Appendix 4.5-A

Assessment of Benthic Invertebrate and Juvenile Fish Populations in Goathorn and Tenas Creeks and the Lower Telkwa Rivers (Bustard 1984)

TELKWA COAL
LIMITED

ASSESSMENT OF BENTHIC INVERTEBRATE AND JUVENILE FISH POPULATIONS IN GOATHORN AND TENAS CREEKS AND THE LOWER TELKWA RIVER. SEPTEMBER 1983.

by

DAVID BUSTARD

for

READ ENVIRONMENTAL & PLANNING ASSOCIATES LTD.

prepared for

CROWS NEST RESOURCES LIMITED

January, 1984

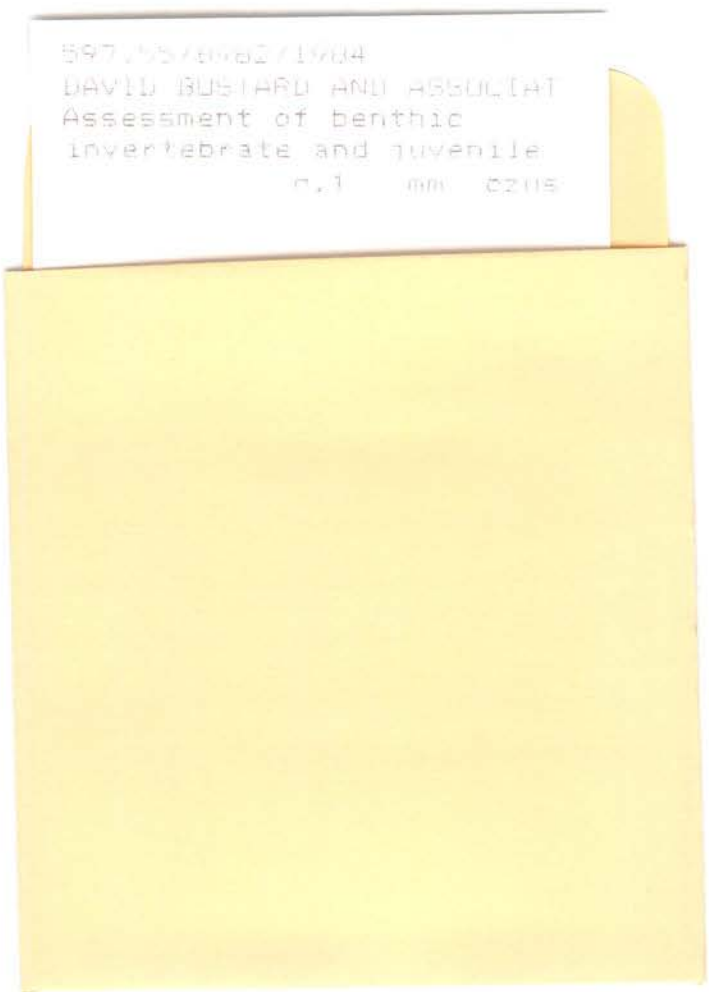

597.55/BUS/1984
DAVID BUSTARD ANU ASSOCIAT
Assessment of benthic
invertebrate and juvenile
c.1 mm czus

Table —. Biotic Condition Indices for benthic macroinvertebrate samples collected in Goathouse and Tenmile creeks and the Tallahoma River side channels.

Community Tolerance Quotients.

	CTQp [1]	CTQa [2] (1984)	CTQa (1983)	BCI (1984)	BCI (1983)
G1	50	105.4		47	73
G2	50	40.7	71.1	123	70
G3	50	34.5	45.4	145	110
G 3A	50	39.5	-	127	-
G 4	50	36.2	42.6	138	117
G5	50	42.3	43.6	118	115
G5A	50	44.3		113	
T1	50	69.4		72	
T2	50	41.5		120	
SC1	53	54.4		97	
SC2	53	42.0		126	

CTQp - Predicted Community Tolerance Quotient

CTQa - Actual Community Tolerance Quotient

Wednesday

Table. Tolerance quotients of aquatic invertebrates present in the study area based upon tolerance to alkalinity, sulphate and sedimentation. (From Winget and Mangum, 1979).

	Tolerance Quotient's
INSECTA	
Ephemereoptera	
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
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
Cyclorrhapha	Exclude
Coleoptera	72
Hydrophilidae	72
Psephenidae	
Dytiscidae	72
Heteroptera	
Corixidae	108
Hydrometridae (Gerridae)	-
Collembola	
Sminthuridae — Poduridae	108
	108
HIRUDINEA	108
OLIGOCHAETA	108
ACARINA	
Sphaeridae	108

Read
Environmental & Planning Associates Ltd.
230-10451 SHELLBRIDGE WAY, RICHMOND, B.C. V6X 2W8 (604) 273-3803

March 12, 1984
File: 03035

Malcolm Ross
Supervisor, Environmental & Regulatory Affairs
Crows Nest Resources Limited
Eau Claire Place
525 - 3rd Avenue S.W.
Calgary, Alberta
T2P 2M7

Dear Malcolm:

Re: Telkwa Aquatic Studies

Read Environmental & Planning Associates Ltd. is pleased to deliver the Assessment of Benthic Invertebrate and Juvenile Fish Populations in Goathorn and Tenas Creeks and the Lower Telkwa River, September, 1983.

The 1983 studies in Goathorn and Tenas creeks and the Lower Telkwa indicate that at least portions of all these streams provide important rearing habitat for juvenile steelhead trout. Steelhead trout were the predominant fish species present in all sample areas except upper Goathorn and upper Tenas creeks where Dolly varden char were more common. No coho salmon were captured in Goathorn or Tenas creeks, confirming previous observations that these streams have limited potential for coho. Tenas Creek was consistently the most productive of the three.

Resident cutthroat trout were the most common species captured in the upper portions of Hubert and Helps creeks. Coho salmon and steelhead trout utilize the lower sections of Hubert Creek. The beaver ponds along the lower reach create ideal habitat for juvenile coho rearing.

Given the absence of coho juveniles near the mine site, no further work is recommended on adult coho salmon. Emphasis in any further adult salmonid studies should be placed on the steelhead population. Results of the 1983 sampling program should be considered in location of mine access and design of ongoing monitoring.

Yours truly,

Simon C. Read
President

SCR:pm
Enclosure

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGEMENTS

The author would like to acknowledge Ted Harding and Chris Morley for their assistance with field studies. Kathleen Stuart conducted the identification and enumeration of the invertebrate benthos samples. As well, the use of Ministry of Environment (Smithers) scale reading facilities and benthos sampler is gratefully acknowledged.

1.C INTRODUCTION

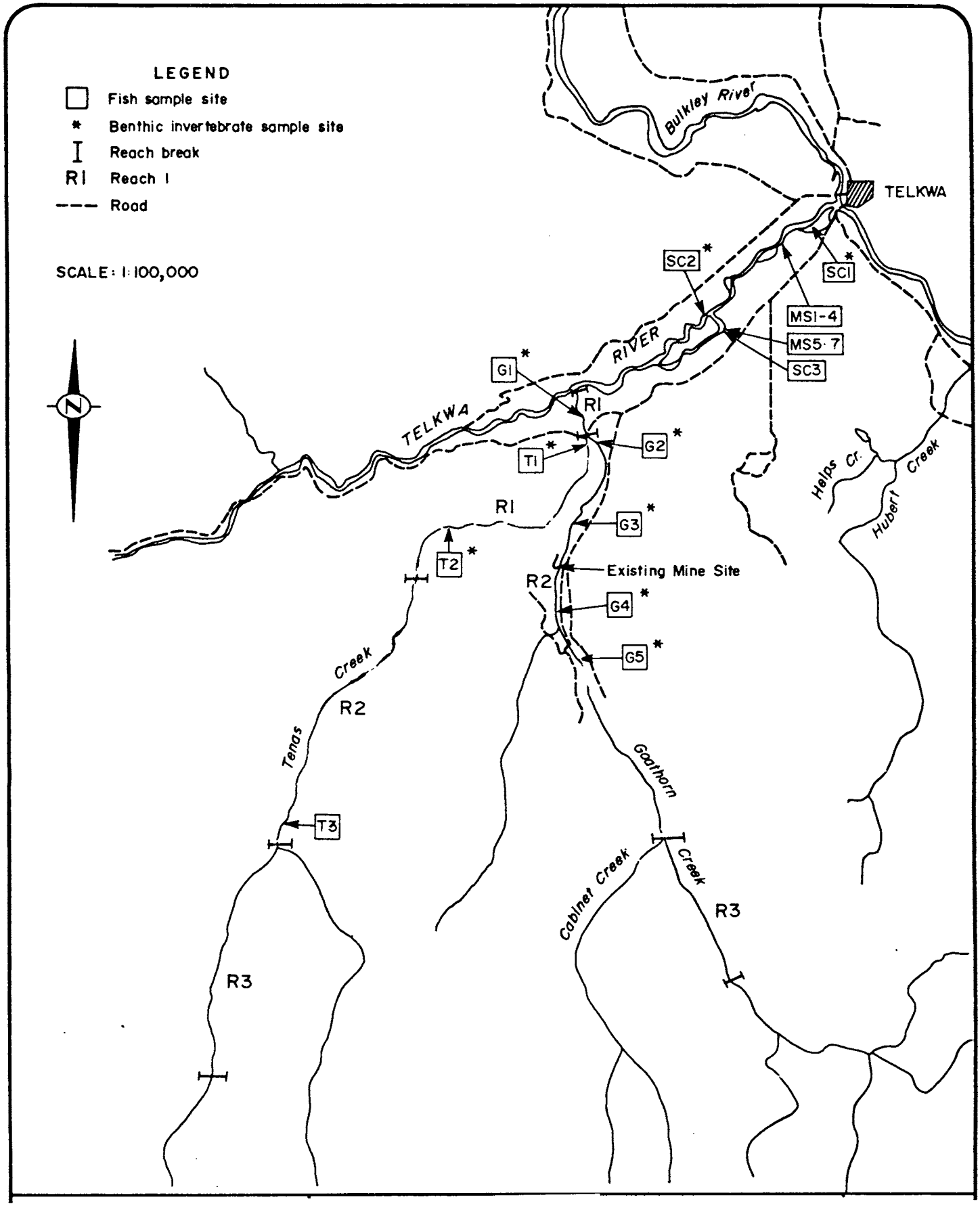
Field studies were conducted in September 1983 to investigate juvenile fish and benthic invertebrate populations in several streams in the vicinity of Telkwa, in north central British Columbia (Figure 1.1). Studies focussed on those areas potentially affected by a coal development proposed by Crows Nest Resources Limited in the Goathorn Creek watershed.

Previous juvenile fish sampling in Goathorn and Tenas creeks and in the lower Telkwa River was limited to a few point samples conducted during Resource Analysis Branch (RAB) surveys in 1974. This information was neither quantitative nor of sufficient detail to serve as a background describing the distribution and abundance of juvenile fish in these systems. No information describing the benthic invertebrate populations in these systems was available. Benthic invertebrates are the main food source for fish populations, and their limited mobility and short life span make them useful for detecting altered stream conditions.

The objective of the 1983 sampling program was to collect juvenile fish and benthic invertebrate information to a level sufficient to evaluate the importance of the aquatic resources of the various stream systems. The sample design and level of information collection was to serve as a baseline for measuring possible changes in future juvenile fish or benthic invertebrate populations. Goathorn and Tenas Creek sites were emphasized due to their immediate proximity to the coal property. Hulbert Creek, a tributary of the Bulkley River was also sampled during these studies (see Figure 2.3, p 7). Portions of this creek lie within a proposed access corridor to the coal property

2.0 METHODS

Field studies were conducted by a crew of three primarily during the last two weeks of September. Sites in upper Helps Creek were sampled in mid-October. Access to all sites was by vehicle except the two upper Tenas Creek sites which were reached by helicopter.


LEGEND
Fish sample site
Benthic invertebrate sample site
Reach break
R1 Reach 1
Road
SCALE: 1:100,000
N
Bulkley River
TELKWA
SC2
SC1
MS1-4
MS5-7
SC3
RIVER
G1
R1
TELKWA
T1
G2
Helps Cr.
Creek
Hubert
R1
G3
T2
Existing Mine Site
R2
G4
G5
Creek
R2
Tenas
Goathorn
T3
Cabinet Creek
Creek
R3
R3

2.1 BENTHIC INVERTEBRATE SAMPLES

Benthic invertebrates were sampled at a total of nine sites in Goathorn and Tenas creeks and in side channels of the lower Telkwa River (Figure 1.1). Six replicates were collected at each site. Benthic invertebrate sample sites were located in riffle sections within or adjacent to fish sample locations. Iron stakes were used as benchmarks on the stream's right bank and samples were taken at equally-spaced intervals across the wetted width of the channel. Samples were collected using a Waters-Knapp sampler (Waters and Knapp 1961) with a 250 um mesh size. (Figure 2.1). The substrate 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 genera, and in most instances species level for the dominant and sub-dominant orders. Information describing water temperature, depth and velocity, as well as substrate characteristics were recorded at the collection sites.

2.2 JUVENILE FISH SAMPLES

Eighteen detailed juvenile fish sample sites were established in Goathorn and Tenas creeks and in the lower Telkwa River (Figure 1.1). Sites throughout Helps Creek were also sampled to determine fish distribution within this system.

Tributary sample sites were selected as representative of the reach characteristics outlined in aquatic resource maps prepared by the RAB (Aquatic Bio-physical Map : 93 L11). As well several sites within a single reach were selected to provide comparative information above and below the coal property on Goathorn and Tenas Creek. Three side channel sites were established, representing small, medium and large side channels characteristic of the Telkwa River. Similarly, seven sites were selected along the edge of the Telkwa River to provide a representative sample of habitat types along the main channel.

Tributary sample sites (excluding Hubert Creek), ranging from 45 to 90 metres in length, were blocked with stopnets at their upstream and downstream ends, and sampled using electroshockers. 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 25 m seine net held in place by rebar positioned two hours prior to sampling (Figure 2.2). 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 with two electroshockers sampled up and back through each site to constitute a single pass. The two-step removal method was also used at one tributary site (T3) 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 1.

Sample site areas were calculated from measurements of length and a series of width measurements made at 5 to 20 m intervals along the sample site. As well, water depths (maximum and mean), substrate and cover characteristics were recorded at each cross section. Substrate characteristics were recorded as D50 and D90 estimates (i.e., the diameter of bed material which is larger than 50% and 90% respectively of the remaining bed material as defined in Chamberlin (1980)). All fish captured were anaesthetized with 2-phenoxyethanol, measured to the nearest millimeter and returned to the stream at the end of the sampling. Scales were removed from 170 juvenile steelhead trout for aging. Weights were determined for 174 steelhead trout, 53 Dolly Varden char and 13 mountain whitefish, and the results were used to determine biomass estimates for each site using regression analyses.

Figure 2.1:

Benthic invertebrates were collected using a Waters-Knapp sampler.

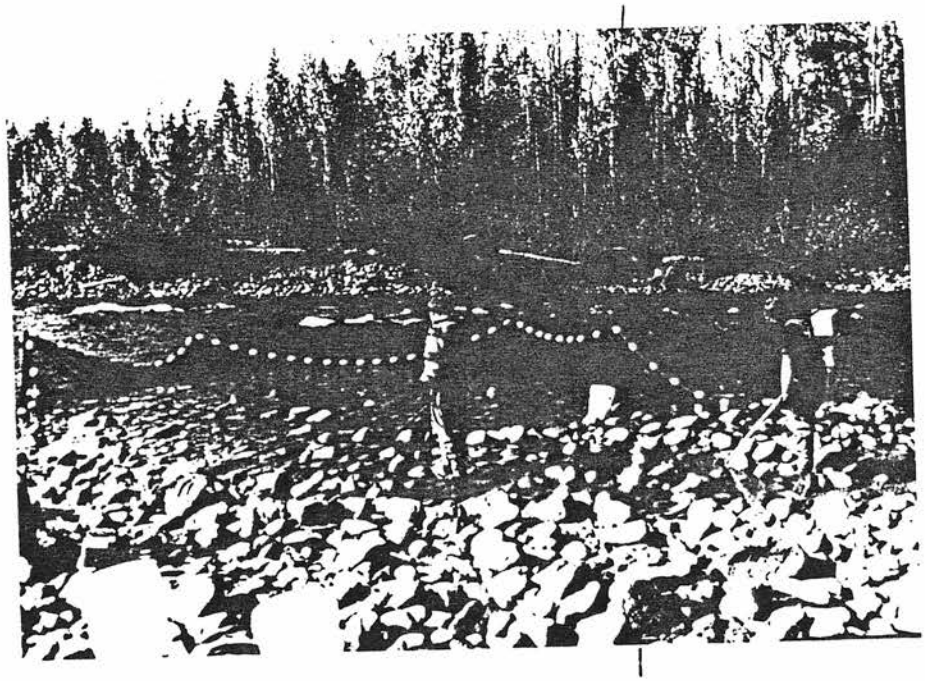


Figure 2.2: Main channel sites were enclosed by a seine net and sampled by electroshocking.

