Assessment of overwintering habitat and distribution of Coho Salmon (*Oncorhynchus kisutch*) in the Mid-Bulkley Watershed (Houston to Bulkley Lake) January to March 1997

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EXECUTIVE SUMMARY

The Mid-Bulkley coho stocks have been depressed and are currently in a condition that threatens continuous decline with difficult opportunities for restoration. Several hypotheses, including degradation and loss of fish habitat, have now been proposed to be factors that may be responsible for the declining population size. The main intents of this study were to conduct a preliminary assessment of the winter distribution of coho salmon, and the locations, suitability, and water qualities of coho overwintering habitats.

Minnow traps were used to sample for fish presence and densities at 15 sites in the Mid-Bulkley watershed during January, February, and/or March. Juvenile coho salmon were found as far upstream as the McQuarrie Creek confluence. Chinook salmon were captured slightly further upstream at Byman Creek in February. Various densities of rainbow trout/steelhead were identified at all sites except "Summit" (Raspberry) Creek. From data interpretation, the extremely low abundances of rainbow trout upstream of the Bulkley River cascade, above the Ailport confluence, indicates that this cascade has recently acted as a barrier to steelhead (spring) migration. However, there is a possibility that the low abundances of rainbow trout upstream from the cascade to Bulkley Lake may also be related to high pH in spring run-off (pH>9), high water temperatures in summer, or limited downstream spawning from Bulkley Lake. Although the cascade is at least a partial barrier to fish migration during optimal flow, the assessment of species distribution in this area implies that beaver dams are presently acting as the main barriers to fall spawning migration.

Suitable overwintering mainstem habitats were identified throughout the Mid-Bulkley watershed. Interestingly, rainbow trout/steelhead densities from Houston upstream to Ailport Creek were very similar in this area to the good abundance indices from Toboggan and Elliot creeks. However, coho densities in the mainstem habitat of the Mid-Bulkley were relatively low compared to the index for good abundance. To estimate the overall amount of good overwintering habitat in the Mid-Bulkley watershed, the suitability of side channel and shallow lake (e.g. Toboggan Lake) habitats still need to be examined.

Temporal variations in coho and rainbow trout survival were not clearly defined by any clear trends of catch per unit effort (CPUE). At some sites, coho CPUE decreased from January to March, but at other sites, coho CPUE increased from January to February, and then decreased to March. Similar variabilities in CPUE were found in rainbow trout data. These results suggest that other variables may temporally influence CPUE.

From analyses of data, no temporal changes in fish conditions (Fulton's condition factors) were identified and only the Barren Creek rainbow trout sample in February showed a significantly spatial difference in condition. However, the significantly higher condition factor was likely related to the unnatural stream disturbance that had occurred at Barren Creek just prior to sampling.

Several recommendations are discussed in this report to provide a list of studies that may provide some better understandings of the limitations to coho distribution and abundance in the Mid-Bulkley watershed.

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1.0 INTRODUCTION

SKR Consultants Ltd was contracted by the Department of Fisheries and Oceans to assess the overwintering habitat and existing distribution of coho salmon (*Oncorhynchus kisutch*) in a section of the Bulkley River and its tributaries between the Morice River confluence and Bulkley Lake. Coho abundance is known to be low in this middle section of the Bulkley River, but no limiting factors have been conclusively established. Site surveys, general water quality sampling, and trapping were conducted throughout this section of the Bulkley watershed during January to March 1997 to categorize the quality of habitat that may be utilized by coho for overwintering. The main objectives of this project were:

- to describe the present winter distribution limits of coho salmon in the Mid-Bulkley watershed,
- to assess the available coho overwintering habitat in this middle section of the Bulkley watershed,
- to assess the relative condition (Fulton's Condition Factor) of coho and rainbow trout at overwintering sites in order to test if habitat characteristics during the winters may be related to low condition, which may be related to lowered winter survival,
- to sample streams (Toboggan and Elliot creeks) well below the distibution limits of coho in the Bulkley watershed, to provide an index for comparisons of coho abundance, condition factors and habitat characteristics with selected sites in the Mid-Bulkley watershed, and
- to provide recommendations and direction for future restoration work in this middle section of the Bulkley River watershed.

2.0 BACKGROUND INFORMATION

Very little information has been collected toward assessing the suitability, characteristcs, and locations of overwintering habitats for coho salmon in northern British Columbia. No information on winter distribution of juvenile coho was available for Toboggan Creek or the section of the Mid-Bulkley watershed that were surveyed. Some information was obtained from coho fence count data to provide a general relationship between adult coho returns and juvenile coho abundance in these two sections of the Bulkley watershed. Table 1 includes fence counts and estimates for total numbers of adult coho moving past the Upper Bulkley and Toboggan Creek counting fences in the past four years.

Toboggan Creek is known to contain excellent natural production of both steelhead *(O. mykiss)* and coho salmon. A counting fence across Toboggan Creek is located approximately five kilometers downstream from the index sample sites used in this study (Figure 1). During this study, Toboggan Creek was used to provide a comparative index of juvenile fish conditions and relative abundance in a "productive" system.

The Upper Bulkley River counting fence is located at Houston, BC. It has recent records of annual returns of coho above the Morice River confluence. Coho returns to this section of the Bulkley River have been drastically low in the past four years and are at a critical state of decline. Management of this stock of coho is presently at the stage of conservation. Many suggestions are now to assess other contributing factors to the decline of this stock aside from commercial harvest.

Table 1. Summary of fence counts of adult coho returns from 1993-1996 at the Upper Bulkley River and the Toboggan Creek fish fences (B. Finnegan, pers. comm.).

Counting Fence	Year	Fence Count	Estimate
Upper Bulkley River @ Houston			
	1993	103	
	1994	?	200
	1995	39	350
	1996	170	
Toboggan Creek			
	1993	1150	
	1994	1690	
	1995	717	
	1996	1200	

3.0 METHODS

3.1 Sampling Methodology

The Mid-Bulkley watershed was inspected on maps and in the field along public roads to locate potential overwintering habitats for coho salmon. Actual assessment sites were limited to mainly easily accessible areas due to time constraints. General water quality attributes were recorded at all sites, including water temperature (°C ± 0.1), pH, conductivity, and dissolved oxygen. Minnow traps were set at most sites for two nights (38-48 hours), with a few sites being trapped. Upstream and downstream photographs were taken at sites during different sampling periods (i.e. January, February, and March).

3.2 Index Sample Sites - Toboggan and Elliot Creeks

The mainstem of Toboggan Creek and Elliot Creek were assessed to provide useful indices for comparisons of its distribution, abundance and condition of species to samples from the Mid-Bulkley watershed. Traps were set in similar fish habitats to Mid-Bulkley sample sites. More traps were set at the index sites to better the quality of indices for comparison to multiple sample sites in the Mid-Bulkley watershed.

3.3 Sample Sites in the Mid-Bulkley Watershed

Sampling sites were selected based on suitability of winter habitat and likelihood of fish presence. In total, 15 sites were selected in areas that would provide a useful description of limits of species distribution and potential overwintering habitat. These 15 sites were not randomly distributed, with five sampling sites along the Bulkley River and 10 sites at accessable locations at the main tributaries to the Bulkley between Houston and Bulkley Lake.

Table 2. List and description of sites surveyed during winter sampling in the mid-Bulkley watershed from January to March, 1997. Site numbers are illustrated on Figure 2.

Stream	Site #	Location
Bulkley River	1	@ Upper Bulkley Fish Counting Fence
	2	@ Knockholt Bridge
	3	@ McQuarrie Creek Confluence
	4	@ Topley Bridge
	5	approximately 1000 meters downstream from Bulkley Lake
Buck Creek	6	@ first bridge on Buck Flats Forest Service Road
	7	@ second bridge up Buck Flats FSR
Unnamed Creek	8	Downstream from culvert under Buck Flats FSR, 100 meters south from Carrier FSR turnoff
"Summit" Creek	9	Downstream from Highway culvert
Aitken Creek	10	100 meters downstream from bridge crossing
Barren Creek	11	Both upstream and downstream of 1 meter culvert under the highway
McQuarrie Creek	12	Immediately downstream from open-bottom culvert under the highway
Byman Creek	13	From railroad crossing, downstream to Perow Creek Confluence
Richfield Creek	14	@ railroad crossing
Ailport Creek	15	Immediately downstream from open-bottom culvert under the highway

