FISHERIES SURVEY OF THE BEAVER CREEK DIVERSION SYSTEM, 1978

Prepared for
Syncrude Canada Ltd.
Environmental Affairs Department

By
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R.L.& L. Environmental Services Ltd.

June 1979

FOREWORD

Syncrude Canada Ltd. is producing synthetic crude oil from a surface mine on the eastern portion of Crown Lease 17, Alberta. This study was commissioned to provide an inventory of fish populations in the Beaver Creek Diversion System.

Syncrude's Environmental Research Monographs are published verbatim from the final reports of professional environmental consultants. Only proprietary technical or budget-related information is withheld. Because we do not necessarily base our decisions on just one consultant's opinion, recommendations found in the text should not be construed as commitments to action by Syncrude.

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This report may be cited as:

O'Neil, J.P. 1979. Fisheries survey of the Beaver Creek diversion system, 1978. Syncrude Environmental Research Monograph 1979-3. 63 pp. + App.

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ACKNOWLEDGMENTS

The author expresses his gratitude to the Environmental Affairs Department, Syncrude Canada Ltd., for providing the opportunity to conduct this study and for the excellent logistic support and field assistance. Thanks are specifically due to Dr. M. Aleksiuk, Messrs. J. Retallack, J. Marchak, B. Fardoe, and T. Van Meer. Special credit is given to the latter individual for his continuing dedication to the task.

Mr. T. Clayton of R.L.& L. Environmental Services Ltd. prepared and aged the fish scales and fin-rays. Drafting services were provided by Mr. J. Maher of RST Business Graphics Ltd.

SUMMARY

On three occasions during the period May-October, 1978, R.L.& L. Environmental Services Ltd. conducted fish sampling in the Beaver Creek Diversion System. These efforts were oriented towards providing an inventory of post-diversion fish populations. The study was designed not only to update the existing data base, but to provide quantified and reproducible catch/unit effort data (CUE) which could effectively serve as a basis for future monitoring of fish populations. Sampling gear employed in the study included gill nets, beach seine, and back-pack electrofisher.

While a total of 11 species were encountered in the study area, only 6 were recorded in the upper diversion system (i.e., upstream of the Poplar Creek dam). Included in this latter group were two species of catostomids (white sucker, longnose sucker), the fathead minnow, brook stickleback, lake chub and spoonhead sculpin (Upper Beaver Creek only). Species collected in Poplar Creek, additional to those recorded in the upper diversion system, were Arctic grayling, northern pike, yellow perch, burbot and trout-perch. The spoonhead sculpin was not collected in Poplar Creek.

The white sucker was the dominant species in both lentic and lotic waterbodies. White suckers contributed 89.5% of the total gillnet catch in the two reservoirs and Ruth Lake. They comprised 52.6% of the total electrofishing catch in Poplar Creek and 36.3% in Upper Beaver Creek.

The fathead minnow and brook stickleback were abundant in both reservoirs and Ruth Lake. They comprised the majority of the total beach seine catch in these areas (i.e., 80.8% - fathead minnow; 16.2% - brook stickleback).

Gillnet capture rates indicated the presence of a large white sucker population in Beaver Creek Reservoir (CUE value of 92.1 fish/net-unit) and, to a lesser extent, in Ruth Lake (36.9 fish/net-unit). The population density in Poplar Creek Reservoir (10.4 fish/net-unit) was considerably lower.

The fathead minnow was recorded in high numbers in standing waterbodies. Beach seine CUE values were 45.9 fish/10 m^2 of surface area (Beaver Creek Reservoir), 61.4 fish/10 m^2 (Ruth Lake) and 51.9 fish/10 m^2 (Poplar Creek Reservoir). An exceptionally large 1978 year-class was largely responsible for the high capture rates obtained.

Electrofishing CUE values for white suckers in Poplar Creek were substantially higher than those recorded in Upper Beaver Creek. This was mainly due to the presence of a spawning run into Poplar Creek from the Athabasca River. Arctic grayling, although never numerous in Poplar Creek, became more abundant during the summer, particularly in riffle-type habitat below drop-structures. Available data suggest that these fish were migrants from the Athabasca River.

Pertinent life history information was collected for each of the species in the study area and subsequently analysed by computer. This material is provided in a separate

data volume. Because of the significance of the white sucker in the diversion system, life history data for this species are presented in this report.

1.0 INTRODUCTION

1.1 PROJECT DESCRIPTION

In April 1978 Syncrude Canada Ltd. retained R.L.& L. Environmental Services Ltd. to conduct a fisheries survey in the Beaver Creek Diversion System (Figure 1.1). The study was designed to provide additional information on the species composition, distribution, and relative abundance of fish populations in the Beaver Creek and Poplar Creek watersheds. A prime consideration during assessment of relative abundance was the collection of quantitative data which would serve as an effective basis for future population monitoring; consequently, the study focused upon a number of representative sample stations in each of the major waterbodies. These designated areas were surveyed on a repetitive basis during spring, summer, and fall to allow for seasonal variability in fish utilization patterns.

Other features of the study included fish tagging and the collection and computer analyses of basic life history data. The tagging program was conducted to establish a pool of marked fish in the study area for monitoring of fish movements during the study and in future years.

The major emphasis of the study was to collect and tabulate fisheries baseline data. The scope of the project allowed only limited interpretation and write-up of the field data generated.

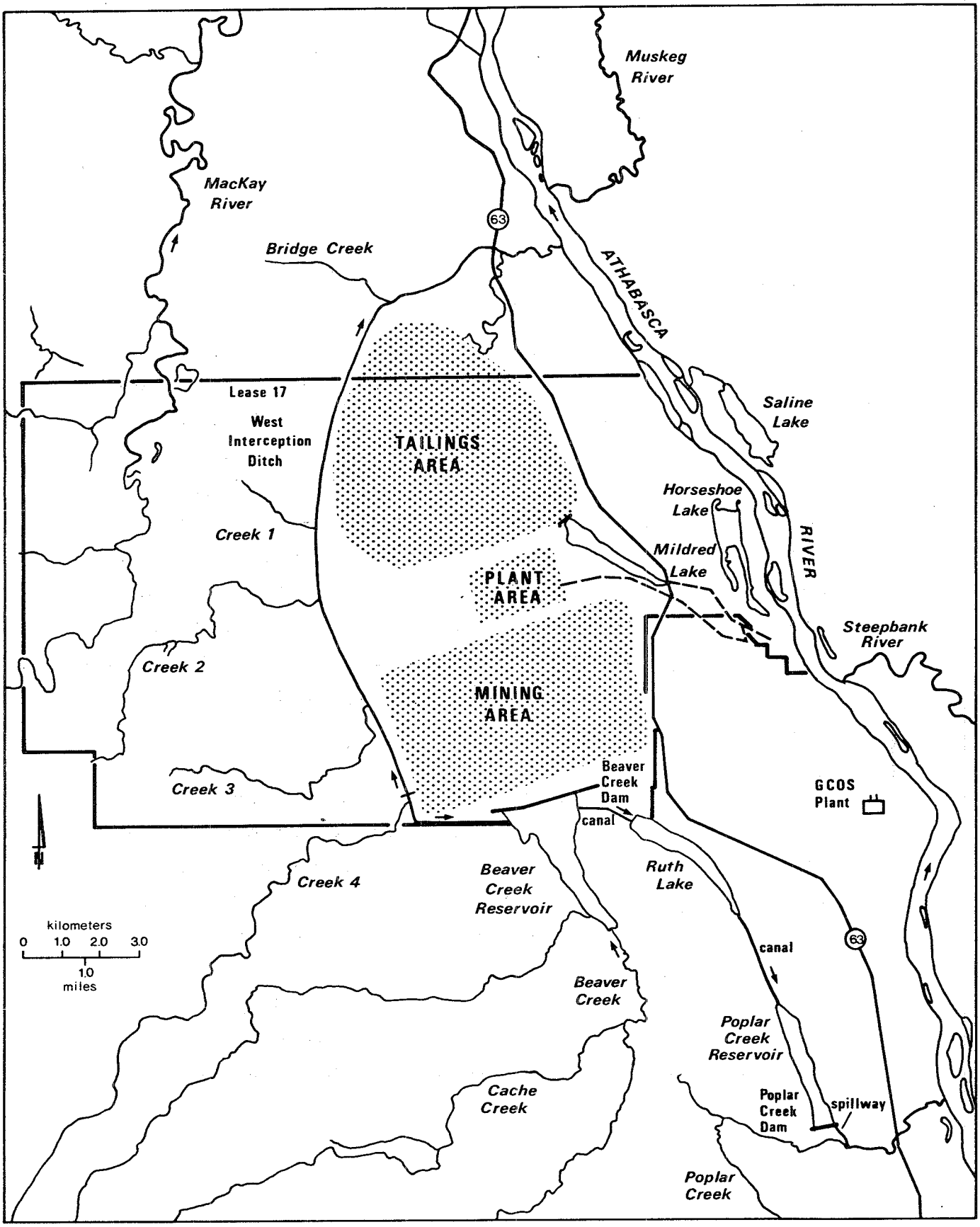

Figure 1.1. Syncrude Lease #17 and the Beaver Creek Diversion System.

1.2 TERMS OF REFERENCE

The terms of reference for the study entitled "Fisheries Survey of the Beaver Creek Diversion System," derived from Agreement 98-8015-CD between Syncrude Canada Ltd. and R.L.& L. Environmental Services Ltd., and dated April 7, 1978 are as follows:

General

1) To provide inventory data on fish populations in the study area which is to include: Poplar Creek from approximately 1 km upstream of the Poplar Creek Spillway to its confluence with the Athabasca River, Poplar Creek Reservoir, Ruth Lake, Beaver Creek Reservoir and Beaver Creek upstream to approximately 1 km above the reservoir.

2) The inventory data collected will include information pertaining to the type, distribution and relative abundance of fish species utilizing the system. In addition the consultant is to provide pertinent life history information (i.e., age, length, weight, gonad maturity and condition).

3) The consultant should not consider any studies on lower food chain levels or any investigation of physical and chemical characteristics since these data are already available.

4) The consultant should consider providing only the project biologist, whereas Syncrude Canada Ltd. will provide assisting personnel in the field, ground transportation, meals and accommodation.

Specific

1) Fish tagging (according to A.O.S.E.R.P. techniques) will be included in the

study but should be considered to be of secondary importance relative to the major study objectives.

2) Throughout the study, as many habitats or habitat types as possible should be regularly sampled.

3) The minimum field sampling effort suggested is: spring (very shortly after break-up), mid-summer (July) and fall (September 15-October 15) with each sample interval consisting of a minimum of 5 days.

4) An examination of waterbodies in the study area should be carried out shortly after break-up to determine if "winter-kill" has occurred over the previous winter.

5) The consultant will be required to provide a brief progress report following the spring field trip for the client to evaluate methods and results. A draft report (3 copies) summarizing the completed project will be required no later than December 15, 1978.

2.0 METHODOLOGY

2.1 STUDY CHRONOLOGY

Spring, summer, and fall field surveys were conducted during the periods May 11-21 (11 days), July 27-August 2 (7 days), and September 27-October 3 (7 days), respectively. The total survey effort was 25 days.

2.2 STUDY LOGISTICS

Access to the Syncrude Mildred Lake operation and in some cases to the sample stations, was provided by the consultant. Syncrude Canada Ltd. provided personnel to assist in the field collections and vehicles for on-site transportation (i.e., outboard jet-equipped boat, canoe, Argo all-terrain vehicle). Accommodation and board at the Lower Camp was made available by Syncrude.

2.3 DISTRIBUTION OF SAMPLE STATIONS

Several factors were considered when selecting sample stations. The primary criterion was to locate stations in each of the discrete habitats. An attempt, however, was made to achieve a wide geographic spread. To the extent possible, sample sites were located in areas which could be effectively sampled over the range of water levels expected. This was particularly important when designating beach seine stations. In some cases, the sample stations coincided with those used by previous investigators (Noton and Chymko 1978). Beach seining was conducted in Mildred Lake on May 20. Although this was not part of the replicate sampling program, the results are provided in Appendix B4.

Table 2.1 summarizes the distribution and sampling periodicity for sample stations in the study area and provides site-specific information as to their location. The general location of sample stations is illustrated for each of the waterbodies in figures 2.1 to 2.5. Typical habitat conditions in the major sample areas are shown in plates 2.1 to 2.7.

2.4 FISH SAMPLING EQUIPMENT AND TECHNIQUES

In lentic habitats, standardized gillnet gangs were used as the primary sampling method for larger fish. They consisted of 15.2-m by 2.4-m net panels covering a range of mesh sizes, including 3.8-cm, 6.4-cm, 8.9-cm, 10.2-cm, and 14.0-cm (stretched measure). All nets were constructed of monofilament nylon except for the 14.0-cm mesh which was multifilament. Each of the 5 mesh sizes was used during the spring survey. The 10.2-cm and 14.0-cm mesh nets were not employed during the summer and fall surveys because of their ineffectiveness in catching fish and their tendency to entangle diving birds.

Although both overnight and daytime net sets were employed in the study, catch results obtained from the overnight sets were used to calculate the catch/unit effort (CUE). The CUE was calculated on a standard unit of effort, namely the application of one net-unit over a 12 hour period. The combined surface area of the 3.8-cm, 6.4-cm, and 8.9-cm mesh panels constituted one net-unit. In addition, CUE values were calculated for a net-unit applied overnight with no indexing to a standard sampling duration (i.e., to 12 h).

TABLE 2.1

Distribution and Description of Sample Stations in the Beaver Creek Diversion Study Area (1978)

Waterbody	Sampling Gear	Site or Reach Designation	Comments
Beaver Creek Reservoir	Gill net	G1-G4	G1, G2 overnight set locations; G3, G4 daytime sets only.
	Beach seine	S1-S6	S1-S4 sampled over entire study: S5, S6 deleted from program after spring survey (i.e., difficult seining conditions).
	Electrofisher	EF	Situated in lower end of Creek #4, below weir. Sampled during summer and fall surveys.
Ruth Lake	Gill net	G1-G3	G1, G2 overnight set locations; G3 daytime set only.
	Beach seine	S1-S3	Only two of three sampled after spring survey, due to difficult seining conditions.
Poplar Creek Reservoir	Gill net	G1-G4	G1, G2 overnight set locations; G3, G4 daytime sets only.
	Beach seine	S1-S4	All but S4 sampled on each occasion.
Upper Beaver Creek	Electrofisher	EF1-EF3	EF1 sampled on three occasions; EF2, EF3 not sampled during summer survey.
Poplar Creek	Beach seine	S2,S3	Situated below drop structures DS 11 and 2, respectively. Sampled in summer and fall surveys.
	Electrofisher	EF1-7	EF1, EF2 situated upstream of diversion; sampled on all three occasions. EF3-6 situated within channelized section; EF3, EF5 sampled during each survey. EF4, EF6 discontinued after spring survey. EF3, EF5 divided into 4 sub-sections based on dissimilarities in habitat and fish distribution; EF3(a), (c) pool habitat above DS 11 and DS 10 respectively; EF3(b), (d) riffle habitat below DS 11, and DS 10 respectively; EF5(a), (c) pool habitat above DS 7 and DS 6, respectively; EF5(b), (d) riffle habitat below DS 7 and DS6, respectively. EF7 situated below channelized section; not sampled during fall survey. Difficult sampling conditions on each occasion.
Poplar Creek (Stilling Basin)	Gill net	G1	One overnight set during spring survey.
	Beach seine	S1	S1 situated in littoral portion of Stilling Basin; sampled on all three occasions.

