2000 Bulkley River Creel Survey

An Evaluation of the Angling Community on the Bulkley River using a Complemented Access-Roving Creel Survey

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Prepared for: **Fisheries Renewal BC**

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ABSTRACT

The Bulkley River is an important angling destination of local residents, anglers from BC and other parts of Canada, and from other countries. In order to manage the anglers attracted to this river so to ensure a high quality angling experience and ensure fishing pressure is within limits that the fish populations can withstand, knowledge of characteristics and behaviour of these anglers is required. To this end, from late August to the end of October 2000 a complement creel survey was undertaken on the Bulkley involving an access point survey, a roving survey, and aerial flights (i.e., survey design was access-roving). Thirty two drifts in the roving survey resulted in 599 interviews and over the same period of September 1 to October 31 the access point yielded 845 angler interviews. There were 14 flights the length of the river to provide instantaneous counts of the number of anglers.

During the sampling period the angler composition by residency was different between the access point survey and the roving creel survey, with 42.3% Local anglers at Trout Creek (32.5% roving), 29.4% BC residents (25.1% roving), 5.7% Canadian (3.0% roving), and 22.6% Non-Canadian (39.4% roving). Combined local and BC residents comprised 57.6 % of the anglers encountered in the roving survey. There are changes in angler composition over the fishing season and also differences in residency composition between weekdays and weekends.

Approximately 75% of anglers throughout the river (roving survey) used fly gear while ~21% used lures, the remainder used a combination of both tackle types. This was different from findings at the Trout Creek access site (33.5% fly, 62.5% lure), and it appears that over the last several years the proportion of fly anglers has risen to and stabilized around 80%. There are differences in gear type between residency categories, throughout the season, and between weekdays and weekends. There are considerable and significant differences in planned fishing time between residency categories (Local < BC < Canadian < Non-Canadian), gear type (Lure < Fly) and through the fishing season. This is likely a function of the changing angler composition (e.g., increasing number of fly fishing, vacationing, Non-Canadian anglers) during peak season, making intensive long duration trips relative to the shoulder seasons. There is good agreement in estimates between 1998 and 2000 and raise questions regarding the validity of the "angler-day" concept. It is suggested that the finer resolution "angler-hour" would more appropriately estimate true angler effort and result in more equitable allocation of angling time between the residency categories.

There does not appear to be any difference in angler success (steelhead success) by residency. The CPUE calculated for the access point site in 2000 (0.09 steelhead per angler-hour) is only approximately one-half previous estimates. However, these different estimates are generated by differing survey methodologies (access point versus roving / observed versus reported) and so care must be taken in any interpretation. The rate of transiency among the anglers was estimated at 8.9% by the roving survey and 18.1% by the access point survey. It is suggested that overall the rate of transiency is similar

between different residencies, but variable from week to week. In combination with differential angler trip lengths, transiency may significantly affect angler counts as the fishing effort is not uniform and the probability of interception of transient anglers by roving creel survey personnel has a lower probability than more stationary anglers.

The number of anglers present on the river were estimated by aerial surveys, and these flights compared with on-river counts to assess accuracy. The mean number of anglers counted within a section by aerial assessment was the same as on-river counts, but there was a trend toward underestimation of aerial counts at angler densities greater than 15 anglers/section and over large time periods (e.g., a day). There is some evidence of considerable angler transition between aerial counts and river drift counts, but this is not conclusive. Finally, aerial counts do not capture the whole days angling activity and appear to significantly underestimate the total number of anglers in a given day.

The uncorrected estimate for fishing effort for 2000 was 5,917 rod days or 38,471 rod-hours. Corrected effort estimates were 8,638 rod days and 55,381 rod hours. These rod-day estimates were divided up into approximately 60% B.C. residents, 4% non-BC Canadian, and 36% Non-Canadian. Angler effort by residency group, when analyzed in relation to angler-hours instead of angler-days, provides a clearer picture of the present state of the fishery on the Bulkley River. In the 2000 Classified Waters period B.C. residents made up 50% of the angling effort, non-B. C. Canadians, 5%, and Non-Canadians 45% of the effort. The total estimated effort is an increase over the estimates from 1997 and 1998. The recent and present effort estimates are evaluated relative to independent data sources ("counter-foils" and the Steelhead Harvest Analysis) and are found likely to significantly underestimate angler effort, and numbers generated from these creel surveys should be viewed critically.

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1. INTRODUCTION

1.1 BACKGROUND

The Bulkley and Morice rivers together are estimated to comprise between 20% and 50% of the total Skeena steelhead (*Oncorhynchus mykiss*) run (Koski et al., 1995; Labelle et al., 1995), and due to this the Bulkley River is an important steelhead angling destination for fishermen from the local communities, other parts of British Columbia and Canada, and other countries. In order to ensure high quality angling experiences and prevent excessive fishing pressure on the steelhead in the river, management/control of the angling population is required. The management of anglers, and consequently the pressure they exert on the fish, may be done through such vehicles as season or area closures, license fee schedules to encourage/discourage groups, or requirements of being guided. These tools may provide managers the ability to distribute anglers in space and time in order to ensure angling pressures on the fish are within bounds that the fish population can withstand, that the angler enjoys a wide variety of high quality fishing experiences, and that on some waters they can fish with relatively few interactions with competing anglers. However, in order for the angling population to be managed to meet these goals, some basic information on angler composition (proportions of population by place of residency), characteristics (angling method, planned length of time angling, and transiency between sites) and effort (number of angler hours or angler days) applied to the river is required. To collect this information, a creel survey of the Bulkley River from the Morice-Bulkley confluence to the Suskwa-Bulkley confluence was conducted through late August to the end of October, 2000.

