A Petersen Mark-Recapture Estimate of the Steelhead Population of the Bulkley/Morice River Systems Upstream of Moricetown Canyon

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Abstract

The Bulkley/Morice river systems are important steelhead systems of the Skeena River watershed for which steelhead abundance has historically been estimated by indirect methods. In 1999-2000, a Petersen mark-recapture program was conducted to provide the first direct estimate of steelhead population in these rivers. Steelhead were tagged by seine and dip-net at Moricetown in Autumn, 1999, and an angling recapture program was conducted in Spring, 2000. The results of this project indicate the steelhead population upstream of Moricetown Canyon was 27,005 (95% confidence intervals 22,261-35,479) in Autumn, 1999. Classification of fish by sex was poor by the tagging crews during the Autumn fisheries. The seine and dip-net fisheries appear to representatively sample fish with respect to size, though there is some indication that they select different sizes. The rate of drop back of fish below the Canyon due to tagging is low. The tagged fish distribute themselves similar to untagged fish throughout the system. The Spring angling methodology appears to sample the fish population representatively with respect to sex, size, and tagged versus untagged. The derived population estimate appears to be an appropriate estimate based on its precision and the lack of significant violations of assumptions or demonstrable biases.

ACKNOWLEDEMENTS

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1.0 INTRODUCTION

1.1 Background

The status of steelhead (*Onchorynchus mykiss*) stocks in the Skeena River has spawned much controversy over the past thirty years. This controversy has resulted from differing allocation requirements by various user groups and the lack of precise estimates of steelhead abundance in the river. Within the Skeena watershed are a number of groups with direct interest in steelhead (First Nations, anglers, guides) and for whom access to the resource is culturally, economically or recreationally very important. Skeena steelhead migrate into the river at the same time as coho (*O. kisutch*), sockeye (*O. nerka*), and pink salmon (*O. gorbuscha*) and are captured incidentally by the commercial fleet targeting these other species. This interception draws the commercial fleet into the resource allocation equation though they do not directly utilize the species. First Nations as well become involved through their mixed stock fishery (sockeye and coho) and incidental catch, while for sport fishers the steelhead is a focus for expanding recreational fisheries on a catch and release basis.

In order to allocate fishing opportunity to various groups and determine if fisheries can proceed, it is critical to have an accurate estimate of the number of fish in the system in order to ensure conservation targets are met. Steelhead stock status reports issued by the Ministry of Environment, Lands and Parks (MELP) in the early 1990's suggested run sizes of less than 20,000 summer run steelhead into the Skeena River (Figure 1; see also Table 10, Section 5.1). These low population estimates led to the initiation of a number of conservation steps by MELP fisheries managers including pressuring the commercial fleet to reduce fishing effort, and therefore steelhead bycatch, and encourage sport anglers (via regulations) to reduce harvest. In 1991, the Department of Fisheries and Oceans (DFO) pledged to reduce the incidental steelhead harvest by 50%. Subsequently, catch and release fisheries were implemented for sportfishermen, and commercial fishermen were restricted by season length and area, as well as being required to revive and release incidentally caught steelhead from their nets. A resurgence in the number of summer run steelhead returning to the Skeena over the past few years (see Figure 1), and a decline in returns of upper Skeena coho has refocused conservation efforts to conserve coho. This emphasis on the salmon is of benefit to steelhead due to their similar run timing as coho into the Skeena. Therefore, protection of one species provides some protection for the other.

The previously presented steelhead estimates are not derived by absolute counts, but instead rest on relative enumeration methodology (e.g., angler effort, commercial fishing effort, and indices). The current method for estimating Skeena steelhead stock abundance is to record the catch of steelhead at the Tyee Test Fishery in the lower Skeena estuary and use a multiplier (245 fish per daily index point; Hooten, 1999) to arrive at an estimate of steelhead entering the river. The method is similar for other Skeena salmon species and is calibrated annually for sockeye on the basis of the number of these fish returning through the Babine River counting fence. There has been no revised calibration of the multiplier used for steelhead at Tyee for many years, leaving the accuracy of any

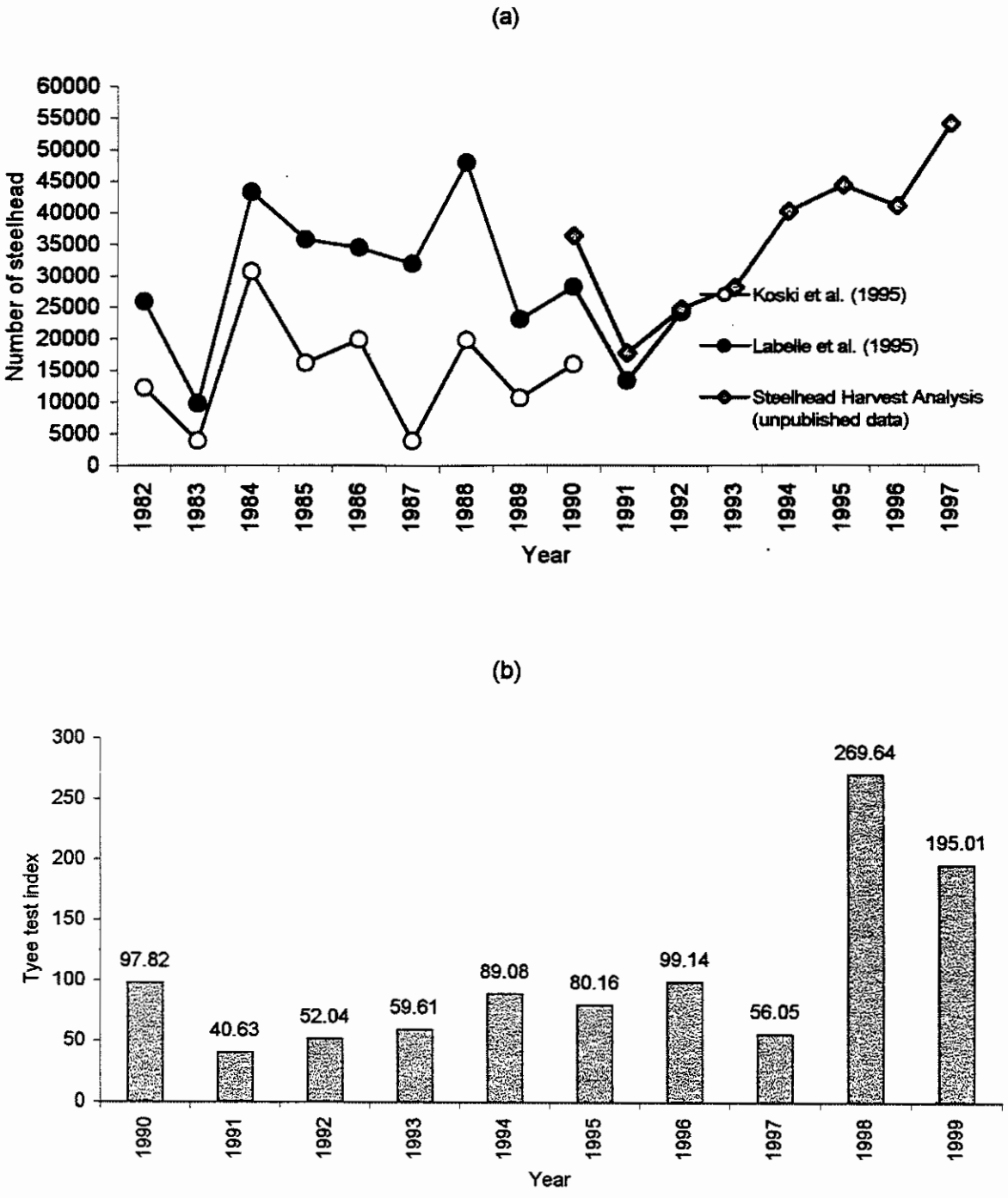

Figure 1: Estimated number of steelhead in Skeena River (a) from various sources, 1982-1997. The historic cumulative Tyee test index for steelhead is presented in (b).

estimate generated open to question. At issue for as long as the Tyee Test Fishery has existed has been the true relationship between it's catch and actual steelhead abundance (Hooten, 1999). Although the Tyee information may be indicative of trends in the population (Figure 1), it is not clear if it accurately estimates the actual strength of the summer run steelhead stocks entering the Skeena.

While the Tyee Test Fishery is considered adequate for management purposes by Provincial Fisheries staff (R. White, Fish and Wildlife Manager, Skeena Region, personal communication), more accurate information may be required to ensure conservation levels are met and that current management practices are appropriate. The increasing demand for fishing opportunity by the commercial sector, and the escalating intensity of catch and release sportfisheries, as well as First Nations requirements, result in increasing fishing pressure on salmonid stocks. The implications to these fisheries of management actions on the basis of estimates that are of unknown accuracy continues to be a source of concern for all users. Therefore, over the last two years the Bulkley Valley Branch of the Steelhead Society of BC (SSBC) has attempted to conduct mark-recapture programs to provide more accurate and precise steelhead abundance estimates.

The difficulties and logistics of conducting rigorous enumeration procedures on a system as large as the Skeena are formidable. However, population estimation programs on smaller components of this system may be successful in providing accurate estimates of the number of fish using the smaller system and provide data to calibrate indices such as Tyee. In the Autumn months of 1998 and 1999 the Wet'suwet'en Fisheries, in conjunction with Fisheries and Oceans Canada (FOC), conducted a coho tagging program at Moricetown, B.C. to assess the numbers of coho returning to the Bulkley/Morice River system. Steelhead caught incidentally in the dip-net and seine fisheries were tagged using tags supplied by MELP. In 1998 approximately 2,000 steelhead were tagged (Mitchell and Wadley, 1999) and in 1999 approximately 1,700 steelhead were tagged providing opportunities for mark-recapture programs to estimate the size of the steelhead population in the Bulkley/Morice system upstream of Moricetown Canyon. It was the first time this number of steelhead had been tagged in a Skeena tributary, and by utilizing standard methodology employed by fisheries scientists and MELP, a population estimate could be generated to estimate the steelhead population passing through Moricetown (English and Link, 1999).

In late 1998 and early 1999 a Fisheries Renewal of British Columbia (FsRBC) project was initiated by the Bulkley Valley Branch of the SSBC through the Bulkley/Morice Salmonid Preservation Group (BMSPG). The goal of this work was to carry out a recapture program in the early Spring of 1999 of the fish tagged in Autumn 1998 at Moricetown. The results of this program were to be used to generate the first Petersen mark-recapture population estimate of the Bulkley/Morice system. Between March 6th and 24th 281 steelhead (24 tagged) were captured in the upper reaches of the Morice system (Mitchell and Wadley, 1999); at this point the scientific collection permit issued by MELP was rescinded. The project was cancelled by MELP prior to completion due to concerns regarding the accuracy of tagging data from Moricetown. A review by a consultant (LGL Ltd., Sydney, B.C.; English and Link, 1999) commissioned by MELP

determined that while the SSBC project and proposed methodology was valid, the original tagging data was not adequate to generate an accurate population estimate as the number of tagged steelhead in the study area was uncertain. The consultant further suggested that information from a future tagging study at Moricetown would help to evaluate any estimate based on the 1998 data.

After cancellation of the SSBC Spring sampling program, MELP committed itself to assist in developing a more scientifically defensible project to estimate the steelhead populations in the Bulkley/Morice system. As part of this commitment they provided a single tag color and consistent tag series for application to the fish in Autumn 1999. This was done to avoid duplication of tag numbers and tag colour problems encountered in the Moricetown data from 1998. MELP supported the concept of an in-canyon estimate of the population that was to be generated by the dipnet recapture, in the canyon, of tagged steelhead from the seine fishery carried out immediately below Moricetown canyon. A consultant (SKR Consultants Ltd., Smithers, B.C.; SKR Consultants, 2000) was retained by the Wet'suwet'en Fisheries to analyze the data collected and provide an estimate of the number of steelhead migrating through Moricetown Canyon in the Fall of 1999 using the in-canyon methodology.

Through the summer and fall of 1999 the Bulkley Valley Branch of the SSBC continued to pursue the opportunity to conduct the Spring 2000 sampling component of the steelhead tagged at Moricetown in Autumn, 1999. MELP called for a peer review of the project proposal from four independent sources before issuing a collection permit. Discussions with MELP continued and the proposal was resubmitted incorporating recommendations from the review team. A decision was made to issue the permit (Appendix 1) in February of 2000 and funding was approved by FsRBC.

