JUVENILE COHO SALMON AND STEELHEAD ASSESSMENT OF LOWER TOBOGGAN CREEK, SEPTEMBER – NOVEMBER, 1998

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ABSTRACT

Juvenile sampling and habitat assessment was conducted in the lower three kilometers of Toboggan Creek from September to November, 1998. The lower two kilometers of the stream is of lower habitat quality (higher gradient, greater velocity, little cover) than the upper kilometer. Population estimates were made at three of the four trap sites and extrapolated to the upper one kilometer for coho (*Oncorhynchus kisutch*) and steelhead (*O. mykiss*) to yield a rough estimate of 53,900 juveniles. Coho present comprised two age classes (0+ and 1+) and steelhead had three (0+, 1+, 2+). There appears to have been a significant increase in juvenile numbers (density) over the last twenty years in this stream. Limitations of population estimations are discussed, and recommendations for future sampling provided.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

Toboggan Creek is a highly productive system, draining an area of 110 km^2 and discharging to the Bulkley River 23 km north-northwest of Smithers, B.C. (Gibson, 1997). The stream originates from twin glaciers on Hudson Bay Mountain and is located within two Biogeoclimatic zones; the Englemann Spruce-Subalpine Fir, wet-very cold (ESSFwv) at higher elevations and the Interior Cedar Hemlock moist-cold (ICHmc) lower down (Gibson, 1997).

Toboggan Creek supports rainbow/steelhead trout (*Oncorhyncus mykiss*), cutthroat trout (*O. clarki clarki*), coho salmon (*O. kisutch*), pink salmon (*O. gorbuscha*), kokanee (*O. nerka*), Dolly Varden char (*Salvelinus malma*), mountain whitefish (*Prosopium williamsoni*), lamprey (*Lampetra* sp.) and sculpins (*Cottus* sp.) (SKR Consultants, 1996; Gibson, 1997). There is an estimated 17 km of available fish habitat in the system distributed between the mainstem and tributaries (Tredger, 1979).

The stream has been an area of intensive adult coho salmon and steelhead enumeration efforts; coho have been counted annually since 1989, and steelhead since 1993 (O'Neill cited in SKR, 1996). In addition, coho smolt enumeration was conducted in 1995 and 1996 (SKR Consultants 1995 & 1996) and juvenile salmonid populations sampled in 1996 (Taylor, 1997).

The purpose of this project was to initiate a long term effort to evaluate habitat specific juvenile densities of coho salmon and steelhead in the lower three kilometers of Toboggan Creek below the fish counting fence. Specifically, the goals were to:

- Determine relative abundance of coho and steelhead juveniles in the lower three kilometers of Toboggan Creek
- Determine the amount and extent of habitat in the lower three kilometers, and use this to estimate numbers of juveniles present
- Over the long term determine proportion of wild versus hatchery-reared coho juveniles leaving Toboggan Creek, and combined with adult sampling, estimate hatchery versus wild survival to returning adult.
- Establish "permanent" sample sites to be used over time to assess changes

A tertiary goal was to determine if juvenile steelhead and coho are leaving Toboggan Creek and rearing in the mainstem Bulkley River. This report summarizes the findings of the initial stage of this project.

2.0 STUDY AREA

The study area of this project was Toboggan Creek from its confluence with the Bulkley River (UTM coordinates 6089350 N, 607925 E) upstream for three kilometers to the semi-permanent fish counting fence on the property owned by Mr. K. Landrock (UTM coordinates 6087650 N, 609650 E) (Figure 1). Property along the three kilometers is privately owned. Average discharge through this section is estimated at 1.7 m^3/s with maximum discharge of 8-11 m^3/s (Tredger, 1979). There is one tributary stream (unnamed), draining approximately 20 ha, entering the Toboggan mainstem within the study area.

The stream through this length flows through a channel with generally intact riparian vegetation, though there are several areas of bank slumping contributing fines to the stream. For a complete report on the watershed and details on this three kilometer stretch see Gibson (1997).

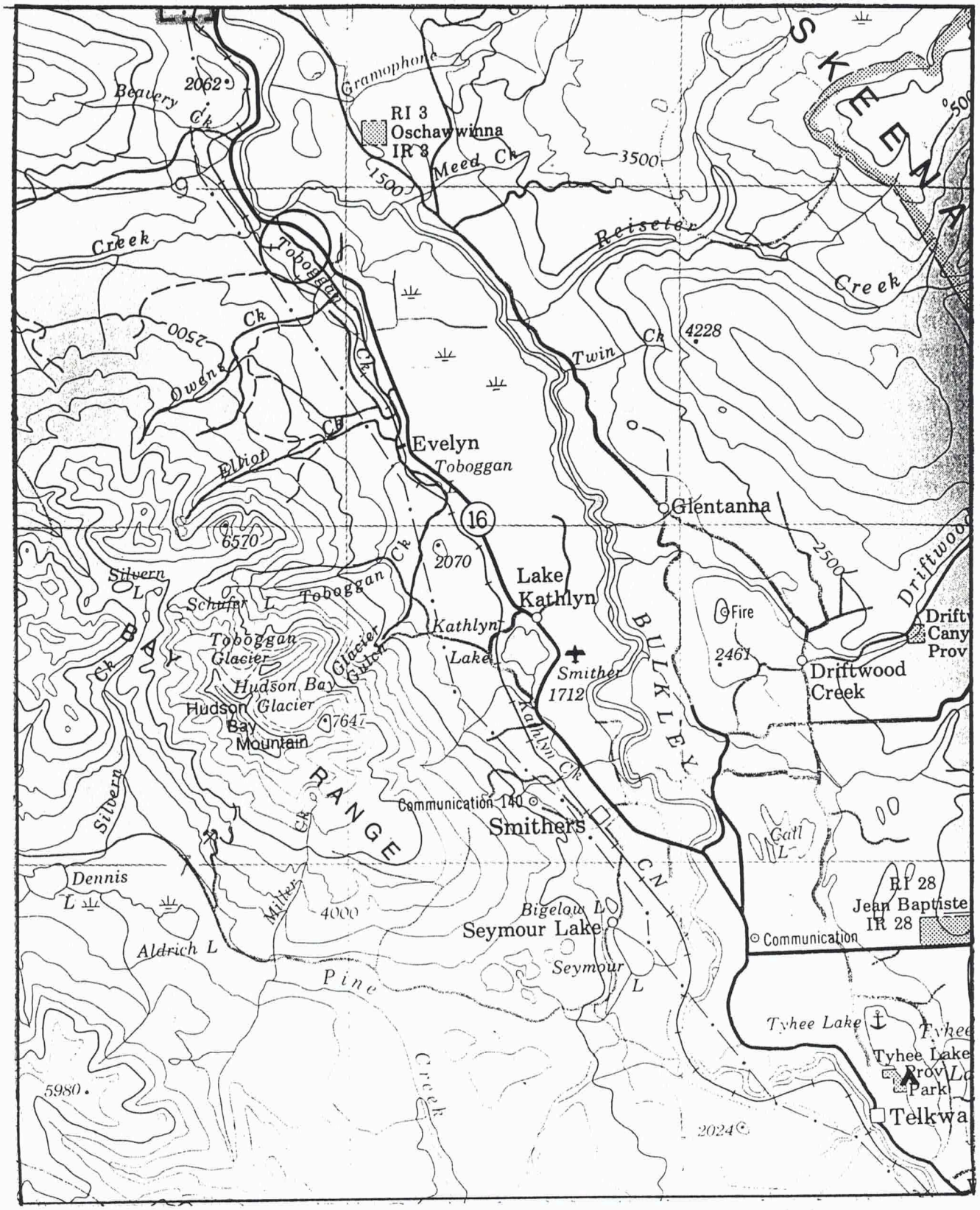

Figure 1: Toboggan Creek and surrounding area. Study area is circled.
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3.0 MATERIALS AND METHODS

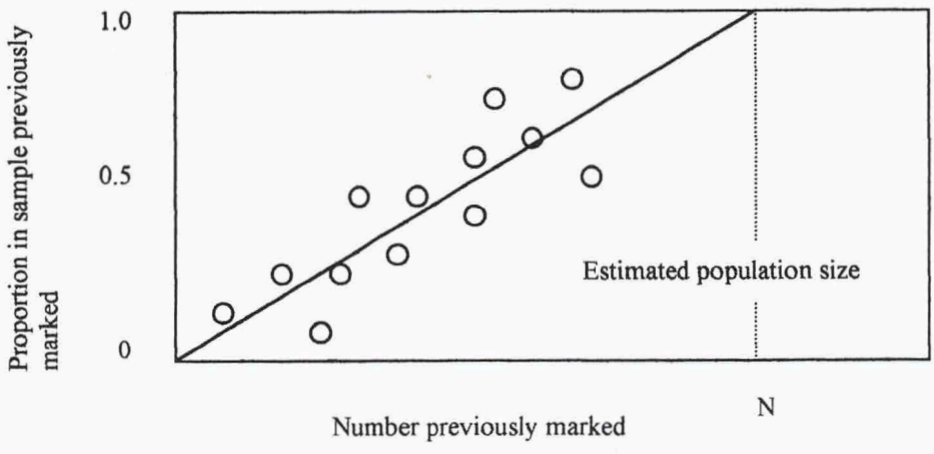
Field sampling of juvenile salmonids and other fishes was conducted in three periods during 1998 – September 2 to 8, October 3 to 12, and November 3 to 12 at between three to five sites. During the September period three sites (Sites 1, 2, 4) were sampled for three nights, October entailed four sites (Sites 1, 2, 3, 4) for four nights, and November included four sites (Sites 1, 2, 3, 4) for two nights and five sites (Sites 1, 2, 3, 4, and mainstem Bulkley) for two nights. Sampling was done using Gee (minnow) traps (mesh diameter 3 mm square) baited with salmon roe. Two or three traps were set per site and left for between 14.75 and 21.5 hours (i.e., overnight).

Captured fish were identified to species, anaesthetized using an antacid, measured for fork length, and the coho were marked by clipping a small portion of the dorsal lobe of the caudal fin.

Habitat sampling was conducted over two days, September 25 and 26, 1998. The stream through the study area was walked and broken into 100 m sections. Within each section, hydraulic (width, depth, gradient), reach characteristics (pool, riffle, glide, substrate composition) and habitat (undercut banks, Large Woody Debris (LWD)) parameters were measured/estimated. In addition, every 500 m water velocity was also measured in order to calculate discharge. Detailed habitat sampling of the trap sites (pool size, depth, substrate composition, LWD, gradient, UTM coordinates) was conducted on two dates , October 5 and November 5.

