FALL FISHERIES INVESTIGATIONS IN THE ATHABASCA AND CLEARWATER RIVERS UPSTREAM OF FORT MCMURRAY

Volume I

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ABSTRACT

Fisheries investigations were undertaken in the Athabasca and Clearwater rivers upstream of Fort McMurray in the fall of 1977. The major emphasis of these studies was to delineate actual and potential spawning areas for lake whitefish in the Athabasca and Clearwater rivers.

Lake whitefish were found to spawn during mid-October in the mainstem of the Athabasca River from Fort McMurray upstream to Cascade Rapids, a distance of approximately 32 km. The major concentrations of spawning lake whitefish were immediately below Mountain Rapids (24 km upstream of Fort McMurray). There was no evidence of lake whitefish spawning in the Clearwater River.

Spawning generally occurred in fast water over broken rock, rubble, and coarse gravel substrates. While recaptures were insufficient to calculate a population estimate by scientific means, the spawning population is large, certainly numbering tens of thousands of fish. Post-spawning tag returns indicate that the lake whitefish spawners moved downstream immediately after spawning, returning to the Peace-Athabasca Delta.

The Athabasca River upstream of Fort McMurray provides critical spawning habitat for lake whitefish. Other important fish species, including goldeye, longnose sucker, walleye, and northern pike, also occur in the project study area.

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1. INTRODUCTION

In September 1977, Aquatic Environments Limited of Calgary, Alberta, began a study, funded by the Alberta Oil Sands Environmental Research Program (AOSERP), of fisheries resources in the Athabasca and Clearwater rivers upstream of Fort McMurray. Little previous data were available for this part of the AOSERP study area (Figure 1) but studies downstream (McCart et al. 1977) had indicated that, in late summer, substantial numbers of lake whitefish moved upstream, presumably on a spawning migration.

The major objectives of this study were:

1. to determine the species composition, relative abundance, and biology of major fish species in the Athabasca and Clearwater rivers (including lower reaches of the Christina River) upstream from Fort McMurray to the southern boundary of the AOSERP study area;
2. to identify the migration patterns of major fish species in the study area, with special emphasis on lake whitefish; and
3. to delineate actual and potential spawning areas for lake whitefish in the Athabasca and Clearwater rivers.

To meet these objectives, as many fish as possible, of the major fish species present, were to be tagged with numbered Floy dart tags first to document their movements and second to estimate population size.

This report consists of two volumes. Volume I is an explanatory text complete with summary tables and maps. Volume II is a data volume containing catch data, dissection data, and tagging forms.

2. THE STUDY AREA

Figure 2 indicates the location of the project study area. On the Athabasca River, it extends upstream from the junction of the

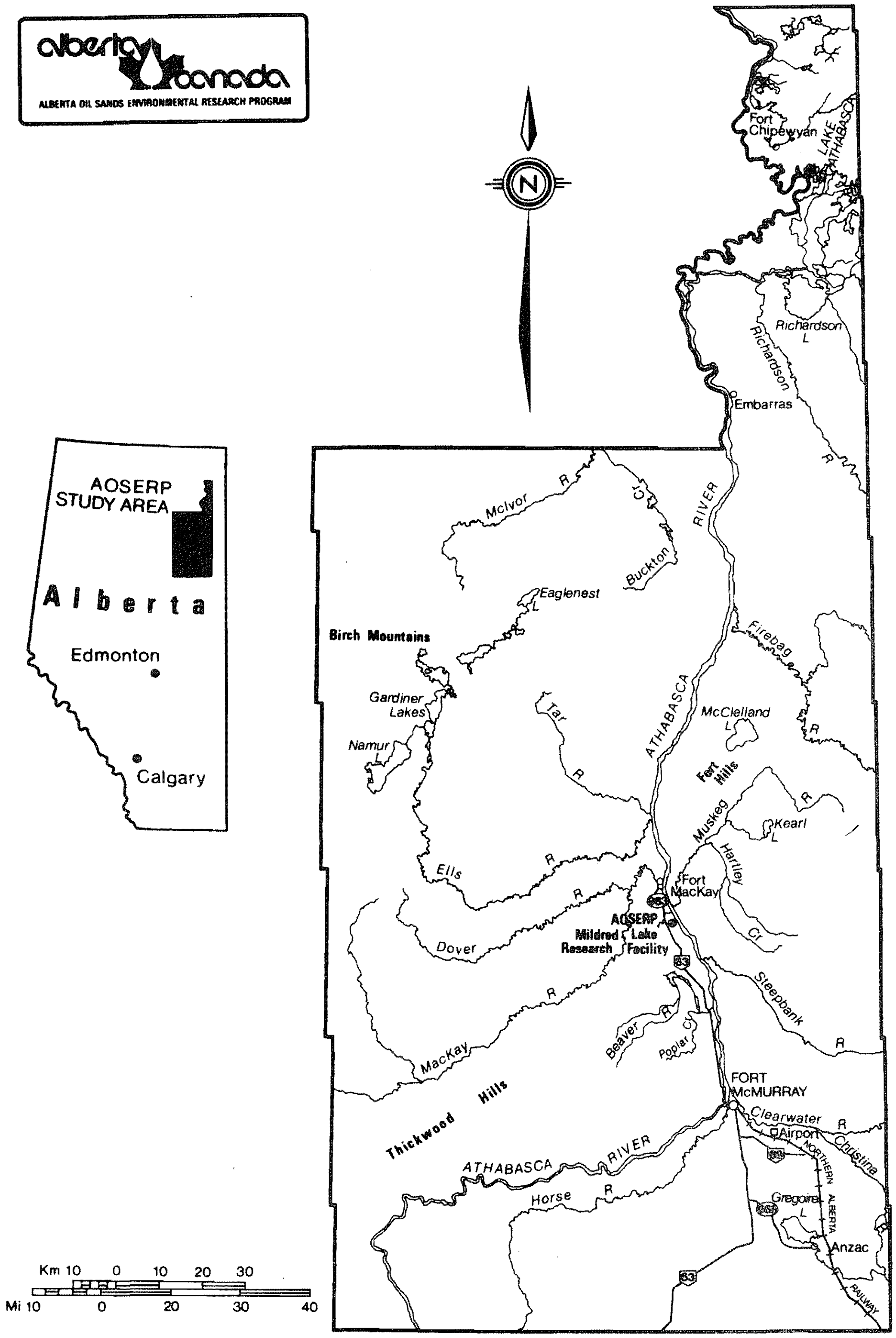

Figure 1. The AOSERP study area.

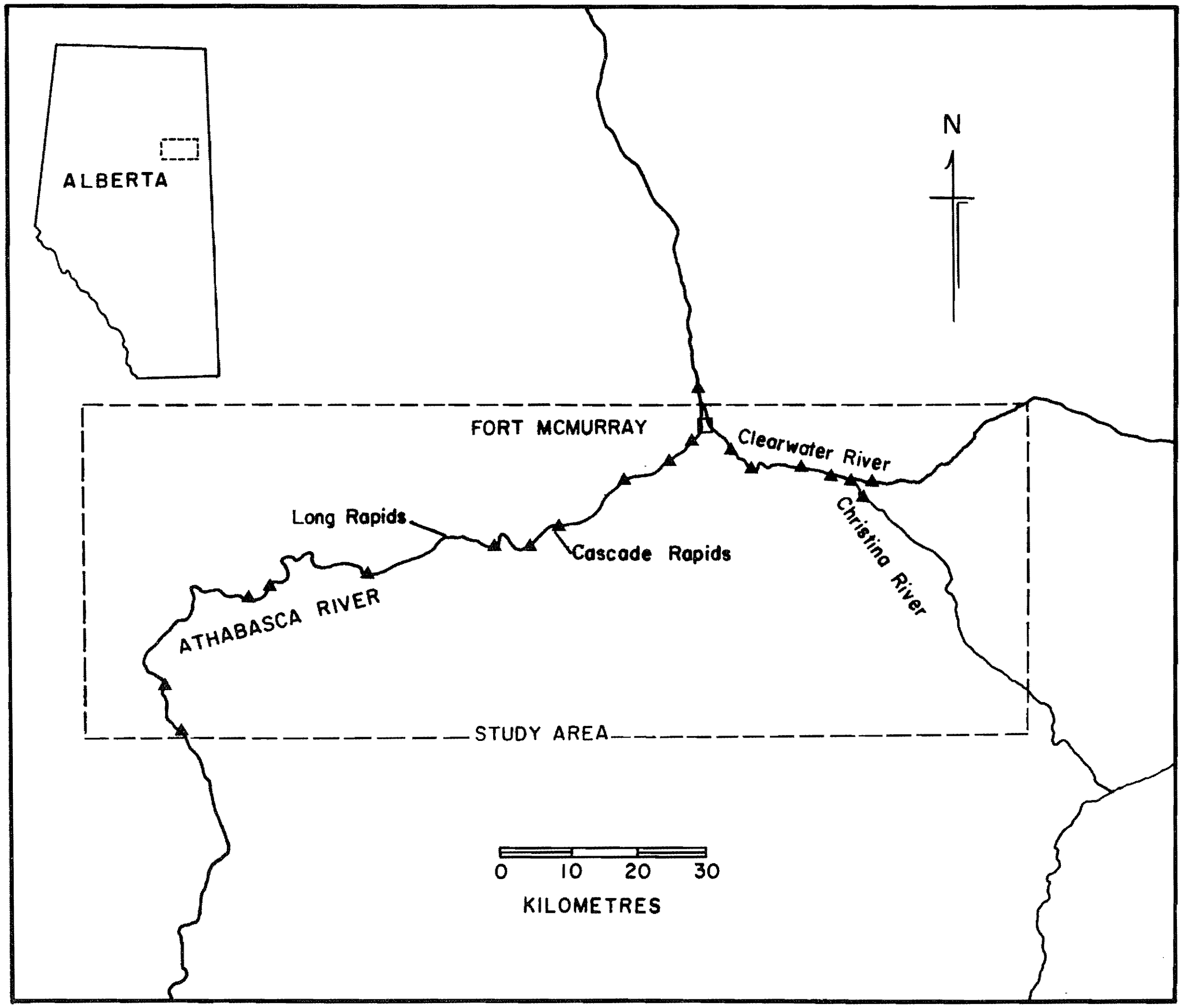

Figure 2. The project study area and approximate locations (indicated by triangles) of fish sampling stations. (See Volume II for details of sampling locations.)

Athabasca and Clearwater rivers at Fort McMurray to the southern boundary of the AOSERP study area. On the Clearwater River, the project study area extends upstream to a point about 1 km above the junction of the Clearwater and Christina rivers. It includes one station on the Christina River approximately 1 km above its mouth. The approximate location of fish sampling stations are indicated in Figure 2. There was a single station on the Athabasca River downstream of the junction of the Athabasca and Clearwater rivers. There were 11 on the Athabasca River upstream of Fort McMurray, six on the Clearwater River, and one on the Christina River. Details of the location of sampling areas are included in Volume II.

3. METHODS

The study began in early September with a helicopter reconnaissance of the project study area. Subsequently, outboard jet powered riverboats were used to reach sampling sites on the Clearwater and Christina rivers and on the Athabasca River as far upstream as Long Rapids (Figure 2). A helicopter was used to reach sample stations above Long Rapids. Later in the fall, as water levels dropped, Cascade Rapids (Figure 2) became impassable to navigation upstream and toward the end of the study it was necessary to drag the boat over rock sills in shallow water on the north side of the river in order to bypass the rapids.

Stations on the upper Clearwater and Christina rivers were sampled approximately once a week. Stations on the lower Clearwater River and on the Athabasca as far upstream as Cascade Rapids were sampled twice weekly. Stations on the Athabasca River, from above Cascade Rapids to the vicinity of Grand Rapids, were sampled at approximately two-week intervals.

Gillnets and seines were the primary means of capturing fish. The gillnets most often used were multiple mesh, research gangs containing six, ten-foot panels of 1.5, 2, 2.5, 3, 3.5, and 4 inch stretched mesh, respectively. Most nets were set overnight for a period of approximately 24 hours. Occasionally, single 50 feet monofilament panels of various mesh sizes were used for short periods to determine the presence or absence of lake whitefish or to increase the catch of specimens for life history analysis.

The seines used for surveys were fine mesh minnow seines, either 20 or 60 feet long and 8 feet deep. Where concentrations of lake whitefish occurred, a 100 foot, large mesh (4 inch stretched mesh) seine was used to capture large numbers of fish for tagging. All fish were tagged on the left side of the body just below the base of the dorsal fin.

A sample of each major fish species was retained for life history analysis. Retained specimens were dissected and subjected to analysis as described by McCart et al. (1972).

In the field laboratory, each fish was measured to the nearest millimetre and weighed to the nearest 0.1 g. Egg diameters were determined to the nearest 0.1 mm by calculating the mean diameter of 10 unpreserved eggs of the largest size class lined up in a row. Gonads were removed and weighed to the nearest 0.1 g. For fecundity determination, a weighed subsample, including both eggs and ovarian tissue, amounting to about 20% of 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.

The gonads of fish were classified as either immature (negligible development; fish would not have spawned in the spawning season subsequent to capture) or mature (sufficient development to indicate that the fish would have spawned in the spawning season subsequent to capture). Mature specimens were further classified as green, ripe, or spawned out as defined by:

1. Mature-green: fish which would have spawned in the forthcoming spawning season; generally characterized by large body size, large gonads, as well as large egg size.
2. Mature-ripe: fish from which sex products could

be extruded by gentle pressure on the abdomen.

3. Spawned-out: fish which had recently completed spawning as indicated by coluration and vascularization of the gonads and absence of most sex products.

Egg surveys were conducted in suspected lake whitefish spawning areas to determine the presence or absence of viable eggs. An area of substrate approximately 1 m^2 in size was stirred vigorously with the feet or an oar, depending on depth, while dipnets were held immediately downstream of the site. Any eggs that were dislodged from the substrate were carried by the current into the nets where they could be counted and examined.

Otoliths and/or scales were removed from fish specimens during dissection and preserved for age determination. Otoliths were read with the aid of a binocular microscope and scales were read using a projecting microscope. Ages were estimated by two independent readers and differences reconciled at a joint reading with a third, independent, observer. Results were compared to those obtained during other studies.

Fish stomach contents were analysed in the field laboratory. Food items were identified to major taxa (Order or Family, depending on group) with the aid of a binocular microscope.

During the course of the study, water temperature (pocket thermometer) and dissolved oxygen levels (Hach OX-10 dissolved oxygen kit) were measured daily at each sample site.

4. RESULTS

4.1 SPECIES COMPOSITION AND RELATIVE ABUNDANCE

The 14 species of fish captured in the project study area are indicated in Table 1. Lake whitefish were by far the most abundant. Overall, they constituted 68.2% of the total catch from gillnets and seines. The second most abundant species was longnose sucker (6.8%), followed by goldeye (6.6%), walleye (4.3%), northern pike (3.9%), and white sucker (2.4%). Capture locations, by species and method, are shown in Figures 3 to 5.

Table 1. List of common and scientific names of fish captured in the study area. Four-letter codes of fish names used in this study are also listed.

