APPENDIX 12

# AQUATIC RESOURCES ASSESSMENT

DAVID BUSTARD & ASSOCIATES

1985

TELKWA COAL PROJECT

AQUATIC RESOURCE ASSESSMENT (1985)

DAVID BUSTARD & ASSOCIATES

SMITHERS, B.C.

V.II

## ACKNOWLEDGEMENTS

The author wishes to acknowledge Murray Feenstra, Dirk Septer and Karen McKeown for their assistance with field studies. Kathleen Stuart conducted the identification and enumeration of invertebrate samples. Chris Perrin (Limnotek Research and Development Corp.) undertook the periphyton studies with assistance from Mary Bolin who did the algal taxonomy. Ted Harding assisted the habitat assessment studies and MacLaren Plansearch Corp. was responsible for the word processing and drafting of this report.

## EXECUTIVE SUMMARY

Studies were undertaken during 1984 to evaluate aquatic resources in the Telkwa Project study area in west-central British Columbia. Stream periphyton, invertebrates and fish populations were assessed in Goathorn and Tenas creeks and the lower Telkwa River. As well potential impacts associated with the proposed coal mine and rail access, and means of mitigating impacts or enhancing fish populations in the area were evaluated.

Stream periphyton accumulation rates and community composition were measured over a 6-week period above and below the proposed mining operations on Goathorn Creek. The periphyton community was comprised entirely of diatoms at both sites. The studies suggest that periphyton growth in Goathorn Creek is presently limited by the low availability of nitrogen, and that the rates of accumulation are near the lowest values reported for extreme nutrient deficient streams in British Columbia.

A second year of information describing the composition and abundance of benthic invertebrates in the study area was collected in 1984. Numbers of invertebrates were more than 30% lower than in 1983. As well, their development rate was slower throughout the study areas compared to 1983. As in the previous year, the benthic community was typically dominated by mayflies and stoneflies, although there were some differences between years, particularly in lower Goathorn Creek.

Studies of stream drift and fish stomach contents were also undertaken on Goathorn Creek in 1984. The drift, comprised predominantly of aquatic invertebrates (83%), was three times more abundant above the proposed mining operation than below. Steelhead trout and Dolly Varden char in Goathorn Creek feed primarily on aquatic invertebrates, particularly mayflies.

The tolerance to changes in water quality of the various taxa of aquatic invertebrates found within the study area were described and a Biological Condition Index was calculated for the benthic invertebrate sample sites. This index provides a means of comparing stream condition from year to year based on the composition and abundance of invertebrates at each site.

A detailed evaluation of fish habitat within the study area (including Hubert Creek) was undertaken in the 1984 studies. In addition, a second year of juvenile fish sampling at index sites in Goathorn and Tenas creeks and the lower Telkwa River was conducted. The results of this program confirm the importance of the study streams as rearing areas for steelhead trout. Fish

distribution, biomass and density estimates for older age classes of fish were generally similar to the 1983 results. However, both steelhead trout and Dolly Varden char fry numbers were sharply lower in 1984 throughout the Telkwa system. As well, fish were smaller in 1984 suggesting that growing conditions in the study streams were poor compared to 1983.

Additional fish studies undertaken during the 1984 program included measuring metal concentration in the muscle tissue of 30 fish from Goathorn and Tenas creeks, sampling wetland areas adjacent to the lower Telkwa River, and conducting aerial counts of coho salmon spawners in the Telkwa River.

Potential impacts to the aquatic resources in the study area could result from acid mine drainage and stream sedimentation. Based on information from other study components, these potential problems can be managed. There may be some displacement of cutthroat trout habitat in upper Helps Creeks resulting from the east waste dump site and settling pond location. The proposed rail access to the mine site poses some minor problems to the aquatic resources along Hubert Creek.

Mitigation and enhancement options for the various study streams are feasible and include steelhead trout fry plantings and stream fertilization in the tributary streams and coho salmon and steelhead trout fry plantings and side channel development in the Telkwa River.

## TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd.)

TABLE OF CONTENTS (Cont'd.)

## LIST OF FIGURES

LIST OF FIGURES (Cont'd.)

LIST OF FIGURES (Cont'd.)

# LIST OF TABLES

LIST OF TABLES (Cont'd.)

LIST OF TABLES (Cont'd.)

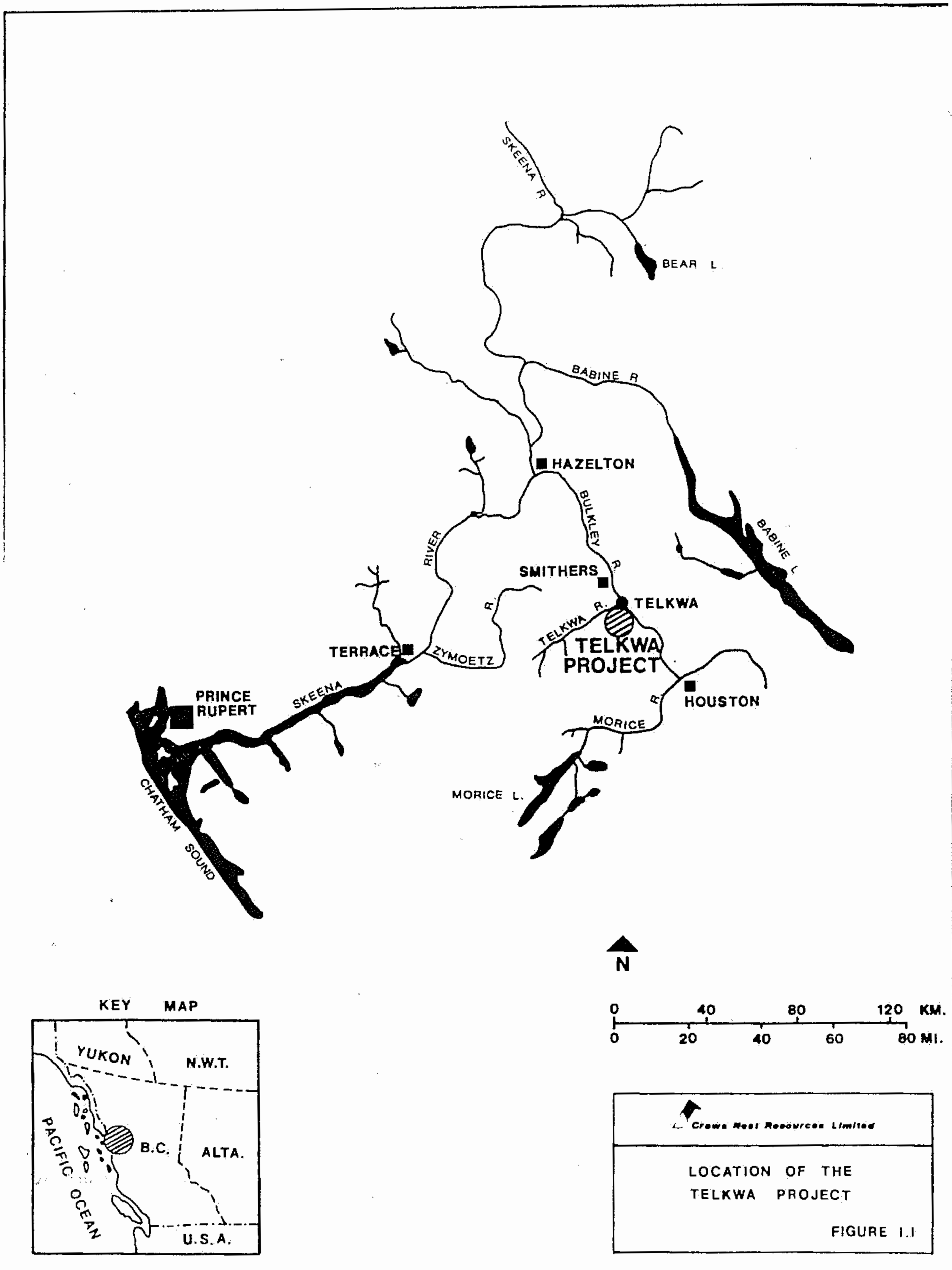
LIST OF TABLES (Cont'd.)

## 1. INTRODUCTION

Aquatic studies were undertaken from August to late November 1984 to supplement information collected for Crows Nest Resources Limited (CNRL) since 1982. These studies were undertaken as part of CNRL's Stage II assessment of the Telkwa Project located in west-central British Columbia (Figure 1.1). Several aspects of the studies were designed in response to comments from government resource agencies to the Stage I submission (CNRL 1983). The studies focussed on areas potentially affected by the coal development proposed primarily within the Goathorn Creek watershed, but they included work in the lower Telkwa River (Figure 1.2). As well, work was undertaken in Hubert Creek and in several sections of the Bulkley River in the vicinity of proposed transportation route options.

The aquatic studies, while emphasizing the fish resources of the study area, also include studies of the stream periphyton and invertebrate communities. The program focussed on developing biological data of sufficient detail to serve as background in evaluating year-to-year variability within the system prior to the mine start-up and to detect possible changes resulting from the mine's operation. As well, the studies have been designed such that sites above the proposed mine property in Goathorn and Tenas creeks can serve as controls for monitoring changes that might occur in downstream locations over time. The studies also provide the information base required for assessing potential impacts of the proposed mine and associated transportation routes and to develop a strategy for mitigation or enhancement of the aquatic resources in the study area should such a strategy be required.

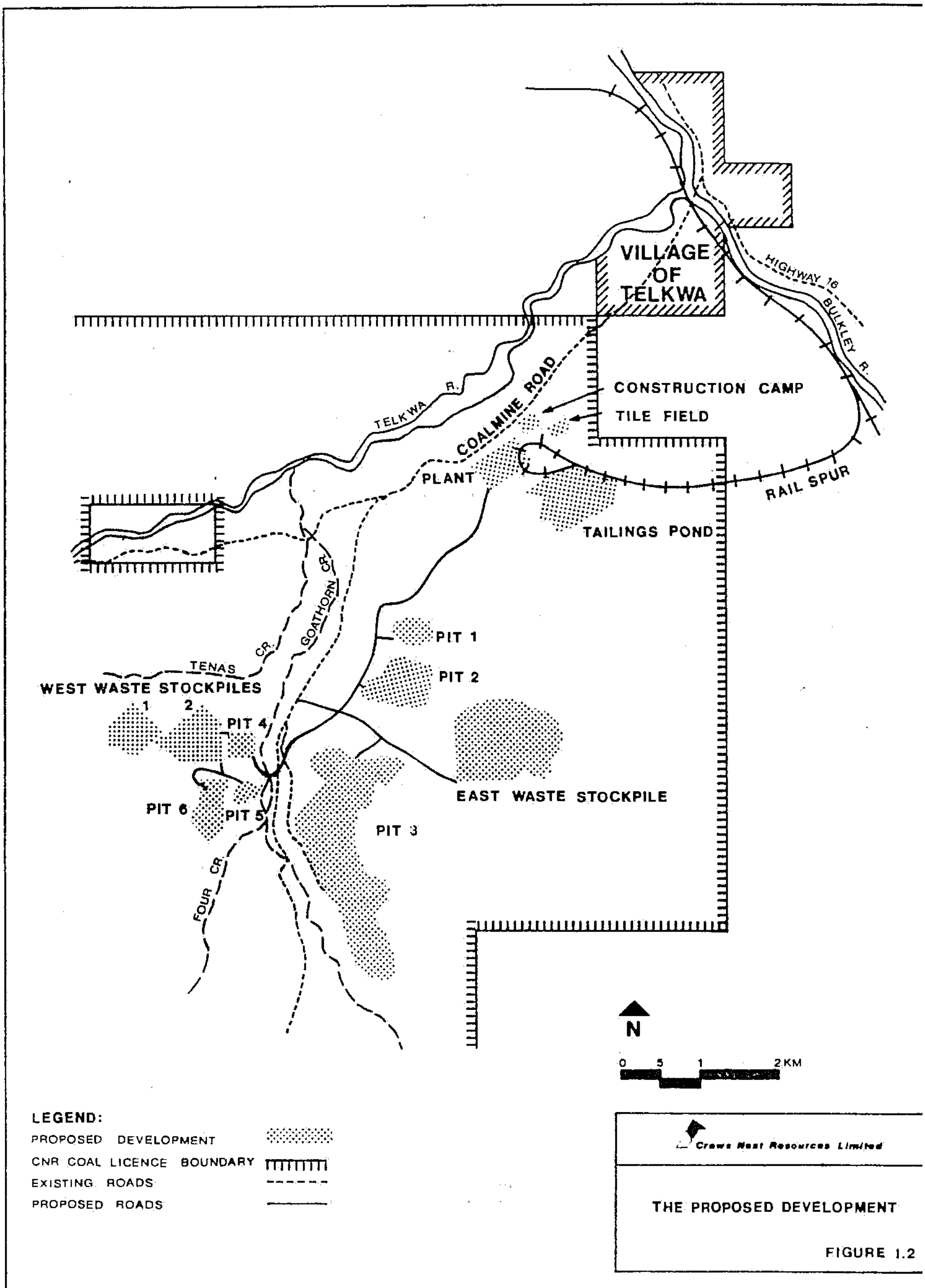
Periphyton refers to the assemblage of aquatic microflora including algae, bacteria and fungi that grow on the stream substrata. It is an important food source for a wide variety of stream insects that are adapted for either grazing attached periphyton or collecting drift particles, often from sloughed periphyton. The characterization of periphyton in Goathorn Creek serves as an aid in evaluating water quality and nutrient deficiencies. As well, periphyton accumulation on substrata is sensitive to chemical change and is ideal for experimental detection of chemical impacts. In this study, the periphyton algae of Goathorn Creek have been described in terms of community structure and accumulation rates on artificial substrata,




Crows Nest Resources Limited

LOCATION OF THE TELKWA PROJECT

FIGURE 1.1




THE PROPOSED DEVELOPMENT

FIGURE 1.2

and findings are discussed relative to the ambient chemical characteristics of Goathorn Creek.

Stream invertebrates are important intermediaries in the utilization of plant material such as algae, leaves and wood, and are a major food source for fish. Their limited mobility and short life span make them useful for detecting altered stream conditions. The 1984 studies provide a second year of detailed evaluation of benthic invertebrate numbers and composition at sites in Goathorn and Tenas creeks and in the lower Telkwa River. The invertebrate studies were supplemented by an evaluation of stream drift and fish utilization of invertebrate populations based on analyses of their stomach contents.

Fish populations occur in all of the larger streams associated with the Telkwa Coal Project. Summer steelhead trout are the main species utilizing Goathorn and Tenas creeks and the lower Telkwa River. Tributaries such as these contribute to the valuable summer steelhead trout sport fishery that exists on the Bulkley River. Coho, chinook and pink salmon, cutthroat trout, and Dolly Varden char are also present within the study area. The common and scientific names of all fish species mentioned in the text are listed in Appendix 1.

Studies undertaken during 1984 provide a second year of detailed juvenile fish population estimates in the study streams. Additional sample sites were added to the program to provide better distribution and production information. Samples of fish muscle tissue were analyzed to provide background metal concentrations occurring in fish within the main study streams. A second evaluation of coho salmon spawning distribution within the Telkwa system was conducted during 1984 and more detailed assessments of aquatic habitat in the study area were undertaken to aid in identifying fish production limitations and areas of potential enhancement.

The final sections of this report outline the potential impacts of the proposed coal mine and its ancillary developments on the area's aquatic resources, and present options for mitigation or enhancement of fish stocks within the systems.

## 2. METHODS

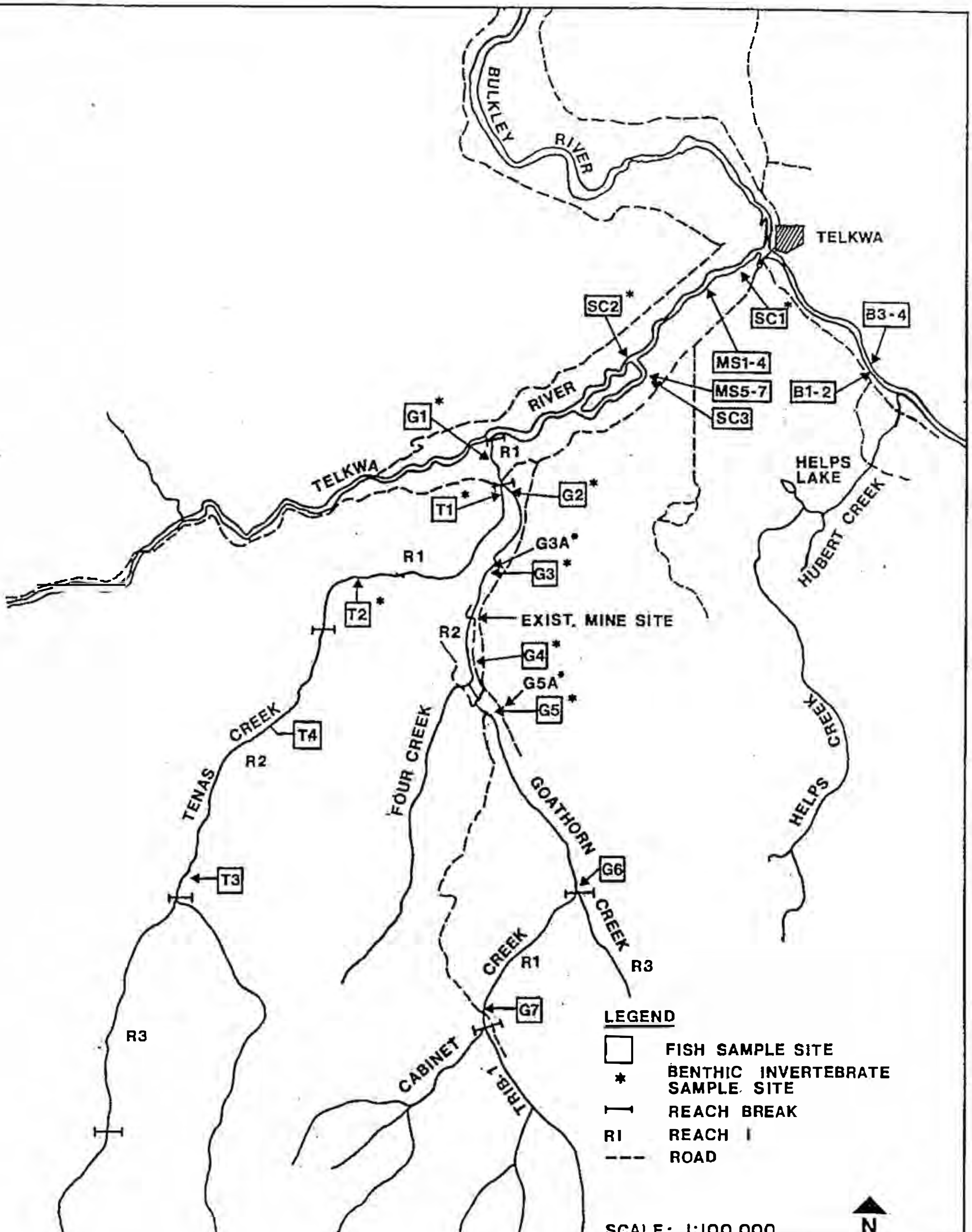
Field studies were conducted primarily during September and October 1984, although some wetland sampling was undertaken in August and adult fish surveys continued until the end of November. The main juvenile fish and invertebrate sampling program was conducted by a crew of three during the latter half of September to correspond with the timing of the 1983 sampling program. Access to all sites was by vehicle except to the three upper Tenas Creek sites and to a site at the confluence of Goathorn and Tenas creeks. These sites were reached by helicopter.

### 2.1 PERIPHYTON STUDIES

Periphyton were characterized at sites G2 and G5 in Goathorn Creek (Figure 2.1) using measurements of community taxonomy, chlorophyll *a* accumulation rates on artificial substrata and tissue nitrogen: phosphorus (N:P) ratios. All samples for these analyses were collected from four replicate *in situ* styrofoam substrata which consisted of 0.6 cm x 30.5 cm x 30.5 cm sheet of styrofoam DB (Snow Foam Products Inc., El Monte, California) attached to a rigid plate of similar proportions. This, in turn, was bolted to a 30.5 x 30.5 x 5 cm concrete block placed in the stream with the styrofoam surface raised several centimeters above the stream bottom. The blocks were placed in sites with similar water depth, velocity and light exposure. Incubations started on September 5, 1984 and were left in place for six weeks (Figure 2.2).

Samples for chlorophyll *a* analysis were collected weekly from each plate (Figure 2.3). Styrofoam cores were extracted using the open end of a 12 dram plastic vial, wrapped in laboratory parafilm, packed on ice in a light-tight cooler, and shipped by air freight to Can Test Ltd. in Vancouver for analysis. Chlorophyll *a* was determined by the fluorometric methods outlined in APHA (1980) after homogenization of the cores in a high speed tissue grinder. Acetone added directly to the homogenized material for pigment extraction completely dissolved all styrofoam residues. Blank tests showed that styrofoam did not interfere with the fluorometric assay.

Accumulation rates of the algal periphyton were calculated by fitting ln transform chlorophyll *a* data for all sampling days to the exponential growth equation for each site:




Crows Nest Resources Limited

LOCATION OF FISH AND BENTHIC INVERTEBRATE SAMPLE SITES

FIGURE 2.1

Figure 2.2 Periphyton accumulation rates and community taxonomy were measured on four replicate styrofoam substrata located above and below the proposed mine property on Goathorn Creek.

Figure 2.3 Samples for measurements of accumulation rate (chlorophyll a) were extracted from the styrofoam sheets on a weekly basis. This photo shows the plates after removal at the end of the incubation period.

$$y = ae^{kt}$$

where y is the cholorphyll $\underline{a}$ concentration (mg chl$\underline{a}$/$m^2$) at day t; a is the ordinate intercept (mg chl$\underline{a}$/$m^2$); and k is the specific net accumulation rate ($d^{-1}$) (Guillard 1973). The ln transform equilibrated unequal variances in the raw data to satisfy requirements of least squares analysis. The influence of rapid initial settlement was limited by beginning calculations of k on day 7. Significant differences between k values at sites G2 and G5 were evaluated using the t-test statistic for comparison of two regression slopes in an analysis of covariance. The period of accumulation from day 0 to day 7 is assumed to represent the initial colonization and relatively little growth. The differences in standing crop between the two sites at day 7 may then be interpreted as an index of differences in the affinity of algae cells to settle on the styrofoam substrata. This difference in settlement may also be evaluated from the regression intercepts. Theoretically, the intercept value represents an initial standing crop (mg chl$\underline{a}$/$m^2$) or inoculum for the observed accumulation rate. Comparisons of these regression intercepts can be used as an index of the settlement affinity of algal cells.

At the end of the six week incubation period (October 17) an additional core was collected from each plate for a taxonomic evaluation and the remainder of the styrofoam was collected for a tissue nitrogen and phosphorus assay. The taxonomic samples were preserved in the field with Lugol's solution and analyzed by the qualitative method of Northcote et. al. (1975). Samples were prepared by scraping cells free of the styrofoam with a stiff-bristle toothbrush followed by settling in Utermöhl chambers. The relative abundance of each algal phyla was determined using an inverted phase, contrast microscope at 500x magnification.

Analyses for tissue organic nitrogen and organic phosphorus were made from a homogenized mixture of styrofoam and accumulated biomass. A concurrent run of styrofoam blanks showed that interference and contamination by the styrofoam was undetectable. Organic nitrogen was determined by the Kjeldahl method of APHA (1980) and organic phosphorus was the difference between total phosphorus and inorganic phosphorus, both determined from the boiling extraction procedures (BEP) of EPA - U.S. Corps. Engineers (1981).

## 2.2 BENTHIC INVERTEBRATE STUDIES

Benthic invertebrates were sampled at 11 sites in Goathorn and Tenas creeks and in two side channels of the Telkwa River (Figure 2.1). The sites were identical to those samples in 1983 (Bustard 1984a) except two additional sites, G3A and G5A, were established just downstream of sites G3 and G5 respectively. Metal benchmarks established during the previous year's sampling served as reference points, and six replicate samples were taken at the same distance from the benchmark as recorded during the previous sampling program.

Samples were collected using a Waters-Knapp sampler (Waters and Knapp 1961) with a 250 $\mu$m-mesh size. The substrata inside the cylinder was agitated to approximately 10 cm depth and larger stones were brushed by hand to loosen adhering organisms. All samples were preserved in formalin solution and subsequently identified to family, and usually genus level for the dominant and sub-dominant orders. Information describing water temperature, depth and velocity, as well as substrate characteristics was recorded at the collection sites.

## 2.3 DRIFT STUDIES

Invertebrate drift was sampled at sites G5 and G2 (Figure 2.1) on September 20 and 21 respectively. The drift samplers had opening dimensions of 15 cm (height) by 10 cm (width) and consisted of a 250 $\mu$m-mesh nitex sock 15 cm in length attached to a plastic collecting bottle. The samplers were held in place by rebar and were positioned so that the surface water was sampled. Drift samplers were located on each side of a glide section of stream, downstream from a riffle. Samples, collected over a 24-hour period, were split into day and night subsamples. The drift samples were preserved in formalin solution and subsequently identified to family and in most cases genus level for the dominant orders of aquatic invertebates.

No effort has been made to estimate total amount of drift in the system. Rather the composition of the drift and how this was reflected in the fish diet studies and in the composition of the stream benthic community was emphasized.

## 2.4 FISH STOMACH CONTENT STUDIES

Stomachs were removed from 25 steelhead trout parr and 25 Dolly Varden char sampled at sites G2 and G5 respectively. These fish, collected in conjunction with the juvenile sampling programs, were measured to the nearest millimeter and weighed to the nearest 0.1 g. Their stomachs were removed and preserved in 10% formalin solution for subsequent identification of contents. Organisms present in the fish stomachs were identified to family, and in most cases to genus level for dominant orders of aquatic invertebrates.

The initial study design was to analyze stomach contents from samples of both fish species at each site. However, insufficient numbers of steelhead parr and Dolly Varden char were captured at sites G5 and G2 respectively to comprise adequate samples.

## 2.5 FISH HABITAT STUDIES

All stream systems in the study area except Hubert Creek have previously had Aquatic Biophysical Maps prepared at a scale of 1:50,000. A summary of these maps was presented in the Environmental Overview submission (Environmental and Planning Assoc. 1982). Fish habitat studies undertaken in 1984 continued to use the reach separations identified on these maps but expanded upon these earlier biophysical data. A combination of air photo analyses and descriptive information collected during field studies have been incorporated into developing the habitat assessments. The early formation of ice in the systems during 1984 resulted in a greater emphasis on air photo interpretation and less field measurements than initially intended. Assessment methods have been separated into those undertaken on tributary streams including Goathorn, Tenas and Hubert creeks, and those undertaken on the lower Telkwa River.

### 2.5.1 Tributaries - Habitat Assessment

Gradient profiles for the main tributary streams were developed using an HP 9225 A digitizing system. This system automatically calculates length and average slope of stream segments between contour intervals and reach breaks. The slopes were derived from 1:50,000 scale topographic maps for the Telkwa watershed and a 1:20,000 scale map for Hubert Creek. Significant features such as reach breaks, fish sample sites, and fish distribution (including potential) were plotted on these profiles. Assessment of potential fish habitat was derived from the known presence of fish in the reach, location of potential barriers and the slope measurements. As soon as the stream slope steepened above 5-6%, the section was omitted as having potential for steelhead trout rearing.

Channel width measurements (including ponded areas) were derived from 1:15,000 scale air photos using a 10-power ocular lens containing a scale graduated in 0.5 mm intervals. These measurements were used in calculating wetted area of habitat in the main fish-producing stream sections for the late summer period (the air photos were taken in mid-August 1983).

Substrate measurements collected during the fish sampling program over the past two years were summarized for the stream reaches and included in the habitat summaries. Substrate characteristics were recorded as D50 and D90 estimates (i.e., the diameter of bed material that is larger than 50% and 90% respectively of the remaining bed material as defined in Chamberlin (1980)). Site specific ground checking for potential spawning gravels in lower Hubert Creek was undertaken in October, while previous field surveys (Bustard 1983) had examined potential spawning sites in Goathorn and Tenas creeks.

### 2.5.2 Telkwa River - Habitat Assessment

The Telkwa River downstream of Goathorn Creek was delineated into main and side channels and wetland habitats on 1:15,000 scale air photos. Side channels were further categorized into active, flood and relic channels based on their source and duration of flow and channel stability. These channel types will be described in more detail in Section 3.6.3. Main channel length was derived from digitized measurements on a 1:50,000 scale topographic map. Side channels and wetland lengths were measured using a map wheel. Widths of all channels were derived from air photos using an ocular lens as described for tributary streams. Wetted areas were calculated for the main channel and each of the 79 side channels and 4 wetlands identified on the air photos. A map was prepared identifying each channel with a reference number corresponding to the habitat description.

Substrate descriptions of main and side channel areas were based on field measurements taken at fish sample sites during the past two years as described in the previous section on tributaries.

## 2.6 JUVENILE FISH POPULATION ESTIMATES

Twenty-one detailed juvenile fish sample sites were evaluated in Goathorn and Tenas creeks and in the lower Telkwa River (Figure 2.1). This total includes 18 sites sampled during previous surveys in 1983, two new sites in upper Goathorn Creek and one additional site in Tenas Creek. As well six wetland areas in the lower Telkwa River and on the Bulkley River were sampled.

Fish sample sites were selected as representative of the reach characteristics outlined on the Aquatic Biophysical Maps for the Telkwa Watershed (93 L11). The 1984 fish sample sites were located in the same location as the previous year's sites, while the three new sites were added to provide better estimates of fish production for the upper sections of Goathorn and Tenas creeks. At tributary and side channel sites sampled previously, the lower stop net was located at a point pre-determined by last year's benchmark and the length of the site was measured upstream to coincide with the same channel length as sampled in 1983. Sample site area varied between the years depending on the discharge on the particular sample date. Mainstem Telkwa River sites were not as closely duplicated between the two years since only a portion of the total channel width was sampled.

Tributary sample sites ranging from 25 to 95 m in length, were blocked with stopnets at their upstream and downstream ends, and sampled using an electroshocker. The modified Peterson mark-and-recapture method (Ricker 1975) was used to estimate populations for the sample sites. A caudal fin clip was used to mark fish and the recapture was conducted several hours after the marked fish were released. Side channel sites in the Telkwa River were similarly sampled.

Main channel sites in the Telkwa River were enclosed with a 30 m seine net held in place by rebar positioned two hours prior to sampling. A two-step removal method (Seber and LeCren 1967) was used to estimate populations, since fish numbers in the small enclosed area were too low to use the mark-and-recapture method.

Main channel sites extended to the edge of the fast water encompassing the habitat estimated to be used by juvenile fish. A crew sampled up and back through each site to constitute a single pass. The two-step removal method was also used at four upper tributary sites (G6, G7, T3 and T4) due to time limitations imposed by helicopter access and in one side channel site (SC3) due to the small sample area involved. Formulas used in calculating the population estimates and standard error are presented in Appendix 2.

Sample site areas were calculated from measurements of length and a series of width measurements made at 5 to 10 m intervals along the sample site. As well, water depths (maximum and mean), subtrate and cover characteristics were recorded at each cross section. Substrate characteristics were recorded as D50 and D90 estimates. All fish captured were anaesthetized with 2-phenoxyethanol, measured to the nearest millimeter and returned to the stream at the end of the sampling. Weights were determined for 142 steelhead trout, 47 Dolly Varden char and 14 mountain whitefish, and the results were used to determine biomass estimates for each site using regression analyses. Length-age characteristics derived from 1983 scale data were used in the separation of age 1+ and older steelhead trout parr.

Wetland areas were sampled for fish presence using minnow traps baited with roe and set over a 24-hour period. A total of 45 traps were set in the six areas. All fish captured were identified to species measured to the nearest millimeter and returned to the system.

## 2.7 ADULT FISH SURVEYS

Two helicopter examinations of adult coho salmon spawning were conducted in the Telkwa River during November. A complete survey between the Telkwa-Bulkley confluence and the Telkwa headwaters was undertaken on November 14, while the second survey concentrated on the main spawning areas upstream of Jonas Creek. The helicopter flew at low speeds approximately 50 m above the river and two observers recorded numbers and location of coho salmon spawners and redds. These observations were located on a 1:100,000 scale topographic map similar to 1982 observations (Bustard 1983).

## 2.8 METAL CONCENTRATIONS IN FISH TISSUE

Ten 20-g samples of steelhead trout and Dolly Varden char were retained for tissue analysis of metals at sites G2 and G5 respectively. Each fish sample was measured, weighed and placed in separate plastic bags. The samples were frozen and shipped air freight to ASL Laboratories for analyses.

Samples of muscle tissue were digested in nitric and perchloric acid. Cadmium and lead concentrations were analyzed using atomic absorption spectrophotometry (AAS) equipped with a graphite furnace atomizer. Arsenic was determined using AAS equipped with a hydride generator. Zinc, copper, iron, aluminum and an additional 17 elements were determined simultaneously using an Inductively Coupled Argon Plasma Spectrograph.

# 3. RESULTS AND DISCUSSION

## 3.1 PERIPHYTON STUDIES

### 3.1.1 Taxonomy

Diatoms comprised 100% of total sample volume at both sites (Table 3.1). The same genera were present at each site and their relative proportions were very similar. The mean percentage composition by volume of *Fragilaria* spp., *Synedra* spp. and *Gomphonema* spp. was 20, 20 and 10% respectively. Since these diatoms are often found in slightly enriched conditions they are considered indicative of stream nutrient deficiency. However, their chloroplast structure was degrading, suggesting that conditions were becoming less favourable at the time of sampling (October 17) and that they were the early substratum colonizers. The presence of the two larger-celled species, *Hannaea arcus* and *Diatoma tenue* suggest temperatures were shifting lower and/or nutrient deficiency was increasing. These species are also better adapted to cool water (<5°C) with high current velocities. *Achnanthes* spp. comprised 6-8% of sample volume. This wide ranging species is not indicative of specific physical or chemical stream conditions.

### 3.1.2 Macronutrient Chemistry

Small differences in macronutrient concentrations were found between study sites (Table 3.2). Conductivity and total dissolved solids (TDS) were slightly greater at G2 than at G5 but the buffering capacity, as inferred from alkalinity measurements, was moderate at both sites. Concentrations of each of these parameters increased by 5-10% from the September to October sampling dates. Dissolved phosphorous levels were higher at site G5 than at G2. Soluble reactive phosphate (SRP) and total dissolved phosphorus (TDP) were undetectable at G2 although TDP did increase to 0.006 mg/L in October. At G5, SRP (the best available measure of biologically available phosphorus) increased from 0.003 mg/L in September to 0.008 mg/L in October, while TDP increased to 0.025 mg/L. Although the SRP levels at G2 are clearly in the range of potentially P-limited surface waters, those at G5 may reflect biologically surplus phosphorus. For example, SRP levels of 0.002 to 0.005 mg/L in the lower Thompson River have contributed to problem algal growths. Levels of 0.005 - 0.010 mg/L in a coastal stream would be considered

Table 3.1 Taxonomy of Goathorn Creek Periphyton Collected on October 17, 1984, at Sites G2 and G5

| % COMPOSITION BY SAMPLE VOLUME | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Site G2 | | | | Site G5 | | | |
| Replicate | 1 | 2 | 3 | 4 | 1[2] | 2 | 3 | 4 |
| Composition[1] | | | | | | | | |
| <u>Hannaea arcus</u> | 20 | -- | 15 | 20 | -- | 20 | 25 | 15 |
| <u>Fragilaria</u> spp. | 25 | 20 | 20 | 15 | -- | 20 | 20 | 20 |
| <u>Diatoma tenue</u> | 30 | 25 | 25 | 25 | -- | 25 | 25 | 25 |
| <u>Diatoma hiemale</u> | Trace | -- | -- | Trace | -- | -- | -- | Trace |
| <u>Synedra</u> spp. | 15 | 25 | 20 | 25 | -- | 20 | 15 | 25 |
| <u>Achnanthes</u> spp. | 10 | 10 | 5 | -- | -- | 10 | 10 | 5 |
| <u>Gomphonema</u> spp. | -- | 20 | 15 | 15 | -- | 5 | 5 | 10 |

1 The entire community at each site was comprised of diatoms (Class Bacillariophyceae).

2 Since replicate 1 was damaged during the study, no community taxonomy was possible that this site.

Table 3.2 Chemical Characteristics of Goathorn Creek during Periphyton Studies at Sites G2 and G5[1]

| Date | Sample Site[2] | Conductivity (umhos/cm) | $SiO_2$ | TDS | Bicarbonate Alkalinity | $NO_3$-N | $NH_3$-N | SRP | TDP | N:P[3] |
|---|---|---|---|---|---|---|---|---|---|---|
| September/84 | G5 | 105 | 3.00 | 79 | 44.6 | <0.01 | <0.010 | 0.003 | 0.003 | <6.7 |
| | G2 | 119 | 3.05 | 85 | 49.1 | <0.01 | 0.011 | <0.001 | <0.001 | U[4] |
| October/84 | G5 | 110 | 3.50 | 87 | 53.0 | <0.01 | 0.011 | 0.008 | 0.025 | <2.6 |
| | G2 | 113 | 3.42 | 94 | 54.3 | <0.01 | 0.022 | <0.001 | 0.006 | <5.3 |

1 All units in mg/L unless otherwise specified.

2 Water quality data is from CNRL sample stations TH-04 and TH-10. These stations correspond to sites G2 and G5 respectively.

3 Ratio based on N and $NO_3 + NH_3$ and P as SRP. Since SRP was undetectable at G2 in October TDP data was substituted.

4 Undefined: i.e., data inadequate to determine ratio.

an enrichment level based on stream fertilization studies (Perrin et al. 1984).

Nitrate, usually the dominant dissolved inorganic nitrogen form in turbulent streams, was below detection levels at both sites. Ammonia concentrations were detectable. These inorganic forms were combined ($NO_3$ + $NH_3$ - N) for N:P estimates and show values less than 6.7 in all cases. Such low values for supply N:P are known to result in potentially N-limited algal growth conditions (Goldman et al. 1979). $SiO_2$ concentrations measured at each site should not limit growth rates of diatoms (Kilham 1975).

### 3.1.3 Periphyton Nitrogen and Phosphorus Composition

An optimum N:P has been defined as the ratio at which one nutrient limitation switches to the other and has experimentally been shown to be 17 for several algal species (Rhee and Gotham 1980). In Goathorn Creek, replicate N:P values were substantially less than 17 (Table 3.3) suggesting extreme nitrogen deficiency at both sites.

Bothwell (1985) has fitted N:P ratio data collected from the field to curves determined by Goldman et al. (1979) that describe the relation of cellular constituent N:P to relative specific growth rates. Growth rate ($\mu$) expressed as a proportion of maximum growth rate attained under nutrient sufficient conditions ($\mu_{max}$) reduces the influence of physical variation (i.e., light and temperature) when comparisons are made between measurement sites or dates. Thus, by comparing N:P data to the Goldman et al. (1979) curves, specific growth rates as a proportion of $\mu_{max}$ can be determined. Values near 1 suggest the algal community is growing at a rate near the maximum set by temperature and light conditions.

In Goathorn Creek $\mu : \mu_{max}$ values ranged from about 0.40 to 0.75 and between site differences were not apparent (Figure 3.1). The pooled mean using all N:P data was about 0.60. This analysis suggests that periphyton growth was 40% less than the maximum set by temperature and light. Since the Goldman et al. (1979) data in Figure 3.1 was determined from N-limited cultures, this conclusion also implies that periphyton growth in Goathorn Creek was controlled by the availability of nitrogen.

Table 3.3 Nitrogen and Phosphorus Composition of Periphyton at Goathorn Creek Sites G2 and G5 Collected on October 17, 1984

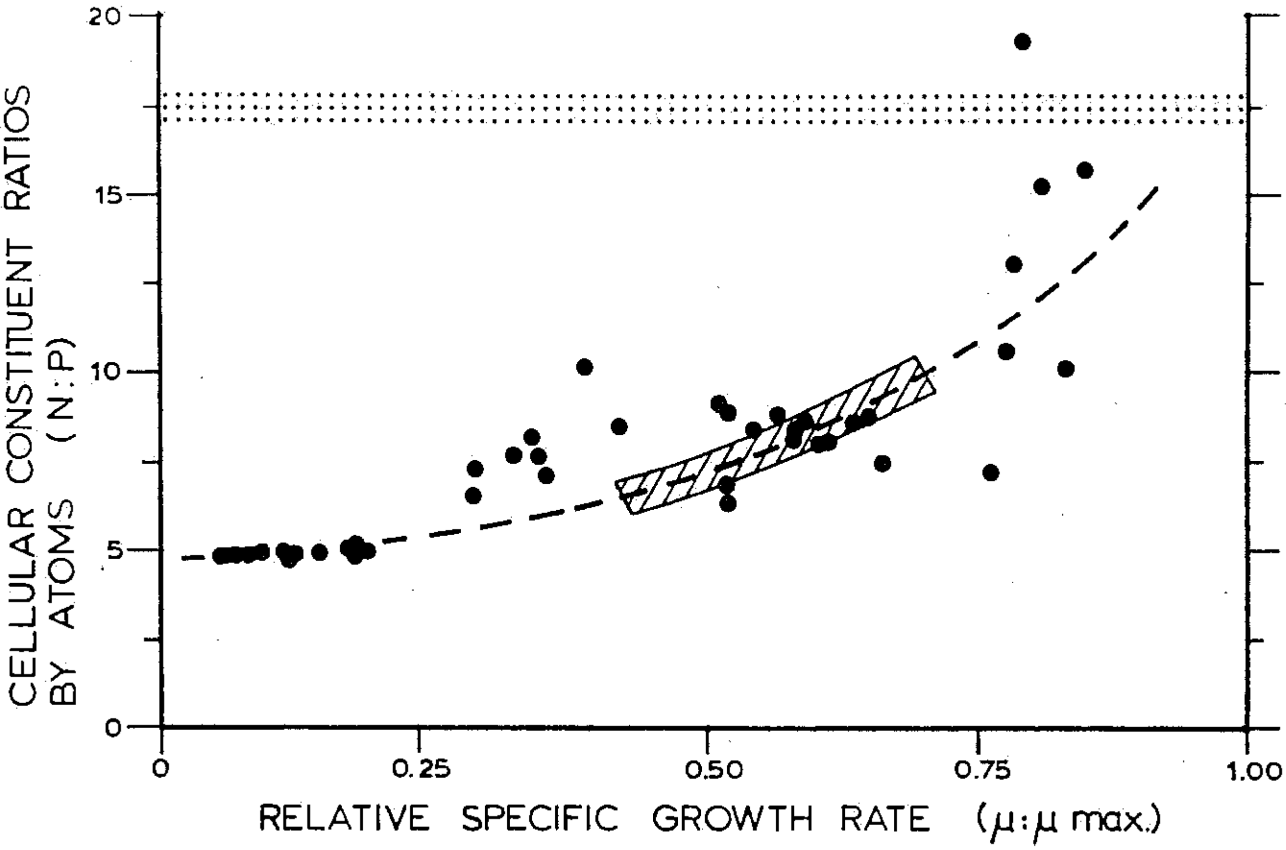
| Site | Organic Nitrogen (mg N/m²) | Organic Phosphorus (mg P/m²) | N:P (wt/wt) | N:P Atomic |
|---|---|---|---|---|
| G2 | 1,319 | 395 | 3.34 | 7.39 |
| G2 | 936 | 220 | 4.25 | 9.42 |
| G5 | 891 | 179 | 4.98 | 11.02 |
| G5 | 658 | 236 | 2.79 | 6.17 |

### 3.1.4 Periphyton Accumulation

The periphyton accumulation rates (k) measured in this study are the net effect of passive settlement, growth, sloughing, and insect grazing. Affinity values in Table 3.4 suggest that passive settlement contributed 14 and 52% of maximum biomass at sites G2 and G5 respectively. These estimates assume that the first 7 days of incubation were primarily a colonization phase. The results indicate that passive settlement contributed significantly to accumulation and that the affinity at G5 was more than four times greater than that at G2. Although higher SRP values at G5 may have contributed to a slightly greater primary production and therefore a higher concentration of cells in suspension, Tables 3.2 and 3.3 suggest nitrogen is primarily limiting. Since the taxonomy was very similar between the sites the community at G5 was not morphologically more suited to adhere to the substratum than at G2. Site physical characteristics such as water velocity could not be controlled and the affinity differences may reflect small differences in site conditions changing the ability of the styrofoam surface to capture drifting particles.

Although passive settlement was lower at G2, specific accumulation rates (k) were three times greater at G2 than at G5 (Table 3.4). Again, comparisons between these sites should be viewed with caution. Different rates of sloughing (detachment of algal biomass) may have occurred, particularly during rising streamflows in the second week of incubation. Similarly, insect grazing on the plates may have been different at the two sites, although few insects were observed. For these reasons, differences in biomass cannot be attributed to a single factor regulating periphyton accumulation, and site variability as well as nitrogen deficiency are probably important factors regulating periphyton biomass in Goathorn Creek.

The accumulation rates measured in Goathorn Creek are some of the lowest values reported for nutrient-deficient streams in British Columbia. Estimates of k determined in the Thompson River (north and south reaches) and the Keogh River, Vancouver Island, both phosphorus deficient systems, range from 0.03 to 0.21 $d^{-1}$. Biomass levels in Goathorn Creek are approximately 5 mg chl<u>a</u>/m$^2$ greater than levels measured in the riffles of the Keogh River for a 30-day September incubation. Unfortunately further comparisons are difficult since different sampling techniques and site conditions in




DATA FROM GOLDMAN ET AL (1979) TO DESCRIBE THE RELATION BETWEEN MACRONUTRIENT RATIOS AND RELATIVE SPECIFIC GROWTH RATE FOR THE DIATOM, THALASSIOSIRA PSEUDONANA GROWN UNDER NITROGEN LIMITATION AT 19°C. LINES ARE DRAWN BY EYE. HATCHED AREA INDICATES THE RANGE OF NUTRIENT RATIOS OBSERVED FOR PERIPHYTON COMMUNITIES IN GOAT-HORN CREEK. HORIZONTAL STIPLED LINE AT N:P=17 INDICATES THE CELLULAR CONSTITUENT RATIO AT WHICH NITROGEN LIMITATION CHANGES TO PHOSPHORUS LIMITATION.

FIGURE 3.1 - CELLULAR CONSTITUENT N:P RATIOS VERSUS RELATIVE SPECIFIC GROWTH RATE FOR N-LIMITED THALASSIOSIRA PSEUDONANA

other rivers confound interpretations of biomass differences or nutrient-limited accrual. For example, styrofoam has only been used consistently as an artificial substratum in the Thompson and Keogh Rivers. Although the Keogh River measurements are comparable, the Thompson River studies were conducted in flow-through troughs that maintained lower current velocities and higher light conditions than at the Goathorn site, leading to higher estimates than would be expected on in situ substrata as used in the Goathorn Creek study.

## 3.2 BENTHIC INVERTEBRATE STUDIES

The results outlining the numbers of benthic invertebrates sampled at 11 sites during 1984 are presented in Table 3.5. Additional detailed information for each site is presented in Appendix 4. As well, some of the 1983 results are included in this section to enable easier comparisons between years while more detailed 1983 information is provided in Bustard (1984a).

The number of benthic invertebrates per $m^2$ ranged from just over 300 at several sites in the mid-section of Goathorn Creek and in SC1, a side channel site on the Telkwa River, to over 11,000 in a sample in lower Goathorn Creek (Table 3.5). The greatest abundance of benthic invertebrates occurred at site G1 with an average of nearly 7,000 organisms per $m^2$ from the six samples at this site. Sample sites in upper Goathorn and Tenas creeks tended to have higher benthic invertebrate numbers than downstream sites (excluding G1), and site SC2 of the Telkwa River had higher numbers of benthic invertebrate than site SC1.

Overall numbers of benthic invertebrates sampled in 1984 were lower than obtained from the same sites in 1983 as shown in Figure 3.2 and in Table 3.6. Site G1 on Goathorn Creek has been excluded from the summary table for reasons that will be discussed.