1.2 Objectives

It has been identified that little data is available for steelhead population sizes in British Columbia and the existing data is inconclusive (Anonymous, 1998). On the Skeena system there is an index derived from the Tyee Test Fishery that estimates the aggregate number of steelhead entering the Skeena from June through August and occasionally into September (this fishery is directed at sockeye abundance estimates and so generally only runs the length of the sockeye migration). There are also fence systems operated during the Autumn on the Upper Sustut River and during Spring migration on Toboggan Creek for enumeration of these respective steelhead stocks. It is with these limited data, in conjunction with the Tyee test fishery and fishing effort, that run estimates of the entire Skeena watershed are currently estimated.

The objectives of the 1999-2000 steelhead mark-recapture estimation project were:

1. To derive an estimate of the population size of steelhead upstream of Moricetown Canyon in the Bulkley/Morice system. This estimate may provide a benchmark of steelhead abundance in this system for future comparison and serve to calibrate the Tyee Test Fishery, at least for this single year.
2. To provide information on ancillary aspects of steelhead movement and behaviour on which there has been a great deal of speculation. Specifically, associated factors for which this project was expected to provide information were:
   - Rate of drop back of tagged fish below the canyon
   - Sampling biases between the seine fishery and dip-net fishery
   - Similarity of (or differences in) distribution of tagged and untagged fish after tagging
   - The final destination of steelhead relative to their timing of movement through the Canyon.
3. To encourage working relations between First Nations, communities and Government. First Nations and community groups are demanding larger roles in the management of natural resources; fostering these working relationships will be important in ensuring integrated management of these resources in the future.

2.0 STUDY AREA

The study area encompasses two of the primary steelhead producing streams of the Skeena River watershed – the Bulkley and Morice Rivers. Together these rivers are considered to be the destination of 33% (Koski et al., 1995) to 45% (Labelle et al., 1995) of the steelhead entering the Skeena River. The drainages account for approximately 15% of the Skeena River discharge (Annual mean discharge 911 m^3/s, range 702-1,230 m^3/s at Usk Station No. 08EF001; this and following discharge data from Anonymous, 1991). The Bulkley River (Annual mean discharge 134 m^3/s, range 100-188 m^3/s at Quick station No. 08EE004) is the largest tributary to the Skeena River, and is itself composed largely of flow from the Morice River (Annual mean discharge 74.4 m^3/s, range 58.1-92.1 m^3/s Houston Station No. 08ED002) which joins it downstream of Houston (Figure 2). For the purpose of this report the Bulkley and Morice rivers are considered together as the Bulkley/Morice.

Originating in a high lake system (i.e., above 850 m) which includes Bulkley, Maxan, Nanika, Kidprice, Atna and Morice lakes, the Bulkley/Morice drains an area of approximately 12,173 square kilometers (Morten, 1999). This drainage flows through the Boreal Interior, Subalpine Southern Cordilleran, and Southern Cordilleran Ecoclimatic Regions (Anonymous, 1989). All species of Pacific salmon (*Oncorhynchus*) are present in the system and resident fish species include rainbow (*O. mykiss*), cutthroat (*O. clarki clarki*), and bull trout (*Salvelinus confluentus*), Dolly Varden char (*S. malma*), kokanee (*O. nerka*), Mountain whitefish (*Prosopium williamsoni*), Pacific lamprey (*Lampetra* sp) and sculpins (*Cottus* sp.).

These river systems extend from the confluence of the Bulkley and Skeena Rivers at Hazelton (Lat. 127°40', Long. 55°15') upstream approximately 218 kilometers to the outflow of Morice Lake (Lat. 127°25', Long 54°75'). The study area encompasses the full length of these rivers, but the focus of this project is the area upstream of Moricetown Canyon. Steelhead are found distributed throughout these systems and existing information suggests that the majority of these fish overwintering reside in the mainstem areas until late April to early May at which time they move into tributaries and suitable mainstem areas to spawn in May and June (see for example Whately and Chudyk, 1979; Saimoto, 1995; O'Neill, 1995,1996; Mitchell, 1999a, 1999b, 2000). While some fish may reside over the winter in lakes and even in minor tributaries, it was determined through discussion with MELP that the mainstem rivers would provide the best opportunity for a representative sample of steelhead present. The effort required to sample smaller tributaries such as the Little Bulkley and Telkwa rivers could not be justified with the time and budget constraints of the present project.

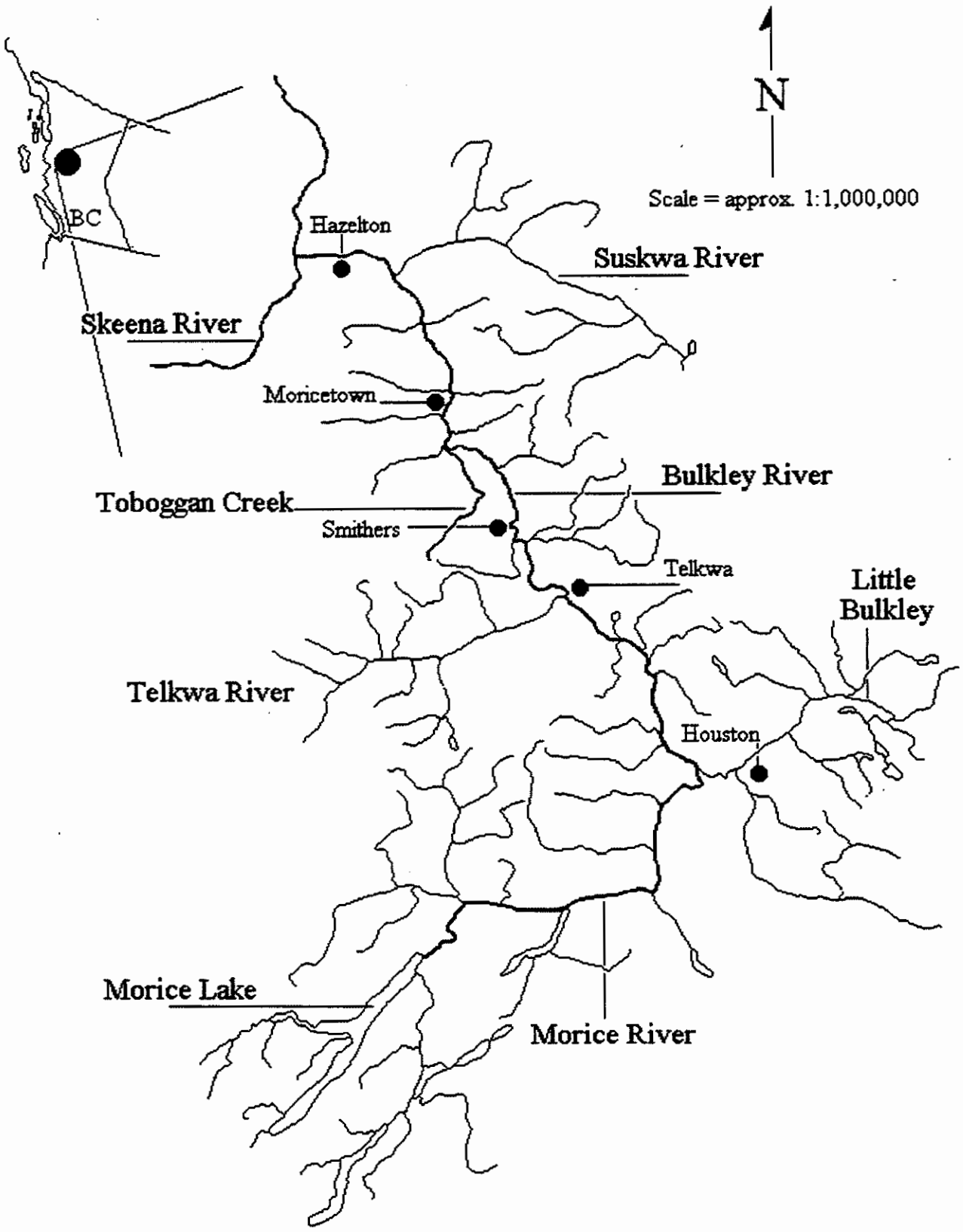

Figure 2: Study area of 1999-2000 Bulkley/Morice steelhead assessment

3.0 MATERIALS AND METHODS

3.1 Tagging and Recapture Procedure

3.1.1 Application (Autumn, 1999)

The Wet'suwet'en Fisheries conducted the 1999 coho and steelhead tagging program from August 8 to October 30, 1999. The following description of methodology is from Anonymous (2000). The tagging program consisted of two crews using different capture methods – a beach seine crew below the canyon and a dip-net crew within the canyon. Marking of steelhead was carried out by applying a numbered spaghetti tag at the base of the dorsal fin with a secondary mark applied by a punch to the upper (seine fishery) or lower (dip-net fishery) lobe of the caudal fin.

Beach seining was carried out in the pool immediately below Moricetown Canyon using a 64 m x 11m seine with 5 cm diagonal mesh set from a jet boat. The net was set in a semi-circle to capture the fish and drawn slowly to the beach to sort, tag and release captured species. Non target species (pink salmon, Dolly Varden, whitefish and bull trout) were released. Coho and steelhead were handled in the water for tagging, secondary mark application and measurement, and released after data was recorded.

Two crews were utilized in the dip-net fishery to tag and release coho and steelhead both within Moricetown Canyon and in the fishway area at the head of the canyon. Each crew was comprised of two fishermen, a runner, a tagger and a data recorder. Steelhead were dipnetted and transported immediately to the tagging location, measured, tagged and punched, and released upstream of the fishways immediately after tagging. Crews normally started fishing half an hour after sunrise and finished a half hour before sunset and did not fish on weekends. One day was lost to snow conditions in October due to safety concerns.

3.1.2 Recovery (Spring, 2000)

The sampling program for the Bulkley/Morice in the Spring of 2000 was developed on the basis of recommendations from MELP staff through 1999. A single pass system was conducted that entailed sampling by angling of fourteen prescribed reaches of the study area (Figure 3). Fishing was by means of bait (roe) and was carried out between March 26 and April 20, 2000 with effort per reach remaining consistent between reaches. Remote areas were accessed via helicopter. The sampling was conducted by experienced local anglers. Anglers were encouraged to beach fish as quickly as possible, keeping them in the water while examining them closely for tags, secondary marks, predator, hook or net scars and measuring them before releasing them back to the river. The dorsal surface of the fish was examined for tag scars as well as the tail. Any fish that were hooked deep or bleeding were recorded as such and the line was cut leaving the hook in to avoid further injury by attempting to remove the hook.

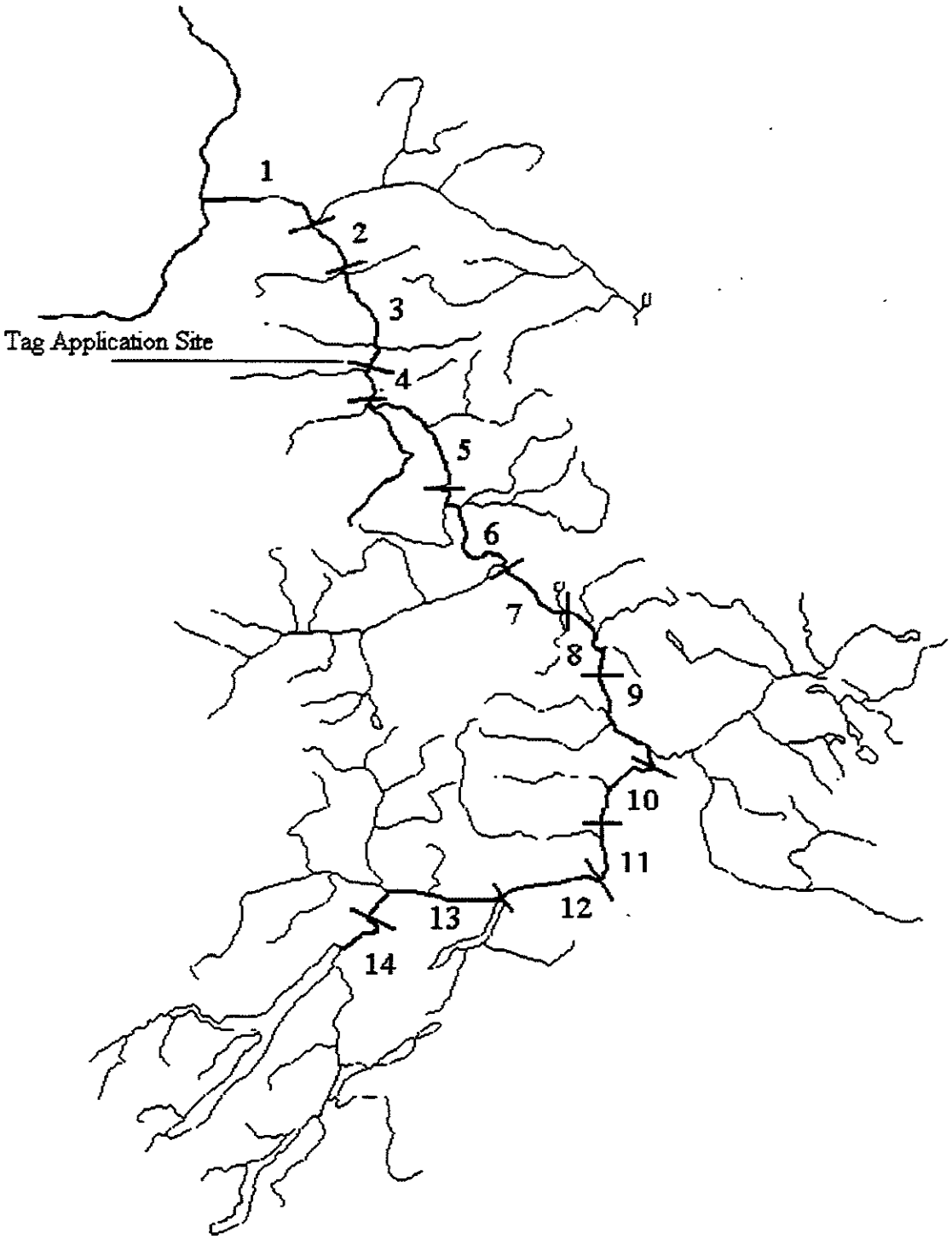

Figure 3: Breakdown of reaches of 1999-2000 Bulkley/Morice steelhead assessment for Spring recovery component. See also Appendix 1 for breakdown of reaches by kilometer.

