SELKIRK COLLEGE

WILDLAND RECREATION PROGRAM

WILDLAND RECREATION 270-271

TECHNICAL IMPACT REPORT

WALLEYE POPULATION IN THE COLUMBIA - KOOTENAY RIVERS

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Due Date : March 30, 1983

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March 30, 1983

Mr. Len Dunsford
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Dear Sirs:

I am pleased to submit the enclosed Technical Impact Report entitled "Walleye Population in the Columbia - Kootenay Rivers." This report is submitted to fulfill the requirements of Wildland Recreation 270-271 for ~~Mr. Len Dunsford, Mr. Jim Howard, and Mr. Gary Hunisette~~.

I have studied the Walleye population and their movements in the Columbia - Kootenay Rivers. My reasons for this choice of topic are as follows: a) the Walleye population is fast increasing, b) Walleye are invading spawning and feeding grounds of kokanee and trout, c) to date no detailed studies exist of Walleye in the Columbia - Kootenay Rivers. My Technical Impact Report covers these areas by conducting several experiments which include: a) stomach content analysis, b) reproductive gonad analysis, c) catch/unit effort, and d) length-weight-age analysis. By analyzing these experiments a relationship can then be made between Walleye and other game fish sharing the same habitat.

I trust this report meets your approval and expectations. Please feel free to contact me if you wish to discuss or require further clarification of the report.

Sincerely yours,

Bill W. Nazaroff

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Technical Impact Report
on
Walleye Population
in the
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Introduction

Purpose

The purpose of this report is to ~~provide an impact~~ study of the Walleye population in the Columbia - Kootenay Rivers. This report will also discuss their seasonal movements in the Columbia - Kootenay Rivers.

Problem

The fisheries and local people want to know what impact Walleye have on other game fish in the Columbia - Kootenay Rivers, such as competition for spawning and feeding grounds. This problem and more will be dealt with by conducting several experiments which include : 1) spawning and feeding habits based on stomach contents, and 2) age, sex, reproductive status and size of Walleye based on scales and reproductive organs. By analyzing these experiments one can then better understand the habits of Walleye and their impact on other fish.

Scope

There is one major limitation that occurs in this impact study on Walleye. I was fortunate to catch Walleye during the summer months to the end of November, 1982. Since then, angling success has been poor. As mentioned before, since I had good angling success during the summer and fall, I have collected a total of 28 Walleye specimens and performed several experiments on five specimens. These experiments include the examination of stomach contents for food competition and scales for determining growth rates and age. Another limitation in this report is, instead of studying Walleye throughout the Columbia and Kootenay Rivers, I chose four areas that proved to be very productive. Three of these areas are located along the Kootenay River and the fourth area is located at the confluence of the Columbia and Kootenay Rivers just below the college.

1.0 BACKGROUND INFORMATION

1.1 Origin and Distribution of Walleye

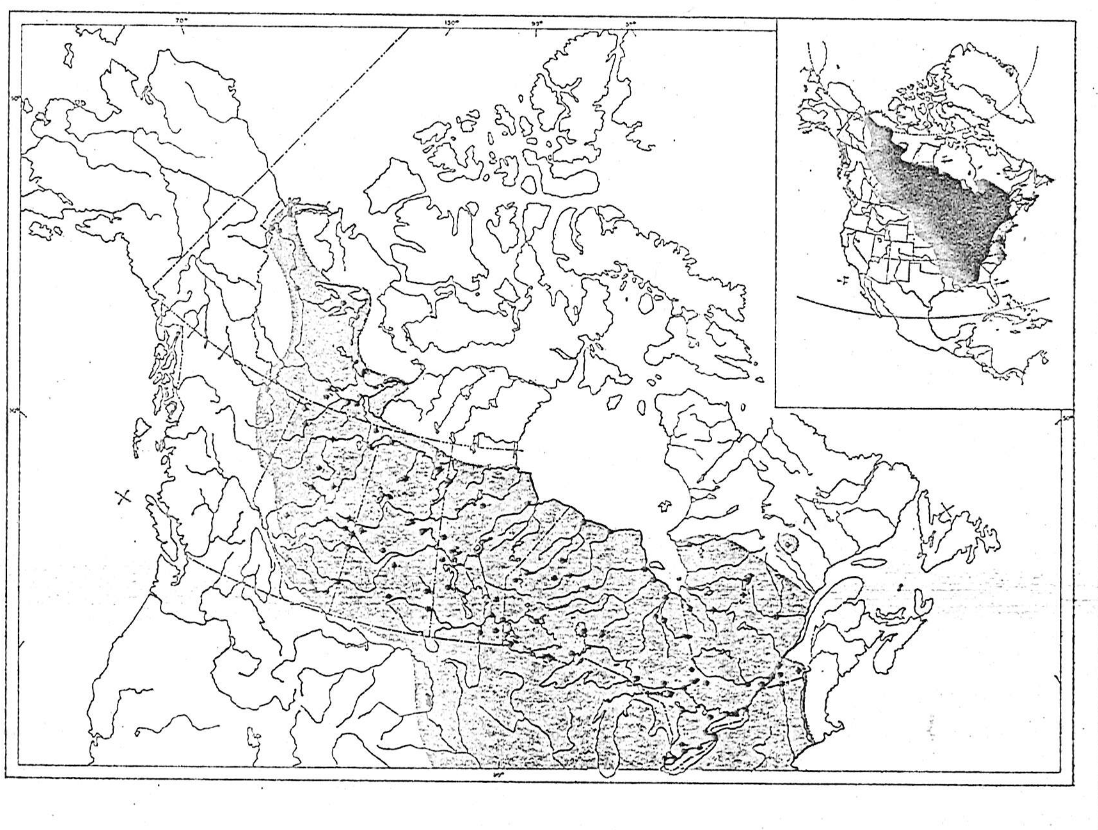
Canadian Walleye stocks originate from a Mississippi and an Atlantic glacial refugium. The Walleye probably spread into northern Ontario, and Quebec via glacial lake Barlow - Ojibway and its outlet. Walleye have been introduced in various places in Canada within its native range where barriers precluded its natural occurrence. (Scott et. al., 1979).

Walleye are limited to fresh water and rarely brackish water of North America. In Canada, Walleye occur generally in Quebec in tributaries of the St. Lawrence downstream to the Manicougan River, north to rivers tributary to the east coast of upper James Bay, northwest from the Hudson Bay coast in Ontario to Athabasca, Great Slave Lake, and Great Bear Lake, north in the Mackenzie River to the delta, south through the Peace River drainage of northeastern British Columbia and southeast of the foothills, to southern Alberta. Walleye form a dominant part of the fish fauna particularly in the boreal forest zone. (Scott et al., 1979). A map of these areas can be seen in fig. 1.

Local Walleye in the Columbia - Kootenay Rivers originally migrated from Lake Roosevelt, Washington, U.S.A. (Steward, 1980). Roosevelt Lake is a reservoir created in 1941 by the construction of the Grand Coulee Dam on the Columbia River which is located 222 km downstream from the Canadian/U.S. border (Washington). Roosevelt Lake reservoir extends to within about 35 km from the border when full. (Water Investigation Branch, 1979).

Local Walleye may have entered into the Columbia - Kootenay River system by two ways. One way is that Walleye may have been

FIGURE 1



WALLEYE DISTRIBUTION IN NORTH AMERICA

introduced into Lake Roosevelt as bait-fish by fishermen. Fishermen use fish for bait and occasionally these bait-fish, including Walleye, wiggle out from the clutches of anglers and swim away, roaming freely throughout the lake. Eventually these bait-fish multiplied in great numbers and required a greater area in which to feed and spawn. With overcrowding, the Walleye started to migrate upriver to satisfy their habitat requirements. (Steward, 1980).

The second way is that Walleye may have entered via other rivers and creek tributaries. Walleye may have entered from the Flathead River system via the Clark Fork and Pend'Oreille River tributaries to the Columbia River. There are also numerous creeks that flow into the Columbia River in the U.S.A. that are inter-connected to major rivers and lakes that contain Walleye. (Steward, 1980).

Within the past few years the Walleye population have been increasing in the West Kootenays, particularly in the Columbia and Kootenay Rivers. The construction of the Brilliant Dam has limited further expansion of the Walleye into the Kootenay River above the dam. Walleye are also found in the Arrow Lakes above Hugh Keenleyside Dam. This distribution is due to the water locks installed at Hugh Keenleyside Dam, allowing fish to move freely from the river to lake.

1.2 Description of Walleye (Stizostedion vitreum)

The head of the Walleye is very deep with a blunt point at the front. The head is about 25% of its total length.

Walleye have very large, glassy, moon-like eyes that contribute to their name.

Its canine teeth are large, and often recurved on the head of the vomer.

Walleye have two dorsal fins that are obviously separated. The first dorsal fin is spiny, high, long, and rounded consisting of about 12-16 strong spines. The second dorsal fin is higher than the first fin with one fine spine and 18-22 square rays to slightly emarginated rays. The caudal fin is long, well forked with rounded tips. The anal fin consists of two spines and 11-14 soft square rays. The pelvic fin tips are rounded with one spine and five rays. The pectoral fins are moderately broad with rounded tips consisting of 13-16 rays.

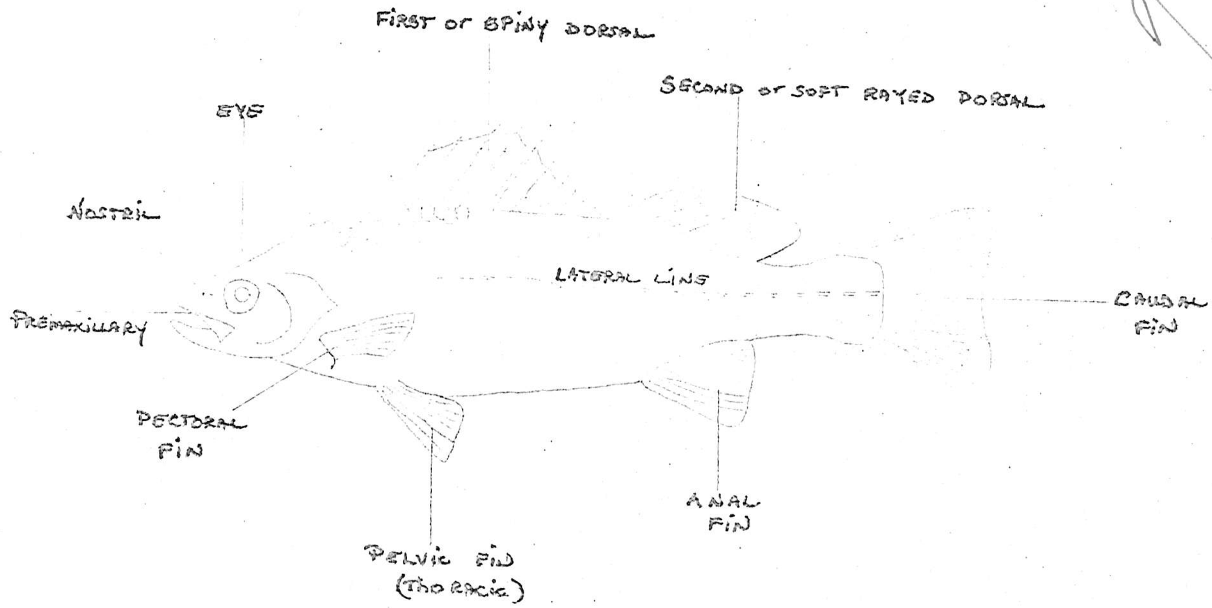
Walleye scales are ctenoid shaped with cheeks only slightly scaled. The lateral line is positioned high on the body and composed of small scales including three to four pitted scales which extend on to the base of the caudal fin. (Scott et. al., 1979). Fig. 2 illustrates the body features of a Walleye.