Sample surveys are a statistical method of obtaining information about a large population (e.g., all Bulkley River anglers) by examining only a small fraction of that population (Rice, 1995). In fisheries work, there are two basic forms of survey. The first, the access point survey, intercepts anglers either as they arrive or leave a discrete location with the probability of interception being equal between all anglers (Jones et al., 1995; Pollock et al., 1997). This type of survey provides the least biased estimates for expenditure data, travel distance and related demographics (Kokel et al., 1991). The second form of survey in creel work is the roving survey in which an interviewer(s) travels through the fishery and interviews anglers in the act of fishing (Hoenig et al., 1997). The probability of interception of anglers in this survey method is proportional to the anglers trip length (Jones et al., 1995; Pollock et al., 1997), and, on average, the angler will be intersected midway through his fishing trip (Hoenig et al., 1997). The 2000 Bulkley River survey used a complemented design (terminology from Pollock et al., 1997) known as access-roving. That is, both access point and roving creel surveys were undertaken in order to maximize information gathered and capitalize on the advantages of each of the respective survey designs. The access point survey (conducted at Trout Creek/Toboggan Creek confluence with the Bulkley) provides high precision estimates of effort and catch while the roving survey (involving sampling the entire river) provides a broader view (with less precision) of the angler composition/characteristics of the entire angling community. The 2000 survey also included flights of the entire river in order to provide instantaneous counts of anglers, but this is to be considered merely another type of roving survey (Pollock et al., 1997).

Previous angler surveys of the Bulkley have been conducted in 1969 (Pinsent, 1970), 1974 (Remington, 1975), 1982, 1983 (both years reported in O'Neill and Whately, 1984), 1989 (Lewynsky and Olmstead, 1990), 1997 (Morten and Parker, 1998), and 1998 (Morten, 1999) and so there is a relatively long record (~30 years) over which to examine changes in some of the measured angler characteristics. However, one aspect that has been ignored until this survey is the transiency of anglers on the river. An angler may choose to fish more than one area of the river within a single day, and this action may affect *i*) counts of anglers on the river (i.e., if he is counted more than once in two separate areas, or is missed as he moves from one area to another), or *ii*) the probability of obtaining an interview since in roving surveys interception is proportional to trip length. A transient angler may be viewed as having two or more "trips" in a day, each of shorter duration (and hence lower probability of interception by survey crew) than a non-transient angler. If the proportion of transiency among anglers is significant, there may be an underestimation of effort and/or catch occurring as anglers are missed entirely due to their transient behaviour. Therefore, it is important to derive an estimate of the proportion of anglers that are transient as they form another source of error in the estimates of effort and the results from the interviews.

For this report I have followed the philosophy of Kokel et al. (1991): "*The data obtained from [such] surveys should be critically analyzed – not merely presented in tabular or summary form*". This report has attempted to not only analyze the 2000 data but also place it in context relative to recent surveys (i.e., 1997 and 1998), as well as past results (pre-1990).

1.2 OBJECTIVES

The objectives of the Bulkley River creel survey in 2000 were to:

1. Document and evaluate angler characteristics (residency, gear type, and planned fishing time) of the Bulkley River steelhead angling community. These characteristics can then be compared with past findings to detect trends and changes.
2. Evaluate transiency of anglers on this system to determine what proportion of total anglers are moving between sites, and to examine the effect of this on total angler counts.
3. Compare aerial counts of anglers with on-river counts to assess accuracy of aerial counts. The aerial counts may be more cost-effective and less labor-intensive than river counts, and so if comparable accuracy can be achieved through either method, aerial counts may be a more practical option for estimation of total anglers.
4. Compare the results of an access point (i.e., complete) survey with a broad scale roving survey to determine viability of extending results from Trout Creek (an easily accessed and surveyable area) to the general Bulkley River angling population.
5. Estimate angling effort applied to the Bulkley system during the 2000 steelhead fishing season. Catch and catch per effort were also estimated at the access point survey.

2. STUDY AREA

Originating in a high lake system (i.e., above 850 m) which includes Bulkley, Maxan, Nanika, Kidprice, Atna and Morice lakes, the Bulkley/Morice watershed 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). The drainage area accounts 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. The length of river within the study area is approximately 141 km of which 116 km is fishable (Anonymous, 1998).

In addition to steelhead, four of the five species of Pacific salmon (*Oncorhynchus*) are common in the Bulkley system, these being coho (*O. kisutch*), pink (*O. gorbuscha*), sockeye (*O. nerka*), and chinook (*O. tschawytscha*). As well as these anadromous species, 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 tridentata*) and sculpins (*Cottus* sp.).

There are five principle communities distributed along the Bulkley River, Hazelton, Moricetown, Smithers, Telkwa, and Houston (Figure 1) though there is residency and land use along its entire length where the terrain permits. Highway 16 follows the river over much of its course, and this together with secondary roads allows many access points for angling. There are also many areas for boat launching. Therefore, anglers have easy access to the majority of the river.

The Bulkley River is a classified water; one of 42 BC rivers designated to preserve the unique fishing opportunities provided by these productive waters (Anonymous, 2000) and has been since 1990 (Morten, 1999). The classified season for angling on the Bulkley River is from September 1 to October 31 (Anonymous, 2000). Fishing effort on the Bulkley River is concentrated in the most accessible and navigable areas, generally through the 90 km between Trout Creek and the Morice River confluence (Anonymous, 1998).