3.2 Statistical Analysis

3.2.1 Population Estimate

The population of steelhead above Moricetown Canyon was estimated by (from Krebs, 1989):

$$N' = ([(M+1) * (C+1)] / [R+1]) - 1$$

Where N' = Estimated population size at time of tagging
M = Number of individuals marked in first sample
C = Total number of individuals captured in second sample
R = Number of individuals in second sample that are marked

95% confidence intervals were calculated as (using Krebs (1989) normal approximation approach):

$$N'' = 1/\delta * M$$

Where N'' = upper/lower 95% confidence interval
$\delta = R/C \pm Z_\alpha$ * square root ([(R/C) * (1-R/C)] / [C-1])
Z_α = 100(1-α)th percentile of the standard normal distribution
(i.e., value of 1.96)

3.2.2 Assessment of Accuracy and Tests of Bias

The accuracy of the measurement of fork length on the same fish between the Autumn application and Spring recovery programs was assessed by a one-sample *t*-test on the difference between the corresponding measurements. For this and all other tests $\alpha = 0.05$ and the null hypothesis is rejected if $p<0.05$. Mean fork lengths were compared between male and female steelhead of the Spring recovery sample using the *t*-test as well.

Biases in sampling were tested using a chi-square analysis for frequency of occurrence of sex and size (fork length). Frequency of occurrence on a spatial scale (i.e., among reaches) and temporal scale (among hours of the day, and weeks of the application season) was also tested using chi-square. The originally proposed Kolmogorov-Smirnov test for evaluation of biases in size was rejected in favour of the chi-square test as the Kolmogorov-Smirnov test would have required grouping of continuous data which is to be avoided (Sokal and Rohlf, 1969; Zar, 1984). To evaluate differences in fork length between sexes and between tagged and untagged fish in the Spring recovery sample, standard Analysis of Variance (ANOVA) and Tukey's multiple comparison procedure were used. The construction of normal probability plots indicated that this data was approximately normally distributed and so standard parametric procedures for tests of means were considered appropriate.

4.0 RESULTS

The following results are divided into five sections 1) Population estimates, 2) Population characteristics/steelhead condition, 3) Accuracy of measurements, 4) Tests of biases, and 5) Other species.

4.1) Population Estimates

Between August 9 and October 27, 1999, there were 1,701 individual steelhead tagged by the seine (173 fish) and dip-net (1,528 fish) fisheries at Moricetown. The Spring angling recapture effort above Moricetown captured a total of 1,236 individuals of which 68 were fish tagged at Moricetown in 1999 (four from the seine fishery, 64 from the dip-net fishery). One fish (untagged) captured in the Spring may have originally carried a tag and lost it (as determined by a possible tail punch) for an estimated tag loss of 1.5%. Of the 68 tagged recaptures, seven of them were caught more than once (six twice, one three times), for a multiple recapture rate of 10.3%. Finally, three tagged fish were captured downstream of Moricetown (thus a total of 71 tagged fish recaptured) for an estimated drop back rate below the canyon of 4.2%. These last three rates (tag loss, multiple recaptures, and drop back) are used to correct the estimate for these processes. In addition, three brown tagged fish were recaptured which could not be traced to Moricetown data, but their tag number series was identified as having been applied in August and September, 1999. These three fish were not included in the analysis as it is unknown how many other fish may have been tagged and unrecorded which would influence the value of M. Deletion of these fish and inclusion of only those fish known to have been recorded at Moricetown was determined to be the most parsimonious approach. The population estimates are presented in Table 1.

Table 1: Population estimates of steelhead above Moricetown Canyon, Autumn, 1999.

	Uncorrected	Corrected
N	**30,512**	**27,005**
M	1701	1630[a]
C	1236	1159[b]
R	68	69[c]
95% CI[d]	25,114-40,214	22,261-35,479

[a] = Corrected for drop back
[b] = Corrected for multiple recaptures
[c] = Corrected for tag loss
[d] = 95% confidence intervals

The population estimates for uncorrected and corrected data range between 27,005 and 30,512, a difference of 3,507 fish (i.e., the range of estimates are within 12% of each other). The confidence intervals range between 18% (lower interval) and 32% (upper interval) of the estimate. These small ranges suggest that the estimates are relatively precise.

4.2) Population Characteristics/Steelhead Condition

Characteristics of the steelhead sampled are presented by capture method and reported sex in Table 2. Condition of the Spring angled fish are summarized in Table 3. Note that these Tables include all fish captured in the Spring fishery (i.e., those above and below the Canyon, and so include 3 tagged and 95 untagged downstream fish that were not used in the population estimate). The distribution of lengths by sex are illustrated in Figure 4. Note that only the Spring recaptured fish are presented in this Figure due to inaccurate sexing of fish in Autumn application procedure (see sex ratio in Table 2, and Section 3 below). When tagged and untagged fish are combined in the Spring recovery sample (the size distributions were the same between these two groups suggesting pooling – see Section 4.4.2), the mean fork length of female fish (701.45 mm $\pm$ 85.52 mm; mean $\pm$ SD) was found to be significantly greater than the male fish (685.07 mm $\pm$ 113.18; $t = 2.854$, d.f. = 1034, p = 0.004).

Table 2: Characteristics of sampled steelhead by capture method and sex for application and recovery samples.

	Moricetown Tagging				Spring Angling			
	Seine		DipNet		Tagged		Untagged	
	Male	Female	Male	Female	Male	Female	Male	Female
n	31	140	365	1151	30	39	552	709
Fork length (mm)								
Mean	719.52	688.55	662.38	687.3	673.67	685.12	685.72	702.35
Std. Dev.	127.0	98.65	132.89	111.14	93.97	78.02	117.41	85.87
Median	740	710	670	700	655	700	650	710
Minimum	530	360	210	160	535	480	440	250
Maximum	985	960	980	990	875	835	1005	965
Sex ratio (F:M)	4.52:1		3.15:1		1.3:1		1.28:1	

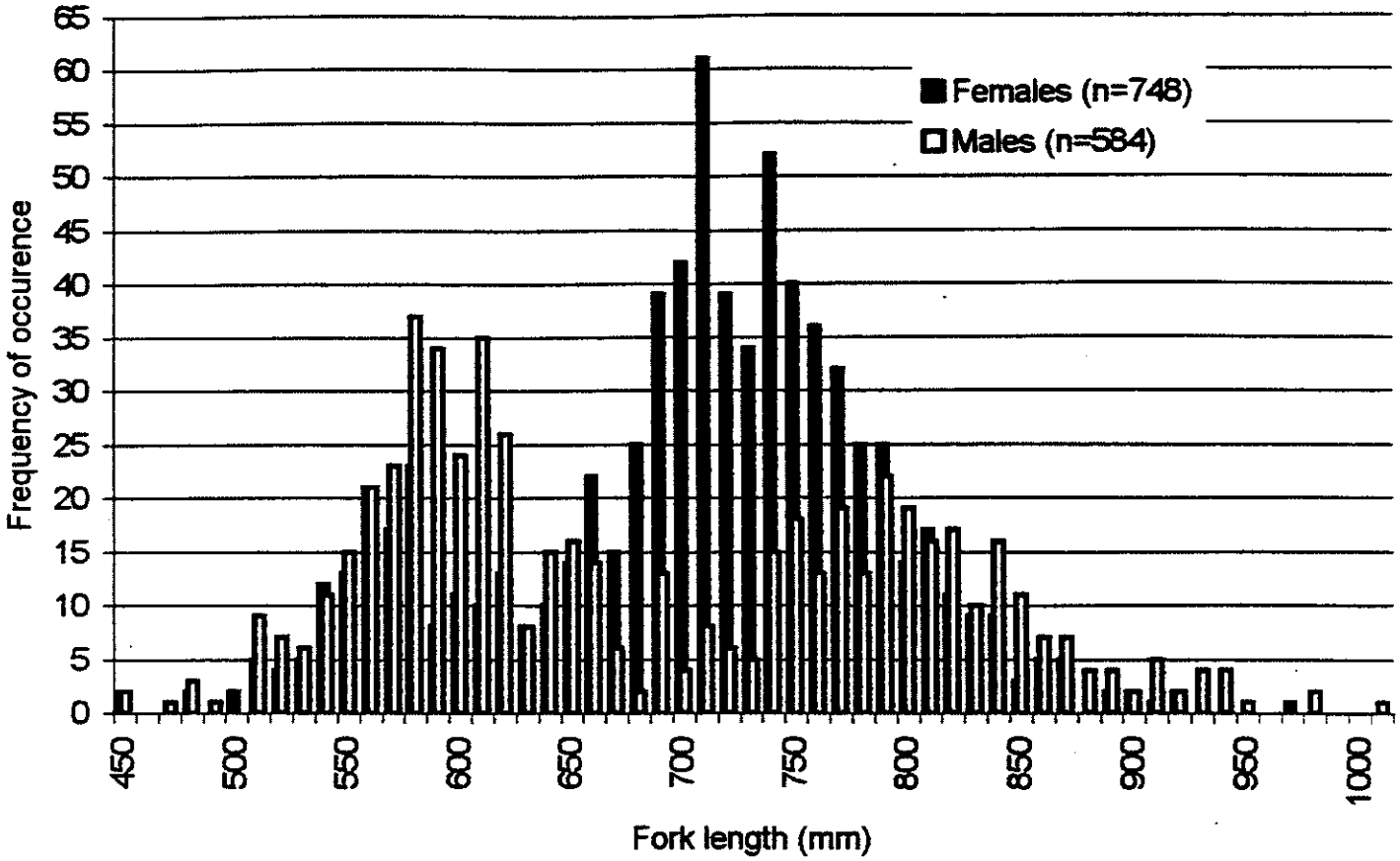

Figure 4: Length-frequency histogram of male and female steelhead recaptured in Spring 2000 sampling of Bulkley/Morice rivers.

Table 3: Condition of the Spring, 2000 angled fish in Bulkley/Morice system. Percentage is of total fish captured (1334) which includes fish above canyon (1,236) and below the canyon (98).

Condition	Number	Percent of total caught
Hook scars/marks	48	3.6
Bleeding	20	1.5
Miscellaneous scarring	88	6.6
Net marks	54	4.0
Damaged tail	19	1.4

4.3) Accuracy of Measurements

Tag application and recovery of the same fish by two different groups of observers allows for a comparison of consistency between the two groups in order to assess the accuracy of their identification and measurements. The sex ratios reported between the two sample periods (presented in Table 2) are obviously very different with the application groups resulting in a skewed female to male ratio. Thirty four of the 71 recaptured steelhead (48%) were inconsistently identified as to sex with one group reporting one gender and the other the opposite. This together with the high female to male ratio suggests that many of the males in the Autumn application period were incorrectly identified as females. Therefore, results which entail stratifying by sex should be interpreted cautiously for the Spring recovery sample, and are likely inaccurate for the Fall application data, due to this misidentification.