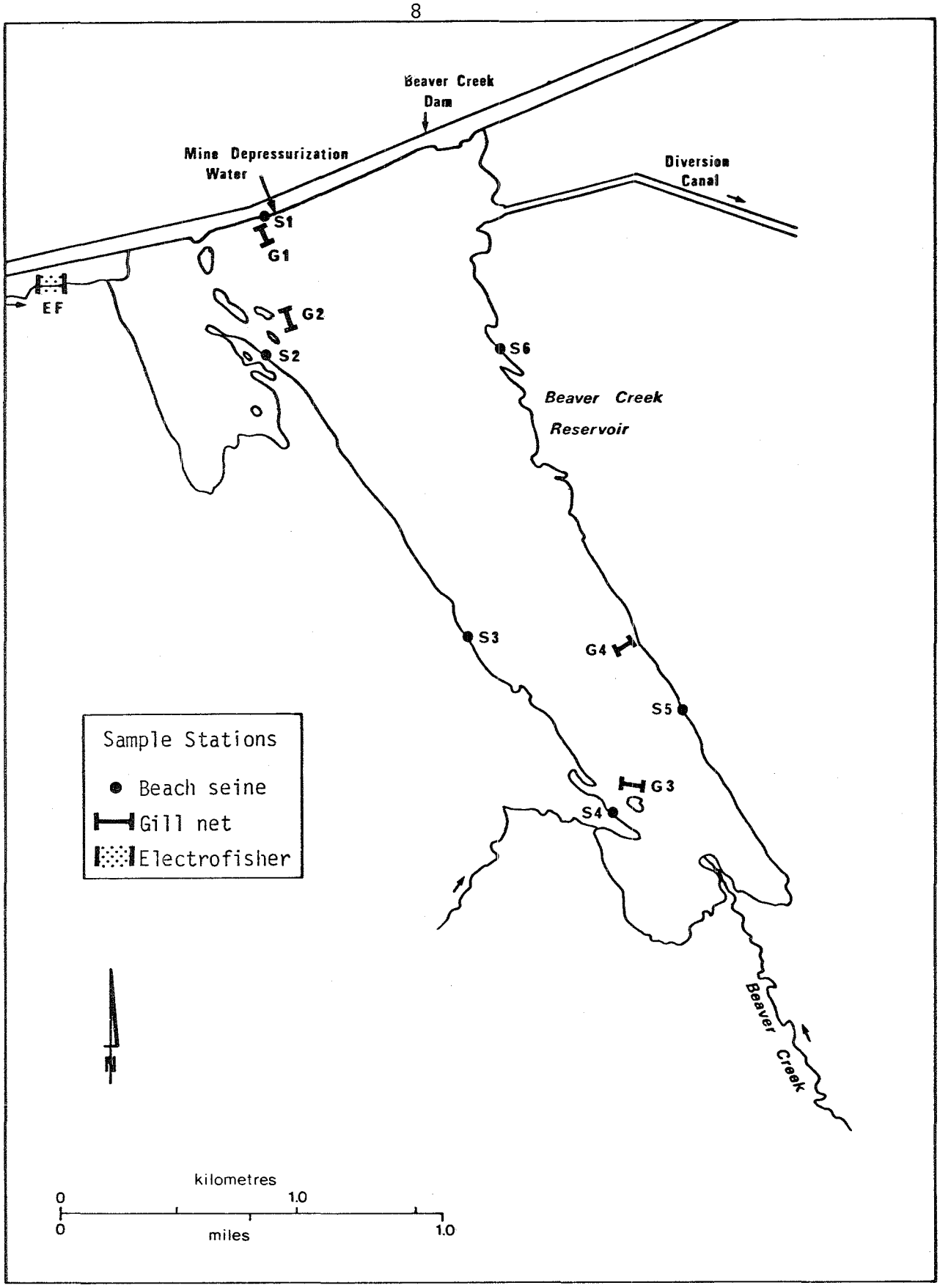

Figure 2.1. Location of sample stations, Beaver Creek Reservoir, 1978.

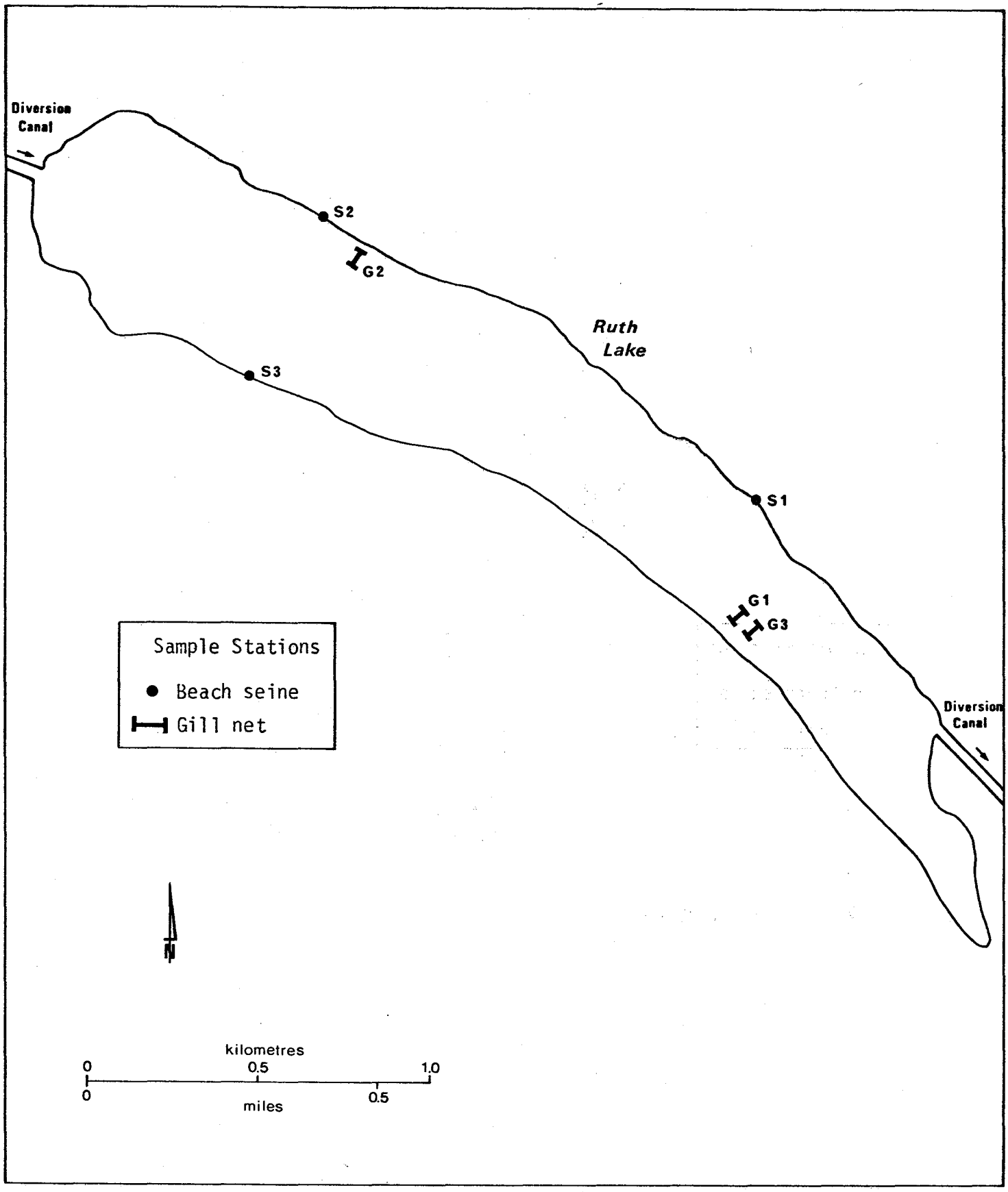

Figure 2.2. Location of sample stations, Ruth Lake, 1978.

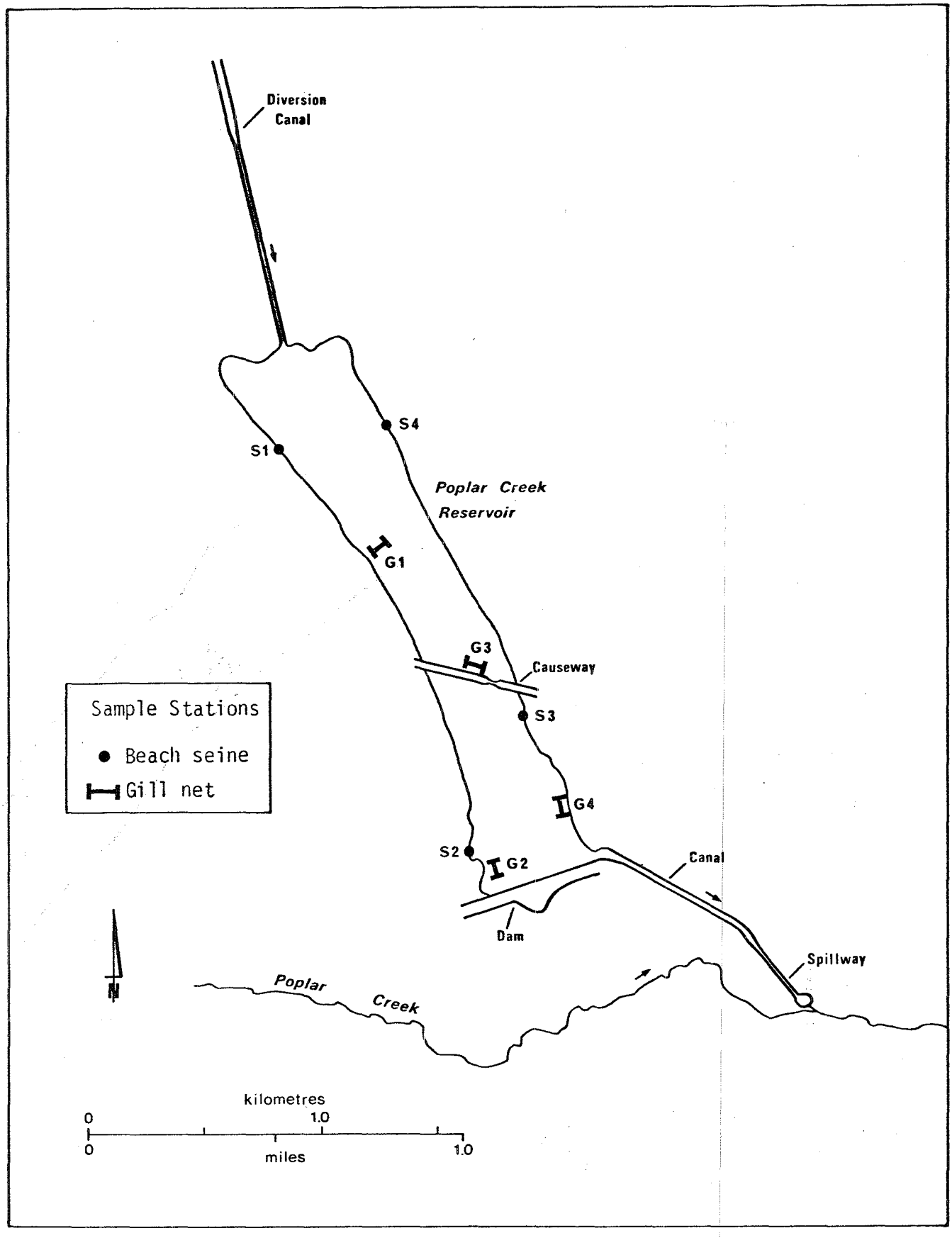

Figure 2.3. Location of sample stations, Poplar Creek Reservoir, 1978.

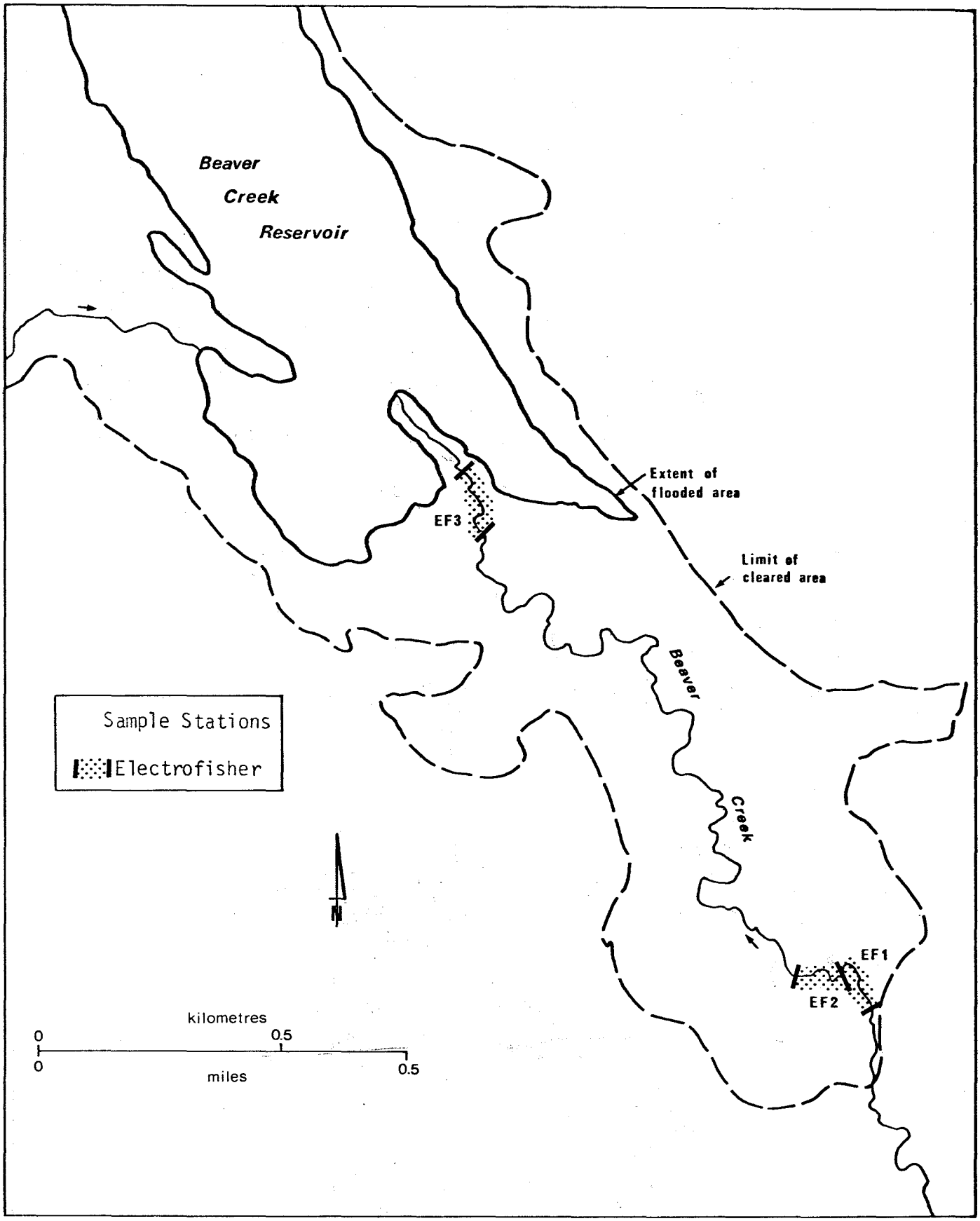

Figure 2.4. Location of sample stations, Upper Beaver Creek, 1978.