Coho and steelhead data was summarized and analyzed for trap effort (Catch Per Unit Effort – CPUE), population estimation, proportion of coho versus steelhead utilizing each trap habitat, fish density at trapping sites, and fork length frequency distribution. Coho population estimates for three of the four sites were conducted using the Schumaker and Eschmeyer regression technique of the

Schnabel method (Greenwood, 1996). For one of the four sites (Site 1) there were insufficient numbers of coho captured to reliably estimate the population. The Schnabel method makes the same assumptions as the traditional Peterson mark-recapture methodology but the Schnabel depends simply on observing how the proportion of marked animals in catches increases over time as more animals are marked (Greenwood, 1996). When the proportion is equal to 1.0, the total number of animals previously marked must be the number in the population. In reality, it is not often that all animals are marked, so instead the procedure is to sample a number of times, recording the number of marked animals caught and marking any unmarked animals prior to release. These individual sample dates are then plotted on a graph of proportion in sample that had been previously marked (y-axis) against total number of animals marked to date (x-axis). A straight line may then be drawn through these points to intersect the y-axis value of 1.0 (i.e., all fish caught have been previously marked) and a second line dropped down to the x-axis – this value is the population estimate (see Box 1). Of course, the actual calculation is somewhat more complicated but the previous description presents the concept. For further details see Greenwood (1996).



Box 1: Illustration of concept behind Schnabel method

The juvenile steelhead population was estimated using the proportion of steelhead to coho found at each trap site:

$$ST_{pop(i)\cdot} = (1 / CO_{prop(i)\cdot} * CO_{pop(i)\cdot}) - CO_{pop(i)\cdot}$$

Where $ST_{pop(i)}$ = steelhead population at trap site *i*
$CO_{prop(i)}$ = median proportion of coho at trap site *i*
$CO_{pop(i)}$ = Calculated coho population at trap site *i* (from Schnabel)

Steelhead and coho densities (number of individual fish per m^2 and per m^3) were calculated for the three trap sites for which reliable population estimates could be made. Population estimates for the upper one kilometer were then made by extrapolating the estimated densities at the trap sites over estimates of the proportion of the reach containing similar habitat, based upon the habitat survey.

Size frequency was analyzed using measured fork lengths. For coho all marked fish (n=343) were pooled and used as there was certainty of not using the same measured fish more than once. However, for steelhead that could not be done as it was not possible to determine if fish caught had been previously captured and measured. Therefore, in each month the night of greatest trap success was used and all of the steelhead captured in the separate traps on that single night were combined for the analysis. This resulted in sample sizes of 46 steelhead in September, 82 in October, and 72 in November.

4.0 RESULTS AND DISCUSSION

4.0.1 Habitat Survey

Any habitat description is partly qualitative in addition to quantitative. In order to minimize qualitative bias introduced by an observer, the "salmonid quality" of each 100 m section was assessed based on Table 1. Detailed results of this habitat survey are presented in Appendix 1.

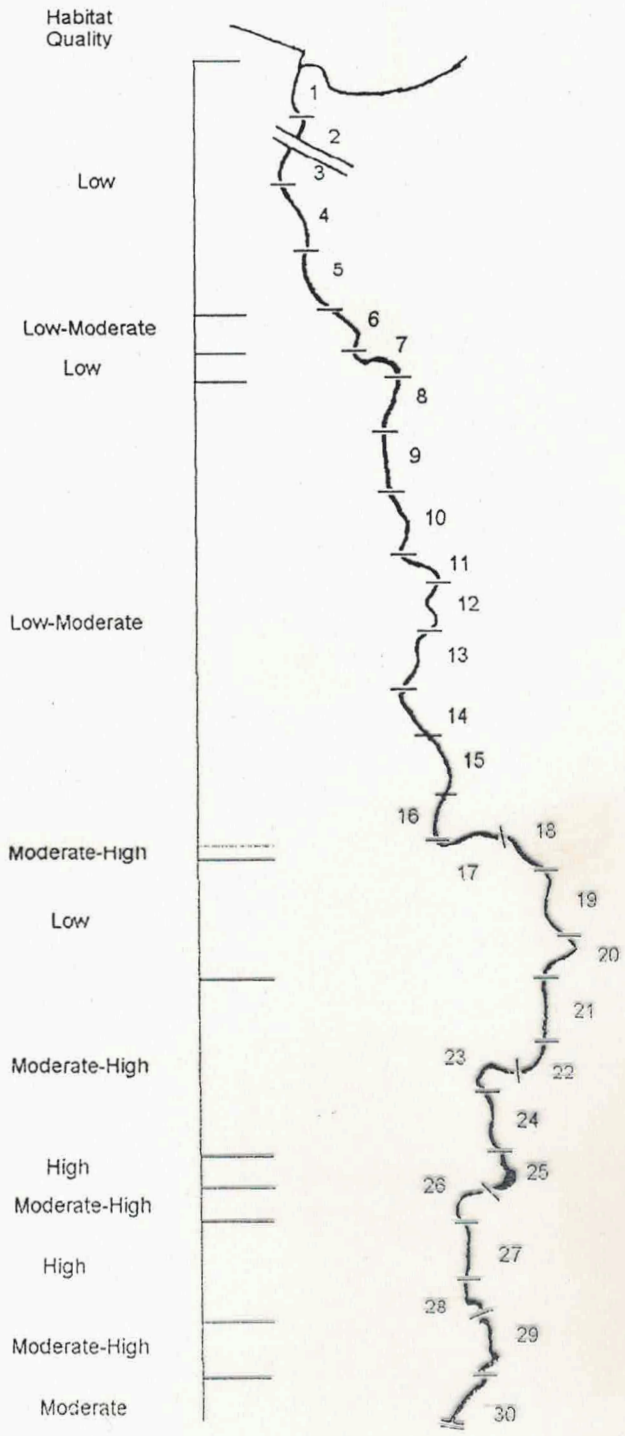
Table 1: Ranking* of habitat characteristics to define "salmonid rearing quality"

Ranking	% Pool	% Cutbank	# LWD pcs	Gradient	Substrate
Low	≤ 5	<10	<5	>1.5	Cobble & Boulder
Moderate	6 – 15	10-30	5 – 15	1.0 – 1.5	Gravels & Cobble
High	>15	>30	>15	<1.0	Gravels

* Low – Moderate and Moderate-High rankings are those sections with a mix of characteristics from each of the respective principal ranks.

Stream discharge at time of sampling was 1.2-2.1 m^3/s (floating chip method, n=6), indicating discharge was at approximately average annual flow (1.7 m^3/s). A total of 900 m (30%) of the 3 km is classed as low quality, 1,000 m (33%) as low-moderate, 100 m (<5%) as moderate, 700 m (23%) as moderate-high, and 300 m (10%) as high quality. These habitat quality classes are distributed as shown in Figure 2.

The first 500 m of Toboggan Creek upstream of its confluence with the Bulkley River are of low habitat quality for rearing juvenile salmonids. This stretch is dominated by riffles and cascades with very few pools (with the exception of the large plunge pool downstream of the highway 16 culvert). There is very little LWD or undercut banks to provide cover, and the relatively high gradient results in high velocity and large size substrate. A large cobble bar exists at the mouth of the creek where it joins the Bulkley River.


Habitat Quality
Low
Low-Moderate
Low
Low-Moderate
Moderate-High
Low
Moderate-High
High
Moderate-High
High
Moderate-High
Moderate
1
2
3
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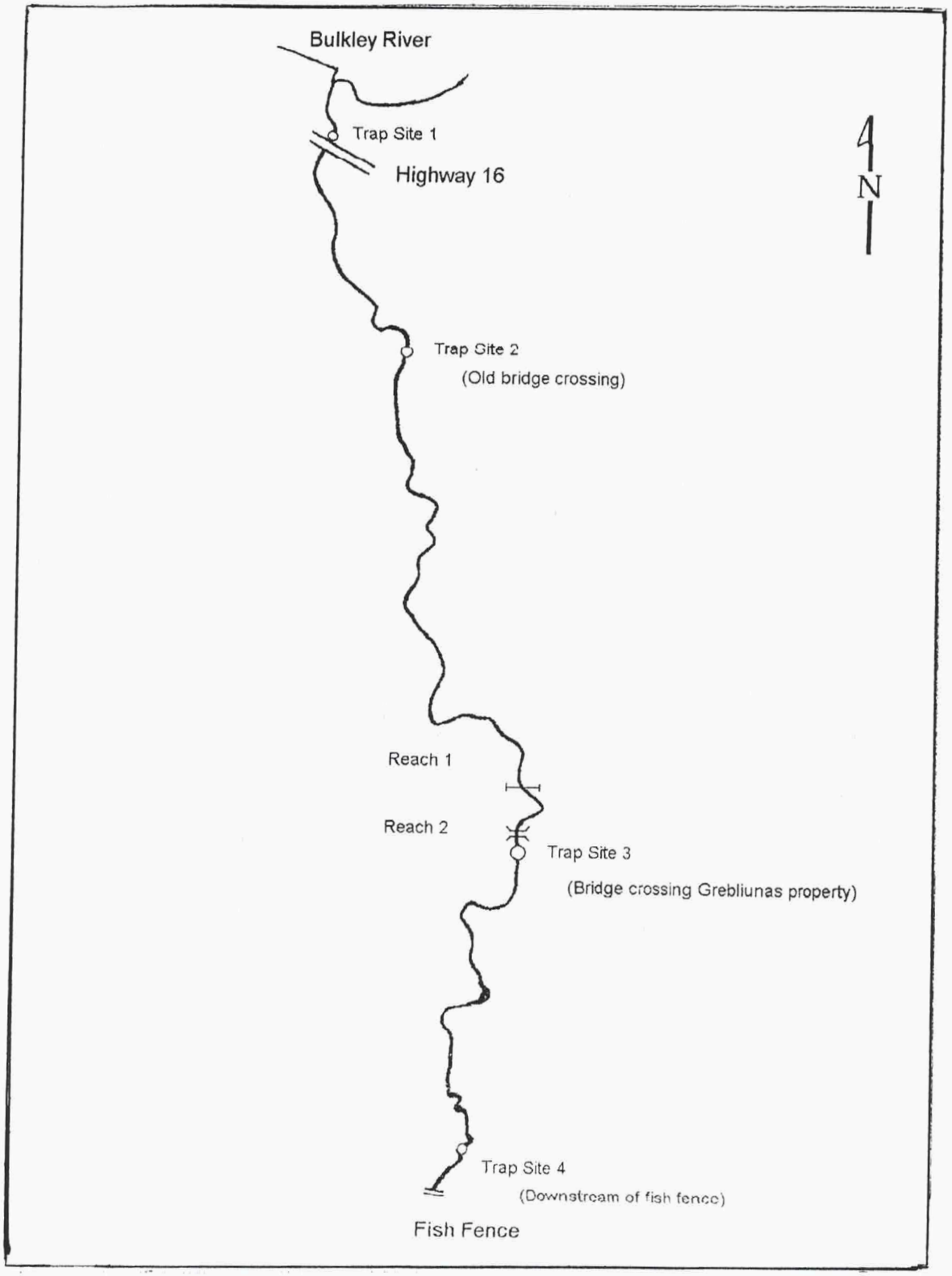

