FISHERY RESOURCES OF THE ATHABASCA RIVER DOWNSTREAM OF FORT McMURRAY, ALBERTA

VOLUME II

by

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ABSTRACT

The fish populations of the Athabasca River between Fort McMurray and the mouth of the Firebag River were sampled from early May to early October 1976. Fish were collected with gill nets, seines, and angling gear in order to identify the species present and their distribution and relative abundance over time, and to obtain samples for life history analysis. A tagging program was undertaken to delineate migration patterns for the major fish species.

Results indicate the presence of 25 fish species within the study area, 11 of which are common. Major spawning migrations of walleye, longnose suckers, and white suckers enter the study area in early spring and a large spawning run of lake whitefish occurs in late summer. The entire study area appears to be important as a summer feeding area for immature goldeye. These goldeye, which may belong to the population that spawns in the Peace-Athabasca Delta, enter the study area in early spring and apparently leave in late fall. Trout-perch, flathead chub, lake chub, and emerald shiners are the major forage fishes occurring within the study area.

Floy tags were applied to 2528 fish and the recapture rate to date is 2%. Preliminary tag return data indicate some movement of suckers, goldeye, lake whitefish, and walleye between the study area and Lake Athabasca.

The fry of many fish species appear in the Athabasca River during June and July. Most of these fry do not remain in the study area but are carried downstream to nursery areas in the lower Athabasca River or Lake Athabasca.

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1. INTRODUCTION

The present and proposed development of the Athabasca Oil Sands may introduce disturbance to some lake and river systems of the lower Athabasca River drainage. Local disruption in the form of land clearing, muskeg drainage and removal, stream diversions, and the construction of access routes may affect the water quality and quantity of streams in addition to the physical alterations produced. Other activities that could affect water quality include tailings pond seepages and saline minewater discharges. The diversion or blockage of streams may affect fish spawning runs. Critical fish rearing, feeding, and overwintering areas may be disturbed or lost altogether. In the case of migrant fish populations, e.g., from Lake Athabasca, such local disruptions could have far-reaching effects.

To provide information that could be used to minimize the adverse effects of development on the fish populations of the Athabasca River and its tributaries, the Alberta Oil Sands Environmental Research Program (AOSERP), through its Aquatic Fauna Technical Research Committee, initiated an integrated series of projects to assess the baseline state of the fish resources of the area. The work, which began in 1976, involved a broadly based fisheries investigation of the Athabasca River as well as site-intensive study of selected tributaries. Tributaries chosen for intensive study were those considered to be most immediately imperilled by future surface mining operations or by increased pressure from a growing human population. The study of the Athabasca River was to concentrate on the section of stream between Fort McMurray and Lake Athabasca.

This report presents the results of work done in 1976, the first year of a two-year study intended to evaluate and describe the baseline state of the fish resources of the Athabasca River downstream of Fort McMurray. A similar data volume will be produced to cover work performed in 1977, and following completion of the study, a summary report will be produced to present the major findings of the study.

Specific objectives for the 1976 Athabasca River study were as follows:

1. To ascertain the seasonal distribution and relative abundance of the major fish species of the Athabasca River downstream from Fort McMurray;
2. To identify the migration patterns throughout the open water period for these major fish species through a conventional tagging program;
3. To document the timing of the downstream movements of fry in the Athabasca River;
4. To identify possible spawning areas in the Athabasca River and in tributary streams through the presence of ripe and/or spawned out fish as well as the presence of eggs and fry; and
5. To establish a data base with respect to the general biology of the major fish species that frequent the Athabasca River (i.e., age, growth, sex ratio, maturity, fecundity, food habits etc.).

2. DESCRIPTION OF THE STUDY AREA

The Athabasca River arises in the Rocky Mountains and flows approximately 1440 km before entering the western end of Lake Athabasca where it contributes to one of North America's major wetlands, the Peace-Athabasca Delta. Approximately 450 km of the river's course lie within the AOSERP study area (Figure 1), 300 km being downstream of Fort McMurray. The total drainage area of the Athabasca River is 156 928 km^2, about 25% of the surface area of Alberta. Approximately 17% of this area (26 880 km^2) is within the AOSERP study area. The long-term mean discharge of the Athabasca River at Fort McMurray is 645.7 m^3/s with the respective minimum and maximum recorded flows being 96.6 m^3/s and 4265.0 m^3/s (Kellerhals et al. 1972). Records obtained from Water Survey of Canada (1977) show a mean daily discharge at Fort McMurray of 679.7 m^3/s during 1976. Fluctuations occurring during the present study are shown in Figure 2.

Upstream of Fort McMurray the Athabasca River descends sharply across resistant bedrock formations producing several series of rapids and a gradient of 1.0 m/km (Northwest Hydraulic Consultants Ltd. 1975). At Fort McMurray the river loses its narrower, gorge-like character and is deflected northward by high bluffs of clay and oil sands overlying Devonian limestone. The stream gradient below Fort McMurray is reduced to about 0.1 m/km, the velocity is approximately 1.0 m/s, and the channel pattern is straight to sinuous. Near the delta an irregular meander pattern exists, the gradient decreases further, and the banks diminish to the level of the delta.

The width and depth of the Athabasca River vary throughout the year with fluctuations in discharge. The approximate range in width is from 300 to 600 m with a narrower main channel in the lower part of the delta. Upstream of the delta the river has an estimated average depth of 3 m with areas over 9 m deep being common. In the delta the main channel appears to be considerably deeper, both in average depth and maximum depth. The Athabasca River remains highly turbid throughout the summer and achieves maximum temperatures of

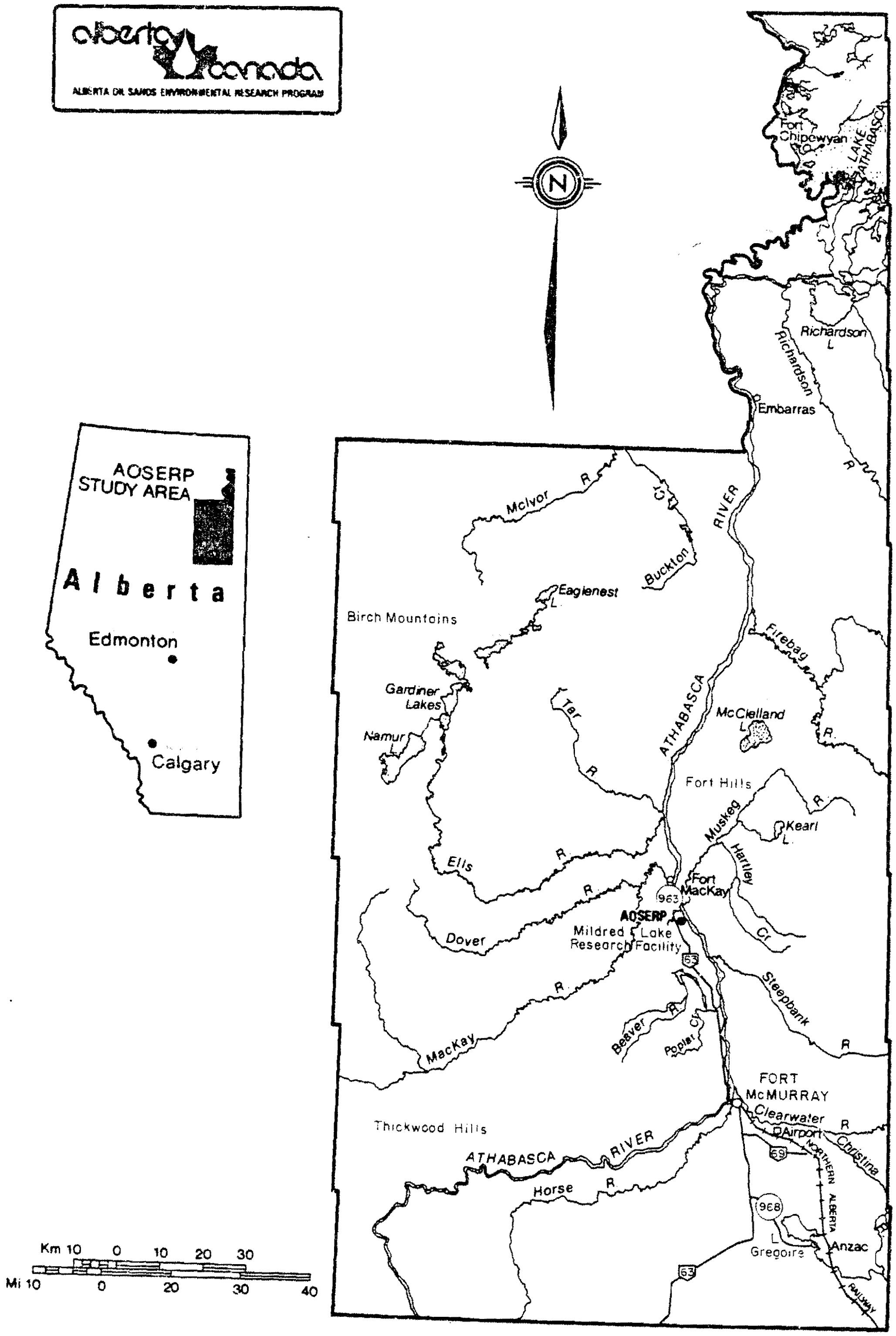

Figure 1. The AOSERP study area.

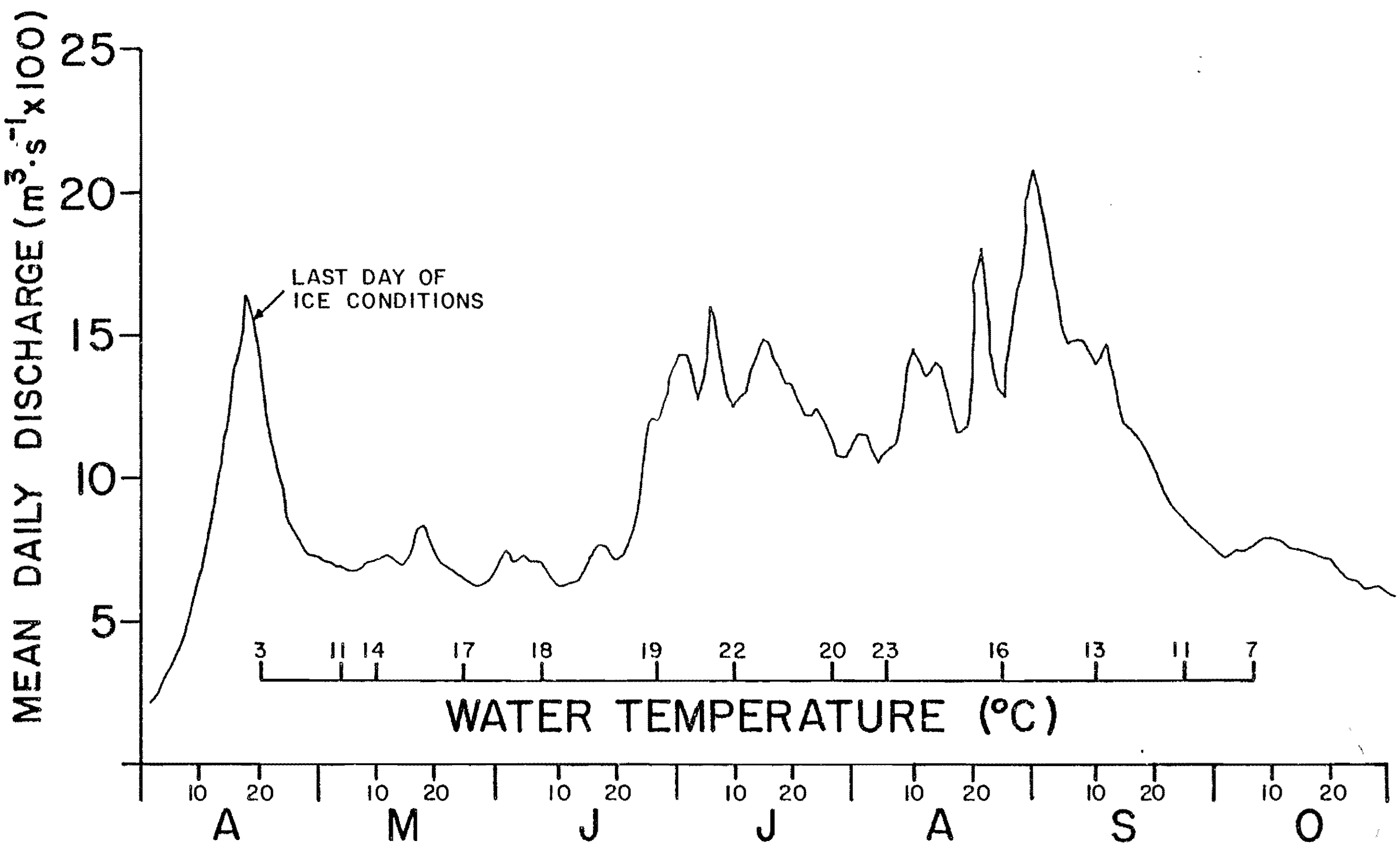

Figure 2. Discharge of the Athabasca River from 1 April to 30 October 1976.

about 23°C. The respective mean dates of freeze-up and break-up at Fort McMurray are 5 November and 7 May (Kellerhals et al. 1972).

The portion of the Athabasca River studied in 1976 consisted of approximately 135 km of stream between the mouth of the Horse River, just upstream of Fort McMurray, and the mouth of the Firebag River (Figure 3). Near the upstream end of the study area, much of the substrate in mid-stream consists of gravel and cobble while sand, silt, and occasional gravel areas are found along the sloping shorelines. The river is occasionally deflected by cliffs of clay, limestone, and oil sands creating eddies that are ideal sampling sites. Here flood channels are limited but a few side sloughs are associated with the main river. Several important tributaries, all low gradient, brown-water streams, enter the Athabasca River in this region (Figures 1 and 3).

Below Fort MacKay (Figure 1) islands become larger and more numerous with vertical banks of sand and silt. These islands are heavily vegetated with willow (*Salix* sp.), poplar (*Populas balsamifera* and *P. tremuloides*), and some spruce (*Picea mariana*). The dominant river bank vegetation consists of poplar, spruce, willow, birch (*Betula papyrifera*), and dogwood (*Cornus stolonifera*). There is a downstream increase in the number of side bars, point bars, and dunes with frequent mid-channel sand bars being exposed at low water.

FIGURE 3.

ATHABASCA RIVER BELOW FORT McMURRY INDICATING LOCATIONS OF MAJOR SAMPLING SITES USED DURING 1976 STUDY

LEGEND

(1) to (12) = STANDARD GANG SITES
△13 to △35 = LARGE MESH SEINE SITES
[36] to [60] = SMALL MESH SEINE SITES
+10 = DISTANCE (km.) BELOW WATERWAYS (km 0)

5 0 5 10 Kilometres
5 0 5 Miles

3. MATERIALS AND METHODS

3.1 GENERAL

The fish populations of the Athabasca River were sampled from early May to early October 1976 using a variety of collection methods including gill nets, large and small mesh beach seines, and angling gear. Sampling was conducted on an irregular basis during May and June as much time had to be spent preparing equipment, training field personnel, and locating favourable sampling sites. During this time a series of sites was established between Fort McMurray and the Firebag River. Each site was precisely described according to its distance (±0.1 km) below Waterways (km 0.0) and whether it was on the left of right bank (looking downstream) by reference to Canadian Hydrographic Service chart #6301, Athabasca and Slave Rivers, 1973. Some sites had to be abandoned during the summer as water conditions varied, but other sites persisted. The major sampling sites utilized during 1976 are indicated in Figure 3 and described in Appendix 6.1.

3.2 FIELD TECHNIQUES

3.2.1 Gill Nets

Twelve gill netting stations (Sites 1 to 12) were established between Fort McMurray and the Firebag River (Figure 3, Appendix 6.1) and systematic sampling of these sites using standard multiple mesh gill net gangs began on 12 July. One overnight set was made at each site during each two-week period (cycle). The sampling at gill netting stations was completed by making six lifts on each of two consecutive days during the first four days of each cycle. Each gang was set between 1600 and 1800 h and lifted between 0800 and 1000 h the next day. After the second night the nets were hung to dry, cleaned, and repaired in preparation for the next cycle. The standard gang employed was 27.4 m long by 2.4 m deep and consisted of equal lengths of 5.1, 7.6, and 10.2 cm braided nylon mesh (stretch mesh). The panels were seamed together with the 10.2 cm mesh in the middle. Gangs were set on the bottom and as perpendicular to the shore as possible.

Fish captured in standard gangs were separated according to mesh size and all were subjected to complete biological analysis. Fork length (±1.0 mm) and body weight (±10 g) were recorded (for burbot, total length was recorded). Scales or pectoral fins (suckers) were retained for age determination. Sex and maturity state were assessed by gonadal examination. Stomachs were removed and preserved in 10% formalin for evaluation of food habits.

During May and June, gill nets (tagging nets) were employed in order to identify the presence of fish in the study area and to obtain fish for tagging. The nets used most commonly for this purpose were 22.9 m long and constructed of 10.2 cm (stretch mesh) braided nylon. Other nets used occasionally were either 22.9 or 3.0 m long with mesh sizes of 3.8, 5.1, 7.6, or 12.7 cm. Tagging nets were set from shore in back eddies and were lifted every one to three hours to ensure minimal mortality.

3.2.2 Large Mesh Beach Seines

A total of 48 sites were sampled with large mesh beach seines. Some turned out to be transitory, their existence depending on river discharge, while 23 sites (Sites 13 to 25)(Figure 3, Appendix 6.1) were more stable and were sampled on a regular basis. The number of large mesh seine hauls made within a sampling cycle ranged from 17 to 38 and these were always scattered along the entire study area. The seines used were constructed of knotted #9 nylon twine of 3.8 cm stretch mesh, and were 33 m long by 1.8 m deep with a 1.8 x 1.8 x 1.8 m bag. Most fish captured in large mesh beach seines were tagged and released. Those too small to tag (<15 cm) were either subjected to complete biological analysis or identified to species, counted, and released unharmed.

3.2.3 Small Mesh Beach Seines

Small mesh beach seines were utilized to sample forage fish populations and to capture small specimens of larger fish species. Although 52 sites were sampled with this gear, only 25 locations (Sites 36 to 60)(Figure 3, Appendix 6.1) were sampled on a regular basis. Small mesh seines were used at approximately one month intervals with between 20 and 36 hauls being made each time. The seines employed were 1.2 m deep and constructed of 6.3 mm delta nylon mesh. In most cases the seines used were 9.1 m long; however, in some restricted areas, such as small tributary mouths, 3.0 m lengths were used. When the number of fish taken in a small mesh seine haul was small, the entire catch was usually preserved in 10% formalin for later identification and analysis. Where the catch was large, a representative subsample was retained and the remainder of the fish were returned to the water after their numbers were estimated. Large fish (>15 cm) captured in small mesh seines were tagged and released.

3.2.4 Angling

Angling was not used uniformly or in any consistent manner as a fish capturing method. Angling gear was used extensively, however, along the entire study area in late June to capture fish for tagging. At that time, waterborne debris, including large quantities of poplar fluff, made the use of other gear types infeasible. Baited snelled hooks were still-fished from shore in late evening (2000 to 0200 h) in shallow, low current areas.

3.2.5 Tagging

Fish to be tagged were removed from the gear and held for a short time (5 to 10 minutes) in tubs to allow them to quiet down. Each fish was measured (±1.0 mm) and weighed (±10 g) and scales were taken for ageing. The tags used were numbered Floy anchor tags (Type FD-68B) which were inserted near the base of the dorsal fin. Tags and guns were held in a 10% Dettol solution and rinsed in fresh water prior to insertion to minimize infection. No anaesthetic was employed.

The tagging program was well publicized by posters and press releases and a two dollar reward was offered for returned tags. Tag returns were made by sport fishermen along the Athabasca River, by domestic fishermen on the Athabasca River and Lake Athabasca, and by commercial fishermen on Lake Athabasca. Personnel of LGL Ltd., Environmental Research Associates, Edmonton, and Aquatic Environments Ltd. Calgary also returned tags.

3.2.6 Habitat Preference Analysis

All sampling sites were classified as belonging to one of four basic habitat types. These included sites associated with: (1) islands and mid-channel sand bars; (2) back eddies; (3) tributary streams; and (4) areas of slack current along point bars, side bars, and bank indentations. The effort expended by each gear type in each habitat type was recorded (Appendix 6.2). Gill net effort was based on the number of hours the gear was fished while seining effort was recorded as the number of seine hauls made.

3.3 LABORATORY TECHNIQUES

3.3.1 Fish Identification

Seine catches were identified using taxonomic keys and descriptions given by Paetz and Nelson (1970) and Scott and Crossman (1973). While most fish could be identified to species, some larval forms (suckers) could be identified only to genus.

3.3.2 Age Determination

Ages for longnose and white suckers were determined from cross-sections of pectoral fin rays using the method described by Beamish and Harvey (1969) and Beamish (1973). After embedding in epoxy, thin sections (0.5 to 1.0 mm) were cut using a jeweller's saw with #6 or #7 blades. The sections were then mounted in Permount on glass slides and read under a dissecting microscope.

Scales, removed from the appropriate location on the fish (Hatfield et al. 1972), were used in determining ages for goldeye, walleye, lake whitefish, northern pike, flathead chub, Arctic grayling, and mountain whitefish. Several scales from each fish were cleaned and mounted between acetate slides and the age determined by counting annuli (growth rings) on the image produced by an Eberback #2700 microprojector.

Age determinations for all other fish species included in this report were made by observing growth patterns on otoliths (ear bones). When necessary, the otolith was ground on a glass surface using carborundum powder. The otolith was then cleared in a 3:1 mixture of benzyl benzoate and methyl salicylate and read under a dissecting microscope using reflected light against a black background.

Age determinations presented are the consensus of two readers. Where discrepancies existed between the results obtained by them, a third opinion was obtained.

3.3.3 Food Habits

The volumetric point system of stomach analysis proposed by Hynes (1950) and modified by Thompson (1959) was used in assessing the food habits of goldeye, walleye, lake whitefish, and northern pike. The amount of food present in each stomach was assigned a point value between 0 and 20 on the basis of its volume. The value 0 was given only when a stomach contained no organic material while the value 20 indicated a gorged state. After separating the various food items according to taxon (order is the lowest taxon reported), the assigned point value for each stomach was subdivided into food item point numbers according to the estimated volume of the individual food items. Results were summated within sampling periods and presented as percentages of the total estimated food volume. Results were also expressed in terms of percentage frequency of occurrence of the various food items. The latter method alone was utilized in assessing the stomach contents of all other fish species.

3.3.4 Length and Weight of Small Fish

Small fish that had been captured in seine hauls and preserved in formalin were measured to the nearest 1.0 mm and weighed either to the nearest 0.1 g on an analytical balance or to the nearest 0.01 g on a torsion balance. Some larval and fry samples (e.g., suckers) that contained many fish of similar size were bulk weighed after removing excess preserving fluid. The fish in the sample were then counted and a mean individual weight assigned to the sample.

3.3.5 Data Analysis

The relative abundance of the various fish species was expressed in terms of absolute numbers, percentage composition, percentage frequency of occurrence, and catch-per-unit-effort. Catch-per-unit-effort was expressed as the number of fish per gang per hour for standard gangs and as the number of fish per haul for large and small mesh beach seines. Catch data for large mesh seines and standard gangs were summarized for each two week sampling cycle. Standard gang data were also assessed for each mesh size (Appendix 6.3) and each sampling site (Appendix 6.4). Results from each gear type were pooled within each cycle for purposes of this report.

Biological data for each fish species were analyzed on an IBM computer terminal with statistical programs in VS Basic TSO. Length-weight least squares regression analyses with log base 10 transformation and length as the independent variable are described by the following equation:

$$\log_{10}W = a + b(\log_{10}L);\ sb =$$

where:

W = weight (g)

L = fork length (mm)

a = y-intercept

b = slope of the regression line

sb = standard deviation of b

Data summaries, computer printouts, and raw data are on file at the AOSERP office, 9820 - 106 Street, Edmonton, Alberta, T5K 2J6.

3.4 LIMITATIONS OF METHODS

The problems associated with sampling the fish populations of large rivers are well known and relate to conditions of current, fluctuating water levels, and water-borne debris. These conditions severely limit the choice of sampling sites as well as the efficiency of the gear employed.

Essentially, sampling sites used in this study were confined to areas in which the current was reduced to such a level as to permit the use of the gear. These, inevitably, were limited to inshore areas and catches made in such areas may not be truly representative of the overall situation.

In order to sample as great a variety of habitats as possible and to collect the greatest variety of fish, both in terms of size of individuals and number of species, it was necessary to employ a variety of collection methods, each of which has certain limitations. We believe, however, that the combination of gill nets, large mesh seines, and small mesh seines has produced reasonably good coverage of all species and all life history stages.

3.4.1 Standard Gill Net Gangs

Gill nets are known to be highly selective for size of fish. Essentially, each mesh size tends to capture fish of a particular size range. This range varies with species and depends not only on the size of fish but on whether it is of a species that tends to be captured by wedging itself in a mesh (e.g., lake whitefish, flathead chub) or entangling itself by teeth or spines (e.g., pike, walleye, goideye). Fish captured by entangling usually demonstrate a wider size range in a particular mesh size.

Because of the limited size range over which a gill net of a given mesh size is effective, fish populations are best sampled by employing gangs of gill nets of varying mesh sizes whose selectivity curves overlap broadly. Unfortunately, the gangs utilized in this study consisted of only three mesh sizes (5.1, 7.6, and 10.2 cm) and the catches produced may have been biased by gill net selectivity. This certainly appears to be the case with goldeye and flathead chub for which species, 79.2 and 98.9%, respectively, of the total standard gang catch were taken in the 5.1 cm mesh (Appendix 6.3). Lake whitefish were captured most efficiently (73.1%) in the 10.2 cm mesh (Appendix 6.3).

The length of the standard gang used (27.3 m) may also have contributed to its inefficiency. Because many of the sampling sites were not large enough to accommodate the entire gang, the offshore end often protruded into the main current where it became fouled with debris more quickly than the portion in the eddy.

Gill net efficiency is thought to have varied considerably with changes in river conditions. Generally, efficiency decreased during floods when debris tended to clog or damage the nets. Because such effects were not constant from site to site or throughout the summer, comparisons of catch-per-unit-effort on a site to site basis are often meaningless.

Because standard gangs were fished on the bottom, they may have tended to select for bottom dwellers (e.g., walleye) and to have underestimated fish that tend to swim in mid-water or near the surface (e.g. goldeye).

3.4.2 Large Mesh Beach Seines

These seines were found to be an extremely useful method of capturing fish for tagging. Using this gear, large numbers of fish could often be taken in a short period of time with minimal physical damage. They were effective for the same species of fish as were captured in standard gangs and retained all fish greater than about 200 mm fork length. Large mesh seines complemented the standard gangs to a certain extent. Whereas the gill nets were fished only on the bottom, the large mesh seines fished only the upper metre of the deeper eddies.

No standard length or time of haul was employed for large mesh seines and the area seined by each haul did tend to vary somewhat as a result of differences in current or the presence of snags. Overall, however, hauls made with this gear possessed a high degree of uniformity.

3.4.3 Small Mesh Beach Seines

These seines were effective for capturing small fish under a wide variety of conditions. They were difficult to use, however, in a strong current, in deep water, or where rocks or logs interfered with the haul.

Because of mesh limitations, these seines could not sample adequately the early life stages of most species. Few fish less than 20 mm in length were captured.

Small mesh seine hauls were not standardized but, in fact, varied considerably in duration depending on the site. Thus, catch-per-unit-effort comparisons between sites may be meaningless. The average catch-per-unit-effort values produced in each sampling cycle, however, are believed to be fairly comparable and provide a reasonable estimate of the relative abundance of the small fishes.

4. RESULTS AND DISCUSSION

4.1 GENERAL

Sampling of the Athabasca River between Fort McMurray and the Firebag River from early May to early October 1976 documented the presence of 25 fish species representing 10 families (Table 1). Eleven species were common in the samples (>1.0% of total catch), while 14 species were uncommon or found rarely (Table 2).

A total of 16 561 fish were captured. Trout-perch was the most abundant species, comprising 32.4% of the total. Suckers (longnose and white suckers were combined because of the difficulty in distinguishing between fry of the two species) made up 20.6%, goldeye (11.6%), walleye (7.2%), emerald shiner (6.4%), lake whitefish (6.3%), lake chub (5.9%), northern pike (2.9%), flathead chub (2.7%), and spottail shiner (1.9%). The remaining 14 species represented only 2% of the total catch (Table 2).

Regular use of standard gangs began on 12 July. These nets were fished for a total of 1375 hours, and captured 1546 fish of 10 species. Table 3 summarizes the results obtained in standard gangs by sampling cycle, while results from each sampling location are presented in Appendix 6.4.

Large mesh beach seines captured 1887 fish of 11 species. Results of 141 hauls in terms of percentage composition, percentage frequency of occurrence, and catch-per-unit-effort for each species are summarized by sampling period in Table 4.

An estimated 11 725 fish of 25 species were taken in 112 small mesh seine hauls. The percentage composition, percentage frequency of occurrence, and average catch per seine haul for the various species in each of four sampling periods are presented in Table 5.

