INTERIM REPORT ON AN INTENSIVE STUDY OF THE FISH FAUNA OF THE MUSKEG RIVER WATERSHED OF NORTHEASTERN ALBERTA

by

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ABSTRACT

The fish fauna of the Muskeg River was studied during spring and summer, 1976. Migrations of non-resident fish from the Athabasca River into the Muskeg River watershed were monitored through the use of a two-way counting fence between 28 April and 30 July. A total of 6153 fish were passed through the upstream trap of which white suckers (46%) and longnose suckers (46%) comprised the vast majority. Arctic grayling (5%) and northern pike (2%) accounted for most of the remainder. After spawning in the lower reaches of the Muskeg River, migrant suckers of both species returned to the Athabasca River. Arctic grayling, however, remained in the tributary throughout the summer.

Floy tags applied to 2269 migrant fish yielded a 1.2% return rate for fish recaptured outside the Muskeg watershed.

Small fish collections made throughout the summer demonstrated the importance of the lower Muskeg drainage as a rearing area for young-of-the-year white suckers, longnose suckers and Arctic grayling. Lake chub, slimy sculpin and brook stickleback were the most abundant forage fish species.

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1. INTRODUCTION

The proposed development of the Athabasca Oil Sands is expected to introduce large scale disturbance to the lake and river systems of the lower Athabasca River drainage. Especially suspectible is that section of the surface-mineable area for which the Alberta Energy Resources Conservation Board has granted development approval. Local disruption in the form of land clearing, muskeg drainage and removal, stream diversions and the construction of access routes will affect the water quality and quantity of streams in addition to the physical alterations produced. Other activities that may affect water quality include tailings pond seepages and saline minewater discharge. The diversion or blockage of streams may affect fish spawning runs. Traditional fish rearing and feeding areas might be distrubed or lost altogether. In the case of migrant fish populations, such local disruptions could be felt over much wider areas.

In order to minimize the adverse effects of development on fish populations of the Athabasca River and its tributary streams, the Alberta Oil Sands Environmental Research Program, 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 involves a broadly based fisheries investigation of the Athabasca River downstream from Fort McMurray as well as site-intensive study of selected tributaries. Tributaries selected for intensive study are those considered to be most immediately imperilled by future surface mining operations. Those tributary streams located more remotely from the surface mining area and in the in-situ area which are not considered to be in immediate danger are to be assessed through a program of synoptic surveys.

This report presents preliminary results of work done in 1976 on the Muskeg River, a medium sized watershed on the east side of the Athabasca River. The Muskeg watershed was the first tributary stream selected for intensive study because a large portion of the drainage lies within the surface-mineable area and because the Alberta Energy Resources Conservation Board has approved the construction here of two synthetic crude oil plants, one by Shell Canada Ltd. and the other by Home Oil Co.Ltd. and Alminex Ltd. Construction of these plants would involve massive disturbance of the watershed and the eventual diversion of both the Muskeg River and its major tributary, Hartley Creek.

The general objective of the project is to describe the baseline states of the fish resources of the Muskeg River watershed and to provide a quantitative estimate of the significance of the watershed to the fisheries of the Athabasca River system.

This report is to be considered interim in nature pending completion of field work in 1977.

2. RESUMÉ OF CURRENT STATE OF KNOWLEDGE

Information relative to the fish fauna of the Muskeg River is limited to that generated by Griffiths' (1973) preliminary survey and subsequent baseline studies conducted by Shell (Lombard-North Group Ltd. 1973) and Shell and Home (Renewable Resources Consulting Services Ltd. 1974). The latter two studies were performed as part of an environmental assessment of Shell's lease 13 mining project and a summary of the work is included in the lease 13 environmental impact assessment that was filed with Alberta Environment in 1975 (Shell Canada Ltd. 1975).

Since Griffiths' work was part of a broad regional study intended to evaluate the sport fishery potential of a large number of streams in the oil sands area, his treatment of any one stream was, of necessity, cursory. He did, however, document the presence of eight fish species in the Muskeg River, five of which he found only at the mouth. Griffiths also identified the presence of a grayling population in the lower reaches of the Muskeg River and reported capturing mature grayling here on 27 September, 1972. Griffiths did not examine the upper Muskeg watershed nor did he sample Hartley Creek.

The work by Shell (1973) and Shell and Home (1974) while extending our knowledge of the fish fauna of the Muskeg River, left many questions unanswered. These studies, although they were unable to enumerate the runs, suggested an important role for the Muskeg in terms of providing spawning areas for longnose suckers and white suckers. The capture of Arctic grayling, longnose and white suckers and mountain whitefish in Hartley Creek suggested a greater importance for that tributary than was predicted by Griffiths. The significance of the mouth region for fish populations from the Athabasca River was implied.

On the other hand, because these studies concentrated on the region within leases 13 and 30, they provided no information on the resident fish populations of the upper reaches of the watershed or the extent to which this region is utilized by migrant populations. Since no attempt was made to capture small fish, the likely presence of several species was not detected nor were the younger age classes of larger species sampled. Small sample sizes precluded an adequate description of the life history and general biology of several species.

Our present data base is insufficient to permit an adequate description of the fish resources of the Muskeg River watershed. The composition and distribution of resident species within the watershed must be described. We require quantification of migrant populations that utilize the Muskeg watershed on a seasonal basis and a clear description of such seasonal utilization patterns. Areas within the watershed that are critical in the life histories of the various species must be defined. Life history patterns and general biological features of all species require further elucidation.

A recent report by Jantzie (1975) provides a complete review of the literature review to the fisheries of the AOSERP study area.

3. DESCRIPTION OF THE STUDY AREA

The Muskeg River originates in the Muskeg Mountain uplands and travels a distance of approximately 90 km before joining the Athabasca River 58 km downstream from Fort McMurray (Fig. 1). The area drained by the Muskeg River is 1464 km^2 of which 80 percent is forest and 20 percent muskeg (NHCL 1974). Only 2 percent of the total watershed area is lakes, the largest of which, Kearl Lake (Fig. 2), is only 5.4 km^2 in surface area with a maximum depth of 2 m. Hartley Creek (Fig. 2), the major tributary of the Muskeg River, drains 325 km^2 south of the main stream and enters the Muskeg River about 33 km upstream from its confluence with the Athabasca River. The water of the Muskeg River and Hartley Creek is stained brown as a result of the presence of humic and fulvic acids.

The climate of the study area is continental, characterized by cold winters, short cool summers and wide seasonal temperature fluctuations. January is usually the coldest month with a mean daily maximum of -15C and a mean daily minimum of -26C. The warmest month is July with corresponding values of 25C and 9C. Temperature extremes can reach -45C and 32C (INTEG 1973). Precipitation records for the Muskeg Mountains show the average annual precipitation to be 49.8 cm of which 33.5 cm falls between May and September (NHCL 1974).

In its upper portion, the Muskeg River watershed is well drained and vegetated by mixed spruce and areas of treed muskeg. Surficial deposits consist of relatively thick drift composed mainly of till (NHCL 1974) while the bedrock material is largely

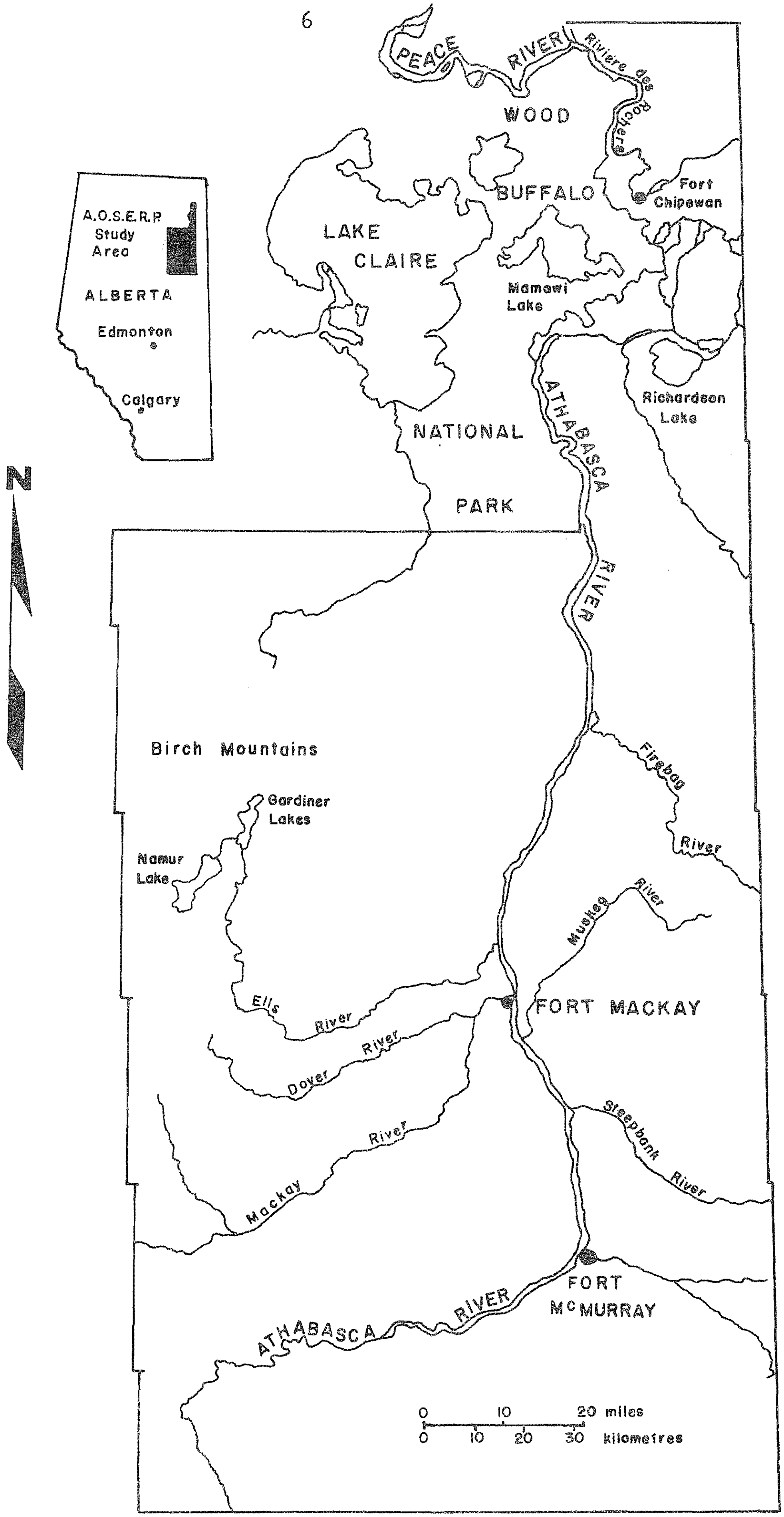


Figure 1. Map of AOSERP study area indicating location of Muskeg River.

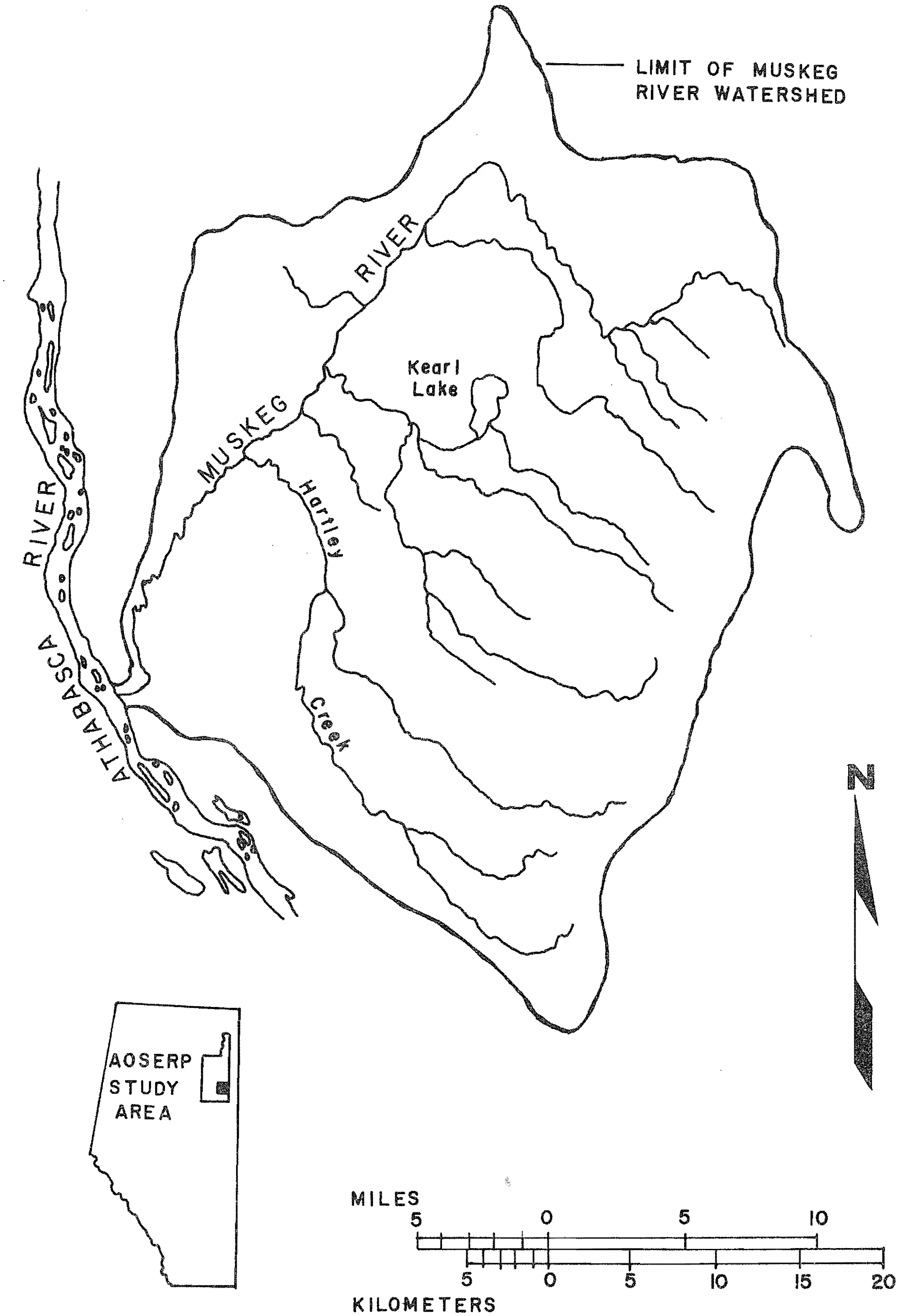


Figure 2. Map of Muskeg River drainage basin.

Cretaceous shales and sandstones. The large central area of the watershed is flat, poorly drained and covered with marshland and treed muskeg. In this area a thin surficial layer of outwash sand is underlain by the McMurray Oil Sands Formation. In the lower 16 km of its course the Muskeg River leaves the flat central portion of its watershed and begins to cut through the McMurray Oil Sands and Waterways limestone (NHCL 1974). The lower reaches of the river valley are stream cut and the channel is frequently confined by bedrock outcroppings. The stream channel in this area is fairly stable, the substrate consisting of large areas of gravel with occasional areas of boulders and bedrock.

The Muskeg River generally freezes over in late October and remains ice covered until late April. Under ice cover, water temperatures remain near 0C but the stream can warm quickly in the spring and reach high temperatures in mid summer. In 1976 ice left the Muskeg on April 15 (Fig. 3). By April 28 the daily maximum water temperature was 9.5C and a reading of 25C was recorded on July 3. Considerable cooling can occur at night and daily fluctuations of up to 8C were recorded.

Discharge records for the Muskeg River, obtained from the Water Survey of Canada show a mean daily discharge of 223 cfs (9-1490) in 1974 and 215 cfs (12-968) for 1975. After the spring flood water levels generally decline through the summer although considerable fluctuation may occur as a result of heavy precipitation (Fig. 3).

The physical and chemical characteristics of Muskeg River water are given in Table 1.

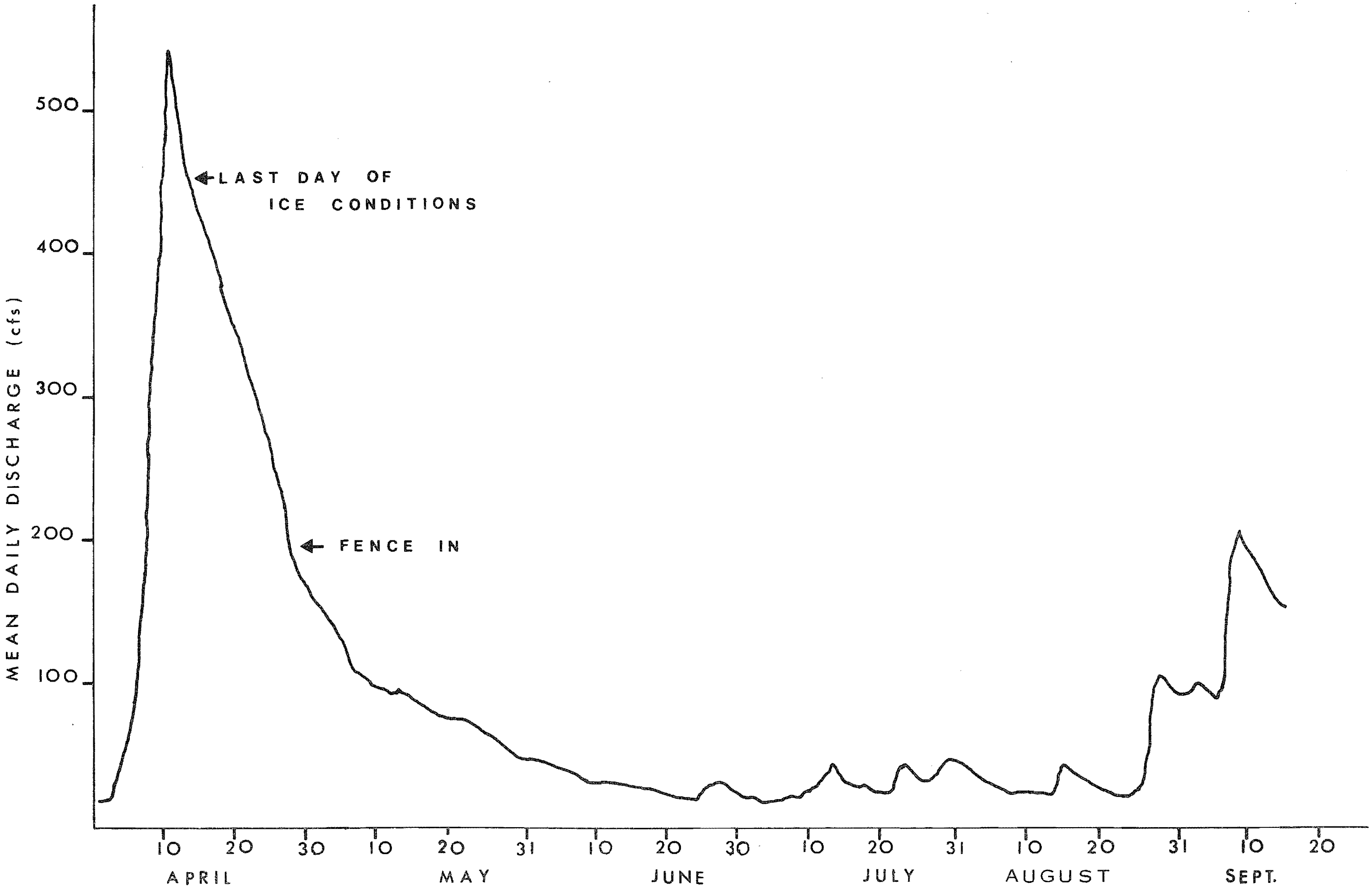


Figure 3. Discharge of the Muskeg River from April 1 to September 15, 1976.

Table 1. Summary of physical and chemical characteristics of the Muskeg River on several dates, 1976[1]. Except as indicated, data are expressed as $mg\ell^{-1}$.

Parameter	Date			
	Feb. 11	May 14	July 27	Sept. 7
Discharge (cfs)	15.8	92.0	30.9	104.0
pH (pH units)	7.7	8.1	7.8	7.8
Specific conductance (μmhos/cm @ 25C)	367	259	380	270
Turbidity (JTU)	6.3	2.8	17.0	14.6
Colour (Hazen units)	65	70	35	80
Total alkalinity	119	136	228	148
Total hardness	139	137	196	137
Humic acid	8	4	9	8.5
Fulvic acid	10	20	9	8.5
Filterable residue	-	181	276	162

[1]Data provided by Mr. C.R. Froelich, Alberta Oil Sands Environmental Research Program.

4. MATERIALS AND METHODS

Study of the fish fauna of the Muskeg River began in late April, 1976. During the spring and summer various methods were employed to collect fish throughout the watershed. The major emphasis, however, was on the construction and operation of a two-way fish counting fence to monitor the spring movements of fish into and out of the Muskeg River. The fence was established approximately 1 km from the confluence of the tributary with the Athabasca River, making it possible to enumerate virtually every fish moving from the main river into the Muskeg River watershed. The counting fence was in continuous operation from 28 April to 30 July, 1976.

4.1 COUNTING FENCE CONSTRUCTION

The counting fence (Fig. 4) was constructed in such a way as to form a complete temporary barrier to fish. Fish travelling upstream or downstream encountered the fence at some point and were led into one of the holding boxes.

The traps themselves were constructed of 2.5 cm x 2.5 cm welded wire fabric over a frame of 5.1 cm x 10.2 cm lumber with a floor of 1.9 cm thick plywood. The trap entrance was formed by two hinged doors set at such an angle that they tapered to a 10.2 cm wide slot. Fish passed through the slot over a 10.2 cm high ramp that elevated the trap entrance above the floor. The back of the trap contained two sliding doors stacked one above the other. The upper door could be removed to facilitate passage of fish by personnel working inside the trap or both doors could be taken out to permit free passage of fish. Overall dimensions of the traps

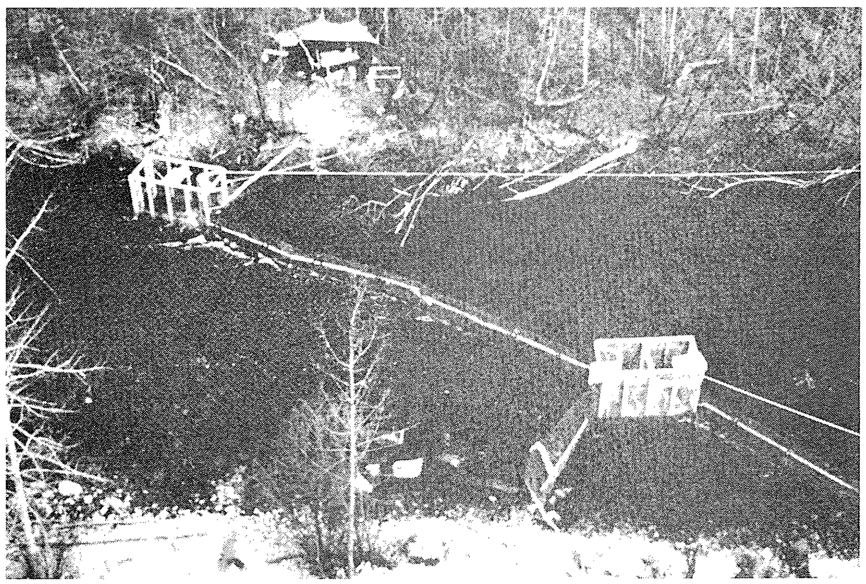


Figure 4. The Muskeg River counting fence, 1976.

were 2.4 m long x 1.8 m high by 1.2 m wide.

The fence proper was also constructed of 2.5 cm x 2.5 cm welded wire fabric, wired to spruce pole stringers to form panels up to 4.6 m long. Once constructed, the panels were floated into place on supporting steel stakes that had been driven into the substrate. Each panel was wired to the steel stakes and to adjacent panels.

Both the fence panels and the traps were anchored in place by piling rocks upon a skirt of wire mesh that had been affixed to the bottom of these structures.

4.2 COUNTING FENCE OPERATION

4.2.1 Sampling schedule

Fence construction was completed at 1930 hours on 28 April. Thus 29 April represents the first full day of fence operation. From 29 April to 14 June the traps were checked five to seven times daily although additional checks were necessary at times of heavy fish movements. After 14 June, traps were checked less frequently, usually once or twice daily until operations ceased on 30 July. The complete sampling schedule from 29 April to 30 June inclusive is shown in Table 2.

4.2.2 Trap checks

Each trap check was performed by two persons, one working inside the trap and the other serving as recorder. As fish were passed through the fence (in the direction they were moving) a complete record was made of the number of fish of each species. For white suckers and longnose suckers the development of pearl organs on the males made it possible to distinguish males from

TABLE 2. Sampling schedule for Muskeg River counting fence, spring, 1976.

Date	Time of Fence Check*																	
		0300		0900		1200			1500			1800			2100			2400
Apr. 29					1000			1400				+			+			+
30				+		+			+			+			+			+
May 1				+		+			+			+			+			+
2				+		+			+			+			+			+
3				+		+			+			+			+			+
4				+		+			+			+			+			+
5				+		+			+			+			+			+
6				+		+			+			+			+			+
7		+		+				1400	+	1600	1700	+	1900		+			+
8		+		+			1300			1600								+
9		+				+			+		1700	+	1900	2000		2200		+
10		+		+		+			+			+			+			+
11		+		+		+			+			+			+			+
12		+		+		+			+			+			+			+
13		+		+		+			+			+			+			+
14		+		+		+			+			+			+			+
15		+		+		+			+			+			+			+
16		+	0600			+			+			+			+			+
17		+		+		+			+			+			+			+
18		+		+		+			+			+			+			+
19		+		+		+			+			+			+			+
20		+				+				1600	1700	+	1900		+			+
21		+				+			+			+			+			+
22		+				+			+			+			+			+
23		+				+			+			+			+			+
24		+				+			+			+			+			+
25		+							+			+			+			+
26		+				+			+			+			+			+
27		+				+			+			+			+		2300	
28	0100								+			+			+		2300	
29	0100					+			+			+			+		2300	
30	0100					+			+			+			+		2300	
31	0100	+							+			+			+			+

TABLE 2. (Cont'd)

Date	Time of Fence Check*						
	0300	0900	1200	1500	1800	2100	2400
June 1	+			+	+	+	+
2	+			+	+	+	2300
3			+	+	+	+	2300
4			+	+	+	+	2300
5	0100		+	+	+	+	2300
6	0100		+	+	+	+	2300
7	0100		+	+	+	+	2300
8			+	+	+	+	+
9			+	+	+	+	+
10			+	+	+	+	+
11			+	+	+	+	+
12			+	+	+	+	+
13			+	+	+	+	+
14			+	+	+	+	+
15		1000		+			

*Actual check time indicated where different from scheduled check time.

Checks once daily from June 16 to July 30.

females between 3 May and 16 May. The only exceptions to this were small fish that were either females or immature males and such fish were recorded as being of unknown sex. After spawning, the pearl organs were lost very quickly and their presence or absence became difficult to determine, especially in the dark. Thus their usefulness for sex determination became doubtful after 16 May.

Handling of fish was minimized by using a scoop constructed of PVC pipe and rochelle netting.

At each check, relative water level was read from a staff gauge situated 10 m above the upstream trap and water temperature was taken from a max-min thermometer suspended in the water at the fence. A continuous record of stream temperatures was provided by a Ryan Model D15 recording thermometer. Relative water levels and daily water temperatures are given in Table 3.

The fence was examined daily for evidence of holes developing and was cleaned as required to remove debris.

4.2.3 Tagging

Numbered Floy tags were applied to as many white suckers and longnose suckers as was practicable. A small number of northern pike were also tagged. Tags were inserted into the left side of the fish near the base of the dorsal fin. The risk of infection was minimized by holding the tagging gun in disinfectant and then rinsing in fresh water before each insertion.

No anaesthetic was used. However, suckers retained in a holding pen up to 15 minutes after tagging rarely showed any ill effects. Grayling did not appear to cope well with the stress imposed by the tagging process and, therefore, tagging of this

Table 3. Daily water temperatures and relative levels recorded at the Muskeg River fence site, 1976.

Date	Daily Water Temperatures (°C) Max.	Min.	Mean	Daily Water Levels (cm)
April 28	9.5			
29	9.5	7.0	8.25	50
30	10.0	7.5	8.75	49
May 1	10.0	7.0	8.50	47
2	9.5	6.5	8.00	46
3	9.5	7.0	8.25	45
4	9.5	7.5	8.50	46
5	10.5	6.5	8.50	43
6	10.0	5.5	7.75	39
7	11.0	7.0	9.00	38
8	9.5	7.0	8.25	36
9	12.0	5.5	8.75	35
10	14.0	7.5	10.75	36
11	11.5	10.0	10.75	35
12	14.0	10.0	12.00	36
13	13.0	10.0	11.50	36
14	12.0	9.0	10.50	36
15	13.5	7.5	10.50	35
16	15.0	8.5	11.75	33
17	13.0	10.5	11.75	33
18	13.0	9.0	11.00	39
19	12.5	10.0	11.25	29
20	14.0	9.0	11.50	29
21	11.5	10.5	11.00	29
22	15.0	9.5	12.25	27
23	16.5	11.5	14.00	28
24	18.0	13.0	15.50	28
25	16.5	13.5	15.00	27
26	18.5	13.5	16.00	26
27	18.5	13.0	15.75	26
28*	16.5	15.0	15.75	25
29	19.0	14.5	16.75	24
30	17.5	15.5	16.50	23
31	17.5	15.0	16.25	22
June 1	19.0	15.0	17.0	22
2	19.0	15.0	17.0	22
3	16.5	14.0	15.25	21
4	17.0	15.0	16.0	20
5	17.5	13.5	15.5	21
6	20.0	15.0	17.5	19
7	20.0	15.5	17.75	19
8	21.0	18.0	79.5	17
9	23.0	20.0	21.5	18
10	22.0	20.0	21.0	17

Table 3. cont'd

Date	Daily Water Temperatures (°C) Max.	Min.	Mean	Daily Water Levels (cm)
June 11	21.0	20.0	20.5	17
12	17.0	16.5	16.75	18
13	17.5	15.5	16.5	18
14	17.5	15.5	16.5	18
15	20.0	15.0	17.50	18
16	18.5	13.0	15.75	-
17	20.0	12.5	16.25	-
18	21.5	15.0	18.25	16
19	20.5	17.0	18.75	-
20	18.0	16.0	17.00	-
21	19.5	14.0	16.75	-
22	21.0	13.0	17.00	13
23	17.0	15.0	16.00	-
24	14.0	14.0	14.00	14
25	15.5	13.0	14.25	18
26	17.0	14.5	15.75	18
27	19.5	15.0	17.25	-
28	21.5	16.0	18.75	18
29	23.0	16.5	19.75	17
30	23.0	17.5	20.25	19

*From May 28 to June 14 inclusive, water temperatures were recorded with a max.-min. thermometer.

species was discontinued after the first day.

Tagging was conducted only during the daylight hours. At all times care was taken not to impede the progress of the fish any more than necessary. If fish were observed to be backing up in front of the trap, tagging was discontinued and the remaining fish were simply passed through and enumerated.

For each fish tagged fork length (± 1.0 mm) was recorded and the sex noted if possible. Tagged fish were not weighed and no structures were retained for purposes of age determination.

The tagging program was well publicized by posters and press releases and a two dollar reward was offered for returned tags.

4.2.4 Dead samples

A small number of fish were sacrificed each day for biological analysis. For such fish, fork length (±1.0 mm) and weight were recorded. At the outset weight was recorded to the nearest 50 g but the arrival of a new scale in mid-May permitted weight determinations to the nearest 20 g. Sex and stage of maturity were determined by examination of the gonads. Stomach contents were noted and a small number of stomachs were preserved in 10% formalin for a more detailed assessment of food habits. Ovaries were removed from several white suckers, longnose suckers and Arctic grayling and preserved in Gilson's fluid. For purposes of age determination, scales were removed from the appropriate location (Hatfield et al. 1972) for grayling, pike, mountain whitefish, lake whitefish and walleyes. Otoliths (ear bones) were taken from burbot and for suckers the left pectoral fin was retained for this purpose.

4.2.5 Problems associated with the fence operation

Several problems were encountered with the fence operation that may have a bearing on the interpretation of our results and should be recorded.

During the first few days of the project it was discovered that some fish, after being passed through the upstream trap, failed to continue upstream and instead entered the downstream trap minutes later, from which they were released downstream. Some tagged fish, released downstream on one such occasion later renegotiated the upstream trap. There was some double counting, therefore, of a number of fish (mostly longnose suckers). After 4 May the door to the downstream trap was closed prior to passing fish through the upstream trap and on 7 May the downstream trap was closed completely, to be re-opened at 1500 hours on 15 May.

A second problem was the result of rapidly dropping water levels during the first week of the project. The result was a drastic reduction in flow through the upstream trap. This problem was rectified by re-locating the upstream trap closer to midstream. This operation commenced at 0900 hours on 7 May and the fence was re-established by 1230 hours. It is believed that few, if any fish passed through the fence during this interval.

The third problem involves the question of the efficiency of the traps in retaining fish. In the case of the upstream trap this efficiency was observed to be very high, only the very rare fish escaping. However, the downstream trap left much to be desired in this respect. Because of the fact that the fish orient into the current, the entrance to the downstream trap was in plain view of fish inside this trap. On some occasions, suckers seemed to enter and leave the "trap" almost at will. There is some question, therefore, as to how closely our data will describe the pattern of downstream migrations.

4.3 OTHER FISH COLLECTION TECHNIQUES

Apart from the counting fence, fish were collected from the Muskeg River by various methods including drift nets, dip nets, minnow traps, gill nets, electrofishing, angling and small mesh seines. Large fish captured by these methods were completely sampled as described previously for dead samples or measured and tagged. Small fish were preserved in 10% formalin for subsequent analysis. These were later transferred to 50% isopropyl alcohol.

4.3.1 Small fish collection sites

Small fish were collected from 10 general areas in the Muskeg River watershed (Fig. 5). Each area consisted of from 10 m to 3 km of stream channel which was sampled in such a way as to obtain a representative sample of the fish population of the area. No standard unit of effort was applied.

It was not possible in 1976 to sample all areas on a regular basis and areas 3, 4, 5, 8 and 9 were sampled only once each. Areas 6 and 10 were each sampled twice, once in June and once in late March, 1977.

Complete habitat descriptions for each area will be provided in a subsequent report.

