ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROGRAM

Fisheries and Habitat Investigations of Tributary Streams in the Southern Portion of the AOSERP Study Area.
Volume I: Summary and Conclusions

Project WS 1.6.2
June 1980

Sponsored jointly by

Alberta ENVIRONMENT

Environment Canada Environnement Canada

15th Floor, Oxbridge Place
9820 - 106 Street
Edmonton, Alberta, Canada
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ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROGRAM

RESEARCH REPORTS

These research reports describe the results of investigations funded under the Alberta Oil Sands Environmental Research Program, which was established by agreement between the Governments of Alberta and Canada in February 1975 (amended September 1977). This 10-year program is designed to direct and co-ordinate research projects concerned with the environmental effects of development of the Athabasca Oil Sands in Alberta.

A list of research reports published to date is included at the end of this report.

Enquiries pertaining to the Canada-Alberta Agreement or other reports in the series should be directed to:

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Fisheries and Habitat Investigations of Tributary Streams in the Southern Portion of the AOSERP Study Area
Volume I: Summary and Conclusions

Project WS 1.6.2

AOSERP Report 92

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The Hon. J. W. (Jack) Cookson
Minister of the Environment
222 Legislative Building
Edmonton, Alberta

and

The Hon. John Roberts
Minister of the Environment
Environment Canada
Ottawa, Ontario

Sir:

Enclosed is the report "Fisheries and Habitat Investigations of Tributary Streams in the Southern Portion of the AOSERP Study Area. Volume I: Summary and Conclusions".

This report was prepared for the Alberta Oil Sands Environmental Research Program, through its Water System, under the Canada-Alberta Agreement of February 1975 (amended September 1977).

Respectfully,

W. Solodzuk, P.Eng.
Chairman, Steering Committee, AOSERP
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FISHERIES AND HABITAT INVESTIGATIONS OF TRIBUTARY STREAMS IN THE SOUTHERN PORTION OF THE AOSERP STUDY AREA VOLUME I

DESCRIPTIVE SUMMARY

BACKGROUND

This study was conducted in the tributary streams bounded by the Athabasca and Clearwater rivers and the south and east boundaries of the AOSERP study area. It was conducted in conjunction with AOSERP Project WS 1.6.1 (Report 84, Investigations of the Spring Spawning Fish Populations in the Athabasca and Clearwater Rivers Upstream from Fort McMurray), which was intended to describe the habitat and biology of the major spring spawning fish populations of the Athabasca and Clearwater rivers. Other AOSERP fisheries studies also have documented spawning habitats in the Athabasca River downstream of Fort McMurray (Report 89), the MacKay River (Project WS 1.3.1), the Steepbank River (Report 61), and the Muskeg River (Report 76).

The information generated serves to establish the habitat characteristics and biology of the major spring spawning fish populations. These data will be necessary in assessing the impact of in situ oil sand processing activities on fish populations.

ASSESSMENT

This study is presented in two volumes: the first volume contains the summary of the results along with the discussion and conclusions; the second volume (Open File Report 16) contains the data on benthic macroinvertebrate and fish collections. Along with AOSERP Report 84, this report helps to complete the fisheries picture for the region south of Fort McMurray.

The report was reviewed by scientists in Alberta Environment and the Universities of Saskatchewan and British Columbia.

The Alberta Oil Sands Environmental Research Program accepts the two volume report, "Fisheries and Habitat Investigations of Tributary Streams in the Southern Portion of the AOSERP Study Area", as an important and valid document and thanks the researchers, P.J. McCart and P.T.P. Tsui, for their contributions. Volume I will receive wide distribution and Volume II will be placed in the AOSERP Open File System.

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FISHERIES AND HABITAT INVESTIGATIONS
OF TRIBUTARY STREAMS
IN THE SOUTHERN PORTION
OF THE AOSERP STUDY AREA
VOLUME I

by

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for

ALBERTA OIL SANDS ENVIRONMENTAL
RESEARCH PROGRAM

Project WS 1.6.2

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ABSTRACT

This report presents the results of studies conducted from May to October 1978 on tributary streams in the southern portion of the AOSERP study area. The major objectives of these investigations were:

1. To describe the baseline states of the major components of the aquatic ecosystems in the southern portion of the AOSERP study area;
2. To describe, in detail, aquatic habitats of the southern portion of the AOSERP study area; and
3. To provide a quantitative estimate of the biological significance of the watersheds to the Athabasca River system.

Three streams, the Christina, Gregoire, and Hangingstone, were selected for detailed study and were examined in early and late spring, late summer, and late autumn. Together, these three streams are representative of most of the major stream habitat types occurring within the project study area. Other waterbodies were sampled once only during late summer.

The results are presented and discussed in three sections:

1. Stream habitats. Stream habitats were broadly classified into five categories and their distribution in the southern portion of the AOSERP study area is discussed. Individual streams are described with regard to habitat categories and the physical characteristics measured at each station.
2. Benthos. Seasonal and longitudinal variations in species composition, abundance, distribution, community structure, standing crop, and invertebrate drift are discussed in detail for the Hangingstone and Christina rivers. Similar data, for late summer only, are presented for the other waterbodies sampled during the study.

3. Fish. The species composition, distribution, and relative abundance of fish collected in the southern portion of the AOSERP study area are described and compared with previous studies in the AOSERP study area. The life histories of six major species, including Arctic grayling, goldeye, northern pike, longnose sucker, white sucker, and walleye, are described. Discussion of the other fish species captured is restricted primarily to their distribution and relative abundance.

ACKNOWLEDGEMENTS

The field assistance of Rita Ford, Robert Strugnell, and Ronald Tanasichuk is gratefully acknowledged. Valuable assistance during the preparation of this report was provided by Cecilia Gossen, Joyce Harris, and Joanne Tripp.

The authors would also like to thank the personnel of the AOSERP Mildred Lake Facility for their support and assistance.

This research project WS 1.6.2 was funded by the Alberta Oil Sands Environmental Research Program, a joint Alberta-Canada research program established to fund, direct, and co-ordinate environmental research in the Alberta Oil Sands area of north-eastern Alberta.

1. INTRODUCTION

The Alberta Oil Sands Environmental Research Program (AOSERP) has, as part of its mandate, the responsibility of determining the baseline states of various aspects of aquatic ecosystems in the AOSERP study area (Figure 1) in order to assess the probable impact of oil sands development. This study, an investigation of fish populations, benthic invertebrate communities, and stream habitats in tributary streams in the southern portion of the AOSERP study area (Figure 1) was conducted from May to October 1978 in an area where little detailed information was previously available.

Griffiths (1973) conducted an extensive survey of the commercial and sports fishery throughout the oil sands area. Because of the large area surveyed, his treatment of many waterbodies, particularly the smaller ones, was, of necessity, rather cursory. While Griffiths did investigate some waterbodies within the present study area (e.g., the Christina, Horse, Algar, and Hangingstone rivers, Surmont Creek, and Gregoire Lake), his data are insufficient to support any definite conclusions regarding the biological significance of various streams and lakes within the area.

There have been several studies (Griffiths 1973; Jones et al. 1978; Tripp and McCart 1979) of those segments of the Clearwater and Athabasca rivers south of Fort McMurray. During the course of these studies, it was determined that large numbers of lake whitefish and longnose suckers migrate upstream and spawn in the Athabasca River in the vicinity of the Mountain and Cascade rapids located upstream of Fort McMurray. It also appeared that there were major spawning areas for northern pike and burbot in the Clearwater River upstream of its confluence with the Christina River. It is not clear, however, what the relationships of these and other fish populations inhabiting the Athabasca and Clearwater rivers were to those found in tributaries such as the Christina, Horse, Algar, and Hangingstone rivers draining the project study area.

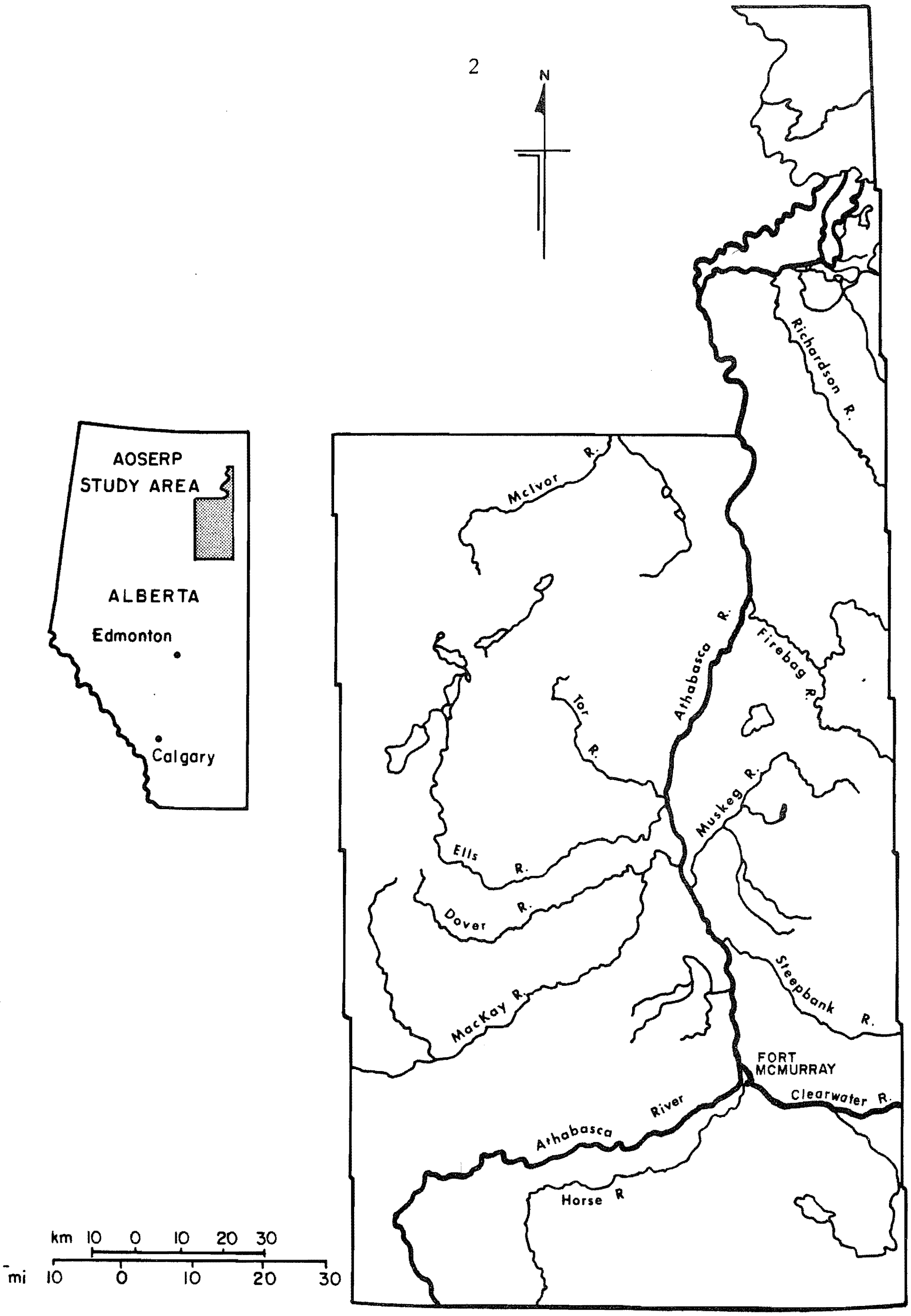


Figure 1. The AOSERP study area. The areas outlined in the southern portion of the AOSERP study area (a, b, and c) represent the approximate areas covered by succeeding maps.

The overall objective of this study was to assess aquatic habitats within the study area and, more specifically:

1. To describe the baseline states of the major components of the aquatic ecosystems in the southern portion of the AOSERP study area;
2. To describe, in detail, aquatic habitats of the southern portion of the AOSERP study area; and
3. To provide a quantitative estimate of the biological significance of the watersheds to Athabasca River system.

To meet these objectives, three streams in the southern portion of the AOSERP study area were selected for detailed study. These included:

1. The lower portion of the Christina River, lying within the AOSERP study area;
2. Its tributary the Gregoire River; and
3. The Hangingstone River.

Together, the three streams are representative of all of the major stream habitat types within the AOSERP study area south of Fort McMurray. Regular sampling stations were established on these streams which were sampled on four occasions during the study period (early and late spring, late summer, and late autumn) to provide information on seasonal changes in water quality and in the characteristics of benthic macroinvertebrate and fish populations.

In addition to the three representative streams, a variety of other waterbodies within the project study area were sampled during a single extensive survey in August. The August surveys provided information on the overall distribution of aquatic habitat types and on the variability in various water quality and biological parameters among waterbodies within the study area during a period of relatively high biological productivity.

This report consists of two volumes. Volume I is an explanatory text complete with summary tables and maps, while Volume II contains benthic macroinvertebrate and fish catch data.

2. THE STUDY AREA

The area under study during this investigation (Figure 2) covers approximately 4700 km^2 in the southern part of the AOSERP study area. It extends east from the Athabasca River to the Clearwater River and the eastern edge of the AOSERP study area, and south from Fort McMurray to the southern boundary of the AOSERP study area. With the major exception of the Stony Mountain uplands, located in the southern part of this area, most of the region is relatively flat with extensive tracts of sphagnum moss-black spruce muskeg. Aspen is the dominant vegetation with mixed stands of white spruce, balsam fir, and birch scattered throughout the area.

Within this area, there are 10 named streams, innumerable small tributaries, and many lakes. Because of the generally flat terrain, the majority of these streams have a low gradient for most of their length and, as a result, they frequently meander within their floodplains. Several of the smaller unnamed tributaries, particularly those draining muskeg areas, are basically a series of beaver dams and ponds.

All 10 of the named streams in the southern portion of the AOSERP study area were investigated during this study. They included the Algar River, Cameron Creek, Christina River, Gregoire River, Horse River, Hangingstone River, Prairie Creek, Saline Creek, Saprae Creek, and Surmont Creek. As already indicated, the Christina, Gregoire, and Hangingstone rivers were examined in considerably more detail than the other streams. Algar and Gregoire lakes, the two largest lakes in the area, were also sampled, though for fish and benthos only.

The locations of regular sampling sites, sampled routinely during the study, are shown in Figure 2. Four were located on the Christina River, three on the Gregoire River, and ten on the Hangingstone River. Permanent sites were also located at the mouth of the Horse River, near the mouth of Saline Creek, and on Surmont Creek. The locations of stations that were sampled on only one (or sometimes two) occasions are also shown. These

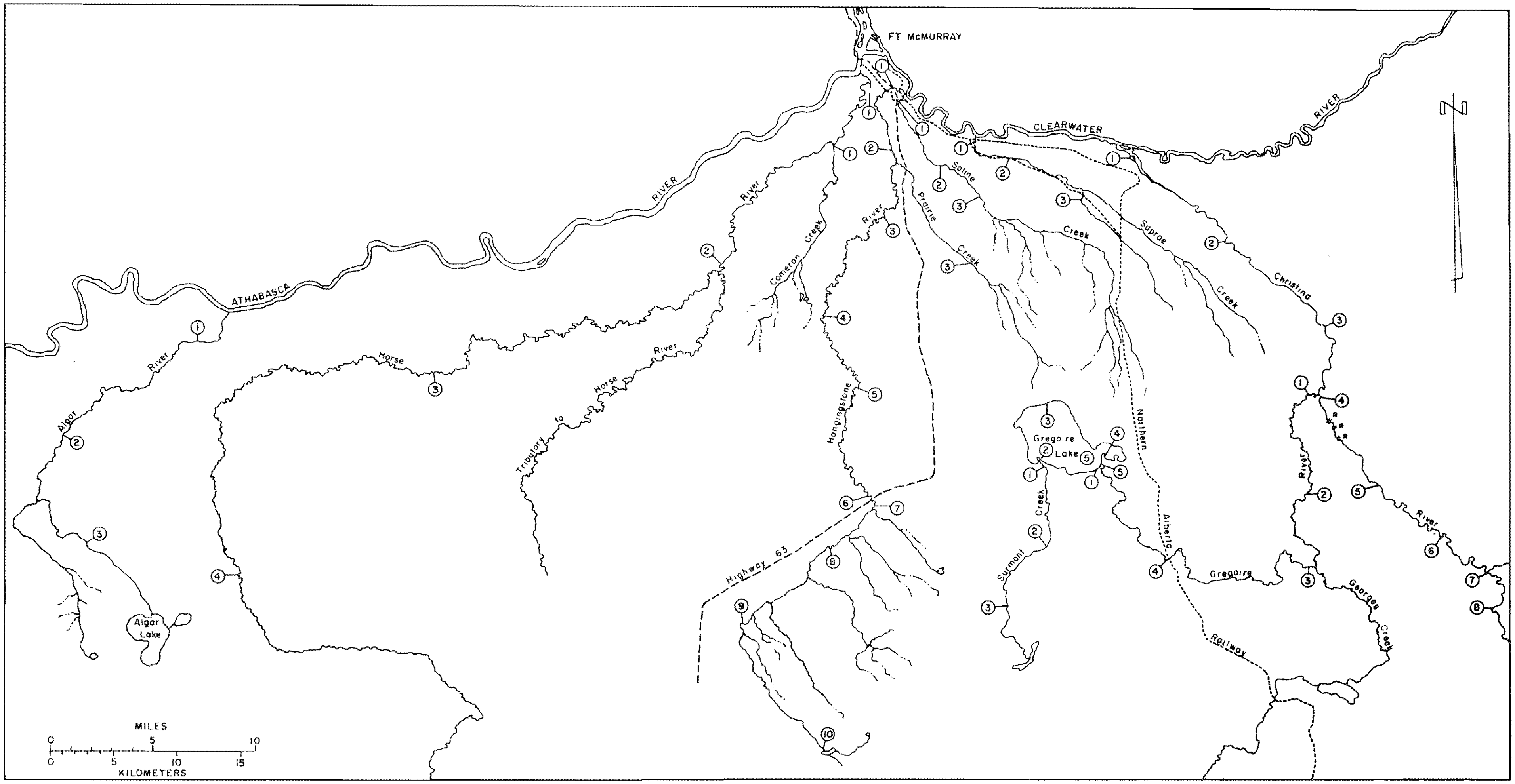


Figure 2. The project study area showing the location of sampling stations.

include those sites that were surveyed in an attempt to further delineate the spawning areas of spring spawners (Sites 5 to 8 on the Christina River, Site 7 on the Hangingstone); a site added at a late date as water levels declined (Site 2 on the Gregoire River); and sites that were part of the more generalized August survey of waterbodies in the project study area.

3. METHODS

Field studies were conducted during four periods in 1978: 3 to 19 May (spring), 12 to 21 June (late spring), 12 to 21 August (late summer), and 9 to 18 October (late autumn). The exact dates on which individual sites were sampled are summarized in Table 1.

3.1 STREAM HABITATS

Aquatic habitats of the permanent sampling stations on the Christina River, Gregoire River, Hangingstone River, Horse River, Saline Creek, and Surmont Creek were examined during both the late spring and fall surveys. Aquatic habitats at all other stations in the project study area were investigated in late summer only, during the August survey.

The parameters used in describing stream habitats at sampling sites were, with some additions, those recommended by Brown et al. (1978). They include the following:

1. Oxygen concentration was measured with a Hach dissolved oxygen kit;
2. Water temperature was measured with a pre-calibrated pocket thermometer;
3. Rooted width, the width of the channel from rooted vegetation to rooted vegetation, was measured to the nearest 0.5 m with a tape measure;
4. Stream width, width of the stream wetted at any particular time, was measured to the nearest 0.5 m with a tape measure;
5. Stream gradients were determined from Canada National Topographic System maps. A map scale of 1:50 000 was used for Cameron Creek, most of the Hangingstone River, the lower section of the Horse River, Saline Creek, Saproe Creek, and Surmont Creek. Since 1:50 000 scale topographical maps are not available for the other streams in the project study area, 1:250 000 scale maps were used instead. Distances

Table 1. Schedule of sampling times for sampling stations in the southern portion of the AOSERP study area. M = May, J = June, A = August, O = October.

Stations									
1	2	3	4	5	6	7	8	9	10
Algar River									
21A	21A	21A							
Cameron Creek									
23A									
Christina River									
5M	8M	8M	8M	14M	8M	10M	14M		
27M	10M	14M	10M		14M				
8J	14M	13J	14M						
13J	13M	15J	13J						
15J	15J	14A	15J						
21J	14A	13O	14A						
14A	13O		14O						
13O									
Gregoire River									
19M	17A	19M	19M	17A					
15J	14O	16J	16J						
17A		17A	17A						
14O		15O	15O						
Hangingstone River									
1M	9M	19J	9M	9M	3M	9M	14M	17A	20J
12J	19A	19A	20J	19J	4M	16J	16J	17O	14O
12A	18O	18O	19A	19A	9M	20J	19J		
8O			18O	18O	19J	17A	17A		
					19A		17O		
					11O				
Horse River									
15M	21A	21A	21A						

Continued ...

Table 1. Concluded.

Stations									
1	2	3	4	5	6	7	8	9	10
Horse River									
18M									
25M									
8J									
23J									
12A									
7O									
13O									
Prairie Creek									
17A									
Saline Creek									
3M	9O	12A							
12J									
12A									
9O									
Saprae Creek									
20A	20A	20A							
Surmont Creek									
21A	19M	21A							
	16J								
	17A								
	21A								
	14O								
Algar Lake									
23A									
Gregoire Lake									
16A	21A	16A	21A	23A					

along the Hangingstone River were compared using both map scales in order to calculate a correction factor, for the less accurate, large-scale maps;

6. Velocity was measured at mid-depth at five equally spaced points across the stream width using a Gurley Pygmy Current Meter;
7. Depth was measured at five equally spaced points across the stream width using either the staff attached to the current meter or a metre stick;
8. Turbidity samples were taken in a plastic bottle at the stream surface and values for shaken values (as JTU's) were determined in the laboratory using a Hach Model 2100A Turbidimeter;
9. Substrate composition was visually categorized according to Lagler (1956) as a modification of Roloef (1944). Particle sizes were defined as follows: bedrock, boulder (>300 mm), rubble (75.0 to 300 mm), gravel (2.5 to 75.0 mm), and sand/silt (<2.5 mm); and
10. Channel form, stream flow characteristics, and stream bank characteristics (form, height, process, cover) were described using the descriptive terminology set forth by the Resource Analysis Branch of the British Columbia Ministry of the Environment.

3.2 BENTHOS

With a few exceptions, the regular sampling stations on the Christina, Gregoire, Hangingstone, and Horse rivers and on Saline and Surmont creeks were sampled for benthos during each of the late spring, summer, and autumn surveys. The other stations were sampled only during August.

In streams, when water depths permitted, three replicate samples were taken at each station along a single transect across the stream (Cummins 1962). Either a standard Surber sampler (sampling area 930 cm^2, mesh size 600 µm) or an Ekman grab sampler (sampling area 225 cm^2) was used depending on substrate composition. Where water depths exceeded 25 cm, the depth of the apparatus, Surber samples were taken from shallow nearshore areas only.

On each visit, the principal habitats (riffles, pools, margins, macrophyte beds, submerged logs) at each site were also kick sampled (Hynes 1961) with a dipnet (mesh size 600 μm).

In Gregoire and Algar lakes, triplicate Ekman grab samples were taken in August along a half-transect of three (Algar Lake) to five (Gregoire Lake) stations so that the benthos from both the littoral and deeper areas of the lake were sampled.

A benthic invertebrate drift study was conducted near the mouth (Site 1) of the Hangingstone River on 12 and 13 August 1978. Three nets were placed in the stream for 1 h every 4 h for a total of seven 1 h sample periods during the 24 h diel period. The drift nets had an opening of 30 cm x 45 cm with a nylon net 90 cm long and a mesh size of 250 μm. They were anchored in the stream with steel stakes pounded into the substrate. Current velocity and water depth were measured at the opening of each net at the beginning of each 1 h sampling period so that the number of invertebrates collected could be related to the volume of water sampled.

All invertebrate samples were preserved in a solution of 10% formalin and Rose Bengal (100 mg Rose Bengal per litre of formalin) for future analysis. In the laboratory, the samples were washed through a 600 μm seive, transferred to 70% isopropanol, sorted, and then identified to the lowest practicable taxonomic level (genus and species for most, family for some).

The major taxonomic references used included Allen and Edmunds (1961a, 1961b, 1965), Jensen (1966), Jewett (1959), Needham et al. (1935), Pennak (1953), Ricker (1943, 1964), Usinger (1963), and Ward and Whipple (1959). The Chironomidae were identified according to a provisional key by Hamilton and Saether (unpublished).

Shannon-Weaver species diversity indices (Shannon and Weaver 1949) were computed for all benthic samples by the machine formula of Lloyd et al. (1968). This formula is:

$$\bar{d} = \frac{C}{N} (N \, \text{Log}_{10} \, N - \Sigma n_i \, \text{Log}_{10} \, n_i)$$

where: $C = 3.32193$

N = total number of individuals

n_i = total number of individuals in the i^{th} species (form)

Species diversity is dependent on the number of species (richness) and the distribution of individuals among the species (evenness). Shannon and Weaver's theoretical measure of mean species diversity per individual ($\bar{d}$) is sensitive to, and increases with, both species richness and evenness. The value of $\bar{d}$ is proportional to the uncertainty of identification of an individual selected at random from a multi-species population. In general, $\bar{d}$ values range from zero to any positive number, but are seldom greater than 10. The $\bar{d}$ value is at a minimum when all individuals belong to the same species, whereas $\bar{d}$ is at a maximum value when each species contains the same number of individuals. Most benthic freshwater communities in streams which are not severely polluted have diversities ranging from 2 to 4 (Wilhm 1970). In this study, each $\bar{d}$ value obtained was compared with a hypothetical maximum based on MacArthur's broken stick model (MacArthur 1957) of natural populations (population with a few relatively abundant species and increasing numbers of species with only a few individuals). Such a comparison results in an index termed "equitability" or "e" by Lloyd and Ghelardi (1964). Equitability values were computed by using Table 5 in Weber (1973) in conjunction with the following formula:

$$e = \frac{S'}{S}$$

where: S = number of species (forms) in the sample

S' = the tabulated number of species from MacArthur's model of equal diversity.

Values of "e" normally range from 0 to 1, provided the stream communities are adequately censused. When they are, Environmental Protection Agency biologists in the U.S. have found the equitability index to be very sensitive to even slight levels of environmental degradation. In natural streams, "e" values range between 0.6 and 0.8, while in stressed streams values are usually below 0.5. Values higher than 1.0 result when the distribution of individuals among the species is more even than predicted by MacArthur's broken stick model (MacArthur 1957).

3.3 FISH

At each visit to both regular and survey stations, fish were sampled with either gillnets or seines, depending on conditions. The gillnets used were variable mesh, standard gangs consisting of six individual panels 3.0 m long and 2.4 m deep of the following mesh sizes: 3.8, 5.1, 6.3, 7.6, 8.9, and 10.2 cm stretch mesh. Gillnets were set for periods ranging from 1 to 25 h, depending on stream conditions. During the spring survey, it was not possible to set nets for long periods because of the large amounts of drifting debris. Careful records were kept of the duration of sets and the numbers of each species caught.

Inshore habitats were sampled with a pole-mounted, fine mesh (3.2 mm) minnow seine, 1.2 m deep and 3.0 m in length. Again, careful records were kept of the number of hauls, the length of shoreline seined, and the catch of each species.

Captured fish were either retained for later analysis or released alive. Fish released alive, that were mature and close to spawning, were categorized as:

1. Mature-green: fish that would spawn in the forthcoming spawning season, generally characterized by large body size, large gonads, and secondary evidence of maturity such as nuptial tubercles and body colouration;
2. Mature-ripe: fish from which sex products would be extruded by gentle pressure on the abdomen; and

3. Spawned-out: fish which had recently completed spawning as indicated by a flaccid abdomen and the absence or diminished volume of sex products expressed by gentle pressure on the abdomen.

In the laboratory, fish retained for detailed analysis were measured to the nearest millimetre and weighed, on a triple beam balance, to the nearest gram. Gonads were removed and weighed to the nearest 0.1 g. Sex and maturity were also recorded. Mature fish were further classified as either green, ripe, or spawned-out in a manner similar to that described above. Additional criteria included egg size, gonad weight, looseness of eggs, colouration, and extensive haemorrhaging of the gonads.

Eggs were measured to the nearest 0.1 mm by calculating the mean diameter of 10 unpreserved eggs of the largest size class aligned on a millimetre scale. For fecundity determinations, a weighed subsample including both eggs and ovarian tissue, amounting to about 10% of the total gonad weight was preserved in 10% formalin for later enumeration. Eggs in the subsample were counted under magnification and the total fecundity calculated by direct proportion.

For age determination, either otoliths or scales, depending on the fish species, were removed from fish specimens during dissection. Otoliths were read with the aid of a binocular microscope using Nordeng's (1961) criteria for the identification of annuli. Scales were read with the aid of a projecting microscope using Lagler's (1956) criteria for the identification of annuli.

Fish stomach contents were examined in the laboratory and identified to major taxa (order or family) or other suitable category (e.g., insect parts, digested material, fish remains). Data on presence or absence were used to calculate frequency of occurrence for various food items.

4. RESULTS AND DISCUSSION

4.1 STREAM HABITAT CLASSIFICATION

Stream habitats in the southern portion of the AOSERP study area can be broadly classified into five categories, largely on the basis of stream gradient, substrate, and flow regime.

Category I includes small, low gradient stream reaches located in poorly drained muskeg areas where stream flow is generally very slow. Beaver dams are a common feature resulting in a series of ponds flooding the surrounding area. The substrate is composed of sand or mud-silt with large amounts of organic debris. Aquatic vegetation is usually present. The banks are low, stable and generally undercut. The surrounding bank vegetation is typically composed of scattered willows with grasses and sedges although black spruce may also be dominant. Fish populations in these streams are usually depauperate and composed of only one or two species, typically pearl dace, lake chub, or brook stickleback.

Category II also includes small streams. The stream gradient is, however, much higher than that of the muskeg streams in Category I, resulting in faster stream flows over boulder, rubble, and gravel substrates. The banks are of low to moderate height and generally stable, although undercutting and bank erosion can occur during periods of high water. The banks are usually well vegetated with grasses, shrubs, overhanging willows, or alder while the crown cover is normally dominated by aspen and white spruce. Unless the stream is blocked by some obstruction or an intervening stretch of muskeg, these streams typically serve as spawning and rearing areas for Arctic grayling. Slimy sculpin is normally a codominant species with grayling in these streams although longnose sucker and lake chub may also occur.

Category III includes reaches of the larger streams in the study area characterized by low gradient, slow stream flows, and a predominantly sandy substrate. The height of the banks ranges from moderate to high. These are frequently eroded, particularly on the outside curves of meanders. Meandering is extensive and channel scars, side channels, cut-offs and ox-bow lakes are common.

Category IV includes those reaches of the larger streams in the study area having a moderate gradient and a substrate composed primarily of boulders, rubble, and gravel. Pools and races predominate although riffles or rapids are also conspicuous features. The banks are generally stable and well vegetated with grasses, shrubs, overhanging willows, and alder. The crown cover is dominated by white spruce, aspen, and birch.

Category V includes those sections of the larger streams in the study area that have a steep gradient and high flow rates. Riffles or rapids predominate and the substrate is largely composed of boulders and coarse rubble. The channel is typically confined between high, steep valley walls which are often exposed and occasionally slumping. Alder, aspen, and white spruce form most of the surrounding vegetation.

Figure 3 shows the distribution of the various habitat types in the project study area. Streams falling in Category I, muskeg streams, include most of the Algar River, the upper Horse River, a short section of the upper Hangingstone River and its associated tributaries, most of Cameron and Prairie creeks, and the upstream half of Saline and Saprae creeks. The upper reaches of the Gregoire River draining out of Gregoire Lake is also classified as Category I mainly because of the surrounding vegetation composed of grasses, sedges, and open willows on low, undercut banks, as well as its low gradient and meandering nature and its mixed sand and organic substrate. However, unlike other muskeg streams which normally have a depauperate fish population, the Gregoire River drains a large and relatively productive lake which supports a number of self-sustaining fish populations. Besides serving as an important spawning and rearing area for northern pike and suckers, the uppermost reach of the Gregoire River is an important fish migration route between the lake and spawning and feeding areas located elsewhere in the drainage.

Stream segments in Category II include a short section of stream located near the mouth of the Algar River, most of the upper

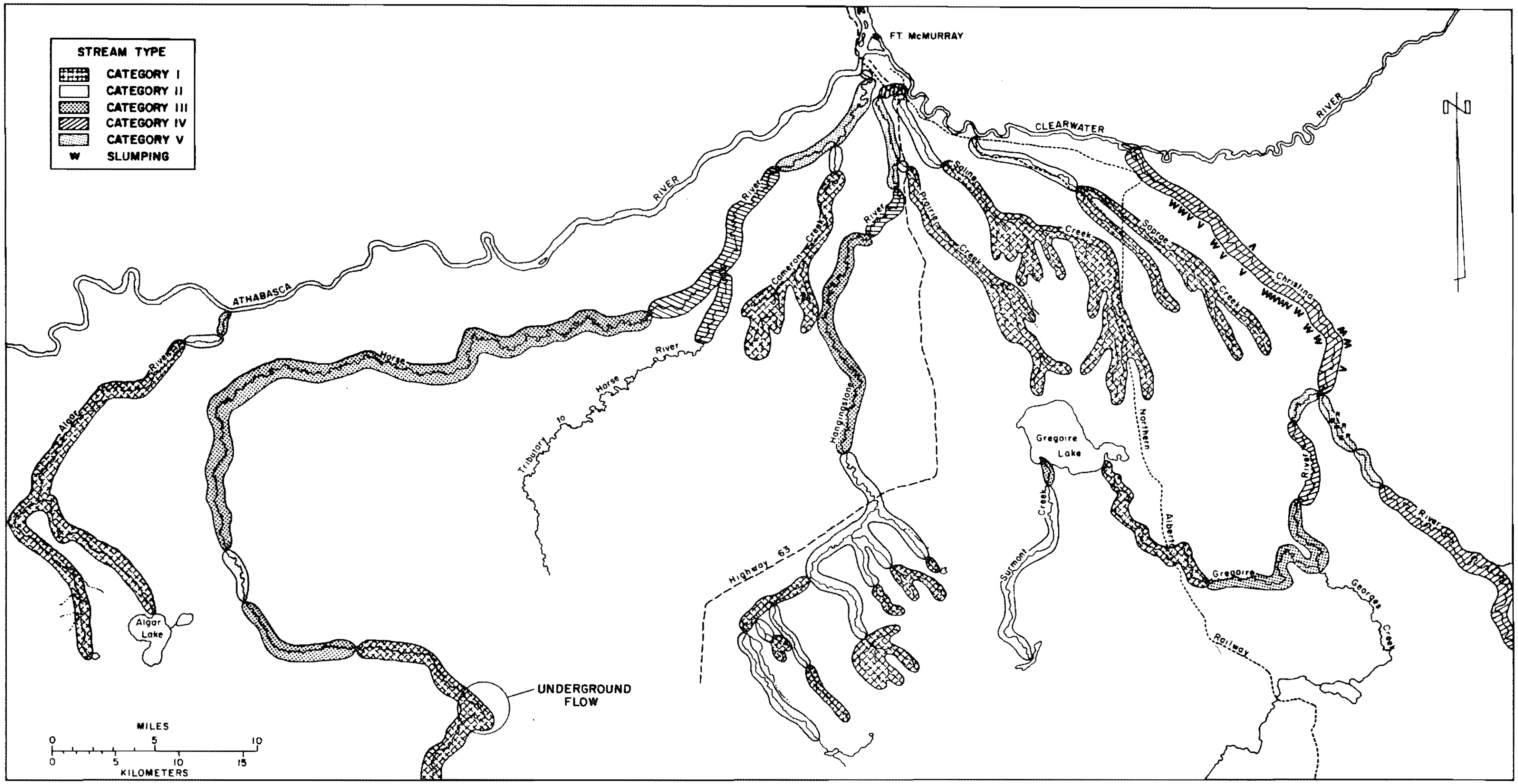


Figure 3. The distribution of stream habitat categories I to V in the project study area.

Hangingstone River, almost all of Surmont Creek, and the lower reaches of Cameron, Prairie, Saline, and Saprae creeks.

There are extensive stretches of Category III habitat including the middle reaches of the Gregoire, Hangingstone, and Horse rivers.

Stream habitats in Category IV are located in the lower reaches of the Gregoire, Hangingstone, and Horse rivers and along most of the Christina River.

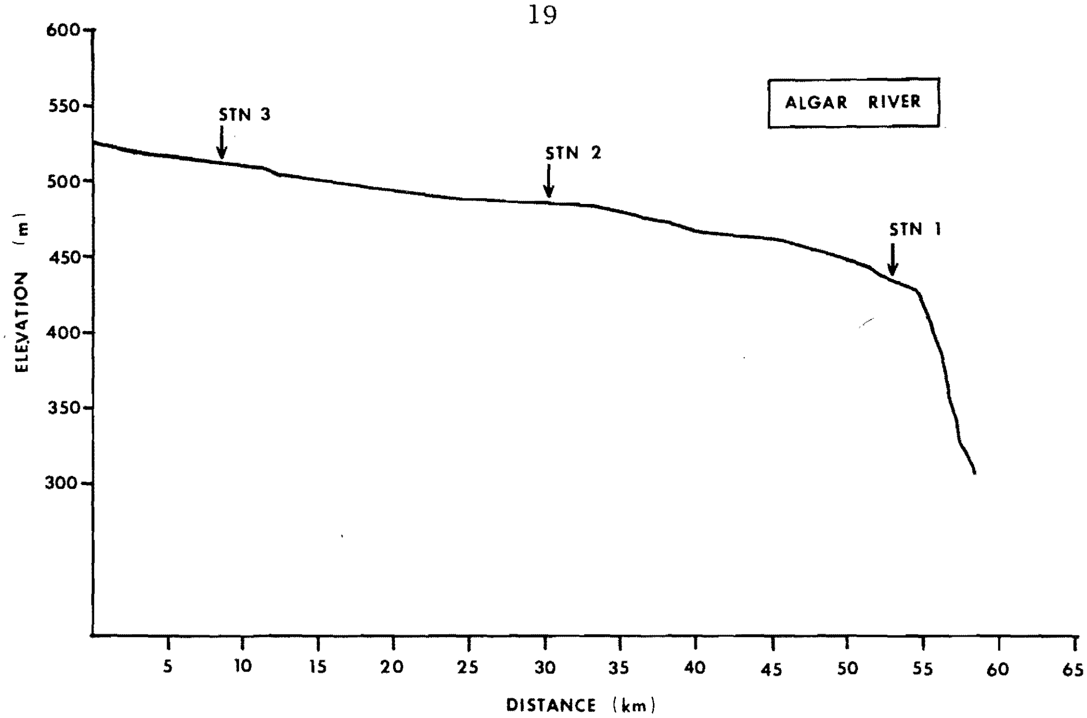
Category V includes several relatively short sections of stream located near the mouths of the Algar, Gregoire, Hangingstone, and Horse rivers as well as a short section of rapids located on the Christina River just upstream of its confluence with the Gregoire River.

4.2 DESCRIPTIONS OF INDIVIDUAL STREAMS

In what follows, the aquatic habitat characteristics of each waterbody investigated during the present study are described, largely on the basis of the various parameters measured at each sampling site. Whenever possible, these included a determination of stream gradient, width, depth, current, substrate composition, turbidity, water temperature, and dissolved oxygen concentration along with descriptions of channel flow and bank characteristics. Only a brief summary of information on fish populations and benthic macroinvertebrate communities is presented here since these are described in considerably more detail in later sections of this report.

4.2.1 Algar River

The Algar River (Figure 3) flows a total distance of 58 km from Algar Lake to a point on the Athabasca River approximately 64 km upstream of Fort McMurray. The average gradient is 0.4% (Figure 4), ranging from 0.3% over most of its length as it slowly meanders across a poorly drained muskeg area to a steep 0.5% near the mouth where it drops down suddenly to the Athabasca River. It is a small stream with a rooted width ranging from 4 m at Station 3



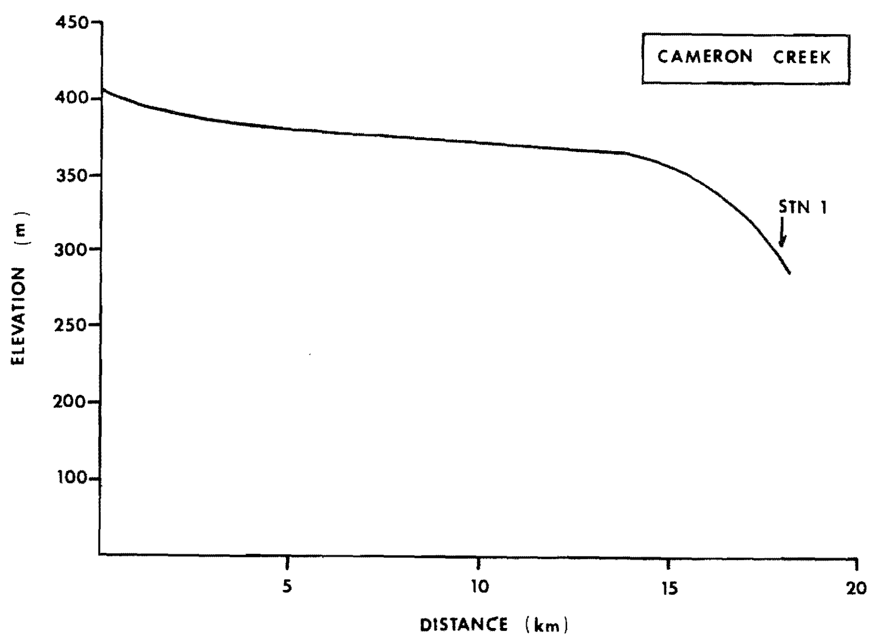


Figure 4. Altitudinal profiles of the Algar River and Cameron Creek showing locations of sampling stations.

to 10 m at Station 1 (Table 2). In August, the discharge at Station 1 was estimated at 0.2 m^3/sec. Water temperatures were 10 to 11°C while dissolved oxygen concentrations ranged from 6.8 mg/L at Station 2 to 10.6 mg/L at Station 3. Turbidity ranged from 2.1 JTU's in the slow flowing upper reaches to 28.0 JTU's in the lower reaches where the high steep banks are being constantly eroded. The substrate is composed of organic debris and silt in the upper reaches while boulders and coarse rubble predominate in the lower reaches.

Small immature pearl dace and brook stickleback were the only fish species captured in the upper (muskeg) portion of the Algar River. Both young-of-the-year and small juvenile suckers were, however, abundant closer to the mouth where they occurred with smaller numbers of pearl dace, lake chub, and longnose dace.

The macrobenthic fauna at Station 1 on the Algar River was dominated by larvae of Tricoptera (*Arctopsyche* sp. and *Hydropsyche* sp.) and nymphs of Ephemeroptera (*Heptagenia* sp.). The muskeg areas upstream were dominated by Oligochaeta, pill clams (*Pisidium* sp.), and the larvae of Chironomidae (*Thienemannimyia* sp.) and Tricoptera (*Ptilostomis* sp.).

4.2.2 Cameron Creek

Cameron Creek, a small tributary of the Horse River, flows for a total distance of 18 km, most of it through muskeg and a complex series of beaver dams, before suddenly descending to the Horse River (Figure 3). The average stream gradient is 0.7%, ranging from 0.3% in the slow-flowing and meandering upper reaches to 1.8% near the mouth (Figure 4). In August, at the mouth (Station 1), the stream was 2.0 m wide and averaged 0.11 m in depth with an estimated discharge of 0.03 m^3/sec (Table 3). The substrate is composed of boulders and coarse rubble while the banks are high, steep, and stable. Dense, overhanging alder and white spruce comprise most of the surrounding vegetation.

A few small, immature slimy sculpins were the only fish taken near the mouth of Cameron Creek. It is likely, however, that pearl dace and/or brook stickleback are also present in the upper reaches.

Table 2. Stream habitat characteristics of the Algar River, 21 August 1978.

Station	1	2	3
Distance upstream from mouth (km)	5.0	28.0	50.0
Channel Characteristics			
Pattern	irregular	irregular meander	irregular
Flow	tumbling, broken	placid	placid
Confinement	confined	unconfined	unconfined
Percent Gradient	0.36	0.05	0.11
Rooted Width (m)	10.0	5.5	4.0
Wetted Width (m)	4.0	5.5	4.0
Average Depth (m)	0.11	1.3	0.4
Average Current (m/sec)	0.26	NMF[a]	NMF
Approximate Discharge (m^3/sec)	0.20	ND[b]	ND
Pool: Riffle Ratio	1:1	1:0	1:0
Stream Bank Characteristics			
Form	steep	undercut	undercut
Height	high	low	low
Process	failing	stable	stable
Cover	50%; alder pine, spruce	100%; grass, willow	100%; sedges, grass
Substrate Composition (%)			
Boulder	75	0	0
Rubble	20	0	0
Gravel	5	0	0
Sand-silt	0	0	0
Organic	0	100	100
Temperature (°C)	10.0	10.0	11.0
Dissolved Oxygen (mg/L)	8.6	6.8	10.6
Turbidity (JTU's)	28.0	2.5	2.1
Dominant Benthos	Trichoptera Ephemeroptera Plecoptera	Oligochaeta Mollusca	Mollusca Chironomidae
Dominant Fish Species			
Gillnets	ND	ND	ND
Minnow Seine	pearl dace longnose sucker	pearl dace	pearl dace
Aquatic Macrophytes	none	35% coverage; *Potomageton* sp. *Sparganium* sp. *Caltha* sp. *Ranunculus* sp. *Sium* sp.	65% coverage; *Ranunculus* sp. *Sparganium* sp.

Table 3. Stream habitat characteristics of Cameron Creek, August 1978.

Station	1
Distance upstream from mouth (km)	0.5
<u>Channel Characteristics</u>	
Pattern	straight
Flow	broken, tumbling
Confinement	confined
Percent Gradient	4.62
Rooted Width (m)	3.0
Wetted Width (m)	2.0
Average Depth (m)	0.11
Average Current (m/sec)	0.09
Approximate Discharge (m^3/sec)	0.03
Pool: Riffle Ratio	1:10
<u>Stream Bank Characteristics</u>	
Form	steep
Height	high
Process	stable
Cover	100%; alder, spruce
<u>Substrate Composition</u> (%)	
Boulder	75
Rubble	15
Gravel	5
Sand-silt	5
Organic	0
Temperature (°C)	12
Dissolved Oxygen (mg/L)	8.6
Turbidity (JTU's)	7.1
<u>Dominant Benthos</u>	Trichoptera
<u>Dominant Fish Species</u>	
Gillnets	ND
Minnow Seine	slimy sculpin
<u>Aquatic Macrophytes</u>	None

The macrobenthos was dominated by larvae of the trichopterans *Glossosoma* sp. and *Brachycentrus* sp.

4.2.3 Christina River

The Christina River, a major tributary of the Clearwater River and the largest stream investigated during this study, flows a total distance of 326 km (Griffiths 1973). Only the lower 27 km, however, from the mouth of the Christina River to its confluence with the Gregoire River, lie within the AOSERP study area.

Within this region, the Christina River is a fairly homogeneous stream flowing through a steep valley approximately 1.5 km wide and 125 m deep. The stream has a moderate gradient (0.37%), moderate flow rates, and a substrate composed largely of boulders, rubble, and gravel (Figure 3). As indicated in Table 4, however, there is a general trend from the mouth to the upper reaches toward a higher degree of channel confinement between high, steep valley walls, a higher gradient, more frequent rapids, and a greater proportion of boulders and rubble in the substrate. Although current velocities were not measured, stream flow rates in the upper reaches also appeared to be, on the average, faster than those downstream.

Stream widths range from 25 m upstream to 60 m downstream. Along straight segments of the river, the banks are generally of low to moderate height, stable, and well-vegetated with alder, aspen, birch, and some spruce. Exceptions are the banks at meander curves which are often high, exposed, and subject to erosion on the outside curve. In contrast, the banks along inside curves are usually low, wide gravel bars. There is extensive slumping higher up away from the immediate stream banks, particularly on the west side of the valley (Figure 3).

Water temperatures ranged from 5°C (October at Station 2) to 17.5°C (June at Station 4), dissolved oxygen from 9.8 mg/L (June at Station 4) to 11.2 mg/L (October at Station 4), and turbidity from 8.0 JTU's (October at Station 2) to 13.0 JTU's (June at Station 3) (Table 4).

Table 4. Stream habitat characteristics of the Christina River. Letters in brackets refer to the sampling period as follows: J = June, A = August, O = October.

Station	1	2
Distance upstream from mouth (km)	1.0	11.0
Channel Characteristics		
Pattern	sinuous	sinuous
Flow	placid, swirling	swirling, placid
Confinement	occassionally confined	occassionally confined
Percent Gradient	0.20	0.20
Rooted Width (m)	∿65	∿60
Welted Width (m)	∿60	∿50
Average Depth (m)	ND	ND
Average Current (m/sec)	ND	ND
Approximate Dishcarge (m^3/sec)	ND	ND
Pool: Riffle Ratio	5:1	4:1
Stream Bank Characteristics		
Form	steep(right), reposed(left)	flat(right), reposed(left)
Height	moderate	moderate
Process	failing	stable
Cover	90%; grass, willow, aspen, spruce	75%; grass, aspen, spruce
Substrate Composition (%)		
Boulder	5	50
Rubble	70	30
Gravel	20	10
Sand-silt	5	10
Organic	0	0
Temperature (°C)	16.0(J), 5.0(0)	17.0(J), 5.0(0)
Dissolved Oxygen (mg/L)	10.6(J), 10.8(0)	10.4(J), 10.8(0)
Turbidity (JTU's)	8.5(J), 10.0(0)	12.0(J), 8.0(0)
Dominant Benthos	Ephemeroptera Chironomidae	Ephemeroptera Chironomidae
Dominant Fish Species		
Gillnets	northern pike longnose sucker goldeye	northern pike goldeye longnose sucker
Minnow Seine	longnose sucker longnose dace lake chub	lake chub longnose sucker longnose dace
Aquatic Macrophytes	none	none

Continued...

Table 4. Concluded.

Station	3	4
Distance upstream from mouth (km)	21.0	27.0
Channel Characteristics		
Pattern	meander	sinuous
Flow	rolling, swirling	broken, swirling
Confinement	frequently confined	confined
Percent Gradient	0.29	0.48
Rooted Width (m)	∿60	∿35
Welted Width (m)	∿50	∿25
Average Depth (m)	ND	ND
Average Current (m/sec)	ND	ND
Approximate Discharge (m^3/sec)	ND	ND
Pool: Riffle Ratio	3:1	1:3
Stream Bank Characteristics		
Form	flat(right), steep(left)	steep(right), flat(left)
Height	moderate	moderate
Process	stable	stable
Cover	50%; aspen, spruce	50%; grass, willows
Substrate Composition (%)		
Boulder	15	70
Rubble	50	15
Gravel	20	5
Sand-silt	15	10
Organic	0	0
Temperature (°C)	17.0(J), 5.0(O)	17.5(J), 5.5(O)
Dissolved Oxygen (mg/L)	10.6(J), 10.8(O)	9.8(J), 11.2(O)
Turbidity (JTU's)	13.0(J), 10.0(O)	10.0(J), 9.3(O)
Dominant Benthos	Ephemeroptera Trichoptera Chironomidae	Ephemeroptera Trichoptera
Dominant Fish Species		
Gillnets	northern pike longnose sucker white sucker	white sucker longnose sucker northern pike
Minnow Seine	longnose sucker lake chub longnose dace	longnose sucker lake chub
Aquatic Macrophytes	none	none

The seasonal pattern of discharge for the Christina River in 1978 is shown in Figure 5. Because there is no gauging station on the Christina River itself, these data were obtained by subtracting the daily discharge rate for the Clearwater River just upstream of the Christina River from those recorded on the Clearwater River at Draper. Between these two stations, there are no significant contributions to stream flow in the Clearwater River other than flow from the Christina River.

Stream discharge in 1978 went from a low of 4.0 m^3/sec in January to a sudden peak of 124.9 m^3/sec at spring breakup on 24 April. Thereafter, stream flows subsided to a summer low of 14.7 m^3/sec on 12 August but later increased to a maximum of 132.2 m^3/sec on 25 September during a fall flood. Stream flows dropped through freeze-up (around 5 November) to a low of 2.3 m^3/sec on 3 December.

Northern pike were by far the most abundant fish taken in gillnet catches from the Christina River. During their spring spawning period, catches per unit gillnet effort (hours) for northern pike in the Christina River averaged considerably higher than any catches reported elsewhere in the AOSERP study area. Other common species were goldeye, longnose sucker, and white sucker. Lake chub young-of-the-year and juveniles, longnose suckers, and longnose dace dominated the catch in small mesh seines.

Nymphs of the Ephemeroptera [*Ephemerella* (*E.*) *inermis*, *Rithrogena* sp., *Baetis* sp., *Tricorythodes* sp., *Heptagenia* sp.] and the larvae of the Chironomidae (primarily *Rheotanytarsus* sp. but also *Atherix* sp., *Chironomus* sp., *Cricotopus* sp., and *Tanytarsus* sp.) and the Trichoptera (*Oecetis* sp., *Cheumatapsyche* sp., and *Hydropsyche* sp.) dominated the macrobenthos at one time or another in the Christina River. In June, the Ephemeroptera were the major group sampled at Stations 1 and 4 while the larvae of the Chironomidae predominated at Station 2 and the Trichoptera predominated at Station 3. In August, the Chironomidae, and in October, the Ephemeroptera predominated at all stations.

