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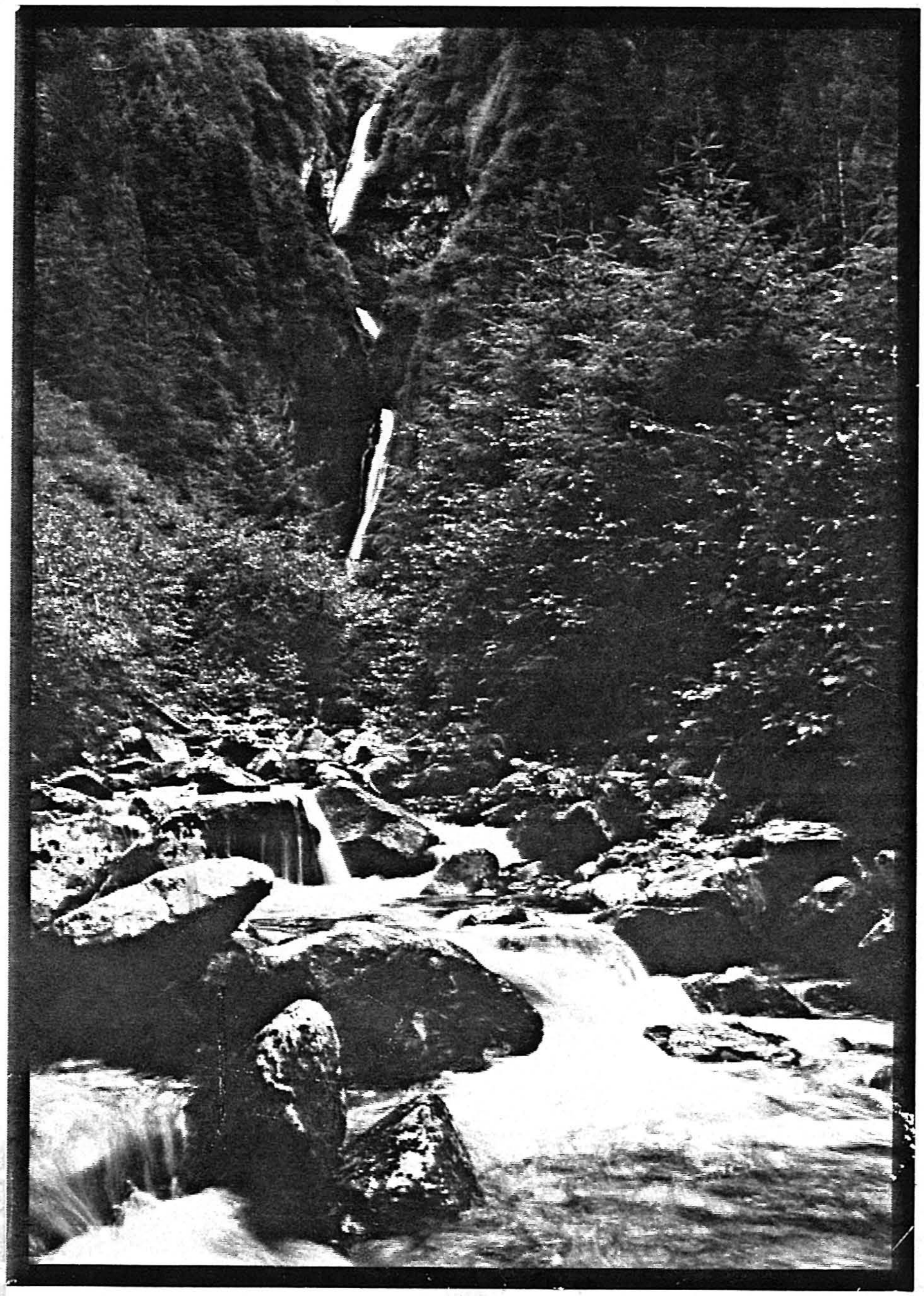

BIOLOGICAL - ECOLOGICAL INVESTIGATIONS ON THE BLACK BEAR CREEK SYSTEM NEAR KLAWOCK, ALASKA

AUGUST 1982

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BLACK BEAR CREEK SYSTEM

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TABLES, FIGURES, PLATES AND MAP

PROJECT INVESTIGATORS

This study has been completed through the joint efforts of Dan Bishop, project leader, Alexander Milner, aquatic biologist, and Leigh Smith, wildlife biologist and camp manager.

Leigh Smith has operated backcountry camps in Connecticut, Washington, Alaska, and Yukon Territory, Canada. He worked five seasons in Glacier Bay National Park as a field biologist recording observations for a large mammal survey, and studying the flora and fauna of Southeast Alaska. He has canoed thousands of miles in the north and, as an active outdoorsman, has hunted and tracked for twenty years. He is currently nearing completion of a B.A. in American History.

Alexander Milner, M.Sc. University of London, conducted dissertational studies of streams in Glacier Bay National Monument to determine patterns of colonization and succession in streams following glacial recession. He instructed courses at the University of Alaska, Juneau, in Limnology and Aquatic Entomology. He anticipates receiving his doctorate in hydrobiology in 1982 from the University of London.

Daniel Bishop has extensive experience with the bio-hydrology of coastal Alaskan streams. He worked eleven years as a research scientist and as hydrologist for the U.S. Forest Service in Southeast Alaska before beginning land-water resource consultant work in 1973. He has extensive experience with salmon habitat, salmon hatchery siting, water quality control and land planning efforts. His most recent work has involved environmental hydroelectric investigations on Black Bear Creek and West Creek, near Skagway.

- Acknowledgements -

In particular, we thank Steve Hansen, Steve Bates, and the crew at the Alaska Department of Fish and Game Klawock Hatchery, who have helped us generously over the last two years.

Our thanks also to Bob Wood, Alaska Department of Fish and Game, for his counsel, to Jeff Koenings, Alaska Department of Fish and Game, for analyzing water and plankton samples and for valuable advice, to the National Marine Fisheries Service in Juneau and Auke Bay for loan of equipment as well as valuable discussions of findings, to Southern Southeast Regional Aquaculture Association for loan of equipment, and to Sealaska Timber Corporation for frequent use of aerial photos.

INTRODUCTION

This work was completed under a series of contracts with HARZA Engineering Company of Chicago, Illinois. We have worked with Mr. Jack Robinson, of HARZA, and Mr. Brent Petrie, of Alaska Power Authority, to develop a base of hydro-biologic and wildlife information that can contribute to feasibility, planning and design of the proposed Black Bear Lake Hydroelectric Project. The first contract work began in late summer, 1980, and was reported to HARZA December 15, 1980, as Black Bear Lake Aquatic Study: Phase I. The second contract, in the spring of 1981, was begun in mid-March, 1981, and reported May 15, 1981, as a Preliminary Study of Outmigrant Fry from Black Bear Creek, Prince of Wales Island, Alaska. These efforts led to the present contractual work, which began in early August, 1981, resulting in an interim report November 2, 1981, for the summer-fall work: An Interim Report on Biological-Ecological Work on the Black Bear Creek System. In this report, we have drawn upon all of the previous pieces, focusing the work to date to reach the objectives of this study.

SCOPE AND OBJECTIVES OF WORK

The principal scope of this work concerned fish/fish habitats and wildlife/wildlife habitats above Black Lake and including Black Bear Lake. Work extending below Black Lake included fyke net outmigrant trapping and thermograph operation near the mouth of Black Bear Creek as well as at the outlet of Black Lake. Hydrologic and lake observations and measurements were made as part of this effort.

Due to heavy snow and ice conditions remaining in Black Bear Lake through June, 1982, no significant work was accomplished to determine rainbow numbers or spawning area in this lake.

Additional work on stream cross sections was completed in response to agency concerns expressed regarding effects of variable regulated flow conditions on spawning and rearing habitats.

The specific objectives established in the program of work (proposal, June 24, 1981) were as follows:

1. Biological work on Black Bear Lake: to estimate the size of the stocked rainbow trout population and to identify spawning areas.

2. Biological work on Black Lake: to estimate the rearing population of juvenile salmonids in Black Lake and to ascertain lake productivity with an appraisal of its potential as rearing habitat.

3. Biological and related physical work on the stream above Black Lake: to quantify the extent of suitable spawning and rearing habitat above Black Lake; to determine the number and species

of adult and juvenile fish using this section of the system where the largest impact of alteration in flow regime is likely to occur; to evaluate the respective stream flow contributions of subdrainages above Black Lake; and to approximate the number of beaver and black bear using this part of the drainage, identifying key habitats.

CHARACTERISTICS OF UPPER BLACK BEAR CREEK DRAINAGE

Physical

Climate, weather

The climatic characteristics of Black Bear Creek drainage are probably most nearly represented by the Craig station record between 1938 and 1952, shown in Table 1.

Our experience in the drainage, however, has identified some specific characteristics of Black Bear Creek climate and weather. Winter visits, particularly in January, 1982, indicate that this drainage is significantly colder during cold periods. Overnight minimums of 0-10°F in Craig-Klawock were matched with temperatures about 10°F colder in the vicinity of Black Bear Creek and even upper Big Salt Lake. Periods when southeasterly storms were moving through the general area, often produced fierce williwaw (vertical) blasts of wind coming down (to the north) from the vicinity of Black Bear Lake. Passage of local fronts produced rapid wind reversals.

TABLE 1: Craig Climatic Information

Month	MONTHLY VALUES Average Temp.	Average Max. Temp.	Average Min. Temp.	Precip.
J	34.5°F	39.5°F	29.5°F	12.16"
F	35.6	40.9	30.2	7.69
M	37.6	44.0	31.2	8.58
A	42.1	49.0	35.2	8.80
M	48.1	55.9	40.2	5.22
J	52.6	59.7	45.4	3.73
J	56.6	62.7	50.4	4.48
A	56.7	63.4	50.0	5.75
S	53.3	59.5	47.0	9.47
O	46.3	51.5	41.1	14.62
N	39.6	44.4	38.8	13.49
D	36.0	40.5	31.4	11.98
Annual	44.9°F	50.9°F	38.9°F	105.97"

Observations were made of rainfall during periods of significant residence at Black Lake. These are shown in Figure 3, along with fluctuating levels of Black Lake. No station -- at Craig or Klawock -- was available for comparison of observed rainfall levels.

Configuration of area

This study focuses principally on Black Bear Creek above the outlet of Black Lake. Earlier work by CH_2MHill and by Environaid showed that stream flow and temperature conditions in the creek below Black Lake are increasingly buffered from impact by the headwater hydroelectric project. The Black Bear Lake drainage area proposed for regulation, 1.82 square miles, is simply too small a fraction (about 10.4%) of the total watershed to impact the lower stream. Yet, this regulated area is sufficient to impact the stream above Black Lake. Black Bear Lake basin represents 28.9% of the watershed above the Black Lake inlet stream, 34.5% of the upper watershed which includes the south tributary and 58.7% of the Black Bear watershed immediately upstream of the south tributary. The area of principal study for this project is shown in Figure 1. Black Lake, which acts as major buffer zone for flow and temperature variability in the upper basin is approximately 60 acres in area with a maximum depth of 35-40 feet (see Appendix Figure 1). The south tributary, above Black Lake, drains a basin of about 2.2 square miles, much of it in a subalpine basin. The spring fork is fed entirely by ground water, while the northerly fork, which leads to the waterfall below Black Bear Lake, is an intermittent stream, with 400-500 yards of steep, coarse streambed below the large slide area being dry at intermediate to low flows. The Black Bear Lake system above the south tributary drains about 3.34 square miles, while Black Bear Lake, at its mouth, has a watershed of 1.82 square miles.

Streamflow characteristics

Streamflow characteristics of Black Bear Creek, with primary emphasis on the Black Bear Lake basin, were developed by CH_2MHill for the feasibility report of 1981. The additional hydrologic work completed for this environmental investigation has been directed primarily toward the Black Bear Creek drainage above the mouth of Black Lake. Flow and lake level

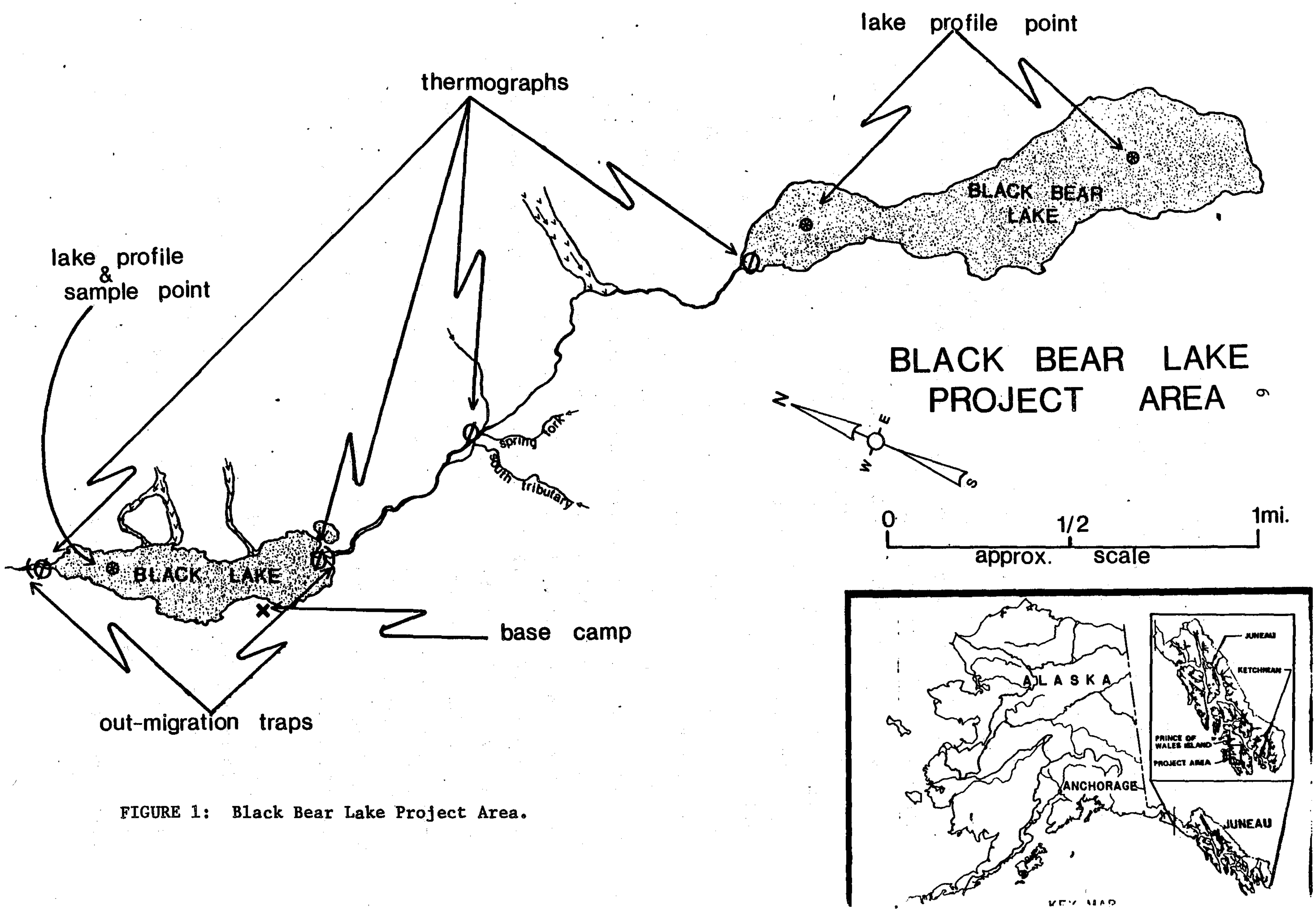


FIGURE 1: Black Bear Lake Project Area.

data has been collected, and is examined here as a basis for evaluating possible effects of flow alteration on habitats of fish and beaver below Black Bear Lake and above the mouth of Black Lake.

Black Lake, estimated at 62 acres from aerial photos (Appendix Figure 1A) is a relatively shallow lake (average depth estimated at 25 feet). Its outlet is controlled in level by a natural log jam about 1,000 feet below the mouth. There is no bedrock showing at the mouth and the gravel stream bottom appears to come from the nearby easterly valley wall. A series of flow measurements have begun to develop a relation between lake level and outlet discharge. This relation is shown in Figure 2 and is used later to estimate change in lake regime and to evaluate inlet stream cross sections.

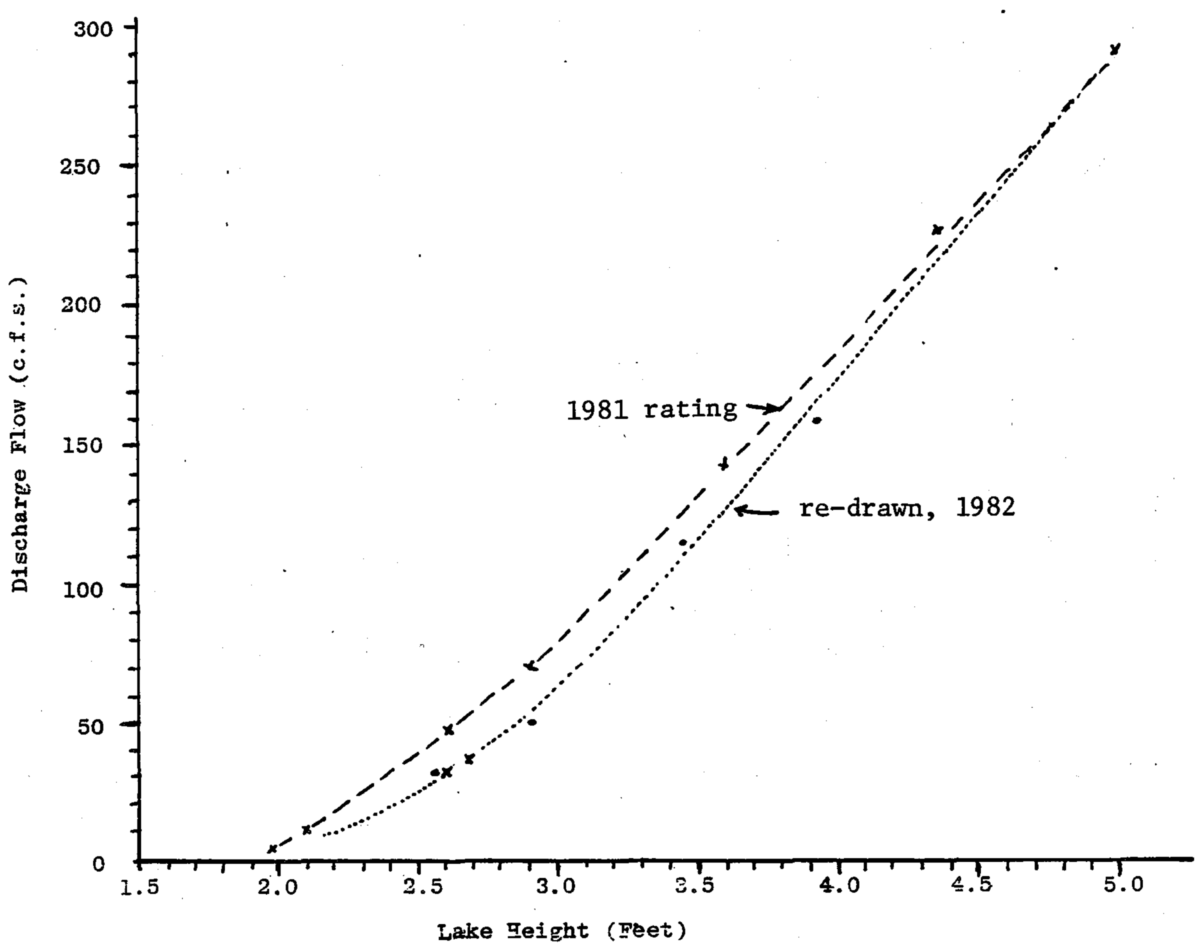


FIGURE 2: Black Lake Height - Outlet discharge relation

The observed fluctuations in Black Lake level during our work periods in the area are shown in Figure 3. In the summer-fall, 1981, Black Lake fluctuated through a range of about 3½ feet. The spring, 1982, range was about 3 feet. The lowest lake levels we observed were in early April, 1982, though we did not read the staff until a few days later, when ice was chopped from the lake staff.

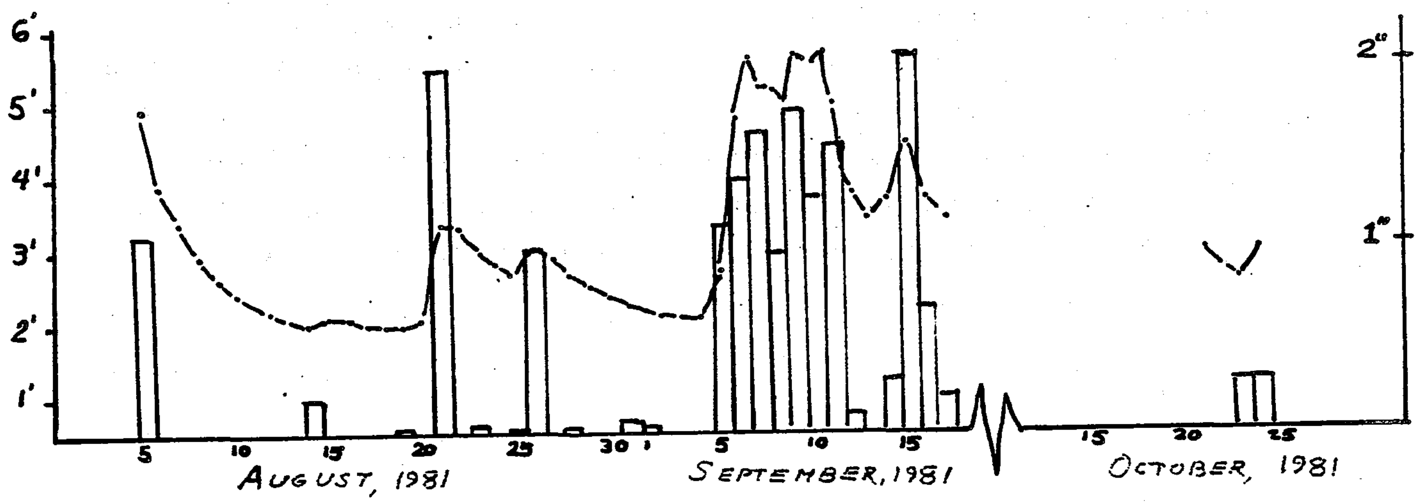
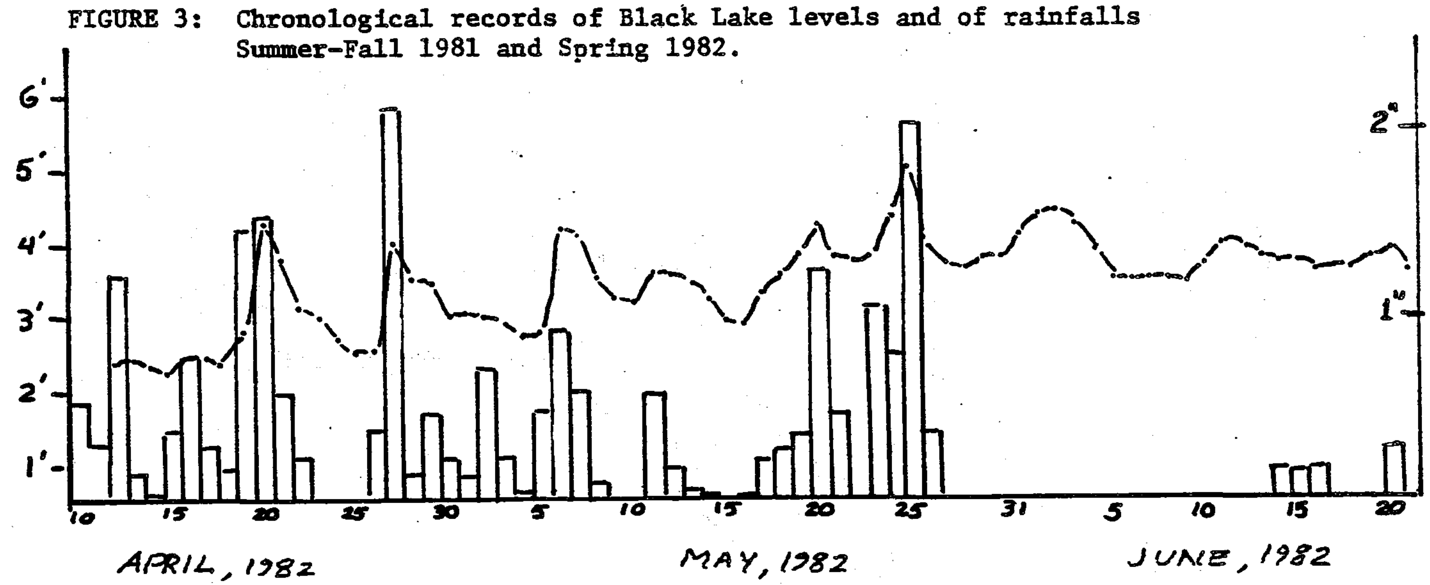


FIGURE 3: **Chronological records of Black Lake levels and of rainfalls Summer-Fall 1981 and Spring 1982.**



Black Lake controls the water level in the inlet stream extending upstream nearly to the first stream forks. In the first 2,400 feet of channel above Black Lake, the stream level at low flows increases only about 0.3 foot.

The stream forks above the low gradient region and separates into channels of the south tributary and Black Bear Lake-derived waters. (See large map in pocket.)

The south tributary, which drains approximately 2.2 square miles, rapidly increases in gradient as its channel swings toward the steep valley wall. The channel carries a bedload of gravel and reddish iron-stained rocks in the tributary's lower reaches, indicating it receives springflow into the surface channel. The south tributary was periodically measured just upstream of its first partial confluence with the Black Bear Lake fork.

Two primary channels derive from Black Bear Lake. The spring fork is entirely spring fed, with very stable volumes of flow measured at between 17 and 25 c.f.s. Lowest flow in this channel was not measured, though observation suggests natural minimum flows which seldom fall below 10 c.f.s. The gradients found in spring fork vary from a minimum of around 0.3% up to greater than 2% near the spring flow source of the flow.

The channel which leads from below the waterfall terminates in an area extensively dammed, ponded and flooded by beaver activity. Below the beaver ponds, this branch shortly joins with the spring fork, and then with the south fork. Above the beaver pond area, the channel rapidly increases in grade, running with water slopes of 1 to 3% in a coarse, dominantly cobble-sized streambed, until the perennial bed terminates about 500 feet upstream of the beaver ponds.

Up channel from the perennial bed, the channel rapidly steepens, with grades estimated at 5-10%, and many boulders in the streambed. Numerous logs and windfalls cross the channel up to the vicinity of the power house site. This location is roughly 1,000 feet beyond the point of perennial flows and a similar distance below the base of the falls. The vicinity of the power house is where the moderate to low streamflows disappear into the boulder bed materials.

More than fifty flow measurements have been taken at various locations in the Black Bear Creek drainage. Most of these measurements were between Black Lake outlet and the waterfall below Black Bear Lake. They are shown in Appendix Table 1. This data has been used in conjunction with U.S.G.S. flow values for Black Bear Lake outlet, and flow estimates for Black Lake outlet (derived from lake level observations and Figure 2 rating curve) to compare flow contributions of respective upper drainage areas. These comparisons are shown as Figure 4, and as Appendix Figures A-2 and A-3.

Several noteworthy relationships appear on Figure 4, comparing U.S.G.S. measured flows from outlet Black Bear Lake with estimated flows on the same days at outlet Black Lake.

August 5-20, 1981, recession flows: This dry-period recession followed for 15 days after a rainy period which ended in about an inch of rain on August 5. For the first two days after the heavy rain, Black Bear Lake discharged at a much higher rate than Black Lake, in terms of their respective drainage areas. By the third day, the relation of respective lake discharges had approached more closely to the relation of yield in accordance with proportioned drainage area. As flows diminished, however, the contribution of Black Bear Lake became increasingly vital in sustaining Black Lake outflows. At the lowest point on this recession (August 18, 1981), a discharge measurement at outlet Black Lake showed 7.2 c.f.s., while the U.S.G.S. flow value for Black Bear Lake on that date is 4.1 c.f.s. This illustrates that a 15-day summer recession results in a large part of Black Lake's outflow deriving from Black Bear Lake. It also suggests that the groundwater system supplying the spring fork does not contain much storage capacity, and probably is as much a pipe as it is a reservoir.

The plot (Figure 4) of daily values in September, 1981, also suggests high initial yields from Black Bear Lake, and again shows lower flow values approaching, but not reaching, the relation of proportioned area yield.

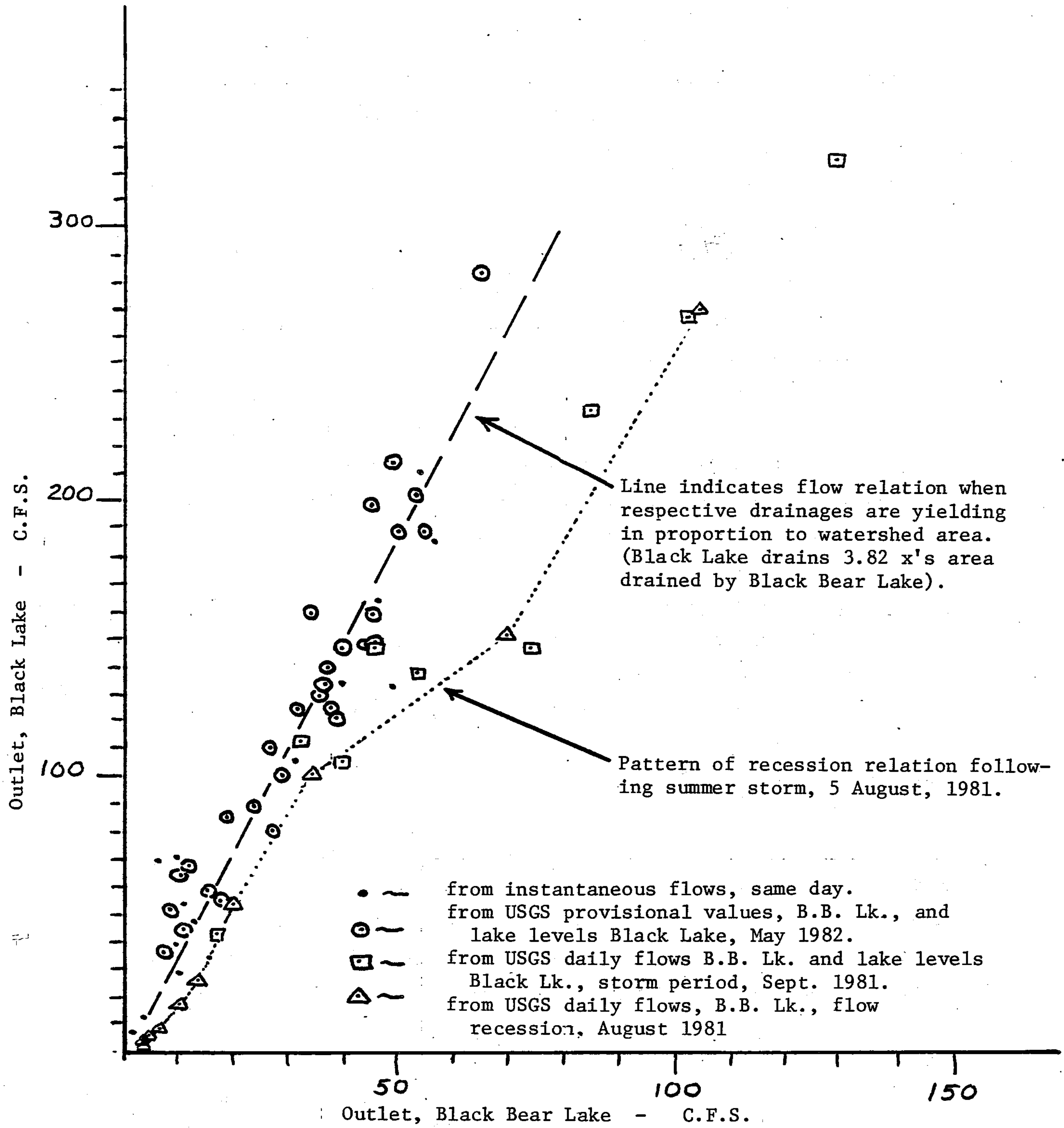


FIGURE 4: Relation of daily flow from Black Bear Lake (USGS records) to observed level - flow from Black Lake.

The relation of comparative flow values in May, 1982, is considerably different from the previous two periods examined. During this month, when snow melt water was a major source of flow along with much rain, the flow relation described in Figure 4 follows closely the line defining flows in proportion to area.

Similar graphical relationships were developed between estimated Black Lake discharge values and (a) stream discharge values taken at the lowest point on the Black Bear Lake outlet fork (Figure A-2, Appendix), and (b) stream discharge values taken near the mouth of the south fork (Figure A-3, Appendix). Both of these plots suggest relationships in which the respective headward fork is producing flows at a lower yield per square mile than the Black Creek basin as a whole. The number of points available and, in the case of the south fork, the scatter of points limits the conclusions which can safely be drawn.

Groundwater emergence

Groundwater emergence plays a vital role in the hydrology and fisheries habitats of Black Bear Creek above Black Lake. Its characteristics, however, have been observed wherever possible, but few quantitative measurements have been taken. Groundwater features are identified and located in Figure 5.

Much of the spawning gravel area in upper Black Bear Creek probably receives emerging groundwater. This is evident from temperature measurements taken with hand thermometer, as well as from the record of the recording thermograph. It is also indicated by iron deposition on surface gravel where iron in groundwater solution oxidizes as it reaches the surface.

Springflows remained over 2°C in the coldest period of winter, 1981-82. Temperatures measured in August, 1981, showed streamflows entering groundwater routes below the falls at around 12°C and emerging at temperatures varying from 9.5 to 12°C according to specific location of emergence. This information indicates a rapid transit through at least some groundwater flow routes.

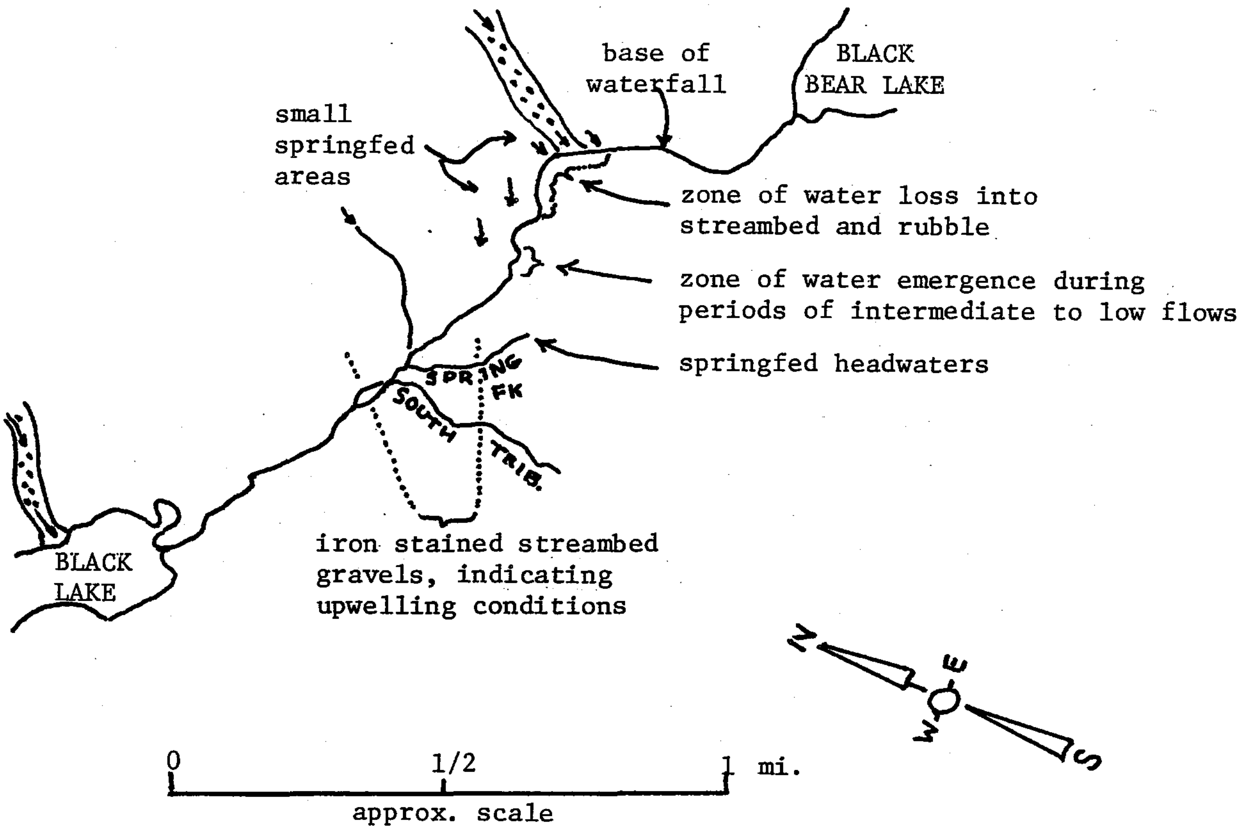


FIGURE 5: General location and features of groundwater system of Black Bear Creek above Black Lake.

Dissolved oxygen levels of emerging groundwater have not been measured. Fingerling salmon utilize springfed pools, however.

Flow measurements taken during spring, 1982, in spring fork indicate the capacity of spring flow is in the range of 17-25 c.f.s. Observation of the spring fork in January, 1982, suggested a winter minimum of around 10 c.f.s., but this flow was not measured. The summer minimum flow in spring fork was not measured either, but the flow values cited earlier for August 18 indicate that the summer minimum was about 5 c.f.s.

Stream sediment characteristics

Although it is evident that stream sediments from boulder size to silts are in downstream migration below the falls, no dramatic streambed movements or channel shifts have been seen in the perennial flow streambed above Black Lake. The most important change in channel conditions has been made by beaver. A new dam on the south tributary has backwatered a significant area and undoubtedly is trapping sediment of gravel size and smaller. The beaver dam located on the lake-fed tributary is also an effective sediment trap.

Boulders can occasionally be seen in pools at several locations along the sand-silt bedded stream channel for the first 2,000 feet above Black Lake. An old torrent-flow jam is located not far up the south tributary. Both the recent and the distant past suggest a more active sediment movement than we have seen. Years of mild sediment movement and channel stability below the falls, such as we have seen, may well be punctuated by major sediment pulses coming from the large slide immediately below the falls or from torrents in the south tributary.

Stream temperatures

Stream temperatures have been measured in the Black Bear Creek drainage with both recording thermographs and hand thermometers. Four thermographs (ENDECO Model 109) were installed in August, 1980, at lower Black Bear Creek, near tidewater; at the outlet of Black Lake; at the inlet of Black Lake; and at the outlet of Black Bear Lake. A fifth thermograph was added in August, 1981, in Black Bear Creek above Black Lake, installed in gravels of the principal spawning habitat of concern. The only difficulties encountered in obtaining good records occurred in lower Black Bear Creek near tidewater, where a log settled on the thermograph unit, and where the unit was also tampered with. These units record to the nearest 0.1°C and have excellent timers.

Results of thermograph measurements are summarized in Figures 6 and 7. Temperature data for 1981-82 is also provided in Appendix Table A-2.

FIGURE 6: Mean Daily Water Temperature for Four Stations on Black Bear Creek, August 1980 through July 1981

BBL: Black Bear Lake Station
UBL: Upper Black Lake Station
LBL: Lower Black Lake Station
MBC: Mouth, Black Bear Creek, near tidewater

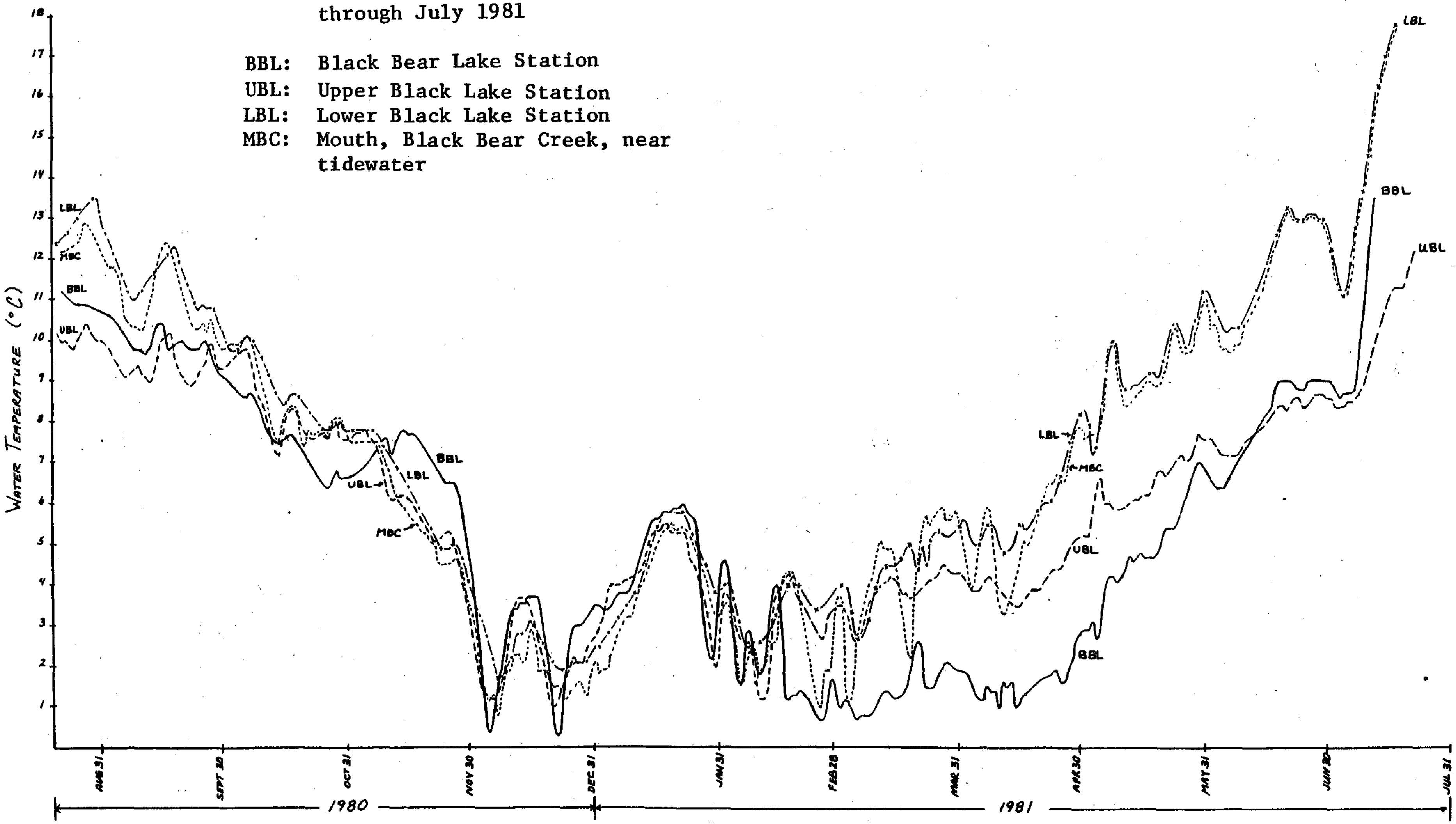
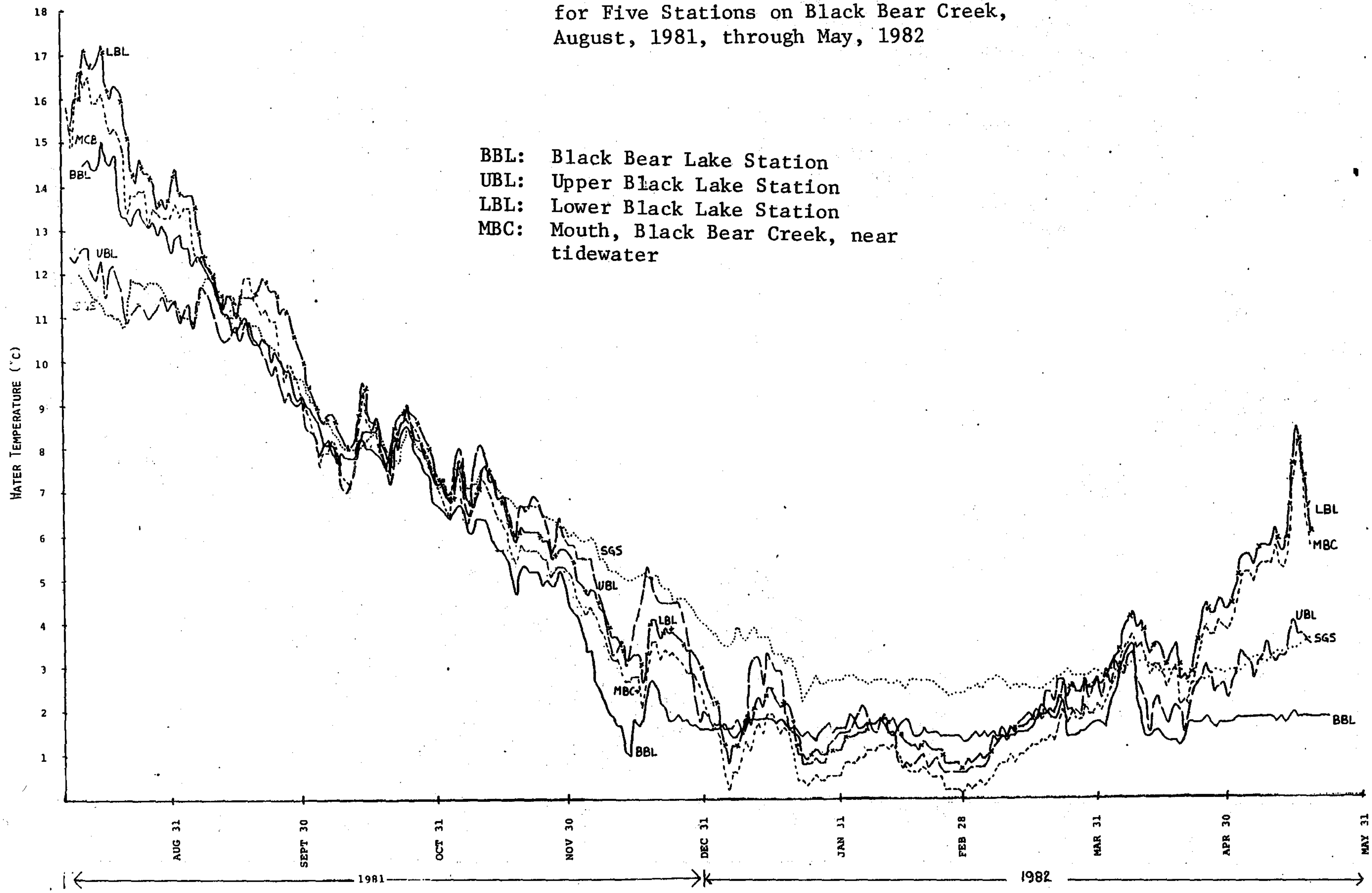


FIGURE 7: Mean Daily Water Temperature for Five Stations on Black Bear Creek, August, 1981, through May, 1982



Some features shown on these figures require further comment. In winter 1980-81, Black Bear Lake outlet temperature reached lower levels than in winter 1981-82. This may be due to the minimal ice cover in 1980-81, allowing for periods of greater chill and heat loss.

In August, 1981, during a period of warm weather, lower Black Lake exceeded 17°C, when lake inlet temperature was about 12½°C. Black Lake surface waters received much heat. During this same period, note that the outlet of Black Bear Lake reached 15°C, while upper Black Lake had a maximum of 12.6°C. This drop suggests a temperature decrease in groundwater routes of 2-3°C, and was also verified by field measurement with hand thermometer on August 13 and 16. Water temperature of Black Bear Creek below the falls was measured at 12°C, with upwelling temperatures at the head of perennial stream flow showing predominantly 9.5°C.

The marked drop of temperature at the mouth of Black Lake (L.B.L.) following 17 May, 1982, provides an example of the effect on water temperature of heavy rain falling upon ripe snow.

An interesting set of measurements was made on the sunny days of June 18 and 20, 1982. On June 18, Black Bear Lake at the outlet was measured at 1°C with hand thermometer. Black Bear Lake outlet on that date was open only about 100 feet to the edge of the ice. On June 20, 1982, water temperature at the base of the falls was 5.5°C. Air temperature was 9.2°C. It is unlikely that water temperature at outlet Black Bear Lake changed much from June 18 to 20. Hence, a warming due to the waterfall of about 4.5°C is suggested for this condition.

In an effort to examine the temperature range found within specific days at key times of the years, hourly temperature plots were made for sunny days in August, 1980 and 1981, and for winter days in December, 1981, and February, 1982. These plots are shown in Figures 8a, b and c.

The two August plots (Figures 8a and b) indicate markedly different heating characteristics. Days which produce high water temperatures, as shown on Figure 8b, also show much greater temperature range. It is also evident from these plots that sunny weather produces temperature peaks in the two lakes (B.B.L., L.B.L.) at essentially the same time. Peak temperatures at the inlet to Black Lake (U.B.L.) appear to lag 3 to 4 hours behind peaks at Black Bear Lake (B.B.L.).

The streambed thermograph (S.G.S.) record was interpreted to show a lag behind Black Bear Lake (B.B.L.) of about 3 hours. This time value, which may bear upon groundwater flow rates, could probably be strengthened by additional study of the records.

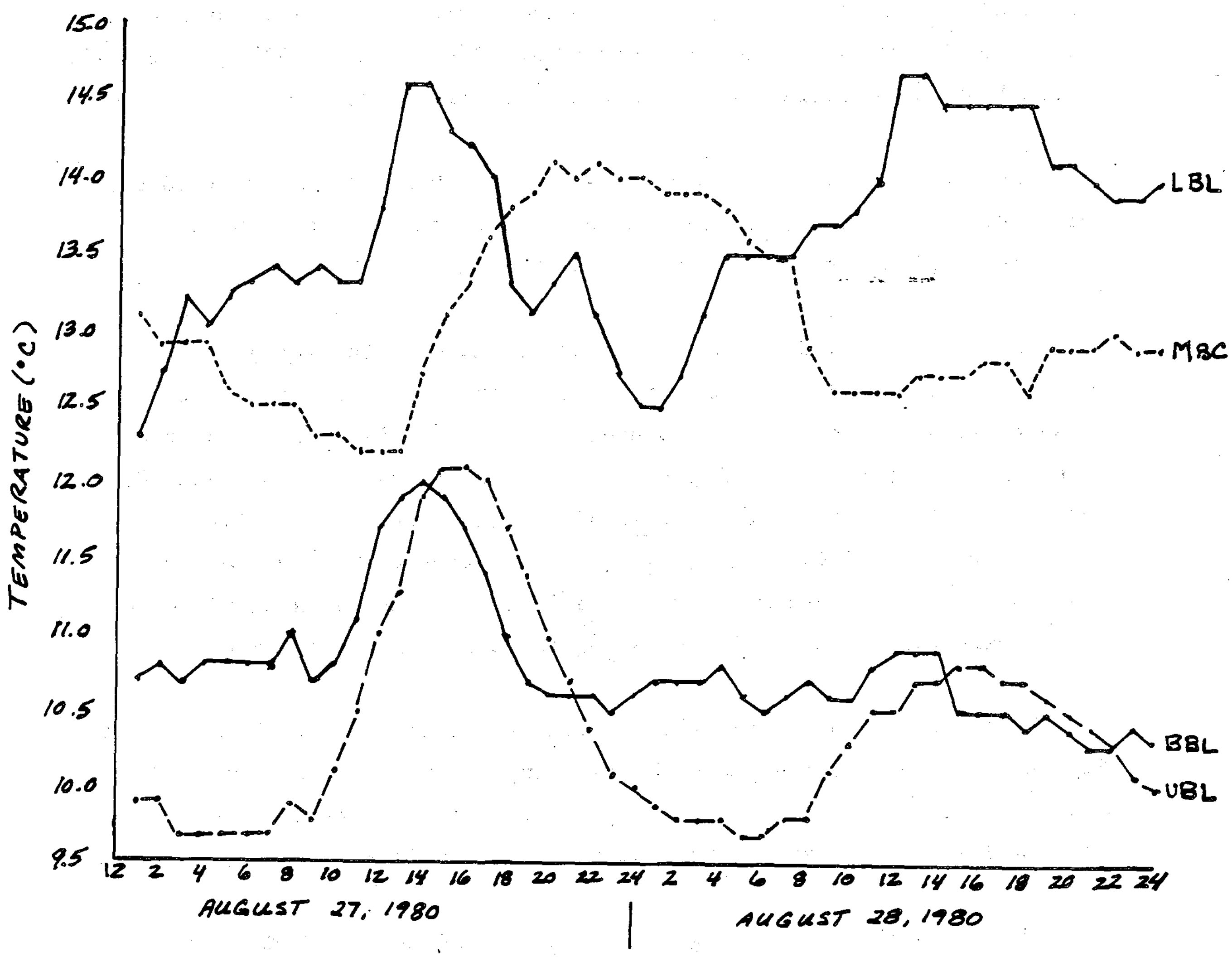


FIGURE 8a: Hourly fluctuations in stream temperature, Black Bear Creek, August 27-28, 1980.

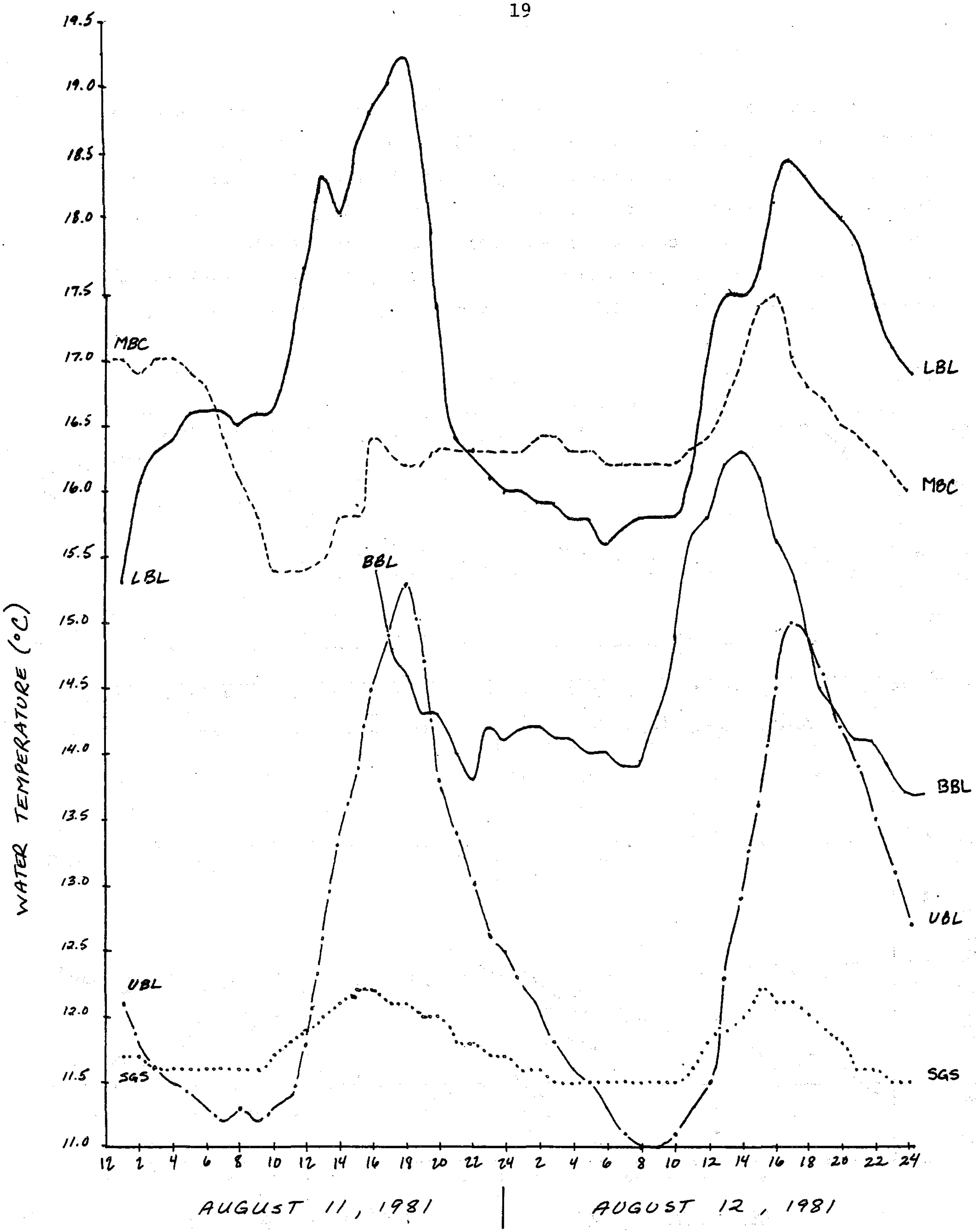


FIGURE 8b: Hourly fluctuations in stream temperature, Black Bear Creek, August 11-12, 1981.

The winter plots shown in Figure 8C serve primarily to show contrasting temperatures between an "open" winter (1980-81) and a cold winter with strong ice cover over the lakes (1981-82). Given the fact that February 25, 1982, was a bitterly cold day with air temperature at -18°C or less, the record indicates that ice cover favors warmer temperatures than may be found during winter in open condition in Black Bear Lake (BBL). In contrast, the outlet of Black Lake (L.B.L., elevation 80 feet) indicates just the

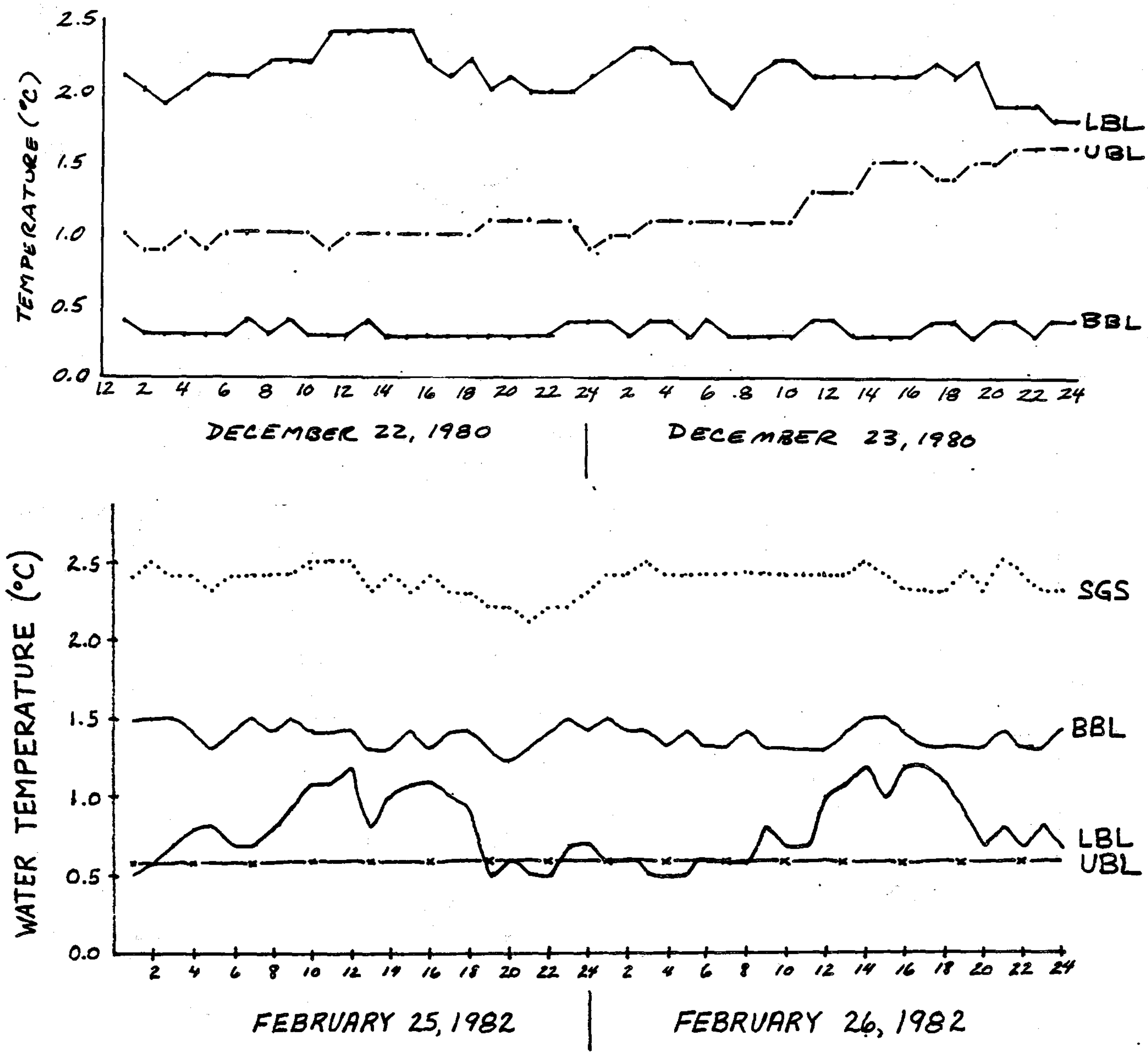


FIGURE 8c: Hourly fluctuations in stream temperature, Black Bear Creek, December 1980, and February, 1981.

reverse, where ice cover in 1981-82 depressed L.B.L. in comparison to the "open" conditions (1980-81).

An analysis of water temperature units for 1980-81 and 1981-82 was made for the time-period 1 September to 30 April. Results are shown in Figure 9a and b, and demonstrate differences between "open" and "heavy" winters.

It is unfortunate that the stream gravel thermograph (S.G.S.) was not installed until August, 1981, since this thermograph probably is nearest to representing temperature conditions in the spawning gravels above Black Lake. If an S.G.S. curve were available for 1980, it would probably be considerably closer to the 1981 S.G.S. curve than other station comparisons. This temperature unit analysis is an important tool in examining possible hydroelectric project effects, and is discussed further in that context.

