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INDEXING MINNESOTA FISH LAKES RELATIVE TO POTENTIAL SUSCEPTABILITY TO ACIDIC DEPOSITION

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INDEXING MINNESOTA FISH LAKES RELATIVE TO POTENTIAL SUSCEPTIBILITY TO ACIDIC DEPOSITION

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ABSTRACT

Existing water quality data was integrated with information on Minnesota inland lake fisheries resources to identify those systems which might be subject to damage from acid deposition. Acid susceptibility was based on total alkalinity and fish lakes having $\leq$ 10.0 mg/l $CaCO_3$ were indexed. Using this criteria, 13 Minnesota counties were found to contain 155 fish lakes classified as extremely sensitive (0.0 - $\leq$ 5.0 mg/l $CaCO_3$) and 315 classified as moderately sensitive (> 5.0 - $\leq$ 10.0 mg/l $CaCO_3$) to acid deposition. These 470 fish lakes had a surface area of 55,580 ha, constituting 15% by number and 6% by area of all Minnesota fish lakes. Data on the ecological classification and fish species composition for each sensitive lake is provided, along with limited physical and chemical characteristics. Of primary concern to Minnesota are possible adverse impacts on naturally reproducing populations of walleye, smallmouth bass, lake trout and the forage base on which these species subsist. Sensitive populations of these species are, for the most part, situated in northeastern portions of the state, particularly Cook, Lake, St. Louis and Itasca counties. Recommendations for further evaluation are made.

INTRODUCTION

Minnesota has been, through both research and legislative action, aggressive in addressing the issue of acid deposition. The Acid Precipitation Act of 1980 initiated investigations by the Minnesota Department of Natural Resources (MDNR), Pollution Control Agency (MPCA) and Department of Health (MDH) into resource susceptibility and potential impacts from acid deposition. The results of these studies prompted the Acid Deposition Control Act of 1982, the first governmental legislation of its kind. This act mandated MPCA to identify areas of Minnesota containing acid-susceptible resources by 1 May 1983; establish deposition standards for areas so delineated by 1 January 1985; develop a control plan for the attainment and maintenance of those standards by 1 January 1986; and ensure compliance with the control plan by in-state sources emitting in excess of 100 tons sulfur dioxide annually by 1 January 1990.

The concern over potential impacts of acid deposition on freshwater resources in Minnesota stems from the presence of geologically acid-sensitive environments and precipitation pH and sulfate deposition rates similar to levels believed to have caused biological degradation in Sweden, Norway and portions of northeastern North America (Thornton et al. 1982). Comparisons of current and historical values (corrected for technique) of total alkalinity indicate that buffering capacities in a number of lakes may have been eroded over the past 25-30 years (Thornton et al. 1982) though no acidified lakes have yet been identified in Minnesota.

The total economic impact of potential degradation of fishing waters from acid deposition remains uncertain. The Minnesota sport fishery contributes an estimated $515 million annually to the economy of the state

(U.S. Department of the Interior 1982). It has been postulated that losses of fisheries resources or contamination of fish flesh could result in annual losses as high as $40 million on the periphery of the Boundary Waters Canoe Area Wilderness (BWCAW) alone (Blank 1981). Of more practical concern than actual losses at this time are possible public perceptions that such losses or contamination are presently being incurred or are imminent. False perceptions and misconceptions of damage magnitudes can result in economic ramifications prior to actual impacts. The need for detailed quantitative and qualitative analysis of acid-susceptible resources, their status relative to acidification and associated economic analysis is therefore paramount.

The identification of fisheries resources potentially susceptible to the effects of sustained acidic deposition or from acidic pulses created by rapid snowmelt or heavy precipitation events has been a major objective of the MDNR acid deposition program. The location of such resources is expected to be regionally oriented due to the geological composition of Minnesota which in general consists of a transition zone between the forested regions of the northeast and the prairies of the southwest. This transition zone is characterized by gradients in soils, vegetative types and climate as well as precipitation pH.

The range of aquatic habitats provided through this zone supports biological communities of varying susceptibility to acidification. The exposed bedrock and shallow, non-calcareous soils which predominate in the watersheds of northeastern Minnesota result in low levels of dissolved minerals which inherently offer little acid buffering capacity. It is within these areas that we would expect to find most acid sensitive fisheries resources. Watersheds within these regions do, however, show

considerable geographic variation, as do the lakes within them. Relatively oligotrophic waters having low ionic concentrations and pH values may be adjacent to fertile, hardwater systems having discrete biotic communities. This diversity curtails a blanket characterization of lakes in a given area as to their acid susceptibility.

The central portion of Minnesota is characterized by higher levels of dissolved minerals thus creating an increased ability to neutralize added acids. Lower densities of acid sensitive lakes would be expected in this area. In contrast, areas of southwestern and western Minnesota have very high levels of dissolved minerals and corresponding buffering capacity. These areas would be expected to contain only isolated acid sensitive systems, if any.

The efforts of the MPCA have generally been directed at determining geographic areas of susceptibility for establishment of deposition control standards (Twaroski et al. 1983). Other studies have focused on relatively restricted regions of known acid sensitivity, particularly the BWCAW (Glass and Loucks 1980; Heiskary et al. 1982; Thornton et al. 1982). These investigations have examined all lake systems within their respective study areas, whether or not fish populations were present.

This report provides an initial, broad listing of softwater lakes in Minnesota managed for their fisheries resources which may be susceptible, based on water quality parameters and fish community structure, to acidic deposition. It should be emphasized that the lake listings herein are meant only to identify those fish lakes having waters soft enough to be sensitive to acid deposition not those which the MDNR feels will be unquestionably impacted.

STUDY AREA

This study was designed to identify softwater fish lakes throughout Minnesota which might be susceptible to damage from acid deposition. For the most part, such waters are located in north central and northeastern portions of the state. While expanded monitoring efforts on a statewide basis may identify additional softwater lakes, the major portion of acid sensitive waters in Minnesota undoubtedly occur in the northeastern one-third of the state.

METHODS

The initial step was to select a criterion by which to estimate the degree of susceptibility of a lake to acid deposition. The most common criteria presently used is total alkalinity measured as mg/l $CaCO_3$. Alkalinity data is relatively easy to obtain, is available for most lakes and provides some basis for historical comparison. While sensitivity schemes based on other parameters exist which may circumstantially provide a better conceptual picture of the susceptibility of a given water, much of the necessary data is not yet available on a broad basis in Minnesota. The value of alternate systems as applied to extremely soft waters remains questionable.

The selection of specific alkalinity values as cutoff demarcations for susceptibility ranking is somewhat arbitrary and several schemes have been proposed. General consensus can be found, however, for considering waters having alkalinities of $\leq$ 10-15 mg/l $CaCO_3$ as at least moderately sensitive to acidification (Altshuller and McBean 1979; Glass and Loucks 1980). The scheme developed by Thornton et al. (1982) for use in Minnesota was chosen as a basis for lake selection. This system

identifies waters sensitive to acid deposition based on mg/l $CaCO_3$: acidified ($\leq$ 0.0 mg/l); extremely sensitive (> 0.0 - $\leq$ 5.0 mg/l); moderately sensitive (> 5.0- $\leq$ 10.0 mg/l); potentially sensitive (> 10.0 - $\leq$ 20.0 mg/l); and non-sensitive (> 20.0 mg/l). Appendix A provides a more detailed definition of each sensitivity classification. Fish lakes having alkalinities of $\leq$ 10.0 mg/l $CaCO_3$, encompassing extremely and moderately sensitive waters using this ranking scheme, were identified. Some concerns do exist for potential biodegradation elicited as a loss in system productivity for potentially sensitive waters (> 10.0 - $\leq$ 20.0 mg/l $CaCO_3$), but are not addressed here.

The individual identification of fish lakes having alkalinities of $\leq$ 10.0 mg/l $CaCO_3$ was accomplished by merging water quality data bases from the National Forest Service, U.S. Environmental Protection Agency, MPCA and MDNR with lakes managed for fisheries resources by the MDNR. Information from these files was compiled on the fish communities each lake would be inherently expected to support and on those species presently inhabiting the lake. Species composition data was determined from gill net and trap net data which provides information on the presence of principal species. Each fish lake was classified by ecological type, based in terms of the naturally occurring fish populations best adapted to the physical, chemical and biological characteristics of the lake (Scidmore 1970). The nine ecological types comprising this categorization include: trout; softwater walleye; hardwater walleye; centrachid-walleye; centrarchid; roughfish-gamefish; bullhead; northern pike-sucker; and unclassified. This information was used to further evaluate the sensitivity of a lake based on differing species tolerances to acidification. A description of the general physical and chemical

characteristics of each ecological type is provided in Appendix B.

The size of extremely and moderately sensitive fish lakes was plotted by ecological type as smaller lakes are generally expected to be more acid sensitive. Water quality parameters (secchi disc, color, pH and total alkalinity) were recorded for each lake for which such data was available.

RESULTS

Number and location of acid sensitive fish lakes

Merging existing water quality data bases with lakes managed for fisheries resources by MDNR identified 155 fish lakes classified as extremely sensitive to acid deposition (> 0.0 - $\leq$ 5.0 mg/l $CaCO_3$) and 315 classified as moderately sensitive (> 5.0 - $\leq$ 10.0 mg/l $CaCO_3$). Thirteen Minnesota counties contained at least one fish lake having a total alkalinity of $\leq$ 10.0 mg/l $CaCO_3$ (Fig. 1). The approximate locations of extremely and moderately acid sensitive fish lakes are depicted in Figs. 2-4. The 470 fish lakes within this alkalinity regime constitute approximately 15% of the total number of Minnesota fish lakes. As was expected from previous sensitivity mapping efforts (Thornton et al. 1982; Twaroski et al. 1983), most softwater systems were located in north central and northeastern regions of Minnesota.

The number of extremely and moderately sensitive fish lakes inventoried, total area and median sizes are listed in Table 1 for each county in which they were found. Indexed lakes ranged in size from 4 to 4,142 ha. Average and median sizes for acid sensitive fish lakes were 115 ha and 33 ha, respectively, compared to an average size of 313 ha for all Minnesota fish lakes. The total surface area encompassed by sensitive fish lakes was 55,580 ha (13,799 ha and 40,849 ha for extremely and moderately sensitive lakes, respectively). Acid sensitive fish lakes

approximate 6% of the surface area of all Minnesota fish lakes. An individual, alphabetical listing of extremely and moderately sensitive fish lakes and data associated with each is found by county in Appendix C.

While indexed lakes were distributed over 13 counties, 88% by number and 96% by area were located in Cook, Lake, St. Louis and Itasca Counties. These counties contain 44% by number and 24% by area of all Minnesota fish lakes (Peterson 1971). Approximately 30% of the fish lakes contained within this 4 county area have alkalinities of $\leq$ 10 mg/l $CaCO_3$.

Size Distribution

It would be expected that many of the smaller lakes located in the upper reaches of their respective watersheds and/or those lakes having a low ratio of drainage area to lake volume or surface area would contain some of the softest waters. While drainage area ratios to lake volume or surface area is not yet readily available for many Minnesota fish lakes, 57% of the sensitive lakes indexed were $\leq$ 40 ha in size (59% and 56% of extremely and moderately sensitive lakes, respectively). This compares with 12% of the sensitive fish lakes which were in excess of 200 ha (8% and 14% of extremely and moderately sensitive lakes, respectively). These larger lakes, however, constitute 65% of the surface area of sensitive lakes (56% and 71% of extremely and moderately sensitive lakes, respectively). The size distribution of sensitive fish lakes is presented in Fig. 5.

Ecological Classification

The distribution of sensitive fish lakes by ecological classification is found in Fig. 6. Those lakes classified as trout, softwater walleye, centrarchid, northern pike-sucker and unclassified contain 85% and 89% of the extremely and moderately sensitive fish lakes, respectively. The

ecological classification system provides broad guidelines to estimate the general biological communities expected to naturally subsist within a relatively limited number of parameters.

It should also be noted that 37 lakes managed for stream trout are included in the inventory. While 20 of these lakes are classified as trout lakes, 17 retain the ecological classification assigned prior to trout stocking. Those lakes managed for stream trout (rainbow, brook, brown trout and splake) are noted with the abbreviation ST under the ecological classification in Appendix C. The scientific names of all fish species referenced to in this report are included in the prelude to Appendix C. The number and area of sensitive fish lakes by ecological classification are found by county in Appendix D1-D3. The size distribution and median size of fish lakes by ecological classification are found in Appendix D4-D6.

Species Composition

Gill net and trap net data were compiled from the most recent MDNR fisheries survey on each lake to determine the composition of major fish species. This data represents the larger fish species with many smaller species such as cyprinids being poorly represented (Tables 2-4).

The fish species most frequently found in lakes having alkalinities of $\leq$ 10.0 mg/l $CaCO_3$ were northern pike, yellow perch, white sucker, walleye and bluegill. The inland lake species of most concern relative to acidic deposition and the Minnesota sport fishery, based on limited tolerance ranges to increased acidification, are walleye, lake trout, smallmouth bass and rainbow trout. A total of 207 (44%) of the acid sensitive fish lakes contained at least one of these four species. These 207 lakes constitute 61% of the surface area of all sensitive lakes.

When examined by size distribution, 26% of the number and 8% of the area of sensitive lakes containing at least one of these four fish species was ≤ 100 ha. Lakes in these acid sensitive, smaller size categories make up 7% of the number and 0.5% of the area of all Minnesota fish lakes.

Water quality

The water quality data provided in Appendix C is limited to secchi disc readings, pH, total alkalinity and a visual field interpretation of water color. The color interpretations are of limited value alone but in conjunction with the secchi disc readings provide some indication as to water clarity. Secchi disc readings averaged 2.4 m for the 376 lakes which had recorded values (2.4 m and 2.5 m for extremely and moderately sensitive fish lakes, respectively). Peterson and Potthoff (1979) estimated statewide mean secchi disc readings for softwater lakes (≤ 40 mg/l $CaCO_3$) at 2.7 m. A total of 122 (72%) of the extremely sensitive lakes had recorded pH values. Using the most current values for each of these lakes, the average pH was 6.4. Twenty-eight of the extremely sensitive lakes (23%) had a pH of ≤ 6.0.

A total of 228 (72%) of the moderately sensitive lakes had recorded pH values. The average pH, again using only the most recent data, was 6.8. Eight of the moderately sensitive lakes (4%) had a pH ≤ 6.0.

The 350 sensitive lakes having recorded pH values had an average pH of 6.7. Thirty-six lakes (10%) had a pH ≤ 6.0. Statewide mean pH for softwater lakes (≤ 40 mg/l $CaCO_3$) is 7.3 (Peterson and Potthoff 1979).

DISCUSSION

Identification and distribution

The 470 fish lakes currently identified as having alkalinities of ≤ 10.0 mg/l $CaCO_3$ provide a minimal estimate of such lakes in Minnesota.

This number is expected to increase as expanded MDNR monitoring efforts identify lakes on which information is not presently available and/or as historical, colormetrically determined alkalinity values are updated using current techniques. Most lakes on which new information is obtained, however, are expected to be smaller systems ($\leq$ 20 ha) located in areas where restricted accessibility has limited fishing pressure and which may be relatively low on a fisheries management priority basis. Colormetric techniques have tended to provide over-estimates of actual alkalinity values (American Public Health Association et al. 1980), and while lakes may move in or out of the $\leq$ 10.0 mg/l $CaCO_3$ range, a net increase in the number of extremely or moderately sensitive lakes is expected. The magnitude of this increase is uncertain but it would seem realistic to anticipate an additional 50-100 fish lakes being classified as acid sensitive. These additional lakes would result in the percentage of all Minnesota fish lakes classified as acid sensitive increasing from the presently estimated 15% to between 16% and 18%. It should be noted here that some 3,200 lakes are presently managed for their fisheries resources in Minnesota. This does not mean that numerous other lakes do not contain some type of fish species as many do and in some instances provide a sport fisheries.

The relatively small size of these additional lakes is expected to result in an increase of less than 1% of the total area of all Minnesota fish lakes considered acid sensitive. Estimates in this report indicate that approximately 6% of the total area of all Minnesota fish lakes are sensitive to acidic input, proportionate to the estimate of Twaroski et al. (1983) that 5.5% of the total land area of Minnesota contains sensitive aquatic systems.

The location of sensitive fish lakes was generally predictable from the geochemical and geophysical makeup of Minnesota and as such corresponded with the previous modeling efforts of MPCA (Thornton et al. 1982; Twaroski et al. 1983). Most were found in areas of exposed bedrock and shallow, non-calcareous soils. Those identified outside bedrock regions (Twaroski et al. 1983) were primarily associated with moraines, typically being small, high in the watershed, having no inlets and being perched above the regional groundwater system.

While acid sensitive fish lakes may be identified in other areas, Cook, Lake, St. Louis and Itasca counties will undoubtedly remain the primary areas of susceptibility. Only 12% by number and 4% by surface area of sensitive fish lakes were found outside these counties. The geological setting of these counties is reflected in their containing twice the number and four times the surface area of sensitive lakes than might be predicted from the percentage of all Minnesota fish lakes found within their boundaries.

The area encompassed by these counties, in addition to being the most geologically acid sensitive in Minnesota, contains some of the most pristine environments, such as the BWCAW. This area also receives some of the highest levels of acid deposition, having average annual precipitation pH of 4.3-4.6 and sulfate deposition rates of approximately 20 kg/ha/yr (Thornton et al. 1982; Verry 1983). Some studies indicate that pH changes in the most sensitive lakes might occur at sulfate deposition rates of 15 kg/ha/yr and in less sensitive systems at 30 kg/ha/yr (Almer et al. 1978). Caution should be exercised in interpolating this data to Minnesota resources due to inherent differences in geographic regions. Some indication, however, is provided as to levels which might be of concern

for potential adverse biological impact to Minnesota waters.

Aitkin, Carlton, Cook, Koochiching, Lake, St. Louis and Itasca counties compose Minnesota Economic Development Region 3 within which occurs 22% of Minnesota fishing trips (Anthony 1979). Expenditures within this region, therefore, could account for approximatley $110 million of the $515 million spent annually by sport fishermen in Minnesota. With approximately one-third of the lakes in this region acid sensitive, potential economic impacts are the most severe. Additional information and refinement of economic data related to the fishery in this area are needed, particularly pertaining to the contribution of Lake Superior and its North Shore tributaries. Lake Superior, due to its size and relatively hard water (40 mg/$CaCO_3$), is not itself directly susceptible to acidification though it may not be immune to atmospherically deposited substances. Tributaries to the lake, which provide spawning areas for anadromous species and a quality fishery in their own right, may be much more susceptible.

Size distribution

A wide range in size distribution was prevalent for acid sensitive fish lakes. While 57% of these lakes were $\leq$ 40 ha, 12% were in excess of 200 ha. This compares to 73% of all Minnesota lakes (fish lakes and otherwise) which are $\leq$ 40 ha in size (MN Dept. Conservation 1968). The degree of acid susceptibility of the larger systems, which comprise 65% of the area of sensitive lakes, remains somewhat questionable in Minnesota, albeit their very soft waters. There is evidence, however, that such systems may be impacted. Pfieffer and Festa (1980), in a report on the acidity status of lakes in the Adirondack region of New York, indicate that lakes undergoing acidification ranged in size from 15 ha to 2,823 ha.

