Syncrude Canada Ltd., 1973. Beaver Creek: An ecological baseline survey. Syncrude Canada Ltd., Edmonton, Alberta. Environmental Research Monograph 1973-2. 39 pp.

FOREWORD

Syncrude Canada Ltd. has been involved in environmental studies since the beginning of its research and development activities in the Athabasca Tar Sands. Many of the early studies had direct engineering implications. More recently, Syncrude has commissioned studies to document baseline ecological conditions and to explore mitigation possibilities relative to alteration of biological resources resulting from its proposed development.

Syncrude Canada Ltd. recognized the need for an understanding of the ecosystem in which its development would be taking place. Renewable Resources Consulting Services Limited, ecological consultants of Edmonton, Alberta, were retained to carry out the studies presented in this publication.

The Management of Syncrude Canada Ltd. feel that scientific information which results from its studies should be made available to the public. We feel a responsibility to contribute to the body of knowledge necessary for orderly development of the Tar Sands, in order to minimize damage and maintain the ecological integrity of the area.

Other studies, many of a preliminary or first-survey nature, have also been carried out. It is the intention of Syncrude Canada Ltd. to release other information in subsequent environmental research monographs. We hope that this information will be helpful to the scientific community and to the citizens of Alberta who are concerned with the management of resources on a sound ecological basis.

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SYNCRUDE CANADA LTD.

ENVIRONMENTAL POLICY STATEMENT

Syncrude Canada Ltd. works with the conviction that human use of the environment need not be destructive. With careful planning, based upon good information, man-altered and natural ecosystems can exist in harmony. In order to accomplish this planning, Syncrude considers resource development from a total-systems point of view. This comprehensive approach corrects the frequent tendency to attempt resolution of problems on a single purpose basis. The total-systems analysis approach leads to a plan of operations using the best practicable technology, both in resource development and in environmental protection. An ecosystem approach to resource development, an integral part of our approach, implies an understanding of and respect for the potential of natural systems and the use of the economy of nature, wherever possible.

Through a comprehensive program of surveillance of the effects of our technology and careful application of that technology, we aim to prevent accidental damage to the environment. Total effects will be examined by professional ecologists and study results provided to public representatives.

February 23, 1973

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Summary of Results

1) Beaver Creek rated 55% on the calculation of habitat percent of optimum. This value is considered low.
2) Low dissolved oxygen and percent saturation occur in the slackwater area of Beaver Creek.
3) The river is high in total dissolved solids but normal for pH, methyl orange alkalinity and total hardness.
4) Water temperatures are within the tolerance limits for Arctic grayling.
5) Abundance of food organisms is rated as poor on the basis of bottom and drift sampling.
6) Tar sand-rubble substrate may limit production of benthic organisms.
7) Beaver Creek was utilized exclusively by the people of the Ft. McMurray area for recreation purposes during the survey period. Use was associated with existing access points downstream from the Syncrude lease.
8) Angling was the major form of recreation, however picnicking and camping were also important. Recreational use, based on man hours, was low.
9) Beaver Creek is one of twenty-nine streams comprising a total length of 2,308 miles, within a 50-mile radius of the proposed plant site.
10) Lake chub, and suckers, constituted 88% of the total sample, which numbered 659 fish. Arctic grayling accounted for only 8% of the total.
11) Only two creel-sized grayling were taken during the entire sampling period.
12) Young-of-the-year Arctic grayling were collected only in the lower portion of Beaver Creek, between its confluence with the Athabasca River and the Ft. MacKay road. This area is considered to provide the best spawning and rearing habitat.
13) Chub, suckers, and brook stickleback were the only fish species taken from Mildred Lake. No sport fish were taken.

Summary of Conclusions

1) Fisheries habitat for Arctic grayling is considered marginal in Beaver Creek due primarily to habitat restrictions.
2) Arctic grayling (creel size) comprised 0.3% of the total species sampled indicating that the sport fishery capability of the river for this species is extremely low.
3) Possible limiting factors to grayling production include:
   a) Lack of suitable spawning substrate;
   b) Low dissolved oxygen concentrations occurring in the slackwater area;
   c) Low production of benthic organisms in riffle areas thus limiting food supply.
4) The lack of a catchable population precludes any economic analysis based upon the existence of a harvestable fish stock.
5) Data indicate that the creek is used primarily by residents of the Ft. McMurray area with angling only a part of the recreational value. Existing recreation demands on the creek are considered light.
6) While Arctic grayling production is low, evidence indicates that the species utilizes lower Beaver Creek as a spawning and rearing area. The size of the spawning run is unknown. Construction of a dam and retention pond would eliminate this potential spawning area.
7) The impact of the Syncrude development on other species (primarily chub and suckers) in Beaver Creek would be negligible upstream of the development.

I. INTRODUCTION

The tar sands development being contemplated by Syncrude Canada Ltd. will result in ecological disturbances within the lease, especially in the mining areas.

The initial mining area and retention pond will straddle Beaver Creek which flows through the lease to its confluence with the Athabasca River some sixteen miles from the southern lease boundary. The Syncrude development would eliminate the lower reaches of Beaver Creek in the mining and retention pond areas, and modify downstream flows.

The study reported here was initiated on July 26, 1971, to provide ecological baseline information on Beaver Creek. Field surveys were carried out from August 7th to August 24th. Of particular interest to this study was the acquisition of quantitative data on fisheries populations as a means of determining if harvestable populations of sport fish occur in Beaver Creek. Specific objectives of the study were as follows:

1) To conduct a fisheries habitat survey.
2) To conduct systematic sampling of invertebrate fauna.
3) To conduct systematic sampling of the fish populations.
4) To attempt identification of spawning areas.
5) To assess the use made of Beaver Creek by inhabitants of the Fort McMurray area for fishing and other forms of water-oriented recreation.
6) To assess the relative importance of Beaver Creek in a regional context.

II. GENERAL DESCRIPTION

Beaver Creek is located near the town of Ft. McMurray, in northeastern Alberta. Flowing north out of a bog area, it is a tributary of the Athabasca River (Fig. 1). The upper section of the creek is composed almost entirely of slackwater, flowing over a heavily-silted substrate. "Slackwater" in the remainder of this report refers to evenly flowing, smooth-surfaced water in the upper sections of the creek, i.e.; greater than ten miles above the confluence of Beaver Creek and the Athabasca River. In the lower ten miles of the creek the gradient becomes steeper resulting in alternating riffles and long pools.

In the fastwater areas, adjacent banks are steep and heavily-wooded. Black spruce *(Picea mariana)*, bog birch *(Betula glandulosa)*, and balsam poplar *(Populus balsamifera)* are the dominant tree species. Further upstream, willow *(Salix spp.)* gradually replaces birch as the dominant brush species. Throughout all areas, reed canary grass *(Phalaris spp.)* grows along the stream bank and provides both cover and bank stabilization (Fig. 2).

III. METHODS AND MATERIALS

A. Physical Habitat:

An aerial survey of the creek was carried out to ascertain its general habitat characteristics. The aerial survey encompassed the upper reaches of the creek and its tributaries. Ground access to this section was impossible even by all-terrain vehicle.

A series of nine sample stations were set up along the creek at one mile intervals beginning at the south lease boundary. The stations were marked with wooden stakes with the total length of each station comprising 200 feet of stream. Transects of 90^{0} across the stream at the upper, lower, and middle sections of the stations were used for sampling