<u>Lake profile information</u>

These profiles of upper and lower Black Bear Lake and Black Lake include measures of conductivity, dissolved oxygen, and temperatures for the 1980 to spring, 1982, period. The spring, 1982, profile for Black Bear Lake was not taken because of ice cover and access problems. All measurements were taken with YSI Model 33 (SCT) and Model 57 (D.O.) meters.

Lower Black Bear Lake profile data is shown graphically in Figures 10a, b and c. Upper Black Bear Lake data, which is very similar to lower Black Bear Lake profiles, is found in Appendix Figures A-4 and A-5. Black Lake profiles are shown as Figures 11a, b and c.

Black Bear Lake conductivity is seen to range generally around 10 to 20 mmhos, frequently showing an increase with depth.

Dissolved oxygen in Black Bear Lake profiles shows the lowest value (on 1-21-82) at just under 9 ppm (depth 60 feet), and the highest on the

FIGURE 9a: Temperature Unit (°C) Accumulation Curve for the Four Black Bear Creek Stations, 1980-81.

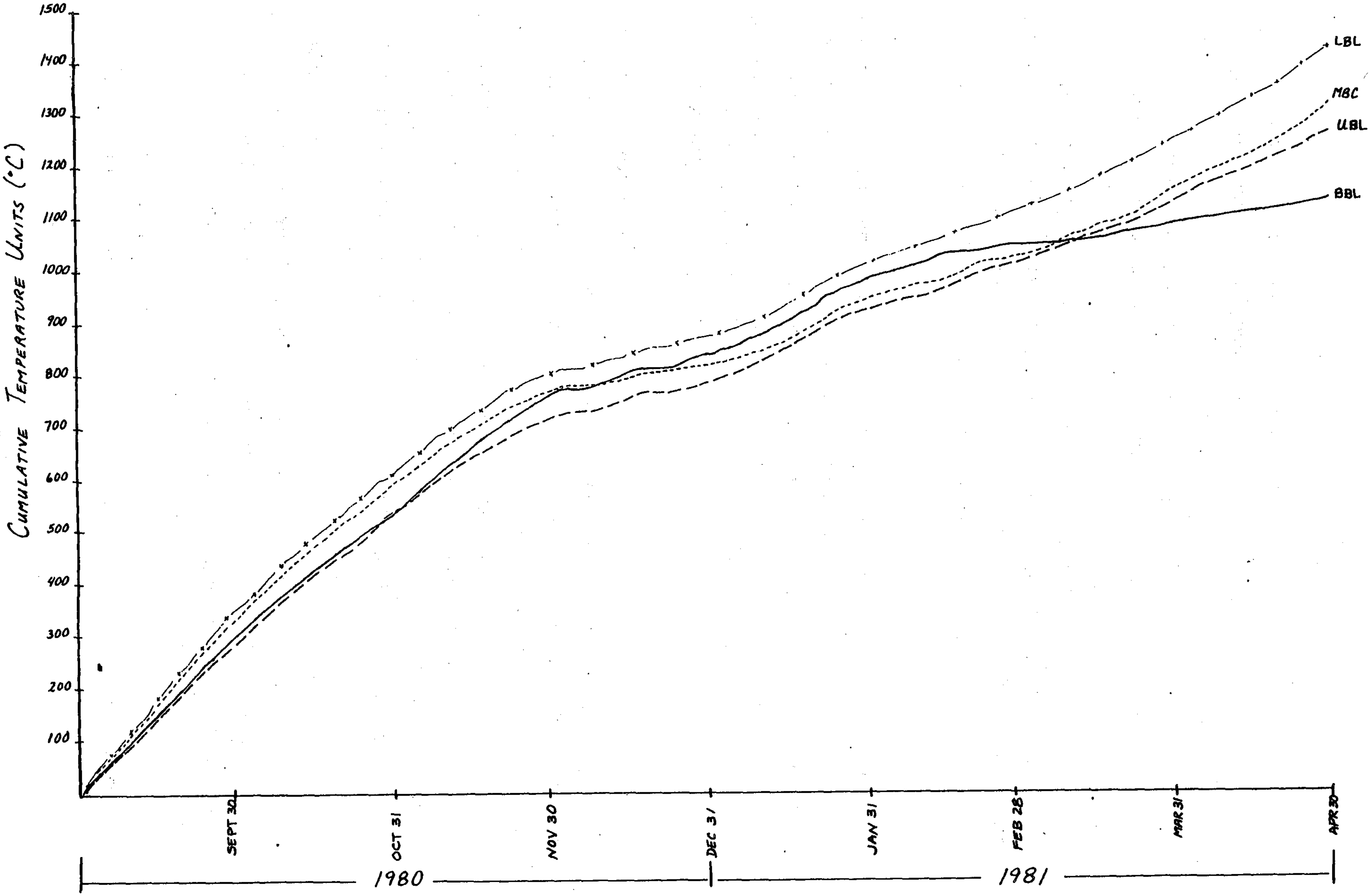
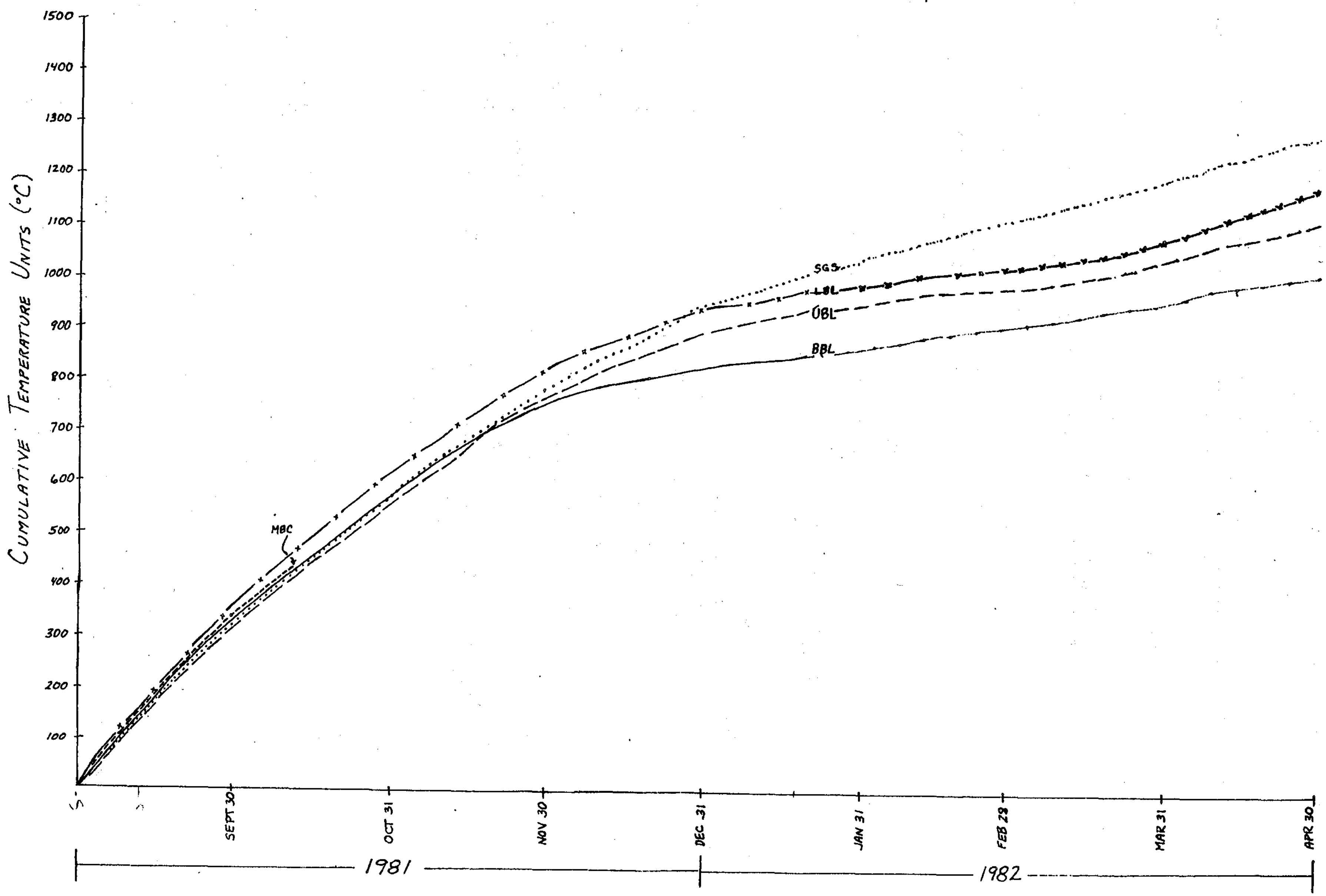


FIGURE 9b: Temperature Unit (°C) Accumulation Curve for the Five Black Bear Creek Stations, 1981-82.



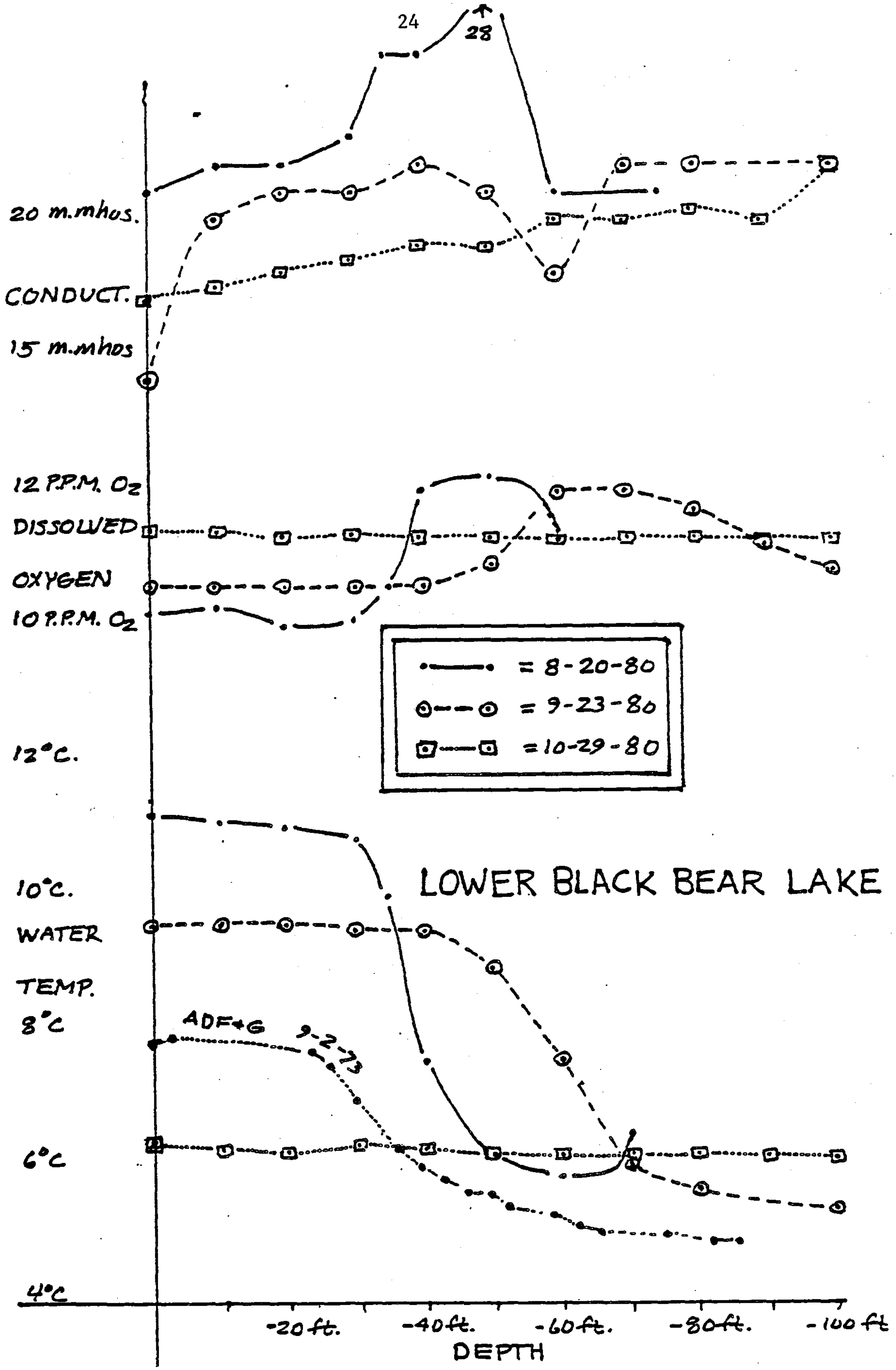


FIGURE 10a: Profiles of Conductivity, Dissolved Oxygen, and Temperature in Lower Black Bear Lake. 1980

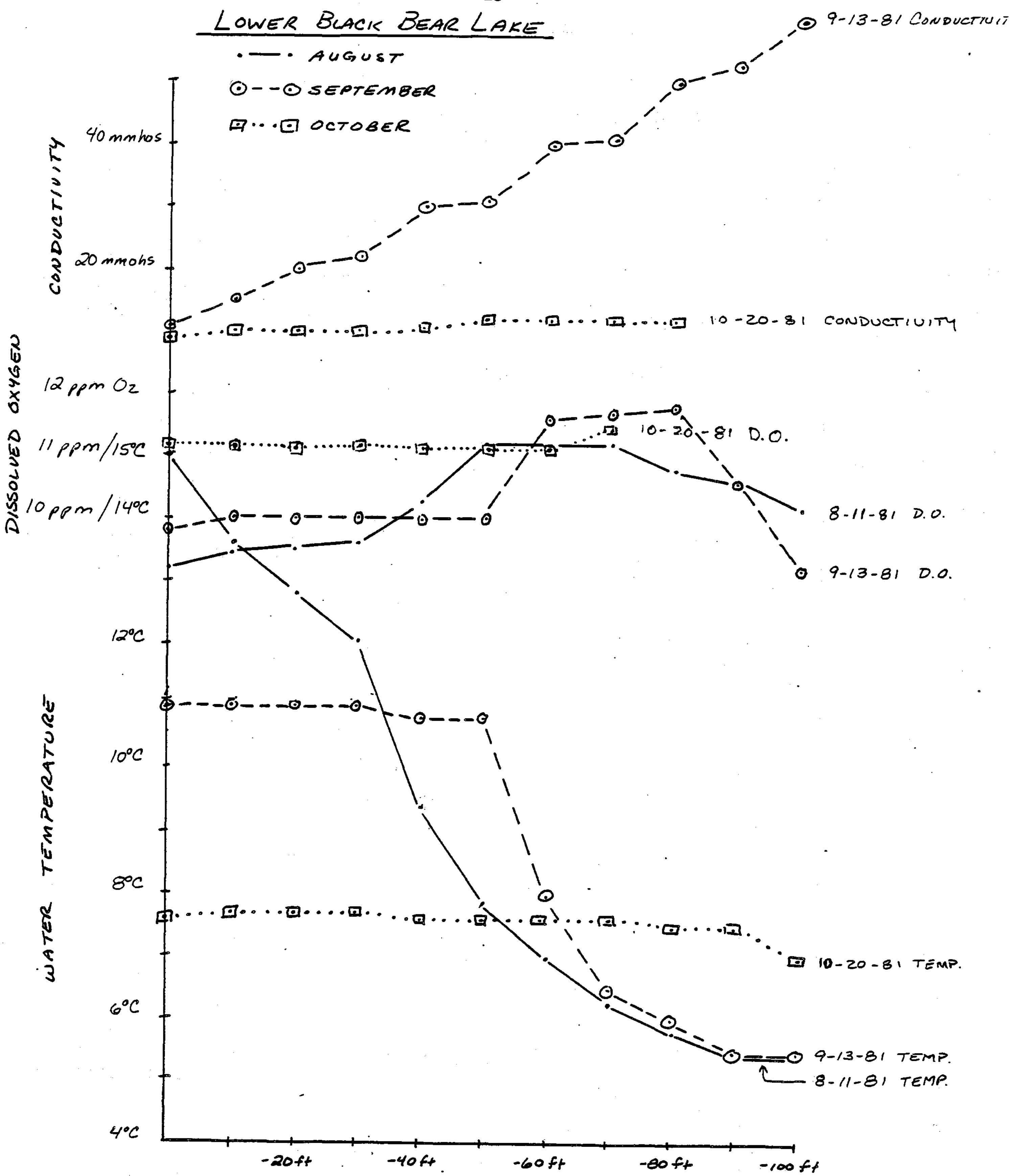


FIGURE 10b: Profiles of Conductivity, Dissolved Oxygen, and Temperature in Lower Black Bear Lake. 1981

LOWER BLACK BEAR LAKE

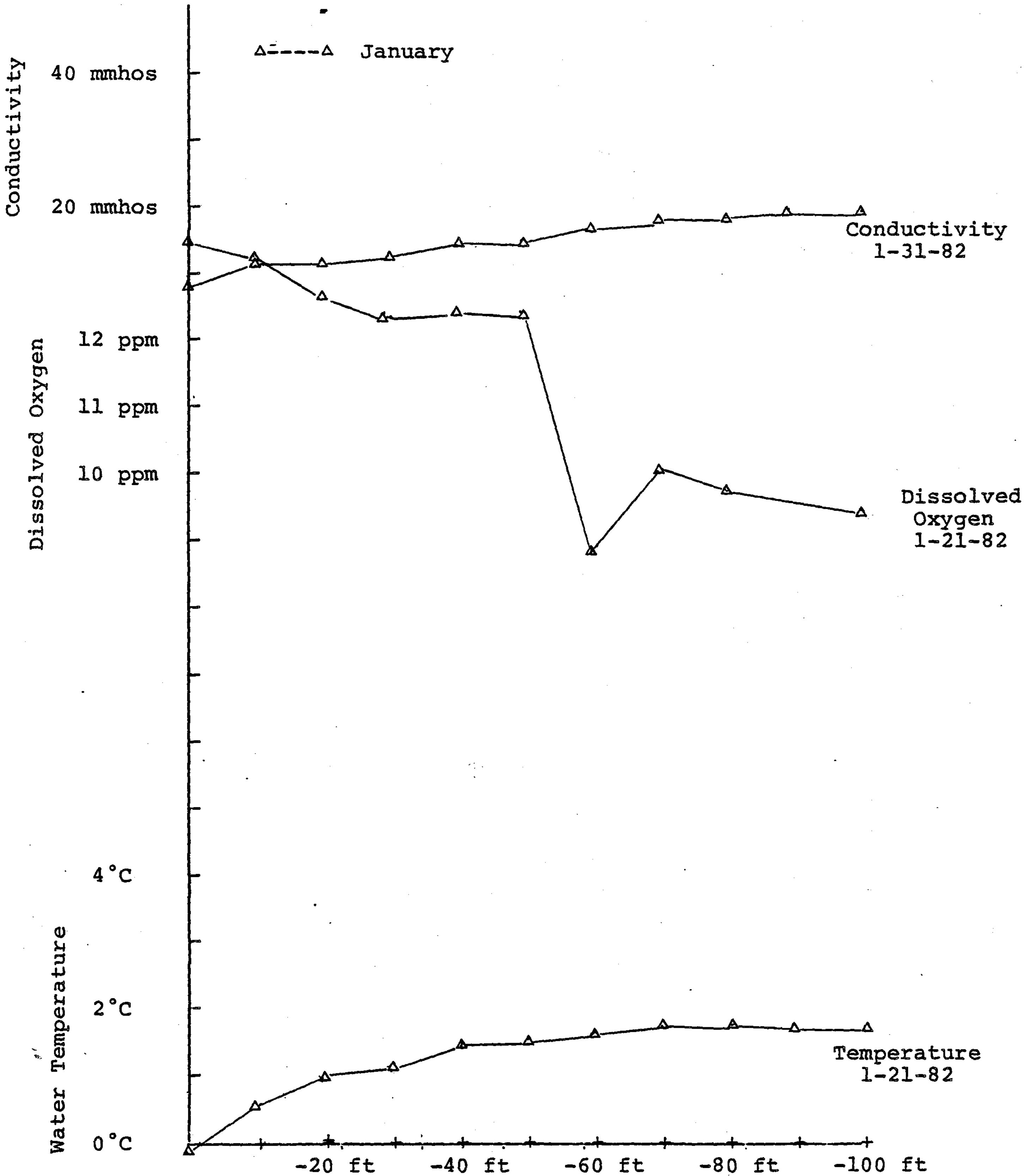


FIGURE 10c: Profiles of Conductivity, Dissolved Oxygen, and Temperature in Lower Black Bear Lake. 1982

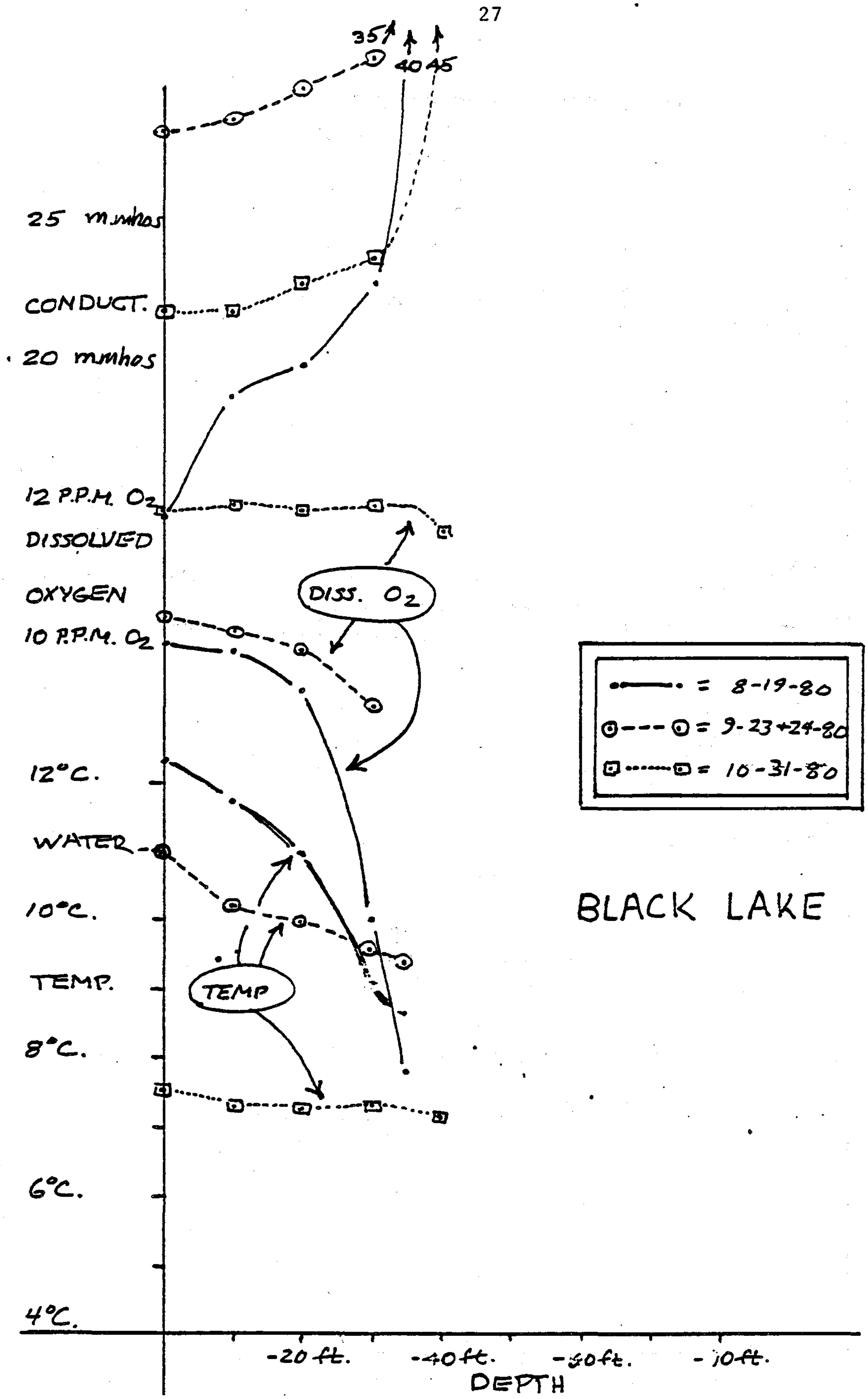


FIGURE 11a: Profiles of Conductivity, Dissolved Oxygen, and Temperature in Black Lake. 1980

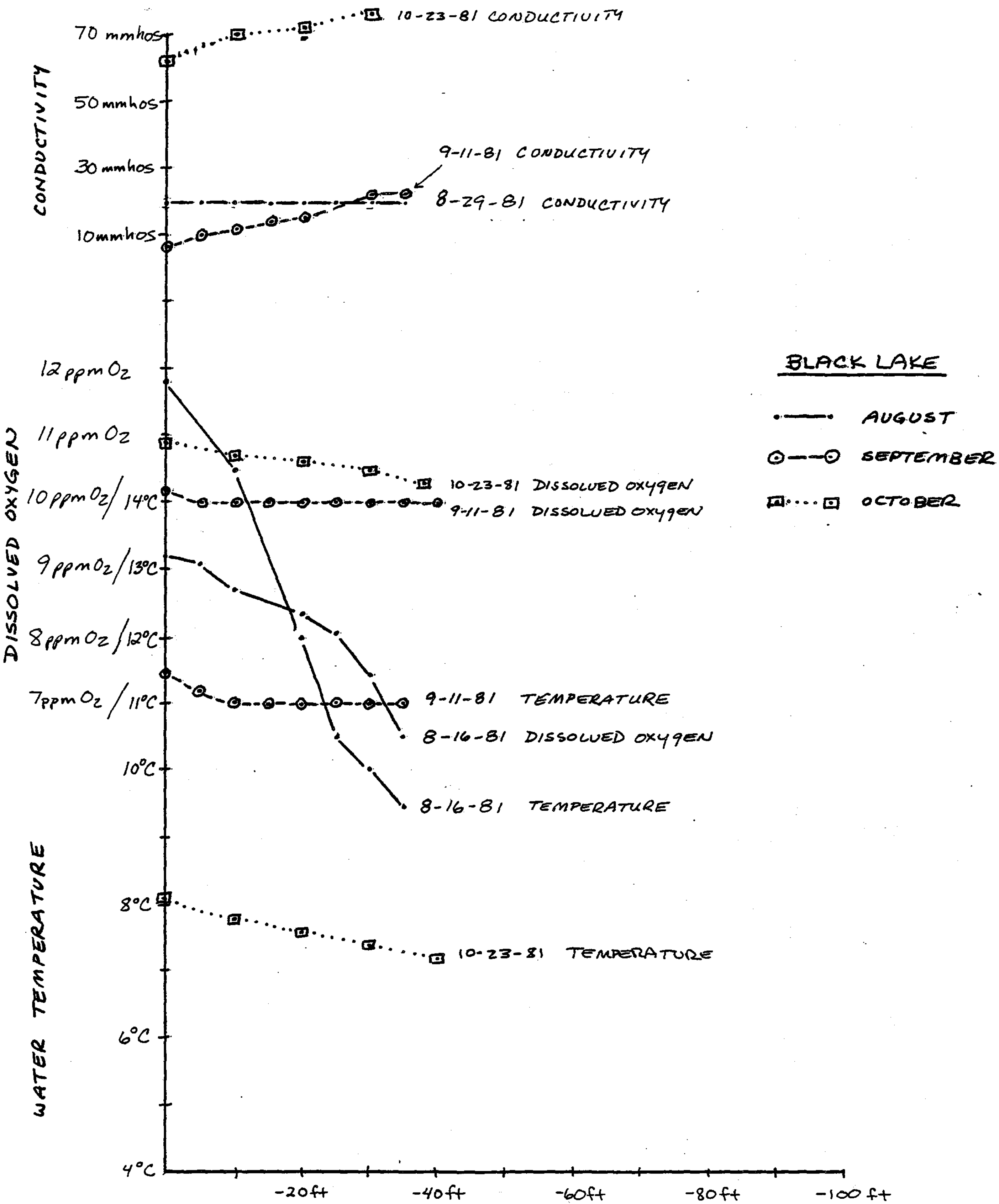


FIGURE 11b: Profiles of Conductivity, Dissolved Oxygen and Temperature in Black Lake 1981

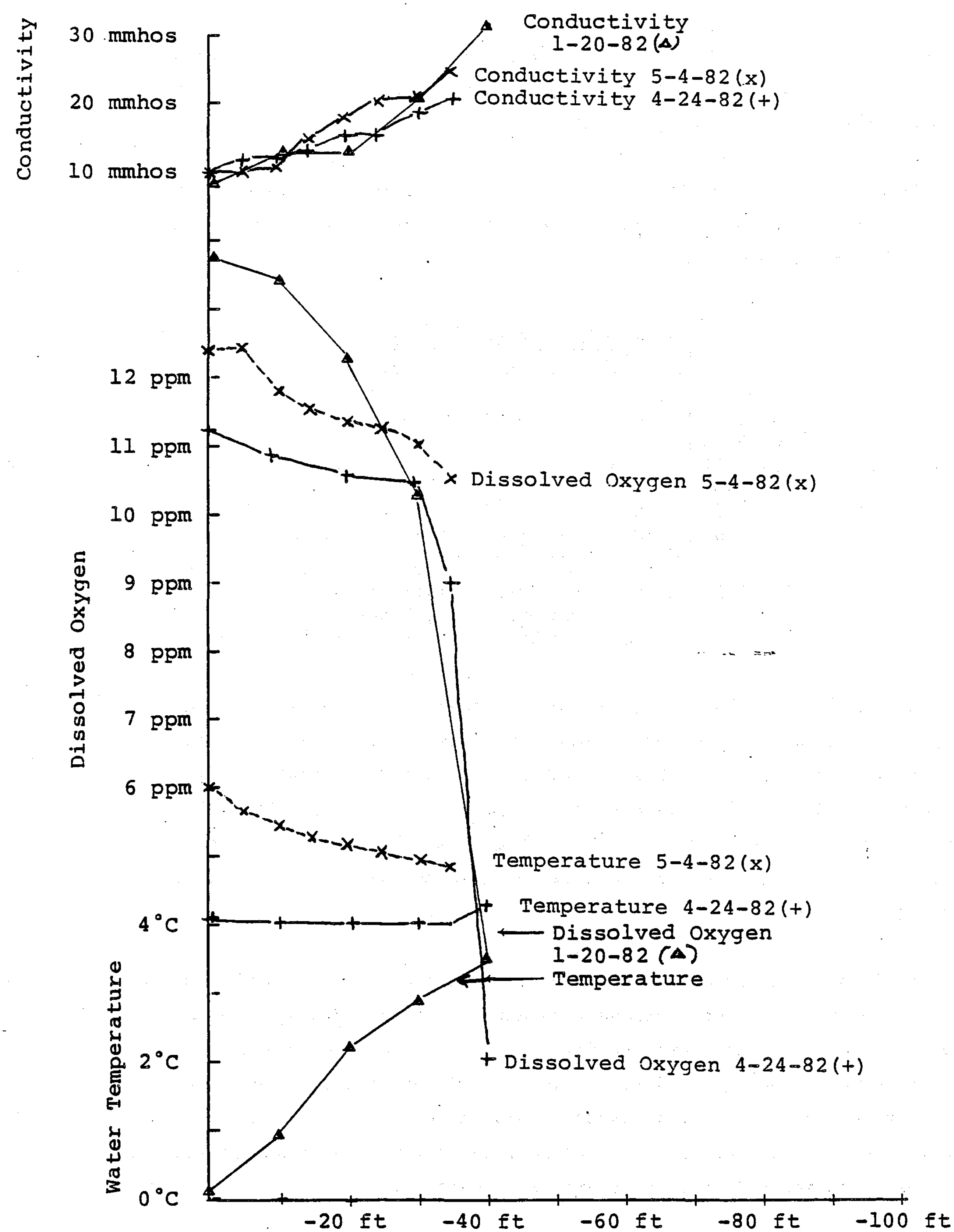


FIGURE 11c: Profiles of Conductivity, Dissolved Oxygen, and Temperatures in Black Lake, 1982.

same date at 13.5 ppm (surface). The lake was ice covered on that date. Other dissolved oxygen values range between 10 and 12 ppm with increases in values showing as the sample point reaches 30 to 50 feet depth.

The critical feature in temperature profiles for this project is the rate of change of temperature in the first thirty feet below the suface. This condition is summarized in Table 2.

Date	Change with reference to surface		
	-10 ft	-20 ft	-30 ft
8-20-80	-0.1°C	-0.2°C	-0.4°C
9-23-80	0.0	0.0	-0.1
10-29-80	-0.1	-0.1	0.0
8-11-81	-1.5	-2.3	-3.0
9-13-81	0.0	0.0	0.0
10-20-81	+0.1	+0.1	+0.1
1-21-82	+0.6	+1.0	+1.2

TABLE 2: Change in profile temperatures, Lower Black Bear Lake, between surface and 10, 20, 30 foot depths.

It will be seen that a spring sampling date is lacking in Table 2. Based upon examination of other thermal profiles, it is unlikely that the spring profile after a "heavy" winter will exceed the winter profile (January 21, 1982) in temperature gradient. In the case of an "open" winter or early spring, greater lake surface disturbance will reduce the thermal gradient. Accordingly, the winter gradient is also suggested as a "worst case" assumption.

Profiles of Black Lake, Figures 11a, b and c show conductivity values are consistently low, but increase with depth. Dissolved oxygen levels drop quite markedly with depth during summer, and when ice covers the lake or is newly gone (as 4-24-82). In fall-winter months, when ice does not cover the lake, dissolved oxygen remains high through the water depth. The lake is isothermal in the fall and spring, but makes pronounced reversals from increasing temperatures with depth (winter) to the reverse in summer.

Water chemistry data

Water chemistry information was collected during Phase I of Black Bear Creek environmental work. In addition, samples were taken as part of Phase II work to estimate lake productivity. The Phase I data is presented here, while the other results have been incorporated into the biological discussion on productivity.

The results of Phase I water chemistry are summarized in Table 3 and shown graphically in Figures 12a, b and c.

These data show very dilute and unbuffered bicarbonate waters of acid pH with low hardness. Calcium and magnesium are in the low range compared with other Southeast Alaskan waters; Ca/Mg ratio is similar to other southeastern waters. Heavy metal anomalies were not found in sample results. Phosporus and total nitrogen values are low, as is common for the region. Total nitrogen may increase at the stream mouth. Stream color is consistently lacking above Black Lake and increases markedly at the stream mouth during the September visit. This color increase resulted from flushing of the lower watershed as a result of .47 inches of rain 24-25 September. Total dissolved solids show a small increase from surface, Black Bear Lake, to -50 ft. depth and a more graphic increase from headwater to stream mouth. Small conductivity increases with lake depths may result from water density differences between deeper lake waters and surface waters more subject to rainfall dilution. The increase in conductivity moving downstream may be at least partly due to dissolution of marine sediments found along the stream channel (particularly seen about ¼ mile above the highway bridge). Conductivity measurements (shown in Figures a, b and c, and in the miscellaneous data of Table 3) also show small increases with lake depth, particularly near lake bottoms, and show increases in a downstream direction, as well.

Table 3: Water Chemistry Data.

Parameter	Concentrations in P.P.M.									
	Bl.Bear Lk. - 50 Feet		Mouth, Black Bear Lake		Upper Black Lake		Lower Black Lake		Mouth Black Bear Creek	
	Aug.	Oct.	Aug.	Oct.	Aug.	Oct.	Aug.	Oct.	Aug.	Oct.
SO_4	2.0	< 0.5	2.0	< 0.5	3.0	1.0	2.0	4.0	4.0	3.0
Cl	<2.0	< 1.0	<2.0	< 1.0	<2.0	<1.0	<2.0	<1.0	< 2.0	<1.0
K	0.1	0.2	0.1	0.2	0.2	0.3	0.2	0.4	0.2	0.4
Na	0.8	0.8	0.7	0.8	0.9	1.1	0.9	1.0	1.0	1.1
Ca	2.3	1.2	1.9	1.3	1.4	1.3	1.8	1.4	2.4	2.0
Mg	0.2	0.2	0.2	0.2	0.3	0.2	0.3	0.4	0.4	0.3
Fe	0.02	.02	0.08	0.01	0.09	0.12	0.19	1.5	0.19	0.19
Mo	<0.02	< 0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cu	.013	< .002	<.002	<.002	<.007	<.002	.007	.006	.010	.006
Zn	.018	< .002	.045	< .002	.005	<.002	.029	<.002	.018	<.002
Pb	< .05	< .02	< .05	< .02	<.05	<.02	<.05	< .02	< .05	< .02
Ag	<.002	.015	<.002	<.002	<.002	<.002	<.002	<.002	<.002	<.002
Au	< .01	< .01	< .01	< .01	<.01	<.01	<.01	< .01	< .01	<.01
T diss Sol.	12.0	7.0	7.0	4.0	20.0	20.0	20.0	22.0	23.0	20.0
Alk($CaCO_3$)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Alk(HCO_3)	14.0	4.0	15.0	4.0	10.0	3.0	14.0	< 1.0	13.0	3.0
H'dness	3.0	3.0	2.0	4.0	5.0	3.0	4.0	4.0	7.0	5.0
T.Phos.	<.05	< .05	< .05	< .05	<.05	0.2	<.05	< .05	<.05	<.05
T.(Kjel)N	.01 Sept.	.04	0.1 Sept.	<.1	0.2 Sept.	0.1	0.1 Sept.	< .1	0.3 Sept.	0.4
Color	5 Sept.	5	5 Sept.	5	5 Sept.	5	5 Sept.	5	30 Sept.	5
Turbidity	0.7 Sept.	.3	0.6 Sept.	.2	0.6 Sept.	.3	1.0 Sept.	.9	1.0 Sept.	.6

	Bl.Bear Lk. -50 ft.			Mouth, Black Bear Lake			Upper Black Lake			Lower Black Lake			Mouth Black Bear Creek		
	Aug.	Sept	Oct.	Aug.	Sept	Oct.	Aug.	Sept	Oct.	Aug.	Sept	Oct.	Aug.	Sept	Oct
pH	-	6.6	6.7	7.0	6.5	6.7	6.3	6.3	6.4	6.2	6.3	6.4	6.5	6.4	6.7

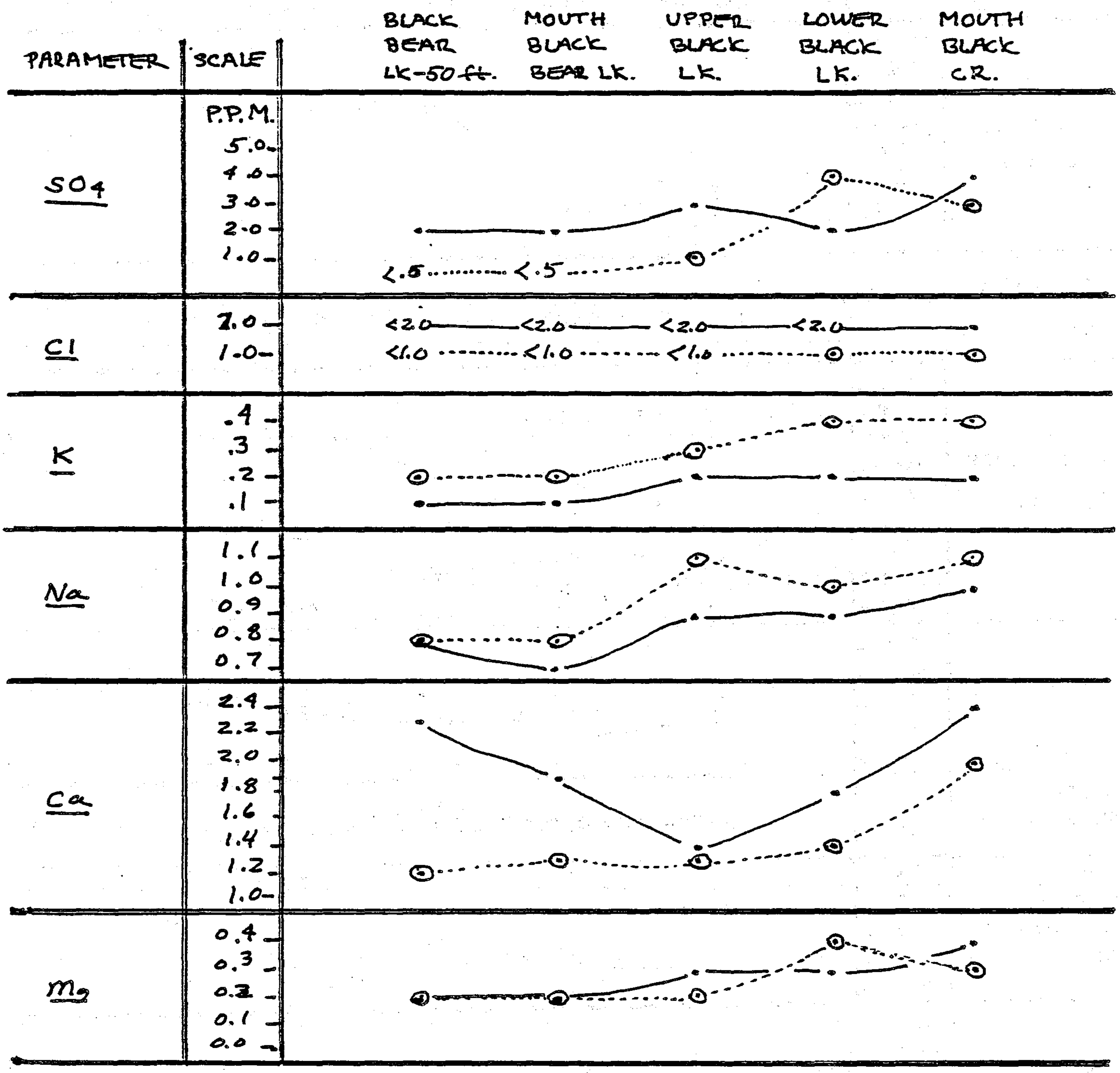


FIGURE 12a: Graphical Presentation of Water Chemistry at Five Stations in Black Bear Watershed

. ________ . ______ . = Late August sampling, except as shown.

.... = Late October sampling.

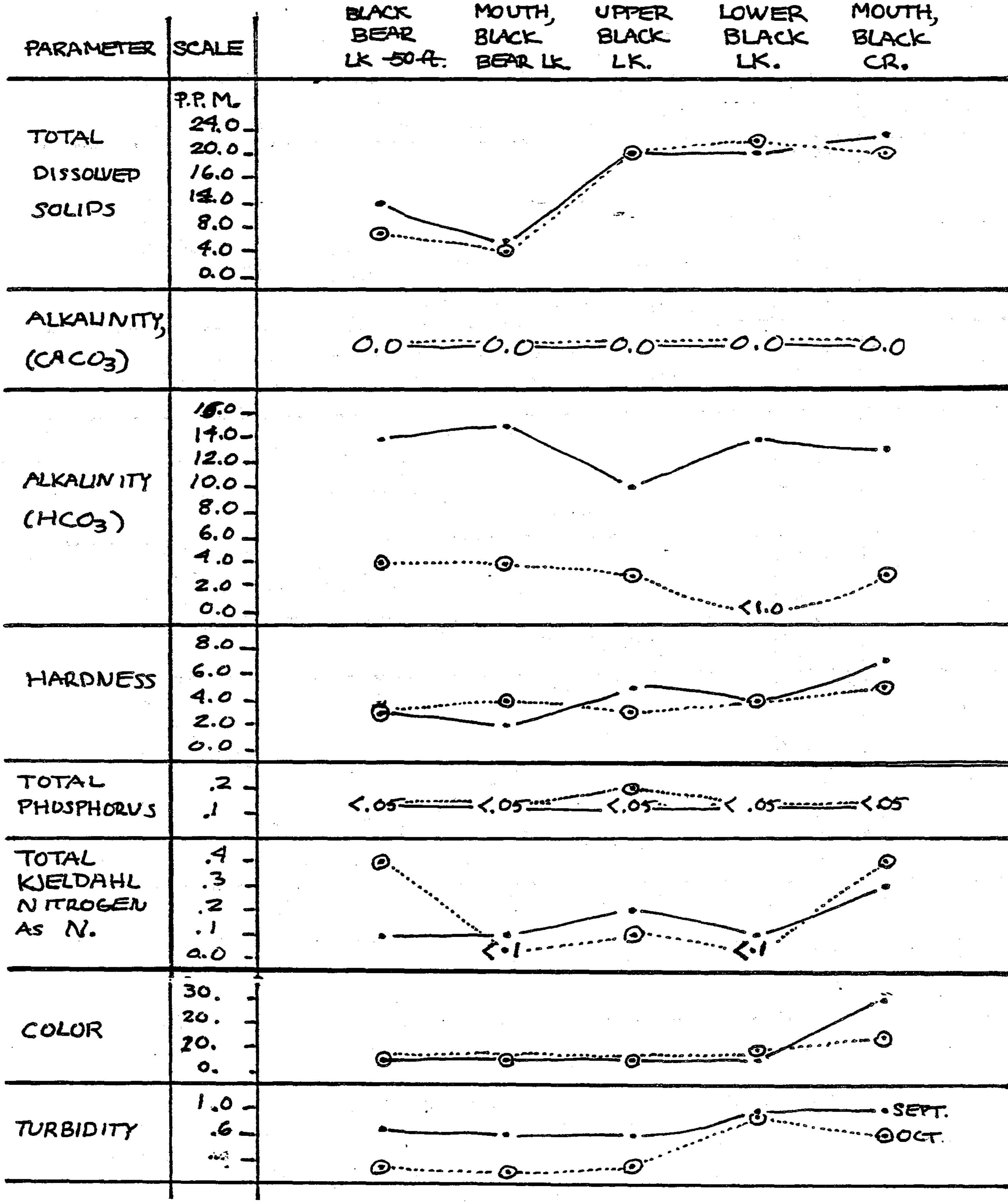


FIGURE 12b: Continued.

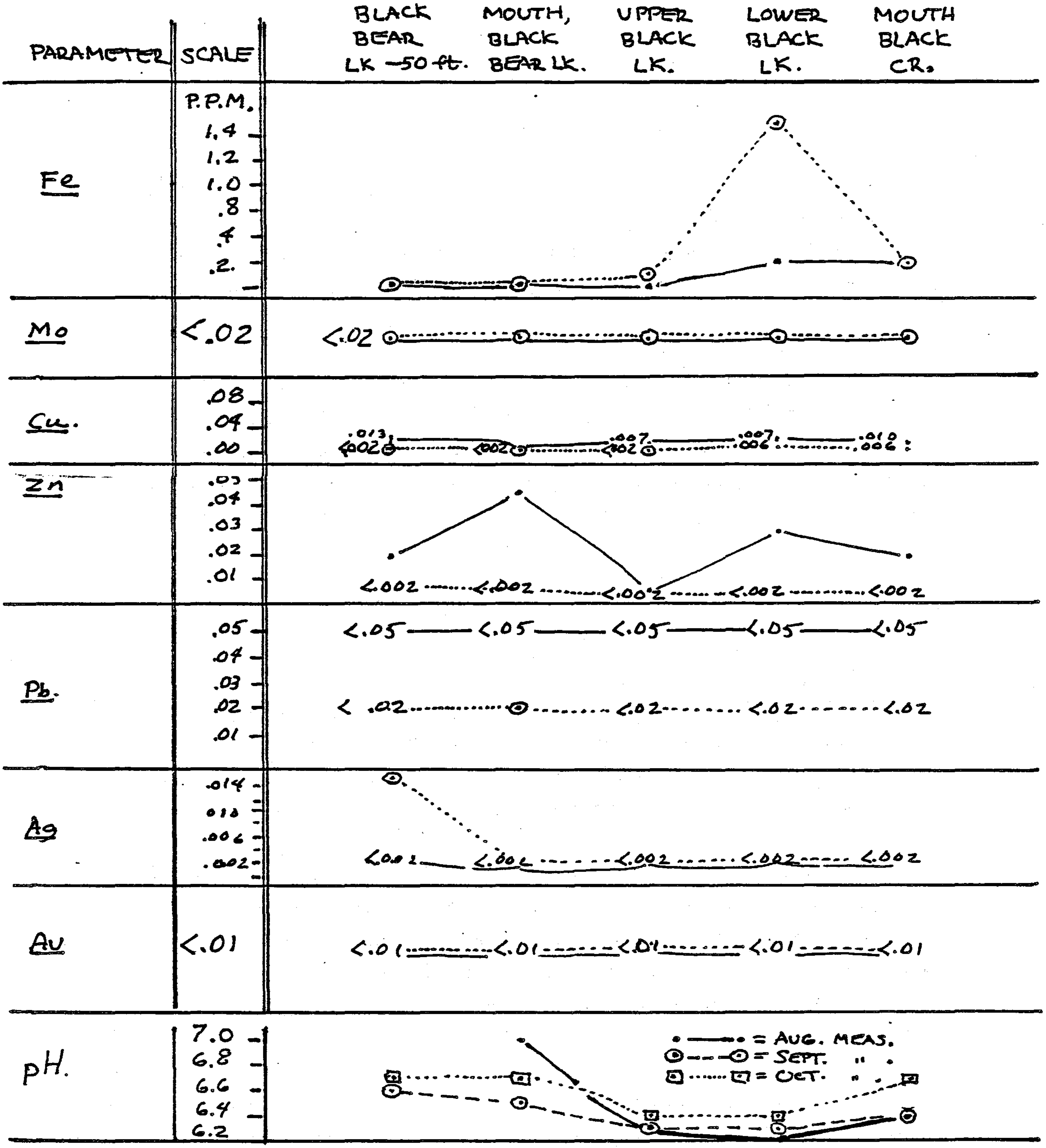


FIGURE 12c: Continued.

Biological - Fisheries

Black Bear Lake

A resident self sustaining population of rainbow trout exists in Black Bear Lake stocked by A.D.F.G. for sport fishing recreational use to visitors to Black Bear Lake.

Previous statements concerning the levels of this population have been drawn from the log kept in the U.S.F.S. cabin at Black Bear Lake by visitors and by verbal communication with persons who have fished the lake. Reports vary from 'good' to 'poor' or 'slow'. A survey by A.D.F.G. on August 30, 1973, produced three rainbow trout on rod and line.

24 cm	3+
32 cm	4+
39.5 cm	5+

It was proposed to undertake a multiple mark and recapture investigation over a ten-day period in August, 1981, with rod and line. However, with only one fish being caught on the first day, it was decided that this approach was not feasible.

Consequently, the proposal was to undertake a survey toward the end of May, 1982, to observe spawners and areas of spawning and to trap fish using baited hoop traps at a time when they were more densely distributed. Unfortunately, ice remained on the lake until the end of the field season in mid-June and, thus, access with equipment was impossible.

It is planned to make a further attempt at a multiple mark and recapture experiment this August with hoop traps and large wire traps.

ADULT SALMONID ESCAPEMENT

Introduction

Previous studies of adult escapement are limited to 22 years of aerial surveys, a 1976 A.D.F.G. stream survey, and earlier visual observations. Pink salmon peak escapement surveys are given in Table 4. The average escapement count for pink salmon into the whole system over a 22-year period is 14,218. In the mid-forties, there were two very large runs of 350,000 and 110,000. Apart from these peak runs, counts have ranged from 30 fish in 1978 to 62,000 fish in 1963. Since 1975, the stream has shown a definite odd/even trend with the heavy runs occurring in the odd years. In 1981, excellent returns of pinks were observed in most southern southeastern Alaska, with escapement above expected numbers (Jones, et al., 1982).

Year(Date)	Escapement	Year(Date)	Escapement
1960 (9/27)	7,000	1971 (8/26)	14,000
1961 (8/15)	11,600	1972 (9/5)	6,100
1962 (9/3)	23,300	1973 (9/7)	7,000
1963 (8/12)	62,000	1974 (9/3)	5,000
1964 (9/10)	23,000	1975 (8/27)	42,300
1965 (9/11)	3,400	1976 (8/23)	510
1966 (9/1)	5,500	1977 (8/16)	8,400
1967	None Seen	1978 (8/2)	30
1968 (8/27)	3,700	1979 (8/13)	22,000
1969 (9/11)	2,630	1980 (8/22)	4,503
1970 (8/27)	20,000	1981 (8/16)	26,600

TABLE 4: Pink Salmon Peak Escapement Surveys of Black Bear Creek 1960 - 1981 (A.D.F.& G., Division of Commercial Fisheries).

Where the timing of other runs of salmon have coincided with those of pinks, estimates of other species have been made. It is known that chum runs have previously been recorded up to 10,000, coho up to 6,500, and sockeye up to 700. It would appear that chum runs are presently on the decline in Southeast Alaska (Ward, A.D.F.G., pers. comm.).

As the principal effects of the proposed project are likely to concern the stream section above Black Lake, extensive surveys of adult salmonids were conducted in this area from the end of July until October 24, 1981. Surveys were also conducted in the spring of 1982. The method employed followed the two-man team strategy of Straty (1980). Both members of the team covered a given length of the stream either on foot or by canoe, making separate counts of the adults observed. The counts were totalled and the average recorded. Counts were recorded for respective different sections of the stream so as to identify the principal spawning areas.

Results

Results are summarized with respect to each species in Tables 5a,b, c, and d. A diagrametric summary of the distribution of adult salmonids is given on the map found in the rear pocket of the report.

[No spawning was observed in the section of stream from 160 feet below the junction of the main stream channel with the west branch of the south fork to the entrance to the lake due to the absence of suitable spawning gravels.]

Sockeye (Onchorhynchus nerka)

Early counts in August, 1981, showed the majority of the sockeye to be in the lower section of the stream below any suitable spawning areas. Although pairing was observed in those fish that were on spawning gravels at this time, no actual redd digging was observed until August 18 when 1,022 sockeye were recorded above Black Lake. 657 were still in schools in the lower sections, 283 were in the south fork, and 82 in the spring fork of the Black Bear Lake system. The peak of sockeye spawning was in the last week of August when a larger percentage of fish moved into the Black Bear system with 500 being counted in comparison to 380 in the south fork. By the middle of September, only 23 live fish were recorded. Extrapolating for mortality between counts, it is estimated that 700 sockeye spawned in the Black Bear system and 575 fish in the south fork.

No sockeyes were observed to spawn in the lake fork of the Black Bear system above the beaver dam as they were unable to run above it with the low August flows. A few isolated efforts by sockeye to beach spawn in the lake were observed. Approximately 10-15% of spawning sockeyes were identified as 'jacks' or precocious males.

Pink salmon (Oncorhynchus gorbuscha)

An aerial estimate by A.D.F.G. on August 16, 1981, gave 26,600 pinks in the Black Bear system. At the beginning of August, schools of pink salmon were observed to be in Black Lake and began congregating around the mouth of Black Bear Creek where it enters Black Lake. These appeared to be fish that had moved through the entire section of the lower stream due to the large numbers of fish competing for spawning habitat. Sixteen pinks had entered the lower section of the creek by August 18. Three inches of rain in seven days from the 21st of August caused the stream to markedly rise, whereupon large schools of pinks entered the creek and on August 28, 1,168 pinks were counted in the system. By September 5, 1,671 fish were found on spawning grounds in the south fork and 1,487 in the Black Bear Lake arm. Further rain and rising of the creek permitted pink salmon to pass over the beaver dams on the lake fork and to utilize this section of the stream for spawning. The peak of pink salmon spawning was in the middle of September when 1,900 fish were observed in the south tributary and 1,730 in the Black Bear system. The total number of pink salmon that spawned in the Black Bear system above Black Lake was estimated to be in the region of 2,000 and, in the south fork, 2,400.

In the spring fork a number of pinks were observed spawning right up to where the upwellings arose from the ground among the moss-covered stones. Pinks were undoubtedly superimposing on redds previously occupied by sockeye salmon.

In the lake fork, pinks were observed in all branches up to where the stream gradient starts to markedly rise in the lake outlet channel. They were recorded spawning in channels that had previously been dry during the low August flows. Heavy continual storms in late August and early September created high flows and allowed pinks to migrate over the beaver

TABLE 5a: Numbers of Spawning Sockeye (<u>Oncorhynchus nerka</u>) in the Stream System Above Black Lake. 1981

	Date / Location	August 5	August 10	August 13	August 18	August 28	September 5	September 16
	Mouth of creek to West Fork of South tributary	420	345	309	546	165	42	0
	Main creek from West Fork of South tributary to junction with the South tributary	NC	60	92	111	145	71	0
	West Fork of the South tributary	NC	10	34	59	43	36	6
	South tributary	NC	133	205	224	337	292	10
BLACK BEAR LAKE SYSTEM	Lake Fork to Beaver Pond	NC	0	0	0	0	19	0
	Beaver Pond on Lake Fork	NC	0	0	0	0	0	0
	Lake Fork above Beaver Pond	NC	0	0	0	0	0	0
	Spring Fork	NC	50	90	82	500	396	7
TOTAL			598	730	1,022	1,190	856	23

TABLE 5b: Numbers of Spawning Pink Salmon (*Oncorhynchus gorbuscha*) in the Stream System Above Black Lake, 1981

Date / Location	August 5	August 10	August 13	August 18	August 28	September 5	September 16
Mouth of creek to West Fork of South tributary	0	0	0	16	629	830	121
Main creek from West Fork of South tributary to junction with the South tributary	0	0	0	0	51	280	156
West Fork of the South tributary	0	0	0	0	14	270	148
South tributary	0	0	0	0	250	1,401	1,752
BLACK BEAR LAKE SYSTEM: Lake Fork to Beaver Pond	0	0	0	0	18	22	127
BLACK BEAR LAKE SYSTEM: Beaver Pond on Lake Fork	0	0	0	0	0	0	24
BLACK BEAR LAKE SYSTEM: Lake Fork above Beaver Pond	0	0	0	0	0	0	468
BLACK BEAR LAKE SYSTEM: Spring Fork	0	0	0	0	206	1,265	1,111
TOTAL				16	1,168	4,068	3,907

TABLE 5c: Numbers of Spawning Chum Salmon (*Oncorhynchus keta*) in the Stream System Above Black Lake, 1981

Date / Location		August 5	August 10	August 13	August 18	August 28	September 5	September 16
Mouth of creek to West Fork of South tributary		0	0	3	4	0	0	0
Main creek from West Fork of South tributary to junction with the South tributary		0	0	0	0	0	0	0
West Fork of the South tributary		0	0	0	0	0	0	0
South tributary		0	0	0	0	0	0	0
BLACK BEAR LAKE SYSTEM	Lake Fork to Beaver Pond	0	0	0	0	0	0	0
	Beaver Pond on Lake Fork	0	0	0	0	0	0	0
	Lake Fork above Beaver Pond	0	0	0	0	0	0	0
	Spring Fork	4	4	2	0	0	1	1
TOTAL		4	4	5	4	0	1	1

TABLE 5d: Observations of Spawning Coho Salmon (*Oncorhynchus kisutch*) in the Stream System Above Black Lake 1981

Date / Location		September 5	September 16	October 21	October 22	October 24
Mouth of creek to West Fork of South tributary		0	3	1	5	16
Main creek from West Fork of South tributary to junction with the South tributary		0	0	0	0	0
West Fork of the South tributary		0	0	1	1	2
South tributary		0	0	7	6	20
BLACK BEAR LAKE SYSTEM	Lake Fork to Beaver Pond	0	1	0	0	0
	Beaver Pond on Lake Fork	0	6	1	2	2
	Lake Fork above Beaver Pond	0	0	0	0	0
	Spring Fork	0	1	4	6	2
TOTAL		0	11	14	20	42

dams. 1981 may have been an atypical year in terms of the pink run, for it is unusual for pink salmon to run through a lake and spawn. Nevertheless, other incidents of this occurring have been reported on Prince of Wales Island, notably Klawock Lake. Here, in the last two years, large runs have entered the stream from saltwater and have moved through the lake in search of suitable spawning habitat and spawned in feeder streams (Steve Hansen, A.D.F.& G., pers. comm.). Below Black Lake pinks were also observed spawning in shallow, intermittent run-off streams which only flowed after high levels of rainfall. Three or four pinks were observed attempting to spawn in an inlet stream in the western part of the lake.

Chum salmon (Oncorhynchus keta)

Only nine chum salmon were observed above the lake. Five spawned at the upwellings in the spring fork. Four of these fish spawned early in August. The association of chum salmon spawning with upwellings has been documented previously.

Coho salmon (Oncorhynchus kisutch)

Eleven coho were observed in the system above Black Lake, six of these being in the beaver pond on the lake fork. Two counts of coho in the third week of October located 42 fish above Black Lake, a high percentage of these fish being in the south tributary. Coho were seen jumping in Black Lake during the last week of observations and, thus, fish probably continued entering and spawning in the creek well into the winter. Coho have been recorded spawning in the Klawock system as late as March 1 (Steve Hansen, A.D.F.G., pers. comm.). An estimate, therefore, of coho spawners was made in conjunction with an evaluation of the fry migration and rearing populations. Analyzing fry estimates for 1981 above and in Black Lake and with a rough extrapolation using estimated fecundity and mortality, a figure of 85 to 100 coho spawned in 1980. It is likely that a similar number spawned in 1981 above Black Lake.

Steelhead (*Salmo gairdneri*)

Steelhead trout were observed to enter the creek this spring, 1982. Twelve fish were estimated to have moved through a pool below a large log-jam just above the location of the L.B.L. fyke net between May 1 and May 17. Two steelhead were also observed in the creek near the outlet of the lake during this time. Rod and line captured three of the fish in the pool by the log-jam. A fourth fish was hooked near the site of the M.B.C. fyke net but was not landed, and 3-4 fish were observed visually in this region of the stream. A survey of suitable spawning areas above Black Lake showed that no steelhead passed through Black Lake and, thus, all spawning occurred in the stream section below it. An estimate of 20 to 25 steelhead were in the upper creek below Black Lake this spring.

Catch Statistics

690 mm	2,350 gms	6+ 4 fresh, 2 saltwater
406 mm	568 gms	no scales taken
385 mm	606 gms	scales all regenerated

Dolly Varden (*Salvelinus malma*)

Schools of Dolly Varden were observed in the stream system above Black Lake in August and September, 1981. The number did not exceed 200 and they were principally located in the south tributary. None were observed in spawning coloration.

However, Dolly Varden do spawn in the system as shown by the occurrence of juveniles, which are discussed later. It is possible that these fish were in the system to feed on salmon eggs.