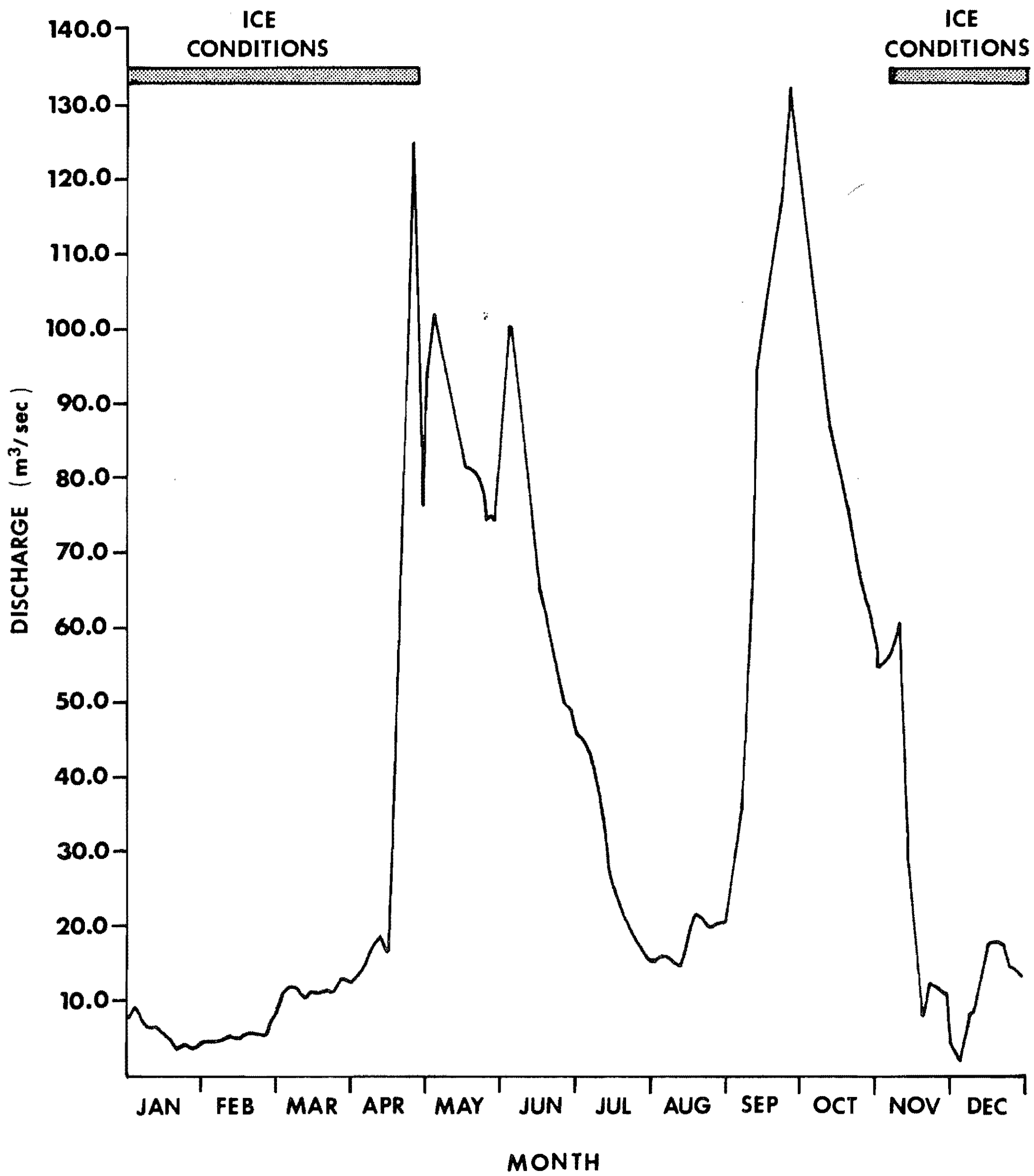


Figure 5. Seasonal pattern of daily discharge rates for the Christina River, 1978.

4.2.4 Gregoire River

The Gregoire River flows from Gregoire Lake, a distance of 83 km, before joining the Christina River. For most of its length, it is a placid, slow-flowing, and meandering stream with a sandy substrate and low, undercut banks (Figure 3, Table 5). Closer to the mouth, the flow rate increases and the substrate changes to boulders and rubble as the stream drops down through a deep valley to the Christina River. The overall stream gradient is 0.2% ranging from 0.05% near the lake outlet to 0.6% near the mouth (Figure 6).

Stream width varies from 15 m near the lake to 31 m near the mouth. Stream discharge ranged from a low of 1.5 m^3/sec recorded at the lake outlet (Station 5) in August to 6.9 m^3/sec recorded near the mouth (Station 1) in October. Water temperatures ranged from 4°C (October at Stations 1 and 2) to 15°C (June at Stations 1, 3, and 4), dissolved oxygen from 8.2 mg/L (August at Station 5) to 10.2 mg/L (October at Station 1), and turbidity from 7.7 JTU's (October at Station 4) to 13 JTU's (June at Station 4).

The Gregoire River serves as an important migration route and spawning area for northern pike, longnose suckers, and white suckers. Gillnet catches per unit effort were, however, much lower than catches in the Christina River. Lake chub, longnose sucker young-of-the-year, and white sucker young-of-the-year were the most common species taken in minnow seines.

The bottom fauna at Station 1, where the substrate is composed of boulders and rubble, was dominated by nymphs of Ephemeroptera (*Baetis* sp.) and Plecoptera (*Arcynopteryx* sp.) and larvae of Trichoptera (*Hydropsyche* spp.). The larvae of Chironomidae (*Tanytarsus* sp.), Tipulidae (*Limnophila* sp.), and Trichoptera (*Brachycentrus* sp.) dominated the benthos at Stations 3 and 4 upstream where the substrate is predominantly sand mixed with organic debris.

4.2.5 Horse River

The Horse River originates in a large muskeg area located in the southern region of the project study area and flows a total

Table 5. Stream habitat characteristics of the Gregoire River. Letters in brackets refer to the sampling period as follows: J = June, A = August, O = October.

Station	1	2
Distance upstream from mouth (km)	2.0	18.0
Channel Characteristics		
Pattern	irregular	irregular meander
Flow	broken, swirling	placid, broken
Confinement	confined	occassionaly confined
Percent Gradient	0.56	0.21
Rooted Width (m)	31	22
Wetted Width (m)	26 to 31	22(O)
Average Depth (m)	0.23(J), 0.25(O)	0.24(O)
Average Current (m/sec)	0.51(J), 0.65 (O)	0.50(O)
Approximate Discharge (m^3/sec)	3.8(J), 6.9(O)	6.9(O)
Pool: Riffle Ratio	1:2	10:1
Stream Bank Characteristics		
Form	reposed	undercut
Height	moderate	moderate
Process	generally stable some slumping	stable
Cover	65%; alder, spruce, birch, aspen	90%; alder, aspen
Substrate Composition (%)		
Boulder	45	0
Rubble	45	5
Gravel	5	5
Sand-silt	5	90
Organic	0	0
Temperature (°C)	15.0(J), 4.0(O)	4.0(O)
Dissolved Oxygen (mg/L)	9.0(J), 10.2(O)	9.8(O)
Turbidity (JTU's)	10.0(J), 10.0(O)	ND
Dominant Benthos	Ephemeroptera Plecoptera	ND
Dominant Fish Species		
Gillnets	longnose sucker northern pike white sucker	pike Arctic grayling
Minnow Seine	lake chub longnose sucker white sucker	lake chub longnose sucker white sucker
Aquatic Macrophytes	none	10% coverage in backwaters, primarily *Potomogeton richardsoni* also *Suggittaria* sp. *Ranunculus* sp.

Continued...

Table 5. Continued.

Station Distance upstream from mouth (km)	3 32.0	4 65.0
Channel Characteristics		
Pattern	irregular meander	irregular meander
Flow	placid	placid
Confinement	unconfined	unconfined
Percent Gradient	0.08	0.09
Rooted Width (m)	15	15
Wetted Width (m)	13(J)	11(J), 15(O)
Average Depth (m)	0.49(J)	0.35(J), 0.71(O)
Average Current (m/sec)	0.23(J)	0.22(J), 0.14(O)
Approximate Discharge (m^3/sec)	2.1(J)	1.5(J), 2.4(O)
Pool: Riffle Ratio	1:0	1:0
Stream Bank Characteristics (%)		
Form	undercut	undercut
Height	moderate	moderate
Process	stable	stable
Cover	95%; grass, alder, spruce	100%; grass, willows
Substrate Composition		
Boulder	0	0
Rubble	0	0
Gravel	5	5
Sand-silt	90	85
Organic	5	10
Temperature (°C)	15.0(J), 4.5(O)	15.0(J), 5.0(O)
Dissolved Oxygen (mg/L)	9.2(J), 9.5(O)	9.4(J), 9.6(O)
Turbidity (JTU's)	12.0(J), ND(O)	13.0(J), 7.7(O)
Dominant Benthos	Chironomidae Tipulidae	Trichoptera
Dominant Fish Species		
Gillnets	white sucker longnose sucker walleye	longnose sucker white sucker northern pike
Minnow Seine	white sucker pearl dace longnose sucker	white sucker
Aquatic Macrophytes	10% coverage *P. richardsoni* *P. pectinatus* *Caltha* sp. *Ranunculus* sp.	15% coverage primarily *Sparganium* sp. *P. richardsoni* also *P. pectinatus*, *Caltha* sp. *Ranunculus* sp. *Myriophylum* sp. *Sagitarria* sp.

Continued...

Table 5. Concluded.

Station Distance upstream from mouth (km)	5 83.0
Channel Characteristics	
Pattern	irregular meander
Flow	placid
Confinement	unconfined
Percent Gradient	0.05
Rooted Width (m)	15
Wetted Width (m)	14.5(A)
Average Depth (m)	0.37(A)
Average Current (m/sec)	0.19(A)
Approximate Discharge (m^3/sec)	1.5(A)
Pool: Riffle Ratio	1:0
Stream Bank Characteristics	
Form	undercut
Height	low
Process	stable
Cover	100%; grass, willows
Substrate Composition (%)	
Boulder	0
Rubble	0
Gravel	5
Sand-silt	75
Organic	20
Temperature (°C)	6(A)
Dissolved Oxygen (mg/L)	8.2(A)
Turbidity (JTU's)	12.0(A)
Dominant Benthos	ND
Dominant Fish Species	
Gillnets	ND
Minnow Seine	spottail shiner northern pike
Aquatic Macrophytes	10% coverage, primarily *P. richardsoni*, also *Typha* sp. *Callitriche* sp. *Ceratophylum* sp. *Sium* sp. *Sparganium* sp.

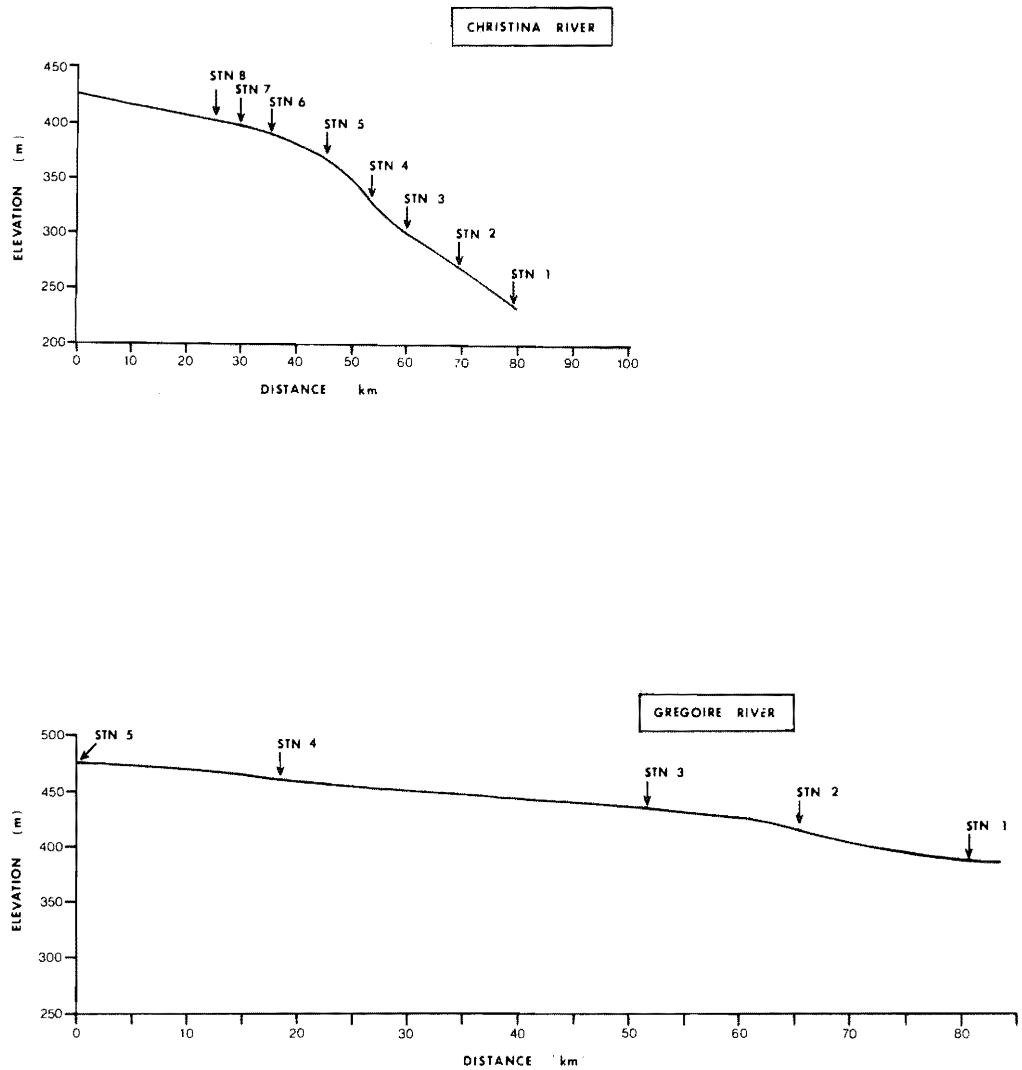
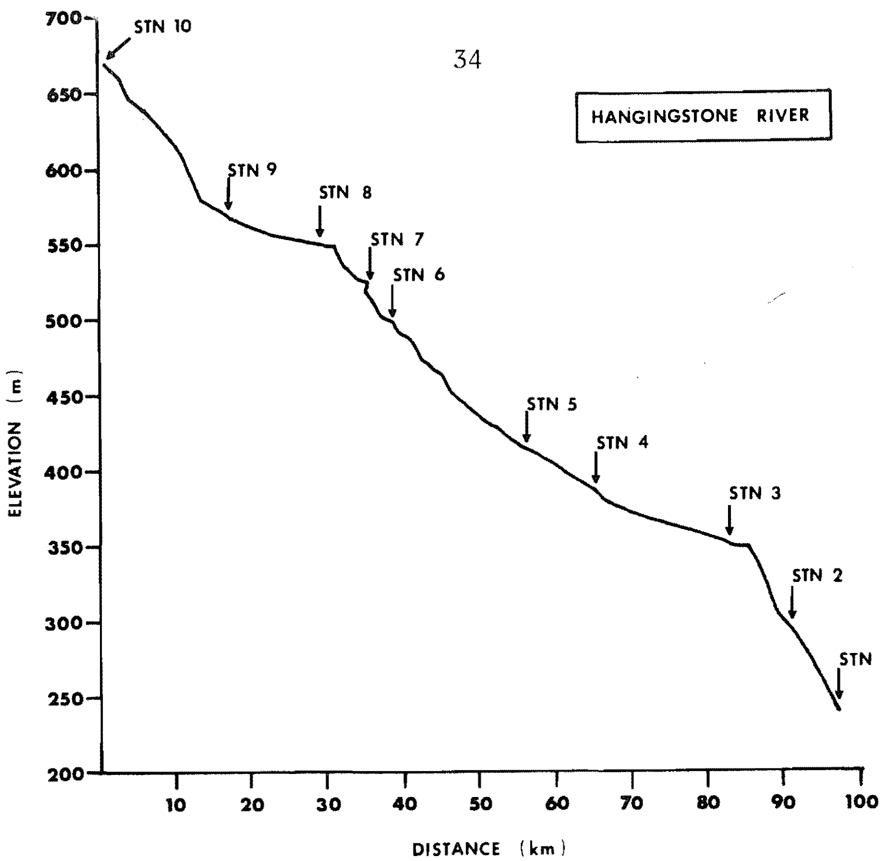


Figure 6. Altitudinal profiles of the Christina and Gregoire rivers showing locations of sampling stations.

distance of close to 200 km before joining the Athabasca River near Fort McMurray. Like the Algar and Gregoire rivers, it is a slow-flowing, placid stream which meanders for most of its length. The overall gradient is 0.2%, ranging from 0.1% in the upper reaches to 0.5% over a 25 km stretch near the mouth where the Horse River cuts down to the level of the Athabasca River (Figure 7).

In Figure 3, the Horse River is shown divided into seven reaches including four of the five stream categories described previously. The upper 25 km are typical of most muskeg areas in the project study area with low, undercut banks that are heavily vegetated with grasses, willows, or bordered by a strip of black spruce. There is, however, a section where the stream apparently flows underground for a distance of approximately 5 km. For the next 130 km, the Horse River meanders over substrates consisting primarily of mud and sand occasionally interrupted by short stretches of boulder or rubble substrates. The banks range from low, stable banks that are heavily vegetated to high, open, sandy banks that are being actively eroded. Old channel scars, cut-offs, and ox-bow lakes are common in this region. Farther downstream, the stream gradient increases with a corresponding increase in stream flow rates and changes in substrate to one composed mainly of rubble and gravel. The banks are of moderate height, stable, and densely vegetated with alder, spruce, and aspen. Closer to the mouth, the stream flow rate increases as the Horse River cuts down to the level of the Athabasca River over boulder and rubble substrates. In this region, the banks are generally of moderate height, vegetated with aspen, and stable though some erosion does occur during periods of high water. There are, however, some locations where a steep exposed section of the valley forms the bank. Chief among these are the steep bituminous bluffs situated 1 km upstream of the mouth of the Horse River. Because of their high water content, these banks are actively slumping into the Horse River.

Stream discharge in the Horse River ranged from 0.9 m^3/sec (August at Station 4) to 11.7 m^3/sec (June at Station 1) (Table 6).



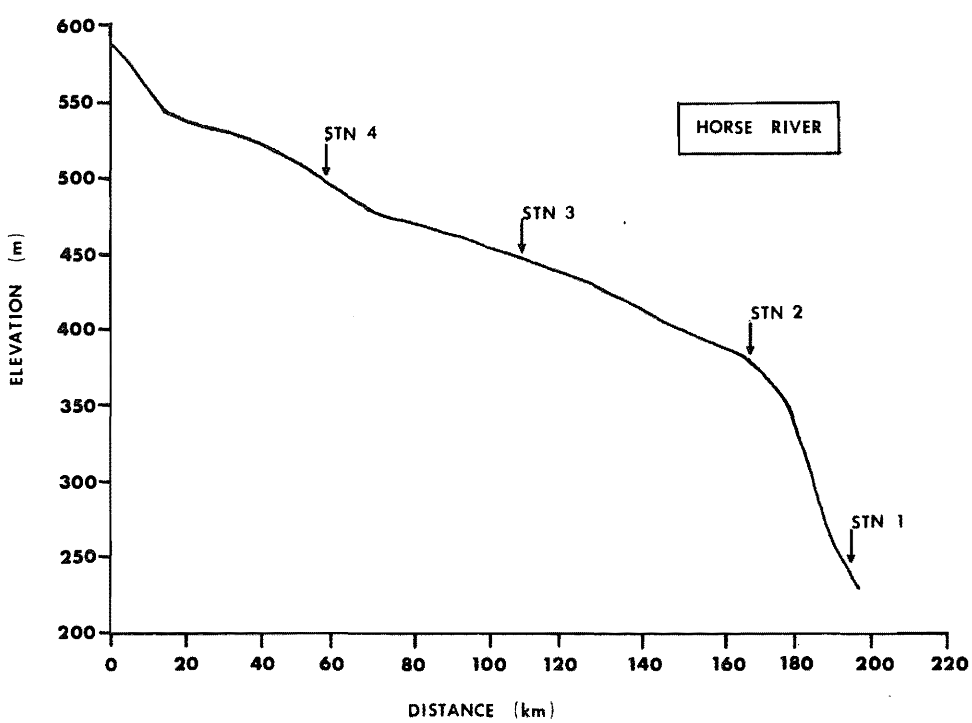


Figure 7. Altitudinal profiles of the Hangingstone and Horse rivers showing locations of sampling stations.

Table 6. Stream habitat characteristics of the Horse River. Letters in brackets refer to the sampling period as follows: J = June, A = August, O = October.

Station	1	2
Distance upstream from mouth (km)	1.0	28.0
Channel Characteristics		
Pattern	irregular meander	irregular meander
Flow	swirling, broken	placid, broken
Confinement	confined	occasionally confined
Percent Gradient	0.38	0.12
Rooted Width (m)	35.0	ND
Wetted Width (m)	35.0(J), 24.0(A), ND(O)	ND
Average Depth (m)	0.32(J), 0.48(A), ND(O)	ND
Average Current (m/sec)	0.79(J), 0.14(A), ND(O)	ND
Approximate Discharge (m^3/sec)	11.71(J), 1.88(A), ND(O)	ND
Pool: Riffle Ratio	1:1	3:1
Stream Bank Characteristics		
Form	steep	reposed
Height	high	moderate
Process	failing	stable
Cover	50%; aspen, spruce	95%; alder, spruce, aspen
Substrate Composition (%)		
Boulder	30	10
Rubble	60	40
Gravel	5	40
Sand-silt	5	10
Organic	0	0
Temperature	15.0(J), 16.0(A), 6.0(O)	12.0(A)
Dissolved Oxygen (mg/L)	9.4(J), 9.2(A), 10.2(O)	9.6(A)
Turbidity (JTU's)	8.0(J), 8.0(A), 13.0(O)	2.7(A)
Dominant Benthos	Ephemeroptera Chironomidae	Trichoptera Chironomidae
Dominant Fish Species		
Gillnets	goldeye longnose sucker	ND
Minnow Seine	fathead minnow lake chub yellow perch	lake chub trout-perch
Aquatic Macrophytes	none	none

Continued...

Table 6. Concluded.

Station	3	4
Distance upstream from mouth (km)	88.0	140.0
Channel Characteristics		
Pattern	tortuous meander	irregular meander
Flow	placid	placid
Confinement	unconfined	unconfined
Percent Gradient	0.10	0.10
Rooted Width (m)	19.5(A)	14.0(A)
Wetted Width (m)	15.9(A)	14.0(A)
Average Depth (m)	0.20(A)	0.52(A)
Average Current (m/sec)	0.33(A)	0.12(A)
Approximate Discharge (m^3/sec)	1.01(A)	0.87(A)
Pool: Riffle Ratio	1:0	10:1
Stream Bank Characteristics		
Form	steep	reposed
Height	high	low
Process	failing	stable
Cover	65%; grass, herbs, willow	90%; alder, birch, spruce
Substrate Composition (%)		
Boulder	0	0
Rubble	0	50
Gravel	0	45
Sand-silt	100	0
Organic	0	5
Temperature (°C)	12.0(A)	11.0(A)
Dissolved Oxygen (mg/L)	8.6(A)	9.8(A)
Turbidity (JTU's)	13.0(A)	6.1(A)
Dominant Benthos	Chironomidae	Trichoptera Chironomidae Ephemeroptera
Dominant Fish Species		
Gillnets	ND	ND
Minnow Seine	lake chub longnose sucker	slimy sculpin longnose sucker
Aquatic Macrophytes	none	1% coverage; *Callitriche* sp.

Water temperatures varied from 6°C (October at Station 1) to 16°C (August at Station 1), dissolved oxygen concentrations from 8.6 mg/L (August at Station 3) to 10.2 mg/L (October at Station 1), and turbidity from 2.7 JTU's (August at Station 2) to 18.0 JTU's (August at Station 1).

Goldeye were by far the most common fish taken in gillnets in the vicinity of Station 1 near the mouth of the Horse River followed by walleye, flathead chub, and longnose suckers. Arctic grayling, northern pike, and white suckers were also taken although catches were low. Fathead minnow, lake chub, and yellow perch were, overall, the most common species in minnow seine collections at Station 1. Lake chub were fairly common at all times while fathead minnows were present only during the spring and yellow perch only in late summer. Lake chub were also the dominant fish taken farther upstream of Stations 2 and 3 together with trout-perch and young-of-the-year longnose suckers. Slimy sculpins and longnose suckers predominated at Station 4.

The larvae of Trichoptera and Chironomidae were, overall, the most abundant groups among the benthos sampled in the Horse River. At Station 1, however, the Ephemeroptera, including *Baetis* sp. and *Ameletus* sp. predominated.

4.2.6 Hangingstone River

The Hangingstone River originates in a set of low hills situated near the southern boundary of the AOSERP study area and flows north for a total distance of 98 km before joining the Clearwater River at Fort McMurray. It is a small river which, during periods of high water, ranges in width from 6 m near its headwaters to 30 m near its mouth. The seasonal pattern of discharge for 1978 (Figure 8) shows winter base flow rates around 0.3 m^3/sec, a sudden peak of 24.6 m^3/sec at spring breakup on 28 April, a summer low of 0.4 m^3/sec in July, and a second peak of 25.2 m^3/sec during a late freshet in September. Thereafter, stream flows declined through freeze-up (about 4 November) to 0.6 m^3/sec at the end of December.

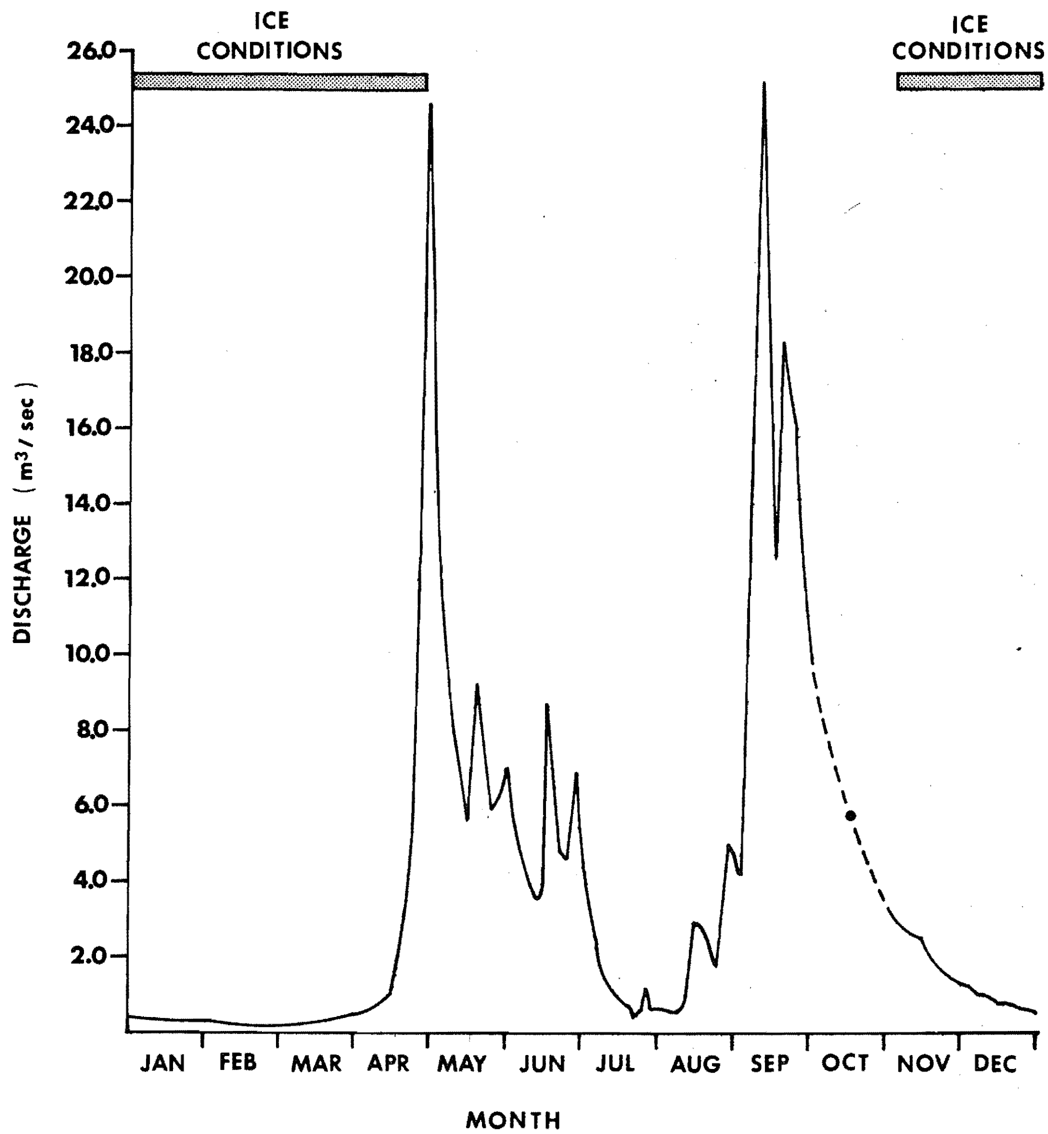


Figure 8. Seasonal pattern of daily discharge rates for the Hangingstone River, 1978.

The Hangingstone River includes all five of the stream habitat categories described previously (Figure 3). With the exception of a short stretch of muskeg, most of the upper reach falls into Category II, a small stream with a moderate gradient partly entrenched in a valley, moderate to fast flow rates, a high incidence of riffles and a substrate composed largely of rubble, boulders, and gravel (Stations 5, 6, 7, 8 and 10) (Table 7). Within the reach classified as Category II, stream width ranges from 6 to 13 m while the banks are of low to moderate height and well-vegetated with overhanging alder, aspen, and spruce. In general, the banks are stable although there are isolated instances where erosion and slumping occur during periods of high water.

Approximately halfway down the stream, the Hangingstone River changes, becoming a wider, slow-flowing, placid stream with a great deal of meandering and sandy substrate. Beaver dams are a common feature of this reach. Closer to the mouth, the stream gradient again increases (Figure 7) as the Hangingstone cuts down through a steep, narrow valley to the floodplain of the Clearwater River at Fort McMurray.

Water temperatures in the Hangingstone River ranged from a low of 2°C (October at Stations 5 and 8) to a high of 17°C (June at Station 1) with a general trend toward higher temperatures downstream (Table 7). Dissolved oxygen concentrations ranged from 7.6 mg/L (June at Station 10) to 11.0 mg/L (October at Station 1) and turbidity from 2.6 JTU's (October at Station 10) to 32.0 JTU's (August at Station 1).

Longnose sucker was the most abundant species taken in gillnets, most of which were set in the lower reaches of the Hangingstone River. Catches per unit effort were, however, by far the lowest recorded in the project study area. Lake chub, longnose suckers, and longnose dace dominated minnow seine catches in the lower reaches of the Hangingstone River while slimy sculpin was by far the most common species taken in the upper reaches. Trout-perch was the most frequent species taken in slow-flowing, sandy bottomed middle reaches.

Table 7. Stream habitat characteristics of the Hangingstone River. Letters in brackets refer to the sampling period as follows: J = June, A = August, O = October.

Station Distance upstream from mouth (km)	1 1.0	2 7.0
Channel Characteristics		
Pattern	sinuous	straight
Flow	swirling, broken	broken, tumbling
Confinement	occasionally confined	confined
Percent Gradient	0.80	0.46
Rooted Width (m)	28	31
Wetted Width (m)	9 to 16	13 to 31
Average Depth (m)	0.31(J), 0.33(A)	0.32(J), 0.41(0)
Average Current (m/sec)	0.74(J), 0.31(A)	0.57(J), 0.47(0)
Approximate Discharge (m^3/sec)	4.1(J), 1.8(A)	6.9(J), 6.8(0)
Pool: Riffle Ratio	3:1	1:3
Stream Bank Characteristics		
Form	reposed	steep
Height	moderate	high
Process	stable	generally stable, some failing
Cover	65%; grass, alder, spruce	50%; alder, spruce
Substrate Composition (%)		
Boulder	15	20
Rubble	75	50
Gravel	10	0
Sand-silt	0	0
Organic	0	0
Temperature (°C)	17.0(J), 15.5(A), 5.5(0)	13.5(J), 5.0(0)
Dissolved Oxygen (mg/L)	10.2(J), 9.8(A) 11.0(0)	10.6(J), 9.2(0)
Turbidity (JTU's)	5.0(J), 32.0(A) 12.0(0)	ND(J), 7.2(0)
Dominant Benthos	Chironomidae Oligochaeta Ephemeroptera	Ephemeroptera Trichoptera Plecoptera
Dominant Fish Species		
Gillnets	longnose sucker	no catch
Minnow Seine	lake chub longnose sucker longnose dace	lake chub longnose sucker longnose dace
Aquatic Macrophytes	none	none

Continued...

Table 7. Continued.

Station Distance upstream from mouth (km)	3 15.0	4 33.0
Channel Characteristics		
Pattern	tortuous meander	tortuous meander
Flow	placid, broken	placid
Confinement	frequently confined	unconfined
Percent Gradient	0.15	0.32
Rooted Width (m)	32	19
Wetted Width (m)	15 to 26	14.5 to 19
Average Depth (m)	0.32(J), 0.36(O)	0.45(J), 0.38(O)
Average Current (m/sec)	0.75(J), 0.32(O)	0.27(J), 0.25(O)
Approximate Discharge (m^3/sec)	6.9 (J), 4.6 (O)	3.1 (J), 4.1 (O)
Pool: Riffle Ratio	2:1	10:1
Stream Bank Characteristics		
Form	reposed	reposed
Height	moderate	moderate
Process	generally stable, some failing	stable
Cover	80%; elder, aspen, spruce	100%; alder, aspen, spruce
Substrate Composition (%)		
Boulder	50	10
Rubble	35	5
Gravel	15	5
Sand-silt	0	80
Organic	0	0
Temperature (°C)	15.0(J), 4.0(O)	12.0(J), 3.0(O)
Dissolved Oxygen (mg/L)	10.2(J), 9.2(O)	10.4(J), 8.8(O)
Turbidity (JTU's)	15.0(J), 6.6(O)	9.5(J), 7.1(O)
Dominant Benthos	Ephemeroptera Trichoptera	Ephemeroptera Plecoptera
Dominant Fish Species		
Gillnets	longnose sucker grayling	longnose sucker
Minnow Seine	lake chub trout-perch	trout-perch lake chub
Aquatic Macrophytes	none	none

Continued...

Table 7. Continued.

Station	5	6
Distance upstream from mouth (km)	42.0	59.0
Channel Characteristics		
Pattern	irregular meander	irregular
Flow	placid, broken	swirling, broken
Confinement	unconfined	occasionally confined
Percent Gradient	0.27	0.55
Rooted Width (m)	15	13
Wetted Width (m)	10 to 12	11 to 13
Average Depth (m)	0.45(J), 0.19(O)	0.26(J), 0.37(O)
Average Current (m/sec)	0.26(J), 0.33(O)	0.48(J), 0.35(O)
Approximate Discharge (m^3/sec)	1.9 (J), 2.0 (O)	2.2 (J), 2.6 (O)
Pool: Riffle Ratio	3:1	2:1
Stream Bank Characteristics		
Form	reposed	reposed
Height	moderate	moderate
Process	stable	stable
Cover	90%; aspen, spruce	90%; alder, aspen, spruce
Substrate Composition (%)		
Boulder	0	5
Rubble	25	45
Gravel	65	40
Sand-silt	10	10
Organic	0	0
Temperature (°C)	14.0(J), 2.0(O)	13.0(J), 4.0(O)
Dissolved Oxygen (mg/L)	9.4(J), 10.4(O)	10.0(J), 10.0(O)
Turbidity (JTU's)	15.0(J), 7.1(O)	ND(J), 4.4(O)
Dominant Benthos	Ephemeroptera	Ephemeroptera Trichoptera Chrionomidae
Dominant Fish Species		
Gillnets	no catch	no catch
Minnow Seine	slimy sculpin	slimy sculpin
Aquatic Macrophytes	none	none

Continued...

Table 7. Continued.

Station	7	8
Distance upstream from mouth (km)	63.0	69.0
Channel Characteristics		
Pattern	irregular	irregular meander
Flow	swirling, broken	placid, broken
Confinement	frequently confined	frequently confined
Percent Gradient	0.80	0.21
Rooted Width (m)	12	13
Wetted Width (m)	10	9 to 11
Average Depth (m)	0.34(J)	0.31(J), 0.34(0)
Average Current (m/sec)	0.38(J)	0.30(J), 0.47(0)
Approximate Discharge (m^3/sec)	2.3(J)	1.5 (J), 4.1 (0)
Pool: Riffle Ratio	2:1	9:1
Stream Bank Characteristics		
Form	reposed	reposed
Height	moderate	moderate
Process	generally stable, some failing	generally stable, some failing
Cover	90%; alder, spruce, aspen	85%; willow, birch, spruce
Substrate Composition (%)		
Boulder	15	5
Rubble	50	40
Gravel	25	40
Sand-silt	10	15
Organic	0	0
Temperature (°C)	11.0(J)	10.5(J), 2.0(0)
Dissolved Oxygen (mg/L)	10.6(J)	9.6(J), 9.2(0)
Turbidity (JTU's)	12.0(J)	4.5(J), 4.1(0)
Dominant Benthos	ND	Ephemeroptera Trichoptera Chironomidae
Dominant Fish Species		
Gillnets	no catch	ND
Minnow Seine	slimy sculpin grayling	slimy sculpin
Aquatic Macrophytes	none	none

Continued...

Table 7. Concluded.

Station Distance upstream from mouth (km)	9 81.0	10 98.0
Channel Characteristics		
Pattern	irregular meander	irregular
Flow	placid	placid
Confinement	unconfined	unconfined
Percent Gradient	0.22	0.35
Rooted Width (m)	7	6
Wetted Width (m)	6	6
Average Depth (m)	0.44(0)	0.11
Average Current (m/sec)	0.28(0)	0.30
Approximate Discharge (m^3/sec)	1.2(0)	0.3
Pool: Riffle Ratio	1:0	20:1
Stream Bank Characteristics		
Form	undercut	undercut
Height	low	low
Process	stable	stable
Cover	100%; grass, sedges, willow	100%; grass, sedges
Substrate Composition (%)		
Boulder	0	95
Rubble	0	0
Gravel	10	0
Sand-silt	90	0
Organic	0	5
Temperature (°C)	9.0(J), 4.0(0)	15.0(J), 4.0(0)
Dissolved Oxygen (mg/L)	8.4(J), 9.5(0)	7.6(J), 9.5(0)
Turbidity (JTU's)	ND(J), 3.4(0)	ND(J), 2.6(0)
Dominant Benthos	Trichoptera Chironomidae Ephemeroptera	Ephemeroptera Chironomidae Trichoptera
Dominant Fish Species		
Gillnets	ND	pike
Minnow Seine	slimy sculpin	no catch
Aquatic Macrophytes	5% coverage; *Sparganium* sp. *Ranunculus* sp. *Equisetom* sp.	none

Ephemeropteran nymphs dominated the stream benthos at all stations sampled on the Hangingstone River in June. The major species were *Baetis* sp. (Stations 2, 6, 8, and 9), *Ephemerella (E.) inermis* (Station 1), and *Pseudocloen* sp. (Stations 3 and 5). In August, chironomid larvae predominated at Stations 1, 3, 6, 8, 9, and 10, including *Cricotopus* sp. (Stations 1 and 8), *Cladotanytarsus* sp. (Station 3), *Odontomesa* sp. (Station 6), *Tanytarsus* sp. (Station 9), and *Eukiefferiella* spp. (Station 10). Ephemeroptera (*Baetis* sp.) was the major group at Stations 4 and 5 while Trichoptera (*Brachycentrus* sp.) predominated at Station 2. In October, ephemeropterans (*Baetis* sp. and *Rhithrogena* sp.) were the major benthos collected at Stations 2, 3, 4, and 5 while trichopteran larvae were common at Stations 6, 8 (primarily *Brachycentrus* sp.), and 9 (*Brachycentrus* sp. and *Glossosoma* sp.). Chironomids, including *Diamesa* (s.s.), *Orthocladius* sp., and *Thienemannimyia* sp., predominated at Station 10 in October, although *Leptophlebia* sp. (Ephemeroptera) was also abundant.

4.2.7 Prairie Creek

Prairie Creek is a small tributary of the lower Hangingstone River that flows for a total distance of 24 km. Like Cameron Creek, Prairie Creek meanders through muskeg and a series of beaver dams for most of its course (Figure 3) before flowing through a short, steep valley to the Hangingstone River. The overall gradient is 0.7%, ranging from 0.5% in the muskeg areas to 2.3% at its lower end.

In August, the stream was sampled at one station, located approximately 10 km upstream from its mouth. At the station, the stream was 1.6 m wide and 0.5 m deep with an average current of 0.08 m/sec (Table 8) and an estimated discharge of 0.06 m^3/sec. The banks in the vicinity of the station are low, undercut, and well-stabilized with grasses, sedges, and willows. Water temperature was 16°C, dissolved oxygen 8.4 mg/L, and turbidity 1.5 JTU's. Aquatic macrophytes, primarily *Caltha* sp., *Ranunculus* spp., and *Sparganium* spp., were very common.

Table 8. Stream habitat characteristics of Prairie Creek, August 1978.

Station	1
Distance upstream from mouth (km)	13.0
Channel Characteristics	
Pattern	irregular meander
Flow	placid
Confinement	unconfined
Percent Gradient	0.34
Rooted Width (m)	1.6
Wetted Width (m)	1.6
Average Depth (m)	0.52
Average Current (m/sec)	0.08
Approximate Discharge (m^3/sec)	0.06
Pool: Riffle Ratio	1:0
Stream Bank Characteristics	
Form	undercut
Height	low
Process	stable
Cover	100%; grass, open willow
Substrate Composition (%)	
Boulder	0
Rubble	0
Gravel	0
Sand-silt	70
Organic	30
Temperature (°C)	16
Dissovled Oxygen (mg/L)	8.4
Turbidity (JTU's)	1.5
Dominant Benthos	Mollusca Oligochaeta
Dominant Fish Species	
Gillnets	ND
Minnow Seine	brook stickleback
Aquatic Macrophytes	50% coverage; *Caltha* sp. *Ranunculus* spp. *Sparganium* sp. *Sium* sp.

Brook sticklebacks were the only fish taken in Prairie Creek. The bottom fauna was dominated by the pill clam, *Pisidium* sp., together with Oligochaeta and the Amphipoda, *Gammarus lacustris*.

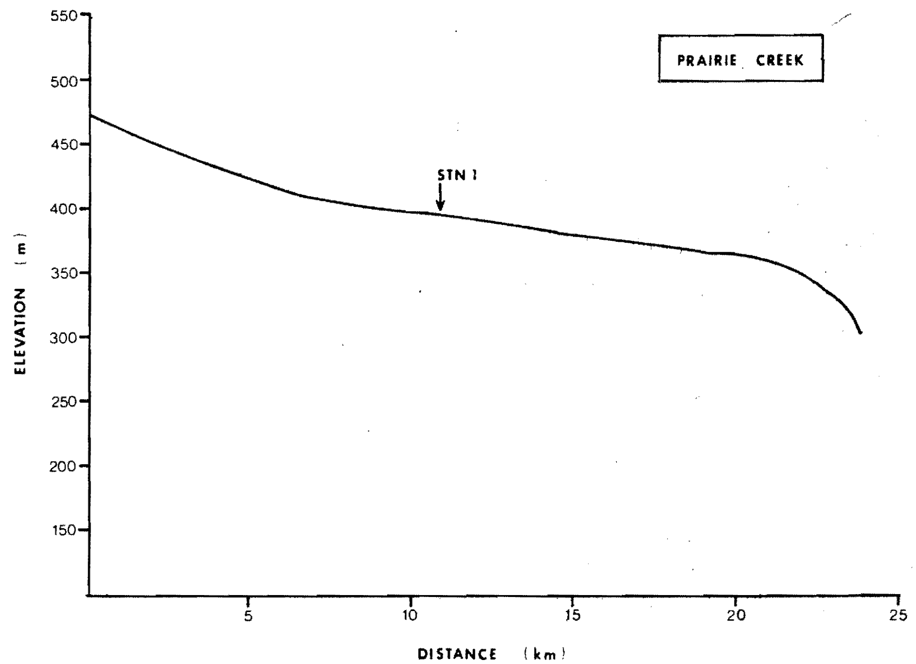
4.2.8 Saline Creek

Saline Creek flows a total distance of 26 km at an average gradient of 0.6% (Figure 9) before joining the Hangingstone River in the town of Fort McMurray. It is a small stream ranging in width from 5 to 11 m (Table 9) with estimated discharges of 0.6 m^3/sec in June and 1.1 m^3/sec in October. It can be divided into two distinct reaches (Figure 3) by the road that goes from Highway 63 to the Fort McMurray airport. Upstream of the road crossing, the stream is slow-flowing, meandering, and generally typical of other muskeg areas in the study area. The banks are normally low, undercut, and well vegetated with thick overhanging willows. In most places, the substrate is composed of organic material together with mud and sand, although there are instances where the substrate is predominantly boulders and rubble (e.g., Station 3) (Table 9). Aquatic macrophytes, including *Sparganium* sp., *Caltha* sp., *Myriophylum* sp., and *Callitriche* sp., are common.

Downstream of the road crossing, the character of Saline Creek changes as the gradient increases. Stream flows are generally much faster over a substrate composed largely of boulders and coarse rubble. The banks are of low to moderate height and generally stable. In most areas, they are well vegetated with overhanging willows, aspen, and spruce. Exceptions are those areas that have been cleared or altered as a result of the increasing urban development around Fort McMurray.

Water temperatures in Saline Creek ranged from 6°C (October at Station 1) to 14°C (June at Station 1), dissolved oxygen from 7.8 mg/L (August at Station 3) to 10.4 mg/L (October at Station 1), and turbidity from 1.5 JTU's (August at Station 3) to 2.1 JTU's (October at Station 1).

Longnose sucker and Arctic grayling young-of-the-year and lake chub were the major species taken in the lower portions



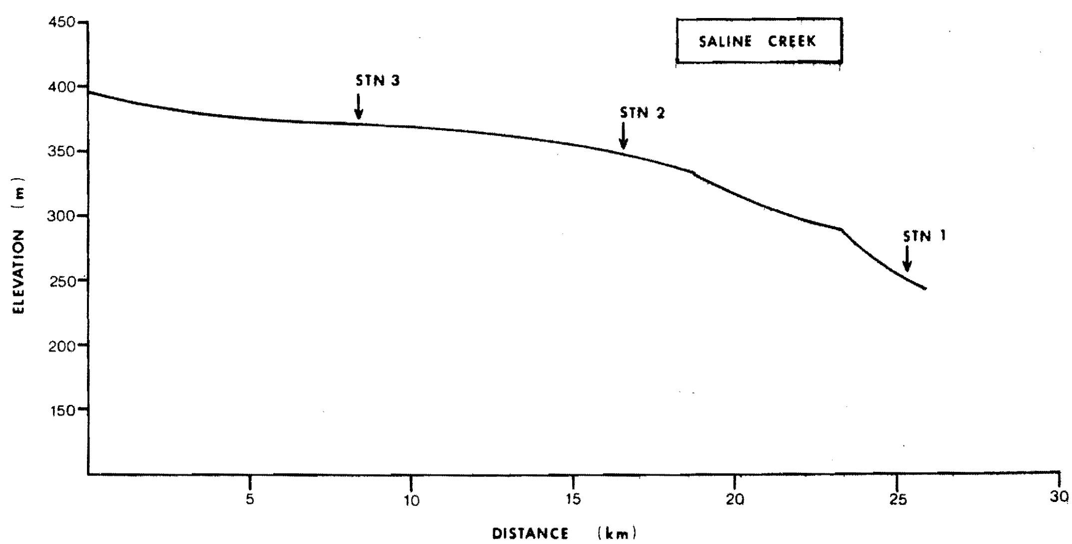


Figure 9. Altitudinal profiles of Prairie and Saline creeks showing locations of sampling sites.

Table 9. Stream habitat characteristics of Saline Creek. Letters in brackets refer to the sampling period as follows: J = June, A = August, O = October.

Station Distance upstream from mouth (km)	1 1.0	3 18.0
Channel Characteristics		
Pattern	straight	irregular meander
Flow	broken	placid
Confinement	frequently confined	unconfined
Percent Gradient	1.50	0.17
Rooted Width (m)	11	5
Wetted Width (m)	6 to 8	5
Average Depth (m)	0.17(J), 0.15(O)	0.23(A)
Average Current (m/sec)	0.29(J), 0.52(O)	0.30(A)
Approximate Discharge (m^3/sec)	0.51(J), 1.14(O)	0.21(A)
Pool: Riffle Ratio	1:20	1:1
Stream Bank Characteristics		
Form	reposed	undercut
Height	moderate	low
Process	stable	stable
Cover	100%; willow	100%, alder, spruce
Substrate Composition (%)		
Boulder	30	40
Rubble	50	40
Gravel	15	0
Sand-silt	5	20
Organic	0	0
Temperature (°C)	14.0(J), 6.0(O)	11.0(A)
Dissolved Oxygen (mg/L)	10.0(J), 10.4(O)	7.8(A)
Turbidity (JTU's)	2.0(J), 2.1(O)	1.5(A)
Dominant Benthos	Ephemeroptera Oligochaeta	Ephemeroptera Trichoptera
Dominant Fish Species		
Gillnets	ND	ND
Minnow Seine	longnose sucker grayling lake chub	brook stickleback
Aquatic Macrophytes	none	30% coverage; *Sparganium* sp. *Caltha* sp. *Myriophylum* sp. *Callitriche* sp.

of Saline Creek although catches of all species were low. Brook stickleback was the major species sampled in the upper reaches.

In August, only five benthic invertebrate taxa were sampled at Station 1 on Saline Creek. Of these, *Baetis* sp. (Ephemeroptera) and Oligochaeta were by far the most common. At Station 3, *Baetis* sp. and *Brachycentrus* sp. (Trichoptera) were the most common of 12 taxa sampled.

4.2.9 Saprae Creek

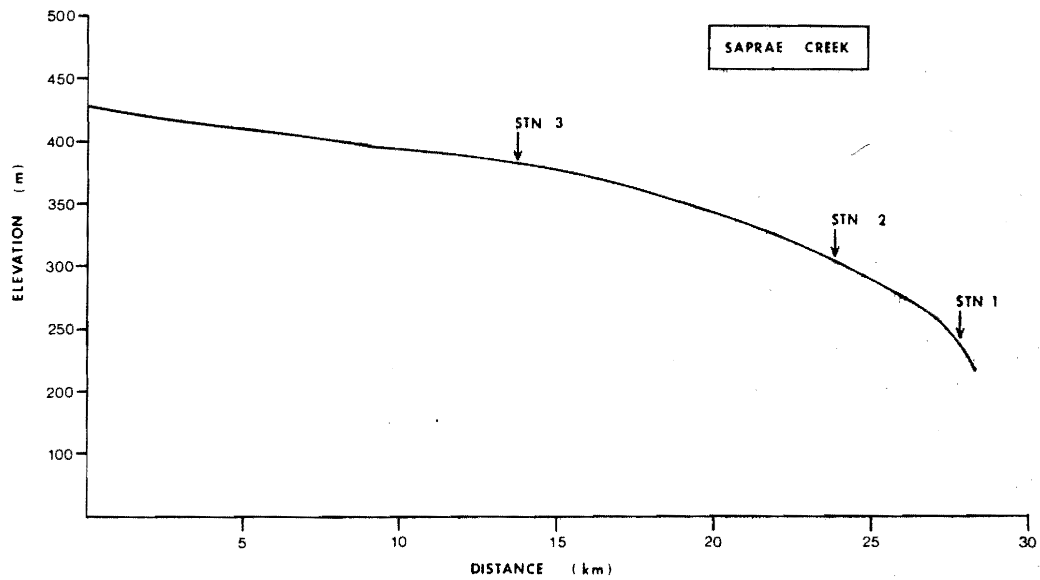
Saprae Creek is a small tributary of the Clearwater River, ranging in width from 4 to 8 m with an estimated discharge in August ranging from 0.1 m^3/sec upstream (Station 3) to 0.6 m^3/sec downstream (Station 1) near the mouth (Table 10). The stream flows a total distance of 28 km at an average gradient of 0.7%, ranging from 0.3% upstream to 1.2% downstream (Figure 10). Like Saline Creek, it can be divided into two reaches of approximately equal length, a typical meandering muskeg-like stream with low, heavily vegetated banks, and an organic substrate in the upper reaches and a fast flowing, straight section with a boulder and rubble substrate in the lower reaches (Figure 3).

The Northern Alberta Railroad parallels most of the lower reaches of Saprae Creek, crossing the stream several times along its course. There is, however, no evidence of any disturbance in the form of bank erosion or instability. The stream banks along the railroad right-of-way are well vegetated with grasses and herbs. Overhanging alder, aspen, and spruce predominate elsewhere. In August, water temperatures ranged from 11°C (Stations 2 and 3) to 12°C (Station 1), dissolved oxygen from 7.4 mg/L (Station 3) to 10.2 mg/L (Station 2), and turbidity from 1.9 JTU's (Station 3) to 3.8 JTU's (Station 2).

Three species of fish, including Arctic grayling (primarily young-of-the-year), slimy sculpin, and white sucker, were collected from Saprae Creek. Of these, grayling were by far the most abundant and catches per unit seine effort for this species were among the highest recorded during the present study.

Table 10. Stream habitat characteristics of Saprae Creek, August 1978.

Station	1	2	3
Distance upstream from mouth (km)	1.0	5.0	15.0
Channel Characteristics			
Pattern	irregular	straight	irregular
Flow	broken, placid	broken	placid
Confinement	frequently confined	confined	unconfined
Percent Gradient	1.25	1.25	0.29
Rooted Wight (m)	8.0	7.0	4.0
Wetted Width (m)	7.5	6.5	3.0
Average Depth (m)	0.27	0.11	0.19
Average Current (m/sec)	0.24	0.33	0.13
Approximate Discharge (m^3/sec)	0.60	0.42	0.10
Pool: Riffle Ratio	1:1	1:19	19:1
Stream Bank Characteristics			
Form	reposed	reposed	undercut
Height	moderate	moderate	low
Process	stable	stable	stable
Cover	90%; alder, spruce aspen	100%; grass, herbs alder, spruce	100%; alder, spruce
Substrate Composition (%)			
Boulder	5	90	5
Rubble	60	10	5
Gravel	35	0	5
Sand-silt	0	0	85
Organic	0	0	0
Temperature	12.0	11.0	11.0
Dissolved Oxygen (mg/L)	8.4	10.2	7.4
Turbidity (JTU's)	3.6	3.8	1.9
Dominant Benthos	Ephemeroptera Trichoptera	Ephemeroptera Trichoptera	Chironomidae Trichoptera Amphipoda
Dominant Fish Species			
Gillnets	ND	ND	ND
Minnow Seine	grayling	grayling	grayling
Aquatic Macrophytes	none	none	5% coverage; *Sparganium* sp. *P. richardsoni* *Ranunculus* sp.