Table 3.6 Summary of Mean Number of Invertebrates/$m^2$

| | Goathorn Creek (G2,G3,G4,G5) | Tenas Creek (T1,T2) | Telkwa River (SC1, SC2) | Mean |
|---|---|---|---|---|
| 1983 | 1,542 | 2,586 | 1,705 | 1,944 |
| 1984 | 1,102 | 1,406 | 1,340 | 1,283 |

8

Table 3.4 Periphyton Accumulation Rates and Settlement affinity Values at Goathorn Creek Sites G2 and G5[1]

| Site | Settlement Affinity[2] (mg chla $m^{-2}$) | Specific Net Accumulation Rate (k) ± SE ($d^{-1}$) | Biomass (mg chla/$m^2$) ± SE |
|---|---|---|---|
| G2 | 2.97 | 0.06 ± 0.010 | 20.7 ± 1.61 |
| G5 | 12.97 | 0.02 ± 0.004 | 24.9 ± 4.28 |

1 Values are based on semi-ln transformed linear regression models. See Appendix 3 for raw data.

2 Affinity data are ln values transformed back to original units.

Table 3.5 Benthic Invertebrates per $m^2$ and Number of Taxa per Sample Collected at Eleven Sample sites in Goathorn and Tenas Creeks and the Telkwa River in September 1984

TOTAL NUMBER

| | Goathorn Creek | | | | | | | Tenas Creek | | Telkwa River | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Replicate[1] | G1 | G2 | G3 | G3A[2] | G4 | G5 | G5A[2] | T1 | T2 | SC1 | SC2 |
| 1 | 7,165 | 458 | 656 | 375 | 740 | 1,896 | 271 | 2,615 | 2,260 | 625 | 2,250 |
| 2 | 9,063 | 792 | 1,688 | 552 | 1,083 | 1,344 | 1,448 | 990 | 729 | 614 | 1,969 |
| 3 | 11,052 | 802 | 2,886 | 760 | 1,354 | 1,021 | 1,135 | 427 | 802 | 333 | 1,854 |
| 4 | 5,584 | 1,073 | 542 | 625 | 1,313 | 1,542 | 1,656 | 729 | 1,781 | 479 | 2,115 |
| 5 | 1,438 | 771 | 427 | 323 | 1,354 | 1,792 | 1,594 | 1,188 | 3,177 | 448 | 2,708 |
| 6 | 7,240 | 438 | 313 | 427 | 552 | 1,635 | 1,750 | 813 | 1,354 | 573 | 2,115 |
| Mean | 6,922 | 722 | 1,085 | 510 | 1,066 | 1,538 | 1,309 | 1,127 | 1,684 | 512 | 2,169 |
| SD[3] | 1,337 | 98 | 413 | 68 | 141 | 130 | 225 | 315 | 382 | 46 | 121 |

TOTAL TAXA

| Replicate | G1 | G2 | G3 | G3A | G4 | G5 | G5A | T1 | T2 | SC1 | SC2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 11 | 11 | 14 | 9 | 18 | 20 | 10 | 19 | 14 | 11 | 18 |
| 2 | 12 | 17 | 16 | 19 | 22 | 18 | 19 | 18 | 14 | 11 | 19 |
| 3 | 13 | 13 | 19 | 17 | 17 | 14 | 15 | 14 | 16 | 12 | 17 |
| 4 | 11 | 20 | 14 | 16 | 20 | 19 | 15 | 17 | 16 | 15 | 19 |
| 5 | 11 | 15 | 13 | 12 | 15 | 20 | 16 | 21 | 16 | 12 | 16 |
| 6 | 14 | 14 | 9 | 15 | 16 | 21 | 15 | 15 | 17 | 16 | 19 |
| Mean | 12.0 | 15.0 | 14.2 | 14.7 | 18.0 | 18.7 | 15.0 | 17.3 | 15.5 | 12.8 | 18.0 |
| SD | 0.5 | 1.3 | 1.4 | 1.5 | 1.1 | 1.0 | 1.2 | 1.1 | 0.5 | 0.9 | 0.5 |

1 The numbers collected for each sample (Appendix 4) have been corrected by a factor (10.417) to allow them to be expressed on a $m^2$ basis.

2 These sites were not sampled in 1983.

3 SD refers to the standard deviation of the mean.

The lower numbers in 1984 may reflect this year's cool and rainy summer. A combination of cooler water temperatures and higher streamflows than during the latter part of the 1983 summer may have resulted in a slower development rate of benthic invertebrate populations. The 1984 samples contained more invertebrates approaching the hatching stage, while in 1983, many of these insects had hatched and the early instar stages of the next generation were already present. This resulted in higher numbers of smaller individuals in the 1983 sample and could account for the lower numbers present in this year's samples. As shown in Table 3.7, the 1984 Goathorn Creek streamflows are more typical of the long-term mean than the 1983 flows.

Table 3.7 Mean Monthly Flows ($m^3$/sec) Goathorn Creek

| | July | August | September | October |
|---|---|---|---|---|
| 1960-84[1] | 3.47 | 1.89 | 1.28 | 1.53 |
| 1983 | 3.46 | 1.26 | 0.88 | 0.59 |
| 1984[1] | 3.15 | 1.73 | 0.91 | 1.57 |

Source: Environment Canada (1983)
[1]Preliminary Data

Although site G1 had by far the greatest invertebrate numbers, this was almost entirely the result of the presence of large numbers of chironomid larvae (nearly 6,600/$m^2$ compared to 700/$m^2$ in 1983). Mayflies were virtually absent from this site in 1984, and although some stoneflies were present, they were mainly from the genus Capnia which prey upon chironomid larvae. It is probable that this shift in numbers and composition reflects a large beaver dam located 150 m upstream that diverts water into other channels (particularly during high flows). As a result, sediments have accumulated in the substrate at G1 leading to conditions more suited for chironomids. Hynes (1972) reports a similar shift in the community structure of invertebrates due to beaver activity in an Ontario stream.

Sites G3A and G5A were added to the sampling program in 1984 to intensify the sampling in the area downstream of the existing mine site on Goathorn Creek where numbers were low in 1983, and upstream of this site where numbers were high. Benthic invertebrate numbers were low at the new site G3A but relatively higher at G3 in 1984 compared to 1983 (Figure 3.2). Samples within this latter site were more variable than any site other than G1 (Table 3.5). This may be at least partially a result of locating two of the samples in a side channel of Goathorn Creek at this location. Results at site G5A were quite similar to site G5 and re-affirms the trends for higher numbers of benthic invertebrates in upper Goathorn Creek than at sites lower in the system (excluding G1).

Numbers of invertebrates at site SC2 have been at least twice those at SC1 during both years of sampling (Figure 3.2). SC1 is located in a short flood channel of the Telkwa River that is more exposed to the direct influence of flow fluctuations (including possible dewatering during the late winter low-flow period) and higher turbidity than SC2. This latter site is located at the lower end of a side channel buffered from the mainstem river flows by debris accumulations at its upper end. Ward et al. (1979) found that side channels buffered from high turbidity and flow extremes such as SC2 tend to have more productive invertebrate communities than exposed sites such as SC1.

Taxa numbers per sample ranged from a low of 9 at intermediate sites in Goathorn Creek to a high of 22 in a sample taken just upstream of the existing mine site in Goathorn Creek (Table 3.5). The means for the sample sites ranged from 12 to 19 at all sites. Site G1 on Goathorn Creek and SC1 of the Telkwa River had the lowest diversity of taxa while sites in upper Goathorn Creek and in SC2 of the Telkwa River had the highest diversity.

The mean number of taxa per sample was generally similar in 1984 compared to 1983 although taxa numbers were slightly lower in Tenas Creek and higher in the Telkwa River side channels as shown in Table 3.8.

Table 3.8 Summary of Mean Number of Invertebrate Taxa/Sample

| | Goathorn Creek | Tenas Creek | Telkwa River | Mean |
|---|---|---|---|---|
| 1983 | 15.6 | 18.2 | 12.0 | 15.3 |
| 1984 | 15.6 | 16.4 | 15.4 | 15.8 |

Taxa numbers at site G1 decreased from approximately 18 to 12 and taxa numbers at SC2 increased from 12 to 18. SC2 was the only site

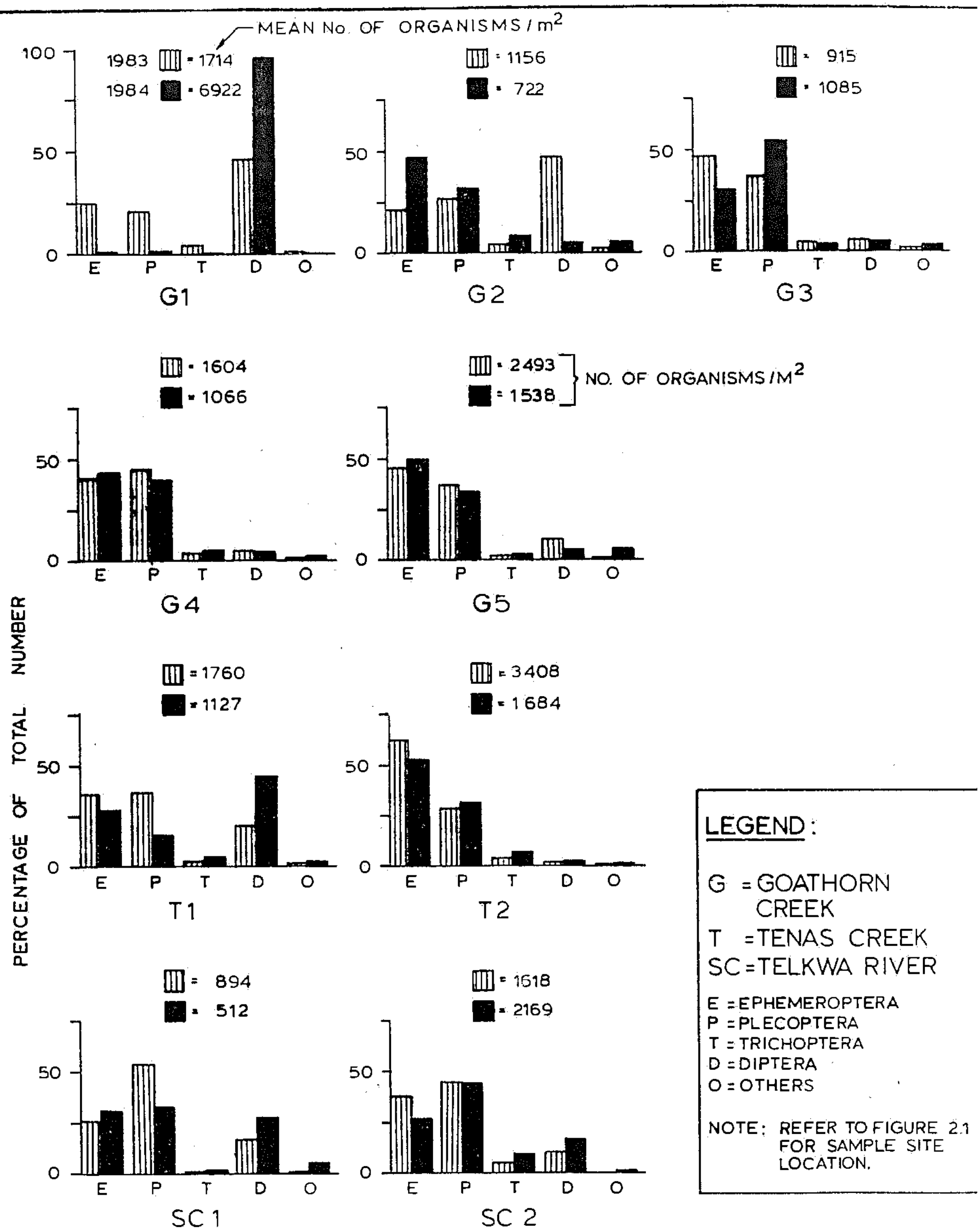



FIGURE 3.2 - BENTHIC COMMUNITY COMPOSITION CALCULATED AS A PERCENTAGE OF TOTAL NUMBER CONTRIBUTED BY EACH ORDER IN 1983 AND 1984.

that demonstrated a marked increase in numbers (34% increase) and species diversity from 1983 to 1984.

Table 3.9 summarizes the composition of the benthic invertebrate communities at the 11 sample sites. Most samples were comprised largely of individuals from the orders Ephemeroptera (mayflies) and Plecoptera (stoneflies). These two orders comprised 80% or more of the benthic fauna at the Goathorn Creek sites upstream of G1 and the upper Tenas Creek site. In addition to the high numbers of Diptera found at site G1 on lower Goathorn Creek, site T1 on lower Tenas Creek and site SC1 on the lower Telkwa River had high proportions of Diptera (45% and 28% respectively). At most of the other sites Diptera comprised less than 10% of the samples. Similarly, Trichoptera (caddis-flies) were generally less than 10% of the samples, while other invertebrates (Hirudinea, Oligochaeta, Acarina, Collembola, Hymenoptera, Homoptera, and Coleoptera) were of minor importance to the overall benthic community, and usually comprised less than 6% of the total numbers collected (Table 3.9).

The dominance of mayflies and stoneflies in most samples was similar to that found in 1983 with several exceptions (Figure 3.2). Site G2 had a higher proportion of stoneflies and mayflies, reflecting a decline in the number of chironomid larvae from 1983. Site T1 had a decline in stoneflies, largely a result of fewer organisms from the genera _Arcynopteryx_ and _Nemoura_ (Appendix 4). Caddis-flies of the genus _Sericostoma_, present at four sites in lower Goathorn and Tenas creeks in 1983, were completely absent from all sample sites in 1984.

The collection of adult specimens in drift samples resulted in the identification of two genera of stoneflies which had been mis-identified in the 1983 benthos samples (Bustard 1984a). _Kathroperla_ from 1983 has been identified as _Capnia_ and _Chloroperla_ has been identified as _Hastoperla_ in the 1984 samples.

The number of invertebrates/$m^2$ derived in this study (Table 3.5) are similar to estimates typically ranging from 700 - 1500 invertebrates/$m^2$ made in Foxy and Buck creeks, two nearby tributaries of the Bulkley River (Bustard 1984b; Hallam and Kussat 1974). However, they are considerably lower than those obtained in a study of 25 coastal streams (Wasserman et al. 1984) where values ranged from a low of 5,000 invertebrates/$m^2$ to over

Table 3.9 Summary of Composition of Benthic Invertebrate Communities at Eleven Sample Sites in Goathorn and Tenas Creeks and Telkwa River, September 1984

| Site[1] | N | % Composition (Number) | | | | |
|---|---|---|---|---|---|---|
| | | Ephemeroptera | Plecoptera | Trichoptera | Diptera | Other |
| **Goathorn Creek** | | | | | | |
| G1 | 3,987 | 0.4 ( 15) | 2.4 ( 94) | 0.2 ( 8) | 96.8 (3,861) | 0.2 ( 9) |
| G2 | 416 | 46.9 (195) | 32.7 (136) | 8.4 (35) | 6.2 (26) | 5.8 (24) |
| G3 | 625 | 30.7 (192) | 55.1 (344) | 4.8 (30) | 5.1 (32) | 4.3 (27) |
| G3A | 294 | 52.0 (153) | 27.2 ( 80) | 10.9 (32) | 5.8 (17) | 4.1 (12) |
| G4 | 614 | 44.5 (273) | 40.7 (250) | 6.0 (37) | 5.4 (33) | 3.4 (21) |
| G5 | 886 | 50.2 (445) | 34.7 (307) | 3.4 (30) | 5.5 (49) | 6.2 (55) |
| G5A | 754 | 36.7 (277) | 46.7 (352) | 5.6 (42) | 7.3 (55) | 3.7 (28) |
| **Tenas Creek** | | | | | | |
| T1 | 649 | 28.4 (184) | 16.9 (110) | 6.5 (42) | 45.1 (923) | 3.1 (20) |
| T2 | 970 | 53.8 (522) | 32.9 (319) | 8.5 (82) | 3.1 (30) | 1.7 (17) |
| **Telkwa River** | | | | | | |
| SC1 | 295 | 31.2 ( 92) | 33.2 ( 98) | 2.0 ( 6) | 27.8 (82) | 5.8 (17) |
| SC2 | 1,249 | 27.2 (340) | 45.3 (565) | 9.5 (119) | 17.5 (219) | 0.5 ( 6) |

[1] Refer to Figure 2.1 for specific site locations.

30,000 invertebrates/m$^2$ in the more productive streams. Invertebrate numbers were also lower than the 1500 to over 4000 invertebrates/m$^2$ sampled during September in the Flathead River, and tributaries in southeast B.C. using similar methods (Sheehan et al. 1980).

## 3.3 DRIFT STUDIES

The results of the invertebrate drift sampling in Goathorn Creek are summarized in Table 3.10. A more detailed breakdown of the samples is presented in Appendix 5.

Drift at site G5 was approximately 3 times as abundant as at site G2 (Table 3.10). The samples at G5 were taken one day earlier (September 20) than at site G2. A significant hatch of adult mayflies and stoneflies was in progress. These emerging adults have been omitted from the data presented in Table 3.10 to allow for a less biased comparison. The greater abundance of aquatic drift at G5 compared to G2 is in agreement with the higher benthic invertebrate numbers found at this upper site (Table 3.5).

The drift at the two sites was comprised of 83% aquatic and 17% terrestrial invertebrates (Table 3.10). The day drift, which is more available to feeding fish, was comprised of a higher proportion of terrestrial invertebrates (27%) than the night drift (10%). These samples were conducted during a period when large numbers of leaves from streamside vegetation were falling into the stream, and this may have increased the terrestrial input above levels occurring during other time periods.

A total of 29 taxa of aquatic invertebrates were present in the drift (Appendix 5). The dominant order was Ephemeroptera (31%), followed by Diptera (22%), Plecoptera (16%) and Trichoptera (11%). The terrestrial drift was comprised of 18 taxa, mainly from the orders Diptera (45%) and Hymenoptera (31%).

Approximately 10 times as many adult mayflies and stoneflies were captured at G5 compared to G2, one day later. Most (76%) of these adults were captured in the daytime drift, so many of these emerging insects were available to feeding fish. Most of the emerging insects were mayflies, predominantly Baetis, Ephemerella, Rithrogena and Iron and the stonefly Hastaperla (Appendix 5). All of these insects

Table 3.10 Summary of Composition of Invertebrate Drift Samples Collected in Goathorn Creek, September 1984[1]

| | | Number of Organisms | | | |
|---|---|---|---|---|---|
| | | G2[2] | G5[2] | Total | % |
| Ephemeroptera | Day | 12 | 88 | 100 | 31.0 |
| | Night | 19 | 145 | 164 | |
| Plecoptera | Day | 2 | 45 | 47 | 16.0 |
| | Night | 23 | 66 | 89 | |
| Trichoptera | Day | 8 | 21 | 29 | 10.6 |
| | Night | 6 | 55 | 61 | |
| Diptera (Aquatic) | Day | 30 | 58 | 88 | 22.0 |
| | Night | 46 | 53 | 99 | |
| Other Aquatic Invertebrates | Day | 2 | 0 | 2 | 3.1 |
| | Night | 15 | 9 | 24 | |
| Total Aquatic Invertebrates | Day | 54 | 212 | 266 | 82.7 |
| | Night | 109 | 328 | 437 | |
| Terrestrial Invertebrates | Day | 22 | 78 | 100 | 17.3 |
| | Night | 10 | 37 | 47 | |
| Total | | 195 | 655 | 850 | 100.0 |

1 Adult Ephemeroptera and Plecoptera have been excluded from the sample since a hatch occurting at G5 during the sample period strongly influenced the drift results. See Appendix 5 for a detailed breakdown of results.

2 Represents combined results from drift samplers located on each side of the stream.

were common in the benthos except Ephemerella spinifera which occurred infrequently in the benthos samples taken at G2 and G5. Mayfly and stonefly nymph and caddis-fly larva drift was more common at night.

## 3.4 FISH STOMACH CONTENT STUDIES

### 3.4.1 Steelhead Trout

Stomachs from a sample of 25 steelhead trout parr were taken at site G2 on Goathorn Creek. The parr ranged in size from 67-125 mm fork length (mean fork length of 93 mm) with an average weight of 12 g (Appendix 6.1). All stomachs contained at least one organism, with an average of 4.5 organisms per stomach. A summary of the composition of the steelhead parr stomachs is presented in Table 3.11 while the detailed results for each fish are in Appendix 6.2.

Approximately 79% of the organisms were aquatic and 21% terrestrial invertebrates (Table 3.11). This compares to the daytime drift at this site which was comprised of 29% terrestrial organisms. Ephemeroptera and Trichoptera were the most common insects in the steelhead trout parr stomachs.

Caddis-fly larvae of the genus Glossosoma were present in 10 of the 25 stomachs examined. This larva was not common in either the drift or the benthos samples taken at this site, suggesting that steelhead trout parr were specifically selecting it over other organisms. Mayflies were also present in 10 of the 25 stomachs examined. Important genera of mayflies included Baetis, Ephemerella, Rithrogena and Iron in both the nymph and adult stages. Adults from the family Corixidae (Heteroptera), common in the steelhead trout parr stomachs, were present in the drift samples collected at night (Appendix 6.2)

Diptera comprised approximately 5% of the number of organisms present in the steelhead trout parr stomachs despite comprising nearly 40% of the daytime drift at site G2. Chironomid larvae may provide an adequate meal for fry but are generally too small to serve as a suitable food item for steelhead trout parr.

Table 3.11 Percentage Composition, Based on Number of Specimens in the Guts, of Food of Steelhead Trout Parr and Dolly Varden Char in Goathorn Creek, September 1984

| | % Composition (Number) | |
|---|---|---|
| | Steelhead Trout (G2) | Dolly Varden Char (G5) |
| Ephemeroptera[1] | 36.6 (41) | 65.1 (136) |
| Plecoptera | 6.2 ( 7) | 12.0 ( 25) |
| Trichoptera | 21.4 (24) | 4.3 ( 9) |
| Diptera | 5.4 ( 6) | 3.8 ( 8) |
| Heteroptera | 8.1 ( 9) | 0.0 ( 0) |
| Others | 0.9 ( 1) | 0.0 ( 0) |
| Total Aquatic Invertebrates | 78.6 (88) | 85.2 (178) |
| Immature | 63.6 (56) | 41.0 ( 73) |
| Adults | 36.4 (32) | 59.0 (105) |
| Terrestrial Invertebrates | 21.4 (24) | 14.8 ( 31) |
| Total Number of Invertebrates | 112 | 209 |
| Number of Fish Examined | 25 | 25 |

[1] See Appendix 6.2 for more detailed information.

### 3.4.2 Dolly Varden Char

Stomachs from a sample of 25 Dolly Varden char were taken at site G5 on Goathorn Creek. The Dolly Varden char were larger than the steelhead trout sampled, ranging in length from 67 - 180 mm (mean fork length of 116 mm) with an average weight of approximately 24 grams (Appendix 6.1). All of the stomachs contained at least one food item, with an average of 8.4 organisms per stomach. A maximum number of 37 invertebrates was found in Fish 10. A summary of the composition of the Dolly Varden char stomach contents is presented in Table 3.11 while the more detailed results for each fish are in Appendix 6.2.

Approximately 85% of the organisms were aquatic and 15% terrestrial invertebrates (Table 3.11). The daytime drift at site G5 was 27% terrestrial (Table 3.10), suggesting that Dolly Varden char may have been selecting for aquatic organisms. Ephemeroptera were by far the dominant order of invertebrates and comprised 65% of the number of organisms found in the stomachs. Plecoptera (12%), Trichoptera (4%) and Diptera (4%) all constituted a much smaller percentage of the stomach contents. Adult mayflies, particularly of the genera Baetis and Rithrogena were found in 12 of the 25 stomachs examined, indicating that the Dolly Varden char were taking advantage of the hatch occurring at this site during the sample period. These genera were also very common in the daytime drift samples at this site (Appendix 5). Three genera of stoneflies, Nemoura, Arcynopteryx and Hastaperla, common in the drift samples, were also present to a limited extent in the stomach contents.

Although Diptera were common in the daytime drift (24%), they comprised a minor portion (4%) of the stomach contents of the Dolly Varden char sampled at G5.

## 3.5 POLLUTION TOLERANCE OF AQUATIC INVERTEBRATES

Table 3.12 presents an index of the tolerance of the various aquatic invertebrate taxa found in the benthos and drift samples in this study. The tolerance values are derived from the taxon's tolerance to sediment, alkalinity and sulphate and provides a measure of species tolerance to changes in water quality (Winget and Mangum 1979). Values range from 2 to greater than 100 with the larger values indicating greater tolerance. In general, members of the

Table 3.12 Tolerance Quotients of Aquatic Invertebrates Present in the Study Area Based Upon Tolerance to Alkalinity, Sulphate and Sedimentation

| INSECTA | | | Tolerance Quotients |
|---|---|---|---|
| Ephemeroptera | Baetidae: | *Baetis* sp. | 72 |
| | Siphlonuridae. | *Ameletus* sp. | 48 |
| | Ephemerellidae: | *Ephemerella doddsi* | 4 |
| | | *E. spinifera* | 24 |
| | Heptageniidae: | *Rithrogena* sp. | 21 |
| | | *Iron* sp. | 21 |
| | | *Cinygmula* sp. | 21 |
| | Leptophlebiidae: | *Paraleptophlebia* sp. | 24 |
| Plecoptera | Perlodidae: | *Diura* sp. | 24 |
| | | *Isogenus* sp. | 48 |
| | | *Arcynopteryx* sp. | 48 |
| | Chloroperlidae: | *Hastaperla* sp. | 24 |
| | Nemouridae: | *Nemoura* sp. 1 | 24 |
| | | *Nemoura* sp. 2 | 24 |
| | Capniidae: | *Capnia* sp. | 32 |
| Trichoptera | Psychomyiidae: | *Tinodes* sp. larva | 108 |
| | | *Tinodes* sp. pupa | 108 |
| | Hydropsychidae: | *Parapsyche* sp. | 6 |
| | Leptoceridae: | *Leptocella* sp. | 54 |
| | Brachycentridae: | *Brachycentrus* sp. | 24 |
| | Rhycacophilidae: | *Rhyacophila* sp. | 18 |
| | Glossosomatidae: | *Glossosoma* sp. | 24 |
| Diptera | Chironomidae larva | | 108 |
| | Chironomidae pupa | | 108 |
| | Chironomidae adult | | 108 |
| | Simuliidae larva | | 108 |
| | Simuliidae pupa | | 108 |
| | Simuliidae adult | | 108 |
| | Empididae larva | | 108 |
| | Empididae pupa | | 108 |

Source: Winget and Mangum (1979)

Table 3.12 Tolerance Quotients of Aquatic Invertebrates Present in the Study Area Based Upon Tolerance to Alkalinity, Sulphate and Sedimentation (Cont'd)

| INSECTA | | | Tolerance Quotients |
|---|---|---|---|
| | Ephydridae: | *Ephydra* sp. larva | 108 |
| | | *Ephydra* sp. pupa | 108 |
| | Blephariceridae: | *Philorus* sp. | 2 |
| | Ceratopogonidae: | *Culicoides* sp. | 108 |
| | Tipulidae: | *Tipula* sp. | 36 |
| | | *Antocha* sp. | 24 |
| | Rhagionidae: | *Atherix* sp. | 24 |
| | Deuterophlebiidae: | *Deuterophlebia* sp. | 4 |
| *Coleoptera* | Hydrophilidae | | 72 |
| | Psephenidae | | 72 |
| | Dytiscidae | | 72 |
| *Heteroptera* | Corixidae | | 108 |
| *Collembola* | Sminthuridae | | 108 |
| | Poduridae | | 108 |
| HIRUDINEA | | | 108 |
| OLIGOCHAETA | | | 108 |
| ACARINA | | | 108 |
| PELECYPODA | Sphaeridae | | 108 |

Source: Winget and Mangum (1979)

orders Ephemeroptera and Plecoptera are less tolerant than Diptera although there are exceptions. For example the genera *Philorus* and *Deuterophlebia* are very intolerant Diptera that generally do not live in degraded water conditions, while the mayfly *Baetis* is generally quite tolerant.

Organisms of the genus *Deuterophlebia*, along with the mayfly *Ephemerella doddsi*, another very intolerant invertebrate, are present within most of the sample sites in Goathorn Creek and should serve as good indicators of water quality conditions in this stream in future years. The change in conditions at site G1 during 1984 (largely due to an increase in fine sediments) was reflected in a decline in mayflies (*Ephemerella doddsi* were not present in 1984) and the more sensitive stoneflies and caddis-flies with an increase in the very tolerant chironomid larvae.

The Biotic Condition Index (Winget and Mangum 1979) incorporates the stream habitat (gradient and substrate composition), water quality (alkalinity and sulphate), and environmental tolerances of aquatic invertebrates (Table 3.12). It is a function of the Predicted Community Tolerance Quotient (CTQp) divided by the Actual Community Tolerance Quotient (CTQa) calculated as follows:

$$BCI = \frac{CTQp}{CTQa} \times 100$$

The CTQp is a function of stream habitat and water quality parameters while CTQa is calculated by multiplying the assigned value for each taxon by the number of individuals of that taxon that were found. The products are summed and divided by the total number of individuals collected.

This index provides a means of comparing stream condition from year to year based on the composition and abundance of invertebrates. It evaluates community structure and makes use of the indicator species concept without placing undue emphasis on species that do not appear in significant numbers. Values close to or above 100 generally reflect a healthy stream environment with an invertebrate population comprised of a large proportion of the less tolerant organisms (Table 3.13). In situations such as at site G1 where much of the community is comprised of tolerant chironomids, the BCI is lower. In 1984, the calculated BCI for site G1 was 47 (73 in 1983) compared to all other Goathorn Creek sites which exceed 100 (Table 3.13). The Biotic Condition Index can serve as a means of detecting shifts in the aquatic invertebrate community towards more tolerant species, a situation that would tend to occur if water quality was degraded in Goathorn Creek as a result of the proposed mine development.

## 3.6 FISH HABITAT STUDIES

Low nutrient levels resulting in limitations to fish food production, and cold water temperatures restricting fish growth to a relatively short period each year both have an important influence on fish production in streams within the study area. As well, the physical characteristics of the various study streams play a major role in determining the eventual fish production in these systems. This section describes the aquatic habitats of Goathorn, Tenas and Hubert creeks, and the Telkwa River downstream of Goathorn Creek and suggests how these habitats may influence fish distribution and production.

The habitat information derived in this study, in conjunction with experience gained from other adjacent systems is used to identify probable limitations within the systems to fish production, and provides the background for identifying methods of increasing fish production within these systems to be discussed in a subsequent section.

### 3.6.1 Goathorn Creek Habitat Assessment

Goathorn Creek, approximately 15 km in length, has been separated into five reaches (Figure 3.3). Fish are present in the lower two reaches (10 km) and are suspected to occur in Reach 3 (2 km). Waterfalls located in a canyon area approximately 13 km upstream are the probable upper extent of fish use. In addition Cabinet Creek, a major tributary of Goathorn Creek, provides another 9.5 km of habitat suitable for fish use (Figure 3.3). Presently, at least lower Cabinet Creek is utilized by Dolly Varden char. Sites upstream of Reach 3 in Goathorn Creek and above Tributary 1 on Cabinet Creek are generally high gradient and provide poor quality fish habitat. A summary of existing fish use in the system is outlined in Figure 3.3.

Table 3.13 Biotic Condition Indices (BCI) for Benthic Invertebrate Sample Sites in Goathorn and Tenas Creeks and Telkwa River Side Channels

| Site | CTQp[1] | CTQa[2] (1984) | CTQa (1983) | BCI (1984) | BCI (1983) |
|---|---|---|---|---|---|
| G1 | 50 | 105.4 | 68.5 | 47 | 73 |
| G2 | 50 | 40.7 | 71.1 | 123 | 70 |
| G3 | 50 | 34.5 | 45.4 | 145 | 110 |
| G3A | 50 | 39.5 | NE[3] | 127 | NE[3] |
| G4 | 50 | 36.2 | 42.6 | 138 | 117 |
| G5 | 50 | 42.3 | 43.6 | 118 | 115 |
| G5A | 50 | 44.3 | NE[3] | 113 | NE[3] |
| T1 | 50 | 69.4 | 54.5 | 72 | 92 |
| T2 | 50 | 41.5 | 52.5 | 120 | 95 |
| SC1 | 53 | 54.4 | 45.1 | 97 | 118 |
| SC2 | 53 | 42.0 | 40.2 | 126 | 132 |

1 CTQp - Predicted Community Tolerance Quotient.

2 CTQa - Actual Community Tolerance Quotient.

3 These sites were not evaluated in 1983.

Much of the lower 10 km of Goathorn Creek is characterized by cobble and small boulder bed material generally in the 10 - 30 cm size range. This substrate is clean and ideal for use by larger juvenile fish for cover. The stream lacks shallow, low velocity habitat suitable for newly-emerged fry.

Goathorn Creek particularly Reach 2, also lacks suitable spawning sites for fish. Ground reconnaissance in 1982 (Bustard 1983) indicated less than 1% of the lowest reach in Goathorn Creek offered suitable spawning gravels, while upstream spawning sites were even less common, usually restricted to a few sites in side channels or the tail end of pools. Reach 1, with a 2-3% gradient offers marginal spawning opportunities for pink salmon. This species prefers low gradient streams with small but more stable substrate than present in lower Goathorn Creek. A large beaver dam located 0.6 km upstream on Goathorn Creek restricts pink salmon access to areas upstream and would probably limit coho salmon access during most years.

Goathorn Creek downstream of Cabinet Creek is of sufficient width and energy to maintain a continuous profile (Figures 3.4 and 3.5). Debris is generally deposited on the sides of the stream in small accumulations that have little influence on the stream morphology.

The flow regime of Goathorn Creek strongly influences the amount of habitat and its suitability for use by different fish species. High flows typically occur from late April through July as a result of snowmelt. The high flows enable steelhead trout that overwinter in the Bulkley and Telkwa rivers to move into tributaries to spawn in May and June. These fish can pass over obstacles such as the beaver dam at 0.6 km that would prevent passage at lower flows. Streamflows remain relatively high through the summer until steelhead trout emergence in August and provide good incubation conditions for eggs although there is probably some risk of egg scouring during high-flow years.

The main period for juvenile fish activity and growth occurs from May through late October when water temperatures are above 5°C. Juvenile fish are generally inactive from early November through April. At this time they usually move into spaces in the substrate or within debris cover to overwinter. Goathorn Creek offers excellent substrate for overwintering fish.

| GOATHORN CREEK | | | | | | | |
|---|---|---|---|---|---|---|---|
| REACH | SLOPE (%) | LENGTH (m) | WIDTH (m) | AREA ($m^2$) | D50 (cm) | D90 (cm) | SIDE CHANNEL LENGTH (m) |
| R1 | 2.8 | 1140 | 9.3 | 10 602 | 11 | 28 | 684 |
| R2 | 2.5 | 9130 | 8.1 | 73 953 | 11 | 26 | 2625 |
| R3 | 2.2 | 2090 | 3.6 | 1254 | — | — | — |
| R4 | 5.6 | 4340 | — | — | — | — | — |
| R5 | 1.3 | 2330 | — | — | — | — | — |

| CABINET CREEK | | | | | | |
|---|---|---|---|---|---|---|
| REACH | SLOPE (%) | LENGTH (m) | WIDTH (m) | AREA ($m^2$) | D50 (cm) | D90 (cm) |
| R1 | 4.7 | 3360 | 10.6 | 35 616 | 8 | 17 |
| R2 | 7.8 | 3230 | — | — | — | — |
| R3 | 13.7 | 2000 | — | — | — | — |
| R4 | 9.0 | 1180 | — | — | — | — |

| CABINET CR. TRIB. 1 | | |
|---|---|---|
| REACH | SLOPE (%) | LENGTH (m) |
| R1 | 6.0 | 1680 |
| R2 | 3.4 | 4530 |
| R3 | 24.9 | 1720 |

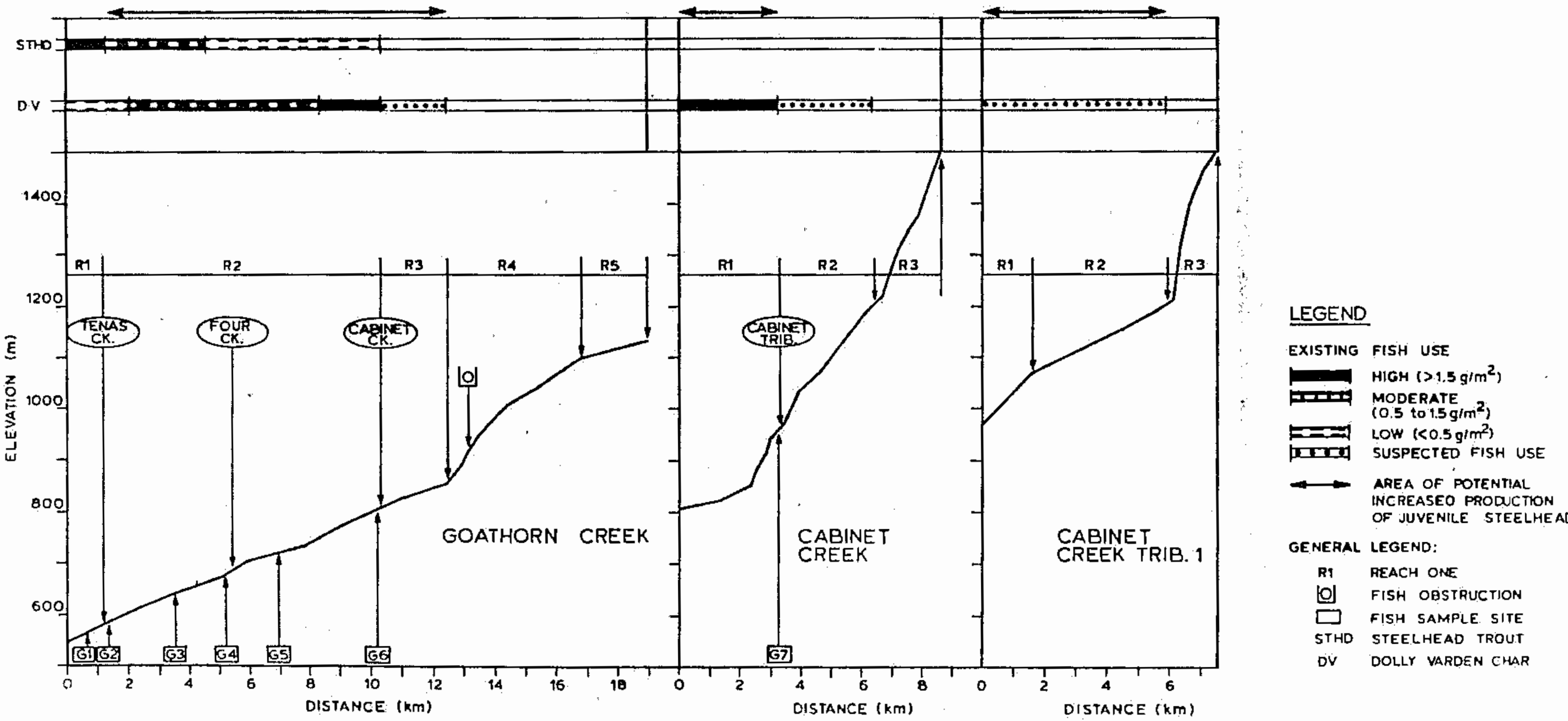



FIGURE 3.3 - STREAM PROFILES AND FISH HABITAT SUMMARIES OF GOATHORN CREEK AND TRIBUTARIES

Crows Nest Resources Limited

Figure 3.4 Much of Goathorn Creek is characterized by cobble bed material. Debris tends to be deposited at the stream edge in small accumulations that have little direct influence on the stream profile.

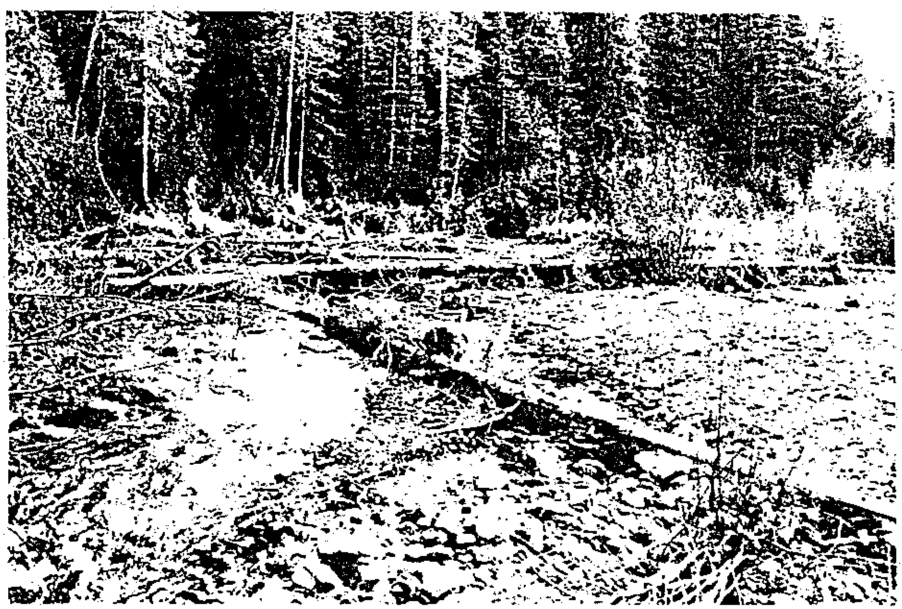


Figure 3.5 Large organic debris that falls into the stream from adjacent streambank areas creates a more stepped profile in Tenas Creek than in Goathorn Creek.

Figure 3.6 Anchor ice started to form in Goathorn Creek during a cold period in late October. This photo was taken from the lower bridge on October 28, 1984.

Figure 3.7 Water levels in Goathorn Creek had risen over 30 cm by October 31, 1984. Anchor ice development as illustrated in these photos limits the streams suitability for coho salmon spawning and may cause significant juvenile fish mortalities.

The creek usually freezes over in November, although this can occur in late October as observed in 1984 (Figures 3.6 and 3.7). The combination of low fall flows limiting upstream access and extensive subsurface ice conditions developing during the freeze-up period probably limits coho salmon use of Goathorn Creek. As well, the system possesses few wetlands and side channel sites typically used by juvenile coho salmon for rearing.

The lowest flows in Goathorn Creek occur during the late winter (usually March) when flows are normally less than 20% of the lowest summer/fall flows. Based on observations in other Bulkley River tributaries (Bustard in prep.), some juvenile fish stranding, particularly fry in side channels, may occur during this period.

### 3.6.2 Tenas Creek Habitat Assessment

Tenas Creek is 21 km in length and drains an area of 63 $km^2$ or approximately one-third of the Goathorn Creek watershed. Most fish production in Tenas Creek occurs in the lower 12 km of the system (Reaches 1 and 2 in Figure 3.8) where the stream gradient is typically 2-3%. Additional areas of potential production include a 3.5 km section of Reach 3 and the lowest 1 km of Tributary 1. Upstream of Reach 3 the stream gradient increases to greater than 9% and is unsuitable for fish production.

The bed material in Tenas Creek is mainly comprised of cobble with some large gravel and boulders and tends to be smaller than Goathorn Creek bed material. Lower streamflows and a narrower channel in Tenas Creek have resulted in some significant differences in stream morphology. Large organic debris that falls into the streams from adjacent streambank areas has created a more stepped stream profile and more habitat diversity than in Goathorn Creek (Figure 3.5). Pool areas have formed downstream of logs and root wads, and gravel has been deposited at the tail-outs from these pools creating more spawning areas in Tenas Creek compared to Goathorn Creek. Lower flows in Tenas Creek have also resulted in more low-velocity shallow sites suitable for fry rearing. This increased spawning and fry rearing habitat may account for the more extensive use by steelhead trout of Tenas Creek compared to Goathorn Creek as indicated by juvenile surveys during the past two years.

TENAS CREEK

| REACH | SLOPE (%) | LENGTH (m) | WIDTH (m) | AREA ($m^2$) | D50 (cm) | D90 (cm) |
|---|---|---|---|---|---|---|
| R1 | 2.0 | 5790 | 6.6 | 38 214 | 9 | 22 |
| R2 | 3.4 | 5930 | 5.5 | 32 615 | 9 | 28 |
| R3 | 5.9 | 3820 | — | — | - | — |
| R4 | 9.9 | 1540 | — | — | - | — |
| R5 | 9.3 | 1510 | — | — | - | — |
| R6 | 18.3 | 2230 | — | — | - | — |

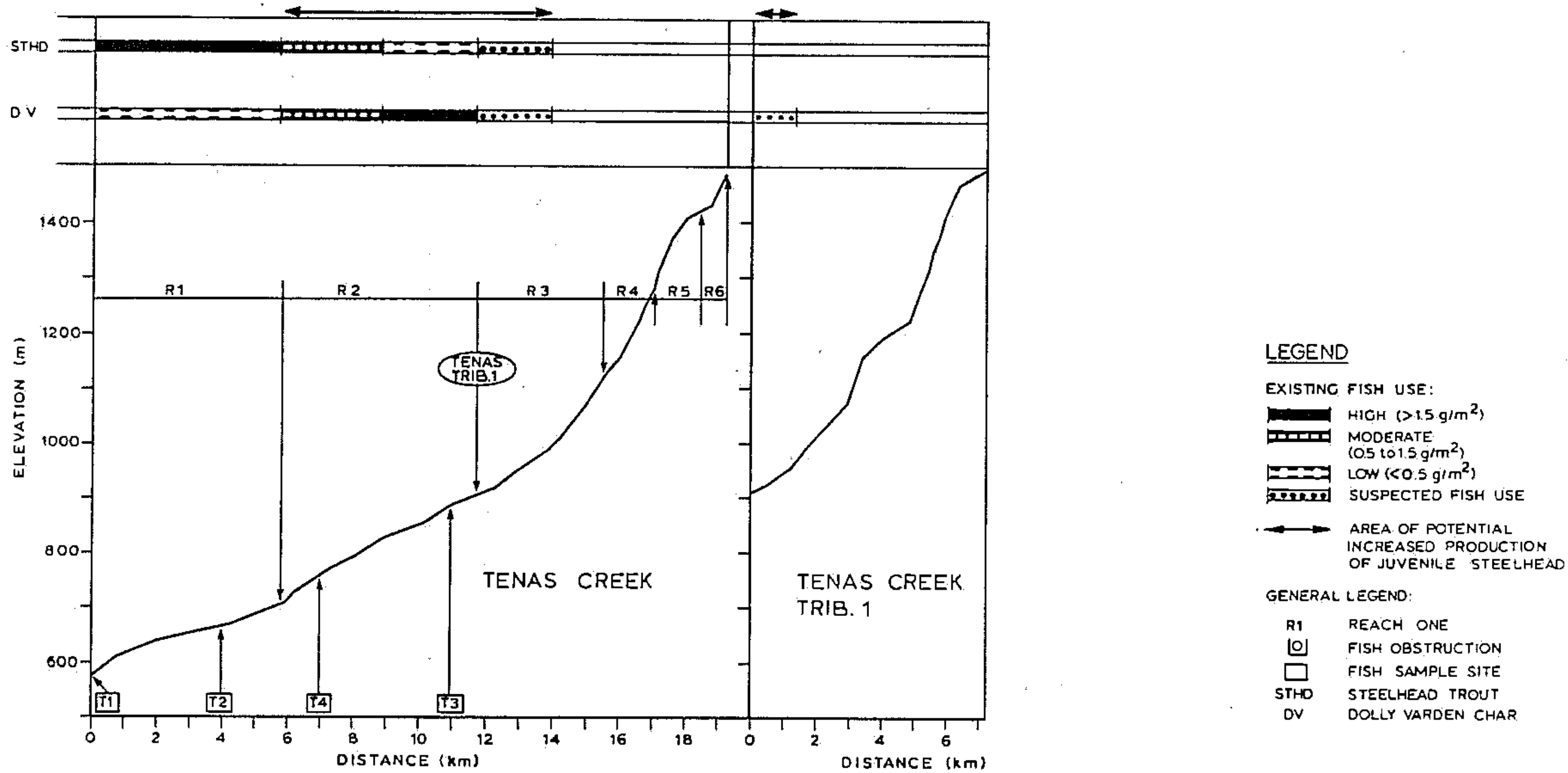



FIGURE 3.8 - STREAM PROFILES AND FISH HABITAT SUMMARIES OF TENAS CREEK AND TRIBUTARY

Crows Nest Resources Limited

Similarly to Goathorn Creek, the flow regime directly affects the amount of useable stream habitat on a seasonal basis. The Tenas Creek flow regime has several differences that may influence fish production. Lower fall flows in Tenas Creek make access for salmon spawners even more difficult than in Goathorn Creek. As well groundwater inputs to Tenas Creek may be more significant than in Goathorn Creek. This groundwater may be important in moderating water temperatures and ice conditions in Tenas Creek providing a benefit to overwintering juveniles.

### 3.6.3 Lower Telkwa River Habitat Assessment

The Telkwa River from its confluence with Goathorn Creek to the Bulkley River has a slope of less than 1% and is part of the lowest reach of the Telkwa River delineated on the biophysical map for the Telkwa Watershed (Environmental and Planning Assoc. 1982). This section of the Telkwa River is complex and multi-channelled. Measurements made from air photos indicate there are approximately 18 km of side channels ranging from less than 100 m to over 2 km in length in this 8-km section of the Telkwa River. Approximately two-thirds of these side channels (based on length) are potentially productive juvenile salmonid rearing areas.

Side channels have been sub-divided into three categories - relic, active and flood channels. A description of each of these channel types and their relative importance to fish production is presented in Table 3.14 while Figure 3.9 outlines the location of each channel in the lower Telkwa River. Length, width and area calculations for each of the 79 side channels are presented in Appendix 7. The active and flood channels are the main fish-producing channels, while most relic channels are not presently productive but could be developed as spawning and juvenile rearing areas.