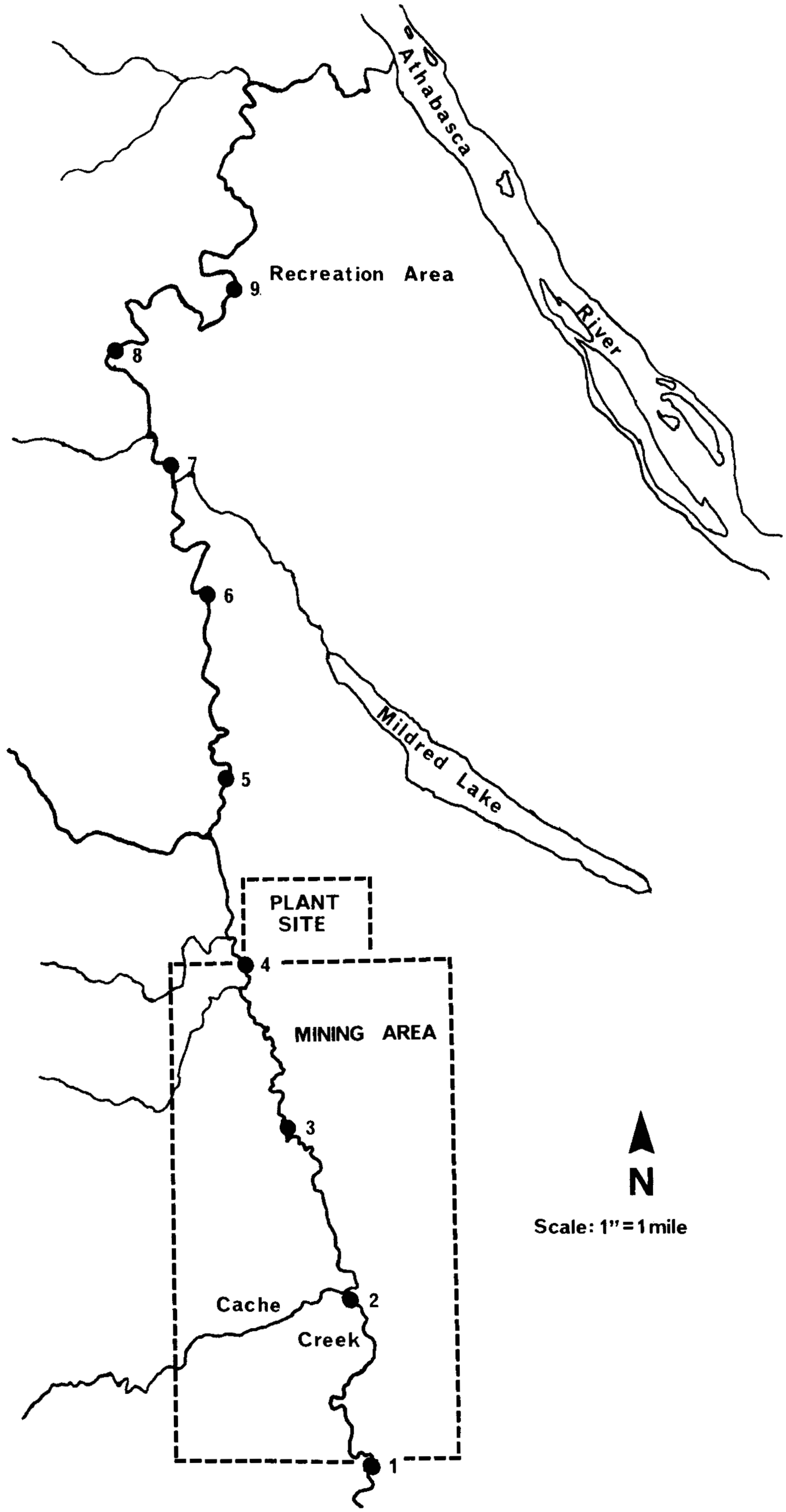

Figure 1: Map of Beaver Creek and Sample Sites, August 1971.

purposes. At each transect, physical and chemical measurements were made. Width was measured to the nearest foot at the existing water line and depth to the nearest inch to assist in determining the average depth of the stream. Pool depth was similarly measured at all sample stations.

Two classes of water surface-pools and riffles were established. The designation of a pool was largely subjective. Pool quality classes were designated on the basis of pool size, water depth and fish shelter as described by Herrington and Dunham (1967).

Six types of bottom material were noted and recorded as follows:

1) Debris
2) Silt
3) Sand
4) Gravel--rocks 0.1 to 2.9 inches in diameter
5) Rubble--rocks 3 to 11.9 inches in diameter
6) Boulder--rocks greater than 12 inches in diameter.

Banks were rated as stable or unstable with 1, 2, or 3 points assigned depending on stability. Bank ratings are subjective and based upon the amount of vegetative cover and fish shelter they provide.

B. Chemical Environment:

Dissolved oxygen, methyl orange alkalinity, total hardness and pH were measured using packaged test kits, and total dissolved solids were measured with a conductivity meter.

Continuous water temperatures were recorded with a maximum - minimum thermometer read every two days. When collecting fish, temperatures were measured with a pocket thermometer.

C. Fish Collection:

Fish collections were made using 30' sections of prima cord explosives. Areas sampled included: the slackwater, pools riffles, beaver dams, and backwaters. Sampling populations by electro-fishing was attempted but had to be discontinued as a result of equipment failures.

Four stream parameters were measured at each sample site to determine the relationship between the density of grayling and measurable habitat characteristics. While these parameters were correlated with other species, emphasis was placed on grayling because of their importance as sport fish. Habitat included stream depth, substrate size, temperature, and water type.

To survey the existing fish fauna of the area, Mildred Lake (Figure 3) was also sampled using prima cord explosives and gill nets. Nets were set overnight and pulled the following morning. The nets used were 50 yards in length with 3½", 4½", and 5½" stretch mesh. Horseshoe Lake was completely choked with aquatic vegetation and could not be sampled.

D. Invertebrate Sampling:

To assess food availability, drifting organisms were sampled in two riffles. Each riffle was sampled with two 1 mm. mesh nets having a mouth size of one foot by two feet. Drift samples were gathered in the nets for 24 hours. Nets were emptied at three hour intervals.

To determine the effect of tar sand substrate on insect production as well as to quantify the production of bottom fauna in the stream, eight 12" by 12" bottom samples were taken. Four samples in rubble-tar sand substrates and four in areas of rubble substrate were taken to allow comparison of the numbers of organisms from the two substrates. This procedure was carried out twice during the study period.

All organisms collected were sorted, classified by order, counted, and their volumes measured.

E. Stream-Oriented Recreation:

Data were tabulated on numbers of anglers who fished the study water. The angler survey was carried out on one weekday and one weekend day each week during the study period. A two-hour count interval was used with counts made from 8:00 a.m. to 8:00 p.m. on the designated days.

F. The Status of Beaver Creek in a Regional Context:

A compilation of numbers, size, and length of other rivers within a 50-mile radius of Beaver Creek was determined from maps of the areas. A mean meander factor was calculated and used to calculate the stream length of all rivers noted.

IV. RESULTS

A. Physical Habitat

From the aerial survey it was observed that Beaver Creek is divided into two major habitat zones. The first, extending from its confluence with the Athabasca River upstream ten miles, is characterized by good riffle-pool separation and generally fast flow. The second, extending from that point to the headwaters, consists almost entirely of slow-moving slackwater. The only exceptions were three small riffle areas approximately 40 miles from the confluence. The upper areas of the river were more open than the lower areas and were heavily populated by beaver as evidenced by the many beaver dams observed (Fig. 4).

Between its confluence and the south lease boundary, the stream is sixteen miles in length, has an average width of 33 feet and an average depth of 28 inches (Table 1). These values represent close to minimum dimensions for this stream since data was collected during the seasonal low flow period.

Pool areas are generally regarded as ideal habitat for most fish species. In the area surveyed, 68% of Beaver Creek was classified as "pool." Seventy-nine percent of the total pools scored as quality Class I (Appendix I)*. Only three percent of the pool areas were assigned to a quality class lower than Class III (Fig. 5).

Silt was the predominant substrate type present, comprising 48% of the total bottom area sampled (Fig. 5). Conversely, ideal spawning habitat for Arctic grayling (i.e. sand and/or gravel) comprised 6% of the total habitat sampled.

The study area included portions of both habitat zones previously mentioned. The upper zone, which includes the creek above the plant site, exhibits a rather uniform gradient consisting of slack-water flowing over heavily-silted substrate. The second zone from the pit area downstream to the Beaver Creek recreational area, has a moderate gradient, generally fast flow and a series of pools and riffles with

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*Quality classes are assigned on the basis of several habitat criteria. These are presented in detail in Appendix II.

Figure 2: Portion of the Beaver River near Station #5. Note the excellent bank stability and cover. August 1971.

Figure 3: General view of Mildred Lake looking north west.

Figure 4: Slackwater area of the Beaver River upstream from the proposed plant site. Note the evidence of beaver activity.

TABLE 1

SUMMARY OF BEAVER CREEK PHYSICAL CHARACTERISTICS, AUGUST 1971

Number of stations	9
Length of stations	200'
Average depth	28"
Average width	33'
Adjusted stream length	16 mi.
Riffle area	32%
Pool area	68%
Total length of pools	1,471'
Maximum possible points for bank observations	36
Total points for bank observations	26
Estimated amount of gravel	30'
Estimated amount of rubble	540'
Streamside Vegetation:	
Forest	24%
Brush	42%
Grass	34%

