

REGIONAL COPPER-NICKEL STUDY

LAKE FISHERIES REPORT

MEQB Regional Copper-Nickel Study

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Abstract

Minnesota Department of Natural Resources lake survey data was compiled to characterize lake fish populations in the Regional Copper-Nickel Study Area (Study Area) to predict possible impacts from copper-nickel mining development on lake ecosystems.

There are 310 lakes located within the Study Area. Of 112 lakes studied, 42 are small, shallow lakes of marginal fish value. Lakes managed for walleyes make up 60% of the remaining 70 lakes which are managed for game fish. All of the Study Area lakes managed for walleyes are softwater walleye lakes. Walleye, northern pike, and white suckers are the most commonly found species in these lakes.

Size and abundance of walleye and northern pike were similar north and south of the Laurentian Divide but white suckers were significantly higher in both numbers and size in southern lakes.

Generally, abundance and weight of walleye, northern pike, and white suckers are higher than the statewide medians, but only the weight per net of these species and the abundance of walleyes is greater than the Region II (includes Cook, Lake, St. Louis, Carlton, Koochiching and Itasca Counties) medians.

Walleye and northern pike are similar in abundance but smaller in size in Study Area lakes than in statewide hardwater walleye lakes. White suckers are similar in size but greater in abundance in Study Area lakes than in hardwater walleye lakes.

The northeastern corner of Minnesota contains virtually all the managed lake trout lakes found in the state. Lake trout lakes are generally cold and deep containing relatively few species of fish.

Northern pike lakes in the Study Area are usually small and shallow and therefore receive little management because of their inability to sustain a sport fishery.

INTRODUCTION TO THE REGIONAL COPPER-NICKEL STUDY

The Regional Copper-Nickel Environmental Impact Study is a comprehensive examination of the potential cumulative environmental, social, and economic impacts of copper-nickel mineral development in northeastern Minnesota. This study is being conducted for the Minnesota Legislature and state Executive Branch agencies, under the direction of the Minnesota Environmental Quality Board (MEQB) and with the funding, review, and concurrence of the Legislative Commission on Minnesota Resources.

A region along the surface contact of the Duluth Complex in St. Louis and Lake counties in northeastern Minnesota contains a major domestic resource of copper-nickel sulfide mineralization. This region has been explored by several mineral resource development companies for more than twenty years, and recently two firms, AMAX and International Nickel Company, have considered commercial operations. These exploration and mine planning activities indicate the potential establishment of a new mining and processing industry in Minnesota. In addition, these activities indicate the need for a comprehensive environmental, social, and economic analysis by the state in order to consider the cumulative regional implications of this new industry and to provide adequate information for future state policy review and development. In January, 1976, the MEQB organized and initiated the Regional Copper-Nickel Study.

The major objectives of the Regional Copper-Nickel Study are: 1) to characterize the region in its pre-copper-nickel development state; 2) to identify and describe the probable technologies which may be used to exploit the mineral resource and to convert it into salable commodities; 3) to identify and assess the impacts of primary copper-nickel development and secondary regional growth; 4) to conceptualize alternative degrees of regional copper-nickel development; and 5) to assess the cumulative environmental, social, and economic impacts of such hypothetical developments. The Regional Study is a scientific information gathering and analysis effort and will not present subjective social judgements on whether, where, when, or how copper-nickel development should or should not proceed. In addition, the Study will not make or propose state policy pertaining to copper-nickel development.

The Minnesota Environmental Quality Board is a state agency responsible for the implementation of the Minnesota Environmental Policy Act and promotes cooperation between state agencies on environmental matters. The Regional Copper-Nickel Study is an ad hoc effort of the MEQB and future regulatory and site specific environmental impact studies will most likely be the responsibility of the Minnesota Department of Natural Resources and the Minnesota Pollution Control Agency.

PURPOSE

This regional characterization is intended to describe the dominant taxa of the region and their relationships, as well as the similarities and differences between the sites sampled. It provides a basis for assessing the potential impacts of copper-nickel development. It does not, in general, provide the baseline data necessary to detect impacts of development at particular sites. Techniques for developing such a baseline and ways in which these data might be used in planning a baseline monitoring program are discussed in a separate report, Biological Monitoring of Aquatic Ecosystems (Regional Copper-Nickel Study 1978).

INTRODUCTION

Fish are an important component of aquatic ecosystems. They feed on algae, invertebrates and fish and provide a food source for man and other animals. Because of their reliance on lower forms of aquatic life, and because fish have specific environmental requirements, fish communities reflect overall biological, physical and chemical conditions in aquatic ecosystems.

The standing crop of fish reflects the overall productivity of an aquatic system. The biological productivity of lakes is closely related to lake morphometry (basin shape), lake bottom type, soil type, geology of the surrounding watershed and latitude. The Minnesota Department of Natural Resources (MDNR) has classified Minnesota lakes based on their potential for supporting major fish and/or game species. The ecological classification described by Scidmore (1970) classifies lakes according to the fish species best adapted to the chemical, physical, and biological characteristics of a lake. Table 1 describes the ecological lake types found in Minnesota. Table 2 describes the physical and chemical characteristics of these lake types. Softwater walleye and trout lakes are generally located in northeastern Minnesota while other lake types occur more frequently in the southern and western portions of the state.

The MDNR lake management classification system describes the species or combinations of species to which management effort is directed (Table 3). Management types generally parallel ecological lake types except when management activities are used to favor desirable game species. Lake reclamation, fish stocking and angling regulations may be used to alter the species composition of a lake.

Most lakes within the Regional Copper-Nickel Study Area (Study Area) have been previously surveyed by the MDNR. The emphasis of this portion of the Regional Copper-Nickel Study was the compilation of this information to better predict the potential for impact from copper-nickel development on lake ecosystems. By relating physical, chemical and biological data collected in other phases of the Regional Copper-Nickel Study to fish data, a better description of conditions in lakes not sampled for these parameters may be possible. Public interest in Minnesota's fishery resources also make characterization of lakes fish populations an important aspect of the Regional Copper-Nickel Study.

METHODS

Study Area

The Study Area is a 5516 km² (2130 mi²) area in Lake and St. Louis counties in northeastern Minnesota (Figure 1). It is divided into two major watersheds by the Laurentian Divide. Water in the southern portion of the Study Area flows into Lake Superior while water in the northern portion flows through the Rainy River system into Hudson Bay. There are approximately 310 lakes in the Study Area. The majority are located in the northern part of the Study Area.

Lakes in the Study Area are generally shallow, mesotrophic lakes. The ratio of littoral area to profundal area is small and the photic zone is narrow. The majority of lakes are bog-stained from the high humus content and total alkalinities are low.

Field Procedures

Lakes within the Study Area have been surveyed by the MDNR during the past 20 years. The methods currently in use for lake surveys are discussed by

Scidmore (1970). It was felt that existing lake survey information would suffice for a regional characterization, however, updated surveys were requested for 10 aquatic biology and water quality primary and survey lakes which were surveyed by the MDNR prior to 1966. A list of these lakes is presented in Table 4.

