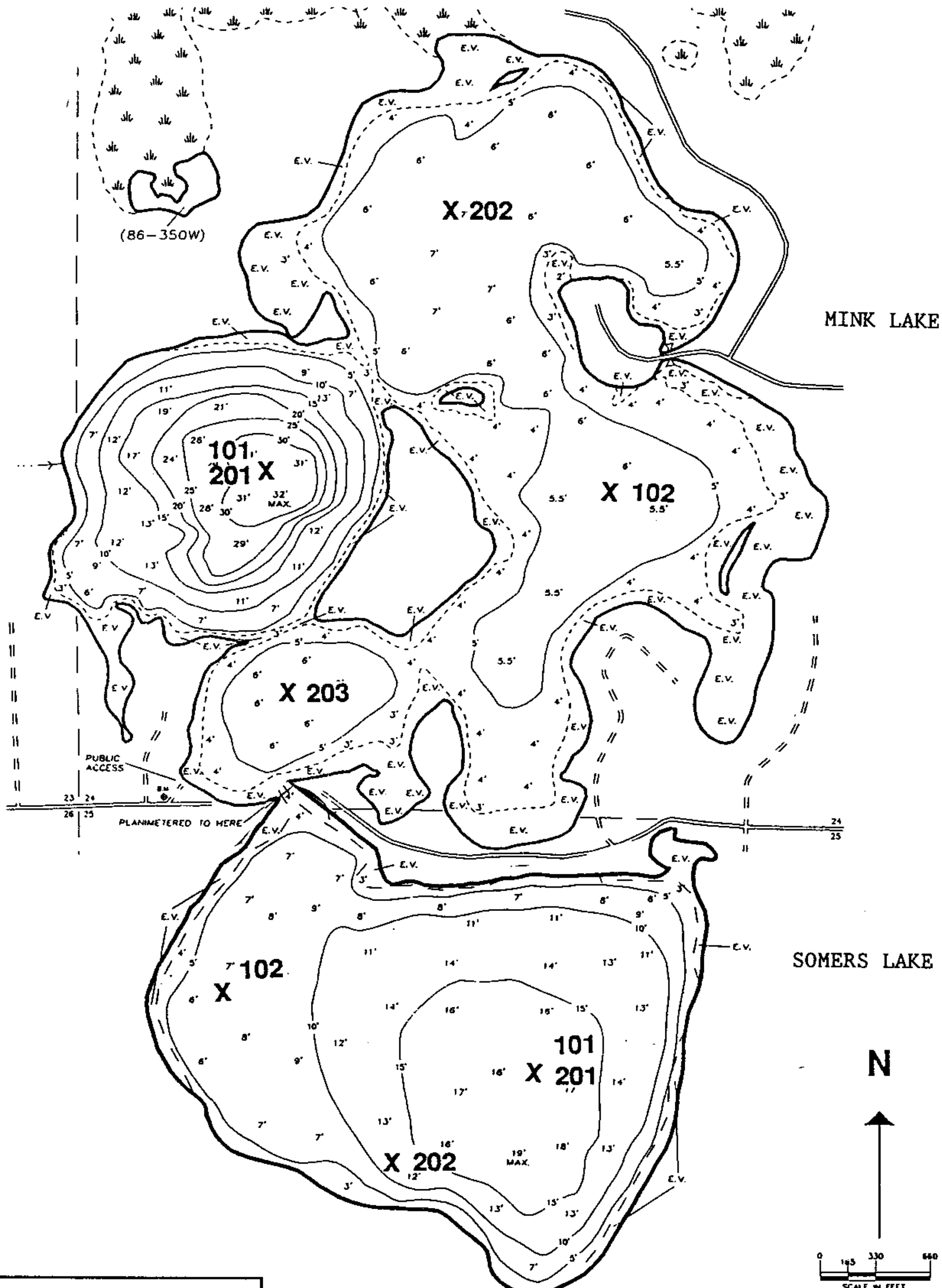
In-lake Conditions: 1993

Dissolved oxygen and temperatures profiles were taken at the point of maximum depth at site 101 in both lakes. Profiles for site 101 in both lakes are plotted in Figure 3. Data is found in the Appendix.

Somers Lake was well mixed (Figure 3) on all sampling dates, with little or no change in temperature from top to bottom due to the shallow depth of the lake (maximum depth 19 feet). Water column (0-6 meters) temperature ranged from 11°C in May, warming to 23°C in July. Dissolved oxygen was well mixed on the May, July 29, and September sampling. A decline in dissolved oxygen (between 4 and 6 meters) was noted on the June and July 1 sampling with readings below 5 mg/L.

Mink Lake was well mixed on the May sampling date, with little or no change in temperature from top to bottom, dissolved oxygen concentrations declined in the hypolimnion (lower cooler layer)(Figure 3). By June, thermal stratification had begun, with a weak thermocline (zone of greatest change in temperature over a small depth range) at about 8 meters (26 feet). Dissolved oxygen concentrations declined in the hypolimnion to 0.2 mg/L. By July 1st, a distinct thermocline had formed between 5-7 m (16-23 feet). Oxygen levels fell below 1 mg/L throughout the hypolimnion. This would be too low for game fish, which typically require a dissolved oxygen concentration of 5 mg/L or greater for long-term survival. This would tend to force any "cool water" fish into the warmer waters of the epilimnion. Mink Lake remained stratified on the July 29 sampling date (reported as August on Figure 3). Fall overturn occurred in September. Temperature was consistent from the surface to near bottom and dissolved oxygen concentrations were at about 5 mg/l (whole column) down to 6 m (20 feet). Based on the dissolved oxygen and temperature profiles, Mink Lake would be considered dimictic (mixes once in spring and fall). Somers Lake would be considered polymictic (well mixed on all sampling dates).

Figure 2. MINK AND SOMERS LAKES BATHYMETRIC MAP



Key

200 Series----CLMP Lake Stations
100 Series----MPCA Lake Stations

Map - MDNR

MINNESOTA POLLUTION CONTROL AGENCY
DIVISION OF WATER QUALITY
JANUARY 1994

FIGURE 3a SOMERS LAKE DISSOLVED OXYGEN AND TEMPERATURE PROFILES

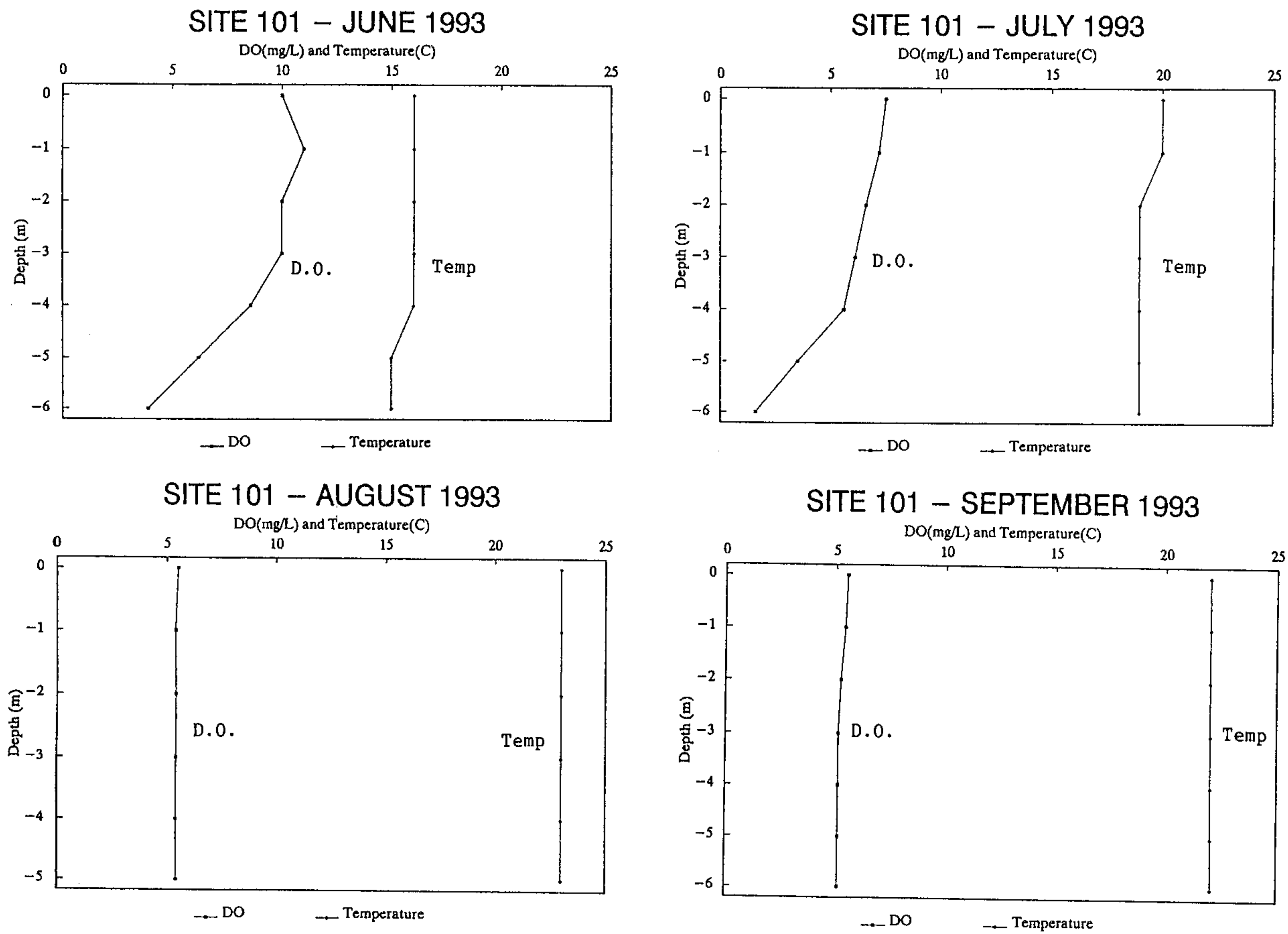


Figure 3b MINK LAKE DISSOLVED OXYGEN AND TEMPERATURE PROFILES.