Measurement of the fork length of the fish between the Autumn and Spring sampling programs was much more consistent than the sex reporting. There was no statistically significant difference in fork length measurements between the Autumn application and the Spring angling (mean difference 2.36 mm $\pm$ 48.75 mm; n=70; t=0.404; t_{crit}=1.995; p>0.5). This suggests that fork lengths as measured by either team are accurate and consistent.

4.4) Tests of Biases

The Petersen mark-recapture method requires the meeting of five assumptions for a valid estimate of population size (Krebs, 1989) (see Discussion for summary of these assumptions). In order to evaluate whether these assumptions are being met, to examine the responses of the fish to the tagging operation, and to assess bias introduced by the sampling methodology, the sex and size distributions of the captured fish as well as spatial and temporal representativeness of the sampling procedures were examined. Each of these is discussed in turn below.

4.4.1 Sex

In assessing the distribution of the sexes, the requirement is that each sex have an equal probability of capture in both the application sample and the recovery sample. Table 4 presents the results of the Autumn and Spring sampling and the statistical evaluation of these results. It is determined that the relative number of males and females for the recovered (via Spring angling) and non-recovered component of the seine application are similar and so there is no evidence of bias for one sex over the other in the Spring recovery of the fish (i.e., the recovered fish are present in the same sex ratio as the larger sample of non-recovered fish). This, however, requires a caveat. The sample size is small relative to the dip-net and Spring fisheries (suggesting low power) and the p-value is quite low implying that there is some suggestion that the recovered and non-recovered rates of males and females from the seine fishery may not be the same. This, in conjunction with inaccurate sexing of these fish suggest that these results be viewed as suggestive only, not definitive.

In the Spring recapture effort, the relative number of males and females between tagged and untagged fish were not different indicating the angling is not preferentially taking one sex due to tag presence or absence. This provides evidence that the angling is sampling the tagged fish by sex in proportion similar to the untagged fish. For the dip-net fishery, however, the relative number of females to males is elevated. This results in what appears a significant difference in the captures of male and female in this fishery. However, it is likely that the identification of the sex of the fish is in error for a large number of these fish, making interpretation of these results problematic.

Table 4: Number of fish of each sex caught within various sampling methods and results of chi-square analysis (df = 1, $\chi^2_{crit} = 3.841$).

	Application				Recovery	
	Seine		Dip-Net			
	Recovered[a]	Not recovered[b]	Recovered	Not recovered	Tagged[c]	Untagged
Male	2	29	28	337	30	552
Female	2	138	37	1114	40	709
χ^2	2.803		13.412		0.0023	
p-value	0.05<p<0.1		P<0.001		p>0.9	

[a] = recaptured in Spring angling program
[b] = tagged in Autumn but not recovered in Spring angling program
[c] = One of 71 tagged recovery sex not reported, thus 70 fish in this column

4.4.2 Size (Fork length)

If all methodologies are sampling representatively from the population (i.e., not selectively taking small or large fish over the other size group) then the size distribution of the catches are expected to be approximately equal between the sampling systems. The distribution of fork lengths between the recaptured and non-recaptured fish were

equal for both the seine and dip net fishery (Table 5). The fork length distribution was also equal for the recaptured fish between the seine and dip net fisheries. However, size distribution was not equivalent between the populations of non-recaptured fish between the seine and dip net fisheries. This suggests that these two sampling methodologies may not be sampling the population in the same way; one or both of these methods are selecting particular sizes of fish.

In the Spring angling recovery program the size distributions were equivalent between the tagged and untagged fish for both the male and female (sex stratification was only conducted on the recovery sample because of the previously mentioned ambiguity of sexes in the application samples). Further, the mean size of the fish in the recovery sample was compared between tagged and untagged males and females (Table 6). Mean female and male fork lengths were significantly different for only the untagged group of fish. Tagged females were similar in length to tagged males, untagged females and males. Tagged males were likewise similar to tagged and untagged females, and untagged males.

Table 5: Results of chi-square analysis of fork length distributions between the various sampling methodologies.

	χ^2	χ^2_{crit}	d.f.	p-value range
Application Sample				
Seine: recap vs. non-recap	46.309	55.758	40	0.1<p<0.25
Dip-net: recap vs non-recap	61.633	69.832	52	0.1<p<0.25
Seine recap vs. Dip-net recap	43.706	43.773	30	0.05<p<0.1
Seine non-recap vs. Dip-net non-recap	84.054	69.832	52	0.001<p<0.005
Recovery Sample				
Tagged vs. untagged (males)	46.115	67.505	50	0.5<p<0.75
Tagged vs. untagged (females)	48.009	60.481	44	0.25<p<0.5

Table 6: Results of analysis of differences between mean fork length of sexes in tagged and untagged components of the Spring angling recovery sample.

ANOVA (F=3.424, d.f. = 1327, MSE = 10025.78, p = 0.016)

Comparison	Tukey's *q*	p-value range
Tagged female vs. tagged male	0.666	>0.5
Tagged female vs. untagged female	1.478	>0.5
Tagged female vs. untagged male	0.047	>0.5
Tagged male vs untagged female	2.173	0.2<p<0.5
Tagged male vs. untagged male	0.906	>0.5
Untagged female vs untagged male	4.415	<0.01

Thus it appears that there may be differences in sampling between the two methodologies of the application (seine and dip-net), but angling does not appear to selectively sample fish based on size distribution between tagged and untagged groups. The difference between males and females within the untagged group reflects the difference found when this data is all combined (see Section 4.2).

4.4.3 Spatial Distribution

The determination of whether tagged fish are distributing themselves within the river similar to untagged fish, i.e., that they are behaving in the same manner, is important in validating the underlying assumptions of the Petersen methodology. The number of tagged and untagged fish captured per reach are presented in Table 7 and the frequency of occurrence of these two groups of the fish were not statistically different ($\chi^2 = 14.598$, df = 13, $\chi^2_{crit} = 22.362$, $0.25<p<0.5$). This suggests that the tagged fish are distributing themselves in a similar manner to the untagged fish.

Table 7: Number of tagged and untagged fish captured per reach in Spring sampling (see Figure 3 for illustrations of reaches). The total number of fish is 1333 as one of the 1334 Spring recaptures did not have reach recorded.

Reach	Tagged	Untagged	Total
1	0	20	20
2	0	30	30
3	3	45	48
4	2	78	80
5	12	224	236
6	10	110	120
7	6	63	69
8	12	115	127
9	8	135	143
10	4	66	70
11	4	101	105
12	5	143	148
13	5	131	136
14	0	1	1

4.4.4 Temporal Distribution

To ensure representative sampling of fish it is useful to examine the distribution of captures over time, both on a daily and seasonal basis. Table 8 presents the Spring angling recapture data stratified by daily time of tag application and week of the season of application. No significant difference was found in either case between the frequency of occurrence of recaptured and non-recaptured fish between either hourly strata or weekly strata (Analysis of hourly strata $\chi^2 = 8.88$; df=11; $\chi^2_{crit} = 19.675$; $0.5<p<0.75$. Weekly strata $\chi^2 = 5.82$; df=11; $\chi^2_{crit} = 19.675$; $0.75<p<0.9$). These results suggest that

the Spring angling recaptures caught steelhead proportional to the rate at which they were tagged on a daily and seasonal basis (i.e., there is no evidence of temporal bias).

Table 8: Number of Spring recaptured and non-recaptured (i.e., tagged in Autumn fisheries and not recovered) steelhead in Spring fishery stratified by hour of the day and week of the season. Note: due to ambiguity in reported hours of tag applications for this analysis the day was established as 9AM to 9PM.

Week of application	Recaptured	Non-recaptured	Total
1	0	13	13
2	2	75	77
3	21	442	463
4	19	426	445
5	14	265	279
6	6	190	196
7	3	74	77
8	0	56	56
9	3	59	62
10	1	20	21
11	2	72	74
12	0	9	9

Hour of application	Recaptured	Non-recaptured	Total
0900	3	138	141
1000	4	140	144
1100	9	162	171
1200	8	199	207
1300	6	170	176
1400	3	155	158
1500	6	135	141
1600	9	115	124
1700	5	114	119
1800	5	113	118
1900	7	117	124
2000	6	143	149

Further assessment of the representativeness of the sampling of the steelhead run during tag application was done by plotting the cumulative frequency of steelhead through Moricetown Canyon over time (Figure 5) and it can be seen that the number encountered per day decline considerably by the time application sampling ended; the cumulative frequency levels off and according to this, 95% of the run had passed by

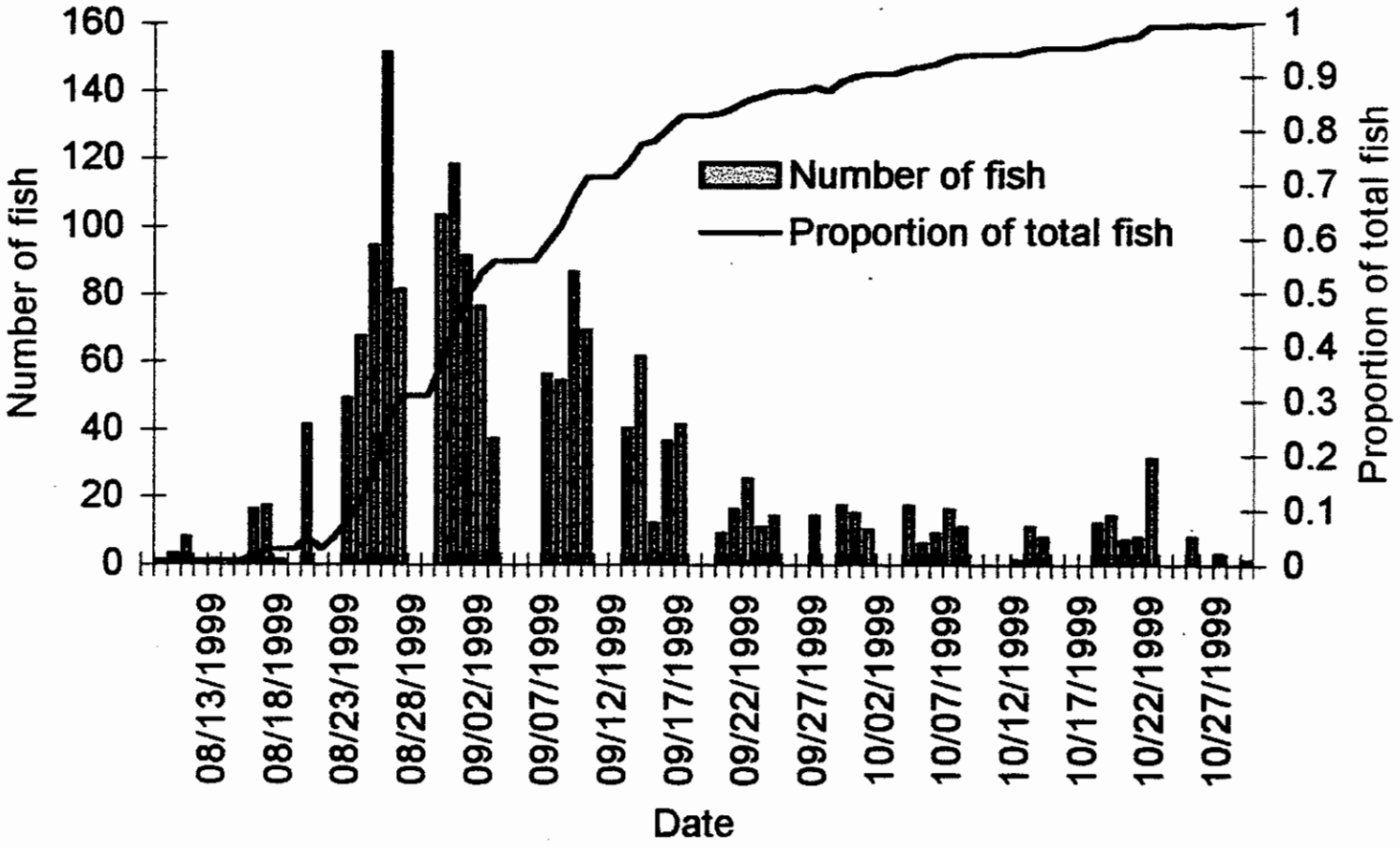

Figure 5: Number and proportion of fish tagged in seine and dip-net fisheries combined at Moricetown Canyon, August 8 – October 30, 1999.

October 15th. Sampling continued past this date and so it is reasonable to conclude that the greatest part of the population was sampled.

In addition, plotting the destination of the tagged fish (reaches 1-14) against week of the season of tagging (1-12) (Figure 6) shows the early run consists of fish that moved to more distant reaches while the later run remained closer downstream. There is a general trend for those fish which move farthest upstream to move through the canyon earliest and those fish which overwinter further downstream to pass through later. This implies that to sample representatively, the entire run must be sampled as truncated sampling would only capture particular stocks. Application samples appear to have included both of these, the early and late run components further suggesting representative and comprehensive sampling coverage of the entire steelhead run through the Canyon.