In perspective, New York lakes, which have acidified since 1974 had an average size of 20 ha. Muniz and Leivistad (1980) found that 62% of Swedish lakes studied which were $\leq$ 100 ha were devoid of fish life. This compared to 36% of lakes $\geq$ 100 ha having no existing fish populations. Again one must use discreton in making interregional comparisons.

Ecological Types

The predominant ecological lake types represented by softwater systems, softwater walleye, trout, centrarchid, northern pike-sucker and unclassified, are not surprising considering classification parameters. One of the general characteristics of northern pike-sucker lakes is total alkalinities of $\leq$ 20.0 mg/l $CaCO_3$ and for trout and softwater walleye lakes $\leq$ 40.0 mg/l $CaCO_3$. Most unclassified lakes in north central and northeastern Minnesota have characteristics and population structures most closely associated with northern pike-sucker lakes. The predominance of sensitive lakes in these ecological types is therefore expected. The reason for the proportionately large number of sensitive centrarchid lakes is not as obvious with general alkalinity values expected to be around 100 mg/l $CaCO_3$. The number of centrarchid lakes having low alkalinities reflects these lakes fitting other parameters more closely than total alkalinity. The ecological classification system provides only broad guidelines by which to fit the general fish community expected to naturally subsist. As with any general classification system, there are lakes which do not comfortably fit into any distinct category and as such are placed in the classification most applicable. There are also infrequent examples of lakes which have apparently been allocated erroneous classifications (i.e. the single hardwater walleye lake). The small number of such cases exerts little influence on generally

interpreting the existing information.

Thirty-seven of the sensitive lakes (8%) were lakes managed for stream trout. These lakes should be regarded independently from other sensitive lakes as 20 were chemically renovated and all are sustained by periodic fingerling or yearling stocking. These sizes of fish are not as susceptible to the effects of acidification as are early life history stages. Such lakes are specifically managed for one or two stream trout species and should be viewed from both a management and ecological standpoint as trout lakes. McKim (1977) found that while brook trout adults were tolerant of pH values of 3.5-4.5, embryos were tolerant of only 4.5-6.5 and fry of 4.4-6.1. The primary concern within these lake types would be the potential effects on sustaining the food web of invertebrates and/or forage fish species which in many cases are more acid sensitive than the managed fish species itself.

Species composition

While the ecological classification scheme provides general guidelines as to expected fish communities, the composition of individual fish species in each lake is of particular interest. The most common species of fish found in sensitive lakes were northern pike (275 lakes) white sucker (272 lakes), yellow perch (270 lakes) and walleye (147 lakes).

The northern pike is a ubiquitous species found within a broad range of physical and chemical environments in Minnesota. Northern pike, along with walleye and panfish, are the game fish species most commonly caught by Minnesota resident anglers (Scidmore and Wroblewski 1973). This species is generally viewed as being moderately sensitive to acidification with natural reproduction occurring at pH values as low as 4.2-5.2

(Beamish et al. 1975; Harvey 1980). Generally they should be able to sustain populations at existing water quality levels.

Yellow perch are among the most acid tolerant species maintaining natural reproduction at pH values of 4.2-4.8 (Beamish et al., 1975; Harvey 1980). Yellow perch are often the most important link between the production of a lake and the well-being of predatory fish species particularly northern pike, walleye and largemouth bass. This species should be able to sustain populations under existing conditions as well.

The walleye, however, is one of the most acid sensitive species, experiencing reproductive problems at pH values of 5.2-6.0 (Beamish et al. 1975; Beamish 1976). Those lakes having natural reproduction, due to the increased susceptibility of early life stages and the desire to maintain indigenous inhabitants, are of particular concern. Most lakes containing walleye have a total alkalinity of > 5.0 mg/l $CaCO_3$ and no evidence of adverse impacts to acidification have yet been documented.

Populations of smallmouth bass were identified in 53 sensitive lakes. Smallmouth bass are acid sensitive, experiencing reproductive difficulties at pH values of 4.4-6.0 (Beamish 1976; Pfieffer and Festa 1980; Harvey 1980). Additional information on the contribution of this species to the fishery, particularly in the northern part of the state, is necessary. Natural reprouction appears to be occurring in lakes having total alkalinities of approximately 2.0 mg/l $CaCO_3$ and again no biological damage has been documented.

Lake trout were found in 27 sensitive lakes. Along with smallmouth bass and walleye, the lake trout is one of the most acid sensitive species, experiencing reproductive problems at pH values of 4.4-6.8 (Harvey 1980) and generally not found in lakes having pH values $\leq$ 6.0).

Four of the acid sensitive populations found in Minnesota are heritage, having no records of supplemental stocking.

In light of species occurrence and acid susceptibility, the major concern regarding the sport fishery of north central and northeastern Minnesota are those naturally reproducing populations of walleye, smallmouth bass and lake trout. While other species may be impacted, particularly through indirect effects on the food web, these three species warrant the most attention in our softwater lakes. Rainbow trout, while a sensitive species, are generally stocked at size ranges not particularly susceptible to existing pH regimes in Minnesota lakes. Much more concern is elicited for this species in North Shore streams which may be the most acid sensitive aquatic systems in Minnesota. It should also be pointed out that though no evidence of acid-related biological damage has been documented, few biological studies have been conducted.

Water quality

The intent of this report is to identify, based on available data, those lakes which might be impacted by acid deposition, not to provide a detailed listing and analysis of water quality parameters within such lakes. As such, the more detailed information which is available on a number of indexed lakes was not tabulated and the reader is referred to computerized data bases such as USEPA STORET. The inclusion of more specific, detailed water quality data will be of increased value upon completion of the extensive monitoring program and subsequent provision of a more comprehensive listing of sensitive fish lakes. It is anticipated that the initial listing provided here would be updated within two years to include such data.

The color of lakes as presented in MDNR lake survey reports, coupled

with secchi disk readings, does allow the formulation of a general picture of water clarity. It would be desirable to measure color in platinum-cobalt units obtained over a relatively narrow time span and from comparable locations.

Some obvious problems arise in attempts to interpret pH data. The temporal and spatial variation in pH alone make many comparisons difficult even without considering differences in methodology. Many values obtained in 1978 and subsequent years were determined using electronic pH meters with the idea of providing values as comparable as possible. These efforts should be sustained to allow the establishment of a meaningful data base.

From data which was available, the average pH of sensitive lakes, 6.66, is substantially higher than vaues found in other sensitive areas, i.e. 4.98 in Florida lakes (Crisman et al. 1980). Thirty-six lakes had pH values of $\leq$ 6.0, a regime where concern for fisheries populations is more acute. Heiskary et al. (1982) found that 9% of spring sampled lakes and 4% of fall sampled lakes in the BWCA had a pH $\leq$ 6.0. In addition to the resulting reproductive problems encountered by such species as walleye, smallmouth bass and lake trout at these low pH values, cyprinids, which in many cases provide the major forage base, are not expected to exist at pH values of $\leq$ 5.4 (Rahel and Magnuson 1980).

Many of the values for total alkalinity have been derived using either fixed end point or Gran plots, techniques which are reasonably comparable. Thornton et al. (1982) used a correction factor of 2.3 mg/l $CaCO_3$ subtracted from historical values to make comparisons with current data more viable. While such an approach is valuable when working with averages, it should be recognized that such factors are not as valid when

looking at individual lakes. This is evident when the data in Appendix C, obtained over a period of years using several techniques, is viewed. Of particular concern are values obtained using the Hach kit, which are of minimal if any value and should as a general rule be discarded from comparative analysis.

SUMMARY

The statewide percentage of Minnesota fish lakes having waters soft enough to be sensitive to acidification may surficially appear relatively small. The geological orientation of these lakes to a small portion of northeastern Minnesota greatly magnifies regional importance. The acid sensitive lakes in these areas alone provide more fishing waters than are contained in many states. Additional lakes identified as acid sensitive are most likely to be within these same areas, increasing their proportion over the current 30%. Many of these new lakes, while not presently major fisheries, do contain game fish, primarily northern pike and centrarchids. We should not lose sight of the immeasurable value of maintaining the environmental integrity of these waters, irregardless of the biological communities they support.

Portions of Minnesota are presently receiving acid deposition at rates near or above levels believed to have caused biological damage in other regions. Minnesota also contains a large number of waters having low enough buffering capacities to be susceptible to sustained acid additions. How comparable the situation in Minnesota is to impacted regions needs clarification due to differences in precipitation, deposition, water quality and watershed composition.

Some degree of optimism is warranted, as no acidified lakes or biological damage resulting from acidification have yet been documented in

Minnesota. The passage of state legislation establishing deposition standards for areas identified as sensitive to acidification and in-state control of emission sources to meet these standards is a major step in the right direction. Enactment of federal legislation, however, will be necessary to adequately address acid deposition in Minnesota due to the large portion (80%) of deposition which originates outside Minnesota state boundaries. Until levels of deposition can be controlled, the potential exists for biological impacts.

Initial impacts from culturally induced acidification may be subtle and the magnitude difficult to ascertain. Such damages may gradually be incurred over a period of several decades before being documented. The importance of expiditious emission controls should be recognized in light of the practical irreversibility of damages which can result. While the need for additional studies to refine our knowledge of acid deposition as it relates to Minnesota is not in doubt, neither is the need, based on existing knowledge, for immediate control of acidic precursors. The following is a list of suggestions for further evaluation of acid deposition in Minnesota:

- Increased emphasis should be placed on cooperative studies among agencies investigating acid deposition in Minnesota. While such ventures are being pursued to some degree, the number and variety of groups engaged in studies should be conducive to more coordinated efforts and perhaps offer a more holistic approach.
- Increased efforts to investigate forage species and reproductive success of game and forage fish species should be made. Standard survey methods are not adequate for such

measurements in many shield lakes, which do not readily lend themselves to shoreline seining or electrofishing.

- More detailed investigations of heavy metals, both body burdens and environmental levels, are necessary. Elevated levels of mercury and aluminum are of particular concern at the present time.
- The hydrology of lakes and streams needs additional investigation with regards to potential acidification.
- Biological studies on streams of the North Shore of Lake Superior should be conducted. These systems may be the most susceptible waters in Minnesota as a result of soft waters and the effects of snowmelt. Reproductive success and survival through smoltification should be evaluated for anadromous species.
- Extensive efforts to gather accurate water quality data on a statewide basis should be pursued to establish solid baseline data. Area fisheries headquarters should be equipped with electronic equipment to acquire such information.

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Table 1. Number, total area and median size of Minnesota fish lakes having total alkalinities of > 0.0 - ≤ 5.0 and > 5.0 - ≤ 10.0 mg/l $CaCO_3$, by county.

County	> 0.0 - ≤ 5.0 mg/l $CaCO_3$			> 5.0 - ≤ 10.0 mg/l $CaCO_3$			Combined		
	No. lakes	Size (ha) Total	Median	No. lakes	Size (ha) Total	Median	No. lakes	Size (ha) Total	Median
Aitkin	4	127	30	3	168	50	7	295	43
Anoka	0	0	0	2	9	5	2	9	5
Carlton	4	132	34	4	321	43	8	453	43
Cass	6	104	10	7	169	19	13	292	15
Clearwater	0	0	0	1	26	26	1	26	26
Cook	15	2,324	64	114	11,059	31	129	13,383	36
Crow Wing	1	37	37	6	246	30	7	283	33
Itasca	33	627	13	46	1,150	13	79	2,699	13
Kanabec	4	184	30	4	86	24	8	270	26
Lake	17	1,785	34	62	10,736	57	79	12,512	76
Morrison	1	28	28	0	0	0	1	28	28
Pine	7	107	10	5	111	19	12	218	15
St. Louis	63	8,344	50	61	11,768	47	124	25,112	49
TOTALS	155	13,799	33	315	40,849		470	55,580	33

Table 2. Fish species, determined from gill and trap netting data, found in Minnesota fish lakes having total alkalinities of >0.0 - ≤ 5.0 mg/l $CaCO_3$.

County	No. fish lakes per county >0.0 - ≤5.0 mg/l $CaCO_3$	Number of fish lakes containing each species																												
		Bowfin	Northern cisco	Lake Whitefish	Coho salmon	Rainbow trout	Brown trout	Brook trout	Lake trout	Splake	Northern pike	Muskellunge	Golden shiner	Fathead minnow	White sucker	Yellow bullhead	Black bullhead	Brown bullhead	Burbot	Rock bass	Green sunfish	Pumpkinseed	Bluegill	Smallmouth bass	Largemouth bass	Black crappie	Yellow perch	Walleye	None recorded
Aitkin	4										3					1		1	1	1		1	1		1	1	3		
Anoka	0										0																			
Carlton	4										4				3		1					2	2		2	4	4	2	
Cass	6	1				1		2			1		1					1				1	1		1		2		
Clearwater	0																													
Cook	15		1	1		2	2	1	3		7	1		1	13				3		1	1		2			5	5	1
Crow Wing	1										1					1		1				1	1		1	1	1		
Itasca	33					1					11		2	1	8	1	2	1		3	1	7	11	2	17	9	15	4	2
Kanabec	4										3					1	2	1				1	3		2	2	2		1
Lake	17		2			1		4			9		1	2	11					7	2	2	3	1		1	10	8	
Morrison	1																													
Pine	7										4		3	1	3	1	4	4		1	1	3	4		3	3	6	1	7
St. Louis	63	—	11	1	2	4	—	1	1	—	41	—	—	4	45	—	2	1	2	18	4	8	15	12	8	10	45	23	—
TOTALS	155	1	14	2	2	9	2	8	4	0	84	1	7	9	83	5	11	9	6	30	9	27	41	17	35	31	93	43	11

Table 3. Fish species, determined from gill and trap netting data, found in Minnesota fish lakes having total alkalinities of > 5.0 - ≤ 10.0 mg/l $CaCO_3$.

County	No. fish lakes per county > 5.0 - ≤ 10.0 mg/l $CaCO_3$	Number of fish lakes containing each species																												
		Bowfin	Northern cisco	Lake Whitefish	Coho salmon	Rainbow trout	Brown trout	Brook trout	Lake trout	Splake	Northern pike	Muskellunge	Golden shiner	Fathead minnow	White sucker	Yellow bullhead	Black bullhead	Brown bullhead	Burbot	Rock bass	Green sunfish	Pumpkinseed	Bluegill	Smallmouth bass	Largemouth bass	Black crappie	Yellow perch	Walleye	None recorded
Aitkin	3	1									2						2					2	2	1		2	2	1	1
Anoka	2																												1
Carlton	4	1									4				1		3			1		2	3		1	3	4	2	
Cass	7										2				1	1	1	1			1	2	2		1	2	2	1	1
Clearwater	1										1									1		1	1				1	1	
Cook	114		6	3	1	3		8	15	1	70	1	4		86				9	1	2	7		11	1		61	34	16
Crow Wing	6					1					2		2		2	1	1	1				2	1		2	2	2	1	1
Itasca	46	1	1			4	1	1			16				12	2	2	3		2		9	13	4	20	10	15	6	11
Kanabec	4										1										1	2	1		2	1	1		1
Lake	62		21	13			1	1	4		48		3	3	49				2	29		1	13		2	7	44	38	6
Morrison																													
Pine	5										4		1		2	2	4	4				4	2		3	2	4	1	
St. Louis	61		15	4		6		2	4		41		3	1	36			3	7	16		12	13	6	4	13	41	19	4
TOTALS	315	3	43	20	1	14	2	12	23	1	191	1	13	4	189	7	13	13	18	50	4	44	51	36	42	42	177	104	43

Table 4. Fish species, determined from gill and trap netting data, found in Minnesota fish lakes having total alkalinities of 0.0 - ≤10.0 mg/l $CaCO_3$.

County	No. fish lakes per county ≤ 10.0 mg/l $CaCO_3$	Number of fish lakes containing each species																												
		Bowfin	Northern cisco	Lake Whitefish	Coho salmon	Rainbow trout	Brown trout	Brook trout	Lake trout	Splake	Northern pike	Muskellunge	Golden shiner	Fathead minnow	White sucker	Yellow bullhead	Black bullhead	Brown bullhead	Burbot	Rock bass	Green sunfish	Pumpkinseed	Bluegill	Smallmouth bass	Largemouth bass	Black crappie	Yellow perch	Walleye	None recorded
Aitkin	7	1						2			5					2	2	2	1	1		3	3	1	1	3	5	1	1
Anoka	2																												2
Carlton	8	1									8				4		4			1		4	5		3	7	8	4	
Cass	13	1				1					3		1		1	1	1	2			1	3	3		2	2	1	1	1
Clearwater	1										1									1		1	1				1	1	
Cook	129		7	4	1	5	2	9	18	1	77	2	4	1	99				12	1	3	8		13	1		66	39	17
Crow Wing	7								1		3				2	2	1	1				3	2		3	3	3	1	1
Itasca	79	1	1			5	1	1			27		2	1	20	3	4	4		5	2	16	24	6	37	19	30	10	13
Kanabec	8										4					1	2	1				3	4		4	3	3		2
Lake	79		23	13		1	1	5	4		57		4	5	60				2	35	2	3	16	8	2	8	54	46	6
Morrison	1																												
Pine	12										8		4	1	5	3	8	8		1	1	7	6	1	6	5	10	2	
St. Louis	124		26	5	2	10		3	5		82		3	5	81		2	4	9	34	4	20	28	24	12	23	86	42	11
TOTALS	470	4	57	22	3	22	4	20	28	1	275	2	18	13	272	12	24	22	24	79	13	71	92	53	71	73	270	147	54

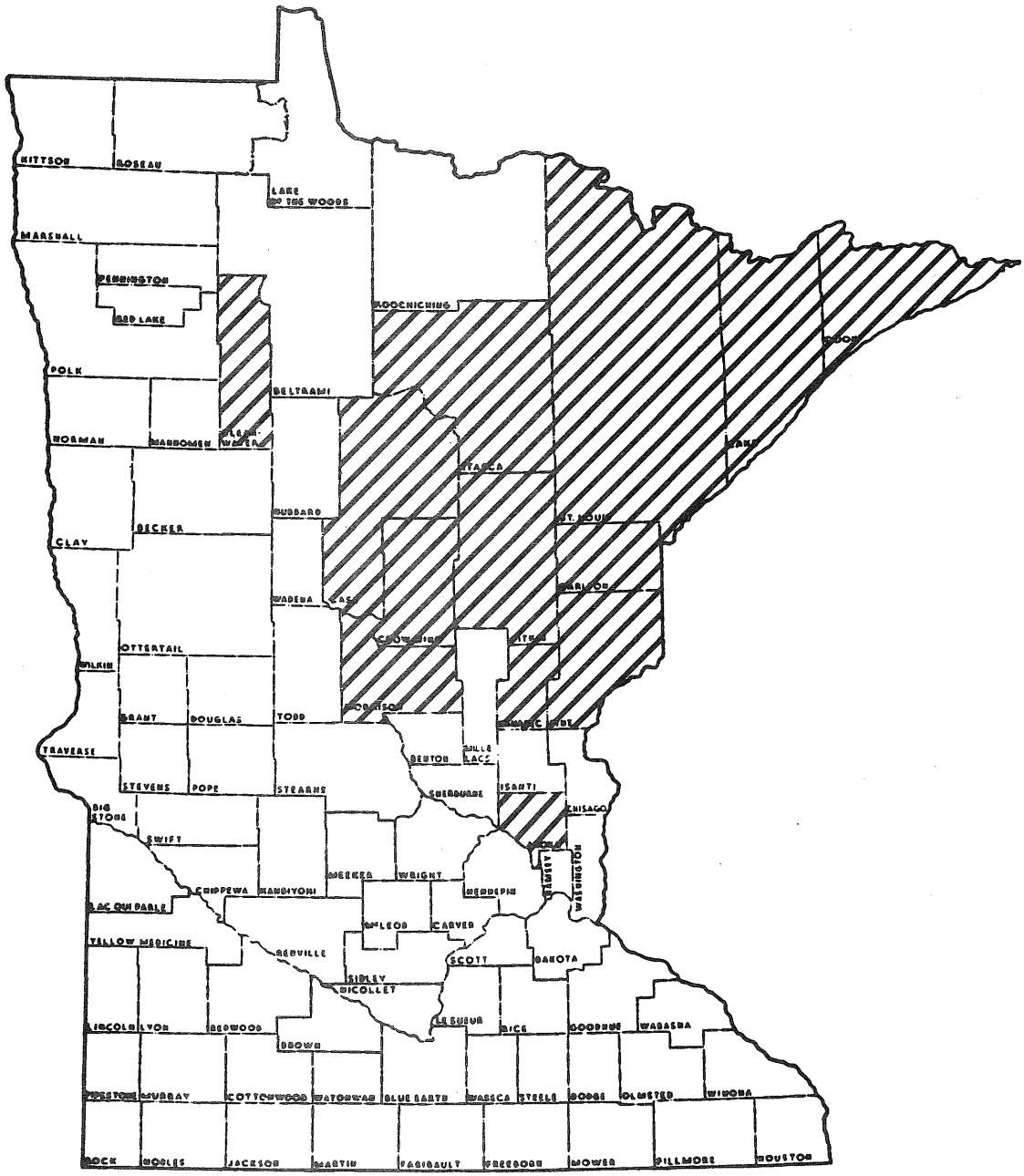

Figure 1. Minnesota counties containing at least one fish lake having a total alkalinity of $\leq$ 10.0 mg/l.

