PRELIMINARY STUDY OF AQUATIC RESOURCES RELATIVE TO MEAGER MOUNTAIN GEOTHERMAL DEVELOPMENT

Report No. ESS-53 September 1982

Prepared by: R. Beniston
K. Machniak

This report was prepared for the British Columbia Hydro and Power Authority ("BC Hydro"). BC Hydro does not:

(a) represent, guarantee or warrant to any third party, either expressly or by implication: (i) the accuracy, completeness or usefulness of; (ii) the intellectual or other property rights of any person or party in; or (iii) the merchantability, safety or fitness for purpose of; any information, product or process disclosed, described or recommended in this report,

(b) assume any liability of any kind arising in any way out of the use by a third party of any information, product or process disclosed, described or recommended in this report, or any liability arising out of reliance by a third party upon any information, statements or recommendations contained in this report.

Should third parties use or rely on any information, product or process disclosed, described or recommended in this report, they do so entirely at their own risk.

ACKNOWLEDGEMENTS

We are grateful to Pat Shera of the Aquatic Studies Branch, B.C. Ministry of Environment, Victoria for providing data obtained during their 1980 survey of the upper Lillooet watershed.

We also thank the federal Department of Fisheries and Oceans Scale Laboratory in Vancouver for analysis of coho salmon scales and Lyle Enderud (fishery officer, Squamish) and Daryl Fisher (fisheries technician, B.C. Hydro) for their assistance in coho salmon spawning counts.

R.G. Ferguson, D.J.F. Maxwell, H.A. Smith and C.E. Walker reviewed the manuscript.

PRELIMINARY STUDY OF AQUATIC RESOURCES RELATIVE

TO MEAGER MOUNTAIN GEOTHERMAL DEVELOPMENT

CONTENTS

CONTENTS - (Cont'd)

TABLES

FIGURES

CONTENTS - (Cont'd)

PLATES

APPENDICES

SUMMARY

A preliminary description of the aquatic resources of the upper Lillooet River watershed and the potential effects of geothermal development are presented. It was concluded that geothermal development at Meager Mountain could have adverse effects on both resident and anadromous fish populations in the upper Lillooet River and Meager Creek. All stages of geothermal development will have to be reviewed in more detail with continued project activities.

1.0 INTRODUCTION

British Columbia Hydro is investigating the feasibility of developing the geothermal potential of the Meager Mountain area (Fig. 1) near the headwaters of the Lillooet River in southwest B.C.

Geothermal development could affect the temperature regime, sediment transport into, hydrology and water quality of the upper Lillooet River watershed and downstream reaches. Other concerns with respect to the fisheries resource are increased angler accessibility to the region and the potential impact on resident and anadromous fish populations as well as the effects of trace elements (such as arsenic and mercury) and dissolved gases (such as H_2S and CO_2) on the aquatic system.

(a) Background

Previous studies on aquatic resources in the study area are limited. The Aquatic Studies Branch, B.C. Ministry of Environment conducted extensive habitat surveys of the upper Lillooet watershed in 1977 and 1980. A brief survey was also carried out in 1979 by Environmental and Socio- economic Services, B.C. Hydro.

In addition, studies on surface water hydrology and water quality characteristics were conducted from 1978 to 1980 by Reid, Crowther and Partners Ltd. as part of their environmental reconnaissance of the project area.

This report presents and discusses the results of aquatic studies performed from August 1981 to February 1982.

An assessment of adult coho salmon spawning in the Lillooet-Meager area was conducted in November and December 1981. A brief investigation was carried out in February 1982 to obtain information on the winter habitat of important fish species in the area, i.e. coho salmon, Dolly Varden char and cutthroat trout. An assessment of the potential impacts of the development based on available

information and recommendations for further studies have also been provided.

(b) Study Objectives

The objectives of the study were twofold. First, to provide preliminary baseline information of fish resources in the upper Lillooet mainstem and tributary reaches which could be influenced by the proposed development. Emphasis was placed on determining species composition and relative abundance, identifying juvenile rearing and overwintering areas, and assessing adult coho spawning.

Second, the potential effects of the proposed development on the aquatic resources were identified and evaluated.

(c) Study Area

The Lillooet River has a drainage area of 2163 km^2. Its source is approximately 160 km north of Vancouver at the Lillooet Ice Cap. It flows from Silt Lake at the base of the glacier southeast for 90 km through Lillooet Lake, then on to Harrison Lake 55 km to the southeast. The Lillooet River is extremely turbid except during winter months and carries a heavy sediment load into Lillooet Lake.

Flow records indicate that maximum discharges occur in July on the upper Lillooet and minimum flow usually occurs in February. The mean annual discharge of the Lillooet River measured at Station No. 08MG005 near Pemberton, from 1914 to 1976, was 4490 m^3/s (Water Survey of Canada, 1977).

The aquatic study area was the upper Lillooet River and tributaries upstream of the North and South creeks confluences (Fig. 1).

The assessment of coho salmon spawning concentrated on Meager Creek and a section of the Lillooet River from downstream of Lillooet falls (Plate 1) to 6.5 km below the Meager Creek confluence. A larger study area could not be adequately covered with the available manpower. A limited number of locations downstream of this area were also surveyed for spawning coho salmon.

2.0 METHODOLOGY

(a) Sampling Sites

Sampling sites are illustrated in Fig. 2. In this report, sampling sites are referenced with respect to mileage posts along the Lillooet River logging road or kilometre markers on the Meager Creek road. Most sampling concentrated on tributaries and side channels, but the mainstem Lillooet River was also sampled, time and access permitting.

Water temperature, secchi disk transparency, and specific conductivity were measured at all sampling sites (Appendix A). Maximum/minimum thermometers and Taylor thermographs (calibrated weekly) recorded water temperatures in Meager Creek and the upper Lillooet River (Appendix B). Site specific habitat information was also collected (Appendices C, D and E).

(b) Fish Collection Techniques

Gee wire minnow traps were used to assess the use of tributaries and side channels by young-of-the-year and juvenile fish. The traps were baited with frozen coho salmon roe, placed in selected streamside habitats such as cut banks, back eddies, and lees of small log jams, and fished for 24 hours.

Fish were also collected using a beach seine (15.2 m long and 1.8 m deep) and a portable Smith-Root Mark VII electrofisher. Capture data are summarized in Appendices C, D and E.

(c) Adult Coho Salmon Studies

Studies of adult coho salmon attempted to ascertain:

1. size of escapement, i.e. the number of coho spawners that returned to tributaries and side channels of the upper Lillooet,

2. timing of spawning,

3. age and size of spawners, and

4. egg retention of spawned-out females.

The preliminary assessment of coho spawning was conducted from 6 November to 29 December 1981. Methods are outlined in the following sections:

(i) Spawning Ground Live Counts and Dead Recovery

Live count surveys and carcass recovery was conducted on side channels and tributaries of Meager Creek and the upper Lillooet River (Appendix F). Since the location of coho spawning grounds in the study area were unknown considerable time was spent locating these areas. Live counts and dead recovery were then initiated on the accessible spawning grounds except during heavy snowfalls. The study area was covered on foot. Areas of spawning concentrations were noted. The length of each location surveyed was visually estimated. Live count estimates (Appendix F, Table F-1) were made when it was thought that some spawners may have been missed due to turbidity or inaccessible stream sections.

All carcass recoveries were counted and cut in half to prevent double counts.

Two aerial surveys were conducted by helicopter on 24 and 28 November to obtain information on mainstem spawning and to survey additional areas not covered by foot.

(ii) Size, Age, Sex and Egg Retention

Length measurements and scale samples were obtained from as many fish as possible to determine mean size (Appendix F, Tables F-2 and F-3) and age composition (Appendix F, Tables F-4 and F-5). Both orbital-hypural length (posterior edge of eye socket to posterior edge of hypural plate) and fork length (tip of snout to fork of tail) were recorded to the nearest 1.0 cm. Five scales were taken from each sampled fish between the vent and the posterior insertion of the dorsal fin above the lateral line. Scale analysis was carried out by personnel of the Vancouver Scale Laboratory of the Department of Fisheries and Oceans.

Age designation in this report follow the system of Gilbert and Rich (1927) for anadromous fish. For example, a salmon in its third year, which migrated to sea in its second year (i.e. having one freshwater annulus and one ocean annulus), would be designated as 3_2.

All coho salmon dead recoveries were identified as to sex. Each female sampled for size and age was also examined to determine the number of eggs retained (Appendix F, Table F-2).

(iii) Population Estimates

Stream population estimates were obtained by summation of dead recoveries and live counts. In addition, several stream

population estimates were obtained in the following manner. Live counts of spawning coho were plotted against time (Fig. 4). The area under the curve represents the spawning effort in fish-days. Estimates were derived by dividing the total number of fish-days by the average redd life (the number of days a female spends on the spawning site).

Total estimates of escapement for both the upper Lillooet River study section and Meager Creek were formed by summation of the individual population estimates.

3.0 AQUATIC RESOURCES

(a) Mainstem Lillooet

The Lillooet River system supports populations of chinook salmon (Oncorhynchus tshawytscha), sockeye salmon (O. nerka), coho salmon (O. kisutch), steelhead (Salmo gairdneri) and sea-run cutthroat (S. clarki clarki), as well as resident rainbow trout (S. gairdneri), cutthroat trout (S. clarki clarki), Dolly Varden char (Salvelinus malma), mountain whitefish (Prosopium williamsoni), kokanee (O. nerka) and sturgeon (Acipenser transmontanus) (DFO, unpubl. data).

The Lillooet River is accessible to anadromous fish up to a falls approximately 16 km above Meager Creek (Plate 1). Limited information is available for spawning distributions in the mainstem Lillooet due to high turbidity. Sockeye salmon may spawn in the mainstem Lillooet between Mount Currie and Meager Creek as this portion of the river has large areas of suitable gravel, water depths and velocities for spawning, however none have been sighted (Brown, Musgrove and Marshall, 1979).

Two aerial spawning surveys conducted by B.C. Hydro biologists and Lyle Enderud, DFO officer, Squamish, on 24 and 28 November when

turbidity was low (0.5 m), indicated that coho spawning is confined to side channels and tributaries throughout the study area. No chinooks were captured during this study. However, a small number of chinooks may spawn in the study area since one chinook smolt was reportedly captured in the study area during the 1980 Aquatic Studies Branch survey.

During this study and the 1980 Aquatic Studies Branch survey cutthroat trout were the only species captured by electrofishing above the Lillooet falls (Table 1 and Appendix C). It is unlikely that cutthroat would attain a size larger than 250 mm above the falls due to the harsh and limiting environment (the largest cutthroat captured above the falls was 150 mm in fork length).

Beach seining in the Lillooet River below the confluence of Meager Creek (BS-2 and BS-3, Fig. 2) yielded Dolly Varden char, mountain whitefish and coastrange sculpin (Cottus aleuticus) (Table 2 and Appendix E). Electrofishing in the mainstem below the Meager Creek confluence (ES-4A, Fig. 2) during February 1982, obtained only coastrange sculpin (Appendix C). The 1980 Aquatic Studies Branch survey confirms the presence of these three species in the study area at other mainstem sampling locations below the Lillooet falls.

To date, sampling of the mainstem Lillooet has been extremely limited. Therefore, it is not known how extensively this area is utilized by rearing coho and cutthroat. The high turbidity and extreme water level fluctuations probably limit utilization by rearing coho and cutthroat.

(b) Tributaries and Side Channels

While most of the large tributaries in the area are precipitous, unstable and unproductive (Plate 2), there are also many small streams and side channels that are important as rearing, spawning

and overwintering habitats (Plates 3, 4 and 5). A number of side channels of the upper Lillooet River appear to be groundwater-fed from the main channel and are therefore relatively stable environments.

Juvenile coho and cutthroat were the dominant species captured from sampling in tributaries and side channels (Table 3). Other species collected included Dolly Varden char, coastrange sculpin, redside shiner (Richardsonius blateatus) and western brook lamprey (Lampetra richardsoni) ammocoetes (Appendices C and D).

Dolly Varden char rear and overwinter in Meager Creek (Appendices C and D; ES-5B, MT-9). The capture of small juvenile Dolly Varden char in the south fork of Meager Creek and the capture of adults in Angel Creek at the confluence (Table 1; ES-7, ES-8) suggests that these areas are utilized for spawning as well. The 1980 Aquatic Studies Branch survey found juvenile Dolly Varden char in other tributaries, side channels and the mainstem of the upper Lillooet River below the Lillooet falls. Further studies are required to determine if adult Dolly Varden are a resident type or anadromous.

In this study, only two mountain whitefish were captured from sampling of tributaries and side channels (Table 2). However, the 1980 Aquatic Studies Branch survey captured mountain whitefish throughout the study area except above the Lillooet falls. Mountain whitefish spawn in Meager Creek (Pat Shera, Aquatic Studies Branch, pers. comm.).

Coastrange sculpin are present in the upper Lillooet watershed below the falls, including Meager Creek. The large number of ammocoetes captured in a small tributary (Table 1; ES-1) indicates that western brook lamprey spawn in this stream. Redside shiner can be captured in some pondage areas and streams of the upper Lillooet River below Meager Creek. The capture of fry and sexually mature largescale suckers (Catostomus macrocheilus) in a

number of side channels and tributaries of the upper Lillooet River just upstream of the South Creek confluence during early June (Aquatic Studies Branch 1980) indicates that this area is utilized for spawning. The majority of these largescale suckers probably reside in the lower reaches of the upper Lillooet River and/or Lillooet Lake and migrate upstream to spawn.

Cutthroat trout are present in virtually all accessible streams within the upper Lillooet watershed. As previously discussed, cutthroat trout above the Lillooet falls are probably a resident dwarf population, whereas the population downstream of the falls may consist of both resident and lake dwelling individuals and perhaps sea-run cutthroat. The largest sized cutthroat captured below the falls in sampling from August to February was 165 mm (fork length). Maturity of these individuals was not determined. Mature cutthroat as large as 320 mm (fork length) were captured in the study area during June 1980 by the Aquatic Studies Branch. Further studies are required to determine the characteristics of the cutthroat trout population present below the Lillooet falls.

(c) Coho Salmon

Coho rearing is extensive in side channels and small tributaries to the upper Lillooet River below the Meager Creek confluence. Rearing areas of juvenile coho salmon in Meager Creek are scarce due to the morphological features of the area such as steep gradient. Rearing coho utilize side channels and small tributaries to Meager Creek downstream of the Meager Creek hot springs.

Data collected in November to December 1981 on coho salmon spawning in the Lillooet-Meager area is discussed below:

(i) Spawning Distribution

Coho spawning distribution as determined from carcass recoveries and spawning count surveys (Appendix F, Table F-1) is shown in Fig. 3. Coho spawning appears to be confined to side channels and tributaries as indicated previously.

In the Meager Creek drainage the heaviest concentration of spawning occurred in a small tributary (area A, Fig. 3) located approximately 1 km below the Meager Creek hot springs. Several locations downstream from this area were also utilized for spawning. No spawners were observed in the south fork of Meager Creek. In fact, no spawners were observed in Meager Creek upstream of area A (Fig. 3). Steep gradients, narrow valley bottom and coarse bottom materials limit coho spawning in Meager Creek.

In the upper Lillooet River the heaviest concentration of spawning occurred in a groundwater-fed side channel (area F, Fig. 3) just downstream of the Meager Creek confluence. No spawners were observed upstream of the Meager Creek confluence. A number of other tributaries and side channels downstream of location F (Appendix F, Table F-1) were used for spawning as well. The distribution of coho spawning indicated in Fig. 3 is preliminary. Many of the streams and side channels downstream of area I were observed to be utilized for spawning, but were not surveyed due to manpower availability.

(ii) Spawning Timing

Coho spawning in the study area occurred from early November to late December which is consistent with the reported spawning timing for other upper Lillooet River tributaries (Appendix F, Tables F-1 and F-6). Peak spawning for areas A and F (Fig. 3) as determined from counts of live spawners,

occurred on 24 November (Fig. 4). Peak spawning for area I (downstream) occurred slightly earlier. Peak coho salmon migrations to the spawning grounds are probably initiated by an increase in river discharge (from 19 to 170 m^3/s during 30 October to 1 November and 22 to 95 m^3/s from 10 to 11 November) and a decrease in water temperatures (Fig. 5).

(iii) Age Composition

A breakdown of age composition by sex and recovery stream as determined from 39 dead recoveries is given in Appendix F, Table F-2. Age 3_2 fish comprised 87.5 percent of the sample with the remainder 4_3. No jack coho (age 2_2) were recovered in this survey suggesting that they form a minimal or nil component of the escapement. These results are similar to the data obtained from 146 coho dead recoveries from the Birkenhead River in 1976 which showed 97 percent were 3_2 with the remainder 4_3 (DFO, unpublished data).