4.5. Other Species

During the Spring angling recovery component, four additional species (rainbow, cutthroat, and bull trout, and Mountain whitefish) were captured and fork lengths and sex recorded. These are presented in Table 9.

Table 9: Summary of fork lengths (mm) of other species captured during Spring angling recovery effort.

	Rainbow Trout			Cutthroat Trout		
	Female	Male	Unrecorded	Female	Male	Unrecorded
n	2	1	7	1	4	2
Mean	415	205	336.43	410	385	312.5
Std.Dev.	7.07		71.46		99.83	53.03
Median	415		360		360	312.5
Minimum	410		250		300	275
Maximum	420		420		520	350
	Bull Trout			Mountain Whitefish		
	Female	Male	Unrecorded	Female	Male	Unrecorded
n	27	30	120			4
Mean	443.15	470.33	429.83			383.75
Std. Dev.	85.76	78.71	90.83			61.83
Median	465	497.5	432.5			395
Minimum	240	300	100			300
Maximum	610	610	620			445

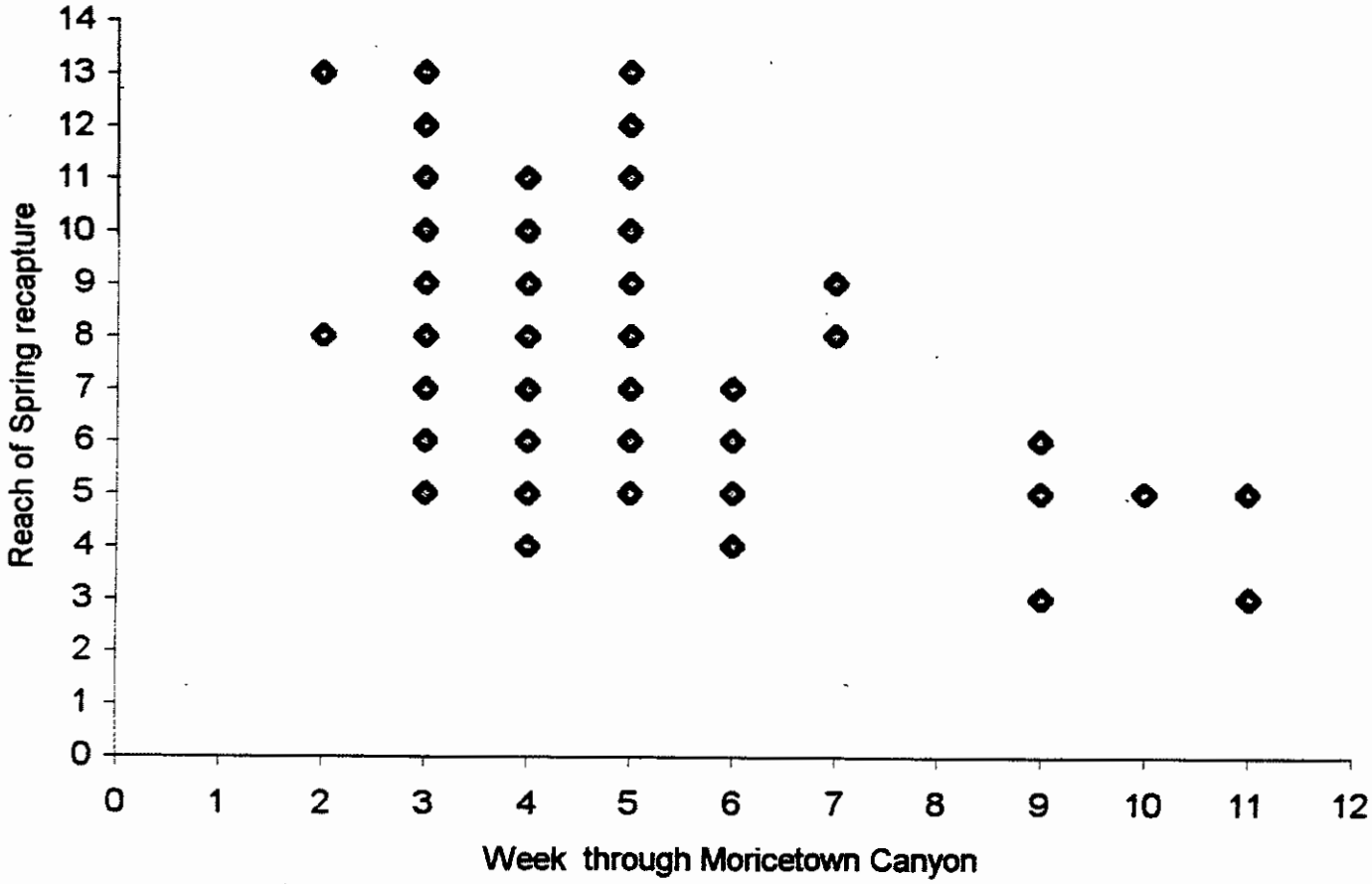

Figure 6: Locations of Spring recaptured steelhead (see Figure 3 for Reach locations) as function of time of passage through Moricetown Canyon between August 8 (beginning of week 1) and October 30 (end of week 12). Each point indicates an individual recaptured fish.

5.0 DISCUSSION

5.1 Population Estimate

The population estimate of steelhead within the Bulkley/Morice system upstream of Moricetown Canyon for the summer 1999 run ranges between 27,005 and 30,512. This is the first population estimate to be generated for this area using this methodology and so there is little to compare this estimate with. However, one estimate developed by SKR Consultants (2000) using the seine and dip-net fisheries as the application and recovery samples respectively (i.e., an in-canyon estimate) yielded estimates ranging from 15,835 to 37,913 steelhead with 95% confidence intervals ranging from 10,353 to 58,350 fish. They concluded that 28,527 fish (95% confidence intervals 16,250-58,350) was the most conservative and representative estimate from the data. The SKR analysis used an earlier version of the same data set in which they used a total of 1,695 tags applied at Moricetown (164 in the seine fishery, 1,531 in the dip-net fishery). The data used in the estimates in this document differ slightly (173 seine-captured fish, 1,527 dip-net fish, 1 unrecorded location for a total of 1,701 fish; these numbers differ from those in Table 2 due to inclusion here of fish of unreported sex). These discrepancies in numbers between the two analyses was due to errors being detected and removed/corrected in the dataset between the time of the two analyses. The in-canyon estimate of SKR results in a value similar to that derived here but with very large confidence intervals (i.e., low precision of estimate).

Toboggan Creek, eight kilometers upstream of the canyon, has maintained a fish counting fence since 1993 and the recovery of Moricetown tags here, together with population estimates derived for this stream, may be useful in evaluating the derived Petersen estimate presented here. In the Spring of 1999 twelve of 255 handled steelhead (4.7%) above Toboggan Creek counting fence had Moricetown applied tags and in Spring 2000, nine of 183 (4.9%) handled fish in this same area bore the brown Moricetown tags. In 1998 there had been between 1,950 and 2,250 tags applied at Moricetown (Mitchell and Wadley, 1999) and so Toboggan Creek may be estimated to represent 0.5-0.6% of the total run past Moricetown (12/2250, 12/1950). In 2000 Toboggan Creek contained (9/1701 = 0.5%) of the Moricetown tags. Steelhead Petersen population estimates above the fish counting fence in Toboggan Creek were 357 fish in 1999 and 286 in 2000 (Mitchell, 1999a, 2000). Unfortunately, use of the stream by steelhead in the lower 2.5 km below the fence is not quantified.

The Tyee Test Fishery provides further data which may be used to compare a previous population estimate. Based on 1998 data, Mitchell and Wadley (1999) suggested in excess of 36,000 fish in the Bulkley/Morice system in 1998. The 1999 Tyee test cumulative index was 195.01 which may then be calibrated as (27,370 / 195.01) 140.35 steelhead above Moricetown for each Tyee index point. Hooten (1999) reports that the multiplier of the Tyee Test Fishery used for the entire Skeena River is 245 fish per daily index point. For 1998, therefore (Tyee index = 269.64) the Tyee data suggests there were 37,844 (=269.64 * 140.35) steelhead upstream of Moricetown and 66,062

(=269.64 * 245) steelhead within the Skeena River. Of interest is that this implies that the proportion of Skeena steelhead accounted for by the Bulkley/Morice is 54% (Table 10).

The study reported here has provided an important linkage in scale between steelhead estimates of the Skeena watershed (drainage area 51,200 km^2; Koski et al., 1995), the Bulkley/Morice tributary (drainage area 12,173 km^2; Morten, 1999) and a tributary of this system (Toboggan Creek, drainage area 110 km^2; Tredger, 1979). Table 10 provides steelhead abundance estimates of these three scales over time from a variety of sources. The proportion of the Skeena steelhead within the Bulkley/Morice according to the Steelhead Harvest Analysis (Table 10) appears to be low (approx. 20%) compared to results reported for radio-tracking of fish through the Skeena to their final destination (33-45% of Skeena run in these systems; Koski et al., 1995; Labelle et al., 1995). Estimates of the proportion of Skeena run which enter the Bulkley/Morice based on the Tyee Test Fishery and Mitchell and Wadley (1999) (i.e., 54% in 1998; Table 10) and this study (57%) are greater than that estimated by the radio-tracking. It is uncertain at this time which values are the more accurate. Within the Bulkley/Morice system itself, Koski et al. (1995) report 21 radio-tracked fish in the Bulkley and 5 in the Morice (i.e., 81% in Bulkley, 19% in Morice). Tagged recaptures in the Spring angling effort resulted in 53 recoveries in the Bulkley and 18 in the Morice (75% in the Bulkley, 25% in Morice).

Estimates of tag loss (1.5%) and multiple recaptures (10.3% of captures) were used to correct the Petersen estimate (see below for discussion of tag loss). In the 1998 Autumn recreational steelhead fishery 10% of tagged fish were recaptured twice and 0.6% recaptured three times (estimates derived from data in Morten (1999)). Results from the 1999 recreational fishery are not yet released. The study reported here showed a recapture rate of tagged fish of 8.8% captured twice and 1.5% captured three times. The multiple recapture rate of tagged fish by angling between the two years appears to be quite similar.

5.2 Sex and Size of Steelhead

Based on the elevated sex ratios for the Moricetown application samples (3.15:1 and 4.5:1) relative to the Spring angling (1.3:1), and compared with Toboggan Creek sex ratios for the last eight years (range 0.54:1 to 1.19:1, mean 0.82:1 females to males ; Mitchell, 2000) the number of females reported in the Moricetown fisheries appear high. This together with the high proportion of inconsistent sexing between Autumn and Spring sampling suggest that many of what are probably males were misidentified as females during the application fishery. The workers during this fishery are required to rapidly process large numbers of steelhead and coho salmon in brief time periods, and the steelhead at this time of their migration are notoriously difficult to sex as they have not yet developed significant secondary sex characteristics such as color or the kype in males. Accurate identification of sex at this time of year requires experience and a keen eye. Intensive training in sex identification of these fish during this period of their migration may improve accuracy in future sampling. This existing uncertainty regarding sex

classification for this years program limits comparisons or conclusions of these sampled populations regarding differences (i.e., fork length). The Spring angling recovery component appears to have produced more realistic sex ratios which agree more closely with historic Toboggan Creek ratios.

Table 10: Historic estimated steelhead abundance of the Skeena River watershed, the Bulkley/Morice system and Toboggan Creek. Numbers in brackets are percent of run in larger system which smaller system accounts for according to these reported values.

Year	Skeena [a,b,f]	Bulkley/Morice [a,c,d]	Toboggan Creek [e*]
1982	12,287		
1983	3,923		
1984	30,625		
1985	16,107		
1986	19,844		
1987	3,914		
1988	19,742		
1989	10,600		
1990	41,552	8,113 (19.5)	
1991	20,300	3,819 (18.8)	
1992	28,352	4,970 (17.5)	435 (8.7)
1993	32,224	6,314 (19.6)	237 (3.7)
1994	46,108	8,744 (19.0)	330 (3.8)
1995	50,704	10,170 (20.0)	120 (1.2)
1996	46,996	9,648 (20.5)	543 (5.6)
1997	61,980	13,106 (21.1)	381 (2.9)
1998	66,000	36,000 (54%)	357 (1.0)
1999	47,777	27,370 (57%)	286 (1.0)

[a] = Steelhead Harvest Analysis, unpublished data
[b] = Kadowaki et al. (1992) as reported in Koski et al. (1995)
[c] = Mitchell and Wadley (1999)
[d] = This study
[e] = Mitchell (2000)
[f] = Hooten (1999)
* = Toboggan creek data is the Spring spawning periods of the previous summer run

Female steelhead were slightly, but significantly, larger than males in the Spring recovery sample. Again comparison with historic Toboggan Creek data reveals that in the years 1997 and 1998 the females were larger than the males while for the years 1993-1996, and 1999 (Mitchell 1999a) the reverse was true. In 2000 there was no significant difference in fork length between the sexes (Mitchell, 2000). It appears that consistent size difference between sexes is not to be found though the variability within and between stocks is unknown and it is uncertain how comparable the results for the Bulkley/Morice system is with the Toboggan Creek stock.