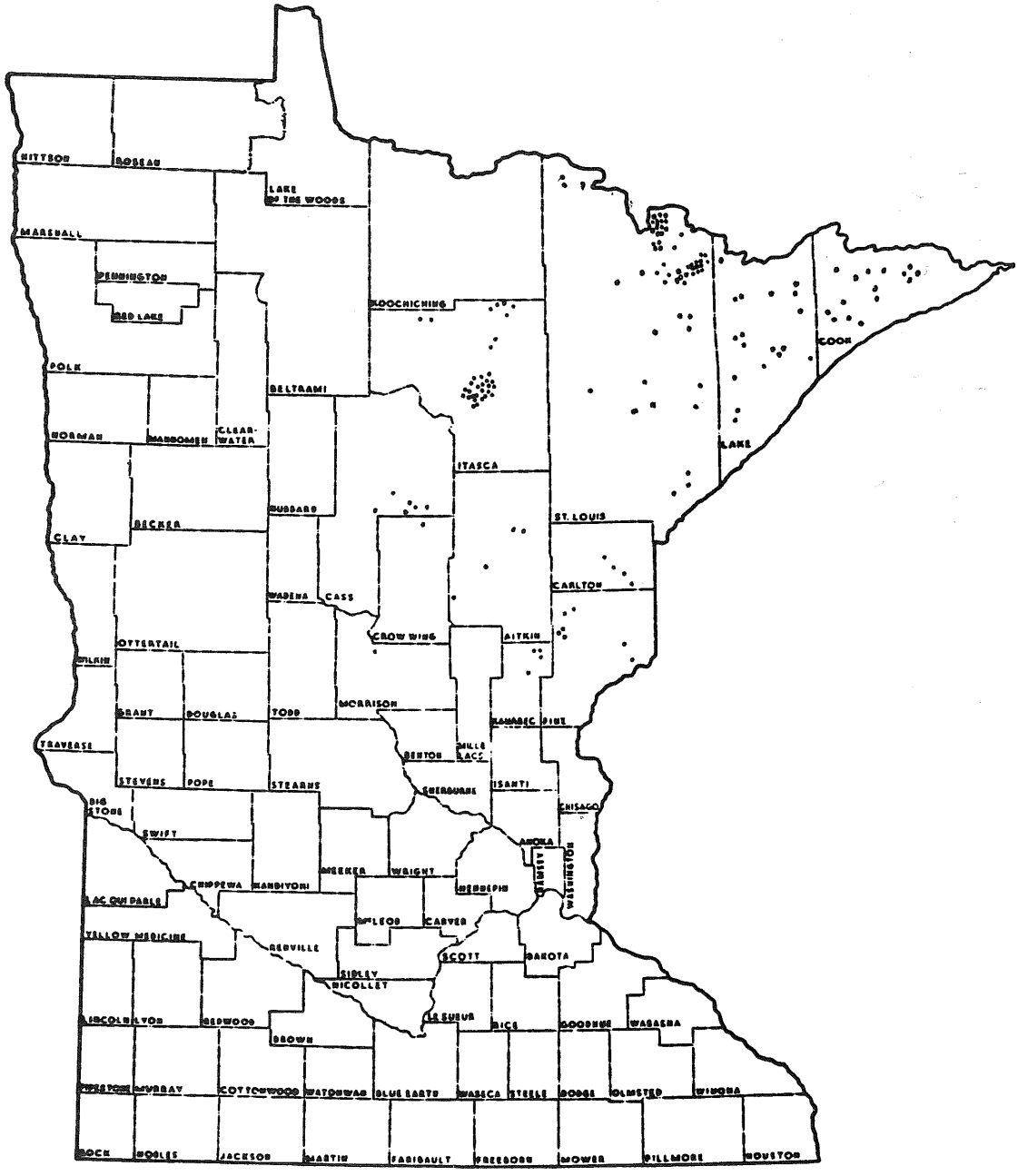

Figure 2. Approximate locations of Minnesota fish lakes having total alkalinities of $> 0.0 - \leq 5.0$ mg/l $CaCO_3$.

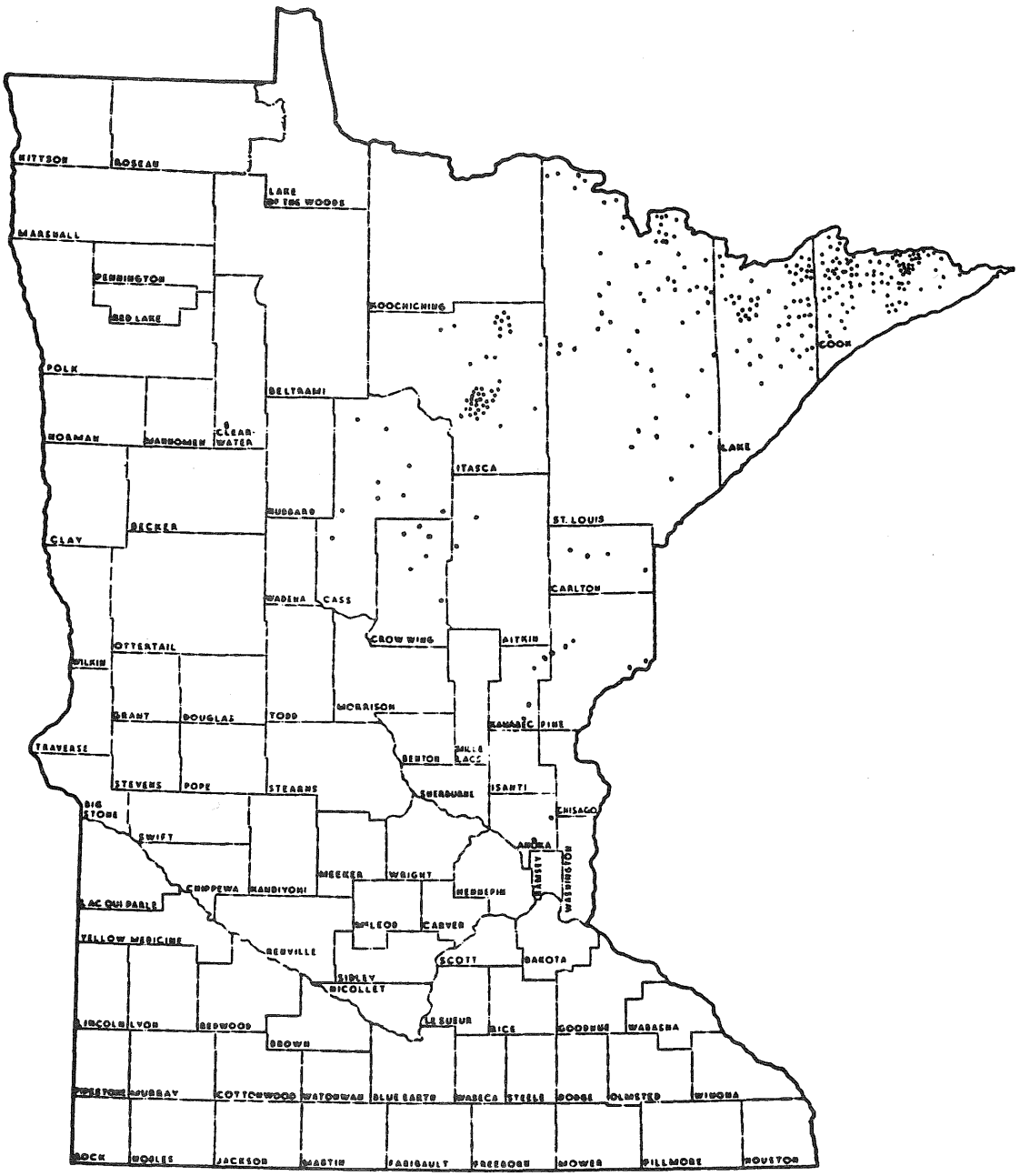

Figure 3. Approximate locations of Minnesota fish lakes having total alkalinities of $> 5.0 - \leq 10.0$ mg/l $CaCO_3$.

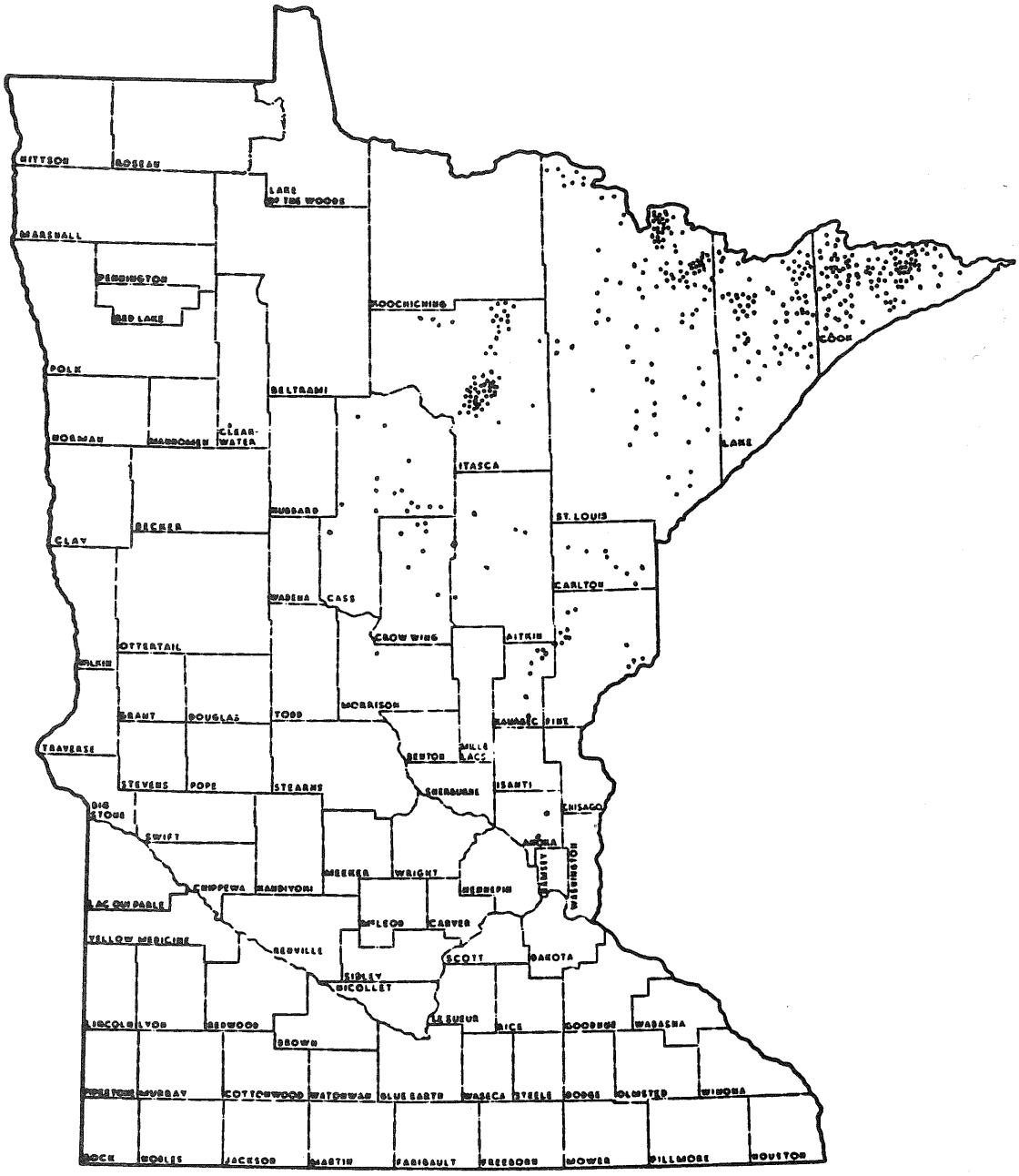

Figure 4. Approximate locations of Minnesota fish lakes having total alkalinities of $\leq$ 10.0 mg/l $CaCO_3$.

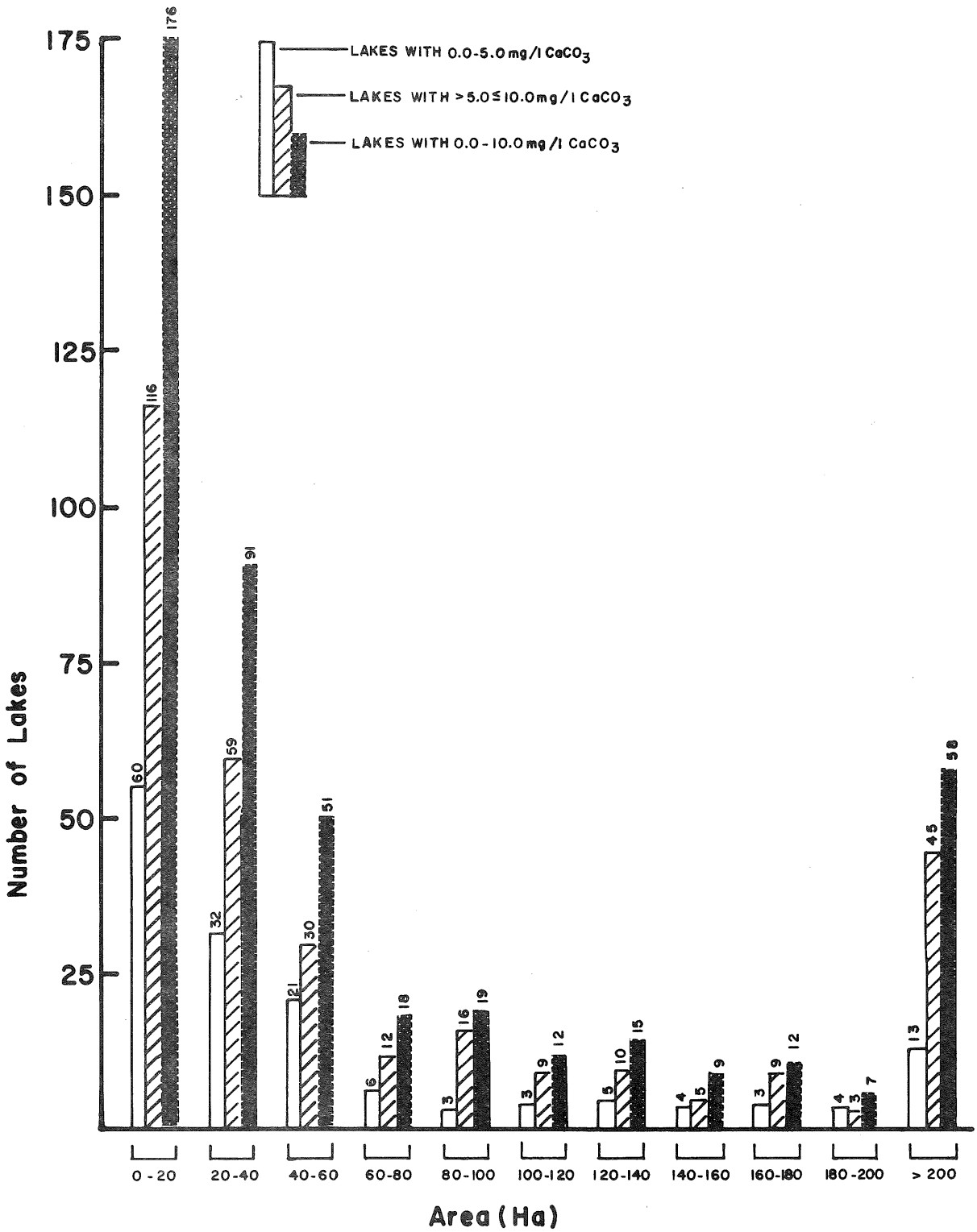

Figure 5. Size distribution of Minnesota fish lakes having total alkalinities of $\leq$ 10.0 mg/l $CaCO_3$.