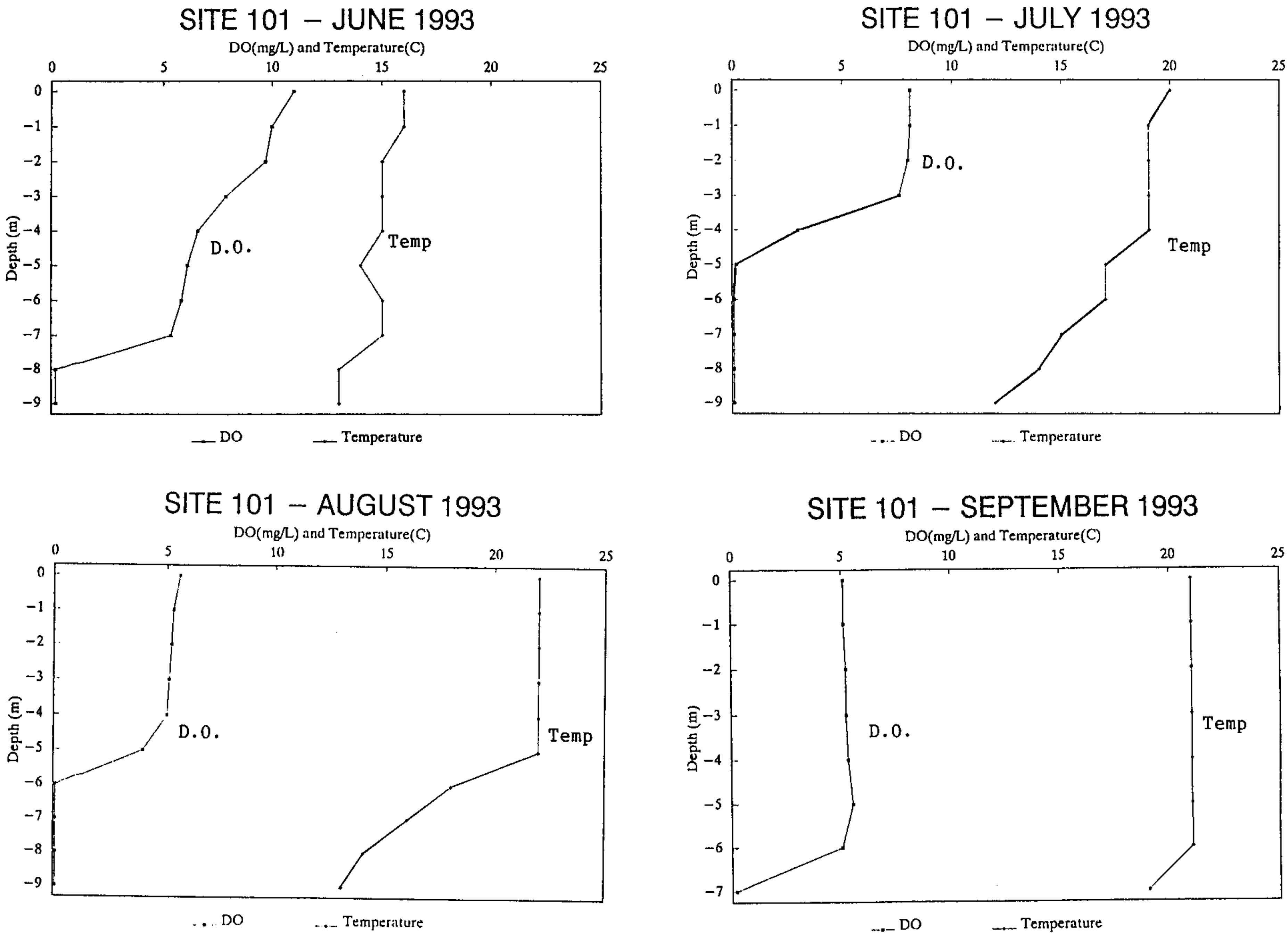
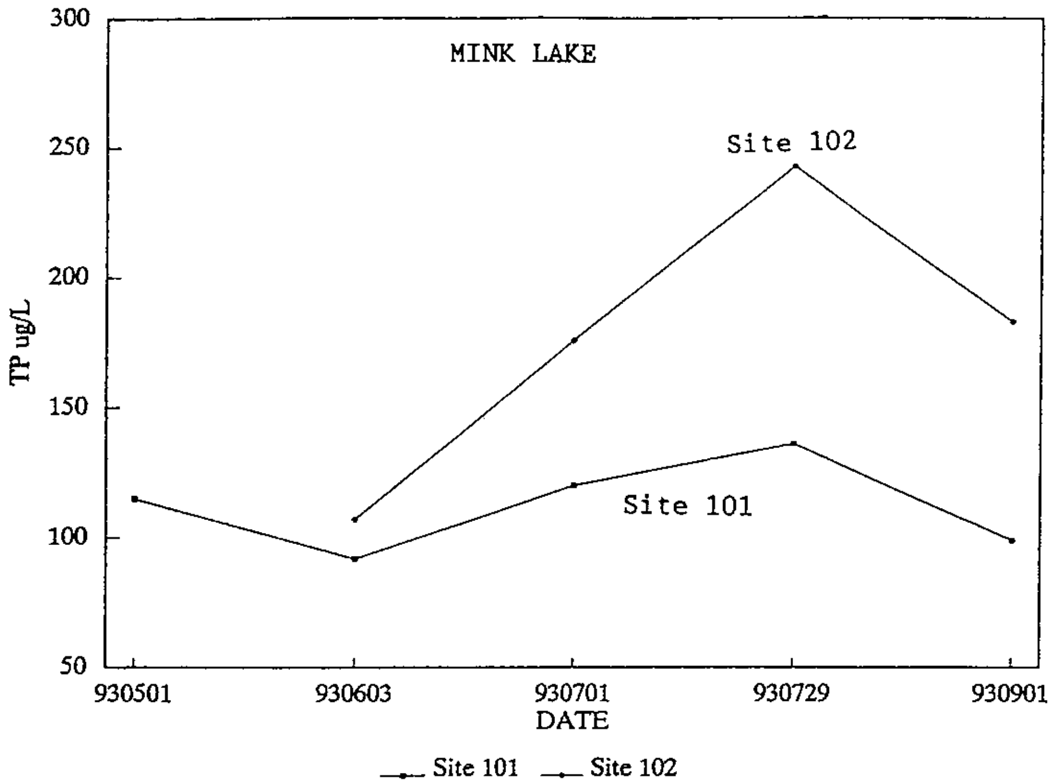


Figure 4a. MINK AND SOMERS LAKES EPILIMNETIC PHOSPHORUS CONCENTRATION



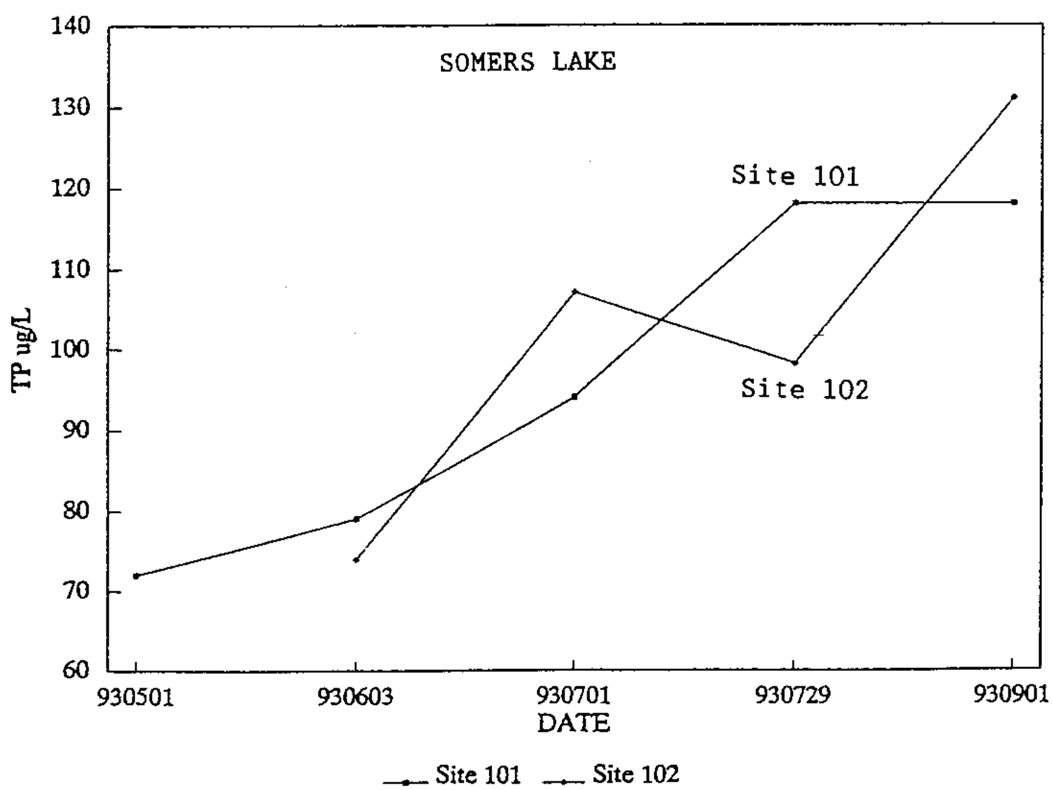
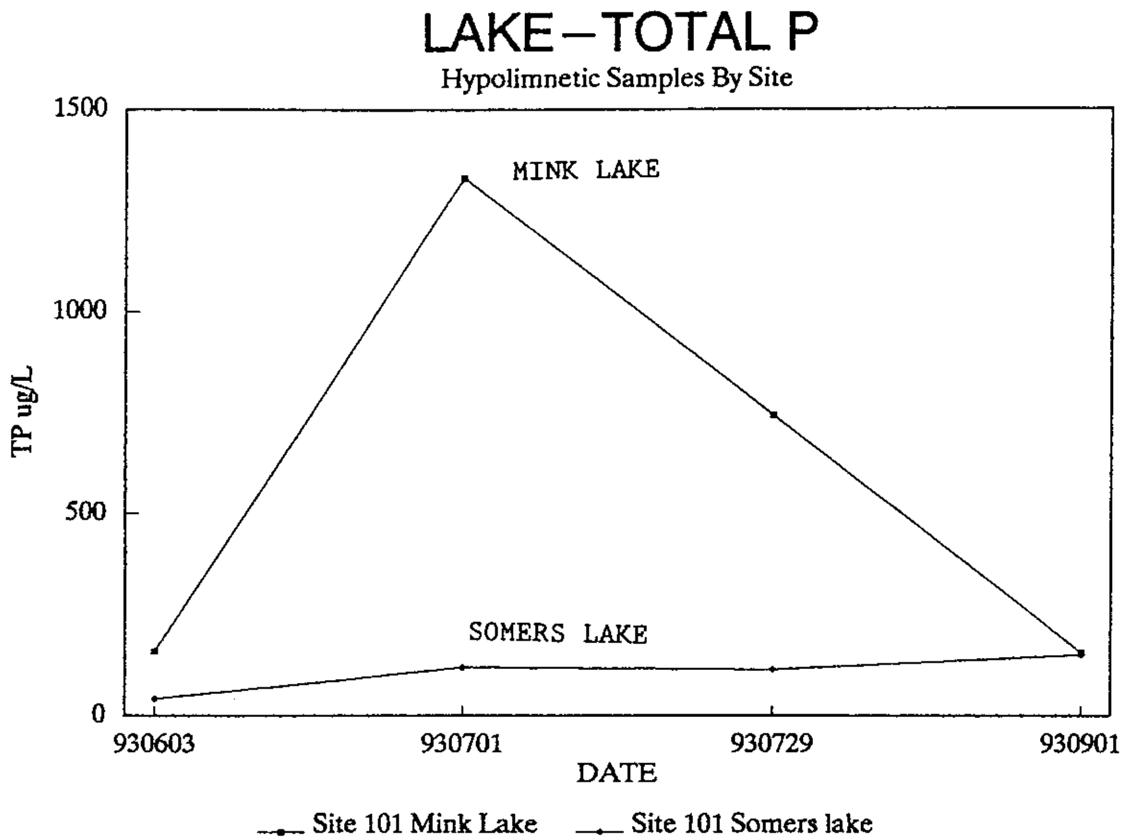


Figure 4b MINK AND SOMERS LAKES HYPOLIMNETIC PHOSPHORUS CONCENTRATION



Total phosphorus (TP) concentrations (an important nutrient for plant growth) averaged approximately 124 µg/L (micrograms per liter or parts per billion) in the epilimnion for the entire lake (both lakes) during the summer of 1993. This value is much higher than the range of concentrations typically found in reference lakes in the NCHF ecoregion (Table 2). Mink Lake averaged 145 µg/L and Somers Lake averaged 102 µg/L over the summer.

The summer-mean epilimnetic phosphorus concentrations are fairly comparable between site 101 and 102 (102 µg/L) in Somers Lake. Epilimnetic concentrations in Mink Lake's main basin, site 101, ranged between 92-120 µg/L and averaged 112 µg/L. Site 102 (which is in a shallow bay) epilimnetic concentrations ranged between 107-243 µg/L and averaged 177 µg/L during the summer of 1993 (Figure 4a).

Hypolimnetic (1 meter off the bottom) phosphorus samples were taken on the June - September sample dates at site 101 in both lakes. Phosphorus concentrations in the hypolimnion in Somers Lake (Figure 4b) ranged from 42 µg/L in the spring to 151 µg/L in September. Phosphorus concentration in the hypolimnion of Mink Lake was the highest during July 1st at 1,330 µg/L. Phosphorus is released by the sediments under anoxic (void of oxygen) conditions. This was the case from June through September at site 101 in Mink Lake and from July 1 to September at site 101 in Somers Lake. Although this phosphorus is effectively trapped in the hypolimnion while the lake is stratified, it will be mixed into the water column when stratification breaks down (due to cooling of the water and wind mixing) in the fall. This probably occurred in Mink Lake based on the temperature profiles (Figure 3) and the in-lake phosphorus measures. Somers Lake has low hypolimnetic phosphorus until later in the summer (July 1 - September).

Total nitrogen (TN) concentrations, which consists of total Kjeldahl nitrogen plus nitrite and nitrate-N, averaged 2.1 mg/L over the summer. This concentration is high for this region. Nitrite and nitrate-N concentrations are greater than 0.01 mg/L, which is also higher than typical for lakes in this region.

The ratio of TN:TP can provide an indication as to which nutrient is limiting the production of algae in the lake. For Mink/Somers Lakes, the TN:TP ratio is about 17:1. This suggests that phosphorus is the limiting nutrient in Mink/Somers Lakes. Generally, phosphorus is the least abundant nutrient and, therefore, is the limiting nutrient for biological productivity in a lake. The TN:TP ratio is lower than reference lakes in this region. The ratio is low because of the high phosphorus concentration in each lake.