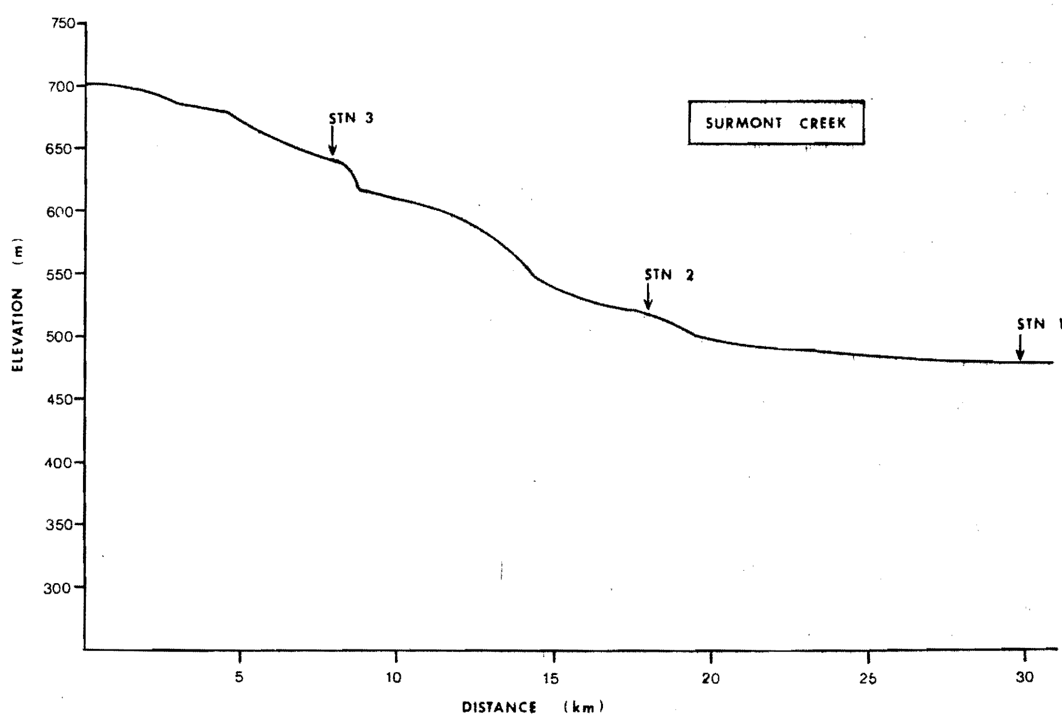


Figure 10. Altitudinal profiles of Saprae and Surmont creeks showing locations of sampling stations.

The nymphs of Ephemeroptera, including *Rhithrogena* sp., *Heptagenia* sp., and *Ephemerella (Drunella) spinifera*, and the larvae of Trichoptera, including *Hydropsyche* sp. and *Glossosoma* sp., predominated at Stations 1 and 2 where the substrates were largely composed of boulders, rubble, and gravel. Chironomids and trichopteran (*Lenarchus* sp., *Amiocentrus* sp.) larvae and amphipods predominated at Station 3 where currents were lower and substrates sandier.

4.2.10 Surmont Creek

Within the project study area, Surmont Creek flows a total distance of 31 km from Surmont Lake at the southern edge of the AOSERP study area to Gregoire Lake. The overall gradient is 0.7%, ranging from 0.8% upstream to 0.2% near the mouth (Figure 10). It is a small, fast-flowing stream for most of its length, ranging from 4 to 14 m rooted width (Table 11). Discharge estimates for the month of August ranged from 0.05 m^3/sec near the headwaters (Station 3) to 0.75 m^3/sec at the mouth (Station 1). The substrate is largely composed of gravel, rubble, and a few boulders changing to sand for a short distance near the mouth. The stream banks are of low to moderate height, generally stable, and well-vegetated with alder, birch, aspen, or spruce in the steeper areas upstream and grass and open willows in the low-lying areas downstream.

Water temperatures ranged from 12°C (August at Station 1) to 5°C (October at Station 2), while dissolved oxygen concentrations ranged from 8.2 mg/L (August at Station 1) to 10.8 mg/L (October at Station 2). The water was clear with turbidities ranging from 3.7 JTU's (August at Station 2) to 5.6 JTU's (August at Station 1).

The Arctic grayling, primarily young-of-the-year, was by far the single most abundant and widely distributed fish species taken in Surmont Creek followed by slimy sculpin. White sucker young-of-the-year were common in the slower flowing reaches near the mouth.

Chironomid larvae, primarily *Heterotrissocladius marcidus* grp., *Monodiamesa* sp., and *Polypedilium* sp., dominated the sandy substrates at Station 1 on Surmont Creek. At Station 2 and 3, upstream

Table 11. Stream habitat characteristics of Surmont Creek. Letters in brackets refer to the sampling period as follows: J = June, A = August, O = October.

Station Distance upstream from mouth (km)	1 1.0	2 13.0	3 23.0
Channel Characteristics			
Pattern	irregular	irregular	straight
Flow	placid	broken, placid	broken, placid
Confinement	unconfined	occasionally confined	frequently confined
Percent Gradient	0.18	0.70	0.80
Rooted Width (m)	7.0	8 to 14	4.0
Wetted Width (m)	6.5(A)	7.0(J), 5.0(A), 13.5(O)	3.0(A)
Average Depth (m)	0.24(A)	0.21(J),0.13(A) 0.19(O)	0.18(A)
Average Current (m/sec)	0.24(A)	0.43(J),0.54(A), 0.40(O)	0.07
Approximate Discharge (m^3/sec)	0.75	0.86(J),0.62(A) 2.4 (O)	0.05(A)
Pool: Riffle Ratio	1:0	1:2	1:3
Stream Bank Characteristics			
Form	undercut	reposed	reposed
Height	low	moderate	moderate
Process	stable	stable	stable
Cover	100%; grass, willow	90%; alder, aspen, birch, spruce	100%; alder, spruce,
Substrate Composition (%)			
Boulder	0	5	5
Rubble	0	25	5
Gravel	0	70	90
Sand-silt	0	0	0
Organic	100	0	0
Temperature (°C)	12.0 (A)	10.0(J), 8.0(A),	9.0(A)
Dissolved Oxygen (mg/L)	8.2(A)	10.0(J), 9.6(A), 10.8(O)	9.4(A)
Turbidity (JTU's)	5.6(A)	4.0(J), 3.7(A), 4.7(O)	5.4(A)
Dominant Benthos	Chironomidae	Plecoptera Chironomidae Ephemeroptera	Chironomidae Trichoptera
Dominant Fish Species			
Gillnets	ND	ND	ND
Minnow Seine	white sucker	grayling	grayling
Aquatic Macrophytes	none	none	none

where the substrates were largely composed of rubble and gravel, plecopteran nymphs, including *Nemoura (Zapada) cinctipes* and *Hastaperla* or *Alloperla* sp., several species of chironomid larvae and trichopteran larvae (*Brachycentrus* sp.) predominated.

4.2.11 Algar Lake

Algar Lake is a shallow, brown water lake located in the southwestern part of the project study area. It has a surface area of 7.7 km^2 with a maximum recorded depth of 2.0 m. The substrate is predominantly silt incorporating a large fraction of organic debris.

Only a few small specimens of pearl dace and brook sticklebacks were taken in seine hauls along the shoreline. Forty-eight large mature pearl dace were taken, however, in gillnets set over a 24 h period, 22 to 23 August.

The littoral area of Algar Lake was dominated by the amphipod *Hyalella azteca* and chironomid larvae (*Chironomus* sp. and *Procladius* sp.). In the deeper part of the lake, oligochaetes, the chironomid *Stictochironomus* sp., and the pill clam *Pisidium* sp. dominated the benthos.

4.2.12 Gregoire Lake

Gregoire Lake is the largest lake in the southern portion of the AOSERP study area with a surface area of 26.5 km^2 and a maximum depth of about 7.5 m. It is a major recreational area for the residents of Fort McMurray and has also supported limited commercial and domestic fisheries in the past. Additional information on lake morphometry, physical and chemical characteristics, plankton, fisheries, and the bottom fauna of Gregoire Lake are presented by Griffiths (1973).

Three species of fish, including 16 ciscoes tentatively identified as short-jaw ciscoes (*Coregonus zehithicus*), two northern pike, and 10 walleye were taken in a single 24 h standard gillnet set, 22 to 23 August. Spottail shiner and yellow perch were by far the most numerous species sampled in seine collections along the shore, particularly in the weedy sections located in the shallow bays of the southeast corner (primarily spottail shiners) and near the mouth of Surmont Creek (yellow perch). Seine catches for all species were low along the sandy beaches of the south shore and along the rocky substrates on the north shore. Other species taken include burbot, white sucker, and northern pike young-of-the-year.

No lake whitefish or longnose sucker were taken from Gregoire Lake although both species have been previously reported (Griffiths 1973).

Chironomid larvae dominated the benthic fauna of Gregoire Lake, accounting for 76% of the total benthos sampled. *Polypedilum* sp., *Tanytarsus* sp., and *Procladius* sp. were common in the profundal zone while *Stictochironomus* sp. dominated the littoral zone.

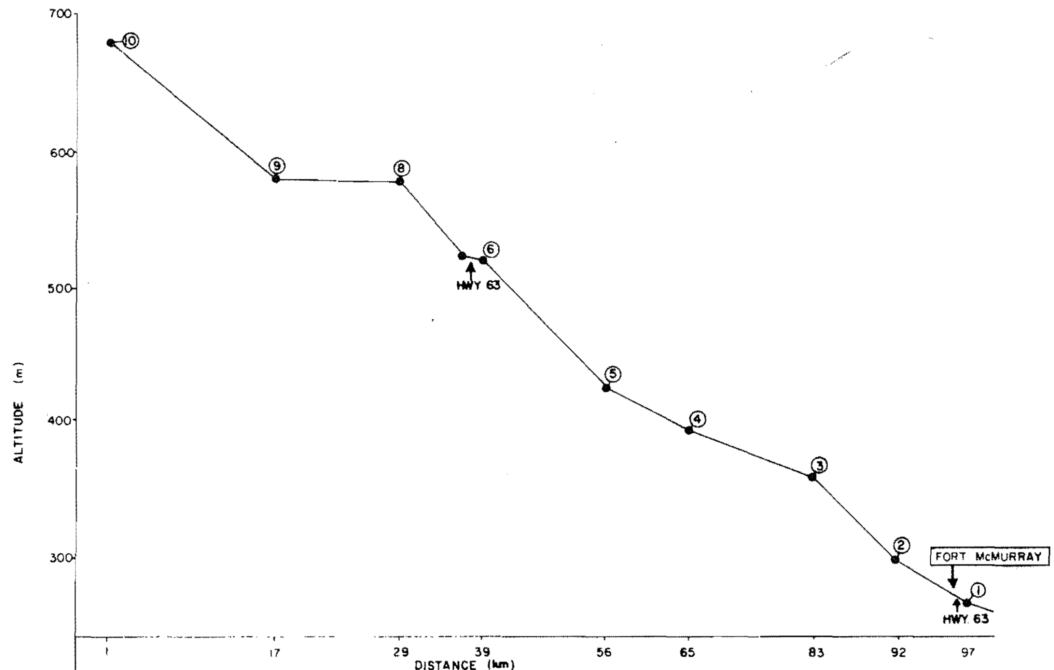
4.3 BENTHOS

The objective of this portion of the study is to describe spatial and temporal changes in species composition, diversity, relative abundance, and biomass of the macrobenthos of streams in the southern portion of the AOSERP study area.

Two streams, the Hangingstone and Christina, were selected for detailed study since together they include most of the aquatic habitats found within the study area. In addition, a summer (August) reconnaissance was conducted in several other waterbodies within the project study area, including the Horse, Gregoire, and Algar rivers, Saprae, Saline, Prairie, Surmont, and Cameron creeks, and Gregoire and Algar lakes.

4.3.1 Hangingstone River

The nine benthos sampling stations were located in seven distinct stream reaches along the Hangingstone River. Figure 11 is a longitudinal profile of the river showing certain environmental factors that are important in determining the ecological characteristics of reaches. These factors varied considerably along the length of the river and are probably major determinants of the observed patterns of distribution of the benthos (Pennak 1971).



STATION	10	9	8	6	5	4	3	2	1
WIDTH (m)	6	7	13	13	15	19	32	31	28
CURRENT SPEED (m/sec)	0.30	0.28	0.39	0.41	0.29	0.26	0.54	0.52	0.52
SUBSTRATE TYPES	95% BOULDER 5% ORGANIC DEBRIS	90% SAND 10% GRAVEL	40% RUBBLE 40% GRAVEL 5% BOULDER 5% SAND	45% RUBBLE 40% GRAVEL 10% SAND 5% BOULDER	65% GRAVEL 25% RUBBLE 10% SAND	80% SAND 10% BOULDER 5% RUBBLE 5% GRAVEL	50% BOULDER 35% RUBBLE 15% GRAVEL	50% BOULDER 50% RUBBLE	75% RUBBLE 15% BOULDER 10% GRAVEL
GRADIENT (%)	0.35	0.22	0.21	0.55	0.27	0.15	0.32	0.46	0.80
JUNE TEMP. (°C)	15.0	9.0	10.0	13.0	14.0	12.0	15.0	13.0	17.0

Figure 11. A longitudinal profile of the Hangingstone River, with descriptions of key environmental factors of the macrobenthos sampling stations.

4.3.1.1. The macrobenthos. The Hangingstone River has a rich macrobenthic fauna; a total of 134 taxa (mostly species) was identified, of which 90% were aquatic insects. The Diptera were the most diversified order and Chironomidae the most diversified family. The numbers of taxa (mostly species) within each major insect order are compared in Figure 12. Data on the seasonal composition, species diversity, density, and biovolume of the macrobenthos from the nine sampling stations are given in Volume II, Tables 1 to 17.

Longitudinal variation in habitats along the Hangingstone River (Figure 11) has influenced the zonal distribution and abundance of many macrobenthic taxa. Some species have restricted distributions, especially those which occur in the headwater area, whereas others extend over long stretches of the river. Even when comparisons between sampling sites indicated considerable similarity in species composition, the relative abundance of species was often very different.

The longitudinal distribution of benthos within streams is affected by a host of ecological factors (Hawkes 1975) among them: (1) current velocity and substrate; (2) flow; (3) temperature; (4) dissolved oxygen; (5) dissolved nutrients and hardness; and (6) interactions with other organisms.

Data describing longitudinal variation in species composition and in the abundance of various macrobenthic taxa within the Hangingstone River are presented in Tables 12 through 18, and Figures 13 through 17.

Twenty species of Ephemeroptera nymphs were collected, of which *Baetis* sp., *Ephemerella (Ephemerella) inermis*, and *Heptagenia* sp. were the most common (Table 12, Figure 13). There was a tendency to zonal distribution among the various heptageniids [*Heptagenia, Rithrogena, Cinygmula,* and *Epeorus* (*Iron*)] and ephemerellids (*Ephemerella inermis, E. simplex, E. spinifera,* and *E. aurivillii*) (Table 12). Figure 13 illustrates the relative abundance of the dominant mayfly species at the sampling sites.

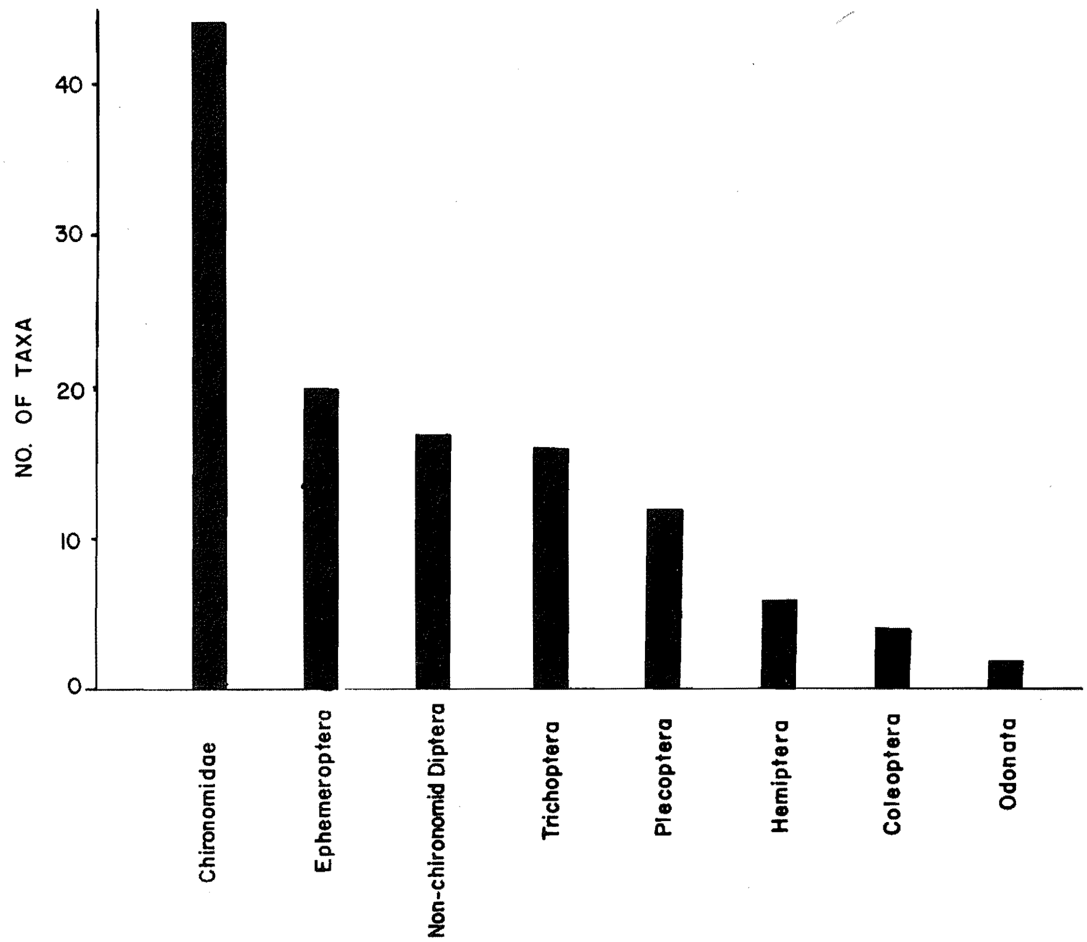


Figure 12. Taxonomic diversity of seven insect orders in the Hangingstone River, Alberta, June to October 1978.

Table 12. Longitudinal distribution of Ephemeroptera nymphs at Hangingstone River, Alberta, during the study period, June to October 1978.

Ephemeroptera	Station 1	2	3	4	5	6	8	9	10
Baetis sp.	----	----	----	----	----	----	----	----	----
Ephemerella (Ephemerella) inermis	----	----	----	----	----	----	----	----	
Heptagenia sp.	----	----	----	----	----	----	----		----
Rhithrogena sp.	----	----	----	----	----	----	----		
Pseudocloeon sp. 1	----	----	----	----	----	----			----
Pseudocloeon sp. 2	----	----	----	----					
Tricorythodes minutus	----								
Parameletus sp.	----								
Ameletus sp.		----		----	----	----	----		----
Metretopus borealis	----		----						
Brachycercus sp.			----						
Ephemerella simplex			----						
Cinygmula sp.			----		----	----	----	----	
Centroptilum sp.			----	----	----		----	----	
Stenonema sp.			----	----					----
Epeorus (Iron) sp.				----	----		----	----	
Ephemerella spinifera					----	----	----	----	----
Ephemerella aurivillii					----				
Leptophlebia sp.					----				----
Paraleptophlebia sp.							----		----
Total Number of Ephemeroptera Species	9	7	12	10	12	8	10	6	8

Table 13. Longitudinal distribution of Plecoptera and Odonata nymphs at Hangingstone River, Alberta, during the study period, June to October 1978.

	Station								
Plecoptera	1	2	3	4	5	6	8	9	10
Hastaperla sp.		----	----	----	----	----	----	----	----
Arcynopteryx sp.		----	----	----	----	----	----		----
Taeniopteryx sp.		----	----	----	----	----	----		
Pteronarcys (s.s.) *dorsata*		----	----	----	----	----			
Isoperla sp.		----	----	----		----			
Claassenia sabulosa		----	----				----		
Acroneuria sp.		----							
Capnia sp.		----					----		
Pteronarcella regularis			----	----	----	----	----	----	
Arcynopteryx (Megarcys) sp.				----					
Nemoura (Zapada) cinctipes				----	----	----	----		----
Leutra sp.							----		
Total Number of Plecoptera Species	0	8	7	8	5	7	8	2	3
Odonata									
Ophiogomphus sp.	----	----	----	----	----				
Somatochlora minor			----	----					
Total Number of Odonata Species	1	1	2	2	1	0	0	0	0

Table 14. Longitudinal distribution of Trichoptera larvae at Hangingstone River, Alberta, during the study period, June to August 1978.

Trichoptera	Station 1	2	3	4	5	6	8	9	10
Arctopsyche sp.	----	----		----	----		----	----	
Brachycentrus sp.		----	----	----	----	----	----	----	----
Glossosoma sp.		----	----	----	----	----	----	----	----
Hydropsyche sp. 4		----	----	----	----	----	----		----
Hydropsyche sp. 1		----		----	----	----	----		----
Hydropsyche sp. 2		----	----		----		----		----
Lepidostoma sp.		----	----			----			----
Cheumatopsyche sp.		----	----		----		----		----
Psychomyia flavida		----	----				----		
Onocosmoecus sp.		----				----			
Hydropsyche sp. 3			----	----			----		----
Apatania sp.								----	
Oecetis sp.									----
Polycentropus sp.									----
Hesperophylax sp.									----
Psychoglypha sp.									----
Total Number of Trichoptera Species	1	10	8	6	7	6	9	4	12

Table 15. Longitudinal distribution of Hemiptera and Coleoptera at Hangingstone River, Alberta, during the study period, June to August 1978.

Hemiptera	Station 1	2	3	4	5	6	8	9	10
Callicorixa audeni	----				----				
Gerris sp.					----				
Mesovelia mulsanti					----				
Hesperocorixa atopodonta						----	----		
Sigara solensis						----			
Sigara washingtonensis							----		----
Total Number of Hemiptera Species	1	0	0	0	3	2	2	0	1
Coleoptera									
Gyrinus sp.						----			
Dubiraphia sp.							----	----	
Agabus sp.									----
Optioservus sp.									----
Total Number of Coleoptera Species	0	0	0	0	0	1	1	1	2

Table 16. Longitudinal distribution of Diptera larvae (other than chironomids) at Hangingstone River, Alberta, during the study period, June to October 1978.

Diptera	Station 1	2	3	4	5	6	8	9	10
Hemerodromia sp.	----	----			----	----	----	----	----
Atherix sp.	----	----		----	----	----	----	----	
Bezzia sp.	----							----	
Tipula sp.	----					----		----	
Hexatoma sp.	----								
Simulium sp.		----	----	----			----	----	----
Limnophila sp.		----		----			----		
Wiedemannia sp.		----							
Chrysops sp.			----	----		----	----	----	
Ormosia sp.			----					----	
Chelifera sp.					----	----	----	----	
Dicranofa sp.						----	----	----	----
Pericoma sp.						----			
Rhaphium sp.							----	----	
Antocha sp.							----	----	
Limnophora sp.							----		
Chaoborus sp.									----
Total Number of Diptera Species	5	5	3	4	3	7	10	11	4

Table 17. Longitudinal distribution of Chironomidae larvae at Hangingstone River, Alberta, during the study period, June to August 1978.

Chironomidae	Station 1	2	3	4	5	6	8	9	10
Cricotopus sp.	----	----	----	----	----	----	----	----	----
Thienemannemyia sp.	----	----	----	----			----	----	----
Polypedilum fallax grp.	----		----	----		----	----		----
Eukiefferiella sp. 1	----			----			----		----
Parametriocnemus sp.	----	----					----		----
Ablabesmyia sp.	----			----					----
Nanocladius sp.	----					----		----	----
Brillia sp.	----	----	----				----		----
Orthocladius sp. 1	----	----	----			----	----		----
Odontomesa sp.	----					----	----	----	
Tanytarsus sp.	----				----	----	----	----	
Potthastia sp.	----			----			----		
Phaenopsectra (Tribelos) sp.	----	----			----				
Rheotanytarsus sp.	----	----	----		----				
Procladius sp.	----		----						
Cryptochironomus sp.	----								
Demicryptochironomus sp.	----								
Paratanytarsus sp.	----								
Cricotopus sp. 2		----				----			----
Eukiefferiella sp. 2		----							----
Polypedilum sp.		----	----			----		----	
Zavrelia sp.		----	----			----		----	
Cricotopus sp. 3		----							
Eukiefferiella sp. 3		----							
Eukiefferiella sp. 4		----							
Rheocricotopus sp.		----							
Paracladopelma sp.			----	----		----		----	----
Cladotanytarsus sp.			----	----		----			----
Chironomus sp.			----		----	----			

Continued...

Table 17. Concluded.

Chironomidae	Station 1	2	3	4	5	6	8	9	10
Paralauterborniella sp.			----						
Stictochironomus sp.				----	----	----		----	----
Thienemanniella sp.				----			----		----
Micropsectra sp.				----		----	----		----
Synorthocladius sp.				----					----
Parakiefferiella sp.				----		----		----	
Syncricotopus sp.				----					----
Monodiamesa sp.					----	----	----	----	
Paratrichocladius sp.						----			
Diamesa sp.							----		----
Pseudodiamesa sp.							----		
Orthocladius sp.							----		
Heterotrissocladius marcidus grp.								----	
Metriocnemus sp.									----
Nilotanypus sp.									----
Total Number of Chironomidae Species	18	15	13	14	7	17	16	12	21

Table 18. Longitudinal distribution of Oligochaeta, Nematoda, Hirudinea, Crustacea, Amphipoda, Hydracarina, and Mollusca at the Hangingstone River, Alberta, during the study period, June to October 1978.

Taxa	Station 1	2	3	4	5	6	8	9	10
Oligochaeta	----	----	----	----	----	----	----	----	----
Nematoda				----			----		----
Diura parva								----	----
Glossiphonia complanata									----
Helobdella stagnalis									----
Nephelopsis obscura									----
Daphnia pulex									----
Hyalella azteca					----				----
Hydracarina sp.							----		----
Ferrissia sp.	----								
Pisidium sp.									----
Sphaerium sp.									----
Promenetus sp.									----
Physa sp.									----

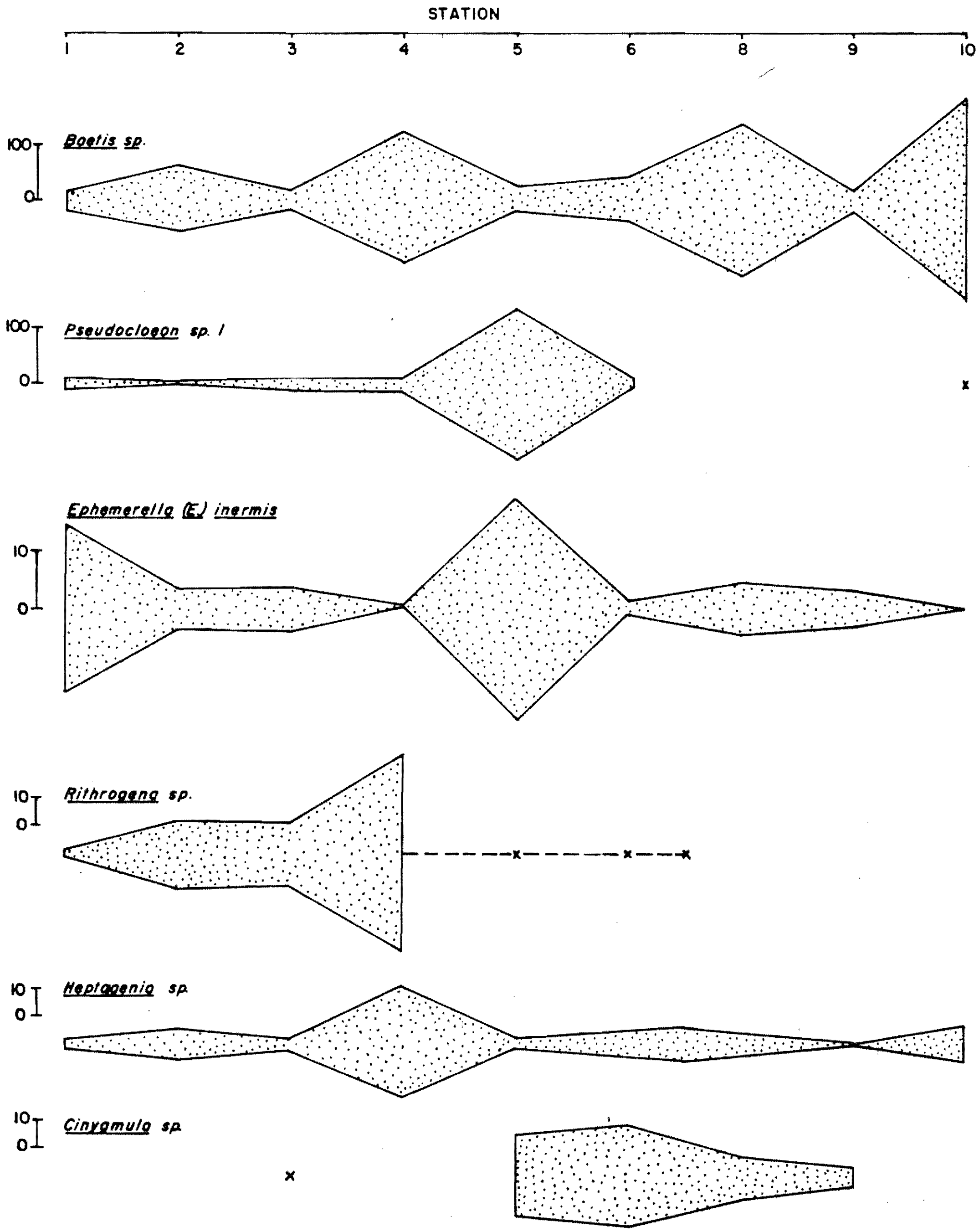


Figure 13. Longitudinal distribution and abundance (no./m^2) of dominant Ephemeroptera species in the Hangingstone River, June to October 1978.

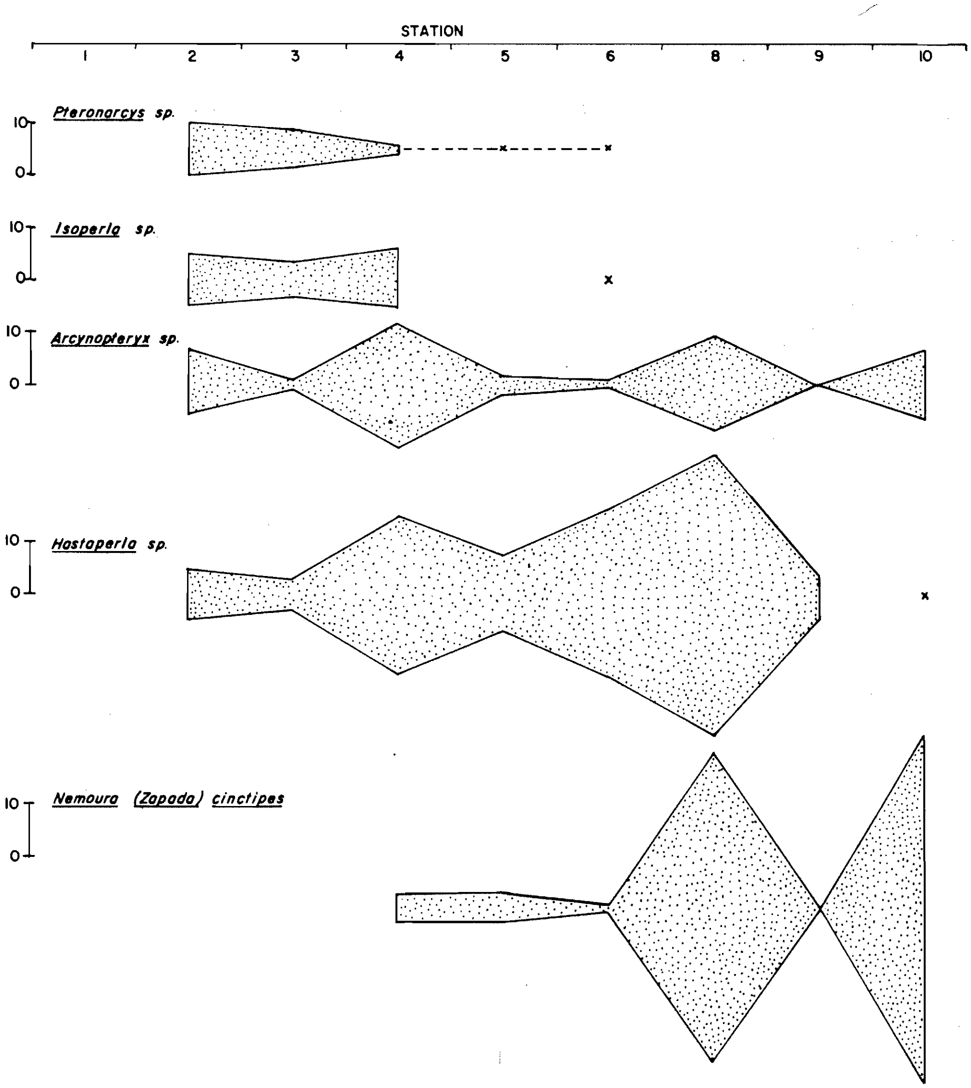


Figure 14. Longitudinal distribution and abundance (no./m^2) of dominant Plecoptera species from the Hangingstone River, June to October 1978.

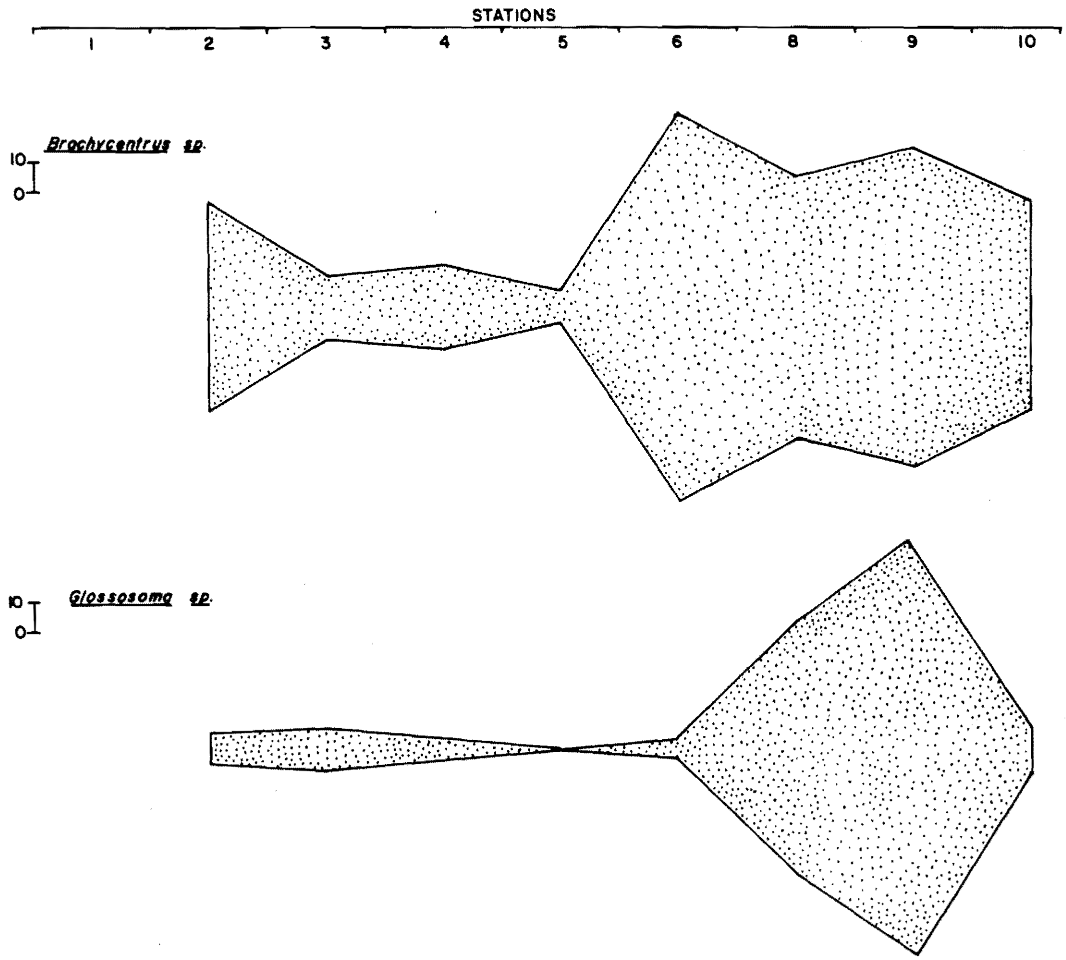


Figure 15. Longitudinal distribution and abundance of two Trichoptera species in the Hangingstone River, June to October 1978.

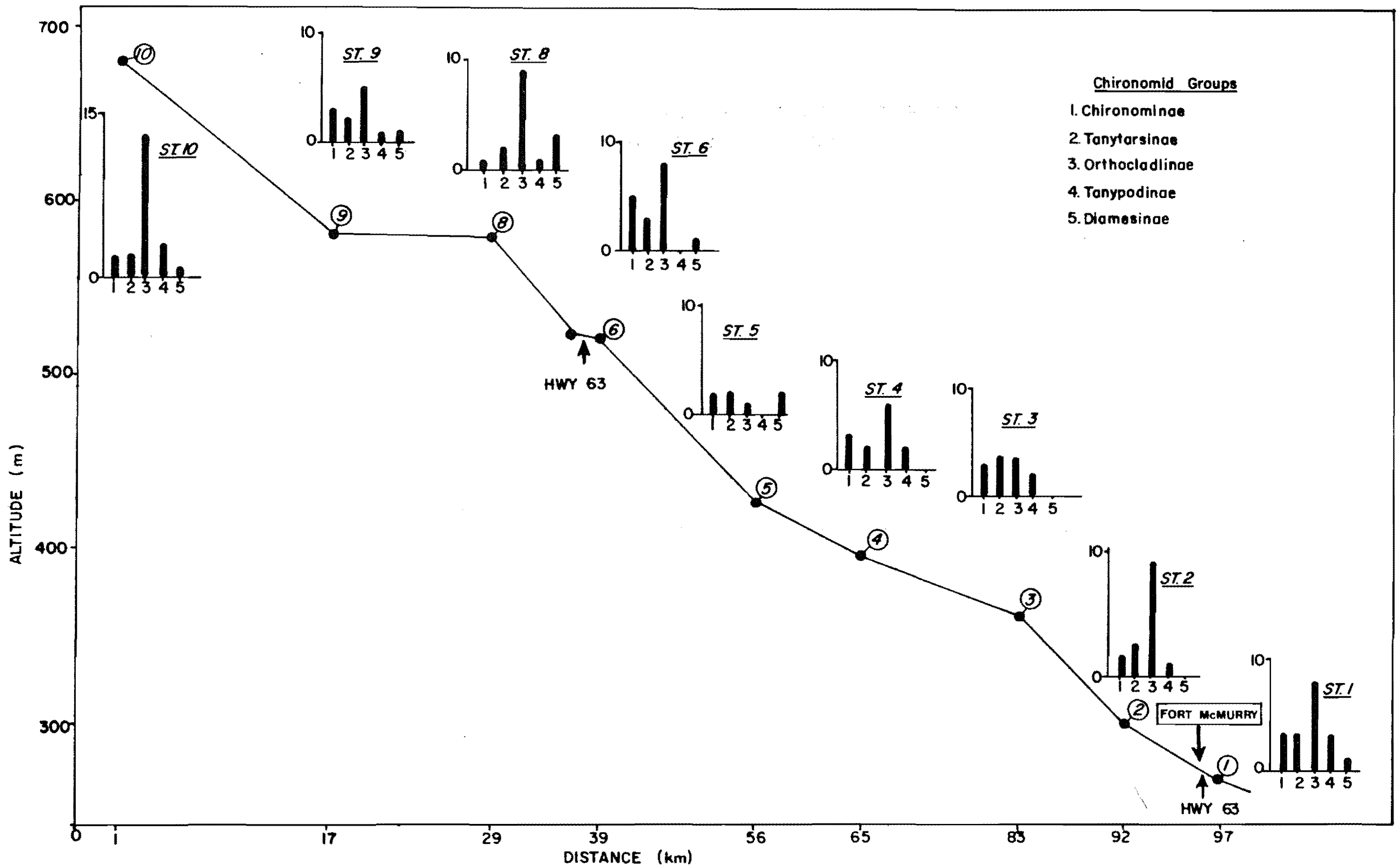


Figure 16. Number of Chironomidae species within each major chironomid group (sub-family) of the Hangingstone River, Alberta, June to October 1978.

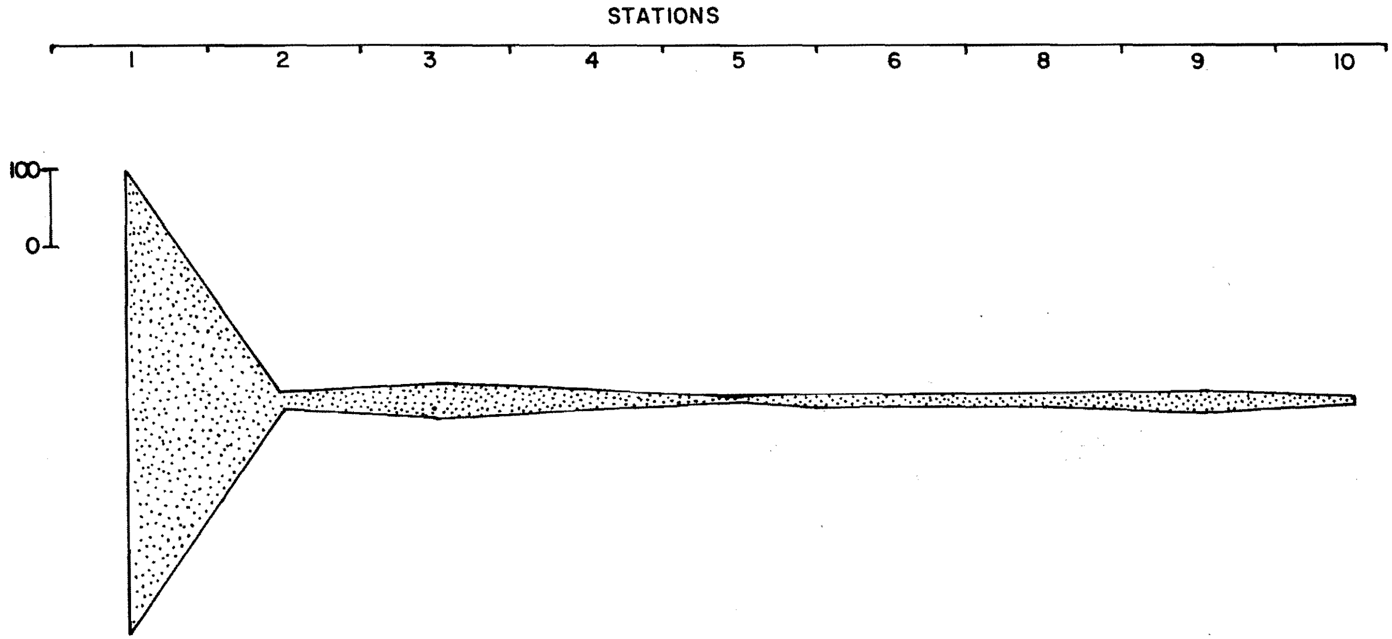


Figure 17. Longitudinal distribution and abundance (no./m^2) of Oligochaeta in the Hangingstone River, June to October 1978.

Twelve species of Plecoptera nymphs were collected from the Hangingstone River (Table 13, Figure 14). The longitudinal distribution and abundance of several dominants are shown in Table 13 and Figure 14. *Hastaperla* (probably *brevis* sp.) and *Arcynopteryx* sp. appeared to be the more common species in the river system. *Pternonarcys dorsata* and *Isoperla* sp. appeared to be more abundant in the lower reaches whereas *Nemoura (Zapada) cinctipes* was more common in the upper reaches. It is noteworthy that stoneflies were absent at Station 1, which is situated in the town of Fort McMurray. Urban runoff may have been responsible for the absence of stoneflies.

Only two species of Odonata nymphs have been collected from the project study area, *Ophiogomphus* sp. and *Somatochlora minor*. Both species occurred only in the lower reaches of the Hangingstone River with *S. minor* occurring only in the slow-flowing areas (Table 13).

Sixteen species of Trichoptera larvae have been identified from the collections (Table 14 and Figure 15). *Brachycentrus* sp. and *Glossosoma* sp. were the two dominant species. Both species appeared to be more abundant in the upper reaches of the Hangingstone River (Figure 15). *Oecetis* sp., *Polycentropus* sp., *Hesperophylax* sp., and *Psychoglypha* sp. appeared to be confined to the slow flowing headwater areas (Station 10). As with the stoneflies, caddisfly larvae were virtually absent at Station 1, the exception being a hydropsychid species (*Arctopsyche* sp.).

Hemiptera, collected in the Hangingstone River, appeared to have a restricted distribution. *Callicorixa ardent* was the only species found below Station 5 (Table 15).

The four species of Coleoptera found in the Hangingstone River were all confined to the upper reaches (Table 15).

Sixty-one Diptera species were differentiated in the Hangingstone River collections, of which 44 were Chironomidae (Tables 16 and 17, Figure 16). The empidid species, *Hemerodromia*, and the carnivorous larvae of *Atherix* sp., appeared to be the common non-chironomid dipterans (Table 16). Blackfly larvae, *Simulium* sp., were also widely distributed in the watershed. Longitudinal distribution of the 44 chironomid species is shown in Table 17.

No distinct zonal distribution patterns were identifiable at the subfamilial level (Figure 16); however, it appeared that the Orthocladiinae were the dominant group in most stretches of the river. At the specific level, *Cricotopus* sp. and *Thienemannemyia* sp. were the common chironomid species (Table 17). Coldwater species (e.g., *Diamesa, Pseudodiamesa, Heterotrissocladius marcidus* grp.) were all restricted to the headwater areas, whereas silt tolerant species (e.g., *Cryptochironomus* and *Procladius*) were confined to the lower reaches of the river.

Data on the distributions of other invertebrates are presented in Table 18. Oligochaeta occurred at all stations with the highest density at Station 1 (Figure 17). This may be an indication of localized eutrophication as a result of urban runoff from Fort McMurray.

Four species of Hirudinea were found (*Diura parva, Glossiphonia complanata, Helobdella stagnalis, Nephelopsis obscura*), all confined to the headwater areas (Station 10). Of the five species of Mollusca found in the study area, *Pisidium* sp., *Sphaerium* sp., *Promenetus* sp., *Physa* sp., and *Ferrissia* sp., only the latter was found below Station 10.

4.3.1.2 Seasonal variation in community structure There were distinct seasonal variations in macrobenthic community structure (Figure 18). Only data for the Ephemeroptera, Plecoptera, Trichoptera, and Diptera will be presented since together they constituted about 90% of the benthic population. In June, Ephemeroptera were the dominant order at most stations. In August, however, there was a shift in dominance to Trichoptera and/or Diptera at most stations. The decline in benthic mayfly populations during August results from the fact that many of them (e.g., *Metrotopus borealis, Ephemerella inermis, Baetis* sp., *Pseudocloen* sp., and *Cinygmula* sp.) are in the winged stage during the summer. The increases in trichopteran and dipteran densities during August were most likely due to the hatching of caddisflies (*Brachycentrus* sp. and *Glossosoma* sp.) and of many chironomid species, in particular *Cricotopus* sp.

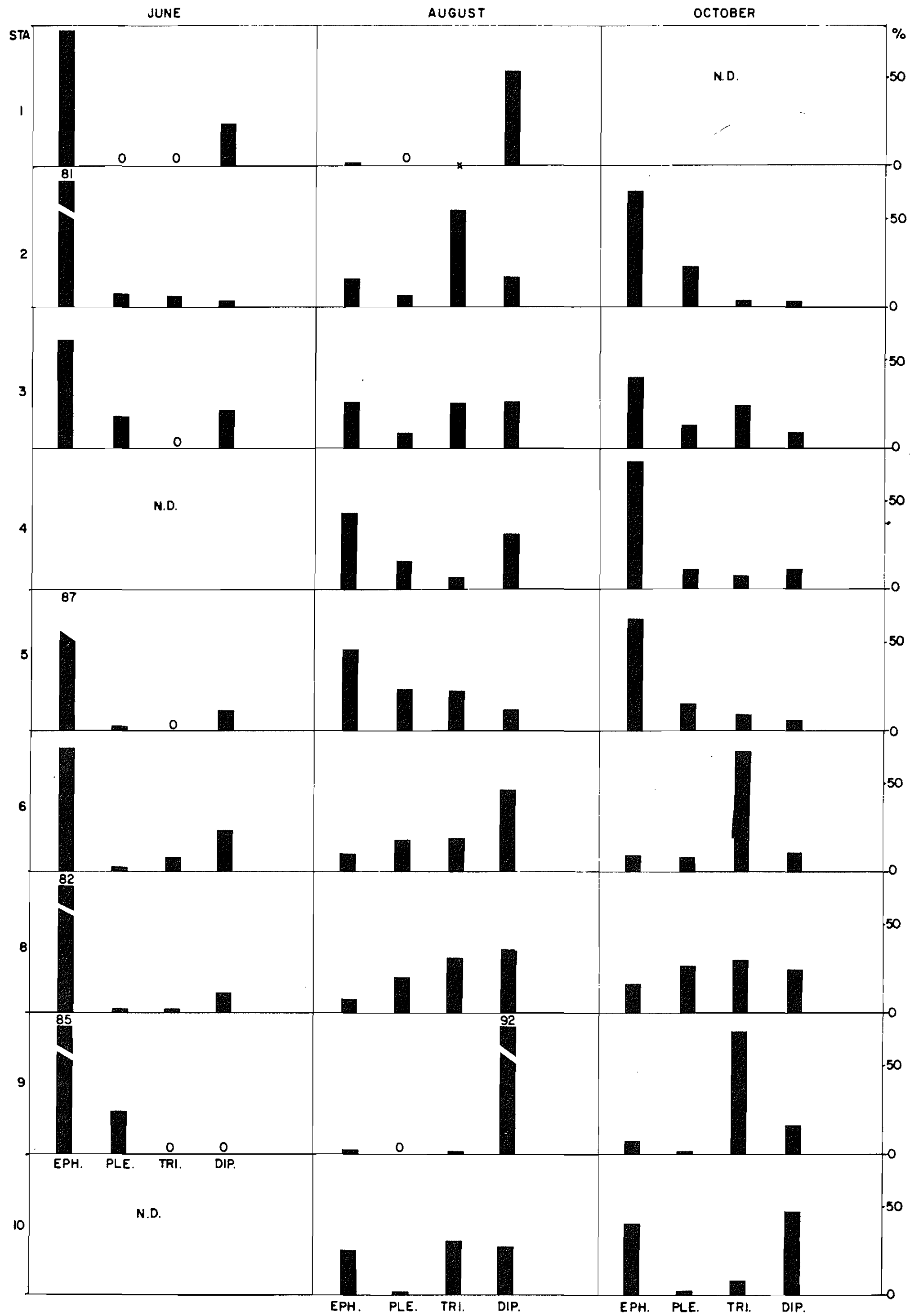


Figure 18. Longitudinal and seasonal variations in the percentage composition of the major macrobenthic invertebrate taxa of the Hangingstone River, Alberta, June to October 1978. EPH=Ephemeroptera, PLE=Plecoptera, TRI=Trichoptera, DIP=Diptera.

In October, the lower half of the Hangingstone River (Stations 1 to 5) was dominated by young Ephemeroptera nymphs (*Ephemerella inermis*, *Baetis* sp., *Heptagenia* sp., and *Rhithrogena* sp.). In the upper half (Stations 6 through 10) of the river, there was a continuous (or delayed) hatching of large numbers of the larvae of the caddisfly *Brachycentrus* sp. In August, maximum densities of larval *Brachycentrus* in the lower and upper halves of the Hangingstone River were $207/m^2$ and $100/m^2$, respecively; in October, they were $68/m^2$ and $336/m^2$, respectively. Stream temperature was most likely the factor (Figure 11) which caused this difference in emergence peaks. Stream temperatures were generally lower in the upper segment of the stream than in the lower (see Table 7).

4.3.1.3 Seasonal variations in community diversities. Parameters used in describing the benthic community included the Shannon-Weaver species diversity index ($\bar{d}$), equitability (e - a measure of population evenness), and the total number of invertebrate taxa collected (s). Seasonal and longitudinal variations in these parameters are shown in Figure 19.

Diversity tended to be slightly higher in August than in June or October at most stations, e showed little variation with season at most stations, and s showed no consistent trend with season at individual stations. Longitudinal trends in $\bar{d}$ apparently varied with season, although the trends were never pronounced. Diversity tended to decrease slightly from Station 1 to 10 in June, increase slightly from Stations 1 to 10 in August, and showed no trend in October. Equitability showed no longitudinal trend in any season, and s showed no consistent trend, but in October was higher at Stations 8, 9, and 10 than at Stations 1 to 6.

4.3.1.4 Seasonal variations in standing crop. The standing crop of the macrobenthos was determined both as density (no./m^2) and biovolume (cc/m^2). Figure 20 shows seasonal and longitudinal variations in standing crop of macrobenthos during the study period.