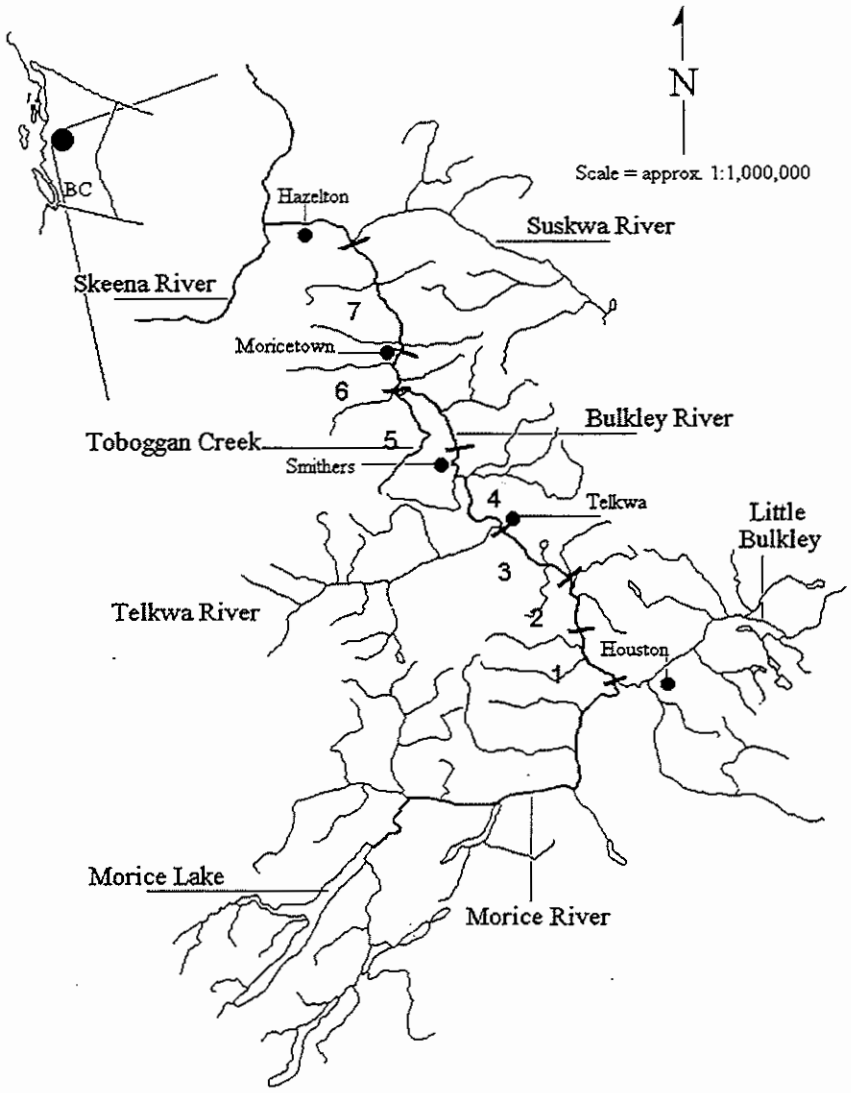


Figure 1: Study area for 2000 Bulkley Creel Survey with river sections 1 to 7 numbered.

3. MATERIALS AND METHODS

3.1 SURVEY DESIGN

The 2000 Bulkley River creel survey involved three components – an access point survey, a roving survey, and aerial flights. The access point survey was conducted at the Trout Creek/Toboggan Creek confluence with the Bulkley River from August 21 to October 31. Anglers were observed for four to six hours each day during this period, and their time spent fishing and observed catch recorded. Personal interviews (see copy of the questionnaire in Appendix 1) then allowed collection of information on angling characteristics. This approach allowed complete coverage of a single area providing a very precise estimation of angler behavior/characteristics.

The roving survey took place between September 1 and October 31 in which sections of the river were drifted by survey personnel and encountered anglers interviewed (see questionnaire in Appendix 1). The sampling period was divided into nine weeks and the river into seven sections (Table 1 and Figure 1). The design of this component was a stratified random sampling regime with non-uniform sampling effort. The period of September 1 to October 31 was stratified by week, and each week by weekday and weekend. The dates and time of day of drifts were randomly selected within each stratum with sampling effort distributed as 60% from September 15-October 15 (peak angling effort) and 20% each for September 1-15 and October 16-31 ("shoulder" angling periods). Within a week, sampling effort was designed to approximate 60% effort on weekends/holidays and 40% during weekdays. Once time of drifts were selected, the river section to be sampled was then randomly selected with target effort of 60% of drifts in the sections above the Telkwa bridge and the remaining 40% in the sections below this.

Fixed wing flights of the entire river, from the Morice-Bulkley confluence to the Suskwa-Bulkley confluence, were conducted to provide instantaneous angler counts and were originally scheduled for twice weekly (randomly selected day and time with probabilities of weekend versus weekday similar to drift effort), but weather conditions resulted in the cancellation of four of these flights. On those days in which a flight occurred the drifts were scheduled to coincide with the flight in order to allow estimation of the number of anglers within a section by both aerial and drift counts.

The purpose of this three-fold design was to allow precise estimation of angler characteristics/effort/success at a single point on the river (Trout Creek – not representative, but useful for comparison with past years), provide estimates of angler characteristics and effort throughout the length of the river to provide a larger scale assessment (roving survey), and evaluate the accuracy of flight counts in enumerating anglers as part of effort estimation.

Table 1: Sampling dates and description of river sections used in the 2000 Bulkley River creel survey. See also Figure 1 for river section designations.