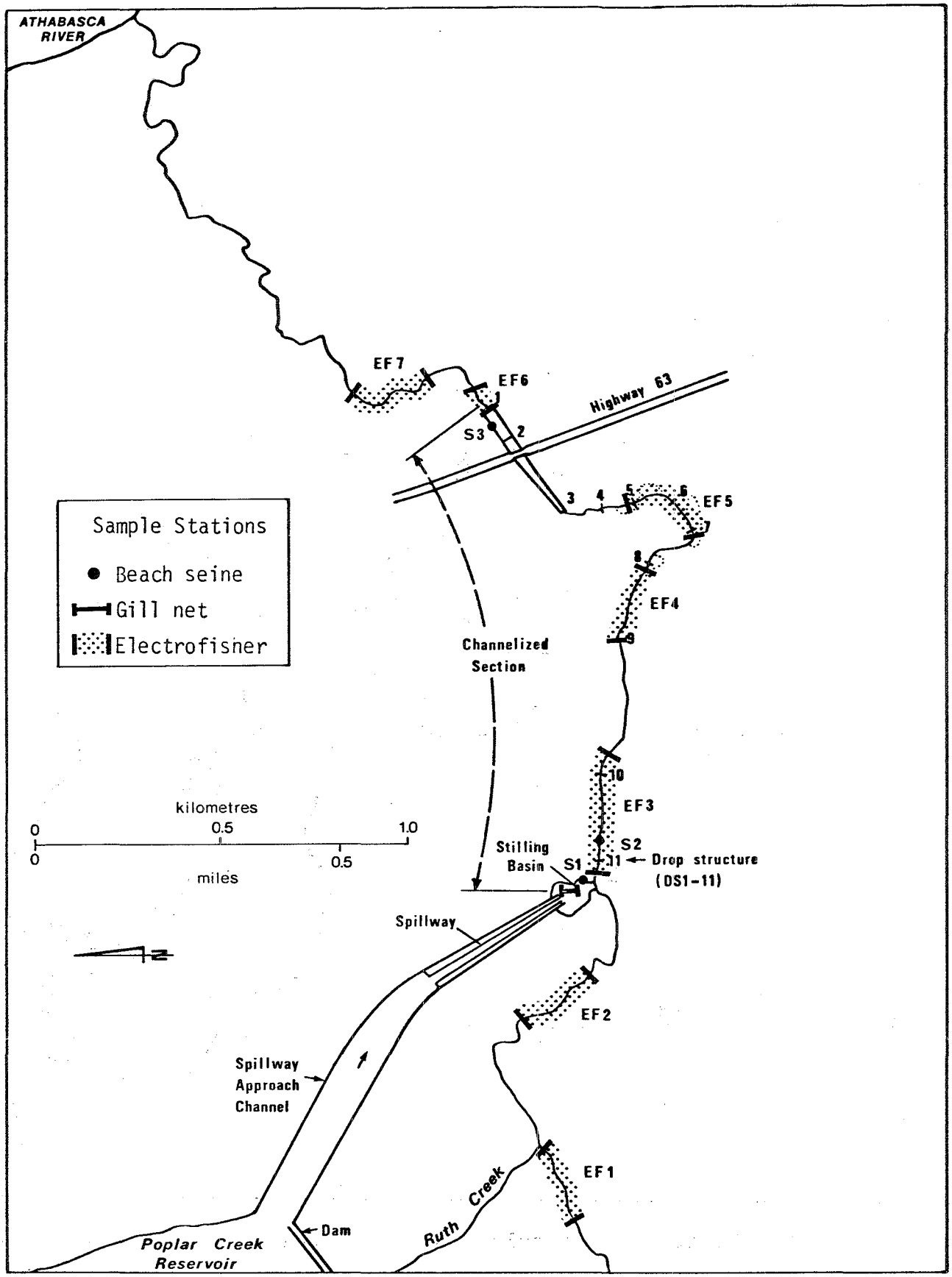

Figure 2.5. Location of sample stations, Poplar Creek, 1978.

Plate 2.1. Beaver Creek Reservoir (beach seine station S2) illustrating typical shoreline habitat.

Plate 2.2. Ruth Lake (beach seine station S1) illustrating typical shoreline habitat.

Plate 2.3. Poplar Creek Reservoir (beach seine station S3) illustrating atypical shoreline habitat (i.e., exposed beach with gravel-cobble substrate).

Plate 2.4. Upper Beaver Creek (electrofishing station EF1) illustrating typical habitat in this reach (i.e., low gradient and silt-sand substrate).

Plate 2.5. Poplar Creek (electrofishing station EF2) illustrating typical habitat upstream of the diversion (i.e., riffles with gravel-cobble substrate and moderate current velocity).

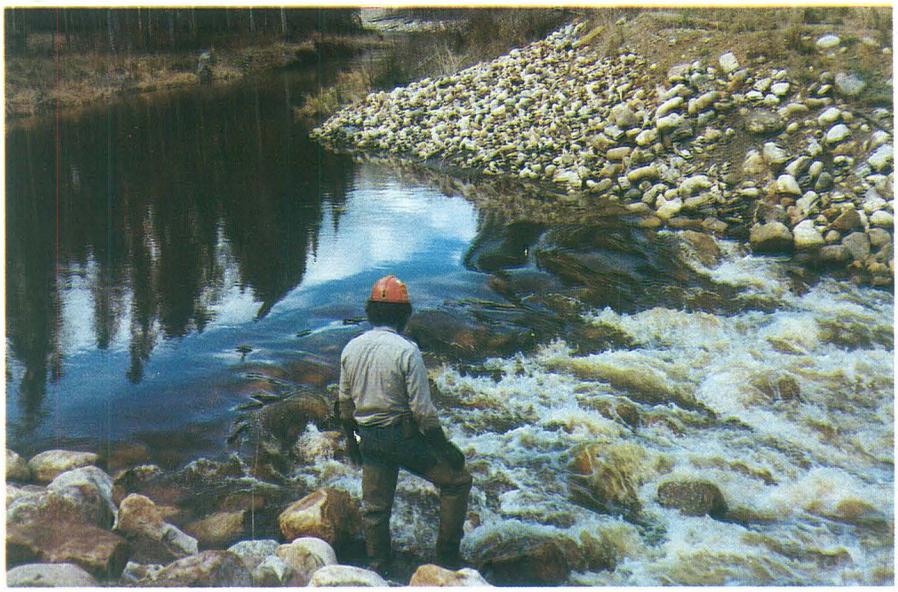

Plate 2.6. Poplar Creek (in the vicinity of electrofishing station EF5) illustrating typical habitat conditions in the channelized section of the stream. Note the drop structure in the foreground (DS7) and the low gradient habitat separating DS7 and DS6 (upstream and not shown).

Plate 2.7. Poplar Creek (electrofishing station EF7) illustrating typical habitat conditions in the lower, unchannelized section of the stream.

Data from the daytime sets provided an indication of the representative nature of the catch in overnight sets (i.e., in terms of species composition and rate of capture).

Gill nets were set at or near the surface of the water column. Water depth at set locations generally ranged from 2.5 m to 5.0 m (Beaver Creek Reservoir), 2.0 m to 2.5 m (Ruth Lake), and 2.0 m to 4.0 m (Poplar Creek Reservoir). Maximum depths recorded at net set locations were 7.0 m (Beaver Creek Reservoir), 3.0 m (Ruth Lake), and 5.0 m (Poplar Creek Reservoir). Syncrude Canada Ltd. provided an echo sounder for locating gillnet stations and determining depths of set.

Electrofishing in Poplar Creek and Upper Beaver Creek was conducted with a Smith-Root Type VII backpack electrofisher. The majority of the sampling was carried out with the unit producing 300 VDC (pulsed) at 0.5 A to 1.2 A. Pulse rate and pulse width were normally set at 60 Hz and 6 ms, respectively.

Stream reaches selected for replicate sampling were flagged during the spring survey. The primary sample sections (i.e., sampled on all three occasions) were approximately 300 m in length. Catch/unit effort values were based on a standard unit of effort, in this case, electrofisher operating time (min). Operating time rather than stream length or area, was selected as the unit of sampling effort because it was more readily quantified and allowed comparisons of catch between sites. Length and area of stream sampled varied considerably between sites in response

to seasonal changes in stream flow and/or wading conditions. Sampling efficiency was rated on each survey based on a scale of 1-4, with 1 representing the highest level of efficiency. Also recorded was information describing fish distribution-habitat preferences and stream habitat conditions.

A 9.1-m x 1.5-m beach seine was used to collect smaller fish (e.g., cyprinids and young-of-the-year white suckers) in standing waterbodies and to a minor extent in Poplar Creek. The main body of the seine utilized 1.3-cm mesh (stretched measure), whereas the center-mounted collection bag consisted of 0.6-cm mesh (stretched measure).

Three seine hauls were conducted at each site to partially account for localized differences in habitat type and the habitat preferences displayed by the various fish species. The three haul sites at each station were selected during the spring survey, and to the extent possible, were duplicated during subsequent surveys. The relocation of individual haul sites or entire stations was necessary, in certain cases, due to water level changes which affected sampling efficiency (e.g., higher water levels resulting in flooding of vegetative debris).

Haul length was set at 25 m; haul width was dependent upon shoreline depth profiles but generally ranged between 6 m and 10 m. Maximum water depth in sampled areas varied between 30 cm and 100 cm. Median depth (i.e., the depth at a point midway between shore and the off-shore end of the haul) was recorded for each haul to allow characterization of the depth profile. Other parameters recorded included extent of aquatic vegetation, substrate type, and fish distribution-habitat preferences.

Sampling efficiency during each haul was rated on a scale of 1-4 with 1 representing the highest level of efficiency. Only data from hauls assessed ratings of 1 or 2 were considered valid in CUE calculations. In some cases this involved conducting additional hauls to obtain three effective replicates. CUE calculations were based on the number of fish/unit area (i.e., number fish/10 m^2 of surface area) and the number of fish/haul.

2.5 FISH TAGGING PROCEDURES

Tagging methods similar to those utilized in the Alberta Oil Sands Environmental Research Program (A.O.S.E.R.P.) were employed in this study. This involved the use of Floy FD67 anchor tags (yellow); these were labeled with the abbreviated company name and a sequential number (e.g., RLL0001). A Dennison Mark II applicator gun was used to insert tags into the dorsal musculature (left side) immediately below the anterior insertion of the dorsal fin. Some fin clipping was also carried out in the present study. For catostomids the posterior four dorsal fin-rays were clipped, whereas for Arctic grayling, the adipose fin was removed.

2.6 FISH AGING PROCEDURES

Scales were the primary method of age determination. They were removed from the left side of the fish immediately below the anterior insertion of the dorsal fin, mounted between glass microscope slides, and read on a 3M Model SRC 816 microfiche reader.

The majority of fish aged in the present study were white suckers. Scales are known to underestimate the age of white suckers from the older age-classes. This is apparently due to a reduction in growth rate following the achievement of sexual maturity which makes establishment of valid annuli very difficult (Beamish and Harvey 1969; Beamish 1973). In view of this situation, pectoral fin-rays were collected from representative specimens to validate ages derived by scale reading. In general, scales appeared to be adequate for establishing the age of white suckers collected from standing waterbodies in the study area. This is probably due to the fact that the populations developed only recently and consist mainly of fish less than four years of age. The aging procedure followed for fin-rays included sectioning with a jeweller's saw, mounting in glycerin on a microscope slide, and reading through a binocular dissecting microscope.

2.7 DATA STORAGE AND ANALYSIS

Fish collection data and pertinent habitat information, obtained during gillnet, beach seine, and electrofishing surveys, were recorded on standardized field data forms for later analyses.

Life history data (i.e., age, length, weight, maturity, etc.) collected during the study were entered onto computerized fish data forms. At the completion of the field work, the data were keypunched and submitted to the computer for sorting and analyses. The analytical output consisted of length-frequency, length-weight regression, age-growth, condition factor, and age-at-maturity analysis.

The computer print-outs of life history data and individual field data records have been presented under separate cover.

3.0 RESULTS

3.1 SPECIES COMPOSITION

Eleven species of fish were recorded in the study area during 1978 (Table 3.1). Of these, only six species were collected from the upper diversion system (Beaver Creek Reservoir, Ruth Lake, Poplar Creek Reservoir, Upper Beaver Creek) (Table 3.2). Northern pike and Arctic grayling, two species of sport fishery importance, were not captured in the upper diversion system during 1978, although they were encountered during 1977 studies (Noton and Chymko 1978). Both species, however, were collected in Poplar Creek in the present study.

3.2 GENERAL POPULATION STATUS

3.2.1 Lentic Habitats

White Sucker

Of the two species of catostomids (white sucker and longnose sucker) occupying lentic waterbodies in the study area, the white sucker was dominant. In 1978 gillnet collections, the white sucker contributed 95.7% (Beaver Creek Reservoir), 98.7% (Ruth Lake), and 100% (Poplar Creek Reservoir) of the total catch of harvestable sized fish (adults and older juveniles) (Table 3.3). They were also encountered in 100% of the net sets in Beaver Creek Reservoir and Ruth Lake, further demonstrating their prominence in these systems. The species was encountered in only 71.4% of net sets in Poplar Creek Reservoir, indicating the presence of a more dispersed population in this system.