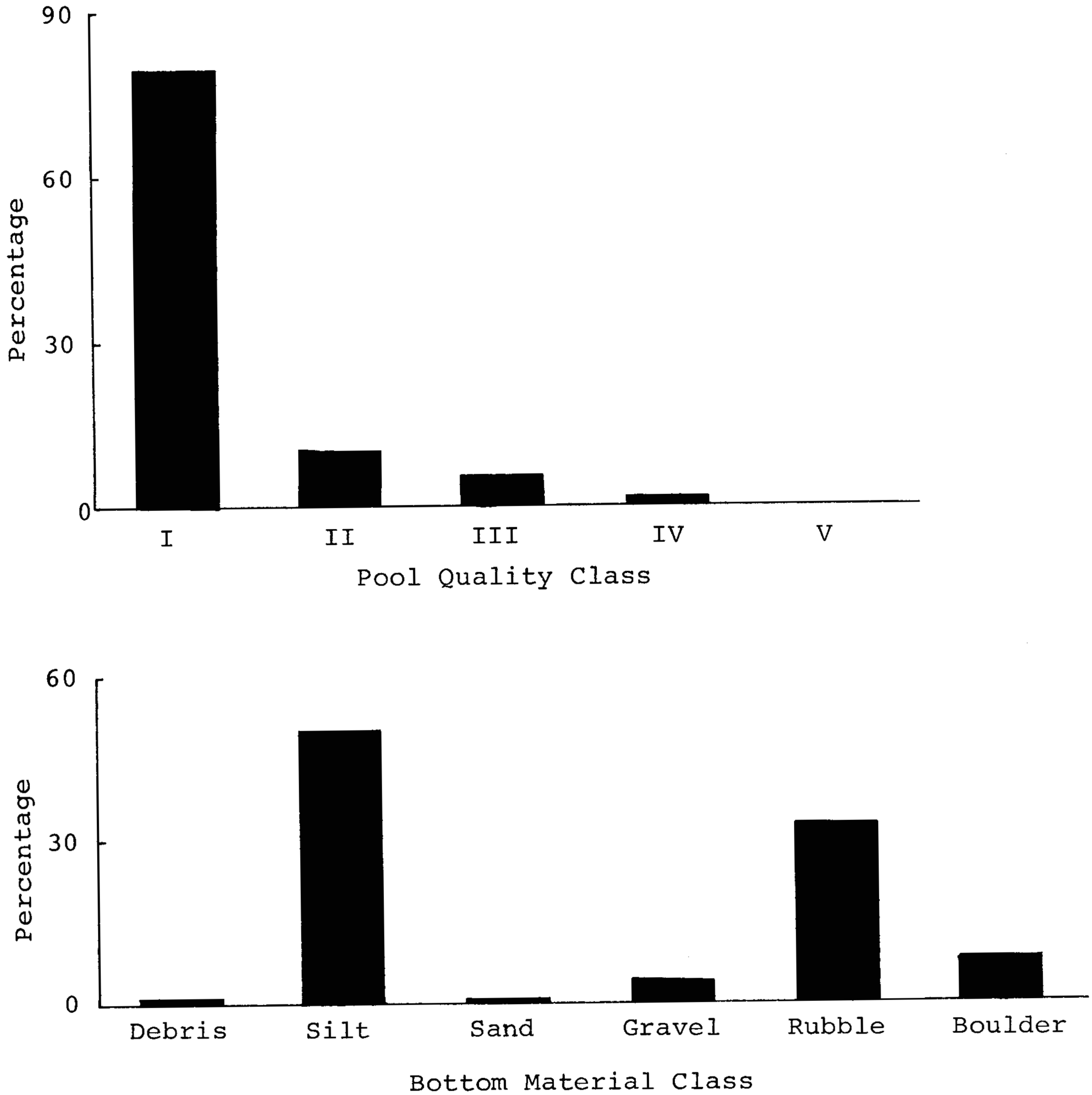

Figure 5: The estimated percentage of pool quality and bottom material classes found in Beaver Creek, August 1971.

boulder and rubble substrates (Fig. 6).

The calculation of habitat percent of optimum is a measure of the suitability of the stream to salmonid production. A perfect score of 100% indicates the stream has a perfect environment for salmonid species. Beaver Creek percent of optimum scored at 55% (Appendix II). This low rating was due primarily to the high proportion of slackwater in the river and scores calculated for stream bottom characteristics. A score of 55% indicates that Beaver Creek is not a good stream for salmonid habitat even though abundant bank cover is present.

B. Water Chemistry:

Total dissolved solids were quite high in spite of their fluctuations through the length of the river. Alkalinity, hardness and pH remained fairly constant while dissolved oxygen fluctuated with the type of water habitat (Fig. 7, 8). In slackwater sections of the creek the oxygen content was low with a saturation of 43% recorded at one point. Values for the lower portions of the stream (more riffle area) increased to a high saturation of 115%. In general, the percent of saturation was low for a stream of this type.

The average recorded water temperature during the study period was 62.8^{o}F. with a maximum recorded temperature of 71^{o}F and a minimum recorded temperature of 57^{o}F. These temperatures are within the tolerance range of salmonid species (Fig. 9).

C. Invertebrate Sampling:

Repeated benthic sampling revealed seven orders of invertebrates present in riffle areas of Beaver Creek (Table 2). The order Trichoptera (Caddis flies) were by far the most numerous followed by the orders Diptera, Coleoptera, and Ephemeroptera.

In Beaver Creek the mean volume for the sixteen bottom samples measured 0.6 c.c. and the average number per square foot 23 indicating that insect production is extremely poor. Two factors which may account for the low insect production observed are:

a) The presence of a tar sand substrate in many of the riffle areas;

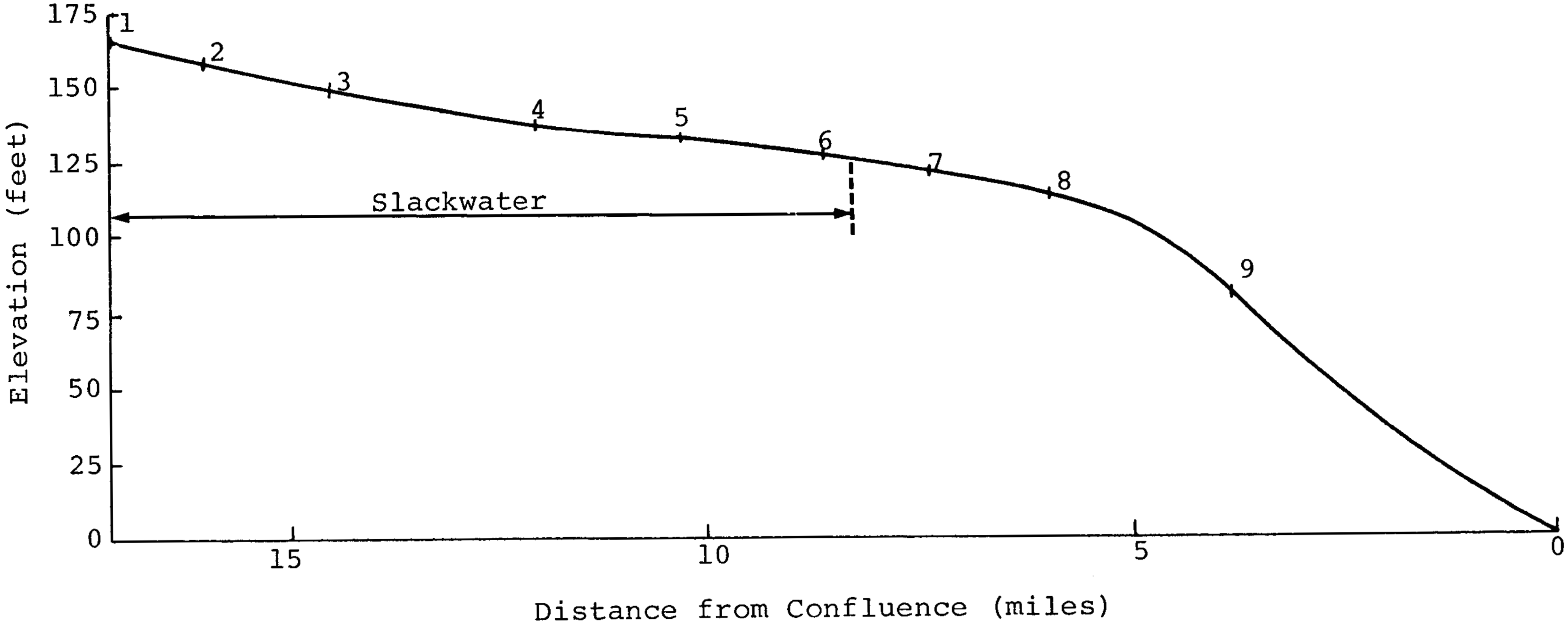

Figure 6: Stream profile of the Beaver Creek Study Area. Numbers indicate the sites of the sample stations. August 1971.