Week #	Dates	Section #	Description
1	Sept. 1-7	1	Bulkley-Morice confluence to Walcott bridge
2	Sept. 8-14	2	Walcott bridge to Quick bridge
3	Sept. 15-21	3	Quick bridge to Telkwa bridge
4	Sept. 22-28	4	Telkwa bridge to Chicken Creek
5	Sept. 29 – Oct. 5	5	Chicken Creek to Trout Creek
6	Oct. 6-12	6	Trout Creek to Moricetown Canyon
7	Oct. 13-19	7	Moricetown Canyon to Suskwa River confluence
8	Oct. 20-26		
9	Oct. 27-31		

3.2 SURVEY SAMPLING

During each interview in both the access and the roving surveys, information was gathered from the angler on place of residency, angling gear type, landed catch, and whether the angler planned on fishing another site on the Bulkley River that day (see questionnaires in Appendix 1). In addition, at Trout Creek the angling time (observed by creel personnel) was recorded. The roving survey asked two additional questions compared with the access survey 1) How long does the angler plan on fishing that day (i.e., planned fishing trip length), and 2) was the angler on the river when the plane for the aerial count flew over (on those days an aerial flight occurred). These last two questions were to allow estimation of the length of planned fishing trip (estimation of the actual lengths of trips not possible in roving creel surveys) and also as a method of assessing how many anglers in a section are missed by the instantaneous count of an aerial flight. The flights along the river began at the Bulkley-Morice confluence and proceeded downstream to the Suskwa-Bulkley rivers confluence. Observers recorded the number of anglers, number of jet boats, and number of drift boats on the river.

3.3 ANALYSES

Analysis of the information collected in the 2000 survey was conducted under six categories:

1) Angler residency
2) Gear type
3) Planned fishing time
4) Catch
5) Transiency
6) Number of anglers and effort

3.3.1 Angler Residency

The proportions of anglers by residency forming the Bulkley River angling community was estimated at three scales/dimensions – 1) over the whole nine week season, 2) for each week individually, and 3) spatially by river section. Angler residency was defined as:

Local anglers (locals) – come from a community between, and including, Hazelton and Houston,

BC residents (BC) – Come from location in BC but not a local angler as defined previously,

Canadian resident (Can) – comes from another area of Canada, outside the province of British Columbia, and

Non-Canadians (Non-Can) – Residents of another country.

Estimates of proportions and bounds on the estimates for the roving survey over the nine week period were produced using the stratified proportion estimator (Equations 1 – 3). Estimation of proportion and associated bounds of total anglers represented by each residency group within each week, and separately within each river section, was done using simple random sample proportion estimates (Equations 4 – 6). The bound on the estimate is approximately equal to standard 95% confidence intervals when the data is approximately normal and always greater than 75% irrespective of the underlying distribution (Scheaffer et al., 1990). Estimates of proportions of anglers at the Trout Creek (access point) site were done with standard proportion estimates and 95% confidence intervals (Equations 7 and 8). Due to the access point sample being a complete census rather than a survey (i.e., the anglers were all sampled, there was no randomized design used) a proportion based on a complete count is appropriate.

By stratifying the survey by weekend/holiday and weekdays within each week it was also possible to test for differences in angler composition between the two periods within a week. This was done using chi square analysis of contingency tables. The observed counts were used in the contingency table cells as this approach, though used for testing differences in frequency (e.g., proportions), should not use proportions within the cells (Zar, 1984).

3.3.2 Gear type

The proportions of anglers by gear types were estimated similarly to angler residency. That is, proportions based on stratified random sampling (Equations 1-3) were used for estimates over the entire season, and proportion from simple random sampling (Equation 4-6) were used for analysis by individual weeks, by river section, and in determining proportion of gear type by angler residency. Trout Creek (access point) results were calculated using Equations 7 and 8 for complete counts.

3.3.3 Planned fishing time

The responses to planned fishing time (number of hours) were assessed for normality (via normal probability plot) and determined to come from a normal distribution; thus parametric statistical techniques were employed on these data. The mean length of planned fishing time was compared by single factor Analysis of Variance (ANOVA) when comparing more than two groups, and if a significant difference detected, multiple pairwise comparisons conducted using Tukey Honestly Significant Difference (Tukey HSD) to determine which means were different. When comparing only two groups (e.g., weekend versus weekday) the Students *t*-test (unequal variance assumed) was conducted. All tests were conducted at $\alpha = 0.05$.

3.3.4 Catch

The species and number of individuals captured were recorded during the roving survey, and summarized. The hypothesis that there was a difference in steelhead capture success dependent upon angler residency was tested using chi square analysis. Proportions and bounds on the estimate of contribution by species to total catch was determined using Equations 7 and 8. Catch per unit effort (CPUE) was not calculated for the roving survey, but was for the access point survey. See Struthers (2001) for greater detail on catch at the access point in 2000.

3.3.5 Transiency

The proportion of the total anglers within a residency category which were transient (i.e., fishing more than one area that day) was estimated using the simple random sampling proportion estimator (Equations 4-6). Comparisons between residence categories over the entire season, on a weekly basis, and weekday versus weekend were all conducted via chi square analyses.

3.3.6 Number of anglers and effort

Comparisons of methods of estimating the number of anglers present were based on four data sources for each day a flight occurred, *i*) the on-river drift count by the survey crew for the section they covered, *ii*) the corresponding aerial count of anglers for that section, *iii*) angler counts at the access point by creel personnel, and *iv*) aerial counts of anglers at Trout Creek. These data were assessed for normality (normal probability plots) and found to be approximately normal ($r = 0.92$-0.98, r_{crit} for $n=14$ is 0.94 at $\alpha = 0.05$; see pgs 574-475 in DeVore (1987) for details of this test). In order to test for differences between aerial and on-river counts, paired *t*-tests were conducted using the simultaneous independent estimates. The relationships between the aerial and on-river estimates were also examined graphically.

Angler effort (rod hours and rod days) was estimated by multiplying the number of anglers fishing by time spent fishing (Pierce and Bindman, 1994; Hoenig et al., 1997;

Newman et al., 1997). Unfortunately, due to cancelled flights a stratified estimator of effort was not possible, five of the nine weeks had zero or only a single flight and thus an estimate of the weekly variance was not possible. Therefore effort was estimated by simple random sampling (Equations 9 – 11) and this results in a greater variance of the estimate than would be derived by the originally intended stratified random sampling. Effort was estimated for each flight day for each residency category by multiplying the number of observed anglers by the proportion per residence category for that weekday or weekend period. This estimate of number of anglers by residency was then multiplied by mean planned length of fishing trip (from Section 4.3) to determine number of hours fished that day by all members of that residency category. This resulted in an estimate of effort in rod hours by each residency category for each flight day. For rod days the number of anglers calculated per residence category were used (i.e., an angler present indicated one rod-day). Total effort per flight day was then estimated by summing across the four residence categories. Total effort for the season was calculated as presented below (Equation 9).