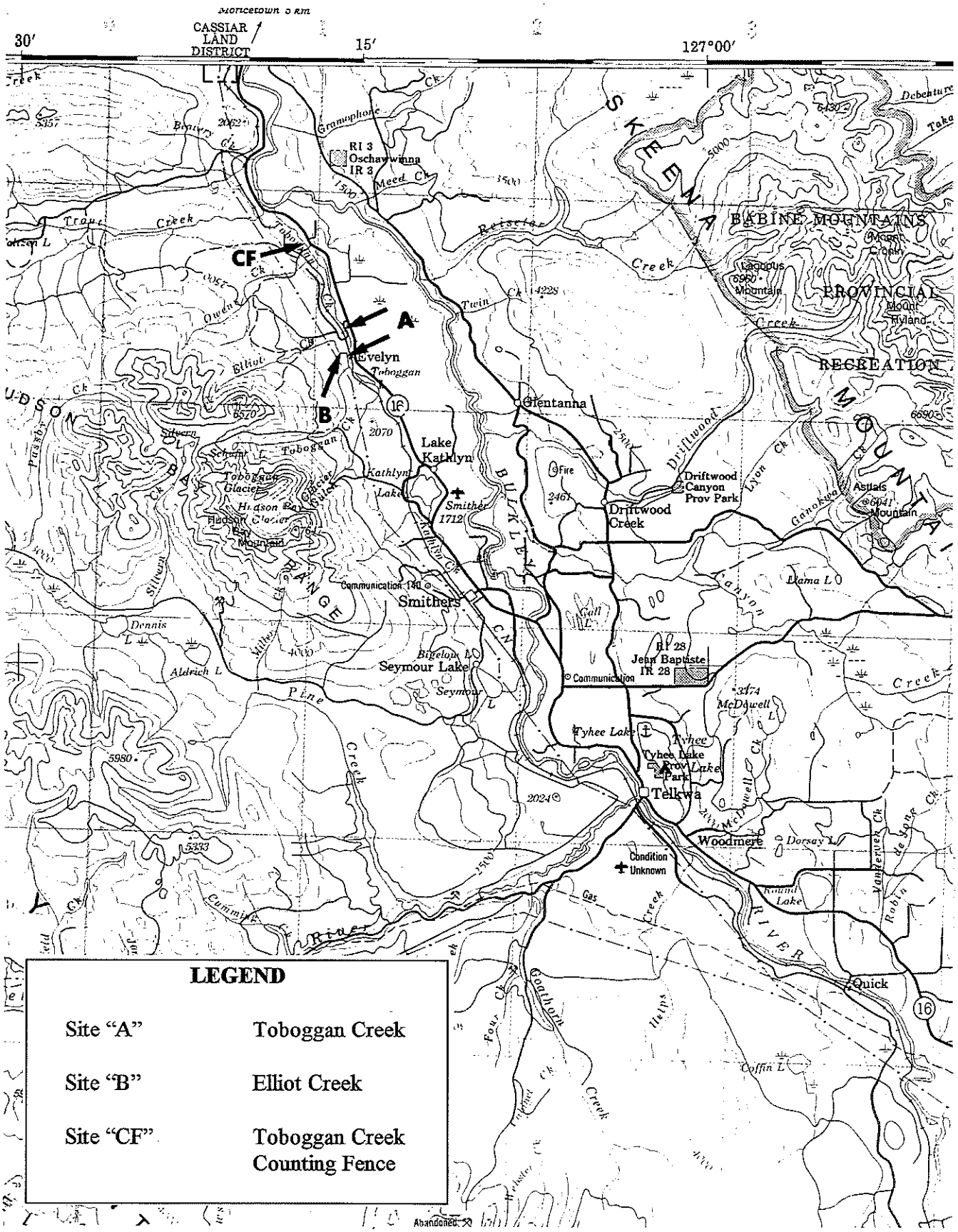

Figure 1. Location map of Toboggan Creek and Elliot Creek sample sites (1:250 000 NTS Map 93L).

3.2 Data Analyses

The analyses of fish data collected were in search for a relationship between poor abundance / condition and potential differences in habitat qualities among sites. Catch per unit effort and condition factors were the two main targets of analysis in this study. No statistical analyses of general water quality data were conducted.

Catch per unit efforts (CPUE) were calculated for comparison of relative abundance of different species at different sites sampled:

$$CPUE = \text{number of fish/trap/\# of nights the trap was set}$$

Results from this evaluation were only for rough interpretation and very general comparisons of abundance and species distribution.

Fulton's Condition Factors (K) (Ricker 1975) were also calculated for all rainbow trout and coho captured for site comparisons of relative fitness:

$$K = w/l^3 * 100\ 000$$

w = weight (grams)

l = fork length (millimeters)

For coho samples, a condition index was established from statistical analyses of data from Toboggan and Elliot creeks which are known to be part of a relatively productive system. Analysis of Variance (ANOVA) was conducted to evaluate temporal and/or spatial differences in condition. Conditions of coho samples acquired from the Mid-Bulkley watershed are compared to these indices.

An analysis of rainbow trout data was included in this assessment of coho overwintering habitat. This analysis was added to provide a general comparison of fish condition and habitat quality in the Mid-Bulkley watershed to the known productive indices from Toboggan and Elliot creeks. Rainbow trout are a useful alternative due to their higher abundance in the Mid-Bulkley watershed and their use of similar winter habitats to coho during winter rearing.

From samples of rainbow trout, several comparisons were conducted to test differences of mean conditions of samples from different locations. Two factor ANOVAs were conducted to test for differences among the sample condition factors from different sites. Because samples were not attained at all sites for all three months, a combination of comparisons were analysed:

- All sites with adequate sample sizes for January, February, and March
- All sites with adequate sample sizes for February and March
- All sites with adequate sample sizes for January
- All sites with adequate sample sizes for February
- All sites with adequate sample sizes for March

Post-hoc Tukey tests were also conducted on variables with statistical differences to determine where the differences actually occurred.

4.0 RESULTS and DISCUSSION

4.1 Site Descriptions

The following sub-sections summarize field notes for the site characteristics and comments from various locations visited in this study. Figures 1 and 2 also provide references to general locations of all sites sampled.

4.1.1 Toboggan Creek and Elliot Creek: Sites A and B

Data were collected from Toboggan Creek and Elliot Creek in order to establish indices of condition and general water quality associated with productive overwintering habitat.

Site A - Toboggan Creek near bridge @ hatchery turn-off

A 400 meter section of Toboggan Creek was assessed in January, February and March. Traps were set from approximately 50 meters downstream from the infiltration gallery to approximately 100 meters upstream of the Elliot Creek confluence. Traps were set in deep runs and pools, amongst large organic debris (LOD) and under overhanging vegetation and cutbanks. This site offered excellent salmonid overwintering habitat due to the well-established stream environment. General water quality data (Table 3) also gives a good indication of suitable characteristics for good overwintering habitat. However, a strong septic odour was noted during the February and March sampling.

Table 3. Summary of general water quality data taken at site A from Toboggan Creek.

Date Sampled	air temp. °C	water temp °C	Conductivity µS/cm	Diss. Oxygen (ppm)	pH	percent open water
January 28	-5	0.8	69.0	11.3	7.4	60
February 27	7	2.0	125.5,	11.8	6.7	95
March 26	6	2.5	129.0	10.8	8.0	100

Plate #1. Upstream views of Toboggan Creek from the infiltration gallery, taken on January 28 (above left), January 30 (above right) and March 26 (right).

Plate #2. Downstream views of Toboggan Creek from the infiltration gallery, taken on January 28 (above) and March 26 (below).

Plate #3. Upstream view (above left) and downstream view (left) of Toboggan Creek at the Elliot Creek confluence, taken on January 30. Upstream view of Toboggan Creek at the Elliot Creek confluence, taken on March 26 (above right).

Site B - Elliot Creek @ CN railroad bridge

A 150 meter section of Elliot Creek, from the Toboggan Creek confluence to approximately 50 meters upstream of the CNR crossing served as the Elliot Creek sample site. Assessment and trapping was conducted in January, February and March. The stream below the bridge remained almost entirely free of ice throughout the course of the study. Traps were set in deeper sections of runs, under overstream vegetation and amongst rootwads and LOD. This section offered some overwintering habitat for salmonids. General water quality data (Table 4) appears to present optimum characteristics for good overwintering habitat for salmonids. An underground water source was identified along the upstream side of the railroad and appeared to be the main source of warm water. Salmonid overwintering habitat was limited in Elliot Creek upstream from the railroad bridge.

Table 4. Summary of general water quality data taken at site B from Elliot Creek.

Date Sampled	air temp. °C	water temp °C	Conductivity µS/cm	Diss. Oxygen (ppm)	pH	percent open water
January 28	-5	2.0	113.0	12.3	7.6	80
February 27	7	3.0	113.0	11.4	7.3	90
March 26	6	5.0	110.3	11.3	8.2	100

Plate #4. Upstream view of Elliot Creek in January at 70 meters downstream from the railroad bridge.

Plate #5. Upstream view (above) and downstream view (below) of Elliot Creek from the railroad bridge, taken in March.