Angling gear was not employed as a regular capture method but was used mainly in late June as a means of capturing fish for tagging purposes. At that time, rising water levels and heavy concentrations of poplar fluff in the water made the use of other gear

Table 1. Scientific and common names of fish species captured from the Athabasca River during 1976.

Family and Generic Names	Common Names
Family Salmonidae	
Coregonus clupeaformis (Mitchill)	Lake whitefish
Prosopium williamsoni (Girard)	Mountain whitefish
Thymallus arcticus (Pallas)	Arctic grayling
Family Hiodontidae	
Hiodon alosoides (Rafinesque)	Goldeye
Family Esocidae	
Esox lucius Linnaeus	Northern pike
Family Cyprinidae	
Chrosomus neogaeus (Cope)	Finescale dace
Couesius plumbeus (Agassiz)	Lake chub
Hybognathus hankinsoni Hubbs	Brassy minnow
Notropis atherinoides Rafinesque	Emerald shiner
Notropis hudsonius (Clinton)	Spottail shiner
Pimephales promelas Rafinesque	Fathead minnow
Platygobio gracilis (Richardson)	Flathead chub
Rhinichthys cataractae (Valenciennes)	Longnose dace
Semotilus margarita (Cope)	Pearl dace
Family Catostomidae	
Catostomus catostomus (Forster)	Longnose sucker
Catostomus commersoni (Lacépède)	White sucker
Family Gadidae	
Lota lota (Linnaeus)	Burbot
Family Gasterosteidae	
Culaea inconstans (Kirtland)	Brook stickleback
Pungitius pungitius (Linnaeus)	Ninespine stickleback
Family Percopsidae	
Percopsis omiscomaycus (Walbaum)	Trout-perch
Family Percidae	
Perca flavescens (Mitchill)	Yellow perch
Stizostedion vitreum (Mitchill)	Walleye
Etheostoma exile (Girard)	Iowa darter
Family Cottidae	
Cottus cognatus Richardson	Slimy sculpin
Cottus ricei (Nelson)	Spoonhead sculpin

Table 2. Number of fish[a] taken by each capture method during 1976.

Species	Number of fish: Tagging Nets	Standard Gangs	Angling Gear	Large Mesh Seines	Small Mesh Seines	Total	% of Total
Goldeye	92	624	157	982	67	1 922	11.6
Walleye	437	174	179	40	368	1 198	7.2
Yellow perch	0	0	0	3	161	164	1.0
Northern pike	104	105	86	161	29	485	2.9
Lake whitefish	34	487	0	518	12	1 051	6.3
Mountain whitefish	1	1	0	0	9	11	0.1
Arctic grayling	0	4	0	5	8	17	0.1
Longnose sucker	187	46	0	6	ND	239	1.4
White sucker	52	12	0	40	ND	104	0.6
Sucker spp.	0	0	0	0	3 087	3 087	18.6
Trout-perch	0	0	0	3	5 360	5 363	32.4
Burbot	0	1	11	1	3	16	0.1
Flathead chub	27	92	34	128	162	443	2.7
Lake chub	0	0	0	0	978	978	5.9
Emerald shiner	0	0	0	0	1 059	1 059	6.4
Spottail shiner	0	0	0	0	316	316	1.9
Brassy minnow	0	0	0	0	19	19	0.1
Longnose dace	0	0	0	0	20	20	0.1
Pearl dace	0	0	0	0	1	1	<0.1
Finescale dace	0	0	0	0	2	2	<0.1
Iowa darter	0	0	0	0	1	1	<0.1
Fathead minnow	0	0	0	0	2	2	<0.1
Ninespine stickleback	0	0	0	0	2	2	<0.1

continued ...

Table 2. Concluded

Species	Number of Fish: Tagging Nets	Standard Gangs	Angling Gear	Large Mesh Seines	Small Mesh Seines	Total	% of Total
Brook stickleback	0	0	0	0	2	2	<0.1
Slimy sculpin	0	0	0	0	21	21	0.1
Spoonhead sculpin	0	0	0	0	36	36	0.2
Total	934	1 546	467	1 887	11 725	16 561	

[a] Numbers are actual except for those shown for small mesh seines. In some cases, fish captured in a small mesh seine haul were only partially counted and then the total number was estimated.

Table 3. Numbers (N), percentage composition (%), catch-per-unit-effort (C/E)[a], and percentage frequency of occurrence (FO) for fish captured in standard gangs, Athabasca River, 1976. (All sampling locations combined.)

Species	Date of Sample															
	12 to 25 July				26 July to 8 August				9 to 22 August				23 Aug. to 5 Sept.			
	N	%	C/E	FO	N	%	C/E	FO	N	%	C/E	FO	N	%	C/E	FO
Goldeye	141	70.9	.744	100	54	55.1	.301	92	136	63.5	.666	92	93	50.3	.433	83
Walleye	22	11.0	.115	67	14	14.3	.078	75	16	7.5	.078	67	31	16.7	.144	92
Northern pike	6	3.0	.031	50	11	11.2	.061	68	8	3.7	.039	50	20	10.8	.093	58
Lake whitefish	10	5.0	.052	25	5	5.1	.028	17	9	4.2	.044	33	20	10.8	.093	50
Mountain whitefish	0	0.0	.000	0	0	0.0	.000	0	0	0.0	.000	0	1	0.5	.004	8
Arctic grayling	0	0.0	.000	0	0	0.0	.000	0	0	0.0	.000	0	0	0.0	.000	0
Longnose sucker	4	2.0	.021	25	5	5.1	.028	42	1	0.5	.005	8	7	3.8	.033	50
White sucker	0	0.0	.000	0	1	1.0	.005	8	1	0.5	.005	8	3	1.6	.014	17
Burbot	0	0.0	.000	0	0	0.0	.000	0	0	0.0	.000	0	0	0.0	.000	0
Flathead chub	16	8.0	.084	58	8	8.1	.045	42	43	20.1	.211	83	10	5.4	.046	50
Total	199				98				214				185			
Total Hours Fished	190.5				180.0				204.0				215.0			

continued ...

Table 3. Concluded.

	6 to 19 September				20 Sept. to 3 Oct.				4 to 17 October				Total			
	N	%	C/E	FO	N	%	C/E	FO	N	%	C/E	FO	N	%	C/E	FO
Goldeye	125	45.2	.590	100	49	21.0	.222	75	26	7.4	.170	75	624	40.4	.454	87
Walleye	39	16.6	.184	92	22	9.4	.099	67	30	8.6	.197	75	174	11.3	.127	77
Northern pike	17	6.3	.080	75	21	9.0	.095	67	22	6.3	.144	75	105	6.8	.076	63
Lake whitefish	68	25.2	.321	75	118	50.6	.534	83	257	73.4	1.685	100	487	31.5	.354	53
Mountain whitefish	0	0.0	.000	0	0	0.0	.000	0	0	0.0	.000	0	1	0.1	.001	1
Arctic grayling	0	0.0	.000	0	0	0.0	.000	0	4	1.1	.026	25	4	0.3	.003	3
Longnose sucker	8	2.9	.037	58	13	5.6	.059	50	8	2.0	.053	38	46	3.0	.033	39
White sucker	4	1.5	.019	33	0	0.0	.000	8	3	0.8	.020	38	12	0.8	.009	13
Burbot	1	0.4	.005	8	0	0.0	.000	0	0	0.0	.000	0	1	0.1	.001	1
Flathead chub	5	1.8	.023	33	10	4.3	.045	42	0	0.0	.000	0	92	6.0	.067	47
Total	267				233				350				1546			
Total Hours Fished	212.0				221.0				152.5				1375.0			

[a] Catch-per-unit-effort is expressed as numbers of fish per standard gang per hour.

Table 4. Numbers (N), percentage composition (%), average catch per seine haul (C/E) and percentage frequency of occurrence (FO) for fish captured in large mesh beach seines, Athabasca River, 1976.

Species	Date of Sample															
	31 May to 13 June				12 to 25 July				26 July to 8 Aug.				9 to 22 Aug.			
	N	%	C/E	FO	N	%	C/E	FO	N	%	C/E	FO	N	%	C/E	FO
Goldeye	12	80.0	4.0	67	63	60.1	3.7	76	249	77.6	6.6	89	201	77.6	8.7	91
Walleye	0	0.0	0.0	0	7	6.7	0.5	29	9	2.8	0.2	13	2	0.8	0.1	9
Yellow perch	0	0.0	0.0	0	1	1.0	0.1	6	0	0.0	0.0	0	2	0.8	0.1	4
Northern pike	0	0.0	0.0	0	12	11.5	0.7	35	22	6.8	0.6	28	25	9.6	0.6	26
Lake whitefish	1	6.7	0.3	33	0	0.0	0.0	0	6	1.9	0.2	7	15	5.8	0.7	17
Arctic grayling	0	0.0	0.0	0	1	1.0	0.1	6	0	0.0	0.0	0	0	0.0	0.0	0
Longnose sucker	0	0.0	0.0	0	0	0.0	0.0	0	1	0.3	0.1	2	0	0.0	0.0	0
White sucker	0	0.0	0.0	0	0	0.0	0.0	0	2	0.6	0.1	8	1	0.4	0.1	4
Trout-perch	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	0	3	1.2	0.1	4
Burbot	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	0
Flathead chub	2	13.3	0.7	33	20	19.2	1.2	35	33	10.2	0.9	42	10	3.8	0.4	26
Total	15				104				322				259			
Number of seine hauls			3				17				38				23	

continued ...

Table 4. Concluded.

Species	Date of Sample											
	6 to 19 September				20 Sept. to 3 Oct.				Total			
	N	%	C/E	FO	N	%	C/E	FO	N	%	C/E	FO
Goldeye	286	43.0	8.7	73	171	32.7	6.4	63	982	52.0	6.96	79
Walleye	14	2.1	0.4	21	8	1.5	0.3	22	40	2.1	0.28	18
Yellow perch	0	0.0	0.0	0	0	0.0	0.0	0	3	0.2	0.02	1
Northern pike	87	13.1	2.6	61	15	2.9	0.6	30	161	8.5	1.14	35
Lake whitefish	207	31.1	6.3	67	289	55.4	10.8	89	518	27.4	3.67	38
Arctic grayling	2	0.3	0.1	6	2	0.4	0.1	4	5	0.3	0.04	3
Longnose sucker	3	0.4	0.1	6	2	0.4	0.1	7	6	0.3	0.04	4
White sucker	22	3.3	0.7	12	15	2.9	0.6	22	40	2.1	0.28	16
Trout-perch	0	0.0	0.0	0	0	0.0	0.0	0	3	0.2	0.02	1
Burbot	0	0.0	0.0	0	1	0.2	0.1	4	1	0.1	0.01	1
Flathead chub	44	6.6	1.3	42	19	3.6	0.7	30	128	6.8	0.90	35
Total	665				522				1887			
Number of seine hauls			33				27				141	

Table 5. Numbers (N), percentage composition (%), average catch per seine haul (C/E), and percentage frequency of occurrence (FO) for fish captured in small mesh beach seines, Athabasca River, 1976.

Species	Date of Sample											
	20 to 27 June				14 to 23 July				14 to 19 August			
	N	%	C/E	FO	N	%	C/E	FO	N	%	C/E	FO
Goldeye	0	0.0	0.0	0	39	0.9	1.1	29	23	1.1	0.6	25
Walleye	66	2.0	3.3	40	254	6.1	7.4	71	34	1.6	0.9	46
Yellow perch	0	0.0	0.0	0	32	0.8	0.9	26	114	5.3	3.1	52
Iowa darter	0	0.0	0.0	0	0	0.0	0.0	0	1	<0.1	<0.1	3
Northern pike	0	0.0	0.0	0	11	0.3	0.3	24	11	0.5	0.3	16
Lake whitefish	0	0.0	0.0	0	11	0.3	0.3	3	1	<0.1	<0.1	3
Mountain whitefish	3	0.1	0.2	5	3	0.1	<0.1	9	1	<0.1	<0.1	3
Arctic grayling	6	0.2	0.3	10	0	0.0	0.0	0	2	0.1	<0.1	5
Longnose sucker	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
White sucker	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sucker spp.	2640	80.0	132.0	90	123	3.0	3.6	53	194	9.1	5.3	55
Trout-perch	217	6.6	10.8	60	3072	74.1	90.3	94	1066	49.9	29.6	75
Burbot	0	0.0	0.0	0	1	<0.1	<0.1	3	2	0.1	<0.1	5
Flathead chub	3	0.1	0.3	10	76	1.8	2.2	24	77	3.6	2.1	19
Lake chub	2	0.1	0.1	5	25	0.6	2.2	38	186	8.7	5.1	69
Emerald shiner	345	10.4	17.2	60	435	10.5	12.7	65	221	10.3	6.1	52
Spottail shiner	7	0.2	0.3	30	20	0.5	0.5	24	184	8.6	5.1	25
Longnose dace	1	<0.1	<0.1	5	6	0.1	0.1	3	10	0.5	0.2	22
Pearl dace	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	0
Finescale dace	0	0.0	0.0	0	2	0.1	<0.1	3	0	0.0	0.0	0
Fathead minnow	0	0.0	0.0	0	0	0.0	0.0	0	2	0.1	<0.1	3
Brassy minnow	0	0.0	0.0	0	14	0.3	0.4	3	0	0.0	0.0	0
Ninespine stickleback	0	0.0	0.0	0	0	0.0	0.0	0	1	<0.1	<0.1	3
Brook stickleback	0	0.0	0.0	0	1	<0.1	<0.1	3	1	<0.1	<0.1	3
Slimy sculpin	0	0.0	0.0	0	1	<0.1	<0.1	3	1	<0.1	<0.1	3
Spoonhead sculpin	10	0.3	0.5	25	15	0.4	0.4	21	5	0.3	0.1	19
Total	3300				4141				2137			
Number of seine hauls			20				34			36		

continued ...

Table 5. Concluded.

Species	Date of Sample 13 to 18 September				Total			
	N	%	C/E	FO	N	%	C/E	FO
Goldeye	5	0.2	0.2	9	67	0.6	0.6	19
Walleye	14	0.7	0.6	23	368	3.1	3.2	48
Yellow perch	15	0.7	0.6	27	161	1.4	1.4	30
Iowa darter	0	0.0	0.0	0	1	<0.1	<0.1	<1
Northern pike	7	0.3	0.3	9	29	0.3	0.2	14
Lake whitefish	0	0.0	0.0	0	12	0.1	0.1	<1
Mountain whitefish	2	0.1	<0.1	5	9	0.1	<0.1	<1
Arctic grayling	0	0.0	0.0	0	8	0.1	<0.1	<1
Longnose sucker	ND	ND	ND	ND	ND	ND	ND	ND
White sucker	ND	ND	ND	ND	ND	ND	ND	ND
Sucker spp.	130	6.0	5.9	77	3 087	26.3	27.5	65
Trout-perch	1 005	46.8	45.6	77	5 360	45.7	47.8	79
Burbot	0	0.0	0.0	0	3	<0.1	<0.1	<1
Flathead chub	6	0.3	0.2	9	162	1.4	1.4	17
Lake chub	765	35.6	34.7	91	978	8.3	8.7	53
Emerald shiner	58	2.7	2.6	23	1 059	9.0	9.4	52
Spottail shiner	105	4.9	4.7	50	316	2.7	2.8	30
Longnose dace	3	0.1	0.1	5	20	0.2	0.1	10
Pearl dace	1	<0.1	<0.1	5	1	<0.1	<0.1	<1
Finescale dace	0	0.0	0.0	0	2	<0.1	<0.1	<1
Fathead minnow	0	0.0	0.0	0	2	<0.1	<0.1	<1
Brassy minnow	5	0.2	0.2	9	19	0.2	0.1	<1
Ninespine stickleback	1	<0.1	<0.1	5	2	<0.1	<0.1	<1
Brook stickleback	0	0.0	0.0	0	2	<0.1	<0.1	<1
Slimy sculpin	19	0.9	0.8	9	21	0.2	0.1	<1
Spoonhead sculpin	6	0.3	0.2	9	36	0.3	0.3	19
Total	2 147				11 725			
Number of seine hauls			22				112	

impracticable. Angling resulted in the capture of 467 fish of five species (Table 6).

Floy tags were applied to 2528 fish of eight species. The majority of tags were applied to goldeye (44.4%), lake whitefish (18.3%), walleye (17.2%), and northern pike (11.2%), but small numbers of longnose suckers (4.1%), white suckers (3.1%), flathead chub (1.3%), and burbot (0.5%) were also tagged (Table 7). Prior to spring, 1977, 51 tagged fish had been recaptured for a recapture rate of 2.0%. Fish recaptured at the original tagging site on the same day or on the following day were not included in the figures given in Table 7. Complete details of all tag recaptures are presented in Appendix 6.5.

4.2 LIFE HISTORIES OF FISH SPECIES

4.2.1 Goldeye

4.2.1.1 Distribution and relative abundance. Goldeye was the third most abundant species taken during the study comprising 11.6% of the total combined catch (Table 2). This species, however, dominated the catch in standard gangs and large mesh seines. Goldeye were taken in 87% of all standard gangs accounting for 40.4% of the total catch (Table 3). The corresponding values for large mesh seines were 79% and 52.0% (Table 4).

Tagging gill nets set in mid-May indicated that goldeye were present throughout the study area in considerable numbers at that time. Catch-per-unit-effort values produced by standard gangs (Table 3) and large mesh seines (Table 4) showed that goldeye were also present in abundance throughout the study area during July and August. A decrease in catch-per-unit-effort was observed in late September, however, suggesting a general movement of goldeye out of the study area at that time.

During the present study most goldeye were captured at Sites 1 to 12, 13 to 35, 36 to 40, 51, 52, 54, and 55 (Figure 3,

Table 6. Numbers (N) and percentage composition (%) for fish captured by angling, Athabasca River, 1976[a].

Species	Date of Sample								Total	
	June		July		August		September			
	N	%	N	%	N	%	N	%	N	%
Goldeye	136	40.6	21	52.5	0	0.0	0	0.0	157	33.7
Walleye	161	48.1	7	17.5	2	3.1	9	33.3	179	38.4
Northern pike	4	1.2	2	5.0	62	96.9	18	66.7	86	18.5
Flathead chub	24	7.2	10	25.0	0	0.0	0	0.0	34	7.3
Burbot	11	3.3	0	0.0	0	0.0	0	0.0	11	2.4
Total	336		40		64		27		467	

[a] No record was kept of angling effort although the major use of angling gear occurred in late June and early July.

Table 7. Summary of tag releases and recaptures by species for fish tagged in the Athabasca River, 1976.

Species	Tag Releases N	Tag Releases %	Tag Recaptures N	Tag Recaptures %
Walleye	434	17.2	19	4.4
Goldeye	1123	44.4	9	0.8
Northern pike	282	11.2	18	6.4
Lake whitefish	464	18.3	5	1.1
Longnose sucker	103	4.1	0	0.0
White sucker	77	3.1	0	0.0
Flathead chub	32	1.3	0	0.0
Burbot	13	0.5	0	0.0
Total	2528		51	

Appendix 6.1). Although captured in all habitat types, goldeye seemed to be most abundant in back eddies. While only 43.3% of the total large mesh seine fishing effort was expended in back eddies, these areas yielded 76.3% of all goldeye taken in this gear (Appendix 6.2). In terms of standard gangs, back eddies produced 58.5% of the total catch while absorbing 55.4% of the total fishing effort (Appendix 6.2).

4.2.1.2 Age and growth. Goldeye from all sources ranged in fork length from 24 mm to 374 mm with 98% falling within the 210 to 319 mm range. Similar results were produced using either standard gangs or large mesh seines, and no differences in length frequency distribution were observed between male and female goldeye (Table 8).

Age determinations were performed on 493 goldeye captured in standard gangs. While these goldeye ranged from age 2 to age 6, the vast majority were age 4 (53.9%) and age 5 (41.7%). The latter two age groups correspond to the 1972 and 1971 year classes, respectively. The 1971 year class for goldeye produced in the Lake Claire-Lake Mamawi system of the Peace-Athabasca Delta is known to have been a particularly successful one (Kooyman 1973; Donald and Kooyman 1974). This success could account for the high numbers of five year old fish in our samples. The 1972 year class, however, is reputed to have been relatively unsuccessful, thus providing no explanation for the preponderance of age 4 fish in the present study other than errors in age determination.

Kennedy and Sprules (1967) noted an absence of age 5 goldeye in samples taken from Lake Winnipegosis and Lake Claire that could not be explained on the bases of year class weakness or sampling bias. These authors also found a fluvial population in the Saskatchewan River delta of Manitoba to be dominated by age 5 fish. On the basis of these observations, Kennedy and Sprules suggested that age 5 goldeye, and to some extent, age 4 and age 6 goldeye as well, have developed a unique behaviour that is associated with approaching maturity. They postulated that, in lacustrine goldeye populations,

Table 8. Length-frequency distribution for goldeye captured in three different gear types, Athabasca River, 1976.

Fork Length (mm)	Standard Gangs				Large Mesh Seines	Angling Gear	Total	
	Male	Female	Unsexed	Total			N	%
150 to 159	0	0	1	1	0	0	1	0.1
160 to 169	0	0	0	0	1	0	1	0.1
170 to 179	0	0	1	1	1	0	2	0.1
180 to 189	0	0	1	1	1	0	2	0.1
190 to 199	0	0	1	1	2	0	3	0.2
200 to 209	0	0	2	2	3	0	5	0.3
210 to 219	0	1	4	5	7	0	12	0.7
220 to 229	2	1	8	11	17	0	28	1.7
230 to 239	12	7	18	37	70	6	113	6.7
240 to 249	22	30	66	118	210	24	352	21.0
250 to 259	43	48	84	175	283	37	495	29.5
260 to 269	45	45	18	108	191	24	323	19.2
270 to 279	24	32	7	63	89	10	162	9.6
280 to 289	14	16	1	31	51	2	84	5.0
290 to 299	12	13	2	27	22	1	50	3.0
300 to 309	5	6	1	12	22	0	34	2.0
310 to 319	1	5	0	6	3	1	10	0.6
320 to 329	0	0	0	0	1	0	1	0.1
330 to 339	0	0	0	0	0	0	0	0.0
Total	180	204	215	599	974	105	1678	

immature fish of age groups 4 to 6 prefer rivers to lakes. If, as Kennedy and Sprules suggest, this behaviour is peculiar to lake populations, it suggests that the goldeye in our study area may come from Lake Athabasca rather than from some upstream location.

Age-length and age-weight data for Athabasca River goldeye captured during the current study are summarized in Table 9. A statistical test of our data indicated no difference in growth rate between males and females over the range of ages available. Therefore, the data for the sexes have been combined. Kennedy and Sprules (1967) also found that young goldeye of both sexes grow at approximately the same rate, but that among older fish females tend to be significantly larger than males of the same age. In Lake Claire, Alberta, eight years was the age at which the growth rates of males and females began to diverge.

Growth rates for Athabasca River goldeye were virtually identical to those reported by Kristensen et al. (1976) for goldeye from the Peace-Athabasca Delta. This represents further evidence that fish from these two areas may be part of the same population.

The mathematical relationship between fork length and body weight for Athabasca River goldeye (n = 494, r = 0.957, range 152 to 333 mm) is described by the equation:

$$\log_{10}W = 3.386(\log_{10}L) - 5.916; \; sb = 0.002$$

No significant difference was observed between the slopes of the regression lines for male and female goldeye, thus the data for the sexes were combined in the above equation.

The value of the exponent (b) varied from 2.480 in May to 3.544 in mid-August, indicating an improvement in condition through the summer.

4.2.1.3 Sex and Maturity. Sex was determined by gonadal inspection for 380 goldeye of which 200 (52.6%) were females. Although females outnumbered males in five of seven sampling periods, at no time was the sex ratio significantly different from unity.

Only 1.1% of the goldeye examined were considered to be

Table 9. Age-length and age-weight relationships for goldeye captured in standard gangs from the Athabasca River, 1976.

Scale Age	Number of Fish	Fork length (mm)			Weight (g)		
		Mean	Std. Dev.	Range	Mean	Std. Dev.	Range
0+	12[a]	40.6	9.81	24 to 50	0.8	0.39	0.2 to 1.2
1	1[b]	164.0			54.0		
2	3	171.7	18.61	152 to 189	56.7	11.54	50 to 70
3	17	234.2	21.29	191 to 271	128.2	38.11	60 to 220
4	267	253.3	77.84	222 to 316	167.9	37.87	90 to 360
5	204	268.7	19.73	231 to 319	211.5	59.99	110 to 390
6	2	305.0	39.59	277 to 333	335.0	162.63	220 to 450
Total	506						

[a] From small mesh seines.

[b] From large mesh seines.

sexually mature. Some gonadal development was observed in 57% of age 4 fish and in 65% of age 5 fish. It appeared that while many five year old fish were likely to mature by age 6, many would not reach sexual maturity until age 7. Kennedy and Sprules (1967) stated that goldeye in Lake Claire, Alberta, begin to mature at age 6 or 7 with males maturing one year earlier than females.

4.2.1.4 Spawning. There is no evidence to suggest either that goldeye spawned within our study area or that spawning migration passed through the study area in 1976. The opposite, in fact, would appear true, as 98.9% of all goldeye examined in this study were sexually immature, and only 12 young-of-the-year were captured.

Major spawning areas for goldeye are known to exist in Mamawi Lake and Lake Claire within the Peace-Athabasca Delta. Mature fish are known to migrate from the lower Peace River into the delta during the spring breakup (Donald and Kooyman 1977).

4.2.1.5 Migrations and movements. Goldeye have been reported to undergo extensive migrations, often travelling considerable distances in short periods of time (Reed 1962; Donald and Kooyman 1977). Donald and Kooyman (1977) describe the distribution and migration of goldeye in the Peace-Athabasca Delta and the Peace River. Despite the relatively large numbers of goldeye tagged during the present study (n = 1123) only nine were recaptured (Table 7). Such results suggest a very large and/or mobile population, and more returns will be required before any trends become apparent. Three goldeye were recaptured at their original tagging sites while one had moved 12 km upstream in 42 days (Appendix 6.5). Downstream movement of from 19 to 58 km was exhibited in four cases. The greatest movement exhibited by a goldeye in this study was 323 km in 50 days. This fish was tagged at km 39.8 (Mile 24.9) on 31 July and recaptured 10 September at the weir on Révillon Coupé, north of Fort Chipewyan (Figure 1). Further evidence that some movement of individual fish does occur between the Peace-Athabasca Delta and our study area was provided by the recapture of a goldeye, tagged in the delta (Mr. J. Kristensen, LGL Ltd., Environmental Research Associates, Edmonton, verbal communication with D. K. Berry, August 1976), at km 74.9 (Mile 46.8) on the Athabasca River. This fish had moved 288 km in 38 days.

Catch data from the present study (Tables 3 and 4) suggest a movement of goldeye out of the study area in late autumn. Such a migration would necessitate a movement back into the study area at another time of the year. Goldeye are known to have been present in the study area by mid-May 1976 as they were commonly taken in tagging nets at that time. The expected in-migration, therefore, may occur in late winter or early spring either under the ice or shortly after spring breakup. This migration is clearly a movement of immature fish between overwintering and summer feeding areas. A spring feeding movement has also been suggested for goldeye in the North Saskatchewan River (Paterson 1966).

4.2.1.6 <u>Food habits</u>. Kennedy and Sprules (1967) reported that goldeye consume a great variety of food. Examination of 632 stomachs of goldeye captured in the Athabasca River in 1976 led to a similar conclusion. Table 10 lists the major food items found and summarizes, in terms of percentage frequency of occurrence, the results obtained on several dates throughout the open-water period. Results of the volumetric analysis are presented in Table 11.

Although goldeye had consumed such things as fish, arachnids, frogs, mice, and organic debris, the diet consisted primarily of insects, with 10 orders being identified from the stomach contents. While terrestrial Hymenoptera (ants) were common in the food, the bulk of the diet, both in terms of frequency of occurrence and volume, consisted of aquatic insects. Especially important were nymphal Plecoptera and Ephemeroptera, and adult Hemiptera. These four insect orders usually made up more than 50% of the food volume (37.3% to

Table 10. Percentage frequency of occurrence of major food items in the stomach contents of goldeye from the Athabasca River, 1976.