In addition, approximately 20 ha of wetland areas adjacent to the lower Telkwa River have been identified (Figure 3.9). Wetlands are located within the flooded area of the main channel and may be connected during high flow periods. These areas provide potential rearing areas for juvenile coho salmon depending on access from the main channel and source of flows during other periods of the year (Figure 3.10). Inflows to these wetlands are often from adjacent slopes.

Table 3.14 Classification and Fish Habitat Assessment of Lower Telkwa River Side Channels[1]

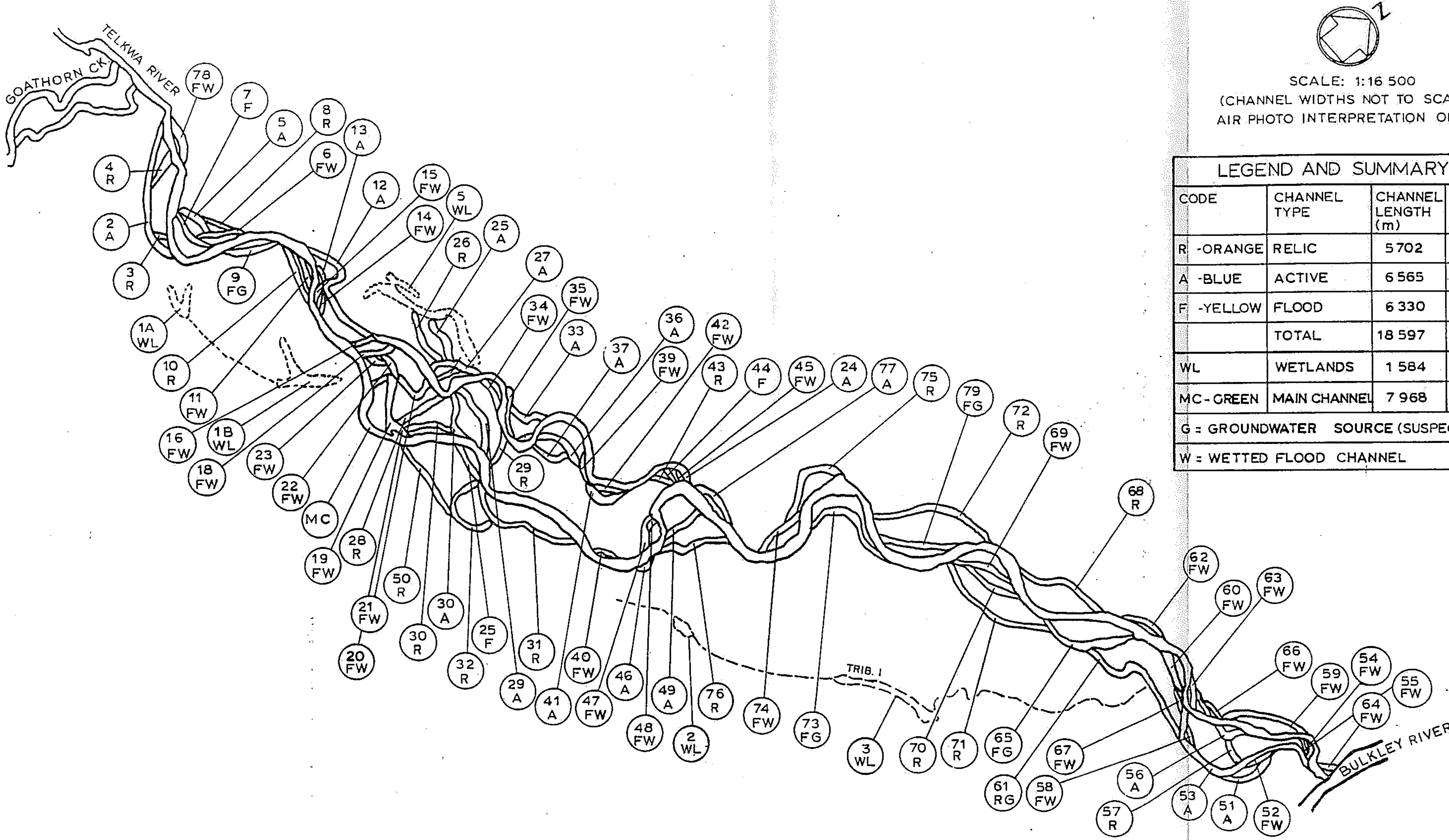
| Side Channel Types | | | |
|---|---|---|---|
| R | = | Relic Channels | - These channels are not connected to the main channel except during peak flows.<br>- Relic channels are heavily vegetated, usually with trees.<br>- Relic channels may have tributary or groundwater inflows.<br>- These channels are usually not utilized by fish but offer suitable sites for side channel development. |
| A | = | Active Channels | - These channels are connected to the main river channel at most flows and usually have some flow through them year-round.<br>- The banks are heavily vegetated and debris is usually present in the channel. This debris may buffer the effects of floods.<br>- Active channels provide high value fish habitat for juvenile steelhead trout and in some locations, coho salmon. Active side channels provide the best potential spawning areas for steelhead trout and pink and coho salmon of all the habitat types in the lower Telwa River. |
| F | = | Flood Channels | - Flood channels are found on bars within the main channel and are subject to lateral migration shifts and the full effects of floods.<br>- These channels usually have little associated debris.<br>- Flood channels can offer high quality habitat for steelhead trout, but tend to dewater more frequently. They offer poorer spawning potential due to substrate shifting and dewatering. |
| WL | = | Wetlands | - Wetlands may be connected to the main channel during high flows.<br>- Wetlands can be productive coho salmon rearing areas if they are at least seasonally accessible and have some inflows from adjacent slopes. |

[1] Refer to Figure 3.9 for channel locations in the lower Telkwa River.

Table 3.14 Classification and Fish Habitat Assessment of Lower Telkwa River Side Channels[1] (Cont'd)

| Side Channel Types | | | |
|---|---|---|---|
| **Additional Symbols** | | | |
| g | = | – | Suspected groundwater source of water. |
| t | = | – | Tributary source of water. |
| w | = | – | Flood channels that at the time of photography had water in them. |
| .... | = | – | Channels where the location is uncertain |

1 Refer to Figure 3.9 for channel locations in the lower Telkwa River.




SCALE: 1:16 500
(CHANNEL WIDTHS NOT TO SCALE)
AIR PHOTO INTERPRETATION ONLY

| LEGEND AND SUMMARY | | | |
|---|---|---|---|
| CODE | CHANNEL TYPE | CHANNEL LENGTH (m) | CHANNEL AREA ($m^2$) |
| R -ORANGE | RELIC | 5 702 | 8 722 |
| A -BLUE | ACTIVE | 6 565 | 55 899 |
| F -YELLOW | FLOOD | 6 330 | 53 321 |
| | TOTAL | 18 597 | 117 942 |
| WL | WETLANDS | 1 584 | 21 296 |
| MC - GREEN | MAIN CHANNEL | 7 968 | 261 350 |
| G = GROUNDWATER SOURCE (SUSPECTED) | | | |
| W = WETTED FLOOD CHANNEL | | | |

NOTE: SEE TABLE 3.14 FOR MORE DETAILED INFORMATION RE CHANNEL CLASSIFICATION AND APPENDIX 7 FOR SPECIFIC INFORMATION DESCRIBING EACH CHANNEL.

FIGURE 3.9
LOCATION AND HABITAT SUMMARY OF LOWER TELKWA RIVER CHANNEL TYPES

Crows Nest Resources Limited

Figure 3.10 Wetlands (WL5) offer excellent potential rearing habitat for juvenile coho salmon. In the lower Telkwa River, this type of habitat is often not presently used due to access limitations from the mainstem river.

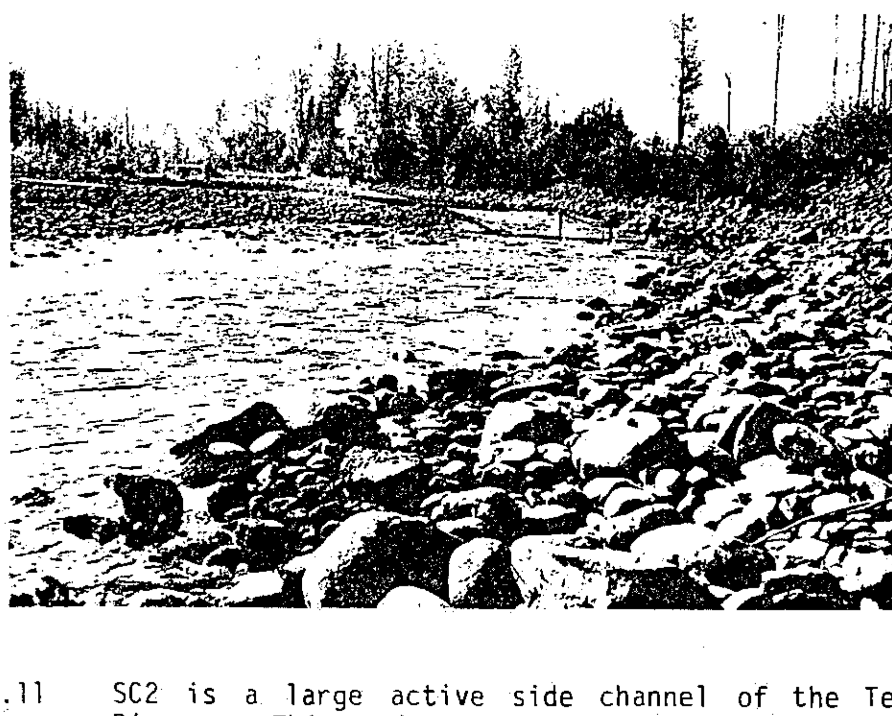


Figure 3.11 SC2 is a large active side channel of the Telkwa River. This substrate, with large interstitial spaces provides excellent cover for juvenile fish.

The combined wetted area of active and flood channels is approximately 11 ha and is less than one-half of the estimated 26 ha of main channel wetted area of the lower Telkwa River. This is a maximum estimate since the measurements were derived from air photos taken during higher flows in early August, 1983. Not all of the wetted area is useable for juvenile salmonids rearing, particularly in the main channel where velocities in mid-stream are typically too high for suitable juvenile rearing. Measurements taken at fish sample sites (45 points during two years of sampling) suggest that approximately 7 m on each side of the main channel provides useable parr rearing habitat during the late summer and fall period. This estimate would be lower for fry, since these small fish tend to occupy slow, shallow sites often right along the margin.

The Telkwa River bed material is predominantly cobble in the 10–30 cm diameter range. However, there is a lot of site variability. For example, the small side channel (SC3) is characterized by silt and sand substrate while other sites, particularly in main channel, consist largely of boulder habitat. Although the bed material at many sites is covered by a fine layer of glacial silt, the substrate tends to be loose with large interstitial spaces providing good cover for fry and parr-sized fish (Figure 3.11). Gravel areas suitable for spawning are interspersed along the lower Telkwa River, particularly in the active side channels. Pink salmon have been observed spawning in Channels 12, 24 and 53 (Figure 3.9) during aerial surveys in 1983 (Bustard 1984c). Although flood channels may have adequate gravel they are less suitable for spawning fish due to their high susceptibility to substrate shifting and dewatering.

Although the general streamflow pattern of the Telkwa River is similar to that discussed for Goathorn Creek, the larger watershed has higher maximum and minimum flows and is more turbid than the tributary streams (CNRL 1983). The complex side channel habitat in the lower Telkwa River provides important refuge areas for fish subject to high turbid flows in the mainstem river for much of the summer period. Log jams and gravel bars tend to buffer many of these channels (particularly the active channels) providing moderated conditions more suited to juvenile fish rearing. However, some of these side channels may be subject to dewatering during the low-flow period in the late winter, and significant fish mortalities could occur in the lower Telkwa River side channels. High overwinter losses have been measured in a multi-channelled section of the Morice River (Figure 1.1), an adjacent system also subject to low winter flows (Bustard in prep.). Anchor and frazil ice conditions are common during November and early December in the Telkwa River. However, ice formation is probably less extreme than in the tributary streams due to higher winter flows in the main river.

### 3.6.4 Hubert Creek Habitat Assessment

Hubert Creek drains a 44 $km^2$ watershed comprised of low to mid-elevation areas. This stream is approximately 12 km long and its one major tributary, Helps Creek, is an additional 8.5 km in length (Figure 3.12).

The lower 2 to 4 km of Hubert Creek is utilized primarily by coho salmon and to a lesser extent by steelhead trout. The stream gradient is less than 0.5% and this reach is characterized by extensive ponds and wetland areas, largely the result of beaver activity. Estimates derived from air photos indicated 3.4 ha of ponded habitat is present in Reach 1 of Hubert Creek.

The mid-reaches of Hubert Creek and the lower two reaches of Helps Creek provide an additional 8.5 km of fish habitat for resident cutthroat trout and a small number of Dolly Varden char (Figure 3.12). The stream gradient exceeds 9% in areas upstream of these reaches and is unsuitable for fish production.

The ponded sites of Hubert Creek are potentially excellent rearing areas for juvenile coho salmon. However, low autumn flows and extensive beaver dams up to 2 m high create access difficulties for adult coho spawners. As well, spawning habitat in the lower system is restricted to a small number of sites just downstream of beaver dams in the stream section 1-2 km upstream from the Bulkley River. Approximately 200 m of poor quality spawning gravel occurs in this section. The presence of only yearling coho salmon upstream of the CN railway bridge during 1983 sampling (Bustard 1984a) suggests that adult coho salmon access to much of the creek system can be limited during some years by beaver dams. Lower Hubert Creek does not offer good quality steelhead trout habitat. This species prefers those short sections of Hubert Creek that were free-flowing (Bustard 1984a).

| HUBERT CREEK | | |
|---|---|---|
| REACH | SLOPE (%) | LENGTH (m) |
| R1 | [illegible] | [illegible] |
| R2 | 1.1 | [illegible] |
| R3 | [illegible] | 3380 |
| R4 | [illegible] | [illegible] |

| HELPS CREEK | | |
|---|---|---|
| REACH | SLOPE (%) | LENGTH (m) |
| R1 | 0.6 | [illegible] |
| R2 | 3.4 | 1260 |
| R3 | 11.9 | [illegible] |

| HELPS CREEK TRIB | |
|---|---|
| SLOPE (%) | LENGTH (m) |
| [illegible] | [illegible] |

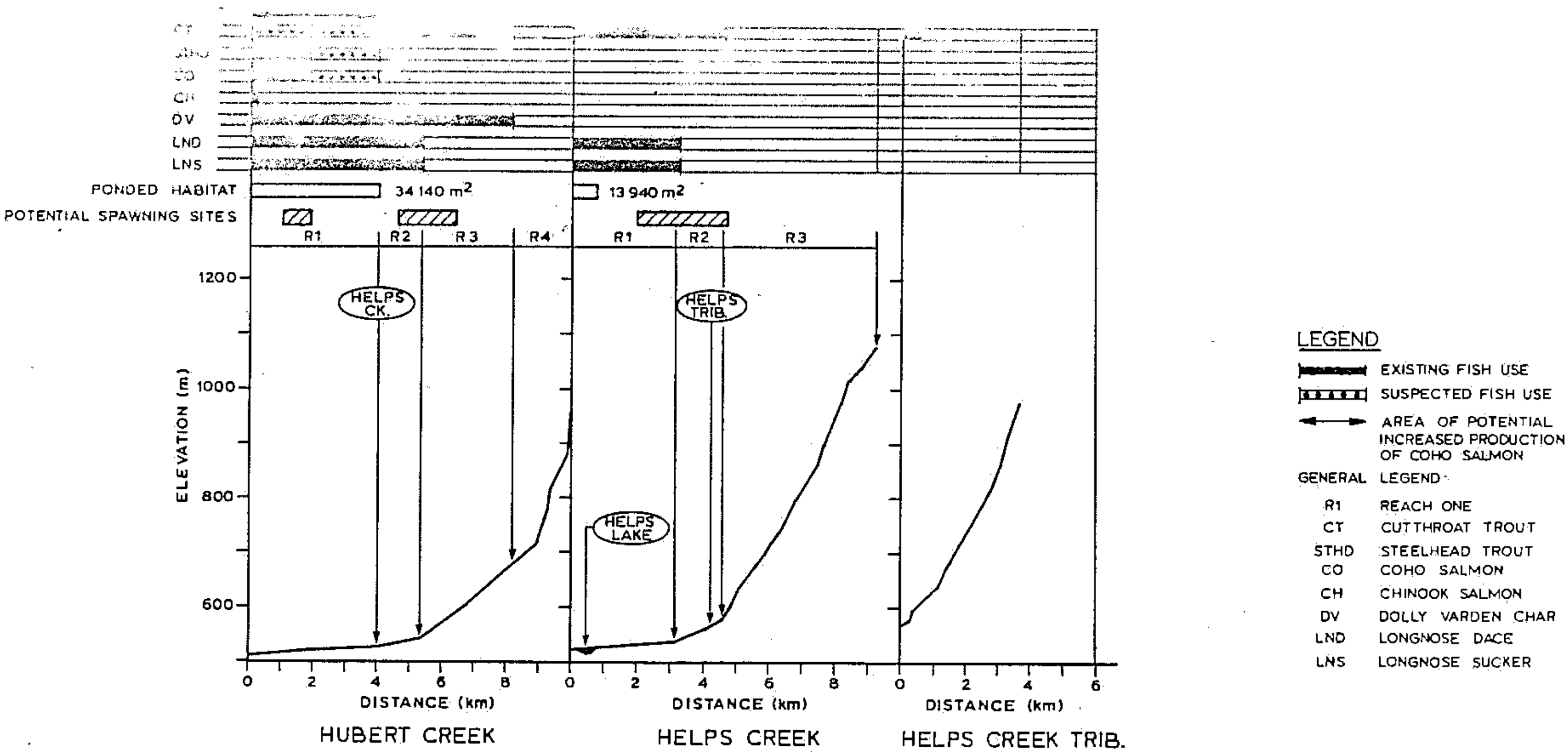



FIGURE 3.12- STREAM PROFILES AND FISH HABITAT SUMMARIES OF HUBERT CREEK AND TRIBUTARIES

Crows Nest Resources Limited

Resident cutthroat trout present in Helps Lake and in the mid-sections of Hubert Creek have more potential areas suitable for spawning (Figure 3.12). However much of the good spawning habitat in Helps Creek has been substantially modified by agricultural clearing and diversions that have exposed the channel creating unstable banks subject to erosion.

Hubert Creek is not subject to the same degree of flow fluctuations as the other systems examined in this study. The combination of extensive ponding and lack of high elevation run-off results in a more moderated flow regime and lower turbidity levels than in the other study streams. Land-use activities such as agricultural clearing, livestock grazing and logging have resulted in considerable habitat degradation in this system.

## 3.7 JUVENILE FISH POPULATION ESTIMATES

Results from the 1984 juvenile fish sampling program presented in the following sections are arranged by stream system. Additional sample sites were added to this year's program (G6 and G7 in Goathorn Creek, T4 in Tenas Creek and four mainstem Bulkley River sites shown in Figure 2.1). The results have been summarized so that comparisons can be made between the two years (excluding the new sites), and some of the 1983 results are included in this section to enable easier comparisons. More detailed 1983 information is presented in Bustard (1984a).

As well, revised stream length calculations have been incorporated into the estimates based on more accurate measurements conducted in 1984. The 1983 results used in the comparisons have been revised using the new stream lengths, resulting in different system production estimates than presented in Bustard (1984a).

### 3.7.1 Goathorn Creek

Approximately 3,500 $m^2$ of the lower two reaches of Goathorn Creek were sampled during 1984. This comprised 351 m of stream length and represents 3.5% of the total 10.2 km of stream in the main fish-producing section of Goathorn Creek. As well, an additional 29 m section of Cabinet Creek was sampled.

Table 3.15 Summary of Fish Species and Age Class Composition for Two Years of Sampling in Goathorn Creek

| | | Goathorn Creek (Sites G1 to G5[1]) | | | |
|---|---|---|---|---|---|
| | | 1984 | | 1983 | |
| Species | Age | Number | % | Number | % |
| Steelhead Trout | 0+ | 383 | 47.9 | 470 | 52.0 |
| | 1+ | 138 | 17.3 | 107 | 11.9 |
| | >2+ | 48 | 6.0 | 58 | 6.4 |
| | | (569) | (71.2) | (635) | (70.3) |
| Dolly Varden Char | 0+ | 78 | 9.8 | 123 | 13.6 |
| | >1+ | 151 | 18.9 | 145 | 16.0 |
| | | (229) | (28.7) | (268) | (29.6) |
| Mountain Whitefish | | 1 | 0.1 | 1 | 0.1 |
| TOTAL | | 799 | 100 | 904 | 100 |
| Area Sampled ($m^2$) | | 3,323 | | 3,238 | |
| Stream Length Sampled (m) | | 323 | | 323 | |

[1] G6 and G7 are not included in this comparison since they were not included in the 1983 sampling program.

Table 3.16 Juvenile Salmonid Densities and Biomass Estimates at Seven Sample Sites in Goathorn Creek, September and October 1984

DENSITY ESTIMATES (Fish/$m^2$)

| Reach | Site | Steelhead Trout 0+ | Steelhead Trout 1+ | Steelhead Trout > 2+ | Dolly Varden Char 0+ | Dolly Varden Char > 1+ | Mountain Whitefish > 1+ | Total |
|---|---|---|---|---|---|---|---|---|
| 1 | G1 | 0.39 | 0.11 | 0.02 | 0.00 | 0.01 | < 0.01 | 0.52 |
| 2 | G2 | 0.09 | 0.07 | 0.01 | 0.00 | < 0.01 | 0.00 | 0.18 |
| 2 | G3 | 0.06 | 0.02 | 0.04 | 0.07 | 0.07 | 0.00 | 0.26 |
| 2 | G4 | 0.01 | < 0.01 | 0.01 | 0.07 | 0.07 | 0.00 | 0.07 |
| 2 | G5 | < 0.01 | < 0.01 | < 0.01 | 0.02 | 0.08 | 0.00 | 0.10 |
| Mean[1] | | 0.11 | 0.04 | 0.02 | 0.03 | 0.05 | < 0.01 | 0.23 |
| 2 | G6 | 0.00 | 0.01 | 0.00 | 0.02 | 0.23 | 0.00 | 0.26 |
| 3 | G7 | 0.00 | 0.00 | 0.00 | 0.00 | 0.22 | 0.00 | 0.22 |

BIOMASS ESTIMATES (g/$m^2$)

| Reach | Site | Steelhead Trout 0+ | Steelhead Trout 1+ | Steelhead Trout > 2+ | Dolly Varden Char 0+ | Dolly Varden Char > 1+ | Mountain Whitefish > 1+ | Total |
|---|---|---|---|---|---|---|---|---|
| 1 | G1 | 0.37 | 0.81 | 0.46 | 0.00 | 0.05 | 0.02 | 1.71 |
| 2 | G2 | 0.06 | 0.42 | 0.30 | 0.00 | 0.08 | 0.00 | 0.86 |
| 2 | G3 | 0.06 | 0.16 | 1.46 | 0.10 | 0.64 | 0.00 | 2.42 |
| 2 | G4 | < 0.01 | 0.02 | 0.29 | 0.09 | 0.78 | 0.00 | 1.18 |
| 2 | G5 | < 0.01 | < 0.01 | 0.06 | 0.03 | 0.99 | 0.00 | 1.08 |
| Mean | | 0.10 | 0.28 | 0.51 | 0.04 | 0.51 | < 0.01 | 1.45 |
| 2 | G6 | 0.00 | 0.05 | 0.00 | 0.02 | 3.11 | 0.00 | 3.18 |
| 3 | G7 | 0.00 | 0.00 | 0.00 | 0.00 | 2.18 | 0.00 | 2.18 |

1 This mean is calculated for those sites that were also sampled in 1983.

Table 3.15 summarizes the fish species and age class composition of the 5 sites in Goathorn Creek that were also sampled in 1983. As in 1983, just over 70% of the catch was comprised of juvenile steelhead trout with the remainder of the catch consisting of Dolly Varden char except for a single juvenile mountain whitefish captured in lower Goathorn Creek. The upper two sites (G6 and G7) not included in this summary, were comprised almost entirely of Dolly Varden char. Overall fish numbers were approximately 13% lower in 1984, largely the result of lower numbers of fry of both species (Table 3.15). The sample area and stream length were almost identical for the two years.

A summary of fish density and biomass estimates for the 1984 program is presented in Table 3.16, while the more detailed fish sampling results are provided in Appendix 8.2. As in 1983, overall fish densities were highest at site G1 (Table 3.16), representative of the lowest 1 km of Goathorn Creek. Densities at this site were approximately three times greater than at sample sites upstream in Goathorn Creek. The high density estimates are largely a reflection of the higher steelhead trout fry numbers in this lower reach of Goathorn Creek.

Total fish biomass ($g/m^2$) ranged from less than 1 $g/m^2$ at site G2 to over 3 $g/m^2$ at G6, a new site located just downstream of the confluence of Goathorn and Cabinet creeks. Mean biomass estimates combined for sites G1 to G5 were approximately 1.5 $g/m^2$ in 1983 and 1984.

## Steelhead Trout

Although juvenile steelhead and rainbow trout cannot be visually separated, most juveniles captured in this study are suspected to be progeny of steelhead trout (Figure 3.13). Evidence in support of this is presented in Bustard (1984a).

Juvenile steelhead trout densities were highest at the lower site (Table 3.16), mainly the result of fry densities (0.4 fry/$m^2$), at least four times higher than at other sites in Goathorn Creek. Steelhead trout fry and parr densities dropped progressively the further upstream sampled. A single steelhead trout yearling was captured at the Goathorn-Cabinet Creek confluence indicating a small number of steelhead trout are present to at least 10 km upstream in

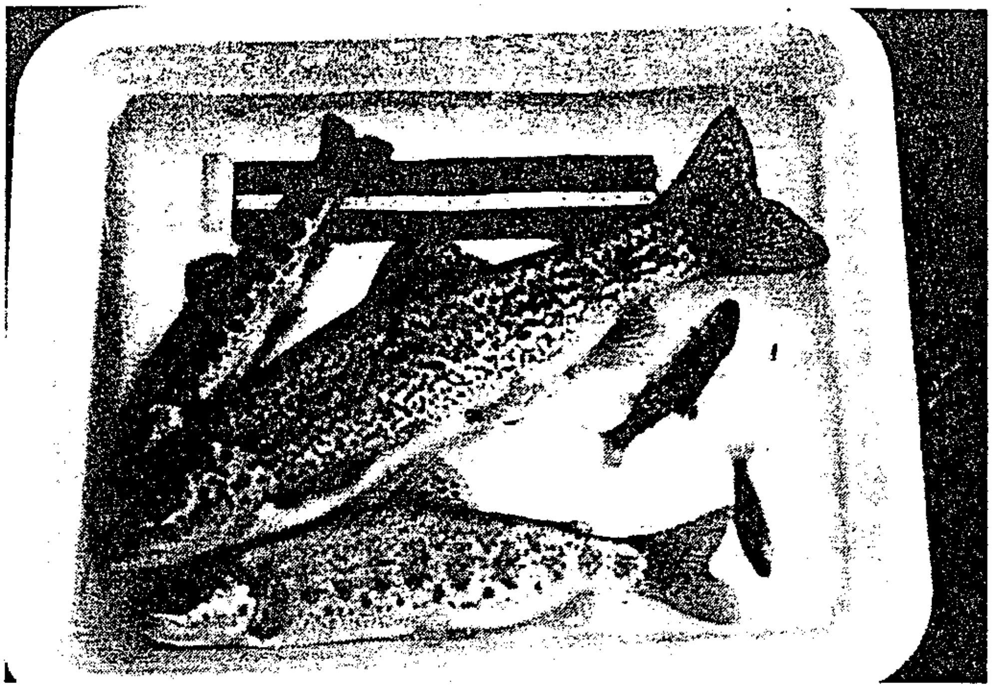


Figure 3.13 Juvenile steelhead trout were the predominant fish species captured in lower Goathorn Creek and Tenas Creek. Some of the larger individuals may be resident rainbow trout.

Figure 3.14 Dolly Varden char dominate fish populations in upper Goathorn and Tenas Creeks. This fish is sexually mature at 20 cm fork length.

Goathorn Creek. No steelhead trout were captured at the Cabinet Creek site (G7).

Site G3, located downstream of the existing mine site had a higher steelhead trout biomass than any of the other sites (Table 3.16), similar to the 1983 results. This site is more complex than the others sampled, and has an excellent pool with debris cover that provides habitat for larger juveniles. This may account for the higher biomass estimates obtained at this site.

Although overall fry densities were slightly lower in 1984 than in 1983, steelhead trout yearling (age 1+) and older parr ( age 2+) densities and biomass estimates combined for the 5 sites sampled in both years were very similar (Table 3.17).

Table 3.17 Summary of Steelhead Trout Density and Biomass Estimates for Goathorn Creek

| | Density (fish/m$^2$) | | | Biomass (g/m$^2$) | | |
|---|---|---|---|---|---|---|
| | 0+ | 1+ | ≥2+ | 0+ | 1+ | ≥2+ |
| 1983 | 0.14 | 0.03 | 0.02 | 0.12 | 0.20 | 0.63 |
| 1984 | 0.11 | 0.04 | 0.02 | 0.10 | 0.28 | 0.51 |

Population estimates have been derived by applying the catch per linear meter of stream sampled to the total stream length represented by each sample (Appendix 9.1). This results in an estimated 7,100 steelhead trout fry in Goathorn Creek, with 70% of this estimate located in the lowest 1 km of stream. As well, an estimated 3,700 steelhead parr (70% age 1+) were utilizing Goathorn Creek during the sample period. This compares with a modified estimate, (i.e., 1984 revised channel length) of 8,200 steelhead trout fry and 3,300 parr (61% age 1+) for 1983.

## Dolly Varden Char

The Goathorn Creek Dolly Varden char are a resident population of fish maturing at a small size and are typical of cold headwater streams as described in Scott and Crossman (1973). Ripe fish in the 150-210 mm fork length range have been found during both years of sampling (Figure 3.14). Larger Dolly Varden (40 cm or more fork length) are known to use lower Goathorn Creek on at least a seasonal basis (Bustard 1984a).

The 1984 sampling program indicated Dolly Varden char were utilizing the upper sections of Goathorn Creek to a greater extent than sites lower in the system (Table 3.16). Densities were highest at new sites established at the Goathorn-Cabinet Creek confluence and in Cabinet Creek. Dolly Varden char fry numbers were low at all sites sampled and were lower than those obtained in 1983. Older age class densities and biomass were very similar for the two years (Table 3.18).

Table 3.18 Summary of Dolly Varden Char Density and Biomass Estimates for Goathorn Creek

| | Density (fish/m$^2$) | | Biomass (g/m$^2$) | |
|---|---|---|---|---|
| | 0+ | > 1+ | 0+ | > 1+ |
| 1983 | 0.05 | 0.05 | 0.07 | 0.50 |
| 1984 | 0.03 | 0.05 | 0.04 | 0.51 |

This summary only includes sites G1 to G5, since these sites were sampled during both years. Density and biomass estimates at the two new upper sites were more than 4 times greater than the mean for the lower sites (Table 3.16).

Estimates derived from the 1984 data suggest a population of 2800 fry and 15,000 older age class fish compared to a modified 1983 estimate (i.e., revised 1984 channel length) of 3,900 fry and 5,800 older age class Dolly Varden char (Appendix 9.1). The 1984 estimates incorporate data from two new sites in the upper creek, and is probably more accurate. However, these numbers should be considered minimums, as there is considerable stream length, particularly in Cabinet Creek, that offers potential Dolly Varden char habitat (Figure 3.3). Since present use is unknown in these areas, they are not included in the system production estimate.

### 3.7.2 Tenas Creek

Approximately 1,350 m$^2$ of the lower two reaches of Tenas Creek were sampled in 1984. This comprised 207 m of stream length or just

Table 3.19 Summary of Fish Species and Age Class Composition for Two Years of Sampling in Tenas Creek

| | | Tenas Creek (Sites T1 to T3[1]) | | | |
|---|---|---|---|---|---|
| | | 1984 | | 1983 | |
| Species | Age | Number | % | Number | % |
| Steelhead Trout | 0+ | 232 | 56.3 | 701 | 76.8 |
| | 1+ | 104 | 25.2 | 99 | 10.8 |
| | >2+ | 35 | 8.5 | 45 | 4.9 |
| | | (371) | (90.0) | (845) | (92.5) |
| Dolly Varden Char | 0+ | 7 | 1.7 | 30 | 3.3 |
| | >1+ | 32 | 7.8 | 38 | 4.2 |
| | | ( 39) | ( 9.5) | ( 68) | ( 7.5) |
| Mountain Whitefish | > 1+ | 2 | 0.5 | 0 | 0 |
| TOTAL | | 412 | 100 | 913 | 100 |
| Area Sampled (m²) | | 1,201 | | 1,154 | |
| Stream Length Sampled (m) | | 182 | | 189 | |

1 T4 is not included in this comparison since it was not included in the 1983 sampling program.

under 2% of the total 10.7 km of stream in the main fish-producing sections of Tenas Creek. The 1984 sample included an additional site in the lower section of Reach 2 (site T4) to provide a more representative sample of this section of stream.

The fish species and age class composition of the 3 sites in Tenas Creek that were also sampled in 1983 are summarized in Table 3.19. Similar to 1983, juvenile steelhead trout were the main species present in Tenas Creek and comprised 90% the estimated total juvenile fish population in the sample sites. The remainder of the catch was comprised of Dolly Varden char except for 2 mountain whitefish captured at the lowest site in Tenas Creek. Mountain whitefish were not captured in Tenas Creek in 1983. Total fish numbers in Tenas Creek in 1984 were less than one-half of those estimated in the 1983 samples. This was largely the result of a decline in the abundance of fry of both species. The sample area and stream length were similar for the two years.

A summary of fish density and biomass estimates for the 1984 sampling program is presented in Table 3.20 while the more detailed fish sampling results are provided in Appendix 8.2. Tenas Creek fish densities were highest at site T1 and declined as sampling proceeded upstream in a similar pattern to 1983. However, overall densities were less than one-half of those obtained in 1983, largely due to a sharp decline in fry numbers at both sites T1 and T2.

Total fish biomass ($g/m^2$) ranged from 1.4 to 2.8 $g/m^2$ in 1984 with a mean estimate approximately 20% less than 1983 levels. The mean biomass estimates for sites T1 to T3 combined were 2.4 $g/m^2$ and 1.9 $g/m^2$ in 1983 and 1984 respectively. Site T2 had the highest biomass levels, largely the result of good steelhead trout parr populations in this section of stream.

<u>Steelhead Trout</u>

Juvenile trout captured in Tenas Creek are assumed to be the progeny of steelhead trout spawners (Bustard 1984a). Juvenile steelhead trout densities were highest at the lowest site (T1), largely the result of fry densities of approximately 0.4 $fry/m^2$ (Table 3.20). Last year's fry densities at this site were 0.9 $fry/m^2$. Steelhead trout parr densities, particularly the older age class parr, were higher at T2 than at T1 during 1984. This is similar to 1983 and is probably a result of more habitat complexity, especially more pool habitat at site T2. Parr densities and biomass estimates combined for the three sites sampled for the two years were very comparable as shown in the Table 3.21.

Table 3.21 Summary of Steelhead Trout Density and Biomass Estimates for Tenas Creek

| | Density (fish/$m^2$) | | | Biomass (g/$m^2$) | | |
|---|---|---|---|---|---|---|
| | 0+ | 1+ | >2+ | 0+ | 1+ | >2+ |
| 1983 | 0.48 | 0.07 | 0.03 | 0.50 | 0.46 | 0.72 |
| 1984 | 0.14 | 0.08 | 0.03 | 0.11 | 0.48 | 0.60 |

A small number of steelhead trout fry were again present at site T3, over 10 km upstream on Tenas Creek, indicating that some steelhead trout utilize the top section of Tenas Creek. Several steelhead trout parr were also captured at this site in 1984.

Fish population estimates have been derived for Tenas Creek based on catch per linear meter and stream length represented by each sample (Appendix 9.2). The Tenas Creek fry population estimates were 8,400 fry compared to 33,500 in 1983. Nearly all of these fry (99%) were located in the lowest 6 km of Tenas Creek. Steelhead trout parr estimates were 7,700 and 8,100 fish for 1984 and 1983 respectively. The 1983 estimates have been revised from those presented in Bustard (1984a) to incorporate better estimates of reach lengths derived in 1984. The 1984 estimates incorporate data collected at an additional site (T4) and therefore provide a better estimate of steelhead trout production.

## Dolly Varden Char

Tenas Creek Dolly Varden char are typically small resident fish similar to those described in the Goathorn Creek section. Densities are higher in the upper system (Reach 2) than at downstream sites (Table 3.20). Fry densities were less than 0.1 fish/$m^2$ at all sites and mean fry and older age class densities were both lower than in 1983 (Table 3.22).

Table 3.22 Summary of Dolly Varden Char Density and Biomass Estimates for Tenas Creek

| | Density (fish/m$^2$) | | Biomass (g/m$^2$) | |
|---|---|---|---|---|
| | 0+ | >1+ | 0+ | >1+ |
| 1983 | 0.05 | 0.06 | 0.05 | 0.69 |
| 1984 | 0.01 | 0.04 | 0.01 | 0.56 |

Fry densities at the new site (T4) were higher than other sites but older age class Dolly Varden char densities were lower than at site T3 located upstream (Table 3.20).

Estimates derived for 1984 (Appendix 9.2) suggest a population of approximately 2,000 fry and 3,500 older age class Dolly Varden char compared to a modified estimate (i.e., revised 1984 channel length) of 3,100 fry and 3,400 older age class fish derived in 1983. These estimates are probably low since at least 3 km of potential fish habitat upstream of Reach 2 are not included in the production figures.

### 3.7.3 Telkwa River

Approximately 2,100 m$^2$ of main and side channel habitat was sampled in the Telkwa River downstream of the Goathorn Creek confluence (Figure 2.1). The sites included 152 m of side channel and 129 m of main channel margin. The sample sites comprised less than 1% of the total channel length in this section of the Telkwa River. In total, 20% more area was sampled in 1984 than in 1983, largely the result of increasing the area sampled at SC2.

Steelhead trout juveniles comprised 79% of the 660 juvenile fish estimated in the sample site (Table 3.23). The remainder of the sample was comprised of coho salmon (11%), mountain whitefish (7%), chinook salmon (2%), and Dolly Varden char (1%). A single longnose dace was captured in SC1. Overall fish numbers were 18% lower in 1984, despite sampling more area. Steelhead trout fry and mountain whitefish numbers were less than one-half of the 1983 totals while steelhead trout parr (particularly age 1+ fish) and juvenile coho salmon numbers were more than double the 1983 totals. As well, more chinook salmon fry were captured in the Telkwa River in 1984 at sites up to 4 km upstream of the Bulkley River confluence.

Table 3.23 Summary of Fish Species and Age Class Composition for Two Years of Sampling in the Lower Telkwa River (Combined Side and Main Channel Sites)

| Species | Age | 1984 Number | 1984 % | 1983 Number | 1983 % |
|---|---|---|---|---|---|
| Steelhead Trout | 0+ | 255 | 38.6 | 535 | 66.7 |
| | 1+ | 213 | 32.3 | 75 | 9.4 |
| | >2+ | 56 | 8.5 | 42 | 5.2 |
| | | (524) | (79.4) | (652) | (81.2) |
| Coho Salmon | <1+ | 75 | 11.4 | 34 | 4.2 |
| Chinook Salmon | 0+ | 11 | 1.7 | 1 | 0.1 |
| Mountain Whitefish | 0+ | 43 | 6.5 | 105 | 13.1 |
| | >1+ | 2 | 0.3 | 3 | 0.4 |
| | | ( 45) | ( 6.8) | (108) | (14.0) |
| Dolly Varden Char | >1+ | 4 | 0.6 | 7 | 0.9 |
| Longnose Dace | | 1 | 0.1 | 0 | 0 |
| TOTAL | | 660 | 100 | 802 | 100 |
| Area Sampled ($m^2$) | | 2,089 | | 1,812 | |
| Stream Length Sampled (m) | | 281 | | 237 | |

A summary of fish densities and biomass estimates for main and side channel sites is presented in Tables 3.24 and 3.25, while the more detailed results are presented in Appendix 8.2. Overall fish density estimates in side channels (1.0 fish/$m^2$) were more than three times the estimates obtained in main channel locations (0.3 fish/$m^2$). This difference was largely the result of very high numbers of fish in SC3, a small side channel with high juvenile coho salmon densities. Biomass estimates were also higher in side channels (2.4 g/$m^2$) compared to main channels (1.4 g/$m^2$). If results from SC3 were not included in the totals, then both the biomass and density estimates for the remaining two side channels were similar to main channel results.

The 1984 density and biomass estimates in Telkwa River side channels were more than twice those obtained in 1983, largely the result of SC3 which had biomass estimates 4 times as high as in 1983. Main channel densities were slightly lower in 1984 (0.3 fish/$m^2$ compared to 0.4 fish/$m^2$) reflecting fewer steelhead trout fry, but biomass estimates were slightly higher due to more steelhead trout parr (1.4 g/$m^2$ compared to 1.2 g/$m^2$ in 1983).

Steelhead Trout

Steelhead trout fry comprised 49% of the 524 steelhead trout juveniles sampled in the Telkwa River in 1984 (Table 3.23). Steelhead trout fry were present in all sites but one main channel location (Tables 3.24 and 3.25). As in 1983, highest fry densities occurred in SC3, a small side channel with heavy debris cover. Nearly 80% of the 213 steelhead trout parr sampled were age 1+. Steelhead trout parr numbers were again highest at MS7 and MS1 (Table 3.25), two main channel sites with clean cobble substrate. There was little difference in fry and parr densities between side and main channel locations (Table 3.24 and 3.25).

A summary of juvenile steelhead trout density and biomass estimates combined for all sites in the Telkwa River is shown in Table 3.26.

Table 3.26 Summary of Steelhead Trout Density and Biomass Estimates for the Telkwa River

| | Density (Fish/$m^2$) | | | Biomass (g/$m^2$) | | |
|---|---|---|---|---|---|---|
| | 0+ | 1+ | > 2+ | 0+ | 1+ | >2+ |
| 1983 | 0.32 | 0.04 | 0.02 | 0.28 | 0.21 | 0.46 |
| 1984 | 0.20 | 0.08 | 0.02 | 0.16 | 0.44 | 0.52 |

Steelhead trout fry densities in the Telkwa River (0.2 fry/$m^2$) in 1984 were slightly less than in 1983 (0.3 fry/$m^2$). Age 1+ steelhead trout parr densities were double the 1983 estimates while older age classes of steelhead trout had similar densities during the two years. Biomass estimates showed a similar pattern of lower fry and higher yearling biomass.

Population estimates derived for the 8 km of main channel and approximately 13 km of productive side channel habitat in the Telkwa River suggest a population of 26,000 fry and 25,000 parr (Appendix 9.3). This compares to an estimated 63,000 fry and 15,000 parr calculated for 1983. Steelhead trout production is spread equally between main and side channel areas. Side channels may account for less production than indicated in this estimate, since wetted channel lengths were evaluated during August flows. Many of these channels may not provide productive salmonid habitat during the lower flow late winter period.

Coho Salmon

Juvenile coho salmon had a limited distribution in the lower Telkwa River, although their numbers were more than double those obtained in 1983 (Table 3.23). They were present in low numbers at 3 of the 7 main channel sites and in all of the side channel locations except SC3 where high densities of juvenile coho salmon were present. This small channel has low water velocities and abundant debris cover, providing excellent coho salmon habitat away from the mainstem river. All but 5 of the 75 juvenile fish captured during the 1984 sampling program were age 0+ fish.

Minnow trapping at 5 wetland sites in the lower Telkwa River indicated that coho salmon do not presently use these sites (Appendix 10). Several of these wetlands offer excellent potential

Table 3.24 Juvenile Salmonid Densities and Biomass Estimates at Three Sample Sites in Telkwa River Side Channels, September 1984

DENSITY ESTIMATES (Fish/m$^2$)

| Site | Steelhead Trout 0+ | Steelhead Trout 1+ | Steelhead Trout >2+ | Coho Salmon <1+ | Chinook Salmon 0+ | Mountain Whitefish 0+ | Mountain Whitefish >1+ | Longnose Dace | Total |
|---|---|---|---|---|---|---|---|---|---|
| SC1 | 0.13 | 0.15 | 0.02 | <0.01 | 0.02 | 0.05 | <0.01 | <0.01 | 0.37 |
| SC2 | 0.05 | 0.08 | 0.03 | 0.01 | <0.01 | 0.01 | 0.00 | 0.00 | 0.18 |
| SC3 | 0.52 | 0.00 | 0.00 | 1.85 | 0.00 | 0.00 | 0.00 | 0.00 | 2.37 |
| Mean | 0.23 | 0.08 | 0.02 | 0.62 | 0.01 | 0.02 | <0.01 | <0.01 | 0.97 |

BIOMASS ESTIMATES (g/m$^2$)

| Site | Steelhead Trout 0+ | Steelhead Trout 1+ | Steelhead Trout >2+ | Coho Salmon <1+ | Chinook Salmon 0+ | Mountain Whitefish 0+ | Mountain Whitefish >1+ | Longnose Dace | Total |
|---|---|---|---|---|---|---|---|---|---|
| SC1 | 0.10 | 0.80 | 0.40 | 0.01 | 0.11 | 0.10 | 0.02 | 0.01 | 1.55 |
| SC2 | 0.04 | 0.47 | 0.62 | 0.03 | 0.02 | 0.02 | 0.00 | 0.00 | 1.20 |
| SC3 | 0.41 | 0.00 | 0.00 | 4.06 | 0.00 | 0.00 | 0.00 | 0.00 | 4.47 |
| Mean | 0.18 | 0.41 | 0.34 | 1.37 | 0.04 | 0.04 | 0.01 | <0.01 | 2.41 |

SC1 – Medium (Mean width – 7.1 m)
SC2 – Large (Mean width – 15.2 m)
SC3 – Small (Mean width – 1.3 m)

Table 3.25 Juvenile Salmonid Densities and Biomass Estimates at Seven Sample Sites in the Telkwa River Main Channel, September 1984

DENSITY ESTIMATES (Fish/$m^2$)

| Site | Steelhead Trout 0+ | Steelhead Trout 1+ | Steelhead Trout >2+ | Coho Salmon <1+ | Dolly Varden Char >1+ | Mountain Whitefish 0+ | Mountain Whitefish >1+ | Total |
|---|---|---|---|---|---|---|---|---|
| MS1 | 0.12 | 0.17 | 0.09 | 0.00 | 0.00 | 0.00 | 0.00 | 0.38 |
| MS2 | 0.14 | 0.05 | 0.03 | 0.02 | 0.00 | 0.01 | 0.00 | 0.24 |
| MS3 | 0.15 | 0.12 | 0.03 | 0.01 | 0.00 | 0.02 | 0.00 | 0.33 |
| MS4 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.07 |
| MS5 | 0.32 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.32 |
| MS6 | 0.23 | 0.06 | 0.02 | 0.00 | 0.00 | 0.03 | 0.00 | 0.34 |
| MS7 | 0.17 | 0.18 | 0.07 | 0.03 | 0.03 | 0.01 | 0.01 | 0.48 |
| Mean | 0.16 | 0.09 | 0.03 | 0.01 | < 0.01 | 0.01 | < 0.01 | 0.31 |

BIOMASS ESTIMATES (g/$m^2$)

| Site | Steelhead Trout 0+ | Steelhead Trout 1+ | Steelhead Trout >2+ | Coho Salmon <1+ | Dolly Varden Char >1+ | Mountain Whitefish 0+ | Mountain Whitefish >1+ | Total |
|---|---|---|---|---|---|---|---|---|
| MS1 | 0.10 | 0.89 | 2.36 | 0.00 | 0.00 | 0.00 | 0.00 | 3.35 |
| MS2 | 0.11 | 0.23 | 0.40 | 0.05 | 0.00 | 0.02 | 0.00 | 0.81 |
| MS3 | 0.14 | 0.58 | 0.52 | 0.03 | 0.00 | 0.04 | 0.00 | 1.31 |
| MS4 | 0.00 | 0.36 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.38 |
| MS5 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.20 |
| MS6 | 0.19 | 0.35 | 0.28 | 0.00 | 0.00 | 0.05 | 0.00 | 0.87 |
| MS7 | 0.15 | 0.89 | 1.38 | 0.05 | 0.42 | 0.01 | 0.14 | 3.04 |
| Mean | 0.13 | 0.47 | 0.71 | 0.02 | 0.06 | 0.02 | 0.02 | 1.42 |

habitat, particularly WL5 (Figure 3.9). The main factor limiting coho salmon use of these areas is probably lack of access from the main channel preventing recruitment of fish into them. Studies in an adjacent system (Bustard in prep.) indicated that wetland areas can provide very productive coho salmon rearing areas if they have a suitable water source and access to the main river for at least some period of the year.

Chinook Salmon

Chinook salmon fry comprised just under 2% of the 1984 sample. The 11 fry were captured at two side channel sites in the lower Telkwa River (Table 3.23). Only a single fry was captured in the 1983 sample. Although it is most probable that these fry move up into the Telkwa River from the Bulkley River, it is possible that a few pairs of chinook salmon spawners may utilize the Telkwa River for spawning during some years.