4.4 LABORATORY TECHNIQUES

4.4.1 Fish identification

In the laboratory, preserved fish specimens were identified

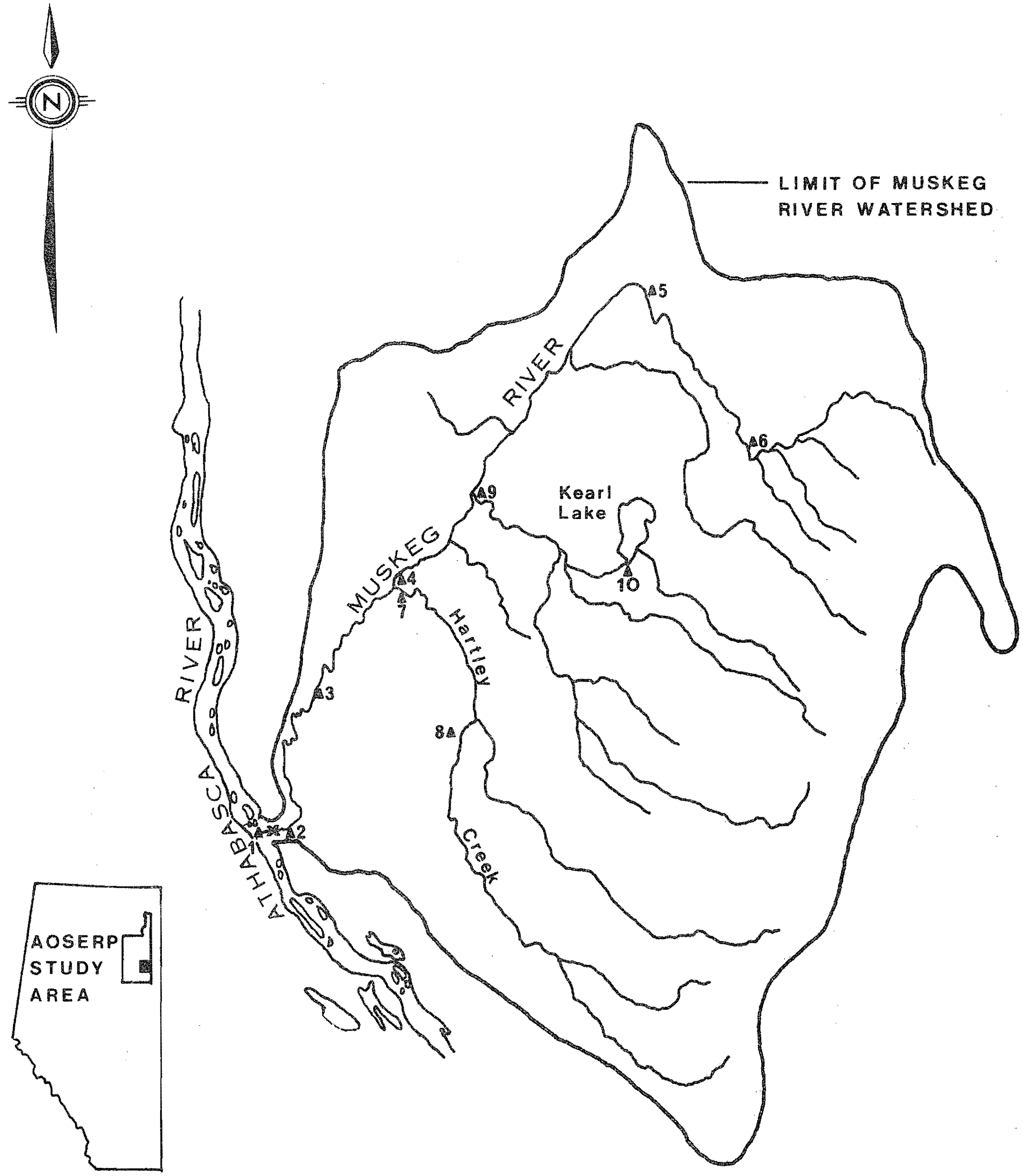
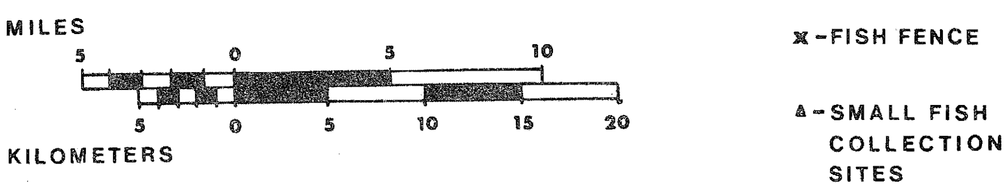


Figure 5. Map of Muskeg River drainage basin indicating location of counting fence and small fish collection sites.



using taxonomic keys and descriptions given by Paetz and Nelson (1970) and Scott and Crossman (1973). While most fish could be identified to species, larval Catostomids could often be identified only to genus.

4.4.2 Age determination

For Arctic grayling, mountain whitefish, lake whitefish, walleye and northern pike, ages were determined by the scale method. For each fish, several scales were cleaned and mounted between two glass slides and the annuli read from the image produced by an Eberbach microprojector.

Ages for white suckers and longnose suckers were determined from cross sections of pectoral fin rays as described by Beamish and Harvey (1969) and Beamish (1973). After embedding the dried fin rays in epoxy, thin sections (0.5 mm to 1.0 mm) were cut by hand using a jeweller's saw with No. 6 or No. 7 blades. These sections were then mounted in Permount on glass slides and read under a microscope.

For all other fish included in this report, ages were determined from otoliths. Where required the otolith was ground by hand on a carborundum. 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.

In all cases independent age determinations were made by three people. Where discrepancies existed among the three results, the readers conferred until a consensus was achieved.

4.4.3 Fecundity

Fecundity was determined for several white suckers, longnose suckers and Arctic grayling using the gravimetric method of estimation described by Healey and Nichol (1975).

In this method the ovarian tissue is removed from the sample and the separated eggs dried to constant weight. The weight of a subsample of eggs is determined and the total number of ova is then derived by extrapolation. The accuracy of our estimates was assessed by performing total counts on several ovaries.

4.4.4 Food habits

Analysis of food habits was limited by time considerations. For those fish that were examined in the laboratory, the stomach contents were removed and the food items identified to the lowest possible taxon. Results were expressed as percentage frequency of occurrence, percentage of total number and (in some cases) percentage of total volume.

4.4.5 Length and weight of small fish

Small, preserved fish specimens were measured to the nearest 0.5 mm (nearest 1.0 mm in some cases) and weighed either to the nearest 0.1 g on a triple beam balance or to the nearest 0.01 g on an analytical balance.

4.4.6 Data analysis

Data were analyzed for graphic and tabular presentation using a Hewlett-Packard Model 9810-A programmable calculator.

Length-weight relationships are described by the power equation:

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

where: W = weight in grams,

L = fork or total length in millimeters,

a = y-intercept,

b = slope of the regression line, and

sb = standard deviation of b.

Data summaries and raw data are presently on file at the Freshwater Institute in Winnipeg.

Table 4. List of fish species captured in the Muskeg River drainage during 1976.

Family and Generic Names	Common Names
Family Coregonidae	
Coregonus clupeaformis (Mitchill)	Lake whitefish
Prosopium williamsoni (Girard)	Mountain whitefish
Family Thymallidae	
Thymallus arcticus (Pallas)	Arctic grayling
Family Esocidae	
Esox lucius Linnaeus	Northern pike
Family Cyprinidae	
Semotilus margarita nachtriebi (Cox)	Northern pearl dace
Couesius plumbeus (Agassiz)	Lake chub
Rhinichthys cataractae (Valenciennes)	Longnose dace
Notropis hudsonius (Clinton)	Spottail shiner
Family Catostomidae	
Catostomus commersoni (Lacépède)	White sucker
Catostomus catostomus (Forster)	Longnose sucker
Family Percopsidae	
Percopsis omiscomaycus (Walbaum)	Trout-perch
Family Gadidae	
Lota lota (Linnaeus)	Burbot
Family Gasterosteidae	
Culaea inconstans (Kirtland)	Brook stickleback
Family Cottidae	
Cottus cognatus Richardson	Slimy sculpin
Family Percidae	
Stizostedion vitreum vitreum (Mitchill)	Walleye

5. RESULTS

5.1 FISH SPECIES OF THE MUSKEG RIVER

Work in 1976 documented the presence in the Muskeg River watershed of 15 fish species representing 10 families (Table 4).

5.2 RELATIVE ABUNDANCE AND DISTRIBUTION

A total of 6153 fish (8 species) were counted through the upstream trap during the operation of the counting fence (Table 5). White suckers and longnose suckers occurred in equal numbers (46.1%) while Arctic grayling (5.0%) and northern pike (2.1%) made up most of the remainder of large fish captured.

Small fish collections made throughout the watershed produced 3411 fish. The relative abundance and distribution of these fish are indicated in Table 6.

5.3 TAGGING RESULTS

5.3.1 Tag releases and recaptures

Floy tags were applied to 2269 fish with longnose suckers (55.8%) and white suckers (38.6%) accounting for the vast majority (Table 7). Recapture results have been disappointing with only a 1.2% return rate to date. It is anticipated that an increased number of tags in the system and increased activity by AOSERP fishery crews in the study area will produce better results in 1977.

5.3.2 Movement of tagged fish

White suckers

Of 8 recaptured white suckers, 1 was captured upstream of the Muskeg River while the remaining 7 had moved downstream in the Athabasca River. Two white suckers tagged at the fence travelled 162 km downstream in just 8 days while one had travelled

Table 5. Summary of fish passed through the Muskeg River counting fence, 1976.

Species	Number of Fish	
	Upstream Trap	Downstream Trap
White sucker	2839	1669
Longnose sucker	2837	2191
Arctic grayling	305	78
Northern pike	131	155
Mountain whitefish	33	101
Lake whitefish	3	14
Walleye	4	3
Burbot	1	2
Total	6153	4213

Table 6. Distribution and composition of fish species captured by seine, minnow trap and backpack electroshocker in the Muskeg River drainage, 1976.

Species	Muskeg River												Hartley Creek				Kearl Creek				Total
	Area 1		Area 2*		Area 3		Area 4		Area 5		Area 6		Area 7		Area 8		Area 9		Area 10		
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	
Arctic grayling	23	1.5	7	1.4	17	5.7							82	20.1	6	20.0					135
Pearl dace			4	0.8																	4
Lake chub			23	4.6	84	28.3					8	14.3	127	31.4	14	46.7	6	4.2			262
Longnose dace			72	14.9									1	0.3							75
Spottail shiner			1	0.2																	1
Sucker spp.	1292	83.1	40	8.1			355	99.2					98	24.1							1785
White sucker	197	12.7	160	32.2	100	33.7							20	4.9	6	20.0	129	89.5			612
Longnose sucker			10	2.0	1	0.3							5	1.2	1	3.3	8	4.6			25
Trout-perch	40	2.6	2	0.4																	42
Burbot			3	0.6																	3
Brook stickleback			4	0.8	22	7.4	3	0.8	61	100	48	85.7	54	13.3	3	10.0	1	0.7	8	100	204
Slimy sculpin	2	0.1	167	33.6	73	24.2							19	4.7							261
Walleye			2	0.4																	2
Totals	1554		497		297		358		61		56		406		30		144		8		3411

*Other species recorded (from fence operation) in Area 2 include: lake whitefish, mountain whitefish and northern pike.

Table 7. Summary of tag releases and recaptures by species for fish tagged at Muskeg River counting fence, 1976.

Species	Number Tagged	Percent of Total Number Tagged	Number Recaptured	Percent Recaptured
White sucker	876	38.6	8	0.9
Longnose sucker	1267	55.8	1	+
Northern pike	119	5.2	18	15.1
Arctic grayling	3	0.1	0	0
Walleye	4	0.2	0	0
Total	2269	100.0	27	1.2

approximately 280 km in 32 days when it was recaptured in Lake Athabasca (Table 8).

Longnose suckers

Only 1 longnose sucker was recaptured out of a total of 1267 tagged. This fish was at large for 84 days before being recaptured in the Athabasca River only 5 km downstream from the Muskeg River (Table 8).

Northern pike

A total of 18 tagged northern pike were recaptured which was 15.1% of all pike tagged. Generally, pike demonstrated little tendency to move around as 12 fish were recaptured at the fence site or at the mouth of the Muskeg after 10 to 75 days (Table 8). One pike, however, had travelled 72 km in 43 days when it was recaptured.

5.4 LIFE HISTORIES OF FISH SPECIES

5.4.1 White suckers

5.4.1.1 Seasonal timing of upstream migration. The seasonal pattern of the 1976 upstream migration of white suckers into the Muskeg River is shown in Fig. 6 and Table 9.

White sucker spawning migrations appear to be initiated by increasing water temperatures and often begin when the daily maximum water temperature approaches 10C (Geen et al. 1966; Bond 1972).

At the time of the installation of the 1976 counting fence on the Muskeg River the daily maximum water temperature was already at 9.5C. The run appeared to have commenced initially on 29 April. However, when daily maximum water temperature dropped below 10C during the first few days of May, the number of upstream

Table 8. Dates of tagging and recapture, location of recapture, distances travelled and elapsed time between release and recapture for fish tagged at Muskeg River counting fence, 1976.

Species	Date Tagged	Location Recaptured[1]	Date Recaptured	Distance Travelled Miles	km	Elapsed Time (Days)
White sucker	May 6/76[2]	Mile 26	May 22/76	10	16	2
	May 18/76	Mile 135	May 26/76	101	162	8
	May 18/76	Mile 135	May 26/76	101	162	8
	May 19/76	Lake Athabasca	June 20/76	175	280	32
	June 26/76	Mile 37	Aug. 15/76	3	5	50
	June 28/76	Mile 37	Aug. 15/76	3	5	48
	June 28/76	Mile 37	Aug. 15/76	3	5	48
	July 11/76	Mile 37	Sept. 30/76	3	5	81
Longnose sucker	May 23/76	Mile 37	Aug. 15/76	3	5	84
Northern pike	May 4/76[3]	Mile 26	June 8/76	10	16	7
	May 4/76	Fence	June 19/76	-	-	46
	June 9/76	Mile 33	July 21/76	3	5	42
	June 10/76	Mile 79	July 23/76	45	72	43
	June 15/76	Mile 26	July 20/76	10	16	35
	June 22/76	Mile 33	July 21/76	3	5	29
	June 22/76	Mile 35[4]	July 25/76	0.6	1	33
	June 26/76	Mile 26	Sept. 20/76	10	16	86
	June 26/76	Mile 35	Aug. 10/76	0.6	1	45
	June 27/76	Fence	July 21/76	-	-	24
	June 29/76	Mile 35	July 25/76	0.6	1	26
	July 1/76	Fence	July 11/76	-	-	10
	July 1/76	Mile 35	Sept. 15/76	0.6	1	75

Table 8. (Cont'd)

Species	Date Tagged	Location Recaptured	Date Recaptured	Distance Travelled Miles	Distance Travelled km	Elapsed Time (Days)
Northern pike	July 8/76	Mile 35	July 25/76	0.6	1	17
	July 13/76	Mile 35	July 25/76	0.6	1	12
	July 21/76	Mile 35	Sept. 15/76	0.6	1	45
	July 24/76	Mile 35	Sept. 14/76	0.6	1	52
	July 27/76	Mile 35	Aug. 16/76	0.6	1	20

[1]Mileage refers to distance below Fort McMurray.

[2]This fish was tagged going upstream on May 6/76 and was passed through downstream trap on May 20/76.

[3]This fish was tagged going upstream on May 4/76 and was passed through downstream trap on June 1/76.

[4]Mile 35 refers to the mouth of the Muskeg River.

Table 9. Summary of fish enumerated during the counting fence operation in the Muskeg River, 1976. Percentage values indicate composition of fish moving through upstream and downstream traps.

Date	Upstream Trap						Downstream Trap						
	Longnose Sucker	White sucker	Arctic grayling	Northern pike	Mountain whitefish	Daily Totals	Longnose sucker	White sucker	Arctic grayling	Northern pike	Mountain whitefish	Lake whitefish	Daily Totals
April 27	1	4	1	-	-	6	-	-	-	-	-	-	0
28	65	2	19	-	2	88	9	-	3	-	-	-	12
29	130	72	61	8	2	273	25	4	7	-	1	-	37
30	213	96	30	10	1	350	19	6	8	-	-	-	33
May 1	132	34	25	13	1	205	13	1	8	-	-	-	22
2	109	10	29	8	1	157	33	1	7	-	-	-	41
3	186	4	6	6	1	203	17	-	1	-	-	-	18
4	117	34	21	1	3	176	25	-	2	-	1	-	28
5	21	1	9	7	-	38	3	-	-	-	-	-	3
6	65	69	5	2	3	144	2	7	2	-	-	-	11
7	124	697	15	5	3	844	4	2	-	-	-	-	6
8	79	270	6	5	4	364	-	-	-	-	-	-	0
9	359	561	6	4	-	930	-	-	-	-	-	-	0
10	398	407	7	3	2	817	-	-	-	-	-	-	0
11	134	203	3	-	1	341	3	17	-	-	-	-	20
12	164	112	12	1	5	294	1	28	1	-	-	-	30
13	133	93	7	4	1	238	-	-	-	-	-	-	0
14	144	35	6	9	-	195*	-	5	-	-	-	-	5
15	116	28	9	1	-	156*	28	206	1	4	-	-	239
16	68	22	5	2	-	97	53	164	1	4	-	-	222
17	9	14	4	2	-	30*	65	81	-	1	-	2	149
18	4	3	1	2	1	11	51	121	-	1	-	-	173

Table 9. (Cont'd)

Date	Upstream Trap						Downstream Trap						
	Longnose sucker	White sucker	Arctic grayling	Northern pike	Mountain whitefish	Daily Totals	Longnose sucker	White sucker	Arctic grayling	Northern pike	Mountain whitefish	Lake whitefish	Daily Totals
May 19	-	-	-	2	-	2	43	81	-	4	1	-	129
20	-	-	2	3	1	6	232	172	2	-	1	-	407
21	3	8	-	-	-	11	75	20	-	-	-	1	96
22	4	6	2		-	13	224	89	-	1	-	2	316
23	3	9	1	1	-	14	90	38	-	1	-	1	130
24	1	2	-	2	-	5	25	15	-	1	1	-	42
25	-	4	-	2	-	6	39	28	-	3	1	1	72
26	-	4	2	1	-	7	91	19	1	2	1	-	115^{+}
27	-	1	-	-	-	1	105	10	1	1	-	1	118
28	-	1	-	-	-	1	62	3	1	-	1	1	68
29	-	-	-	2	-	2	179	12	3	3	1	-	198
30	-	-	-	-	-	0	100	17	-	2	-	-	119
31	-	2	2	3	-	7	25	10	-	2	1	-	38
June 1	22	13	3	2	-	40	30	14	3	4	-	1	52
2	16	6	-	2	-	25*	5	3	-	-	2	-	10
3	-	1	-	-	-	1	32	3	-	1	4	-	40
4	3	-	-	2	-	5	122	36	2	4	3	-	167
5	1	-	2	-	-	3	71	21	-	2	2	1	97
6	-	2	1	-	-	3	28	17	-	1	7	-	53
7	4	-	-	-	-	4	12	4	-	1	3	-	20
8	4	-	-	1	-	5	7	6	-	2	1	-	16
9	3	-	-	1	-	4	35	27	-	5	4	2	73
10	2	1	2	3	-	8	23	13	6	7	10	-	59
11	-	-	-	4	1	5	13	11	3	5	10	-	42

Table 9. (Cont'd)

Date	Upstream Trap: Longnose sucker	White Sucker	Arctic grayling	Northern pike	Mountain whitefish	Daily Totals	Downstream Trap: Longnose sucker	White sucker	Arctic grayling	Northern pike	Mountain whitefish	Lake whitefish	Daily Totals
June 12	-	-	-	1	-	1	2	-	1	2	16	-	21
13	-	-	1	-	-	1	7	7	-	4	-	-	18
14	-	-	-	1	-	1	1	3	-	1	4	-	9
15	-	-	-	-	-	0	-	-	-	3	-	-	3
16	-	-	-	1	-	1	-	1	-	3	2	-	6
17	-	-	-	-	-	0	-	-	-	-	-	-	0
18	-	-	-	-	-	0	2	-	-	4	1	-	7
19	-	-	-	-	-	0	2	-	-	2	-	1	5
20	-	-	-	-	-	0	-	-	-	-	-	-	0
21	-	-	-	-	-	0	-	-	-	-	-	-	0
22	-	-	-	-	-	0	2	-	-	7	7	-	16
23	-	-	-	-	-	0	2	1	-	3	4	-	10
24	-	-	-	-	-	1*	4	-	-	1	-	-	5
25	-	-	-	-	-	0	-	-	-	-	-	-	0
26	-	-	-	-	-	0	30	27	-	8	4	-	70+
27	-	-	-	-	-	0	6	5	-	4	2	-	17
28	-	-	-	1	-	1	13	13	-	1	3	-	30
29	-	2	-	-	-	2	2	3	-	4	-	-	9
30	-	-	-	-	-	0	3	1	1	1	1	-	7
July 1	-	-	-	-	-	0	4	7	1	5	-	-	17
2	-	-	-	-	-	0	-	1	1	-	-	-	2
3	-	-	-	-	-	0	8	-	1	-	1	-	10
4	-	-	-	-	-	2*	3	2	2	2	-	-	9

Table 9. (Cont'd)

Date	Upstream Trap: Longnose sucker	White sucker	Arctic grayling	Northern pike	Mountain whitefish	Daily Totals	Downstream Trap: Longnose sucker	White sucker	Arctic grayling	Northern pike	Mountain whitefish	Lake whitefish	Daily Totals
July 5	-	-	-	-	-	0	1	-	-	1	-	-	2
6	-	-	-	-	-	0	3	-	-	2	-	-	5
7	-	-	-	-	-	0	-	-	1	3	-	-	4
8	-	-	-	-	-	0	1	2	-	5	-	-	8
9	-	-	-	-	-	0	7	12	-	1	-	-	21+
10	-	-	-	-	-	0	1	-	1	3	-	-	5
11	-	-	-	-	-	0	23	44	-	-	-	-	67
12	-	3	-	-	-	3	11	57	-	1	-	-	69
13	-	2	-	1	-	3	1	20	-	5	-	-	26
14	-	-	-	-	-	0	17	88	1	1	-	-	107
15	-	-	-	-	-	0	4	19	1	2	-	-	28+
16	-	-	-	-	-	0	2	22	1	1	-	-	26
17	-	-	-	1	-	1	1	3	-	-	-	-	4
18	-	-	-	-	-	0	-	-	1	-	-	-	1
19	-	-	-	-	-	0	-	2	1	-	-	-	3
20	-	-	-	-	-	0	2	2	-	3	-	-	7
21	-	-	-	-	-	0	-	1	-	2	-	-	3
22	-	-	-	-	-	0	1	-	-	-	-	-	1
23	-	-	-	-	-	0	-	2	-	1	-	-	3
24	-	-	-	-	-	0	1	2	-	3	-	-	6
25	-	-	-	-	-	0	1	6	-	-	-	-	7
26	-	-	-	-	-	0	-	1	-	1	-	-	2
27	-	1	-	-	-	1	1	1	-	1	-	-	3

Table 9. (Cont'd)

Date	Upstream Trap						Downstream Trap						
	Longnose sucker	White sucker	Arctic grayling	Northern pike	Mountain whitefish	Daily Totals	Longnose sucker	White sucker	Arctic grayling	Northern pike	Mountain whitefish	Lake whitefish	Daily Totals
July 27	-	1	-	-	-	1	1	1	-	1	-	-	3
28	-	-	-	-	-	0	-	-	-	1	-	-	1
29	-	-	-	-	-	0	1	1	1	1	-	-	4
30	-	-	-	-	-	0	2	1	-	-	-	-	3
Totals	2837	2839	305	131	33	6153	2191	1669	78	155	101	14	4213
%	46.1	46.1	5.0	2.1	0.5		52.0	39.6	1.9	3.7	2.4	0.3	

*Other species counted through the upstream trap: three lake whitefish, May 15, 17 and June 2; four walleye, May 14, June 24 and July 4 (two fish), and one burbot, May 15.

+Other species counted through the downstream trap: three walleye, May 26, June 26 and July 9; two burbot, July 15.

migrants decreased. With increasing water temperature the main run of white suckers began on 7 May as 79.3% of all migrants passed upstream between 7 May and 12 May inclusive. The greatest numbers of migrating fish were observed on days when daily maximum water temperature exceeded 10C.

5.4.1.2 Diel timing of upstream migration. The majority of spawners (75%) moved upstream between noon and midnight with a maximum usually in the late afternoon and evening hours (Table 10). This maximum daily movement appeared to occur just following the time of highest daily water temperature.

5.4.1.3 Spawning period. The actual spawning period of white suckers in 1976 lasted approximately two weeks. The first ripe male and female suckers were captured on 29 April (Table 11). The first spent fish were collected at the downstream trap on 14 May and by 18 May all fish taken were spawned out.

5.4.1.4 Spawning areas and behaviour. Throughout the second week of May, 1976, white suckers in spawning coloration were observed throughout the lower 3 km of the Muskeg River. This region contains large areas of suitable spawning gravel.

Mr. Malcolm Orr observed white suckers spawning immediately below the counting fence on 11 May 1976, at which time the water temperature varied between 10C and 11.5C. Spawning suckers occupied an area of approximately 726 m^2. In most of this area the substrate consisted of coarse gravel (6-15 cm in diameter) interspersed with finer gravel (<6 cm). Water depth at the time averaged about 30 cm in this region.

During the spawning act, fish were rather vigorous, 5.4.1.6 Length of time on spawning grounds. The length of time spent by individual white suckers on the spawning grounds was determined from fish tagged going upstream and recaptured passing through the downstream trap. The actual times varied greatly from 3 to 84 days although the majority of fish (64%) returned downstream within 19 days (Fig. 7).

5.4.1.7 Spawning mortality. Between 18 June and 30 July, 112 white suckers were found dead in the Muskeg River. The number of mortalities increased and the general condition of the fish decreased through July. At this time many white suckers were found blind in one or both eyes, displayed signs of physical deterioration and were often heavily infested with the parasitic copepod *Argulus sp.* Spawning mortality among white suckers in north-western Canada is usually around 15-20% (Scott and Crossman 1973).

5.4.1.8 Size composition of migrant white suckers. During the 1976 counting fence operation, fork lengths were determined for 1205 white suckers of which sex was determined in 432 cases (Table 13 and Fig. 8). Migrant suckers ranged in length from 155 mm to 587 mm and in weight from 40 g to 3200 g. The length-frequency polygon (Fig. 8) shows 3 major modes in the length distribution (350-369; 390-409 and 450-469 mm).

Considering only the upstream migration, female suckers were generally larger than males as indicated in Figure 9. Females had a mean fork length of 410 mm (Range: 239-587 mm) while males showed a mean fork length of 368 mm (Range: 218-515 mm).

Table 10. Summary of diel timing of the upstream migration of white suckers in the Muskeg River, 1976. Fish which were counted at times other than those indicated were included in the next check period. Asterisks indicate times not checked.

Date	Time Checks 0300	0900	1200	1500	1800	2100	2400	Number of Fish
April 27	*	*	*	*	*	4	*	4
28	*	*	*	-	-	2	-	2
29	-	66	-	-	-	5	1	72
30	*	52	-	-	11	-	33	96
May 1	*	25	-	-	1	-	8	34
2	*	5	-	-	-	-	5	10
3	*	-	-	-	1	-	3	4
4	*	27	-	-	1	-	6	34
5	*	1	-	-	-	-	-	1
6	*	-	-	-	68	-	1	69
7	-	-	-	167	300	142	88	697
8	79	47	40	14	*	*	90	270
9	46	-	14	13	180	183	125	561
10	111	26	-	69	74	65	62	407
11	114	10	1	15	Trap Closed		63	203
12	11	5	-	28	4	64	Trap closed	112
13	22	9	-	22	20	-	20	93
14	17	2	-	1	-	-	15	35
15	2	2	1	1	8	1	13	28
16	10	-	-	-	-	-	12	22
17	8	5	-	-	-	-	1	14
18	-	1	-	-	-	-	2	3
19	-	-	-	-	-	-	-	0
20	-	*	-	-	-	-	-	-
21	3	*	-	-	1	-	4	8
22	4	*	-	-	-	-	2	6
23	8	*	-	1	-	-	-	9
24	2	*	-	-	-	-	-	2
25	-	*	-	1	3	-	-	4
26	2	*	-	-	-	-	2	4
27	-	*	1	-	-	-	-	1
28	-	1	*	-	-	-	Trap closed	1
29	-	*	-	-	-	-	-	0
30	-	*	-	-	-	-	-	0
31	-	*	*	-	2	-	Trap closed	2
Totals	439	284	58	332	674	466	556	2808
% Grand Total	16%	10%	2%	12%	24%	17%	20%	

Table 11. Condition of spawning white suckers sampled during the Muskeg River run, 1976. Spawning conditions were determined by dissection.

	Spawning Condition-Females				Spawning Condition-Males			
Date	N	% Mature	% Ripe	% Spent	N	% Mature	% Ripe	% Spent
April 27					4	100		
28					1	100		
29	2		100		8	25	75	
30	8	12	88		5	40	60	
May 2	1		100		3		100	
4	2	50	50		3		100	
6	4	25	75		5		100	
7	5	40	60		8	25	75	
8	12	80	20		20	20	80	
9	4	100						
10					1	100		
11	2	50	50		1	100		
12	3	33	67		7		100	
13					3	33	67	
14	4			100	2		50	50
15	3			100	12		83	17
17	3	33		67	3		33	67
18	3			100	3			100
19	5			100				
20	2			100	3			100
21					1			100
Totals	63				93			

exposing their backs and splashing water. Most spawning activity was seen to occur from mid-afternoon until late evening, coinciding with the period of highest daily water temperature.

By 15 May, only a few fish remained on the spawning grounds. These were often observed to move around, apparently combing the substrate as if feeding.

From fry collections made in June, it seems likely that suckers spawned on suitable substrate downstream from Hartley Creek and in the lower reaches of Hartley Creek itself. No young-of-the-year suckers were taken upstream of Area 4 (Fig. 5) in 1976 although a large number of yearling white suckers were captured on 21 June, 1976 near the mouth of Kearl Creek (Area 9, Fig. 5).

5.4.1.5 Return of spawners. The seasonal pattern of the downstream movement of spent white suckers in 1976 is shown in Figure 6. The main movement of spent fish from the Muskeg River began on 15 May, about 16 days after the spawning migration began (Table 9). Although the downstream trap was closed for a few days prior to 15 May, the fence was under constant observation and no fish were seen near the trap before that date.

The downstream migration showed a peak between 15 May and 20 May and thereafter, fish continued to trickle downstream through 30 July after which time the fence was no longer monitored.

The downstream migration took place mainly in the early evening and night with 79% of the spent fish being counted between 1800 and 0300 hours (Table 12). Maximum movement occurred during the period following highest daily water temperature.

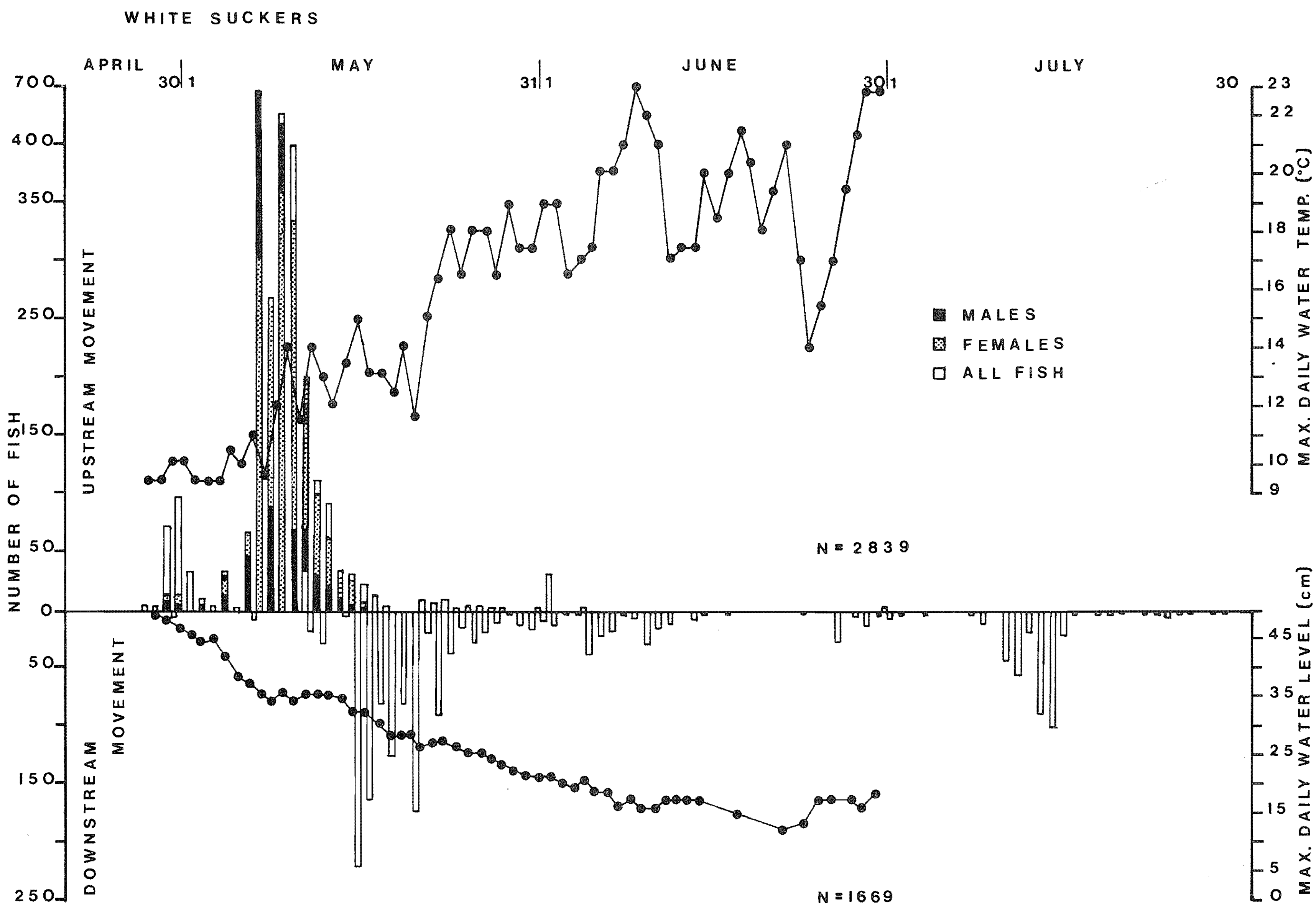


Figure 6. Seasonal timing of white sucker migration, 1976.

Table 12. Summary of diel timing of the downstream movement of white suckers in the Muskeg River, 1976. Fish which were counted at times other than those indicated were included in the next check period. Asterisks indicate times not checked.