Figure 2: Lower 3 km of Toboggan Creek showing locations of 1998 juvenile trapping sites. The overlay maps out habitat quality and delineates the thirty 100 m sections assessed during the habitat survey. Scale is approximately 1:14,000

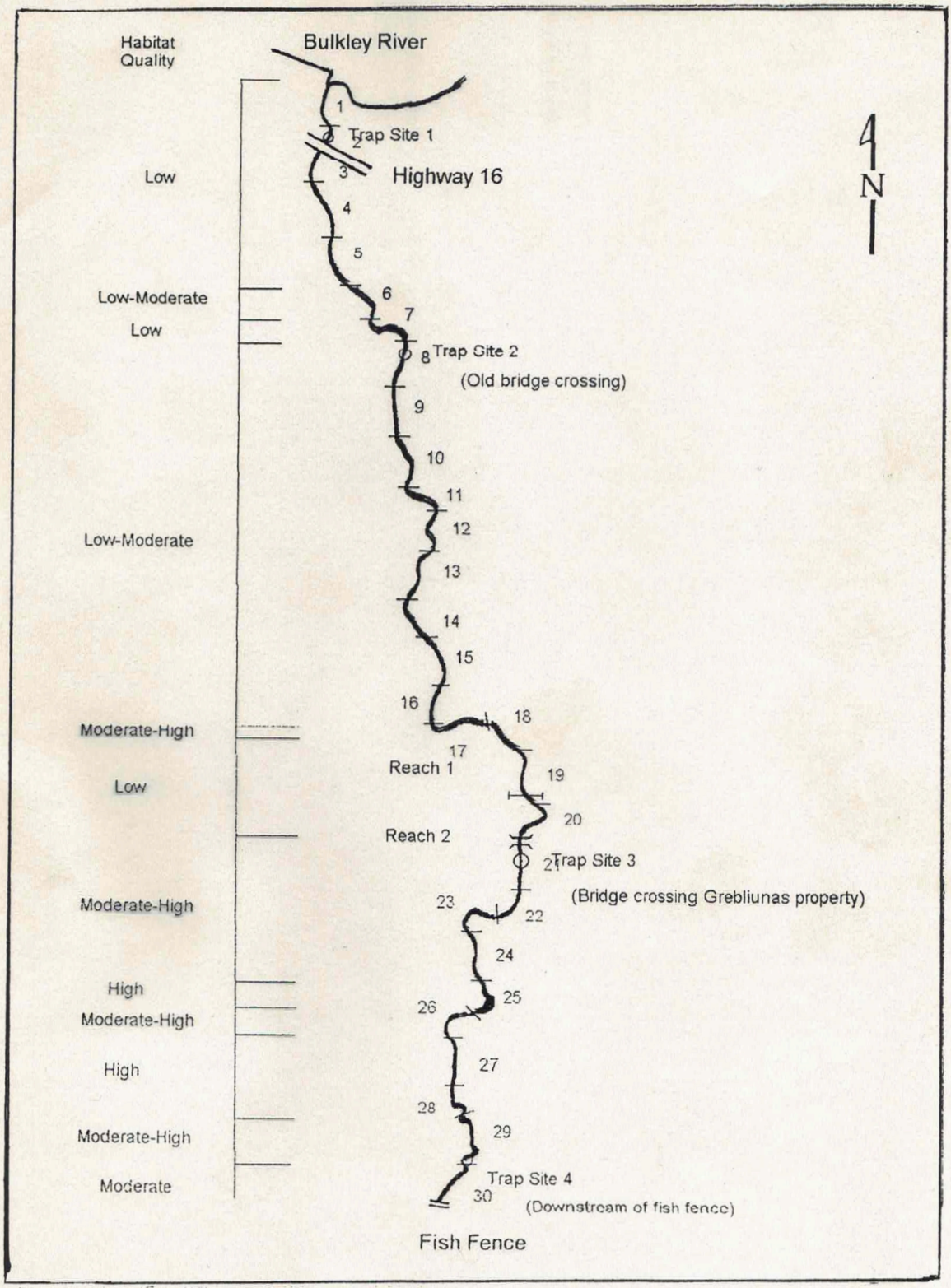

Figure 2: Lower 3 km of Toboggan Creek showing locations of 1998 juvenile trapping sites. The overlay maps out habitat quality and delineates the thirty 100 m sections assessed during the habitat survey. Scale is approximately 1:14,000

For a distance 1,100 m upstream of this low quality habitat (i.e., from 500 m to 1,600 m) the habitat is ranked as low-moderate with an isolated section of low quality habitat. This 1,100 m stretch is still characterized by predominately riffle habitat units, but there are increasing numbers and sizes of pools and glides. The stream gradient is less than that further downstream and the substrate is composed principally of cobble. The most significant difference is an increase in the amount of LWD which contributes to the creation of hydraulic diversity and isolated areas of rearing for juvenile fish.

From 1,600 to 1,700 m the habitat improves to moderate-high mainly due to a local area of decreasing gradient; this results in decreasing stream velocity, and is combined with a large number of LWD pieces and increased pool presence. For a distance of 300 m upstream (to 2,000 m from the mouth) of this moderate-high quality habitat, the quality deteriorates to low with increasing gradient, almost 100% riffle presence, very little pool presence, a lack of LWD and undercut banks, and an increase in substrate size from cobble to cobble/boulder.

The remaining 1,000 m, from 2,000 m to the fish counting fence, is comprised of 10% moderate, 60% moderate-high, and 30% high quality habitat. This 1,000 m stretch is characterized by a more equal hydraulic distribution of pools, riffles and glides, the presence of numerous deep pools, large quantities of functional LWD, a high degree of undercut banks, and smaller substrate size. This section has excellent diversity and, for the most part, has a well developed riparian community adjacent to the stream contributing the large woody debris.

In general, the lower 2,000 m of Toboggan Creek provides marginal conditions for rearing juveniles; the water is high velocity, there are few refugia, and there is little cover to provide protection. A previous assessment also defined a reach break at 2,000 m (Gibson, 1997). However, as indicated at Trap Site 2 (see Section 4.0.2) there are isolated areas in this lower 2,000 m which are

providing excellent habitat; these areas are generally small and discrete, but are still of great importance for fish using these lower two kilometers. The upper 1,000 m appears to provide the greatest habitat for juvenile rearing in the lower three kilometers. Pools are deep, water velocity is relatively low, and there is extensive cover in the form of LWD and cutbanks. Riffle areas, for macroinvertebrate production to provide food for the rearing fishes, are also present and interspersed with the pools.

4.0.2 Fish Sampling

Trap Site Descriptions

Physical and fish habitat attributes of the four fish trapping sites are presented in Tables 2 and 3. Sampling locations are illustrated in Figure 2.

Sampling effort at Trap Site 1 (downstream of the highway 16 crossing) was a combination of small, isolated discrete pools and the large culvert plunge pool. This is a high velocity section of the stream and so fish present were thought to be concentrated in the few small pools and the culvert plunge pool. The habitat quality is rated as low (Habitat survey section # 2, Figure 2).

Trap Site 2 is the site of an old bridge crossing. One trap was placed in a small pool formed by bridge pilings along the right bank and one trap each was placed in a small beaver pond and a side-channel along the left bank. The habitat in this area outside of the pools is largely riffle-glide; these pools represent the majority of obvious coho habitat in this section. Habitat quality is rated as low-moderate (Habitat survey section #8, Figure 2).

Trap Site 3, upstream of a bridge on the Grebliunas property was only sampled in October and November. This section of creek is largely cascade-riffle. A single large deep pool with LWD, approximately 20 m upstream of the

Table 2: Physical attributes of pools sampled in lower Toboggan Creek, as measured in October and November, 1998

Sample Site	Trap #	Width (m)	Length (m)	Mean depth (m)	Max. depth (m)	Estimated Surface area (m^2)	Estimated Volume (m^3)	GPS coordinates
1	1	1.1-2	4.5	0.35-0.4	~0.45	9	3.5	6089200N; 607950E
	2a	0.8	1.5	0.5		1.2	0.6	
	2b & 3	12		2.5 (est.)		113	95	
2	1	1.0-2.0	2.5 - 5	0.35	0.45	5	1.5	6088850N; 608200E
	2	8.0-10.0	3.0-5.0		0.25-0.40	20	2.5	
	3	3.0-3.5	10.0-15.0	0.15	0.35	30-40	5	
3	1&2	1.5	7	0.25-0.4	0.5	10	2	6088350N; 609100E
	3	1.2-2	2.5-4	0.25-0.3	0.42-0.4	5	1	
4	1	8	10	0.55	0.8-0.9	75	15	6087650N; 609550E
	2	1.2	8	0.6		10	2.0-3.0	
	3	1	3.5	0.2-0.25	0.35	3	0.5	

Table 3: Fish habitat attributes of pools sampled in lower Toboggan Creek, as measured in October and November, 1998

Sample Site	Trap #	Reach Classification	Local Gradient (%)	Pool Formation	Cover	Estimated LWD (# pcs)	Estimated SWD (# pcs)	Substrate
1	1	Step-pool	2.5	Bank projection	LWD/SWD & cutbank	5	4	Gravels
	2a	Step-pool	2.5	Boulders	Boulder & LWD	2		Cobble/Boulder
	2b & 3	Pool	<1	Plunge pool	Deep water & LWD	4		Unknown
2	1	Pool-Riffle	1-1.5	Bank projection	LWD/SWD	4	6	Sands & fines
	2	Pool-Riffle	1-1.5	Beaver dam	SWD		12 to 15	mud & fines
	3	Pool-Riffle	1-1.5	Sde channel	Boulders & LWD	4		mud & fines
3	1&2	Pool riffle & plane-bed	1.5	Bank projection	Boulders, LWD/SWD	4	>20	Fines with some boulder
	3	Pool riffle & plane-bed	1.5	Free form	SWD		8 to 10	gravels w/ fines coating
4	1	Pool riffle	<1.0	Free formed	LWD/SWD	4 to 5	40 to 50	gravel/cobble
	2	Pool riffle	<1.0	Bank projection	LWD/SWD & cutbank	4	10	gravels
	3	Pool riffle	<1.0	Free formed	SWD		2	cobble/boulder

2a sampled from Sept 2 - Oct 8
2b sampled from Oct 12 - Nov 12

bridge, was used for setting two traps, the third was set in a small pool approximately 15 m further upstream. All traps were set along the left bank. The habitat quality for this area of Toboggan Creek is rated as moderate-high (Habitat survey section #21, Figure 2).