Chlorophyll a concentrations provide an estimate of the amount of algal production in a lake (Figure 5). During the summer of 1993, chlorophyll a concentrations for Somers Lake ranged from about 23 µg/L to 97 µg/L with an average of 65 µg/L. Chlorophylla concentrations ranged from 34 µg/L to 207 µg/L with an average of 103 µg/L in Mink Lake. Concentrations from 10-20 µg/L are frequently perceived as a mild algal bloom, while concentrations greater than 30 µg/L may be perceived as a severe nuisance (Heiskary and Walker, 1988). Both the average and maximum chlorophyll a concentrations for Mink/Somers Lakes are much higher than the reference lakes for this region. No significant difference was noted in the chlorophyll a concentrations between sites 101 and 102 on Somers Lake. However, a significant difference was noted between sites 101 and 102 on Mink Lake. Site 102 in the shallow bay had a much higher concentration.

TABLE 2: Mink/Somers: AVERAGE SUMMER WATER QUALITY AND TROPHIC STATUS INDICATORS. Based on 1993 epilimnetic data.

Parameter	Mink Mean	Somers Mean	Mink/Somers Mean	Typical Range NCHF Ecoregion[1]
Total Phosphorus (µg/L)	145	102	124	23-50
Chlorophylla (µg/L)				
Mean	103	65	84	5-22
Maximum	207	97	207	7-37
Secchi disk (feet)[3]	1.6 (0.48m)	1.8 (0.55 m)	1.7 (0.52 m)	4.9-10.5 (1.5 - 3.2 m)
Total Kjeldahl Nitrogen (mg/l)	2.0	2.0	2.0	<0.60-1.2
Nitrite + Nitrate-N (mg/l)	0.03	0.07	0.05	<0.01
Alkalinity (mg/l)	123	118	121	75-150
Color (Pt-Co Units)	20	20	20	10-20
pH (SU)	8.1	8.3	8.2	8.6-8.8
Chloride (mg/l)	19	18	19	4-10
Total Suspended Solids (mg/l)	20	18	19	2-6
Total Suspended Inorganic Solids	7.8	6.6	7.2	1-2
Turbidity (NTU)	10.8	13.7	12	1-2
Conductivity (umhos/cm)	289	271	280	300-400
TN:TP Ratio	14:1	20:1	17:1	25-35:1
Trophic Status Indicators				
TSIP (TP)	75	71	73	
TSIC (chl-a)	74	70	72	
TSIS (Secchi)	70	70	70	
TSI (Mean)	72	71	72	
Ecoregion Percentile[2]	15	16	15	

[1] Derived from Heiskary and Wilson (1990).
[2] Relative to approximately 700 assessed lakes in North Central Hardwood Forest Ecoregion, whereby the lower the trophic state (TSI), the higher the percentile ranking (100 percent level implies lowest TP or deepest Secchi disk for that ecoregion).
[3] Includes CLMP data.

The composition of the phytoplankton (algae) population of Somers Lake is presented in Figure 5. Data are presented in terms of algal type. Samples were collected at site 101. The May sample was dominated by the diatoms. By June, the diatoms were less prominent, while the blue-green algae increased in dominance. During July through September, the blue greens were dominant with the genera Anabaena and Microcystis being the most prominent. Chlorophyll a concentrations during July through September would be equated to severe bloom conditions. The seasonal transition in the algae from diatoms to greens to blue-green is rather typical for mesotrophic and eutrophic lakes in Minnesota.

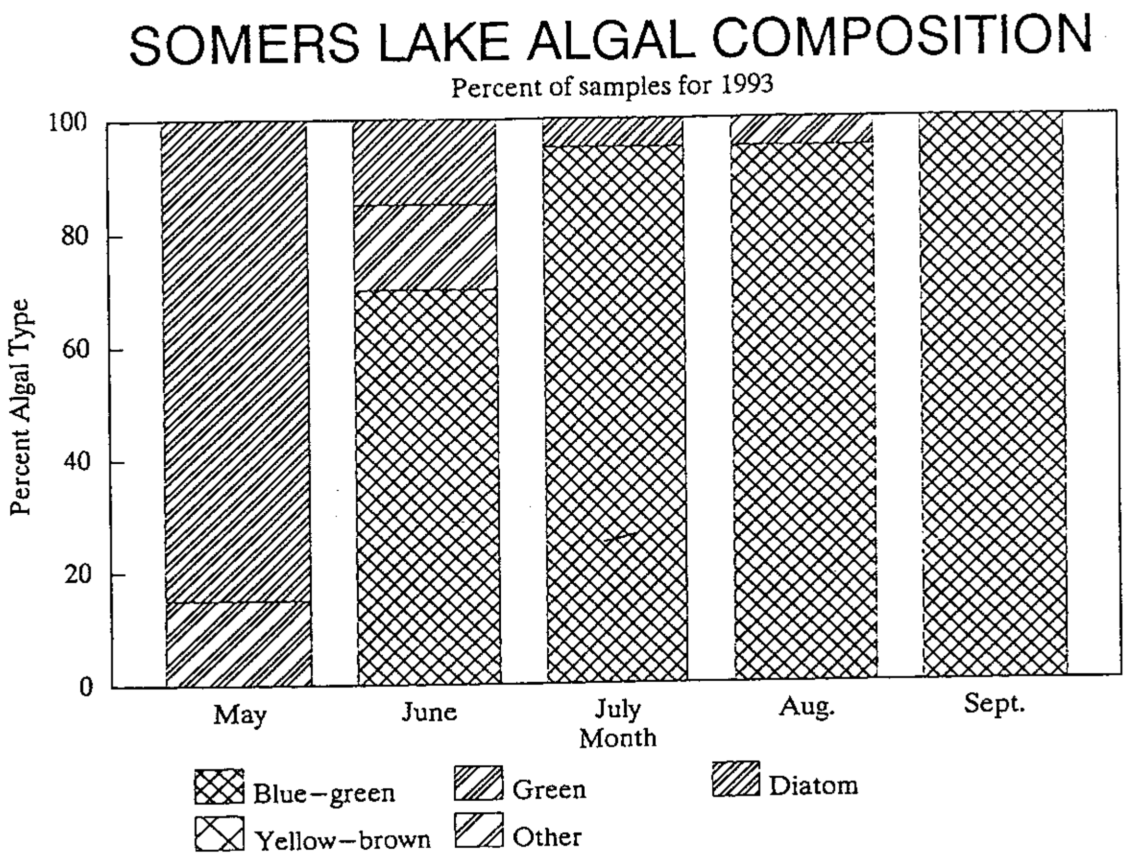
Secchi disk transparency is generally a function of the amount of algae in the water. Suspended sediments or color due to dissolved organics may also reduce water transparency. Color averaged 20 Pt-Co Units indicating low coloration. Total suspended solids averaged 19 mg/L over the summer. A large portion (abut 65 percent) of the total suspended solids are caused by suspended algae and other organic matter. The total suspended solids value is high when compared to reference lakes in this region. These levels of color and total suspended solids should not appreciably limit water transparency in Mink/Somers Lakes. Secchi disk transparency ranged from 0.5 to 2.5 feet (.2 to .8 m) and averaged 1.5 feet (0.5 m) in Somers Lake during the summer of 1993 based on measures taken at one site by the CLMP volunteer (Figure 6). Mink Lake's transparency ranged from 1.0 to 2.5 feet (.3 to .8 m) and averaged 1.5 feet (.5 m). These transparency measures are much lower than the typical range for reference lakes in this ecoregion (Table 2).

Along with CLMP transparency measurements, subjective measures of Mink/Somers Lakes "physical appearance" and "recreational suitability" were made by the CLMP observer (Figure 6). Physical appearance ratings range from "crystal clear" (Class 1) ... to "dense algal blooms, odor, etc." (Class 5) and recreational suitability ratings range from "beautiful, could not be any nicer" (Class 1) ... to "no recreation possible" (Class 5) in this rating system (Heiskary and Wilson, 1988). Transparency, physical appearance, and recreational suitability ratings for CLMP sites are presented in Figure 6.

The "physical appearance" and "recreational suitability" ratings were fairly similar between the one site in each lake. Lake conditions (physical appearance) were typically characterized as "definite algal green" (Class 3) to "high algal levels" (Class 4) throughout most of the summer (Figure 6). Secchi transparency is less than two feet and chlorophyll a (algae) concentrations are typically much greater than 50 μg/L during this period of time.

The change in the transparency of Mink/Somers Lakes over the course of the summer, is fairly typical for mesotrophic and eutrophic lakes in Minnesota. Transparency is high in the spring when the water is cool and algae populations are low. Frequently, zooplankton (small crustaceans which feed on algae) populations are high at this time of year also, but will decline later in the summer because of predation by young fish. As the summer goes on, the waters warm, the algae make use of available nutrients and as algae become more abundant, transparency declines. The decrease in the abundance of zooplankton may allow for further increases in the amount of algae. Later in the summer, surface blooms of algae may appear. On a day-to-day basis, transparency may differ between each lake site measured, but the overall pattern is fairly consistent among the two CLMP sites.