Extensive beaver dams creating deep slow water sites throughout much of lower Hubert Creek prevented the use of electroshocking for determining fish distribution within this system. Instead, 34 minnow traps were set throughout Hubert and Helps creeks (Figure 2.3). Traps were baited with salmon roe and set for 24 hours. As well, a single monofilament gill net (10 m x 1.5 m x 4 cm mesh) was set overnight in Helps Lake (Figure 2.3). All captured fish were measured as previously outlined, and a sample of scales from trout species was removed for age analysis.

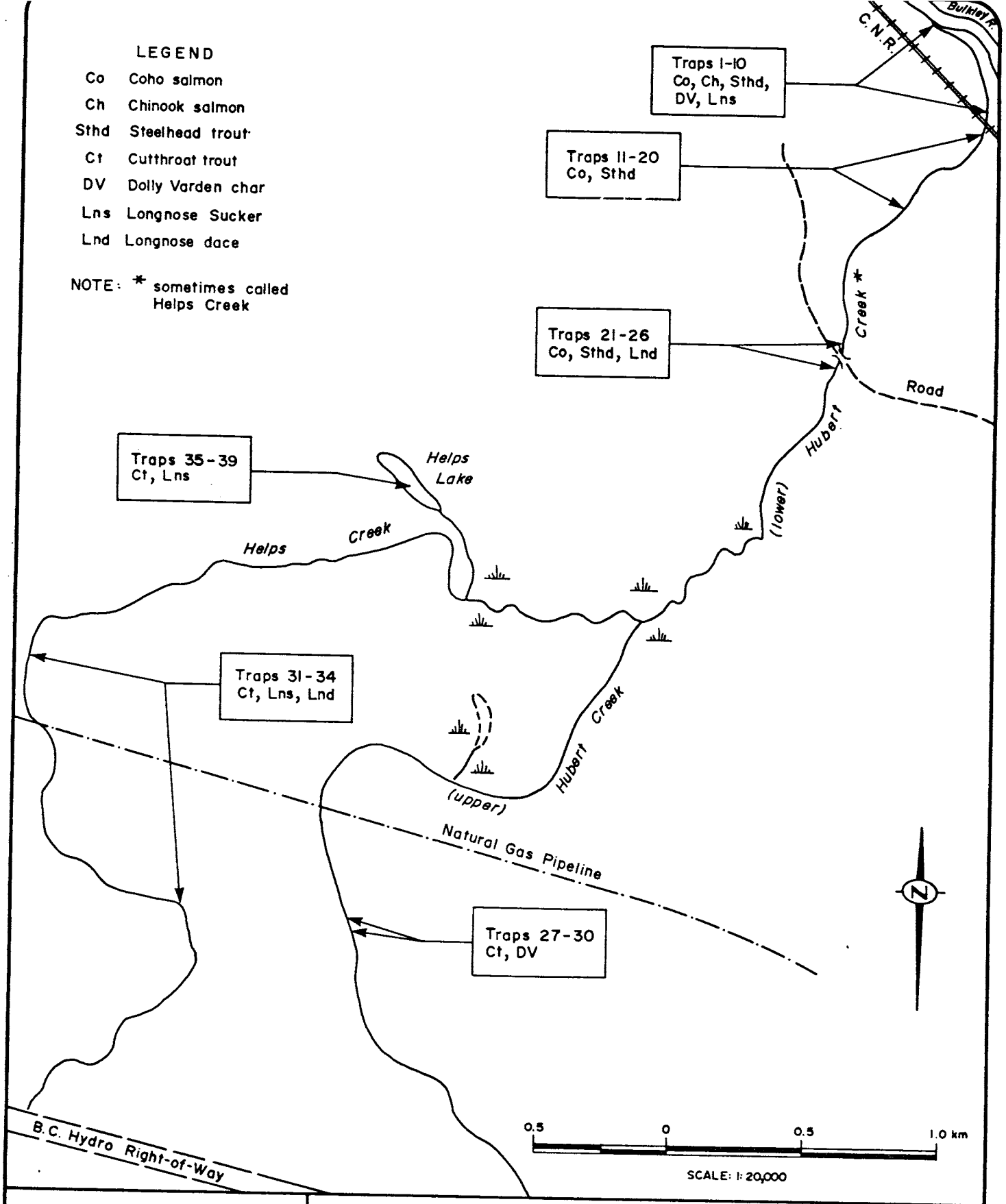
3.0 RESULTS

3.1 BENTHIC INVERTEBRATES

The results outlining the number of benthic invertebrates sampled at the nine sites are presented in Table 3.1. Additional detailed information for each sample site is presented in Appendix 2.

The number of benthic invertebrates per m^2 ranged from just over 300 in several samples in Goathorn Creek to over 5,000 in a sample in Tenas Creek (Table 3.1). The greatest abundance of benthic invertebrates occurred at sites in Tenas Creek and in upper Goathorn Creek. Numbers from these sites were more than double the benthic invertebrate numbers obtained at intermediate sites on Goathorn Creek (G2 and G3) and in Telkwa River side channels.

The total number of taxa represented in the samples provides an indication of the richness of the benthic community (Platts et al. 1983). Taxa numbers per sample ranged from a low of 8 in a side channel of the Telkwa River to a high of 25 in a sample from Tenas Creek, with the means for the sites ranging from 12 to 18 at all sites (Table 3.1). Generally, the sites with the highest numbers of invertebrates also had the greatest species diversity.



Environmental & Planning Associates

Fish distribution and sample sites in Helps Creek and Hubert Creek

FIGURE 2.3

Table 3.1: Summary of benthic invertebrates/m^2 and number of taxa per sample collected at nine sample sites in Goathorn and Tenas Creeks and the Telkwa River in September 1983.

		GOATHORN CREEK					TENAS CREEK		TELKWA RIVER	
	* Replicate	G1	G2	G3	G4	G5	T1	T2	SC1	SC2
TOTAL NUMBER	1	2125	1469	1042	677	2250	2271	896	552	625
	2	2083	979	1667	1552	1906	885	4885	1167	1500
	3	1573	521	1292	1417	3500	1802	5125	1083	1917
	4	667	1063	802	3385	3438	2115	3427	896	1000
	5	1510	1448	354	2115	1281	1552	4052	1281	1438
	6	2323	1458	333	479	2583	1938	2063	385	3229
	Mean	1714	1156	915	1604	2493	1760	3408	894	1618
	SD **	247	155	215	432	355	202	675	146	370
TOTAL TAXA	1	22	16	19	15	18	17	14	11	8
	2	14	15	13	18	19	13	18	12	13
	3	16	8	15	14	17	13	19	10	15
	4	13	17	14	15	22	25	18	13	11
	5	18	17	10	15	15	24	23	14	15
	6	23	11	8	13	18	18	16	11	11
	Mean	17.7	14.0	13.2	15.0	18.2	18.3	18.0	11.8	12.2
	SD	1.7	1.5	1.6	0.7	0.9	2.1	1.2	0.6	1.1

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

** SD refers to the standard deviation of the mean.

Table 3.2 summarizes the composition of the benthic invertebrate communities at the nine sample sites. Most samples were largely comprised of individuals of the orders Ephemeroptera and Plecoptera, particularly in the upper sites of Tenas and Goathorn creeks where these two orders represented 80% of the benthic fauna. Dipterans showed the largest variation within the samples and ranged from a low of 2% in the upper Tenas Creek site (T2) to a high of over 45% in the lowest sites on Goathorn Creek (G1 and G2).

Site G3, located just downstream of the existing mine, had the lowest abundance of benthic invertebrates of the five sites sampled on Goathorn Creek. The main difference between this site and the two sites further downstream was the 10-fold decline in Dipterans in the samples (Appendix 2). This decline persisted into the upstream sites (G4 and G5) despite increased total benthic numbers at these upper sites. The lower site on Tenas Creek (T1) also demonstrated an increased proportion of Dipterans compared to the upper site (T2).

Trichopterans generally comprised less than 5% of the total sample. Other invertebrates, (Hirudinea, Oligochaeta, Acarina, Araneae) were of minor importance to the overall benthic community, usually comprising less than 3% of the total numbers collected (Table 3.2).

3.2 JUVENILE FISH

Results from the fish sampling program presented in the following sections are arranged by different stream systems. The common and scientific names of all fish species mentioned in the text are listed in Appendix 3.

Table 3.2: Summary of composition of benthic invertebrate communities at nine sample sites in Goathorn and Tenas creeks and the Telkwa River, September 1983.

Site *	N	% COMPOSITION				
		Ephemeroptera	Plecoptera	Trichoptera	Diptera	Other
GOATHORN CREEK						
G1	987	25.5	23.3	4.0	45.7	1.6
G2	666	20.0	26.1	4.1	47.4	2.4
G3	527	47.8	37.0	5.3	7.0	2.8
G4	924	41.8	46.5	4.5	5.5	1.7
G5	1436	46.0	38.9	2.4	11.3	1.4
TENAS CREEK						
T1	1014	36.0	37.3	3.8	21.5	1.4
T2	1963	63.0	29.4	4.7	2.5	0.3
TELKWA RIVER						
SC1	515	26.6	54.8	0.4	17.5	0.8
SC2	932	38.2	45.5	6.1	10.2	0

* Refer to Figure 1.1 for specific site locations.

3.2.1 Goathorn Creek

Approximately 3,200 m^2 of the lower two reaches of Goathorn Creek were sampled. This comprised 323 m of stream length and represents just under 4% of the total 9 km of stream in the main fish-producing sections of Goathorn Creek.

Steelhead trout juveniles were the main species present and comprised approximately 70% of the total 904 juvenile fish estimated within the sample sites. The remainder of the catch was comprised of Dolly Varden char, except for a single mountain whitefish juvenile captured in lower Goathorn Creek. No coho salmon juveniles were captured at any of the sites. A summary of juvenile density and biomass estimates is presented in Table 3.3, while the more detailed fish sampling results are provided in Appendix 4.

Overall fish densities were highest at site G1 (Table 3.3), representative of the lowest 1 km of Goathorn Creek, downstream of the confluence with Tenas Creek (Figure 3.1). Densities at this site were approximately three times greater than in sample sites upstream in Goathorn Creek. However, total fish biomass (g/m^2) was generally constant throughout the lower four sample sites and only slightly lower in the uppermost site (Table 3.3). Biomass estimates ranged from 1-2 g/m^2 at all sites. Presumably, the high density estimates in Reach 1 reflect the abundance of steelhead fry in this section. However, these fry have a minor influence on the biomass estimates for the system.

Steelhead Trout

Juvenile rainbow and steelhead trout cannot be visually separated in the field. Several factors suggest that juveniles in Goathorn Creek are primarily the progeny of steelhead trout. Radiotelemetry studies conducted by the B.C. Fish and Wildlife Branch indicate that steelhead trout spawn in Tenas Creek (Mike Lough, B.C. Fish and Wildlife Branch, Smithers). As well, resident rainbow

Figure 3.1: Highest fish densities in Goathorn Creek were at the lowest site.

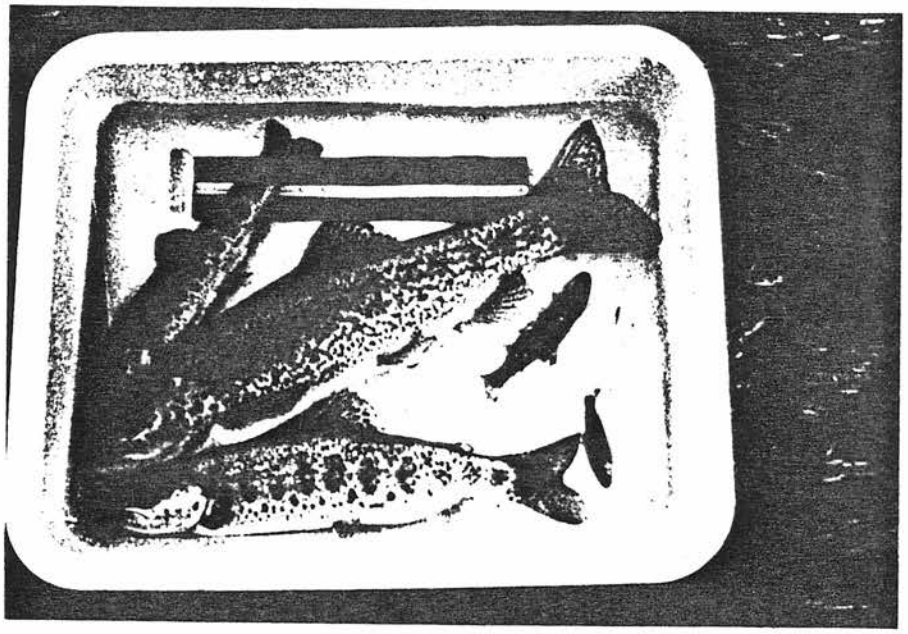


Figure 3.2: A variety of age classes of young steelhead trout were present in Goathorn Creek.

Table 3.3 Summary of juvenile salmonid densities and biomass estimates at five sample sites in Goathorn Creek, September 1983

DENSITY ESTIMATES (fish/m^2)

Reach	Site	Steelhead Trout			Dolly Varden Char		Mountain Whitefish	Total
		0+	1+	>2+	0+	>1+	>1+	
1	G1	.49	.08	.03	<.01	.01	<.01	.61
2	G2	.13	.04	.03	<.01	.02	0	.21
2	G3	.05	.04	.02	.06	.04	0	.21
2	G4	.03	<.01	.01	.14	.09	0	.27
2	G5	<.01	0	.01	.03	.08	0	.12
Mean		.14	.03	.02	.05	.05	<.01	.28

BIOMASS ESTIMATES (g/m^2)

Reach	Site	Steelhead Trout			Dolly Varden Char		Mountain Whitefish	Total
		0+	1+	>2+	0+	>1+	>1+	
1	G1	.43	.49	.82	<.01	.08	.02	1.84
2	G2	.11	.28	.76	<.01	.24	0	1.39
2	G3	.04	.22	1.09	.10	.54	0	1.99
2	G4	.03	.03	.26	.23	.79	0	1.34
2	G5	<.01	0	.23	.04	.86	0	1.13
Mean		.12	.20	.63	.07	.50	<.01	1.54

trout are not commonly angled in the Telkwa River or its tributaries, and only one rainbow over 25 cm (maximum steelhead smolt size) was captured during the surveys in 1983. Although the possibility of a small resident rainbow population exists, juveniles are collectively referred to as steelhead trout. Nearly all juvenile steelhead captured were aged 3+ or less (Figure 3.2).

Juvenile steelhead trout densities were greatest in the lowest reach, mainly resulting from high fry densities of approximately 0.5 fry/m^2 (Table 3.3). In the steeper-gradient Reach 2, both fry and parr densities dropped progressively the further upstream sampled, although some steelhead trout juveniles were still present in the upper site (G5) located over 5 km upstream on Goathorn Creek (Figure 3.3). The presence of several fry in the upper sample suggests that some steelhead trout spawning probably occurs upstream or in the vicinity of this site.

Population estimates have been derived by applying the catch per linear metre of stream sampled to the total stream length represented by each sample (Appendix 5). This results in an estimated 7,700 steelhead fry in Goathorn Creek, with 64% of this estimate located in the lowest 1 km of stream. As well, an estimated 3,100 steelhead parr (62% age 1+) were utilizing Goathorn Creek during the September sample. It has been assumed that steelhead trout do not occur upstream of the Cabinet Creek confluence, although this was not confirmed.

Dolly Varden char

Dolly Varden char densities were lowest in the downstream sites on Goathorn Creek and increased progressively as sampling extended upstream, except at the uppermost site (Table 3.3). The highest abundance of fry occurred at site G4, just upstream from the existing mine site on Goathorn Creek. Older age classes of Dolly Varden char were most common in the upper two sites.

Figure 3.3: Upper Goathorn Creek has a steeper gradient than lower sections of this creek.

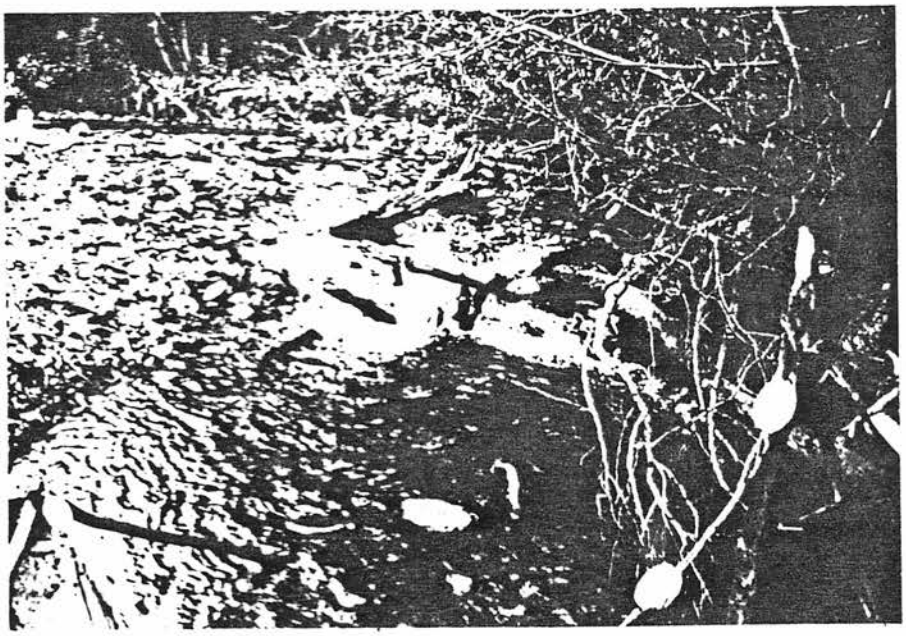


Figure 3.4: Sections of Tenas Creek provided good juvenile steelhead trout rearing areas.