RESULTS AND DISCUSSION

Management Classifications of Study Area Lakes

Management classifications for large lakes are shown in Figure 1. Information was compiled for 112 lakes in the Study Area; 42 (37.5%) of which are primarily small, shallow lakes of marginal fish value (Table 5). The remaining 70 lakes are classified as walleye (60%), northern pike (15.8%), centrarchid or walleye-centrarchid (11.4%), trout (7.1%) and regular winterkill (5.7%).

Distribution of Fish Species in the Study Area

The frequency of occurrence of fish species in the lakes of the Study Area is shown in Table 6. Northern pike and white suckers are present in 88.5% and 90.0% of the lakes, followed by yellow perch (82.8%) and walleye (67.1%). Species lists for Study Area lakes are presented in Tables 7 and 8. Common and scientific names of fishes found in the Study Area appear in Table 9.

Walleyes occur more frequently in lakes south of the Laurentian Divide, while tullibee and whitefish are found more frequently north of the Divide. Bullheads and catfish do not occur north of the Divide but are found in lakes south of the Divide. There are no lake trout or stream trout lakes in the Study Area south of the Divide because most lakes south of the Divide are too shallow and warm in the summer to support trout.

Data concerning the distribution of fishes can be misleading because different types of sampling equipment are used in different lakes. Gill and trapnets

are selective for certain species and sizes of fish (Lagler 1971). Small-mouth and largemouth bass are generally netted in low numbers because of their movement habits and avoidance of nets. Minnows and forage species may not be accurately represented in gill and trapnet data because of their small size. Species such as common, spottail, and mimic shiners, brook sticklebacks and mottled sculpins are usually not included in species lists for lakes unless seining data are available. Seining, in lakes of the Study Area, is often difficult or impossible because of muck bottoms, steep and boulder strewn shorelines.

Walleye Lakes in the Study Area

Sixty percent of the lakes managed for gamefish in the Study Area are managed specifically for walleyes. All of the managed walleye lakes in the Study Area are soft-water walleye lakes. Although total alkalinity exceeds 40 mg/l in several lakes (Tables 7 and 8) it does not exceed 100 mg/l, the lower limit for hardwater walleye lakes (Table 2).

Data from 40 lakes managed for walleyes (Tables 10, 11 and 12) were compiled to summarize the characteristics of walleye lakes in the Study Area for comparison with walleye lakes throughout the State of Minnesota. The most frequently collected fish species were walleye and northern pike found in 97.5 percent of the Study Area walleye lakes, followed by white sucker (95%) and yellow perch (92.5%).

A variety of minnows are known to occur but the species list presented in Table 10 is not complete because of the lack of extensive seining data.

Abundance and Size of Walleye, Northern Pike and White Suckers in Study Area Walleye Lakes

The average number and weight of the three most commonly collected species (walleye, northern pike and white sucker) were compared for Study Area lakes

north and south of the Laurentian Divide using a students "t" test. The average number and weight of walleyes and northern pike were similar for lakes north and south of the Divide ($P > .05$) while the average number and weight of white suckers were significantly different ($P < .05$), being higher for lakes south of the Divide.

Walleye production in Study Area walleye lakes is greatest in Shagawa Lake (Tables 11 and 12). It had the greatest number of walleyes per net (37.9), the greatest weight per net (22.6 kg), and the second largest value for weight per fish (0.59 kg) for lakes north of the Divide. Gabbro, White Iron, Fall, Birch and Bald Eagle lakes also lie north of the Divide and produce large numbers of walleyes relative to other lakes in the Study Area. South of the Laurentian Divide, Bassett and Cadotte lakes had high numbers of walleyes relative to other lakes south of the Divide, as well as all walleye lakes in the Study Area. Wynne Lake had the largest fish of all walleye lakes studied but fewer walleyes per net.

Birch and Gabbro lakes north of the Divide and Pine, Round, Esquagama and Cadotte lakes south of the Divide have large northern pike. Esquagama Lake south of the Divide and Birch Lake north of the Divide had the largest average weight per fish.

White suckers were most abundant in Slate and Dunnigan Lakes each with an average of 15.0 suckers per net. Shagawa Lake had the second largest number (11.0 fish/net) and the largest average size (86 kg/fish) white suckers north of the Divide. South of the Divide, the largest white sucker populations recorded were from Round (9.0 fish/net) and Pine (6.7 fish/net) Lakes. The largest white suckers were found in Round Lake (1.26 kg/fish).

To compare overall fish productivity in Study Area lakes the weight per net of walleye, northern pike and white sucker were summed for each lake, values are shown in Table 13. For lakes not assigned a value, weight data are lacking for one or more species. Lakes north of the Laurentian Divide are generally more productive than lakes south of the Divide. Shagawa and Greenwood Lakes had the highest productivity indices; 34.64 and 23.14 respectively. South of the Laurentian Divide Bassett and Round lakes were most productive with values of 19.82 and 16.29 respectively.

Comparison of Study Area Walleye Lakes to other Walleye Lakes in Minnesota

The median number and weight per gill net of walleye, northern pike and white suckers are presented in Table 14. The median numbers per net for these three species in Study Area walleye lakes are higher than the statewide medians.

The median weights per net are higher than the statewide medians for walleye and white suckers but lower than the statewide median for northern pike.

The median number per net for Study Area walleye lakes is higher than the Region II median for northern pike but lower for walleye and white suckers. The median weight per net is higher for Study Area lakes than the Region II median for all three species.

Table 15 presents the mean number per net, weight per net and weight per fish for 12 typical hardwater walleye lakes in Minnesota. Comparisons with Study Area lakes were made using a student's "t" test. The mean number and weight per net for walleye and northern pike were not significantly different ($P > .05$) in Study Area lakes than hard water walleye lakes. The mean weight per fish was significantly higher ($P < .05$) in hardwater walleye lakes for walleye and northern pike. The mean number and weight per net of white suckers was significantly higher ($P < .05$) in Study Area lakes, but the mean weight per fish was not significantly different ($P > .05$). The white sucker is basically a coldwater species and is well adapted to the coldwater lakes of northern Minnesota (Petersen 1974).

It is therefore, generally found in greater numbers in northern Minnesota than southern and western Minnesota lakes.

Lake Trout Lakes in the Study Area

Virtually all lakes in Minnesota managed for lake trout are in MDNR Region II. Within this Region, there are 106 lake trout lakes with a surface area of 155,484 acres. Ninety-seven percent of these lakes are within the northern one-half of St. Louis, Lake and Cook counties and 55% are managed for lake trout and are stocked with trout according to specific management requests. The remaining "unmanaged" lakes rely on natural reproduction for maintenance of lake trout populations.