3.3.7 Equations

The following notation is used in Equations 1 to 11.

Stratified random sampling (Equations 1 – 3).

$\hat{p}_{st}$ = estimate of proportion over all strata
N = Total number of sampling units (each day is a potential sampling unit, therefore, N = 61 days)
N_i = Number of sampling units per stratum *i* (7 days per week, 2-3 days for weekends, 4-5 days for weekdays)
L = Number of strata (each week is a stratum, thus L=9)
$\hat{p}_i$ = Estimated proportion of stratum *i*
$\hat{q}_i = 1 - \hat{p}_i$ (the complement of $\hat{p}_i$ for each stratum)
n_i = Number of sampling units sampled in stratum *i* (days sampled per week)
n = total number of sampled units across all strata (total days sampled = 32)
fpc = finite population correction = ((N-n)/N)

Simple random sampling (Equations 4 – 6 and 9 - 11)

$\hat{p}_s$ = estimate of proportion
$\hat{q}_s = 1 - \hat{p}_s$ (the complement of $\hat{p}_s$)
y_i = Observed number of "successes" (i.e., responses of a characteristic type (e.g., fly fisher =success, non-fly angler = non-success))
n = total number of responses
s^2 = sample variance
fpc = as above

Using complete data (Equations 7 and 8)

$\hat{p} = \hat{p}_s$ = estimate of proportion
$\hat{q} = 1 - \hat{p} = 1 - \hat{p}_s$ (complement of $\hat{p}$)
y_i = as above
n = as above
$Z_{\alpha/2}$ = 100(1-α)th percentile of the standard normal distribution (1.96 at $\alpha = 0.05$)

Proportions in Stratified Random Sampling (from Scheaffer et al., 1990)

Equation 1: Estimate of proportion ($\hat{p}_{st}$)

$$\hat{p}_{st} = 1/N * \sum_{i=1}^{L} N_i \hat{p}_i$$

Equation 2: Estimate of variance (V) of proportion $\hat{p}_{st}$

$$V(\hat{p}_{st}) = 1/N^2 * \sum_{i=1}^{L} N_i^2 * fpc * (\hat{p}_i \hat{q}_i / (n_i - 1))$$

Equation 3: Estimate of Bounds (B) on estimate of proportion $\hat{p}_{st}$

$$B(\hat{p}_{st}) = 2 * \sqrt{V(\hat{p}_{st})}$$

Proportions in Simple Random Sampling (from Scheaffer et al., 1990)

Equation 4: Estimate of proportion ($\hat{p}_s$)

$$\hat{p}_s = \sum_{i=1}^{n} y_i / n$$

Equation 5: Estimate of variance of proportion $\hat{p}_s$

$$V(\hat{p}_s) = (\hat{p}_s \hat{q}_s / n - 1) * fpc$$

Equation 6: Estimate of Bounds on estimate of proportion $\hat{p}_s$

$$B(\hat{p}_s) = 2 * \sqrt{V(\hat{p}_s)}$$

Proportion using complete data (from DeVore, 1987)

Equation 7: Estimate of proportion ($\hat{p}$)

$$\hat{p} = \sum_{i=1}^{n} y_i / n$$

Equation 8: Estimate of 95% confidence interval on $\hat{p}$

$$\hat{p} \pm z_{\alpha/2} * \sqrt{\hat{p}\hat{q}/n}$$

Estimates of Effort (from Scheaffer et al., 1990)

Equation 9: Estimate of population total ($\hat{\tau}$)

$$\hat{\tau} = N\bar{y} = N \sum_{i=1}^{n} y_i / n$$

Equation 10: Estimate of variance of population total ($\hat{\tau}$)

$$V(\hat{\tau}) = N^2 * (s^2 / n)(fpc)$$

Equation 11: Bound on estimate of population total ($\hat{\tau}$)

$$B(\hat{\tau}) = 2 * \sqrt{V(\hat{\tau})}$$

4. RESULTS AND DISCUSSION

4.1 SAMPLING EFFORT

There were 599 interviews conducted during 32 drifts (Table 2), with the drifts being distributed quite uniformly over the nine sampling weeks. Weeks 1 and 7 (the weeks with the largest number of drifts) together comprise approximately 35% of the drifts. Three planned drifts (one each in river sections 4, 5, and 7) were cancelled (September 19, October 26 and 27) due to high flows and turbidity (i.e., the river was "out"), below Telkwa. Spatially, drifts were concentrated in Sections 1 to 4 (i.e., upstream of the Chicken Creek confluence and accounting for 91% of all drifts); Section 6 (Trout Creek to Moricetown Canyon) was not drifted at all. Section 6 is difficult to navigate and is not fished intensively due to lack of holding water and access, thus it was not sampled. The number of interviews per week peaked in weeks 3 and 4 (Sept. 15-28), these two weeks together accounting for about 41% of total interviews; each other week represented between one (Week 9) and 13% (Week 5) of the total interviews. Interviews were primarily in river sections 1 to 4 (93% of all interviews) but this is probably a reflection of being where the greatest drift effort was expended rather than a larger number of anglers. Thus, though sampling appears to be well distributed temporally, it is concentrated spatially to the upper reaches, generally from the Bulkley-Morice confluence downstream to the Chicken Creek confluence. In addition to the 599 interviews, there were an additional 32 anglers observed but not interviewed for various reasons (i.e., interviewers in transit, anglers could not be accessed). During the period of September 1 to October 31, the access point survey resulted in 845 interviews. There were an additional 182 interviews at this site between August 21 and August 31, bringing the total number of interviews at Trout Creek to 1,027.

