CN 170

REGIONAL COPPER-NICKEL STUDY

STREAM FISH

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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).

ABSTRACT

A survey of stream fish populations was conducted in 1976 and 1977 to characterize streams in the Regional Copper-Nickel Study Area (Study Area). Data were compiled on species composition, relative abundance and distribution of fish throughout the Study Area. Cosmopolitan streams (those containing populations of several gamefish species) comprise 45% of the classified stream kilometers in the Study Area. The remaining classified kilometers are distributed between trout (15%), northern pike (17%), minnow (21%) and walleye (0.81%) management classifications.

Data were compiled on the distribution of fish by stream order. The most abundant non-game species in first order streams were brook stickleback, finescale dace and central mudminnow. Brook trout were the most abundant gamefish in first order streams. The most abundant non-game species in second and third order streams were blacknose dace, common shiner, white sucker and yellow perch. Northern pike were the most abundant gamefish in third order streams while brook trout were most abundant in second order. In fourth order streams, blacknose shiner and yellow perch were the most abundant non-game species and rock bass the most abundant game species.

Data from the Kawishiwi River indicated that it is more like Study Area lakes than Study Area rivers in the mean number per net and mean weight per fish and may therefore offer greater potential as a sport fishery than other rivers in the Study Area.

STREAM FISH

Introduction

Fish are an important component of aquatic ecosystems. They feed on algae invertebrates and other fish and provide a food source for man and other animals. Lower forms of aquatic life integrate physical, chemical and biological conditions within a water body (Regional Copper-Nickel Study 1978) and in turn affect the composition and distribution of fish populations.

Investigations of fish communities in streams were undertaken to:

1) characterize fish populations in Study Area streams,
2) classify streams based on their fish populations,
3) provide baseline data for development of long-term monitoring, and
4) evaluate the potential for impact on fish by copper-nickel development.

To characterize fish populations, information was compiled on species composition, relative abundance and distribution of fish throughout the Study Area.

Fish distributions may change with varying ecological conditions. Physical, chemical, biological and geographical factors determine the species and abundance of fish present at a given location. In streams, a gradual change in physical and chemical conditions such as current velocity, substrate, depth, width and temperature occurs when moving from the source to the mouth of a river, providing a range of different habitats that may support fish.

Current velocity is important because of its direct influence on fish, and indirectly because of its effect on substrate composition and dissolved oxygen (Brown 1975). Fish inhabiting headwater stream have a streamlined body shape while those inhabiting areas of lower current velocity have a more rounded form. Rocks and logs provide shelter in headwater streams while macrophytes, fallen trees and undercut banks provide the same protection in larger rivers.

The substrate influences fish distribution indirectly by: supporting food organisms; providing shelter from the current; and, providing spawning habitat. Most fish require specific substrate types for spawning (Hynes 1970). Fish that spawn in headwater areas usually bury their eggs in the gravel while those that spawn in larger rivers with unstable substrates usually have adhesive eggs that are attached to logs or vegetation.

In general, the number of species increases from the source to the mouth of a river with increasing habitat diversity and greater stability of physical-chemical conditions (Harrel et al. 1967). Although the total number of individuals of all species may decrease per unit area, individuals are usually larger in downstream areas.

Water volume and depth affect fish movement and migration, subsequently affecting distribution and diversity (Sheldon 1968). Flooding forces most adult fish downstream to quieter water, or into smaller tributaries although several species depend on floods for spawning. Hynes (1970) states that "high water favors spawning and breeding fails in its absence, but if levels are too high, oviposition occurs on flooded land away from the riverbed and young fish become stranded." Drought may reduce streams to stagnating pools, exposing fish to high temperatures and de-oxygenation (Larimore et al. 1959). Fish usually survive in "faunal reservoirs" (Slack 1955) or "faunal havens" (Paloumpis 1956) when unfavorable conditions exist. These reservoirs may be pools, downstream areas, or substrate interstices. Recolonization begins shortly after resumption of normal flows (Hynes 1970).

All species of fish have a preferred temperature range and actively seek to remain within that range. Temperature affects growth rates, swimming performance, spawning, and egg and larval development, that also influence distribution (Brown 1975). Temperature requirements necessary for successful spawning are discussed by the Regional Copper-Nickel Study (1978).

Dissolved oxygen concentration is the most important requirement for fish because of its effect on survival, growth, swimming performance and larval development (Doudoroff and Shumway 1970, cited in Brown 1975). Normally, dissolved oxygen remains near 100 percent saturation and presents no problem except for species, such as trout, in which the metabolism rate rises rapidly with increasing temperature.

Factors that affect primary or secondary production also affect the distribution of fish in a river. As food supplies decrease, interspecific competition increases, causing decreased biomass (Brown 1975). Species not able to tolerate increased competition will die or move to more favorable habitats.

Biotic factors such as fecundity, growth rate, competition, mortality and spawning time also influence the presence of a species at a certain time. Nikolsky (1963), Norman (1963), Marshall (1965), Weatherly (1972) discuss physical and chemical factors in relation to fish ecology.

Fish have not been widely used as ecological indicators because their mobility enables them to escape unfavorable conditions. Hynes (1960) found fish to be less desirable indicators of water quality changes than algae or invertebrates because: they are able to avoid substances they find distasteful; they are difficult to see or catch; they are less abundant than smaller organisms; and they can rapidly recolonize an area following impact.

METHODS

Study Area

The Regional Copper-Nickel Study Area (Study Area) encompasses 5516 km^2 (2130 mi^2) in Lake and St. Louis counties in northeastern Minnesota (Figure 1). This area is divided into two major watersheds by the Laurentian Divide. Water north of this Divide flows through the Rainy River system to Hudson Bay. Water south of the Divide flows into Lake Superior.

There are 2624.9 km (1630.4 mi) of streams in the Study Area. These streams are generally bog stained because of the high humus content and conductivities range from 11 to 1200 μmho/ml. Dominant vegetation types include: (1) aspen-birch, (2) spruce-fir, and (3) red, white and jack pine.

Field Procedures

Qualitative and quantitative sampling of fish populations are subject to limitations imposed by gear selectivity, fish mobility and recruitment of new individuals to the population. These factors, combined with physical and chemical factors at individual sampling locations required that several types of equipment be used to adequately sample fish populations in the Study Area.

Detailed descriptions of equipment construction and operation can be found in the Regional Copper-Nickel Study, Fisheries Operations Manual (1976).

A backpack shocker was used to sample small, shallow and relatively inaccessible streams with conductivites of 14-275 μmho/ml. In streams with specific conductance below 50 μmho/ml, the original cathode was replaced with 9.1 m of woven steel cable. Streams with a specific conductance below 30 μmho/ml required 15.2 m of steel cable.