The color of the Walleye is highly variable, depending on and to lesser extent, with size. In turbid water the Walleye is paler and less marked, with an obvious black pattern. In clear water, the Walleye is more vividly marked. The background is usually olive-brown, to golden-brown, to yellow. The dorsal surface of the head is darker and the sides of the fish are paler and often with golden flecks on the scales. The ventral surface is milk-white or yellow-white in color. (Scott et. al., 1979). This coloration can be seen in fig. 3.

1.3 Spawning - Feeding Behavior and Preferred Habitat

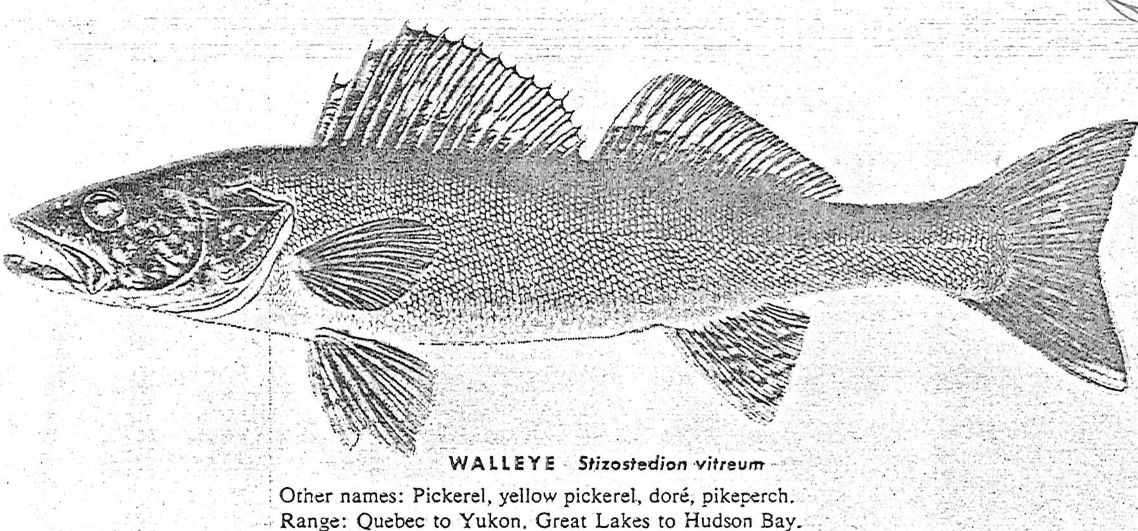
Walleye spawn in the spring from April to May depending on latitude, water temperature and ice break-up. Preferred spawning water temperatures are between 6.7°C - 8.9°C but Walleye have been known to spawn over a range of 5.6°C - 11.1°C. Males move to the spawning grounds first. Spawning grounds are wind-beaten

FIGURE 2



SKETCH OF ANATOMICAL WALLEYE FEATURES

FIGURE 3



WALLEYE *Stizostedion vitreum*

Other names: Pickerel, yellow pickerel, doré, pikeperch.
Range: Quebec to Yukon. Great Lakes to Hudson Bay.
Size: To 23½ lbs. Average weight 2–3 lbs.
Caught by angling and commercial netting. Spawns in spring.

COLOR DIAGRAM OF A WALLEYE

shores, mouths of tributary streams and richly oxygenated waters beneath dams and currents. (Acerrano, 1982).

Walleye often move into tributary rivers immediately after the rivers are ice free and while the lakes are still ice covered. Spawning takes place at night in groups of one large female and one or two smaller males. Males are not territorial so there is no need for a nest to be built. Most females deposit most of their eggs in one night of spawning. The eggs are broadcast and fall into crevices in the substrate. Egg number has been given as high as 612,000 in females. Eggs hatch in 12-18 days if preferred water temperatures prevail on the spawning grounds and by 10-15 days after hatching the young disperse into the upper levels of open water. (Scott et. al., 1979).

Walleye, a member of the perch family, are carnivorous. The Walleye are principally fish eaters as adults. The food of the Walleye shifts very quickly, with increased size, from invertebrates to fish. This is in part a reflection of their change in habitat from surface to bottom. Walleye are highly cannibalistic if forage fish are not readily available. The relative amounts of various species of fish are taken, apparently, depending on availability. Some fish species included in Walleye meals are smelts, suckers, white fish, shiners, bass, burbot, and small Walleye, as well as various minnows. Other food such as cray-fish, snails, frogs, mud puppies, and small mammals are sometimes taken. (Scott et. al., 1979). Some Walleye population, even as adults, feed almost exclusively on aquatic insects and emerging larvae such as caddis fly nymphs, mayfly nymphs, and midge larvae. The local Walleye population have a preference for maggots, caddis flies, locust, kokanee, and trout.

Walleye are tolerant of a great range of environmental situations, but appear to reach greatest abundance in large, shallow, turbid lakes. Walleye often use sunken trees, boulder shoals, weed beds, or thicker layers of ice and snow as a shield from the sun. In clear lakes, Walleye often lie in contact with the bottom apparently "sleeping". In these lakes, Walleye often feed from top to bottom at night. In more turbid water, Walleye are more active during the day, swimming slowly in schools close to the bottom. (Scott et. al., 1979).

Once spawning is finished and the water warms, Walleye retreat to deeper zones. Travelling in large schools, Walleye live in comparatively tiny pockets of deep water. Walleye utilize the deep water center zone, for the rest and safety, making periodic feeding forays up the adjacent structures. Walleye are often associated with other species such as yellow perch, northern pike, muskellunge, small mouth bass, trout, white fish, suckers, kokanee, and dollies. The habitat of Walleye does not change in winter except for an avoidance of strong water currents. Walleye are active all winter, and are taken by ice fishermen. Walleye are found in moderately shallow water to very deep water depending on the season. (Acerrano, 1982).

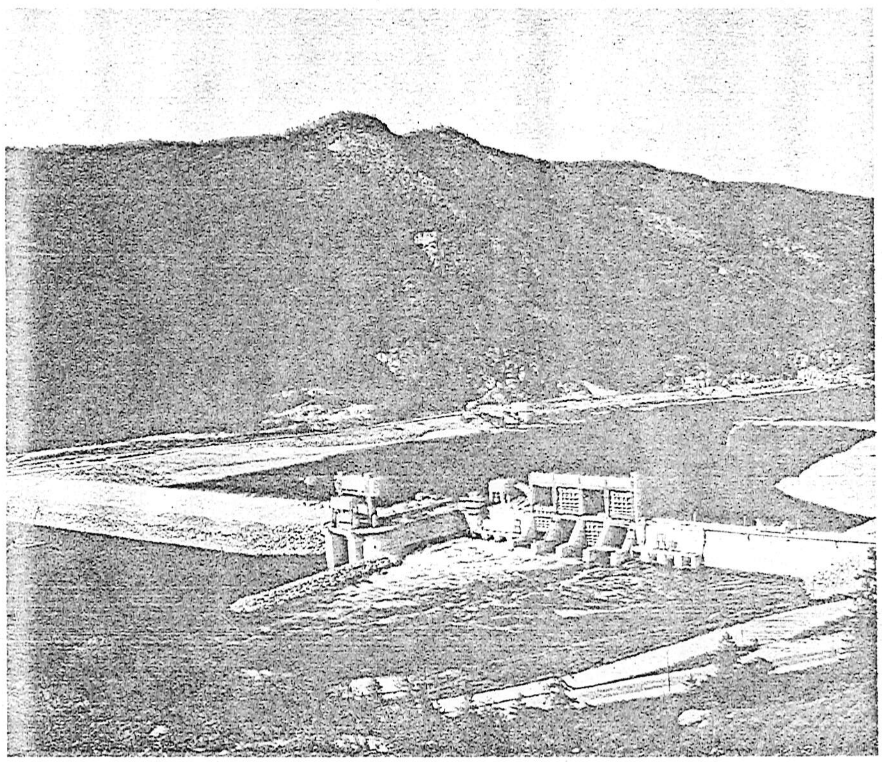
1.4 Columbia River - History of Hugh Keenleyside Dam and its Effects on Aquatic Insects and Fish

In 1969 the High Arrow Dam began its operation but was renamed Hugh Keenleyside Dam that same year. The construction of this dam was mainly due to the signing of the Columbia River Treaty in Washington, D.C. by President Eisenhower and Mr. Diefenbaker on January 17, 1961. The construction of the Hugh Keenleyside Dam was credited to Dr. Keenleyside who was the Chairman of the B.C. Power Commission. The total cost for the construction of Hugh Keenleyside Dam exceeded $66,000,000. With the construction of Hugh Keenleyside Dam the Columbia River water was backed up 150 miles from Castlegar to Revelstoke, drowning about 90% of the habitable land. The total amount of acreage involved in this flooding of the dam amounts to approximately 40,000 acres. (Waterfield, 1970). See fig. 4, photograph of Hugh Keenleyside Dam.

At low river flow, Celgar pulp mill in Castlegar has a direct influence on aquatic life. At low river flow, the pulp mill effluent causes sub-lethal stress on aquatic life between the mill and the Kootenay River. Bottom life has also been affected by log storage and handling in the Columbia River between the Hugh Keenleyside Dam and the pulp mill. The discharge of water over the sluiceway of the Hugh Keenleyside Dam causes high level dissolved gas supersaturation in the river. These levels could cause gas bubble disease in fish. During low flow periods, the water discharge from Hugh Keenleyside Dam has a noticeable effect on water quality (Table I). (Water Investigation Branch, 1979).

The flucuations in the Columbia River have an effect on insects that dwell on or near the river bank. With frequent water level flucuations caused by Hugh Keenleyside Dam, the effluents on the bottom are stirred up to the surface of the Columbia River and are then carried further down the river only to settle down to the bottom again and smother the spawned eggs and aquatic insects which are very important food source for all species of fish.