TABLE 3.1

Fish Species Recorded in the Beaver Creek Diversion Study Area (1978)

Arctic grayling (AG)	*Thymallus arcticus* (Pallas)
Northern pike (NP)	*Esox lucius* Linnaeus
Yellow perch (YP)	*Perca flavescens* (Mitchill)
Burbot (LING)	*Lota lota* (Linnaeus)
White sucker (WS)	*Catostomus commersoni* (Lacépède)
Longnose sucker (LNS)	*Catostomus catostomus* (Forster)
Lake chub (LKC)	*Couesius plumbeus* (Agassiz)
Fathead minnow (FHM)	*Pimephales promelas* Rafinesque
Brook stickleback (BS)	*Culaea inconstans* (Kirtland)
Trout-perch (TP)	*Percopsis omiscomaycus* (Walbaum)
Spoonhead sculpin (SHS)	*Cottus ricei* (Nelson)
Total number species = 11	

TABLE 3.2

Fish Species Recorded in the Beaver Creek Diversion Study Area in 1977 by Previous Investigators (Noton and Chymko 1978) and in the Present Study (1978)

Species	Beaver Creek Reservoir		Ruth Lake		Poplar Creek Reservoir		Upper Beaver Creek		Poplar Creek	
	1977	*1978*	*1977*	*1978*	*1977*	*1978*	*1977*	*1978*	*1977*	*1978*
Arctic grayling							+		+	+
Northern pike	+								+	+
Yellow walleye									+	
Yellow perch									+	+
Burbot									+	+
Lake whitefish									+	
Mountain whitefish									+	
White sucker	+	+	+	+	+	+	+	+	+	+
Longnose sucker	+	+	+	+			+	+	+	+
Lake chub	+	+		+		+	+	+	+	+
Fathead minnow	+	+	+	+	+	+	+	+	+	+
Spottail shiner									+	
Finescale dace									+	
Brook stickleback	+	+	+	+	+	+	+	+	+	+
Trout-perch									+	+
Spoonhead sculpin								+		
Total species (16)	6	5	4	5	3	4	6	6	15	10

TABLE 3.3

Percentage Composition and Frequency of Occurrence of Various Fish Species in Gillnet Collections, Beaver Creek Reservoir, Ruth Lake, and Poplar Creek Reservoir (1978)

Location	Longnose sucker		White sucker		Lake chub	
	% comp.	*Freq. occur.*	*% comp.*	*Freq. occur.*	*% comp.*	*Freq. occur.*
Beaver Creek Reservoir (7)*	3.5	71.4	95.7	100	0.8	14.3
Ruth Lake (5)	1.3	40.0	98.7	100	-	-
Poplar Creek Reservoir (7)	-	-	100	71.4	-	-

*Total number of sampling events (i.e., individual net-units).

Beach seining in the reservoirs and Ruth Lake produced limited catches of young-of-the-year (age 0+) and young juveniles (age I+) (Table 3.4). In Beaver Creek Reservoir samples, these age-classes comprised only 4.2% of the total numerical catch. The numerical contribution by these same age-classes was even lower in Poplar Creek Reservoir (0.8%) and Ruth Lake (0.1%). With respect to the two reservoirs and Ruth Lake, white sucker young-of-the-year and juveniles were recorded most often in individual seine hauls conducted in Beaver Creek Reservoir (i.e., frequency of occurrence of 45.2%). Values of 33.3% and 23.8% were obtained for Poplar Creek Reservoir and Ruth Lake, respectively.

Longnose Sucker

Adult longnose suckers were captured by gill net in low numbers from Beaver Creek Reservoir and Ruth Lake; they were absent in the Poplar Creek Reservoir catch (Table 3.3). They contributed only 3.5% to the total catch in Beaver Creek Reservoir, although they were a frequent addition to the catch (i.e., present in 71.4% of the net sets). In Ruth Lake, longnose suckers contributed 1.3% to the total gillnet catch and were recorded in only 40% of the net sets. Young-of-the-year and juveniles of the species were not captured in the reservoirs or Ruth Lake during the beach seining program (Table 3.4).

TABLE 3.4

Percentage Composition and Frequency of Occurrence of Various Fish Species in Beach Seine Collections, Beaver Creek Reservoir, Ruth Lake, and Poplar Creek Reservoir (1978)

Location	Fathead minnow		Brook stickleback		Lake chub		White sucker (juv. & y-o-y)	
	% comp.	*Freq. occur.*	*% comp.*	*Freq. occur.*	*% comp.*	*Freq. occur.*	*% comp.*	*Freq. occur.*
Beaver Creek Reservoir (42)*	71.9	85.7	22.8	92.9	1.1	30.9	4.2	45.2
Ruth Lake (21)	92.2	76.2	7.7	95.2	<0.1	9.5	0.1	23.8
Poplar Creek Reservoir (33)	88.7	84.8	10.5	51.5	<0.1	3.0	0.8	33.3

*Total number of sampling events (i.e., individual seine hauls).

Other Species

Of the remaining fish species recorded in lentic habitats, which included the fathead minnow, brook stickleback, and lake chub, the fathead minnow was most abundant. This species accounted for 92.2%, 88.7%, and 71.9% of the total beach seine catch in Ruth Lake, Poplar Creek Reservoir, and Beaver Creek Reservoir, respectively (Table 3.4). It was also present in the majority of seine hauls in each of the three areas (frequency occurrence ranging between 76.2% and 85.7%).

The brook stickleback was also recorded frequently in seine hauls, particularly in Beaver Creek Reservoir and Ruth Lake (frequency of occurrence of 92.9% and 95.2%, respectively) (Table 3.4). This species, however, contributed considerably less, numerically, to the total beach seine catch than did the fathead minnow.

Lake chub contributed least to the total beach seine catch in each of the three waterbodies; they also exhibited a low frequency of occurrence (Table 3.4).

3.2.2 Lotic Habitats

White Sucker

White suckers were an important component of the total electrofishing catch in both upper Beaver Creek (percentage composition 36.3%) and Poplar Creek (percentage composition 52.6%) (Table 3.5). In addition to their high numerical abundance, they also exhibited a widespread

TABLE 3.5

Percentage Composition and Frequency of Occurrence of Various Fish Species in Electrofishing Collections, Poplar Creek and Upper Beaver Creek (1978)

Species	Poplar Creek		Upper Beaver Creek	
	% comp.	*Freq. occur.*	*% comp.*	*Freq. occur.*
Arctic grayling	1.7	43.8	-	-
Northern pike	0.5	31.3	-	-
White sucker	52.6	93.4	36.3	85.7
Longnose sucker	1.1	31.3	0.7	14.3
Burbot	0.3	12.5	-	-
Lake chub	27.8	62.5	33.6	42.9
Fathead minnow	11.2	18.8	18.4	28.6
Brook stickleback	4.8	25.0	10.3	28.6
Spoonhead sculpin	-	-	0.7	14.3
No. sampling events*	16		7	

*Total number of electrofishing surveys, over all seasons and including all sample sections.

distribution, both seasonally and geographically (frequency of occurrence 85.7% and 93.4% for Upper Beaver Creek and Poplar Creek, respectively).

Longnose Sucker

Longnose suckers were not well represented in the electrofishing catch in lotic habitats, particularly in Upper Beaver Creek where they comprised only 0.7% of the total catch and were recorded in only 14.3% of the samples (Table 3.5). Although they were more common in Poplar Creek, they comprised only 1.1% of the total catch and were present in only 31.3% of the samples.

Arctic Grayling

Arctic grayling were not captured during electrofishing surveys in Upper Beaver Creek during 1978 (Table 3.5). The species has been recorded previously in this area, subsequent to dam closure in the fall of 1975. Noton and Chymko (1978) collected a single juvenile grayling in July 1977 and also documented reports of grayling being caught by sport fishermen in Upper Beaver Creek, upstream of the sampled area. The absence of grayling during the present study could be expected due to the existence of severe habitat limitations (e.g., silt-sand substrate, and low habitat diversity).

Arctic grayling were captured on an irregular basis by electrofishing in Poplar Creek (Table 3.5). Although they were not a major component of the overall catch, they

contributed significantly on a site-specific and seasonal basis (e.g., common in sections of EF3 during the summer survey).

Other Species

A number of other species were also captured during electrofishing surveys in Upper Beaver Creek and Poplar Creek (Table 3.5). Notable in this group was the lake chub which was encountered frequently and contributed most to the total catch.

3.3 CATCH/UNIT EFFORT (CUE)

3.3.1 Lentic Habitats

The gillnet catch results provide an indication of the abundance of the adult and older juvenile components of fish populations in the reservoirs and Ruth Lake. Catch/unit effort (CUE) data based on overnight net sets are summarized in tables 3.6 to 3.8. The catch results and mesh efficiencies for individual net sets are presented in Appendix A.

The catch results obtained during the beach seine program provide an indication of the abundance of the juvenile age-classes of the larger fish species (e.g., white sucker) and the size of resident populations of smaller fish (e.g., cyprinids). Catch/unit effort (CUE) data for the two reservoirs and Ruth Lake are given in tables 3.9 to 3.11. The catch results for individual seine hauls are provided in Appendix B.

TABLE 3.6

Sampling Effort and Catch/Unit Effort (CUE) for Overnight Gillnet Sets, Beaver Creek Reservoir (1978)

Location	Species CUE*			Set duration (*h*)
	LNS	WS	LKC	
Spring				
G1	4.1 (5)	106.8 (129)	-	14.5
G2	1.5 (2)	29.3 (39)	-	16.0
Summer				
G1	9.2 (10)	95.1 (103)	-	13.0
Fall				
G1	-	141.6 (177)	4.0 (5)	15.0
All stations	3.5 (4.3) (n=17)	92.1 (112.0) (n=448)	1.1 (1.3) (n=5)	$\bar{x}$ = 14.6 (Total = 58.5)

*CUE based on standard net-unit (15.2-m x 2.4-m panels of 3.8-cm, 6.4-cm, 8.9-cm monofilament mesh). Results expressed as number fish/net-unit/12 h; number fish/standard net-unit/overnight set given in parentheses.

TABLE 3.7

Sampling Effort and Catch/Unit Effort (CUE) for Overnight Gillnet Sets, Ruth Lake (1978)

Location	Species CUE* LNS	Species CUE* WS	Set duration (*h*)
Spring			
G1	0.9 (1)	23.1 (26)	13.5
G1	1.1 (2)	34.3 (60)	21.0
Summer			
G2	-	31.7 (41)	15.5
Fall			
G2	-	55.7 (78)	16.8
All stations	0.6 (0.8) (n=3)	36.9 (51.3) (n=205)	$\bar{x}$ = 16.7 (Total = 66.8)

*CUE based on standard net-unit (15.2-m x 2.4-m panels of 3.8-cm, 6.4-cm, 8.9-cm monofilament mesh). Results expressed as number fish/net-unit/12 h; number fish/standard net-unit/overnight set given in parentheses.

TABLE 3.8

Sampling Effort and Catch/Unit Effort (CUE) for Overnight Gillnet Sets, Poplar Creek Reservoir and Stilling Basin (1978)

Station	Species CUE*			Set duration (*h*)
	LNS	WS	NP	
Poplar Creek Reservoir				
Spring				
G1	-	4.0 (5)	-	15.0
G2	-	4.4 (7)	-	19.0
Summer				
G1	-	32.3 (43)	-	16.0
Fall				
G1	-	2.1 (3)	-	17.0
All stations	- (n=0)	10.4 (14.5) (n=58)	- (n=0)	$\bar{x}$ = 16.8 (Total = 67)
Stilling Basin				
Spring				
G1	11.6 (13)	72.9 (82)	0.9 (1)	13.5

*Standard net-unit employed in Poplar Creek Reservoir (15.2-m x 2.4-m panels of 3.8-cm, 6.4-cm, 8.9-cm monofilament mesh). The net-unit for Stilling Basin was 15.2-m x 2.4-m panel of 6.4-cm monofilament mesh.

CUE expressed as number fish/net-unit/12 h; number of fish/net-unit/overnight set given in parentheses.

TABLE 3.9

Sampling Effort and Catch/Unit Effort (CUE) for Beach Seine Hauls, Beaver Creek Reservoir (1978)

Station	Species CUE*							Haul Area (m^2)
	FHM	BS	LKC	WS (y-o-y)	WS (juv)	WS (y-o-y, juv)	All Species	
Spring								
S1	0.4 (8)	0.2 (3)	0.3 (6)	-	0.3 (5.7)	-	1.2 (22.7)	575.0
S2	-	<0.1 (0.5)	-	-	-	-	<0.1 (0.5)	325.0
S3	0.1 (1.7)	0.2 (2.7)	-	-	<0.1 (0.7)	-	0.3 (5.0)	500.0
S4	1.2 (21.3)	0.2 (3)	-	-	<0.1 (0.7)	-	1.4 (25.0)	550.0
S5	0.2 (3.3)	0.6 (12.3)	-	-	0.1 (1.0)	-	0.8 (16.7)	625.0
S6	-	-	-	-	-	-	-	-
All stations (hauls = 14)	0.4 (7.4)	0.3 (4.6)	0.1 (1.3)	-	0.1 (1.7)	-	0.8 (14.9)	$\bar{x}$ = 515 (Total = 2575)
Summer								
S1	65.1 (1111.7)	26.9 (458.7)	4.2 (71.7)	0.2 (3.3)	1.3 (21.7)	-	97.6 (1667.0)	512.5
S2	241.0 (4318.3)	58.7 (1052.3)	-	-	-	30.8 (552.7)	330.5 (5921.3)	537.5
S3	42.4 (724.7)	43.3 (739.3)	2.0 (33.3)	-	-	0.6 (10.7)	88.3 (1508.0)	512.5
S4	97.1 (1618.0)	46.3 (771)	1.6 (26.7)	-	0.6 (10.0)	-	145.5 (2425.7)	500.0
All stations (hauls = 12)	113.1 (1943.2)	43.9 (755.3)	1.9 (32.9)	0.1 (0.8)	0.5 (7.9)	8.2 (140.8)	167.6 (2880.5)	$\bar{x}$ = 515.6 (Total = 2062.5)
Fall								
S1	113.7 (1989.0)	6.10 (107.3)	0.8 (14.3)	-	<0.1 (0.67)	-	120.6 (2111.3)	525.0
S2	34.6 (461.3)	7.3 (43.3)	<0.1 (0.3)	-	-	-	37.9 (505.0)	400.0
S3	7.3 (101.0)	3.7 (50.7)	-	-	-	-	11.0 (151.7)	412.5
S4	1.1 (12.3)	3.2 (36.3)	0.1 (0.7)	-	-	-	4.4 (49.3)	337.5
All stations (hauls = 12)	45.9 (640.9)	4.3 (59.4)	0.3 (3.8)	-	<0.1 (0.2)	-	50.5 (704.3)	$\bar{x}$ = 418.8 (Total = 1675)

*CUE expressed as number fish/unit area; i.e., 10 m^2 of surface area; number fish/haul given in parentheses.