Small to medium sized, wadable streams were sampled with a stream shocker. Electrofishing equipment was mounted in a 3.7m pram and pulled upstream by wading crew members. Station lengths varied from 100 to 200 meters.

Large rivers were sampled with a boom shocker or mini-boom shocker depending on the accessibility of a sampling location. The mini-boom shocker had the advantage of greater portability and allowed access to areas that could not be shocked with the larger boom shocking unit.

Gill and trap nets were used to sample deeper stretches of rivers than possible with electrofishing equipment. Gill nets were standard nylon experimental gill nets with five different mesh sizes. Trap nets were 1.9 cm mesh with 12.2 m leads. Trap nets were set in water less than 2 m deep. Both trap and gill nets remained in the water for 24 hours.

In 1976 stations were sampled only once. Efforts were concentrated on the St. Louis and Kawishiwi rivers and Filson and Keeley creeks. Seasonal collections (spring, summer, and fall) in 1977 included 52 sites on four watersheds: Partridge, St. Louis, Dunka, and Stony. Additional sampling was conducted on the Little Isabella River and Bear Island Creek in 1977.

RESULTS

Management Classifications

The management classifications currently being used by the Minnesota Department of Natural Resources (MDNR) (Petersen 1969) are described in Appendix 1. Approximately 1/3 (35.97%) of the total stream kilometers in the Study Area are unclassified by the MDNR. Those streams that have been classified fall into 5 management catagories based on their potential to support certain fish populations.

Table 1 indicates the extent and proportion of management classifications by stream order for individual watersheds and the total Study Area. Cosmopolitan streams comprise 44.47% of the classified stream kilometers and are usually the main stem of larger rivers such as the Kawishiwi, Stony, St. Louis, Partridge and Embarrass. Trout streams are usually small, first and second order streams and they comprise 14.94% of the classified stream kilometers in the Study Area. Northern pike and minnow streams range in size from small, headwater streams to medium sized rivers and comprise 16.74% and 21.29% of the classified stream kilometers respectively. The only walleye stream in the Study Area is the Isabella River which comprises .75% of the classified stream kilometers in the Study Area.

Comparison of Stream Orders

The species composition and relative abundance of fish vary with stream order. A comparison of fish distribution by stream order was made, and relative abundance and presence-absence data are presented in Table 2.

The most abundant non-game species in first order streams were brook stickleback (32.3 percent), finescale dace (14.7 percent) and central mudminnow (14.4 percent). Brook trout were the most abundant gamefish in first order streams comprising 98.3 percent of the indivicuals collected in first order streams throughout the Study Area. These trout were collected most commonly in the Isabella watershed where they comprised 89.8 percent of the individuals collected in first order streams.

Blacknose dace (16.9 percent), common shiner (11.0 percent) and white suckers (14.4 percent) were the most abundant non-game species in second order streams while brook trout were the most abundant gamefish (2.4 percent).

The most abundant non-game species in third order streams were blacknose dace (8.0 percent), yellow perch (10.2 percent) and white sucker (19.4 percent). Northern pike were the most abundant gamefish collected in third order streams comprising 2.5 percent of the total individuals collected in third order streams throughout the Study Area.

In fourth order streams, blacknose shiner and yellow perch were the most abundant non-game species comprising 22.2% and 19% respectively. All gamefish, except brook trout, found in the Study Area reach their greatest abundance in fourth order streams. Rock bass were the most abundant gamefish comprising 1.6% of the individuals collected in fourth order streams.

Comparison of Watersheds

Table 3 shows the relative abundance of fish by year for watersheds in the Study Area. The following observations can be made from the relative abundance data in Table 3:

1) Brook trout were collected only in the Stony watershed in 1976. Brook trout were most abundant in the Isabella watershed in 1977, followed by the Stony watershed.

2) Northern pike were most common in the Partridge watershed in 1976 and the Embarrass watershed in 1977.

3) White suckers were most numerous in the Dunka watershed during 1976 and 1977.

4) Largemouth and rock bass were most abundant in the Partridge watershed in 1976 and 1977.

5) Walleye were most numerous in the St. Louis watershed in 1976; the Stony watershed in 1977.

6) Yellow perch were most common in the St. Louis watershed during both 1976 and 1977.

For all watersheds, except Filson Creek, the total number of taxa increased from 1976 to 1977. In 1976 the Dunka and Embarrass watersheds were lowest (12 taxa each), while in 1977 Filson Creek and the Embarrass were lowest with 12 and 17 taxa respectively. The number of taxa collected for the total Study Area increased from 32 in 1976 to 40 in 1977.

There are several reasons or factors that may account for the increase in the number of taxa collected in the Study Area from 1976 to 1977:

a) the number of sampling sites and the frequency of sampling each site was increased from one to three times in 1977,

b) the fisheries crew became more proficient in the use of the sampling gear, sampling methods improved and there were fewer equipment breakdowns,

c) most of the sampling completed in 1976 was done during a period of extreme drought thus, fish distributions in the Study Area streams probably were not "normal". In 1977 after normal stream flows resumed additional species re-colonized areas that were formerly uninhabitable by fish during the drought.

The following species collected in 1977 were not found in 1976: bluntnose minnow, spottail shiner, mimic shiner, brassy minnow, channel catfish and smallmouth bass.

Watersheds north of the Laurentian Divide have greater numbers of brook trout, dace, brook stickleback, mottled sculpin and two species of shiners. Watersheds south of the Divide contain greater relative numbers of warmwater species including bass, sunfish, perch, walleye, bullheads and burbot.

Stations in five watersheds were sampled seasonally in 1977. The average number of fish collected during one hour of shocking is shown in Table 4. The total number of fish collected decreased from spring to fall for all watersheds except the Stony in which the number of fish collected was highest in summer.

Table 5 lists the mean number and weight of fish collected in five watersheds in 1977. The variability of the data makes specific comparisons difficult, however some general observations can be made. The Dunka River, unlike other watersheds contains only suckers and forage species. Walleyes were collected in low numbers by all sampling methods and in all watersheds except the Dunka River watershed.

Watershed descriptions are located in Appendix II.

Kawishiwi River Watershed

The South Branch of the Kawishiwi River is located in the northeast corner of the Regional Copper-Nickel Study Area in northeastern Minnesota. The river flows southeast from the Boundary Waters Canoe Area to Birch Lake then north through the Garden Lake chain to Fall Lake. The river has characteristics of both a lake and river with deep sections of slow moving water connected by shallow riffles. Because of its unique morphology, large size, and proximity to the BWCA, characterization of fish populations in the South Kawishiwi River was of major importance to the Regional Copper-Nickel Fisheries Section.