The above results indicate that most juveniles migrate to salt water after their first winter. It is possible that winter annuli may have resulted from conditions experienced downstream of the study area (eg. Lillooet Lake). For example, in Washington State, Peterson (1979) has documented fall and winter movements of coho up to 33 km downstream to overwinter in side channels or ponds. However, electrofishing and minnow trapping in February 1982 determined that a component of the coho population overwinters within the study area (Appendices C and D, MT-2, MT-4 and MT-8).

(iv) Size Composition

Length frequency data from spawners are presented by age class in Appendix F, Tables F-3 and F-4. The mean postorbital-hypural length and mean nose-fork length were 51.7 cm and 65.6 cm respectively. The largest coho salmon recovered was an age 3_2 female with a postorbital-hypural length of 65 cm and a fork length of 80 cm.

(v) Sex Ratio

Coho sex composition from the Lillooet-Meager area indicates that 67 percent were females (Appendix F, Table F-2). The true percentages of females is likely to be lower than spawning ground sampling would indicate since:

1. only a small sample size (n=52) of dead coho was obtained with 73 percent of the sample collected over a 3-day period.

2. male spawners may wander and subsequently die at some point remote from the spawning area (C. Walker, pers. comm.).

(vi) Population Size and Egg Deposition

An estimate of the coho salmon population in Meager Creek and the upper Lillooet study section (i.e. downstream of the falls to 6.5 km below the Meager Creek confluence) is presented in Table 4. Stream population estimates were based on periodic counts on the spawning riffles and were obtained by summation of dead recoveries and live counts. In addition, estimates of the number of spawners in the Meager Creek tributary at 6.0 km, the Lillooet River tributary at 20 Mile and the Lillooet River side channel at 22.5 Mile, were derived from spawning effort and redd life (see Table 4). A

redd life of 13.1 days (Koski, 1966) was used for this calculation.

As indicated in Table 4 estimates of the number of spawners derived from the spawning effort and redd life were higher than estimates formed from summation of dead recoveries and live counts except for the Lillooet River side channel at 22.5 Mile. In fact, for the site at 22.5 mile, the peak live count (89) is even higher than the estimated number of spawners from the spawning effort and redd life (83). Therefore, this indicates that a large number of coho salmon spawning in the Lillooet River side channel at 22.5 Mile were not enumerated. It should be noted that the estimates in Table 4 are conservative. All of the spawners were not enumerated since some coho spawning grounds were inaccessible.

The documented escapement record for the upper Lillooet River (including tributaries) is presented in Table 5.

Assuming that 350 coho spawned in the Lillooet-Meager area, with females making up 50 percent (67 percent as determined from this study is probably an overestimate for reasons already discussed) of the population, depositing between 2100 to 2789 eggs (Scott and Crossman, 1973) and correcting for 1.2 percent egg retention (calculated from Appendix F, Table F-2) egg deposition is roughly 363 125 to 482 220.

4.0 AQUATIC RESOURCE UTILIZATION

Aquatic resource utilization within the project area is virtually non-existent. The lower Lillooet River system does however support important Indian and sport fisheries.

Further studies will be required to assess the significance of the

study area to the Lillooet River fishery as a whole.

5.0 WATER QUALITY

Existing water quality data for surface waters in the geothermal development area are summarized in the Status of Environmental Studies Report prepared by Reid Crowther and Partners Ltd. (1981). Additional baseline information collected during this survey is summarized in Appendices A and B.

More detailed water quality and temperature data for the upper Lillooet watershed and its tributaries will be required to establish an adequate baseline and to predict project impacts.

6.0 POTENTIAL IMPACTS OF GEOTHERMAL DEVELOPMENT

(a) Introduction

A geothermal development at Meager Mountain may affect the aquatic resources in a variety of ways. These include:

1. Impact to surface waters via:

    a. accidental spills of drilling wastes,

    b. powerplant air emissions,

    c. geothermal fluid discharges,

    d. well discharge testing,

    e. cooling tower drift and cooling tower circulating waters,

f. sanitary facilities, and

g. construction activities (e.g. sediment introduction).

2. Impact of recreation activities by the construction and operational personnel and general public on aquatic resources.

The following, as reviewed by Chorney and Sherwood (1981), outlines some of the potential concerns and impacts relevant to aquatic resources.

(b) Thermal Pollution

Hot water/wet steam systems have water temperatures greater than 150°C. The discharge of surplus heat to receiving water bodies can seriously damage fisheries. For example, Kaya (1977) found that brown trout (Salma trutta) in a naturally heated section of the Firehole River in Yellowstone National Park had poor reproductive success whereas in an unheated part of the river they reproduced well. High temperature discharges can also serve as thermal barriers to migratory fish, e.g. salmon. On the other hand, warmer temperatures and changed food availability allow fish to grow more rapidly in geothermally heated streams (Kaeding and Kaya, 1978).

(c) Water Pollution

The chemical characteristics of geothermal fluids vary considerably both in number and concentration of chemical constituents (see Chorney and Sherwood, 1981). Geothermal waters can range from potable to highly saline and corrosive.

To date the best representative sample of the geothermal fluids from the Meager Creek reservoir were obtained from the first deep (3000 m) wellhole MC-1. The major constituents of interest in the

geothermal fluids are shown in Table 6. It should be noted that two exploratory drill holes had TDS of 6000 to 10 400 ppm and high boron contents of 22 to 28 ppm (Fairbank, Openshaw, Souther and Stauder, 1981). Significant water quality changes in receiving streams could have adverse impacts on the aquatic environment.

Aquatic life criteria for some of the more common chemical constituents in geothermal fluids are listed in Table 7.

(d) Air Pollution

The acidity of rainwater and resulting runoff may also increase as a result of development of geothermal sites. This can be caused by oxidation of hydrogen sulfide or sulfur dioxide and the formation of hydrogen and sulfate ions. Axtmann (1975) noted that dissolved H_2S has deleterious effects on incubating eggs and fry of rainbow trout.

Mercury emissions associated with geothermal facilities have caused concern because of its toxicity, volatility, and presence in most geothermal fluids (Suter, 1978). Other gases emitted in significant amounts by geothermal plants are essentially inert (N_2 and H_2) or are not likely to affect natural ecosystems in the quantities and forms emitted by a geothermal plant (NH_3, Rn and CH_4) (Suter, 1978).

(e) Habitat Disturbance

During exploration and development, drilling can produce waterborne silts, mud solids, drill cuttings, soil disturbance, possible sump failure or overflow and well blowouts. All of the above would have the greatest impact on aquatic resources during the low flow winter months. Liquid-dominated wells such as those at Meager are less likely to blow out because mud, rather than air is used to reach completion depth and because of the greater weight of liquid water in the well bore. The effects of

accidental spills of geothermal fluids, possibly mixed with drilling wastes, would depend on the sensitivity of the receiving system, chemical and physical properties of the fluid, and the volume and duration of the release. Accidental spills which were toxic to fish have occurred in the past at the geysers in California (Weres, Tsao and Wood, 1977; Price, Kubicek and Enriquez, 1976).

(f) Impacts Within the Project Area

Any alteration of the thermal and water quality regime of the streams in the area could seriously affect the aquatic system. At present, field studies and impact evaluation should concentrate mainly on Meager Creek since the potential effects to this area are considered the most critical due to its proximity to the proposed site and continued drilling. Further studies are required to assess the fishery importance of the area. To evaluate potential impacts, further knowledge is required of the chemistry and quality of potential pollutants, powerplant design and operation, meteorologic and hydrologic conditions and existing water quality conditions.

(g) Potential Downstream Effects

Downstream consequences of geothermal development may be significant since this study has indicated that many tributaries and side channels of the upper Lillooet River are important as rearing, spawning and overwintering habitat for fish, particularly coho salmon and cutthroat trout. More detailed evaluations of mainstem Lillooet spawning and rearing are required before downstream impacts can be assessed.

7.0 FURTHER STUDIES REQUIRED

The following information is required to better predict impacts and to determine mitigation and compensation possibilities:

1. Assess the commercial, native and recreational value of fish in upper Lillooet River.

2. Quantify the effects of geothermal development on water quality, flows, sediment and temperature levels in tributaries and in the mainstem Lillooet River.

3. Quantify present habitat use by the various life history stages (spawning, rearing, overwintering) of fish species found in the area. Estimate population levels of resident fish species.

4. Obtain information on salmon (principally coho) migration timing, spawning and rearing distributions, age and size composition. Enumerate the salmon stock and/or fry production to provide the data base needed to assess the fishery contribution of the upper Lillooet.

5. Assessment of the benthic fauna of the study area to be used to determine fish rearing habitat suitability and productivity.

8.0 LITERATURE CITED

1. Axtmann, R.C. 1975. Chemical Aspect of the Environmental Impact of Geothermal Power. Proceedings of the Second United Nations Symposium on the Development and Use of Geothermal Resources, 20 to 29 May 1975, San Francisco. pp. 1323-1327, Lawrence Berkeley Laboratory, University of California, Berkeley, Ca.

2. Brown, R.F., M.M. Musgrove and D.E. Marshall. 1979. Catalogue of Salmon Streams and Spawning Escapements of Pemberton-Lillooet

Sub-District. Fisheries and Marine Service Data Report 161. 88 pp.

3. Chorney, R.J. and R.L. Sherwood (eds.). 1981. Geothermal electric energy and its impacts on the environment. Department of Environment, Environmental Protection Service, Pacific and Yukon Region. Regional Program Report 81-05. 37 pp.

4. Department of Fisheries and Oceans. 1977. Lillooet-Birkenhead System. Review of fisheries information and report on reconnaissance surveys, February 1977. Unpubl. data from DFO files. 27 pp. plus appendices.

5. Fairbank, B.D., R.E. Openshaw, J.G. Souther and J.J. Stauder. 1981. Meager Creek Geothermal Project - an exploration case history. Geothermal Resources Council Bulletin, July 1981: 3-7.

6. Gilbert, C.H. and W.L. Rich. 1927. Investigations concerning the red salmon runs of the Karluk River, Alaska. Bull. Bur. of Fisheries, 43: 1-69.

7. Hartley, R.P. 1978. Pollution Control Guidance for Geothermal Energy Development. Industrial Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio, EPS-600/7-78-101.

8. Kaeding, L.R. and C.M. Kaya. 1978. Growth and diets of trout from contrasting environments in a geothermally heated stream: The Firehole River of Yellowstone National Park. Trans. Am. Fish. Soc. 107: 432-438.

9. Kaya, C.M. 1977. Reproductive biology of rainbow and brown trout in a geothermally heated stream: The Firehole River of Yellowstone National Park. Trans. Am. Fish. Soc. 106: 354-361.

10. Koski, K.V. 1966. The survival of coho salmon (Oncorhynchus kisutch) from egg deposition to emergence in three Oregon coastal streams. M.S. Thesis, Oregon State Univ., Corvallis. 84 pp.

11. Peterson, W.P. 1979. The role of spring ponds in the winter ecology and natural production of coho salmon on the Olympic Peninsula, Washington. M. Sc. Thesis, Univ. Washington, Seattle. 96 pp.

12. Price, D.G., P.F. Kubicek and L.A. Enriquez. 1976. Geysers Unit 17 Site Specific Studies: Fisheries Resources, Water Quality Characteristics and Stream Sedimentation, Report 7784. 13-76. Pacific Gas and Electric Company, Department of Engineering Research. 44 pp.

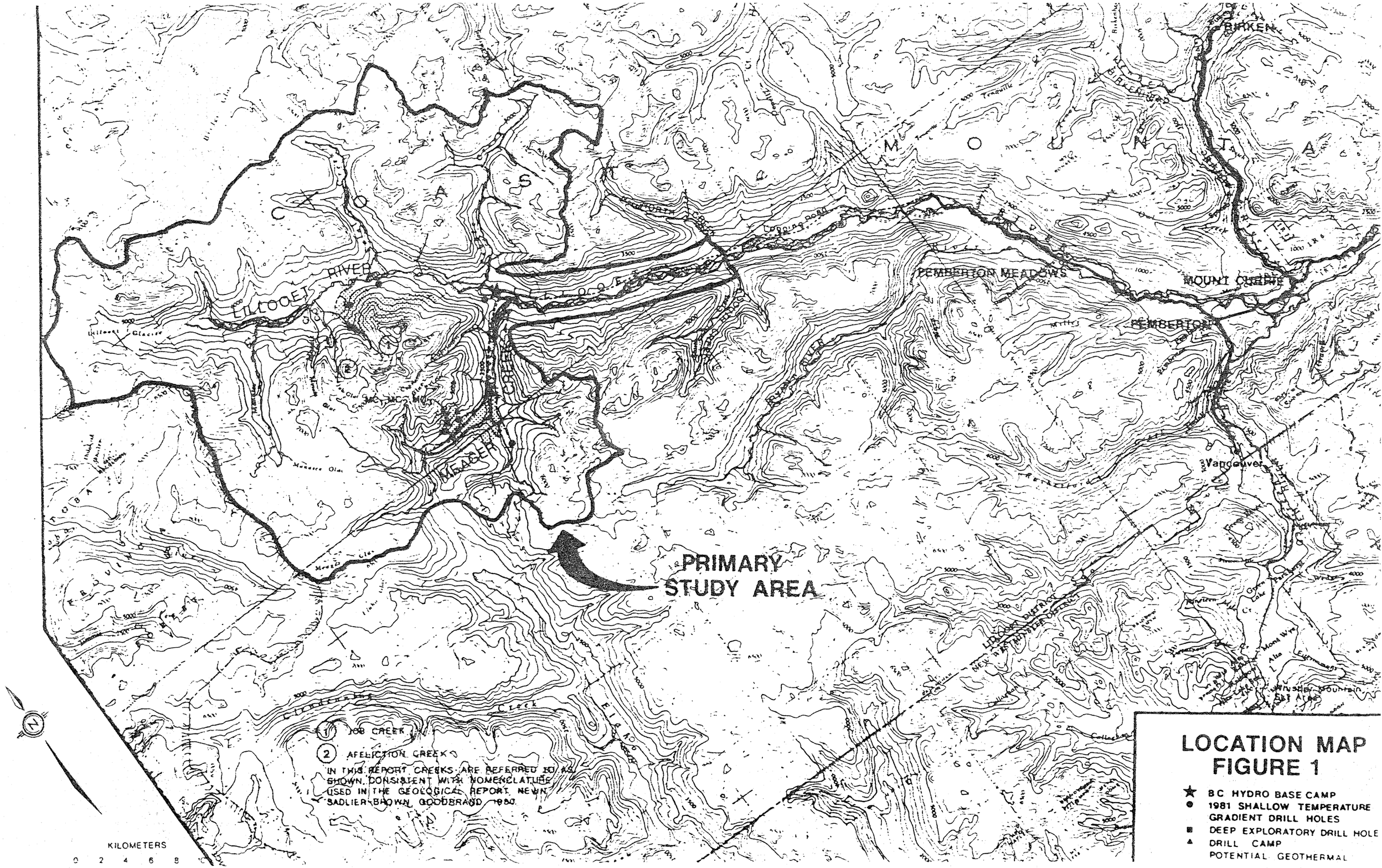
13. Reid, Crowther and Partners Ltd. 1981. Meager Mountain Geothermal Project. Status of Environmental Studies, Baseline Data, Collection Program. Report prepared for B.C. Hydro by Reid, Crowther and Partners Ltd. 55 pp. plus appendices.

14. Scott, W.B. and E.J. Crossman. 1973. Freshwater Fishes of Canada. Fish. Res. Board Can., Bull. 184: 966 pp.

15. Suter, G.W. 1978. II. Topical Briefs: Fish and Wildlife Resources and Electric Power Generation, No. 6: Effects of Geothermal Energy Development on Fish and Wildlife. Oak Ridge National Laboratory, Tenn.