FIGURE 4



PHOTOGRAPH OF HUGH KEENLEYSIDE DAM

TABLE I

MEASURED BY THE PROVINCE OF B.C. FROM JUNE 1975 TO JULY 1977

FACTORS mg/L	AVERAGE
ALKALINITY	48.0
ARSENIC	< 0.005
CARBON	2.0
COPPER	0.001
IRON	0.1
LEAD	< 0.001
NITROGEN, AMMONIA	0.007
OXYGEN	12.1
pH	8.1
SOLIDS, DISSOLVED	75.0
SOLIDS, SUSPENDED	1.9
SULPHATE	2.6

WATER QUALITY IN THE COLUMBIA RIVER

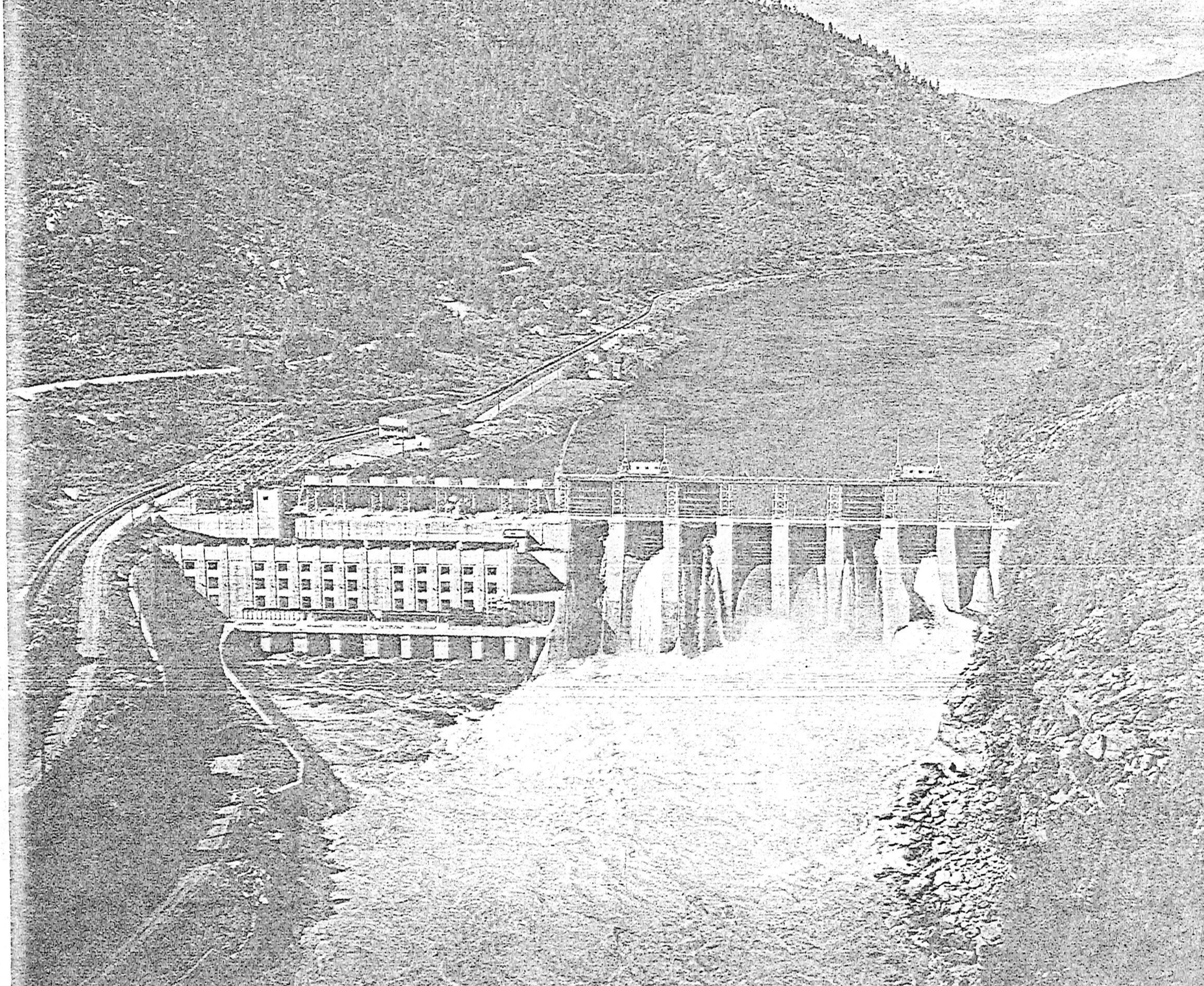
1.5 Kootenay River - History of Brilliant Dam and its Effects on Aquatic Insects and Fish

Brilliant Dam was built in the early 1900's during the depression years. Brilliant Dam was one of the first dams built on the Kootenay River which permanently cut-off the salmon spawning migration in the upper Kootenays. This dam is constructed mostly out of high grade cement with metal bars and plates inserted into the foundations to increase the strength. Most of the labourers that contributed to the construction of Brilliant Dam were Doukabour people that lived in the surrounding areas. See fig. 5 photograph of Brilliant Dam.

With the construction of Brilliant Dam, large amounts of pollutants and unsoluables in the water, altered to some degree the habitat of fish and insects. These pollutants such as sand, silt, and scrap metal, destroyed spawning grounds of many species of fish that existed in the Kootenay River. Brilliant Dam was not the only contributor to these pollutants in the Kootenay River. Other contributors include Lower and Upper Bonnington Dams, Corralynn Dam, and the most recent, the Kootenay Canal which contributed most of the undesired pollutants. With the steadily flucuations of water levels in the reservoir of these dams, effluents from the bottom are stirred up to the surface and are carried down the Kootenay River only to settle down again to the bottom and possibly altering the feeding and spawning grounds of fish. (See Table II, Water Quality in Kootenay River.)

These pollutants also smother the hatching aquatic insects which are vital to all fish. In some areas where the movement of water is very slow, the pollutants congregate and possibly

FIGURE 5



PHOTOGRAPH OF BRILLIANT DAM

TABLE II

MEASURED BY THE PROVINCE OF B.C. FROM JUNE 1975 TO JULY 1977

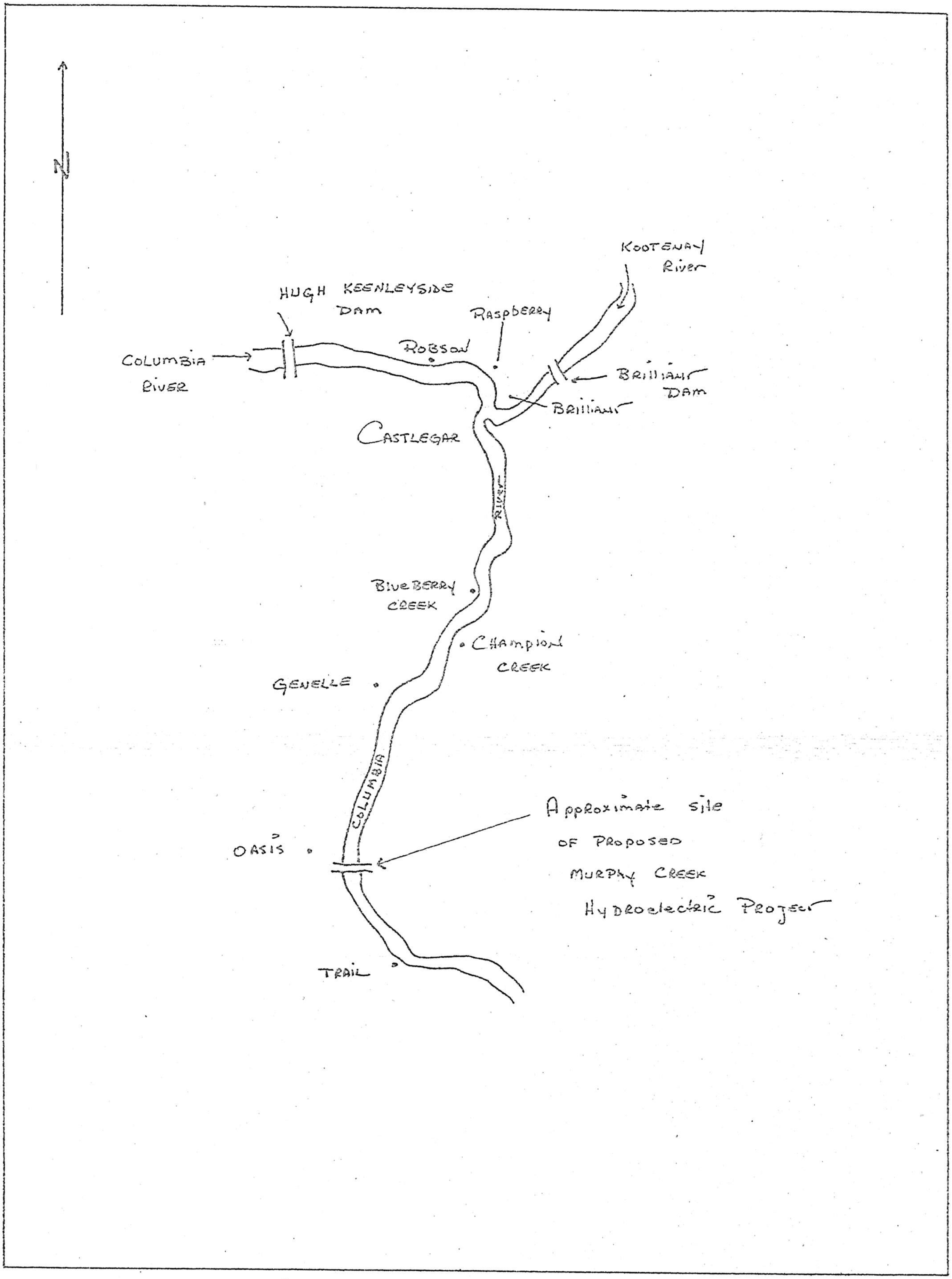
FACTORS mg/L	AVERAGE
ALKALINITY	57.0
ARSENIC	<0.005
CARBON	2.0
COPPER	0.002
IRON	0.1
LEAD	0.001
NITROGEN, AMMONIA	0.009
OXYGEN	12.0
pH	8.1
SOLIDS, DISSOLVED	84.0
SOLIDS, SUSPENDED	2.6
SULPHATE	0.2

WATER QUALITY AT THE MOUTH OF KOOTENAY RIVER destroy the habitat of insects and fish to a point where the habitat cannot be utilized for long periods of time. With great water level decreases the insects that dwell near the river banks may become stranded, depleting the food supply for fish. But with great water level increases the insects may be washing out into the river, increasing the food supply for fish.

1.6 Future Conditions of Columbia - Kootenay Rivers (Proposed Murphy Creek Project)

The condition of the Columbia and Kootenay Rivers may be altered if Hydro is granted approval for the construction of the Murphy Creek Project. The Murphy Creek site is located on the Columbia River approximately 3 km upstream from Trail and 25 km downstream from the confluence of the Columbia and Kootenay Rivers. One of the main purposes of the feasibility study (B.C. Hydro and Power Authority, 1980) is to establish the optimum economical operating level of the reservoir. A range of reservoir levels is therefore being considered to allow a rational selection which would lie within the range of 424 metres to 430 metres elevation. The Murphy Creek Project reservoir would back water up to the Hugh Keenleyside Dam, 35 km upstream. (fig. 6). The Keenleyside Dam is the main water flow regulator along the lower reaches of the Columbia River. Any increase in water levels at the Hugh Keenleyside Dam would reduce the discharge capability of the dam. These flucuating reservoir levels will have great effects on B.C. Timber Lumber mill, the nearby pulp mill and on various water supply and sewage disposal facilities around the reservoir perimeter at Castlegar. (See fig. 7, Location of Murphy Creek Project.)