5.3 Assumptions of Mark-Recapture Methodology

The validity of the Petersen mark-recapture methodology rests on five assumptions and much of the analysis reported here (i.e., Section 4.4) is an attempt to evaluate how well these assumptions are being met. These underlying assumptions are (from Krebs, 1989):

1. The population is closed so N is constant
2. All animals have the same chance of being caught in the first sample
3. Marking individuals does not affect their catchability
4. Animals do not lose marks between the two sampling periods
5. All animals are reported on discovery in the second sample.

Assumption 1: Closed population

The steelhead population above Moricetown Canyon is not closed. Long term drop back below Moricetown has been documented here and there may have been unknown immigration/emigration, loss of fish to First Nations fishery, the Fall sport fishery (hooking mortality), poaching and natural mortality. One of the seven tagged fish recaptured more than once moved between reaches, moving upstream from Reach 5 to reach 7.

The rate of drop-back (the proportion of fish which drop down below the Canyon and remain there; i.e., "emigration") has been the subject of considerable speculation with this study providing the first direct evidence of the rate (3 of 71 recaptured fish). The Wet'suwet'en Fisheries (Anonymous, 2000) estimate that 16 of 1,531 (1.04%) tags applied at the dip-net fishery in Autumn 1999 were recaptured downstream in the seine fishery. Unfortunately, it is not possible to determine whether these seine recaptured fish remained below the canyon or continued upstream despite this setback. The 4.2% estimate of drop back which remain downstream (at least until Spring) derived here is higher than the Wet'suwet'en estimate but is still relatively low in magnitude and suggests that drop back may not be a significant problem of the tagging process. However, this data is very limited, any statements regarding drop back must be viewed as preliminary and further sampling through 2001 and the future is required to truly understand the extent of drop back from the canyon due to tagging.

Commonly, in order to minimize the effects during a study such as this of fish movement into and out of an area and mortality, the application and recovery samples are conducted close to each other in time. This was not possible in this study due to MELP management decisions not allowing the recapture phase to occur during the Autumn sport fishery, and winter river conditions preventing sampling from occurring prior to early Spring. It is recommended that in future recovery sampling be conducted in the late Fall months, soon after application, to minimize movement of fish into and out of the study area and moralities, and so better meet the requirement of population closure.

Assumption 2: Equal probability of capture in application sample

Difficulties with the sexing of the steelhead captured in the Moricetown fisheries in Autumn 1999 result in interpretation of sex biases of sampling gear to meet this assumption not being possible. Training of tagging personnel for accurate determination of sex during this difficult-to-identify time is necessary in order to evaluate whether each sex has an equal probability of capture in the application fishery. The Spring recovery program does appear to sample each sex equally, thereby meeting this assumption for the recovery component.

The results for the size distributions indicate that neither the seine nor the dip-net fisheries select one size of fish over the other, within that sampling method. However, there may be a difference in size distributions between the dip-net and seine catches of those fish tagged but not recaptured. This, however, may be due to the difference in sample sizes (8.6 times more fish in dip-net fishery than in seine) rather than a true sampling bias. Future sampling of steelhead, and a comparison of coho size distributions caught by these two methods (historic data is available to test for size distributions of coho between these two fisheries), would provide evidence as to the importance of this potential bias and so how well this assumption is being met. The Spring recovery does not appear to sample selectively for size.

The Autumn tagging crews did not sample on weekends and so the fish which may have passed through during these days did not have an equal probability of capture as during the weekdays. While recognizing the logistical and financial problems of trying to sample every day over an extended period, future sampling should attempt to be as comprehensive as possible and include sampling on all days.

Assumption 3: Marking individuals does not affect catchability

Rigorous tests of catchability (e.g., Cormack's, Leslie', or Chitty's tests of catchability) are not possible with only a single recapture effort (Krebs, 1989) and so the catchability must be inferred rather than explicitly tested. The results of the bias testing of the Spring recovered fish indicates that there was not a significant sex bias by angling, the size distribution of fish was similar between tagged and untagged fish, and the tagged and untagged fish distributed themselves similarly throughout the system. This suggests that the fish responded to the sampling methodology (angling) in similar manners with respect to their population characteristics (sex and size) and that they were behaving in a similar manner to untagged fish in distributing themselves through the river. There is no apparent evidence that tagging individuals affected subsequent catchability in this study.

Assumption 4: No tag loss between sampling periods

Some of the tags applied to fish are likely to be lost during the fishes activity or, sometimes, by the recovery methodology (e.g., nets). English and Link (1999) suggest that spaghetti tag loss is less than 5%. Lough (1995) found a 0% tag loss of steelhead between Autumn and Spring sampling on the Morice River, and Parken and Atagi (1998)

report one of 18 steelhead (5.6%) losing their [Floy] tag in the Cranberry River. Six years of tagging data (1994-1996, 1998-2000) from Toboggan Creek (O'Neill, 1995, 1996, unpublished data; Mitchell, 1999a, b, 2000) show a range of tag loss from 0 to 18.75% over short term periods (< 3 months). The Cranberry River result and the high estimate for Toboggan Creek are both based on very small sample sizes (18 and 32 tagged fish, respectively) and so, under these conditions, the loss of even a single tag will be highly influential. Parken and Atagi (1998) also cite studies (Begich, 1992; 1997) conducted in Alaska which showed a range of from 3% to 11% tag loss over one to four months. Clearly, tag loss is variable among systems, years, and sampling methodology, and the estimated loss for this study appears to be at the lower end of the estimates. By estimating tag loss using the secondary mark it was possible to correct the Petersen estimate for this and so accept that though this assumption is not strictly met, the effect of tag loss is compensated for.

Assumption 5: Reporting on discovery in second sample

The high degree of consistency of fork length measurements between Autumn and Spring captures, combined with the level of detail recorded on the condition of the fish, suggest that the anglers were conscientious in examining the fish closely for tags and caudal punches. By classifying the condition of all captured fish in the Spring fishery, the sampling indicates 229 of 1334 (17.2%) of fish are in some way scarred or marked by natural predators or fishing (angling, nets) or the tagging operation (e.g., torn tails and dorsal fins). Only 1.4% of captured fish had torn tails. Due to the secondary punch at Moricetown being applied to the caudal lobes, damaged tails could mask tag loss as the torn component may hide the secondary punch or the punched portion may have been lost. The observed low incidence of damaged tails however, suggest that if a large number of punched fish had lost tags after application, they would not be overlooked as the vast majority of tails were whole and complete. This is indirect evidence that the rate of tag loss is as low as estimated. A second piece of information provided by this classification of condition is the low proportion of fish bleeding due to the angling process (1.5%). Mortality due to angling in early Spring was raised as a concern to this sampling program (see Section 5.4). While fish may die without showing external bleeding, or die after an extended period after showing only light bleeding, the low rate of fish showing any bleeding at all upon release provides an indication of the physical harm caused immediately by angling. This value is very low and the use of highly experienced, dedicated anglers with the knowledge and skills to reduce the stress on the fish likely contributed to this low incidence of bleeding.

The results of this analysis indicate that the Autumn and Spring sampling was probably representative of the fish passing through Moricetown ("entire" run sampled and proportional sampling relative to final distribution), and the evidence suggests that the Spring sampling was unbiased with respect to sex, size or presence/absence of tags. There is some evidence of size bias between the seine and dip-net samples though this may be a function of sample size. The Petersen assumptions have been met or quantified and compensated for to the degree practical. Based on these analyses and results, the derived population estimate of 27,005 (95% confidence intervals 22,261-35,479) is

suggested as an accurate estimate of the true population passing through Moricetown Canyon between August 8 and October 30, 1999.

5.4 The Controversy

Although unusual in a scientific document, a brief discussion of the controversy surrounding this project is warranted as a lesson in foreseeing political/public relations conflicts during project development. In both the cancelled program (1998/99) and the successful one (1999/2000), the project was constantly under intense public and political scrutiny with the debate of the value of it ranging through the media (e.g., local and Provincial newspapers, radio, the internet). Indicative of this scrutiny was that the project proposal was reviewed by four different groups (DFO, Ministry of Fisheries, MELP, and an independent consultant [Cascadia Natural Resource Consulting]). The principle area of controversy appeared to be that the recapture component of the project involved angling for steelhead in the Spring during a perceived sensitive period for the fish. Specifically the resistance to the sampling focused on:

Angling with bait: There was concern raised that bait-hooked fish suffer greater mortality than other angling methodologies due to the tendency to rapidly inhale and swallow the hook rather than taste and spit it out. The mortality issue has been researched by MELP as bait fishing has been the preferred method for sampling in their mark-recapture programs and broodstock collection in the past. Broodstock bait angling on Thompson River tributaries (1982-1995) attributes 7 of 436 (1.61%) mortalities to bait fishing. On the Coquihalla River (1985-1995) one of 306 bait caught fish (0.31%) was recorded as a mortality. On Vancouver island (1981-1987) 140 of 3947 bait captured fish (3.5%) were considered as direct mortality (Previous values from MELP unpublished data). Angling using bait was MELP's recommended method for this project and although it is recognized a few of the fish may have subsequently died (i.e., 1.5% based on appearance of bleeding, or approximately 20 of the 1334 fish handled), it appears that the anglers involved were conducting their catch and release efforts to minimize associated mortality.

Angling during a closed period: All rivers in the upper Skeena are closed to angling from December 31 through to June 15 to protect summer run steelhead during overwintering and spawning periods. These regulations were put in place during the late 1980's. Prior to the regulations there was little sport fishing taking place during the winter due to weather and ice conditions on these rivers. There was a perception (e.g., see articles by Brown and Hume, Appendix 2) that the Spring sampling was merely "an exclusive fishing derby" arranged to allow a select group of anglers to fish. However, the preferred recapture time was the Fall open fishing season prior to winter, but management decisions by MELP would not allow the recapture phase to occur during this time. Ice then prevented it through the winter. Spring recovery was the only remaining option and it is hoped that the results detailed in this document will satisfy the critics regarding the validity of the

program in providing an accurate and precise estimate of the steelhead population as well as allay fears of extensive angling-related mortalities.

Angling when fish are near to spawning: Steelhead in the Upper Skeena and tributaries are known to spawn in May and June. It appears that once water temperatures have started to increase in late April that steelhead initiate movement into tributaries and spawning areas (Whately and Chudyk, 1979; O'Neill, 1995, 1996; Mitchell 1999a, 1999b, 2000). Concern was expressed that the stress of angling these fish when they were near their spawning period may be harmful to the fish and increase mortality due to added stress on weakened fish (having overwintered). This is a significant concern. However, as discussed previously, the recapture phase was not permitted to occur earlier and the low incidence of bleeding suggests that the fish may not be as weak and sensitive as some of the critics suggest. Further, of an estimated 27,005 fish only 1236 (4.6%) were captured, and these likely of different stocks as fishing was distributed throughout the length of the rivers. This is a very small proportion of the total fish present, and so if the imposed stress was significant it was applied relatively evenly to a small proportion of the total run and so unlikely to have an effect on the Bulkley/Morice at a population level. As further indirect evidence that these Spring fish were not significantly at risk relative to Autumn fish is the similarity in multiple recaptures of individual fish between the Spring 2000 and Autumn, 1998 recreational fishery (see Section 5.1). These data suggest that the Spring fish are responding in roughly similar manner as Autumn fish, suggesting they may not be as vulnerable as feared.

As stated in the Introduction, many groups and individuals have proprietary interests in these fish and thus a project that allows preferential treatment to some anglers (i.e., those sampling in Spring during a closed season and using bait) may be predicted to meet with some opposition. Public education of the value of the project was very important in its successful completion in the second year; once other anglers realized it was not simply a group of elitist anglers exploiting an opportunity to fish, there was wide local support for the project. However, during, and even continuing after the project, letters and commentaries appeared in local newspapers (see Appendix 2 for samples) opposing the project. The lesson from this was the critical importance of garnering local understanding and support when working with a high profile species outside authorized fishing seasons.