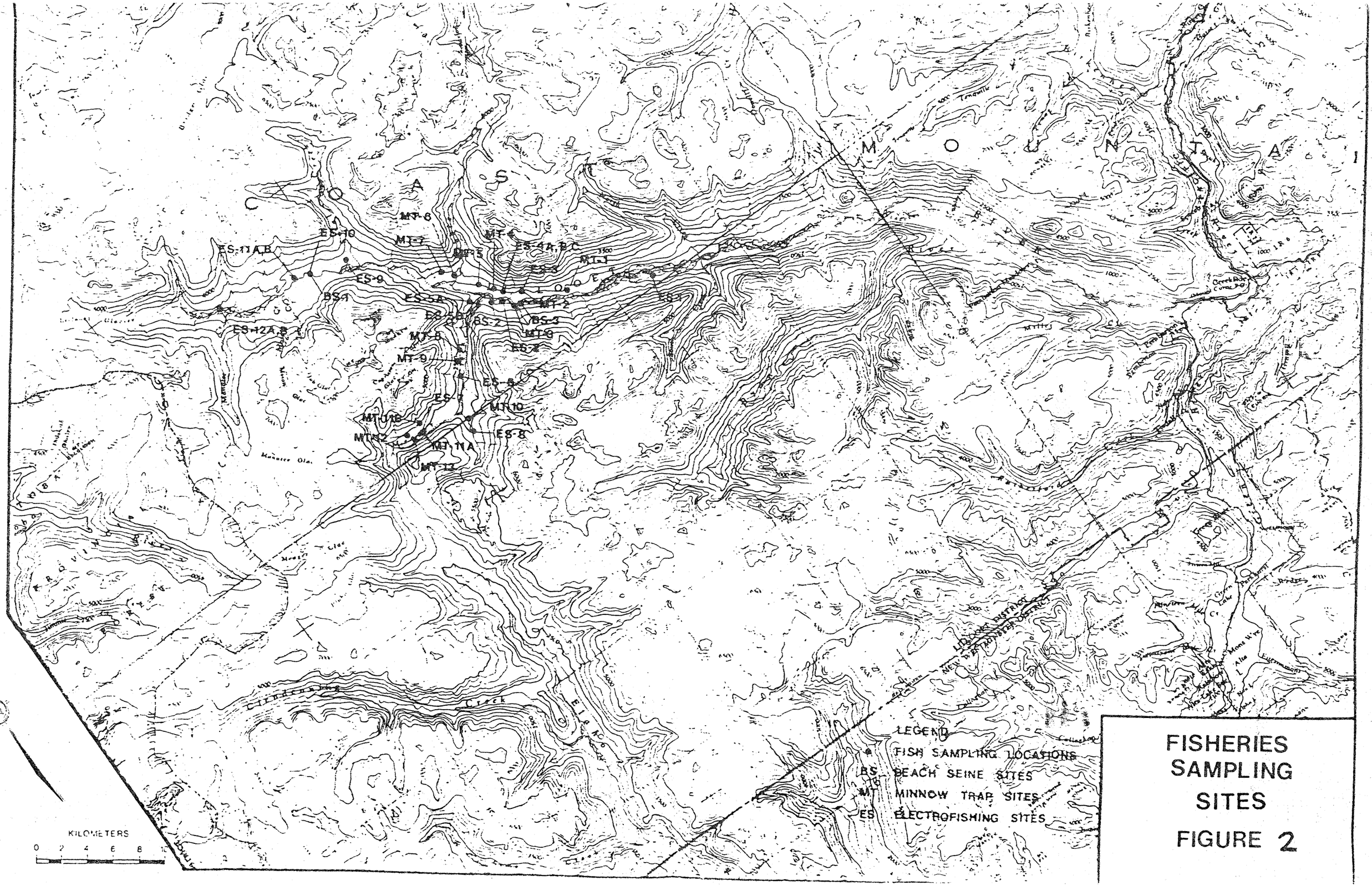
16. Water Survey of Canada. 1977. Historical streamflow summary, British Columbia. Fish. Environ. Can., Water Resour. Br., Inland Waters Directorate. 758 pp.

17. Weres, O., K. Tsao and B. Wood. 1977. Resource Technology and Environment at the Geysers. Lawrence Berkeley Laboratory, University of California, Berkeley, Ca. 385 pp.



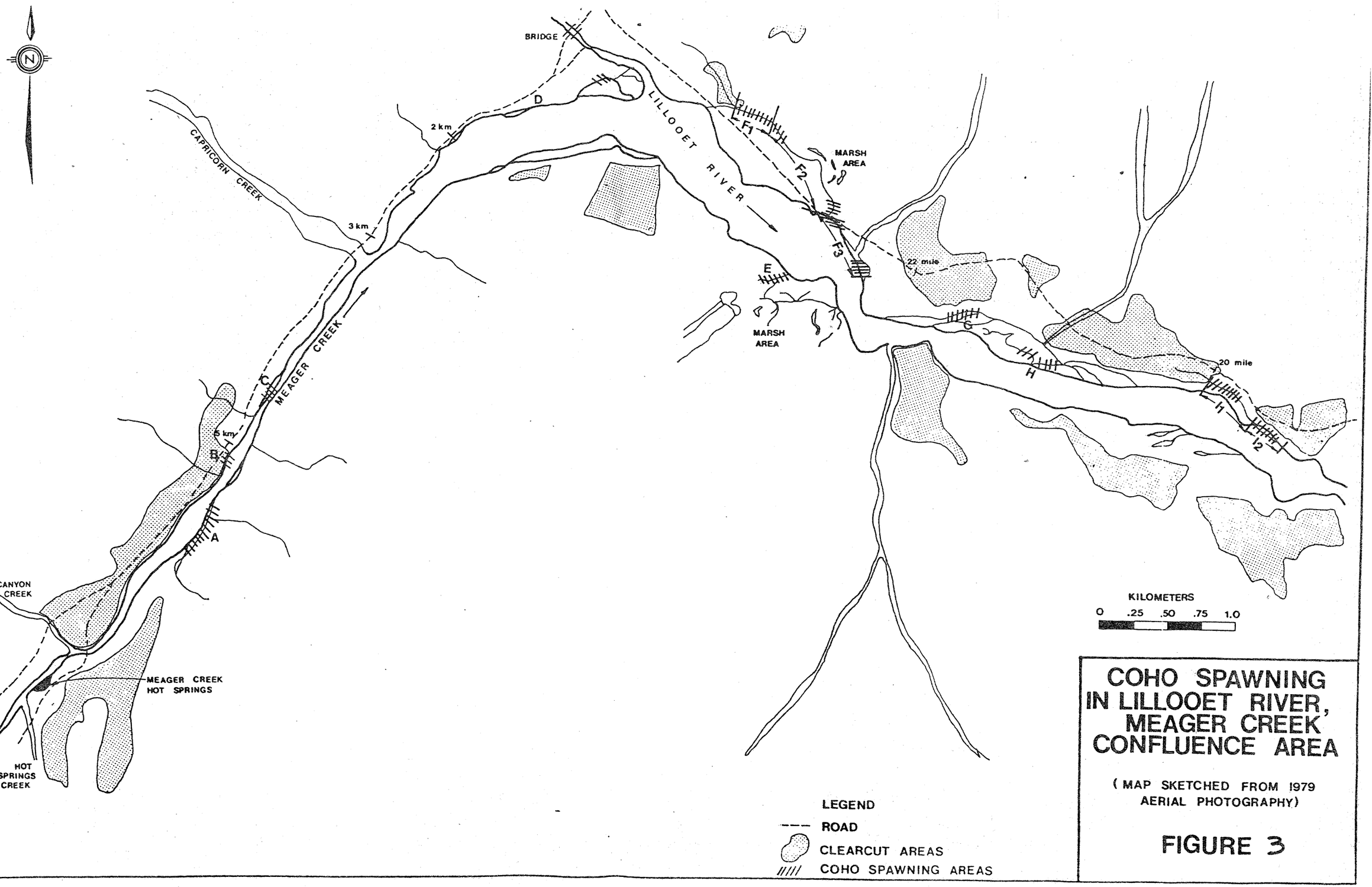
LOCATION MAP
FIGURE 1

- ★ BC HYDRO BASE CAMP
- ● 1981 SHALLOW TEMPERATURE GRADIENT DRILL HOLES
- ■ DEEP EXPLORATORY DRILL HOLE
- ▲ DRILL CAMP
- POTENTIAL GEOTHERMAL



FISHERIES SAMPLING SITES

FIGURE 2

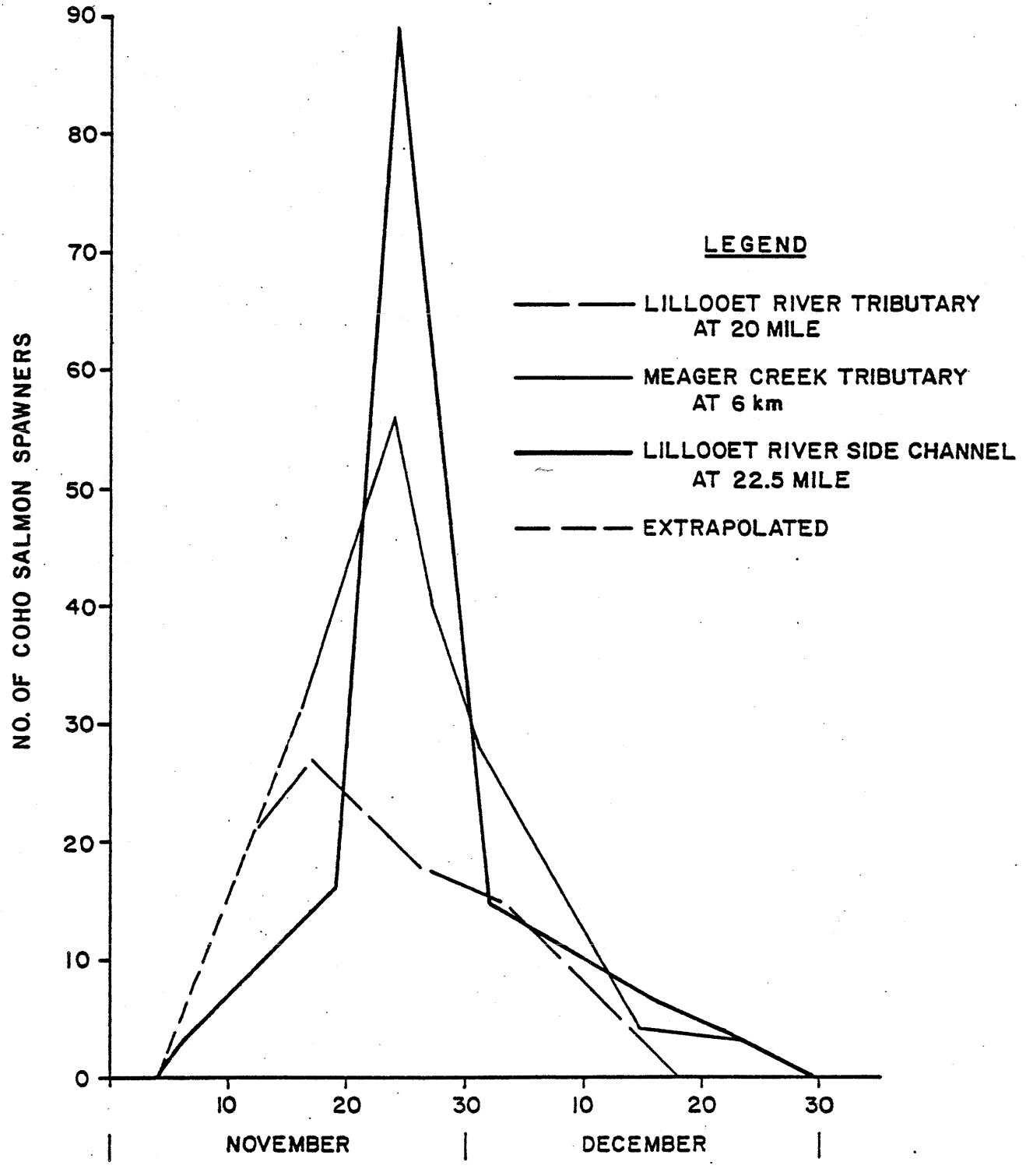


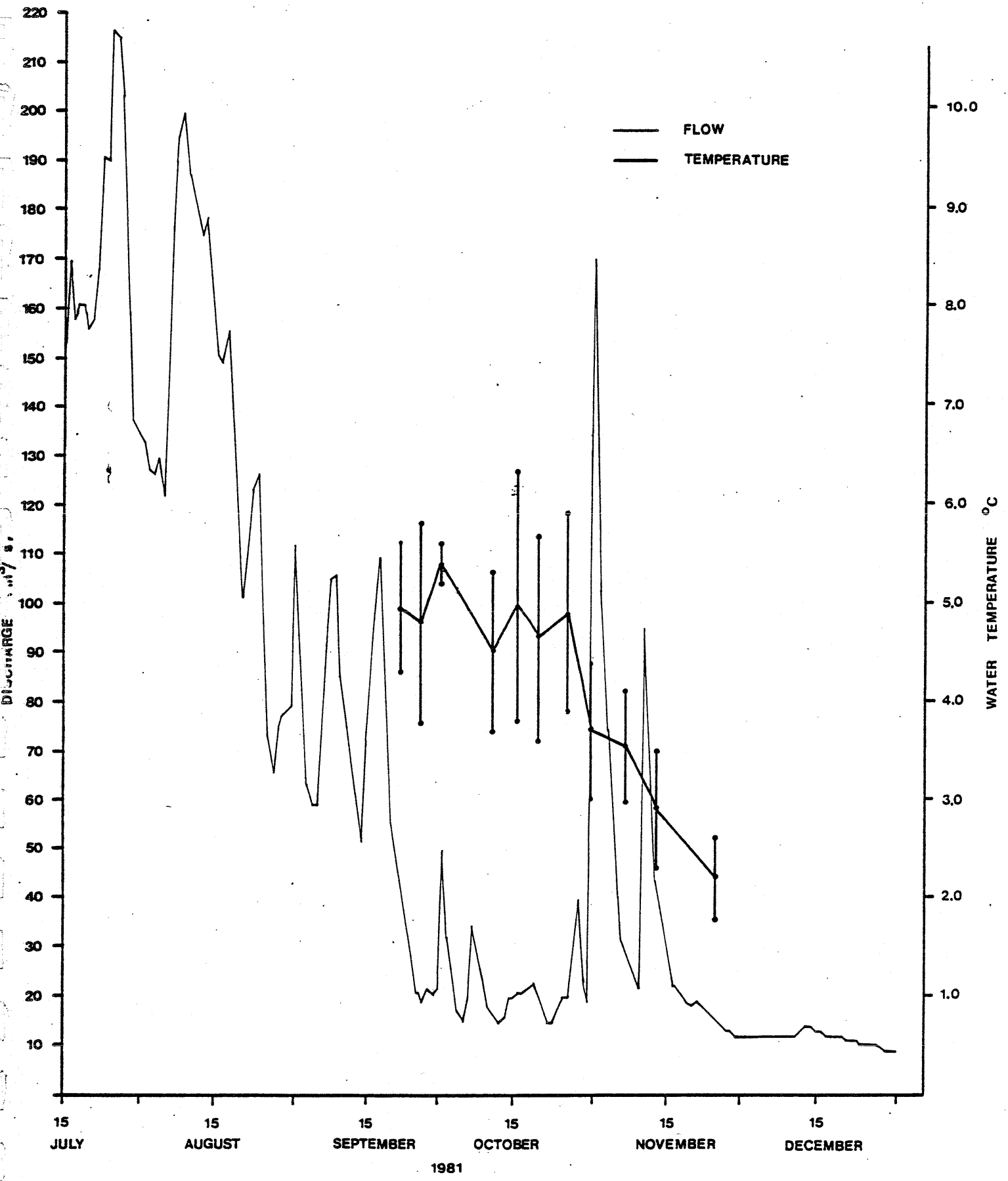
COHO SPAWNING IN LILLOOET RIVER, MEAGER CREEK CONFLUENCE AREA

(MAP SKETCHED FROM 1979 AERIAL PHOTOGRAPHY)

FIGURE 3

FIGURE 4
LIVE COUNT OF COHO SPAWNERS
IN UPPER LILLOOET WATERSHED
FALL, 1981





TEMPERATURE AND FLOW OF THE UPPER LILLOOET RIVER
UPSTREAM OF THE MEAGER CREEK CONFLUENCE

(NOTE: TEMPERATURE DATA FROM 18 SEPTEMBER TO 25 NOVEMBER)

FIGURE 5

TABLE 1

UPPER LILLOOET RIVER AND TRIBUTARIES ELECTROFISHING SUMMARY
AUGUST 1981 TO FEBRUARY 1982

Location and Map Reference Number*[1]	Date	Shocking Duration (s)	Catch*[2]	CPuE*[3]	CPuA*[4]	Mean Fork Length (mm)	S.D.*[5]	Sample Size (n)
Tributary at 13.9 mile (ES-1)	15 September 1981	335	34 CO	0.102	0.138	54.7	5.10	11
			7 CT	0.021	0.029	46.7	5.50	7
			7 CAL	0.021	0.029	105.0	6.60	7
			500 BL approx.					
Tributary at 22 mile (ES-2)	15 September 1981	435	36 CO	0.083	0.103	65.6	14.8	13
			19 CT	0.044	0.054	52.0	17.4	10
			1 CAL	0.002	0.003	110.0		1
Side channel at 20 mile (ES-3)	18 August 1981	307	8 CO	0.026	0.068	66.9	7.4	7
			3 CT	0.010	0.026	104.7	1.5	3
Tributary at 20 mile (MT-2 site)	16 February 1982	315	3 CT	0.009	0.048	91.7	13.5	3
Side channel at 22.5 mile (MT-4 site)	16 February 1982	541	11 CO	0.020	0.045	60.0	10.3	11
			10 CT	0.019	0.040	48.3	16.2	10
Mainstem Lillooet at 22.2 mile (ES-4A)	17 February 1982	329	2 CAL	0.006	0.011	110.0	24.0	2
Side channel at 22.2 mile (ES-4B)	17 February 1982	631	8 CO	0.013	0.012	71.0	10.3	8
			1 DV	0.001	0.001	124.0		1
			1 CAL	0.001	0.001	108.0		1