Lake trout lakes range from 24 to 19,820 acres and average 1487 acres in surface area. A typical lake trout lake in northeastern Minnesota is greater than 30 M deep, has high dissolved oxygen concentrations below the thermocline and maximum summer temperatures in the surface waters less than 21°C. Fertility of these lakes as measured by total alkalinity and phosphorus concentrations, is generally low. Substrate types in shallow waters consists of 30-100% bedrock and boulders. Organic matter usually comprises less than 10% of shoal bottom types while sand and gravel make up the remainder. The total alkalinity of 35 lake trout lakes in St. Louis and Cook counties averaged 27 mg/l and ranged from 34-51.3 mg/l as CaCO₃ (Arthur Peterson, MDNR, Personal Communication).

Table 16 shows the fish species composition of seven lake trout lakes in northeastern Minnesota. These lakes have relatively few species of fish commonly sampled by gillnets. On the average, 5 to 6 species of fish were collected per lake. Lake trout, northern pike, yellow perch, white sucker, walleye and rock bass and tullibeas were most commonly represented. Other species collected in gillnets include burbot, whitefish, shorthead redhorse,

black crappie, bluegill, black bullhead, sauger, and smallmouth bass. Minnows and other forage species are not well represented in gillnet or trapnet catches, but limited shoreline data indicate that longnose dace, mimic, common, golden, and spottail shiners, blacknose minnows, log perch, johnny and Iowa darters, trout-perch, and madtoms are present.

Managed Stream Trout Lakes in the Study Area

Seventy-one percent of the 144 managed stream trout lakes in Minnesota are found in St. Louis, Lake and Cook counties (Anonymous, 1976). Twelve managed stream trout lakes totaling 529 acres are within the Study Area. They range in size from 5.2 to 319 acres and are stocked with either brook or rainbow trout. Many of these lakes are stocked on an annual basis with fingerlings. Most of these lakes are in the Ely-Winton area although a few are in the Virginia-Eveleth area (Table 17). Tofte Lake is one of the Study Area survey lakes and has been stocked exclusively with rainbow trout since 1968. The fish species found in Tofte Lake are listed in Table 7. This list is probably representative of Study Area stream trout lakes.

Maximum depths range from about 25 to 75 feet, and high dissolved oxygen concentrations exist below the thermocline. Fertility as measured by total alkalinity and phosphorus concentrations is generally low (range 7 to 80 ppm as CaCO_3). Shoal water soils are mostly rubble, boulders and bedrock with some gravel and sand. Lake bottoms may have high percentages of muck as well as rubble and boulders.

In many cases, lakes managed for stream trout have been reclaimed with fish toxicants prior to introduction of the desired trout species. Typically these small lakes contained some combination of the following fish species prior to lake reclamation: northern pike, yellow perch, rock bass, various species of sunfish, white suckers, large and or smallmouth bass, tullibeas and a

variety of minnows.

There are no managed stream trout lakes in the potential mining zone. However, there are a few small spring-fed pools associated with small cold-water streams which support isolated brook trout populations found in the Stony and Isabella River watersheds.

Northern Pike Lakes in the Study Area

Northern pike lakes in the Study Area are generally shallow, less than 100 acres in size and lack good spawning habitat for walleyes and bass. Total alkalinity for Study Area northern pike lakes is low (8-62.5 mg/l) and dissolved oxygen concentrations usually remain high, although severe winters may cause winter-kill. Growth rates for northern pike and associated forage species such as white sucker and yellow perch are usually low. These lakes receive little or no management and fish produced in these lakes are usually too small to sustain a quality sport fishery. Examples of northern pike lakes in the Study Area include Perch, Turtle, Two Deer, Fran, Chow, Long, and Big.

Comparison of Updated Lake Surveys with Old Surveys

Table 18 provides a comparison of lake survey data from 1961 with updated surveys for 6 primary and survey lakes in the Study Area. All lakes had greater numbers of walleye, northern pike and white suckers in 1977 than during previous surveys with the exception of Clearwater and Lower McDougal lakes, although statistical significance was not determined. Northern pike and white sucker numbers decreased in Clearwater Lake and walleyes decreased in Lower McDougal Lake.

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Table 1. Ecological classification of Minnesota lakes*.

- (1) Trout - Deep, rocky, infertile lakes with oxygen throughout. Tullibee and suckers are other principal components of the population. Typical lakes: Mountain, Clearwater - Cook County.
- (2) Softwater walleye - Infertile, medium to large size lakes in northeastern Minnesota iwth natural walleye populations. Typical lakes: Pike - Cook County, Vermilion - St. Louis County.
- (3) Hardwater walleye - Moderately fertile, medium to large size lakes in which walleyes are well established naturally. Typical lakes: Mille Lacs, Winnibigoshish, Leech.
- (4) Centrarchid - walleye - Medium to large sized, usually lakes consisting of many ecologically different bays or sections, some being natural walleye habitat, others more suitable for panfish species. May also have substantial bullhead nad/or carp and/or buffalo populations. Typical lakes: Minnetonka, Sally, Minnewaska.
- (5) Centrarchid - Medium and small sized, weedy, fertile, hardwater lakes. Usually no large open areas. May also contain moderate to substantial populations of carp; and/or buffalo and/or bullheads. Typical lakes: Gladstone - Crow Wing County, Maple - Douglas County.
- (6) Roughfish - gamefish - Fertile herdwater lakes in southern and central Minnesota characterized by relatively large rough-fish (carp, buffalo, sheepshead, bullhead) populations. Many may occasionally winter-kill. Typical lakes: Tetonka - Le Sueur County, Long - Ramsey County, and Washington - Blue Earth County.
- (7) Bullhead - Shallow lakes, in which frequent winter-kills promote the dominance of bullheads. Typical lakes: Christina, Star Bear
- (8) Unclassified - These are often small lakes whose native fish populations do not fit any of the above categories. Lakes reclaimed for stream trout stocking may fall in this category. Use this classification with caution; it is not intended as a catchall or a substitute for careful analysis.
- (9) **Minnow or freeze-out lake - Infertile, relatively small and shallow, may winter-kill frequently, generally lacking good habitat for larger game species. May have populations of brook sticklebacks, fine scale dace and mud minnows.

*From Scidmore (1970)

**Not discussed by Scidmore but currently being used by MDNR personnel.

TABLE 2 Physical and chemical characteristics of principal Minnesota fish lake types*.