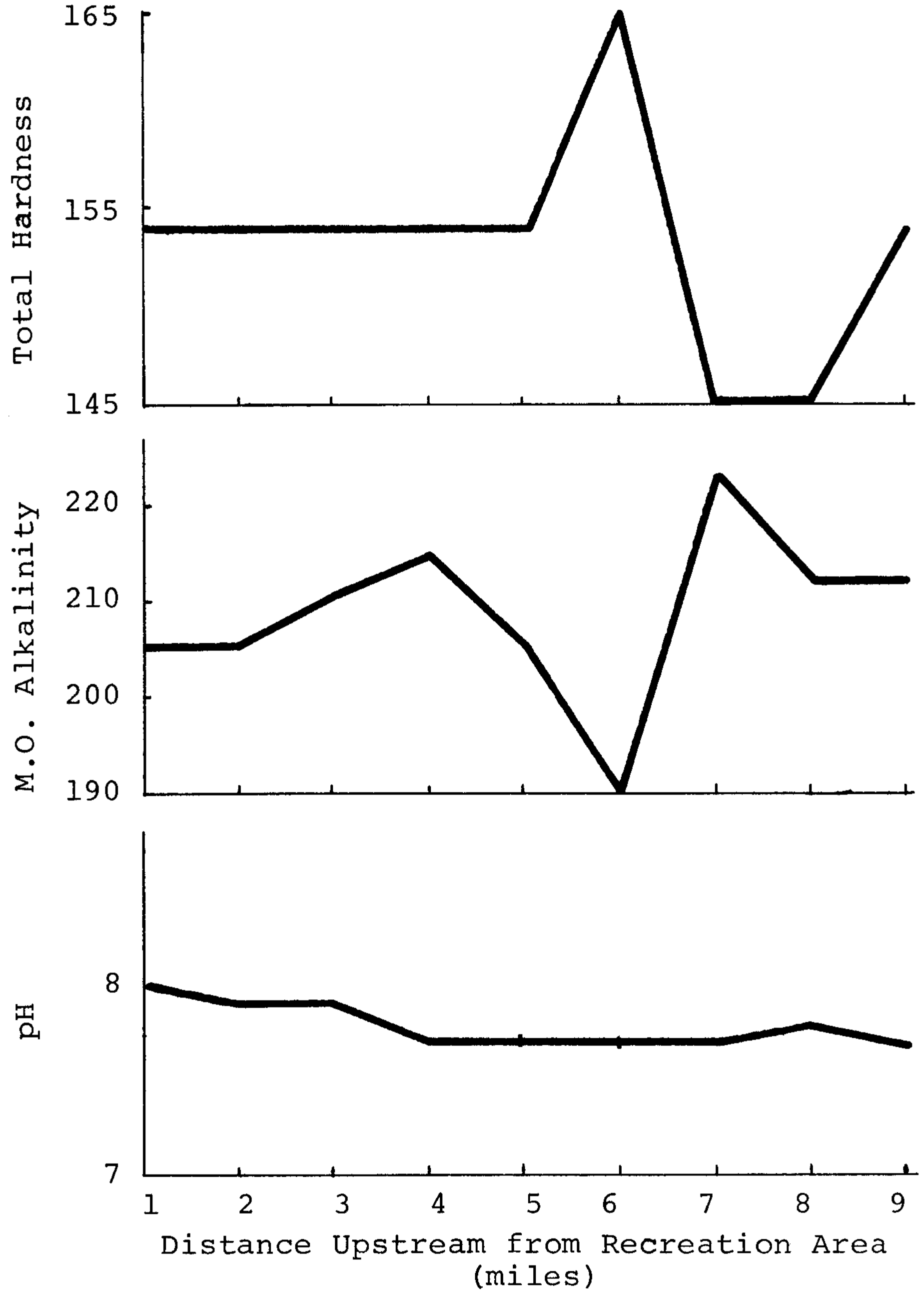

Figure 7: Water Chemistry Analysis of total hardness, methyl orange alkalinity and pH, Beaver Creek, August 1971

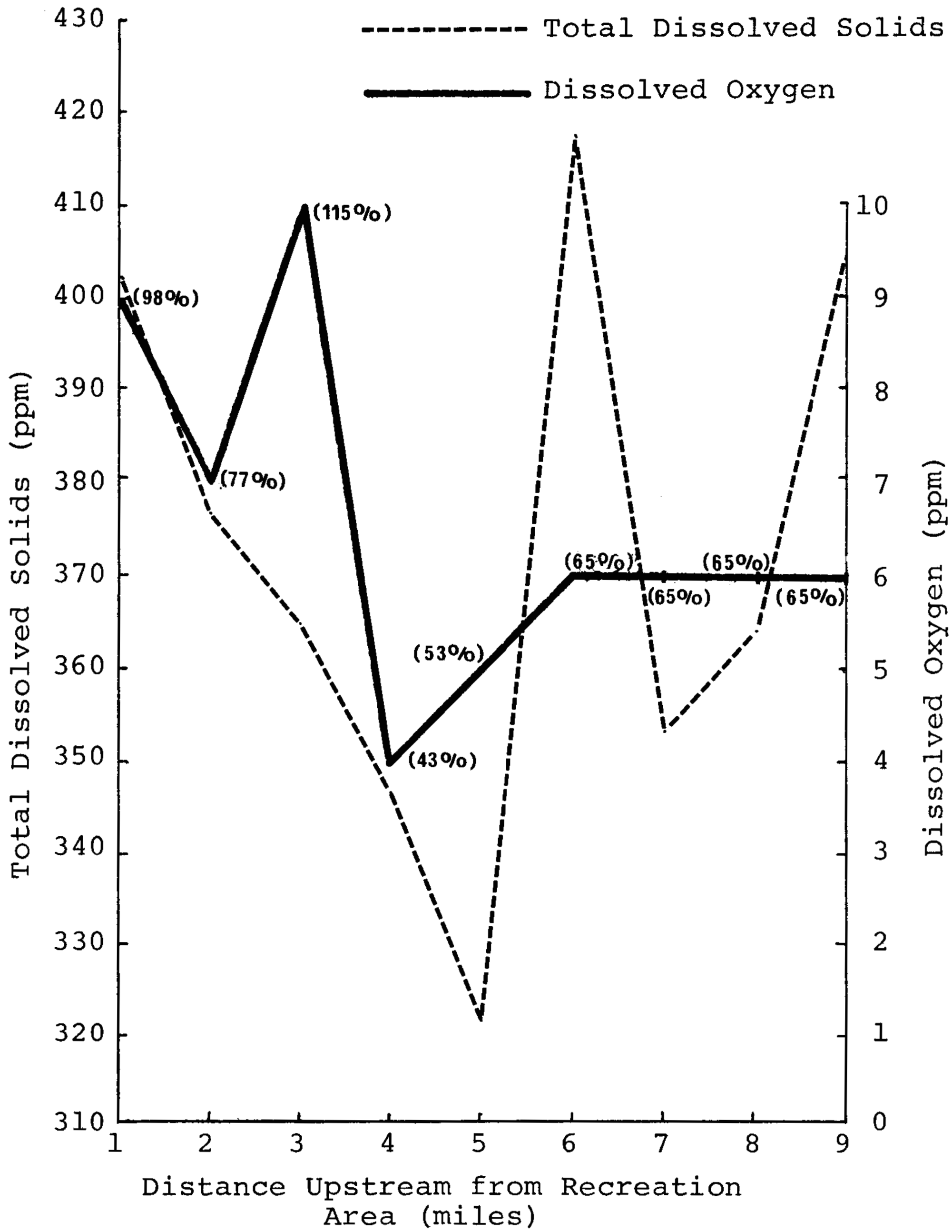

Figure 8: Total dissolved solids (25^{O}C) and dissolved oxygen concentrations in Beaver Creek, August 1971. Percentages indicate the amount of oxygen saturation in the sample.

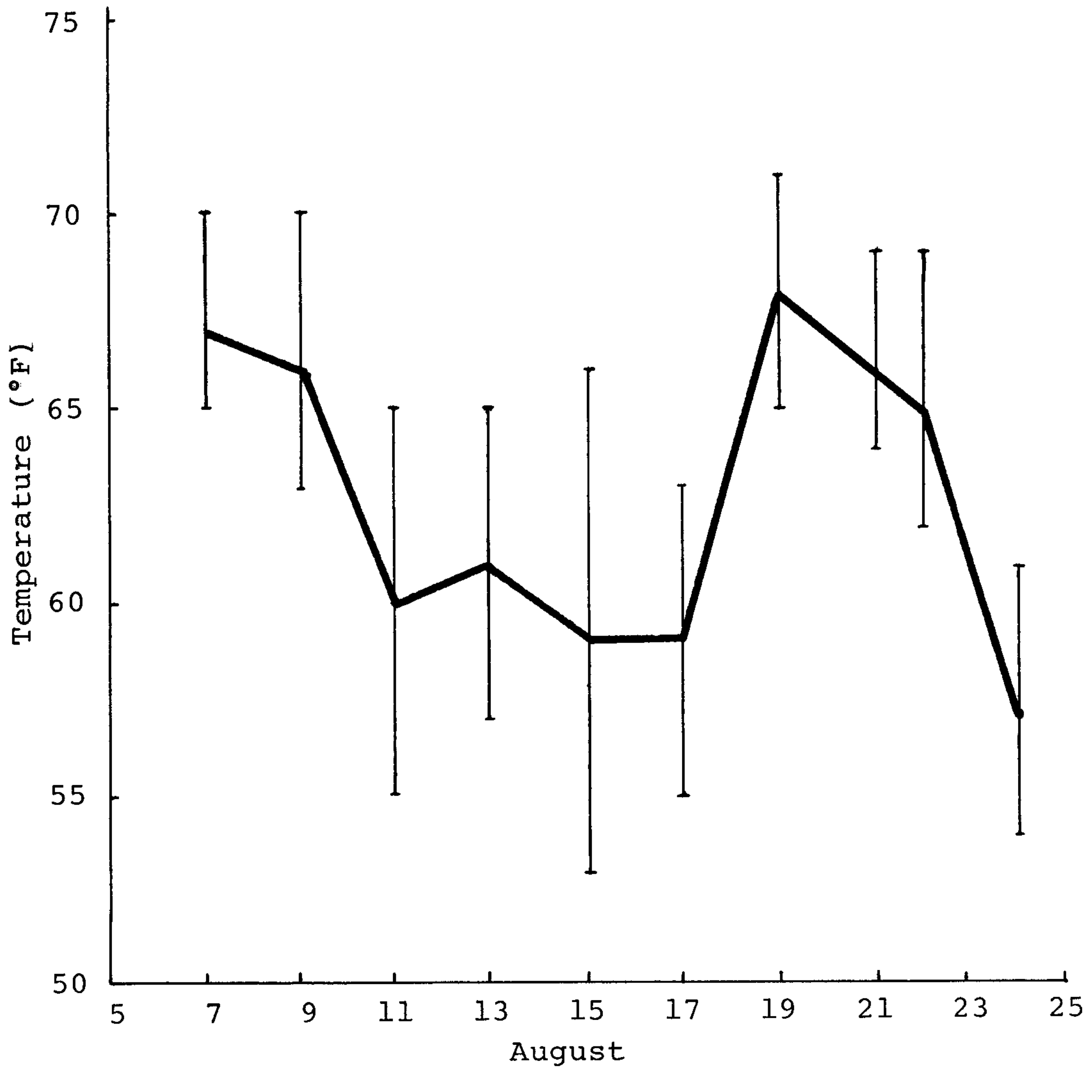

Figure 9: Mean Water Temperature with maximum - minimum values indicated, Beaver Creek, August 1971.