Date	Time Checks							Number of Fish
	0300	0900	1200	1500	1800	2100	2400	
April 27	*	*	*	*	*	-	*	0
28	*	*	*	-	-	-	-	0
29	-	4	-	-	-	-	-	4
30	*	2	-	-	2	-	2	6
May 1	*	1	-	-	-	-	-	1
2	*	1	-	-	-	-	-	1
3	*	-	-	-	-	-	-	0
4	*	-	-	-	-	-	-	0
5	*	-	-	-	-	-	-	0
6	*	-	-	-	-	5	2	7
7	2	-	-					0
8								0
9					Downstream trap closed			0
10								0
11		17						17
12		28						28
13								0
14		5						5
15	-	16	1	-	35	-	154	206
16	68	4	4	5	20	-	63	164
17	34	1	-	2	1	3	40	81
18	8	-	-	23	71	2	17	121
19	10	-	-	4	60	2	5	81
20	9	*	-	18	109	27	9	172
21	6	*	3	1	-	1	9	20
22	16	*	7	41	18	-	7	89
23	2	*	4	29	2	-	1	38
24	-	*		5	2	1	7	15
25	20	*	1	1	5	2	-	28
26	3	*	-	2	5	1	8	19
27	2	*	-	4	2	-	2	10
28	2	*	*	-	1	-	Trap closed	3
29	4	*	1	2	-	-	5	12
30	5	*	2	2	2	-	6	17
31	10	*	*	-	-	-	Trap closed	10
Totals	201	79	22	139	335	44	337	1157
% Grand Total	17%	7%	2%	12%	29%	4%	29%	

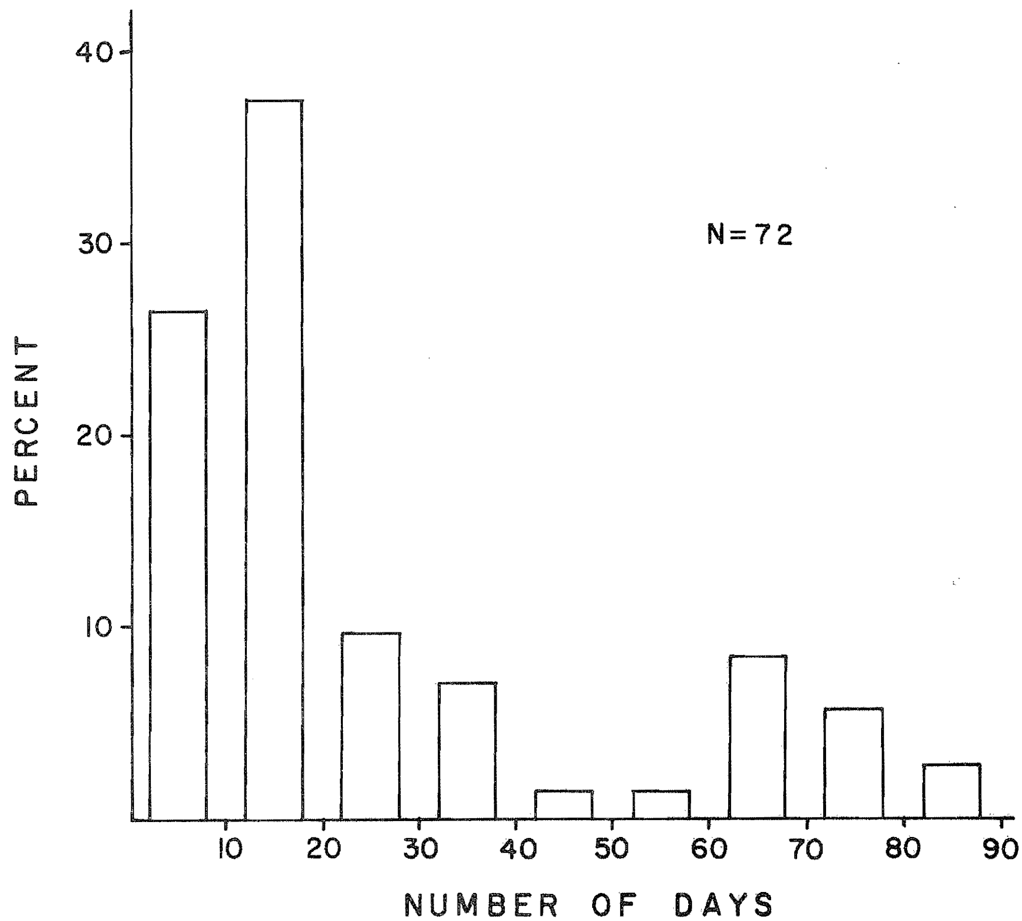


Figure 7. Number of days spent in Muskeg River by individual white suckers.

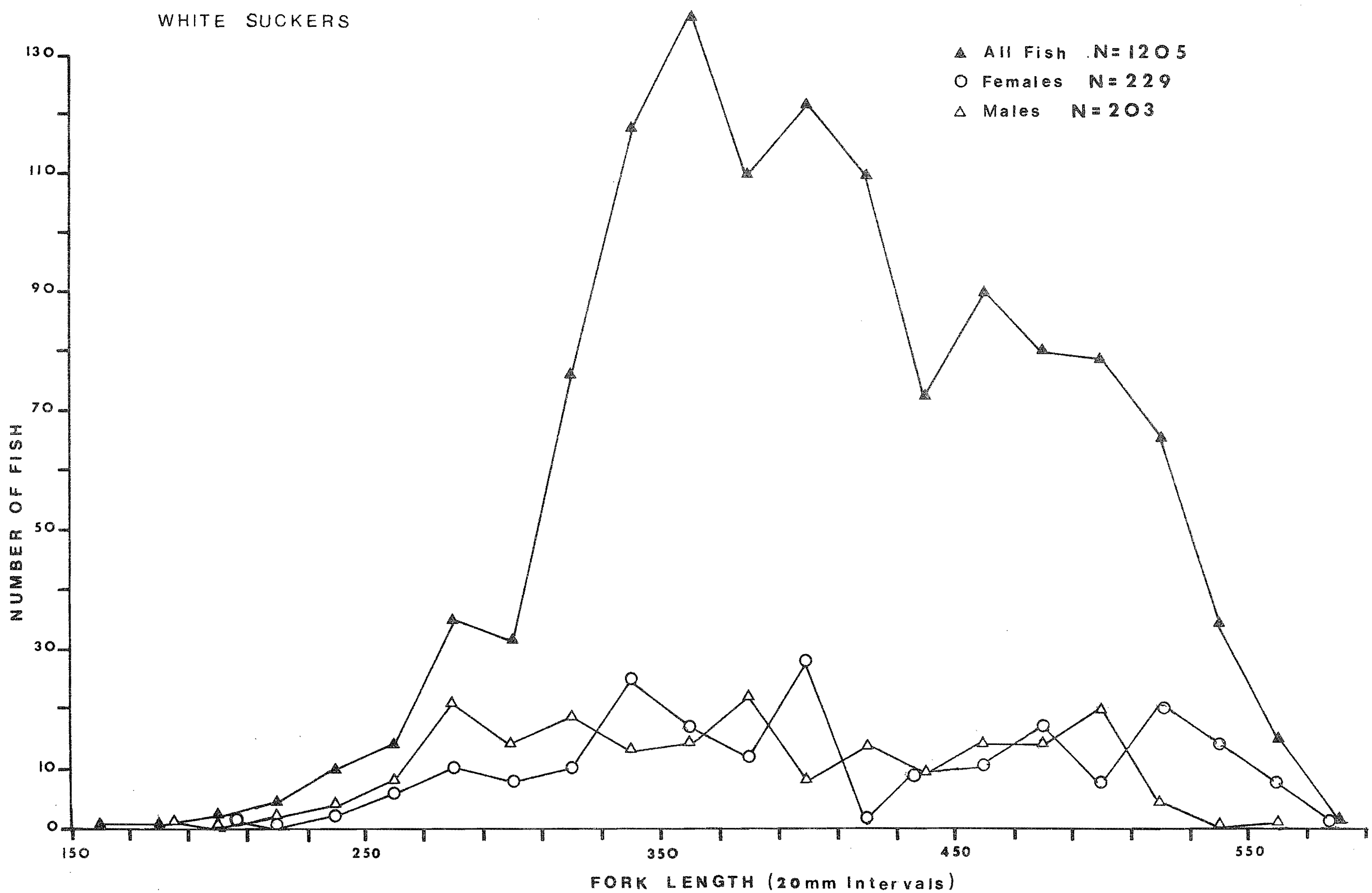


Figure 8. Length-frequency distribution for white suckers measured during counting fence operation.

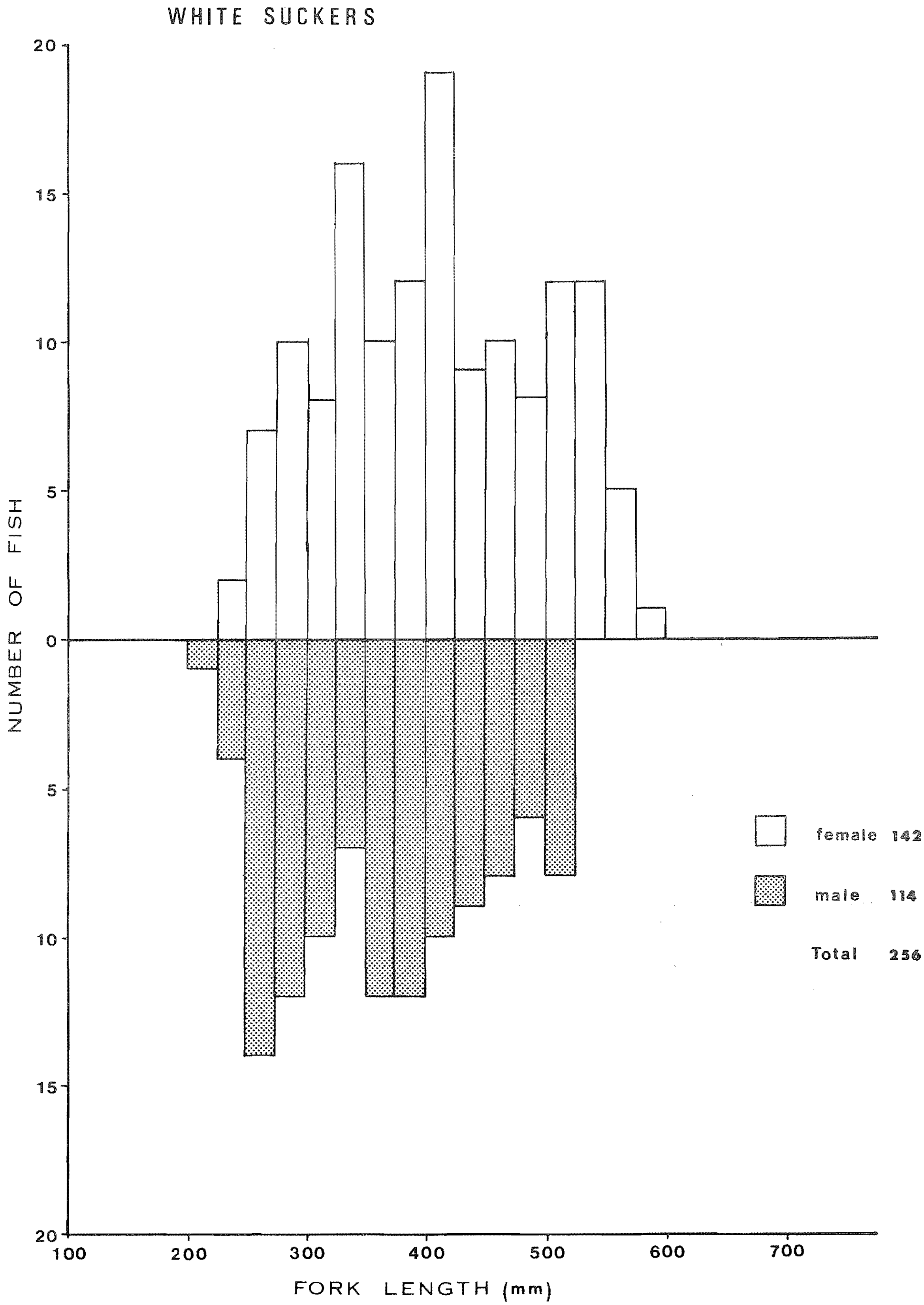


Figure 9. Length-frequency distribution for male and female white suckers during upstream migration.

Table 13. Length-frequency distribution of white suckers sampled and/or tagged during fence operations at the Muskeg River, 1976.

Fork Length (10 mm intervals)	Male	Female	Unknown	Fork Length (10 mm intervals)	Male	Female	Unknown
150 - 159			1	400 - 409	2	13	42
160 - 169				410 - 419	7	4	40
170 - 179	1			420 - 429	7	17	35
180 - 189				430 - 439	7	3	28
190 - 199				440 - 449	3	7	25
200 - 209		1	1	450 - 459	3	5	37
210 - 219	1		2	460 - 469	11	6	28
220 - 229	1			470 - 479	7	6	27
230 - 239	1	2		480 - 489	7	11	22
240 - 249	3		4	490 - 499	8	2	26
250 - 259	5	2		500 - 509	12	5	26
260 - 269	3	4		510 - 519	3	11	20
270 - 279	13	6	2	520 - 529	1	10	21
280 - 289	8	4	2	530 - 539		7	14
290 - 299	8	4	5	540 - 549		7	6
300 - 309	6	4	5	550 - 559	1	4	6
310 - 319	12	3	15	560 - 569		4	
320 - 329	7	7	32	570 - 579			
330 - 339	8	8	33	580 - 589		1	
340 - 349	5	17	47	590 - 599			
350 - 359	11	11	52				
360 - 369	3	6	49				
370 - 379	12	8	41	Totals	203	229	773
380 - 389	10	4	35				
390 - 399	6	15	44	Grand Total		1205	

5.4.1.9 Age composition of migrant white suckers. The age composition of the 1976 spawning run is shown in figure 10. The majority of fish in the sample (43%) were 4 or 5 years old. The oldest fish taken was a male, 17 years old. There was no indication in the data that females in this population live longer than males, a situation reported by many authors.

5.4.1.10 Sex ratio for migrant white suckers. Of 2372 white suckers for which sex was determined during the upstream migration, 1467 (62%) were females. This represents a significant deviation ($\chi^2 = 133.2$, $p < 0.001$) from the usual 1:1 ratio.

The sex ratio during the upstream run varied with time. The early portion of the run was dominated by males, the latter by females (Table 14).

The ratio of males to females in the descending run was not determined due to difficulties in sexing fish externally at that time.

5.4.1.11 Fecundity. Ovaries were removed from seven female white suckers in spawning condition and fecundity estimated gravimetrically. The estimated total number of eggs per female (size range 397 to 485 mm fork length) ranged from 21,402 to 51,221 (Table 15). Actual counts on four ovaries revealed errors of from +1.6% to -0.5% for the estimated values.

In 6 cases out of 7 the right ovary contained more eggs than did the left ovary (average 20,409; range 11,482-27,943 eggs).

Length-relative fecundity ranged from 539.1 to 1085.2 ova per cm of fork length while weight-relative fecundity varied from 24.9 to 41.1 eggs per g of body weight.

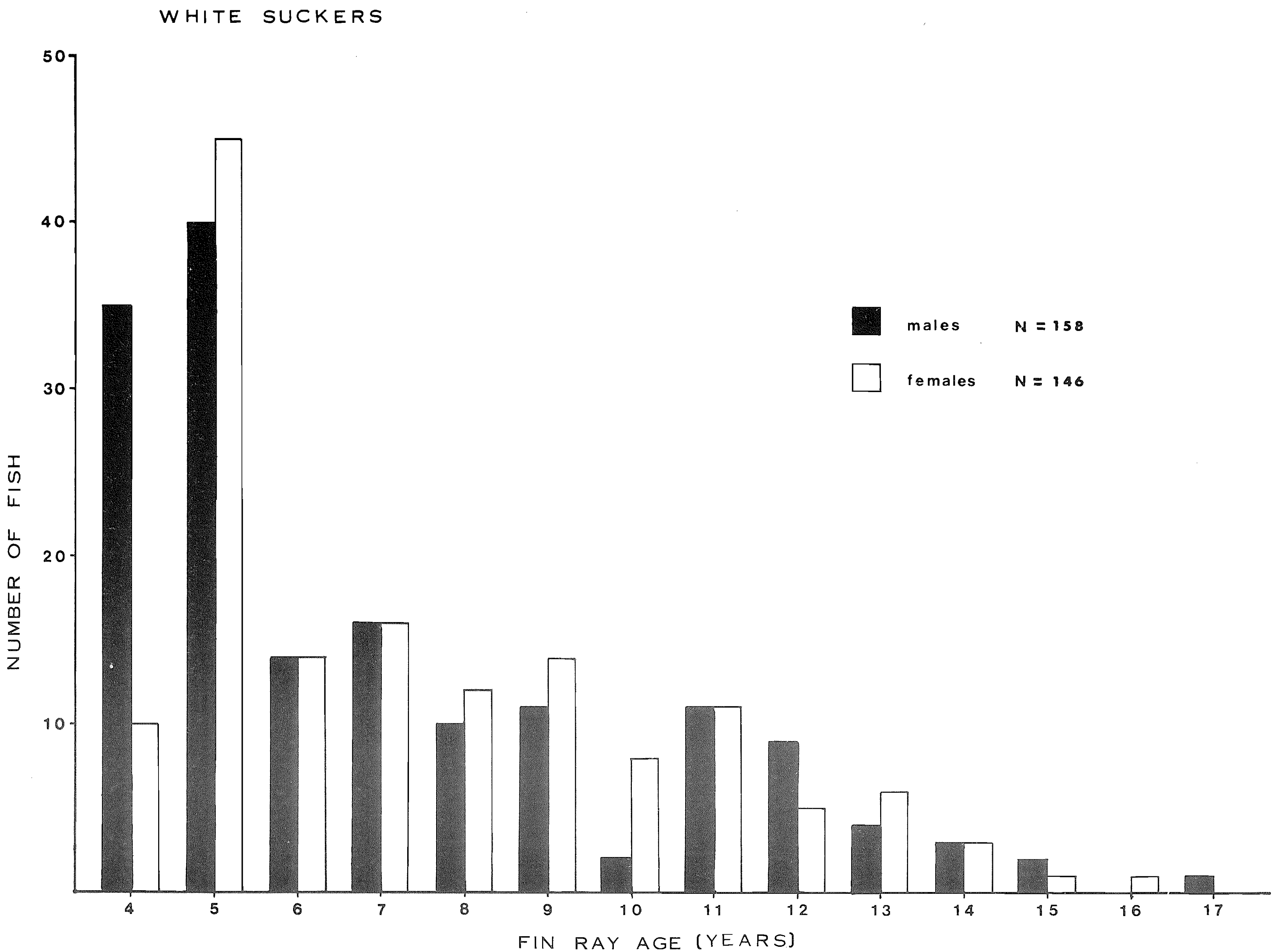


Figure 10. Age composition for white suckers sampled during counting fence operation.

Table 14. Sex ratio for white suckers during upstream migration, Muskeg River, 1976.

Date	Number of Fish: Males	Females	Unknown	Total	Percent Males*
April					
27	4			4	100
28	1		1	2	100
29	8	2	62	72	80
30	4	9	83	96	31
May 1			34	34	
2	4	1	5	10	80
3			4	4	
4	13	17	4	34	43
5			1	1	
6	46	23	-	69	67
7	390	303	4	697	56
8	88	175	7	270	33
9	179	361	21	561	33
10	68	273	66	407	20
11	39	135	29	203	22
12	29	72	11	112	29
13	17	46	30	93	27
14	9	22	4	35	29
15	4	22	2	28	15
16	2	6	14	22	25
17			14	14	
18			3	3	
19					
20					
21			8	8	
22			6	6	
23			9	9	
24			2	2	
25			4	4	
26			4	4	
27			1	1	
28			1	1	
29					
30					
31			2	2	
June 1-July 30			31	31	
Totals	905	1467	467	2839	

*Based on fish of known sex.

Table 15. Fecundity estimates of seven white suckers sampled during the 1976 spawning migration. Asterisks indicate actual egg counts and percentages in parenthesis the error deviation of estimated counts.

Fork Length (mm)	Weight (g)	Number of Eggs: Left Ovary	Number of Eggs: Right Ovary	Number of Eggs: Total	Relative Fecundity (cm)	Relative Fecundity (g)
466	1600	19,263	20,579	39,842	854.9	24.9
427	950	17,474	18,000	35,474	830.8	37.3
426	950	19,900	19,122* (+1.4%)	39,022	916.0	41.1
485	1840	22,226* (-0.5%)	22,615* (+1.6%)	44,841	924.6	24.4
460	1600	20,008* (+0.9%)	21,833	41,841	909.6	26.2
397	800	9,920	11,482	21,402	539.1	26.8
472	1740	23,278	27,943	51,221	1085.2	29.4

Regression analysis indicated a significant ($p < 0.01$), positive correlation between fecundity and fork length ($n = 7$; $r = 0.877$). The relationship between fecundity and fork length is expressed by the equation:

$$\log_{10} \text{Fecundity} = 3.408 \log_{10} \text{Fork Length (mm)} - 4.451$$

5.4.1.12 Age and growth. Growth in fork length proceeded at a constant rate until approximately age 10 at which age white suckers had a mean length of 485 mm (Fig. 11, Table 16). After age 10 little increase in length occurred.

Females were generally longer than males of the same age but the difference was not significant (Student's t test) except for age 14 fish (Table 16).

White suckers gained weight very slowly during the first three years of life, then rapidly up to age 10 (Fig. 12, Table 17). Although females were generally heavier than males of the same age, the weight difference was not significant (Table 17).

5.4.1.13 Sex and maturity. Of 310 white suckers aged and sexed, 53% were males (Table 18). The number of males exceeded that of females in age groups 2 to 4, 15 and 17. The sexes were equally represented in age groups 6, 7, 11 and 14 and females outnumbered males in age groups 5, 8, 9, 10, 13 and 16.

The earliest age of sexual maturity was 3 years for male white suckers and 4 years for females (Table 18). All fish were mature by age 10 although a few immature fish were recorded at older ages. The presence of such fish may indicate that some white suckers do not spawn every year.

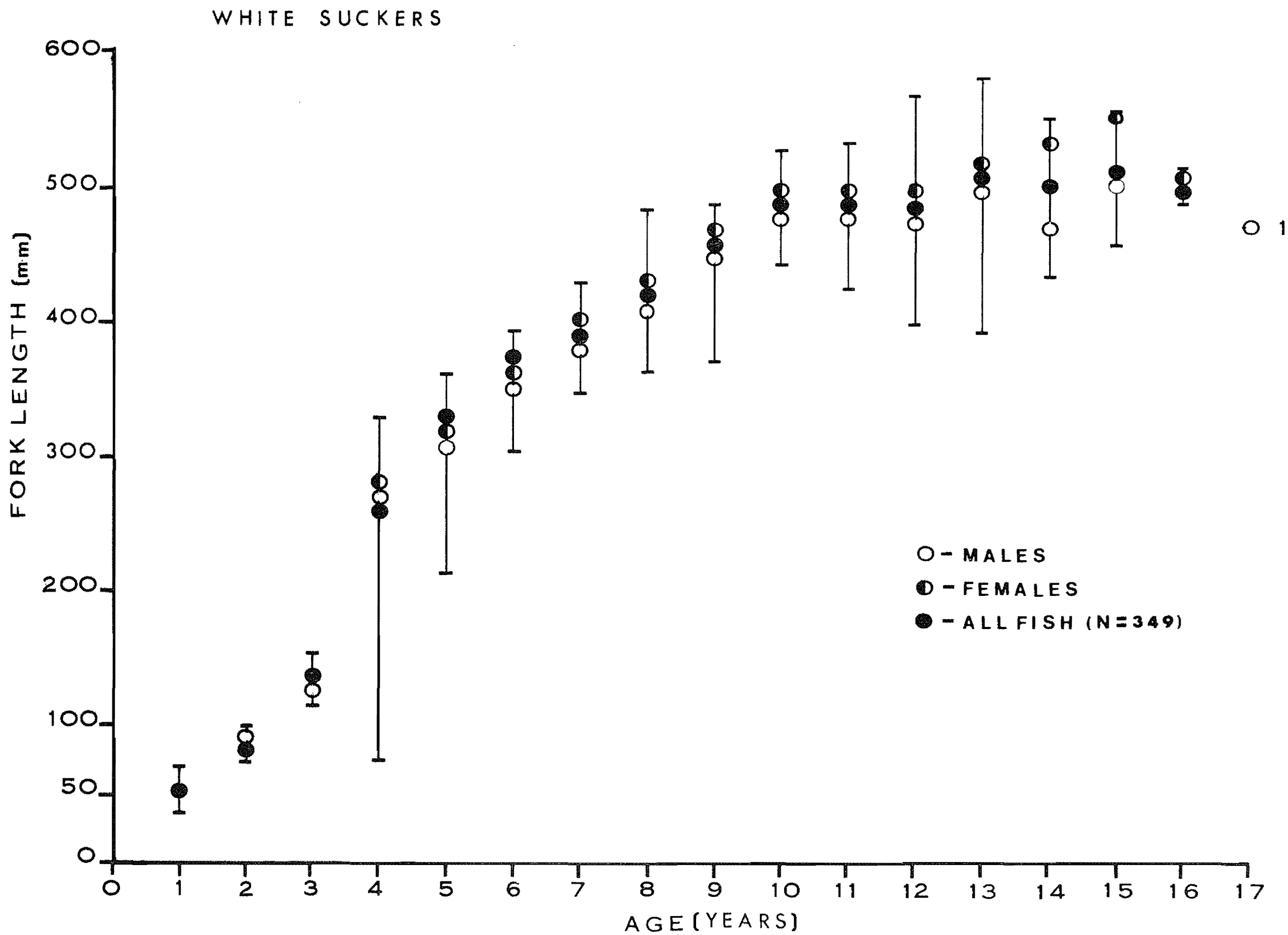


Figure 11. Age-length relationship for white suckers from the Muskeg River watershed, 1976.

TABLE 16. Age-length relationship (derived from fin rays and otoliths) for white suckers captured in the Muskeg River and Hartley Creek, 1976, sexes separate and combined sample (includes unsexed fish). Differences in mean length at each age for males and females were tested for significance using Student's t-test. Asterisk indicates a significant difference in means ($P < 0.05$).

Age	Males				Females				All Fish				t-test
	N	Mean	S.D.	Range	N	Mean	S.D.	Range	N	Mean	S.D.	Range	
1									14	53.00	10.91	36-69	-
2	2	96.00	1.41	95-97	0				3	91.00	8.72	81-97	-
3	3	132.33	14.15	116-141	1	129.00			5	136.20	14.58	116-155	-
4	35	261.40	28.68	77.6-303	10	271.30	45.89	99.8-330	48	260.98	33.66	77.6-330	0.84
5	40	314.75	21.91	259-357	45	314.76	33.23	239-364	91	315.20	17.75	213-364	0.002
6	14	357.79	21.18	308-382	14	367.93	17.14	339-393	32	362.06	19.03	308-395	1.39
7	16	392.13	21.32	350-421	16	396.63	17.46	354-432	35	395.66	19.89	350-432	0.12
8	10	411.50	37.21	367-465	12	420.50	33.21	365-485	26	416.89	20.42	365-485	0.60
9	11	456.10	40.33	374-491	14	460.79	24.18	420-486	25	458.72	31.62	374-491	0.37
10	2	483.50	36.06	458-509	8	491.13	25.69	145-531	10	485.60	25.61	445-531	0.36
11	11	482.27	14.64	465-504	11	491.27	34.16	427-532	23	488.22	26.38	427-532	0.80
12	9	477.56	34.58	400-505	5	501.40	65.38	423-569	15	483.00	46.66	400-569	0.90
13	4	507.25	15.90	490-528	6	516.83	65.77	394-587	10	513.00	50.12	394-587	0.28
14	3	474.33	32.35	438-500	3	537.33	16.17	520-552	6	505.83	41.40	438-552	3.02*
15	2	506.00	65.05	460-552	1	560.00			3	524.00	55.57	460-560	-
16	0				1	519.00			2	505.00	19.80	491-519	-
17	1	475.00							1	475.00			
Totals	163				147				349				

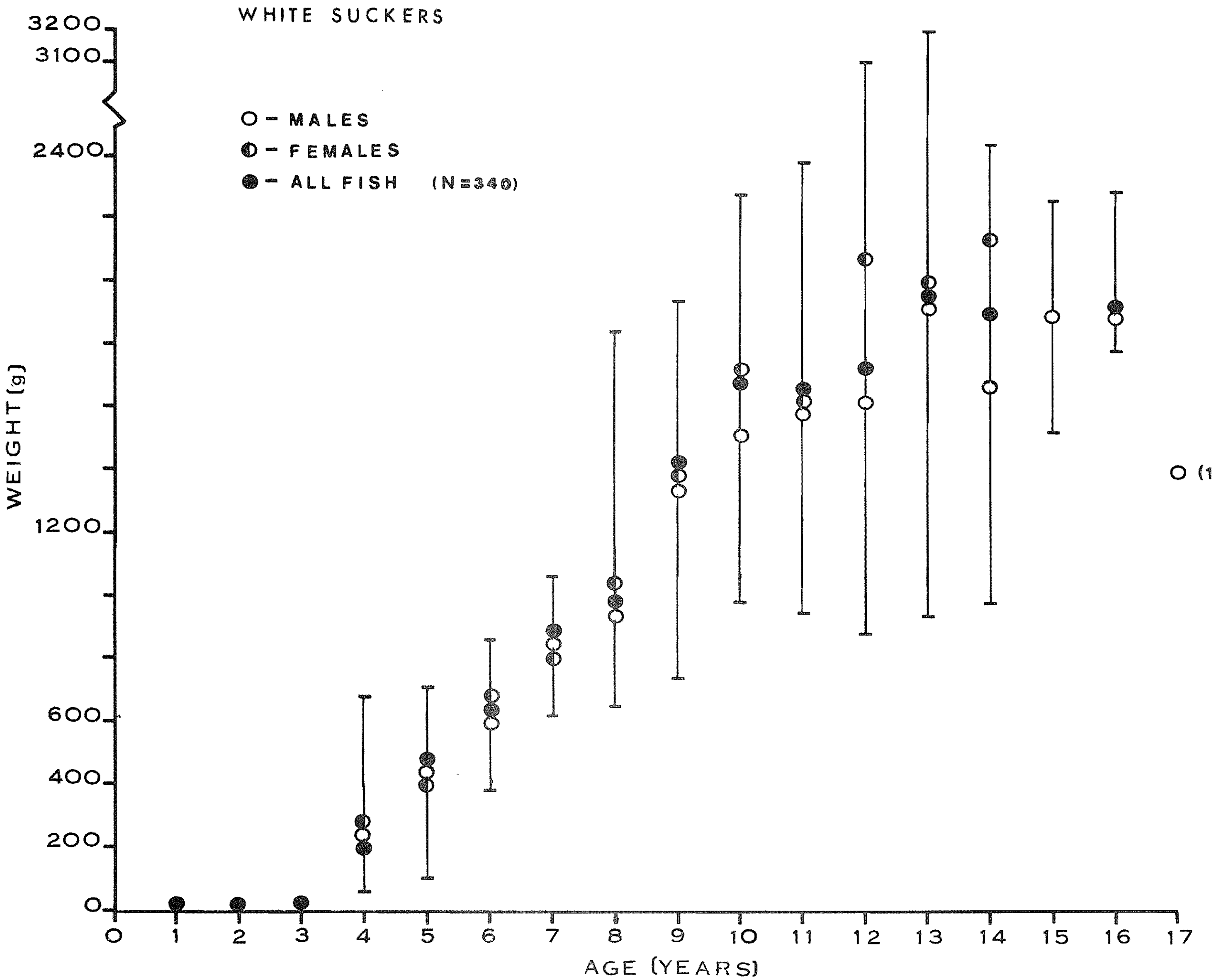


Figure 12. Age-weight relationship for white suckers from the Muskeg River watershed, 1976.

TABLE 17. Age-weight relationship for white suckers captured in the Muskeg River and Hartley Creek, 1976, sexes separate and combined sample (includes unsexed fish). Differences in mean weight at each age for males and females were tested for significance using Student's t-test.

Age	Males				Females				All Fish				t-test
	N	Mean	S.D.	Range	N	Mean	S.D.	Range	N	Mean	S.D.	Range	
1									14	2.56	2.00	.55-7.5	-
2	2	10.35	0.07	10.3-10.4					3	9.67	1.18	8.3-10.4	-
3	3	28.63	11.50	17-40	1	22.8	-	-	5	25.00	2.23	17-40	-
4	35	234.79	70.09	60-350	10	275.98	142.48	99.8-580	48	236.61	92.93	60-580	1.27
5	37	410.81	83.75	240-590	44	407.27	139.47	150-640	87	414.14	20.35	100-710	0.16
6	14	605.71	125.98	380-780	14	634.29	66.07	550-820	31	631.94	25.14	380-860	0.75
7	15	834.00	195.55	620-1160	15	828.67	101.20	640-1060	32	836.88	28.93	620-1160	0.09
8	10	955.00	269.83	650-1460	12	1050.00	362.57	680-1840	26	988.85	31.45	650-1840	0.69
9	11	1343.64	515.45	750-1940	14	1395.00	265.15	950-1800	25	1412.40	335.55	750-1940	0.32
10	2	1510.00	14.14	1500-1520	8	1722.50	365.11	980-2280	10	1680.00	334.27	980-2280	1.30
11	11	1592.73	206.40	1320-2000	11	1615.46	464.87	950-2380	23	1627.00	360.85	950-2380	0.15
12	9	1616.67	40.21	980-2100	5	2076.00	879.71	880-3100	15	1739.33	611.58	880-3100	1.62
13	4	1927.50	354.53	1440-2280	6	1993.33	991.38	940-3200	10	1967.00	767.51	940-3200	0.12
14	3	1660.00	597.33	980-2100	3	2143.33	270.25	1940-2450	6	1901.67	491.95	980-2450	1.28
15	2	1890.00	523.26	1520-2260					2	1890.00	523.26	1520-2260	-
16	0				1	2280.00	-	-	2	2030.00	353.55	1780-2280	-
17	1	1400.00	-	-					1	1400.00	-	-	-
Totals	159				144				340				

Table 18. Age specific sex ratios and maturity for white suckers from the Muskeg River watershed, 1976. Sex ratios were based only on fish for which sex was determined. Maturity data included fish which would either spawn in the year of capture or had spawned previously.

Age	Females N	Females %	Females % Mature	Males N	Males %	Males % Mature	Unsexed Fish	Total
1	0	-	-	0	-	-	14	14
2	0	-	-	2	100	0	1	3
3	1	25	0	3	75	33	1	5
4	10	29	43	35	71	76	3	48
5	45	46	36	40	44	35	6	91
6	14	50	36	14	50	53	4	32
7	16	50	50	16	50	50	3	35
8	12	55	75	10	45	70	4	26
9	14	56	79	11	44	100	0	25
10	8	80	100	2	20	100	0	10
11	11	50	91	11	50	100	1	23
12	5	36	100	9	64	89	1	15
13	6	60	100	4	40	100	0	10
14	3	50	67	3	50	100	0	6
15	1	33	100	2	67	100	0	3
16	1	100	100	0	-	-	1	2
17	0	-	-	1	100	100	0	1
Totals	147	47		163	53		39	349

5.4.1.14 Length-weight relationship. The following length-weight relationships were determined from white suckers captured during the counting fence operation. Both upstream and downstream fish were included.

