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The Impact of the Strutt Lake Hydro Project on the Snare River, N.W.T.

by
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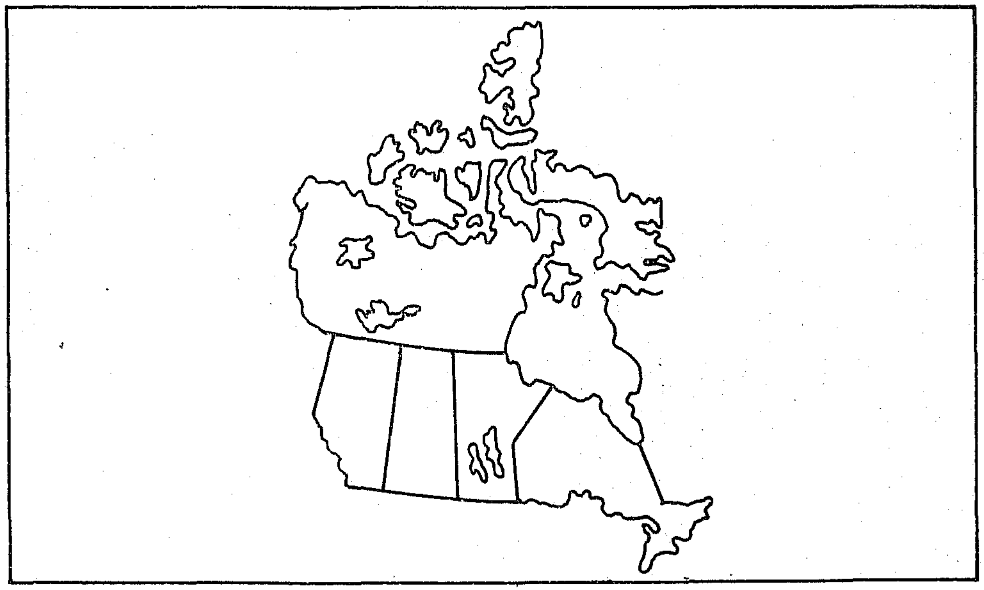
Resource Management Branch
Central Region



DEPARTMENT OF THE ENVIRONMENT
FISHERIES AND MARINE SERVICE

Fisheries Operations Directorate
Central Region

TECHNICAL REPORT SERIES NO.: CEN/T-74-4

THE IMPACT OF THE STRUTT LAKE HYDRO PROJECT ON THE SNARE RIVER, N.W.T.

by

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Multiple Water Use Section
Resource Management Branch

1974

ABSTRACT

A preliminary survey was made of the limnology and fisheries of the Snare River system from the Snare Falls Reservoir to the outlet of Strutt Lake in an attempt to predict the impact of a proposed hydro-electric scheme and to suggest mitigation measures. Little significant difference was found in either growth or condition when comparing the fish populations in the reservoir with those in Judd and Strutt Lakes. Differences were noted in species composition in the three lakes with the most abundant species in the lakes being lake whitefish and the most abundant species in the reservoir being longnose suckers. The three areas showed no significant differences in water chemistry. Once inundation occurs on Judd Lake the grayling populations will be greatly reduced and the longnose suckers will increase. The reduced flows in the Snare River below Judd Lake will reduce grayling in this area and may reduce the walleye populations in Strutt Lake by eliminating a major spawning area. The impact on the fish could be lessened by clearing in the proposed reservoir and providing flow in the present channel of the Snare River.

ACKNOWLEDGMENTS

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INTRODUCTION

An application by the Northern Canada Power Commission "to divert" and "to store" water for the purpose of developing hydroelectric power on the Snare River, N.W.T. was received by the Northwest Territories Water Board on July 20, 1973. Under Section 20 of the Fisheries Act the Minister of the Environment may require dams to be provided with fishways, and may require escapement of water below dams for the safety of fish. Environment Canada, Fisheries and Marine Service, undertook the studies described below to assist in the determination of these requirements.

The Northern Canada Power Commission first developed the Snare River for hydroelectric power in 1948 when the Snare Rapids generating station was opened. This plant uses Big Spruce Lake [approximately 129 sq. km(50 sq. mi)] as a storage reservoir. At present the head is 18.9 m (62 ft) with an annual draw-down of 3.05 m (10 ft), this gives a firm flow of 33.97 cms (1200 cfs) and develops a firm 7 mega watts (MW) of electricity.

In 1962 the Snare Falls generating station was opened. It is located 14.5 km (9 mi) downstream from the Snare Rapids powerhouse. This plant also has a head of 18.9 m (62 ft) and, using the same flows as the Snare Rapids plant, also produces 7 MW of electricity. Here no extensive storage reservoir was needed because of the already regulated river flow. Until recently the Snare Falls plant was used to supply peaking power to the Yellowknife grid.

For the years 1972 and 1973 the power demands of the Yellowknife grid have peaked at 18.7 MW, with the additional 4.7 MW being supplied by diesel units. Electricity generated by diesel is generally more costly than hydroelectric power.

The new plant proposed for the Snare River at Strutt Lake could supply a firm 7 MW and a peak of 14 MW to the Yellowknife grid.

PROPOSED PROJECT

The project described below is as outlined in Northern Canada Power Commission (1973). It should be noted that these are not the final project plans.

Under the proposed project Judd Lake will be used as a reservoir with the water being diverted through Line Lake to a powerhouse on the north end of Strutt Lake. There would be three major components to this project: 1) the spillway and dam near the present outlet of Judd Lake 2) the canal from Judd Lake to Line Lake and 3) the penstocks, control structure and powerhouse situated between Line and Strutt Lake (Fig. 1).

The level of Judd Lake would be raised 14.6 m (48 ft) by the construction of a dam approximately 457 m (1500 ft) downstream from the present lake outlet F.S.L. 182.9 m (600 ft). The spillway would be constructed near Cowboy Lake where a series of dykes would also be necessary to maintain the water level.

The water would leave Judd Lake via a canal leading to Line Lake. This canal would be approximately 259 m (850 ft long).

Another dam 457 m (1500 ft) downstream of Line Lake will contain the inlet of a canal, tunnel or penstock which will ultimately carry the water to the power house situated on Strutt Lake.

The final location of the powerhouse will be dependent on investigations carried out during the summer of 1973. The total head available to the power house is 22.8 m (75 ft) and the reservoir formed will cover 1011 Hect. (2500 A).

This would produce three major areas of impact of concern to fisheries:

1) the inundated areas of the reservoir [approximately 607 Hect. 1500 A],
2) the section of the Snare River from Judd Lake to Strutt Lake which would have greatly reduced flows and,
3) the discharge of the powerhouse into the north end of Strutt Lake.