Figure 5 MINK AND SOMERS CHLOROPHYLL AND PHYTOPLANKTON COMPOSITION



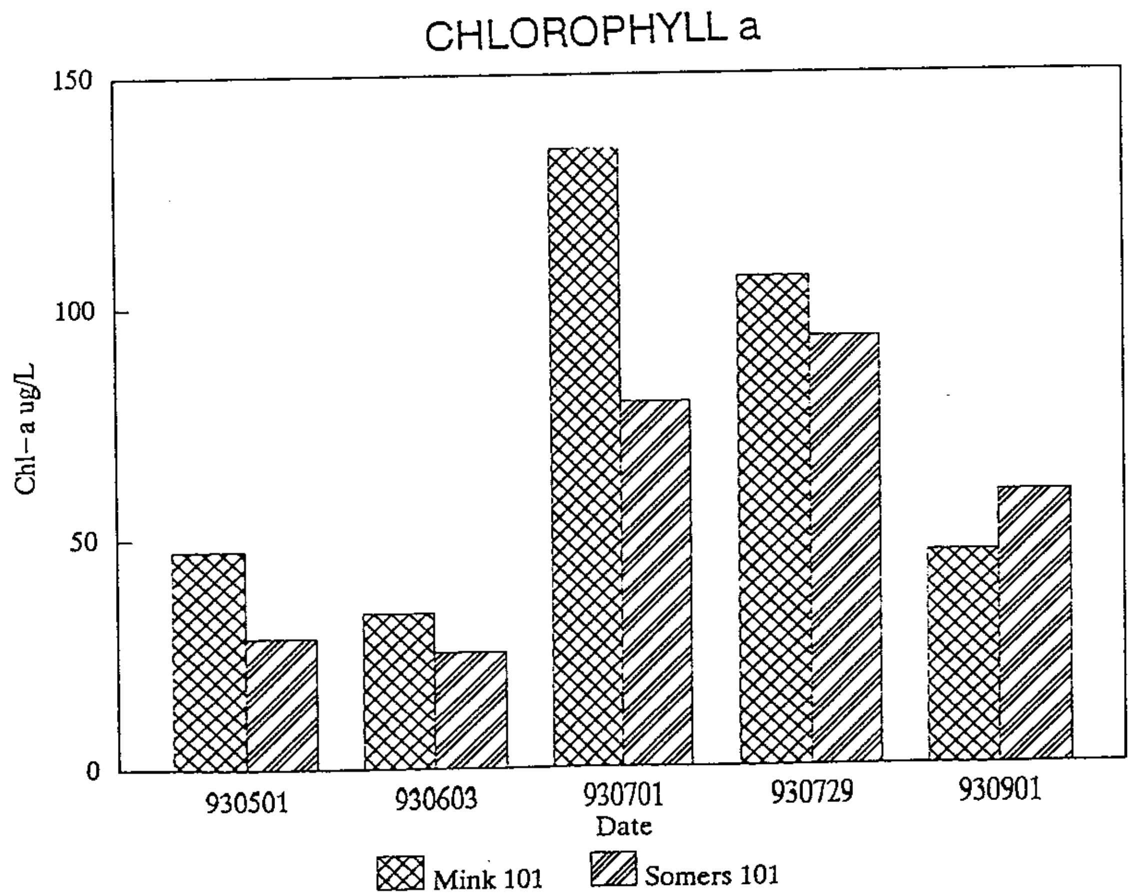
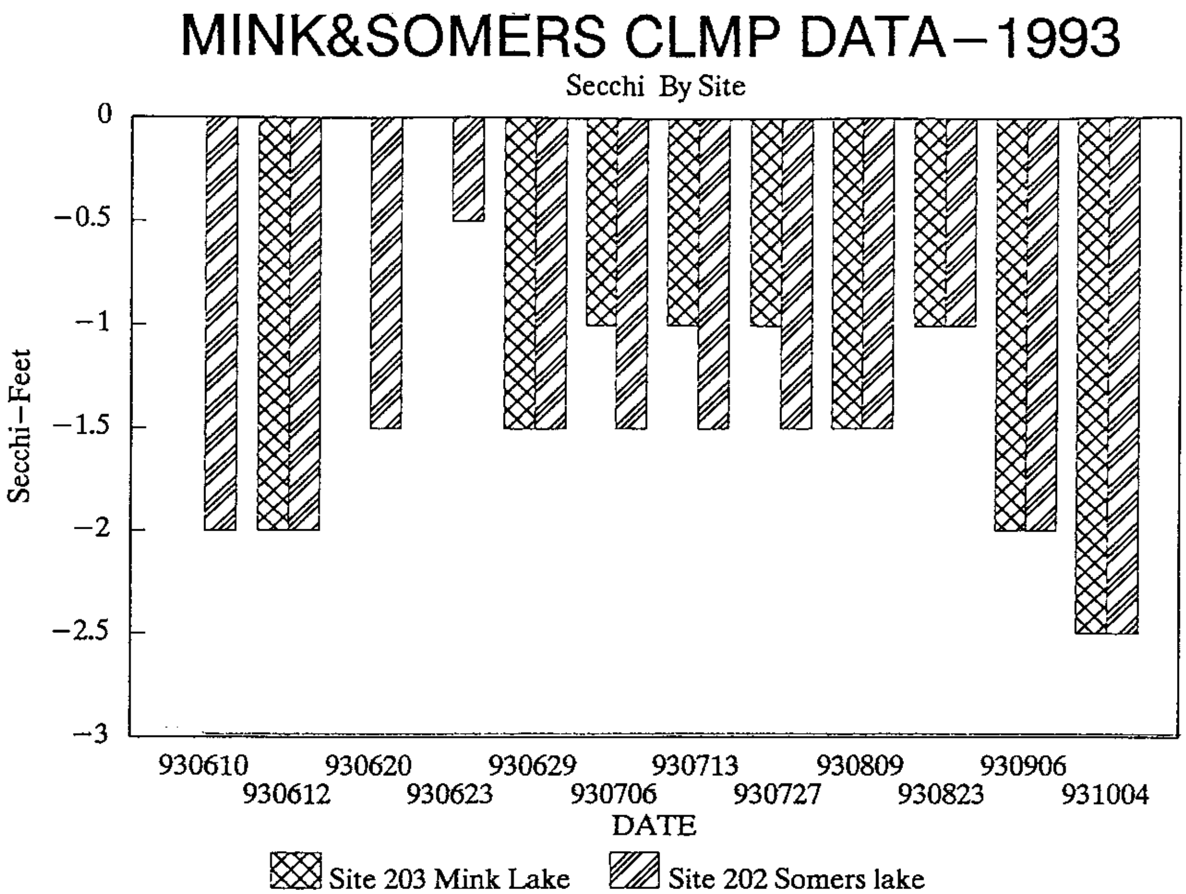
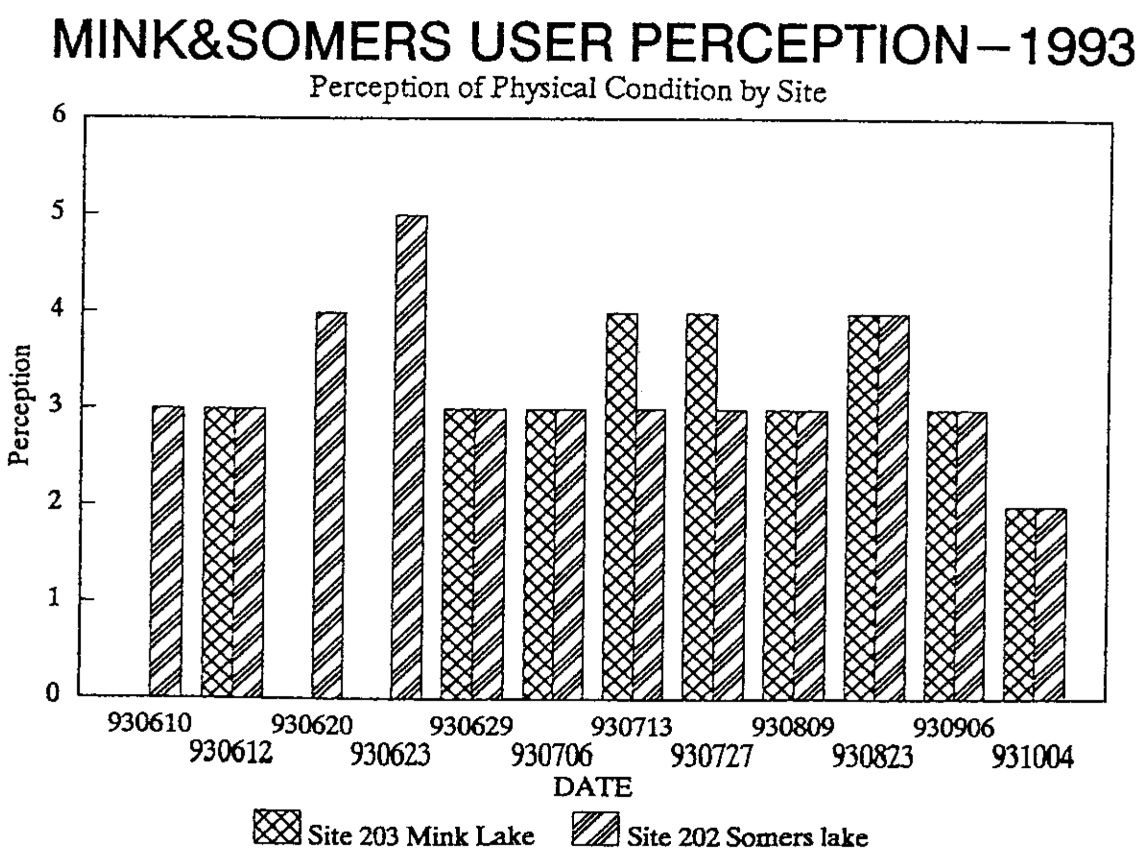


FIGURE 6. 1993 CLMP SECCHI AND USER PERCEPTION





One means to evaluate the trophic status of a lake and to interpret the relationship between total phosphorus, chlorophyll a and Secchi disk readings is Carlson's Trophic State Index (TSI, Carlson 1977). This index was developed from the interrelationships of summer Secchi disk transparency and the concentrations of surface water chlorophyll a and total phosphorus. TSI values are calculated as follows:

Total phosphorus TSI (TSIP) = 14.42 ln (TP) + 4.15
Chlorophyll a TSI (TSIC) = 9.91 ln (Chl a) + 30.6
Secchi disk TSI (TSIS) = 60 - 14.41 ln (SD)

TP and chlorophyll a are in µg/L and Secchi disk transparency is in meters. TSI values range from 0 (ultra-oligotrophic) to 100 (hypereutrophic). In this index, each increase of 10 units represents a doubling of algal biomass.

Average values for the trophic variables in Mink/Somers Lakes and respective TSIs are presented in Figure 7. Based on these values, Mink/Somers Lakes would be considered hypereutrophic in condition. The mean TSI of 72 ranks Mink/Somers Lakes at the 15 percentile relative to 700 other lakes in the North Central Hardwood Forest ecoregion. In other words, its TSI value is lower (less eutrophic) than 15 percent of the lakes assessed in this region. The individual TSI values agree fairly well with one another.

Another means for comparing these three variables is graphically on scatterplots. Values for Mink/Somers Lakes are noted on Figure 8. In general, we note that total phosphorus-chlorophyll a-Secchi transparency relationships in Mink/Somers Lakes are quite comparable to those observed in other Minnesota lakes.

Water Quality trends

Very little is available for determining long-term trends in the quality of Mink/Somers Lakes. CLMP data date back to only 1991 and data do not reveal any trends. The summer average for 1991 is about 3 feet (Appendix). Phosphorus values during the summer of 1991 ranged from 100 µg/L in Mink Lake to a low of 27 µg/L in Somers Lake.

Modeling Summary

Numerous complex mathematical models are available for estimating nutrient and water budgets for lakes. These models can be used to relate the flow of water and nutrients from a lake's watershed to observed conditions in the lake. Alternatively, they may be used for estimating changes in the quality of the lake as a result of altering nutrient inputs to the lake (e.g., changing land uses in the watershed) or altering the flow or amount of water that enters the lake. To analyze the 1993 quality of Mink/Somers Lakes, the models of Reckhow and Simpson (1980) and MINLEAP (Wilson 1988) were used. Reckhow and Simpson's model is used extensively for assessing lake water quality. A more recently developed model, the "Minnesota Lake Eutrophication Analysis Procedures" (MINLEAP), was also used. This model was developed by MPCA staff based on an analysis of data collected from the ecoregion reference lakes. It is intended to be used as a screening tool for estimating lake conditions with minimal input data and is described in greater detail in Wilson and Walker (1988).

Figure 7. CARLSON'S TROPHIC STATE INDEX VALUES
TSI Relationships based on mean summer data for 1993

Changes in the Biological Condition of Lakes With Changes in Trophic State

R.E. Carlson

TSI < 30 Classical oligotrophy: Clear water, oxygen throughout the year in hypolimnion, salmonid fisheries in deep lakes.

TSI 30 - 40 Deeper lakes still exhibit classical oligotrophy, but some shallower lakes will become anoxic in the hypolimnion during the summer.

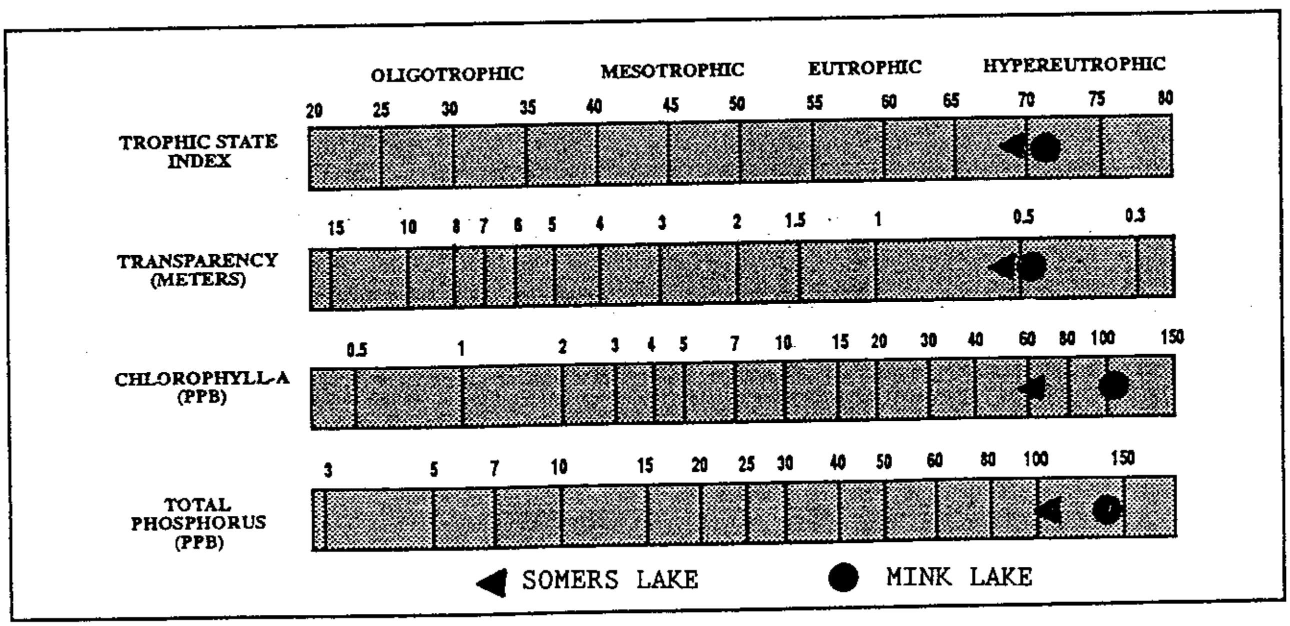
TSI 40 - 50 Water moderately clear, but increasing probability of anoxia in hypolimnion during summer..