Common Name	Scientific Name	Code	Number Captured: Seine N	Seine %	Gillnet N	Gillnet %	Total N	Total %	Number Tagged
lake whitefish	*Coregonus clupeaformis*	LKWT	1429	82.8	79	16.3	1508	68.2	1275
mountain whitefish	*Prosopium williamsoni*	MTWT	0	0.0	16	3.3	16	0.7	0
Arctic grayling	*Thymallus arcticus*	GRAY	6	0.4	19	3.9	25	1.1	0
goldeye	*Hiodon alosoides*	GOLD	1	0.1	144	29.6	145	6.6	67
northern pike	*Esox lucius*	PIKE	28	1.6	58	11.9	86	3.9	14
walleye	*Stizostedion vitreum*	WALL	42	2.4	54	11.1	96	4.3	11
yellow perch	*Perca flavescens*	YWPH	3	0.2	0	0.0	3	0.1	0
longnose sucker	*Catostomus catostomus*	LNSK	78	4.5	73	15.0	151	6.8	40
white sucker	*Catostomus commersoni*	WTSK	28	1.6	24	4.9	52	2.4	11
burbot	*Lota lota*	BURB	6	0.4	9	1.9	15	0.7	0
lake chub	*Couesius plumbeus*	LKCB	5	0.3	0	0.0	5	0.2	0
flathead chub	*Platygobio gracilis*	FHCB	51	3.0	10	2.1	61	2.8	0
trout-perch	*Percopsis omiscomaycus*	TRPH	49	2.7	0	0.0	49	2.2	0
rainbow trout	*Salmo gairdneri*	RBTR	1	0.1	0	0.0	1	0.0	0
Total			1727		486		2213		

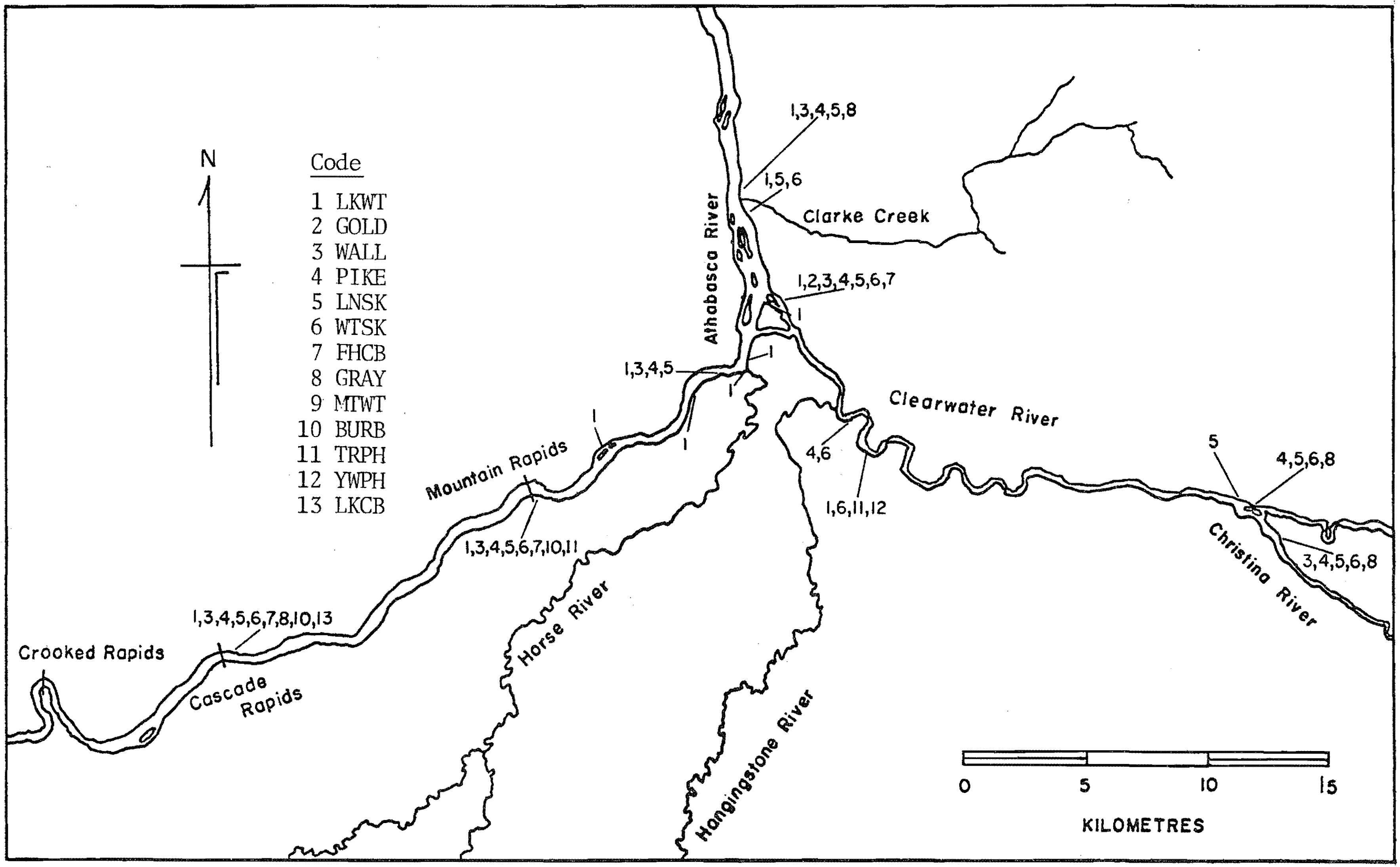

Figure 3. Sample sites and species captured by seine within the project study area.

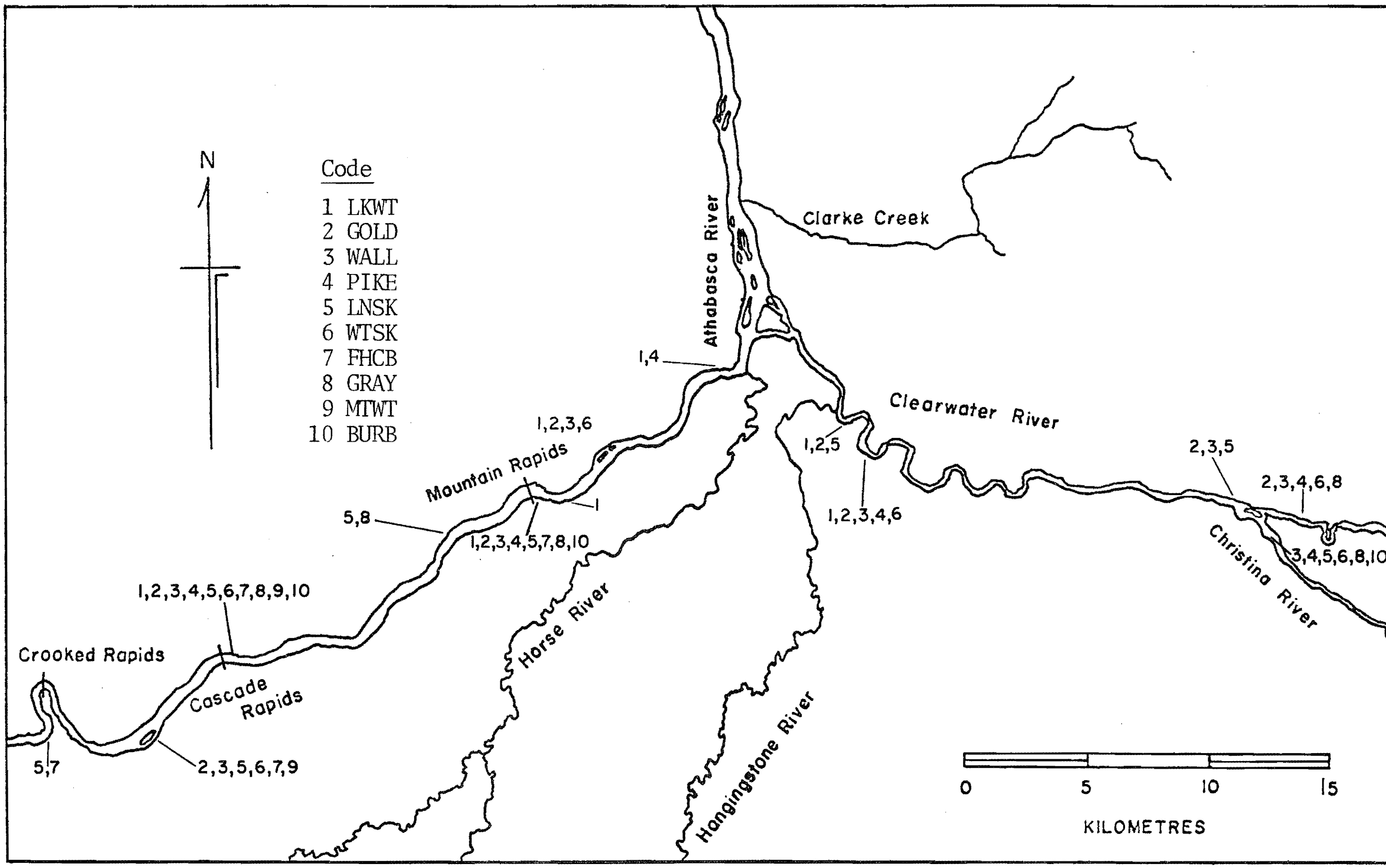

Figure 4. Sample sites and species captured by gillnet within the project study area.

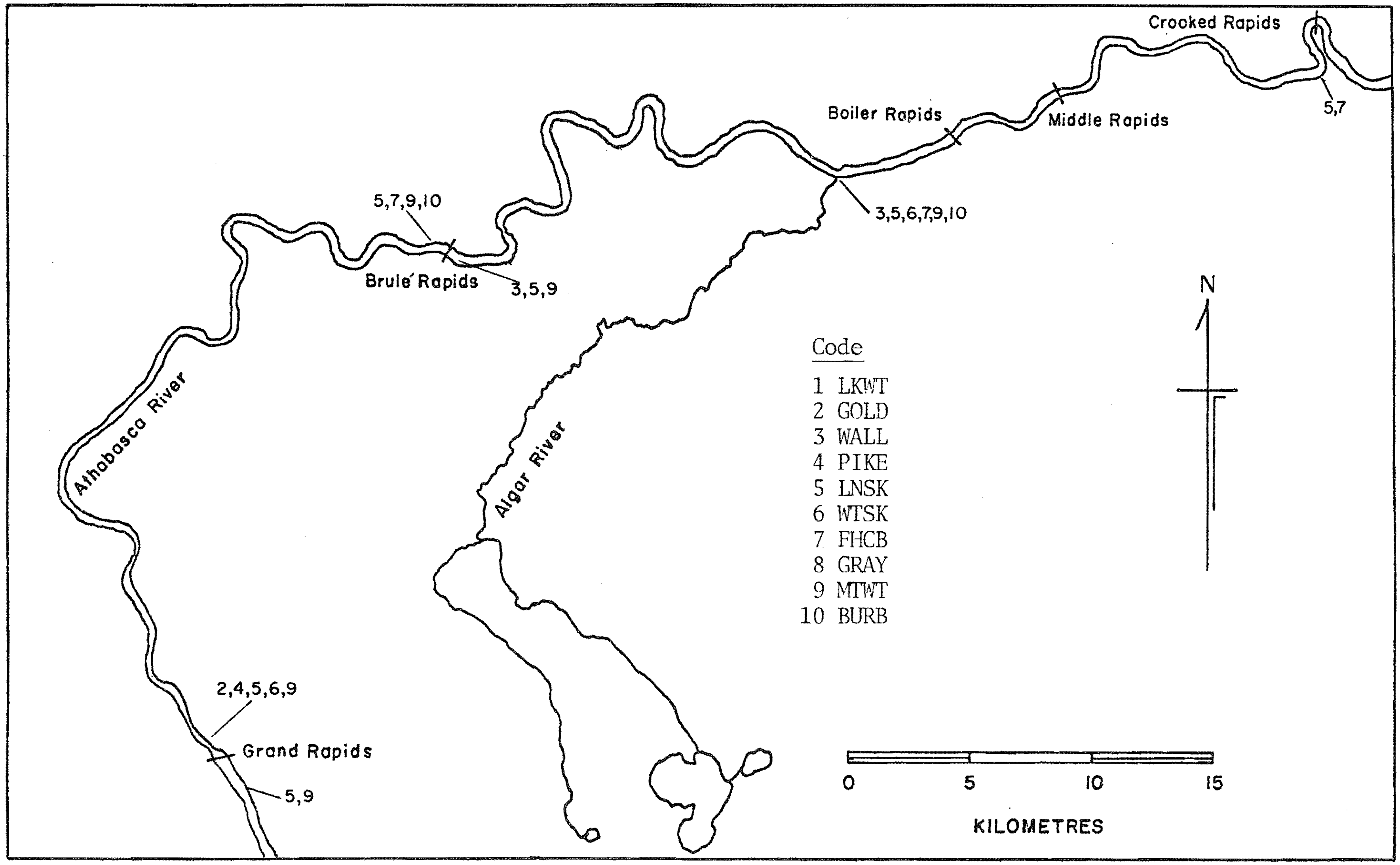

Figure 5. Sample sites and species captured by gillnet within the project study area.

A total of 1,592 hours of gillnetting effort and 128 seine hauls was spent during the course of the study. Tables 2 and 3 summarize gillnet and seine effort and show overall catch per unit effort for the Athabasca, Clearwater, and Christina rivers. Catch per unit effort was considerably higher in the Athabasca River, particularly the section of the river between Fort McMurray and the Cascade Rapids, because of the concentrations of lake whitefish which dominated the catch.

In the section of the Athabasca River above Cascade Rapids, where lake whitefish did not occur, catch per unit effort was similar to that in the Clearwater and Christina rivers. Catch per unit effort will be further discussed by species and by stream in the life history sections of this report.

4.2 LIFE HISTORY STUDIES

4.2.1 Lake Whitefish

4.2.1.1 Distribution and movements. Lake whitefish are widely distributed throughout temperate and northern Canada and Alaska (Scott and Crossman 1973). In Alberta they occur in many lakes and are also known from most of the major river drainages (Paetz and Nelson 1970). In many lakes in Alberta, lake whitefish are fished commercially. At Lake Wabamun west of Edmonton, for example, up to 272,200 kg (600,000 lbs) of lake whitefish have been taken in one year (Paetz and Nelson 1970). Other lake whitefish populations, including the Lake Athabasca and River population, support substantial domestic fisheries.

While considerable information is available describing the life histories of lake-spawning populations of lake whitefish (Scott and Crossman 1973, McPhail and Lindsey 1970), only limited information is available for river-spawning populations such as that which utilizes the Athabasca River.

Lake whitefish are common in the Athabasca River throughout the open water season (McCart et al. 1977). They also

Table 2. Gillnet effort summary.

Location	Total Hours	Total Fish	Fish/Hour	Fish/24 Hr
ATHABASCA RIVER (above Cascade Rapids)	550.5	88	0.16	3.8
ATHABASCA RIVER (Fort McMurray-Cascades)	451.5	317	0.7	16.8
CLEARWATER RIVER	403	65	0.16	3.8
CHRISTINA RIVER	187	27	0.14	3.4
TOTALS	1592	497	0.3	7.2

Table 3. Seine effort summary.

Location	Total Hauls	Total Fish	Average Fish/Haul
Athabasca River	74	1437	19.4
Clearwater River	44	239	5.4
Christina River	10	51	5.1
Totals	128	1727	13.5

enter some of the major tributaries in small numbers on feeding excursions. They have also been taken downstream of Fort McMurray in the lower reaches of the Muskeg (Bond and Machniak 1977), the Steepbank (W.A. Bond, Fisheries and Marine Service, Winnipeg, personal communication), and Muskeg rivers (McCart et al. 1978). During the course of this study, they were found in the Clearwater River for a distance of approximately 8 km above Fort McMurray. In the Athabasca River, they were taken as far upstream as Cascade Rapids (32 km). In over 500 hours of gillnetting, none was captured above Cascade Rapids.

In addition to the movements in summer feeding forays, there is a major spawning run of lake whitefish into the Athabasca River in the fall. During the fall of 1977, the spawning migration of lake whitefish was closely monitored in the Athabasca Delta and in the mainstem of the river downstream of Fort McMurray (Bond and Berry, in prep.) and approximately 1,500 lake whitefish were tagged downstream of Fort McMurray. During the course of our study, an additional 1,275 fish were tagged upstream of Fort McMurray.

The migration of lake whitefish through the Peace-Athabasca Delta, approximately 325 km downstream of Fort McMurray, peaked in the middle of September. By early October the main part of the run had passed by Mildred Lake, approximately 50 km downstream of Fort McMurray (W.A. Bond, personal communication).

Large numbers of lake whitefish arrived in the project study area during the first two weeks of October. Tables 4 and 5 show the sizeable increases in catch per unit effort that occurred when the mature lake whitefish arrived. Seasonal variation in catch per unit effort is shown graphically in Figure 6. The lake whitefish concentrated in large numbers below Mountain Rapids, approximately 25 km upstream of Fort McMurray. Other smaller concentrations occurred below Cascade Rapids (32 km upstream of Fort McMurray), the limit of upstream movement, and at the mouth

Table 4. Seine catch per unit effort. Summary of catches at all stations in designated streams.

Period	CPUE (Fish/Haul)							
	LKWT	WALL	PIKE	LNSK	WTSK	FHCB	MTWT	GRAY
ATHABASCA RIVER								
Sept. 15 - Oct. 4	2.1	1.4	0.33	0.8	0.06	1.7	0.0	0.0
Oct. 5 - Oct. 15	59.0	0.3	0.3	0.3	0.0	0.0	0.0	0.0
Oct. 16 - Oct. 25	9.9	0.15	0.26	1.2	0.2	0.0	0.0	0.07
Oct. 26 - Nov. 3	0.3	0.14	0.03	0.14	0.14	0.14	0.0	0.4
CLEARWATER RIVER								
Sept. 15 - Oct. 4	2.3	0.2	0.06	0.0	0.3	0.06	0.0	0.0
Oct. 5 - Oct. 15	10.7	0.6	0.2	0.2	0.25	0.0	0.0	0.0
Oct. 16 - Oct. 25	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
Oct. 26 - Nov. 3	0.0	0.0	1.0	1.0	1.7	0.0	0.0	0.14
CHRISTINA RIVER								
Sept. 15 - Oct. 4	0.0	0.33	0.0	0.33	1.66	0.0	0.0	0.0
Oct. 5 - Oct. 15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oct. 16 - Oct. 25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oct. 26 - Nov. 3	0.0	0.0	0.3	5.1	0.7	0.0	0.0	0.14

Table 5. Gillnet catch per unit effort. Summary of catches at all stations in designated streams.