TABLE 2

SUMMARY OF BENTHIC ORGANISMS BY NUMBER IN SIXTEEN SQUARE FOOT BOTTOM SAMPLES FROM BEAVER CREEK, AUGUST 1971

Group Sampled	Number	Number/Square Feet
Order Trichoptera	197	12.3
Order Diptera	51	3.2
Order Coleoptera	46	2.9
Order Ephemeroptera	34	2.1
Order Plecoptera	23	1.4
Class Oligochaeta	13	0.8
Class Arachnida	4	0.3
TOTAL	368	23.0

Numbers alone do not provide an adequate supply; volume is also an important consideration. Standards of richness have been developed as an aid in classification of stream as to food supply (Lagler, 1956). This classification is as follows:

FOOD GRADE I: (Exceptional richness)
Volume $\geq$ 2 cc., numbers $\geq$ 50/sq. ft.

FOOD GRADE II: (Average richness)
Volume 1-2 cc., numbers $\geq$ 50/sq. ft.

FOOD GRADE III: (Poor in food)
Volume $<$ 1 cc., and/or numbers $<$ 50/sq. ft.

b) Heavily silted slackwater stretches.

An average of three times as many organisms were found in riffle areas with rubble substrates compared to riffle areas with a tar sand substrate (Fig. 10). Similar results are shown with volumes of insects (Table 3). The actual proportions of the stream with a tar sand substrate could not be ascertained in the present study.

Five orders of aquatic insects (Coleoptera, Diptera, Plecoptera, Ephemeroptera and Trichoptera) composed an average of 94% of the total drift numbers in a 24-hour drift net set (Table 4). Aquatic insects exhibited the alternans* pattern of nocturnal activity with a major peak in numbers occurring in the 2:00 a.m. sample (Table 3), (Fig. 11). Therefore, the majority of aquatic insects entered the drift nets when they were probably unavailable to actively feeding grayling.

D. Recreational Use of the Creek:

Beaver Creek was utilized solely by the people of the Ft. McMurray area during the survey period. No people from outside the Ft. McMurray area were noted in data collected from the six days of the use count.

Fishing was the major form of recreational use on four of the six days with a mean of twenty-six angler hours per week recorded--all confined to the weekend. Camping and picnicking were the next most important recreational uses. These were observed on both weekdays and weekends (Table 5). It should be noted that present recreational use of the creek is restricted by access to two locations: the first at the recreation area, five miles above the confluence on the road to Ft. McKay; and the second two miles south of the recreation area, near the sample station number seven (Fig. 1).

E. Beaver Creek in a Regional Context:

Map measurements were carried out to ascertain the status of Beaver Creek in a regional context. Data were obtained from both 1:50,000 and 1:250,000 scale maps and provide a generalized perspective of the relationship of Beaver Creek to other streams in the region.

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*Greater activity during dark periods.

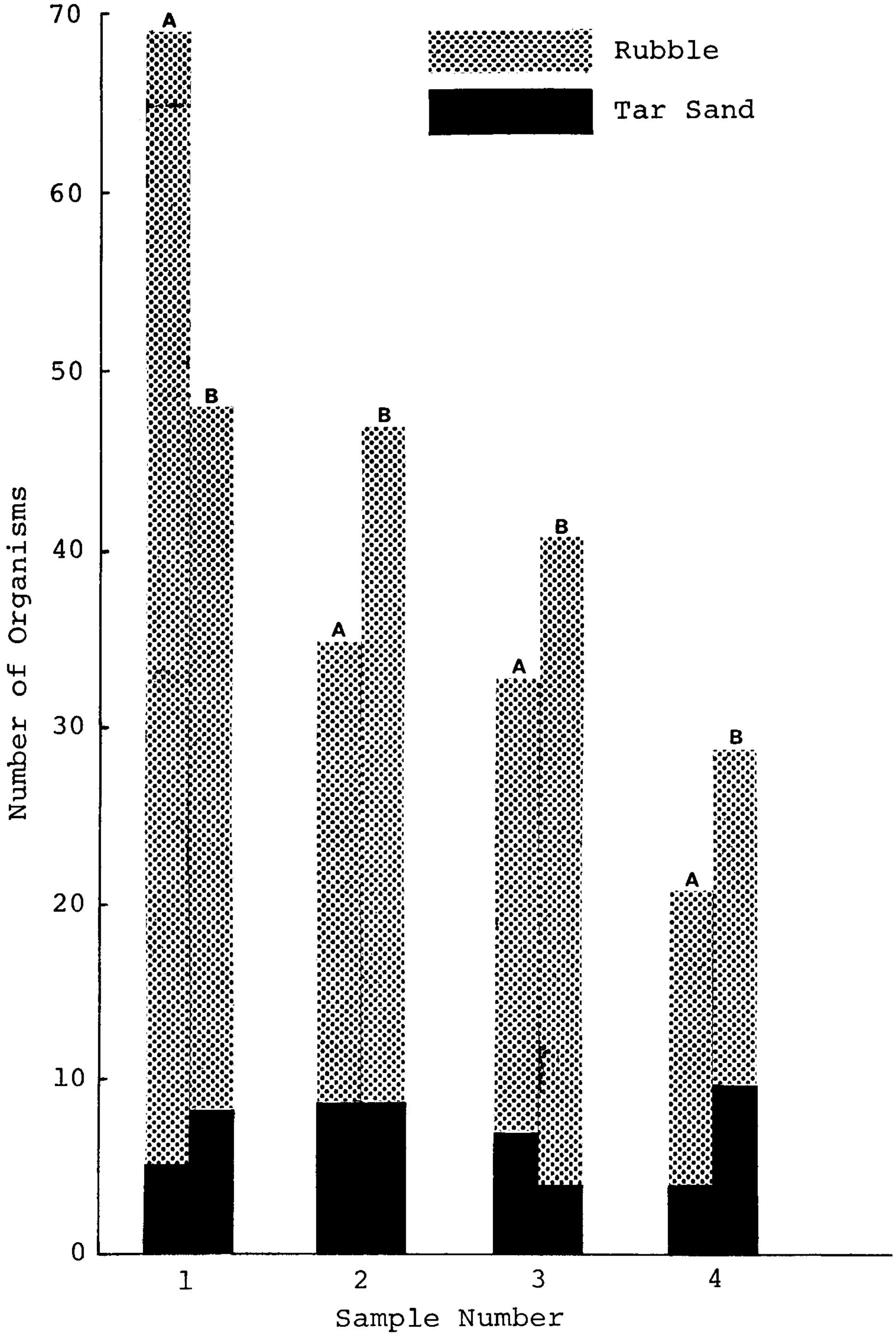

Figure 10: Comparative results of two sets (A & B) of Surber sampling in rubble and rubble-tar sand substrates in Beaver Creek, August 1971.

TABLE 3

SUMMARY OF INSECT SAMPLING VOLUMES (cc.)

BEAVER CREEK, AUGUST 1971

A. Surber Samples (taken August 11th, 20th)

		Tar Sand Substrate (cc. per sq. ft.)	Rubble Substrate (cc. per sq. ft.)
August 11th Samples:			
	1	Trace	1.0
	2	Trace	1.0
	3	0.2	0.4
	4	0.1	0.6
August 20th Samples:			
	1	Trace	1.3
	2	0.1	1.5
	3	Trace	1.1
	4	0.1	0.9

B. Drift Samples (taken August 11th)

Time Sample Taken	Terrestrial Insects	Aquatic Insects	Total
2:00 p.m.	1.4	1.0	2.4
5:00 p.m.	0.4	0.8	1.2
8:00 p.m.	0.9	0.4	1.3
11:00 p.m.	0.6	1.9	2.5
2:00 a.m.	0.1	1.3	1.4
5:00 a.m.	0.4	1.4	1.8
8:00 a.m.	0.6	0.6	1.2
11:00 a.m.	0.4	0.2	0.6

TABLE 4

NUMBER OF DRIFT ORGANISMS TAKEN IN FOUR NETS SET 24 HOURS AND EMPTIED EVERY THREE HOURS, BEAVER CREEK, AUGUST 1971

Terrestrial Orders Occurring in Drift Nets	No.
Hymenoptera;	
Fam. Formicidae	52
Fam. Apidae	2
Diptera	19
Hemiptera	18
Arachnida	5
Lepidoptera	3
Trichoptera (adult)	1
Odonata	4
TOTAL	104

Aquatic Groups Occurring in Drift Nets	No.
Order Coleoptera (adult)	66
Order Trichoptera	51
Order Diptera	41
Order Ephemeroptera	39
Order Plecoptera	25
Order Coleoptera (larvae)	15
Order Hemiptera	7
Order Arachnida	4
Platyhelminthes (Flatworms)	3
Order Odonata	1
Class Hirudinea	1
TOTAL	253