A number of sexually mature Dolly Varden char, 15-20 cm in fork length, were captured in these upper sites. Resident Dolly Varden char populations may mature at a small size in cold headwater streams such as Goathorn and Tenas creeks (Scott and Crossman 1973). A 43 cm Dolly Varden char was angled in lower Goathorn Creek in late August, indicating that Dolly Varden char, considerably larger than those captured in the surveys, are present on at least a seasonal basis in Goathorn Creek.

Population estimates derived for Goathorn Creek suggest a population of 3,610 fry and 5,000 Dolly Varden char of various older age classes in Reaches 1 and 2. Presumably, this estimate would be higher if upper reaches of Goathorn and Cabinet creeks were included, but no estimates for these sections are available.

3.2.2 Tenas Creek

Approximately 1,150 m^2 of the lower two reaches of Tenas Creek were sampled. This comprised 109 m of stream length and represents just under 2% of the total 10.5 km of stream in the main fish-producing sections of Tenas Creek.

Steelhead trout juveniles were the main species present in Tenas Creek and comprised approximately 93% of the estimated total juvenile fish population within the sample sites. The remaining 7% of the sample was comprised of Dolly Varden char. A summary of juvenile density and biomass estimates are presented in Table 3.4, with more detailed estimates presented in Appendix 4.

Overall fish densities were greatest at the lowest site in Tenas Creek and declined progressively as the samples were taken higher in the system (Table 3.4). Densities at site T1 were approximately three times higher than at site T3 located 10 km upstream

Table 3.4: Summary of juvenile salmonid densities and biomass estimates at three sample sites in Tenas Creek, September 1983.

DENSITY ESTIMATES (fish/m^2)

Reach	Site	Steelhead Trout			Dolly Varden Char		Total
		0+	1+	≥2+	0+	≥1+	
1	T1	.87	.10	.03	0	.01	1.02
1	T2	.52	.11	.07	0	.02	.71
2	T3	.05	0	0	.15	.14	.34
Mean		.48	.07	.03	.05	.06	.69

BIOMASS ESTIMATES (g/m^2)

Reach	Site	Steelhead Trout			Dolly Varden Char		Total
		0+	1+	≥2+	0+	≥1+	
1	T1	.88	.68	.70	0	.18	2.44
1	T2	.58	.70	1.46	0	.28	3.02
2	T3	.04	0	0	.16	1.61	1.81
Mean		.50	.46	.72	.05	.69	2.42

on Tenas Creek. Biomass estimates were also less at this upper site with total biomass estimates for the three sites ranging from 1.8 to 3.0 g/m^2 (Table 3.4). The higher densities at lower sites resulted from large numbers of steelhead fry, which tend to contribute less to the overall biomass within the stream.

Steelhead Trout

As in the Goathorn Creek sample, it has been assumed that juvenile trout captured in Tenas Creek are the progeny of steelhead trout although a small number of resident rainbow trout may be present. All juveniles captured in Tenas Creek had fork lengths less than 180 mm, and the parr sample was comprised almost entirely of fish age 2+ or less.

Juvenile steelhead trout densities were greatest in the lowest reach of Tenas Creek, averaging nearly 0.9 fry/m^2 at the lowest site and 0.5 fry/m^2 at the site located approximately 4 km upstream (Figure 3.4). The presence of a small number of steelhead trout fry at site T3, approximately 10 km up Tenas Creek, indicates that a few steelhead trout move up to the top end of Tenas Creek to spawn. However, fry numbers were very low compared to the lower sites. Steelhead trout parr densities ranging from 0.1 - 0.2 parr/m^2 were found at sites in the lowest reach.

Population estimates derived for Tenas Creek (Appendix 5) suggest a population of 28,700 steelhead trout fry, mainly rearing in Reach 1 (97% of total). As well, the steelhead trout parr population is estimated at approximately 7,400 fish (65% age 1+), all rearing in the lowest reach. Since only one site in Reach 2 (in its upper end) was sampled, population estimates for this section of Tenas Creek are of limited accuracy.

Dolly Varden Char

Dolly Varden char densities were very low in Reach 1 of Tenas Creek, with catches consisting entirely of older age class fish. Both fry and older Dolly Varden char were present in the upper reach, where this fish species dominated the fish sample. As in upper Goathorn Creek, a number of the larger Dolly Varden char captured at site T3 were sexually mature.

Population estimates derived for Tenas Creek suggest a population of approximately 2,800 fry and 3,200 older age class Dolly Varden char. All of the fry and approximately 80% of the older age class estimates were for Reach 2 fish. It is assumed that the estimates are low, since potential Dolly Varden char habitat upstream of site T3 was not included in the analysis.

3.2.3 Telkwa River

Approximately 1,800 m^2 of main and side channel habitat was sampled in the Telkwa River downstream of the Goathorn Creek confluence. In total, 116 m of main channel margin and 121 m of side channel length were sampled. These sites comprised less than 1% of the total channel length in this section of the Telkwa River.

Steelhead trout juveniles comprised 81% of the 802 juvenile fish estimated in the sample sites. The remainder of the sample was comprised of mountain whitefish (14%), coho salmon (4%) and Dolly Varden char (1%). A single juvenile chinook salmon was captured 1.5 km upstream in the Telkwa River and is assumed to have moved into the system from the Bulkley River. A summary of juvenile density and biomass estimates for main and side channel sites is presented in Tables 3.5 and 3.6, while the more detailed results are presented in Appendix 4.

Figure 3.5: This riffle site in the Telkwa River had the highest abundance of steelhead parr.

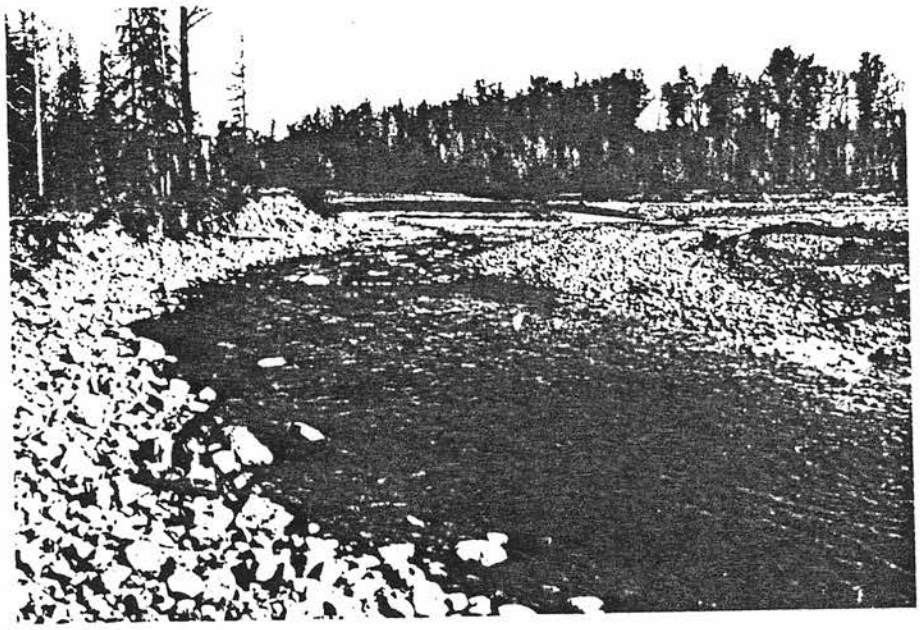


Figure 3.6: Large side channels of the Telkwa River provide rearing areas for juvenile steelhead and mountain whitefish.

Table 3.5: Summary of juvenile salmonid densities and biomass estimates at seven sample sites in the Telkwa River main channel, September 1983.

DENSITY ESTIMATES (fish/m^2)

Site	Steelhead Trout			Coho Salmon		Dolly Varden Char	Mountain Whitefish		Total
	0+	1+	≥2+	0+	1+	≥1+	0+	≥1+	
MS1	.46	.11	.04	0	0	0	0	0	.60
MS2	.37	.03	.02	.02	0	0	.01	0	.45
MS3	.32	.06	.01	0	0	0	0	.01	.40
MS4	.19	0	0	0	0	0	.03	0	.22
MS5	.24	0	0	.10	.01	0	.05	.01	.40
MS6	.35	.04	.02	0	0	0	0	0	.42
MS7	.31	.12	.08	0	0	.04	.01	0	.55
Mean	.32	.05	.02	.02	<.01	.01	.01	<.01	.43

BIOMASS ESTIMATES (g/m^2)

Site	Steelhead Trout			Coho Salmon		Dolly Varden Char	Mountain Whitefish		Total
	0+	1+	≥2+	0+	1+	≥1+	0+	≥1+	
MS1	.36	.53	.59	0	0	0	0	0	1.48
MS2	.26	.15	.26	.06	0	0	.01	0	.74
MS3	.25	.34	.18	0	0	0	0	.05	.82
MS4	.17	0	0	0	0	0	.05	0	.22
MS5	.31	0	0	.26	.06	0	.08	.08	.79
MS6	.31	.23	.42	0	0	0	0	0	.96
MS7	.26	.73	1.95	0	0	.74	.03	0	3.71
Mean	.27	.28	.49	.05	.01	.11	.02	.02	1.25

Table 3.6: Summary of juvenile salmonid densities and biomass estimates at three sample sites in the Telkwa River side channels, September 1983.

DENSITY ESTIMATES (fish/m^2)

Site	Steelhead Trout			Coho Salmon	Chinook Salmon	Dolly Varden Char		Mountain Whitefish		Total
	0+	1+	>2+	0+	0+	0+	>1+	0+	>1+	
SC1	.33	.04	.02	<.01	<.01	<.01	0	.06	<.01	.46
SC2	.20	.04	.03	.01	0	0	<.01	.11	0	.39
SC3	.44	0	0	.26	0	0	0	.09	0	.78
Mean	.32	.03	.02	.09	<.01	<.01	<.01	.09	<.01	.54

BIOMASS ESTIMATES (g/m^2)

Site	Steelhead Trout			Coho Salmon	Chinook Salmon	Dolly Varden Char		Mountain Whitefish		Total
	0+	1+	>2+	0+	0+	0+	>1+	0+	>1+	
SC1	.34	.22	.37	.01	.02	.01	0	.14	.04	1.15
SC2	.22	.21	.88	.01	0	0	.03	.29	0	1.64
SC3	.31	0	0	.56	0	0	0	.18	0	1.05
Mean	.29	.14	.42	.19	.01	<.01	.01	.20	.01	1.28

SC1 - Medium (Mean width - 9.3 m)
SC2 - Large (Mean width - 16.9 m)
SC3 - Small (Mean width - 1.8 m)

Overall fish density estimates were quite similar between main (0.4 fish/m^2) and side channel (0.5 fish/m^2) locations. Mean biomass estimates were almost identical between the two channel types (1.3 g/m^2), although there was considerable variability within the main channel sites. MS7 (Figure 3.5), a riffle site with large clean cobble, was by far the most productive habitat in the system, particularly for steelhead parr. Biomass estimates at this site were three times the overall mean for the Telkwa River (Appendix 4).

Steelhead Trout

Approximately 82% of the 650 steelhead trout captured in the Telkwa River were fry (age 0+). All but one of the 114 steelhead parr captured in the Tekwa River were less than 180 mm fork length. Most parr were age 1+ (66%), with the remainder consisting of age 2+ and 3+ fish. Although cutthroat trout have been reported in the Telkwa River (RAB Aquatic Bio-physical Map:93 L11), none were captured in this sample. It has been assumed that all juvenile trout were progeny of steelhead, since adult steelhead are present throughout the Telkwa River.

Steelhead fry were present at all sample sites. Their densities were remarkably similar at most sites, and mean densities of 0.3 fish/m^2 were the same in main and side channel locations. Steelhead parr densities were slightly lower in side channels (0.05 fish/m^2) compared to main channel sites (0.07 fish/m^2). This difference may reflect the absence of parr in the very small and shallow SC3 and the high catch of parr in MS7 (Tables 3.5 and 3.6).

Population estimates derived for the 6.5 km of main channel Telkwa River, downstream of Goathorn Creek, suggest a steelhead fry population of approximately 25,000 and a parr population of just over 6,000 fish (Appendix 5). These estimates are limited by the small proportion of total channel length sampled. As well, some steelhead parr may have been using sites farther from the edge than enclosed by the nets, suggesting the estimates represent a minimum parr population. It is suspected that side channel sites (Figures 3.6 and 3.7) account for at least as many juvenile steelhead as the main channel sites. Since an estimate of total side channel length in the lower Telkwa River has not been made, steelhead population estimates cannot be derived for side channels.

Coho Salmon

Juvenile coho salmon had a limited distribution in the lower Telkwa River. All but one of the 34 juvenile coho estimated for the sample sites were age 0+. Most of the coho juveniles were captured at two locations - a log jam site in the main channel Telkwa River (Figure 3.8), and in SC3, the smallest side channel sampled. This channel had low water velocities and abundant debris cover, two characteristics typical of coho rearing areas.

Dolly Varden Char

Juvenile Dolly Varden char were present in very low numbers in the lower Telkwa River. Only 2 of the 7 Dolly Varden char estimated in the sample sites were fry. The very low numbers of Dolly Varden char captured during these surveys and the almost complete lack of fry in the sample suggests that the lower Telkwa River is not important for juvenile rearing for this species.

Mountain Whitefish

Mountain whitefish were the second most abundant fish species captured in the Telkwa River. Of the 108 mountain whitefish estimated within the sample sites, all but 3 were age 0+. Mountain

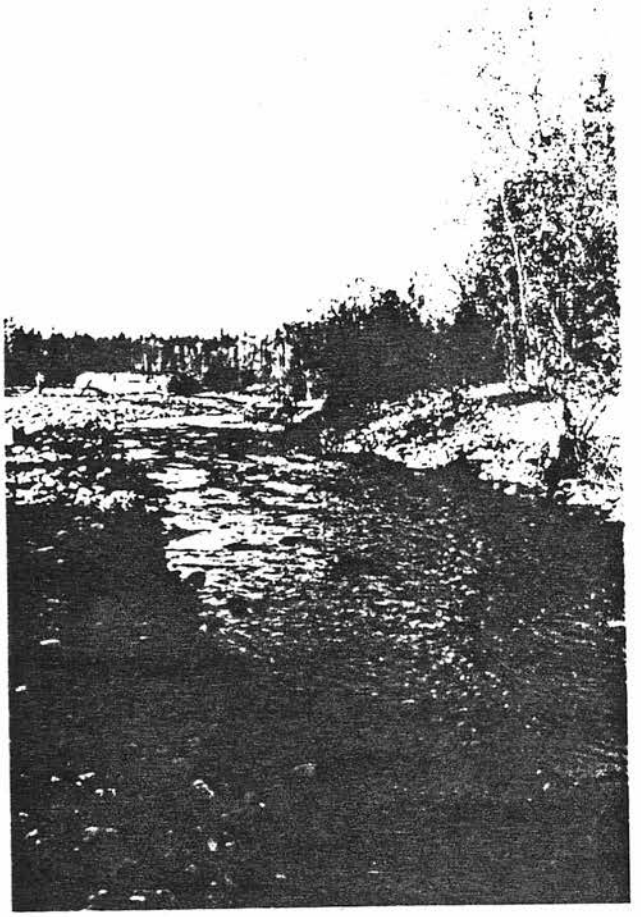


Figure 3.7:

SC1 on the lower Telkwa River is typical of medium-sized side channels.