Trap Site 4, downstream of the fish counting fence, entailed one trap in the large pool (right bank), one approximately 12 m upstream from this pool (left bank) and the third in a pool-glide (right bank) approximately 25 m upstream of Trap 1. This section is rated as moderate-high (Habitat survey section #29, Figure 2).

Captures and Catch Per Unit Effort

Five species of fish were captured over a period of 2,079.5 trap hours (114 trap nights). These were coho salmon (total 343 different individuals) and rainbow/steelhead trout (total 553 captures), chinook salmon (total 5 captures), Dolly Varden char (total 40 captures), and lamprey (total 2 captures). Catch per unit effort (CPUE) was calculated for coho and steelhead and are presented in Table 4.

Table 4: Catch per unit effort (individuals caught per hour) for coho, steelhead and combined coho and steelhead.

Site	Species	Min	Max	Mean	Median	Std. Dev.	n
1	Coho	0	0.075	0.0144	0	0.023	11
	Steelhead	0.025	0.344	0.123	0.114	0.104	11
	Combined	0.028	0.375	0.138	0.114	0.109	11
2	Coho	0.273	1.232	0.675	0.63	0.305	11
	Steelhead	0.039	0.939	0.458	0.45	0.261	11
	Combined	0.385	1.915	1.133	1.032	0.424	11
3	Coho	0.036	0.228	0.128	0.125	0.067	8
	Steelhead	0.036	0.471	0.21	0.2	0.151	8
	Combined	0.072	0.588	0.339	0.329	0.180	8
4	Coho	0.04	0.384	0.225	0.242	0.107	11
	Steelhead	0.04	0.469	0.196	0.162	0.127	11
	Combined	0.08	0.77	0.421	0.452	0.208	11

The median values are presented along with the mean as the mean is quite sensitive to extreme high and low values which will bias it. The median, which is the value at which 50% of the data points are greater than and 50% less than, is not sensitive in the same manner. The median coho CPUE ranges from 0.125-0.63 coho per trap hour (excluding Trap Site 1 due to the very low coho capture) and steelhead CPUE from 0.114-0.45 steelhead per trap hour. Site 2 had the highest combined CPUE followed, in order, by Sites 4, 3 and 1. Site 2, while situated in what appears to be only low-moderate habitat, was consistently the most highly productive in terms of captures. It is suggested that in this area the fish are concentrated into the few small pools (i.e., beaver pond and side-channel) due to the high velocity water in the mainstem. It is further suggested that these numbers in the side channel and beaver dam are probably near maximum (i.e., carrying capacity; see Population Estimates below).

Trapping in the Bulkley River mainstem was conducted for only two nights (80.5 trap hours) in November. This resulted in one each of steelhead, coho and chinook. The Bulkley River near Toboggan Creek is primarily a cobble bar and there is little structure to provide cover. The potential for sampling juveniles in this area is very limited.

Population Estimates of Coho and Steelhead

Population estimates for each species were derived for three of the four trap sites and also for the upper one kilometer of the study area. Only the upper 1 km was used rather than the entire 3 km stretch due to errors introduced by extrapolation of such magnitude. The upper 1 km is relatively homogenous and high value habitat; it is thought to contain the majority of the juvenile coho and steelhead. Representative fish densities for the lower 2 km are not certain at this time and so this area was excluded from the estimate. Table 5 presents these estimates with Table 6 presenting the proportion of coho as total catch. Reliable

Trap Site 1 population estimates could not be developed due to the low capture success of coho at this site.

The population estimates for each site are used to derive densities as presented in Table 7. These density estimates are then multiplied by the estimated surface area of each of the habitat classes in the upper one kilometer (Habitat sections 21 to 30, Figure 2 and Appendix 1) as derived from the habitat assessment (moderate-high = 2.45 CO & 3.0 ST/m^2 (*i.e., average of Sites 3 & 4*), high = 4.3 CO & 4.3 ST/m^2 (*i.e., Site 2*)) in order to estimate the total number of coho and steelhead juveniles utilizing this upper one kilometer.

Table 5: Estimated coho and steelhead populations at each site and for upper one kilometer of study area.

	Pop. Estimate	Lower 95% CI	Upper 95% CI
Coho			
Site 2	255.62	240.97	272.17
Site 3	29.46	23.18	40.4
Site 4	262.4	198.39	387.45
Upper 1 km	25,179		
Steelhead			
Site 2	255.62		
Site 3	56.68		
Site 4	197.14		
Upper 1 km	28,762		

Table 6: Proportion of coho in catch for each site

Site	Min	Max	Mean	Median	Std. Dev.	Sample size
1	0	0.667	0.074	0	0.183	20
2	0	1	0.431	0.5	0.328	33
3	0	1	0.391	0.342	0.35	24
4	0	1	0.513	0.571	0.294	31

The high population estimate for Trap Site 2 is thought to represent crowding from the largely unfavorable environment into the few areas of higher

quality habitat. It is not thought to be representative of that particular section of Toboggan Creek.

95% confidence intervals were established for the coho estimates only as these are based on a statistical approach. The estimation of steelhead population was based on a ratio and the estimate for the upper one kilometer was based on extrapolation; neither of these approaches are amenable to the derivation of confidence limits.

Table 7: Density estimates for coho and steelhead per square metre and cubic meter for the three sites with population estimates.

Site	2	3	4
Surface area (m^2)	60	15	90
Volume (m^3)	10	3	20
Estimated Population			
Coho	256	30	263
Steelhead	256	57	198
Density			
Fish/m^2			
Coho	4.3	2.0	2.9
Steelhead	4.3	3.8	2.2
Fish/m^3			
Coho	25.6	10	13.1
Steelhead	25.6	19	9.9

Past density estimates of coho and rainbow (steelhead) trout were conducted for Toboggan Creek (Tredger, 1979; Holtby and Finnegan, 1997) and a tributary to Toboggan Creek (Taylor, 1997). The results of Tredger (1979) indicate coho densities of 0 to 0.54 fish/m^2 and steelhead densities of 0.1-0.35 fish/m^2. These are an order-of-magnitude lower than estimates derived from this work. However, the 1978 fence count for coho was 850 fish with a historic escapement of 660 fish annually (Tredger, 1979). Recent adult coho counts at the fence indicate an escapement of between 400 and 3,600 (mean = 2,010, n=6) since 1991 (Gibson, 1997); this is three times what the escapements were

when Tredger was doing his work. Similarly, Tredger (1979) estimated an escapement of 45 steelhead to Toboggan Creek in the late '70s. Since 1993 steelhead escapement above the fence has been estimated between 115 and 543 (mean = 336, n=6) (Gibson, 1997; Mitchell, 1998). These values are three to twelve times higher than Tredgers estimate. Thus the discrepancy in density estimations between 1979 and 1998 is probably attributable to larger adult returns at present, resulting in a greater number of juveniles within a similar area of habitat.

Holtby and Finnegan (1997) report a coho juvenile density of less than 1 fish/m^2 for 1995 based on two sample sites. Since coho rear for two years in Toboggan Creek (see Steelhead and Coho Fork Length) this density represents the cohorts of two year – 1993 and 1994. Coho escapement to Toboggan Creek for these two years was 1,690 and 2,416 respectively (Gibson, 1997). The 1998 sampling revealed coho densities greater than 2 fish/m^2; adult coho escapements for the previous years were 394 (1997) and 1,185 (1996) (M. O'Neill, pers. comm.). Outside of the present study area, Taylor (1997) calculated coho densities at between 2.05 and 3.46 fish/m^2 for 1996 (adult returns of 2,416 in 1994 and 1,762 in 1995; Gibson, 1997) and steelhead densities at 0.075 to 0.139 fish/m^2.

Therefore, Holtby and Finnegan (1997) report a lower density of juvenile coho from a greater number of spawners (2.6 times as many returning spawners in 1993&94 than in 1996&97) than the 1998 work indicates. In contrast, Taylor (1997) reports densities similar to the findings of this project despite the juveniles at that time forming the cohorts from an adult population 2.6 times greater than that leading to the cohorts present in 1998. These discrepancies illustrate, and reinforce, the importance of adequate sampling. It is suggested that Holtby and Finnegans (1997) estimate may be low due to the sampling of two sites. Two to three coho/m^2, at least in high quality habitat, is probably a more realistic density estimate. To derive more accurate density estimates an array and diversity of

locations within Toboggan Creek must be sampled to determine juvenile densities over a larger scale.

Accuracy/Limitations of Population Estimates

Coho Estimates

Assumptions made in mark-recapture estimates must be considered in evaluating the accuracy of the resulting estimated population numbers. The assumptions for mark-recapture are (from Davis and Winstead, 1980):

- No loss (or gain) of marks
- No recruitment (births or immigration)
- No difference of mortality between marked and unmarked individuals
- Catchability is the same for marked and unmarked individuals

Over time the mark used in this study (dorsal lobe caudal fin clip) will be lost as the fin regrows. However, a scar will remain which will be detectable on close examination throughout the life of the fish. Therefore, loss of the mark is not a concern, though the probability of overlooking it may increase over time. Some fish (4 coho and 1 steelhead) were caught which had portions of the ventral lobe of their caudal fin naturally amputated, probably in agonistic interactions or near-successful predatory attempts. This raises the question of gaining marks as fish may lose part of their dorsal lobe in these same interactions; the result may appear as a marked fish. However, close examination will reveal that the marked fish have their fin amputated with a clean clip, whereas naturally inflicted amputation leaves a ragged edge to the fin edge. Therefore, close and conscientious examination for marks should ensure that this assumption holds.