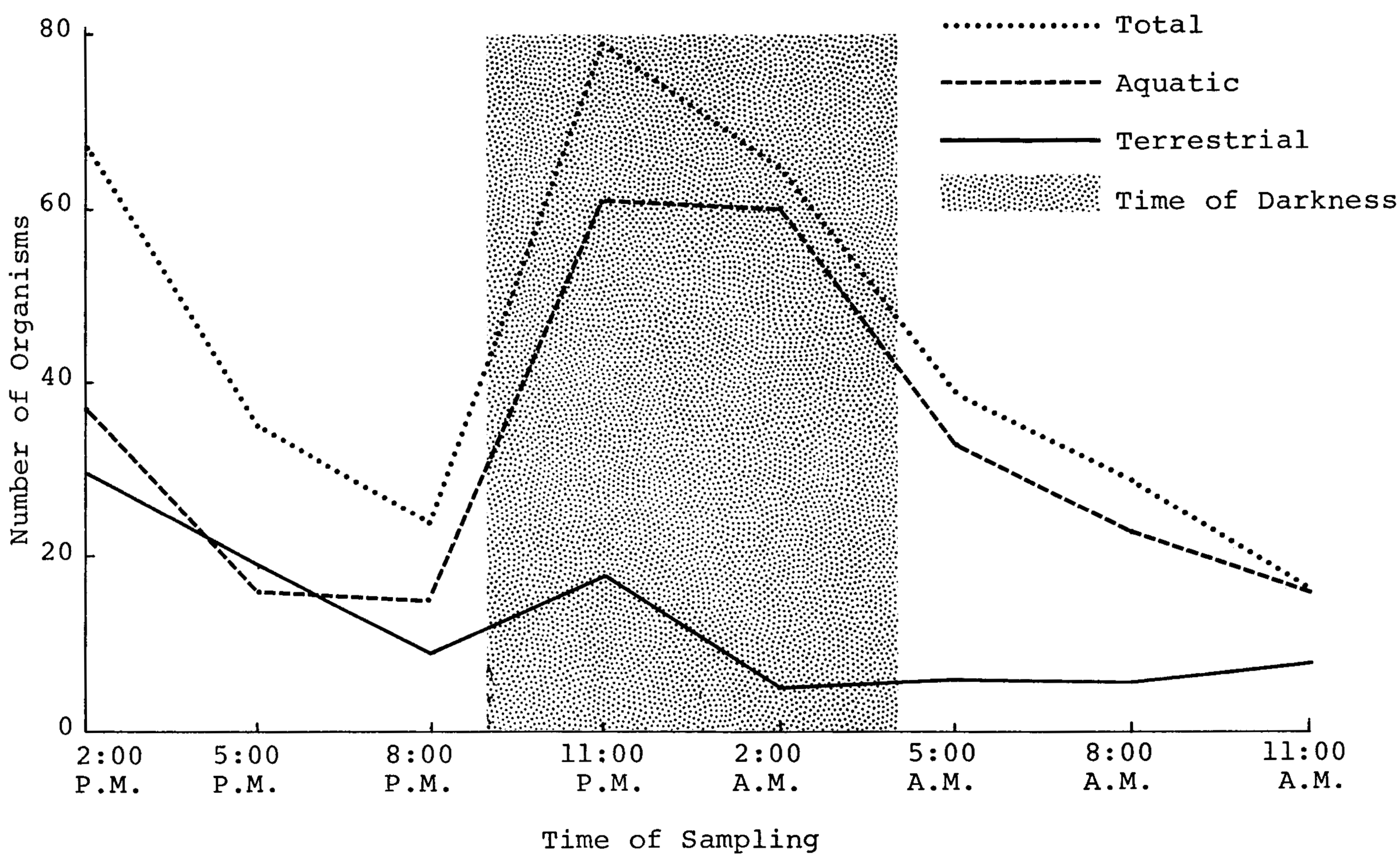

Figure 11: Number of drifting organisms taken every 3 hrs. from 4 drift nets placed in two riffle areas, Beaver Creek, August 1971.

TABLE 5

SUMMARY OF RECREATIONAL USE OF BEAVER CREEK DURING AUGUST, 1971

	Fishing			Other Recreation*		
Sample Week:	1	2	3	1	2	3
Estimated hours on:						
a) Week-ends	22	30	36	14	0	136
b) Week-days	0	0	0	36	0	0
TOTAL HOURS	22	30	36	50	0	136

*Includes camping, picnicking and other outdoor recreation.

TABLE 6

MILES OF STREAM WITHIN A 50-MILE RADIUS OF BEAVER CREEK PROPOSED PLANT SITE

Miles of stream larger than Beaver Creek	792
Miles of stream equal or smaller than Beaver Creek	654
Miles of major tributaries	862
TOTAL MILES OF STREAM	2,308

Within a 50-mile radius of the Syncrude plant site there are twenty-nine rivers, nine of which are accessible by automobile. These rivers constitute a total estimated length of 2,308 miles. Of this amount, 34% are streams larger than Beaver Creek, 28% are approximately the same size and 38% are tributary streams (Table 6). These figures have been corrected by using a meander factor of 1.6 per lineal mile of river measured to obtain actual length. The average meander factor for the larger rivers is 1.6 but it should be considered as the absolute minimum for smaller rivers, creeks, and tributaries.

F. Fish Collection:

Six species of fish were collected during the sampling period. Samples were taken at locations over 16 miles of the creek encompassing the lease area, and downstream.

Species collected were:

Lake Chub, *Couesius plumbeus* (Agassiz)
White Sucker, *Catostomus commersoni* (Lacepede)
Arctic Grayling, *Thymallus arcticus* (Pallas)
Burbot, *Lota lota* (Linnaeus)
Slimy Sculpin, *Cottus cognatus* (Richardson)
Northern Pike, *Esox lucius* (Linnaeus)

The relative abundance of six species of fish sampled by prima cord explosives is indicated in Fig. 12. Lake Chub were the most numerous species, comprising 50% of the total sample. Chub and suckers together constituted 88% of fish collected. The total number of fish sampled was 659. Chub ranged in size from 1½" to 4½" and suckers were from 1½" to 12" long. The majority of suckers were in the smaller size ranges.

Of the five major habitats sampled (slackwater, pools, riffles, backwater, and beaver dams), only two mature grayling* out of a total of 59 specimens were collected. These were taken from pool areas. Chub and suckers occurred in all water types (Fig. 13). Pools were the most productive areas for fish with an average of 25 fish collected per blast (Fig. 14). Backwater areas were least productive with an average of 0.8

*12" and 13" in size

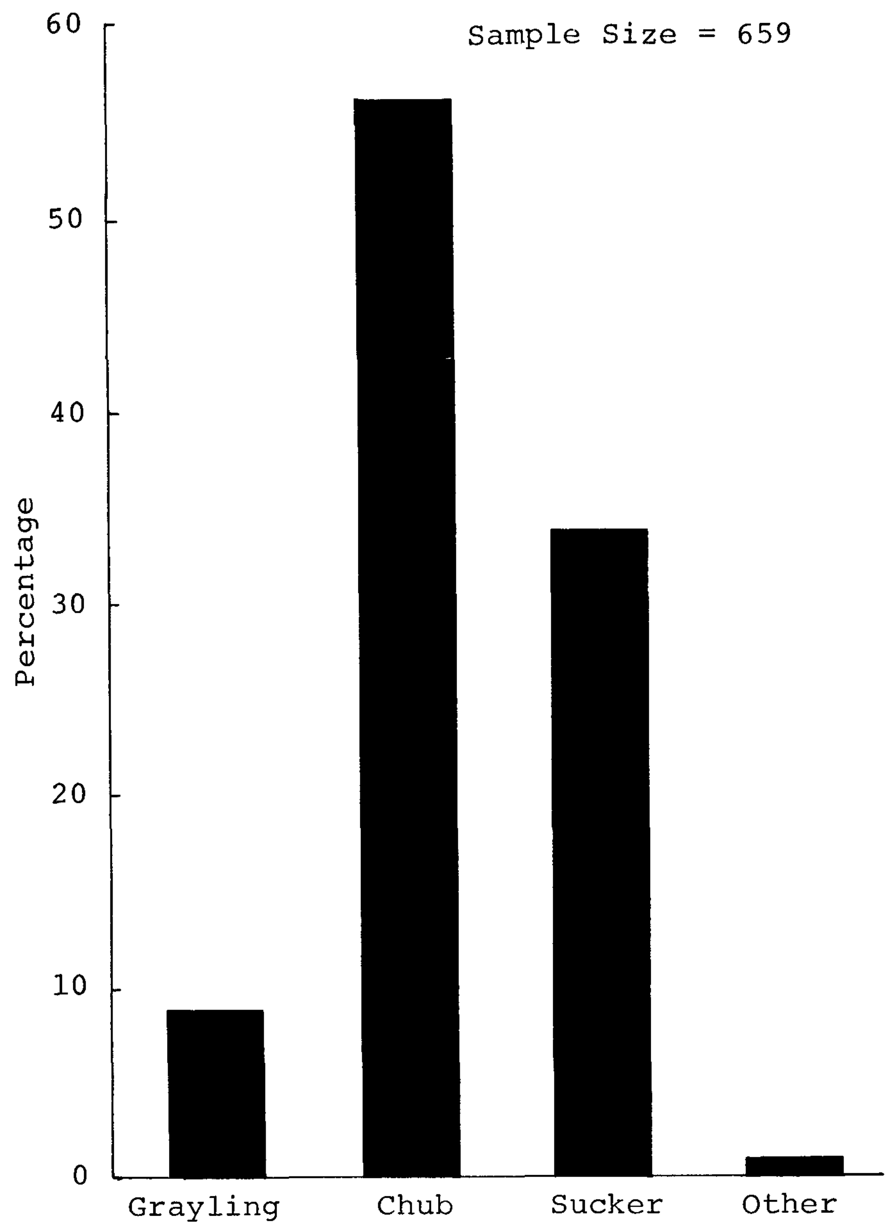

Figure 12: Relative Abundance of species as indicated by prima cord sampling in the Beaver Creek, August 1971.