OUTMIGRATION STUDIES

Introduction

A preliminary study was undertaken in the spring of 1981 at the mouth of Black Bear Creek to estimate the timing and relative size of the outmigration of pink (Oncorhynchus gorbuscha) and chum (Oncorhynchus keta) salmon fry from Black Bear Creek. The peak of the outmigration occurred between March 21 and March 24 and this correlated with increases in water temperature and stream discharge at that time. A smaller peak occurred between April 4 - 6. Two size classes of chum were identified, one group falling predominantly within 29 and 32 mm, while the other group was between 38 and 41 mm.

An extensive fyke net program was operated this spring, 1982. Nets were installed at three sites in an effort to ascertain the timing, and enumerate outmigrating fry from the Black Bear system, particularly from the most sensitive area with respect to the project, the section of stream above Black Lake.

Methods

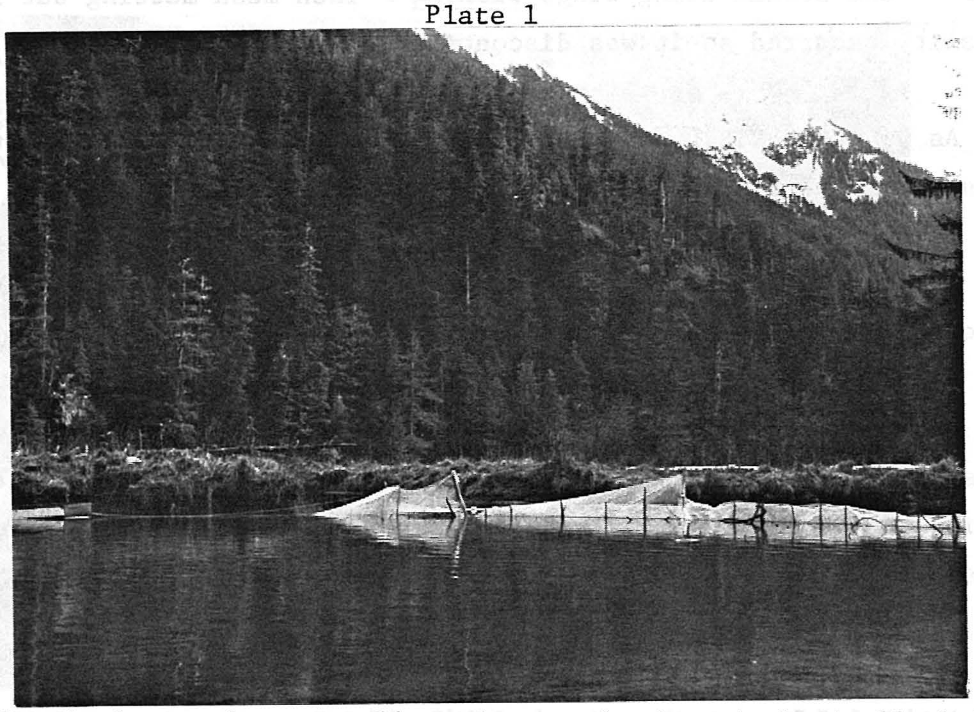
The three sites selected were as follows. A description of the operation of the fyke net is also given.

Upper Black Lake (U.B.L.)

To estimate the total number of fry migrating from the spawning habitat above Black Lake, a net was installed at the entrance of the stream to the lake. The installation made use of a beaver dam across part of the creek with the net being placed adjacent to it. The fyke net, with a 6 foot by 4 foot internal opening and 1/8 inch mesh, was attached to a steel cable fixed across the stream between two trees by means of cable clamps and trolling wire. A 5 foot by 3 foot by 2 foot live box was attached to the cod end of the net and held in position by two ropes staked out to the bank. This box facilitated holding of the fry live after capture (Plate 1).

Stakes were pounded into the creek at 2 foot intervals just upstream of the beaver dam and Visqueen plastic sheeting was attached to them so as to provide a more effective barrier across the stream and direct fish through the net. The net frame had two 1/8 inch mesh wings, one of 20 feet which was attached to the bank and the other of 6 feet which was attached to the dam so that fish migrating upstream from the lake could pass through it.

Plate 1



Although the creek eventually undercut the dam, it basically held throughout the period of operation, except for a few minor repairs. The dam functioned to increase the velocity through the net, for the stream in this area is typically slow flowing.

The net installation was delayed initially due to the presence of ice on Black Lake, but when it was evident that the situation was not going to change for a considerable period of time, operations were carried out by hiking up and down the edge of the lake ice each day.

The net was fished continuously from April 10 until June 8, apart from a period of 3 days between April 20 and April 22 when it was pulled due to extremely high flows. Fish were evaluated for counts on species each morning.

Lower Black Lake (L.B.L.)

A fyke net with a 3 foot by 3 foot opening and 1/8 inch mesh net was placed in the stream 1/3 mile below the outlet of Black Lake. This site was selected as the natural configuration of the stream increased the flow and provided sufficient velocity to operate the net for outmigrating sockeye and coho smolt. An initial attempt was made to fish the entire width of the stream using wings with 1/8 inch mesh metting but fry mortality occurred so it was discontinued.

As with the U.B.L. trap, the net was attached to a cable between two trees with trolling wire and cable clamps. A live box 3 feet, 6 inches by 2 feet, 6 inches, by 2 feet was connected to the cod end of the net. When the sockeye smolt were near their peak, this box was switched with the larger one from U.B.L.

The net was fished every two days from April 9 and then on a daily basis from April 25 until June 9, being set toward sunset and then emptied the next morning. The net was fished in the same position across the stream throughout the phase of the operation.

Mouth of Black Bear Creek (M.B.C.)

A third fyke net was operated 1/3 mile from the mouth of Black Bear Creek at saltwater, at the same site as the 1981 outmigrant trapping program and with a similar installation as at L.B.L.

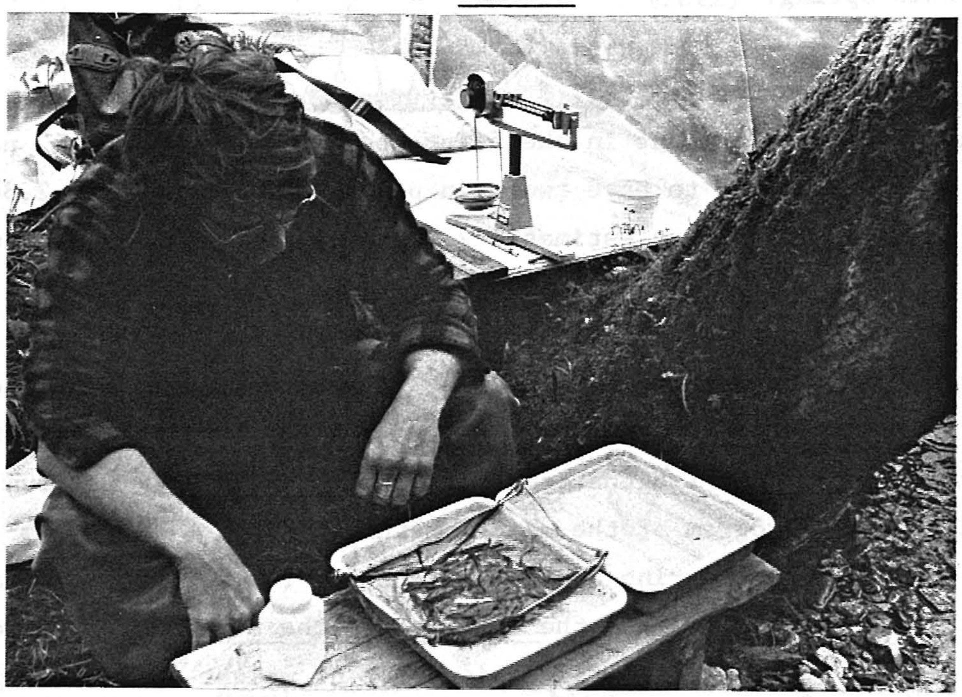
The net was operated approximately every 3 days or when flow conditions permitted. On occasions of high flow, it was moved from its original position so that it could be operated. The installation was washed out in flood conditions on April 20 but was fortunately retrieved downstream and was repaired and reinstalled.

Each net had a 12 inch long zipper on the top section to facilitate cleaning of debris trapped in the net.

Mode of Operation

At each site total counts of fry and smolt were made for each operation of the net. Where numbers of fry exceeded 1,000, an estimate was made by weighing the total number of fish and then weighing a representative subsample. The subsample was then evaluated for numbers of each species. Fork lengths to the nearest millimeter and weights to 1/100 of a gram were made on approximately 25 anaesthetized fish of each species for each operation of the net. All smolt captured were measured and a large percentage weighed.

Plate 2



Water temperatures were taken at each site when sampling occurred and discharge levels were related to the height of Black Lake which was recorded on a daily basis.

In order to estimate the total number of fish outmigrating from Black Lake, an attempt was made to determine the efficiency of the net. Captured sockeye smolt were anaesthetized, marked with a tail punch, held for 12 hours and then released 300 yards upstream of the net. Recaptured marked fish were then recorded.

Of 243 fish marked, only 21 were recaptured, giving an efficiency of approximately 9%. This was considered to be low, as flow measurements showed that 15% of the discharge went through the net. Handling and marking of sockeye smolt produced mortality at Hugh Smith Lake, sometimes reaching 50% (Haddix, 1981). It is possible that a similar mortality occurred in this instance and, thus, an efficiency rate of 15% was used for computation of total numbers and was considered to be closer to the actual value.

Results

Each species will be considered separately with regard to outmigration patterns this spring. (1982)

Sockeye (Oncorhynchus nerka) fry (Figures 13a,b)

Sockeye fry were evident in the first operation of the U.B.L. net on April 10 and appeared to have two main peaks on April 12 with 2,365 fish and on April 19 when an estimated 2,445 fish were collected. Numbers began to fall after April 24, although some catches of 500 were made. From May 12, numbers averaged less than 100, although fry were taken up until May 30. The total number of sockeye fry collected entering the lake was 16,258. Average length was 29.4 mm and weight 0.190 gms. Only small variations in fork lengths occurred over the period of the run as evidenced by the histogram of the mean lengths (Figure 13b) with the slightly larger fish occurring at the peak of the run. Heavier fry also came at the peak of the run and the lightest at the beginning and the end (Figure 13b). However, the regression plot of weight against length gives a very low r^2 value (correlation coefficient squared) of 0.36, illustrating the large variability of the length to weight ratio in the case of these small fry.

It is possible that a large number of sockeye fry entered the lake before April 10 and that these total numbers are inaccurately low. Haddix, A.D.F.& G. (pers. comm.) has observed sockeye fry in Hugh Smith Lake[1/] as early as late March. However, the peak of the run there is typically in May. This outmigration will be discussed later in the summary in conjunction with the sockeye escapement figures.

1/ Located 40 miles southeast of Ketchikan on the mainland.

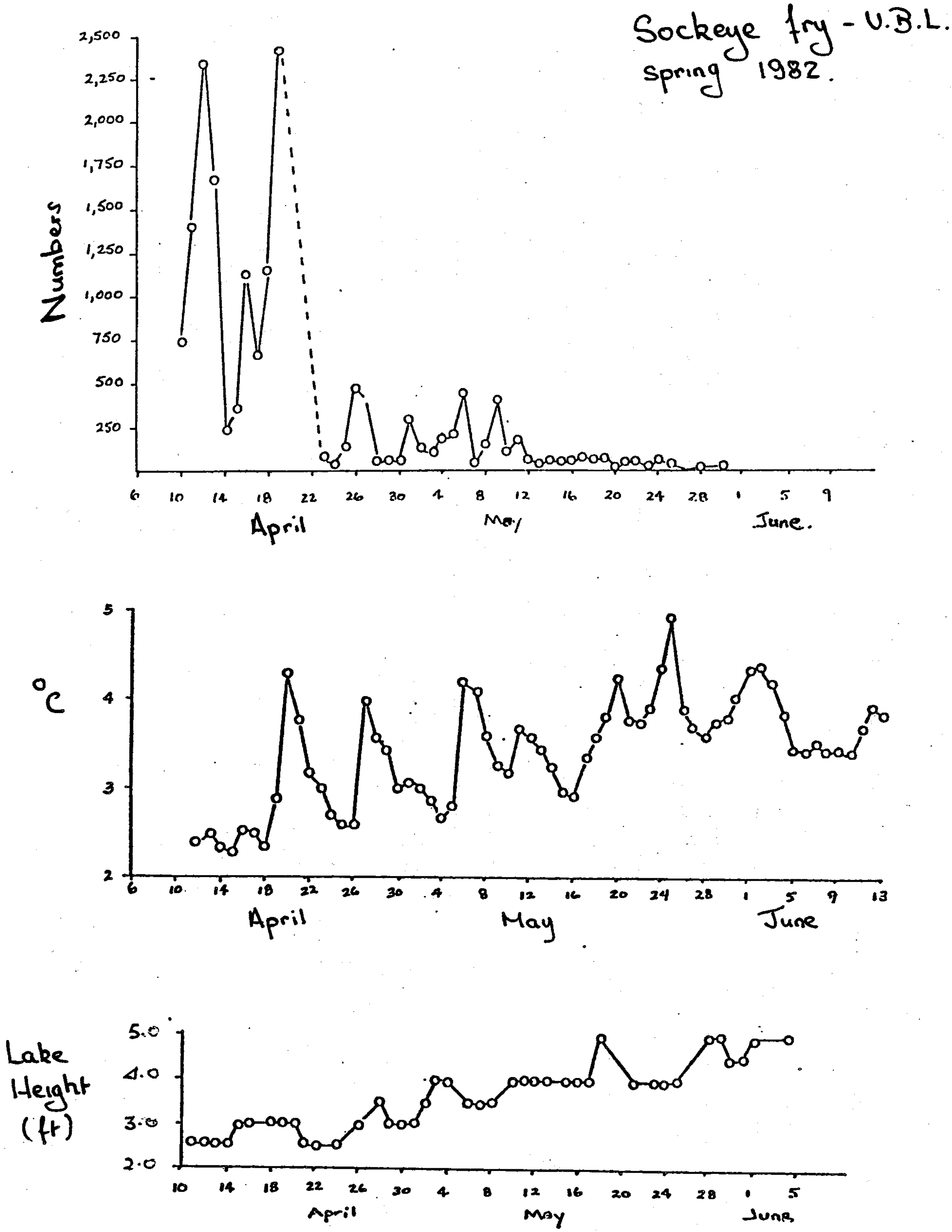


FIGURE 13a: Numbers of outmigrating sockeye fry entering Black Lake with associated temperature and discharge information. Spring, 1982.

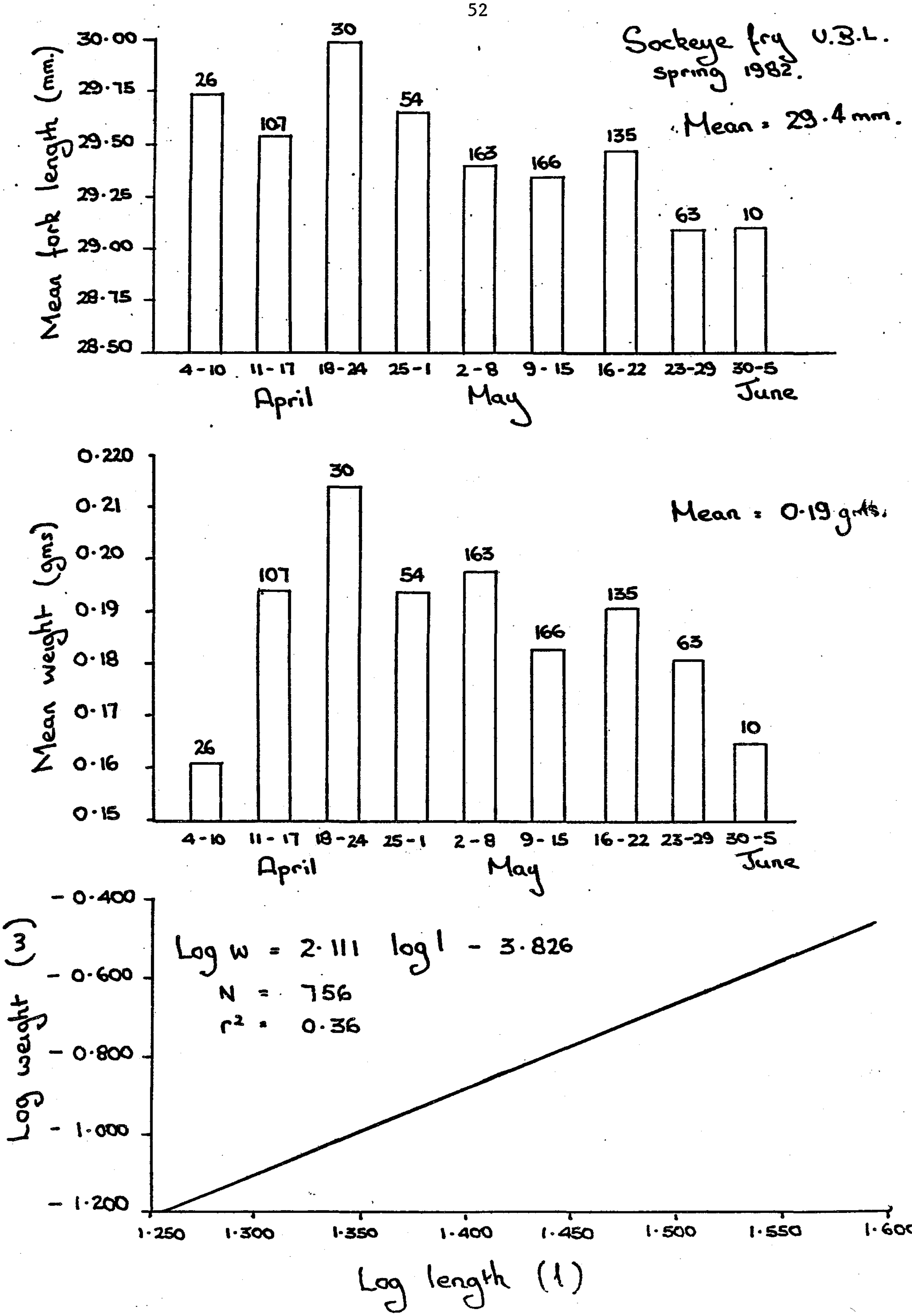


FIGURE 13b: Weekly mean lengths and weights for sockeye fry migrating into Black Lake, April 4 to June 5 and a regression plot of length to weight. Spring, 1982

Pink (Oncorhynchus gorbuscha) fry (Figures 14a-e)

Large numbers of pink fry were captured from the initial installation of the U.B.L. net on April 10 until May 12. Smaller numbers were taken right up until June 1. An average of 11,700 each day were taken during the major part of the run, with peaks of 29,800 on April 16 and 29,300 on May 5 (Figure 14a) A number of fry were missed when the net was pulled between April 20 to April 22 and on May 6, 7 and 8, when flood water came over the top of the dam. This accounts for the drop in the graph on these days. The total number of fry captured was 380,052. Considering that fry must have migrated into the lake before net installation and the losses aforementioned, it is estimated that 440,000 to 460,000 pink fry migrated from spawning habitat above Black Lake into the lake. The two peaks would appear to correspond to increases in discharge at that time (Figure 14a).

The fyke net at lower Black Lake did not capture all the outmigrating fish. The efficiency factor, using recaptured, marked smolt, may be inaccurate in its application to fry but it is felt that it gives an adequate approximation of total numbers.

27,564 pink fry were taken in the net between April 9 and June 1. The numbers in Figure 14b are calculated to incorporate the 15% efficiency factor of the net, giving a total of 183,760 pink fry outmigrating from Black Lake during net operation. Some fry undoubtedly migrated before net installation and during the first 14 days when the net was only fished every two days. Consequently, a total estimate is in the region of 215,000 to 225,000 pink fry.

The peak of the outmigration was on April 27 when an estimated 44,000 left the lake. A smaller peak occurred on the 8th of May. These two peaks mirror high discharges from the lake on these dates.

Figures 14a & b provide an interesting comparison. The large number of pink fry that entered the lake from April 10 are not reflected in the outmigration from the lake until the peak on April 28. Some fry may have been holding in the lake for a short period while others moved virtually

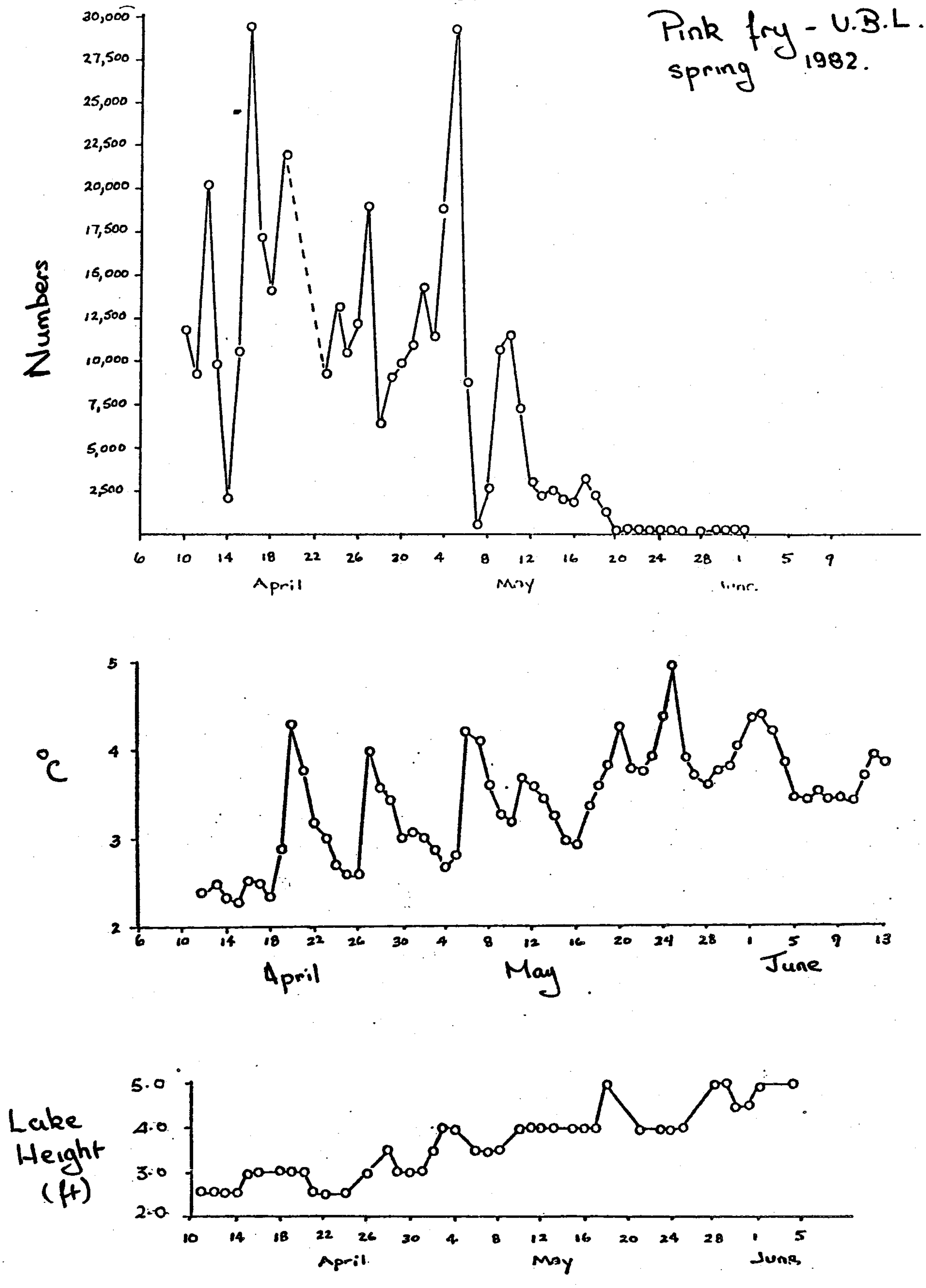


FIGURE 14a: Numbers of outmigrating pink fry entering Black Lake with associated temperature and discharge information., Spring, 1982.

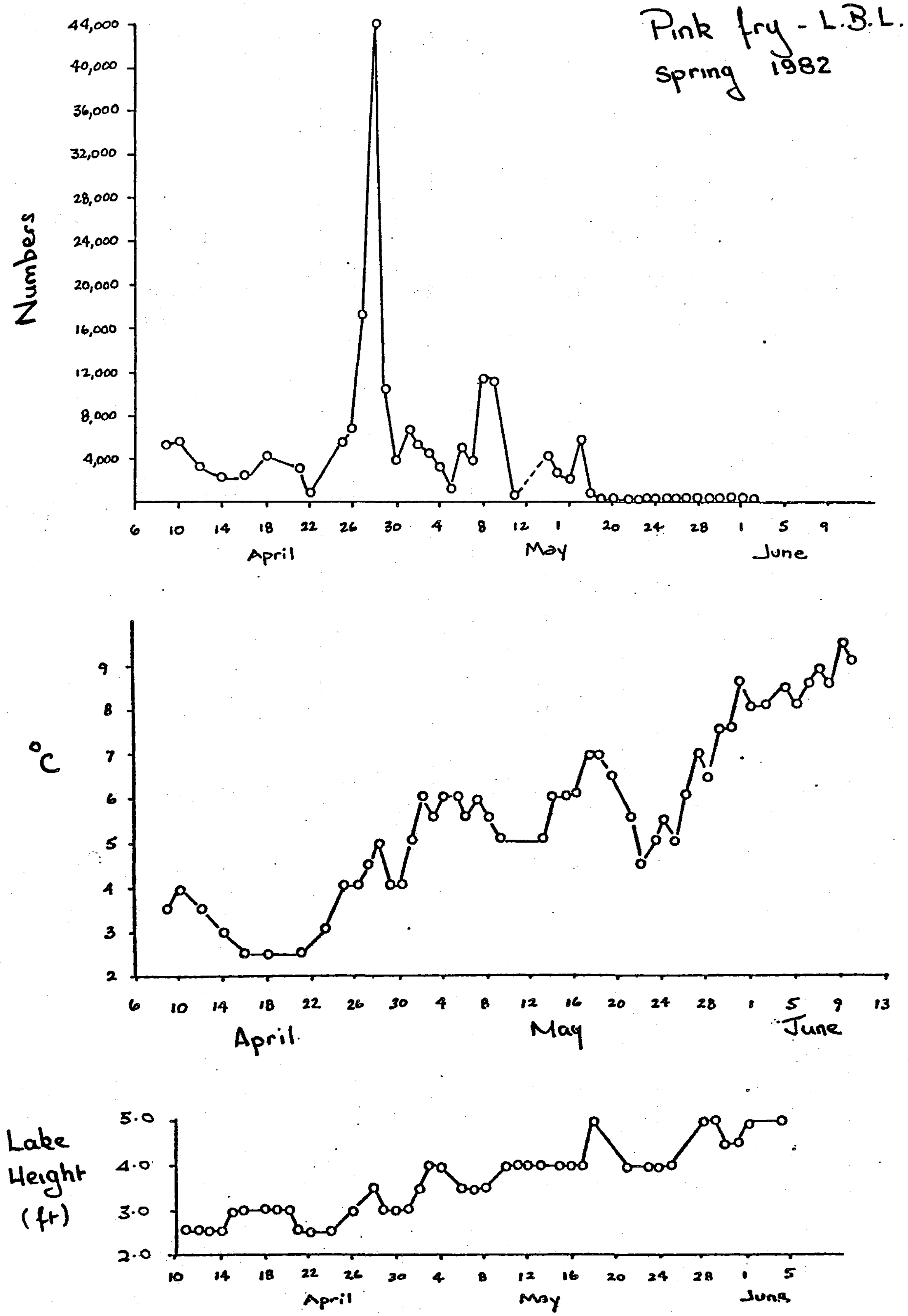


Figure 14b: Numbers of outmigrating pink fry leaving Black Lake with associated temperature and discharge information, Spring, 1982.

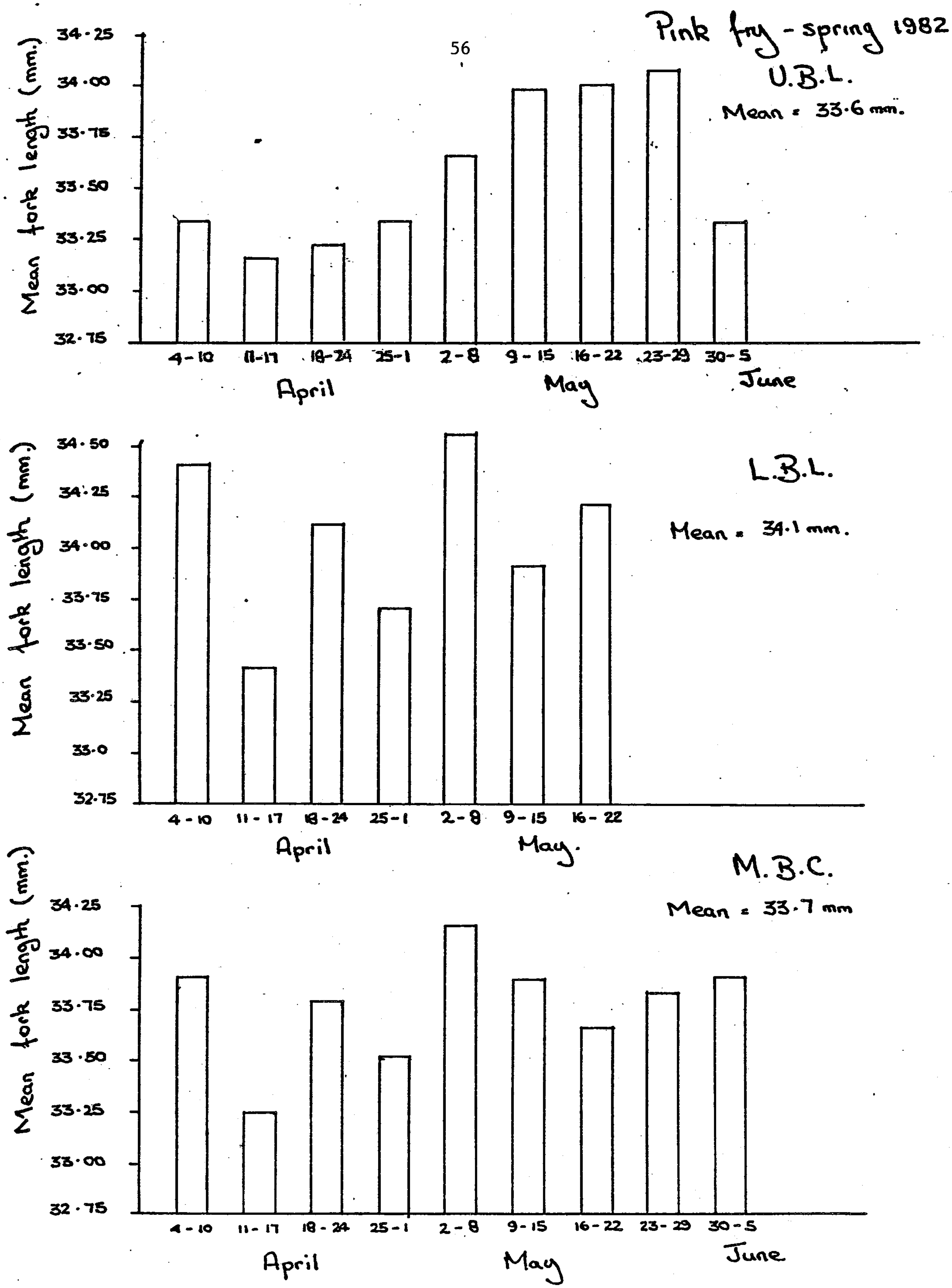


FIGURE 14c: Weekly mean fork lengths (mm) for pink fry entering Black Lake, leaving Black Lake and mouth of Black Bear Creek (April 4 - June 25, 1982)

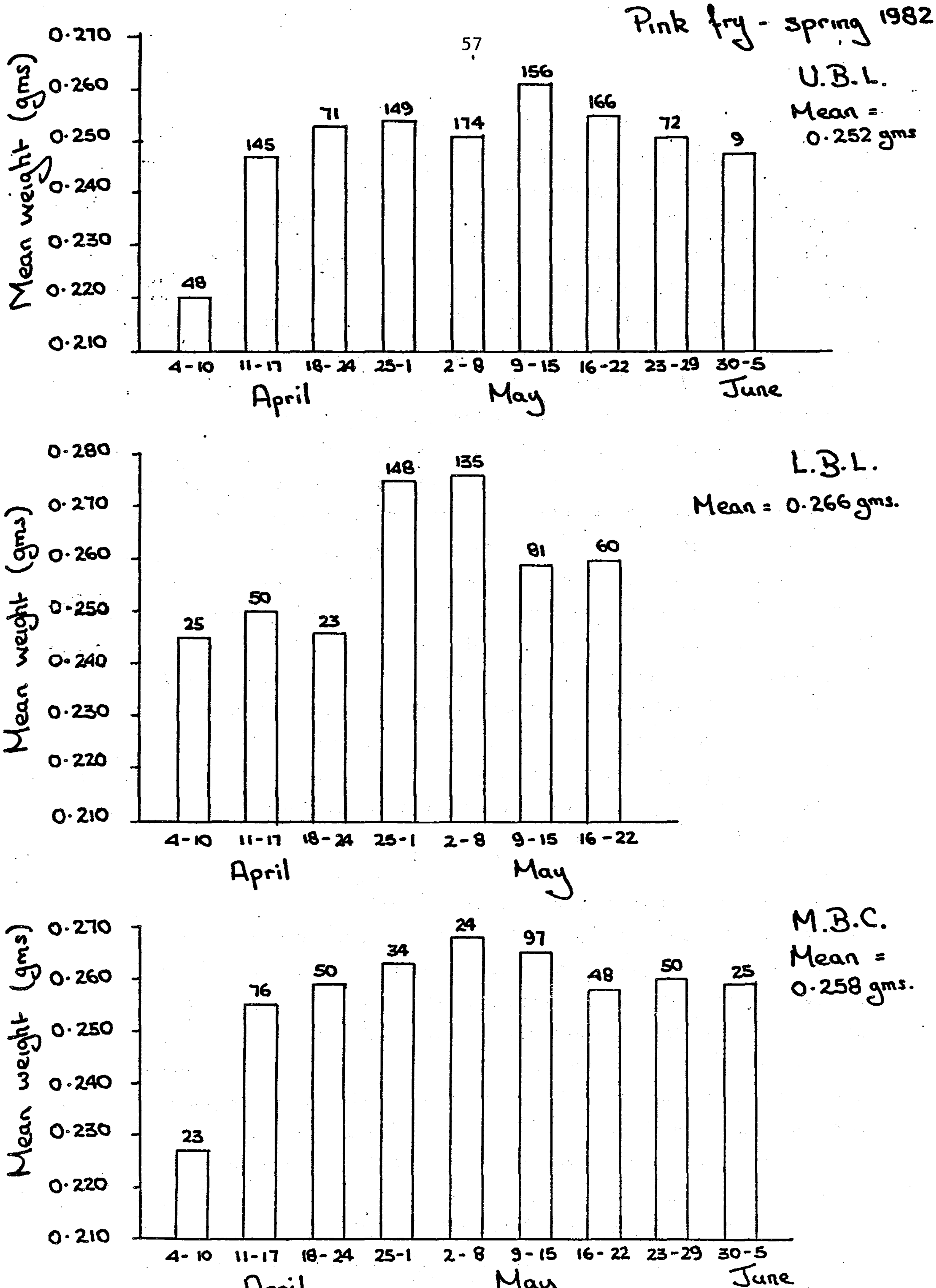


FIGURE 14d: Weekly mean weights (gms) for pink ~~fry~~ entering Black Lake, leaving Black Lake and mouth of Black Bear Creek during the piriod April 5 to May 22, 1982.

straight through. This is possibly reflected by the large variation in size for that time period, from 28 to 37 mm fork length and 0.210 to 0.410 gms. This peak also closely relates to when the ice went out of the lake on April 26. It is possible that movement through the lake was restricted by the presence of ice. The May 8 peak at lower Black Lake would appear to concur with the May 5 peak of 29,311 for upper Black Lake. Pink fry numbers become negligible at lower Black Lake on May 19 which is approximately the same time as upper Black Lake. Indeed, a comparison of estimated total numbers at the two sites is striking -- 215,000 to 225,000 pink fry leaving Black Lake in contrast to 440,000 to 460,000 calculated to have entered it. This gives a mortality rate of 49% of fry moving through the lake. The movement of pink fry through a lake has not been extensively documented and whether they follow lake currents or migrate around the litoral zone until locating the outflow is undetermined. Whatever the case, they are subject to heavy predation, presumably from resident fish, notably cutthroat, Dolly Varden and coho. Overwintering Dolly Varden may also play a role. Although some 20-30 Dolly Varden were observed moving out of the system in May no larger numbers were found. Predation from this source would also vary from year to year according to the number of overwintering Dolly Varden, which may fluctuate widely. For example, in Hugh Smith Lake, 6,000 Dolly Varden were recorded overwintering whereas in the previous year there were only 200 (Mike Haddix, A.D.F.& G., pers. comm.).

The average length of pink fry migrating from Black Lake is 34.1 mm, compared to 33.6 mm entering the lake. The weights are higher with 0.266 gms compared to 0.252 gms leaving the lake (Figures 14c & d). These differences prove highly significant at the p=.001 level with the application of a simple t-test. By examining the weekly mean weights, it can be seen that the average for April 25 to May 1 is 0.275 gms for those fry leaving the lake, which is notably higher than the three previous weeks, again reflecting that fry had possibly remained in the lake before migrating with the high discharge and the ice going out.

Number of pink fry collected at the mouth (M.B.C.) were extremely variable. Two main peaks occurred during the first part of May on the

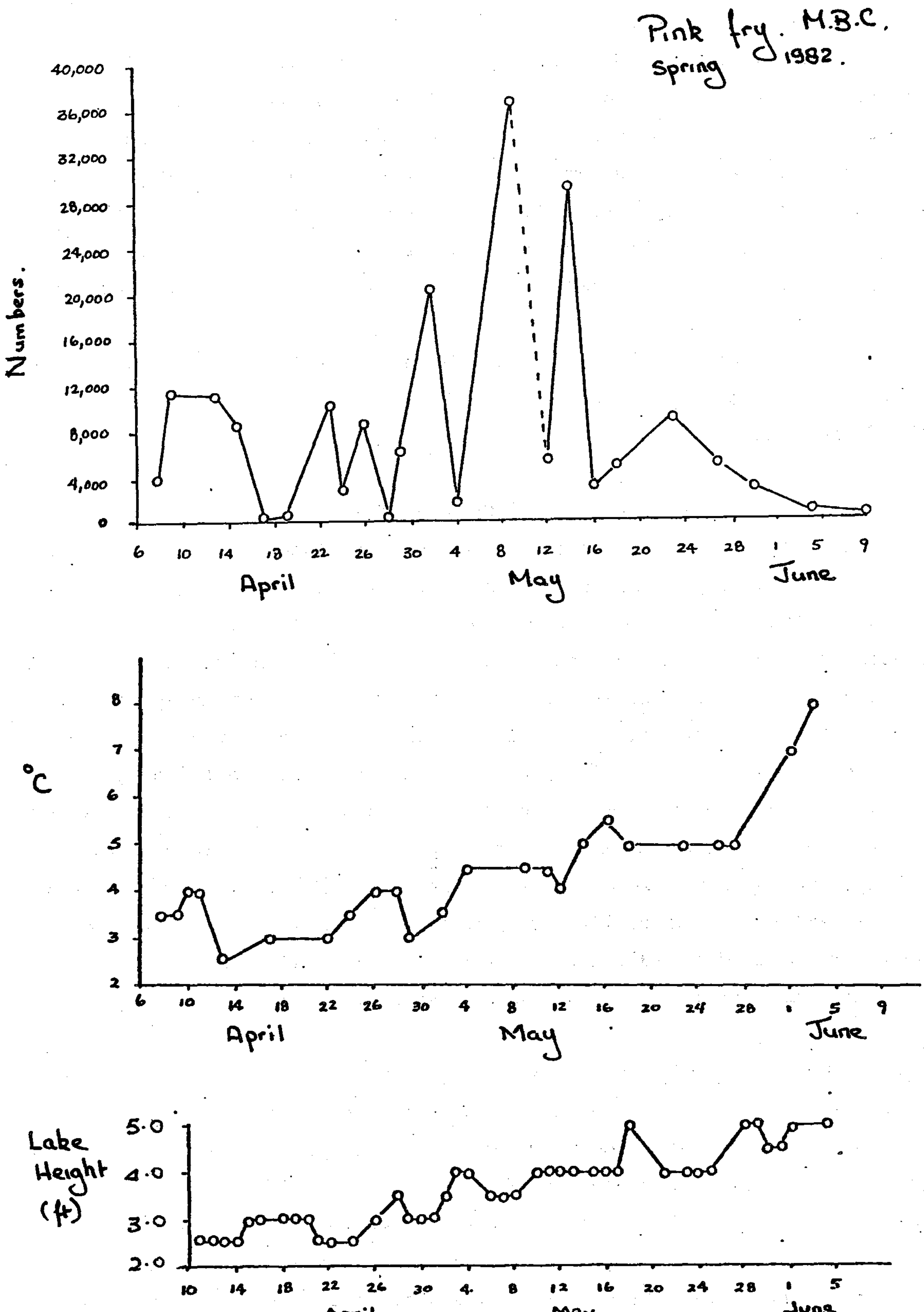


FIGURE 14e: Numbers of outmigrating pink fry at the mouth of Black Bear Creek with associated temperature and discharge information, Spring, 1982.

9th and on the 14th.[1/] These peaks were later than those recorded for the upper Black Lake net, and appreciable numbers of fry were collected right through until the end of May. This later outmigration reflects the large number of pinks (approximately 26,000) that spawned below the lake and it appears from the cumulative temperature unit data (Figure 9b) that accumulation of temperature units is slower in the lower section of the stream during winter than above the lake where the spring flows create higher temperature regimes and, thus, earlier emergence occurs.

Mean fork length of 33.7 mm (Figure 14c) and weight of 0.258 gms, are similar to the upper Black Lake net. Two large pinks were taken at the mouth of the creek with a length of 45 mm.

Chum (Oncorhynchus keta) fry (Figures 15a-e)

It is apparent that the migration of chum fry into the lake may have been partially missed as the largest numbers were on the first day of operation of the net. In total 538 chum were collected entering the lake and, using the 15% efficiency factor of L.B.L., 3,753 leaving it. (Fig.15a&b) Considering that the L.B.L. net was not fished every day until April 25, it is evident that some chum fry emerged from gravel habitat between the lake mouth and the location of the net. 3,410 chum were collected at the mouth of the creek with a peak on April 13 and a smaller one on Apr.26th Fig.15 c). The outmigration was virtually completed by the 12th of May. Mean length and weights for the three sites (Figs. 15d & e) show a negligible amount of variation. No smaller size class was evident in this year's outmigration compared to 1981 and it is possible that the smaller group in that year were sockeye fry which were leaving the system.

Coho (Oncorhynchus kisutch) fry (Figures 16a,b)

Coho fry began to move down into the lake from the stream above Black Lake on April 11 and fluctuated in number throughout the fyke net operation at U.B.L. A peak occurred on April 27 when 725 fish were captured. The total number of coho fry collected entering Black Lake was 3,029. A larger percentage of the coho fry migrated into the lake during the middle of May.[2/] Although it was attempted to screen the entire

1/ Fig.14e

2/ Fig.16a

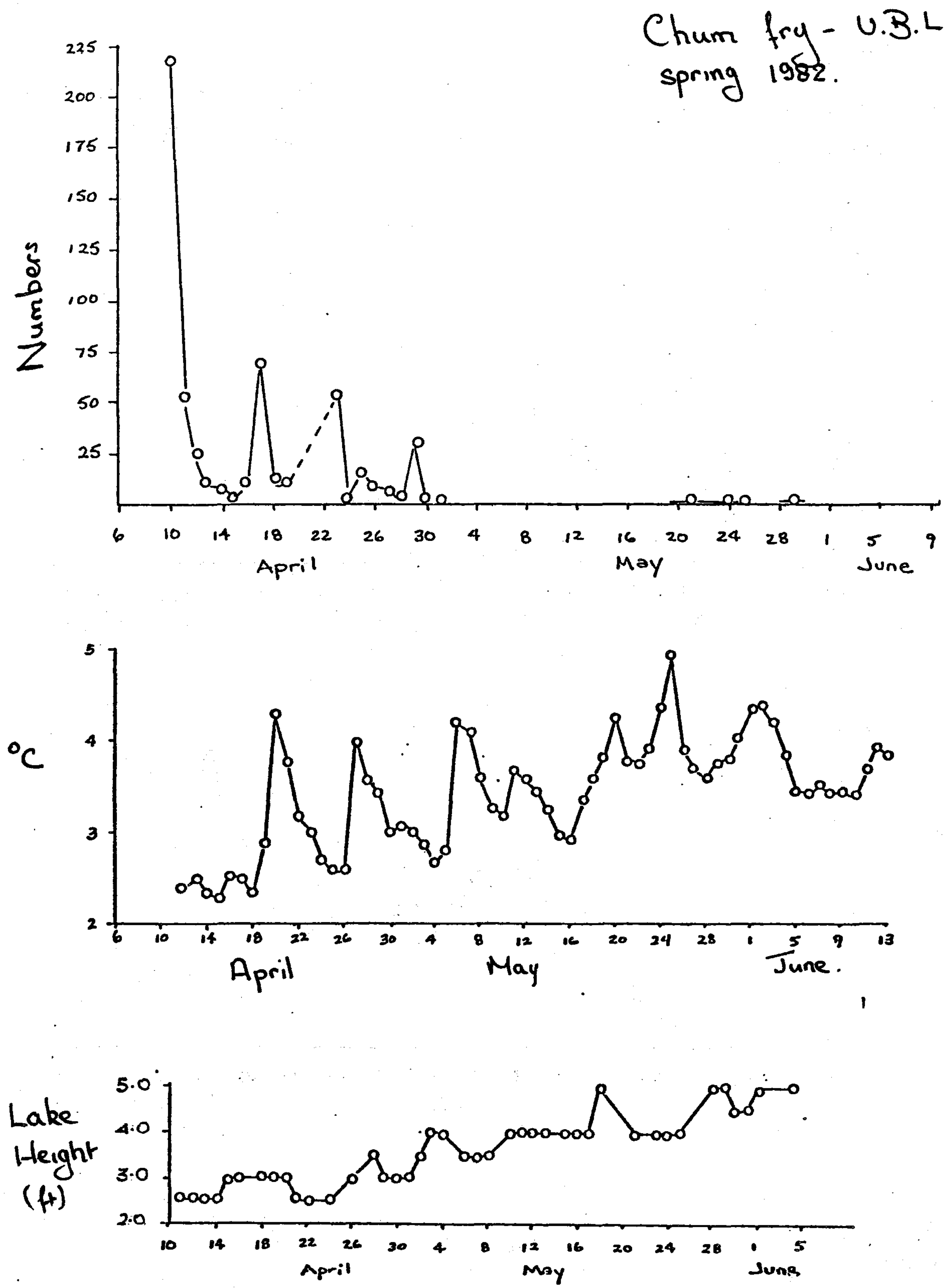


FIGURE 15a: Numbers of outmigrating chum fry entering Black Lake with associated temperature and discharge information. Spring, 1982.

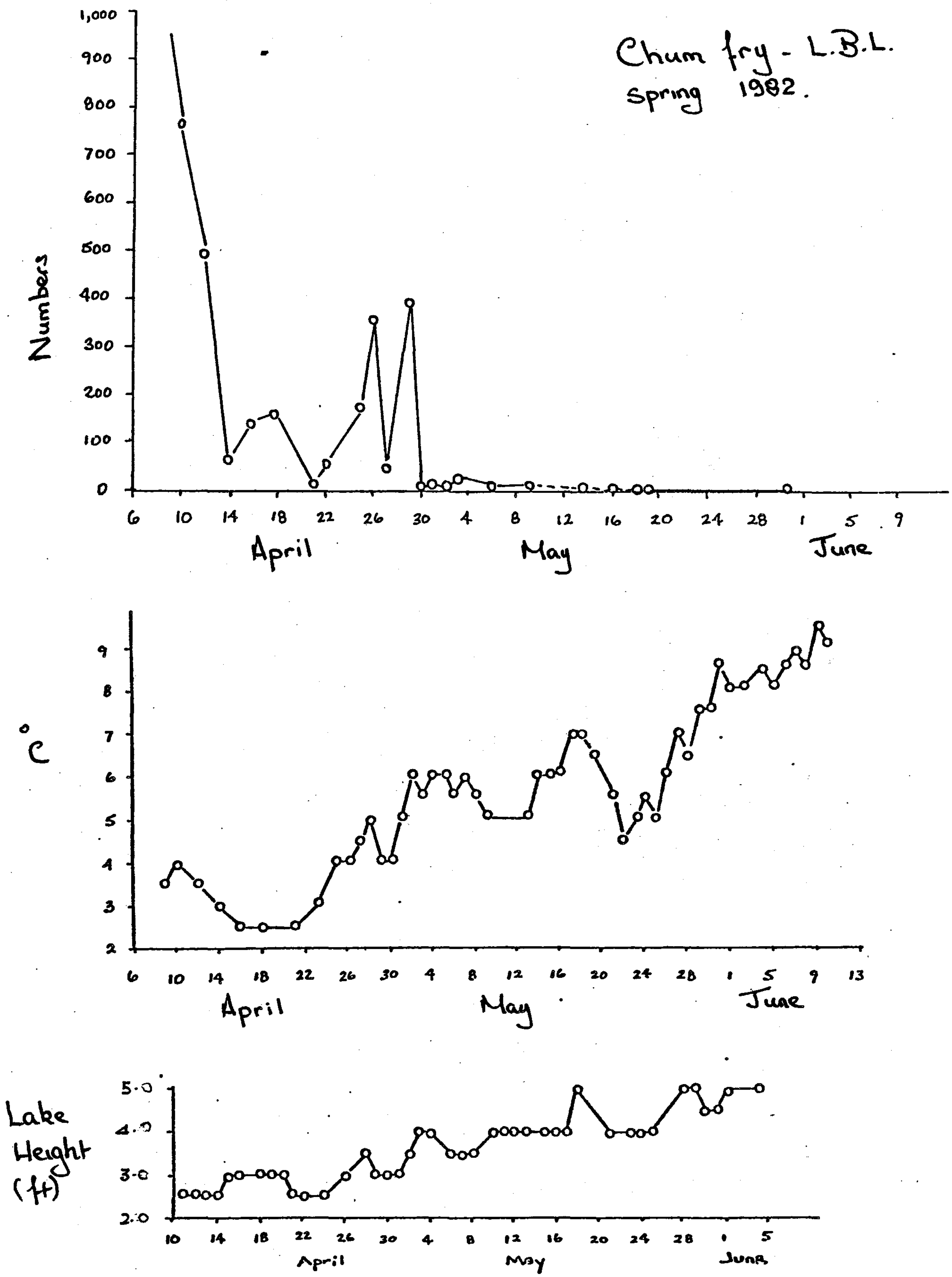


FIGURE 15b: Numbers of outmigrating chum fry leaving Black Lake with associated temperature and discharge information. Spring, 1982.

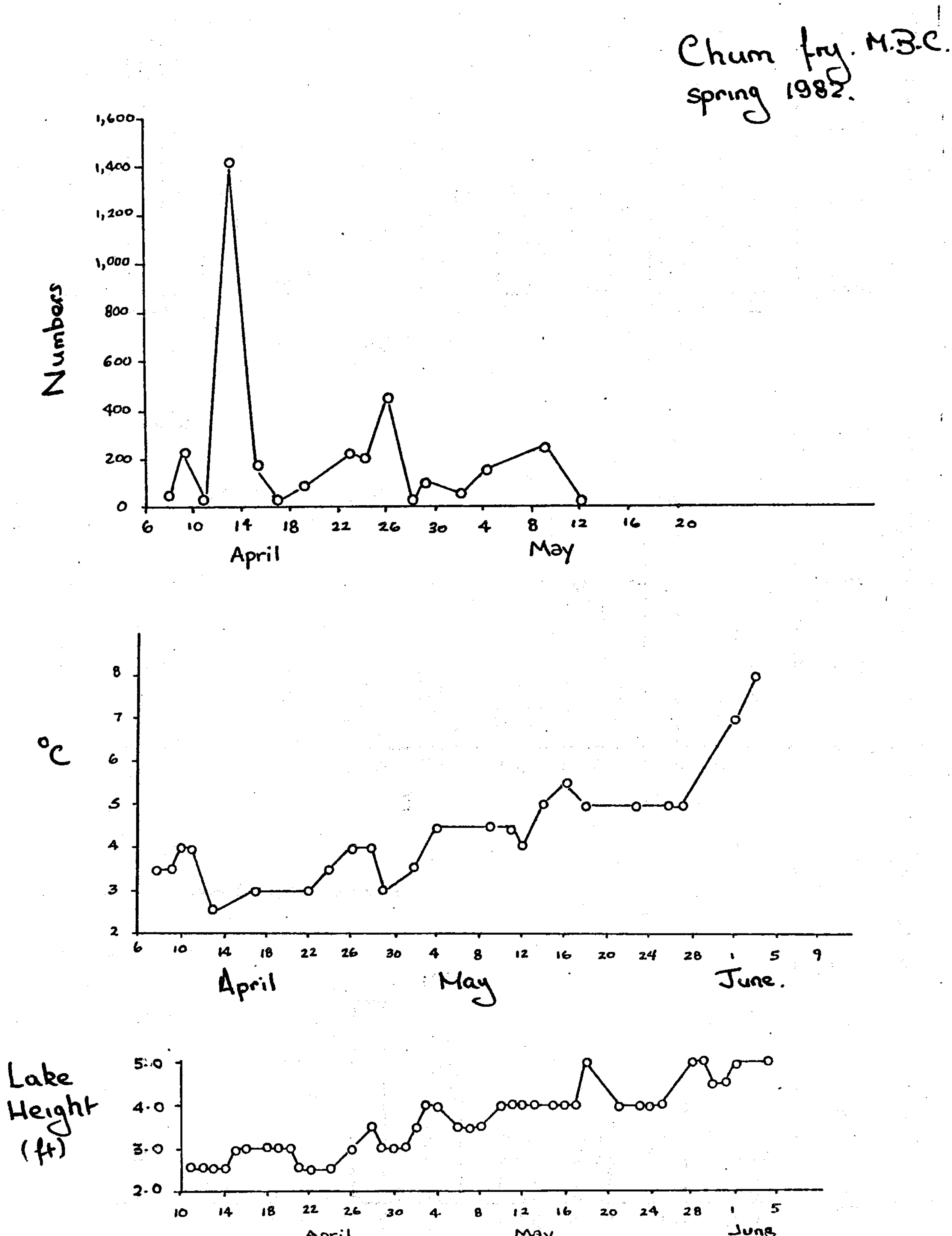


FIGURE 15c: Numbers of outmigrating chum fry at the mouth of Black Bear Creek with associated temperature and discharge information. Spring, 1982.

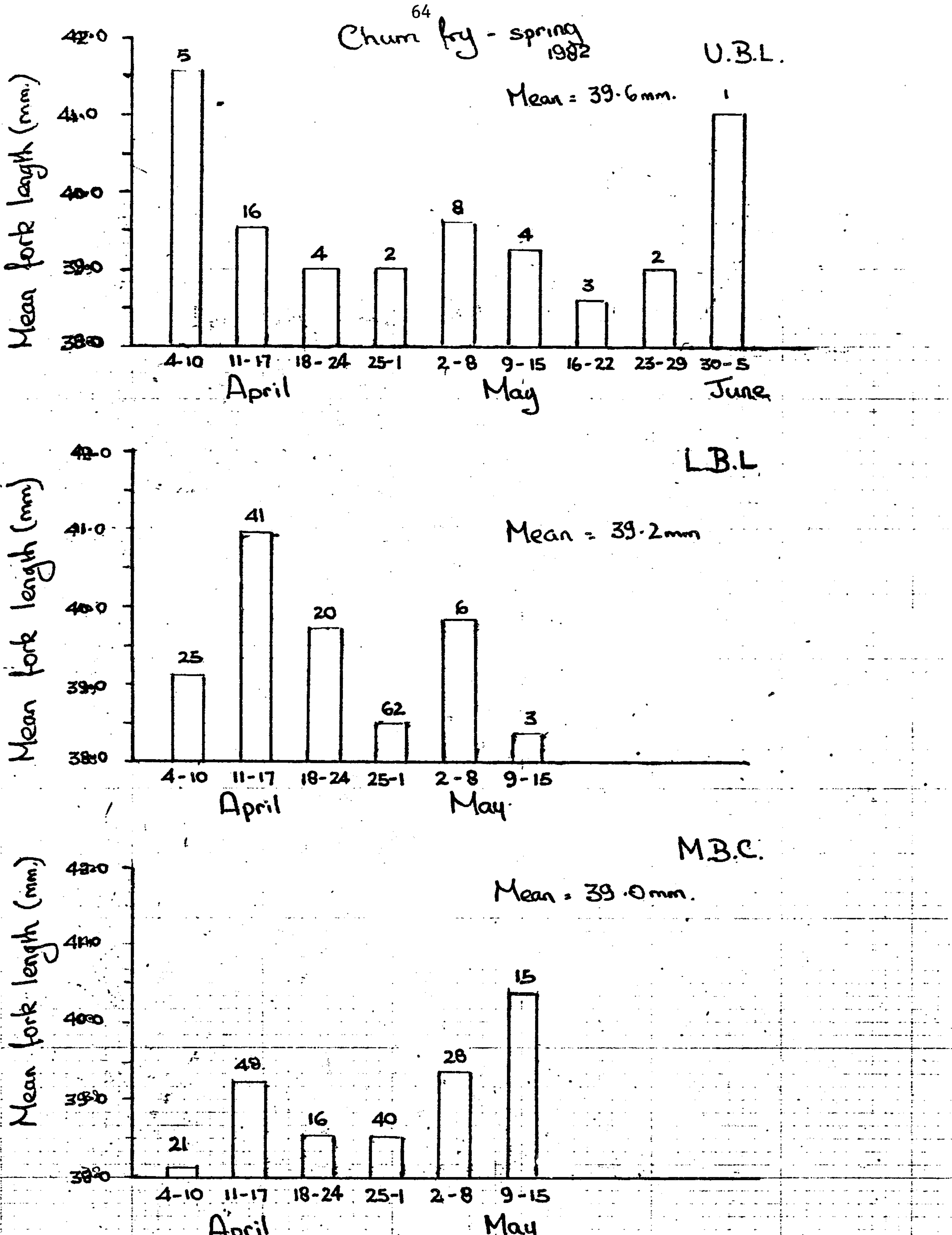


FIGURE 15d: Weekly mean fork lengths (mm) of chum fry entering Black Lake, leaving Black Lake and at the mouth of Black Bear Creek (April 4 - June 5). Spring, 1982.

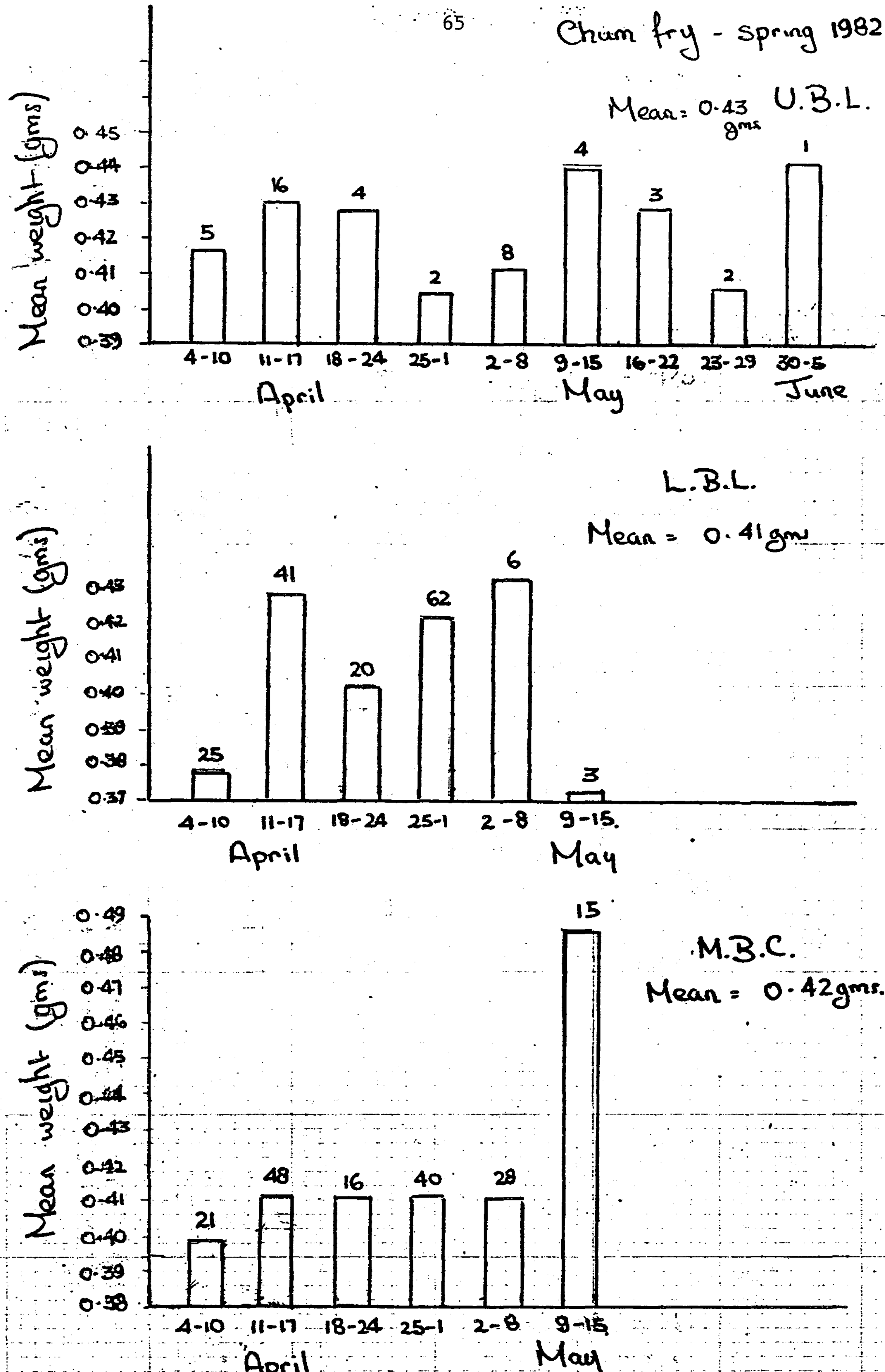


FIGURE 15e: Weekly mean weights (gms) of chum fry entering Black Lake, leaving Black Lake and at the mouth of Black Bear Creek (April 4 - June 5). Spring, 1982.