The MDNR conducted lake surveys of eight sectors of the South Kawishiwi River in 1967. In 1976 the Regional Copper-Nickel Study Fisheries Section duplicated the earlier surveys of the MDNR. Gill and trap nets were used in the survey rather than electrofishing equipment because of the ineffectiveness of shocking equipment in deep water. Data collected from gill and trap nets for 1967 and 1976 surveys and seining data collected in 1967 are presented in Table 6.

The South Kawishiwi River is classified by the MDNR as a cosmopolitan river. Fish species found in the river include: northern pike, walleye, sunfish, bass, suckers, whitefish, ciscoes and a variety of minnows, shiners and darters. A complete species list for the South Kawishiwi River is presented in Table 6.

Comparison with Study Area Rivers and Lakes

Gill net catch indices for the South Kawishiwi River, Study Area rivers and Study Area lakes are shown in Table 7. In general, the South Kawishiwi River is more like area lakes than area rivers in the mean number per net and mean weight per fish. Northern pike were collected in higher numbers in Study Area rivers than Study Area lakes or the South Kawishiwi River, however, the mean weight per fish was significantly lower ($P<.05$) in Study Area rivers. Walleyes are present in higher numbers in Study Area lakes than in the South Kawishiwi River or other Study Area rivers. The weight per fish for walleyes is similar between lakes and the South Kawishiwi River. White suckers are found in higher numbers in Study Area Rivers than in lakes or the South Kawishiwi River but the mean weight per fish is slightly less in rivers.

Coldwater Fishery

Data collected during the 1977 sampling season, as well as data from several Lake Superior north shore streams, were compiled to assess the coldwater fishery resource in the Study Area. The brook trout is the only coldwater gamefish found in Study Area streams. Its distribution is limited primarily to smaller streams in the Study Area that remain below 20°C and are well oxygenated.

Table 8 summarizes data collected from 13 stations in four watersheds in the Study Area. The largest number of trout were collected in first order streams but little difference in size of fish was noted between stream orders.

North shore streams are primarily managed for rainbow and brown trout but some of the headwater areas are managed exclusively for brook trout. Data used for comparison were obtained from MDNR stream surveys and creel census data. Although few specific data were available brook trout have been reported in the headwater streams of the Little Marais, Stewart, Baptism, and French Rivers.

Hale (1954) found that approximately 41 percent of the brook trout collected over a three year period from the West Branch of the Split Rock River were longer than 15.2 cm. The average size of north shore brook trout is very similar to Study Area trout.

CONCLUSIONS

Assessment of stream fishery resources in the Study Area is difficult, especially when attempting to make specific comparisons of watersheds or stream orders. Variability in the data is a result of fluctuating water levels and different stream sizes which influence the efficiency and type of sampling gear used. Also, because this study was qualitative, the data collected did not lend themselves to a statistical analysis which would separate changes in the seasonal and spatial distribution of fish populations from the affects of sampling variability.

Based on data collected during 1976 and 1977 two watersheds appear to offer a greater potential for sport fishing than others in the Study Area. The Little Isabella watershed including Snake River and Snake Creek contains the most kilometers of trout habitat in the Study Area making it unique. Because of its' large size and stable flow the Kawishiwi River is able to support larger individuals and larger populations of game species than other watersheds.

Except for the Kawishiwi River, streams in the Study Area appear to offer less potential for supporting a sport fishery than lakes in the Area. The greater number of individuals, and larger average size per fish found in lakes may be a result of stocking programs and the greater stability of physical and chemical conditions in lakes.

The importance of streams in the Study Area is mainly in providing suitable spawning habitat, and shelter for young fish.

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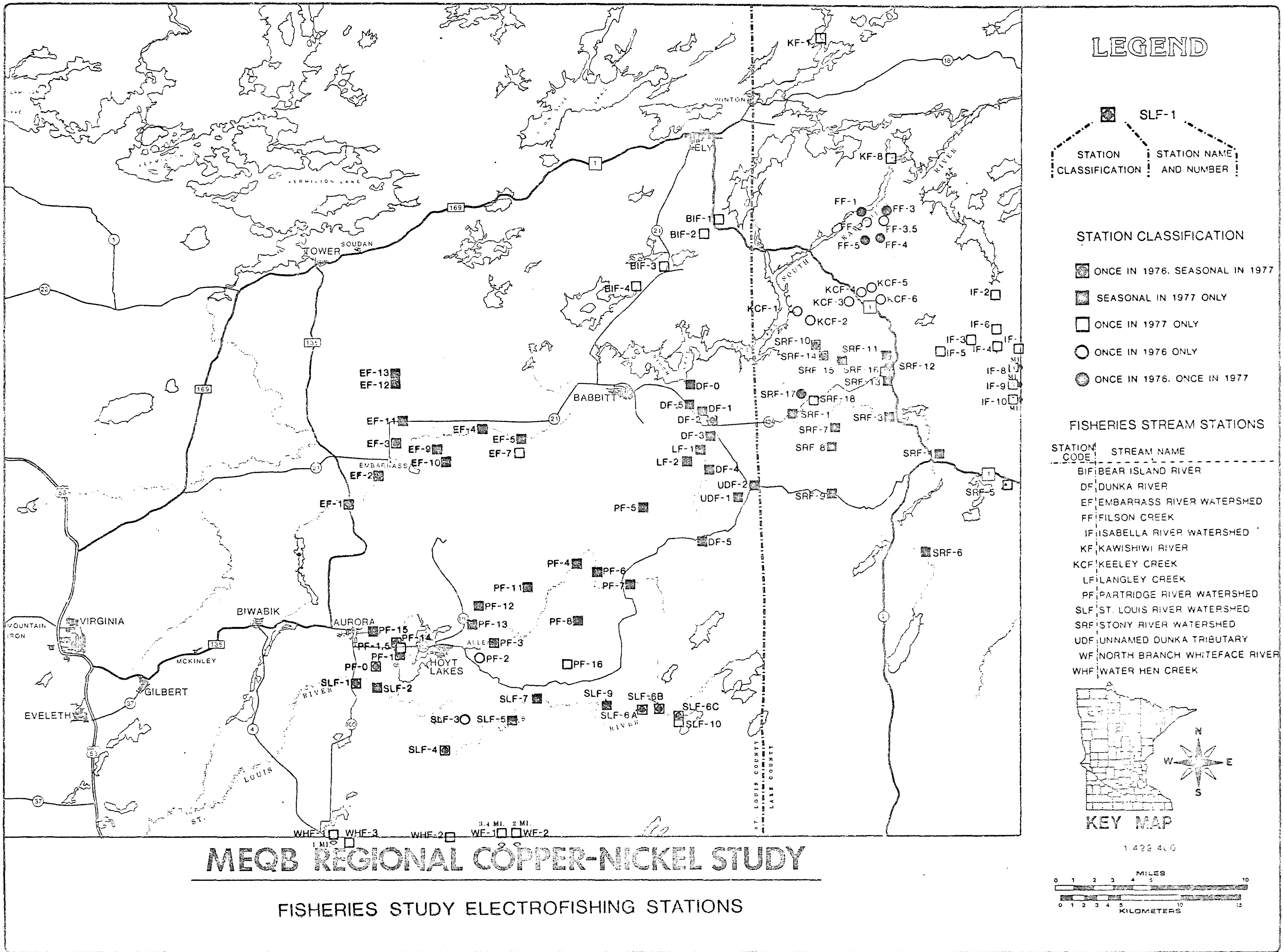
FIC E 1



MEQB REGIONAL COPPER-NICKEL STUDY

FISHERIES STUDY ELECTROFISHING STATIONS

Table 1. Proportion of management classes in each stream order for each watershed in the Study Area. (Numbers in parentheses are the percentages of total stream kilometers in the Study Area).