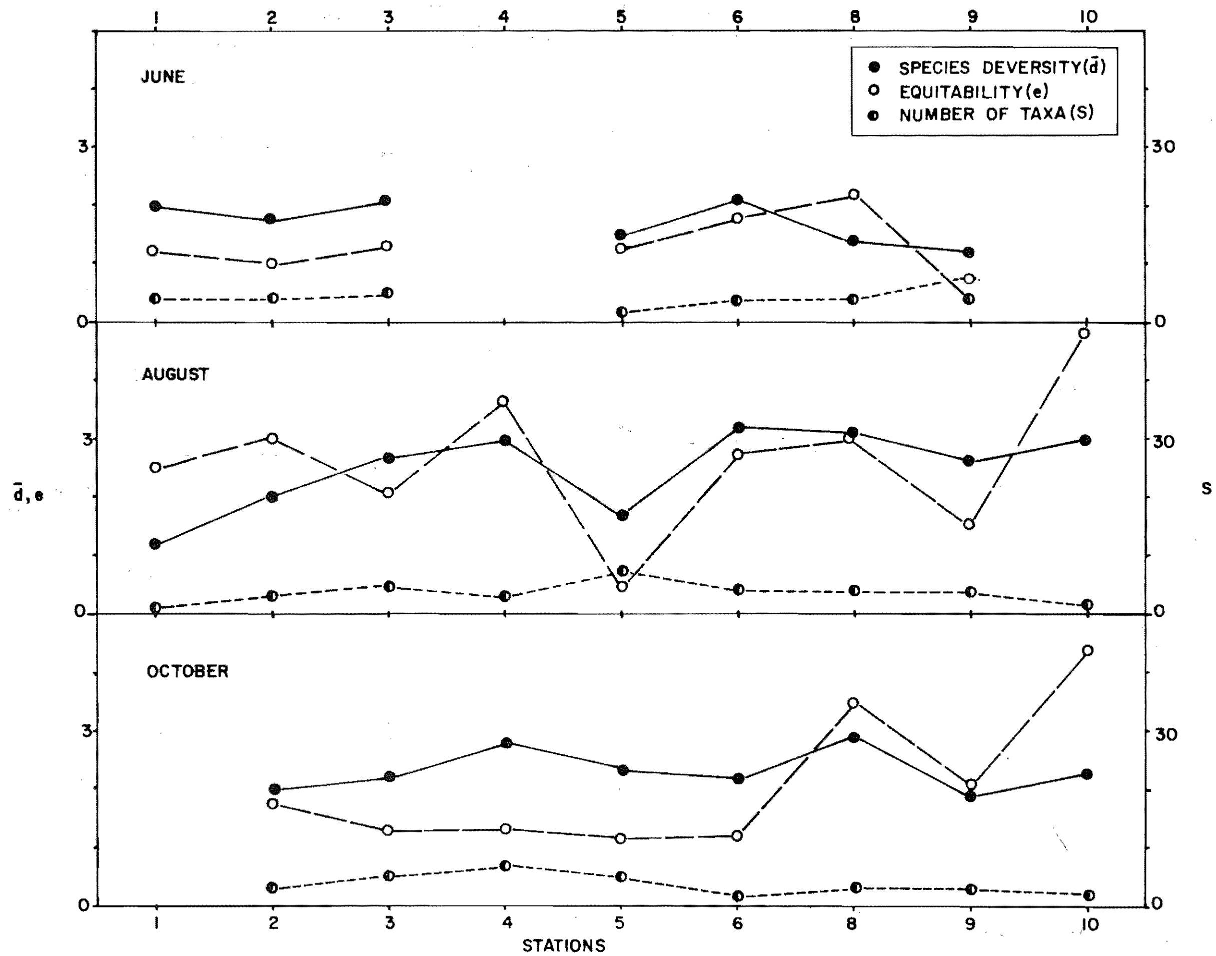


Figure 19. Seasonal and longitudinal variation in the diversity of the macrobenthic community in the Hangingstone River, Alberta, 1978.

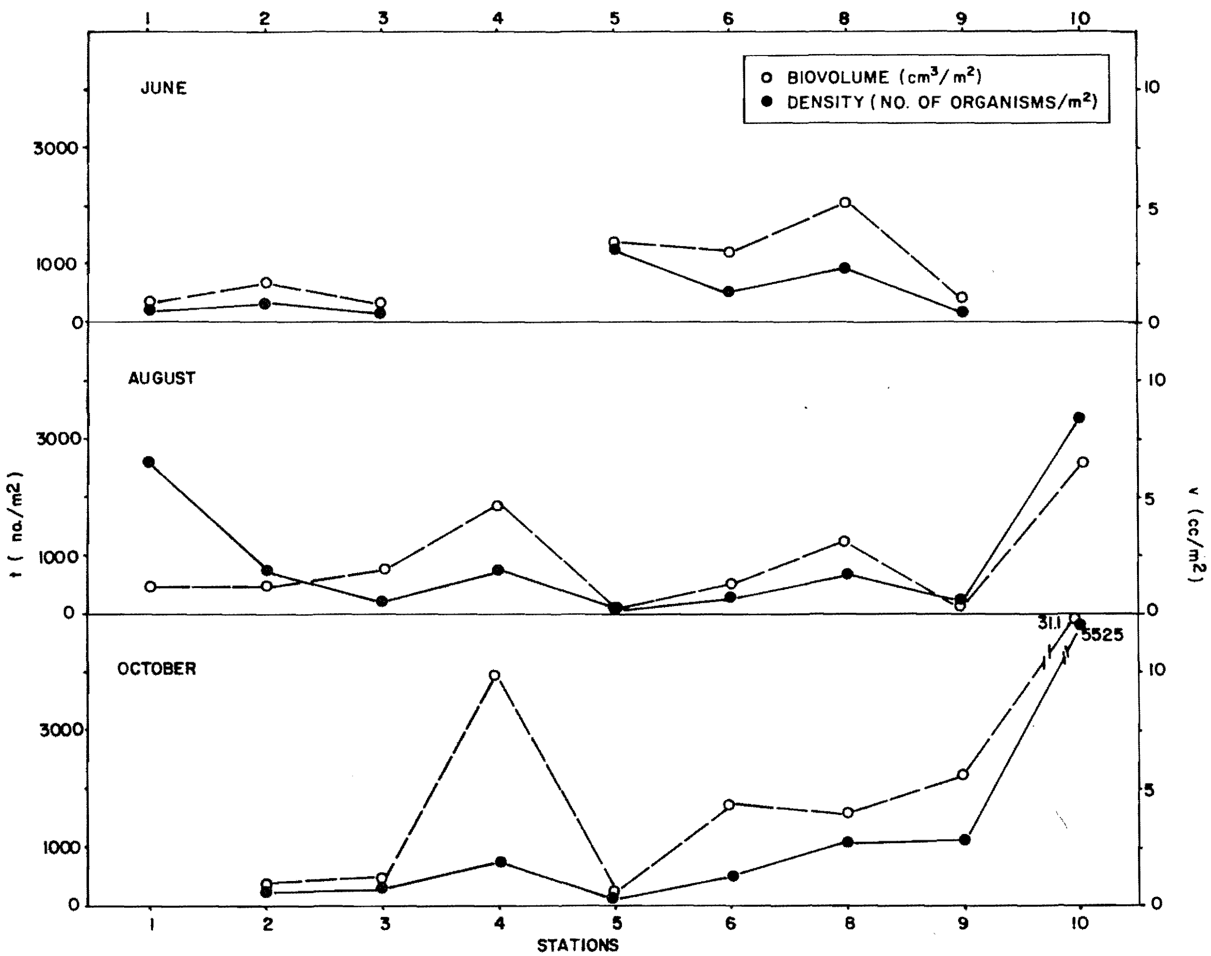


Figure 20. Seasonal and longitudinal variations in standing crop of the macrobenthos in the Hangingstone River, Alberta, 1978.

Standing crop was lowest during June, with densities ranging from 144 to 1252/m^2 and biovolumes from 0.7 to 5.2 cc/m^2, and highest in October, with densities ranging from 205 to 5525/m^2 and biovolumes from 0.1 to 31.1 cc/m^2. Clifford (1978), in his study of a brown-water stream in Alberta, also found a minimum standing crop in spring and maximum numbers in the fall. The low spring standing crop was probably due to the emergence of many aquatic insects while the high autumn standing crop was most likely due to the hatching of large numbers of individuals of the new generation.

4.3.1.5 Invertebrate drift. An invertebrate drift study was conducted on 12 to 13 August 1978 at Station 1 on the Hangingstone River. The objectives of this study were:

1. To determine the qualitative composition of the drift; and
2. To quantify total drift density (no./m^3) and drift rates (no./h).

4.3.1.5.1 Drift Composition. In total, 484 drifting invertebrates were collected in six, one hour drift samples, taken at 4 h intervals over a single diel period. Each sample consisted of three replicates. Table 19 describes the total number of organisms collected and their percentage contribution to the drift. The results indicate that the drift fauna was composed almost entirely of the larvae of chironomid dipterans (58.46%) and oligochaetes (36.98%). In this instance, the qualitative composition of the drift closely approximated that of the benthic fauna at Station 1. Bottom samples taken in August at the same location (Volume II, Table 1) showed that Chironomidae and Oligochaeta made up 51.51% and 45.79%, respectively, of the benthic fauna. Larimore (1974) found that the numbers of oligochaetes, which infrequently drift, increased with declining water quality. The drift data from this study may therefore indicate that water quality in the lower end of the Hangingstone River was rather poor, presumably as a result of urban runoff from the town of Fort McMurray.

Table 19. Total number of drifting invertebrates collected during a single diel period and their relative frequencies at Station 1 of the Hangingstone River, Alberta, 12 to 13 August 1978.

Taxon	No. Collected	Percent
Oligochaeta	179	36.98
Nematoda	1	0.21
Ephemeroptera	7	1.45
Plecoptera	1	0.21
Trichoptera	3	0.62
Diptera		
Chironomidae	283	58.46
Other Dipterans	10	2.07
Total	484	

4.3.1.5.2 Drift rate and drift density. Total stream discharge and discharge rates at the mouth of each drift net were determined during the middle of each one hour sampling period in order to compute the benthic drift rate (number of organisms/hour) and drift density (number of organisms/m^3) at Station 1 on the Hangingstone River. In this study, drift rate is defined as the quantity of organisms passing downstream, per unit time, through the entire width of the stream. Drift density is defined as the quantity of organisms passing downstream per unit-volume of water. The results are presented in Table 20.

The mean drift rate during the 24 h sample period 12 to 13 August was 792.10 organisms/hour, ranging from 35.6 to 2079.4 organisms/hour. For a similar time period, drift rate at the Hangingstone River was much lower than that, 38 825.4 organisms/hour, determined for the MacKay River during the month of August (McCart et al. 1978). Mean drift density in the Hangingstone River was only 0.17 organisms/m^3 during the study period with a peak of 0.38 organisms/m^3 at dusk. By comparison, mean drift density for the MacKay River was 31.72 organisms/m^3 (McCart et al. 1978).

4.3.2 The Christina-Gregoire Drainage

The study area within the Christina-Gregoire drainage consisted of Gregoire Lake, the Gregoire River, and that portion of the Christina River downstream from its confluence with the Gregoire River. Gregoire Lake and Gregoire River were sampled only during the month of August, whereas the Christina was sampled during June, August, and October 1978. Greater emphasis was placed on the Christina since it is typical of large streams of moderate velocity in the southern portion of the AOSERP study area.

4.3.2.1 Gregoire Lake. Twenty-three macrobenthic taxa were found in Gregoire Lake. These had an average density of 2193 organisms/m^2 and an average displacement volume of 5.22 cc/m^2. The lake is dominated by chironomid larvae which accounted for about 76% of the total macrobenthos sampled (Table 21). *Polypedilum* sp.,

Table 20. Fluctuations in total benthic drift densities and drift rates for a single diel period in August at Station 1 of the Hangingstone River, 1978.

				DUSK-	--------DARK------	-----DAWN
Time (MDT)[a]:	1000-1100	1400-1500	1800-1900	2200-2300	0200-0300	0600-0700
Total Drift Rate (No./h)	78.80	1280.50	2079.40	133.20	1145.02	35.60
Total Drift Density (No./m^3)	0.024	0.26	0.38	0.04	0.31	0.01

[a]MDT: Mountain Daylight Time

Table 21. Percent composition of the macrobenthic fauna of Gregoire Lake, Alberta, August 1978.

Arthropoda (88.63)	Insecta (80.79)	Diptera	76.08
		Trichoptera	3.14
		Ephemeroptera	1.57
	Amphipoda (7.84)		7.84
Oligochaeta (7.06)			7.06
Mollusca (4.31)			4.31

Tanytarsus sp., and *Procladius* sp. were common in the deeper area of the lake whereas the littoral zone was dominated by *Stictochironomus* sp. The higher proportion of amphipods to oligochaetes in the littoral and sublittoral zones suggests that the lake is most likely mesotrophic. The higher densities of the chironomid larvae *Polypedilum* sp., *Procladius* sp., and *Tanytarsus* sp. in the profundal zone also suggest mesotrophy.

4.3.2.2 Gregoire River. The Gregoire River has a rich macrobenthic fauna. In total, 82 invertebrate taxa were identified at the three stations sampled during the month of August (Volume II, Table 19). The distribution and abundance of the macrobenthos were largely a function of substrate characteristics.

At Station 1, where the substrate is predominantly boulder and rubble, the bottom fauna was dominated by Ephemeroptera (40%) and Plecoptera (22%) nymphs and Trichoptera larvae (11%). Twenty macrobenthic taxa were identified and the community diversity index ($\bar{d}$) was 2.59. Standing crop at Station 1 was 312 organisms/m^2 with a displacement volume of 1.67 cc/m^2. Dominant species found in this section of the Gregoire River included *Baetis* sp. (mayfly), *Arcynopteryx* sp. (stonefly), and several species of *Hydropsyche* (caddisflies).

Station 3 has a predominantly sand substrate and the bottom fauna was dominated by the larvae of Chironomidae (50%), Tipulidae (23%), and Trichoptera (14%). The dominant species were *Tanytarsus* sp. (chironomid) and *Limnophila* sp. (tipulid), both are commonly found where there are sandy substrates. The taxonomic and community diversity indices were 13 and 2.30, respectively. Density of the bottom fauna was 486 organisms/m^2 with a displacement volume of 4.35 cc/m^2.

Station 4 also has a sandy bottom, and the macrobenthic community was dominated (80%) by a single species of caddisfly of the genus *Brachycentrus*. Larvae of *Brachycentrus* sp. are restricted to running waters, and typically, their cases are built with plant materials. Mecom and Cummins (1964) found the larvae to be predominantly filter-feeders. They ingest diatoms, filamentous algae, vascular plant detritus, and small insects. Although the taxonomic diversity was relatively high (18 species) at Station 4, community diversity was suppressed (1.67) because of the preponderance of a single species, *Brachycentrus* sp. Standing crop was 513 organisms/m^2 and the displacement volume was 3.89 cc/m^2.

4.3.2.3 Christina River. The macrobenthos of the Christina River was sampled at four locations on three different occasions (June, August, and October) during 1978. The results are summarized in Volume II, Tables 20 to 27.

4.3.2.3.1 Community structure. Over 70% of the macrobenthic fauna of the Christina River was made up of Ephemeroptera and Plecoptera nymphs and Trichoptera and Diptera larvae. The proportions of these major invertebrate taxa varied both longitudinally and seasonally (Figure 21). During spring and autumn, mayflies were the dominant order at Stations 1 and 4. Stoneflies appeared to be more common downstream than upstream, but the reverse was true for caddisflies. No distinct distributional pattern was observed for Diptera at the ordinal level, except that, during the summer, it was the dominant order at all stations.

4.3.2.3.2 Species composition. An analysis of the dominant macrobenthic species of the Christina River indicates that the composition of the dominants shifted both longitudinally and seasonally. For purposes of this study, a species is considered to be a dominant when it constitutes 10% or more of the bottom fauna. Table 22 summarizes longitudinal and seasonal variations in the dominant benthos of the Christina River. The mayfly nymphs, *Ephemerella (Ephemerella) inermis*, *Rhithrogena* sp., and *Baetis* sp., together with the larvae of the chironomid *Rheotanytarsus* sp. and the caddisfly *Cheumatopsyche* sp. formed the dominant benthos in the late spring (June). In August, the composition of the dominant benthos varied from station to station. Chironomid species appeared to be

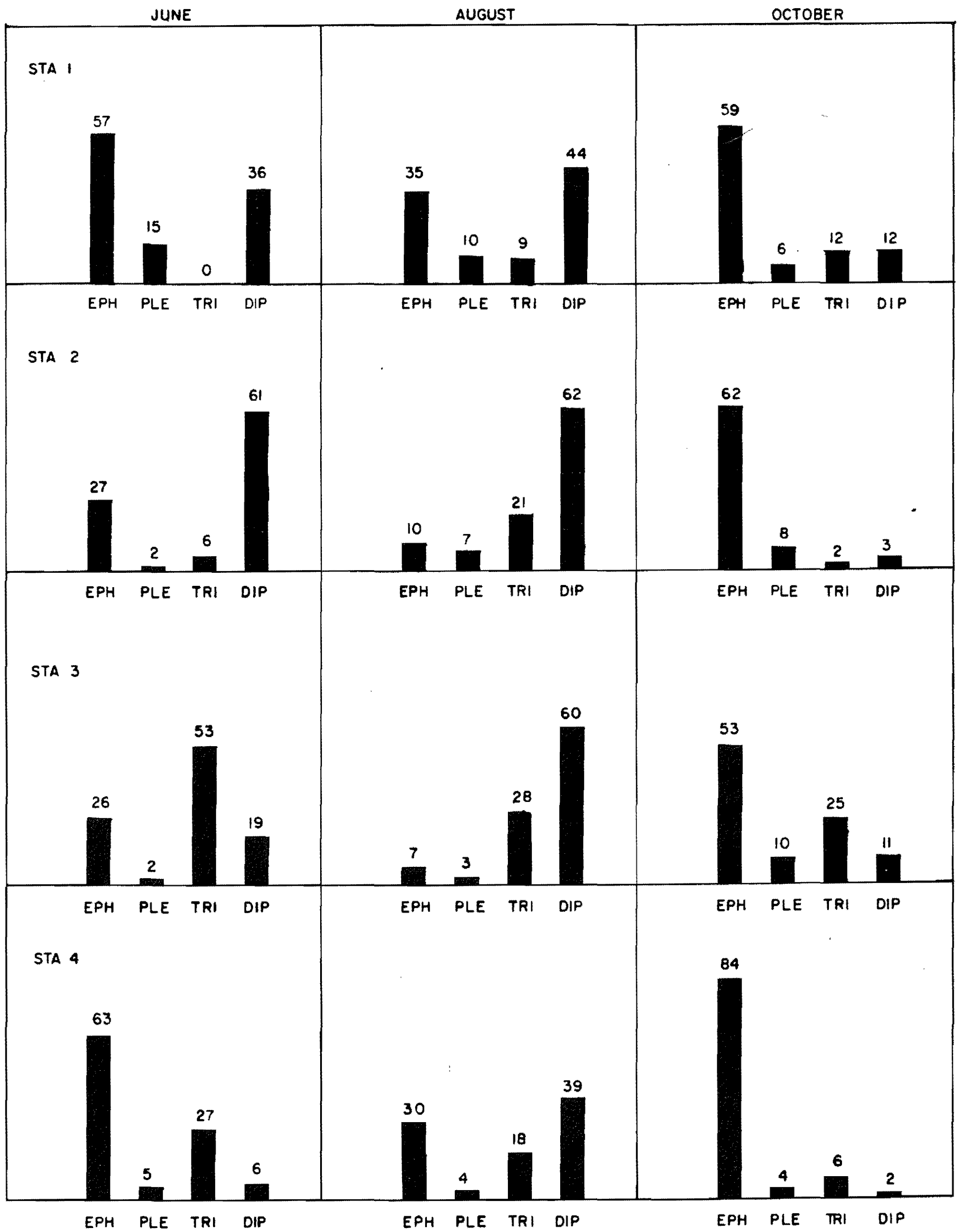


Figure 21. Longitudinal and seasonal variations in the percentage composition of the major macrobenthic taxa of the Christina River, Alberta, June to October 1978. Numbers on top of the bars are percentages. EPH=Ephemeroptera, PLE=Plecoptera, TRI=Trichoptera, DIP=Diptera.

Table 22. Longitudinal and seasonal variation in the dominant macrobenthos at Stations 1 through 4, Christina River, Alberta, June to October 1978.

Station	June	August	October
1	Ephemeroptera *Ephemerella (E.) inermis* *Rhithrogena* sp. Diptera *Rheotanytarsus* sp.	Ephemeroptera *Rhithrogena* sp. Diptera *Chironomus* sp. *Cricotopus* sp. *Rheotanytarsus* sp. *Tanytarsus* sp.	Oligochaeta Ephemeroptera *Baetis* sp. *Ephemerella (E.) inermis* Trichoptera *Oecetis* sp.
2	Ephemeroptera *Ephemerella (E.) inermis* *Rhithrogena* sp. Diptera *Rheotanytarsus* sp.	Ephemeroptera *Tricorythodes* sp. Diptera *Rheotanytarsus* sp.	Oligochaeta Ephemeroptera *Ameletus* sp. *Baetis* sp.
3	Ephemeroptera *Ephemerella (E.) inermis* *Rhithrogena* sp. Trichoptera *Cheumatopsyche* sp.	Trichoptera *Hydropsyche* spp. Diptera *Atherix* sp. *Chironomus* sp. *Rheotanytarsus* sp.	Ephemeroptera *Baetis* sp. *Ephemerella (E.) inermis* *Rhithrogena* sp.
4	Ephemeroptera *Baetis* sp. *Ephemerella (E.) inermis* *Rhithrogena* sp. Trichoptera *Cheumatopsyche* sp.	Ephemeroptera *Baetis* sp. *Heptagenia* sp.	Ephemeroptera *Baetis* sp. *Ephemerella (E.) inermis*

more common in the lower reaches (Stations 1 and 2), whereas mayflies, *Baetis* sp. and *Heptagenia* sp. were more common upstream (Station 4). In October, the mayflies, *Baetis* sp. and *Ephemerella (Ephemerella) inermis*, were the dominant benthos at all stations. Oligochaetes, together with the caddisfly *Oecetis* sp. and the mayflies *Ameletus* sp. and *Rhithrogena* sp., were also common in the fall.

4.3.2.3.3 Species diversity. Data describing longitudinal and seasonal variations in the taxonomic diversity, Shannon-Weaver species diversity indices, and equitabilities are summarized in Table 23. Annual mean values indicate that both taxonomic (t) and species diversity ($\bar{d}$) were highest at Station 3 and lowest at Station 1. Seasonally, the benthic community of Christina River had the greatest diversity during summer (August) and least diversity during the spring (June).

4.3.2.3.4 Standing crop. Data on longitudinal and seasonal variation in the standing crop of the macrobenthic communities of Christina River are summarized in Table 24. On an annual basis, standing crop, in terms of both density and displacement volume, was highest at Station 3 and lowest at Station 1. Seasonally, standing crop was highest in the summer (August) and lowest in spring (June). The mean annual density of the macrobenthos at Christina River was 833 organisms/m^2 and the mean displacement was 3.56 cc/m^2.

4.3.3 Other Waterbodies

4.3.3.1 Algar Lake. Algar Lake is a large, shallow, dystrophic lake located in an area of poorly drained muskeg. Benthos were collected along half transects at three sampling stations (Figure 2) on 21 August. The resultant data are summarized in Volume II, Tables 28 and 29.

Table 23. Longitudinal and seasonal variation in the taxonomic diversity (t), Shannon-Weaver species diversity indices ($\bar{d}$), and equitability (e) of the macrobenthic communities at Stations 1 through 4, Christina River, Alberta, June to October 1978.

Station	Parameter	June	August	October	Annual Mean
1	t	5	34	14	17.67
	$\bar{d}$	1.27	2.50	2.17	1.98
	e	0.60	0.24	0.43	0.42
2	t	17	30	13	20.0
	$\bar{d}$	1.80	2.43	1.65	1.96
	e	0.29	0.25	0.31	0.28
3	t	18	32	30	26.67
	$\bar{d}$	2.10	2.35	2.65	2.34
	e	0.38	0.23	0.29	0.30
4	t	13	31	16	20.0
	$\bar{d}$	2.12	3.06	1.32	2.17
	e	0.43	0.38	0.18	0.33
Seasonal Mean	t	13	31.75	18.25	
	$\bar{d}$	1.82	2.59	1.95	
	e	0.43	0.28	0.30	

Table 24. Longitudinal and seasonal variations in the density (d) and biovolume (v) of the macrobenthos at Stations 1 through 4, Christina River, Alberta, June to October 1978.

Station	Parameter	June	August	October	Annual Mean
1	d[a]	53	1373	410	612
	v[b]	1.10	2.78	1.67	1.85
2	d	381	1168	768	772
	v	1.85	5.92	2.22	3.33
3	d	301	2111	1369	1260
	v	2.76	12.22	5.56	6.85
4	d	223	643	1194	687
	v	1.11	3.33	2.22	2.22
Seasonal Mean	d	239	1324	935	
	v	1.71	6.06	2.92	

[a] number of macrobenthos/m^2

[b] cc of macrobenthos/m^2

A total of 14 macrobenthic species was collected from Algar Lake. The littoral area was dominated by the amphipod *Hyalella azteca* and the chironomid larvae *Chironomus* sp. and *Procladius* sp. In the deeper part of the lake, oligochaetes, the chironomid *Stictochironomus* sp., and the pill clam *Pisidium* sp. made up the greater part of the benthic community. Mean standing crop was 1339 organisms/m^2 and mean displacement was 38.71 cc/m^2.

4.3.3.2 Algar River. Macrobenthos were collected from three sites (Figure 2) in the Algar River, 21 August 1978. The data are presented in Volume II, Tables 30 and 31.

The Algar River is typical of many boreal brown-water streams and supports macrobenthic fauna which is characterized by relatively low diversity but high standing crop.

At Station 1, the substrate is predominantly gravel and rubble. The benthic fauna is dominated by the larvae of the caddisflies *Arctopsyche* sp. and *Hydropsyche* sp., and the nymphs of the mayfly *Heptagenia* sp. The standing crop was 817 organisms/m^2 with a displacement volume of 8.07 cc/m^2.

Stations 2 and 3 were located in a muskeg area where the substrates were predominantly organic detritus. The dominants included oligochaetes, pill clams (*Pisidium* sp.), and the larvae of the chironomid *Thienemannimyia* sp. and the marsh caddisfly *Ptilostomis* sp. A surface-dwelling hemipteran (*Sigara fallenoidea*) and coleopteran adults (*Haliplus* sp.) were also common. Standing crops at Stations 2 and 3 were 266 organisms/m^2 and 1443 organisms/m^2, respectively, with displacement volumes of 4.30 cc/m^2 and 10.75 cc/m^2, respectively.

4.3.3.3 Cameron Creek. The macrobenthos of Cameron Creek was sampled at Station 1 (Figure 2), 23 August 1978. The data are presented in Volume II, Tables 32 and 33.

Twenty macrobenthic invertebrate taxa were found, dominated by the larvae of trichopteran *Glossosoma* sp. and *Brachycentrus* sp. The standing crop was 616 organisms/m , with a displacement volume of 4.28 cc/m^2.

4.3.3.4 Horse River. The macrobenthos of the Horse River was sampled at four stations (Figure 2). The data are summarized in Volume II, Tables 34 and 35.

A total of 71 benthic invertebrate taxa was found, dominated by the Trichoptera and Diptera. Dominant species were larvae of the caddisflies *Cheumatopsyche* sp., *Glossósoma* sp., *Brachycentrus* sp., and the chironomid *Eukiefferiella* sp. The mean standing crop for the four stations was 1545 organisms/m^2 and the mean displacement volume was 4.18 cc/m^2.

4.3.3.5 Prairie Creek. Prairie Creek was sampled at one site on 17 August 1978. Data are presented in Volume II, Tables 36 and 37.

Twenty-one benthic taxa were identified from the collections. Because of the predominantly sand-silt and organic detritus substrates at the sampling sites, the bottom fauna was dominated by the pill clam *Pisidium* sp., oligochaetes, and the amphipod *Gammarus lacustris*. Standing crop was 498 organisms/m^2 with a displacement volume of 1.07 cc/m^2.

4.3.3.6 Saline Creek. Saline Creek was sampled at two sites (Figure 2). The data are presented in Volume II, Tables 38 and 39. Twenty-nine species were identified from the collections. The nymphs of the mayfly *Baetis* sp. were the dominant benthos. Average standing crop was 149 organisms/m^2 with a displacement volume of 1.81 cc/m^2.

4.3.3.7 Saprae Creek. Saprae Creek was sampled at three sites (Figure 2) on 20 August 1978. The data are presented in Volume II, Tables 40 and 41.

Saprae Creek has a diversified benthic fauna. A total of 72 species was identified dominated by Ephemeroptera nymphs and Trichoptera larvae. At the lower site in the lower reaches (Station 1), the rubble and gravel substrate supported a large number of *Hydropsyche* sp., *Rhithrogena* sp., *Baetis* sp., and *Pteronarcys regularis*. The standing crop was 387 organisms/m^2 with a displacement volume of 2.69 cc/m^2.

In the sample site in the middle reaches (Station 2), where the substrate was predominantly boulder, the standing crop was smaller (194 organisms/m^2, 1.08 cc/m^2) together with a shift in the dominant species to *Glossosoma* sp. and *Heptagenia* sp.

At the sample site in the upper reaches (Station 3), the current was slower than at the other two sites and the substrate was predominantly sand and silt. There were large numbers of the amphipod *Gammarus lacustris* and the trichopteran *Lenarchus* sp. Standing crop was highest at this site with a density of 407 organisms/m^2 and a displacement volume of 5.38 cc/m^2.

4.3.3.8 Surmont Creek. Surmont Creek was sampled at three sites (Figure 2). The data are presented in Volume II, Tables 42 and 43.

A total of 67 benthic species was identified from the samples. At the lower station (Station 1), where the creek enters Gregoire Lake, the stream is slow-flowing and has a sandy substrate containing a large amount of organic debris. The standing crop was high, measuring 4195 organisms/m^2 with a displacement volume of 10.75 cc/m^2. The bottom fauna was largely dominated by chironomid larvae (*Heterotrissocladius marcidus* grp., *Monodiamesa* sp., and *Polypedilum* sp.), although larvae of the caddisfly *Psychoglypha* sp. were also common.

In the middle reaches (Station 2), the substrate consisted of gravel and rubble. The benthic fauna was dominated by the nymphs of the stoneflies *Nemoura (Zapada) cinctipes* and *Hastaperla* sp. The standing crop was 213 organisms/m^2 and the displacement volume was 3.23 cc/m^2.

At the upper station (Station 3), where the substrate consisted of gravel, the dominant benthos was the larvae of the trichopteran *Brachycentrus* sp. and the chironomids *Thienemannimyia* grp. and *Chironomus* sp. The standing crop was 592 organisms/m^2 with a displacement volume of 2.69 cc/m^2.

4.3.4 General Discussion

Streams in the southern portion of the AOSERP study area support a rich and diverse macrobenthic fauna. Eighty percent of the streams are dominated by aquatic insects, with only 20% dominated by molluscs. Among the aquatic insects, Ephemeroptera, Diptera, and Trichoptera are the three most common and abundant orders. Both diversity and standing crop of the macrobenthic community appear to be lowest during spring (June). Species diversity appears to be highest during the summer (August), while standing crops can reach peak levels either in the summer (e.g., the Christina River) or in the autumn (e.g., the Hangingstone River).

In Table 25, various aspects of the benthic communities sampled in August are summarized according to their location in the stream habitat categories described earlier. As shown, both species diversity ($\bar{d}$) and the average number of taxa present were generally highest at stations with boulder, rubble, or gravel substrates (stream habitat Categories II, IV, and V) and lowest at stations located in muskeg areas (Category I) or with predominantly sandy substrates (Category III). The mean density of benthic invertebrates, on the other hand, appears to be related more to longitudinal factors rather than the substrate characteristics of each stream habitat category. The mean density of invertebrates (no./m^2) increases steadily from 498.0/m^2 in Category I to 1584.6/m^2 in Category IV and then drops to 765.5/m^2 in Category V. Most streams in the southern portion of the AOSERP study area (e.g., Algar River, Cameron Creek, Hangingstone River, Horse River, Saline Creek, Saprae Creek)(Figure 2) also have a longitudinal progression of habitat types starting with muskeg areas (Category I) at their headwaters, succeeded downstream by stream sections with rubble substrates (Category II), then by placid stretches with sandy bottoms (Category III), and finally by larger, fast-flowing streams with coarse substrates (Categories IV and V) near their mouths. It is possible that a general increase in water temperatures from the headwaters to the mouth of most streams (as in the Hangingstone River) results in higher standing crops becaused of increased productivity.

Table 25. Comparison of benthic invertebrate communities sampled in August at five Stream habitat categories in the present study area. Numbers in brackets after each category are the number of stations sampled in each category.

	Number of Taxa	Number of Organisms/m^2	Diversity ($\bar{d}$)	Equitability (e)
Category I (N=6)				
$\bar{X}$	12.3	998	1.88	0.45
SD	8.5	479	0.90	0.14
Range	3- 27	179- 1443	0.88- 3.01	0.27- 0.67
Category II (N=12)				
$\bar{X}$	22.0	833	2.39	0.40
SD	12.3	965	0.64	0.14
Range	5- 50	51- 3359	1.14- 3.20	0.20- 0.70
Category III (N=5)				
$\bar{X}$	19.2	1243	2.10	0.34
SD	10.2	1620	0.56	0.13
Range	12- 37	338- 4128	1.67- 3.00	0.21- 0.54
Category IV (N=5)				
$\bar{X}$	30.6	1585	2.52	0.29
SD	5.8	1080	0.14	0.12
Range	21- 36	192- 3079	2.35- 2.70	0.21- 0.50
Category V (N=4)				
$\bar{X}$	27.5	765	2.55	0.33
SD	5.1	425	0.43	0.07
Range	20- 31	312- 1331	2.00- 3.06	0.26- 0.40

The equitability index (e) measures the "goodness of fit" of the observed species diversity ($\bar{d}$) to a hypothetical maximum $\bar{d}$ based on MacArthur's (1957) broken stick model of animal abundance. Within the present study area, equitability within habitat categories is inversely correlated to standing crop ($r=0.837$; $P<0.05$)(Figure 22) indicating that the increases in standing crop from the headwaters to the mouth are due more to increases in the numbers of a few species rather than increases in taxonomic diversity.

The dominant taxa (mean percent abundance greater than 10%) in muskeg habitats (Category I) were oligochaetes, chironomid larvae, and the pill clam, *Pisidium* sp. In gravel, rubble, and boulder substrates (stream habitat Categories II, IV, and V), the Ephemeroptera (*Baetis* sp., *Heptagenia* sp., and *Rhithrogena* sp.), Trichoptera (*Brachycentrus* sp., *Glossosoma* sp., and *Hydropsyche* sp.), and the Chironomidae (*Cricotopus* sp., *Cryptochironomus* sp., *Eukiefferiella* spp., *Microtendipes* sp., *Rheotanytarsus* sp., and *Thienemanniella* sp.) tended to predominate. Plecoptera, primarily *Arcynopteryx* sp., were also frequently sampled although they were a dominant taxon only in the second (II) stream habitat category. In sandy bottomed substrates (Category III), chironomid larvae (*Heterotrissocladius marcidus* grp., *Orthocladius* sp., and *Tanytarsus* sp.) predominated followed by trichopteran larvae (*Brachycentrus* sp.) and ephemeropteran nymphs (*Baetis* spp.).

4.4 FISH STUDIES

The main objectives of this portion of the study were to determine the species composition, distribution, and relative abundance of fish populations in the southern portion of the AOSERP study area, to describe the seasonal movements and life histories of the major species present, and to quantify the significance of these populations to those in the Athabasca River system.

To achieve these objectives, three streams, the Christina, Gregoire, and Hangingstone rivers, were chosen for detailed study. Three to nine permanent sampling stations were selected on each of these streams, largely on the basis of accessibility, the number of

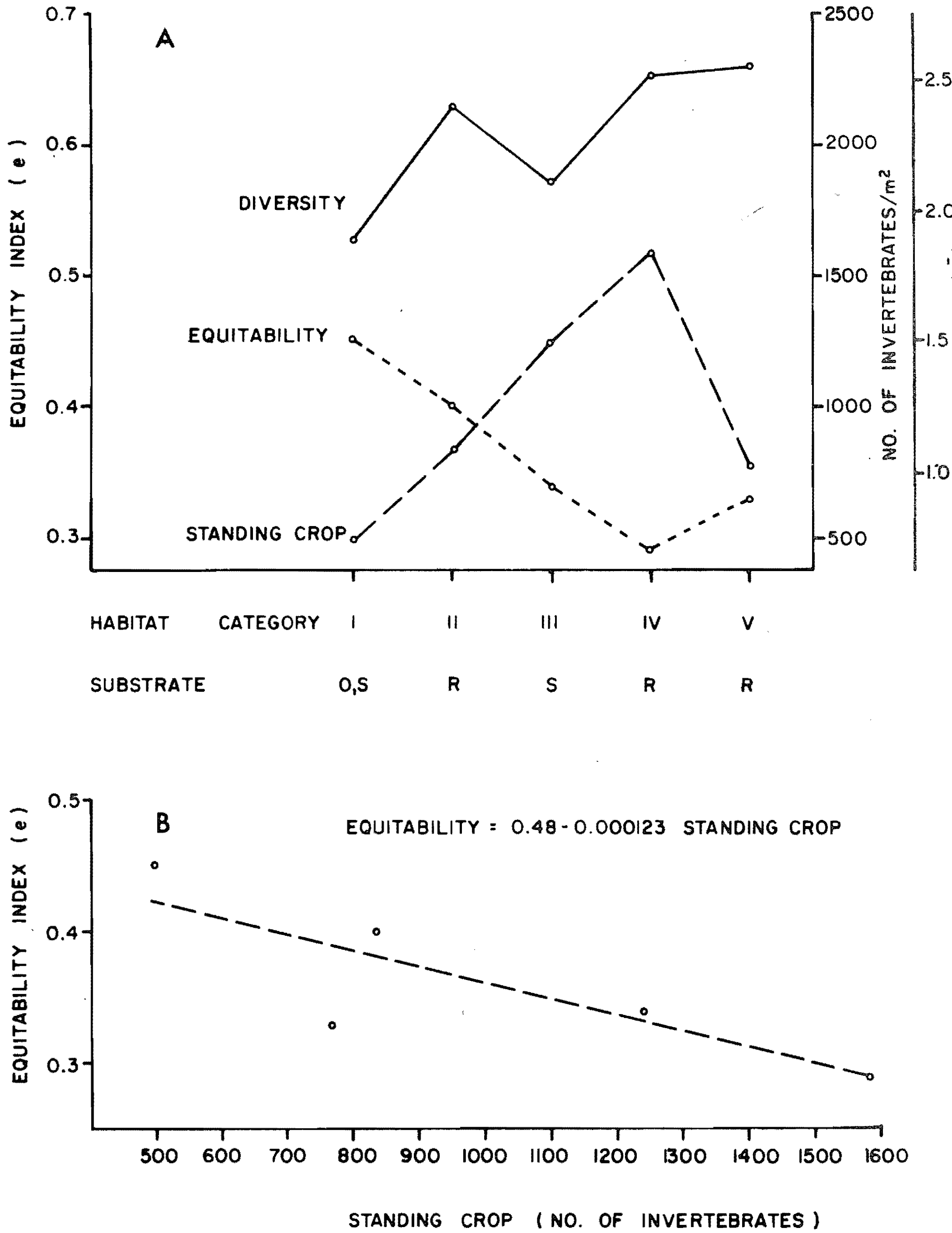


Figure 22. Benthic macroinvertebrate diversity, equitability, standing crop (A), and the relationship between equitability and standing crop (B) in five stream habitat categories in the southern portion of the AOSERP study area (O=organic matter, S=sand, R=gravel, rubble, boulders).

general habitat types present along the stream, and the locations of distinctive features such as rapids, weirs, the mouths of major tributaries, or lake outlets which might influence the movements or distribution of fish. Permanent sampling stations were also located at the mouths of the Horse River and Saline Creek and midway along the length of Surmont Creek.

Permanent sampling stations were sampled once in each of the four surveys that were conducted in the spring, late spring, late summer, and late fall. Additional stations located on the Algar River, Cameron Creek, Horse River, Prairie Creek, Saline Creek, Saprae Creek, Surmont Creek, Algar Lake, and Gregoire Lake were sampled once only, during the late summer survey.

4.4.1 Species Composition

During the course of this study, 22 species of fish were collected representing 11 families (Table 26). There was, however, considerable variation in the number of species sampled from any one waterbody, largely because of differences in the size and flow rates of different streams. In general, the larger the stream and the greater the range of microhabitats present, the more diverse was the species composition. Table 27 shows the distribution of species taken from 10 streams and two lakes in the project study area. A total of 20 species was sampled at the Christina River, the largest stream investigated, followed by 14 in the Horse River, 12 in the Hangingstone, 11 in the Gregoire, etc., to one species in Cameron Creek, the smallest stream sampled. Seven species were collected from Gregoire Lake, the largest lake in the study area, compared to two species (pearl dace and brook stickleback) in Algar Lake, a large but shallow and probably dystrophic lake.

Nine species previously reported elsewhere in the AOSERP study area were not taken in this study. These included Dolly Varden char (*Salvelinus malma*) which was previously reported from the Athabasca (Bond and Berry 1980a; Tripp and McCart 1979), Muskeg (Bond and Machniak 1979), and Steepbank rivers (Machniak and Bond 1979); lake trout (*Salvelinus namaycush*) in several lakes

Table 26. List of scientific names, common names, and four letter codes for fish species collected during the present study.

Family and Generic Name	Common Name	Code
Coregonidae		
Coregonus clupeaformis	lake whitefish	LKWT
Coregonus zenithicus	shortjaw cisco	SJCS
Prosopium williamsoni	mountain whitefish	MTWT
Thymallidae		
Thymallus arcticus	Arctic grayling	GRAY
Hiodontidae		
Hiodon alosoides	goldeye	GOLD
Esocidae		
Esox lucius	northern pike	PIKE
Cyprinidae		
Rhinichthys cataractae	longnose dace	LNDC
Platygobio gracilis	flathead chub	FHCB
Couesius plumbeus	lake chub	LKCB
Semotilus margarita	pearl dace	PLDC
Chrosomus neogaeus	finescale dace	FSDC
Pimephales promelas	fathead minnow	FHMN
Notropis hudsonius	spottail shiner	SPSH
Catostomidae		
Catostomus catostomus	longnose sucker	LNSK
Catostomus commersoni	white sucker	WTSK
Percopsidae		
Percopsis omiscomaycus	trout-perch	TRPH
Gadidae		
Lota lota	burbot	BURB
Gasterosteidae		
Culaea inconstans	brook stickleback	BKST
Percidae		
Perca flavescens	yellow perch	YWPH
Stizostedium vitreum	walleye	WALL
Cottidae		
Cottus cognatus	slimy sculpin	SLSC
Cottus ricei	spoonhead sculpin	SPSC

Table 27. Distribution of fish species in the present study area.

Fish Species	Algar River	Cameron Creek	Christina River	Gregoire River	Hangingstone River	Horse River
lake whitefish			+			
shortjaw cisco						
mountain whitefish			+		+	
Arctic grayling			+	+	+	+
goldeye			+			+
northern pike			+	+	+	+
longnose dace	+		+	+	+	+
flathead chub			+			+
lake chub	+		+	+	+	+
pearl dace	+		+	+	+	
finescale dace			+			
fathead minnow						+
spottail shiner			+	+		+
longnose sucker	+		+	+	+	+
white sucker			+	+	+	+
trout-perch			+	+	+	+
burbot			+			

Continued...

Table 27. Continued.

Fish Species	Algar River	Cameron Creek	Christina River	Gregoire River	Hangingstone River	Horse River
brook stickleback	+		+		+	
yellow perch			+			+
walleye			+	+	+	+
slimy sculpin		+	+	+	+	+
spoonhead sculpin			+			
Total number of species	5	1	20	11	12	14

Continued...

Table 27. Continued.

Fish Species	Prairie Creek	Saline Creek	Saprae Creek	Surmont Creek	Algar Lake	Gregoire Lake
lake whitefish						
shortjaw cisco						+
mountain whitefish						
Arctic grayling		+	+	+		
goldeye						
northern pike						+
longnose dace						
flathead chub						
lake chub		+				
pearl dace	+	+			+	
finescale dace						
fathead minnow						
spottail shiner				+		+
longnose sucker		+				
white sucker		+	+	+		+
trout-perch						
burbot						+

Continued...

Table 27. Concluded.

Fish Species	Prairie Creek	Saline Creek	Saprae Creek	Surmont Creek	Algar Lake	Gregoire Lake
brook stickleback	+	+			+	
yellow perch						+
walleye						+
slimy sculpin			+	+		
spoonhead sculpin						
Total number of species	2	6	3	4	2	7

(Griffiths 1973); rainbow trout *(Salmo gairdneri)*, in the upper Athabasca River (Jones et al. 1978); lake cisco *(Coregonus artedii)*, in the Athabasca River (Bond and Berry 1980a) and several lakes (Griffiths 1973); northern redbelly dace *(Chrosomus eos)*, from the Athabasca River (Bond and Berry 1980b); emerald shiner *(Notropis atherinoides)*, primarily from the Athabasca River (Bond and Berry 1980a, b; Tripp and McCart 1979); brassy minnow *(Hybognathus hankinsoni)*, in the Athabasca River (Bond and Berry 1980a; Tripp and McCart 1979) and Steepbank River (Machniak and Bond 1979); ninespine stickleback *(Pungitius pungitius)*, in the Athabasca Delta (Bond and Berry 1980a); and Iowa darter *(Etheostoma exile)*, also from the Athabasca Athabasca Delta (Bond and Berry 1980a).

One species taken from Gregoire Lake in the project study area has been tentatively identified as the shortjaw cisco *(Coregonus zenithicus)* on the basis of gillraker counts and the ratio of head length divided by snout to eye distance. In this study, it is being reported from the AOSERP study area for the first time. Previous reports of this species in Alberta are from the Alberta portion of Lake Athabasca (Dymond and Pritchard 1930) and from Barrow Lake (Paterson 1969) in the Slave River Drainage.

4.4.2 Distribution of Fish Species in Different Habitats

In Table 28, the distribution of fish species collected in the project study area is shown according to their frequency of occurrence in the five stream habitat categories described previously.

A total of eight species was taken at sample sites located in muskeg habitats, Category I. This includes most of the Algar River, the upper Gregoire River, a short section of the upper Hangingstone River, Prairie Creek, and the upper half of Saline and Saprae creeks. Pearl dace and brook stickleback were, overall, the most frequently taken species in these habitats. Arctic grayling, longnose sucker, white sucker, and slimy sculpin were also relatively common, although these species generally were taken only at those stations that were fairly close to small fast-flowing stream sections in Category II where a certain amount of overlap

Table 28. Distribution and frequency of occurrence (%) of fish species in the southern portion of the AOSERP study area according to stream habitat type.

Fish Species	Frequency of occurrence (%) according to stream habitat type				
	I (muskeg streams)	II (small streams rubble substrates, mod- to fast flow rates)	III (slow flowing streams with sandy substrates)	IV (large streams rubble substrates, moderate flow rates)	V (large streams boulder substrates fast flow rates)
lake whitefish				2.8	
mountain whitefish				2.8	
Arctic grayling	28.6	62.1	40.0	27.8	57.1
goldeye				22.2	
northern pike	14.3		30.0	61.1	42.9
longnose dace		6.9	20.0	55.5	42.9
flathead chub				11.1	
lake chub	7.1	24.1	40.0	77.7	71.4
pearl dace	35.7	10.3	20.0	11.1	
finescale dace				2.8	
fathead minnow				2.8	
spottail shiner			50.0	8.3	
longnose sucker	21.4	31.0	80.0	86.1	85.7

Continued...

Table 28. Concluded.

Fish Species	Frequency of occurrence (%) according to stream habitat type				
	I (muskeg streams)	II (small streams rubble sub-strates, mod-to fast flow rates)	III (slow flowing streams with sandy sub-strates)	IV (large streams rubble sub-strates, mod-erate flow rates)	V (large streams boulder substrates fast flow rates)
whitesucker	28.6	17.2	50.0	50.0	28.6
trout-perch		20.6	50.0	72.2	14.3
burbot				2.8	
brook stickleback	35.7	10.3		2.8	
yellow perch				8.3	
walleye			10.0	30.6	
slimy sculpin	28.6	65.5	40.0	52.8	71.4
spoonhead sculpin				2.8	
No. of times habitat sampled	14	29	10	36	7
No. of species	8	9	11	21	8

in the distribution of these species is likely to occur. As indicated (Table 27), Arctic grayling and slimy sculpin were by far the most frequently sampled fish in Category II habitats, followed by longnose sucker, lake chub, and white sucker. Stream sections sampled in Category II included the mouth of Cameron Creek, most of the upper reaches of the Hangingstone River, a short section of the upper Horse River, the lower half of Saline and Saprae creeks, and most of Surmont Creek.

A total of 11 species was sampled from the middle reaches of the Gregoire, Hangingstone, and Horse rivers which include most of the stream habitats in the project study area that fall into Category III. These are large, slow flowing, meandering streams with sandy substrates. Longnose suckers were the most common fish taken, although other frequently encountered fish included spottail shiners, white suckers, and trout-perch.

Stream habitats in Category IV, larger streams with moderate flow rates and substrates composed primarily of rubble, included most of the Christina River and portions of the lower Gregoire, Hangingstone, and Horse rivers. A total of 21 species was taken in these areas, partly because of the greater sampling effort expended in these areas compared to others and partly because of the greater range of microhabitats available. Longnose suckers were the most frequently sampled fish followed, in order, by lake chub, trout-perch, northern pike, longnose dace, slimy sculpins, and white suckers. Although rarely sampled in other habitats, goldeye and walleye were also common.

A total of eight species was taken at Station 4 on the Christina River and Station 2 on the Hangingstone River, the only two stations including stream habitat in Category V. Longnose suckers were the most frequently sampled fish at these two stations, followed in order by lake chubs, slimy sculpins, and Arctic grayling.

4.4.3 Relative Abundance

Eight species, including Arctic grayling, longnose dace, lake chub, spottail shiner, longnose sucker, white sucker, yellow perch, and slimy sculpin, dominated the combined total catch in gillnet and minnow seines, together accounting for 77% of all fish taken (Table 29). Of these, longnose suckers were the most commonly sampled fish (17.3%), followed closely by lake chub (16.9%) and slimy sculpins (11.4%). These fish, in addition to Arctic grayling, longnose dace, and white sucker, were also among the most widely distributed species in the project study area (Table 27). Spottail shiners and yellow perch, on the other hand, while accounting for 13.8% of the total catch, were relatively restricted in their distribution. Most were taken from Gregoire Lake or at the mouth of the Christina and Horse rivers.

Four species, lake whitefish, mountain whitefish, finescale dace, and spoonhead sculpin, were rarely taken during this study. Together, these species represented less than 0.1% of the total catch.

Northern pike was the most abundant of 11 species collected in gillnets, constituting 28.6% of the total gillnet catch at all sampling stations. Other species commonly taken in gillnets included longnose sucker (18.2%) followed by white sucker (11.1%), goldeye (11.1%), and walleye (9.8%). Pearl dace accounted for 10.6% of the total gillnet catch as a result of a single overnight gillnet set in Algar Lake. None was taken in gillnets anywhere else in the project study area. Shortjaw ciscoes, mountain whitefish, Arctic grayling, flathead chub, and burbot made up the rest (10.6%) of the gillnet catch.

Total catches and catches per unit effort for gillnetting and minnow seining are shown, by species and locality, in Tables 30 and 31. These data are summarized in Tables 32 and 33 to provide an overall impression of the dominant species and their relative abundance in each waterbody.

In the Christina River, northern pike were by far the most abundant fish taken in gillnets (Table 32) followed by goldeye, longnose suckers, and white suckers. Northern pike and longnose sucker were the major species sampled by gillnetting in the Gregoire River. While catch per unit effort for longnose

Table 29. Relative abundance of fish species taken in gillnets and minnow seines during the present study, May to October 1978.

Fish Species	Gillnetting (Total Effort=1063.5 h)			Minnow Seining (Total Effort=5101 m)			Total	%
	Catch per hour X 100	N	%	Catch per metre X 100	N	%		
lake whitefish	0.0	0	0.0	<0.1	2	< 0.1	2	< 0.1
shortjaw cisco	1.5	16	3.5	0.0	0	0.0	16	0.2
mountain whitefish	0.2	2	0.4	0.0	0	0.0	2	< 0.1
Arctic grayling	1.6	17	3.8	6.1	310	4.9	327	4.9
goldeye	4.7	50	11.1	0.0	0	0.0	50	0.7
northern pike	12.1	129	28.6	1.5	76	1.2	205	3.0
longnose dace	0.0	0	0.0	8.5	433	6.9	433	6.4
lake chub	0.0	0	0.0	22.3	1140	18.1	1140	16.9
flathead chub	1.1	12	2.7	<0.1	1	<0.1	13	0.2
pearl dace	4.5	48	10.6	3.1	159	2.5	207	3.1
finescale dace	0.0	0	0.0	<0.1	1	<0.1	1	<0.1
fathead minnow	0.0	0	0.0	1.7	87	1.4	87	1.3
spottail shiner	0.0	0	0.0	>10.2	>519	>8.3	>519	>7.7
longnose sucker	7.7	82	18.2	21.2	1083	17.2	1165	17.3
white sucker	4.7	50	11.1	7.4	376	6.0	426	6.3
unidentified sucker fry	0.0	0	0.0	>10.6	>542	>8.6	>542	>8.0
trout-perch	0.0	0	0.0	4.9	252	4.0	252	3.7
burbot	0.1	1	0.2	0.3	16	0.3	17	0.3
brook stickleback	0.0	0	0.0	2.0	100	1.6	100	1.5
yellow perch	0.0	0	0.0	8.0	410	6.5	410	6.1
walleye	4.1	44	9.8	0.1	5	0.1	49	0.7
slimy sculpin	0.0	0	0.0	15.1	770	12.3	770	11.4
spoonhead sculpin	0.0	0	0.0	<0.1	1	<0.1	1	<0.1
Total	42.4	451	100.0	123.2	6283	100.0	6734	100.0

Table 30. Summary of gillnet catches in the present study area, May to October 1978. Unbracketed figures are catch per hour X 100. Bracketed figures are actual catches.