FIGURE 7



LOCATION OF MURPHY CREEK PROJECT

With the completion of Murphy Creek Project the future of all species of fish is uncertain. The increased water level upstream from the project will have some affect on the fish. The rate of water flow will be drastically decreased influencing possible spawning, and feeding habits of all fish. Also with the construction of Murphy Creek certain migrating fish such as Walleye and Sturgeon will be restricted from further movement. This is due to the impassible structures that are planned to be constructed.

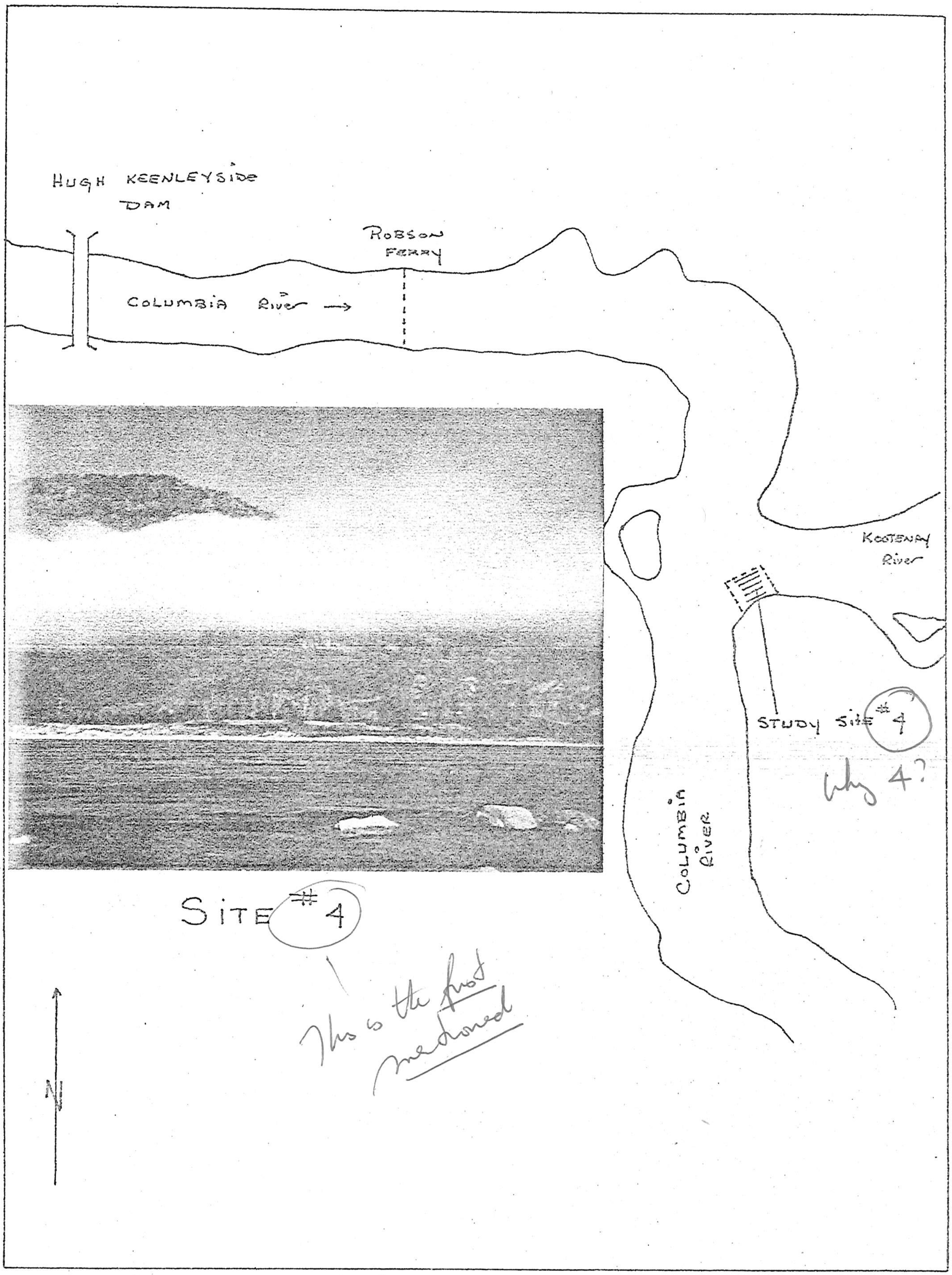
2.0 FIELD RESULTS

2.1 Columbia River Study Location

The area that the experiments in this report are based on begins at the Hugh Keenleyside Dam on the Columbia River and continues downriver just past the converging Kootenay River, located just below Selkirk College.

There is only one main location on the Columbia River in which angling for Walleye was successful. This study area is located exactly where the Columbia and Kootenay Rivers converge just below Selkirk College (fig. 8, photograph of area). This study are contains shallow water with the river bottom gradually sloping downwards. There are many large boulders that protrude from the water surface near the river bank. These boulders are utilized by Walleye and other species of fish for safety and rest. This area also contains a very strong-flowing current on one half of the area and a series of back-eddies on the other half. The river bottom contains large boulders, gravel, and sand. The dimensions of this area is approximately 50 metres long by 100

FIGURE 8



COLUMBIA RIVER STUDY LOCATION

metres wide. This study area for the collection of data for Walleye fish success proved to be the most successful with eleven Walleye specimens (Table III).

2.1.1 Seasonal Occurrence Determined from Angling Success

Angling success of Walleye is directly related to their seasonal occurrence. Beginning from January, 1982 to March, 1983 a total of eleven Walleye specimens were caught in the Columbia River. No Walleye were caught during the winter season. During the spring season, only one Walleye specimen was caught. The summer season proved to be the most productive with six Walleye specimens. During the fall season, four Walleye specimens were caught (Table III). A systematic schedule was developed to angle for Walleye. This schedule consists of alternate angling days which occur on Saturdays and Wednesdays. With this type of schedule, results can then be summarized. Therefore, concrete conclusions can then be made about the habits of Walleye in the Columbia River.

2.1.2 Catch/Unit Effort

The systematic schedule also consists of a maximum of two angling hours on Saturdays and Wednesdays. Since no Walleye were caught during the winter season, no results were recorded. During the spring season the time it took to catch Walleye gradually decreased to one hour per Walleye. During the summer and fall seasons, the time it took to catch Walleye drastically decreased to twenty minutes per Walleye. This drastic increase in catch per hour climaxed at the end of September and then began to decrease drastically to the end of the winter season. A majority of Walleye

TABLE III

	LOCATION	DATE	TIME	SEX	WEIGHT	LENGTH	STOMACH CONTENTS
1	Brilliant Dam	January 22	Noon	Male	1 3/4 lbs.	13 in.	- Hellgramites
2	Brilliant Dam	February 5	Morning	Male	1 lb.	11 in.	- 3-in. trout, Hellgramites
3	Brilliant Bridge	April 25	Morning	Female	2 1/4 lbs.	17 in.	- Fish eggs, Hellgramites
4	College	May 10	Noon	Male	2 1/2 lbs.	17 in.	- Maggots, Fish eggs
5	Brilliant Bridge	June 5	Afternoon	Female	2 lbs.	15 in.	- Hellgramites, Locust
6	College	July 28	Noon	Female	3 1/2 lbs.	19 in.	- Locust, Caddis flies
7	College	July 28	Afternoon	Female	3 lbs.	20 in.	- Grasshopper, snails
8	College	August 3	Afternoon	Male	3 3/4 lbs.	21 in.	- Snails, caddis flies
9	Brilliant Bridge	August 5	Afternoon	Male	3 1/2 lbs.	21 in.	- 2-in. Kokanee
10	College	August 5	Evening	Male	3 3/4 lbs.	22 in.	- Grasshopper, Cricket
11	College	August 6	Evening	Female	4 1/2 lbs.	25 in.	- Fish eggs, Snails
12	Brilliant Bridge	August 10	Afternoon	Female	4 1/2 lbs.	26 in.	- Grasshopper
13	College	August 11	Evening	Male	2 1/2 lbs.	19 in.	- Snails, maggots
14	Brilliant Dam	August 15	Noon	Female	3 1/2 lbs.	20 in.	
15	Brilliant Dam	August 30	Noon	Male	3 3/4 lbs.	23 in.	- Grasshopper, Maggots
16	Brilliant Dam	September 3	Evening	Female	4 lbs.	25 in.	- Stonefly, Sculpin
17	Brilliant Bridge	September 7	Morning	Male	4 1/2 lbs.	28 in.	- 2-in. trout, snails
18	Brilliant Bridge	September 12	Morning	Female	4 1/4 lbs.	27 in.	- Stone fly, Grasshopper
19	Brilliant Dam	September 25	Morning	Female	2 1/2 lbs.	18 in.	- Grasshopper, Snails
20	Brilliant Bridge	September 29	Afternoon	Male	2 1/4 lbs.	20 in.	
21	Brilliant Dam	September 29	Afternoon	Male	2 3/4 lbs.	21 in.	- Caddis flies

WALLEYE FISHING SUCCESS
IN THE
COLUMBIA — KOOTENAY RIVERS 1982-1983

TABLE III (CON'T)

	LOCATION	DATE	TIME	SEX	WEIGHT	LENGTH	STOMACH CONTENTS
22	College	October 2	Morning	Female	5 lbs.	28 in.	- Snails
23	College	October 6	Evening	Female	3½ lbs.	24 in.	—
24	Brilliant Bridge	October 9	Morning	Male	1½ lbs.	17 in.	- Snails
25	Brilliant Bridge	October 13	—	—	—	—	—
26	College	October 16	—	—	—	—	—
27	College	October 20	Afternoon	Male	1½ lbs.	15 in.	- Snails
28	Brilliant Bridge	October 23	Morning	Male	1¾ lbs	18 in.	- Snails
29	College	October 27	—	—	—	—	—
30	Brilliant Dam	October 30	—	—	—	—	—
31	College	November 3	—	—	—	—	—
32	College	November 6	Morning	Male	1½ lbs.	14 in.	- Snails
33	Brilliant Dam	November 10	Morning	Female	2½ lbs.	21 in.	- Snails
34	College	November 17	—	—	—	—	—
35	Brilliant Dam	November 20	—	—	—	—	—
36	Brilliant Bridge	November 27	—	—	—	—	—
37		December	*	NO	Success		
38		January	*	NO	Success		
39		February	*	NO	Success		
40		March	*	NO	Success		

WALLEYE FISHING SUCCESS
IN THE
COLUMBIA - KOOTENAY RIVERS

specimens were caught within one hour of angling time during the summer months and a minority of Walleye specimens were caught in two hours during the winter and spring months. (fig. 9).