TABLE 1 - (Cont'd)

Location and Map Reference Number*[1]	Date	Shocking Duration (s)	Catch*[2]	CPuE*[3]	CPuA*[4]	Mean Fork Length (mm)	S.D.*[5]	Sample Size (n)
Side channel at 22.6 mile (ES-4C)	18 August 1981	557	8 CO	0.014	0.080	71.9	7.30	8
Meager Creek at 2.0 km (ES-5A)	15 September 1981	555	1 CO	0.002	0.003	65.0		1
			2 CT	0.004	0.007	83.0	1.41	2
			2 DV	0.004	0.007	61.5	10.60	2
Meager Creek at 2.0 km (ES-5B	28 August 1981	778	12 DV	0.015	0.038	77.6	17.40	12
	17 February 1982	1129	5 DV	0.004	0.008	113.2	26.30	5
Meager Creek tributary at 4.5 km (MT-8 site)	18 February 1982	568	8 CO	0.014	0.027	84.5	13.30	8
			4 CT	0.009	0.017	100.7	34.20	4
			1 DV	0.002	0.003	78.0		1
Meager Creek tributary at 6.5 km (ES-6)	14 August 1981	53	14 CT	0.264	0.233	96.9	21.70	14
Angel Creek (ES-7)	17 September 1981	550	5 DV	0.009	0.017	224.0	46.10	5
Meager Creek South Fork (ES-8)	16 September 1981	644	4 DV	0.006	0.018	56.5	5.74	4
			1 CT	0.002	0.004	34.0		1
Tributary above Lillooet falls (ES-9)	16 September 1981	69	3 CT	0.044	0.044	62.0	7.10	3
Tributary above Lillooet falls (ES-10)	16 September 1981	135	NIL					

TABLE 1 - (Cont'd)

Location and Map Reference Number*[1]	Date	Shocking Duration (s)	Catch*[2]	CPuE*[3]	CPuA*[4]	Mean Fork Length (mm)	S.D.*[5]	Sample Size (n)
Side channel above Lillooet falls (ES-11A)	17 September 1981	276	1 CT	0.004	0.006	76.0		1
Tributary above Lillooet falls (ES-11B)	17 September 1981	175	2 CT	0.011	0.025	135.0	21.21	2
Side channel above Lillooet falls (ES-12A)	17 September 1981	300	NIL					
Tributary above Lillooet falls (ES-12B)	17 September 1981	100	NIL					

*[1] Refer to Fig. 2 for location.

*[2] CO = coho salmon, CT = cutthroat trout, CAL = coastrange sculpin, BL = western brook lamprey, DV = Dolly Varden char.

*[3] Catch (number of fish) per unit effort (seconds shocked).

*[4] Catch (number of fish) per unit area (square meters shocked).

*[5] Standard Deviation.

TABLE 2

UPPER LILLOOET RIVER BEACH SEINE SUMMARY
1981

Location and Map Reference Number*[1]	Date	Area Sampled (m^2)	Catch*[2]	Mean Fork Length (mm)	S.D.*[3]	Sample Size (n)
Lillooet River (BS-1)	16 September 1981	300 m^2	NIL			
Lillooet River (BS-2)	15 September 1981	760 m^2	1 DV	200.0		1
Lillooet River (BS-3)	17 September 1981	465 m^2	2 MW 1 CAL	252.5 80.0	24.75	2 1

*[1] See Fig. 2 for locations.

*[2] DV = Dolly Varden, MW = mountain whitefish, CAL = coastrange sculpin.

*[3] Standard Deviation.

TABLE 3

UPPER LILLOOET RIVER AND TRIBUTARIES MINNOW TRAPPING SUMMARY
AUGUST 1981 TO FEBRUARY 1982

Location and Map Reference Number*[1]	Period Set	Number of Traps Set	Catch*[2]	Mean Fork Length (mm)	S.D.*[3]	Sample Size (n)
Marsh area at 17.5 mile (MT-1)	28-29 October 1981	5	2 RSC	63.50	2.12	2
			22 CT	79.84	14.06	19
			3 CO	69.00	10.39	3
Tributary at 20 mile (MT-2)	6-7 August 1981	6	13 CT	102.75	26.09	12
			24 CO	86.54	10.81	22
	28-29 October 1981	6	1 CT	88.00		1
			28 CO	87.44	10.88	27
	16-17 February 1982	6	1 CT	105.00		1
			15 CO	78.20	8.16	15
Marsh area at 21 mile (MT-3)	20-22 October 1981	10	24 CT	94.17	17.14	24
Side channel at 22.5 mile (MT-4)	17-18 September 1981	6	5 CT	65.60	25.16	5
			70 CO	57.25	6.66	28
	16-17 February 1982	6	1 CT	45.00		1
Tributary at 24 mile (MT-5)	9-10 September 1981	6	26 CT	80.48	15.42	25
Pebble Creek (MT-6)	19-20 October 1981	10	NIL			

TABLE 3 - (Cont'd)

Location and Map Reference Number*[1]	Period Set	Number of Traps Set	Catch*[2]	Mean Fork Length (mm)	S.D.*[3]	Sample Size (n)
Tributary at 26 mile	24-25 September 1981	10	8 CT	99.50	33.54	8
Tributary at 4.5 km (MT-8)	25-26 August 1981	5	9 CT	88.00	18.86	9
			52 CO	64.92	6.22	38
Tributary at 5.1 km (MT-9)	24-25 September 1981	5	5 DV	90.00	10.12	5
Side channel near Barr Creek (MT-10)	20-21 August 1981	5	NIL			
Angel Creek at:						
1. the confluence (MT-11A)	19-20 August 1981	5	NIL			
2. Meager Road (MT-11B)	13-14 August 1981	5	NIL			
Tributary at 12 km (MT-12)	12-13 August 1981	5	NIL			
Side channel at the upper hot springs (MT-13)	28-29 October 1981	5	NIL			

*[1] See Fig. 2 for locations.

*[2] CT = cutthroat trout, CO = coho salmon, DV = Dolly Varden, RSC = redside shiner.

*[3] Standard Deviation.

TABLE 4

ESTIMATED ESCAPEMENTS OF COHO SALMON TO THE LILLOOET-MEAGER STUDY AREA, 1981

Location	Reference Map Letter*[1]		Escapement Estimates
Lillooet River Study Section			
1. Side channel at 22.5 mile	F		126 (83)*[2]
2. Tributary at 21 mile	E		25
3. Side channel at 22 mile	G		8
4. Tributary at 21 mile	H		6
5. Tributary at 20 mile	I		43 (47)*[2]
		TOTAL	212
Meager Creek			
1. Tributary at 6.0 km	A		60 (80)*[2]
2. Tributary at 5.0 km	B		3
3. Tributary at 4.5 km	C		6
4. Side channels from 2.0 km to the confluence	D		3
		TOTAL	92

*[1] See Fig. 3 for locations.

*[2] Are Escapements derived by dividing the total number of fish-days (area under each curve in Fig. 4) by the average redd life (the number of days a female spends on the spawning site or redd).

TABLE 5

ESCAPEMENT RECORD FOR THE UPPER LILLOOET RIVER
INCLUDING TRIBUTARIES

Year	Sockeye	Chinook	Coho
1947	750		1 500
1948	750		7 500
1949	750		3 500
1950	750		1 500
1951	750		7 500
1952	750		15 000
1953	750		1 500
1954	750		200
1955			25
1956	25		200
1957	25		200
1958			75
1959			75
1960			200
1961			75
1962			400
1963			750
1964			75
1965			75
1966			750
1967			300
1968			200
1969			800
1970			1 500
1971			2 500
1972			750
1973			750
1974			750
1975		400	3 500
1976		400	400
1977		400	3 500
1978		400	3 500
1979		750	1 500
1980		300	6 500
1981		300	4 000
TIMING:			
ARRIVE		May	Oct
START		Sep	Oct
PEAK		Nov	Nov
END		Nov	Dec

Source: Brown, Musgrove and Marshall (1979).

TABLE 6

PARTIAL CHEMICAL COMPOSITION OF GEOTHERMAL FLUIDS
OBTAINED FROM THE MC-1 DRILL HOLE ON 2 FEBRUARY 1982

Parameter and Description	Sample Concentration (ppm)
pH (Temp. °C)	8.40 (21.4)
Ammonia	1.30
Total Carbonate as CO_2	110.00
H_2S as S	-
Silica (SiO_2)	360.00
Sulphates (SO_4)	220.00
As (dissolved)	0.24
Boron	7.00
Ca (dissolved)	48.00
Chloride	1040.00
Fluoride	2.80
K (dissolved)	62.00
Li (dissolved)	1.90
Mg (dissolved)	0.60
Na (dissolved)	740.00

Source: (C. Harvey; Kingston, Reynolds, Thom and Allardice Ltd., pers. comm.)

TABLE 7

AQUATIC LIFE CRITERIA FOR CONSTITUENTS IN GEOTHERMAL FLUID

Constituent	Criteria for Fresh Water	Criteria for Marine Water	Remarks
Ammonia (un-ionized)	0.02 mg/L		Toxicity pH dependent
Arsenic			Daphnia impaired by 4.3 mg/L
Barium			Toxicity level > 50 mg/L
Beryllium	0.11 mg/L - soft water 1.1 mg/L - hard water		Toxicity hardness - dependent
Boron			Toxic to minnows at 19 000 mg/L
Cadmium	0.004-.0004 mg/L - soft water 0.012-.0012 mg/L - hard water	0.005 mg/L	Toxic at < 0.5 mg/L all tests
Chromium	0.1 mg/L		Toxicity varies with pH and oxidation state
Copper	0.1 96 hr LC_{50}	0.1 96 hr LC_{50}	Toxicity alkalinity - dependent
Iron	1.0 mg/L		Toxicity variable
Lead	0.01 96 hr LC_{50} (sol. lead)		Salmonids most sensitive fish
Manganese		0.1 mg/L	Not a problem in fresh water

TABLE 7 - (Cont'd)

Constituent	Criteria for Fresh Water	Criteria for Marine Water	Remarks
Mercury	0.0005 mg/L	0.0001 mg/L	High bio-accumulation and thus affects human food
Nitrates			Toxicity to fish > 900 mg/L
Phosphorus		0.0001 mg/L P	Eutrophication factor
Selenium	0.01 96 hr LC_{50}	0.01 96 hr LC_{50}	Toxic at > 2.5 mg/L
Silver	0.01 96 hr LC_{50}	0.01 96 hr LC_{50}	Toxicity dependent on compound
H_2S	0.0002 mg/L	0.0002 mg/L	Toxic at very low levels
Zinc	0.01 96 hr LC_{50}		Toxicity dependent of temperature, DO, hardness
Total Dissolved Solids (TDS)			Osmotic effects - variable

Source: Hartley, 1978, p. 34.

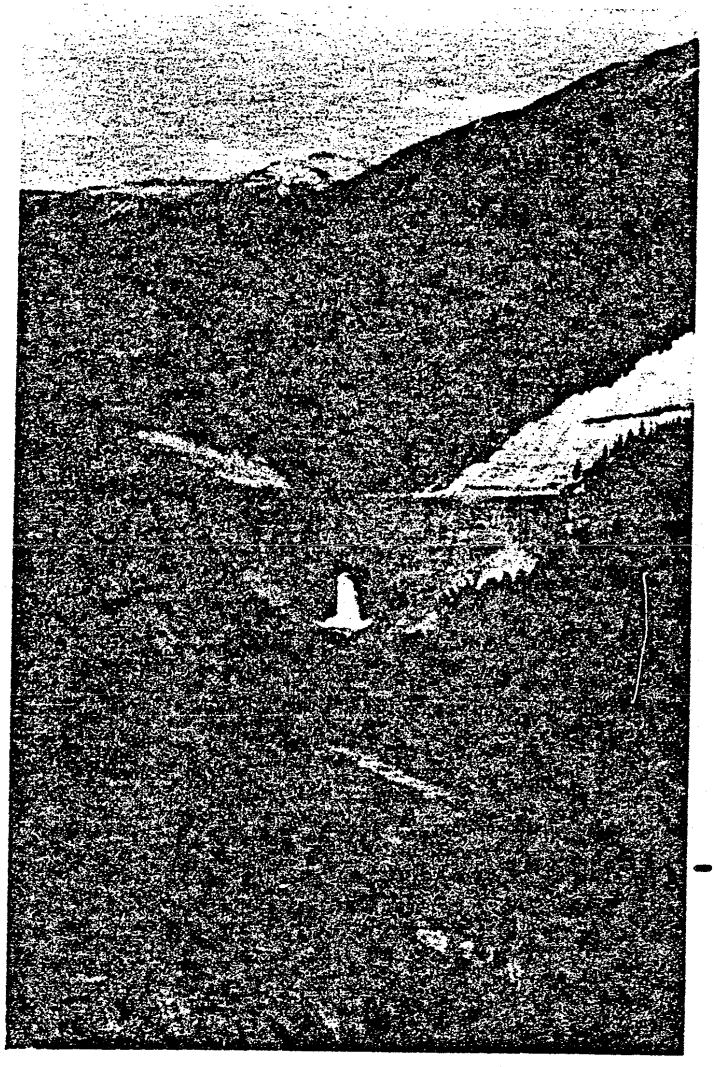


Plate 1. Falls on the upper Lillooet River. These falls define the upper limit of anadromous fish migration in the Lillooet drainage.

Plate 2. Typical high gradient tributary of the Upper Lillooet watershed.

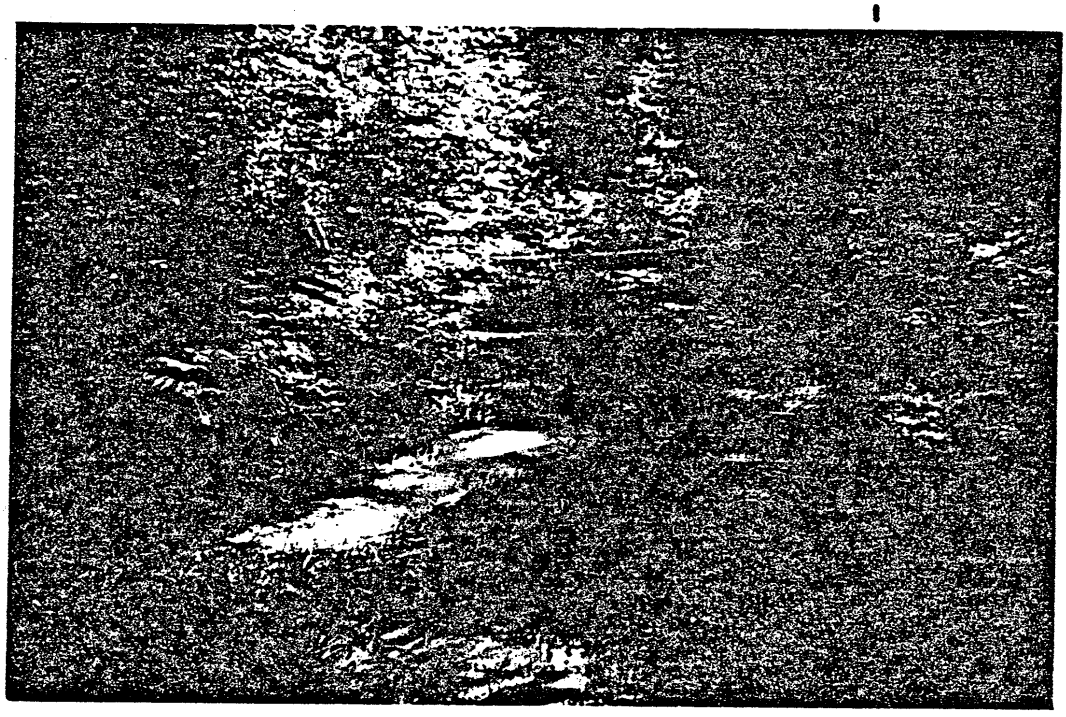


Plate 3. Unnamed tributary (ES-2) illustrating vegetative cover utilized as rearing habitat by coho salmon and cutthroat trout.