4.1.2 Bulkley River: Sites 1-5

Five sites along the Bulkley River were selected between Houston and Bulkley Lake to help assess limits of coho distribution.

Site 1 - Upper Bulkley @ Houston Fish Fence

A 500 meter section of the river was assessed in January, February, and March. This section of the river was almost entirely frozen in January, with only a few open pockets of fast flow. Minnow traps were set in February and March, when very narrow channels were opening up along the banks. Sampling sites were restricted to immediate shoreline, but in depths up to 2.0 meters. The Bulkley River at this location offers suitable water quality (Table 5) and some overwintering habitat for salmonids.

Table 5. Summary of general water quality data taken at site 1 from the Bulkley River.

Date Sampled	air temp. °C	water temp °C	Conductivity µS/cm	Diss. Oxygen (ppm)	pH	percent open water
January 22	-5	0.5	131.1	13.9	7.1	<1
February 22	5	1.0	134.8	12.4	7.8	1
March 21	6	1.0	128.0	12.6	8.1	15

Plate #6. Upstream view of the Upper Bulkley River in January, at the Houston fish fence.

Plate #7. Upstream view (above) and downstream view (below) of the Upper Bulkley River at the Houston fish fence, taken in March.

Site 2 - Upper Bulkley @ Knockholt

A 250 meter section of the Bulkley River at the Knockholt bridge was assessed in January, February, and March. Very little open water was observed while surveying during the cold snap in January and no traps were set. The river was opening up a little bit in February and traps were set under the bridge in approximately 1.5 meters of slow moving water and just upstream of the bridge in a narrow open channel. The river was almost fully open in March and traps were set in deep water amongst LOD at a log jam approximately 60 meters downstream of the bridge. General water quality data (Table 6), deep flowing water, LOD and backeddies indicate that this site would be capable of providing good overwintering habitat for salmonids.

Table 6. Summary of general water quality data taken at site 2 from the Bulkley River.

Date Sampled	air temp. °C	water temp °C	Conductivity µS/cm	Diss. Oxygen (ppm)	pH	percent open water
January 22	-4	0.5	135.2	12.3	7.4	10
February 21	1	1.0	140.7		7.8	25
March 21	2	1.0	131.4	11.6	7.4	70

Plate #8. Downstream view of the Upper Bulkley River at Knockholt, taken in January.

Plate #9. Downstream views of the Upper Bulkley River at Knockholt, taken in February (above) and March (below).

Site 3 - Upper Bulkley @ McQuarrie Creek Confluence

A 250 meter section of the Upper Bulkley was assessed in January, February and March. This site remained open throughout the study probably due to the warmer water flowing from McQuarrie Creek. A 40 meter run approximately 0.6 meters deep was trapped from the north bank. As the river opened up in February and March, traps were set further upstream to approximately 20 meters above the confluence with McQuarrie Creek. General water quality data (Table 7), the warm water influence from McQuarrie Creek, deep flowing water, cut-banks and riparian vegetation would provide good overwintering habitat for salmonids at this location.

Table 7. Summary of general water quality data taken at site 3 from the Bulkley River.

Date Sampled	air temp. °C	water temp °C	Conductivity µS/cm	Diss. Oxygen (ppm)	pH	percent open water
January 23	-12	0.5	75.5	12.4	7.5	15
February 19	3	1.0			7.8	30
March 20	4	1.0	111.2	12.6	7.6	60

Plate #10. Downstream view of the Upper Bulkley River at the McQuarrie Creek confluence, taken in January.

Plate #11. Upstream view (above) and downstream view (below) of the Upper Bulkley River at the McQuarrie Creek confluence, taken in March.

Site 4 - Upper Bulkley @ Topley

A 200 meter section of the Bulkley River approximately 300 meters downstream of the bridge on the Sunset Lake Road was assessed. This section was parallel to Severson Road. Very little open water was accessible throughout the study. Traps were set in deep, slow flowing water in cobble and gravel substrate under riparian vegetation and along the cutbank of a large turn in the river. Traps were set in water approximately 0.5 to 1.5 meters deep. General water quality data (Table 8) and deep flowing water with some large substrate and cut-banks indicate that this site would be capable of providing good overwintering habitat for salmonids.

Table 8. Summary of general water quality data taken at site 4 from the Bulkley River.

Date Sampled	air temp. °C	water temp °C	Conductivity µS/cm	Diss. Oxygen (ppm)	pH	percent open water
January 23	-13	0.5	85.1	15.6		<1
February 21	3	1.0	125.7	12.4	7.8	<1
March 21	4	1.0	112.7	11.7	7.4	<1

Plate #12. Upstream view of the Upper Bulkley River at Topley, taken in January.

Plate #13. Upstream view (above) and downstream view (below) of the Upper Bulkley River at Topley, taken in March.

Site 5 - Upper Bulkley near Forestdale

A 300 meter section of the Bulkley River approximately 700 meters downstream of the Forestdale Bridge was assessed in January, February and March. A stretch of river comprised of a series of pools, runs and riffles remained consistently ice-free for the duration of the study. Traps were set in deep slow flowing water, under cutbanks and amongst LOD. General water quality data (Table 9), slow deep runs and abundant cover indicate that site contains excellent overwintering habitat for salmonids.

Table 9. Summary of general water quality data taken at site 5 from the Bulkley River.

Date Sampled	air temp. °C	water temp °C	Conductivity µS/cm	Diss. Oxygen (ppm)	pH	percent open water
January 22	-3	1.5	86.0	10.6	7.8	85
February 19	2	1.5	88.5	11.6	7.9	80
March 19	7	2.5	84.1	11.9	7.4	95

Plate #14. Downstream view of the Upper Bulkley River at Forestdale, taken in January.

Plate #15. Downstream view (above) and upstream view (below) of the Upper Bulkley River at Forestdale, taken in March.

4.1.3 Buck Creek and one upper tributary

Site 6 and 7 - Buck Creek @ Buck Bridge #1 and Buck Bridge #2

200 meter sections of Buck Creek at Buck Bridge #1 and Buck Bridge #2 were assessed in February and March. These sites had moderate amounts of open water in areas of faster flow. Traps were set under cut-banks, amongst LOD and in the deeper, slower runs. The Buck Bridge #1 site had more complex habitat with deep runs and pools combined with considerable amounts of LOD. General water quality data (Table 10) and the complex habitat at the Buck Bridge #1 site indicate that this site had excellent overwintering habitat for juvenile salmonids. The Buck Bridge #2 site offers good overwintering habitat.

Table 10. Summary of general water quality data taken at sites 6 and 7 from Buck Creek.

Date Sampled	air temp. °C	water temp °C	Conductivity µS/cm	Diss. Oxygen (ppm)	pH	percent open water
February 22	2	1.0	123.4	13.0	7.8	20
March 21	-2	1.0	115.9	12.2	7.5	40

Plate #16. Upstream view of Buck Creek from the Buck Bridge #1, taken in February.

Plate #17. Upstream view (above) and downstream view (below) of Buck Creek from the Buck Bridge #1, taken in March.

Plate #18. Upstream view of Buck Creek, taken in February (above left). Upstream view (above right) and downstream view (right) of Buck Creek, taken in March. All photos were taken from the Buck Bridge #2.

Site 8 - Unnamed Tributary to Buck Creek

A 50 meter section of an unnamed tributary to Buck Creek was surveyed in February and March. This stream is located approximately 200 meters south of the Carrier Forest Service Road and drains a large wetland complex. Minnow traps were set in the pool below a group of three culverts under the Buck Flats Road. The pool was 70% ice-free in February but had a covering of ice approximately 3 centimeters thick in March. The pool offered excellent overwintering habitat for salmonids due to its depth and the amount of cover available under cutbanks and amongst the boulder substrate. The stream downstream of the pool had large amounts of overstream vegetation and contained areas of faster flow which were also ice-free. General water quality data (Table 11) supports the suitability of this location for good salmonid overwintering habitat.

Table 11. Summary of general water quality data taken at site 8 from an unnamed tributary to Buck Creek.

Date Sampled	air temp. °C	water temp °C	Conductivity µS/cm	Diss. Oxygen (ppm)	pH	percent open water
February 22	2	1.0	132.0	13.8	7.8	20
March 21	-2	0.8	121.7	13.5	7.6	20

Plate #19. Upstream view of an unnamed tributary to Buck Creek located 200 meters south of the Carrier Forest Service Road, taken in February.

Plate #20. Downstream views of an unnamed tributary to Buck Creek located 200 meters south of the Carrier Forest Service Road, taken in February (above) and March (below).