TSI 50 - 60 Lower boundary of classical eutrophy: Decreased transparency, anoxic hypolimnia during the summer, macrophyte problems evident, warm-water fisheries only.

TSI 60 - 70 Dominance of blue-green algae, algal scums probable, extensive macrophyte problems.

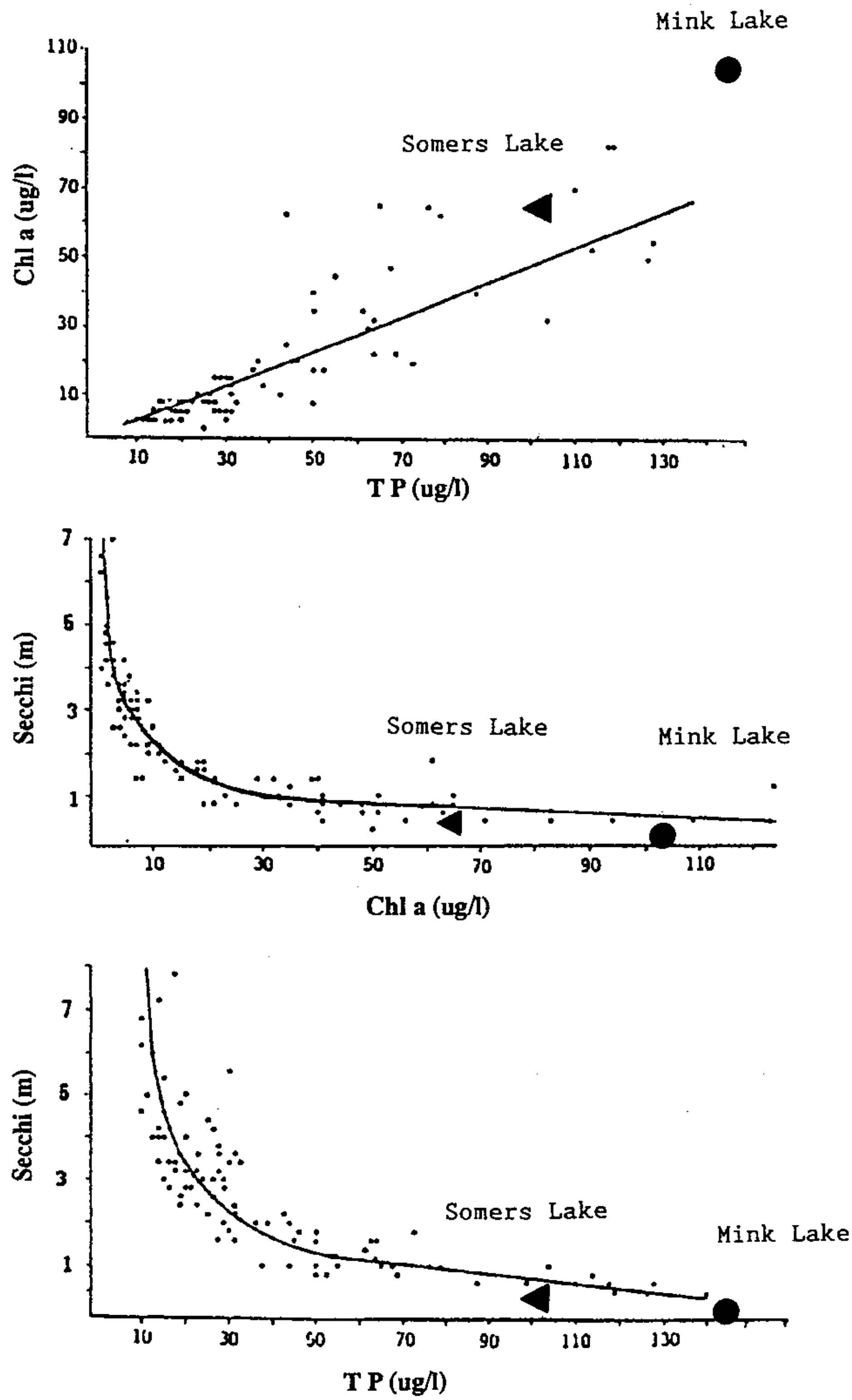
TSI 70 - 80 Heavy algal blooms possible throughout the summer, dense macrophyte beds, but extent limited by light penetration. Often would be classified as hypertrophic..

TSI > 80 Algal scums, summerfish kills, few macrophytes, dominance of rough fish.



After Moore, l. and K. Thornton, [Ed.] 1988. Lake and Reservoir Restoration Guidance Manual. USEPA> EPA 440/5-88-002..

Figure 8. SCATTERPLOTS OF CHLOROPHYL-a, TOTAL PHOSPHORUS AND SECCHI TRANSPARENCY. Based on summer data from a set of representative lakes from four ecoregions in Minnesota.



No actual measure of water flow into or out of the lake or measures of nutrient concentrations into or out of the lake were made. Rather, published runoff coefficients, precipitation and evaporation data, and nutrient export coefficients were used in this modeling. Precipitation and evaporation data were derived from Gunnard (1985) and preliminary data from the State Climatology Office 1993.

The MINLEAP model predicts a much lower phosphorus concentration than was observed in Mink and Somers Lakes in 1993 (Table 3). The model predicted a phosphorus concentration of 42 µg/L compared to the observed 1993 summer mean of 124 µg/L (Table 3). The high phosphorus value may be due to the higher amount of precipitation and runoff (higher nutrient loading) in 1993. As expected, the predicted chlorophyll value was lower than measured and the predicted secchi transparency was greater than was measured.

Based on MINLEAP, the water residence time (average time it would take to replace the entire volume of the lake) for Mink/Somers Lakes is on the order of 3 years. Mink/Somers Lakes retains approximately 76 percent of the phosphorus that enters the lake.

For the Reckhow and Simpson modeling estimates of precipitation, runoff and evaporation for the 1993 water were used. Land use composition for the watershed was supplied by Wright County SWCD based on the most recent survey. The number of seasonal and permanent residences were taken from Lake Association files. Phosphorus export coefficients were taken from the literature and/or were calculated based on equations presented by Prairie and Kalff (1986). The range of P exports used are consistent with previous LAP studies. Their premise is that in large agricultural watersheds, much of the phosphorus exported by the various land uses is retained in the watershed. This is probably realistic in watersheds where the drainage is not heavily channelized and there exists a number of lakes or wetlands which may act as sinks for phosphorus. This does not seem to be the case for Mink/Somers Lakes watershed. These calculated coefficients are often lower than those in the literature.

The soil retention coefficient is a means for estimating the soil's ability to trap phosphorus which may leach from septic tanks and potentially reach the lake. A high retention coefficient in the case of this model can reflect a high degree of trapping by the soils and/or well maintained septic systems. In contrast, a low soil retention coefficient (0.25 can reflect minimal trapping by soils and/or poorly maintained septic systems. The results from the septic system survey can be used to help determine which coefficients may be appropriate.

For Mink and Somers Lakes, the estimated P loading (814 Kg/yr) based on the "high" P export values (Output Section 1 in Table 4) provides the best approximation of the in-lake P (83 µg/L compared to 124 µg/L observed). Based on the high P export values, watershed sources contribute about 70 percent of the P load, precipitation about 6 percent, and septic systems about 23 percent. However, this loading rate (814 Kg P/yr) underestimates the in-lake concentration in Mink and Somers in 1993 and thus it is likely the lakes are receiving additional phosphorus loading from the watershed and/or internal recycling for the lake sediments.

TABLE 3 MINLEAP MODEL SUMMARY

```
Minnesota Lake Eutrophication Analysis Procedure
ENTER INPUT VARIABLES
LAKE NAME ? MINK/SOMERS
ECOREGION NUMBER 1=NLF,2=CHF,3=WCP,4=NGP ? 2
WATERSHED AREA (HA)          ? 1041
LAKE SURFACE AREA (HA)       ? 174
LAKE MEAN DEPTH (M)          ? 2.5
OBSERVED MEAN LAKE TP (UG/L) ? 124
OBSERVED MEAN CHL-A (UG/L)   ? 84
OBSERVED MEAN SECCHI (M)     ? .58

INPUT DATA:
LAKE NAME =MINK/SOMERS         ECOREGION=CHF
LAKE AREA = 174  HA
WATERSHED AREA (EXCLUDING LAKE) = 1041  HA
MEAN DEPTH = 2.5  METERS
OBSERVED MEAN TP = 124  UG/L
OBSERVED MEAN CHL-A = 84  UG/L
OBSERVED MEAN SECCHI = .58  METERS

<press ENTER to view results>



LAKE = MINK/SOMERS                          ECOREGION = CHF
AVERAGE INFLOW TP = 177.4464  UG/L          TOTAL P LOAD      = 252.4884  KG/YR
LAKE OUTFLOW      = 1.4229  HM3/YR          AREAL WATER LOAD  = .8177585 M/YR
RESIDENCE TIME    = 3.057137  YRS           P RETENTION COEF  = .7608499

VARIABLE  UNITS       OBSERVED PREDICTED STD ERROR  RESIDUAL    T-TEST
TOTAL P   (UG/L)        124.00     42.44     15.60      0.47      2.66
CHL-A     (UG/L)         84.00     15.73     10.12      0.73      2.41
SECCHI    (METERS)        0.58      1.53      0.65     -0.42     -2.16
NOTE: RESIDUAL = LOG10(OBSERVED/PREDICTED)
      T-TEST FOR SIGNIFICANT DIFFERENCE BETWEEN OBS. AND PREDICTED

CHLOROPHYLL-A INTERVAL FREQUENCIES (%)
CHL-A            PREDICTED PREDICTED PREDICTED
  PPB  OBSERVED    CASE A    CASE B    CASE C
   10    100.00     75.95     74.23     65.89
   20     99.70     22.92     24.68     33.33
   30     97.16      5.64      7.16     17.86
   60     67.80      0.12      0.26      3.93
CASE A = WITHIN-YEAR VARIATION CONSIDERED
CASE B = WITHIN-YEAR + YEAR-TO-YEAR VARIATION CONSIDERED
CASE C = CASE B + MODEL ERROR CONSIDERED
```

TABLE 4 RECKHOW-SIMPSON MODELING SUMMARY

I N P U T   S E C T I O N

****

	MINK/SOMERS		
Watershed Area (ha)	1041	0.124	=Observed TP (mg/l)
Lake Area (ha)	174	0.03	=Observed TP StDev
Water Runoff (m)	0.2	16	=N
Precipitation (m)	0.91	84	=Observed Chla (ug/l)
Mean Evaporation (m)	0.92	0.58	=Observed Secchi (m)
Mean Depth (m)	2.5	4.35	=Calc. Volume (Hm3)
County capitas/cabin	2.8		
No. Seasonal Cabins	53		
No. Permanent Res.	76		

****Fill in Est. Number Animal Units at a102****

	Before	After	Delta	%Total
Forest Area (ha)	51	51	0	5%
Agric Area (ha)	727	727	0	70%
Urban Area (ha)	82	82	0	8%
Wetland Area (ha)	137	137	0	13%
Pasture/Open (ha)	43	43	0	4%
	1040			

Export Values		Low	Average	High
Forest P Export		0.1	0.1	0.15
Agric P Export		0.2	0.4	0.6
Urban P Export		0.5	1	1.25
Wetland P Export		0.1	0.1	0.1
Pasture/open Export		0.2	0.3	0.4
Atmospheric Export		0.3	0.3	0.3
Soil Retention Coef		0.75	0.5	0.25
Point Source Before	kg/yr	0	0	0
Point Source After	kg/yr	0	0	0
Delta Point Source kg/yr		0	0	0
Capita Years		244.7	244.7	244.7

TABLE 4 RECKHOW-SIMPSON MODELING SUMMARY (continued)

O U T P U T S E C T I O N #1
Reckhow-Simpson Modeling Summary

KG P/YEAR Low	Average	High	kg P/year
5	5	8	Forested Flux
145	291	436	Ag flux
41	82	103	Urban flux
14	14	14	Wetland flux
9	13	17	Pasture/Open flux
52	52	52	Ppt flux
61	122	184	Septic flux
0	0	0	Point Souce
327	579	814	Total P Flux
188	333	468	P LOAD (kg)
157	278	391	Inflow P ug/l
			Predicted inlake P
45	66	83	CANFIELD/BACHMANN
			ug/L