2.1.3 Feeding Habits Based on Stomach Contents

During this study in the Columbia River, Walleye specimens were collected and their stomach contents thoroughly analyzed for food (Table III). Walleye specimens caught in the spring season were analyzed and their stomach contents contained food such as caddis fly, locust, grasshopper, snails, and crickets. During the fall season, the stomach contents of Walleye included mainly snails and many food objects that were not identified (fig. 10). During this study several various types of live bait were used to catch Walleye. These baits included fish eggs, maggots, and caddis flies.

Walleye specimens caught in the Columbia River ranged from 14 inches to 28 inches in length and 1.1 pounds to 5 pounds in weight (fig. 11). The largest of these Walleye specimens were caught during the summer and fall seasons and the smallest Walleye were caught during the winter and spring seasons (Table III).

2.1.4 Age, Sex, and Reproductive Status - Growth Analysis

A total of four Walleye specimens were carefully examined for growth rates (Table IV-a). The procedure involved to accomplish age analysis is to measure the distance between each annulus (growth rings) and insert the measurements into a formula (Table IV-b). The end result shows the various

FIGURE 9

Catch Unit Effort

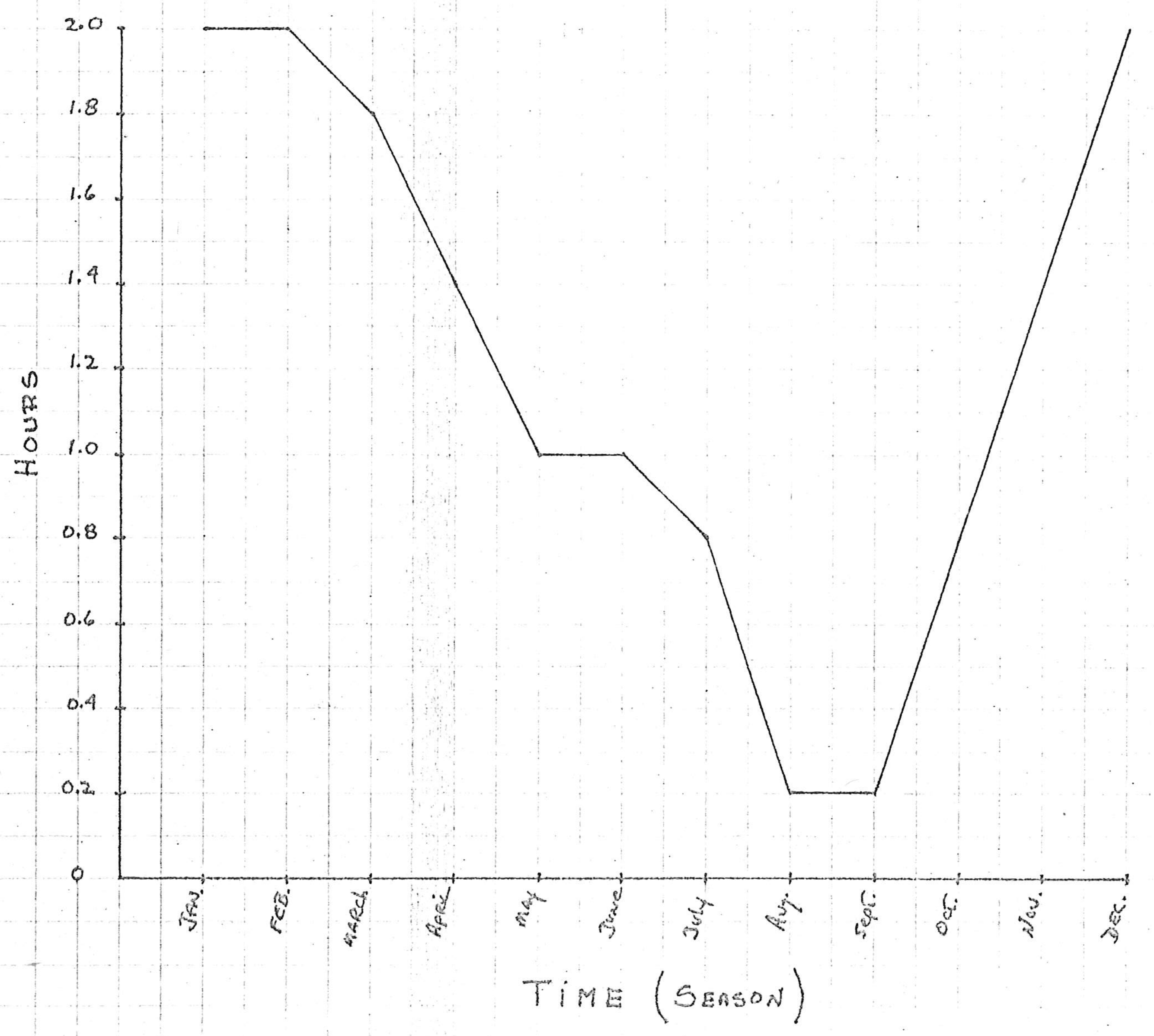


FIGURE 10

Feeding Analysis by Season - 1982/83

Season — Specimens	Grasshopper	Hellgramite	Locust	Caddis Fly	Snail	Stone Fly	Cricket	Maggot	Fish Eggs	Fish: Trout	Fish: Kokanee	Fish: Sculpin	Not Identified	Nothing	Total
Jan.		2													2
Feb.		/								/					2
March														✓	0
April		/							4						5
May								2	2						4
June		/	/												2
July	/		/	3	2										7
Aug.	6			4	8		2	5	4		/				30
Sept.	3				/	5				/		/	3		14
Oct.					2								2		4
Nov.					/								/		2
Dec.														✓	0
Total	10	5	2	7	14	5	2	7	10	2	/	/	6	2	

FIGURE 11

LENGTH - WEIGHT ANALYSIS

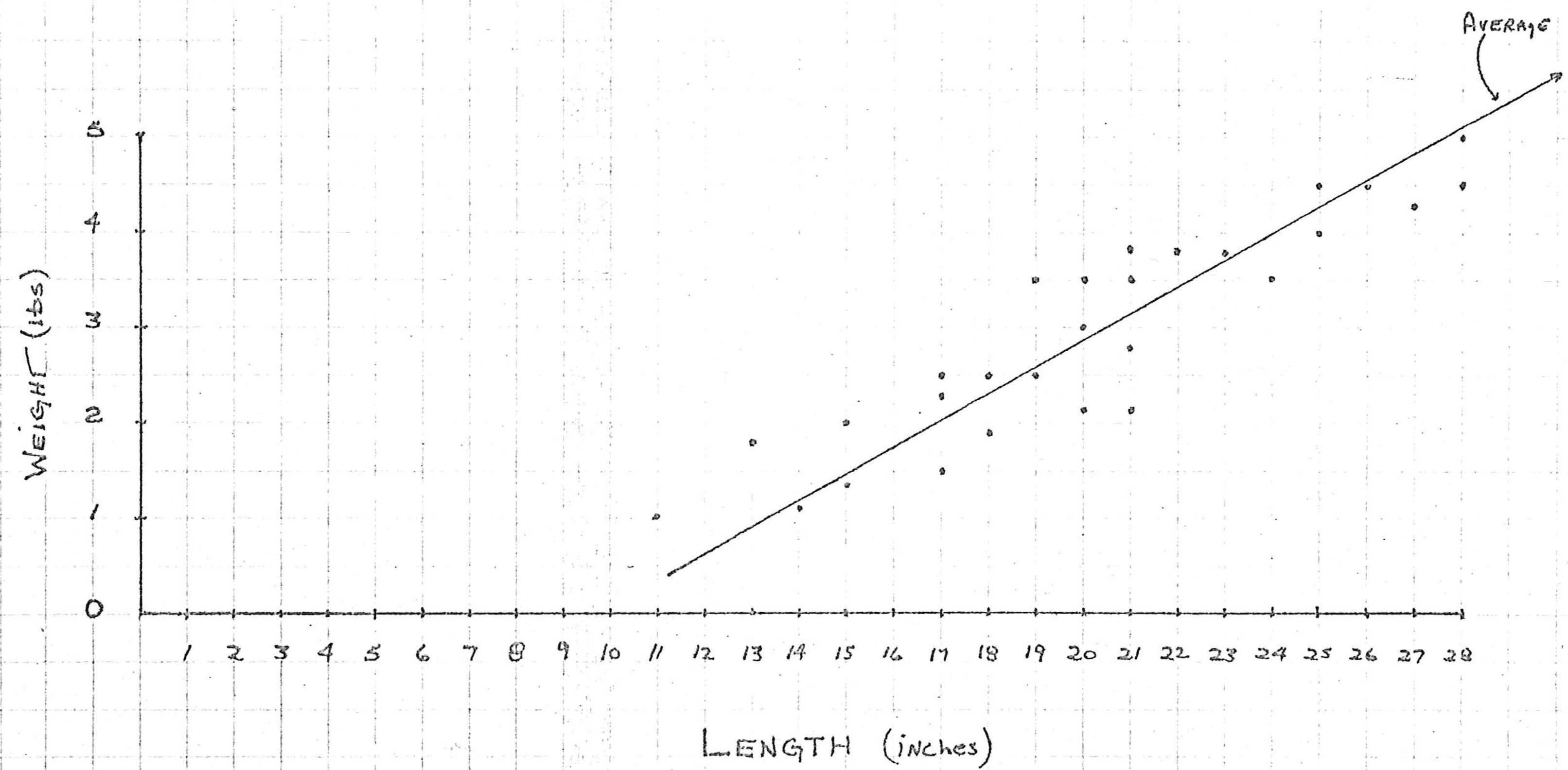


TABLE IV (a)

FISH #	SCALE #	LENGTH TO ANNULUS (mm) A1	A2	A3	A4	A5	TOT.	LOCATION
1	a	18	35	40			46	COLUMBIA RIVER
15 IN.		0.39	0.76	0.87				
2	a	25	38	44			50	COLUMBIA RIVER
14 IN.		0.50	0.76	0.88				
3	a	17	29	38			42	KOOTENAY River
20 IN.		0.40	0.69	0.90				
4	a	31	41	45	48		53	Columbia River
24 IN.		0.58	0.77	0.85	0.91			
5	a	11	26	40	43	46	50	COLUMBIA River
28 IN.		0.22	0.53	0.80	0.86	0.92		

GROWTH RATE ANALYSIS

TABLE IV (b)

FISH #

1. $A_1 = 5.3 + 0.39(15-5.3) = 9.1$ inches during first year. (FISH LENGTH)
$A_2 = 5.3 + 0.76(15-5.3) = 12.7$ " " second " . " "
$A_3 = 5.3 + 0.87(15-5.3) = 13.7$ " " third " . " "

2. $A_1 = 5.3 + 0.50(14-5.3) = 9.7$ inches during first year. (FISH LENGTH)
$A_2 = 5.3 + 0.76(14-5.3) = 11.9$ " " second " . " "
$A_3 = 5.3 + 0.88(14-5.3) = 12.9$ " " third " . " "