Dolly Varden Char

As in 1983, very low numbers of juvenile Dolly Varden char were captured in the lower Telkwa River. None of the four Dolly Varden char sampled were fry, indicating that this section of river is not important as a juvenile rearing area for this species.

Mountain Whitefish

Mountain whitefish were present in low densities at five main channel sites and in two side channels (Table 3.24 and 3.25). Total mountain whitefish numbers were lower in 1984 (45 fish) compared to 1983 (108 fish). They comprised just under 7% of the 1984 sample, and all but two of the fish sampled were fry. The largest decline from the 1983 totals occurred in the side channel locations.

### 3.7.4 Bulkley River

Four mainstem sites on the Bulkley River just downstream from Hubert Creek (Figure 2.1) were added to the 1984 sampling program. These sites are located near the proposed junction for the rail link between CNR's existing rail line and the mine site (Figures 1.2 and 3.15).

In total 247 $m^2$ of area and 86 m of river margin were sampled. The results are summarized in Table 3.27 while the detailed results are presented in Appendix 8.2. Juvenile steelhead trout (fry and parr) comprised 70% of the 60 fish captured at the sites. The remainder of the sample consisted of chinook salmon fry (27%) and mountain whitefish (3%).

Steelhead trout fry and parr densities were approximately 0.1 fish/$m^2$ (Table 3.27). Biomass estimates at the sites ranged from 1-2 g/$m^2$ with a mean of 1.5 g/$m^2$. The steelhead trout fry density estimates were similar to those reported in a 1982 study of the mainstem Bulkley River (Envirocon 1983), while parr density estimates are higher than the 0.02 parr/$m^2$ estimates reported. Chinook salmon densities of 0.06 fry/$m^2$ are identical to those obtained in the 1982 study.

### 3.7.5 Summary of Juvenile Fish Surveys

The results from the 1984 fish sampling program provide a second year of detailed juvenile fish distribution and abundance information for Goathorn and Tenas creeks and the lower Telkwa River. The results confirm the importance of these systems as rearing areas for juvenile steelhead trout, the predominant species present in all locations except upper Goathorn and Tenas creeks. As in 1983, coho and chinook salmon were present in low numbers in the study area, although their numbers were higher than in the previous year's sample. The higher coho salmon numbers may be a reflection of the good coho salmon spawning escapement into the Telkwa River in 1983. Juvenile salmon were not present at samples sites in Goathorn or Tenas creeks.

The results of the 1984 juvenile sampling program showed a number of similarities to the 1983 results. For example, species distributions within each system were very close to those determined in 1983. As well, the fish biomass and density estimates for the older age classes of fish were very comparable at most locations between the two years. A summary of overall density and biomass estimates is shown in Table 3.28.

Figure 3.15 This site on the Bulkley River just downstream of Hubert Creek provides rearing habitat for juvenile steelhead trout and chinook salmon.

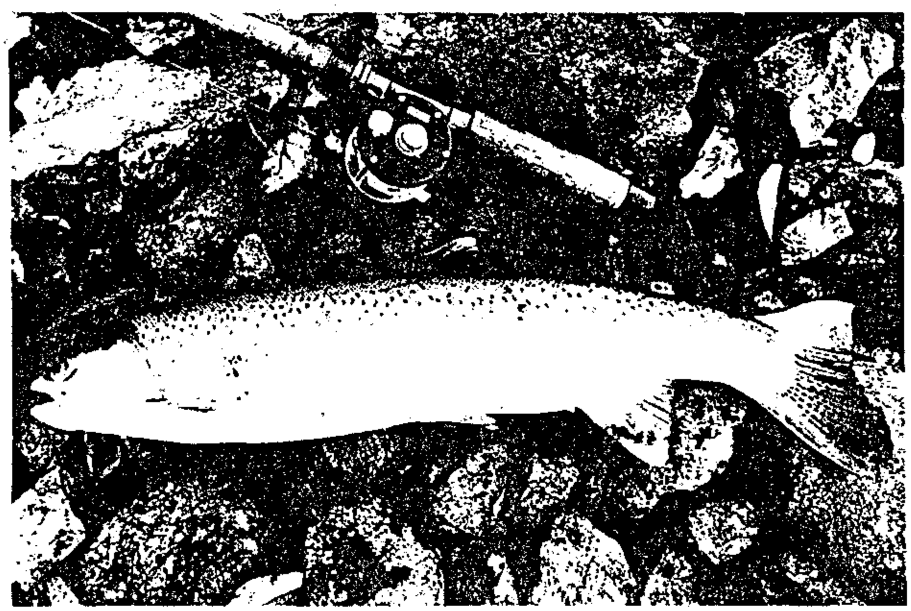


Figure 3.16 The sport fishery for Telkwa River steelhead trout occurs primarily in the Bulkley River.

Table 3.27 Juvenile Salmonid Densities and Biomass Estimates at Four Sample Sites in the Bulkley River, October 1984

DENSITY ESTIMATES (Fish/$m^2$)

| Site | Steelhead Trout | | | Chinook Salmon | Mountain Whitefish | | Total |
|---|---|---|---|---|---|---|---|
| | 0+ | 1+ | ≥ 2+ | 0+ | 0+ | ≥ 1+ | |
| B1 | 0.08 | 0.06 | 0.04 | 0.12 | 0.00 | 0.00 | 0.30 |
| B2 | 0.04 | 0.00 | 0.08 | 0.02 | 0.00 | 0.00 | 0.13 |
| B3 | 0.15 | 0.06 | 0.02 | 0.08 | 0.02 | 0.00 | 0.32 |
| B4 | 0.11 | 0.02 | 0.02 | 0.03 | 0.00 | 0.02 | 0.19 |
| Mean | 0.10 | 0.04 | 0.04 | 0.06 | 0.01 | 0.01 | 0.24 |

BIOMASS ESTIMATES (g/$m^2$)

| Site | Steelhead Trout | | | Chinook Salmon | Mountain Whitefish | | Total |
|---|---|---|---|---|---|---|---|
| | 0+ | 1+ | ≥ 2+ | 0+ | 0+ | ≥ 1+ | |
| B1 | 0.13 | 0.42 | 0.69 | 0.73 | 0.00 | 0.00 | 1.97 |
| B2 | 0.07 | 0.00 | 1.51 | 0.10 | 0.00 | 0.00 | 1.68 |
| B3 | 0.22 | 0.30 | 0.23 | 0.40 | 0.04 | 0.00 | 1.19 |
| B4 | 0.14 | 0.10 | 0.61 | 0.13 | 0.00 | 0.06 | 1.04 |
| Mean | 0.14 | 0.20 | 0.76 | 0.34 | 0.01 | 0.02 | 1.47 |

Table 3.28 Summary of Fish Production in the Study Area

| | | Goathorn Creek | Tenas Creek | Telkwa[1] River |
|---|---|---|---|---|
| Density (fish/m$^2$) | 1983 | 0.28 | 0.69 | 0.43 |
| | 1984 | 0.23 | 0.30 | 0.30 |
| Biomass (g/m$^2$) | 1983 | 1.5 | 2.4 | 1.3 |
| | 1984 | 1.4 | 1.9 | 1.4 |

[1]SC3 estimates have been excluded from the summary. Although this site comprised less than 2% of the sample area, it substantially altered estimates due to the method of calculating means.

This summary indicates that despite lower fish densities during 1984 in Goathorn Creek and in the Telkwa River, biomass remained near 1983 levels. Tenas Creek had the largest decline in both fish density and biomass, dropping to levels only slightly higher than the other systems. These results are very different from those obtained in 1983 that suggested Tenas Creek was considerably more productive than these other systems. Bulkley River main channel sites had comparable density (0.24 fish/m$^2$) and biomass (1.4 g/m$^2$) estimates to the other three systems (Table 3.27).

The most conspicuous difference in the results from the two years of fish sampling was the marked decline in numbers of steelhead trout fry present in 1984 compared to 1983. Overall fry numbers were approximately 50% of those obtained in 1983 with levels in Tenas Creek only 25% of the 1983 levels. At the same time, there was a 75% increase in age 1+ steelhead trout in 1984 reflecting good survival of the high numbers of fry present during 1983. Yearling numbers were most conspicuously higher in Telkwa River sites where estimates were double those determined for 1983.

The low steelhead trout fry numbers in 1984 compared to 1983 are in general agreement with adult spawner estimates for the Bulkley River and tributaries such as the Telkwa River. These estimates suggest that the 1982 steelhead trout escapement (i.e., the source of the 1983 fry recruitment) was higher than normal while the 1983 escapement (i.e., the source for 1984 fry recruitment) was low (Lough pers. comm. 1984). Data for the two years provide an indication of the variability that can exist within the fry population following high and low escapement years. The high 1983 fry numbers have been carried through to the yearling population of steelhead trout in the 1984 sample, while numbers of older age class steelhead trout parr ( 2+) have remained constant for the two years sampled. Juvenile fish surveys in other Bulkley River tributaries during 1984 have also shown this trend for low fry and high parr numbers (Lough pers. comm. 1984).

Similar to steelhead trout, Dolly Varden char populations in Goathorn and Tenas creeks also had poor fry recruitment in 1984. Fry numbers were approximately 50% of the 1983 levels while numbers of older age class individuals remained the same for the two sample years. Reasons for poor Dolly Varden char fry recruitment are not known.

Dolly Varden char populations in both Goathorn and Tenas creeks tended to be highest in those stream sections with low or no steelhead trout populations. Habitat characteristics of some of these sections such as in Reach 2 of Goathorn Creek appear similar (Figure 3.3), and the results suggest that Dolly Varden char may not compete successfully in those stream systems where juvenile steelhead trout are present. A similar pattern of Dolly Varden char juveniles utilizing those stream sections not utilized by juvenile steelhead trout and coho salmon has been observed in other Bulkley River tributaries (Envirocon 1981).

Juvenile steelhead trout were consistently smaller in 1984 compared to 1983 (Table 3.29). This pattern occurred in all of the systems and for all age classes, suggesting that growing conditions in the study streams were poor compared to 1983. Mean fork lengths for steelhead trout fry averaged nearly 7 mm less than during the same period in 1983. Fry in the 29-30 mm size range were captured during the late September sampling program suggesting that some emergence was still occurring up to this period. Small fry entering the winter period tend to have poorer overwinter survival than large fish. Size differences were not as great for Dolly Varden char fry, averaging 2 mm smaller in 1984 compared to 1983 (Table 3.29).

## 3.8 ESTIMATED ADULT STEELHEAD TROUT PRODUCTION

An estimate of the number of adult steelhead trout produced in Goathorn and Tenas creeks and the lower Telkwa River can be made by assuming survival rates from the parr to smolt stage and subsequently to returning adults (Table 3.30). It should be emphasized that these assumptions have limited application, since steelhead trout survival rates at various life history stages are dependent upon the particular characteristics of the system and vary from year to year. Nevertheless, these estimated survival rates do provide a method of making a rough approximation of adult populations of steelhead trout, a fish species that is very difficult to enumerate by other means.

These estimates suggest spawning populations in the order of 52 steelhead trout in Goathorn Creek, 107 in Tenas Creek and 347 in the lower Telkwa River (Table 3.30). The Goathorn and Tenas creek estimates are very similar to 1983 estimates while the Telkwa River estimates are 70% higher in 1984, largely the result of a large increase in the numbers of age 1+ steelhead trout.

The assumed 35% survival from parr to smolt stage may be high considering the preponderance of age 1+ fish classified as parr. However, this possible over-estimate may be offset by the tendency of juvenile steelhead trout to move downstream into larger systems as they grow. Some steelhead trout parr rearing in the Bulkley River are probably derived from populations originally spawned in Telkwa River tributary streams such as Tenas Creek.

These estimates assume a 2:1 ratio of intercepted fish to spawners. This means that for every one adult steelhead trout which spawns in the system, two adults are intercepted enroute to the spawning grounds, either in the commercial, Indian or sport fishery. Although angler harvest data indicate that typically less than 10 steelhead trout each year are harvested in the Telkwa River (Fish and Wildlife Branch 1970-1982), Telkwa River steelhead trout probably contribute significantly to the Bulkley River steelhead trout sport fishery. It is probable that most Telkwa River fish hold in the Bulkley River during the fall and winter period, and are available to anglers at this time (Figure 3.16). The Bulkley River and its tributaries supports one of the most intensive summer steelhead trout fisheries in British Columbia and is ranked in the top two rivers in

Table 3.29 Summary of Length and Age Data for Juvenile Steelhead Trout and Dolly Varden Char in Goathorn and Tenas Creeks and the Lower Telkwa River[1]

| | | Steelhead Trout | | | | | |
|---|---|---|---|---|---|---|---|
| | | 0+ | | 1+ | | ≥2+ | |
| | Age | 1984 | 1983 | 1984 | 1983 | 1984 | 1983 |
| Goathorn Creek | n | 378 | 470 | 138 | 107 | 48 | 58 |
| | % | 67.0 | 74.0 | 24.5 | 16.9 | 8.5 | 9.1 |
| | fl (mm) | 38.3 | 43.7 | 77.7 | 79.7 | 125.5 | 144.7 |
| Tenas Creek | n | 232 | 701 | 104 | 99 | 35 | 45 |
| | % | 62.5 | 83.0 | 28.1 | 11.7 | 9.4 | 5.3 |
| | fl (mm) | 38.0 | 45.1 | 78.5 | 83.2 | 123.2 | 126.1 |
| Telkwa River | n | 255 | 538 | 213 | 75 | 56 | 39 |
| | % | 48.7 | 82.5 | 40.6 | 11.5 | 10.7 | 6.0 |
| | fl (mm) | 37.8 | 45.5 | 76.2 | 82.6 | 126.6 | 132.9 |
| Total | n | 865 | 1,709 | 455 | 281 | 139 | 142 |
| | % | 59.3 | 80.2 | 31.2 | 13.2 | 9.5 | 6.7 |
| | fl (mm) | 38.1 | 44.8 | 77.2 | 81.7 | 125.3 | 135.6 |

1 These results are based only on those sites that were also sampled in 1983.

Table 3.29 Summary of Length and Age Data for Juvenile Steelhead Trout and Dolly Varden Char in Goathorn and Tenas Creeks and the Lower Telkwa River[1] (Cont'd)

| | | Dolly Varden Char | | | |
|---|---|---|---|---|---|
| | | 0+ | | > 1+ | |
| | | 1984 | 1983 | 1984 | 1983 |
| Goathorn Creek | n | 78 | 123 | 151 | 145 |
| | % | 34.1 | 45.9 | 65.9 | 54.1 |
| | fl (mm) | 47.8 | 50.7 | 100.0 | 100.9 |
| Tenas Creek | n | 7 | 30 | 32 | 38 |
| | % | 17.9 | 44.1 | 82.1 | 55.9 |
| | fl (mm) | 44.7 | 45.2 | 109.5 | 109.2 |
| Total | n | 85 | 153 | 183 | 183 |
| | % | 31.7 | 45.5 | 68.3 | 54.5 |
| | fl (mm) | 47.5 | 49.6 | 101.7 | 102.6 |

1 These results are based only on those sites that were also sampled in 1983.

Table 3.30 Estimated Adult Steelhead Trout Production in 1983 and 1984 Based on Steelhead Trout Parr Populations and Assumed Survival to Smolt and Adult Stages

| | | Estimated Parr Population[1] | Estimated Smolt Population[2] | Total Adult Production[3] | Estimated Spawner Population[4] |
|---|---|---|---|---|---|
| Goathorn Creek | 1983 | 3,289 | 1,151 | 138 | 46 |
| | 1984 | 3,735 | 1,307 | 157 | 52 |
| Tenas Creek | 1983 | 8,099 | 2,834 | 340 | 113 |
| | 1984 | 7,650 | 2,678 | 321 | 107 |
| Lower Telkwa River[5] | 1983 | 14,517 | 5,081 | 610 | 203 |
| | 1984 | 24,766 | 8,668 | 1,040 | 347 |
| TOTAL | 1983 | 25,905 | 9,066 | 1,088 | 362 |
| | 1984 | 36,151 | 12,653 | 1,518 | 506 |

1 See Appendix 9. 1983 estimates have been revised based on new habitat measurements derived in 1984 and reduced smolt survival estimates.

2 Assumes 35% survival parr to smolt (Tredger, 1982).

3 Assumes 12% survival from smolt to adult (Lough pers. comm. 1984).

4 Assumes a 2:1 interception ratio for adult fish (Lough pers. comm. 1984).

5 This estimate is for a combination of main and side channel habitat from Goathorn Creek to the Bulkley River.

the province in terms of angler-days expended in 1982 and 1983 (Billings 1982; 1983). The section of the Bulkley River in the vicinity and downstream of the Telkwa River confluence is one of the most heavily fished sections of the system (O'Neill and Whately 1984).

## 3.9 ADULT FISH SURVEYS

Adult fish surveys in 1984 focussed on aerial counts of coho salmon abundance and distribution to supplement information collected in 1982 (Bustard 1983). As well, Goathorn Creek was walked from the beaver dam barrier downstream to determine whether pink salmon were present in this section in 1984. No pink salmon were observed during this September 17 survey despite good visibility. Previous surveys (Bustard, 1984c) indicate small numbers of pink salmon use lower Goathorn Creek during years of high Bulkley River escapements. Pink salmon numbers in the Bulkley River were relatively low during 1984 (Fisheries and Oceans 1984), typical of even-year runs.

Local anglers report that Telkwa River coho salmon usually move upstream from mid-August through to the first week of September. The first coho salmon captured in the Telkwa River (near the CNR bridge) occurred on August 15 in both 1983 and 1984 (Fearnside pers. comm. 1984).

Aerial reconnaissance of the mainstem Telkwa River indicated coho salmon spawning at a number of locations between 30 km and 46 km upstream on the river (Figure 3.17). Totals of 75 and 104 adult coho salmon were observed on November 14th and 30th respectively (Appendix 11). This compares with a maximum count of 80 coho salmon counted in 1982 (Bustard 1983), another relatively poor year for coho salmon escapements in the Bulkley River and tributaries (Fisheries and Oceans 1984). The presence of unoccupied redd sites and the increased number of fish in the upper sections during the later survey suggest that a minimum of 250 coho salmon spawners were probably present in the upper section of the Telkwa River in 1984. Coho salmon spawning occurs over a long period from the end of October through December (Bustard 1983). Since ripening fish tend to hold under cover and in deeper pools, this estimate could easily be 50% lower than the actual number of fish present. The lack of carcasses observed suggests that spawning had not yet reached a

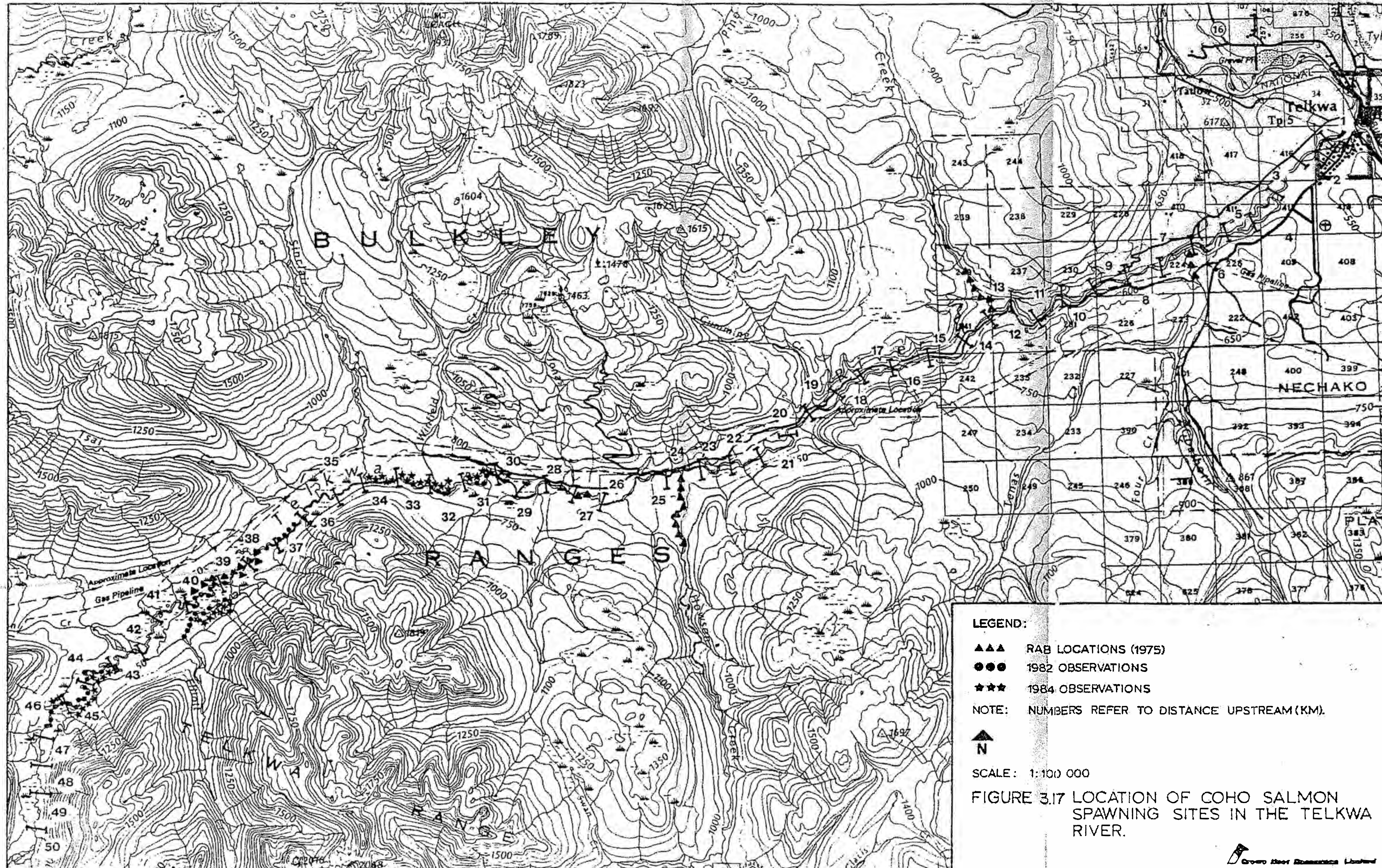



FIGURE 3.17 LOCATION OF COHO SALMON SPAWNING SITES IN THE TELKWA RIVER.

peak. Historical escapement estimates since 1960 have ranged from 100 to 1,200 fish annually (Hancock et al. 1983).

A 4-km section between Km 30-34 (Figure 3.17) had the highest spawner use based on counts during both flights. Previous surveys indicated heaviest use in the section located between Km 44-46 just upstream of Milk Creek (Bustard 1983).

An additional 22 and 13 coho salmon spawners were observed in Elliott Creek on November 14th and 30th respectively. The lower 1 km of this tributary had been previously identified as an important coho salmon spawning area based on the 1982 surveys.

Anchor and frazil ice were present throughout most of the Telkwa River during both surveys, particularly during the mid-November flight. Anchor ice was usually present in the faster riffle sections while frazil ice was most prevalent downstream of Howson Creek. Elliott Creek and the Telkwa River upstream of Milk Creek (Km 43) were ice-free. Coho salmon would be unable to spawn at locations with anchor ice present. As well, egg incubation would probably be impeded due to restricted subsurface flow in ice-covered areas.

The 1984 surveys confirm the importance of the upper Telkwa River for coho salmon spawning. The combination of low-gradient stream sections with suitable spawning gravel and ice-free conditions (probably groundwater-influenced), and abundant wetland rearing habitat for juveniles in this upper river section probably favours coho salmon use. Although sites lower on the river have potential, particularly in side channel locations, no adult use has been observed. Tributaries such as Goathorn and Tenas creeks have had extensive subsurface ice during both years of surveys, suggesting they are poor candidate streams for late fall spawning fish such as coho salmon.

## 3.10 METAL CONCENTRATIONS IN FISH TISSUE

Results of analyses of concentrations of seven metals in the muscle tissue of 30 fish taken from Goathorn and Tenas creeks are summarized in Table 3.31. Detailed results for each fish are presented in Appendix 12.1 with results of an additional 17 elements (including metals) analyzed in the fish tissue also summarized in Appendix 12.2. Measurements of metal concentrations in a single

Table 3.31 Summary of Fish Tissue Metal Analyses and Comparison to Results from Other Studies

| | | µg/g dry weight | | | | | | |
|---|---|---|---|---|---|---|---|---|
| System | Species | As | Cd | Cu | Pb | Zn | Fe | Al |
| Goathorn (G2) | Steelhead Trout | 0.07 | 0.14 | 2.0 | 0.20 | 31.4 | 45.5 | 7.5 |
| Goathorn (G5) | Dolly Varden Char | 0.06 | 0.13 | 1.7 | <0.10 | 31.8 | 24.2 | 1.5 |
| Tenas (T2) | Steelhead Trout | 0.06 | 0.06 | 1.6 | 0.12 | 31.3 | 25.2 | 4.3 |
| Foxy Ck[1] | Rainbow Trout | <0.10 | <0.10 | 2.6 | 0.13 | 32.2 | ---- | --- |
| Buck Ck[2] | Steelhead Trout | 0.11 | <0.10 | 2.2 | 0.17 | 31.2 | ---- | --- |
| Aldrich Lk[3] | Cutthroat Trout | <26. | <1. | <1. | <10. | 30.1 | 21.0 | <2. |
| McQuarrie Lk[4] | Rainbow Trout | 22. | 1. | 2. | 10. | 22. | 46. | 2. |
| Lower Fraser River[5] | Rainbow Trout | ---- | 0.2-0.3 | 0.7 | 0.2 | 5.0 | 5.9 | --- |
| Lower Fraser River[5] | Dolly Varden Char | ---- | 0.2-0.3 | 0.6 | 0.2 | 4.9 | 4.3 | --- |

1 Based on 10 samples collected in lower Foxy Creek during August 1982 (Data courtesy Equity Silver Mines Ltd., Houston, B.C.)

2 Based on 10 samples collected in Buck Creek downstream of Goosly Lake during August 1982 (Data courtesy of Equity Silver Mines Ltd., Houston, B.C.)

3 MacLean (1983)

4 Fish and Wildlife Branch (1984). Based on average from 4 fish

5 Northcote et al. (1975) - expressed as ppm wet weight

fish at site T2 have been excluded from the summary due to unusually high levels of iron and aluminum possibly a result of sample contamination (Appendix 12.1).

Levels of arsenic, copper and zinc are very similar in fish taken from all three sites regardless of species (Table 3.31). Tenas Creek fish had slightly lower levels of cadmium than Goathorn Creek fish. As well, fish taken from the lower site on Goathorn Creek (G2) had higher levels of lead, iron and aluminum than fish taken at other sites. These differences are minor and are not reflected in water quality samples taken at corresponding sites. However, total concentrations of a metal in water samples may not accurately reflect the biological availability of a particular metal.

Dolly Varden char sampled in upper Goathorn Creek had lower levels of lead, iron, and aluminum than steelhead trout parr taken downstream. Differences in metal accumulation rates between these two fish species have not been identified in other studies. Northcote et al. (1975) found generally similar levels of copper, zinc, and iron in the two species sampled in the Fraser River (Table 3.31), but the Dolly Varden char sample size was small. Diet studies (Section 3.4) suggest that both species rely heavily upon aquatic invertebrates for food, suggesting that the major source of metals (through the food items they ingest) should be similar.

Metal concentrations in the muscle tissue of Goathorn and Tenas creek fish are generally similar to those levels reported in trout species in Foxy and Buck creeks, two other tributary streams of the Bulkley River (Table 3.31). Zinc and iron levels were similar to those obtained in nearby Aldrich Lake (MacLean 1983). Rainbow trout from McQuarrie Lake in the upper Bulkley River watershed had similar levels of copper in their muscle tissue but higher iron and lower zinc levels than fish from the study streams (Table 3.31). Analyses of other metals in Aldrich and McQuarrie lakes were not to sufficient detection levels to enable comparisons. The concentrations of copper, zinc and iron in fish muscle tissue at all sites in this study were considerably higher than levels found in lower Fraser River fish (Table 3.31). The copper levels were lower than levels found in rainbow trout from Okanagan Basin lakes, an area of high copper mineralization, while zinc levels were higher (Northcote et al. 1972). The concentration of metals in this study were within the range of those reported by Reeder et al. (1979) for fish from a number of locations in Canada (aluminum and iron were not included in their review). The concentrations of cadmium, zinc and copper were in the upper range of their reported levels. Results from a broad study of metal concentrations in fish in B.C. lakes (Peterson et al. 1970) were not comparable since nearly all results are for liver tissue. Fish sampled in this study were too small to provide adequate liver samples for analyses.

The analyses in this study provide a base-line range of heavy metal concentrations to which any future environmental contamination involving these metals can be compared. The apparent acclimation of fish to sub-lethal levels of some metals (Alderdice and MacLean 1982) suggests that it is most meaningful to compare metal levels within one system over time rather than establishing threshold levels based on studies conducted within other watersheds.

# 4. IMPACT ASSESSMENT

The Stage I application (CNRL 1983) identified four potential impacts of the proposed Telkwa Coal Project on the aquatic resources in the study area. These included:

1) The potential for acid mine drainage and associated heavy metal mobilization in surface water and groundwater exists at the Telkwa Property due to the high pyritic sulphur content of some of the coal seams.

2) Increased sedimentation of streams due to surface disturbance, diversion channels, waste rock disposal, coal washing processes and road construction could impact aquatic resources.

3) Water removal from streams for mine requirements during lower flow periods might affect fish populations.

4) The access corridor to the minesite may affect aquatic resources depending on the route selection and construction techniques.

Subsequent to the Stage I application, the above concerns have been addressed by additional studies. The following sections describe the more detailed assessment of these potential impacts in light of the additional information now available.

Experience at some coal mines in southeast British Columbia suggests that leaching of nitrogen from the incomplete combustion of explosives could impair aquatic life due to elevated levels of nitrate, nitrite, and ammonia to toxic levels (Pommen 1983), and to excessive algal growth when combined with phosphorus loading from sewage or reclamation programs (Nordin 1982). Since the proposed mining process at the Telkwa Project will not include the extensive use of explosives, elevated nitrogen levels due to incomplete combustion of explosives should not be a significant factor.

## 4.1 ACID MINE DRAINAGE

Acid generation and associated mobilization of heavy metals can result from the oxidation of sulphide minerals in waste rock in the presence of air and moisture. The effects on aquatic life of increased acidity and exposure to abnormally high concentrations of heavy metals has been studied extensively as reviewed in Baker (1982), Wood and McDonald (1982) and Alderdice and McLean (1982).

Much of this work has focused on the sublethal deleterious effects on reproduction (including embryonic development), osmoregulation, and effects on oxygen uptake and transport.

Evaluations undertaken since the Stage I assessment indicate that the potential for acid generation does exist in some strata at the Telkwa Property. However, careful material handling to ensure that potentially acid-toxic materials are neutralized by carbonate rich materials as well as the existing high buffering capability of the surface waters and groundwater of the project area should minimize the potential for acid generation from the mine's operation (Sturm Environmental Services 1985). Based on these assessments, the potential threat of increased acidity and metal mobilization to aquatic organisms within the study area should be minimal.

## 4.2 STREAM SEDIMENTATION

Sediment inputs from the mine and waste dumps, plant operation, and associated road and channel developments (Figure 1.2) could affect various aspects of aquatic resources in the project area. A number of studies have reviewed the detrimental impacts of sediment on the spawning and rearing environment of salmonids and their food sources (Phillips 1971; Hynes 1970; Slaney et al. 1977; Bjornn et al. 1977; Cederholm and Salo 1979).

Most of the streams in the study area, particularly the Telkwa River, presently have high suspended sediment loads during the snowmelt run-off period and during periods of heavy rainfall. Over time, aquatic organisms tend to adapt to these patterns, but sediment introductions at other periods may be harmful. For example, Noggle (1978) demonstrated a 20-fold change in the tolerance of salmonids to suspended sediment depending on the season, with least tolerance occurring during the summer period.

The stream gradient and magnitude of flow fluctuations play a large role in a system's capability to tolerate sediment inputs. Cederholm and Salo (1979) found that stream systems with a gradient less than

2% and characterized by large organic debris accumulations can retain sediments in the substrata for long periods of time. High maximum-minimum flow ratios tend to flush fine materials through a system in a short period. The fish-producing sections of Goathorn and Tenas creeks downstream of the proposed mine activity have a 2-3% gradient (Figures 3.3 and 3.8) but a relatively low maximum-minimum flow ratio of approximately 20:1 compared to estimates of 400-500:1 in coastal systems where these comparisons are made. The slopes of Hubert and Helps creeks are less than 1% in the lower reaches, but 1-3% in the main fish-producing sections upstream (Figure 3.12).

Much of the Telkwa Project is located on relatively flat topography suited for the construction of headwater diversion channels and interceptor ditches to minimize the contamination of surface water in the mine area. As well, potentially contaminated water will be directed into settling ponds constructed at five locations in the project area, and this procedure should keep sediment production to a minimum. It is anticipated that some fine silts and clays may be released from the ponds. The proposed layout of the drainage system and settling ponds is presented in Klohn Leonoff Ltd. (1985).

At present, drainage from different aspects of the mine's operation flows into a number of systems with varying sensitivity to sediment introduction. Since the detailed mine and water management plans are not fully complete at this time, the following comments on the potential for sediment production and the sensitivity of various receiving waters (as perceived from the aquatic resource standpoint) to sediment are subject to revision based on future mine planning.

1) Interceptor ditches associated with Pits 1 and 2 and most of Pit 3 convey water into Settling Pond #2 and then via a spillway into Goathorn Creek. Consideration should be given to directing the water from this pond directly into the wetland area of the Telkwa River (designated WL1a and WL1b on Figure 3.9). These wetlands are not utilized by fish and could serve as an excellent back-up settling system. Much of this drainage area has historically flowed directly into the Telkwa wetlands via an ephemeral stream.

2) Drainage from Pits 4, 5 and 6, and from the west waste dump is into Settling Ponds #3 and #4 and then into Goathorn Creek via culverts to prevent erosion on the steep valley wall. Any of the finer component of sediment material introduced into this section of Goathorn Creek would probably by carried through this fairly high-energy system into the Telkwa River and subsequently down to the Bulkley River. In addition to having some implications to aquatic life downstream of the source area, there could be a deterioration of water clarity for the Bulkley River sports fishery if adequate controls were not undertaken in upstream areas. Particular care should be directed towards Pits 4 and 5, as they are located alongside the steep valley wall and there is greater difficulty in handling surface drainage at these sites. As well, care in preventing erosion from any portion of Pit 3 that extends below the topography break will be required.

   The main haul road and crossing structure on Goathorn Creek will have to be designed to ensure that erosion is kept to a minimum and that fish movements upstream are not impeded. Goathorn Creek should be considered moderately sensitive to sediment inputs relative to other receiving waters in the study area.

3) A headwater diversion ditch around the western operations is proposed to drain into Tenas Creek. This will result in a 2% increase in the Tenas Creek catchment area. Although diversion ditches will be armoured and are designed to be non-erodible during peak flows, particular care will have to be exercised in developing the ditch down the valley wall of Tenas Creek. This creek is an important steelhead trout spawning and rearing area. If the option is available, drainage from the headwater areas should be directed towards Goathorn Creek and away from the more sensitive Tenas Creek system.

4) Drainage from the proposed east waste dump and from the mine plant tailings system is into Helps Creek, a tributary of Hubert Creek. Although the waste dump itself is located just upstream of fish habitat, the associated ditching and Settling Pond #1 are located in an area that may be presently utilized by cutthroat trout, and there could be some impact on any fish presently spawning and rearing in this area. The extent of

fish use of this section has not been evaluated in detail to date. As well, spawning areas in Reach 1 and 2 above Helps Lake (Figure 3.12) are susceptible to possible sediment introduction from the waste dump or from the tailings dam. The extensive wetland ponds located from Helps Lake downstream would probably serve as sediment settling areas protecting downstream sites utilized by coho salmon and steelhead trout.

5) Drainage from an interceptor ditch around the plant site is through Settling Pond #5 and then towards the Telkwa River through an area of relatively low sensitivity. As well, an emergency spillway from the tailings dam would drain into this channel.

## 4.3 WATER REMOVAL FOR MINE REQUIREMENTS

Infiltration galleries or shallow wells located on the Telkwa River bottomlands (Figure 1.2) will be used to collect water needed for the mine's operation. Estimated maximum mine requirements (i.e., peak make up water demand) is expected to be only 1% of the 10-year extreme minimum daily flow (Klohn Leonoff Ltd. 1985). The proposed site for the make-up water intake system is near a relic channel of the Telkwa River (designated 50R on Figure 3.9). This channel is not suitable for fish use.

It is recommended that water removal be minimized during the late winter period (February to mid-April) when streamflows are lowest in the Telkwa River. During low flow years, discharge in the Telkwa River can drop below 1 $m^3$/sec (CNRL 1983) and water removal during this period could accentuate dewatering in side channels located downstream. Removal of water at other periods should pose no problems to the aquatic resources of the Telkwa River. Infiltration galleries located on the Telkwa River are preferrable to water removal from Goathorn Creek which presently experiences very low flows during the winter period.

## 4.4 ACCESS ROUTE ASSESSMENT

The Stage I application (CNRL 1983) identified two alternative corridors to move coal from the mine site to the existing CN rail line.

One corridor ran north from the mine and required a crossing of the Telkwa River and the other ran east in the vicinity of Hubert Creek. Preliminary analysis of potential impacts suggested an easterly route would be more favourable (CNRL 1983).

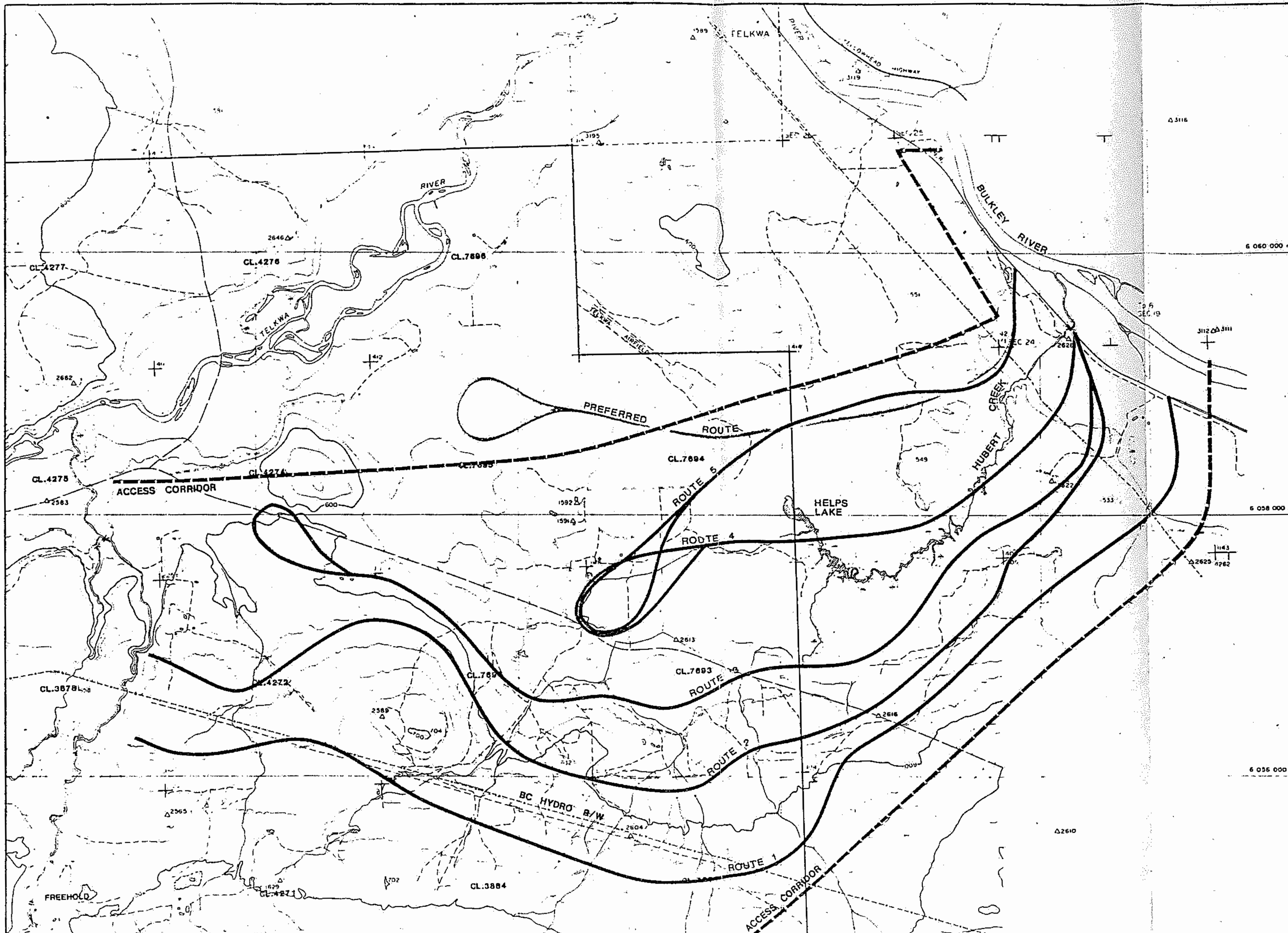
Since this early assessment, the proposed location of the plant site has been relocated further to the northeast of the property than in the earlier proposals. Six alternate routes for a rail spur line were considered in the east corridor (Figure 4.1). The preferred route is also shown on the proposed mine layout (Figure 1.2).

Preferred Route - This route avoids crossing any fish-bearing streams. Its location away from streams should help to minimize sediment from construction and eliminate any interference with fish movements in Hubert Creek and tributaries. For these reasons, this route is considered the best option from the aquatic resource perspective. The one area that would require special care during construction is that portion of the route located immediately adjacent to the Bulkley River at the junction of the spur and main rail line. Care should be taken to avoid introducing sediment into the Bulkley River at this point, and the new grade should be cut back from the existing line to avoid any encroachment on the river. This is a good steelhead trout holding area and pink salmon are known to spawn in the Bulkley River at this location. As well, fish sampling indicates that juvenile steelhead trout and chinook salmon rear along the river's edge in this section.

Alternate Routes 1-3 - These three routes all run south and east of Hubert Creek and join the main rail line just east of the existing crossing of Hubert Creek. Sampling undertaken in 1983 (Bustard 1984a) indicate that fish (mainly cutthroat trout) use Hubert and Helps creeks to approximately the B.C. Hydro right-of-way. Route 1 crosses these tributaries upstream of the area of fish use while Routes 2 and 3 cross these streams in at least three locations that would require structures capable of passing fish upstream. Route 3 crosses at locations suspected to be used by spawning cutthroat trout. These three routes are considerably longer than other options, and potential for sediment production at numerous small stream crossings is greater than with other route options.

Alternate Route 4 - This route crosses Helps Creek at three locations and involves loading facilities located adjacent to cutthroat trout spawning areas in Helps Creek. Stream crossings, particularly in the Helps Lake area and in lower Helps Creek would require bridges. Extensive beaver activity in the low gradient sections of this creek would make culverts inoperable at crossing sites. Route 4 is the poorest access route option.

Alternate Route 5 - This route crosses Helps Creek upstream of the lake and then avoids any further stream crossings, staying to the north of Hubert Creek. The main concern with this route is that the rail loop and plant site would be located in the vicinity of a cutthroat trout spawning area on Helps Creek.




Crows Nest Resources Limited

ALTERNATE RAIL ACCESS ROUTES TO THE TELKWA COAL PROPERTY

FIGURE 4.1

## 5. ENHANCEMENT AND MITIGATION OPTIONS

A number of enhancement opportunities to increase production of fish above present levels exist within the study streams. These proposals are outlined as enhancement options but could be considered mitigation if impacts of the proposed mine were identified and realized at some future date. Steelhead trout enhancement is emphasized in Goathorn and Tenas creeks while the lower Telkwa River has opportunities for steelhead trout and coho salmon enhancement. Coho salmon are the most appropriate target species for any enhancement in Hubert Creek.

### 5.1 GOATHORN CREEK

The two main options considered for enhancing steelhead trout populations in Goathorn Creek are steelhead trout fry plantings upstream of Reach 1 and stream fertilization.

#### 5.1.1 Steelhead Trout Fry Plantings

Goathorn Creek has little spawning habitat upstream of the lowest 6 km. The substrate is typically a mix of cobble and small boulder, ideal for juvenile steelhead trout rearing, but with very little spawning gravel area. Higher fry densities in the lower reach (probably resulting from recruitment from Tenas Creek) suggest that the stream is capable of rearing steelhead trout juveniles, but lacks fry recruitment upstream of the Tenas Creek confluence.

A program of releasing fed steelhead trout fry into upper Goathorn and Cabinet creeks could lead to a considerable increase in fish production within the system. These fry would be derived from adult steelhead trout captured in the lower creek system, with the young fish hatched in a facility (possibly in conjunction with an on-going Salmonid Enhancement Program using a hatchery located at Toboggan Creek). Fed fry would be the most appropriate to release into Goathorn and Cabinet creeks since these systems lack shallow marginal sites suitable for rearing newly-emerged fry.

Estimates derived in this study (Figure 3.3) suggest that up to 23 km of Goathorn and Cabinet creeks would be suitable for steelhead fry plantings. Presently, slightly more than 1 km appears to be adequately seeded.

The upper Goathorn Creek Dolly Varden char population may pose a potential predator problem to these fry plantings (Horner and Bjornn 1976). Previous steelhead fry plantings in systems with Dolly Varden char populations have met with mixed success in two nearby stream systems. Plantings of steelhead trout fry in Passby Creek in the upper Zymoetz River (Figure 1.1) appear to have been successful while plantings in upper Gosnell Creek in the Morice River have not done well based on preliminary evaluations (Lough pers. comm. 1984). It is not known whether lack of success in upper Gosnell Creek is related to interactions with Dolly Varden char.

Some in-stream development in conjunction with fry plantings to improve spawning habitat for returning adult fish to Goathorn Creek might be feasible. Spawning gravel pads located in side channels of the creek system have some potential for success. Over 2 km of side channels were identified in Reach 2 of Goathorn Creek based on air photo analysis (Figure 3.3). It is not recommended that any main channel spawning habitat development be attempted since Goathorn Creek is a high-energy stream system capable of moving gravel-sized material during freshet periods.

### 5.1.2 Stream Fertilization

A second method of enhancing fish production in Goathorn Creek is to undertake a program of stream fertilization (in conjunction with fry planting). Macronutrient concentrations are extremely deficient in Goathorn Creek, and the production of fish food organisms via both the autotrophic food chain and decomposition processes is probably strongly nutrient limited. Evidence is accumulating, particularly from studies in British Columbia, that fertilizer additions to nutrient-deficient streams can greatly enhance their autotrophic activity (Perrin et al. 1984) and salmonid standing crop (Slaney and Perrin in prep.) yet maintain superior water quality. For example, the salmonid biomass in a section of the Keogh River was doubled by raising nitrogen and phosphorous concentrations by only a few parts per billion with fertilizer additions.

Based on the results of this study, both nitrogen and phosphorus would be required for Goathorn Creek fertilization. The studies suggests that a 40% gain in relative specific growth rate of periphyton may be realized with nitrogen additions before light and temperature become limiting (Figure 3.1). But, the curve assumes phosphorus replete conditions, a status that would not be the case in Goathorn Creek if nitrogen were added. Orthosphosphate levels are at or near detection limits, suggesting that increases in nitrogen concentrations would likely drive the system into phosphorus-limitation. Thus, the 40% differential in Figure 3.1 can be interpreted as the specific growth added before phosphorus limitation occurs. If phosphorus additions complemented the nitrogen additions, one would expect a further gain in growth rate before light and temperature would exert limitations. Although any increase in periphyton standing crop is unpredictable based on present data, gains could potentially be reflected in a substantially increased organic matter base for use by fish food organisms and subsequently by the fish themselves.

## 5.2 TENAS CREEK

The steelhead trout fry planting and stream fertilization options discussed for Goathorn Creek could also be applied to Tenas Creek, although there are several differences.

The lower 6 km of Tenas Creek are presently extensively utilized by juvenile steelhead trout. However, the two year's of sampling data suggests that fry recruitment can vary substantially. Fry production in 1984 was only 25% of the 1983 production. The potential for fry plantings in lower Tenas Creek will depend on whether or not the low 1984 fry production results in low parr populations in subsequent years.

An additional 9 km of Tenas Creek upstream of Reach 1 (Figure 3.8) presently has a sparse population of steelhead trout and could support additional fry plantings. Potential problems with Dolly Varden char predation on fry as discussed for Goathorn Creek could also occur with steelhead trout fry planted in upper Tenas Creek. No instream developments of spawning habitat are recommended in Tenas Creek, as this system possesses more suitable spawning gravels than Goathorn Creek.

A stream fertilization program similar to that outlined for Goathorn Creek could improve the productive potential of Tenas Creek. However, logistical problems associated with fertilizer applications to upper sections of Tenas Creek are greater due to lack of road access.