Period	CPUE (Catch per Gillnet Hour)									
	LKWT	GOLD	WALL	PIKE	LNSK	WTSK	FHCB	MTWT	GRAY	BURB
ATHABASCA RIVER										
Sept. 7 - Oct. 4	0.05	0.36	0.09	0.04	0.05	0.02	0.015	0.006	0.0	0.003
Oct. 5 - Oct. 18	0.09	0.004	0.015	0.02	0.09	0.0	0.008	0.02	0.0	0.008
Oct. 19 - Oct. 25	0.10	0.0	0.0	0.23	0.0	0.0	0.0	0.05	0.06	0.01
Oct. 26 - Nov. 3	0.003	0.0	0.006	0.05	0.07	0.006	0.006	0.15	0.03	0.012
CLEARWATER RIVER										
Sept. 7 - Oct. 4	0.06	0.12	0.03	0.02	0.009	0.05	0.0	0.0	0.0	0.0
Oct. 5 - Oct. 18	0.0	0.0	0.0	0.0	0.0	0.03	0.0	0.0	0.014	0.0
Oct. 19 - Oct. 25	0.0	0.0	0.0	0.0	0.0	0.02	0.0	0.0	0.0	0.0
Oct. 26 - Nov. 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CHRISTINA RIVER										
Sept. 13 - Oct. 4	0.0	0.0	0.06	0.04	0.05	0.06	0.0	0.0	0.0	0.01
Oct. 5 - Oct. 18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.04	0.0
Oct. 19 - Oct. 25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.05	0.0
Oct. 26 - Nov. 3	0.0	0.0	0.0	0.0	0.02	0.0	0.0	0.0	0.0	0.0

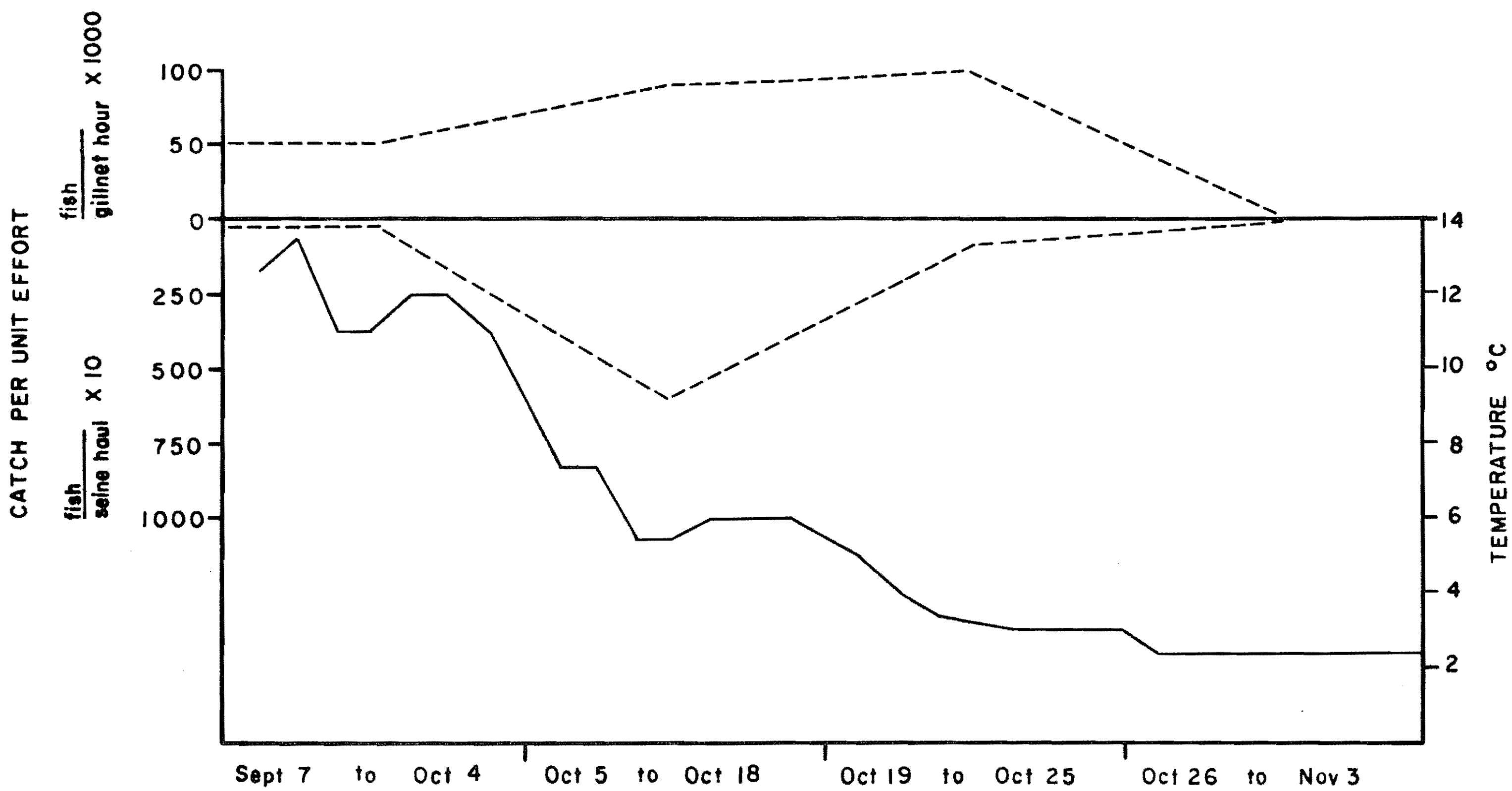

Figure 6. Temperature profile and seasonal seine and gillnet catch per unit effort for lake whitefish from the Athabasca River, 1977.

of the Clearwater River.

By 5 October, nearly all male fish captured were ripe (milt could be easily expressed from the gonads with slight pressure). The gonads of females captured at the same time were still hard and green (Table 6).

The first ripe females were captured below Cascade Rapids and Mountain Rapids on 13 October. The majority of females captured on 13 October were still green (Table 6). Nearly all fish, males and females, were ripe by 18 October and some fish captured showed evidence of being partially spawned-out. The concentration of lake whitefish disappeared from the vicinity of the mouth of the Clearwater. These fish, which were predominantly large green females, had apparently used the relatively slack water at the mouth of the Clearwater as a resting area before continuing their migration up the Athabasca River. No lake whitefish were captured beyond a point approximately 8 km upstream from the mouth of the Clearwater River and no lake whitefish in spawning condition were ever captured in the Clearwater River.

By 20 October, the numbers of lake whitefish on the spawning grounds were greatly reduced and most fish captured were spawned-out (Table 6). After 26 October no lake whitefish were captured within the study area. Small numbers of lake whitefish were still present downstream of the study area, however, near the mouth of Clarke Creek.

The spawning period for lake whitefish in the study area was between 13 October and 25 October. Water temperatures at the beginning of the spawning period were approximately 6^{o}C, decreasing to about 3^{o}C by the time the spawning was completed.

On 27 and 28 October, an attempt was made to locate lake whitefish eggs in areas where ripe fish had been captured. Figure 7 is a map indicating sample sites and the average number of eggs per site where developing eggs were found. Highest densities of eggs occurred immediately downstream of Mountain Rapids where as many as 75 eggs per square metre were collected.

Table 6. Spawning condition of lake whitefish from the Athabasca River, 1977.

Date	Males[a]				Females[a]			
	N	G	R	S.O.	N	G	R	S.O.
Sept. 22	1	1	0	0	2	2	0	0
Sept. 27	4	4	0	0	2	2	0	0
Oct. 1	1	0	1	0				
Oct. 5	12	2	10	0	7	7	0	0
Oct. 6	45	0	45	0	37	37	0	0
Oct. 7	134	0	134	0	161	161	0	0
Oct. 8	24	0	24	0	102	102	0	0
Oct. 13	70	0	70	0	188	137	51	0
Oct. 18	80	0	80	0	20	3	17	0
Oct. 19	114	0	114	0	16	1	15	0
Oct. 20					3	0	0	3
Oct. 23					3	0	0	3
Oct. 24	12	0	7	5	6	0	1	5
Oct. 25	32	0	20	12	7	0	0	7

[a]Symbols: N=number, G=green, R=ripe, S.O.=spawned out.

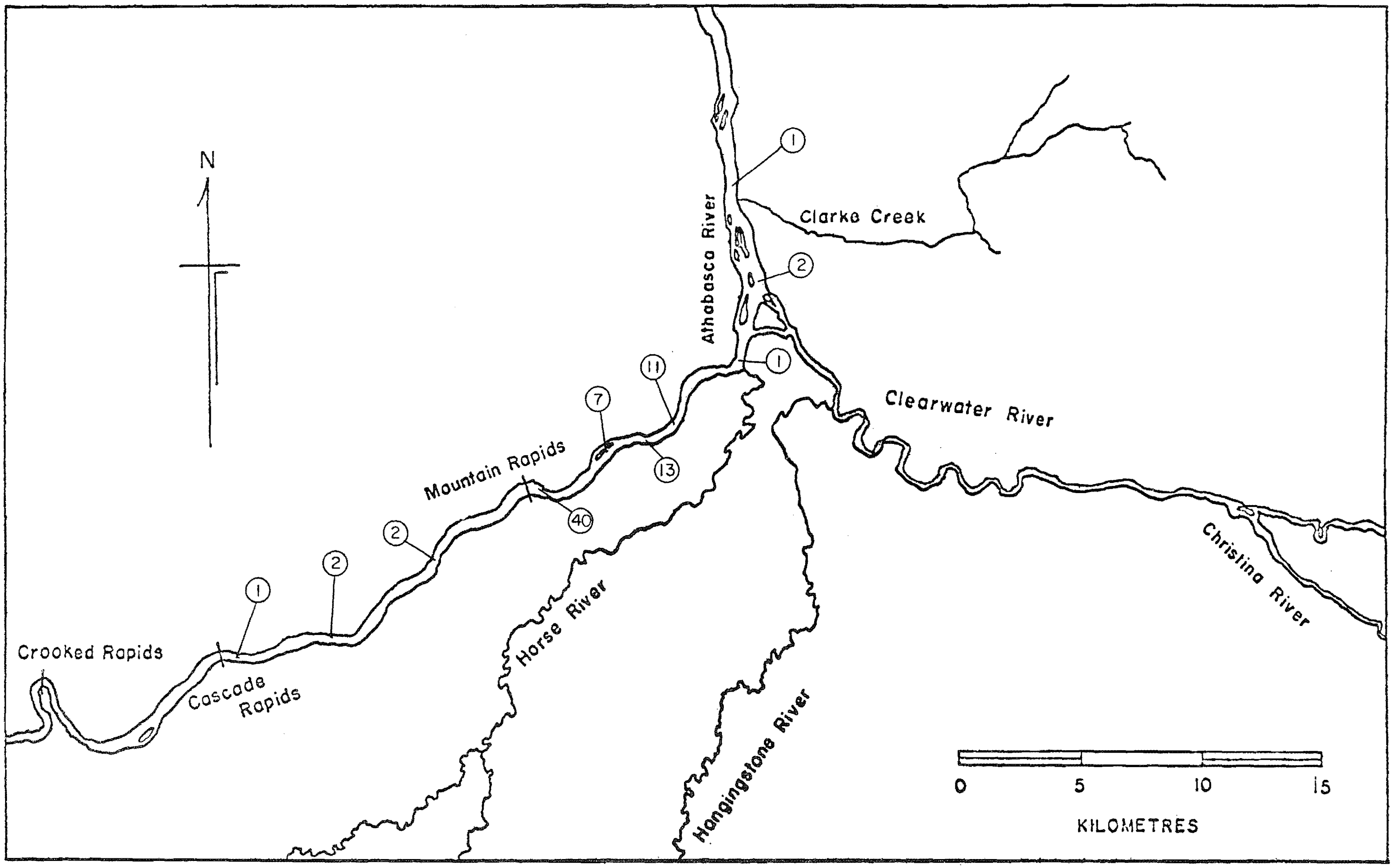

Figure 7. Egg survey sites on the Athabasca River where developing lake whitefish eggs were found. Circled number indicates the average number of eggs per sample for each site. October 27 and 28, 1977.

Egg sampling was limited to shallow water areas, primarily riffles that were 1 m or less in depth. It is not known whether spawning occurred in deep water as well as shallow water or to what extent eggs were scattered by the current. Substrates where eggs were found ranged from rock and boulder to mixed gravel and sand. Highest densities of eggs occurred in boulder and broken rock substrates. No eggs were found in pure sand or mud substrates.

Tag returns indicate that lake whitefish moved out of the spawning area and down the Athabasca River towards the Delta and Lake Athabasca very soon after spawning. Five lake whitefish tagged in the study area were recaptured a week later by native fishermen near the mouth of the Embarras River. The Embarras River is approximately 300 km downstream of the project study area. Another four lake whitefish were recaptured near the mouth of the Embarras River between November 1977, and January 1978.

Two other lake whitefish tagged in the project study area were recaptured in December 1977. One was recaptured near Quatre Fourches and the other near Popular Point on the east side of Lake Mamawi in the Peace-Athabasca Delta. To reach this part of the Peace-Athabasca Delta, these fish had to go completely down the Athabasca River, into Lake Athabasca, then into the Chenel des Quatre Fourches, a distance of approximately 375 km. Based upon these tag returns, it seems most likely that the lake whitefish which spawn in the Athabasca River are part of the Lake Athabasca populations.

4.2.1.2 Length-frequency. Figure 8 shows the size distribution for all lake whitefish measured during the study. Only one juvenile was captured out of 1,366 fish. Table 7 shows that out of 1,033 sexed fish, females were larger, averaging 407 mm (range 332-492) in length while males averaged 388 mm (range 328-495) in length. McCart et al. (1977) reported a similar size distribution.

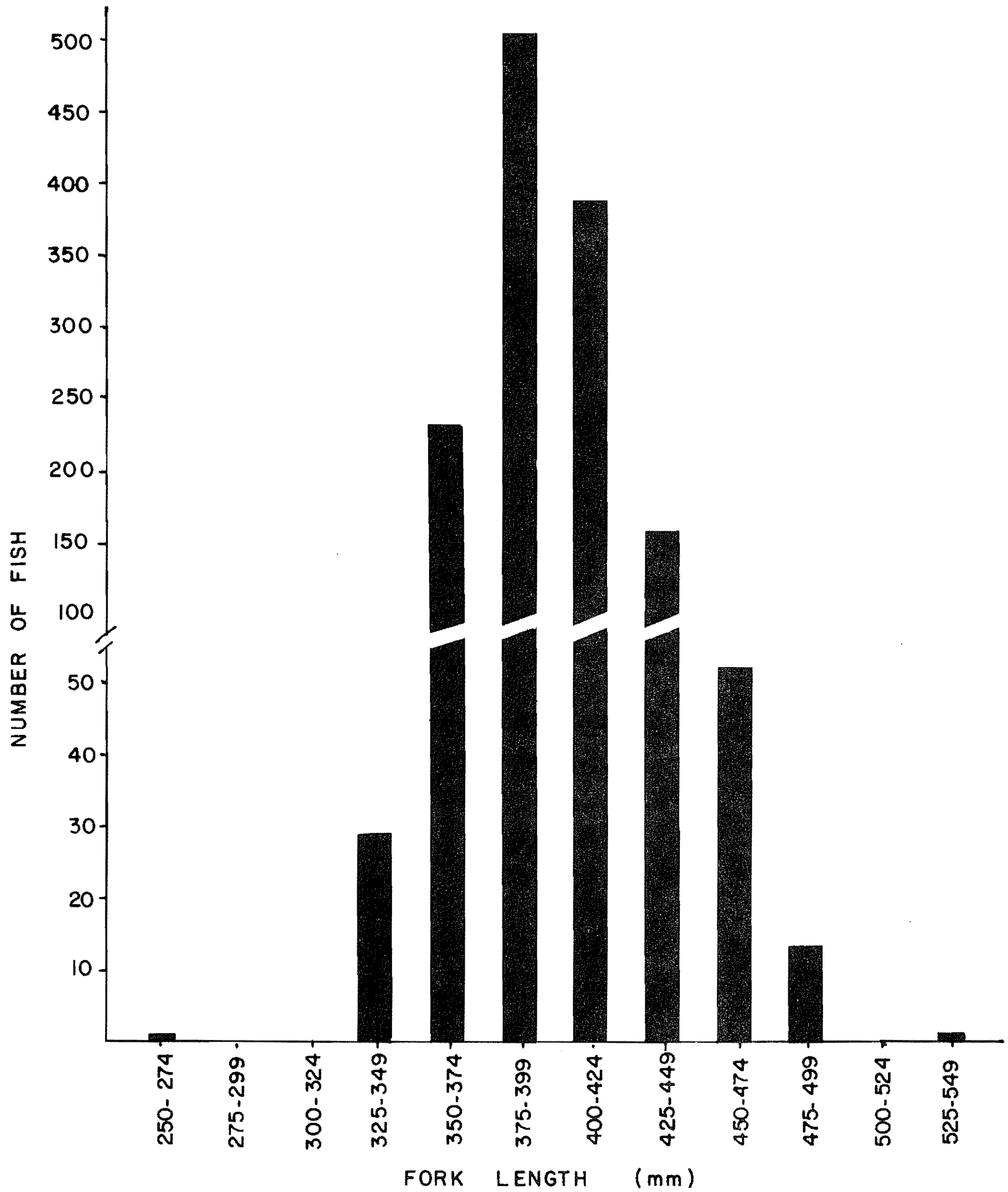

Figure 8. Length frequency for lake whitefish from Athabasca and Clearwater rivers upstream of Fort McMurray.