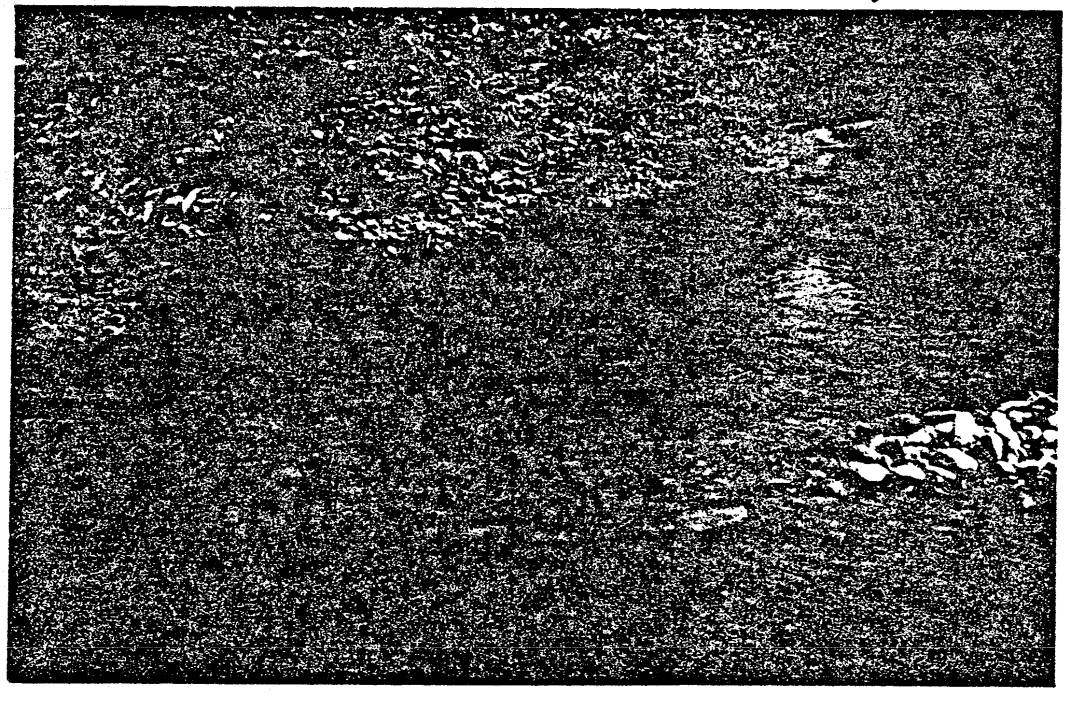


Plate 4. Unnamed tributary (ES-1) showing pool/riffle complexes. Note the good spawning gravel.

Plate 5.- Unnamed tributary (MT-2) utilized as a rearing and overwintering area by coho salmon and cutthroat trout. Note the slow flowing water and overhanging snowbanks.

APPENDIX A

MISCELLANEOUS TEMPERATURE, SECCHI DISK TRANSPARENCY AND SPECIFIC CONDUCTIVITY MEASUREMENTS FROM FISH SAMPLING SITES

TABLE A-1

MISCELLANEOUS WATER TEMPERATURE, SECCHI DISK TRANSPARENCY AND SPECIFIC CONDUCTIVITY MEASUREMENTS FROM FISH SAMPLING SITES

Map Reference Location*1	Date	Temp (°C)	Secchi Reading (cm)	Specific Conductance (umhos/cm)
ES-12A	17 September 1981	5.0	5	185.0
ES-12B	17 September 1981	8.0	100+	170.0
ES-11A	17 September 1981	7.0	5	180.0
ES-11B	17 September 1981	9.0	100+	150.0
ES-10	16 September 1981	3.0	100+	185.0
BS-1	16 September 1981	7.5	5	190.0
ES-9	16 September 1981	11.0	100+	72.5
MT-7	24 September 1981	6.5	100+	-
MT-6	14 October 1981	5.0	100+	-
MT-5	9 September 1981	13.0	100+	-
ES-5A	15 September 1981	6.0	5	180.0
ES-5B	28 August 1981	6.5	10	-
	17 February 1981	0	100+	210.0
MT-8	25 August 1981	8.0	100+	-
	18 February 1981	5.0	100+	-
MT-9	24 September 1981	7.0	100+	-
ES-6	14 August 1981	9.0	100+	-
MT-10	20 August 1981	8.0	100+	-
ES-8	16 September 1981	6.0	15	100.0
ES-7	17 September 1981	12.0	100+	145.0
MT-11A	18 August 1981	10.0	100+	-
MT-11B	13 August 1981	9.0	100+	-
MT-12	12 August 1981	9.0	-	-
MT-13	28 October 1981	13.0	100+	-
MT-4	17 September 1981	10.0	100+	160.0
	16 February 1981	1.5	100+	105.0
BS-2	15 September 1981	8.0	5	-
ES-2	5 September 1981	9.0	100+	145.0
ES-4	18 August 1981	9.0	-	-
ES-3	18 August 1981	10.0	-	-
MT-2	6 August 1981	10.0	100+	-
	28 October 1981	7.0	100+	-
	16 February 1982	4.0	100+	290.0
BS-3	17 September 1981	9.5	5	-
MT-1	28 October 1981	6.0	100+	-
ES-1	15 September 1981	14.5	100+	135.0

*1 See Fig. 2 for locations.

APPENDIX B

MONTHLY MEAN WATER TEMPERATURES IN THE UPPER LILLOOET RIVER AND MEAGER CREEK (AUGUST 1981 TO FEBRUARY 1982)

TABLE B-1

SUMMARY OF THE TEMPERATURE REGIMES IN LILLOOET RIVER AND MEAGER CREEK FOR AUGUST AND SEPTEMBER 1981
DATA FROM MAX/MIN THERMOMETERS AND TAYLOR THERMOGRAPHS
(°C)

Location*	Month	Monthly Mean	Mean Max	Mean Min	Range
1	August	8.3	8.9	7.7	5.0 - 12.5
1	September	5.2	5.7	4.7	2.8 - 8.0
2	August	7.7	8.6	6.7	4.0 - 12.0
2	September	7.3	8.5	6.2	5.0 - 12.0
3	August	42.6	43.2	42.0	41.0 - 44.0
3	September	45.3	46.1	44.4	42.0 - 49.0
4	August	7.6	8.9	6.3	6.0 - 10.0
4	September	6.2	7.6	4.8	3.0 - 13.0
5	August	8.2	9.5	6.8	5.0 - 11.0
5	September	5.3	5.8	4.8	2.8 - 9.0

*1 Lillooet River at the B.C. Hydro Camp.

2 Lillooet River below the Meager Creek confluence.

3 Meager Creek Hot Springs.

4 Meager Creek above the Hot Springs confluence.

5 Meager Creek below the Hot Springs confluence.

TABLE B-2

SUMMARY OF THE TEMPERATURE REGIME IN A SMALL UNNAMED TRIBUTARY (M10 CREEK) TO MEAGER CREEK ORIGINATING NEAR THE WESTBURNE DRILLING SITE
DATA FROM A PEABODY RYAN THERMOGRAH
(°C)

Month	Mean	Mean Max	Mean Min	Range
13 - 31 August 1981	9.7	10.9	8.5	7.0 - 13.0
1 - 30 September 1981	8.7	9.7	7.7	6.0 - 12.0
1 - 21 October 1981	7.2	7.90	6.4	5.0 - 9.0

TABLE B-3

SUMMARY OF THE TEMPERATURE REGIMES IN
LILLOOET RIVER AND MEAGER CREEK FOR OCTOBER 1981
DATA FROM MAX/MIN THERMOMETERS AND TAYLOR THERMOGRAPHS
(°C)

Location*	Monthly Mean	Mean Max	Mean Min	Range
1	4.6	5.6	3.6	1.8 - 6.8
2	4.6	5.5	3.8	2.3 - 6.7
3	47.0	48.7	47.0	45.0 - 49.5
4	3.6	4.2	2.9	1.3 - 5.7
5	4.6	5.3	4.0	2.5 - 6.4

*1 Lillooet River at the B.C. Hydro Camp.

2 Lillooet River below the Meager Creek confluence.

3 Meager Creek Hot Springs.

4 Meager Creek above the Hot Springs confluence.

5 Meager Creek below the Hot Springs confluence.

TABLE B-4

SUMMARY OF THE TEMPERATURE REGIMES IN THE LILLOOET RIVER, MEAGER CREEK, AND "M10" CREEK FOR NOVEMBER 1981
DATA FROM MAX/MIN THERMOMETERS AND TAYLOR THERMOGRAPHS
(°C)

Location*	Monthly Mean	Mean Max	Mean Min	Range
1	2.8	3.3	2.3	0.8 - 4.7
2	2.9	3.3	2.5	0.0 - 5.3
3	48.2	48.8	46.7	45.0 - 49.5
4	2.3	2.6	1.9	0.0 - 4.4
	Period 16 Nov - 28 Dec			
5	4.4	5.0	3.9	2.0 - 6.0

*1 Lillooet River at the B.C. Hydro Camp.

Note: Thermograph did not operate on the 3, 4, 11, 15 to 18 and 26 to 30 November.

2 Lillooet River below the Meager Creek confluence.

Note: Thermograph did not operate on the 3, 4, 9 and 10 to 18 November.

3 Meager Creek Hot Springs - calculated from 26 October to 4 December from a max/min thermometer.

4 Meager Creek below the Hot Springs.

Note: Thermograph did not operate on the 1 to 4 and 16 to 18 November.

5 "M10" Creek (at Westburne) - calculated from max/min from 16 November to 28 December.

TABLE B-5

SUMMARY OF THE TEMPERATURE REGIMES IN THE LILLOOET AND MEAGER CREEK (°C)

Location*	Month	Monthly Mean	Mean Max	Mean Min	Range
1	January	0.9	1.3	0.6	0.3 - 1.9
1	February	1.2	1.6	0.7	0.0 - 2.8
2	January	1.5	1.8	1.1	0.0 - 3.9
2	February	2.5	2.9	2.1	1.1 - 4.2

*1 Lillooet River at the water level gauging station.

Note: Thermograph did not operate on the 1 to 3 and 24 January.

2 Meager Creek below the Hot Springs.

Note: Thermograph did not operate on the 1 to 3 and 21 to 25 January, 3 to 8 and 20 to 24 February.

APPENDIX C

UPPER LILLOOET RIVER AND TRIBUTARIES

ELECTROFISHING SUMMARY

AUGUST 1981 TO FEBRUARY 1982

ELECTROFISHING DATA SUMMARY

LOCATION: Unnamed tributary to the Lillooet River at 13.9 mile West Lillooet River Road (re: 3 mile u/s from South Creek) (Map Reference ES-1).

Date	Time	Temp (°C)	Substrate	Distance Fished (m)	Wetted Width (m)	Effort (electro-seconds)	Catch	Comments
09/15/81	1330-1430	14.5	80% gravel 10% cobble 10% boulder	50	0 3.7 10 3.6 20 4.2 30 4.8 40 7.3 50 5.8 = 4.90	335	34 CO 63, 60, 54, 53, 53, 57, 54, 56, 57, 52, 43 7 CT 36, 53, 49, 50, 46, 49, 44 7 CAL 105, 106, 112, 108, 92, 102, 110 Total 34 CO *2 7 CT *3 7 CAL *4 500 BL *5	*1 23 CO released approximately 500 lamprey amocoetes shocked out of the bottom silt.

*1 - Maximum depth shocked = 0.3 m
- Conductivity = 135 umhos/cm
- Secchi disk transparency = 1.0 + m
- Good substrate for Coho or Trout spawning
- 5 lamprey taken for specimens

*2 - CO = Coho Salmon

*3 - CT = Cutthroat Trout

*4 - CAL = Coastrange Sculpin (Cottus aleuticus)

*5 - BL = Western Brook Lamprey

ELECTROFISHING DATA SUMMARY

LOCATION: Unnamed tributary to the Lillooet River at 1.25 km d/s of the Meager/Lillooet confluence on the right bank (Map Reference ES-2).

Date	Time	Temp (°C)	Substrate	Distance Fished (m)	Wetted Width (m)	Effort (electro-seconds)	Catch	Comments
09/15/81	1110-1141	9.0	30% sand 70% cobble/boulder	60	0 5.6 10 5.2 20 5.6 30 4.1 40 10.0 50 5.5 60 4.9 = 5.84	435	36 CO 64, 55, 91, 90, 64, 81, 60, 74, 65, 63, 44, 46, 56 19 CT 47, 37, 80, 78, 44, 43, 72, 43, 40, 36 1 CAL 110 Total 36 CO 19 CT 1 CAL	*[1] 23 CO released unmeasured 9 CT released unmeasured

*[1] - Only shocked 40% of the wetted width - shocking was started 200 m u/s from the mouth
- Secchi disk transparency = 1.0 + m
- Conductivity = 145 umhos/cm
- Maximum depth shocked = 0.6 m
- Noted what looks like redds in the lower portion of the creek

ELECTROFISHING DATA SUMMARY

LOCATION: Small side channel of the Lillooet River at 20 mile (Map Reference ES-3).

Date	Time	Temp (°C)	Substrate	Distance Fished (m)	Wetted Width (m)	Effort (electro-seconds)	Catch	Comments
08/18/81	1030-1110	10.0	100% sand	75	0 2.5 10 1.4 20 1.8 30 1.0 40 1.5 50 2.1 60 1.2 70 1.5 75 1.1 = 1.57	307	8 CO 63, 73, 58, 80, 67, 63, 64 3 CT 105, 103, 106 Total 8 CO 3 CT	1 CO escaped measurement *[1]

*[1] - Maximum depth shocked = 0.3 m
- 90% run/10% pool

ELECTROFISHING DATA SUMMARY

LOCATION: Small side channel of the Lillooet River at 22.6 mile on the left bank (Map Reference ES-4C)

Date	Time	Temp (°C)	Substrate	Distance Fished (m)	Wetted Width (m)	Effort (electro-seconds)	Catch	Comments
08/18/81	0900-1000	9.0	10% boulder 30% cobble 55% gravel 5% sand	50	0 2.5 10 1.7 20 1.9 30 1.7 40 1.9 50 2.3 = 2.0	557	8 CO 85, 75, 62, 68, 67, 73, 73, 75 Total 8 CO	6 fish escaped capture, probably CO *[1]

*[1] - 75% pool/25% riffle
- All the CO captured were obtained in the first 30 m shocked
- Shocking was started at the mouth and worked upstream for 50 m.
- Maximum depth shocked = 0.4 m

ELECTROFISHING DATA SUMMARY

LOCATION: A creek flowing through a clearcut on the left bank of the Lillooet River at 20 mile (MT-2 site)

Date	Time	Temp (°C)	Substrate	Distance Fished (m)	Wetted Width (m)	Effort (electro-seconds)	Catch	Comments
02/16/82	1600-1630	4.0	100% organic	25	2.5	315	3 CT 105, 92, 78	*[1]
						Total	3 CT	

*[1] - Secchi disk transparency = 1.0 + m when bottom not disturbed
- Conductivity = 290 umhos/cm
- Shocked a 25 m section where the minnow traps were going to be set

ELECTROFISHING DATA SUMMARY

LOCATION: Mainstem of the Lillooet River (left bank) and a side channel at 22.5 mile (see map)

Date	Time	Temp (°C)	Substrate	Distance Fished (m)	Wetted Width (m)	Effort (electro-seconds)	Catch	Comments
Mainstem (Map Reference ES-4A)								
02/17/82	1530-1600	2.5	40% cobble 40% boulder 20% gravel/sand	60	25	329	2 CAL 127, 93 Total 2 CAL	*1
Side Channel (Map Reference ES-4B)								
02/17/82	1600-1620	2.5	40% cobble 30% sand 20% gravel 10% boulder	150	(3.0-6.0)	631	8 CO 83, 75, 79, 74, 78, 64, 53, 62 1 DV 124 1 CAL 108 Total 8 CO 1 DV*3 1 CAL	*2

*1 - Secchi disk transparency = 1.0 + m
- Shocked a 60 m section along the left bank (width shocked = 3.0 m)
- Maximum depth shocked = 1.50 m

*2 - Secchi disk transparency = 1.0 + m
- Shocked a 150 m section along the right bank of the side channel (width shocked = 3.0 m)
- Maximum depth shocked = 1.0 m

*3 - DV - Dolly Varden char

ELECTROFISHING DATA SUMMARY

LOCATION: Groundwater-fed side channel at 22.5 mile (MT-4 site)

Date	Time	Temp (°C)	Substrate	Distance Fished (m)	Wetted Width (m)	Effort (electro-seconds)	Catch	Comments
02/16/82	1400-1430	1.5	60% sand 20% gravel 15% cobble 5% boulder	70	3.5	541	11 CO 72, 73, 54, 77, 52, 60, 64, 56, 57, 44 10 CT 93, 43, 50, 45, 42, 37, 40, 44, 41, 48	*[1]
						Total	11 CO 10 CT	

*[1] - Secchi disk transparency = 1.0 + m
- Shocked a 70 m section d/s of the bridge
- Maximum depth shocked - 0.50 m

ELECTROFISHING DATA SUMMARY

LOCATION: Meager Creek on the right bank 2 km Meager Main Road (access was from the other side) (Map Reference ES-5A)

Date	Time	Temp (°C)	Substrate	Distance Fished (m)	Wetted Width (m)	Effort (electro-seconds)	Catch	Comments
09/15/81	0910-1000	6.0	50% sand 30% gravel 20% boulder	65	0 5.1 10 7.8 20 3.7 30 5.9 40 7.8 50 4.1 60 1.5 65 1.0 = 4.61	555	2 CT 84, 82 2 DV 69, 54 1 CO 65 Total 2 CT 2 DV 1 CO	*[1] 2 unidentified fish escaped

*[1] - Secchi disk transparency = 0.05 m
- Conductivity = 180 umhos/cm
- Maximum depth shocked = 0.30 m
- 90% run, 10% pool

ELECTROFISHING DATA SUMMARY

LOCATION: Braided Section of Meager Creek at 2.0 km on the left bank (Map Reference ES-5B)

Date	Time	Temp (°C)	Substrate	Distance Fished (m)	Wetted Width (m)	Effort (electro-seconds)	Catch	Comments
08/28/81	0915-1015	6.5	Mainly boulder and cobble	80 (cumulative)	3-5	778	12 DV 130, 75, 76, 68, 86, 71, 70, 66, 78, 70, 74, 67	*[1]
						Total	12 DV	

*[1] - Secchi disk transparency = 0.10 m
- Maximum depth shocked = 0.45 m
- Catch is cumulative from shocking 3 side channels in the gravel bar section.
- 1 specimen retained.