Watershed	S T O N Y				K E E L Y		B O B B A Y	F I L S O N	
Stream Order	1	2	3	4	1	2	1	1	2
Management Class									
Trout	29.4 (.73)	19.9 (.73)							
Cosmopolitan	14.2 (.35)	26.8 (.98)	70.1 (3.08)	80.8 (2.66)					
Northern pike	23.0 (.57)	26.1 (.96)	29.9 (1.32)	19.3 (.63)	100 (.94)	100 (.61)			
Minnow	33.4 (.83)	27.2 (1.00)					100 (.23)	100 (.84)	100 (.02
Walleye									

Table 1. Proportion of management classes in each stream order for each watershed in the Study Area. (Numbers in parentheses are the percentages of total stream kilometers in the Study Area) (continued)

Watershed	BEAR ISLAND			WATERHEN		CLOQUET		
Stream Order	1	2	3	1	2	1	2	3
Management Class								
Trout						100 (3.74)	100 (1.13)	
Cosmopolitan		100 (.86)						100 (1.01)
Northern pike	100 (.13)		55.0 (1.06)					
Minnow			45.0 (.87)	100 (.57)	100 (.67)			
Walleye								

Table 1. Proportion of management classes in each stream order for each watershed in the Study Area. (Numbers in parentheses are the percentages of total stream kilometers in the Study Area) (continued)

Watershed	PARTRIDGE				DUNKA		
Stream Order	1	2	3	4	1	2	3
Management Class							
Trout	42.8 (2.54)	29.4 (1.4)					36.5 (.38)
Cosmopolitan			100 (.41)	100 (2.55)			
Northern pike	15.7 (.93)	35.1 (1.67)					
Minnow	42.6 (2.52)	32.7 (1.56)			100 (2.86)	100 (1.31)	63.5 (.67)
Walleye							

Table 1. Proportion of management classes in each stream order for each watershed in the Study Area. (Numbers in parentheses are the percentages of total stream kilometers in the Study Area) (continued)

Watershed	W H I T E F A C E #2			ISABELLA	S T. L O U I S			
Stream Order	1	2	3	5	1	2	3	4
Management Class								
Trout					11.7 (1.32)	13.7 (.17)		
Cosmopolitan	66.4 (.25)	100 (.24)	100 (.70)		6.3 (.10)		100 (5.31)	100 (4.42)
Northern pike								
Minnow	33.6 (.50)				82.0 (.19)	86.3 (1.03)		
Walleye				100 (.75)				

Table 1. Proportion of management classes in each stream order for each watershed in the Study Area. (Numbers in parentheses are the percentages of total stream kilometers in the Study Area) (continued)

Watershed	KAWISHIWI					EMBARRASS		
Stream Order	1	2	3	4	5	1	2	3
Management Class								
Trout	15.9 (.98)	17.0 (1.13)	23.6 (.89)			32.7 (.43)		
Cosmopolitan		45.8 (3.04)	34.9 (1.32)	100 (3.51)	100 (5.84)		16.7 (.18)	100 (6.50)
Northern pike	52.8 (3.28)	23.9 (1.59)	41.4 (1.57)				58.6 (.63)	
Minnow	31.3 (1.94)	13.3 (.88)				67.3 (.89)	24.7 (.27)	
Walleye								

Table 1. Proportion of management classes in each stream order for each watershed in the Study Area. (Numbers in parentheses are the percentages of total stream miles in the Study Area) (continued)

Watershed	LITTLE ISABELLA			TOTAL STUDY AREA					
Stream Order	1	2	3	1	2	3	4	5	TOTAL
Management Class									
Trout	65.8 (.98)	80.5 (1.27)		33.58 (9.61)	24.6 (4.06)	4.04 (1.28)			14.95
Cosmopolitan				3.33 (.95)	22.4 (5.32)	74.5 (23.64)	93.2 (8.72)	88.65 (5.84)	44.47
Northern pike				23.4 (6.69)	23.2 (5.48)	12.4 (3.94)	6.8 (.634)		16.74
Minnow	34.2 (.51)	19.5 (.31)	100 (2.20)	39.7 (11.37)	29.8 (7.04)	9.06 (2.88)			21.29
Walleye								11.35 (.75)	.75

Table 3. Relative abundance of fish by watersheds from 1976 and 1977 electrofishing. (continued)

	North of the Divide								South of the Divide							
Species	Dunka		Stony		Filson Creek		Isabella		Partridge		St. Louis		Embarrass		Study Area	
	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977
Trout-perch		.63		.66			NO SAMPLING		3.61	3.30	18.20	.14		.39	5.80	.90
Burbot				1.86	2.52			.36	6.58	8.34	.22	4.56	9.80	9.16	2.65	3.04
Brook stickleback	8.24	10.90	2.13	9.73	31.09	40.63		.42		.39				.19	3.08	5.91
Largemouth bass			.27	.03					2.04	2.91	.37	.98		.58	.45	.64
Smallmouth bass										.11						.02
Rock bass				.51				.12	3.13	9.23	.37	4.21	.54	1.17	.63	2.29
Bluegill									11.44	.56		.21			1.57	.12
Pumpkinseed											.07	.21			.02	.03
Black crappie									.31	.73	.59				.22	.12
Yellow perqh		.14	.09	15.26				.84	3.76	4.76	11.91	21.46	2.59	5.07	4.42	8.36
Walleye		.09		.98		.52			1.25	.50	3.03	.84	.14	.58	1.08	.51
Log perch		.45		2.48				1.32	.63	1.23	.07	3.16			.11	1.55
Johnny darter	4.03	.41		.76				2.04	1.57	11.53	.15	3.37	8.16	12.28	2.03	3.53
Iowa darter	.55	.50	.18	.19	6.27	.60		.12		.06					.45	.23
Mottled sculpin	.55	1.18		.19	3.36	16.67		4.92	.31	2.74		1.26			.28	1.96
Unidentified*		[1].86		[4]3.60				.12		[3]4.20		.07		[2]19.69		2.87
Total taxa	12	22	16	28	13	12		22	19	29	18	25	12	17	32	40

*1) 15 of 19 total at one site
2) 100 of 101 total at one site
3) 75 total at one site
4) 100 of 114 total at one site, 4 of 114 total--chrosomus sp.