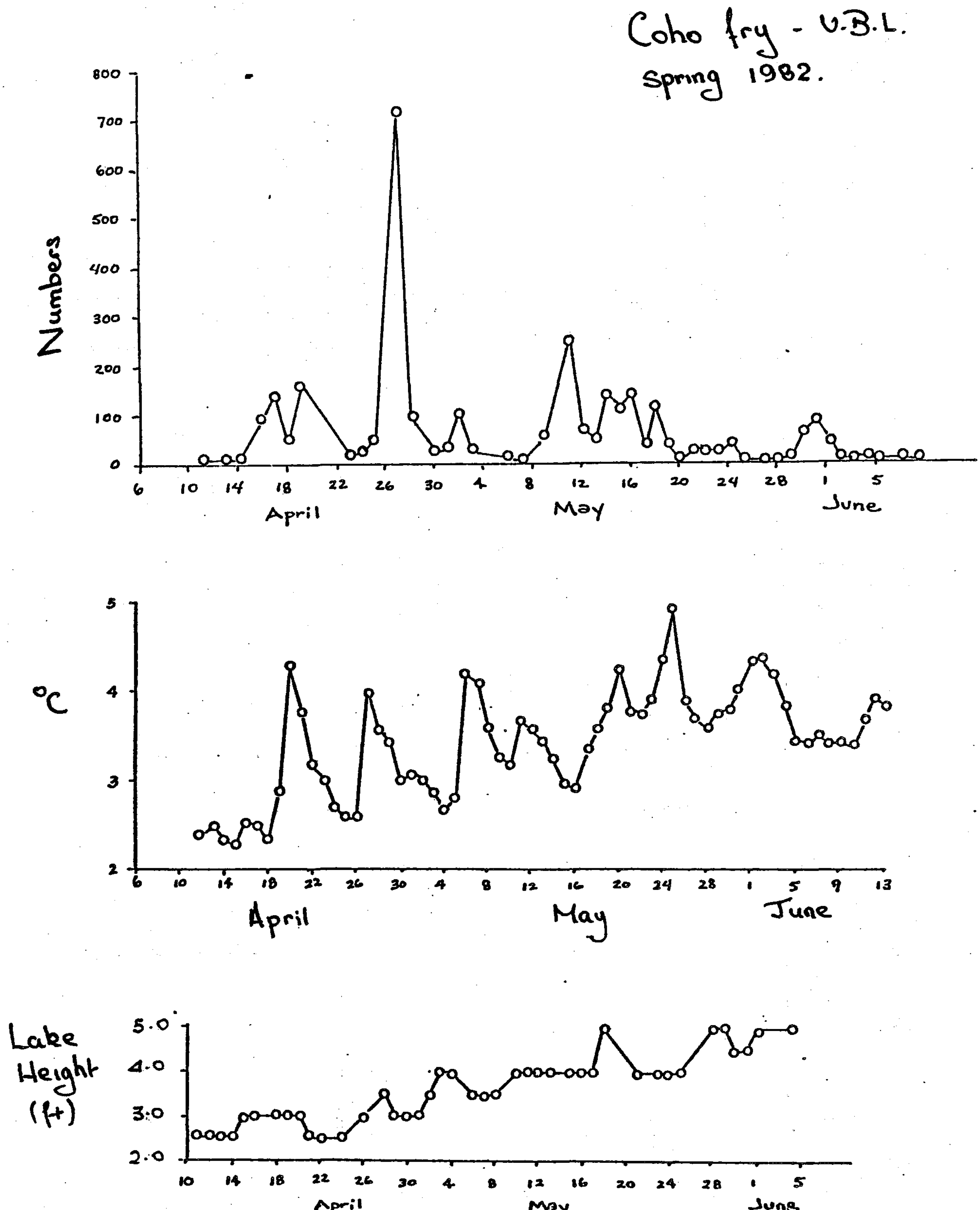


FIGURE 16a: Numbers of outmigrating coho fry entering Black Lake with associated temperature and discharge information. Spring, 1982.

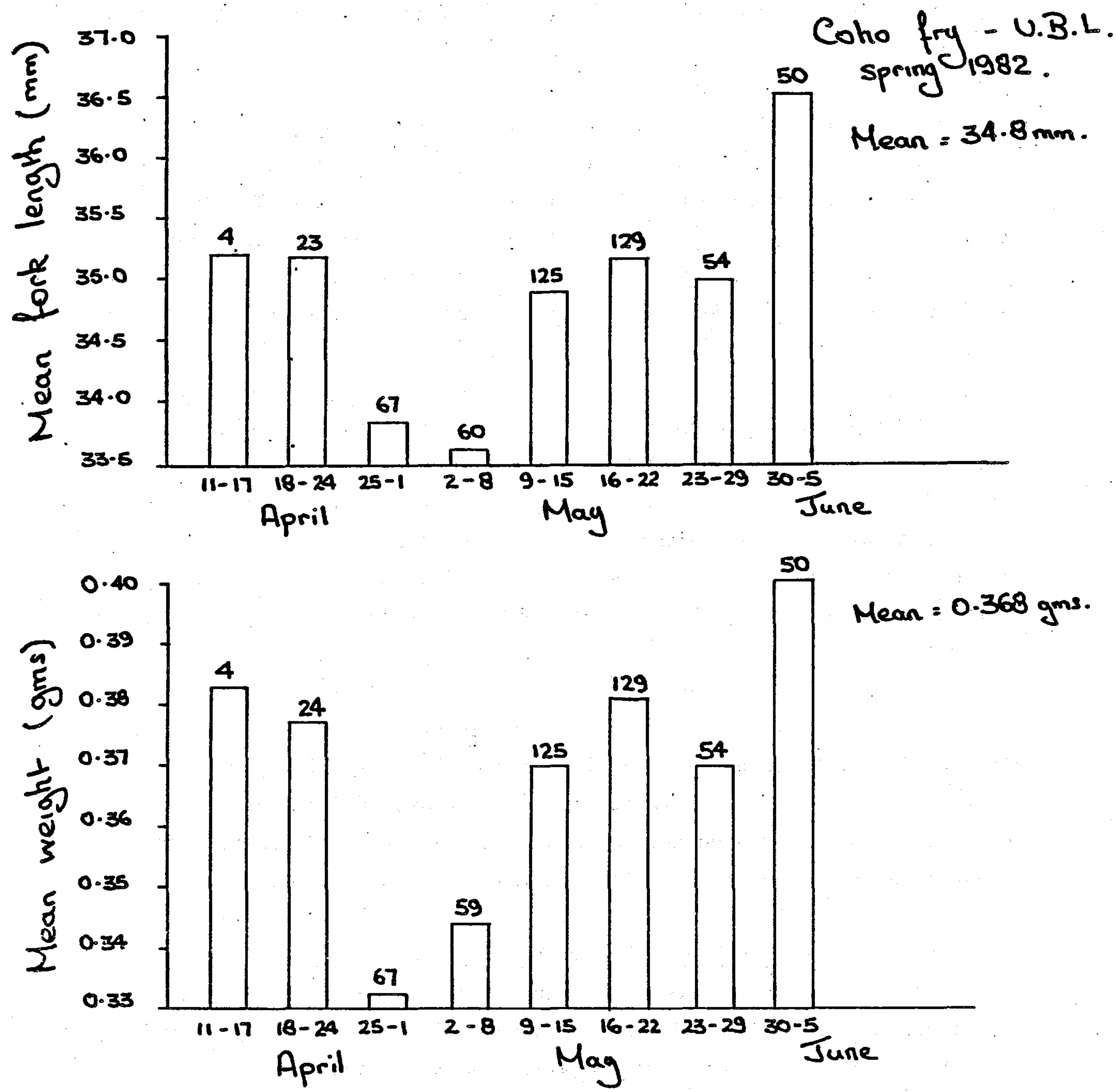


FIGURE 16b: Weekly mean fork lengths for coho fry entering Black Lake during the period April 11 to June 5. Spring, 1982.

sample of fish in the live box for coho fry, numbers were principally estimated from the subsample taken. With the large number of pink fry being present, it was evident that the presence or absence of a few coho fry in the subsample would significantly influence the final coho fry estimation.

Mean length and weight were typically larger in May and at the beginning of June (Figure 16b). It is probable that these fry had emerged from the gravel earlier and had spent time in the stream. In the territorial competition for niches, these fish had become displaced and, thus, were moving down into the lake to seek out suitable habitat. A small number of fry probably continued to move down after removal of the net.

Coho fry were taken in the net at lower Black Lake, principally from the middle of May onwards. A total of 849 fry were collected. Although some of these fry may have come through the lake, it is considered that this movement reflects emergence of fry from below the lake. Their later movement than the upper Black Lake again indicates possible later emergence below the lake as a result of lower temperature regimes during winter.

693 coho fry were captured at the mouth of the creek in the M.B.C. net in five settings between May 23 and June 8. Only 12 fry were trapped before this date. These nomadic fish are probably being displaced from the system due to competition for rearing habitat and the aggressive behavior of dominant individuals (Chapman, 1962).

Sockeye (Oncorhynchus nerka) smolt (Figures 17a - d)

The first smolt commenced to emigrate from Black Lake on April 18 and continued until June 10. The main peak of the run was May 27 and May 28 (Figure 17a) with numbers showing a marked increase from May 17. This corresponds to when the temperature of the lake outflow attained 7.0°C. The temperature then began to fall, reaching 4.5°C on May 22, corresponding to fluctuations in number of outmigrants during this time,

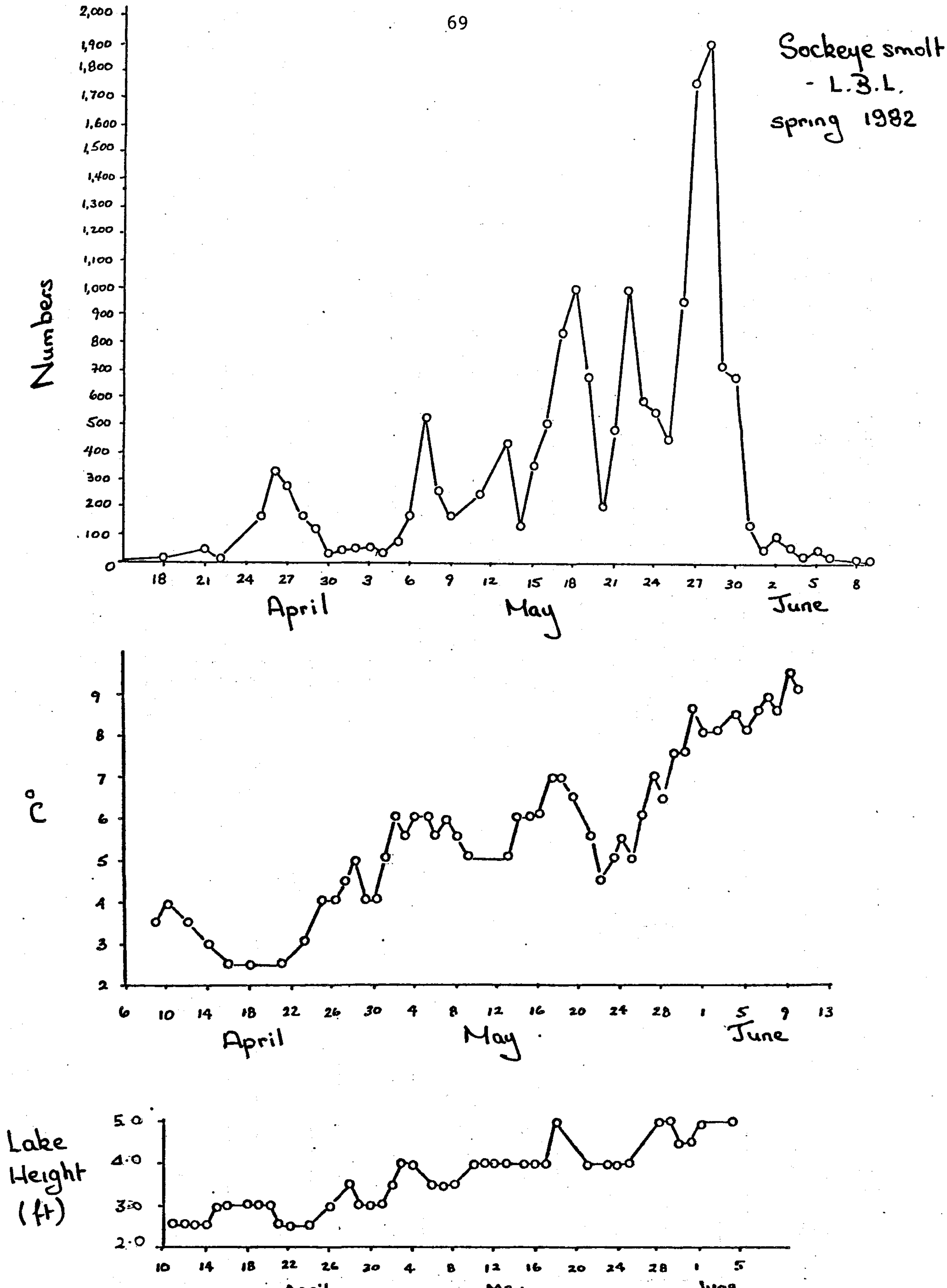


FIGURE 17a: Numbers of outmigrating sockeye smolt leaving Black Lake with associated temperature and discharge information. Spring, 1982.

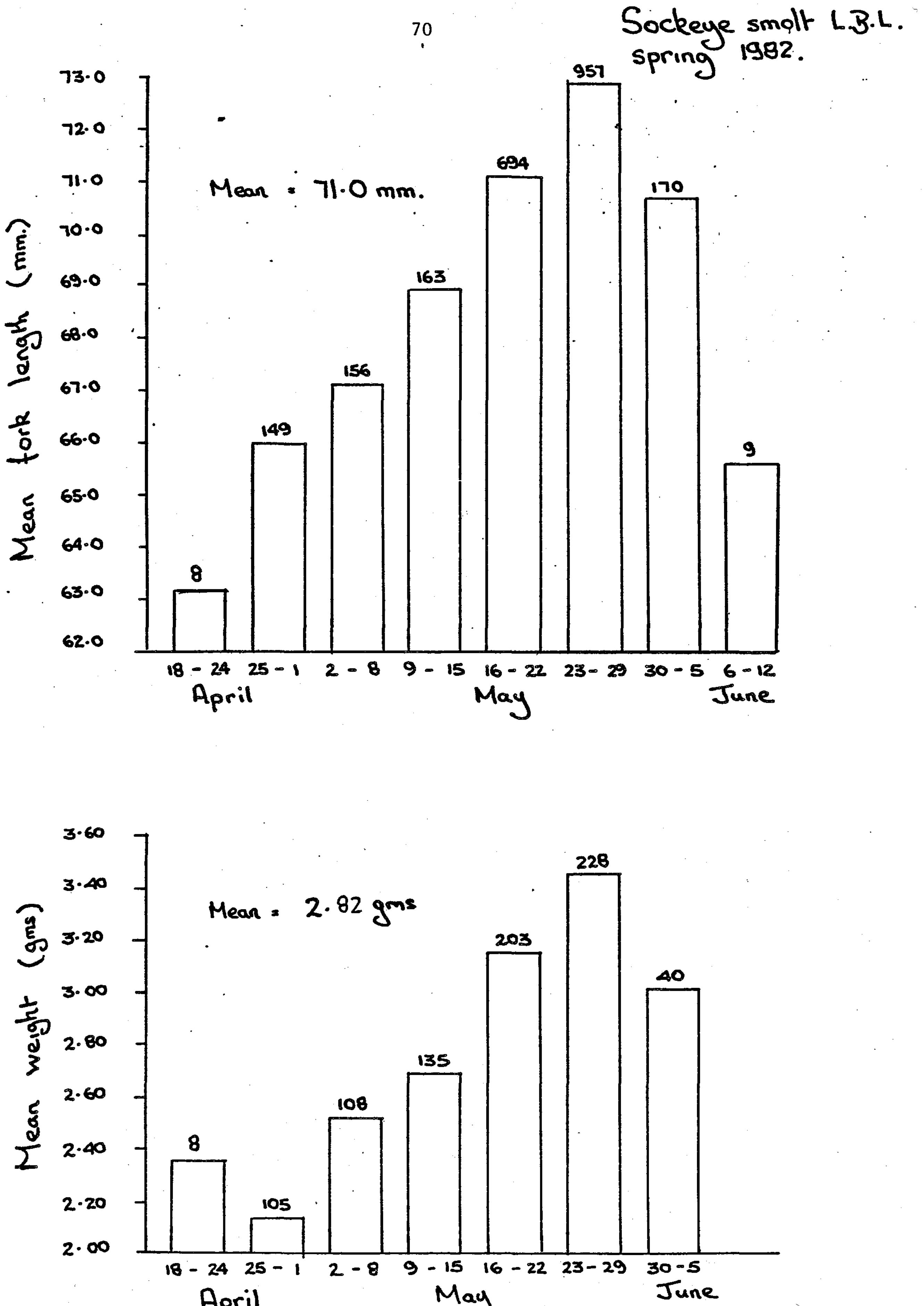


FIGURE 17c: Weekly mean fork lengths and weights for sockeye smolt leaving Black Lake. (April 18 to June 12, 1982.

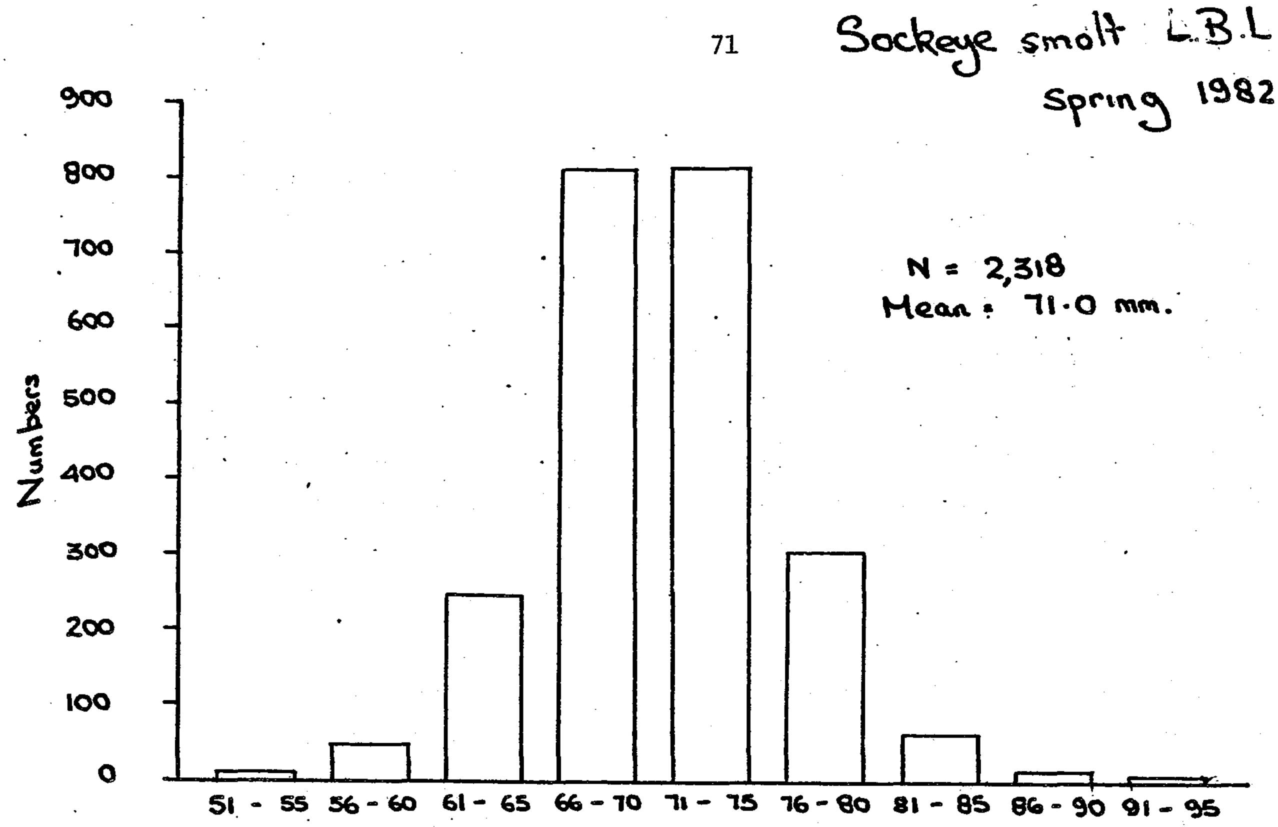


FIGURE 17b: Length frequencies of sockeye smolt leaving Black Lake. April 18 - June 12.

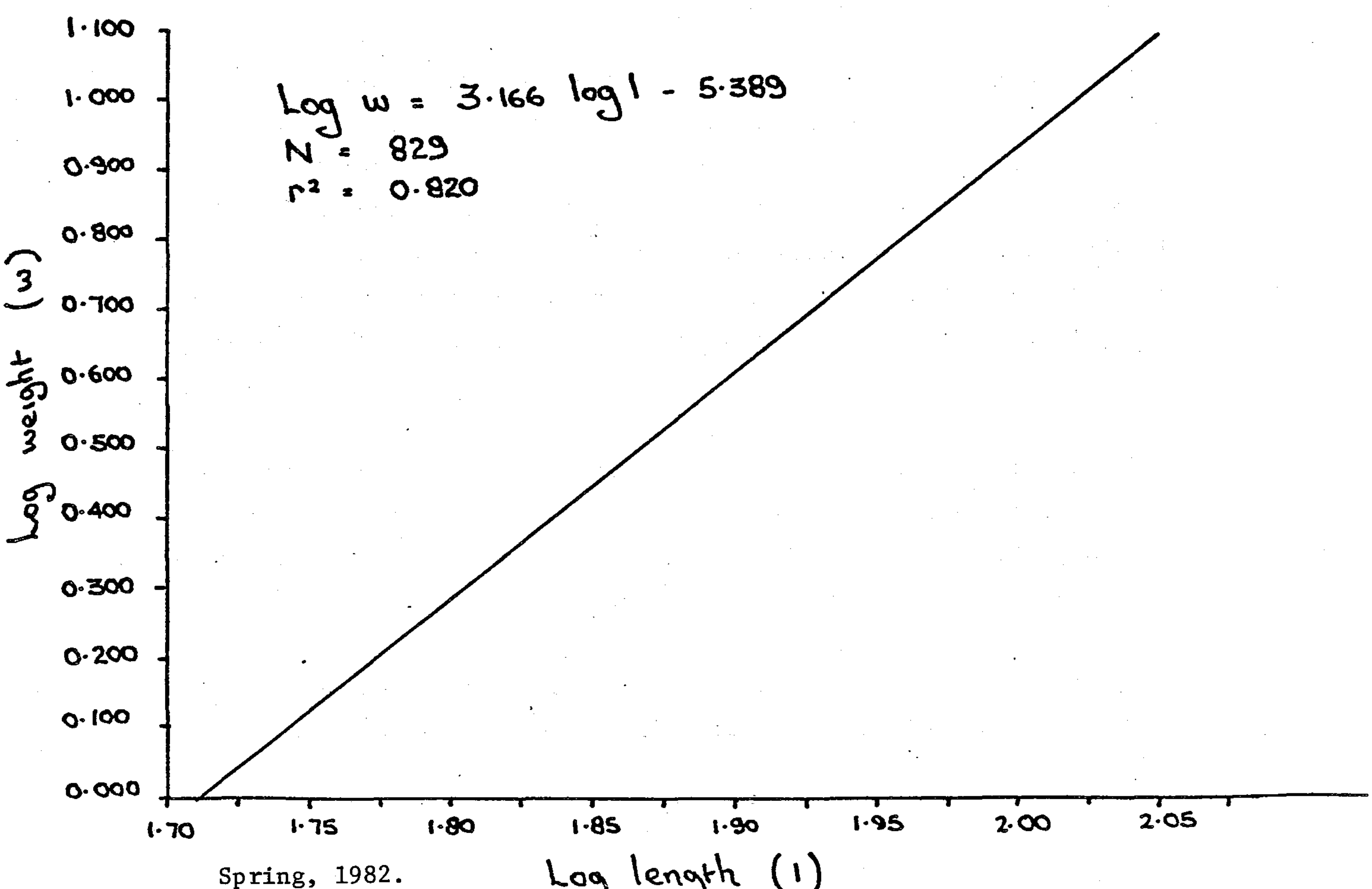


FIGURE 17d: Regression of log weight to log length for sockeye smolt leaving Black Lake. Spring, 1982.

before rising back to 7.0°C on May 27, when the principal peak occurred. Temperature appears to have been a more important factor than lake discharge, although the two are correlated. The fall in temperature from May 19 corresponds to increased lake levels at that time due to heavy snowmelt as a result of high levels of rain.

A total of 2,488 sockeye smolt were captured in the L.B.L. fyke net. Applying the 15% efficiency factor, which was calculated by marking sockeye smolt and releasing at three different stages of flow, the total sockeye smolt emigration was estimated to be in the region of 16,500.

Length and weight measurements were undertaken on 827 fish and fork lengths on a total of 2,306. Length frequencies of sockeye smolt are presented in Figure 17b & weekly mean lengths and weights are given in Figure 17c.

Mean length of smolt was 71.0 mm and mean weight was 2.82 gms. The range was 49 mm to 103 mm and 1.10 gms to 10.95 gms, respectively.

The mean length of the fish increased as the outmigration progressed with the larger fish occurring at the peak of the run. In the last week of the outmigration, the fish were considerably smaller than the average. This pattern contrasts with 1980 Hugh Smith Lake smolt studies (Haddix, 1981) where in the first stages of the outmigration from May 5 to May 16, larger fish emigrated, 63% being age II smolt. Later in the emigration, from May 17 to June 22, the fish were typically smaller, 93% being age I smolt.

Scales were taken from a sample of smolt. At the time of writing, it has not been possible to age the entire sample, but from a subsample of 35 fish, all were aged as I. All fish measured less than 78 mm, thus it is estimated that 85% or greater of the outmigrating smolt were aged I.

The length weight regression plot for the sockeye smolt is given in Fig. 17d and a correlation coefficent (r^2) of 0.827 was computed.

Fulton's (1911) condition factor (K) was calculated for the sockeye smolt emigrating from the lake where

$$K = \frac{w}{l^3} \times 10^5$$

w = weight in grams
l = length in millimeters
10^5 = factor to bring the value of K near unity (Carlander, 1969)

The value of K = 0.82. This compares with a value of 0.93 for Hugh Smith Lake.

Sockeye smolt from Klawock Lake display a greater rate of growth and most age I smolt fall between the 80 to 90 mm range (Ward, pers. comm.).

Coho (Oncorhynchus kisutch) smolt (Figure 18a-e)

1,141 coho smolt were taken in the L.B.L. net between April 18 to June 8. Applying the 15% efficiency factor which may be an over-estimate as coho are more likely to avoid the net than sockeye, 7,606 coho smolt emigrated from Black Lake and the stream section above it. Mean length was 91.6mm and weight was 8.75gms. Fulton's condition factor was 1.04. The peak of the run May 13 to May 24 (Figure 18a). The larger fish came out at this time (figure 18b). The main size range was 85 mm to 100 mm (Figure 18c) being predominantly 2+ fish.

Coho smolt were also trapped at the mouth of the creek (M.B.C.). The peak of the run was over a similar time period as L.B.L. (Figure 18d), with the larger fish coming out at that time, particularly May 16 - 22 (Figure 18e). Mean length was 92.4 and weight 8.64 gms. Fulton's condition factor was 1.02.

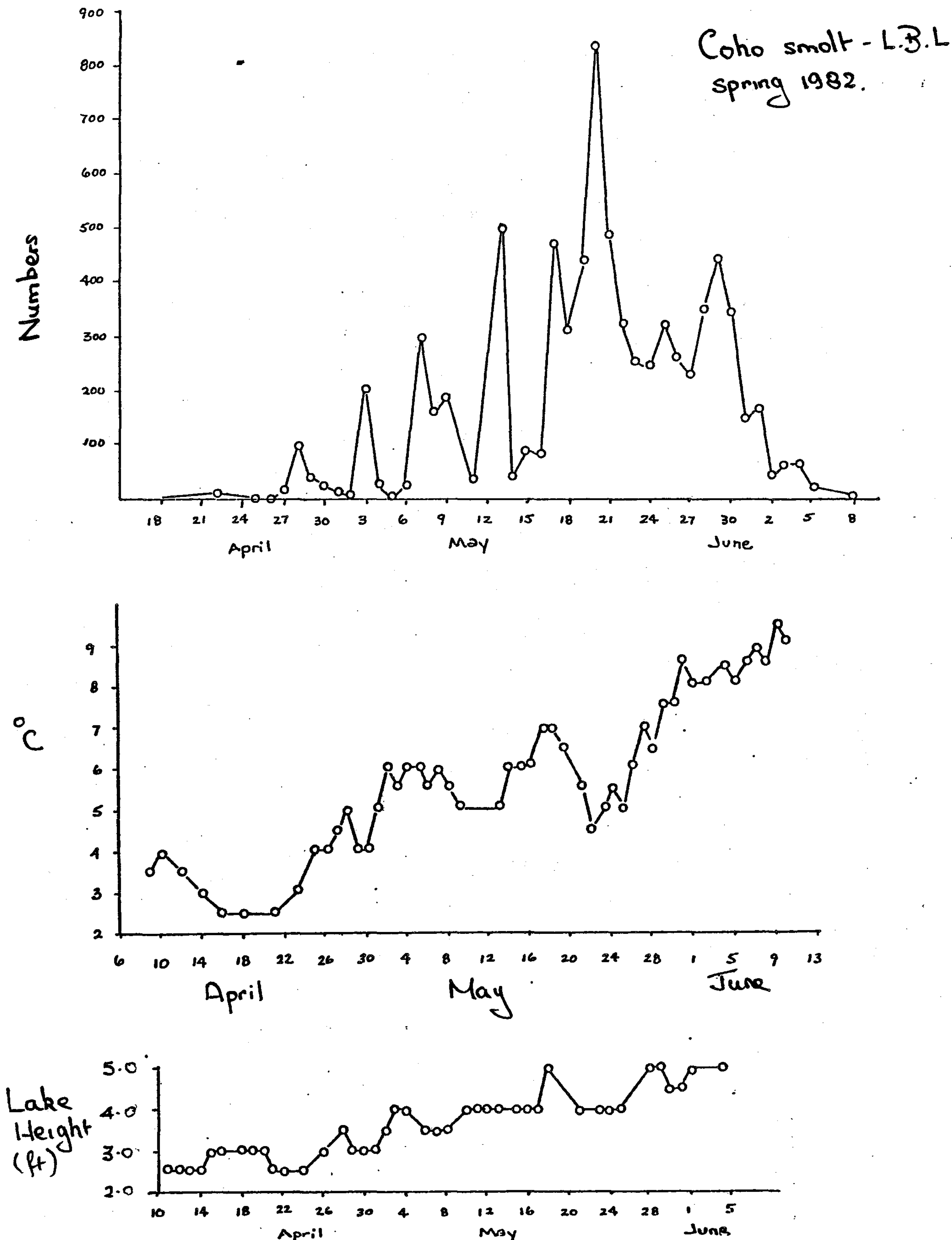
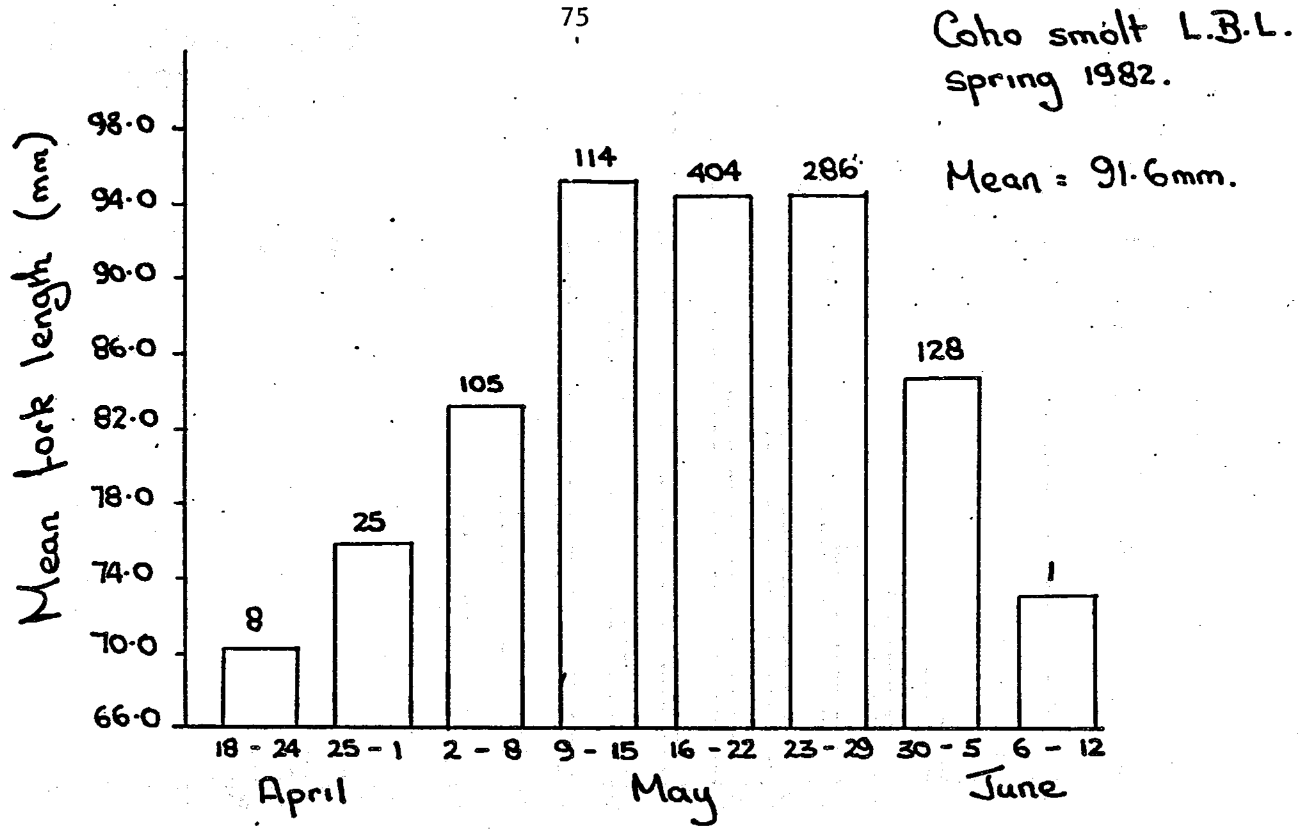


FIGURE 18a: Numbers of outmigrating coho smolt leaving Black Lake with associated temperature and discharge information. Spring, 1982.



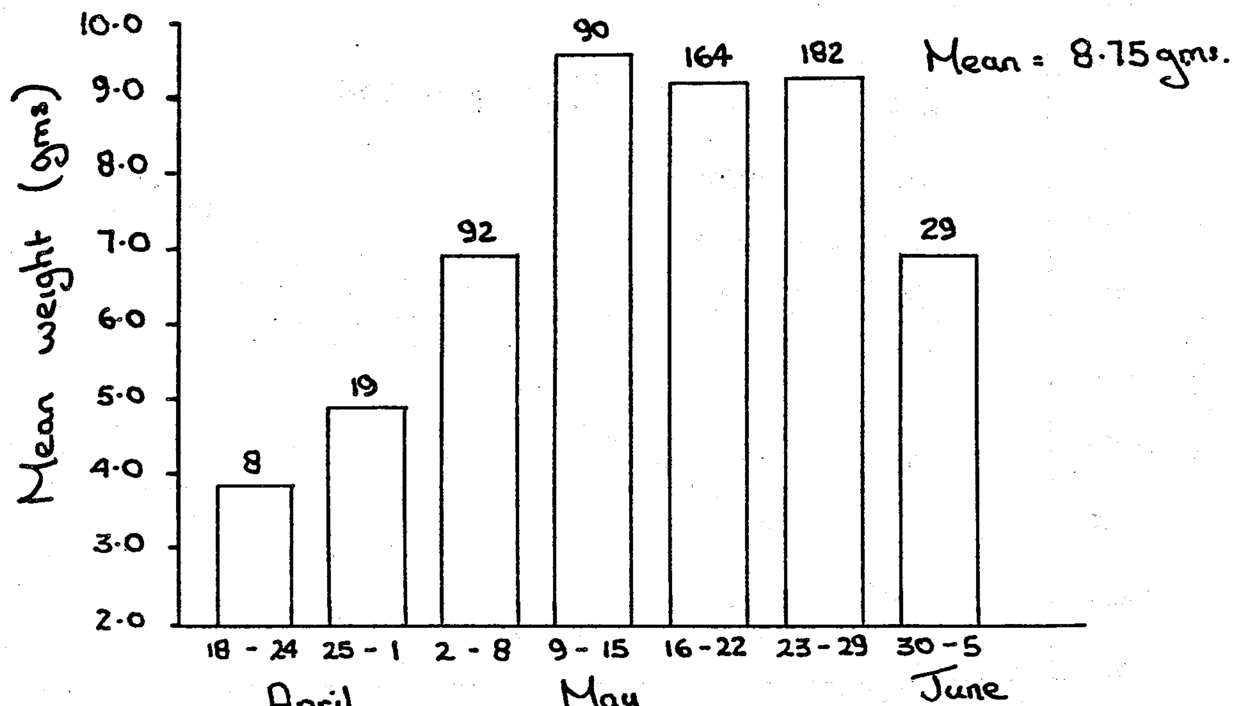
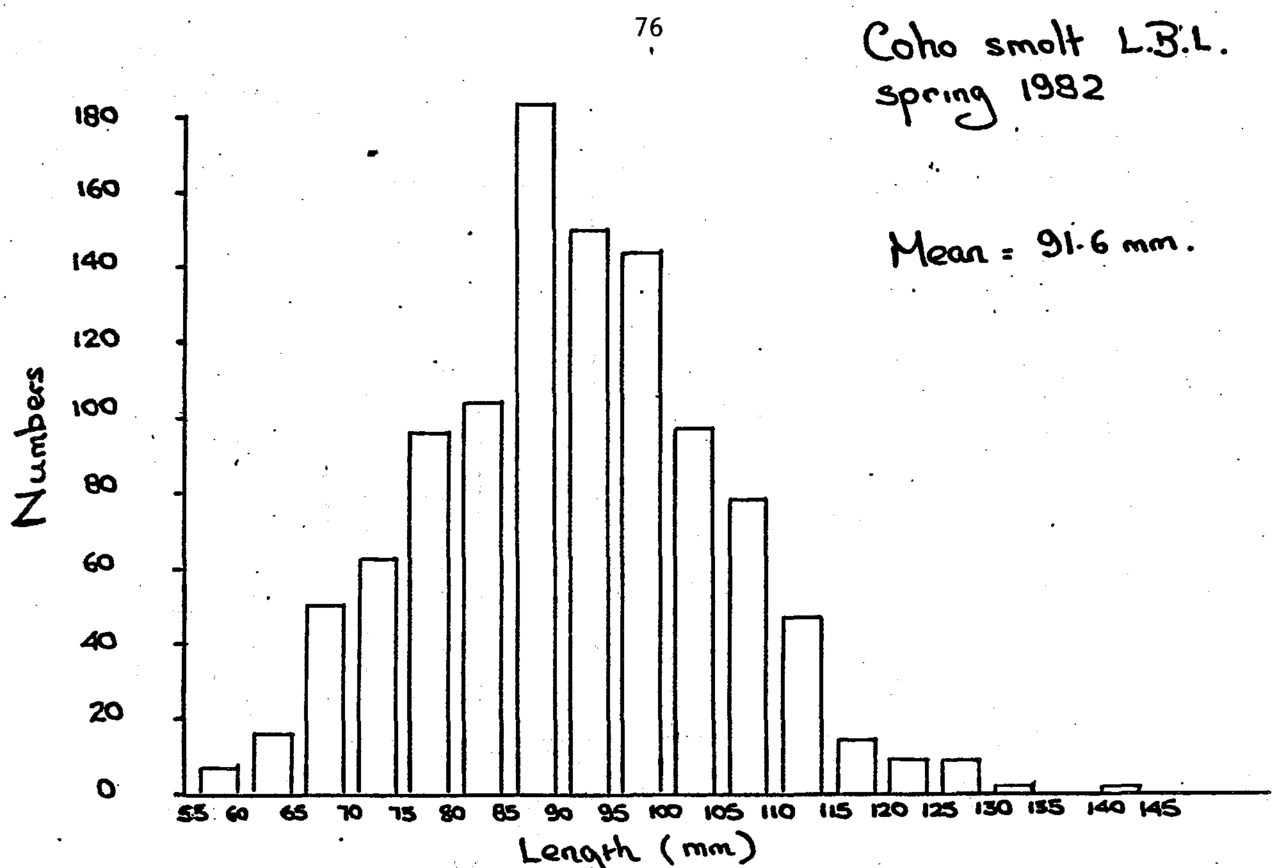


FIGURE 18b: Weekly mean fork lengths and weights for coho smolt leaving Black Lake. Spring 1982.



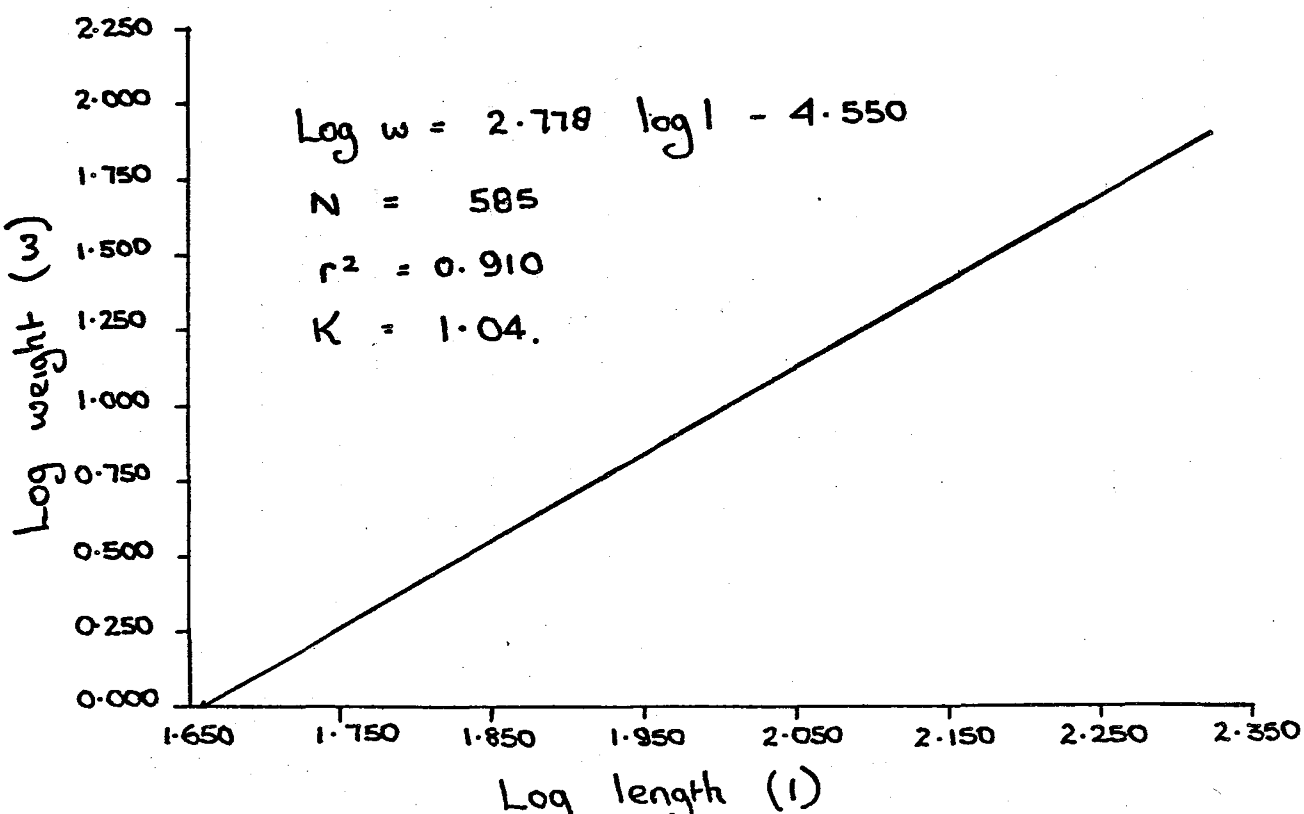


FIGURE 18c: Length frequencies of coho smolt leaving Black Lake during the period April 18 to June 12 and length - weight regression plot. Spring, 1982.

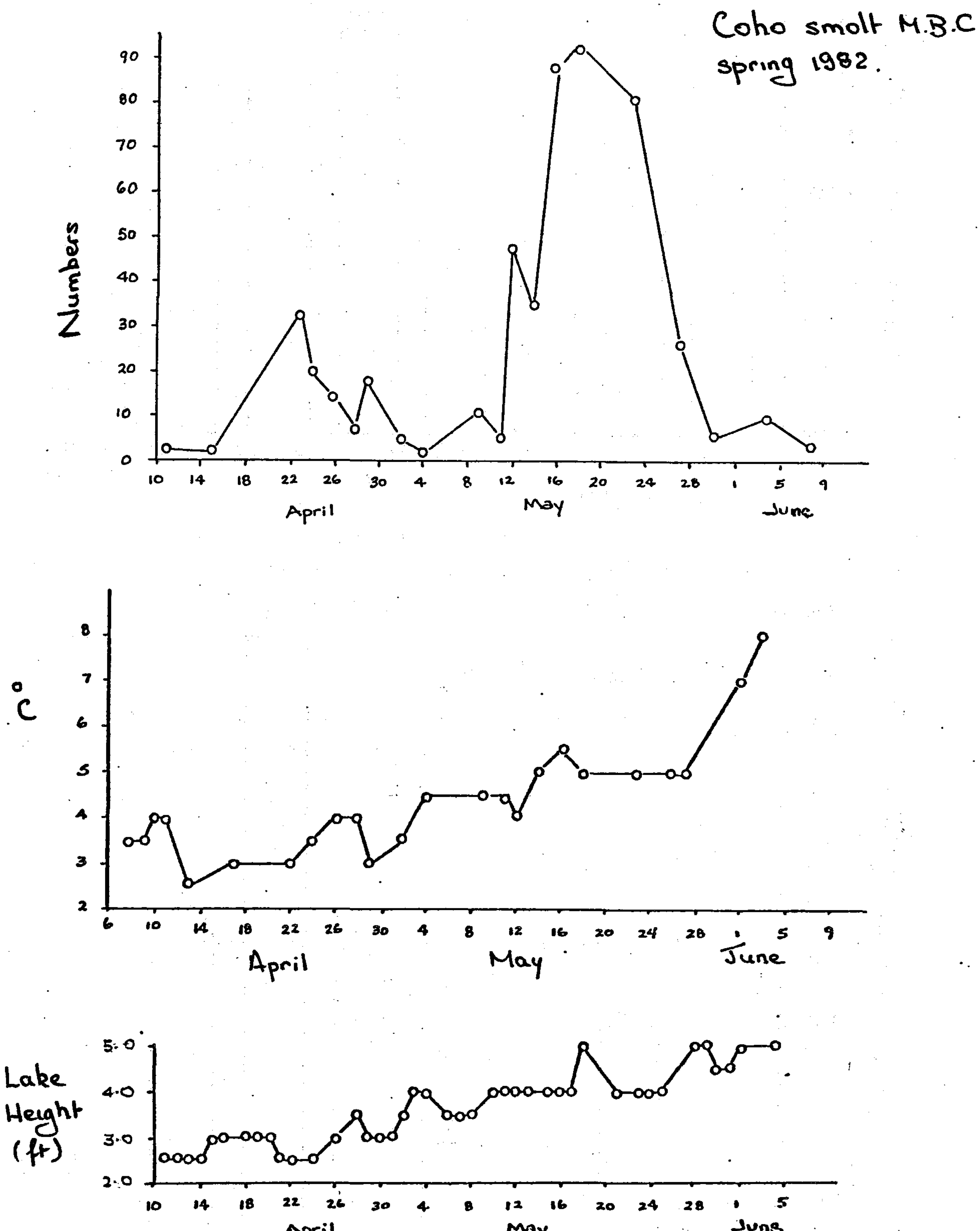


FIGURE 18d: Numbers of outmigrating coho smolt at the mouth of Black Bear Creek with associated temperature and discharge information. Spring, 1982.

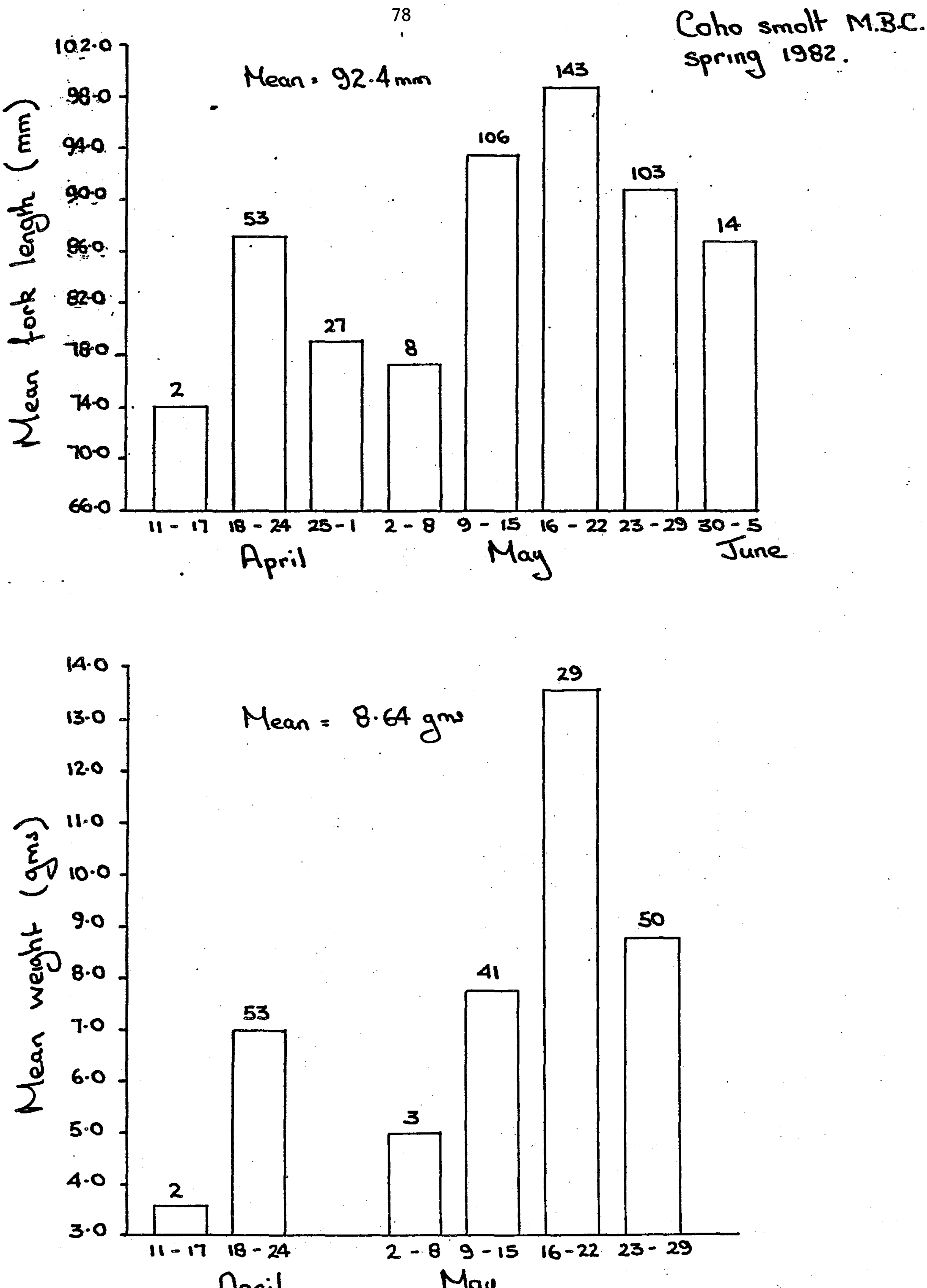


FIGURE 18 e: Weekly mean fork lengths and weights for coho smolt at the mouth of B lack Bear Creek for a period April 11 to June 5. Spring, 1982.

BLACK LAKE

An evaluation of the role of Black Lake in the Black Bear Creek system as a supporter of fish production in terms of resident trout and rearing juvenile salmonids was undertaken.

The lake is populated by cutthroat trout (Salmo clarki), Dolly Varden (Salvelinus malma) and by rearing coho (Oncorhynchus kisutch) and sockeye (Oncorhynchus nerka) salmon. Threespine sticklebacks (Gasterosteus aculeatus) are abundant.

Cutthroat trout

Large wire minnow traps baited with salmon eggs were fished throughout the lake for an eight-day period from September 7 to September 14. In 32 settings, one cutthroat (125 mm) was trapped. Rod and line fishing in August and September yielded only two fish.

Three cutthroat trout were captured in the U.B.L. fyke net migrating downstream into the lake in spring, 1982.

342 mm	365 gms	5+
340 mm	452 gms	scales mounted-all regenerated
201 mm	76.26 gms	3+

Fishermen report having taken cutthroat from the lake but the fishing was termed as 'slow'.

These observations indicate that the cutthroat population of Black Lake is low.

Dolly Varden

In the extensive mark and recapture experiment described later for coho juveniles, only two Dolly Varden were captured in eight days.

Resident rearing population of Dolly Varden appears to be extremely low.

20 to 30 Dolly Varden were known to overwinter in Black Lake this year and left the lake at the beginning of May.

Coho juveniles

A multiple mark and recapture over an eight-day period from September 7 to September 15, 1981, was undertaken using minnow traps of 1/8" and 1/4" mesh. 45 traps were placed at suitable intervals in the litoral margins of the lake each day. Fish captured were marked with a caudal fin punch and numbers of recaptured fish with marks each day were recorded.

Fish <65 mm were considered young of the year (0+) and >65 mm fingerlings (1+).

A population estimate for 0+ and 1+ coho juveniles was then made using Schumacher and Eschmeyer's (1943) estimate.

Coho 1+ = 2,628

95% confidence limits = 2,196 to 3,271

Coho 0+ = 2,394

95% confidence limits = 1,930 to 3,154

see Table 11.

These figures represent a ratio of 1+ to 0+ coho in Black Lake of 1.09.

A regression plot of length to weight is given in Figure 19a for 1+ coho. Mean length was 72.7 mm and weight 4.23 gms. The regression coefficient squared (r^2) was high = 0.97, indicating a strong correlation.

Fulton's condition factor (p), K, was calculated for the 1+ coho collected.

K = 1.115.

From minnow trap returns, young of the year were typically found in similar areas to the 1+ fish. The most productive areas of the lake were the extensive shallow litoral zones[1/] near the northeasterly end of the lake and in the s.w. corner on the southern shore near the mouth of the lake. Many of the banks on the northern shore are steep-sided with restricted litoral areas and here minnow trap returns of coho were small.

It is thought that Black Lake provides important over-wintering habitat for coho juveniles as visual observations indicated that very few fish were present in the stream system during February.

Carrying capacity of Black Lake

The potential yield of Black Lake for fish production was investigated.

Ryder (1965) considers fish production in lakes to be affected by morphometric, edaphic and climatic factors and developed a morphoedaphic index (MEI) for estimating potential productivity in north temperate lakes.

$$\text{MEI} = \frac{\text{Total Dissolved Solids (mg/l)}}{\text{Mean Depth (feet)}}$$

For Black Lake the MEI = $\frac{21}{25} = \underline{0.84}$.

Values of the MEI for 22 other lakes in Southeast Alaska are given in Table 6 . Black Lake has a higher MEI than 14 of these lakes.

However, the predictive power of the MEI depends upon constraints imposed by the range of mean depths, lake surface area, and total dissolved solids over which the indices apply. Hanson and Leggett (1982) consider the MEI performs poorly when compared with other available indices using unconstrained data. They favor an indice based on total phosphorus concentration.

Consequently, water samples were taken after the spring overturn in 1982 at 1/3 and 2/3 rds of the water column at the sampling station established in the deepest point of the lake (approximately 12 meters).

1/ See Appendix Figure A-1.

TABLE 6: **Morphoedaphic index of 22 lakes in southeast Alaska.** 1/

Lake	Specific Conductance (µmhos)	Residue Dissolved Calculated Sum (mg/l)	Surface Area (ha)	$\bar{x}$ Depth (m)	MEI*	Potential Yield** (kg/ha)
Red	93	65***	166	10.4	6.25	2.41
Finger	28	20***	347	10.7	1.87	1.32
Tammy	25	18***	134	10.0	1.80	1.30
Green	39	22	70	12.3	1.79	1.29
Klawak	39	24	1,177	17.7	1.36	1.13
Auke	28	20	46	19.0	1.05	0.99
Virginia	18	13***	258	13.0	1.00	0.97
Manzanita	60	42***	625	49.0	0.86	0.89
Salmon Bay	30	21***	388	26.7	0.79	0.86
Heckman	17	14	163	19.7	0.71	0.81
Spurt	16	14	107	22.2	0.63	0.77
Karta	26	16	508	27.6	0.58	0.74
DeBoer	13	13	51	23.0	0.58	0.72
Wilson	51	36***	468	54.0	0.67	0.69
Ella	47	33***	710	70.0	0.47	0.66
Patching	17	14	207	30.2	0.46	0.66
Blue	33	22	538	52.0	0.42	0.63
Turner	15	10***	1,270	30.0	0.33	0.55
Osprey	20	14	109	60.0	0.23	0.46
Swan	20	16	208	91.4	0.18	0.41
Lonieof	5	4***	179	55.1	0.07	0.25
Rezanof	3	2***	354	71.2	0.03	0.17

*MEI = Morphoedaphic Index = $\frac{\text{Total Dissolved Solids}}{\text{Mean Depth}}$ (Ryder 1965).

**Ryder (1965) described the equation $y \backsim 2\sqrt{x}$ where y = yield in pounds per acre and mean depth was in feet. The metric expression (Ryder et al. 1974) is therefore $y \backsim 0.966\sqrt{x}$ where yield is fish yield as kg/ha and x = MEI.

***Calculated as 0.70 x specific conductance in micromhos.

Source: Schmidt, 1979.

1/ This table was taken from: An Assessment of Environmental Effects of Construction and Operation of the Proposed Tyee Lake Hydroelectric Project Petersburg and Wrangell, Alaska, AEIDC October, 1980

The samples were analyzed for phosphorus and other nutrients that influence lake productivity (Table 7).

Conductivity was low and the lake is poorly buffered. Silica levels were above limiting values. The nitrogen to phosphorus ratio (N:P) was 85:1, which is well in excess of the 15:1 ratio considered to indicate a nitrogen limitation. Values of phosphorus are very low and is the limiting nutrient for primary and, consequently, secondary production in Black Lake. Comparative values of total phosphorus for other lakes in the region are given in Table 8 and it can be seen that Black Lake is fairly similar.

To supplement this chemical nutrient information and to obtain a further indication of lake productivity, zooplankton samples were collected in August, 1981, and in May, 1982. Vertical hauls were made from the bottom to the surface at the sampling station on Black Lake using a 153 micron mesh net with a 0.5 meter circular mouth. Two samples were taken for each collection date and preserved in 4% formaldehyde. The samples were enumerated and types identified (Table 9).

Black Lake zooplankton in August, 1981, was dominated by low numbers of the cladoceran Bosmina longirostris. No other cladocerans were evident. The copepod Cyclops sp. was found in smaller numbers with chydorids and rotifers also present. In the sample this May, rotifers were more abundant, they being frequently the first plankton to develop after the spring turnover. Numbers of Bosmina longirostris were extremely low. The mean length of Bosmina was 0.29 mm to 0.3 mm and these were some of the lowest values recorded in other Alaskan lakes (Koenings, A.D.F. & G., pers. comm.).

This information indicates heavy predation pressure by the sockeye on the zooplankton. Their preferred prey, the cladoceran Daphnia sp. may have been entirely grazed to negligible numbers. Thus, the sockeye were having to utilize the less preferential Bosmina resulting in low density and small size.

Chemical parameter	3.5 m	7 m
Conductivity (mmhos cm^{-1} at 25°C)	19	15
pH	6.05	5.80
Alkalinity (mg L^{-1} as $CaCO_3$)	3	2
Calcium (mg L^{-1})	2.3	1.6
Magnesium (mg L^{-1})	<0.5	<0.5
Total Phosphorus (µg L^{-} as P)	4.0 to 5.0	3.5
Total filtered phosphorus (µqL^{-1} as P)	4.85	3.9
Filtrate reactive phosphorus (µqL^{-1} as P)	2.3	2.6
Nitrate & nitrite (µqL^{-1} as N)	91.5	85.8
Ammonia N (µgL^{-1} as N)	11.36	1.8
Reactive Silica (µqL^{-1} as Si)	149.8	144.1
Iron Fe (µqL^{-1} as Fe)	120.3	80.85

TABLE 7: Chemical data for Black Lake at spring turnover (sampled May 15, 1982).

Lake	Eplimnion	Hypolimnion
Bakewell	3.8	2.6
Haida	3.8	5.3
Heckman	3.6	3.2
Hugh Smith	5.2	5.5
Keegan	4.6	3.9
Klawock	4.4	4.6
McDonald	2.9	4.2
Salmon	3.6	6.1

TABLE 8: Total Phosphorus (µgL^{-1}) in May for other lakes in vicinity of Black Lake (courtesy of Jeff Koenings, A.D.F. & G., Soldotna).