6.0 CONCLUSIONS

In Autumn, 1999, an estimated 27,005 steelhead passed through Moricetown Canyon on to the Bulkley/Morice River systems. The rate of "long term" drop back, a concern of the tagging operations in the Canyon, appears to be very low suggesting that the majority of fish handled at Moricetown are not prevented from completing their regular migration. However, this is only one years data. Further sampling is required to confirm this as the rate may vary between years and dependant upon water conditions and other environmental variables. The tagging operation does not appear to affect the final distribution of fish throughout the river systems. Of the sampling methodologies employed here, angling appears to sample most representatively as opposed to the seine and dip-net fisheries for which there is some suggestion of preferential capture of sizes. Rate of tag loss appears to be low as does potential mortality due to angling in the Spring. The consistency in measuring fork length between the Autumn tagging crews and Spring recapture crews was high, suggesting high precision of measurements. However, sex identification of the fish at Moricetown was problematic, likely due to the lack of obvious secondary sex characteristics of the fish, lack of experience in sexing by the crews and large numbers of fish to be processed in short periods of time.

7.0 RECOMMENDATIONS:

The 1999/2000 Bulkley/Morice mark-recapture project was very successful in meeting its objectives. However, several aspects may be improved in future years. These include:

1. A late Autumn angling-based tag recovery program in place of the Spring schedule should be conducted in order to minimize emigration out of the study area and tag loss.
2. Training of tagging crews on the identification of the sex of the fish for these difficult to sex migrants. This will not only improve accuracy of identification but provide greater consistency in how observers classify the fish.
3. If practical, the hiring of more crews during the Autumn tag application period in order to sample weekends as well as during the week would increase the number of fish tagged and improve the probability of meeting assumption 2 – Equal probability of capture in the application sample.
4. A DNA analysis of existing tissue samples from the Tyee Test Fishery may provide further information on the proportion of the Skeena run which has the Bulkley/Morice as a destination. This information may help to evaluate the conflicting estimates (Section 5.1) and provide evidence of the true Skeena River run component from the Bulkley/Morice systems.
5. An analysis of the coho salmon size distributions between the seine and dip-net fisheries would provide more information on potential bias of these different methodologies. Large coho databases already exist for such analysis.
6. A comprehensive compilation of various steelhead population estimation procedures would provide an indication of the accuracy (i.e., agreement between methods) of this derived value. Such other procedures include mark-recaptures on tributaries, fence counts, Steelhead Harvest Analysis data, creel surveys, and the Tyee test fishery.
7. Mark-recapture programs similar to this one should be conducted every three to five years to provide accurate population estimates with which to compare/calibrate indices and other indirect estimation procedures. As well, repeated programs like this will provide further ancillary information on drop-back from the Canyon, sampling biases by gear, variations in sizes of fish between years, etc.

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Appendix 1: Fish Collection Permit authorizing Spring recovery sampling

BRITISH COLUMBIA

FISH COLLECTION PERMIT

Pursuant to Section 19 and to Section 110 (4) of the

Wildlife Act,

and as provided in Section 18 of B.C. Reg. 125/90;

Mary Lou Burleigh,
Chairperson, Steelhead Society of British Columbia
Bulkley Valley Branch
Box 550
Smithers BC V0J 2N0

and

any individual named in an appendix, "Bulkley Steelhead Society Permittee List",
issued pursuant to clause three (3) of this permit

is hereby authorized

to collect fish for scientific purposes from non-tidal waters
subject to the conditions set forth herein:

Objective:
Capture adult steelhead to conduct a steelhead population estimate utilizing appropriate mark /recapture technique and methodologies.

Permitted Waters:
The Morice River from Morice Lake to the Bulkley River confluence, and the Bulkley River from Topley downstream to the confluence with the Skeena River.

Permitted Times:
February 15, 2000 to May 15, 2000.

Permitted Species:
All species except salmon, with steelhead the primary target.

Permitted Gear:
Conventional angling methods, including angling with bait.

Ministry of Environment, Lands and Parks
Environment and Lands
Skeena Region
Mailing Address:
PO Box 5000
Smithers BC V0J 2N0
Location Address:
3726 Alfred Avenue
Smithers BC
Telephone: (250) 847-7260
Facsimile: (250) 847-7728

General Conditions:

1. This collection permit is valid for collecting steelhead only, by angling, and only if the permittee possesses a valid freshwater fishing licence and a steelhead stamp. Permittees are reminded that angling licences expire March 31, 2000.

2. Prior to commencing activities authorized under this permit, a Permittee must attend a fish handling information session that will be convened by B.C Environment fisheries staff.

3. A maximum of 24 persons nominated by the holder of this permit may be listed as permittees in an appendix, "Bulkley Steelhead Society Permittee List". This appendix will be issued at a later date.

4. This permit must be carried by the permittee while engaged in fish collecting and produced for inspection upon request of a Conservation Officer, Wildlife Officer, Fishery Officer or Constable.

5. District Conservation Officers in Houston, Smithers, and Hazelton, **MUST** have **PRIOR** notice of the permittee's weekly schedule for collecting activities in their areas. Any changes to this schedule must be submitted in writing (fax or e-mail) at least 24 hours prior to fish collection.

   Houston - Tobe Sprado phone (250) 845-7836 fax 845-7682 e-mail: tobe.sprado@gems4.gov.bc.ca
   Smithers – Kevin Nixon phone (250) 847-7262 fax 847-7243 e-mail: kevin.nixon@gems4.gov.bc.ca
   Hazelton - Dan Aikenhead phone (250) 842-5319 fax 842-6174 e-mail: dan.aikenhead@gems6.gov.bc.ca

6. Sampling is to be carried out by groups of not more than four (4) permittees including a group supervisor. Each group supervisor should be substantially on the water throughout the study period when collecting is occurring and should ensure fish handling techniques, data collection, and methodological consistency is maintained throughout the study.

7. All angling must be conducted with single barbless hook and all fish captured must be released unharmed in the least possible time. The fish must remain in the water at all times during handling for measurements and tag inspections. Fish must be handled with bare hands only (i.e. no gloves of any kind may be used).

8. To minimize repeated capture and handling stress; if two (2) steelhead have been "recaptured" from the same days angling activities in the same pool or run, the sampling location shall be moved to the next pool or run.

9. All fish hooked in or near vulnerable areas (i.e. gill arches, gill rakers, gill filaments; deep in the esophagus, or in the tongue area) must be set free as soon as possible; to minimize tissue damage the leader must be severed immediately and the hook left in situ.

10. In keeping with the assumptions inherent in mark recapture population estimation methodology, angling effort must be applied relatively consistently and uniformly over the permitted waters. For sampling and data recording purposes, it is recommended that these rivers be divided into the following sections:

    Skeena River Confluence (Km 0) to Suskwa River Confluence (Km 20)
    Suskwa River Confluence (Km 20) to Porphry Creek (Km 31)
    Porphry Creek (Km 31) to Moricetown (km 49)
    Moricetown (km 49) to Trout Creek (km 57)
    Trout Creek to Smithers Highway 16 Bridge (km 87)
    Bridge to Telkwa (km 100)
    Telkwa to Quick (km 114)
    Quick to Walcott (km 128)

Ministry of Environment, Lands and Parks
Environment and Lands
Skeena Region
Mailing Address:
PO Box 5000
Smithers BC V0J 2N0
Location Address:
3726 Alfred Avenue
Smithers BC
Telephone: (250) 847-7260
Facsimile: (250) 847-7728

Walcott to Bymac Park (km 147)
Bymac Park to Aspen (km 160)
Aspen to Owen Creek (km 171)
Owen Creek to Lamprey Creek (km 187)
Lamprey Creek to Morice West bridge crossing (km 207)
Bridge crossing to Morice Lake outlet (km 218)
and
Topley to Bulkely-Morice Confluence

11. A written record of all activities conducted under authority of this permit must be submitted to the Head, Fisheries Section, Ministry of Environment, Smithers, weekly. The term of this report will be from Monday to the following Sunday. The deadline for submission is Tuesday of each week for which the permit is valid. Those records must include: the data, name(s) anglers fishing each section of river each day, group supervisor, the cumulative total number of hours of angling effort in each section of river on each day, the nose to fork length (measured to the nearest half centimetre) and sex of each steelhead captured, the precise location where caught (river kilometer 0 is Hazelton, km 87 is Smithers Bridge, etc.,), the Floy tag number and tag colour of tagged fish, and any comments regarding fish condition which may be noteworthy (e.g. net scars, bleeding fish, scraped head, torn fins, and previous hooking scars). The number of fish of other species (i.e. rainbow trout, bull trout, etc.) captured and the location of capture must also be recorded. The above information must be summarized in a single document/spreadsheet.

12. All reports prepared on the basis of information collected under the authority of this permit shall be provided to the Regional Fish and Wildlife Manager, Ministry of Environment, Smithers, immediately upon completion. We require both hard copies and electronic copies in MS Excel (version7.0) and MS Word (version 7.0).

13. This permit allows for the collection of fisheries information in a one pass study design on the authorized waters. If in the regional managers opinion, sufficient time has elapsed to meet this purpose or conditions exist that limit that purpose, the permitted authority to collect fish may be suspended by written notice.

14. This collection permit is subject to cancellation at any time and shall be surrendered to a Conservation Officer on demand or to the issuer immediately upon written notice of its cancellation.

15. For further information about this permit, phone (250) 847-7279 or fax (250) 847-7728.

Reid D White, R.P.Bio., P.Eng.
Regional Manager
Fish and Wildlife Program

Date: February 14, 2000
Our File: 34770-20/SS2000 -
Bulkley River Mark Recapture
Receipt # 037158 K

Any contravention or failure to comply with the terms and conditions of this permit is an offense under the Wildlife Act, SBC 57/82 and B.C. Reg. 337/82 Sec. 8.

Ministry of Environment, Lands and Parks
Environment and Lands
Skeena Region
Mailing Address:
PO Box 5000
Smithers BC V0J 2N0
Location Address:
3726 Alfred Avenue
Smithers BC
Telephone: (250) 847-7260
Facsimile: (250) 847-7728

Sample editorials from the popular press and Internet regarding the Bulkley/Morice steelhead project

Hume, M. www.ariverneversleeps.com, April 4, 2000
Hume, S. the Vancouver Sun, April 10, 2000
Brown, R. the Terrace Standard, April 5, 2000

Private steelhead opening smells distinctly fishy

Stephen Hume

The environment minister's staff ignore objections to an unscientific 'fishing derby.'

Stories about political expedience shoving aside science continue to ooze out of our profoundly dysfunctional provincial government like PCBs from a toxic landfill.

Recently Environment Minister Joan Sawicki's staff trashed scientific discourse by suspending habitat biologist Dionys de Leeuw of Terrace for seeking departmental colleagues' comment on a paper critiquing statistical methods used to justify hunting grizzlies.

Now, the NDP boneheads are ignoring objections from scientists to permit what critics like former Steelhead Society director Joe Saysell complain amounts to an exclusive fishing derby for local anglers on a prized steelhead river that's closed now and restricted to catch and release when fishing is allowed.

This travesty will occur near Smithers under the authority of a "scientific collection permit" issued by the environment ministry to a local sport fishing lobby.

"This thing really, really smells," says Jerry Wintle, who has been fishing Bulkley River steelhead for more than 50 years. "That's the last place we should be catching fish. It's the last of the run, they've gone through hell to get there, they're in a weakened condi-

ley and Morice river systems. In reality, it will allow vulnerable spawning fish to be killed without providing information that reputable fisheries biologists deem trustworthy.

The proposed methodology is "completely inappropriate and will not provide statistically valid data," wrote Barry Finnegan of the Pacific Biological Station.

There is no evidence that the proponents of the study have the technical competence to plan, execute, analyse or interpret whatever data they hope to obtain, wrote Tom Johnston, a provincial fish scientist.

This study will skew whatever data is obtained to show more fish in the river than are actually there, wrote Bob Hooton, perhaps B.C.'s leading steelhead expert.

"Serious flaws are inherent in the study design," wrote Neil Schubert of the department of fisheries and oceans' stock assessment team. "This study will produce population estimates that are highly biased."

Furthermore, there are serious ethical concerns raised by a study which "will have a large effect on the [steelhead] population because mortality, stress and altered behaviour are expected," wrote Charles Parken, a fish scientist with Cascadia Natural Resource Consulting.

Small wonder that when this so-called study failed to pass a technical review last year it was rejected by environment ministry staff convinced it could not produce credible results.

But why let science derail an NDP gravy train?

This "study" will pay a coordinator $300-a-day, "technicians" $250-a-day, provide car and boat allowances of $150-a-day and fork out $400-a-day for whoever gets chosen to write up a report that scientists already say will have little worth.