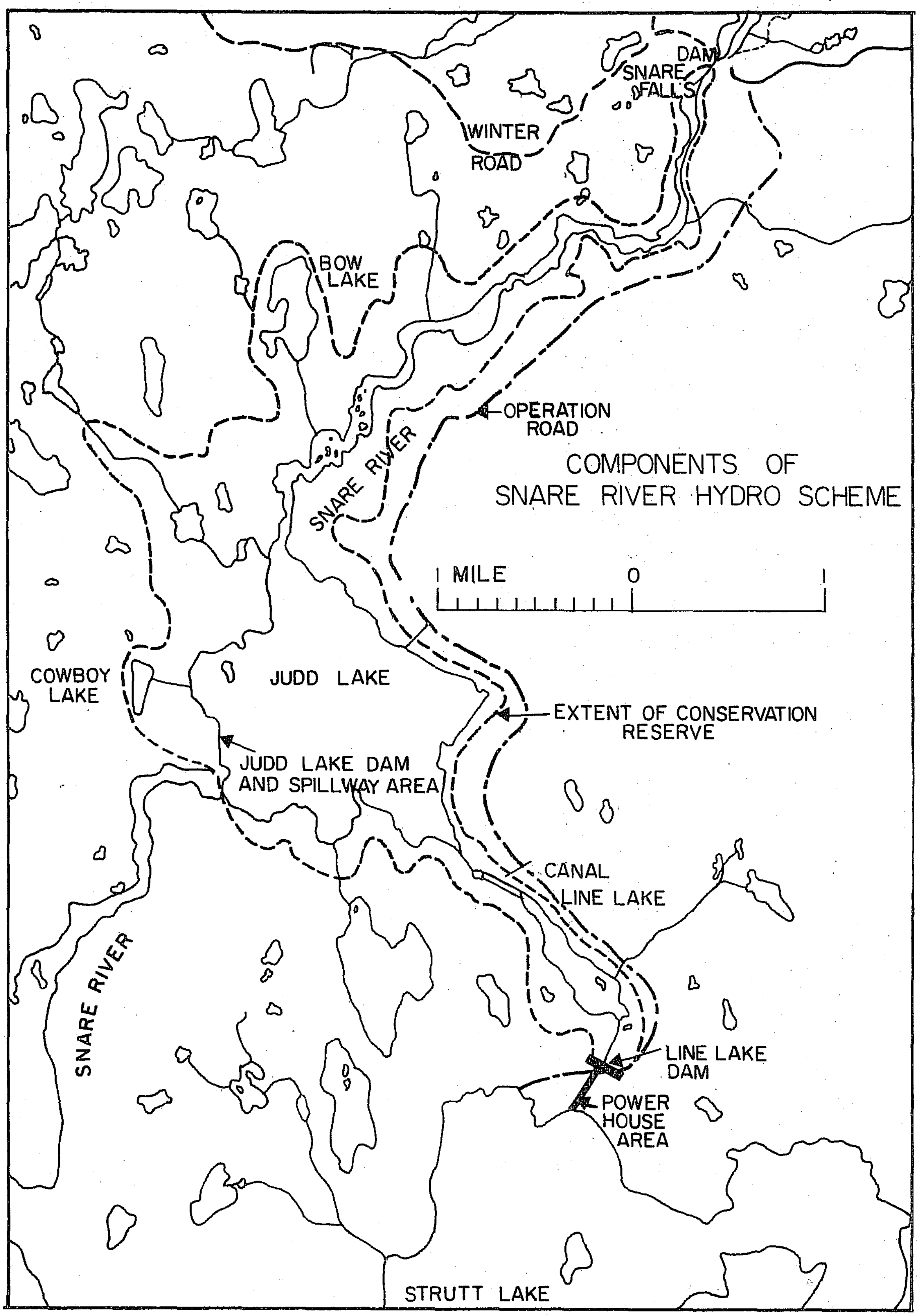

Figure 1: The proposed hydro project showing the approximate location of the components and the approximate extent of flooding.

STUDY AREA

The headwaters of the Snare River are near the treeline at the 65th parallel. The river system flows in a southerly direction for approximately 483 km (300 mi) before entering into the north arm of Great Slave Lake. There are four larger lakes on the river system, Snare, Indin, Whitewolf and Big Spruce. The latter lake is presently part of the reservoir for the Snare Rapids power development. There is a second power development at Snare Falls immediately downstream of Snare Rapids with a much smaller conservation reservoir.

The study area (Figure 2), Snare Falls to Strutt Lake, is a Precambrian Shield area with exposed metamorphic rock. There are deposits of glacial drift in sheltered areas and glacial material is common in the river bed. The west bank of the Snare River has a low relief but is very rugged at ground level. The east bank has hills rising to 152 m (500 ft) above the river bed. Sporadic beach-like formations are common throughout the area and contain sand, fine gravel and some water-sorted cobble.

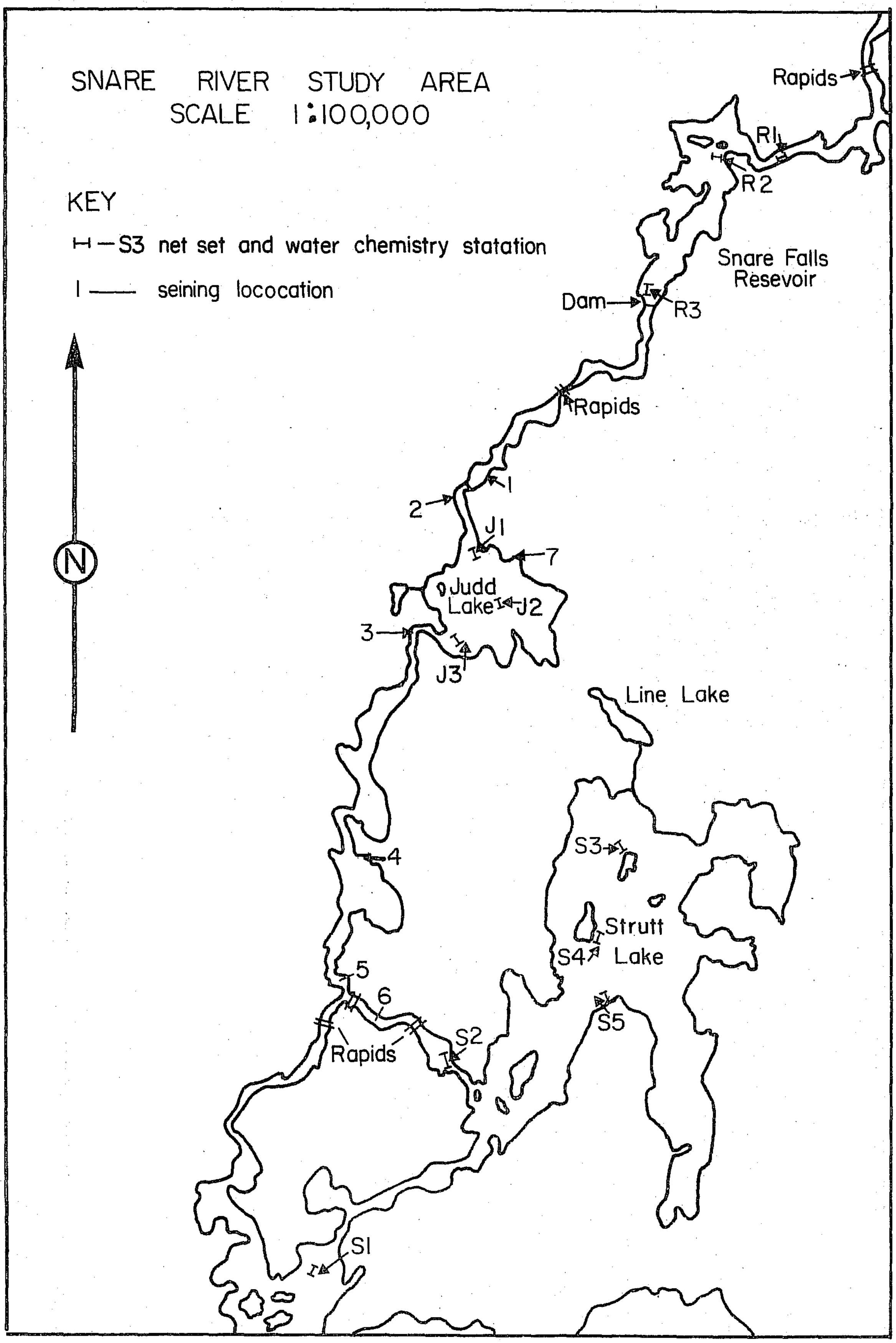

Figure 2: The study area showing the location of gill net sets, water chemistry stations and seining locations.