For male white suckers ($n = 149$, $r = 0.992$, range 175-504 mm) the relationship between fork length and body weight is described by the equation:

$$\log_{10} W = 3.2052 (\log_{10} L) - 5.3962; \; sb = 0.0346$$

For female white suckers ($n = 141$, $r = 0.971$, range 209-587 mm) the length-weight relationship is expressed by the equation:

$$\log_{10} W = 3.2427 (\log_{10} L) - 5.5048; \; sb = 0.0539$$

Analysis of covariance indicated a significant difference ($p < 0.05$) between adjusted means ($F = 3.6136$), but not the slopes ($F = 0.3597$) of the length-weight relationships of male and female white suckers.

5.4.1.15 Growth of young-of-the-year. The spawning period for white suckers in 1976 was the first two weeks of May. Although it is not certain when the young-of-the-year emerged from the gravel it is likely that this event commenced between the last week of May and the first week of June.

At hatching, larval white suckers usually have a mean length of approximately 10 mm and begin their downstream movement at about 12 mm.

By mid-June, 1976, sucker fry were abundant throughout the lower reaches of the Muskeg River and Hartley Creek. Most of these fry had a modal length of 18 mm at this time and ranged in length from 14 to 31 mm (Fig. 13). While it was not possible to

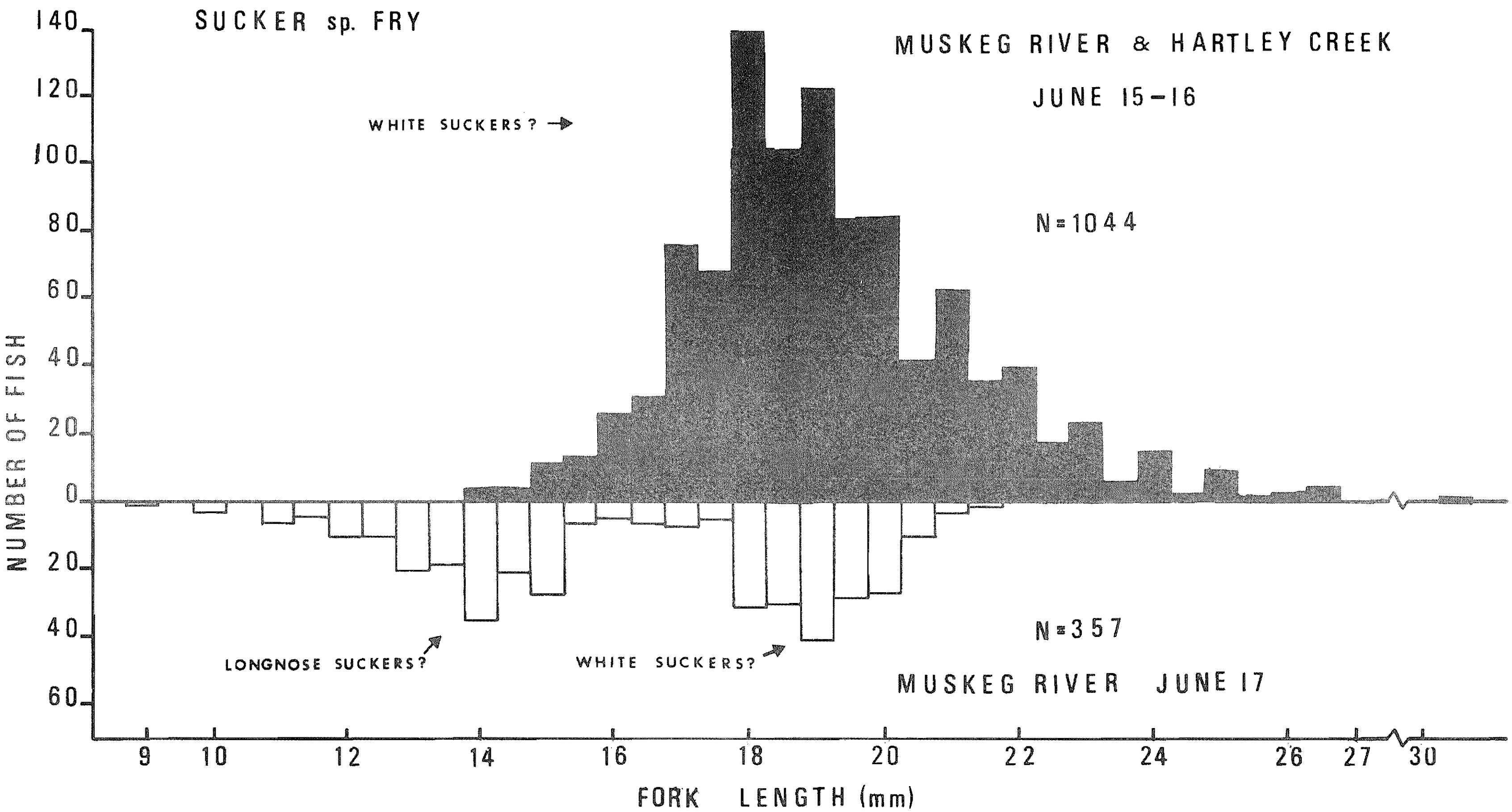


Figure 13. Length-frequency distribution for young-of-the-year suckers captured in the Muskeg River and Hartley Creek, June 15-17, 1976.

state for sure what percentage of these fry were white suckers and what percentage were longnose suckers it seems likely that the majority were white suckers. Longnose sucker fry are usually smaller than white suckers at this stage as suggested in the lower portion of figure 13. We interpret the two modes in this figure as representing the two species of suckers.

By early July, young-of-the-year white suckers showed a mean fork length of 34 mm (Range 26-38). Fork length increased to 44 mm (Range 24-56) by early August and a sample taken in September averaged 44 mm (Range 32-57) in length (Table 19), indicating a slowing down of growth rate in late summer.

5.4.1.16 Food habits. Time limitations precluded an analysis of the food habits of young suckers in the Muskeg River. Field analysis of sucker stomachs during the spawning period indicated that migrant fish were not feeding at that time. Of 270 sucker stomachs observed, 97% were empty. The remainder contained only traces of food (insects and vegetable matter).

5.4.2 Longnose suckers

5.4.2.1 Seasonal timing of upstream migration. The seasonal pattern of the 1976 upstream migration of longnose suckers into the Muskeg River is shown in Figure 14 and Table 9.

Longnose sucker spawning migrations appear to be initiated by increasing water temperatures and often begin when the daily maximum water temperature approaches 5C (Geen et al. 1966).

At the time of fence installation in 1976, the daily maximum water temperature was already at 9.5C and it appeared that the spawning migration was well under way as 68 longnose suckers passed upstream on 28 April. The run probably commenced several days prior to this date.

Table 19. Comparison of mean fork lengths (mm) and mean weights (g) of young-of-the-year and juvenile suckers collected from the Muskeg River, Hartley and Kearl creeks, 1976. Numbers in parenthesis indicate ranges and those in brackets, original sample sizes.

Species/Age Location	Date	N	Mean Fork Length (mm) ± Std. Dev.	Mean Weight (g) ± Std. Dev.
Longnose sucker				
Age 0+ Muskeg River	4/8/76	1	38	0.55
	11/9/76	8	45.8 ± 6.1 (36 - 56)	1.08 ± 0.49 (0.45 - 1.95)
Age 1+ Hartley Creek	16/6/76	2	50.0 ± 1.3 (45 - 55)	1.25 ± 0.64 (0.80 - 1.70)
White sucker				
Age 0+ Muskeg River	7/7/76	18[58]	33.9 ± 3.2 (26 - 38)	0.43 ± 0.13 (0.20 - 0.65)
	4/8/76	80	43.9 ± 6.3 (24 - 56)	0.95 ± 0.41 (0.30 - 1.90)
	10-11/9/76	73	43.5 ± 6.1 (32 - 57)	0.91 ± 0.40 (0.40 - 1.90)
Age 1+ Muskeg River	15/6/76	1	62	2.50
	4/8/76	1	68	2.45
Hartley Creek	16-21/6/76	12	51.0 ± 10.4 (36 - 69)	2.08 ± 1.54 (0.60 - 5.10)
Kearl Creek	21/6/76	60[129]	40.7 ± 3.2 (34 - 51)	0.80 ± 0.22 (0.45 - 1.50)

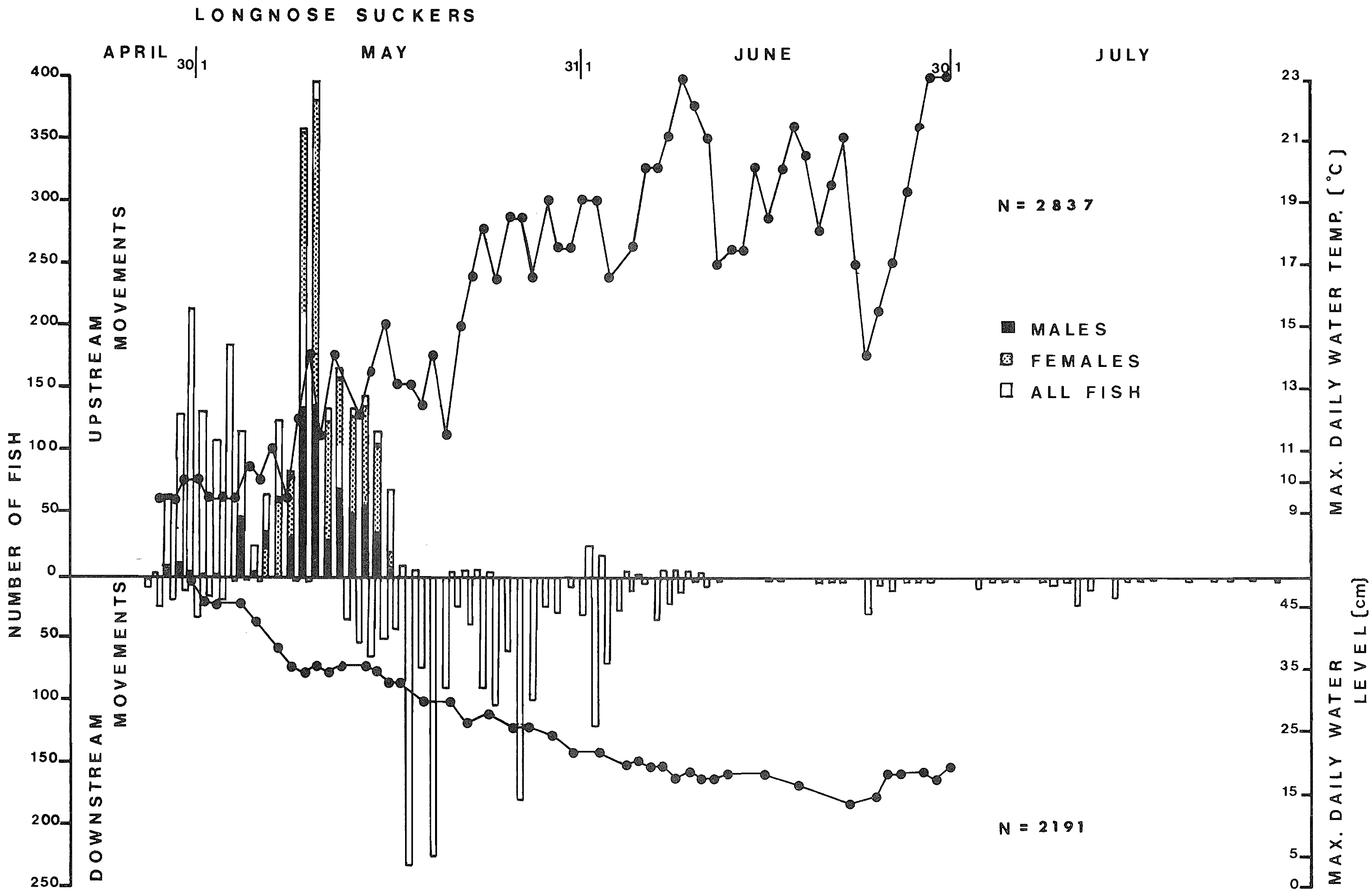


Figure 14. Seasonal timing of longnose sucker migration, 1976.

The portion of the spawning run monitored in 1976 had a bimodal character (Fig. 14 and Table 9) with peak counts occurring on 30 April (n = 213) and again on 10 May (n = 398). Although the sex of most fish was not assessed during the first few days of operation it is likely that the first mode consisted largely of male fish. The second mode, on the other hand (May 5-15) was dominated by females (59.7%). The upstream migration continued until 16 May.

5.4.2.2 Diel timing of upstream migration. The majority of spawners (76%) moved upstream between 1500 and 2400 hours with a maximum in the evening hours (Table 20). Maximum upstream movement appeared to occur each day just following the time of highest water temperature.

5.4.2.3 Spawning period. The spawning period of longnose suckers lasted at least two weeks in 1976. The first ripe female was captured on 27 April and the first ripe male was taken 28 April (Table 21).

The first spent male was caught 1 May while the first spent female was reported on 9 May at the downstream trap. By 20 May all fish taken were spawned out (Table 21).

5.4.2.4 Spawning areas and behaviour. Although the spawning act itself was not observed in 1976 numerous fish were observed in spawning colouration. On 3 May, a fish fitting the description of a male longnose sucker in spawning colours was observed in Hartley Creek (Dr. R. Hartland-Rowe, pers. comm.).

Since the specific spawning requirements of longnose suckers are similar to those of white suckers spawning probably

Table 20. Summary of diel timing of the upstream migration of longnose suckers in the Muskeg River, 1976. Fish which were counted at times other than those indicated were included in the next check period. Asterisks indicate times not checked.

	Time Checks							
Date	0300	0900	1200	1500	1800	2100	2400	Number of Fish
April 27	*	*	*	*	*	1	*	1
28	*	*	*	-	-	65	-	65
29	-	13	-	-	4	113	1	130
30	*	37	-	-	98	-	78	213
May 1	*	17	-	-	68	-	47	132
2	*	3	-	-	6	-	100	109
3	*	7	-	-	86	15	78	186
4	*	16	-	-	35	2	64	117
5	*	1	-	-	15	4	1	21
6	*	-	-	-	65	-	-	65
7	8	-	-	9	46	3	58	124
8	51	8	-	-	*	*	20	79
9	8	-	10	6	72	114	149	359
10	35	58	1	48	103	72	81	398
11	50	5	1	12	Trap closed		66	134
12	3	4	-	73	2	82	Trap closed	164
13	21	15	-	11	22	-	64	133
14	11	2	-	84	-	14	33	144
15	1	17	1	1	38	14	44	116
16	3	1	-	-	8	-	56	68
17	4	4	-	-	-	-	1	9
18	-	1	-	2	1	-	-	4
19	-	-	-	-	-	-	-	0
20	-	*	-	-	-	-	-	0
21	2	-	1	-	-	-	-	3
22	-	-	-	3	-	-	1	4
23	2	-	-	-	-	-	1	3
24	-	-	-	1	-	-	-	1
25	-	-	-	-	-	-	-	0
26			No movements					
27				to end				
28				of May				
Totals	199	209	14	250	669	499	942	2782
% Grand Total	7%	8%	1%	9%	24%	18%	34%	

Table 21. Condition of spawning longnose suckers sampled during the Muskeg River run 1976. Spawning conditions were determined by dissection.

	Spawning Condition-Females				Spawning Condition-Males			
Date	N	% Mature	% Ripe	% Spent	N	% Mature	% Ripe	% Spent
April								
27	1		100					
28	7	71	29		6	50	50	
29	2		100		8		100	
30	7		100		8	12	88	
May 1	8	63	37		3	33	33	33
2					1		100	
3	4		100		4		100	
4	8	25	75		5		100	
6	1	100			5		100	
9	7	71		29	3	100		
11	2	50	50		3		100	
12	1		100		3		100	
13	2	50	50		1	100		
14	1			100	2		100	
15	3		33	67	2		50	50
16					2	50	50	
17	4		25	75	2			100
20	2			100	5			100
22	4			100	1			100
Totals	64				64			

occurred in the same general areas for both species although perhaps somewhat earlier in the season for longnose suckers.

5.4.2.5 Return of spawners. The seasonal pattern of the downstream movement of longnose suckers in 1976 is shown in figure 13. The main downstream movement of spent fish started at least 18 days after the spawning migration began (Table 9).

The highest count of downstream fish (n = 232) was made on 20 May (Table 9 and Fig. 14) and while suckers continued to trickle downstream through 30 July, the majority (66.9%) had passed the downstream trap by 30 May. This percentage was higher in reality since suckers caught in the downstream trap between 28 April and 4 May were upstream fish that had drifted into the downstream trap after passing through the upstream trap.

Diel timing of the downstream movement of spent longnose suckers is summarized in Table 22. The majority of downstream fish were captured between 0900 and 1800 hours (50%) with 41% being taken between 2100 and 0300 hours. The maximum downstream movement of longnose suckers occurred each day during the period of highest water temperature.

5.4.2.6 Length of time on spawning grounds. The length of time spent by individual longnose suckers on the spawning grounds was determined from fish tagged going upstream and recaptured passing through the downstream trap. The actual time varied greatly from 2 to 87 days although the majority of fish (81.6%) returned downstream within 29 days (Fig. 15).

5.4.2.7 Spawning mortality. Between 18 June and 30 July, a total of 63 longnose suckers were found dead in the Muskeg River.

Table 22. Summary of diel timing of the downstream movement of longnose suckers in the Muskeg River, 1976. Fish which were counted at times other than those indicated were included in the next check period. Asterisks indicate times not checked.

Date	Time Checks 0300	0900	1200	1500	1800	2100	2400	Number of fish
April 28	*	*	*	*	*	9	*	9
29	4	*	*	1	2	13	5	25
30	*	3	-	2	5	-	9	19
May 1	*	2	-	-	-	2	9	13
2	*	4	1	-	*	-	28	33
3	*	2	-	-	7	5	3	17
4	*	1	-	-	8	-	16	25
5	*	2	-	-	1	-	-	3
6	*	-	-	-	-	1	1	2
7	4	-	Downstream trap closed	Downstream trap closed	Downstream trap closed	Downstream trap closed	Downstream trap closed	4
8	Downstream trap closed	Downstream trap closed	Downstream trap closed	Downstream trap closed	Downstream trap closed	Downstream trap closed	Downstream trap closed	0
9	Downstream trap closed	Downstream trap closed	Downstream trap closed	Downstream trap closed	Downstream trap closed	Downstream trap closed	Downstream trap closed	0
10	Downstream trap closed	Downstream trap closed	Downstream trap closed	Downstream trap closed	Downstream trap closed	Downstream trap closed	Downstream trap closed	0
11	Downstream trap closed	3	Downstream trap closed	Downstream trap closed	Downstream trap closed	Downstream trap closed	Downstream trap closed	3
12	Downstream trap closed	1	Downstream trap closed	Downstream trap closed	Downstream trap closed	Downstream trap closed	Downstream trap closed	1
13	Downstream trap closed	Downstream trap closed	Downstream trap closed	Downstream trap closed	Downstream trap closed	Downstream trap closed	Downstream trap closed	0
14	Downstream trap closed	Downstream trap closed	Downstream trap closed	Downstream trap closed	Downstream trap closed	Downstream trap closed	Downstream trap closed	0
15	-	7	-	-	-	-	21	28
16	33	1	-	2	-	4	13	53
17	19	-	-	-	-	-	46	65
18	13	4	-	1	18	5	10	51
19	9	-	-	-	17	4	13	43
20	25	*	3	9	124	29	42	232
21	20	*	-	1	-	32	22	75
22	16	*	56	119	5	4	24	224
23	5	*	14	65	5	-	1	90
24	1	*	4	14	-	-	6	25
25	14	*	*	3	2	5	15	39
26	4	*	4	24	33	3	23	91
27	15	*	23	14	19	4	30	105
28	27	*	*	16	7	12	Trap closed	62
29	20	*	3	54	16	16	70	179
30	9	*	43	14	14	4	16	100
31	4	*	*	21	-	-	Trapclosed	25
June 1	4	*	*	14	4	1	7	30
2	5	*	*	-	-	-	-	5
3	*	*	-	29	3	-	-	32
4	*	*	32	13	9	-	68	122
5	7	*	54	2	-	-	8	71
Totals	258	30	237	418	299	153	506	1901
% Grand Total	14%	2%	12%	22%	16%	8%	27%	

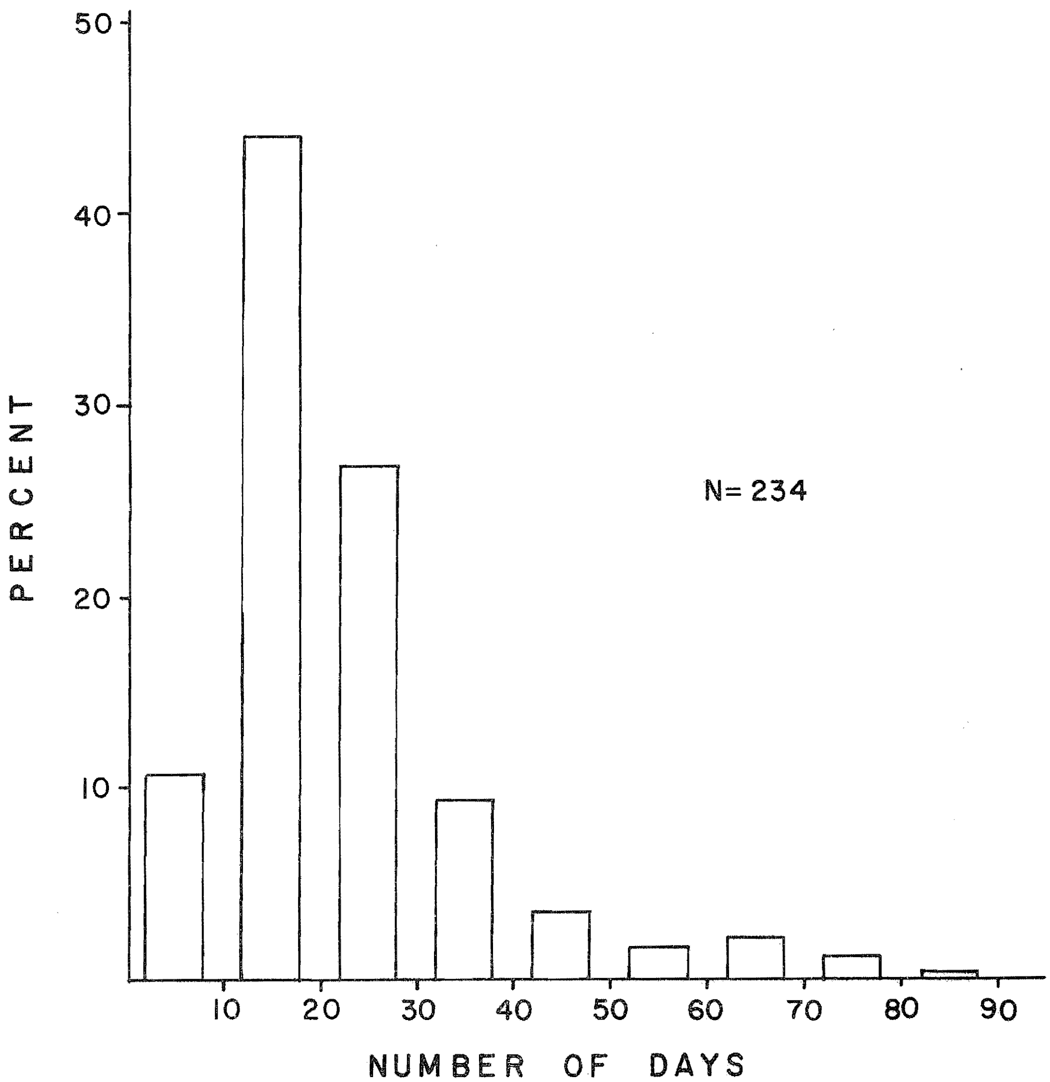


Figure 15. Number of days spent in Muskeg River by individual longnose suckers.

Natural spawning mortality among longnose suckers usually runs about 10-25% (Scott and Crossman 1973).

5.4.2.8 Size composition of migrant longnose suckers. During the 1976 counting fence operation fork lengths were determined for 1440 longnose suckers of which sex was determined in 459 cases (Table 23 and Fig. 16). Migrant suckers ranged in length from 130 mm to 487 mm and in weight from 20 to 1350 g. The length-frequency polygon (Fig. 16) demonstrated a strong single mode containing fish between 340 and 459 mm. Of the total sample, 89.8% fell within this length range.

Considering only the upstream migration, female longnose suckers tended to be larger than the males (Fig. 17). Females had a mean fork length of 395 mm (Range 277-468 mm) while males showed a mean length of 371 mm (Range 192-487 mm).

5.4.2.9 Age composition of migrant longnose suckers. The age composition of the 1976 spawning run is shown in Figure 18. Age determinations from fin rays showed that migrating longnose suckers ranged in age from 4 to 13 years with age groups 7 to 11 comprising 85% of the total. All fish less than 7 years old were sexually immature.

5.4.2.10 Sex ratio for migrant longnose suckers. Of 1815 longnose suckers for which sex was determined during the upstream migration, 1050 (58%) were females. This represents a significant deviation ($X^2 = 44.75$, $p < 0.01$) from the usually observed 1:1 ratio. The actual sex ratio may have been closer to unity than observed since the first few days of the upstream migration were probably missed. This portion of the run may have been dominated by males just as the latter portion was dominated by females (Table 24).

Table 23. Length-frequency distribution of longnose suckers sampled and/or tagged during fence operations at the Muskeg River, 1976.

Fork Length (10 mm intervals)	Male	Female	Unknown	Fork Length (10 mm intervals)	Male	Female	Unknown
120 - 129			1	330 - 339	5	6	34
130 - 139			1	340 - 349	15	6	42
140 - 149			3	350 - 359	26	9	71
150 - 159				360 - 369	39	20	128
160 - 169				370 - 379	49	23	129
170 - 179			2	380 - 389	34	29	135
180 - 189	1		1	390 - 399	25	30	120
190 - 199			1	400 - 409	16	26	103
200 - 209				410 - 419	6	29	61
210 - 219		1		420 - 429	1	25	55
220 - 229	1			430 - 439	2	15	25
230 - 239	1			440 - 449	1	7	17
240 - 249			4	450 - 459		4	9
250 - 259			1	460 - 469		1	2
260 - 269				470 - 479			
270 - 279	1	1	2	480 - 489	1		1
280 - 289			1				
290 - 299			1	Totals	225	234	981
300 - 309			3				
310 - 319	1		11	Grand Total		1440	
320 - 329		2	17				

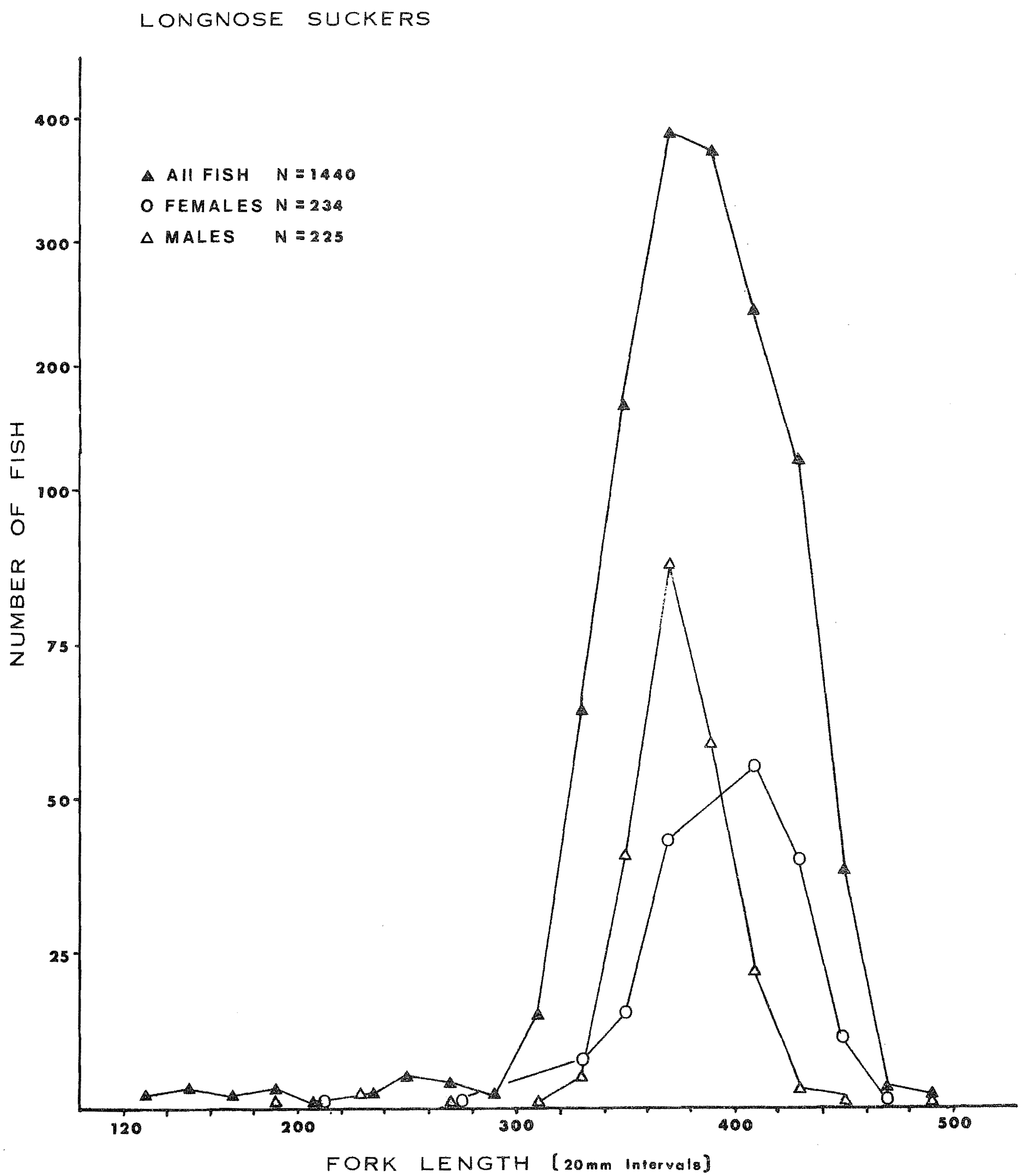


Figure 16. Length-frequency distribution for longnose suckers measured during counting fence operation.

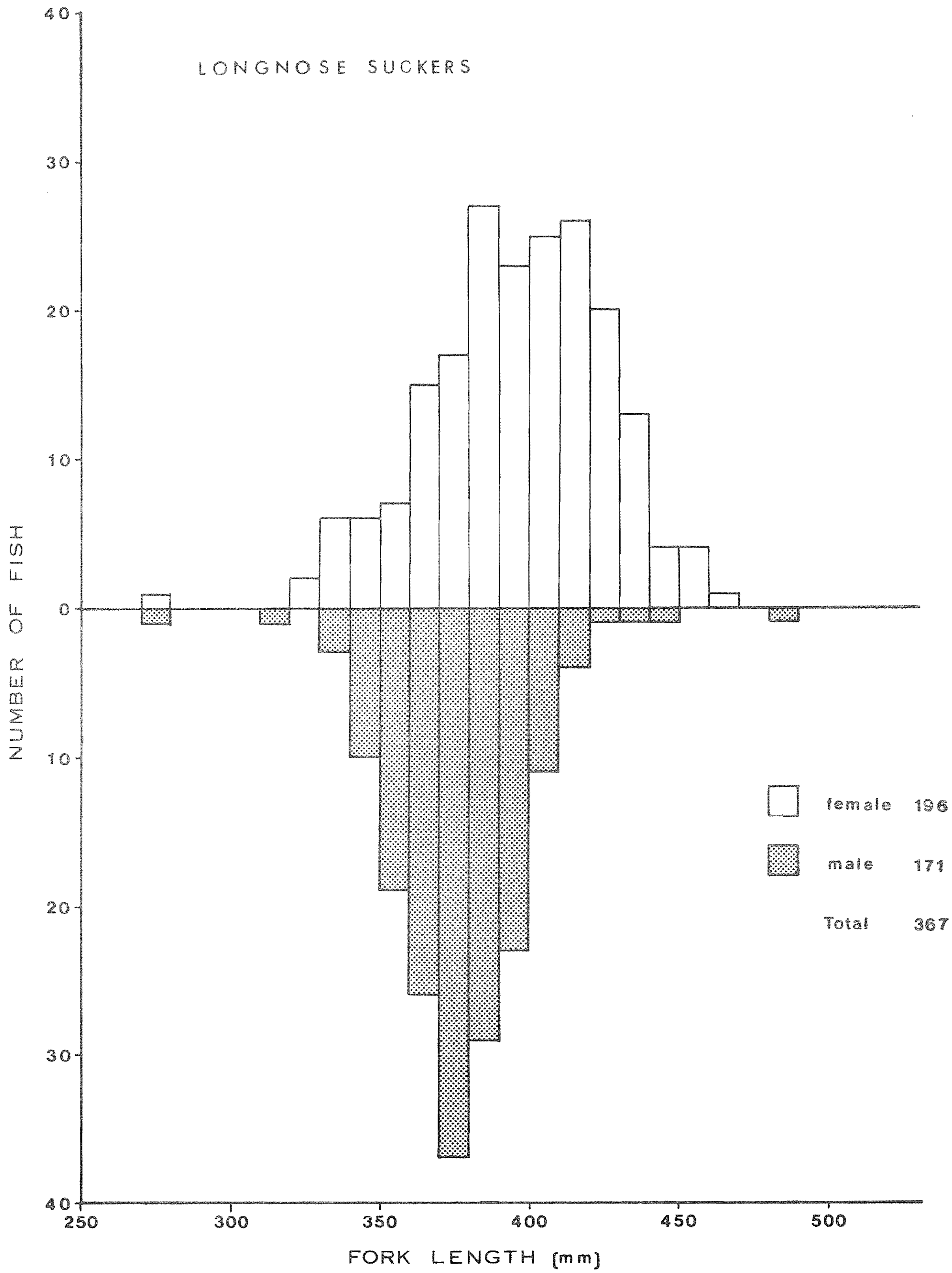


Figure 17. Length-frequency distribution for male and female longnose suckers during upstream migration.