Date of Sample		August 5, 1981			August 15, 1981			May 4, 1982		
Zooplankton		nos/m^2 12 meter water column	nos/m^3	average size	nos/m^2 11 meter water column	nos/m^3	average size	nos/m^2 11 meter water column	nos/m^3	average size
Chydoridae		255	21		153	13		257	23	
Cladocera	*Bosmina longirostris*	39,083	3,258	0.25 mm	35,205	2,951	0.3 mm	41	4	
Copepoda	*Cyclops sp.*	433	36	0.49 mm	1,079	90		8	1	
Rotifera	*Kellicottia longispina*				1,546	141		492	45	
	Asplanchna sp.	331	28		357	30		1,595	145	

TABLE 9: Zooplankton abundance and average size in Black Lake, summer, 1981, and spring, 1982. Counts from the average of two hauls.

In contrast, the mean length of plankton from Black Bear Lake (Table 10) which was sampled in August, 1981, were Bosmina 0.44 mm and Cyclops 0.76 mm. Predation pressure was not so extensive. The zooplankton community was characterized by copepods with Diaptomus sp. being dominant. Rainbow trout will select for cladocerans and avoid the copepods.

An examination of the outmigrating sockeye smolt data gave 16,500 fish leaving Black Lake this spring. Approximately 85% of these fish were age I.

Mean length was 71.0 mm and the condition factor (K) equal to 0.82. Average length for the age I smolt was approximately 69.0 to 70.0 mm, being just above the 60-65 mm at which smoltification occurs.

The small size and low condition factor of the sockeye smolt, coupled with the zooplankton and total phosphorus data, indicate that Black Lake is at full carrying capacity with respect to sockeye fish production and possibly exceeding the maximum level it can optimally support.

This data is still in the process of being evaluated, in particular, the contribution that the spawned out carcasses of pinks, sockeye and coho make to the phosphorus levels of the lake.

Date of Sample		August 11		
Zooplankton		nos/m^2 30 m water column	nos/m^3	average size
Cladocera	Bosmina longirostris	2,694	88	0.44 mm
	Holopedium sp.	10,112	337	0.98 mm
Copepoda	Cyclops sp.	13,347	445	0.76 mm
	Diaptomus sp.	24,785	827	1.85 mm
Rotifera	Kellicottia longispina	943	31	

TABLE 10 : Zooplankton abundance and average size in Black Bear Lake, summer, 1981. Counts from the average of two hauls.

REARING JUVENILE SALMONID POPULATIONS IN THE STREAM SYSTEM ABOVE BLACK LAKE

Estimates were made of the rearing populations in four sections of the stream above Black Lake and in associated beaver ponds. Sections A, B, C, and D were approximately 300 to 350 feet long and are described under the habitat section (p. 92) and their location given on the foldout map.

Minnow traps (1/8 and 1/4" mesh) baited with boraxed salmon eggs were used to trap fish. Other possible methods of capture, for example, seine nets and electro-shocking, were thought to be unsuitable due to the large amount of fallen logs and log debris in the stream and the presence of large numbers of adult spawning salmonids.

In the stream, 40 traps were placed in each section, principally along the margins. Fish captured were marked with a hole in the caudal fin. Traps were set in the same location the following day and the ratio of marked fish to unmarked fish recorded. Population estimates were then made using Chapman's (1951) modification of the Petersen formula.

A multiple mark and recapture technique as employed in the lake (p. 79) was used in the two major sets of beaver ponds and estimates made from the method of Schumacher and Eschmeyer.

Table 11 summarizes the estimates obtained. Coho were divided into young of the year (0+) and fingerlings (1+) according to fork length. This varied with relation to the date of sampling. In the middle of August, the dividing length used was 55 mm and this was increased to 65 mm by the middle of September.

Length weight regressions were plotted for 1+ coho for these two locations (Figures 19b&c) and Fulton's condition factor K calculated (Table 11).

This data will be evaluated in conjunction with the habitat survey (p. 92).

			COHO (0+)			COHO (1+)				Coho 1+ to Coho 0+ Ratio	Dolly Varden	
Location	Date of Sample	Method of Estimate	Fork Length	Popn Estimate	95% Confidence Intervals	Fork Length	Popn Estimate	95% Confidence Intervals	Condition Factor (K)		Popn Estimate	95% Confidence Intervals
Black Lake	9/7 to 9/15	Schumacher & Eschmeyer	<65mm	2,394	1,930 to 3,154	>65mm	2,628	2,196 to 3,271	1.12	1.09	low	
Section A (approx. 350 ft)	9/3 to 9/4	Petersen	<60mm	1,962	1,780 to 2,165	>60mm	372	240 to 341	1.13	0.18		
Section B (approx. 350 ft)	8/8 to 8/9	Petersen	Percentage of marked fish recaptured too low to give an accurate estimate.									
Section C (approx. 325 ft)	8/29 to 8/30	Petersen				>60mm	213	119 to 434				
Section D (approx. 250 ft)	9/1	Petersen	Juvenile fish of very low density - insufficient to complete mark and recapture experiment.									
Beaver Ponds south side near mouth of creek	8/15 to 8/19	Schumacher & Eschmeyer	<55mm	588	471 to 787	>55mm	504	440 to 593	1.15	0.86	50	46 to 55
Beaver Ponds on lake fork	8/30 to 9/1	Schumacher & Eschmeyer	<60mm	777	541 to 1,319	>60mm	442	344 to 615		0.57	82	74 to 92

TABLE 11: Population estimates of resident rearing juvenile salmonids in Black Lake and stream system above the lake.

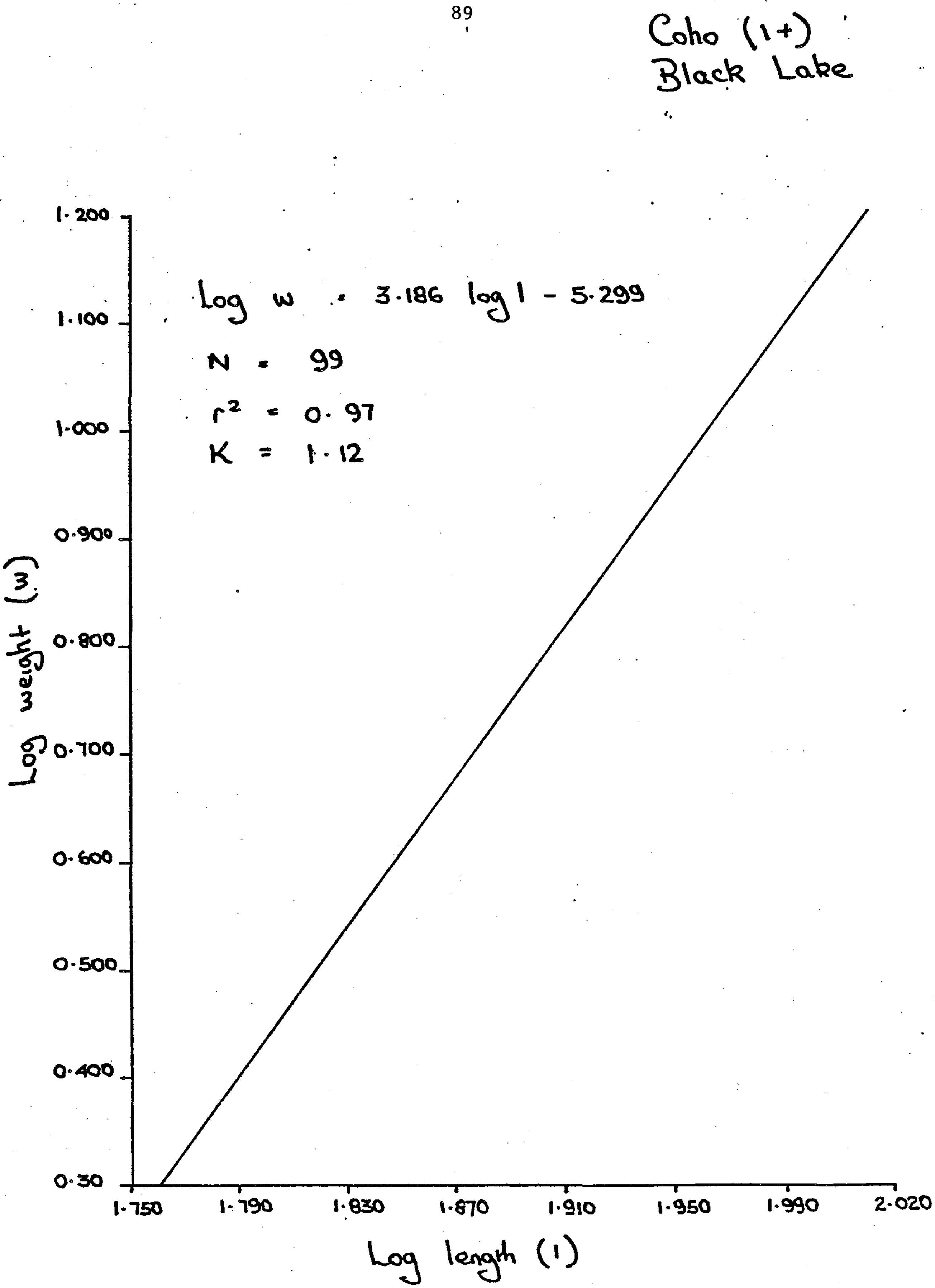


FIGURE 19a: Length and weight regression plot for 1+ coho in Black Lake, Spetember 1981. K = Fulton's condition factor.

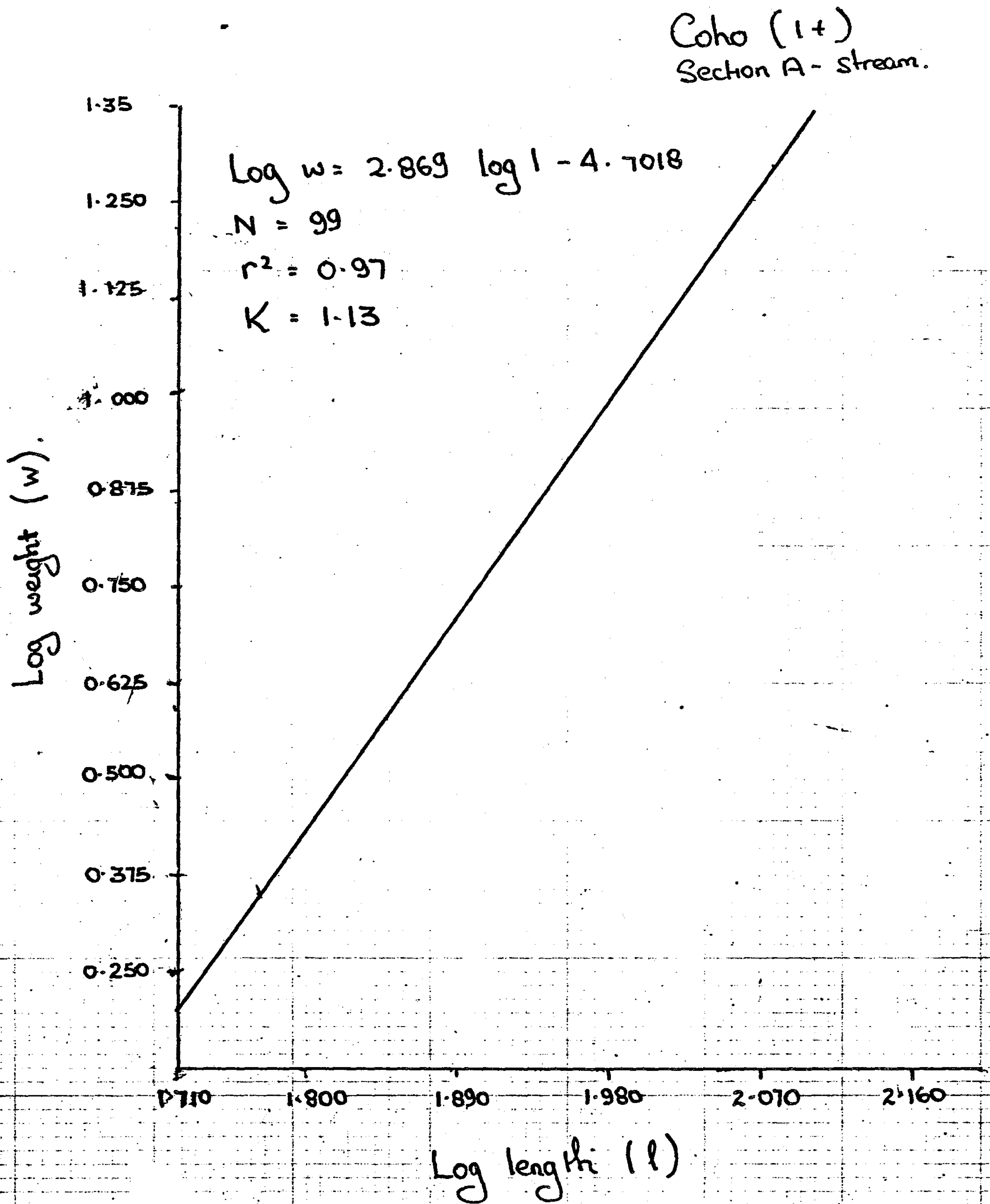


FIGURE 19b: Length - weight regression plot for I+ coho from Section A in zone I of the mainstream above Black Lake, September 1981.

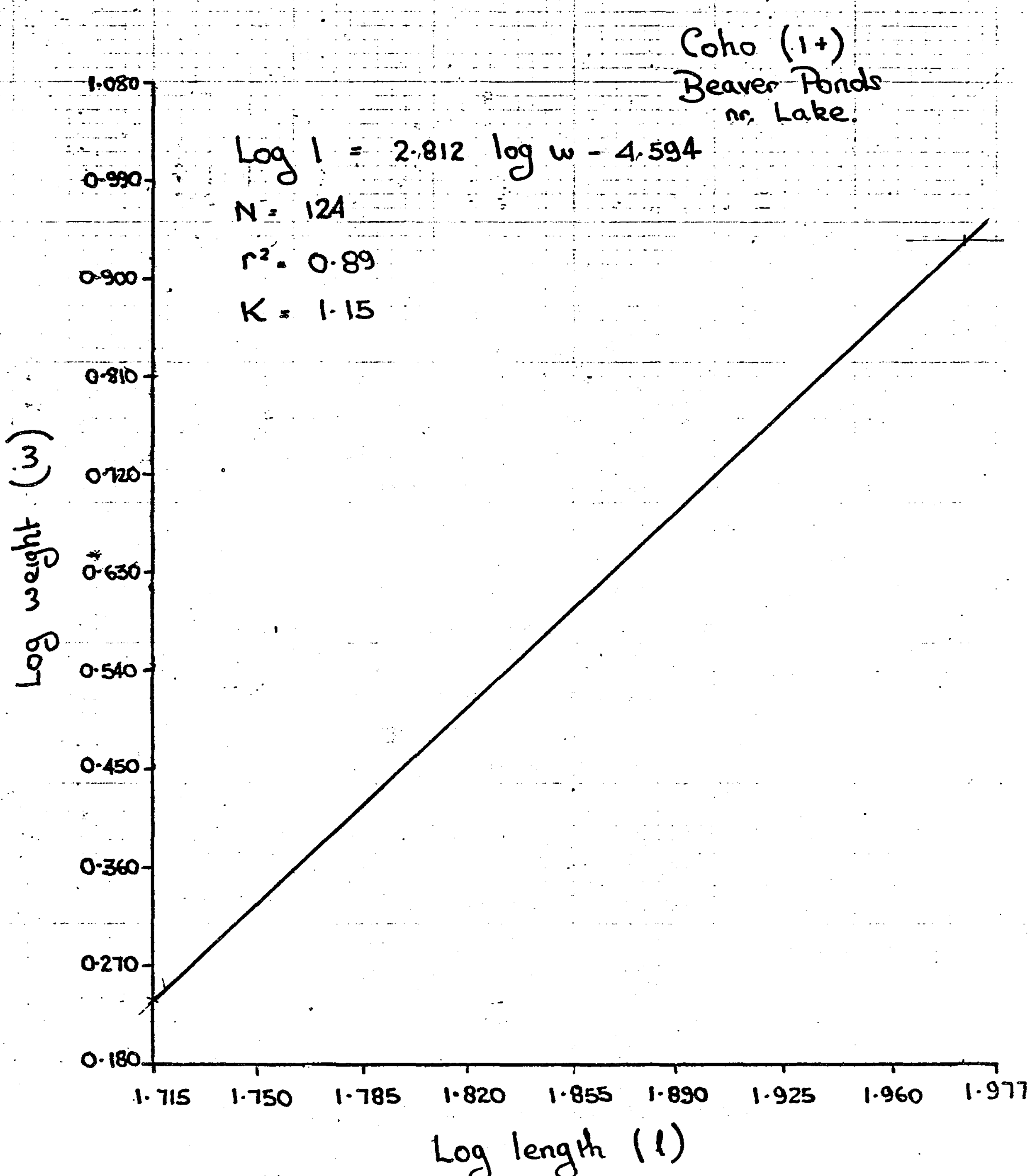


FIGURE 19c: Length - weight regression plot for 1+ coho from beaver pond near stream entrance to lake. August 1981.

HABITAT STUDIES ABOVE BLACK LAKE

To evaluate and characterize the use of the Black Bear system above Black Lake by rearing and spawning salmonids and to examine the effects of regulated flow regimes, an extensive survey of stream habitats was undertaken.

A scale map (1 inch to 50 feet) was made of the stream channel, displaying gradient, side channels, beaver dams and associated beaver ponds. This map was then used to identify principal spawning areas from escapement observations, major rearing areas for resident juvenile fish, undercut banks, streambank vegetation, streambed substrate characteristics, fallen logs and log debris and streamflow regime types. The map produced is in the back of the report.

From this initial survey, we considered that the Black Bear System could be divided on a habitat basis into four distinct zones, I to IV.

ZONE I From the entrance of Black Bear Creek into Black Lake to the junction of the west branch of the south tributary with the main channel.

ZONE II From the west branch of the south tributary to where the gradient of the main stream channel from Black Lake starts to markedly increase.

ZONE III From the above point to the base of the falls from Black Bear Lk.

ZONE IV The beaver ponds.

To further characterize zones I and II, two representative sections of approximately 300 to 350 feet were mapped in detail in each zone --

sections A and B in zone I and C and D in zone II (Figures 20a to d). A scale of 1 inch to 50 feet was used and the characteristics recorded are given in the key (Figure 20e). The location of these sections are given on the foldout map. Plates 3 to 6 are taken from the bottom of each section looking upstream.

To examine the effects of regulated streamflow on the habitat, 27 cross sections were surveyed. In each of the four sections, A to D, five cross sectional transects were made together with a further seven at locations where habitat effects may occur. Depths were recorded at one-foot intervals across the channel. The left bank was viewed in an upstream direction. Average substrate size was measured every foot and the compactness and shape of spawning gravel was estimated. The cross sections are shown later in the report in relation to the discussion of pre and post-project flows and their location on the map.

Zone I

Immediately above Black Lake begins about 3,000 feet of streambed with sustained, slow-moving water in a channel that is principally between 50 to 75 feet wide. This zone of the stream encompasses sections A and B. The gradient is negligible -- approximately .04%. A series of beaver dams along this area of stream enhance the slow-flowing, ponded condition of the stream. The streambed is predominantly made up of sands and silts, occasionally over-lain by fine organic matter. Log debris and numerous logs are present on the streambed (see Figures 20a & b) which occasionally have some sparse filamentous algae attached. Some cobbles are present as exemplified in the upper part of section B but this is rare.

The flow regime can be termed as a "flat", being typically slow-flowing, estimated at 0.2 to 0.3 feet/sec. Pools range from 6-8 feet deep even at low water. Numerous indentations occur in the banks and there are a number of side channels which are principally attributable to beaver runs. These are frequently overhung by riparian vegetation.

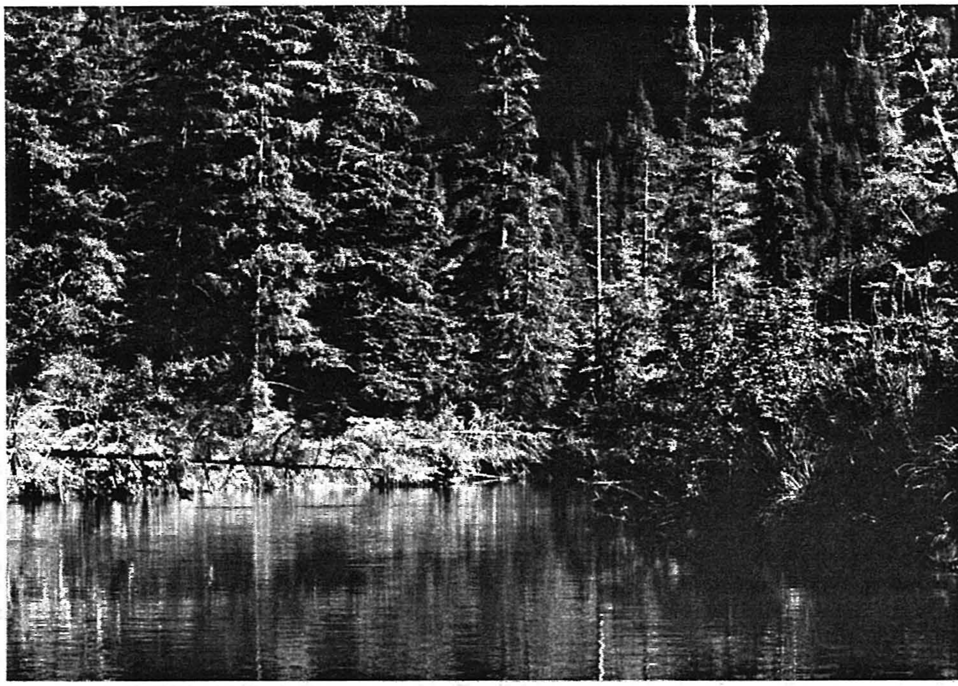


Plate 3: Section A

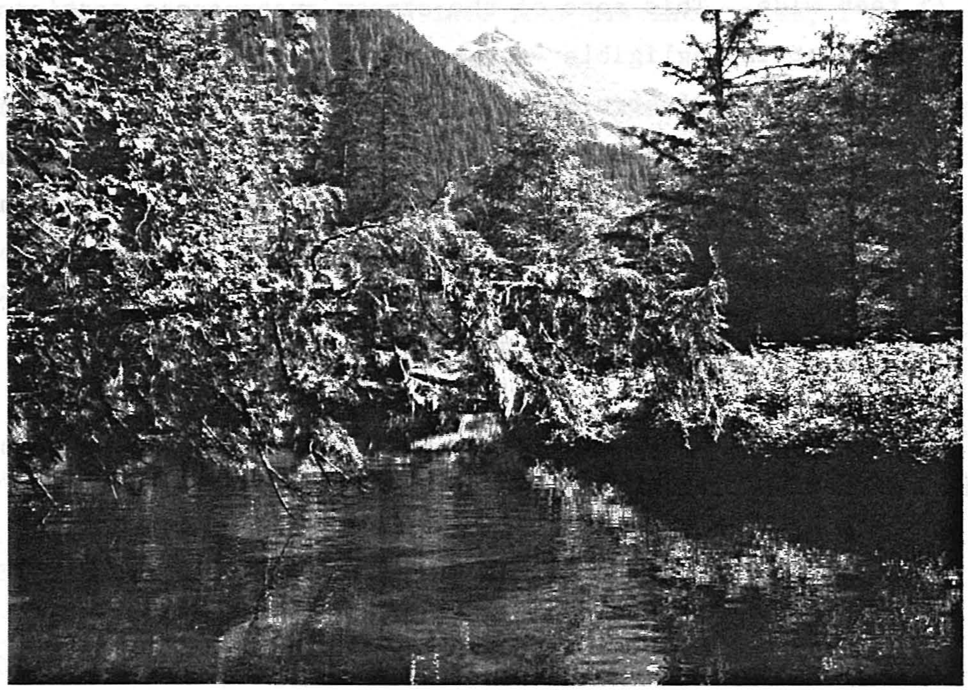


Plate 4: Section B

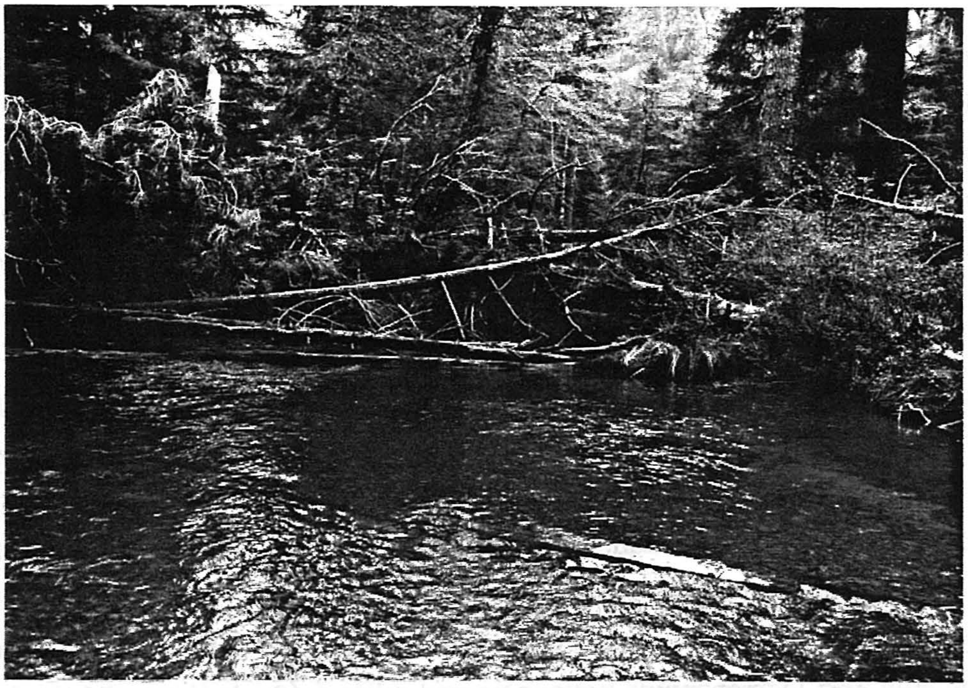


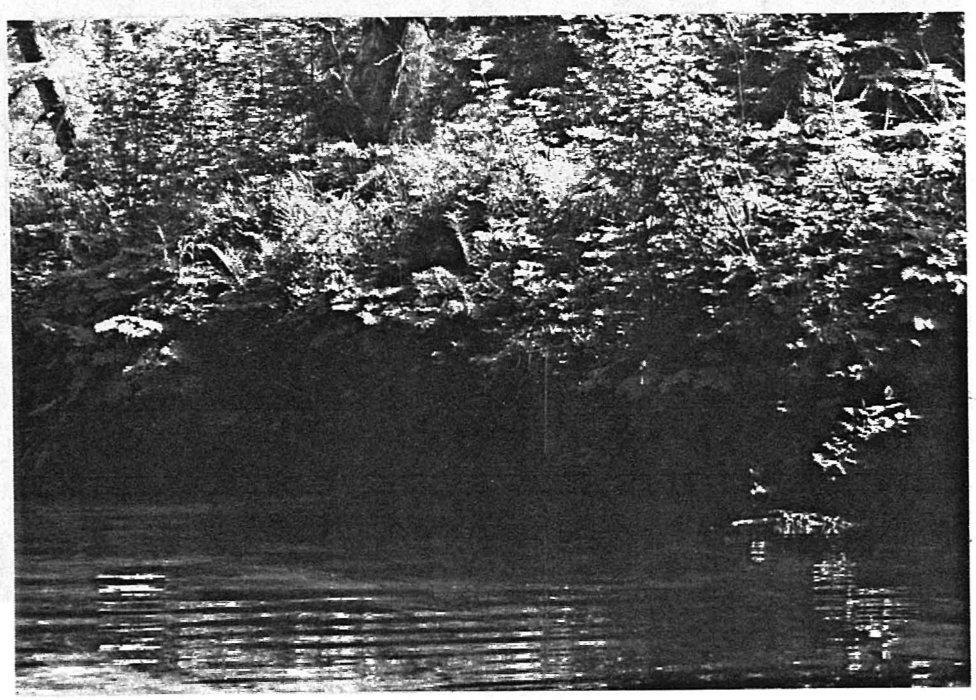
Plate 5: Section C

Plate 6: Section D

As illustrated by cross sections in Figures 34 to 41, the banks on both sides are typically vertical, reaching 4 to 8 feet above the streambed. The banks are usually stable, although some erosion and collapse was noted on the south side. Banks are frequently undercut, typically 1 to 1½ feet, this being more characteristic of the south bank.

The riparian vegetation is extensive on both banks. Sedges, ferns and grasses frequently overhang the water's edge and Hellebore (Veratrum viride) and skunk cabbage (Lysichitum americanum) are prevalent. Taller vegetation is principally made up of Devil's club (Oplopanax horridus), salmonberry (Rubus spectablis), high bushcranberry (Viburnum edule), deerberry (Maiantheum dilatatum). . Other plants on the banks in less abundance are twistedstalk (Streptopus roseus), red elder (Sambucus callicarpa) and Sanguisorba stipulata. The vegetation is in many stretches overhanging the stream bank, sometimes to 6 feet or more and this is mapped in Figures 20a and b and illustrated in Plate 7. More overhanging vegetation occurs on the south bank.

Plate 7

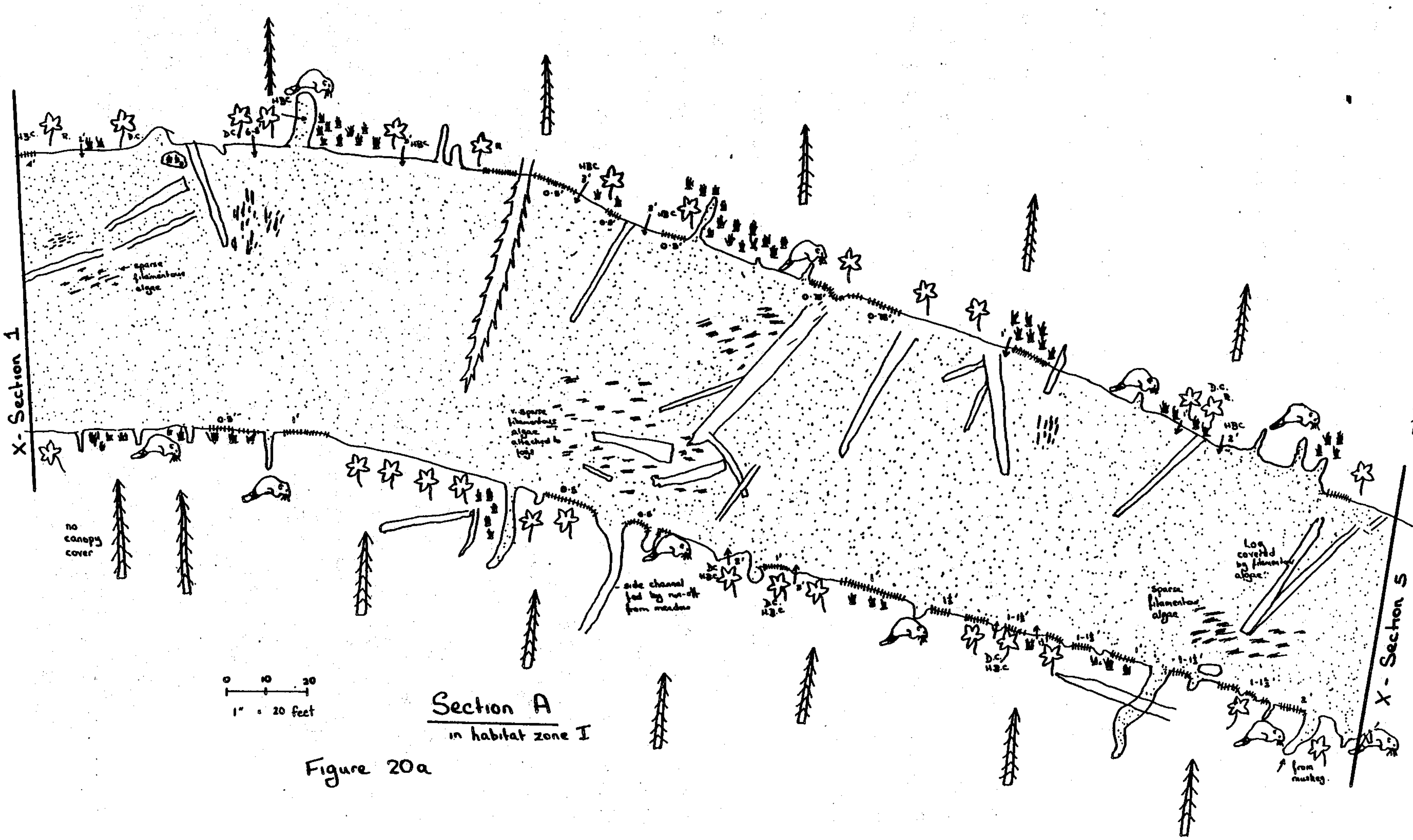


Old growth Sitka spruce (Picea sichensis) and western hemlock (Tsuga heteropylla) dominate the nearby terrain with some alder (Alnus rubra). These stands are fairly open and provide a negligible amount of canopy cover to the stream. Blow down trees are common and their branches provide further areas of instream cover.

No spawning by salmonids was observed in this area due to the unsuitable substrate and flow conditions. Mark and recapture experiments described earlier indicate the importance of this area for rearing coho. 372 (240 to 431 95% confidence intervals) was the population estimate of I+coho for section A in early September, 1981, giving an estimated value of 3,100 (1,978 to 3,552 95% confidence intervals) for the length of zone I. Coho in their second year provide perhaps the most useful index of the state of the juvenile population since mortalities among fry can be as high as 90%.

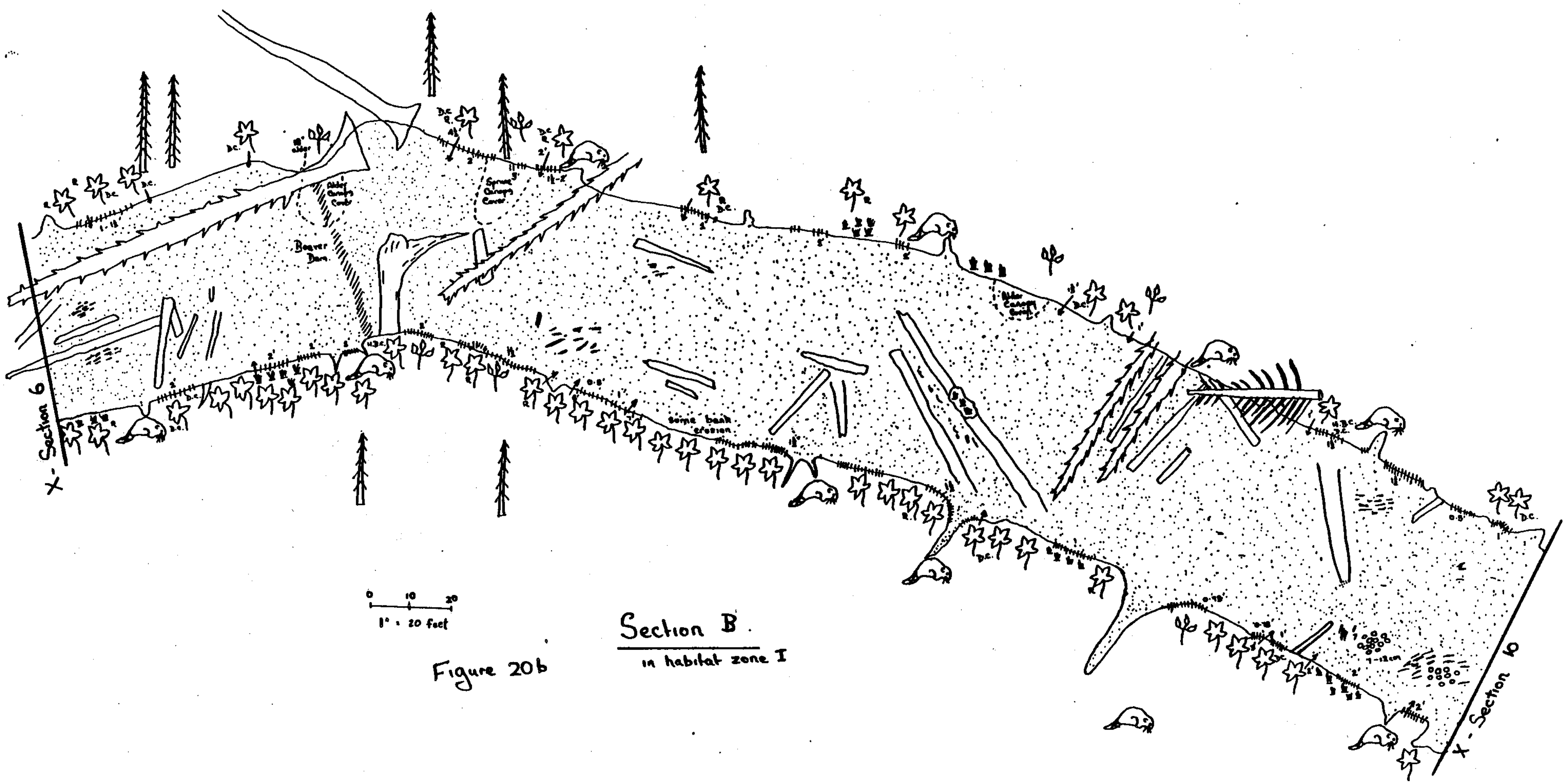
Results from the minnow trapping and visual observations indicate that juvenile coho are predominantly distributed along the margins of the streams, selecting the cover of the overhanging vegetation, the undercut banks and logs and branches of fallen trees. Minnow traps placed in central areas of the stream typically had poor returns. The indentations and beaver runs were also favored by immature coho, particularly fry. These areas are probably of importance at higher stages of the main channel as the current velocity in them is negligible. At lower stages, these retreats are not so critical due to the slow flowing nature of the main channel. However, at low August flows, it was observed that the height of the main channel did not maintain water in a large number of these side channels and their role as habitat was lost. Additionally, low summer flows resulted in some loss of cover in terms of overhanging vegetation and the undercut banks.

Only a very few Dolly Varden were recorded in this section of the stream but the threespined stickleback was abundant. No other species were trapped.



Section A
in habitat zone I

Figure 20a



Section B
in habitat zone I

Figure 20b

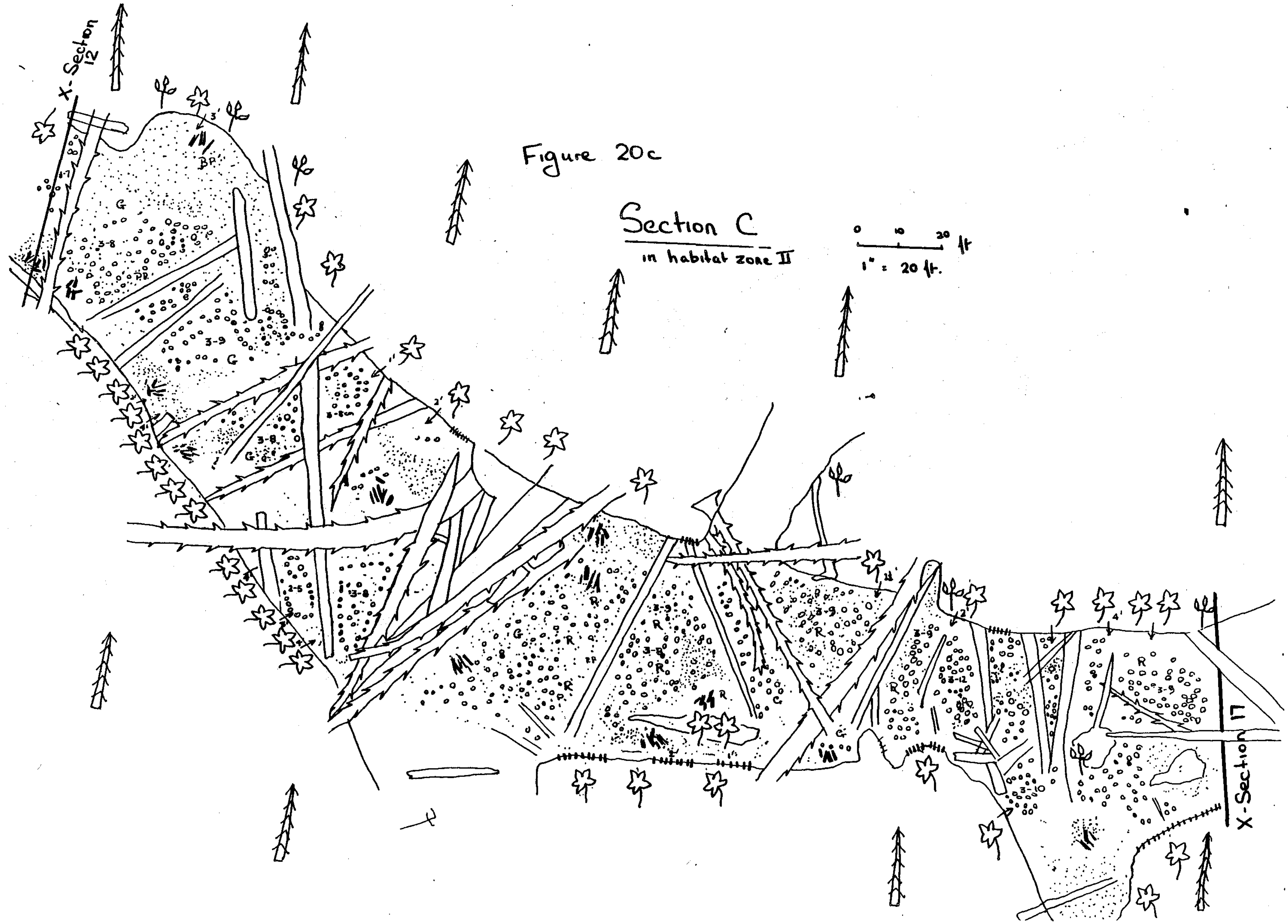


Figure 20c

Section C

in habitat zone II

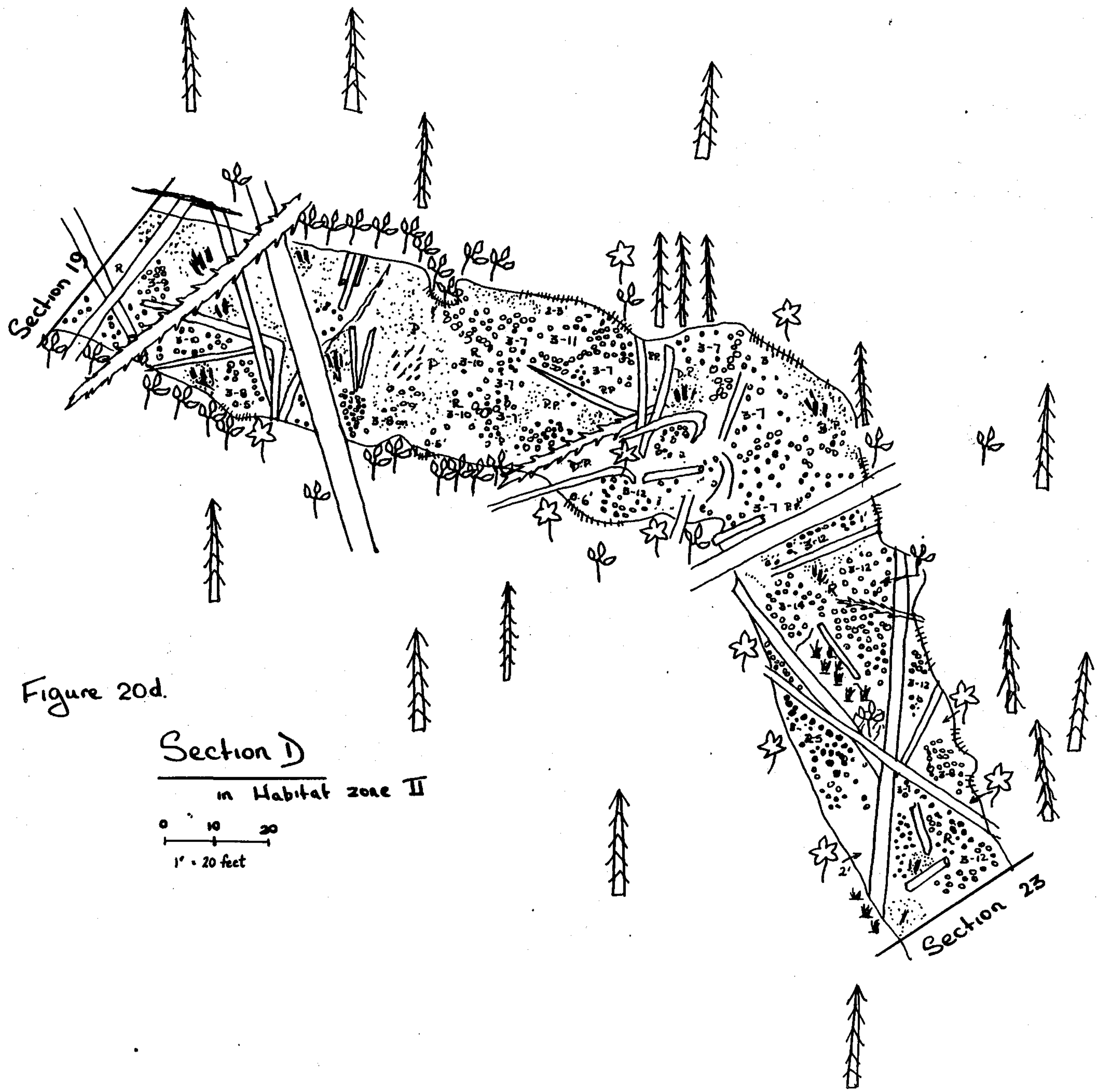
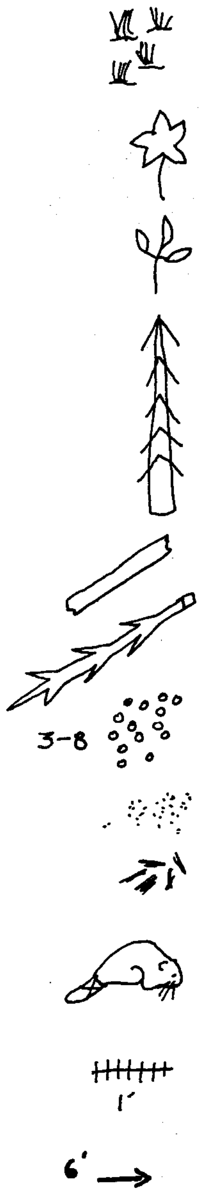


Figure 20d.

Section D

in Habitat zone II

Key to Habitat mapping.



Sedges and Grasses

Riparian Vegetation made up principally of Devil's Club, High Bush Cranberry, Elderberry and Salmonberry

Alder.

Old growth Spruce and Hemlock

Log in stream

Aerial Log

Coarse gravel and cobble with predominant size.

Sand and silt

Log debris on stream bed.

Activity associated with beaver

Undercut Bank - one foot

Extent of overhanging vegetation.

F. Flat - deeper slower flowing areas over fine substrate.

R = Riffles - normally shallow water with broken surface

G = Glides - even flow with no broken surface, usually after riffles.

S.C.P - Secondary channel pools

B.P - Backwater pools

P.P = Plunge pools

DP = Damned pools.

. Moss covered stones.

Figure 20e. Key to habitat mapping of Sections A, B, C and D.

Zone II

From the junction of the west branch of the south tributary up to where the gradient starts to markedly rise constitutes zone II. This includes the two major forks of the Black Bear system -- the lake fork and the spring fork.

Two Sections, C and D, were extensively mapped in this zone (Figures 20c and d). Section C is in the lower part and section D in the upper part of the spring fork. The total length of zone II is some 1,000 feet and channel width is variable.

For the first 300 feet to the primary forks and the separation of the south tributary from the Black Bear Lake system, the substrate is a mixture of fine sand and silt together with coarse gravel and small cobble averaging 3 to 8 cm, which is uniformly iron-stained. Numerous fallen logs are present on the streambed and overhanging the stream. Banks are stable, vertical and with little undercutting. Width is typically between 35 to 50 feet. Gradient is nearly 1%.

Above the junction with the south tributary extends some 700 feet of streambed in two forks, the lake fork and the spring fork. Channel width is between 25 and 30 feet in each fork, except where the channel divides and it may be considerably narrower. Logs and fallen trees provide significant hydraulic controls. The gradient is higher toward the upper end of the zone, reaching 2% in section D.

The substrate is predominantly coarse gravel and small cobble from 3 to 12 cm. The streambed material tends to be larger toward the upper sections of this zone, with less fine sand and silt. The gravels and cobble are typically angular, compact and embedded at a maximum of 25% in finer material. No iron staining is present in the lake fork but was observed in the spring fork.

"Riffles" and "glides" dominate this zone, which at times is subject to large fluctuation in flow, particularly in the lake fork. The spring fork tends to be more uniform. Numerous plunge pools exist created by logs on the streambed and a number of dammed pools are present behind logs. These are most evident in the lake fork below the beaver dam, where the stream flow is moderated. Backwater pools are present behind root wads and in larger indentations in the main channel. Two examples can be seen in the lower and upper parts of section C, but these areas of slow-moving water are restricted. Pools within secondary channels are found in the upper sections of the lake fork at low summer flows.

Banks are typically stable, rising vertically 2 to 3 feet above the stream bottom, although some gradual bars of gravel and shallow sloping grass banks are present.

The riparian vegetation is less dense than in zone I but the species are similar. It is frequently overhanging. A few stands of alder are present in close proximity to the stream, providing some canopy cover as do closely bordering old growth hemlock and Sitka spruce. Undercut banks are present but not to the same extent as in zone I and are principally located in the spring fork.

A negligible amount of filamentous algal growth occurs in this zone. Near the upwellings that feed the spring fork and part of the lake fork, moss covered cobble was present indicating the stability and uniformity of these flows.

Plate 8

This zone is the principal area of salmonid spawning, together with some 700 feet of channel in the south tributary which was not surveyed. The distribution of species has been previously discussed in the escapement survey.

The spawning gravels immediately above the fork were first selected by the early spawners possibly because of their smaller more uniform nature and potentially higher quality (Plate 9).

Plate 9

Later in the run the spawners became widely distributed throughout the zone. The beaver dam on the lake fork provided an impassable barrier for sockeye, but at higher flows in September, pinks were able to migrate over it and spawn in this section of stream. Spawning gravels in this area are of lower quality in that the substrate is larger than in the spring fork, being made up principally of small cobble (6.5 to 13 cm) with some material up to 25 cm. Flows are more variable and certain areas are liable to drying up at low flows.

Spawnings density were high in 1981 and it was observed that superimposition of redds occurred, notably in the case of pinks overdepositing on sockeye. This was particularly true in the lower areas of the spring fork.

Rearing populations of juvenile salmonids in this zone are low. Results from extensive minnow trapping in sections C and D and in other areas support the mapping survey that suitable habitat for rearing is limited. The most productive areas were the backwater pools, particularly below the beaver dam in the lake fork and in certain areas of section C. The flow through the dammed pools was in many instances too swift for rearing fish, as was the case with the main channel even where undercut banks and overhanging vegetation provided cover. Small numbers of coho fry were visually observed in the pools liable to dessication in the main channel of the lake fork at the low August flows.

Zone III

Beyond the channel on the lake fork that is illustrated on the map is an intermittently flowing channel originating below the falls from Black Bear Lake. The gradient is steep (approximately 5-10%) and the substrate is typically large, composed of large cobble (13.0 to 25 cm) and boulder (greater than 25 cm). Many fallen logs and trees cross the streambed. The flow regime is variable, and when it is continuous cascade type riffles dominate. Here the water flows in a series of steps with many small pools behind rocks and below small waterfalls. During periods of receding flow the stream loses its flow into the bed and will become intermittent and then dry if lower flow conditions persist. (Plate 10)

The banks are variable due to the extreme fluctuation in flow and frequently difficult to define. Bordering vegetation is similar to zone II.

No spawning and very little rearing occur in this zone.

Plate 10

Zone IV

Beaver pond habitat makes up zone IV. Two principal areas occur. The first is near the mouth of the creek on the south shore where the beaver have ponded run-off water that enters the main channel by a series of small dams (Plate 11).

Plate 11

The area is made up of a series of ponds connected by narrow channels (Figure 21).

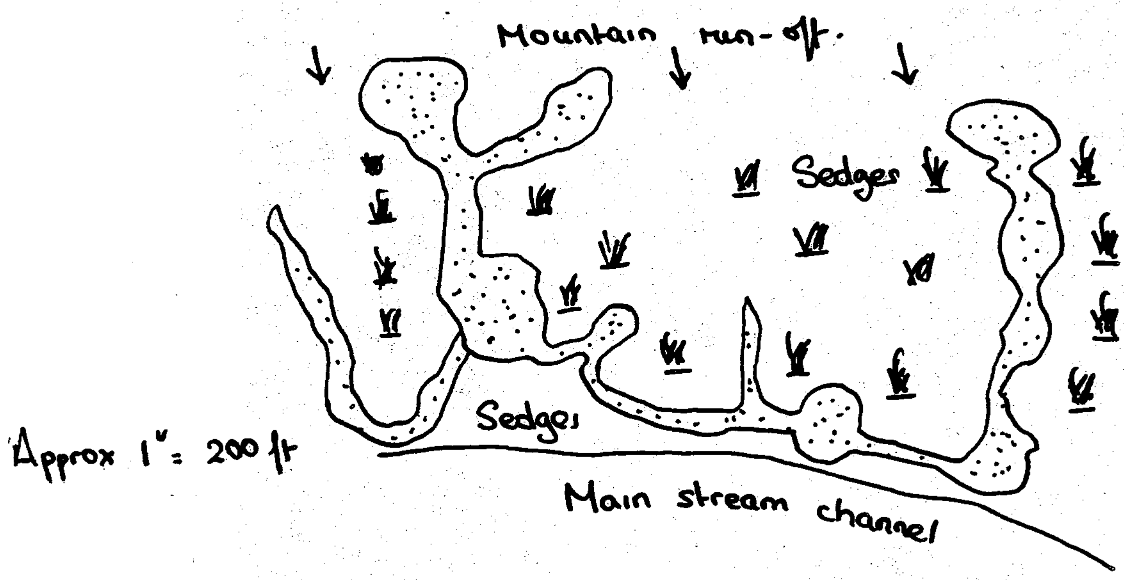


Figure 21

Mid-August temperatures were 10°C and pH between 6.15 to 6.3. Depth which is fairly constant varies between 2 feet to 5 feet. The area is dominated by sedges and some grasses which frequently overhang the channels. Skunk cabbage is also abundant.

The second set of major ponds is on the lake fork created by two principal dams. A number of fallen logs are present and grasses, sedges and alder are the bordering vegetation. In the long backwater to the side of these ponds the alder provides significant canopy cover.

Significant populations of rearing juvenile salmonids were found in these ponds (Table 11). An estimate of 504 (95% confidence intervals 440 to 593) for 1+ coho juveniles was obtained for the beaver ponds near the mouth of the creek. A condition factor of 1.15 was slightly higher than section A in zone I of the main channel (1.13) and Black Lake (1.12). There was a high ratio of 1+ coho to fry (0+) in these ponds -- 0.86 compared with the stream (zone I), which recorded a ratio of 0.18. This is presumably a function of access to these ponds only being at extremely high flows and thus many fish may move into these ponds only with the fall storms. These ponds may provide important overwintering habitat. The beaver ponds on the lake fork had a ratio of 1+ coho to 0+ of 0.57, probably as a result of the easier access for young of the year. 442 1+ coho (95% confidence intervals 344 to 615) were estimated. Hence, a total estimate of 946 for 1+ coho (95% confidence intervals 784 to 1,265) for the major areas of beaver ponds was obtained. This contrasts with an estimate of 3,100 (95% confidence intervals 1,978 to 3,552) for zone I, the principal rearing area of the stream, indicating the significant percentage that the beaver ponds contribute to coho rearing habitat -- above Black Lake -- an estimated 15-20% taking into account the limited amount that occurs in zone II.

The beaver ponds also support the principal Dolly Varden (Salvelinus malma) rearing populations, although numbers are low. Dolly Varden were not found in significant numbers in any other zones of the stream or in Black Lake. The threespined stickleback (Gasterosteus aculeatus) was present in large number in the beaver ponds.

Extensive minnow trapping throughout the system did not produce any cutthroat (Salmo clarki) or steelhead (Salmo gairdneri).

SUMMARY

The Black Bear Creek system is used by chum, coho, pink and sockeye salmon and cutthroat, Dolly Varden and steelhead trout.

All four species of salmon spawn in the stream above Black Lake. The principal spawning areas are the south fork & in the Black Bear Creek system from the junction of the west branch of the south fork to where the gradient starts to markedly rise in the main channel (Zone II).

In 1981, the peak of the sockeye run was late August. 700 sockeye were estimated to have spawned in the Black Bear Creek system, 575 in the south fork. No sockeye spawned above the beaver dam on the lake fork of the Black Bear system.

With a fairly large run of pink salmon in 1981 estimated at 26,600 into the system, some 4,400 fish moved through Black Lake and spawned above it. An estimated 2,400 spawned in the south fork and 2,000 in the Black Bear system of which all channels were used, including the lake fork above the beaver dams. In this fork, fish spawned in channels that are dry at low flows. Pink salmon superimposed on redds previously used by sockeye, with their peak of spawning being in the middle of September.

A small number of chum spawned near the upwelling in the spring fork. From outmigration studies of fry, it is evident that some chum also spawn below Black Lake.

Coho counts in October, 1981, located 42 fish above Black Lake. Analyzing fry estimates for 1981 above and in Black Lake and with a rough extrapolation using estimated fecundity and mortality, a figure of 85 to 100 coho spawned in 1980. It is likely that a similar number spawned in 1981 above Black Lake.

Dolly Varden trout are known to spawn in this section of stream, although numbers of rearing fish are small. Steelhead trout did not spawn above Black Lake in 1982.

From outmigration studies in the spring of 1982, the emigration of pink and chum fry were later than in 1981 due to the colder winter.

Pink fry migration through Black Lake resulted in large mortalities which were estimated to be in the region of 50%. Some fry remained in the lake for a short period, possibly due to the presence of lake ice. The peak of the outmigration through the lake was related to a high lake discharge and the ice leaving the lake.

Assuming a 50:50 ratio of females to males and a 1,800 to 2,000 egg fecundity rate, it is calculated from the estimated 440,000 to 460,000 pink fry that entered Black Lake and the 4,400 adults that spawned above Black Lake in 1981 that the egg to fry survival rate was 10.8%.

Similarly for sockeye, assuming a 4,000 to 5,000 fecundity rate and a 50:50 ratio of females to males, the egg to fry survival rate was 0.7%. This is extremely low and is possibly attributable to large number of fry moving into the lake before the net was set on April 10. However, the heavy mortality could have been a result of the superimposition of sockeye redds by the high density of overspawning pink salmon. Rounsefell (1958) reported a similar situation in the Karluk River system, Alaska.

The sockeye smolt emigration from Black Lake in spring, 1982, was estimated at 16,587. Approximately 85% were age I. Assuming a typical 1% survival rate from egg to smolt, if no large mortality of eggs occurred would give an escapement figure in 1980, using a 4,000 to 5,000 fecundity rate, of 313 females or 626 total. Although this figure is below the number of adults observed in 1981, it indicates that there was no abnormal mortality at the egg to fry stage as may have occurred this year. In 1980, the pink escapement was only 4,503 and thus it is probably that all the fish spawned below the lake due to low spawning density. Thus overspawning upon the sockeye redds is unlikely to have occurred.

If the egg to fry survival rate was as low as 0.7%, then the anticipated sockeye smolt outmigration in 1983 will be considerably lower than this year. The peak of the outmigration in 1982 was when the temperature reached 7.0°C.

Figure 9b gives information on the number of temperature units for egg to fry emergence for pink and sockeye from spawning gravels above Black Lake using peak of spawning and peak of fry outmigration dates. The result for sockeye was calculated assuming that no substantial number of fry entered the lake before April and, thus, this figure should be considered possibly inaccurate.

Temperature Units	Sockeye - 1,240
egg to fry emergence	Pink - 1,048

Outmigration studies showed that pink fry emerged earlier from spawning gravels above Black Lake than below it. A comparison of the thermograph records (Figure 9b) show a greater accumulation of temperature units during the winter at S.G.S. (spawning gravels, spring fork) than at L.B.L. and U.B.L. This is a result of the higher temperature regime of the spring flows.

The major areas of coho rearing above Black Lake are the slow-flowing stream section below the forks (Zone I) and the beaver ponds. The beaver ponds make up a significant percentage of the rearing habitat and had a higher ratio of 1+ coho to fry (0+) than the stream. The beaver ponds are important for Dolly Varden juveniles and also as overwintering habitat for coho. The lake, from population estimates, had a high number of 1+ coho in relation to fry and is also significant in providing overwintering habitat for coho. Densities of Dolly Varden and cutthroat in the lake were low.

Total spring phosphorus levels, zooplankton number and speciation and the size and condition factor of the outmigrating sockeye smolt indicate that Black Lake is at its full carrying capacity for sockeye.

Biological - Wildlife

Methods of observation

On all access hikes to gather daily salmonid fry measurement data, weekly stream flow measurements, and frequent juvenile salmonid rearing-habitat mapping excursions, stream banks were closely examined for mammal sign. This sign included tracks, den and bedding sites, feeding areas, scats, remnant hair from animal passage, bones, and actual sightings. This sign was recorded as observed.

In addition to mammal data collected during routine fisheries biology and hydrology work which was stream- and lake-intensive, five traverses of upper Black Bear Creek valley were made in late summer of 1981, three in the spring of 1982 with the sole objective of observing mammal sign. Two hikes from Black Lake to Black Bear Lake were made as well, in August, 1981, and June, 1982, in order to service the Black Bear Lake thermograph and to observe mammal use of the valley headwall area.

Numerous hikes inland from upper Black Bear Creek on both sides were undertaken, crisscrossing the muskegs and blowdowns and following the forest fringe with the sole purpose of seeking mammal sign. By means of the above itineraries, two complete circumambulations of Black Bear Creek valley above Black Lake were achieved, with more intensive, frequent thrusts into areas found on these hikes to be heavily used by mammals.

Black bear tracks were measured to identify individual animals. Three to five front tracks were measured across the widest point of the pad and then averaged (after Streveler and Smith, 1978), thus distinguishing one bear's tracks from another. By actual sightings and frequency and location of tracks, bear territories were approximated and mapped. Wolf tracks were catalogued in the same manner.