Note: Data from S6 (Spring) declared invalid due to low sampling efficiency.

TABLE 3.10

Sampling Effort and Catch/Unit Effort (CUE) for Beach Seine Hauls, Ruth Lake (1978)

Station	Species CUE*						Haul Area (m^2)
	FHM	BS	LKC	WS (y-o-y)	WS (juv)	All Species	
Spring							
S1	1.4 (34.7)	0.4 (9.0)	-	-	<0.1 (1)	1.9 (44.7)	725.0
S2	2.5 (48)	0.3 (6.3)	<0.1 (0.7)	-	0.3 (5.3)	3.2 (60.3)	575.0
S3	-	0.3 (4.3)	-	-	<0.1 (0.3)	0.3 (4.6)	475.0
All stations (hauls = 9)	1.4 (27.6)	0.3 (6.6)	<0.1 (0.2)	-	0.1 (2.2)	1.9 (36.6)	$\bar{x}$ = 591.7 (Total = 1775)
Summer							
S1	43.9 (768.0)	12.8 (224.7)	-	-	-	567 (992.7)	525.0
S2	281.2 (5390.0)	22.4 (430.0)	<0.1 (0.3)	-	<0.1 (0.7)	303.7 (5821.0)	575.0
All stations (hauls = 6)	167.9 (3079.0)	17.9 (327.3)	<0.1 (0.2)	-	<0.1 (0.3)	185.8 (3406.8)	$\bar{x}$ = 550 (Total = 1100)
Fall							
S2	69.1 (1036.7)	0.5 (7.3)	-	-	-	69.6 (1044.0)	450
S3	54.3 (905.7)	0.2 (2.7)	-	-	-	54.5 (908.4)	500
All stations (hauls = 6)	61.4 (971.2)	0.3 (5.0)	-	-	-	61.7 (976.2)	950

*CUE expressed as number fish/unit area; i.e., 10 m^2 of substrate; number fish/haul given in parentheses.

TABLE 3.11

Sampling Effort and Catch/Unit Effort (CUE) for Beach Seine Hauls, Poplar Creek Reservoir (1978)

Station	Species CUE* FHM	BS	LKC	WS (y-o-y)	WS (juv)	All Species	Haul Area (m^2)
Spring							
S1	0.2 (3.0)	<0.1 (0.3)	-	-	0.1 (1.0)	0.3 (4.3)	475.0
S2	<0.1 (0.3)	-	-	-	-	<0.1 (0.3)	575.0
S3	<0.1 (0.7)	-	-	-	-	<0.1 (0.7)	600
S4	0.5 (9.3)	<0.1 (0.3)	-	-	<0.1 (0.3)	0.5 (10.0)	550
All stations (hauls = 12)	0.2 (3.3)	<0.1 (0.2)	-	-	<0.1 (0.3)	0.2 (3.8)	$\bar{x}$ = 550 (Total = 2200)
Summer							
S1	34.5 (646.7)	3.2 (60.0)	-	-	0.5 (9.3)	38.2 (716.0)	562.5
S2	28.1 (584.3)	5.6 (117.0)	-	0.2 (4.0)	0.3 (5.7)	34.1 (711.0)	625.0
S3	9.8 (184.3)	7.1 (132.3)	<0.1 (0.3)	0.2 (3.3)	0.1 (2.3)	17.2 (322.7)	562.5
S4	84.2 (1262.3)	1.6 (24.0)	-	-	-	85.8 (1286.3)	450
All stations (hauls = 12)	36.5 (669.4)	4.6 (83.3)	<0.1 (0.1)	0.1 (1.8)	0.2 (4.3)	41.4 (759.0)	$\bar{x}$ = 550 (Total = 2200)
Fall							
S1	3.7 (41.3)	-	-	-	-	3.7 (41.3)	337.5
S2	2.7 (33.7)	0.2 (2.3)	-	-	-	2.9 (36.0)	375.0
S3	5.5 (80.7)	-	-	-	-	5.5 (80.7)	437.5
All stations (hauls = 9)	4.1 (51.9)	0.1 (0.8)	-	-	-	4.1 (52.7)	$\bar{x}$ = 383.3 (Total = 1150)

*CUE expressed as number fish/unit area; i.e., 10 m^2 of surface area; number fish/haul given in parentheses.

White Sucker

Catch/unit effort values obtained for overnight gillnet sets indicate differences in the size of white sucker populations in the three standing waterbodies. The seasonally averaged capture rate obtained in Beaver Creek Reservoir was 92.1 fish/net-unit. This represents a high rate of capture and indicates the presence of a large population. The capture rate calculated for Ruth Lake (i.e., 36.9 fish/net-unit) was substantially lower than that obtained for Beaver Creek Reservoir, suggesting the presence of a comparatively smaller population in Ruth Lake. The low rate recorded in Poplar Creek Reservoir (i.e., 10.4 fish/net-unit) indicates the presence of a much reduced white sucker population in this system, relative to Beaver Creek Reservoir and Ruth Lake.

The distribution of the catch amongst the various mesh sizes is shown in Table 3.12. The 3.8-cm mesh was the most efficient in sampling the size range of fish available in the three areas. The selectivity displayed by the three mesh sizes, with respect to length of fish captured, is illustrated in Figure 3.1. The catch in the 3.8-cm and 6.4-cm mesh nets exhibited major modes in the 160-179 mm and 260-279 mm fork length ranges, respectively. In contrast, the 8.9-cm mesh exhibited bimodal capture selectivity with individual modes between 230-319 mm and between 340-359 mm. While this may be due to small sample size, it may also be a result of size differences between fish "wedged" in the net or "gilled" (Baranov 1914 *in* Hamley 1975).

TABLE 3.12

Distribution of Gillnet Captured White Suckers in Various Mesh Sizes, Beaver Creek Diversion Study Area (1978)

Location	3.8 cm		6.4 cm		8.9 cm		All meshes	
	Number	*Per-cent*	*Number*	*Per-cent*	*Number*	*Per-cent*	*Number*	*Per-cent*
Beaver Creek Reservoir	325	53.6	240	39.6	41	6.8	606	100
Ruth Lake	158	70.5	59	26.3	7	3.2	224	100
Poplar Creek Reservoir	45	76.3	14	23.7	-	-	59	100

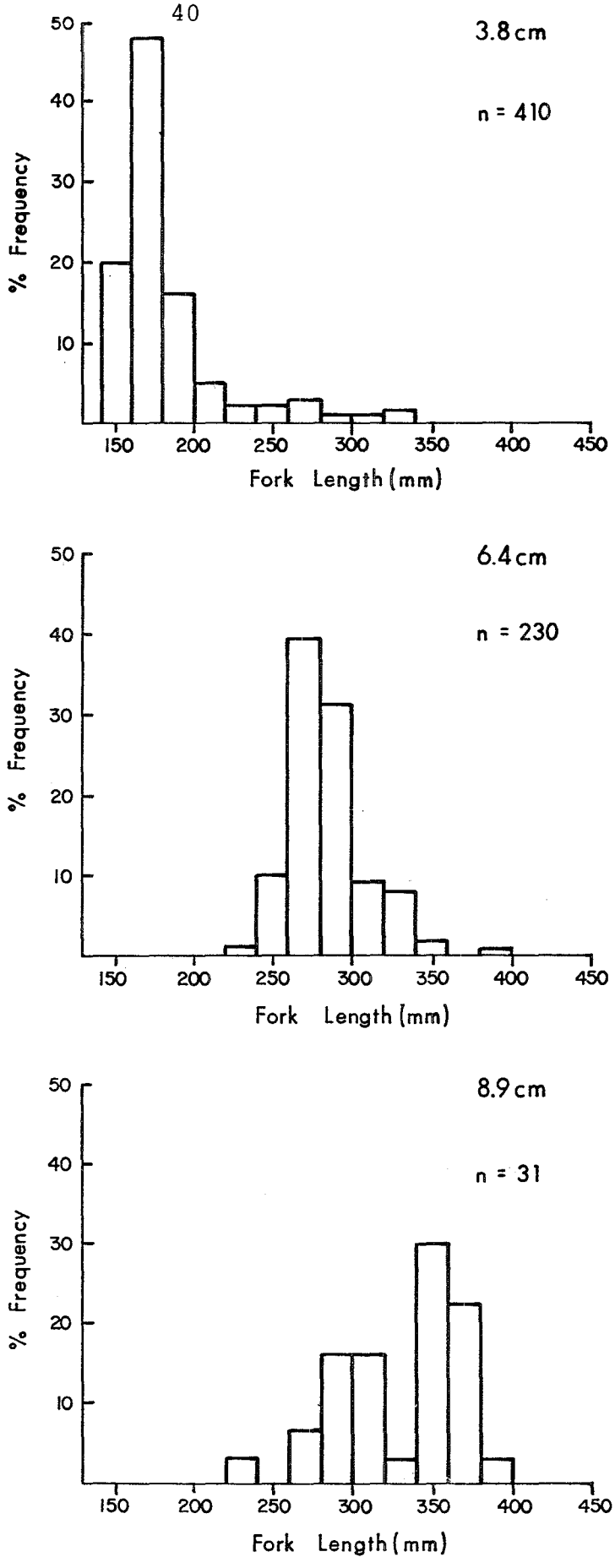

Figure 3.1. Length-frequency distribution of white suckers captured by gill nets of various mesh size, Beaver Creek Reservoir and Ruth Lake (May-October, 1978).

The I+ and II+ age-classes comprised a majority of the catch in the 3.8-cm mesh nets, whereas the 6.4-cm mesh nets sampled a wider range of age groups (i.e., II+ to IV+). Age-classes II+ through VI+ contributed to the catch in the 8.9-cm mesh nets, although the majority were in the older age-classes (i.e., older than four years of age).

In comparison to the numbers of fathead minnow and brook stickleback collected in each of the three areas, white sucker juveniles contributed very little to the total seine haul catch. Of the juvenile white suckers captured, the majority belonged to the 1977 year-class (I+), although individuals from the 1978 year-class (0+) were also encountered. The CUE data indicate that population recruitment in 1978 was more successful in Beaver Creek Reservoir than in Ruth Lake or Poplar Creek Reservoir. In this waterbody, individuals from both the 1977 and 1978 year-classes were recorded, although the former year-class appeared much stronger.

No young-of-the-year white suckers were captured in Ruth Lake in 1978; a similar situation was reported during 1977 (Noton and Chymko 1978). It appears that white suckers do not reproduce successfully in Ruth Lake; this is not surprising due to the lack of suitable spawning habitat. Age I+ juveniles were collected in Ruth Lake in 1978, but in low numbers. The presence of individuals from this age-class might indicate that some spawning success was achieved in Ruth Lake during 1977; however, it is more likely the result of a movement of juveniles from Beaver Creek Reservoir to rearing areas within Ruth Lake.

Although age I+ and age 0+ fish were collected in Poplar Creek Reservoir during the present study, capture

rates were low. Noton and Chymko (1978) failed to collect juveniles or young-of-the-year white suckers in this reservoir during 1977. Based on sampling results from the two years it appears that population recruitment has been largely unsuccessful since reservoir formation. This could be due to the low numbers of adult white suckers in the system.

Longnose Sucker

Catch/unit effort data derived from gillnet catches indicate that longnose suckers are present in very low numbers in standing waterbodies in the study area. Highest capture rates were recorded in Beaver Creek Reservoir, with a seasonally averaged CUE of 3.5 fish/net-unit. An exceptionally low value of 0.6 fish/net-unit was recorded for Ruth Lake. This species was not encountered in gill nets in Poplar Creek Reservoir during 1978, nor in 1977 by previous investigators (Noton and Chymko 1978).

No young-of-the-year or juvenile longnose suckers were collected from lentic habitats in the 1978 beach seining program nor were they encountered during 1977 (Noton and Chymko 1978). Apparently, population recruitment in the reservoirs and in Ruth Lake during the post-diversion period has been unsuccessful.

Fathead Minnow

Catch results from the beach seining program indicate that the fathead minnow is the most abundant of the

smaller fish (i.e., cyprinids and young-of-the-year white suckers) in the reservoir system. A seasonally averaged CUE of 64.2 fish/unit area (i.e., per 10 m^2) was obtained for Ruth Lake, indicating the presence of an extremely large population. Beaver Creek Reservoir, with a capture rate of 49.3 fish/unit area also supports a large population. The species is well established in Poplar Creek Reservoir (15.4 fish/unit area), although during 1978 it did not reach a population level comparable to that recorded in Ruth Lake or Beaver Creek Reservoir.

An abundant 1978 year-class was largely responsible for the high capture rates obtained in each of the waterbodies. Young-of-the-year first entered the seine haul catch during the summer survey. At this time seasonal CUE values peaked at 167.9 fish/unit area in Ruth Lake, 113.1 fish/unit area in Beaver Creek Reservoir, and 36.5 fish/unit area in Poplar Creek Reservoir.

Brook Stickleback

As indicated by the seining results, brook sticklebacks are well established in each of the standing waterbodies; however, they were recorded at lower population densities than the fathead minnow. The highest seasonally averaged CUE values were obtained from Beaver Creek Reservoir (15.6 fish/unit area), followed by Ruth Lake (5.4 fish/unit area) and Poplar Creek Reservoir (1.8 fish/unit area). Seasonal values peaked in the summer due to the entrance of 1978 young-of-the-year into the catch. Summer values of 43.9 fish/unit area, 17.9 fish/unit area, and 4.6 fish/unit area were recorded in Beaver Creek Reservoir, Ruth Lake, and Poplar Creek Reservoir, respectively.

Lake Chub

Apart from several large adults collected during the fall survey in Beaver Creek Reservoir, this species was not encountered in the gillnet catch.

Beach seining results from 1978 indicate that lake chub populations in the reservoirs and Ruth Lake are relatively small compared to fathead minnow and brook stickleback populations. Seasonally averaged CUE values of 0.7 fish/unit area, <0.1 fish/unit area, and <0.1 fish/unit area were obtained for Beaver Creek Reservoir, Ruth Lake, and Poplar Creek Reservoir, respectively.

Noton and Chymko (1978) reported that lake chub were "common to abundant" in seine hauls conducted in Beaver Creek Reservoir in 1977. They did not, however, encounter the species in either Ruth Lake or Poplar Creek Reservoir.

3.3.2 Lotic Habitats

Catch results obtained during electrofishing surveys were used to assess the relative abundance of fish populations in Upper Beaver Creek and Poplar Creek. Sampling effort, efficiency, and catch/unit effort (CUE) values are given in tables 3.13 and 3.14. The catch results for individual sampling events are presented in Appendix C.