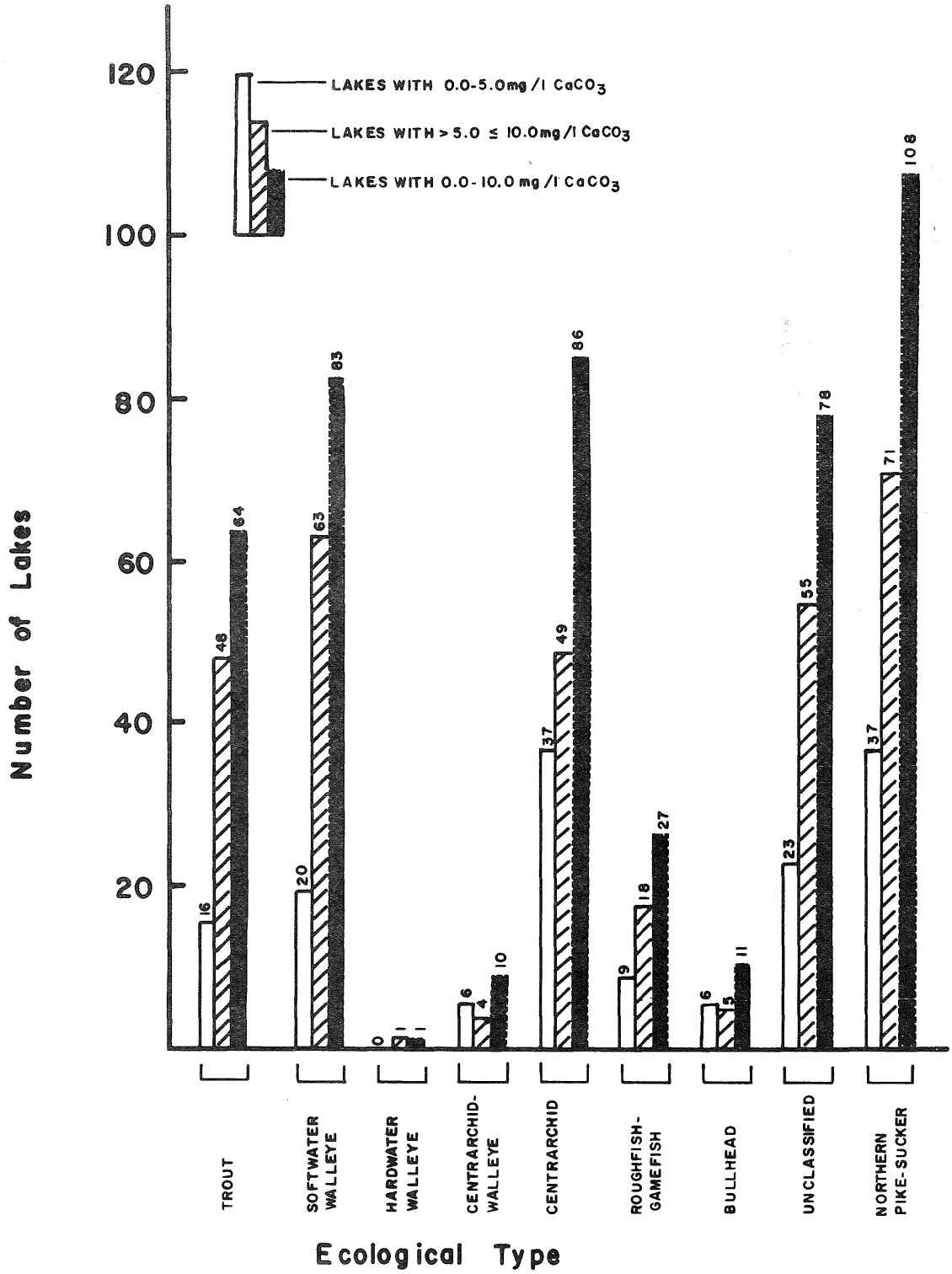

Figure 6. Number of Minnesota fish lakes having total alkalinities of $\leq$ 10.0 mg/l $CaCO_3$ by ecological classification.

APPENDIX

Appendix A. Minnesota classification system for ranking lake susceptibility to acidification (Thornton et al. 1982).

ACIDIFIED LAKES - Lakes with alkalinity values < 0.0 are considered to be acidified. The pH of an acidified lake is typically < 5.0 and such lakes will have severely stressed fish populations. Many species may be absent or in extreme cases the lake may be completely without fish. Acidified lakes will be very clear. Many other aquatic organisms suich as mollusks, snails, amphibians and insects may be absent.

NATURALLY ACIDIC - Highly "colored" lakes may be naturally acidic due to the presence of natural organic acids that are produced in bogs, fens and peatlands. These organic acids are responsible for the tea-stained color in such lakes. In the absence of reliable historical data, colored lakes (> 20 ptu) with alkalinity value $\leq$ 0.0 are classified as naturally acidic to indicate that their current condition may be natural. However, colored lakes are not immune to the effects of acid deposition. Colored lakes that have a measurable alkalinity are highly sensitive to additional acid inputs.

EXTREMELY SENSITIVE - Lakes with alkalinity values > 0.0 but $\leq$ 5.0 mg/l as $CaCO_3$ (100 ueq/l) are considered to be extremely sensitive. The pH and chemical content of these lakes is probably healthy enough to support aquatic species indigenous to the lake. Such lakes will likely lose their alkalinities and become acidified with continued or increased acid loadings. Eposodic pH depression may occur during snowmelt which could lead to stressed fish populations, and in extreme cases, missing year classes.

MODERATELY SENSITIVE - Moderately sensitive lakes have alkalinity values > 5.0 but $\leq$ 10.0 mg/l as $CaCO_3$ (200 ueq/l). Some moderately sensitive lakes will likely be affected by continued long-term acidic deposition at current or increased levels. Some snowmelt problems may occur in these lakes but aquatic species are generally at less risk than in extremely sensitive lakes.

POTENTIALLY SENSITIVE - These lakes have alkalinity values > 10.0 but $\leq$ 20.0 mg/l (400 ueq/l). Certain of these lakes may be affected by long-term deposition at current levels but most may not show any effects unless acid loadings increase in the future.

NON-SENSITIVE - These lakes have alkalinity values > 20.0 mg/l and are thought to contain enough buffering capacity to neutralize acidic deposition for an indefinite period of time.

Appendix B. General physical and chemical characteristics of Minnesota fish lakes by ecological classification. [a]

	Ecological Classification							
	Trout	Softwater walleye	Hardwater walleye	Centrachid-walleye	Centrachid	Roughfish-gamefish	Bullhead	Northern pike-Sucker
Shoal bottom type (%)								
Bedrock boulder	30-100	30-100	---	---	---	---	---	---
Gravel-sand	20	20	90	75	75	80	30	variable
Organic	10	20	10	25	25	20	70-100	variable
Littoral area (%)	15-20	15-20	25-35	25-50	25-50	35-70	75-100	variable
Dissolved oxygen (mg/l below thermocline)	5	may be absent	may be absent	may be absent	usually absent	may be unstratified	usually unstratified	may be unstratified
Maximum epilimnetic temperature (C)	21	21	24	27	27	29	29	27
Total alkalinity (mg/l $CaCO_3$)	40	40	100	100	100	100	100	20
Total phosphorus (mg/l)	0.020	0.025	0.030	0.050	0.050	0.050	0.100	0.050
Typical size (ha)	15 (stream trout) 400 (lake trout)	400	400	240	120	variable	variable	usually <60, up to 200
Typical maximum depth (m)	20	15	10	8	8	variable	6	variable

[a] After Scidmore 1970.

Appendix C. Compilation of individual lake data for Minnesota fish lakes having total alkalinities of 0.0 - $\leq$ 5.0 mg/l $CaCO_3$ and > 5.0 $\leq$ 10.0 mg/l $CaCO_3$, respectively, listed alphabetically and by county.

Abbreviations and sources:

DOW No. - identification number provided for each lake in "An Inventory of Minnesota Lakes," Minnesota Department of Conservation Bulletin No. 25 (referenced in Literature Cited Section).

Ecol. Type (Ecological Classification) -

Trout	- T
Softwater walleye	- SW
Hardwater walleye	- HW
Centrarchid-walleye	- CW
Centrarchid	- C
Roughfish-gamefish	- RG
Bullhead	- BH
Northern pike-sucker	- NPS
Unclassified	- U
Stocked	- ST

Dates: Sp - spring

Sm - summer

Fl - fall

Wt - winter

(e.g. SP 81 - sample taken in spring, 1981).

Method (total alkalinity measurements):

Field - MDNR field survey (colorometric)

PM - potentionmetric titration

LMIC - data from Land Management Information Center

Lab - MDNR laboratory analysis

Hach - MDNR field survey (Hach kit pillows)

Fish species (abbreviations and scientific names):

Bowfin	*Amia calva*	BON
Northern ciscoe	*Coregonus artedii*	NCS
Lake whitefish	*Coregonus clupeaformis*	LWF
Coho salmon	*Oncorhynchus kisutch*	COS
Rainbow trout	*Salmo gairdneri*	RBT
Brown trout	*Salmo trutta*	BNT
Brook trout	*Salvelinus fontinalis*	BKT
Lake trout	*Salvelinus namaycush*	LAT
Splake	Lake trout X brook trout	SPK
Rainbow smelt	*Osmerus mordax*	RBS
Central mudminnow	*Umbra limi*	CMM
Northern pike	*Esox lucius*	NOP
Muskellunge	*Esox masquinongy*	MUE
Emerald shiner	*Notropis atherinoides*	EMS
Common shiner	*Notropis cornutus*	CSH
Golden shiner	*Notemigonus crysoleucas*	GLS
Fathead minnow	*Pimephales promelas*	FHM
Dace	_____	DAC
Creek chub	*Semotilus atromaculatus*	CRC
Longnose sucker	*Catostomus catostomus*	LNS
White sucker	*Catostomus commersoni*	WHS
Silver redhorse	*Moxostoma aniserum*	SRH
Northern redhorse	*Moxostoma macrolepidotum*	NRH
Yellow bullhead	*Ictalurus natalis*	YEB
Black bullhead	*Ictalurus melas*	BLB

Brown bullhead	*Ictalurus nebulosis*	BRB
Tadpole madtom	*Noturus gyrinus*	TMT
Burbot	*Lota lota*	BUR
Rock bass	*Ambloplites rupestris*	RKB
Green sunfish	*Lepomis cyanellus*	GSF
Pumpkinseed	*Lepomis gibbosus*	PSF
Bluegill	*Lepomis macrochirus*	BLG
Smallmouth bass	*Micropterus dolomieui*	SMB
Largemouth bass	*Micropterus salmoides*	LMB
Black crappie	*Pomoxis nigromaculatus*	BLC
Yellow perch	*Perca flavescens*	YEP
Walleye	*Stizostedion vitreum*	WAE
Darters		DAR
No fish or data		NONE

Aitkin County
0.0 - ≤ 5.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Long	01-101	16.2	RG	Yes	1.7	Brown		2.5	Field	1971	NOP,YEP,LMB,BRB
Remote	01-038	54.6	CW	No	2.8	Brown	6.3(Sp81)	1.2 3.2	Field PM	1971 1981	NOP,YEP,BLC,BLG, PSF,YEB,BUR
Spectacle	01-156	43.3	RG	No	0.5	Brown		8.0 4.6	Field PM	1968 1981	Cyprinids
Townline	01-024	13.0	NPS (ST)	Yes	3.7	Clear	6.7(Sp81)	8.0 4.6	Lab PM	1970 1981	NOP,YEP,RKB,RBT

Aitkin County
> 5 - ≤ 10.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Buss (Bass)	01-195	49.8	C	No	1.2	Brown		12.5 10.0	Field Lab	1978 1978	NOP,YEP,SMB,BLC,BLG, PSF,BLB,BRB,BON
Moulton	01-212	114.1	CW	Yes	1.2	Brown		15.0 25.0 12.5 20.0 6.8	Field Field Field Lab PM	1951 1968 1979 1979 1981	NOP,YEP,WAE,BLC,BLG, PSF,BLB,YEB
Schoolhouse	01-216	4.1	C	No	2.6	Brown-green	6.7(Sp81)	10.0	Field	1956	No data

Anoka County
> 5.0 - ≤ 10.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Kirkpatrick	02-046	4.9	RG	No	0.9	Clear		7.5	Field	1952	None recorded
Twin, West	02-033	4.1	RG	No	0.9	Clear		5.5	Field	1956	None recorded

Carlton County
0.0 - ≤ 5.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Graham	09-003	18.6	C	Yes				4.0	LMIC	----	NOP,YEP,WHS,WAE,LMB, BLC,BLG,PSF,BLB
Munson	09-019	14.6	NPS	No	0.9	Brown	6.0(74)	34.2	Field	1974	NOP,YEP,WHS,BLC
								2.0	LMIC	----	
Sandy	09-016	49.8	C	No	2.0	Brown		17.5	Field	1959	NOP,YEP,WAE,BLC
							6.8(Sm80)	2.5	PM	Sm80	
							6.6(F180)	4.8	PM	F180	
Torchlight	09-025	49.0	C	No	1.7	Orange-brown		5.0	Field	1957	NOP,YEP,WHS,LMB,BLC BLG,PSF

Carlton County
> 5.0 - ≤ 10.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Big	09-032	229.1	C	Yes	2.1	Clear	7.4(Sm82)	12.0	Field	1956	NOP,YEP,WHS,WAE,LMB,
								20.0	Field	1967	BLB,BLC,BLG,PSF
								12.4	PM	F180	
								10.0	PM	Sm82	
Cross	09-062	44.5	C	Yes	0.9	Brown		10.0	Field	1957	NOP,YEP,WAE,BLC,BLG, PSF,RKB,BLB,BON
Hay	09-010	41.7	C	Yes	2.4	Brown		12.5	Field	1955	NOP,YEP,BLC,BLG,BLB
								10.0	LMIC	----	
Spruce	09-054	5.7	U	No	0.9	Brown	4.6(68)	8.6	Hach	1968	NOP,YEP

Cass County
0.0 - ≤ 5.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Margaret	11-045	7.3	C (ST)	Yes	4.6	Brown		10.0 4.5	Field PM	1956 Sm80	RBT
Marion	11-046	5.3	C (ST)	Yes	1.2	Clear		10.0 5.3 4.9	Field PM PM	1955 Sm80 Wt82	BKT
Pavelgrit	11-055	8.1	C	No	2.1	Brown	6.6(81)	12.0 15.0 3.5 4.0	Field Field PM PM	1956 1981 Sm80 F180	YEP,GLS
Snowshoe (L. Andrus)	11-054	11.3	C (ST)	Yes	5.2	Clear	6.0(83)	56.3 3.0 4.0 4.5	Field PM PM PM	1956 Sm80 Sp81 Wt82	BKT
Stevens	11-116	57.5	C	No	3.4	Brown		12.5 4.0 7.7	Field PM PM	1968 Sp81 Sm82	NOP,YEP,LMB,BLG,PSF, BRB,BON,EMS
Twin, Little	11-253	14.6	RG	No	1.8	Brown		5.0 5.0	Field PM	1966 Sp81	Cyprinids

Cass County
>5.0 - ≤ 10.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Carnahan	11-188	11.7	U	Yes				8.0		1980	No data
Egg	11-005	47.0	C	No	1.7	Clear		10.8	Field	1968	NOP,YEP,LMB,BLC,BLG, PSF,BLB,BRB
Goose (Berg Keller)	11-447	15.0	RG	Yes	1.5			10.0	Field	1965	Cyprinids
Green	11-091	18.6	BH	No	1.8	Brown		6.0	PM	1980	Cyprinids

Cass County
> 5.0 - ≤ 10.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Long	11-395	25.9	C	No	2.4	Brown		10.0 8.0	Field PM	1979 Sp81	NOP,YEP,LMB,BLG,PSF
Squeedunk	11-266	5.7	C	No	2.7	Clear		10.0	Field	1955	
Twenty-Six	11-117	45.3	C	No	1.2	Brown		10.0	Field	1968	NOP,YEP,WHS,WAE,BLC, BLG,PSF,GSF,YEB

Clearwater County
> 5.0 - ≤ 10.0 mg/l

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Glanders	15-070	25.5	C	Yes	4.0	Clear		10.0	Field	1940	NOP,YEP,WAE,BLG,PSF

Cook County
0.0 - ≤ 5.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Babble	16-257	9.3	BH	No	1.2	Yellow	5.3(72) 7.0(Sm80)	9.0 2.0	Field PM	1972 Sm80	None
Barto	16-701	50.6	NPS	No	2.0	Yellow	6.7(Sp81)	7.5 4.0	Field PM	1966 Sp81	WHS,GSF,FHM,CRC,DAR
Bouder	16-383	56.7	SW	Yes	1.4	Brown	7.7(Sm80)	10.5 4.0	Field PM	1960 Sm80	YEP,WHS,WAE,MUE
Chester	16-033	20.2	T (ST)	Yes	3.4	Brown	6.9(80)	10.0 3.5	Field PM	1953 Sm80	WHS,BNT,RBS
Cone, North	16-412	36.4	T	Yes	3.4	Yellow-brown	6.7(Sp81)	13.7 2.5	Hach PM	1971 Sp81	NOP,YEP,WHS,WAE,SMB, BUR
Davis	16-435	155.4	T	Yes				3.0	PM	Sp81	NOP,WHS,BUR

Cook County
0.0 - ≤ 5.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Devilfish	16-029	168.8	T	Yes	3.7	Brown	6.6(Sm80) 6.6(Sp81)	7.5 2.0 2.5	Field PM PM	1955 Sm80 Sp81	WHS,WAE,LAT,RBS
Esther	16-023	31.2	T (ST)	Yes	2.4	Brown	6.7(Sm80)	7.5 3.0	Field PM	1956 Sm80	WHS,BKT,RBT,BNT
Grace	16-657	193.8	SW	Yes	1.8	Brown	6.8(72) 6.6(Sp81)	10.0 27.9 2.0	Field Field PM	1963 1972 Sp81	NOP,YEP,WHS,WAE
Greenwood	16-077	841.0	T	Yes	7.4	Green	7.0(77) 7.0(Sp81)	10.0 10.0 2.0	Field Field PM	1955 1977 Sp81	YEP,WHS,WAE,GSF,LAT, LWF,NCS,CRC
Gust	16-380	64.4	NPS	Yes	0.9	Brown	8.0(Sm80)	7.5 5.0 5.0	Field PM PM	1960 Sm80 F180	NOP,YEP,WHS,WAE,PSF
Leo	16-198	46.1	CW (ST)	Yes	4.3	Brown- green	8.0(Sm80) 6.9(F180)	12.5 5.0 7.6	Field PM PM	1957 Sm80 F180	SMB,RBT
Long Island	16-460	393.0	U				6.7 (Sp81)	5.0	PM	Sp81	NOP,LAT
Pipe	16-375	129.1	SW	No	4.0	Green	6.8(75) 7.2(Sp81)	6.8 5.0	Hach PM	1975 Sp81	NOP,YEP,WHS
Rush	16-299	127.9	U				7.0(Sp81)	5.0	PM	Sp81	NOP,WHS,BUR

Cook County
> 5.0 - ≤ 10.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Ada	16-515	11.3	NPS	No	2.7	Brown	6.8(75)	6.8	Hach	1975	NOP,WHS
Alder	16-114	138.4	T	Yes	4.9	Clear	7.0(81)	17.1 8.2	Hach PM	1969 Sp81	NOP,YEP,WHS,WAE,SMB, GSF,LAT
Alton	16-622	435.5	T	Yes	4.6	Clear	7.1(80) 7.4(81)	26.3 21.0 8.0	Field Field PM	1956 1980 Sp80	NOP,YEP,WHS,WAE,SMB, LAT,BUR,TUL