Figure 13: The relative abundance and distribution of species according to water habitat, Beaver Creek, August 1971.

Figure 14: A sample of the fish collected with prima cord explosive from a pool area on the Beaver River, August 19, 1971.

fish per blast.

The density of young-of-the-year and age I+ Arctic grayling is related independently to depth, substrate, and water type when density is related to the individual parameter. Since there is a correlation between parameters, e.g.; rubble substrate associated with riffle, the separation of habitat for individual analysis does not represent the actual pattern of habitat occupancy. However, it allows comparison of immature grayling for each parameter and time. Univariate analysis (i.e.; one independent variable vs. the dependent variable) demonstrates the importance of sand and pools as variables influencing young-of-the-year grayling density in August (Table 7). Brown (1938) and Ward (1951) reported grayling spawned in sand and fine gravel respectively. It is in these areas where most young-of-the-year were found. Grayling of age I+ on the other hand showed a clear preference for rubble substrate but other parameters were not as well defined as to preference.

The length frequencies of immature grayling collected in Beaver Creek formed three distinct modes when plotted (Fig. 15). The modes measured 1½", 3-3/4" and 7" respectively and represented the total lengths of age groups 0+, I+ and II+.

Gillnetting of Mildred Lake resulted in five white suckers being taken in 3½" stretch mesh net. These fish averaged 14" in length. Using prima cord sampling, 197 lake chub (average size 2") and 29 brook stickleback, *Culaea inconstans* (Kirtland) were obtained. In neither instance were sport fish found in Mildred Lake. It is doubtful if sport fish would overwinter in Mildred Lake in any event because of its shallowness. Horseshoe Lake could not be sampled due to the heavy weed growth covering the lake's surface. This made conventional sampling methods impossible.

V. DISCUSSION

A. Beaver Creek as Fisheries Habitat

Results of this study indicate fisheries habitat in the Beaver Creek is marginal for sport fish, in particular Arctic grayling. The river ecosystem appears quite stable and does not appear to have undergone any major changes in the past few years which would affect fish populations.

TABLE 7

OCCURRENCE OF IMMATURE ARCTIC GRAYLING

IN THREE HABITAT PARAMETERS,

BEAVER CREEK, AUGUST 1971

Age Group	Water Type			Depth (feet)					Substrate		
	Backwater	Pool	Riffle	1	2	3	4	5	Sand	Silt	Rubble
0+	1	31	-	4	-	28	-	-	32	-	-
1+	-	9	7	11	1	1	-	3	1	3	12

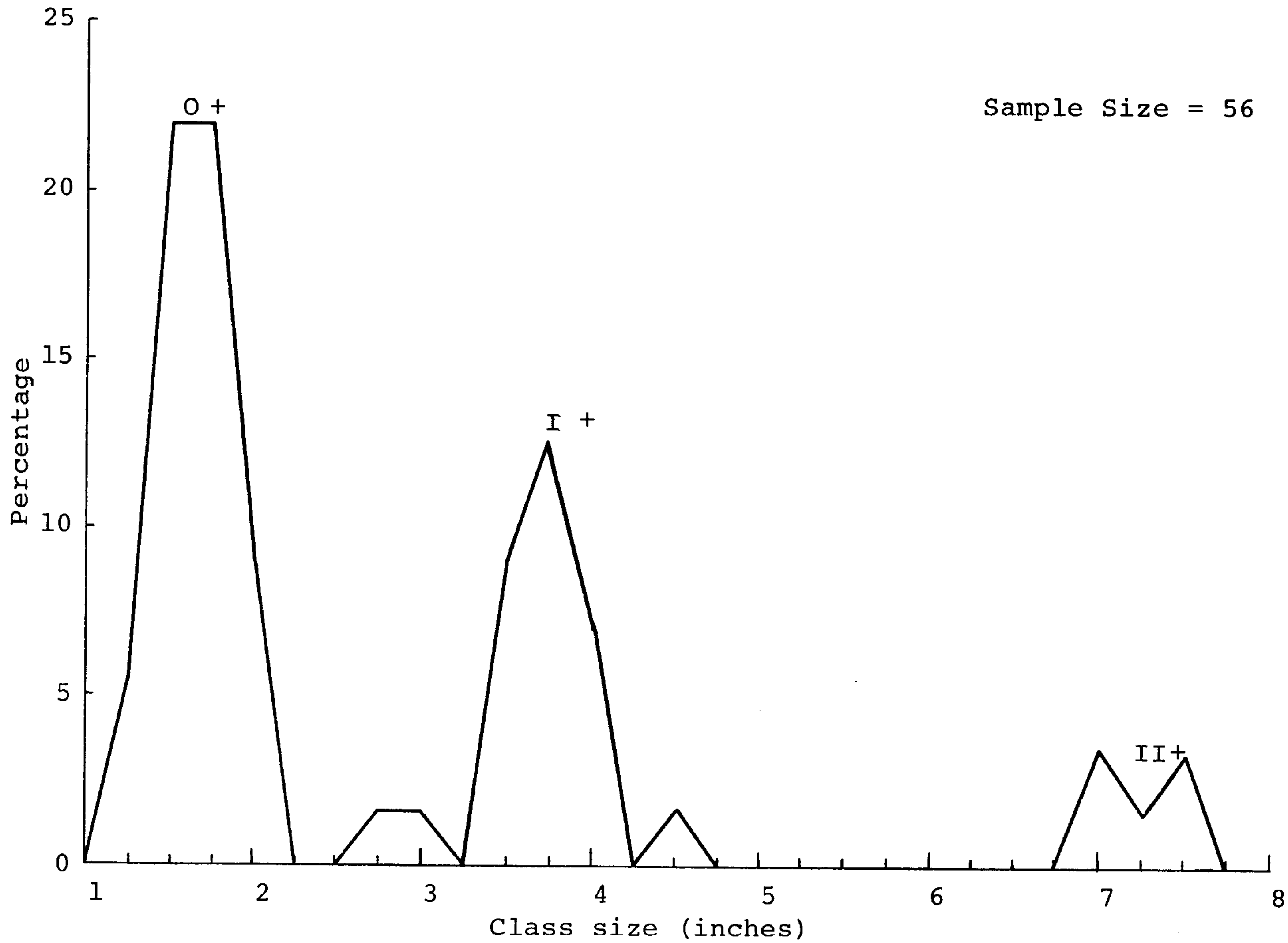

Figure 15: Length - frequency analysis of immature grayling taken from Beaver Creek, August 1971.

Since the habitat rating derived in the present study differs from that presented by Robertson (1970) this aspect warrants separate discussion.

B. Habitat Ratings

The 1970 study established a habitat rating of 70% of optimum and concluded the stream had excellent potential for salmonid production. In contrast, the current study has derived a value of 55%, or low quality rating for salmonid production (Appendix II). The discrepancy is due primarily to the higher pool area (68%) calculated in the present study. More slackwater areas, which are classed as pools, occurred at stations* established in this study, hence a larger pool environment. The lower reaches contain a much more favorable pool to riffle ratio; however, the rating includes the entire area of the river to be altered by the development. The aerial survey revealed slackwater as the predominant habitat type extending some 30 miles upstream from the plant site. However, data presented in this report are accurate only for the study area and the foregoing is a general observation of the major habitat condition upstream on the creek.

We do not feel that difference in flow conditions between the time of the two studies is a significant factor influencing the habitat rating since pool:riffle separation is most evident during low water conditions which prevailed at the time of the survey.

Beaver Creek exhibits streamflow patterns typical of most small streams: high spring discharge, then dropping steadily throughout the summer except during periods of high precipitation when they rise slightly. Fluctuating water levels destroy bottom organisms, lowering the productivity of a stream. However, in general we consider that other factors discussed in this report have a more significant bearing on the fisheries of the stream than does the flow regime.

The chemical environment of the creek appears stable except for dissolved oxygen values which are minimal for salmonids in the slackwater. Total dissolved solids can be considered as a gross measure of the primary production of a stream. Generally, high productivity is associated with high total dissolved solids. Total dissolved solids vary according to many factors and differences in values between the 1970 study and current data can be attributed to the time of year. However, both studies indicate

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*Stations were set at one mile intervals to avoid biases.

SPECIES DISTRIBUTION ACCORDING TO HABITAT TYPES, BEAVER CREEK, AUGUST 1971

A. WATER TYPE

Species	Type				
	Slackwater	Riffle	Backwater	Beaver Dam	Pool
Grayling	0%	12.5%	3.5%	0%	84.0%
Chub	19.0%	5.0%	0%	6.5%	69.5%
Sucker	19.0%	3.5%	0.5%	70.0%	70.0%
Other	0%	25.0%	0%	0%	75.0%

B. WATER DEPTH

Species	Depth				
	1'	2'	3'	4'	5'
Grayling	31.5%	5.0%	58.5%	0%	5.0%
Chub	14.0%	9.0%	74.0%	24.0%	10.0%
Sucker	16.0%	11.5%	57.0%	9.5%	6.0%
Other	37.5%	0%	50.0%	12.5%	0%

C. SUBSTRATE TYPE

Species	Type				
	Silt	Sand	Gravel	Rubble	Boulder
Grayling	17.0%	64.0%	0%	22.0%	17.0%
Chub	35.0%	2.0%	9.5%	43.0%	10.5%
Sucker	27.0%	11.0%	5.0%	37.0%	20.0%
Other	0%	50.0%	12.5%	25.0%	12.5%

relatively high T.D.S. values. These values of potential productivity are not reflected in actual fisheries production. This is attributed to habitat factors such as the pool:riffle ratio, generally low substrate quality and low dissolved oxygen values at certain times of the year.