Deer, beaver, and mustelid tracks were observed primarily for frequency and location, with no attempt at identifying individual territories.

Specific Observations

Black Bear (Ursus americanus) (Figure 22)

1981 - From 7/31 to 8/17, the tracks of one small individual prevailed throughout the study area; this was the only animal present until 8/18 when the tracks of a larger black bear were first observed in the muskeg fringe back of the lower beaver ponds southeast of Black Bear Creek above Black Lake, and on the southeast shore of Black Lake. The tracks of this bear correspond in size to those of a large black bear seen swimming across upper Black Lake in March, 1981. These two animals staked out their territories, with the smaller bear ranging widely throughout the Forks area of Black Bear Creek and using bedding sites along spring fork and south fork, and the larger bear using the area from upper Black Lake to just below the Forks. Both bears fed heavily on sockeye and pink salmon during August and early September.

On 9/3, the tracks of a third bear were first observed on the north bank of Black Bear Creek just above the lake. This bear was accompanied by two cubs with identical-sized tracks.

These five bears, as of 9/16, all fed heavily on the pink salmon in the three upper branches of Black Bear Creek, with many feeding access trails appearing through the brush. On 9/16, while walking the system for an escapement count, over 200 fresh, partially-eaten pink salmon carcasses were seen hauled out on the stream banks, with heavy bear sign abundantly dispersed throughout the upper Forks area.

During the late-October coho salmon escapement counts, the tracks of the smaller bear were still abundant and fresh throughout the Forks area. By this time, these were the only bear tracks occurring in the study area, with the exception of one set of tracks belonging to the larger bear (noted above) heading down the lake from behind the lower beaver ponds.

On 10/22, a bear scat was found on lower west branch shoreline containing deer hair; the only known deer carcass in the area was found on 10/21 near the M.B.C. thermograph station by the mouth of Black Bear Creek just above the bridge by Big Salt Lake.

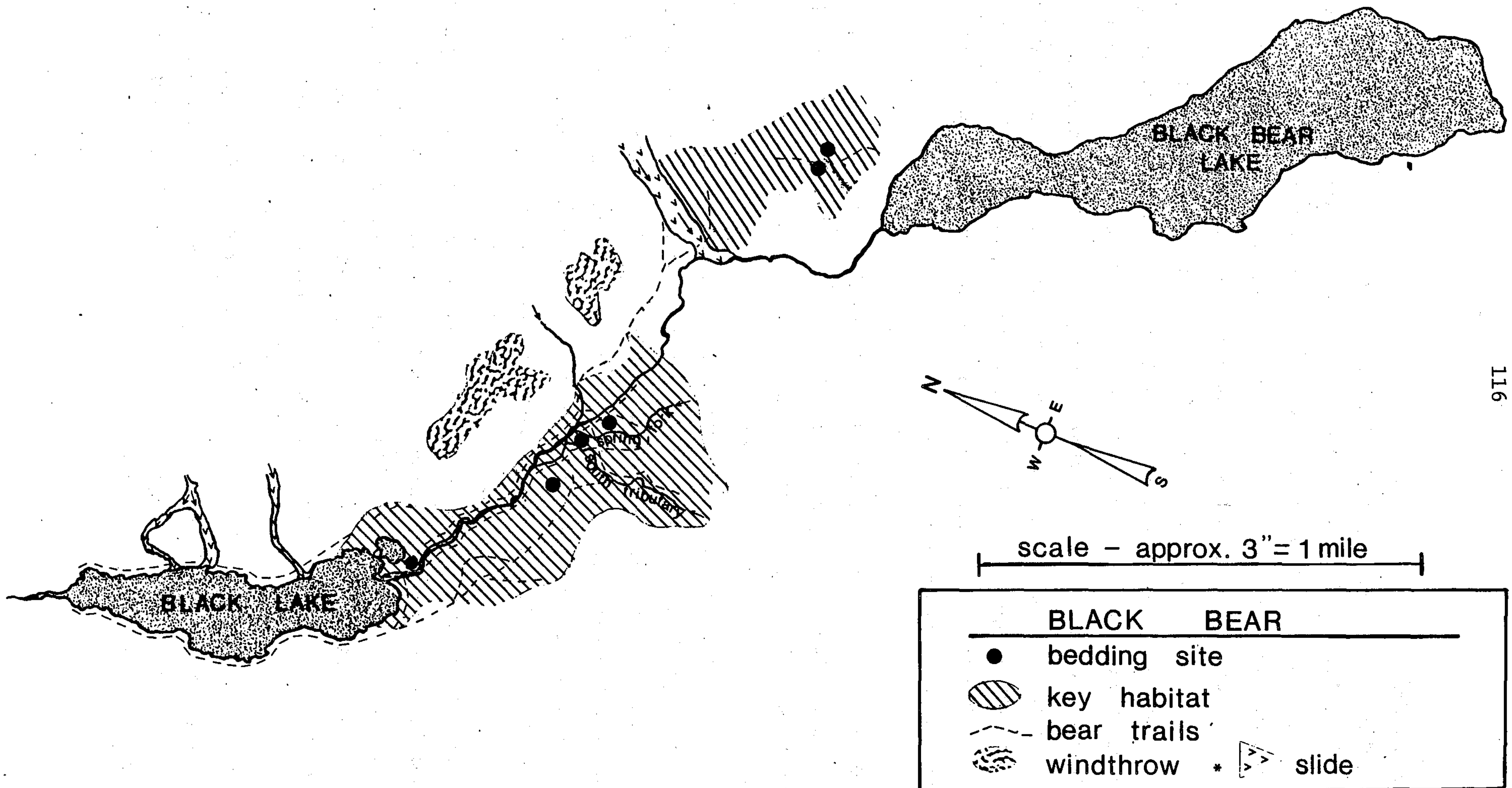

BLACK BEAR LAKE
BLACK LAKE
Spring
South tributary
N
E
W
S
scale - approx. 3"= 1 mile
BLACK BEAR
bedding site
key habitat
bear trails
windthrow
slide

FIGURE 22

1982 - During the course of a week in late January, while walking and skiing through the study area, no black bear sign was observed. Several possible den sites were examined for evidence of recent bear use with negative results.

From 4/8 to 5/29 the tracks of one small bear were found in the study area above Black Lake. These tracks correspond in size to those of the bear resident in the summer and fall of 1981. Sign was restricted to the sedge tussock areas fringing the upper end of Black Lake, the skunk cabbage-dominant marshes surrounding the muskegs -- in particular, around the lower beaver ponds -- and casual browsing around the shores of Black Lake. Toward the end of May, tracks and scats were observed in the Forks area.

On 5/29, a large black bear was seen on the southeast shore of Black Lake, grazing extensively on sedges. This bear was seen again in the same area on 6/8. Sign of this animal occurred regularly from 5/29 onward on the south side of Black Bear Creek up as far as the lower south fork and inland to the base of the ridge above the valley floor.

As of 5/29, there were two black bears using the valley. The larger bear (13.5 cm. track) ranged from Black Lake to the lower south fork and inland; the smaller bear (12.0 cm. track) used the opposite side of Black Bear Creek, ranging from lower Black Lake up to the vicinity of the proposed power house.

On 6/18, during a climb of the valley headwall north of Black Bear Lake falls, sign of a third, smaller bear (11.3 cm. track) was observed. This animal appeared to be resident on this steep slope. Several heavily used bedding sites were examined, with 11.3 cm. bear tracks profusely distributed from the area of the power house upstream on the north side of Black Bear Creek and up the slide area which joins Black Bear Creek approximately 75 meters below the falls. The headwall above and northeast of the falls all the way to the top of the ridge above Black Bear Lake was found to be crisscrossed with this bear's tracks and scats and sign of feeding, particularly on Fauria. Tracks of this bear were also seen on the ice near the mouth of Black Bear Lake on 6/18.

Beaver (Castor canadensis) (Figure 23)

1981 - Beaver sign was found throughout the study area from the upper Black Bear Creek valley down to Black Lake and all the way down Black Bear Creek to Big Salt Lake. This sign consisted of shrub and sapling cuttings, tracks, gnawed stumps, peeled sticks, dams, scent mounds, scats, riverbank slides, and actual sightings. There is abundant old beaver sign along Black Bear Creek, lake fork, spring fork, and west branch of south fork. Several old dams occur in the main flow of Black Bear Creek between the Forks and Black Lake, as well as on lake fork above the existing pond, and on the west branch of south fork fifteen meters above its confluence with Black Bear Creek. These dams appear to be many years old, with the logs and saplings of the structures well-rotted; the dam above the present pond on lake fork as 3-4" diameter alders growing on top of it. There are many old, beaver-chewed stumps in close proximity to these dams.

Heavy, fresh beaver sign was consistently found on lake fork from its confluence with spring fork to approximately 100 meters upstream. This pond on lake fork had between 8 and 12 regularly visited scent mounds on its perimeter, with well-maintained dams. Fresh cuttings were observed nearby on thirty occasions.

Beaver use of the lower ponds adjacent to Black Bear Creek appeared to be regular, although light in the presence of people. Eight days of intensive minnow trapping in this area drove the beaver upstream; they returned to the ponds two days after the minnow trapping was concluded.

An adult beaver was seen swimming in Black Bear Creek just opposite the lower pond on the morning of 8/13 -- the only beaver seen all summer.

No small tracks ascribable to juvenile beaver were seen, but frequent adult tracks were observed along Black Bear Creek streambanks during times of low water in Black Lake (8/9-8/20; 8/28-9/5) and in the mud along the shores of west branch and lake fork.

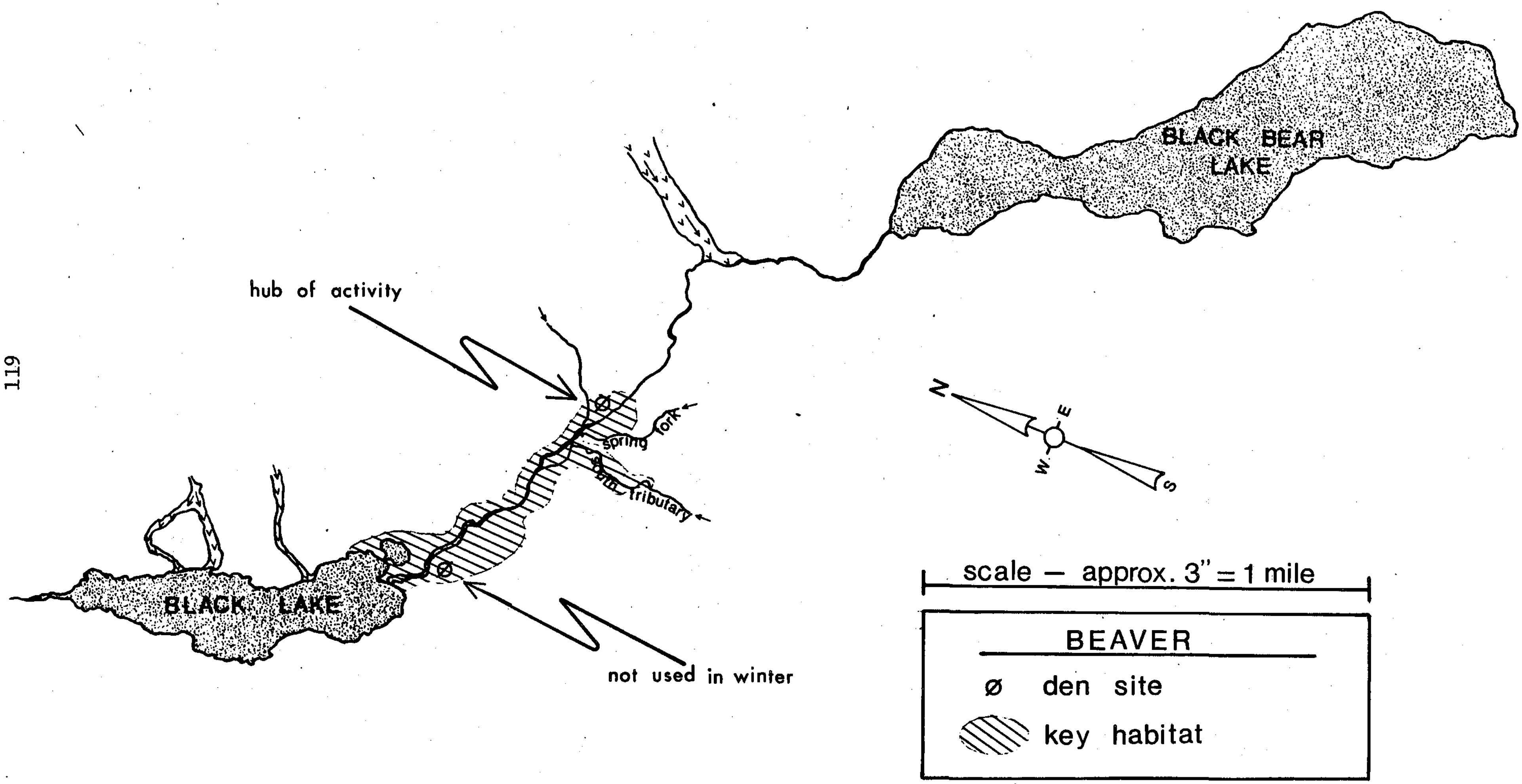

BLACK BEAR LAKE
hub of activity
spring fork
tributary
BLACK LAKE
not used in winter
N
E
W
S
scale – approx. 3" = 1 mile
BEAVER
ø den site
key habitat

FIGURE 23

Beaver were active throughout the Black Bear Creek system between Black Lake and the Forks, with most of the approximately 40 riverbank slides used frequently enough to inhibit revegetation.

1982 - On January 21, fresh beaver tracks were observed in the snow around the pond on lake fork. Many recently cut alder saplings were seen under the ice on the pond, as well as several piles of these cuttings in a food cache on shore within 6 feet of the water's edge, underneath large fallen logs and well-protected from snowfall. Fresh tracks were also seen on the shores of spring fork just south of the lake fork pond. No fresh beaver sign was observed anywhere else in the Black Bear Creek system above Black Lake.

In early April, beaver sign was found to be heavy in the vicinity of the Forks and along the banks of Black Bear Creek down to the lake. The lower stream section had numerous well-used riverbank slides or runs on both sides and the lower pond edges were beaver-trampled, with fresh-cut shoots on the dam and the pond runways cleared of aquatic vegetation.

The lake fork pond showed heavy, current use, with eight fresh scent mounds on its perimeter, 300-500 peeled sticks washed up against the dam from winter feeding, and many tracks around the shores. At this time of the year, beaver were feeding on a variety of plants, most notably skunk cabbage (Lysichiton americanum) which is abundant throughout the study area and provides an important early season food resource for bear and deer as well.

A dam was discovered at this time on the south fork approximately 50 meters upstream from the confluence with spring fork. This dam was not present in October of 1981 and had been built during the late fall, winter and early spring of 1982. A pond of approximately five thousand square feet was impounded by this new structure, and the perimeter was marked with occasional scent-mounds, fresh cuttings, tracks, and access slides.

Adult beaver were seen several times in the early evening along the shores of lower Black Bear Creek above the lake, as these crepuscular and nocturnal animals took to the streambanks to feed. On all occasions they tailslapped in alarm and dove when they sighted the observer; throughout the study period the beaver in this drainage have been chary of humans.

Deer (*Odocoileus hemionus sitkensis*) (Figure 24)

1981 - Deer sign in the study area was sparse throughout the study period. In light of this, all observations are listed below as summarized from notes:

8/7 - tracks of one animal seen in upper Black Lake bottom silt; no good estimate of age.

8/8 - recent tracks of one deer were seen along lower Black Bear Creek shore, disappearing into the marsh on the south side of the creek.

8/13 - tracks several days old of one deer on the north shore of lower Black Bear Creek; these tracks were exposed by falling water level in the creek.

8/24 - evidence of at least one deer's passage toward the high country, in the form of a scat pile and old tracks ¼ mile northwest of Black Bear Creek falls.

10/21 - deer skeleton, 2-3 weeks dead, found in Black Bear Creek below Black Lake by M.B.C. thermograph station. Skull missing, with the remainder of the frame intact. Unable to determine the nature of death. This was the only deer seen in the drainage over the course of fourteen months.

Pilots who regularly fly over the area stated that they have in the past seen deer on the slopes above both lakes during the summer months but had seen none this year. All of the sign seen in August could be attributed to one deer's passage.

1982

1/20 - one set of tracks seen on logging road one mile downstream from Black Lake.

4/7 - one set of fresh tracks crossing the logging road in the same area as above, headed toward the dense old growth forest on opposite side of lower Black Bear Creek.

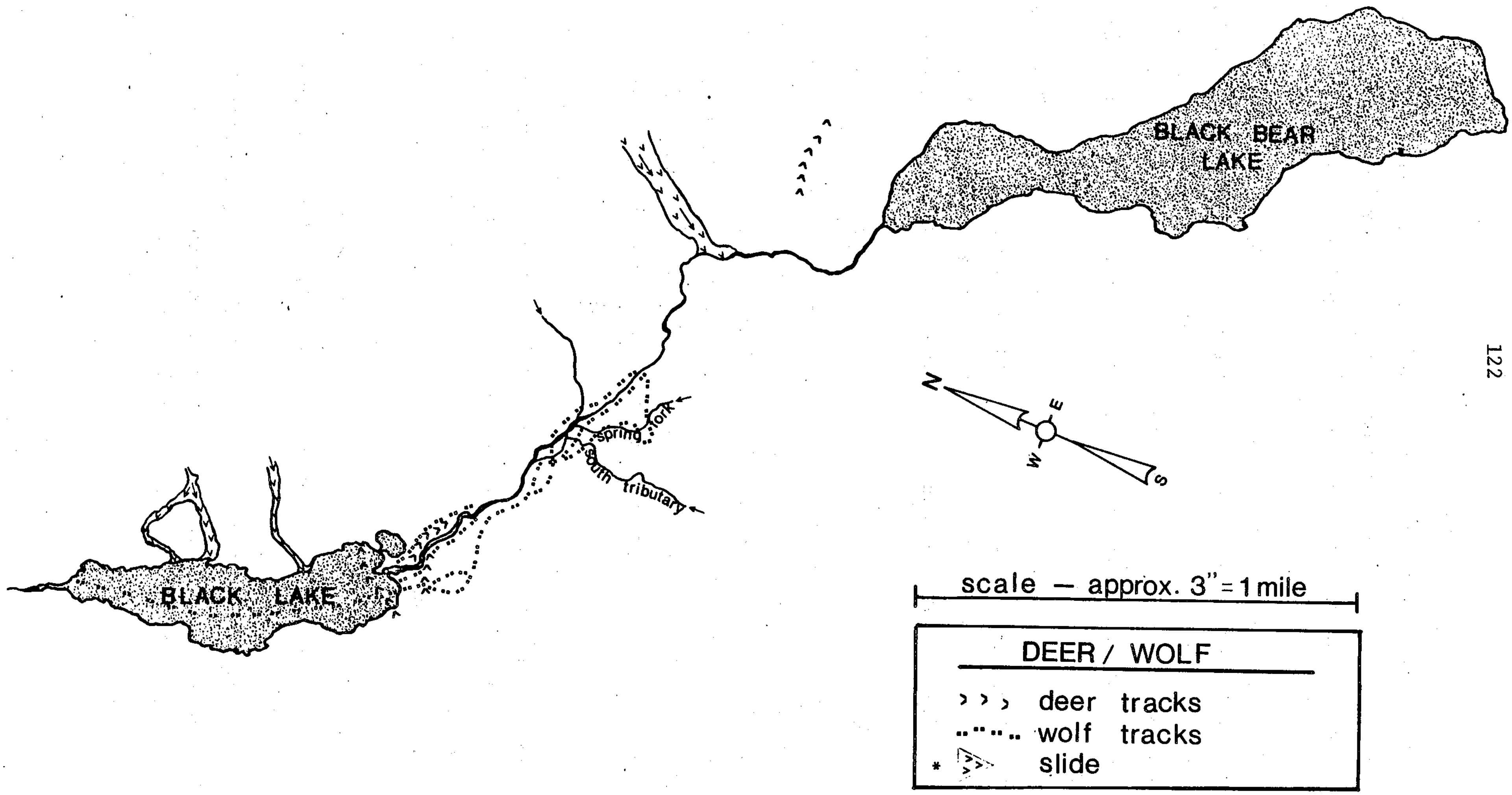

BLACK BEAR LAKE
BLACK LAKE
spring fork
south tributary
N
E
W
S
scale — approx. 3"=1 mile
DEER / WOLF
deer tracks
wolf tracks
slide

FIGURE 24

4/10 - clumps of deer hair trapped in detritus in fyke net at head of Black Lake.

5/10- winter kill discovered 200 meters downstream of fyke net station at mouth of Black Lake. Heavy sign of wolf traffic around this skeleton, dating to winter.

5/26 - two does seen on logging road in same spot as mentioned above.

6/8 - one spike buck seen in same area on logging road.

No deer sign was observed in the drainage above Black Lake during the spring fyke-netting period from 4/5 to 6/22.

Wolf (Canis lupus) (Figure 24)

1981 - Tracks of two individuals were seen on two occasions, indicating the passage of a large adult downstream near the head of Black Lake on 8/13; a smaller adult's tracks were seen in the same area on 8/10. There was no other wolf sign encountered in the study area, although intermittent game trails of the sort wolves frequent were discovered on the south side of Black Lake and on the north side of lake fork above the beaver pond and heading up toward the general area of the falls.

1982 - On 1/21, fresh tracks of two adults were encountered on the snow on Black Lake, headed up-valley. These two animals ranged widely throughout the valley, along both banks and back on the muskeg fringe of the lower beaver pond, thence upstream to the Forks area. Wolves were heard howling in the early morning of 1/21 in the vicinity of Big Salt Lake.

In early April, fresh tracks of two adults were seen on the snow on Black Lake heading down toward the clearcut. Two wolves were seen on the logging road one mile downstream from Black Lake, heading toward the creek. On 4/26, tracks of three adults were seen on the edge of Black Bear Creek in the mud, just above the U.B.L. thermograph site, heading downstream. Two adults were seen again on the logging road in early May, different wolves than those observed earlier.

Mustelids (Figure 25)

Mink (Mustela vison)

Mink tracks were commonly seen along the creek banks on virtually every trip upstream, in the summer of 1981, in January of 1982, and throughout the spring fyke-netting session, April through June.

Otter (Lutra canadensis)

Otter sign was first observed in the study area in October, 1981. From this time onward, otter sign was noted regularly from just below Black Lake all the way up to the Forks area, dispersed thinly throughout the area, with several preferred haulout sites along the banks of Black Bear Creek between the lower beaver pond and upper spring fork and lake fork.

Otter tracks were seen on the snow on Black Lake during a January visit, and along upper Black Bear Creek beyond the Forks. Scats were found containing small fish bones, and fresh sign was common in the Forks area.

In April through June, widely dispersed otter sign was found in the area above Black Lake, particularly heavy by the lower beaver pond, at the Forks, and along lake and spring forks.

Marten (Martes americana)

Marten sign was seen to be less abundant than mink, but occurred more diffusely throughout the upper valley, extending up south fork to at least the lower falls; up spring fork and lake fork, sign was less abundant. Marten tracks were seen in snow along the shores of Black Bear Creek above Black Lake in January, 1982, several sets. Two marten were seen in the old growth forest near Black Lake camp in May, 1982, as was one marten apparently resident in a slash pile along the lower side of Black Lake.

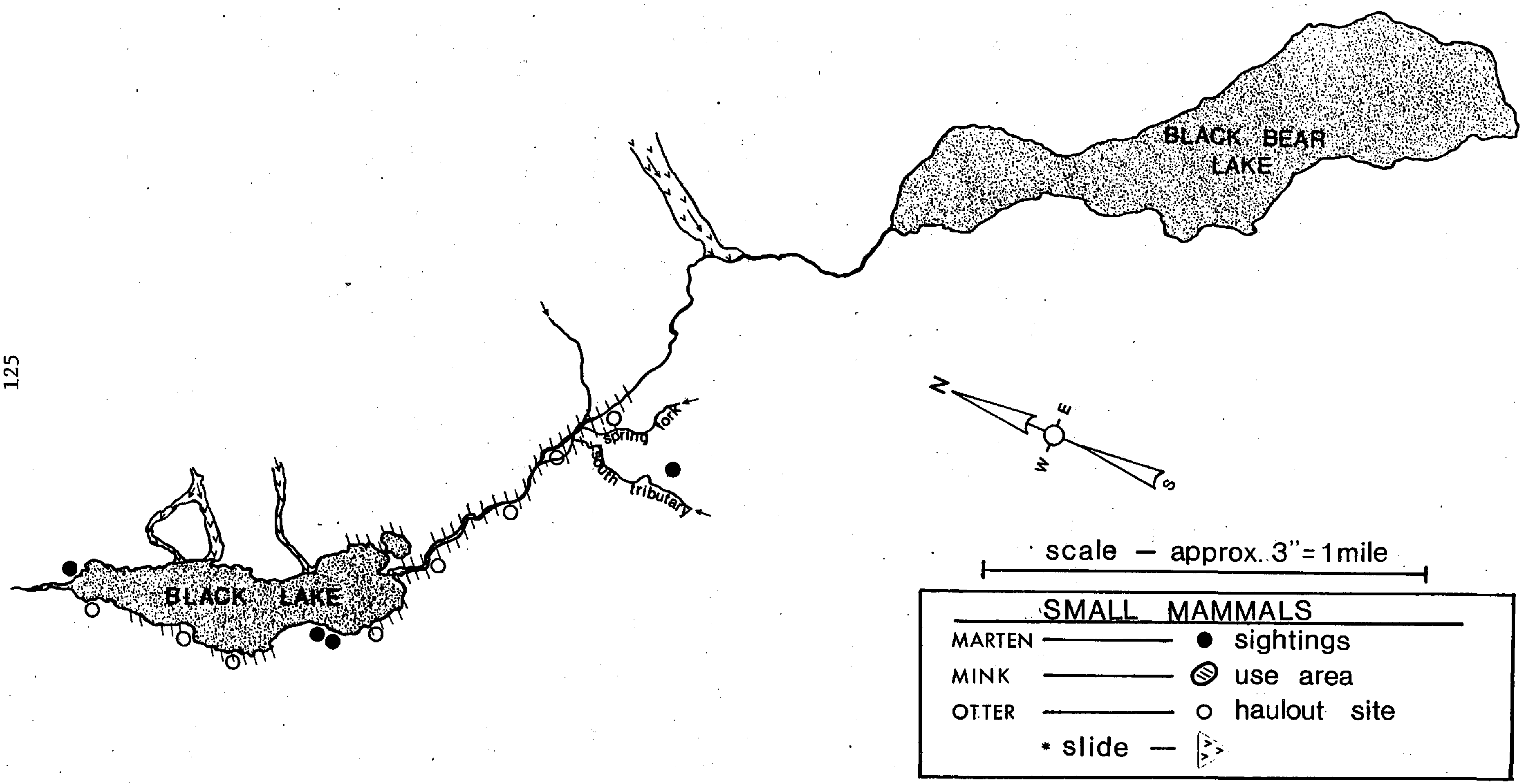

BLACK BEAR LAKE
BLACK LAKE
spring fork
south tributary
N
E
W
S
scale — approx. 3"=1mile
SMALL MAMMALS
MARTEN ● sightings
MINK use area
OTTER ○ haulout site
* slide —

FIGURE 25

General Observations

Black Bear

In 1981, one small black bear resided in the drainage above Black Lake in mid-summer; this bear was joined in mid-August by another adult, and in early September by a sow with two cubs.

These arrivals of the latter four bears coincided with the return of large numbers of spawning sockeye and pink salmon to the drainage, and all five animals fed heavily on salmon during September. As the supply of fish in Black Bear Creek expanded, the territories of the bears diminished and overlapped, until in mid-September, all five animals were working the Forks area in close proximity to each other.

The marshy areas back of lower Black Bear Creek appeared to be important feeding areas in the spring, when sedges and skunk cabbage were heavily grazed. In mid-summer, these areas were used for access to the upper valley and to the extensive blueberry (Vaccinium spp.) and salmonberry (Rubus spectabilis) patches along Black Bear Creek, its tributaries, and amongst the windthrows and old growth forest.

Bears use the headwall of the valley for transit to the high country for spring and summer feeding.

In 1982, one small bear was found in the drainage above Black Lake in the early spring. This bear's tracks correspond in size to those of the small bear resident in the area in summer of 1981. It is probable that this bear overwintered in the valley. In January, 1982, some effort was given to finding bear den sites, with negative results. It is likely that an overwintering bear would use the heavy, extremely brushy and jumbled windthrow areas at the base of the valley walls.

The second bear in the area in 1982 left tracks similar to the large bear which arrived in late summer 1981. It is possible that this is the same bear.

Bears use the logging road for access to the Black Lake area and have been seen on the road by loggers in the past years.

As the salmon spawning in upper Black Bear Creek tapered off, all but one bear left the area, until by late October, the small bear mentioned above was the only resident animal, and was ranging widely throughout the Forks area.

Black bears are commonly seen on the slopes above Black Bear Lake in the summer and fall, as attested to in the visitor log in the Forest Service cabin on the lake. One was seen by the observer in September, 1980, 300 feet above the lake on a south-facing slope in the afternoon.

The bear population in the area between Black Lake and Black Bear Lake is estimated to be no more than two full-time resident adults, with a transient number of animals coming into the area to feed on salmon in September, of which there were three in 1981. Presently, in June, 1982, there are three adults in the study area.

Beaver

Beaver sign is heavy throughout the system, with the hub of year-round activity occurring in the pond on lake fork.

Beaver maintain the dams on the two lower ponds on the south side of Black Bear Creek, showing consistent heavy presence from early spring to late fall, but appear to depart this area in winter, visiting only occasionally for casual feeding, on salmonberry and high-bush cranberry stalks and alder saplings.

Beaver in the study area are extremely wary of humans.

The beaver population in the study area appears to be expanding, as shown by the new dam on south fork and much increased activity in this immediate vicinity.

The ponded areas created by beaver dams contain many young coho salmon.

It is likely that the beaver population in the study area consists of one extended family group. During cold and snowy winters it is known that beaver sometimes utilize a communal lodge, abandoning summer dwellings (Hay, 1958). In this instance, it is likely that dwellings in undercut banks are abandoned in favor of communal life in the lake fork pond, where the only large stored food supply was found, and where the added thermal value inherent in the close proximity of kin would reduce one element of climatic stress. The lake fork area abounds with small alders, which are a mainstay food item in this biome; extensive groves of small alders do not occur in immediate proximity to the lower ponds.

The presence of much old beaver sign, estimated at ten to twenty years old and older, in conjunction with recent sign, of perhaps five years past, intimates that this is a recently reestablished beaver population. An old tent platform on the southeast shore of Black Lake and several old marten sets suggests the presence some years past of a trapper. It is speculated that this population was trapped out about ten years ago and has returned to the study area in recent years. No trapping records for this area can be found.

It is estimated that the beaver population in the area above Black Lake is 7-12 animals.

Deer

The study area is not currently heavily used by deer. Deer sign is much more abundant in the area between Black Lake and Big Salt Lake along the creek and in the adjacent old growth forest.

There are no indications that deer use the upper Black Bear Creek drainage for winter habitat.

Deer populations are lower this year than in recent years and may account in part for the scarcity of sign.

Wolf

Wolves are infrequent visitors to the study area, and appear to use the logging road for acces to Black Lake.

It is probable that wolves hunt more regularly in the drainage below Black Lake due to the larger presence of deer. Wolf visitation to upper Black Bear valley would increase proportionate to increased deer use (Wood, pers. comm.). The tracks observed in January, 1982, indicated a day trip to the upper valley from below Black Lake; there were no resting sites identified, and although the tracks indicated a fairly extensive search of the area, no signs of predation were seen and the tracks headed back down the lake.

It is not known if wolves use the upper valley as an access route to the high country, although there is a fairly well-used, intermittent game trail parallelling the upper creek in the direction of the falls and a steep, passable slide area.

EFFECTS OF PROPOSED HYDROELECTRIC PROJECT ON FISHES AND THEIR HABITAT

Black Bear Lake habitat

Effects on rainbow trout and habitats of Black Bear Lake cannot be evaluated at this time. The late snow-ice melt season on Black Bear Lake in spring, 1982, prevented the accomplishment of necessary field work. Principal questions requiring examination include magnitude of rainbow population, preferred residence habitats, and usable spawning areas.

Spawning habitats above Black Lake

Spawning habitats above Black Lake which may be affected by the hydroelectric project are found in zone II (see p. 92), principally in spring and lake forks of the Black Bear Lake outflow. While the south tributary contains roughly half the spawning habitat above Black Lake, its flows or water quality are not likely to be affected by the project. It was not studied in detail in the course of our investigations.

The principal physical features which may influence fish and fish habitats in the course of a hydroelectric project include stream discharge, water temperature, springflow characteristics, streambed dynamics and streambed quality, and water quality features including dissolved oxygen or water chemistry. The first three of these elements are closely interrelated and form the core of this analysis of effects on spawning habitat. The other elements -- streambed and water quality features -- are handled more briefly.

In general terms, the flow regime proposed for this project (summarized in Figures W-5 through W-17 of Exhibit W of the FERC License Application) compares with natural conditions as follows:

January February March	Average project flow releases exceed mean monthly natural flows, as synthesized. Neither peak nor low regulated flows reach the extremes expected under natural conditions.
April	Average project flows coincide with mean monthly natural flows. Range of regulated flows less than natural.
May	Average project flows less than natural; but range of project flows less than natural.
June	Average project flows less; range of low flows the same as natural; peak flow range less than natural.
July	Average project flow greater than natural range of low flows reduced from natural but high flows increased above natural.
August	Average project flow greater and ranges less than natural flows.
September	Average project flow same as natural: ranges reduced.
October	Average project flow less than natural: range of low flows same; high flows reduced compared to natural.
November	Average project flow coincides with natural: ranges reduced.
December	Average project flow less than natural; range of low flow similar to natural; high flows less than natural.

This overview suggests that during the spawning-incubation period (August through April) projected flows, as a singular feature, could be a problem primarily in October and December.

The effects of altered flow conditions in October and December were examined by use of stream cross sections which were surveyed throughout the fisheries habitats above Black Lake. The principal objective of this work was to provide a tool to evaluate present, as well as regulated, conditions of channel flow, identifying loss or gain of spawning or rearing habitats.

Cross sections 12 through 27, as identified on the map in the rear pocket, are located on spawning habitats of varied quality. The results of this survey work are discussed here in convenient groupings. Wherever possible or useful, individual cross sections were rated showing projected stream levels for normal (N) and regulated (R) flows in October and December, the two most critical flow months in the regulated regime.

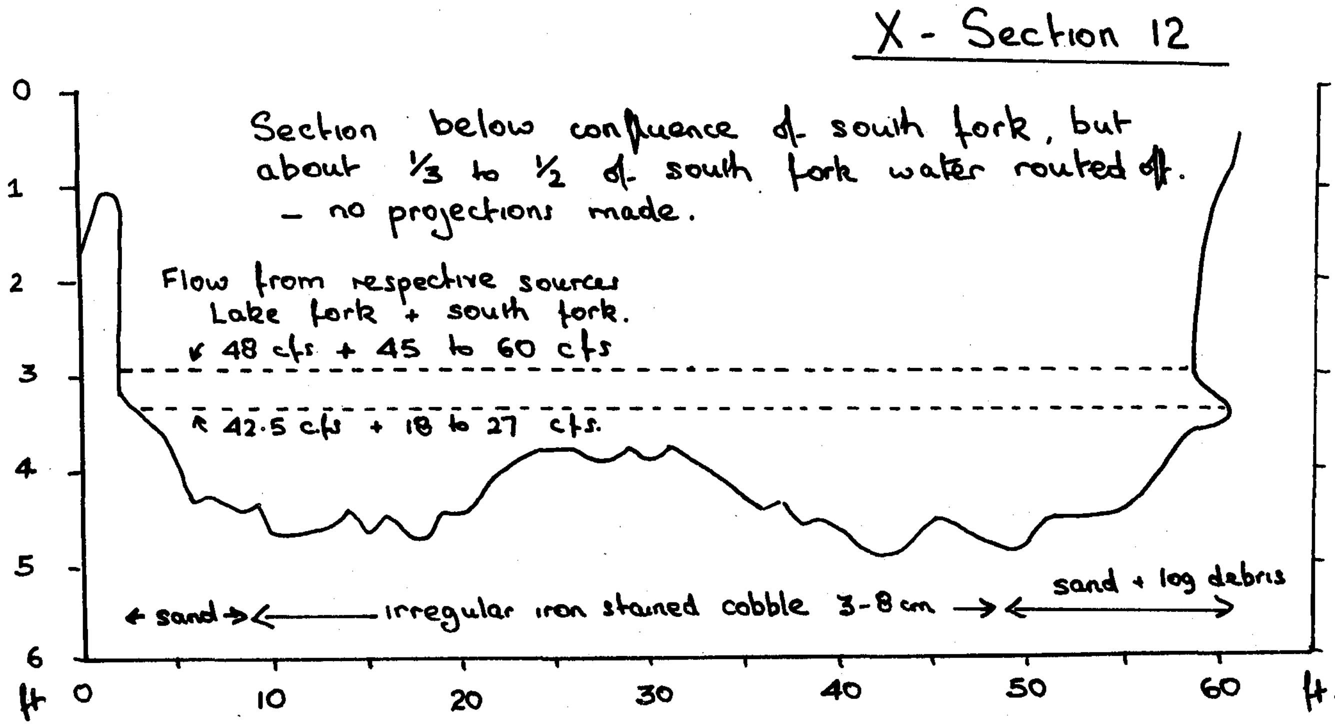
Cross sections 12 and 13 are located in the first spawning habitat area in zone II, immediately below the confluence of the south fork with the lake-fed stream. These cross sections, while descriptive of the channel characteristics, could not be fitted with projected flow levels because of the confounding pattern of partial south fork confluence with the lake-fed system immediately upstream (see map). The sections serve, however, to indicate that this spawning habitat area is not particularly susceptible to exposure as the water level drops. That is, the banks are sufficiently steep so that spawning gravels are not readily exposed until quite low flow conditions.

About 300 feet upstream of sections 12 and 13 is the confluence of the south fork with the lake-fed system. Cross section 14 lies at the mouth of the south fork and is not essential to this work, while cross section 15 is also the stream discharge station used for the lake-fed system. The flow rating lines shown on cross section 15 (Figure 27) represent the Harza Feasibility Report's October and December synthesized flows under unregulated (Natural) and projected (Regulated) regimes for the point on the drainage immediately upstream of the south fork.[1/] This section indicates that October and December project flows (R) are at levels which are not likely to limit spawning success in the vicinity of cross section 15.

Cross sections 16, 17, 18, and 19 were not evaluated with regard to levels of regulated flows. In this section of the stream, the major flow source is the spring fork, but an important second source comes from overflows from the lower lake fork near and above the beaver pond area (see map). This made meaningful approximations of projected flow levels difficult.

1/ See figures W-5 and W-13 of FERC License Application - Exhibit W.

FIGURE 26


X - Section 12
Section below confluence of south fork, but about 1/3 to 1/2 of south fork water routed off. – no projections made.
Flow from respective sources Lake fork + south fork.
48 cfs + 45 to 60 cfs
42.5 cfs + 18 to 27 cfs.
sand
irregular iron stained cobble 3-8 cm
sand + log debris
ft
ft.

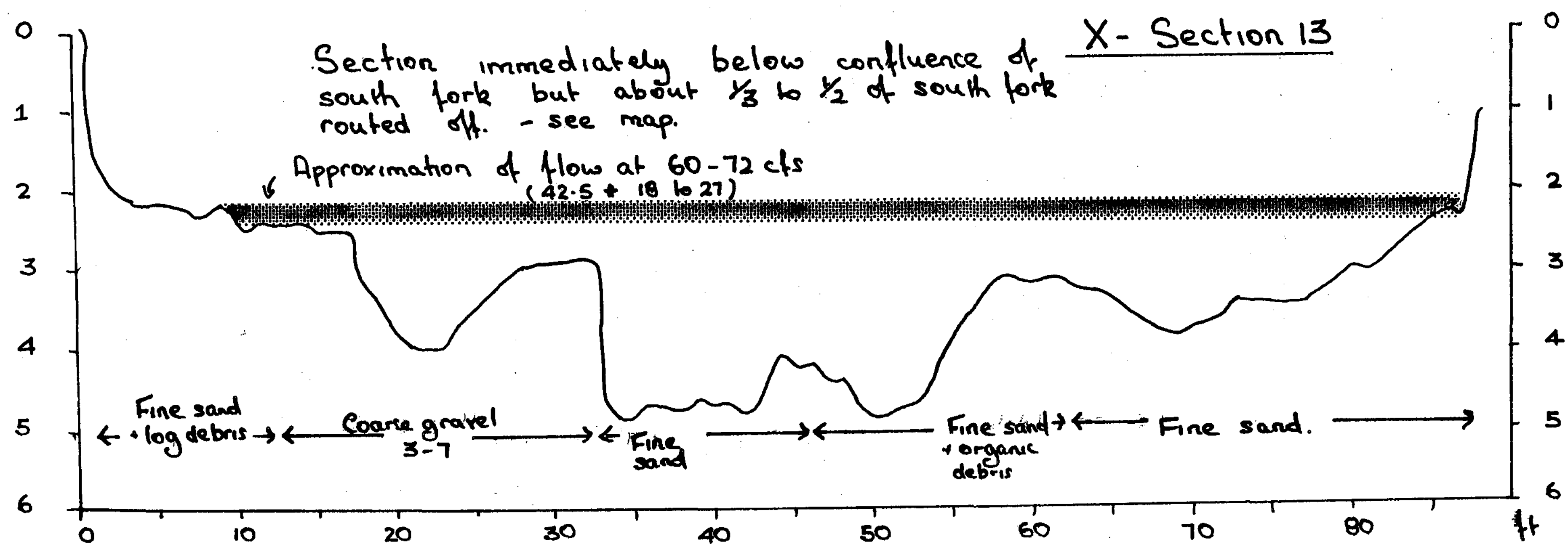
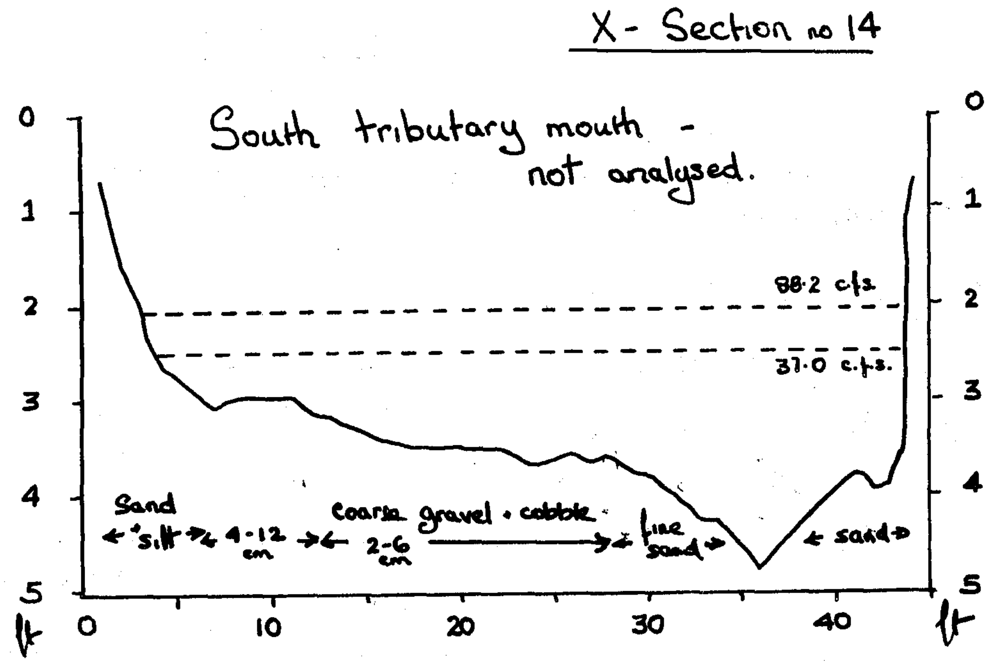

X- Section 13
Section immediately below confluence of south fork but about 1/3 to 1/2 of south fork routed off. - see map.
Approximation of flow at 60-72 cfs (42.5 + 18 to 27)
Fine sand + log debris
Coarse gravel 3-7
Fine sand
Fine sand + organic debris
Fine sand.
ft

FIGURE 27


X- Section no 14
South tributary mouth -
not analysed.
88.2 c.f.s.
37.0 c.f.s.
Sand + silt
4-12 cm
coarse gravel + cobble
2-6 cm
fine sand
sand
0
1
2
3
4
5
ft
0
10
20
30
40
ft

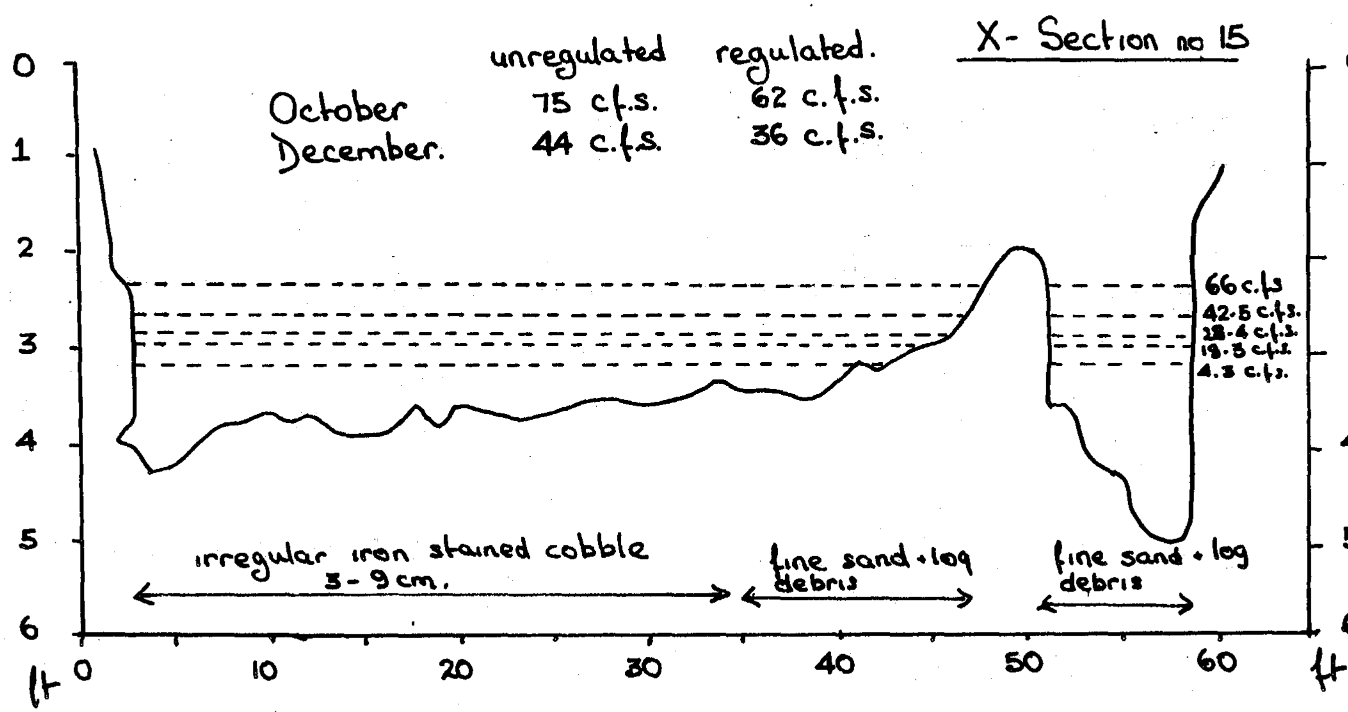
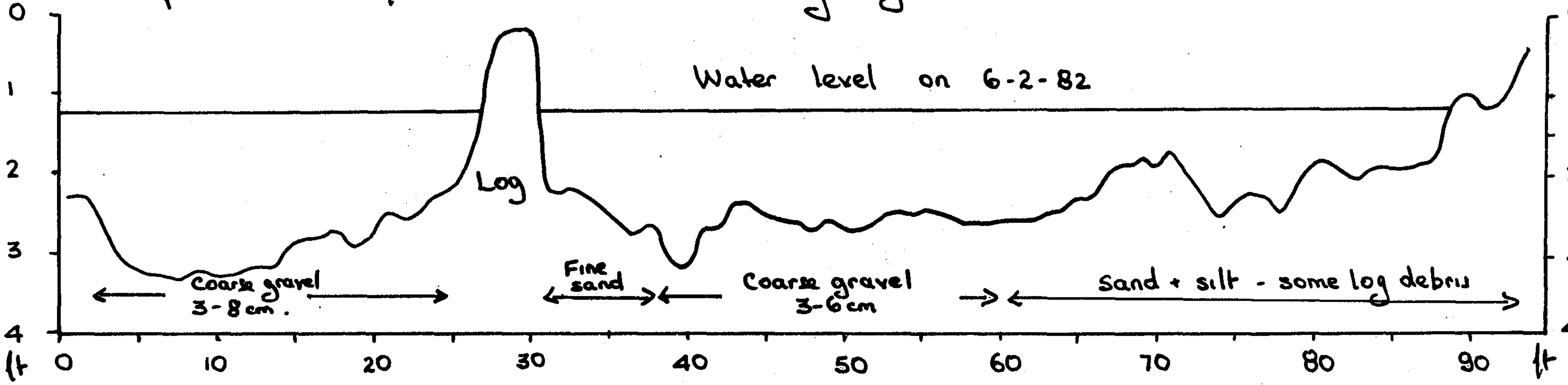

X- Section no 15
unregulated
regulated.
October
75 c.f.s.
62 c.f.s.
December.
44 c.f.s.
36 c.f.s.
66 c.f.s.
42.5 c.f.s.
irregular iron stained cobble
3 - 9 cm.
fine sand + log debris
fine sand + log debris
0
1
2
3
4
5
6
ft
0
10
20
30
40
50
60
ft

FIGURE 28

No flow estimations possible in sections 16, 17, 18 and 19. These sections receive all of spring fork and variable leakage from lake fork which is immediately adjacent.

X-Section 16



X-Section 17

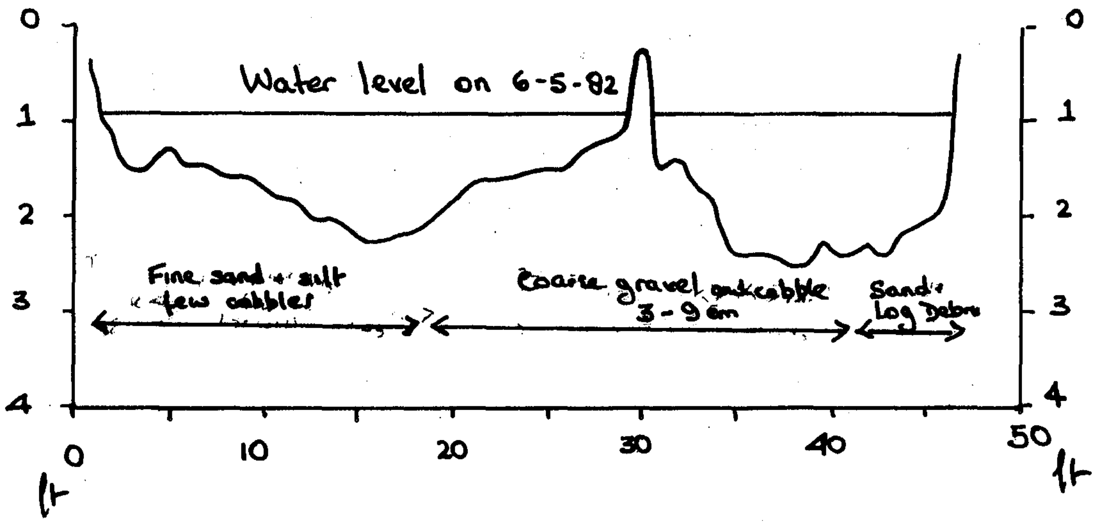
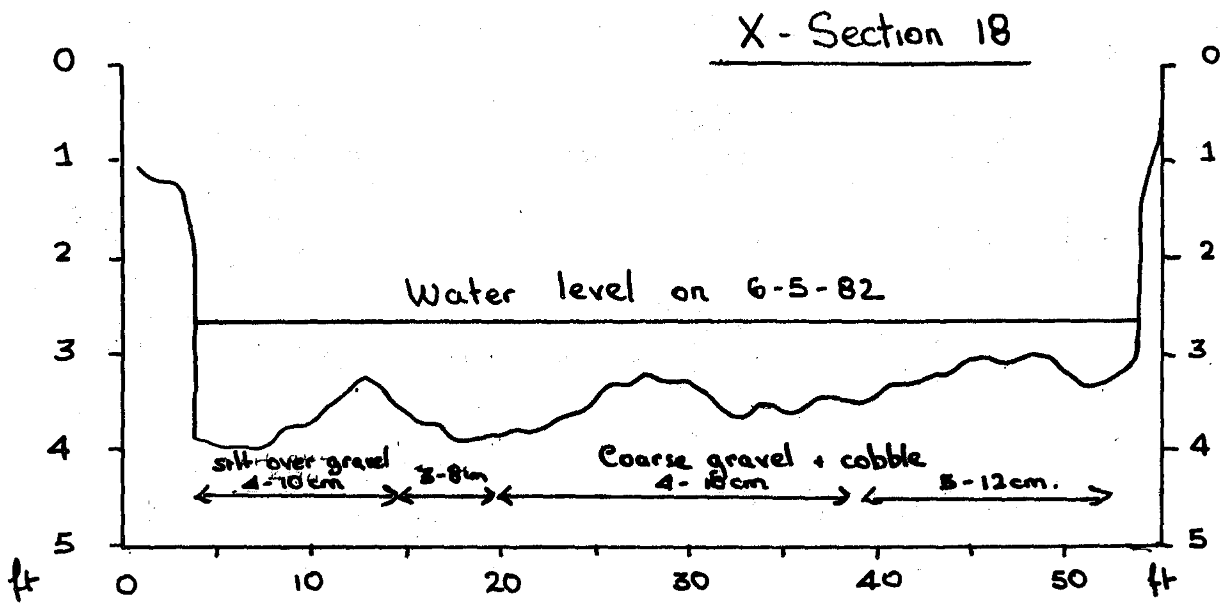
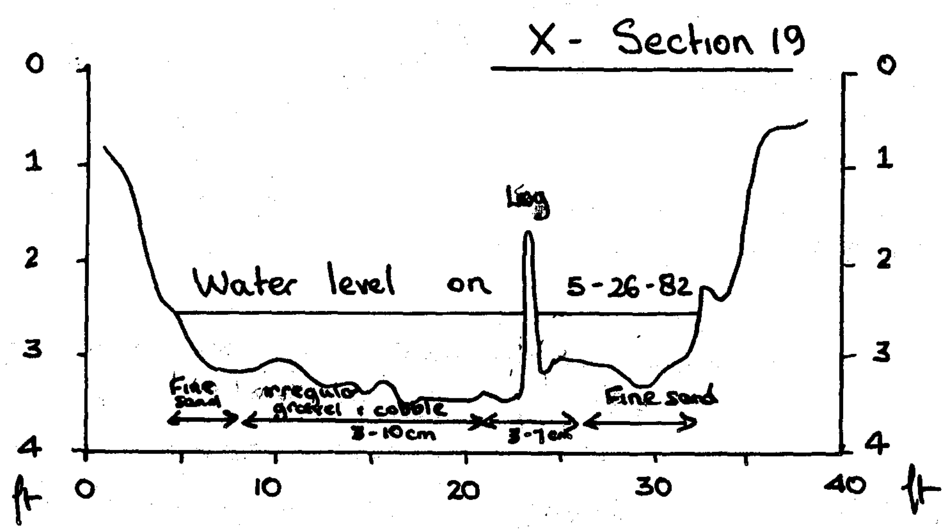


FIGURE 29


X - Section 18
Water level on 6-5-82
silt over gravel
4-10cm
3-8cm
Coarse gravel + cobble
4-18cm
3-12cm.
0
1
2
3
4
5
ft
0
10
20
30
40
50
ft


X - Section 19
Water level on 5-26-82
Log
Fine sand
gravel + cobble
3-10cm
3-7cm
Fine sand
0
1
2
3
4
ft
0
10
20
30
40
ft

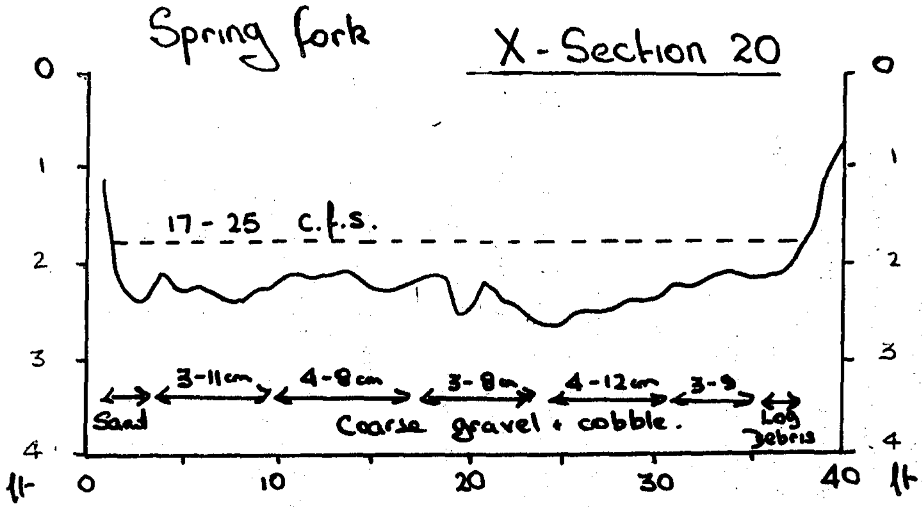
The cross sections 16 through 19 show channels with generally vertical banks and form capable of dropping at least ½ foot below the early June, 1982, level before significant dewatering of the bed occurs.

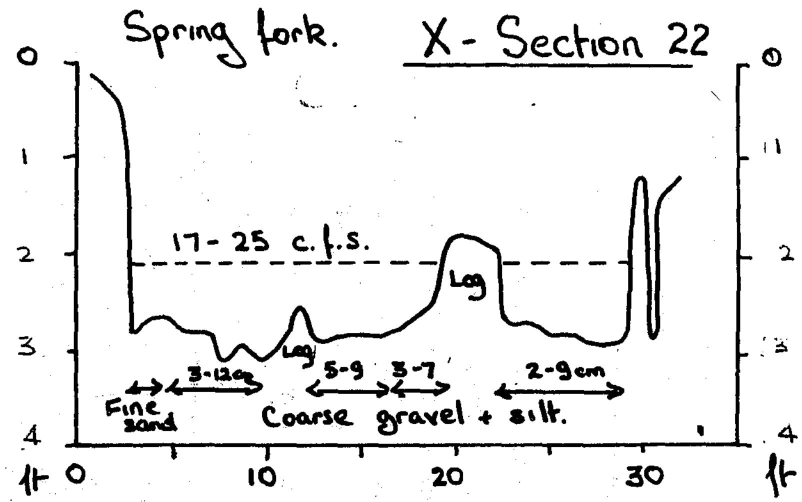
The upper spring fork is represented by cross sections 20, 21, 22, and 23. These sections are shown only with the flow level, 17-25 c.f.s., which, from limited observation and measurement, seems to be the upper limit of spring-fed waters into this fork. As noted elsewhere, flows in spring fork are believed to drop to around 5 c.f.s., but the shape of the cross sections, with characteristically vertical banks, and quite flat streambeds, limits the dewatering of the bed. The flow levels for October and December are not shown because this channel area receives only groundwater regulated flows from upper lake fork. A flow criteria recommended for use in groundwater related designs for this project is to maintain at least 10 c.f.s. in this channel area during spawning period -- August through September -- and a winter minimum of 5 c.f.s.

Above the beaver ponds found on the lake fork is the remaining channel of zone II. This spawning area is represented by cross sections 24, 25, 26, and 27. These sections (Figs. 31-33) illustrate the rougher, more troughed character of this channel. Banks often show more sloped, as opposed to vertical, sides. These channel characteristics are responses to the large streambed materials, the variable flow conditions, and the more active bed load present.

In order to evaluate the October and December flow levels with synthesized (Natural) and projected (Regulated) conditions, an allocation of respective flows below the power house was made. (See also Figures W-5 and W-12 of FERC License Application, Exhibit W). The assumptions are:

	unregulated flow at vicinity of powerhouse	regulated flow below tailrace	allocation to spring fork		allocation to lower lake fork	
			using N	using R	using N	using R
	(N)	(R)				
October	48 cfs	38 cfs	18	17 cfs	30	21 (est)
December	25	17	13	10	12	7 (est)





Sections 20, 21 and 22 represent spring fork channel above major leakage from lake fork. Spring fork believed to peak at about 25 c.f.s. with low flows in summer and winter which may reach 3 c.f.s.