Cook County
> 5.0 - ≤ 10.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Baker	16-486	8.9	SW	Yes	1.5	Brown	6.6(80)	13.7 6.8	Hach PM	1970 F180	NOP,YEP,WHS
Ball Club	16-182	93.5	SW	Yes	2.6	Yellow-brown	6.5(80) 7.2(81)	21.0 5.2 8.0	Field PM PM	1969 F180 Sp81	NOP,YEP,WHS
Bat	16-752	36.8	T	Yes	5.3	Green		20.5 9.6	Hach PM	1980 Sp81	WHS
Bean, South	16-073	7.3	NPS	No	2.1	Brown	6.8(76)	6.8	Hach	1976	WHS
Bearskin, E.	16-146	260.2	T	Yes	3.4	Brown	6.9(80)	20.0 15.0 15.0 8.0	Field Field Field PM	1948 1956 1964 F180	NOP,YEP,WHS,WAE,SMB, LMB
Bench	16-063	11.3	NPS (ST)	Yes	2.3	Brown-green		6.8	Hach	1975	None
Beth	16-659	75.3	NPS	Yes	3.0	Green		7.5	Field	1963	NOP,YEP,WHS
Blueberry	16-151	7.7	U	No	1.5	Brown		6.8	Hach	1975	None
Bow	16-211	12.1	C	Yes	1.2	Yellow		6.8	Hach	1974	NOP,YEP,WHS,WAE,PSF
Brule	16-348	2106.0	T	Yes	6.6		7.0(77) 6.5(80) 7.1(81)	12.5 10.0 6.0 5.2	Field Field PM PM	1954 1977 F180 Sp81	NOP,YEP,WHS,WAE,SMB, LAT,NCS
Burnt	16-477	160.3	SW	No	1.4	Orange-brown	6.7(73) 7.0(81)	13.7 9.2	Hach PM	1973 Sp81	NOP,YEP,WHS,WAE
Cascade	16-346	216.1	SW	Yes	2.1	Clear	6.8(80)	21.0 5.6	Hach PM	1969 F180	NOP,YEP,WHS,WAE
Cascade, L.	16-347	123.8	SW	No	1.7	Yellow-green	7.1(81)	13.7 5.5	Hach PM	1970 Sp81	NOP,YEP,WHS
Clam	16-518	27.1	NPS	No	2.6	Brown	6.8(75)	6.8	Hach	1975	NOP,WHS
Cow	16-271	18.6	T	No	3.6	Brown		10.0	Field	1974	YEP
Crescent	16-454	338.3	SW	Yes	2.4	Yellow-green	7.3(77) 6.5(80)	13.7 6.0	Hach PM	1977 F180	NOP,YEP,WHS,WAE,MUE

Cook County
> 5.0 - ≤ 10.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Crow	16-287	21.0	NPS	No	0.9	Brown	6.8(76)	6.8	Hach	1976	NOP,YEP,WHS,WAE
Crystal	16-090	85.0	T	Yes				9.6	PM	Sp81	NOP,YEP,WHS,WAE,SMB, LAT
Dawkins	16-457	31.2	NPS	Yes	1.4	Green-brown	6.8(79)	6.8	Hach	1979	NOP,YEP,WHS,WAE
Digit	16-152	8.9	U	No	1.5	Brown	6.8(75)	6.8	Hach	1975	None
Eagle	16-288	36.0	NPS	No	1.2	Brown		6.8	Hach	1976	NOP,YEP,WHS,WAE
Edith	16-604	4.1	NPS	No	2.6	Green-brown	6.8(79)	6.7	Hach	1979	NOP,YEP,WHS
Elbow	16-805	164.3	NPS	No	1.5	Brown	7.0(73) 6.8(80)	27.0 9.8	Field PM	1970 1980	NOP,YEP,WHS
Elbow	16-096	168.0	NPS	Yes	0.9	Red-brown	7.1(81)	7.5 6.0	Field PM	1960 Sp81	NOP,YEP,WHS,WAE
Ella	16-658	24.3	NPS	No	1.5			7.5	Field	1963	NOP,YEP,WHS
Fag	16-212	4.1	U	No	0.6	Brown	6.8(75)	6.8	Hach	1975	YEP,WHS
Fault	16-040	24.7	NPS	No	0.8	Brown	6.5(80)	6.0	Field	1980	WHS,GLS
Gabimichigame	16-811	318.9	T	Yes			6.8(81)	8.2	PM	Sp81	YEP,WHS,LAT,BUR
Gaskin	16-319	182.5	T	Yes			6.9(78)	7.4	PM	1978	NOP,LAT
Gillis	16-753	284.5	T	No	6.4	Clear	6.5(80) 7.0(81)	20.5 9.4	Hach PM	1980 Sp81	YEP,WHS,LAT,BUR
Glenn	16-209	11.7	NPS	No	1.5	Orange	6.7(74)	6.8	Hach	1974	NOP,WHS
Green	16-628	18.2	NPS	No	4.1	Green	7.2(80) 7.3(F179)	20.5 8.5	Hach PM	1980 F179	WHS,CRC
Gulf	16-631	14.2	NPS	No	2.3	Brown	6.8(75)	6.8	Hach	1975	NOP,YEP,WHS,PSF
Ham	16-608	53.8	SW	No	2.9	Yellow-brown	7.4(81)	13.7 5.6	Hach PM	1970 Sp81	WHS,CSH,NOP,YEP,WAE, BUR
Hand	16-238	38.5	RG	No	2.7	Yellow		6.8	Hach	1970	None

Cook County
> 5.0 - ≤ 10.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Handle	16-522	6.1	NPS	No	2.1	Brown	6.8(75)	6.8	Hach	1975	NOP,YEP,WHS
Hilly	16-377	13.0	NPS	No	2.1	Yellow	6.8(74)	6.8	Hach	1974	NOP
Hog	16-653	82.2	NPS	No	1.4	Clear		7.5	Field	1966	NOP,YEP,WHS,DAR
Homer	16-406	208.8	SW	Yes	2.1	Yellow	6.8(80) 7.0(81)	6.8 6.6 6.0	Hach PM PM	1970 F180 Sp81	NOP,YEP,WHS,WAE
Iron	16-328	55.8	SW	Yes	0.6	Green-brown	6.6(80)	17.5 10.0	Field PM	1980 F180	NOP,YEP,WHS,WAE
Ivory	16-116	7.7	U	No	1.4	Yellow	6.8(74)	6.8	Hach	1974	None
Juno	16-402	98.3	SW	No	2.3	Brown	6.0(73) 6.8(81)	13.7 5.5	Hach PM	1973 Sp81	NOP,YEP,WHS
Kemo	16-188	78.1	T	No	4.9	Green	7.5(77) 6.3(79)	13.7 9.2	Hach PM	1977 1979	WHS,LAT,BKT
Knight	16-807	37.2	NPS	No	1.5	Brown		7.5	Field	1963	NOP,YEP,WHS,PSF,GSF, DAR
Lace	16-201	8.1	U	No				7.5	Field	1935	None
Larch	16-582	57.5	NPS	Yes	2.1	Yellow	6.8(74)	6.8	Hach	1974	NOP,YEP,WHS
Lichen	16-382	123.8	SW	Yes	1.4	Brown	6.6(80)	16.7 7.6	Field PM	1960 F180	NOP,YEP,WHS,WAE,MUE
Locket	16-149	8.9	NPS	Yes	1.2	Brown	6.8(74)	6.8	Hach	1974	NOP,WHS
Lullaby	16-100	9.7	U	No	0.9	Brown	6.5(79)	6.8	Hach	1979	None
Magnetic	16-463	80.5	T	No	4.6	Green-brown	6.8(76)	9.5	Field	1976	NOP,YEP,WAE,SMB,LAT, BUR,NCS,LNS
Manymoon	16-473	10.9	U	Yes	1.5	Green-brown	6.8(76)	6.8	Hach	1976	BKT
Mavis	16-528	4.1	T	Yes	6.4	Clear		7.9	Field	1959	RBT,BKT
McDonald	16-235	39.7	SW	Yes	1.8	Brown	7.1(81)	13.7 8.0	Hach PM	1969 Sp81	NOP,YEP,WHS,WAE,SMB

Cook County
> 5.0 - ≤ 10.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Merganser	16-107	12.1	NPS	No	0.9	Brown	6.8(76)	6.8	Hach	1976	NOP,YEP,PSF
Mit	16-193	38.0	T	No	2.7	Yellow	 5.9(79)	13.7 9.8	Hach PM	1970 1979	NOP,WHS
Monker	16-094	40.5	U (ST)	Yes	1.2	Brown	8.8(74)	6.5	Hach	1974	BKT,CRC
Morgan	16-220	36.0	U	No			7.2(81)	10.0	PM	Sp81	NOP
Muckwa	16-105	20.6	T (ST)	Yes	1.8	Green		6.8	Hach	1971	RBT
Muma	16-106	7.3	RG	Yes	2.3	Green		6.8	Hach	1971	None
Mush	16-109	11.7	RG	No	1.7	Green-brown		6.8	Hach	1971	None
Musquash	16-104	33.2	T (ST)	Yes	2.4	Brown	7.2(81)	20.0 7.5	Field PM	1958 Sp81	WHS,SPK,CRC
Nancy	16-	22.7	U	No	0.9	Brown		8.8	Field	1956	Cyrinids
Northern Light	16-089	179.3	SW	Yes	1.5	Yellow-brown	7.2(81)	21.0 9.6	Field PM	1969 Sp81	NOP,YEP,WHS,WAE,SMB, PSF
Paddle	16-113	8.5	NPS	No	2.1	Yellow	6.8(74)	6.8	Hach	1974	NOP,YEP,WHS,WAE,SMB
Parsnip	16-120	9.7	U	No	1.5	Brown	6.8(76)	6.8	Hach	1976	WHS
Pendant	16-163	10.5	U	No	1.2	Brown	6.8(75)	6.8	Hach	1975	DAC
Peter	16-757	119.0	T	No	6.2	Green	7.4(80) 7.0(81)	20.5 9.6	Hach PM	1980 Sp81	YEP,WHS,LAT,BUR
Phoebe	16-808	296.6	SW	Yes	3.4	Brown	6.8(76)	10.0 20.5	Field Hach	1963 1976	NOP,YEP,WHS,WAE
Pine Mountain	16-108	48.2	NPS (ST)	Yes	3.4	Clear		14.0 6.9	Field PM	1960 1979	WHS,RBT,BKT
Pipe, E.	16-386	55.0	NPS	No	1.5	Brown	6.8(75)	6.8	Hach	1975	NOP,WHS,WAE
Pipe, W.	16-387	8.1	RG	No	1.5	Brown	6.8(75)	6.8	Hach	1975	NOP

Cook County
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Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Pocket	16.162	10.1	U	No	1.2	Brown	6.8(75)	6.8	Hach	1975	CRC
Pope, E.	16-342	17.8	NPS	Yes	4.2	Green-brown	6.5(77) 6.6(80)	15.0 13.7 7.5	Field Hach PM	1957 1977 F180	NOP,YEP,WHS,WAE
Poplar	16-239	384.5	T	Yes	4.0	Brown	6.5(80) 6.7(80)	40.0 40.0 17.0 8.5	Field Field Hach PM	1948 1955 1980 F180	NOP,YEP,WHS,WAE,LWF
Powers	16-018	10.9	U	Yes	1.5	Brown	6.8(75)	6.8	Hach	1975	None
Prout	16-013	12.1	BH	No	1.5	Green-brown	6.8(75)	6.8	Hach	1975	None
Quiver	16-210	7.3	NPS	No	1.2	Yellow	6.8(74)	6.8	Hach	1974	NOP,YEP,WHS,BUR
Rice	16-453	93.1	SW	No	1.5	Yellow-green	7.2(81)	24.0 9.0	Field PM	1969 Sp81	NOP,YEP,WHS,WAE
Rocky	16-115	33.6	NPS	No	2.1	Yellow	6.8(74)	6.8	Hach	1974	NOP,WHS
Romance	16-630	68.0	T	No	3.4	Brown	6.8(74)	6.8 6.8	Hach PM	1975 Sp81	NOP,NCS
Saganaga, L.	16-809	794.0	T	Yes			7.0(Sp81)	6.8	PM	Sp81	NOP,LAT,BUR
Sawbill	16-496	382.0	SW	Yes	3.7	Brown	7.5(77) 6.6(80) 7.1(81)	15.3 13.7 9.0 7.0	Field Hach PM PM	1935 1977 F180 Sp81	NOP,YEP,WHS,WAE
Shoko	16-208	19.8	NPS	Yes	1.5	Yellow	6.8(74)	6.8	Hach	1974	NOP,YEP,WHS
Shrike	16-258	13.0	NPS	No	0.9	Brown	6.8(76)	6.8	Hach	1976	NOP,YEP,WHS
Skoop	16-514	4.5	U	No	1.4	Brown	6.8(75)	6.8	Hach	1975	None
Spaulding	16-062	19.0	T	No	3.2	Green-brown	6.8(75)	6.8	Hach	1975	None
Squaw	16-024	5.3	T (ST)	Yes	2.6	Yellow-brown		6.8	Hach	1971	WHS,LAT,BKT

Cook County
> 5.0 - ≤ 10.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Squint	16-202	7.3	SW	No	2.1	Yellow	6.6(80)	11.3 13.7 6.5 9.0	Field Hach PM PM	1935 1971 Su80 F180	YEP,WHS,WAE,GSF,FHM
Squire	16-408	36.0	NPS	No	1.4	Brown	6.8(74)	6.8	Hach	1974	NOP,YEP,WHS
Star	16-405	48.6	SW	Yes	1.5	Yellow		24.2 6.3	Field PM	1970 1979	NOP,YEP,WHS
Stem	16-455	18.2	NPS	No	4.6	Green	6.8(75)	6.8	Hach	1975	NOP
Surber	16-343	4.1	RG (ST)	Yes	3.4	Yellow	6.8(74) 6.8(80)	6.8 16.5 9.0	Hach PM PM	1974 Sm80 F180	BKT,COS,GLS
Swamp	16-215	84.2	SW	Yes	0.3	Green	6.8(74)	6.8	Hach	1974	NOP,YEP,WHS,WAE,PSF
Swamper	16-128	21.0	NPS	Yes	1.7	Brown	6.7(79)	6.8	Hach	1979	NOP,YEP,WHS,RKB,PSF
Table	16-064	4.5	U	No	1.2	Brown	6.8(75)	6.8	Hach	1975	None
Temperance, N.	16-456	85.8	T	No	4.1	Yellow-brown	7.3(81)	13.7 6.0	Hach PM	1970 Sp81	NOP,YEP,WHS
Tepee	16-621	38.9	NPS	No	2.9		7.0(79) 7.1(Sp79)	13.7 9.9	Hach PM	1979 Sp79	NOP,YEP,WHS
Thrush	16-191	8.1	T (ST)	Yes	5.5	Green	6.0(72)	6.8(72)	Hach	1972	LAT
Tobacco	16-376	7.3	RG	No	2.1	Yellow-brown	6.8(75)	6.8	Hach	1975	NOP,YEP
Tom	16-019	166.3	SW	Yes	3.1	Clear	6.0(55) 7.0(81)	17.5 7.0	Field PM	1955 Sp81	NOP,YEP,WHS,WAE
Toohey	16-645	149.3	SW	Yes	1.4	Brown	6.9(8/82)	20.0 8.3	Hach PM	1980 8/82	NOP,YEP,WHS,WAE
Tuscarora	16-623	350.5	T	Yes	4.9	Green	6.8(74)	6.8	Hach	1974	NOP,YEP,WHS,LAT,BUR
Twin, W.	16-186	58.7	SW	Yes	4.9	Clear	6.4(79)	17.5 8.1	Field PM	1960 1979	WHS,WAE
Unnamed	16-206	4.1	NPS	No	1.1	Brown	6.8(74)	6.8	Hach	1974	NOP,YEP

Cook County
> 5.0 - ≤ 10.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Unnamed	16-614	7.3	U	No	1.8	Brown	6.8(75)	6.8	Hach	1975	None
Unnamed	16-796	5.7	NPS	No	3.4	Yellow	6.8(74)	6.8	Hach	1974	None
Vernon	16-267	119.4	T	No	5.1	Clear	7.3(81)	6.8 7.5	Hach PM	1970 Sp81	NOP,WHS,WAE,SMB,LWF, NCS
Watap	16-138	31.2	SW	Yes	3.0	Brown-green	7.5(78)	6.8	Hach	1978	YEP,WHS
Wench	16-398	10.1	T (ST)	Yes	5.8	Yellow	6.8(72) 6.8(81)	13.7 5.6	Hach PM	1972 Sp81	BKT
Winchell	16-354	405.5	T	Yes			7.1(81)	6.5	PM	Sp81	NOP,WHS,LAT,LWF,NCS
Zoo	16-259	42.1	NPS	No	1.8	Brown	6.8(76)	6.8	Hach	1976	NOP,WHS

Crow Wing County
0.0 - ≤ 5.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Papoose	18-206	36.8	C	No	2.1	Brown		17.5	Field	1966	NOP,YEP,LMB,BLC,BLG,
								4.8	PM	Sm80	PSF,YEB

Crow Wing County
> 5.0 ≤ 10.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Allen	18-208	20.2	C (ST)	Yes	3.7	Clear	6.0(83)	15.0	Field	1966	RBT
								10.0	PM	Wt83	
Bass	18-191	33.2	C	No	1.5	Brown	5.4(83)	17.5	Field	1967	NOP,YEP,BLG,PSF,BLB,
								8.0	PM	Sp81	BRB,
								7.6	PM	Wt82	
Clears (Lone Pine)	18-292	8.1	C	No	1.5	Yellow-brown		10.0	Lab	1968	
Fool	18-224	101.2	Minnow	No				12.5	Field	1952	WHS,LMB,BLC,GLS,FHM,
								9.0	PM	Sp81	TMT
Squaw	18-207	57.5	C	No	1.8	Green	7.0(81)	15.0	Lab	1966	NOP,YEP,WHS,WAE,YEB,
								7.0	PM	Sm80	LMB,BLC,PSF,BRB,GLS
								6.0	PM	Sp81	
								18.0	PM	1981	
Wilson	18-049	25.5	G	No	0.3	Brown		13.0	Lab	1968	None
								9.0	PM	Sp81	

Itasca County
0.0 - ≥ 5.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Beaver	31-848	13.0	C	No	0.9	Bog	6.0(72)	13.7	Field	1972	YEP,BLC,BRB
								4.8	PM	Wt82	
Black Island	31-416	41.7	C	No	2.4	Brown	5.0(75)	3.3	PM	Sp81	NOP,YEP,WHS,WAE,SMB,
							6.4(83)	7.6	PM	Wt82	LMB,BLC,BGL,PSF,RKB
Blandin	31-484	37.6	NPS	No	3.7	Brown	6.5(79)	17.1	Hach	1979	NOP,LMB,BLG,PSF
							6.2(83)	3.6	PM	Wt82	
Bosley	31-403	12.6	U	No	0.8	Brown		5.0	Field	1953	YEP,WHS,PSF,GLS
								1.0	PM	Sm80	
Broom	31-326	5.7	BH	No	1.7	Brown	7.0(71)	3.0	Field	1971	NOP
							7.2(82)	45.0	PM	Wt82	
Brown	31-425	7.7	C	No	2.1	Brown	6.6(83)	5.0	PM	Wt82	FHM,CSH
Burnt Shanty	31-424	70.4	C	No	3.7	Clear	5.9(83)	4.6	PM	Wt82	NOP,YEP,WHS,LMB,BLC, BLG,PSF,YEB
Dock	31-649	12.1	U				6.5(81)	1.6	Field		LMB,BLC,BLG
							6.3(83)	5.3	PM	Sp81	
								6.4	PM	Wt83	
Doe (Lost)	31-482	7.7	C	No		Bog	6.1(83)	3.2	PM	Wt82	NOP,LMB,BLC,BLG
Elbow	31-328	15.4	U	No			6.5(82)	3.0	PM	Wt82	WAE
Forjer	31-589	6.9	T					5.0	LMIC		Cyrinids
Glove	31-889	5.7	U	No			7.8(79)	1.3	Field	1979	BLB
Harrigan	31-172	5.3	BH	No	2.4	Brown	5.7(82)	2.0	PM	Wt82	YEP
Hill	31-600	17.0	C	Yes		Brown	6.4(47)	12.5	Field	1947	YEP,LMB,BLG
							6.4(81)	4.0	PM	Sm80	
							6.5(82)	6.8	PM	Wt82	
Horn, L	31-588	15.4	T	Yes			6.1(82)	4.6	PM	Wt82	YEP,LMB
Horseshoe	31-325	15.0	C	No			5.3(82)	2.0	PM	WT82	NOP
Island, Spruce	31-644	13.8	C	No	2.7	Clear	7.0(78)				
							6.8(81)	4.0	PM	Wt83	SMB,LMB
							6.4(82)	5.6	PM	Wt83	