Location	Effort (hours)	Total Catch	Catch Per Unit Effort X 100 (N) SJCS	MTWT	GRAY	GOLD	PIKE	FHCB
Christina River	403.0	59.1(239)	0.0(0)	0.2(1)	0.5(2)	7.2(29)	26.0(105)	1.7(7)
Gregoire River	252.0	24.6(62)	0.0(0)	0.0(0)	3.6(9)	0.0(0)	7.1(18)	0.0(0)
Hangingstone River	279.5	8.3(23)	0.0(0)	0.4(1)	1.8(5)	0.0(0)	0.4(1)	0.0(0)
Horse River	81.0	62.9(51)	0.0(0)	0.0(0)	1.2(1)	25.9(21)	3.7(3)	6.2(5)
Algar Lake	24.0	200.0(48)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)
Gregoire Lake	24.0	117.7(28)	66.7(16)	0.0(0)	0.0(0)	0.0(0)	8.3(2)	0.0(0)

Continued...

Table 30. Concluded.

Location	Effort (hours)	Total Catch	Catch Per Unit Effort X 100 (N)				
			PLDC	LNSK	WTSK	BURB	WALL
Christina River	403.0	59.1(239	0.0(0)	9.9(40)	9.7(39)	0.2(1)	3.7(15)
Gregoire River	252.0	24.6(62)	0.0(0)	9.1(23)	2.8(7)	0.0(0)	2.0(5)
Hangingstone River	279.5	8.3(23)	0.0(0)	4.6(13)	1.1(3)	0.0(0)	0.0(0)
Horse River	81.0	62.9(51)	0.0(0)	7.4(6)	1.2(1)	0.0(0)	17.3(14)
Algar Lake	24.0	200.0(48)	200.0(48)	0.0(0)	0.0(0)	0.0(0)	0.0(0)
Gregoire Lake	24.0	117.7(28)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	41.7(10)

Table 31. Seine catches in the present study area, 3 May to 18 October 1978. Unbracketed figures are catch per metre of shore seined x 100. Bracketed numbers are actual catches.

Location	Distance (m)	Total	Catch Per Metre of Shore Seined X 100 (N) LKWT	GRAY	PIKE	LNDC	FHCB
Algar River	53	184.9(98)	0.0(0)	0.0(0)	0.0(0)	3.8(2)	0.0(0)
Christina River	1059	160.3(1698)	0.2(2)	0.2(2)	5.9(63)	19.3(203)	0.1(1)
Gregoire River	527	280.1(1476)	0.0(0)	3.4(18)	1.7(9)	23.1(122)	0.0(0)
Hangingstone River	2026	60.0(1215)	0.0(0)	2.7(55)	0.1(1)	3.9(79)	0.0(0)
Horse River	303	173.3(525)	0.0(0)	2.6(8)	0.0(0)	8.2(25)	0.0(0)
Saline Creek	271	61.6(167)	0.0(0)	10.0(27)	0.0(0)	0.0(0)	0.0(0)
Saprae Creek	165	37.0(61)	0.0(0)	32.1(53)	0.0(0)	0.0(0)	0.0(0)
Surmont Creek	322	63.3(204)	0.0(0)	45.6(147)	0.0(0)	0.0(0)	0.0(0)
Algar Lake	100	6.0(6)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)
Gregoire Lake	375	224.4(834)	0.0(0)	0.0(0)	0.8(3)	0.0(0)	0.0(0)

Location	Distance (m)	Total	Catch Per Metre of Shore Seined X 100 (N) LKCB	PLDC	FSDC	FHMN	SPSH
Algar River	53	184.9(98)	7.5(4)	120.7(64)	0.0(0)	0.0(0)	0.0(0)
Christina River	1059	160.3(1698)	25.9(274)	0.2(2)	0.1(1)	0.0(0)	0.1(1)
Gregoire River	527	280.1(1476)	89.3(471)	11.2(59)	0.0(0)	0.0(0)	0.9(5)
Hangingstone River	2026	60.0(1215)	10.1(206)	1.6(33)	0.0(0)	0.0(0)	0.0(0)
Horse River	303	173.3(525)	53.8(163)	0.0(0)	0.0(0)	28.7(87)	0.3(1)
Saline Creek	271	61.6(167)	8.1(22)	0.4(1)	0.0(0)	0.0(0)	0.0(0)
Saprae Creek	165	37.0(61)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)
Surmont Creek	322	63.3(204)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	0.9(3)
Algar Lake	100	6.0(6)	0.0(0)	1.0(1)	0.0(0)	0.0(0)	0.0(0)
Gregoire Lake	375	224.4(834)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	>135.7(>504)

Continued...

Table 31. Concluded.

Location	Distance (m)	Total	Catch Per Metre of Shore Seined X 100 (N)				
			LNSK	WTSK	Sucker fry	BURB	TRPH
Algar River	53	184.9(98)	52.8(28)	0.0(0)	0.0(0)	0.0(0)	0.0(0)
Christina River	1059	160.3(1698)	51.0(541)	0.5(5)	> 37.8(>400)	0.0(0)	7.4(78)
Gregoire River	527	280.1(1476)	53.3(281)	53.5(282)	> 26.5(>140)	0.0(0)	7.8(41)
Hangingstone River	2026	60.0(1215)	5.6(114)	2.3(46)	0.1(2)	0.0(0)	4.8(98)
Horse River	303	173.3(525)	31.3(95)	1.0(3)	0.0(0)	0.0(0)	11.5(35)
Saline Creek	271	61.6(167)	8.8(24)	3.3(9)	0.0(0)	0.0(0)	0.0(0)
Saprae Creek	165	37.0(61)	0.0(0)	1.8(3)	0.0(0)	0.0(0)	0.0(0)
Surmont Creek	322	63.3(204)	0.0(0)	8.4(27)	0.0(0)	0.0(0)	0.0(0)
Algar Lake	100	6.0(6)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)
Gregoire Lake	375	224.4(834)	0.0(0)	0.3(1)	0.0(0)	4.3(16)	0.0(0)

Location	Distance (m)	Total	Catch Per Metre of Shore Seined X 100 (N)				
			BKST	YWPH	WALL	SLSC	SPSC
Algar River	53	184.9(98)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)
Christina River	1059	160.3(1698)	0.5(5)	7.7(82)	0.2(2)	3.1(33)	0.1(1)
Gregoire River	527	280.1(1476)	0.0(0)	0.0(0)	0.0(0)	9.1(48)	0.0(0)
Hangingstone River	2026	60.0(1215)	0.3(6)	0.0(0)	0.1(2)	28.2(573)	0.0(0)
Horse River	303	173.3(525)	0.0(0)	7.6(23)	0.3(6)	27.7(24)	0.0(0)
Saline Creek	271	61.6(167)	31.0(84)	0.0(0)	0.0(0)	0.0(0)	0.0(0)
Saprae Creek	165	37.0(61)	0.0(0)	0.0(0)	0.0(0)	3.0(5)	0.0(0)
Surmont Creek	322	63.3(204)	0.0(0)	0.0(0)	0.0(0)	8.4(27)	0.0(0)
Algar Lake	100	6.0(6)	5.0(5)	0.0(0)	0.0(0)	0.0(0)	0.0(0)
Gregoire Lake	375	222.4(834)	0.0(0)	81.3(305)	0.0 (0)	0.0 (0)	0.0 (0)

Table 32. Relative abundance of fish species taken in gillnets from streams and lakes in the present study area.

	Catch per gillnetting hour X 100				
Waterbody	>25.0	10.0 to 24.9	5.0 to 9.9	1.0 to 4.9	0.1 to 0.9
Christina River	northern pike		goldeye	flathead chub	mountain whitefish
			longnose sucker	walleye	Arctic grayling
			white sucker		burbot
Gregoire River			longnose sucker	white sucker	
			northern pike	Arctic grayling	
				walleye	
Hangingstone River				Arctic	mountain whitefish
				grayling	northern pike
				longnose sucker	
				white sucker	
Horse River	goldeye	walleye	flathead chub	Arctic grayling	
			longnose sucker	northern pike	
				white sucker	
Algar Lake	pearl dace				
Gregoire Lake	shortjaw cisco		northern pike		
	walleye				

Table 33. Relative abundance of fish species taken in small mesh seines from streams and lakes in the present study area.

Catch per metre of shore seined X 100					
>50.0	25.0 to 49.9	10.0 to 24.9	5.0 to 9.9	1.0 to 4.9	<0.1 to 0.9
Christina River					
longnose sucker	lake chub	longnose dace	northern pike	slimy sculpin	lake whitefish
	unidentified sucker fry		trout-perch		Arctic grayling
			yellow perch		flathead chub
					pearl dace
					finescale dace
					spottail shiner
					white sucker
					brook stickleback
					walleye
					spoonhead sculpin
Gregoire River					
lake chub	unidentified sucker fry	longnose dace	trout-perch	Arctic grayling	spottail shiner
longnose sucker		pearl dace	slimy sculpin	northern pike	
white sucker					

Continued...

Table 33. Continued.

Catch per metre of shore seined X 100					
>50.0	25.0 to 49.9	10.0 to 24.9	5.0 to 9.9	1.0 to 4.9	<1.0 to 0.9
Hangingstone River					
	slimy sculpin	lake chub	longnose sucker	Arctic grayling	northern pike
				longnose dace	unidentified sucker fry
				pearl dace	brook stickleback
				white sucker	walleye
				trout-perch	
Horse River					
lake chub	fathead minnow	trout-perch	longnose dace	Arctic grayling	spottail shiner
	longnose sucker		yellow perch		walleye
	slimy sculpin				
Algar River					
pearl dace			lake chub	longnose dace	brook stickleback
longnose sucker					
Saline Creek					
	brook stickleback	Arctic grayling	lake chub	white sucker	pearl dace
			longnose sucker		

Continued...

Table 33. Concluded.

Catch per metre of shore seined X 100					
>50.0	25.0 to 49.9	10.0 to 24.9	5.0 to 9.9	1.0 to 4.9	<0.1 to 0.9
<u>Saprae Creek</u>		Arctic grayling		slimy sculpin	white sucker
<u>Surmont Creek</u>					
	Arctic grayling		white sucker slimy sculpin		spottail shiner
<u>Algar Lake</u>					
			brook stickleback	pearl dace	
<u>Gregoire Lake</u>					
spottail shiner yellow perch				burbot	northern pike white sucker

suckers in both rivers was similar, northern pike, were, however, considerably less abundant in the Gregoire River than in the Christina River. Gillnet catches in the Hangingstone River were dominated by Arctic grayling, longnose suckers, and white suckers although catches were among the lowest recorded in the project study area. Goldeye and walleye were the most commonly sampled fish at the mouth of the Horse River while walleye and shortjaw cisco were the major species collected in gillnets in Gregoire Lake. Pearl dace was the only species gillnetted in Algar Lake where they were very abundant.

Lake chub and longnose sucker, the latter species consisting primarily of young-of-the-year and small juveniles, were the most abundant species taken in small mesh seine collections from the Christina, Gregoire, and Horse rivers. Other commonly sampled species from these rivers included white sucker from the Gregoire River and fathead minnow and slimy sculpin from the Horse River. The slimy sculpin was the most abundant fish species in the Hangingstone River followed by lake chub and longnose sucker. Like the gillnet catches, seine catches in the Hangingstone River were, on the average, considerably lower than those in the larger rivers.

Arctic grayling, primarily young-of-the-year, was the dominant fish species taken in most of the smaller streams with predominantly boulder and rubble substrates. Such stream sections include most of Surmont Creek and the lower sections of Saline and Saprae creeks. Smaller numbers of slimy sculpins and longnose sucker young-of-the-year were also usually present.

Pearl dace and brook stickleback were the only two species recorded from Algar Lake, a large but shallow (<2 m), dystrophic lake. In Gregoire Lake, both spottail shiners and yellow perch were exceedingly abundant, particularly along the sheltered and weedy shorelines. Smaller numbers of young-of-the-year northern pike, white suckers, and burbot were also present.

4.4.4 Catch Per Unit Effort

Total catches per unit effort for gillnetting and minnow seining are summarized in Tables 34 and 35, respectively, for each waterbody sampled in August, the only occasion when all waterbodies were sampled at approximately the same time. The total catches per unit effort are weighted according to the approximate surface area of each stream or lake in order to provide a rough comparison of the total number of fish present in each area. For streams, the surface area was determined by multiplying the length of stream sampled by its average width. A planimeter was used to measure the surface area of lakes.

Algar Lake had the highest recorded catch per gillnet hour (2.0) as a result of a single 24 h gillnet set that captured 48 pearl dace. Gregoire Lake had the next highest catch per gillnet hour (1.2), consisting mainly of ciscos and walleye. The weighted catch for Gregoire Lake was, however, considerably higher than anywhere else in the project study area because of its large surface area. In streams, the highest catch per hour was recorded in the Christina River (0.4), followed, in order, by the Horse (0.3), Gregoire (0.2), and Hangingstone (0.1) rivers.

In August, seine catches per metre of shoreline seined (Table 35) showed relatively high (>2.0 fish per metre of shore) fish densities in the Gregoire River and Gregoire Lake, moderate densities (1.0 to 2.0 fish per metre of shore) in the Algar, Christina, and Horse rivers and in Saline and Surmont creeks, and relatively low densities (<1.0 fish per metre of shore) in the Hangingstone River, Saprae Creek, and Algar Lake. A comparison of the weighted catches per unit effort further emphasizes the importance of Gregoire Lake as a rearing area for small fish followed in order by the Horse, Gregoire, and Christina rivers. Because of their limited size, the weighted catches, and therefore the total numbers of fish, were considerably lower in the smaller streams (including the Algar River and Saline, Saprae, and Surmont creeks) than in the larger streams.

Table 34. Summary of catches per unit gillnet effort (hours) for streams and lakes in the present study area, August 1978. Weighted catches per unit effort are the product of catch per unit effort multiplied by the approximate surface area of each waterbody sampled.

Waterbody	Approximate Surface Area	Effort (hours)	Catch (numbers)	Catch per hour	Weighted Catch per hour
Christina River	2.5	76.0	28	0.37	0.93
Greogire River	1.4	90.5	7	0.08	0.11
Hangingstone River	1.2	83.0	17	0.20	0.24
Horse River	mouth only	24.0	7	0.29	ND
Algar Lake	7.7	24.0	48	2.00	15.40
Gregoire Lake	26.5	24.0	28	1.17	30.95

Table 35. Summary of catches per unit of fine mesh seining effort (metres of shoreline seined, number of seine hauls) for streams and lakes in the present study area, August, 1978. Weighted catches per unit effort are the product of catch per unit effort multiplied by the approximate surface area of each waterbody sampled.

Waterbody	Approximate Surface Area(km^2)	No. of hauls	Distance Seined (m)	Catch (numbers)	Catch per Haul	Catch per Metre	Weighted Catch per haul	Weighted Catch per Metre
Algar River	0.03	6	53	98	16.3	1.85	0.5	0.06
Christina River	2.5	20	277	308	15.4	1.11	38.5	2.77
Gregoire River	1.4	20	270	633	31.7	2.34	44.4	3.28
Hangingstone River	1.2	48	692	646	13.5	0.93	16.2	1.12
Horse River	3.9	14	235	372	26.6	1.58	103.7	6.16
Saline Creek	0.16	8	80	147	18.4	1.84	2.9	0.29
Saprae Creek	0.17	13	165	61	4.7	0.37	0.8	0.06
Surmont Creek	0.25	13	150	200	15.4	1.33	3.9	0.33
Algar Lake	7.7	4	100	6	1.50	0.06	11.6	0.46
Gregoire Lake	26.7	13	375	>834	64.1	2.22	1171.5	59.27

4.4.5 Comparison with Other Areas

In Table 36, gillnet and seine catches per unit effort are used to compare the relative abundance of fish in the Christina, Gregoire, and Hangingstone rivers with those fish elsewhere in the AOSERP study area. In most cases, the comparisons are based on fish collections taken throughout the open-water period with similar sampling gear. Catches per gillnet hour for the Athabasca River in the vicinity of Syncrude Canada Limited's Lease 17 in 1975 (McCart et al. 1977) and for the MacKay River in 1977 (McCart et al. 1978) are exceptions. In these studies, gillnet gangs consisting of two 15 m panels of stretched mesh, 6.4 and 8.9 cm, were used instead of the standard gillnet gangs used in this and other studies in the Athabasca and Clearwater rivers. A 6.0 m small mesh seine was also used in the MacKay River, while a 3.0 m seine was used in this and other studies in the upper Athabasca and Clearwater rivers. Data for the Athabasca and Clearwater rivers upstream of Fort McMurray (1977 and 1978) are from Jones et al. (1978) and Tripp and McCart (1979), while those from the Athabasca River, Mildred Lake area, and the Athabasca Delta (1977) are taken from Bond (1980).

The highest overall catches per gillnet hour in the project study area were recorded in the Christina River (0.59 fish per hour), largely because of the high numbers of northern pike, longnose suckers, and white suckers captured during their spring spawning migrations. Later on in late spring and summer, goldeye were also abundant. Gillnet catches in the Christina River were higher than those in either the Clearwater River or in Athabasca River upstream of the Cascade Rapids, while similar catches were recorded in the Athabasca River between Fort McMurray and the Cascade Rapids, the Athabasca River near Syncrude's lease areas, the Athabasca Delta, and in the MacKay River, a tributary of the Athabasca. The highest recorded gillnet catches in the AOSERP study area were, however, those reported by Bond and Berry (1980b) for the Mildred Lake study area on the Athabasca River (1.21 fish per hour).

Table 36. Comparison of gillnet and seine catches per unit effort for various sampling areas in the AOSERP study area. Weighted catches per unit effort are the product of catches per unit effort multiplied by the approximate surface area of each stream section investigated.

Stream	Approximate Surface Area (km^2)	Gillnets: No. of Hours	Gillnets: No. of Fish	Gillnets: Catch per Hour	Gillnets: Weighted Catch per Hour	Small Mesh Seines: No. of Hauls	Small Mesh Seines: Distance Seined (m)	Small Mesh Seines: No. of Fish	Small Mesh Seines: Catch per Haul	Small Mesh Seines: Catch per Metre	Small Mesh Seines: Weighted Catch per Haul	Small Mesh Seines: Weighted Catch per Metre
Christina River, 1978	2.5	403.0	239	0.59	1.47	81	1059	1698	21.0	1.60	52.5	4.00
Gregoire River, 1978	1.4	252.0	62	0.25	0.35	46	527	1470	32.1	2.80	44.9	3.92
Hangingstone River, 1978	1.2	279.5	23	0.08	0.10	172	2026	1215	7.1	0.60	8.5	0.72
Clearwater River,	6.5											
1977(fall)		403.0	65	0.16	1.04	ND	ND	ND	ND	ND	ND	ND
1978(spring)		284.5	158	0.56	3.64	74	602	3421	46.2	5.68	300.3	36.92
Combined		687.5	223	0.32	2.08	74	602	3421	46.21	5.68	300.3	36.92
Athabasca River above the Cascade Rapids	38.0											
1977(fall)		550.5	88	0.16	6.08	ND	ND	ND	ND	ND	ND	ND
1978(spring)		330.0	147	0.45	17.10	45	550	1164	25.9	2.12	984.2	80.56
Combined		880.5	235	0.27	10.26	45	550	1164	25.9	2.12	984.2	80.56
Athabasca River upstream of Fort McMurray to the Cascade Rapids	11.0											
1977(fall)		451.5	317	0.70	7.7	ND	ND	ND	ND	ND	ND	ND
1978(spring)		241.0	197	0.82	9.02	162	2447	6503	40.1	2.66	441.1	29.26
Combined		692.5	514	0.74	8.14	162	2447	6503	40.1	2.66	441.1	29.26
Athabasca River at Mildred Lake, 1977	37.5	810.0	982	1.21	45.37	ND	ND	ND	ND	ND	ND	ND
Athabasca Delta, 1977	37.0	797.0	478	0.60	22.20	ND	ND	ND	ND	ND	ND	ND
Athabasca River in the vicinity of the Syncrude lease area, 1975	20.5	872.0	523	0.60	12.30	ND	ND	ND	ND	ND	ND	ND
Mackay River, 1977	2.2	268.0	206	0.77	1.69	64	ND	4997	78.1	ND	171.8	ND

The lowest overall catches per gillnet hour in the entire AOSERP study area were those recorded in the Gregoire (0.25 fish per hour) and Hangingstone (0.08 fish per hour) rivers. Because of their relatively small size, differences between the probable number of catchable size fish present is even more apparent when weighted catches are compared. The Gregoire River, for example, has a slightly greater surface area than the Hangingstone River. The weighted catch per gillnet hour in the Gregoire River was, however, three and a half times greater than weighted catches for the Hangingstone River. The surface area of the Christina River within the AOSERP study area is approximately twice that of the Hangingstone River. According to differences in the weighted catch, there are, however, 15 times as many larger fish in the Christina River as in the Hangingstone River.

The highest overall catches per unit effort for small mesh seines in the project study area were recorded in the Gregoire River (Table 36) followed by the Christina River. Because of the latter's larger surface area, however, the total numbers of small fish and rearing young-of-the-year present in the two streams is probably similar as indicated by the similarity in weighted catches per unit effort. Seine catches in the Hangingstone River were, like the gillnet catches, the lowest recorded in the AOSERP study area.

Seine catches in the Gregoire River were higher than those in the Athabasca River upstream of Fort McMurray but considerably lower than those in the Clearwater River. Catches in the Clearwater River, however, are based on collections made in the spring when young-of-the-year sucker fry were extremely abundant. The average total catch per seine haul in the MacKay River was two to four times greater than catches in the Christina and Gregoire rivers. Because a larger seine (6.0 m versus 3.0 m) was used in the MacKay River, the average density of small fish in the MacKay River could be closer to the average density in the Christina or Gregoire River than otherwise indicated.

4.4.6 Life Histories of Major Species

4.4.6.1 Arctic grayling. Although not particularly abundant, the Arctic grayling is a prized sport fish in the AOSERP study area. During the open-water period, grayling are a negligible portion of the total catch in the Athabasca River from the Athabasca River Delta upstream to the Grand Rapids (Bond and Berry 1980b; McCart et al. 1977; Jones et al. 1978; Tripp and McCart, 1979). They are also scarce in the Clearwater and MacKay rivers (McCart et al. 1978), two of the largest tributaries of the Athabasca River.

The largest concentrations of Arctic grayling in the AOSERP study area are located in some of the smaller tributaries of the Athabasca River. In two of these, the Muskeg (Bond and Machniak 1979) and Steepbank (Machniak and Bond 1979) rivers, grayling migrate upstream to spawn during, or shortly after, breakup. After spawning, grayling remain to feed throughout the summer before migrating downstream in the autumn presumably to overwintering areas located in the Athabasca River. This pattern is similar to those already described for larger streams in the Tanana River drainage in Alaska (Reed 1964) and in the Donnelly River (Tripp and McCart 1974), a tributary of the Mackenzie River. In smaller streams, adult or maturing fish typically move back downstream soon after spawning (Craig and Poulin 1975).

4.4.6.1.1 Distribution and abundance. The Arctic grayling was not an abundant fish species in the project study area, constituting only 3.8% of the total gillnet catch and 4.9% of the total minnow seine catch though they were the dominant species in a few streams. They were also widespread (Appendix 7, Figure 36).

Small numbers of large juvenile and mature grayling were collected in the Christina River, in the lower reaches of the Gregoire River upstream to the mouth of George Creek, in the Hangingstone River as far upstream as Station 8, in the Horse River at both the mouth (Station 1) and the uppermost station (Station 4), in the lower reaches of Saline and Saprae creeks, and at Station 2 on Surmont Creek.

Young-of-the-year and small juveniles in their second season of growth were captured in the lower reaches of the Gregoire River, throughout most of the Hangingstone River, at both the mouth and uppermost station on the Horse River, in the lower reaches of Saline and Saprae creeks, and throughout most of Surmont Creek.

Table 37 compares gillnet catches of Arctic grayling taken during this study with those taken in other studies in the AOSERP study area. Unfortunately, there are no data available for gillnet catches in the Muskeg and Steepbank rivers, the only two streams previously shown to have sizeable populations of Arctic grayling (Bond and Machniak 1979; Machniak and Bond 1979). Generally, gillnet catches of grayling in the AOSERP study area are low. The highest catch per unit effort (gillnet hour x 100) was 3.6 in the Gregoire River followed by 2.3 for the Athabasca River between Fort McMurray and the Cascade Rapids, 32 km upstream of Fort McMurray. In the latter area, almost all of the grayling taken were captured in the week prior to freeze-up, coinciding with a downstream movement of grayling from tributaries to overwintering areas (Jones et al. 1978). Elsewhere, gillnet catches per unit effort ranged from 1.8 in the Hangingstone River and 1.2 at the mouth of the Horse River to 0.0 to 0.1 in the lower Athabasca River (Bond and Berry 1980b; McCart et al. 1977).

A comparison of minnow seine catches per unit effort (catch per metre of shoreline seined x 100) of grayling, primarily young-of-the-year, suggests that the major grayling spawning areas in the project study area are located in Surmont Creek and the lower reaches of Saline and Saprae creeks (Table 31). In these streams, catches per unit effort ranged from 45.7 grayling in Surmont Creek to 10.0 in Saline Creek. By comparison, catches per unit effort elsewhere in the project study area were low, ranging from 3.4 in the Gregoire River to 0.2 in the Christina. Grayling were absent from the Algar River, Algar Lake, Cameron Creek, Gregoire Lake, and Prairie Creek.

Before this study, the Hangingstone River was reputed to be one of the finest Arctic grayling streams in the region. The

Table 37. Relative abundance of Arctic grayling in the AOSERP study area based on catches per gillnet hour x 100.

Location	Number of Gillnet Hours	Number of Arctic Grayling	Catch per Gillnet hour x 100
Christina River	403.0	2	0.5
Gregoire River	252.0	9	3.6
Hangingstone River	279.0	5	1.8
Horse River (mouth)	81.0	1	1.2
Athabasca River upstream of the Cascade Rapids	880.5	2	0.2
Athabasca River between Fort McMurray and the Cascade Rapids	692.5	16	2.3
Athabasca River, Syncrude Area	872.0	0	0.0
Athabasca River, Mildred Lake Area	810.0	1	0.1
Athabasca River Delta	797.0	0	0.0
Clearwater River	687.5	4	0.6
MacKay River	262.0	1	0.4

apparent scarcity of grayling in the Hangingstone River is therefore noteworthy.

Part of this reputation was undoubtedly the result of its easy accessibility at Fort McMurray and at a campground located where the Hangingstone River is crossed by Highway No. 63. It was also likely due to a combination of ignorance of, and limited access to, other streams known to have grayling, such as the Muskeg and Steepbank rivers. Mr. Marvin Dorin, formerly a Fish and Wildlife Officer at Fort McMurray, reports (a personal communication to the senior author in May 1978), however, that anglers had no problems catching large mature grayling at the Hangingstone River by Highway No. 63 during the spring spawning period before 1977, largely because fish were concentrated downstream of an old weir that obstructed their upstream movements. Although this stretch of the Hangingstone River has been closed to fishing during the spring since 1977, it is possible that over-exploitation has led to a severe reduction of grayling populations in the Hangingstone River.

4.4.6.1.2 Seasonal abundance. Catches of Arctic grayling in gillnets (Table 38, Figure 23) were generally too small to be used in describing seasonal patterns of movements. The slight increase in grayling catches per unit gillnet effort in the Gregoire and Hangingstone rivers during October is thought, however, to represent a downstream movement to overwintering areas.

In early May, no grayling were captured in minnow seines in either the Christina, Gregoire, or Hangingstone rivers (Table 39). In mid-June, catches of grayling, consisting primarily of recently emerged young-of-the-year, peaked in the Gregoire and Hangingstone rivers and then declined in August and October. Young-of-the-year were rare at any time in the Christina River.

4.4.6.1.3 Spawning. Arctic grayling spawning was not observed in this study, nor were green, ripe, or recently spawned-out grayling taken anywhere during the spring spawning period. There is,

Table 38. Seasonal patterns of catch per gillnet hour X 100 for selected fish species in the Christina, Gregoire, and Hangingstone rivers, May to October 1978. Bracketed numbers are actual catches.

Stream	Effort	Catch per hour X 100 (N)					
		GRAY	GOLD	PIKE	LNSK	WTSK	WALL
<u>Christina River</u>							
5 May to 14 May	109.0	0.0(0)	3.7(4)	55.0(60)	33.0(36)	25.7(28)	0.9(1)
27 May to 15 June	122.0	0.0(0)	13.9(17)	21.3(26)	2.5(3)	4.1(5)	9.8(12)
14 Aug.	76.0	0.0(0)	10.5(8)	15.8(12)	1.3(1)	6.6(5)	2.6(2)
13 Oct. to 14 Oct.	96.0	2.1(2)	0.0(0)	7.3(7)			
Total	403.0	0.5(2)	7.2(29)	26.0(105)	9.9(40)	9.7(39)	3.7(15)
<u>Gregoire River</u>							
19 May	104.0	0.0(0)	0.0(0)	16.0(2)	64.0(8)	24.0(3)	0.0(0)
15 June to 16 June	60.5	1.7(1)	0.0(0)	3.3(2)	21.5(13)	1.7(1)	8.3(5)
17 Aug.	90.5	0.0(0)	0.0(0)	2.2(2)	2.2(2)	3.3(3)	0.0(0)
14 Oct. to 15 Oct.	88.5	9.0(8)	0.0(0)	13.6(2)	0.0(0)	0.0(0)	0.0(0)
Total	252.0	3.6(9)	0.0(0)	7.1(8)	9.1(23)	2.8(7)	2.0(5)
<u>Hangingstone River</u>							
1 May to 9 May	80.0	0.0(0)	0.0(0)	0.0(0)	1.3(1)	0.0(0)	0.0(0)

Continued...

Table 38. Concluded.

Stream	Effort	Catch per hour X 100 (N)					
		GRAY	GOLD	PIKE	LNSK	WTSK	WALL
Hangingstone River							
12 June to 20 June	55.0	0.0(0)	0.0(0)	1.8(0)	1.8(0)	0.0(0)	0.0(0)
12 Aug. to 19 Aug.	83.0	2.4(2)	0.0(0)	0.0(0)	13.2(11)	3.6(3)	0.0(0)
8 Oct. to 18 Oct.	61.5	4.9(3)	0.0(0)	0.0(0)	0.0(0)	0.0(0)	0.0(0)
Total	279.5	1.8(5)	0.0(0)	0.4(1)	4.6(13)	1.1(3)	0.0(0)

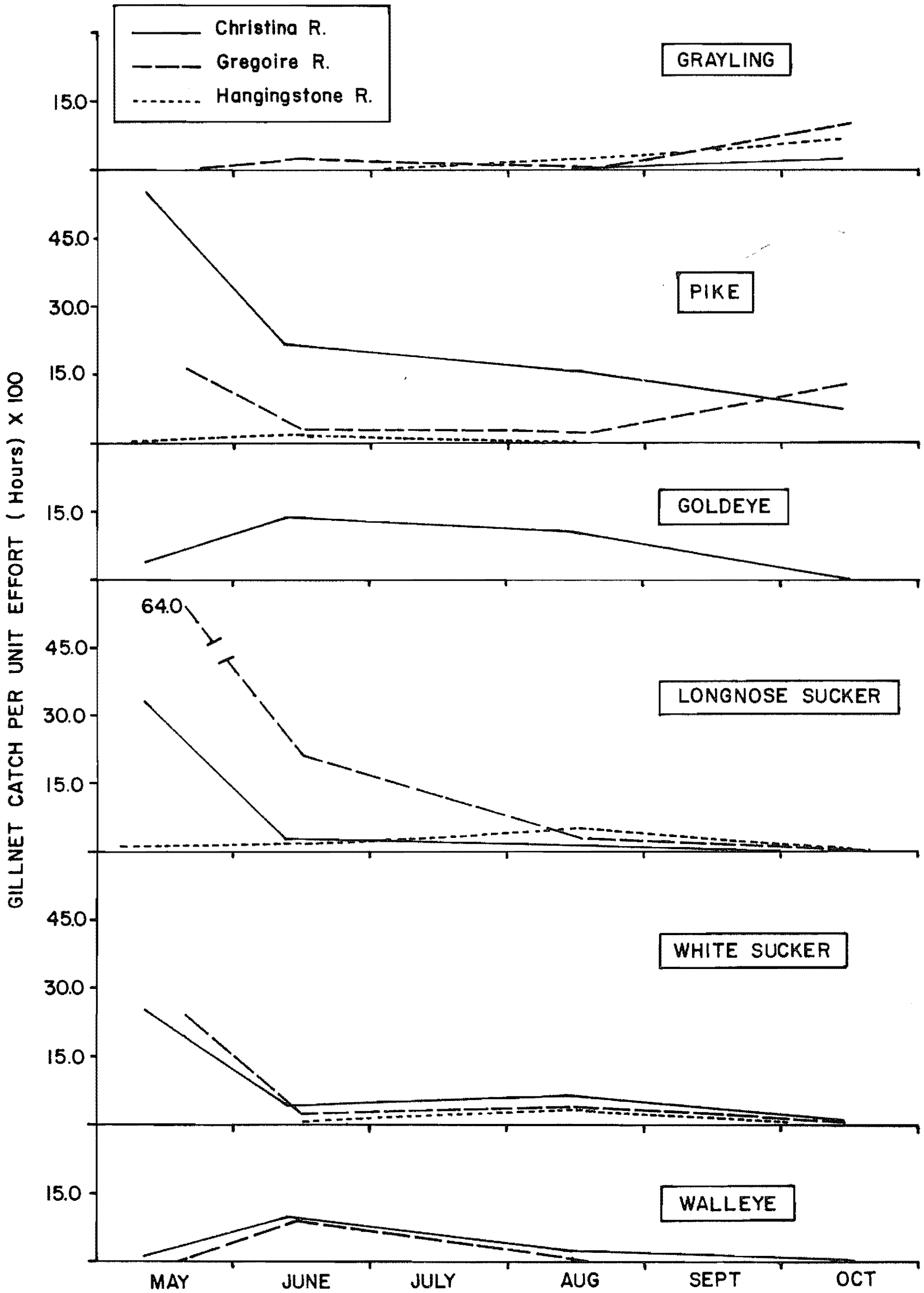


Figure 23. Seasonal patterns of catch per gillnet hour X 100 for Arctic grayling, northern pike, goldeye, longnose sucker, white sucker and walleye in the Christina, Gregoire and Hangingstone rivers, 1978.

Table 39. Seasonal patterns of catch per metre of shoreline seined X 100 for selected fish species in the Christina, Gregoire, and Hangingstone rivers, May to October 1978. Bracketed numbers are actual catches.

Stream	Effort (m)	Catch per metre seined X 100 (N)			
		GRAY	LNDC	LKCB	LNSK
Christina River					
5 May to 10 May	227	0.0(0)	33.0(75)	50.2(114)	91.6(208)
13 June to 21 June	293	0.0(0)	22.5(66)	40.6(119)	67.2(197)
13 Aug. to 14 Aug.	277	0.0(0)	20.6(57)	7.9(22)	42.2(117)
14 Oct.	262	0.8(2)	2.7(7)	7.2(19)	7.2(19)
Total	1059	0.2(2)	19.3(205)	25.9(274)	51.0(541)
Gregoire River					
19 May	33	0.0(0)	3.0(1)	81.8(27)	24.2(8)
13 June to 15 June	79	17.7(14)	0.0(0)	3.8(3)	2.5(2)
16 Aug.	270	0.7(2)	41.8(113)	118.1(319)	20.0(54)
14 Oct.	145	1.4(2)	5.5(8)	84.1(122)	149.6(27)
Total	527	3.4(18)	23.1(122)	89.3(471)	53.3(281)
Hangingstone River					
3 May to 14 May	406	0.0(0)	0.0(0)	11.8(48)	1.5(6)

Continued...

Table 39. Continued.

Stream	Effort (m)	Catch per metre seined X 100 (N)			
		GRAY	LNDC	LKCB	LNSK
Hangingstone River					
12 June to 19 June	372	8.1(30)	0.0(0)	16.7(62)	4.0(15)
12 Aug. to 19 Aug.	692	1.4(10)	11.4(79)	12.7(88)	11.1(77)
9 Oct. to 18 Oct.	556	2.7(15)	0.0(0)	1.4(8)	2.9(16)
Total	2026	2.7(55)	3.9(79)	10.1(206)	5.6(114)

Continued...

Table 39. Continued.

Stream	Effort (m)	Catch per metre seined X 100 (N) WTSK	Unidentified Sucker fry	TRPH	SLSC
Christina River					
5 May to 10 May	227	0.0(0)	0.0(0)	13.2(30)	4.4(10)
13 June to 21 June	293	0.0(0)	>136.5(>400)	5.8(17)	0.3(1)
13 Aug. to 14 Aug.	277	0.0(0)	0.0(0)	5.8(16)	3.2(9)
14 Oct.	262	1.3(5)	0.0(0)	5.7(15)	5.0(13)
Total	1059	0.5(5)	>37.8(>400)	7.4(78)	3.1(33)
Gregoire River					
19 May	33	0.0(0)	0.0(0)	3.0(1)	3.0(1)
13 June to 15 June	79	0.0(0)	>177.2(>140)	0.0(0)	0.0(0)
16 Aug.	270	33.5(96)	0.0(0)	2.6(7)	10.0(27)
14 Oct.	145	128.3(186)	0.0(0)	22.7(33)	13.8(20)
Total	527	53.5(282)	>26.5(>140)	7.8(41)	9.1(48)
Hangingstone River					
3 May to 14 May	406	0.0(0)	0.0(0)	1.0(4)	2.5(10)

Continued...

Table 39. Concluded.

Stream	Effort (m)	Catch per metre seined X 100 (N)			
		WTSK	Unidentified Sucker fry	TRPH	SLSC
Hangingstone River					
12 June to 19 June	372	0.8(3)	0.5(2)	5.1(19)	5.9(22)
12 Aug. to 19 Aug.	692	4.5(31)	0.0(0)	7.4(51)	42.9(297)
9 Oct. to 18 Oct.	556	2.2(12)	0.0(0)	4.3(24)	43.9(244)
Total	2026	2.3(46)	0.1(2)	4.8(98)	28.2(573)

however, indirect evidence from the distribution and relative abundance of young-of-the-year (Table 31) that, as discussed earlier, major spawning areas are located in Saline, Saprae, and Surmont creeks. Relatively low catches of young-of-the-year in the Gregoire, Hangingstone, and Horse rivers suggest that limited spawning also occurs in these streams.

4.4.6.1.4 Length-frequency distributions. The length-frequency distribution of sexed Arctic grayling captured in the southern portion of the AOSERP study area in 1978 was very even (Figure 24), ranging in fork length from 110 to 349 mm. Earlier studies on the Muskeg (Bond and Machniak 1979) and Steepbank rivers (Machniak and Bond 1979) have usually shown distinct modes corresponding to specific age groups.

4.4.6.1.5 Age and growth. Age-length data for 36 Arctic grayling captured in the project study area are presented in Table 40. The majority of grayling in the study sample ranged from one to four years and in fork length from 105 to 330 mm. One grayling, taken at the mouth of the Horse River, was 8 years old and 341 mm long. The growth rate determined for the study sample is very similar to those reported by other investigators in the AOSERP study area (Bond and Machniak 1979; Griffiths 1973; Machniak and Bond 1979; Ward 1951), although older fish were more common than they were in this study.

Young-of-the-year Arctic grayling in the southern portion of the AOSERP study area had a mean fork length of 23.1 ± 2.2 mm (SD,N=12) around 12 to 16 June, 77.8 ± 13.7 mm (SD,N=45) around 17 to 21 August, and 97.1 ± 13.2 mm (SD,N=7) around 8 to 15 October.

4.4.6.1.6 Length-weight relationships. The following length-weight relationship was determined for Arctic grayling in the southern portion of the AOSERP study area:

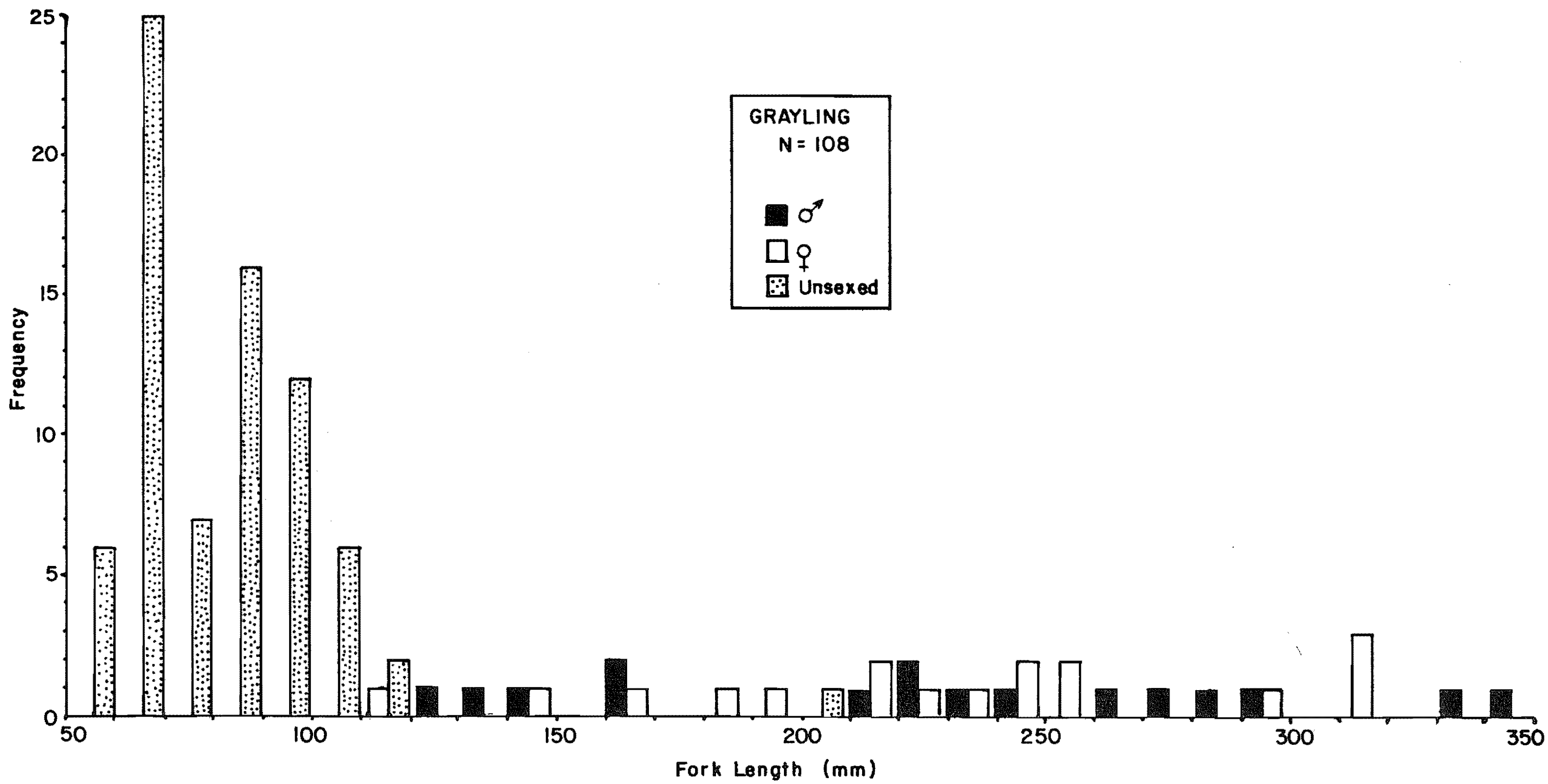


Figure 24. The length-frequency distribution for Arctic grayling collected in the southern portion of the AOSERP study area, May to October, 1978.

Table 40. Age-length relationship with age-specific sex ratios and percent maturity for Arctic grayling taken from the study area, 1978.

Age	Fork Length (mm)			Males			Females			Unsexed	Total
	Mean	S.D.	Range	N	%	%Mature	N	%	%Mature		
1	123.0	32.7	105-190	1	50	0	1	50	0	4	6
2	172.3	23.1	147-210	4	57	25	3	43	0	1	8
3	237.9	19.3	210-276	6	43	67	8	57	37	0	14
4	307.1	15.4	288-330	3	43	100	4	57	100	0	7
8	341	0	0	1	100	100	0	0	0	0	1
Total				15	49		16	51		5	35

Log_{10} Weight (g) = 3.113 Log_{10} Length (mm) - 5.223
(N=41, Range 92 to 355 mm, rxy=0.996)

4.4.6.1.7 Sex ratios and maturity. The overall sex ratio (15 males, 16 females) of the study sample (Table 40) did not deviate significantly (X^2=0.03, p>0.05) from an expected 1:1 ratio nor were there any significant differences within age groups.

A few males reach sexual maturity as early as age 2, although most probably do not spawn until at least age 3 (Table 40). By age 4, all males in the study sample were mature. Females appeared to be slower to mature than males. All were mature by age 4.

4.4.6.1.8 Food habits. A total of 29 stomachs was examined for stomach contents from grayling collected throughout the project study area (Table 41). All were found to contain some food. Insects, particularly adult corixids and trichopteran larvae, were by far the most frequently encountered items, although unidentified fish remains were also present in a small percentage of the stomachs examined.

4.4.6.2 Goldeye. Previous studies (Bond and Berry 1980b; Jones et al. 1978; Tripp and McCart 1979) have shown that goldeye populations in the Athabasca and Clearwater rivers are made up largely of juveniles in the 230 to 300 mm range. In the spring, they apparently move upstream from the Peace-Athabasca Delta on a feeding run at least as far as the Grand Rapids on the Athabasca River and the Christina River, a tributary of the Clearwater River. During the open-water period, they are among the most abundant fish taken by gillnets in these streams, accounting for 27 to 32% of the total catches. They are also common in the MacKay River (McCart et al. 1978), a large tributary of the Athabasca River, but are absent from smaller tributaries such as the Muskeg and Steepbank rivers (Bond and Machniak 1979; Machniak and Bond 1979). In autumn, goldeye disappear as they move downstream to overwintering areas in the Peace-Athabasca Delta.

Table 41. Frequency of occurrence of food items in stomachs of Arctic grayling, northern pike, goldeye and walleye taken from the present study area, 1978. Percent occurrence values are based only on stomachs which contained food.

Food Item	Arctic grayling		northern pike		goldeye		walleye	
	N	%	N	%	N	%	N	%
Insects								
Corixidae	16	55.2	0	0	1	4.4	0	0
Plecoptera	6	20.6	0	0	0	0	0	0
Ephemeroptera	6	20.6	1	2.9	0	0	0	0
Trichoptera	11	37.9	0	0	0	0	0	0
Odonata	1	3.5	1	2.9	0	0	0	0
Hymenoptera	4	13.8	0	0	2	8.7	0	0
Coleoptera	7	24.1	0	0	4	17.4	0	0
Chironomidae	0	0	0	0	1	4.4	0	0
Tabanidae	6	20.6	0	0	0	0	0	0
Fish								
Arctic grayling	0	0	1	2.9	0	0	0	0
flathead chub	0	0	1	2.9	0	0	0	0
longnose sucker	0	0	1	5.7	0	0	0	0
white sucker	0	0	1	2.9	0	0	0	0
spottail shiner	0	0	1	2.9	0	0	0	0
trout-perch	0	0	1	2.9	0	0	0	0
yellow-perch	0	0	1	2.9	0	0	0	0
sculpins	0	0	1	2.9	0	0	0	0
Insect Remains	4	13.8	2	5.7	13	56.5	0	0
Fish Remains	4	13.8	19	54.3	1	4.4	16	94.1
Digested Matter	3	10.3	5	14.3	6	26.1	2	11.8
Vegetable Matter	2	6.9	1	2.9	9	39.1	0	0
Stomachs Containing Food	29	100.0	35	0	23	0	17	0
Empty Stomachs	0	0	78	0	0	0	19	0
Stomachs Analysed	29	0	113	0	23	0	36	0

4.4.6.2.1 Distribution and abundance. In the project study area, goldeye were captured in the Christina River as far upstream as the Gregoire River and at the mouth of the Horse River, a tributary of the Athabasca River. None was taken anywhere else in this study (Appendix 7, Figure 37).

In Table 42, gillnet catches of goldeye taken during this study are compared with those reported from other studies in the AOSERP study area. These include studies conducted on the Athabasca and Clearwater rivers upstream of Fort McMurray (autumn Jones et al. 1978; spring, Tripp and McCart 1979), studies on the lower Athabasca River in the vicinity of Syncrude Canada Limited's lease sites (McCart et al. 1977), studies on the Athabasca River Delta and the Athabasca River in the vicinity of Mildred Lake (Bond and Berry 1980b), and studies on the MacKay River (McCart et al. 1978).

The highest catches of goldeye are recorded in the Athabasca River, from the Athabasca Delta to the Cascade Rapids, located approximately 32 km upstream of Fort McMurray. Upstream of the Cascade Rapids, which appear to be at least a partial barrier to upstream movement, goldeye catches are considerably lower (2.3 fish per gillnet hour x 100) than those downstream (28.6 fish per gillnet hour x 100).

Catches at the mouth of the Horse River (25.9 fish per gillnet hour x 100) are, not suprisingly, similar to those in the adjacent Athabasca River. Catches in both the Clearwater and MacKay rivers (11.3 and 12.6 fish per gillnet hour x 100) are about half those in the mainstem Athabasca. They are still lower in the Christina River (7.2).

4.4.6.2.2 Seasonal abundance. The seasonal pattern of gillnet catches of goldeye in the Christina River (Table 38, Figure 23) shows an increase in abundance from early May to mid-June. Thereafter, catches per unit effort declined slightly in August. By October, goldeye had evidently left the Christina River, presumably to overwintering areas located downstream in Lake Athabasca, the

Table 42. Relative abundance of goldeye in the AOSERP study area based on catches per gillnet hour x 100.

Location	Number of Gillnet Hours	Number of Goldeye	Catch per Gillnet Hour x 100
Christina River	403.0	29	7.2
Gregoire River	252.0	0	0.0
Hangingstone River	279.0	0	0.0
Horse River (mouth)	81.0	21	25.9
Athabasca River upstream of the Cascade Rapids	880.5	20	2.3
Athabasca River between Fort McMurray and the Cascade Rapids	692.5	198	28.6
Athabasca River, Syncrude Area	872.0	122	14.0
Athabasca River, Mildred Lake Area	810.0	475	58.6
Athabasca River Delta	797.0	183	23.0
Clearwater River	687.5	78	11.3
MacKay River	262.0	33	12.6

Peace-Athabasca Delta, or the Peace River (Bond and Berry 1980b). The seasonal pattern of abundance of goldeye at the mouth of the Horse River was similar to that described for the Christina River.

4.4.6.2.3 Length-frequency distribution. Goldeye captured during this study ranged from 260 to 329 mm fork length (Figure 25). Similar length frequency distributions are reported elsewhere in the AOSERP study area (Bond and Berry 1980b; Jones et al. 1978; McCart et al. 1977, 1978; Tripp and McCart 1979). Males predominated in the smaller size classes while females were most abundant in the larger size classes.

4.4.6.2.4 Age and growth. Goldeye in the sample ranged from 3 to 6 years and in fork length from 266 to 319 mm (Table 43). Most of the sample (57%) were age 4 fish with a mean fork length of 287.2 ± 8.9 (SD) mm.

4.4.6.2.5 Length-weight relationships. Because of the small sample size, no comparisons were made between the length-weight relationships of males and females. The length-weight relationship for males, females, and unsexed fish combined was:

$$\text{Log}_{10}\ \text{Weight (g)} = 3.614\ \text{Log}_{10}\ \text{Length (mm)} - 6.446$$

(N=23, Range 226 to 321 mm, rxy=0.846)

4.4.6.2.6 Maturity and sex ratios. Within the sample, female goldeye (N=17) were significantly more abundant than males (N=5, X^2=6.5, $p<0.05$). All males were age 4 and immature while females ranged from 3 to 6 years. Mature females, aged 5 and 6, were probably fish that would spawn for the first time in the spring of the following year.

4.4.6.2.7 Food habits. Twenty-three goldeye stomachs were examined for food contents. Since most of these goldeye were, however, dead

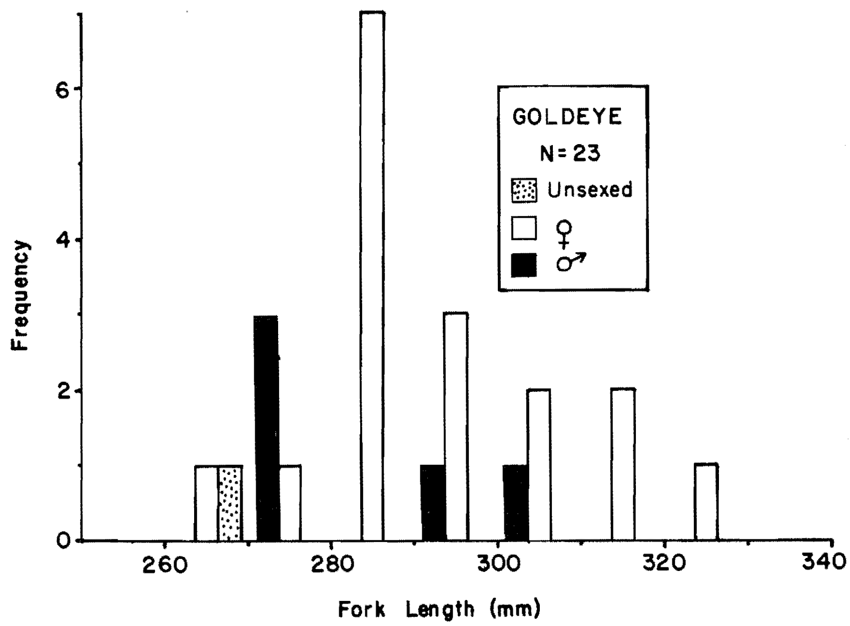


Figure 25. The length-frequency distribution for goldeye collected in the southern portion of the AOSERP study area, May to October 1978.