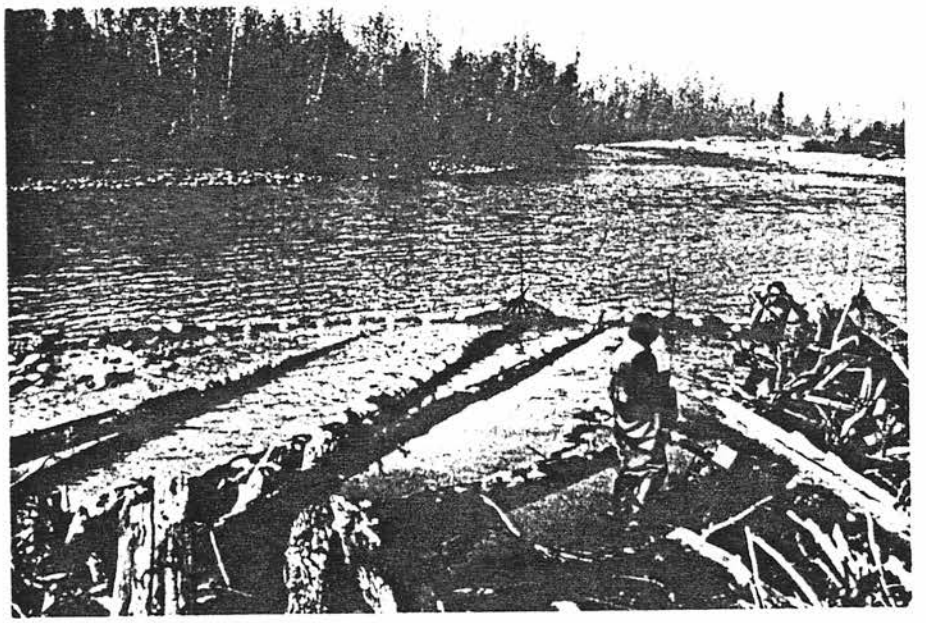


Figure 3.8: Log jams provided limited rearing habitat for juvenile coho salmon.

whitefish were common in all of the side channel sites (Table 3.6) but had a scattered distribution within the main channel locations (Table 3.5). Mean densities in side channels were nine times greater than in the main channel sites. It is probable that older age classes of mountain whitefish utilized those faster and deeper habitats in the main channel Telkwa River which could be effectively sampled during this study.

3.2.4 Hubert and Helps Creeks *

A total of 217 fish were captured in 34 minnow traps set at a variety of sites in Hubert and Helps Creeks (Table 3.7). Trap locations are outlined in Figure 2.3. It should be recognized that minnow traps are size- and species-selective. Minnow trap catches identify fish species present in a site and provide a general indication of relative abundance. However, catch information should not be compared to electroshocking results in other systems. Detailed catches at each site are presented in Appendix 6.

Juvenile coho salmon were the most common species captured at sites in lower Hubert Creek and comprised approximately 68% of the total fish sample. As well, steelhead trout (28%) and a small number of chinook salmon, Dolly Varden char, longnose suckers and longnose dace were captured in the samples.

Numerous beaver dams cause extensive ponding throughout lower Hubert Creek, but create habitat ideally suited to juvenile coho

---

* Ditching for agriculture and the difficulty of identifying stream channels in the bog areas near Helps Lake result in confusion as to which stream is tributary to the other on the various government topographic maps which are available. This report follows local usage in treating Hubert Creek as the main stream and Helps Creek as tributary. The reach downstream from the confluence is called lower Hubert Creek.

Table 3.7: Minnow trap sampling results in Hubert and Helps Creeks, September and October 1983.

Location	Number of Traps	Species	Age	Total Number of Fish	% Composition	Catch/ Trap
Lower Hubert Creek	26	Coho Salmon	0+	15		
			1+	84		
			All	99	67.8	3.8
		Steelhead Trout	0+	18		
			1+	17		
			≥2+	6		
			All	41	28.1	1.6
		Chinook Salmon	0+	3	2.0	0.1
		Dolly Varden Char	≥1+	1	0.7	<0.1
		Longnose Sucker	≥1+	1	0.7	<0.1
		Longnose Dace	≥1+	1	0.7	<0.1
		Total		146	100	5.6
Upper Helps Creek	4	Cutthroat Trout	0+	18		
			1+	18		
			≥2+	5		
			All	41	69.5	10.2
		Longnose Sucker	≥1+	16	27.1	4.0
		Longnose Dace	≥1+	2	3.4	0.5
		Total		59	100	14.7
Upper Hubert Creek	4	Cutthroat Trout	1+	11	91.7	2.8
		Dolly Varden Char	<1+	1	8.3	0.2
		Total		12	100	3.0

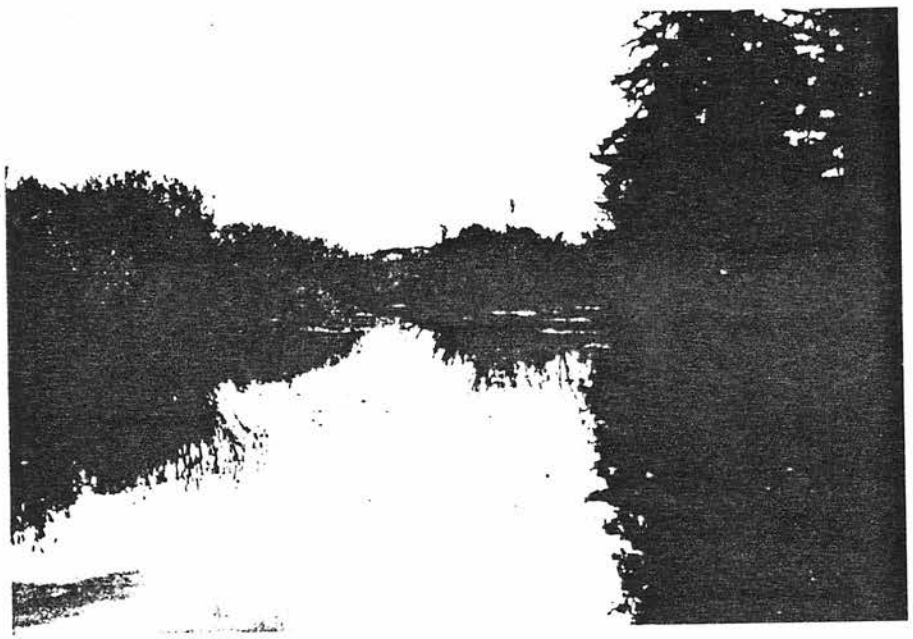


Figure 3.9: Beaver dams on lower Hubert Creek create habitat ideally suited to juvenile coho rearing.

Figure 3.10:

Portions of Upper Helps Creek have been altered by agricultural clearing and logging. Cutthroat trout are present here.

rearing (Figure 3.9). However, the presence of only yearling coho at sites above the CN railway bridge suggests that adult coho access to much of the creek system can be limited during some years by beaver dams.

It is assumed that the juvenile rainbow trout captured in lower Hubert Creek were the progeny of steelhead trout, since adult steelhead trout are known to spawn in this creek system (Mike Whately, B.C. Fish and Wildlife Branch, Smithers). There are some short stretches of lower Hubert Creek which are free-flowing, and most steelhead captured during sampling were in this type of habitat. A variety of juvenile age classes were present in Hubert Creek, indicating that steelhead trout do not have access limitations to at least the lower 2 km of Hubert Creek. No juvenile steelhead trout or coho salmon were captured at the upper sample sites (Figure 2.3).

It is probable that the three chinook salmon captured in lower Hubert Creek (Table 3.7) moved into this creek from the Bulkley River, as they were captured within 100 m of the creek mouth. There are no potential chinook salmon spawning sites in this lowest section of the creek.

Cutthroat trout juveniles were the most common species captured in upper Hubert and Helps creeks (Table 3.7). As well, longnose suckers were common in Helps Creek, and a small number of Dolly Varden char and longnose dace were present in the upper portions of these creeks. These upper sites have more rearing habitat diversity than the lower ponded sections of the creek. As well, there are more sites suitable for spawning fish, particularly in Helps Creek. Much of Helps Creek has been altered by agricultural clearing and logging practices (Figure 3.10). Due to an increasing gradient in the upper end, it is probable that fish habitat does not extend above the B.C. Hydro right-of-way crossing in these systems (Figure 2.3), although this has not been verified.

Results from a gill net set in Helps Lake (Figure 2.3) indicate cutthroat trout are common in this small lake. A total of 38 cutthroat trout ranging from 17-30 cm fork length were captured in a single overnight net set (Appendix 6). The small lake and ponded areas downstream are probably the main habitat areas for the adult population of resident cutthroat trout utilizing upper Hubert and Helps creeks. Adult longnose suckers are also present in Helps Lake (Appendix 6).

4.0 DISCUSSION

The results of the 1983 studies in Goathorn and Tenas creeks and the lower Telkwa River indicate that at least portions of all of these systems provide important rearing habitat for juvenile steelhead trout. Steelhead trout were the predominant fish species present in all sample areas except upper Goathorn and upper Tenas creeks, where Dolly Varden char were more common. No coho salmon were captured in the tributary streams, confirming previous observations that these systems have limited potential for coho salmon (Bustard 1983).

Tenas Creek was consistently the most productive of the stream systems sampled in terms of fish densities, biomass and overall benthic invertebrate production as summarized in Table 4.1 below.

Table 4.1: Summary of stream productivity in Goathorn and Tenas creeks and the Telkwa River.

	Goathorn Creek	Tenas Creek	Telkwa River
Fish Density (fish/m^2)	.28	.69	.48
Fish Biomass (g/m^2)	1.5	2.4	1.3
Invertebrates/m^2	1576	2584	1256

Tenas Creek is smaller and has a lower gradient, more organic debris and more potential spawning areas than Goathorn Creek. Very few pockets of spawning gravel upstream of Reach 1 were found during previous surveys in Goathorn Creek (Bustard 1983). It is probable that this greater habitat diversity in Tenas Creek is responsible for its higher productivity.

Steelhead trout fry densities in the lower reach of Goathorn Creek (.49 fry/m^2) were high compared to upstream areas, but less than those in lower Tenas Creek (.70 fry/m^2). It is probable that many of the steelhead trout fry captured in lower Goathorn Creek originated from fish that had spawned in Tenas Creek, although this could not be confirmed. A small number of steelhead trout juveniles (including newly- emerged fry) were found in sites up to 5 km upstream in Goathorn Creek, suggesting that some steelhead trout adults do spawn in Goathorn Creek itself.

The juvenile steelhead trout sample in Goathorn Creek was comprised of a higher proportion of parr (26%) than either the Tenas Creek (17%) or the Telkwa River (18%) samples (Table 4.2). As well, Goathorn Creek had more older age class parr which resulted in a larger mean size of the age 2+ and older fish. It is not known whether these larger fish (200-250 mm fork length) are resident rainbow trout or residual steelhead trout (i.e., steelhead trout juveniles which continue to rear in freshwater beyond the normal size at which smolting occurs).

Benthic invertebrate numbers in the two uppermost sites in Goathorn Creek were slightly lower in abundance than Tenas Creek sites (Table 3.1). Interestingly, the two sites located in Goathorn Creek downstream of the existing mine site (G2 and G3) had approximately one-half of the numbers of benthic invertebrates per unit area as the two upper sites (G4 and G5). These differences were significant ($p = 0.05$) when compared using the Mann-Whitney test for differences between means (Appendix 7). It is not known whether the differences can be attributed to factors associated with the existing mine site in Goathorn Creek. However, total fish biomass at these two sites did not seem to be similarly

Table 4.2: Summary of length and age data for juvenile steelhead in Goathorn and Tenas Creeks and the lower Telkwa River.

		Juvenile Steelhead Trout *		
	Age:	0+	1+	≥2+
Goathorn Creek	n	470	107	58
	%	74.0	16.9	9.1
	$\bar{fl}$ (mm)	43.7	79.7	144.7
Tenas Creek	n	701	99	45
	%	83.0	11.7	5.3
	$\bar{fl}$ (mm)	45.1	83.2	126.1
Telkwa River	n	538	75	39
	%	82.5	11.5	6.0
	$\bar{fl}$ (mm)	45.5	82.6	132.9
Total	n	1709	281	142
	%	80.2	13.2	6.7
	$\bar{fl}$ (mm)	44.8	81.7	135.6

* Refer to Appendix 8 for more detailed results of length-age determinations.

affected (Table 3.3). In fact, fish biomass was the highest of any site in Goathorn Creek at Site G3 located immediately downstream of the mine site.

Both steelhead trout fry and parr densities in lower Tenas and lower Goathorn creeks are comparable to densities found in other similar-sized productive steelhead trout tributaries of the Bulkley River (Table 4.3). Upper Goathorn Creek sites had much lower densities than these other systems. It should be emphasized that these comparisons are for different years, but they do provide a useful perspective between systems. Comparable information is not available for benthic invertebrate abundance in these other systems.

Table 4.3: Juvenile steelhead densities in Goathorn and Tenas creeks compared to three similar-sized productive steelhead tributaries in the Bulkley River watershed.

System	Steelhead Trout (fish m^2)		Data Source and Location
	Fry	Parr	
Buck Creek	.30	.14	Tredger (1982a) for Reaches 2 and 3 (1981 data)
Lamprey Creek	.48	.17	Tredger (1983) for 5 sites ($\bar{x}$ of 1980 and 1981 data)
Owen Creek	1.06	.17	Tredger (1983) for 5 sites ($\bar{x}$ of 1980 and 1981)
Tenas Creek	.70	.16	Reach 1 (Sites T1 and T2)
Goathorn Creek	.49	.11	Reach 1 (Site G1)
Goathorn Creek	.05	.04	Reach 2 (Sites G2 - G5)

Although the lower Telkwa River had higher fish densities than Goathorn Creek, total biomass and benthic invertebrate abundance were slightly

less. Benthic invertebrate numbers in Tenas Creek sites were approximately double those in two side channel sites sampled in the lower Telkwa River. The Telkwa River is considerably larger than these two tributaries, and considering the typically large fluctuations in discharge and high silt load that this system carries, the results of the fish sampling were surprisingly high.

Table 4.4 compares steelhead fry and parr abundance in the Telkwa River to a summary of results in the Bulkley, Morice and Kispiox rivers - nearby important steelhead trout systems. The results indicate that steelhead trout fry and parr densities in the lower Telkwa River are considerably higher than in the Bulkley or Morice rivers. Density estimates are similar to Kispiox River samples except for lower steelhead fry densities in Telkwa River side channels. The method of sampling was similar in all of the systems except the Kispiox River, where the estimates are based on small samples and single pass estimates with out total site enclosure. Also the comparisons are for different years.

Table 4.4: Juvenile steelhead densities in the Telkwa River compared to Morice, Bulkley and Kispiox rivers.

System	Steelhead (fish/m^2)		Data Source
	Fry	Parr	
Morice River Main Channel	.04	.02	Envirocon (1983) for 1982 data
Morice River Side Channel	.06	.03	Envirocon (1983) for 1982 data
Bulkley River Main Channel	.08	.02	Envirocon (1983) for 1982 data
Kispiox River Main Channel	.28	.06	Tredger (1982b) $\bar{x}$ of 1980 and 1981 data
Kispiox River Side Channel	.85	.06	Tredger (1982b) $\bar{x}$ of 1980 and 1981 data
Telkwa River Main Channel	.32	.07	Table 3.5
Telkwa River Side Channel	.32	.05	Table 3.6

Juvenile coho salmon abundance was generally low at sites in the lower Telkwa River. Adult coho salmon spawn at a variety of sites in the upper portions of the river (Bustard 1983). Presumably, most juvenile coho salmon remain in the extensive wetland areas in the upper Telkwa River to rear. As well, some pond habitats adjacent the lower Telkwa River may be utilized but these areas were not sampled in this study.

An estimate of the number of adult steelhead trout produced in Goathorn and Tenas creeks and the main channel Telkwa River can be made by assuming survival rates for steelhead trout derived in other systems (Table 4.5). It should be emphasized that these assumptions have limited application, and that 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 a species that is very difficult to enumerate by other means.

These estimates suggest spawning populations in the order of 55 steelhead in Goathorn Creek, 130 steelhead trout in Tenas Creek, and 110 steelhead trout in the main channel of the lower Telkwa River. The lower Telkwa River estimates could probably be doubled to account for additional production in side channels. As well, the tributary estimates may be low. Since juvenile steelhead tend to move downstream into larger systems as they grow, steelhead trout parr in the Telkwa or Bulkley rivers may be derived from populations originally spawned in 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.

Table 4.5: Estimated adult steelhead production based on steelhead parr populations and assumed survival to smolt and adult stage.

	Estimated Parr Population [1]	Estimated Smolt Population [2]	Total Adult Production [3]	Estimated Spawner Population [4]
Goathorn Creek	3135	1097	165	55
Tenas Creek	7370	2580	387	129
Lower Telkwa River (main channel only) [5]	6240	2184	328	109

1 See Appendix 5.

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

3 Assumes 15% survival from smolt to adult (Tredger (1982a).

4 Assumes a 2:1 interception ratio for adult fish (B.C. Fish and Wildlife Branch, Smithers).

5 This estimate is for the main channel only from Goathorn Creek to the Bulkley River. Extensive side channel habitat in this section would bring this estimate considerably higher if incorporated into the analysis.

In conclusion, the 1983 juvenile fish studies indicate that Goathorn and Tenas creeks and the lower Telkwa River all provide important rearing areas for juvenile steelhead trout. Tributaries such as these help provide the basis for the valuable summer steelhead sport fishery in the Bulkley River. Water quality in these systems should be maintained at levels which assure a continued productive habitat for steelhead trout.