Food Item	Percentage Frequency of Occurrence[a]									Totals	
	20 May	10 June	12 July	25 July	9 Aug.	25 Aug.	8 Sept.	20 Sept.	5 Oct.	N	%
Insects											
Plecoptera	79.4	100.0	31.1	24.4	33.3	25.5	7.8	14.9	26.9	148	28.5
Ephemeroptera	26.3	33.3	48.1	42.2	41.9	21.8	2.9	2.1	0.0	137	26.4
Hemiptera	12.8	0.0	2.8	13.3	19.4	10.9	59.2	100.0	100.0	172	33.1
Hymenoptera	2.6	16.7	19.8	33.3	47.3	25.5	40.8	8.5	7.7	144	27.7
Trichoptera	0.0	0.0	10.4	4.4	6.5	5.5	1.9	2.1	0.0	25	4.8
Odonata	7.7	83.3	15.1	22.2	24.7	18.2	22.3	19.2	7.7	101	19.4
Diptera	46.2	16.7	7.6	6.7	5.4	5.5	9.7	0.0	0.0	48	9.2
Coleoptera	12.8	66.7	22.6	11.1	19.4	16.4	22.3	14.9	7.7	97	18.7
Lepidoptera	0.0	0.0	2.8	4.4	1.1	1.8	2.9	2.1	0.0	11	2.1
Orthoptera	0.0	0.0	0.0	0.0	1.1	0.0	0.0	2.1	0.0	2	0.4
Insect Remains	74.4	100.0	43.4	35.6	45.2	63.6	32.0	21.3	34.6	226	43.5
Fish Remains	2.6	0.0	5.7	8.9	1.1	5.5	3.9	0.0	3.9	20	3.9
Nematomorpha	7.7	33.3	0.0	0.0	1.1	0.0	0.0	0.0	0.0	6	1.2
Arachnida	0.0	0.0	0.0	0.0	2.2	0.0	8.7	2.1	0.0	12	2.3
Frogs	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	1	0.2
Mice	0.0	0.0	0.9	4.4	0.0	0.0	3.9	0.0	0.0	7	1.4
Debris	7.7	100.0	29.3	42.2	46.2	23.6	35.9	10.6	11.5	160	30.8
No. Stomachs Examined	39	6	138	50	121	85	120	47	26	632	
No. Stomachs With Food	39	6	106	45	93	55	103	47	26	520	
No. Stomachs Gorged	0	1	5	3	3	0	3	39	2	56	

[a] Number of occurrences expressed as a percentage of the number of stomachs containing food.

Table 11. Estimated percentage composition by volume of major food items in the stomach contents of goldeye captured from the Athabasca River, 1976.

Food Item	Estimated Percentage Composition by Volume									Food Item Point Totals	
	20 May	10 June	12 July	25 July	9 Aug.	25 Aug.	8 Sept.	20 Sept.	5 Oct.	N	%
Insects											
Plecoptera	46.1	33.7	13.5	4.5	9.6	15.4	3.1	1.0	4.1	471	10.5
Ephemeroptera	3.5	2.4	33.2	41.2	24.9	9.2	0.4	0.1	0.0	592	13.1
Hemiptera	1.9	0.0	0.5	1.7	3.0	4.7	31.4	93.9	87.5	1401	31.1
Hymenoptera	0.3	1.2	6.0	6.2	23.2	8.1	17.2	0.4	0.7	397	8.8
Miscellaneous[a]	11.9	26.5	18.8	11.9	16.1	19.0	20.8	2.7	1.8	609	13.5
Insect Remains	30.9	12.0	16.2	9.3	14.5	28.8	8.3	1.2	3.7	556	12.3
Fish Remains	1.6	0.0	1.4	4.0	0.4	8.1	0.8	0.0	1.1	69	1.5
Miscellaneous and Debris[b]	3.8	24.2	10.4	21.2	8.3	6.7	18.0	0.7	1.1	413	9.2
No. Stomachs Examined	39	6	138	50	121	85	120	47	26	632	
Total Food Points Assigned	369	83	666	354	695	358	796	916	271	4508	100.0

[a] Miscellaneous insects include: Tricoptera, Diptera, Coleoptera, Odonata, Lepidoptera, Orthoptera.

[b] Miscellaneous and debris include: Nematomorpha, Arachnida, Frogs, Mice, Debris.

The diet of goldeye was found to vary through the summer. Tables 10 and 11 indicate that Plecoptera nymphs were especially important food items during May and June. During July and August, the food consisted largely of nymphal Ephemeroptera and adult Hymenoptera while Hemiptera dominated the stomach contents in September and October.

4.2.2 Walleye

4.2.2.1 Distribution and relative abundance. Walleye comprised only 7.2% of the total combined catch (Table 2) but they were abundant in the study area during early May. Tagging gill nets (10.2 cm stretched mesh) produced a catch-per-unit-effort of 1.82 ± 0.41 walleye per 22.9 m per hour on 4 to 10 May. By 19 to 23 May the catch-per-unit-effort in the same nets had decreased to 0.61 ± 0.22 walleye, and on 7 to 10 June the value was 0.13 ± 0.02 walleye. A decrease in abundance was clearly evident at this time.

During the summer, walleye were present in small numbers throughout the study area. They were captured in 77% of all standard gangs but accounted for only 11.3% of the total catch in this gear (Table 3, Appendix 6.4). Large mesh seines captured few walleye. Walleye were taken in only 18% of all large mesh seine hauls and made up only 2.1% of the total catch in this gear (Table 4).

Young-of-the-year walleye were taken in 48% of all small mesh seine hauls averaging 3.2 individuals per haul (Table 5). Fish of this age group were usually found in small schools. They were most common during July at which time they were caught in 71% of all small mesh seine hauls. The reduced catch-per-unit-effort in August and September (Table 5) suggests an early downstream movement of walleye fry, possibly to nursery areas in the delta or Lake Athabasca.

The majority of walleye were captured at Sites 1 to 12, 14, 17, 20 to 29, 33, 36 to 45, 47, 52, 56, 59, 60, and at island sites opposite Site 12, above Site 9, and 3 km below Fort MacKay (Figure 3,

Appendix 6.1). On the basis of catch in relation to the amount of sampling effort expended, more walleye were present in back-eddies and tributary-associated sites than in other areas (Appendix 6.2).

4.2.2.2 Age and growth. Walleye ranged in fork length from 22 mm to 611 mm. Excluding young-of-the-year (22 to 115 mm), fish in the 370 to 529 mm range comprised 70.6% of the total (Table 12). From the data available it is not possible to detect any differences in the length-frequency distribution for males and females.

Scale ages were determined for 364 walleye. Twenty-three of these fish were young-of-the-year, captured in August, while 151 were taken in tagging nets in May during the spawning migration. The remainder were captured in standard gangs between July and October. Walleye ranged up to eight years in age with most (75.8%) of the sample being age 4 to age 7 inclusive (Table 13).

Age-length data (Table 13) show Athabasca River walleye to be among the fastest growing walleye reported in the literature. Males were longer than females in age groups 3, 5, and 7 but these differences were not statistically significant. Females were significantly longer than male walleye at age 6 (Table 13). Typically, the growth rates of male and female walleye are similar up to approximately the age of first sexual maturity, after which the females tend to be larger (Mraz 1968; Priegel 1969; Rawson 1957).

Athabasca River walleye in the present study increased in fork length at a rate almost identical to that reported for Lake Athabasca fish by Kristensen et al. (1976). This fact suggests that walleye in our study area may be part of the Lake Athabasca population.

Walleye gained weight slowly during the first three years of life (Table 14). The rate of weight gain was rapid during years 4 to 6, after which it appeared to decrease. Female walleye were heavier than males in age groups 4, 5, 6, and 8 with a significant difference occurring at age 6 (Table 14). Males outweighed females at age 3 (significant) and age 7.

Table 12. Length-frequency distribution for walleye captured by four gear types from the Athabasca River, 1976. For tagging nets set during May and for standard gangs the number of male (M) and female (F) walleye are indicated.

Fork Length (mm)	May Tagging Nets			Standard Gangs			Large Mesh Seines	Angling Gear	Combined Total[a]
	M	F	Total [a]	M	F	Total [a]			
110 to 119	0	0	0	0	0	1	0	0	1
120 to 129	0	0	0	0	0	0	0	0	0
130 to 139	1	0	1	0	0	1	0	0	2
170 to 179	0	0	0	0	0	0	3	0	3
190 to 199	0	0	0	0	0	0	2	1	3
200 to 109	0	0	0	0	0	0	1	0	1
210 to 219	0	0	0	1	0	1	0	0	1
220 to 229	0	0	0	0	0	0	1	1	2
230 to 239	0	0	0	0	0	2	0	0	2
240 to 249	0	0	0	2	2	8	0	2	10
250 to 259	0	0	0	1	0	4	0	2	6
260 to 269	2	0	3	2	1	4	1	4	12
270 to 279	5	0	6	2	0	4	1	8	19
280 to 289	0	0	0	1	0	4	1	3	8
290 to 299	0	0	0	0	2	6	3	11	20
300 to 309	0	0	1	3	1	6	1	15	23
310 to 319	0	0	1	1	0	2	0	7	10
320 to 329	0	0	0	5	2	8	1	3	12
330 to 339	3	0	5	6	0	8	2	13	28
340 to 349	1	0	2	1	1	2	2	12	18
350 to 359	0	0	3	7	0	7	2	11	23
360 to 369	0	0	2	4	0	4	1	9	16
370 to 379	1	0	2	4	2	6	1	7	16
380 to 389	8	1	10	2	1	3	1	4	18
390 to 399	6	1	7	8	1	9	0	6	22
400 to 409	10	0	12	10	3	13	2	6	33
410 to 419	18	0	24	5	1	6	0	4	34
420 to 429	27	0	37	8	3	11	0	9	57
430 to 439	36	0	41	9	3	12	1	2	56
440 to 449	40	2	47	9	3	12	3	10	72
450 to 459	45	2	57	10	7	17	0	4	78
460 to 469	29	0	34	6	5	11	1	4	50
470 to 479	23	2	32	8	2	10	0	1	43
480 to 489	18	2	24	6	2	8	0	0	32
490 to 499	13	1	15	2	3	7	0	1	23
500 to 509	11	0	12	3	2	5	0	0	17
510 to 519	2	1	4	4	2	6	0	1	11
520 to 529	1	1	3	2	0	2	0	0	5
530 to 539	1	1	3	0	1	1	0	1	5

continued ...

Table 12. Concluded.

Fork Length (mm)	May Tagging Nets			Standard Gangs			Large Mesh Seines	Angling Gear	Combined Total[a]
	M	F	Total[a]	M	F	Total[a]			
540 to 549	1	0	2	0	0	0	0	0	2
550 to 559	2	1	3	0	3	3	0	0	6
560 to 569	0	0	0	0	0	0	0	0	0
570 to 579	0	0	0	1	0	1	0	0	1
580 to 589	0	0	0	0	0	1	0	0	1
610 to 619	0	0	0	1	0	1	0	0	1
Totals	304	15	393	134	53	217	31	162	803

[a] Includes unsexed fish.

Table 13. Age-length (mm) relationship for walleye captured from the Athabasca River, 1976[a]. Sexes separate and combined (includes unsexed fish).

Scale Age (Year Class)	Males				Females				All Fish				t-test
	N	Mean	S.D.	Range	N	Mean	S.D.	Range	N	Mean	S.D.	Range	
0+ (1976)	ND				ND				23	93.7	10.7	69 to 115	
1 (1975)	ND				ND				7	178.5	39.5	116 to 238	
2 (1974)	2	262.5	6.3	258 to 267	ND				8	254.9	22.7	220 to 291	
3 (1973)	15	309.5	66.1	205 to 434	5	267.8	25.5	243 to 295	32	294.2	52.3	205 to 434	2.028
4 (1972)	37	384.8	50.2	247 to 461	7	410.9	35.8	345 to 450	58	378.4	55.6	247 to 461	1.642
5 (1971)	54	423.3	52.3	289 to 556	11	419.6	59.0	325 to 483	72	413.3	63.2	289 to 556	0.193
6 (1970)	69	450.9	34.4	345 to 517	22	485.3	49.1	393 to 585	91	459.2	41.0	345 to 585	2.959[b]
7 (1969)	45	478.8	29.7	422 to 576	10	467.2	66.1	398 to 611	55	475.7	38.8	398 to 611	0.542
8 (1968)	17	474.1	32.4	419 to 548	1	532.0			18	477.3	34.3	419 to 548	
Total	239				56				364			69 to 611	

[a] Includes 151 fish taken in 10.2 cm gill nets in May during spawning run; 190 fish caught in standard gangs in July to October; 23 young-of-the-year captured in small mesh seines in August.

[b] Significant difference in means (P <0.05) for males and females.

Table 14. Age-weight (g) relationship for walleye captured from the Athabasca River, 1976[a]. Sexes separate and combined (includes unsexed fish).

Scale Age (Year Class)	Males				Females				All Fish				t-test
	N	Mean	S.D.	Range	N	Mean	S.D.	Range	N	Mean	S.D.	Range	
0+ (1976)	ND				ND				23	8.9	3.1	3.6 to 18.7	
1 (1975)	ND				ND				7	67.9	37.7	18 to 130	
2 (1974)	2	180.0			ND				8	150.0	41.1	100 to 220	
3 (1973)	15	360.0	210.6	130 to 850	5	194.0	70.2	130 to 280	32	287.2	173.2	130 to 850	2.643[b]
4 (1972)	37	651.3	250.5	130 to 1140	7	784.3	205.5	460 to 980	58	627.2	264.2	130 to 1140	1.513
5 (1971)	54	861.7	276.9	340 to 1650	11	912.7	383.2	350 to 1400	72	825.3	337.3	160 to 1650	0.420
6 (1970)	69	1018.8	210.1	420 to 1520	22	1365.0	381.7	720 to 2110	91	1102.5	300.5	420 to 2110	4.062[b]
7 (1969)	45	1216.9	236.3	850 to 2120	10	1190.0	456.8	740 to 2280	55	1212.0	283.6	740 to 2280	0.181
8 (1968)	17	1174.1	248.1	840 to 1760	1	2060.0			18	1223.3	318.6	840 to 2060	
Total	239				56				364				

[a] Includes 151 fish taken in 10.2 cm gill nets in May during spawning run; 190 fish caught in standard gangs in July to October; 23 young-of-the-year captured in small mesh seines in August.

[b] Significant difference in means ($P < 0.05$) for males and females.

The ranges in both length and weight within age groups (Tables 13 and 14) are great and overlap broadly. This is believed to result from the fact that samples were taken over several months.

The mathematical relationship between fork length and body weight for male walleye captured in standard gangs during 1976 ($n = 136$, $r = 0.969$, range 218 to 576 mm) is expressed by the equation:

$$\log_{10}W = 3.072(\log_{10}L) - 5.151; \ sb = 0.005$$

For female walleye ($n = 50$, $r = 0.985$, range 343 to 611 mm) the length-weight relationship is:

$$\log_{10}W = 3.218(\log_{10}L) - 5.515; \ sb = 0.006$$

A test of homogeneity indicated no significant difference between the slopes of the regression lines for males and females ($t = 1.260$; $P < 0.05$).

4.2.2.3 Sex and maturity. Age-specific sex ratios and maturity data for walleye collected during 1976 are presented in Table 15. Data for the period 4 to 23 May were gathered during the spring spawning run. This sample was dominated by males which comprised 97.4% of the total. Such a ratio suggests that the sample was obtained either during the early stages of the run before the females had entered the study area, or during the late stages after the females had departed. Priegel (1970) states that male walleye precede the females onto the spawning grounds and remain there throughout the spawning season, whereas females enter the spawning area, spawn, and leave immediately. Although male walleye usually outnumber females during the spawning run (Machniak 1975a), the male:female ratio usually ranges from 0.8:1 to 14:1 (Johnson 1961).

Between July and October, male walleye continued to outnumber females in our samples although only by a ratio of 4:1 (Table 15). This may indicate that females leave the area very quickly after spawning whereas the post-spawning movement of males may be more gradual.

Table 15. Age-specific sex ratios and maturity for walleye from the Athabasca River in 1976. Sex ratios were based only on fish for which sex was determined.

Date/Age (Year Class)	Males N	Males %	Males % Mature	Females N	Females %	Females % Mature	Unsexed Fish	Total N	Total %	X^2
4 to 23 May (Tagging Nets)										
2 (1974)	2	100.0	0.0	0	0.0	0.0	0	2	1.3	
3 (1973)	5	100.0	40.0	0	0.0	0.0	0	5	3.3	
4 (1972)	18	100.0	88.8	0	0.0	0.0	0	18	11.9	
5 (1971)	26	100.0	96.0	0	0.0	0.0	0	26	17.3	
6 (1970)	51	96.2	92.2	2	3.8	100.0	0	53	35.1	
7 (1969)	34	100.0	100.0	2	5.6	100.0	0	36	23.8	
8 (1968)	11	100.0	100.0	0	0.0	0.0	0	11	7.3	
Totals	147	97.4	91.2	4	2.6	100.0	0	151	100.0	69.12[a]
July to October (Standard Gangs)										
1 (1975)	ND			ND			7	7	3.7	
2 (1974)	ND			ND			6	6	3.2	
3 (1973)	10	66.7	10.0	5	33.3	0.0	12	27	14.2	0.83
4 (1972)	19	73.1	47.4	7	26.9	14.3	14	40	21.0	2.77
5 (1971)	28	71.8	85.7	11	28.2	45.5	7	46	24.2	4.26[a]
6 (1970)	18	47.4	88.9	20	52.6	80.0	0	38	20.0	0.01
7 (1969)	11	57.9	100.0	8	42.1	100.0	0	19	10.0	0.44
8 (1968)	6	85.7	100.0	1	14.3	100.0	0	7	3.7	1.79
Totals	92	63.9	73.9	52	36.1	59.6	46	190	100.0	5.55[a]
Grand Totals	239	81.9	84.5	56	19.0	62.5	46	341		57.58[a]

[a] Signficiant differences ($P < 0.05$) between numbers of males observed and expected for unity (Chi-square test).

The youngest mature female walleye captured during the study was four years old. At age 5, approximately half the females examined were mature while 81.8% were sexually mature at age 6 (Table 15). Males tended to mature at a younger age than females, the youngest mature male being age 3. At age 4, 64.9% of the males captured were sexually mature while 90.7% were mature at five years of age. Bidgood (1971) reported that in Richardson Lake (Figure 1), male walleye spawned for the first time at age 4 and females first matured at four to six years of age.

4.2.2.4 Spawning. It was evident that a spawning migration was in progress at the commencement of the study. Ripe males dominated the catch during the period 4 to 23 May. The first spent fish (both male and female) were taken in early June, suggesting that spawning probably occurred in late May or early June.

Walleye usually spawn in the rapids of streams or over boulder or gravel shoals in lakes. Fish often leave ice-covered lakes to move into streams, or headwater lakes of streams, from which the ice has just gone out. Spawning occurs over a water temperature range of 5.6 to 11.1°C (Scott and Crossman 1973).

Although spawning was not observed during the present study, there would seem to be numerous sites within the study area where walleye could spawn. Most of the tributaries in the area possess sites apparently suitable for spawning although Bond and Machniak (1977) report that walleye did not spawn in the Muskeg River in 1976. In the Athabasca River, Site 37 (Figure 3, Appendix 6.1) appeared to be a possible spawning area. The locations with the greatest potential for walleye spawning, however, appear to be the bouldery areas of the Clearwater and Athabasca rivers upstream from Fort McMurray.

4.2.2.5 Migrations and movements. As previously mentioned, a walleye spawning migration was under way at the commencement of the study in early May 1976. An abrupt decrease in catch-per-unit-effort in late May and early June (in tagging nets) and low catches throughout the remainder of the summer (Tables 3 and 4) suggest that most walleye do not remain in the study area but depart shortly after spawning.

Evidence from tag returns (Appendix 6.5) suggests that, after spawning, walleye move downstream to the Athabasca delta and Lake Athabasca. This movement may be very rapid as three fish recaptured in the Athabasca delta, had moved 180 to 210 km downstream in 27 to 30 days. Six other fish were recaptured in Lake Athabasca, having moved 264 to 286 km in 26 to 132 days.

4.2.2.6 Growth of young-of-the-year. Walleye fry captured in the Athabasca River on 27 June 1976 had a mean fork length of 37.2 mm (range 23 to 56 mm). Fry taken from several tributary streams between 5 and 14 July showed a mean fork length of 58.4 mm (range 43 to 89 mm). By 21 July, young-of-the-year walleye from the Athabasca River had a mean fork length of 70.8 mm (range 22 to 102 mm), and the mean length had increased to 93.7 mm (range 69 to 115 mm) by 15 August (Table 16).

4.2.2.7 Food habits. Most young-of-the-year walleye stomachs (89.2%) contained some food. By contrast, 74.5% of the older fish examined had empty stomachs (Table 17).

Young-of-the-year walleye had a diet consisting largely of fish. Among those stomachs that contained some food, 86.1% contained fish remains. Insects had been consumed in small quantities by young-of-the-year walleye (Table 17).

Older walleye were also mainly piscivorous with fish remains occurring in 44.6% of those stomachs that contained some food (Table 17). Among larger walleye, fish accounted for 79.7% of the total estimated food volume. However, immature aquatic insects of the orders Plecoptera, Odonata, and Ephemeroptera made up 14.3% of the food volume overall and were especially important in the diet during the first half of the summer (Table 18).

Table 16. Comparison of mean fork lengths and mean weights for young-of-the-year walleye collected from the Athabasca River and tributary streams during 1976.

Source	Date	Number of Fish	Fork length (mm)			Weight (g)		
			Mean	S.D.	Range	Mean	S.D.	Range
Athabasca River	27 June	58	37.2	6.8	23 to 56	0.51		0.2 to 1.8
Athabasca River	21 July	150	70.8	11.6	22 to 102	3.38	1.80	0.3 to 10.5
Athabasca River	15 August	23	93.7	10.7	69 to 115	8.87	3.10	3.6 to 18.7
Steepbank River[a]	5 July	40	51.8	7.8	43 to 80	1.31	0.61	0.7 to 4.2
Steepbank River[b]	5 July	22	50.1	5.1	44 to 65	1.25	0.46	0.6 to 2.9
Ells River[c]	9 July	40	67.5	10.6	49 to 89	3.35	1.09	1.9 to 6.7
Ells River[d]	9 July	19	60.5	11.3	49 to 89	3.10	1.48	2.1 to 7.6
MacKay River[e]	9 July	39	61.5	10.0	50 to 83	2.46	1.58	1.1 to 6.8
Tar River[f]	14 July	28	56.0	5.2	44 to 68	1.80	0.51	0.9 to 2.9

[a] Mouth of Steepbank River.
[b] 2 km upstream of confluence with Athabasca River.
[c] Mouth of Ells River
[d] 2 km upstream of confluence with Athabasca River.
[e] 8 km upstream of confluence with Athabasca River.
[f] Mouth of Tar River.

Table 17. Percentage frequency of occurrence of major food items in the stomach contents of young-of-the-year and older walleye from the Athabasca River, 1976.

Food Item	Young-of-the-year[a]		Age Groups 1 to 8[b]	
	Frequency	%[c]	Frequency	%[c]
<u>Insects</u>				
Plecoptera	0	0.0	15	18.1
Odonata	0	0.0	7	8.4
Ephemeroptera	4	3.5	8	9.6
Diptera	3	2.6	0	0.0
Hemiptera	1	0.9	0	0.0
Insect Remains	2	1.7	0	0.0
<u>Fish</u>				
Flathead chub	0	0.0	2	2.4
Mountain whitefish	0	0.0	1	1.2
Trout-perch	2	1.7	2	2.4
Burbot	0	0.0	1	1.2
Goldeye	0	0.0	1	1.2
Arctic grayling	0	0.0	1	1.2
Sculpins	1	0.9	0	0.0
Yellow perch	1	0.9	0	0.0
Suckers	4	3.5	0	0.0
Fish Remains	99	86.1	37	44.6
<u>Miscellaneous</u>				
Debris	15	13.0	9	10.8
No. Stomachs Examined	129		326	
No. Stomachs With Food	115		83	

[a] Captured in small mesh seines.

[b] Captured in standard gangs.

[c] Expressed as percentage of total number of stomachs containing food.

Table 18. Estimated percentage composition by volume of major food items in the stomach contents of adult walleye captured from the Athabasca River, 1976.

Food Item	Estimated Percentage Composition by Volume										Food Item Point Total	
	10 May	20 May	10 June	12 July	25 July	9 Aug.	25 Aug.	8 Sept.	20 Seot,	5 Oct.	N	%
<u>Insects</u>												
Plecoptera	15.0	62.5	1.8	10.1	5.9	0.0	4.9	0.0	1.5	0.0	39	6.3
Odonata	0.0	33.0	0.0	2.5	0.0	40.0	2.1	0.0	0.0	2.4	24	3.9
Ephemeroptera	0.0	0.0	1.8	13.9	19.1	0.0	0.0	0.0	0.0	0.0	25	4.1
<u>Miscellaneous</u>												
Fish Remains	75.0	4.2	96.4	73.5	70.6	60.0	92.3	97.8	61.8	87.8	490	79.7
Debris	10.0	0.0	0.0	0.0	4.4	0.0	0.7	2.2	36.7	9.8	37	6.0
No. Stomachs Examined	86	58	14	9	14	24	28	37	21	25	326	0
Total Food Points Assigned	20	24	56	79	68	25	142	92	68	41	615	100.0

4.2.3 Lake Whitefish

4.2.3.1 Distribution and relative abundance. Lake whitefish accounted for 6.3% of the total catch in all gear types (Table 2). However, this species was taken in 53% of all standard gangs and in 38% of all large mesh seine hauls, comprising 31.5% and 27.4%, respectively of the total catch in these gear types (Tables 3 and 4).

Standard gang (Table 3) and large mesh seine (Table 4) results show that lake whitefish were sparsely distributed and occurred only in small numbers in the study area until late August. During September, however, catch-per-unit-effort values increased rapidly in both gear types as a large spawning migration entered the study area. During the period 20 September to 3 October, whitefish were taken in 89% of all large mesh seine hauls and comprised 55.4% of the total catch (Table 4).

Most lake whitefish were captured at Sites 2, 4 to 12, 13, 14, 18, and 20 to 35 (Figure 3, Appendix 6.1). Back eddies and tributary-associated sites produced the greatest numbers of lake whitefish with few fish being taken in other habitat types (Appendix 6.2). During September, large numbers were taken in large mesh beach seines in back eddies and at the larger tributary sites. These areas are believed to be important to lake whitefish as staging and resting areas during their fall spawning migration.

4.2.3.2 Age and growth. Lake whitefish captured in gill nets and large mesh seines ranged from 240 to 509 mm in fork length with fish in the 340 to 439 mm range comprising 87.1% of the total (Table 19). Lake whitefish taken in standard gangs had a modal length interval of 360 to 369 mm, tending to be slightly smaller than those captured in large mesh seines where the mode fell in the 390 to 399 mm interval (Table 19).

Whitefish ranged in age from 2 to 10 years with most specimens (94.2%) being age 4 to 7 inclusive (Table 20). Age groups 4 (26.5%), 5 (34.1%), and 6 (26.5%) dominated the spawning migration

Table 19. Length-frequency distribution for lake whitefish captured by standard gangs and large mesh beach seines, Athabasca River, 1976.

Fork Length (mm)	Standard Gangs			Large Mesh Seines	Total	
	Male	Female	Total		N	%
240 to 249	0	0	0	1	1	0.1
250 to 259	0	1	1	0	1	0.1
260 to 269	0	0	0	1	1	0.1
270 to 279	0	0	0	0	0	0.0
280 to 289	0	0	0	1	1	0.1
290 to 299	0	0	0	2	2	0.2
300 to 309	1	1	2	1	3	0.3
310 to 319	3	0	3	2	5	0.5
320 to 329	2	1	3	1	4	0.4
330 to 339	8	11	19	8	27	2.7
349 to 349	16	8	24	5	29	2.9
350 to 359	34	20	54	21	75	7.5
360 to 369	37	26	63	55	118	11.8
370 to 379	32	19	51	41	92	9.2
380 to 389	34	25	59	57	116	11.6
390 to 399	22	32	54	82	136	13.6
400 to 409	24	27	51	61	112	11.2
410 to 419	17	16	33	53	86	8.6
420 to 429	14	13	27	37	64	6.4
430 to 439	14	8	22	21	43	4.3
440 to 449	7	7	14	21	35	3.5
450 to 459	4	4	8	14	22	2.2
460 to 469	0	1	1	11	12	1.2
470 to 479	2	0	2	8	10	1.0
480 to 489	0	0	0	2	2	0.2
490 to 499	0	0	0	1	1	0.1
500 to 509	0	0	0	1	1	0.1
Totals	271	220	491	508	999	

Table 20. Age composition for lake whitefish captured from the Athabasca River, 1976.

Scale Age (Year Class)	May to August N	May to August %	6 Sept. to 19 Sept. N	6 Sept. to 19 Sept. %	20 Sept. to 3 Oct. N	20 Sept. to 3 Oct. %	4 Oct. to 17 Oct. N	4 Oct. to 17 Oct. %	Total N	Total %
2 (1974)	1	1.5	0	0.0	0	0.0	0	0.0	1	0.2
3 (1973)	1	1.5	0	0.0	1	0.9	5	2.0	7	1.4
4 (1972)	11	16.7	10	14.7	27	23.9	75	29.8	123	24.6
5 (1971)	19	28.8	32	47.1	34	30.1	78	31.0	163	32.7
6 (1970)	24	36.4	22	32.4	29	25.7	61	24.2	136	27.3
7 (1969)	8	12.1	4	5.8	12	10.6	24	9.5	48	9.6
8 (1968)	1	1.5	0	0.0	7	6.2	9	3.6	17	3.4
9 (1967)	1	1.5	0	0.0	2	1.8	0	0.0	3	0.6
10 (1966)	0	0.0	0	0.0	1	0.9	0	0.0	1	0.2
Totals	66		68		113		252		499	

that occurred in September and October (Table 20).

Growth in fork length was rapid during the first few years of life with age 3 fish having a mean fork length of 335.4 mm. After age 3, growth in length continued but at a reduced rate (Table 21). No statistically significant differences in mean fork length were observed between male and female whitefish of the same scale age except at age 8 (Table 21). The mean fork lengths for lake whitefish between age 3 and age 6 are intermediate to those reported by Bidgood (1973) for Pigeon and Buck lakes in central Alberta.