Table 43. Age-length relationship with age-specific sex ratios and percent maturity for goldeye taken from the Christina River, 1978.

Age	Fork Length (mm) Mean	S.D.	Range	Males N	%	%Mature	Females N	%	%Mature[a]	Unsexed	Total
3	275.5	13.4	266-285	0	0	0	2	100	0	1	3
4	287.2	8.9	273-300	5	38	0	8	62	0	0	13
5	307.2	13.3	289-319	0	0	0	6	100	50	0	6
6	313	0	0	0	0	0	1	100	100	0	1
Total				5	24		17	76		1	23

[a]probably maturing for the first time

specimens taken in overnight gillnet sets during the summer warm water period, the stomach contents were in an advanced state of decomposition. The enumeration of food items was therefore biased toward the most recently consumed items or items resistant to digestion such as vegetable matter and hard insect parts. As shown in Table 41, these were in fact the most frequently encountered items. Adult corixids, hymenopterans, coleopterans, and chironomid larvae were also recorded in a small percentage of the stomachs examined.

4.4.6.3 Northern pike. There is little evidence from previous studies in the AOSERP study area to indicate that northern pike in the mainstems of the Athabasca and Clearwater rivers undertake extensive migrations such as those which characterize lake whitefish, goldeye, or longnose suckers. Catches of northern pike in these streams have been sporadic, generally small (Bond and Berry 1980a, b; Jones et al. 1978; McCart et al. 1977, 1978; Tripp and McCart 1979), and cannot be used to describe patterns of seasonal movements.

Weir studies on the Muskeg (Bond and Machniak 1979) and Steepbank (Machniak and Bond 1979) rivers, tributaries of the Athabasca River, have shown, however, that pike undertake shorter migrations into tributaries of the Athabasca River during the month of May. These are believed to be migrations to summer feeding areas rather than spawning areas. In these streams, young-of-the-year are rarely captured, suitable spawning areas are limited, and the runs are composed largely of immature and spent fish.

4.4.6.3.1 Distribution and abundance. In the project study area, northern pike were distributed throughout the Christina and Gregoire rivers, in Gregoire Lake, and at the mouth of the Horse River (Appendix 7, Figure 38). A single pike was also sampled at the uppermost station (10) of the Hangingstone River near the mouth of a small lake where an isolated, resident population likely exists. Most of the northern pike collected were either mature fish or fish that were maturing for the first time. Young-of-the-year were not nearly as common as larger fish but were present in the slow flowing upper reaches of the Gregoire River (Stations 3, 4, and 5) and along the weedy sections of Gregoire Lake. None was taken elsewhere in the project study area.

By far the largest concentration of northern pike was located in the Christina River where they dominated the overall gillnet catch. In Table 44, the overall seasonal gillnet catch for northern pike in the Christina River is compared with catches elsewhere in the AOSERP study area using the same data sources described earlier. As shown, catches of northern pike in the Christina River are three to four times higher than those in the Athabasca River from the delta upstream to the Cascade Rapids and in the MacKay River. The differences are even more apparent when compared to other areas such as the Athabasca River upstream of the Cascade Rapids and the Clearwater, Gregoire, Horse, and Hangingstone rivers.

4.4.6.3.2 Seasonal abundance. The seasonal patterns of abundance for northern pike in the project study area (Table 38, Figure 23) show a major migration in the Christina River during the spring. From 5 to 14 May 1978, the average gillnet catch per hour x 100 for northern pike in the Christina River was 55.0, dropping to 21.3 in June, 15.8 in August, and 7.3 in September. In the Gregoire River, the seasonal pattern was similar although catches were substantially lower.

It is clear that the migration in the Christina River is a spawning migration, unlike those reported for other tributaries of the Athabasca River, including the Muskeg (Bond and Machniak 1979) and Steepbank (Machniak and Bond 1979) rivers. In these streams, most of the northern pike taken were immature or spawned-out fish, while those taken in the Christina River during the spring spawning period were green or ripe. It is not clear, however, where the northern pike in the Christina River came from or whether they were moving upstream or downstream. There are

Table 44. Relative abundance of northern pike in the AOSERP study area based on catches per gillnet hour x 100.

Location	Number of Gillnet Hours	Number of Northern Pike	Catch per Gillnet Hour x 100
Christina River	403.0	105	26.1
Gregoire River	252.0	8	3.2
Hangingstone River	279.0	1	0.3
Horse River (mouth)	81.0	3	3.7
Athabasca River upstream of the Cascade Rapids	880.5	25	2.8
Athabasca River between Fort McMurray and the Cascade Rapids	692.5	53	7.7
Athabasca River, Syncrude Area	872.0	39	4.5
Athabasca River, Mildred Lake Area	810.0	56	6.9
Athabasca River Delta	797.0	67	8.4
Clearwater River	687.5	31	4.5
MacKay River	262.0	21	8.0

several possibilities:

1. The Clearwater River upstream of its confluence with the Christina River appears to be a major spawning area for northern pike (Tripp and McCart 1979). It is possible that northern pike migrating upstream from the lower reaches of the Clearwater River to this spawning area also move upstream into the Christina River. There was, however, no evidence of a migration in the lower Clearwater River (Tripp and McCart 1979);
2. Northern pike spawning in the upper Clearwater River may also migrate downstream and then up into the Christina River;
3. Northern pike in the Christina River could also be migrating downstream to spawning areas in the upper Clearwater River; and
4. Northern pike may move downstream from the Gregoire Lake-Gregoire River system to spawning areas upstream in the Christina River and downstream in the Clearwater River. Although the catches of northern pike recorded in the Gregoire River during this study were not high, Alberta Fish and Wildlife personnel noted large numbers of pike, most of them spent, moving upstream through a fish ladder situated at the outlet of Gregoire Lake in late May.

Further studies are needed to determine which of the four possibilities outlined above is most likely.

4.4.6.3.3 Spawning. Northern pike in the Christina and Gregoire rivers spawned over a 1 wk period from 7 May, when the first ripe females were taken, to 14 May, when the last ripe females were taken (Table 45). Undoubtedly, there were northern pike spawning before and after this time as well. It is likely, however, that spawning peaked around 10 to 14 May when a large percentage of both males (84%, N=45) and females (42%, N=26) were

Table 45. Summary of seasonal variation in spawning condition of northern pike in the Christina and Gregoire rivers, 5 May to 15 June 1978. G = green; R = ripe; S = spawned out; WS = won't spawn.

Date	Males				Females				
	N	%G	%R	%SO	N	%G	%R	%SO	%WS
5 May	3	33	67	0	0	0	0	0	0
7 May	1	100	0	0	3	0	100	0	0
8 May	3	100	0	0	1	100	0	0	0
10 May	25	8	92	0	20	50	45	5	0
14 May	20	0	75	25	6	33	33	33	0
19 May	2	0	0	100	0	0	0	0	0
27 May	0	0	0	0	1	100	0	0	0
8 June	0	0	0	0	2	0	0	100	0
13 June	1	100	0	0	0	0	0	0	0
14 June	1	100	0	0	4	0	0	75	25
15 June	8	13	0	87	9	0	0	44	56
Total	64	16	63	21	46	30	30	27	13

ripe. During this period, water temperatures in the Christina River ranged from 6 to 9°C.

There is little evidence for northern pike spawning in the lower reaches of the Christina River despite the presence of ripe and recently spawned-out fish. In this area, there appears to be no suitable spawning areas nor were young-of-the-year ever captured in this area. It is likely that the Christina River is, instead, a major migration route to spawning areas located downstream in the Clearwater River or upstream in the weedy backwaters and tributaries of the upper Christina River. The Gordon River is one such tributary where, on 10 May, a large concentration of northern pike in spawning condition was discovered a short distance upstream of its mouth.

Other possible spawning areas include the slow-flowing and weedy upper reaches of the Gregoire River (Stations 3, 4, and 5) and the shallow weedy sections of Gregoire Lake. Although never abundant, young-of-the-year were present in each of these areas.

4.4.6.3.4 Length-frequency distribution. Northern pike captured in the southern portion of the AOSERP study area in 1978 ranged in fork length from 225 to 694 mm (excluding young-of-the-year), with the largest percentage (73%) in the 375 to 549 mm range. The modal length for both males and females (Figure 26) fell in the 475 to 499 mm range, although females predominated in the larger size classes while males predominated in the smaller size classes. Generally, the size distribution of northern pike captured in the project study area consisted of smaller fish than those reported for the mainstem Athabasca and Clearwater rivers (Bond and Berry 1980b; Bond and Machniak 1977; McCart et al. 1977; Jones et al. 1978; Tripp and McCart 1979).

4.4.6.3.5 Age and growth. Age-length data for 103 northern pike captured in the project study area are presented in Table 46. Pike in this sample ranged from 0 to 10 years of age and in fork length

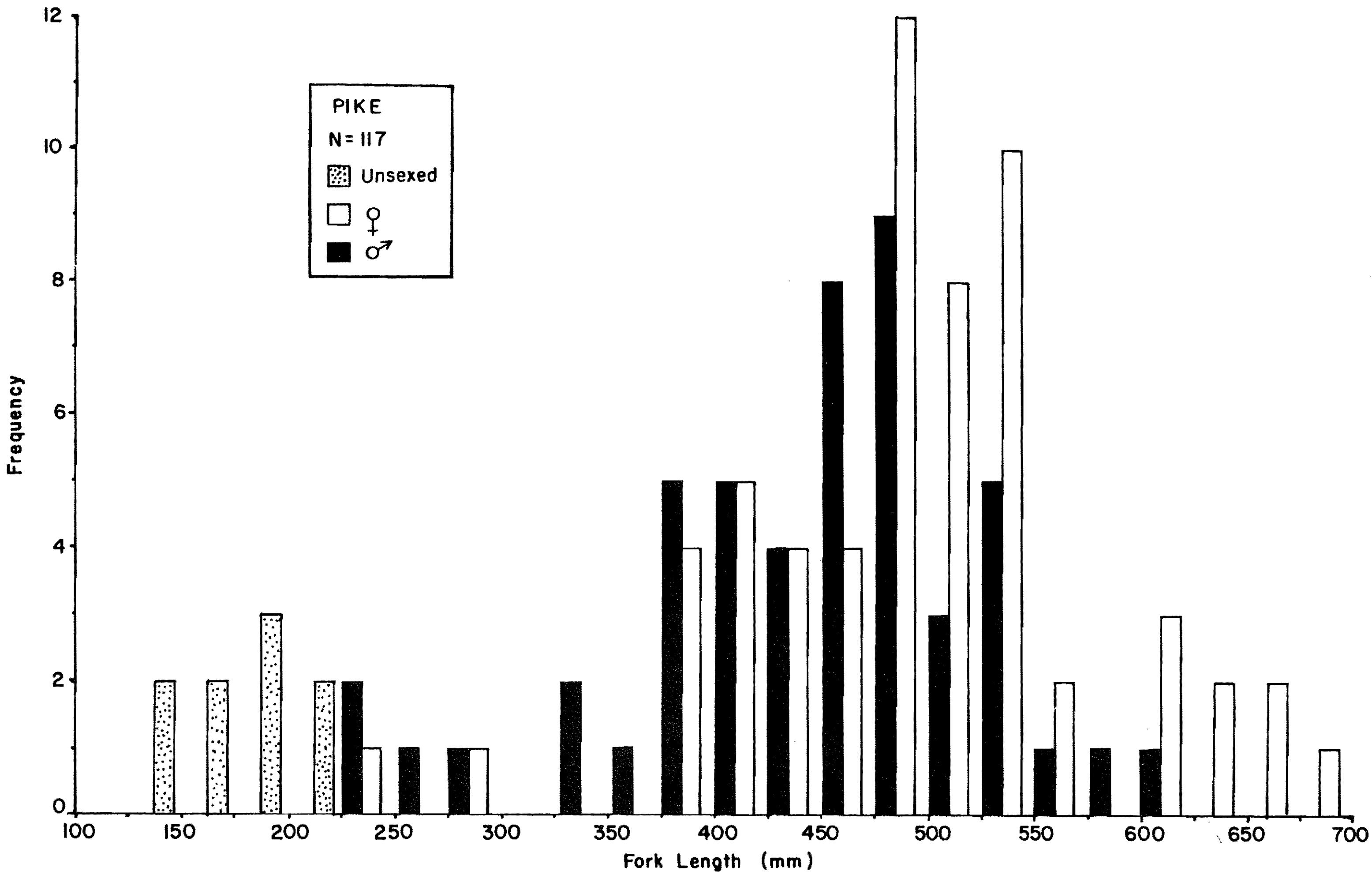


Figure 26. The length-frequency distribution for northern pike collected in the southern portion of the AOSERP study area, May to October, 1978.

Table 46. Age-length (mm) relationship for northern pike from the Christina and Gregoire rivers 1978. Differences in mean fork length for males and females at each age were tested using Student's t-test.

	Males					Females						All Fish			
Age	N	Mean	S.D.	Range	%Mature	N	Mean	S.D.	Range	%Mature	t	N	Mean	S.D.	Range
0	0	0	0	0	0	0	0	0	0	0	0	4	171.5	16.2	156-190
1	3	229.0	12.7	220-238	33	2	264.0	33.9	240-288	0	1.73	6	237.0	34.5	184-288
2	4	359.7	30.1	328-385	75	2	390.5	3.5	388-393	50	1.36	6	370.0	28.3	328-393
3	11	419.4	41.0	362-480	90	5	436.2	50.0	377-505	80	0.71	16	424.6	43.1	362-505
4	10	459.2	29.9	390-485	100	18	468.4	48.7	401-568	61	0.54	28	465.1	42.6	390-568
5	7	483.7	46.3	418-554	100	16	520.4	46.3	476-674	81	1.75	23	509.2	48.4	418-674
6	5	518.8	19.7	492-545	100	6	533.8	39.3	490-605	100	0.77	11	527.0	31.5	490-605
7	2	496.5	51.6	460-533	100	4	614.3	30.8	558-647	100	3.24[a]	6	575.0	71.7	460-647
8	0	0	0	0	0	1	684	0	0	100	0	1	684	0	0
9	0	0	0	0	0	1	610	0	0	100	0	1	610	0	0
10	0	0	0	0	0	1	661	0	0	100	0	1	661	0	0

[a] $P<0.05$

from 156 to 684 mm, although few fish exceeded 7 years or a fork length of 575 mm. Both the oldest and largest fish were females. The mean fork length of females exceeded that of males at every age. The differences were, however, significant ($t=3.24$, $p<0.05$) only at age 7.

For the first three years, the growth rate of northern pike taken in this study is similar to those of northern pike reported by Griffiths (1973) for the AOSERP study area and by Jones et al. (1978) for pike in the Athabasca and Clearwater rivers (Figure 27). The growth rate then declines in older fish and approaches that reported for the Athabasca and Clearwater rivers by McCart et al. (1977) and Tripp and McCart (1979).

4.4.6.3.6 Length-weight relationships. Length-weight relationships for northern pike were calculated for three randomly selected fish from each 25 mm size class over the entire size range. The following relationships were obtained for males and females:

Males (N=29, Range 238 to 554 mm, $r_{xy}=0.989$)

$\log_{10}$ Weight (g) = 2.849 $\log_{10}$ Length (mm) - 4.808

Females (N=33, Range 288 to 684 mm, $r_{xy}=0.977$)

$\log_{10}$ Weight (g) = 3.087 $\log_{10}$ Length (mm) - 5.442

Analysis of covariance (ANCOVA) indicated, however, that there were no significant differences between either slopes ($F=1.995$, $p>0.05$) or intercepts ($F=0.006$, $p>0.05$). The relationship for the combined sample including unsexed fish was:

Combined (N=68, Range 156 to 684 mm, $r_{xy}=0.991$)

$\log_{10}$ Weight (g) = 3.001 $\log_{10}$ Length (mm) - 5.210

4.4.6.3.7 Sex ratios and maturity. Of 98 northern pike, for which both age and sex were determined (Table 46), 56 (57%) were females. This sex ratio did not differ significantly ($X^2=3.0$, $p>0.05$) from an expected 1:1 ratio nor were there significant differences within age groups.

A small percentage of the male northern pike in the project study area reach maturity as early as age 1 but most

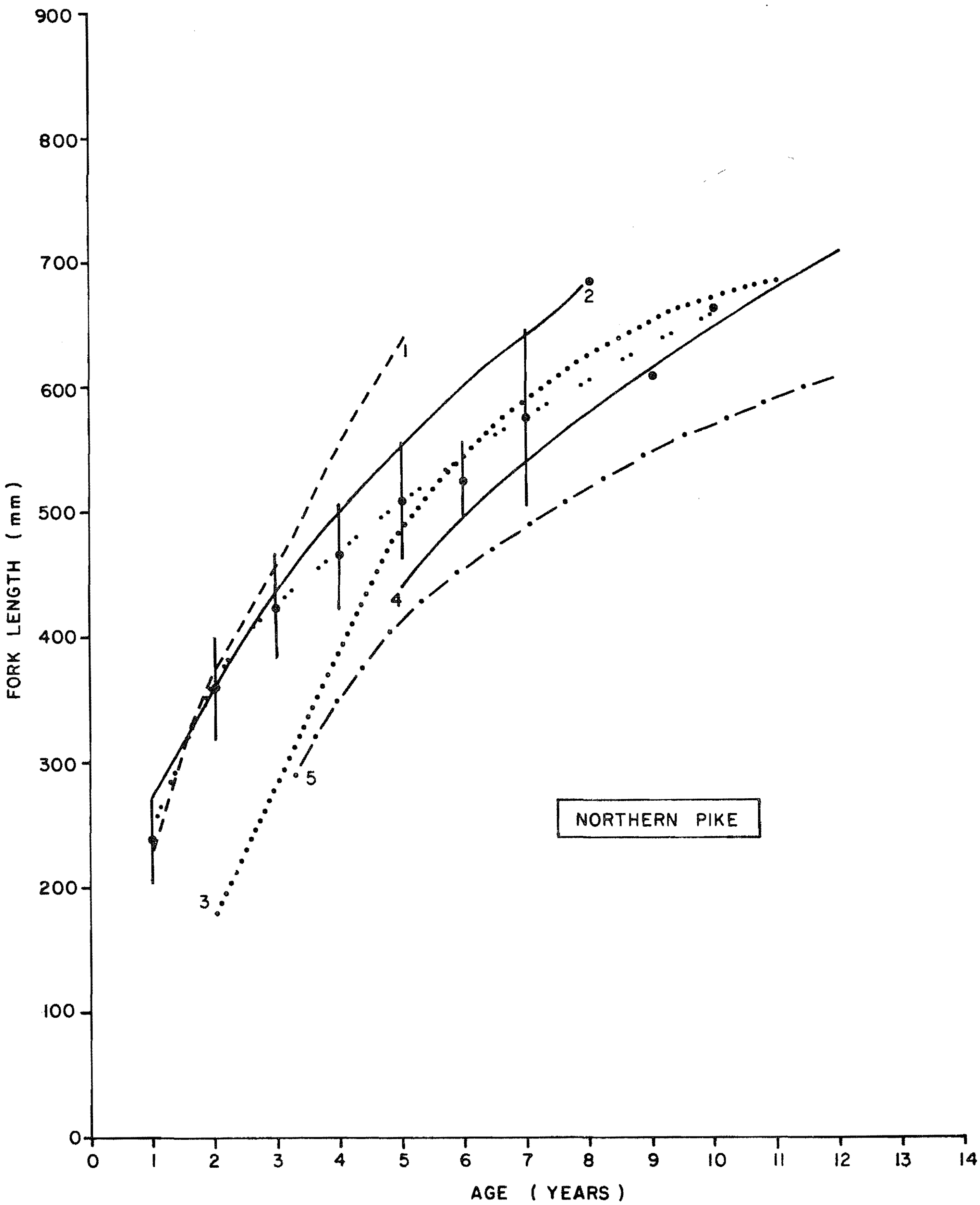


Figure 27. Comparison of northern pike growth rates in the present study area with growth rates of northern pike elsewhere in the AOSERP study area: 1. AOSERP study area (Griffiths 1973); 2. upper Athabasca River and Clearwater River (Jones et al. 1978); 3. Athabasca River, Syncrude Area (McCart et al. 1977) 4. upper Athabasca River and Clearwater River (Tripp and McCart 1979); and 5. MacKay River (McCart et al. 1978). Points with vertical lines are individual fish.

probably do not spawn until at least age 2 (Table 46). By age 4, all males in the study sample were mature. Females are slower to mature than males, reaching first maturity at age 2 and probably spawning for the first time at age 3. All fish, age 6 and older, had mature gonads, indicating that once maturity is reached, spawning occurs every year.

4.4.6.3.8 Fecundity. The estimated fecundity of 13 mature green northern pike sampled from the Christina and Gregoire rivers 8 to 14 May 1978 was 15 328 ± 6283 (SD) eggs (Table 47), ranging from 5778 for a pike 539 mm fork length to 23 651 for a smaller pike, 483 mm fork length. The average fork length of the sample was 541.8 ± 57.5 (SD) mm, ranging from 476 to 661 mm. Total gonad weight, including eggs, membranes, and blood vessels, averaged 7.0 ± 1.9 (SD)% of total body weight, ranging from 3.0 to 9.6%.

Estimated fecundities for pike taken elsewhere in the AOSERP study area ranged from 28 896, for pike 554 to 657 mm in fork length from the lower Athabasca River (Bond and Berry 1980b), to 42 614, for pike 518 to 872 mm fork length from the Athabasca River upstream of Fort McMurray (Tripp and McCart 1979).

4.4.6.3.9 Food habits. A total of 113 stomachs was examined of which 35 (31%) were found to contain food (Table 41). Fish, including Arctic grayling, flathead chub, longnose suckers, white suckers, spottail shiners, trout-perch, and sculpins, were by far the most common identifiable items. Insects, including ephemeropteran and odonate nymphs, were also eaten, primarily by young-of-the-year and small juveniles.

4.4.6.4 Longnose suckers. Longnose suckers are among the most abundant and widespread fish species in the AOSERP study area. As a result, they have been the subject of considerable study. Major longnose sucker spawning migrations have been documented for several tributaries of the Athabasca River, including the MacKay (McCart et al. 1977), Muskeg (Bond and Machniak 1977), and

Table 47. Egg counts from northern pike taken from the Christina and Gregoire rivers, 8 to 14 May 1978.

	Fork Length (mm)	Weight (gm)	Age	Egg Size (mm)	Gonad Weight (gm)	% Gonad Wt. of Body Wt.	Number of Eggs
	624	1 456	7	1.7	79.2	5.4	15 860
	610	1 512	9	1.9	136.6	9.0	23 165
	480	648	4	2.0	46.1	7.1	11 365
	523	880	6	2.0	71.5	8.1	19 658
	483	780	5	2.1	39.9	5.1	23 651
	527	973	6	1.8	74.2	7.6	11 924
	521	852	5	2.0	81.4	9.6	21 272
	534	942	6	1.8	66.0	7.0	12 088
	539	1 018	6	2.0	36.6	3.6	5 778
	508	801	6	1.9	36.9	4.6	6 562
	476	661	5	1.9	49.6	7.5	9 605
	558	1 062	7	2.0	98.9	9.3	15 962
	661	2 186	10	1.7	146.0	6.7	22 376
Mean	541.8	1 059.3	6.3	1.9	74.1	7.0	15 328.2
SD	57.5	428.4	1.7	0.1	35.6	1.9	6 283.0
SE	16.0	118.8	0.5	<0.1	9.9	0.5	1 742.6
Range	476-661	648-2 186	4-10	1.7-2.1	36.6-146.0	3.6-9.6	5 778-23 651

Steepbank (Machniak and Bond 1979) rivers. It is likely that other large tributaries of the lower Athabasca River, such as the Ells and Firebag rivers, are also important spawning areas. It is also known that large numbers of longnose suckers migrate upstream to spawn in the mainstem Athabasca River upstream of Fort McMurray as far as the Cascade Rapids (Tripp and McCart 1979), the same area used by fall spawning lake whitefish (Jones et al. 1978).

4.4.6.4.1 Distribution and abundance. In the project study area, large juvenile and adult longnose suckers were collected throughout the Christina and Gregoire rivers and at the mouth of the Horse River (Appendix 71, Figure 39). In the Hangingstone River, large juveniles were present at most stations as far upstream as Station 8. Mature fish, however, were taken only at Station 3. Small juvenile and young-of-the-year longnose suckers were present throughout the Christina, Gregoire, and Hangingstone rivers, in the upper reaches (Stations 3 and 4) of the Horse River, and near the mouths of the Algar River and Saline Creek. They were absent in Algar Lake, Gregoire Lake, Cameron Creek, Surmont Creek, Prairie Creek, and the upper reaches of the Algar River as well as Saline and Saprae creeks.

Longnose suckers were the most abundant fish overall in the southern portion of the AOSERP study area, representing 18.2% of the total gillnet catch and 17.2% of the total minnow seine catch.

In Table 48, gillnet catches per unit effort (catch per hour x 100) for longnose suckers in the project study area are compared with catches elsewhere in the AOSERP study area. The highest catches per unit gillnet effort were recorded in the MacKay River (13.4) and the lowest in the Athabasca Delta (3.4) and Clearwater River (3.9). In the project study area, catches of longnose suckers per unit effort in the Christina (9.9) and Gregoire (9.1) rivers were similar and among the highest recorded in the AOSERP study area. In contrast, catches in the Hangingstone (4.7) and Horse (4.0) rivers were among the lowest.

Table 48. Relative abundance of longnose suckers in the AOSERP study area based on catches per gillnet hour x 100.

Location	Number of Gillnet Hours	Number of Long-nose Suckers	Catch per Gillnet hour x 100
Christina River	403.0	40	9.9
Gregoire River	252.0	23	9.1
Hangingstone River	279.0	13	4.7
Horse River (mouth)	81.0	4	5.0
Athabasca River upstream of the Cascade Rapids	880.5	86	9.8
Athabasca River between Fort McMurray and the Cascade Rapids	692.5	38	5.5
Athabasca River, Syncrude Area	872.0	61	7.0
Athabasca River, Mildred Lake Area	810.0	75	9.3
Athabasca River Delta	797.0	27	3.4
Clearwater River	687.5	27	3.9
MacKay River	262.0	35	13.4

Longnose sucker catches per unit effort minnow seining (catch per metre of shoreline seined x 100)(Table 31) were about equally high in the Algar (52.8), Christina (51.0), and Gregoire (53.3) rivers and relatively low in the Hangingstone River (5.6) and Saline Creek (8.8).

4.4.6.4.2 Seasonal abundance. Seasonal variation in catches per unit gillnet effort (catch per hour x 100) for longnose suckers (Table 38, Figure 23) shows a major peak in abundance in both the Christina and Gregoire rivers that coincides with the spawning migration of longnose suckers in early May. Thereafter, catches dropped suddenly and, by October, longnose suckers had evidently left the Christina and Gregoire rivers for overwintering areas located elsewhere. Catches in the Hangingstone River were low throughout the year with no evidence of any significant movements by longnose suckers.

4.4.6.4.3 Spawning. Seasonal variation in the spawning condition of female longnose suckers (Table 49) indicates that most spawning in the Gregoire and Christina rivers probably occurred between 14 and 19 May. During this period, water temperatures ranged from 9 to 14°C.

The only direct observations of longnose suckers spawning were made 19 May, at the road crossing of the Gregoire River near the outlet of Gregoire Lake. Indirect evidence from the distribution of young-of-the-year suggests, however, that longnose suckers probably spawn in many areas throughout the length of both the Gregoire and Christina rivers. Young-of-the-year were also abundant in the upper reaches of the Horse River but relatively rare elsewhere.

4.4.6.4.4 Length-frequency distribution. The length-frequency distribution of longnose suckers captured in the southern portion of the AOSERP study area is shown in Figure 28. Longnose suckers ranged from less than 25 mm to 449 mm fork length, with fish less

Table 49. Summary of seasonal variation in the spawning condition of longnose suckers in the Christina and Gregoire rivers, 5 May to 16 June 1978. G = green; R = ripe; SO = spawned out.

	Males				Females			
Date	N	%G	%R	%SO	N	%G	%R	%SO
5 May	18	100	0	0	9	100	0	0
7 May	0	0	0	0	10	100	0	0
8 May	15	40	60	0	10	100	0	0
14 May	3	0	100	0	7	72	14	14
19 May	1	0	0	100	5	0	20	80
14 June	0	0	0	0	1	0	0	100
15 June	1	0	0	100	2	0	0	100
16 June	1	0	0	100	2	0	0	100
Total	39	62	31	7	46	74	4	22

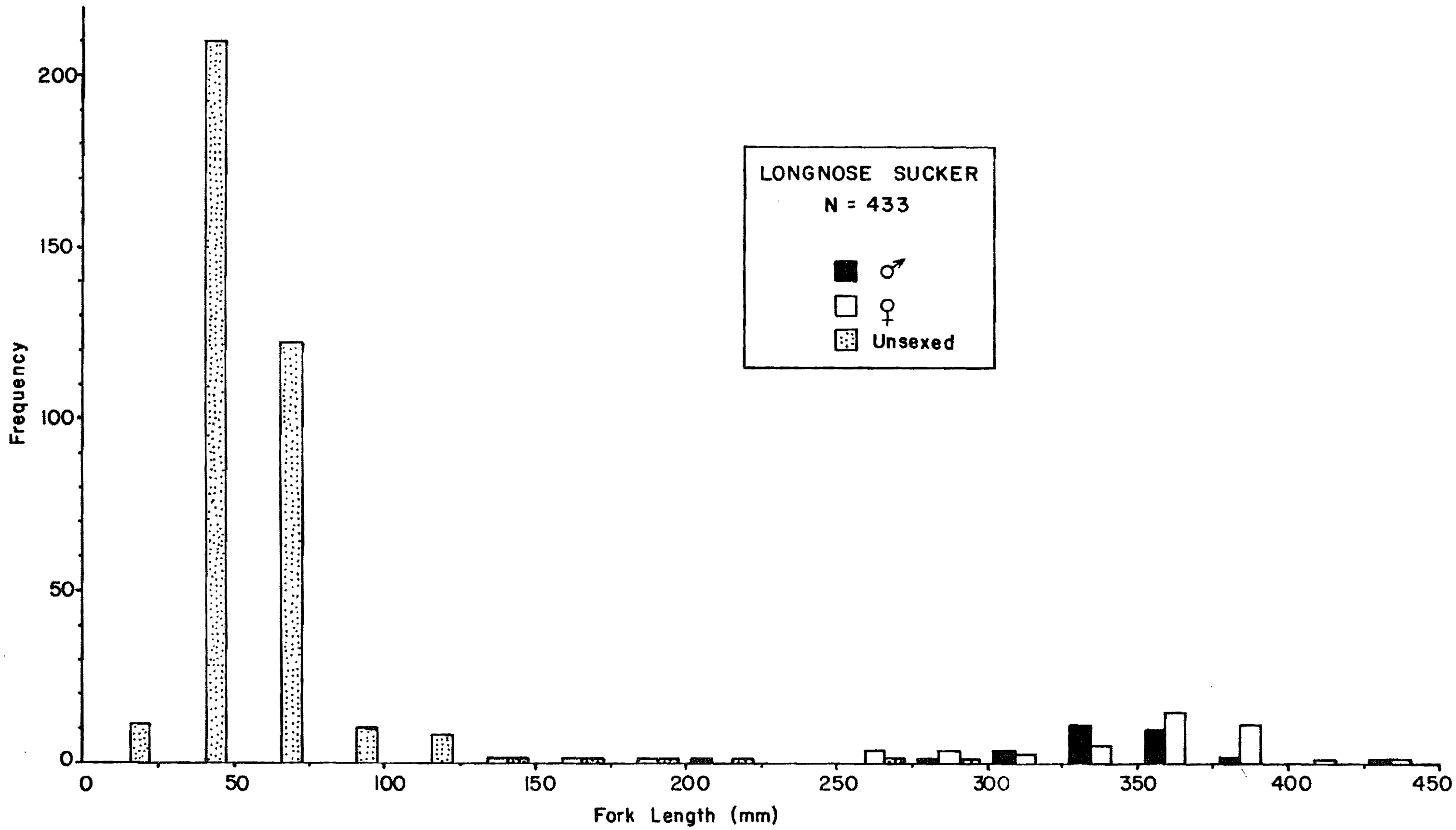


Figure 28. The length-frequency distribution for longnose suckers collected in the southern portion of the AOSERP study area, May to October 1978.

than 100 mm (young-of-the-year and juveniles in their second season of growth) representing most of the catch in minnow seines, and fish from 250 to 399 mm fork length representing most of the gillnet catch. Part of the reason for the apparent scarcity of fish in the 125 to 249 mm range is undoubtedly related to sampling bias although real differences in the distributions of young-of-the-year, juveniles, and adults are also possible.

4.4.6.4.5 Age and growth. Age-length data for 64 longnose suckers captured in the Christina and Gregoire rivers are presented in Table 50. Longnose suckers in the sample ranged in age from 2 to 20 years and in fork length from 115 to 426 mm with most (78%) ranging from 8 to 13 years and 275 to 393 mm in length.

From 2 to 7 years, the growth rate of longnose suckers is similar to those of longnose suckers reported by Bond and Machniak (1979) for the Muskeg River and McCart et al. (1977) for suckers in the lower Athabasca River (Figure 29). The growth rate then suddenly drops at about the age of first maturity. In succeeding years, the growth rate is among the slowest reported in the AOSERP study area with relatively small incremental increases in fork length each year.

In October, at the end of one season's growth, young-of-the-year longnose suckers were 36.9 ± 5.2 (SD) fork length in the Gregoire River (N=35), 43.7 ± 6.8 mm in the Hangingstone River (N=13), and 51.4 ± 10.0 mm in the Christina River (N=14).

4.4.6.4.6 Length-weight relationships. Length-weight relationships for longnose suckers were calculated separately for males and females based on three randomly selected fish from each 10 mm size class. The following relationships were obtained:

Males (N=20, Range 285 to 425 mm, rxy=0.916)

Log_{10} Weight (g) = 2.313 Log_{10} Length (mm) - 3.142

Females (N=25, Range 290 to 440 mm, rxy=0.983)

Log_{10} Weight (g) = 3.314 Log_{10} Length (mm) - 5.685

Table 50. Age-length relationship with age specific sex ratios and percent maturity for longnose suckers taken from the Christina and Gregoire rivers, 1978.

Age	Fork Length (mm)			Males			Females			Unsexed	Total
	Mean	S.D.	Range	N	%	%Mature	N	%	%Mature		
2	122.0	7.0	115-129	0	0	0	1	100	0	2	3
4	205.7	45.0	167-255	0	0	0	0	0	0	3	3
7	317.7	13.6	305-332	2	67	100	1	33	0	0	3
8	332.5	37.2	275-371	3	25	100	9	75	67	1	13
9	348.7	8.1	343-358	1	33	100	2	67	50	0	3
10	343.4	19.4	313-365	2	0	100	7	0	86	0	9
11	357.2	23.4	318-391	5	0	100	7	0	100	0	12
12	337.6	24.8	310-378	3	60	100	2	40	100	0	5
13	370.9	19.4	345-393	6	75	100	2	25	100	0	8
14	388	0	0	0	0	0	1	100	100	0	1
15	377.7	17.0	358-388	1	33	100	2	67	100	0	3
16	384	0	0	0	0	0	1	100	100	0	1
20	426	0	0	1	100	100	0	0	0	0	1
Totals				24	41		35	59		6	64

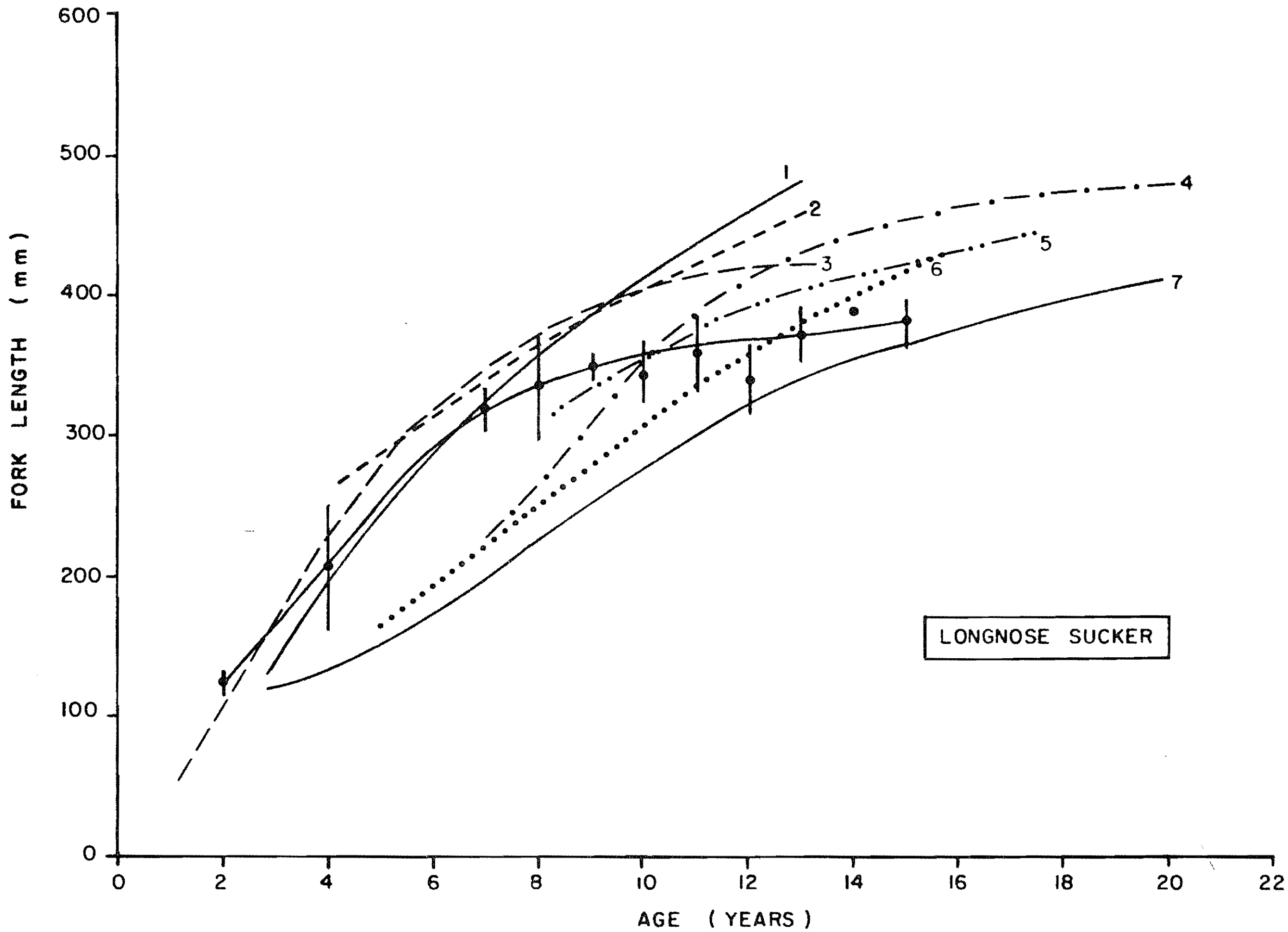


Figure 29. Comparison of longnose sucker growth rates in the present study area with growth rates of longnose sucker elsewhere in the AOSERP study area: 1. Athabasca River, Syncrude area (McCart et al. 1977); 2. upper Athabasca River and Clearwater River (Jones et al. 1978); 3. Muskeg River (Bond and Machniak 1979); 4. Athabasca River between Fort McMurray and the Cascade Rapids (Tripp and McCart 1979); 5. MacKay River (McCart et al. 1978); and 7. Athabasca River upstream of the Cascade Rapids (Tripp and McCart 1979). Points with vertical lines are mean fork lengths ± standard deviation while points without vertical lines are individual fish.

Analysis of covariance (ANCOVA) indicated a significant difference between the slopes (F=16.107, P<0.05) but not the intercepts (F=0.333, P>0.05) of the above equations. The relationship for the combined sample is:

Combined (N=45, Range 285 to 440 mm, rxy=0.954)

Log_{10} Weight (g) = 2.932 Log_{10} Length (mm) - 4.713

4.4.6.4.7 Sex ratios and maturity. Of 59 longnose suckers for which both age and sex were determined (Table 50), 35 (59%) were females. This sex ratio did not differ significantly from an expected 1:1 ratio (X^2=2.05, P>0.05) nor were there any significant differences within age groups.

All males in the study sample were mature, the youngest age 7. Females are slower to mature than males, reaching first maturity at age 8. All fish age 11 and older were mature indicating that, once mature, fish spawn every year. Other investigators report ages at first maturity ranging from 5 (Bond and Machniak 1979; Jones et al. 1978) in both the Muskeg and Athabasca rivers to 8 years in the Athabasca and Clearwater rivers upstream of Fort McMurray (Tripp and McCart 1979).

4.4.6.4.8 Fecundity. The average fecundity of 15 longnose suckers sampled from the Christina and Gregoire rivers, just before spawning, was 16 180 ± 5605 (SD)(N=15), ranging from 6623 for a female 331 mm fork length, to 32 269 for a female 440 mm fork length (Table 51). Average fork length of the sample was 373.4 ± 25.5 (SD) mm ranging from 331 to 440 mm. Total gonad weight, including eggs, ovarian membranes, and blood vessels, was 10.1 ± 1.0% of the total body weight.

The average fecundity of longnose suckers sampled elsewhere in the AOSERP study area was 21 843 for longnose suckers (309 to 497 mm fork length) from the Athabasca River upstream of Fort McMurray (Tripp and McCart 1979), 19 408 for longnose suckers (387 to 491 mm fork length) in the lower Athabasca River (Bond and Berry 1980b), 23 639 for longnose suckers (370 to 440 mm fork length)

Table 51. Egg counts from longnose suckers taken from the Christina and Gregoire rivers, 8 to 14 May 1978.

Fork Length (mm)	Weight (gm)	Age	Egg Size (mm)	Gonad Weight (gm)	% Gonad Wt. of Body Wt.	Numbers of Eggs
391	804	11	2.1	84.5	10.5	19 301
388	810	15	1.8	37.5	4.6	11 880
388	823	14	1.8	89.7	10.9	17 904
391	744	13	1.9	67.5	9.1	14 342
440	1183	ND	1.9	166.4	14.1	32 269
375	791	11	2.0	85.4	10.8	13 592
331	501	12	1.8	43.1	8.6	6 623
352	588	16	1.9	64.1	10.9	13 068
364	671	10	1.6	70.5	10.5	14 353
384	675	11	1.8	74.6	11.1	18 015
357	608	11	1.7	60.0	9.9	19 192
360	579	8	1.6	63.4	11.0	13 587
371	651	8	1.9	71.5	11.0	17 903
358	654	11	1.7	61.5	9.4	17 754
351	607	8	1.7	52.8	8.7	12 912

Continued...

Table 51. Concluded.

	Fork Length (mm)	Weight (gm)	Age	Egg Size (mm)	Gonad Weight (gm)	% Gonad Wt. of Body Wt.	Numbers of Eggs
Mean	373.4	712.6	10.9	1.8	72.8	10.1	16 179.7
S.D.	25.5	162.4	2.1	0.1	29.7	2.0	5 604.7
S.E.	6.6	41.9	0.6	<0.1	7.7	0.5	1 447.1
Range	109(331-440)	682(501-1183)	7(8-15)	0.5(1.6-2.1)	128.9(37.5-166.4)	9.4(4.6-14.1)	25 646 (6 623-33 269)

in the Muskeg River (Bond and Machniak 1979), and 29 502 for longnose suckers (389 to 499 mm fork length) in the Steepbank River (Machniak and Bond 1979).

4.4.6.4.9 Food habits. Longnose sucker stomach contents were generally unidentifiable under field conditions and therefore no feeding data are presented for this species.

4.4.6.5 White suckers. White suckers are found throughout the AOSERP study area in both the Athabasca River and its tributaries. The ecology of this species is similar to that of the longnose sucker and the two are often found closely associated in streams. During the spring, white suckers, like longnose suckers, move up the Athabasca River on a spawning migration from possible overwintering areas in the lower Athabasca River, the Peace-Athabasca Delta, or Lake Athabasca. Major spawning runs for both species have been documented in several tributaries of the Athabasca River including the MacKay (McCart et al. 1978), Muskeg (Bond and Machniak 1979), and Steepbank (Machniak and Bond 1979) rivers. There is, however, no evidence that white suckers, unlike longnose suckers (Tripp and McCart 1979) also spawn in the Athabasca River.

4.4.6.5.1 Distribution and abundance. White suckers were among the most abundant fish species in the southern portion of the AOSERP study area, representing 11.1% of the total gillnet catch, 6.0% of the total minnow seine catch, and 6.3% of the total combined catch in both gillnets and minnow seines.

Large juvenile and mature white suckers were sampled throughout the Christina and Gregoire rivers, at the mouths of Saline Creek and the Horse River, and in the upper reaches of the Hangingstone River at Stations 4, 6 and 8 (Appendix 7, Figure 40). White suckers collected in the Hangingstone River are noteworthy in that they appear to be a dwarfed and possibly resident population (see discussion below).

Young-of-the-year and small juveniles had a wider distribution. They were collected throughout the Christina and Gregoire rivers, in the Hangingstone River as far upstream as Station 6, in the upper reaches of the Horse River (Stations 3 and 4), at the middle and upper stations on Saline Creek, in Gregoire Lake, and at the mouth of Surmont Creek.

In Table 52, gillnet catches of white suckers in the project study area are compared with gillnet catches elsewhere in the AOSERP study area on a catch per unit effort basis (catch per gillnet hour x 100). As shown, catches of white suckers were generally low throughout most of the AOSERP study area, ranging from 0.0 in the Athabasca River Delta (Bond and Berry 1980b) to 3.5 in the Clearwater River (Jones et al. 1978; Tripp and McCart 1979) and 3.6 in the Athabasca River near Syncrude Canada Limited's Lease 17 (McCart et al. 1977). In the project study area, catches in the Gregoire, Hangingstone, and Horse rivers were also low (1.1 to 2.8) while catches in the Christina River (9.7) were, together with those in the MacKay River (15.3)(McCart et al. 1978), among the highest recorded in the AOSERP study area. Although gillnet data are lacking, there are also major populations of white suckers in the Muskeg (Bond and Machniak 1979) and Steepbank rivers (Machniak and Bond 1979).

A comparison of catches per unit minnow seine effort (catch per metre of shoreline seined x 100)(Table 31) for the project study area indicates that by far the largest concentrations of young-of-the-year white suckers are located in the Gregoire River. In the Gregoire River, catch per unit effort x 100 for white suckers was 53.5 compared with 0.0 to 8.4 elsewhere.

4.4.6.5.2 Seasonal abundance. Seasonal variation in catches per unit gillnet effort (catch per hour x 100) for white suckers in the Christina, Gregoire, and Hangingstone rivers (Table 38, Figure 23) indicates a major peak in abundance in both the Christina and Gregoire rivers in early May. Catches dropped markedly in June, and by late October, most white suckers had evidently left the

Table 52. Relative abundance of white suckers in the AOSERP study area based on gillnet catches per hour x 100.

Location	Number of Gillnet Hours	Number of White Suckers	Catch per Gillnet Hour x 100
Christina River	403.0	39	9.7
Gregoire River	252.0	7	2.8
Hangingstone River	279.0	3	1.1
Horse River (mouth)	81.0	1	1.2
Athabasca River upstream of the Cascade Rapids	880.5	17	1.9
Athabasca River between Fort McMurray and the Cascade Rapids	692.5	7	1.0
Athabasca River, Syncrude Area	872.0	31	3.6
Athabasca River, Mildred Lake Area	810.0	6	0.7
Athabasca River Delta	797.0	0	0.0
Clearwater River	687.5	24	3.5
MacKay River	262.0	40	15.3

project study area, presumably to overwintering areas elsewhere. Catches in the Hangingstone River were low throughout the year and do not indicate any significant white sucker movements.

4.4.6.5.3 Spawning. Seasonal variation in the spawning condition of white suckers in the Christina and Gregoire rivers (Table 53) indicates that while some spawning probably occurred as early as 8 May, most white suckers spawned after 14 May. Of 11 mature females collected from 8 to 14 May, 10 were green and only one, taken 8 May, was ripe.

There were no direct observations of white suckers spawning in the present study. Indirect evidence, based on the distribution and relative abundance of white sucker young-of-the-year, suggests that, while spawning areas are widespread (Table 31), the most important spawning areas are located in the Gregoire River. Within the Gregoire River, white sucker catches per metre of shoreline seined over the study period averaged 36.6 at Station 1, 100.0 at Station 2, 119.6 at Station 3, 16.9 at Station 4, and 0.0 at Station 5 (Gregoire Lake outlet).

4.4.6.5.4 Length-frequency distribution. The length-frequency distribution of white suckers captured in the Christina and Gregoire rivers is presented in Figure 30. White suckers ranged from less than 25 mm to 449 mm, with fish less than 100 mm (primarily young-of-the-year) representing most of the catch in minnow seines and fish from 275 to 399 mm representing most of the fish taken in gillnets. A similar size distribution for fish larger than 275 mm was reported for the Clearwater and Athabasca rivers upstream of Fort McMurray during the fall (Jones et al. 1978) although considerably larger white suckers predominated in the same area during the spring (Tripp and McCart 1979). As with longnose suckers, the scarcity of juveniles is likely the result of both sampling bias and differences in the distribution of juveniles and adults.

Table 53. Summary of seasonal variation in the spawning condition of white suckers in the Christina and Gregoire rivers 7 May to 16 June 1978. G = green; R = ripe; SO = spawned out.

	Males				Females			
Date	N	%G	%R	%SO	N	%G	%R	%SO
7 May	2	100	0	0	0	0	0	0
8 May	6	50	50	0	3	67	33	0
10 May	1	0	100	0	3	100	0	0
14 May	4	0	100	0	5	100	0	0
19 May	3	0	100	0	0	0	0	0
13 June	1	0	0	100	0	0	0	0
15 June	1	0	0	100	3	0	0	100
16 June	0	0	0	0	1	0	0	100
Total	18	28	61	11	15	67	7	26

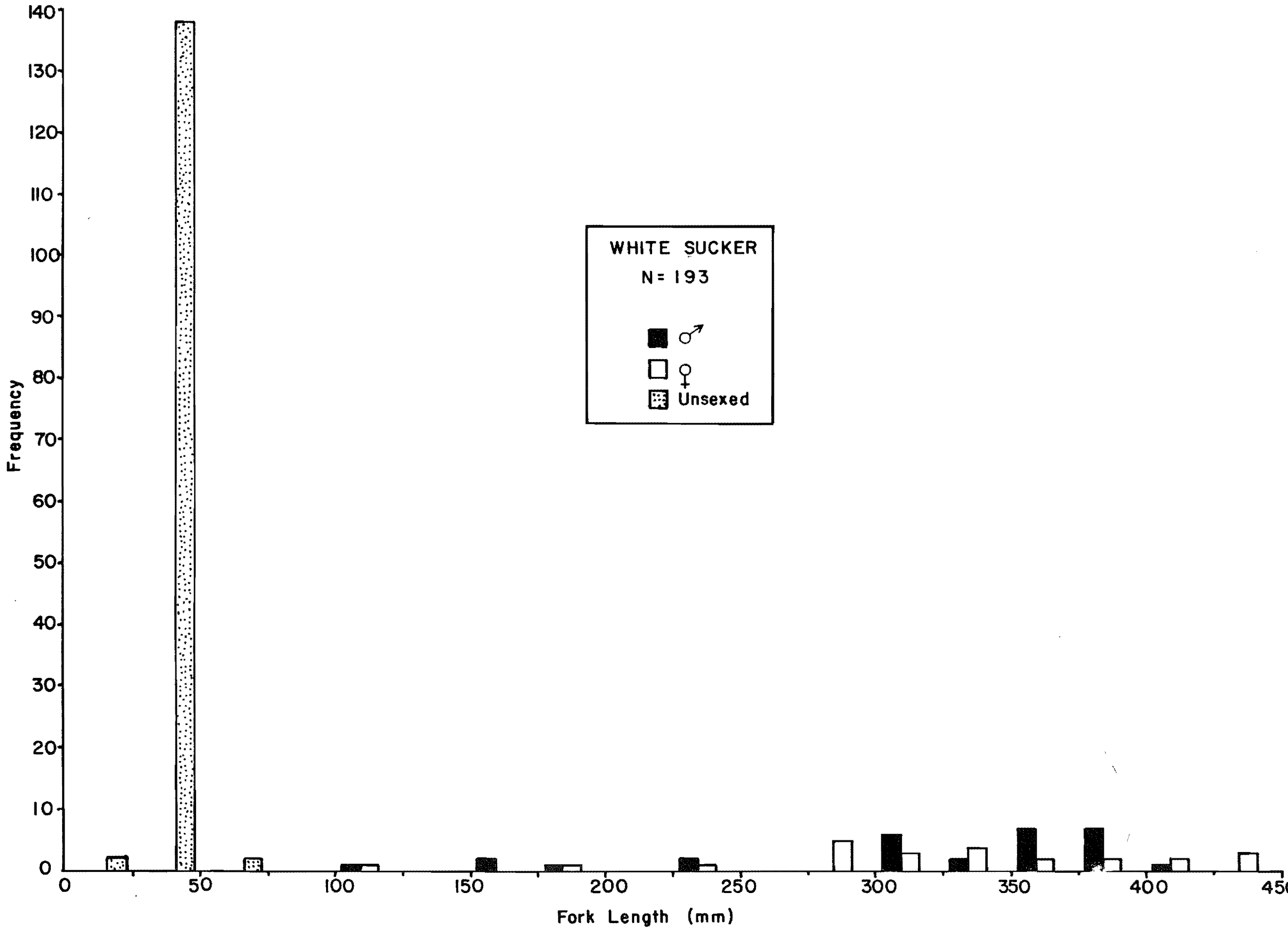


Figure 30. The length-frequency distribution for white sucker collected in the southern portion of the AOSERP study area, May to October 1978.