FIGURE 30

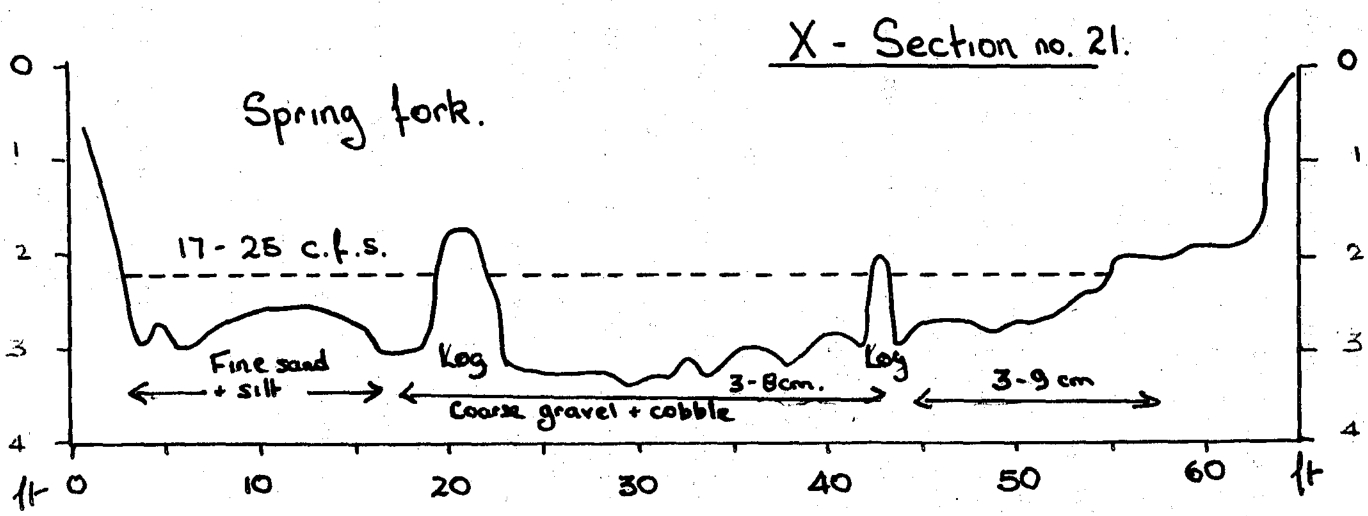
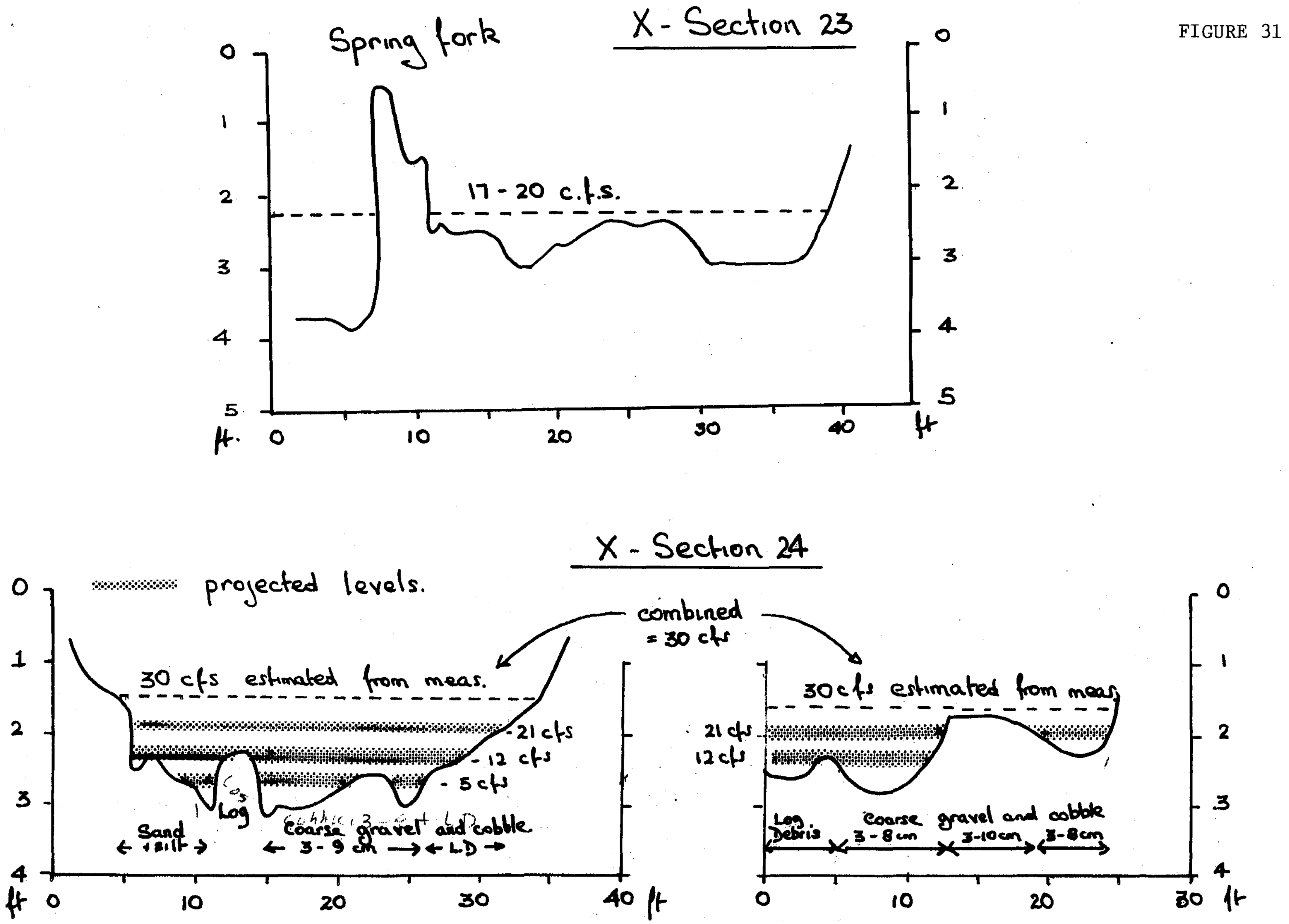
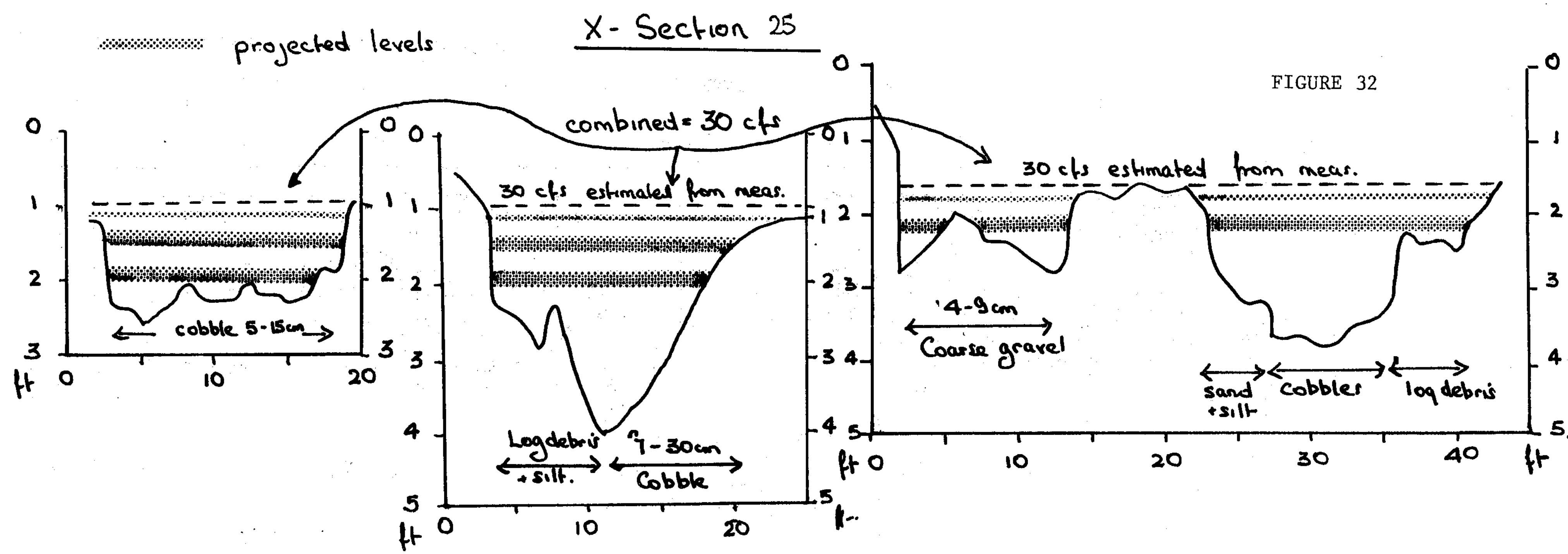


FIGURE 31



Sections 24 to 27 are located in the lake fork above beaver ponds.

FIGURE 32


projected levels
X- Section 25
combined = 30 cfs
30 cfs estimated from meas.
cobble 5-15cm
Log debris + silt.
7-30cm Cobble
4-9cm Coarse gravel
sand + silt
cobbles
log debris
ft

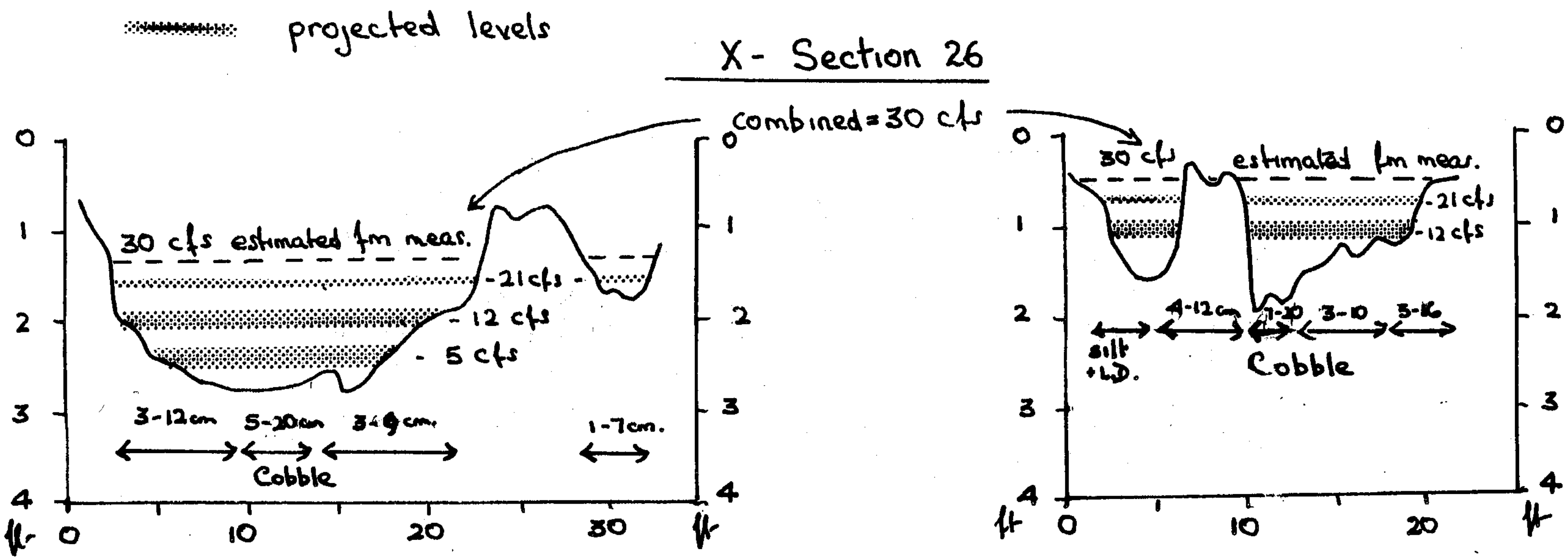
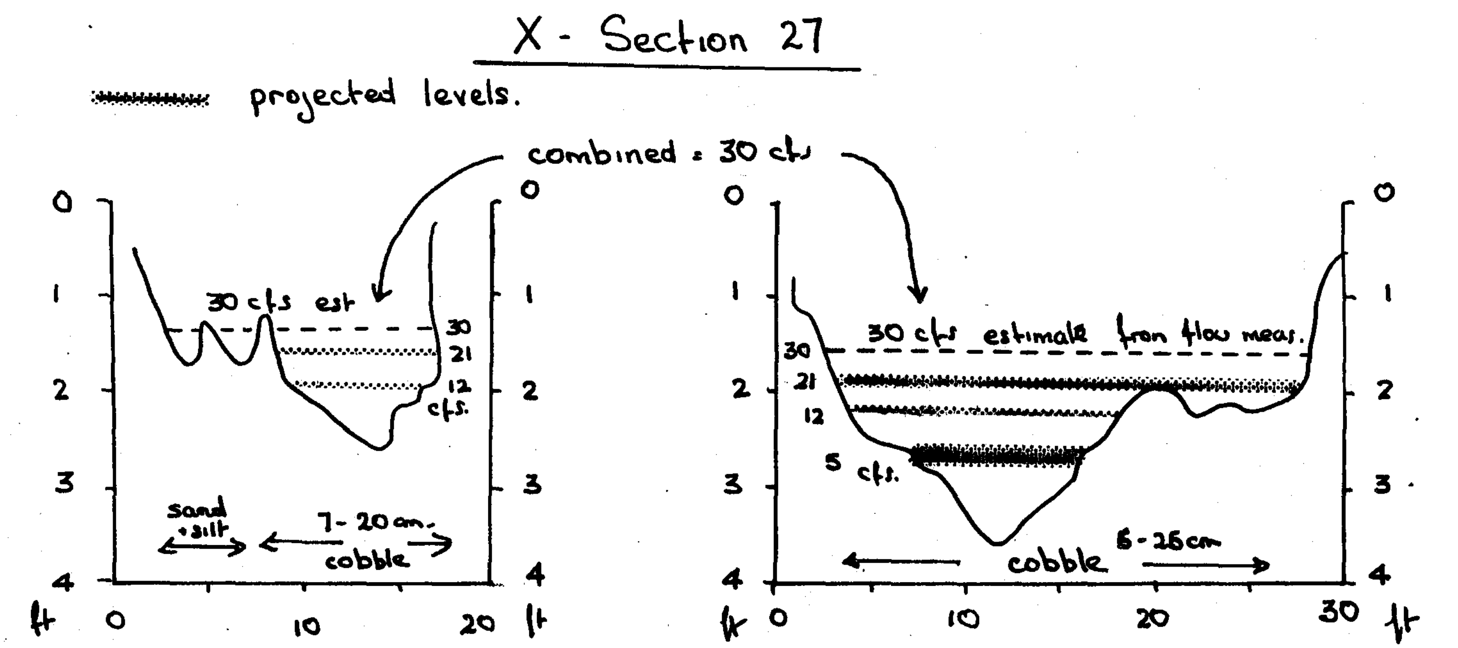

projected levels
X- Section 26
combined = 30 cfs
30 cfs estimated fm meas.
-21 cfs
-12 cfs
-5 cfs
3-12cm
5-20cm
3-9cm.
1-7cm.
Cobble
4-12cm
3-10
3-16
silt + L.D.
ft

FIGURE 33



X - Section 27
projected levels.
combined = 30 cfs
30 cfs est
30
21
12
cfs.
sand + silt
7 - 20 cm.
cobble
30 cfs estimate from flow meas.
30
21
12
5 cfs.
cobble
5 - 25 cm
0
1
2
3
4
ft
0
10
20
30
ft

These assumptions are conservative values for lower lake fork, because neither N nor R values include additional flows generated by the watershed below Black Bear Lake. The assumed December level for a regulated flow of 7 c.f.s. above the lake fork beaver ponds is significantly lower than the assumed mean monthly (Natural) flow for December, suggesting that spawning habitat is lost, as interpreted in Figures 31,32 & 33. However, a realistic comparison should also recognize that the unregulated December flows drop this fork below the 12 c.f.s. means, as our observations have also found. The predicted December average minimum flow over the synthesized record (30 years) is about 7 c.f.s. at the outlet of Black Bear Lake, which would yield very little flow in the lake fork spawning section. Thus the spawning habitat in the lake fork may fare better under the regulated regime, if the anticipated 7 c.f.s. minimum flow in the channel is delivered.

In order to similarly evaluate stream temperature difference during the spawning-incubation period, a table showing spring fork stream temperatures under Natural and Regulated conditions was developed. It will be seen that construction of Table 12 involves speculative assumptions which have been discussed earlier.

Month	1/ Temperature mouth of B.B.L.	2/ Temperature at base of falls	Intake 3/ Temperature, Bl. Bear Lk. (at -17 ft depth)	2/ Temperature in stream at groundwater emergence	
				Natural	Regulated
Aug	11.0°C	11.5°C	(-1.8°C) = 9.2°C	9.5	8.5
Sept	10.5	10.5	(0.0) =10.5	9.0	9.0
Oct	7.5	7.5	(+0.1) = 7.6	7.5	7.5
Nov	6.5	5.5	(+0.3) = 6.8	7.0	7.0
Dec	2.0	1.0	(+0.5) = 2.5	2.5	3.0
Jan	1.5	0.5	(+0.8) = 2.3	2.5	3.0
Feb	1.5	0.5	(+0.8) = 2.3	2.0	2.5
Mar	2.0	1.5	(+0.5) = 2.5	2.5	3.0
Apr	2.0	2.0	(+0.2) = 2.2	3.0	2.5
May	4.0	4.5	(+0.0) = 4.0	5.0	4.5
June	8.0	9.0	(-0.2) = 7.8	8.0	7.0
July	10.5	11.0	(-1.0) = 9.5	9.0	8.5

TABLE 12: Speculative derivation of Natural and Regulated water temperature in stream at groundwater emergence into spring fork.

1/ Interpreted from two seasons of record.

2/ From interpretation of miscellaneous measurements. See text.

3/ Mid-operating range for each of the three intake ports would occur at 17 ft. below lake surface. Thus, assuming use of one intake port at a time, temperatures of intake waters were taken at - 17 ft. depth from lake profiles (Figures 10a,b,c,) for respective seasons of the year.

FIGURE 34

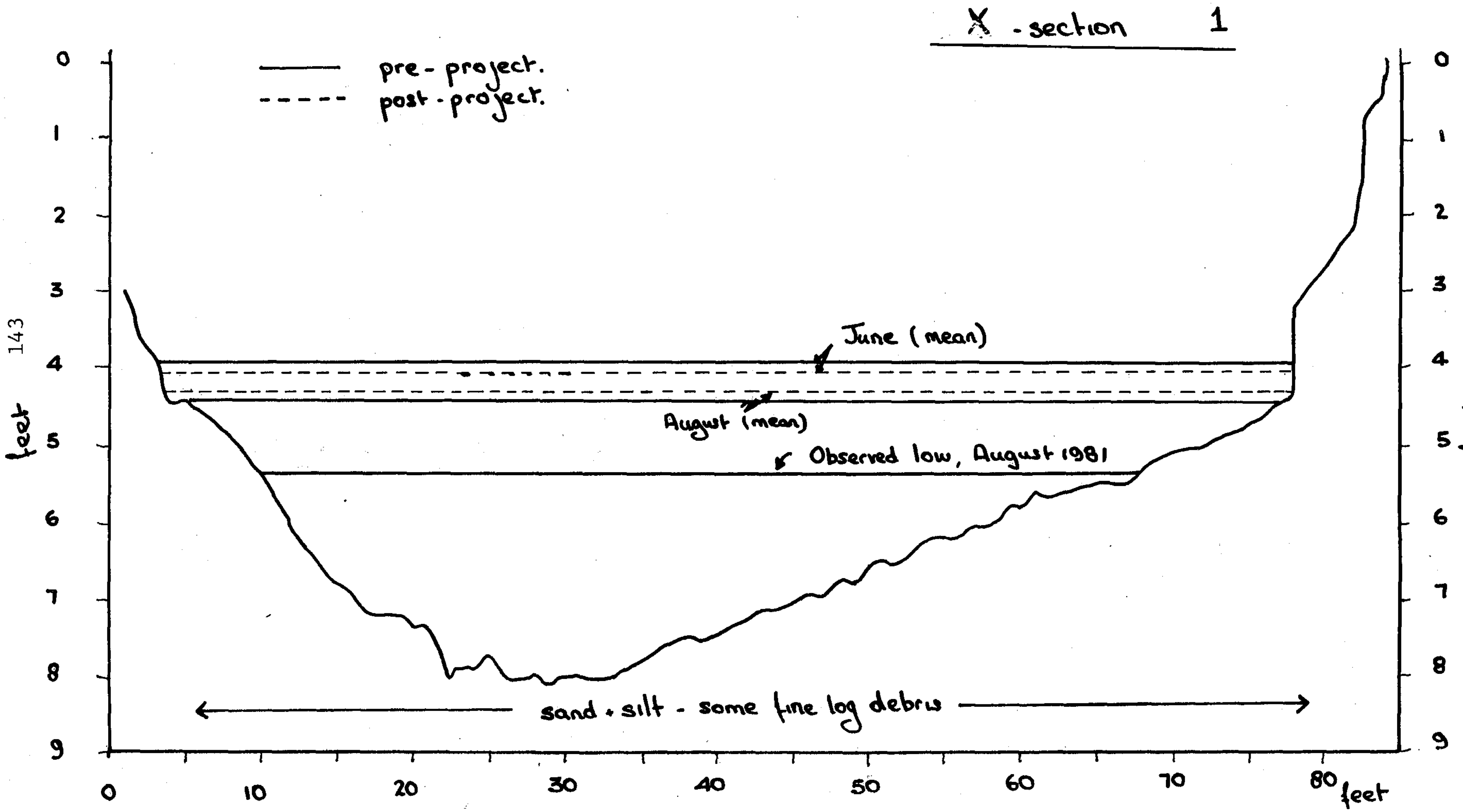
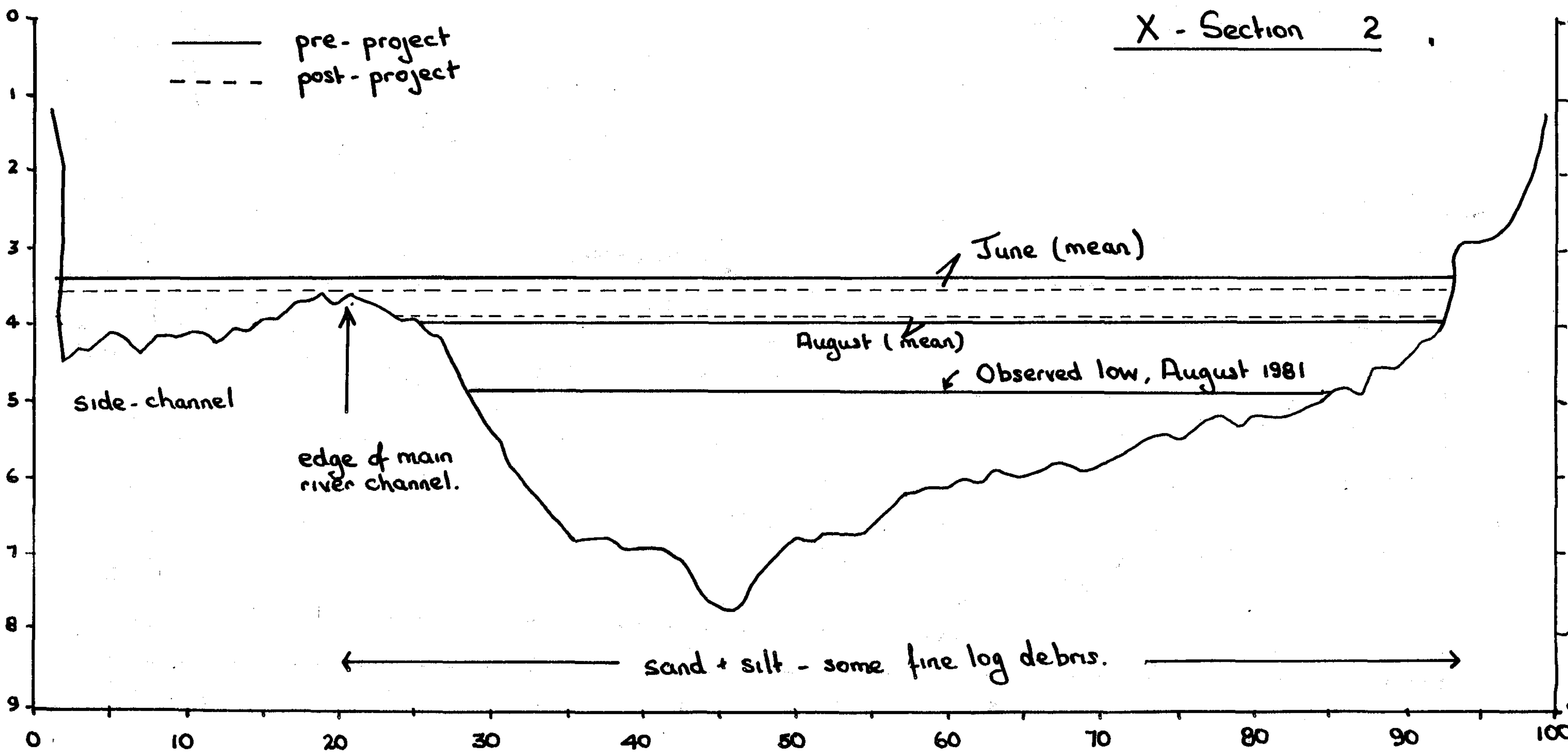

X - section 1
pre - project.
post - project.
June (mean)
August (mean)
Observed low, August 1981
sand + silt - some fine log debris
feet
feet
0
1
2
3
4
5
6
7
8
9
0
10
20
30
40
50
60
70
80
feet

FIGURE 35


X - Section 2
pre - project
post - project
June (mean)
August (mean)
Observed low, August 1981
side - channel
edge of main river channel.
sand + silt - some fine log debris.
0
1
2
3
4
5
6
7
8
9
0
10
20
30
40
50
60
70
80
90
100

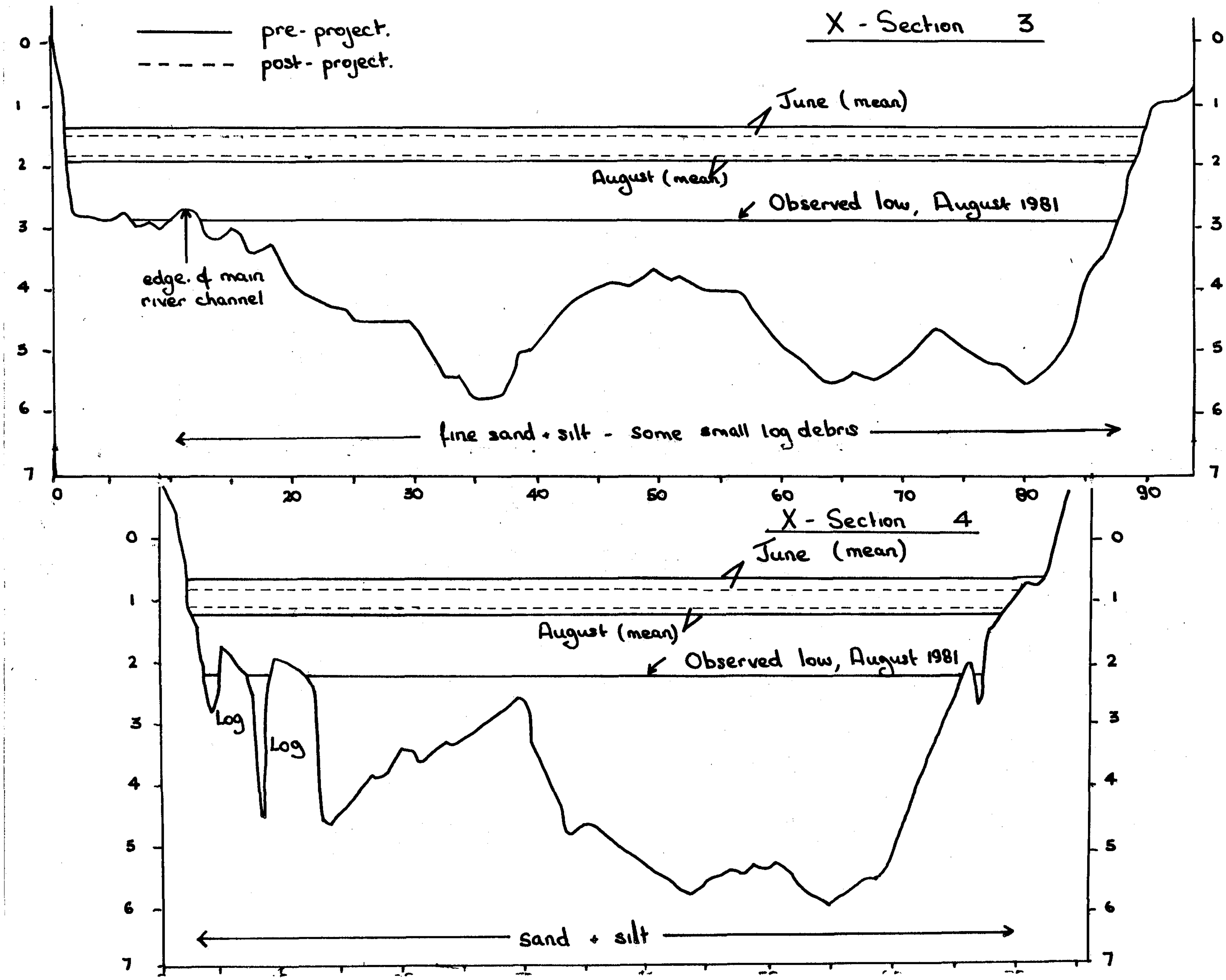

X - Section 3
pre-project.
post-project.
June (mean)
August (mean)
Observed low, August 1981
edge of main river channel
fine sand + silt - some small log debris
0
1
2
3
4
5
6
7
0
20
30
40
50
60
70
80
90
X - Section 4
June (mean)
August (mean)
Observed low, August 1981
Log
Log
sand + silt

FIGURE 36

Table 12 serves particularly to illustrate the interactions which produce stream temperature conditions under natural or regulated conditions, respectively. It also suggests that differences in stream temperature conditions under regulated conditions during the spawning and incubation period are more likely in December through April, with December through March being warmer under regulated conditions by a half degree and April regulated stream temperatures being a half degree cooler. Not shown is the likelihood that temperatures under regulated conditions are apt to be more consistent from day to day.

The effect of these changes in temperature regime upon salmonids could be somewhat earlier emergence of fry from the streambed in the spring. One-half degree increase in intragravel water over December through March (120 days) suggest 60 more temperature units as of 1 April, and perhaps several weeks earlier fry emergence. Sockeye and coho fry would migrate earlier into Black Lake, or into downstream rearing habitats. Pink and chum fry would reach the estuary earlier.

A major key to interpreting project impacts upon spawning above Black Lake will be the degree of success obtained in reintroducing tailrace water in the groundwater route of flow, whether through the existing natural channel or by engineered design. The groundwater aquifer regime produced several beneficial conditions. First, it stabilizes spring fork's flow regime within an observed range of about 4 to 25 c.f.s. Secondly, it acts to dampen the extremes of water temperature -- this is probably most useful in winter when freezing conditions are prevented. Thirdly, the position of the spring fork, being somewhat removed and isolated from the natural channel, makes the bed of the spring fork more stable with reduced mortality. In this evaluation, it has been assumed that the groundwater system will remain under regulated conditions, though possibly altered in temperature conditions, as suggested in the preceeding section.

The effects of hydroelectric regulation on streambed dynamics and bedload movement have only been observed casually in this investigation.

It is evident that the lake fork carries a sizable volume of coarse bedload which produces frequent channel changes. Equally evident is the conclusion that this activity will be reduced when the outflow from Black Bear Lake becomes regulated. This change could prove beneficial to the spawning habitat of the lake fork if the new flow regime re-forms the bed and its materials toward a new dynamic balance with lowered peak flow conditions.

No adverse effects are expected of this project with regard to dissolved oxygen or water chemistry. The primary way in which super saturation of gases could occur in this hydroelectric project would be through allowing a vortex to develop above the lake intake, thus entraining air into the penstock and through the turbines. This condition is as important to avoid from an engineering standpoint as it is from the view of water quality.

In summary, if the groundwater system is maintained, the principal effect on spawning habitat may be alteration of temperature regime. This change is difficult to evaluate because of the important, but poorly understood, role of groundwater flow in moderating water temperatures. The temperature changes expected are small -- $1^{\circ}C$ or less -- but a cumulative temperature unit effect on fry emergence may occur. Earlier emergence by several weeks is possible. For rearing species, sockeye and coho, this alteration might have little significance, since the fry would move earlier into Black Lake or into stream habitats. For the few chum salmon, or the pink run (suspected to occur erratically or on alternate years above Black Lake), earlier emergence and migration into the estuary may induce greater mortality.

The flow and streambed characteristics of spawning habitat in the lake fork could be improved. This would principally benefit the pink run, which seems to utilize this area.

Rearing habitats above Black Lake

Rearing habitats above Black Lake, identified as zone I in this report, include the mainstream channel and the beaver ponds located on the westerly side of the lower creek and in the lake fork. Coho fry and fingerling are the principal users, along with a few Dolly Varden. About 80-85% of coho fingerling use was in the main stream, with the remainder being nearly evenly divided between the lower beaver ponds and the upper ponds on the lake fork.

Principal hydroelectric effects which may influence rearing habitat and production are water level/water velocity and water temperature. In addition, the indirect effect of improved access to trap and remove the beaver population may impact pond rearing areas.

The first 2,500-3,000 feet of stream channel above Black Lake is in zone I, and channel cross sections 1 through 11 (Figures 34 - 42) are provided to evaluate effects on channel water levels from hydroelectric regulation. These cross sections have been fitted with average monthly flow levels for June and August, which are derived from the evaluation of Black Lake levels under regulation shown in Figure 43. June and August were selected because they show the largest regulated change from natural conditions of months during the active rearing season. Also used are elevation adjustments according to small, surveyed increases in stream water level upstream from Black Lake. This amounted to 0.3 feet between the lake mouth and cross section 11.

Cross sections 1-11 show that the regulated reductions of averaged June water levels will have little effect on stream habitat, nor do the regulated increases in August show much change compared to the monthly mean of natural levels. The stream level difference produced under regulated versus natural flow regimes are more likely to be a function of the extremes than the means, as suggested in the figures by the level of the observed low, August, 1981, which clearly shows in a number of sections the loss of streamside habitat valuable to rearing coho. A display of levels of extreme lows under natural and regulated regimes was not attempted, but the earlier work by Harza with synthesized flows (Feasibility Report and FERC license application) clearly shows that sizable reductions in the range of low flows and consequently beneficially reduced range of lake and atream levels compared to natural conditions are anticipated in all summer months.

FIGURE 37

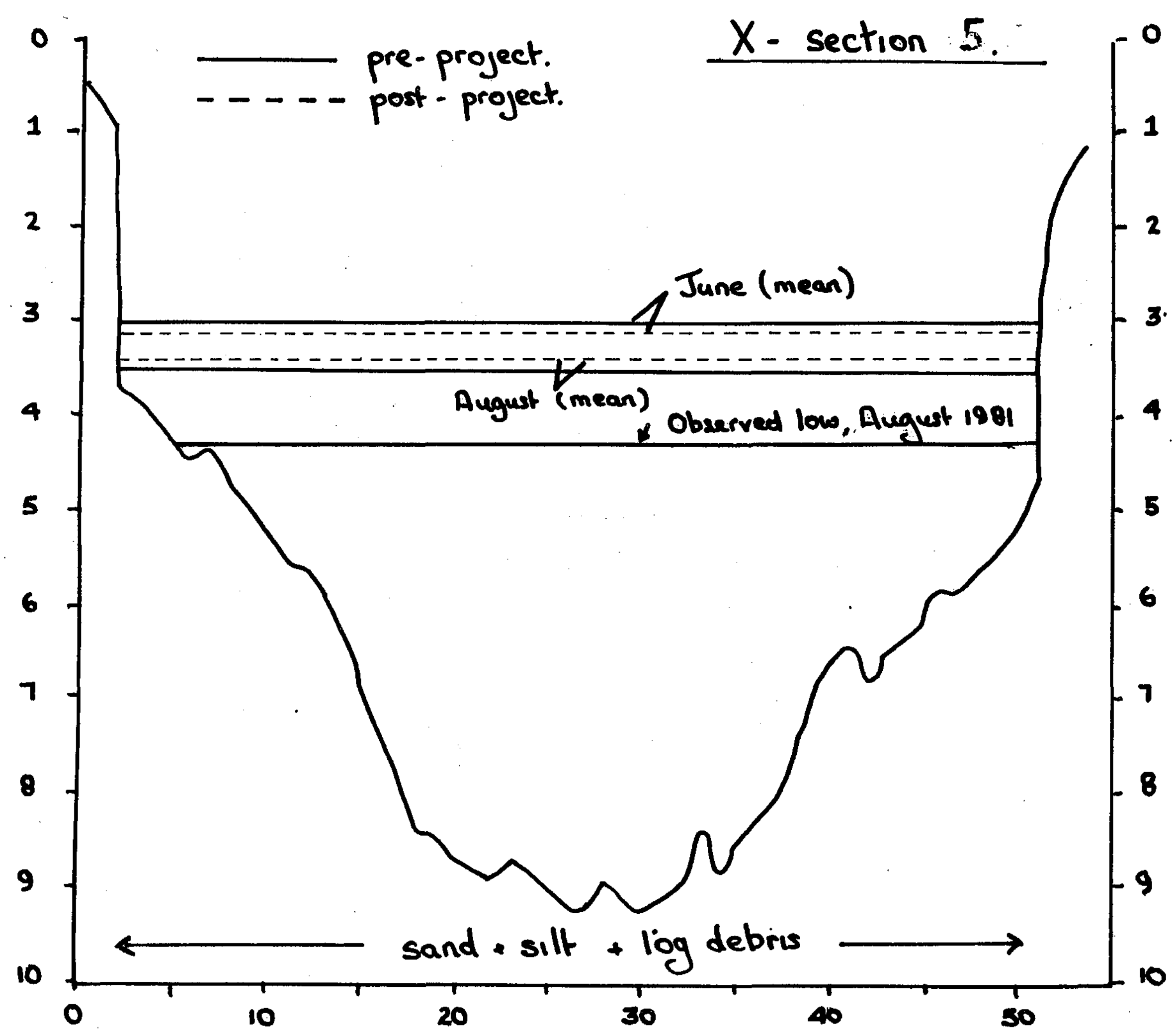
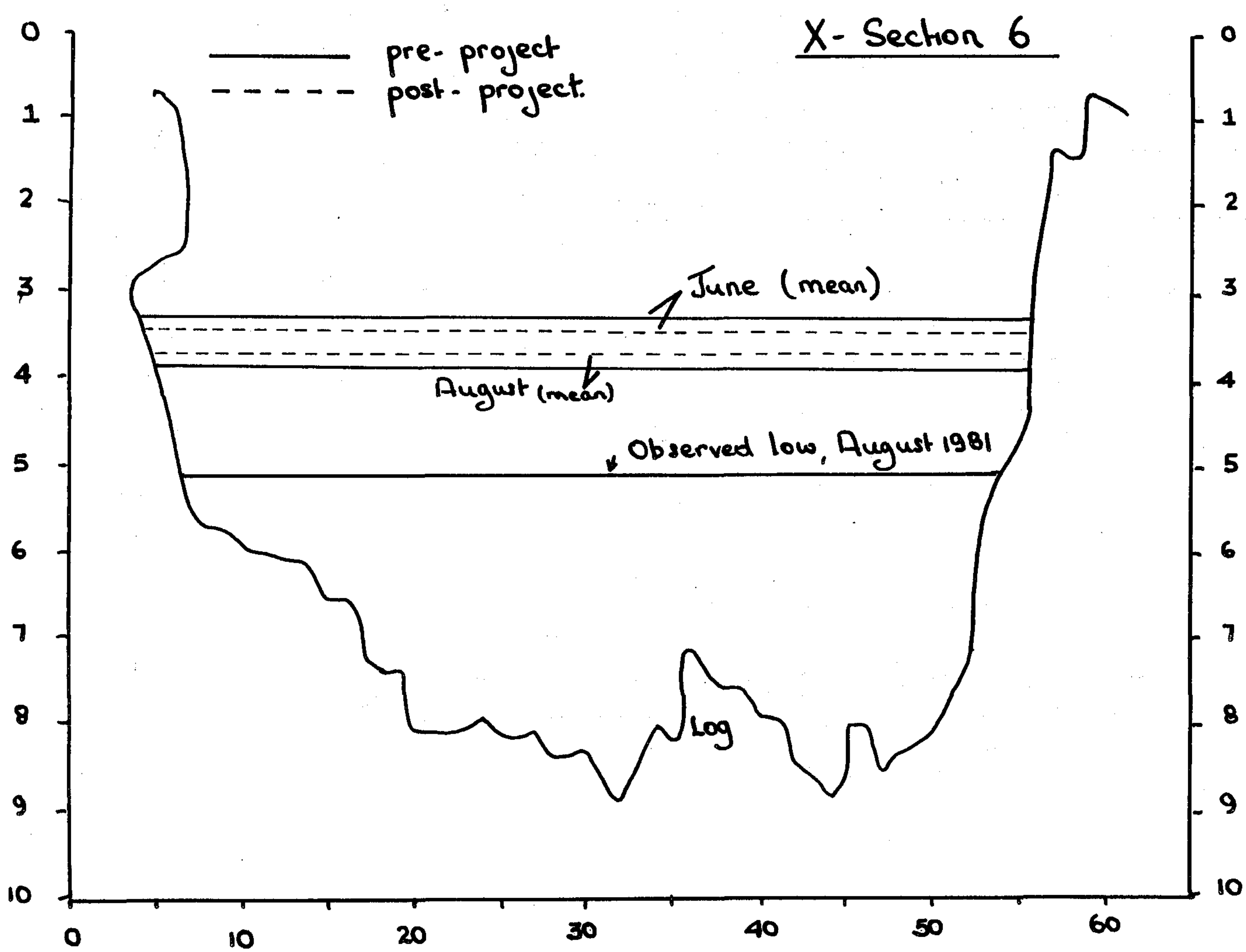

X - section 5.
pre- project.
post - project.
June (mean)
August (mean)
Observed low, August 1981
sand + silt + log debris
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50

FIGURE 38



X- Section 6
pre- project
post- project
June (mean)
August (mean)
Observed low, August 1981
Log
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60

FIGURE 39

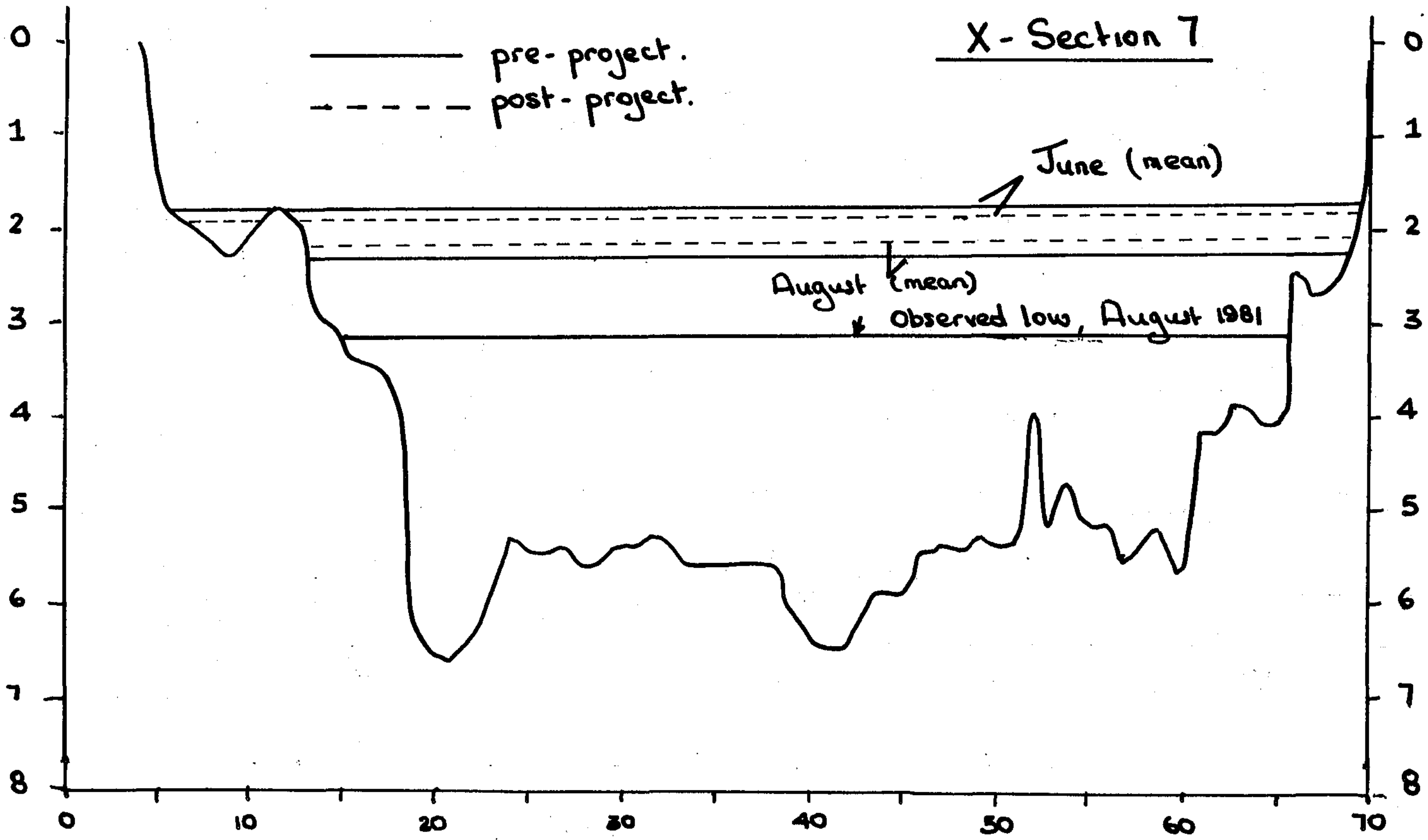
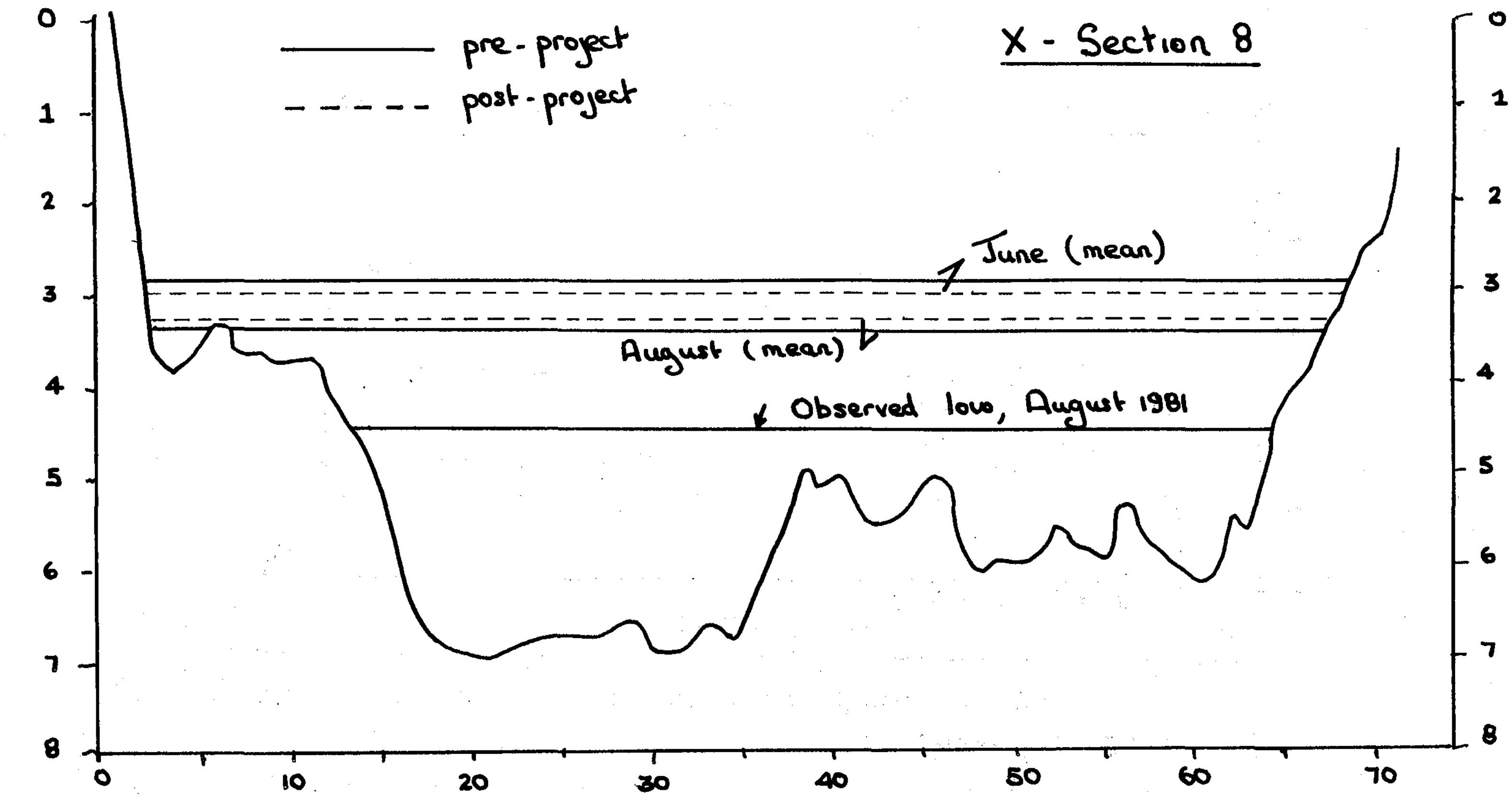
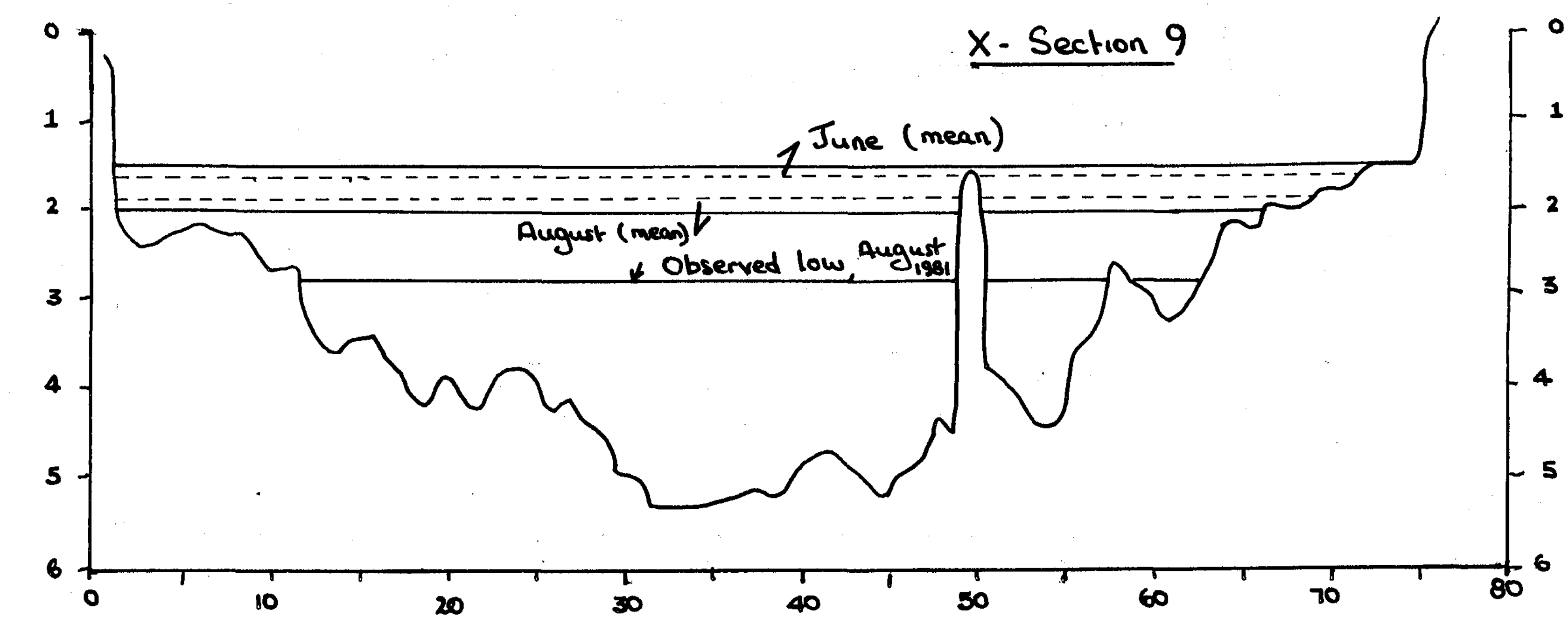

X - Section 7
pre- project.
post- project.
June (mean)
August (mean)
Observed low, August 1981
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70

FIGURE 40

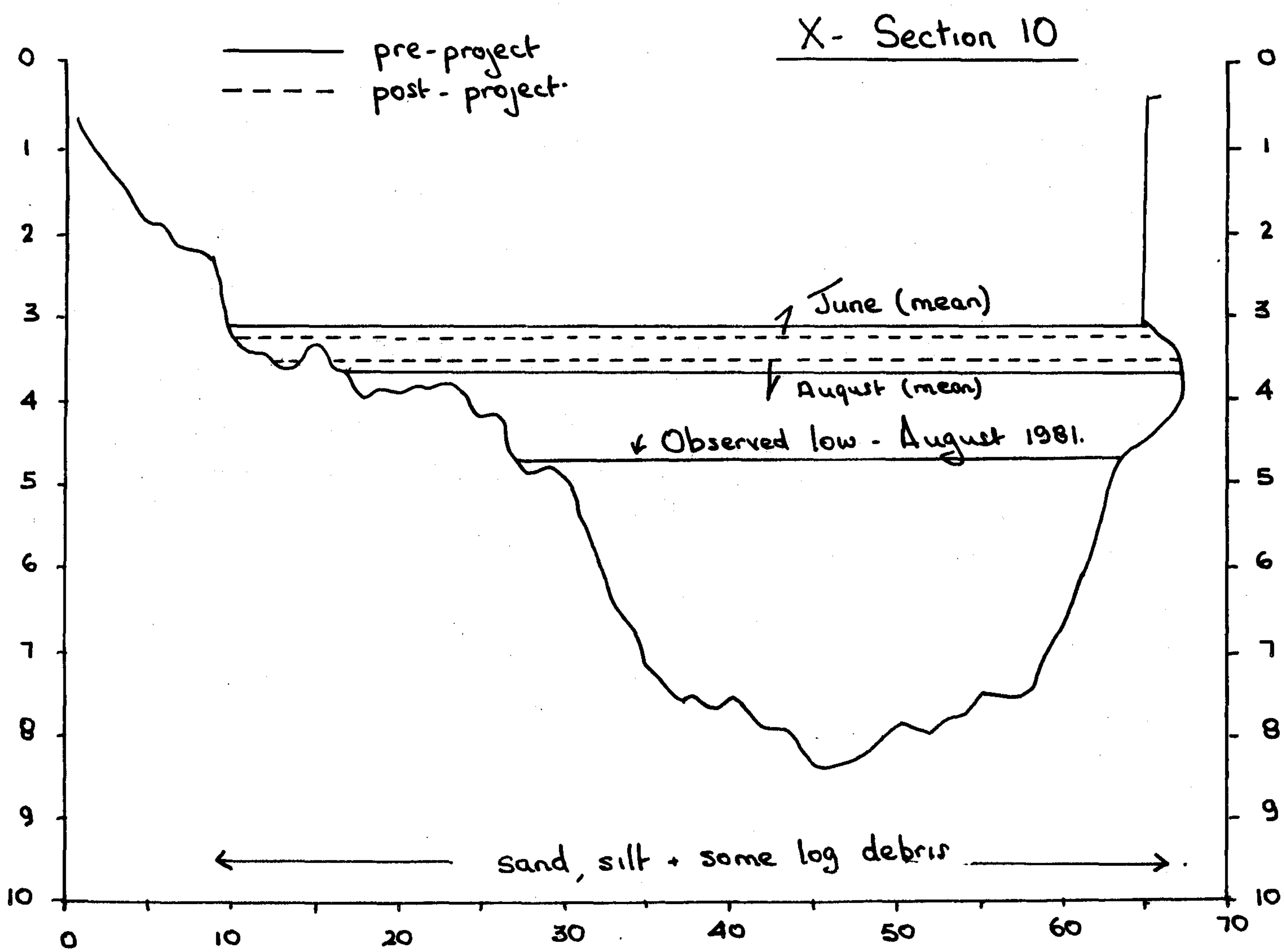


X - Section 8
pre - project
post - project
June (mean)
August (mean)
Observed low, August 1981
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70



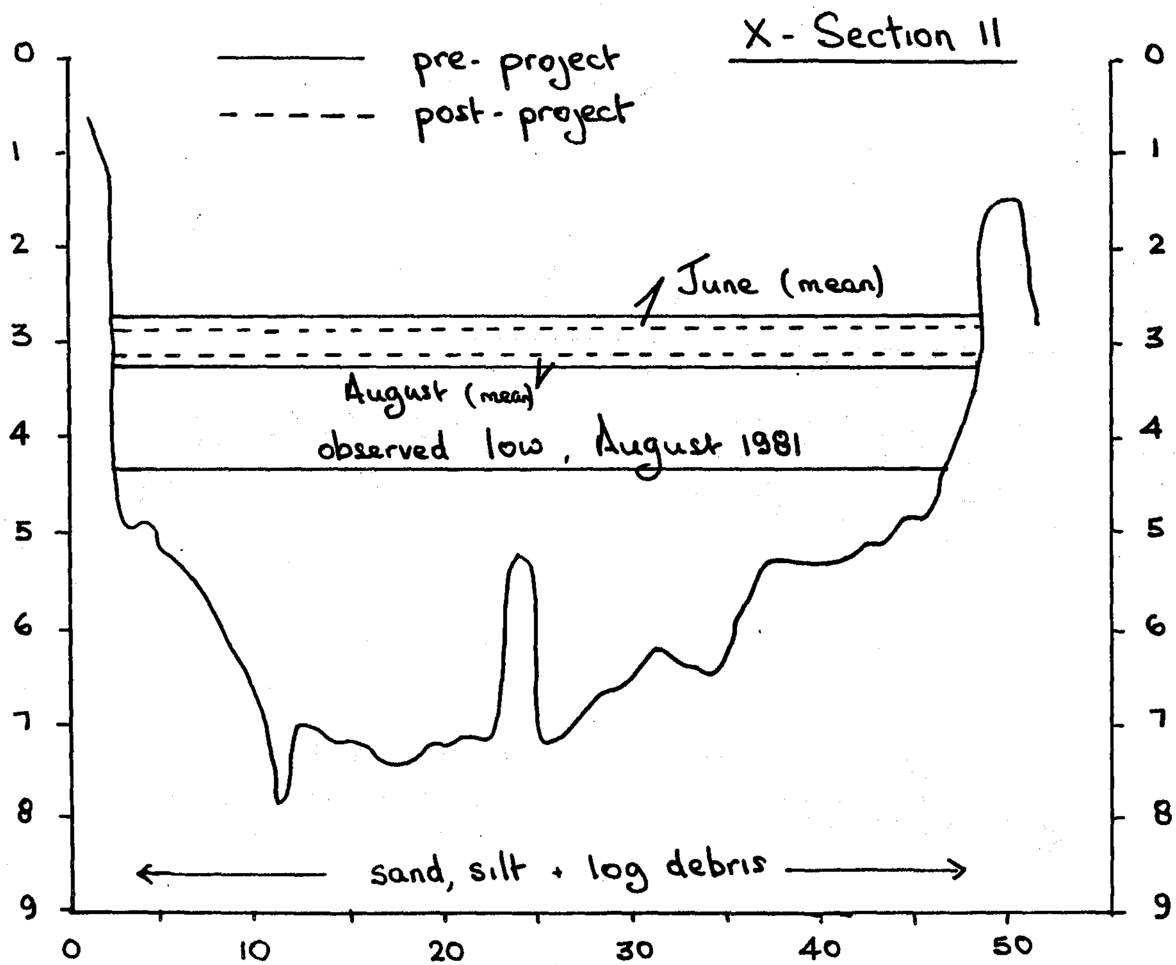
X - Section 9
June (mean)
August (mean)
Observed low, August 1981
0
1
2
3
4
5
6
0
10
20
30
40
50
60
70
80

FIGURE 41



X- Section 10
pre-project
post-project
June (mean)
August (mean)
Observed low - August 1981.
sand, silt + some log debris
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70

FIGURE 42


X - Section 11
pre - project
post - project
June (mean)
August (mean)
observed low, August 1981
sand, silt + log debris
0
1
2
3
4
5
6
7
8
9
0
10
20
30
40
50

This will reduce lows such as in August, 1981. In that month, for example, the measured low flow at Black Bear Lake (U.S.G.S.) for August was 4.1 c.f.s. This compares with a projected tailrace discharge for August ranging between 23 and 39 c.f.s. Rearing fish will benefit from the more constant stream levels with regulated flows.

The changes in water temperatures suggested in the Effects on spawning habitat section are generally valid here, although the differences between natural and regulated temperatures will be less in this downstream location. These temperature differences will have little direct effect on rearing habitat. A temperature factor of greater importance is the more sustained volume of flow during summer months, which prevents or reduces the occurrence of local high temperature along shoreline pool areas. The sum of project effects on coho habitat in the mainstream is likely to be favorable.

Beaver pond areas above Black Lake are not likely to fare as well with regard to rearing habitat. Two factors may combine to reduce the effectiveness of beaver pond habitat: loss of access into the ponds by salmon adults and young during high water periods; and reduced beaver population from possibly trapping with resulting deterioration in beaver dams and swim routes.

In time, the lack of beaver maintenance of ponds may result in elimination of the pond area in the lake fork, and in gradual reduction in ponded area in the lower part of the system.

Reduction in number of beaver in the upper drainage will depend upon trapping pressure and also immigration of new beaver populations. The more conservative assumption, however, is that beaver will be eliminated and their ponds after them. Accordingly, possible losses in productive coho rearing area may result from increased human access.

In summary, the most important mainstream rearing habitat will not be harmed by hydroelectric project regulation, and may well be benefitted. No quantitive fix was attempted on the magnitude of this benefit.

On the other hand, much of the beaver pond habitat could be damaged from improved access. The portion of the rearing fish in the beaver ponds in zone I is about 15 - 20% of the total.

Black Lake as a rearing habitat and migrating route for salmonids

An evaluation was made of Black Lake levels during averaged flow conditions with and without regulation. The discharge/lake level relation shown in Figure 2 was used to convert flow assumptions provided in the FERC License Application into average monthly lake levels (Figure 43). The flows assumed for this synthesis (see Table 13) are derived from the FERC License Application, Figure W-16 of Exhibit W.