Flights were relatively evenly distributed through the sampling time with the exception of Week 6 in which the October 8th flight was cancelled due to weather. An additional three flights were also cancelled (September 17 and 28, and October 28) due to weather conditions, resulting in a total of 14 flights during the Classified Waters period rather than the originally scheduled 18 (i.e., bi weekly). There was also a single flight prior to this period (August 27).

4.2 ANGLER RESIDENCY

Of the 599 interviews conducted by the roving survey in 2000, local anglers formed 32.5% (bound $\pm$ 14.6%), BC residents, 25.1% ($\pm$13.5%), Canadians 3.0% ($\pm$4.1%) and Non-Canadians 39.4% ($\pm$ 14.9%) of the total interviews. Local and BC resident anglers combined accounted for 57.6% $\pm$ 15.0% of the total anglers over the 2000 season. Local anglers were largely from Smithers (125 respondents), with the other communities between Hazelton and Houston contributing fewer anglers (together providing 51 respondents). Non-local BC residents were largely from the Cariboo (49 respondents) and the Lower Mainland (47 respondents), with the Kootenays, Okanagan, Vancouver Island and Northern BC areas combined providing approximately the same number of anglers (49 respondents). Canadian residents from outside BC were few (23, and all reported being from Alberta). Non residents reported coming from South Africa

Table 2: Summary of number of drifts, interviews and flights for roving and access creel surveys on Bulkley River between September 1 and October 31, 2000.

	Number of Drifts			Number of Interviews		
Week	Total	Weekday	Weekend	Total	Weekday	Weekend
1	5	3	2	38	20	18
2	3	2	1	58	46	12
3	3	1	2	125	56	69
4	4	2	2	119	52	67
5	4	3	1	80	54	26
6	3	1	2	64	14	50
7	6	4	2	74	56	18
8	2	1	1	31	18	13
9	2	1	1	10	1	9
Total	**32**	**18**	**14**	**599**	**317**	**282**

	Access Site Interviews			Number of Flights		
Week	Total	Weekday	Weekend	Total	Weekday	Weekend
1	183	78	105	3	1	2
2	145	94	51	2	1	1
3	112	49	63	1	1	0
4	121	56	65	1	0	1
5	97	61	36	2	1	1
6	85	30	55	0	0	0
7	68	39	29	3	2	1
8	24	6	18	1	0	1
9	10	7	3	1	1	0
Total	**845**	**420**	**425**	**14**	7	7

River Section	Number of drifts	Number of interviews
1	8	142
2	7	62
3	6	158
4	8	198
5	2	28
6	0	0
7	1	11
Total	**32**	**599**

(1 respondent), Japan (2 respondents), nine European countries (60 respondents), and 19 American states (192 respondents). The estimated angler composition by residency based on the Trout Creek access point survey was different from the roving survey. At Trout Creek local anglers formed 42.3% ± 3.0%, BC residents 29.4% ± 2.8%, Canadians 5.7% ± 1.4%, and Non-Canadians 22.6% ± 2.6% (these values may differ slightly from Struthers (2001) due to truncation of the access point data to September 1 in this analysis). Using a comparison of proportions (Zar, 1984) the proportion of BC residents is similar between the access and roving surveys ($z = -1.80$, $p = 0.072$), while the proportions for the other three categories are significantly different (Locals $z = -3.74$, $p < 0.001$; Canadians $z = -2.42$, $p = 0.015$; Non Canadians $z = 6.854$, $p < 0.001$). It thus appears that the high profile easily accessed Trout Creek site is used to a larger extent by locals than the remainder of the river in general, and less so by Non-Canadian residents, while BC residents use it to the same extent as the rest of the river.

In comparison with the 1997 and 1998 surveys (Morten and Parken, 1998; Morten, 1999), angler composition by residency based on the roving survey (access point not comparable with these previous studies which were roving methods) has remained relatively stable between 1997 and 2000. Local anglers formed 27.9% of total anglers in 1998 (this category was not used in 1997) versus 32.5% in 2000. BC resident anglers (including locals) formed 49.2% of total in 1997, 59.2% in 1998 and 57.6% in 2000. Canadian residents comprised 7.1% (1997), 5.6% (1998) and 3.0% in 2000. Non-Canadian anglers have formed 43.5% in 1997, 35.2% in 1998 and 39.4% in 2000. In all cases the 1997 and 1998 results fall within the bounds of error of the 2000 estimates suggesting that estimated proportions are similar between years.

Several angler surveys have been conducted on the Bulkley River in the past; the results of these surveys are presented in Table 3. The proportion of BC resident anglers forming the total angling community appears to fluctuate, having increased through the 1970's and '80s and is currently dropping back to lower levels (Figure 2). Canadian residents from outside BC have formed a consistently relatively small proportion of the angling community, though they have comprised as much as 10-13% of anglers on the Bulkley River. The proportion of Non-Canadian anglers have shown an increase over time, with the survey in 2000 reporting the second highest proportion of Non-Canadian anglers to date.

Table 3: Angler composition of the Bulkley River by residency from various surveys. Table adapted from Morten (1999).