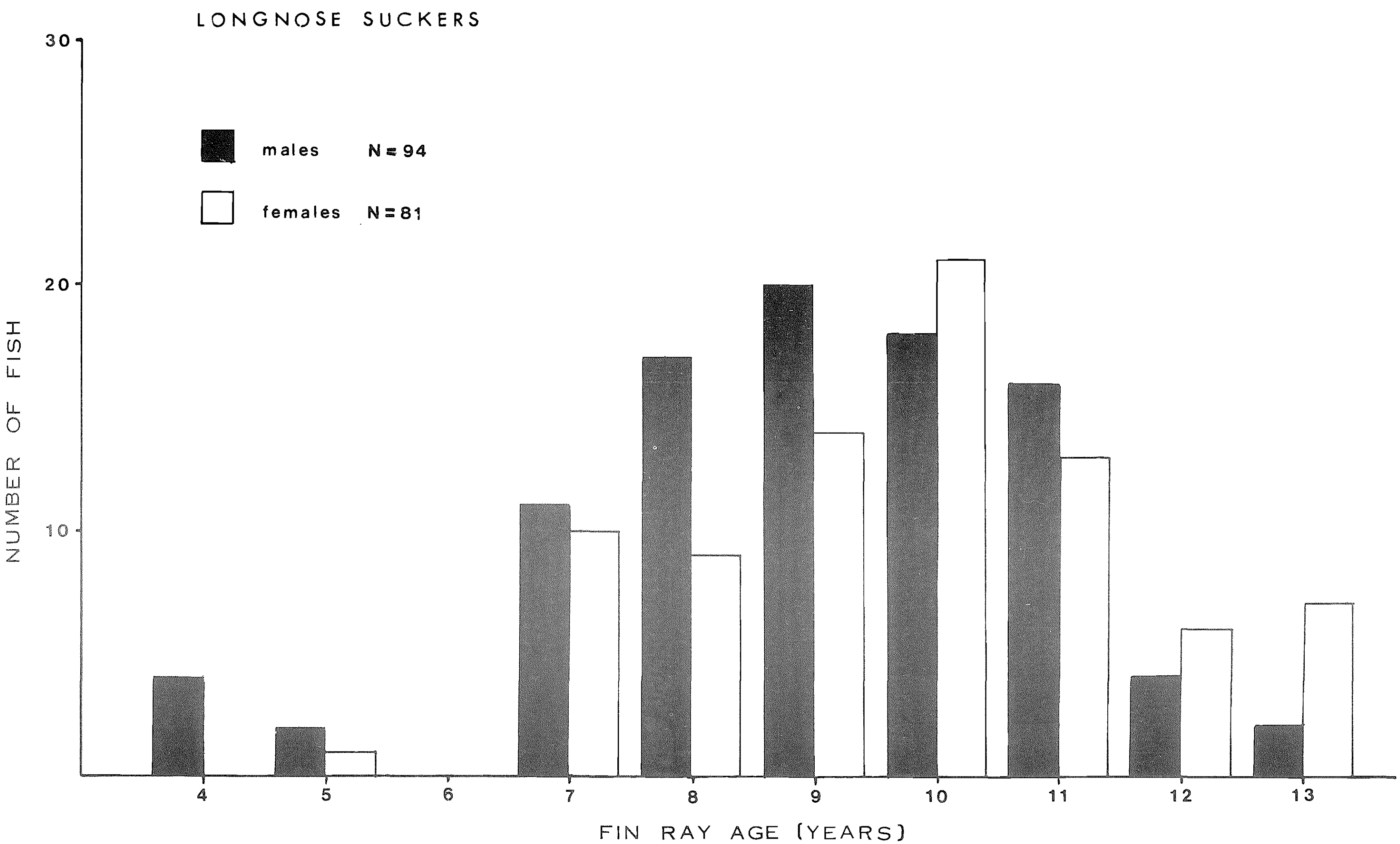


Figure 18. Age composition for longnose suckers sampled during counting fence operation.

Table 24. Sex ratio for longnose suckers during upstream migration, Muskeg River, 1976.

Date	Number of Fish				Percent Males*
	Males	Females	Unknown	Total	
April					
27		1		1	
28	3	7	55	65	30
29	8	2	120	130	80
30	5	6	202	213	45
May 1	1	5	126	132	17
2	1		108	109	100
3	2	3	181	186	40
4	54	58	5	117	48
5	1	3	17	21	25
6	39	25	1	65	61
7	62	61	1	124	50
8	31	43	5	79	42
9	146	211	2	359	41
10	140	228	30	398	38
11	34	84	16	134	29
12	73	87	4	164	46
13	53	66	14	133	45
14	62	80	2	144	44
15	43	69	4	116	38
16	7	11	50	68	39
17			9	9	
18			4	4	
19					
20					
21			3	3	
22			4	4	
23			3	3	
24			1	1	
25					
26					
27					
28					
29					
30					
31					
June 1-July 30				55	
Totals	765	1050	967	2837	

*Based on fish of known sex.

The ratio of males to females in the descending run was not determined due to difficulties in sexing fish externally at that time.

5.4.2.11 Fecundity. Ovaries were removed from seven female longnose suckers in spawning condition and fecundity estimated gravimetrically. The estimated total number of eggs per female (size range 410-440 mm) ranged from 16,068 to 31,572 (Table 25), with an average of 21,203 per female. Actual counts on five ovaries revealed discrepancies of from +7.2% to -4.4% for the estimated values.

Length-relative fecundity ranged from 390.0 to 717.5 ova per cm of fork length while weight-relative fecundity varied from 17.9 to 33.2 eggs per gram of body weight.

Regression analysis indicated a significant ($p < 0.01$), positive correlation between fecundity and fork length ($n = 7$; $r = 0.776$). The relationship between fecundity and fork length is expressed by the equation:

$$\log_{10} \text{Fecundity} = 7.319 \, (\log_{10} \text{Fork Length}) - 14.890$$

5.4.2.12 Age and growth. Table 26 presents the age-length relationship for longnose suckers captured during the present study. Most growth in length was achieved during the first 8 years of life at which age longnose suckers had a mean fork length of 373 mm. After age 8, suckers showed little increase in length (Fig. 19).

Female longnose suckers were generally longer than males of equal age with the differences in mean fork length being significant (Student's t-test) in age groups 7 to 11 inclusive (Table 26).

Table 25. Fecundity estimates of seven longnose suckers sampled during the 1976 spawning migration. Asterisks indicate actual egg counts and percentages in parenthesis the error deviation of estimated counts.

Fork Length (mm)	Weight (g)	Number of Eggs			Relative Fecundity	
		Left Ovary	Right Ovary	Total	(cm)	(g)
432	1000	12,000	11,939	23,939	554.1	23.9
414	850	11,438* (-1.7%)	13,428	24,866	600.6	29.3
410	800	8,509* (-1.9%)	7,806	16,315	397.9	20.4
440	950	16,429	15,143	31,572	717.5	33.2
413	850	8,400* (+7.2%)	9,500	17,900	433.4	21.1
412	900	7,917* (-0.3%)	8,151	16,068	390.0	17.9
424	850	8,384* (-4.4%)	9,375	17,759	418.8	20.9

TABLE 26. Age-length relationship (derived from fin rays and otoliths) for longnose suckers captured in the Muskeg River and Hartley Creek, 1976, sex separate and combined sample (includes unsexed fish). Differences in mean length at each age for males and females were tested for significance using Student's t-test. Asterisks indicate significant differences in means ($P < 0.05$).

Age	Males				Females				All Fish				t-test
	N	Mean	S.D.	Range	N	Mean	S.D.	Range	N	Mean	S.D.	Range	
0+									9	44.9	6.30	36-56	-
1	0				0				2	50.0	7.07	45-55	-
2	0				0				1	89.0	-	-	-
3	3	129.33	25.48	100-146	4	138.50	5.80	130-143	12	136.58	13.67	100-148	0.72
4	4	197.25	24.58	175-229	0				7	189.00	20.82	172-229	-
5	2	214.00	31.11	192-236	1	215.00	-	-	4	208.50	21.42	191-236	-
6	0				0				3	304.33	21.13	280-318	-
7	11	354.64	13.47	332-376	10	373.80	16.87	351-399	31	359.87	18.58	320-399	2.89*
8	17	366.12	16.07	337-389	9	386.44	20.18	366-427	28	372.82	19.63	335-427	2.81*
9	20	368.55	19.15	345-416	14	402.93	20.69	372-439	38	382.13	28.03	340-444	4.99*
10	18	380.06	15.78	358-410	21	416.00	17.89	384-455	39	399.41	24.69	358-449	6.60*
11	16	392.38	15.94	371-436	13	411.92	25.69	363-442	31	399.48	23.13	363-442	2.56*
12	4	398.00	25.78	375-434	6	413.83	22.50	391-444	12	399.67	28.53	352-444	1.03
13	2	412.00	52.33	375-449	7	433.29	32.05	412-468	10	421.70	33.25	375-444	0.75
Totals	97				85				227				

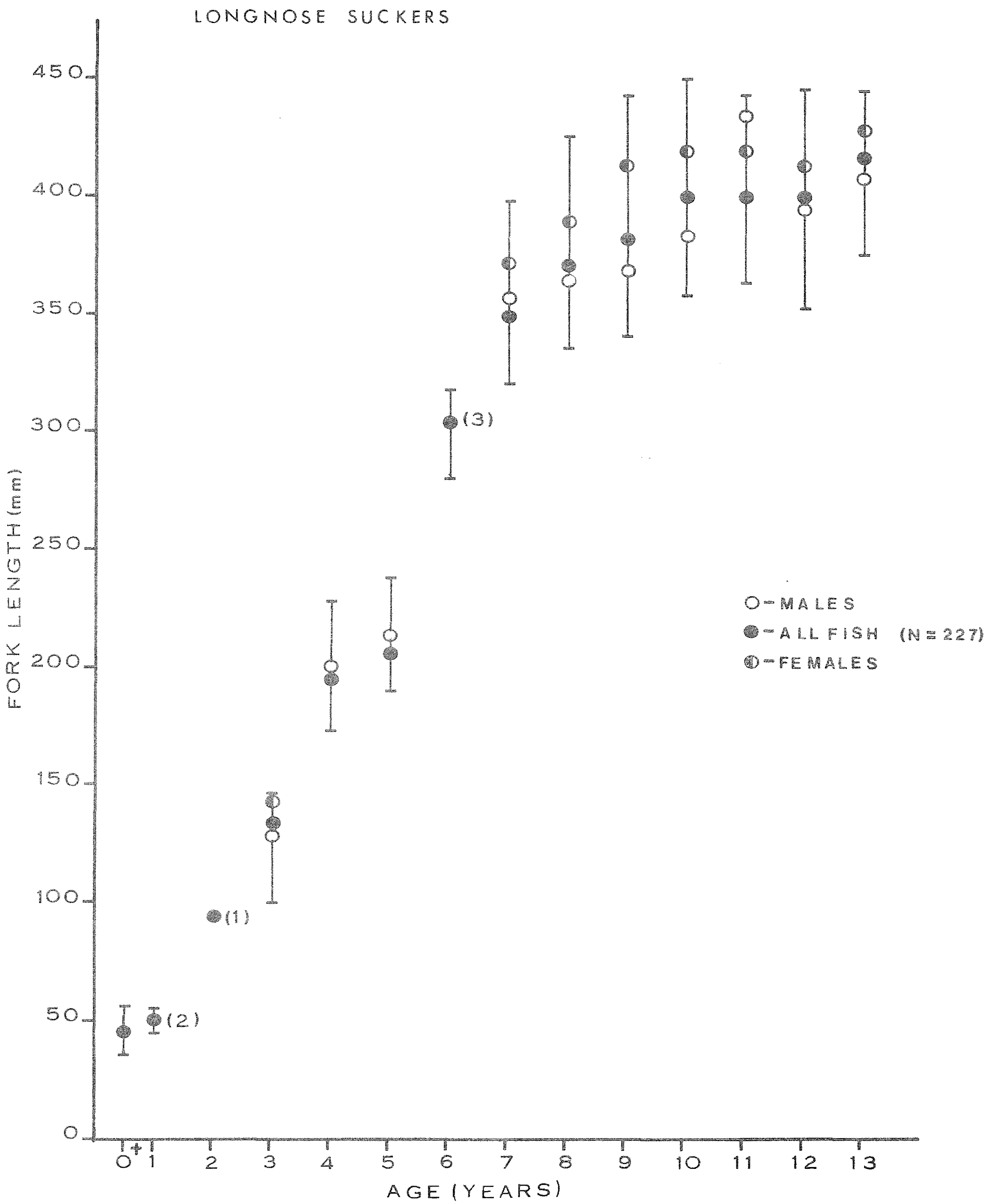


Figure 19. Age-length relationship for longnose suckers from the Muskeg River watershed, 1976.

During the first few years of life longnose suckers added weight slowly with age 4 fish averaging 86 grams (Table 27). The rate of weight gain then increased for the next several years, decreasing again after about age 9 (Fig. 20). Female longnose suckers were generally heavier than males of the same age with the differences in mean weight being statistically significant (Student's t-test) for age groups 8-11 inclusive (Table 27).

5.4.2.13 Sex and maturity. Of 182 longnose suckers aged and sexed, 53% were males (Table 27).

Both male and female longnose suckers appear to mature at the relatively late age of 7 years (Table 28). Virtually all fish were sexually mature by age 9. The presence of a few immature fish at older ages may indicate that some longnose suckers do not spawn every year.

5.4.2.14 Length-weight relationship. The following length-weight relationships were determined from longnose suckers captured during the counting fence operation. Both upstream and downstream fish were included.

For male longnose suckers (n = 93, r = 0.960, range 181-449 mm) the mathematical relationship between fork length and body weight is expressed by the equation:

$$\log_{10} W = 3.0085 (\log_{10} L) - 4.9494; sb = 0.0917$$

For female longnose suckers (n = 141, r = 0.971, range 209-587 mm) the equivalent expression is:

$$\log_{10} W = 3.0003 (\log_{10} L) - 4.9133; sb = 0.1034$$

Analysis of covariance indicated a significant difference ($p < 0.05$) between adjusted means ($F = 3.942$) but not the slopes ($F = 0.003$) of the length-weight regressions of male and female longnose suckers.

TABLE 27. Age-weight relationship for longnose suckers captured in the Muskeg River and Hartley Creek, 1976, sexes separate and combined sample (includes unsexed fish). Differences in mean weight at each age for males and females were tested for significance using Student's t-test. Asterisks indicate significant differences in means ($P < 0.05$).

Age	Males				Females				All Fish				t-test
	N	Mean	S.D.	Range	N	Mean	S.D.	Range	N	Mean	S.D.	Range	
0+									9	1.02	0.49	0.45-1.95	-
1									2	1.25	0.64	0.8-1.7	-
2									1	6.8	-	-	-
3	3	26.4	12.66	11.8-34.3	4	35.00	2.54	31.3-36.7	12	32.00	8.83	11.8-36.7	1.37
4	4	96.58	42.41	73.1-160	0				7	86.56	33.15	60-160	-
5	2	105.00	77.78	50-160	1	100.00	-	-	4	97.50	46.46	50-160	-
6	0	-	-	-	0	-	-	-	3	350.00	62.45	280-400	-
7	11	581.82	58.28	490-680	10	636.00	80.58	520-750	30	594.00	82.49	400-750	1.78
8	17	584.12	102.90	400-800	9	712.22	84.38	550-800	28	628.93	109.79	400-800	3.20*
9	18	588.89	80.94	480-790	14	830.00	136.44	650-1040	34	703.82	165.42	480-1150	6.23*
10	18	662.78	91.12	500-800	21	876.67	95.99	760-1050	39	777.95	142.24	500-1050	7.10*
11	16	707.50	111.45	550-1000	13	853.85	142.57	600-1050	31	767.10	142.93	550-1050	3.11*
12	4	800.00	227.30	650-1100	6	890.00	164.92	710-1100	12	810.83	196.49	560-1100	0.73
13	2	780.00	169.71	660-900	7	980.00	195.87	800-1000	10	908.00	208.05	660-1350	1.30
Totals	95				85				222				

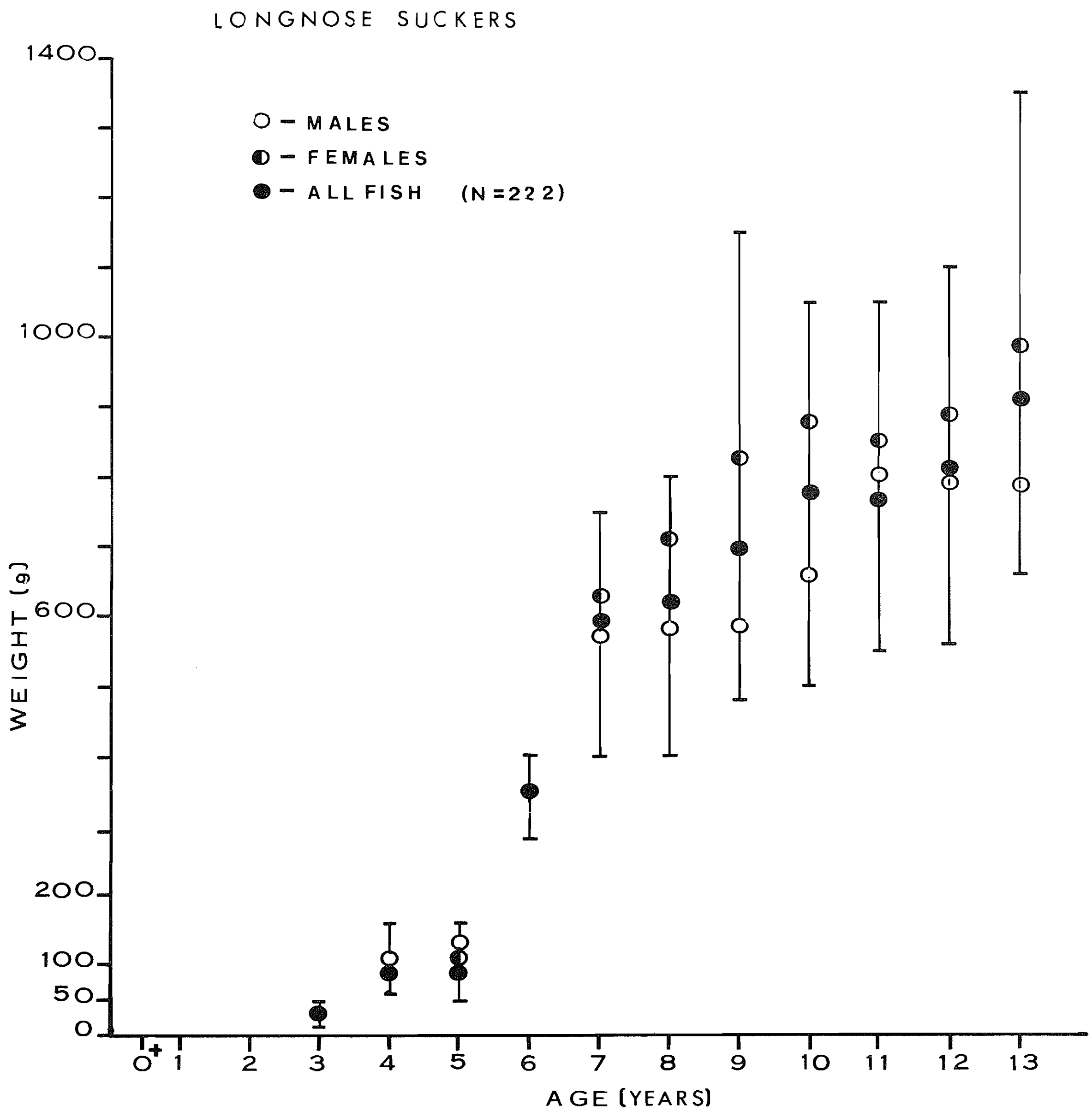


Figure 20. Age-weight relationship for longnose suckers from the Muskeg River watershed, 1976.

Table 28. Age specific sex ratios and maturity for longnose sucker from the Muskeg River and Hartley Creek, 1976. Sex ratios were based only on fish for which sex was determined. Maturity data included fish which would either spawn in the year of capture or had spawned previously.

	Females			Males				
Age	N	%	% Mature	N	%	% Mature	Unsexed Fish	Total
0+	0	-	-	0	-	-	9	9
1	0	-	-	0	-	-	2	2
2	0	-	-	0	-	-	1	1
3	4	57	0	3	43	0	5	12
4	0	-	-	4	100	0	3	7
5	1	33	0	2	67	0	1	4
6	0	-	-	0	-	-	3	3
7	10	48	90	11	52	50	10	31
8	9	35	78	17	65	69	2	28
9	14	41	86	20	59	90	4	38
10	21	54	95	18	46	89	0	39
11	13	45	100	16	55	94	2	31
12	6	60	83	4	40	100	2	12
13	7	78	86	2	22	100	1	10
Totals	85	47		97	53		45	227

5.4.2.15 Growth of young-of-the-year. In 1976, longnose suckers completed spawning in the first two weeks of May.

By mid-June, young-of-the-year suckers were abundant throughout the lower reaches of the Muskeg River and Hartley Creek. While it was not possible to distinguish white sucker fry from longnose fry at this time the majority are thought to have been white suckers (modal length = 18 mm). Most of the small suckers collected at this time showed only a single mode in the length-frequency distribution (Fig. 13). One sample, however, collected June 17 at site 4 (Fig. 5) showed a distinctly bi-modal distribution (Fig. 13), with one mode at 14 mm and the other at 19 mm.

As white sucker fry are generally larger than longnose fry at this stage of development we interpret these two modes as representing the two species of suckers with longnose suckers being the smaller.

The fact that this bi-modal distribution appeared only in the one sample plus the fact that only 9 positively identified age 0+ and only 2 age 1+ longnose suckers were collected from the Muskeg watershed suggests that most young-of-the-year longnose suckers vacate the tributary very shortly after emergence.

One young-of-the-year longnose sucker taken in the Muskeg River on August 4 had a fork length of 38 mm. Eight others captured September 11 had a mean fork length of 46 mm (Range 36-56)(Table 19).

5.4.2.16 Food habits. Time limitations precluded an analysis of the food habits of young suckers in the Muskeg River. Field analysis of stomachs during the spawning period indicate that longnose suckers did not feed at that time. Of 157 stomachs examined, 92% contained no food. The remainder contained only traces of food (insects and plant matter).

5.4.3 Arctic grayling

5.4.3.1 Spring movement. An upstream migration of Arctic grayling was under way in the Muskeg River at the time the 1976 counting fence was installed (Fig. 21 and Table 9). Although a total of 305 grayling were counted through the upstream trap the major movement occurred in the first few days of operation as 72% of upstream fish had passed the fence by 7 May. At this time most grayling examined were immature (63%).

Grayling tended to move upstream during the afternoon and evening hours or around the time of maximum daily water temperature. Of 221 fish passed upstream prior to 7 May, 90% were caught between 1200 and 2100 hours. Largest catches were recorded between 1500 and 1800 hours (47%).

There appeared to be no downstream migration as such for Arctic grayling during the period of fence operation although the odd fish was taken in the downstream trap through July. The largest number (49%) of downstream fish were taken prior to 6 May (Fig. 21). It is believed that these were upstream migrants that had entered the downstream trap within a short period after traversing the upstream trap.

5.4.3.2 Spawning. Spawning of Arctic grayling was not observed in the Muskeg River in 1976 although the presence of fry in mid-June indicated that it had occurred. It is likely that the lower reaches of Hartley Creek and the Muskeg River are principal spawning sites.

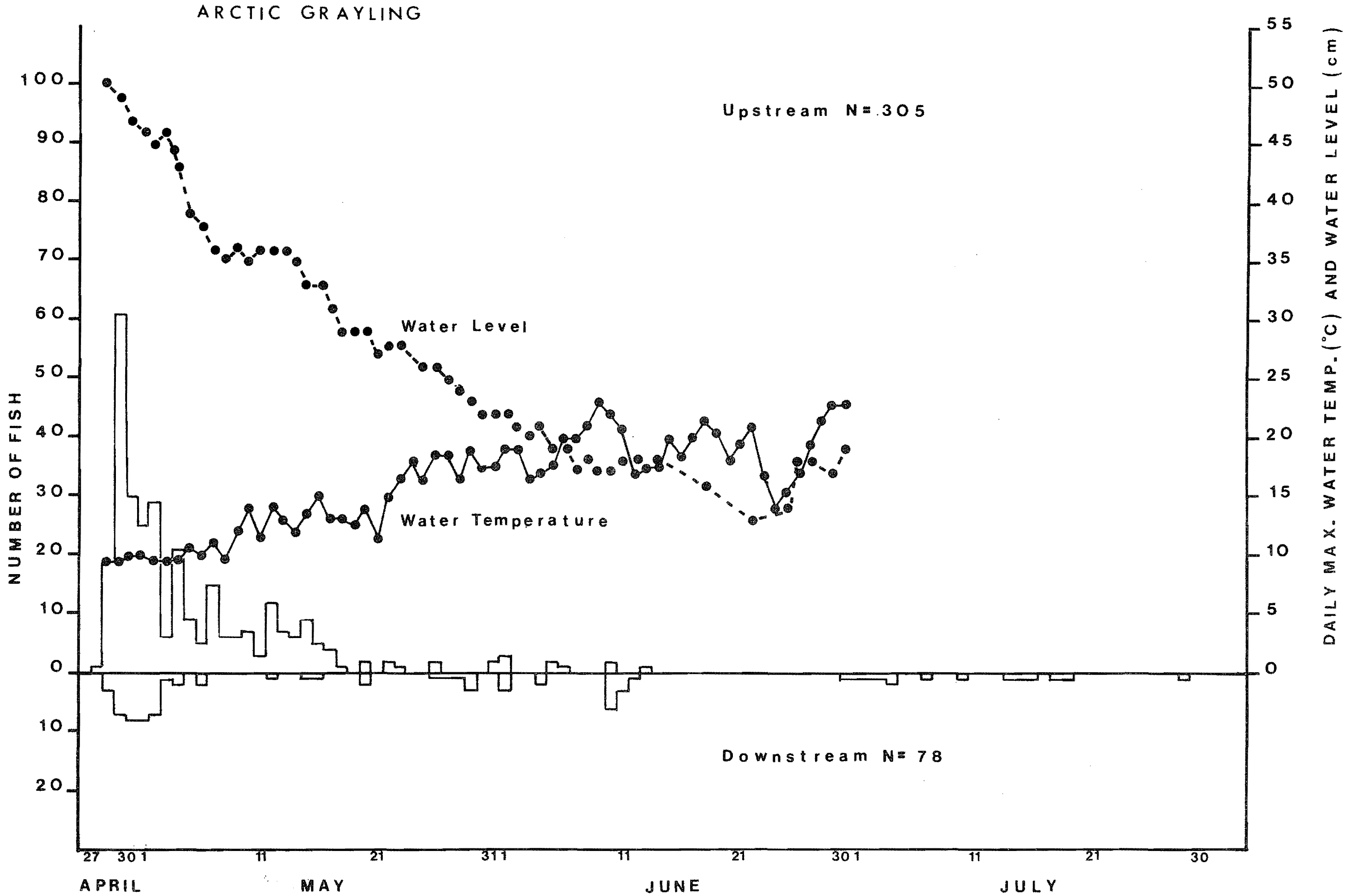


Figure 21. Seasonal timing of Arctic grayling migration, 1976.

Grayling generally undertake upstream spawning migrations shortly after ice break-up in the spring. Spawning is usually reported to occur at water temperatures between 5 and 10C (numerous authors).

It seems likely that the main spawning migration of grayling up the Muskeg River was missed during the 1976 fence operation and that spawning occurred in late April and early May in 1976. Ripe males and females were collected at the counting fence on May 1-2 while a spent female was caught on 7 May.

5.4.3.3 Summer residence of migrant grayling. As mentioned previously there was no distinct downstream grayling migration in the Muskeg River during the time of counting fence operation. This may indicate that grayling remain in the lower Muskeg to feed after spawning is completed.

Throughout the summer, angling produced considerable numbers of grayling in the lower 10 km of the Muskeg River. The creel included mature fish. On August 8 and 10, 1976, 10 angler hours applied in the area between 3 and 10 km upstream from the Athabasca River produced 28 Arctic grayling. Of this number, 11 proved to be age 1 (in their second summer); 6 were age 2, 7 were age 3 and 2 were 4 years old.

Although the counting fence was not established in the fall there is evidence to suggest that grayling left the Muskeg River at that time, probably to overwinter in the Athabasca River or near the mouth of the Muskeg. AOSERP fishery crews working on the main river reported catching grayling in the Athabasca in the first week of October whereas few had been taken during the summer months.

5.4.3.4 Overwintering. The extent and location of overwintering areas of Arctic grayling in the Muskeg River watershed are at present unknown. However, Dr. D. Barton (pers. comm.) reported sighting 6-10 juvenile grayling through the ice on 30 October 1976 at area 7 on Hartley Creek (Fig. 4).

5.4.3.5 Age and growth. A total of 110 Arctic grayling were captured in the Muskeg River watershed exclusive of young-of-the-year fish. These fish ranged in size from 130 to 378 mm in fork length (Fig. 22). Age determinations were made for 103 of these grayling, 92 of which were sexed.

The above fish ranged in age from 1 year to 7 years although only four fish exceeded age 4.

Growth in fork length was rapid for the first four years of life (Fig. 23) with a mean fork length of 310 mm being reached by age 4. Although males tended to be longer than females of the same age for ages 1-4 (Table 29), there were no significant differences between the sexes (Student's t-test).

Growth in weight for Arctic grayling is summarized in Table 30 and presented graphically in Figure 24. Where sample sizes permitted, mean weight at each age for male and female grayling were compared (Table 30). Significant differences ($p < 0.05$) were found at age 2 and age 4 with females being heavier than males at age 2 and the reverse occurring at age 4.

5.4.3.6 Sex and maturity. Of 92 grayling aged and sexed, 62% were males (Table 29), representing a significant deviation from a 1:1 ratio ($X^2 = 5.26$, $p > 0.05$).

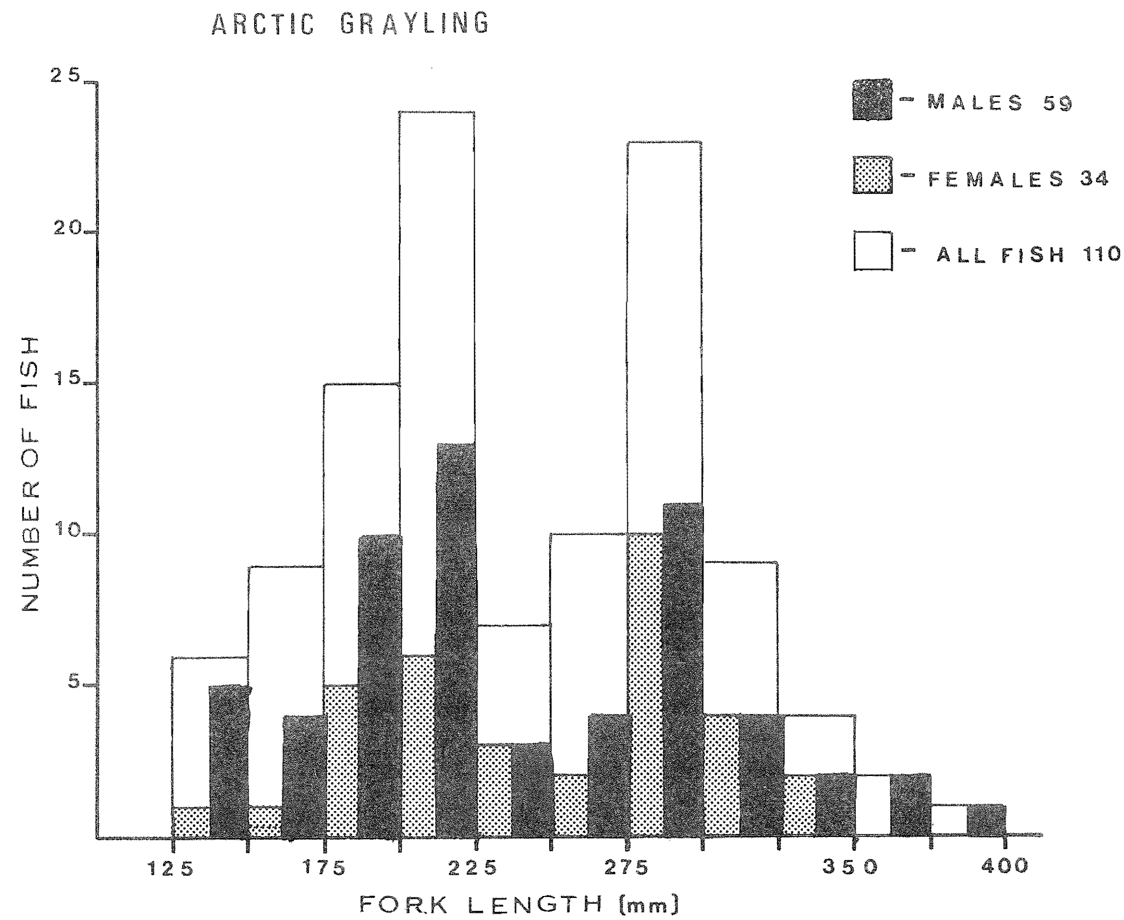


Figure 22. Length-frequency distribution for Arctic grayling measured during counting fence operation.

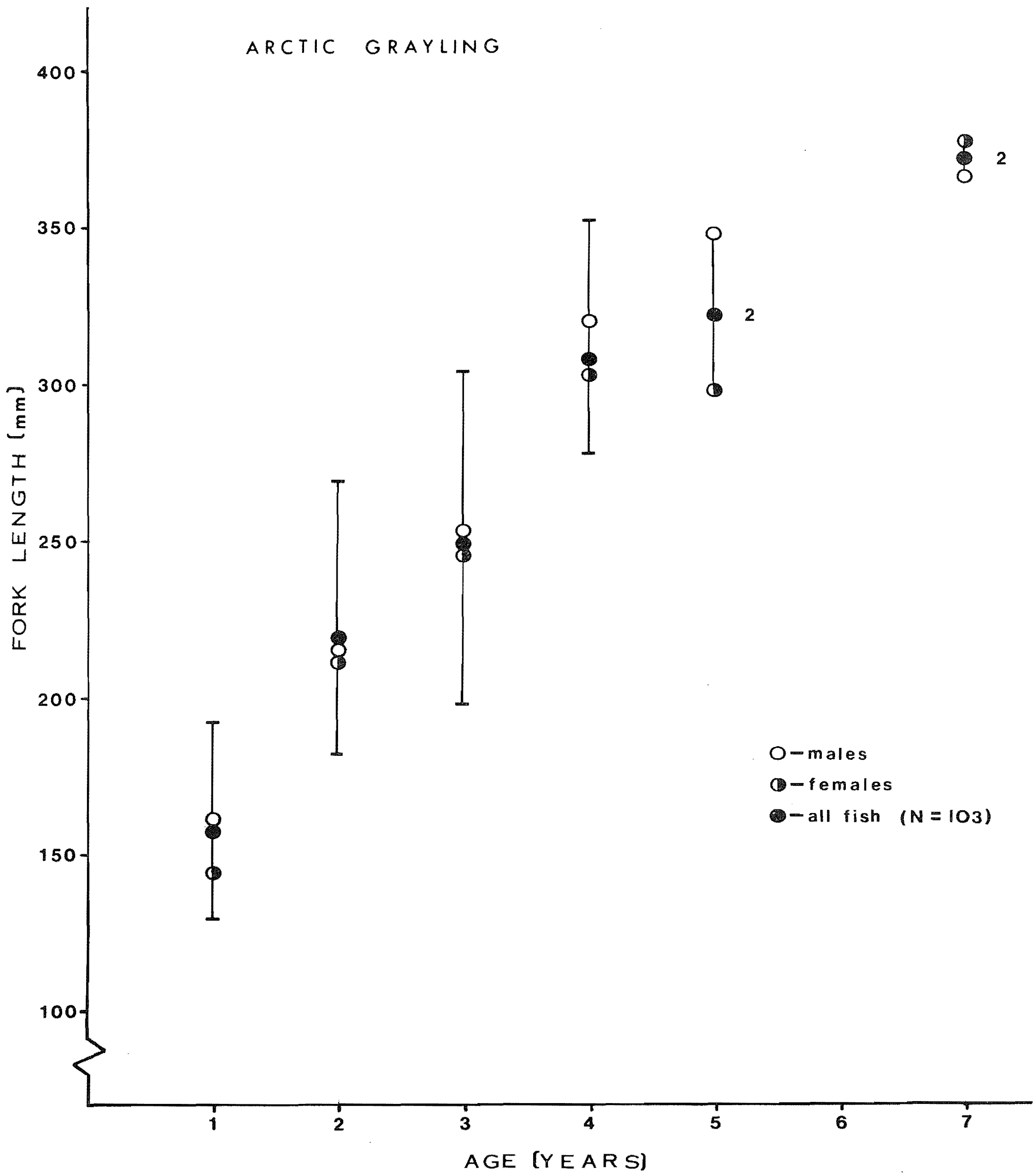


Figure 23. Age-length relationship for Arctic grayling from the Muskeg River watershed, 1976.