TABLE 3.13

Sampling Effort, Efficiency, and Catch/Unit Effort (CUE) for Electrofishing, Upper Beaver Creek (1978)

Station	Species CUE*						Effort (*min*)	Eff.**
	WS	LNS	FHM	LKC	BS	SHS		
Spring								
EF1	1.8	0.2	-	-	-	-	4.5	3
EF2	1.0	-	-	-	-	-	4.0	3
EF3	-	-	-	-	-	-	4.3	3
All stations	0.9	0.1	-	-	-	-	12.8	3
Summer								
EF1	3.4	-	2.4	4.4	1.2	-	10.6	2
Fall								
EF1	0.4	-	-	0.4	-	-	2.8	3
EF2	0.3	-	0.7	0.3	0.5	0.3	4.0	3
EF3	0.6	-	-	-	-	-	4.9	3
All stations	0.4	-	0.2	0.2	0.2	0.1	11.7	3

*CUE expressed as number fish/minute of electrofisher operating time (includes fish captured and observed).

**Sampling efficiency rating (1-4); 1 representing highest level.

TABLE 3.14

Sampling Effort, Efficiency, and Catch/Unit Effort (CUE) for Electrofishing, Poplar Creek (1978)

Station	Species CUE* AG	NP	LING	WS	LNS	FHM	LKC	BS	Effort (*min*)	Eff.**
Spring										
EF1	0.1	-	-	0.2	-	-	-	-	8.6	1
EF2	-	-	-	3.9	-	-	-	-	9.8	1
EF3 (combined)	-	0.3	-	2.6	0.1	-	-	-	7.4	1-2
EF3(a)***	-	-	-	1.7	-	-	-	-	2.3	2
EF3(b)***	-	1.5	-	14.9	-	-	-	-	0.7	2
EF3(c)***	-	-	-	-	-	-	-	-	2.3	2
EF3(d)***	-	0.5	-	2.4	0.5	-	-	-	2.1	1
EF4	-	-	-	9.4	0.3	-	-	-	3.4	2
EF5 (combined)	-	0.4	-	6.7	-	-	0.2	-	4.8	2
EF5(a,b)***	-	1.1	-	17.2	-	-	0.6	-	1.8	2
EF5(c,d)***	-	-	-	0.3	-	-	-	-	3.0	2
EF6	-	-	-	2.3	0.3	-	0.3	-	3.1	2
EF7	-	-	-	-	-	-	-	-	1.8	3
All stations	<0.1	0.1	-	3.3	0.1	-	0.1	-	38.9	1-3
Summer										
EF1	0.1	-	-	6.6	-	2.4	0.7	-	12.5	1
EF2	0.4	-	-	7.9	-	1.2	3.8	0.4	11.2	1
EF3 (combined)	0.9	-	0.2	12.5	0.8	-	7.2	-	10.0	1-2
EF3(a)***	-	-	-	-	-	-	-	-	1.5	2
EF3(b)***	2.4	-	0.4	26.4	1.6	-	19.6	-	2.5	1
EF3(c)***	-	-	-	0.3	-	-	-	-	3.0	2
EF3(d)***	1.0	-	0.3	16.4	1.3	-	7.7	-	3.0	1
EF5 (combined)	0.2	0.2	-	10.5	0.9	-	3.1	-	6.7	1-2
EF5(a)***	0.4	-	-	16.4	1.6	-	8.4	-	2.5	1
EF5(b)***	-	-	-	-	-	-	-	-	1.3	2
EF5(c)***	-	0.3	-	10.0	0.7	-	-	-	2.9	1
EF7	-	0.2	-	2.0	-	-	0.2	-	6.0	3
All stations	0.4	<0.1	<0.1	8.1	0.3	0.4	3.2	0.1	46.4	1-3
Fall										
EF1	0.3	-	-	2.7	-	-	0.4	-	14.3	2
EF2	0.1	-	-	3.4	-	-	12.0	0.3	10.8	2
EF3 (combined)	-	0.1	-	21.7	-	16.2	14.4	6.8	9.4	2-3
EF3(a)***	-	0.4	-	67.9	-	46.8	38.2	21.4	2.8	3
EF3(b)***	-	-	-	1.1	-	-	-	-	1.8	3
EF3(c)***	-	-	-	3.2	-	6.2	8.2	1.2	3.4	3
EF3(d)***	-	-	-	0.7	-	-	-	-	1.4	3
EF5 (combined)	-	-	0.5	1.3	-	-	-	-	4.0	3
EF5(a,b)***	-	-	0.4	1.3	-	-	-	-	2.3	3
EF5(c)***	-	-	0.6	1.2	-	-	-	-	1.7	3
All stations	0.1	<0.1	0.1	7.4	-	4.0	7.0	1.7	38.5	2-3

*CUE expressed as number/minute (includes fish captured and observed).
**Sampling efficiency rating (1-4); 1 representing highest level.
***EF3(a,c) and EF5(a,c) riffle-type habitat below DS11, DS10 and DS7, DS6, respectively. EF3(b,d) and EF5(b,d) pool-type habitat below DS11, DS10, and DS7, DS6, respectively.

TABLE 3.13

Sampling Effort, Efficiency, and Catch/Unit Effort (CUE) for Electrofishing, Upper Beaver Creek (1978)

Station	Species CUE*						Effort (*min*)	Eff.**
	WS	LNS	FHM	LKC	BS	SHS		
Spring								
EF1	1.8	0.2	-	-	-	-	4.5	3
EF2	1.0	-	-	-	-	-	4.0	3
EF3	-	-	-	-	-	-	4.3	3
All stations	0.9	0.1	-	-	-	-	12.8	3
Summer								
EF1	3.4	-	2.4	4.4	1.2	-	10.6	2
Fall								
EF1	0.4	-	-	0.4	-	-	2.8	3
EF2	0.3	-	0.7	0.3	0.5	0.3	4.0	3
EF3	0.6	-	-	-	-	-	4.9	3
All stations	0.4	-	0.2	0.2	0.2	0.1	11.7	3

*CUE expressed as number fish/minute of electrofisher operating time (includes fish captured and observed).

**Sampling efficiency rating (1-4); 1 representing highest level.

TABLE 3.14

Sampling Effort, Efficiency, and Catch/Unit Effort (CUE) for Electrofishing, Poplar Creek (1978)

Station	Species CUE* AG	NP	LING	WS	LNS	FHM	LKC	BS	Effort (*min*)	Eff.**
Spring										
EF1	0.1	-	-	0.2	-	-	-	-	8.6	1
EF2	-	-	-	3.9	-	-	-	-	9.8	1
EF3 (combined)	-	0.3	-	2.6	0.1	-	-	-	7.4	1-2
EF3(a)***	-	-	-	1.7	-	-	-	-	2.3	2
EF3(b)***	-	1.5	-	14.9	-	-	-	-	0.7	2
EF3(c)***	-	-	-	-	-	-	-	-	2.3	2
EF3(d)***	-	0.5	-	2.4	0.5	-	-	-	2.1	1
EF4	-	-	-	9.4	0.3	-	-	-	3.4	2
EF5 (combined)	-	0.4	-	6.7	-	-	0.2	-	4.8	2
EF5(a,b)***	-	1.1	-	17.2	-	-	0.6	-	1.8	2
EF5(c,d)***	-	-	-	0.3	-	-	-	-	3.0	2
EF6	-	-	-	2.3	0.3	-	0.3	-	3.1	2
EF7	-	-	-	-	-	-	-	-	1.8	3
All stations	<0.1	0.1	-	3.3	0.1	-	0.1	-	38.9	1-3
Summer										
EF1	0.1	-	-	6.6	-	2.4	0.7	-	12.5	1
EF2	0.4	-	-	7.9	-	1.2	3.8	0.4	11.2	1
EF3 (combined)	0.9	-	0.2	12.5	0.8	-	7.2	-	10.0	1-2
EF3(a)***	-	-	-	-	-	-	-	-	1.5	2
EF3(b)***	2.4	-	0.4	26.4	1.6	-	19.6	-	2.5	1
EF3(c)***	-	-	-	0.3	-	-	-	-	3.0	2
EF3(d)***	1.0	-	0.3	16.4	1.3	-	7.7	-	3.0	1
EF5 (combined)	0.2	0.2	-	10.5	0.9	-	3.1	-	6.7	1-2
EF5(a)***	0.4	-	-	16.4	1.6	-	8.4	-	2.5	1
EF5(b)***	-	-	-	-	-	-	-	-	1.3	2
EF5(c)***	-	0.3	-	10.0	0.7	-	-	-	2.9	1
EF7	-	0.2	-	2.0	-	-	0.2	-	6.0	3
All stations	0.4	<0.1	<0.1	8.1	0.3	0.4	3.2	0.1	46.4	1-3
Fall										
EF1	0.3	-	-	2.7	-	-	0.4	-	14.3	2
EF2	0.1	-	-	3.4	-	-	12.0	0.3	10.8	2
EF3 (combined)	-	0.1	-	21.7	-	16.2	14.4	6.8	9.4	2-3
EF3(a)***	-	0.4	-	67.9	-	46.8	38.2	21.4	2.8	3
EF3(b)***	-	-	-	1.1	-	-	-	-	1.8	3
EF3(c)***	-	-	-	3.2	-	6.2	8.2	1.2	3.4	3
EF3(d)***	-	-	-	0.7	-	-	-	-	1.4	3
EF5 (combined)	-	-	0.5	1.3	-	-	-	-	4.0	3
EF5(a,b)***	-	-	0.4	1.3	-	-	-	-	2.3	3
EF5(c)***	-	-	0.6	1.2	-	-	-	-	1.7	3
All stations	0.1	<0.1	0.1	7.4	-	4.0	7.0	1.7	38.5	2-3

*CUE expressed as number/minute (includes fish captured and observed).
**Sampling efficiency rating (1-4); 1 representing highest level.
***EF3(a,c) and EF5(a,c) riffle-type habitat below DS11, DS10 and DS7, DS6, respectively. EF3(b,d) and EF5(b,d) pool-type habitat below DS11, DS10, and DS7, DS6, respectively.

White Sucker

In general, capture success in Upper Beaver Creek was low for all species. This was probably due, in part, to the presence of low quality habitat in the sampled reaches. It should be pointed out, however, that sampling efficiency was low during the spring and fall surveys. During these particular periods, the high water levels made wading impossible, thus necessitating the use of a less efficient sampling technique (i.e., using the back-pack electrofisher from a boat).

Of the species encountered in Upper Beaver Creek, highest capture rates were obtained for the white sucker. A CUE value of 0.9 fish/min (calculated from actual electrofisher operating time) was obtained for white suckers during the spring survey; all fish were adults in spawning condition. A higher rate of capture (3.4 fish/min) was recorded during the summer survey. The increase was due to the appearance in the catch of juveniles (age I+) and, to a lesser extent, of 1978 young-of-the-year. The amount of white sucker population recruitment occurring in reaches of Upper Beaver Creek, as typified by 1978 sample sections, remains uncertain. However, based on the presence of adults in spawning condition during spring and the subsequent capture of young-of-the-year in summer, the occurrence of successful recruitment in the area cannot be discounted, despite the apparent lack of suitable spawning habitat.

White suckers dominated the electrofishing catch in all sample sections in Poplar Creek during 1978. CUE values ranged from 3.3 fish/min in the spring survey to 3.9 fish/min in the summer, and 7.4 fish/min in the fall.

The electrofishing catch in the spring was dominated by adults in spawning condition. Pre-spawning aggregations were recorded in riffle-type habitat in the lower 150 m of EF2 (up to the beaver dams), EF3(b) (immediately downstream of DS11)*, EF4 (downstream of DS9) and EF5(a,b) (downstream of DS7). The individual CUE values for these sections were 3.9 fish/min (EF2), 14.9 fish/min (EF3(b)), 9.4 fish/min (EF4) and 17.2 fish/min (EF5(a,b)). Stream reaches situated between drop structures and the upper section of EF2 (upper 150 m) were characterized by low current velocities and sand-silt substrate. Lower capture rates were obtained in these areas suggesting that they were largely unsuitable for white sucker spawning.

During the summer, high capture rates for white suckers were obtained in all sample sections compared to spring. This was largely due to the appearance in the catch of juveniles and 1978 young-of-the-year. Adult white suckers, which were present in substantial numbers during the spring survey, contributed little to the summer catch. This indicates that the population is migratory, probably originating from the Athabasca River.

White sucker young-of-the-year and young juveniles remained abundant in the system during the fall; however, a decrease in the numbers of larger juveniles and young adults relative to the summer survey was apparent. This indicates that an out-migration, probably to the Athabasca River, had occurred prior to the fall survey. Areas of

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*DS refers to drop structure.

low current velocity, situated between drop structures, provided excellent late-season rearing habitat for young-of-the-year and juveniles. The rearing capacity of these areas was enhanced due to high water levels during fall, which made riparian vegetation available for shelter. A CUE value of 67.9 fish/min was recorded in EF3(a); this provides an indication of the high population densities at that time.

Longnose Sucker

The longnose sucker was not a common inhabitant of Upper Beaver Creek (as typified by sample reaches EF1-EF3). Only one individual was encountered--a ripe male sampled during spring in EF1. Based on the apparent lack of a defined spawning run and the absence of 1978 young-of-the-year in summer and fall collections, it is concluded that population recruitment does not occur in the area. This is expected due to the limited availability of useable spawning habitat. Sampling conducted in Upper Beaver Creek during 1977 indicated a similar status for longnose suckers (Noton and Chymko 1978).

In Poplar Creek, longnose suckers exhibited a sporadic distribution both on a site and seasonal basis. CUE values were substantially lower than those calculated for the more abundant white sucker. Values ranged from 0.1 fish/min (spring) to 0.3 fish/min (summer); no longnose suckers were encountered in the fall surveys. The electrofishing catch during the spring survey was comprised largely of adults, some of which were in spawning condition; however, numbers were too low to indicate the presence

of a significant and well defined spawning run in Poplar Creek. The fact that no young-of-the-year were collected during the summer or fall surveys could be a further indication that spawning utilization of Poplar Creek is minimal. The possibility remains, however, that a downstream movement of young-of-the-year occurred prior to the summer survey, and that the system provides only early-season rearing habitat for this age-class.

During the summer survey, juvenile longnose suckers comprised the majority of the electrofishing catch. They exhibited a preference for areas at, and immediately downstream from, drop structures for purposes of holding and feeding. The absence of juvenile longnose suckers in the spring and fall collections suggests that these age-classes are migratory in nature, entering Poplar Creek from the Athabasca River.

Arctic Grayling

During the 1978 electrofishing survey of Upper Beaver Creek, Arctic grayling were not encountered. In contrast, they were a common addition to the electrofishing catch in Poplar Creek. Only one individual was obtained from Poplar Creek in the spring survey, that being an adult captured in sample section EF1. An apparent movement of adults into the system, probably from the Athabasca River, resulted in increased capture success during the summer survey. At this time, localized feeding aggregations were encountered in suitable riffle habitat downstream of DS11, DS10 (EF3), and DS7 (EF5). Juvenile and young-of-the-year Arctic grayling were also recorded during the

summer survey; however, numbers were low. Lower capture rates for this species were obtained during the fall survey due mainly to the absence of adults in the catch. The data suggest that adult Arctic grayling migrated to overwintering areas outside the system, prior to the fall survey. Juveniles and young-of-the-year were recorded during the fall in EF1 and EF2 but capture rates were low.