## 5.3 TELKWA RIVER

A number of options exist for enhancing steelhead trout and coho salmon production in the Telkwa River. These include coho salmon fry plantings in wetlands, steelhead trout fry plantings in the Telkwa River and tributaries, and side channel development for rearing and spawning fish.

### 5.3.1 Coho Salmon Fry Plantings

Planting of coho salmon fry into those wetlands associated with the Telkwa River that are presently not used due to restricted access from the mainstem river is an attractive means of increasing coho salmon production in this system. Such a program would be expensive to undertake for a single system, but might be effective if it was undertaken in conjunction with an on-going program of raising coho salmon fry for plantings presently being undertaken at a hatchery on Toboggan Creek by the Department of Fisheries and Oceans.

Marshall and Britton (1980) have reviewed coho salmon smolt trapping studies on a number of pond and small lake habitats in British Columbia. Results from these studies indicate output of smolts ranges from 9 to 110 coho salmon smolts/100 $m^2$ of habitat, with a mean estimate of 50 fish/100 $m^2$. Coho salmon smolt output of 6 smolts/100 $m^2$ from a wetland pond adjacent to the Morice River (Bustard in prep.) suggests estimates in the lower end of the range might be more applicable for Telkwa River wetlands. However, it is possible that with higher fry recruitment, the Morice River pond would have yielded higher numbers of smolts.

Pond sites at WL3 and WL5 (Figure 3.9) are particularly attractive for coho salmon fry plantings, and assuming an output of 25 coho salmon smolts/100 $m^2$, these two areas could yield 4,000 smolts. A number of other potential sites for coho salmon fry outplantings, including tributary streams, exist throughout the Telkwa Watershed.

### 5.3.2 Steelhead Trout Fry Plantings

Data from the past two year's sampling programs indicate that the Telkwa River downstream of Goathorn Creek is used extensively by steelhead trout fry and parr. It is not clear whether many of these steelhead trout in the lower Telkwa River are from fish that originally spawned in Tenas Creek. A small sampling program in the Telkwa River upstream of Goathorn Creek undertaken by the Ministry of Environment suggests juvenile steelhead trout abundance may be low in this upstream area (Lough pers. comm. 1984). If this is a consistent trend, then the Telkwa River upstream of Goathorn Creek to at least Howson Creek would be a good area for steelhead trout fry plantings.

### 5.3.3 Side Channel Development

The development of potential spawning and rearing habitat in side channels of the Telkwa River is another attractive enhancement option. A total of 18 km of side channel habitat has been identified in the river section downstream of Goathorn Creek (Figure 3.9). Approximately two-thirds of this channel length is presently considered productive for salmonid rearing and some spawning use. The remaining one-third consists of relic channels. These are old river channels that have been cut off from the main river except during highest flows and are at various stages of re-vegetation. The relic channels with some external flow either from a tributary or groundwater are good candidate side channels for development.

Side channel 61RG (Figure 3.9) is probably the best potential area for enhancement work. It has an external water source (Tributary 1) that collects seepage from the adjacent slopes and apparently flows for most of the year. The development of an infiltration system to increase flow at the top end of this channel in addition to some instream work to improve substrate and habitat complexing could make this a good site for spawning (all species including pink salmon) and rearing fish. Side channel developments in areas with groundwater inflows have been quite successful at other sites in B.C. (Marshall in prep.).

## 5.4 HUBERT CREEK

Hubert Creek, with its extensive system of beaver dams and ponds, is most suited to coho salmon enhancement. Measurements taken from air photos indicate approximately 3.4 ha of ponded habitat occurs downstream of Helps Lake (Figure 3.12). Coho salmon and some steelhead trout use at least the lower portions of this system, but access is limited by an extensive network of beaver dams up to 2 m high. Coho salmon fry plantings into these ponded areas similar to those discussed for the Telkwa River, would probably do very well.

Assuming 25 coho salmon smolts/100 $m^2$ of area, over 8,000 salmon coho smolts could be produced in this tributary. The plantings should be restricted to the area downstream of Helps Lake, as the upper system and lake possesses a resident cutthroat trout population.

## 6. LITERATURE CITED

Alderdice, D.F. and W.E. McLean. 1982. A review of the potential influence of heavy metals on salmonid fishes in the Campbell River, Vancouver Island, B.C. Can. Tech. Rep. Fish. and Aquat. Sci. 1104: 60 pp.

American Public Health Association (APHA). 1980. Standard methods for the examination of water and wastewater. 15th ed.

Baker, J.P. 1982. Effects on fishes of metals associated with acidification. In. Proc. of an Int. Sym. on Acidic Prec. and Fishery Impacts in N.E. North America. Cornell Univ. Ithaca, New York.

Billings, S.J. 1982. Steelhead harvest analysis 1981-1982. Fish. Tech. Cir. No. 56. Fish and Wildlife Branch, Ministry of Environment. Victoria, B.C. 25 pp.

__________ 1983. Steelhead harvest analysis 1982-1983. Fish. Tech. Circ. No. 59. Fish and Wildlife Branch, Ministry of Environment. Victoria, B.C. 23 pp.

Bjornn, T.C., M.A. Brusven, M.P. Molnau and J.H. Milligan. 1977. Transport of granitic sediment in streams and its effects on insects and fish. For. Wildl. and Range Expt. Stn., Completion Rep. Water Resource Res. Inst. Proj. B-036. IDA. Univ. Idaho, Fort Collins. 38 pp.

Bothwell, M.L. 1985. Phosphorus limitation of lotic periphyton growth rates: An intersite comparison using continuous - flow troughs (Thompson River System, British Columbia). Limnol. and Oceanog. (in press).

Bothwell, M.L. and S. Jasper. 1983. A light and dark trough methodology for measuring rates of lotic periphyton settlement and net growth. In Wetzel, R.G. (ed.). Periphyton and Freshwater Ecosystems. Dr. W. Junk Publishers, The Hague.

Bustard, D.R. 1983. 1982 investigations of adult coho salmon in the Telkwa River. Unpubl. MS prep. for Crows Nest Resources Limited. 12 pp. + app.

__________ 1984a. Assessment of benthic invertebrate and juvenile fish populations in Goathorn and Tenas creeks and the lower Telkwa River, September 1983. Prep. for Crows Nest Resources Limited. 38 pp. + app.

__________ 1984b. Assessment of benthic invertebrate and juvenile fish populations in Foxy and Buck creeks, September 1984. Prep. for Equity Silver Mines Limited. 26 pp. + app.

__________ 1984c. 1983 investigations of adult pink salmon in the Telkwa River. Prep. for Crows Nest Resources Limited. 11 pp.

__________ in prep. Some differences between coastal and interior streams and the implications to juvenile fish production. In: Proc. of a Habitat Improvement Workshop. Whistler, B.C., sponsored by Dept. Fish. and Oceans, May 8-10, 1984.

Cederholm, C.J. and E.O. Salo. 1979. The effects of logging road landslide siltation on salmon and trout spawning gravels of Stequaleho Creek and the Clearwater River Basin, Jefferson County, Washington, 1972-1978. Wash. State Dept. of Nat. Res., Final Report - Part III.

Chamberlin, T.W. 1980. Aquatic survey terminology. Assessment and Planning Division Tech. Paper 2. Aquatic Studies Branch, Ministry of Environment. Victoria, B.C. 30 pp.

Crows Nest Resources Limited. 1983. Telkwa Project Stage I Application.

Envirocon Ltd. 1981. Fisheries resources: Morice River System. Vol. 4. Kemano Completion Hydroelectric Development Baseline Environmental Studies (revised draft). prep. for ALCAN. 125 pp. + app.

Envirocon Ltd. 1983. Distribution and abundance of juvenile salmonids in the Morice/Bulkley River system during October, 1982. Draft report for Kemano Completion Hydroelectric Development. prep. for ALCAN. 43 pp.

Environment Canada, 1983. Historical streamflow summary. British Columbia to 1982. Inland Waters Directorate, Water Resources Branch, Water Survey of Canada. Ottawa, Ont.

Environmental Protection Agency, Corps. of Engineers. 1981. Procedures for handling and chemical analysis of sediment and water samples. U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Tech. Rep. EPA-CE-81-1.

Environmental and Planning Assoc. 1982. Environmental overview of the Telkwa Project area. Prep. for Crows Nest Resources Limited.

Fearnside, D. 1984. Local angler, Smithers, B.C. Personal Communication.

Fish and Wildlife Branch. 1970 through 1982. Steelhead harvest analyses. Fisheries Management Division, Fish and Wildlife Branch, Ministry of Environment. Victoria, B.C.

Fish and Wildlife Branch. 1984. Unpublished Files. Smithers, B.C.

Fisheries and Oceans. 1984. Unpublished Files. Smithers, B.C.

Guillard, R.R.L. 1973. Division rates. In: Stein, J.R. (ed.). Handbook of Phycological Methods; Culture Methods and Growth Measurements. Cambridge University Press.

Goldman, J.C., J.J. McCarthy and D.G. Peavey. 1979. Growth rate influence on the chemical composition of phytoplankton in oceanic waters. Nature. 279: 210-215.

Hallam, R. and R. Kussat. 1974. A biological survey of the watershed adjacent to a proposed mine site near Houston, B.C. Environ. Prot. Serv. Rep. No. EPS-5-PR-74-4. 41 pp.

Hancock, M.J., A.J. Leaney-East and D.E. Marshall. 1983. Catalogue of salmon streams and spawning escapements of Statistical Area 4 (Upper Skeena River). Can. Data Rep. Fish. and Aquat. Sci. No. 394.

Horner, N. and T.C. Bjornn. 1976. Survival, behavior and density of trout and salmon fry in streams. Progress Rep. for 1975 (No. 56) Forest, Wild. and Range Exptl. Stat. Univ. Idaho, Moscow. 38 pp.

Hynes, H.B.N. 1970. The ecology of stream insects. Ann. Rev. Entomol. 15: 25-42.

Hynes, H.B.N. 1972. The Ecology of Running Waters. Univ. of Toronto Press.

Kilham, S.S. 1975. Kinetics of silicon-limited growth in the freshwater diatom, Asterionella formosa. J. Phycol. 11: 396-399.

Klohn Leonoff Ltd. 1985. Stage II geotechnical, hydrogeological and hydrological design report. Prep. for Crows Nest Resources Limited.

Lough, M. 1984. Fisheries Biologist. B.C. Fish and Wildlife Branch, Ministry of Environment. Smithers, B.C. Personal Communication.

MacLean, D.B. 1983. Aldrich Lake: A data report on water quality and biological data from the receiving waters of the area around the abandoned Duthie Mine. Rep. No. 83-05. Waste Mmgt. Branch, Ministry of Environment. Smithers, B.C. 20 pp.

Marshall, D.E. in prep. Instream pits and side channel development. In: Proc. of a Habitat Improvement Workshop, Whistler, B.C., sponsored by Fish. and Oceans, May 8-10, 1984.

Marshall, D.E. and E.W. Britton. 1980. Carrying capacity of coho streams. Fish. and Oceans, Unpubl. MS. 19 pp.

Noggle, C. 1978. Behavioral, physiological and lethal effects of suspended sediment on juvenile salmonids. M.Sc. thesis. Univ. of Wash. 86 pp.

Nordin, R.N. 1982. The effects on water quality of explosives use in surface mining. Vol. 2: The effect on algal growth. Water Mmgt. Branch, Ministry of Environment. Victoria, B.C. 34 pp.

Northcote, T.G., T.G. Halsey and S.J. MacDonald. 1972. Fish as indicators of water quality in the Okanagan Basin Lakes, British Columbia. Canada-British Columbia Okanagan Basin Agreement, Preliminary Rep. 22: 78 pp.

Northcote T.G., G.L. Ennis and M.H. Anderson. 1975. Periphytic and planktonic algae of the lower Fraser River in relation to water quality conditions. Tech. Rep. No. 8. Westwater Research Centre. Vancouver, B.C.

Northcote, T.G., N.T. Johnston and K. Tsumura. 1975. Trace metal concentrations in lower Fraser River fishes. Tech. Rep. No. 7. Westwater Research Center. Vancouver, B.C. 41 pp.

O'Neill, M.J. and M.R. Whately. 1984. Bulkley River steelhead trout - a report on angler use, tagging, and life history studies conducted in 1982 and 1983. Skeena Fish. Rep. No. 83-3. Ministry of Environment. Smithers, B.C. 33 pp. + app.

Perrin, C.J., M.L. Bothwell and P.A. Slaney. 1984. Change in periphyton accumulation rates and phosphorus deficiency by organic and inorganic enrichment in a coastal river. Amer. Soc. Limnol. and Oceanog. 47th Annual Meeting.

Peterson, G.R., H.V. Warren, R.E. Delavault and K. Fletcher. 1970. Heavy metal content of some freshwater fishes in British Columbia. Fish. Tech. Circular No. 2. Fish and Wildlife Branch, Ministry of Environment. Victoria, B.C. 34 pp.

Phillips, R.W. 1971. Effects of sediment on the gravel environment and fish production. In: Proc. of a Symp. on Forest Land Uses and Stream Environment. Oregon State Univ., Corvallis. 12 pp.

Pommen, L.W. 1983. The effects on water quality of explosives use in surface mining. Vol. 1: Nitrogen sources, water quality, and prediction and management of impacts. Water Mmgt. Branch, Ministry of Environment, Victoria, B.C. 87 pp.

Reeder, S.W., A. Demayo and M.C. Taylor. 1979 and 1980. Guidelines for surface water quality. Vol. 1 Inorganic chemical substances. Inland Waters Directorate. Ottawa, Ont.

Rhee, G.Y. and I.J. Gotham. 1980. Optimum N:P ratios and coexistence of planktonic algae. J. Phycol. 16: 486-489.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bull. 191. Fish. Res. Bd. Can. Ottawa, Ont.

Scott, W.B. and E.J. Crossman. 1973. Freshwater fishes of Canada. Bull 184. Fish. Res. Bd. Can. Ottawa, Ont. 966 pp.

Seber, G.A.F. and E.D. LeCren. 1967. Estimating population parameters from catches large relative to the population. J. Anim. Ecol. 36: 631-643.

Sheehan, S.W., G.L. Ennis, and R.L. Hallam. 1980. A water quality study of the Flathead River Basin in British Columbia prior to proposed coal mining. Water Quality Branch of the Inlands Water Directorate, Environment Canada. 137 pp.

Slaney, P.A., T.G. Halsey and A.F. Tautz. 1977. Effects of forest harvesting practices on spawning habitat of stream salmonids in the Centennial Creek Watershed, British Columbia. Mmgt. Rept. No. 73. Fish and Wildlife Branch, Ministry of Environment, Victoria, B.C. 45 pp.

Slaney, P.A. and C.J. Perrin. in prep. Juvenile salmonid response to inorganic and organic enrichment in a coastal British Columbia stream. Can. J. Fish. Aquat. Sci. Ottawa, Ont.

Sturm Environmental Services. 1985. Geochemical evaluation of soils and overburdens for Telkwa Coal Project. Prep. for Crows Nest Resources Limited.

Tredger, C.D. 1982. Upper Bulkley River reconnaissance with reference to juvenile steelhead carrying capacity. Unpub.

MS., Fish and Wildlife Branch, Ministry of Environment. Victoria, B.C.

Ward, G.M., K.W. Cummins, R.W. Speaker, A.K. Ward, S.V. Gregory and T.L. Dudley. 1979. Habitat and food resources for invertebrate communities in South Fork Hoh River, Olympic National Park. In: Proc. 2nd Conf. on Sci. Res. in the National Parks, November 1979. San Francisco, Ca.

Wasserman, L.J., C.J. Cederholm and E.O. Salo. 1984. The impacts of logging on benthic community structure in selected watersheds of the Olympic Peninsula, Washington. FRI-UW-8403. Univ. of Wash. Seattle. 39 pp.

Waters, R.F. and R.J. Knapp. 1961. An improved stream bottom sampler. Trans. Amer. Fish Soc. 90(2): 225-226.

Winget, R.N., and F.A. Mangum. 1979. Biotic condition index: integrated biological, physical, and chemical parameters for management. U.S. Dept. of Agriculture, Forest Service, Intermountain Region, Odgen. 51 pp.

Wood, C.M. and D.G. McDonald. 1982. Physiological mechanisms of acid toxicity to fish. In: Proc. of an Int. Sym. on Acidic Prec. and Fishery Impacts in N.E. North America. Cornell Univ. Ithaca, New York.

# APPENDICES

Appendix 1. Common and Scientific Names of Fish Species Mentioned in the Text

| Family | Common Name | Scientific Name |
|---|---|---|
| Salmonidae | Steelhead trout | *Salmo gairdneri* Richardson |
| | Rainbow trout | *Salmo gairdneri* Richardson |
| | Cutthroat trout | *Salmo clarki* Richardson |
| | Dolly Varden char | *Salvelinus malma* (Walbaum) |
| | Chinook salmon | *Oncorhynchus tshawytscha* (Walbaum) |
| | Coho salmon | *Oncorhynchus kisutch* (Walbaum) |
| | Pink salmon | *Oncorhynchus gorbuscha* (Walbaum) |
| | Mountain whitefish | *Prosopium williamsoni* (Girard) |
| Catostomidae | Longnose suckers | *Catostomus catostomus* (Forster) |
| Cyprinidae | Longnose dace | *Rhinichthys cataractae* (Valenciennes) |
| Petromyzontidae | Pacific lamprey | *Lampetra tridentata* (Gairdner) |

Appendix 2. Formulas used in Deriving Fish Population Estimates and Standard Errors

1) Modified Petersen Mark-and-Recapture Population Estimates (Ricker 1975)

$$\hat{N} = \frac{(m + 1)(c + 1)}{r + 1} - 1$$

$\hat{N}$ = Population estimate

m = Total number of marked fish released after the 1st pass

c = Total number of marked and unmarked fish in the recapture

r = Marks recaptured

$$S.E. (\hat{N}) = \hat{N} \sqrt{\frac{(\hat{N} - m)(\hat{N} - c)}{m\, c\, (\hat{N} - 1)}}$$

2) Two-Step Removal Method (Seber and LeCren 1967)

$$\hat{N} = \frac{(U_1)^2}{U_1 - U_2}$$

$\hat{N}$ = Population estimate

$U_1$ = Number of fish collected in first removal

$U_2$ = Number of fish collected in second removal

T = Total number of fish collected ($U_1 + U_2$)

$$S.E. (\hat{N}) = \sqrt{\frac{(U_1)^2 \times (U_2)^2 \times T}{(U_1 - U_2)^4}}$$

Appendix 3. Chlorophyll a data ($mg/m^2$) collected from replicate styrofoam substrata at Goathorn Creek Sites G2 and G5 Over a 6-Week Period, September 12 through October 17, 1984.

| SAMPLING DATE (d/m/y) | DAYS SUBSTRATA INCUBATED | G2 1 | G2 2 | G2 3 | G2 4 | G5 1 | G5 2 | G5 3 | G5 4 |
|---|---|---|---|---|---|---|---|---|---|
| 12/9/84 | 7 | 6.3 | 4.4 | 7.3 | 3.5 | 12.8 | 13.7 | 17.4 | 16.6 |
| 19/9/84 | 14 | 7.4 | 8.5 | 2.3 | 4.6 | 17.4 | 15.2 | 21.8 | 18.3 |
| 26/9/84 | 21 | 8.9 | 14.2 | 12.6 | 6.9 | 18.5 | 19.9 | 26.1 | 14.2 |
| 3/10/84 | 28 | 17.3 | 18.3 | 16.4 | - | - | - | 27.5 | - |
| 10/10/84 | 35 | 22.7 | 17.5 | 21.8 | - | - | 30.8 | 27.3 | 16.6 |
| 17/10/84 | 42 | 21.0 | 22.0 | 18.0 | 22.0 | - | 19.7 | 28.0 | 23.0 |

Appendix 4.1 Detailed Results of Benthic Invertebrate Sampling in Goathorn and Tenas Creeks and the Telkwa River, September 1984

SITE: GOATHORN CREEK - G1 DATE: 17 SEPTEMBER, 1984

| INSECTA | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| *Ephemeroptera* | | | | | | |
| Baetidae: *Baetis* sp. | 1 | | | | 1 | |
| Siphlonuridae: *Ameletus* sp. | | 1 | | | | 1 |
| Ephemerellidae: *Ephemerella doddsi* | | | | | | |
| *E. spinifera* | | | | | 1 | |
| Heptageniidae: *Rithrogena* sp. | | | | | | |
| *Iron* sp. | | | | | | |
| *Cinygmula* sp. | | 2 | 1 | | 3 | 2 |
| Leptophlebiidae: *Paraleptophlebia* sp. | | | 2 | | | |
| *Plecoptera* | | | | | | |
| Perlodidae: *Diura* sp. | 1 | | 8 | 3 | 10 | 4 |
| *Isogenus* sp. | | | | | | |
| *Arcynopteryx* sp. | | | | | | |
| Chloroperlidae: *Hastaperla* sp. | 1 | 1 | 1 | 1 | 4 | |
| Nemouridae: *Nemoura* sp. 1 | 1 | 1 | 3 | | 3 | |
| *Nemoura* sp. 2 | | 1 | | | | 1 |
| Capniidae: *Capnia* sp. | | 1 | 22 | 7 | 10 | 10 |
| *Trichoptera* | | | | | | |
| Psychomyiidae: *Tinodes* sp. larva | | | 2 | | | |
| *Tinodes* sp. pupa | | | | | | |
| Hydropsychidae: *Parapsyche* sp. | | | | | | 1 |
| Leptoceridae: *Leptocella* sp. | | | | | | |
| Brachycentridae: *Brachycentrus* sp. | | | | | | |
| Rhycacophilidae: *Rhyacophila* sp. | 2 | | | | | 1 |
| Glossosomatidae: *Glossosoma* sp. | | | 1 | | 1 | |
| *Diptera* | | | | | | |
| Chironomidae larva | 664 | 852 | 1016 | 508 | 102 | 656 |
| Chironomidae pupa | | | | 1 | | |
| Chironomidae adult | | | | | | |
| Simuliidae larva | | | | | | |
| Simuliidae pupa | | | | | | |
| Simuliidae adult | | | | | | |
| Empididae larva | 3 | | 1 | 1 | | 2 |
| Empididae pupa | | | | | | |
| Ephydridae: *Ephydra* sp. larva | 2 | 1 | | 1 | 2 | |
| *Ephydra* sp. pupa | 9 | 6 | 1 | 6 | | 11 |
| Blephariceridae: *Philorus* sp. | | | | | | |
| Ceratopogonidae: *Culicoides* sp. | | | | | | |
| Tipulidae: *Tipula* sp. | | 2 | 1 | 6 | | 1 |
| *Antocha* sp. | 2 | 1 | | | | 1 |
| Rhagionidae: *Atherix* sp. | | 1 | | | | |
| Deuterophlebiidae: *Deuterophlebia* sp. | | | | | | |
| Cyclorrhapha | 1 | | | | | |
| *Coleoptera* | | | | | | |
| Hydrophilidae | | | | | | 1 |
| Psephenidae | | | | | | |
| *Homoptera* | | | | | | |
| Aphidae (Terrestrial) | | | | | | |
| Cercopidae (Terrestrial) | | | | | | |
| *Hymenoptera* | | | | | | |
| Braconidae (Terrestrial) | | | | | | |
| *Collembola* | | | | | | |
| Sminthuridae | | | | | | |
| HIRUDINEA | | | | 1 | | 3 |
| OLIGOCHAETA | | | 2 | 1 | 1 | |
| ACARINA | | | | | | |
| Sphaeridae | | | | | | |
| TOTAL NO. OF TAXA | 11 | 12 | 13 | 11 | 11 | 14 |
| TOTAL NO. OF ORGANISMS | 687 | 870 | 1061 | 536 | 138 | 695 |

Appendix 4.1 Cont'd

SITE: GOATHORN CREEK - G2 DATE: 26 SEPTEMBER, 1984

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| INSECTA | | | | | | |
| Ephemeroptera | | | | | | |
| Baetidae: Baetis sp. | 7 | 12 | 3 | 3 | 9 | 11 |
| Siphlonuridae: Ameletus sp. | | | | | 1 | 1 |
| Ephemerellidae: Ephemerella doddsi | 8 | 10 | 4 | 2 | 11 | 3 |
| E. spinifera | | 1 | | 2 | | |
| Heptageniidae: Rithrogena sp. | 6 | 21 | 23 | 10 | 25 | 6 |
| Iron sp. | | 2 | 1 | 7 | 2 | 2 |
| Cinygmula sp. | | | | | 2 | |
| Leptophlebiidae: Paraleptophlebia sp. | | | | | | |
| Plecoptera | | | | | | |
| Perlodidae: Diura sp. | | | 6 | 5 | 3 | |
| Isogenus sp. | | | | | | |
| Arcynopteryx sp. | 2 | 3 | 5 | 16 | 2 | 3 |
| Chloroperlidae: Hastaperla sp. | 5 | 3 | 11 | 10 | 5 | |
| Nemouridae: Nemoura sp. 1 | | 2 | | 8 | 3 | |
| Nemoura sp. 2 | | | | | | |
| Capniidae: Capnia sp. | 3 | 5 | 14 | 15 | 5 | 2 |
| Trichoptera | | | | | | |
| Psychomyiidae: Tinodes sp. larva | | 2 | 2 | 6 | 3 | 1 |
| Tinodes sp. pupa | 1 | | | | | |
| Hydropsychidae: Parapsyche sp. | | 4 | | 4 | | 1 |
| Leptoceridae: Leptocella sp. | | | | | | |
| Brachycentridae: Brachycentrus sp. | | | | | | |
| Rhycacophilidae: Rhyacophila sp. | | | | 2 | | |
| Glossosomatidae: Glossosoma sp. | 2 | 1 | 2 | 1 | | 3 |
| Diptera | | | | | | |
| Chironomidae larva | 6 | 2 | 4 | 1 | 1 | 3 |
| Chironomidae pupa | | | | 2 | | 1 |
| Chironomidae adult | | | | | | |
| Simuliidae larva | | | | 1 | | |
| Simuliidae pupa | | | | | | |
| Simuliidae adult | | | | | | |
| Empididae larva | | | | | | |
| Empididae pupa | | | | | | |
| Ephydridae: Ephydra sp. larva | | | | | | |
| Ephydra sp. pupa | | | | | | |
| Blephariceridae: Philorus sp. | | | | | | |
| Ceratopogonidae: Culicoides sp. | | | | | | |
| Tipulidae: Tipula sp. | | | | | | |
| Antocha sp. | | | | | | |
| Rhagionidae: Atherix sp. | | | | | | |
| Deuterophlebiidae: Deuterophlebia sp. | | 3 | | 1 | | |
| Cyclorrhapha | | | 1 | | | |
| Coleoptera | | | | | | |
| Hydrophilidae | | | | | | |
| Psephenidae | | 2 | | | | |
| Homoptera | | | | | | |
| Aphidae (Terrestrial) | | | | | | |
| Cercopidae (Terrestrial) | | | | | | |
| Hymenoptera | | | | | | |
| Braconidae (Terrestrial) | | | | | | |
| Collembola | | | | | | |
| Sminthuridae | | | | | | |
| HIRUDINEA | 2 | 2 | 1 | 6 | 1 | 2 |
| OLIGOCHAETA | 2 | 1 | | 1 | 1 | 3 |
| ACARINA | | | | | | |
| Sphaeridae | | | | | | |
| TOTAL NO. OF TAXA | 11 | 17 | 13 | 20 | 15 | 14 |
| TOTAL NO. OF ORGANISMS | 44 | 76 | 77 | 103 | 74 | 42 |

Appendix 4.1 Cond'd

SITE: GOATHORN CREEK - G3 DATE: 19 SEPTEMBER, 1984

| INSECTA | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Ephemeroptera | | | | | | |
| Baetidae: Baetis sp. | 8 | 5 | 4 | 1 | 7 | 5 |
| Siphlonuridae: Ameletus sp. | | | | | | |
| Ephemerellidae: Ephemerella doddsi | 6 | 9 | 3 | 3 | | |
| E. spinifera | | 2 | | | | |
| Heptageniidae: Rithrogena sp. | 13 | 62 | 17 | 3 | 2 | 1 |
| Iron sp. | 2 | 3 | 5 | 2 | 4 | 8 |
| Cinygmula sp. | | | 3 | | 7 | 7 |
| Leptophlebiidae: Paraleptophlebia sp. | | | | | | |
| Plecoptera | | | | | | |
| Perlodidae: Diura sp. | | 3 | 4 | 1 | | |
| Isogenus sp. | | 2 | 5 | | 1 | 2 |
| Arcynopteryx sp. | 5 | 12 | 35 | 5 | 7 | |
| Chloroperlidae: Hastaperla sp. | 2 | 28 | 55 | 7 | 1 | |
| Nemouridae: Nemoura sp. 1 | 2 | 2 | 36 | 1 | 4 | 1 |
| Nemoura sp. 2 | | | | | | |
| Capniidae: Capnia sp. | 17 | 24 | 64 | 17 | | 1 |
| Trichoptera | | | | | | |
| Psychomyiidae: Tinodes sp. larva | 3 | 3 | 10 | 1 | 1 | |
| Tinodes sp. pupa | 1 | | | | | |
| Hydropsychidae: Parapsyche sp. | 1 | 1 | 4 | | | |
| Leptoceridae: Leptocella sp. | | | | | | |
| Brachycentridae: Brachycentrus sp. | | | | | | |
| Rhycacophilidae: Rhyacophila sp. | | | | | | |
| Glossosomatidae: Glossosoma sp. | | | 1 | 4 | | |
| Diptera | | | | | | |
| Chironomidae larva | | | 14 | 1 | 3 | |
| Chironomidae pupa | 1 | 1 | 4 | | | |
| Chironomidae adult | | | | | | |
| Simuliidae larva | | | 2 | | | |
| Simuliidae pupa | | | | | | |
| Simuliidae adult | | | | | | |
| Empididae larva | | | | | | |
| Empididae pupa | | | | | | |
| Ephydridae: Ephydra sp. larva | 1 | | | | | |
| Ephydra sp. pupa | | | | | | |
| Blephariceridae: Philorus sp. | | | | | | |
| Ceratopogonidae: Culicoides sp. | | | | | 1 | |
| Tipulidae: Tipula sp. | | | | | | |
| Antocha sp. | | | | | | |
| Rhagionidae: Atherix sp. | | 1 | | | | |
| Deuterophlebiidae: Deuterophlebia sp. | | | 3 | | | |
| Cyclorrhapha | | | | | | |
| Coleoptera | | | | | | |
| Hydrophilidae | | | | | | |
| Psephenidae | | | | | | |
| Homoptera | | | | | | |
| Aphidae (Terrestrial) | | | | | | |
| Cercopidae (Terrestrial) | | | | | | |
| Hymenoptera | | | | | | |
| Braconidae (Terrestrial) | | | | | | |
| Collembola | | | | | | |
| Sminthuridae | | | | | | |
| HIRUDINEA | 1 | 4 | 8 | 4 | 2 | 1 |
| OLIGOCHAETA | | | | | 1 | 4 |
| ACARINA | | | | | | |
| Sphaeridae | | | | 2 | | |
| TOTAL NO. OF TAXA | 14 | 16 | 19 | 14 | 13 | 9 |
| TOTAL NO. OF ORGANISMS | 63 | 162 | 277 | 52 | 41 | 30 |

Appendix 4.1 Cont'd

SITE: GOATHORN CREEK - G3A

DATE: 19 SEPTEMBER, 1984

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| INSECTA | | | | | | |
| Ephemeroptera | | | | | | |
| Baetidae: Baetis sp. | 3 | 4 | 8 | 9 | | 7 |
| Siphlonuridae: Ameletus sp. | 1 | | | 1 | | |
| Ephemerellidae: Ephemerella doddsi | 11 | 3 | 8 | 6 | 3 | |
| E. spinifera | | 1 | 4 | | 5 | 1 |
| Heptageniidae: Rithrogena sp. | 9 | 9 | 12 | 8 | 1 | 7 |
| Iron sp. | 1 | 5 | 2 | 8 | 6 | 3 |
| Cinygmula sp. | | 1 | 3 | | 1 | 2 |
| Leptophlebiidae: Paraleptophlebia sp. | | | | | | |
| Plecoptera | | | | | | |
| Perlodidae: Diura sp. | | | | | | |
| Isogenus sp. | | | | | | |
| Arcynopteryx sp. | 2 | 2 | 2 | 4 | | 2 |
| Chloroperlidae: Hastaperla sp. | 5 | 5 | 12 | 4 | 6 | |
| Nemouridae: Nemoura sp. 1 | | 3 | 2 | 5 | 4 | 5 |
| Nemoura sp. 2 | | | | | | |
| Capniidae: Capnia sp. | | 6 | 6 | 2 | 1 | 2 |
| Trichoptera | | | | | | |
| Psychomyiidae: Tinodes sp. larva | 2 | 3 | 3 | 4 | 2 | 3 |
| Tinodes sp. pupa | | | | 1 | | |
| Hydropsychidae: Parapsyche sp. | | 1 | 1 | | | |
| Leptoceridae: Leptocella sp. | | 1 | | | | |
| Brachycentridae: Brachycentrus sp. | | | | | | |
| Rhycacophilidae: Rhyacophila sp. | | | | | | |
| Glossosomatidae: Glossosoma sp. | | 3 | 2 | 4 | 1 | 1 |
| Diptera | | | | | | |
| Chironomidae larva | | 2 | 2 | 1 | 1 | 2 |
| Chironomidae pupa | | | | | | 1 |
| Chironomidae adult | | | | | | |
| Simuliidae larva | | | 1 | | | |
| Simuliidae pupa | | | | 1 | | 1 |
| Simuliidae adult | | | | | | |
| Empididae larva | | | | | | |
| Empididae pupa | | | | | | |
| Ephydridae: Ephydra sp. larva | | | | | | |
| Ephydra sp. pupa | | | | | | |
| Blephariceridae: Philorus sp. | | | | | | |
| Ceratopogonidae: Culicoides sp. | | | | | | |
| Tipulidae: Tipula sp. | 2 | 1 | | | | |
| Antocha sp. | | | | | | |
| Rhagionidae: Atherix sp. | | | | | | |
| Deuterophlebiidae: Deuterophlebia sp. | | | | 1 | 1 | |
| Cyclorrhapha | | | | | | |
| Coleoptera | | | | | | |
| Hydrophilidae | | | | | | |
| Psephenidae | | | | | | |
| Homoptera | | | | | | |
| Aphidae (Terrestrial) | | 1 | | | | |
| Cercopidae (Terrestrial) | | | | | | |
| Hymenoptera | | | | | | |
| Braconidae (Terrestrial) | | | | | | |
| Collembola | | | | | | |
| Sminthuridae | | | | | | |
| HIRUDINEA | | 1 | 4 | 1 | 2 | 1 |
| OLIGOCHAETA | | 1 | 1 | | | |
| ACARINA | | | | | | |
| Sphaeridae | | | | | | |
| TOTAL NO. OF TAXA | 9 | 19 | 17 | 16 | 12 | 15 |
| TOTAL NO. OF ORGANISMS | 36 | 53 | 73 | 60 | 31 | 41 |

Appendix 4.1 Cont'd

SITE: GOATHORN CREEK - G4 DATE: 18 SEPTEMBER, 1984

| INSECTA | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Ephemeroptera | | | | | | |
| Baetidae: *Baetis* sp. | 4 | 5 | 6 | 21 | 11 | 7 |
| Siphlonuridae: *Ameletus* sp. | | | | 4 | | |
| Ephemerellidae: *Ephemerella doddsi* | 2 | 5 | 1 | 8 | 5 | 7 |
| *E. spinifera* | 1 | | 1 | 2 | | |
| Heptageniidae: *Rithrogena* sp. | 7 | 12 | 22 | 21 | 25 | 6 |
| *Iron* sp. | 15 | 18 | 14 | 10 | 1 | 2 |
| *Cinygmula* sp. | 7 | | 8 | 7 | 2 | 4 |
| Leptophlebiidae: *Paraleptophlebia* sp. | | | 2 | | | |
| Plecoptera | | | | | | |
| Perlodidae: *Diura* sp. | 2 | 2 | 7 | 5 | 8 | 1 |
| *Isogenus* sp. | | | | | | |
| *Arcynopteryx* sp. | 2 | 2 | 17 | 9 | 13 | 2 |
| Chloroperlidae: *Hastaperla* sp. | | 17 | 32 | 8 | 14 | 2 |
| Nemouridae: *Nemoura* sp. 1 | 15 | 8 | 4 | 3 | 2 | 3 |
| *Nemoura* sp. 2 | 1 | 1 | | | | |
| Capniidae: *Capnia* sp. | 1 | 8 | 9 | 11 | 39 | 2 |
| Trichoptera | | | | | | |
| Psychomyiidae: *Tinodes* sp. larva | 1 | 4 | 2 | 4 | 4 | 8 |
| *Tinodes* sp. pupa | | 1 | | 1 | | |
| Hydropsychidae: *Parapsyche* sp. | | 3 | | | | 2 |
| Leptoceridae: *Leptocella* sp. | | | | | | |
| Brachycentridae: *Brachycentrus* sp. | | | | | | |
| Rhycacophilidae: *Rhyacophila* sp. | | | | | | |
| Glossosomatidae: *Glossosoma* sp. | | 3 | | | 3 | 1 |
| Diptera | | | | | | |
| Chironomidae larva | 7 | 1 | 1 | 1 | | |
| Chironomidae pupa | | | 1 | 1 | | 2 |
| Chironomidae adult | | | | | | |
| Simuliidae larva | | 1 | | | | |
| Simuliidae pupa | | | | | | |
| Simuliidae adult | | | | | | |
| Empididae larva | | | | | | |
| Empididae pupa | | 4 | | | | |
| Ephydridae: *Ephydra* sp. larva | 1 | | | 1 | | |
| *Ephydra* sp. pupa | | | | | | |
| Blephariceridae: *Philorus* sp. | | | | | | |
| Ceratopogonidae: *Culicoides* sp. | | 1 | | | | |
| Tipulidae: *Tipula* sp. | | 2 | | | | |
| *Antocha* sp. | | | | | | |
| Rhagionidae: *Atherix* sp. | | 1 | | | 1 | |
| Deuterophlebiidae: *Deuterophlebia* sp. | | 3 | 1 | 1 | | |
| Cyclorrhapha | 2 | | | | | |
| Coleoptera | | | | | | |
| Hydrophilidae | | | | | | 1 |
| Psephenidae | | | | | | |
| Homoptera | | | | | | |
| Aphidae (Terrestrial) | | | | 1 | | |
| Cercopidae (Terrestrial) | | | | | | |
| Hymenoptera | | | | | | |
| Braconidae (Terrestrial) | | | | | | |
| Collembola | | | | | | |
| Sminthuridae | | | | | | |
| HIRUDINEA | 1 | 2 | 2 | 7 | 1 | 3 |
| OLIGOCHAETA | 1 | | | | 1 | |
| ACARINA | 1 | | | | | |
| Sphaeridae | | | | | | |
| TOTAL NO. OF TAXA | 18 | 22 | 17 | 20 | 15 | 16 |
| TOTAL NO. OF ORGANISMS | 71 | 104 | 130 | 126 | 130 | 53 |

Appendix 4.1 Cont'd

SITE: GOATHORN CREEK - G5 DATE: 20 SEPTEMBER, 1984

| INSECTA | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Ephemeroptera | | | | | | |
| Baetidae: *Baetis* sp. | 33 | 12 | 14 | 16 | 12 | 33 |
| Siphlonuridae: *Ameletus* sp. | 1 | | | | 3 | 1 |
| Ephemerellidae: *Ephemerella doddsi* | 5 | 3 | 7 | 9 | 3 | 6 |
| *E. spinifera* | | 2 | | 3 | 2 | 1 |
| Heptageniidae: *Rithrogena* sp. | 72 | 31 | 38 | 41 | 29 | 31 |
| *Iron* sp. | 3 | 1 | | 5 | 6 | 4 |
| *Cinygmula* sp. | | 6 | 1 | 5 | 4 | 2 |
| Leptophlebiidae: *Paraleptophlebia* sp. | | | | | | |
| Plecoptera | | | | | | |
| Perlodidae: *Diura* sp. | 3 | 8 | 2 | 6 | 6 | 8 |
| *Isogenus* sp. | | | | | | |
| *Arcynopteryx* sp. | 4 | 5 | 7 | 12 | 10 | 7 |
| Chloroperlidae: *Hastaperla* sp. | 19 | 12 | 9 | 4 | 8 | 13 |
| Nemouridae: *Nemoura* sp. 1 | 4 | 1 | 3 | 3 | 7 | 2 |
| *Nemoura* sp. 2 | 1 | | | | 1 | 1 |
| Capniidae: *Capnia* sp. | 10 | 26 | 8 | 18 | 48 | 31 |
| Trichoptera | | | | | | |
| Psychomyiidae: *Tinodes* sp. larva | 6 | 4 | 1 | 4 | 1 | 1 |
| *Tinodes* sp. pupa | | | | | | |
| Hydropsychidae: *Parapsyche* sp. | 3 | | | | | |
| Leptoceridae: *Leptocella* sp. | 1 | | | | | |
| Brachycentridae: *Brachycentrus* sp. | | | | | | |
| Rhycacophilidae: *Rhyacophila* sp. | | | | 1 | | |
| Glossosomatidae: *Glossosoma* sp. | 3 | | | 2 | 1 | 2 |
| Diptera | | | | | | |
| Chironomidae larva | 5 | 4 | 1 | 5 | 10 | 3 |
| Chironomidae pupa | | 1 | | 1 | 1 | 1 |
| Chironomidae adult | | | | | | |
| Simuliidae larva | | | | | | |
| Simuliidae pupa | | 1 | | 1 | | 1 |
| Simuliidae adult | | | | | | 1 |
| Empididae larva | 2 | 1 | 2 | | | |
| Empididae pupa | | | | | | |
| Ephydridae: *Ephydra* sp. larva | | | | | | 2 |
| *Ephydra* sp. pupa | | | | | | |
| Blephariceridae: *Philorus* sp. | | | | | | |
| Ceratopogonidae: *Culicoides* sp. | | | | 1 | | |
| Tipulidae: *Tipula* sp. | 1 | | | | | |
| *Antocha* sp. | | | | | | |
| Rhagionidae: *Atherix* sp. | | | 3 | | 1 | |
| Deuterophlebiidae: *Deuterophlebia* sp. | | | | | | |
| Cyclorrhapha | | | | | | |
| Coleoptera | | | | | | |
| Hydrophilidae | | | | | 2 | |
| Psephenidae | | | | | | |
| Homoptera | | | | | | |
| Aphidae (Terrestrial) | | | | | | |
| Cercopidae (Terrestrial) | 1 | | | | | |
| Hymenoptera | | | | | | |
| Braconidae (Terrestrial) | | | | | | |
| Collembola | | | | | | |
| Sminthuridae | | 1 | | | | |
| HIRUDINEA | | 10 | 2 | 11 | 17 | 6 |
| OLIGOCHAETA | 5 | | | | - | |
| ACARINA | | | | | | |
| Sphaeridae | | | | | | |
| TOTAL NO. OF TAXA | 20 | 18 | 14 | 19 | 20 | 21 |
| TOTAL NO. OF ORGANISMS | 182 | 129 | 98 | 148 | 172 | 157 |

Appendix 4.1 Cont'd

SITE: GOATHORN CREEK - G5A | DATE: 27 SEPTEMBER, 1984

| INSECTA | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Ephemeroptera | | | | | | |
| Baetidae: Baetis sp. | 3 | 17 | 11 | 13 | 16 | 37 |
| Siphlonuridae: Ameletus sp. | | | | | | |
| Ephemerellidae: Ephemerella doddsi | 2 | 2 | 5 | 10 | 3 | 2 |
| E. spinifera | | 1 | | | | |
| Heptageniidae: Rithrogena sp. | 10 | 21 | 22 | 32 | 18 | 13 |
| Iron sp. | 1 | 2 | 3 | 2 | 3 | 7 |
| Cinygmula sp. | | | | | | |
| Leptophlebiidae: Paraleptophlebia sp. | 2 | 1 | 9 | 7 | 2 | |
| Plecoptera | | | | | | |
| Perlodidae: Diura sp. | 2 | 12 | 8 | 11 | 9 | 12 |
| Isogenus sp. | | | | | | |
| Arcynopteryx sp. | 3 | 6 | 5 | 9 | 8 | 7 |
| Chloroperlidae: Hastaperla sp. | 1 | 5 | 6 | 14 | 10 | 11 |
| Nemouridae: Nemoura sp. 1 | | 14 | 14 | 10 | 17 | 8 |
| Nemoura sp. 2 | | | | | | |
| Capniidae: Capnia sp. | | 21 | 12 | 28 | 33 | 56 |
| Trichoptera | | | | | | |
| Psychomyiidae: Tinodes sp. larva | | 5 | 3 | 7 | 10 | 6 |
| Tinodes sp. pupa | 1 | | | | 2 | |
| Hydropsychidae: Parapsyche sp. | | 4 | | 1 | | 1 |
| Leptoceridae: Leptocella sp. | | | | | | |
| Brachycentridae: Brachycentrus sp. | | | | | | |
| Rhycacophilidae: Rhyacophila sp. | | | | | | |
| Glossosomatidae: Glossosoma sp. | 1 | 1 | | | | |
| Diptera | | | | | | |
| Chironomidae larva | | 12 | 7 | 4 | 12 | 4 |
| Chironomidae pupa | | 4 | | 1 | 3 | 1 |
| Chironomidae adult | | | | | | |
| Simuliidae larva | | | | | | |
| Simuliidae pupa | | | | | | |
| Simuliidae adult | | | | | | |
| Empididae larva | | 1 | | | 3 | 2 |
| Empididae pupa | | | | | | |
| Ephydridae: Ephydra sp. larva | | | | | | |
| Ephydra sp. pupa | | | | | | |
| Blephariceridae: Philorus sp. | | | | | | |
| Ceratopogonidae: Culicoides sp. | | | | | | |
| Tipulidae: Tipula sp. | | | 1 | | | |
| Antocha sp. | | | | | | |
| Rhagionidae: Atherix sp. | | | | | | |
| Deuterophlebiidae: Deuterophlebia sp. | | | | | | |
| Cyclorrhapha | | | | | | |
| Coleoptera | | | | | | |
| Hydrophilidae | | | | | | |
| Psephenidae | | | | | | |
| Homoptera | | | | | | |
| Aphidae (Terrestrial) | | | | | | |
| Cercopidae (Terrestrial) | | | | | | |
| Hymenoptera | | | | | | |
| Braconidae (Terrestrial) | | 1 | | | | |
| Collembola | | | | | | |
| Sminthuridae | | | | | | |
| HIRUDINEA | | 9 | 2 | 10 | 4 | 1 |
| OLIGOCHAETA | | | 1 | | | |
| ACARINA | | | | | | |
| Sphaeridae | | | | | | |
| TOTAL NO. OF TAXA | 10 | 19 | 15 | 15 | 16 | 15 |
| TOTAL NO. OF ORGANISMS | 26 | 139 | 109 | 159 | 153 | 168 |

Appendix 4.1 Cont'd

SITE: TENAS CREEK - T1 DATE: 12 SEPTEMBER, 1984

| INSECTA | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Ephemeroptera | | | | | | |
| Baetidae: Baetis sp. | 24 | 7 | 8 | 5 | 10 | 4 |
| Siphlonuridae: Ameletus sp. | 3 | | 1 | | 2 | |
| Ephemerellidae: Ephemerella doddsi | | 2 | 2 | 2 | 2 | 6 |
| E. spinifera | 1 | | 1 | | | |
| Heptageniidae: Rithrogena sp. | 2 | 4 | 5 | 13 | 7 | 13 |
| Iron sp. | 4 | 1 | 7 | 12 | 17 | 8 |
| Cinygmula sp. | | | | 2 | | 2 |
| Leptophlebiidae: Paraleptophlebia sp. | 3 | 1 | | | 3 | |
| Plecoptera | | | | | | |
| Perlodidae: Diura sp. | 8 | 2 | 1 | 1 | 12 | 6 |
| Isogenus sp. | | | | | | |
| Arcynopteryx sp. | 10 | 5 | 2 | 3 | 8 | 13 |
| Chloroperlidae: Hastaperla sp. | | 4 | | 2 | 2 | |
| Nemouridae: Nemoura sp. 1 | 1 | 1 | 1 | | 4 | 3 |
| Nemoura sp. 2 | | 1 | | 1 | 1 | |
| Capniidae: Capnia sp. | 2 | 2 | 3 | 2 | 7 | 2 |
| Trichoptera | | | | | | |
| Psychomyiidae: Tinodes sp. larva | | 2 | | 2 | 1 | 1 |
| Tinodes sp. pupa | | | | | | |
| Hydropsychidae: Parapsyche sp. | | | | 5 | | |
| Leptoceridae: Leptocella sp. | | | | | 1 | 1 |
| Brachycentridae: Brachycentrus sp. | | | | | | |
| Rhycacophilidae: Rhyacophila sp. | 3 | 2 | 1 | | 2 | |
| Glossosomatidae: Glossosoma sp. | 4 | 1 | | 6 | 8 | 2 |
| Diptera | | | | | | |
| Chironomidae larva | 180 | 57 | 7 | 8 | 17 | 12 |
| Chironomidae pupa | 1 | | | 1 | | 1 |
| Chironomidae adult | 1 | | | | | |
| Simuliidae larva | | | | | | |
| Simuliidae pupa | | | | | | |
| Simuliidae adult | | | | | | |
| Empididae larva | | | | | | |
| Empididae pupa | | | | | | |
| Ephydridae: Ephydra sp. larva | 1 | 1 | | | 1 | |
| Ephydra sp. pupa | | | | | | |
| Blephariceridae: Philorus sp. | | | | | | |
| Ceratopogonidae: Culicoides sp. | | | | | | |
| Tipulidae: Tipula sp. | | | | | | |
| Antocha sp. | | 1 | | | | |
| Rhagionidae: Atherix sp. | | | | | 2 | |
| Deuterophlebiidae: Deuterophlebia sp. | | | | | | |
| Cyclorrhapha | 1 | 1 | | | | |
| Coleoptera | | | | | | |
| Hydrophilidae | | | | | | |
| Psephenidae | | | | | | |
| Homoptera | | | | | | |
| Aphidae (Terrestrial) | | | | | | |
| Cercopidae (Terrestrial) | | | | | | |
| Hymenoptera | | | | | | |
| Braconidae (Terrestrial) | | | | | | |
| Collembola | | | | | | |
| Sminthuridae | | | | | | |
| HIRUDINEA | 1 | | 1 | 4 | 6 | 4 |
| OLIGOCHAETA | 1 | | 1 | 1 | 1 | |
| ACARINA | | | | | | |
| Sphaeridae | | | | | | |
| TOTAL NO. OF TAXA | 19 | 18 | 14 | 17 | 21 | 15 |
| TOTAL NO. OF ORGANISMS | 251 | 95 | 41 | 70 | 114 | 78 |