3. $A_1 = 5.3 + 0.40(20-5.3) = 11.2$ inches during first year. (FISH LENGTH)
$A_2 = 5.3 + 0.69(20-5.3) = 15.4$ " " second " . " "
$A_3 = 5.3 + 0.90(20-5.3) = 18.5$ " " third " . " "

4. $A_1 = 5.3 + 0.58(24-5.3) = 16.1$ inches during first year. (FISH LENGTH)
$A_2 = 5.3 + 0.77(24-5.3) = 19.7$ " " second year. " "
$A_3 = 5.3 + 0.85(24-5.3) = 21.2$ " " third " . " "
$A_4 = 5.3 + 0.91(24-5.3) = 22.3$ " " fourth " . " "

5. $A_1 = 5.3 + 0.22(28-5.3) = 10.3$ inches during first year. (FISH LENGTH)
$A_2 = 5.3 + 0.53(28-5.3) = 17.3$ " " second " . " "
$A_3 = 5.3 + 0.80(28-5.3) = 23.5$ " " third " . " "
$A_4 = 5.3 + 0.86(28-5.3) = 24.8$ " " fourth " . " "
$A_5 = 5.3 + 0.92(28-5.3) = 26.2$ " " fifth " . " "

FORMULA : $L' = C + \left(\frac{s'}{s}\right) L - C$

L' = LENGTH at YEAR INTERVALS
L = LENGTH at CAPTURE (in.)
s' = DISTANCE from FOCUS to ANNULUS (mm)
s = DISTANCE from FOCUS to exterior of SCALE (mm)
C = CONSTANT (5.3)

GROWTH RATE ANALYSIS

lengths of a particular Walleye at any given year. These results show various growth rates that occurred throughout the seasons. The growth rate of the four Walleye sampled from the Columbia River proved to be very rapid and consistent (fig. 12-a,b,d,e,). On the average, as the age of a Walleye increases the distance between each growth ring decreases (fig. 13). The ages of Walleye caught in the Columbia River range from three years to five years.

A total of six males and five females were caught in the Columbia River. During the winter season, the total population of males was limited to one Walleye. The spring and summer seasons showed an increase in male population peaking in August. During the fall season the male population gradually decreased (fig. 14-a). The females showed a similar trait in their population status but their traits were more gradual in August and September (fig. 14-b). A complete status analysis of Walleye caught in the Columbia River can be seen in Appendix I.

2.2 Kootenay River Study Locations

The general areas that the experiments in this report are based on begin at Brilliant Dam on the Kootenay River and continues downriver converging into the Columbia River just below Selkirk College.

There are three locations on the Kootenay River in which angling for Walleye was successful (fig. 15, photograph of study areas). There are two data collection areas near Brilliant Dam. One of these areas occurs approximately 100 metres away from the dam on the Ootischenia side of Kootenay River. This study area contains deep and fast running water with boulders protruding at