METHODS

The study was conducted from September 6 to 16th, 1973 by a two-man crew from Environment Canada, Fisheries and Marine Service, Winnipeg. September 6th through 9th were spent on Strutt Lake, 9th through 12th on Judd Lake and 12th through 16th on the Snare Falls Reservoir.

The fish populations were sampled by gill net and beach seines. Two gangs of gill nets were used. The first consisted of seven 9.14 meter (10 yds) panels of monofilament with the following stretch mesh sizes: 3.81, 5.08, 6.35, 7.62, 8.89, 10.16 and 12.70 centimeters (1.5, 2, 2.5, 3, 3.5, 4 and 5 inches). The second consisted of three 45.7 m (50 yds) panels of nylon net with stretch mesh sizes of 3.81, 6.35 and 8.89 cm (1.5, 2.5 and 3.5 inches); both gangs were 1.82 meters (six feet) deep. There were 5 sets in Strutt, 3 sets in Judd and 3 sets in the reservoir (Figure 2). Sets S-1, J-2, and R-3 were the nylon gang, all others were monofilament. The gangs were left overnight at each set. The beach seine was 9.14 m (30 ft) long, 1.21 m (4 ft) deep with .63 cm (1/4 inch) mesh. All seine hauls, except #7, were made in stretches of the river and during daylight hours. No. 7 was a night haul in Judd Lake. All fish collected by gill net were weighed to the nearest gram, measured to the nearest millimeter (fork length), their sex and maturity noted and, except for suckers, scale samples taken. Fins from the suckers were taken to determine age. The maturity of the fish was classified as follows: 1-immature, 2-maturing, 3-mature, 4-ripe, 5-spent. In the case of "2" the fish's gonads were developing but spawning was not likely to occur during the current season; for "3" the fish were going to spawn during the current season. The ages of all species, except suckers, were determined by scale reading. Representative samples of seine hauls were preserved in 10% formalin and returned to the lab for identification.

Back calculations of length at age were made for pike and whitefish, using the formula described by Tesch (1968):

$$ln = \frac{Sn}{S}$$

where ln = length of fish at a given annulus
1 = fork length of fish at time of sampling
Sn = radius of given annulus
S = total scale radius

This formula was chosen because of the smaller sample size and it was used only to compare fish from the three areas. Five pike from Strutt Lake, five from Judd Lake and four from the reservoir were used for the back calculations. Fourteen lake whitefish from Strutt Lake, 15 from Judd Lake and 10 from the reservoir were used for back calculations.

The "condition" of all species from the three sample areas were determined by the formula:

$w = a\,1^{b}$

where w = weight of fish
a = y- axis intercept
1 = length of fish
b = slope of the line

This formula can also be written in the logarithmic form:

$$\log_{10} w = \log_{10} a + b\,(\log_{10} 1)$$

The slopes (b) of the formulae and the elevations (a) were compared by the analysis of covariance (Snedecor and Cochran 1967).

Catch per unit of effort (c.u.e.) was calculated by area for each species to determine the relative abundance. The limited number of net sets from each area reduce the reliability of estimates of relative abundance.

Water chemistry samples were taken at gill net stations S-1, S-2, S-4, S-5, J-1, J-2, J-3, R-1, R-2 and R-3. Each sample was taken from 1 meter below the surface. Dissolved oxygen, pH, alkalinity and hardness were measured, using a HACH water chemistry kit. Conductivity and temperature were measured using a Yellow Springs Model 33 conductivity meter. Transparency was measured with a Secchi disc.

Water samples were collected as outlined in Figure 3. Sub-sample 1) was analysed for silicon, sodium, potassium, magnesium and calcium. Filter paper 2) was analysed for suspended carbon and nitrogen. Filter paper 3) was analysed for total dissolved solids (TDS) and suspended phosphorous. Filter paper 4) was analysed for chlorophyll. Sub-sample 5) was analysed for chloride and sulphate.

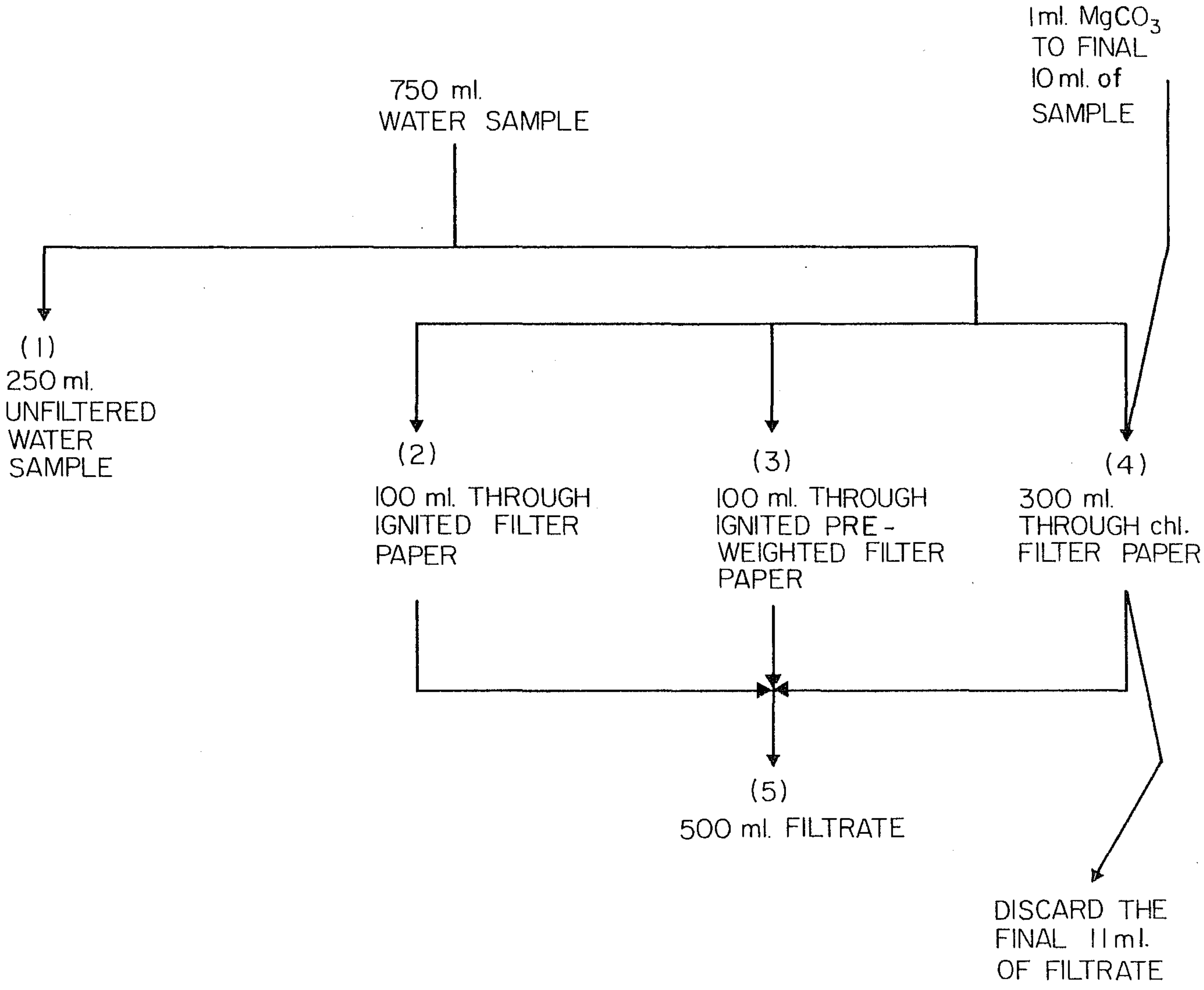

Figure 3: Schematic diagram of water sampling procedure.