4.1.4 Summit Lake Outlet Creek

Site 9 - unnamed creek @ Highway 16 crossing

A 150 meter section of the stream was assessed in March. This stream was covered with snow and ice in January and February. A section downstream of the road crossing was ice-free and was trapped to determine presence of juvenile salmonids. No fish were caught. The stream upstream of the road crossing was not yet free of ice and snow. The stream offered cover in the form of abundant riparian vegetation and a 60 centimeter deep pool at the downstream end of the culvert. The substrate was predominantly composed of gravel and fines. General water quality data (Table 12) indicates suitable conditions in March, but minimal discharge and relatively shallow depth indicate that overwintering habitat for salmonids may be very limited in the section surveyed.

Table 12. Summary of general water quality data taken at site 9 from the outlet stream from Summit Lake.

Date Sampled	air temp. °C	water temp °C	Conductivity µS/cm	Diss. Oxygen (ppm)	pH	percent open water
March 21	6	1.5	134.9	13.0	8.4	20

Plate #21. Downstream view of the unnamed outlet stream from Summit Lake, taken from the Highway 16 road crossing in March.

4.1.5 Aitken Creek

Site 10 - Aitken Creek @ 150 meters downstream of road crossing

A 100 meter section of Aitken Creek was assessed in February and March. Traps were set in deeper runs, under ice shelves and in pools up to 60 centimeters deep. The steeper gradient of this stretch likely keeps it free of ice. An approximately 10 meter high waterfall approximately one kilometer downstream of the site was identified in March as a definite barrier to fish migration (*see* Figure 2). This stretch offers some good overwintering habitat and potential spawning habitat for fish in the lakes upstream or stream residents. Sufficient discharge and suitable general water quality (Table 13) indicate that good overwintering habitat for salmonids exists from this stream's confluence with the Bulkley River, upstream to the falls.

Table 13. Summary of general water quality data taken at site 10 from Aitken Creek.

Date Sampled	air temp. °C	water temp °C	Conductivity µS/cm	Diss. Oxygen (ppm)	pH	percent open water
February 22	8	1.0	185.8	12.7	7.6	25
March 21	-2	1.0	161.8	12.9	7.3	30

Plate #22. Upstream view of Aitken Creek, taken in February.

Plate #23. Upstream view (above) and downstream view (below) of Aitken Creek, taken in March.

4.1.6 Barren Creek

Site 11 - Barren Creek @ Highway 16 road crossing

A 200 meter section of Barren Creek was assessed in February and March. Work had been done by heavy machinery around the culverts at this site shortly prior to sampling (between January and February sampling times). A filter-fabric barrier had been installed at the downstream end of the work area. Work had been done to approximately 20 meters above and 15 meters below the culvert. Traps were set in the two large pools both upstream and downstream of the culvert and in faster moving water downstream from the filter fabric. The deep pools (up to 1.5 meters deep) with slow flow offered excellent overwintering habitat for salmonids. The shallow nature of the riffle area downstream and the lack of instream cover would provide limited overwintering habitat. General water quality data (Table 14) at this site were optimal for overwintering fish at the times surveyed.

Table 14. Summary of general water quality data taken at site 11 from Barren Creek.

Date Sampled	air temp. °C	water temp °C	Conductivity µS/cm	Diss. Oxygen (ppm)	pH	percent open water
February 21	3	1.5	133.1	13.5	8.0	20
March 21	8	1.0	128.7	13.6	7.6	40

Plate #24. Upstream view of Barren Creek, taken from Highway 16 in February.

Plate #25. Upstream view (above) and downstream view (below) of Barren Creek, taken from the filter fabric barrier in February.

4.1.7 McQuarrie Creek

Site 12 - McQuarrie Creek @ Highway 16 road crossing

A 200 meter section of McQuarrie Creek was assessed in January, February and March. The 100 meters upstream of the Highway 16 crossing consisted of a high gradient, shallow reach that remained relatively ice-free during the study. Trapping was not conducted in the upstream section. The 100 meters immediately downstream from the culvert consisted of a large pool approximately 1.3 meters deep and a riffle area at the tail-out of the pool. Traps were set in the mouth of the culvert and throughout the pool. Due to ice cover in March, several traps were set in the tail-out area. This area offered excellent overwintering habitat for salmonids. General water quality data (Table 15) indicated good conditions for overwintering fish at this location.

Table 15. Summary of general water quality data taken at site 12 from McQuarrie Creek.

Date Sampled	air temp. °C	water temp °C	Conductivity µS/cm	Diss. Oxygen (ppm)	pH	percent open water
January 23	-4	0.5	105.4	17.4	7.7	55
February 19	4	1.0	107.2	15.8	8.1	35
March 20	4	1.0	99.7	13.2	7.9	30

Plate #26. Downstream view of McQuarrie Creek, taken from Highway 16 in January.

Plate #27. Upstream view (above) and downstream view (below) of McQuarrie Creek, taken from Highway 16 in March.

4.1.8 Byman Creek

Site 13 - Byman Creek @ CN railroad crossing

A 250 meter section of Byman Creek was assessed in January, February and March. This section contained some rip-rap and confined areas immediately upstream and downstream of the railroad bridge. The stabilized banks consisted of large cobble and boulder substrate which, combined with the deeper water, offered good refuge areas for fish. The section downstream of the railroad bridge was shallower, consisting mainly of riffles with occasional cutbanks and deeper sections around rootwads. General water quality data (Table 16) and the variety of different habitats make this site excellent for overwintering juvenile salmonids.

Table 16. Summary of general water quality data taken at site 13 from McQuarrie Creek.

Date Sampled	air temp. °C	water temp °C	Conductivity µS/cm	Diss. Oxygen (ppm)	pH	percent open water
January 23	-13	0.5	106.4	12.5	7.8	30
February 19	3.5	1.0	117.8	15.6	7.8	80
March 20	3	1.0	105.4	13.3	7.6	20

Plate #28. View of the typical substrate found downstream of the railroad bridge at Byman Creek.

Plate #29. Downstream views of Byman Creek, taken in January (above left), February (above right) and March (right).

4.1.9 Richfield Creek

Site 14 - Richfield Creek @ CN railroad crossing

A 75 meter section of Richfield Creek was briefly assessed in February and then in more detail in March. Limited open water was available in March, but the ice had thinned enough to break through and set traps. This section seemed to consist of a fairly shallow (<40 cm.) riffle/ run complex. The substrate downstream from the railroad right-of-way was mainly cobble and boulder with some gravel. Some LOD and overstream vegetation was also present at this site. This site appeared to offer some overwintering habitat for juvenile salmonids. General water quality data (Table 17) indicated good conditions at the time surveyed. Fish presence (rainbow trout) in March also supports that some overwintering habitat is available in the lower reaches of this stream.

Table 17. Summary of general water quality data taken at site 14 from Richfield Creek.

Date Sampled	air temp. °C	water temp °C	Conductivity µS/cm	Diss. Oxygen (ppm)	pH	percent open water
March 21	4	1.0	102.4	13.3	7.4	0

4.1.10 Ailport Creek

Site 15 - Ailport Creek @ Highway 16 road crossing

A 75 meter section of Ailport Creek was assessed in February and March. This site was located immediately downstream from the culvert under Highway 16. Traps were set in the 1.5 meter deep pool below the culvert. A further section of the stream approximately 40 meters downstream from the culvert was trapped in March. This section exhibited deep channels and abundant LOD and overstream vegetation. These areas offer excellent overwintering habitat and some spawning habitat for salmonids. General water quality data (Table 18) indicates the suitability of this site as good salmonid overwintering habitat.

Table 18. Summary of general water quality data taken at site 15 from Ailport Creek.

Date Sampled	air temp. °C	water temp °C	Conductivity µS/cm	Diss. Oxygen (ppm)	pH	percent open water
February 22	9	1.0	140.6	12.0	7.9	5
March 19	8	1.0	140.2	12.5	7.4	15

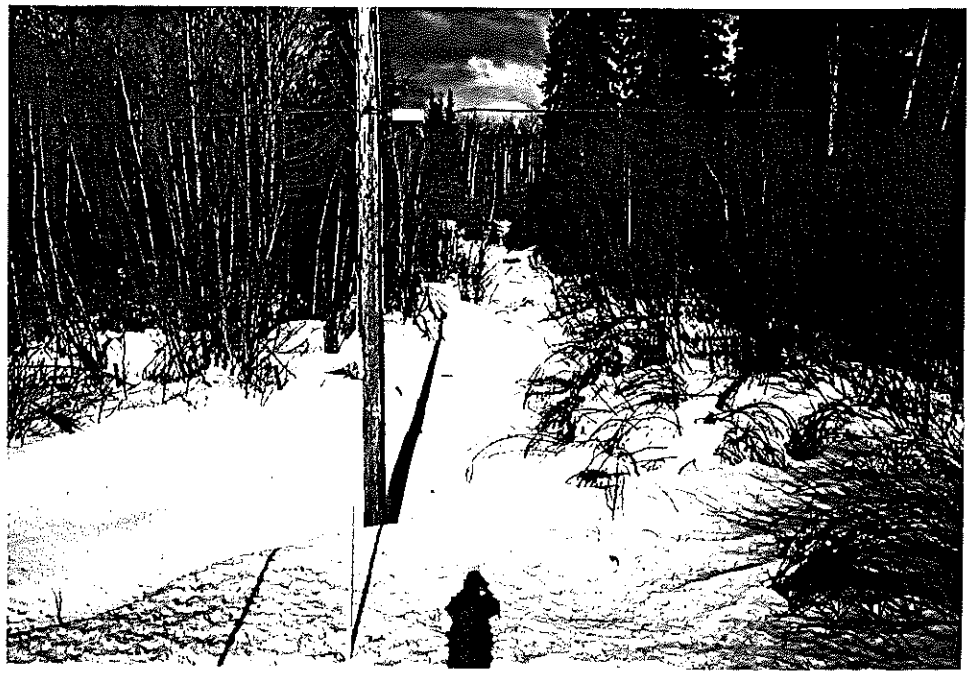

Plate #30. Downstream view of Ailport Creek, taken in February (above left). Downstream view (above right) and upstream view (right) taken in March.