Lake Type	Trout	Softwater Walleye	Hardwater Walleye	Centrarchid Walleye	Centrarchid	Northern Pike**	Roughfish Gamefish	Bullheads	Minnow**
Shoal Bottom Type									
Bedrock-Boulder (%)	30-100	30-100	-	-	-	-	-	-	-
Gravel-Sand (%)	< 20	< 20	> 90	> 75	< 75	< 50	< 80	< 30	< 30
Organic (%)	< 10	< 20	< 10	< 25	> 25	> 50	> 20	70-100	70-100
Percent Littoral Area	15-20	15-20	25-35	25-50	25-50	50-100	35-70	75-100	75-100
Dissolved O ₂ below Thermocline	> 5.0ppm	may be absent	may be absent	may be absent	usually absent	may be unstratified	may be unstratified	usually unstratified	usually unstratified
Temperature (Maximum in Epilimnion)	< 70°F	< 70°F	< 75°F	< 80°F	< 80°F	< 80°F	< 85°F	< 85°F	< 85°F
Total Alkalinity (mg/l)	< 40	< 40	> 100	> 100	> 100	< 50	> 100	> 100	variable
Total Phosphorus (mg/l)	< .02	< .025	< .03	< .05	< .05	-	> .05	> .10	-
Typical Size (acres)	35 stream trout 1000 lake trout	1000	1000	600	300	< 100	variable	variable	< 100
Typical Maximum Depth, (ft)	> 65	> 50	> 35	> 25	> 25	< 50	variable	< 20	< 20

*From Scidmore(1970)

**Developed for Regional Copper-Nickel Study

Table 3. Management classifications for Minnesota lakes*.

- (1) Trout - Specify by species. Lake trout management usually restricts introductions to this species unless a two-story condition prevails. Stream trout management usually involves elimination of competitive species and the introduction of fingerlings of the appropriate species.
- (2) Walleye - These lakes are managed to favor established walleye populations and northern pike. Usually little or no management of other sport fishes.
- (3) Walleye - centrarchid - (formerly walleye - bass - panfish) This type of management is designed to furnish a walleye fishery of moderate size, without displacing largemouth or smallmouth bass or panfish populations.
- (4) Centrarchid - (formerly bass - panfish) Specify as largemouth or smallmouth bass since physical characteristics of the lakes managed will differ depending on the species. In addition to bass and panfish, considerable attention is usually given to the northern pike.
- (5) Gamefish - This classification is designed to cover those lakes in southern and central Minnesota where roughfish removal and stocking of rescued fish are common management procedures. They include lakes which occasionally winter-kill where management is aimed at building up a desirable fish population in as short time as possible.
- (6) Regular winter-kill - Management of lakes in this classification is usually confined to rescue work and/or walleye fry stocking.
- (7) **Northern pike- Little or no actual management is extended toward these lakes; they are not stocked. Northern pike are generally small and not acceptable to the average angler.
white sucker-
yellow perch-

*From Scidmore (1970).

**Developed for the Regional Copper-Nickel Study.

Table 4. Primary and survey lakes resurveyed in 1977

<u>Lake</u>	<u>Original Survey</u>
Clearwater	1962
Turtle	1962
Little Gabbro	—
Gabbro	1963
Lower McDougal	1961
August	1962
Bald Eagle	1963
Perch	—

Table 5. Lakes of marginal fish value in the Study Area.

Lake	D.O.W. Number	Area (Acres)	Remarks	Year of Survey
Crockett	38-177	20	No information available	
Perch	69-58	91	Mgt. type should be NP-S-YP	
Baird	38-694	18	Game lake	1963
Climber	38-695	15	No information available	
Gesend Pond	38-689	12	Possible winter-kill--use as walleye rearing pond	1975
Labrador	—	10	Freeze-out lake	
Leatherleaf	—	10	Freeze-out lake	
Nickel	38-705	22	Mgt. type NP-S-YP, possible winter-kill	
Robin	38-661	25	Freeze-out lake	1971
Starling	38-697	10	Freeze-out lake	
Heart	38-692	42	Game lake	
Kangas	69-57	35	Probable NP-S-YP	
Hanson	69-189	<20	Private pond stocked with trout	
Pearl	—	<20	Private pond stocked with trout	
Round (Bonga)	38-762	138	Freeze-out lake	
Pitcha	38-676	39	Freeze-out lake	
Tony	38-696	10	Freeze-out lake	1971
Little Wampus	38-684	24	Minnow lake	
Gypsy	38-665	26	Minnow lake	1961
Lobo	38-766	132	Minnow lake	1972
Wampus	38-685	146	Minnow lake, probable winter-kill	1961
Perch (Cougar)	38-767	71	Game lake	1967

Table 5. continued

Lake	D.O.W. Number	Area (Acres)	Remarks	Year of Survey
Denley	38-773	22	Game lake	
Beaver Hut	38-737	32	Unclassified	
Fools	38-761	14		
Gunsten	—	19	Unclassified--potential trout lake	
Jackpot	38-772	13	Unclassified	
Alsike	38-672	30	Game lake	1964
Stony	38-660	409	Game lake	1963
Little Spring	—	5	Game lake--walleye rearing pond	1963
Stone	69-46	230	Unclassified	1976
Swamp	69-45	77	Unclassified	1976
Ridgepole	38-759	23	Unclassified	
Mud	69-47	44	Unclassified	
Hush	—	<80	Unclassified	
Lillian	38-542	<40	Unclassified	
Culkin	38-764	58	Unclassified	
Continental	38-765	<40	Unclassified	
Bird	—	<80	Unclassified	
Mud	69-148	33	Part of Reserve Mining operation	
Iron	69-152	180	Part of Reserve Mining operation	1965
Norway	38-688	33	Centrachid	

Table 6. Occurrence of fish species in lakes in the Study Area.

Species	Lakes North of Laurentian Divide (52)		Lakes South of Laurentian Divide (18)		Total (70)	
	Number	Percent	Number	Percent	Number	Percent
Northern pike	45	86.5	17	94.4	62	88.5
Yellow perch	43	82.7	15	83.3	58	82.8
White sucker	48	92.3	15	83.3	63	90.0
Walleye	33	63.4	14	77.7	47	67.1
Rock bass	19	36.5	5	27.7	24	34.3
Tullibee	17	32.7	3	16.6	20	28.5
Bluegill	17	32.7	7	38.8	24	34.2
Black crappie	15	28.8	8	44.4	23	32.9
Burbot	3	5.7	1	5.5	4	5.7
Tadpole madtom	3	5.7	2	11.1	5	7.1
Whitefish	6	11.5	0	0.0	6	8.5
Largemouth bass	8	15.3	2	11.1	10	14.2
Smallmouth bass	6	11.5	0	0.0	6	8.6
Shorthead redhorse	2	3.8	1	5.5	3	4.3
Pumpkinseed	6	11.5	3	16.6	9	12.9
Hybrid sunfish	3	5.7	0	0.0	3	4.3
Black bullhead	0	0	2	11.1	2	2.9
Brown bullhead	0	0	1	5.5	1	1.4
Channel catfish	0	0	2	11.1	2	2.9
Rainbow trout	1	1.9	0	0.0	1	1.4
Brook trout	1	1.9	0	0.0	1	1.4
Muskellunge	2	3.8	0	0.0	2	2.9