EXPERIMENTAL FISHING

A list of the common and scientific names of species captured during the study are given in Table 1. There are most likely species in the study area that were missed because of the limited fishing effort.

Table 2 gives the distribution and number of species caught in gillnets. The occurrence of lake trout in Judd Lake was the only unexpected observation. Table 3 indicates the presence of each species at the seven seining locations. Grayling were angled in several areas on the river itself but were not caught in either the gillnets or seines.

Fish Condition: Table 4 outlines the condition formulae for the fish species encountered in the study area and compares them with the formulae for other populations. Walleye, lake trout and longnose suckers have formulae similar to those from other areas (excepting the walleye from Judd Lake where the small sample size is believed to have biased the data).

Only lake whitefish and pike had sample sizes, from all three areas, large enough to permit an analysis of covariance of the regression formulae. The slopes (b) for the length weight relationships for the lake whitefish from all three areas showed no significant differences at the 5% level of confidence. Although there was no significant difference between the elevations of the curves for the Reservoir and Judd and the Reservoir and Strutt, there was a significant difference between the elevations of the curves for Judd and Strutt lakes. This meant that for a given length the lake whitefish from Strutt Lake would be significantly heavier than the lake whitefish from Judd Lake.

In comparing the slopes of the length-weight regressions for the northern pike, no significant differences were found between Judd and the Reservoir or Judd and Strutt at the 5% level of confidence. There was a significant difference between Strutt and the reservoir indicating the pike from the reservoir showed more increase in weight with increased length than they did in Strutt Lake. No significant differences were found between the elevations of any of the curves. The length-weight relationships for whitefish and pike are graphed in Figures 4 and 5 respectively.

These results indicate that the condition of both lake whitefish and pike are similar in all three sample areas. The significant difference between the slope of the regression formulae for pike on Strutt and the Reservoir may have been directly related to the small sample size in both areas (reservoir, n = 4, Strutt, n = 21). The value (3.16) was only slightly larger than the 5% Student - t value of 1.71.

Back Calculations and Age: Figure 6 shows the length for a given age of the whitefish plotted from the back calculated data from the three study areas. The fish from all three areas have similar year I lengths but show separation thereafter. Judd and Strutt Lakes appear similar, with the reservoir having a much longer length at a specific age than either of the lakes. The differences in growth in the reservoir are most likely related to the available food. As lake whitefish condition in the three areas is similar, the increased length of a given age could indicate that the lake whitefish in the reservoir have, for short periods of the year, more food available. This situation was noted in the Bay d'Espoir Reservoir system in Newfoundland where massive caddis fly hatches were used extensively by trout as food but were only available for short periods of the summer (Wiseman pers. comm.). This could cause an initial increase in both length and weight which would not occur in other areas. As these food supplies decreased, the length would not decrease but the weight would drop, leading to a condition similar to the other areas.

Figure 7 shows the back calculated data for northern pike. No reasons can be noted for the increased growth rate in Judd Lake over the other two areas. The small sample size may have biased the data.

Lake whitefish from the three sample areas generally were slower growing than those from Lac la Martre (Bond, MS 1973) and Great Bear Lake (Kennedy, 1949) and had similar growth rates to those from Lac la Ronge (Rawson and Atton, 1953) and Southern Indian Lake (Ayles, MS 1973). These observations were made by visual comparison of the individual growth curves.

Northern pike from Judd Lake had a similar growth rate to those from Lac la Ronge (Rawson and Atton, 1953) and Trout Lake, Saskatchewan (Koshinsky pers. comm.). Strutt Lake and the Reservoir had lower growth rates.

These observations indicate that the Snare river system, in certain areas, was as productive as other shield lakes to the south. Lac la Martre is not a shield lake and exhibits a higher whitefish growth rate.

Figure 8 illustrates the frequency distribution of the ages for lake whitefish, northern pike and walleye from the three sample areas. It appears that for both lake whitefish and northern pike from Strutt Lake there was a higher percentage of older fish, than in Judd Lake and the Reservoir. The sample size for walleye was too small to show any trend.

Catch per Unit of Effort: The catch per unit of effort for all species and all mesh sizes in the three sample areas was 5 fish/net/24 hrs, 5 fish/net/24 hrs and 6 fish/net/24 hrs for the Reservoir and Judd and Strutt Lakes, respectively. (The above figures lump catches per 91 m (100 yd) from both monofilament and nylon nets). Considering the limited fishing effort and sample sizes, this is only a crude estimate of fish abundance from the three areas. The species composition in the three areas varied markedly. In Strutt Lake, whitefish were the most common species, being 3.5 times more plentiful than pike and 4 times more plentiful than walleye. In Judd Lake, lake whitefish and pike were equally plentiful, being twice as plentiful as lake trout. In the Reservoir, however, longnose suckers were the most plentiful, being 2.5 times as plentiful as lake whitefish, 7 times as plentiful as pike and 9 times as plentiful as walleye.

Table 1. Partial list of fish species from the Snare River study area.

COMMON NAME	SCIENTIFIC NAME
Burbot	*Lota lota*
Grayling	*Thymallus arcticus*
Lake Chub	*Couesius plumbeus*
Lake Cisco	*Coregonus artedii*
Lake Trout	*Salvelinus namaycush*
Lake Whitefish	*Coregonus clupeaformis*
Longnose Sucker	*Catostomus catostomus*
Ninespine Stickleback	*Pungitius pungitius*
Northern Pike	*Esox lucius*
Round Whitefish	*Prosopium cylindraceum*
Slimy Sculpin	*Cottus cognatus*
Spottail shiner	*Notropis hudsonius*
Trout Perch	*Percopsis omiscomaycus*
Walleye	*Stizostedion vitreum vitreum*

Table 2. Species composition as determined by gillnet for each lake sampled, total number of species netted in each area.

SPECIES	RESERVOIR	JUDD	STRUTT
Pike	4	14	21
Lake Trout	-	8	4
Lake Whitefish	11	17	73
Walleye	3	3	17
Longnose sucker	28	1	1
Round Whitefish	1	-	-
Burbot	-	-	1
Lake Cisco	-	1	1
TOTAL FISH	47	44	118
Mono-Yards Set	140	140	280
Nylon Yards Set	150	150	150
TOTAL YARDS	290	290	430

Table 3. Presence of fish in seine hauls on the Snare River system. Stations located on Figure 2.

	STATIONS						(Night)
SPECIES	1	2	3	4	5	6	7
Slimy Sculpin	X	X	X		X	X	X
Ninespine Stickleback				X			X
Longnose Sucker	X	X		X			X
Trout Perch							X
Lake Chub							X
Spottailed Shiner				X		X	
Northern Pike	X	X				X	
Lake whitefish							X

Table 4. A comparison of length-weight regression formulae of each fish species from the three study lakes with those of other areas. (Logarithms to the base 10, length in millimeters, weight in grams)

Species	Area	Formula	n	Author
Lake Whitefish	Reservoir	$\log w=-5.7399 + 3.330 \log l$	11	
	Judd Lake	$\log w=-5.000 + 3.093 \log l$	17	
	Strutt Lake	$\log w=-7.214 + 3.734 \log l$	73	
	Great Slave Lake	$\log w=-5.706 + 3.333 \log l$		Kennedy (1953)
	Lac la Martre	$\log w=-5.702 + 3.314 \log l$		Bond (1973)
	Lac la Ronge	$\log w=-6.16 + 3.48 \log l$		Qadri (1955)
	Arctic Red River	$\log w=-5.486 + 3.247 \log l$		Hatfield *et al.* (1972)
	Norman Wells	$\log w=-5.552 + 3.243 \log l$		" "
	Fort Simpson	$\log w=-4.854 + 2.988 \log l$		" "
Northern Pike	Reservoir	$\log w=-9.994 + 4.075 \log l$	4	
	Judd Lake	$\log w=-6.351 + 3.176 \log l$	14	
	Strutt Lake	$\log w=-5.602 + 2.731 \log l$	21	
	Southern Indian Lake	$\log w=-6.71 + 2.6 \log l$		Ayles (MS 1973)
	Lac la Ronge	$\log w=-5.4 + 3.1 \log l$		Koshinsky (MS 1972)
	Lake of the Woods	$\log w=-6.2 + 3.1 \log l$		Carlander (1945)
	Arctic Red River	$\log w=-5.279 + 3.052 \log l$		Hatfield *et al.* (1972)
	Norman Wells	$\log w=-5.021 + 2.959 \log l$		" "
	Fort Simpson	$\log w=-5.297 + 3.068 \log l$		" "

(cont'd.)