The juvenile fish and benthic invertebrate sample sites established in 1983 provide a solid background for monitoring stream productivity should the proposed mine development proceed. Additional samples collected at the same time of year and at the same locations before development would help in evaluation of natural year-to-year variability occurring in these systems.

Any access corridor routing in the vicinity of Hubert or Helps creeks should recognize that these systems support resident fish populations in their upper ends and that coho salmon and steelhead trout populations utilize the lower sections of Hubert Creek.

5.0 LITERATURE CITED

Bustard, D.R. 1983.
1982 Investigations of adult coho salmon in the Telkwa River. Unpubl. MS prepared for Crows Nest Resources Limited. 12 pp. and appendices.

Chamberlain, T.W. 1980.
Aquatic survey terminology, APD Tech. Paper 2. Aquatic Studies Branch, Ministry of Environment, Victoria, 30 pp.

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. 43 pp.

Platts, W.S., W.F. Megahan and G.W. Minshall, 1983.
Methods for evaluating stream, riparian, and biotic conditions. U.S.D.A. For. Ser. Gen. Tech. Rep. INT-138

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

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

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

Tredger, C.D. 1982a.
Upper Bulkley River reconnaissance with reference to juvenile steelhead carrying capacity. Unpub. MS., Fish and Wildlife Branch, Ministry of Environment, Victoria, B.C.

Tredger, C.D. 1982b.
Juvenile steelhead population monitoring in the Kispiox River System, 1981. Unpubl. MS. Fish and Wildlife Branch, Ministry of Environment, Victoria, B.C.

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

Zar, J.H. 1974
Biostatistical Analysis. Prentice-Hall, Toronto.

APPENDICES

Appendix 1: 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 2 : Detailed Results of Benthic Invertebrate Sampling in Goathorn and Tenas Creeks and the Telkwa River, September 1983.

SITE: GOATHORN CREEK - G1 DATE: 19 SEPTEMBER, 1983

	1	2	3	4	5	6
INSECTA						
Ephemeroptera:						
Baetis sp.	17	14	15	3	8	25
Ameletus sp.	1			1	3	
Ephemerella doddsi	6	1	1		2	6
Ephemerella spinifera	5	2				4
Rithrogena sp.	9	14	32	1	8	56
Iron sp. = Ephorus	2	2				7
Paraleptophlebia sp.						3
Cinygmula sp.	1					3
Trichoptera:						
Tinodes sp.	2	4	2	2	2	2
Sericostoma sp.	2				1	1
Leptocella sp.						
Parapsyche sp.	4		1			5
Rhyacophila sp.						
Glossosoma sp.	10					1
Plecoptera:						
Kathroperla sp. = changed to Capnia in 1984 based on drift.	9		5	1	3	15
Diura sp. based on drift (1984)	2	2	2		1	1
Chloroperla sp. = Hastaperla?	1	3	9	2	2	2
Nemoura sp.1	11		14	3	11	6
Nemoura sp.2	15		2		2	3
Arcynopteryx sp. = Paral. 48	4	19	17	8	8	46
Megaloptera:						
Corydalidae		1				1
Diptera:						
Chironomidae larva	101	125	39	35	84	25
pupa	5		4	5	5	5
Empididae larva	1	1	4			3
pupa	2			1	2	1
Simuliidae larva						
pupa						
adult						
Muscidae	2					
Cecidomyiidae						
Blepharocaridae						
Ceratopogonidae						
Ephydra sp.						
Tipula sp.	1					
Atherix sp.						
Deuterophlebia sp.						
Cyclorrhapha - subsumed under Diptera - General diverse indicator.						
Homoptera:						
Aphidae						
Hymenoptera:						
Formicidae						
HIRUDINEA		3	2		1	2
OLIGOCHAETA			2			
ACARINA				1	1	
ARANEAE						
Sphaeridae				1	1	
TOTAL NUMBER	204	200	151	64	145	223
TOTAL TAXA	22	14	16	13	18	23

SITE: GOATHORN CREEK - G2

DATE: 16 SEPTEMBER, 1983

	1	2	3	4	5	6
INSECTA						
Ephemeroptera:						
Baetis sp.	1	6	8	5	5	5
Ameletus sp.	18				1	
Ephemerella doddsi		7	1	7	3	
Ephemerella spinifera						
Rithrogena sp.	2	26	9	22	4	
Iron sp.		1				
Paraleptophlebia sp.						2
Cinygmula sp.						
Trichoptera:						
Tinodes sp.	1	5		3	6	3
Sericostoma sp.	2					
Leptocella sp.						
Parapsyche sp.					1	
Rhyacophila sp.		1	1	1	2	1
Glossosoma sp.						
Plecoptera:						
Kathroperla sp.		5	1	12	10	
Diura sp.				1		
Chloroperla sp.	15	12	3	6	3	3
Nemoura sp.1	5	1		1	3	18
Nemoura sp.2				11	2	3
Arcynopteryx sp.	13	12	11	13	7	3
Megaloptera:						
Corydalidae	1					
Diptera:						
Chironomidae larva	67	11	16	13	84	100
pupa	1			1	3	1
Empididae larva	3	1			1	
pupa						
Simuliidae larva						
pupa						
adult						
Muscidae						
Cecidomyiidae						
Blapharocaridae						
Ceratopogonidae		2			1	
Ephydra sp.	6	1		1		
Tipula sp.	2			1		
Atherix sp.						
Deuterophlebia sp.						
Cyclorrhapha						
Homoptera:						
Aphidae				1		
Hymenoptera:						
Formicidae		3		3		1
HIRUDINEA	1				3	
OLIGOCHAETA						
ACARINA						
ARANEAE	3					
Sphaeridae						
TOTAL NUMBER	141	94	50	102	139	140
TOTAL TAXA	16	15	8	17	17	11

SITE: GOATHORN CREEK - G3

DATE: 22 SEPTEMBER, 1983

	1	2	3	4	5	6
INSECTA						
Ephemeroptera:						
Baetis sp.	7	15	33	4	2	6
Ameletus sp.				22		
Ephemerella doddsi	3	2	14			
Ephemerella spinifera						
Rithrogena sp.	31	71	22	13	3	
Iron sp.	1	1	1			
Paraleptophlebia sp.						
Cinygmula sp.					1	
Trichoptera:						
Tinodes sp.	3	7	3	1		
Sericostoma sp.						
Leptocella sp.	1			1		
Parapsyche sp.	2					
Rhyacophila sp.						
Glossosoma sp.		2	5	1	1	1
Plecoptera:						
Kathroperla sp.	3	9	9	8		
Diura sp.	2		2	1		
Chloroperla sp.	7	13	8	4	2	
Nemoura sp.1	8		1	7	12	10
Nemoura sp.2	6		7			
Arcynopteryx sp.	12	28	15	10	6	5
Megaloptera:						
Corydalidae						
Diptera:						
Chironomidae larva	5	2	2	3	3	2
pupa						1
Empididae larva	1	2				
pupa						
Simuliidae larva						
pupa						
adult						
Muscidae						
Cecidomyiidae						
Blapharocaridae	1					
Ceratopogonidae				1		
Ephydra sp.		7	1			
Tipula sp.						
Atherix sp.					3	3
Deuterophlebia sp.						
Cyclorrhapha						
Homoptera:						
Aphidae						
Hymenoptera:						
Formicidae						
HIRUDINEA	2	1	1			
OLIGOCHAETA	2			1		
ACARINA						
ARANEAE						
Sphaeridae	3				1	4
TOTAL NUMBER	100	160	124	77	34	32
TOTAL TAXA	19	13	15	14	10	8

SITE: GOATHORN CREEK - G4

DATE: 20 SEPTEMBER, 1983

	1	2	3	4	5	6
INSECTA						
Ephemeroptera:						
Baetis sp.	5	13	12	26	38	4
Ameletus sp.	1					
Ephemerella doddsi		5	5	10	13	
Ephemerella spinifera	3	2				
Rithrogena sp.	22	23	39	94	28	2
Iron sp.	3	3	13	11	9	2
Paraleptophlebia sp.						
Cinygmula sp.						
Trichoptera:						
Tinodes sp.	4	5	1	9	3	1
Sericostoma sp.						
Leptocella sp.		1	1	2	4	1
Parapsyche sp.						
Rhyacophila sp.						
Glossosoma sp.	1	3	3	2		
Plecoptera:						
Kathroperla sp.	1	11	1	6	5	6
Diura sp.		1				1
Chloroperla sp.		14	9	14		4
Nemoura sp.1	5	6	3	9	6	5
Nemoura sp.2	5		5	19	8	5
Arcynopteryx sp.	8	41	38	114	70	10
Megaloptera:						
Corydalidae						
Diptera:						
Chironomidae larva	4	14	3	1	10	3
pupa				1	2	
Empididae larva	1	4				
pupa					1	
Simuliidae larva						
pupa						
adult						
Muscidae	1	1	3			
Cecidomyiidae					1	
Blapharocaridae		1				
Ceratopogonidae						
Ephydra sp.						
Tipula sp.						
Atherix sp.						
Deuterophlebia sp.						
Cyclorrhapha						
Homoptera:						
Aphidae						
Hymenoptera:						
Formicidae						
HIRUDINEA	1	1		7	5	2
OLIGOCHAETA						
ACARINA						
ARANEAE						
Sphaeridae						
TOTAL NUMBER	65	149	136	325	203	46
TOTAL TAXA	15	18	14	15	15	13

SITE: GOATHORN CREEK - G5

DATE: 16 SEPTEMBER, 1983

	1	2	3	4	5	6
INSECTA						
Ephemeroptera:						
Baetis sp.	32	16	63	29	23	18
Ameletus sp.		2		3	1	20
Ephemerella doddsi	3	4	14	7	3	2
Ephemerella spinifera	6		3	6		
Rithrogena sp.	58	47	111	103	13	49
Iron sp.	2	3	5	8		2
Paraleptophlebia sp.		1		3		
Cinygmula sp.						
Trichoptera:						
Tinodes sp.	4	2	6	5	2	3
Sericostoma sp.						
Leptocella sp.						
Parapsyche sp.	1				1	
Rhyacophila sp.						
Glossosoma sp.	3		2	2	2	1
Plecoptera:						
Kathroperla sp.	6	11	3	10	11	29
Diura sp.	6	3	1	1	4	
Chloroperla sp.	6	4	11	28	9	20
Nemoura sp.1	3	7	5	8	9	21
Nemoura sp.2	7	5	10	1	3	5
Arcynopteryx sp.	49	45	81	79	21	37
Megaloptera:						
Corydalidae						
Diptera:						
Chironomidae larva	19	22	12	14	17	29
pupa	2	2		7		2
Empididae larva	4	5	4	4	4	5
pupa						
Simuliidae larva						
pupa						
adult						1
Muscidae						
Cecidomyiidae						
Blapharocaridae						
Ceratopogonidae						
Ephydra sp.		1		1		
Tipula sp.				3		
Atherix sp.		1		1		2
Deuterophlebia sp.						
Cyclorrhapha						
Homoptera:						
Aphidae						
Hymenoptera:						
Formicidae						
HIRUDINEA	5	2	3	7		
OLIGOCHAETA			2			
ACARINA						2
ARANEAE						
Sphaeridae						
TOTAL NUMBER	216	183	336	330	123	248
TOTAL TAXA	18	19	17	22	15	18

SITE: TENAS CREEK - T1

DATE: 13 SEPTEMBER, 1983

	1	2	3	4	5	6	
INSECTA							
Ephemeroptera:							
Baetis sp.	27	34	51	33	3	3	151
Ameletus sp.					4	11	15
Ephemerella doddsi	3	2	4	9	3	1	22
Ephemerella spinifera							
Rithrogena sp.	31	3	44	19	16	44	157
Iron sp.	2			1			3
Paraleptophlebia sp.				3	9	3	15
Cinygmula sp.						2	2
Trichoptera:							
Tinodes sp.	3	1	2	2	2	1	11
Sericostoma sp.				2	2		4
Leptocella sp.					1	1	2
Parapsyche sp.		1		4	1		6
Rhyacophila sp.		1	1	1	2	1	6
Glossosoma sp.	3	1	3	2		1	10
Plecoptera:							
Kathroperla sp.	3		1	2	7	9	22
Diura sp.	11	2		1			14
Chloroperla sp.	4	1	4	3	3	5	20
Nemoura sp.1	18	6	14	9	29	24	100
Nemoura sp.2	6	6	5	15	6	7	45
Arcynopteryx sp.	19	26	40	32	13	47	177
Megaloptera:							
Corydalidae							
Diptera:							191
Chironomidae larva	82		3	48	35	23	7
pupa	2			3		2	2
Empididae larva					2		
pupa				2			2
Simuliidae larva	1						1
pupa							
adult							
Muscidae							
Ceclomyiidae							
Blapharocaridae							
Ceratopogonidae	2			2	2		6
Ephydra sp.				2	1		3
Tipula sp.				1	1		2
Atherix sp.				1			1
Deuterophlebia sp.					2	1	3
Cyclorrhapha							
Homoptera:							
Aphidae							
Hymenoptera:							
Formicidae							
		1	1	5	3		10
HIRUDINEA	1			1	1		3
OLIGOCHAETA							
ACARINA					1		1
ARANEAE							
Sphaeridae							
TOTAL NUMBER	218	85	173	203	149	186	1014
TOTAL TAXA	17	13	13	25	24	18	

SITE: TENAS CREEK - T2

DATE: 23 SEPTEMBER, 1983

	1	2	3	4	5	6	
INSECTA							
Ephemeroptera:							
Baetis sp.	27	293	278	147	127	69	941
Ameletus sp.	6				2		8
Ephemerella doddsi		5	6	7	5		23
Ephemerella spinifera							
Rithrogena sp.	9	57	22	24	91	19	222
Iron sp.	1	3	7	9	4	2	26
Paraleptophlebia sp.	4	4	5		4		17
Cinygmula sp.							
Trichoptera:							
Tinodes sp.		4	2	5	3	6	20
Sericostoma sp.		1	1	1	7	4	14
Leptocella sp.							
Parapsyche sp.		1	10	8	11	2	32
Rhyacophila sp.				2			2
Glossosoma sp.		2		2	20	1	25
Plecoptera:							
Kathroperla sp.	1	13	13	9	11	6	53
Diura sp.	1	3	6	4	4	2	20
Chloroperla sp.	4	11	22	8	7	3	55
Nemoura sp.1	7	10	38	24	18	12	109
Nemoura sp.2	3	15	43	15	18	29	123
Arcynopteryx sp.	17	41	28	54	43	35	218
Megaloptera:							
Corydalidae							
Diptera:							
Chironomidae larva	2		4	5	5	6	22
pupa	3		1		3	1	8
Empididae larva	1	3	2	1	1		8
pupa							
Simuliidae larva			3	4		1	8
pupa							
adult							
Muscidae							
Cecidomyiidae							
Blepharoceridae					1		1
Ceratopogonidae							
Ephydra sp.		2					2
Tipula sp.							
Atherix sp.		1					1
Deuterophlebia sp.							
Cyclorrhapha							
Homoptera:							
Aphidae							
Hymenoptera:							
Formicidae					1		1
HIRUDINEA							
OLIGOCHAETA					2		2
ACARINA							
ARANEAE							
Sphaeridae			1		1		2
TOTAL NUMBER	86	469	492	329	389	198	1963
TOTAL TAXA	14	18	19	18	23	16	

SITE: TELKWA RIVER - SC1 DATE: 27 SEPTEMBER, 1983

		1	2	3	4	5	6
	INSECTA						
	Ephemeroptera:						
13	Baetis sp.	4	2	1	1	4	1
4	Ameletus sp.		1				3
12	Ephemerella doddsi	3		1	4	3	1
-	Ephemerella spinifera						
106	Rithrogena sp.	1	9	21	39	26	10
-	Iron sp.						
2	Paraleptophlebia sp.					1	1
-	Cinygmula sp.						
	Trichoptera:						
1	Tinodes sp.					1	
-	Sericostoma sp.						
-	Leptocella sp.						
-	Parapsyche sp.						
-	Rhyacophila sp.						
1	Glossosoma sp.				1		
	Plecoptera:						
10	Kathroperla sp.		2		7		1
	Diura sp.						
23	Chloroperla sp.	1	6	8	3	3	2
116	Nemoura sp.1	15	25	26	14	32	4
12	Nemoura sp.2		1	8		2	1
121	Arcynopteryx sp.	12	42	24	10	29	4
	Megaloptera:						
	Corydalidae						
	Diptera:						
61	Chironomidae larva	11	19	7	2	13	9
6	pupa	2		2	1	1	
2	Empididae larva		1			1	
-	pupa						
18	Simuliidae larva	2	3	6	2	5	
	pupa						
	adult						
	Muscidae						
	Cecidomyiidae						
1	Blapharocaridae				1		
	Ceratopogonidae						
	Ephydra sp.						
2	Tipula sp.	1	1				
	Atherix sp.						
	Deuterophlebia sp.						
	Cyclorrhapha						
	Homoptera:						
	Aphidae						
	Hymenoptera:						
	Formicidae						
3	HIRUDINEA	1				2	
	OLIGOCHAETA						
	ACARINA						
1	ARANEAE				1		
	Sphaeridae						
515	TOTAL NUMBER	53	112	104	86	123	37
	TOTAL TAXA	11	12	10	13	14	11