The assumption of no recruitment (i.e., the population is closed) is essential to most mark-recapture techniques. The Jolly-Seber method is not constrained by this assumption but requires that each individual be recognizable (Greenwood, 1996); this was beyond the scope of this project. Does this

assumption hold in Toboggan Creek? By sampling in the Autumn months it is ensured that there are no births added to the population, but immigration is likely. Fish may move as resources change (e.g., altered food supply, increased predation, crowding, inter- and intra-specific competition, loss of habitat, formation of new habitat, etc.), therefore assuming that there was no immigration into the trap sites during the three months of this study may not be valid. Using the naturally gained ventral lobe clips described previously as secondary marks, two of these ventrally marked fish were found to move between trap sites. One moved downstream from Trap Site 4 to Trap Site 2 and the other upstream from Trap Site 2 to Trap Site 3. This is further suggestive that this population is not closed.

Assuming no difference in mortality between marked and unmarked fish is also of questionable validity considering the manner of marking. The caudal fin is of primary importance in acceleration and thus vital in feeding and escaping predation. The effects on these behaviours may be minimized by minimizing the amount of fin amputated, and in this study, a maximum of 10 to 20% of the dorsal lobe was the target value for clipping. Two of the fish missing the majority of the ventral lobe of their caudal fin were identifiable by the combination of size and missing fin portion. These fish were first caught on October 9th and 12th and recaptured on the last day of sampling, November 12th. This indicates that even missing substantial portions of their ventral lobe they could survive at least 31-34 days. However, this very small sample is not sufficient to prove that the assumption holds.

Catchability – the likelihood of a given fish entering the trap – is assumed to be constant for both marked and unmarked fish. This is a difficult assumption to evaluate and remains untested.

The foregoing illustrates several of the uncertainties underlying population estimates using mark-recapture. Fortunately, Greenwood (1996) provides a

rough manner of checking assumptions for the Schnabel method. By plotting the proportion of individuals in each sample that have been previously marked against the total number of previously marked individuals (see Figure 3) the "expected" marks per sample may be estimated. This is based on the assumption that as more fish within the population are marked (i.e., x-axis in Box 1 – Materials and Methods) more fish within the sample will be marked (y-axis, Box 1) until when all of the fish are marked the number of captured fish should equal 100%. If the data forms a straight line, the assumptions for a Schnabel estimate are probably met. That is, there is a linear relationship marks per capture and total marked in the population when the mark-recapture assumptions are true. Data points for Trap Site 2 fall on a straight line and so it is assumed the Schnabel method is appropriate; therefore these population estimates may be accepted with a moderately high level of confidence. Trap Site 3 data points fall in a relatively straight line but there are fewer of these points (i.e. n is small). Also, there is a noticeable outlier at x=18. Therefore, this population estimate should be accepted with some reservation. Data from Trap Site 4 is quite non-linear, this population estimate should be accepted only as a rough estimate. The method used to estimate is probably biased. Therefore, the Schnabel method appears appropriate for Trap Sites 2 and 3, but the previous caveats (immigration, survivability) must be borne in mind. For Trap Site 4 the population estimate should be viewed with some trepidation. The resulting estimates are intended as rough guides, the "true" population is dynamic, linked to upstream and mainstem Bulkley populations, and subject to losses through predation. Thus, the resulting estimates are to be recognized only as very rough approximations of the current population.

Steelhead Estimates

Steelhead population estimates were made using a ratio of the number of individual steelhead to the number of coho in the traps, and multiplying this ratio by the estimated coho population. This estimate assumes that the ratio of

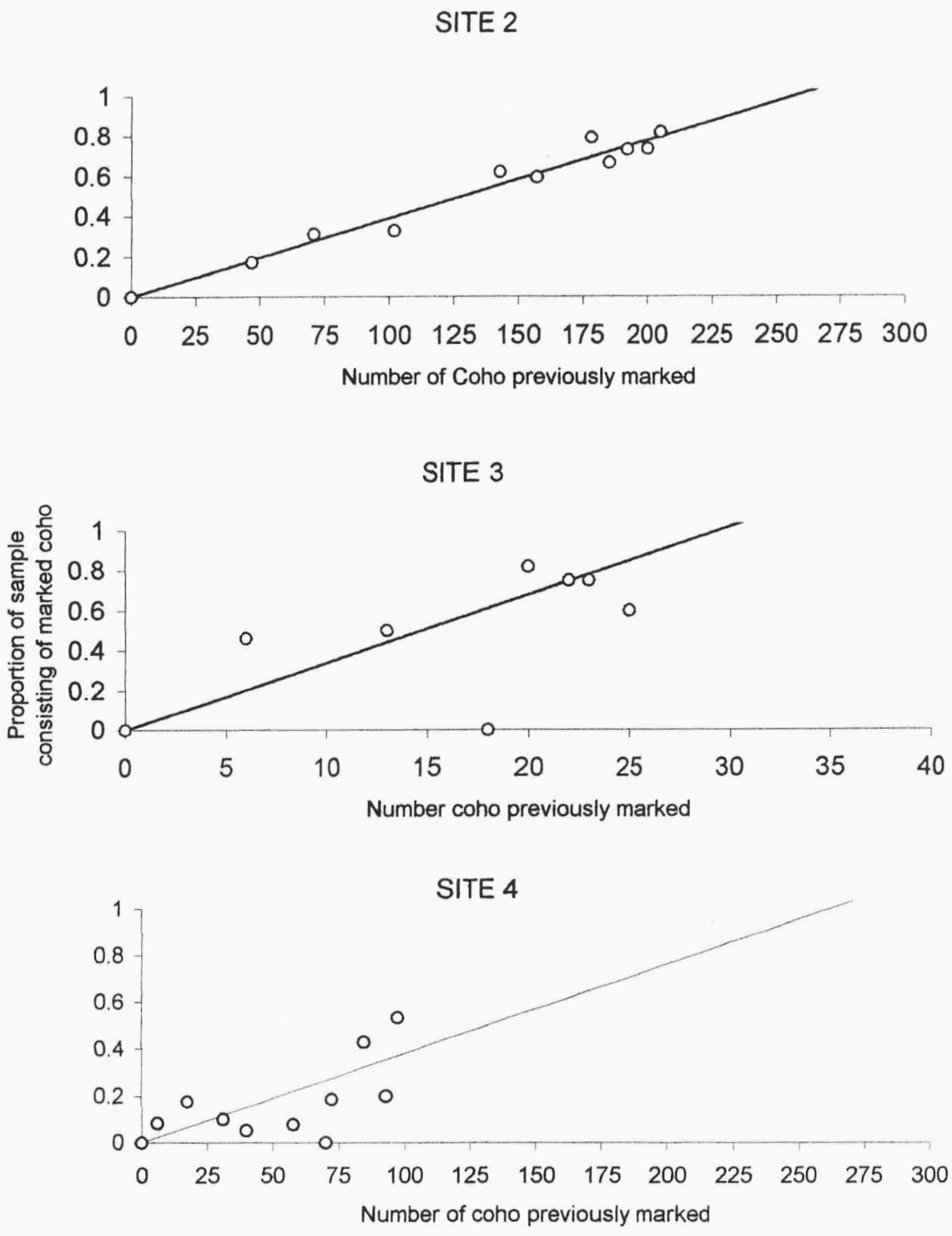

Figure 3: Plots for determining validity of underlying assumptions for Schnabel mark-recapture methodology. Open circles are data points from each trapping session (Sites 2 and 4 n=11, Site 3 n=8).

steelhead to coho in the trap is similar to the ratio in the stream (i.e., that they are equally likely to enter the trap). As with the coho estimates, the derived values are to be recognized as very rough approximations only.

Population Estimates for Upper One Kilometer of Study Area

The population estimates for the upper one kilometer of the study area is extrapolation from calculated densities and estimated habitat qualities. Extrapolation assumes that the established relationship is true outside of sampled conditions (i.e., that the densities are the same in similar habitats outside the sites of intensive sampling). This may be true, false or partially true; by definition extrapolation is outside of the bounds of known conditions and so the validity of these assumptions are unknowable. As well, there exists the inherent error in the calculated densities and estimated habitat qualities. The imprecision of these estimates are cumulative as they are extrapolated over the length of the stream, therefore uncertainties in the density estimation and habitat classification combine to produce greater uncertainty in the final estimate.

Due to all of the assumptions discussed previously (coho mark-recapture, steelhead estimates, extrapolation) the resulting estimates of coho and steelhead population over the upper kilometer must be accepted with caution. The "true" value may be greater or lesser by an unknowable magnitude.