4.2 Summary of Sampling Effort and Catch Data

In total, 17 sites were sampled by overnight minnow trapping. Trapping efforts and months when various sites were sampled are summarized in table 19. In general, sampling duration for each trap setting was two nights, however, some traps were only left to soak for one night. The trapping effort (CPUE) calculated for each site and month of sampling (Table 19) gives a clearer indication of sampling intensity, as it incorporates the number of traps set, and the duration of trapping.

Seven of the 17 sites sampled were sampled in all three months of the project. The remaining 10 sites were not sampled in January due to heavy ice coverand poor accessable habitats, and partly due to additional sites being selected as the project proceeded. Of these remaining 10 sites, all but two ("Summit" Creek and Richfield Creek) were sampled for fish presence in February and March. "Summit" and Richfield creeks were late additions to the list of sites and were only sampled in March due to late openings in the ice during the period of warmer weather in March.

Table 19. Summary of minnow trap sampling effort at the 17 sites sampled (*see* Figures 1 and 2) from January to March, 1997 (Note: Toboggan Creek and Elliot Creek had higher sampling effort to provide data for a useful index).

Location	JANUARY			FEBRUARY			MARCH		
	# of traps (T)	# of nights set (N)	trap effort (N*T)	# of traps (T)	# of nights set (N)	trap effort (N*T)	# of traps (T)	# of nights set (N)	trap effort (N*T)
Toboggan Ck									
Site A	10	2	**20**	25	2	**50**	25	2	**50**
Elliot Creek									
Site B	3	2	**6**	5	2	**10**	5	2	**10**
Bulkley River									
Site 1				6	2	**12**	10	1	**10**
Site 2				5	2	**10**	5	2	**10**
Site 3	1	2	**2**	5	2	**10**	10	3	**30**
Site 4	10	2	**20**	5	2	**10**	5	2	**10**
Site 5	7	2	**14**	10	2	**20**	10	2	**20**
Buck Creek									
Site 6				5	2	**10**	5	2	**10**
Site 7				5	2	**10**	5	2	**10**
Buck Ck Trib.									
Site 8				5	2	**10**	5	2	**10**
"Summit" Ck									
Site 9							5	1	**5**
Aitken Creek									
Site 10				5	1	**5**	5	2	**10**
Barren Creek									
Site 11				5	4	**20**	5	2	**10**
McQuarrie Ck									
Site 12	4	2	**8**	10	2	**20**	5	3	**15**
Byman Creek									
Site 13	5	2	**10**	10	2	**20**	10	3	**30**
Richfield Creek									
Site 14							5	2	**10**
Ailport Creek									
Site 15				4	2	**8**	5	2	**10**

4.2.1 Coho/Chinook

Table 20 summarizes catch data from this study and provides catch per unit effort values (CPUE) to allow general comparisons of relative abundance. Although this data is not usable for statistical comparisons, it does appear that ratios of overwintering juveniles caught at Toboggan Creek and the lower sites in the Upper Bulkley closely match the ratios of adults counted at the Toboggan and Upper Bulkley fences (*see* Table 1). This gives some general indication that productivity and winter survival may not be critical factors related to the large differences in abundance of coho in these two systems. CPUEs for chinook salmon appear very similar between Toboggan Creek and the lower section of the Mid-Bulkley River watershed.

Table 20. Summary of total catches and catch/trap/night (CPUE) of juvenile coho (CO) and chinook (CH) salmon at the 17 sites surveyed (*see* Figures 1 & 2).

	JANUARY			FEBRUARY			MARCH		
Location	Trap Effort*	Catch	CPUE	Trap Effort*	Catch	CPUE	Trap Effort*	Catch	CPUE
Toboggan Ck									
Site A	20	**15 CO**	**0.75**	50	**109 CO**	**2.18**	50	**50 CO**	**1.000**
					3 CH	**0.06**		**4 CH**	**0.080**
Elliot Creek									
Site B	6	**3 CO**	**0.50**	10	**36 CO**	**3.60**	10	**6**	**0.600**
Bulkley River									
Site 1				12	**0**	**0.00**	10	**0**	**0.00**
Site 2				10	**1 CO**	**0.10**	10	**0**	**0.00**
					4 CH	**0.40**			
Site 3	2	**1 CO**	**0.50**	10	**0 CO**	**0.00**	30	**3 CO**	**0.10**
					2 CH	**0.20**		**0 CH**	**0.00**
Site 4	10	**0**	**0.00**	10	**0**	**0.00**	10	**0**	**0.00**
Site 5	7	**0**	**0.00**	20	**0**	**0.00**	20	**0**	**0.00**
Buck Creek									
Site 6				10	**0**	**0.00**	10	**0**	**0.00**
Site 7				10	**0**	**0.00**	10	**0**	**0.00**
Buck Ck Trib.									
Site 8				10	**0**	**0.00**	5	**0**	**0.00**
"Summit" Creek									
Site 9							10	**0**	**0.00**
Aitken Creek									
Site 10				5	**0**	**0.00**	10	**0**	**0.00**
Barren Creek									
Site 11				20	**1 CO**	**0.05**	15	**0**	**0.00**
					2 CH	**0.10**			
McQuarrie Ck									
Site 12	8	**0**	**0.00**	20	**1 CO**	**0.05**	30	**0**	**0.00**
Byman Creek									
Site 13	10	**0**	**0.00**	20	**2 CH**	**0.10**	10	**0**	**0.00**
Richfield Creek									
Site 14							10	**0**	**0.00**
Ailport Creek									
Site 15				8	**0**	**0.00**			

* for description of trapping effort, see Table 19

4.2.2 Rainbow Trout/Steelhead/Cutthroat Trout

Rainbow trout data and catch per unit effort (CPUE) were summarized in this study (Table 21) to further investigate the potential for habitat limitations on fish production in the Upper Bulkley River. In fact, the CPUE's of rainbow trout in the Mid-Bulkley indicate that densities of juvenile rainbow trout/steelhead are relatively similar to densities at Toboggan Creek which is known to maintain a high production of steelhead. This implies that the overwintering habitat for rainbow trout in the Mid-Bulkley is presently providing similar production to the conditons in Toboggan Creek. Coho may rely on slightly different sub-habitats and may be affected differently by levels of interspecies competition, but this information still supports that low coho numbers in the upper Bulkley River is not predominantly caused by a lack of suitable overwintering habitat.

Table 21. Summary of total catches and catch/trap/night (CPUE) of rainbow trout/steelhead (RB), and cutthroat trout (CT) at the 17 sites surveyed (*see* Figures 1 & 2).