Appendix 4.1 Cont'd

SITE: TENAS CREEK - T2 DATE: 28 SEPTEMBER, 1984

| INSECTA | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Ephemeroptera | | | | | | |
| Baetidae: Baetis sp. | 75 | 19 | 5 | 93 | 72 | 23 |
| Siphlonuridae: Ameletus sp. | | | | | | |
| Ephemerellidae: Ephemerella doddsi | 6 | 5 | 2 | 6 | 7 | 1 |
| E. spinifera | | | | | | |
| Heptageniidae: Rithrogena sp. | 31 | 15 | 18 | 18 | 23 | 19 |
| Iron sp. | 12 | 1 | 4 | 6 | 29 | 21 |
| Cinygmula sp. | | | 1 | | | |
| Leptophlebiidae: Paraleptophlebia sp. | 6 | | | 1 | 1 | 2 |
| Plecoptera | | | | | | |
| Perlodidae: Diura sp. | 7 | | | | 23 | 7 |
| Isogenus sp. | | | | | | |
| Arcynopteryx sp. | 28 | 8 | 4 | 14 | 19 | 4 |
| Chloroperlidae: Hastaperla sp. | 5 | 3 | 4 | 4 | 16 | 13 |
| Nemouridae: Nemoura sp. 1 | 11 | 2 | | 3 | 48 | 4 |
| Nemoura sp. 2 | 1 | | | | | |
| Capniidae: Capnia sp. | 27 | 5 | 24 | 11 | 22 | 2 |
| Trichoptera | | | | | | |
| Psychomyiidae: Tinodes sp. larva | 3 | 1 | 1 | 1 | 4 | 6 |
| Tinodes sp. pupa | | | | | | |
| Hydropsychidae: Parapsyche sp. | 3 | 3 | 2 | 2 | 29 | 14 |
| Leptoceridae: Leptocella sp. | | | | | | |
| Brachycentridae: Brachycentrus sp. | | | | | | |
| Rhycacophilidae: Rhyacophila sp. | | | | | | 1 |
| Glossosomatidae: Glossosoma sp. | | 1 | | 3 | 3 | 5 |
| Diptera | | | | | | |
| Chironomidae larva | 2 | 2 | 2 | 2 | 6 | |
| Chironomidae pupa | | | | 1 | 2 | 1 |
| Chironomidae adult | | | | | | |
| Simuliidae larva | | | 1 | | 1 | |
| Simuliidae pupa | | | | | | |
| Simuliidae adult | | | | | | |
| Empididae larva | | | | | | |
| Empididae pupa | | | | | | |
| Ephydridae: Ephydra sp. larva | | | 5 | | | |
| Ephydra sp. pupa | | | | | | |
| Blephariceridae: Philorus sp. | | | | | | |
| Ceratopogonidae: Culicoides sp. | | | | | | |
| Tipulidae: Tipula sp. | | | | | | |
| Antocha sp. | | | | | | |
| Rhagionidae: Atherix sp. | | 1 | 2 | 1 | | |
| Deuterophlebiidae: Deuterophlebia sp. | | | | | | |
| Cyclorrhapha | | | 1 | | | |
| Coleoptera | | | | | | |
| Hydrophilidae | | | | | | |
| Psephenidae | | | | | | |
| Homoptera | | | | | | |
| Aphidae (Terrestrial) | | | | | | |
| Cercopidae (Terrestrial) | | | | | | |
| Hymenoptera | | | | | | |
| Braconidae (Terrestrial) | | | | | | |
| Collembola | | | | | | |
| Sminthuridae | | | | | | |
| HIRUDINEA | | 4 | | 5 | | 5 |
| OLIGOCHAETA | | | 1 | | | 2 |
| ACARINA | | | | | | |
| Sphaeridae | | | | | | |
| TOTAL NO. OF TAXA | 14 | 14 | 16 | 16 | 16 | 17 |
| TOTAL NO. OF ORGANISMS | 217 | 70 | 77 | 171 | 305 | 130 |

Appendix 4.1 Cont'd

SITE: TELKWA RIVER - SC1 DATE: 14 SEPTEMBER, 1984

| INSECTA | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Ephemeroptera | | | | | | |
| Baetidae: *Baetis* sp. | 1 | 3 | 2 | 2 | 2 | 3 |
| Siphlonuridae: *Ameletus* sp. | | | | | | 1 |
| Ephemerellidae: *Ephemerella doddsi* | | | | 3 | | 1 |
| *E. spinifera* | 2 | 2 | 1 | 5 | 4 | |
| Heptageniidae: *Rithrogena* sp. | 9 | 3 | 4 | 8 | 15 | 5 |
| *Iron* sp. | 3 | 1 | | 3 | 4 | 4 |
| *Cinygmula* sp. | | | | | 1 | |
| Leptophlebiidae: *Paraleptophlebia* sp. | | | | | | |
| Plecoptera | | | | | | |
| Perlodidae: *Diura* sp. | 25 | 10 | 3 | 4 | 3 | 4 |
| *Isogenus* sp. | | | | | | |
| *Arcynopteryx* sp. | 2 | 3 | 2 | 3 | 4 | 2 |
| Chloroperlidae: *Hastaperla* sp. | 2 | 5 | 4 | 4 | 2 | 13 |
| Nemouridae: *Nemoura* sp. 1 | | | 1 | | | 1 |
| *Nemoura* sp. 2 | | | | | | |
| Capniidae: *Capnia* sp. | | | | | 1 | |
| Trichoptera | | | | | | |
| Psychomyiidae: *Tinodes* sp. larva | | | | | | 1 |
| *Tinodes* sp. pupa | | 1 | | | | 1 |
| Hydropsychidae: *Parapsyche* sp. | | | | | | |
| Leptoceridae: *Leptocella* sp. | | | | | | |
| Brachycentridae: *Brachycentrus* sp. | | | | | | |
| Rhycacophilidae: *Rhyacophila* sp. | | | | | | |
| Glossosomatidae: *Glossosoma* sp. | | | 1 | | 2 | |
| Diptera | | | | | | |
| Chironomidae larva | 10 | 28 | 7 | 5 | 3 | 15 |
| Chironomidae pupa | 2 | 1 | | 3 | | |
| Chironomidae adult | | | | | | |
| Simuliidae larva | | | | | | |
| Simuliidae pupa | | | 1 | 2 | | |
| Simuliidae adult | | | | | | |
| Empididae larva | | | | | | |
| Empididae pupa | | | | | | |
| Ephydridae: *Ephydra* sp. larva | | | | | | 1 |
| *Ephydra* sp. pupa | | | | | | 1 |
| Blephariceridae: *Philorus* sp. | | | | | | |
| Ceratopogonidae: *Culicoides* sp. | | | | | | |
| Tipulidae: *Tipula* sp. | | | | | | |
| *Antocha* sp. | | | | | | |
| Rhagionidae: *Atherix* sp. | | | | | | 1 |
| Deuterophlebiidae: *Deuterophlebia* sp. | | | | 1 | | |
| Cyclorrhapha | | | | 1 | | |
| Coleoptera | | | | | | |
| Hydrophilidae | | | | | | |
| Psephenidae | | | 1 | 1 | | |
| Homoptera | | | | | | |
| Aphidae (Terrestrial) | | | | | | |
| Cercopidae (Terrestrial) | | | | | | |
| Hymenoptera | | | | | | |
| Braconidae (Terrestrial) | | | | | | |
| Collembola | | | | | | |
| Sminthuridae | | | | | | |
| HIRUDINEA | 3 | 2 | 5 | 1 | 2 | |
| OLIGOCHAETA | 1 | | | | | 1 |
| ACARINA | | | | | | |
| Sphaeridae | | | | | | |
| TOTAL NO. OF TAXA | 11 | 11 | 12 | 15 | 12 | 16 |
| TOTAL NO. OF ORGANISMS | 60 | 59 | 32 | 46 | 43 | 55 |

Appendix 4.1 Cont'd

SITE: TELKWA RIVER - SC2

DATE: 29 SEPTEMBER, 1984

| INSECTA | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Ephemeroptera | | | | | | |
| Baetidae: Baetis sp. | 16 | 8 | 4 | 2 | 2 | 9 |
| Siphlonuridae: Ameletus sp. | 5 | | | 1 | | |
| Ephemerellidae: Ephemerella doddsi | 2 | 11 | 9 | 8 | 13 | 3 |
| E. spinifera | 1 | 4 | 1 | 1 | 8 | 3 |
| Heptageniidae: Rithrogena sp. | 1 | 13 | 41 | 63 | 59 | 27 |
| Iron sp. | 4 | 3 | 4 | 1 | | 3 |
| Cinygmula sp. | | | 8 | | | |
| Leptophlebiidae: Paraleptophlebia sp. | | 1 | | 1 | | |
| Plecoptera | | | | | | |
| Perlodidae: Diura sp. | 19 | 11 | 3 | 5 | | 4 |
| Isogenus sp. | | | | | | |
| Arcynopteryx sp. | 22 | 43 | 28 | 25 | 68 | 49 |
| Chloroperlidae: Hastaperla sp. | 11 | 8 | 48 | 49 | 37 | 43 |
| Nemouridae: Nemoura sp. 1 | 20 | 15 | 3 | 7 | 14 | 12 |
| Nemoura sp. 2 | | | | | | |
| Capniidae: Capnia sp. | 3 | 9 | 1 | 2 | 3 | 3 |
| Trichoptera | | | | | | |
| Psychomyiidae: Tinodes sp. larva | 1 | 3 | 1 | 1 | 2 | 1 |
| Tinodes sp. pupa | | | | | | |
| Hydropsychidae: Parapsyche sp. | | 19 | 14 | 5 | 28 | 21 |
| Leptoceridae: Leptocella sp. | | | | | | |
| Brachycentridae: Brachycentrus sp. | | | 1 | | | |
| Rhycacophilidae: Rhyacophila sp. | 1 | 2 | 1 | | 2 | |
| Glossosomatidae: Glossosoma sp. | | 3 | 2 | 1 | 6 | 4 |
| Diptera | | | | | | |
| Chironomidae larva | 104 | 33 | 9 | 28 | 12 | 15 |
| Chironomidae pupa | | | | | | |
| Chironomidae adult | | | | | | |
| Simuliidae larva | | | | | 4 | 2 |
| Simuliidae pupa | 1 | | | | | |
| Simuliidae adult | | | | | | |
| Empididae larva | 2 | | | | 1 | 1 |
| Empididae pupa | | | | | | |
| Ephydridae: Ephydra sp. larva | | | | | | 1 |
| Ephydra sp. pupa | 1 | | | | | |
| Blephariceridae: Philorus sp. | | 1 | | 1 | | |
| Ceratopogonidae: Culicoides sp. | | | | | | 1 |
| Tipulidae: Tipula sp. | | 1 | | | | |
| Antocha sp. | | | | | | |
| Rhagionidae: Atherix sp. | | | | | | |
| Deuterophlebiidae: Deuterophlebia sp. | | | | | | |
| Cyclorrhapha | | | | 1 | | |
| Coleoptera | | | | | | |
| Hydrophilidae | | | | | | |
| Psephenidae | | | | 1 | | |
| Homoptera | | | | | | |
| Aphidae (Terrestrial) | | | | | | |
| Cercopidae (Terrestrial) | | | | | | |
| Hymenoptera | | | | | | |
| Braconidae (Terrestrial) | | | | | | |
| Collembola | | | | | | |
| Sminthuridae | | | | | | |
| HIRUDINEA | | | | | 1 | 1 |
| OLIGOCHAETA | 2 | | | | | |
| ACARINA | | | | | | |
| Sphaeridae | | 1 | | | | |
| TOTAL NO. OF TAXA | 18 | 19 | 17 | 19 | 16 | 19 |
| TOTAL NO. OF ORGANISMS | 216 | 189 | 178 | 203 | 260 | 203 |

Appendix 4.2 Supplemental Benthos Sample Site Descriptions

SITE G3A

Location: Goathorn Creek - Downstream of G3 approximately 80 m. Bench mark located on the right side.

| Sample No. | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Dist. from BM (m) | 19 | 20 | 21 | 23 | 24.5 | 26.5 |
| Depth (cm) | 18 | 18 | 21 | 23 | 31 | 14 |
| D 50 (cm) | 1 | 2 | 1 | 3 | 6 | 4 |
| D 90 (cm) | 10 | 10 | 10 | 12 | 20 | 16 |

Avg. Water Velocity 0.77 m/sec

SITE G5A

Location: Goathorn Creek - The site is located approximately 10 m downstream of the periphyton sample blocks at the old upper bridge crossing site. Bench mark on right side.

| Sample No. | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| | | | | 1.5 m above | | |
| Dist. from BM (m) | 7 | 9 | 11 | 13 | 15 | 16 |
| Depth (cm) | 19 | 19 | 28 | 32 | 14 | 10 |
| D 50 (cm) | 5 | 3 | 4 | 4 | 2 | 4 |
| D 90 (cm | 13 | 12 | 13 | 11 | 13 | 14 |

Avg. Water Velocity 0.70 m/sec

ppendix 5. Detailed Results of Drift Samples in Goathorn Creek, September 1984

| NSECTA | Stage[1] | Aq/T[2] | SITE G2 Day | SITE G2 Night | SITE G5 Day | SITE G5 Night |
|---|---|---|---|---|---|---|
| phemeroptera | | | | | | |
| aetidae: Baetis sp. | N | Aq | 2 | 23 | 28 | 50 |
| Baetis sp. | A | Aq | 10 | | 96 | 33 |
| iphlonuridae: Ameletus sp. | N | Aq | 2 | 1 | 4 | 3 |
| Ameletus sp. | A | Aq | | | | |
| phemerellidae: Ephemerella doddsi | N | Aq | 6 | 3 | 10 | 5 |
| Ephemerella doddsi | A | Aq | | | 4 | 5 |
| Ephemerella spinifera | N | Aq | | 2 | 3 | 7 |
| Ephemerella spinifera | A | Aq | | | 25 | 4 |
| eptageniidae: Rithrogena sp. | N | Aq | 1 | 2 | 28 | 62 |
| Rithrogena sp. | A | Aq | 15 | | 86 | 36 |
| Iron sp. | N | Aq | 1 | 9 | 13 | 11 |
| Iron sp. | A | Aq | 6 | | 24 | |
| Cinygmula sp. | N | Aq | | | 2 | 7 |
| lecoptera | | | | | | |
| erlodidae: Diura sp. | N | Aq | | 10 | 6 | 1 |
| Diura sp. | A | Aq | 1 | 2 | | |
| Arcynopteryx sp. | N | Aq | | | 11 | 11 |
| Arcynopteryx sp. | A | Aq | | | 4 | |
| hloroperlidae: Hastaperla sp. | N | Aq | 1 | 9 | 12 | 13 |
| Hastaperla sp. | A | Aq | 1 | 1 | 16 | 2 |
| emouridae: Nemoura sp. 1 | N | Aq | | 4 | 10 | 34 |
| Nemoura sp. 1 | A | Aq | | 1 | 8 | 4 |
| Nemoura sp. 2 | N | Aq | 1 | | | |
| apniidae: Capnia sp. | N | Aq | | | 6 | 1 |
| richoptera | | | | | | |
| sychomyiidae: Tinodes sp. | L | Aq | | 1 | 3 | 9 |
| Tinodes sp. | P | Aq | 4 | | 16 | 30 |
| Tinodes sp. | A | Aq | 2 | 2 | | 8 |
| ydropsychidae: Parapsyche sp. | L | Aq | | 1 | | 6 |
| Parapsyche sp. | A | Aq | | 1 | 2 | 2 |
| hyacophilidae: Rhyacophila sp. | P | Aq | 1 | | | |
| lossosomatidae: Glossosoma sp. | L | Aq | 1 | 1 | | |
| iptera | A | T | 7 | | 19 | |
| hironomidae | L | Aq | 9 | 36 | 19 | 11 |
| hironomidae | P | Aq | | | | 2 |
| hironomidae | A | Aq | 1 | 1 | 11 | 4 |
| imuliidae | L | Aq | 1 | 4 | | 4 |
| imuliidae | P | Aq | | | | 2 |
| imuliidae | A | Aq | 2 | | | 2 |
| mpididae | A | Aq | 1 | | | 7 |
| phydridae: Ephydra sp. | A | Aq | 6 | 2 | 12 | 5 |
| ecidomyiidae | A | Aq | 5 | | 5 | 4 |
| ipulidae: Tipula sp. | A | Aq | 1 | | 8 | 6 |
| Deuterophlebiidae: Deuterophlebia sp. | L | Aq | 3 | 3 | 1 | 6 |
| Dolichopodidae | A | Aq | 1 | | 2 | |
| Bibionidae | A | T | 3 | 2 | 2 | |
| uscidae | A | T | 3 | 2 | 15 | 13 |

Appendix 5 Cont'd

| | | | | | | |
|---|---|---|---|---|---|---|
| <u>Coleoptera</u> | | | | | | |
| Dytiscidae | A | Aq | | 1 | | 1 |
| Chrysomelidae | A | T | 1 | 1 | 2 | |
| Staphylinidae | A | T | | | 3 | |
| <u>Heteroptera</u> | | | | | | |
| Corixidae | A | Aq | | 13 | | 7 |
| Lygaeidae | A | T | | | 1 | |
| <u>Homoptera</u> | | | | | | |
| Aphidae | A | T | 1 | | 2 | 4 |
| Membracidae | A | T | | | 1 | |
| Fulgoridae | A | T | | | 1 | |
| Cercopidae | A | T | | 1 | 5 | |
| <u>Hymenoptera</u> | | | | | | |
| Ichneumonidae | A | T | | | 13 | 12 |
| Formicidae | A | T | | 1 | 12 | 3 |
| Braconidae | A | T | 1 | | 2 | |
| Trichogrammatidae | A | T | | 1 | | |
| Tenthredinidae | L | T | 1 | | | |
| <u>Lepidoptera</u> | | | | | | |
| Geometridae | A | T | | | | 2 |
| Lymantriidae | L | T | | 1 | | |
| <u>Collembola</u> | | | | | | |
| Poduridae | A | Aq | | 1 | | |
| ACARINA | | Aq | | | | 1 |
| ARANEAE | | T | 5 | 1 | | 3 |
| OLIGOCHAETA | | Aq | 2 | | | |
| TOTAL NO. OF TAXA | | | 35 | 33 | 43 | 43 |
| TOTAL NO. OF ORGANISMS | | | 109 | 144 | 553 | 443 |

1 <u>Stage</u> N = Nymph L = Larva P = Pupa A = adult G2 - September 21, 1984

2 <u>Aq/T</u> Aquatic or Terrestrial G5 - September 20, 1984

Appendix 6.1 Length and Weight Characteristics of Fish Analyzed for Stomach Contents, September 1984

| Site G2 - Steelhead Trout | | | Site G5 - Dolly Varden Char | | |
|---|---|---|---|---|---|
| FISH NUMBER | LENGTH (mm) | WEIGHT (g) | FISH NUMBER | LENGTH (mm) | WEIGHT (g) |
| 1 | 103 | 14.4 | 1 | 126 | 17.5 |
| 2 | 93 | 11.6 | 2 | 113 | 14.3 |
| 3 | 125 | 20.8 | 3 | 112 | 12.7 |
| 4 | 125 | 23.9 | 4 | 90 | 8.7 |
| 5 | 104 | 17.0 | 5 | 80 | 6.4 |
| 6 | 111 | 18.0 | 6 | 115 | 14.5 |
| 7 | 107 | 14.6 | 7 | 175 | 66.1 |
| 8 | 75 | 6.7 | 8 | 180 | 79.3 |
| 9 | 120 | 20.9 | 9 | 173 | 66.0 |
| 10 | 118 | 19.1 | 10 | 134 | 24.8 |
| 11 | 105 | 17.1 | 11 | 150 | 45.8 |
| 12 | 93 | 12.4 | 12 | 122 | 17.3 |
| 13 | 88 | 9.2 | 13 | 83 | 7.4 |
| 14 | 67 | 6.9 | 14 | 157 | 51.7 |
| 15 | 80 | 7.9 | 15 | 113 | 12.8 |
| 16 | 78 | 8.3 | 16 | 91 | 8.9 |
| 17 | 86 | 9.3 | 17 | 167 | 51.9 |
| 18 | 80 | 9.0 | 18 | 137 | 26.6 |
| 19 | 76 | 8.0 | 19 | 137 | 25.9 |
| 20 | 93 | 11.7 | 20 | 84 | 7.9 |
| 21 | 79 | 7.7 | 21 | 73 | 4.2 |
| 22 | 94 | 12.2 | 22 | 73 | 5.2 |
| 23 | 85 | 9.0 | 23 | 79 | 4.8 |
| 24 | 78 | 8.0 | 24 | 82 | 6.5 |
| 25 | 72 | 6.5 | 25 | 67 | 4.1 |
| Mean | 93.4 | 12.4 | Mean | 116.5 | 23.7 |
| Range | 67-125 | 6.5-23.9 | Range | 67-180 | 4.1-79.3 |

Appendix 6.2 Detailed Results of Stomach Samples from Steelhead Trout and Dolly Varden Char in Goathorn Creek, September 1984

SITE: G2

DATE: September 26, 1984 SPECIES: Steelhead Trout

| | Stage[1] | Aq/T[2] | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| INSECTA | | | | | | | | | | | |
| Ephemeroptera | | | | | | | | | | | |
| Baetidae: Baetis sp. | N | Aq | | | | | 1 | | | | 2 |
| Baetis sp. | A | Aq | | | | | 2 | | | | 1 |
| Siphlonuridae: Ameletus sp. | N | Aq | | | | | | | | | |
| Ephemerellidae: E. doddsi | N | Aq | | 1 | | | | | | | |
| E. spinifera | N | Aq | | | | | | | | | 4 |
| E. spinifera | A | Aq | | | | | | | | | |
| Heptageniidae: Rithrogena sp. | N | Aq | | 1 | | 1 | 1 | | | | |
| Rithrogena sp. | A | Aq | | | | | | | | | 1 |
| Iron sp. | N | Aq | | | | | | | | | 10 |
| Iron sp. | A | Aq | | | | | | | | | |
| Cinygmula sp. | N | Aq | | | | | | | | | |
| Plecoptera | A | Aq | | | | | | | | | |
| Perlodidae: Diura sp. | N | Aq | | | | | | | | | |
| Arcynopteryx sp. | N | Aq | | | | | | | | | |
| Arcynopteryx sp. | A | Aq | | 1 | | | | | | | |
| Chloroperlidae: Hastaperla sp. | N | Aq | | 1 | | | | | | | |
| Hastaperla sp. | A | Aq | | | | | | | | | |
| Capniidae: Capnia sp. | A | Aq | | | | | | | | | |
| Nemouridae: Nemoura sp. 1 | N | Aq | | | | | | | | | 1 |
| Trichoptera | A | Aq | | | | | | | | | |
| Psychomyiidae: Tinodes sp. | L | Aq | | | | | | | | | |
| Tinodes sp. | P | Aq | | | | | | | | | |
| Hydropsychidae: Parapsyche sp. | L | Aq | | | | | | | | | 1 |
| Brachycentridae: Brachycentrus sp. | L | Aq | | | | | | | | | |
| Glossosomatidae: Glossosoma sp. | L | Aq | | | 2 | 1 | | 2 | 2 | | |
| Diptera | A | T | | | | | | | | | 1 |
| Chironomidae | L | Aq | | | | | | | | | 1 |
| Chironomidae | A | Aq | | | | | | | | | |
| Simuliidae | L | Aq | | | | | | | | | |
| Simuliidae | A | Aq | | | | | | | | | |
| Ephydridae: Ephydra sp. | A | Aq | | | | | | | | | |
| Muscidae | A | T | | | | | | 1 | | | |
| Syrphidae | A | T | | | | | | | | | |
| Bibionidae | A | T | | | | | | | | | |
| Coleoptera | A | T | 1 | | | | | | | | |
| Dytiscidae | A | Aq | | | | | | | | | |
| Carabidae | A | T | | | | | | | | | |
| Chrysomelidae | A | T | | | | | | | | 1 | |
| Staphylinidae | A | T | | | 1 | | | | | | |
| Heteroptera | | | | | | | | | | | |
| Corixidae | A | Aq | | 1 | 2 | 1 | 3 | | | | |
| Homoptera | | | | | | | | | | | |
| Cercopidae | A | T | | 1 | 1 | | | | | | |
| Membracidae | A | T | | | | | 1 | | | | |
| Cicadellidae | A | T | | | | | | | | | |
| Fulgoridae | A | T | | | | | | | | | |
| Aphidae | A | T | | | | | | | | | |
| Hymenoptera | | | | | | | | | | | |
| Formicidae | A | T | | | | | 1 | | | | |
| Tenthredinidae | A | T | | | | 1 | | | | | |
| Ichneumonidae | A | T | | | 1 | | 1 | | | | |
| Lepidoptera | A | T | | | | | | | | | |
| Geometridae | L | T | | | | | | | | | 1 |
| Sphingidae | L | T | | | | | | | | | |
| ARANEAE | | T | | | | | | | | | |
| ANNELIDAE | | T | | | | | | | | | |
| MILLIPEDEA | | T | | | | | | | | | |

[1] Stage: N = Nymph L = Larvae P = Pupa A = Adult

[2] Aq/T: Aquatic or Terrestrial

Appendix 6.2 Cont'd

SITE: G2 DATE: September 26, 1984 SPECIES: Steelhead Trout

| | Stage[1] | Aq/T[2] | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| INSECTA | | | | | | | | | | | |
| Ephemeroptera | | | | | | | | | | | |
| Baetidae: Baetis sp. | N | Aq | 1 | | | | 3 | 1 | | | |
| Baetis sp. | A | Aq | | | | | | | | | |
| Siphlonuridae: Ameletus sp. | N | Aq | | | | | | | | | |
| Ephemerellidae: E. doddsi | N | Aq | | | | | | | | | |
| E. spinifera | N | Aq | | | | | | | | | |
| E. spinifera | A | Aq | | | | | | | | | |
| Heptageniidae: Rithrogena sp. | N | Aq | | | | | | | | | |
| Rithrogena sp. | A | Aq | | | | | | | | | |
| Iron sp. | N | Aq | | | | | | | | | |
| Iron sp. | A | Aq | | | | | | | | | |
| Cinygmula sp. | N | Aq | | | | | | | | | |
| Plecoptera | A | Aq | | | 2 | | | | | | |
| Perlodidae: Diura sp. | N | Aq | | | | | | | | | |
| Arcynopteryx sp. | N | Aq | | | | | | | | | |
| Arcynopteryx sp. | A | Aq | | | | | | | | | |
| Chloroperlidae: Hastaperla sp. | N | Aq | | | | | | 1 | | | |
| Hastaperla sp. | A | Aq | | | | | | | | | |
| Capniidae: Capnia sp. | A | Aq | | | | | | | | | |
| Nemouridae: Nemoura sp. 1 | N | Aq | 1 | | | | | | | | |
| Trichoptera | A | Aq | | | | | | | | | |
| Psychomyiidae: Tinodes sp. | L | Aq | | | | | | | | | |
| Tinodes sp. | P | Aq | | | | | | | | | |
| Hydropsychidae: Parapsyche sp. | L | Aq | | | | | | | | | |
| Brachycentridae: Brachycentrus sp. | L | Aq | | | | | | | | | |
| Glossosomatidae: Glossosoma sp. | L | Aq | 1 | 6 | | 1 | | | | | |
| Diptera | A | T | | | | | | | | 2 | |
| Chironomidae | L | Aq | | | | | | | | | |
| Chironomidae | A | Aq | | | | | 1 | | | | |
| Simuliidae | L | Aq | | | | | | | | | |
| Simuliidae | A | Aq | 1 | | | | | | | | |
| Ephydridae: Ephydra sp. | A | Aq | | | | | | | | | |
| Muscidae | A | T | | | | | | | | | |
| Syrphidae | A | T | | | 2 | | | | | | |
| Bibionidae | A | T | | | | | | | | | |
| Coleoptera | A | T | | | | | | | | | |
| Dytiscidae | A | Aq | | | | | | | | | 1 |
| Carabidae | A | T | | | | | | | | | |
| Chrysomelidae | A | T | | | | | | | | | |
| Staphylinidae | A | T | | | | | | | | | |
| Heteroptera | | | | | | | | | | | |
| Corixidae | A | Aq | | | | | | | | | 1 |
| Homoptera | | | | | | | | | | | |
| Cercopidae | A | T | | | | | | | | | |
| Membracidae | A | T | | | | | | | | | |
| Cicadellidae | A | T | | | | | | | | | |
| Fulgoridae | A | T | | | | | | | | | |
| Aphidae | A | T | | | | | | | | | |
| Hymenoptera | | | | | | | | | | | |
| Formicidae | A | T | 1 | | | | | | | 1 | |
| Tenthredinidae | A | T | | | | | | | | | |
| Ichneumonidae | A | T | | | | 1 | | | | | |
| Lepidoptera | A | T | | | | | | | | | |
| Geometridae | L | T | | | | | | | | | |
| Sphingidae | L | T | | | | | | 1 | | | |
| ARANEAE | | T | | | | | | | | | |
| ANNELIDAE | | T | | | | | | | | | |
| MILLIPEDEA | | T | | | | | | | | | |

1 Stage: N = Nymph L = Larvae P = Pupa A = Adult

2 Aq/T: Aquatic of Terrestrial

Appendix 6.2 Cont'd

SITE: G2 — DATE: September 26, 1984 — SPECIES: Steelhead Trout

| | Stage[1] | Aq/T[2] | 19 | 20 | 21 | 22 | 23 | 24 | 25 | |
|---|---|---|---|---|---|---|---|---|---|---|
| INSECTA | | | | | | | | | | |
| Ephemeroptera | | | | | | | | | | |
| Baetidae: *Baetis* sp. | N | Aq | | | | | | | | |
| *Baetis* sp. | A | Aq | | | | | | | | |
| Siphlonuridae: *Ameletus* sp. | N | Aq | | | | | | | | |
| Ephemerellidae: *E. doddsi* | N | Aq | | | | | | | | |
| *E. spinifera* | N | Aq | | | | | | | | |
| *E. spinifera* | A | Aq | | | | 5 | | | | |
| Heptageniidae: *Rithrogena* sp. | N | Aq | | | | | | | | |
| *Rithrogena* sp. | A | Aq | | | | 3 | | | | |
| *Iron* sp. | N | Aq | | | | | | | | |
| *Iron* sp. | A | Aq | | | | | | | | |
| *Cinygmula* sp. | N | Aq | | | | | | | | |
| Plecoptera | A | Aq | | 1 | | | | | | |
| Perlodidae: *Diura* sp. | N | Aq | | | | | | | | |
| *Arcynopteryx* sp. | N | Aq | | | | | | | | |
| *Arcynopteryx* sp. | A | Aq | | | | 1 | | | | |
| Chloroperlidae: *Hastaperla* sp. | N | Aq | | | | | | | | |
| *Hastaperla* sp. | A | Aq | | | | | | | | |
| Capniidae: *Capnia* sp. | A | Aq | | | | | | | | |
| Nemouridae: *Nemoura* sp. 1 | N | Aq | | | | | | | | |
| Trichoptera | A | Aq | | | | | | | 1 | |
| Psychomyiidae: Tinodes sp. | L | Aq | | | | | 1 | | | |
| *Tinodes* sp. | P | Aq | | | | | | | | |
| Hydropsychidae: *Parapsyche* sp. | L | Aq | | | | | | | | |
| Brachycentridae: *Brachycentrus* sp. | L | Aq | | | | | | | | |
| Glossosomatidae: *Glossosoma* sp. | L | Aq | | | 1 | | | 2 | 1 | |
| Diptera | A | T | | | | | | | | |
| Chironomidae | L | Aq | | | | | | | 2 | |
| Chironomidae | A | Aq | | | | | | | 1 | |
| Simuliidae | L | Aq | | | | | | | | |
| Simuliidae | A | Aq | | | | | | | | |
| Ephydridae: *Ephydra* sp. | A | Aq | | | | | | | | |
| Muscidae | A | T | | | | | | | | |
| Syrphidae | A | T | | | | | | | | |
| Bibionidae | A | T | | | | | | | | |
| Coleoptera | A | T | | | | | | | | |
| Dytiscidae | A | Aq | | | | | | | | |
| Carabidae | A | T | | | | 1 | | | | |
| Chrysomelidae | A | T | | | | | | | | |
| Staphylinidae | A | T | | | | | | | | |
| Heteroptera | | | | | | | | | | |
| Corixidae | A | Aq | | 1 | | | | | | |
| Homoptera | | | | | | | | | | |
| Cercopidae | A | T | 1 | | | 1 | | | | |
| Membracidae | A | T | | | | 1 | | | | |
| Cicadellidae | A | T | | | | 1 | | | | |
| Fulgoridae | A | T | | | | | | | | |
| Aphidae | A | T | | | | | | | | |
| Hymenoptera | | | | | | | | | | |
| Formicidae | A | T | | | | | 1 | | | |
| Tenthredinidae | A | T | | | | | | | | |
| Ichneumonidae | A | T | | | | | | | | |
| Lepidoptera | A | T | | | | | | | | |
| Geometridae | L | T | | | | | | | | |
| Sphingidae | L | T | | | | | | | | |
| ARANEAE | | T | | | | | | | | |
| ANNELIDAE | | T | | | | | | | | |
| MILLIPEDEA | | T | | | | | | | | |

[1] Stage: N = Nymph L = Larvae P = Pupa A = Adult

[2] Aq/T: Aquatic or Terrestrial

Appendix 6.2 Cont'd

SITE: G5 DATE: September 20, 1984 SPECIES: Dolly Varden Char

| INSECTA | Stage[1] | Aq/T[2] | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Ephemeroptera | | | | | | | | | | | |
| Baetidae: Baetis sp. | N | Aq | | 1 | | | 2 | 1 | | 3 | |
| Baetis sp. | A | Aq | | | | | 8 | 3 | 9 | | |
| Siphlonuridae: Ameletus sp. | N | Aq | | | | | | | | | |
| Ephemerellidae: E. doddsi | N | Aq | | | | | | | | | |
| E. spinifera | N | Aq | | | 1 | | | | | 1 | 3 |
| E. spinifera | A | Aq | | | | | | | | | 3 |
| Heptageniidae: Rithrogena sp. | N | Aq | | | 2 | | 1 | | | 1 | 1 |
| Rithrogena sp. | A | Aq | | | | | | | 3 | 2 | 1 |
| Iron sp. | N | Aq | | | | | | | | 3 | |
| Iron sp. | A | Aq | | | | | | | | | |
| Cinygmula sp. | N | Aq | | 1 | | | | | | 1 | |
| Plecoptera | A | Aq | | | | | | | | | |
| Perlodidae: Diura sp. | N | Aq | | | | | | | | | |
| Arcynopteryx sp. | N | Aq | | | | | | | | | 1 |
| Arcynopteryx sp. | A | Aq | | | | | | | | | |
| Chloroperlidae: Hastaperla sp. | N | Aq | 1 | | | | | | | | |
| Hastaperla sp. | A | Aq | | | | | | | | | |
| Capniidae: Capnia sp. | A | Aq | | | | | | | | | 1 |
| Nemouridae: Nemoura sp. 1 | N | Aq | | 1 | | | 1 | 1 | | | |
| Trichoptera | A | Aq | | | | 1 | | | | | |
| Psychomyiidae: Tinodes sp. | L | Aq | | 1 | | | | | | | |
| Tinodes sp. | P | Aq | 1 | | | | | | | | |
| Hydropsychidae: Parapsyche sp. | L | Aq | | | | | | | | | |
| Brachycentridae: Brachycentrus sp. | L | Aq | | | | | | | | | |
| Glossosomatidae: Glossosoma sp. | L | Aq | | | | | | | | | |
| Diptera | A | T | | | | 1 | | | 1 | | |
| Chironomidae | L | Aq | | | | | | | | | |
| Chironomidae | A | Aq | | | | | | | | | |
| Simuliidae | L | Aq | | | 1 | | | | | | |
| Simuliidae | A | Aq | | | | | | | | | |
| Ephydridae: Ephydra sp. | A | Aq | | | | | | 1 | | | |
| Muscidae | A | T | | | | | | | | | |
| Syrphidae | A | T | | | | | | | | | |
| Bibionidae | A | T | | | | | | | 1 | | |
| Coleoptera | A | T | | | | | | | | | |
| Dytiscidae | A | Aq | | | | | | | | | |
| Carabidae | A | T | | | | | | | | | |
| Chrysomelidae | A | T | | | | | | | | | |
| Staphylinidae | A | T | | | | | | | | | |
| Heteroptera | | | | | | | | | | | |
| Corixidae | A | Aq | | | | | | | | | |
| Homoptera | | | | | | | | | | | |
| Cercopidae | A | T | | | | | | | | | |
| Membracidae | A | T | | | | | | | | | |
| Cicadellidae | A | T | | | | | | | 1 | | |
| Fulgoridae | A | T | | | | | | | | | |
| Aphidae | A | T | | | | | | | | | |
| Hymenoptera | | | | | | | | | | | |
| Formicidae | A | T | | | 1 | 1 | | | | | 5 |
| Tenthredinidae | A | T | | | | | 1 | | | | |
| Ichneumonidae | A | T | | 1 | | | | | 2 | | 1 |
| Lepidoptera | A | T | | | | | | | | | |
| Geometridae | L | T | | | | | | | | | |
| Sphingidae | L | T | | | | | | | | | |
| ARANEAE | | T | | | | | | | | | 1 |
| ANNELIDAE | | T | | | | | | | 1 | | |
| MILLIPEDEA | | T | | | | | | | | | |

[1] Stage: N = Nymph L = Larvae P = Pupa A = Adult

[2] Aq/T: Aquatic or Terrestrial

Appendix 6.2 Cont'd

SITE: G5 DATE: September 20, 1984 SPECIES: Dolly Varden Char

| INSECTA | Stage[1] | Aq/T[2] | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 1E |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Ephemeroptera | | | | | | | | | | | |
| Baetidae: Baetis sp. | N | Aq | | | | 1 | | | | 1 | 1 |
| Baetis sp. | A | Aq | 5 | | 1 | 4 | | | | 1 | |
| Siphlonuridae: Ameletus sp. | N | Aq | | | | 1 | | 2 | 1 | | |
| Ephemerellidae: E. doddsi | N | Aq | | | | | | | | | |
| E. spinifera | N | Aq | 3 | | | | | | 1 | | 1 |
| E. spinifera | A | Aq | 4 | | | 1 | | | 2 | | |
| Heptageniidae: Rithrogena sp. | N | Aq | 2 | | 1 | | | | 2 | 3 | 2 |
| Rithrogena sp. | A | Aq | 16 | | | 9 | | | 2 | | |
| Iron sp. | N | Aq | | | 1 | | | | | | |
| Iron sp. | A | Aq | | | | 1 | | | | | |
| Cinygmula sp. | N | Aq | | | | | | | | | |
| Plecoptera | A | Aq | | | | | | | | | |
| Perlodidae: Diura sp. | N | Aq | | | | | | | | | |
| Arcynopteryx sp. | N | Aq | | | | | | | | | |
| Arcynopteryx sp. | A | Aq | 3 | | | | | | | | |
| Chloroperlidae: Hastaperla sp. | N | Aq | | | | | | | | | |
| Hastaperla sp. | A | Aq | | | | | 1 | | | 2 | |
| Capniidae: Capnia sp. | A | Aq | 1 | | | | | | | | |
| Nemouridae: Nemoura sp. 1 | N | Aq | | | | | | 1 | | 5 | |
| Trichoptera | A | Aq | | | | | 1 | | | | |
| Psychomyiidae: Tinodes sp. | L | Aq | | | | | | | | | |
| Tinodes sp. | P | Aq | | | | | | | | | |
| Hydropsychidae: Parapsyche sp. | L | Aq | | | 1 | | | | | | |
| Brachycentridae: Brachycentrus sp. | L | Aq | | | | | | | | | |
| Glossosomatidae: Glossosoma sp. | L | Aq | | | | | | | | | |
| Diptera | A | T | 2 | | | | | | | | |
| Chironomidae | L | Aq | | | | | | | | 1 | |
| Chironomidae | A | Aq | | | | | | | | | |
| Simuliidae | L | Aq | | | | | | | | | |
| Simuliidae | A | Aq | | | | | | | | | |
| Ephydridae: Ephydra sp. | A | Aq | 1 | | | 1 | 2 | | | | |
| Muscidae | A | T | | | | 1 | | | | | |
| Syrphidae | A | T | | | | | | | | | |
| Bibionidae | A | T | | | | | 1 | | | | |
| Coleoptera | A | T | | | | | | | | | |
| Dytiscidae | A | Aq | | | | | | | | | |
| Carabidae | A | T | | | | | | | | | |
| Chrysomelidae | A | T | | | | | | | | | |
| Staphylinidae | A | T | | | | | | | | | |
| Heteroptera | | | | | | | | | | | |
| Corixidae | A | Aq | | | | | | | | | |
| Homoptera | | | | | | | | | | | |
| Cercopidae | A | T | | | | | 1 | | | | |
| Membracidae | A | T | | | | | | | | | |
| Cicadellidae | A | T | | | | | | | | | |
| Fulgoridae | A | T | | | | | 1 | | | | |
| Aphidae | A | T | | | | | | | | | 1 |
| Hymenoptera | | | | | | | | | | | |
| Formicidae | A | T | | 1 | 1 | | | | | | 1 |
| Tenthredinidae | A | T | | | | | | | | | |
| Ichneumonidae | A | T | | | | | 1 | | | | 1 |
| Lepidoptera | A | T | | | | | 1 | | | | |
| Geometridae | L | T | | | | | | | | | |
| Sphingidae | L | T | | | | | | | | | |
| ARANEAE | | T | | | | | | | | | |
| ANNELIDAE | | T | | | | | | | | | |
| MILLIPEDEA | | T | | | | | 1 | | | | |

1 Stage: N = Nymph L = Larvae P = Pupa A = Adult

2 Aq/T: Aquatic or Terrestrial

Appendix 6.2 Cont'd

SITE: G5

DATE: September 20, 1984 SPECIES: Dolly Varden Char

| | Stage[1] | Aq/T[2] | 19 | 20 | 21 | 22 | 23 | 24 | 25 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| INSECTA | | | | | | | | | | | |
| Ephemeroptera | | | | | | | | | | | |
| Baetidae: *Baetis* sp. | N | Aq | | 1 | | | | 1 | | | |
| *Baetis* sp. | A | Aq | | 4 | | | | 1 | | | |
| Siphlonuridae: *Ameletus* sp. | N | Aq | | | | | | | | | |
| Ephemerellidae: *E. doddsi* | N | Aq | | | | | | | | | |
| *E. spinifera* | N | Aq | 2 | | | | | | | | |
| *E. spinifera* | A | Aq | | 1 | | | | | | | |
| Heptageniidae: *Rithrogena* sp. | N | Aq | | | | | | | | | |
| *Rithrogena* sp. | A | Aq | | | | | | 3 | | | |
| *Iron* sp. | N | Aq | 1 | | | | | 1 | | | |
| *Iron* sp. | A | Aq | | | | | | | | | |
| *Cinygmula* sp. | N | Aq | | | 1 | | | | | | |
| Plecoptera | A | Aq | | | | | | | | | |
| Perlodidae: *Diura* sp. | N | Aq | | 1 | | | | | | | |
| *Arcynopteryx* sp. | N | Aq | | | | | | | | | |
| *Arcynopteryx* sp. | A | Aq | | | | | 1 | | | | |
| Chloroperlidae: *Hastaperla* sp. | N | Aq | | | | | | | | | |
| *Hastaperla* sp. | A | Aq | | | | | | | | | |
| Capniidae: *Capnia* sp. | A | Aq | | | 1 | | | | | | |
| Nemouridae: *Nemoura* sp. 1 | N | Aq | | | | | 1 | | | | |
| Trichoptera | A | Aq | | | | | | | | | |
| Psychomyiidae: *Tinodes* sp. | L | Aq | | | 1 | | | | | | |
| *Tinodes* sp. | P | Aq | | | | | | | | | |
| Hydropsychidae: *Parapsyche* sp. | L | Aq | | | | | | | | | |
| Brachycentridae: *Brachycentrus* sp. | L | Aq | | | | | 1 | | | | |
| Glossosomatidae: *Glossosoma* sp. | L | Aq | | | | | | | | | |
| Diptera | A | T | | | | | | | | | |
| Chironomidae | L | Aq | | | | | | 1 | | | |
| Chironomidae | A | Aq | | | | | | | | | |
| Simuliidae | L | Aq | | | | | | | | | |
| Simuliidae | A | Aq | | | | | | | | | |
| Ephydridae: *Ephydra* sp. | A | Aq | | | | | | | | | |
| Muscidae | A | T | | | | | | | | | |
| Syrphidae | A | T | | | | | | | | | |
| Bibionidae | A | T | | | | | | | | | |
| Coleoptera | A | T | | | | | | | | | |
| Dytiscidae | A | Aq | | | | | | | | | |
| Carabidae | A | T | | | | | | | | | |
| Chrysomelidae | A | T | | | | | | | | | |
| Staphylinidae | A | T | | | | | | | | | |
| Heteroptera | | | | | | | | | | | |
| Corixidae | A | Aq | | | | | | | | | |
| Homoptera | | | | | | | | | | | |
| Cercopidae | A | T | | | | | | | 1 | | |
| Membracidae | A | T | | | | 1 | | | | | |
| Cicadellidae | A | T | | | | | | 1 | | | |
| Fulgoridae | A | T | | | | | | | | | |
| Aphidae | A | T | | | | | | | | | |
| Hymenoptera | | | | | | | | | | | |
| Formicidae | A | T | | | | | | | | | |
| Tenthredinidae | A | T | | | | | | | | | |
| Ichneumonidae | A | T | | | | | | | | | |
| Lepidoptera | A | T | | | | | | | | | |
| Geometridae | L | T | | | | | | | | | |
| Sphingidae | L | T | | | | | | | | | |
| ARANEAE | | T | | | | | | | | | |
| ANNELIDAE | | T | | | | | | | | | |
| MILLIPEDEA | | T | | | | | | | | | |

[1] Stage: N = Nymph L = Larvae P = Pupa A = Adult

[2] Aq/T: Aquatic or Terrestrial

Appendix 7. Length and Area Calculations for Lower Telkwa River Side Channel and Wetland Habitat[1]

| CODE[2] | RELIC CHANNELS[3] | | | ACTIVE CHANNELS | | | FLOOD CHANNELS | | | WETLANDS | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Length (m) | Width (m) | Area (m²) | Length (m) | Width (m) | Area (m²) | Length (m) | Width (m) | Area (m²) | Length (m) | Width (m) |
| 2A | | | | 676 | 2.1 | 1420 | | | | | |
| 3R | 82 | 3.3 | 271 | | | | | | | | |
| 4R | 135 | 5.0 | 675 | | | | | | | | |
| 5A | | | | 165 | 4.4 | 726 | | | | | |
| 6Fw | | | | | | | 226 | 3.3 | 746 | | |
| 7Fd | | | | | | | 82 | dry | | | |
| 8R | 152 | dry | | | | | | | | | |
| 9Fg | | | | | | | 256 | 8.8 | 2253 | | |
| 10R | 248 | 3.3 | 818 | | | | | | | | |
| 11Fw | | | | | | | 152 | 9.4 | 1429 | | |
| 12A | | | | 544 | 2.8 | 1523 | | | | | |
| 13A | | | | 63 | 1.6 | 101 | | | | | |
| 14Fw | | | | | | | 68 | 9.9 | 673 | | |
| 15Fw | | | | | | | 41 | 8.2 | 336 | | |
| 16Fw | | | | | | | 102 | 12.1 | 1234 | | |
| 18Fw | | | | | | | 134 | 14.3 | 1916 | | |
| 19Fw | | | | | | | 408 | 23.6 | 9626 | | |
| 20Fw | | | | | | | 117 | 6.1 | 714 | | |
| 21Fw | | | | | | | 190 | 1.6 | 304 | | |
| 22Fw | | | | | | | 148 | 2.2 | 326 | | |
| 23Fw | | | | | | | 35 | 2.5 | 87 | | |
| 24A (SC2) | | | | 1980 | 14.5 | 28710 | | | | | |
| 25A | | | | 191 | 7.2 | 1375 | | | | | |
| 25Fd | | | | | | | 180 | dry | | | |
| 26R | 233 | 6.1 | 1421 | | | | | | | | |
| 27A | | | | 186 | 5.0 | 930 | | | | | |
| 28R | 201 | dry | | | | | | | | | |
| 29A | | | | 307 | 5.0 | 1535 | | | | | |
| 29R | 137 | dry | | | | | | | | | |
| 30R | 180 | 2.2 | 396 | | | | | | | | |
| 30A | | | | 182 | 3.3 | 601 | | | | | |
| 31R | 495 | dry | | | | | | | | | |
| 32R | 478 | dry | | | | | | | | | |
| 33A | | | | 201 | 2.2 | 442 | | | | | |

Appendix 7 Cont'd

| CODE[2] | RELIC CHANNELS[3] | | | ACTIVE CHANNELS | | | FLOOD CHANNELS | | | WETLANDS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Length (m) | Width (m) | Area ($m^2$) | Length (m) | Width (m) | Area ($m^2$) | Length (m) | Width (m) | Area ($m^2$) | Length (m) | Width (m) | Area ($m^2$) |
| 34Fw | | | | | | | 172 | 1.6 | 275 | | | |
| 35Fw | | | | | | | 186 | 6.1 | 1135 | | | |
| 36A | | | | 252 | 5.5 | 1386 | | | | | | |
| 37A | | | | 167 | 2.5 | 418 | | | | | | |
| 39Fw | | | | | | | 104 | 7.7 | 801 | | | |
| 40Fw | | | | | | | 122 | 3.3 | 403 | | | |
| 41A | | | | 82 | 8.2 | 672 | | | | | | |
| 42Fw | | | | | | | 97 | 6.6 | 640 | | | |
| 43R | 101 | dry | | | | | | | | | | |
| 44Fd | | | | | | | 71 | dry | | | | |
| 45Fw | | | | | | | 35 | 2.5 | 88 | | | |
| 46A (SC3) | | | | 125 | 14.8 | 1850 | | | | | | |
| 47Fw | | | | | | | 158 | 16.0 | 2528 | | | |
| 48Fw | | | | | | | 59 | 8.2 | 484 | | | |
| 49A | | | | 186 | 2.2 | 409 | | | | | | |
| 50R | 163 | dry | | | | | | | | | | |
| 51A | | | | 211 | 3.3 | 696 | | | | | | |
| 52Fw | | | | | | | 124 | 9.9 | 1228 | | | |
| 53A | | | | 742 | 13.6 | 10091 | | | | | | |
| 54Fw | | | | | | | 64 | 17.6 | 1126 | | | |
| 55Fw | | | | | | | 33 | 9.9 | 327 | | | |
| 56A | | | | 153 | 4.4 | 673 | | | | | | |
| 57R | 132 | dry | | | | | | | | | | |
| 58Fw (SC1) | | | | | | | 107 | 9.9 | 1059 | | | |
| 59Fw | | | | | | | 330 | 5.8 | 1914 | | | |
| 60Fw | | | | | | | 162 | 16.5 | 2673 | | | |
| 61Rg | 627 | 8.2 | 5141 | | | | | | | | | |
| 62Fw | | | | | | | 152 | 5.2 | 790 | | | |
| 63Fw | | | | | | | 144 | 24.8 | 3571 | | | |
| 64Fw | | | | | | | 82 | 7.7 | 631 | | | |
| 65Fg | | | | | | | 462 | 8.8 | 4066 | | | |
| 66Fw | | | | | | | 69 | 4.4 | 304 | | | |
| 67Fw | | | | | | | 111 | 9.4 | 1043 | | | |
| 68R | 396 | dry | | | | | | | | | | |

Appendix 7 Cont'd

| CODE[2] | RELIC CHANNELS[3] | | | ACTIVE CHANNELS | | | FLOOD CHANNELS | | | WETLANDS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Length (m) | Width (m) | Area (m²) | Length (m) | Width (m) | Area (m²) | Length (m) | Width (m) | Area (m²) | Length (m) | Width (m) | A[illegible] |
| 69Fw | | | | | | | 280 | 6.1 | 1708 | | | |
| 70R | 254 | dry | | | | | | | | | | |
| 71R | 528 | dry | | | | | | | | | | |
| 72R | 528 | dry | | | | | | | | | | |
| 73Fg | | | | | | | 412 | 3.1 | 1277 | | | |
| 74Fw | | | | | | | 210 | 6.1 | 1281 | | | |
| 75R | 330 | dry | | | | | | | | | | |
| 76R | 302 | dry | | | | | | | | | | |
| 77A | | | | 152 | 15.4 | 2341 | | | | | | |
| 78Fw | | | | | | | 198 | 11.6 | 2297 | | | |
| 79Fg | | | | | | | 247 | 8.2 | 2025 | | | |
| | | | | | | | | | | | | |
| WL1a | | | | | | | | | | 162 | 9.4 | [illegible] |
| WL1b | | | | | | | | | | 346 | 8.7 | [illegible] |
| | | | | | | | | | | | | |
| WL2 | Part of tributary 1 | | | | | | | | | | | |
| WL3 | Pond on tributary 1 | | | | | | | | | 412 | 9.1 | [illegible] |
| WL4 | Included in 61 Rg | | | | | | | | | | | |
| WL5 | | | | | | | | | | 664 | 19.6 | [illegible] |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| TOTALS | 5702 | | 8722[4] | 6565 | | 55899 | Fw-5597 | | 53321 | 1584 | | [illegible] |
| | | | | | | | Fd-333 | | | | | |

[1] Since these measurements were derived from air photos taken on August 8, 1983, (a period where streamflows were still high), the estimates represent the maximum amount of habitat in channels.