Steelhead and Coho Fork Length

The size frequency of coho juveniles in the lower 3 km of Toboggan Creek is unimodal and slightly skewed to lower values (Figure 4). It appears that the predominant age at the time of sampling is 0+ (i.e., this years cohort); the peak is at 60-69 mm. Based on Figure 13 in Tredger (1979) the 0+ fish are generally less than 75 mm fork length and the 1 + fish are larger. Using this, it is estimated

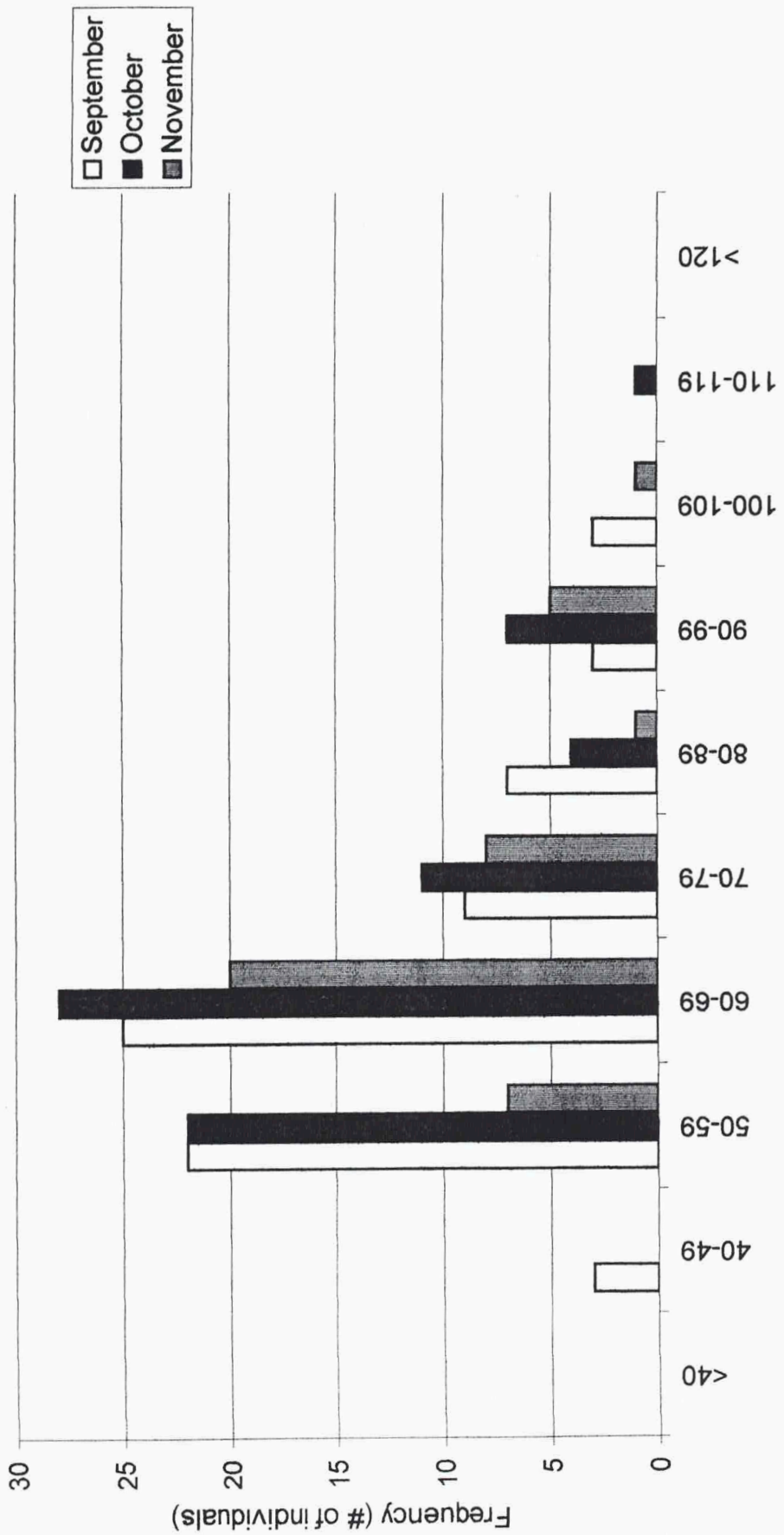

Figure 4: Size frequency of Coho in lower Toboggan Creek between September and November, 1998

that the 1998 coho juvenile population is composed of approximately 70% 0+ fish and 30% 1+ age. The mean size of juvenile coho is 70.4 mm (SD = 42 mm, n=343). Taking 20% as the percentage of 1+ fish in the spring (subtract 10% to account for over-winter mortality) and multiplying by the total estimated coho population for the upper kilometer (25,179) it is possible to estimate a smolt output of approximately 5,035 for this lower area of the creek. Holtby and Finnegan (1997) estimate Toboggan creek coho smolt production above the fish fence as ranging between approximately 20,000 and 100,000 from 1989 to 1997, with the estimate between 20,000 and 30,000 between 1995 and 1997. These numbers may be used as a validation source of the estimated smolt production (and so also juvenile densities) from this project. The lower three kilometers comprises 0.176 of the 17 km of available habitat estimated by Tredger (1979) and so may be expected to produce this portion of the smolts. The upper one kilometer comprises the vast majority of available habitat in this three kilometer section and therefore the majority of smolts are assumed to be produced from here; contributions from the lower two kilometers are assumed negligible for this calculation. Using the range of 20,000 to 30,000 smolts from Holtby and Finnegan (1997) for production above the fence (i.e., over 14 km) the estimated smolt production from the lower three kilometers is 4,300 to 6,400 in addition to what is produced above the fence. It must be recognized that the fence demarcation is an artificial barrier imposed by workers, it has no reality from the fish's perspective. In 1997 only an estimated 18 coho spawned downstream of the fence (M. O'Neill pers. comm.), this is not thought to be sufficient to account for the observed juvenile densities; it is highly likely that juveniles moved into these areas from upstream to rear.

The size frequency distribution of steelhead in Toboggan Creek is bimodal with peaks at 40-60 mm and 80-110 mm (Figure 5). Based on Figure 11 in Tredger (1979) age 0+ fish are generally <70 mm fork length, 1+ from 70 to 120 mm fork length, and age 2+ >120 mm fork length. Based on these divisions, the

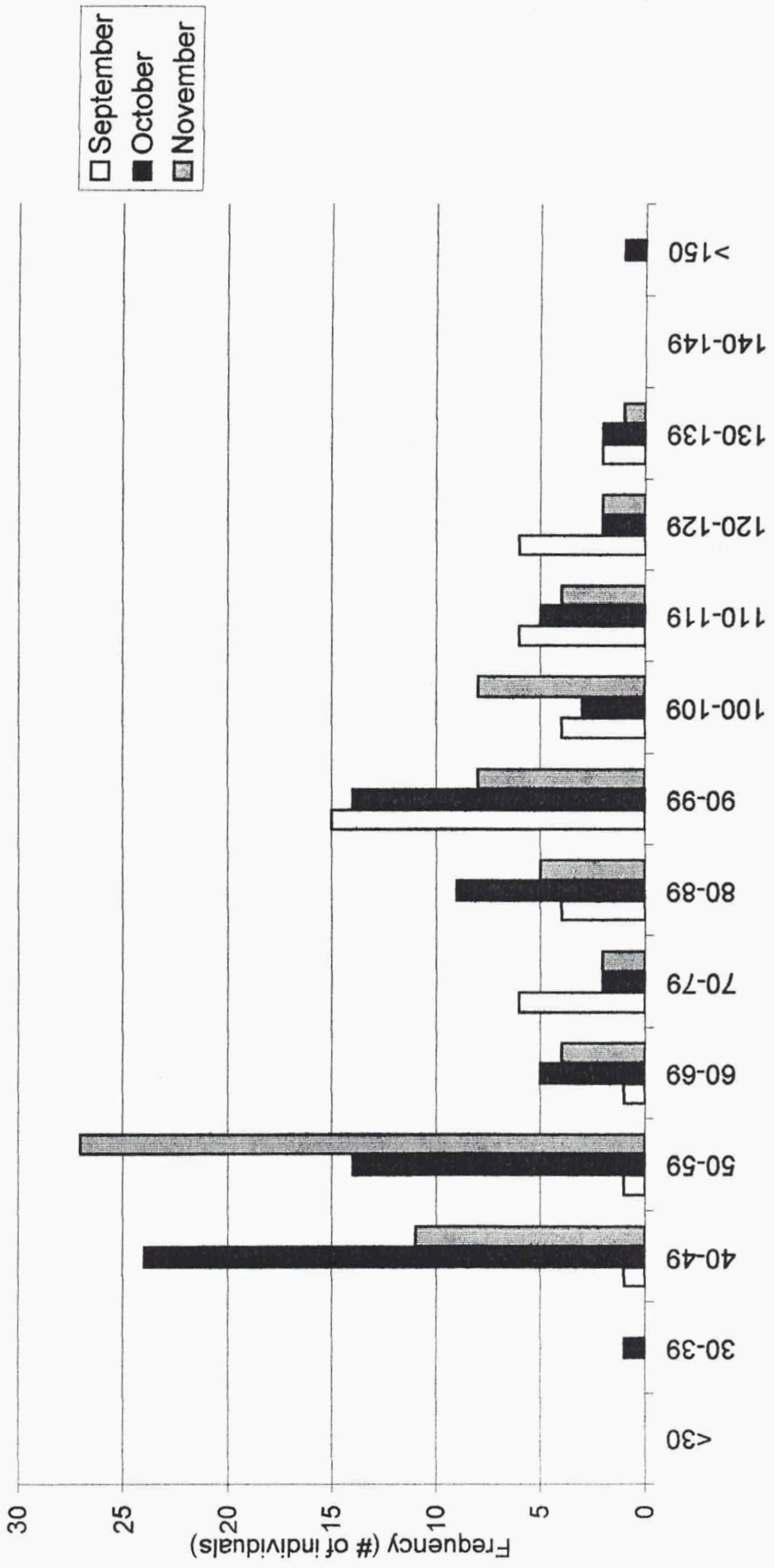

Figure 5: Size frequency of steelhead in lower Toboggan Creek between September and November, 1998

distribution of observed steelhead in Toboggan creek is approximately 45% 0+, 48% 1+ and 7% 2+. Using the same procedure as was used above for the coho, an estimated smolt production of 2,000 is calculated. Unfortunately, a validation source similar to the coho is not available for steelhead. The distribution is also seen to shift over the three months of sampling with an increase in the frequency of small (i.e., < 60 mm) steelhead in October and November. It is suggested that during September the pools are held by the larger size class and with their exit downstream, possibly to over-winter in the mainstem, vacancies are created for smaller fish to take over in these pools.

5.0 CONCLUSIONS

Within the lower 3 km of Toboggan creek the principle coho habitat is in the top 1000 m, steelhead appear to use most of the 3 km stretch. The majority (66%) of the 3 km is classed as low to low-moderate habitat. Isolated sections within these low to moderate habitat are very important areas with high productivity.

This area is estimated to support on the order of 54,000 juvenile coho and steelhead. These species appear to use Toboggan Creek through to age 1+ for coho and 2+ for steelhead. The population estimates for Trap Sites 2 and 3 are thought to be relatively accurate, while for Trap Site 4 important assumptions appear to be significantly violated. There appears to have been an order-of magnitude increase in juvenile numbers (density) between the late 1970's and present.

Determination of Toboggan Creek juvenile use of the Bulkley River will require another method rather than direct sampling for marked fish in the mainstem Bulkley. There is far too great an area for the fish to disperse and there is a lack of suitable habitat near the Toboggan Creek confluence to keep the fish in that area.