Itasca County
0.0 - ≥ 5.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Joy (Toy)	31-181	9.7	U	No	1.2	Brown	6.2(82)	3.4	PM	Wt82	Cyrinids
Moon	31-414	10.9	U	No			6.2(83)	4.0	PM	Wt82	LMB
Moonshine	31-224	5.7	U					5.0	PM	1978	No data
Moore	31-535	32.8	C	No	4.0	Clear	7.5(74) 6.5(82) 6.5(83)	17.0 3.6 5.8	Field PM PM	1974 Wt82 Wt82	YEP,LMB,BLG,RKB
Moss	31-431	11.3	U	No			6.4(83)	3.2	PM	Wt82	LMB
Nose	31-417	41.3	C	Yes	3.0	Clear	7.0(73) 6.7(81) 6.6(83)	25.6 4.8 2.6 8.2	Field PM PM PM	1973 1981 Sp81 Wt82	NOP,YEP,WHS,LMB,BLC, BLG,PSF
Otter (Whiskey)	31-471	21.5	C	No	2.4	Clear		3.8	PM	1981	YEP,WHS,WAE,LMB,BLG
Pine	31-478	26.3	U				6.5(82)	2.6 5.2	-- PM	----- Wt82	NOP,YEP,LMB,BLG
Plummber	31-251	12.6	U	No			5.8(83)	2.5	PM	Wt82	None
Pughole	31-602	45.7	C	Yes	2.7	Green	7.0(78) 8.1(78) 6.6(83)	119.7 4.0 7.6	Hach PM PM	1977 1978 Wt83	NOP,YEP,WHS,WAE,BLG, BLC,PSF
Rainbow	31-297	5.7	RG	Yes			6.3(82)	4.0	PM	Wt82	NOP,YEP
Spring	31-428	9.7	U	No			6.2(83)	4.4	PM	Wt82	LMB
Sunrise	31-437	11.3	U	No			6.4(83)	3.6	PM	Wt82	LMB
Surprise	31-646	8.9	T (ST)	Yes		Clear		15.0 5.0	Field PM	1949 Sm80	WHS,RBT,BLB
White Swan	31-260	57.5	C	No	2.1	Brown	6.0(56)	13.0 3.4	Field Field	1977 1981	NOP,YEP,WHS,LMB,BLC, BLG,PSF,RKB,GLS
Woods	31-469	13.4	C	No			5.8(83)	1.8	PM	Wt82	YEP

Itasca County
> 5.0 - ≤ 10.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Adele	31-642	8.9	U	No			6.9(79) 6.4(82)	8.0 6.6	Field PM	1979 Wt82	LMB
Allen	31-488	22.7	U	No			6.4(83)	6.2	PM	Wt82	NOP,BLC,BLG,PSF,BRB,
Antler	31-306	21.5	U	No			6.5(83)	8.4	PM	Wt82	LMB
Baldy	31-615	8.1	U	No			6.3(83)	6.8	PM	Wt82	None
Bass	31-316	45.3	C	Yes	3.4	Green		85.5 11.8 10.0	Field PM LMIC	1980 Sp81 ----	NOP,YEP,WHS,SMB,LMB, BLG,RKB
Bass, L.	31-295	7.3	U	No			6.3(82)	7.2	PM	Wt82	No data
Bass, L. (Poplar)	31-332	10.5	C	No		Stain	6.7(82)	8.0	PM	Wt82	NOP,LMB,BLC,BLG,BRB
Bay	31-844	10.1	U	No			7.3(79) 6.3(83)	10.0 8.6	PM PM	1979 Wt82	No data
Beatrice	31-058	48.2	C	Yes	4.9(75) 2.6(80)		9.0(75) 6.5(80)	35.0 34.4 10.0	Field Field LMIC	1969 1980 ----	NOP,YEP,WHS,WAE,BLC, BLG,PSF
Beaver	31-436	8.1	U	No		Clear	6.3(83)	5.2	PM	Wt82	None
Beaver	31-590	21.5	C	No			 6.6(82)	17.1 7.4	Field PM	1980 Wt82	NOP,BLC,RKB
Beaver	31-638	5.3	U	No		Brown	6.6(82) 7.3(78)	7.8 9.2	PM PM	Sp81 Wt82	BLG,FHM
Beavertail	31-447	7.7	U	No			6.2(83)	6.3	PM	Wt82	BLB
Bee Cee	31-443	9.7	C (ST)	RBT	3.4(76) 3.0(80)	Clear	7.0(76) 7.0(80) 6.6(83)	34.0 34.2 9.6	Field Hach PM	1976 1980 Wt82	RBT
Blue Ridge	31-182	6.1	C	No	3.7	Clear	6.2(82)	6.0	PM	Wt82	SMB
Burrows	31-413	110.0	C	Yes	2.4	Clear	7.5(79)	34.2 10.4 10.0	Hach PM LMIC	1979 Sp81 ----	NOP,YEP,WHS,WAE,LMB, BLC,BLG
Candy	31-324	7.3	RG	No			6.2(82)	6.4	PM	Wt82	No data

Itasca County
> 5.0 - ≤ 10.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Charlotte	31-537	12.6	C	No	2.4	Brown	6.5(78)	34.2	Field	1978	NOP,YEP,WHS,WAE,BLC, BLG,PSF
Clear	31-209	37.2	U	No			6.6(82)	9.0	PM	Wt82	None
Courtney	31-475	8.1	C	No		Bog	6.4(83)	8.2	PM	Wt82	NOP
Crum (Spring)	31-171	8.5	C	No	4.0	Clear	5.9(82)	1.0	PM	Wt82	WHS,LMB
Day	31-637	18.6	C	Yes		Brown	6.7(82)	20.0 10.0 10.0	Field PM PM	1947 1978 Wt82	YEP,LMB,BLG,PSF
Doctor	31-643	13.0	U	No		Bog	6.5(82)	6.0	PM	Wt82	LMB
Dora (Cuttooth)	31-882	180.9	HW	Yes	1.8(75) 1.8(80)	Brown	8.5(75) 7.6(79) 8.0(80)	12.0 12.0 9.5 17.1	Field Field PM Field	1957 1975 1979 1980	NOP,YEP,WHS,WAE,PSF, TUL,BON,BLB,BRB,SRH
Erskin	31-311	15.8	T (ST)	Yes	6.1		6.6(82)	27.4 9.4	Field PM	1980 Wt83	RBT
Horn, Big	31-598	12.1	C	No	2.4(70) 2.7(79)	Brown	6.5(79) 6.4(82)	17.0 7.2	Hach PM	1979 Wt82	YEP,LMB,BLG
Horseshoe	31-329	4.5	C	No	2.4	Brown	6.7(82)	8.0	PM	Wt82	NOP,LMB,BLG
Island, L.	31-423	27.9	C	No	4.6	Green	7.0(79)	34.2	Hach	1979	NOP,YEP,WHS,LMB,BLC, BLG,PSF,YEP
Island, Big	31-671	89.0	C	Yes	4.6	Clear	6.9(78)	17.1 7.0	Field PM	1974 1978	NOP,YEP,LMB,BLC,BLG
Jaw	31-628	8.1	U	No			6.5(83)	6.2	PM	Wt82	LMB
Kremer	31-645	25.9	T (ST)	Yes		Clear		15.0 6.5 6.5	 PM PM	1949 Sm80 Sp81	BKT
Lawrence	31-604	20.2	C	Yes				6.9	PM	Sp81	YEP,WHS,LMB,BLG

Itasca County
> 5.0 - ≤ 10.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Long (Button Box)	31-175	34.8	C	No	3.0 4.0 3.0	Brown		37.0 17.1 10.0	Field Hach PM	1961 1980 1981	YEP,WHS,SMB
Lucky	31-603	4.5	T (ST)	Yes			6.4(82)	5.4 7.0	PM PM	Sp81 Wt82	BNT
Lum	31-487	19.4	C	No			6.6(83)	6.8	PM	Wt82	NOP,WHS,LMB,BGL
Lynx	31-304	19.4	U					8.4			NOP,YEP,LMB,BLG,PSF
McKewen	31-682	8.5	U	No			6.2(83)	5.8	PM	Wt82	None
Miller	31-748	22.7	U	No				8.0	LMIC	----	None
Moonshine	31-444	9.7	C (ST)	Yes	2.7	Brown	7.0(78) 6.2(83)	17.5 5.0 6.0	Field PM PM	1958 1978 Wt82	RBT
Nickel	31-470	5.3	C (ST)	Yes	5.5	Clear	6.4(83)	7.5 20.5 5.3	Field Field PM	1955 1981 Wt82	LMB,RBT
Orange	31-587	38.9	C	No	4.9	Clear	7.2(81) 6.7(82)	14.0 34.2 8.6	Field Hach PM	1978 1981 Wt82	YEP,WHS,SMB,LMB,BLG, MUE
Red	31-189	4.5	BH	No	1.5	Brown	6.4(82)	6.8	PM	Wt82	None
Smith, E.	31-616	59.1	C	No	4.3	Clear		10.0 9.8	PM PM	Sp81 Wt83	NOP,YEP,WAE,LMB,BLC, BLG,PSF
Snowshoe	31-434	9.7	U				6.8(83)	9.8	PM	Sp81	None
Twin	31-026	53.0	C	No	2.2	Green	7.3(77) 6.4(83)	34.2 6.2	Hach PM	1977 Wt83	NOP,YEP,WHS,WAE,LMB, BLC,BLG,PSF
Willey's	31-412	19.4	U	No			6.4(83)	5.6	PM	Wt82	None

Kanabec County
0.0 - ≤ 5.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Beauty	33-002	25.9	RG	No	1.1	Red-brown	6.5(81)	10.0 3.8	Field PM	1967 Sp81	NOP,BLG
Featherbed	33-006	15.4	RG	No	0.6	Red-brown	5.9(67) 5.9(81)	5.0 2.2	Lab PM	1967 Sp81	None
Five	33-003	34.4	C	Yes	1.8	Clear	6.8(81)	10.0 3.6	Field PM	1963 Sp81	NOP,YEP,LMB,BLC,BLG, BLB
Pomroy	33-009	108.1	BH	Yes	2.5	Brown	6.4(81) 6.3(82)	22.5 3.8 2.0	Field PM PM	1959 Sp81 Sm82	NOP,YEP,BLB,BRB,YEB LMB,BLC,BLG,PSF

Kanabec County
> 5.0 - ≤ 10.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Full of Fish	33-024	34.4	C	Yes	1.8	Green	6.7(81)	12.5 5.8	Field PM	1960 Sp81	NOP,YEP,LMB,PSF,YEB
Sells	33-018	25.9	G	No	0.9	Brown	6.4(81)	6.2	PM	Sp81	None
Thirteen	33-005	21.5	C	Yes	2.1	Clear	6.4(81)	7.5 3.4	Field PM	1959 Sp81	LMB,BLC,BLG,PSF,YEB
Unnamed	33-014	4.5	G	No	0.6	Brown	6.4(81)	9.6	PM	Sp81	Cyrinids

Lake County
0.0 - ≤ 5.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Alsike	38-672	12.1	RG	No	2.6	Clear	5.7(82)	0.5	PM	Wt82	YEP
Christianson	38-750	63.9	NPS					26.3	Field	1956	NOP,YEP,WHS,BLC,PSF,
								1.0	PM	F180	GLS
Divide	38-256	27.9	NPS (ST)	Yes			5.5(82)	3.8	Field	1938	YEP,RKB,BKT,RBT,FHM
								2.0	PM	F180	
								0.9	PM	Sm82	
Dunnigan	38-664	34.0	CW	Yes	3.2	Clear	6.7(78)	9.0	Field	1961	WHS,WAE,SMB,BLG,RKB
							6.8(81)	7.5	Field	1978	
							6.0(82)	2.0	PM	F180	
								2.7	PM	Sp81	
								2.5	PM	Sm82	
Goldeneye	38-029	4.1	T (ST)	Yes				5.0	PM	Sm80	BKT
								6.0	PM	F180	
Greenwood	38-656	594.5	SW	Yes	0.6	Brown	6.5(78)	11.5	Field	1951	NOP,YEP,WAE
							6.1(79)	13.7	Hach	1978	
								4.8	PM	Sp79	
								4.0	PM	F180	
Gypsy	38-665	10.5	U (ST)	Yes	2.4	Brown		5.0	Field	1961	BKT
Horse	38-792	293.0	SW	No	2.1	Clear	6.5(74)	13.7	Hach	1974	NOP,YEP,WHS,WAE,BLG,
							6.8(81)	4.2	PM	Sp81	RKB,NCS,NRH
								5.1	PM	Sp81	
Kane	38-651	43.7	NPS	Yes	3.4	Clear	6.8(78)	7.5	Field	1951	NOP,YEP,WHS,WAE,PSF,
							6.4(82)	10.3	Field	1978	
								13.0	PM	1980	
								3.4	PM	Sm82	
Kawishiwi	38-080	189.4	SW	No	1.5	Brown	6.6(78)	12.5	Field	1961	NOP,YEP,WHS,WAE
								13.6	Hach	1978	
								4.5	PM	Sp81	
Nickel	38-705	9.3	NPS	Yes	0.9	Brown	6.0(83)	4.0	PM	Sm83	NOP,YEP,FHM,DAR
Osier	38-420	32.8	NPS	Yes	1.9	Brown	4.5(82)	5.0	Field	1961	WHS
								0.5	PM	Sm82	

Lake County
> 5.0 - ≤ 10.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Basketong	38-073	32.8	NPS	No	1.2	Brown		7.5	Field	1962	NOP,WHS
Bog	38-443	128.3	SW	No	1.2	Brown		10.0	Field	1962	NOP,YEP,WHS,WAE
Boot	38-503	87.4	SW	Yes	5.2	Clear	7.0(74)	6.8	Hach	1974	NOP,WHS,WAE,RKB,NCS, NRH
Boulder	38-140	127.1	NPS	No	4.0	Brown	7.1(81)	15.0 7.6 8.4	Field PM PM	1964 Sp81 Sp81	NOP,YEP,WHS,WAE,RKB, GLS,DAR
Cattyman	38-510	12.1	U	No			7.0(82)	7.0	PM	Sm82	NOP,YEP,WHS,WAE
Clear	38-722	96.7	SW	Yes	1.5	Brown	7.0(80) 6.9(81)	17.5 17.1 8.0	Field Hach PM	1964 1980 Sp81	NOP,YEP,WHS,WAE,LMB, BLC,BLG,RKB
Clearwater	38-638	248.9	SW	Yes	5.9	Clear		15.0 17.1 9.6	Field Hach PM	1962 1977 Sp81	NOP,YEP,WHS,LWF
Coffee	38-064	56.3	NPS	Yes	1.4	Brown	6.8(80)	15.0 21.0 5.5	Field Field PM	1961 1980 Sp81	NOP,YEP,WHS,WAE,RKB
Crosscut	38-257	5.3	U	No			6.3(82)	5.1	PM	F182	YEP
Eskwagama	38-707	32.0	NPS	No	1.1	Brown		10.0	Field	1964	NOP,WHS
Farm	38-779	537.4	SW	Yes	2.0	Brown		20.0 10.0	Field PM	1965 F180	NOP,YEP,WHS,WAE,SMB, BLC,RKB,NCS
Farm, S.	38-778	250.1	SW	Yes	1.8	Brown		8.0	PM	Sm83	NOP,YEP,WHS,WAE,SMB, BLC,BLG,NCS
Ferne	38-311	61.9	SW	No	1.1	Brown		10.0	Field	1962	
Fourtown	38-813	390.5	SW	Yes	2.1	Brown	6.5(74)	6.8	Hach	1974	NOP,YEP,WHS,WAE,SMB, RKB,NCS
Fraser	38-372	328.2	T	Yes	4.9		6.6(76) 7.2(81)	17.5 17.1 8.8 9.0	Field Hach PM PM	1950 1976 Sp81 Sp81	NOP,WHS,WAE,RKB,LAT, NCS

Lake County
> 5.0 - ≤ 10.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Gabbro	38-701	475.1	SW	No	1.7	Brown		20.0 51.3 7.2	Field Hach PM	1963 1977 Sp81	NOP,YEP,WHS,WAE,BLC, RKB,NCS
Gibson	38-508	14.6	U	Yes			7.1(82)	7.0	PM	Sm82	None
Gull	38-590	200.3	SW	Yes	1.5	Brown	6.8(81)	12.5 5.6 6.2	Field PM PM	1962 Sp81 Sp81	NOP,YEP,WHS,WAE,SMB, RKB,GLS,DAR
Hare	38-026	19.4	T	Yes	1.8	Brown		9.2	Field	1956	YEP,WHS,BKT,BNT,FHM, CSN
Hazel	38-069	40.5	NPS	No	1.2	Brown- green		10.0	Field	1963	NOP,YEP,WHS,PSF,DAR
Hide (Bearskin)	38-553	11.3	NPS	Yes	2.0	Brown- green		7.5	Field	1962	NOP,YEP,WHS,WAE,BLC
Homestead	38-269	20.2	SW	Yes	2.0	Brown		15.0 41.0 8.4 6.5	Field Field PM PM	1961 1976 Sm80 F180	NOP,YEP,WHS,LMB,BLC, MUE
Horseshoe	38-580	79.3	SW	No	1.8	Brown		10.0	Field	1963	NOP,YEP,WHS,WAE,BLG, RKB,BUR,LWF,NCS
Ima	38-400	349.3	T	Yes	3.8	Brown- green	7.2(81)	34.0 9.8 10.2	Field PM PM	1972 Sp81 Sp81	NOP,WHS,LAT,NCS
Insula	38-397	1032.0	SW	No	3.0	Brown	7.0(75)	17.5 17.1 7.0	Field Hach PM	1950 1975 Sp81	NOP,YEP,WHS,WAE,BLG, RKB,LWF,NCS
Isabella	38-396	533.4	SW	Yes	1.7	Brown	6.9(76) 6.9(81)	20.5 6.7 10.5	Hach PM PM	1976 Sp81 Sp81	NOP,YEP,WHS,WAE,RKB, LWF
Jitterbug	38-509	13.0	U	No			6.3(82)	8.0	PM	Sm82	NOP,YEP,WHS
Kawasachong	38-070	71.6	SW	No	1.4	Brown- green		10.0	Field	1962	NOP,YEP,WHS,WAE,RKB
Koma	38-098	107.6	SW	No	1.8	Brown		10.0	Field	1963	NOP,YEP,WHS,WAE,BLG, RKB,LWF,NCS