TABLE 29. Age-length relationship (derived from scales) for Arctic grayling captured in the Muskeg River, 1976, sexes separate and combined sample (includes unsexed fish). Differences in mean length at each age for males and females were tested for significance using Student's t-test.

Age	Males				Females				All Fish				t-test
	N	Mean	S.D.	Range	N	Mean	S.D.	Range	N	Mean	S.D.	Range	
1	14	161.3	20.2	130-193	2	144.5	20.5	130-159	18	159.8	19.4	130-193	1.10
2	13	215.5	29.2	183-269	10	215.4	24.5	191-263	27	215.7	26.8	183-269	0.01
3	22	253.0	35.9	198-304	10	247.6	33.3	213-295	37	251.4	34.5	198-304	0.33
4	6	321.8	23.5	292-353	11	303.2	19.8	278-334	17	309.8	22.4	278-353	1.74
5	1	348.0	3.2	348-348	1	298.0	3.2	298-298	2	323.0	35.4	298-348	-
6	0	-	-	-	0	-	-	-	0	-	-	-	-
7	1	366.0	3.2	366-366	1	378.0	3.2	378-378	2	372.0	8.5	366-378	-
Totals	57				35				103				

TABLE 30. Age-weight relationship for Arctic grayling captured in the Muskeg River, 1976, sexes separate and combined sample (includes unsexed fish). Differences in mean weight at each age for males and females were tested for significance using Student's t-test. Asteriks indicate significant differences in means (P < 0.05).

Age	Males				Females				All Fish				t-test
	N	Mean	S.D.	Range	N	Mean	S.D.	Range	N	Mean	S.D.	Range	
1	6	32.2	8.9	25-43	1	25	-	-	8	33.5	10.5	25-50	-
2	10	87.1	9.8	50-150	8	106.3	14.7	50-150	20	93.6	11.6	50-150	3.32*
3	20	185.3	35.2	50-320	8	163.8	29.8	80-250	31	176.3	32.8	50-320	1.52
4	4	375.0	20.6	300-520	10	332.0	20.5	220-480	14	344.3	21.7	220-520	3.54*
5	1	490.0	3.2	490-490	1	280.0	3.2	280-280	2	385.0	35.4	280-490	-
6	0	-	-	-	0	-	-	-	0	-	-	-	
7	1	560.0	3.2	560-560	1	620.0	3.2	620-620	2	590.0	8.5	560-620	-
Totals	42				29				77				

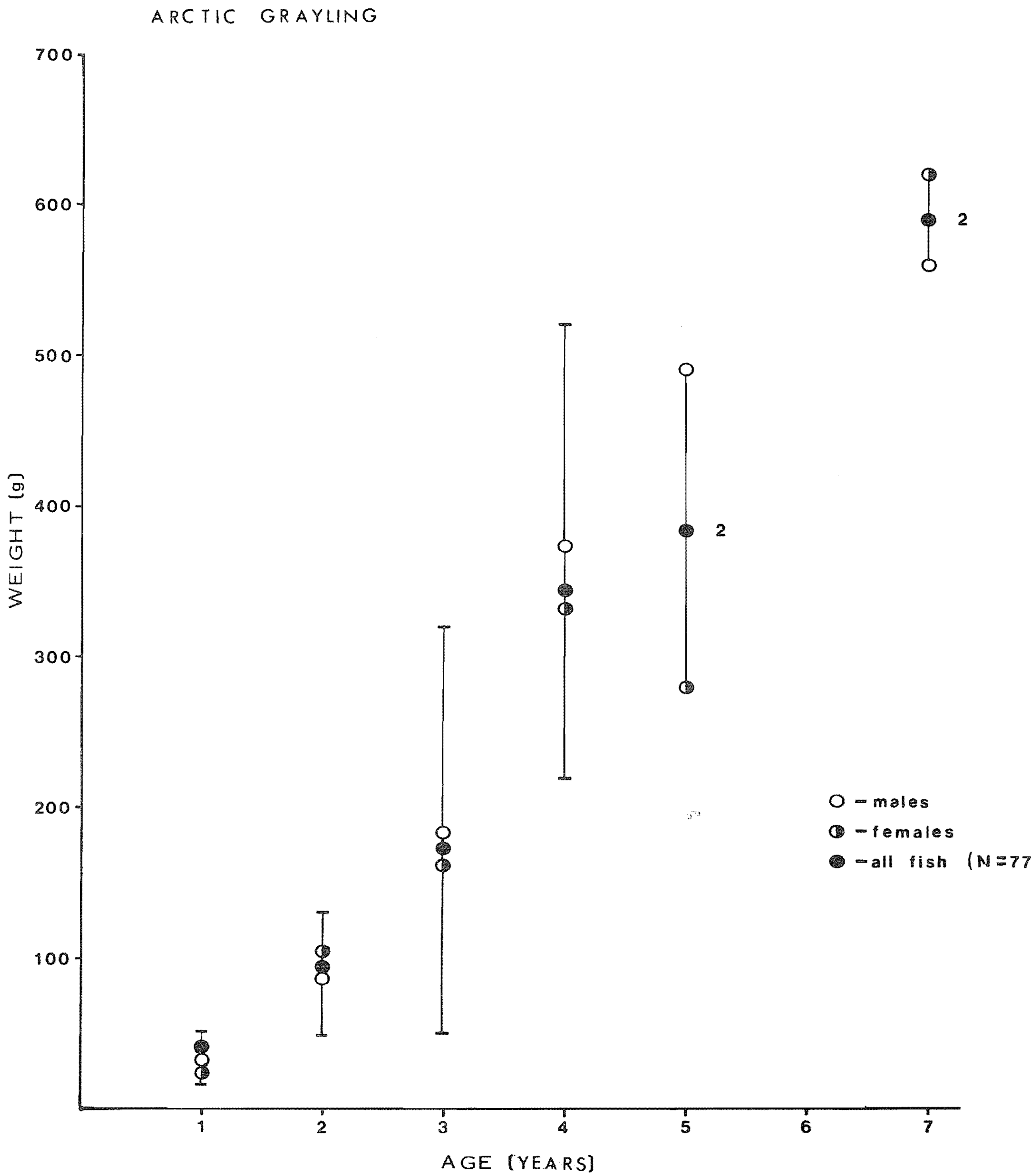


Figure 24. Age-weight relationship for Arctic grayling from the Muskeg River watershed, 1976.

The earliest age of sexual maturity was 2 years for males and 3 years for females. At age 3, 50% of both sexes were sexually mature (Table 31).

5.4.3.7 Fecundity. Total egg counts were performed on two grayling captured at the counting fence. One grayling (fork length 225 mm) contained 271 g ova while the other (fork length 308 mm) contained 6971 eggs (Table 32).

5.4.3.8 Length-weight relationship. A comparison of length-weight relationships indicated no significant difference ($p > 0.05$) between male and female grayling in slope or elevation. Therefore, the data for the two sexes were combined.

For Arctic grayling ($n = 81$, $r = 0.971$, Range 130-378 mm) the relationship between fork length and body weight is described by the equation:

$$\log_{10} W = 3.1157 (\log_{10} L) - 5.2341; sb = 0.0863$$

5.4.3.9 Growth of young-of-the-year. In 1976, spawning of Arctic grayling within the Muskeg River watershed probably occurred in late April or early May.

Grayling fry were first collected from the Muskeg River on 15 June at a mean fork length 36.7 mm. Young-of-the-year collected from Hartley Creek on June 16-21 averaged 32 mm in fork length (Table 33). Growth was rapid and by 4 August, fry in the Muskeg River had a mean fork length of 82 mm. Subsequent growth appeared slow since fish captured on 11 September had a mean length of 85 mm.

Although our sample was limited, young-of-the-year grayling appeared to grow more slowly in Hartley Creek than in the Muskeg River (Table 33).

Table 31. Age specific sex ratios and maturity of Arctic grayling captured and aged from the Muskeg River, 1976. Sex ratios were based only on fish for which sex was determined. Maturity data included fish which would either spawn in the year of capture or had spawned previously.

	Females			Males				
Age	N	%	% Mature	N	%	% Mature	Unsexed Fish	Total
1	2	13	0	14	87	0	2	18
2	10	43	0	13	57	7	4	27
3	10	31	50	22	69	50	5	37
4	11	65	73	6	35	100	0	17
5	1	50	0	1	50	0	0	2
6	0	-	-	0	-	-	0	0
7	1	50	0	1	50	100	0	2
Totals	35	38		57	62		11	103

Table 32. Actual egg counts of two Arctic grayling sampled during the 1976 spawning migration.

		Number of Eggs			Relative Fecundity	
Fork Length (mm)	Weight (g)	Left Ovary	Right Ovary	Total	(cm)	(g)
308	350	3601	3370	6971	226.3	19.9
225	150	1247	1472	2719	120.8	18.1

Table 33. Comparison of mean fork lengths (mm) and mean weights (g) of young-of-the-year grayling collected from the Muskeg River and Hartley Creek, 1976. Numbers in parenthesis indicate ranges.

Location	Date	N	Mean Fork Length (mm) ± Std. Dev.	Mean Weight (g) ± Std. Dev.
Muskeg River	15/6/76	23	36.7 ± 2.9 (32 - 42)	0.56 ± 0.14 (0.3 - 0.8)
	4-7/8/76	7	82.3 ± 4.4 (75 - 88)	5.93 ± 0.97 (4.3 - 7.1)
	11/9/76	17	85.0 ± 6.9 (71 - 101)	6.23 ± 1.73 (3.5 - 10.6)
Hartley Creek	16-21/6/76	77	32.5 ± 2.9 (27 - 38)	0.39 ± 0.12 (0.2 - 0.7)
	11/9/76	3	83.7 ± 0.6 (83 - 84)	5.90 ± 0.36 (5.6 - 6.3)

Length-frequency distributions for young-of-the-year Arctic grayling taken from the Muskeg River and Hartley Creek are given in figure 25.

5.4.3.10 Food habits. A total of 60 grayling stomachs were examined in the field and only 10 were empty. Most stomachs were ¼ to ½ full, the contents consisting mainly of aquatic insects.

Detailed laboratory analysis of four age 1+ grayling from Hartley Creek revealed a diet consisting mainly of insects; chironomid, trichopteran and tipulid larvae, plecopteran and ephemeropteran nymphs, ants and beetles (Table 34).

The food habits of young-of-the-year grayling from the Muskeg River and Hartley Creek (Table 35) were similar although the diet of Muskeg River fish was somewhat more varied.

5.4.4 Northern pike

5.4.4.1 Spring movement. A total of 286 pike were counted through the fish fence, 131 going upstream and 155 downstream (Table 9 and Fig. 26).

5.4.4.2 Spawning. The Muskeg River drainage does not appear to contain areas that are suitable for spawning of northern pike. Any areas that might provide spawning habitat in years of high runoff were certainly inaccessible during 1976 when little flooding occurred.

Although there was a large upstream movement of pike in the Muskeg River during the early spring many of these fish appeared to be immatures. Of those fish for which sexual maturity was determined (n = 24), only 4 were mature, 4 ripe and 1 spent.

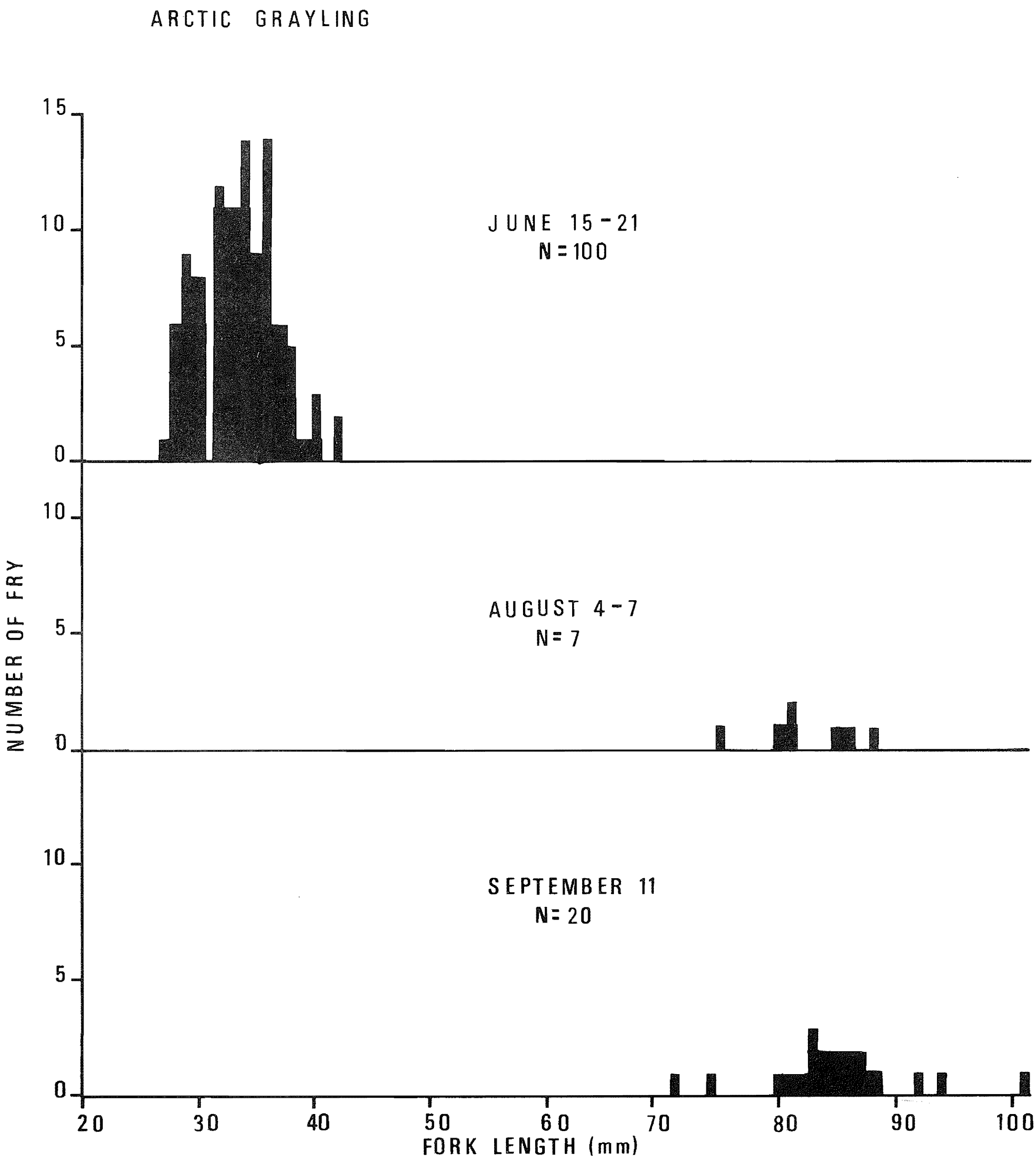


Figure 25. Length-frequency distribution for young-of-the-year Arctic grayling taken from the Muskeg River and Hartley Creek on three collecting dates.

Table 34. Food habits of yearling Arctic grayling in Hartley Creek, 1976 (N = 4).

Food Item	Number	Percent	Volume (mℓ)	Percent
Diptera				
Chironomidae larvae	20	20.0	+	+
Simuliidae larvae	1	1.0	+	+
pupae	1	1.0	+	+
Tipulidae larvae	9	9.0	0.01	0.4
Dipteran adults	4	4.0	0.02	0.8
Trichoptera (larvae)	8	8.0	0.06	2.3
Plecoptera				
nymphs	3	3.0	0.10	3.9
adults	10	10.0	0.85	33.1
Ephemeroptera (nymphs)	13	13.0	0.05	1.9
Coleoptera (adults)	8	8.0	0.08	3.1
Hemiptera	1	1.0	+	+
Hymenoptera (ants)	12	12.0	0.06	2.3
Unidentified insects	4	4.0	0.08	3.1
Hydracarina	1	1.0	+	+
Insect remains	+	+	0.96	37.4
Nematoda	1	1.0	+	+
Nematomorpha	2	2.0	+	+
Arachnida	1	1.0	+	+
Fish remains	1	1.0	0.30	11.7
Total	100	100.0	2.57	100.0

Table 35. Food habits of young-of-the-year Arctic grayling from the Muskeg River and Hartley Creek, 1976.

Food Item	Muskeg River						Hartley Creek			
	June 15 (N = 10)		Aug. 4 (N = 5)		Sept. 11 (N = 7)		June 16 (N = 23)		Sept. 11 (N = 3)	
	% Frequency	% No.	% Frequency	% No.	% Frequency	% No.	% Frequency	% No.	% Frequency	% No.
Diptera										
Chironomidae	100.0	40.1	100.0	89.4	100.0	76.6	100.0	76.3	100.0	61.5
Simuliidae	10.0	1.3	20.0	0.8	-	-	43.5	2.9	-	-
Tipulidae	-	-	-	-	42.9	3.2	4.3	0.2	33.3	2.6
Rhagionidae	-	-	20.0	0.4	-	-	-	-	-	-
Trichoptera	10.0	1.3	80.0	8.4	59.1	5.6	17.4	0.8	100.0	20.5
Plecoptera	20.0	2.5	20.0	0.4	14.3	0.8	4.3	0.2	-	-
Ephemeroptera	100.0	55.0	20.0	0.4	-	-	100.0	18.3	66.7	9.0
Coleoptera	-	-	-	-	14.3	0.8	-	-	33.0	1.3
Hemiptera	-	-	-	-	42.9	3.2	-	-	33.3	1.3
Hymenoptera	-	-	-	-	-	-	-	-	66.7	2.6
Insect remains	100.0	-	100.0	-	100.0	-	100.0	-	100.0	-
Nematoda	-	-	-	-	14.3	0.8	-	-	33.3	1.3
Arachnida	-	-	-	-	14.3	0.8	-	-	-	-
Hydracarina	-	-	-	-	28.6	1.6	-	-	-	-
Nematomorpha	-	-	-	-	14.3	0.8	-	-	-	-
Copepoda	-	-	-	-	14.3	0.8	-	-	-	-
Cladocera	-	-	-	-	28.6	3.2	-	-	-	-
Fish	-	-	-	-	14.3	0.8	-	-	-	-

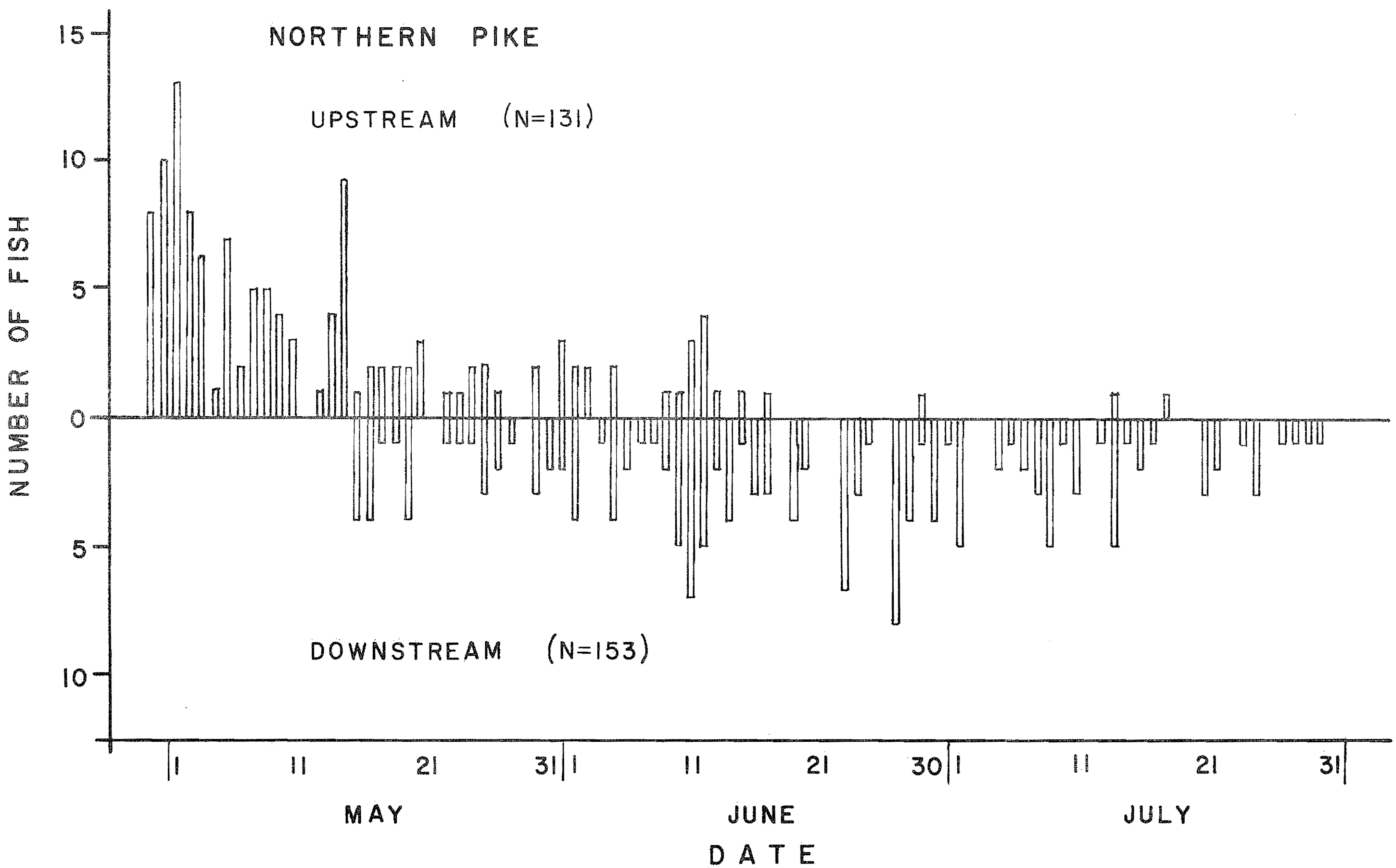


Figure 26. Seasonal timing of northern pike migration, 1976.

No young-of-the-year pike were collected from the study area in 1976.

5.4.4.3 Distribution of pike in Muskeg watershed. Within the Muskeg watershed, northern pike seem to be confined to the lower reaches and mouth. Angling results indicate that, in 1976, pike did not ascend more than 6 or 7 km upstream in the Muskeg. In years of higher water it is likely that they ascend considerably farther.

Tagging results (Table 8) indicate that pike generally tended to move very little during the summer.

5.4.4.4 Age and growth. Northern pike sampled from the study area ranged in fork length from 267 to 950 mm (Fig. 27). Most fish were in the 400 to 500 mm range. The scale age-fork length analysis for 20 northern pike is presented in Table 36. Pike captured from the Muskeg River ranged in age from 2-7 years with all the older fish (5-7 years) being females.

The age-length relationship for northern pike is shown in Figure 28.

5.4.4.5 Sex and maturity. Of 20 northern pike for which age and sex was determined, 50% were males (Table 36). The earliest age at which mature fish were observed was 4 years for both sexes.

5.4.4.6 Length-weight relationship. The length-weight relationship for northern pike (n = 23, r = 0.979) is described by the equation:

$$\log_{10} W = 3.4515 (\log_{10} L) - 6.3611; \; sb = 0.1584$$

5.4.4.7 Food habits. Twenty-one northern pike stomachs were examined in the field. Of these 15 were empty and 6 contained fish remains (slimy sculpin and white sucker) and some insects.

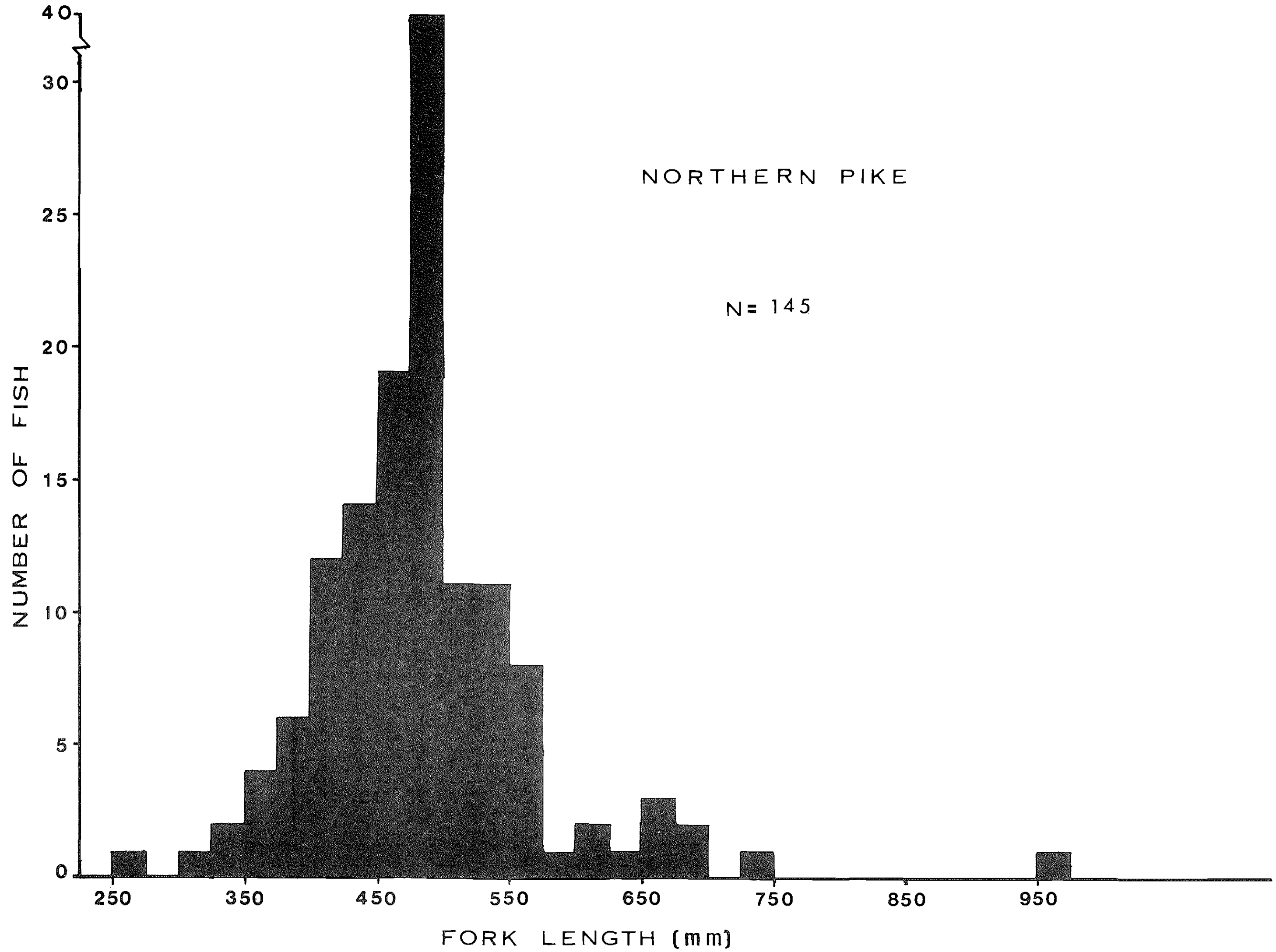


Figure 27. Length-frequency distribution for northern pike from the Muskeg River, 1976.

TABLE 36. Age-length relationships (derived from scales and otoliths*), age specific sex ratios and maturity of lake whitefish, mountain whitefish, northern pike, walleye and burbot captured from Muskeg River in 1976.

Species/Age	Females			Males			Unsexed	Total	Fork length (mm)		
	N	%	% Mature	N	%	% Mature	Fish	Sample	Mean	S.D.	Range
Lake whitefish											
3	1	100	100					1	318.0	-	-
4	1	100	0					1	298.0	-	-
6	1	33	100	2	67	100		3	382.7	21.5	359-401
7	1	50	100	1	50	100		2	379.5	28.9	359-400
8	1	50	100	1	50	100		2	391.0	24.0	374-408
9				1	100	100		1	411.0	-	-
Totals	5			5				10			
Mountain whitefish											
2				2	100	0	2	4	186.8	5.9	180-194
3	3	43	33	4	57	50	1	8	263.6	24.4	213-290
4	4	67	50	2	33	50	1	7	325.7	13.9	255-353
5	2	100	50					2	320.0	31.0	289-351
Totals	9			8			4	21			
Northern pike											
2				1	100	0		1	267.0	-	-
3				5	100	0		5	372.8	27.5	331-403
4	2	33	100	4	67	50		6	417.7	22.9	390-455
5	3	100	67					3	534.7	99.2	453-645
6	4	100	50					4	663.8	53.1	610-737
7	1	100	0					1	684.0	-	-
Totals	10			10				20			

TABLE 36. (Cont'd)

Species/Age	Females			Males			Unsexed	Total	Fork length (mm)		
	N	%	% Mature	N	%	% Mature	Fish	Sample	Mean	S.D.	Range
Walleye											
0+							2	2	83.0	9.1	68-98
5				1	100	100		1	347.0	-	-
12				1	100	100		1	424.0	-	-
15	1	100	0					1	540.0	-	-
Totals	1			2			2	5			
Burbot*											
2	1	100	0				2	3	131.0	11.4	119-139
Totals	1						2	3			

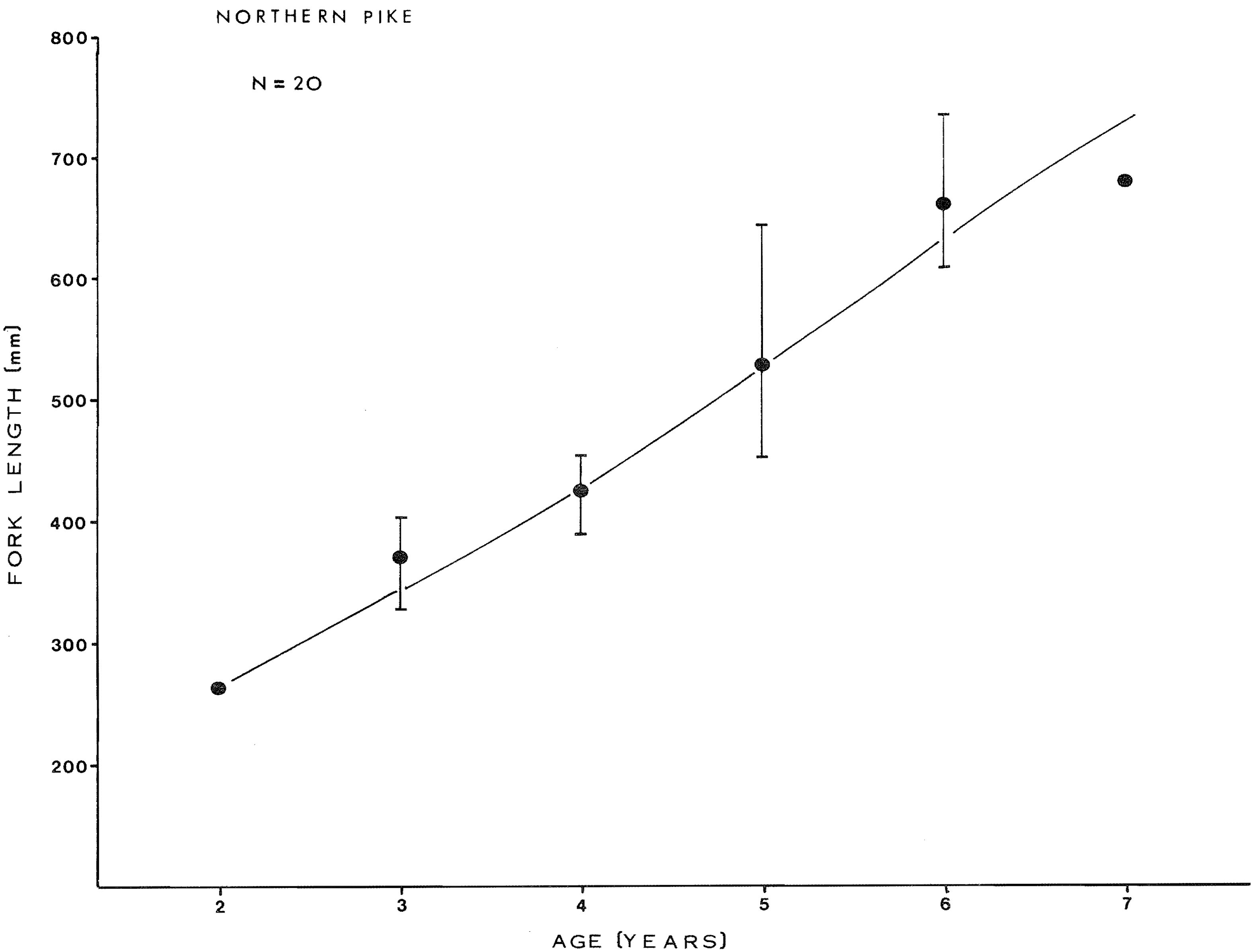


Figure 28. Age-length relationship for northern pike from the Muskeg River, 1976.

5.4.5 Mountain whitefish

5.4.5.1 Spring movement. A total of 134 mountain whitefish were counted through the fish fence, 33 going upstream and 101 coming downstream (Table 9 and Fig. 29).

5.4.5.2 Spawning. Mountain whitefish usually spawn in October or early November, the young hatching about March (Paetz and Nelson 1969). Whether mountain whitefish spawn in the Muskeg watershed is unknown. However, no young-of-the-year mountain whitefish were collected during the present study.

5.4.5.3 Age and growth. The length-frequency distribution for 23 mountain whitefish is shown in Figure 30. Age-length data for the sample are presented in Table 36 and Figure 31.

5.4.5.4 Sex and maturity. Of 17 mountain whitefish for which sex and age were determined, 9 were females (Table 36). The youngest mature male was age 3 as was the youngest mature female.

5.4.5.5 Length-weight relationship. The length-weight relationship for mountain whitefish ($n = 23$, $r = 0.977$) is described by the equation:

$$\log_{10} W = 2.7510 (\log_{10} L) - 4.3008; \; sb = 0.1313$$

5.4.5.6 Food habits. Field examinations were made of 19 mountain whitefish stomachs. Of these, 15 were empty and only 3 contained identifiable food (insects).