Should be here

FIGURE 12

Growth Rate Analysis

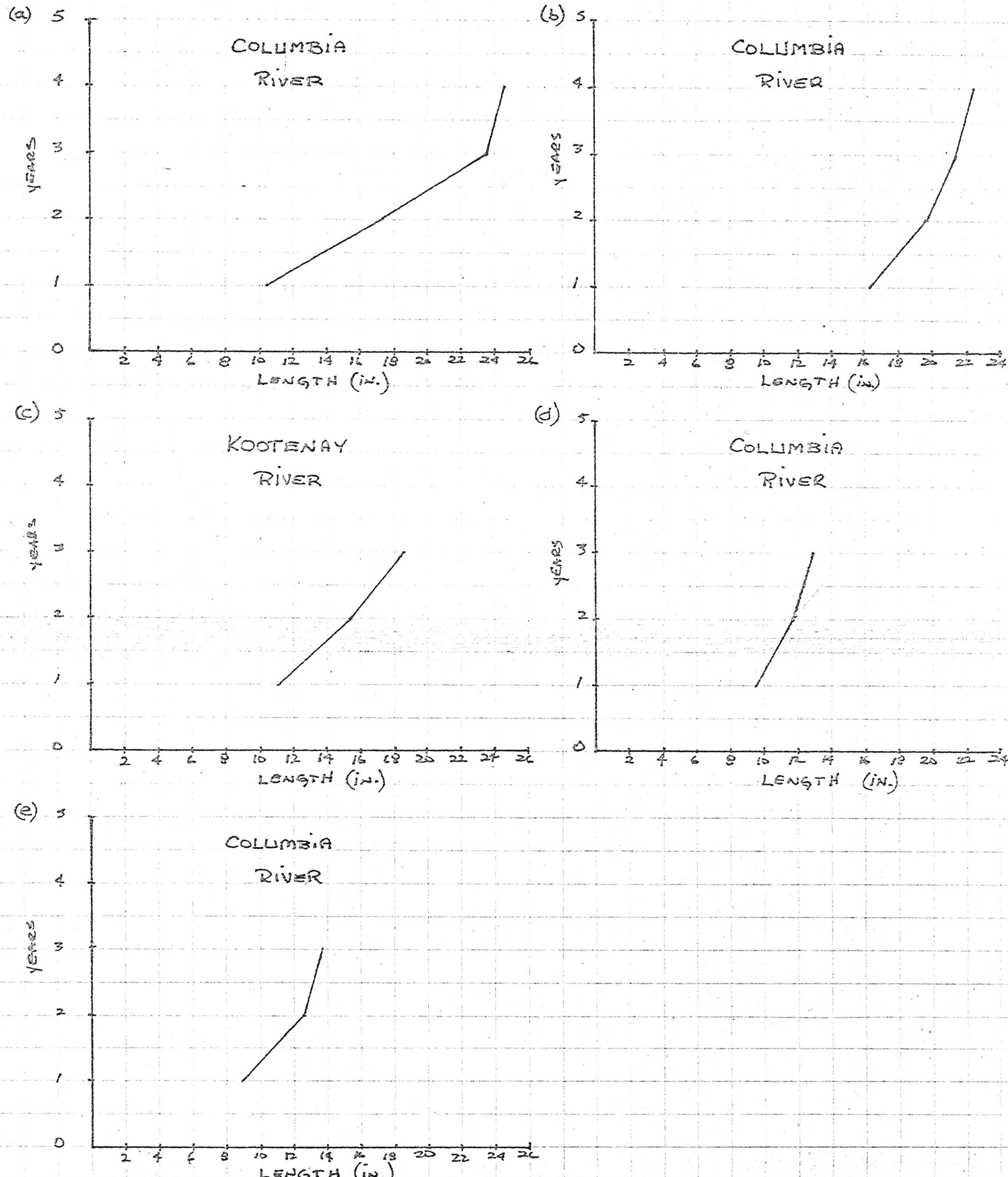


FIGURE 13

Scale Analysis

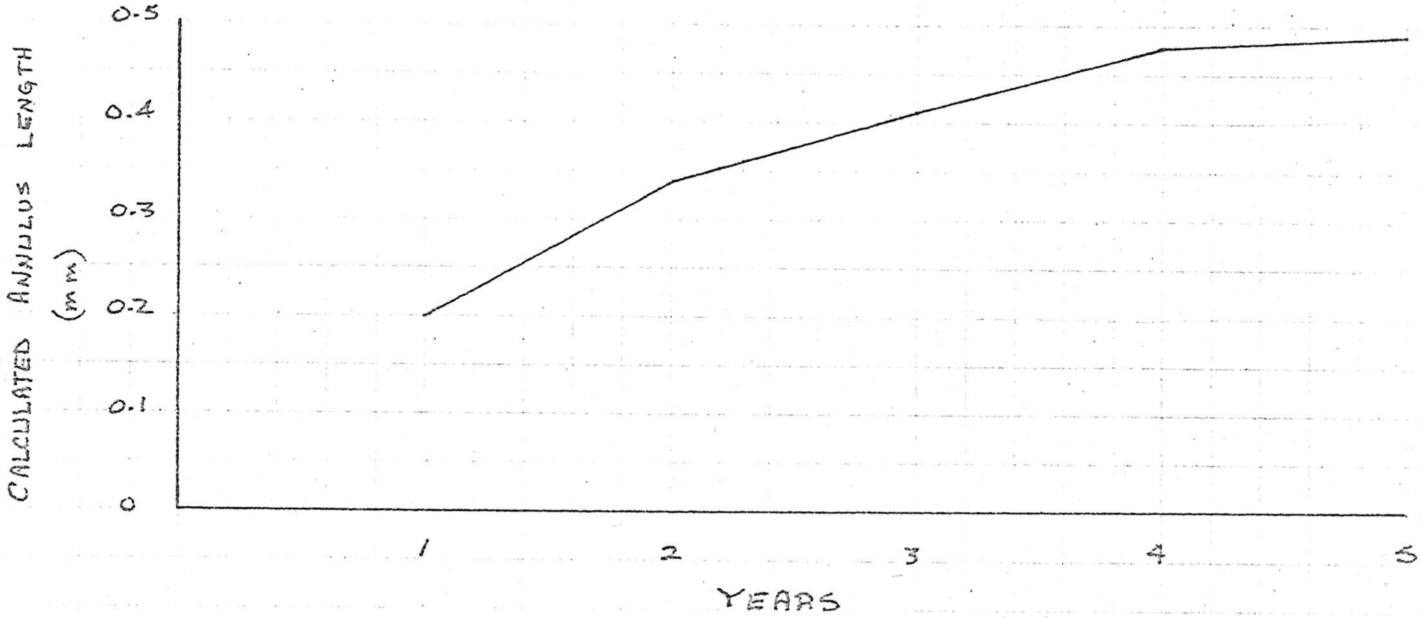


FIGURE 14

Reproductive Status by Sexes

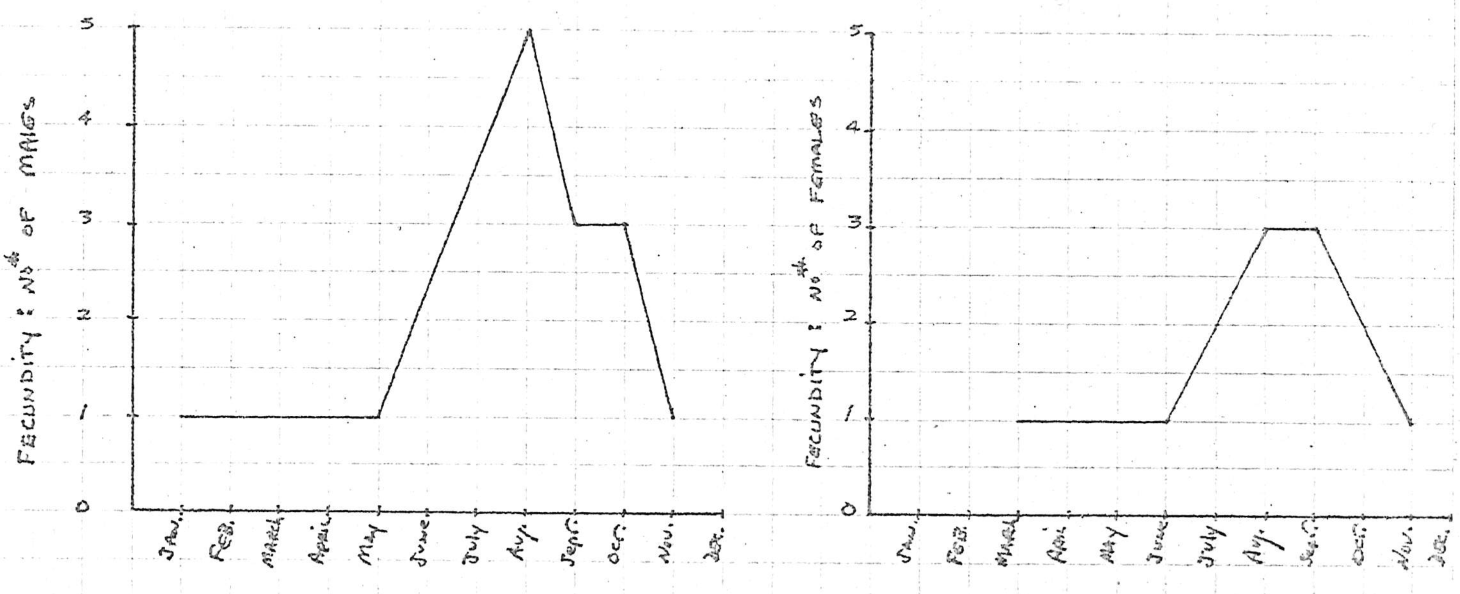
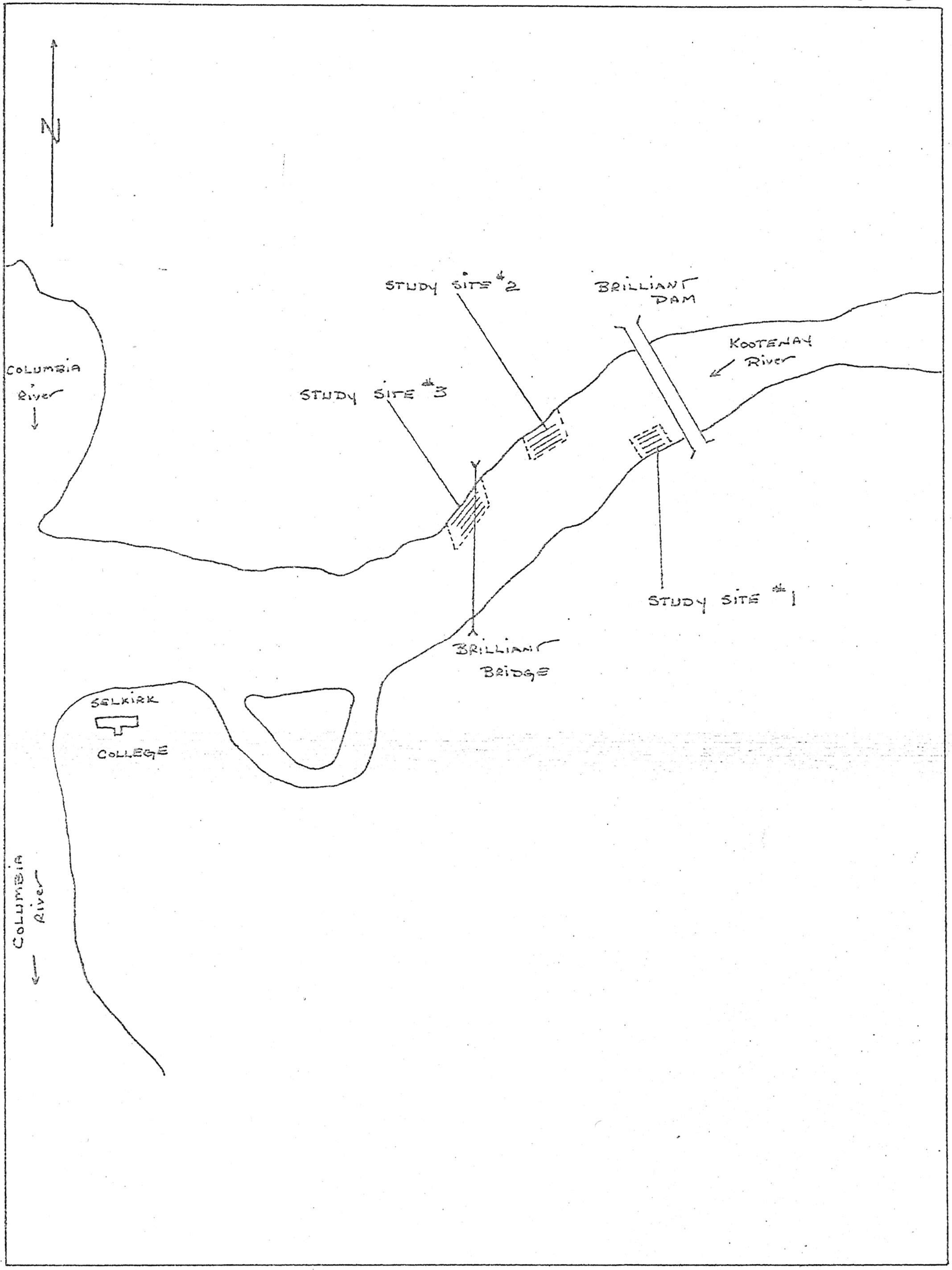


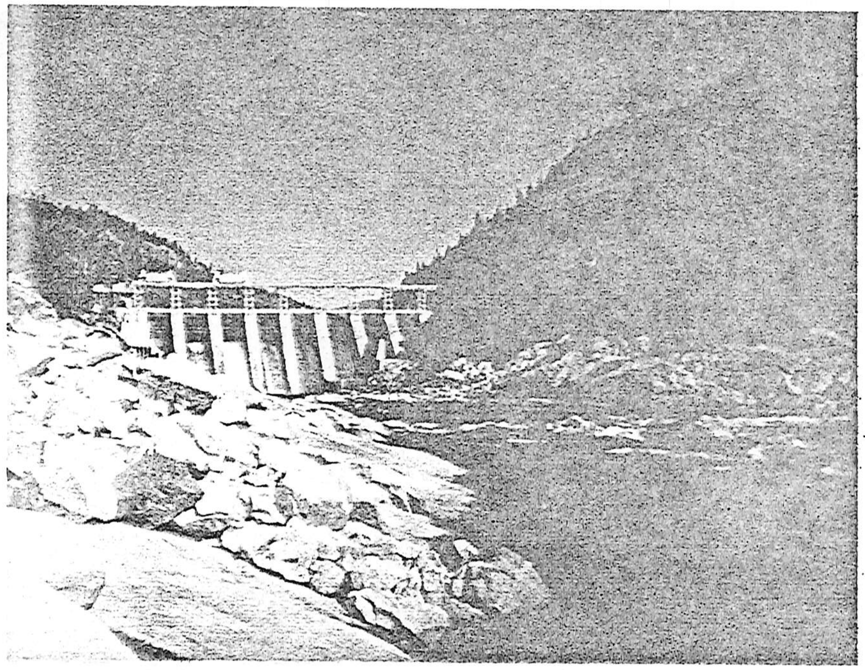
FIGURE 15 Should be closer to 2.2



KOOTENAY RIVER STUDY LOCATIONS

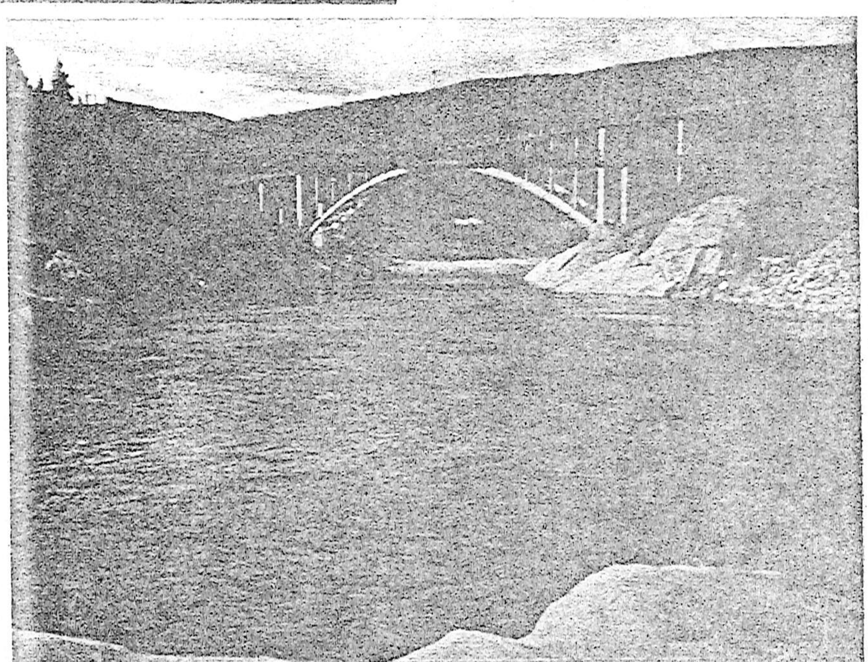
FIGURE 15 (CON'T)

SITE #1



SITE #2

SITE #3



the head of the current. This area also contains many back-eddies that circulate throughout the area. The perimeter of this study area is approximately 100 metres long by 100 metres wide.

The second study area near Brilliant Dam occurs about 500 metres away from the Brilliant Dam on the Brilliant side. This study area contains shallow water with moderate running water rushing over the substrate. The river bottom profile of this area contains smooth bedrock with a few boulders and gravel. The perimeter of this area is approximately 200 metres long by 50 metres wide.

The third data collection area is located just beneath Brilliant bridge on the Brilliant side of the Kootenay River. One section of this area is very deep and the other area, located only a few metres away, is very shallow with a water depth of two feet. The first section contains slow moving water but the current speed increases as the water enters the second section. The river bottom profile in this area contains gravel and sand. The perimeter of this area is about 50 metres long by 50 metres wide.

2.2.1 Seasonal Occurrence Determined from Angling Success

The angling success for Walleye in the Kootenay River is related to their seasonal occurrence. Beginning from January, 1982 to March, 1983, at total of seventeen Walleye specimens were caught in the Kootenay River. Only two Walleye were caught during the winter season.

During the spring season, three Walleye specimens were caught. The fall season proved to be the most productive with nine Walleye specimens (Table III). Of these study areas chosen on the Kootenay River, the most productive area for Walleye proved to be just beneath Brilliant bridge on Brilliant side. The other two study areas near Brilliant Dam also proved to be productive with eight Walleye specimens caught. A systematic schedule was also developed for fishing the Kootenay River consisting of alternate angling days.