Table 6. continued

Species	Lakes North of Laurentian Divide (52)		Lakes South of Laurentian Divide (18)		Total (70)	
	Number	Percent	Number	Percent	Number	Percent
Yellow bullhead	0	0	1	5.5	1	1.4
Sculpin spp.	1	1.9	2	11.1	3	4.3
Iowa darter	10	19.2	1	5.5	11	15.7
Johnny darter	13	25.0	4	22.2	17	24.3
Log perch	5	9.6	0	0.0	5	7.1
Trout-perch	2	3.8	0	0.0	2	2.9
Spottail shiner	6	11.5	1	5.5	7	10.0
Blacknose shiner	11	21.1	0	0.0	11	15.7
Common shiner	4	7.7	1	5.5	5	7.1
Mimic shiner	4	7.7	0	0.0	4	5.7
Golden shiner	7	13.4	0	0.0	7	10.0
Hornyhead chub	1	1.9	0	0.0	1	1.4
Bluntnose minnow	6	11.5	0	0.0	6	8.6
Lake trout	3	5.7	0	0.0	3	4.3
Finescale dace	3	5.7	0	0.0	3	4.3
Brook stickle- back	3	5.7	0	0.0	3	4.3
Blacknose dace	1	1.9	0	0.0	1	1.4
Northern redbelly dace	2	3.8	0	0.0	2	2.9
Fathead minnow	2	3.8	0	0.0	2	2.9
Central mudminnow	2	3.8	0	0.0	2	2.9

Table 7. Fish species composition of Hudson Bay drainage lakes in the Regional Copper-Nickel Study Area.

Hudson Bay Drainage	Lake Number	Type and Date of Sampling	Ecological Classification	Management Classification	Plan Area Acres	Total Alkalinity ppm	Northern pike	Walleye	Smallmouth bass	Largemouth bass	Lake trout	Rainbow trout	Brook trout	Tullibee	Whitefish	Bluegill	Pumpkinseed	Hybrid sunfish	Green sunfish	Rock bass	Black crappie	White sucker	Shorthead redhorse	Yellow perch	Channel catfish	Black bullhead	Brown bullhead	Tadpole madtom	Burbot	Muskellunge	Sculpin spp.	Iowa darter	Johnny darter	Log perch	Trout-perch	Spottrail shiner	Blacknose shiner	Common shiner	Mimic shiner	Golden shiner	Hornyhead chub	Bluntnose minnow	Yellow bullhead	Finescale dace	Brook stickleback	Blacknose dace	Northern redbelly dace	Fathead minnow	Central mudminnow	Sampling Gear Used		
Tofte*	38-724		NP-SP	Tr	134		+	+			+																																								G	
Triangle	38-715	LS-75	C-W	C-W	397	34.2	+		+	+																																										G,T
Bass	69-63	LS-74	C	C-W	144	34.2	+																																												G,T	
Fall	38-811	LS-59 FT-77	SW-W	W	2173		+	+																																											G,T,S	
Lake One	38-605	LS-58	SW-W	W	876	10	+	+																																										G,T,S		
Clearwater	38-638	LS-77	NP-S-P	Tr	641	17.1	+																																											G,S		
White Iron	69- 4	LS-58	SW-W	W	3429		+	+																																											G,T	
Bear Island	69-115	LS-52	SW-W	W	1972	17.5	+	+																																										G,T		
Perch	69-58	LS-77	NP-C	NP,S,P	109	17.1	+																																											G,S, MT		
Gabbro	38-701	LS-63,77	SW-W	W	896	51.3	+	+																																										G,S		
Turtle	38-704	LS-62,77	NP-S-P	NP,S,P	337	42.7	+																																												G,S	
August	38-691	LS-62,77	SW-W	W	218	20/ 20.5	+	+																																											G,T	
Birch	69- 3	LS-75,54 FT-76	SW-W	W	5628	54.3	+	+																																												G,T,S
Greenwood	38-656	LS-51 FT-76	—	W	1240	11.5	+	+																																												G
Sand	38-735	LS-61	SW-W	W	476	27.5	+	+																																												G,T,S

*Tofte Lake was reclaimed and subsequently converted to a stream trout lake.

**Abbreviations used: G=Gillnet; MT=Minnow trap; T=Trapnet; S=Seine; Tr=Trout; HW=Hardwater; SW=Softwater; W=Walleye; NP=Northern pike; S=White sucker; P=Yellow perch; C=Centrarchid.

Table 9. Family, scientific and common names of all fishes collected in the Regional Copper-Nickel Study Area

FAMILY NAME	SCIENTIFIC NAME	COMMON NAME
Salmonidae	<i>Salvelinus fontinalis</i>	Brook trout
	<i>Salvelinus namaycush</i>	Lake trout
	<i>Salmo gairdneri</i>	Rainbow trout
	<i>Coregonus clúpeaformis</i>	Lake whitefish
	<i>Coregonus artedi</i>	Cisco, Tullibee
Osmeridae	<i>Osmerus mordax</i>	Rainbow smelt
Umbridae	<i>Umbra limi</i>	Central mudminnow
Esocidae	<i>Esox lucius</i>	Northern pike
	<i>Esox masquinongy</i>	Muskellunge
Cyprinidae	<i>Rhinichthys atratulus</i>	Blacknose dace
	<i>Rhinichthys cataractae</i>	Longnose dace
	<i>Couestius plumbeus</i>	Lake chub
	<i>Semotilus atromaculatus</i>	Creek chub
	<i>Semotilus margarita</i>	Pearl dace
	<i>Chrosomus eos</i>	Northern redbelly dace
	<i>Chrosomus neogaeus</i>	Finescale dace
	<i>Notemigonus crysoleucas</i>	Golden shiner
	<i>Pimephales notatus</i>	Bluntnose minnow
	<i>Pimephales promelas</i>	Fathead minnow
	<i>Notropis anogenus</i>	Pugnose shiner
	<i>Notropis atherinoides</i>	Emerald shiner
	<i>Notropis cornutus</i>	Common shiner
	<i>Notropis hudsonius</i>	Spottail shiner
<i>Notropis heterolepis</i>	Blacknose shiner	

Table 9. continued

FAMILY	SCIENTIFIC NAME	COMMON NAME
Cyprinidae(contd)	<i>Notropis volucellus</i>	Mimic shiner
	<i>Notropis heterodon</i>	Blackchin shiner
	<i>Hybognathus hankinsoni</i>	Brassy minnow
Catostomidae	<i>Moxostoma macrolepidotum</i>	Northern redhorse
	<i>Catostomus commersoni</i>	White sucker
Ictaluridae	<i>Ictalurus punctatus</i>	Channel catfish
	<i>Ictalurus nebulosus</i>	Brown bullhead
	<i>Ictalurus melas</i>	Black bullhead
	<i>Ictalurus natalis</i>	Yellow bullhead
	<i>Noturus gyrinus</i>	Tadpole madtom
Percopsidae	<i>Percopsis omiscomaycus</i>	Trout-perch
Gadidae	<i>Lota lota</i>	Burbot
Gasterosteidae	<i>Culaea inconstans</i>	Brook stickleback
Centrarchidae	<i>Micropterus salmoides</i>	Largemouth bass
	<i>Micropterus dolomieu</i>	Smallmouth bass
	<i>Ambloplites rupestris</i>	Rock bass
	<i>Lepomis macrochirus</i>	Bluegill
	<i>Lepomis gibbosus</i>	Pumpkinseed
	<i>Pomoxis nigromaculatus</i>	Black crappie
	Percidae	<i>Perca flavascens</i>
<i>Stizostedion v. vitreum</i>		Walleye
<i>Percina caprodes</i>		Log perch
<i>Etheostoma nigrum</i>		Johnny darter
<i>Etheostoma exile</i>		Iowa darter
Cottidae	<i>Cottus bairdi</i>	Mottled sculpin
	<i>Cottus cognatus</i>	Slimy sculpin