OUTPUT SECTION 2 WATERSHED CONTRIBUTIONS

P load contribution

	Low flux	%	Avg flux	%	High flux	%
Wshed	214	65%	405	70%	578	71%
Septic	61	19%	122	21%	184	23%
Ppt	52	16%	52	9%	52	6%
Point	0	0%	0	0%	0	0%
Sum kg/yr	327		579		814	

OUTPUT SECTION 3. Reckhow-Simpson and MINLEAP Modeling Summary
Predicted changes in Secchi, Chlorophyll and Trophic Status

		Observed	Low Predicted	Average Predicted	High Predicted	MINLEAP Predicted	
			Predicted inlake P conc. or insert other values.				kg P/yr
LAKE TP	mg/l	0.124	0.045	0.066	0.083	0.042	
LAKE CHLA	ug/l	84	17.1	30	41.9	15.7	
LAKE SECCHIm		0.58	1.5	1	0.9	1.5	
TSI TP		74	59	65	68	58	
TSI CHLA		74	59	64	67	58	
TSI SD		68	54	60	62	54	

Hydrologic Summary Information

Est Flow= 2081998. 2.08 =HM3
Est Qs = 1.2
NOTE: 1HM3 = 1,000,000 M3; HM3=A-P/811; Ha=2.47*Ac; Km2=2.59*Mi2
2.10 =Water Residence (year)

TABLE 4 RECKHOW-SIMPSON MODELING SUMMARY (continued)

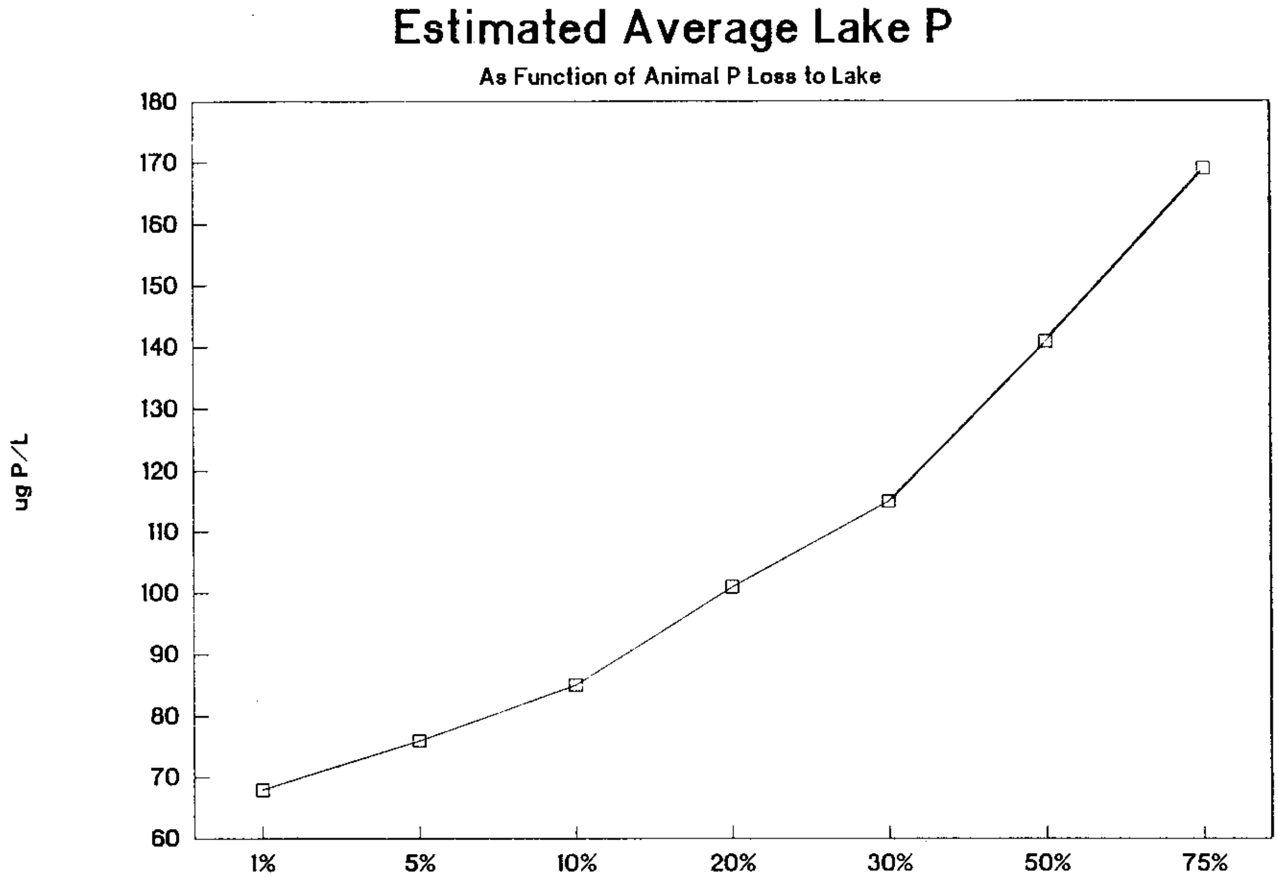
OUTPUT SECTION 4.
Estimated P Generation Potential from Animal Units

		P kg/Year Low	ML	High
	Cows	3	6	12
	Pigs	0.9	1.6	3.8
	Sheep	0.5	0.75	1.1
Fillin estimated number	Poultry	0.1	0.1	0.2
of animal units here	Horses	3	5	7.8
405 =Estimated Number	Cows	1215	2430	4860
85 =Estimated Number	Pigs	76.5	136	323
0 =Estimated Number	Sheep	0	0	0
0 =Estimated Number	Poultry	0	0	0
20 =Estimated Number	Horses	60	100	156
Total Estimated Kg P/Year Generation Potential		1352	2666	5339 kg
Ws Estimated Total Load (*Without Animal P Loads)		327	579	814 kg
Animal P Load Addition Potential (Magnitude of Animal Unit P Generation Potential)		413%	460%	656%

Sensitivity Analysis
Estimated Animal P Generation

Low	ML	High
1352	2666	5339

Figure 9 ESTIMATED IMPACT OF ANIMAL P LOSS ON IN-LAKE P
Estimated as a function of percent of animal P load reaching the lake.



Sensitivity Analysis
Estimated Animal P Generation

	Low	ML	High
	1352	2666	5339
1%	14	27	53
5%	68	133	267
10%	135	267	534
20%	270	533	1068
30%	405	800	1602
50%	676	1333	2670
75%	1014	2000	4004

Use Most Likely Value to Estimate Net Predicted Inlake P due to Increase From Animal Units

Loss Rate	ML 2666	Adj.	Net	PredictedInflowP	Predicted P
1%	27	606	348	291	68
5%	133	712	409	342	76
10%	267	846	486	407	85
20%	533	1112	639	535	101
30%	800	1379	793	663	115
50%	1333	1912	1099	919	141
75%	2000	2579	1482	1240	169

&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
Loss rate as a percent of the total P produced by animal units identified above. This is for illustrative purposes and should be tempered by the identification of likely scenarios by watershed analysis.

The previous estimates of P loading from the watershed did not include estimated P loads from animals in the watershed, in particular feedlots. Estimates of the number of animals pastured in the watershed were obtained from the Wright SWCD (Table 4, Output Section 4). The "potential" P loading from these animals ranges from about 1,350-5,300 Kg P/yr. This potential P loading is substantial compared to the previously estimated P loading to the lakes -- 814 Kg P/yr. We can estimate the impact of this additional loading on the lakes by assuming a percentage loss of the animal generated P to the lake, ranging from 1 percent to 75 percent (Table 4, Output Section 4). The impact on in-lake P concentration is presented in Figure 9. In this case, the animal generated P load is added to the most likely (average) P loading (579 kg P/yr) estimated from the model. Based on this analysis, if only 30 percent of the animal generated P reached the lake, the in-lake P concentration is estimated at 115 µg/L, which is quite comparable to the 124 µg/L measured in 1993.

Based on this analysis, a P loading rate of approximately 1,379 KgP/yr (30% loss rate, Figure 9) is a more realistic estimate of the P loading to the lake (compared to Output Section 1). Using a loading rate of 1,379 Kg P/yr, septic system contributions are likely in the range of 9 percent (if soils retain 50 percent of P) to 13 percent (if soils retain 25 percent of P).

The analysis of the impact of P generation from animals in the watershed is based on numerous estimates and should not be considered an exact representation of the P loading from the source. However, the analysis indicates that animals (pastured or feedlots) in the watershed of Mink/Somers Lakes may be a significant source of P to the lake and, thus, should be considered in any strategy aimed at reducing the P loading to the lake.

Goal Setting

Total phosphorus concentrations and subsequently chlorophyll *a* concentrations are very high in Mink and Somers Lakes relative to lakes in the North central Hardwood Forests ecoregion. The high phosphorus concentrations in the lakes are likely the result of excess P loading from the watershed, some internal recycling of P from the sediments, and the shallowness of the lakes. Poor land use practices in the watershed, including runoff from feedlots and pastured lands, erosion of cultivated lands, excess fertilization of lawns, and leaching from poorly maintained septic systems all serve to increase the phosphorus loading to the lakes.

For lakes in this part of the state, in-lake phosphorus concentration of 40 µg/L or less are desirable if the lake is to provide "swimmable" conditions throughout the majority of the summer. At a phosphorus concentration of 40 µg/L "severe nuisance" blooms of algae (chlorophyll *a* >30 µg/L) would occur less than ten percent of the summer and Secchi transparency would remain above one meter for the majority (90 percent) of the summer. This would be a substantial improvement over 1993 conditions in Mink and Somers Lakes which experienced severe nuisance blooms and Secchi transparency less than one meter throughout most of the summer. The MINLEAP model predicts an in-lake P concentration of 42 µg/L based on the size of the lakes, watershed area, and the ecoregion the lakes are located in. Substantial reduction in the P loading to these lakes would be required in order to achieve an in-lake P concentration of 40 µg/L.

Based on MINLEAP modeling, a P loading rate of about 250 Kg P/yr would be required to achieve a P concentration of approximately 40 µg/L in Mink and Somers lakes. This loading rate is approximately 20 percent of the estimated 1,379 Kg P/yr. Thus, an 80 percent reduction in P loading would be required to achieve an in-lake P concentration of approximately 40 µg/L in 1993.

Further study, such as a Clean Water Partnership study, is required to determine whether a goal of 40 µg/L or lower is reasonable for these lakes (i.e. could necessary reductions in P loading be achieved). This study would also determine where efforts to reduce P loading should be targeted. However, obvious sources near the lake should be addressed first. This should include feedlots and heavily pastured lands, cultivated lands, residential areas (including septic tanks) near the lake, and any other sources which may be identified in a more comprehensive assessment of the watershed.

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APPENDIX

LAKE WATER QUALITY DATA. All MPCA data in STORET.