Year	Months	BC Resident[a]	Canadian	Non-Canadian	Source
1969	Oct., Nov.	52%	b	b	Pinsent, 1970
1974	Sept., Oct., Nov.	77%	10%	13%	Remington, 1975
1982	Sept., Oct., Nov.	81%	6%	13%	O'Neill and Whately, 1984
1983	Sept., Oct., Nov.	83%	4%	13%	O'Neill and Whately, 1984
1989	Aug.- Oct.	57%	13%	30%	Lewynsky and Olmstead, 1990
1997	Sept., Oct.	49%	7%	44%	Morten and Parker, 1998
1998	Aug.-Nov.	59%	6%	35%	Morten, 1999
2000	Sept., Oct.	57.6%	3.0%	39.4%	This study

[a] = Locals and non-local BC residents combined in this column to allow comparison with past studies
[b] = Canadian and Non-Canadian anglers together comprise remaining 48% in this study

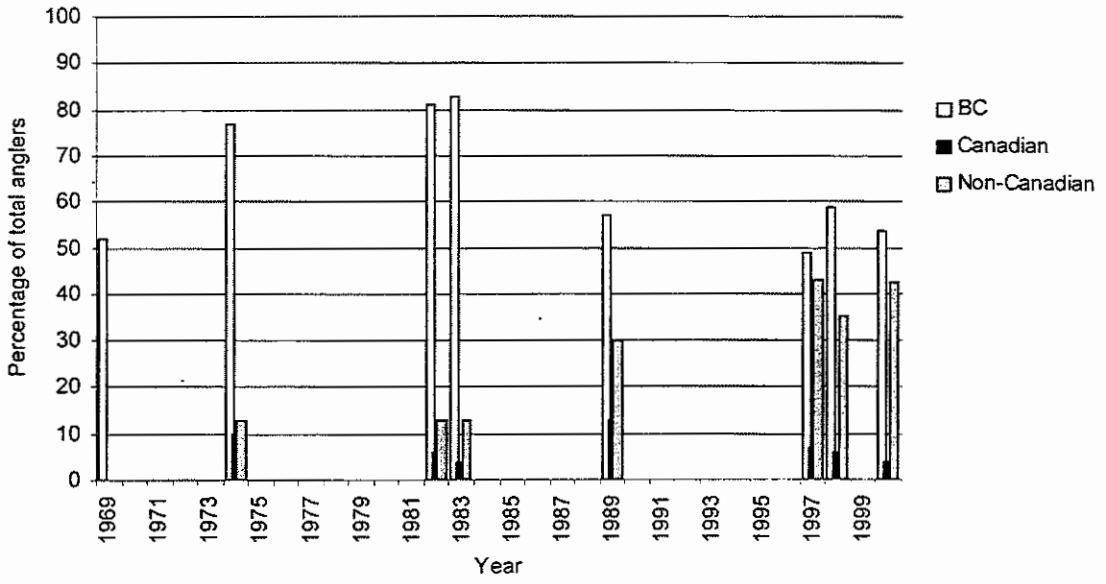


Figure 2: Angler composition by residency on the Bulkley River based on eight surveys between 1969 and 2000. For data sources see Table 3.

Over the entire nine week sampling period there occurred changes in the residency make-up of the anglers. Local and BC anglers made up > 90% of anglers interviewed in weeks 1 and 9 and dropped to less than 60% through weeks 2 to 8 (Figure 3, Table 4). During this interval of relatively low BC anglers, the proportion of Non-Canadian anglers was > 40% (with the exception of week 5).

The angler survey in 2000 was stratified by weekday and weekend/holidays to examine differences in fishing pressure/characteristics through a week. The residency of the anglers interviewed was found to be significantly different (χ^2 analysis; $p<0.001$) between weekdays and weekends for all residency categories (Table 4). Local anglers appear to preferentially fish on weekends during peak season (i.e., Sept. 15 to Oct. 15; weeks 3-7) while during this time Non-Canadians fish largely weekdays with lesser presence on weekends. BC residents are intermediate between these extremes with greater weekend presence between Sept. 15-30 and greater weekday presence from Oct 1-15. The shoulder periods (Sept. 1-15 and Oct 16-31) show overall fewer anglers (Figures 3 and 4) and there is no clear pattern in weekday versus weekend use by residency. Morten (1999) examined the 1998 survey data for differences between weekdays and weekends and also found a significant difference in residency between these two periods, with the proportion of local anglers interviewed being higher on weekends than weekdays, and the opposite (proportions during weekdays greater than weekends) for BC, Canadian and Non-Canadian anglers. Therefore the results agree between these two surveys, locals appear to angle to a greater degree on weekends rather than weekdays while the other categories reverse this pattern. It is of note that the two analyses were conducted using different approaches; Morten (1999) grouped all weeks and so was comparing residence on weekend versus weekdays as pooled over the whole

sampling season (late August-November). The approach in 2000 treated each week as an individual cell in the contingency table and each residence category was evaluated separately. It is encouraging that these two different analyses, at two different scales (whole season versus weekly) yield similar results.