	JANUARY			FEBRUARY			MARCH		
Location	Trapping Effort*	Catch	CPUE	Trapping Effort*	Catch	CPUE	Trapping Effort*	Catch	CPUE
Toboggan Ck Site A	20	**21 RB**	**1.02**	50	**28 RB** **1 CT**	**0.56** **0.02**	50	**11 RB**	**0.22**
Elliot Creek Site B	6	**3 RB**	**0.50**	10	**8 RB**	**0.80**	10	**5 RB** **2 CT**	**0.50** **0.20**
Bulkley River									
Site 1				12	**1 RB**	**0.13**	10	**9 RB**	**0.90**
Site 2				10	**7 RB**	**0.70**	10	**4RB**	**0.40**
Site 3	2	**12 RB**	**6.00**	10	**12 RB**	**1.20**	30	**9RB**	**0.30**
Site 4	10	**2 RB**	**0.20**	10	**0**	**0.00**	10	**0**	**0.00**
Site 5	7	**2 RB**	**0.28**	20	**0**	**0.00**	20	**1 RB**	**0.05**
Buck Creek									
Site 6				10	**5 RB**	**0.50**	10	**1 RB**	**0.10**
Site 7				10	**9 RB**	**0.90**	10	**0**	**0.00**
Buck Ck Trib. Site 8				10	**3 RB**	**0.30**	10	**1 RB**	**0.10**
"Summit" Creek Site 9							10	**0**	**0.00**
Aitken Creek Site 10				5	**1 RB**	**0.20**	10	**0**	**0.00**
Barren Creek Site 11				20	**27 RB**	**1.35**	15	**3 RB**	**0.20**
McQuarrie Ck Site 12	8	**13 RB**	**1.83**	20	**23 RB**	**1.15**	30	**8 RB**	**0.27**
Byman Creek Site 13	10	**9 RB**	**0.90**	20	**34 RB**	**1.70**	10	**8 RB**	**0.80**
Richfield Creek Site 14							10	**7 RB**	**0.70**
Ailport Creek Site 15				8	**36 RB**	**4.50**	10	**18 RB**	**1.80**

* for description of trapping effort, see Table 19

4.2.3 Other Fish Species

Two other species from the Family Salmonidae were captured during samlping in Toboggan Creek: Dolly Varden char (*Salvelinus malma*) and mountain whitefish (*Prosopium williamsoni*). Neither of these two species were captured during this winter sampling in the Mid-Bulkley watershed.

Three non salmonid species were captured in the mainstem of the Bulkley River: longnose dace (*Rhinichthys cataractae*), redside shiner (*Richardsonius balteatus*), and largescale sucker (*Catostomus macrocheilus*).

Table 22. Summary of total catches and catch/trap/night (CPUE) of Dolly Varden char (DV), rocky mountain whitefish (MW), large scale sucker (CSU), longnose dace (LNC), and redside shiner (RSC) at the 17 sites surveyed (*see* Figures 1 & 2).

	JANUARY			FEBRUARY			MARCH		
Location	Trapping Effort*	Catch	CPUE	Trapping Effort*	Catch	CPUE	Trapping Effort*	Catch	CPUE
Toboggan Ck Site A	20	**6 DV**	**0.30**	50	**29 DV**	**0.58**	50	**10 DV** **1 MW**	**0.40** **0.04**
Elliot Creek Site B	6	**9 DV**	**1.35**	10	**9 DV**	**0.90**	10	**8 DV**	**0.80**
Bulkley River									
Site 1				12			10		
Site 2				10			10		
Site 3	1			10			30		
Site 4	10	**2 LNC** **1 RSC**	**0.20** **0.10**	10	**2 LNC**	**0.10**	10	**1CSU**	**0.10**
Site 5	7			20			20		
Buck Creek									
Site 6				10			10		
Site 7				10			10		
Buck Ck Trib. Site 8				10			5		
"Summit" Creek Site 9							10		
Aitken Creek Site 10				5			10		
Barren Creek Site 11				20			15		
McQuarrie Ck Site 12	8			20			30		
Byman Creek Site 13	10			20			10		
Richfield Creek Site 14							10		
Ailport Creek Site 15				8					

* for description of trapping effort, see Table 19

4.3 Species Distribution during Winter 1996/97

4.3.1 Coho Distribution

Small numbers of fall spawning salmonids appear to be migrating as far up the Bulkley River as somewhere between Byman Creek and Topley. Juvenile coho were caught as far upstream as McQuarrie Creek and in the Bulkley River, just upstream from McQuarrie Creek. A series of beaver dams and the relatively steep cascade on the Bulkley River just upstream from the Richfield Creek confluence appear to have been the limiting factors for upstream migration over the recent past.

Buck Creek and Aitken Creek are the two main tributaries that appear to contain the most usable overwintering habitat in this section of the watershed. Overwintering habitats for anadromous species are partially limited at both of these larger tributaries by waterfall barriers (*see* Figure 2). The majority of overwintering habitat in the smaller Bulkley tributaries, along this section of the Bulkley River, appears to be limited to short distances less than one or two kilometers upstream from the mainstem..

Shallow side channels less than two or three meters deep are not likely usable overwintering habitats due to oxygen depletion. A few spring fed channels along the highway remained open for most of the study time, but access appeared limited and/or habitats were not suitable.

4.3.2 Chinook Distribution

It appears that juvenile chinook and coho in this section of the Bulkley River overwinter in the same general areas of the system. The distribution limits for chinook and coho salmon during winter 1996/1997 appeared to be very similar, although juvenile chinook were captured a little farther upstream at Byman Creek in February. Areas for potential chinook overwintering habitats are very similar to coho salmon and are described in section 4.3.1.

4.3.3 Rainbow Trout/Steelhead

Juvenile steelhead and rainbow trout (*Oncorhynchus mykiss*) are impossible to distinguish, but general abundances in this study appear to indicate the limits of steelhead migration due to the limited use of the upper section of the Bulkley mainstem by resident rainbow trout.

Excellent overwintering habitat for *O. mykiss* was identified throughout the mainstem and tributaries along the Bulkley River from Houston to Bulkley Lake. However, sampling indicates that very few steelhead are able to migrate past the cascade upstream of the Ailport confluence to the Bulkley. Small densities of *O. mykiss* were estimated in the Bulkley River near Forestdale, despite relatively intense trapping and the presence of excellent overwintering

and summer habitats. This implies that the cascade has been a limiting factor to spring migration in this upper section of the Bulkley River. Relatively good abundance of *O. mykiss* and verbal reports of sightings in Ailport Creek imply that steelhead might be making it slightly further upstream during spring migration than fall spawners (i.e. coho and chinook).

4.3.4 Dolly Varden Char Distribution

No juvenile Dolly Varden char were caught anywhere in the Mid Bulkley watershed. However, the absence or extremely low abundance of Dolly Varden char in this section of Bulkley watershed does not appear to be related to overwintering habitat.

4.4 Analysis of Fulton's Condition Factors

Weight (w) to fork length (l) relationships were used to test for differences in physical condition of coho and rainbow trout. Mean Fulton's Condition Factors (K) were calculated for samples taken at all sites and sampling times independently. Samples from the Toboggan/Elliot index site were analysed for differences and results were used as standards for comparisons to the Mid-Bulkley sample sites. Table 23 summarizes the index conditions of fish from the Toboggan/Elliot sampling sites.

Table 23. Summary of Fulton's Condition Factors for samples of coho and rainbow trout taken from Toboggan/Elliot index sites.

Location	Species	Month	Sample Size	Fulton's Condition Factor for sample	Standard Deviation
Toboggan Creek					
Site A	CO	January	15	1.050	0.100
		February	109	0.992	0.128
		March	50	1.010	0.093
	RB	January	21	1.001	0.092
		February	28	1.021	0.099
		March	11	1.121	0.168
	DV	January	6	0.907	0.120
		February	29	0.901	0.084
		March	10	0.958	0.107
Elliot Creek					
Site B	CO	January	3	1.112	0.209
		February	36	0.976	0.148
		March	6	0.968	0.065
	RB	January	3	1.038	0.127
		February	8	1.043	0.129
		March	5	1.121	0.168
	DV	January	9	0.998	0.075
		February	9	0.945	0.194
		March	8	1.058	0.320

4.4.1 Comparisons of Coho Condition

4.4.1.1 The Toboggan Creek/Elliot Creek Index

Some notable skewness to the distribution of condition factors for coho salmon were noted, and variance appeared variable between sites or sample month. Although analysis of variance (ANOVA) is robust to unequal variance with relatively equal sample sizes (Zar 1984), sample sizes between months and sites were considerably different. To alleviate potential problems

with violations of assumptions in parametric ANOVA, a two factor ANOVA of ranked data (Conover and Iman, 1981) and a multi-sample Tukey test of ranked data (Zar 1984) were conducted to determine differences of condition among sampling times and sites at Toboggan and Elliot creeks. A significant decline of condition was noted from January to February but condition appeared to stabilize between February and March sampling times. No significant differences of condition between Toboggan Creek and Elliot Creek were present, so data from Site A and Site B were pooled. Due to some notable change of condition over sampling times, condition indices for each sampling month were generated:

- January 1.0607
- February 0.9877
- March 1.0052

These Fulton's Condition Factors are calculated to provide indices that represent the expected condition of juvenile coho salmon in "good" overwintering habitat during January, February, and March 1997. These indices are used in the following sections to give some suggestions of the relative condition of coho salmon at various sites in the Mid-Bulkley watershed.