SITE: TELKWA RIVER - SC2

DATE: 29 SEPTEMBER, 1983

	1	2	3	4	5	6	
INSECTA							
Ephemeroptera:							
Baetis sp.	1	2	5	1	2	9	20
Ameletus sp.	2						2
Ephemerella doddsi		9	10	2	3	8	32
Ephemerella spinifera							
Rithrogena sp.	2	52	49	41	42	109	295
Iron sp.							
Paraleptophlebia sp.							
Cinygmula sp.			2		3	2	7
Trichoptera:							
Tinodes sp.		2	2		3	1	8
Sericostoma sp.							
Leptocella sp.							
Parapsyche sp.		6	10	2	15	6	39
Rhyacophila sp.							
Glossosoma sp.			6	2	2		10
Plecoptera:							
Kathroperla sp.							
Diura sp.			1		1		2
Chloroperla sp.	3	10		6	10	28	57
Nemoura sp.1	15	1	9			5	30
Nemoura sp.2		3	2		4		9
Arcynopteryx sp.	26	43	65	26	32	134	326
Megaloptera:							
Corydalidae							
Diptera:							
Chironomidae larva	9	10	17	12	15	2	65
pupa			2	2	2		6
Empididae larva		2	1	1	2		6
pupa							
Simuliidae larva	2	3	3	1	2	6	17
pupa							
adult							
Muscidae							
Cecidomyiidae							
Blapharocaridae		1					1
Ceratopogonidae							
Ephydra sp.							
Tipula sp.							
Atherix sp.							
Deuterophlebia sp.							
Cyclorrhapha							
Homoptera:							
Aphidae							
Hymenoptera:							
Formicidae							
HIRUDINEA							
OLIGOCHAETA							
ACARINA							
ARANEAE							
Sphaeridae							
TOTAL NUMBER	60	144	184	96	138	310	932
TOTAL TAXA	8	13	15	11	15	11	

Appendix 3 : 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)
	Mountain whitefish	*Prosopium williamsoni* (Girard)
Catostomidae	Longnose suckers	*Catostomus catostomus* (Forster)
Cyprinidae	Longnose dace	*Rhinichthys cataractae* (Valenciennes)
Petromyzontidae	Pacific lamprey	*Lampetra tridentata* (Gairdner)

Appendix 4 : Site descriptions and detailed results of fish sampling in Goathorn and Tenas creeks and the Telkwa River, September 1983.

Table A.4.1 : Key to abbreviations used in Appendix 4.

BM	benchmark
D50	diameter of bed material larger than 50 percent of the remaining bed material.
D90	diameter of bed material larger than 90 percent of the remaining bed material.
x	average
fl	fork length
$\overline{fl}$	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 1)
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
Lns	longnose sucker
Lnd	longnose dace
Ct	cutthroat trout
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.

SITE DESCRIPTION - G1

Location: Approx 70 m downstream of gas pipeline crossing of Goathorn Creek (below beaver dam). Area: 651 m^2 Crew: DB,TH,CM.
Date: September 19, 1983. Length of stream margin: 65 m. Photos: 1-3 (R2) Gradient: 1% Water Temp. 4.6° @ 1040 hrs.

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)	2.5	4.5	6.5	8.5	13.5	15.5
Depth (cm)	19	17	17	9	7	22

Avg. Water Velocity 0.43 m/sec

FISH SAMPLE SITE:

Location (m)	Width (m)	Mean Depth (cm)	Max. Depth (cm)	Bank Cover	Debris Cover	D50/D90 (cm)
0	17.7	15	25	x	-	12/23
20	12.5	25	37	-	-	10/22
40	6.9	35	45	-	x	10/32
60	6.5	32	37	-	-	10/32
65	6.5					

x = cover present - = cover not present

FISH SAMPLE:

Species	Age	fl-range (mm)	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+	32-58	44.4	0.87	101	166	53	314	24.3	7	321	.493	4.94	0.43
Sthd	1+	64-100	78.5	6.02	35	43	29	52	2.3	1	53	.081	0.82	0.49
Sthd	≥2+	109-180	137.6	29.44	11	10	6	18	3.1	-	18	.028	0.28	0.82
DV	0+	40	40	0.70	0	1	0	1	N/A	-	1	.002	0.02	<.01
DV	≥1+	81-124	97.2	9.64	3	2	1	5	2.5	-	5	.008	0.08	0.08
MW	≥1+	106	106	10.23	1	1	1	1	N/A	-	1	.002	0.02	0.02
Total											399	.613	6.14	1.84

Note: For abbreviations and symbols used in this table see first page of appendix.

SITE DESCRIPTION - G2

Location: Lower net located at water gauging station above lower bridge on Goathorn Creek. Area: 832 m^2. Crew: DB, TH, CM
Date: September 16, 1983. Length of stream margin: 70 m. Photos: #35, 36 (R1). Gradient: 2.5% Water Temp. 6° @ 1200 hrs.

BENTHOS SAMPLE SITE: Location: Bench Mark located on right bank 10 m upstream of upper fish sample net.

Sample #	1	2	3	4	5	6 (split sample)
Dist. from BM (m)	4.5	6.5	8.5	10.5	12.5	14.5
Depth (cm)	20	30	40	20	20	15
D50						
D90						
Avg. Water Velocity						

FISH SAMPLE SITE:

Location (m)	Width (m)	Mean Depth (cm)	Max. Depth (cm)	Bank Cover	Debris Cover	D50/90 (cm)
0	12.4	28	40	-	x	10/20
10	12.5	25	37	-	x	12/30
20	12.3	24	26	-	-	15/25
30	10.5	26	34	-	-	15/27
40	12.2	23	30	-	x	20/38
50	12.3	31	38	-	x	18/38
60	11.4	29	30	-	-	15/35
70	11.5	30	32	-	-	20/40

Comment - Good Sthd fry areas on right side channel x = cover present - = cover not present

FISH SAMPLE:

Species	Age	fl-range (mm)	$\bar{x}$ 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+	30-52	42.6	0.84	40	32	12	103	19.1	3	106	.127	1.51	0.11
Sthd	1+	70-93	81.4	6.61	23	17	11	35	4.5	-	35	.042	0.50	0.28
Sthd	≥2+	109-225	137.4	29.2	12	8	4	22	5.8	-	22	.026	0.31	0.76
DV	0+	54	54	1.88	1	0	0	1	N/A	-	1	.001	0.01	<.01
DV	≥1+	77-173	111.2	14.39	11	10	8	14	1.3	-	14	.017	0.20	0.24
Total											178	.214	2.54	1.39

Note: For abbreviations and symbols used in this table see first page of appendix.

SITE DESCRIPTION - G4

Location: Approx. 400 m upstream from present coal mine on Goathorn. Site located 40 m below a side channel confluence. Crew:DB, TH, CM
Date: September 20, 1983. Length of stream margin 51.0 m. Photos: #4,5 & 6 (R2) Gradient: 2.0% Water Temp. 7° @ 1230 hrs. Area 451 m^2

BENTHOS SAMPLE SITE: Location: Benthos site in lower section of fish sample site. Bench mark near 1.5 m cottonwood.

Sample #	1	2	3	4	5	6
Dist. from BM (m)	4.5	6.5	8.5	10.5	12.5	14.5
Depth (cm)	14	24	28	37	14	19
D50						
D90						
Avg. Water Velocity	0.46 m/sec					
Wetted Width	11 m.					

FISH SAMPLE SITE:

Location (m)	Width (m)	Mean Depth (cm)	Max. Depth (cm)	Bank Cover	Debris Cover	D50/90 (cm)
0	11.6	31	35	-	-	15/30
10	12.0	25	35	-	-	10/25
20	8.3	32	45	x	-	9/18
30	6.8	30	42	x	x	10/18
40	6.4	32	46	-	x	12/30
50	8.0	29	42	-	x	10/16
$\bar{x}$	8.8					

Comment - 50% glide and 50% riffle. x = cover present - = cover not present

FISH SAMPLE:

Species	Age	fl-range (mm)	$\bar{x}$ fl(mm)	Weight(g)	M	C	R	N	S.E.	Morts	Corr.	N/m^2	Linear m	g/m^2
Sthd	0+	37-43	39.4	0.78	7	5	2	15	6.1	-	15	.033	0.29	0.03
Sthd	1+	82-90	87.0	7.73	2	1	1	2	N/A	-	2	.004	0.04	0.03
Sthd	≥2+	123-190	149.7	37.8	3	3	3	3	N/A	-	3	.007	0.06	0.26
DV	0+	42-61	52.0	1.67	15	11	2	63	31.1	-	63	.140	1.24	0.23
DV	≥1+	65-138	95.8	9.18	24	26	16	39	3.5	-	39	.086	0.76	0.79
Total											122	.271	2.39	1.34

Note: For abbreviations and symbols used in this table see first page of appendix.

SITE DESCRIPTION - G3

Location: Old mine site (McNeil) between power line and coalmine site. Access by road down hillside. Area. 490 m^2 Crew: DB, TH, CM.
Date: September 22, 1983. Length of stream margin: 44.5 m. Photos: #7 & 8 (R2) Gradient: 2.5% Water Temp. 6° @ 1100 hrs.

BENTHOS SAMPLE SITE: Location: Riffle located just where road meets creek. Site was split by gravel bar.

Sample #	1	2 (split)	3	4	5	6
Dist. from BM (m)	5.5	7.5	9.5	11.5	16.0	17.0
Depth (cm)	7	20	22	14	7	10
D50	8	5	7	2	4	4
D90	20	10	20	6	9	9

Avg. Water Velocity Main (1-4) .70 m/sec
Side (5-6) .49 m/sec

FISH SAMPLE SITE:	Location (m)	Width (m)	Mean Depth (cm)	Max. Depth (cm)	Bank Cover	Debris Cover	D50/90 (cm)
Side Channel	0	4.4	8	10	-	-	8/24
	10	3.6	8	10	-	-	8/24
	20	3.1	8	13	-	-	8/15
Main Channel	0	14.2	31	48	-	-	12/25
	10	8.5	41	48	-	x	12/25
	20	8.6	33	46	x	-	12/30
	30	8.0	96	150	x	x	7/30
	40	5.3	40	52	-	-	15/40
	44.5	10.1	26	40	-	-	1/40
	$\bar{x}$	9.1 (Main)					

x = cover present. - = cover not present.

FISH SAMPLE: Species	Age	fl-range (mm)	$\bar{fl}$(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+	33-51	43.1	0.84	12	11	5	25	6.0	-	25	.051	0.56	0.04
Sthd	1+	69-95	79.0	6.17	11	13	10	14	0.6	1 + 2 net	17	.035	0.38	0.22
Sthd	≥2+	115-260	163.9	49.40	5	7	3	11	2.9	-	11	.022	0.25	1.09
DV	0+	44-60	50.3	1.50	13	10	4	30	9.0	+ 2 net	32	.065	0.72	0.10
DV	≥1+	77-155	107.9	13.15	7	15	5	20	3.6	-	20	.041	0.45	0.54
Total											105	.214	2.36	1.99

Note: abbreviation and symbols used in this table see first page of appendix

SITE DESCRIPTION - G5

Location: Goathorn Creek approx. 0.5 km upstream of new bridge crossing to Hunter Basin 50 m upstream of old bridge crossing. Crew:DB,TH,CM
Date: September 14, 1983. Length of stream margin 92.0 m. Photos: #32,33,34 (R1) Gradient: 3.0% Water Temp. 7.5° @ pm.hr. Area 814 m^2

BENTHOS SAMPLE SITE: Location: Permanent hub at top end of fish sample site.

(Sept.15/83)

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)	20	33	32	25	12	12

D50 $\bar{x}$ = 20

D90 $\bar{x}$ = 45

Avg. Water Velocity 0.43 m/sec

FISH SAMPLE SITE:

Location (m)	Width (m)	Mean Depth (cm)	Max. Depth (cm)	Bank Cover	Debris Cover	D50/90 (cm)
0	8.0	30	42	-	-	12/40
20	7.0	26	35	-	-	20/40
40	10.6	22	32	-	-	10/22
60	8.5	20	28	-	-	10/18
80	7.0	20	30	x	-	12/40
92	12.0	10	12	-	-	12/40
$\bar{x}$	8.8					

Comment - side channel in upper end of site. x = cover present. - = cover not present.

FISH SAMPLE:

Species	Age	fl-range (mm)	$\bar{fl}$(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+	34-36	35.0	0.71	1	1	0	3	N/A	-	3	.004	0.03	<.01
Sthd	1+	-	-	-	-	-	-	-	-	-	-	-	-	-
Sthd	≥2+	108-230	160.2	46.0	3	4	3	4	N/A	-	4	.005	0.04	0.23
DV	0+	38-58	48.1	1.29	14	6	3	25	8.0	1	26	.032	0.28	0.04
DV	≥1+	65-175	99.9	10.47	34	36	18	67	7.5	-	67	.082	0.73	0.86
Total											100	.123	1.09	1.13

Note: 8 of the large DV males were ripe.

Note: For abbreviations and symbols used in this table see first page of appendix.

SITE DESCRIPTION - T1

Location: Approx 30 m above lower bridge on Tenas Creek upstream for 90 m. Area: 548 m^2 Crew: DB, TH, CM.
Date: September 13, 1983. Length of stream margin: 90 m. Photos: #28-31 (R1) Water Temp. 9° @ 1200 hrs. 10° @ 1440 hrs.

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)	15	14	21	12	16	11

Avg. Water Velocity 0.37 m/sec

Wetted Width 6m

FISH SAMPLE SITE:

Location (m)	Width (m)	Mean Depth (cm)	Max. Depth (cm)	Bank Cover	Debris Cover	D50/D90 (cm)
0	6.5	21	29	-	-	10/30
10	6.0	18	20	-	-	10/25
20	6.3	15	10	x	x	6/20
30	7.1	19	25	-	x	13/30
40	4.0	20	28	-	-	13/26
50	6.0	19	24	-	-	16/32
60	6.0	13	19	-	x	11/17
70	8.1	11	17	x	x	6/13
80	7.4	19	25	x	-	9/20
90	3.5	21	27	-	-	9/20
$\bar{x}$	6.1					

x = cover present - = cover not present

FISH SAMPLE:

Species	Age	fl-range (mm)	$\bar{x}$ 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+	31-59	44.6	1.01	158	172	60	450	36.7	15+13 net	478	.872	5.31	.88
Sthd	1+	65-101	83.8	6.82	38	30	21	54	4.3	1	55	.100	0.61	0.68
Sthd	≥2+	107-149	125.0	21.23	13	14	10	18	1.4	-	18	.033	0.20	0.70
DV	0+	-	-	-	0	0	-	-	-	-	0	0	0	-
DV	≥1+	98-143	123.0	19.50	3	2	1	5	2.5	-	5	.009	0.06	0.18
Total											556	1.015	6.18	2.44

Note: For abbreviations and symbols used in this table see first page of appendix.

SITE DESCRIPTION - T2

Location: Approx 4 km upstream in Tenas Creek below major bend in creek system. Helicopter access. Area: 410 m^2 Crew: DB, TH, CM.
Date: September 23, 1983. Length of stream margin: 62 m. Photos: #17-19 (R2) Water Temp. 7° @ 1300 hrs Gradient: 3.5%

BENTHOS SAMPLE SITE: Location: Approx. 20 m upstream from 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)	15	19	18	23	28	13

D50 $\bar{x}$ = 8

D90 $\bar{x}$ = 25

Avg. 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	6.3	28	34	-	x	4/14
10	6.9	27	40	x	x	10/15
20	6.4	19	22	-	x	6/15
30	5.4	17	25	-	x	9/20
40	5.0	29	34	-	x	7/25
50	5.9	33	39	x	x	6/17
60	9.7	24	38	x	x	6/12
62	+ 6m^2 additional area					

Comment: This site has more debris cover than other sites to date. Numerous log steps creating scour pools.
Also suitable pockets of gravel for spawning fish. x = cover present - = cover not present

FISH SAMPLE:

Species	Age	fl-range (mm)	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+	33-57	46.3	1.12	89	88	37	210	19.9	4	214	.522	3.45	.58
Sthd	1+	66-105	82.5	6.55	23	29	15	44	4.6	-	44	.107	0.71	0.70
Sthd	≥2+	107-175	126.9	22.13	19	16	11	27	2.8	-	27	.066	0.44	1.46
DV	0+	-	-	-	0	0	-	-	-	-	0	0	0	-
DV	≥1+	118-126	122.0	18.97	2	4	1	6	2.7	-	6	.015	0.10	0.28
Total											219	.710	4.69	3.02

Note: For abbreviations and symbols used in this table see first page of appendix.