LAKEID=86-0229 MINK LAKE

DATE	SITE	D	TP	RTP	TKN	N2N3	RN2N3	TSS	TSIN	ALK	PHF	CL	CONF	TURB	COLOR	CHLA	PHEO	SDF	PHYS	REC
810629	101	0	.152		2.62	0.01	K	.	.	100	.	.	.	.	40	131.00	0.12	1.6		
910606	101	0	.156		2.85	0.01	K	29.0	7.0	120	.	19	.	20	50	114.00	0.80	.	3	3
910606	101	29	.184		3.05	.		.	.	.	.	.	.	.	.	.	.	.		
910711	101	0	.010	K	2.58	0.03		11.0	3.2	120	9.2	17	265	10	40	34.40	0.80	3.0	3	3
910711	101	29	.840		6.36	.		.	.	.	.	.	.	.	.	.	.	.		
910812	101	0	.030		2.44	0.01	K	20.0	6.0	120	9.3	16	310	22	30	48.40	1.28	2.6	4	4
910812	101	29	1.04		5.26	.		.	.	.	.	.	.	.	.	.	.	.		
930501	101	0	.115		1.45	0.01		14.0	6.8	130	8.2	18	310	4.3	20	47.40	12.8	3.0	2	2
930603	101	0	.092		1.47	0.06		11.0	4.4	140	8.6	19	320	5.3	20	34.00	7.69	3.3	3	3
930603	101	27	.160		2.12	0.01	K	.	.	.	.	.	.	.	.	.	.	.		
930603	102	0	.107		1.56	0.02		.	.	.	.	.	320	.	.	45.50	1.92	2.5	3	3
930701	101	0	.120		2.13	0.01	K	23.0	8.0	120	8.5	18	290	10	20	134.00	0.64	1.6	4	4
930701	101	29	1.33		6.84	.		.	.	.	.	.	.	.	.	.	.	.		
930701	102	0	.176		2.79	.		.	.	.	8.4	.	300	.	.	139.00	5.13	1.3	4	4
930729	101	0	.136		0.10	0.01	K	30.0	13.0	110	7.5	19	270	18	20	106.00	5.13	1.3	4	4
930729	101	28	.741		5.60	.		.	.	.	.	.	.	.	.	.	.	.		
930729	102	1	.243		4.10	.		.	.	.	.	.	.	.	.	207.00	11.2	.		
930901	101	0	.099		1.67	0.05	K	14.0	5.8	120	7.5	18	265	10	20	46.40	1.60	1.6	4	3
930901	101	21	.156		1.08	.		.	.	.	.	.	.	.	.	.	.	.		
930901	102	0	.183		2.18	.		.	.	.	7.8	.	270	.	.	111.00	2.14	1.0	4	3

LAKEID=86-0230 SOMERS LAKE

DATE	SITE	D	TP	RTP	TKN	N2N3	RN2N3	TSS	TSIN	ALK	PHF	CL	CONF	TURB	COLOR	CHLA	PHEO	SDF	PHYS	REC
810629	101	0	.114		2.01	0.12		.	.	100	.	.	.	.	25	57.00	0.04	3.6		
910606	101	0	.033		2.16	0.22		9.8	4.6	120	.	17	.	5.5	20	16.80	4.81	.	3	3
910606	101	16	.081		2.69	.		.	.	.	.	.	.	.	.	.	.	.		
910711	101	0	.026		3.10	0.02		19.0	7.0	90	9.5	16	220	15	30	42.50	0.80	2.3	3	3
910711	101	16	.117		3.50	.		.	.	.	.	.	.	.	.	.	.	.		
910812	101	0	.023		2.43	0.06		27.0	9.0	86	9.5	16	250	17	20	67.30	0.64	2.3	4	4
910812	101	16	.057		2.08	.		.	.	.	.	.	.	.	.	.	.	.		
930501	101	0	.072		1.33	0.38		12.0	5.6	130	8.3	18	310	4.5	20	28.50	5.45	3.1	2	2
930603	101	0	.079		1.44	0.13		10.0	3.4	140	8.3	18	300	5.8	20	25.30	1.92	3.3	4	4
930603	101	18	.042		1.48	0.12		.	.	.	.	.	.	.	.	.	.	.		
930603	102	0	.074		1.57	0.13		.	.	.	8.7	.	300	.	.	23.10	1.28	3.1	3	3
930701	101	0	.094		2.30	0.01	K	17.0	6.0	120	8.4	18	280	24	20	78.90	0.80	2.0	4	4
930701	101	18	.120		1.84	.		.	.	.	.	.	.	.	.	.	.	.		
930701	102	0	.107		2.47	.		.	.	.	8.5	.	280	.	.	96.90	0.80	1.6	4	4
930729	101	0	.118		2.89	0.01	K	25.0	10.0	110	8.0	17	260	15	20	92.90	4.81	1.6	4	4
930729	101	13	.114		2.58	.		.	.	.	.	.	.	.	.	.	.	.		
930729	102	0	.098		2.87	.		.	.	.	7.9	.	250	.	.	81.70	1.60	1.6	4	4
930901	101	0	.118		1.39	0.05	K	19.0	7.0	100	8.1	18	250	10	20	59.30	1.60	2.0	3	3
930901	101	18	.151		1.28	.		.	.	.	.	.	.	.	.	.	.	.		
930901	102	0	.131		1.32	.		.	.	.	8.3	.	250	.	.	60.90	4.81	1.8	3	3

Abbreviations and Units

SITE= sampling site ID
DM= sample depth in meters(0-0-2 m integrated)
D= sample depth in feet
TP= total phosphorus in mg/l
TKN= total Kjeldahl nitrogen in mg/l
N2N3= nitrite+nitrate N in mg/l
PH= pH in SU (field)
PHL= pH in SU (lab)
ALK= alkalinity in mg/l (lab)
TSS= total suspended solids in mg/l
TSV= total suspended volatile solids in mg/l
TSIN= total suspended inorganic solids in mg/l
TURB= turbidity in NTU

COND= conductivity in umhos/cm (l=lab)
CONF= conductivity (field)
CL= chloride in mg/l
DO= dissolved oxygen in mg/l
TEMP= temperature in degrees centigrade
SD= Secchi disk in meters
SDF= Secchi disk in feet
CHLA= chlorophyll-a in ug/l
PHEO= pheophytin in ug/l
PHYS= physical appearance rating
REC= recreational suitability rating
RTP, RN2N3...= remark code; K=less than,
Q = Sample held beyond normal holding time

LAKE WATER QUALITY DATA. All MPCA data in STORET

MINK LAKE

LAKEID=86-0229

SITE	DATE	DM	DO	TEMP	TPUG
101	930501	0	10	11	115.000
101	930501	1	10	11	.
101	930501	2	9.8	11	.
101	930501	3	9.8	11	.
101	930501	4	9.8	11	.
101	930501	5	9.6	11	.
101	930501	6	9.0	11	.
101	930501	7	7.5	11	.
101	930501	8	6.9	11	.
101	930501	9	4.8	10	.
101	930603	0	11	16	92.00
101	930603	1	10	16	.
101	930603	2	9.7	15	.
101	930603	3	7.9	15	.
101	930603	4	6.6	15	.
101	930603	5	6.1	14	.
101	930603	6	5.8	15	.
101	930603	7	5.3	15	.
101	930603	8	0.2	13	.
101	930603	9	0.2	13	.
101	930701	0	8.1	20	120.00
101	930701	1	8.1	19	.
101	930701	2	8.0	19	.
101	930701	3	7.6	19	.
101	930701	4	3.0	19	.
101	930701	5	0.2	17	.
101	930701	6	0.1	17	.
101	930701	7	0.1	15	.
101	930701	8	0.1	14	.
101	930701	9	0.1	12	1330.00
101	930729	0	5.6	22	136.00
101	930729	1	5.3	22	.
101	930729	2	5.2	22	.
101	930729	3	5.1	22	.
101	930729	4	5.0	22	.
101	930729	5	3.9	22	.
101	930729	6	0.1	18	.
101	930729	7	0.1	16	.
101	930729	8	0.1	14	.
101	930729	9	0.1	13	.
101	930901	0	5.1	21	99.00
101	930901	1	5.1	21	.
101	930901	2	5.2	21	.
101	930901	3	5.2	21	.
101	930901	4	5.3	21	.
101	930901	5	5.5	21	.
101	930901	6	5.0	21	.
101	930901	7	0.2	19	.

SOMERS LAKE

LAKEID=86-0230

SITE	DATE	DM	DO	TEMP	TPUG
101	930501	0	11	11	72.0000
101	930501	1	11	11	.
101	930501	2	10	11	.
101	930501	3	11	11	.
101	930501	4	10	11	.
101	930501	5	10	11	.
101	930501	6	10	11	.
101	930603	0	10	16	79.000
101	930603	1	11	16	.
101	930603	2	10	16	.
101	930603	3	10	16	.
101	930603	4	8.6	16	.
101	930603	5	6.2	15	.
101	930603	6	3.9	15	.
101	930701	0	7.5	20	94.000
101	930701	1	7.2	20	.
101	930701	2	6.6	19	.
101	930701	3	6.1	19	.
101	930701	4	5.6	19	.
101	930701	5	3.5	19	.
101	930701	6	1.6	19	.
101	930729	0	5.5	23	118.000
101	930729	1	5.4	23	.
101	930729	2	5.4	23	.
101	930729	3	5.4	23	.
101	930729	4	5.4	23	114.000
101	930729	5	5.4	23	.
101	930901	0	5.5	22	118.000
101	930901	1	5.4	22	.
101	930901	2	5.2	22	.
101	930901	3	5.1	22	.
101	930901	4	5.1	22	.
101	930901	5	5.1	22	.
101	930901	6	5.1	22	.

Legend
DM = Depth in meters
DO = Dissolved Oxygen
TEMP = Temperature in degrees centigrade
TPUG = Total Phosphorus in μg/L

Minnesota Pollution Control Agency
Citizen Lake-Monitoring Program

LAKEID: 86-0229

LAT.LON.: 451630 940130
LAKE: MINK
LOCATION: 2 MI N OF MAPLE LAKE
COUNTY: WRIGHT
AREA: 301 acres
MAXDEPTH: 39 feet

DATE	TIME	D	00029 SITE	*00078 SECCHI FEET	84141 PHYSCON 1-5	84142 RECSUIT 1-5
910601	0001	0	201	2.33	-	-
910608	0001	0	"	2.00	-	-
910615	0001	0	"	1.83	-	-
910622	0001	0	"	1.50	-	-
910624	0001	0	"	1.33	-	-
910712	0001	0	"	2.00	-	-
910718	0001	0	"	2.00	-	-
910802	0001	0	"	2.00	-	-
910811	0001	0	"	2.00	-	-
910601	0002	0	202	9.00	-	-
910608	0002	0	"	1.50	-	-
910615	0002	0	"	1.25	-	-
910622	0002	0	"	9.00	-	-
910624	0002	0	"	9.00	-	-
910712	0002	0	"	1.50	-	-
910718	0002	0	"	1.50	-	-
910802	0002	0	"	1.00	-	-
910811	0002	0	"	1.50	-	-

DATE	TIME	D	00029 SITE	*00078 SECCHI FEET	84141 PHYSCON 1-5	84142 RECSUIT 1-5
930612	1215	0	203	2.00	3	3
930629	1710	0	"	11.50	3	3
930706	1927	0	"	1.00	3	3
930713	1731	0	"	1.00	4	4
930727	1701	0	"	1.00	4	4
930809	1801	0	"	1.50	3	3
930823	1800	0	"	1.00	4	4
930906	1831	0	"	2.00	3	3
931004	1501	0	"	2.50	2	2

LAKEID: 86-0230

LAT.LON.: 451600 940130
LAKE: SOMERS
LOCATION: 1 MI N OF MAPLE LAKE
COUNTY: WRIGHT
AREA: 158 acres
MAXDEPTH: 21 feet

DATE	TIME	D	00029 SITE	*00078 SECCHI FEET	84141 PHYSCON 1-5	84142 RECSUIT 1-5
910601	0001	0	201	4.00	-	-
910608	0001	0	"	3.50	-	-
910615	0001	0	"	3.00	-	-
910622	0001	0	"	2.50	-	-
910624	0001	0	"	2.00	-	-
910712	0001	0	"	2.50	-	-
910718	0001	0	"	2.50	-	-
910802	0001	0	"	2.33	-	-
910811	0001	0	"	1.00	-	-

DATE	TIME	D	00029 SITE	*00078 SECCHI FEET	84141 PHYSCON 1-5	84142 RECSUIT 1-5
930610	1100	0	202	2.00	3	3
930612	1200	0	"	2.00	3	3
930620	1800	0	"	1.50	4	4
930623	1800	0	"	0.50	5	5
930629	1700	0	"	1.50	3	3
930706	1926	0	"	1.50	3	3
930713	1730	0	"	1.50	3	3
930727	1700	0	"	1.50	3	3
930809	1800	0	"	1.50	3	3
930823	1801	0	"	1.00	4	4
930906	1830	0	"	2.00	3	3
931004	1500	0	"	2.50	2	2

Physical Condition

Please use the ONE number, each day that you sample, that best describes the physical condition of the lake water AT YOUR SAMPLING SITE.

1 = Crystal clear water
2 = Not quite crystal clear – a little algae present/visible
3 = Definite algal.green, yellow, or brown color apparent
4 = High algal levels with limited clarity and/or mild odor apparent
5 = Severely high algae levels with one or more of the following:
- massive floating scums on the lake or washed up on shore
- strong, foul odor
- fish kill (please note the number and types of fish)

Suitability for Recreation

Please use the ONE number, each day that you sample, that best describes your opinion of how suitable the lake is for recreation and aesthetic enjoyment.