Table 10. Occurance of fish species in managed walleye lakes
in the Study Area

Species	Lakes North of Laurentian Divide (27)		Lakes South of Laurentian Divide (13)		Total Study Area (40)	
	Number	Percent	Number	Percent	Number	Percent
Norther Pike	26	96.3	13	100	39	97.5
Yellow perch	26	96.3	11	84.6	37	92.5
White sucker	27	100	11	84.6	38	95
Walleye	26	96.3	13	100	39	97.5
Rock bass	15	55.6	5	38.5	20	50
Tullibee	12	44.4	2	15.4	14	35
Bluegill	10	37.0	6	46.2	16	40
Black crappie	11	40.7	8	61.5	19	47.5
Burbot	3	11.1	1	7.7	4	10
Tadpole madtom	3	11.1	0	-	3	7.5
Whitefish	3	11.1	0	-	3	7.5
Largemouth bass	2	7.4	2	15.4	4	10
Smallmouth bass	4	14.8	0	-	4	10
Shorthead redhorse	2	7.4	1	7.7	3	7.5
Pumpkinseed	3	11.1	3	23.1	6	15
Hybrid sunfish	0	-	0	-	0	-
Black bullhead	0	-	2	15.4	2	5
Brown bullhead	0	-	1	7.7	1	2.2
Channel catfish	0	-	2	15.4	2	5
Muskellunge	1	3.7	0	-	1	2.5
Yellow bullhead	0	-	1	7.7	1	2.5
Sculpin spp.	0	-	2	15.4	2	5
Iowa darter	2	7.4	1	7.7	3	7.5
Johnny darter	9	33.3	4	30.8	13	32.5
Log perch	5	18.5	0	-	5	12.5
Trout perch	2	7.4	0	-	2	5
Spottail shiner	6	22.2	0	-	6	15
Blacknose shiner	6	22.2	0	-	6	15
Common shiner	1	3.7	1	7.7	2	5
Mimic shiner	1	3.7	0	-	1	2.5
Golden shiner	4	14.8	0	-	4	5
Hornyhead chub	1	3.7	0	-	1	-
Bluntnose minnow	2	7.4	0	-	2	-
Central mudminnow	1	3.7	0	-	1	2.5

Table 11. Number and weight of walleye, northern pike and white sucker in managed walleye lakes north of the Laurentian Divide (from MDNR lake surveys, gillnet data, 1950-1977).

LAKE	DOW #	WALLEYE			NORTHERN PIKE			WHITE SUCKER		
		Mean # Per Net	Mean Wt Per Net (Kg)	Mean Wt Per Fish (Kg)	Mean # Per Net	Mean Wt Per Net (Kg)	Mean Wt Per Fish (Kg)	Mean # Per Net	Mean Wt Per Net (KG)	Mean Wt Per Fish (Kg)
Fall	38-811	14.3	3.77	0.27	5.3	3.43	0.68	3.5	2.16	0.63
Newton	38-784	9.5	-	-	2.3	-	-	5.8	-	-
Shagawa	69-69	37.9	22.6	0.59	3.7	2.59	0.72	11.0	9.45	0.86
White Iron	69-4	12.6	4.30	0.36	3.8	3.40	0.90	7.6	5.54	0.72
Lake One	38-605	4.7	1.22	0.27	3.1	1.97	0.63	8.7	4.73	0.54
Clear	38-722	2.8	-	-	2.3	-	-	4.3	-	-
Farm	38-779	3.6	-	-	0.1	-	-	3.5	-	-
South Farm	38-778	8.0	-	-	0.8	-	-	6.3	-	-
Garden	38-738	6.2	-	-	0.2	-	-	3.5	-	-
Bear Island	69-115	8.3	5.04	0.59	1.5	1.34	0.90	2.4	1.51	0.63
One Pine	69-61	6.1	-	-	5.4	-	-	5.4	-	-
Johnson	69-117	0.5	-	-	3.0	-	-	5.5	-	-
Gabbro	38-701	7.5	4.05	0.54	5.3	5.45	1.04	4.9	0.77	0.18
August	38-691	4.9	-	-	3.0	-	-	6.3	-	-
Bald Eagle	38-637	14.3	3.77	0.27	7.4	6.43	0.86	5.6	4.35	0.77
Little Gabbro	38-703	4.3	1.88	0.45	3.3	2.48	0.77	2.3	1.74	0.77
Gull	38-590	6.9	-	-	1.6	-	-	2.1	-	-
Birch	69-3	8.0	5.22	0.68	2.4	3.38	1.40	5.7	3.85	0.68
Little	69-56	9.0	-	-	3.7	-	-	4.3	-	-
Greenwood	38-656	6.9	6.26	0.32	4.9	4.59	0.45	4.4	12.29	0.77
North McDougal	38-686	7.6	3.56	0.45	3.3	2.25	0.68	8.7	5.95	0.68
South McDougal	38-659	9.0	-	-	11.0	-	-	9.0	-	-
Sand	38-735	21.0	-	-	6.3	-	-	5.0	-	-
Slate	38-666	5.0	-	-	2.0	-	-	15.0	-	-
East Chub	38-674	3.0	-	-	6.0	-	-	7.0	-	-
West Chub	38-675	-	-	-	9.4	-	-	4.2	-	-
Dunnigan	38-664	14.5	-	-	-	-	-	15.0	-	-
Mean		9.09	5.61	0.62	3.89	3.39	0.87	6.19	4.76	.77

Table 12. Number and weight of walleye, northern pike and white sucker in managed walleye lakes south of the Laurentian Divide (from MDNR lake surveys, gillnet data, 1950-1977).