Table 3. Percent relative abundance of fish by watersheds from 1976 and 1977 electrofishing. Stations were pooled by watershed and percent calculated on total fish collected within that watershed.

	North of the Divide								South of the Divide							
Species	Dunka		Stony		Filson Creek		Isabella		Partridge		St. Louis		Embarrass		Study Area	
	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977
Brook trout		.27	.27	3.06			NO SAMPLING	4.80		.28					.11	1.73
Central mudminnow	.92	1.67	2.40	4.11	2.94	4.69		.66	.16	1.12		5.47	30.75	2.73	6.25	2.69
Northern pike			.53	1.42	1.68	11.98		.12	4.39	4.20	1.78	2.03	4.08	11.11	1.47	2.13
Blacknose dace	11.90	3.48	19.79	5.78				33.85				1.75	3.81	1.75	6.81	7.89
Longnose dace		2.13	.18	1.90				14.47		6.16		7.57	28.16	4.29	4.51	4.78
Creek chub	3.66	9.55	11.54	1.93				6.18							3.23	3.45
Pearl dace	24.73	4.84	7.90	8.69	.42			.90		2.41					4.85	4.05
Northern redbelly dace		1.58	3.11	3.38	18.81	1.04									1.62	1.32
Finescale dace		12.08	12.51	4.93	2.94	13.54		.12		.11					3.19	4.26
Golden shiner				.73				.54	1.25		13.98	3.23		.97	4.25	.76
Bluntnose minnow				.06												.02
Fathead minnow		6.70		.63				.06		.73			.27	.19	.04	1.68
Emerald shiner										4.20						.69
Common shiner	30.95	8.42	19.17	3.95	23.95	4.17		16.51	50.63	10.02	6.07	4.35		.58	18.26	7.62
Spottail shiner				.06	3.36											.02
Blacknose shiner	.55	.63	15.44	18.33		1.56		2.70			36.54	2.31		.19	14.64	6.26
Mimic shiner								2.70								.41
Brassy minnow		.36														.07
Shorthead redhorse								1.0	2.04	1.06	.15	1.33			.32	.36
White sucker	13.74	33.08	4.53	4.68	1.26	2.08		6.12	2.66	17.92	3.70	5.26	11.56	29.04	6.06	13.96
Channel catfish									3.61			1.19				.15
Brown bullhead										.34	1.63	.49			.97	.12
Black bullhead										.22	1.18	19.57	.14		.37	2.60
Yellow bullhead										.06		.35				.06
Tadpole madtom	.18	.05		.41	2.94	.52		.63	.56			4.63			.26	.84

Table 2. Percent relative abundance of stream fish by stream order collected by electrofishing in 1977. Stations and dates were pooled by stream order within watersheds and percent calculated on total fish collected within that stream order.

Species	Partridge				Stony				St. Louis				Isabella				Embarrass			Dunka			Filson		Total Study Area			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	1	2	3	1	2	1	2	3	4
Brook trout	6.41				8.48	6.06	.13						89.80	2.85	.99							.40			8.28	2.43	.11	0
Central mudminnow	17.95	.49	1.85		12.11	6.61	.54		75.53		.40			.74	.59				1.97	4.27	3.24	.79	4.5[illegible]		14.41	2.37	.79	0
Northern pike		1.22	10.65	4.64			2.16	2.56			2.25	1.59		.18				14.29	10.92				11.9[illegible]		1.48	.65	2.50	3.51
Blacknose dace					2.29	17.61	7.96	.97			2.01		4.08	29.87					1.97	1.42	4.25	3.50			1.63	16.91	8.00	.91
Longnose dace			18.98	.10		.18	6.07	1.24			8.19	9.52		12.41	45.15	37.50			4.80			3.10			0	5.20	7.72	1.05
Creek chub					3.23	4.59	1.62							6.25	6.73	4.17				1.90	5.47	11.88			2.07	4.59	4.83	.05
Pearl dace		10.49			10.63	34.86	.54	.18							2.57	8.33				1.42	5.47	5.08			6.06	9.95	2.01	.18
No. redbelly dace					9.56	1.65	3.64													.95	5.47	.40	1.04		5.54	1.38	.71	0
Finescale dace		.49			11.84	8.44	2.97								.40					40.28	23.48	5.02	13.5[illegible]		14.71	6.27	2.14	0
Golden shiner							.94	1.47			3.69			.83					1.09						0	.34	1.24	.73
Bluntnose minnow						.37																			0	.08	0	0
Fathead minnow		2.68		.20	.81	2.57								.09				2.04			15.99	4.55			.44	4.06	1.48	.09
Emerald shiner				7.40																					0	0	0	3.42
Common shiner	1.28	1.71	.93	16.67			13.50	2.21			4.98			23.90	2.77	4.17			.67	2.84	4.25	10.50	4.17		1.11	11.02	7.27	7.25
Spottail shiner								.18																	0	0	0	.09
Blacknose shiner					1.62	2.02	9.45	42.98			2.65			4.14					.22		.81	.66	1.56		1.48	2.30	2.44	22.21
[illegible]le shiner														4.14											0	1.72	0	0
Brassy minnow																				.47	1.21	.07			.07	.23	.02	0
Shorthead redhorse				1.87							1.44	3.17													0	0	.38	.96
White sucker	29.49	30.78	3.70	12.82	.94	6.61	9.31	3.18	24.47		2.65	12.70		5.97	7.33			20.41	30.35	3.32	21.05	40.92		2.08	4.58	14.38	19.38	7.94
Channel catfish											1.28														0	0	.34	0
Brown bullhead				.59							.56														0	0	.15	.27
Black bullhead				.39							22.39														0	0	5.97	.18
Yellow bullhead				.10							.40														0	0	.11	.05
Tadpole madtom			.46	.89				1.15			5.06	4.76										.07		.52	0	.04	1.39	1.14
Trout-perch		.24	18.98	1.68				1.85			.16			.09	.40	12.50		2.04	.22			.92			0	.08	1.24	1.71
Burbot	3.87	4.88	5.56	11.24			5.26	1.77			3.93	22.22	6.12		.79			34.69	6.56						.30	1.64	2.82	6.89
Brook stickleback	3.78	.98			35.80	6.42	.94											2.04		41.23	9.31	7.13	40.63		32.30	3.29	2.54	0
Largemouth bass		3.17		3.85			.13				1.12			.18				2.04	.44						0	.56	.36	1.[illegible]
Smallmouth bass				.20																					0	0	0	.09
Rock bass	1.28		.93	15.98		2.15	4.41	7.94			4.41	7.94							1.31						1.26	.08	1.35	7.62
Bluegill				.99							.24														0	0	.06	.65
Pumpkinseed											.24														0	0	.06	0
Black crappie				1.28																					0	0	0	.59
Yellow perch			13.89	5.42			16.19	32.04			23.92			1.29				2.04	5.46			.20			0	.57	10.18	19.07
Walleye		.49		.69		.37	.54	1.94			.48	9.52							.66			.13	.52		.07	.15	.[illegible]	1.60
Log perch			2.78	1.58			2.43	4.50			2.81	15.87		2.02								.66			0	.84	1.76	3.24
Johnny darter		32.20	18.06	3.45			.94	1.50			3.29	11.11		1.19	4.16			20.41	11.57			.59			0	5.93	3.78	2.69
Iowa darter	1.28				.13	.92								.09	.20							.73	2.60		.44	.27	.26	0
Mottled Sculpin	14.62	2.20	3.24	.59	.13		.27	.26			1.36	1.59		3.68	7.13	25.00	100		21.83			1.72	8.33	8.33	3.25	2.49	1.88	.73
Unidentified				7.40	.27	.73	14.44	.09			.08	.09		.20						1.90		.99			.52	.19	4.77	3.47
Total number of taxa																									19	29	34	29