6.0 RECOMMENDATIONS

The following recommendations are made for future sampling in this lower section of Toboggan Creek.

- Continued trapping and marking in the established sites to refine population estimates. The use of a separate marks in different years(e.g., ventral lobe caudal clip in 1999) will allow separation of fish depending upon time of marking. This will be particularly valuable when these fish are returning as adults.
- Marking of juvenile steelhead in a similar manner as the coho to refine steelhead population estimates.
- Juvenile trapping in other areas, particularly in upper 1,000 m. Two more trap sites should be established in the upper 800 m (i.e. within habitat sections 22-29).
- In order to evaluate juvenile movement into the Bulkley River, intensive sampling within habitat sections 1 and 2 is suggested (i.e., periodic and regular) electroshocking. There are very few marked fish at this time, therefore any marked fish will have to have come from upstream.
- Testing of mark-recapture assumptions, particularly immigration, differential mortality between marked and unmarked, and equal catchability of marked and unmarked, would allow a quantitative estimate of the accuracy of the resulting population estimates.

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Personal Communications

Mike O'Neill. 1996 Coho Assessment at Toboggan Creek and 1997 Coho Assessment at Toboggan Creek memos to Barry Finnegan (Pacific Biological Station) Feb 3, 1997 and Jan 5, 1998

Appendix 1

Detailed Results of Habitat Sampling

	Section	1	2	3	4	5	6	7	8	9	10	11	12
Hydraulic													
	Wetted width (m)	13.50	13.50	8.40	11.70	8.80	10.80	12.20	10.90	7.90	7.40	7.40	8.00
	Channel width (m)	16.50	16.50	7.70	12.80	10.80	15.20	15.50	15.10	10.80	8.90	10.90	10.00
	Mean depth (m)	0.40	0.40	0.25	0.22	0.32	0.21	0.18	0.21	0.22	0.25	0.25	0.22
	Maximum depth (m)	0.60	3.0 - 4	0.35	0.28	0.40	0.40	0.45	0.41	0.35	0.35	0.38	0.35
	Velocity (m/s)			1.03				1.30					1.38
	Gradient (%)	2.5	2.5	1.5 - 2	1.5 - 2	2.0	1.5	2 - 2.5	1 - 1.5	1.5	1.5	1 - 1.5	1.5
Habitat Types													
	Reach Classification												
	% Pool-riffle						5		90				5
	% Forced pool-riffle						15	20	10	100	10		15
	% Plane-bed	10.0 - 15		100	100	85	80	80			90	95	80
	% Step-pool	85 - 90	100			15							
Habitat Units													
	% Pool	<5	30		<2	<5	10	<2	<10	10	<5		<5
	% Riffle	75	20	95	>95	80	80	90	60	70	90	95	80
	% Glide	<10		0		15	10	<10	35	20	5	5	15
	% Cascade	15	50										
	% Undercut banks	<5			<10	<5	<5		<5			<5	<5
	LWD (# of pcs)	3 pcs	7 pcs	3 pcs	2 pcs	4 pcs	8 pcs	10 pcs	~15 pcs	10 pcs	6 pcs	6 pcs	12 pcs
Substrate													
	Predominant size	cobble	boulder	cobble/boulder	cobble/boulder	cobble/boulder	cobble	cobble	cobble	cobble	cobble	cobble	cobble
	% Boulder	15	40	30	20	20	15	15	15	10	5	5	<5
	% Large cobble	30	nr	30	40	30	25	30	25	25	25	25	20
	% Small cobble	25	nr	25	20	25	25	25	25	25	25	30	20
	% Large gravel	20	nr	15	20	20	20	20	20	20	25	25	30
	% Small gravel	10	nr			5	10	10	10	10	15	15	25
	% Fines					<2	5		5	10	5		
Fish Habitat Quality		L	L	L	L	L	L-M	L	L-M	L-M	L-M	L-M	L-M

L = Low
L-M = Low-Moderate
M = Moderate
M-H = Moderate-High
H = High

	Section	13	14	15	16	17	18	19	20	21	22	23
Hydraulic												
	Wetted width (m)	13.90	6.20	6.90	8.00	13.00	9.70	9.60	7.40	9.30	9.50	5.50
	Channel width (m)	17.00	13.20	12.60	10.40	14.90	12.90	10.90	7.90	12.80	10.00	11.80
	Mean depth (m)	0.24	0.28	0.38	0.32	0.26	0.30	0.28	0.36	0.27	0.26	0.42
	Maximum depth (m)	0.46	0.45	0.48	0.60	0.34	0.45	0.35	0.60	0.40	0.55	0.60
	Velocity (m/s)					0.63					0.95	
	Gradient (%)	1.5 - 2	1.5 - 2	2.0	1.5 - 2	1.5	2.0	2.0	2.0	1.5	1.0	1 - 1.5
Habitat Types												
	Reach Classification											
	% Pool-riffle		40							50	100	100
	% Forced pool-riffle	5				20				20		
	% Plane-bed	95	60	99	95	70	99	99	100	30		
	% Step-pool					10						
Habitat Units												
	% Pool	<5	15	<1	<5	15-20	<5	<5	5	20	15	20
	% Riffle	70	70	~100	80	70	~100	~100	70	40	60	50
	% Glide	25	20			10	<2			40	25	30
	% Cascade				15				25			
	% Undercut banks	10	10	10	10					20	50	25
	LWD (# of pcs)	9 pcs	10 pcs	6 pcs	12 pcs	17 pcs	1 pc	2 pcs	0 pcs	17 pcs	nr	17 pcs
Substrate												
	Predominant size	cobble	cobble	cobble	cobble	cobble	boulder/cobble	cobble/boulder	boulder/cobble	cobble/gravel	cobble	gravel
	% Boulder	<5	5	<5	15	15	15	20	20	<5	<5	<1
	% Large cobble	20	40	30	35	30	40	40	40	15	25	5
	% Small cobble	20	30	20	25	30	25	30	20	25	30	25
	% Large gravel	35	15	25	15	15	20	10	20	25	30	40
	% Small gravel	20	10	20	10	10				20	10	20
	% Fines			5						10		10
Fish Habitat Quality		L-M	L-M	L-M	L-M	M-H	L	L	L	M-H	M-H	M-H

	Section	24	25	26	27	28	29	30
Hydraulic								
	Wetted width (m)	5.80	6.50	16.50	5.50	9.40	7.50	11.10
	Channel width (m)	10.80	10.60	17.50	9.40	10.70	10.10	12.00
	Mean depth (m)	0.41	0.29	0.20	0.28	0.22	0.42	0.24
	Maximum depth (m)	>0.6	0.35	0.30	0.40	0.45	>0.9	0.35
	Velocity (m/s)				1.03			
	Gradient (%)	1.0	1.0	1.0	<1	1-1.5	<1	<1
Habitat Types								
	Reach Classification							
	% Pool-riffle	70	85	80	100	30	40	100
	% Forced pool-riffle	30	15			70	60	
	% Plane-bed			20				
	% Step-pool							
Habitat Units								
	% Pool	15	20	20	20	20	20	15
	% Riffle	40	20	60	60	50	40	70
	% Glide	45	60	20	20	30	40	15
	% Cascade							
	% Undercut banks	35	40	20		30-40	25	5
	LWD (# of pcs)	>20 pcs	>40 pcs	nr	27 pcs	>20 pcs	7 pcs	5 pcs
Substrate								
	Predominant size	gravel	gravel	gravel/cobble	gravel	gravel	gravel	cobble
	% Boulder	<2	<2	<5	<1	<1	<1	10
	% Large cobble	15	10	15	10	5	<5	15
	% Small cobble	20	15	25	15	25	15	35
	% Large gravel	35	40	30	25	30	40	20
	% Small gravel	20	25	20	30	25	25	10
	% Fines	10	10	10	20	15	15	<10
Fish Habitat Quality		M-H	H	M-H	H	H	M-H	H

Appendix 2

Raw Data of Juvenile Sampling

Toboggan Creek Juvenile Sampling Results (values in mm [fork lengths]) for Site 1

	03-Sep-98			06-Sep-98			09-Sep-98			03-Oct-98			06-Oct-98		
	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3
Coho			Not Set			Not Set			Not Set	118		Not Set	92		Not Set
Steelhead	41 52 94	0		128			132	0		135 108 104 105 135 135 140	90 130 118 146		96	56 102	
Dolly Varden					158						104				
Lamprey															

	03-Sep-98	06-Sep-98	09-Sep-98	03-Oct-98	06-Oct-98
# traps	2	2	2	2	2
Time set	17 hrs	15.5 hrs	16.5 hrs	16 hrs	18.75 hrs
Total Hours	34	31	33	32	37.5

Toboggan Creek Juvenile Sampling Results (values in mm [fork lengths]) for Site 1 (Con't)

	09-Oct-98			12-Oct-98			03-Nov-98			06-Nov-98			09-Nov-98			12-Nov-98		
	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3
Coho			Not Set			Not Set		70	Not Set								91	Not Set
																	RECAPTURES	
																	100	
Steelhead	111	152			102		78	106		76	50	61		98	95		106	
	118						88	139			55	104		99	95			
	133						89	108			145	95		106	115			
							86	100			81			150				
							96				100							
							111											
							105											
Dolly Varden																		
Lamprey		135																
	09-Oct-98			12-Oct-98			03-Nov-98			06-Nov-98			09-Nov-98			12-Nov-98		
# traps	2			2			2			3			3			2		
Time set	17.5 hrs			18 hrs			19.25 hrs			20.25			19.5			20		
Total Hours	35			36			38.5			60.75			58.5			40		

Toboggan Creek Juvenile Sampling Results (values in mm [fork lengths]) for Site 2