LAKE	DOW #	W A L L E Y E			N O R T H E R N P I K E			W H I T E S U C K E R		
		Mean # Per Net	Mean Wt Per Net (Kg)	Mean Wt Per Fish (Kg)	Mean # Per Net	Mean Wt Per Net (Kg)	Mean Wt Per Fish (Kg)	Mean # Per Net	Mean Wt Per Net (KG)	Mean Wt Per Fish (Kg)
Seven Beaver	69-2	9.8	3.86	0.41	4.0	2.19	0.54	3.0	3.09	1.04
Pine	69-1	3.0	1.16	0.41	2.0	3.12	1.58	6.7	-	-
Round	69-48	10.0	5.22	0.54	1.5	1.55	1.04	9.0	9.52	1.26
Colby	69-249	1.3	0.59	0.45	0.67	0.57	0.81	3.0	3.27	1.08
Whitewater	69-376	3.67	1.36	0.36	2.0	1.40	0.72	1.7	2.07	1.26
Wynne	69-434	4.7	3.45	0.72	3.5	2.65	0.77	0.8	0.86	1.04
Embarrass	69-496	3.2	0.95	0.32	2.3	1.89	0.81	-	-	-
Cedar Island	69-568	1.33	0.53	0.41	12.0	6.22	0.54	2.3	5.70	0.86
Esquagama	69-565	4.7	1.27	0.27	3.7	1.65	1.67	2.0	0.90	0.90
Sabin	69-429	1.7	0.91	0.54	6.0	4.60	0.77	2.7	2.66	0.99
Whiteface Reservoir	69-375	5.7	1.85	0.32	1.5	0.85	0.59	3.3	3.14	0.95
Cadotte	69-114	15.9	6.33	0.41	0.2	0.33	1.53	1.4	0.82	0.59
Bassett	69-41	28.3	16.12	0.59	0.5	0.23	0.45	4.1	2.47	0.81
Mean		7.17	3.35	.44	3.06	2.09	.68	3.07	2.73	.88

Table 13. Productivity indices for 40 softwater walleye lakes in the Study Area.

LAKES NORTH OF THE DIVIDE		LAKES SOUTH OF THE DIVIDE	
Fall	9.36	Seven Beaver	9.14
Newton	-	Pine	-
Shagawa	34.64	Round	16.29
White Iron	13.24	Colby	4.43
Lake One	7.92	Whitewater	4.83
Clear	-	Wynne	6.96
Farm	-	Embarrass	-
South Farm	-	Cedar Island	12.45
Garden	-	Esquagama	3.82
Bear Island	7.89	Sabin	8.17
One Pine	-	Whiteface	5.84
Johnson	-	Cadotte	7.48
Gabbro	10.27	Bassett	19.82
August	-		
Bald Eagle	14.55		
Little Gabbro	6.1		
Gull	-		
Birch	12.45		
Little	-		
Greenwood	23.14		
South McDougal	11.76		
North McDougal	-		
Sand	-		
Slate	-		
East Chub	-		
West Chub	-		
Dunnigan	-		

Table 14. Gillnet catch indices for 40 Study Area walleye lakes, MDNR Region II and Minnesota

Species	Median Number per Net				Median Weight per Net			
	State	Region II*		Study Area	State	Region II		Study Area
		SW	HW			SW	HW	
Walleye	3.60	7.1	6.0	6.9	2.34	3.27	2.81	3.66
Northern pike	2.67	1.3	2.7	3.1	2.55	1.14	1.91	2.36
White sucker	1.90	5.0	2.8	4.4	1.15	1.15	1.63	3.12

SW = softwater walleye lake, total alkalinity 0-50 mg/l as CaCO₃

HW = hardwater walleye lake, total alkalinity 51-151 mg/l a CaCO₃

State wide figures from Scidmore (1970)

Region II figures from lake surveys 1948-1958

*Region II is a six county area in northeastern Minnesota that includes Cook, Lake, St. Louis, Carlton, Koochiching and Itasca counties.

Table 15. Average number and weight of fish from major hardwater walleye lakes in Minnesota.

LAKE	WALLEYE			NORTHERN PIKE			WHITE SUCKER		
	Mean # Per Net	Mean Wt. Per Net (kg)	Mean Wt. Per Fish (kg)	Mean # Per Net	Mean Wt. Per Net (kg)	Mean Wt. Per Fish (kg)	Mean # Per Net	Mean Wt. Per Net (kg)	Mean Wt. Per Fish (kg)
Woman	4.29	1.72	.404	5.43	4.94	.912	2.42	2.982	1.230
Winnibigoshish	5.80	3.31	.572	3.60	4.49	1.248	--	--	--
Winnibigoshish	2.83	1.72	.599	8.50	13.05	1.534	1.63	1.802	1.107
Moose	4.94	2.01	.408	1.30	.967	.744	1.80	.681	.376
Many Point	6.30	3.72	.590	3.00	3.90	1.302	4.70	2.724	.581
Toad	19.80	11.11	.653	2.40	2.81	.780	7.80	5.193	.667
Toad	9.20	5.93	.644	4.30	3.35	1.171	--	2.020	1.121
Mille Lacs	7.70	4.06	.526	0.16	.304	1.902	--	.708	.812
Osakis	9.50	5.09	.621	1.40	1.67	1.198	0.33	.181	.603
Miltona	11.55	7.86	.681	5.55	5.90	1.062	4.88	4.412	.903
Minnetonka	2.11	1.34	.634	2.78	2.06	.740	--	.308	.581
White Bear	3.10	2.95	.953	0.05	.681	1.362	1.10	.862	.785
White Bear	1.25	1.76	1.407	10.13	8.79	.867	0.88	1.321	1.502
Mean	6.80	4.24	.623	3.77	4.07	1.079	2.39	1.766	.738

Table 16. Species composition of selected lakes with lake trout populations in St. Louis, Lake and Cook counties, northeastern Minnesota (from MDNR lake surveys).

Lake Name	Burntside	Snowbank	Ojibway (Upper Twin)	Basswood	Lac La Croix	Loon	Pine	Devilfish
Species								
Tullibee	+	+	+	+	+	+	+	
Whitefish	+			+	+			
Lake trout	+	+	+	+	+	+	+	+
Northern pike	+			+	+	+	+	+
White sucker	+	+	+	+	+	+	+	
Shorthead red- horse	+	+		+	+			
Silver redhorse					+			
Sturgeon					+			
Silver lamprey					+			
Smallmouth bass	+	+		+	+	+	+	
Largemouth bass	+							
Green sunfish	+							
Pumpkinseed	+							
Bluegill	+							
Rock bass	+	+		+	+			
Black crappie	+			+	+			
Burbot	+	+		+	+		+	
Walleye	+	+	+	+	+	+	+	+
Yellow perch	+	+	+	+	+	+	+	+
Sauger					+			
Log perch	+	+						
Johnny darter	+	+				+		
Iowa darter	+					+		
Golden shiner	+	+						
Spottail shiner	+	+						
Mimic shiner	+	+						
Blacknose shiner		+	+			+		
Common shiner		+	+					
Bluntnose minnow	+	+	+			+		
Fathead minnow			+			+	+	+
Creek chub	+						+	
Northern red- belly dace	+							
Number of species	25	17	9	12	16	12	10	5
Sampling gear	G,T,S	G,S	G,T,S	G,T	G	G,T,S	G,T,S	G,T,S*