Table 4. Average number of fish collected by season--boomshocking 1 hour.

	St. Louis			Partridge			Embarrass			Stony			Dunka		
	Spring	Summer	Fall	Spring	Summer	Fall	Spring	Summer	Fall	Spring	Summer	Fall	Spring	Summer	Fall
Northern pike	5.19	2.20	.66	8.33	8.89	4.285	15.69	5.87	4.5	2.00	2.46	1.06	—	—	—
White sucker	6.85	1.33	3.55	34.33	5.89	11.785	12.15	18.83	7.92	17.71	6.87	3.22	85.5	76.5	57.75
Walleye	3.52	.66	—	.66	2.03	1.14	—	1.32	—	3.00	1.14	1.14	—	—	—
Forage species	16.11	99.71	22.54	77.63	20.77	20.49	16.76	3.63	4.78	40.26	104.44	75.27	39.0	33.0	7.5
Others	223.48*	10.41	17.17	68.65	49.59	8.56	8.00	.86	.92	1.0	2.84	1.50	—	—	—
#Stations sampled	3	3	3	2	2	2	2	2	2	3	3	3	1	1	1
Total	255.15*	114.31	43.92	189.6	87.17	46.26	52.6	30.51	18.12	63.97	117.75	82.19	124.5	109.5	65/25

*Reflects the large number of bullheads collected

Table 5. Average number and size of fish collected--summer, 1977.

	ST. LOUIS						PARTRIDGE					
	Boom*		Trap+		Gill+		Boom		Trap		Gill	
	#	l	#	Wt	#	Wt	#	l	#	Wt	#	Wt
Northern pike	2.2	37.6	4.6	301.9	15.0	318.8	6.65	33.2	5.61	440.1	3.0	390.0
White sucker	1.33	28.3	2.0	741.5	10.3	717.9	4.29	23.3	7.23	553.3	1.66	908.7
Walleye	.66	35.3	-	—	4.0	115.0	1.35	24.25	.285	701.7	.33	201.8
Forage species	99.69	—	.166	—	4.0	—	33.42	—	.61	—	1.33	—
Others	10.41	—	5.66	—	7.33	—	24.39	—	1.71	—	1.33	—
#Stations or #Nets	[illegible]		6		3		3		21		3	

	EMBARRASS						STONY						DUNKA					
	Boom		Trap		Gill		Boom		Trap		Gill		Boom		Trap		Gill	
	#	l	#	Wt	#	Wt	#	l	#	Wt	#	Wt	#	l	#	Wt	#	l
Northern pike	5.87	46.6	.33	—	1.0	180.0	2.16	25.2	2.75	357.2	15.0	544.6	—	—	—	—	—	—
White sucker	18.83	36.1	.66	160.3	2.0	970.0	14.41	6.9	2.0	645.0	3.66	399.8	60.76	7.00	10.75	129.5	21.0	173.2
Walleye	1.32	29.7	.166	602.4	—	—	.92	18.52	0.5	200.0	.33	727.2	—	—	—	—	—	—
Forage species	3.63	—	.33	—	2.0	—	78.6	—	—	—	.33	—	83.83	—	1.25	—	1.00	—
Others	.86	—	.33	—	3.0	—	9.07	—	—	—	.33	—	—	—	—	—	—	—
#Stations or #Nets	2		6		1		5		4		3		3		4		1	

*Average #/1 hour run
+Average #/set

length (CM); weight (g)

Table 6. Regional Copper-Nickel Study fish species composition south branch Kawishiwi River 1967, 1976.

Common Name	Scientific Name	AS	BS	CS	DS	ES	FS	GS	HS
Northern cisco	*Coregonus artedii*	X	X		X	X	X	X	X
Lake whitefish	*Coregonis clupeaformis*		X		X			X	X-76
Northern pike	*Esox lucius*	X	X	X	X	X	X	X	X
Golden shiner	*Notemigonus crysoleucus*		X-67				X-67		X-67
Common shiner	*Notropis cornutus*		X-67	X-67	X-67	X-67	X-67	X-67	X-67
Blackchin shiner	*Notropis heterodon*			X-67					
Blacknose shiner	*Notropis heterolepis*	X-67	X-67		X-67	X-67	X-67		
Spottail shiner	*Notropis hudsonius*	X-67	X-67			X-67		X-67	X-67
Bluntnose minnow	*Pimephales notatus*	X-67			X-67	X-67		X-67	X-67
White sucker	*Catostomus commersoni*	X	X	X	X	X	X	X	X
Tadpole madtom	*Noturus gyrinus*	X-67	X-67	X-67	X-67	X-67	X-67	X-67	
Burbot	*Lota lota*				X	X-67			
Bluegill	*Lepomis macrochirus*		X	X-67	X	X-67	X-67	X	X
Pumpkinseed	*Lepomis gibbosus*			X-67	X-67	X			X-76
Rock bass	*Ambloplites rupestris*	X	X	X	X	X	X	X	X
Largemouth bass	*Micropterus salmoides*	X-67						X-67	X-67
Black crappie	*Pomoxis nigromaculatus*	X	X	X-67	X-67	X-67	X-67	X	X
Iowa darter	*Etheostoma exile*					X-67		X-67	X-67
Johnny darter	*Etheostoma nigrum*	X-67	X-67	X-67	X-67	X-67	X-67	X-67	X-67
Logperch	*Percina caprodes*	X-67	X-67		X-67			X-67	X-67
Yellow perch	*Perca flavescens*	X	X	X	X	X	X	X	X
Walleye	*Stizostedium vitreum*	X	X	X	X	X	X	X	X
Slimy sculpin	*Cottus cognatus*	X-67		X-67		X-67	X-67		

X = Fishes captured 1967 and 1976

X-67 = Fishes taken in 1967 (gill netting, trap netting, seining)

X-76 = Fishes captured in 1976 only (gill netting, trap netting)

Table 7. Gill net catch indices for the South Kawishiwi River, Study Area rivers, and Study Area lakes.