SITE DESCRIPTION - T3

Location: Approx 11 km upstream on Tenas Creek just downstream of major fork into headwater source areas. Helicopter access. Area: 196 m^2
Date: September 23, 1983. Length of stream margin: 37 m. Photos: #20-21 (R2) Water Temp. 6° @ 16.45 hrs. Gradient: 2.5% Crew: DB, TH, CM.

BENTHOS SAMPLE SITE: Location:

Sample #	1	2	3	4	5	6
Dist. from BM (m)						
Depth (cm)						
D50			NOT CONDUCTED			
D90						
Avg. Water Velocity						

FISH SAMPLE SITE:

Location (m)	Width (m)	Mean depth (cm)	Max. depth (cm)	Bank Cover	Debris Cover	D50/D90 (cm)
0	6.5	18	25	-	-	7/25
10	5.6	25	40	-	-	10/40
20	5.3	20	35	-	x	8/30
30	4.8	30	38	-	-	7/30
37	4.3	21	23	-	-	6/30

Comment: This site was located in the upper most section of this reach to determine whether fish were present. A small accumulation of debris was located at the confluence of a small tributary within this site.
A small site, and two-step removal was used due to time restriction related to helicopter access.
x = cover present - = cover not present

FISH SAMPLE:

Species	Age	fl-range (mm)	- fl (mm)	Mean Weight(g)	U1	U2	T	N	S.E.	N/m^2	N/ Linear m	Biomass g/m^2
Sthd	0+	38-44	41.3	0.82	9	0	9	9	0	.046	0.24	.04
Sthd	1+	-	-	-	0	0	0	0	0	-	-	-
Sthd	≥2+	-	-	-	0	0	0	0	0	-	-	-
DV	0+	34-53	45.2	1.05	11	7	18	30	20.4	.153	0.81	0.16
DV	≥1+	74-170	103.8	11.70	22	4	26	27	7.1	.138	0.73	1.61
Total								66		.337	1.78	1.81

Note: For abbreviations and symbols used in this table see first page of appendix.

SITE DESCRIPTION - MS1

Location: Mainstem Telkwa River 1.5 km from mouth. Access from the end of Ash Road in Telkwa. Crew: DB, TH, CM.
Date: September 28, 1983 Area: 83.5 (m^2) Length of stream margin: 14.5 m Photos: #14 & 15 (R3) Water Temp: 4° @ 1300 hrs.

BENTHOS SAMPLE SITE: Location:

Sample #	1	2	3	4	5	6
Dist. from BM (m)						
Depth (cm)						
D50 (cm)		NOT CONDUCTED				
D90 (cm)						
Avg. Water Velocity:						

FISH SAMPLE SITE:

Location	Width (m)	Mean Depth (cm)	Max. Depth (cm)	Bank Cover	Debris Cover	D50/D90 (cm)
1	4.0		50			Cobble
2	6.1		60			"
3	6.5		60			"
4	7.0		50			"
5	5.2		60			"
$\bar{x}$	5.86					

Comment: This site was on the edge of a mainstem riffle. Cobble substrate provided good fish cover.

FISH SAMPLE:

Species	Age	fl-range (mm)	fl (mm)	Mean Weight(g)	U1	U2	T	N	S.E.	N/m^2	N/ Linear m	Biomass g/m^2
Sthd	0+	33-51	42.4	0.80	29	7	36	38	2.5	.455	2.62	0.36
Sthd	1+	67-91	78.7	4.90	9	0	9	9	0	.108	0.62	0.53
Sthd	$\geq$2+	108-137	119.0	16.5	3	0	3	3	0	.036	0.21	0.59
Total								50		.599	3.45	1.48

Note: For abbreviations and symbols used in this table see first page of appendix.

SITE DESCRIPTION - MS2

Location: Mainstem Telkwa River 1.5 km upstream from mouth. Access from the end of Ash Road in Telkwa. Crew: DB, TH, CM.
Date: September 28, 1983 Area: 104.9 (m^2) Length of stream margin: 19.8 m Photos: #16 & 17 (R3) Water Temp. 4° @ 1300 hrs.

BENTHOS SAMPLE SITE: Location:

Sample #	1	2	3	4	5	6
Dist. from BM (m)						
Depth (cm)						
D50 (cm)		NOT CONDUCTED				
D90 (cm)						
Avg. Water Velocity:						

FISH SAMPLE SITE:

Location	Width (m)	Mean Depth (cm)	Max. Depth (cm)	Bank Cover	Debris Cover	D50/D90 (cm)
1	4.0		80			
2	5.5		80			
3	6.4		67	See comments below		
4	6.8		40			
5	6.2		30			
6	2.8		9			
x	5.3					

Comment: This site is located upstream of MS1 at the top end of a berm on the river's left bank (Ash Road)
50% of the site consists of loose cobble substrate offering good fry cover.
50% of the site consists of silt substrate. Overhanging alder and bank cover
supported few fish.

FISH SAMPLE:

Species	Age	fl-range (mm)	fl (mm)	Mean Weight(g)	U1	U2	T	N	S.E.	Others	N Corr.	N/m^2	N/ Linear m	Biomass g/m^2
Sthd	0+	32-52	40.2	0.69	37	2	39	39	0.38	-	39	.372	1.97	0.26
Sthd	1+	65-92	80.0	5.10	3	0	3	3	0	-	3	.029	0.15	0.15
Sthd	>2+	110-115	112.5	13.7	2	0	2	2	0	-	2	.019	0.10	0.26
Co	0+	65-70	67.5	3.24	2	0	2	2	0	-	2	.019	0.10	0.06
MW	0+	51	51	1.11	1	0	1	1	0	-	1	.010	0.05	0.01
Total								47			47	.448	2.37	0.74
Pacific Lamprey		46	46		1									

Note: For abbreviations and symbols used in this table see first page of appendix.

SITE DESCRIPTION - MS3

Location: Mainstem Telkwa River 1.5 km from mouth. Approx. 150 m downstream from MS1. Crew: DB, TH, CM.
Date: September 28, 1983 Area: 82.1 (m^2) Length of stream margin: 11.1 m Photos: #18 & 19 (R3) Water Temp. 4° @ 1300 hrs.

BENTHOS SAMPLE SITE: Location:

Sample #	1	2	3	4	5	6
Dist. from BM (m)						
Depth (cm)						
D50 (cm)		NOT CONDUCTED				
D90 (cm)						
Avg. Water Velocity:						

FISH SAMPLE SITE:

Location	Width (m)	Mean Depth (cm)	Max. Depth (cm)	Bank Cover	Debris Cover	D50/D90 (cm)
1	7.1		38			
2	9.6		15			
3	7.7		40	See comments below		
4	5.2		15			
$\bar{x}$	7.4					

Comment: This site is a shallow cobble flat along the edge of mainstem Telkwa River. No debris in site.

FISH SAMPLE:

Species	Age	fl-range (mm)	- fl (mm)	Mean Weight(g)	U1	U2	T	N	S.E.	N/m^2	N/ Linear m	Biomass g/m^2
Sthd	0+	32-55	42.1	0.78	24	2	26	26	0.5	.317	2.34	0.25
Sthd	1+	73-92	82.5	5.53	4	1	5	5	1.0	.061	0.45	0.34
Sthd	>2+	115	115	14.8	1	0	1	1	-	.012	0.09	0.18
MW	>1+	81	81	4.51	1	0	1	1	-	.012	0.09	0.05
Total								33		.402	2.97	0.82

Note: For abbreviations and symbols used in this table see first page of appendix.

SITE DESCRIPTION - MS4

Location: Mainstem Telkwa River 1.5 km from mouth. Approx. 30 m downstream from MS3. Crew: DB, TH, CM.
Date: September 28, 1983 Area: 64.8 (m^2) Length of stream margin: 18.5 m Photos: #20 (R3) Water Temp. 4° @ 1300 hrs.

BENTHOS SAMPLE SITE: Location:

Sample #	1	2	3	4	5	6
Dist. from BM (m)						
Depth (cm)						
D50 (cm)			NOT CONDUCTED			
D90 (cm)						
Avg. Water Velocity:						

FISH SAMPLE SITE:

Location	Width (m)	Mean Depth (cm)	Max. Depth (cm)	Bank Cover	Debris Cover	D50/D90 (cm)
1	3.5		45			
2	4.8		50			
3	4.6		46	See comments below		
4	2.9		46			
5	1.7		25			
$\bar{x}$	3.5					

Comment: This site is deeper than MS3 with virtually no water velocity. Substrate consists of larger gravels and cobble.

FISH SAMPLE:

Species	Age	fl-range (mm)	- fl (mm)	Mean Weight(g)	U1	U2	T	N	S.E.	N/m^2	N/ Linear m	Biomass g/m^2
Sthd	0+	38-49	45.1	0.94	9	2	11	12	1.2	.185	0.65	0.17
MW	0+	55-62	58.5	1.68	2	0	2	2	-	.031	0.11	0.05
Total								14		.216	0.76	0.22

Note: For abbreviations and symbols used in this table see first page of appendix.

SITE DESCRIPTION - MS5

Location: Approx. 3.5 km upstream of Telkwa River (Lot 412). Access through farmer's field on south side of river. Crew: DB, TH, CM.
Date: September 30, 1983 Area: 151.2 (m^2) Length of stream margin: 24.0 m Photos: #2 & 4 (R4) Water Temp. 3° @ 1100 hrs.

BENTHOS SAMPLE SITE: Location:

Sample #	1	2	3	4	5	6
Dist. from BM (m)						
Depth (cm)						
D50 (cm)		NOT CONDUCTED				
D90 (cm)						
Avg. Water Velocity:						

FISH SAMPLE SITE: Location	Width (m)	Mean Depth (cm)	Max. Depth (cm)	Bank Cover	Debris Cover	D50/D90 (cm)
1	6.0		15			2/30
2	9.0		50			<2
3	12.3		70			<2
4	5.5		50			<2/30
5	3.8		10			5/30
6	1.0		5			10/30
$\bar{x}$	6.3					

Comment: This site includes a back eddy pool with a log jam and a small inflow at the top end of back eddy. Coho were found in log jam. Steelhead fry were found in small channel with cobble substrate. Mark and recapture technique used due to difficulty of sampling the log jam.

FISH SAMPLE: Species	Age	fl-range (mm)ge	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+	33-49	50.7	1.29	21	22	14	33	3.1	3 morts	36	.238	1.50	0.31
Co	0+		62.1	2.58	5	4	1	14	8.2	1 mort	15	.099	0.62	0.26
Co	1+	95	95	8.36	0	1	0	1	N/A	-	1	.007	0.04	0.06
MW	0+	46-68	58.8	1.70	3	1	0	7	N/A	-	7	.046	0.29	0.08
MW	1+	109	109	11.14	0	1	0	1	N/A	-	1	.007	0.04	0.08
Total											60	.397	2.5	0.79

Pacific Lamprey ammocoetes - several present in silt-bottomed portion of site.

Note: For abbreviations and symbols used in this table see first page of appendix.

SITE DESCRIPTION - MS6

Location: Approx. 3.5 km upstream of Telkwa River (Lot 412). Access past farmer's house one road down from old dump site.
Date: September 30, 1983 Area: 91.0 (m^2) Length of stream margin: 13.0 m Photos: #3 (R4) Water Temp. 3° @ 1100 hrs. Crew: DB, TH, CM

BENTHOS SAMPLE SITE: Location:

Sample #	1	2	3	4	5	6
Dist. from BM (m)						
Depth (cm)						
D50 (cm)		NOT CONDUCTED				
D90 (cm)						
Avg. Water Velocity:						

FISH SAMPLE SITE:

Location	Width (m)	Mean Depth (cm)	Max. Depth (cm)	Bank Cover	Debris Cover	D50/D90 (cm)
1	8.2		40	-	-	5/15
2	9.0		50	-	-	<2/25
3	7.0		40	-	-	2/15
4	3.8		25	-	-	2/15
$\bar{x}$	7.0					

Comment: This site is located at the edge of pool habitat with no debris cover and a mixture of cobble and fine substrate. Location is approximately 10 m upstream from MS5.

FISH SAMPLE:

Species	Age	fl-range (mm)	fl (mm)	Mean Weight(g)	U1	U2	T	N	S.E.	N/m^2	N/ Linear m	Biomass g/m^2
Sthd	0+	37-54	44.0	0.88	26	5	31	32	1.6	.352	2.46	0.31
Sthd	1+	75-85	80.5	5.19	2	2	4	4	N/A	.044	0.31	0.23
Sthd	≥2+	115-133	124.0	18.9	2	0	2	2	N/A	.022	0.15	0.42
Total								38		.418	2.92	0.96

Pacific Lamprey ammocoetes present.

Note: For abbreviations and symbols used in this table see first page of appendix.

SITE DESCRIPTION - MS7

Location: Approx. 3.5 km upstream of Telkwa River (Lot 412). See MS6 for access. Site immediately above MS6. Crew: DB, TH, CM
Date: September 30, 1983 Area: 103.5 (m^2) Length of stream margin: 15.0 m Photos: #6 (R4) Water Temp: 5.5° @ 1400 hrs.

BENTHOS SAMPLE SITE: Location:

Sample #	1	2	3	4	5	6
Dist. from BM (m)						
Depth (cm)						
D50 (cm)		NOT CONDUCTED				
D90 (cm)						
Avg. Water Velocity:						

FISH SAMPLE SITE:

Location	Width (m)	Mean Depth (cm)	Max. Depth (cm)	Bank Cover	Debris Cover	D50/D90 (cm)
1	5.3		15	-	-	10/30
2	6.8		15	-	-	10/30
3	9.0		10	-	-	10/30
4	6.4		10	-	-	10/30
$\bar{x}$	6.9					

Comment: This very productive site was in a shallow riffle along the edge of the mainstem Telkwa River. Large loose cobble provided excellent cover for fry and parr. No debris present.

FISH SAMPLE:

Species	Age	fl-range (mm)	fl (mm)	Mean Weight(g)	U1	U2	T	N	S.E.	N/m^2	N/ Linear m	Biomass g/m^2
Sthd	0+	34-54	43.4	0.85	21	7	28	32	4.0	.309	2.13	0.26
Sthd	1+	69-96	86.5	6.25	9	2	11	12	1.2	.116	0.80	0.73
Sthd	$\geq$2+	110-156	135.4	25.3	5	2	7	8	2.9	.077	0.53	1.95
DV	$\geq$1+	105-137	121.0	18.97	2	1	3	4	N/A	.039	0.27	0.74
MW	0+	70	70	2.90	1	0	0	1	N/A	.010	0.07	0.03
Total								57		.551	3.8	3.71

Note: For abbreviations and symbols used in this table see first page of appendix.

SITE DESCRIPTION - SC1

Location: Telkwa River side channel at end of Cottonwood Road in village. Second channel out from road.
Approx. 1.5 km from mouth of Telkwa River. Area: 651 (m^2) Crew: DB, TH, CM. Gradient: 1%
Date: September 27, 1983. Length of stream margin: 70 m. Photos: #12 & 13 (R3) Water Temp: 4.5° @ 1100 hrs.

BENTHOS SAMPLE SITE: Location: Mid-way up side channel. Willows (marked) and metal rod are benchmarks.

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)	19	12	11	16	13	13

D50 (cm) x = 6
D90 (cm) x = 13
Avg. Water Velocity: 0.53 m/sec
Note: There are a lot of fine glacial silts on the rock surfaces.

FISH SAMPLE SITE:

Location (m)	Width (m)	Mean Depth (cm)	Max. Depth (cm)	Bank Cover	Debris Cover	D50/D90 (cm)
0	7.5	20	24	-	-	7/23
10	6.6	21	24	-	-	6/22
20	5.5	19	25	-	-	7/20
30	6.0	17	20	-	-	7/16
40	6.7	26	40	-	x	2/14
50	9.5	10	14	-	-	8/22
60	15.7	10	12	-	x	7/19
70	17.0	12	13	-	x	9/23
$\bar{x}$	9.3					7/20

Comment: Sample site represents a riffle/pool/riffle/glide sequence. This channel was sampled one day after a high flow from a rainstorm event. The total surface area measured is considerably higher than flows after a longer period without a storm. Therefore density estimates are low compared to what they may be given no storm event.
This site represents a medium-sized side channel. x = cover present - = cover not present

FISH SAMPLE:

Species	Age	fl-range (mm)	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+	36-60	46.8	1.04	101	93	44	212	17.3	3	215	.330	3.07	0.34
Sthd	1+	62-100	81.3	5.32	11	6	2	27	11.9	-	27	.041	0.39	0.22
Sthd	>2+	111-166	129.2	21.70	4	6	2	11	4.2	-	11	.017	0.16	0.37
Co	0+	64-68	66.0	3.05	0	2	0	2	N/A	-	2	.003	0.03	0.01
Ch	0+	91	91	7.70	0	1	0	1	N/A	-	1	.002	0.01	0.02
DV	0+	64	64	2.77	2	1	1	2	N/A	-	2	.003	0.03	0.01
MW	0+	55-76	63.5	2.16	19	26	12	41	5.3	-	41	.063	0.59	0.14
MW	>1+	128	128	18.20	0	1	0	1	N/A	-	1	.002	0.01	0.04
Total											300	.461	4.29	1.15

Note: For abbreviations and symbols used in this table see first page of appendix.