Growth in weight of lake whitefish occurred at a rapid and fairly constant rate over the age range of the sample although the rate showed some tendency to decrease after age 4 (Table 22). Female whitefish were heavier than males of the same age at ages 5, 6, and 7, but such differences were statistically significant only at age 8 where males were heavier than females (Table 22).

The mathematical relationship between fork length and body weight for male lake whitefish captured in standard gangs during 1976 ($n = 247$, $r = 0.930$, range 301 to 479 mm) is described by the equation:

$$\log_{10}W = 2.840(\log_{10}L) - 4.411;\ sb = 0.005$$

For female whitefish ($n = 209$, $r = 0.927$, range 251 to 453 mm) the corresponding expression is:

$$\log_{10}W = 2.992(\log_{10}L) - 4.797;\ sb = 0.007$$

A test for homogeneity revealed no significant difference between the slopes of the regression lines for male and female whitefish ($t = 0.843$; $P > 0.05$).

4.2.3.3 Sex and maturity. Sex was determined for 493 lake whitefish during the study of which 55.6% were males (Table 23). The overall sex ratio, therefore, did not differ significantly from unity. A significant difference was observed, however, during one sampling period in September when males accounted for 63.1% of the sample (Table 23).

Table 21. Age-length (mm) relationship for lake whitefish collected from the Athabasca River in late September and early October, 1976. Sexes separate and combined (includes unsexed fish).

Scale Age	Males				Females				All Fish				t-test
	N	Mean	S.D.	Range	N	Mean	S.D.	Range	N	Mean	S.D.	Range	
0+	0				0				12	63.8	4.2	55 to 73	
1	0				0				2	138.5	2.1	137 to 140	
2	0				1	251.0			1	251.0			
3	3	346.7	11.9	333 to 355	4	327.0	20.0	302 to 349	7	335.4	18.9	302 to 355	1.623
4	38	366.4	23.1	301 to 411	37	366.8	20.0	333 to 407	75	366.6	19.0	301 to 407	0.085
5	44	387.0	25.4	345 to 454	34	385.7	28.7	331 to 438	78	386.4	26.7	331 to 454	0.211
6	30	397.3	28.7	328 to 454	31	400.3	30.3	349 to 460	61	398.8	29.3	328 to 460	0.388
7	12	420.8	19.9	388 to 448	12	406.5	19.3	386 to 454	24	413.6	20.5	386 to 454	1.785
8	11	439.3	19.1	408 to 479	5	410.2	12.0	391 to 422	16	430.2	21.8	391 to 479	3.702[a]
9	0				3	429.3	11.7	416 to 438	3	429.3	11.7	416 to 438	
10	1	475.0			0				1	475.0			
Totals	139				127				280				

[a] Significant difference between means for males and females ($P < 0.05$).

Table 22. Age-weight (g) relationship for lake whitefish collected from the Athabasca River in late September and early October, 1976. Sexes separate and combined (includes unsexed fish).

Scale Age	Males				Females				All Fish				t-test
	N	Mean	S.D.	Range	N	Mean	S.D.	Range	N	Mean	S.D.	Range	
0+	0				0				12	2.8	0.5	1.8 to 3.8	
1	0				0				2	31.6	0.4	31.3 to 31.9	
2	0				1	210.0			1	210.0			
3	3	630.0	105.3	530 to 740	4	490.0	95.9	360 to 580	7	550.0	117.9	360 to 740	1.807
4	38	765.8	131.8	530 to 960	37	755.1	122.0	540 to 1000	75	760.5	126.3	530 to 1000	0.365
5	44	906.1	204.9	620 to 1440	34	914.1	198.8	470 to 1420	78	909.6	201.0	470 to 1440	0.174
6	30	957.0	242.9	560 to 1380	31	1034.8	246.7	670 to 1480	61	996.5	245.9	560 to 1480	1.241
7	12	1080.0	171.0	840 to 1290	12	1093.3	160.6	860 to 1420	24	1086.7	162.4	840 to 1420	0.196
8	11	1283.4	172.7	1060 to 1550	5	1048.0	184.3	810 to 1220	16	1209.8	202.8	810 to 1550	2.415[a]
9	0				3	1250.0	187.3	1100 to 1460	3	1250.0	187.3	1100 to 1460	
10	1	1530.0			0				1	1530.0			
Totals													
	139				127				280				

[a] Significant difference between means for males and females (P <0.05).

Table 23. Sex ratios for lake whitefish sampled from the Athabasca River, 1976.

Date	Number of Fish				Percent Males[a]	X^2
	Males	Females	Unknown	Total		
4 to 10 May	2	4	11	17	33.3	
20 to 23 May	4	4	3	11	50.0	
12 to 14 July	6	4	0	10	60.0	
25 to 28 July	4	1	0	5	80.0	
9 to 11 August	4	5	0	9	44.4	
25 to 28 August	10	10	0	20	50.0	
Sub-total 4 May to 28 August	30	28	14	72	51.7	0.14
8 to 10 September	39	29	0	68	57.4	0.74
20 to 22 September	72	42	0	114	63.1	3.95[b]
4 to 5 October	133	120	0	253	52.6	0.33
Totals	274	219	14	507	55.6	3.07

[a] Based on fish of known sex.

[b] Significant difference for sex ratio from unity, Chi square text ($P < 0.05$).

While some lake whitefish appear to achieve sexual maturity by age 3, the majority do not spawn until age 4. By age 4, 98.5% of all males and 96.2% of females were sexually mature (Table 24).

4.2.3.4 Spawning. Although primarily a lake spawner, lake whitefish are also known to spawn in rivers and streams, usually in shallow running water, or in rapids over a gravel and rubble bottom (Machniak 1975b). While spawning has been reported at water temperatures of 0.5 to 10.0°C, Machniak (1975b) states that these temperatures probably represent extremes. Most whitefish spawning probably occurs at water temperatures of 3.0 to 8.0°C.

Whitefish spawning was not observed within our study area in 1976 despite the fact that the water temperature at the termination of the study (5 October) was 7°C. Many males were found to be fully ripe at that time although females were not yet in full spawning condition. Potentially, there appear to be many spawning locations for lake whitefish within the study area but it is suspected that most spawning occurs over bouldery areas in the Athabasca and/or Clearwater rivers above Fort McMurray. Because of the temperature-dependent nature of this event, spawning time can vary considerably from year to year. In 1976, spawning probably began around the second week of October.

4.2.3.5 Migrations and movements. A large upstream spawning migration of lake whitefish entered the study area in late August, reaching a peak during the first week of October (Tables 3 and 4). During this period of increased whitefish abundance, water temperatures, discharge (Figure 2), and turbidity were rapidly decreasing.

It is not known how long the whitefish remained in the study area. Whitefish spawning periods recorded by a number of authors (Machniak 1975b) average about one week. Bidgood (1972), however, reported an extended spawning period in Pigeon Lake, Alberta, where ripe whitefish were found on spawning beds from September to late January over a temperature range of from 9.2 to 1.0°C.

Table 24. Age-specific sex ratios and maturity for lake whitefish captured in standard gangs, Athabasca River, 1976. Sex ratios were based only on fish for which sex was determined.

Scale Age (Year Class)	Males			Females			Unsexed Fish	Total	
	N	%	% Mature	N	%	% Mature		N	%
2 (1974)	0			1	100.0	0.0	0	1	0.2
3 (1973)	3	42.9	33.3	4	57.1	25.0	0	7	1.4
4 (1972)	67	52.3	98.5	53	47.7	96.2	2	122	24.3
5 (1971)	81	52.3	98.8	76	47.7	98.7	2	159	31.6
6 (1970)	81	68.1	100.0	59	31.9	98.3	1	141	28.0
7 (1969)	25	59.5	100.0	19	40.5	100.0	3	47	9.3
8 (1968)	16	72.7	100.0	6	27.3	100.0	0	22	4.4
9 (1967)	1	50.0	100.0	1	50.0	100.0	0	2	0.4
10 (1966)	1	100.0	100.0	0			1	2	0.4
Totals	275	55.7	98.5	219	44.3	96.3	9	503	100.0

Three lake whitefish tagged in late September 1976, were recaptured in Lake Athabasca in January 1977. Two of these, when recaptured near Fort Chipewyan (Figure 1), had travelled 225 and 272 km in 119 and 123 days (Appendix 6.5). The other fish had travelled over 338 km in approximately 122 days when recaptured on the north shore of Lake Athabasca near the Alberta-Saskatchewan border.

The Athabasca River appears to be a major migration route for lake whitefish moving from Lake Athabasca to spawning sites in or upstream of the study area. After spawning, these whitefish probably return to the lake.

4.2.3.6 Food habits. Most whitefish stomachs examined between 20 May and 8 September contained little or no food. Most fish captured in late September and early October contained food and a few had gorged themselves. Aquatic insects formed the bulk of the lake whitefish diet. Hemiptera (Corixidae) occurred in 80.3% of those stomachs that contained food (Table 25) and accounted for 83.0% of the total food volume (Table 26).

4.2.4 Northern Pike

4.2.4.1 Distribution and relative abundance. Northern pike were taken in relatively low numbers during the study, comprising only 2.9% of the total catch (Table 2). This species made up 6.8% of the catch in standard gangs (Table 3) and 8.5% of all fish taken in large mesh beach seines. The catch-per-unit-effort values for pike fluctuated very little over the study period. These values averaged 0.076 fish per standard gang per hour and 1.14 fish per large mesh seine haul (Tables 3 and 4).

Pike appeared to be most common near tributary mouths and could usually be captured by angling at these sites throughout the summer. The majority of pike were captured at Sites 2 to 12, 14, 15, 17, 18, 20 to 35, 42, 43, 48, 51, 52, 59, and 60 (Figure 3, Appendix 6.1).

Table 25. Percentage frequency of occurrence of major food items in the stomach contents of lake whitefish from the Athabasca River, 1976.

Food Item	Percentage Frequency of Occurrence[a]							Totals	
	20 May	12 July	9 Aug.	25 Aug.	8 Sept.	20 Sept.	5 Oct.	N	%
Insects									
Hemiptera	100.0	0	0	0.0	0.0	97.5	70.6	159	80.3
Coleoptera	0.0	0	0	0.0	0.0	1.2	3.9	5	2.5
Ephemeroptera	0.0	0	0	0.0	33.3	0.0	1.0	3	1.5
Plecoptera	0.0	0	0	0.0	0.0	1.2	0.0	1	0.5
Insect Remains	0.0	0	0	0.0	0.0	30.9	33.3	59	29.8
Miscellaneous									
Pelecypoda	25.0	0	0	0.0	16.7	4.9	4.9	12	6.1
Debris	75.0	0	0	100.0	50.0	2.5	4.9	17	8.6
No. Stomachs Examined	10	15	9	20	69	101	189	413	
No. Stomachs With Food	8	0	0	1	6	81	102	198	
No. Stomachs Gorged	0	0	0	0	0	3	1	4	

[a] Number of occurrences expressed as a percentage of the number of stomachs containing food.

Table 26. Estimated percentage composition by volume of major food items in the stomach contents of lake whitefish from the Athabasca River, 1976.

Food Item	Estimated Percentage Composition by Volume							Food Item Point Totals	
	20 May	12 July	9 Aug.	25 Aug.	8 Sept.	20 Sept.	5 Oct.	N	%
Insects									
Hemiptera	0.0	0	0	0.0	0.0	91.2	83.5	1178	83.0
Miscellaneous	57.1	0	0	0.0	57.9	0.4	0.8	40	2.8
Insect Remains	0.0	0	0	0.0	0.0	5.5	10.3	102	7.2
Miscellaneous									
Pelecypoda	14.3	0	0	0.0	10.5	2.5	3.2	49	3.5
Debris	28.6	0	0	100.0	31.6	0.4	2.2	50	3.5
No. Stomachs Examined	10	15	9	20	69	101	189	413	
Total Food Points Assigned	35	0	0	4	19	749	593	1419	100.0

4.2.4.2 Age and growth. Northern pike ranged in fork length from 41 to 1042 mm. The majority (79.9%) of pike taken by angling, standard gangs, and large mesh beach seines were between 340 and 679 mm (Table 27).

Northern pike ranged in age from 0+ to 7 years with age groups 3 to 5 inclusive comprising 65.1% of the total (Table 28).

Growth in fork length was most rapid during the first year of life. Four young-of-the-year pike captured in Coffey Creek (Figure 3) on 20 June had a mean fork length of 46.3 ± 5.0 mm while six fish taken from the Athabasca River between July and October measured 210.5 ± 80.5 mm. After the first year, growth in length occurred at a slower but constant rate through age 7 (Table 28). Female pike were consistently longer than males of the same age with significant differences in the means occurring at ages 4 and 5 (Table 28).

Northern pike gained weight slowly during their first three years but more rapidly thereafter (Table 29). Female pike were consistently heavier than males of equivalent age, statistically significant differences occurring between the means for age groups 4 and 5 (Table 29).

For male northern pike ($n = 64$, $r = 0.987$, range 250 to 789 mm), the mathematical relationship between fork length and body weight (Table 30) is described by the equation:

$$\log_{10}W = 3.002(\log_{10}L) - 5.136;\ sb = 0.004$$

The equivalent expression for female pike ($n = 73$, $r = 0.973$, range 311 to 829 mm) is:

$$\log_{10}W = 3.072(\log_{10}L) - 5.336;\ sb = 0.007$$

No significant difference occurred between the slope values for male and female pike ($t = 0.666$; $P > 0.05$).

4.2.4.3 Sex and maturity. Sex was determined for 139 northern pike and males and females were found to occur in approximately equal numbers, both in the overall sample and within age groups (Table 31).

Table 27. Length-frequency distribution for northern pike from the Athabasca River, 1976.

Fork Length (20 mm Intervals)	Gill Nets Male	Gill Nets Female	Gill Nets Total	Large Mesh Seines	Angling Gear	Total N	Total %
200 to 219	0	0	0	2	0	2	0.5
220 to 239	0	0	0	3	0	3	0.8
240 to 259	1	0	1	2	0	3	0.8
260 to 279	2	0	2	5	1	8	2.0
280 to 299	0	0	2	4	0	6	1.5
300 to 319	5	2	8	7	2	17	4.3
320 to 339	1	1	2	7	0	9	2.3
340 to 359	0	1	5	4	1	10	2.5
360 to 379	2	1	3	8	3	14	3.5
380 to 399	1	0	1	6	8	15	3.8
400 to 419	3	2	5	3	8	16	4.0
420 to 439	2	2	5	14	8	27	6.8
440 to 459	6	1	8	11	4	23	5.8
460 to 479	3	4	7	10	7	24	6.0
480 to 499	6	3	11	12	4	27	6.8
500 to 519	2	4	6	3	6	15	3.8
520 to 539	5	1	7	4	5	16	4.0
540 to 559	1	8	10	7	5	22	5.5
560 to 579	10	9	25	5	4	34	8.5
580 to 599	3	1	6	7	3	16	4.0
600 to 619	4	2	9	2	1	12	3.0
620 to 639	4	8	15	2	0	17	4.3
640 to 659	2	6	12	4	3	19	4.8
660 to 679	0	6	7	2	3	12	3.0
680 to 699	2	2	5	1	0	6	1.5
700 to 719	0	1	2	3	1	6	1.5
720 to 739	0	0	0	0	3	3	0.8
740 to 759	1	2	3	0	2	5	1.3
760 to 779	0	3	5	0	0	5	1.3
780 to 799	1	0	1	0	0	1	0.3
800 to 819	0	0	0	1	0	1	0.3
820 to 839	0	2	2	0	0	2	0.5
840 to 859	0	0	1	0	0	1	0.3
560 to 879	0	0	0	0	1	1	0.3
1000 plus	0	0	0	1	0	1	0.3
Totals	67	72	176	140	83	399	

Table 28. Age-length (mm) relationship for northern pike from the Athabasca River, 1976. Sexes separate and combined (includes unsexed fish).

Scale Age	Males				Females				All Fish				t-test
	N	Mean	S.D.	Range	N	Mean	S.D.	Range	N	Mean	S.D.	Range	
0+	2	258.5	12.0	250 to 267	ND				6	210.5	80.5	108 to 307	
1	7	303.9	13.7	277 to 322	4	332.3	30.8	311 to 378	14	311.9	25.7	277 to 378	
2	8	437.4	37.8	390 to 495	9	471.1	58.7	355 to 540	19	443.8	59.4	342 to 540	1.421
3	13	477.1	49.0	369 to 563	13	502.1	49.6	416 to 570	27	488.4	48.2	369 to 570	1.292
4	18	522.3	59.5	419 to 698	16	597.6	63.5	516 to 777	34	573.6	65.5	419 to 777	3.554[a]
5	14	592.8	48.1	499 to 658	22	653.4	43.0	578 to 771	36	629.8	54.9	499 to 771	3.836[a]
6	4	645.8	93.0	557 to 753	5	684.8	66.5	625 to 770	9	667.4	76.6	557 to 770	0.709
7	1	785.0			3	807.8	43.1	758 to 836	4	802.0	37.0	758 to 836	
Totals	67				72				149				

[a] Significant difference in means (P <0.05) for males and females.

Table 29. Age-weight (g) relationship for northern pike from the Athabasca River, 1976.

Scale Age	Males				Females				All Fish				t-test
	N	Mean	S.D.	Range	N	Mean	S.D.	Range	N	Mean	S.D.	Range	
0+	2	125.0	21.2	110 to 140	0				6	90.0	74.4	10 to 200	
1	7	218.6	33.4	170 to 260	4	287.5	95.0	240 to 430	14	237.1	65.3	160 to 430	1.402
2	8	636.3	200.6	430 to 1000	9	834.4	328.7	330 to 1360	19	691.6	308.4	140 to 1360	1.517
3	13	795.4	272.7	330 to 1220	13	951.5	271.1	390 to 1390	27	866.3	275.2	330 to 1390	1.464
4	18	1204.4	363.9	550 to 1940	16	1664.4	637.2	960 to 3470	34	1420.9	554.1	550 to 3470	2.542[a]
5	14	1689.3	401.3	1020 to 2350	22	2105.5	639.5	1260 to 3870	36	1943.6	589.5	1020 to 3870	2.399
6	4	2245.0	915.6	1410 to 3180	5	2588.0	956.0	1720 to 3720	9	2435.6	896.6	1410 to 3720	0.548
7	1	4200.0			3	4333.3	1196.0	3110 to 5500	4	4300.0	978.8	3110 to 5500	
Totals	67				72				149				

[a] Significant difference in means (P <0.05) for males and females.

Table 30. Length-weight relationships for northern pike, longnose suckers, white suckers, trout-perch, flathead chub, lake chub, emerald shiners, and spottail shiners from the Athabasca River, 1976.

Species	Sex	Number of Fish	Range in Fork Length (mm)	Value of Slope (b)	Value of Intercept (a)	sb	Correlation Coefficient (r)
Northern pike	Male	64	250 to 789	3.002	-5.136	0.004	0.987
	Female	73	311 to 829	3.072	-5.336	0.007	0.973
Longnose sucker	Male	13	232 to 431	3.141	-5.246	0.008	0.995
	Female	35	365 to 521	2.532	-3.675	0.026	0.939
White sucker	Combined	23	302 to 481	3.303	-5.617	0.078	0.965
Trout-perch	Male	78	28 to 78	3.051	-5.034	0.001	0.993
	Female	85	26 to 89	3.084	-5.098	0.002	0.995
Flathead chub	Male	25	167 to 257	3.401	-5.866	0.036	0.961
	Female	87	199 to 311	3.041	-5.011	0.009	0.959
Lake chub	Combined	54	17 to 42	3.242	-5.305	0.018	0.975
Emerald shiner	Combined	174	35 to 96	3.121	-5.243	0.019	0.984
Spottail shiner	Combined	60	32 to 90	2.844	-4.671	0.019	0.993

Table 31. Age-specific sex ratios and maturity data for northern pike sampled from the Athabasca River in 1976. Sex ratios were based only on fish for which sex was determined.

Scale Age (Year Class)	Males			Females			Unsexed Fish	Total		X^2
	N	%	% Mature	N	%	% Mature		N	%	
0+ (1976)	2	100.0		0			4	6	4.0	
1 (1975)	7	63.6	14.3	4	36.4		3	14	9.4	0.41[a]
2 (1974)	8	47.0	62.5	9	53.0	55.5	2	19	12.8	0.03[a]
3 (1973)	13	50.0	76.9	13	50.0	76.9	1	27	18.1	0.00[a]
4 (1972)	18	52.9	94.4	16	47.1	93.7	0	34	22.8	0.06[a]
5 (1971)	14	38.9	100.0	22	61.1	100.0	0	36	24.2	0.89[a]
6 (1970)	4	44.4	100.0	5	55.6	100.0	0	9	6.0	0.05[a]
7 (1969)	1	33.3	100.0	3	66.7	100.0	0	4	2.7	0.50[a]
Totals	67	48.2	76.7	72	51.8	82.2	10	149	100.0	0.09[a]

[a] Non-significant differences, Chi-square test (P <0.05).

The youngest mature pike was an age 1 male. Most pike, however, did not mature until age 3 or 4. All fish were sexually mature at age 5 (Table 31). Scott and Crossman (1973) state that in southern Canada females mature at age 3 or 4 and males at age 2 or 3.

4.2.4.4 Spawning. Northern pike generally spawn in April and early May, immediately after the ice melts, at water temperatures of 4.4 to 11.1°C (Scott and Crossman 1973). Although pike may spawn in a variety of habitats, the presence of vegetation appears to be a requirement of the spawning site (Machniak 1975c). Marshes or marsh-like conditions along small streams seem to be preferred areas.

Marshy areas suitable for pike spawning are available adjacent to the Athabasca River at Leggett Creek (Site 43), opposite Site 44, near Mile 29, and at Coffey Creek (Site 59)(Figure 3). Spawning sites are probably also available in tributaries within the study area. Bond and Machniak (1977) report northern pike running up the Muskeg River during late April and early May 1976 although it was not clear whether or not this tributary was utilized for spawning purposes.

The 1976 season may have been a poor one in terms of northern pike spawning success in the study area because of low water levels both in the Athabasca River and in tributary streams. Some successful spawning did occur as 10 young-of-the-year were captured during the summer. In late May, however, four females were captured whose eggs were in the process of resorption indicating that some pike did not spawn successfully. Bond and Machniak (1977) suggest that low spring water levels may have prevented pike from reaching potential spawning areas in the Muskeg River. A similar situation undoubtedly occurred in other tributaries as well.

4.2.4.5 Movements. Northern pike of the AOSERP study area enter some tributaries in late April and early May. These movements may be related to spawning or feeding (Bond and Machniak 1977). A slight increase in catch-per-unit-effort for pike detected in the Athabasca

River during September and early October (Tables 3 and 4) may indicate a movement out of the tributaries and back into the Athabasca River at that time. Apart from these spring and fall movements, however, pike generally appear to move around very little. Of 282 pike tagged in 1976, 18 (6.4%) were recaptured (Appendix 6.5), of which 13 were recaptured at the original tagging site after 6 to 78 days. Some individuals may move considerable distances. One recaptured pike had moved 50 km downstream in 14 days while another had moved downstream 85 km in 62 days.

4.2.4.6 Food habits. A total of 125 pike stomachs were examined for food of which 78 (62.4%) were empty. Among the stomachs containing food, fish and fish remains occurred in 89.4% and comprised 94.5% of of the estimated total food volume (Table 32). While 10 fish species were represented in the food, flathead chub, suckers, and trout-perch were the most important forage species. Northern pike were found in 6.4% of the stomachs that contained food and accounted for 8.1% of the estimated food volume.

4.2.5 Longnose Sucker

4.2.5.1 Distribution and relative abundance. Although suckers represented 20.7% of all fish captured during the study (Table 2), the majority were young-of-the-year that could not be identified to species. Longnose suckers appeared to be abundant in the Athabasca River during early May 1976 when they were captured readily in tributary-associated sites and back eddies. Tagging nets (10.2 cm mesh size) set between 4 and 10 May produced a catch-per-unit-effort of 0.956 ± 0.56 longnose suckers per hour per 22.9 m of gear. Between 19 and 23 May the catch-per-unit-effort in the same gear was only 0.181 ± 0.18 fish per hour. Throughout the remainder of the summer longnose suckers were seldom captured. Overall, longnose suckers were taken in 39% of standard gang sets with an average catch-per-unit-effort of 0.033 fish per gang per hour (Table 3, Appendix 6.4).

Table 32. Percentage frequency occurrence and estimated percentage by volume of the major food items in the stomach contents of northern pike from the Athabasca River, 1976.

Food Item	Occurrence		Volume (as food points)	
	N	%[a]	N	%
Fish				
Flathead chub	7	14.9	117	23.1
Suckers	7	14.9	81	16.0
Northern pike	3	6.4	41	8.1
Trout-perch	5	10.6	41	8.1
Walleye	1	2.1	0	0.0
Mountain whitefish	1	2.1	0	0.0
Brook stickleback	1	2.1	0	0.0
Lake whitefish	1	2.1	91	17.9
Emerald shiner	1	2.1	0	0.0
Goldeye	1	2.1	0	0.0
Fish remains	14	29.8	108	21.3
Fish Totals	42	89.4	479	94.5
Insects				
Plecoptera	1	2.1	ND	ND
Odonata	2	4.2	ND	ND
Lepidoptera	1	2.1	ND	ND
Insect Totals	4	8.5	7	1.4
Miscellaneous				
Frogs	1	2.1	ND	ND
Mice	1	2.1	ND	ND
Miscellaneous Totals	2	4.2	21	4.1
No. Stomachs Examined	125			
No. Stomachs With Food	47			
Total Food Points Assigned			507	100.0

[a] Number of occurrences expressed as a percentage of the number of stomachs containing food.

This species occurred in only 4% of all large mesh seine hauls, averaging 0.04 fish per haul (Table 4).

The abundance of longnose suckers in the study area in early May was related to movements onto spawning grounds in tributary streams at that time. Bond and Machniak (1977) reported an upstream spawning migration of 2837 longnose suckers in the Muskeg River (Figure 1) in late April and early May 1976. These authors stated that most longnose suckers had left the Muskeg River and returned to the Athabasca River by 30 May although small numbers remained in the tributary through 30 July.

The low catch-per-unit-effort values obtained throughout the summer (Tables 3 and 4) suggest that longnose suckers did not remain in the study area after leaving the tributaries. It is likely that these fish returned to the lower reaches of the Athabasca River or to Lake Athabasca although tag return evidence is lacking at this time.

Sucker fry (2 species) accounted for 26.3% of the total catch in small mesh beach seines (Table 5). They were present in greatest abundance in late June, at which time they occurred in 90% of all small mesh seine hauls, averaged 132 fry per haul, and made up 80.0% of all fish captured in that gear. Young suckers were taken in largest numbers at Sites 36 to 45, 47 to 56, and 58 to 60 (Figure 3, Appendix 6.1). The largest individual collections were usually made at tributary-associated sites. The frequency of occurrence for sucker fry in small mesh seines remained high (> 50% of all seine hauls) throughout the summer. The catch-per-unit-effort, however, decreased to a low level after June (< 6 fry per haul) indicating a movement of fry out of the study area.

4.2.5.2 Age and growth. Excluding young-of-the-year, longnose suckers ranged from 200 to 539 mm in fork length with fish in the 360 to 479 mm range comprising 85.2% of the total sample (Table 33). Pectoral fin ray analysis showed longnose suckers to range in age from 3 to 16 years with 55.2% of the sample (n = 58) belonging to

Table 33. Length-frequency distribution for longnose suckers from the Athabasca River, 1976.

Fork Length (20 mm intervals)	Gill Nets[a] Male	Gill Nets[a] Female	Gill Nets[a] Total	Large Mesh Seines	Total N	Total %
200 to 219	0	0	1	1	2	1.0
220 to 239	0	0	7	0	7	3.3
240 to 259	0	0	1	0	1	0.5
260 to 279	0	0	0	0	0	0.0
280 to 299	0	0	0	0	0	0.0
300 to 319	0	0	2	0	2	1.0
320 to 339	0	0	1	1	2	1.0
340 to 359	0	1	2	2	4	1.9
360 to 379	4	8	16	1	17	8.1
380 to 399	7	6	23	1	24	11.4
400 to 419	19	14	42	0	42	20.0
420 to 439	22	7	41	0	41	19.5
440 to 459	7	18	35	0	35	16.7
460 to 479	2	13	20	0	20	9.5
480 to 499	2	3	7	0	7	3.3
500 to 519	1	3	4	0	4	1.9
520 to 539	0	2	2	0	2	1.0
Totals	64	75	204	6	210	

[a] Includes tagging nets and standard gangs.

age groups 9 to 13 inclusive (Table 34). Although the sample is small, most growth appears to occur prior to age 8. After age 8, the rate of growth, both in fork length and body weight, appears to decrease (Table 34).

The mathematical relationship between fork length and body weight (Table 30) for male longnose suckers ($n = 13$, $r = 0.995$, range 232 to 431 mm) is described by the equation:

$$\log_{10}W = 3.141(\log_{10}L) - 5.246; \; sb = 0.008$$

The equivalent expression for female longnose suckers ($n = 35$, $r = 0.939$, range 365 to 521 mm) is:

$$\log_{10}W = 2.532(\log_{10}L) - 3.675; \; sb = 0.026$$

A test of homogeneity showed the slopes of the regression lines for male and female longnose suckers to be significantly different from each other ($t = 2.917$; $P < 0.05$). This difference probably results from the small samples available for analysis. Bond and Machniak (1977) found no significant difference between the slopes of the regressions for male and female longnose suckers in the Muskeg River.