Table 7. Comparison of lengths of male and female lake whitefish from the Athabasca and Clearwater rivers, 1977.

	No. of Fish	Average Length (mm)	Range	S.D.
Males	539	388	328-495	24.5
Females	494	407	332-492	24.9
All[a]	1366	398	328-538	27.2

[a]Includes males, females, and 333 unsexed fish.

4.2.1.3 Age and growth. Age-length data for the 91 dissected lake whitefish are presented in Table 8 and the growth rate is compared to those of other populations in Figure 9. Ages ranged from 4 to 13 years with most fish aged between 6 and 8 years. Ages were obtained from otoliths. No information is available from the Athabasca River for fish younger than 4 years. In particular, nothing is known about young-of-the-year lake whitefish that hatch out in the Athabasca River.

4.2.1.4 Reproductive development. Except for one juvenile aged 4 years, all of the 91 lake whitefish that were dissected were mature and six or more years old (Table 8). McCart et al. (1977) reported more juvenile fish from their study area further downstream.

Fecundities were calculated for 17 green fish (Table 9 and Figure 10). The estimated fecundities of individual fish ranged from 7,965 to 48,246, averaging 23,882. Ages of the fish sampled ranged from 6 to 12 years. Eggs averaged 2.1 mm in size and total gonad weight averaged 188.2 g. Fecundity was significantly correlated with fish size ($r=0.78$, $P<0.01$):

$$\log_{10} \text{Fecundity} = 3.38 \log_{10} \text{Length (mm)} - 4.48$$

4.2.1.5 Sex ratio. Among the 1,033 lake whitefish that were sexed, males were slightly more numerous (52%, N=539) than females. The difference is not significant ($X^2=0.98$, $P>0.05$, $N=1{,}033$). In the dissected sample (N=91), 64.8% were males (Table 8). McCart et al. (1977) reported 54% females out of a total sample of 61 fish from the Athabasca River in the vicinity of the Syncrude development. It is likely that a nearly equal ratio of males to females exists in the Athabasca River lake whitefish population.

4.2.1.6 Food habits. Table 10 shows the percent occurrence of food items in 63 lake whitefish stomachs that contained food. Prior to the onset of spawning, stomachs contained mostly adult corixids. After sampling began, nearly every stomach was gorged with whitefish eggs. McCart et al. (1977) report a more varied

Table 8. Age-length relationship, sex ratio, and percent mature for lake whitefish from the Athabasca and Clearwater rivers, 1977.

Age	No.	% Male	% Mature Male	% Mature Female	Length (mm) x̄	Length (mm) Range	Length (mm) S.D.	Length (mm) S.E.
4	1	ND	ND	ND	183			
6	22	77.3	100.0	100.0	363.8	333-398	18.25	3.89
7	30	60.0	100.0	100.0	381.9	334-428	19.93	3.64
8	13	53.85	100.0	100.0	401.7	374-419	12.95	3.59
9	6	66.7	100.0	100.0	422.2	402-449	15.82	6.46
10	6	50.0	100.0	100.0	411.8	386-428	16.09	6.57
11	6	50.0	100.0	100.0	448.5	414-470	18.84	7.69
12	5	80.0	100.0	100.0	437.6	391-479	32.40	14.49
13	2	100.0	100.0		462.5	442-483	28.99	20.50
Totals	91	64.84	100.0	100.0		183-483		

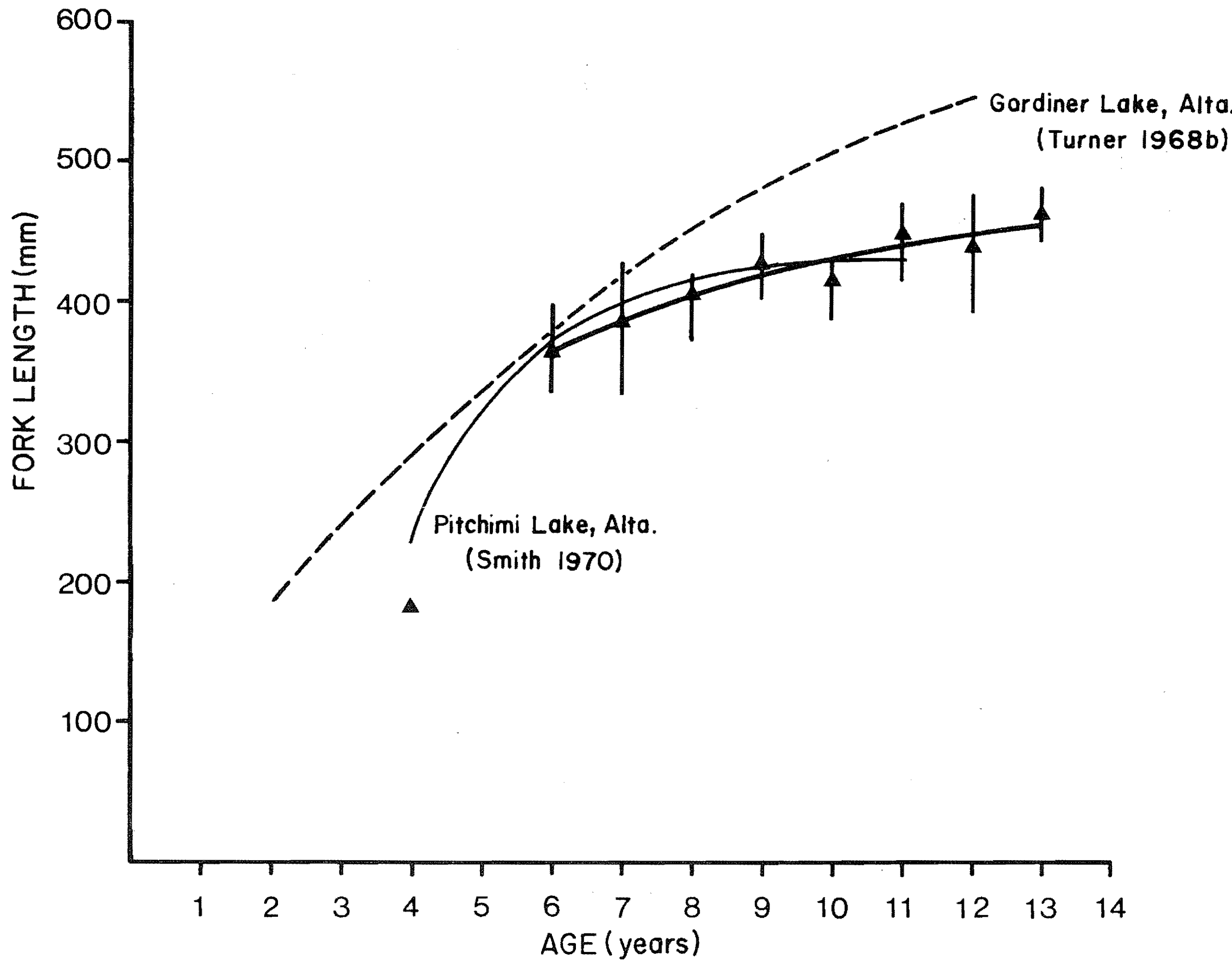

Figure 9. Comparison of growth rates of lake whitefish captured in the project study area with two other areas in Alberta. Triangles indicate mean fork lengths and vertical lines indicate ranges for each age class.

Table 9. Fecundities of lake whitefish from the Athabasca River.

	Length (mm)	Weight (g)	Age	Egg Size (mm)	Gonad Weight (g)	No. Eggs
	336	983.8	6	2.1	132.8	15,196
	352	654.2	6	2.2	74.7	7,966
	378	794.0	7	2.0	77.5	13,692
	380	864.7	6	2.0	163.8	20,876
	385	998.5	7	1.95	141.1	22,511
	390	876.0	7	1.75	95.8	20,424
	391	869.5	7	1.6	97.5	24,014
	399	904.2	7	2.2	166.1	18,785
	406	964.9	8	2.3	169.0	19,936
	408	1056.1	8	2.1	143.4	16,578
	415	1042.6	8	2.1	191.0	22,733
	420	1220.3	10	ND	201.0	23,905
	448	1444.2	11	2.4	307.7	34,945
	453	1624.5	ND	2.15	253.9	25,570
	458	1801.7	11	2.3	403.5	48,247
	470	1615.9	11	2.2	359.7	47,467
	479	1678.0	12	2.3	221.2	23,150
$\bar{x}$	409.88	1140.71	8.2	2.1031	188.22	23,882
SE	9.8469	85.9232		0.0523	23.1897	2,491.9
SD	40.6	354.27		0.2093	95.6137	10,686.9
Range	336-479	654.2-1801.7	6-12	1.6-2.4	74.7-403.5	7,965-48,241

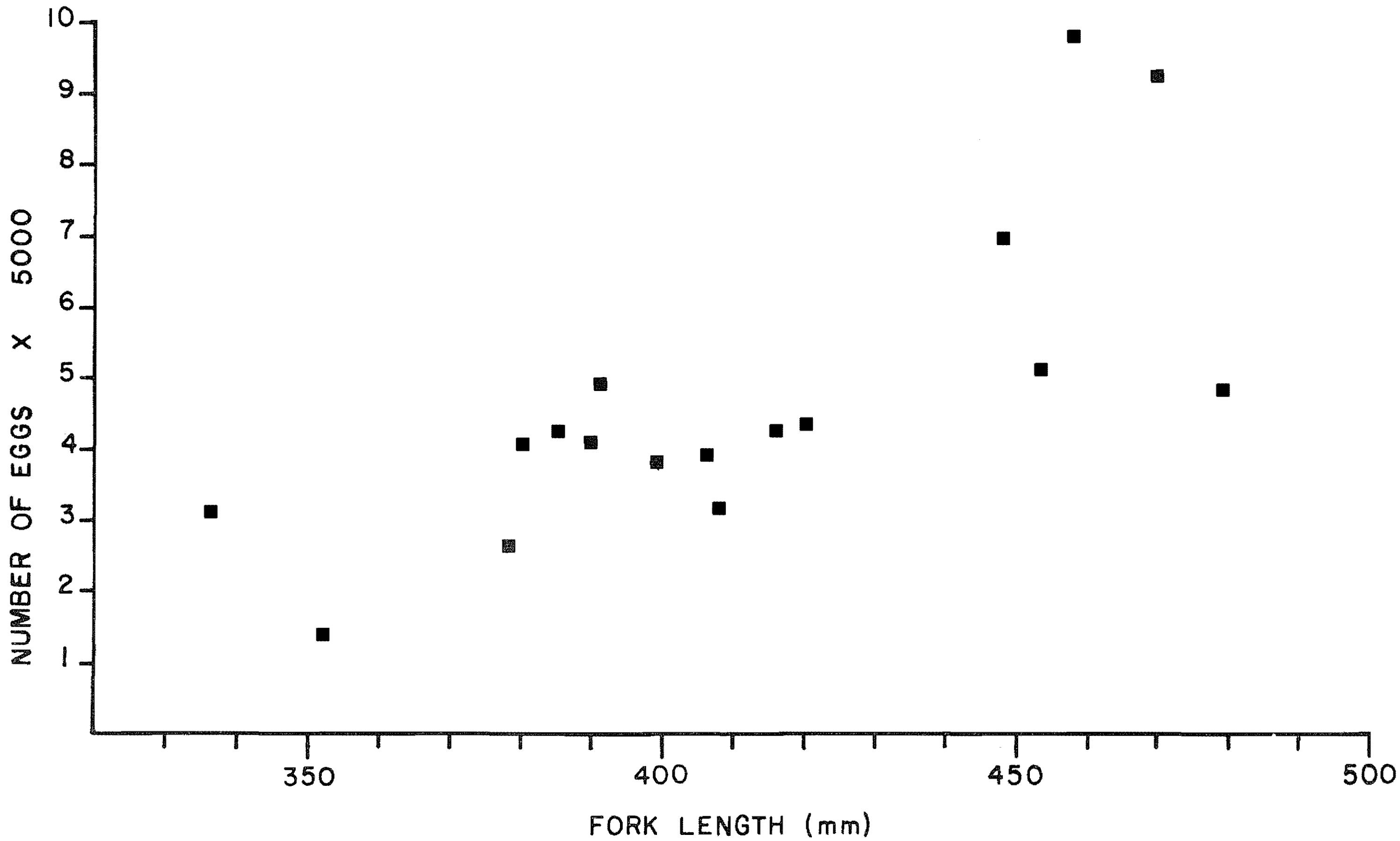

Figure 10. Length-fecundity relationship for lake whitefish from the Athabasca River, 1977.

Table 10. Stomach contents of lake whitefish captured in the Athabasca and Clearwater rivers, September through October 1977. Per cent occurrence values are based only on stomachs which contained food.

Food Item		Percent Occurrence
Corixidae adults		44.4
whitefish eggs		65.1
unidentified digested material		6.4
gravel		3.2
Empty stomachs	37	37.0
Total No. stomachs examined	100	

diet for lake whitefish further downstream on the Athabasca River.

4.2.2 Goldeye

4.2.2.1 Distribution and movements. Goldeye are widely distributed throughout central North America from the Northwest Territories south to Alabama. They occur in lakes and rivers and appear to be adapted to water of high turbidity (Paetz and Nelson 1970). There are goldeye populations in most of the major river systems of Alberta (Paetz and Nelson 1970) as well as in Lake Athabasca and the Peace-Athabasca Delta.

Goldeye were found throughout the project study area in the Athabasca River when the study commenced in early September (Figures 3 to 5). Numbers were highest downstream of Cascade Rapids but small numbers of goldeye were found as far upstream as Grand Rapids. They were also found in the Clearwater River to a point approximately 8 km upstream. Goldeye are known to undertake long feeding migrations from overwintering and spawning areas (Kennedy and Sprules 1967, Paterson 1966, McCart and Jones 1974).

Goldeye were the most abundant species (0.36 fish/hour) captured in gillnets during the period from 7 September to 4 October (Table 5). As soon as water temperatures began to drop, numbers of goldeye decreased rapidly. No goldeye were captured within the project study area after 18 October. It is most likely that the goldeye moved down river towards overwintering areas in Lake Athabasca or the Peace-Athabasca Delta. Some tagged goldeye from the Peace-Athabasca Delta have been recaptured in the Athabasca River suggesting that they are one and the same population (W.A. Bond, personal communication).

During the course of the study, 67 goldeye were tagged with dart tags. To date, there have been no returns.

4.2.2.2 Length frequency. Figure 11 shows the size distribution of goldeye taken in the Athabasca and Clearwater rivers upstream of Fort McMurray. McCart et al. (1977) report a very similar

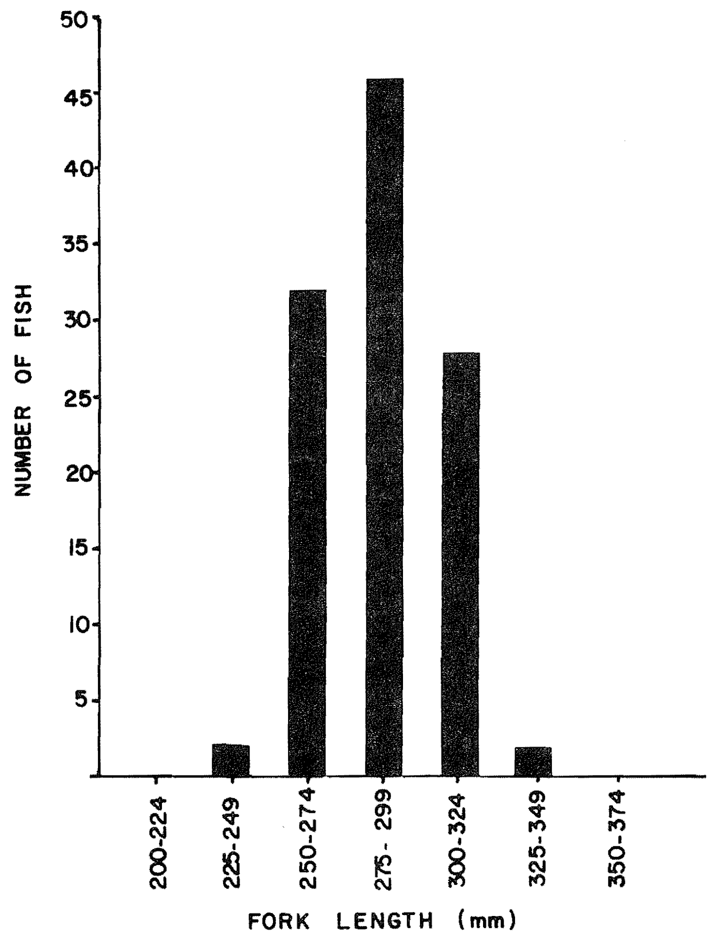

Figure 11. Length-frequency for goldeye from Athabasca and Clearwater rivers upstream of Fort McMurray.

size distribution.