Northern Pike

Northern pike were not encountered in Upper Beaver Creek. Similarly, the species was not captured in this system in 1977 by Noton and Chymko (1978); however, they considered it likely that northern pike were present in this system due to the existence of a small population in Beaver Creek Reservoir. Sampling in 1978 indicated that the reservoir population is no longer present; therefore, the presence of northern pike in Upper Beaver Creek is doubtful.

Northern pike were encountered infrequently in Poplar Creek during 1978, the majority being adults. Several of the adults captured during the spring survey were in spawning condition. Based on the limited availability of suitable spawning habitat and the absence of young-of-the-year in the summer and fall electrofishing catch, the presence of a significant and defined spawning run in the channelized section of Poplar Creek and upstream of the diversion, is unlikely. Due to difficulties in adequately sampling the lower, unchannelized reaches of Poplar Creek, the extent of northern pike spawning is uncertain. The spawning suitability of this reach, however, appears to

be higher than in the upper, channelized zone. Although the presence of a northern pike spawning run into Poplar Creek has not been documented, it should be noted that, in 1978, a northern pike sport fishery of considerable local importance occurred in the vicinity of the Highway 63 bridge crossing. Angling effort was particularly intense during the spring of the year.

Burbot

Burbot were not encountered in Upper Beaver Creek in the present study; similar results were obtained in 1977 (Noton and Chymko 1978). In Poplar Creek during the present study, burbot were captured on an infrequent basis. Although they were not present in the electrofishing catch in the spring survey, a small number of adults were encountered during the summer. These individuals were captured immediately downstream from DS10 and DS11 (EF3). These areas apparently provide favorable holding and feeding conditions (i.e., deep-fast riffles, back-eddies, concentrations of prey, etc.). No adult burbot were captured during the fall survey which suggests that prior out-migration to the Athabasca River had occurred. Juvenile burbot were captured in low numbers during the fall; they exhibited a preference for small holding areas within predominantly high-velocity drop structures in EF5 (i.e., DS6 and DS7).

Fathead Minnow

In Upper Beaver Creek, fathead minnows were not collected during the spring electrofishing survey but were present in low numbers during the summer and fall surveys. In Poplar Creek, the species was abundant in the upper sections (EF1-EF3) during the summer and fall. Summer seine haul results from the Stilling Basin (S1) also indicated an abundance of fathead minnows. The highest capture rate recorded was in EF3(a) (between the Stilling Basin and DS11) during the fall survey (46.8 fish/min). At this time fathead minnows were utilizing flooded riparian vegetation extensively for rearing habitat. The absence of fathead minnows during the spring survey in both the electrofishing catch (Poplar Creek proper) and in seine hauls (Stilling Basin) indicates that this species enters the Poplar Creek system from Poplar Creek Reservoir. The possibility of a downstream origin, such as the Athabasca River, is unlikely since it is doubtful that fathead minnows could successfully negotiate the series of drop structures in lower Poplar Creek.

Brook Stickleback

Brook stickleback were not encountered during spring electrofishing surveys in Upper Beaver Creek but were present in low numbers during the summer and fall. These fish may have moved into the system from Beaver Creek Reservoir during the summer; however, the presence of a resident population cannot be discounted. A similar situation occurred in Poplar Creek where the species was not encountered in spring but became more numerous as the season

progressed. The brook stickleback population in Poplar Creek probably originates from Poplar Creek Reservoir, in much the same manner as the fathead minnow population.

Lake Chub

Lake chub were common in Upper Beaver Creek, although electrofishing capture rates were generally low. A variety of year-classes were encountered, ranging from adults to young-of-the-year. Since lake chub were not well represented in Beaver Creek Reservoir, it appears that the Upper Beaver Creek population is fluvial in nature and self-supporting.

Lake chub were frequently encountered during electrofishing surveys in Poplar Creek. High capture rates were recorded during the summer and fall surveys. These were largely due to the entry of young-of-the-year into the catch, although a variety of year-classes were represented (i.e., juveniles, adults). The lake chub population in Poplar Creek, or at least a portion of it, is evidently migratory in nature being supported by migrants from the Athabasca River. This conclusion is based on the near absence of adult lake chub in the spring collections, in contrast to the high population levels observed during the summer and fall surveys. Lake chub have not successfully established in Poplar Creek Reservoir; therefore, this system is discounted as a potential source for recruitment. The presence of a small resident population in upper Poplar Creek (i.e., upstream of the diversion) remains a possibility.

3.4 LIFE HISTORY ANALYSIS

Life history data in raw form, appropriately sorted for ease of interpretation, are provided in the separate data volume, for each of the species of fish present in the study area. Additional data are included describing, in a detailed manner, pertinent life history relationships such as age-length, length-weight, length-frequency, and condition factor (k).

Due to the dominant status of the white sucker in the diversion system, life history data for this species are described in the present volume. The following discussion is further restricted to white sucker populations contained within the diversion by dam structures; excluded is the Poplar Creek population which is migratory in nature, hence less useful in terms of future monitoring. Life history information from the three standing waterbodies was very similar in all respects. As a result, samples were combined for purposes of analysis.

3.4.1 White Sucker

The results of the gillnet program provide the basis for assessing the present age structure of white sucker populations in Beaver Creek Reservoir, Ruth Lake, and Poplar Creek Reservoir. Conclusions based on the use of gill nets, however, should be formulated with caution due to the influence of gear selectivity. Figure 3.1, discussed previously, illustrates the size selectivity exhibited by the various mesh sizes employed. Figure 3.2 provides a seasonal breakdown of the gillnet catch with respect

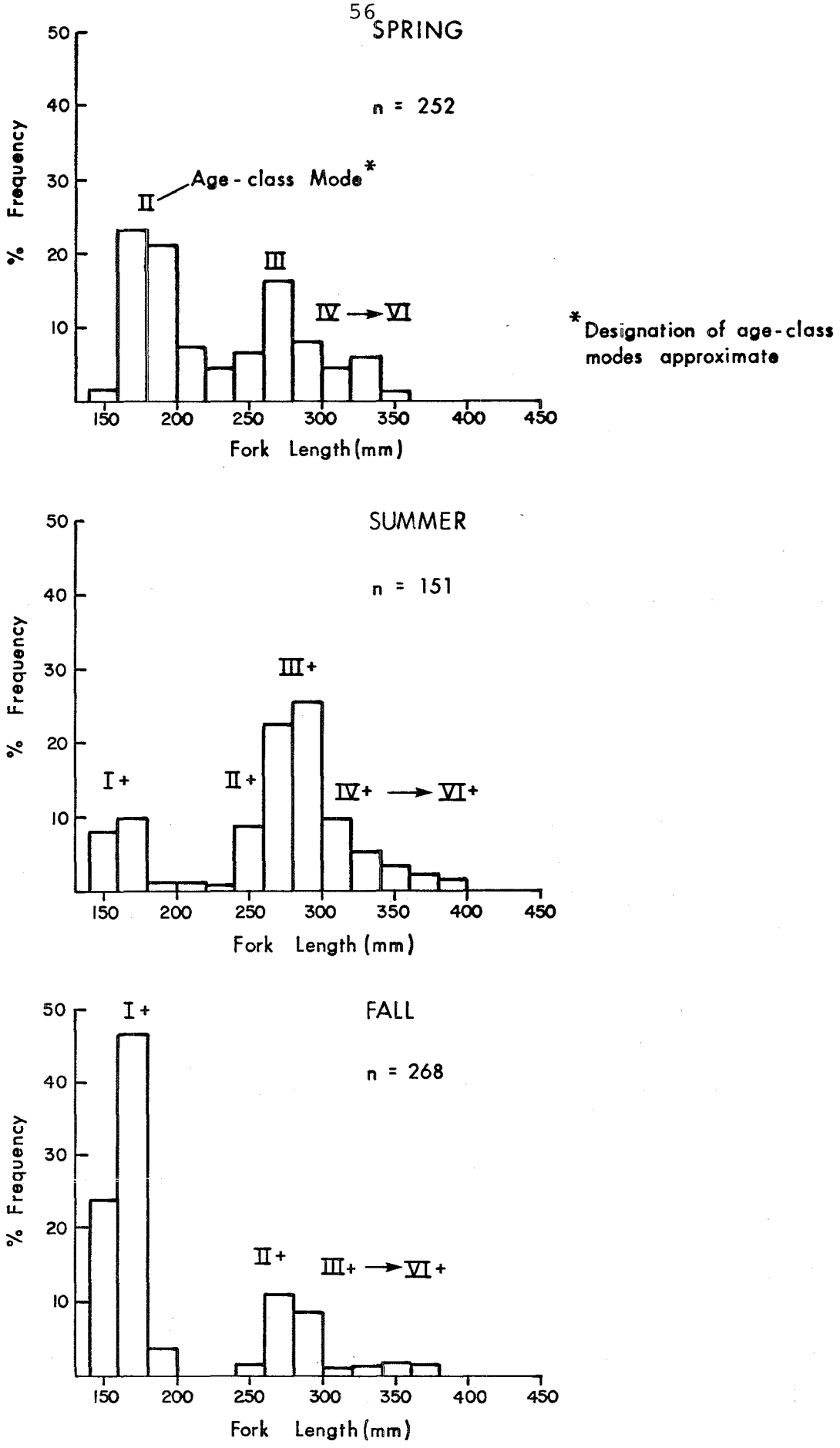

Figure 3.2. Seasonal variation in length-frequency and age-class distribution of white suckers captured in gill nets, Beaver Creek Reservoir and Ruth Lake (May-October, 1978).

to length-frequency and age distribution. The influence of gear selectivity notwithstanding, it is evident that the population is dominated by individuals from the 1975, 1976, and 1977 year-classes. The strength of the 1978 year-class is uncertain since these fish were not susceptible to the smallest mesh size utilized (i.e., 3.8-cm). Based on the 1978 seine haul results, population recruitment did not appear to be highly successful, although this would have to be verified by additional gillnetting in 1979.

White suckers captured in the three lentic waterbodies ranged from age 0+ (young-of-the-year) to age VI. Males apparently attain sexual maturity earlier than females. A portion of the males were mature at age II and all were mature at age III. Although a small number of females were mature at age II, the majority were not mature until age III or age IV.

Tables 3.15 and 3.16 summarize age-length and age-weight relationships for white suckers in the study area. The age-length relationship is illustrated in Figure 3.3. White suckers in the study area exhibit a good growth rate, and gonad maturation occurs early in life.

The length-weight relationship calculated for white sucker (n=473) in Beaver Creek Reservoir was $\log W = -5.024 + 3.072 \log L$ ($r^2 = 0.9178$). The equation for the Ruth Lake sample (n=205) was $\log W = -4.605 + 2.892 \log L$ ($r^2 = 0.9270$). Condition factors (k) for the two populations were $k = 1.4038$ with S.E. = 0.0086 (Beaver Creek Reservoir); and $k = 1.4484$ with S.E. = 0.0456 (Ruth Lake). No length-weight relationships or condition factors were calculated for Poplar Creek Reservoir due to small sample size.

TABLE 3.15

Age-Length Relationships for White Suckers, Beaver Creek Reservoir and Ruth Lake (Combined), May 1978

Age class	*n*	Mean Fork Length (*mm*)	Standard Error of Mean	Length Range	
				Max.	*Min.*
I*	14	59	1.87	71	49
II	72	185	1.85	227	156
III	43	267	3.61	309	214
IV	8	315	7.65	340	270
V	-	-	-	-	-
VI**	1	345	-	-	-
Total samples aged = 138					

*Ruth Lake sample only.
**Beaver Creek Reservoir sample only.

TABLE 3.16

Age-Weight Relationships for White Suckers, Beaver Creek Reservoir and Ruth Lake (Combined), May 1978

Age class	*n*	Mean weight (*g*)	Standard error of mean	Weight range	
				Max.	*Min.*
I	-	-	-	-	-
II	71	88	3.10	150	50
III	43	270	11.54	400	130
IV	8	448	42.66	660	220
V	-	-	-	-	-
VI*	1	490			
Total samples aged = 123					

*Beaver Creek Reservoir sample only.

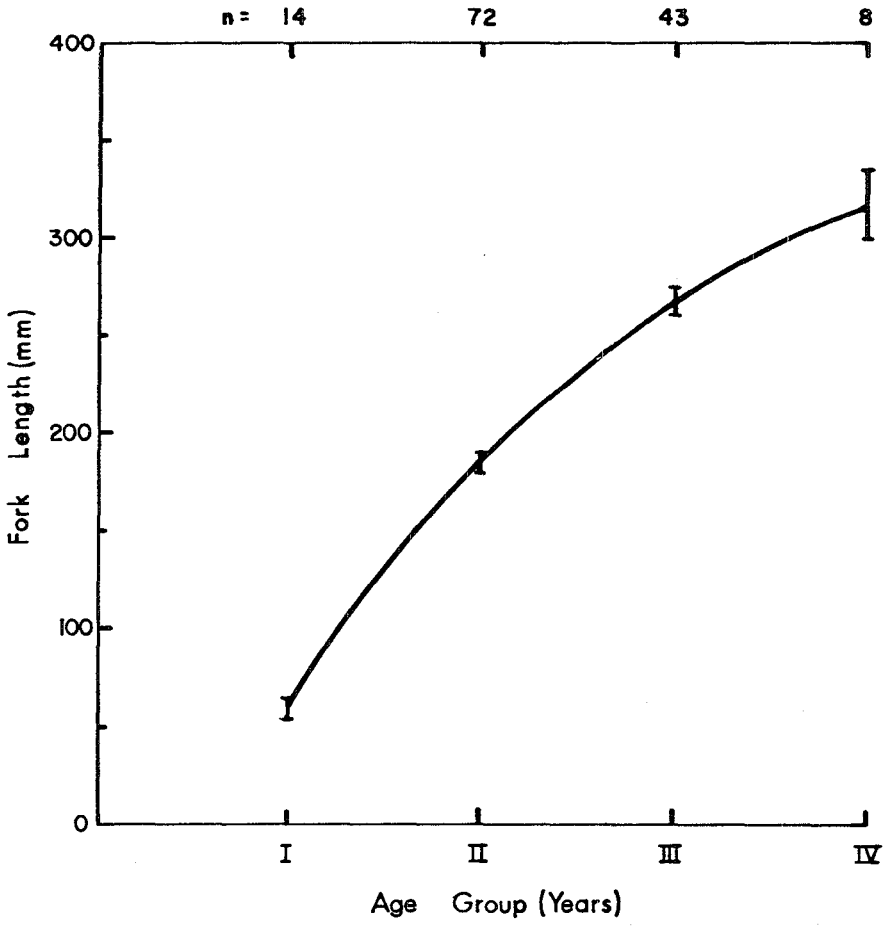

Figure 3.3. Growth rate of white suckers, Beaver Creek Reservoir and Ruth Lake (combined), 1978. (Mean Fork Length, 95% confidence limits for the mean).