4.2.5.3 Sex and maturity. Age and sex were determined for only 48 longnose suckers, of which 35 (72.9%) were females (Table 35). The youngest mature male was age 8 while the youngest mature female was age 6. Bond and Machniak (1977) reported that both sexes matured at age 7 in the Muskeg River.

4.2.5.4 Spawning. Longnose suckers usually enter spawning streams in April or May when stream temperatures reach 5°C (Scott and Crossman 1973). The Muskeg River is known to have had a longnose sucker run in 1976 (Bond and Machniak 1977), and other tributaries of the Athabasca River in the study area are also suspected of providing spawning sites for this species. Longnose suckers were not observed spawning in the Athabasca River but young-of-the-year suckers of two species were found throughout the study area throughout the summer.

Table 34. Age-length relationship and age-weight relationship for longnose suckers from the Athabasca River, 1976.

Fin Ray Age	Number of Fish			Fork Length (mm)			Weight (g)		
	Male	Female	Total	Mean	S.D.	Range	Mean	S.D.	Range
3	0	0	3	249.7	14.0	234 to 261	196.7	41.6	150 to 230
4	1	0	4	248.3	37.9	226 to 305	200.0	113.7	130 to 370
5	0	0	2	215.0	8.5	209 to 221	115.0	21.2	100 to 130
6	0	1	1	404.0			880.0		
7	0	2	4	338.0	24.4	314 to 369	459.5	89.1	360 to 548
8	2	1	3	391.3	43.3	342 to 423	783.3	258.9	490 to 980
9	3	6	9	396.3	18.0	371 to 421	822.2	104.0	670 to 980
10	1	3	4	407.3	15.9	388 to 427	887.5	151.7	720 to 1160
11	2	5	7	429.4	34.7	392 to 490	1028.6	248.5	800 to 1480
12	0	7	7	409.6	38.1	369 to 466	922.9	179.6	730 to 1190
13	1	4	5	429.6	45.4	370 to 479	960.0	198.0	780 to 1180
14	0	2	2	496.0	35.3	471 to 521	1520.0	495.0	1170 to 1870
15	3	3	6	399.5	32.3	365 to 431	817.3	200.4	604 to 1070
16	0	1	1	505.0			1380.0		
Totals	13	35	58						

Table 35. Age-specific sex ratios and maturity data for longnose suckers from the Athabasca River, 1976. Sex ratios were based only on fish for which sex was determined.

Fin Ray Age	Female			Male			Unsexed Fish	Total	
	N	%	% Mature	N	%	% Mature		N	%
3	0			0			3	3	5.2
4	0			1	100.0		4	4	6.9
5	0			0			2	2	3.4
6	1	100.0	100.0	0			0	1	1.7
7	2	100.0	100.0	0			2	4	6.9
8	1	33.3	100.0	2	66.7	50.0	0	3	5.2
9	6	66.7	100.0	3	33.3	100.0	0	9	15.5
10	3	75.0	100.0	1	25.0	100.0	0	4	6.9
11	5	71.4	100.0	2	28.6	100.0	0	7	12.1
12	7	100.0	100.0	0			0	7	12.1
13	4	80.0	100.0	1	20.0	100.0	0	5	8.6
14	2	100.0	100.0	0			0	2	3.4
15	3	50.0	67.7	3	50.0	100.0	0	6	10.3
16	1	100.0	100.0	0			0	1	1.7
Totals	35	72.9		13	27.1		11	58	99.9

4.2.5.5 Food habits. The diet of longnose suckers is known to be highly variable consisting largely of benthic invertebrates (Scott and Crossman 1973). Twenty-five longnose sucker stomachs were examined during the present study of which 6 (24.0%) were empty. Those stomachs with food contained mostly Hemiptera, Pelecypoda, and unidentifiable insect remains (Table 36).

4.2.6 White Sucker

4.2.6.1 Distribution and relative abundance. During the first week of May 1976, 52 white suckers were captured in tagging nets set in the Athabasca River. They appeared to be abundant in the study area at that time. After this early peak, however, white suckers were seldom taken with the exception of young-of-the-year. Standard gangs captured only 12 white suckers producing an average catch-per-unit-effort of 0.009 fish per gang per hour (Table 3, Appendix 6.4). White suckers were captured in 16% of all large mesh seine hauls with an average catch-per-unit-effort of 0.28 fish per haul (Table 4). Of 40 white suckers captured in large mesh seines 37 were taken between 13 September and 5 October. White suckers were captured at Sites 2, 4, 7, 9, 10, 18, 20, 23, 24, 27, 34, and 47 (Figure 3, Appendix 6.1).

The abundance of white suckers noted in the study area in early May was related to movements onto spawning grounds in tributary streams at that time. Bond and Machniak (1977) reported an upstream migration of 2808 white suckers in the Muskeg River (Figure 1) in late April and early May 1976. These authors stated that white suckers had completed spawning by 18 May and indicated that most fish had left the tributary and returned to the Athabasca River by the end of May.

The low catch-per-unit-effort values obtained during the summer suggest that white suckers did not remain in the study area after leaving the spawning streams. It is likely that most returned to the lower reaches of the Athabasca River or to Lake Athabasca.

Table 36. Percentage frequency of occurrence for food items found in the stomach contents of longnose suckers, white suckers, trout-perch, flathead chub, emerald shiner, and spottail shiner from the Athabasca River, 1976. Diptera (1), Ephemeroptera (2), Trichoptera (3), Hemiptera (4), Coleoptera (5), Hymenoptera (6), Insect parts (7), Amphipoda (8), Cladocera (9), Plant material (10), Detritus (11), and Pelecypoda (12).

Species	No. of Stomachs		Percentage Frequency of Occurrence[a]											
	Examined	With Food	1	2	3	4	5	6	7	8	9	10	11	12
Longnose suckers	25	19	0.0	10.5	0.0	36.8	0.0	5.3	42.1	0.0	0.0	0.0	31.6	15.8
White suckers	8	8	0.0	0.0	0.0	25.0	0.0	0.0	62.5	0.0	0.0	0.0	25.0	50.0
Trout-perch	110	88	70.5	12.5	0.0	0.0	0.0	0.0	14.8	5.7	4.6	1.1	5.7	0.0
Flathead chub	67	53	1.9	20.8	3.8	17.0	5.7	7.6	79.3	0.0	0.0	0.0	18.9	7.6
Lake chub	47	41	26.8	0.0	4.9	34.2	0.0	29.3	80.5	0.0	0.0	0.0	9.8	0.0
Emerald shiners	61	53	18.9	5.7	3.8	13.2	5.7	15.1	71.7	0.0	0.0	0.0	9.4	0.0
Spottail shiners	54	44	34.1	0.0	0.0	0.0	0.0	0.0	38.6	0.0	13.6	40.9	4.6	0.0

[a] Number of stomachs containing the food item as a percentage of the number of stomachs containing food.

Although no tagged white suckers have been recaptured to date in the present study, white suckers tagged in the Beaver River (Shell Canada Ltd. 1975) and the Muskeg River (Shell Canada Ltd. 1975; Bond and Machniak 1977) have been recaptured in Lake Athabasca.

The rise in catch-per-unit-effort observed in large mesh seines between 13 September and 5 October suggests that some white suckers may have remained in the tributaries throughout the summer. Bond and Machniak (1977) showed that while the main part of the downstream run in the Muskeg River occurred in late May, white suckers continued to trickle downstream through 30 July.

Sucker fry (2 species) accounted for 26.3% of the total catch in small mesh beach seines (Table 5). They were present in greatest abundance in late June, at which time they occurred in 90% of all small mesh seine hauls, averaged 132 fry per haul, and made up 80.0% of all fish captured in that gear. Young suckers were taken in largest numbers at Sites 36 to 45, 47 to 56, and 58 to 60 (Figure 3, Appendix 6.1). The largest individual collections were usually made at tributary-associated sites. The frequency of occurrence for sucker fry in small mesh seines remained high ($>50\%$ of all seine hauls) throughout the summer. The catch-per-unit-effort, however, decreased to a low level after June (<6 fry per haul) indicating a movement of fry out of the study area.

4.2.6.2 Age and growth. Excluding young-of-the-year, white suckers varied in fork length from 237 to 498 mm with 68.3% of the sample being in the 340 to 419 mm range (Table 37). Ages for 16 white suckers ranged from 4 to 11 years (Table 38). White suckers captured during the 1976 spawning run in the Muskeg River ranged from age 4 to age 17 with 4 and 5 year old fish accounting for 43% of the sample (Bond and Machniak 1977).

The mathematical relationship between fork length and body weight for white suckers from the Athabasca River ($n = 23$, $r = 0.965$, range 302 to 481 mm)(Table 30) is described by the equation:

$$\log_{10}W = 3.303(\log_{10}L) - 5.617; \ sb = 0.078$$

Table 37. Length-frequency distribution for white suckers from the Athabasca River, 1976.

Fork Length (20 mm intervals)	Gill Nets[a]			Large Mesh Seines	Total	
	Male	Female	Total		N	%
220 to 239	1	0	1	0	1	1.0
240 to 259	0	0	0	0	0	0.0
260 to 279	1	0	1	1	2	2.0
280 to 299	0	0	0	0	0	0.0
300 to 319	2	1	3	1	4	4.0
320 to 339	0	0	2	3	5	5.0
340 to 359	1	2	7	14	21	20.8
360 to 379	5	3	11	9	20	19.8
380 to 399	7	2	10	3	13	12.9
400 to 419	3	6	10	5	15	14.9
420 to 439	3	1	8	1	9	8.9
440 to 459	1	6	8	0	8	7.9
460 to 479	0	1	2	0	2	2.0
480 to 499	0	0	0	1	1	1.0
Totals	24	22	63	38	101	

[a] Includes tagging nets and standard gangs.

Table 38. Age-length relationship and age-weight relationship for white suckers from the Athabasca River, 1976.

Fin Ray Age	No. of Fish	Age-Length (mm)			Age-Weight (g)		
		Mean	S.D.	Range	Mean	S.D.	Range
4	1	237.0			170.0		
5	5	371.6	43.3	302 to 407	828.0	360.8	280 to 1170
6	3	384.0	90.4	302 to 481	953.3	676.5	440 to 1720
7	2	381.0	89.1	318 to 444	875.0	572.8	470 to 1280
8	2	427.0	7.1	422 to 432	1065.0	49.5	1030 to 1100
9	1	404.0			910.0		
10	1	388.0			900.0		
11	1	476.0			2000.0		
Totals	16						

The sexes were combined for purposes of calculating this relationship because of the small sample size.

4.2.6.3 Sex and maturity. Age and sex were determined for only 16 white suckers of which nine were males (Table 39). Only three fish were considered sexually immature. Bond and Machniak (1977) report the earliest age of maturity for white suckers in the Muskeg River to be three years for males and four years for females.

4.2.6.4 Spawning. White suckers were not observed spawning in the Athabasca River in 1976 and it is not known whether this event occurs in the main river. The Muskeg River, however, a tributary of the Athabasca (Figure 1), is known to have had a white sucker spawning migration in late April and early May 1976 (Bond and Machniak 1977) and other tributaries in the study area are also thought to provide spawning sites for this species.

4.2.6.5 Food habits. The stomachs of eight white suckers were examined, all of which contained some food (Table 36). Hemiptera were observed in 25.0% of the stomachs examined while unidentifiable insect remains occurred in 62.5% of all stomachs. Fifty percent of the stomachs contained Pelecypoda.

4.2.7 Trout-perch

4.2.7.1 Distribution and relative abundance. Trout-perch was the most abundant fish species captured from the Athabasca River during the present study, comprising 32.4% of the total combined catch (Table 2) and 45.7% of all fish taken in small mesh seines (Table 5). This species occurred in 79% of all small mesh seine hauls with an average catch-per-unit-effort of 47.8 fish per haul (Table 5). Trout-perch were most abundant in the study area in mid-July when they were captured in 94% of all small mesh seine hauls, comprised 74.1% of the catch in that gear, and had a catch-per-unit-effort of 90.3 individuals per haul (Table 5). Their numerical strength at

Table 39. Age-specific sex ratios and maturity data for white suckers from the Athabasca River, 1976. Sex ratios were based only on fish for which sex was determined.

Fin Ray Age	Females			Males			Total	
	N	%	% Mature	N	%	% Mature	N	%
4	0			1	100.0	0.0	1	6.3
5	2	40.0	50.0	3	60.0	100.0	5	31.2
6	1	33.3	100.0	2	66.7	50.0	3	18.8
7	0			2	100.0	100.0	2	12.4
8	1	50.0	100.0	1	50.0	100.0	2	12.4
9	1	100.0	100.0	0			1	6.3
10	1	100.0	100.0	0			1	6.3
11	1	100.0	100.0	0			1	6.3
Totals	7	43.7		9	56.3		16	

that time appeared to reflect an influx of young-of-the-year fish into the study area. With the dispersal of this year class the catch-per-unit-effort decreased somewhat later in the summer but the species remained very common throughout the remainder of the study period.

Trout-perch were captured at Sites 36 to 60 (Figure 3, Appendix 6.1) but showed a strong preference for island and mid-channel sand bar areas. Appendix 6.2 indicates that, while only 16.1% of the small mesh seine sampling effort was expended in island and mid-channel sand bar sites, these areas produced 37.9% of the total trout-perch catch. In back-eddies, 12.5% of the sampling effort yielded 22.2% of the total catch while the corresponding values for tributary-associated sites were 53.5% and 25.7% (Appendix 6.2).

4.2.7.2 Age and growth. Fork lengths for trout-perch ranged from 10 to 89 mm with fish in the 25 to 49 mm range comprising 52.4% of the total (Table 40). Three distinct modes were observed in the overall length-frequency distribution; however, when the length-frequencies for each sampling date are examined separately (Table 40), the distribution on each date is bimodal. The smaller mode in each case is believed to represent young-of-the-year fish while the larger mode consists mainly of age 1 trout-perch. Trout-perch older than age 1 were not captured in numbers sufficient to produce similar modes in the length-frequency distributions.

Prolonged preservation in formalin had caused deterioration of trout-perch otoliths, rendering them unsuitable for purposes of age determination. A preliminary analysis of scales indicated that trout-perch in the study area live to age 3. Table 40 suggests that young-of-the-year and age 1 individuals dominated the trout-perch population of the study area, producing strong modes in the length-frequency distributions. Young-of-the-year had a modal fork length in the 20 to 24 mm range in June and by mid-September the modal length was in the 40 to 44 mm range. Since the fish had likely

Table 40. Length-frequency distribution for trout-perch from the Athabasca River, 1976.

Fork Length (10 mm intervals)	June	July	Aug.	Sept.	Total	Aug. - Sept.[a]	
						Male	Female
10 to 14	3	0	0	0	3	0	0
15 to 19	27	0	0	0	27	0	0
20 to 24	60	11	1	0	72	0	0
25 to 29	22	25	9	0	56	2	2
30 to 34	0	52	33	13	98	10	9
35 to 39	0	31	50	22	103	18	16
40 to 44	4	6	33	52	95	13	9
45 to 49	10	1	10	35	56	13	8
50 to 54	22	8	3	12	45	4	4
55 to 59	8	43	2	12	65	7	0
60 to 64	2	36	4	16	58	5	5
65 to 69	2	21	7	24	54	4	11
70 to 74	0	7	4	11	22	2	6
75 to 79	0	5	2	9	16	2	6
80 to 84	0	3	0	2	5	0	2
85 to 89	0	1	2	0	3	0	2
Totals	160	250	160	208	778	80	80

[a] Sexed fish in these columns are included under columns for August and September.

completed most of their annual growth by mid-September the latter figure is probably a good estimate of the length attained during the first year of life. Age 1 trout-perch, beginning their second growing season, had a modal fork length in the 50 to 54 mm range during June and by mid-September had a modal length in the 65 to 69 mm size range.

The following length-weight relationships were calculated for trout-perch captured from the Athabasca River during August and September 1976 (Table 30).

The mathematical relationship between fork length and body weight for male trout-perch (n = 78, r = 0.993, range 28 to 78 mm) is described by the equation:

$$\log_{10}W = 3.051(\log_{10}L) - 5.034;\ sb = 0.001$$

while for female trout-perch (n = 85, r = 0.995, range 26 to 89 mm) the equivalent expression is:

$$\log_{10}W = 3.084(\log_{10}L) - 5.098;\ sb = 0.002$$

No significant difference was found between the slopes of the regression lines for male and female fish ($t = 0.617$; $P > 0.05$).

4.2.7.3 Sex and maturity. Sex was determined by dissection for 165 trout-perch of which 81 (49.1%) were males. Age-specific sex ratios and maturity data are not available because of the problems encountered with age determinations. It appears, however, that in some populations at least some individuals mature at age 1. In Red Lake, Minnesota, most males and a few females spawn at age 1 while most females spawn for the first time at two years of age (Magnuson and Smith 1963). In Great Slave Lake, Northwest Territories, a few males (3.7%) but no females spawn at age 1. At age 2, 90.9% of male and 84.2% of female trout-perch are sexually mature (W. A. Bond, Unpublished Data).

4.2.7.4 Spawning. Trout-perch generally spawn in May along the sandy shores of lakes or in small tributary streams (Scott and Crossman 1973). Lawler (1954) reported that trout-perch in Heming

Lake, Manitoba, ascend small tributary streams in May to spawn over silt and boulder bottoms at water temperatures between 4.4 and 10.0°C. No ripe adults were collected in the June samples during the present study but young-of-the-year were present as early as 20 June. Bond and Machniak (1977) reported a ripe age 3 female in the Muskeg River on 14 May 1976 and captured 40 young-of-the-year trout-perch (10 to 17 mm in length) near the mouth of that tributary on 15 June 1976. Although it is not known whether trout-perch spawn in the Athabasca River proper, it seems likely that spawning does occur in the lower reaches of some tributary streams in late May or early June.

4.2.7.5 Food habits. The stomach contents of 110 trout-perch were examined for food and the results described in terms of precentage frequency of occurrence (Table 36). Diptera larvae (mostly Chironomidae) were the most common food item, occurring in 70.5% of the stomachs that contained food. Other food items identified from the stomach contents were Ephemeroptera nymphs (12.5%), Amphipoda (5.7%), Cladocera (4.6%), detritus (5.7%), and plant material (1.1%).

4.2.8 Flathead Chub

4.2.8.1 Distribution and relative abundance. Flathead chub were common throughout the study area but were never captured in large numbers. Among those species susceptible to capture by standard gangs, flathead chub ranked fifth in abundance comprising 6.0% of the catch with an average catch-per-unit-effort of 0.067 fish per gang per hour (Table 3, Appendix 6.4). In large mesh seines, flathead chub had an average catch-per-unit-effort of 0.90 individuals per haul and accounted for 6.8% of the total catch (Table 4). Chub were taken in 47% of all standard gangs and in 35% of all large mesh seine hauls. Flathead chub occurred in only 17% of small mesh seine hauls, made up 1.4% of the total catch in that gear, and had an average catch-per-unit-effort of 1.4 fish per haul (Table 5).

An analysis of catch in relation to sampling effort (Appendix 6.2) indicated that the larger chub (> 140 mm) taken by standard gangs and large mesh seines occurred most often at sites associated with islands and mid-channel sand bars, back eddies, and tributaries. Areas of slack current along point bars, side bars, and bank indentations yielded few flathead chub. Small chub (< 100 mm) were taken in greatest numbers at island and mid-channel sand bar sites. Although only 16.1% of the small mesh seine effort was expended in these locations they produced 89.5% of the flathead chub captured in small mesh seines (Appendix 6.2). Overall, chub were captured most frequently at Sites 2, 4 to 11, 13, 14, 17, 19 to 21, 24, 26, 28 to 34, 37, 40, 41, 47, 51, and 54 (Figure 3, Appendix 6.1).

4.2.8.2 Age and growth. Flathead chub ranged in fork length from 17 to 311 mm. Small mesh seines produced a large number of fish in the 17 to 89 mm length range while other sampling techniques captured chub in the 145 to 311 mm range (Table 41). The virtual absence of flathead chub in the 80 to 150 mm range may be related to sampling bias, such fish being small enough to be unsusceptible to capture in large mesh seines and standard gangs and large enough to avoid small mesh beach seines.

Flathead chub grew rapidly reaching a mean fork length of 203.3 mm at age 3 (Table 42). After age 3, the rate of increase in fork length declined. Females were generally longer than males of the same age in our sample (Table 42). Growth in weight was slow during the first year of life as chub (n = 74) achieved a mean weight of 2.5 grams at age 1 (Table 43). After the first year, however, weight gain occurred at a rapid and constant rate through age 7. Females were consistently heavier than males of equal age (Table 43).

The mathematical relationship between fork length and body weight (Table 30) for male flathead chub (n = 25, r = 0.961, range 167 to 257 mm) is described by the equation:

$$\log_{10}W = 3.401(\log_{10}L) - 5.866;\ sb = 0.036$$

Table 41. Length-frequency distribution for flathead chub from the Athabasca River, 1976.

Fork Length (10 mm intervals)	Small Mesh Seines					Large Mesh Seines	Angling Gear	Gill Nets	Total	
	June	July	Aug.	Sept.	Total				N	%
10 to 19	0	1	0	0	1	0	0	0	1	0.3
20 to 29	0	10	9	1	20	0	0	0	20	6.4
30 to 39	0	8	6	2	16	0	0	0	16	5.1
40 to 49	0	1	1	1	3	0	0	0	3	0.9
50 to 59	0	16	11	1	28	0	0	0	28	8.9
60 to 69	2	23	11	1	37	0	0	0	37	11.8
70 to 79	1	3	2	0	6	0	0	0	6	1.9
80 to 89	0	1	0	0	1	0	0	0	1	0.3
90 to 99	0	0	0	0	0	0	0	0	0	0.0
100 to 109	0	1	1	0	2	0	0	0	2	0.6
110 to 119	0	0	0	0	0	0	0	0	0	0.0
120 to 129	0	0	0	0	0	0	0	0	0	0.0
130 to 139	0	0	0	0	0	0	0	0	0	0.0
140 to 149	0	0	0	0	0	6	0	0	6	1.9
150 to 159	0	0	0	0	0	10	0	1	11	3.5
160 to 160	0	0	0	0	0	12	0	2	14	4.5
170 to 179	0	0	0	0	0	3	0	1	4	1.3
180 to 189	0	0	0	0	0	7	0	0	7	2.2
190 to 199	0	0	0	0	0	6	1	0	7	2.2
200 to 209	0	0	0	0	0	3	0	5	8	2.5
210 to 219	0	0	0	0	0	4	1	9	14	4.5
220 to 229	0	0	0	0	0	4	0	24	28	8.9
230 to 239	0	0	0	0	0	3	1	13	17	5.4
240 to 249	0	0	0	0	0	3	3	19	25	8.0
250 to 259	0	0	0	0	0	6	1	16	23	7.3
260 to 269	0	0	0	0	0	0	3	11	14	4.5
270 to 279	0	0	0	0	0	0	2	6	8	2.5
280 to 289	0	0	0	0	0	0	5	4	9	2.9
290 to 299	0	0	0	0	0	0	2	1	3	0.9
300 to 309	0	0	0	0	0	0	1	0	1	0.3
310 to 319	0	0	0	0	0	0	1	0	1	0.3
Total	3	64	41	6	114	67	21	112	314	

Table 42. Age-length (mm) relationship for flathead chub from the Athabasca River, 1976. Sexes separate and combined (includes unsexed fish).

Scale Age	Males				Females				All Fish			
	N	Mean	S.D.	Range	N	Mean	S.D.	Range	N	Mean	S.D.	Range
0+	ND				ND				39	29.0	5.74	17 to 43
1	ND				ND				74	60.9	7.29	47 to 81
2	1	109.0			1	101.0			13	144.4	18.57	101 to 160
3	9	202.6	23.73	167 to 225	13	220.7	9.21	199 to 231	34	203.3	25.67	154 to 231
4	11	227.2	12.03	215 to 257	38	237.6	14.44	206 to 259	49	235.3	14.50	206 to 259
5	5	236.0	7.45	226 to 245	27	262.0	12.39	240 to 284	32	257.9	15.10	226 to 284
6	0				6	274.7	13.49	258 to 293	6	274.7	13.49	258 to 293
7	0				2	307.5		304 to 311	2	307.5		304 to 311
Totals	26				87				249			

Table 43. Age-weight (g) relationship for flathead chub from the Athabasca River, 1976. Sexes separate and combined (includes unsexed fish).

Scale Age	Males				Females				All Fish			
	N	Mean	S.D.	Range	N	Mean	S.D.	Range	N	Mean	S.D.	Range
0+	ND				ND				39	0.3	0.21	0.02 to 1.27
1	ND				ND				74	2.5	0.89	1.21 to 5.47
2	1	20.4			1	10.9			13	40.8	14.98	10 to 60
3	9	98.9	35.51	50 to 140	13	132.3	20.47	80 to 150	34	105.9	36.94	40 to 160
4	11	143.6	29.76	110 to 210	38	168.2	32.03	100 to 250	49	162.7	32.90	100 to 250
5	5	164.0	19.49	140 to 190	27	219.6	38.48	140 to 300	32	310.9	41.38	140 to 300
6	1				6	253.3	39.83	210 to 320	6	253.3	39.83	210 to 320
7	1				2	375.0		370 to 380	2	375.0		370 to 380
Totals	26				87				249			

The equivalent expression for female chub ($n = 85$, $r = 0.952$, range 199 to 293 mm) is:

$\log_{10}W = 3.006(\log_{10}L) - 4.927$; $sb = 0.011$

No significant difference was found between the slopes of the regression lines for male and female flathead chub ($t = 0.937$; $P > 0.05$).

4.2.8.3 Sex and maturity. Sex and age were determined for 113 flathead chub of which 77% were females (Table 44). The sex ratio, therefore, was significantly different from 1:1 ($X^2 = 16.5$, $P < 0.05$). Most fish of both sexes were mature by age 4 and all age 5 fish examined were mature (Table 44). The smallest mature male was in the 210 to 219 mm length range while the smallest mature female occurred in the 200 to 209 mm length range.

4.2.8.4 Spawning. Little information is available in the literature concerning spawning of flathead chub. Paetz and Nelson (1970) state that spawning probably occurs in July and August. McPhail and Lindsey (1970) report that spawning was in progress on 27 June at 64°N in the Mackenzie River. Spawning of flathead chub was not observed during the present study but ripe females were captured in early July. The first spent individuals were obtained in late July and a large number of spent fish were noted in the early August samples. Young-of-the-year were first captured in small mesh seines during the 14 to 23 July period at which time they ranged in fork length from 17 to 39 mm. Flathead chub probably spawn within the Athabasca River rather than in tributaries as this species is seldom encountered in clear water (McPhail and Lindsey 1970).

4.2.8.5 Food habits. Of 67 flathead chub stomachs examined 53 (79.1%) contained food. Chub had fed primarily on aquatic insects of the orders Ephemeroptera, Hemiptera, Hymenoptera, Coleoptera, Trichoptera, and Diptera and on Pelecypods (Table 36).

Table 44. Age-specific sex ratios and maturity for flathead chub, Athabasca River, 1976. Sex ratios were based only on fish for which sex was determined.

Scale Age	Males			Females			Unsexed Fish	Total	
	N	%	% Mature	N	%	% Mature		N	%
0+	ND			ND			39	39	15.7
1	ND			ND			74	74	29.7
2	1	50	0	1	50	0	11	13	5.2
3	9	41	0	13	59	0	12	34	13.7
4	11	22	82	38	78	92	0	49	19.7
5	5	16	100	27	84	100	0	32	12.9
6	0			6	100	100	0	6	2.4
7	0			2	100	100	0	2	0.8
Totals	26	23		87	77		136	249	

4.2.9 Lake Chub

4.2.9.1 Distribution and relative abundance. Lake chub was seventh in abundance among the fish species captured during the study making up 5.9% of the total combined catch (Table 2). In small mesh seines, the only effective gear utilized for this species, lake chub ranked fourth in abundance accounting for 8.3% of the total catch (Table 5). Overall, lake chub occurred in 53% of all small mesh seine hauls averaging 8.7 individuals per haul (Table 5). Lake chub abundance was low in June but increased steadily through the summer and reached a peak in mid-September when the catch-per-unit-effort was 34.7 chub per haul (Table 5).

The majority of lake chub were captured at Sites 36 to 43, 45, and 47 to 59 with concentrations occurring at Sites 37, 38, 41, 50, 53, 54, and 55 (Figure 3, Appendix 6.1). Analysis of the lake chub catch as related to the distribution of sampling effort indicated that lake chub preferred tributary-associated sites and island areas and avoided back eddies and other shoreline locations (Appendix 6.2). At tributary sites, 53.5% of the small mesh seine effort was expended and produced 77.3% of the total chub catch. The corresponding figures for island-associated locations were 16.1 and 18.9% respectively.

4.2.9.2 Age and growth. Lake chub ranged in size from 17 to 92 mm with the vast majority (75.2%) in the 25 to 39 mm fork length range (Table 45).