Table 4. (cont'd).

Species	Area	Formula	n	Author
Walleye	Reservoir	log w = -6.079 + 3.375 log l	3	
	Judd Lake	log w =-1.776 + 1.274 log l	3	
	Strutt Lake	log w = -5.000 + 3.031 log l	17	
	Arctic Red River	log w = -5.318 + 3.140 log l		Hatfield *et al.* (1972)
	Norman Wells	log w = -3.259 + 2.302 log l		" "
	Fort Simpson	log w = -4.690 + 2.886 log l		" "
Lake Trout	Judd Lake	log w = -5.000 + 3.128 log l	8	
	Strutt Lake	log w = -6.210 + 3.304 log l	4	
	Great Slave Lake	log w = -4.970 + 3.02 log l		Kennedy (1954)
	Lac la Martre	log w = -4.970 + 3.02 log l		Bond (1973)
	Superior	log w = -5.770 + 3.282 log l		Rahrer (1965)
Longnose Suckers	Reservoir	log w = -5.477 + 2.916 log l	28	
	Great Slave Lake	log w = -4.457 + 2.88 log l		Harris (1952)
	Lac la Martre	log w = -5.545 + 3.286 log l		Bond (1973)
	Arctic Red River	log w = -3.487 + 2.450 log l		Hatfield *et al.* (1972)
	Norman Wells	log w = -4.967 + 3.012 log l		" "
	Fort Simpson	log w = -5.053 + 3.053 log l		" "

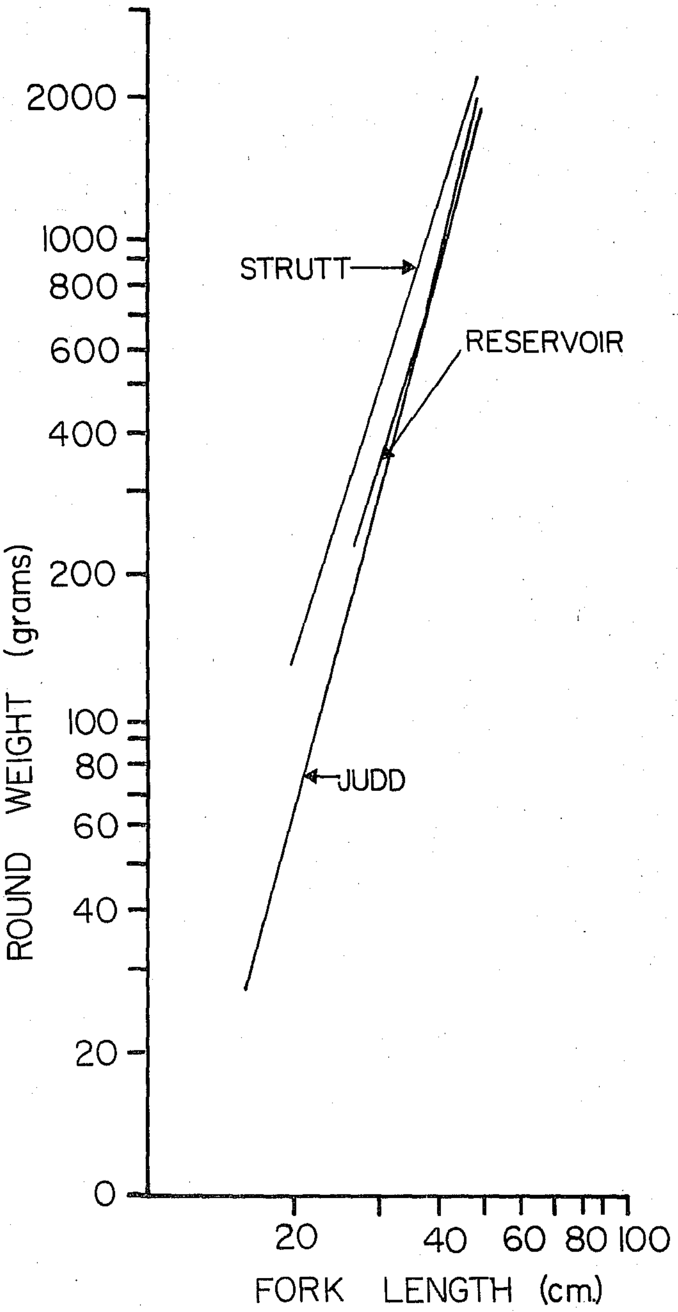

Figure 4: Condition curves for lake whitefish from three study areas.

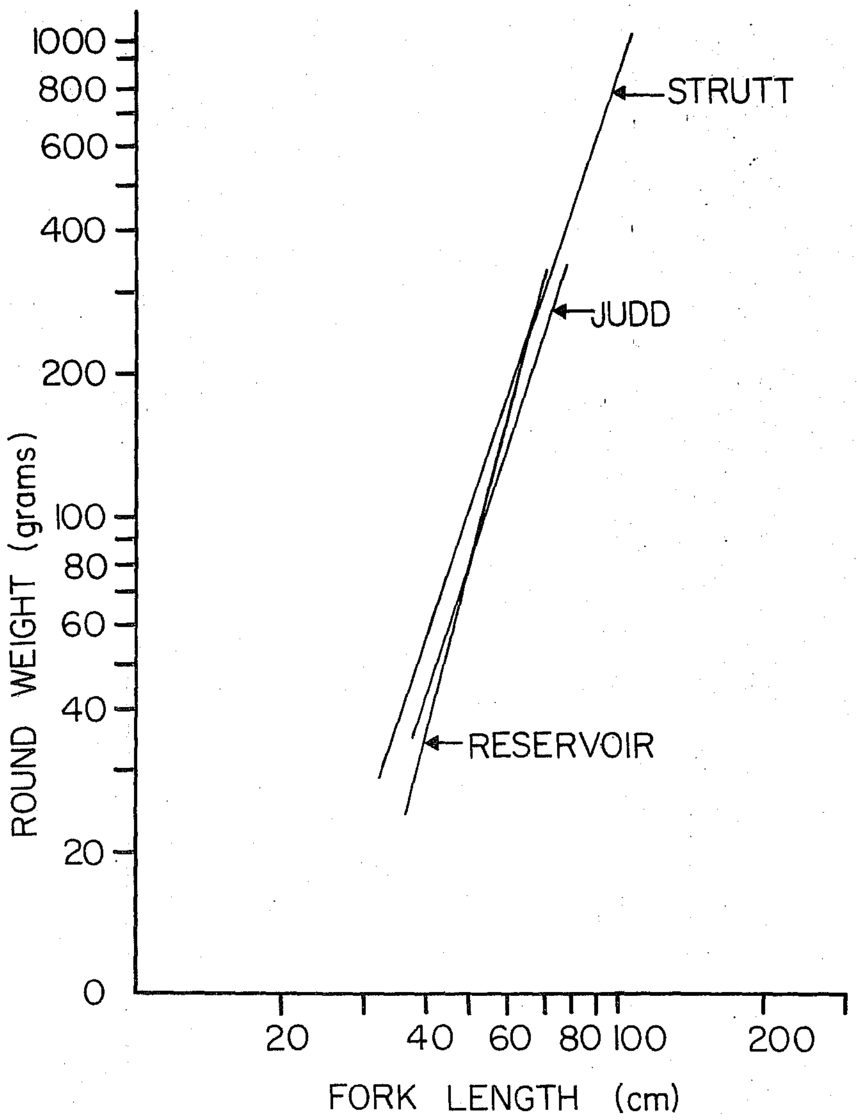

Figure 5: Condition curves for northern pike from the three study areas.