	UNREGULATED CONDITIONS		REGULATED CONDITIONS	
Month	Outlet, Black Lake Unregulated Flow	Black Lake Level	Outlet, Black Lake Regulated Flow	Black Lake Level
Jan	53 cfs	2.88 ft	63 cfs	2.98 ft
Feb	48	2.82	61	2.96
Mar	36	2.68	49	2.83
Apr	65	3.00	65	3.00
May	108	3.42	97	3.32
June	109	3.42	93	3.30
July	60	2.95	76	3.10
Aug	55	2.90	76	3.10
Sept	88	3.25	88	3.25
Oct	150	3.80	140	3.70
Nov	116	3.50	114	3.48
Dec	104	3.40	96	3.32

TABLE 13: Assumed Black Lake outflows under regulated and unregulated conditions, used to derive corresponding Black Lake levels. Assumed outflows are from the License Application. Unregulated flows are synthesized monthly means. Regulated flows are taken as mid-point of environmentally modified regulated flow regime, with no spill.

Levels of Black Lake in January, February, March, July, and August are projected to rise about 0.1 foot with regulation. Levels during May, June, and October would lower by a similar amount.

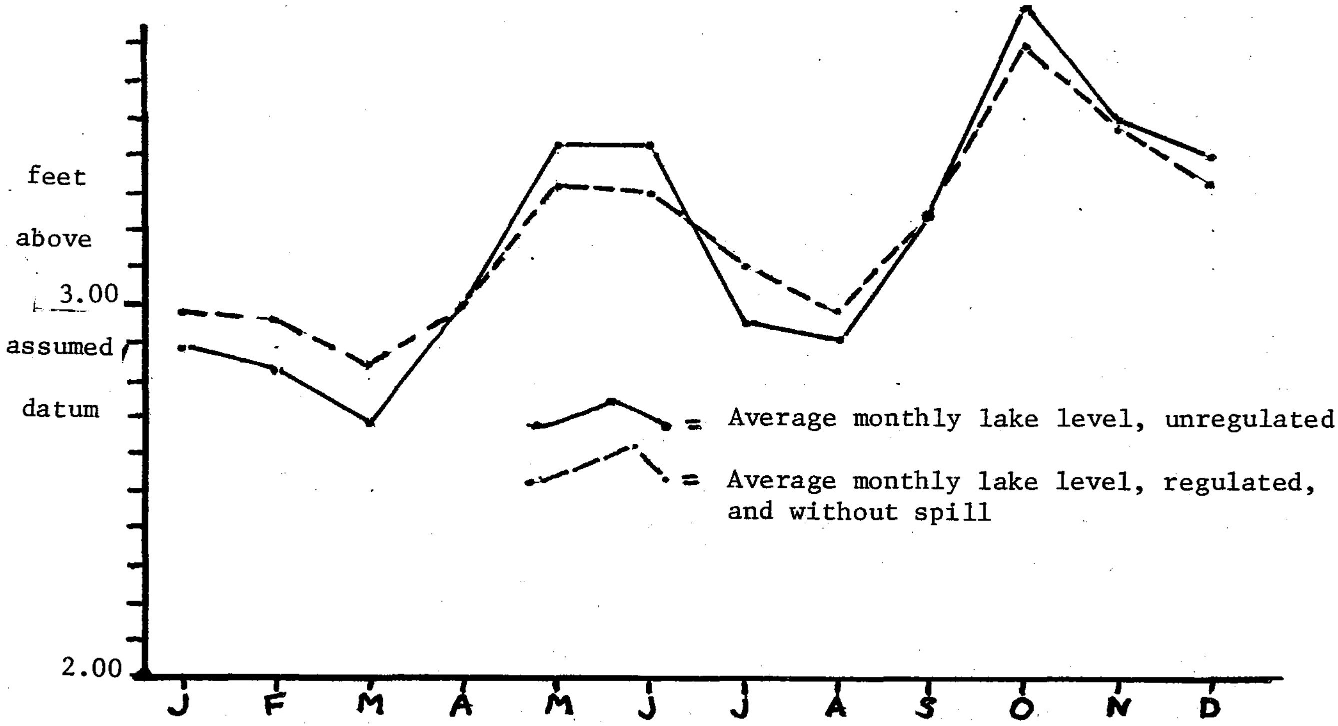


FIGURE 43: Synthesized levels of Black Lake under regulated and unregulated conditions.

These projected levels do not, of course, reflect the natural variability in level which will result from rain or drought periods. The small differences in average level shown in Figure 43 also indicates those periods when normal peak or low extremes of lake levels will be moderated, probably much more than the mean levels shown. This larger moderation of extremes will reflect the fact that about 25% of the Black Lake watershed will be under total regulation.

A related flow effect on Black Lake may concern ice forming and melting conditions. December flows, as projected with no spill (Fig. W-15, License App. Exhibit W) will be reduced about 9% under the normal mean: January flows increase 22%; February flows increase 30%; and March flows increase 40%. This change in flow regime will markedly influence the heat balance in Black Lake. The likely effect may include earlier ice formation if cold weather comes in December, but most importantly, Black Lake ice, when formed, is not as likely to stay or to form thickly, due to a much increased supply of heat laden water. Lake breakup will come earlier.

Change in heat flow into and out of Black Lake does not, however, suggest sizable change in lake water temperatures. We do not have sufficient lake and weather information to calculate lake surface heat losses or gains -- and then to evaluate changes in lake temperatures -- but it is likely that lake surface temperatures in winter will show little increase, with the small increases anticipated upstream, and surface temperatures could actually decrease because the water surface is not protected by ice cover, and is exposed to wind chill.

Summer surface water at the inlet to Black Lake may experience small reductions in temperature as a result of regulations, but this effect is likely to be masked in the lake itself by much larger heating or cooling effects observed to occur in Black Lake. Little change in surface temperature regime is anticipated in Black Lake.

Winter-spring dissolved oxygen levels in Black Lake may increase as a result of reduced ice cover but there has been no evidence of significant oxygen depression in most of the water column of this lake.

No evidence has been found indicating that Black Lake's naturally low productivity will be significantly altered by upstream regulation.

It is possible that as a result of altered ice conditions in Black Lake, fry and smolt migration out or through the lake will be changed.

Below Black Lake

Effects of flow regulation of the hydroelectric project upon Black Bear Creek fishery habitats below Black Lake will result primarily from alteration in stream temperature or streamflow regimes. Both of these features were examined by Environaid in our Phase I study (12-15-80).

Subsequent to that report, it was decided to limit further work to effects above the mouth of Black Lake. Accordingly, no comprehensive attempt will be made to further review possible impacts below Black Lake.

Briefly, those physical effects were determined then, and are still believed, to be:

Temperature	Very small effect at the lower river for most flow conditions. During winter low flow periods: small temp. increases downriver. Summer low flow periods: small temp. decreases downstream. The magnitude of winter temp. projected changes established in the December, 1980, study was based upon 2°C difference between unregulated and regulated water temperatures, since the role of the groundwater system was not recognized at that time. Consequently, the predicted differences at the mouth of Black Bear Creek between unregulated and regulated temperatures in earlier work were higher than are now expected.
Flow	Low flows in both winter and summer would be significantly augmented. A reduction of about 15% in twenty-year peak flow at the stream mouth is projected. Intermediate flows would feel little effect.

We have not studied the fisheries of the stream below Black Lake, and have attempted no review of project impacts upon this resource.

EFFECTS OF PROPOSED HYDROELECTRIC PROJECT ON WILDLIFE AND THEIR HABITATS

Bear

The major effect on large mammals in the upper valley will be the increased access to the area by humans via the road to the power house. Bear hunting is very popular on Prince of Wales Island, and in a small, confined area such as this valley, it will be easy to eliminate the one or two resident bears by hunting. With the bear hunting season running from September to June, the transient bears that come into the area to feed upon salmon will also become targets.

If care is not taken with the disposal of garbage during the construction phase and thereafter, bears may well become camp nuisances, foraging in the waste and abandoning some of their wild ways in favor of an easy handout.

If the salmon runs are adversely affected by the project, bear use of the upper valley may decrease.

Vegetative destruction necessary for the access road is not likely to be of major significance to the bears, nor is the construction of the power house and road. Bears will probably use the road to some extent for transit.

Beaver

Increased access is likely to increase trapping pressure on furbearers, particularly when fur prices are high. One good trapper would have little difficulty in trapping out the beaver population in the valley above Black Lake. As these animals are marvelously efficient in maintaining ponded areas for their own use, simultaneously creating extensive coho rearing areas, efforts should be made to protect them.

If the access road to the power house site skirts the valley wall and does not come close to the creek, and the animals are not trapped, it is possible they may continue to reside in the valley. In the event that the beaver are trapped out, the substantial population of beaver below Black Lake may serve as a reservoir -- these beaver will probably repopulate upper Black Bear Creek in time, provided the area remains in a natural state.

Fluctuating water levels may adversely affect beaver habitat, particularly in winter when a stable water level in a resident bond is desirable.

Deer

Deer use of the study area is presently very low. Increased hunting pressure may occur as a result of increased access, although it is possible that the confined nature of the valley does not lend itself to increased deer use. The major effect on deer is the loss of important old growth habitat in the lower valley below Black Lake; with this habitat diminished, deer are less likely to occur in the drainage.

Wolf, Mink, Marten, Otter, Weasel

These animals are likely to face increased trapping pressure due to greater access by humans. All of these species feed upon salmon as well, and would be directly affected by reductions in anadramous fish populations.

Much of the human pressure upon these resident mammals could be relieved by closing the road from Black Lake to the power house. In the two years of the study, only seven people have walked or paddled to the upper reaches of Black Lake during the time the study team was in the area. The dense brush and generally poor walking conditions preclude all but the highly motivated from venturing up Black Bear Creek above the lake. However, the logging road access to Black Lake has greatly increased sportfishing pressure on the lower lake, and it is likely that when word gets out about the furbearer population in the upper valley, it is merely a matter of time and price before these animals are subjected to trapping pressure -- pressure which the beaver population cannot bear.

APPENDIX

APPENDIX TABLE 1: Streamflow Measurements in Upper Black Bear Creek.

Date	1/ mouth, Bl. Bear Lk. (daily mean)	1000' below falls	Lk. fk. near springs	in spring-fed fork	2/ below Bl. Bear Lk. system	3/ south fk. tributary	4/ at mouth Bl. Lk.
	-cfs-	-cfs-	-cfs-	-cfs-	-cfs-	-cfs-	-cfs-
8-13-81	0800= 2.50 1200= 2.83	-	-	-	0900= 7.79	1000= 3.25	1500=12.38
8-18	1200= 1.41 1800= 2.13	-	-	-	1300= 4.29	1400= 1.72	1600= 7.20
8-28	0800= 9.7	-	-	-	0900=18.38	1000= 9.89	1500=39.51
9-5	0800=15.1 1200=17.1	-	-	-	0900=24.2	1000=32.07	1500=34.64
9-7	0700=110 1200= 92	-	-	-	0800=112.53	0900=54.64	1300=291.26
9-16	0800=50.8 1200=46.5	-	-	-	0900=65.96	1000=37.16	1500=143.75
10-22	0800=12.4 1200=12.0	-	-	-	1000=19.52	1100=13.28	1400=47.54
10-24	0800= 9.96 1200= 9.96	-	-	-	0900=19.29	1000=29.36	1400=70.54
4-16-82	6.5	-	-	-	1700=27.05	1800= 7.42	(70)
4-25	9.0	-	-	-	22.21	7.72	32.41(30)
5- 5	11.0	-	-	-	1530=28.39	1630=24.46	50.13(55)
5-17	30	-	-	-	-	-	1100=114.18(105)
5-18	39	-	-	-	48.27	88.24	(135)
5-20	53	-	-	-	-	-	223.64 228.88(210)
5-26	46	-	-	-	1000=56.42	1100-34.79	158.30(164)
5-28	36	-	-	17.30	42.49	1330=37.06	(135)
5-31	55	-	-	24.58	-	-	(185)
6-18	53 (staff rdg)	-	-	-	-	-	(135)
6-20	-	59.18	28.53	-	-	-	(145)
6-21	-	-	21.07 21.90	16.24 16.90	-	-	(115)

1/ Provisional U.S.G.S. data, except where indicated. Drainage area = 1.92 mi^2.

2/ Drainage area = 3.34 mi^2. Measurements 3/4 mile below Black Bear Lake.

3/ Drainage area = 2.20 mi^2. Measured near (3/), where tributaries meet.

4/ Drainage area = 7.34 mi^2. Values in ( ) are from rating curve. Others are measurements.

TABLE A2: Daily Mean Water Temperatures (°C)

Date	BBL Mean	SGS Mean	UBL Mean	LBL Mean	MBC Mean
8- 7-81					15.8
8			12.4	15.3	14.9
9			12.3	16.0	15.8
10		12.0	12.5	16.0	16.6
11	14.5	11.8	12.6	17.1	16.3
12	14.6	11.7	12.6	16.8	16.5
13	14.4	11.5	12.0	16.7	15.9
14	14.4	11.4	11.9	16.8	15.9
15	15.0	11.3	12.3	17.2	16.1
16	14.6	11.1	11.5	16.4	15.6
17	14.5	11.1	12.1	16.0	15.2
18	14.7	11.0	12.2	16.3	15.3
19	13.9	11.0	11.8	16.2	15.1
20	13.3	10.8	11.5	15.6	14.8
21	13.3	11.4	10.9	15.2	13.4
22	13.1	11.9	11.1	14.4	13.8
23	13.4	11.8	11.2	14.1	13.8
24	13.5	11.8	11.3	14.6	13.9
25	13.2	11.7	11.2	14.3	13.9
26	13.1	11.8	11.0	14.3	13.1
27	13.2	11.8	11.1	14.0	13.5
28	12.9	11.8	11.2	13.5	13.4
29	13.1	11.7	11.5	13.7	13.3
30	12.9	11.4	11.2	13.5	13.3
31	12.5	11.4	11.3	13.9	13.3
9- 1-81	12.8	11.3	11.4	14.4	13.6
2	12.9	11.0	10.9	13.9	13.3
3	12.6	11.0	11.1	13.8	13.5
4	12.6	11.0	11.3	13.8	13.5
5	12.2	10.9	10.8	13.8	12.7
6	12.4	11.2	11.3	13.2	12.3
7	12.3	11.7	11.7	12.6	12.4
8	12.1	11.9	11.6	12.2	12.2
9	11.9	11.9	11.4	12.1	12.0
10	11.7	11.7	11.1	11.8	11.6
11	11.4	11.4	10.7	11.5	11.2
12	11.1	11.1	10.5	11.2	11.0
13	11.1	11.0	10.5	11.5	11.3
14	10.7	11.0	10.6	11.4	11.3
15	10.7	11.1	10.8	11.0	11.1
16	10.9	10.9	10.5	11.5	11.1
17	11.0	10.8	10.9	11.5	11.7
18	10.6	10.8	10.9	11.5	11.7
19	10.4	10.8	10.5	11.5	11.2
20	10.4	10.8	10.4	11.6	11.0
21	10.5	10.5	10.2	11.9	10.9
22	10.4	10.4	10.0	11.8	11.0
23	10.0	10.3	9.7	11.6	10.7

Date	BBL Mean	SGS Mean	UBL Mean	LBL Mean	MBC Mean
9-24-81	10.2	10.2	9.9	11.6	10.7
25	10.0	10.0	9.5	11.1	10.1
26	9.8	9.8	9.1	11.2	9.5
27	9.8	9.8	9.3	11.1	9.9
28	9.4	9.6	9.1	10.7	9.7
29	9.1	9.6	9.0	10.4	9.5
30	9.2	9.6	9.1	10.1	9.1
10- 1-81	9.0	9.3	8.5	9.6	8.9
2	8.9	9.1	8.4	9.3	8.7
3	8.7	9.0	8.3	9.1	8.3
4	8.6	8.7	7.9	8.7	7.6
5	8.1	8.6	8.1	8.6	7.9
6	8.1	8.6	8.2	8.8	7.9
7	8.1	8.4	7.9	8.8	8.2
8	7.7	8.3	7.8	8.5	8.0
9	7.9	8.1	7.2	8.3	7.2
10	7.8	8.0	7.0	8.1	7.1
11	7.8	8.0	7.1	8.0	7.0
12	7.8	8.0	7.4	8.2	7.3
13	8.2	8.0	8.0	8.7	8.4
14	8.2	8.1	8.4	9.5	9.3
15	8.0	8.2	8.4	8.8	8.6
16	8.0	8.3	8.4	8.6	8.4
17	7.9	8.4	8.7	8.6	8.4
18	7.8	8.3	8.0	8.2	7.9
19	7.6	8.0	7.7	8.0	7.7
20	7.9	7.9	7.2	7.7	7.4
21	8.3	7.8	7.8	8.4	8.1
22	8.0	7.7	8.2	8.7	8.4
23	8.4	8.1	8.6	8.8	8.6
24	8.5	8.4	9.0	8.9	8.7
25	8.3	8.4	8.6	8.8	8.6
26	7.9	8.1	8.2	8.7	8.4
27	7.8	8.0	8.2	8.5	8.2
28	7.5	7.9	7.9	8.3	8.0
29	7.4	7.6	7.7	8.1	7.8
30	6.8	7.4	7.4	7.8	7.5
31	6.7	7.1	7.2	7.4	7.1
11- 1-81	6.6	7.3	7.3	7.2	6.9
2	6.5	7.0	7.0	6.9	6.6
3	6.4	6.8	7.0	6.8	6.4
4	6.6	7.3	7.7	6.9	6.6
5	6.7	7.6	8.0	7.7	7.4
6	6.6	7.3	6.9	7.5	7.2
7	6.1	7.1	6.5	6.8	6.4
8	6.1	7.2	7.2	6.7	6.3
9	6.4	7.2	7.9	6.9	6.6
10	6.4	7.5	8.1	7.3	7.0
11	6.4	7.6	7.9	7.6	7.3
12	6.1	7.4	7.3	7.5	7.2
13	5.9	7.2	7.3	7.3	7.0

synthesized values

Date	BBL	SGS	UBL	LBL	MBC
	Mean	Mean	Mean	Mean	Mean
11-14-81	5.9	7.1	6.9	6.9	6.6
15	5.7	6.9	6.9	6.8	6.4
16	5.5	6.9	6.6	6.5	6.1
17	5.1	6.8	6.2	6.1	5.7
18	4.7	6.7	6.0	5.9	5.5
19	5.2	6.7	6.7	6.2	5.8
20	5.3	6.1	6.6	6.7	5.7
21	5.2	6.7	6.7	6.1	5.7
22	5.2	6.7	6.9	6.1	5.7
23	5.2	6.7	6.8	6.1	5.7
24	4.9	6.5	6.5	5.9	5.5
25	5.0	6.4	6.2	5.9	5.5
26	4.9	6.4	5.6	5.5	5.1
27	4.9	6.3	5.8	5.6	5.2
28	5.2	6.2	6.4	5.7	5.3
29	5.0	6.2	6.0	5.7	5.3
30	4.5	6.0	5.8	5.6	5.2
12- 1-81	4.3	6.1	5.8	5.4	5.0
2	4.2	6.0	5.5	5.0	4.6
3	3.9	5.9	5.5	4.9	4.4
4	3.4	5.9	5.5	4.7	4.2
5	3.4	6.0	5.5	4.8	4.4
6	2.8	5.9	5.0	4.7	4.2
7	2.5	5.5	4.6	4.4	3.9
8	2.3	5.5	4.3	4.3	3.8
9	2.0	5.2	3.8	4.0	3.5
10	1.9	5.2	3.3	3.7	3.2
11	1.7	5.2	3.4	3.7	3.2
12	1.7	5.1	3.6	3.5	3.0
13	1.1	5.0	3.1	3.2	2.7
14	1.0	5.0	3.3	3.2	2.7
15	1.8	5.1	3.9	3.3	2.8
16	1.7	5.1	4.2	3.3	2.8
17	1.8	5.2	4.6	2.7	2.1
18	2.4	5.1	5.3	3.5	3.0
19	2.7	5.0	5.0	4.1	3.6
20	2.6	5.1	4.6	4.1	3.6
21	2.2	4.9	4.5	3.7	3.2
22	2.1	4.8	4.5	3.9	3.4
23	1.8	4.8	4.5	3.8	3.3
24	1.8	4.5	4.5	3.8	3.3
25	1.9	4.6	4.5	3.7	3.2
26	1.8	4.6	4.2	3.6	3.1
27	1.8	4.5	3.9	3.4	2.9
28	1.7	4.4	3.0	3.4	2.9
29	1.7	4.2	2.3	3.3	2.8
30	1.6	4.1	1.8	3.1	2.6
31	1.6	4.0	2.0	2.8	2.2
1- 1-82	1.6	3.9	1.9	2.5	1.9
2	1.6	3.8	1.7	2.3	1.7
3	1.6	3.6	1.7	2.0	1.4

← synthesized values →

Date	BBL Mean	SGS Mean	UBL Mean	LBL Mean	MBC Mean
1- 4-82	1.7	3.5	1.6	1.3	0.7
5	1.6	3.5	1.6	0.8	0.2
6	1.4	3.6	1.6	1.2	0.6
7	1.4	3.9	1.8	1.2	0.6
8	1.6	3.7	1.5	1.5	0.9
9	1.6	3.6	1.7	1.9	1.3
10	1.8	3.8	3.0	1.7	1.1
11	1.8	3.9	3.2	2.1	1.5
12	1.8	3.7	3.2	2.3	1.7
13	1.8	3.7	2.6	2.1	1.5
14	1.8	3.7	3.3	2.5	1.9
15	1.8	3.4	2.5	2.5	1.9
16	1.7	3.3	2.9	2.3	1.7
17	1.8	3.3	2.9	2.1	1.5
18	1.7	3.1	2.0	2.2	1.6
19	1.6	3.2	1.6	2.1	1.5
20	1.6	3.0	1.5	1.6	1.0
21	1.5	2.7	1.4	1.0	0.4
22	1.4	2.2	0.8	1.0	0.4
23	1.5	2.4	0.8	0.9	0.3
24	1.4	2.6	0.8	1.0	0.4
25	1.3	2.8	0.9	1.1	0.5
26	1.5	2.6	0.8	1.0	0.4
27	1.6	2.6	0.8	1.0	0.4
28	1.7	2.7	1.2	1.1	0.5
29	1.5	2.7	1.3	1.1	0.5
30	1.6	2.7	1.6	1.1	0.5
31	1.6	2.7	1.5	1.1	0.5
2- 1-82	1.6	2.8	1.6	1.4	0.8
2	1.9	2.8	1.5	1.4	0.8
3	1.8	2.8	1.7	1.4	0.8
4	1.6	2.7	1.9	1.5	0.9
5	1.6	2.7	2.1	1.5	0.9
6	1.7	2.6	1.9	1.7	1.1
7	1.7	2.6	1.6	1.7	1.1
8	1.7	2.7	1.5	1.7	1.1
9	1.8	2.7	1.7	1.8	1.2
10	1.7	2.7	1.9	1.8	1.2
11	1.5	2.6	1.5	1.7	1.1
12	1.4	2.6	1.5	1.8	1.2
13	1.6	2.7	0.9	1.6	1.0
14	1.7	2.6	0.7	1.4	0.8
15	1.8	2.5	0.8	1.3	0.7
16	1.6	2.7	0.7	1.2	0.6
17	1.4	2.7	0.8	1.2	0.6
18	1.4	2.7	0.9	1.1	0.5
19	1.6	2.7	1.0	1.3	0.7
20	1.5	2.7	0.7	1.2	0.6
21	1.5	2.7	0.8	1.1	0.5
22	1.5	2.6	0.9	1.1	0.5
23	1.4	2.5	0.7	1.1	0.5

synthesized values

Date	BBL Mean	SGS Mean	UBL Mean	LBL Mean	MBC Mean
2-24-82	1.4	2.4	0.6	0.8	0.2
25	1.4	2.3	0.6	0.8	0.2
26	1.4	2.4	0.6	0.8	0.2
27	1.4	2.4	0.6	0.8	0.2
28	1.3	2.4	0.6	0.7	0.1
3- 1-82	1.3	2.5	0.6	0.9	0.3
2	1.4	2.5	0.7	0.8	0.2
3	1.5	2.6	0.7	0.9	0.3
4	1.4	2.5	0.7	1.0	0.4
5	1.5	2.6	0.7	0.9	0.3
6	1.4	2.7	0.9	1.0	0.4
7	1.5	2.7	1.4	1.1	0.5
8	1.4	2.8	1.3	1.3	0.7
9	1.4	2.7	1.6	1.4	0.8
10	1.3	2.6	1.4	1.4	0.8
11	1.4	2.5	1.6	1.6	1.0
12	1.4	2.6	1.5	1.4	0.8
13	1.5	2.5	1.7	1.6	1.0
14	1.5	2.6	1.8	1.6	1.0
15	1.5	2.5	1.9	1.7	1.1
16	1.6	2.5	1.8	1.8	1.2
17	1.8	2.5	2.0	1.8	1.2
18	2.1	2.5	1.8	1.9	1.3
19	2.0	2.6	2.4	1.9	1.3
20	1.9	2.6	2.4	2.0	1.4
21	1.8	2.7	2.2	1.9	1.3
22	1.9	2.8	2.7	2.2	1.6
23	2.2	2.8	2.7	2.6	2.0
24	1.4	2.9	2.0	2.3	1.7
25	1.4	2.8	2.0	2.6	2.0
26	1.4	2.8	2.0	2.4	1.8
27	1.5	2.8	1.9	2.4	1.8
28	1.5	2.8	2.6	2.7	2.1
29	1.6	2.8	2.3	2.5	1.9
30	1.7	2.9	2.6	2.5	1.9
31	1.7	2.9	2.7	2.7	2.1
4- 1-82	1.7	2.8	2.3	2.6	2.0
2	1.6	2.9	2.9	2.8	2.2
3	2.1	3.0	2.6	3.0	2.5
4	2.4	2.9	3.1	3.2	2.7
5	2.7	2.9	2.9	3.3	2.8
6	3.1	3.0	3.0	3.8	3.3
7	3.4	3.0	3.4	4.0	3.5
8	3.5	3.1	3.5	4.2	3.7
9	2.5	3.1	2.9	3.9	3.4
10	2.0	3.1	2.7	4.0	3.5
11	1.4	3.1	2.4	3.7	3.2
12	1.4	3.0	1.7	3.3	2.8
13	1.5	3.0	2.3	3.5	3.0
14	1.5	2.9	2.5	3.5	3.0
15	1.4	2.9	2.2	3.3	2.8

MBC column, 2-24-82 through 4-14: ↑ synthesized values ↓

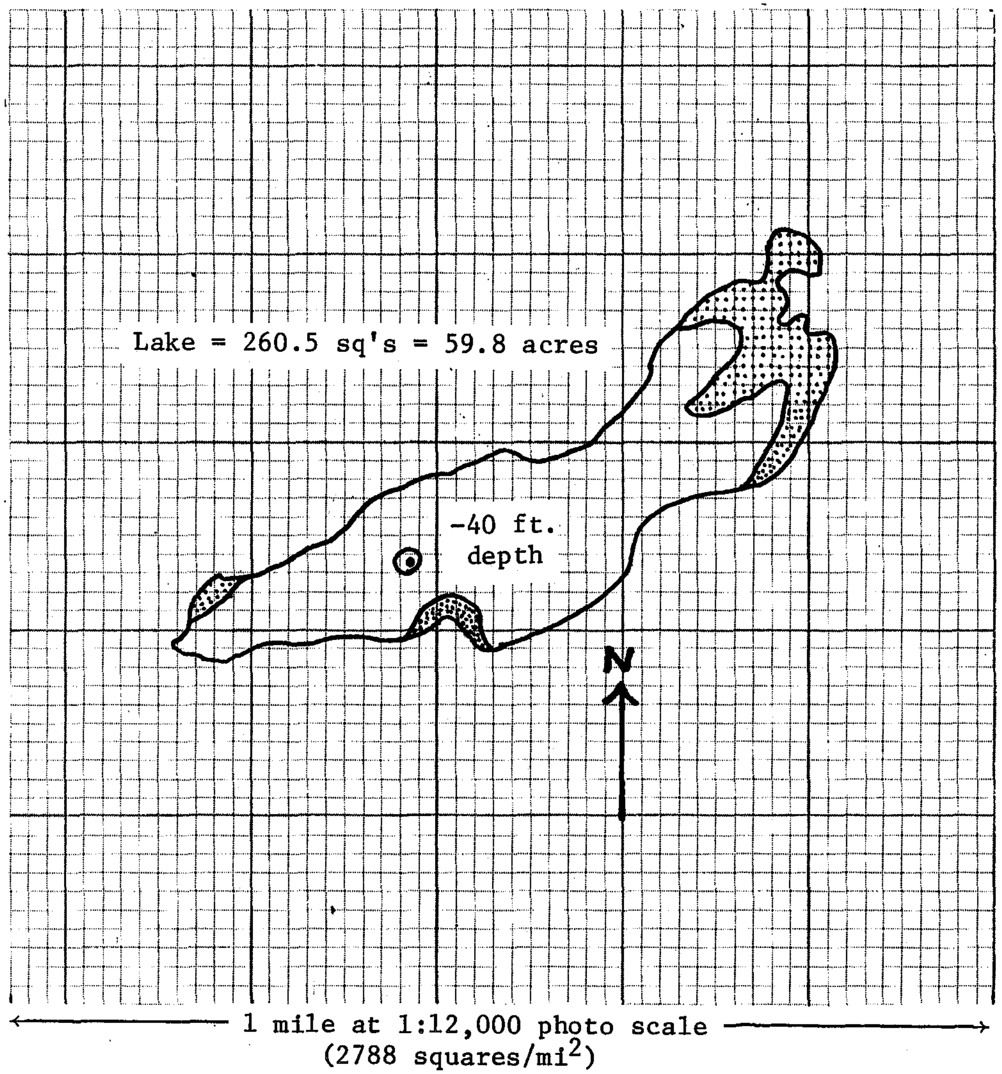
Date	BBL Mean	SGS Mean	UBL Mean	LBL Mean	MBC Mean
4-16-82	1.3	2.9	1.9	3.0	2.5
17	1.3	2.9	2.1	3.3	2.8
18	1.3	2.9	2.3	3.5	3.0
19	1.2	2.9	2.2	2.7	2.1
20	1.4	2.7	1.7	2.8	2.2
21	1.7	2.6	2.1	2.7	2.1
22	1.7	2.6	2.6	3.1	2.6
23	1.7	2.6	2.8	3.5	3.0
24	1.7	2.7	2.9	4.0	3.5
25	1.8	2.7	3.2	4.4	3.9
26	1.7	2.8	3.0	4.2	3.7
27	1.6	2.9	2.6	4.2	3.7
28	1.7	2.9	2.7	4.5	4.0
29	1.7	2.8	2.8	4.4	3.9
30	1.7	2.9	2.5	4.3	3.8
5- 1-82	1.7	2.9	2.8	4.5	4.0
2	1.8	3.0	3.0	4.8	4.4
3	1.8	2.9	3.5	5.4	5.0
4	1.8	3.0	3.4	5.5	5.1
5	1.8	3.1	3.3	5.5	5.1
6	1.8	3.2	2.9	5.3	4.9
7	1.8	3.2	3.2	5.6	5.2
8	1.8	3.1	3.4	5.7	5.3
9	1.8	3.1	3.7	5.7	5.3
10	1.8	3.2	3.4	5.7	5.3
11	1.7	3.3	3.3	6.1	5.7
12	1.8	3.3	3.4	5.7	5.3
13	1.7	3.3	3.4	5.6	5.2
14	1.8	3.4	3.8	6.3	5.9
15	1.9	3.4	4.2	7.5	7.2
16	1.8	3.4	3.9	8.4	8.1
17	1.8	3.5	3.9	7.9	7.6
18	1.8	3.6	3.8	7.1	6.8
19	1.8	3.6	3.7	6.1	5.7
20	1.8				
21	1.8				
22	1.8				
23	1.8				

synthesized values

TABLE A3: Cumulative Temperature Data (1981-82).

Date	BBL	SGS	UBL	LBL	MBC
9- 1-81	12.8	11.3	11.4	14.4	13.6
5	63.1	55.2	55.5	69.7	66.6
10	123.5	113.6	112.6	131.6	127.1
15	178.5	169.2	165.7	188.2	183.0
20	231.8	223.3	218.9	245.8	239.7
25	282.9	274.7	268.2	303.8	293.1
30	330.2	323.1	313.8	357.3	340.8
10- 1-81	339.2	332.4	322.3	366.9	349.7
5	373.5	367.8	355.0	402.6	382.2
10	413.1	409.2	393.1	445.1	420.6
15	453.1	449.5	432.4	488.3	461.2
20	492.3	490.4	472.4	529.4	501.0
25	533.8	530.8	514.6	573.0	543.4
30	571.2	569.8	554.0	614.4	583.3
11- 4-81	604.0	605.3	590.2	649.6	616.9
9	635.9	641.7	626.7	685.2	650.8
14	666.4	678.5	664.2	721.8	685.9
19	692.6	712.5	696.6	753.3	715.4
24	718.4	745.8	730.1	783.6	743.7
29	743.4	777.3	760.1	812.0	770.1
12- 4-81	763.7	807.2	788.2	837.6	793.5
9	776.7	835.3	811.4	859.8	813.5
14	784.1	860.8	828.1	877.1	828.3
19	794.5	886.3	851.1	894.0	842.6
24	805.0	910.4	873.7	913.3	859.4
29	813.9	932.7	891.6	930.7	874.3
1- 3-82	821.9	952.1	900.7	943.4	884.1
8	829.6	970.3	908.8	949.4	887.1
13	838.4	989.0	922.5	959.5	894.2
18	847.2	1,005.8	936.1	971.1	902.8
23	854.8	1,019.3	942.2	977.7	906.4
28	862.3	1,032.6	946.7	982.1	908.6
2- 2-82	870.5	1,046.3	954.2	988.2	911.7
7	878.9	1,059.7	964.4	997.0	916.5
12	887.0	1,073.1	972.5	1,005.8	922.3
17	895.1	1,086.3	976.4	1,012.5	926.0
22	902.6	1,099.7	980.7	1,018.3	928.8
27	909.6	1,111.7	983.8	1,022.6	930.1
3- 4-82	916.5	1,124.2	987.3	1,026.9	931.4
9	923.8	1,137.7	993.2	1,032.6	
14	930.9	1,150.5	1,002.2	1,040.2	938.7
19	939.9	1,163.1	1,012.1	1,049.3	
24	949.1	1,176.9	1,024.1	1,060.3	
29	956.5	1,190.0	1,034.9	1,072.9	962.4

Date	BBL	SGS	UBL	LBL	MBC
4- 4-82	967.7	1,208.3	1,051.1	1,089.7	
9	982.9	1,223.4	1,066.8	1,108.9	992.5
14	990.7	1,238.5	1,078.4	1,126.9	
19	997.2	1,253.0	1,089.1	1,142.7	
24	1,005.4	1,266.2	1,101.2	1,158.8	1,034.6
30	1,015.6	1,283.2	1,118.0	1,884.8	1,057.6



Scale: 1" = 1000 ft

Deepest point in Black Lake is approximately -40 ft from soundings. Shoal areas are shaded in drawing. Average depth is estimated at 25 ft.

FIGURE A - 1: Black Lake surface area, and general depth conditions.

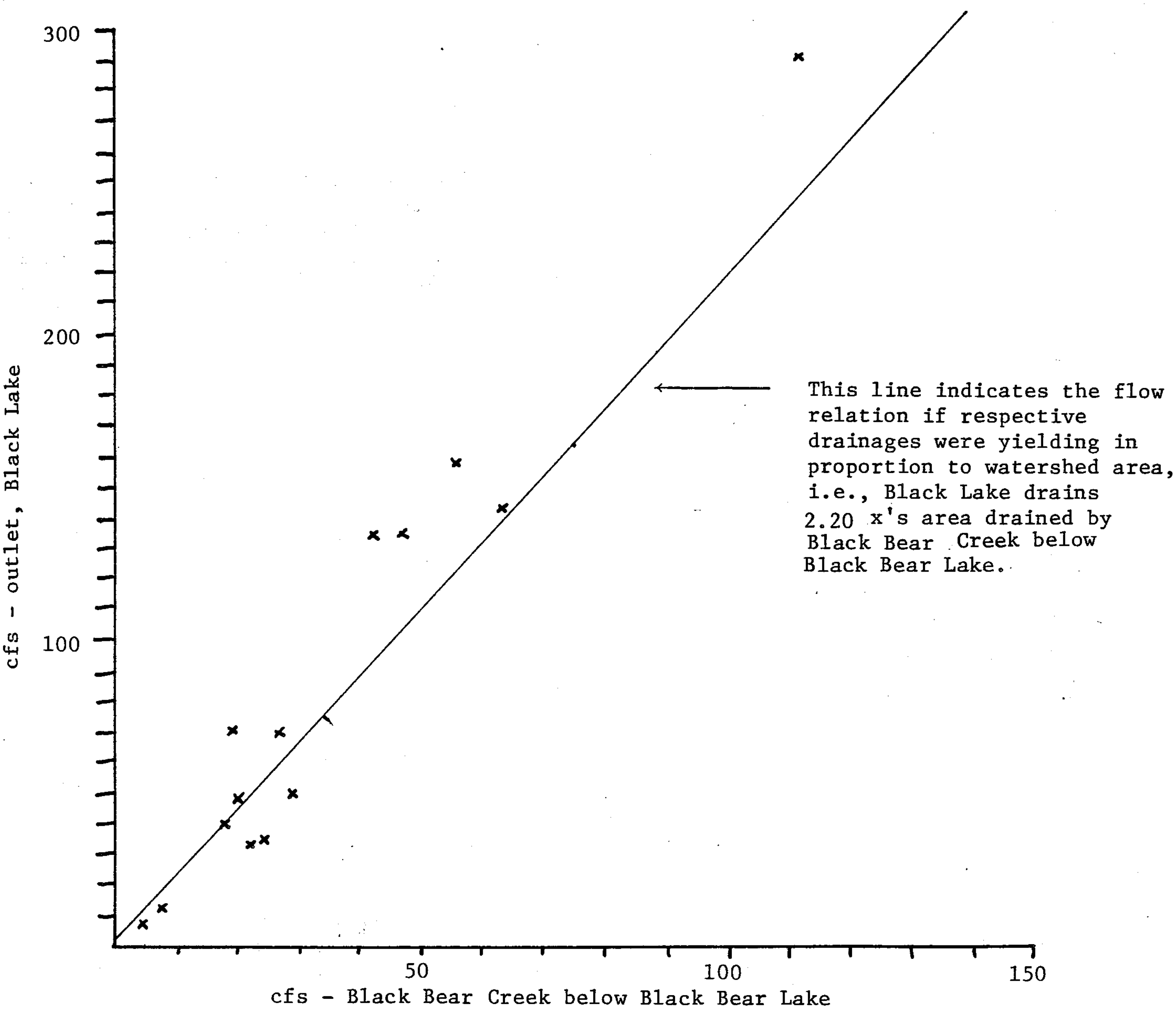


FIGURE A2: A General Comparison of Streamflow in Black Bear Creek below Black Bear Lake and Outflow from Black Lake. This relation is based upon limited information.

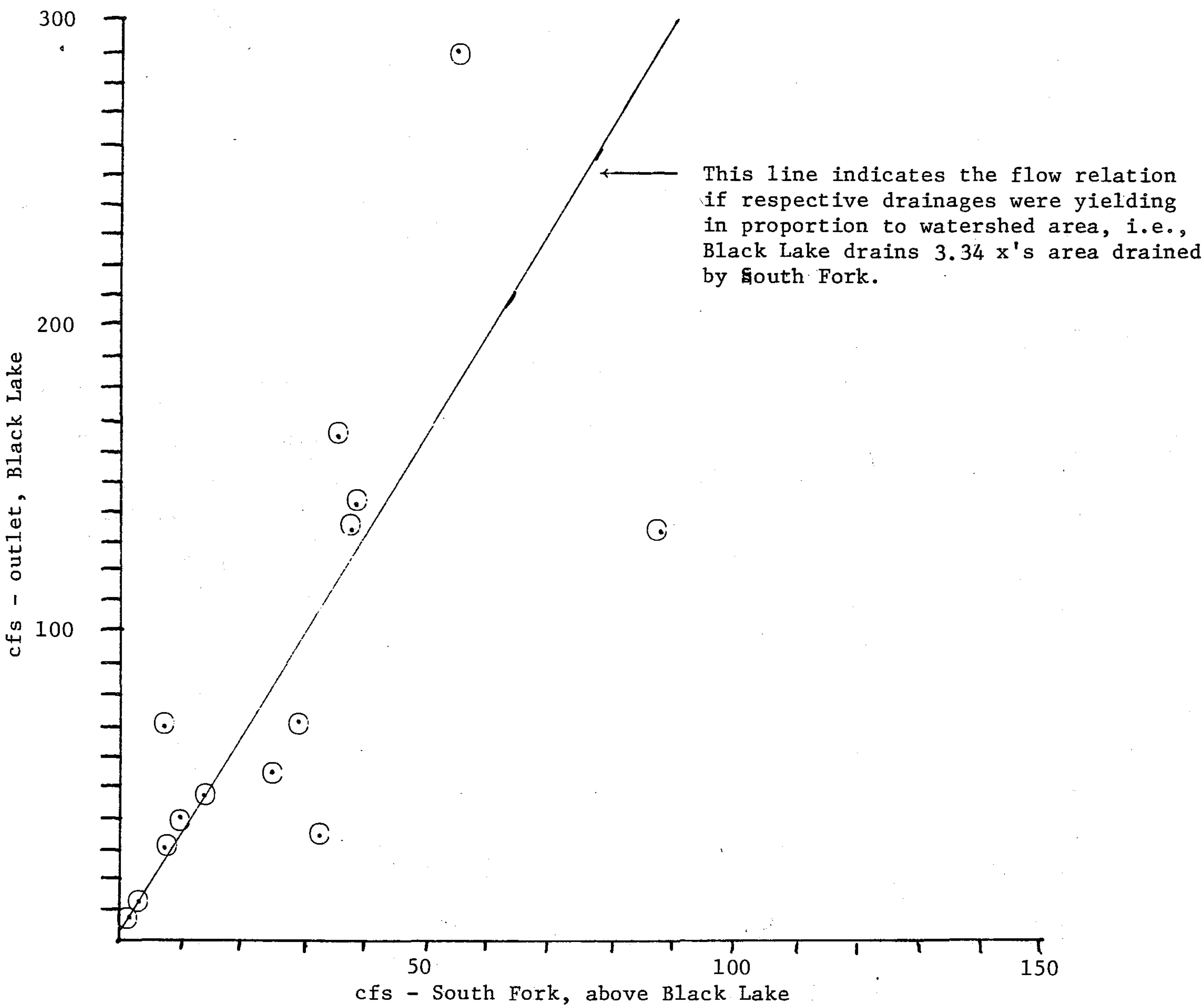


FIGURE A3: A General Comparison of Streamflow from South Fork and Outflow from Black Lake. This relation is based upon limited information.

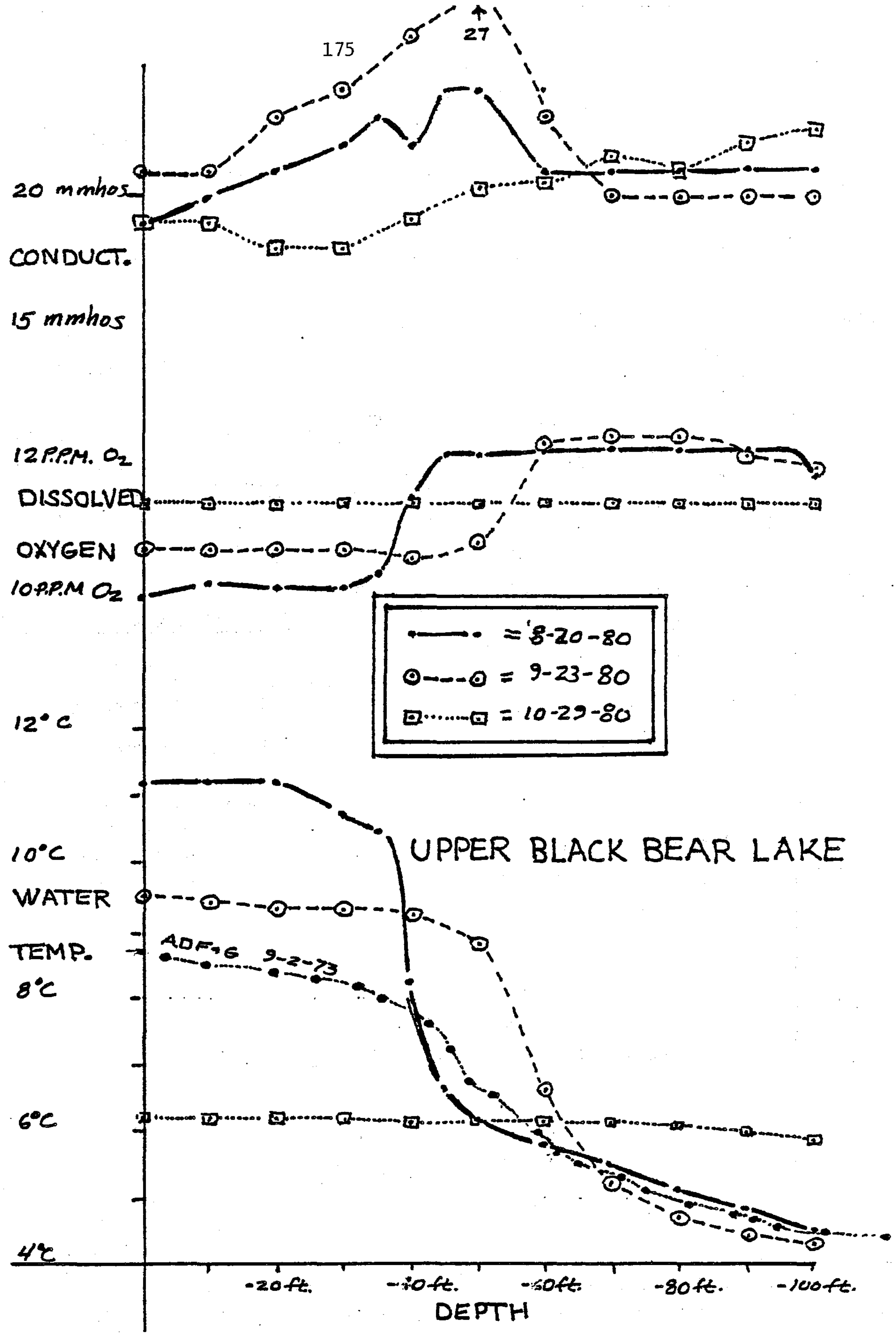


FIGURE A - 4: Profiles of Conductivity, Dissolved O_2, and Temperature in Upper Black Bear Lake

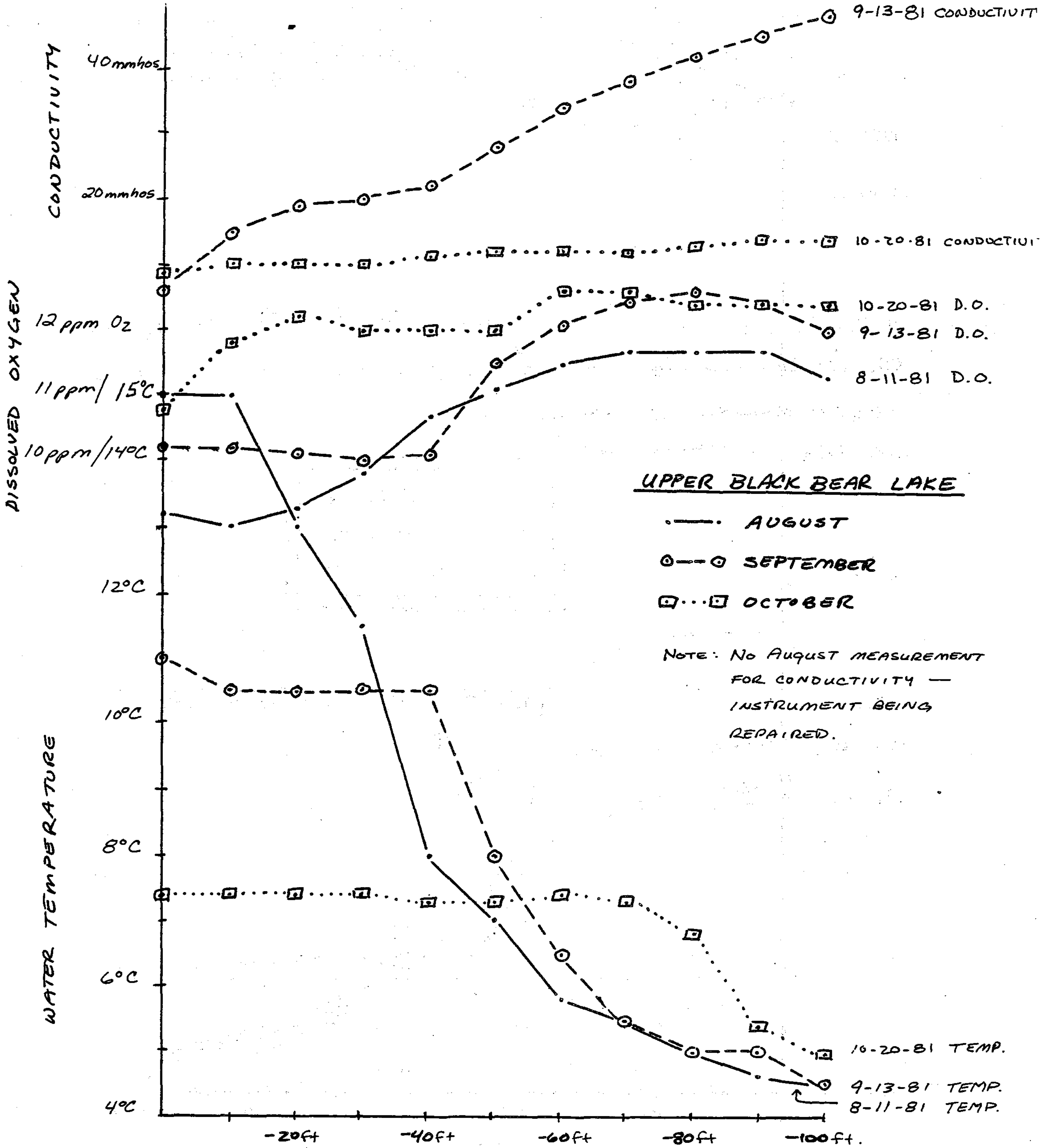


FIGURE A - 5: Profiles of Conductivity, Dissolved Oxygen and Temperature in Upper Black Bear Lake

FIGURE A - 6a

CALCULATIONS OF CHANNEL ROUGHNESS (MANNINGS "n") FOR TWO MEASURED REACHES

Method

See U.S.G.S. WSP 1849, Roughness Characteristics of Natural Channels.

As applied to two-section, confining reaches:

$$n = \frac{1.486}{Q} \quad \frac{(h + h_v)_1 - (h + h_v)_2}{\frac{L_{1 \cdot 2}}{Z_1 Z_2}}$$

where, h = elevation of water surface at respective sections above a common datum;

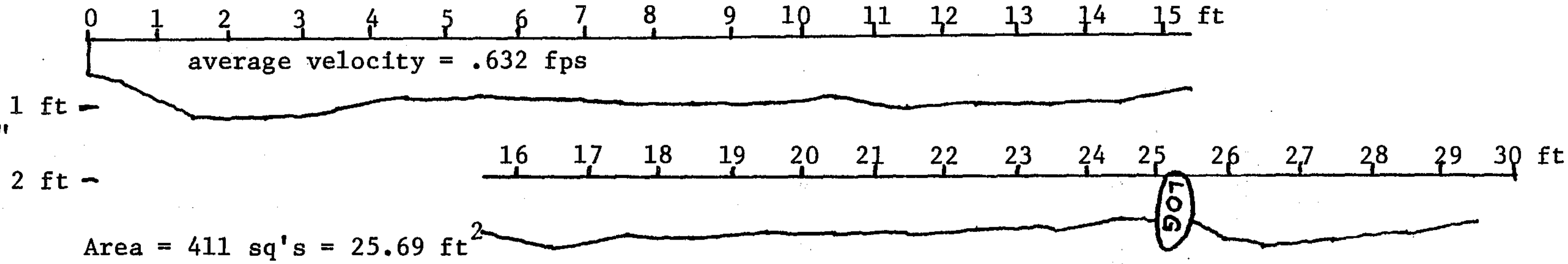
h_v = velocity head at the respective sections = $\alpha V^2/29$

$L_{1 \cdot 2}$ = channel length between the two sections

$Z_1 Z_2$ = $AR^{2/3}$ for sections 1, 2 respectively.

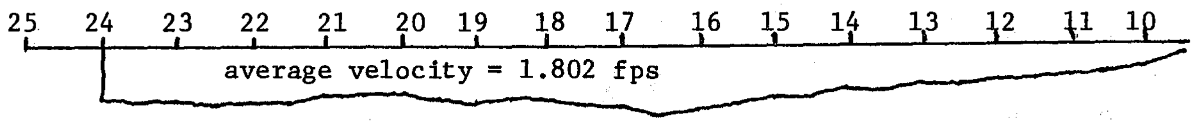
SPRING FORK

(1) at "sec. 8"



Area = 411 sq's = 25.69 ft^2
Perimeter = 30.0 ft
Hydraulic radius = .8563 ft

(2) 75 ft below "section 8"



Area = 150 sq's = 9.375 ft^2
Perimeter = 15.3 ft
Hydraulic radius = .6127 ft

Distance between sections = 75 ft.
Averaged elevation, water surface section (1) is 1.289 ft higher than averaged elevations for water surface, section (2).

Calculation of Manning's roughness "n"

$$n = \frac{1.486}{Q}\sqrt{\frac{(h-h_v)_1 - (h-h_v)_2}{\frac{L_{1 \cdot 2}}{Z_1 Z_2}}}$$

$$(h + h_v)_1 = 1.289 + (.632)^2/(8.02)^2 = 1.2952 \text{ ft}$$

$$(h + h_v)_2 = 0 + (1.802)^2/(8.02)^2 = .0505$$

difference = 1.2447 ft

$L_{1 \cdot 2} = 75$ ft

$$Z_1 = (25.69)(.8563)^{2/3} = 23.1657$$

$$Z_2 = (9.375)(.6127)^{2/3} = 6.7628$$

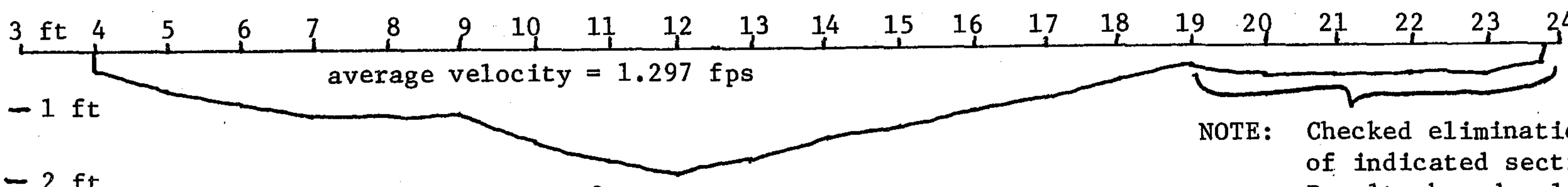
$$Z_1 Z_2 = 156.665$$

$$n = \frac{1.486}{16.57}\sqrt{\frac{1.2447}{\frac{75}{156.665}}} = \boxed{0.1446} \longleftarrow$$

FIGURE A - 6b

LAKE FORK

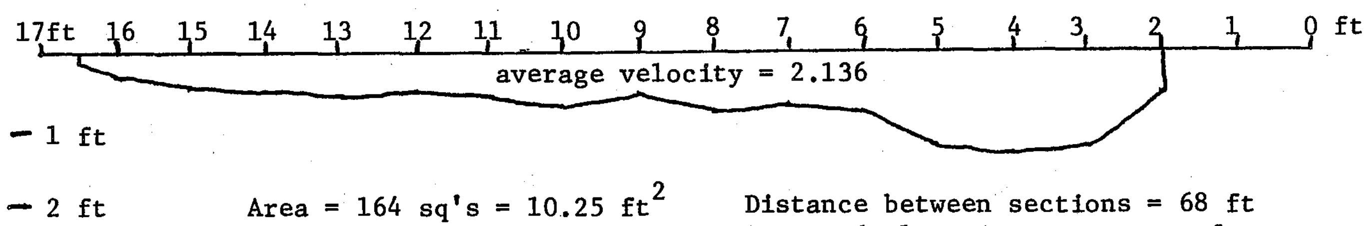
(1) at "x-sec A"



NOTE: Checked elimination of indicated section. Result showed only small change in "n".

Area = 260 sq's = 16.25 ft^2
Perimeter = 20.25 ft
Hydraulic radius = .80 ft

(2) 68 ft downstream from section (1)



Area = 164 sq's = 10.25 ft^2
Perimeter = 15.5 ft
Hydraulic radius = .67 ft

Distance between sections = 68 ft
Averaged elevations, water surface, section (1) is 1.00 ft. higher than averaged elevations of water surface, section (2).

Calculation of Manning's roughness, "n"

$$n = \frac{1.486}{Q}\sqrt{\frac{(h+h_v)_1 - (h+h_v)_2}{\frac{L_{1\cdot 2}}{Z_1 Z_2}}}$$

$(h + h_v)_1 = 1 + (1.297)^2/(8.02)^2 = 1.0262$

$(h + h_v)_2 = 0 + (2.136)^2/(8.02)^2 = \underline{0.0709}$

difference = .9553

$L_{1\cdot 2} = 68$ ft

$Z_1 = (16.25)(.8)^{2/3} = 14.0037$

$Z_2 = (10.25)(.67)^{2/3} = 7.8482$

$Z_1 Z_2 = 109.9038$

$$n = \frac{1.486}{21.4845}\sqrt{\frac{.9553}{\frac{68}{109.9038}}} = \boxed{0.0859} \leftarrow$$

FIGURE A- 6c

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SPRING FORK

BLACK LAKE
OUTMIGRANT FRY TRAPPING STATION, SPRING, 1982
UPPER BLACK LAKE THERMOGRAPH
ZONE I
ZONE IV
BEAVER PONDS
SECTION A
MUSKEG
MUSKEG
MATCH LINE A
MATCH LINE B
ZONE IV
BEAVER PONDS
BELOW THIS POINT TO MOUTH OF STREAM IS CHARACTERISTICALLY HOMOGENEOUS, DEEPER, SLOWER FLOWING WATER (0.2 to 1.5 ft./sec.), WITH SAND, SILT & ORGANIC SUBSTRATE. UNDERCUT BANKS & OVERHANGING RIPARIAN VEGETATION PROVIDE COHO REARING HABITAT.
START OF SUITABLE SPAWNING HABITAT FOR ADULT SALMONIDS.
SECTION C
BLACK BEAR SYSTEM
LAKE FORK
SPRING FORK
ZONE II
RIFFLES & GLIDES DOMINATE THIS SECTION OF STREAM ABOVE THE FORKS, TOGETHER WITH POOLS BEHIND LOGS. SOME UNDERCUTTING OF BANKS & OVERHANGING RIPARIAN VEGETATION. SIZE OF STREAMBED GRAVELS: 3 to 15 cm.
THERMOGRAPH BURIED IN GRAVEL BED, 12 in.
FLOW MEASUREMENT STATIONS.
SOUTH TRIBUTARY
STREAM SPAWNING HABITAT EXTENDS 800 to 1000 ft.
MARSH
OLD BEAVER DAM
WEST FORK OF SOUTH TRIBUTARY
(NOT MAPPED IN DETAIL – MANY LOGS & DEBRIS)
SOCKEYE SPAWNING
ZONE II
29°
TRUE
MAGNETIC
SECTION B
SCALE: 1" = 50'
ELEVATION DATUM: 0.0' ON BLACK LAKE GAUGE EQUALS AN ASSUMED ELEV. OF 100.0'.
ZONE II
TERMINATION OF OBSERVED SALMON SPAWNING
MAIN CHANNEL FROM BLACK BEAR LAKE. GRADIENT BEGINS TO MARKEDLY INCREASE. SUBSTRATE BECOMES LARGE COBBLES: 12.7 to 25.4 cm.
UPWELLINGS AT LOW FLOWS, MODERATE WATER TEMPERATURES
DRY AT LOW FLOW
THIS AREA FORMS POOLS AT LOW FLOWS WHICH ARE SUBJECT TO DRYING UP.
ZONE II
ZONE III TO FALLS BELOW BLACK BEAR LAKE
SPRING FORK SOURCE
SECTION D
LEGEND:
SHORELINE
BEAVER DAM
ELEVATION
CROSS SECTION X-S 2
MOSS COVERED STONES
UPWELLINGS
UNDERCUT BANKS
LOG IN STREAM
AERIAL LOG
OLD GROWTH HEMLOCK & SPRUCE
ALDER
RIPARIAN VEGETATION MADE UP PRINCIPALLY OF DEVILS CLUB, SALMONBERRY, DEERBERRY, RED ELDER & HIGH BUSH CRANBERRY
SEDGES, HELLEBORE & GRASSES
SPAWNING GRAVEL & COBBLE WITH PREDOMINATE SIZE 3-8 cm
SUBSTRATE OF SAND & SILT WITH SOME DETRITUS
RIFFLES – SHALLOW WATER WITH TURBULENCE AND BROKEN SURFACE R
GLIDES – NORMALLY MODERATELY SHALLOW WITH EVEN FLOW G
POOLS P
FLATS – DEEPER, SLOW FLOWING WATER, NORMALLY OVER A SAND AND SILT SUBSTRATE F
PRINCIPAL LOCATIONS OF:
SPAWNING PINK SALMON
SPAWNING SOCKEYE SALMON
SPAWNING CHUM SALMON
SPAWNING COHO SALMON
RESIDENT REARING SALMONIDS, PRINCIPALLY COHO
PRINCIPAL HABITAT ZONES ZONE I
BIG SALT LAKE
PRINCE OF WALES ISLAND
R81E R82E
T72S T73S
R82E R83E
BLACK LAKE
PROJECT
BLACK BEAR LAKE
SCALE: 1:63,360
VICINITY MAP
FISH USE AND HABITAT OF BLACK BEAR CREEK ABOVE BLACK LAKE
FOR: ENVIRONAID
DRAWN BY:
SURVEY DATE: 8/7/81
CONSTRUCTION ENGINEERING SERVICES
DATE: July 1982
SHEET 1 of 1