	WALLEYE		NORTHERN PIKE		WHITE SUCKER	
	Mean #/Net	Mean Wt/Fish	Mean #/Net	Mean Wt/Fish	Mean #/net	Mean Wt/Fish
South Kawishiwi River	3.73	.323	3.2	.600	4.77	.454
Study Area Rivers	.93	.208	6.8	.286	7.9	.573
Study Area Lakes	8.7	.52	3.45	.81	4.75	.76

Table 8. Regional Copper-Nickel Study coldwater fishery resource summary table.

Watershed	RCNS Site	Creek Name	Date Sampled	Stream Order	Number of Fish	Length Range (cm)	Length Average (cm)	Length Average (in)	Management Classification
Dunka	DF-0	Dunka R.	4-24-77	3	1		11.6	4.6	Warmwater feeder-minnow
			8-5-77		2	18.8-22.2	20.5		
	DF-.5	Dunka R.	8-5-77	3	1		19.4	7.6	Warmwater feeder-minnow
	DF-1	Dunka R.	9-19-77	3	2	22.1-28.5	25.3	10.0	Warmwater feeder-minnow
					6	11.6-28.5	20.4	8.0	
Partridge	PF-12	Wyman	6-2-77	1	3	18.1-22.1	20.5	8.1	Trout
			7-25-77		1		17.0	6.7	Trout
					4	17.0-22.1	19.6	7.7	
Isabella	IF-4	Snake	6-10-77	3	5	5.8-16.9	12.1	4.8	Trout feeder
	IF-5	Trib. to Snake	6-13-77	1	44	3.3-13.2	4.9	1.9	Trib. to trout feeder
	IF-8	L. Isabella River	6-15-77	2	1		20.5	8.1	Trout
	IF-9	L. Isabella River	6-15-77	2	30	4.2-22.9	12.9	5.1	Trout
					80	3.3-22.9	8.5	3.3	
Stony	SRF-8	Nip	5-10-77	3	1		7.3	2.9	Warmwater feeder
	SRF-9	Nip	9-21-77	1	1		19.7	7.8	Trout feeder
	SRF-11	Nira	7-13-77	2	4	7.1-13.6	11.4	4.5	Warmwater feeder
			9-26-77		1		12.0	4.7	
	SRF-12	Nira	5-4-77	2	11	9.6-12.6	11.2	4.4	Warmwater feeder
			6-28-77		9	11.5-19.0	15.3	6.0	
			9-20-77		9	13.3-18.8	16.3	6.4	
	SRF-13	Nira	5-4-77	1	14	7.0-15.0	9.8	3.9	Warmwater feeder
			7-1-77		22	5.8-15.7	10.7	4.2	
			9-9-77		25	8.0-17.0	12.1	4.8	
					97	5.8-19.7	12.0	4.7	
Total for: All Watersheds	13		20		187	3.3-28.5	10.9	4.3	

Appendix I.

Classification of Minnesota Streams for Fish Management Purposes*

STREAMS

TYPE A. Trout Streams

Defined as streams capable of supporting an acceptable sport fishery through natural reproduction. Streams in this group will be managed by: protection of the stream from physical abuse of the habitat; development of the stream for public fishing areas through acquisition of stream frontage and improvement of the habitat and regulation to promote the optimum sustained recreational use. As a general procedure, trout populations in these streams will not be maintained at artificial levels by maintenance or put-and-take stocking.

Because trout streams in this category range from small brushy feeder streams characterized by cold water and small trout to the large productive main channel areas, they should be divided into two sub-categories:

TYPE A1. Main channel streams--Streams large enough to support a significant fishery with all types of common gear--bait, spin-cast, and fly fishing.

TYPE A2. Feeder streams--Defined as too small or brushy to provide more than a limited trout fishery.

NOTE: It is probable that Type A2 (feeder streams) will comprise a significant segment of total Minnesota trout streams. It is important both for inventory and management purposes to differentiate these small streams from the more fishable downstream areas. First, it would be unwise to confuse these

*From Petersen 1969

small streams with top-notch large fishable trout streams on a quantitative basis; second, the feeder streams are unique in some aspects. In some cases these small streams may be directly tributary to non-trout water, but still may afford a bona fide trout fishery in their own right. In many cases the greatest value of these small streams is found in their contribution of cold water and recruitment of small trout to the larger downstream areas. In any case such streams that have more than one type should be divided into sectors and each classified individually.

TYPE B. Trout streams

Defined as streams capable of supporting a trout population of dominant interest to the sport fishery except for the lack of natural reproduction or over-abundant competing species. Streams in this group will be managed similarly to Type A streams except that efforts may be called for to maintain trout populations at artificially high levels. Population manipulation practices for this purpose may include artificial spawning areas, maintenance stocking of fish, and population control with fish toxicants.

TYPE D. Associated streams-trout

Defined as streams not capable of supporting trout populations over extended periods of time, or streams that may contain limited populations of trout, but that have a greater interest or value to the sport fishery in supporting other species of fish. Streams in this group will not be regulated as designated trout waters. If managed for trout fishing, it should be on a put-and-take basis utilizing catchable sized rainbow trout.

TYPE E. Warmwater gamefish streams

Defined as streams capable of supporting an acceptable resident sport fishery through natural reproduction. Such stream classification will be subdivided according to the principal species sought although other game and coarse fish species may be present. Streams in this group will be managed by: preservation and development of the habitat and natural spawning sites; development of the stream for public fishing areas through acquisition of stream frontage; maintenance of minimum water flows where regulated by upstream reservoirs; and regulation to promote the optimum sustained recreational use. Usually gamefish populations in these streams will not be maintained at artificial levels by maintenance or put-and-take stocking, except trophy fish species such as muskellunge may be stocked in certain streams managed for this species.

The subdivisions of warmwater gamefish stream classification are as follows:

E-1 Walleye

E-2 Northern pike

E-3 Cosmopolitan (large river)

TYPE G. Warmwater connector streams

Defined as streams having a sport fishery owing its existence to fish populations in adjacent lakes or larger tributaries. In general such streams may vary from mouths of large tributaries to streams conducting the flow from lake to lake. Streams in this group will be managed by protection of the stream habitat including their free-flowing condition and minimum flows, and by development of the stream for public fishing areas through acquisition of stream frontage.