[2] See Figure 3.9 for channel locations.

[3] Refer to Table 3.14 for a definition of channel classification.

[4] Many of the relic channels were dry.

Appendix 8.1 Key to Abbreviations Used in Appendix 8.2

| | |
|---|---|
| BM | benchmark |
| D50 | diameter of bed material larger than 50% of the remaining bed material |
| D90 | diameter of bed material larger than 90% of the remaining bed material |
| x | average |
| fl | fork length |
| fl | average fork length |
| U1 | number of fish collected in first removal |
| U2 | number of fish collected in second removal |
| T | total number of fish collected ($U_1 + U_2$) |
| M | number of fish marked after first pass |
| C | number of marked and unmarked fish recaptured |
| R | number of recaptured marked fish |
| N | number; total population of fish in site (estimated from sample - see Appendix 2) |
| S.E. | standard error of population estimate |
| Morts | number of mortalities in sampling |
| N Corr. | population estimate corrected for mortalities |
| Rbt | rainbow trout |
| Sthd | steelhead trout |
| DV | Dolly Varden char |
| MW | mountain whitefish |
| Co | coho salmon |
| Ch | chinook salmon |
| Lnd | longnose dace |
| 0+ | fish in their first growing season prior to their first winter |
| 1+ | fish in their second growing season after one winter |
| 1-3 (R2) | Photo reference number from D. Bustard files. |

Appendix 8.2 Site Descriptions and Detailed Results of Fish Sampling in Goathorn and Tenas Creeks and the Telkwa and Bulkley Rivers, September and October, 1984

## SITE DESCRIPTION - G1

Location: Approximately 70 m downstream of gas pipeline crossing of Goathorn Creek. Area: 725 $m^2$. Crew: DB, MF, DS.
Date: September 17, 1984. Length of stream margin: 62 m. Photos: 17-19 (R2). Water Temperature: 7°C @ 1400 hr.
Comment: Same site as in 1983 but flows are higher and fry habitat in the lower end is more extensive.

**BENTHOS SAMPLE SITE:** Location: Bench Mark located on right bank approx. 150 m below beaver dam and 10 m below lower stop net

| Sample # | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Dist. from BM (m) | 3.0 | 4.5 | 6.5 | 8.5 | 13.5 | 15.5 |
| Depth (cm) | 22 | 25 | 18 | 15 | 15 | 40 |
| D50 | 6 | 8 | 5 | 6 | 3 | 11 |
| D90 | 12 | 13 | 18 | 17 | 18 | 22 |

Avg. Water Velocity - 0.62 m/sec Comment: A lot of algae present this year, especially in samples 1-4

**FISH SAMPLE SITE:**

| Location (m) | Width (m) | Mean Depth (cm) | Max. Depth (cm) | Bank Cover | Debris Cover | D50/D90 (cm) |
|---|---|---|---|---|---|---|
| 0 | 17.6 | 24 | 31 | - | - | - |
| 10 | 14.8 | 25 | 34 | - | - | 8/25 |
| 20 | 13.4 | 32 | 43 | - | - | - |
| 30 | 13.7 | 25 | 50 | x | x | 9/30 |
| 40 | 7.0 | 40 | 65 | x | x | 12/30 |
| 50 | 7.7 | 30 | 50 | - | x | 13/30 |
| 60 | 7.5 | 30 | 45 | - | x | 12/28 |
| 62 | | | | | | |
| $\bar{x}$ | 11.7 | | | | | |

| FISH SAMPLE: Species | Age | fl-range (mm) | $\overline{fl}$ (mm) | Mean Weight (g) | M | C | R | N | S.E. | Morts | N Corr. | N/$m^2$ | N/ Linear m | Biomass g/$m^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sthd | 0+ | 32-57 | 39.1 | 0.95 | 94 | 101 | 35 | 268 | 28.7 | 14 | 282 | 0.389 | 4.55 | 0.37 |
| Sthd | 1+ | 62-92 | 79.9 | 7.62 | 42 | 46 | 25 | 77 | 6.6 | 0 | 77 | 0.106 | 1.24 | 0.81 |
| Sthd | ≥2+ | 105-129 | 115.5 | 22.39 | 7 | 5 | 2 | 15 | 6.1 | 0 | 15 | 0.021 | 0.24 | 0.46 |
| DV | 0+ | | | | 0 | 0 | 0 | 0 | - | 0 | 0 | - | - | 0.00 |
| DV | ≥1+ | 63-115 | 90.3 | 8.45 | 2 | 2 | 1 | 4 | 2.3 | 0 | 4 | 0.006 | 0.06 | 0.05 |
| MW | ≥1+ | 112 | 112.0 | 15.28 | 0 | 1 | 0 | 1 | NA | 0 | 1 | 0.001 | 0.02 | 0.02 |
| Total | | | | | | | | | | | 379 | 0.523 | 6.11 | 1.71 |

Note: For abbreviations and symbols used in this table see first page of Appendix 8

SITE DESCRIPTION - G2

Location: Lower net located at water gauging station above lower bridge on Goathorn Creek (as in 1983). Area: 714 $m^2$
Crew: DB, MF, DS. Date: September 26, 1984. Length of stream margin: 70 m. Photos: 1 & 2 (R4). Gradient: 2.5%.
Water Temperature: 2°C @ 9:45. Comment: Flows are lower than last year at this site.

BENTHOS SAMPLE SITE: Location: 10 m upstream of upper fish sample site

| Sample # | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Dist. from BM (m) | 4.5 | 6.5 | 8.5 | 10.5 | 12.5 | 2 m up from 13 |
| Depth (cm) | 27 | 27 | 35 | 18 | 15 | 20 |
| D50 | 2 | 4 | 3 | 3 | 3 | 4 |
| D90 | 12 | 20 | 15 | 10 | 10 | 18 |

Average water velocity - 0.86 m/sec

FISH SAMPLE SITE:

| Location (m) | Width (m) | Mean Depth (cm) | Max. Depth (cm) | Bank Cover | Debris Cover | D50/D90 (cm) |
|---|---|---|---|---|---|---|
| 0 | 8.7 | 15 | 34 | x | - | 11/32 |
| 10 | 12.2 | 20 | 42 | x | - | 5/30 |
| 20 | 12.2 | 25 | 40 | - | x | 7/30 |
| 30 | 11.1 | 25 | 35 | - | - | 8/35 |
| 40 | 12.8 | 23 | 40 | x | - | 10/35 |
| 50 | 12.3 | 20 | 35 | - | - | 12/50 |
| 60 | 11.4 | 25 | 35 | - | - | 15/50 |
| 70 | 10.9 | 30 | 40 | - | - | 3/50 |
| $\bar{x}$ | 11.4 | | | | | |

| FISH SAMPLE: Species | Age | fl-range (mm) | $\overline{fl}$ (mm) | Mean Weight (g) | M | C | R | N | S.E. | Morts | N Corr. | N/$m^2$ | N/ Linear m | Biomass g/$m^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sthd | 0+ | 29-42 | 35.3 | 0.70 | 24 | 30 | 12 | 59 | 9.2 | 5 | 64 | 0.090 | 0.91 | 0.06 |
| Sthd | 1+ | 62-95 | 73.7 | 6.02 | 34 | 37 | 26 | 48 | 2.4 | 2 | 50 | 0.070 | 0.71 | 0.42 |
| Sthd | >2+ | 103-125 | 113.8 | 21.48 | 7 | 9 | 6 | 10 | 0.7 | 0 | 10 | 0.014 | 0.14 | 0.30 |
| DV | 0+ | - | - | - | 0 | 0 | 0 | 0 | - | | 0 | 0 | 0 | 0 |
| DV | >1+ | 106-125 | 118.7 | 17.95 | 3 | 1 | 1 | 3 | NA | 0 | 3 | 0.004 | 0.04 | 0.08 |
| MW | | | | | | | | | | | | | | |
| Total | | | | | | | | | | | 127 | 0.178 | 1.80 | 0.86 |

Note: For abbreviations and symbols used in this table see first page of Appendix 8

Appendix 8.2 Cont'd

SITE DESCRIPTION - G3

Location: Old mine site (McNeil) between power line and coal mine site (as in 1983). Area: 453 $m^2$. Crew: OB, MF, OS.
Date: September 19, 1984. Length of stream margin: 44 m. Photos: 3 & 4 (R3). Gradient: 2.5% Water Temperature: 4°C @ 10:00 hr., 6°C @ 13:00 hr.

BENTHOS SAMPLE SITE: Location: Riffle located where road and creek meet (as in 1983). Site was split by gravel bar

| Sample # | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Dist. from BM (m) | 6.0 | 7.5 | 9.5 | 11.0 | 16.0 | 17.0 |
| Depth (cm) | 20 | 19 | 28 | 30 | 12 | 11 |
| D50 | 3 | 5 | 5 | 4 | 3 | 3 |
| D90 | 8 | 15 | 13 | 15 | 9 | 12 |

Average water velocity: Main (1-4) = 0.90 m/sec. Side (5-6) = 0.45 m/sec.

| FISH SAMPLE SITE: | Location (m) | Width (m) | Mean Depth (cm) | Max. Depth (cm) | Bank Cover | Debris Cover | D50/D90 (cm) |
|---|---|---|---|---|---|---|---|
| Side Channel | 0 | 4.5 | 12 | 17 | - | - | 7/11 |
| | 10 | 4.0 | 16 | 21 | - | - | 7/11 |
| | 20 | 5.3 | 10 | 14 | - | - | 4/9 |
| Main Channel | 0 | 9.5 | 35 | 42 | - | - | 11/15 |
| | 10 | 8.3 | 38 | 41 | - | - | 9/17 |
| | 20 | 8.2 | 30 | 42 | - | - | 12/22 |
| | 30 | 7.7 | 90 | 147 | - | x | 4/19 |
| | 40 | 7.4 | 35 | 43 | - | - | 10/17 |
| | 44 | | | | | | |
| | $\bar{x}$ | 8.2 | | | | | |

| FISH SAMPLE: Species | Age | fl-range (mm) | $\overline{fl}$ (mm) | Mean Weight (g) | M | C | R | N | S.E. | Morts | N Corr. | N/$m^2$ | N/ Linear m | Biomass g/$m^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sthd | 0+ | 31-50 | 39.5 | 0.98 | 13 | 9 | 4 | 27 | 7.8 | 2 | 29 | 0.064 | 0.66 | 0.06 |
| Sthd | 1+ | 71-93 | 81.6 | 8.15 | 9 | 4 | 4 | 9 | NA | 0 | 9 | 0.020 | 0.20 | 0.16 |
| Sthd | ≥2+ | 101-205 | 134.3 | 34.91 | 10 | 10 | 5 | 19 | 4.0 | 0 | 19 | 0.042 | 0.43 | 1.46 |
| DV | 0+ | 41-59 | 48.0 | 1.48 | 17 | 9 | 5 | 29 | 6.9 | 1 | 30 | 0.066 | 0.68 | 0.10 |
| DV | ≥1+ | 71-137 | 93.9 | 9.41 | 17 | 16 | 9 | 30 | 4.6 | 1 | 31 | 0.068 | 0.70 | 0.64 |
| MW | | | | | | | | | | | | | | |
| Total | | | | | | | | | | | 118 | 0.260 | 2.67 | 2.42 |

Note: For abbreviations and symbols used in this table see first page of Appendix 8

## SITE DESCRIPTION - G4

Location: Approximately 400 m upstream from coal mine (as in 1983). Crew: DB, MF, DS. Date: September 18, 1984.
Length of margin: 52 m. Photos: 1 & 2 (R3). Gradient: 2.0% Water Temperature: 5°C @ 10:00 hrs. Area: 458 $m^2$

BENTHOS SAMPLE SITE: Location: Lower section of fish sample site (as in 1983). Mid section of channel too fast to use sampler

| Sample # | 1 | 2 (split) | 3 | 4 2 m above | 5 | 6 |
|---|---|---|---|---|---|---|
| Dist. from BM (m) | 4.5 | 6.5 | 8.5 | 13 m | 12.5 | 14.5 |
| Depth (cm) | 27 | 30 | 38 | 28 | 27 | 29 |
| D50 | 7 | 5 | 8 | 3 | 2 | 5 |
| D90 | 20 | 22 | 25 | 16 | 10 | 15 |

Average water velocity: 0.88 m/sec.

FISH SAMPLE SITE:

| Location (m) | Width (m) | Mean Depth (cm) | Max. Depth (cm) | Bank Cover | Debris Cover | D50/D90 (cm) |
|---|---|---|---|---|---|---|
| 0 | 13.0 | 38 | 43 | - | - | 11/21 |
| 10 | 9.3 | 85 | 94 | x | - | 11/19 |
| 20 | 7.2 | 38 | 46 | x | - | 12/20 |
| 30 | 6.8 | 40 | 47 | x | x | 19/30 |
| 40 | 7.3 | 37 | 67 | - | - | 14/18 |
| 50 | 9.0 | 31 | 45 | - | x | 9/23 |
| 52 | | | | | | |
| $\bar{x}$ | 8.8 | | | | | |

Comment: Stream flows are high and the upper 25 m of this site are fast flowing and difficult to sample.

| FISH SAMPLE: Species | Age | fl-range (mm) | $\overline{fl}$ (mm) | Mean Weight (g) | M | C | R | N | S.E. | Morts | N Corr. | N/$m^2$ | N/ Linear m | Biomass g/$m^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sthd | 0+ | 28-29 | 28.3 | 0.37 | 2 | 1 | 0 | 5 | NA | - | 5 | 0.011 | 0.10 | <0.01 |
| Sthd | 1+ | 81 | 81.0 | 7.94 | 1 | 0 | 0 | 1 | NA | - | 1 | 0.002 | 0.02 | 0.02 |
| Sthd | ≥2+ | 105-185 | 146.0 | 44.46 | 3 | 3 | 3 | 3 | NA | - | 3 | 0.006 | 0.06 | 0.29 |
| DV | 0+ | 38-56 | 47.2 | 1.41 | 13 | 9 | 4 | 27 | 7.8 | 3 | 30 | 0.066 | 0.58 | 0.09 |
| DV | ≥1+ | 66-151 | 98.7 | 10.80 | 24 | 12 | 9 | 32 | 4.3 | 1 net | 33 | 0.072 | 0.63 | 0.78 |
| MW | | | | | | | | | | | | | | |
| Total | | | | | | | | | | | 72 | 0.157 | 1.39 | 1.18 |

Note: For abbreviations and symbols used in this table see first page of Appendix 8

Appendix 8.2 Cont'd

SITE DESCRIPTION - G5

Location: Approximately 0.5 km upstream from new bridge crossing to Hunter Basin; 50 m upstream of old crossing (as in 1983).
Crew: DB, MF, DS. Date: September 20, 1984. Length of stream margin: 94.5 m. Photos: 8 (R3). Water Temperature: 4°C @ 1100 hr
Area: 973 $m^2$.

BENTHOS SAMPLE SITE: Location: Top end of fish sample site (as in 1983)

| Sample # | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Dist. from BM (m) | 4.0 | 5.5 | 7.0 | 8.5 | 10.0 | 11.5 |
| Depth (cm) | 28 | 40 | 30 | 32 | 21 | 20 |
| D50 | 2 | 4 | 5 | 3 | 2 | 2 |
| D90 | 10 | 16 | 18 | 14 | 17 | 18 |

Average water velocity: 0.60 m/sec.

FISH SAMPLE SITE:

| Location (m) | Width (m) | Mean Depth (cm) | Max. Depth (cm) | Bank Cover | Debris Cover | D50/D90 (cm) |
|---|---|---|---|---|---|---|
| 0 | 11.4 | 37 | 50 | - | - | 12/22 |
| 10 | 10.1 | 32 | 46 | - | - | 11/19 |
| 20 | 8.9 | 26 | 28 | - | - | 10/22 |
| 30 | 11.9 | 27 | 33 | x | - | 9/20 |
| 40 | 14.1 | 22 | 42 | x | x | 12/25 |
| 50 | 14.8 | 23 | 40 | x | - | 8/28 |
| 60 | 9.1 | 28 | 40 | x | x | 5/18 |
| 70 | 7.4 | 28 | 40 | - | x | 12/22 |
| 80 | 7.8 | 34 | 36 | x | - | 7/19 |
| 90 | 7.4 | 33 | 40 | - | - | 6/22 |
| 94.5 | - | - | - | - | - | - |
| $\bar{x}$ | 10.3 | | | | | |

| FISH SAMPLE: Species | Age | fl-range (mm) | $\overline{fl}$ (mm) | Mean Weight (g) | M | C | R | N | S.E. | Morts | N Corr. | N/$m^2$ | N/ Linear m | Biomass g/$m^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sthd | 0+ | 27-28 | 27.5 | 0.34 | 1 | 1 | 0 | 3 | NA | 0 | 3 | 0.003 | 0.03 | <0.01 |
| Sthd | 1+ | 64 | 64.0 | 4.00 | 1 | 1 | 1 | 1 | NA | 0 | 1 | 0.001 | 0.01 | <0.01 |
| Sthd | ≥2+ | 163 | 163.0 | 61.52 | 1 | 0 | 0 | 1 | NA | 0 | 1 | 0.001 | 0.01 | 0.06 |
| DV | 0+ | 31-58 | 48.3 | 1.51 | 14 | 5 | 4 | 17 | 3.0 | 1 | 18 | 0.018 | 0.19 | 0.03 |
| DV | ≥1+ | 62-180 | 102.6 | 12.01 | 35 | 42 | 18 | 80 | 9.7 | 0 | 80 | 0.082 | 0.85 | 0.99 |
| MW | | | | | | | | | | | | | | |
| Total | | | | | | | | | | | 103 | 0.105 | 1.09 | 1.08 |

Note: 5 of the larger DV were ripe fish.

Note: For abbreviations and symbols used in this table see first page of Appendix 8

SITE DESCRIPTION - G6

Location: Immediately downstream of the Goathorn/Cabinet Creek confluence. Helicopter access. New site in 1984. Crew: DB, MF
Date: October 24, 1984. Length of stream margin: 28.5 m. Photos: 8-10 (R5). Water Temperature: 1°C @ 1500 hr. Area: 185 $m^2$

BENTHOS SAMPLE SITE: Location:

| Sample # | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Dist. from BM (m) | | | | | | |
| Depth (cm) | | | NOT CONDUCTED | | | |
| D50 | | | | | | |
| D90 | | | | | | |
| Average water velocity | | | | | | |

FISH SAMPLE SITE:

| Location (m) | Width (m) | Mean Depth (cm) | Max. Depth (cm) | Bank Cover | Debris Cover | D50/D90 (cm) |
|---|---|---|---|---|---|---|
| 0 | 5.0 | 35 | 55 | - | x | 10/28 |
| 5 | 5.8 | 30 | 66 | - | - | 8/15 |
| 10 | 8.1 | 25 | 30 | - | - | 5/21 |
| 15 | 7.1 | 30 | 40 | - | - | 5/21 |
| 20 | 6.4 | 40 | 50 | - | - | 10/25 |
| 25 | 6.5 | 40 | 52 | - | x | 10/20 |
| $\bar{x}$ | 6.5 | | | | | |

Comment: This site is 80% glide and 20% riffle

| FISH SAMPLE: Species | Age | fl-range (mm) | $\overline{FL}$ (mm) | Mean Weight (g) | U1 | U2 | T | N | S.E. | Morts | N Corr. | N/$m^2$ | N/ Linear m | Biomass g/$m^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sthd | 0+ | - | - | - | 0 | 0 | 0 | 0 | - | 0 | 0 | - | | |
| Sthd | 1+ | 88 | 88.0 | 10.11 | 1 | 0 | 1 | 1 | NA | 0 | 1 | 0.005 | 0.04 | 0.05 |
| Sthd | $\geq$2+ | - | - | - | 0 | 0 | 0 | 0 | - | - | 0 | - | | |
| DV | 0+ | 41-46 | 42.8 | 1.08 | 2 | 2 | 4 | 4 | NA | 0 | 4 | 0.022 | 0.14 | 0.02 |
| DV | $\geq$1+ | 63-210 | 106.7 | 13.38 | 32 | 8 | 40 | 43 | 2.8 | 0 | 43 | 0.232 | 1.51 | 3.11 |
| MW | | | | | | | | | | | | | | |
| Total | 3 of the larger DV were ripe spawners (172-210 mm) | | | | | | | | | | 48 | 0.259 | 1.69 | 3.18 |

Note: For abbreviations and symbols used in this table see first page of Appendix 8

SITE DESCRIPTION - G7

Location: Upper net approximately 20 m downstream from Cabinet Creek logging bridge. Truck access: New site. Crew: DB, DS
Date: September 13, 1984. Length of stream margin: 23.6 m. Photos: 7-8 (R2). Water Temperature: 4°C @ 1600 hr.
Gradient: 1.5%. Area: 250 $m^2$. Comment: Site is approximately 70% glide, 5% pool, 25% riffle. Flows high but clear after heavy rains (est. 50 cfs).

BENTHOS SAMPLE SITE: Location:

| Sample # | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Dist. from BM (m) | | | | | | |
| Depth (cm) | | | NOT CONDUCTED | | | |
| D50 | | | | | | |
| D90 | | | | | | |
| Average water velocity m/sec | | | | | | |

FISH SAMPLE SITE:

| Location (m) | Width (m) | Mean Depth (cm) | Max. Depth (cm) | Bank Cover | Debris Cover | D50/D90 (cm) |
|---|---|---|---|---|---|---|
| 0 | 12.8 | 25 | 50 | x | x | 10/35 |
| 5 | 12.1 | 25 | 50 | - | x | 8/15 |
| 10 | 10.7 | 30 | 40 | - | x | 8/18 |
| 15 | 9.5 | 30 | 40 | - | x | 10/18 |
| 20 | 8.1 | 40 | 50 | - | x | 3/20 |
| 23.6 | | | | | | |
| x̄ | 10.6 | | | | | |

| FISH SAMPLE: Species | Age | fl-range (mm) | $\overline{fl}$ (mm) | Mean Weight (g) | U1 | U2 | T | N | S.E. | Morts | N Corr. | N/$m^2$ | N/ Linear m | Biomass g/$m^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sthd | 0+ | | | | 0 | 0 | 0 | - | - | - | - | - | - | - |
| Sthd | 1+ | | | | 0 | 0 | 0 | - | - | - | - | - | - | - |
| Sthd | ≥2+ | | | | 0 | 0 | 0 | - | - | - | - | - | - | - |
| DV | 0+ | | | | 0 | 0 | 0 | - | - | - | - | - | - | - |
| DV | ≥1+ | 57-195 | 95.1 | 9.75 | 39 | 10 | 49 | 52 | 3.2 | 4 net | 56 | 0.224 | 2.37 | 2.18 |
| MW | | | | | | | | | | | | | | |
| Total | | | | | | | | | | | 56 | 0.224 | 2.37 | 2.18 |

Note: For abbreviations and symbols used in this table see first page of Appendix 8

SITE DESCRIPTION - T1

Location: Approximately 30 m above lower bridge on Tenas Creek upstream for 83 m. Area: 582.4 $m^2$. Crew: DB, MF, DS. Date: September 12, 1984. Length of stream margin: 83.2 m. Photos: - Water temperature: 8°C @ 1400 hr. Heavy rains during the past two weeks have kept flow levels high. Shocker problems on second pass - resolved.

BENTHOS SAMPLE SITE: Location: Approx. 30 m upstream from bridge

| Sample # | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Dist. from BM (m) | 4.5 | 5.5 | 6.5 | 7.5 | 8.5 | 9.5 |
| Depth (cm) | 42 | 34 | 32 | 27 | 28 | 18 |
| D50 | 12 | 18 | 5 | 12 | 8 | 6 |
| D90 | 22 | 10 | 12 | 25 | 18 | 15 |

Average water velocity 0.88 m/sec

FISH SAMPLE SITE:

| Location (m) | Width (m) | Mean Depth (cm) | Max. Depth (cm) | Bank Cover | Debris Cover | D50/D90 (cm) |
|---|---|---|---|---|---|---|
| 0 | 7.5 | 30 | 35 | - | - | 12/25 |
| 10 | 7.4 | 25 | 30 | - | - | 12/25 |
| 20 | 7.4 | 25 | 35 | x | x | 10/30 |
| 30 | 6.0 | 25 | 30 | - | x | 12/42 |
| 40 | 6.9 | 20 | 28 | - | - | 12/30 |
| 50 | 5.2 | 25 | 32 | - | - | 8/18 |
| 60 | 8.9 | 15 | 45 | - | x | 12/30 |
| 70 | 7.8 | 25 | 30 | x | x | 12/25 |
| 80 | 5.9 | 25 | 38 | x | - | 7/22 |
| 83.2 | | | | | | |
| $\bar{x}$ | 7.0 | | | | | |

FISH SAMPLE:

| Species | Age | fl-range (mm) | $\overline{fl}$ (mm) | Mean Weight (g) | M | C | R | N | S.E. | Morts | N Corr. | N/$m^2$ | N/ Linear m | Biomass g/$m^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sthd | 0+ | 29-52 | 38.4 | 0.83 | 98 | 50 | 24 | 201 | 25.3 | 12 | 213 | 0.366 | 2.56 | 0.30 |
| Sthd | 1+ | 62-99 | 78.4 | 6.10 | 33 | 22 | 16 | 45 | 13.3 | 0 | 45 | 0.077 | 0.54 | 0.47 |
| Sthd | ≥2+ | 129-139 | 134.0 | 27.35 | 0 | 2 | 0 | 2 | NA | 0 | 2 | 0.003 | 0.02 | 0.09 |
| DV | 0+ | - | - | - | 0 | 0 | - | - | - | - | - | | | |
| DV | ≥1+ | 106-205 | 146.8 | 32.23 | 4 | 3 | 3 | 4 | NA | 0 | 4 | 0.007 | 0.05 | 0.22 |
| MW | ≥1+ | 195-277 | 236.0 | 138.36 | 2 | 1 | 1 | 2 | NA | 0 | 2 | 0.003 | 0.02 | 0.48 |
| Total | | | | | | | | | | | 266 | 0.456 | 3.19 | 1.56 |

Note: For abbreviations and symbols used in this table see first page of Appendix 8

## SITE DESCRIPTION - T2

Location: Approximately 4 km upstream in Tenas Creek below major bend in system. Helicopter access. Area: 409.2 $m^2$
Crew: DB, MF, DS. Date: September 28, 1984. Length of stream margin: 62 m. Photos: 10-12 (R). Water Temp: 2.5°C @ 10:30, 4.5°C @ 1500 hr. Gradient: 3.5%. Comment: Slightly more flow than in '83. Some debris shifting at top end of site. Good pools associated with debris.

**BENTHOS SAMPLE SITE:** Location: As in 1983. i.e. 20 m upstream of fish sample site

| Sample # | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Dist. from BM (m) | 5.5 | 6.5 | 7.5 | 8.5 | 9.5 | 10.5 |
| Depth (cm) | 17 | 15 | 15 | 20 | 27 | 18 |
| D50 | 4 | 4 | 5 | 5 | 6 | 3 |
| D90 | 12 | 15 | 20 | 20 | 20 | 18 |

Average water velocity 0.59 m/sec

**FISH SAMPLE SITE:**

| Location (m) | Width (m) | Mean Depth (cm) | Max. Depth (cm) | Bank Cover | Debris Cover | D50/D90 (cm) |
|---|---|---|---|---|---|---|
| 0 | 5.7 | 20 | 25 | - | x | 7/15 |
| 10 | 7.9 | 25 | 43 | x | x | 8/20 |
| 20 | 6.1 | 20 | 26 | - | - | 4/25 |
| 30 | 6.8 | 12 | 18 | x | x | 7/15 |
| 40 | 6.1 | 20 | 25 | - | x | 10/20 |
| 50 | 6.0 | 18 | 40 | - | x | 4/22 |
| 60 | 7.7 | 20 | 30 | - | x | 6/30 |
| 62 | | | | | | |
| $\bar{x}$ | $\overline{6.6}$ | | | | | |

| FISH SAMPLE: Species | Age | fl-range (mm) | $\overline{fl}$ (mm) | Mean Weight (g) | M | C | R | N | S.E. | Morts | N Corr. | N/$m^2$ | N/ Linear m | Biomass g/$m^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sthd | 0+ | 28-37 | 33.0 | 0.54 | 5 | 5 | 1 | 17 | 10.2 | 1 Net | 18 | 0.044 | 0.29 | 0.02 |
| Sthd | 1+ | 60-94 | 78.9 | 6.21 | 41 | 28 | 23 | 50 | 3.0 | 3 | 53 | 0.130 | 0.85 | 0.80 |
| Sthd | ≥2+ | 99-171 | 122.5 | 21.28 | 17 | 15 | 8 | 31 | 5.3 | 2 | 33 | 0.081 | 0.53 | 1.72 |
| DV | 0+ | - | - | | 0 | 0 | - | - | - | - | 0 | - | - | - |
| DV | ≥1+ | 99-132 | 116.3 | 16.97 | 6 | 1 | 1 | 6 | NA | 0 | 6 | 0.015 | 0.10 | 0.25 |
| MW | | | | | | | | | | | | | | |
| Total | | | | | | | | | | | 110 | 0.270 | 1.77 | 2.79 |

Note: For abbreviations and symbols used in this table see first page of Appendix 8

SITE DESCRIPTION - T3

Location: Approximately 11 km upstream on Tenas Creek (as in 1983). Helicopter access: 209 $m^2$. Date: September 28, 1984.
Length of stream margin: 37 m. Photos: 13, 14 (R4). Water Temperature: 4.5°C @ 17:30. Gradient: 3.0% Crew: DB, MF, DS.

BENTHOS SAMPLE SITE: Location:

| Sample # | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Dist. from BM (m) | | | | | | |
| Depth (cm) | | | NOT CONDUCTED | | | |
| Average water velocity m/sec | | | | | | |

FISH SAMPLE SITE:

| Location (m) | Width (m) | Mean Depth (cm) | Max. Depth (cm) | Bank Cover | Debris Cover | D50/D90 (cm) |
|---|---|---|---|---|---|---|
| 5 | 6.5 | 20 | 28 | - | - | 10/30 |
| 10 | 5.2 | 25 | 32 | - | x | 10/30 |
| 15 | 4.6 | 20 | 30 | - | - | 10/30 |
| 20 | 6.0 | 20 | 25 | - | - | 10/35 |
| 25 | 5.7 | 18 | 30 | - | - | 10/35 |
| 30 | 4.8 | 22 | 30 | - | - | 3/15 |
| 35 | 4.3 | 20 | 30 | - | - | 4/20 |
| 37 | | | | | | |
| $\bar{x}$ | 5.3 | + 13 $m^2$ in a small side channel | | | | |

| FISH SAMPLE: Species | Age | fl-range (mm) | $\overline{fl}$ (mm) | Mean Weight (g) | U1 | U2 | T | N | S.E. | Morts | N Corr. | N/$m^2$ | N/ Linear m | Biomass g/$m^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sthd | 0+ | 40 | 40.0 | 0.93 | 1 | 0 | 1 | 1 | NA | 0 | 1 | 0.005 | 0.03 | <0.01 |
| Sthd | 1+ | 61-83 | 75.7 | 5.53 | 5 | 1 | 6 | 6 | 0.8 | 0 | 6 | 0.029 | 0.16 | 0.16 |
| Sthd | >2+ | - | - | - | 0 | 0 | 0 | 0 | - | - | 0 | - | - | - |
| DV | 0+ | 40-49 | 44.7 | 1.22 | 7 | 0 | 7 | 7 | NA | 0 | 7 | 0.033 | 0.19 | 0.04 |
| DV | >1+ | 56-175 | 100.8 | 11.44 | 20 | 2 | 22 | 22 | 0.6 | 0 | 22 | 0.105 | 0.59 | 1.20 |
| MW | | | | | | | | | | | | | | |
| Total | | | | | | | | | | | 36 | 0.172 | 0.97 | 1.40 |

Note: For abbreviations and symbols used in this table see first page of Appendix 8

SITE DESCRIPTION - T4

Location: Approximately 7 km upstream on Tenas Creek about 200 m below logged setting. Helicopter access. Area: 150 $m^2$
Date: October 24, 1984. Length of stream margin: 25 m. Photos: 5-7 (R5). Water Temperature: 1°C @ 1100 hr.
Crew: DB, MF, BH. Comment: This site is a riffle/glide complex (50% of each). Flows are higher than normal due to rain and snow. New site

BENTHOS SAMPLE SITE: Location:

| Sample # | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Dist. from BM (m) | | | | | | |
| Depth (cm) | | | NOT CONDUCTED | | | |
| Average water velocity m/sec | | | | | | |

FISH SAMPLE SITE:

| Location (m) | Width (m) | Mean Depth (cm) | Max. Depth (cm) | Bank Cover | Debris Cover | D50/D90 (cm) |
|---|---|---|---|---|---|---|
| 0 | 6.3 | 15 | 30 | - | - | 20/30 |
| 5 | 9.5 | 20 | 30 | - | - | 15/35 |
| 10 | 5.8 | 25 | 40 | - | x | 20/35 |
| 15 | 5.0 | 25 | 42 | - | - | 2/12 |
| 20 | 4.2 | 35 | 50 | - | x | 6/15 |
| 25 | 5.2 | 30 | 40 | - | x | 4/15 |
| $\bar{x}$ | 6.0 | | | | | |

| FISH SAMPLE: Species | Age | fl-range (mm) | $\overline{fl}$ (mm) | Mean Weight (g) | U1 | U2 | T | N | S.E. | Morts | N Corr. | N/$m^2$ | N/Linear m | Biomass g/$m^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sthd | 0+ | - | - | - | 0 | 0 | 0 | 0 | - | - | 0 | - | - | - |
| Sthd | 1+ | 70-85 | 76.0 | 5.89 | 5 | 1 | 6 | 6 | 0.8 | 0 | 6 | 0.040 | 0.24 | 0.24 |
| Sthd | ≥2+ | 102-128 | 111.5 | 16.36 | 7 | 0 | 7 | 7 | NA | 0 | 7 | 0.047 | 0.28 | 0.77 |
| DV | 0+ | 43-51 | 47.7 | 1.46 | 7 | 3 | 10 | 12 | 4.1 | 0 | 12 | 0.080 | 0.48 | 0.12 |
| DV | ≥1+ | 57-135 | 84.1 | 6.95 | 8 | 2 | 10 | 11 | 1.4 | 0 | 11 | 0.073 | 0.44 | 0.51 |
| MW | | | | | | | | | | | | | | |
| Total | | | | | | | | | | | 36 | 0.240 | 1.44 | 1.64 |

Note: For abbreviations and symbols used in this table see first page of Appendix 8

SITE DESCRIPTION - SC1

Location: Telkwa River side channel at end of Cottonwood Rd. in village. Approximately 1.5 km from mouth of Telkwa River (as in 1983). Area: 551 $m^2$. Crew: DB, MF, DS. Gradient: 1%. Date: September 14, 1984. Length of stream margin: 77.6 m
Photos: 15, 16 (R2). Water Temperature: 7°C @ 11:45 hr.

BENTHOS SAMPLE SITE: Location: Mid-way up side channel. Flagging present but couldn't find metal rod (as in 1983)

| Sample # | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Dist. from BM (m) | 11.5 | 12.5 | 13.5 | 14.5 | 15.5 | 16.5 |
| Depth (cm) | 11 | 9 | 13 | 7 | 16 | 15 |

Average water velocity: 0.55 m/sec.

FISH SAMPLE SITE:

| Location (m) | Width (m) | Mean Depth (cm) | Max. Depth (cm) | Bank Cover | Debris Cover | D50/D90 (cm) |
|---|---|---|---|---|---|---|
| 0 | 7.7 | 18 | 20 | - | - | As in 1983 |
| 10 | 6.6 | 18 | 21 | - | - | |
| 20 | 5.8 | 15 | 19 | - | - | |
| 30 | 6.9 | 13 | 19 | - | - | " |
| 40 | 6.8 | 23 | 30 | - | x | |
| 50 | 4.5 | 41 | 52 | - | - | " |
| 60 | 5.9 | 16 | 25 | - | x | |
| 70 | 12.6 | 10 | 15 | - | x | " |
| 77.6 | | | | | | |
| $\bar{x}$ | 7.1 | | | | | |

FISH SAMPLE:

| Species | Age | fl-range (mm) | $\overline{fl}$ (mm) | Mean Weight (g) | M | C | R | N | S.E. | Morts | N Corr. | N/$m^2$ | N/ Linear m | Biomass g/$m^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sthd | 0+ | 31-47 | 37.8 | 0.79 | 26 | 30 | 11 | 69 | 12.3 | 1 | 70 | 0.127 | 0.90 | 0.10 |
| Sthd | 1+ | 59-99 | 75.3 | 5.25 | 47 | 31 | 17 | 84 | 10.7 | 0 | 84 | 0.152 | 1.08 | 0.80 |
| Sthd | ≥2+ | 110-151 | 132.8 | 24.72 | 4 | 3 | 1 | 9 | 5.0 | 0 | 9 | 0.016 | 0.12 | 0.40 |
| Co | 0+ | 78 | 78.0 | 5.22 | 1 | 0 | 0 | 1 | NA | 0 | 1 | 0.002 | 0.01 | 0.01 |
| Ch | 0+ | 69-96 | 80.0 | 6.98 | 1 | 4 | 0 | 9 | NA | 0 | 9 | 0.016 | 0.12 | 0.11 |
| MW | 0+ | 49-64 | 56.0 | 1.97 | 12 | 12 | 5 | 27 | 6.6 | 0 | 27 | 0.049 | 0.35 | 0.10 |
| MW | ≥1+ | 115 | 115.0 | 13.60 | 1 | 1 | 1 | 1 | NA | 0 | 1 | 0.002 | 0.12 | 0.02 |
| Lnd | | 56 | 56.0 | 3.60 | 0 | 1 | 0 | 1 | NA | 0 | 1 | 0.002 | 0.12 | 0.01 |
| Total | - | | | | | | | | | | 202 | 0.367 | 2.82 | 1.55 |

Note: For abbreviations and symbols used in this table see first page of Appendix B

SITE DESCRIPTION - SC2

Location: Approximately 3.5 km upstream on Telkwa (as in 1983) although a longer section was sampled. Crew: DB, MF, OS. Date: September 29, 1984. Area: 745 $m^2$. Length of stream margin: 49 m. Photos: 15-20 (R4). Water Temperature: 4°C @ 1100 hr. Comment: Lower flows and less trap litter made for easier sampling than in 1983.

BENTHOS SAMPLE SITE: Location: Riffle area approx. 100 m upstream from top net set (as in 1983). Unable to find right marker

| Sample # | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Dist. from BM (m) | 19 | 23 | 25 | 27 | 31 | 35 |
| Depth (cm) | 10 | 20 | 25 | 27 | 20 | 16 |
| D50 | 10 | 10 | 6 | 12 | 3 | 4 |
| D90 | 19 | 13 | 15 | 14 | 10 | 12 |

Average water velocity: 0.53 m/sec.

FISH SAMPLE SITE:

| Location (m) | Width (m) | Mean Depth (cm) | Max. Depth (cm) | Bank Cover | Debris Cover | D50/D90 (cm) |
|---|---|---|---|---|---|---|
| 0 | 14.8 | 30 | 36 | - | - | 6/19 |
| 10 | 14.4 | 33 | 39 | - | - | 9/30 |
| 20 | 16.5 | 35 | 46 | - | - | 7/20 |
| 30 | 14.2 | 33 | 46 | - | - | 6/17 |
| 40 | 14.2 | 30 | 52 | - | - | 7/20 |
| 49 | 17.1 | 28 | 50 | - | - | 7/18 |
| $\bar{x}$ | 15.2 | | | | | |

FISH SAMPLE:

| Species | Age | fl-range (mm) | $\overline{fl}$ (mm) | Mean Weight (g) | M | C | R | N | S.E. | Morts | N Corr. | N/$m^2$ | N/ Linear m | Biomass g/$m^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sthd | 0+ | 30-50 | 38.9 | 0.86 | 9 | 10 | 2 | 36 | 17.0 | 0 | 36 | 0.048 | 0.73 | 0.04 |
| Sthd | 1+ | 67-96 | 78.8 | 5.92 | 28 | 30 | 14 | 59 | 8.0 | 0 | 59 | 0.079 | 1.20 | 0.47 |
| Sthd | ≥2+ | 100-166 | 127.6 | 22.23 | 13 | 15 | 9 | 21 | 2.3 | 0 | 21 | 0.028 | 0.43 | 0.62 |
| Co | 0+ | 55-74 | 66.0 | 3.05 | 3 | 3 | 1 | 7 | 3.8 | 0 | 7 | 0.009 | 0.14 | 0.03 |
| Ch | 0+ | 73-80 | 76.5 | 6.25 | 0 | 2 | 0 | 2 | NA | 0 | 2 | 0.003 | 0.04 | 0.02 |
| MW | 0+ | 52-59 | 57.3 | 2.11 | 1 | 7 | 1 | 7 | NA | 0 | 7 | 0.009 | 0.14 | 0.02 |
| Total | - | | | | | | | | | | 132 | 0.176 | 2.68 | 1.20 |

Note: For abbreviations and symbols used in this table see first page of Appendix B

SITE DESCRIPTION - SC3

Location: Approximately 3.5 km upstream of Telkwa (Lot 412). As in 1983. Crew: DB, NF, DS. Date: September 27, 1984.
Area: 32.5 $m^2$. Length of stream margin: 25 m. Photos: 7 & 8 (R4). Water Temperature: 4°C @ 14:30.