Most (88%) of the lake chub examined are believed to be young-of-the-year with a mean fork length of 30.8 mm (range 17 to 46 mm) and a mean weight of 0.38 g (range 0.04 to 1.21 g). The remaining fish could not be aged reliably because of the deterioration of the periphery of the otoliths by formalin but all showed at least one annulus (Table 46). The largest lake chub captured was a mature female with a fork length of 92 mm. This specimen was estimated to be three years old.

Table 45. Length-frequency distribution for lake chub, emerald shiner, and spottail shiner captured from the Athabasca River, 1976. Sampling periods indicated are June (1), July (2), August (3), September (4), and Total (T).

Fork Length (mm)	Lake chub					Emerald shiner					Spottail shiner				
	1	2	3	4	T	1	2	3	4	T	1	2	3	4	T
15 to 19	0	1	4	1	6	0	0	0	0	0	0	0	2	0	2
20 to 24	0	2	11	17	30	0	0	0	0	0	0	0	25	5	30
25 to 29	0	3	47	70	120	0	0	0	0	0	0	0	39	10	49
30 to 34	0	5	51	78	134	0	0	0	1	1	0	0	46	12	58
35 to 39	0	3	35	53	91	4	0	0	3	7	0	0	26	13	39
40 to 44	0	0	9	22	31	3	0	0	2	5	0	1	3	9	13
45 to 49	1	1	2	18	22	0	8	3	0	11	0	4	1	3	8
50 to 54	0	2	0	2	4	0	3	5	0	8	0	2	8	0	10
55 to 59	0	1	1	2	4	0	0	15	0	15	0	3	18	0	21
60 to 64	0	4	0	2	6	4	0	19	4	27	1	1	7	0	9
65 to 69	0	1	0	2	3	46	7	0	4	57	1	1	0	0	2
70 to 74	1	1	0	0	2	74	29	22	1	126	0	2	2	0	4
75 to 79	0	1	1	2	4	34	36	38	4	112	1	0	0	0	1
80 to 84	0	0	0	1	1	9	5	11	9	34	3	0	0	0	3
85 to 89	0	0	0	0	0	5	2	2	2	11	1	5	0	0	6
90 to 94	0	0	0	1	1	2	2	0	0	4	0	1	0	0	1
95 to 99	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0
Total	2	25	161	271	459	183	92	115	30	420	7	20	177	52	256

The length-weight relationship for lake chub (Table 30), determined for both sexes combined ($n = 54$, $r = 0.975$, range 17 to 42 mm), is described by the equation:

$$\log_{10}W = 3.242(\log_{10}L) - 5.305; \; sb = 0.018$$

4.2.9.3 Sex and maturity. Of 54 lake chub considered to be age 1 or older, 57% were females (Table 46). The observed sex ratio, therefore, did not differ significantly from unity ($X^2 = 0.593$; $P > 0.05$).

Six females (19.4%) and four males (17.4%) were sexually mature. The mean fork lengths for these mature fish were 79.7 mm for females and 66.0 mm for males. Bond and Machniak (1977) report that lake chub of both sexes spawn for the first time at age 3 in the Muskeg River. These authors state that the smallest mature males were between 55 and 59 mm in fork length while the smallest mature females were in the 70 to 74 mm size range. In the Montreal River, Saskatchewan, female chub first spawned at age 3, at which age they had a mean total length of 95.1 mm (Brown et al. 1970). Paetz and Nelson (1970) believe that lake chub in Alberta reach maturity at age 3 or 4 and that few live more than five years.

4.2.9.4 Spawning. The lake chub is reported to undertake spawning migrations into tributary streams from April to June (Scott and Crossman 1973). In the Montreal River, Saskatchewan, lake chub were observed spawning in shallow water from 21 to 27 May when water temperatures reached 10°C (Brown 1969). Bond and Machniak (1977) captured ripe females until 21 July 1976 in the Muskeg River where young-of-the-year chub had a fork length of 27 mm on 29 June.

The virtual absence of lake chub in the Athabasca River during June may indicate that most chub moved out of the main river to spawn in tributaries. But the fact that few lake chub older than one year were captured at all during the present study suggests that this species is more typical of tributary streams than of the Athabasca River proper. Bond and Machniak (1977) found lake chub throughout the Muskeg River watershed and reported that

Table 46. Age-length (mm) and age-weight (g) relationships (derived from otoliths)[a], age specific sex ratios, and maturity of lake chub, emerald shiner, and spottail shiner captured from Athabasca River in 1976.

Species	Age	Females			Males			Unsexed	Total	Fork Length (mm)			Weight (g)		
		N	%	% Mature	N	%	% Mature			Mean	S.D.	Range	Mean	S.D.	Range
Lake chub	0+	ND			ND			169	169	30.8	6.1	17-46	0.38	0.23	0.04-1.21
	1-3	31	57	19.4	23	43	17.4	0	54	53.1	14.1	32-92	2.06	1.68	0.46-9.06
	Totals	31			23			169	223						
Emerald shiner	0+	ND			ND			6	6	37.8	3.5	34-43	0.56	0.17	0.41-0.81
	1-3	74	52	81.0	69	48	94.2	31	174	69.4	11.8	35-96	3.49	1.64	0.35-8.87
	Totals	74			69			37	180						
Spottail shiner	0+	ND			ND			93	93	30.4	6.4	17-46	0.37	0.22	0.07-1.1
	1-3	29	53	27.6	26	47	23.1	5	60	57.2	16.4	32-90	2.60	2.14	0.40-8.46
	Totals	29			26			98	153						

[a] Otolith ages could not be determined reliably because of deterioration of periphery of otolith resulting from prolonged formalin preservation.

chub was the most abundant species (excluding young suckers) in that tributary. Lake chub have also been reported in several other streams in the AOSERP study area (Griffiths 1973).

4.2.9.5 Food habits. Lake chub had fed predominantly on aquatic insects. Among the fish whose stomachs contained some food (89.4%), the most common food items were adult Hemiptera with a frequency of occurrence of 34.2% (Table 36). Adult Hymenoptera (29.3%) and larval Diptera (26.8%) were also important in the diet.

4.2.10 Emerald Shiner

4.2.10.1 Distribution and relative abundance. Emerald shiners were the third most abundant species captured in small mesh seines (9.0%) and fifth overall, accounting for 6.4% of the total combined catch from all gear types (Tables 2 and 5). Shiners were abundant in the study area during June at which time they were captured in 60% of all small mesh seine hauls with an average catch-per-unit-effort of 17.2 individuals per haul. Abundance decreased through the summer and during September the species occurred in only 23% of small mesh seines with a catch-per-unit-effort of 2.6 (Table 5).

Most emerald shiners were captured at Sites 36 to 39, 41 to 43, 45, 47 to 60, 7, 8, and 32 (Figure 3, Appendix 6.1). On the basis of catch data related to distribution of sampling effort, emerald shiners demonstrated a strong preference for sites associated with islands and mid-channel sand bars. Although only 16.1% of the sampling effort was expended at such sites, they yielded 34.8% of the total catch of emerald shiners (Appendix 6.2).

4.2.10.2 Age and growth. Emerald shiners ranged from 34 to 96 mm in fork length with the majority (78.3%) being in the 65 to 84 mm size range (Table 45).

Otolith ages for emerald shiners could not be determined reliably because of deterioration of the otoliths as a result of prolonged preservation in formalin. Mean fork lengths and weights for 414 emerald shiners whose otoliths showed at least one annulus are summarized in Table 46. Only six young-of-the-year emerald shiners were captured during the study. These fish were taken in September and had a mean fork length of 37.8 mm (range 34 to 43 mm). Emerald shiners are about 4 mm long at hatching and are reported to be weak swimmers (Fuchs 1967). Considering their small initial size and their susceptibility to current, it is likely that most young-of-the-year hatched in the study area were quickly transported to downstream locations.

The maximum age attained by emerald shiners in the sample is believed to be three years (a mature female 92 mm in fork length). The majority, however, are thought to be age 2 and in their third summer at time of capture. It is these fish that contributed most to the strong mode in the length-frequency distribution occurring in the 70 to 79 mm fork length range (Table 45). The drastic reduction in abundance seen in September for shiners of this size (Table 45) may indicate a massive mortality or migration out of the study area at that time.

The apparent paucity of one year old shiners in the study area is puzzling as Fuchs (1967) found that age 1 fish (mean total length 66 mm) made up 60% of the summer samples in Lewis and Clarke Lake, South Dakota. He reported few emerald shiners living beyond age 3. McCrimmon (1956) noted that in Lake Simcoe, Ontario, few emerald shiners survived until the autumn of their third year (age 2).

The mathematical relationship between fork length and body weight for emerald shiners (Table 30), calculated for the sexes combined ($n = 174$, $r = 0.984$, range 35 to 96 mm) is described by the equation:

$$\log_{10}W = 3.121(\log_{10}L) - 5.243; \; sb = 0.019$$

4.2.10.3 Sex and maturity. Females comprised 52% of those emerald shiners for which sex was determined (Table 46) but the sex ratio did not differ significantly from unity ($X^2 = 0.087$; $P > 0.05$). The majority of fish in the sample were sexually mature (Table 46).

The smallest mature males were in the 60 to 64 mm fork length range while the smallest mature females were in the 65 to 69 mm interval. Fuchs (1967) found that emerald shiners in Lewis and Clarke Lake reached sexual maturity in their second summer (age 1) at a total length greater than 60 mm.

4.2.10.4 Spawning. Spawning of emerald shiners was not observed during the present study but is believed to have occurred in the Athabasca River in June and July. A few ripe individuals were collected from the Athabasca River in June and spent individuals were taken in July and August. Athabasca River water temperatures between late June and early August ranged from about 19 to about 23°C (Figure 2), similar to the spawning temperatures reported by McCormick and Kleiner (1976). Scott and Crossman (1973) report a spawning temperature of 24°C with hatching occurring in less than 24 hours. As mentioned previously, newly hatched fry were probably transported downstream by the current. Young-of-the-year were not collected from the study area until September at which time they ranged from 34 to 43 mm in fork length (Table 46).

4.2.10.5 Food habits. Emerald shiners in lakes are reported to feed primarily on zooplankton and algae with insects being of minor importance (Fuchs 1967). In the Mackenzie River, however, shiners had fed mainly on insects (Hatfield et al. 1972). During the present study, 61 emerald shiner stomachs were examined of which 53 (86.9%) contained food. Virtually all stomachs contained insects with Diptera larvae and Hymenoptera adults being the most common, occurring in 18.9 and 15.1%, respectively, of the stomachs that contained food (Table 36). Other common food items were Hemiptera adults (13.2%), Ephemeroptera nymphs (5.7%), and Coleoptera adults (5.7%).

4.2.11 Spottail Shiner

4.2.11.1 Distribution and relative abundance. Spottail shiners comprised only 1.9% of the total combined catch from all gear types

(Table 2) and were sixth in abundance (2.7%) among species captured in small mesh seines (Table 5). Spottails were taken in only 30% of all small mesh seine hauls with an average catch-per-unit-effort of 2.8 individuals per haul (Table 5). During June and July, few spottail shiners were found in the study area, the catch-per-unit-effort for those months being 0.3 and 0.5 fish per haul, respectively. An increase in the catch-per-unit-effort in August (to 5.1) marked the appearance of young-of-the-year spottails in the study area.

Most spottail shiners were captured at Sites 36 to 38, 40, 42, 43, 45, 47, 48, 51 to 53, and 56 to 60 with concentrations noted at Sites 43, 52, 53, 54, and 59 (Figure 3, Appendix 6.1). Spottails showed a definite preference for tributary-associated sites and were seldom captured in other habitat types. Of the total catch, 94.6% were taken at tributary sites (Appendix 6.2).

4.2.11.2 Age and growth. Spottail shiners captured during the present study ranged in fork length from 17 to 90 mm with the majority (68.8%) being in the 20 to 39 mm size range (Table 45).

Otoliths for spottail shiners could not be read reliably beyond age 1 due to the effect of storage of the samples in formalin. Most of the fish in the sample, however, (76.6%) were young-of-the-year. These fish, captured in August and September, had a mean fork length of 30.4 mm and varied from 17 to 46 mm (Table 46). A second, smaller mode in the length-frequency distribution occurring at 55 to 59 mm (Table 45), probably represents age 1 spottail shiners in their second summer of life. The largest spottail shiner captured from the Athabasca River in 1976 was a mature female, 90 mm in fork length. This fish was estimated to be three years old. In Nemeiben Lake, Saskatchewan (Peer 1966), spottail shiners captured in the spring had modal total lengths of 38.9, 62.2, and 83.1 mm at ages 1, 2, and 3, respectively. At Crooked Lake, Saskatchewan (Peer 1966), the corresponding modal total lengths were 47.0, 68.5, and 90.4 mm.

The combined length-weight relationship (Table 30) for Athabasca River spottail shiners (n = 60, r = 0.993, range 32 to 90 mm) is described by the equation:

$$\log_{10}W = 2.844(\log_{10}L) - 4.671; \; sb = 0.019$$

4.2.11.3 Sex and maturity. Of those spottail shiners for which sex was determined, females accounted for 53% (Table 46) but the sex ratio did not differ significantly from unity ($X^2 = 0.082$; $P > 0.05$). Most of the fish examined are believed to have been age 1 and most were immature. The smallest mature spottails were in the 65 to 69 mm fork length range for both sexes. Most spottail shiners in the study area probably achieve sexual maturity at age 2. In Crooked Lake, Saskatchewan, Peer (1966) observed that during June all spottail shiners exceeding 67 mm total length (age 2 and older) were in spawning condition.

4.2.11.4 Spawning. Spottail shiner spawning was not observed during the present study but this event probably occurred in July. Samples taken during July contained both ripe and spent individuals and the first young-of-the-year (17 to 41 mm fork length) were captured on 14 to 19 August. In the Kalamazoo River, Michigan (Wells and House 1974) and in Red Lake, Minnesota (Smith and Kramer 1964), spottail shiners spawn in June. Spawning occurs during July in Crooked Lake, Saskatchewan (Peer 1966). Paetz and Nelson (1970) state that spottail shiners probably spawn from June to August in Alberta.

In the study area, spottail shiners probably spawn in the Athabasca River or in the lower reaches of tributary streams. The strong association of this species with tributary-associated sites (Appendix 6.2) suggests the latter. Spottail shiners apparently spawn in the lower reaches of north shore tributaries in Lake Superior although most evidence suggests that Canadian populations prefer to spawn over sandy shoals (Scott and Crossman 1973).

4.2.11.5 Food habits. Gut analysis showed that spottail shiners from the study area had fed mainly on Diptera larvae, plant material, and Cladocera which were found in 34.1, 40.9, and 13.6%, respectively, of all stomachs that contained food (Table 36). Similar results were reported by Smith and Kramer (1964) and McCann (1959).

4.2.12 Other Species

4.2.12.1 Mountain whitefish. A total of 11 mountain whitefish were captured from the Athabasca River during the present study (Table 47). Nine young-of-the-year were captured near tributary Sites 36, 38, 45, and 48. These fish ranged in fork length from 39 mm in June to 65 mm in September. One age 2 (183 mm, 90 g) and one age 4 mountain whitefish (309 mm, 390 g) were captured at Site 5 (Figure 3, Appendix 6.1). Examination of the stomach contents of seven mountain whitefish showed them to have fed mainly on Diptera larvae and pupae and on Ephemeroptera nymphs (Table 48).

Scott and Crossman (1973) state that mountain whitefish appear to have few predators. In the present study, a mountain whitefish (age 2, fork length 223 mm) was found in the stomach of a northern pike captured 27 July at Site 2 (Figure 3). Another whitefish (age 1, fork length 180 mm) was found in a walleye taken 25 August at Site 2.

Mountain whitefish may be more abundant in the AOSERP study area than indicated by the results of the present study. This species has been reported in the Clearwater and Firebag rivers (Figure 2) by Griffiths (1973). The only information on movements of mountain whitefish in this area is presented by Bond and Machniak (1977) who documented a migration of juvenile and adult whitefish into the Muskeg River in late April and early May 1976. These fish left the tributary returning to the Athabasca River in June.

Spring feeding migrations of mountain whitefish into tributary streams have been reported in the Sheep River, Alberta (Davies and Thompson 1976), and in the Snake River, Utah (Erickson 1966). Davies and Thompson (1976) state that whitefish later leave the tributaries and undergo summer feeding movements into the upper Sheep River before undertaking a downstream spawning migration in September. A similar downstream movement to overwintering areas in larger pools was noted by Pettit and Wallace (1975) in Kelly Creek, Idaho.

Spawning was not observed during this study. Mountain whitefish usually spawn in October or early November (Paetz and Nelson

Table 47. Age-length and age-weight relationships (derived from length and weight frequencies and otoliths), age specific sex ratios, and maturity of less frequently captured fish species of the Athabasca River, 1976.

Species	Age	Females			Males			Unsexed Fish	Total	Fork Length (mm)			Weight (g)		
		N	%	% Mature	N	%	% Mature			Mean	S.D.	Range	Mean	S.D.	Range
Mountain whitefish	0+	0			0			9	9	55.4	7.9	39-65	1.63	0.54	0.66-2.34
	2	0			0			1	1	183.0			90.0		
	4	1	100.0	100.0	0			0	1	309.0			390.0		
	Totals	1			0			10	11						
Arctic grayling	0+	0			0			8	8	47.0	18.4	34-83	1.65	2.21	0.38-6.4
	3	2	67.0		1	33.0		0	3	225.0	14.0	209-235	123.3	20.8	100-140
	4	1	100.0	100.0	0			0	1	301.0			300.0		
	Unaged	0			0			0	5[a]	<150.0					
	Totals	3			1			8	17[a]						
Finescale dace	0+	0			0			2	2	29.5	0.7	29-30	0.33		
	Totals	0			0			2	2						
Brassy minnow	1	8	53.3		7	46.7		0	15	49.3	2.9	44-53	1.35	0.19	1.04-1.56
	2	2	50.0	100.0	2	50.0	100.0	0	4	61.3	3.3	59-66	2.36	0.38	2.13-2.92
	Totals	10			9			0	19						
Fathead minnow	1	2	100.0		0			0	2	42.5	4.9	39-46	0.84	0.33	0.61-1.07
	Totals	2			0			0	2						

continued ...

Table 47. Continued.

Species	Age	Females N	Females %	Females % Mature	Males N	Males %	Males % Mature	Unsexed Fish	Total	Fork Length(mm) Mean	Fork Length(mm) S.D.	Fork Length(mm) Range	Weight (g) Mean	Weight (g) S.D.	Weight (g) Range
Longnose dace	0+	0			0			20	20	24.0	5.3	14-37	0.17	0.11	0.02-0.51
	Totals	0			0			20	20						
Pearl dace	1	1	100.0		0			0	1	61.0			1.53		
	Totals	1			0			0	1						
Burbot	0+	0			0			2	2	83.0	12.7	74-92	2.77	1.03	2.04-3.50
	9+	0			1	100.0	100.0	0	1	611.0			1060.0		
	Unaged	0			0			13	13	496.1	101.7	255-655	736.7	348.7	360-1400
	Totals	0			1			15	16						
Iowa darter	Unaged	0			0			1	1	35.0			0.33		
	Totals	0			0			0	0						
Brook stickleback	0+	1	100.0		0			0	1	25.0			0.15		
	1	0			1	100.0	100.0	0	1	36.0			0.63		
	Totals	1			1			0	2						
Ninespine stickleback	0+	1	100.0		0			0	1	34.0			0.25		
	1	0			1	100.0	100.0	0	1	47.0			0.44		
	Totals	1			1			0	2						

continued ...

Table 47. Concluded.

Species	Age	Females			Males			Unsexed Fish	Total	Fork Length (mm)			Weight (g)		
		N	%	% Mature	N	%	% Mature			Mean	S.D.	Range	Mean	S.D.	Range
Yellow perch	0+	0			0			59	160[b]	39.5	6.1	29-59	0.75	0.38	0.23-2.33
	1	0			0			3	3	72.3	5.5	66-76	4.5	1.40	3.0-5.8
	2	0			0			1	1	115.0			26.7		
	Totals	0			0			63	164[b]						
Slimy sculpin	0+	0			0			21	21	32.7	5.2	17-39	0.29		
	Totals	0			0			21	21						
Spoonhead sculpin	0+	0			0			35	35	28.5	5.5	19-39	0.22		
	1	0			0			1	1	67.0			1.21		
	Totals	0			0			36	36						

[a] 5 Arctic grayling were released unsampled.

[b] 101 yellow perch were not sampled.

Table 48. Percentage frequency of occurrence for food items found in the stomach contents of the less frequently captured fish species of the Athabasca River, 1976. Sample size (N), Diptera (1), Ephemeroptera (2), Trichoptera (3), Hemiptera (4), Coleoptera (5), Hymenoptera (6), Insect parts (7), Amphipoda (8), Copepoda (9), Cladocera (10), Gastropoda (11), Fish remains (12), Detritus (13), and Empty (14).

Species	Percentage Frequency of Occurrence[a]														
	N	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mountain whitefish	7	71.4	71.4	0.0	0.0	0.0	0.0	28.6	0.0	0.0	0.0	0.0	0.0	0.0	14.3
Arctic grayling	12	66.7	50.0	16.7	33.3	16.7	8.3	41.7	8.3	0.0	0.0	0.0	0.0	0.0	0.0
Finescale dace	2	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Brassy minnow	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
Fathead minnow	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0
Longnose dace	20	20.0	0.0	0.0	0.0	0.0	0.0	30.0	0.0	0.0	0.0	0.0	0.0	15.0	40.0
Burbot	4	75.0	25.0	0.0	0.0	0.0	0.0	50.0	50.0	25.0	25.0	0.0	25.0	0.0	0.0
Brook stickleback	2	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0
Ninespine stickleback	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	50.0	0.0	0.0	0.0	0.0	50.0
Yellow perch	28	42.9	17.9	0.0	17.9	0.0	0.0	25.0	0.0	0.0	0.0	3.6	0.0	0.0	28.6

[a] Expressed as a percentage of the total number of stomachs examined (N).

1970). Within the study area, mountain whitefish probably spawn and overwinter in larger pools in the Athabasca River although the possibility exists that larger tributaries, such as the Firebag and Clearwater rivers, are also used for these purposes.

4.2.12.2 Arctic grayling. Seventeen Arctic grayling were captured from the Athabasca River (Table 47). Eight young-of-the-year grayling were taken in small mesh seines near tributary mouths at Sites 38, 39, 40, 53, and 60 (Figure 3, Appendix 6.1). These fish ranged in fork length from 34 mm in June to 83 mm in August. Standard gill net gangs took four grayling (age 3 and 4) at Sites 2 and 10 in October. An additional five grayling (< 150 mm fork length and probably age 1) were captured in large mesh beach seines at sampling Sites 21, 24, and 27. Examination of the contents of 12 stomachs showed that grayling had fed on a variety of food items, predominantly Diptera larvae and pupae, Ephemeroptera nymphs, and terrestrial insects (Table 48). An Arctic grayling (age 3, fork length 230 mm) was found in the stomach of a walleye captured 5 October at Site 7.

Although Arctic grayling have been reported in many of the tributary streams of the Athabasca River below Fort McMurray (Griffiths 1973), specific features of their life history have not been documented in this area. Ward (1951), while studying Arctic grayling in the upper Athabasca River drainage, suggested that grayling occur in the larger rivers at various times of the year but spend most of the summer months in the smaller feeder streams. In the AOSERP study area, small tributaries may be similarly important to Arctic grayling populations. Bond and Machniak (1977) reported that a grayling spawning migration was underway at the commencement of their study on the Muskeg River, 1976. These authors enumerated 305 grayling moving upstream during late April and May but stated that the main portion of the spawning migration was probably missed. In the Muskeg River, grayling did not return to the Athabasca River after spawning but remained in the tributary throughout the summer.

That grayling leave the tributaries in the fall to overwinter in the Athabasca River is suggested by the capture of several adult grayling in the mainstem during the first week of October 1976. Only one adult grayling had been captured from the Athabasca River prior to this time.

4.2.12.3 Finescale dace. Only two finescale dace were found during the study. Both were captured in July near a sand bar at Site 44 (Figure 3, Appendix 6.1). These specimens, both young-of-the-year, averaged 29.5 mm in fork length (Table 47) and had fed on aquatic insects (Table 48). Although finescale dace have not been reported previously from the immediate study area, they have been documented in the Christina River watershed south of Fort McMurray (Paetz and Nelson 1970). Finescale dace most often occur in cool boggy lakes or streams (McPhail and Lindsey 1970).

4.2.12.3 Brassy minnow. Brassy minnow is being reported from the Athabasca River proper for the first time. Previous records for this species are from the Milk River drainage in southeastern Alberta (Paetz and Nelson 1970), Musreau Lake of the Peace River drainage in northwestern Alberta (Bishop 1975), and a single specimen from the Athabasca system mentioned in Bishop (1975). This specimen was identified from collections made by Griffiths and Ferster (1973) while surveying the upper House River (55°50'N, 112°20'W) south of Fort McMurray.

Nineteen specimens were collected in small mesh beach seines at three locations within the Athabasca River. On 19 July, 14 brassy minnows were taken at Site 36, the confluence of the Horse River (56°44'N, 111°28'W) (Figure 3, Appendix 6.1). In September, four specimens were found in sub-samples from an island site (Site 37) near Fort McMurray, while one specimen was collected at Site 44 (Figure 3, Appendix 6.1).

Measurements made on the preserved samples were as follows: total length ranged from 49 to 72 mm; fork length ranged from 44 to 66 mm; lateral line scales ranged from 37 to 41 (mode 39); scales above lateral line six; anal and dorsal fin rays eight; and scale radii ranged from 13 to 19. Four specimens have been placed in the

Museum of Zoology, University of Alberta, Edmonton (UAM #3766).

The mean fork lengths of 15 age 1 and four age 2 brassy minnows were 49.3 ± 2.9 mm and 61.3 ± 3.3, respectively (Table 47). Total length values for brassy minnows from the Athabasca system are only slightly smaller than the values reported by Copes (1975) for brassy minnows in Wisconsin and Wyoming. Examination of 10 stomachs (Table 48) indicated that no feeding had occurred prior to capture which was in the morning for most of the samples. Copes (1975) noted that the most intensive feeding occurred from 1300 to 1500 h for brassy minnows, with the stomachs of fish collected prior to 1000 h being empty. Stomachs containing food indicated that brassy minnows from Sand Creek, Wyoming, fed predominately on algae and lesser amounts of Diptera larvae, Copepoda, Cladocera, and organic debris. In Fish Lake, British Columbia, Ableson (1973) found brassy minnows to spawn among vegetation from early June through July with water temperatures between 16° and 20°C.

4.2.12.5 Fathead minnow. Two fathead minnows were captured at Site 36 (Figure 3, Appendix 6.1) on 14 August. This species has not been previously identified from the study area but is common to the upper Athabasca watershed (Paetz and Nelson 1970) and a few localities in Wood Buffalo National Park (Nelson and Paetz 1972, 1974). Both fathead minnows collected in the Athabasca River were age 1 maturing females, with a mean fork length of 42.5 mm (Table 47).

Markus (1934) found mature age 1 fathead minnows in Iowa ponds and observed that large mortalities occurred after spawning. Peak spawning in these ponds occurred in May and June at water temperatures around 17.8°C (64°F). Carlson (1967) notes that peak spawning in the Des Moines River, Iowa, was in late July and that fathead minnows spawned late do not reach reproductive size the following summer. Age 1 and 2 fathead minnows were abundant in some habitats of the Des Moines River while very few age 3 minnows were captured. Fathead minnows in the Skunk River drainage, Iowa, were most abundant in the headwaters of small creeks (Carlson 1967).

4.2.12.6 Longnose dace. Twenty young-of-the-year longnose dace were captured from the Athabasca River during the present study. These fish were taken in small mesh seines (Table 5) at Sites 36, 37, 38, 39, 48, 49, and 59 (Figure 3, Appendix 6.1). Fork lengths ranged from 14 to 37 mm with a mean of 24 mm (Table 47). Analysis of stomach contents showed longnose dace to have fed primarily on aquatic insects (Table 48).

Griffiths (1973) found longnose dace to be widely distributed in tributary streams of the AOSERP study area. This species is probably more typical of tributary streams than of the Athabasca River proper. Longnose dace probably spawn in the lower reaches of the Muskeg River (Bond and Machniak 1977). Young-of-the-year captured in that tributary on 4 August 1976 ranged in fork length from 18 to 37 mm.

Gee and Northcote (1963) indicated that longnose dace prefer areas with fast currents and are usually found at depths less than 0.3 m. In Manitoba, Bartnik (1970) found spawning to occur in May at 15°C over coarse gravel where the eggs could adhere to the rocks.

4.2.12.7 Pearl dace. Only one pearl dace was captured during the present study. This specimen, captured at Site 37 (Figure 3, Appendix 6.1) on 13 September, was a one year old maturing female measuring 61 mm fork length (Table 47). Pearl dace, although apparently not abundant, have been reported from a number of locations in the AOSERP area (Griffiths 1973). Langlois (1929) observed pearl dace spawning during June in clear water streams in Michigan on sand or gravel bottoms, in or out of the current, while the water temperature was 17.2° to 18.3°C (63° to 65°F).