5.4.6 Lake whitefish

5.4.6.1 General. The lake whitefish is common in the Athabasca River system and AOSERP fishery crews working on the main river documented a large spawning migration into the AOSERP study area in late August 1976. While the mouth of the Muskeg River seems

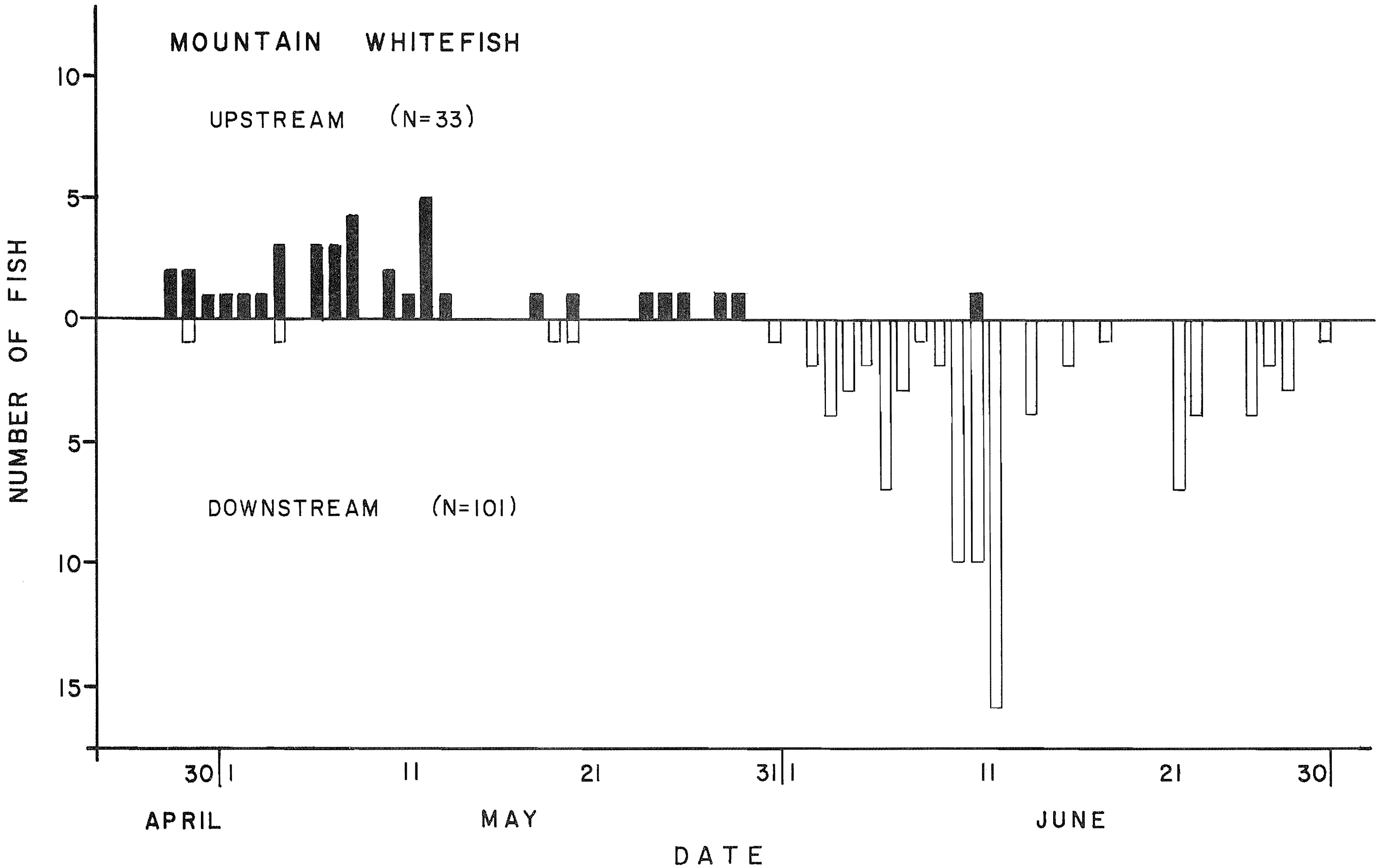


Figure 29. Seasonal timing of mountain whitefish migration in 1976.

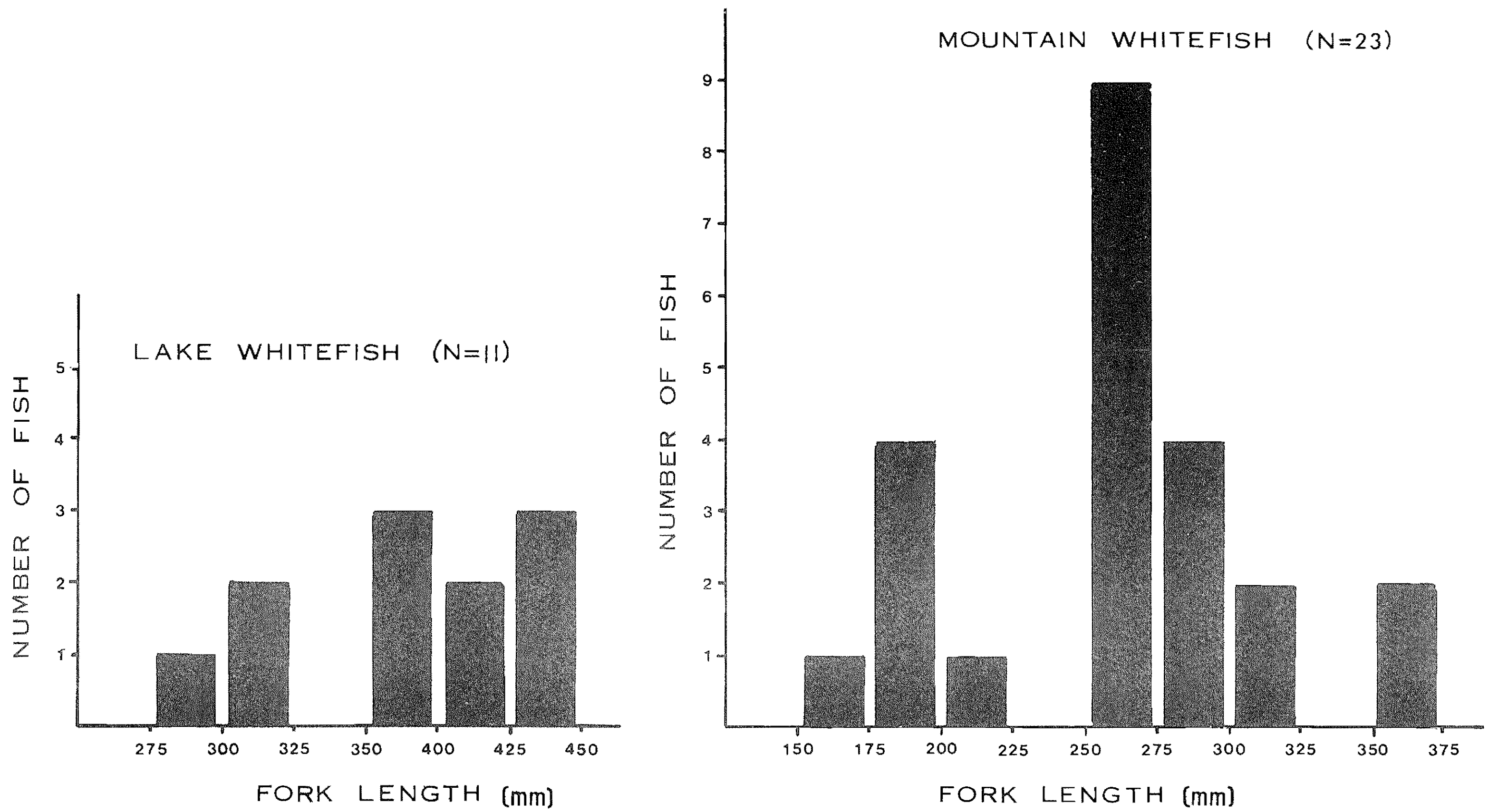


Figure 30. Length-frequency distributions for lake whitefish and mountain whitefish from the Muskeg River, 1976.

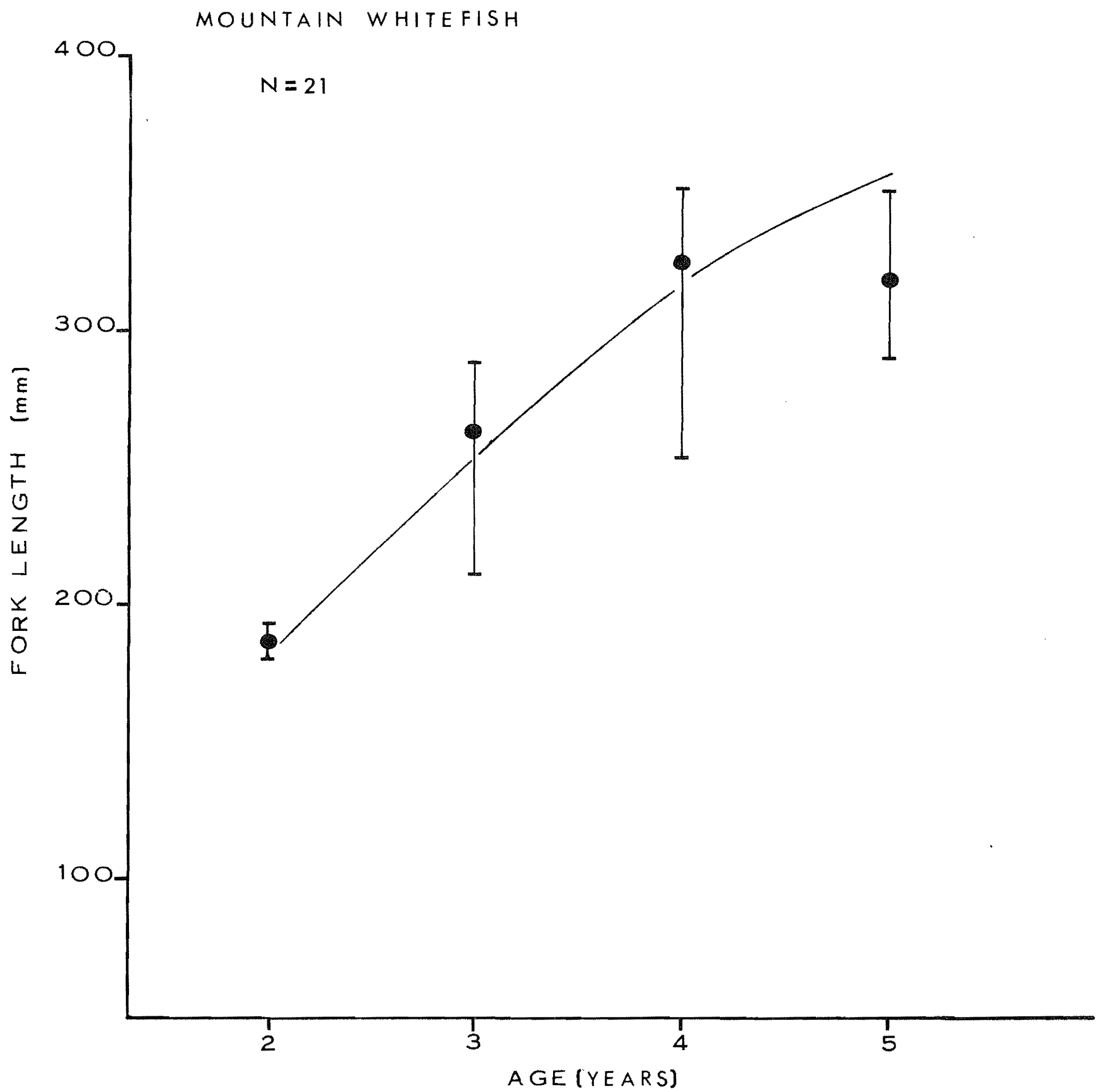


Figure 31. Age-length relationship for mountain whitefish from the Muskeg River, 1976.

to be important in the fall as a resting spot for migrant whitefish, it appears that only occasionally do they move up the Muskeg much beyond the mouth area.

5.4.6.2 Spring movement. A small number of lake whitefish were counted through the fence during the spring. Three of these were counted moving upstream and 14 coming down (Table 9).

5.4.6.3 Spawning. Lake whitefish usually spawn from October to December, the eggs hatching in the spring. We found no evidence of lake whitefish spawning in the Muskeg River and no young-of-the-year whitefish were collected during the present study. It is suspected that lake whitefish spawn in the Athabasca River proper. However actual locations of spawning sites are unknown.

5.4.6.4 Age and growth. The length-frequency distribution for 11 lake whitefish from the Muskeg River is shown in figure 29. Age-length data for the sample are presented in table 36.

5.4.6.5 Sex and maturity. Of 11 lake whitefish sampled, 6 were females. Although the data are limited, the earliest age of sexual maturity for lake whitefish appears to be age 3 (Table 36).

5.4.6.6 Length-weight relationship. The length-weight relationship for lake whitefish ($n = 11$, $r = 0.964$) is described by the equation:

$$\log_{10} W = 3.5233 (\log_{10} L) - 6.2045; sb = 0.3227$$

5.4.6.7 Food habits. Of six lake whitefish stomachs examined in the field only 1 contained food (Corixids).

5.4.7 Walleye

A total of 10 walleye were taken from the Muskeg River during the study; seven were passed through the fence (Table 9), two were gill-netted at the mouth of the tributary and two were collected by seine in Area 2 (Fig. 5) on 4 August.

Five fish were aged from scales (Table 36) the oldest being 15 years old.

One walleye stomach examined in the field contained fish remains (slimy sculpin and an unidentified cyprinid).

Although large numbers of walleye migrate through the AOSERP study area in April on their way to spawning grounds, walleye appear not to utilize the Muskeg River for this purpose.

5.4.8 Burbot

Six burbot were captured in the Muskeg River during the study. Three were passed through the fence (Table 9) and three were taken in minnow traps in Area 2 (Fig. 5) during May.

Three immature burbot (119-139 mm total length) were aged from otoliths and found to be 2 years old (Table 36).

5.4.9 Lake chub

5.4.9.1 Distribution and relative abundance. Excluding suckers, lake chub were the most abundant small fish taken in the Muskeg River watershed in 1976, comprising 27% of the total catch. Lake chub were collected at 6 of the 10 sampling areas with the largest number of specimens collected at Area 7 on Hartley Creek (Table 6).

5.4.9.2 Age and growth. Lake chub from the study area ranged in size from 14 to 118 mm fork length (Fig. 32). The vast majority were in the 27-45 mm range.

Otolith ages were determined for 106 lake chub and the age-length relationship is shown in Table 37. The oldest lake chub captured were 5 year old females that had a mean fork length of 108 mm.

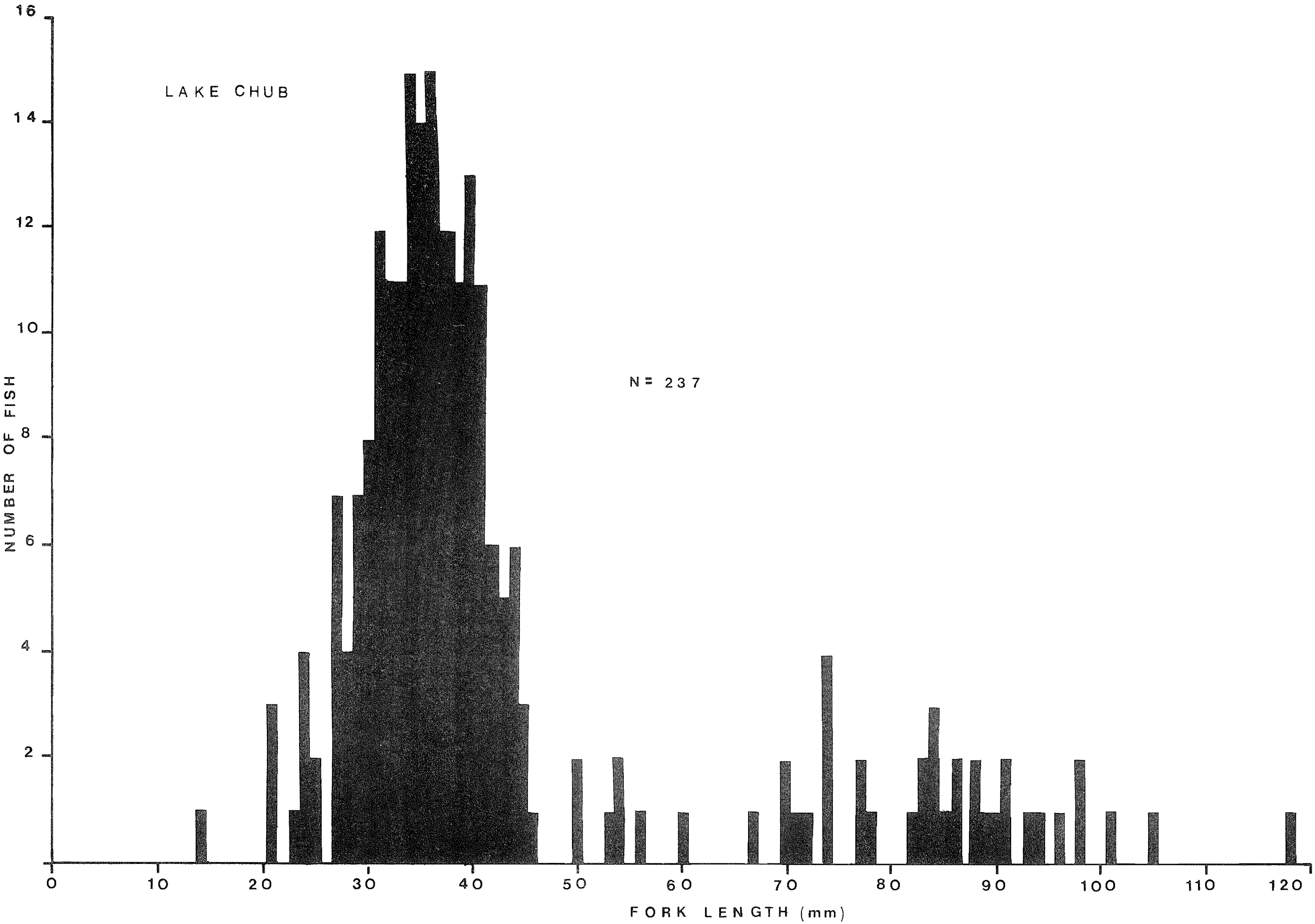


Figure 32. Length-frequency distribution for lake chub from the Muskeg River watershed, 1976.

Table 37. Age-length relationship (derived from otoliths), age-specific sex ratios and maturity of lake chub captured from the Muskeg River, Hartley and Kearl creeks, 1976.

Age	Females			Males			Unsexed Fish	Total Sample	Fork Length (mm)		
	N	%	% Mature	N	%	% Mature			Mean	Std. Dev.	Range
0+	18	50	0	18	50	0	4	40	32.5	6.4	14-44
1	15	58	0	11	42	0	7	33	39.7	7.3	29-56
2	1	25	0	3	75	0	0	4	63.0	7.5	54-71
3	6	46	83	7	54	43	0	13	76.4	5.3	70-88
4	8	62	100	5	38	80	0	13	88.9	4.2	83-96
5	3	100	100	0	-	-	0	3	108.0	8.9	101-118
Totals	51	54		44	46		11	106			

Table 39. Age-length relationship (derived from otoliths), age-specific sex ratios and maturity of slimy sculpin captured from the Muskeg River, 1976.

Age	Females			Males			Unsexed Fish	Total Sample	Total Length (mm)		
	N	%	% Mature	N	%	% Mature			Mean	Std. Dev.	Range
0+	34	71	0	14	29	0	9	57	29.0	5.6	11-38
1	0	0	-	2	100	0	0	2	41.5	4.9	38-45
2	7	58	0	5	42	0	0	12	56.2	3.1	52-63
3	1	25	0	3	75	67	0	4	68.5	2.9	65-72
4	1	100	100	0	-	-	0	1	75	-	-
Totals	43	64		24	36		9	76			

Age-length and age-weight curves for lake chub are shown in figures 33 and 34 respectively.

5.4.9.3 Sex and maturity. Of the lake chub sexed (n = 220) from the study area, 51% were females (Table 38). Of 95 fish aged and sexed, 54% were females (Table 37), but the sex ratio did not differ significantly from unity ($X^2 = 0.52$, $p > 0.05$).

The smallest size at sexual maturity was 55-59 mm for males and 70-74 mm for females (Table 38). The minimum age at which sexual maturity was attained was age 3 for both sexes (Table 37).

5.4.9.4 Length-weight relationship. The length-weight relationship for lake chub from the study area (n = 237, r = 0.994), as determined for both sexes combined is described by the equation:

$$\log_{10} W = 3.019 (\log_{10} L) - 5.000; \ sb = 0.021$$

5.4.9.5 Spawning. Ripe female lake chub were collected until 21 June in the Muskeg River and Hartley Creek. The first young-of-the-year was captured on 29 June (fork length 27 mm).

5.4.10 Slimy sculpin

5.4.10.1 Distribution and relative abundance. Slimy sculpins made up 26% of all small fish captured in the Muskeg River watershed (excluding suckers). This species was common in the lower reaches of the Muskeg (Areas 1, 2 and 3) and in the lower reaches of Hartley Creek (Area 7). These areas possess abundant gravel under which this fish customarily hides. This species was not observed anywhere in the Muskeg River watershed upstream from Hartley Creek (Table 6).

5.4.10.2 Age and growth. Figure 35 gives the length-frequency distribution for slimy sculpin (n = 187) taken from the Muskeg River and Hartley Creek in 1976. While fish ranged in total length from

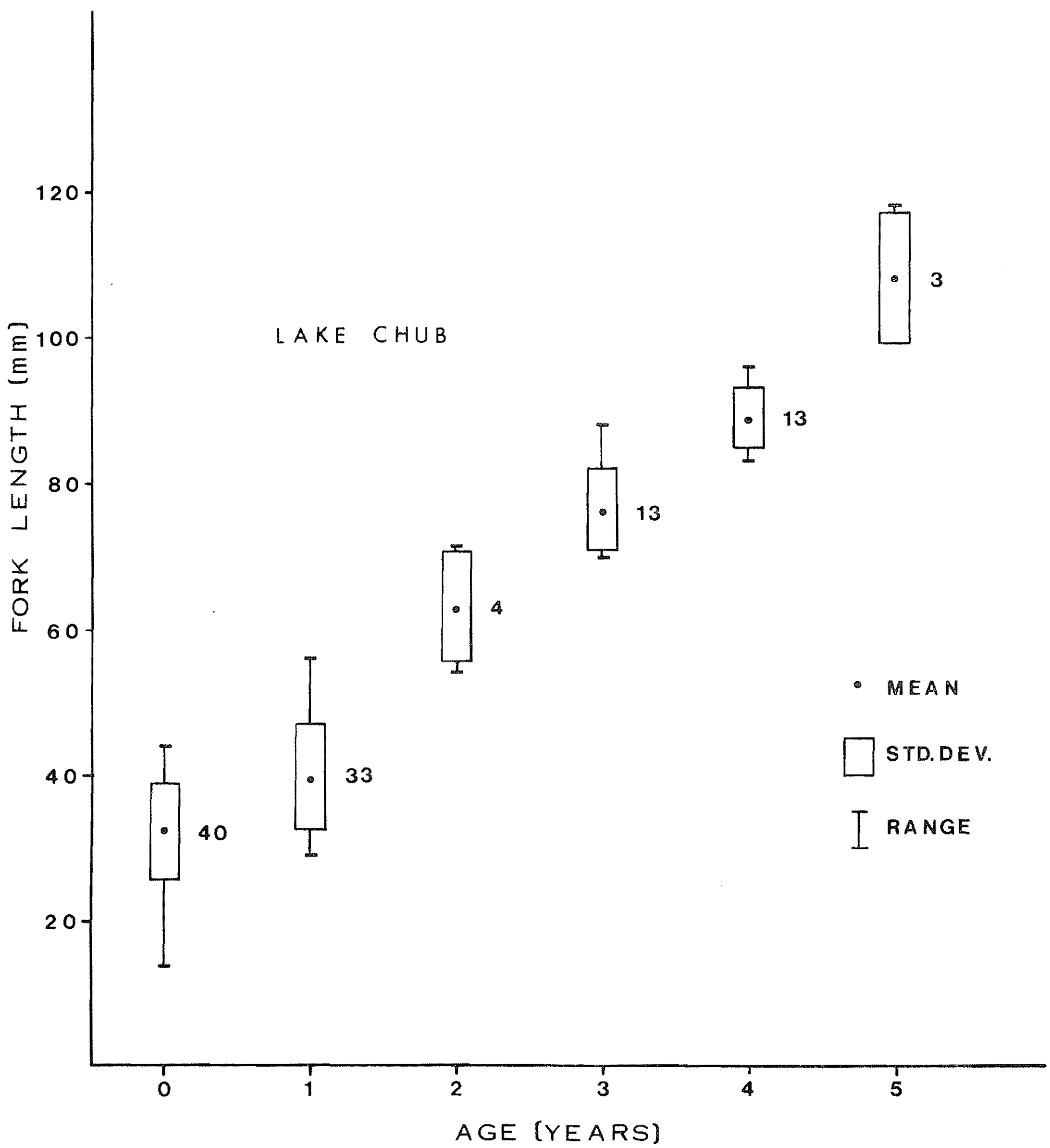


Figure 33. Age-length relationship for lake chub from the Muskeg River watershed, 1976.

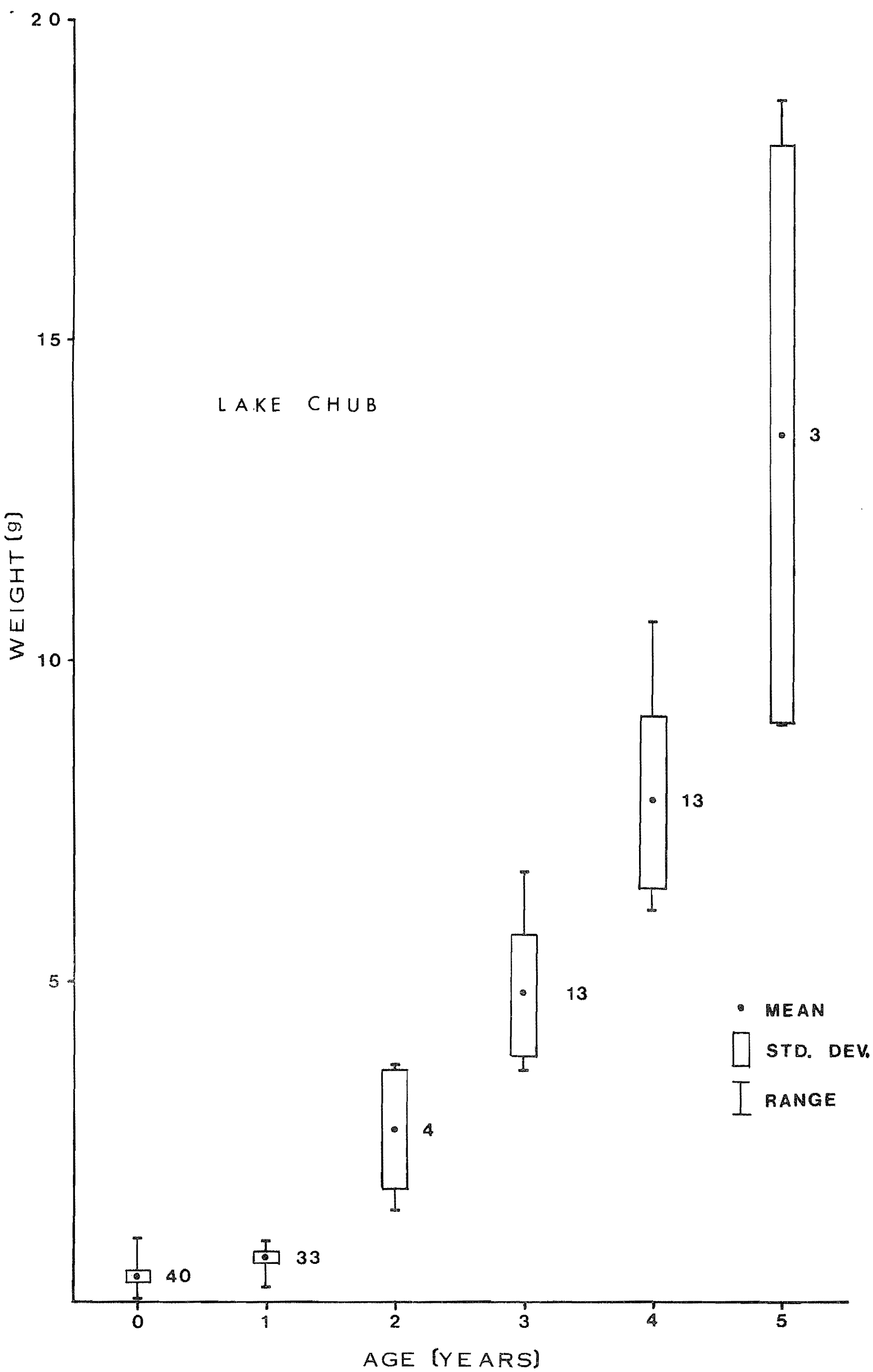


Figure 34. Age-weight relationship for lake chub from the Muskeg River watershed, 1976.

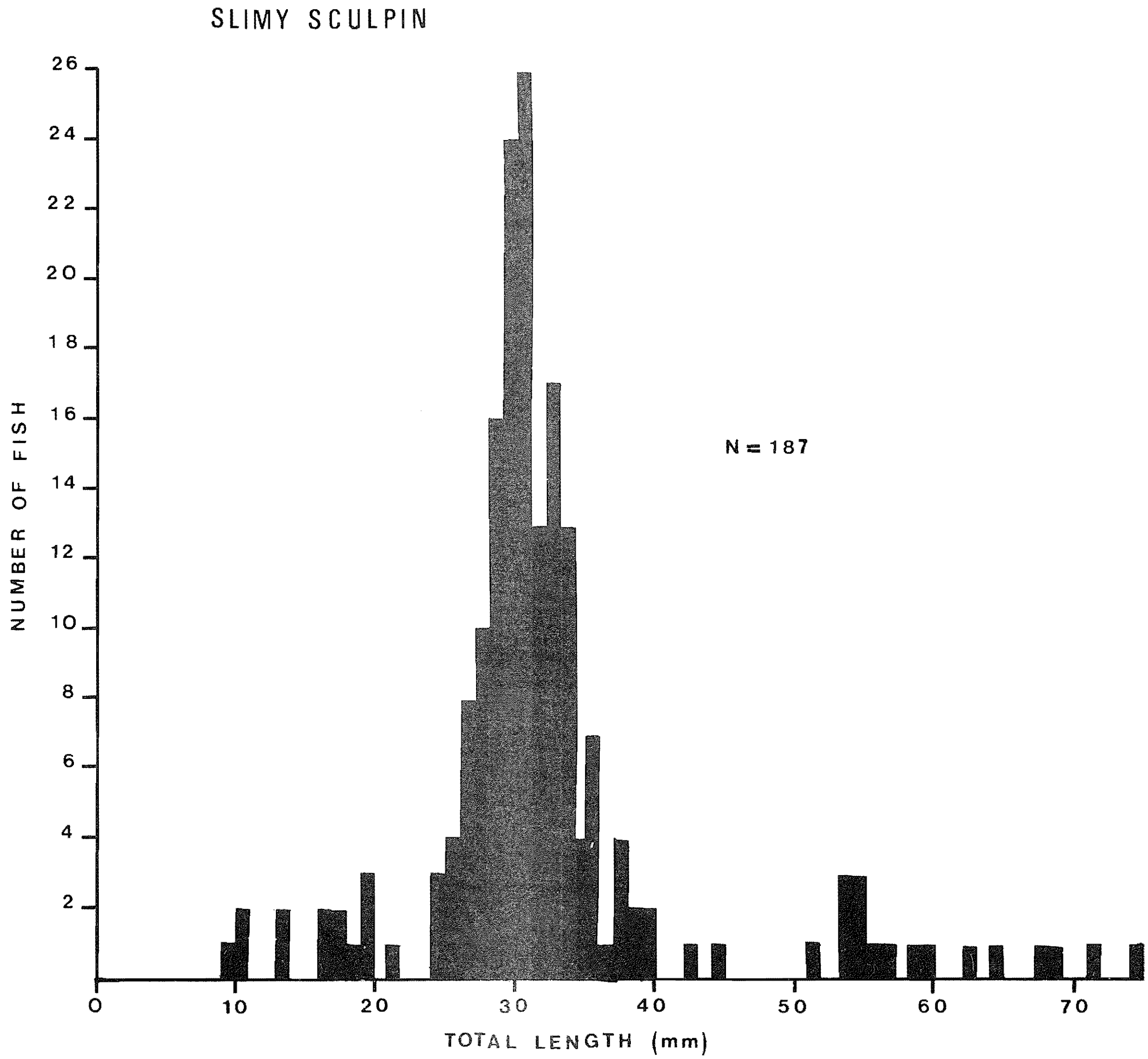


Figure 35. Length-frequency distribution for slimy sculpins from the Muskeg River watershed, 1976.

9 to 75 mm, those in the 25 to 34 mm size range comprised 72% of the total sample.

Otolith ages were determined for 76 slimy sculpin and the age-length relationship is indicated in Table 38. The oldest slimy sculpin taken was a 4 year old female, 75 mm in total length.

Age-length and age-weight curves for slimy sculpin are given in Figures 36 and 37 respectively.

5.4.10.3 Sex and maturity. Overall, male sculpins (53%) were more abundant than females (Table 40) but the sex ratio did not differ significantly from 1:1 ($X^2 = 0.54$, $p > 0.05$).

Most of the sculpins captured were classified as immature fish (Table 40). Only 4 fish, one female and three males, were judged to be mature, i.e., would either spawn in the year of capture or had spawned previously.

The smallest size at sexual maturity was 60-64 mm for male sculpins and 75-79 mm for females (Table 40).

5.4.10.4 Length-weight relationship. The following length-weight relationship (sexes combined) was calculated for slimy sculpins ($n = 187$, $r = 0.989$).

$$\log_{10} W = 3.445 (\log_{10} L) - 5.748, \ sb = 0.038$$

5.4.10.5 Spawning. A ripe female and male slimy sculpin were captured on May 8 and 9 respectively in the Muskeg River (Area 2). The first young-of-the-year fish (11 mm total length) was taken 9 June in Hartley Creek.

5.4.11 Brook stickleback

5.4.11.1 Distribution and relative abundance. Brook stickleback accounted for 21% of all small fish taken in the Muskeg River

Table 38. Sex and maturity ratios, by size class, for lake chub captured from the Muskeg River, Hartley and Kearl creeks, 1976. Sex ratios were based only on fish for which sex was determined. Percent mature included only those fish which would either spawn in the year of capture or had spawned previously.