Lake County
> 5.0 - ≤ 10.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Malberg	38-090	178.9	SW	No	3.4	Brown-green		12.5 8.2	Field PM	1963 Sp81	NOP,YEP,WHS,WAE,BLG, RKB,LWF,NCS
Manomin	38-616	184.1	U	Yes			6.9(81)	6.0 7.7	PM PM	Sp81 Sp81	None
Maniwaki	38-300	46.1	NPS	Yes	0.8	Brown		10.0	Field	1962	WHS,PHM
McDougal, N.	38-686	130.7	SW	Yes	0.7	Brown	6.9(77)	20.0 27.4 8.7	Field Hach PM	1961 1977 1980	NOP,YEP,WHS,WAE
Moosecamp	38-816	68.4	SW	No	2.3	Clear	6.5 6.8(81)	13.7 7.2 6.1	Hach PM PM	1974 Sp81 Sp81	NOP,WHS,WAE,BLG,RKB NCS
Ogishkemuncie	38-180	361.4	T	Yes	4.9	Clear	7.1(81)	34.0 10.0 9.9	Field PM PM	1972 Sp81 Sp81	NOP,YEP,WHS,WAE,LAT, LWF
One	38-605	332.7	SW	Yes	3.7	Brown	7.0(81)	10.0 17.1 7.2	Field Hach PM	1958 1977 Sp81	NOP,YEP,WHS,WAE,BLG, RKB,LWF,NCS
Parent	38-526	166.7	SW	No	3.1	Green	7.3(78) 7.3(81) 6.9(82)	34.2 10.0 10.8 6.0	Hach PM PM PM	1978 Sp81 Sp81 Sm82	NOP,YEP,WHS,WAE,SMB, RKB,NCS
Perent	38-220	746.3	SW	No	2.1	Brown		27.5 5.5 6.3	Field PM PM	1961 Sp81 Sp81	NOP,YEP,WHS,WAE,RKB, GLS,NCS,NRH,CSH,TMT
Pietro	38-584	131.5	NPS	No	3.1	Green		15.0 9.4	Field PM	1962 Sp81	NOP,WHS,PSF,RKB
Plum	38-273	30.0	U	Yes	1.2	Brown	6.2(82)	12.5 5.4	Field PM	1924 F182	PHM
Railroad	38-655	4.5	G	No	0.5	Brown		7.5	Field	1958	None
Raven	38-113	82.6	T	No	6.4	Clear	7.0(75) 7.0(81)	17.1 7.0 7.3	Hach PM PM	1975 Sp81 Sp81	YEP,WHS,LAT

Lake County
> 5.0 - ≤ 10.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Rock Island	38-613	26.3	NPS	Yes	1.2	Yellow-	6.5(79)	7.5	Field	1966	NOP,WHS
								7.5	PM	1978	
								7.1	PM	1979	
Sandpit	38-786	26.3	CW	Yes	4.0	Clear	6.5(74)	20.5	Hach	1974	NOP,WHS,WAE,SMB,BLC,
							7.1(79)	8.9	PM	1979	BLG,RKB
								8.4	PM	Sp81	
Scarp	38-058	17.4	T (ST)	Yes				8.5	PM	Sm80	
Silver Island	38-219	523.7	SW	Yes	1.5	Brown	6.7(82)	12.5	Field	1951	NOP,YEP,WHS,WAE,RKB,
								27.3	Hach	1976	LWF
								8.9	PM	Sm82	
Splash	38-531	39.3	U	No			6.7(83)	6.0	PM	Sm83	No data
Spoon	38-388	115.3	SW	Yes	4.9	Green		51.0	Hach	1972	NOP,YEP,WHS,RKB,NCS
								7.5	PM	Sp81	
Square	38-074	50.6	SW	No	1.6	Brown		10.0	Field	1962	NOP,YEP,WHS,WAE,RKB
T	38-066	124.2	SW	No	1.5	Brown	6.7(76)	15.0	Field	1961	NOP,YEP,WHS,WAE,LWF
								17.0	Hach	1976	
								6.7	PM	1980	
Three	38-600	439.1	SW	Yes	2.3	Brown	7.0(78)	12.5	Field	1963	NOP,YEP,WHS,WAE,BLG,
							6.9(81)	51.3	Hach	1978	RKB,NCS,BUR
								7.0	PM	Sp81	
								7.2	PM	Sp81	
Tin Can Mike	38-785	57.5	U	Yes		Brown	6.9(81)	8.9	PM	Sp81	NOP,YEP,WAE,SMB,BLG, RKB
Turtle	38-704	145.3	SW	Yes	2.4		6.9(81)	12.5	Field	1962	NOP,YEP,WHS
								42.7	Hach	1977	
								5.4	PM	Sp81	
								6.0	PM	Sp81	
Two	38-608	214.1	SW	Yes	2.3	Brown	7.0(78)	12.5	Field	1963	NOP,YEP,WHS,WAE,BLG,
								8.3	PM	1978	RKB,LWF,NCS
Unnamed	38-763	6.5	U	No				7.0	Field	1972	None

Lake County
> 5.0 - ≤ 10.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Unnamed	38-769	4.5	U	Yes			6.6(82)	5.2	PM	Sm82	None
Watonwan	38-079	25.9	SW	No	1.5	Brown	6.8(81)	7.5	Field	1962	NOP,YEP,WHS,WAE
								6.0	PM	Sp81	
								6.8	PM	Sp81	

Morrison County
0.0 - ≤ 5.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Michaels	49-032	27.5	U					4.4	-	1980	Cyrinids

Pine County
0.0 - ≤ 5.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Bass	58-128	13.0	BH	Yes	1.7	Brown	6.5(81)	12.5	Field	1967	YEP,BLG,PSF,BRB,GLS
								1.8	PM	Sp81	
Bass, Little	58-127	7.3	C	No	1.7	Brown	6.5(80)	10.0	Field	1967	NOP,YEP,LMB,BLC,BLG
							6.6(81)	2.0	PM	Sm80	
								3.6	PM	Sp81	
Clear	58-104	10.1	C	Yes		Green	5.9(81)	10.0	Field	1958	NOP,YEP,LMB,BLC,BLG, BLB,GSF
Clear	58-108	5.7	BH	No	1.1	Brown		5.0	Field	1967	WHS,BLB,BRB,GLS,CMM
Dollar	58-025	8.1	C	Yes	0.5	Brown	5.3(81)	2.5	Field	1967	NOP,YEP,WHS,BLC,PSF,
								0.4	PM	Sp81	BLB,BRB,YEB

Pine County
0.0 - ≤ 5.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Miller	58-135	30.4	C	Yes	1.1	Yellow	6.5(81)	7.5 4.4	Field PM	1967 Sp81	NOP,YEP,LMB,BLG,PSF, RKB,BLB,BRB,GLS,FHM, CMM,BRS
Rock	58-007	32.8	U	Yes	1.8	Green- brown	5.5(82)	18.0 12.5 8.7 2.0	Field Lab Field PM	1967 1975 1975 Sm82	YEP,WHS,WAE,GSF

Pine County
> 5.0 - ≤ 10.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Bass	58-137	51.8	C	Yes	1.2	Green		12.6 15.0 10.0 17.5	Field Field Lab Field	1949 1967 1976 1976	NOP,YEP,WHS,WAE,LMB, BLC,BLG,PSF,BLB,BRB, YEB
Indian	58-132	29.1	C	No	0.6	Brown	6.6(81)	17.5 5.8	Field PM	1967 Sp81	YEP,PSF,BLB,BRB,YEB
Stevens	58-009	7.3	C	No	1.1	Yellow- brown		2.5 7.5	Field Field	1967 1967	NOP,YEP,WHS,SMB,LMB, BLC,BLG,BLB,BRB,YEB
Unnamed	58-133	4.1	C	Yes	0.6	Yellow- brown		10.0	Field	1967	NOP,YEP,BLC,PSF,BLB, BRB,GLS
Wilbur	58-045	19.0	RG	No	3.4	Green	7.0(67)	8.0 8.0	Field Lab	1967 1967	NOP,MIN

St. Louis County
0.0 - ≤ 5.0 mg/l $CaCO_3$

Lake Name	DOW Type	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Agawato	69-334	15.8	U	No	2.3	Red-brown	7.5(74)	13.7 2.7	Hach PM	1974 1978	YEP,WHS
Agnes	69-223	432.6	SW	No	2.1	Brown	7.0(74)	17.1 4.0	Hach PM	1974 Sp81	NOP,YEP,WHS,WAE,SMB, RKB,NCS,NRH
Battle	69-300	30.4	C	Yes	1.9	Yellow		5.0	Field	1966	NOP,WHS,WAE
Bear	69-112	50.6	NPS	No	1.5	Brown		42.5 3.0	Field PM	1965 F180	NOP,YEP,WHS,PSF,BRB, NRH
Big	69-190	829.2	NPS	Yes	2.7	Brown		5.0 18.0 5.2	Field PM PM	1951 Sm80 Sp81	NOP,YEP,WHS,WAE,SMB, BLG,PSF,RKB
Boot	69-100	124.7	SW	No	0.9	Brown	6.0(73)	13.7 4.2	Hach PM	1973 Sp81	NOP,YEP,WHS,WAE,RKB, NRH
Boot	69-868	23.1	C	No	2.7	Brown		17.5 4.9	Field PM	1970 1978	YEP,WHS,MUE
Boot Jack	69-870	119.0	C	No	1.8	Brown		15.0 3.0	Field PM	1970 1978	YEP,WHS,MUE
Boot Leg	69-452	142.5	U	No			6.6(81)	3.0	PM	Sp81	None
Boulder	69-373	1800.9	CW	Yes	1.7	Brown	7.0(78)	20.5 34.2 0.0	 Hach	1954 1968 1978	NOP,YEP,WHS,WAE,BLC, PSF,RKB,BLB,TMT
Buck	69-381	92.3	NPS	No	1.9	Brown	6.5(76) 6.6(81)	17.1 3.0	Hach PM	1976 Sp81	NOP,YEP,WHS,WAE
Chant	69-172	6.5	C	Yes			6.3(83)	3.5	PM	Sm83	RBT
Crab	69-220	173.2	SW	Yes	4.6	Brown	7.0(80)	12.5 17.1 4.0	Field Hach PM	1950 1980 Sp81	NOP,YEP,WHS,WAE,SMB, LMB,BLC,BLG,NCS,NRH
Everett	69-120	49.8	CW	Yes	2.1	Clear	5.9(83)	7.5 3.5 3.0	Field PM PM	1966 Sm80 Sm83	NOP,YEP,WHS,WAE,RKB
Fat	69-481	43.7	T	No	6.4	Clear	8.0(74)	6.8 4.4	Hach PM	1974 1978	WHS,LAT

St. Louis County
0.0 - ≤ 5.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Fenske	69-085	56.7	NPS	Yes	3.5	Brown	6.8(79)	20.0 34.0 3.0	Field Hach PM	1960 1979 Sm83	NOP,YEP,WHS,WAE,SMB, LMB,BLG
Fig	69-644	36.4	CW	Yes	1.6	Brown		7.5 1.0	Field PM	1965 F180	NOP,YEP,WHS,WAE,BLC
First	69-119	7.7	NPS	Yes	2.3	Brown	6.5(80)	12.5 34.2 2.0 1.0	Field Hach PM PM	1961 1980 Sm80 Sm83	NOP,WHS,LMB,BLC,RKB
Grassy	69-082	140.8	NPS	Yes	1.8	Brown	6.5(75) 6.5(81)	17.1 3.0	Hach PM	1975 Sp81	NOP,YEP,WHS,SMB,LMB, BLC,BLG
Gun	69-487	81.7	T	Yes	7.6	Clear	8.0(74) 6.7(81)	34.2 4.0	Hach PM	1974 Sp81	NOP,WHS,WAE,SMB,BLG, RKB
Hanson	69-189	8.1	T (ST)	Yes	8.5	Clear	5.9(83)	7.5 2.5	Field PM	1961 Sm83	WHS,LMB,RBT
Hustler	69-343	9.0	NPS	Yes	3.4	Clear	6.5(74)	13.7 4.0	Hach PM	1974 Sp81	NOP,YEP,WHS,BLG,RKB, BUR,NCS
Jeannette	69-456	258.2	SW	Yes	1.8	Brown	7.0(74) 6.7(81) 6.4(82)	34.2 6.5 5.0 4.0	Hach PM PM PM	1974 Sm80 Sp81 Sm82	NOP,YEP,WHS,WAE
Johnson	69-117	191.4	NPS	Yes	1.4	Brown	6.5(79) 6.5(81) 6.2(83)	10.0 34.2 15.0 4.2 6.0	Field Hach PM PM PM	1965 1979 F180 Sp81 Sm83	NOP,YEP,WHS,WAE,LMB, BLC,BLG,PSF,RKB
Kumpala	69-424	30.4	U	No			6.6(82)	4.0	PM	Sm82	NOP,YEP,WHS,WAE,LMB, BLG,BLC,PSF,BLB
La Pond	69-177	71.2	G	No	1.1		4.9(82)	10.0 0.2	Field PM	1949 Sm82	No data
Loon	69-470	1047.8	T	Yes				4.2	PM	Sp81	NOP,YEP,WHS,WAE,SMB, GSF,RKB,BUR,NCS,NRH LWF
Long	69-044	178.9	NPS	No	0.7	Brown	6.2(68)	1.5	Hach	1968	NOP,YEP,CSH,TMT

St. Louis County
0.0 - ≤ 5.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Maude	69-590	35.6	NPS	Yes	1.2	Brown	6.5(76)	17.1 3.0	Hach PM	1976 Sm80	NOP,YEP,WHS,WAE
Meander	69-329	40.9	SW	Yes	4.4	Brown		17.0 3.0	Field PM	1972 Sp83	YEP,WHS,SMB,BLG
Meat (Nixon)	69-305	11.3	NPS	Yes	2.3	Clear		5.0	Field	1966	NOP,YEP,BKT,CSH
Muckwa	69-159	61.5	NPS	Yes	1.2	Yellow-brown		1.5	Field	1964	None
Mudro	69-078	32.4	SW	Yes	2.1	Brown	6.5(76)	17.1 3.0	Hach PM	1976 Sm83	NOP,YEP,WHS,WAE,SMB, BLG,RKB,NCS,NRH
Nels	69-080	80.9	SW	Yes	2.3	Brown	6.2(81)	25.0 1.6	Field PM	1972 Sp81	NOP,YEP,WHS,WAE,RKB
Nigh	69-457	16.2	NPS	No	1.4	Brown	6.5(74)	17.1 4.5	Hach PM	1974 Sm80	NOP,YEP,WHS
North	69-488	66.0	NPS	Yes	3.0	Brown	6.5(74)	5.0 3.42 6.1	Field Hach PM	1939 1974 1978	NOP,YEP,WHS,WAE,BLC, RKB,PSF
Norway	69-477	23.5	NPS	No	3.1	Clear	7.5(74)	6.8 5.0	Hach PM	1974 1978	NOP,YEP,WHS
Oriniack	69-587	302.7	SW	No	1.6	Brown	6.7(81)	17.1 4.4	Hach PM	1977 Sp81	NOP,YEP,WHS,WAE
Pauline	69-588	24.3	C	Yes	2.4	Clear	6.5(74) 6.7(81)	51.3 4.4 6.0	Hach PM PM	1974 1978 Sm80	NOP,YEP,WHS,PSF,RKS, NRH
Perch	69-058	36.8	NPS	Yes	2.5	Brown	6.5(81)	10.0 17.1 4.6	Field Hach PM	1964 1977 Sp81	NOP,YEP,WHS
Picket	69-079	31.6	NPS	Yes	0.9	Brown	7.0(75) 5.6(83)	17.1 1.5	Hach PM	1975 Sm83	NOP,YEP,WHS,BLG
Pine	69-448	369.1	SW	Yes	1.6	Brown	6.6(81)	17.1 5.0	Hach PM	1977 Sp81	NOP,YEP,WHS,WAE,PSF, RKB
Rocky	69-342	49.4	NPS	No	2.1	Clear	7.0(74) 6.5(81)	34.2 3.8	Hach PM	1974 Sp81	NOP,YEP,WHS,PSF,RKB

St. Louis County
0.0 - ≤ 5.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Pcol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Rosendahl	69-739	17.8	NPS	Yes	1.5	Brown	6.5(80) 5.8(83)	17.1 1.0	Hach PM	1980 Sm83	YEP
Santa Claus	69-139	4.5	U					4.0	PM	Sm80	
Shipman Bass	69-168	14.2	C	No	2.1	Clear	6.9(81) 6.2(83)	1.25 4.8 3.0	Field PM PM	1966 Sp81 Sm83	NOP,YEP,WHS,RKB,NCS
Silver	69-563	15.0	NPS (ST)	Yes			6.0(83)	5.0	PM	Sm83	LMB,BLC,BLG,RBT
Sletton	69-084	13.0	C	Yes	4.1	Clear	6.5(35) 6.5(83)	34.2 4.5 7.0 5.5	Hach PM PM PM	1975 Sm80 Sp81 Sm83	YEP,GSF,NRH
Sletton, L.	69-086	8.1	C	No	3.4	Brown	6.3(81) 6.3(83)	12.5 4.0 4.0 4.6	Field PM PM PM	1965 Sm80 Sp81 Sm83	YEP,WHS,LMB,NCS
Slim	69-181	148.9	SW	Yes	4.3	Clear	6.7(79) 6.6(81) 6.4(82)	17.5 17.1 3.0 1.0	Field Hach PM PM	1964 1979 Sp81 Sm82	YEP,WHS,WAE
Slim	69-478	56.7	NPS	No	2.7	Brown	7.0	5.0 13.7	Field Hach	1939 1974	NOP,YEP,WHS
Sprite	69-304	5.7	NPS	Yes	0.9	Brown		5.0	Field	1966	NOP,YEP
Steele	69-		U	No	0.8	Brown		4.0 7.5	Lab Field	1960 1960	None
Stuart	69-205	325.4	NPS	No	2.1	Brown	6.5(74) 6.5(81)	13.7 3.8	Hach PM	1974 Sp81	NOP,YEP,WHS,GSF
Sunset	69-764	125.1	G	Yes	0.6		6.1(81) 5.3(83)	10.0 6.2 1.0	Field PM PM	1951 Sp81 Sm83	None
Tesoker	69-390	8.9	C	No	4.1	Red	8.0(74)	3.42	Hach	1974	YEP,WHS,BLG,NCS
Thirteen	69-794	31.6	NPS	Yes			6.2(83)	2.5 3.2	PM PM	1980 Wt82	NOP,WHS,BLG,PSF

St. Louis County
0.0 - ≤ 5.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Thumb	69-337	4.1	SW	No	3.4	Brown	7.0(80)	5.0	Field	1939	NOP,WHS,WAE,PSF,RKB,
Thumb	69-352	29.1	U	No				3.3	PM	1978	No data
Twigg	69-389	12.1	T (ST)	Yes	4.8	Clear	8.0(74)	3.4	Hach	1974	RBT
Weir	69-831	33.2	U	No			6.7	4.5 7.1	PM PM	1978 ----	YEP,MIN
Whatta	69-	16.2	NPS	No	0.9	Brown		5.0	Field	1955	NOP,BLC
Winchester	69-690	129.5	NPS	Yes	2.9	Red	7.5(79) 6.9(81)	3.4 5.4	Hach PM	1974 Sp81	NOP,YEP,WHS,SMB,NCS