4.2.12.8 Burbot. A total of 16 burbot were captured from the Athabasca River during the present study. Eleven of these fish were taken in June by angling late at night with baited hooks at Sites 21, 25, 29, and 12 (Figure 3, Appendix 6.1). The ease with which burbot were captured using angling gear suggests a larger population than indicated by gill net and beach seine results.

In August, two young-of-the-year burbot were caught in small mesh seines at Sites 54 and 59. These specimens measured 74 and 92 mm in total length (Table 47). Twelve young-of-the-year taken in June 3 km upstream in Coffey Creek (Site 59) had a mean total length of 31.9 ± 3.7 mm.

Examination of three stomachs showed that young burbot had fed on immature insects (Table 48). On 27 August, a burbot (age 0+, total length 50 mm) was found in the stomach of a walleye captured at Site 6.

For burbot captured in the present study (n = 13, r = 0.823, range 74 to 611 mm), the relationship between total length and body weight is described by the equation:

$$\log_{10}W = 2.646(\log_{10}TL) - 4.360; \ sb = 0.295$$

In central and southern Canada, burbot are usually found in the deep waters of lakes, whereas in northern Canada, they also occur in large, cool rivers (Scott and Crossman 1973). McCrimmon and Devitt (1954) suggest that while a few burbot may spawn in rivers tributary to Lake Simcoe, Ontario, the principal spawning areas were in the lake. These authors noted a postspawning migration out of the lake into the rivers beneath the ice in late winter and early spring.

4.2.12.9 Brook stickleback. Small mesh beach seining in the Athabasca River captured only two brook stickleback. These specimens, captured along the shore of an island below Site 2 and at Site 60 (Figure 3, Appendix 6.1), had total lengths of 25 mm (age 0+) and 36 mm (age 1+). The larger fish was a male and was judged to be sexually mature (Table 47). Both stickleback had been feeding on Diptera larvae (Table 48). A brook stickleback (28 mm total length) was found in the stomach of a northern pike captured 26 August at Site 5.

While seldom found in the Athabasca River proper, the brook stickleback occurs in many tributary streams in the AOSERP study area (Griffiths 1973). In the Muskeg River, AOSERP fishery crews found this species to be abundant, particularly in the headwater areas (Bond and Machniak 1977). These authors report capturing ripe stickleback between 12 May and 18 June with young-of-the-year being captured 17 June at 10 to 11 mm total length.

In Astotin Lake, Alberta, brook stickleback spawned within rooted aquatic vegetation from mid-June to early August at water temperatures of 16° to 26°C (Smiley 1972). Following breakup of the Roseau River, Manitoba, brook stickleback moved upstream from over-wintering areas into warm, shallow meltwater ponds and ditches and spawned there in May and early June (MacLean and Gee 1971).

4.2.12.10 <u>Ninespine stickleback</u>. Ninespine stickleback have been reported from several locations in the Athabasca system (Paetz and Nelson 1970). However, only two were collected during the present study and they appear to be rare in this area. Both specimens were obtained near tributary confluences, one at Site 47 and the other at Site 59 (Figure 3, Appendix 6.1). The former specimen was a mature age 1 male (47 mm total length) captured in September, while the latter was an immature age 0+ female (34 mm total length) taken in August (Table 47). Jones and Hynes (1950) found that both males and females at age 1 were mature and ranged in size from 28 to 48 mm total length. Cameron et al. (1973) and Hynes (1950) found chironomid larvae and copepods to be major food items of the ninespine stickleback. One of the two Athabasca River specimens contained six copepods (Table 48).

4.2.12.11 <u>Yellow perch</u>. A total of 164 yellow perch were taken during the study, with 114 (70%) being captured in August (Table 5). Of the August sample, 74 fish (65%) were collected in the mouth of the Firebag River above Site 12 (Figure 3). The remaining perch were captured in small numbers at Sites 36 to 38, 40, 42, 43, 48, 49, 52 to 56, 58, and 59 (Figure 3, Appendix 6.1).

The majority (98%) of the perch captured were young-of-the-year with a mean fork length of 39.7 ± 6.1 mm (Table 47). Three age 1 perch had a mean fork length of 72.3 ± 5.5 mm, while one 2 year old measured 115 mm in fork length (Table 47). Stomach analysis of 28 fish showed that perch had fed primarily on Diptera larvae and pupae, Ephemeroptera nymphs, and Hemiptera (Corixidae) nymphs and adults (Table 48). In Beaver Lake, Alberta, Nursall and Pinsent (1969) noted that smaller yellow perch (< 110 mm fork length) depended chiefly on pelagic prey, e.g., chironomid pupae, mayfly nymphs, and cladocerans. Sieffert (1972) found cyclopoid copepods and cladocerans to be the dominant food items of larval yellow perch (< 15.9 mm total length) in Park Lake, Minnesota.

The perch captured during the present study are not thought to represent a resident population of the Athabasca River since no mature fish were taken. Rather, they are thought to have originated in tributary streams and their headwater lakes either within or upstream of the study area. Perch have been reported from many of the watersheds tributary to the Athabasca River (Paetz and Nelson 1970), including the Ells and Christina rivers within the AOSERP study area.

4.2.12.12 Iowa darter. The Iowa darter occurs in lakes and clear, slow streams, particularly in shallow water around aquatic vegetation. They spend most of their time on the bottom and feed primarily on aquatic insects. Spawning occurs in the spring (Paetz and Nelson 1970). This species is known from a few tributaries of the Athabasca River and dense populations have been found in two lakes in Wood Buffalo National Park, Alberta (Nelson and Paetz 1972, 1974).

During the present study, only one Iowa darter was collected. This specimen was captured in a small mesh seine at Site 59 (Figure 3, Appendix 6.1) on 19 August and measured 35 mm in total length (Table 47).

4.2.12.13 Slimy sculpin. Only 21 slimy sculpins were taken from the Athabasca River in 1976. Eighteen were captured at Site 48 (Figure 3, Appendix 6.1) in September while single occurrences were recorded at Sites 36, 38, and 41 in July, August, and September, respectively. All fish were young-of-the-year measuring from 17 to 39 mm in total length (Table 47).

Slimy sculpins were seldom captured in the Athabasca River but this species is common in streams throughout the AOSERP study area. Griffiths (1973) reported slimy sculpins from several tributary streams within the study area. Bond and Machniak (1977) found slimy sculpins to be common in the lower reaches of the Muskeg River. These authors captured ripe slimy sculpins on 8 May, with young-of-the-year appearing by 9 June.

4.2.12.14 Spoonhead sculpin. Thirty-six spoonhead sculpins were captured during the present study. Of this number, 35 were young-of-the-year with a mean total length of 28.5 mm (range 19 to 39 mm), while one age 1 sculpin measured 67 mm in total length (Table 47). Spoonheads were taken in 19% of all small mesh seine hauls (Table 5) and were collected from Sites 36, 37, 38, 39, left bank near 16, 40, 41, 42, 44, 45, 55, 56, 57, and 59 (Figure 3, Appendix 6.1).

The biology of spoonhead sculpin is poorly understood. McPhail and Lindsey (1970) state that despite having a wide distribution and occupying a diversity of habitats this species is seldom found in abundance. They suggest that perhaps it is common to deep areas of large turbid rivers where little sampling has occurred. Even the time of spawning appears uncertain for this species. Delisle and Van Vliet (1968) captured ripe males on 1 August in Pemichangan Lake, Quebec. Scott and Crossman (1973) observed female spoonhead sculpins in Ontario to have larger eggs in August than in June or July and suggested that spawning occurred in late summer or early fall. On the other hand, Paetz and Nelson (1970) state that spoonhead sculpins are probably spring spawners. In Alberta, spawning has been observed in late April in the Medicine and Red Deer rivers and during May in the Tay and Clearwater rivers at water temperatures above 6.5°C (Mr. Wayne Roberts, Museum of Zoology, University of Alberta, Edmonton, verbal communication with D. K. Berry, November 1976).

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6. APPENDIX

6.1 DESCRIPTIONS FOR SAMPLING SITES USED IN THE 1976 STUDY OF THE ATHABASCA RIVER

The locations described below refer to the standard gang and large mesh and small mesh seine sites shown in Figure 3 of this report. Many of the sites became difficult to sample at high Athabasca River discharge rates ($> 1416\ m^3 \cdot s^{-1}$) and have been indicated as such. Discharge values given with descriptions of tributary-associated sites refer to the 1976 mean annual discharge for the tributary (Water Survey of Canada 1977).

6.1.1 Standard Gang Sites

Site 1 (km 10.6)(Mile 6.6) Slack water site at the tail of a mid-channel island with a current sweep on both sides. Shallow area, almost exposed at low water. Substrate of sand and gravels.

Site 2 (km 11.2)(Mile 7.0) Right bank. Large deep back eddy formed behind gravel delta area of Clark Creek. Persists through high discharge levels. Vertical limestone bank, sloping mud over gravel shore. Fast drop off. Water quality influenced by Clearwater River.

Site 3 (km 22.7)(Mile 14.2) Small slack water area formed behind island and sand bar. Moderately deep with fast drop off and sandy bottom. Best during low to medium discharge levels.

Site 4 (km 37.0)(Mile 23.1) Right bank. Eddy behind point of limestone bluff, diminishing with high discharges. Shallow with mud bottom sloping to gravels.

Site 5 (km 42.1)(Mile 26.3) Left bank. Large eddy behind point of limestone bluff, persisting through high discharge levels. Shallow along shore sloping to deep at mid-channel. Mud shore sloping to gravels.

Site 6 (km 59.5)(Mile 37.2) Right bank. Eddy behind point of limestone cliff, diminishing with high discharges. Mud shore sloping to sand and gravels, dropping off to deep at mid-channel.

Site 7 (km 70.6)(Mile 44.1) Right bank. Medium size eddy created by old barge docking site, best at medium discharge levels. Bitumen bank with fast drop off.

Site 8 (km 74.9)(Mile 46.8) Left bank. Low current area downstream of mud bank, diminishing with medium to high discharge. Shallow with sloping mud shore and bottom.

Site 9 (km 95.8)(Mile 59.9) Right bank. Medium to large size eddy, indentation in high clay bank near small tributary ($< 0.03\ m^3 \cdot s^{-1}$). Persists through high discharge levels. Mud shore sloping steeply to deep mid-channel area.

Site 10 (km 100.0)(Mile 62.5) Left bank. Mouth of Eymundson Creek ($\simeq 0.42\ m^3 \cdot s^{-1}$). Tributary warm and usually highly turbid from silts. Flow often held back by high Athabasca discharge. Slack water hole and small eddy at stream mouth behind deflection point of oil sand bluff. Shallow in tributary mouth with bottom of mud and sand. Fast drop off.

Site 11 (km 123.7)(Mile 77.3) Right bank. Low current area along gravel shoreline. Shallow, sloping gravel bottom, diminishing rapidly with increases above medium discharges.

Site 12 (km 133.3)(Mile 83.3) Right bank. Small low current site created by bank slump. Drops off quickly in fast current. Diminishes with high discharge. Influenced by Firebag River ($21.7\ m^3 \cdot s^{-1}$), a warm, clear, brown-water stream.

6.1.2 Large Mesh Seine Sites

Site 13 (km 6.6)(Mile 4.1) Back eddy site at tip of Rocke Island near confluence of Clearwater River. Mud shore, sloping to drop off. Clearwater River, large, brown-water stream ($141.0\ m^3 \cdot s^{-1}$), relatively clear and warm.

Site 14 (km 11.2)(Mile 7.0) (See standard gang Site 2). Vertical bank makes bank difficult to seine at high discharges.

Site 15 (km 16.2)(Mile 10.1) Right bank. Small eddy behind bank slump, discharge dependent. Fast drop off.

Site 16 (km 22.7)(Mile 14.2) (See standard gang Site 3). Not suitable at high discharge when sand bar becomes inundated.

Site 17 (km 30.6)(Mile 19.1) Right bank. Slack water area and small eddy behind point of limestone cliff, diminishing with high discharge. Shallow with sloping shore of mud over sand and gravel.

Site 18 (km 35.8)(Mile 22.4) Right bank. Eddy created at barge docking site. Small but deep, diminishing at higher discharge.

Site 19 (km 37.0)(Mile 23.1) (See standard gang Site 5).

Site 20 (km 39.8)(Mile 24.9) Left bank. Eddy created at low to medium discharge by gravel point bar. Mud shore, mud over gravel bottom, shallow.

Site 21 (km 40.0)(Mile 25.0) Right bank. Confluence of Steepbank River (4.1 $m^3 \cdot s^{-1}$), a clear, warm, brown-water stream. Eddy formed by bitumen delta at low to medium discharge. Alternate site - Steepbank channel when flow held back by high Athabasca discharge.

Site 22 (km 42.1)(Mile 26.3) (See standard gang Site 5).

Site 23 (km 55.5)(Mile 34.7) Right bank. Confluence of Muskeg River (2.1 $m^3 \cdot s^{-1}$), a warm, clear brown-water stream. Gravel substrate. Best at high Athabasca discharge when Muskeg River is backed up.

Site 24 (km 59.5)(Mile 37.2) Left bank. Slack water behind sand bar exposed at low discharge. Confluence of MacKay River (14.7 $m^3 \cdot s^{-1}$), a warm, clear, brown-water stream. Gravel substrate. Flow held back at high Athabasca discharge.

Site 25 (km 59.7)(Mile 37.3) (See standard gang Site 6).

Site 26 (km 70.6)(Mile 44.1) (See standard gang Site 7).

Site 27 (km 76.8)(Mile 48.0) Left bank. Slack water behind sand bar which is exposed at low discharge. Confluence Ells River (6.3 $m^3 \cdot s^{-1}$), a warm, brown-water stream. Often slight turbidity. Flow held back at high Athabasca discharge.

Site 28 (km 81.8)(Mile 51.1) Right bank. Eddy created by large bank slumps, persists through high discharge. Vertical bank, sloping mud shore, gravel substrate. Fast drop off.

Site 29 (km 94.1)(Mile 58.8) Left bank. Small eddy associated with Pierre River (0.2 $m^3 \cdot s^{-1}$), a clear, slightly brown-water stream. Shallow with sloping mud shore.

Site 30 (km 95.8)(Mile 59.9) (See standard gang Site 9). Willows on low bank make this site difficult to seine at high discharge levels.

Site 31 (km 100.0)(Mile 62.5) (See standard gang Site 10). Vertical banks make this site difficult to seine at high discharge levels.

Site 32 (km 102.6)(Mile 64.1) Left bank. Small eddy diminishing with medium to high discharge. Vertical bank, sloping mud shore, shallow.

Site 33 (km 110.1)(Mile 68.8) Right bank. Several small eddies created by gravel side bars. Dominant eddy varies with discharge level. Sloping gravel shore, shallow.

Site 34 (km 123.7)(Mile 77.3) (See standard gang Site 11).

Site 35 (km 126.4)(Mile 79.0) Right bank. Slack water hole at confluence of Coffey Creek. Side channel appearance, low flow (sluggish) warm, clear drainage from marsh lakes area. Subject to back flooding at high Athabasca discharge. Mud shore and bottom with some aquatic plant life.

6.1.3 Small Mesh Seine Sites

Site 36 Horse Creek (9.3 $m^3 \cdot s^{-1}$), a warm, clear, brown-water stream. Gravel substrate. Small slack water area at confluence, shallow with silt bottom. Creek enters east side of Athabasca River just upstream of Fort McMurray.

Site 37 (km 7.4)(Mile 4.6) Low current shorelines of island near Fort McMurray, shallow with gravel substrate.

Site 38 (km 10.9)(Mile 6.8) Right bank. Confluence of Clark Creek (small, clear, cool) gravel substrate.

Site 39 (km 16.2)(Mile 10.1) Right bank. Confluence of Donald Creek (small, clear, cool).

Site 40 (km 24.5)(Mile 15.3) Right bank. Confluence of McLean Creek (small, clear, cool).

Site 41 (km 25.8)(Mile 16.1) Right bank. Confluence of Wood Creek (small, clear, cool).

Site 42 (km 27.4)(Mile 17.1) Left bank. Confluence of Poplar Creek (1.1 $m^3 \cdot s^{-1}$), a clear, warm, brown-water stream whose flow is held back at high Athabasca discharge.

Site 43 (km 29.6)(Mile 18.5) Right bank. Confluence Leggett Creek, a small, sluggish, clear, warm, brown-water stream. Deep side channel appearance. Emergent aquatic plants. Floods back at high Athabasca discharge.

Site 44 (km 34.9)(Mile 21.8) Left bank. Island-sand bar, shallow slack water site.

Site 45 (km 40.0)(Mile 25.0) (See large mesh seine Site 21).

Site 46 (km 42.1)(Mile 26.3) (See standard gang Site 5).

Site 47 (km 54.2)(Mile 33.9) Left bank. Confluence Beaver River (0.7 $m^3 \cdot s^{-1}$). Mud bottom, warm often turbid (dammed and diverted upstream).

Site 48 (km 55.5)(Mile 34.7) (See large mesh seine Site 23).

Site 49 (km 59.5)(Mile 37.2) (See large mesh seine Site 24).

Site 50 (km 59.7)(Mile 37.3) (See standard gang Site 6).

Site 51 (km 76.8)(Mile 48.0) (See large mesh seine Site 27).

Site 52 (km 78.9)(Mile 49.3) Left bank. Confluence of Tar River (0.9 $m^3 \cdot s^{-1}$), a warm, clear, brown-water stream. Shallow with mud-sand substrate.

Site 53 (89.0)(Mile 55.6) Left bank. Confluence Calumet RIver (0.2 $m^3 \cdot s^{-1}$), a warm, clear, slightly brown-water stream. Shallow with mud-sand substrate and debris.

Site 54 (km 94.1)(Mile 58.8) (See large mesh seine Site 29).

Site 55 (km 95.8)(Mile 59.9) (See standard gang Site 9).

Site 56 (km 100.0)(Mile 62.5) (See standard gang Site 10).

Site 57 (km 110.1)(Mile 68.8) (See large mesh seine Site 33).

Site 58 (km 123.5)(Mile 77.2) (See standard gang Site 11).

Site 59 (km 126.4)(Mile 79.0) (See large mesh seine Site 35).

Site 60 (km 126.6)(Mile 79.1) Left bank. Confluence of Redclay Creek, a small, warm, clear, slightly brown-water stream. Shallow with mud-sand substrate.

6.2 CATCH DATA BY SPECIES RELATED TO DISTRIBUTION OF SAMPLING EFFORT FOR EACH GEAR TYPE AND EACH HABITAT TYPE. (TABLES 49, 50, 51, and 52).

Table 49. Catch data by species related to distribution of standard gang sampling effort for each habitat type.

Habitat Type	Effort Expended		Goldeye		Walleye		Lake Whitefish		Northern Pike		Longnose Suckers		White Suckers		Flathead Chub	
	No. Hours	% Total Hours	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Islands	185.5	13.5	107	17.2	15	8.6	0	0.0	2	1.9	4	8.7	0	0.0	21	22.8
Back Eddies	762.0	55.4	365	58.5	103	59.2	347	71.3	70	66.7	18	39.1	11	91.7	34	37.0
Tributaries	219.5	16.0	78	12.5	34	19.5	106	21.8	18	17.1	13	28.3	1	8.3	25	27.2
Other[a]	208.0	15.1	74	11.9	22	12.6	34	7.0	15	14.3	11	23.9	0	0.0	12	13.0
Total	1375.0		624		174		487		105		46		12		92	

[a] Includes areas of slack water along point bars, side bars, and bank indentations.

Table 50. Catch data by species related to distributions of large mesh seine sampling effort for each habitat type.

Habitat Type	Effort Expended		Goldeye		Walleye		Lake Whitefish		Northern Pike		Longnose Suckers		White Suckers		Flathead Chub	
	No. Seine Hauls	% Total Effort	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Islands	15	10.6	23	2.3	1	2.5	2	0.4	3	1.9	0	0.0	0	0.0	20	15.6
Back Eddies	61	43.3	749	76.3	17	42.5	273	52.7	35	21.7	3	50.0	3	7.5	65	50.8
Tributaries	36	25.5	160	16.3	20	50.0	233	45.0	99	61.5	3	50.0	34	85.0	21	16.4
Other[a]	29	20.6	50	5.1	2	5.0	10	1.9	24	14.9	0	0.0	3	7.5	22	17.2
Total	141		982		40		518		161		6		40		128	

[a] Includes areas of slack water along point bars, side bars, and bank indentations.

Table 51. Catch data by species related to distribution of small mesh seine sampling effort for each habitat type.

Habitat Type	Effort Expended		Trout-perch		Suckers spp.		Goldeye		Walleye		Flathead Chub		Emerald Shiner		Lake Chub		Spottail Shiner	
	No. Seine Hauls	% Total Effort	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Islands	18	16.1	2031	37.9	216	7.0	14	20.9	68	19.2	145	89.5	369	34.8	185	18.9	8	2.5
Back Eddies	14	12.5	1190	22.2	80	2.6	17	25.4	53	15.0	5	3.1	181	17.1	15	1.5	3	1.0
Tributaries	60	53.5	1378	25.7	2664	86.3	28	41.8	184	52.0	8	4.9	333	31.4	756	77.3	299	94.6
Other[a]	20	17.9	761	14.2	127	4.1	8	11.9	49	13.8	4	2.5	176	16.6	22	2.3	6	1.9
Total	112		5360		3087		67		354		162		1059		978		316	

[a] Includes areas of slack water along point bars, side bars, and bank indentations.

Table 52. Catch data by species related to distribution of tagging net[a] sampling effort for each habitat type.

Habitat Type	Effort Expended		Goldeye		Walleye		Lake Whitefish		Longnose Suckers		White Suckers		Flathead Chub	
	No. Hours	% Total Hours	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Islands	0.0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Back Eddies	513.0	71.3	84	91.3	416	95.2	29	85.3	164	87.7	32	61.5	22	81.5
Tributaries	1.0	0.1	0	0.0	15	3.4	1	2.9	8	4.3	15	28.9	0	0.0
Other[b]	205.0	28.5	8	8.7	6	1.4	4	11.8	15	8.0	5	9.6	5	18.5
Total	719.0		92		437		34		187		52		27	

[a] Tagging gill nets were of variable mesh size and length and were utilized during May and June.

[b] Includes areas of slack water along point bars, side bars, and bank indentations.

6.3 NUMBERS (N) AND PERCENTAGES (%) FOR FISH CAPTURED IN EACH MESH SIZE OF STANDARD GANGS, ATHABASCA RIVER, 1976. (TABLE 53).

Table 53. Numbers (N) and percentages (%) for fish captured in each mesh size of standard gangs, Athabasca River, 1976.

Species	Mesh Size (cm)	Date of Sample														Total	
		12 to 14 July		25 to 28 July		9 to 11 August		25 to 28 August		8 to 10 September		20 to 22 September		4 to 5 October			
		N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Goldeye	5.1	139	98.6	49	90.7	125	91.9	71	76.3	85	68.0	18	36.7	7	26.9	494	79.2
	10.2	0	0	4	0.07	6	4.4	6	6.5	6	4.8	2	4.1	1	3.8	25	4.0
	7.6	2	0.01	1	0.02	5	3.7	16	17.2	34	27.2	29	59.2	18	69.2	105	16.8
Walleye	5.1	20	90.9	9	64.3	10	62.5	16	51.6	6	15.4	4	18.2	1	3.3	66	37.9
	10.2	2	9.1	4	28.6	4	25.0	8	25.8	23	59.0	14	63.6	19	63.3	74	42.5
	7.6	0	0	1	7.1	2	12.5	7	22.6	10	25.6	4	18.2	10	33.3	34	19.5
Lake whitefish	5.1	0	0	2	40.0	0	0	2	10.0	2	2.9	19	16.1	28	10.9	53	10.9
	10.2	10	100.0	3	60.0	6	66.7	17	85.0	61	89.7	75	63.6	184	71.6	356	73.1
	7.6	0	0	0	0	3	33.3	1	5.0	5	7.4	24	20.3	45	17.5	78	16.0
Northern pike	5.1	6	100.0	9	81.8	7	87.5	16	80.0	14	82.4	9	42.9	7	31.8	68	64.8
	10.2	0	0	2	18.2	0	0	1	5.0	3	17.6	8	38.1	6	27.3	20	19.0
	7.6	0	0	0	0	1	12.5	3	15.0	0	0	4	19.0	9	40.9	17	16.2
Flathead chub	5.1	16	100.0	8	100.0	42	97.7	10	100.0	5	100.0	10	100.0	0	0	91	98.9
	10.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	7.6	0	0	0	0	1	2.3	0	0	0	0	0	0	0	0	1	1.1
Suckers	5.1	3	75.0	3	50.0	0	0	1	10.0	1	8.3	2	15.4	8	72.7	18	31.0
	10.2	1	25.0	2	33.3	0	0	7	70.0	8	66.7	6	46.1	2	18.2	26	44.8
	7.6	0	0	1	16.7	2	100.0	2	20.0	3	25.0	5	38.5	1	9.1	14	24.2

6.4 NUMBER (N), PERCENTAGE (%), AND CATCH-PER-UNIT-EFFORT FOR FISH CAPTURED IN STANDARD GANGS AT EACH SAMPLING SITE DURING EACH SAMPLING PERIOD, ATHABASCA RIVER, 1976. (TABLES 54, 55, 56, 57, 58, 59, AND 60).

Abbreviations used for fish species are as follows:

GO - Goldeye
WA - Walleye
NP - Northern Pike
LW - Lake Whitefish
MW - Mountain Whitefish
AG - Arctic Grayling
LS - Longnose Sucker
WS - White Sucker
BU - Burbot
FC - Flathead Chub

Site numbers refer to Figure 3 and Appendix 6.1.

Table 54. Number (N), percentage (%), and catch-per-unit-effort (C/E) for fish captured in standard gangs at each sampling site on the Athabasca River, 12 to 25 July 1976.

Site		Species Captured										Total
		GO	WA	NP	LW	MW	AG	LS	WS	BU	FC	
1	N	18	0	0	0	0	0	1	0	0	8	27
	%	66.7	0	0	0	0	0	3.7	0	0	29.6	
	C/E	1.161	0	0	0	0	0	0.065	0	0	0.516	1.742
2	N	9	0	0	1	0	0	2	0	0	0	12
	%	75.0	0	0	8.3	0	0	16.7	0	0	0	
	C/E	0.600	0	0	0.066	0	0	0.133	0	0	0	0.080
3	N	5	2	0	0	0	0	1	0	0	1	9
	%	55.6	22.2	0	0	0	0	11.1	0	0	11.1	
	C/E	0.313	0.125	0	0	0	0	0.063	0	0	0.063	0.563
4	N	12	4	1	0	0	0	0	0	0	1	18
	%	66.7	22.2	5.6	0	0	0	0	0	0	5.6	
	C/E	0.750	0.250	0.063	0	0	0	0	0	0	0.063	1.12
5	N	9	2	0	0	0	0	0	0	0	1	12
	%	75.0	16.7	0	0	0	0	0	0	0	8.3	
	C/E	0.563	0.125	0	0	0	0	0	0	0	0.063	0.750
6	N	15	1	1	0	0	0	0	0	0	2	19
	%	78.9	5.3	5.3	0	0	0	0	0	0	10.5	
	C/E	0.938	0.063	0.063	0	0	0	0	0	0	0.125	1.188
7	N	2	0	1	0	0	0	0	0	0	1	4
	%	50.0	0	25.0	0	0	0	0	0	0	25.0	
	C/E	0.118	0	0.058	0	0	0	0	0	0	0.058	0.235

continued ...

Table 54. Concluded.

Site		GO	WA	NP	LW	MW	AG	LS	WS	BU	FC	Total
		Species Captured										
8	N	23	4	0	0	0	0	0	0	0	0	27
	%	85.2	14.8	0	0	0	0	0	0	0	0	
	C/E	1.394	0.242	0	0	0	0	0	0	0	0	1.636
9	N	27	4	0	2	0	0	0	0	0	0	33
	%	81.8	12.1	0	6.1	0	0	0	0	0	0	
	C/E	1.742	0.258	0	0.129	0	0	0	0	0	0	2.129
10	N	5	2	1	0	0	0	0	0	0	0	8
	%	62.5	25.0	12.5	0	0	0	0	0	0	0	
	C/E	0.313	0.125	0.063	0	0	0	0	0	0	0	0.500
11	N	8	3	1	0	0	0	0	0	0	2	14
	%	57.1	21.4	7.1	0	0	0	0	0	0	14.3	
	C/E	0.500	0.188	0.063	0	0	0	0	0	0	0.125	0.875
12	N	8	0	1	7	0	0	0	0	0	0	16
	%	50.0	0	6.3	43.8	0	0	0	0	0	0	
	C/E	0.533	0	0.067	0.438	0	0	0	0	0	0	1.067
Com-	N	141	22	6	10	0	0	4	0	0	16	199
bined	%	70.9	11.1	3.0	5.0	0	0	2.0	0	0	8.0	
	C/E	0.744	0.115	0.031	0.052	0	0	0.021	0	0	0.084	1.045
% Occurrence		100.0	66.7	50.0	25.0	0	0	25.0	0	0	58.3	

Table 55. Number (N), percentage (%), and catch-per-unit-effort (C/E) for fish captured in standard gangs at each sampling site in the Athabasca River, 26 July to 8 August 1976.