4.2.2.3 Age and growth. As indicated in Table 11, 37 of the 40 goldeye dissected were aged 5 or 6 years. One fish was 4 years old, and two were 7.

4.2.2.4 Reproductive development. None of the 40 fish dissected appeared to be mature. McCart et al. (1977) reported 16 mature male goldeye and one mature female out of a sample of 122 fish. It appears likely that most of the goldeye found in the study area are large juveniles from the Peace-Athabasca Delta goldeye population.

4.2.2.5 Food habits. Percent occurrence of food items from 41 goldeye stomachs is shown in Table 12. They ate a variety of aquatic surface and terrestrial insects as well as animal and vegetable matter.

4.2.3 Northern Pike

4.2.3.1 Distribution and movements. The northern pike has a circumpolar distribution. In Canada it is absent only from the High Arctic, the Maritimes, Newfoundland, and most Pacific drainages in British Columbia. The species occurs in a wide range of lake and river habitats but is particularly well adapted to warm, clear, well vegetated waters (Scott and Crossman 1973).

Northern pike were captured throughout the study area in seines and gillnets (Figures 3 to 5). Pike constituted 3.9% of the total catch. In the Athabasca River, pike were captured throughout the sampling period in relatively constant numbers (Tables 4 and 5). In the Clearwater and Christina rivers, catches were more sporadic. There were no trends in catch per unit effort for pike in the study area which might suggest a pattern of movement. Fourteen pike were tagged but no returns have been received.

Table 11. Age-length relationship, sex ratio, and percent mature for goldeye from the Athabasca and Clearwater rivers, 1977.

Age	No.	% Male	% Mature Male	% Mature Female	Length (mm) $\bar{x}$	Length (mm) Range	Length (mm) S.D.	Length (mm) S.E.
4	1	100.00	0	0	287			
5	16	31.25	0	0	277.5	253-299	13.17	3.29
6	21	19.05	0	0	294.76	261-342	18.34	4.00
7	2	0.0	0	0	308.5	305-312	4.95	3.5
Totals	40	25.0	0	0		253-342		

Table 12. Stomach contents of goldeye captured in the Athabasca and Clearwater rivers, September through October 1977. Percent occurrence values are based only on stomachs which contained food.

Food Item		Percent Occurrence
Corixidae adults		95.1
Hymenoptera adults		2.4
Coleoptera adults (terrestrial)		2.4
Trichoptera larvae		2.4
Rodent remains		4.9
Vegetation		4.9
Unidentified digested material		4.9
Empty stomachs	0	0.0
Total No. of Stomachs Examined	41	

4.2.3.2 Length frequency. Size distribution for northern pike is shown in Figure 12. Out of a sample of 97 fish, only two fish smaller than 400 mm were captured. McCart et al. (1977) report a similar size distribution from their study area in the vicinity of Syncrude's Lease 17.

4.2.3.3 Age and growth. Scales were used to age the 80 pike which appear in Table 13. Ages ranged from 1 to 9 years with only one fish younger than 4 or older than 7. Age and growth of pike from the project study area is compared with the results of other studies in Figure 13.

4.2.3.4 Reproductive development. All of the male northern pike from the study area, age 4 and older, were mature spawners. A high percentage of the females (83-100%) age 4 and older were mature spawners (Table 13). The gonads of some females in each age class, however, classified as immature. This suggests that either males mature earlier than females or that some alternate year spawning occurs among females of this species. McCart et al. (1977) report that, in the Athabasca, males mature earlier than females.

4.2.3.5 Sex ratios. Female northern pike (58%) outnumbered males in this sample. The difference was not, however, significant (X^2=0.90, P<0.05).

4.2.3.6 Food habits. Of 84 pike stomachs examined, 64 (76.2%) were empty (Table 14). Of the ones that contained food, fish of various species constituted the bulk of food items present. The remains of rodents were the only other food item present, occurring in 5% of the stomachs that contained food.

4.2.4 Walleye

The walleye *(Stizostedion vitreum)* is widely distributed in Canadian fresh waters east of the continental divide. It is a highly valued sport and commercial species in Canada and it is

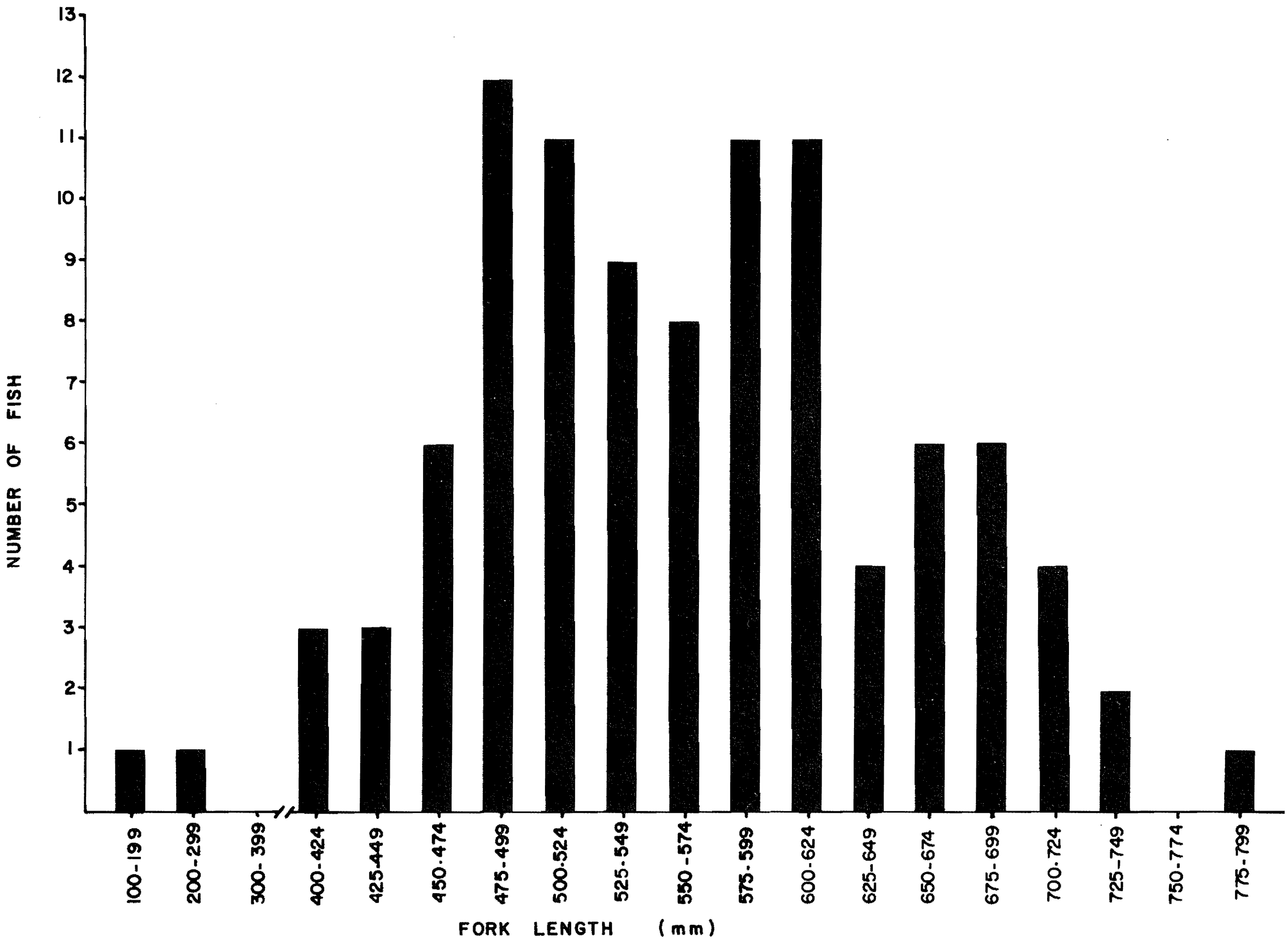

Figure 12. Length frequency for northern pike from Athabasca and Clearwater rivers upstream of Fort McMurray.

Table 13. Age-length relationship, sex ratio, and percent mature for northern pike from the Athabasca, Clearwater, and Christina rivers, 1977.

Age	No.	% Male	% Mature Male	% Mature Female	Length (mm) $\bar{x}$	Length (mm) Range	Length (mm) S.D.	Length (mm) S.E.
1	1	ND	ND	ND	250			
4	11	45.45	100.0	83.33	452.09	411-483	25.56	7.71
5	30	53.33	100.0	92.86	535.17	476-633	41.41	7.56
6	24	33.33	100.0	93.75	603.5	497-740	61.46	12.55
7	13	30.77	100.0	88.89	669.62	545-737	51.52	14.29
9	1	0.0		100.0	793			
Totals	80	42.5	97.06	91.3		250-740		

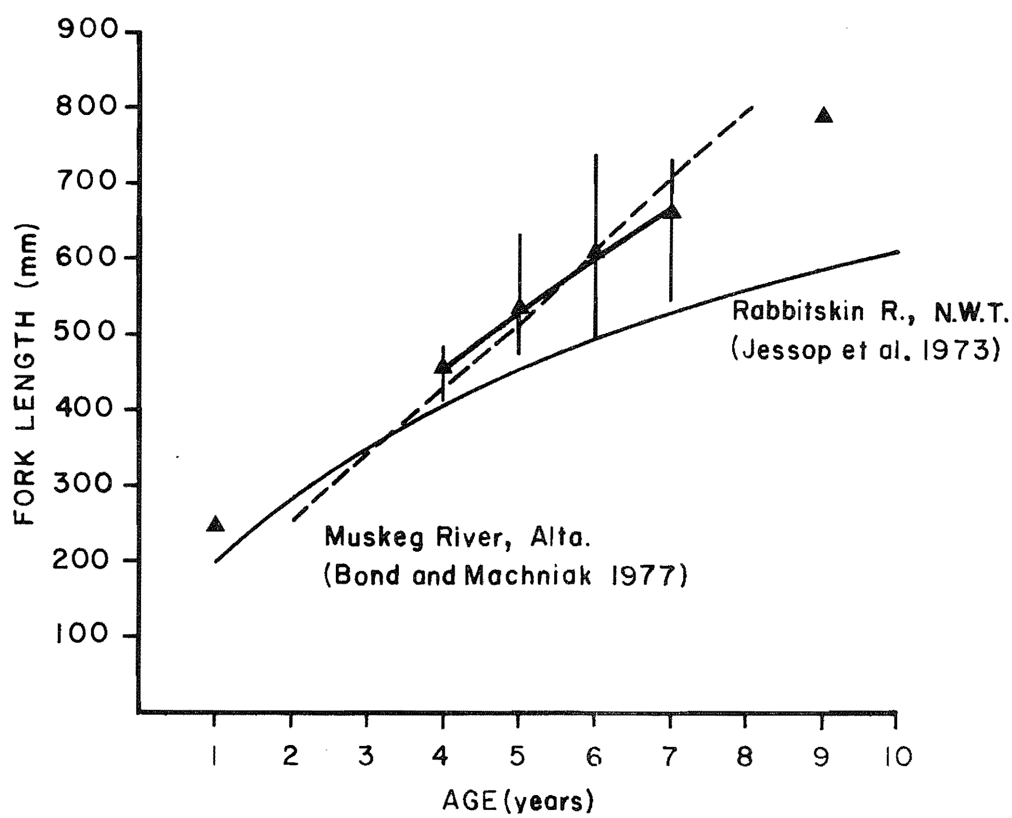

Figure 13. Comparison of growth rates for northern pike from the project study area and from two other locations. Triangles indicate mean fork lengths and vertical lines indicate ranges within each age class.

Table 14. Stomach contents of northern pike captured in the Athabasca, Clearwater, and Christina rivers, September through October 1977. Percent occurrence values are based only on stomachs which contained food.

Food Item		Percent Occurrence
northern pike		5.0
burbot		5.0
mountain whitefish		5.0
flathead chub		5.0
trout-perch		5.0
white sucker		5.0
sucker sp.		15.0
unidentified fish remains		50.0
rodent remains		5.0
Empty stomachs	64	76.2
Total No. of Stomachs Examined	84	

common and abundant in large turbid rivers and lakes in the prairie provinces. The walleye is a spring spawning species (April to June), preferring rocky rapids in rivers and coarse rubble lake shoals for this purpose.

The biology of the walleye has been extensively reviewed in Canada (Ryder 1968, Regier et al. 1969, Scott and Crossman 1973) and several aspects of life history of the species in the AOSERP study area have been recently studied (McCart et al. 1977, McCart et al. 1978).

4.2.4.1 Distribution and movements. From 7 September to 4 October, a total of 82 walleye was captured in the study area with gillnets and seines. Walleye were captured at most sampling sites in all three drainages examined (Figures 3 to 5). In the Athabasca River walleye were most abundant in gillnet and seine catches during the first study period (15 September to 4 October) and their numbers declined steadily throughout the remainder of the study (Tables 4 and 5). Fewer walleye were captured in the Clearwater River; however, there was a similar trend towards declining catches in the later periods. Walleye may have been moving out of the project study area to overwintering areas further downstream in the Athabasca River. A previous study on the Athabasca River immediately downstream of our study area (McCart et al. 1977) documented a late season (late August to mid September) increase in the abundance of walleye followed by a gradual decline through to late October.

Eleven mature walleye were dart-tagged and released during the study period; however, none has been recaptured to date.