BENTHOS SAMPLE SITE: Location:

| Sample # | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Dist. from BM (m) | | | | | | |
| Depth (cm) | | | NOT CONDUCTED | | | |
| Average water velocity m/sec | | | | | | |

FISH SAMPLE SITE:

| Location (m) | Width (m) | Mean Depth (cm) | Max. Depth (cm) | Bank Cover | Debris Cover | D50/D90 (cm) |
|---|---|---|---|---|---|---|
| 0 | 1.2 | 8 | 10 | - | - | 1/10 |
| 5 | 1.4 | 5 | 7 | - | - | <1/10 |
| 10 | 2.0 | 20 | 40 | - | x | <1 |
| 15 | 1.6 | 20 | 35 | - | x | <1 |
| 20 | 0.5 | 5 | 8 | - | - | <1 |
| 25 | 1.0 | 8 | 15 | - | x | <1 |
| $\bar{x}$ | 1.3 | | | | | |

| FISH SAMPLE: Species | Age | fl-range (mm) | TT (mm) | Mean Weight (g) | U1 | U2 | T | N | S.E. | Morts | N Corr. | N/$m^2$ | N/ Linear m | Biomass g/$m^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sthd | 0+ | 32-47 | 37.8 | 0.79 | 11 | 4 | 15 | 17 | 3.5 | 0 | 17 | 0.523 | 0.68 | 0.41 |
| Sthd | 1+ | - | - | | 0 | 0 | 0 | 0 | - | 0 | 0 | - | - | |
| Sthd | >2+ | - | - | | 0 | 0 | 0 | 0 | - | 0 | 0 | - | - | |
| Co | <1+ | 38-100 | 59.6 | 2.20 | 50 | 8 | 58 | 60 | 1.7 | 0 | 60 | 1.846 | 2.40 | 4.06 |
| DV | | | | | | | | | | | | | | |
| MW | | | | | | | | | | | | | | |
| Total | | | | | | | | | | | 77 | 2.369 | 3.08 | 4.47 |

Note: For abbreviations and symbols used in this table see first page of Appendix 8

SITE DESCRIPTION - MS1

Location: Mainstem Telkwa River 1.5 km from mouth (as in 1983). Crew: DB, MF, DS. Date: September 24, 1984.
Area: 89.3 $m^2$. Length of stream margin: 19 m. Photos: - Water Temperature: 5°C @ 16:00 hr.

BENTHOS SAMPLE SITE: Location:

| Sample # | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Dist. from BM (m) | | | | | | |
| Depth (cm) | | | NOT CONDUCTED | | | |
| Average water velocity m/sec | | | | | | |

FISH SAMPLE SITE:

| Location (m) | Width (m) | Mean Depth (cm) | Max. Depth (cm) | Bank Cover | Debris Cover | D50/D90 (cm) |
|---|---|---|---|---|---|---|
| 1 | 1.7 | 12 | 15 | - | - | 16/25 |
| 2 | 3.2 | 12 | 20 | - | - | 17/20 |
| 3 | 5.5 | 21 | 36 | - | - | 11/14 |
| 4 | 7.1 | 38 | 47 | - | - | 11/17 |
| 5 | 5.3 | 25 | 50 | - | - | 9/14 |
| 6 | 5.4 | 38 | 46 | - | - | 9/15 |
| $\bar{x}$ | 4.7 | | | | | |

| FISH SAMPLE: Species | Age | fl-range (mm) | $\bar{fl}$ (mm) | Mean Weight (g) | U1 | U2 | T | N | S.E. | Morts | N Corr. | N/$m^2$ | N/ Linear m | Biomass g/$m^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sthd | 0+ | 32-48 | 38.4 | 0.83 | 8 | 2 | 10 | 11 | 1.4 | 0 | 11 | 0.123 | 0.58 | 0.10 |
| Sthd | 1+ | 59-91 | 75.6 | 5.28 | 11 | 3 | 14 | 15 | 1.9 | 0 | 15 | 0.168 | 0.79 | 0.89 |
| Sthd | ≥2+ | 114-148 | 135.4 | 26.18 | 7 | 1 | 8 | 8 | 0.5 | 0 | 8 | 0.090 | 0.42 | 2.36 |
| Total | | | | | | | | | | | 34 | 0.381 | 1.79 | 3.35 |

Note: For abbreviations and symbols used in this table see first page of Appendix 8

SITE DESCRIPTION - MS2

Location: Mainstem Telkwa River 1.5 km from mouth. Upstream of MS1 at the top end of the berm. Crew: DB, MF, DS.
Date: September 24, 1984. Area: 102 $m^2$. Length of stream margin: 21.7 m. Photos: - Water Temperature: 5°C @ 16:00 hr

BENTHOS SAMPLE SITE: Location:

| Sample # | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Dist. from BM (m) | | | | | | |
| Depth (cm) | | | NOT CONDUCTED | | | |
| Average water velocity m/sec | | | | | | |

FISH SAMPLE SITE:

| Location (m) | Width (m) | Mean Depth (cm) | Max. Depth (cm) | Bank Cover | Debris Cover | D50/D90 (cm) |
|---|---|---|---|---|---|---|
| 1 | 3.7 | 10 | 25 | - | - | 13/19 |
| 2 | 4.6 | 30 | 40 | - | - | 10/17 |
| 3 | 6.9 | 42 | 60 | - | - | 10/18 |
| 4 | 7.0 | 55 | 69 | - | x | 7/13 |
| 5 | 5.6 | 60 | 85 | x | x | 9/18 |
| 6 | 3.4 | 50 | 83 | x | - | 8/11 |
| 7 | 1.8 | 37 | 66 | x | - | 6/11 |
| $\bar{x}$ | 4.7 | | | | | |

| FISH SAMPLE: Species | Age | fl-range (mm) | $\bar{fl}$ (mm) | Mean Weight (g) | U1 | U2 | T | N | S.E. | Morts | N Corr. | N/$m^2$ | N/ Linear m | Biomass g/$m^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sthd | 0+ | 31-44 | 37.6 | 0.78 | 9 | 3 | 12 | 14 | 2.6 | 0 | 14 | 0.137 | 0.65 | 0.11 |
| Sthd | 1+ | 68-82 | 72.0 | 4.62 | 4 | 1 | 5 | 5 | 1.0 | 0 | 5 | 0.049 | 0.23 | 0.23 |
| Sthd | ≥2+ | 100-115 | 107.0 | 13.68 | 2 | 1 | 3 | 3 | NA | 0 | 3 | 0.029 | 0.14 | 0.40 |
| Co | 0+ | 54-72 | 63.0 | 2.63 | 1 | 1 | 2 | 2 | NA | 0 | 2 | 0.020 | 0.09 | 0.05 |
| DV | | | | | | | | | | | | | | |
| MW | 0+ | 51 | 51.0 | 1.50 | 1 | 0 | 1 | 1 | NA | 0 | 1 | 0.010 | 0.05 | 0.02 |
| Total | | | | | | | | | | | 25 | 0.245 | 1.16 | 0.81 |

Note: For abbreviations and symbols used in this table see first page of Appendix B

Appendix 8.2 Cont'd

SITE DESCRIPTION - MS3

Location: Mainstem Telkwa River 1.5 km from mouth. Approximately 150 m downstream from MS1. Crew: DB, MF, DS.
Date: September 24, 1984. Area: 104 m$^2$. Length of stream margin: 16.0 m. Photos: - Water Temperature: 5°C @ 16:00 hr

BENTHOS SAMPLE SITE: Location:

| Sample # | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Dist. from BM (m) | | | | | | |
| Depth (cm) | | | NOT CONDUCTED | | | |
| Average water velocity m/sec | | | | | | |

FISH SAMPLE SITE:

| Location (m) | Width (m) | Mean Depth (cm) | Max. Depth (cm) | Bank Cover | Debris Cover | D50/D90 (cm) |
|---|---|---|---|---|---|---|
| 1 | 1.5 | 12 | 18 | - | - | 12/28 |
| 2 | 3.6 | 20 | 28 | - | - | 10/23 |
| 3 | 10.4 | 20 | 38 | - | - | 13/28 |
| 4 | 9.2 | 25 | 57 | - | - | 15/26 |
| 5 | 8.4 | 30 | 50 | - | - | 12/30 |
| 6 | 6.8 | 25 | 37 | - | - | 17/26 |
| 7 | 5.7 | 30 | 37 | - | - | 11/28 |
| $\bar{x}$ | 6.5 | | | | | |

FISH SAMPLE:

| Species | Age | fl-range (mm) | $\overline{fl}$ (mm) | Mean Weight (g) | U1 | U2 | T | N | S.E. | Morts | N Corr. | N/m$^2$ | N/ Linear m | Biomass g/m$^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sthd | 0+ | 31-50 | 40.1 | 0.93 | 7 | 4 | 11 | 16 | 10.3 | 0 | 16 | 0.154 | 1.00 | 0.14 |
| Sthd | 1+ | 64-88 | 74.2 | 5.02 | 11 | 1 | 12 | 12 | 0.4 | 0 | 12 | 0.115 | 0.75 | 0.58 |
| Sthd | $\geq$2+ | 107-135 | 117.7 | 17.82 | 3 | 0 | 3 | 3 | NA | 0 | 3 | 0.029 | 0.19 | 0.52 |
| Co | 0+ | 67 | 67.0 | 3.20 | 1 | 0 | 1 | 1 | NA | 0 | 1 | 0.010 | 0.06 | 0.03 |
| MW | 0+ | 56 | 56.0 | 1.97 | 0 | 2 | 2 | 2 | NA | 0 | 2 | 0.019 | 0.12 | 0.04 |
| Total | | | | | | | | | | | 34 | 0.327 | 2.12 | 1.31 |

Note: For abbreviations and symbols used in this table see first page of Appendix 8

SITE DESCRIPTION - MS4

Location: Mainstem Telkwa River 1.5 km from mouth. Approximately 30 m downstream from MS3. Crew: DB, MF, DS.
Date: September 24, 1984. Area: 80 $m^2$. Length of stream margin: 16.0 m. Photos: - Water Temperature: 5°C @ 16:00 hr

BENTHOS SAMPLE SITE: Location:

| Sample # | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Dist. from BM (m) | | | | | | |
| Depth (cm) | | NOT CONDUCTED | | | | |
| Average water velocity m/sec | | | | | | |

FISH SAMPLE SITE:

| Location (m) | Width (m) | Mean Depth (cm) | Max. Depth (cm) | Bank Cover | Debris Cover | D50/D90 (cm) |
|---|---|---|---|---|---|---|
| 1 | 1.4 | 25 | 30 | - | - | 10/22 |
| 2 | 5.3 | 30 | 45 | - | - | 8/25 |
| 3 | 6.3 | 30 | 40 | - | - | 7/20 |
| 4 | 7.2 | 30 | 45 | - | - | 10/22 |
| 5 | 6.1 | 30 | 40 | - | - | 7/20 |
| 6 | 3.8 | 25 | 35 | - | - | 8/20 |
| $\bar{x}$ | 5.0 | | | | | |

FISH SAMPLE:

| Species | Age | fl-range (mm) | $\overline{fl}$ (mm) | Mean Weight (g) | U1 | U2 | T | N | S.E. | Morts | N Corr. | N/$m^2$ | N/ Linear m | Biomass g/$m^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sthd | 0+ | - | - | - | 0 | 0 | 0 | 0 | - | 0 | 0 | - | - | - |
| Sthd | 1+ | 72-90 | 77.8 | 5.73 | 5 | 0 | 5 | 5 | NA | 0 | 5 | 0.062 | 0.31 | 0.36 |
| Sthd | $\geq$2+ | - | - | | 0 | 0 | 0 | 0 | - | 0 | 0 | - | - | |
| MW | 0+ | 56 | 56.0 | 1.97 | 0 | 1 | 0 | 1 | NA | 0 | 1 | 0.012 | 0.06 | 0.02 |
| Total | | | | | | | | | | | 6 | 0.074 | 0.37 | 0.38 |

Note: For abbreviations and symbols used in this table see first page of Appendix 8

Appendix 8.2 Cont'd

SITE DESCRIPTION - MS5

Location: 3.5 km upstream on Telkwa River (as in 1983). Access through farmer's field. Crew: OB, MF, DS.
Date: September 27, 1984. Area: 117 $m^2$. Length of stream margin: 22.5 m. Photos: 3 (R4). Water Temperature: 1°C @ 10:05
Comment: Flows are slightly lower. Less fry in small channel with cobble and less wetted area under debris jam. Ice on pool.

BENTHOS SAMPLE SITE: Location:

| Sample # | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Dist. from BM (m) | | | | | | |
| Depth (cm) | | | NOT CONDUCTED | | | |
| Average water velocity m/sec | | | | | | |

FISH SAMPLE SITE:

| Location (m) | Width (m) | Mean Depth (cm) | Max. Depth (cm) | Bank Cover | Debris Cover | D50/D90 (cm) |
|---|---|---|---|---|---|---|
| 0 | 3.2 | 25 | 40 | - | - | <1 |
| 5 | 8.2 | 20 | 36 | - | x | <1/30 |
| 10 | 9.0 | 20 | 40 | - | x | <1 |
| 15 | 4.2 | 25 | 40 | - | - | <1 |
| 20 | 1.2 | 5 | 7 | - | - | <1/20 |
| $\bar{x}$ | 5.2 | | | | | |

FISH SAMPLE:

| Species | Age | fl-range (mm) | $\overline{fl}$ (mm) | Mean Weight (g) | U1 | U2 | T | N | S.E. | Morts | N Corr. | N/$m^2$ | N/ Linear m | Biomass g/$m^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sthd | 0+ | 29-40 | 34.6 | 0.62 | 14 | 11 | 4 | 35 | 10.8 | 3 | 38 | 0.325 | 1.69 | 0.20 |
| Sthd | 1+ | - | - | | 0 | 0 | 0 | 0 | - | - | - | - | - | - |
| Sthd | ≥2+ | - | - | | 0 | 0 | 0 | 0 | - | - | - | - | - | - |
| Total | | | | | | | | | | | 38 | 0.325 | 1.69 | 0.20 |

Note: For abbreviations and symbols used in this table see first page of Appendix 8

SITE DESCRIPTION - MS6

Location: Approximately 3.5 km upstream of Telkwa River. Lot 412 (as in 1983). Access through farmer's field. Crew: DB, MF, DS. Date: September 27, 1984. Area: 126.7 $m^2$. Length of stream margin: 17.6 m. Photos: 4 (R4). Water Temperature: 1.5°C @ 1100hr.

BENTHOS SAMPLE SITE: Location:

| Sample # | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Dist. from BM (m) | | | | | | |
| Depth (cm) | | | NOT CONDUCTED | | | |
| Average water velocity m/sec | | | | | | |

FISH SAMPLE SITE:

| Location (m) | Width (m) | Mean Depth (cm) | Max. Depth (cm) | Bank Cover | Debris Cover | D50/D90 (cm) |
|---|---|---|---|---|---|---|
| 1 | 7.6 | 36 | 48 | - | - | <1/18 |
| 2 | 8.0 | 34 | 42 | - | - | 8/20 |
| 3 | 7.3 | 37 | 47 | - | - | 5/16 |
| 4 | 6.1 | 22 | 30 | - | - | 5/20 |
| $\bar{x}$ | 7.2 | | | | | |

FISH SAMPLE:

| Species | Age | fl-range (mm) | $\overline{fl}$ (mm) | Mean Weight (g) | U1 | U2 | T | N | S.E. | Morts | N Corr. | N/$m^2$ | N/ Linear m | Biomass g/$m^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sthd | 0+ | 27-44 | 38.3 | 0.82 | 12 | 7 | 19 | 29 | 14.6 | 0 | 29 | 0.229 | 1.65 | 0.19 |
| Sthd | 1+ | 68-85 | 76.8 | 5.52 | 4 | 2 | 6 | 8 | 4.9 | 0 | 8 | 0.063 | 0.45 | 0.35 |
| Sthd | >2+ | 108-127 | 117.5 | 17.70 | 2 | 0 | 2 | 2 | NA | 0 | 2 | 0.016 | 0.11 | 0.28 |
| MW | 0+ | 48-55 | 51.8 | 1.56 | 4 | 0 | 4 | 4 | NA | 0 | 4 | 0.032 | 0.23 | 0.05 |
| Total | | | | | | | | | | | 43 | 0.340 | 2.44 | 0.87 |

Note: For abbreviations and symbols used in this table see first page of Appendix 8

Appendix 8.2 Cont'd

SITE DESCRIPTION - MS7

Location: 3.5 km upstream on Telkwa River (as in 1983). Immediately above MS6. Crew: DB, MF, DS. Date: September 27, 1984
Area: 142 $m^2$. Length of stream margin: 16.5 m. Photos: 5 & 6 (R4). Water Temperature: 4°C @ 14:30 hr.

BENTHOS SAMPLE SITE: Location:

| Sample # | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Dist. from BM (m) | | | | | | |
| Depth (cm) | | | NOT CONDUCTED | | | |
| Average water velocity m/sec | | | | | | |

FISH SAMPLE SITE:

| Location (m) | Width (m) | Mean Depth (cm) | Max. Depth (cm) | Bank Cover | Debris Cover | D50/D90 (cm) |
|---|---|---|---|---|---|---|
| 1 | 6.4 | 15 | 19 | - | - | 4/25 |
| 2 | 10.6 | 14 | 18 | - | - | 10/25 |
| 3 | 11.1 | 11 | 20 | - | - | 10/25 |
| 4 | 6.4 | 16 | 25 | - | - | 15/22 |
| $\bar{x}$ | 8.6 | | | | | |

FISH SAMPLE:

| Species | Age | fl-range (mm) | $\overline{fl}$ (mm) | Mean Weight (g) | U1 | U2 | T | N | S.E. | Morts | N Corr. | N/$m^2$ | N/ Linear m | Biomass g/$m^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sthd | 0+ | 29-55 | 39.2 | 0.88 | 23 | 1 | 24 | 24 | 0.2 | 0 | 24 | 0.169 | 1.45 | 0.15 |
| Sthd | 1+ | 64-91 | 74.5 | 5.08 | 23 | 2 | 25 | 25 | 0.5 | 0 | 25 | 0.176 | 1.52 | 0.89 |
| Sthd | >2+ | 114-130 | 122.3 | 19.72 | 7 | 2 | 9 | 10 | 1.7 | 0 | 10 | 0.070 | 0.61 | 1.38 |
| Co | 0+ | 50-61 | 55.5 | 1.75 | 3 | 1 | 4 | 4 | 1.5 | 0 | 4 | 0.028 | 0.24 | 0.05 |
| DV | >1+ | 81-125 | 111.5 | 15.11 | 4 | 0 | 4 | 4 | NA | 0 | 4 | 0.028 | 0.24 | 0.42 |
| MW | 0+ | 56 | 56.0 | 1.97 | 1 | 0 | 1 | 1 | NA | 0 | 1 | 0.007 | 0.06 | 0.01 |
| | >1+ | 124 | 124.0 | 20.61 | 1 | 0 | 1 | 1 | NA | 0 | 1 | 0.007 | 0.06 | 0.14 |
| Total | | | | | | | | | | | 69 | 0.485 | 4.18 | 3.04 |

Note: For abbreviations and symbols used in this table see first page of Appendix 8

SITE DESCRIPTION - B1

Location: Bulkley River just downstream from Hubert Creek; 100 m downstream from rock outcrop (river's left side).
Crew: DB, MF, BH. Date: October 26, 1984. Area: 66.3 $m^2$. Length of stream margin: 21.4 m. Photos: 16-18 (R5).
Water Temperature: 3.5°C @ 1100 hr.

BENTHOS SAMPLE SITE: Location:

| Sample # | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Dist. from BM (m) | | | | | | |
| Depth (cm) | | | NOT CONDUCTED | | | |
| Average water velocity m/sec | | | | | | |

FISH SAMPLE SITE:

| Location (m) | Width (m) | Mean Depth (cm) | Max. Depth (cm) | Bank Cover | Debris Cover | D50/D90 (cm) |
|---|---|---|---|---|---|---|
| 1 | 1.3 | 25 | 42 | - | - | 12/25 |
| 2 | 2.7 | 40 | 70 | - | - | 15/25 |
| 3 | 3.4 | 50 | 75 | - | - | 15/40 |
| 4 | 4.1 | 40 | 70 | - | - | 10/25 |
| 5 | 3.9 | 40 | 60 | - | - | 10/20 |
| 6 | 3.2 | 35 | 60 | | | 5/15 |
| $\bar{x}$ | 3.1 | | | | | |

FISH SAMPLE:

| Species | Age | fl-range (mm) | $\overline{fl}$ (mm) | Mean Weight (g) | U1 | U2 | T | N | S.E. | Morts | N Corr. | N/$m^2$ | N/ Linear m | Biomass g/$m^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sthd | 0+ | 47-52 | 49.8 | 1.69 | 5 | 0 | 5 | 5 | NA | 0 | 5 | 0.075 | 0.23 | 0.13 |
| Sthd | 1+ | 79-95 | 83.8 | 7.01 | 4 | 0 | 4 | 4 | NA | 0 | 4 | 0.060 | 0.19 | 0.42 |
| Sthd | >2+ | 110-115 | 111.7 | 15.42 | 3 | 0 | 3 | 3 | NA | 0 | 3 | 0.045 | 0.14 | 0.69 |
| Ch | 0+ | 68-82 | 75.4 | 6.01 | 8 | 0 | 8 | 8 | NA | 0 | 8 | 0.121 | 0.37 | 0.73 |
| DV | | | | | | | | | | | | | | |
| MW | | 1 lamprey ammocoete | | | | | | | | | | | | |
| Total | | | | | | | | | | | 20 | 0.301 | 0.93 | 1.97 |

Note: For abbreviations and symbols used in this table see first page of Appendix 8

APPENDIX 8.2 Cont'd

SITE DESCRIPTION - B2

Location: Bulkley River just downstream from Hubert Creek; 100 m downstream of site B1 (river's left side). Crew: DB, MF, BH.
Date: October 26, 1984. Area: 52.5 $m^2$ Length of stream margin: 25 m. Photos: - Water Temperature: 3.5°C @ 1100 hr.
Comment: This site is located in rip-rap along railroad. Deep and fast 3 m from water's edge.

BENTHOS SAMPLE SITE: Location:

| Sample # | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Dist. from BM (m) | | | | | | |
| Depth (cm) | | | NOT CONDUCTED | | | |
| Average water velocity m/sec | | | | | | |

| FISH SAMPLE SITE: Location (m) | Width (m) | Mean Depth (cm) | Max. Depth (cm) | Bank Cover | Debris Cover | D50/D90 (cm) |
|---|---|---|---|---|---|---|
| 1 | 2.0 | 50 | 85 | - | - | 15/60 |
| 2 | 2.1 | 50 | 95 | - | - | 40/60 |
| 3 | 2.4 | 50 | 75 | - | - | 10/30 |
| 4 | 2.3 | 45 | 75 | - | - | 20/50 |
| 5 | 2.3 | 35 | 60 | - | - | 15/35 |
| 6 | 2.3 | 50 | 65 | - | - | 20/30 |
| 7 | 1.5 | 25 | 40 | - | - | 15/30 |
| $\bar{x}$ | 2.1 | | | | | |

| FISH SAMPLE: Species | Age | fl-range (mm) | $\overline{fl}$ (mm) | Mean Weight (g) | U1 | U2 | T | N | S.E. | Morts | N Corr. | N/$m^2$ | N/ Linear m | Biomass g/$m^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sthd | 0+ | 49-52 | 50.5 | 1.75 | 2 | 0 | 2 | 2 | NA | 0 | 2 | 0.038 | 0.08 | 0.07 |
| Sthd | 1+ | - | - | | 0 | 0 | 0 | 0 | NA | 0 | 0 | 0 | 0 | |
| Sthd | $\geq$2+ | 106-151 | 122.5 | 19.82 | 3 | 1 | 4 | 4 | 1.5 | 0 | 4 | 0.076 | 0.16 | 1.51 |
| Ch | 0+ | 71 | 71.0 | 5.16 | 1 | 0 | 1 | 1 | NA | 0 | 1 | 0.019 | 0.04 | 0.10 |
| DV | | | | | | | | | | | | | | |
| MV | | 1 lamprey ammocoete | | | | | | | | | | | | |
| Total | | | | | | | | | | | 7 | 0.133 | 0.28 | 1.68 |

Note: For abbreviations and symbols used in this table see first page of Appendix 8

SITE DESCRIPTION - B3

Location: Bulkley River downstream of Hubert Creek. Approximately 200 m below B2 but on river's right side. Crew: OB, MF, BH.
Date: October 26, 1984. Area: 66 m$^2$. Length of stream margin: 19.4 m. Photos: 20 (R5). Water Temperature: 3.5°C @ 1100 hr.

BENTHOS SAMPLE SITE: Location:

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Sample # | 1 | 2 | 3 | 4 | 5 | 6 |
| Dist. from BM (m) | | | NOT CONDUCTED | | | |
| Depth (cm) | | | | | | |
| Average water velocity m/sec | | | | | | |

FISH SAMPLE SITE:

| Location (m) | Width (m) | Mean Depth (cm) | Max. Depth (cm) | Bank Cover | Debris Cover | D50/D90 (cm) |
|---|---|---|---|---|---|---|
| 1 | 1.8 | 30 | 55 | - | - | 10/35 |
| 2 | 3.5 | 45 | 80 | | | 8/25 |
| 3 | 4.2 | 40 | 60 | | | 8/25 |
| 4 | 4.6 | 60 | 75 | | | 10/30 |
| 5 | 4.2 | 55 | 70 | | | 10/25 |
| 6 | 3.6 | 40 | 65 | | | 15/35 |
| 7 | 1.6 | 25 | 50 | | | 10/25 |
| x̄ | 3.4 | | | | | |

FISH SAMPLE:

| Species | Age | fl-range (mm) | $\overline{fl}$ (mm) | Mean Weight (g) | U1 | U2 | T | N | S.E. | Morts | N Corr. | N/m$^2$ | N/ Linear m | Biomass g/m$^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sthd | 0+ | 43-51 | 46.9 | 1.43 | 7 | 2 | 9 | 10 | 1.7 | 0 | 10 | 0.152 | 0.52 | 0.22 |
| Sthd | 1+ | 59-86 | 73.8 | 4.95 | 4 | 0 | 4 | 4 | NA | 0 | 4 | 0.061 | 0.21 | 0.30 |
| Sthd | ≥2+ | 112 | 112.0 | 15.52 | 1 | 0 | 1 | 1 | NA | 0 | 1 | 0.015 | 0.05 | 0.23 |
| Ch | 0+ | 64-75 | 71.2 | 5.20 | 4 | 1 | 5 | 5 | 1.0 | 0 | 5 | 0.076 | 0.26 | 0.40 |
| MW | 0+ | 63 | 63.0 | 2.77 | 1 | 0 | 1 | 1 | NA | 0 | 1 | 0.015 | 0.05 | 0.04 |
| | 1 lamprey ammocoete | | | | | | | | | | | | | |
| Total | | | | | | | | | | | 21 | 0.319 | 1.09 | 1.19 |

Note: For abbreviations and symbols used in this table see first page of Appendix 8

APPENDIX 8.2 Cont'd

SITE DESCRIPTION - B4

Location: Bulkley River downstream of Hubert Creek. Approximately 50 m below B3 (river's right side). Crew: DB, MF, BH.
Date: October 26, 1984. Area: 62 $m^2$. Length of stream margin: 20 m. Photos: 21 (R5). Water Temperature: 3.5°C @ 1100 hr.

BENTHOS SAMPLE SITE: Location:

| Sample # | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Dist. from BM (m) | | | | | | |
| Depth (cm) | | | NOT CONDUCTED | | | |
| Average water velocity m/sec | | | | | | |

FISH SAMPLE SITE:

| Location (m) | Width (m) | Mean Depth (cm) | Max. Depth (cm) | Bank Cover | Debris Cover | D50/D90 (cm) |
|---|---|---|---|---|---|---|
| 1 | 1.6 | 25 | 50 | - | - | 10/39 |
| 2 | 3.7 | 50 | 80 | - | - | 15/25 |
| 3 | 4.1 | 60 | 80 | - | - | 12/18 |
| 4 | 4.0 | 62 | 85 | - | - | 13/25 |
| 5 | 4.2 | 60 | 80 | - | - | 13/20 |
| 6 | 2.7 | 30 | 70 | - | - | 12/22 |
| 7 | 1.3 | 22 | 40 | - | - | 8/20 |
| $\bar{x}$ | 3.1 | | | | | |

FISH SAMPLE:

| Species | Age | fl-range (mm) | $\overline{fl}$ (mm) | Mean Weight (g) | U1 | U2 | T | N | S.E. | Morts | N Corr. | N/$m^2$ | N/ Linear m | Biomass g/$m^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sthd | 0+ | 41-51 | 44.9 | 1.27 | 7 | 0 | 7 | 7 | NA | 0 | 7 | 0.113 | 0.35 | 0.14 |
| Sthd | 1+ | 79 | 79.0 | 6.00 | 1 | 0 | 1 | 1 | NA | 0 | 1 | 0.016 | 0.05 | 0.10 |
| Sthd | ≥2+ | 144 | 144.0 | 37.93 | 1 | 0 | 1 | 1 | NA | 0 | 1 | 0.016 | 0.05 | 0.61 |
| Ch | 0+ | 60-67 | 63.5 | 3.91 | 1 | 0 | 2 | 2 | NA | 0 | 2 | 0.032 | 0.10 | 0.13 |
| MW | ≥1+ | 70 | 70.0 | 3.81 | 1 | 0 | 1 | 1 | NA | 0 | 1 | 0.016 | 0.05 | 0.06 |
| Total | | | | | | | | | | | 12 | 0.193 | 0.60 | 1.04 |

Note: For abbreviations and symbols used in this table see first page of Appendix 8

Appendix 9.1 Population Estimates of Juvenile Salmonids in Goathorn Creek, September and October 1984

**STEELHEAD TROUT**

| Site | Number of Fish per Linear Meter 0+ | 1+ | ≥2+ | Length of Stream Represented by Sample Site (m) | Population Estimates by Section 0+ | 1+ | ≥2+ |
|---|---|---|---|---|---|---|---|
| G1 | 4.55 | 1.24 | 0.24 | 1,100 | 5,005 | 1,364 | 264 |
| G2 | 0.91 | 0.71 | 0.14 | 1,000 | 910 | 710 | 140 |
| G3 | 0.66 | 0.20 | 0.43 | 1,500 | 990 | 300 | 645 |
| G4 | 0.10 | 0.02 | 0.06 | 1,000 | 100 | 20 | 60 |
| G5 | 0.03 | 0.01 | 0.01 | 3,000 | 90 | 30 | 30 |
| G6 | 0.00 | 0.04 | 0.00 | 4,300 | 0 | 172 | 0 |
| G7 | 0.00 | 0.00 | 0.00 | 1,700 | 0 | 0 | 0 |
| Total | | | | 13,600 | 7,095 | 2,596 | 1,139 |

**DOLLY VARDEN CHAR**

| Site | Number of Fish per Linear Meter 0+ | ≥1+ | Length of Stream Represented by Sample Site (m) | Population Estimates by Section 0+ | ≥1+ |
|---|---|---|---|---|---|
| G1 | 0.00 | 0.06 | 1,100 | 0 | 66 |
| G2 | 0.00 | 0.04 | 1,000 | 0 | 40 |
| G3 | 0.68 | 0.70 | 1,500 | 1,020 | 1,050 |
| G4 | 0.58 | 0.63 | 1,000 | 580 | 630 |
| G5 | 0.19 | 0.85 | 3,000 | 570 | 2,550 |
| G6 | 0.14 | 1.51 | 4,300 | 602 | 6,493 |
| G7 | 0.00 | 2.37 | 1,700 | 0 | 4,029 |
| Total | | | 13,600 | 2,772 | 14,858 |

Appendix 9.2 Population Estimates of Juvenile Salmonids in Tenas Creek, September and October 1984

| Site | Number of Fish per Linear Meter | | | Length of Stream Represented by Sample Site (m) | Population Estimates by Section | | |
|---|---|---|---|---|---|---|---|
| STEELHEAD TROUT | | | | | | | |
| | 0+ | 1+ | >2+ | | 0+ | 1+ | >2+ |
| T1 | 2.56 | 0.54 | 0.02 | 2,900 | 7,424 | 1,566 | 58 |
| T2 | 0.29 | 0.85 | 0.53 | 2,900 | 841 | 2,465 | 1,537 |
| T3 | 0.03 | 0.16 | 0.00 | 2,900 | 87 | 464 | 0 |
| T4 | 0.00 | 0.24 | 0.28 | 3,000 | 0 | 720 | 840 |
| Total | | | | 11,700 | 8,352 | 5,215 | 2,435 |
| DOLLY VARDEN CHAR | | | | | | | |
| | 0+ | | >1+ | | 0+ | | >1+ |
| T1 | 0.00 | | 0.05 | 2,900 | 0 | | 145 |
| T2 | 0.00 | | 0.10 | 2,900 | 0 | | 290 |
| T3 | 0.19 | | 0.59 | 2,900 | 551 | | 1,711 |
| T4 | 0.48 | | 0.44 | 3,000 | 1,440 | | 1,320 |
| Total | | | | 11,700 | 1,991 | | 3,466 |

Appendix 9.3 Population Estimates of Juvenile Steelhead in Main and Side Channels of the Telkwa River, September 1984

MAIN CHANNEL

| Site | Number of Fish per Linear Meter | | | Total Main[1] Channel Length (m) | Population Estimates Corrected for Main Channel Length | | |
|---|---|---|---|---|---|---|---|
| | 0+ | 1+ | >2+ | | 0+ | 1+ | >2+ |
| MS1 | 0.58 | 0.79 | 0.42 | | | | |
| MS2 | 0.65 | 0.23 | 0.14 | | | | |
| MS3 | 1.00 | 0.75 | 0.19 | | | | |
| MS4 | 0.00 | 0.31 | 0.00 | | | | |
| MS5 | 1.69 | 0.00 | 0.00 | | | | |
| MS6 | 1.65 | 0.45 | 0.11 | | | | |
| MS7 | 1.45 | 1.52 | 0.61 | | | | |
| Mean | 1.00 | 0.58 | 0.21 | 16,000 | 16,000 | 9,280 | 3,360 |

SIDE CHANNEL

| Site | Number of Fish per Linear Meter | | | Total Side[2] Channel Length (m) | Population Estimates Corrected for Side Channel Length | | |
|---|---|---|---|---|---|---|---|
| | 0+ | 1+ | >2+ | | 0+ | 1+ | >2+ |
| SC1 | 0.90 | 1.08 | 0.12 | | | | |
| SC2 | 0.73 | 1.20 | 0.43 | | | | |
| SC3 | 0.68 | 0.00 | 0.00 | | | | |
| Mean | 0.77 | 0.76 | 0.18 | 12,900 | 9,933 | 9,804 | 2,322 |

1 The 8,000 m of main channel has been doubled to account for the two sides of the river. Fish/linear meter refers to one side of the river only.

2 Combined total length of active and flood channels. The total does not include relic side channels (Figure 3.9).

Appendix 10 Results of 1984 Wetland Minnow Trapping Program Along the Telkwa and Bulkley Rivers

| Trap Site No. | Location[1] | Date | Wetted Area ($m^2$) | # of Traps Set | Fish Captured | Water Temp. | Comments |
|---|---|---|---|---|---|---|---|
| WL1 | Km 5 south side | Sept. 13 | 4,530 | 9 | None | 11°C | This wetland area is located at the base of the hillside draining from mine site area. No water flowing between ponds. |
| WL2 | Km 3 south side | Sept. 13 | N/A | 6 | None | 8°C | This channel (Tributary 1) is crossed by bridge leading to a farm. Channel blocked from mainstem by beaver dam. There is water flowing year round in this channel which historically has had fish in it (local resident's comments). |
| WL3 | Km 2 south side | Sept. 13 | 3,749 | 5 | 21 longnose suckers (43-126 mm) | 8°C | Beaver dam at pond outlet. Most suckers captured below this dam. The small outlet stream flows through Telkwa and is proposed to be diverted into a dyke area. The lower end of this channel was sampled by electroshocking in spring 1984. No fish captured at that time. |
| WL4 | Km 1 south side | Sept. 13 | 5,141 | 5 | none | 11°C | The top end of this relic channel was sampled. Intermittent with old beaver dams present. The lower end of channel is directly connected to the Telkwa and juvenile fish have been observed in this area. |
| WL5 | Km 5 north side | Aug. 29 | 13,014 | 10 | None | 16°C (1600 hr) | This is an extensive wetland area with good potential rearing opportunities for coho salmon. Deep and lots of cover. A 1.5 m beaver dam restricts access from the Telkwa River. No visible flow at the outlet - 15 m to the river. |
| WL6 | Bulkley R. south side 4 km east of Telkwa. North corridor route | Aug. 29 | 20,985 | 10 | 75 longnose dace | 16°C (1300 hr) | Traps were set on both sides of the CNR tracks. Suspect little opportunity for coho salmon. No flow at base of beaver dam just back from the Bulkley River. This wetland area is quite stagnant and water quality appears poor. Opportunity for enhancement by opening culverts through CNR line. |

1

Appendix 11 Summary of Aerial Reconnaissance of Coho Salmon Spawners in the Telkwa River on November 14 and 30, 1984

| | River Section (km)[1] | Number of Coho Salmon Spawners | Redds | Comment |
|---|---|---|---|---|
| NOVEMBER 14 | 30 | 6 | | Active digging. Fish are starting to colour up and some evidence of fungus. |
| | 31 | 2 | | Approx. 1 km below Water Survey cableway. |
| | 32 | 25 | | |
| | 33 | | 3 | At cableway. |
| | 34 | 40 | | Approx. 1 km above cableway. No carcasses. |
| | Elliott Ck. | 22 | | Lowest 1 km - 1 carcass from eagle kill. |
| | 44-47 | | 8 | This section has signs of digging but no fish. |
| | 46 | 2 | | Near log - holding. |
| | TOTAL | 97 | 11 | |
| NOVEMBER 30 | 31 | 20 | | Active spawning |
| | 33 | 13 | | At cableway |
| | 34 | 54 | | 1 km above cableway |
| | Elliott Ck. | 13 | | Open water - 0.5 C |
| | 44 | | 11 | Lots of apparent digging but no fish |
| | 45 | 2 | 4 | |
| | 46 | 15 | 2 | |
| | TOTAL | 117 | 17 | |

| | November 14 | November 30 |
|---|---|---|
| Weather: | Overcast and snowing upstream of 40 km. | High overcast and sunny periods. |
| Ice Conditions: | Slush and some surface ice downstream of Howson Creek. Anchor ice present throughout system in riffle sections. | Less anchor and slush ice than during November 14 flight. River upstream of km 43 was free of ice. |
| Extent of Survey: | Km 0 to Km 46 | Km 28 to Km 47 |

1 See Figure 3.17 for section locations.

Appendix 12.1 Detailed Results of Metal Concentrations (Micrograms of Element per Gram of Dry Tissue) in Fish Muscle Tissue from Goathorn and Tenas Creeks, 1984

| SITE | SPECIES | SAMPLE NO. | FT (mm) | % MOISTURE | As | Cd | Cu | Pb | Zn | Fe | Al |
|---|---|---|---|---|---|---|---|---|---|---|---|
| G2 | Sthd | 1 | 103/93[1] | 79.3 | 0.10 | 0.25 | 2.2 | 0.10 | 33.5 | 50 | 6.1 |
| G2 | Sthd | 2 | 125 | 79.5 | *[2] | 0.10 | 2.8 | 0.20 | 32.8 | 89 | 5.5 |
| G2 | Sthd | 3 | 125 | 79.0 | 0.06 | 0.08 | 2.0 | * | 34.6 | 104 | 5.8 |
| G2 | Sthd | 4 | 104 | 79.4 | * | 0.10 | 2.2 | * | 27.5 | 31 | 17.2 |
| G2 | Sthd | 5 | 111 | 78.9 | 0.10 | 0.14 | 1.8 | 0.25 | 30.9 | 32 | 5.9 |
| G2 | Sthd | 6 | 107/75 | 79.7 | 0.10 | 0.20 | 1.7 | 0.25 | 29.6 | 30 | 5.1 |
| G2 | Sthd | 7 | 120 | 80.0 | 0.06 | 0.10 | 1.6 | 0.28 | 31.6 | 24 | 6.7 |
| G2 | Sthd | 8 | 118 | 80.3 | 0.06 | 0.15 | 1.8 | 0.20 | 28.9 | 42 | 9.1 |
| G2 | Sthd | 9 | 105 | 79.6 | * | 0.12 | 2.0 | 0.30 | 34.3 | 28 | 5.5 |
| G2 | Sthd | 10 | 93/88 | 79.8 | 0.06 | 0.14 | 1.7 | 0.25 | 30.8 | 25 | 8.3 |
| | Mean[3] | | | 79.6 | 0.07 | 0.14 | 2.0 | 0.20 | 31.4 | 45.5 | 7.5 |
| | Range | | | | < 0.05-0.10 | 0.08-0.25 | 1.6-2.8 | < 0.10-0.30 | 27.5-34.3 | 24-104 | 5.1-17.2 |
| G5 | DV | 1 | 126 | 78.8 | * | 0.18 | 1.5 | * | 31.2 | 22 | 1.5 |
| G5 | DV | 2 | 113/70 | 79.2 | 0.06 | 0.16 | 1.7 | * | 28.6 | 25 | 0.3 |
| G5 | DV | 3 | 112/90 | 80.0 | 0.07 | 0.18 | 1.1 | * | 34.0 | 25 | * |
| G5 | DV | 4 | 80/115 | 79.6 | * | 0.16 | 1.2 | * | 36.0 | 20 | 2.3 |
| G5 | DV | 5 | 175 | 79.8 | * | 0.10 | 2.2 | * | 34.5 | 30 | 1.4 |
| G5 | DV | 6 | 180 | 78.9 | 0.06 | 0.10 | 2.4 | * | 26.3 | 29 | 3.4 |
| G5 | DV | 7 | 173 | 79.2 | * | 0.12 | 2.6 | * | 30.3 | 30 | 1.0 |
| G5 | DV | 8 | 134 | 79.8 | 0.07 | 0.12 | 1.1 | * | 29.3 | 16 | 2.3 |
| G5 | DV | 9 | 150 | 79.8 | * | 0.10 | 2.0 | 0.10 | 30.4 | 25 | 2.7 |
| G5 | DV | 10 | 122 | 79.7 | * | 0.10 | 1.5 | * | 37.1 | 20 | * |
| | Mean | | | 79.5 | 0.06 | 0.13 | 1.7 | 0.10 | 31.8 | 24.2 | 1.5 |
| | Range | | | | < 0.05-0.07 | 0.10-0.18 | 1.1-2.6 | < 0.10-0.10 | 26.3-37.1 | 16-30 | < 0.05-3.4 |

| SITE | SPECIES | SAMPLE NO. | FT (mm) | % MOISTURE | As | Cd | Cu | Pb | Zn | Fe | Al |
|---|---|---|---|---|---|---|---|---|---|---|---|
| T2 | Sthd | (1)[4] | 133 | (79.9) | (*) | (0.06) | (1.6) | (0.30) | (36.9) | (195) | (189) |
| T2 | Sthd | 2 | 129 | 78.9 | * | 0.08 | 1.5 | * | 28.0 | 26 | 6.0 |
| T2 | Sthd | 3 | 140 | 80.0 | 0.07 | 0.06 | 2.1 | 0.25 | 37.7 | 31 | 6.3 |
| T2 | Sthd | 4 | 111 | 80.2 | 0.09 | 0.08 | 1.4 | 0.10 | 31.7 | 25 | 5.1 |
| T2 | Sthd | 5 | 172 | 79.6 | * | 0.09 | 2.4 | 0.10 | 23.6 | 34 | 4.3 |
| T2 | Sthd | 6 | 107/94 | 79.8 | 0.07 | 0.06 | 1.9 | * | 37.0 | 28 | 5.8 |
| T2 | Sthd | 7 | 119 | 80.3 | * | * | 1.0 | * | 33.8 | 20 | 0.9 |
| T2 | Sthd | 8 | 135 | 79.9 | * | * | 1.3 | 0.10 | 30.6 | 25 | 6.2 |
| T2 | Sthd | 9 | 114 | 80.2 | * | * | 1.1 | * | 28.6 | 22 | 2.3 |
| T2 | Sthd | 10 | 136 | 79.8 | * | * | 1.3 | * | 31.0 | 16 | 1.9 |
| | Mean | | | 79.9 | 0.06 | 0.06 | 1.6 | 0.12 | 31.3 | 25.2 | 4.3 |
| | Range | | | | < 0.05-0.09 | < 0.05-0.09 | 1.0-2.4 | < 0.10-0.25 | 23.6-37.7 | 16-34 | 0.9-6.3 |
| DETECTION LIMITS | | | | | 0.05 | 0.05 | 0.10 | 0.10 | 0.10 | 1.0 | 0.05 |

1 Sample is comprised of two different fish.

2 Levels less than detection limits.

3 When the mean was calculated, minimum detection limits were used for those samples that have levels less than the detection limits.

4 Excluded from sample due to possible contamination.

Table 12.2 Results of Analyses of 17 Additional Elements in Fish Tissues From Goathorn and Tenas Creeks, 1984[1]

| ELEMENT | DETECTION LIMIT | SITE G2 MEAN[2] | SITE G2 RANGE | SITE G5 MEAN | SITE G5 RANGE | SITE T2 MEAN | SITE T2 RANGE |
|---|---|---|---|---|---|---|---|
| Silver | 0.1 | < 0.1 | < 0.1-0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1-0.1 |
| Gold | 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 |
| Barium | 0.1 | 0.2 | < 0.1-0.3 | 0.1 | < 0.1-0.2 | 0.1 | < 0.1-0.1 |
| Bismuth | 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| Calcium | 5 | 1170 | 969-1400 | 863 | 618-1080 | 1036 | 816-1320 |
| Cobalt | 0.1 | 0.1 | < 0.1-0.2 | 0.1 | < 0.1-0.5 | 0.1 | < 0.1-0.3 |
| Chromium | 0.1 | < 0.1 | < 0.1-0.3 | 0.2 | < 0.1-0.4 | 0.4 | 0.2-0.8 |
| Potassium | 1 | 14950 | 14200-16700 | 13600 | 11300-15100 | 13700 | 12400-14700 |
| Magnesium | 1 | 998 | 971-1040 | 1020 | 968-1090 | 987 | 922-1070 |
| Manganese | 0.1 | 0.2 | < 0.1-0.4 | 0.2 | < 0.1-0.4 | 0.4 | 0.2-0.6 |
| Molybdenum | 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1-0.1 | < 0.1 | < 0.1-0.1 |
| Sodium | 50 | 2765 | 2420-3360 | 2630 | 2140-3200 | 2730 | 2290-3020 |
| Nickel | 0.1 | 1.5 | 0.1-6.9 | 0.3 | < 0.1-0.7 | 0.6 | < 0.1-1.7 |
| Phosphorus | 5 | 9840 | 1070-11100 | 10600 | 9650-11300 | 10400 | 9960-10700 |
| Antimony | 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 - 2 |
| Tin | 0.1 | < 0.1 | < 0.1-0.8 | < 0.1 | < 0.1 | < 0.1 | < 0.1 |
| Strontium | 0.1 | 0.1 | 0.1-0.2 | 0.1 | 0.1 | 0.2 | 0.1-0.3 |

1 Results and detection limits are expressed as micrograms of element per gram of dry tissue. See Appendix Table 12.1 for moisture content and description of fish species and size.

2 When the mean was calculated, minimum detection limits were used for those samples where levels were less than the detection limits.

Table 12.2 Results of Analyses of 17 Additional Elements in Fish Tissues From Goathorn and Tenas Creeks, 1984[1]

| ELEMENT | DETECTION LIMIT | SITE G2 | | SITE G5 | | SITE T2 | |
|---|---|---|---|---|---|---|---|
| | | MEAN[2] | RANGE | MEAN | RANGE | MEAN | RANGE |
| Silver | 0.1 | 0.1 | 0.1-0.1 | 0.1 | 0.1 | 0.1 | 0.1-0.1 |
| Gold | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Barium | 0.1 | 0.2 | 0.1-0.3 | 0.1 | 0.1-0.2 | 0.1 | 0.1-0.1 |
| Bismuth | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Calcium | 5 | 1170 | 969-1400 | 863 | 618-1080 | 1036 | 816-1320 |
| Cobalt | 0.1 | 0.1 | 0.1-0.2 | 0.1 | 0.1-0.5 | 0.1 | 0.1-0.3 |
| Chromium | 0.1 | 0.1 | 0.1-0.3 | 0.2 | 0.1-0.4 | 0.4 | 0.2-0.8 |
| Potassium | 1 | 14950 | 14200-16700 | 13600 | 11300-15100 | 13700 | 12400-14700 |
| Magnesium | 1 | 998 | 971-1040 | 1020 | 968-1090 | 987 | 922-1070 |
| Manganese | 0.1 | 0.2 | 0.1-0.4 | 0.2 | 0.1-0.4 | 0.4 | 0.2-0.6 |
| Molybdenum | 0.1 | 0.1 | 0.1 | 0.1 | 0.1-0.1 | 0.1 | 0.1-0.1 |
| Sodium | 50 | 2765 | 2420-3360 | 2630 | 2140-3200 | 2730 | 2290-3020 |
| Nickel | 0.1 | 1.5 | 0.1-6.9 | 0.3 | 0.1-0.7 | 0.6 | 0.1-1.7 |
| Phosphorus | 5 | 9840 | 1070-11100 | 10600 | 9650-11300 | 10400 | 9960-10700 |
| Antimony | 1 | 1 | 1 | 1 | 1 1 | 1 | - 2 |
| Tin | 0.1 | 0.1 | 0.1-0.8 | 0.1 | 0.1 | 0.1 | 0.1 |
| Strontium | 0.1 | 0.1 | 0.1-0.2 | 0.1 | 0.1 | 0.2 | 0.1-0.3 |

1 Results and detection limits are expressed as micrograms of element per gram of dry tissue. See Appendix Table 12.1 for moisture content and description of fish species and size.

2 When the mean was calculated, minimum detection limits were used for those samples where levels were less than the detection limits.