	03-Sep-98			06-Sep-98			09-Sep-98			03-Oct-98			06-Oct-98			09-Oct-98		
	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3
Coho	58	71	86	85	72	100		59	59		61	80	62	54	65	78	61	54
		52	92	63	63	52		54	60		87	65		53	60	66	61	59
		60	80			94		53	66		74	51		60	87		53	63
		95	55			95		58	68		51	61		50	81		73	56
		81	92			68		59	59		61	69		46	58		47	87
		62	62			58		105	66		52	52		42	62		65	85
		55	70			72		60	46		65	76			58		60	65
		64	62			84		51	60		65	55					62	69
		80	51			60		84	61		64	90					112	73
		80	66			69		50	52		54	65					65	
		55	52			70		49	62		51	92						
		51	63			57		63	69		53	60						
		66	95			54		62	74		58	60						
		51	94			68		55	56		51	58						
		94	62			50		50			91	60						
		58	94			50		52				58						
		58	75			85		51				56						
		54	50			62						67						
		88				100						60						
		65				98						65						
		59										55						
		60										75						
		56										87						
		51										62						
		62										66						
		50										95						
		63																
		95																
	RECAPTURES			RECAPTURES			RECAPTURES			RECAPTURES			RECAPTURES			RECAPTURES		
						68		70	69		97	68		90	54		62	65
						65			61			55		68	59		80	71
						58			61			56		57	50		62	54
						66			82			60		58	54		66	64
						94			65			61		52	63		62	68
									58			51		64	63			51
									49			54		61	57			52
									74			65			63			62
									57			62			55			53
									64			68			69			87
									68			91			52			53
									51			70			52			75
									58			54			61			54
												52			55			64
												54			53			75
												70			54			64
												64						51
												60						63
												59						80
																		68
																		62
																		60
																		61
																		70
																		57
																		66

Toboggan Creek Juvenile Sampling Results (values in mm [fork lengths]) for Site 2 (Con't)

	12-Oct-98			03-Nov-98			06-Nov-98			09-Nov-98			12-Nov-98		
	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3
Coho			55		60	53		59	69			76			47
			75		79	72			66			89			92
			89		85	62			103			78			72
			73			57			76			91			
			60						62			88			
			101						52						
			53						59						
	RECAPTURES			RECAPTURES			RECAPTURES			RECAPTURES			RECAPTURES		
	48	54		67	65		68	69		68	47		68	55	
	63	66			65		87	76		66	57			55	
	61	63			61		68	71		67	63			51	
	64	54			62		75	65		60	73			89	
	62	52			65			73			73			76	
	52	66			52			55			62			54	
		69			69			54			59			60	
		65			60			51			65			58	
		58			55			68			68			65	
		55			63			60			74			51	
		57			68			65						50	
		65			54			59						64	
		66			55			62						66	
		65						56							
		54						74							
		65						64							
		64						66							
		53						59							
		55													
		55													
		56													

Toboggan Creek Juvenile Sampling Results (values in mm [fork lengths]) for Site 2 (Con't)

	03-Sep-98			06-Sep-98			09-Sep-98			03-Oct-98			06-Oct-98			09-Oct-98		
	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3
Steelhead	75		85	89	137		90	79	86	58	51	93	87	42	50	94	46	78
				124	125		99	39	44	82	111	120		47	52	86	98	47
				136	100		126	43	45	132	122	47		36	47	78	51	40
				91	128			50	48	129	46	48		39	132	106	51	44
				120	111			48	77		49	89		48	54		55	35
				44 (dead)	109			80			41	47		50	42		58	46
				100	113			41			49	47		50	93		55	90
				99	98			48			54			60	96		42	37
					92						45			48	57		42	83
					78						85			39	40		44	
					112						49			49	70		43	
														49	43		49	
																	51	
																	46	
																	43	
																	45	
																	49	
																	44	
																	41	
																	49	
																	85	
																	50	
																	81	
																	93	
																	51	
																	48	
																	47	
																	53	
																	49	
																	54	
																	60	
																	49	
																	44	
																	50	
																	42	
																	92	
																	50	
Dolly Varden												108					55	126
												104						118
Lamprey																	140	
	03-Sep-98			06-Sep-98			09-Sep-98			03-Oct-98			06-Oct-98			09-Oct-98		
# traps	3			3			3			3			3			3		
Time set	17 hrs			15.5 hrs			16.5 hrs			16.5 hrs			18.5 hrs			17.75 hrs		
Total Hours	51			46.5			49.5			49.5			55.5			53.25		

Toboggan Creek Juvenile Sampling Results (values in mm [fork lengths]) for Site 2 (Con't)

	12-Oct-98			03-Nov-98			06-Nov-98			09-Nov-98			12-Nov-98		
	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3
Steelhead	130	36	45	51	47	51	122	49	51	50	57	49	108	46	44
	96	44	53	115	42	89	95	52	46	50	51	91		49	45
	100	51	48	109	52	92		42	46	97	50	82		58	36
	92	49	49		90	50		42	51		51	58		51	54
		50	62		85	52		50	57		45	107		80	48
		43	49		52	54		46	46		42	47		51	48
		41	82		123	49		44	54		46	79			49
		40	93		128	62		51	46		50	47			49
		41	116		104			51	67		45	66			81
		42	115		44			42	46		52	87			83
		49	70		53			50	57		50				57
		48	55		51			51	57		53				49
		68	50		49			57	63		52				52
		50	51		50			95	46		59				50
		51	50		113						85				45
		46	53		50										46
		43	47		51										63
		48			91										45
		55			57										53
		67			49										
		48													
		58													
		44													
Dolly Varden	116					120						109			
Lamprey															
	12-Oct-98			03-Nov-98			06-Nov-98			09-Nov-98			12-Nov-98		
# traps	3			3			3			3			3		
Time set	18 hrs			19.5 hrs			20			19.75			20.75		
Total Hours	54			58.5			60			59.25			62.25		

Toboggan Creek Juvenile Sampling Results (values in mm [fork lengths]) for Site 3

	03-Oct-98			06-Oct-98			09-Oct-98			12-Oct-98			03-Nov-98		
	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3
Coho	65	56		60	71			65	75	60		75		88	68
		66			76			65							
		67			60			71							
		54			97			75							
		60			65										
					67										
					RECAPTURE			RECAPTURE						RECAPTURE	
				65	60			54					54	78	
					68			60					69	73	
					57			68					57	63	
					54			67						68	
					66			67						69	
														66	
Steelhead	132	95	41	85	90	88	85	97		84	64		51	39	46
	115	112	151	95	95	74	60	100					42	114	121
	111	152	132	97	112								48	91	124
	90	124	132	93	78								39	91	85
	85	81	110	94	91								55		
	91	98	105	110	93								48		
	81	104	122	54									90		
	89	88	82	60											
				109											
				91											
Dolly Varden	118	99			120	160	135								
		130													
Lamprey															
		03-Oct-98			06-Oct-98			09-Oct-98			12-Oct-98			03-Nov-98	
# traps		3			3			3			3			3	
Time set		17 hrs			19 hrs			18 hrs			18.5 hrs			20 hrs	
Total Hours		51			57			54			55.5			60	

Toboggan Creek Juvenile Sampling Results (values in mm [fork lengths]) for Site 3 (Con't)

	06-Nov-98			09-Nov-98			12-Nov-98		
	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3
Coho		65			69				94
					60				90
		RECAPTURE			RECAPTURE			RECAPTURE	
	69	66		69	60	77		60	
		73		58	69			69	
				54				58	
Steelhead	63	134	54	42	53	45	55	64	
	45	97	96	54	88	108	114		
	85	82	82		79	84	42		
	92	65	102		100		97		
	103		94						
	91								
	98								
	90								
	92								
	89								
Dolly Varden					126				
Lamprey									
		06-Nov-98			09-Nov-98			12-Nov-98	
# traps		3			3			3	
Time set		20.5			20			21	
Total Hours		61.5			60			63	

Toboggan Creek Juvenile Sampling Results (values in mm [fork lengths]) for Site 4

	03-Sep-98			06-Sep-98			09-Sep-98			03-Oct-98			06-Oct-98			09-Oct-98		
	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3
Coho	61	95	75	71	68	88	88	71	57	73	70	76	58	61	102	89	77	
	72	94		56	107	71	57	98	91		79	95	90	63		66	74	
	89			86		95	85		78		86		92	63		72	59	
				65			62		85		69		90	109		65	62	
				75			88		101		74		106	70		68	65	
				82			72				60		94	75			65	
							100						71				62	
													84					
													93					
													90					
													77					
	RECAPTURES			RECAPTURES			RECAPTURES			RECAPTURES			RECAPTURES			RECAPTURES		
				88			84	65		111				74			90	
							98											
Steelhead	96	80	112	77	118	70	88	80	126	58	92	55	54	81	59	95	111	58
	87	100	120	95		87	61	113	99		61	80		86	108	82	112	67
			108	129		90	77	114	93		102			121	122	120	122	
			92			75	100	100	117		66			100			111	
							82	96	99		85						62	
							63				87							
							123				105							
							119											
							122											
Chinook											70					59	74	
																72		
																66		
Dolly Varden		118	118	91		126	129				91	135	121	100		95	118	
			138	134		122	142										80	
				127		109	113											
						113	127											
	03-Sep-98			06-Sep-98			09-Sep-98			03-Oct-98			06-Oct-98			09-Oct-98		
# traps	3			3			3			3			3			3		
Time set	17.5 hrs			16.5 hrs			17 hrs			14.75 hrs			16.5 hrs			16.5 hrs		
Total Hours	52.5			49.5			51			44.25			49.5			49.5		

Toboggan Creek Juvenile Sampling Results (values in mm [fork lengths]) for Site 4 (Con't)

	12-Oct-98			03-Nov-98			06-Nov-98			09-Nov-98			12-Nov-98		
	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3	Trap 1	Trap 2	Trap 3
Coho		73		62	62	62	84	67		70			76		92
		72		69	65		67	72		71			90		
				71	92		64			66			90		
				77	90		75			73			75		
				100	90		64						83		
					75		64						70		
					69										
	RECAPTURES			RECAPTURES			RECAPTURES			RECAPTURES			RECAPTURES		
					75		108	76		64			63	60	
					75			64					73	75	
					75			64					64	90	
								75					71	75	
								76							
Steelhead			49	52	57	50	55	75	51	78		52	98	77	
			55	53	57	44		87	50	88		59		83	
				68	96	52		65	53	91		56		95	
				55	78	51			59			60			
				60	104	50			51						
				91		50			50						
				54		105			52						
				49		54									
				56		49									
				96											
				41											
Chinook															
Dolly Varden				134						134					
	12-Oct-98			03-Nov-98			06-Nov-98			09-Nov-98			12-Nov-98		
# traps	3			3			3			3			3		
Time set	16.75 hrs			17.75 hrs			18			21.75			21		
Total Hours	50.25			53.25			54			65.25			63		