ELECTROFISHING DATA SUMMARY

LOCATION: Braided Section of Meager Creek at 2.0 km on the left bank (Map Reference ES-5B)

Date	Time	Temp (°C)	Substrate	Distance Fished (m)	Wetted Width (m)	Effort (electro-seconds)	Catch	Comments
02/17/82	0930-1039	0.0	60% cobble 20% gravel 15% boulder 5% sand	180	3-4	1129	5 DV 115, 125, 150, 89, 87	*[1]
							Total 5 DV	

*[1] - Secchi disk transparency = 1.0 + m
- Conductivity = 210 umhos/cm
- Catch is cumulative from shocking several side channels in the gravel bar section.

ELECTROFISHING DATA SUMMARY

LOCATION: Meager Creek Tributary at 4.5 km (left bank) (MT-8 site)

Date	Time	Temp (°C)	Substrate	Distance Fished (m)	Wetted Width (m)	Effort (electro-seconds)	Catch	Comments
02/18/82	1330-1410	*1	60% sand 20% gravel 20% cobble/boulder	100	3.0 (est)	568	4 CT 53, 99, 125, 126 8 CO 97, 97, 72, 80, 98, 94, 68, 70 1 DV 78	*2
						Total	4 CT 8 CO 1 DV	

*1 - Water temperature in the creek upstream of the seeps is 2.5°C
- Water temperature in the creek downstream of the seeps is 5.0°C

*2 - Secchi disk transparency = 1.0 + m
- Mainflow of the creek originates from two warm water seeps (re: 4.5°C and 7.5°C)

ELECTROFISHING DATA SUMMARY

LOCATION: Small unnamed creek which is a tributary to Meager Creek (approximately 0.5 km in length). Origin is near the CRB Logging A-Frame (Map Reference ES-6).

Date	Time	Temp (°C)	Substrate	Distance Fished (m)	Wetted Width (m)	Effort (electro-seconds)	Catch	Comments
08/14/81	0800-0915	9.0	Mainly sand	60	1.0	53	14 CT 80, 86, 87, 97, 108, 107, 94, 95, 89, 82, 100, 78, 88, 165	4 fish escaped unidentified, probably CT. *[1]
							Total 14 CT	

*[1] - Voltage = 500
- 50/50 Pool, Run
- Maximum depth shocked = 0.30 m

ELECTROFISHING DATA SUMMARY

LOCATION: Angel Creek on the Meager Creek Flood Plain (Map Reference ES-7)

Date	Time	Temp (°C)	Substrate	Distance Fished (m)	Wetted Width (m)	Effort (electro-seconds)	Catch	Comments
09/17/81	1500-1515	12.0	70% gravel 15% boulder 15% sand	150*[1]	2.0*[1]	550	5 DV 200, 180, 210, 230, 300 Total 5 DV	*[1]

*[1] - Shocked two side channels
- Secchi disk transparency = 1.0 + m
- Maximum depth shocked = 0.60 m
- Conductivity = 145 umhos/cm
- 1 DV taken for a specimen

ELECTROFISHING DATA SUMMARY

LOCATION: Meager Creek South Fork (access: logging road at the M-12 drill site) (Map Reference ES-8)

Date	Time	Temp (°C)	Substrate	Distance Fished (m)	Wetted Width (m)	Effort (electro-seconds)	Catch	Comments
09/16/81	1000-1040	6.0	30% sand 30% boulder 20% cobble 20% gravel	45 (est)	5.0	644	4 DV 60, 60, 58, 48 1 CT 34	*[1]
						Total	4 DV 1 CT	

*[1] - Conductivity = 100 umhos/cm
- Maximum depth shocked = 0.80 m
- Secchi disk transparency = 0.15 m
- Shocked along the margins only - mainly on the right bank
- All except 1 CT were captured in a small side channel flowing over the Flood plain
- KM angled for 5 minutes in a pool section - hooked 1 CT (100) not landed.

ELECTROFISHING DATA SUMMARY

LOCATION: Small tributary to the Upper Lillooet River below "Moose Meadows" (Map Reference ES-9)

Date	Time	Temp (°C)	Substrate	Distance Fished (m)	Wetted Width (m)	Effort (electro-seconds)	Catch	Comments
09/16/81	1630-1640	11.0	80% gravel 15% cobble 5% boulder	20	1.0	69	3 CT 67, 57, 45 Total 3 CT	*[1]

*[1] - Maximum depth shocked = 0.20 m
- Secchi disk transparency = 1.0 + m
- Conductivity = 72.5 umhos/cm
- Shocked a 20 m section to verify that the fry that we saw were cutthroat

ELECTROFISHING DATA SUMMARY

LOCATION: Unnamed tributary to the Lillooet River at the steel bridge. Confluence is 50 m d/s from the bridge on the right bank (Map Reference ES-10)

Date	Time	Temp (°C)	Substrate	Distance Fished (m)	Wetted Width (m)	Effort (electro-seconds)	Catch	Comments
09/16/81	1545-1610	3.0	*[1]	50 (est)	3.0	135	Nil	*[2]

*[1] - Substrate: Lower 25 m - 95% sand, 10% gravel
Upper 25 m - 80% gravel, 15% cobble, 5% boulder

*[2] - No fish sighted
- Conductivity = 185 umhos/cm
- Secchi disk transparency = 1.0 + m

ELECTROFISHING DATA SUMMARY

LOCATION: Side channel of the Upper Lillooet River at 0.50 km u/s from the steel bridge on the left bank (Map Reference ES-11A)

Date	Time	Temp (°C)	Substrate	Distance Fished (m)	Wetted Width (m)	Effort (electro-seconds)	Catch	Comments
09/17/81	1330	7.0	*1	60 (est)	3.0	276	1 CT 76	*2
						Total	1 CT	

*1 - Substrate: Lower 40 m - 100% sand
Upper 20 m - 20% gravel, 40% cobble, 40% boulder

*2 - CT was captured at the entrance of a small creek
- Maximum depth shocked = 0.35 m
- Conductivity = 180 umhos/cm
- Secchi disk transparency = 0.05 m

ELECTROFISHING DATA SUMMARY

LOCATION: Unnamed tributary to the Lillooet River at 0.50 km u/s of the steel bridge on the left bank (Map Reference ES-11B)

Date	Time	Temp (°C)	Substrate	Distance Fished (m)	Wetted Width (m)	Effort (electro-seconds)	Catch	Comments
09/17/81	1300	9.0	20% gravel 50% cobble 30% boulder*2	40 (est)	2.0	175	2 CT 120, 150 Total 5 CT	3 CT escaped*2

*1 - Maximum depth shocked = 0.50 m
- Conductivity = 150 umhos/cm
- Secchi disk transparency = 1.0 + m

*2 - Bottom covered with an orange ppt. (probably Fe)

ELECTROFISHING DATA SUMMARY

LOCATION: Side channel of the Upper Lillooet River - 1.5 km d/s of Silt Lake on the left bank (Map Reference ES-12A)

Date	Time	Temp (°C)	Substrate	Distance Fished (m)	Wetted Width (m)	Effort (electro-seconds)	Catch	Comments
09/17/81	1245-1300	5.0	80% sand 20% gravel	75 (est)	3.0	300	Nil	*[1]

*[1] - No fish sighted while shocking
- Maximum depth shocked = 0.35 m
- Conductivity = 185 umhos/cm
- Secchi disk transparency = 0.05

ELECTROFISHING DATA SUMMARY

LOCATION: Unnamed tributary to the Lillooet River - 1.5 km d/s of Silt Lake on the left bank (Map Reference ES-12B)

Date	Time	Temp (°C)	Substrate	Distance Fished (m)	Wetted Width (m)	Effort (electro-seconds)	Catch	Comments
09/17/81	1200	8.0	20% boulder 40% cobble 10% sand 30% gravel	50 (est)	5.0	100	Nil	*[1]

*[1] - No fish sighted while shocking
- Only shocked along one margin
- Maximum depth shocked = 0.40 m
- Conductivity = 170 umhos/cm
- Secchi disk transparency = 1.0 + m

APPENDIX D

UPPER LILLOOET RIVER AND TRIBUTARIES

MINNOW TRAPPING SUMMARY

AUGUST 1981 TO FEBRUARY 1982

MINNOW TRAPPING DATA SUMMARY

LOCATION: A large marsh area on the left bank of the Lillooet River at 17.5 mile (Map Reference MT-1).

Trap No.	Date In	Date Out	Time In	Time Out	Temp (°C) In	Temp (°C) Out	Depth (cm)	Distance From Bank (m)	Substrate	Catch	Comments
1	10/28/81	10/29/81	1152	1300	6.5	7.0	90.0	0.00	100% organic	1 RSC 65	set in a pond in an undercut bank*[1]
2	10/28/81	10/29/81	1154	1316	6.0	7.0	22.0	0.76	100% gravel	7 CT 56, 75, 80, 58, 81	2 CT escaped
3	10/28/81	10/29/81	1155	1314	6.0	7.0	14.0	0.45	100% gravel	3 CO 75, 75, 57 6 CT 100, 80, 88, 72, 90 1 RSC 62	1 CT escaped
4	10/28/81	10/29/81	1156	1312	6.0	7.0	13.0	1.00	100% organic	5 CT 90, 91, 110, 70, 75	set in amongst weeds
5	10/28/81	10/29/81	1157	1310	6.0	7.0	12.0	0.22	50% gravel 50% sand	4 CT 80, 80, 85, 56	set at the base of a beaver dam
										Total 2 RSC*[2] 22 CT 3 CO	

*[1] - Traps 2 to 5 were set in an outlet creek from a pond.
- Marsh area has many outlet creeks - some have small beaver dams - possible obstructions to salmon fry migration.
- Fish sighted (unidentified) in the ponds.
- Possible trout spawning in the spring.
- Secchi disk transparency = 1.0 + m.

*[2] - RSC - Redside Shiner, CT - Cutthroat trout, CO - Coho salmon

MINNOW TRAPPING DATA SUMMARY

LOCATION: A creek flowing through a clearcut on the left bank of the Lillooet River at 20 mile (Map Reference MT-2).

Trap No.	Date In	Date Out	Time In	Time Out	Temp (°C) In	Temp (°C) Out	Depth (cm)	Distance From Bank (m)	Substrate	Catch	Comments
1	02/16/82	02/17/82	1620	1345	4.0	5.0	30.0	0.40	100% organic	9 CO 74, 64, 69, 81, 82, 78, 88, 95, 71	*[1]
2	02/16/82	02/17/82	1622	1350	4.0	5.0	22.0	0.30	100% organic	1 CO 75	
3	02/16/82	02/17/82	1623	1350	4.0	5.0	18.0	0.40	100% organic	Nil	
4	02/16/82	02/17/82	1624	1355	4.0	5.0	15.0	0.80	100% organic	Nil	
5	02/16/82	02/17/82	1625	1357	4.0	5.0	17.0	0.50	100% organic	Nil	
6	02/16/82	02/17/82	1626	1400	4.0	5.0	20.0	0.75	100% organic	5 CO 85, 76, 87, 73, 75 1 CT 105	
									Total	15 CO 1 CT	

*[1] - Secchi disk transparency = 1.0 + m when bottom not disturbed
- Conductivity = 290 umhos/cm

MINNOW TRAPPING DATA SUMMARY

LOCATION: A creek flowing through a clearcut on the left bank of the Lillooet River at 20 mile (Map Reference MT-2).

Trap No.	Date In	Date Out	Time In	Time Out	Temp (°C) In	Temp (°C) Out	Depth (cm)	Distance From Bank (m)	Substrate	Catch	Comments
1	08/06/81	08/07/81	1500	1400	10.0	10.5	20.0	1.0	50% gravel 50% sand	3 CO 85, 83, 7 3 CT 75, 84, 82	*[1]
2	08/06/81	08/07/81	1505	1415	10.0	10.5	21.0	2.0	100% organic	4 CO 96, 85, 100	1 CO escaped
3	08/06/81	08/07/81	1515	1418	10.0	10.5	23.0	1.5	100% organic	5 CO 80, 80, 98, 67, 95 2 CT 115, 100	
4	08/06/81	08/07/81	1520	1422	10.0	10.5	20.0	1.1	100% organic	1 CO 91 2 CT 130, 125	
5	08/06/81	08/07/81	1523	1426	10.0	10.5	18.0	0.9	100% organic	6 CO 105, 93, 76, 62, 85 2 CT 73	1 CT and 1 CO escaped measurement
6	08/06/81	08/07/81	1525	1430	10.0	10.5	18.0	0.5	100% organic	5 CO 84, 100, 91, 91, 84 4 CT 130, 82, 150, 87	
										Total 24 CO 13 CT	

*[1] - CO and 1 CT taken for identification purposes.

MINNOW TRAPPING DATA SUMMARY

LOCATION: A creek flowing through a clearcut on the left bank of the Lillooet River at 20 mile (Map Reference MT-2).

Trap No.	Date In	Date Out	Time In	Time Out	Temp (°C) In	Temp (°C) Out	Depth (cm)	Distance From Bank (m)	Substrate	Catch	Comments
1	10/28/81	10/29/81	1130	1412	7.0	7.0	15.0	1.50	50% gravel 50% sand	1 CT 88 1 CO 75	1 navigator shrew*[1]
2	10/28/81	10/29/81	1132	1410	7.0	7.0	18.0	0.68	100% organic	2 CO 95	1 CO escaped
3	10/28/81	10/29/81	1133	1409	7.0	7.0	22.0	2.00	100% organic	2 CO 89, 95	
4	10/28/81	10/29/81	1134	1407	7.0	7.0	18.0	0.91	100% organic	2 CO 101, 100	
5	10/28/81	10/29/81	1135	1405	7.0	7.0	20.0	0.66	100% organic	4 CO 80, 96, 69, 75	
6	10/28/81	10/29/81	1136	1400	7.0	7.0	19.0	0.18	100% organic	17 CO 90, 99, 80, 105, 93, 80, 98, 105, 80, 78, 83, 72, 96, 93, 72, 82, 80	
										Total 28 CO 1 CT	

*[1] - Same site as trapped previously on 08/06/81 to 08/07/81.
- Secchi disk transparency = 1.0 + m.

MINNOW TRAPPING DATA SUMMARY

LOCATION: On the right bank of the Lillooet River at 21 mile (Map Reference MT-3).

Trap No.	Date In	Date Out	Time In	Time Out	Temp (°C) In	Temp (°C) Out	Depth (cm)	Distance From Bank (m)	Substrate	Catch	Comments
1	10/20/81	10/22/81	1253	1430	5.0	4.0	20.0	1.00	100% organic	Nil	*1
2	10/20/81	10/22/81	1254	1432	5.0	4.0	14.0	0.70	100% organic	4 CT 80, 88, 100, 50	
3	10/20/81	10/22/81	1255	1434	5.0	4.0	37.0	0.60	100% organic	10 CT 105, 100, 110, 94, 84, 90, 92, 115, 85, 100	
4	10/20/81	10/22/81	1256	1436	5.0	4.0	20.0	0.35	100% organic	1 CT 78	
5	10/20/81	10/22/81	1257	1438	5.0	4.0	50.0	0.30	100% organic	4 CT 135, 60, 98, 95	
6	10/20/81	10/22/81	1306	1440	5.0	4.0	16.0	5.00	100% organic	Nil	
7	10/20/81	10/22/81	1307	1442	5.0	4.0	30.0	5.00	100% organic	2 CT 88, 95	
8	10/20/81	10/22/81	1308	1444	5.0	4.0	22.0	5.00	100% organic	3 CT 110, 110, 98	
9	10/20/81	10/22/81	1309	1446	5.0	4.0	50.0	1.40	100% organic	Nil	
10	10/20/81	10/22/81	1310	1448	5.0	4.0	65.0	1.10	100% organic	Nil	
										Total 24 CT	

*1 - Secchi disk transparency = 1.0 + m.
- All traps set in slow flowing water in amongst the weeds.