SITE DESCRIPTION - SC2

Location: Approx. 3.5 km upstream on Telkwa (north side). Access via farmers field (down steep hill). Crew: DB, TH, CM.
Date: September 29, 1983 Area: 434 (m^2) Length of stream margin: 25.7 m Photos: #1 & 2 (R4) Water Temp. 5° @ 13100 hrs.

BENTHOS SAMPLE SITE: Location: Riffle area approx. 100 m upstream from top net set.

Sample #	1	2	3	4	5	6
Dist. from BM (m)	14	19	23	27	31	35
Depth (cm)	14	30	22	22	28	17
D50 (cm)	10	18	10	15	7	4
D90 (cm)	25	20	24	23	18	10

Avg. Water Velocity: 0.68 m/sec

FISH SAMPLE SITE:

Location (m)	Width (m)	Mean Depth (cm)	Max. Depth (cm)	Bank Cover	Debris Cover	D50/D90 (cm)
0	15.5	52	65	-	-	10/45
10	16.0	42	60	-	-	10/40
20	17.8	30	55	-	-	12/30
25.7	18.4	43	80	-	-	15/30
						11/36
$\bar{x}$	16.9					

Comment: This site represents a large side channel in the Telkwa River. Very difficult to maintain stop nets at this site due to its large flow.

- = cover not present.

FISH SAMPLE:

Species	Age	fl-range (mm)	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+	38-55	47.4	1.08	20	11	2	83	41.6	5 net	88	.203	3.42	0.22
Sthd	1+	67-100	85.5	6.07	11	4	3	14	3.2	1 net	15	.035	0.58	0.21
Sthd	≥2+	110-213	144.5	31.3	5	7	4	9	1.5	3 net	12	.028	0.47	0.88
DV	≥1+	117	117	17.1	1	0	0	0	N/A	-	1	.002	0.04	0.03
MW	0+	55-77	67.1	2.56	7	8	2	23		9 morts 17 net	49	.113	1.91	0.29
Co	0+	62-64	63	2.68	2	0	0	2	N/A		2	.005	0.08	.01
Total											167	.385	6.50	1.64

Note: For abbreviations and symbols used in this table see first page of appendix.

SITE DESCRIPTION - SC3

Location: Approx. 3.5 km upstream on Telkwa (Lot 412). Access through farmers field on south side of river. Crew: DB, TH, CM.
Date: September 30, 1983 Area: 46 (m^2) Length of stream margin: 25 m Photos: none. Water Temp: 3° @ 1500 hrs.

BENTHOS SAMPLE SITE: Location:

Sample #	1	2	3	4	5	6
Dist. from BM (m)						
Depth (cm)						
D50 (cm)			NOT CONDUCTED			
D90 (cm)						
Avg. Water Velocity:						

FISH SAMPLE SITE: Location (m)	Width (m)	Mean Depth (cm)	Max. Depth (cm)	Bank Cover	Debris Cover	D50/D90 (cm)
5	1.1		15	-	x	Silt
10	2.2		15	-	-	"
15	2.5		20	-	x	"
20	2.2		20	-	x	"
25	1.2		10	-	x	5/25
$\bar{x}$	1.8					

Comment: This side channel represents small side channels in the Telkwa River. Two-step removal used due to time limitations and the low numbers of fish present. x = cover present. - = cover not present.

FISH SAMPLE: Species	Age	fl-range (mm)	fl (mm)	Mean Weight(g)	U1	U2	T	N	S.E.	N/m^2	N/ Linear m	Biomass g/m^2
Sthd	0+	34-48	40.7	0.71	16	3	19	20	3.9	.435	0.80	0.31
Co	0+	49-69	58.2	2.15	9	2	11	12	1.2	.261	0.48	0.56
MW	0+	60-65	63.0	2.10	2	1	3	4	N/A	.087	0.16	0.18
Total								36		.783	1.44	1.05

Note: For abbreviations and symbols used in this table see first page of appendix.

Appendix 5 : Population estimates for juvenile salmonids in Goathorn Creek, Tenas Creek and the Telkwa River, September 1983.

Table A.5.1 : Population estimates for juvenile salmonids in Goathorn Creek, September 1983

Site	Number of Fish per Linear Metre			Length of Stream Represented by Sample Site (m)	Population Estimates by Section		
				STEELHEAD TROUT			
	0+	1+	≥2+		0+	1+	≥2+
G1	4.94	0.82	0.28	1000 1100	~~4940~~ 5434	~~820~~ 902	~~280~~ 308
G2	1.51	0.50	0.31	1000	1510	500	310
G3	0.56	0.38	0.25	1500	840	570	375
G4	0.29	0.04	0.06	1000	290	40	60
G5	0.03	0	0.04	~~4500~~ 5600	~~135~~ 168	-	~~180~~ 224
Total				9000 10200	~~7715~~ 8242	~~1930~~ 2012	~~1205~~ 1277
				DOLLY VARDEN CHAR			
	0+	≥1+			0+	≥1+	
G1	0.02	0.08		1000 1100	20 22	80 88	
G2	0.01	0.20		1000	10	200	
G3	0.72	0.45		1500	1080	675	
G4	1.24	0.76		1000	1240	760	
G5	0.28	0.73		~~4500~~ 5600	~~1260~~ 1508	~~3285~~ 4088	
Total				~~9000~~ 10200	~~3610~~ 3720	~~5000~~ 5803	

Table.A.5.2 : Population estimates for juvenile salmonids in Tenas Creek, September 1983

Site	Number of Fish per Linear Metre			Length of Stream Represented by Sample Site (m)	Population Estimates by Section		
				STEELHEAD TROUT			
	0+	1+	≥2+		0+	1+	≥2+
T1	5.31	0.61	0.20	~~2000~~ 2900	15399 ~~10620~~	1769 ~~1220~~	580 ~~400~~
T2	3.45	0.71	0.44	5000	17250	3550	2200
T3	0.24	0	0	~~3500~~ 3800	912 ~~840~~	0	0
Total				~~10500~~ 11,700	~~28710~~ 33561	~~4770~~ 5319	~~2600~~ 2780
				DOLLY VARDEN CHAR			
	0+	≥1+			0+	≥1+	
T1	0	0.06		~~2000~~ 2900	0	~~120~~ 174	
T2	0	0.10		5000	0	500	
T3	0.81	0.73		3500 3800	3078 ~~2835~~	2774 ~~2555~~	
Total				~~10500~~ 11,700	~~2835~~ 3078	~~3175~~ 3448	

Table A.5.3 : Population estimates for juvenile steelhead in the main channel Telkwa River, September 1983.

Site	Number of Fish per Linear Metre 0+	1+	≥2+	Total Main Channel Length (m) *	Population Estimate Corrected for Main Channel Length 0+	1+	≥2+
MS1	2.62	0.62	0.21				
MS2	1.97	0.15	0.10				
MS3	2.34	0.45	0.09				
MS4	0.65	0	0				
MS5	1.50	0	0				
MS6	2.46	0.31	0.15				
MS7	2.13	0.80	0.53				
Mean	1.95	0.33	0.15	16,000 ~~13,000~~	31,200 ~~25,350~~	5,280 4,290	2400 1,950
Sc	2.43	.32	.21	12900	31347	4128	2709

Adult estimates **

1) Assume 35% survival parr to smolt -(6240 x .35) = 2184 smolts

2) Assume 15% survival smolt to adult -(2184 x .15) = 328 adults

3) Assume 2:1 interception ratio of adult fish = 109 adult steelhead spawners.

* The 6,500 m of main channel has been doubled to account for the two sides of the river. Fish/linear metre refers to one side of the river only.

** This estimate does not include production from those steelhead fry and parr which may leave the Telkwa River to rear in downstream areas. Survival estimates are from Tredger (1982a).

Appendix 6 : Detailed results of fish sampling in Hubert and Helps Creeks.

Table A.6.1 : Minnow trap results from lower Hubert Creek, September 24-25, 1983.

Site #	Location	Water Type	Catch Co 0+	Co 1+	Sthd 0+	Sthd 1+	Sthd ≥2+	Others
1	30 m from Bulkley River	Glide	1	0				Ch 1
2	30 m from Bulkley River	"		1	1			Ch 1
3	Below 1st beaver dam	"	5	2	14			Ch 1 Lns 1
4	Above 1st beaver dam	Pond	3	1				
5	Below 2nd beaver dam	"		2				DV 1
6	Above 2nd beaver dam	"	1	2				
7	Below 1.5 m dam 150 m below railroad bridge		4	5	1	2		
8	Same as 7	"	1	3				
9	Above dam @ Site #7	"		1				
10	Under railroad trestle	"		1				
11	Just upstream from railroad	"		7				
12	Lower road bridge (near CNR)	"		2				
13	Pond area above lower road	"		2				
14	Below 1st beaver dam above Site 12	"						
15	As in Site #14. Weeds blocking trap ?							
16	Approx. 200 m above lower road	"		5				
17	Pond area below lower powerline	"		3			1	
18	Ponded area near bridge to powerline	"		10				
19	200 m below powerline	"		4				
20	100 m below powerline	"		3				
21	100 m below main road crossing	Pool			2		1	
22	50 m below " " "	"		3	2	5	1	
23	10 m " " " "	Glide		3	2	5	1	
24	10 m above " " "	Pool		4		1	1	Lnd 1
25	20 m " " " "	"		11		1		
26	50 m " " " "	"		10		1		

Table A.6.2 : Minnow trap results from Upper Hubert and Helps Creeks, October 19-20, 1983.

Site #	Location	Water type	Catch Ct 0+	Ct >1+	Lns	Others
27	Upper Hubert Ck. between gas line and hydro R/W	Pool		1		
28	As in 27	"		2		
29	As in 27	"		1		DV 1
30	As in 27	"		8		
31	200 m above Helps pond, Upper Helps Creek	"		4	6	
32	350 m above Helps pond, Upper Helps Creek	"		1	1	
33	Bridge crossing in Help's field	"	10	3	9	Lnd 1
34	Downstream of culvert just above field	"	8	15		Lnd 1
35 - 39	Along margin of Helps Lake	Lake		3	1	

Sthd = Steelhead trout
Ct = Cutthroat trout
Co = Coho salmon
Ch = Chinook Salmon
DV = Dolly Varden char
Lns = Longnose sucker
Lnd = Longnose dace

Table A.6.3 : Helps Lake - length and weight data for fish Captured in gill net set October 20, 1983.

	Length (cm)	Weight (g)	Length (cm)	Weight (g)
Longnose Sucker				
	22.9	135.3		
Cutthroat Trout				
	23.0	129	23.5	131
	22.7	115	25.5	155
	18.3	61	23.3	118
	23.9	133	23.8	146
	23.8	130	25.3	160
	21.0	100	27.0	200
	26.0	175	26.5	186
	24.1	140	24.3	141
	23.1	133	23.0	131
	22.7	121	22.7	119
	21.3	98	23.9	137
	24.2	135	21.5	104
	23.7	136	22.5	125
	26.3	174	27.1	183
	25.5	173	23.5	139
	29.6	256	27.1	208
	24.0	156	23.2	133
	23.9	135	24.3	144
	23.3	140	17.0	56
(Cutthroat Trout)				
Sample Size	38	38		
Mean	23.8	141		
Range	17.0 - 29.6	56 - 256		
S.D. (Mean)	2.3	37		

Appendix 7 : Mann-Whitney Test for differences between benthic invertebrate numbers above and below the existing coal mine site on Goathorn Creek.

Benthic Invertebrates Below Coal Mine * (G2 & G3)	Rank	Benthic Invertebrates Above Coal Mine (G4 & G5)	Rank
141	10	65	20
94	18	149	9
50	21	136	13
102	16	325	3
139	12	203	6
140	11	46	22
100	17	216	5
160	8	183	7
124	14	336	1
77	19	330	2
34	23	123	15
32	24	248	4
$n_1 = 12$	$R_1 = 193$	$n_2 = 12$	$R_2 = 107$

$$U = n_1 n_2 + \frac{n_1 (n_1 + 1)}{2} - R_1 = 29$$

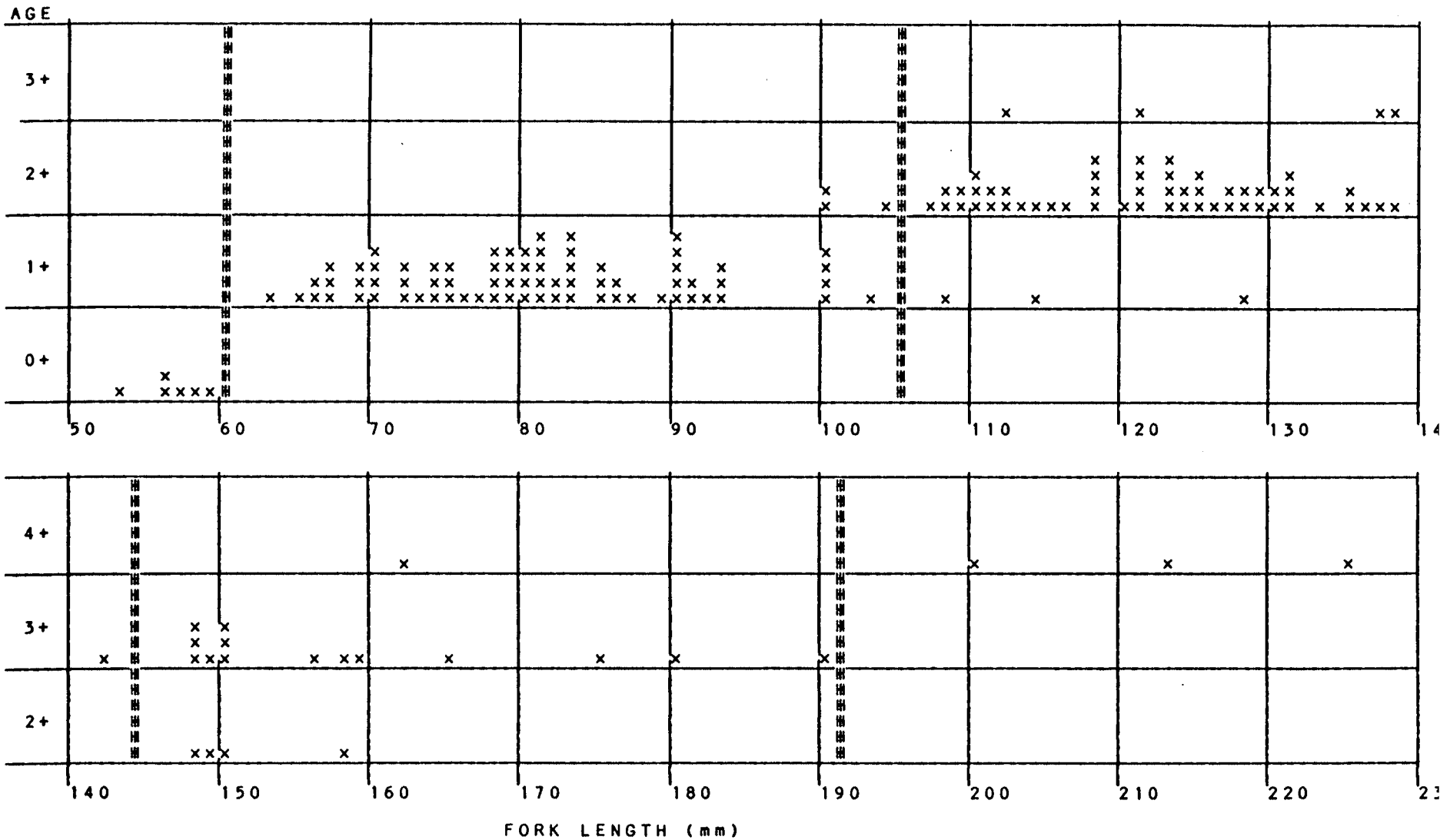
$$U' = n_1 n_2 + \frac{n_2 (n_2 + 1)}{2} - R_2 = 115$$

$U_{0.05}(2)\ 12, 12 = 107$

$U' > U_{0.05}$ Therefore samples are statistically different at 95% confidence level (Zar 1974).

* Refers to number of benthic invertebrates per sample (Appendix 2).

Appendix 8 : Length-age estimates from analyses of juvenile steelhead scales from the Telkwa River and Tenas and Goathorn creeks, September 1983.



Approximate Length/Age Separation

< 60 mm	= 0+
61-105 mm	= 1+
106-145 mm	= 2+
146-190 mm	= 3+
191-235 mm	= 4+
236-260 mm	= 5+

* Larger Fish 230 mm - 4
236 mm - 4
260 mm - 5