3.5 WINTERKILL OF FISH IN THE STUDY AREA

An objective of the present study was to examine waterbodies in the study area shortly after break-up for evidence of fish winterkill. No indication of winterkill was noted during the spring survey (May 11-21). Due to the timing of the initial survey (i.e., well past break-up) the results are to be expected. To adequately determine the extent of winterkill would require field studies immediately prior to, and during, the break-up period, as well as shortly after. The decision was made to delay the onset of the initial survey in order to optimize the amount of data generated (i.e., ice-free reservoirs to avoid sampling problems and to allow maximum penetration of migrant spawners in Poplar Creek).

3.6 FISH TAGGING/RECAPTURE

A total of 271 fish were tagged with Floy anchor tags during the study; 248 were white suckers. The remaining marked fish were longnose suckers (19), Arctic grayling (2), and northern pike (2). Tagging locations are indicated in Table 3.17. An additional 39 white suckers and 8 longnose suckers from Beaver Creek Reservoir, and 2 Arctic grayling from Poplar Creek, were marked by fin clipping. No recaptures were made during the study. Dates and location of tagging for each specimen marked are provided with the computer analyzed life history data under separate cover.

TABLE 3.17

Tagging Location for Fish Marked With Anchor Tags, Beaver Creek Diversion System (1978)

Location	Species				Total
	WS	LNS	AG	NP	
Beaver Creek Reservoir	138	6	-	-	144
Ruth Lake	50	3	-	-	53
Poplar Creek Reservoir	10	-	-	-	10
Upper Beaver Creek	4	1	-	-	5
Poplar Creek	46	9	2	2	59
Total	248	19	2	2	271

4.0 LITERATURE CITED

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APPENDICES

APPENDIX A

Numbers of Fish Captured in, and Mesh Efficiency of, Gill Nets, Beaver Creek Diversion System (1978)

TABLE A1

Numbers of Fish Captured in, and Mesh Efficiency of, Gill Nets, Beaver Creek Reservoir (1978)

Station (Date)	Longnose sucker				White sucker				Lake chub			
	3.8 cm	6.4 cm	8.9 cm	Total	3.8 cm	6.4 cm	8.9 cm	Total	3.8 cm	6.4 cm	8.9 cm	Total
Spring												
*G1 (5/18)	3	2	0	5	86	43	0	129	-	-	-	-
*G2 (5/17)	2	0	0	2	28	11	0	39	-	-	-	-
All stations	5	2	0	7	114	54	0	168	-	-	-	-
Summer												
*G1 (7/29)	4	5	1	10	22	59	22	103	-	-	-	-
G3 (7/28)	4	0	0	4	5	52	7	64	-	-	-	-
G4 (7/28)	1	0	0	1	6	24	4	34	-	-	-	-
All stations	9	5	1	15	33	135	33	201	-	-	-	-
Fall												
*G1 (9/28)	-	-	-	-	132	37	8	177	5	0	0	5
G4 (9/30)	-	-	-	-	46	14	0	60	-	-	-	-
All stations	-	-	-	-	178	51	8	237	5	0	0	5
Total	14	7	1	22	325	240	41	606	5	0	0	5

*Overnight net sets; remainder set during day-time.

TABLE A2

Numbers of Fish Captured in, and Mesh Efficiency of, Gill Nets, Ruth Lake (1978)

Station (*Date*)	Longnose sucker				White sucker			
	3.8 cm	6.4 cm	8.9 cm	Total	3.8 cm	6.4 cm	8.9 cm	Total
Spring								
*G1 (*5/17*)	-	1	-	1	7	18	1	26
*G1 (*5/17*)	1	1	-	2	47	13	-	60
All stations	1	2	-	3	54	31	1	86
Summer								
*G2 (*8/2*)	-	-	-	-	18	17	6	41
Fall								
*G2 (*9/30*)	-	-	-	-	68	10	-	78
G3 (*9/30*)	-	-	-	-	18	1	-	19
All stations	-	-	-	-	86	11	0	97
Total	1	2	0	3	158	59	7	224

*Overnight net sets; remainder set during day-time.

TABLE A3

Numbers of Fish Captured in, and Mesh Efficiency of, Gill Nets, Poplar Creek Reservoir and Stilling Basin (1978)

Station (Date)	Longnose sucker				White sucker				Northern pike			
	3.8 cm	6.4 cm	8.9 cm	Total	3.8 cm	6.4 cm	8.9 cm	Total	3.8 cm	6.4 cm	8.9 cm	Total
Poplar Creek Reservoir												
Spring												
*G1 (5/20)	-	-	-	-	-	5	-	5	-	-	-	-
*G2 (5/21)	-	-	-	-	-	7	-	7	-	-	-	-
Summer												
*G1 (7/31)	-	-	-	-	42	1	-	43	-	-	-	-
G2 (7/31)	-	-	-	-	-	-	-	-	-	-	-	-
G3 (7/31)	-	-	-	-	-	-	-	-	-	-	-	-
Fall												
*G1 (10/2)	-	-	-	-	2	1	-	3	-	-	-	-
G4 (10/2)	-	-	-	-	1	-	-	1	-	-	-	-
Total	-	-	-	-	45	14	-	59	-	-	-	-
Poplar Creek Stilling Basin												
Spring												
*G1 (5/21)	13	N/A	N/A	13	82	N/A	N/A	82	1	N/A	N/A	1

*Overnight net sets; remainder set during day-time.
N/A - Mesh sizes not utilized.

APPENDIX B

Numbers of Fish Captured by Beach Seining, Beaver Creek Diversion System (1978)

TABLE B1

Numbers of Fish Captured by Beach Seining, Beaver Creek Reservoir (1978)

Station (Date)	FHM	BS	LKC	WS (y-o-y)	WS (juv)	WS (y-o-y, juv)	All species
Spring							
S1 (5/14)	24	9	18	-	17	-	68
S2 (5/14)	-	1	-	-	-	-	1
S3 (5/14)	5	8	-	-	2	-	15
S4 (5/14)	64	9	-	-	2	-	75
S5 (5/14)	10	37	-	-	3	-	50
S6 (5/14)	1	5	-	-	16	-	22
All stations (hauls = 18)	104	69	18	-	40	-	231
Summer							
S1 (7/29)	3 335	1 376	215	10	65	-	5 001
S2 (7/28)	12 955	3 157	-	-	-	1 658	17 770
S3 (7/28)	2 174	2 218	100	-	-	32	4 524
S4 (7/28)	4 854	2 313	80	-	30	-	7 277
All stations (hauls = 12)	23 318	9 064	395	10	95	1 690	34 572
Fall							
S1 (9/27)	5 967	322	43	-	2	-	6 334
S2 (9/28)	1 384	130	1	-	-	-	1 515
S3 (9/28)	303	152	-	-	-	-	455
S4 (9/28)	37	109	2	-	-	-	148
All stations (hauls = 12)	7 691	713	46	-	2	-	8 452
Total	31 113	9 846	459	10	137	1 690	43 255

TABLE B2

Numbers of Fish Captured by Beach Seining, Ruth Lake (1978)

Station (*Date*)	FHM	BS	LKC	WS (juv)	All Species
Spring					
S1 (*5/17*)	104	27	-	3	134
S2 (*5/18*)	144	19	2	16	181
S3 (*5/18*)	-	13	-	1	14
All stations (hauls = 9)	248	59	2	20	329
Summer					
S1 (*8/1*)	2 304	674	-	-	2 978
S2 (*8/1*)	16 170	1 290	1	2	17 463
All stations (hauls = 6)	18 474	1 964	1	2	20 441
Fall					
S2 (*9/29*)	3 110	22	-	-	3 132
S3 (*9/29*)	2 717	8	-	-	2 725
All stations (hauls = 6)	5 827	30	-	-	5 857
Total	24 549	2 053	3	22	26 627

TABLE B3

Numbers of Fish Captured by Beach Seining, Poplar Creek Reservoir (1978)

Station (*Date*)	FHM	BS	LKC	WS (y-o-y)	WS (juv)	All species
Spring						
S1 (*5/19*)	9	1	-	-	3	13
S2 (*5/20*)	1	-	-	-	-	1
S3 (*5/20*)	2	-	-	-	-	2
S4 (*5/19*)	28	1	-	-	1	30
All stations (hauls = 12)	40	2	-	-	4	46
Summer						
S1 (*7/31*)	1940	180	-	-	28	2148
S2 (*7/31*)	1753	351	-	12	17	2133
S3 (*7/31*)	553	397	1	10	7	968
S4 (*7/31*)	3787	72	-	-	-	3859
All stations (hauls = 12)	8033	1000	1	22	52	9108
Fall						
S1 (*10/3*)	124	-	-	-	-	124
S2 (*10/3*)	101	7	-	-	-	108
S3 (*10/3*)	242	-	-	-	-	242
All stations (hauls = 9)	467	7	-	-	-	474
Total	8540	1009	1	22	56	9628

TABLE B4

Numbers of Fish Captured by Beach Seining, Poplar Creek and Mildred Lake (1978)

Station (*Date*)	FHM	LKC	WS (y-o-y)	WS (juv)	NP (ad)	YP (juv)	TP	BS	All species	Haul area (m^2)
Poplar Creek										
Spring										
S1 (*5/12*) (hauls=4)	-	1	-	-	-	-	-	-	1	1255
Summer										
S1 (*8/2*)	576	88	1400	200	1	-	-	-	2265	150
S2 (*8/2*)	96	1104	1048	200	-	-	-	-	2448	175
S3 (*7/27*) (hauls=3)	25	23	350	150	1	2	2	-	553	200
Fall										
S1 (*10/2*) (hauls=1)	4	11	19	1	-	-	-	-	35	225
Mildred Lake										
Spring										
S1 (SE end) (*5/20*)	288	-	-	-	-	-	-	33	321	150
S2 (NW end) (*5/20*) (hauls=2)	3	-	-	-	-	-	-	25	28	200

TABLE C1

Fish Enumerated During Electrofishing Surveys, Upper Beaver Creek (1978)

Station (*Date*)	WS	LNS	FHM	LKC	BS	SHS
Spring						
EF1 (*5/17*)	*8(3)	1(1)	-	-	-	-
EF2 (*5/17*)	4(2)	-	-	-	-	-
EF3 (*5/17*)	-	-	-	-	-	-
Summer						
EF1 (*8/2*)	36(16)	-	25(10)	47(17)	13(4)	1(1)
Fall						
EF1 (*9/29*)	1(0)	-	-	1(1)	-	-
EF2 (*9/29*)	1(1)	-	2(2)	1(1)	2(2)	-
EF3 (*9/29*)	3(1)	-	-	-	-	-
Total	53(23)	1(1)	27(12)	49(19)	15(6)	1(1)

*Total number captured and observed; number of fish actually captured in parentheses.

APPENDIX C

Fish Enumerated During Electrofishing Surveys, Beaver Creek Diversion System (1978)

TABLE C2

Fish Enumerated During Electrofishing Surveys, Poplar Creek (1978)

Station (*Date*)	AG	NP	LING	WS	LNS	FHM	LKC	BS
Spring								
EF1 (*5/12*)	*1(1)	-	-	2(0)	-	-	-	-
EF2 (*5/20*)	-	-	-	38(19)	-	-	-	-
EF3(a) (*5/12*)	-	-	-	4(1)	-	-	-	-
EF3(b) (*5/12*)	-	1(1)	-	10(4)	-	-	-	-
EF3(c) (*5/12*)	-	-	-	-	-	-	-	-
EF3(d) (*5/12*)	-	1(1)	-	5(2)	1(1)	-	-	-
EF4 (*5/15*)	-	-	-	32(9)	1(1)	-	-	-
EF5(a,b) (*5/15*)	-	2(0)	-	31(6)	-	-	1(1)	-
EF5(c,d) (*5/15*)	-	-	-	1(0)	-	-	-	-
EF6 (*5/15*)	-	-	-	7(5)	1(1)	-	1(1)	-
EF7 (*5/15*)	-	-	-	-	-	-	-	-
All stations	1(1)	4(2)	0(0)	130(46)	3(3)	0(0)	2(2)	0(0)
Summer								
EF1 (*7/30*)	6(4)	-	-	82(38)	-	4(2)	9(3)	1(1)
EF2 (*7/29*)	4(3)	-	-	88(54)	-	13(8)	43(33)	4(2)
EF3(a) (*7/29*)	-	-	-	-	-	-	-	-
EF3(b) (*7/29*)	6(2)	-	1(1)	66(31)	4(1)	-	49(19)	-
EF3(c) (*7/29*)	-	-	-	1(1)	-	-	-	-
EF3(d) (*7/29*)	3(1)	-	1(1)	58(23)	4(1)	-	23(3)	-
EF5(a) (*7/30*)	1(1)	1(1)	-	41(21)	4(2)	-	21(6)	-
EF5(b) (*7/30*)	-	-	-	-	-	-	-	-
EF5(c) (*7/30*)	-	-	-	29(11)	2(1)	-	-	-
EF7 (*7/27*)	-	1(1)	-	12(2)	-	-	1(1)	-
All stations	20(11)	2(2)	2(2)	377(181)	14(5)	17(10)	146(65)	5(3)
Fall								
EF1 (*10/1*)	4(4)	-	-	38(26)	-	-	6(5)	-
EF2 (*10/1*)	1(1)	-	-	37(21)	-	-	130(80)	3(3)
EF3(a) (*10/2*)	-	1(1)	-	190(143)	-	131(101)	107(80)	60(45)
EF3(b) (*10/2*)	-	-	-	2(1)	-	-	-	-
EF3(c) (*10/2*)	-	-	-	11(8)	-	21(16)	28(21)	4(3)
EF3(d) (*10/2*)	-	-	-	1(1)	-	-	-	-
EF5(a,b) (*10/2*)	-	-	1(1)	3(3)	-	-	-	-
EF5(c) (*10/2*)	-	-	1(1)	2(0)	-	-	-	-
All stations	5(5)	1(1)	2(2)	284(203)	0(0)	152(117)	271(186)	67(51)
Total	26(17)	7(5)	4(4)	791(430)	17(8)	169(127)	419(253)	72(54)

*Total number captured and observed; number of fish actually captured in parentheses.

Conditions of Use

O'Neil, J.P., 1979. Fisheries survey of the Beaver Creek diversion system, 1978. Syncrude Canada Ltd., Edmonton, Alberta. Environmental Research Monograph 1979-3. 76 pp.