C. Prima Cord Explosives as a Sampling Tool

The advantage of prima cord as a sampling device is that a collector can obtain more fish, more quickly, over a larger area, than other conventional sampling methods. The species selectivity and lethal range of prima cord is largely unknown, therefore data are subject to possible biases. In most of the blasts conducted, however, size or species selectivity did not appear significant. Some bias can occur depending upon the site chosen for blasting. In pool areas all dead fish do not surface after the blast and may be missed by the collector. On the other hand, blasts set in fastwater results in fish drifting downstream before being collected. Despite these inherent limitations, the prima cord technique has less serious biases than conventional methods and we consider that a representative sample of the fish populations of Beaver Creek was obtained during the survey.

D. Sport Fisheries Potential

Forage and coarse fish are the most abundant species in Beaver Creek. Suckers and chub represent 88% of the total species composition and we conclude that these are the major species present in the stream. Of the fish collected, grayling and pike are considered sport fish. However, both species were negligible in occurrence. Arctic grayling, of catchable size, which can be considered the most desirable species present, represented less than one percent of the fish taken.

Available data are insufficient to quantify factors limiting grayling. However, we believe that a combination of habitat and food restrictions are the main limiting factors.

Arctic grayling require small gravel or sand substrates on which to spawn. This type of substrate on Beaver Creek is estimated at 5% of the total stream bed, confined mainly to the lower reaches. Silt substrates, which are unsuitable for the survival of grayling eggs, are estimated at 50%, mainly occurring 10 - 40 miles upstream where the creek is almost entirely slackwater. Data on water chemistry indicated low dissolved oxygen concentrations occur in the slackwater areas. Concurrent with dissolved oxygen values as low as 4 ppm, saturation values as low as 45% were recorded. The most common condition was 6 ppm and 65% saturation. These low values likely result from a combination of factors including:

a) Abundant streamside cover, (Fig. 2), which may inhibit wind action.
b) The low gradient of the stream in its upper reaches.
c) The presence of numerous beaver dams which would tend to produce low oxygen concentrations.

Composition of benthic invertebrate samples indicate food may be limited in the Beaver River. Robertson (1970) found low numbers of benthic organisms and attributed it to sampling phenomenon. Our sampling also produced low numbers in both rubble and tar sand substrate. Since the two independent samples agree with one another, it is likely that insect production is actually low rather than a sampling phenomenon. Numbers of insects in drift samples support this interpretation. Production of benthic organisms in riffle areas over rubble-tar sand substrates was negligible, while over straight rubble areas, invertebrate numbers increased by a factor of three to five times. However, in terms of volume and numbers, invertebrate production is generally low even in areas of suitable habitat.

E. The Value of Beaver Creek for Sport Fishing

Data obtained in the present study clearly indicate that the occurrence of harvestable sport fish species is negligible in Beaver Creek. An earlier survey of Beaver Creek conducted by the Alberta Fish and Wildlife Division (Robertson, 1970) rated the stream as having an excellent potential for salmonid production but quantitative data on the fisheries of the Creek were not presented in that study. Results presented by Robertson did show that angling was unproductive when attempted during that study.

Discussions with local anglers support the contention that fishing for grayling is poor in the stream. It appears that while occasional creel size grayling and pike occur, these individuals are widely distributed and present in very low numbers through the system.

The lack of a catchable population precludes any economic analysis predicated on the existence of harvestable fish stocks. Any attempt to assign dollar values to the stream based entirely on sport fishing capability would be hypothetical since the basic requirement (sport fish available for harvest) is lacking.

We interpret that present recreational use reflects aesthetic considerations more so than an attraction provided by opportunities to catch fish. The lower reaches of Beaver Creek have desirable aesthetic attributes--scenery, and diverse terrain which contribute to present recreational use. It is significant that a high proportion of activities associated with the river at existing access points are related to recreation apart from angling. While access is presently limited, it appears that existing demands on the area are light. The use survey was conducted during the time of year when outdoor activities are most prevalent, therefore results obtained would reflect the importance of the area to residents of Ft. McMurray.

In summary, the data obtained indicates little basis upon which to place an economic value on sport fishing. The sporadic distribution of suitable species and their low numbers indicates that Beaver Creek has an extremely low capability for sport fishing. The use and significance of the creek to grayling populations is discussed in the following section.

F. The Impact of the Tar Sands Development on Beaver Creek

Evidence collected during this study indicates that Arctic grayling production is low; however, this species utilizes Beaver Creek as a spawning and rearing area. The presence of young-of-the-year fish all taken from similar habitat is evidence of a spawning run. Since grayling are a spring spawning species, no indication of the size of the run could be obtained from our investigation. Presumably adult fish move up Beaver Creek from the Athabasca River in the spring, spawn, and then return gradually to the Athabasca. The majority of the habitat suitable for spawning grayling occurs in the lower ten miles where pool:riffle ratios, cover, and substrate are favorable. The construction of a retention pond and dam upstream of the recreation area would eliminate the main rearing area mentioned and effectively obstruct any spawning migrations into the upper reaches of the creek, thus eliminating any existing grayling population.

The impact on other fish populations would be similar downstream of the dam. In the upper reaches, the impact of Syncrude's proposed development would not likely affect existing populations of suckers and chub.

APPENDIX I

POOL DESIGNATIONS

Quality Class No.	Length or Width	Depth	Shelter[1]
1	Greater than a.c.w.[2]	2' or deeper	Abundant[3]
	Greater than a.c.w.	3' or deeper	Exposed[4]
2	Greater than a.c.w.	2' or deeper	Exposed
	Greater than a.c.w.	Less than 2'	Intermediate[5]
	Greater than a.c.w.	Less than 2'	Abundant
3	Equal to a.c.w.	Less than 2'	Intermediate
	Equal to a.c.w.	Less than 2'	Abundant
4	Equal to a.c.w.	Shallow	Exposed
	Less than a.c.w.	Shallow	Abundant
	Less than a.c.w.	Shallow	Intermediate
	Less than a.c.w.	Less than 2'	Intermediate
	Less than a.c.w.	2' or deeper	Abundant
5	Less than a.c.w.	Shallow	Exposed

[1] Logs, stumps, boulders and vegetation in or overhanging pool, or overhanging banks.

[2] Average channel width.

[3] More than one-half perimeter of pool has cover.

[4] Less than one-quarter of pool perimeter has cover.

[5] One-quarter to one-half perimeter of pool has cover.

APPENDIX II

CALCULATION OF HABITAT PERCENT OF OPTIMUM

Number of square feet of pool = 39,387

Number of square feet of riffle = 18,113

Number of square feet of total sample = 57,500

Therefore, pool area is 68% of total sample area.

Riffle area is 32% of total sample area.

1) Pool Measure:

When total area of pool is this percent of sample total area	Then rating % is:	When total area of pool is this percent of sample total area	Then rating % is:
50	100	25 or 75	50
49 or 51	98	24 or 76	48
48 or 52	96	23 or 77	46
47 or 53	94	22 or 78	44
46 or 54	92	21 or 79	42
45 or 55	90	20 or 80	40
44 or 56	88	19 or 81	38
43 or 57	86	18 or 82	36
42 or 58	84	17 or 83	34
41 or 59	82	16 or 84	32
40 or 60	80	15 or 85	30
39 or 61	78	14 or 86	28
38 or 62	76	13 or 87	26
37 or 63	74	12 or 88	24
36 or 64	72	11 or 89	22
35 or 65	70	10 or 90	20
34 or 66	68	9 or 91	18
33 or 67	66	8 or 92	16
32 or 68	64	7 or 93	14
31 or 69	62	6 or 94	12
30 or 70	60	5 or 95	10
29 or 71	58	4 or 96	8
28 or 72	56	3 or 97	6
27 or 73	54	2 or 98	4
26 or 74	52	1 or 99	2
		0 or 100	0

2) Pool Structure = % rating of pool measure (1 above) X

$$\frac{\text{total ft. of Quality Class 1, 2, 3 rated pools}}{\text{total ft. in pools}}$$

$$= 64 \times \frac{1471}{1800}$$

$$= 52.5\%$$

3) Stream Environment $= \frac{\text{total points of bank observation}}{\text{max. possible points if all forested}} \times 100$

$$= \frac{26}{36} \times 100$$

$$= 72.2\%$$

4) Stream Bottom $= \frac{\text{ft. of gravel and ft. of rubble}}{\text{total ft. in sample}} \times 100$

$$= \frac{30 + 540}{1800} \times 100$$

$$= 31.7\%$$

5) Habitat Percent of Optimum

$$= \frac{\text{pool measure + pool structure + stream bottom + stream environment}}{400}$$

$$= \frac{64 + 52.5 + 31.7 + 72.2}{400}$$

$$= 55\%$$

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