4.4.1.2 Condition of Coho in the Mid-Bulkley Watershed

Very few coho salmon were collected from sample sites surveyed in the Mid-Bulkley watershed due to the very low abundance of coho salmon in these upper limits of coho distribution. Coho were caught in only four of the 15 sites sampled: Bulkley River @ Knockholt, Barren Creek, Bulkley River @ McQuarrie Creek confluence, and McQuarrie Creek. Condition factors of individual fish captured are summarized in Table 24. The small sample sizes of coho from the Mid-Bulkley sites made it not possible to statistically compare samples to the indices. In a general comparison of condition factors, no obvious difference in coho conditions from the Toboggan/Elliot indices were noted.

Table 24. Summary of Fulton's Condition Factors for coho sampled from various sites in the Mid-Bulkley Wateshed. Indices for good condition representing expected population conditions are included for general interpretation of relative condition of fish sampled.

Location	Species	Fulton's Condition Factor	Month	INDEX for "Good" Condition
Bulkley River				
Site 2	CO	1.0177	February	0.9877
Site 3	CO	0.8630	January	1.0607
	CO	0.9788	March	1.0052
	CO	1.0023	March	1.0052
	CO	1.0667	March	1.0052
Barren Creek				
Site 11	CO	1.1678	February	0.9877
McQuarrie Creek				
Site 12	CO	1.0076	February	0.9877

4.4.2 Comparsions of Rainbow Trout Condition

Reasonable sized samples of rainbow trout were attained from almost all sites where rainbow trout were captured. At sites where data for less than three rainbow trout were obtained, non-statistical comparisons to the Toboggan/Elliot indices were made. Detailed analysis of sites with sufficient data was conducted to compare sample condition factors. Due to skewness of distribution of condition factors in most samples, two factor ANOVA's on ranked data (Conover & Iman 1981) were conducted to test for differences among the sample condition factors from different sites and at different sample dates. Tukey tests on ranked data (Zar 1984) were also conducted for variables with statistical differences to determine where the differences actually occurred. Possible factors in determining temporal and spatial differences in condition are hypothesized in the following sections.

4.4.2.1 The Toboggan/Elliot Creek Index

Fulton's conditon factors for rainbow trout/steelhead in productive habitats during winter months were compared using two factor ANOVA on ranked data. Statistical results indicated no significant differences of condition (α=0.05) among sites or times sampled. However, samples from both Toboggan and Elliot creeks showed similar tendencies of slightly increased condition from January to February and even more notable increase from February to March. Due to the only moderate sample sizes that were analysed, and the visual interpretation of data, indices for condition factors for rainbow trout were evaluated by month with pooled data from Toboggan and Elliot creeks:

- January 1.013
- February 1.026
- March 1.081

These indices are assumed to be condition factors for good condition fish and are provided for a general interpretation of the relative condition of individual fish at sites in the Mid-Bulkley watershed where very small sample sizes were obtained.

4.4.2.2 Condition of O. mykiss in the Mid-Bulkley Watershed

Non-Statistical Interpretations

Seven samples had two or fewer rainbow trout/steelhead. No statsitical comparisons of this data seemed suitable, so data on conditon is simply summarized (Table 25) with its relation to the indices for good condition. No real conclusions can be drawn from this data, but conditions of the rainbow trout captured at Buck Creek and Aitken Creek appeared to be relatively low.

Table 25. Summary of Fulton's Condition Factors for rainbow trout that were captured in very small numbers at various sites in the Mid-Bulkley Watershed. Indices for good condition representing expected population conditions are included for general interpretation of relative condition of fish sampled.

Location	Species	Fulton's Condition Factor	Month	INDEX for Good Condition
Bulkley River				
Site 1	RB	1.020	February	1.026
Site 4	RB	1.008	January	1.013
	RB	0.977	January	1.013
Site 5	RB	0.920	January	1.013
	RB	1.064	January	1.013
	RB	0.963	March	1.018
Buck Creek				
Site 6	RB	0.797	March	1.081
Buck Ck tributary				
Site 8	RB	1.226	March	1.081
Aitken Creek				
Site 10	RB	0.771	February	1.026

Statistical Comparisons between Sites and Sampling Dates

Condition factors for all samples of rainbow trout obtained are summarized in table 26. A series of ANOVAs are conducted to compare condition factors from various sites in the Mid-Bulkley watershed to the Toboggan/Elliot index samples.

Sites with January, February, and March Data

A two factor ANOVA on ranked data was conducted to test for differences among mean condition factors for January, February, March samples of rainbow trout from:

- Toboggan Creek,
- Elliot Creek,
- **Bulkley River @ McQuarrie Creek,**
- **McQuarrie Creek**, and
- **Byman Creek**.

In this comparison, both Elliot Creek and Toboggan Creek data are included as indices for good condition. No significant differences among any sites ($p=0.201$), months ($p=0.270$), or site*months ($p=0.392$) were identified. These results imply that fish in McQuarrie Creek, Richfield Creek and the Bulkley River @ McQuarrie Creek have good condition.

Table 26. Summary of Fulton's Condition Factors (K) for rainbow trout samples from the 17 sites surveyed (*see* Figures 1 & 2).

Location	JANUARY			FEBRUARY			MARCH		
	sample size	range in FL (mm)	Condition Factor (K0	Sample Size	range in FL (mm)	Condition Factor (K)	Sample Size	range in FL (mm)	Condition Factor (K)
Toboggan Ck Site A	21	47-126	**1.000**	28	44-124	**1.010**	11	46-107	**1.110**
Elliot Creek Site B	3	82-96	**1.038**	8	52-111	**1.043**	5	51-98	**0.992**
Bulkley River Site 1				1	107	**1.020**	9	51-103	**1.132**
Site 2				7	80-145	**1.051**	4	86-108	**1.054**
Site 3	12	48-133	**0.958**	12	43-104	**1.001**	9	46-121	**1.031**
Site 4	2	121,122	**0.992**	0			0		
Site 5	2	63,67	**0.992**	0			1	47	**0.963**
Buck Creek Site 6				5	58-107	**1.061**	1	56	**0.797**
Site 7				4	94-124	**0.978**	0		
Buck Ck Trib. Site 8				3	94-112	**1.084**	1	99	**1.226**
"Summit" Ck Site 9							0		
Aitken Creek Site 10				1	81	**0.772**	0		
Barren Creek Site 11				27	44-94	**1.083**	3	48-107	**0.975**
McQuarrie Ck Site 12	13	42-126	**0.966**	23	44-107	**1.029**	8	81-108	**1.101**
Byman Creek Site 13	9	82-111	**0.973**	34	44-125	**1.034**	8	53-117	**1.105**
Richfield Creek Site 14							7	82-109	**0.935**
Ailport Creek Site 15				40	68-132	**1.0346**	18	47-124	**1.003**

* for description of trapping effort, see Table 19

Sites with February and March Data

A two factor ANOVA on ranked data was conducted to test for differences among mean condition factors for February and March samples of rainbow trout from:

- Toboggan Creek,
- Elliot Creek,
- Bulkley River @ McQuarrie Creek,
- McQuarrie Creek,
- Byman Creek,
- **Bulkley River @ Knockholt,**
- **Ailport Creek, and**
- **Barren Creek**

In this comparison,Toboggan Creek, Elliot Creek, Bulkley River @ McQuarrie Creek, McQuarrie Creek, and Byman Creek data are included as indices for good condition. No significant differences among any sites ($p=0.201$) or months ($p=0.270$) implies that the sample from all sites have good condition. However, a statistically significant interaction of month and site was found in the ANOVA ($p=0.016$). Post-hoc testing using a Tukey test on ranked data indicates that the March sample of rainbow trout ($N=3$) at Barren Creek had significantly lower condition than its February sample and the March sample at McQuarrie Creek ($p<0.05$). This may be related to un-natural disturbance at the Barren Creek in February.

Sites with January Data

An ANOVA on ranked data was conducted to test for differences among mean condition factors for January samples of rainbow trout from:

- Toboggan Creek,
- Elliot Creek,
- Bulkley River @ McQuarrie Creek,
- McQuarrie Creek,
- Byman Creek, and
- **Bulkley River @ Forestdale.**

In this comparison,Toboggan Creek, Elliot Creek, Bulkley River @ McQuarrie Creek, McQuarrie Creek, and Byman Creek data are included as indices for good condition. No significant differences between samples from any sites ($p=0.873$) implies that the sample from the Bulkley River near Forestdale have good condition.