Fork Length (mm)	Sample Size	Maturity: Males % Immature	Maturity: Males % Mature	Maturity: Females % Immature	Maturity: Females % Mature	% Unsexed	Sex Ratio % Female	Sex Ratio % Male
10-14	1	-	-	-	-	100	-	-
15-19	0	-	-	-	-	0	-	-
20-24	8	100	0	100	0	0	13	87
25-29	20	100	0	100	0	10	20	70
30-34	56	100	0	100	0	5	51	49
35-39	65	100	0	100	0	9	63	37
40-44	41	100	0	100	0	10	46	54
45-49	4	100	0	100	0	0	25	75
50-54	5	100	0	100	0	20	25	75
55-59	1	0	100	-	-	0	0	100
60-64	1	0	100	-	-	0	0	100
65-69	1	100	0	-	-	0	0	100
70-74	8	0	100	0	100	0	50	50
75-79	3	0	100	0	100	0	67	33
80-84	5	0	100	0	100	0	20	80
85-89	8	0	100	0	100	0	62	38
90-94	6	0	100	0	100	0	83	17
95-99	1	-	-	0	100	0	100	0
100-104	1	-	-	0	100	0	100	0
105-109	1	-	-	0	100	0	100	0
110-114	0	-	-	-	-	0	-	-
115-119	1	-	-	0	100	0	100	0
Totals	237	53%	47%	44%	56%	7%	51%	49%

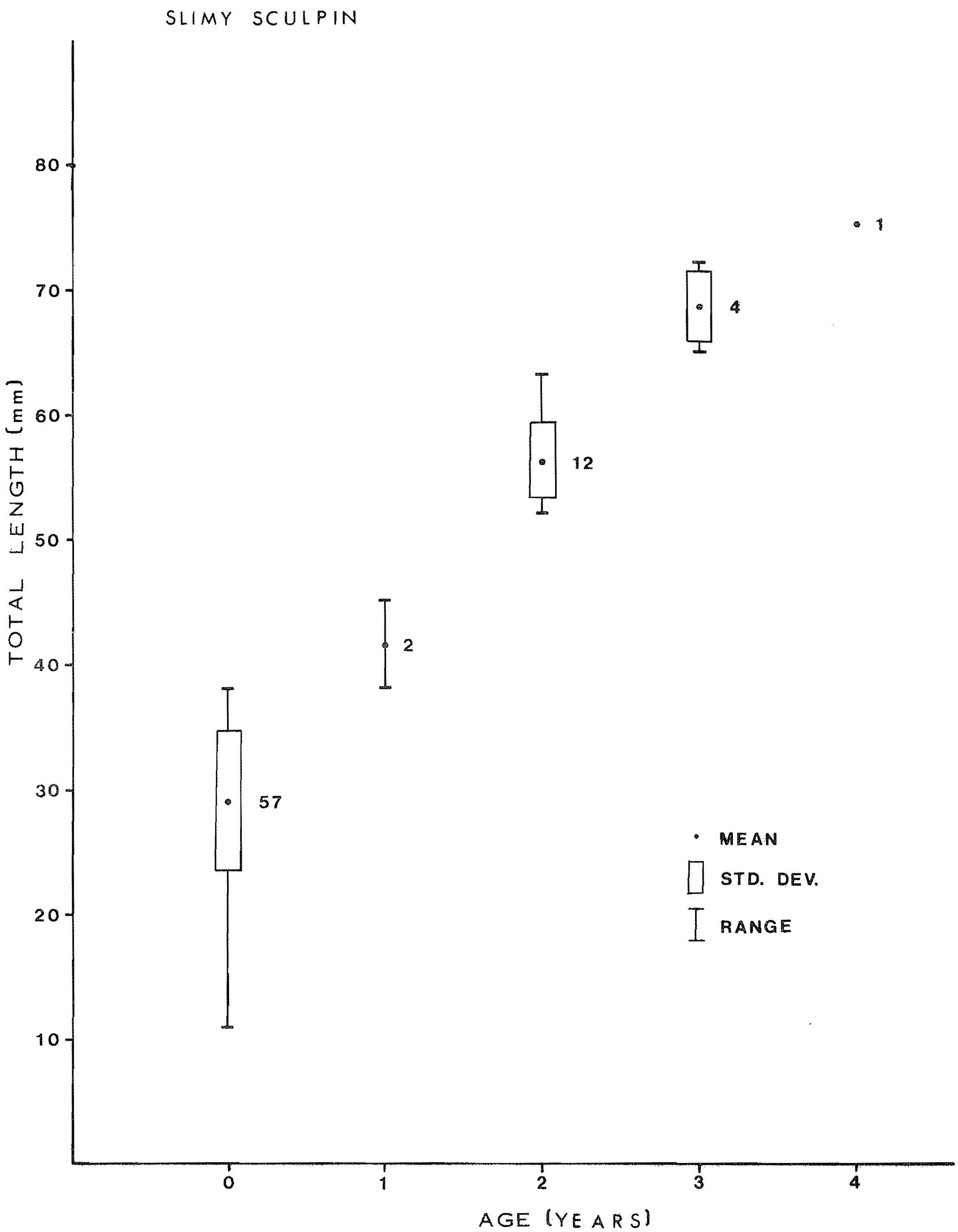


Figure 36. Age-length relationship for slimy sculpins from the Muskeg River watershed, 1976.

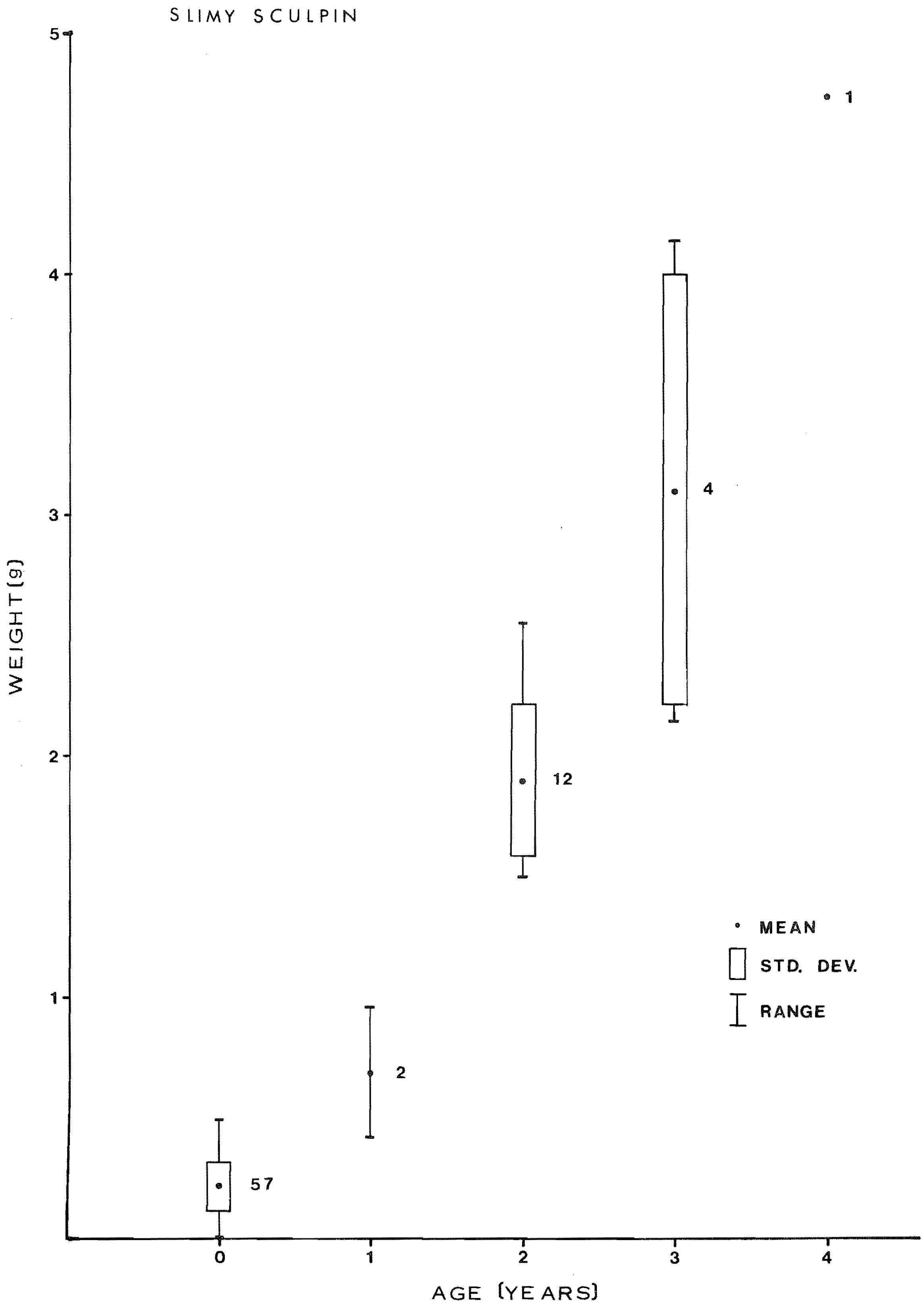


Figure 37. Age-weight relationship for slimy sculpins from the Muskeg River watershed, 1976.

Table 40. Sex and maturity ratios, by size class, for slimy sculpin captured from the Muskeg River, 1976. Sex ratios were based only on fish for which sex was determined. Percent mature included only those fish which would either spawn in the year of capture or had spawned previously.

Total Length (mm)	Sample Size	Maturity: Males % Immature	Maturity: Males % Mature	Maturity: Females % Immature	Maturity: Females % Mature	% Unsexed	Sex Ratio % Female	Sex Ratio % Male
0-4	0	-	-	-	-	-	-	-
5-9	0	-	-	-	-	-	-	-
10-14	5	-	-	-	-	100	-	-
15-19	5	-	-	100	0	80	100	0
20-24	4	100	0	100	0	50	50	50
25-29	42	100	0	100	0	10	76	24
30-34	93	100	0	100	0	12	73	27
35-39	18	100	0	100	0	7	41	59
40-44	2	100	0	-	-	0	0	100
45-49	1	100	0	-	-	0	0	100
50-54	4	100	0	100	0	0	75	25
55-59	6	100	0	100	0	0	67	33
60-64	2	100	0	-	-	0	0	100
65-69	3	0	100	100	0	0	33	67
70-74	1	100	0	-	-	0	0	100
75-79	1	-	-	0	100	0	100	0
Totals	187	91%	9%	89%	11%	19%	47%	53%

watershed (excluding suckers). This species was most commonly seen in the upper watershed areas where the river was deep and of low gradient. They made up 100% of the catch in Areas 5 and 10, and 86% of the total catch in Area 6 where they were associated with lake chub (Table 6). This species is more abundant in Area 10 than indicated in Table 6 but few fish were taken here because of marshy conditions and deep water.

5.4.11.2 Age and growth. The length-frequency distribution for 194 brook sticklebacks is shown in Figure 38. Stickleback from the Muskeg River and Hartley Creek ranged from 10 to 62 mm in total length with a modal length of 39 mm. Fish in the 31-42 mm length range were most common (79% of sample).

Otolith ages were determined for 55 brook stickleback and the age-length relationship is given in Table 41. The oldest fish in the sample were 3 year old males although these comprised only 7% of all stickleback caught.

Age-length and age-weight curves for brook stickleback from the Muskeg River and Hartley Creek are shown in Figures 39 and 40 respectively.

5.4.11.3 Sex and maturity. Female brook stickleback were more abundant than males in our sample making up 57% of the total (Table 42). However, the sex ratio did not differ significantly from unity ($X^2 = 3.52$, $p > 0.05$).

The smallest mature fish were males in the 20-24 mm size class while in the 40-44 mm group, all stickleback were judged to be mature (Table 42). The minimum age of maturity was age 1 for both males and females (Table 41).

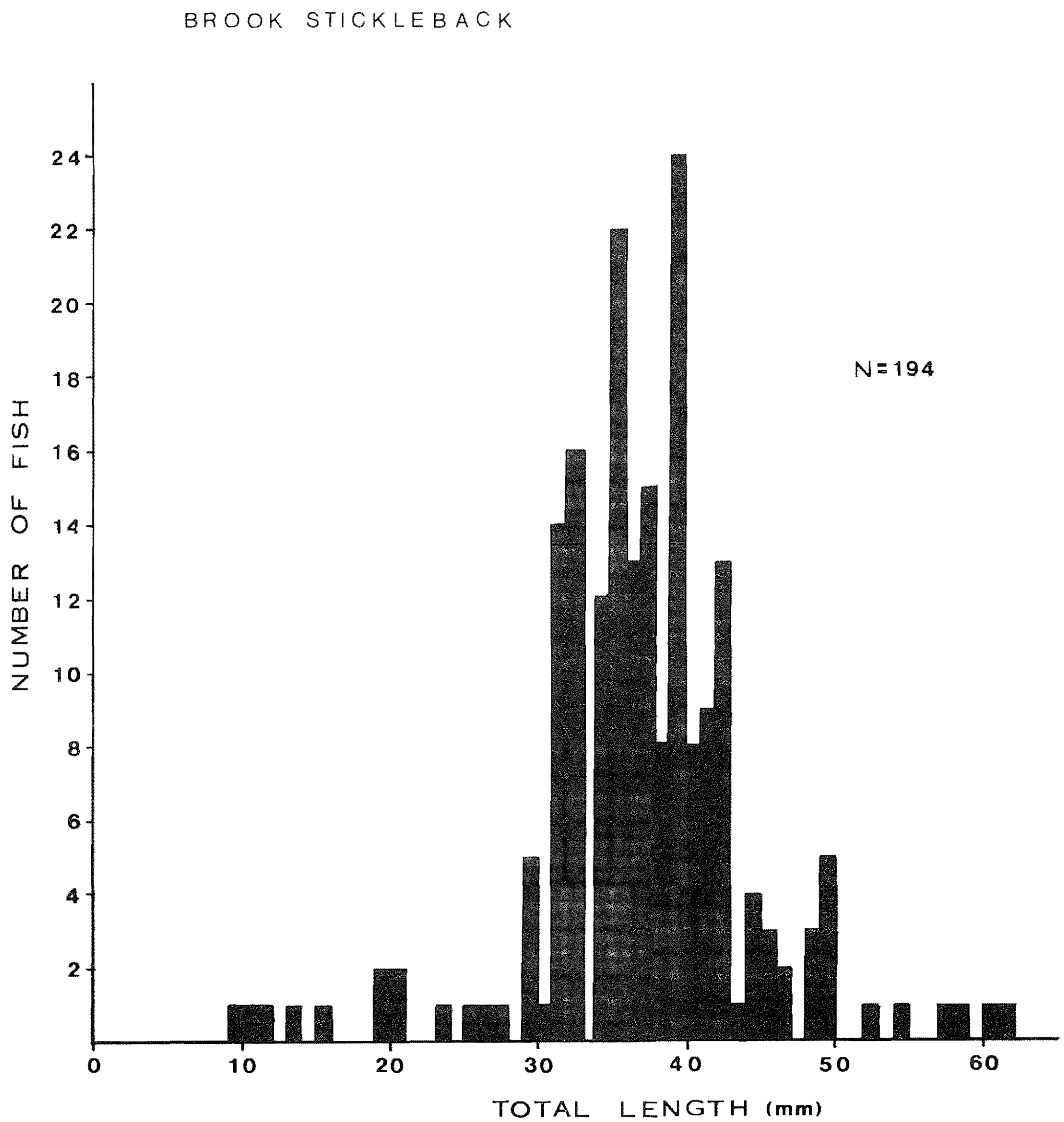


Figure 38. Length-frequency distribution for brook sticklebacks from the Muskeg River watershed, 1976.

Table 41. Age-length relationship (derived from otoliths), age-specific sex ratios and maturity of brook stickleback captured from the Muskeg River, Hartley and Kearl creeks, 1976.

Age	Female			Male			Unsexed Fish	Total Sample	Total Length (mm)		
	N	%	% Mature	N	%	% Mature			Mean	Std. Dev.	Range
0+	4	100	0	0	-	-	5	9	16.1	4.5	10-21
1	10	53	40	9	47	57	0	19	32.8	3.3	27-40
2	12	52	58	11	48	100	0	23	41.6	3.4	37-49
3	0	-	-	4	100	75	0	4	59.5	2.4	57-62
Totals	26	52		24	48		5	55			

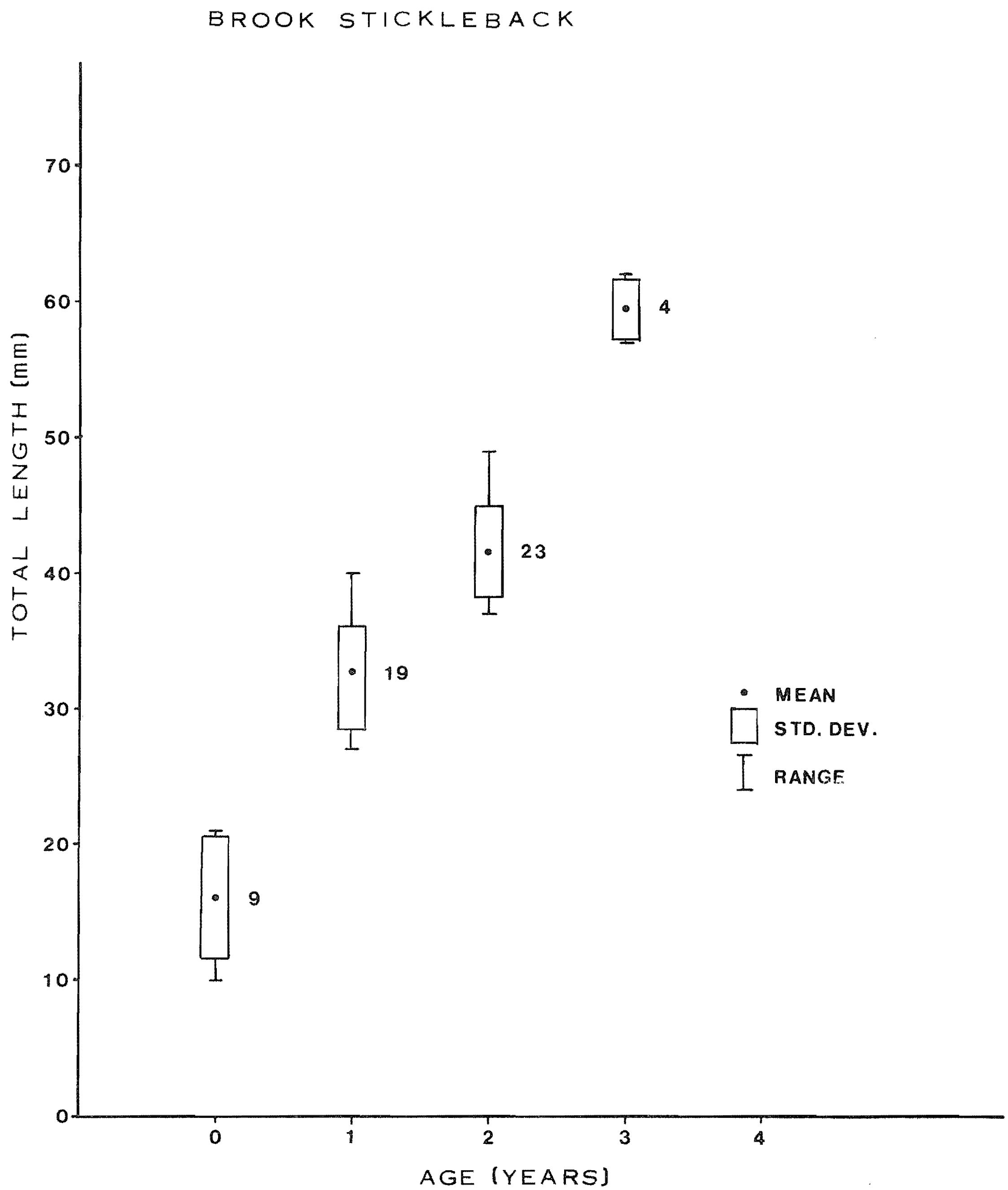


Figure 39. Age-length relationship for brook sticklebacks from the Muskeg River watershed, 1976.

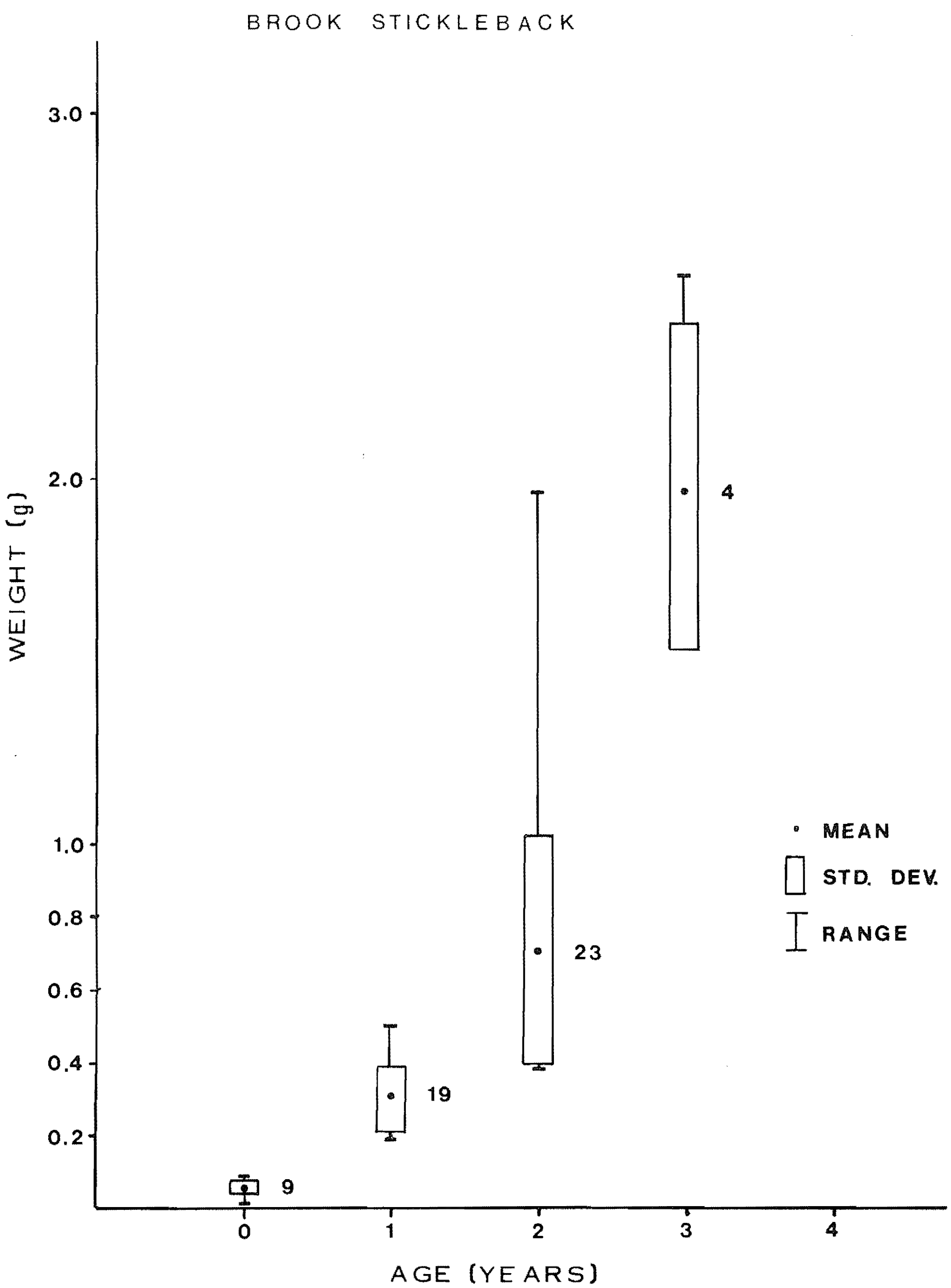


Figure 40. Age-weight relationship for brook sticklebacks from the Muskeg River watershed, 1976.

Table 42. Sex and maturity ratios, by size class, for brook stickleback captured from the Muskeg River, Hartley and Kearl creeks, 1976. Sex ratios were based only on fish for which sex was determined. Percent mature included only those fish which would either spawn in the year of capture or had spawned previously.

Fork Length (mm)	Sample Size	Maturity: Males % Im-mature	Maturity: Males % Mature	Maturity: Females % Im-mature	Maturity: Females % Mature	% Unsexed	Sex Ratio % Female	Sex Ratio % Male
5-9	0	-	-	-	-	-	-	-
10-14	4	-	-	100	0	50	100	0
15-19	1	100	0	-	-	0	0	100
20-24	5	67	33	100	0	0	40	60
25-29	3	0	100	50	50	0	67	33
30-34	43	14	86	10	90	0	49	51
35-39	66	0	100	25	75	0	52	48
40-44	51	0	100	0	100	0	55	45
45-49	12	0	100	0	100	0	50	50
50-54	4	0	100	0	100	0	25	75
55-60	3	0	100	0	100	0	33	67
60-64	2	0	100	-	-	0	0	100
Totals	194	18%	82%	32%	68%	1%	57%	43%

5.4.11.4 Length-weight relationship. A common length-weight relationship was calculated for male and female brook stickleback ($n = 194$, $r = 0.974$). This relationship is described by the equation:

$$\log_{10} W = 3.0435 (\log_{10} L) - 5.1041; sb = 0.0510$$

5.4.11.5 Spawning. Ripe males were first collected on 12 May in the Muskeg River and were still in spawning colouration when taken on 18 June. Ripe females and males in spawning colouration were captured in Hartley Creek as late as 16 June.

The first young-of-the-year (10-11 mm total length) appeared in the Muskeg River catches on 17 June.

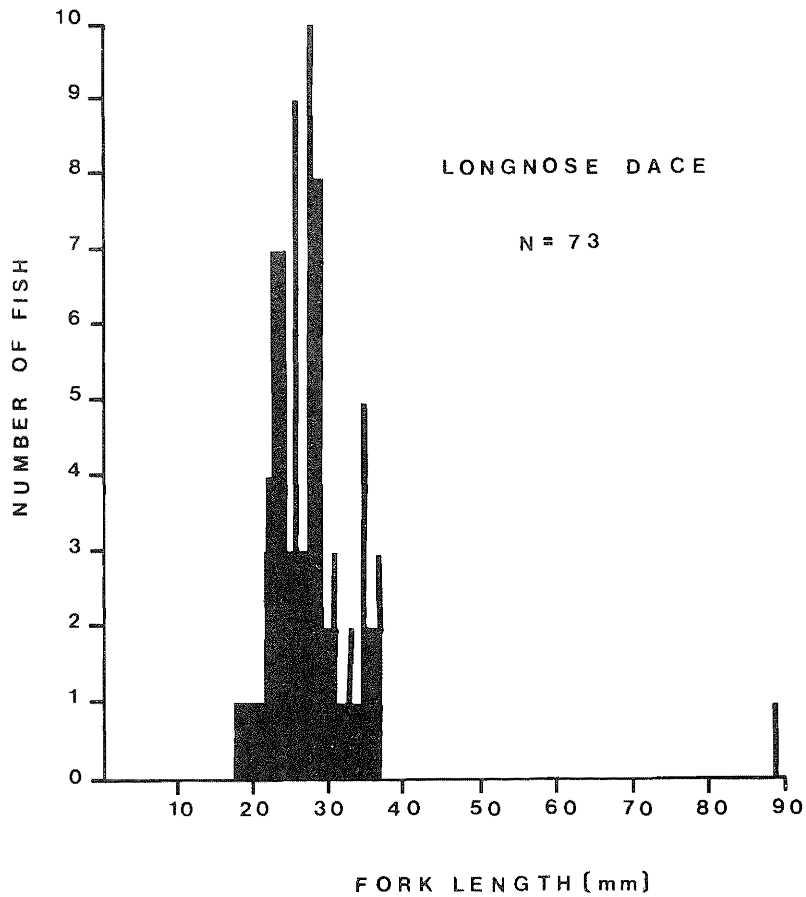
5.4.11.6 Overwintering. Stickleback were collected at the outlet of Kearl Lake (Area 10 in Fig. 5) on 5 March 1977. At this time several hundred feet of Kearl Creek were ice free, one of the few open water areas in the study area at that time. Large numbers of brook stickleback were observed but only a few could be captured because of the difficult seining conditions at this location.

5.4.12 Longnose dace

5.4.12.1 Distribution and relative abundance. A total of 75 longnose dace were collected from the study area with 74 of these being captured in Area 2 (Table 6). This species accounted for 8% of all small fish taken (excluding suckers).

5.4.12.2 Age and growth. Longnose dace ranged in fork length from 18 to 89 mm (Fig. 41).

Otolith ages were determined for 73 longnose dace, the age-length relationship given in Table 41. Of this number, 72 fish were found to be young-of-the-year (age 0+) while one was a 3 year old female, 89 mm in fork length.



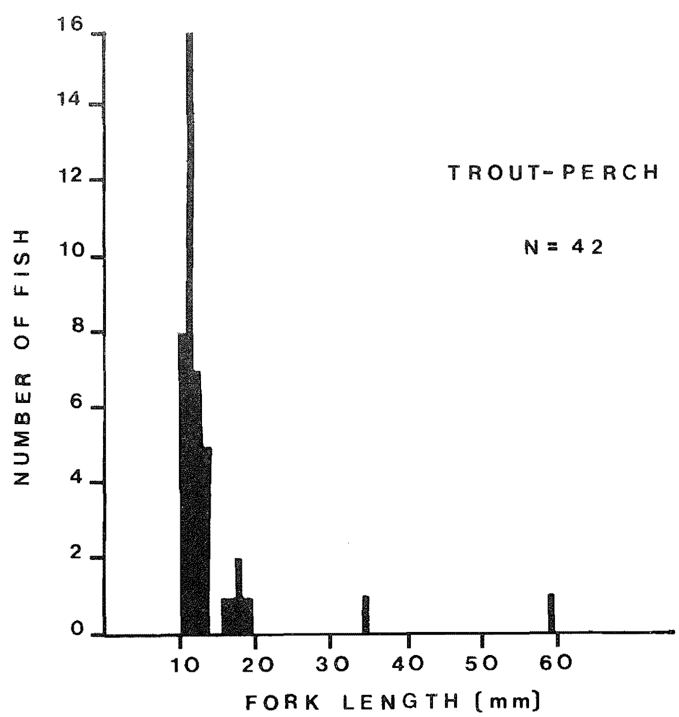


Figure 41. Length-frequency distribution for longnose dace and trout-perch from the Muskeg River watershed, 1976.

5.4.12.3 Spawning. Although only 1 ripe longnose dace (female) was collected, this species probably spawns in the lower reaches of the Muskeg River. Young-of-the-year dace were abundant in Area 2 on 4 August 1976 at which time fork length ranged from 18-37 mm.

5.4.13 Other species

5.4.13.1 Trout-perch. Forty-two trout perch ranging in size from 10 to 58 mm fork length were collected from the Muskeg River (Fig. 4 and Table 43). One fish was a ripe female (age 3), taken in a minnow trap on 14 May. Forty young-of-the-year fish (size range 10-17 mm) were collected at the confluence of the Muskeg and Athabasca rivers (Area 1) on 15 June. This species, while abundant in the Athabasca River, is rarely found in the Muskeg River watershed.

5.4.13.2 Pearl dace. Only four young-of-the-year pearl dace (range 20-25 mm in fork length) were taken from the Muskeg River (Table 43). These fish were seined from Area 2 on 4 August 1976.

5.4.13.3 Spottail shiner. Only 1 young-of-the-year spottail shiner was captured. This fish was 22 mm in fork length (Table 43) and was seined from Area 2 on 4 August 1976.

TABLE 43. Age-length relationships (derived from otoliths and length frequencies), age specific sex ratios and maturity of trout-perch, longnose dace, pearl dace and spottail shiner captured from the Muskeg River in 1976.

Species/Age	Females			Males			Unsexed Fish	Total Sample	Fork Length (mm)		
	N	%	% Mature	N	%	% Mature			Mean	S.D.	Range
Trout-perch											
0+	1	100	0				40	41	12.2	3.5	10-34
3	1	100	100				0	1	58.0	-	-
Totals	2						40	42			
Longnose Dace											
0+	10	50	0	10	50	0	52	72	27.6	4.6	18-37
3	1	100	100					1	89.0	-	-
Totals	11			10			52	73			
Pearl Dace											
0+	2	67	0	1	33	0	1	4	22.3	4.7	20-25
Totals	2			1			1	4			
Spottail Shiner											
0+							1	1	22.0	-	-
Totals							1	1			

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7. LIST OF AOSERP REPORTS

1		AOSERP First Annual Report, 1975
2	AF 4.1.1	Walleye and Goldeye Fisheries Investigations in the Peace-Athabasca Delta- 1975
3	HE 1.1.1	Structure of a Traditional Baseline Data System
4	VE 2.2	Preliminary Vegetation Survey of the AOSERP Study Area
5	HY 3.1	Evaluation of Wastewaters from an Oil Sands Extraction Plant
6		Housing for the North - Stackwall System Construction Report
7	AF 3.1.1	Synopsis of the Physical and Biological Limnology and Fishery Programs within the Alberta Oil Sands Area
8	AF 1.2.1	Impact of Saline Waters upon Freshwater Biota (A Literature Review and Bibliography)
9	ME 3.3	Preliminary Investigation into the Magnitude of Fog Occurrence and Associated Problems in the Oil Sands Area
10	HE 2.1	Development of a Research Design Related to Archaeological Studies in the Athabasca Oil Sands Area
11	AF 2.2.1	Life Cycles of Some Common Aquatic Insects of the Athabasca River
12	ME 1.7	Very High Resolution Meteorological Satellite Study of Oil Sands Weather, a Feasibility Study
13	ME 2.3.1	Plume Dispersion Measurements from an Oil Sands Extraction Plant
14	HE 2.4	Athabasca Oil Sands Historical Research Project (3 volumes) (in preparation)
15	HE 3.4	Climatology of Low Level Air Trajectories in the Alberta Oil Sands Area
16	ME 1.6	The Feasibility of a Weather Radar near Fort McMurray, Alberta
17	AF 2.1.1	A survey of Baseline Levels of Contaminants in Aquatic Biota of the AOSERP Study Area
18	HY 1.1	Alberta Oil Sands Region Stream Gauging Data(in preparation)
19	ME 4.1	Sulphur Dioxide Concentrations at Ground Level (in preparation)
20	HY 3.1.1	Evaluation of Organic Constituents (in preparation)
21		AOSERP Second Annual Report, 1976-77
22	HE 2.3	Maximization of Technical Training and Involvement of Area Manpower(in preparation)
23	AF 1.1.2	Acute Lethality of Mine Depressurization Water on Trout, Perch and Rainbow Trout (in preparation)
24	ME 4.2	Review of Dispersion Models Possible Applications in the Alberta Oil Sands Area (in preparation)
25	ME 3.5.1	Review of Pollutant Transformation Processes Relevant to the Alberta Oil Sands Area (in preparation)
26	AF 4.5.1	An Interim Report on an Intensive Study of the Fish Fauna of the Muskeg River Watershed of Northeastern Alberta

For information regarding any of these publications of the Alberta Oil Sands Environmental Research Program, please contact the Program Office.

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