2.2.2 Catch/Unit Effort

The systematic schedule also consisted of a maximum of two angling hours on Saturdays and Wednesdays. During the winter season the time it took to catch Walleye was a maximum of two full hours. The time it took to catch Walleye during the spring season gradually decreased to one hour per Walleye. The summer and fall seasons proved to be the most productive in catches per hour. The time it took to catch Walleye during the summer and fall seasons decreased to twenty minutes per Walleye. This drastic increase in catch per hour climaxed at the end of September and then began to decrease drastically to the end of the winter season. A majority of Walleye specimens were caught within one hour of angling time during the summer months and a minority of Walleye specimens were caught in two hours during the winter and spring months (fig. 9).

2.2.3 Feeding Habits Based on Stomach Contents

During this study on the Kootenay River, seventeen Walleye specimens were collected and their stomachs thoroughly analyzed for food content (Table III). The two Walleye specimens caught in the winter season were analyzed producing food such as hellgrammites and a three inch trout. Walleye caught during the spring season produced such food as hellgrammites, fish eggs, and locust.

During the summer season the Walleye stomach contents produced such food as grasshopper, a two inch kokanee, maggots, and snails. During the fall season the stomach contents of Walleye produced stonefly, a two inch trout, sculpin, snails, grasshopper, and maggots and several food objects that were not identified (fig. 10). During this study several various types of live bait was used to catch Walleye. These baits included caddis fly, maggots, fish eggs, and stonefly.

Walleye specimens caught in the Kootenay River range from 11 inches to 28 inches in length and 1 pound to 4½ pounds in weight (fig. 11). The largest of these Walleye specimens were caught during the summer and fall seasons and the smaller Walleye were caught during the winter and spring seasons. (Table III).

2.1.4 Age, Sex, and Reproductive Status - Growth Analysis

Only one Walleye specimen was examined for growth rates (Table IV-a). The growth rate of the Walleye specimen sampled in the Kootenay River proved to be very consistent in growth (fig. 12-c). The age of the Walleye specimen caught in the Kootenay River was three years.

A total of nine males and eight females were caught in the Kootenay River. During the winter season, the total population was limited to two males. The spring and summer seasons showed an increase in male population peaking in August. During the fall season the male population gradually decreased (fig. 14-a). The females showed a similar trait in their population status but the peak was more gradual in August and September (fig. 14-b). A complete status analysis

out of order Fig 15 appeared a while ago.

of Walleye caught in the Kootenay River can be seen in Appendix I.

3.0 DISCUSSION

3.1 Feeding Analysis by Season

Most of the Walleye specimens preferred insects as their major food diet. The most abundant type of food that Walleye preferred above the others is snails. Other important foods include grasshoppers, fish eggs, caddis flies, and maggots. Also ~~in this study,~~ small fish were found in the stomachs of larger Walleye specimens. These small fish included one kokanee, one sculpin and two trout. The Walleye diet involves a variety of foods which prove to be very abundant in the Columbia and Kootenay Rivers. This abundance of food is utilized by the Walleye which allow the growth of the Walleye population to prosper rapidly.

Most of the food that Walleye preferred was most abundant during August and September. This also included the three fish species that were eaten by the Walleye. Very few insect species were found during the winter, spring, and fall months. This is due to the occurrence of hatching insects in the Columbia and Kootenay Rivers. Most insects hatch during the summer months when the weather is favorable.

3.2 Catch/Unit Effort by Season

During the winter months the catch per hour was limited to one Walleye every two hours. As the spring season progressed, the catch per hour increased to two Walleye every one hour. August and September were the most productive months with one Walleye every twenty minutes. Therefore, the catch per hour increased as the seasons progressed into summer and fall but the catch per hour drastically decreased in the winter and spring. These flucuations in catch per hour are mainly due to the seasonal occurrence of insect hatches. Since the summer months are the major times of year for emerging insects, all fish including Walleye will feed vigorously on these insects. Also during this time small fish are abundant and are readily preyed upon by larger Walleye specimens.

3.3 Reproductive Status by Season

In this study 15 males and 13 females were caught in the Columbia and Kootenay Rivers. Most of these males were caught in the summer peaking in August. Most of the females were caught in the fall, peaking in September. Male Walleye were caught during the winter months whereas, female Walleye were not. This is due to the Walleye seasonal spawning occurrence. Female Walleye spawn during late winter or early spring. Females that were caught during late spring and summer did not have spawning roe (fish eggs). The females that were caught during the fall did have spawning roe. These females with spawning roe were in their earlier stages of spawning during the fall season.

3.4 Length - Weight - Age by Season - Growth Rate Analysis

The largest Walleye specimen that was analyzed weighed 5 pounds, measured 28 inches in length and was aged at 5^{+} years. The other Walleye specimens that were thoroughly analyzed also showed a similar traite in rate of growth. On the average, during the early stages of growth, the growth rate of Walleye was very rapid. After $2\frac{1}{2}$ to 3 years the growth rate of Walleye gradually decreased. Most of the Walleye were aged at 3 to 4 years with a few Walleye reaching 5^{+} years. The reason for this rapid growth rate of Walleye is mainly due to the abundance of food in the Columbia and Kootenay Rivers. Also another reason for this growth is that both the Columbia and Kootenay Rivers provide excellant habitat that Walleye prefer. This Walleye habitat provides spawning and feeding grounds, protection and resting areas. With these good existing living features in the Columbia and Kootenay Rivers, the Walleye population will continue to flourish. With the present growth rate, Walleye will become one of the major fish species that will be angled for in the West Kootenays.

CONCLUSION

1. Angling success of Walleye is directly related to their seasonal occurrence in the Columbia and Kootenay Rivers. Most Walleye were caught during the summer and fall seasons due to warmer water and abundance of food.
2. The catch per hour increased as the seasons progressed into summer and fall seasons but the catch per hour drastically decreased in the winter and spring seasons.
3. The most common food items found and analyzed in the Walleye specimens were maggots, snails, grasshoppers, locust, fish eggs, and helgramites. Also found in the stomachs of four Walleye specimens were three different species of fish which included two trout, one kokanee, and one sculpin. Walleye food diet varies considerably from insects to fish.
4. The growth rate of the Walleye specimens in the Columbia and Kootenay Rivers proved to increase rapidly and consistently as the seasons progressed from the winter season to the fall season. On the average, during the early stages of the growth of Walleye, their growth rate is very rapid.
5. More Walleye males were caught in the Columbia and Kootenay Rivers than females. Most of the males were caught in the summer, peaking in August. Most of the females were caught in the fall, peaking in September.

In Summary, the growth rate of Walleye is very rapid due to abundance of food. Walleye prefer insects as their major food diet. If tempted, small fish will fall prey to larger Walleye specimens. Therefore, with the large abundance of food available in the Columbia and Kootenay Rivers the population growth of Walleye will continue to increase.

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do not capitalize article titles.

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APPENDIX I (a)

FISH # 1.

LENGTH (IN.) 28.
WEIGHT (lbs.) 5.

A SCALE ANALYSIS:

1. CALCULATED AGE (YRS.) 5+.

2. LENGTH TO ANNULUS

#1	11	.
#2	26	.
#3	40	.
#4	43	.
#5	49	.
#6	—	.
EDGE OF SCALE	50	.

B GONADS:

1. MALE ____.
FEMALE ✓.

2.

	R.H.S.	L.H.S.	TOTAL
VOLUME (CCS)	44.0	44.0	88.0
WEIGHT (GMS)	46.0	44.8	90.8

3. SIZE OF EGGS (MMS) 0.8.

C STOMACH ANALYSIS:

1. % FULL - (0-100%) 1%.

2. CONTENTS:

1.	—	.
2.	—	.
3.	—	.
4.	—	.
5.	—	.
NOT IDENTIFIED	(1)	.

(b)

FISH # 2.

LENGTH (IN.) 24.
WEIGHT (lbs.) 3.5.

A. SCALE ANALYSIS:

1. CALCULATED AGE (YRS.) 4+.

2. LENGTH TO ANNULUS
   - #1 31.
   - #2 41.
   - #3 45.
   - #4 48.
   - #5 —.
   - #6 —.
   - EDGE OF SCALE 53.

B. GONADS:

1. MALE ____.
   FEMALE ✓.

2.

	R.H.S.	L.H.S.	TOTAL
VOLUME (ccs)	23.0	24.0	47.0
WEIGHT (gms)	27.52	26.92	54.44

3. SIZE OF EGGS (mms) 0.5.

C. STOMACH ANALYSIS:

1. % FULL- (0-100%) 2.

2. CONTENTS:
   1. 1- Snail.
   2. ____.
   3. ____.
   4. ____.
   5. ____.

   NOT IDENTIFIED (2).

(C)

FISH # 3.

LENGTH (in.) 14.
WEIGHT (lbs.) 1.1.

A SCALE ANALYSIS:

1. CALCULATED AGE (yrs.) 3+.

2. LENGTH TO ANNULUS
#1 25.
#2 38.
#3 44.
#4 –.
#5 –.
#6 –.
EDGE OF SCALE 50.

B GONADS:

1. MALE ✓.
FEMALE ____.

2.

	R.H.S.	L.H.S.	TOTAL
VOLUME (ccs)	1.0	1.0	2.0
WEIGHT (gms)	0.69	0.62	1.31

3. SIZE OF EGGS (mms) –.

C STOMACH ANALYSIS:

1. % FULL- (0-100%) 5.

2. CONTENTS:
1. (2)- snails.
2. ____.
3. ____.
4. ____.
5. ____.
NOT IDENTIFIED (1).

(d)

FISH # 4.

LENGTH (IN.) 15.
WEIGHT (lbs.) 1.3.

A. Scale Analysis:

1. Calculated Age (yrs.) 3.

2. Length to Annulus

#1	18
#2	35
#3	40
#4	–
#5	–
#6	–
Edge of scale	46

B. Gonads:

1. Male ✓.
   Female ____.

2.

	R.H.S.	L.H.S.	TOTAL
Volume (ccs)	1.0	1.0	2.0
Weight (gms)	1.1	0.8	1.9

3. Size of eggs (mms) –.

C. Stomach Analysis:

1. % Full - (0-100%) 1.

2. Contents:
   1. ____
   2. ____
   3. ____
   4. ____
   5. ____

Not identified (1).

(e)

FISH # 5.

LENGTH (IN.) 20.
WEIGHT (lbs.) 2.2.

A Scale Analysis:

1. Calculated Age (yrs.) 3+.

2. Length to Annulus

#1	17
#2	29
#3	38
#4	—
#5	—
#6	—
Edge of scale	42

B Gonads:

1. Male ✓.
Female ___.

2.

	R.H.S.	L.H.S.	TOTAL
Volume (ccs)	1.8	1.2	3.0
Weight (gms)	1.2	1.1	2.3

3. Size of eggs (mms) —.

C Stomach Analysis:

1. % Full- (0-100%) 25.

2. Contents:
1. (1) - stone fly.
2. 1 - Grasshopper.
3. ___.
4. ___.
5. ___.

Not identified (2).