4.2.4.2 Length frequency. The length-frequency distribution of 82 walleye captured in seines and gillnets in the project study area between 15 September and 3 November 1977 is presented in Figure 14. The smallest fish captured was 79 mm fork length and the largest was 690 mm. Seventy eight percent of the total sample were between 325 and 475 mm fork length. The emphasis on sampling with coarse mesh seines and gillnets may account for the lack of

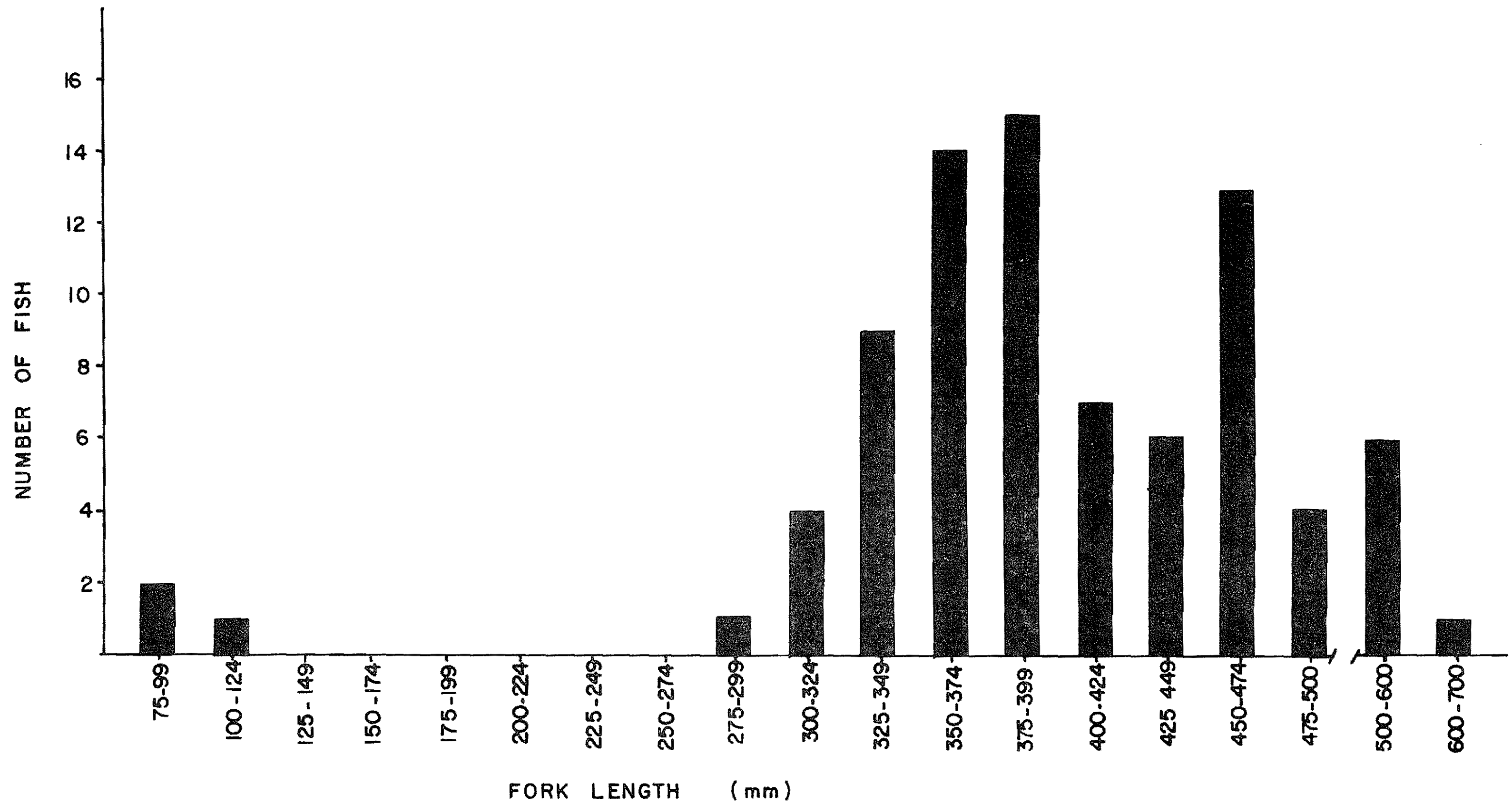

Figure 14. Length frequency for walleye from Athabasca and Clearwater rivers upstream of Fort McMurray.

small juvenile fish and young-of-the-year (<300 mm fork length) in the sample. McCart et al. (1977), however, utilized a wide variety of fish collection techniques in their studies on the Athabasca River, yet they report a similar length-frequency distribution in their sample of walleye.

4.2.4.3 Age and growth. Age-length data for a combined sample of 70 walleye from all three drainages are presented in Table 15. Otolith ages are used in all calculations for this species.

Walleye in the study sample ranged in age from 1 to 15 years; however, age classes 2, 3, and 14 were not represented. Previous studies of walleye in the AOSERP study area have reported maximum scale-based ages of 14 years in the MacKay River (McCart et al. 1978) and 11 years in the Athabasca River (McCart et al. 1977).

In Figure 15, the growth rate of walleye in the project study area is compared with that of two other populations in western Canada. Walleye in the project study area grow at a rate intermediate between the relatively fast growing populations in Kehiwin Lake, Alberta, and Lac La Ronge, Saskatchewan, and the slow growing MacKay River population.

4.2.4.4 Reproductive development and sex ratio. Data describing age at first maturity and the sex ratio of the sample are presented in Table 15. The youngest maturing males were age 5 and the youngest maturing female was age 9. Except for age class 5, however, in which two immature females were recorded, no females were taken in age classes 0 through 8. The overall sex ratio of the aged sample greatly favoured males (70%). The imbalance in the sex ratio is significant (X^2=7.75, P<0.01, N=66). Similar, imbalanced sex ratios have been reported among walleye elsewhere in the AOSERP study area (MacKay River: 92% male, McCart et al. 1978; Athabasca River: 80% male, McCart et al. 1977). Reasons for the imbalance in the representation of the sexes are not known. A possible explanation might be, however, that most females migrate downstream

Table 15. Age-length relationship, sex ratio, and percent mature for walleye from the Athabasca, Clearwater, and Christina rivers, 1977.

Age	No.	% Male	% Mature		Length (mm)			
			Male	Female	x̄	Range	S.D.	S.E.
1	3	ND	ND	ND	95.0	79-108	14.73	8.50
4	1	ND	ND	ND	292			
5	5	60.0	33.3	0.0	326	313-343	13.11	5.87
6	9	100.0	66.7		338.6	321-356	12.74	4.25
7	14	100.0	85.7		373.1	351-388	10.81	2.89
8	7	100.0	100.0		400.0	375-450	23.47	8.87
9	11	54.5	100.0	60.0	427.3	372-454	23.30	7.02
10	9	44.4	100.0	80.0	460.4	394-500	29.64	9.88
11	6	50.0	100.0	66.7	484.8	456-565	44.15	18.02
12	2	50.0	100.0	100.0	560.0	551-569	12.73	9.00
13	2	100.0	100.0		574.5	560-589	20.51	14.50
15	1	0.0		100.0	690			
Totals	70	70.0	85.7	64.7	399.84	79-690	98.74	11.80

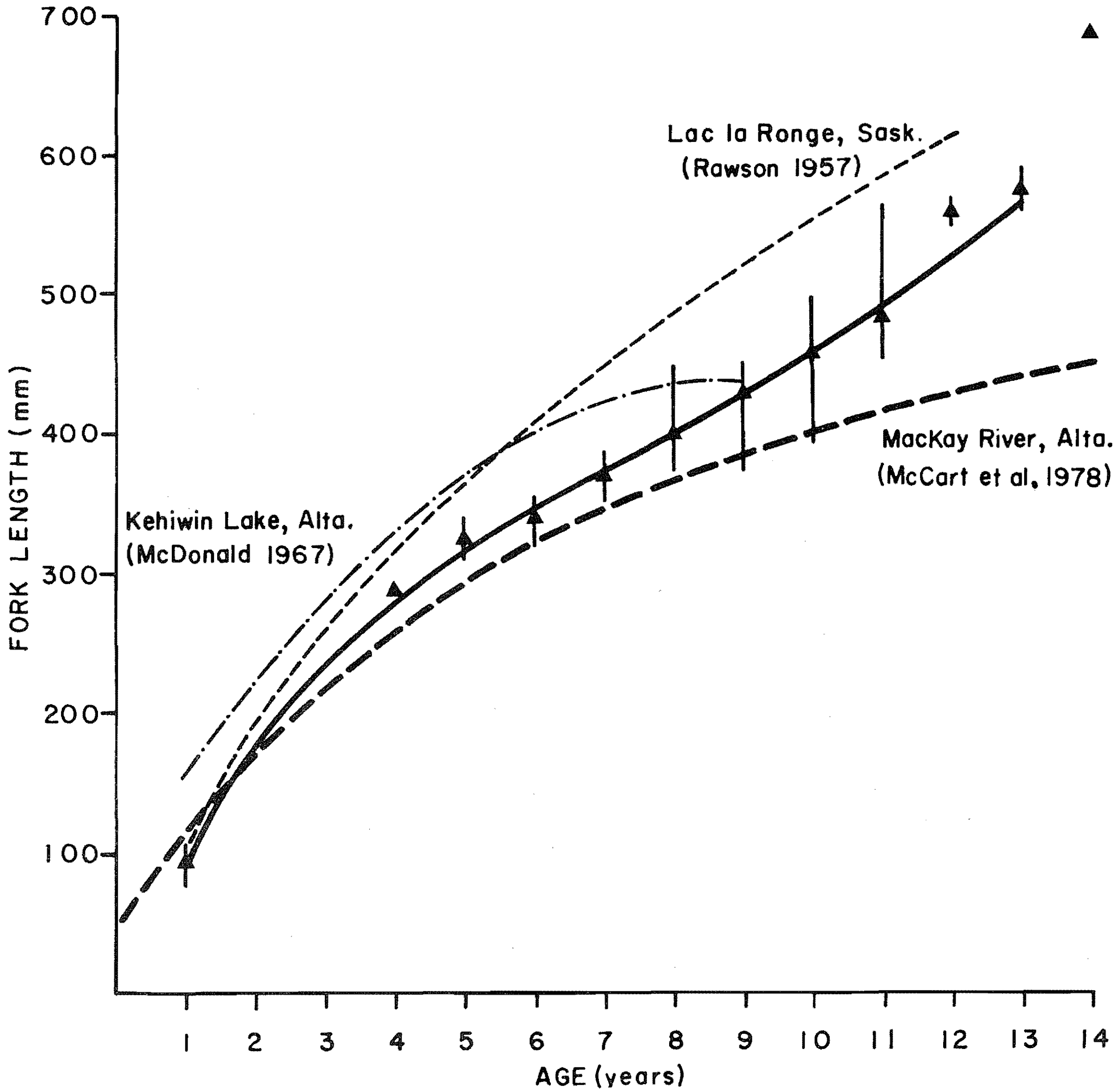

Figure 15. Comparison of growth rates of walleye collected in the project study area and from three other locations. Triangles indicate mean fork

to the lower reaches of the Athabasca River after completion of spawning in May and June while the males tend to remain behind.

4.2.4.5 Food habits. The majority (69.6%) of the 69 walleye stomachs examined were empty (Table 16). Fish and unidentifiable digested fish remains comprised a large proportion (about 53%) of the diet of those individuals which were feeding. Plecoptera nymphs and Corixidae occurred much less frequently (14.3 and 9.5%, respectively) than fish.

4.2.5 Longnose Sucker

The longnose sucker *(Catostomus catostomus)* is widely distributed and abundant in fresh water in north-temperate and Arctic North America. It is a spring spawning species (mid-April to mid-May in Canada) and it is found in both clear and turbid lakes and streams throughout Alberta. The biology of the longnose sucker in Canada has been reviewed by Harris (1962), Geen et al. (1966), and Scott and Crossman (1973). The life history of this species within the AOSERP study area has been described by Bond and Machniak (1977), McCart et al. (1977), and McCart et al. (1978).

4.2.5.1 Distribution and movements. From 7 September to 3 November, a total of 138 longnose suckers was captured in the project study area with gillnets and seines. Longnose suckers were taken in all three drainages sampled (Figures 3 to 5). The average catch per unit effort with gillnets (Table 5) was greater in the Athabasca River (0.5 fish/gillnet hr) than in either the Clearwater (0.003 fish/gillnet hr) or Christina rivers (0.01 fish/gillnet hr). Catch per unit effort with seines was greater in the Christina River (2.05 fish/haul) than in the Athabasca (0.61 fish/haul) or Clearwater rivers (0.35 fish/haul). The Christina River was, however, sampled by seine only at the beginning (early September) and end (late October) of the study period.

Tables 4 and 5 indicate the relative abundance of longnose suckers in gillnet and seine catches in the Athabasca and

Table 16. Stomach contents of walleye captured in the Athabasca, Clearwater, and Christina rivers, September through October 1977. Percent occurrence values are based only on stomachs which contained food.

Food Item		Percent Occurrence
Plecoptera nymphs		14.3
Corixidae adults		9.5
slimy sculpin		4.8
burbot		4.8
unidentifiable fish remains		42.9
unidentified digested material		33.3
Empty stomachs	48	69.6
Total No. Stomachs Examined	69	

Clearwater rivers. In the Athabasca River, longnose sucker were readily captured in both gillnets and seines at the outset of the study. Thereafter, one or the other method was successful in capturing this species. Overall, it appears that longnose suckers remained within the Athabasca River study area in approximately the same numbers throughout the sampling period. In the Clearwater River, longnose suckers were captured in gillnets only during the first sampling period. They first appeared in seine catches during the second period and greatly increased in numbers during the fourth sampling period, immediately prior to freeze-up. This increase in abundance was probably a result of fish moving downstream from the headwaters of the Clearwater River to overwintering areas. In the Christina River, longnose suckers were taken in small numbers in gillnets only during the first and fourth sampling periods. Seining was conducted in the Christina River only during the first and fourth sampling periods. Approximately 15 times as many longnose suckers were captured by this method during the fourth than during the first sampling period. This increase in abundance was probably also a result of downstream movement of suckers from headwater areas to overwintering areas in the lower reaches.

Forty longnose suckers were dart-tagged during the study period. To date, no tag returns have been reported for this species.

4.2.5.2 Length frequency. The length-frequency distribution of 138 longnose sucker captured in the project study area from early September to early November 1977, is presented in Figure 16. Approximately 91% of the total sample was between 275 and 450 mm fork length. The absence of smaller fish from the sample may be partially accounted for by sampling bias. The bulk of the sampling effort was expended in obtaining large numbers of larger fish, particularly whitefish, using coarse mesh beach seines. No young-of-the-year or one year old longnose sucker were captured during the study. Other investigations in the region (Bond and Machniak 1977, McCart et al. 1978) suggest that the smaller tributary streams are more important as juvenile rearing areas than are the large rivers.

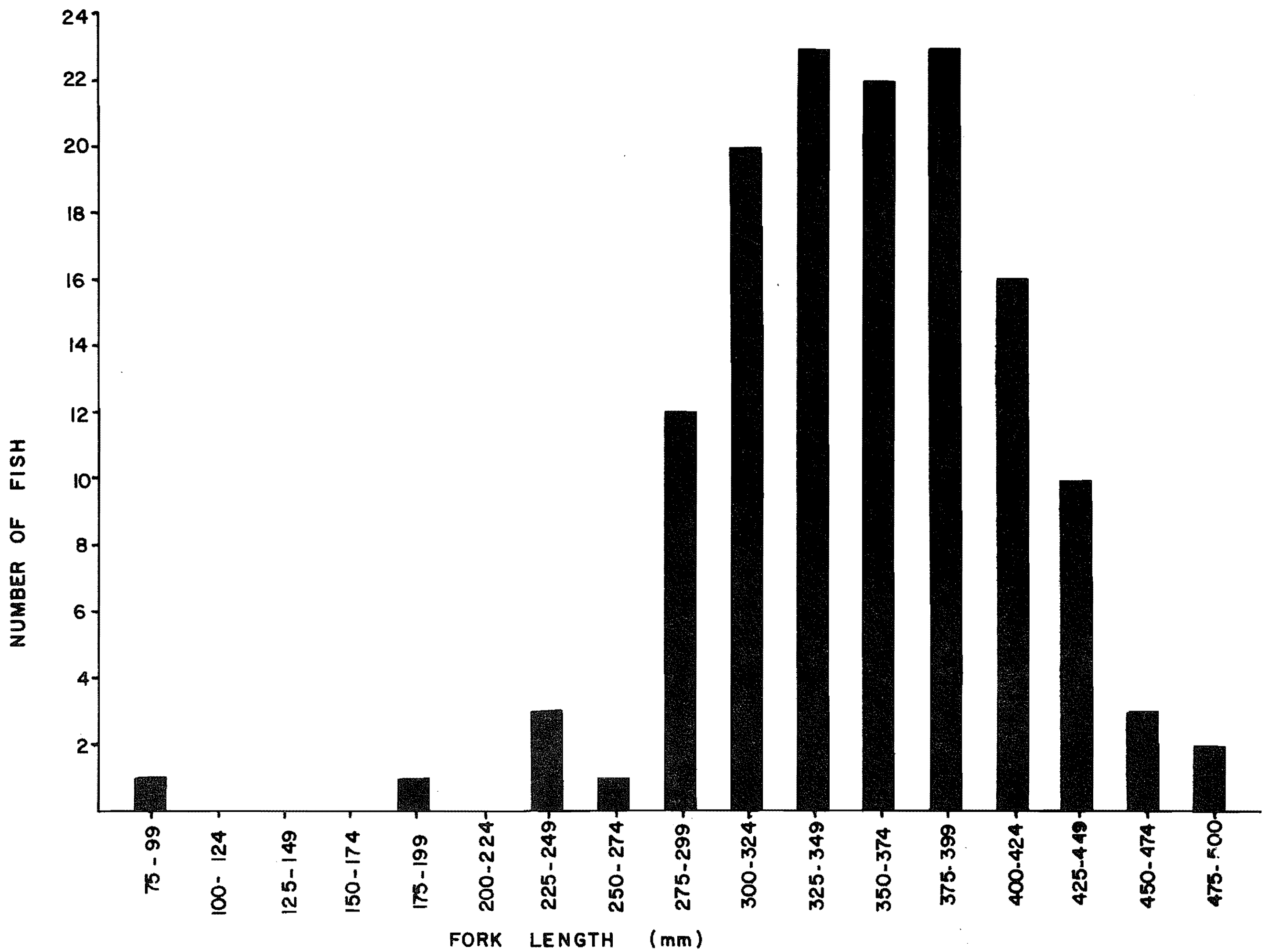

Figure 16. Length frequency for longnose suckers from Athabasca and Clearwater rivers upstream of Fort McMurray.

4.2.5.3 Age and growth. Age-length data for 94 longnose sucker are presented in Table 17 and Figure 17. Otolith ages were used in all calculations for this species. Samples from all three drainages examined were combined for age and growth analysis.