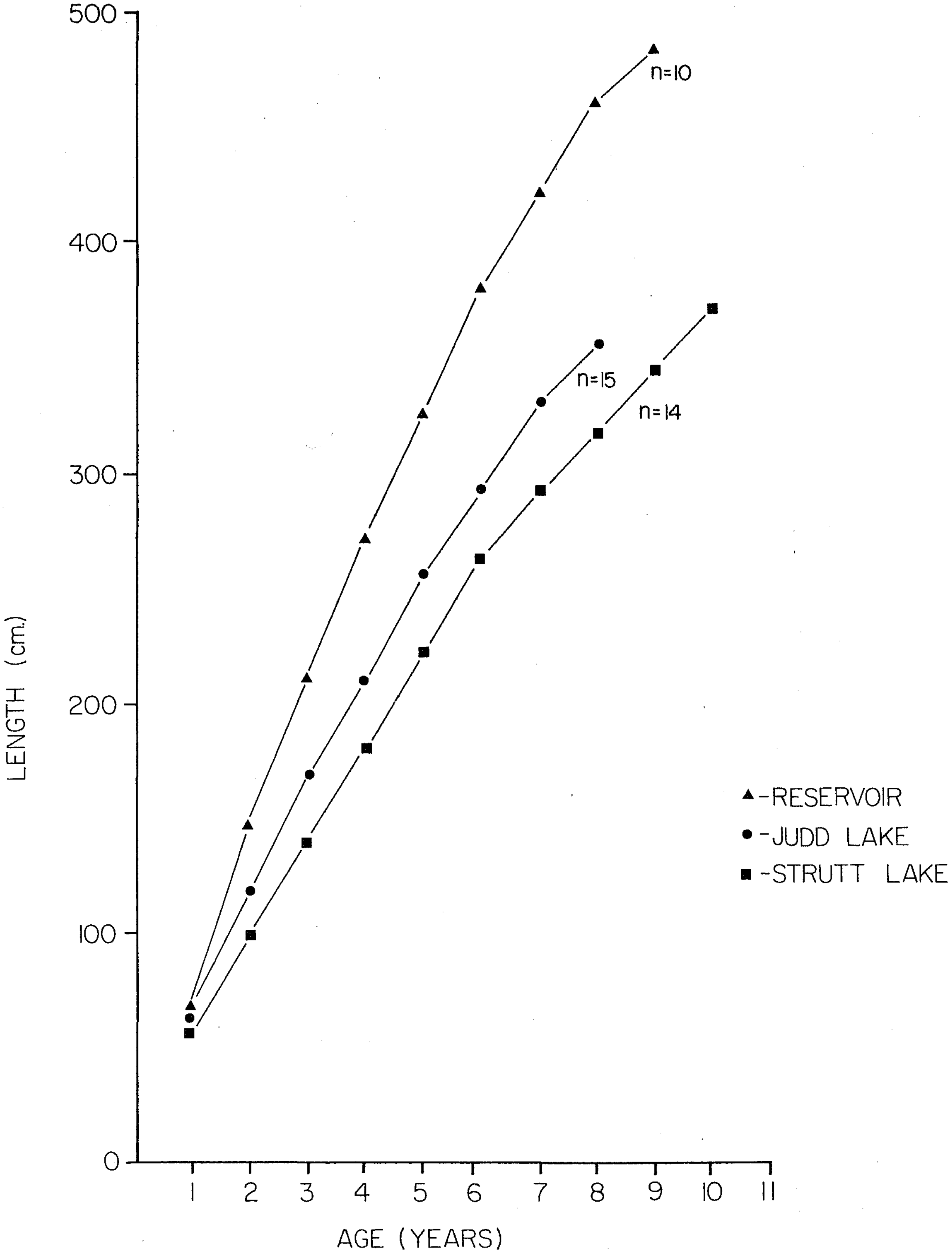

Figure 6: Length at age plotted from back calculated data for lake whitefish from the three study areas

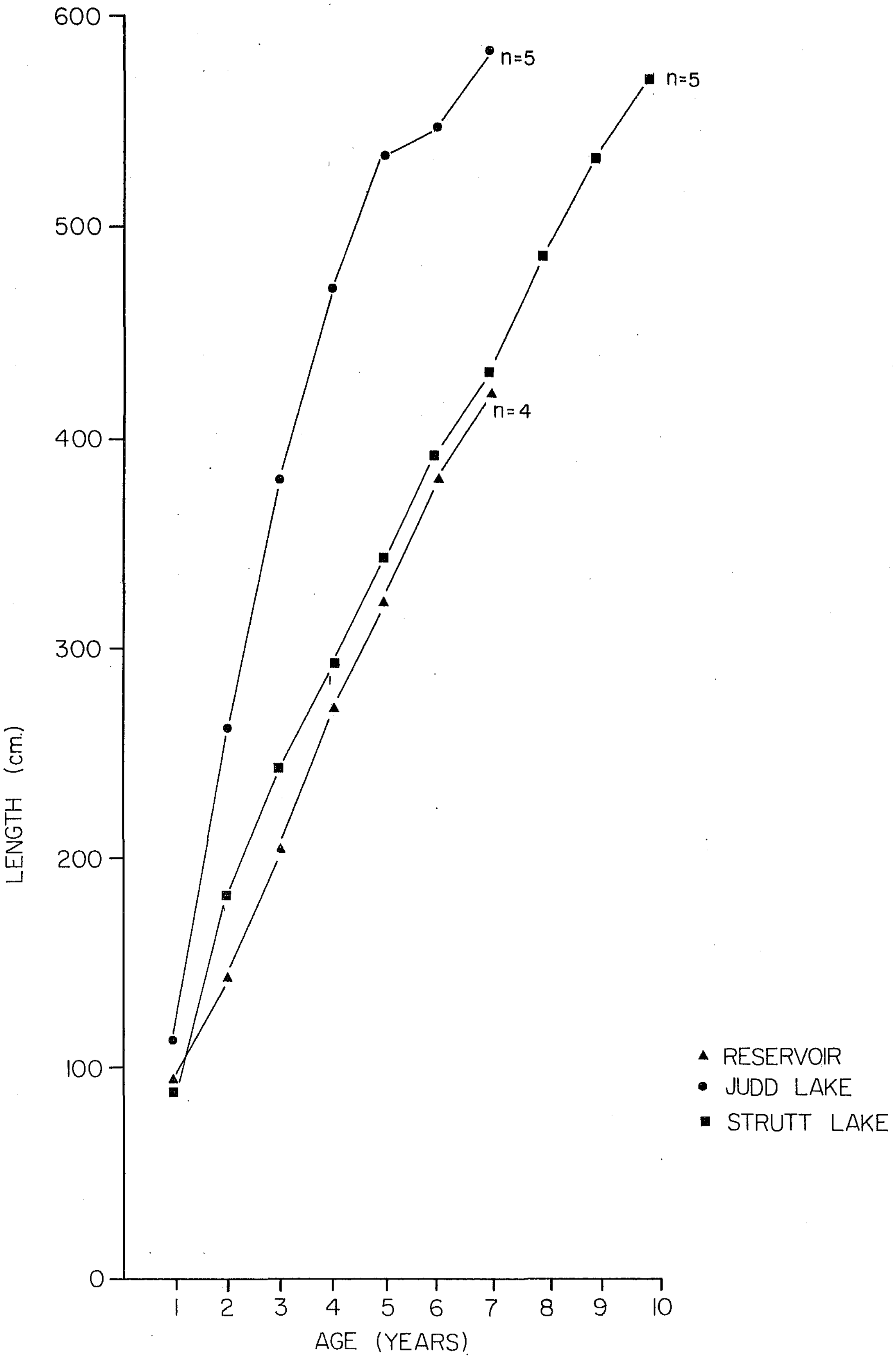

Figure 7: Length at age plotted from the back calculated data for northern pike from the three study areas