MINNOW TRAPPING DATA SUMMARY

LOCATION: Groundwater-fed side channel at 22.5 mile (left bank) (Map Reference MT-4).

Trap No.	Date In	Date Out	Time In	Time Out	Temp (°C) In	Temp (°C) Out	Depth (cm)	Distance From Bank (m)	Substrate	Catch	Comments
1	09/17/81	09/18/81	0820	0820	10.0	11.0	35.0	0.20	90% sand 10% gravel	2 CT 96, 90 6 CO 55, 65, 71, 64, 45	*[1] 1 CO escaped
2	09/17/81	09/18/81	0821	0824	10.0	11.0	20.0	0.20	5% boulder 95% gravel	2 CT 45, 47 1 CO 48	
3	09/17/81	09/18/81	0822	0826	10.0	11.0	30.0	0.50	90% sand 10% cobble	1 CO 57	
4	09/17/81	09/18/81	0823	0828	10.0	11.0	40.0	3.00	100% sand	1 CT 50 6 CO 64, 71, 50, 55, 58, 65	
5	09/17/81	09/18/81	0830	0830	10.0	11.0	22.0	0.80	100% sand	16 CO 57, 58, 59, 63, 54, 53, 56, 53, 58, 55, 50, 53, 58, 62, 46	set in a pool 1 CO escaped
6	09/17/81	09/18/81	0825	0833	10.0	11.0	50.0	1.00	50% sand 30% boulder 20% cobble	40 CO released unmeasured	set in a pool
										Total 5 CT 70 CO	

*[1] - Conductivity 160 umhos/cm
- Secchi disk transparency = 1.0 + m.
- Creek has an orange ppt. along the bottom - probably Fe

MINNOW TRAPPING DATA SUMMARY

LOCATION: Groundwater-fed side channel at 22.5 mile (left bank) (Map Reference MT-4).

Trap No.	Date In	Date Out	Time In	Time Out	Temp (°C) In	Temp (°C) Out	Depth (cm)	Distance From Bank (m)	Substrate	Catch	Comments
1	02/16/82	02/17/82	1500	1445	1.5	3.0	28.0	0.20	50% sand 50% cobble	Nil	*[1]
2	02/16/82	02/17/82	1502	1450	1.5	3.0	18.0	0.20	50% sand 50% cobble	Nil	
3	02/16/82	02/17/82	1503	1452	1.5	3.0	26.0	0.30	50% sand 50% cobble	Nil	
4	02/16/82	02/17/82	1504	1454	1.5	3.0	38.0	0.40	100% sand	Nil	
5	02/16/82	02/17/82	1505	1456	1.5	3.0	40.0	1.00	20% sand 80% cobble	Nil	
6	02/16/82	02/17/82	1506	1458	1.5	3.0	21.0	1.00	20% sand 80% cobble	1 CT 45	
										Total 1 CT	

*[1] - Secchi disk transparency = 1.0 + m when bottom not disturbed
- Conductivity = 105 umhos/cm
- Mesh size of the Gee traps may permit small cutthroat fry to escape
- D.O. = 13.5 ppm

MINNOW TRAPPING DATA SUMMARY

LOCATION: A small, unnamed creek directly opposite of the B.C. Hydro camp (i.e. left bank of the Lillooet River) (Map Reference MT-5).

Trap No.	Date In	Date Out	Time In	Time Out	Temp (°C) In	Temp (°C) Out	Depth (cm)	Distance From Bank (m)	Substrate	Catch	Comments
1	09/09/81	09/10/81	1153	1325	13.0	14.5	32.0	0.05	80% gravel 20% sand	2 CT 80, 100	*[1] set in a pond
2	09/09/81	09/10/81	1155	1320	13.0	14.5	20.0	1.00	100% sand	5 CT 114, 91, 90, 68	set in a log jam 1 CT escaped
3	09/09/81	09/10/81	1150	1315	13.0	14.5	16.0	0.30	50% boulder	9 CT 63, 70, 90, 89, 78, 75, 83, 90, 61	2 morts from the current trap set in a run
4	09/09/81	09/10/81	1200	1310	13.0	14.5	27.0	1.20	100% sand	4 CT 116, 80, 70, 81	1 CT escaped
5	09/09/81	09/10/81	1201	1305	13.0	14.5	22.0	0.80	100% sand	4 CT 89, 82, 67, 59	set in a pool
6	09/09/81	09/10/81	1203	1300	13.0	14.5	16.0	0.22	100% gravel	2 CT 68, 58	set in a pool
										Total 26 CT	

*[1] - The area surrounding the creek has been clear-cut
- no buffering strip has been left
- creek is also clogged with logged debris

MINNOW TRAPPING DATA SUMMARY

LOCATION: Pebble Creek (Map Reference MT-6).

Trap No.	Date In	Date Out	Time In	Time Out	Temp (°C) In	Temp (°C) Out	Depth (cm)	Distance From Bank (m)	Substrate	Catch	Comments
1	10/19/81	10/20/81	1505	1914	5.0	2.5	17.0	1.50	33% sand 33% gravel 33% cobble	Nil	Area 1*[1]
2	10/19/81	10/20/81	1504	0915	5.0	2.5	22.0	0.42	100% sand	Nil	Area 1
3	10/19/81	10/20/81	1500	0917	5.0	2.5	31.0	0.55	50% sand 50% gravel	Nil	Area 1
4	10/19/81	10/20/81	1501	0917	5.0	2.5	13.0	0.33	33% gravel 33% cobble 33% boulder	Nil	Area 1
5	10/19/81	10/20/81	1502	0918	5.0	2.5	21.0	0.00	50% gravel 50% boulder	Nil	Area 1
6	10/19/81	10/20/81	1520	0920	5.0	2.5	22.0	0.72	50% cobble 50% gravel	Nil	Area 2*2
7	10/19/81	10/20/81	1521	0921	5.0	2.5	13.5	0.50	100% gravel	Nil	Area 2
8	10/19/81	10/20/81	1523	0922	5.0	2.5	23.0	0.00	50% cobble 50% boulder	Nil	Area 2
9	10/19/81	10/20/81	1530	0923	5.0	2.5	30.0	0.90	33% gravel 33% sand 33% boulder	Nil	Area 2
10	10/19/81	10/20/81	1530	0924	5.0	2.5	28.0	0.90	33% gravel 33% sand 33% boulder	Nil	Area 2

*[1] - Area 1 at the confluence
*[2] - Area 2 100 m u/s from Area 1
- Secchi disk transparency = 1.0 + m.

MINNOW TRAPPING DATA SUMMARY

LOCATION: A small, unnamed tributary to the Upper Lillooet River at 26 mile (Map Reference MT-7).

Trap No.	Date In	Date Out	Time In	Time Out	Temp (°C) In	Temp (°C) Out	Depth (cm)	Distance From Bank (m)	Substrate	Catch	Comments
1	09/24/81	09/25/81	0935	0926	6.5	5.0	20.0	2.00	100% fine gravel	1 CT 135	*[1] set in a pool
2	09/24/81	09/25/81	0936	0925	6.5	5.0	22.0	0.80	100% fine gravel	1 CT 90	set in a pool
3	09/24/81	09/25/81	0945	0923	6.5	5.0	10.0	0.66	50% sand 50% fine gravel	Nil	set in a pool
4	09/24/81	09/25/81	0947	0921	6.5	5.0	16.0	1.00	100% fine gravel	Nil	set in a log jam
5	09/24/81	09/25/81	0949	0920	6.5	5.0	32.0	0.89	100% fine gravel	3 CT 95, 150, 73	set in a log jam
6	09/24/81	09/25/81	1015	0906	6.5	5.0	22.0	0.45	50% gravel 50% sand	Nil	set in a log jam
7	09/24/81	09/25/81	1014	0907	6.5	5.0	26.0	1.00	50% boulder 50% gravel	1 CT 45	set in a pool
8	09/24/81	09/25/81	1013	0908	6.5	5.0	27.0	0.42	100% gravel	Nil	set in a pool
9	09/24/81	09/25/81	1012	0909	6.5	5.0	21.0	0.27	50% sand 50% cobble	1 CT 115	set in a pool
10	09/24/81	09/25/81	1011	0910	6.5	5.0	26.0	0.00	50% boulder 50% cobble	1 CT 93	set in a pool
										Total 8 CT	

*[1] - Trap Nos. 1 to 5 set below a 30 m high waterfall
- Trap Nos. 6 to 10 set above the waterfall
- Secchi disk transparency = 1.0 + m

MINNOW TRAPPING DATA SUMMARY

LOCATION: A small, unnamed creek that originates from seepages along the left bank of Meager Creek at 4.5 km (Map Reference MT-8).

Trap No.	Date In	Date Out	Time In	Time Out	Temp (°C) In	Temp (°C) Out	Depth (cm)	Distance From Bank (m)	Substrate	Catch	Comments
1	08/25/81	08/26/81	1459	1009	8.0	8.0	22.0	0.50	100% sand	18 CO 69, 65, 58, 60, 59, 63, 68, 65, 58, 57, 60, 58 2 CT 67, 70	4 CO escaped
2	08/25/81	08/26/81	1458	1007	8.0	8.0	30.0	0.70	80% sand 20% gravel	5 CO 1 CT 91	5 CO released, not measured
3	08/25/81	08/26/81	1457	1005	8.0	8.0	30.0	0.30	100% gravel	15 CO 70, 64, 64, 61, 70, 66, 61, 76, 69, 56, 76, 70, 60 1 CT 108	2 CO escaped measurement
4	08/25/81	08/26/81	1456	1003	8.0	8.0	20.0	0.40	100% gravel	5 CO 56, 77, 60, 69, 61 4 CT 116, 83, 105, 88	
5	08/25/81	08/26/81	1455	1000	8.0	8.0	15.0	0.20	100% gravel	9 CO 79, 74, 72, 62, 62, 63, 64, 65 1 CT 64	1 CO escaped measurement *[1]
										Total 52 CO 9 CT	

*[1] - Secchi disk transparency = 1.0 + m
- 50/50 Pool, Run
- Small fry were sighted that might be able to avoid capture (re: swim through the mesh of the trap)

MINNOW TRAPPING DATA SUMMARY

LOCATION: A small, unnamed tributary to Meager Creek at 5.1 km on the left bank (Map Reference MT-9).

Trap No.	Date In	Date Out	Time In	Time Out	Temp (°C) In	Temp (°C) Out	Depth (cm)	Distance From Bank (m)	Substrate	Catch	Comments
1	09/24/81	09/25/81	1122	0955	7.0	5.0	16.0	0.50	100% sand	Nil	*[1] set in a log jam
2	09/24/81	09/25/81	1123	0957	7.0	5.0	25.0	0.15	75% cobble 25% sand	2 DV 85, 84	set in a pool
3	09/24/81	09/25/81	1126	0959	7.0	5.0	21.0	0.27	50% sand 50% cobble	Nil	set in a pool
4	09/24/81	09/25/81	1127	1000	7.0	5.0	47.0	0.10	100% boulder	1 DV 108	set in a pool
5	09/24/81	09/25/81	1128	1002	7.0	5.0	14.0	0.75	100% sand	2 DV 86, 87	set in a pool
										Total 5 DV	

*[1] - Secchi disk transparency = 1.0 + m
- Good area to Electro-shock (re: 250 m run over the Flood plain)

MINNOW TRAPPING DATA SUMMARY

LOCATION: Small side channel of Meager Creek (South Fork) at the confluence with Barr Creek (Map Reference MT-10).

Trap No.	Date In	Date Out	Time In	Time Out	Temp (°C) In	Temp (°C) Out	Depth (cm)	Distance From Bank (m)	Substrate	Catch	Comments
1	08/20/81	08/21/81	1131	0908	8.0	8.5	18.0	0.40	100% sand	Nil	*[1]
2	08/20/81	08/21/81	1130	0910	8.0	8.5	19.0	0.30	50% sand 50% silt	Nil	
3	08/20/81	08/21/81	1129	0912	8.0	8.5	16.0	0.20	100% sand	Nil	
4	08/20/81	08/21/81	1127	0914	8.0	8.5	35.0	0.55	50% sand 50% boulder	Nil	set in a pool
5	08/20/81	08/21/81	1125	0915	8.0	8.5	45.0	0.45	50% sand 50% boulder	Nil	set in a pool

*[1] - Origin of side channel is 40 m u/s of Meager Creek (South Fork)
- Barr Creek has a higher sediment load than the Upper Meager Creek (South Fork).
- Barr Creek water temperature at 1130 was 5.5°C.
- Angling might be a good sampling technique in the Upper Meager Creek (South Fork) area due to lower sediment loads and pool sections.
- Barr Creek appears to be a difficult area to sample due to a steep gradient, high velocity, no pools or side channels - just a straight run.

MINNOW TRAPPING DATA SUMMARY

LOCATION: Angel Creek at North Meager Main Road (Map Reference MT-11B)

Trap No.	Date In	Date Out	Time In	Time Out	Temp (°C) In	Temp (°C) Out	Depth (cm)	Distance From Bank (m)	Substrate	Catch	Comments
1	08/13/81	08/14/81	1605	0700	9.0	8.0	28.0	0.60	100% gravel	Nil	set in a pool
2	08/13/81	08/14/81	1607	0700	9.0	8.0	28.0	0.60	100% gravel	Nil	
3	08/13/81	08/14/81	1609	0710	9.0	8.0	25.0	0.90	100% silt	Nil	set in a pool
4	08/13/81	08/14/81	1611	0710	9.0	8.0	20.0	0.40	100% silt	Nil	
5	08/13/81	08/14/81	1613	0715	9.0	8.0	22.0	1.30	100% silt	2 navigator shrews	*[1]

*[1] - No fish sighted while setting traps.

MINNOW TRAPPING DATA SUMMARY

LOCATION: Angel Creek Fan Area. Small creek originating near the M-10 drill hole (Map Reference MT-12).

Trap No.	Date In	Date Out	Time In	Time Out	Temp (°C) In	Temp (°C) Out	Depth (cm)	Distance From Bank (m)	Substrate	Catch	Comments
1	08/12/81	08/13/81	1615	1447	9.0	9.0	27.0	0.30	100% sand/silt	Nil	
2	08/12/81	08/13/81	1620	1445	9.0	9.0	20.0	0.20	100% sand/silt	Nil	
3	08/12/81	08/13/81	1623	1450	9.0	9.0	40.0	0.50	100% sand	Nil	set in a small pool
4	08/12/81	08/13/81	1625	1455	9.0	9.0	20.0	0.30	10% sand 10% gravel 80% boulder	Nil	
5	08/12/81	08/13/81	1630	1458	9.0	9.0	16.0	0.20	80% gravel' 20% silt	1 navigator shrew	*[1]

*[1] - Creek clogged with logging debris
- No fish sighted while setting traps

MINNOW TRAPPING DATA SUMMARY

LOCATION: On the left bank of Meager North at upper hot spring site (re: 12 km) (Map Reference MT-13).

Trap No.	Date In	Date Out	Time In	Time Out	Temp (°C) In	Temp (°C) Out	Depth (cm)	Distance From Bank (m)	Substrate	Catch	Comments
1	10/28/81	10/29/81	1550	1454	16.5	15.0	20.0	1.5	100% sand	Nil	*1
2	10/28/81	10/29/81	1551	1453	13.0	15.0	20.0	5.0	33% sand 33% cobble 33% boulder	Nil	
3	10/28/81	10/29/81	1555	1452	13.0	12.0	28.0	7.0	33% sand 33% gravel 33% boulder	Nil	
4	10/28/81	10/29/81	1557	1451	12.5	12.0	22.0	7.0	80% sand 20% boulder	Nil	
5	10/28/81	10/29/81	1600	1500	11.5	10.0	24.0	5.2	50% boulder 50% sand	Nil	

*1 - Secchi disk transparency = 1.0 + m
- All traps were set in a small side channel which the hot spring drains into.
- All the traps were set below the inlet from the hot springs.