Longnose sucker grow at a relatively constant rate until approximately age 5; thereafter, annual increments become progressively smaller. In Figure 17, the growth rate of longnose suckers captured in the project study area is compared with those of other populations in Alberta and the Northwest Territories. Suckers in the project study area grow at approximately the same rate as in the Muskeg River, Alberta, and at a rate intermediate between the fast growing Great Slave Lake, N.W.T., population and the slow growing Donnelly River, N.W.T., population. The maximum age of longnose sucker captured in the project study area was 13 years, whereas suckers as much as 22 years old have been captured in the Donnelly River, N.W.T. (Tripp and McCart 1974).

4.2.5.4 Reproductive development. The youngest mature individuals in the aged sample were age 5 for females and age 6 for males. Some individuals as old as 10 years of age had immature gonads suggesting that longnose suckers in the project study area may not spawn every year once maturity is reached. Age at first maturity for this species varies from 5 to 7 in British Columbia (Geen et al. 1966) to 9 to 12 years in the Donnelly River, N.W.T. (Tripp and McCart 1974).

4.2.5.5 Sex ratio. Significantly fewer male than female (30% male, X^2=15.36, P<0.05) longnose suckers were recorded in the aged sample from the study area. This predominance of females is probably a result of sampling error, as other recent investigators in the AOSERP study area (Bond and Machniak 1977, McCart et al. 1977, McCart et al. 1978) have reported balanced sex ratios.

4.2.5.6 Food habits. Stomachs of longnose suckers were examined during dissection; however, contents were too well digested to

Table 17. Age-length relationships, sex ratios, and percent mature for longnose suckers from the Athabasca, Clearwater, and Christina rivers, 1977.

Age	No.	% Male	% Mature		Length (mm)			
			Male	Female	$\bar{x}$	Range	S.D.	S.E.
2	1	ND	ND	ND	97			
3	1	ND	ND	ND	175			
4	4	75.0	0.0	0.0	256.75	233-283	26.44	13.22
5	7	28.57	0.0	20.0	294.43	280-304	8.58	3.24
6	12	33.33	50.0	62.5	305.25	244-332	25.57	7.38
7	19	10.53	100.0	53.33	334.63	286-375	27.67	6.34
8	13	38.46	40.0	62.5	348.54	312-389	23.78	6.60
9	13	38.46	100.0	62.5	367.08	323-401	22.15	6.14
10	11	27.27	66.7	87.5	391.91	374-406	11.22	3.83
11	5	40.0	100.0	100.0	419.8	395-435	19.61	8.77
12	4	0.0		100.0	440.0	419-476	25.78	12.89
13	4	50.0	100.0	100.0	425.25	379-468	36.62	18.31
Totals	94	29.79	57.14	64.52		97-476		

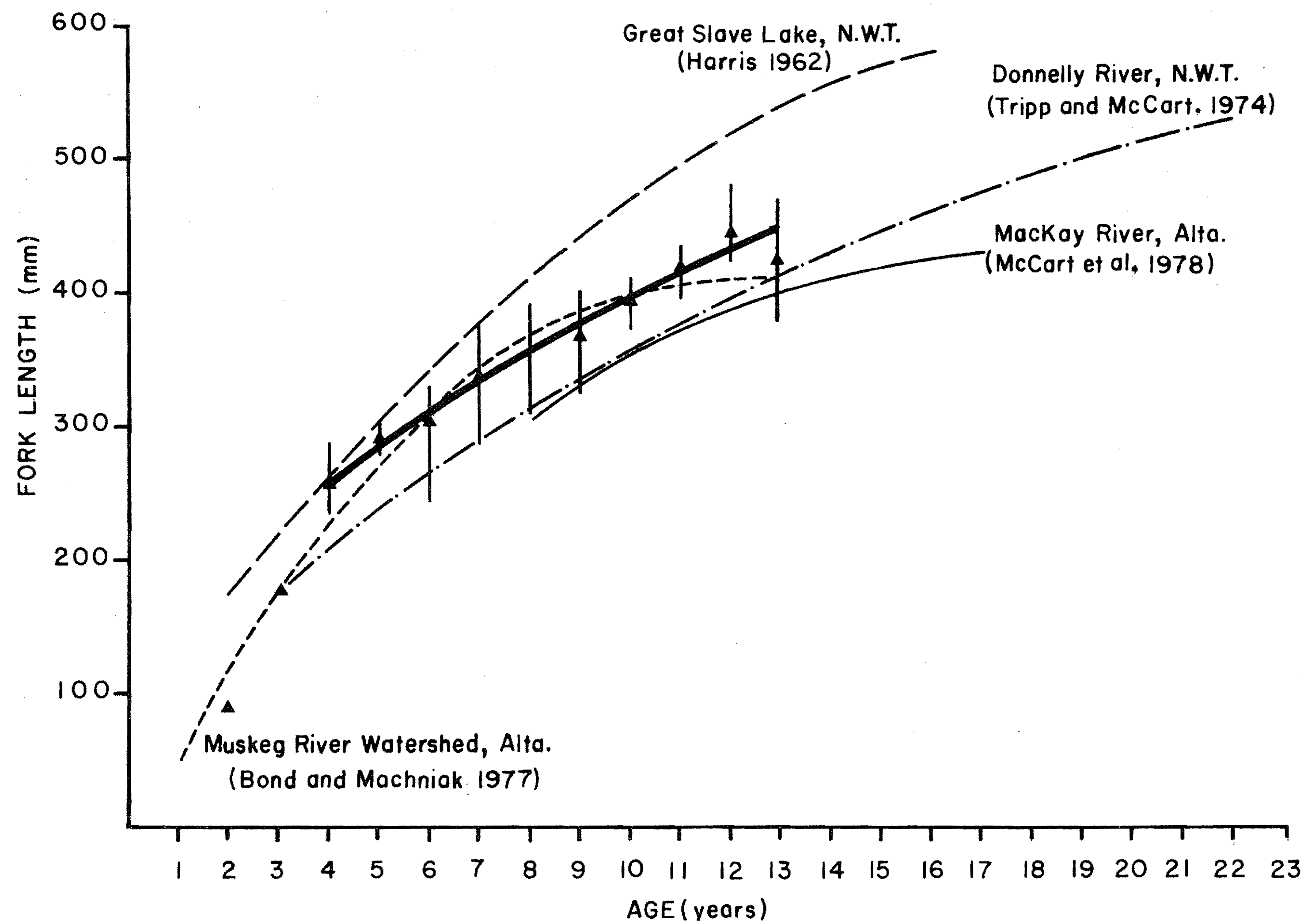

Figure 17. Comparison of growth rates of longnose suckers from the project study area and from four other locations. Triangles indicate mean fork lengths and vertical lines indicate range in each age class.

permit identification of individual food items.

4.2.6 White Sucker

The white sucker *(Catostomus commersoni)* is a widespread and common species found in a variety of freshwater habitats in North America. The ecology of white suckers is similar to that of the longnose sucker and the two species are often found together in lakes and streams. The biology of white suckers in Canada has been reviewed by Geen et al. (1966) and Scott and Crossman (1973). Some aspects of the life history of this species within the AOSERP study area have recently been reviewed by Bond and Machniak (1977), McCart et al. (1977), and McCart et al. (1978).

4.2.6.1 Distribution and movements. From 7 September to 4 November, a total of 45 white suckers was captured in the project study area with gillnets and seines (Tables 4 and 5). White suckers were captured in all three drainages sampled (Figures 3 to 5); however, with gillnets, the average catch per unit effort was low overall (Table 5). In the Athabasca River, gillnet catch per unit effort for this species was greatest during the early portion of the study period (7 September to 4 October), declined to zero from 4 October to 25 October, then rose again to a low value during the final sampling period (26 October to 3 November). Catch per unit effort by gillnet in the Clearwater River was low at the outset of the study and declined steadily until studies terminated in early November (Table 5). In the Christina River, white suckers were taken in gillnets in low numbers during the first period of study, but were absent from catches in subsequent sampling periods (Table 5).

With seines, the greatest catches per unit effort occurred in the Christina River during the first and final sampling periods (Table 4). This drainage was not seined from 5 to 25 October. In the Athabasca River, white suckers were present in seine catches in low numbers in the first sampling period; were absent during the second period, and were relatively abundant in the third and fourth sampling periods. A similar pattern in white sucker seine catches occurred in the Clearwater River. Presumably, white suckers were moving downstream prior to freeze-up to overwintering areas in these larger rivers.

Of the 45 white suckers captured, 11 were dart tagged and released; however, no tag returns have been reported to date.

4.2.6.2 Length frequency. The length-frequency distribution of 45 white suckers captured in the project study area from early September to early November 1977, is presented in Figure 18. The smallest fish captured was 294 mm fork length and the largest was 445 mm; 80% of the total catch was between 300 and 400 mm in length. The absence of smaller fish may be the result of sample bias introduced by the use of coarse mesh beach seines. Other studies in the AOSERP study area, which employed fish mesh seines and gillnets, have indicated that white sucker fry and smaller juveniles are common (McCart et al. 1977, Bond and Machniak 1977).

4.2.6.3 Age and growth. Age-length data for 27 white suckers are presented in Table 18 and Figure 19. Otolith ages were used in all calculations. Samples from all three drainages examined were combined for age and growth analysis.

Only five age classes (ages 5-11 inclusive) were identified in the study sample and two of these are represented by single individuals. The growth curve prepared from the study sample is approximately intermediate between those available from two previous studies of white suckers in the AOSERP study area (Figure 19). There is probably a high degree of exchange of individuals between sucker populations in the Athabasca River and its tributaries. Much of the observed difference in growth rates between these populations (Figure 19) may be attributable to differences in aging techniques. The maximum age determined for the small sample of white suckers from the project study area was 11 years. Other investigators in the AOSERP study area have recorded white suckers as old as 15 years (McCart et al. 1978) and 17 years (Muskeg River, Bond and Machniak 1977).

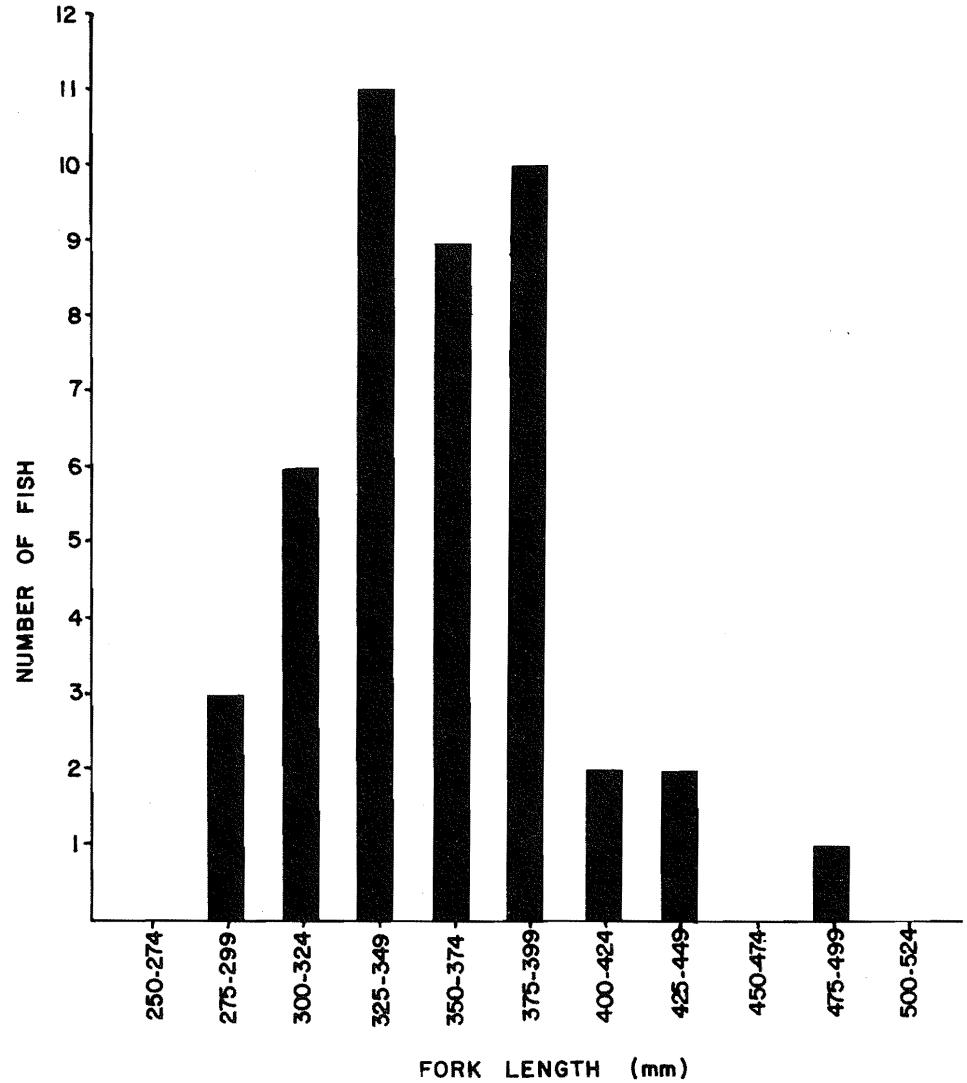

Figure. 18. Length frequency for white suckers from Athabasca and Clearwater rivers upstream of Fort McMurray.

Table 18. Age-length relationships, sex ratio, and percent mature for white suckers from the Athabasca, Clearwater, and Christina rivers, 1977.

Age	No.	% Male	% Mature		Length (mm)			
			Male	Female	$\bar{x}$	Range	S.D.	S.E.
5	3	0.0		33.3	306.33	300-311	5.69	3.28
6	7	42.86	33.3	0.0	330.86	294-355	25.33	9.57
7	9	22.22	100.0	42.86	353.67	311-390	24.78	8.26
8	3	0.0		66.7	381.33	378-384	3.06	1.76
9	1	0.0		100.0	397			
10	1	100.0	100.0		409			
11	3	0.0		100.0	434.67	414-445	17.90	10.33
Totals	27	22.22	66.7	47.62		294-445		

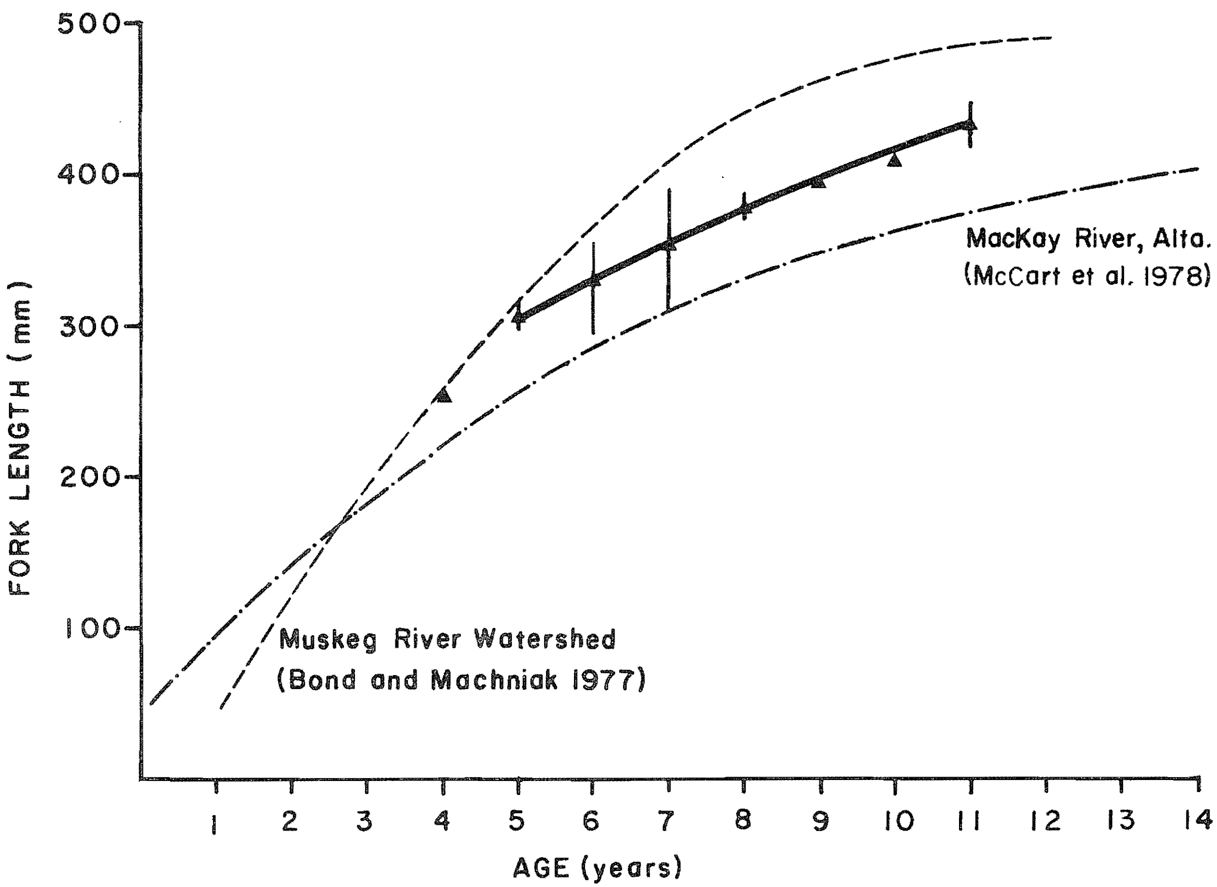

Figure 19. Comparison of growth rates of white suckers from the study area and two other locations in Alberta. Triangles indicate mean fork lengths and vertical lines indicate size range in each year class.