So a scheme dismissed as fatally flawed is now back on the front burner. Sounds like planning for the fast cat ferries to me.

And the new rationale? Harm to the steelhead is outweighed by "improved relationships" between the government and a bunch of anglers who will never vote for the NDP anyway.

shume@islandnet.com

5/10/00 Terrace Standard

SKEENA ANGLER

ROB BROWN

Spawning grounds

The Bulkley Valley Salmonid Preservation Group (BMSPG) is a partnership made up of representatives from community groups, including a small time hatchery, a couple of enhancement projects, a friendship centre, First Nations, DFO and the Bulkley Valley Branch of the Steelhead Society of B.C.

Their purpose is to, "strengthen communication and make more efficient use of the resources regarding salmonid/habitat projects in working towards the rebuilding of salmon stocks in the Bulkley and Morice watersheds."

The goals of this community confederation are to "contribute to the overall health of wild salmonid stocks or the enhancement of salmonid stocks in freshwater life stages," and to "carry out this work in an ecologically sound, economically viable and scientifically defensible manner.".

In the fall of 1998 the DFO undertook a program at Moricetown designed to estimate the number of coho returning to the Bulkley River. The program involved the capture and marking of returning fish.

Part of the summer steelhead run bound for the upper Bulkley and Morice Rivers passes through the Moricetown fish way at the same time as coho. Since these steelhead are the same size as coho, the crew captured a large number of them. The steelhead could have been returned to the river unmarked, but the overseers of project chose to tag them with a different colour of tag than the one they were using for the coho in the hope that the recapture of these steelhead by anglers upstream might provide useful data.

When they heard the DFO was tagging accidentally caught steelhead, members of the Bulkley Valley Branch of the Steelhead Society seized an opportunity to get a spring steelhead fishing opportunity on a river normally closed to protect spawners. Some 50 fishers were hastily assembled to fish ripe Bulkley steelhead to do a population study.

The project smelled so bad that scientists in the federal fisheries department and the environment ministry objected to it, as did prominent sportsmen like Bruce Hill of the Sierra Club, former Sport Fish Advisory Board Chair, John Brockley, Steelhead Society Director and lifetime BC Wildlife Fed member, Joe Saysell, Robert Taylor of Totem Fly fishers, and many others who expressed their surprise at the issuance of the permit and their stout opposition to the putative population study.

In a letter to Paul Kariya, of Fisheries Renewal BC, Hill went right to the core of the matter.

"Steelhead conservation in this watershed has always been fraught with conflict," Hill wrote. "While there are serious needs to resolve some of the science surrounding how steelhead population estimates are arrived at, this study will not provide this data and will not provide any resolution to the ongoing conflicts surrounding steelhead on the Skeena. Indeed, by funding a study that has been condemned as invalid by the leading scientific authorities on this subject you have inflamed this conflict and have added to the burden of fisheries managers already struggling with diminished resources and ever increasing and conflicting demands on their time and the resource itself."

The project was canceled. The original proponents went back to the drawing board, made modifications, then reapplied to the environment ministry for a collection permit.

Once again the proposal was reviewed; once again federal and provincial scientists expressed their reservations with it, as did a private consultant who was asked by MELP to review it; once again Mr. Reid White, biologist, engineer and the regional manager in Skeena issued a permit.

In his reasons for doing so, White acknowledged that the project was scientifically questionable and the technical benefits insignificant, but the purpose of improving relationships with the proponents of the project was enough to offset the potential damage to this year's larger steelhead population. As a result of the issuance of this permit, well over a thousand steelhead were caught. At a very conservative mortality estimate of seven per cent, some 100 spawners were released to die. The shaky information generated from this unethical spawning derby jibed roughly with the population estimate already obtained at the test fishery.

About $30,000 of government money was spent on the derby itself, while thousands of tax generated dollars were spent to pay for the time and resources of MELP staff forced to participate in the program. By bending over backwards to placate the parochial interests of a small segment of the angling community that lives in fear of government bogey men, and figures it deserves special rights because it lives near the Bulkley River, Reid White has demonstrated why brains alone do not a good manager make.

As for the noble ideals of the BMSPG, did they work toward the rebuilding of salmon stocks in the Bulkley and Morice watersheds? Was the work carried out ecologically sound, economically viable and scientifically defensible? Lofty ideals notwithstanding, it appears not. The acquisition and distribution of public money is the over arching principle of the BMSPG, and similar community boards. The project was a misuse of public money, a make work project that has highlighted the administrative dysfunction in MELP and it has done bad by fish.

Posted - mior to April 4/00

[redacted]

Bait on the Bulkley

Using Bad Science to Kill Wild Steelhead

Fishing with bait, in a closed river. 25 sports anglers will be allowed to catch an estimated 800-1,000 summer run steelhead this spring, as the fish prepare to spawn in British Columbia's famed Bulkley River.

The controversial fishery is being allowed under a special scientific collection permit which has been issued to the Bulkley Valley Branch of the Steelhead Society of B.C.

Critics say the project - which proposes to provide biologists with data they say they don't need - is a conservation threat and a poorly disguised effort by local anglers to fish during a closed season.

Supporters argue the project will yield valuable information on the size of the Bulkley River summer run, and may prove what some local anglers have long argued - that there are a lot more fish out there than has been estimated by biologists.

Nobody knows how many of the summer runs, which arrived in the river last fall and are now ripe to spawn, will be killed by the fishery. Mortality estimates range from 40 fish to 100.

Under the proposal, groups of anglers will fish the river over a three month period using bait. They will attempt to catch at least 800 steelhead, looking for tags that were attached to about 1,600 fish last fall when they were netted in a native fishery at Moricetown.

The provincial government has provided about $29,000 to fund the project. The 25 anglers will volunteer their time, but the budget will cover their expenses and will pay for boats and helicopter time, among other things.

Bob Taylor, a member of the Totem fly fishing club, in Vancouver, says he's shocked the government has issued a permit.

"I say close to 100 fish will die. That's 100 prime summer run steelhead," said Mr. Taylor.

"This project has no morality and no scientific validity. I mean, why would you do it?"

He said the tagging project at Moricetown is already providing biologists with baseline population data, and any information gathered by the angling project will be superfluous.

Joe Saysell, a guide and conservation advocate, is even more scathing in his criticism.

"I call it the UI (Unemployment Insurance) fishing team," he said. "This is just a bunch of bait anglers who've figured out a way to go fishing in a closed season, and get their expenses paid by the government."

Mr. Saysell said the Bulkley is traditionally closed at this time of year because biologists have long recognized pre-spawn fish shouldn't be subject to stress.

"The reason it's closed is so that those fish have a chance to rest up and spawn," he said.

"They have been resting under the ice all winter, conserving their energy for the last big push to the spawning beds. And now they are going to subject to harassment from anglers.

"What is this going to do to those spawning fish? We simply don't know what the mortality will be on eggs and fish using their last energy.


Joe Saysell

"And the project in the end is not going to prove anything that we don't already know about the steelhead population."

Mr. Saysell said he is deeply upset the "scientific angling team" is going to use bait.

"Fish take bait a lot differently than an artificial lure," he said. "They swallow it down and it hooks them in the gills. They can't help themselves with bait.

"It's a very, very bad conservation move."

Both Mr. Saysell and Mr. Taylor feel the project has a hidden agenda, aimed at bolstering an argument put forward by members of the Bulkley Valley Branch of the Steelhead Society in the past, calling for a kill fishery on the river.

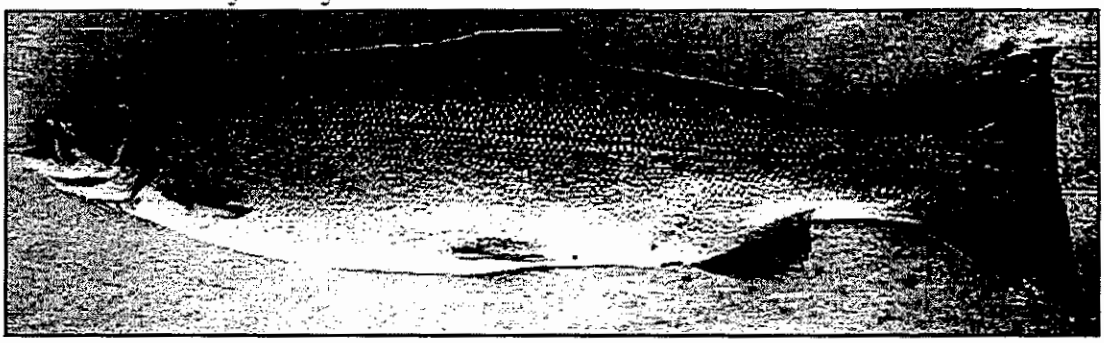
Some local steelheaders have argued the Bulkley's summer run - estimated at around 18,000 fish - is actually double that number. They have proposed opening a "retention fishery" so anglers can once again start killing wild, summer steelhead.

The killing of wild steelhead is forbidden everywhere in B.C. for conservation reasons.

Jamie Alley, director of fisheries management for the B.C. Ministry of Fisheries, said he has rejected calls for a retention fishery in the past and sees no reason to change his mind at the moment.

But he will review the situation next year, if the proposal is revived.

"First of all we have to be confident there is a surplus," he said. "We also have to take into consideration any request from First Nations. If there is a retention fishery - they come first."



First Nations on the Skeena River system, into which the Bulkley flows, have been supportive of efforts to shepherd steelhead through in-river salmon fisheries. If sports anglers make the case that there is now a surplus of steelhead, it's likely that natives will soon start killing thousands of steelhead.

Mr. Alley trod carefully around the issue of the Bulkley River angling project.

"We're supportive of any activity that will assist us in having a better understanding of steelhead in the watershed," he said - which is not the

same thing as saying the project is scientifically valuable.

Reid White, the regional fish and wildlife manager who approved the project, admitted the project's scientific validity is questionable.

He said if the anglers catch a set number of steelhead, and a certain percentage are tagged, they will be able to use a formula to estimate how many steelhead are in the river.

But he also admitted biologists already have an estimate, based on how many steelhead were tagged, and how many tagged fish were taken in the open sports season.

Mr. White said the Bulkley project almost went ahead last year, "but the permit was canceled at the last minute when an independent consultant said the project was not scientifically sound."

This year's project is essentially the same.

A government paper on the project states the project will add some new data, but : "At best this additional information is interesting."

So why was the controversial project approved this year?

Simply because the government is tired of taking heat from local anglers who don't trust the biologists overseeing the Bulkley River.

Mr. White believes it will help smooth things over with the local anglers.

"The clearest benefit is to improve relationships," he says.

His report also notes that because of a strong steelhead run in the fall of 1999, the bait anglers can "test their ideas with this project in an unusual year when the population can best absorb damage."

Gord Wadley, an independent fisheries consultant who is working on the Bulkley project, defends it as a valid study.

He said many people don't trust the data they're getting from fisheries biologists, and he argues the government simply doesn't have a handle on the Bulkley River steelhead population.

"There has been little effort by the ministry to ever put real numbers on the table," he says.

Mr. Wadley said the project will show there are a lot more steelhead than the government thinks.

"They're grossly underestimating the population," he contends, estimating there are 35,000 summer run steelhead in the river - double the government's number.

Government biologists say 24,000 steelhead are needed to seed the river, but Mr. Wadley rejects that as a meaningless number "plucked out of the air."

He describes the relationship between local anglers and government biologists as "strained" but says the Bulkley project should improve things.

Mr. Wadley agreed the sub-text to the project is the distrust the anglers have for government data.

In other words, the anglers want to get their own numbers, and prove the biologists wrong.

"We've been kind of led by the nose. We want to see some changes," he agreed. "We're not trying to take it back over, but . . .we need to collect data that we can all mutually agree on."

Mr. Wadley disagreed that the project is part of the lobby effort to get a kill fishery on the river.

"That is not the intent - to go out and say we've got enough, go ahead and kill them."

He said the 25 anglers on the project will do a good job of releasing fish alive. If any are hooked deep, the line will be cut.

"If we even estimate a 5% mortality, you'd see we might have 40 fish dead," he said.

The project allows the anglers to fish the Bulkley from February until May 15th, but because of ice conditions it will likely start this month.

Steelhead spawn in the Bulkley in April and May, raising the possibility that - in the name of science and public relations - some fish will be taken

right off their redds.

Story by Mark Hume with Photographs by Nick Didlick

(If you would like to express your opinion on this issue to the government. write to B.C. Fisheries Minister Corky Evans at: corky.evans.office@leg.bc.ca. Or Premier Ujjal Dosanjh at: ujjal.dosanjh.office@leg.bc.ca

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