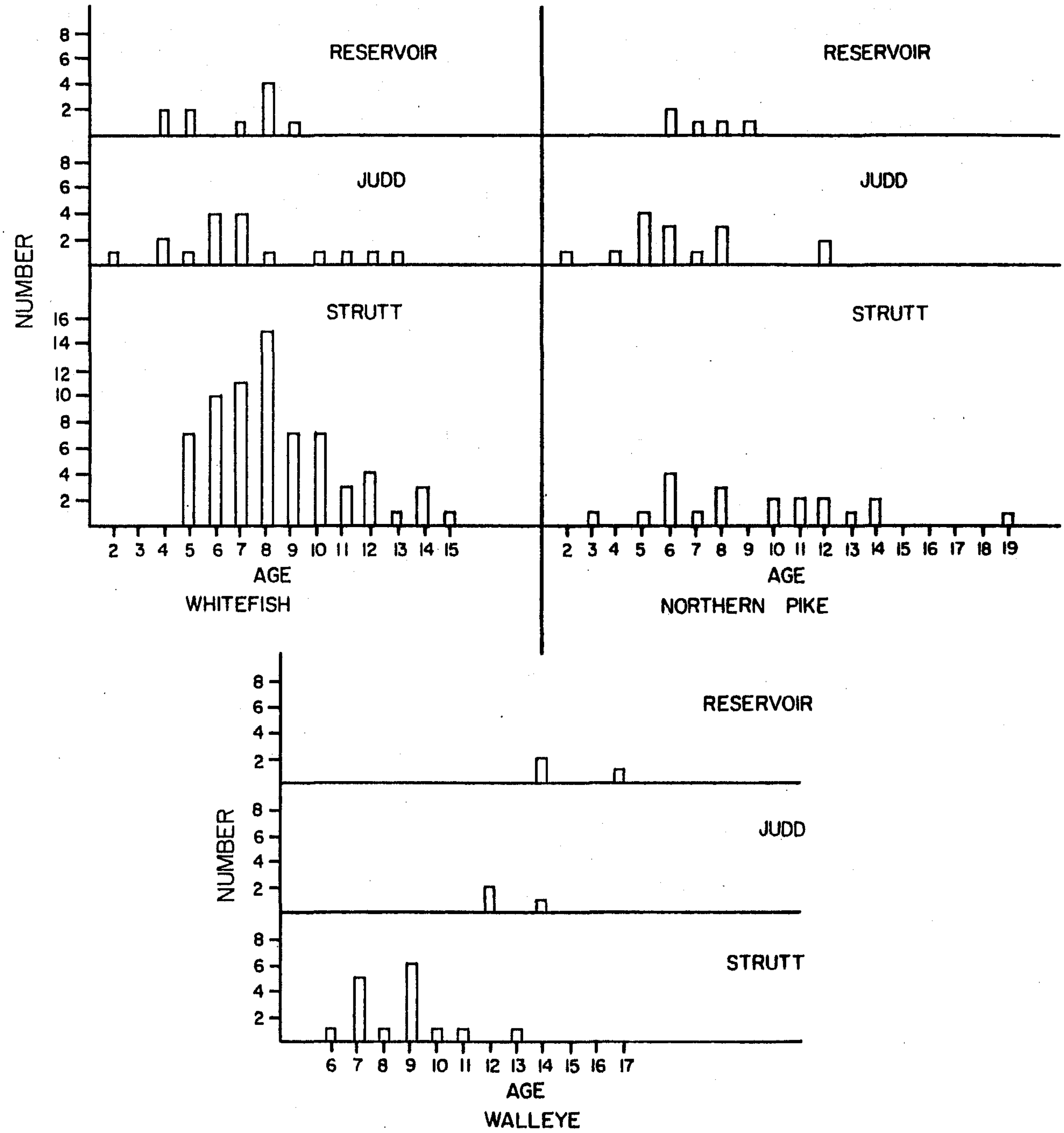

Figure 8: Age frequency distributions for lake whitefish, northern pike and walleye from the three study areas.

WATER CHEMISTRY

Table 5 shows how few differences there were in the water chemistry of the 3 sample areas. The only anomalies appeared at station S-1. Here the higher suspended C and N and T.D.S. and relatively lower temperature can be related to the location. This station was on the Snare River below the outlet of Strutt Lake and probably shows the influence of the river water. The relatively higher temperatures at other Strutt Lake stations indicated the higher resident time of water in these areas and therefore the slower cooling rate.

The reason for the high conductivity readings in Judd Lake stations J-1 and J-2 was unknown.

The chemical parameters examined show similarities to those measured in other lakes of the Canadian Shield as outlined by Armstrong and Schindler (1971).

Recently flooded reservoirs in temperate climates are frequently found to have elevated nutrient levels, soil leaching and decomposition of drowned vegetation (Manitoba Hydro, 1970). The low nutrient levels found in the Reservoir could indicate what the leaching processes have ended and the system has been returned to a static situation, or that the processes have not yet begun. In light of findings in other sub-arctic and boreal reservoirs, the latter seemed more correct (Wiseman pers. comm.) and it may be that leaching in these areas is such a slow process that it is undectectable using our present sampling methods. More extensive water sampling during warmer periods of the year may also indicate changes in the Reservoir's water chemistry.

Table 5 A Survey of the water chemistry parameters determined during the survey of the Snare River, September 1973.

Lake Station Paramater	Reservoir R-1	 R-2	 R-3	Judd J-1	 J-2	 J-3	Strutt S-1	 S-2	 S-4	 S-5
Temperature (C)	11.5^{o}	11.5	12.1	12.5	12.5	13	13	16	17	16.5
Dissolved O_2 (ppm)	9	10	9	10	10	10	9	10	10	9
% sat.	82	92	82	93	93	95	85	100	102	92
pH	7	7	7	7	7	7	7	7	7	7
Conductivity (MHO)	20	19	18	42	59	20	23	20	22	25
Secchi Disc (meters	3.5	4	3	3.5	3	4	3	4	4	3
Susp. N (ug/l)	92	121	66	106	121	95	201	55	110	132
Susp. P (ug/l)	7	6	6	12	21	10	10	8	14	12
Susp. C (ug/l)	710	770	490	630	610	620	1360	540	780	620
Cl (mg/l)	1.2	1.2	1.0	1.0	1.2	1.2	1.2	1.2	1.4	1.2
SO_4	1.8	1.8	1.8	2.0	2.0	2.0	2.2	2.0	2.4	2.4
Si (mg/l)	0.200	0.203	0.203	0.208	0.206	0.196	0.186	0.198	0.167	0.164
N (mg/l)	0.77	0.75	0.73	0.91	0.72	0.72	0.80	0.76	1.07	0.95
K (mg/l)	0.70	0.66	0.66	0.87	0.66	0.65	0.66	0.67	0.76	0.83
Mg (mg/l)	0.99	1.57	1.05	0.86	1.42	1.26	0.91	0.87	1.23	1.20
Ca (mg/l)	2.73	2.62	2.60	2.67	2.64	2.65	2.66	2.54	3.43	3.36

Table 5 (cont'd.)