These streams will be of two types.

G-1 Warmwater connector streams - walleye

G-2 Warmwater connector streams - northern pike

TYPE H. Warmwater feeder streams

Defined as streams not capable of providing any significant sport fishery because of small size, shallow character or intermittent nature. Streams of this group will be managed only if utilized in migration of spawning gamefish species. In such a case acquisition of the stream through easement or purchase will protect it from channelization or barriers.

H-1 Northern pike (spawining)

H-2 Walleye (spawning)

H-3 Minnow

Appendix II

Dunka Watershed

The Dunka River drains an area of 128 km^2 southeast of Babbitt, Minnesota. It's source is in a bog area (T 59N. R12W. S22) and it drains into Birch Lake (T 60N. R12W. S4). Vegetation in the watershed includes: 27.14 percent spruce-fir, 3.06 percent pine, 42.30 percent aspen-birch, and 27.50 percent non-forested or unproductive land.

The main stem of the Dunka River is a third order stream, 25.6 km long and is classified as a sucker-minnow stream by the MDNR (1968). The two major tributaries, Twenty Proof Creek and Langley Creek, are classified as associated trout and sucker-minnow respectively. Substrates consist of muck and boulder in flat water areas and gravel in the riffles. Pools are numberous but shallow and probably unproductive. The majority of the stream is potential northern pike spawning habitat, but the headwaters may provide brook trout spawning habitat.

Stony Watershed

The Stony watershed encompasses an area of approximately 632 km^2 in the Study Area. Its source is on the north side of the Laurentian Divide (T58. R10W. S35) and mouth at Birch Lake (T61. R11W. S25). Major tributaries to the Stony River include: Greenwood River, Nip Creek, Denley Creek and Coyote Creek. Major lakes in the watershed include: Greenwood, Sand, McDougal lakes, Stony, Slate and Chub. Vegetation in the watershed is 15.49 percent pine, 49.18 percent spruce-fir, and 26.05 percent aspen-birch, and 9.21 percent non-forested or unproductive land.

The breakdown of management classifications in the Stony watershed is 6.34 percent trout 8.62 percent warmwater gamefish, 30.59 percent cosmopolitan and 14.36 percent warmwater feeder streams. The remaining 40.1 percent is unclassified. Total stream kilometers include 105.1 km of first order, 85.5 km of second order, 53.0 km of third order and 39.7 km of fourth order.

Substrate types vary from ledgerock to muck and detritus. Water color is stained brown because of the humus content. Brook trout spawning habitat is present in Nip Creek and Mike Kelley Creek; northern pike spawning habitat is present in scattered areas along the length of the river, and potential walleye spawning habitat exists in the river above and below lakes.

Embarrass Watershed

The Embarrass River drains 229 km^2 on the west side of the Study Area. The main stem of the river is 22.9 km long and is classified by the MDNR as a cosmopolitan stream containing a variety of fish species. Its major tributary, Bear Creek, is classified as a warm water feeder-northern pike stream. Gradient of the river averages 1.3 m/km and the substrate type is predominantly sand. Few riffle areas occur along its length and the water is stained brown.

Northern pike spawning habitat is present in areas downstream from Bear Creek. The Embarrass River flows through Wynne and Sabin Lakes both of which have populations of northern pike, walleye, black crappie, tullibee, and white suckers. The majority of the river is accessible but probably receives little fishing pressure.

Vegetation in the Embarrass River includes: 2.00 percent pine, 27.34 percent spruce-fir, 52.13 percent aspen-birch 18.52 percent unproductive or non-forested land.

Bear Island Watershed

The Bear Island Watershed encompasses an area of 177 km^2 in the Study Area. The source of the Bear Island River is Bear Island Lake (T61N. R12W. S.6) in St. Louis County. Major tributaries to the lake include Johnson Creek and the Beaver River. Two lakes, Bear Island and One Pine both lie in the Bear Island watershed.

Stream classifications in the Bear Island watershed include: 41.7 km of unclassified streams, 14.3 km of northern pike stream, and 20.6 km of cosmopolitan waters.

Topography in the watershed varies from low swampy areas to rock outcroppings and gently rolling hills. Cover types include: 5.72 percent pine, 67.33 percent aspen-birch, 14.07 percent spruce-fir, and 12.53 percent unproductive and non-forested land. Areas below rapids offer good walleye spawning habitat while flatter stretches offer fair northern pike spawning habitat. A spring run of white suckers occurs.

Partridge Watershed

The Partridge River contains 335 km^2 of drainage area in the Study Area south of the Laurentian Divide. The Partridge flows into the St. Louis River just south of Aurora, Minnesota. There are 81.1 km in 29 first order tributary streams in the 188.9 total stream km. Of the 177.8 km of classified streams 50 km are trout streams, 27.9 km are warmwater gamefish streams, 41.9 km are cosmopolitan, and 60.0 km are warmwater feeder streams.

Some of the major tributaries include: Colvin Creek, Wyman Creek, First and Second Creeks, and Cranberry Creek. The major lakes in the watershed are: Big Lake, Cranberry Lake, Whitewater Lake, and Colby Lake.

Although the range is from boulder to detritus river substrates are primarily rubble, gravel, muck and detritus. The river contains several riffles but is mainly made up of flat water with some pools. The surrounding topography ranges from rolling forested hills in headwater reaches to low flat swamp forest throughout the remainder of the watershed.

There are several large developments along the Partridge River. The villages of Aurora and Hoyt Lakes are located near the lower end of the river, and several of the northern tributaries are located near two open pit mines.

Spawning habitat is good for northern pike during spring highwater. Trout habitat is good in several of the northern tributaries and walleyes probably spawn in the main channel of the river.

St. Louis Watershed

The St. Louis river system is found south of the Laurentian Divide within the Study Area. It encompasses 350 km^2 of total drainage area above the point south of Aurora, Minnesota where it leaves the Study Area. The St. Louis River eventually drains into Lake Superior. Of the 117.7 km total kilometers of streams only 83.7 km are classified. Warmwater feeder streams make up 27.9 km of first, second, and third order streams. The remaining 55.9 km of third and fourth order streams are cosmopolitan. Laird Creek, Longlake Creek, and Hush Creek are a few of the named headwater tributaries in the St. Louis Watershed.

River substrates range from boulder to detritus but primarily consist of boulder, sand, muck, and detritus. The majority of river topegraphy is flat. Occasional pools and riffles are present but to a small degree. Rolling forested hills surround most of the river although a few low swampy areas can be found.

Physical developments on the St. Louis are few. Logging and beaver dams may have the only direct impacts on flow of the river.

At spring high water, northern pike spawning is good. Walleye and sucker spawning habitat is good in many of the riffle areas.