Site		Species Captured										Total
		GO	WA	NP	LW	MW	AG	LS	WS	BU	FC	
1	N	6	3	0	0	0	0	1	0	0	3	13
	%	46.2	23.1	0	0	0	0	7.7	0	0	23.1	
	C/E	0.375	0.187	0	0	0	0	0.062	0	0	0.187	0.182
2	N	1	1	1	0	0	0	0	0	0	0	3
	%	33.3	33.3	33.3	0	0	0	0	0	0	0	
	C/E	0.062	0.062	0.062								0.187
3	N	0	0	0	0	0	0	0	0	0	0	0
	%	0	0	0	0	0	0	0	0	0	0	
	C/E	0	0	0	0	0	0	0	0	0	0	0
4	N	0	0	2	0	0	0	0	1	0	0	3
	%	0	0	66.7	0	0	0	0	33.3	0	0	
	C/E	0	0	0.125	0	0	0	0	0.062	0	0	0.187
5	N	4	1	1	0	0	0	0	0	0	0	6
	%	66.7	16.7	16.7	0	0	0	0	0	0	0	
	C/E	0.235	0.059	0.059	0	0	0	0	0	0	0	0.353
6	N	4	2	1	0	0	0	1	0	0	0	8
	%	50.0	25.0	12.5	0	0	0	12.5	0	0	0	
	C/E	0.242	0.121	0.061	0	0	0	0.061	0	0	0	0.485
7	N	4	0	0	0	0	0	0	0	0	1	5
	%	80.0	0	0	0	0	0	0	0	0	20.0	
	C/E	0.235	0	0	0	0	0	0	0	0	0.059	0.294

continued ...

Table 55. Concluded.

Site		GO	WA	NP	LW	MW	AG	LS	WS	BU	FC	Total
		Species Captured										
8	N	7	1	2	1	0	0	1	0	0	0	12
	%	58.3	8.3	16.7	8.3	0	0	8.3	0	0	0	
	C/E	0.424	0.061	0.121	0.061	0	0	0.061	0	0	0	0.727
9	N	17	2	1	0	0	0	1	0	0	1	22
	%	77.3	9.1	4.5	0	0	0	4.5	0	0	4.5	
	C/E	1.030	0.121	0.061	0	0	0	0.061	0	0	0.061	1.333
10	N	5	2	1	0	0	0	1	0	0	2	11
	%	45.5	18.2	9.1	0	0	0	9.1	0	0	18.2	
	C.E	0.303	0.121	0.061	0	0	0	0.061	0	0	0.121	0.667
11	N	2	1	0	0	0	0	0	0	0	1	4
	%	50.0	25.0	0	0	0	0	0	0	0	25.0	
	C/E	0.121	0.061	0	0	0	0	0	0	0	0.061	0.242
12	N	4	1	2	4	0	0	0	0	0	0	11
	%	36.4	9.1	18.2	36.4	0	0	0	0	0	0	
	C/E	0.258	0.065	0.129	0.258	0	0	0	0	0	0	0.710
Com-	N	54	14	11	5	0	0	5	1	0	8	98
bined	%	55.1	14.3	11.2	5.1	0	0	5.1	1.0	0	8.1	
	C/E	0.301	0.078	0.061	0.028	0	0	0.028	0.005	0	0.045	0.546
% Occurrence		91.7	75.0	67.7	16.7	0	0	41.7	8.3	0	41.7	

Table 56. Number (N), percentage (%), and catch-per-unit-effort (C/E) for fish captured in standard gangs at each sampling site in the Athabasca River, 9 to 22 August 1976.

Site		Species Captured										Total
		GO	WA	NP	LW	MW	AG	LS	WS	BU	FC	
1	N	23	0	0	0	0	0	0	0	0	3	26
	%	88.5	0	0	0	0	0	0	0	0	11.5	
	C/E	1.278	0	0	0	0	0	0	0	0	0.167	1.444
2	N	12	4	3	0	0	0	0	1	0	0	20
	%	60.0	20.0	15.0	0	0	0	0	5.0	0	0	
	C/E	0.686	0.229	0.171	0	0	0	0	0.057	0	0	1.143
3	N	5	0	1	0	0	0	0	0	0	1	7
	%	71.4	0	14.3	0	0	0	0	0	0	14.3	
	C/E	0.294	0	0.059	0	0	0	0	0	0	0.059	0.412
4	N	3	0	0	0	0	0	0	0	0	1	4
	%	75.0	0	0	0	0	0	0	0	0	25.0	
	C/E	0.176	0	0	0	0	0	0	0	0	0.059	0.235
5	N	15	3	1	0	0	0	0	0	0	3	22
	%	68.2	13.6	4.6	0	0	0	0	0	0	13.6	
	C/E	0.857	0.171	0.057	0	0	0	0	0	0	0.171	1.257
6	N	23	3	1	1	0	0	0	0	0	6	34
	%	67.6	8.8	2.9	2.9	0	0	0	0	0	17.6	
	C/E	1.350	0.176	0.059	0.059	0	0	0	0	0	0.363	2.000
7	N	12	1	0	0	0	0	0	0	0	1	14
	%	85.7	7.1	0	0	0	0	0	0	0	7.1	
	C/E	0.706	0.059	0	0	0	0	0	0	0	0.059	0.824

continued ...

Table 56. Concluded.

Site		Species Captured										Total
		GO	WA	NP	LW	MW	AG	LS	WS	BU	FC	
8	N	18	1	1	0	0	0	0	0	0	5	25
	%	72.0	4.0	4.0	0	0	0	0	0	0	20.0	
	C/E	1.091	0.061	0.061	0	0	0	0	0	0	0.303	1.515
9	N	15	1	0	1	0	0	1	0	0	1	19
	%	78.9	5.3	0	5.3	0	0	5.3	0	0	5.3	
	C/E	0.938	0.062	0	0.062	0	0	0.062	0	0	0.062	1.817
10	N	6	2	0	5	0	0	0	0	0	21	34
	%	17.6	5.9	0	14.7	0	0	0	0	0	61.8	
	C/E	0.353	0.118	0	0.294	0	0	0	0	0	1.235	2.000
11	N	0	0	0	0	0	0	0	0	0	1	1
	%	0	0	0	0	0	0	0	0	0	100.0	
	C/E	0	0	0	0	0	0	0	0	0	0.059	0.059
12	N	4	1	1	2	0	0	0	0	0	0	8
	%	50.0	12.5	12.5	25.0	0	0	0	0	0	0	
	C/E	0.242	0.061	0.061	0.121	0	0	0	0	0	0	0.059
Com-bined	N	136	16	8	9	0	0	1	1	0	43	214
	%	63.5	7.5	3.7	4.2	0	0	0.5	0.5	0	20.1	
	C/E	0.667	0.078	0.039	0.044	0	0	0.005	0.005	0	0.211	1.049
% Occurrence		91.7	66.7	50.0	33.3	0	0	8.3	8.3	0	83.3	

Table 57. Number (N), percentage (%), and catch-per-unit-effort (C/E) for fish captured in standard gangs at each sampling site on the Athabasca River, 23 August to 5 September 1976.

Site		Species Captured										Total
		GO	WA	NP	LW	MW	AG	LS	WS	BU	FC	
1	N	13	1	0	0	0	0	0	0	0	2	16
	%	81.2	6.2	0	0	0	0	0	0	0	12.5	
	C/E	0.743	0.057	0	0	0	0	0	0	0	0.114	0.914
2	N	6	4	2	1	0	0	0	0	0	0	13
	%	46.2	30.8	15.4	7.7	0	0	0	0	0	0	
	C/E	0.343	0.229	0.114	0.057	0	0	0	0	0	0	0.743
3	N	20	4	0	0	0	0	1	0	0	1	26
	%	76.9	15.4	0	0	0	0	3.8	0	0	3.8	
	C/E	1.212	0.242	0	0	0	0	0.061	0	0	0.061	1.576
4	N	0	6	1	0	0	0	1	0	0	0	8
	%	0	75.0	12.5	0	0	0	12.5	0	0	0	
	C/E	0	0.293	0.049	0	0	0	0.049	0	0	0	0.390
5	N	8	3	11	2	1	0	1	0	0	1	27
	%	29.6	11.1	40.7	7.4	3.7	0	3.7	0	0	3.7	
	C/E	0.381	0.143	0.524	0.095	0.048	0	0.048	0	0	0.048	1.286
6	N	9	3	3	5	0	0	1	1	0	1	23
	%	39.1	13.0	13.0	21.7	0	0	4.3	4.3	0	4.3	
	C/E	0.419	0.140	0.140	0.233	0	0	0.047	0.047	0	0.047	1.070
7	N	3	1	1	1	0	0	1	0	0	0	7
	%	42.9	14.3	14.3	14.3	0	0	14.3	0	0	0	
	C/E	0.171	0.057	0.057	0.057	0	0	0.057	0	0	0	0.400

continued ...

Table 57. Concluded.

Site		Species Captured										Total
		GO	WA	NP	LW	MW	AG	LS	WS	BU	FC	
8	N	0	0	0	0	0	0	0	0	0	0	0
	%	0	0	0	0	0	0	0	0	0	0	
	C/E	0	0	0	0	0	0	0	0	0	0	0
9	N	18	3	0	3	0	0	0	2	0	4	30
	%	60.0	10.0	0	10.0	0	0	0	6.7	0	13.3	
	C/E	1.091	0.182	0	0.182	0	0	0	0.121	0	0.242	1.818
10	N	8	3	0	8	0	0	2	0	0	0	21
	%	38.1	14.3	0	38.1	0	0	9.5	0	0	0	
	C/E	0.500	0.187	0	0.500	0	0	0.125	0	0	0	1.312
11	N	5	1	1	0	0	0	0	0	0	1	8
	%	62.5	12.5	12.5	0	0	0	0	0	0	12.5	
	C/E	0.294	0.059	0.059	0	0	0	0	0	0	0.059	0.471
12	N	3	2	1	0	0	0	0	0	0	0	6
	%	50.0	33.3	16.7	0	0	0	0	0	0	0	
	C/E	0.182	0.121	0.061	0	0	0	0	0	0	0	0.364
Combined	N	93	31	20	20	1	0	7	3	0	10	185
	%	50.3	16.7	10.8	10.8	0.5	0	3.8	1.6	0	5.4	
	C/E	0.433	0.144	0.093	0.093	0.004	0	0.033	0.014	0	0.046	0.860
% Occurrence		83.3	91.7	58.3	50.0	8.3	0	50.0	16.7	0	50.0	

Table 58. Number (N), percentage (%), and catch-per-unit-effort (C/E) for fish captured in standard gangs at each sampling site in the Athabasca River, 6 to 19 September 1976.

Site		GO	WA	NP	LW	MW	AG	LS	WS	BU	FC	Total
		Species Captured										
1	N	4	1	0	0	0	0	0	0	0	0	5
	%	80.0	20.0	0	0	0	0	0	0	0	0	
	C/E	0.235	0.059	0	0	0	0	0	0	0	0	0.294
2	N	7	3	2	3	0	0	2	0	0	0	17
	%	41.2	17.6	11.8	17.6	0	0	11.8	0	0	0	
	C/E	0.412	0.176	0.118	0.176	0	0	0.118	0	0	0	1.000
3	N	9	1	1	0	0	0	0	0	0	0	11
	%	81.8	9.1	9.1	0	0	0	0	0	0	0	
	C/E	0.529	0.059	0.059	0	0	0	0	0	0	0	0.647
4	N	11	1	3	7	0	0	1	0	0	0	23
	%	47.8	4.3	13.0	30.4	0	0	4.3	0	0	0	
	C/E	0.629	0.057	0.171	0.400	0	0	0.057	0	0	0	1.314
5	N	32	7	0	11	0	0	0	1	0	1	52
	%	61.5	13.5	0	21.2	0	0	0	1.9	0	1.9	
	C/E	1.829	0.400	0	0.629	0	0	0	0.057	0	0.057	2.971
6	N	4	3	2	0	0	0	0	0	0	0	9
	%	44.4	33.3	22.2	0	0	0	0	0	0	0	
	C/E	0.235	0.176	0.118	0	0	0	0	0	0	0	0.529
7	N	16	4	0	15	0	0	1	1	0	0	37
	%	43.2	10.8	0	40.5	0	0	2.7	2.7	0	0	
	C/E	0.865	0.216	0	0.811	0	0	0.054	0.054	0	0	2.000

continued ...

Table 58. Concluded.

Site		Species Captured										Total
		GO	WA	NP	LW	MW	AG	LS	WS	BU	FC	
8	N	3	9	1	2	0	0	1	0	0	1	17
	%	17.6	52.9	5.9	11.8	0	0	5.9	0	0	5.9	
	C/E	0.154	0.462	0.051	0.103	0	0	0.051	0	0	0.051	0.872
9	N	15	1	1	10	0	0	1	1	0	2	31
	%	48.4	3.2	3.2	32.3	0	0	3.2	3.2	0	6.5	
	C/E	0.769	0.051	0.051	0.513	0	0	0.051	0051	0	0.103	1.590
10	N	19	7	1	14	0	0	1	1	1	1	45
	%	42.2	15.6	2.2	31.1	0	0	2.2	2.2	2.2	2.2	
	C/E	1.118	0.412	0.059	0.824	0	0	0.059	0.059	0.059	0.059	2.647
11	N	3	2	3	4	0	0	1	0	0	0	13
	%	23.1	15.4	23.1	30.8	0	0	7.7	0	0	0	
	C/E	0.176	0.118	0.176	0.235	0	0	0.059	0	0	0	0.765
12	N	2	0	3	2	0	0	0	0	0	0	7
	%	28.6	0	42.9	28.6	0	0	0	0	0	0	
	C/E	0.114	0	0.171	0.114	0	0	0	0	0	0	0.400
Com-	N	125	39	17	68	0	0	8	4	1	5	267
bined	%	46.8	14.6	6.4	25.5	0	0	3.0	1.5	0.4	1.9	
	C/E	0.590	0.184	0.080	0.321	0	0	0.037	0.019	0.005	0.023	1.259
% Occurrence		100.0	91.7	75.0	75.0	0	0	58.3	33.3	8.3	33.3	

Table 59. Numbers (N), percentage (%), and catch-per-unit-effort (C/E) for fish captured in standard gangs at each sampling site in the Athabasca River, 20 September to 3 October 1976.

Site		GO	WA	NP	LW	MW	AG	LS	WS	BU	FC	Total
		Species Captured										
1	N	0	0	0	0	0	0	0	0	0	0	0
	%	0	0	0	0	0	0	0	0	0	0	
	C/E	0	0	0	0	0	0	0	0	0	0	0
2	N	0	4	4	15	0	0	0	0	0	0	23
	%	0	17.4	17.4	65.2	0	0	0	0	0	0	
	C/E	0	0.235	0.235	0.882	0	0	0	0	0	0	1.353
3	N	4	3	0	0	0	0	0	0	0	2	9
	%	44.4	33.3	0	0	0	0	0	0	0	22.2	
	C/E	0.222	0.167	0	0	0	0	0	0	0	0.111	0.500
4	N	4	2	4	8	0	0	0	0	0	0	18
	%	22.2	11.1	22.2	44.4	0	0	0	0	0	0	
	C/E	0.211	0.105	0.211	0.421	0	0	0	0	0	0	0.947
5	N	11	2	3	21	0	0	0	0	0	0	37
	%	29.7	5.4	8.1	56.8	0	0	0	0	0	0	
	C/E	0.595	0.108	0.162	1.135	0	0	0	0	0	0	2.000
6	N	8	0	0	8	0	0	1	0	0	5	22
	%	36.4	0	0	36.4	0	0	4.5	0	0	22.7	
	C/E	0.432	0	0	0.432	0	0	0.054	0	0	0.270	1.189
7	N	2	3	0	3	0	0	1	0	0	1	10
	%	20.0	30.0	0	30.0	0	0	10.0	0	0	10.0	
	C/E	0.105	0.158	0	0.158	0	0	0.053	0	0	0.053	0.526

continued ...

Table 59. Concluded.

Site		Species Captured										Total
		GO	WA	NP	LW	MW	AG	LS	WS	BU	FC	
8	N	2	6	1	3	0	0	6	0	0	1	19
	%	10.5	31.6	5.3	15.8	0	0	31.6	0	0	5.3	
	C/E	0.103	0.308	0.051	0.154	0	0	0.308	0	0	0.051	0.974
9	N	2	1	3	11	0	0	0	0	0	0	17
	%	11.8	5.9	17.6	64.7	0	0	0	0	0	0	
	C/E	0.108	0.054	0.162	0.595	0	0	0	0	0	0	0.919
10	N	14	1	2	40	0	0	3	0	0	1	61
	%	22.6	1.6	3.2	64.5	0	0	4.8	0	0	1.6	
	C/E	0.737	0.053	0.105	2.105	0	0	0.158	0	0	0.053	3.211
11	N	2	0	2	2	0	0	1	0	0	0	7
	%	28.6	0	28.6	28.6	0	0	14.3	0	0	0	
	C/E	0.015	0	0.105	0.105	0	0	0.053	0	0	0	0.368
12	N	0	0	2	7	0	0	1	0	0	0	10
	%	0	0	20.0	70.0	0	0	10.0	0	0	0	
	C/E	0	0	0.111	0.389	0	0	0.056	0	0	0	0.556
Com-	N	49	22	21	118	0	0	13	0	0	10	232
bined	%	21.0	9.4	9.0	50.6	0	0	5.6	0	0	4.3	
	C/E	0.222	0.099	0.095	0.534	0	0	0.059	0	0	0.045	1.054
% Occurrence		75.0	66.7	66.7	83.3	0	0	50.0	0	0	41.7	

Table 60. Number (N), percentage (%), and catch-per-unit-effort (C/E) for fish captured in standard gangs at each sampling site in the Athabasca River, 4 to 17 October 1976.

Site		Species Captured										Total
		GO	WA	NP	LW	MW	AG	LS	WS	BU	FC	
1		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2	N	0	0	6	16	0	0	0	1	0	0	23
	%	0	0	26.1	69.6	0	0	0	4.3	0	0	
	C/E	0	0	0.316	0.842	0	0	0	0.053	0	0	1.211
3		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4	N	9	0	7	8	0	1	0	1	0	0	26
	%	34.6	0	26.9	30.8	0	3.8	0	3.8	0	0	
	C/E	0.474	0	0.368	0.421	0	0.053	0	0.053	0	0	1.368
5	N	11	7	2	64	0	0	0	1	0	0	85
	%	12.9	8.2	2.4	75.3	0	0	0	1.2	0	0	
	C/E	0.057	0.368	0.105	3.368	0	0	0	0.053	0	0	4.414
6	N	2	7	1	24	0	0	0	0	0	0	34
	%	5.9	20.6	2.9	70.6	0	0	0	0	0	0	
	C/E	0.105	0.368	0.053	1.263	0	0	0	0	0	0	1.789
7	N	1	8	0	47	0	0	0	0	0	0	56
	%	1.8	14.3	0	83.9	0	0	0	0	0	0	
	C/E	0.051	0.410	0	2.410	0	0	0	0	0	0	2.872

continued ...

Table 60. Concluded.

Site		Species Captured										Total
		GO	WA	NP	LW	MW	AG	LS	WS	BU	FC	
8	N	1	6	3	57	0	0	1	0	0	0	68
	%	1.5	8.8	4.4	83.8	0	0	1.5	0	0	0	
	C/E	0.053	0.316	0.158	3.000	0	0	0.053	0	0	0	3.579
9	N	2	1	0	24	0	0	2	0	0	0	29
	%	6.9	3.4	0	82.8	0	0	6.9	0	0	0	
	C/E	0.105	0.053	0	1.263	0	0	0.105	0	0	0	1.526
10	N	0	1	3	17	0	3	5	0	0	0	29
	%	0	3.4	10.3	58.6	0	10.3	17.2	0	0	0	
	C/E	0	0.053	0.158	0.895	0	0.158	0.263	0	0	0	1.526
11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Com-bined	N	26	30	22	257	0	4	8	3	0	0	350
	%	7.4	8.6	6.3	73.4	0	1.1	2.3	0.8	0	0	
	C/E	0.170	0.197	0.144	1.685	0	0.026	0.053	0.020	0	0	2.295
% Occurrence		75.0	75.0	75.0	100.0	0	25.0	37.5	37.5	0	0	

Table 61. Number (N), percentage (%), and catch-per-unit-effort (C/E) for fish captured in standard gangs at each sampling site in the Athabasca River, all dates combined, 1976.

Site		Species Captured GO	WA	NP	LW	MW	AG	LS	WS	BU	FC	Total
1	N	64	5	0	0	0	0	2	0	0	16	87
	%	73.6	5.7	0	0	0	0	2.3	0	0	18.4	
	C/E	0.633	0.049	0	0	0	0	0.020	0	0	0.159	0.861
2	N	35	16	18	36	0	0	4	2	0	0	111
	%	31.5	14.4	16.2	32.4	0	0	3.6	1.8	0	0	
	C/E	0.294	0.134	0.151	0.303	0	0	0.034	0.017	0	0	0.933
3	N	43	10	2	0	0	0	2	0	0	5	62
	%	69.4	16.1	3.2	0	0	0	3.2	0	0	8.1	
	C/E	0.509	0.118	0.024	0	0	0	0.024	0	0	0.059	0.734
4	N	39	13	18	23	0	1	2	2	0	2	100
	%	39.0	13.0	18.0	18.0	0	1.0	2.0	2.0	0	2.0	
	C/E	0.312	0.104	0.144	0.184	0	0.008	0.016	0.016	0	0.016	0.800
5	N	90	25	18	98	1	0	1	2	0	6	241
	%	37.3	10.4	7.5	40.7	0.4	0	0.4	0.8	0	2.5	
	C/E	0.711	0.198	0.142	0.775	0.008	0	0.008	0.016	0	0.047	1.905
6	N	65	19	9	38	0	0	3	1	0	14	149
	%	43.6	12.8	6.0	25.5	0	0	2.0	0.7	0	9.4	
	C/E	0.518	0.151	0.072	0.303	0	0	0.024	0.008	0	0.112	1.187
7	N	40	17	2	66	0	0	3	1	0	4	133
	%	30.1	12.8	1.5	49.6	0	0	2.3	0.8	0	3.0	
	C/E	0.319	0.135	0.016	0.526	0	0	0.024	0.008	0	0.032	1.060

continued ...

Table 61. Concluded.

Site		GO	WA	NP	LW	MW	AG	LS	WS	BU	FC	Total
		Species Captured										
8	N	54	27	8	63	0	0	9	0	0	7	168
	%	32.1	16.1	4.8	37.5	0	0	5.4	0	0	4.2	
	C/E	0.434	0.217	0.064	0.506	0	0	0.072	0	0	0.056	1.349
9	N	96	13	5	51	0	0	5	3	0	8	181
	%	53.0	7.2	2.8	28.2	0	0	2.8	1.7	0	4.4	
	C/E	0.790	0.107	0.041	0.420	0	0	0.041	0.025	0	0.066	1.490
10	N	57	18	8	84	0	3	12	1	1	25	209
	%	27.3	8.6	3.8	40.2	0	1.4	5.7	0.5	0.5	12.0	
	C/E	0.473	0.149	0.066	0.697	0	0.025	0.100	0.008	0.008	0.207	1.735
11	N	20	7	7	6	0	0	2	0	0	5	47
	%	42.6	14.9	14.9	12.8	0	0	4.3	0	0	10.6	
	C/E	0.195	0.068	0.068	0.059	0	0	0.020	0	0	0.049	0.459
12	N	21	4	10	22	0	0	1	0	0	0	58
	%	36.2	6.9	17.3	37.9	0	0	1.7	0	0	0	
	C/E	0.212	0.040	0.101	0.222	0	0	0.010	0	0	0	0.586
Combined	N	624	174	105	487	1	4	46	12	1	92	1546
	%	40.4	11.3	6.8	31.5	0.07	0.3	3.0	0.8	0.07	5.9	
	C/E	0.454	0.127	0.076	0.354	0.001	0.003	0.033	0.009	0.001	0.067	1.125
% Occurrence		87.3	77.2	63.3	53.2	1.3	2.5	39.2	12.7	1.3	46.8	

6.5 DATES OF TAGGING AND RECAPTURE, LOCATION OF RECAPTURE, DISTANCES TRAVELLED, AND ELAPSED TIME BETWEEN RELEASE AND RECAPTURE FOR FISH TAGGED IN THE ATHABASCA RIVER, 1976. (TABLE 62).

Table 62. Dates of tagging and recapture, locations of release and recapture, distances travelled, and elapsed time between release and recapture for fish tagged in the Athabasca River, 1976.

Species	Tag Releases Date	Tag Releases Site[b]	Tag Recaptures Date	Tag Recaptures Site[b]	Elapsed Time (Days)	Distances Travelled[a] (km)
Walleye	5 May 1976	24	1 June 1976	A	27	-189
	5 May 1976	5	7 May 1976	5	2	0
	5 May 1976	5	9 June 1976	5	35	0
	6 May 1976	5	14 Sept. 1976	B	132	-286
	7 May 1976	5	6 June 1976	A	30	-210
	7 May 1976	5	18 June 1976	D	42	-264
	10 May 1976	4	6 June 1976	C	27	-180
	10 May 1976	4	18 June 1976	D	39	-269
	10 May 1976	4	23 May 1976	5	13	-5
	19 May 1976	5	16 June 1976	D	28	-266
	21 May 1976	20	15 Aug. 1976[c]	D	96	-267
	22 May 1976	5	4 June 1976	6	13	-17
	23 May 1976	5	18 June 1976	D	26	-264
	15 June 1976	12	22 June 1976	12	7	0
	20 June 1976	21	1 July 1976	24	11	-19
	20 June 1976	21	24 June 1976	21	4	0
	20 June 1976	21	28 June 1976	21	8	0
	21 June 1976	21	28 June 1976	21	7	0
	21 June 1976	21	29 June 1976	21	8	0
Goldeye	6 June 1976[d]	-	14 July 1976	8	38	+288
	22 June 1976	21	9 July 1976	24	17	-19
	20 July 1976	16	17 Aug. 1976	52	28	-56
	31 July 1976	20	19 Sept. 1976	E	50	-323

continued ...

Table 62. Continued.

Species	Tag Releases Date	Tag Releases Site[b]	Tag Recaptures Date	Tag Recaptures Site[b]	Elapsed Time (Days)	Distances Travelled[a] (km)
Goldeye	1 Aug. 1976	22	11 Sept. 1976	10	41	-58
	1 Aug. 1976	23	11 Aug. 1976	8	10	-19
	5 Aug. 1976	30	16 Sept. 1976	27	42	+19
	5 Aug. 1976	33	18 Aug. 1976	33	13	0
	5 Aug. 1976	33	18 Aug. 1976	33	13	0
	16 Aug. 1976	24	21 Aug. 1976	24	5	0
Northern pike	10 May 1976	5	21 July 1976	23	72	-13
	10 May 1976	5	20 May 1976	20	10	+2
	22 May 1976	5	23 July 1976	35	62	-84
	9 July 1976	27	23 July 1976	35	14	-50
	19 July 1976	14	5 Oct. 1976	14	78	0
	23 July 1976	33	18 Aug. 1976	33	26	0
	30 July 1976	14	13 Sept. 1976	14	45	0
	31 July 1976	20	8 Aug. 1976	24	8	-20
	6 Aug. 1976	35	18 Aug. 1976	35	12	0
	6 Aug. 1976	35	18 Aug. 1976	35	12	0
	6 Aug. 1976	35	18 Sept. 1976	35	43	0
	6 Aug. 1976	35	18 Sept. 1976	35	43	0
	16 Aug. 1976	23	14 Sept. 1976	23	29	0
	18 Aug. 1976	35	18 Sept. 1976	35	31	0
	23 Aug. 1976	23	14 Sept. 1976	23	22	0
	8 Sept. 1976	12	15 Nov. 1976[e]	12	68	0
	14 Sept. 1976	22	20 Sept. 1976	22	6	0
	29 Sept. 1976	31	5 Oct. 1976	31	6	0

continued ...

Table 62. Concluded.

Species	Tag Releases		Tag Recaptures		Elapsed Time (Days)	Distances Travelled[a] (km)
	Date	Site[b]	Date	Site[b]		
Lake whitefish	14 Sept. 1976	23	16 Sept. 1976	27	2	-21
	14 Sept. 1976	23	1 Oct. 1976	15	17	+39
	14 Sept. 1976	23	15 Jan. 1977[e]	B	123	-272
	18 Sept. 1976	32	15 Jan. 1977[e]	B	119	-225
	30 Sept. 1976	25	30 Jan. 1977[e]	F	122	-338

A: Richardson River (58°26'N, 111°15')
B: Lake Athabasca-Fort Chipewyan (58°42'N, 111°09')
C: Embarras River distributary (58°22'N, 111°33')
D: Lake Athabasca-Big Point (58°37'N, 110°45')
E: Revillon Coupe (58°54'N, 111°25')
F: Lake Athabasca-Falling Sand Point (59°16'N, 110°05")

[a] Distance shown is either upstream (+) or downstream (-) of tagging site.

[b] Site references are to those shown in Figure 3 and described in Appendix 6.1.

[c] Date of recapture is in question as commercial fishery ended 30 June 1976.

[d] Goldeye tagged at Rivière des Rochers weir (58°55'N, 111°10'W) by LGL Ltd.

[e] Recapture dates are approximate.

7. 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
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