4.4.6.5.5 Age and growth. Age-length data for white suckers sampled in the Christina and Gregoire rivers are presented in Table 54. In this sample, white suckers ranged in age from 3 to 13 years and in fork length from 124 to 448 mm. From 3 to 7 years, the growth rate of white suckers in the Christina and Gregoire rivers (Figure 31) is similar to those described for white suckers in the Muskeg River (Bond and Machniak 1979) and in the Clearwater and Athabasca rivers upstream of Fort McMurray (Jones et al. 1978). The growth rate declines, however, in succeeding years. Although there is no consistent incremental increase in mean fork length, the growth rate for older suckers (8 to 12 years) in the Christina and Gregoire rivers appears to be closest to that of similar age white suckers in the MacKay River (McCart et al. 1978).

White suckers taken from the upper reaches of the Hangingstone River (Stations 4, 6, and 8) are noteworthy in that they are evidently part of a dwarf, possibly a self-sustaining, non-migratory population. As shown in Figure 31, their growth is exceedingly slow. Otolith ages ranged from 6 to 11 years for 8 fish ranging from 174 to 283 mm fork length. The oldest fish (11 years) was a mature female only 190 mm long, while the largest fish (283 mm) was a mature female 8 years old. All of the mature females taken from 16 to 20 June showed evidence of having recently spawned.

4.4.6.5.6 Length-weight relationships. The following relationships were obtained for length and weight for male and female white suckers. Samples were based on three randomly selected fish for each 25 mm size class:

Males (N=11, Range 307 to 402 mm, rxy=0.900)

Log_{10} Weight (g) = 2.412 Log_{10} Length (mm) - 3.366

Females (N=17, Range 282 to 448 mm, rxy=0.988)

Log_{10} Weight (g) = 3.563 Log_{10} Length (mm) - 6.314

Analysis of covariance (ANCOVA) indicated a significant difference between the slopes (F=10.002, P<0.05) but not the

Table 54. Age-length relationship with age-specific sex ratios and percent maturity for white suckers taken from the Christina and Gregoire rivers.

Age	Fork Length (mm)			Male			Females			Unsexed	Total
	Mean	S.D.	Range	N	%	%Mature	N	%	%Mature		
3	124.0	0.0	124	1	50	0	1	50	0	0	2
6	318.7	30.0	282-350	2	50	100	2	50	0	0	4
7	342.9	28.0	314-385	5	63	100	3	37	67	0	8
8	362.7	26.2	320-410	3	30	100	7	70	86	0	10
9	348.0	43.8	317-411	2	67	100	1	33	100	0	3
10	369.7	37.8	315-402	3	75	100	1	25	100	0	4
11	346.0	36.6	296-378	2	50	100	2	50	100	0	4
12	409.5	30.4	388-431	0	0	0	2	100	100	0	2
13	448	0	0	0	0	0	1	100	100	0	1
Total				18	47		20	53		0	38

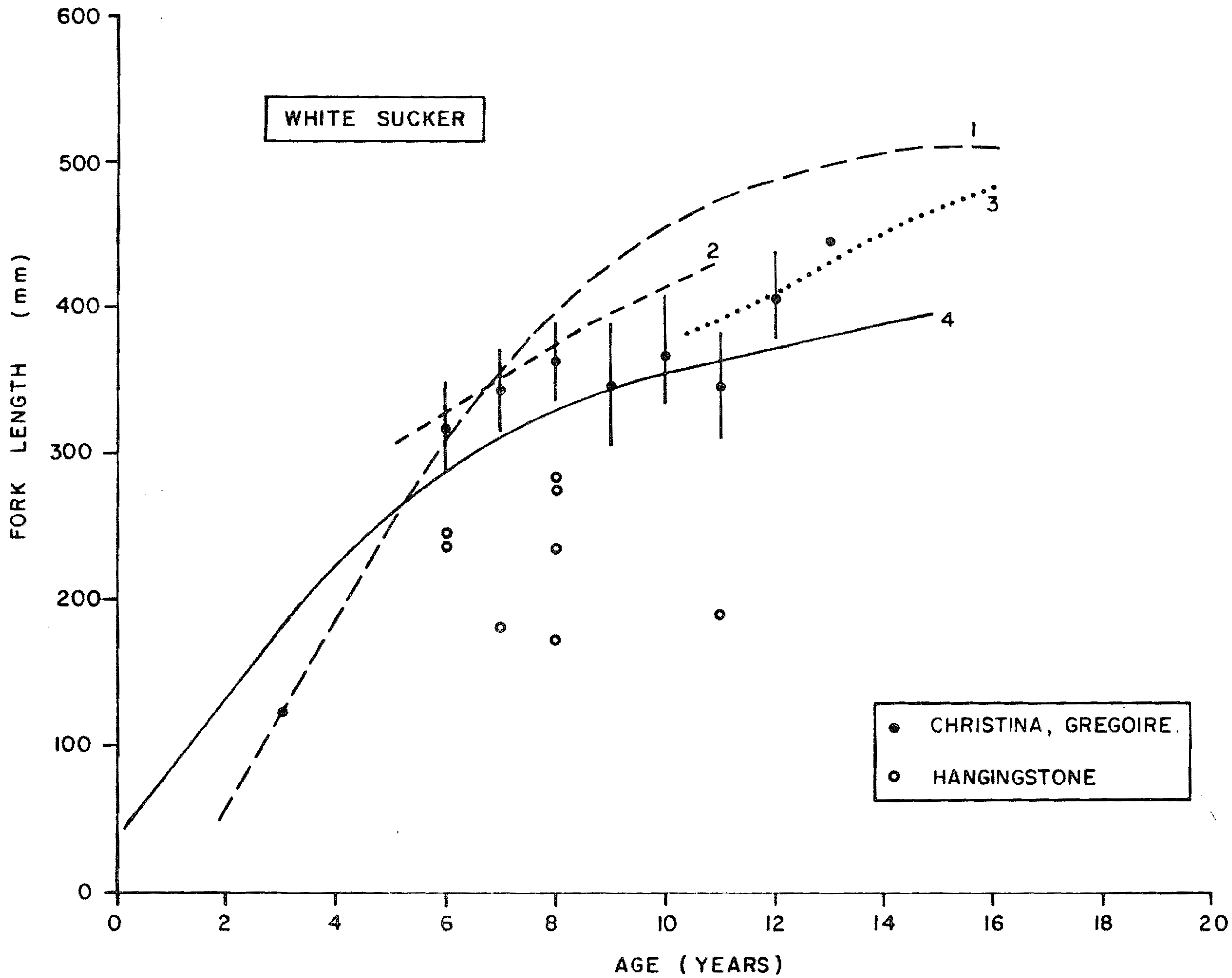


Figure 31. Comparison of white sucker growth rates in the present study area with grwoth rates of white suckers elsewhere in the AOSERP study area: 1. Muskeg River (Bond and Machniak, 1979); 2. upper Athabasca River and Clearwater River (Jones et al., 1978); 3. upper Athabasca River and Clearwater River (Tripp and McCart 1979); and 4. Muskeg River (McCart et al. 1978). Points with vertical lines are mean fork lengths ± one standard deviation while points without vertical lines are individual fish.

intercepts (F=0.568, P>0.05) of the above equations. The relationship for the combined sample is:

Combined (N=28, Range 282 to 448 mm, rxy=0.965)

$$\text{Log}_{10} \text{ Weight (g)} = 3.296 \text{ Log}_{10} \text{ Length (mm)} - 5.627$$

4.4.6.5.7 Sex ratios and maturity. Females (N=20) slightly outnumbered males (N=18) in the study sample taken from the Christina and Gregoire rivers. The difference was not significant (X^2=0.11, P>0.05) nor were there significant differences within age groups (Table 54).

All males in the study sample, aged 6 and older, were mature (Table 54). Females are slower to mature than males, reaching first maturity at age 7. All fish age 9 and older were mature, indicating that once mature, white suckers spawn every year. Age at first maturity for white suckers elsewhere in the AOSERP study area was 3 to 5 years in the Steepbank River (Machniak and Bond 1979) and 4 to 6 years in the Muskeg River (Bond and Machniak 1979).

4.4.6.5.8 Fecundity. Fecundities were determined for a total of seven white suckers taken from the Christina and Gregoire rivers just prior to spawning. The average fecundity (Table 55) was 30 729 ± 11 627 (SD), ranging from 16 726 for a female 368 mm in length to 38 789 for a female 411 mm in length. Average fork length of the sample was 408.1 ± 32.9 (SD) mm, ranging from 360 to 448 mm. Total gonad weight including eggs, ovarian membranes, and blood vessels averaged 10.2 ± 1.8% of total body weight.

The average fecundity of white suckers in the Athabasca River upstream of Fort McMurray (Tripp and McCart 1979) was 43 140 eggs (range 16 640 to 124 030), although these fish were, on the average, considerably larger (385 to 520 mm fork length) than those sampled in this study. Fecundities elsewhere in the AOSERP study area averaged 54 766 in the lower Athabasca River for fish 370 to 565 mm long (Bond and Berry 1980b) and 42 729 in the Muskeg River for fish 397 to 525 mm long (Bond and Machniak 1979).

Table 55. Egg counts from white suckers taken from the Christina and Gregoire rivers, 8 to 14 May 1978.

	Fork Length (mm)	Weight (gm)	Age	Egg Size (mm)	Gonad Weight (gm)	% Gonad Wt. of Body Wt.	Number of Eggs
	431	1264	12	1.7	145.4	11.5	34 888
	360	560	8	1.3	36.1	6.5	19 547
	411	938	9	1.8	110.4	11.8	38 789
	429	1034	ND	1.7	115.8	11.2	36 902
	410	1178	8	1.7	157.2	13.3	47 291
	368	667	8	1.5	57.3	8.6	16 726
	448	1232	13	1.7	103.9	8.4	20 962
Mean	408.1	981.9	9.7	1.6	103.7	10.2	30 729.3
S.D.	32.9	277.6	2.3	0.2	43.8	2.4	11 627.4
S.E.	12.4	104.9	0.9	0.1	16.6	0.9	4 394.8
Range	360- 448	560- 1264	8- 13	1.3- 1.8	36.1- 157.2	6.3- 13.3	16 726- 47 291

4.4.6.5.9 Food habits. Like longnose suckers, the stomach contents of white suckers were unidentifiable under field conditions. Therefore, no feeding data are presented for this species.

4.4.6.6 Walleye. The biology of walleye in Canada has been extensively reviewed (Ryder 1968; Regier et al. 1969; Scott and Crossman 1973). In the AOSERP study area, it is one of the more abundant species, particularly in the mainstem Athabasca River, and is one of the most economically valuable fish as well. It has, therefore, been the subject of considerable study (Bidgood 1968, 1971, 1973; Bond and Berry 1980b; Dietz 1973; Jones et al. 1978; Kristensen et al. 1976; McCart et al. 1977, 1978; Tripp and McCart 1979).

4.4.6.6.1 Distribution and abundance. In the project study area, walleye constituted 9.8% of the total gillnet catch, 0.1% of the total minnow seine catch, and only 0.7% of the total combined catch. They were largely confined to the Christina-Gregoire River-Gregoire Lake system, although small numbers of walleye were also taken near the mouths of the Hangingstone and Horse rivers. None was taken elsewhere (Appendix 7, Figure 41).

In Table 56, the overall seasonal gillnet catches (catch per hour x 100) for walleye in the project study area are compared with catches elsewhere in the AOSERP study area. During the open water period, catches per unit effort are approximately the same throughout the Athabasca River from the Athabasca River Delta (14.3) (Bond and Berry 1980b) upstream to the Mildred Lake area (14.9 to 16.7) (McCart et al. 1977; Bond and Berry 1980b) and the Cascade Rapids above Fort McMurray (11.3) (Jones et al. 1978; Tripp and McCart 1979). Above Cascade Rapids, catches per unit effort were, by comparison, very low (2.2), suggesting that these rapids may limit the upstream distribution of walleye. Similar findings were reported for spawning longnose suckers (Tripp and McCart 1979) and lake whitefish (Jones et al. 1978) migrating upstream from the Peace-Athabasca Delta.

Table 56. Relative abundance of walleye in the AOSERP study are based on catches per gillnet hour x 100.

Location	Number of Gillnet Hours	Number of Walleye	Catch per Gillnet Hour x 100.
Christina River	403.0	15	3.7
Gregoire River	252.0	5	2.0
Hangingstone River	279.0	0	0.0
Horse River (mouth)	81.0	12	14.8
Athabasca River upstream of the Cascade Rapids	880.5	19	2.2
Athabasca River between Fort McMurray and the Cascade Rapids	692.5	78	11.3
Athabasca River, Syncrude Area	872.0	130	14.9
Athabasca River, Mildred Lake Area	810.0	135	16.7
Athabasca River Delta	797.0	114	14.3
Clearwater River	687.5	41	6.0
MacKay River	262.0	70	26.7

Catches per unit effort for walleye in the Clearwater River (6.0) were less than half those in the mainstem Athabasca River. Farther upstream, catches drop again to 3.7 in the Christina River and 2.0 in the Gregoire River, suggesting that these streams are close to the distributional limits of walleye populations in the Athabasca River. It is quite likely, in fact, that walleye present in the Christina and Gregoire rivers are the result of downstream movements from Gregoire Lake where they are known to be abundant.

The relatively high catches of walleye in the MacKay River (26.7 fish per hour x 100)(McCart et al. 1978) are noteworthy. They were approximately twice those in the mainstem Athabasca River, four times higher than those in the Clearwater River, and seven to 13 times higher than those in the Christina and Gregoire rivers.

4.4.6.6.2 Seasonal abundance. The seasonal patterns of gillnet catches for walleye in the Christina and Gregoire rivers were very similar (Figure 23). Catches were very low in early May, peaked in mid-June, and then dropped again in August. By October, walleye had evidently left both streams, presumably for overwintering areas located elsewhere either downstream in the Clearwater or Athabasca rivers or upstream in Gregoire Lake.

4.4.6.6.3 Spawning. Walleye spawn in the spring shortly after spring break-up. In this study, there was no evidence of any major concentrations of spawning walleye in any of the streams investigated nor were young-of-the-year ever found in abundance. Only two young-of-the-year were taken, both at the mouth of the Hangingstone River, and they probably represent a short feeding excursion upstream from the Clearwater River.

4.4.6.6.4 Length-frequency distribution. Walleye captured during this study ranged in fork length from 50 to 549 mm with fish in the 250 to 549 mm range comprising about 95% of the total sample

(N=39) (Figure 32). Females predominated in the larger size classes, accounting for 18 to 25 fish in the 375 to 549 mm range, while males predominated in the smaller size classes (250 to 374 mm).

4.4.6.6.5 Age and growth. Age-length data for 30 walleye taken from the Christina River (N=15), Gregoire River (N=5), and Gregoire Lake (L=10) are presented in Table 57. Fish in this sample ranged from 3 to 10 years in age and from 285 to 536 mm fork length. The growth curve for this sample approximates that reported by McCart et al. (1977) for the Athabasca River downstream of Fort McMurray and is among the highest recorded in the AOSERP study area (Figure 33).

4.4.6.6.6 Length-weight relationships. Length-weight regression formulae were determined separately for males and females:

Males (N=11, Range 285 to 523 mm, rxy=0.990)

$\log_{10}$ Weight (g) = 3.066 $\log_{10}$ Length (mm) - 5.119

Females (N=21, Range 326 to 541 mm, rxy=0.973)

$\log_{10}$ Weight (g) = 2.974 $\log_{10}$ Length (mm) - 4.893

These relationships were compared by analysis of covariance and found not to differ significantly in either slopes (F=0.169, P>0.05). The relationship for the combined sample was:

Combined (N=33, Range 285 to 541 mm, rxy=0.982)

$\log_{10}$ Weight (g) = 3.002 $\log_{10}$ Length (mm) - 4.962

4.4.6.6.7 Sex ratios and maturity. Of 30 walleye, for which both age and sex could be determined (Table 57), 13 were male and 17 were females. This difference did not deviate significantly (X^2=0.53, P>0.05) from an expected 1:1 ratio. Within age groups, females (N=7) were significantly more abundant than males only at age 6 (N=1, X^2=4.50, P<0.05).

Sex ratios favouring males (57 to 97%) have usually been the case in other studies in the AOSERP study area, including the Athabasca and Clearwater rivers upstream of Fort McMurray (Jones

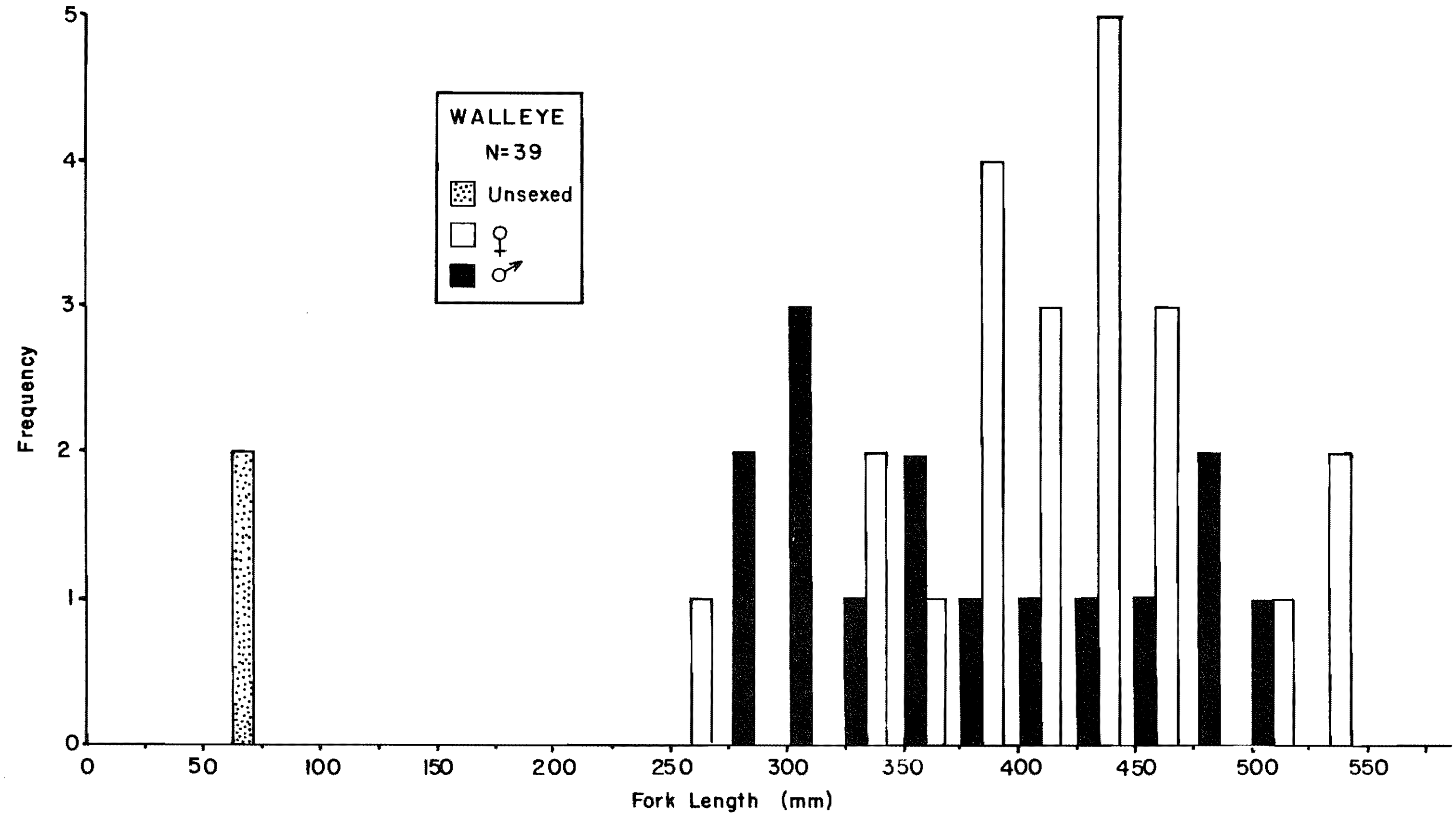


Figure 32. The length-frequency distribution for walleye collected in the southern portion of the AOSERP study area, May to October 1978.

Table 57. Age-length relationship with age-specific sex ratios and percent maturity for walleye taken from the Christina River, Gregoire River, and Gregoire Lake, 1978.

Age	Fork Length (mm)			Males			Females			Unsexed	Total
	Mean	S.D.	Range	N	%	%Mature	N	%	%Mature		
3	290.0	7.1	285-295	2	100	0	0	0	0	0	2
4	329.4	17.3	303-350	3	60	0	2	40	0	0	5
5	373.7	18.4	358-384	2	67	100	1	33	0	0	3
6	406.5	22.5	380-448	1	13	100	7	87	29	0	8
7	455.7	23.6	432-485	2	50	100	2	50	50	0	4
8	490.5	48.0	433-536	1	25	100	3	75	100	0	4
9	497.3	26.5	470-523	2	67	100	1	33	100	0	3
10	541	0	0	0	0	0	1	100	100	0	1
Total				13	43		17	57		0	30

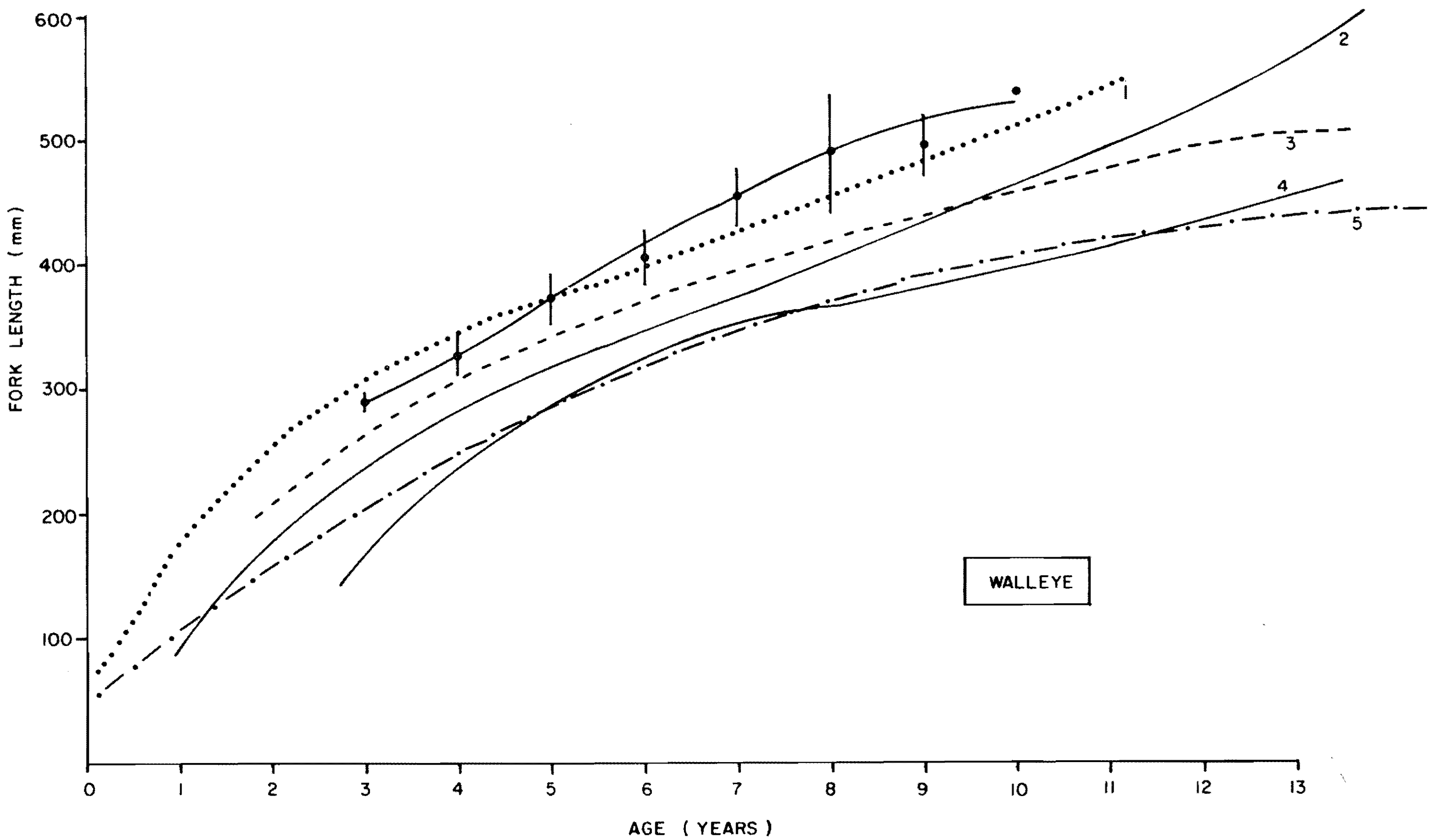


Figure 33. Comparison of walleye growth rates in the present study area with growth rates of walleye elsewhere in the AOSERP study area: 1. Athabasca River, Syncrude area (McCart et al. 1978); 2. upper Athabasca River and Clearwater River (Jones et al. 1978); 3. Athabasca River (Bond and Berry 1980b); 4. upper Athabasca River and Clearwater River (Tripp and McCart 1979); and 5. McKay River (McCart et al. 1978). Points with vertical lines are mean fork lengths ± one standard deviation while single points are individual fish.

et al. 1978; Tripp and McCart 1979), the lower Athabasca River (Bond and Berry 1980b; McCart et al. 1977), and the MacKay River (McCart et al. 1978). Balanced sex ratios have been reported, however, for walleye in the Peace-Athabasca River delta (Bond and Berry 1980b).

All males in the sample, age 5 and older, were mature. Females by comparison, are slower to mature, reaching first maturity at age 6 and complete maturity by age 8. Elsewhere in the AOSERP study area, ages at first maturity of 3 to 4 years (Bond and Berry 1980b), 5 to 6 years (Tripp and McCart 1980), and 5 to 7 years (McCart et al. 1977; Jones et al. 1978) have been reported.

4.4.6.6.8 Fecundity. A single mature green female taken on 10 May from the Christina River had a total egg count of 35 060. This fish was 8 years old and 523 mm fork length. Fecundity estimates for walleye in the Athabasca River (Bond and Berry 1980b) were, by comparison, considerably higher, ranging from 39 470 to 117 600 for fish 473 to 613 mm fork length.

4.4.6.6.9 Food habits. A total of 36 walleye stomachs was examined, half (53%) of which were found to be empty. Unidentifiable fish remains were the most commonly recorded item in stomachs containing food (Table 41).

4.4.6.7 Other species. Other species are those which were captured in the project study area but for which few or no individuals were retained for detailed analysis. These included lake whitefish, shortjaw cisco, mountain whitefish, longnose dace, flathead chub, lake chub, pearl dace, fathead minnow, spottail shiner, trout-perch, burbot, brook stickleback, yellow perch, slimy sculpin, and spoonhead sculpin. In what follows, various aspects of their distribution and abundance are briefly described.

4.4.6.7.1 Lake whitefish. Two lake whitefish young-of-the-year were sampled near the mouth of the Christina River, 13 June. Although previous studies (Jones et al. 1978) have shown that the majority of whitefish spawn in the Athabasca River upstream of Fort McMurray, the presence of small numbers of young-of-the-year suggests that limited spawning may also occur in the Christina River (Appendix 7, Figure 42).

4.4.6.7.2 Shortjaw Cisco. Sixteen ciscos, tentatively identified as shortjaw ciscos (*Coregonus zenithicus*) were taken in a 24 h gillnet set in the middle of Gregoire Lake, 23 August (Appendix 7, Figure 42). The average fork length of the sample was 222.4 ± 19.7 (SD) mm, ranging from 195 to 256 mm and in age from 2 to 4 years. Eleven were mature females, two were mature males, and three were immature males.

Species identification was based on the number of gill-rakers on the first gill arch and the ratio of head length divided by snout to eye distance (Paetz and Nelson 1970). The average gillraker count for seven specimens was 39.4 ± 1.0 (1 SD), ranging from 38 to 41, while the head to snout ratio was 3.66 ± 0.18 (1 SD), ranging from 3.60 to 3.80. Previous reports of this species in Alberta are from Lake Athabasca (Dymond and Pritchard 1930) and from Barrow Lake (Paterson 1969) in the Slave River drainage.

4.4.6.7.3 Mountain whitefish. Two juvenile mountain whitefish were captured in the project study area, one at Station 4 on the Christina River on 10 May and one at Station 3 on the Hangingstone River on 19 August. None were captured elsewhere (Appendix 7, Figure 42).

4.4.6.7.4 Longnose dace. Longnose dace were one of the more abundant species in the project study area, comprising 6.9% of the total seine catch and 6.4% of the total combined catch in gillnets and seines. They were distributed throughout the Christina River and in the lower reaches of the Algar (Station 1), Gregoire (Stations 1 to 3), Hangingstone (Stations 1 to 5), and Horse (Stations 1 and 2) rivers (Appendix 7, Figure 43). Catches per unit seine effort (catch per metre of shoreline seined x 100) ranged from 23.1 in the Gregoire River and 19.3 in the Christina River to less than 4.0 in the Algar and Hangingstone rivers. They ranged in fork length from 15 to 89 mm with most (97%) in the 15 to 49 mm range (Figure 34).

4.4.6.7.5 Flathead chub. Large turbid rivers such as the Athabasca River are the preferred habitat of flathead chub in the AOSERP study area. In this study, they were taken only at the mouths of the Christina and Horse rivers (Appendix 7, Figure 43).

4.4.6.7.6 Lake chub. Lake chub were the most abundant fish taken in minnow seines, comprising 18.1% of the total seine catch. They were distributed widely throughout the Christina and Horse rivers and in the lower reaches of the Algar (Station 1), Gregoire (Stations 1 to 3), and Hangingstone (Stations 1 to 6) rivers. They were also present in both the fast flowing lower reaches and slow flowing upper muskeg reaches of Saline Creek (Appendix 7, Figure 43).

Catches per metre of shoreline seined (x 100) ranged from 89.3 in the Gregoire River, 53.8 in the Horse River, and 25.9 in the Christina River, to 7.5 in the Algar River. With the exception of the Hangingstone River, catches in the major tributaries of the southern portion of the AOSERP study area were considerably higher than those reported for the Clearwater (28.0) or Athabasca (15.0 to 21.0) rivers (Tripp and McCart 1979).

There was no consistent pattern in the seasonal variation of lake chub catches. Catches in the Christina River were highest in May (50.2) and June (40.6) and lowest in August (7.9) and October (7.2). In the Gregoire River, catches were high in May, August, and October (81.8 to 118.1) but very low in June (3.8). Catches in the Hangingstone River remained steady from May to August (11.8 to 16.7) but dropped in October (1.4).

Lake chub in the project study area ranged in fork length from 10 to 109 mm, with the majority falling in the 15 to 49 mm size range (Figure 34).

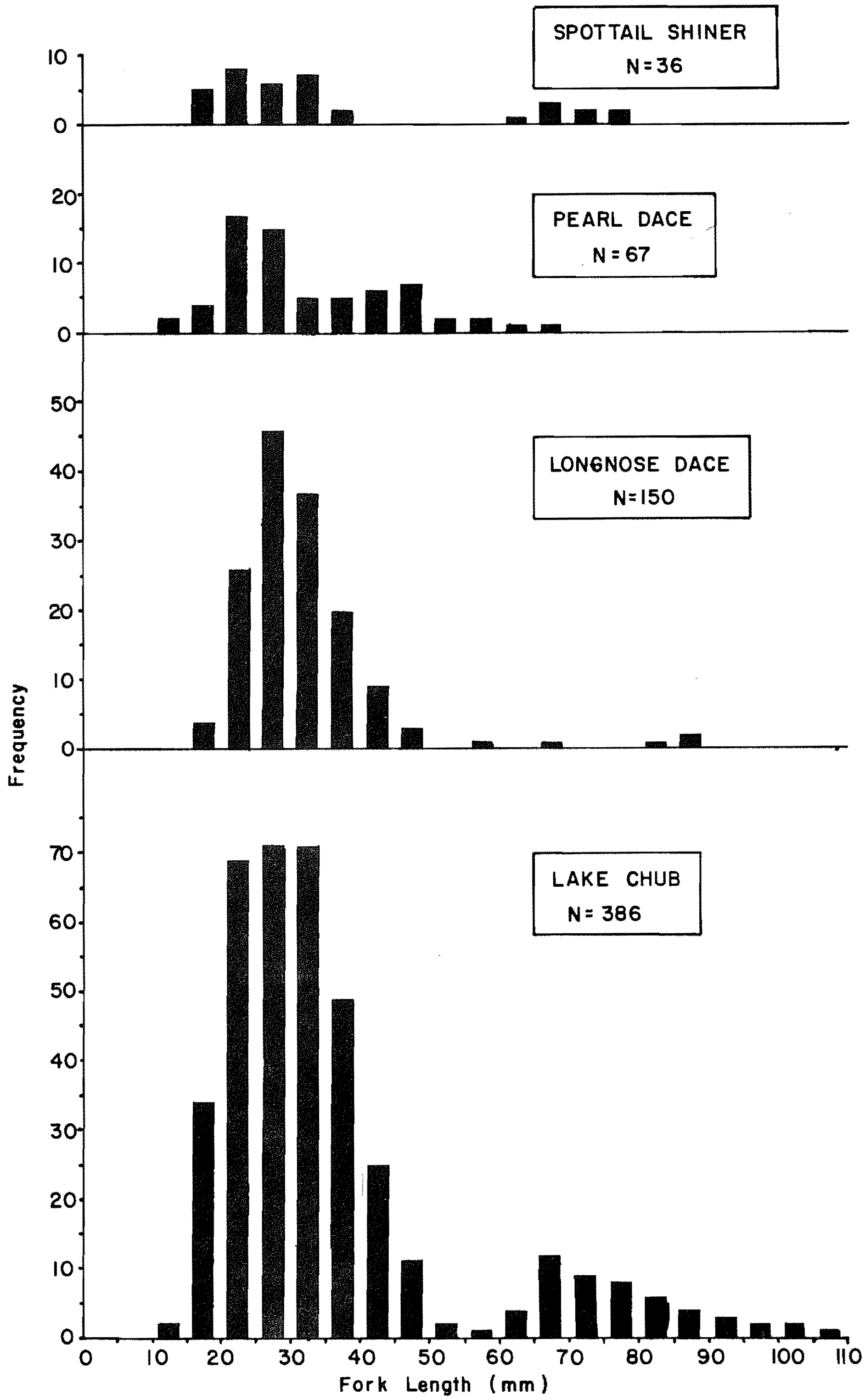


Figure 34. Length-frequency distributions for spottail shiner, pearl dace, and lake chub collected in minnow seines from the southern portion of the AOSERP study area, May to October 1978.

4.4.6.7.7 Pearl dace. Pearl dace constituted 2.5% of total catch in minnow seines and 10.6% of the total gillnet catch as a result of a single 24 h gillnet set in Algar Lake, 23 August, that netted 48 large mature pearl dace. Overall, pearl dace constituted 3.1% of the total combined catch in both gillnets and minnow seines.

In streams, pearl dace were taken throughout the Algar River (Stations 1 to 3), in the Christina River (Stations 1 to 3), in the Gregoire River (Stations 3 and 4), in the upper Hangingstone River (Stations 5 to 9), upper Prairie Creek (Station 1), and in upper Saline Creek (Stations 2 and 3) (Appendix 7, Figure 44). The overall catch per unit seine effort (catch per metre of shoreline seined x 100) was 3.1, ranging from 120.7 in the Algar River to 0.2 in the Christina River. With the exception of the Algar River, catches were, however, generally low throughout most of the project study area.

Pearl dace taken from streams in the project study area ranged in fork length from 10 to 69 mm (Figure 34). Pearl dace gillnetted in Algar Lake were all large, mature individuals in green spawning condition, ranging in fork length from 104 to 130 mm. Females were, however, significantly larger [120.8 ± 4.3 (1 SD) mm, range 112 to 130, N=32] than males [109.3 ± 2.5 (1 SD) mm, range 104 to 113, N=12]. Females were also significantly more abundant (X^2=9.1, $P<0.05$), possibly because of their larger size and greater susceptibility to capture. All were taken in 3.8 cm stretch mesh size gillnet, the smallest mesh size in the standard gillnet gang.

4.4.6.7.8 Finescale dace. One finescale dace was captured 5 May at the mouth (Station 1) of the Christina River (Appendix 7, Figure 44).

4.4.6.7.9 Fathead minnow. Eighty-seven fathead minnows were captured 8 June at the mouth of the Horse River (Appendix 7, Figure 44). None was captured at any other time or place in the project study area and their appearance at the mouth of the Horse River is likely related to the sudden migration of fathead minnows reported at the same time in the Athabasca River (Tripp and McCart 1979).

4.4.6.7.10 Spottail shiner. Spottail shiners comprised 8.3% of the total minnow seine catch, largely because of the high catches recorded for this species in the weedy areas of Gregoire Lake (>135.7 fish per metre of shoreline seined x 100). Spottail shiners were relatively rare elsewhere in the study area, with catch per unit seine effort varying from 0.1 in the Christina River, 0.9 in the Gregoire River and Surmont Creek, and 0.3 at the mouth of the Horse River (Appendix 7, Figure 44).

Fish in the sample fell into two distinct size classes, one ranging from 15 to 39 mm and probably representing young-of-the-year fish, and the other ranging from 60 to 79 mm and probably representing fish in their second season of growth (Figure 35).

4.4.6.7.11 Trout-perch. A total of 252 trout-perch, representing 4.0% of the total minnow seine catch and 3.7% of the total combined catch, was sampled in this study. They were widely distributed throughout the Christina (Stations 1 to 5), Gregoire (Stations 1 to 3), Hangingstone (Stations 1 to 8), and Horse (Stations 1 to 3) rivers. They were, however, absent in other smaller streams in the project study area (Appendix 7, Figure 45). Catches of trout-perch per metre of shoreline seined (x 100) ranged from 11.5 in the Horse River to 4.8 in the Hangingstone River. Similar catches were recorded in the Athabasca and Clearwater rivers upstream of Fort McMurray (Tripp and McCart 1979).

Trout-perch in the project study area ranged from 10 to 84 mm in fork length with the majority (86%) falling in the 20 to 54 mm range (Figure 35).

4.4.6.7.12 Burbot. Seventeen burbot, representing 0.3% of the total catch, were taken in the project study area. Of these, one was a

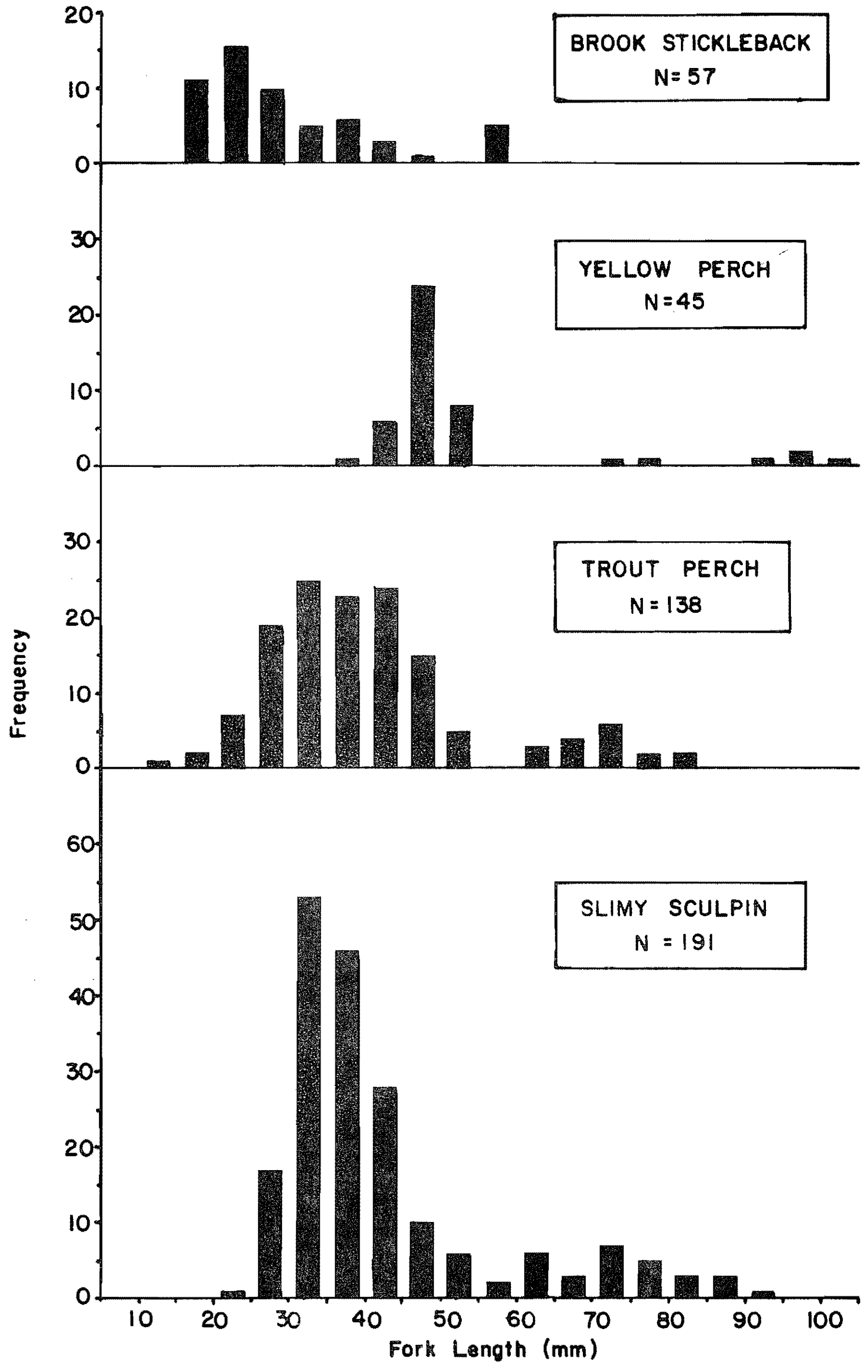


Figure 35. Length-frequency distributions for brook stickleback, yellow perch, trout-perch, and slimy sculpin collected in the southern portion of the AOSERP study area, 1978.

juvenile gillnetted on 8 May at Station 4 on the Christina River while the rest were young-of-the-year collected in Gregoire Lake and ranging in length from 65 to 88 mm (Appendix 7, Figure 45).

4.4.6.7.13 Brook stickleback. Brook sticklebacks are common inhabitants of small muskeg streams in the AOSERP study area. In this study, the largest concentrations of brook sticklebacks were located in the Algar River, Algar Lake, and the upper stations of Saline Creek. Small numbers were also present in the Christina River (Station 7) and the upper reaches of the Hangingstone River (Appendix 7, Figure 45).

A total of 100 brook sticklebacks, representing 1.5% of the total fish catch, was captured in this study. Most ranged from 15 to 49 mm in total length (Figure 35).

4.4.6.7.14 Yellow perch. A total of 410 yellow perch, representing 6.3% of the total fish catch, was collected in this study. Like spottail shiners, most were taken in the weedy areas located along the south shores of Gregoire Lake (Appendix 7, Figure 45). Others were collected in the lower reaches of the Christina River and at the mouth of the Horse River. Catches per metre of shoreline seined (x 100) ranged from more than 81.3 in Gregoire Lake to 7.7 and 7.6 in the Christina and Horse rivers, respectively.

Most of the yellow perch collected ranged from 35 to 54 mm fork length (Figure 35) and were probably young-of-the-year. Others, ranging from 70 and 105 mm fork length, may have been fish in their second season of growth.

4.4.6.7.15 Slimy sculpin. Slimy sculpins were the third most abundant fish, after lake chub and longnose suckers, taken in the project study area, comprising 12.3% of the total seine catch and 11.4% of the total combined catch for gillnets and minnow seines. They were widely distributed throughout the Christina River (Stations 1 to 6), the Gregoire River (Stations 1 to 4), the Hangingstone River (Stations 1 to 9), Surmont Creek (Stations 2 and 3), and Saprae Creek (Stations 1 to 3)(Appendix 7, Figure 46). They were also taken at the mouth (Station 1) and the uppermost station (Station 4) on the Horse River but absent altogether from Algar Lake, the Algar River, and Saline Creek. A single specimen was taken at the mouth of Cameron Creek although they were likely absent in the upper, muskeg-like reaches.

The highest catches per unit effort (catch per metre of shoreline seined x 100) were recorded in the Hangingstone (28.2) and Horse (27.7) rivers, followed by the Gregoire River (9.1), Surmont Creek (8.4), and, lastly, the Christina River (3.1) and Saprae Creek (3.0). In both the Hangingstone (2.5 to 5.9) and Gregoire (0.0 to 3.0) rivers, catches were lowest during early May and mid-June and highest in mid-August and late October (10.0 to 13.8 in the Gregoire and 42.9 to 43.9 in the Hangingstone). By comparison, catches in the Christina River remained low throughout the study period (0.3 to 5.0).

In the project study area, slimy sculpins ranged from 20 to 94 mm in fork length with most (75%) falling in the 25 to 44 mm size class (Figure 35).

4.4.6.7.16 Spoonhead sculpin. A single spoonhead sculpin was captured 13 June at the mouth (Station 1) of the Christina River (Appendix 7, Figure 46).

5. GENERAL DISCUSSION AND CONCLUSIONS

One of the major objectives of this study was to provide a quantitative estimate of the biological significance of watersheds in the southern portion of the AOSERP study area, with the major emphasis on the fisheries of the region. More specifically, the studies were to include an enumeration of adult fish populations and a description of the seasonal and daily movements of migrant fish, including young-of-the-year.

These objectives were not achieved, largely because the limited time and manpower available for the study clearly precluded an investigation of the size implied above. Shorter (6 to 12 d) sampling periods, timed to coinside with the major spawning and migration periods, were considered to be a more feasible approach. It was also decided to confine most of the work to the Christina, Gregoire, and Hangingstone rivers, rather than spread the same effort over the whole area. Since the Christina, Gregoire, and Hangingstone rivers included most of the major stream habitat types in the study area, it was hoped that a single broad survey of the remaining waterbodies would be sufficient to assess their potential importance to the fisheries of the region.

A useful, quantitative estimate of the biological significance of the watersheds south of Fort McMurray would be difficult to achieve, regardless of the information collected. Aside from the problems in obtaining suitable statistics (e.g. fish population sizes, spawning success, migration patterns, mortality rates, total fish production, etc.), there are no comparable studies elsewhere in the AOSERP study area and therefore no baseline against which streams in the present study area could be compared.

Previous studies on the mainstem Athabasca River have largely concentrated on determining the relative abundance, seasonal movements, and major spawning areas of fish using catch per unit fishing effort data (Bond and Berry 1980b; Bond and Machniak 1979; McCart et al. 1977; Jones et al. 1978; Tripp and McCart 1979).

Weir studies on several tributaries of the Athabasca River (Bond and Machniak 1979; Machniak and Bond 1979) provided valuable information on the seasonal migrations, life histories, and spawning of several fish species but did not provide any estimates of population size or an index of fish abundance that could be easily compared to other streams.

Catch per unit fishing effort (catch per gillnet hour and catch per metre of shoreline seined) was used extensively in this study to determine the seasonal movements and relative abundance of fish. The raw data are presented in Tables 45 and 46 of Volume II for the use of future researchers. Similar data from other studies in the AOSERP study area were included in this report and found to be very useful in assessing the significance of streams to the major fish species in the present study area.

Tributary streams in the southern portion of the AOSERP study area support a diverse fish fauna composed of 22 species. Of these, Arctic grayling, northern pike, longnose dace, lake chub, longnose sucker, white sucker, and slimy sculpin are among the most abundant and widespread species. While grayling and slimy sculpin are typical residents of most small, gravel-bottomed streams, the others are common in the larger rivers as well. Other species such as goldeye, flathead chub, walleye, and spoonhead sculpin are found primarily in the Athabasca River and its main tributaries. In this study, they were largely restricted to the Christina River and the mouths of the Hangingstone and Horse rivers. A separate walleye population exists in Gregoire Lake. Pearl dace and brook stickleback were, overall, the most frequently taken species in the headwater streams of muskeg areas. They were rarely taken elsewhere.

The Christina-Gregoire river system is by far the most important drainage in the present study area (Table 58). Besides providing important rearing areas for a number of small species (lake chub, longnose dace), these two streams are major spawning and rearing areas for a large number of longnose and white suckers.

Table 58. Summary of fish abundance and the major significance of tributary streams in the AOSERP study area south of Fort McMurray.

Stream	Average Catch per Gillnet Hour x 100	Average Catch per Metre of Shoreline Seined x 100	Major Significance
Christina River	59.1	160.3	The largest and most important stream in the present study area for a wide variety of species; a major spawning and rearing area for longnose and white suckers, with population sizes probably comparable to those in other major tributaries of the Athabasca River; a major spawning migration route for northern pike; important habitat for several small species as well, including longnose dace and lake chub.
Gregoire River	24.6	280.1	A major tributary of the Christina River; an important spawning and rearing area for longnose sucker, white sucker, and northern pike; longnose dace, lake chub, and pearl dace are also abundant; a minor spawning area for Arctic grayling.
Hangingstone River	8.3	60.0	No major fish populations; primarily longnose sucker with a small, possibly overexploited grayling population and a dwarf, presumably resident population of white suckers in the upper reaches; slimy sculpin are also abundant in the upper reaches while lake chub are the most abundant small fish near the mouth.

Continued...

Table 58. Continued.

Stream	Average Catch per Gillnet Hour x 100	Average Catch per Metre of Shoreline Seined x 100	Major Significance
Horse River	62.9 (mouth only)	173.3	The available data are insufficient to assess the major significance of the Horse River to the Athabasca River system; the lower reaches are used by a variety of species including walleye, goldeye, flathead chub, and longnose sucker; the most intensive use occurs in the spring, probably for longnose sucker and some grayling spawning upstream; lake chub, fathead minnow, and slimy sculpin are the major small fish species.
Algar River	No Data	No Data	A small muskeg drainage with no major significance; a rearing area for a large population of pearl dace in Algar Lake; some longnose sucker spawning near the mouth.
Prairie Creek	No Data	No Data	A muskeg drainage; no major significance.
Cameron Creek	No Data	No Data	A muskeg drainage; no major significance.
Saline Creek	No Data	61.6	Saline Creek downstream of the highway crossing is an important grayling spawning and rearing area; Saline Creek upstream of the road crossing is a muskeg drainage with no major significance.

Continued...

Table 58. Concluded.

Stream	Average Catch per Gillnet Hour x 100	Average Catch per Metre of Shoreline Seined x 100	Major Significance
Saprae Creek	No Data	37.0	A major grayling spawning and rearing area in the lower reaches; a muskeg drainage in the upper reaches with no major significance.
Surmont Creek	No Data	63.3	A major grayling spawning and rearing area.

Based on comparisons of catch per unit gillnet effort, it is likely that the spawning populations of these two species in the Christina River are similar in size to those spawning in various other tributaries of the Athabasca River, including the MacKay, Muskeg, and Steepbank rivers.

The Christina River is also a major spawning migration route during the spring for what appears to be the largest concentration of northern pike yet reported for streams in the AOSERP study area. Further study is needed, however, to determine whether they are pike which migrate upstream via the lower Clearwater River or whether they represent a separate population located in the upper Clearwater and Christina river drainages. The apparent absence of any major migration in the lower Clearwater River (Tripp and McCart 1979) supports the latter interpretation.

Major spawning areas for pike in the southern portion of the AOSERP study area are located in the Clearwater River upstream of the Christina River confluence, the upper portions of the Gregoire River, Gregoire Lake, the Gordon River, a tributary of the Christina River upstream of the AOSERP study area, and several backwaters on the Christina River, also upstream of the AOSERP study area. There was no spawning in the Christina River within the AOSERP study area.

Goldeye and walleye are the only other major species known to use the Christina (both species) or Gregoire (walleye) rivers to any extent, primarily as summer feeding areas. The importance of these streams to goldeye and walleye populations in the AOSERP study area is, however, considerably lower than the Athabasca River or its major tributaries, the Clearwater and MacKay rivers.

The Hangingstone River has been reported to have a significant population of Arctic grayling. Catches in the Hangingstone River for all species with the exception of slimy sculpin are, however, among the lowest recorded (Table 58) in the entire AOSERP study area. The longnose sucker is the most abundant large fish species, while slimy sculpin and lake chub are the most common small fish species. A dwarf, presumably resident population of white sucker exists in the upper reaches. The grayling population is small and composed largely of small juvenile fish in the upper reaches. It is possible that over-exploitation has led to a severe reduction of grayling populations in the Hangingstone River. At present, the existing fish populations in the Hangingstone River are of little significance to the Athabasca River system.

The Horse River was not studied in sufficient detail to assess its significance to the Athabasca River system. Goldeye are the most common large fish at the mouth followed by walleye, flathead chub, and longnose sucker. Northern pike adults, Arctic grayling juveniles, and white sucker adults were also taken although catches were low. Lake chub, fathead minnow, and yellow perch were the most common small species. Farther upstream, lake chub still predominated although longnose sucker young-of-the-year were also common, indicating some spawning. A small number of adult, juvenile, and young-of-the-year grayling were also taken in the upper reaches, suggesting that grayling may also spawn in the Horse River.

Several small streams in the present study area are major spawning and rearing areas for Arctic grayling. They include most of Surmont Creek, a tributary of Gregoire Lake, and the lower halves of Saline and Saprae creeks, tributaries of the Hangingstone and Clearwater rivers (Table 58). Although there are no comparable data for other regions, young-of-the-year densities in these streams, particularly Saprae and Surmont creeks, are likely among the highest in the AOSERP study area. There are no other known major grayling spawning areas south of Fort McMurray, although George Creek and the Horse River with its major tributary probably warrant further investigation.

Many of the streams south of Fort McMurray flow through large muskeg areas. As indicated earlier, these streams generally have depauperate fish populations and therefore have almost no significance to the fisheries in the rest of the Athabasca River system. They include (Table 58) almost all of the Algar River, Cameron Creek, Prairie Creek, the upper halves of Saline and Saprae creeks, and the uppermost reaches of the Hangingstone and Horse rivers.