APPENDIX E

UPPER LILLOOET RIVER BEACH SEINE SUMMARY

SEPTEMBER 1981

BEACH SEINE DATA SUMMARY

LOCATION: Upper Lillooet River right bank 45 m u/s from the steel bridge (Map Reference BS-1)

Date	Time	Temp (°C)	Length of Sn. (m)	Max. Depth (m)	Substrate	Secchi Disk Transparency (m)	Catch	Comments
09/16/81	1600	7.5	15.0	0.70	50% sand 20% cobble 30% gravel	0.05	Nil	*[1]

*[1] - Seine was done off of a gravel bar through a riffle and a pool.
- Conductivity = 190 umhos/cm
- 2 seines set

BEACH SEINE DATA SUMMARY

LOCATION: Right bank of the Lillooet River - 1 km d/s of the Meager/Lillooet confluence (Map Reference BS-2)

Date	Time	Temp (°C)	Length of Sn. (m)	Max. Depth (m)	Substrate	Secchi Disk Transparency (m)	Catch	Comments
09/15/81	1035	8.0	15.0	0.80	50% cobble/boulder 50% sand	0.05	1 DV (adult) 200	- Sn was walked through a riffle section and hauled up on a gravel/sand bar - Sn was done off an island near the right bank

BEACH SEINE DATA SUMMARY

LOCATION: On the right bank of the Lillooet River at 20 mile (Map Reference BS-3)

Date	Time	Temp (°C)	Length of Sn. (m)	Max. Depth (m)	Substrate	Secchi Disk Transparency (m)	Catch	Comments
09/17/81	1550	9.5	15.0	0.80	50% sand 25% cobble 25% boulder	0.05	2 MW 235, 270 1 CAL 80	1 MW preserved *[1]

*[1] - Seine was done off of a gravel bar through a riffle and into a pool.

APPENDIX F

COHO SALMON SPAWNING DATA,

LILLOOET-MEAGER STUDY AREA

NOVEMBER AND DECEMBER 1981

TABLE F-1

COHO SALMON SPAWNING GROUND DEAD RECOVERY DATA FROM THE LILLOOET-MEAGER AREA - 1981

Location	Map Reference Letter*[1]	Date	Time	Live Count Actual	Live Count Estimate	Dead Recovery M	Dead Recovery F	Dead Recovery J*[2]	Dead Recovery Unsexed	Distance Surveyed (m)	Secchi Disk Transparency (m)	Water Temp. (°C)
LILLOOET RIVER												
Side channel at 22.5 mile (l.b.)*[3]	F2*[5]	Nov 6	1500	3	-	-	-	-	-	100	1.0 +	-
	F2	Nov 10	0730	4	5	1	-	-	-	500	1.0 +	5.0
	F3*[5]	Nov 10	0700	2	-	-	-	-	-	700	1.0 +	5.0
	F2	Nov 17	0930	6	7	-	-	-	-	500	1.0 +	4.0
	F3	Nov 17	0900	8	9	-	-	-	-	700	1.0 +	4.0
	F3	Nov 19	0800	15	-	-	-	-	-	700	1.0 +	-
	F1*[5]	Nov 24	1300	72	80	1	14	-	-	300	1.0 +	-
	F2	Nov 24	1500	8	9	-	-	-	-	500	1.0 +	4.0
	F1	Nov 25	0800	not done		4	5	-	-	300	1.0 +	3.0
	F1	Nov 26	0800	not done		5	4	-	-	300	1.0 +	3.5
	F3	Nov 30	0800	1	-	-	2	-	-	700	1.0 +	4.0
	F1	Dec 2	0830	13	14	1	1	-	-	300	1.0 +	5.0
	F1	Dec 10	1400	0	-	-	-	-	-	300	1.0 +	5.0
	F3	Dec 16	0900	6	7	-	-	-	-	700	1.0 +	2.5
	F2	Dec 16	1030	0	-	-	-	-	-	75	1.0 +	2.5
	F1	Dec 17	0900	0	-	-	1	-	-	300	1.0 +	-
	F1	Dec 22	1430	0	-	-	-	-	-	300	1.0 +	-
	F2	Dec 22	1300	0	-	-	-	-	-	75	1.0 +	-
	F3	Dec 22	1330	4	4	-	-	-	-	700	1.0 +	-
	F1	Dec 29	0900	0	-	-	-	-	-	300	1.0 +	2.5
Tributary at 21 mile (r.b.)*[4]	E	Nov 6	0830	4	5	1	-	-	-	300	1.0 +	2.5
		Nov 19	1400	20*[7]	-	-	-	-	-	300	1.0 +	4.0
Tributary 150 m downstream of E (r.b.)	-	Nov 19	1430	0	0	-	-	-	-	100	1.0 +	4.0
Side channel at 22 mile (l.b.)	G	Nov 19	0800	3	-	-	-	-	-	250	1.0 +	-
	G	Nov 20	0800	1	-	3	1	0	-	250	1.0 +	3.5
Tributary at 21 mile (l.b.)	H	Nov 20	0900	-	-	-	1	-	5	300	1.0 +	5.0

TABLE F-1 - (Cont'd)

Location	Map Reference Letter*[1]	Date	Time	Live Count Actual	Live Count Estimate	Dead Recovery M	Dead Recovery F	Dead Recovery J*[2]	Dead Recovery Unsexed	Distance Surveyed (m)	Secchi Disk Transparency (m)	Water Temp. (°C)
LILLOOET RIVER (Cont'd)												
Tributary at 20 mile (l.b.)	I1*[6]	Nov 18	1030	24	27	1	2	-	-	500	1.0 +	7.0
	I1	Nov 26	1030	4	5	-	-	-	-	500	1.0 +	5.0
	I2*[6]	Nov 26	1100	12	13	-	-	-	3	100	0.5	5.0
	I1	Dec 3	0910	5	6	-	-	-	-	100	1.0 +	3.0
	I2	Dec 3	1015	8	9	-	-	-	1	500	1.0 +	-
	I1	Dec 18	0830	0	-	-	-	-	-	100	1.0 +	1.5
	I2	Dec 18	1000	0	-	-	-	-	-	500	1.0 +	-
Tributary at 14 mile (r.b.)	-	Nov 10	1430	7	8	-	-	-	-	1000	1.0 +	3.0
Tributary at 13 mile (r.b.)	-	Nov 6	0900	1	-	-	-	-	-	100	1.0 +	-
		Nov 19	1530	3	4	-	-	-	-	450	1.0 +	6.0
Tributary at 11 mile (r.b.)	-	Nov 6	0930	2	-	-	-	-	-	100	1.0 +	-
Tributaries from 12 to 14 mile (r.b.)	-	Nov 19	-	15*[7]	-	-	-	-	-	-	-	-
Tributary at 16.4 mile (r.b.)	-	Nov 19	-	2*[7]	-	-	-	-	-	-	-	-
Pebble Creek	-	Nov 18	1030	-	-	-	-	-	-	1000	1.0 +	-
Tributary 1 mile upstream of Pebble Creek	-	Dec 1	1315	-	-	-	-	-	-	1500	1.0 +	2.0
MEAGER CREEK												
Tributary at 6.0 km (r.b.)	A	Nov 16	0930	28	31	1	-	-	2	1000	1.0 +	5.0
	A	Nov 24	0800	53	56	1	-	-	-	1000	1.0 +	2.0
	A	Nov 27	1030	39	41	1	1	-	1	1000	1.0 +	3.0
	A	Dec 1	0830	26	28	-	1	-	-	1000	1.0 +	3.0
	A	Dec 15	0830	3	4	-	-	-	1	1000	1.0 +	2.5
	A	Dec 23	0830	3	-	-	-	-	-	1000	1.0 +	-
	A	Dec 29	1300	0	-	-	-	-	-	1000	1.0 +	1.5

TABLE F-1 - (Cont'd)

Location	Map Reference Letter*[1]	Date	Time	Live Count Actual	Live Count Estimate	Dead Recovery M	Dead Recovery F	Dead Recovery J*[2]	Dead Recovery Unsexed	Distance Surveyed (m)	Secchi Disk Transparency (m)	Water Temp. (°C)
MEAGER CREEK (Cont'd)												
Tributary at 5.0 km (l.b.)	B	Nov 16	1300	1	-	-	-	-	-	250	1.0 +	4.5
	B	Dec 3	1345	2	-	-	-	-	-	250	1.0 +	3.0
Tributary at 4.5 km (l.b.)	C	Nov 10	1030	3	-	-	-	-	-	300	1.0 +	4.0
	C	Nov 16	1320	1	2	-	-	-	-	300	1.0 +	5.0
	C	Nov 27	0745	1	-	1	-	-	-	300	1.0 +	3.0
	C	Dec 3	0800	2	-	-	-	-	-	300	1.0 +	3.0
	C	Dec 16	1300	0	-	-	-	-	-	300	1.0 +	-
Side channels on the l.b. from 2 km to the confluence	D	Nov 17	1100	0	-	-	-	-	-	500	0.2	4.0
	D	Nov 18	0800	1	-	-	-	-	-	2000	0.5	4.5
	D	Nov 30	1030	2	-	-	-	-	-	1250	1.0 +	4.0
Side channel on the right bank opposite D	-	Nov 18	1300	0	-	-	-	-	-	1500	1.0 +	4.5
South Fork	-	Nov 17	1345	0	-	-	-	-	-	1500	1.0 +	2.0

*[1] Map Reference Letters are shown in Fig. 3.

*[2] Jack

*[3] Left bank

*[4] Right bank

*[5] F1, F2, F3 - The Lillooet River side channel at 22.5 mile was divided into three sections for enumerating purposes. F1 was the upper most spawning area with a length of 300 m. F2 was designated as the section upstream of the bridge at 22.5 mile and downstream of F1 (length 500 m). The majority of the F2 section was a marsh. F3 was the section downstream of the bridge to the confluence.

*[6] I1, I2 - Similarly, the tributary at 20 mile was divided into 2 sections for enumerating purposes. I1 consisted of a 500 m section upstream of the creek-side channel confluence. I2 was the side channel which the creek flows into (length 100 m).

*[7] DFO officer count (Lyle Enderud - Squamish, B.C.).

TABLE F-2

RECOVERY DATA FOR COHO SALMON FROM THE LILLOOET-MEAGER AREA, 1981

Date Recovered	Sex	Length (cm) HL*[1]	Length (cm) FL*[2]	Condition	Age	Comments*[3]
Lillooet River Side Channel at 22.5 Mile (Left Bank)						
24 November	F	55	66	25 eggs	3_2	
24 November	F	48	67	1 egg	3_2	
24 November	F	53	67	2 eggs	4_3	(2nd year in estuary)
24 November	F	53	60	2 eggs	3_2	
24 November	F	53	67	300 eggs	3_2	
24 November	F	52	68	200 eggs	R	
24 November	F	45	57	50 eggs	3_2	
24 November	M	45	56	spent	3_2	
24 November	F	54	69	12 eggs	R	
24 November	F	53	66	3 eggs	3_2	
24 November	F	53	68	0 eggs	3_2	
24 November	F	43	54	3 eggs	R	
24 November	F	50	64	3 eggs	3_2	
24 November	F	55	69	0 eggs	R	
24 November	F	50	63	200 eggs	3_2	
25 November	F	65	80	2 eggs	3_2	
25 November	M	50	63	spent	3_2	
25 November	M	53	70	spent	3_2	
25 November	M	57	70	spent	3_2	

TABLE F-2 - (Cont'd)

Date Recovered	Sex	Length (cm) HL*[1]	FL*[2]	Condition	Age	Comments*[3]
25 November	M	58	77	spent	3_2	
25 November	F	52	72	2 eggs	3_2	(stress)
25 November	F	51	67	1 egg	3_2	
25 November	F	59	70	20 eggs	3_2	
25 November	F	53	65	0 egg	R	
26 November	M	52	72	not spent	3_2	
26 November	M	40	50	not spent	R	
26 November	F	53	65	0 eggs	3_2	(some estuary)
26 November	F	55	68	2 eggs	4_3	
26 November	F	57	73	48 eggs	3_2	
26 November	M	48	64	spent	3_2	(stress)
26 November	M	52	69	spent	3_2	
26 November	M	55	72	spent	4_3	
26 November	F	54	69	2 eggs	3_2	
26 November	F	48	58	0 eggs	R	
26 November	F	56	72	22 eggs	3_2	
2 December	M	50	66	spent	3_2	
2 December	F	57	69	0 eggs	3_2	
17 December	F	53	-	4 eggs	4_3	
Lillooet River Side Channel at 22 Mile (Left Bank)						
20 November	F	52	63	0 eggs	-	
20 November	M	50	64	spent	-	

TABLE F-2 - (Cont'd)

Date Recovered	Sex	Length (cm) HL*[1]	FL*[2]	Condition	Age	Comments*[3]
20 November	M	38	44	not spent	-	
20 November	M	51	62	spent	-	
Lillooet River Tributary at 21 Mile (Left Bank)						
20 November	F	50	64	0 eggs	-	
Lillooet River Tributary at 20 Mile (Left Bank)						
18 November	M	55	-	spent	3_2	
18 November	F	48	-	0 eggs	3_2	
18 November	F	56	-	0 eggs	4_3	
Meager Creek Tributary at 6.0 km (Right Bank)						
16 November	M	-	72	not spent	3_2	
24 November	M	35	43	not spent	3_2	
27 November	M	49	60	spent	3_2	
27 November	F	63	78	0 eggs	3_2	
1 December	F	55	68	5 eggs	3_2	(stress)
15 December	-	41	-	-	3_2	
Meager Creek Tributary at 4.5 km (Left Bank)						
27 November	M	56	69	spent	-	

*[1] Postorbital-hypural length.

*[2] Nose-fork length.

*3 Comments from scale analysis (DFO).

TABLE F-3

POSTORBITAL-HYPURAL LENGTH FREQUENCY BY AGE CLASS OF COHO SALMON FROM THE LILLOOET-MEAGER AREA DEAD RECOVERY, 1981

Frequency Interval (cm)	Male		Female		Total*[1]
	3_2	4_3	3_2	4_3	
35.0 - 36.9	1				1
37.0 - 37.9					0
38.0 - 39.9					1
40.0 - 41.9					2
42.0 - 43.9					1
44.0 - 45.9	1		1		2
46.0 - 47.9					0
48.0 - 49.9	2		2		5
50.0 - 51.9	2		3		8
52.0 - 53.9	3		7	2	14
54.0 - 55.9	1	1	3	1	8
56.0 - 57.9	1		3	1	7
58.0 - 59.9	1		1		1
60.0 - 61.9					0
62.0 - 63.9			1		1
64.0 - 65.9			1		1
Sample Size	12.00	1.0	22.00	4.00	52.00
Mean	50.33	55.0	53.23	54.25	51.71
S.D.	6.09	-	5.39	1.50	5.58

*[1] Includes lengths of coho where ages were not determined.

TABLE F-4

NOSE-FORK LENGTH FREQUENCY BY AGE CLASS OF COHO SALMON
FROM THE LILLOOET-MEAGER AREA, 1981

Frequency Interval (cm)	Male		Female		Total*[1]
	3_2	4_3	3_2	4_3	
					0
43.0 - 44.9	1				2
45.0 - 46.9					0
47.0 - 48.9					0
49.0 - 50.9					1
51.0 - 52.9					0
53.0 - 54.9					1
55.0 - 56.9	1				1
57.0 - 58.9			1		2
59.0 - 61.9	1		1		2
61.0 - 62.9					1
63.0 - 64.9	2		2		8
65.0 - 66.9	1		3		4
67.0 - 68.9			5	2	8
69.0 - 70.9	3		3		8
71.0 - 72.9	2	1	2		5
73.0 - 74.9			1		1
75.0 - 76.9					0
77.0 - 78.9	1		1		2
79.0 - 80.9			1		1
Sample Size	12.00	1	20.00	2.00	48.00
Mean	65.16	72	68.05	67.50	65.60
S.D.	9.06	-	5.39	0.70	7.43

*[1] Includes lengths of coho whose ages were not determined.

TABLE F-5

AGE COMPOSITION OF COHO SALMON IN THE LILLOOET-MEAGER STUDY AREA, 1981

Sampling Location	Male %		Sample Size	Female %		Sample Size
	3_2	4_3		3_2	4_3	
Lillooet River tributary at 22.5 mile (left bank)	90.0	10.0	10	85.7	14.3	21
Lillooet River tributary at 20 mile (left bank)	100.0		1	50.0	50.0	2
Meager Creek tributary at 6.0 km (right bank)	100.0		3	100.0		2
Overall	92.9	7.1	14	84.0	16.0	25

TABLE F-6

TIMING OF SALMON RUNS IN THE LILLOOET-BIRKENHEAD SYSTEM

River	Species	Arrive	End
Lillooet River	Coho	October	December
Green River	Coho	October	December
	Sockeye	September	October
Pemberton Creek (1 mile)	Coho	October	December
Ryan Creek	Coho	October	January
	Sockeye	October	November
John Sandy Creek	Coho	October	January
	Sockeye	September	November
25 Mile (Sampson) Creek	Coho	November	December
Miller Creek	Coho	October	December
Salmon Slough	Coho	October	January

Birkenhead River

	Arrive	Start	Peak	End
Coho	10 Oct	25 Oct	15 Nov	7 Dec
Sockeye	15 Aug	1 Sep	21 Sep	15 Oct

	Lillooet Narrows	Birk R. Mouth Lillooet Lake	Birk R. Below km 17	Peak	End
Chinook	Mar - Apr	Apr - Jun	Jun - Aug	10 Sep	30 Sep

Source: Coho and Sockeye - Fisheries Service Spawning Reports Chinook - Personal Communications, F. Wheeler, J. Bentley and A. Starks.