Abbreviations used: G = gillnets, T = trapnets, S = shoreline seining

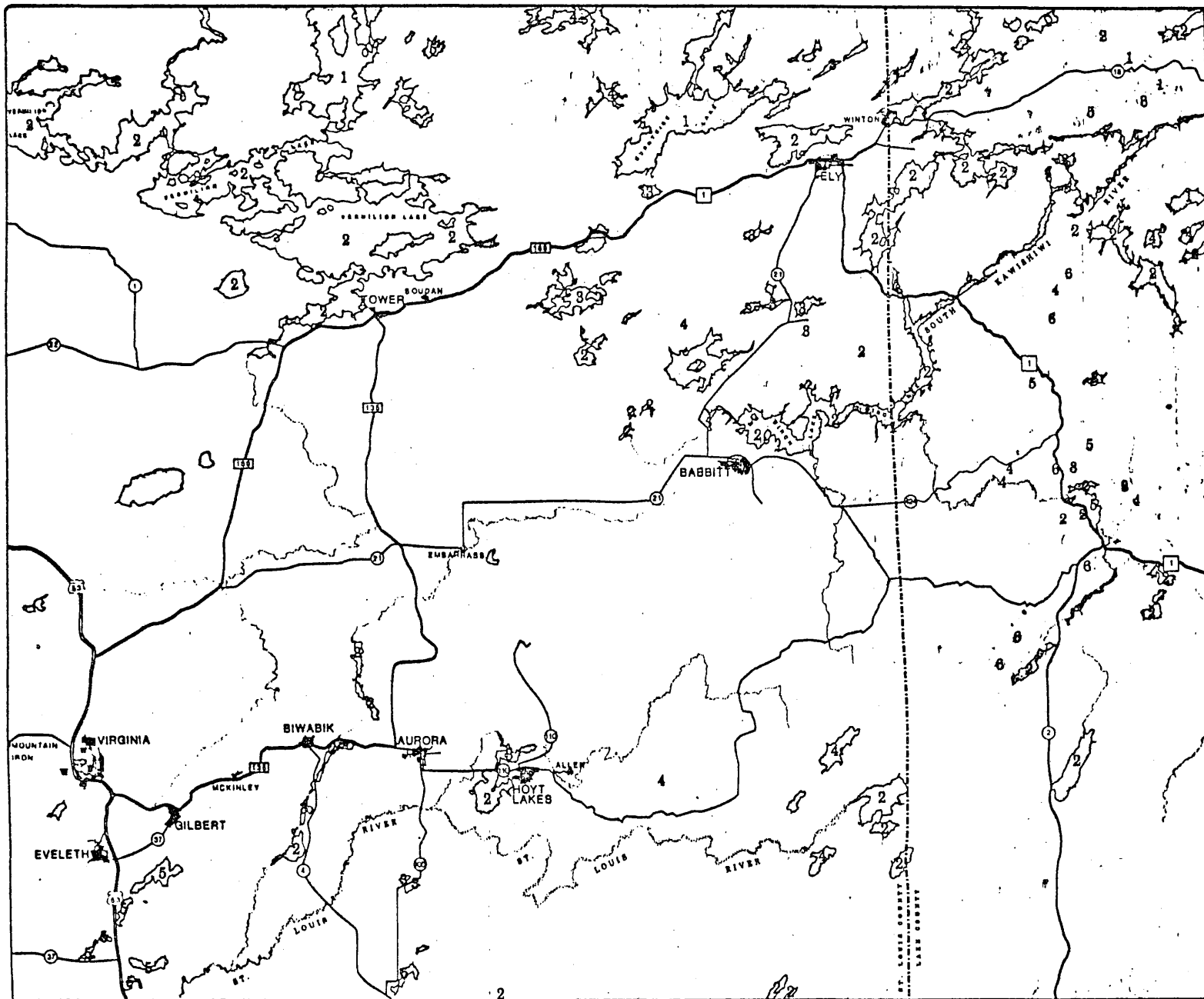
S* = shoreline seining was unsuccessful due to rocks and logs along the shore.

Table 17. Managed Stream Trout Lakes in RCNSA

<u>Lake Name</u>	<u>D.O.W. Number</u>	<u>Acreage</u>	<u>Year Reclaimed</u>	<u>Species</u>	<u>Nearest Town</u>	<u>T.</u>	<u>R.</u>	<u>S.</u>
<u>St. Louis County</u>								
Cedar	69-431	24.5	1966	Brook & Rainbow	Aurora	58	15	20
Cub	none	10.0	-	Brook	Tower	61	14	2
Dry	69-64	75.1	1966	Brook	Ely	63	12	4,9
Little Dry	none	9.4	1966	Brook	Ely	63	12	9
Little Elbow	69-745	8.4	1969	Rainbow	Eveleth	57	18	9,10,16
Hanson	69-189	21.6	1963	Brook & Rainbow	Ely	64	13	36
High	69-71	319.4	1966	Rainbow	Ely	63,64	12	3-5;33,34
Jammer	69-737	18.4	1964	Brook & Rainbow	Virginia	60	18	27
Norberg	none	8.0	1964	Rainbow	Tower	61	14	1
Silver	69-563	34.0	1972	Rainbow	Biwabik	57,58	16	1,36
<u>Lake County</u>								
Glacier Pond II	38-712	5.2	1952	Brook	Winton	63	10	11
Tofte	38-724	111.6	1958	Brook & Rainbow	Winton	63,64	10	2-3;35

Table 18. Number of fish per gillnet for three species of fish for lakes resurveyed in 1977.

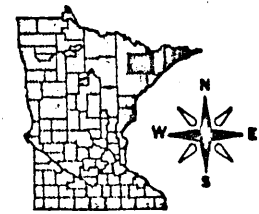
LAKE	WALLEYE		NORTHERN PIKE		WHITE SUCKER		Date of Original Lake Survey
	Original	1977	Original	1977	Original	1977	
Bald Eagle	5.60	14.25	4.40	7.37	2.47	5.62	1963
August	4.86	6.60	3.00	4.40	6.29	8.20	1962
Gabbro	5.60	7.50	3.27	5.25	3.67	4.88	1963
Lower McDougal	17.00	7.66	3.00	3.33	6.00	8.66	1961
Turtle	-	-	2.9	6.25	3.8	25.75	1962
Clearwater	-	-	5.4	3.89	6.15	4.25	1962



LEGEND

LAKE MANAGEMENT CLASSIFICATIONS

- 1 TROUT
- 2 WALLEYE
- 8 WALLEYE-CENTRARCHID
- 4 NORTHERN PIKE-
WHITE BUCKER-
YELLOW PERCH
- 5 CENTRARCHID
- 6 REGULAR WINTERKILL



KEY MAP

1:422,400



MEQB REGIONAL COPPER-NICKEL STUDY

FIGURE 1: FISH MANAGEMENT CLASSIFICATION-LAKES