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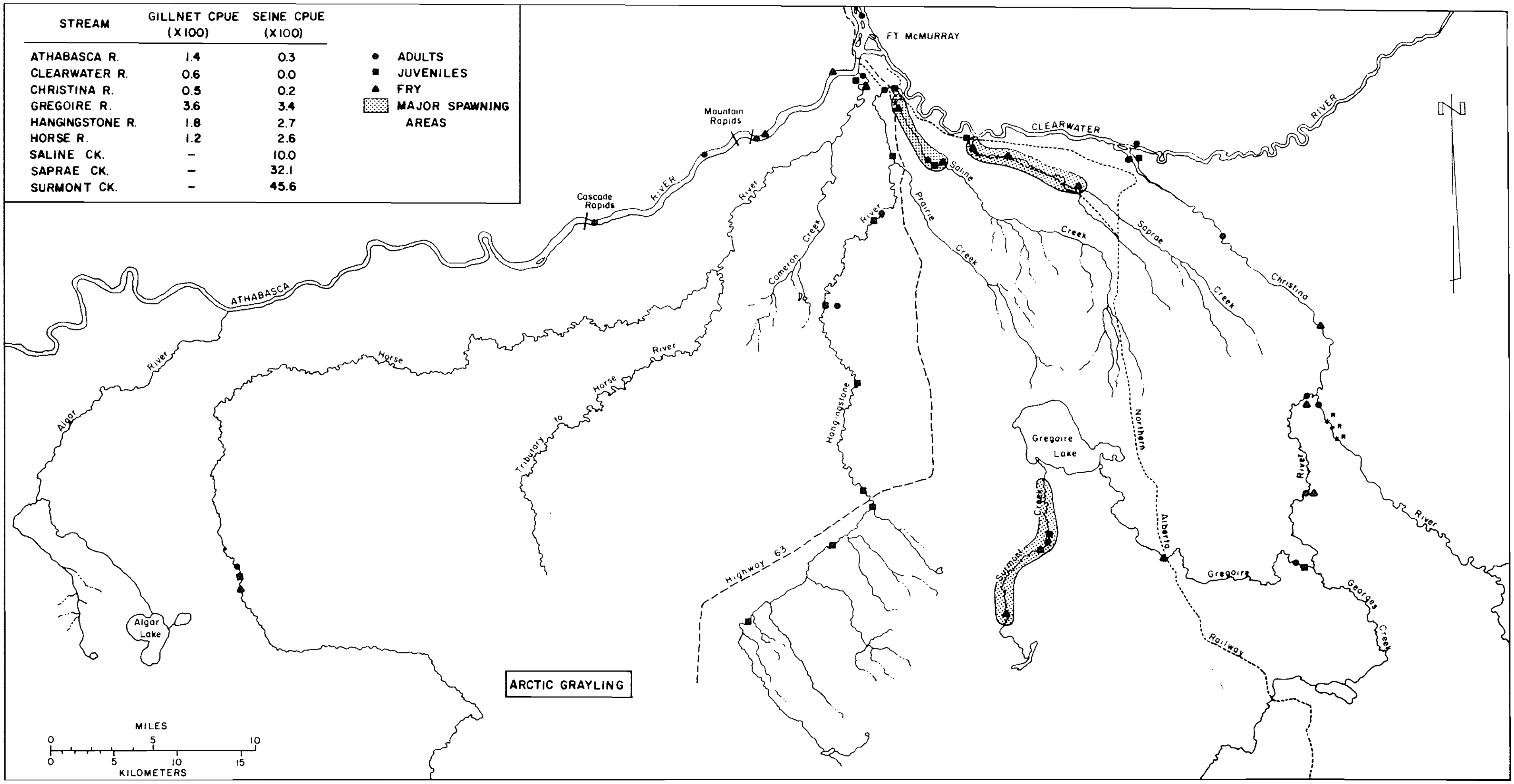
7. APPENDIX

The distribution and relative abundance of each species of fish captured during this study is presented in Figures 36 to 46.



STREAM	GILLNET CPUE (X 100)	SEINE CPUE (X 100)
ATHABASCA R.	1.4	0.3
CLEARWATER R.	0.6	0.0
CHRISTINA R.	0.5	0.2
GREGOIRE R.	3.6	3.4
HANGINGSTONE R.	1.8	2.7
HORSE R.	1.2	2.6
SALINE CK.	-	10.0
SAPRAE CK.	-	32.1
SURMONT CK.	-	45.6

Figure 36. Distribution and relative abundance of Arctic grayling in the southern portion of the AOSERP study area (Gillnet CPUE is gillnet catch per hour; seine CPUE is catch per metre of shoreline seined).

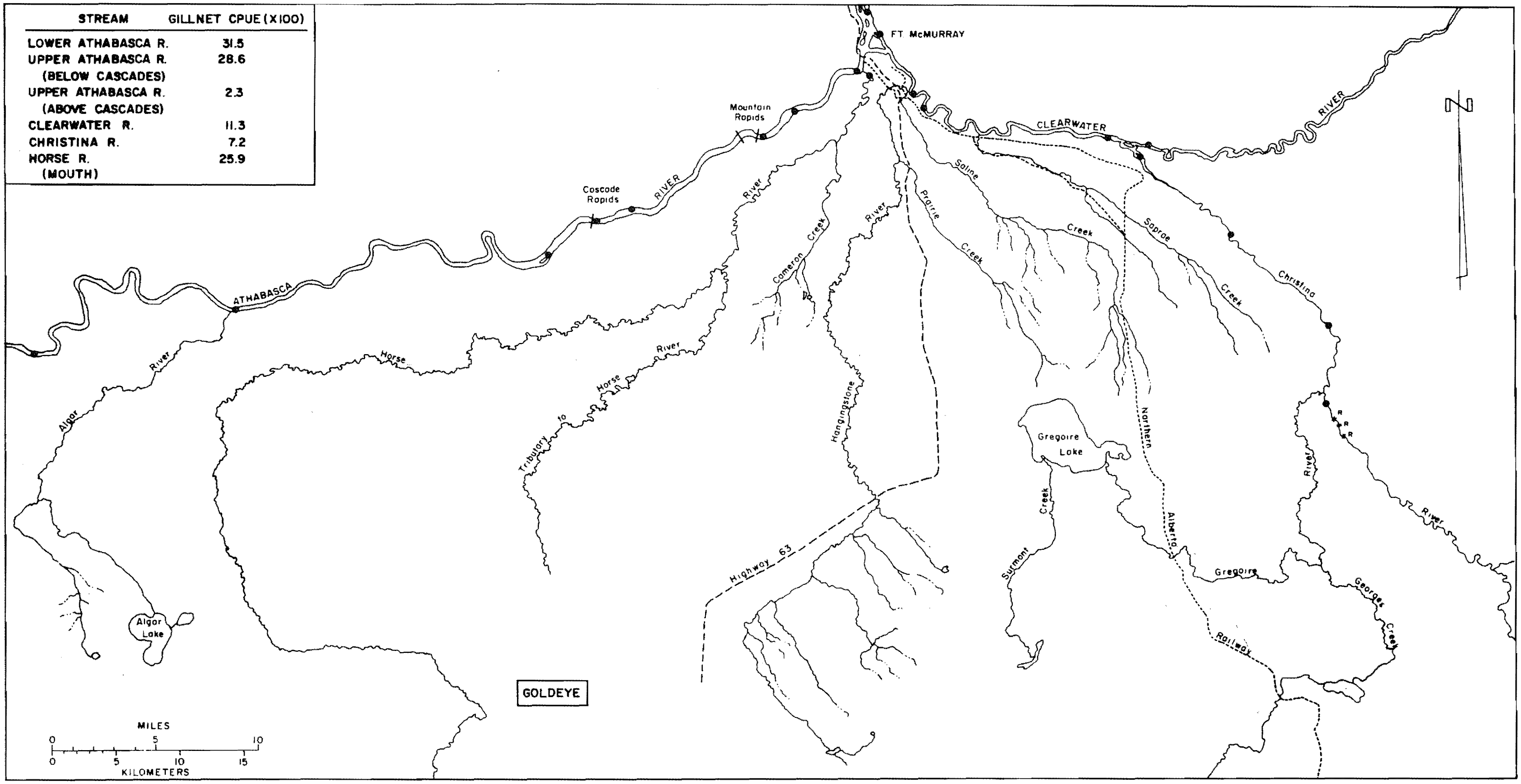


Figure 37. Distribution and relative abundance of goldeye in the southern portion of the AOSERP study area (Gillnet CPUE is gillnet catch per hour).

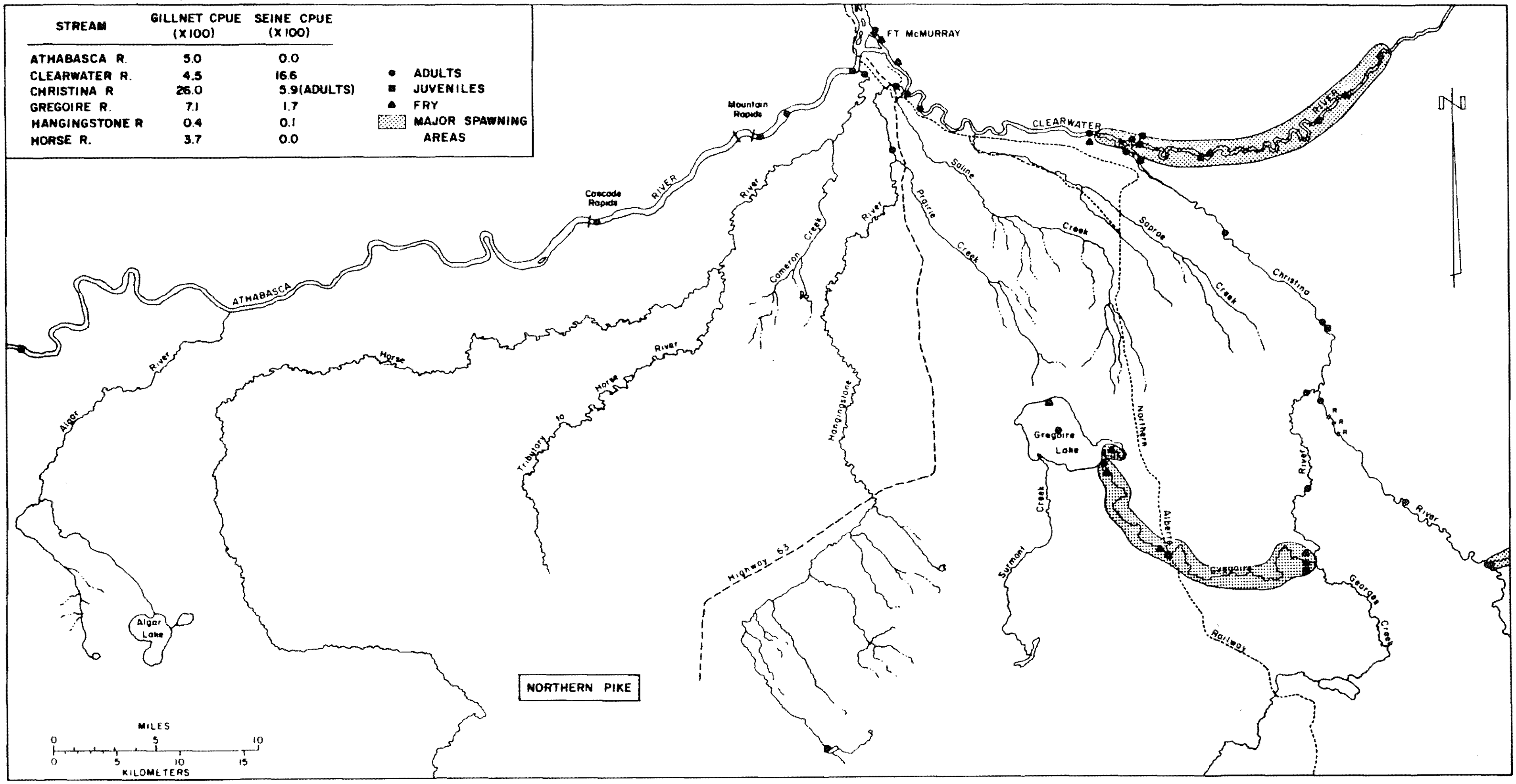


Figure 38. Distribution and relative abundance of northern pike in the southern portion of the AOSERP study area (Gillnet CPUE is catch per gillnet hour; seine CPUE is catch per metre of shoreline seined).

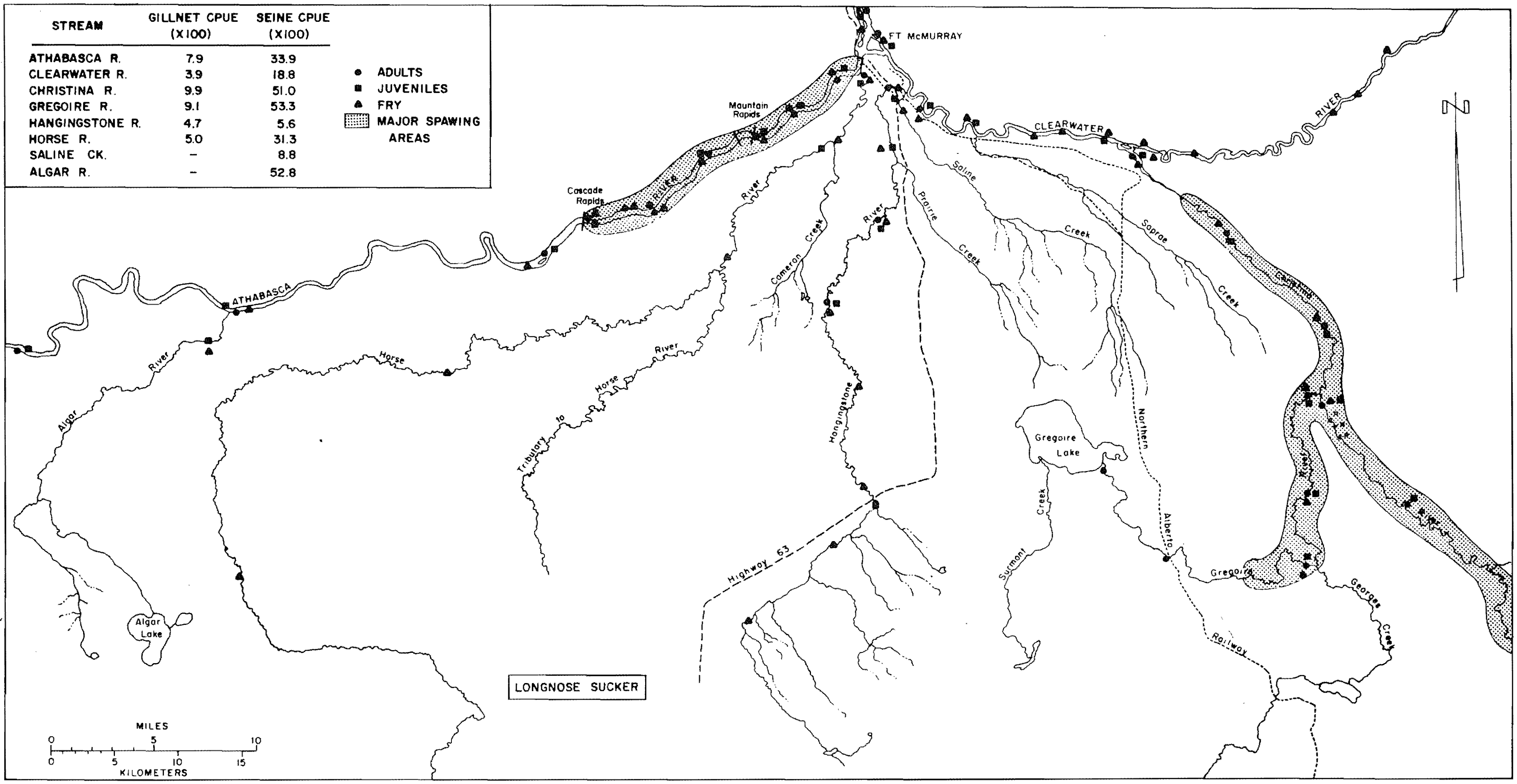


Figure 39. Distribution and relative abundance of longnose sucker in the southern portion of the AOSERP study area (Gillnet CPUE is catche per gillnet hour; seine CPUE is seine catch per metre of shoreline seined. Unidentified sucker fry are not included).

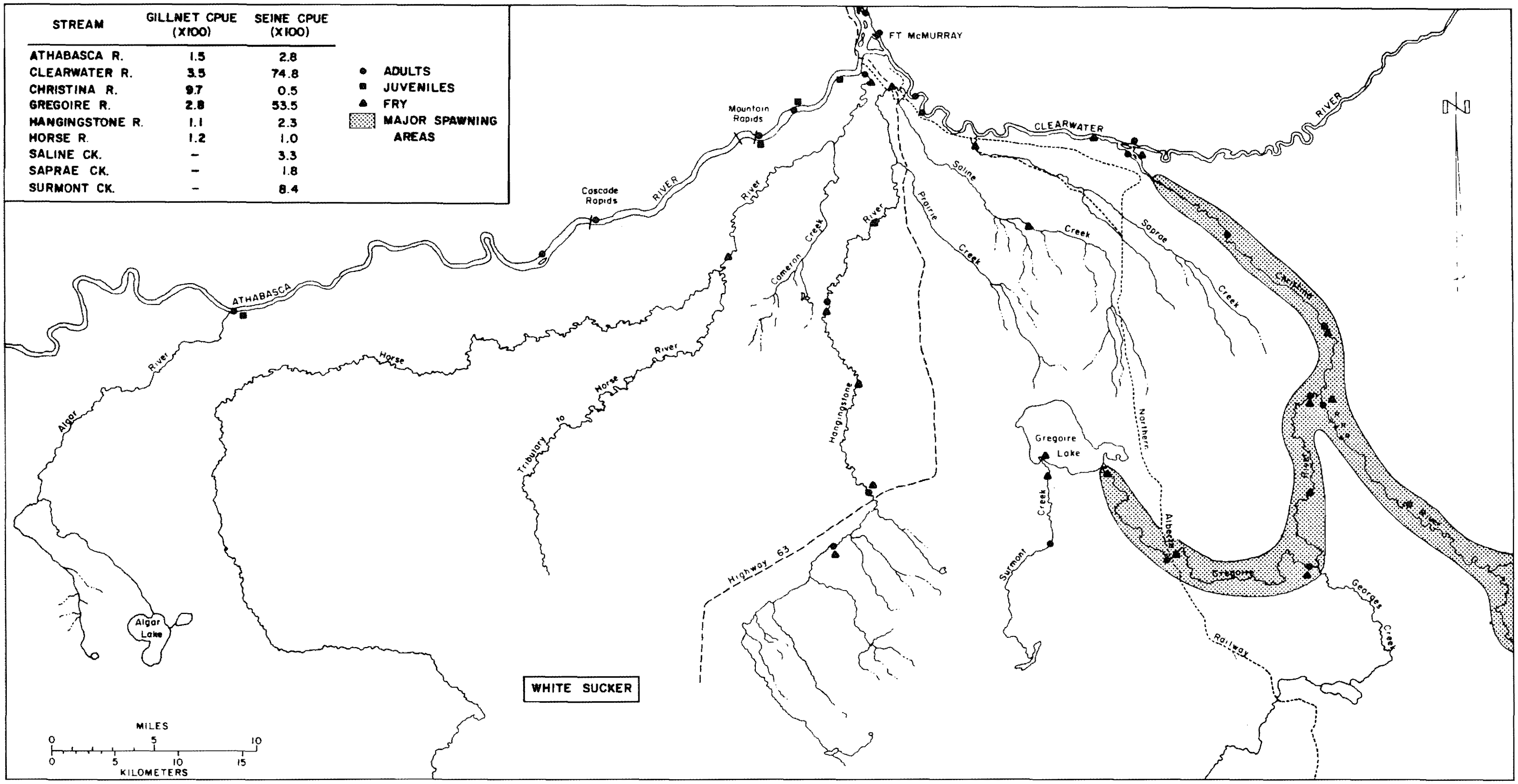


Figure 40. Distribution and relative abundance of white sucker in the southern portion of the AOSERP study area (Gillnet CPUE is catch per gillnet·hour; seine CPUE is catch per metre of shoreline seined. Unidentified sucker fry are not included).

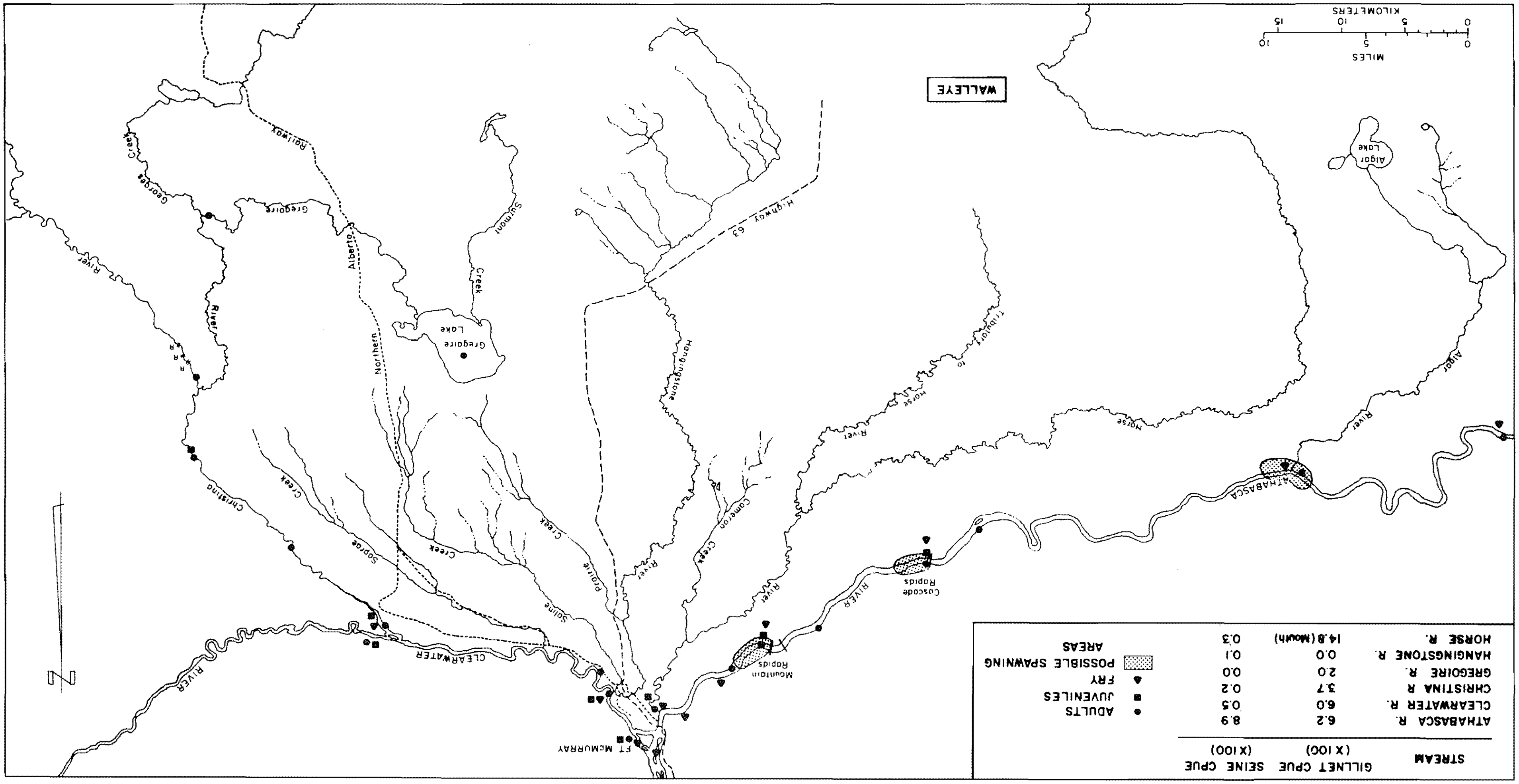


Figure 41. Distribution and relative abundance of walleye in the southern portion of the AOSERP study area (Gillnet CPUE is catch per gillnet hour; seine CPUE is catch per metre of shoreline seined).

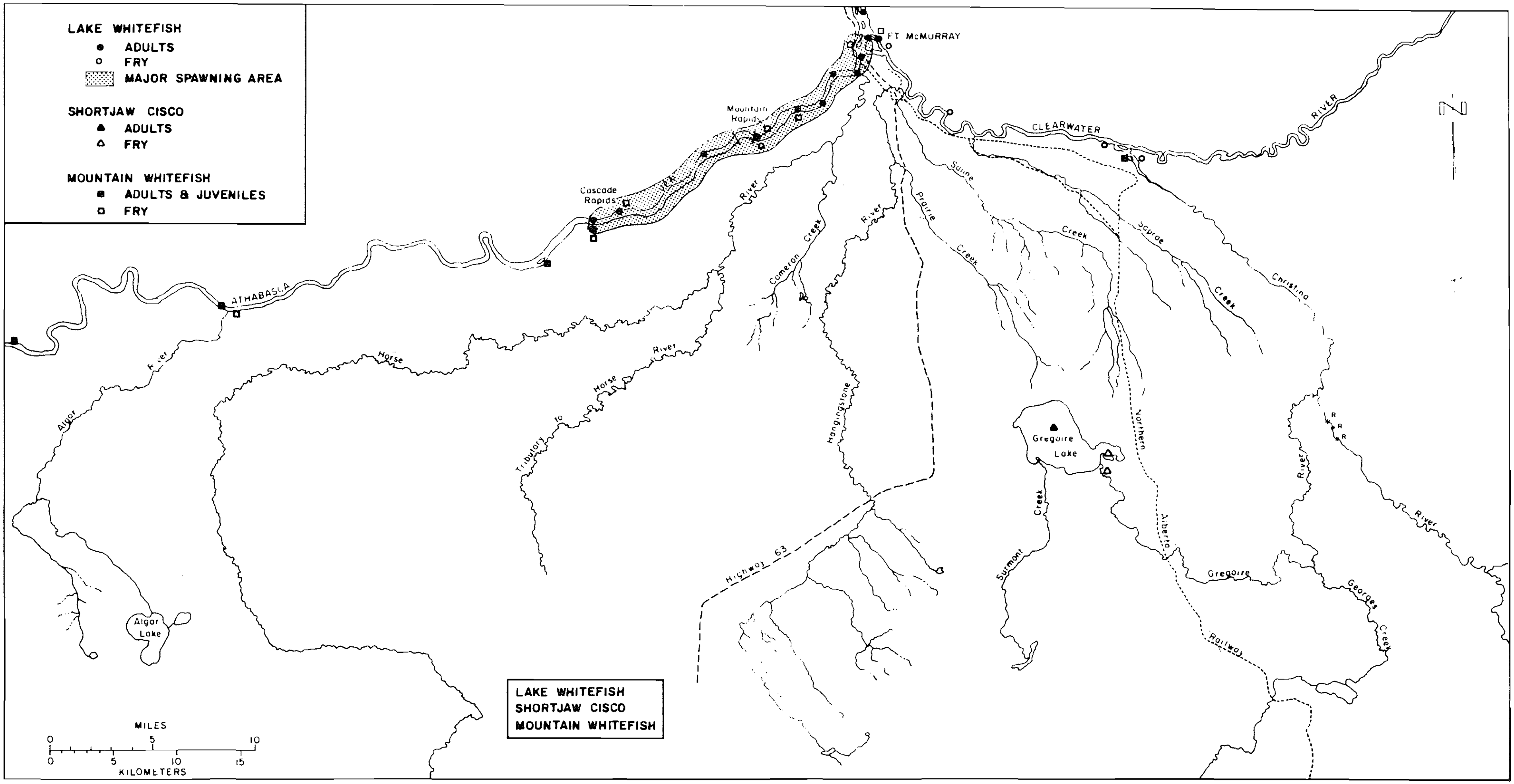
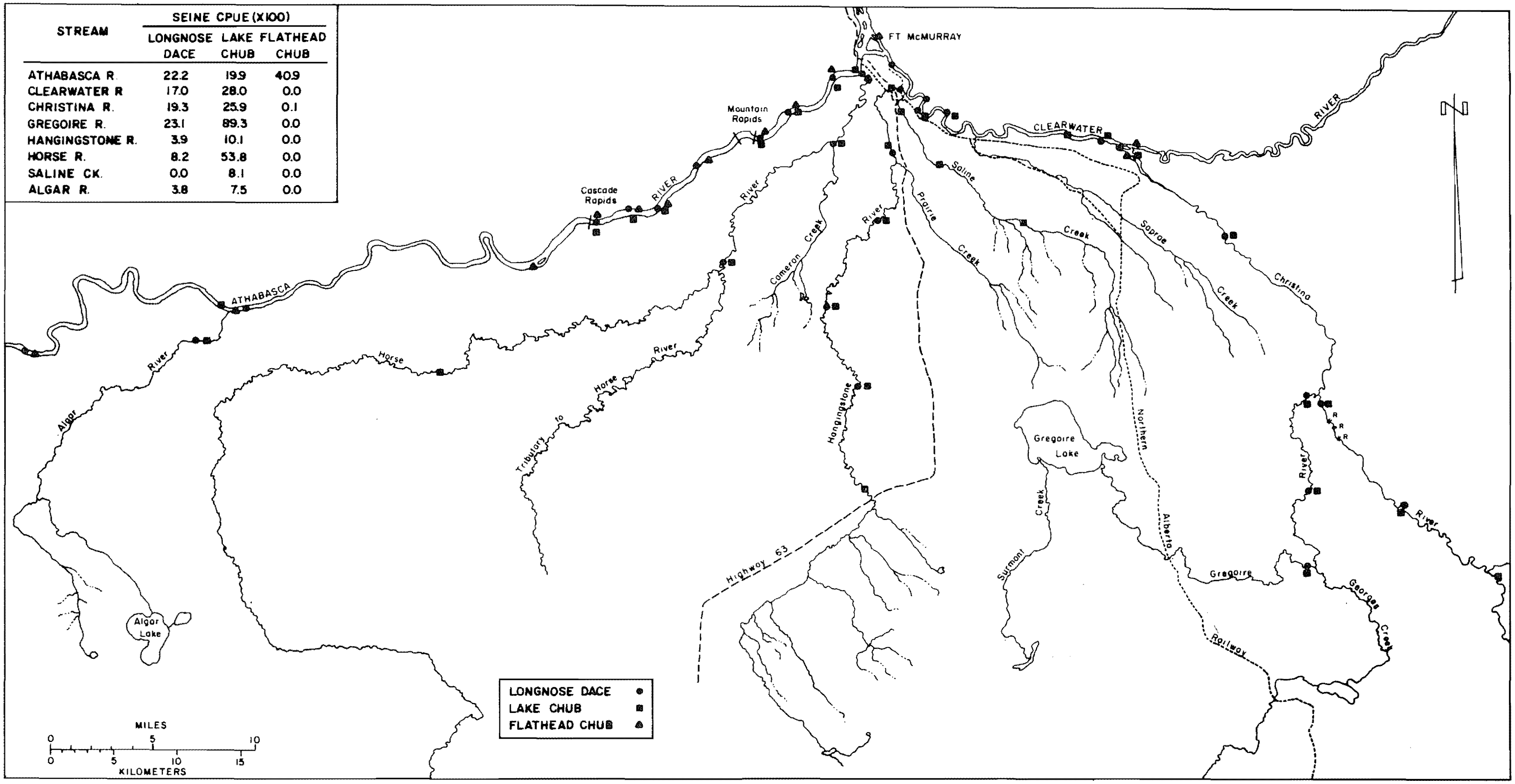
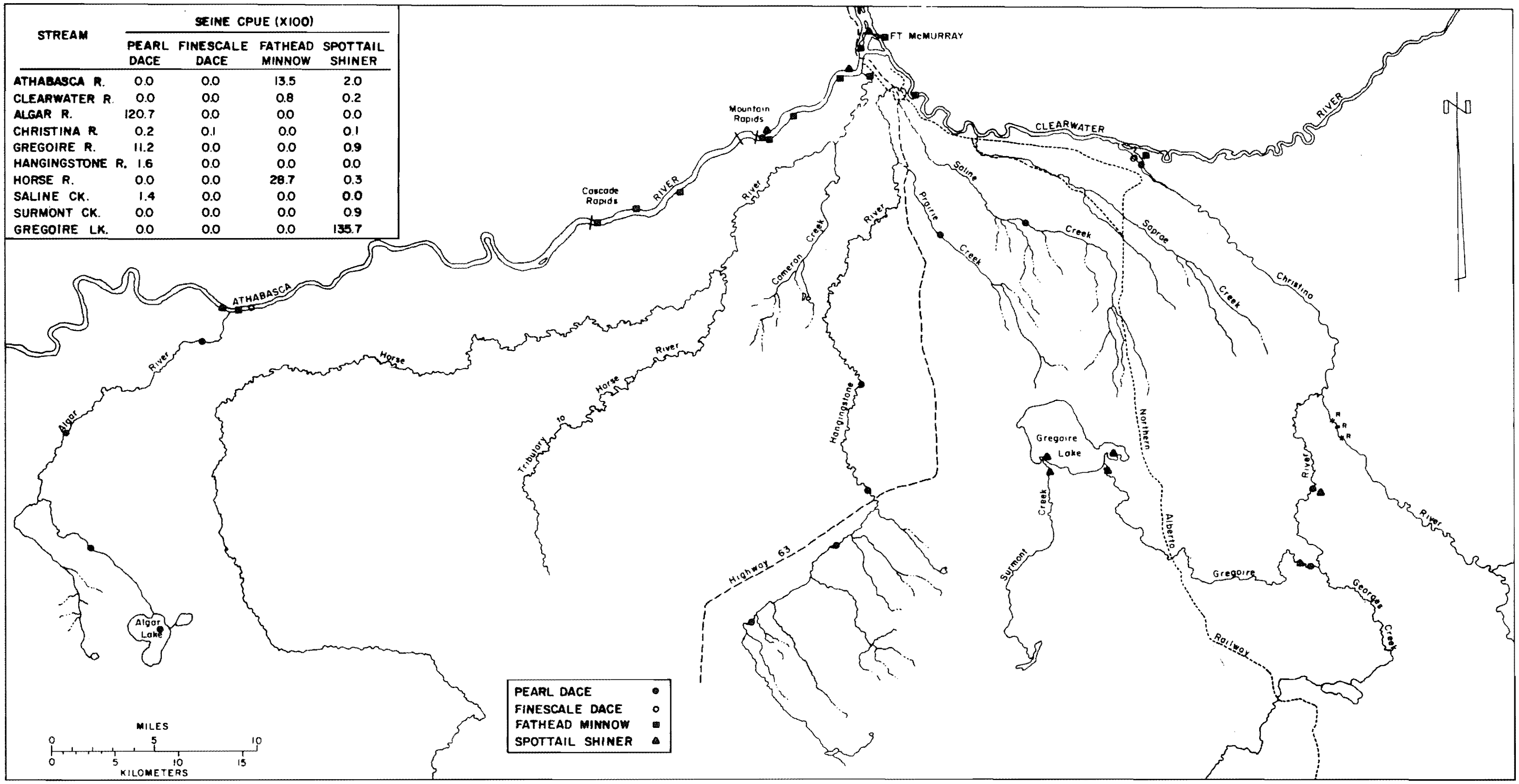


Figure 42. Distribution of lake whitefish, shortjaw cisco, and mountain whitefish in the southern portion of the AOSERP study area.



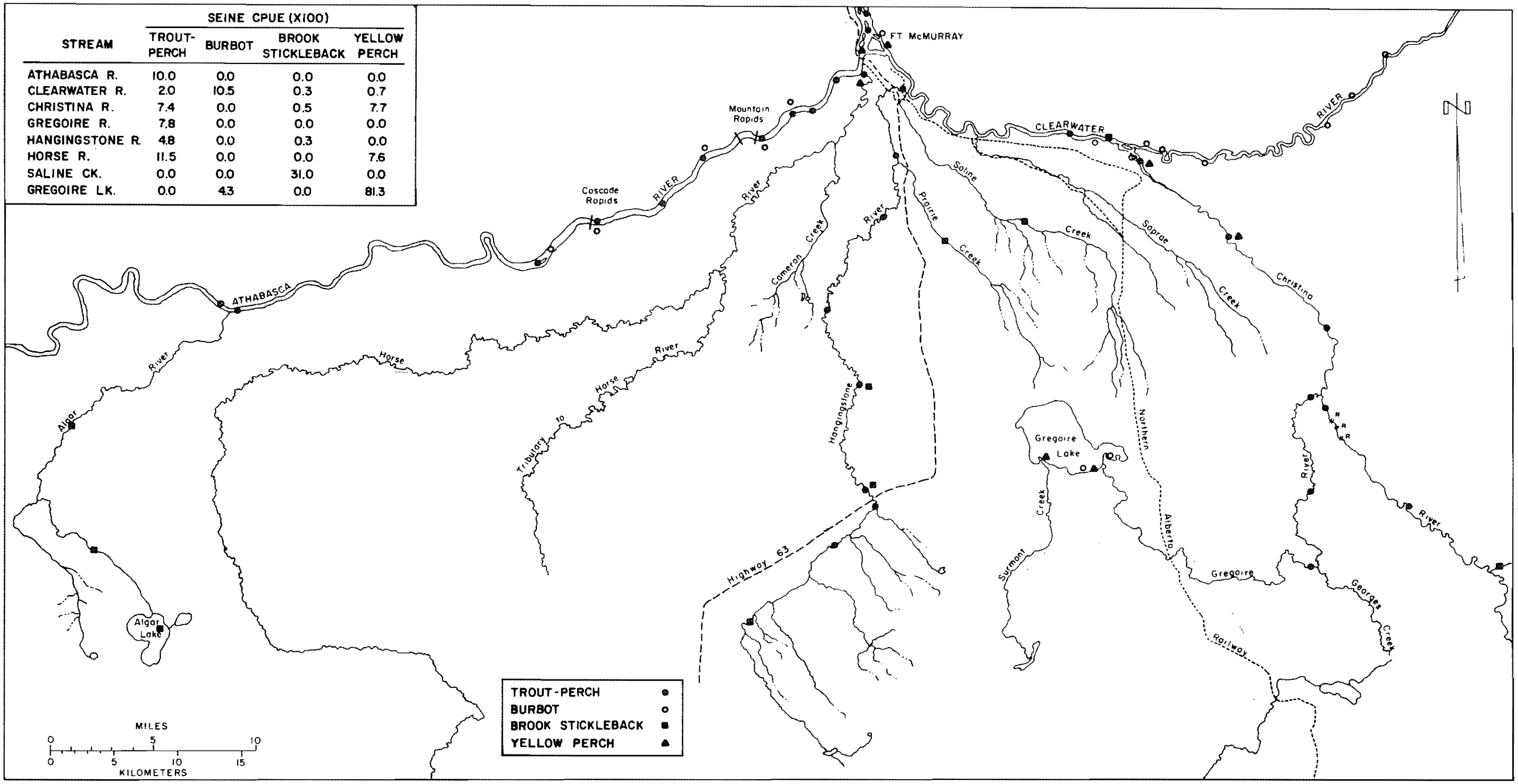
STREAM	SEINE CPUE (X100) LONGNOSE DACE	LAKE CHUB	FLATHEAD CHUB
ATHABASCA R.	22.2	19.9	40.9
CLEARWATER R	17.0	28.0	0.0
CHRISTINA R.	19.3	25.9	0.1
GREGOIRE R.	23.1	89.3	0.0
HANGINGSTONE R.	3.9	10.1	0.0
HORSE R.	8.2	53.8	0.0
SALINE CK.	0.0	8.1	0.0
ALGAR R.	3.8	7.5	0.0

Figure 43. Distribution and relative abundance of longnose dace, lake chub, and flathead chub in the southern portion of the AOSERP study area (Seine CPUE is catch per metre of shoreline seined).



STREAM	SEINE CPUE (X100)			
	PEARL DACE	FINESCALE DACE	FATHEAD MINNOW	SPOTTAIL SHINER
ATHABASCA R.	0.0	0.0	13.5	2.0
CLEARWATER R.	0.0	0.0	0.8	0.2
ALGAR R.	120.7	0.0	0.0	0.0
CHRISTINA R.	0.2	0.1	0.0	0.1
GREGOIRE R.	11.2	0.0	0.0	0.9
HANGINGSTONE R.	1.6	0.0	0.0	0.0
HORSE R.	0.0	0.0	28.7	0.3
SALINE CK.	1.4	0.0	0.0	0.0
SURMONT CK.	0.0	0.0	0.0	0.9
GREGOIRE LK.	0.0	0.0	0.0	135.7

Figure 44. Distribution and relative abundance of pearl dace, finescale dace, fathead minnow, and spottail shiner in the southern portion of the AOSERP study area (Seine CPUE is catch per metre of shoreline seined).



STREAM	SEINE CPUE (X100)			
	TROUT-PERCH	BURBOT	BROOK STICKLEBACK	YELLOW PERCH
ATHABASCA R.	10.0	0.0	0.0	0.0
CLEARWATER R.	2.0	10.5	0.3	0.7
CHRISTINA R.	7.4	0.0	0.5	7.7
GREGOIRE R.	7.8	0.0	0.0	0.0
HANGINGSTONE R.	4.8	0.0	0.3	0.0
HORSE R.	11.5	0.0	0.0	7.6
SALINE CK.	0.0	0.0	31.0	0.0
GREGOIRE LK.	0.0	4.3	0.0	81.3

Figure 45. Distribution and relative abundance of trout-perch, burbot, brook stickleback, and yellow perch in the southern portion of the AOSERP study area (Seine CPUE is catch per metre of shoreline seined).

STREAM	SEINE CPUE (X100) SLIMY SCULPIN	SPOONHEAD SCULPIN
ATHABASCA R.	0.8	0.6
CLEARWATER R.	0.8	0.0
CHRISTINA R.	3.1	0.1
GREGOIRE R.	9.1	0.0
HANGINGSTONE R.	28.2	0.0
HORSE R.	27.7	0.0
SAPRAE CK.	3.0	0.0
SURMONT CK.	8.4	0.0

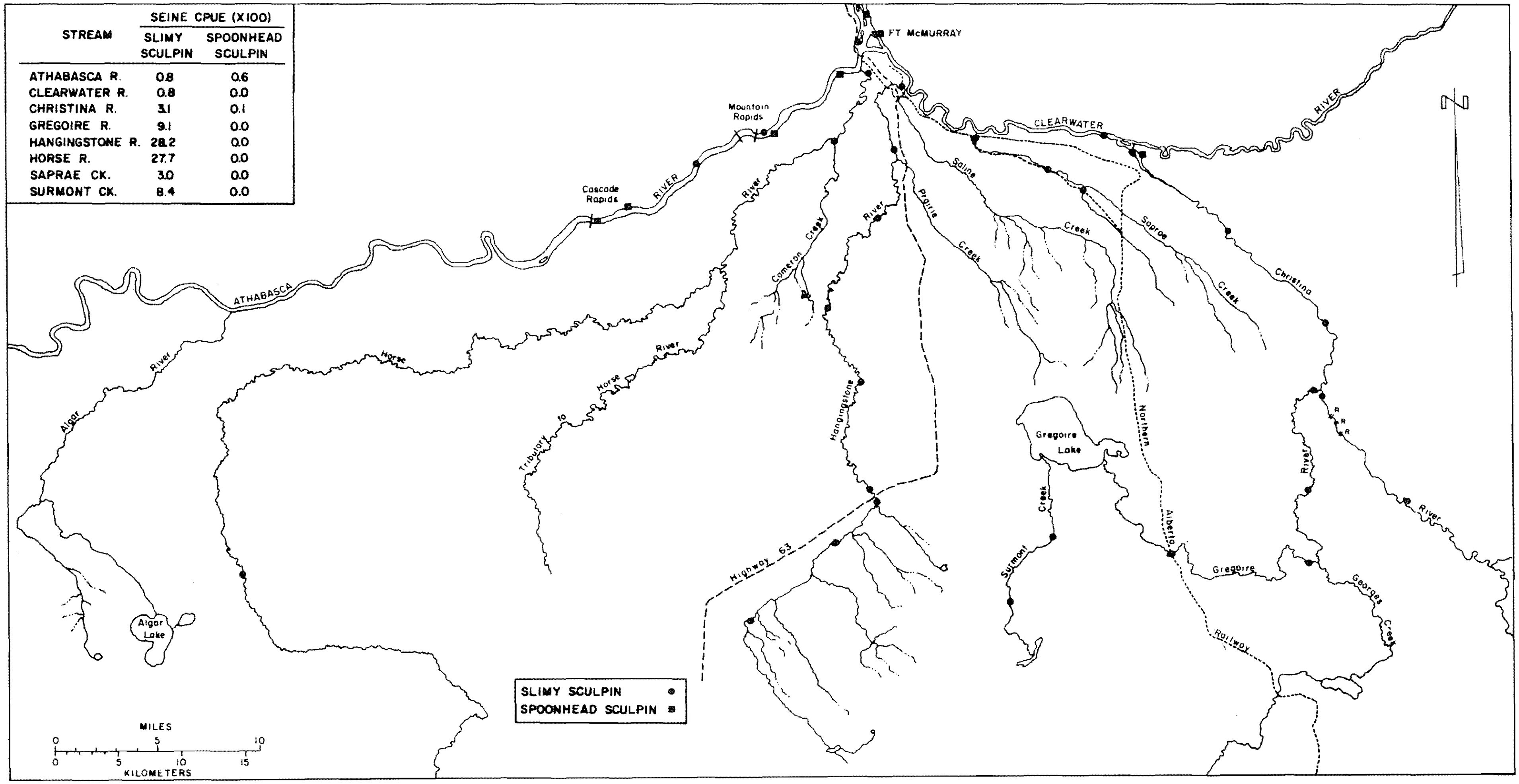


Figure 46. Distribution and relative abundance of slimy sculpin and spoonhead sculpin in the southern portion of the AOSERP study area (Seine CPUE is catch per metre of shoreline seined).

8. AOSERP RESEARCH REPORTS

1.		AOSERP First Annual Report, 1975
2.	AF 4.1.1	Walleye and Goldeye Fisheries Investigations in the Peace-Athabasca Delta--1975
3.	HE 1.1.1	Structure of a Traditional Baseline Data System
4.	VE 2.2	A Preliminary Vegetation Survey of the Alberta Oil Sands Environmental Research Program Study Area
5.	HY 3.1	The Evaluation of Wastewaters from an Oil Sand Extraction Plant
6.		Housing for the North--The Stackwall System
7.	AF 3.1.1	A Synopsis of the Physical and Biological Limnology and Fisheries Programs within the Alberta Oil Sands Area
8.	AF 1.2.1	The Impact of Saline Waters upon Freshwater Biota (A Literature Review and Bibliography)
9.	ME 3.3	Preliminary Investigations into the Magnitude of Fog Occurrence and Associated Problems in the Oil Sands Area
10.	HE 2.1	Development of a Research Design Related to Archaeological Studies in the Athabasca Oil Sands Area
11.	AF 2.2.1	Life Cycles of Some Common Aquatic Insects of the Athabasca River, Alberta
12.	ME 1.7	Very High Resolution Meteorological Satellite Study of Oil Sands Weather: "A Feasibility Study"
13.	ME 2.3.1	Plume Dispersion Measurements from an Oil Sands Extraction Plant, March 1976
14.		
15.	ME 3.4	A Climatology of Low Level Air Trajectories in the Alberta Oil Sands Area
16.	ME 1.6	The Feasibility of a Weather Radar near Fort McMurray, Alberta
17.	AF 2.1.1	A Survey of Baseline Levels of Contaminants in Aquatic Biota of the AOSERP Study Area
18.	HY 1.1	Interim Compilation of Stream Gauging Data to December 1976 for the Alberta Oil Sands Environmental Research Program
19.	ME 4.1	Calculations of Annual Averaged Sulphur Dioxide Concentrations at Ground Level in the AOSERP Study Area
20.	HY 3.1.1	Characterization of Organic Constituents in Waters and Wastewaters of the Athabasca Oil Sands Mining Area
21.		AOSERP Second Annual Report, 1976-77
22.		Alberta Oil Sands Environmental Research Program Interim Report to 1978 covering the period April 1975 to November 1978
23.	AF 1.1.2	Acute Lethality of Mine Depressurization Water on Trout Perch and Rainbow Trout
24.	ME 1.5.2	Air System Winter Field Study in the AOSERP Study Area, February 1977.
25.	ME 3.5.1	Review of Pollutant Transformation Processes Relevant to the Alberta Oil Sands Area

26. AF 4.5.1 Interim Report on an Intensive Study of the Fish Fauna of the Muskeg River Watershed of Northeastern Alberta
27. ME 1.5.1 Meteorology and Air Quality Winter Field Study in the AOSERP Study Area, March 1976
28. VE 2.1 Interim Report on a Soils Inventory in the Athabasca Oil Sands Area
29. ME 2.2 An Inventory System for Atmospheric Emissions in the AOSERP Study Area
30. ME 2.1 Ambient Air Quality in the AOSERP Study Area, 1977
31. VE 2.3 Ecological Habitat Mapping of the AOSERP Study Area: Phase I
32. AOSERP Third Annual Report, 1977-78
33. TF 1.2 Relationships Between Habitats, Forages, and Carrying Capacity of Moose Range in northern Alberta. Part I: Moose Preferences for Habitat Strata and Forages.
34. HY 2.4 Heavy Metals in Bottom Sediments of the Mainstem Athabasca River System in the AOSERP Study Area
35. AF 4.9.1 The Effects of Sedimentation on the Aquatic Biota
36. AF 4.8.1 Fall Fisheries Investigations in the Athabasca and Clearwater Rivers Upstream of Fort McMurray: Volume I
37. HE 2.2.2 Community Studies: Fort McMurray, Anzac, Fort MacKay
38. VE 7.1.1 Techniques for the Control of Small Mammals: A Review
39. ME 1.0 The Climatology of the Alberta Oil Sands Environmental Research Program Study Area
40. WS 3.3 Mixing Characteristics of the Athabasca River below Fort McMurray - Winter Conditions
41. AF 3.5.1 Acute and Chronic Toxicity of Vanadium to Fish
42. TF 1.1.4 Analysis of Fur Production Records for Registered Traplines in the AOSERP Study Area, 1970-75
43. TF 6.1 A Socioeconomic Evaluation of the Recreational Fish and Wildlife Resources in Alberta, with Particular Reference to the AOSERP Study Area. Volume I: Summary and Conclusions
44. VE 3.1 Interim Report on Symptomology and Threshold Levels of Air Pollutant Injury to Vegetation, 1975 to 1978
45. VE 3.3 Interim Report on Physiology and Mechanisms of Air-Borne Pollutant Injury to Vegetation, 1975 to 1978
46. VE 3.4 Interim Report on Ecological Benchmarking and Biomonitoring for Detection of Air-Borne Pollutant Effects on Vegetation and Soils, 1975 to 1978.
47. TF 1.1.1 A Visibility Bias Model for Aerial Surveys for Moose on the AOSERP Study Area
48. HG 1.1 Interim Report on a Hydrogeological Investigation of the Muskeg River Basin, Alberta
49. WS 1.3.3 The Ecology of Macrobenthic Invertebrate Communities in Hartley Creek, Northeastern Alberta
50. ME 3.6 Literature Review on Pollution Deposition Processes
51. HY 1.3 Interim Compilation of 1976 Suspended Sediment Date in the AOSERP Study Area
52. ME 2.3.2 Plume Dispersion Measurements from an Oil Sands Extraction Plan, June 1977

53.	HY 3.1.2	Baseline States of Organic Constituents in the Athabasca River System Upstream of Fort McMurray
54.	WS 2.3	A Preliminary Study of Chemical and Microbial Characteristics of the Athabasca River in the Athabasca Oil Sands Area of Northeastern Alberta
55.	HY 2.6	Microbial Populations in the Athabasca River
56.	AF 3.2.1	The Acute Toxicity of Saline Groundwater and of Vanadium to Fish and Aquatic Invertebrates
57.	LS 2.3.1	Ecological Habitat Mapping of the AOSERP Study Area (Supplement): Phase I
58.	AF 2.0.2	Interim Report on Ecological Studies on the Lower Trophic Levels of Muskeg Rivers Within the Alberta Oil Sands Environmental Research Program Study Area
59.	TF 3.1	Semi-Aquatic Mammals: Annotated Bibliography
60.	WS 1.1.1	Synthesis of Surface Water Hydrology
61.	AF 4.5.2	An Intensive Study of the Fish Fauna of the Steepbank River Watershed of Northeastern Alberta
62.	TF 5.1	Amphibians and Reptiles in the AOSERP Study Area
63.	ME 3.8.3	Analysis of AOSERP Plume Sigma Data
64.	LS 21.6.1	A Review and Assessment of the Baseline Data Relevant to the Impacts of Oil Sands Development on Large Mammals in the AOSERP Study Area
65.	LS 21.6.2	A Review and Assessment of the Baseline Data Relevant to the Impacts of Oil Sands Development on Black Bears in the AOSERP Study Area
66.	AS 4.3.2	An Assessment of the Models LIRAQ and ADPIC for Application to the Athabasca Oil Sands Area
67.	WS 1.3.2	Aquatic Biological Investigations of the Muskeg River Watershed
68.	AS 1.5.3 AS 3.5.2	Air System Summer Field Study in the AOSERP Study Area, June 1977
69.	HS 40.1	Native Employment Patterns in Alberta's Athabasca Oil Sands Region
70.	LS 28.1.2	An Interim Report on the Insectivorous Animals in the AOSERP Study Area
71.	HY 2.2	Lake Acidification Potential in the Alberta Oil Sands Environmental Research Program Study Area
72.	LS 7.1.2	The Ecology of Five Major Species of Small Mammals in the AOSERP Study Area: A Review
73.	LS 23.2	Distribution, Abundance and Habitat Associations of Beavers, Muskrats, Mink and River Otters in the AOSERP Study Area, Northeastern Alberta
74.	AS 4.5	Air Quality Modelling and User Needs
75.	WS 1.3.4	Interim Report on a Comparative Study of Benthic Algal Primary Productivity in the AOSERP Study Area
76.	AF 4.5.1	An Intensive Study of the Fish Fauna of the Muskeg River Watershed of Northeastern Alberta
77.	HS 20.1	Overview of Local Economic Development in the Athabasca Oil Sands Region Since 1961.
78.	LS 22.1.1	Habitat Relationships and Management of Terrestrial Birds in Northeastern Alberta