Lake	Reservoir			Judd			Strutt			
Station Paramater	R-1	R-2	R-3	J-1	J-2	J-3	S-1	S-2	S-4	S-5
Mn (mg/1)	0	0	0	0	0	0	0	0	0	0
TDS (mg/1)	10	20	20	20	20	30	50	20	20	20
Chloro - a (ug/1)	2.3	-	3.2	-	-	-	1.9	1.9	2.1	2.1
TSS (mg/1)	2	1*	1	1	2	1	1*	1	1*	1*
Total Fe (mg/1)	0.07	0.06	0.07	0.09	0.06	0.08	0.14	0.06	0.05	0.06

*Indicated pieces of the filter paper were missing.

VALUE OF THE EXISTING FISHERY RESOURCES

The Snare River system has good sport fishing potential for northern pike, walleye and grayling. Pike up to 8.45 kg (18.59 lb) were gillnetted on Strutt Lake, with the pike up to 5 kg (11 lb) being common. Walleye are common in certain areas but were, on the average, small. The most attractive sport fish in the system is the grayling. Although they were not gillnetted during the study 21 specimens had been examined in June by Resource Management staff while on an NCPC tour of the project site. The largest grayling was 0.57 kgm (1.25 lb) and the average weight was 0.369 kgm (0.8 lb). For example, one recorded sport fishing party in the area produced 20 grayling/rod hr (Stephansson pers. comm.). This is an exceptionally high success rate but the average size was small. Lake trout are present in both Judd and Strutt Lakes but were not abundant and specimens gillnetted were small.

The Snare River project area is approximately 129 km (80 mi) northwest of Yellowknife. It is accessible by water (canoe) from the Yellowknife Highway at Rae. The only similar rivers in the area of Yellowknife are the Yellowknife River [8 km (5 mi) from Yellowknife] and the Cameron River [56 km (35 mi) from Yellowknife], both of which are accessible by road. The Yellowknife and Cameron Rivers both have active sport fisheries but the grayling populations are low (Stephansson pers. comm.). The closest river to Yellowknife, on the Mackenzie highway, with a good grayling fishery is the Kakisa River approximately 370 km (230 mi) distant (Gillman pers. comm.).

The remoteness of the Snare River limits its use for recreation at present. If it were situated closer to a population centre it would no doubt be used extensively.

The present whitefish populations in Strutt Lake could be utilized for a domestic fishery. The stocks are not extensive and could easily be overfished.

IMPACT ON FISH RESOURCES

The three major impacts on fish of the proposed scheme, will result from (1) inundated land (2) the reduced flow in the present Snare River channel and (3) the change of the low regime in Strutt Lake.

It would appear realistic to compare the situation that will develop in the proposed Judd Lake Reservoir after inundation with the present situation in the Snare Falls Reservoir. In relation to water chemistry, after 11 years the water in the Snare Falls Reservoir was virtually identical to the water in both Judd and Strutt Lakes. There appears to be very little available nutrients in the present reservoir and the transparency is similar to the other two lakes. After a similar period we can expect the proposed Judd Lake Reservoir to show similar characteristics. It is likely that even in the years immediately following inundation there will be little change in water chemistry. Even the lowering of transparency during the stabilization of new shorelines will be dampened by the high percentage of bedrock at the new water-soil interface.

The present fish condition and growth rates in the three study areas indicated that inundation had a limited effect on the fish populations. However, the species composition in Judd Lake may change following inundation. Before inundation the Snare Falls Reservoir was entirely river and so the species composition undoubtedly underwent substantial change. The absence of lake trout and the scarcity of lake whitefish could indicate that they were not common in the river at the time of inundation. The absence of grayling from the reservoir indicates that the population had difficulty in coping with the new situation, since they were undoubtedly present in the river before inundation. The abundance of longnose suckers in the reservoir indicates that the species can thrive in inundated areas.

In the proposed Judd Lake reservoir the grayling now present in the river would be greatly reduced. All other species should maintain their populations, except suckers which should increase.

In the reach of the Snare River downstream from Judd Lake there are currently grayling populations. This area is probably isolated by a waterfall near the entrance to Strutt Lake. There is an excellent spawning ground for walleye at the entrance of the river to Strutt Lake. If the flow in this stretch of the river is reduced or eliminated by the proposed scheme, the grayling would be significantly reduced in numbers and the spawning beds for walleye would be eliminated. The latter could severely reduce the walleye populations in Strutt Lake.

Under the proposed scheme, with the Snare River discharging into the north arm of Strutt Lake, there is some indication that the productivity of this area will be increased. At present the increased nutrient load carried by the river is apparent at station S-1. After the project is completed these nutrients will be flowing into a now isolated area of Strutt Lake.

MITIGATION

Fish Passage: At present there is not thought to be any fish movement between Strutt and Judd Lakes. Approximately 91 m (100 yds) upstream from Strutt there are natural obstructions which appear to prevent such movement. Fish inhabiting the river above the obstructions have free movement into Judd Lake. Our observations indicated that the main fish populations in this stretch of the river are grayling and pike. The grayling are unlikely to migrate to Judd Lake because they are primarily stream dwelling and spawning fish. Pike, although they utilize both lake and stream habitat, do not appear to cover much distance in their movement. It would not appear to be justified to install fish passage facilities at the control structure on Judd Lake.

Clearing: The most desirable treatment of reservoirs is total clearing and disposal of all flooded vegetation. Preclearing ensures minimal problems with debris in the river and reduces hazards to navigation. It also helps to maintain the aesthetic value of the area and promotes stabilization of the new shorelines.

The proposed reservoir shoreline will have a high percentage of bedrock-water interface. This leads to quick shoreline stabilization. It is apparent from the Snare Falls Reservoir that after 11 years there is good shoreline development in the more exposed areas. Lake trout and lake whitefish will have higher success rates if clearing is done.

The minimum clearing requirements for the new reservoir should be as follows: (a) clearing, piling and burning of all forested areas to the high-water mark for 1828 m (2000 yds) downstream of the Snare Falls powerstation. This would be in the area of high-flow and would help to preserve portions of the grayling population, (b) clearing, piling and burning along the east and south shorelines of Judd Lake to promote rapid shoreline stabilization for the maintenance of the whitefish and lake trout populations in the reservoirs. Approximately 3657 m (4000 yds) of clearing starting from the Line Lake canal and leading upstream and 1828 m (2000 yds) of clearing starting at the canal and proceeding west, would provide suitable spawning areas for these species.

The west side of Judd Lake, with lower relief and swampy areas, will stabilize slowly and be of less importance for lake trout or whitefish spawning. Pike, however, should thrive in this area whether it is cleared or not.

The alternative option is to clear, pile and burn all the vegetation in the area to be inundated. This would ensure the success of shore spawning species and possibly save a larger proportion of the grayling population.

Minimum Flows: Section 20(10) of the Fisheries Act of Canada states that enough water shall escape over a dam .... "to be sufficient for the safety of fish and for the flooding of the spawning grounds to such depth as will, in the opinion of the minister, be necessary for the safety of the ova deposited thereon". It will be necessary therefore to supply a continuous minimum flow in the present channel of the Snare River to achieve these objectives. It is also desirable to place the spillway on the present channel so that any water spilled will also flow in the present channel. It is estimated that a flow of 5.7 cu. cm/s (200 cfs) will ensure "safety of fish" in the channel and will be sufficient to cover the walleye spawning beds situated at the mouth of the Snare River on Strutt Lake.

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