St. Louis County
> 5.0 - ≤ 10.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Ace	69-013	14.6	NPS	No	2.2	Brown		7.0	Field	1960	NOP,YEP
Alruss	69-005	11.7	T (ST)	Yes		Clear	6.7(83)	6.0	PM	Sm83	BKT,RBT
Astrid	69-589	46.1	C	Yes	2.1	Clear	7.0(74)	13.7 6.0	Hach PM	1974 Sm80	NOP,YEP,WHS,WAE,BUR
Bear Island	69-115	1079.3	SW	Yes	2.4	Brown	7.5(78) 6.7(83) 7.2(83)	17.5 34.2 10.0 13.5	Field Hach PM PM	1951 1978 Sm83 Sm83	NOP,YEP,WHS,WAE,SMB, BLC,BLG,RKB,BUR,NCS
Beaver	69-791	6.1	C	Yes	3.2		6.4(83)	5.8	PM	Wt82	YEP,SMB,BLC
Burntside	69-118	4142.5	T	Yes	3.8	Clear	7.0(81)	17.5 20.0 7.5	Field Field PM	1950 1968 Sp81	NOP,YEP,WHS,WAE,SMB, BLG,LAT,BUR,NCS,LWF
Camp 4	69-788	8.1	T (ST)	Yes	2.4	Brown	7.0(80) 6.5(83)	20.5 7.6	Hach PM	1980 Wt82	RBT,FHM

St. Louis County
> 5.0 - ≤ 10.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Cedar	69-431	11.7	T (ST)	Yes			7.1(82)	8.0	PM	Sm82	RBT
Coe	69-562	24.3	NPS	Yes	2.4	Red-brown	6.3(82)	20.0 2.0	Field PM	1961 Sm82	NOP,YEP,BLC,GLS
Cruiser	69-832	48.6	T	Yes	6.1	Clear	6.5-7.1	5.9-6.9	PM	79-82	YEP,WHS,LAT
Deepwater	69-399	7.3	BH	No	2.7	Brown-green		15.0 6.8	Field PM	 F180	NOP,YEP,WHS,BLC,CSH
Dollar	69-916	4.5	T (ST)	Yes	1.8		7.0(80)	13.7 9.0	Hach PM	1980 Sm80	NOP,YEP,WHS,BLG,PFS, BRB
Dovre	69-604	47.3	NPS	Yes	1.5	Brown	7.0(73)	6.8 6.2	Hach PM	1973 Sp81	NOP,YEP
Ed Shave	69-199	39.3	NPS	Yes	2.1	Brown	7.0(75)	17.1 5.5	Hach PM	1975 Sm80	NOP,YEP,WAE,GLS
Elbow	69-744	618.4	NPS	Yes	2.8	Brown	6.6(81)	10.0 5.3	Field PM	1954 Sp81	NOP,YEP,WHS,WAE,SMB, BLC,RKB,NCS,LWF
Emerald	69-335	30.8	NPS	No	5.8	Clear	7.0(74)	13.7 5.2	Hach PM	1974 1978	YEP,WHS,GSF
Eugene	69-473	73.3	U	No	3.4	Brown	7.0(74)	10.0 6.8	Field Hach	1939 1974	NOP,YEP,WHS,PSF,GSF, RKB,NCS,LWF
Fishmouth	69-834	13.0	NPS	Yes	2.3	Clear	7.1(78)	15.0 7.8	Field PM	1971 1978	NOP,YEP
Gate	69-795	5.7	U	Yes			6.5(83)	9.0	PM	Wt82	WHS
Ge-Be-On-Equat	69-350	263.9	NPS	Yes		Clear	6.8(81)	5.2	PM	Sp81	NOP,YEP,WHS,WAE,GSF, NCS,LWF
Gun	69-093	144.9	SW	No	3.4	Brown	7.0(73) 6.9(81)	13.7 5.4	Hach PM	1973 Sp81	NOP,WHS,WAE,SMB,BLG, RKB
Heritage	69-469	83.0	SW	No	2.7	Green	7.0(74)	6.8	Hach	1974	NOP,YEP,WHS,WAE,BUR, NCS
High	69-071	124.7	T (ST)	Yes		Clear	6.9(81)	6.0	PM	Sp81	WHS,RBT,BKT,SPX

St. Louis County
> 5.0 - ≤ 10.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Hobson	69-923	25.9	U	Yes				7.0	PM	Sm80	NOP,YEP,WHS,SMB,LMB, BLC,BLG,PSF,GLS
Hoodoo	69-802	102.0	U	Yes			6.1(81)	8.2	PM	Sp81	NOP,YEP
Hustler, L.	69-332	29.1	NPS	Yes	5.8	Clear	7.0(74) 6.8(78)	13.7 5.9	Hach PM	1974 1978	NOP,WHS,BLG,PSF,RKB
Jacob	69-077	12.1	T	Yes		Brown		5.5	PM	1978	RBT
Kjostad	69-748	172.3	SW	Yes	2.1	Brown	7.0(81)	12.5 15.0 9.0	Field Field PM	1951 1970 Sp81	NOP,YEP,WHS,WAE,SMB, DAC,PSF,RKB,NCS
Linwood	69-248	108.5	NPS	Yes	1.8	Brown-yellow		25.0 8.4	Field PM	1965 1979	NOP,YEP,WHS,WAE,BLC, BLG,PSF,RKB
Locator	69-936	56.7	NPS	Yes	2.4	Brown	6.7	15.0 5.2	Field PM	1970 1978	NOP,YEP,RKB,GSF,DAR
Loiten	69-872	41.3	C	Yes	2.9	Brown		17.5 5.6	Field PM	1970 1978	YEP,LMB,PSF,RKB,DAR
Long	69-493	81.8	C	Yes	4.4	Green	7.3(82) 9.0	22.5 27.5 PM	Field Field Sm82	1951 1960	NOP,WAE,LMB,BLC,BLG, PSF,GSF
Lynx	69-383	114.1	SW	No	3.2	Green	7.0(74)	6.8	Hach	1974	NOP,WHS,WAE,RKB,NCS
McDivett	69-836	12.1	NPS	No	2.1	Brown	7.0(73)	6.8	Hach	1973	NOP,YEP
Minister	69-065	23.1	NPS	Yes	1.9	Brown		10.0 10.0 5.5	Field Field Sm80	1948 1966	NOP,YEP,WAE,BLC,BLG, NCS
Moose, Big	69-316	451.6	U	Yes			6.9(82)	5.2 4.0	PM PM	Sp81 Sm82	NOP,YEP,WHS,SMB,RKB
Otto	69-144	68.0	NPS	Yes	2.1	Brown		30.0 5.8	Field PM	1965 1979	NOP,YEP,WHS,PSF

St. Louis County
> 5.0 - ≤ 10.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Oyster	69-330	312.4	T	Yes	2.4	Clear	7.0(74) 6.3(82)	17.1 6.8 4.0	Hach PM PM	1974 Sp81 F182	NOP,WHS,LAT,BUR,NCS
Picket	69-591	124.7	NPS	No	2.0	Brown	7.0(76) 6.8(81)	17.1 5.6	Hach PM	1976 Sp81	NOP,YEP,WHS,BLG
Reganbogen	69-081	4.9	NPS (ST)	Yes	3.5	Brown	6.4(83)	10.0 12.5 5.5 5.5	Field Field PM PM	1939 1955 Sm80 Sm83	WHS,RBT
Rice, Big	69-178	168.4	RG	No	1.4	Clear	5.3(82)	7.5 1.0	Field PM	1947 Sm82	NOP,YEP,WHS
Rice, Big	69-669	838.5	G	Yes	0.9	Brown	6.8(82)	6.3 4.0	PM PM	1980 Sm82	NOP,YEP,WHS
Rice, Little	69-180	65.2	NPS	No	1.4	Brown		7.5	Field	1964	YEP,WHS,GSF
Saca	69-298	39.7	NPS	No	1.4	Yellow-brown		7.5	Field	1966	NOP,WHS,SMB
Schubert	69-546	88.2	CW	Yes	2.0	Clear		15.0 6.4	Field PM	1965 F180	NOP,YEP,WHS,WAE,SMB, LMB,BLC,BLG,RKB
Shell	69-461	212.5	SW	No	1.8	Green-red	7.0(74) 6.9(81)	6.8 5.8	Hach PM	1974 Sp81	NOP,YEP,WHS,WAE,PSF, RKB
Shell, Little	69-384	36.4	CW	No	4.2	Green	7.5(74)	6.8	Hach	1974	YEP,WHS,WAE,BLG,RKB, NCS
South	69-474	16.2	NPS	No	3.0	Brown	7.0(74)	7.5 17.1	Field Hach	1939 1974	NOP,YEP,WHS,PSF
Steep	69-475	39.7	NPS	Yes	2.9	Clear	8.0(74)	7.5 13.7	Field Hach	1939 1974	NOP,WHS,RKB,NCS
Strand	69-529	153.4	NPS	Yes	1.1	Brown	6.9(82)	22.5 7.0	Field PM	1957 Sm82	NOP,YEP,WHS,WAE,BLC, BRB
Stuart	69-920	10.5	U	Yes				6.0	PM	Sm80	No data

St. Louis County
> 5.0 - ≤ 10.0 mg/l $CaCO_3$

Lake Name	DOW No.	Size (ha)	Ecol. Type	Stocked	Secchi disc (m)	Color	pH(date)	Tot. Alk. (mg/l $CaCO_3$)	Method	Date	Fish Species Present
Takuemich (Buckshot)	69-309	148.5	T	Yes	6.1	Green	8.0(74) 7.0(81)	20.5 7.2	Hach PM	1974 Sp81	SMB,LAT,BUR,NCS
Tooth	69-756	23.9	NPS	No	3.7	Brown	7.5(73) 7.0(81)	17.1 9.1	Hach PM	1973 1978	NOP,YEP,PSF
Trout, L.	69-455	269.1	SW	No	2.1	Brown	6.6(82)	15.0 6.0	Field PM	1958 Sm82	NOP,YEP,WHS,WAE,NCS
Trout	69-498	3738.2	T	Yes	3.7	Brown	6.7(82)	12.5 7.0 5.0	Field PM PM	1958 Sp81 Sm82	No data
Vermillion, L.	69-608	218.5	U	Yes			7.0(81)	7.0	PM	Sp81	No data
White Feather	69-192	43.7	G	No	1.7		6.5(83)	10.0	Field	1949	No data
White Iron	69-004	2023.5	NPS	Yes	1.2	Brown		20.0 28.0 35.0 8.0 9.0	Field Field Field PM PM	1975 1980 1980 Sp81 Sm83	NOP,YEP,WHS,WAE,SMB, BAC,BLG,RKB,BUR,NCS
Wigwam	69-140	5.7	C	No	1.7	Yellow-brown		7.5	Field	1965	YEP
Winkle	69-522	13.4	BH	No	1.8	Yellow-brown		6.25	Field	1965	NOP,YEP,BRB
Wiyapka	69-759	20.2	U	No	1.2	Brown	6.7(73) 6.8(81)	17.1 8.2	Hach PM	1973 1978	DAR

Appendix D. Number, area, size distribution and median sizes for Minnesota's fish lakes having total alkalinities of $\leq$ 10 mg/l $CaCO_3$.

Table D1. Total number and area of Minnesota fish lakes having total alkalinities of 0.0 - ≤ 5.0 mg/l $CaCO_3$ by ecological classification and county.

	Trout		Softwater walleye		Hardwater walleye		Centrarchid-walleye		Centrarchid		Roughfish-gamefish		Bullhead		Northern pike-sucker		Unclassified	
County	No.	Ha	No.	Ha	No.	Ha	No.	Ha	No.	Ha	No.	Ha	No.	Ha	No.	Ha	No.	Ha
Aitkin	0	0	0	0	0	0	1	55	0	0	2	60	0	0	1	13	0	0
Carlton	0	0	0	0	0	0	0	0	3	117	0	0	0	0	1	15	1	15
Cass	0	0	0	0	0	0	0	0	5	89	1	15	0	0	0	0	0	0
Cook	6	1,253	3	380	0	0	1	46	0	0	0	0	1	9	2	114	2	521
Crow Wing	0	0	0	0	0	0	0	0	1	37	0	0	0	0	0	0	0	0
Itasca	3	31	0	0	0	0	0	0	14	398	1	6	2	11	1	38	11	134
Kanabec	0	0	0	0	0	0	0	0	1	34	2	41	1	108	0	0	0	0
Lake	2	9	6	1,516	0	0	1	34	0	0	1	12	0	0	6	203	1	11
Morrison	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	28
Pine	0	0	0	0	0	0	0	0	4	56	0	0	2	19	0	0	1	33
St. Louis	5	1,193	11	1,968	0	0	3	1,887	9	248	2	196	0	0	26	2,596	7	256
Totals	16	2,486	20	3,864	0	0	6	2,022	37	979	9	330	6	147	37	2,979	23	983

Table D2. Total number and area of Minnesota fish lakes having total alkalinities of > 5.0 - ≤ 10.0 mg/l $CaCO_3$ by ecological classification and county.

	Trout		Softwater walleye		Hardwater walleye		Centrachid-walleye		Centrachid		Roughfish-gamefish		Bullhead		Northern pike-sucker		Unclassified	
County	No.	Ha	No.	Ha	No.	Ha	No.	Ha	No.	Ha	No.	Ha	No.	Ha	No.	Ha	No.	Ha
Aitkin	0	0	0	0	0	0	1	114	2	54	0	0	0	0	0	0	0	0
Anoka	0	0	0	0	0	0	0	0	0	0	2	9	0	0	0	0	0	0
Carlton	0	0	0	0	0	0	0	0	3	315	0	0	0	0	0	0	1	6
Cass	0	0	0	0	0	0	0	4	4	124	1	15	1	19	0	0	1	12
Clearwater	0	0	0	0	0	0	0	0	1	26	0	0	0	0	0	0	0	0
Cook	28	6,490	23	3,018	0	0	0	0	1	12	6	77	1	12	38	1,236	17	214
Crow Wing	0	0	0	0	0	0	0	0	4	119	1	26	0	0	0	0	0	0
Itasca	3	46	0	0	1	181	0	0	23	673	1	7	1	5	0	0	17	238
Kanabec	0	0	0	0	0	0	0	0	2	56	2	30	0	0	0	0	0	0
Lake	6	1,158	33	8,417	0	0	1	26	0	0	1	5	0	0	10	743	11	398
Pine	0	0	0	0	0	0	0	0	4	92	1	19	0	0	0	0	0	0
St. Louis	11	8,563	7	2,080	0	0	2	125	5	181	3	1,051	2	21	23	3,840	8	908
Total	48	16,257	63	13,515	1	181	4	265	49	1,652	18	1,239	5	57	71	5,819	55	1,766

Table D3. Total number and area of Minnesota fish lakes having total alkalinities of ≤ 10.0 mg/l $CaCO_3$ by ecological type and county.

	Trout		Softwater Walleye		Hardwater Walleye		Centrarchid-Walleye		Centrachid		Roughfish-Gamefish		Bullhead		Northern pike-sucker		Unclassified	
County	No.	Ha	No.	Ha	No.	Ha	No.	Ha	No.	Ha	No.	Ha	No.	Ha	No.	Ha	No.	Ha
Aitkin	0	0	0	0	0	0	2	169	2	54	2	60	0	0	1	13	0	0
Anoka	0	0	0	0	0	0	0	0	0	0	2	9	0	0	0	0	0	0
Carlton	0	0	0	0	0	0	0	0	6	432	0	0	0	0	1	15	1	6
Cass	0	0	0	0	0	0	0	0	9	213	2	30	1	19	0	0	1	12
Clearwater	0	0	0	0	0	0	1	46	1	26	0	0	0	0	0	0	0	0
Cook	34	7,743	26	3,398	0	0	0	0	1	12	6	77	2	21	40	1,350	19	735
Crow Wing	0	0	0	0	0	0	0	0	5	156	1	26	0	0	0	0	0	0
Itasca	6	77	0	0	1	181	0	0	37	1,071	2	13	3	16	1	38	28	372
Kanabec	0	0	0	0	0	0	0	0	3	90	4	71	1	108	0	0	0	0
Lake	8	1,167	39	9,933	0	0	2	60	0	0	2	17	0	0	16	946	12	399
Morrison	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	28
Pine	0	0	0	0	0	0	0	0	8	148	1	19	2	19	0	0	1	33
St. Louis	16	9,756	18	4,048	0	0	5	2,012	14	429	5	1,247	2	21	49	6,436	15	1,164
Totals	64	18,743	83	17,379	1	181	10	2,287	86	2,631	27	1,569	11	204	108	8,798	78	2,749

Table D4. Size distribution and median size of Minnesota fish lakes having alkalinities of 0.0 - ≤ 5.0 mg/l $CaCO_3$ by ecological classification.

Ecological Classification	Number of lakes by 20 ha size category											Median size (ha)
	0 20	20 40	40 60	60 80	80 100	100 120	120 140	140 160	160 180	180 200	>200	
Trout	6	4	1	0	1	0	0	1	1	0	2	31
Softwater walleye	1	2	2	0	1	0	2	1	1	3	7	190
Hardwater walleye	0	0	0	0	0	0	0	0	0	0	0	0
Centrarchid-walleye	0	2	3	0	0	0	0	0	0	0	1	48
Centrarchid	20	8	7	1	0	1	0	0	0	0	0	19
Roughfish-gamefish	5	1	1	1	0	0	1	0	0	0	0	16
Bullhead	5	0	0	0	0	1	0	0	0	0	0	6
Northern pike-sucker	10	8	7	4	1	1	1	1	1	1	2	47
Unclassified	37	11	2	1	0	1	0	0	0	1	2	11
TOTALS	60	32	21	6	3	3	5	4	3	4	13	33

Table D5. Size distribution and median size of Minnesota fish lakes having alkalinities of > 5.0 - ≤ 10.0 mg/l $CaCO_3$ by ecological classification.

Ecological Classification	Number of lakes by 20 ha size category											Median size (ha)
	0 20	20 40	40 60	60 80	80 100	100 120	120 140	140 160	160 180	180 200	>200	
Trout	15	5	1	2	4	2	2	1	0	1	15	82
Softwater walleye	2	4	4	6	8	3	5	3	6	0	22	125
Hardwater walleye	0	0	0	0	0	0	0	0	0	1	0	181
Centrarchid-walleye	0	2	0	0	1	1	0	0	0	0	0	62
Centrarchid	20	12	13	0	2	1	0	0	0	0	1	26
Roughfish-gamefish	12	3	1	0	0	0	0	0	1	0	1	12
Bullhead	5	0	0	0	0	0	0	0	0	0	0	13
Northern pike-sucker	25	22	9	3	1	1	3	1	2	0	4	31
Unclassified	37	11	2	1	0	1	0	0	0	1	2	11
TOTALS	116	59	30	12	16	9	10	5	9	3	45	33

Table D6. Size distribution and median size of Minnesota fish lakes having alkalinities of ≤ 10.0 mg/l $CaCO_3$ by ecological classification.

Ecological Classification	Number of lakes by 20 ha size category											Median size (ha)
	0 20	20 40	40 60	60 80	80 100	100 120	120 140	140 160	160 180	180 200	> 200	
Trout	21	9	2	2	5	2	2	2	1	1	17	68
Softwater walleye	3	6	6	6	9	3	7	4	7	3	29	145
Hardwater walleye	0	0	0	0	0	0	0	0	0	1	0	181
Centrachid-walleye	0	4	3	0	1	1	0	0	0	0	1	48
Centrarchid	40	20	20	1	2	2	0	0	0	0	1	22
Roughfish-gamefish	17	4	2	1	0	0	1	0	1	0	1	15
Bullhead	10	0	0	0	0	1	0	0	0	0	0	9
Northern pike-sucker	35	30	16	7	2	2	4	2	3	1	6	36
Unclassified	37	11	2	1	0	1	0	0	0	1	2	11
TOTALS	176	91	51	18	19	12	15	9	12	7	58	33

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