4.2.6.4 Reproductive development. The youngest mature individuals in the aged sample of white suckers were age 5 for females and 6 for males. All fish older than age 8 were judged to be potential spawners. None of the relatively slow-growing MacKay River population (McCart et al. 1978) was mature until age 8 (males) and age 12 (females). In the faster growing Muskeg River population (Bond and Machniak 1977), white suckers matured as early as age 3 (males) and 4 (females).

4.2.6.5 Sex ratio. Significantly fewer male to female (22.2% male, X^2=7.76, P<0.05) white suckers were recorded in the aged sample from the project study area. This observed imbalance may be a result of sampling error as other recent investigations in the AOSERP study area (McCart et al. 1977, McCart et al. 1978) report balanced sex ratios for this species. Bond and Machniak (1977), however, report a significantly greater proportion of females (62%) in the spring spawning run of white suckers in the Muskeg River.

4.2.6.6 Food habits. The advanced state of digestion of white sucker stomach contents precluded detailed identification of individual food items.

4.2.7 Minor Species

Minor species are those of which less than 30 individuals were available for detailed analysis. These include mountain whitefish, Arctic grayling, burbot, flathead chub, trout-perch, lake chub, yellow perch, and rainbow trout.

4.2.7.1 Mountain whitefish. At the start of the study, mountain whitefish were present in the Athabasca River portion of the project study area in small numbers. They increased in numbers as evidenced by higher gillnet catches in mid and late October (Table 5). Capture locations can be seen in Figures 3 to 5. Perhaps these fish were moving out of small tributaries or from areas further upstream on the Athabasca River. No mountain whitefish were ever captured in the Clearwater or Christina rivers.

Only one male of the total sample of 17 was a spawner (Table 19). The others were immature fish. The length-frequency of mountain whitefish from the project study area appears in Figure 20. Mountain whitefish in the Red Deer River spawn in mid October (McCart and Jones 1974). The absence of spawners and the small numbers of mountain whitefish present suggest that no significant spawning areas exist for this species within the project study area.

Table 20 presents a list of food items found in 17 mountain whitefish stomachs examined. As indicated in the table, caddisfly and stonefly larvae constituted the bulk of their diet.

4.2.7.2 Arctic grayling. While Arctic grayling constitute a major species in some of the tributaries to the Athabasca River (i.e., Muskeg and Steepbank rivers), they apparently do not spend much time during the open water season in the project study area. No grayling were captured in the study area until mid October. It was not until late October, when water temperatures reached approximately 2°C, that they appeared in any numbers (Tables 4 and 5). This corresponds closely with the emigration of grayling from the Muskeg and Steepbank rivers which occurred during the fall of 1977 when water temperatures reached about 2°C (W.A. Bond, personal communication).

Only 27 Arctic grayling were captured in the project study area. Capture locations appear in Figures 3 to 5. Length frequency appears in Figure 21.

Of the 27 grayling captured, 23 could be aged by otoliths. Ages ranged from 5 to 12 years and appear in Table 21. All fish were mature spawners and 78% of the sample were males. It is expected that small sample size accounts for the unbalanced sex ratio. Comparison of growth rates for Arctic grayling from the project study area and from the Muskeg River (Bond and Machniak 1977) is presented in Figure 22.

Table 19. Age-length relationship, sex ratio, and percent mature for mountain whitefish from the Athabasca and Clearwater rivers, 1977.

Age	No.	% Male	% Mature Male	% Mature Female	Length (mm) $\bar{x}$	Length (mm) Range	Length (mm) S.D.	Length (mm) S.E.
5	8	75	0	0	276.87	245-309	23.85	8.43
6	5	0		0	324.2	305-336	11.56	5.17
7	4	25	100	0	339.25	335-345	4.35	2.17
Totals	17	41.18	14.29	0		245-345		

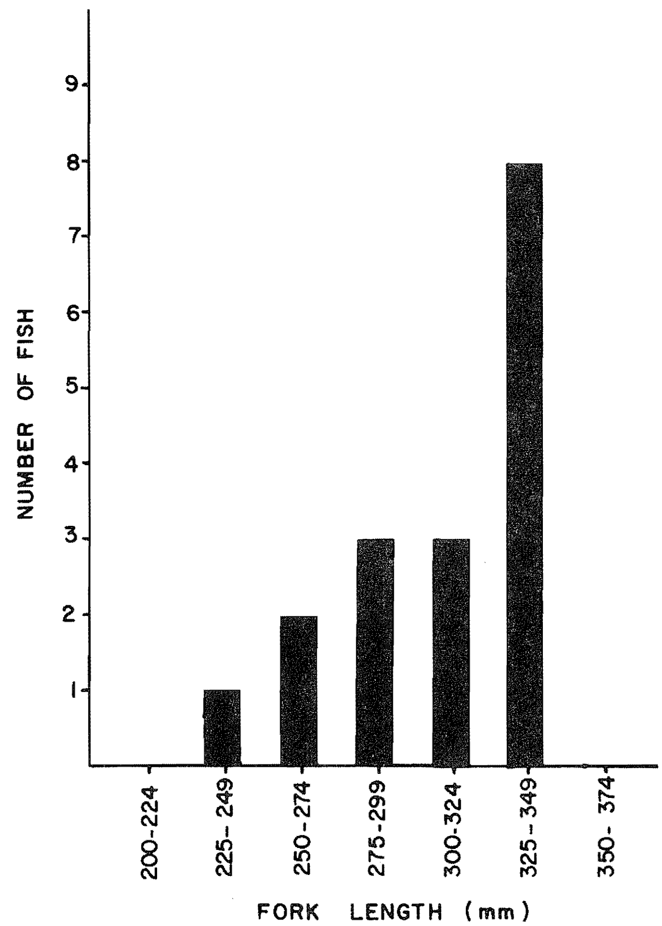

Figure 20. Length frequency for mountain whitefish from Athabasca and Clearwater rivers upstream of Fort McMurray.

Table 20. Stomach contents of mountain whitefish captured in the Athabasca River, September through October 1977. Percent occurrence values are based only on stomachs which contained food.

Food Item		Percent Occurrence
Trichoptera larvae		84.6
Plecoptera nymphs		23.1
Ephemeroptera nymphs		7.7
Unidentified digested material		15.4
Gravel		7.7
Empty stomachs	4	23.5
Total No. Stomachs Examined	17	

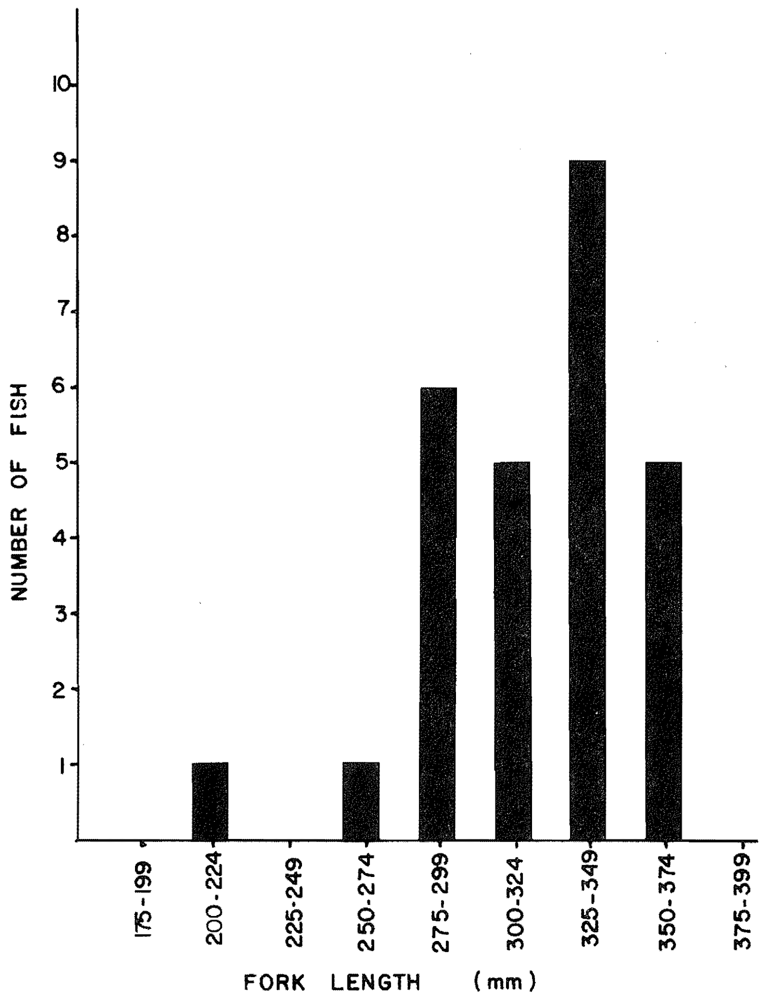

Figure 21. Length frequency for grayling from Athabasca and Clearwater rivers upstream of Fort McMurray.

Table 21. Age-length relationship, sex ratio, and percent mature for Arctic grayling from the Athabasca, Clearwater, and Christina rivers, 1977.

Age	No.	% Male	% Mature		Length (mm)			
			Male	Female	$\bar{x}$	Range	S.D.	S.E.
5	8	50.0	100	100	298.37	274-316	12.43	4.40
6	6	83.3	100	100	331.83	323-340	7.52	3.07
7	3	100.0	100		343.0	334-350	8.19	4.73
8	2	100.0	100		342.5	340-345	3.54	2.5
9	1	100.0	100		370			
10	2	100.0	100		362.5	351-374	16.26	11.5
12	1	100.0	100		354			
Totals	23	78.26	100	100		274-374		

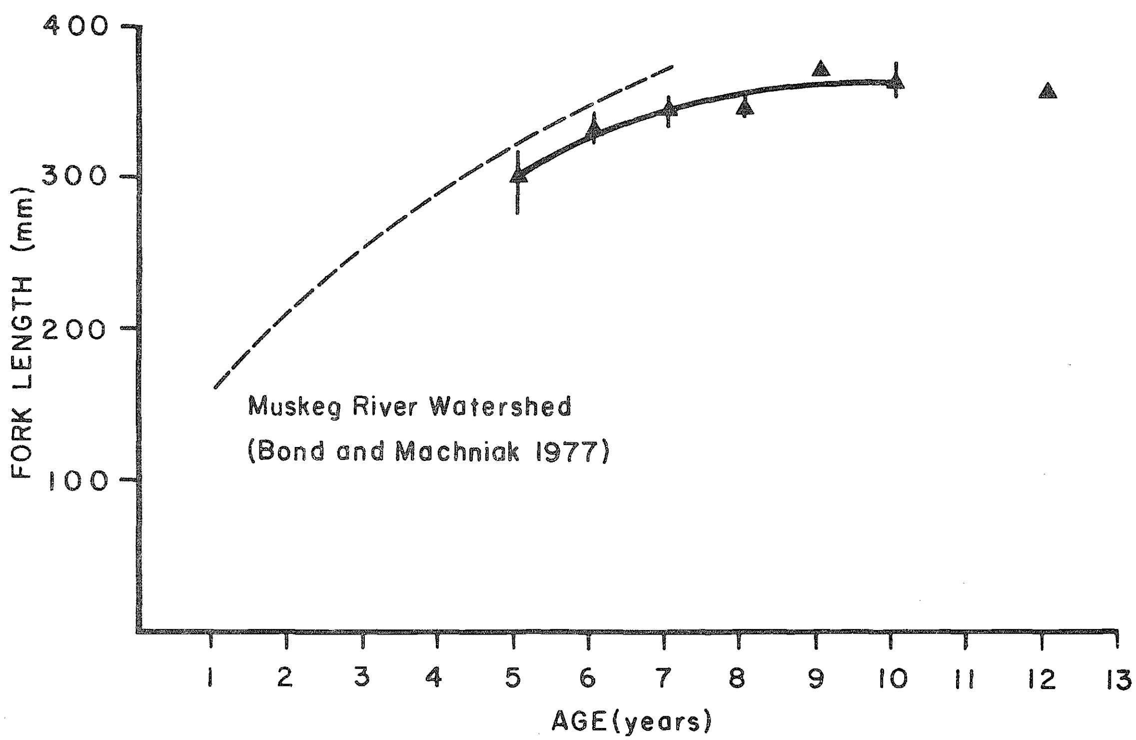

Figure 22. Comparison of growth rate for Arctic grayling from the project study area and from the Muskeg River. Triangles indicate mean fork length and vertical lines indicate range for each age class.

The stomach contents of all grayling captured were analysed. Results appear in Table 22. It appears from the variety of food items present in their diet that grayling are very opportunistic feeders.

4.2.7.3 Flathead chub. In the project study area, flathead chub were restricted to the Athabasca River and lower reaches of the Clearwater River. Capture locations can be seen in Figures 3 to 5. Flathead chub in the study sample ranged in size from 178 to 258 mm (N=9). Ages ranged from 4 to 9 years. Seven out of nine fish were female and a like number were mature.

4.2.7.4 Burbot. Burbot were found in small numbers throughout the project study area. Capture locations appear in Figures 3 to 5. Burbot ranged in size from 464 to 664 mm (N=10), and in age from 6 to 12 years.

4.2.7.5 Trout-perch. Trout-perch were captured at two locations in the project study area (Figures 3 to 5). Five of 25 fish captured were dissected. They ranged in size from 51 to 72 mm and in age from 2 to 3 years. All five fish appeared to be mature.

4.2.7.6 Lake chub. A small number of lake chub (N=10) was captured at two locations, near Cascade and Grand rapids on the Athabasca River. None was retained for dissection.

4.2.7.7 Yellow perch. Yellow perch were captured at one location on the Clearwater River (Figure 3). All of the fish captured (N=12) were small, most likely juveniles. None was retained for life history analysis. McCart et al. (1977) reported small numbers of juvenile yellow perch (size range 35-54 mm) in the Athabasca River in the vicinity of Syncrude's Lease 17.

4.2.7.8 Rainbow trout. One large rainbow trout (578 mm) was captured by seine at the base of Cascade Rapids. This fish may

Table 22. Stomach contents of grayling captured in the Athabasca, Clearwater, and Christina rivers, September through October 1977. Percent occurrence values are based only on stomachs which contained food.

Food Item		Percent Occurrence
Plecoptera nymphs		55.5
Trichoptera larvae		7.4
Tipulidae larvae		7.4
Unidentified Diptera larvae		3.7
Corixidae adults		92.6
Coleoptera adults (aquatic)		7.4
Fish eggs		22.2
Fish remains		3.7
Unidentified digested material		18.5
Vegetation		11.1
Empty stomachs	0	0.0
Total No. Stomachs Examined	27	

have drifted down from the headwaters of the Athabasca River where they are believed to be native (Paetz and Nelson 1970).

5. CONCLUSIONS

The Athabasca and Clearwater rivers upstream of Fort McMurray provide habitat for a number of important fish species. Large populations of lake whitefish, goldeye, walleye, northern pike, and white and longnose suckers and smaller populations of Arctic grayling and mountain whitefish utilize the project study area.

Some of the spring spawning species (e.g., walleye, longnose suckers, and northern pike) may spawn in the project study area. Others (e.g., white suckers and grayling) likely migrate into tributaries such as the Christina River to spawn. It does not appear that goldeye spawn in the project study area.

The Athabasca River, in particular the section between Fort McMurray and the Cascade Rapids, is critical spawning habitat for large numbers of lake whitefish. While tag returns from lake whitefish were insufficient to calculate a population estimate by scientific means, the population of spawners certainly numbers into the tens of thousands. Other fall spawners (e.g., mountain whitefish) may spawn in the project study area upstream of Cascade Rapids.

Tag returns from the Peace-Athabasca Delta suggest that the lake whitefish and possibly the goldeye and walleye populations from the project study area are part of the Lake Athabasca and Peace-Athabasca Delta populations. More tag returns will help to clarify the extent of overlap between these populations.

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