Sites with February Data

An ANOVA on ranked data was conducted to test for differences among mean condition factors for February samples of rainbow trout from:

- Toboggan Creek,
- Elliot Creek,
- Bulkley River @ McQuarrie Creek,
- McQuarrie Creek,
- Byman Creek,
- Ailport Creek,
- **Barren Creek,**
- **Buck Creek, and**
- **Buck Creek Tributary**

In this comparison,Toboggan Creek, Elliot Creek, Bulkley River @ McQuarrie Creek, McQuarrie Creek, Byman Creek, and Ailport Creek data are included as indices for good condition. A significant difference among sites was identified ($p=0.046$). Tukey test results indicated that samples from Buck Creek and the Buck Creek tributary showed good condition, but a significant difference between conditons from Barren Creek and Toboggan Creek ($p=.041$) was identified. The condition of rainbow trout in Barren Creek was discovered to be better than the index sample from Toboggan Creek. It is possible that the better condition in February is associated with the un-natural disturbance of habitat (i.e. road maintenance conducted just prior to sampling) which may have provided temporary food supplements to the fish in this stream.

Sites with March Data

An ANOVA on ranked data was conducted to test for differences among mean condition factors for March samples of rainbow trout from:

- Toboggan Creek,
- Elliot Creek,
- Bulkley River @ McQuarrie Creek,
- McQuarrie Creek,
- Byman Creek,
- Ailport Creek,
- **Bulkley River @ Fish Fence,**
- **Bulkley River @ Knockholt**
- **Richfield Creek, and**
- **Barren Creek**

In this comparison,Toboggan Creek, Elliot Creek, Bulkley River @ McQuarrie Creek, McQuarrie Creek, Byman Creek, and Ailport Creek data are included as indices for good condition. No significant differences between samples from any sites ($p=0.067$) implies that the March samples from the Bulkley River @ Knockholt, the Bulkley River @ the counting fence, Richfield Creek and Barren Creek have good condition.

4.2.3.3 Summary of relative condition of rainbow trout in the mid-Bulkley watershed

Reasonable sized samples were obtained from several locations of overwintering habitat for rainbow trout in the Mid Bulkley watershed and at the Toboggan/Elliot Creek index sites. Condition factors were compared and showed very little difference in condition between the index for good condition and the samples taken from sites within the Mid-Bulkley watershed.

Barren Creek was the only site that showed statistically different conditions of rainbow trout, but differences appeared to be closely related to the road work that occurred at this site. Major disturbance to the stream in early February actually appears to have provided the rearing juvenile rainbow trout with extra nutrients that significantly improved their condition for a short period of time. However, there was also an indication of a low condition of fish captured at this site in March, but this second sample was only three fish. Whatever the case may be, the disturbance from road construction had an immediate effect on the juvenile fish in Barren Creek.

In general, the similarity of condition factors for rainbow trout samples in the Mid-Bulkley watershed to those from the Toboggan/Elliot index sites indicate that overwintering habitats have similar qualities in these two areas.

5.0 RECOMMENDATIONS

Sampling Methodology

The sampling techniques used in this study were suitable but not efficient enough to estimate population sizees during this study time. However, earlier planning (summer) may have provided better and more diverse selections of sampling sites and methodolgies. Ideas for future winter fish sampling in the Mid-Bulkley watershed are listed below.

- Fish sampling to monitor changes in condition during overwintering should be initiated in the fall to allow better interpretations of the fish conditions and their relationship to survival.
- Fall sampling should be conducted prior to water temperatures dropping below 4 °C in order to allow electroshocking and to minimize impacts on juvenile survival.
- Potential overwintering habitats in side channels should be identified in the fall prior to freeze up. Dissolved oxygen data loggers should be set at a few sites for a full winter to monitor suitability of this habitat before winter fish sampling is conducted.
- Minnow trapping in faster flowing, open sections of streams appears to be a suitable and relatively easy method for checking the distribution of coho and chinook salmon in the Mid-Bulkley watershed, but likely only requires one intense sampling period during a winter warm spell.

Literature Reviews and Valuable Summary Reports

Very few fisheries related reports have been published for the Mid-Bulkley watershed. Due to the importance and critical stage of unnatural degradation of this section of the watershed, it is recommended that some comprehensive reports be written to justify fish habitat concerns and their necessities for attention.

- A detailed review of historic information is required to document trends and changes to the Mid-Bulkley watershed related to agriculture, fisheries, forestry, and urbanization. Inclusion of a detailed review of historic air photographs of this section of the Bulkley River may provide recognizable watershed changes and useful ideas for restoration. This information will also be valuable toward ensuring that future restoration plans are actually restoring natural conditions, and not enhancing commercial stocks.
- A detailed review of annual water uptake by agriculture and private users in the Mid and Upper Bulkley watershed would also be an excellent tool for documenting a potential restriction to fish migration. This information may indicate the extent of lost fish habitat due to water management and may aid in arguments to review and alter current water management practices.

- A detailed review of the potential impacts on fish habitat from transportation routes along the Mid-Bulkley River will provide a useful indication of the severity and the priotity for restoration that is required. Some field assessment of identified problem areas would likely be required in this review.

Watershed Restoration Program

The Forest Renewal BC Watershed Restoration Program (WRP) appears to be an excellent source of funding for collection of valuable information for managing and restoring the Mid-Bulkley watershed. Several standard processes under the WRP will provide useful background information and sources for future studies and management of this section of the Bulkley watershed. The Department of Fisheries and Oceans should maintain close contact with the Nadina Community Futures organization that is presently initiating a "Level 1 Assessment" of the Mid-Bulkley watershed.

Study of Winter Survival of Coho

Although this study implies that overwintering habitat is not a critical factor toward the reduction of coho abundance in the Mid-Bulkley, more detailed confirmation and replication may be acquired with sampling from fall to spring.

- Coho sampling at Toboggan Creek (index) and several replicates in the Mid-Bulkley watershed would be useful toward comparing winter survival and analysing the skewing of condition factors that appear to be occurring during the winter.

Study of the Limitations of Overwintering Habitats

Following this preliminary assessment of coho distribution and overwintering habitats in the Mid-Bulkley (1996/97), more detailed assessments are required on the relative abundance and water qualities of these habitats compared to an index (e.g. Toboggan Creek). Ideas for future work on overwintering habitat are listed below.

- The importance of small lake habitat for coho overwintering has not been studied. Toboggan Lake is known to be excellent summer rearing habitat for Toboggan Creek coho. A detailed assessment of water quality and coho abundance in Toboggan Lake during winter months will help to estimate comparative amounts of winter rearing habitats in the Mid-Bulkley. Winter sampling will require floating boxes anchored at various depths (1-4 meters) and locations (near inlets outlets, and shoreline) installed prior to freeze up to ensure efficient trap setting. Floating boxes filled with styrofoam will maintain openings in the ice throughout the winter to permit easy monitoring of water quality and fish abundance in this small shallow

lake. This will also allow some interpretation of the suitability of side channel habitats.

- The importance of side channel habitat for coho overwintering is also not well known. Testing the suitability of side channel habitat for overwintering coho along the Mid Bulkley River will identify its potential relationship to the low abundance of coho in the area. This testing should include summer/fall fish sampling to show fish presence and channel surveys to select winter sampling stations with optimum potential for overwintering habitat. General water quality sampling would likely then be sufficient to measure the potential use of these habitats for overwintering.
- When reviews of all potential overwintering habitats (lakes, side channels, and mainstems) are completed, a good estimate of the amounts of potential overwintering habitats in the Mid Bulkley will be possible. In addition, overwintering habitats could be quantified and qualified among several sub-watersheds in the Bulkley watershed to help show the validity and usefulness of this process.
- Roads and railroads have frequently been viewed as partial barriers to good coho rearing habitat. Assessment of potential winter kills of juvenile coho due to the restrictions to fish movement under road and railroad crossings may define another contributing factor to the relatively low abundance of coho in the Mid-Bulkley watershed. This can be studied by observing culverts under road crossing until freeze-up, and then monitoring fish survival to test if certain types of culverts are blocking downstream migration into overwintering habitats.

Other Interests in the Mid-Bulkley Watershed

- A more detailed assessment of Buck Creek is needed to describe why coho and chinook salmon are restricted from seemingly excellent spawning and rearing habitats on the Buck Flats. An air reconnaissance and aerial photography upstream to the waterfall are recommended to define all existing barriers to fish migration and to describe available habitat types. It will also be interesting to estimate the losses of coho rearing habitat in the lower reach of Buck Creek due to the dykes that have been constructed.
- A complete stream survey of Aitken Creek upstream to the waterfall will provide useful fisheries information toward managing this middle section of the watershed.
- Detailed planning for alteration of the cascade near Ailport Creek should be conducted. It appears that unnaturally low flows and this partial barrier are significantly blocking annual migration of fish to large amounts of potential spawning and rearing habitats upstream from the cascade.
- Increased intensity of water quality sampling upstream of the cascade may be necessary to better describe the suitability of this habitat for spring and summer rearing. In addition to suggested critical summer temperatures, a recently recorded pH in this section of the river was 10 in early April (Donas pers. comm.). This unnaturally high pH identifies another potential impact on fish survival, as salmonid survival is known to be low in waters with pH greater than nine.

6.0 REFERENCES

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