1 = Beautiful, could NOT be better.
2 = Very minor aesthetic problems; excellent for swimming, boating
3 = Swimming and aesthetic enjoyment slightly impaired because of algae levels
4 = Desire to swim and level of enjoyment of the lake substantially reduced because of algae levels (i.e., would not swim, but boating is okay)
5 = Swimming and aesthetic enjoyment of the lake nearly impossible because of algae levels

MINNESOTA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATERS
LAKES-DB
LAKE SUMMARY

REPORT DATE 01/20/94

LAKE NAME: Somers

DNR ID #: 86-0230 00

ALTERNATE NAME:

SHORELAND CLASS:
Recreational Development

NEAREST CITY: MAPLE LAKE

PRIMARY COUNTY: Wright

NUMBER OF COUNTIES: 1

PWI CLASS: P   AREA: 156 AC.   LOCATION: RNG 27 W   TWP 121   SEC 25
MEANDERED: Y

WETLAND TYPE: 5   BULLETIN 25 LOCATION: RNG 27   TWP 121   SEC 24,25
SOURCE: 6

WSHD.NO.: 17004
MAJOR WATERSHED NAME: Mississippi R. -St. Cloud
MINOR WATERSHED NAME: Silver Cr

USGS QUAD: Q13d
ANNANDALE

************************* WATER LEVEL DATA *************************

OHW ELEVATION: 1023.10 DATUM: 1929

100Yr FLOOD ELEVATION: STUDY DATE:

10Yr FLOOD ELEVATION:

HIGHEST KNOWN WATER LEVEL: 1024.50 DATE: Unknown

RECORDED WATER LEVELS:

PERIOD OF RECORD: 01/01/51 - 10/03/93   # OF READINGS: 38

HIGHEST RECORDED: 1023.71 08/28/93

LOWEST RECORDED: 1020.00 01/01/51   RECORDED RANGE: 3.71

AVERAGE OF RECORDED: 1022.77

LAST READING: 1021.95 10/03/93

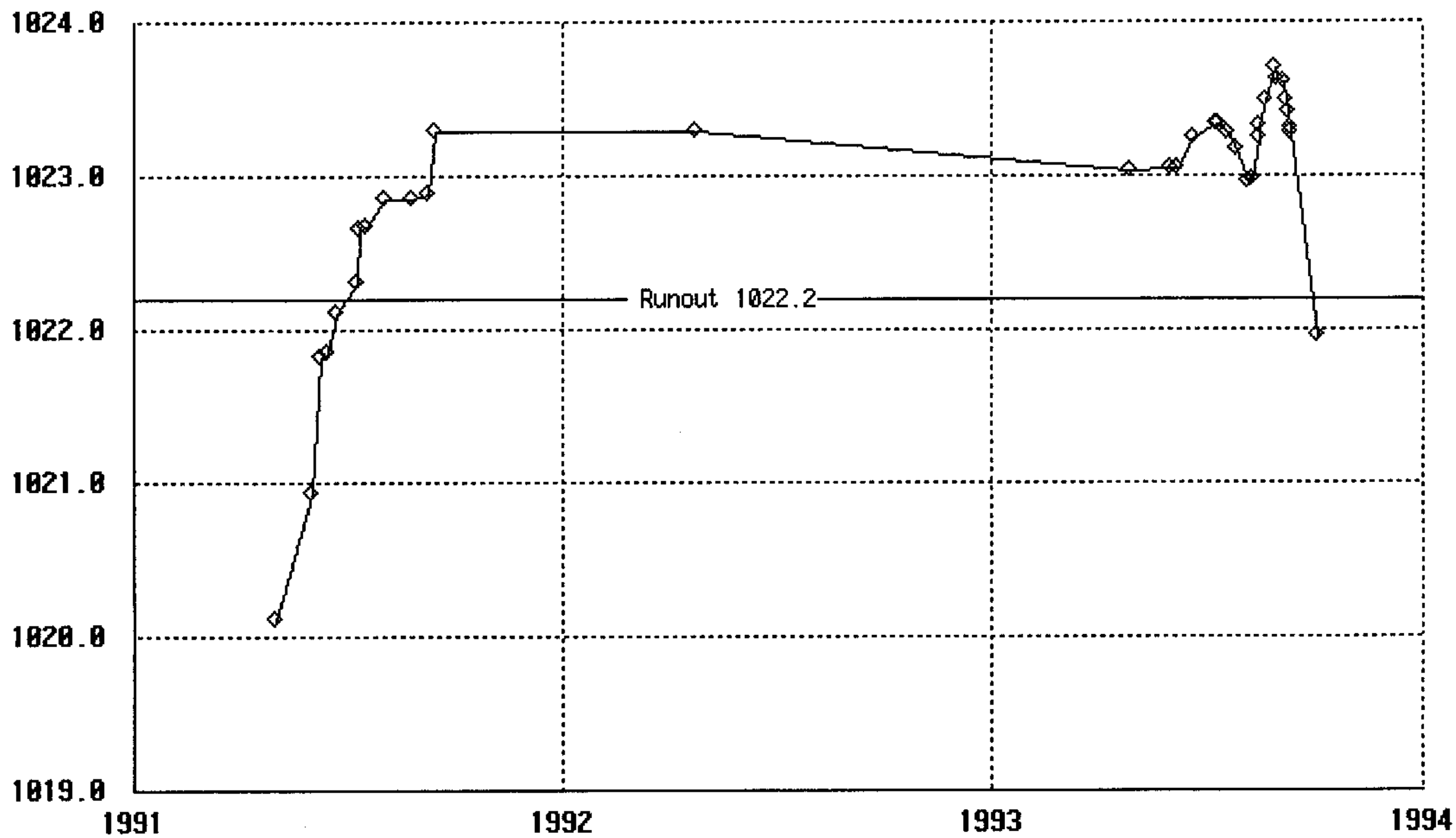
************************* RUNOUT DATA ******************************

RUNOUT ELEVATION: 1022.20 DATUM: 1929

RUNOUT TYPE: LR   Loose rock

LOCATION:	Q-SEC	SEC	TWP	RNG
	SW NW	25	121	27 W

Somers Lake Wright County
RECORDED WATER LEVELS



Septic System Survey Results
Lake: Mink/Somers
Date: 12/19/93

PARTICIPATION
About 140 surveys were sent to property owners around Mink/Somers Lake. About 68 surveys were returned. (49%)

TYPE OF DWELLING	# of Response	%
Seasonal	23	34
Year Round	37	54
Year round, but not a primary residence	8	12

SYSTEM AGES (years)		
0-5	9	13
6-10	14	21
11-15	10	15
16-20	9	13
21-25	3	4
26-30	10	15
31+	4	6
unknown	9	13

DISTANCE FROM LAKE TO CLOSEST POINT OF SYSTEM (feet)		
0-50	8	12
51-100	23	34
101-150	19	28
151-200	5	7
201-250	2	4
251+	5	7
no response	6	9

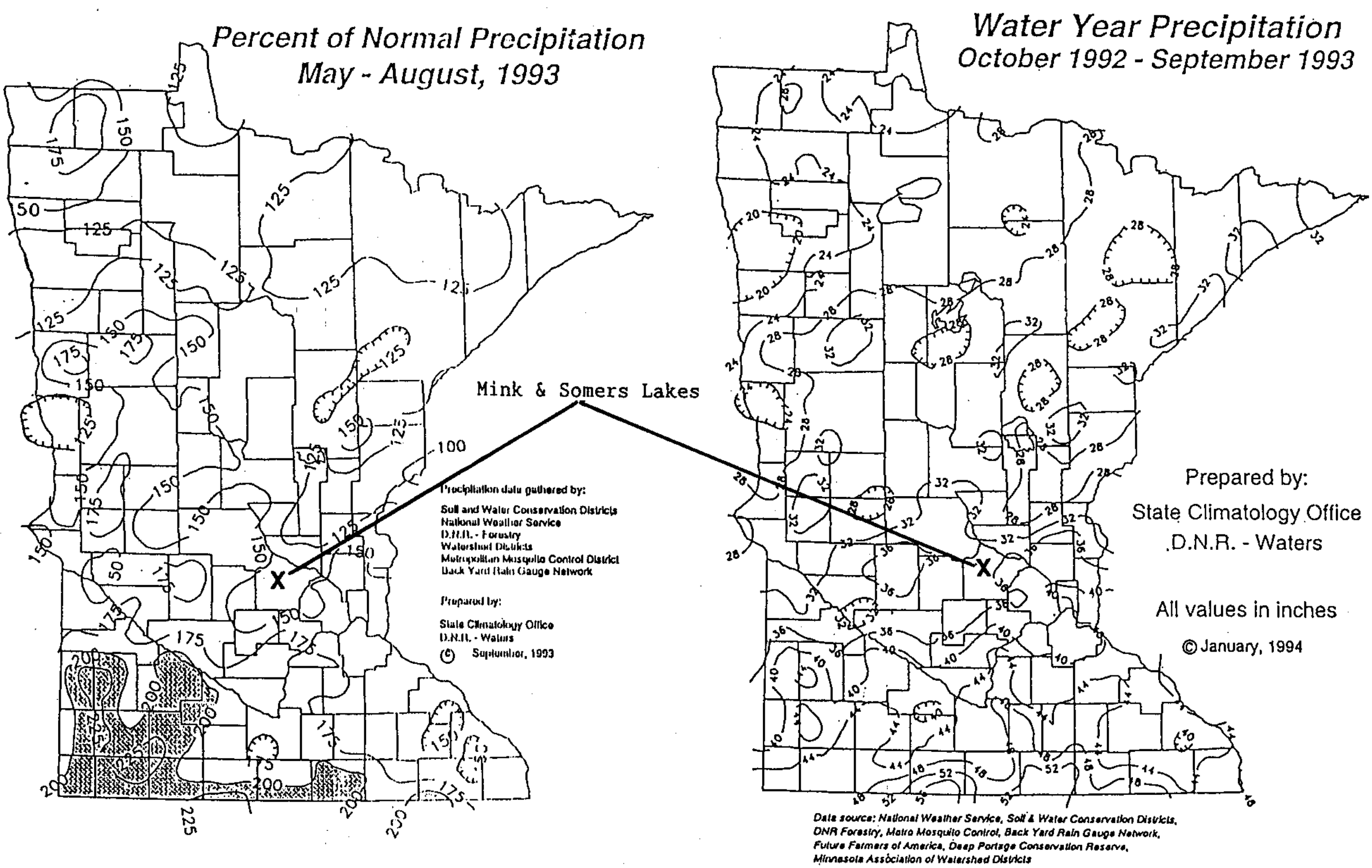
System Types	# of Response	%
Septic tank - drainfield	38	56
Septic tank - drywell	2	3
Shared septic tank - drainfield	0	0
Cesspool	6	9
Holding tank	12	16
Privy	0	0
Mound system	3	4
Don't know	6	9
Other	0	0

System Pumping		
More than once per year	16	24
Every year	10	15
Every 2 years	8	12
Every 3 years	4	6
Every 4 years	1	1.5
Every 5 years	3	4
Every 10 years	4	6
When problems	3	4
Never	12	18
No response	7	10

Problems		
Freeze ups	1	1.5
Back ups	1	1.5
Inadequate drainage	2	3
Some - not bad		
None in the last two years		

Summary of Survey Results Conducted by the Association of Mink and Somers

Many of the returned surveys stated that failing systems were a pollution problem. Many of the systems have not been properly maintained. Less than half of the systems are pumped at least once every five years (holding tanks were not factored in). About 35% of the systems are either of unknown age or are over 25 years old. Many of the property owners that did not respond have systems that are in poor condition. People need to be educated on maintenance. Selling a property can be difficult with a bad system. Non-compliant systems should be updated ASAP. The failing systems not only pollute the lake, but may be contaminating ground water as well.


Percent of Normal Precipitation
May - August, 1993
Water Year Precipitation
October 1992 - September 1993
Mink & Somers Lakes
X
X
Precipitation data gathered by:
Soil and Water Conservation Districts
National Weather Service
D.N.R. - Forestry
Watershed Districts
Metropolitan Mosquito Control District
Back Yard Rain Gauge Network
Prepared by:
State Climatology Office
D.N.R. - Waters
© September, 1993
Prepared by:
State Climatology Office
D.N.R. - Waters
All values in inches
© January, 1994
Data source: National Weather Service, Soil & Water Conservation Districts, DNR Forestry, Metro Mosquito Control, Back Yard Rain Gauge Network, Future Farmers of America, Deep Portage Conservation Reserve, Minnesota Association of Watershed Districts