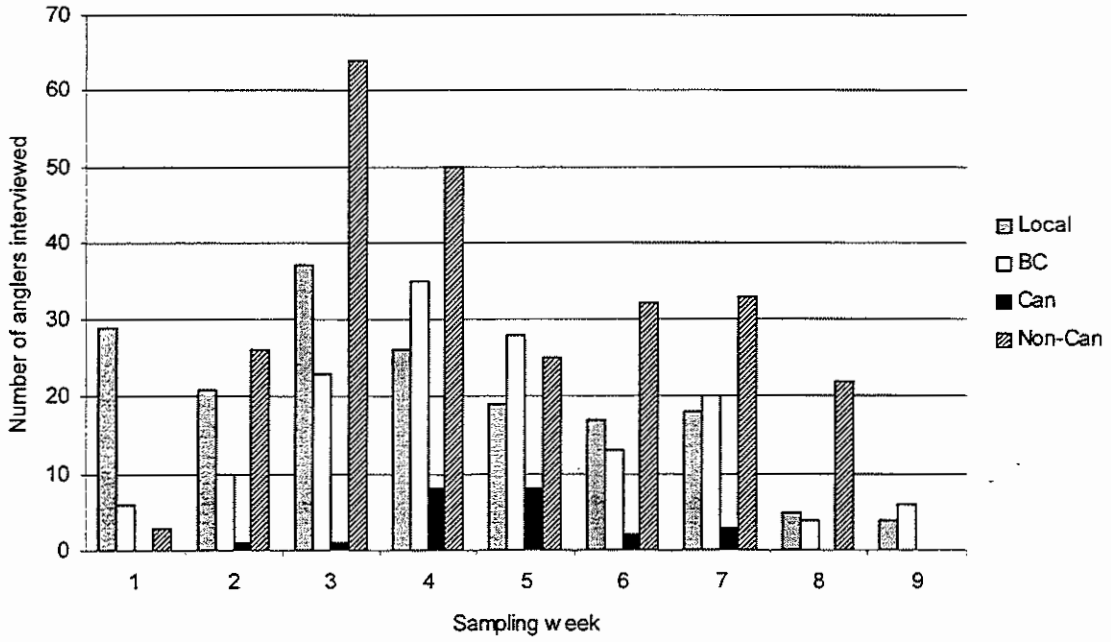


Figure 3: Distribution of anglers by place of residence over nine weeks of sampling period (n=599)

The distribution of anglers by residency over the length of the river is indicated in Figure 5 and Table 5. Local anglers formed > 40% of the interviewed anglers only in Sections 5 (Chicken Creek to Trout Creek) and 7 (below Moricetown Canyon), while local and BC residents combined formed > 50% of interviewed anglers in all sections but Section 3 (Quick to Telkwa). Non-Canadian anglers formed 40% or more of the interviewed anglers in Sections 2, 3 and 7. Based on these results, local anglers (as proportion of total) appear to be quite evenly distributed along the length of the river. It is noteworthy that the estimated proportion of this residency is high in Section 5 (Trout Creek) relative to sections 1 to 4, reflecting the elevated estimate based on the access point sample. Indeed, the two estimates are nearly identical (44% from access point, 43% from roving) providing evidence of the consistency between the two methodologies. BC residents fish largely upstream of Trout Creek, though in these sections they are quite evenly distributed. Canadian anglers form such a small component of the total anglers that their spatial distribution is not considered here. The Non-Canadian anglers are primarily in Sections 1 to 4 (upstream of Chicken Creek confluence). Comparison of Section 5 estimates from Table 5 with access point results indicate high consistency for the Non-Canadian estimates (23% from access point, 25% from roving), and lesser concordance for BC (29% from access point, 21% from roving) and Canadian residents (6% from access point, 11% from roving) between methodologies. However, despite

these encouraging results it must be emphasized that Sections 5, 6 and 7 were undersampled (only three drifts between all three of them), and thus the distribution of anglers within those areas remains largely uncertain for 2000.

Table 4: Proportion (bounds on error of estimate in brackets) of angler composition of Bulkley River by week, weekday and weekend for period of September and October, 2000.

	Local residents			BC residents		
Week	Total	Weekday	Weekend	Total	Weekday	Weekend
1	0.76 (0.23)	0.70 (0.24)	0.83 (0.20)	0.16 (0.19)	0.25 (0.23)	0.06 (0.12)
2	0.36 (0.51)	0.37 (0.52)	0.33 (0.50)	0.17 (0.40)	0.13 (0.36)	0.33 (0.50)
3	0.30 (0.49)	0.09 (0.30)	0.46 (0.53)	0.18 (0.41)	0.18 (0.41)	0.19 (0.42)
4	0.22 (0.31)	0.12 (0.24)	0.30 (0.34)	0.29 (0.34)	0.27 (0.36)	0.31 (0.35)
5	0.24 (0.23)	0.20 (0.21)	0.31 (0.25)	0.35 (0.25)	0.39 (0.26)	0.27 (0.24)
6	0.27 (0.47)	0.26 (0.47)	0.27 (0.47)	0.20 (0.43)	0.57 (0.53)	--
7	0.24 (0.14)	0.21 (0.14)	0.33 (0.16)	0.27 (0.15)	0.36 (0.16)	--
8	0.16 (0.62)	0.17 (0.63)	0.15 (0.61)	0.13 (0.57)	--	0.31 (0.78)
9	0.40 (0.76)	1.00 (0)	0.33 (0.73)	0.60 (0.76)	--	0.67 (0.73)
χ^2 of weekends vs weekdays		χ^2=37.44, df=8, p<0.001			χ^2=29.33, df=8, p<0.001	

	Canadian residents			Non-Canadian residents		
Week	Total	Weekday	Weekend	Total	Weekday	Weekend
1	--	--	--	0.08 (0.14)	0.05 (0.12)	0.11 (0.17)
2	0.02 (0.14)	0.02 (0.16)	--	0.45 (0.53)	0.48 (0.53)	0.33 (0.50)
3	0.01 (0.09)	--	0.01 (0.13)	0.51 (0.53)	0.73 (0.47)	0.33 (0.50)
4	0.07 (0.19)	0.10 (0.22)	0.04 (0.16)	0.42 (0.37)	0.52 (0.38)	0.34 (0.36)
5	0.10 (0.16)	0.07 (0.14)	0.15 (0.19)	0.31 (0.25)	0.33 (0.25)	0.27 (0.24)
6	0.03 (0.19)	--	0.05 (0.23)	0.50 (0.53)	0.17 (0.40)	0.68 (0.50)
7	0.04 (0.07)	0.05 (0.08)	--	0.45 (0.16)	0.38 (0.16)	0.67 (0.16)
8	--	--	--	0.71 (0.76)	0.83 (0.63)	0.54 (0.84)
9	--	--	--	--	--	--
χ^2 of weekends vs weekdays		χ^2=188.34, df=5, p<0.001			χ^2=63.25, df=7, p<0.001	

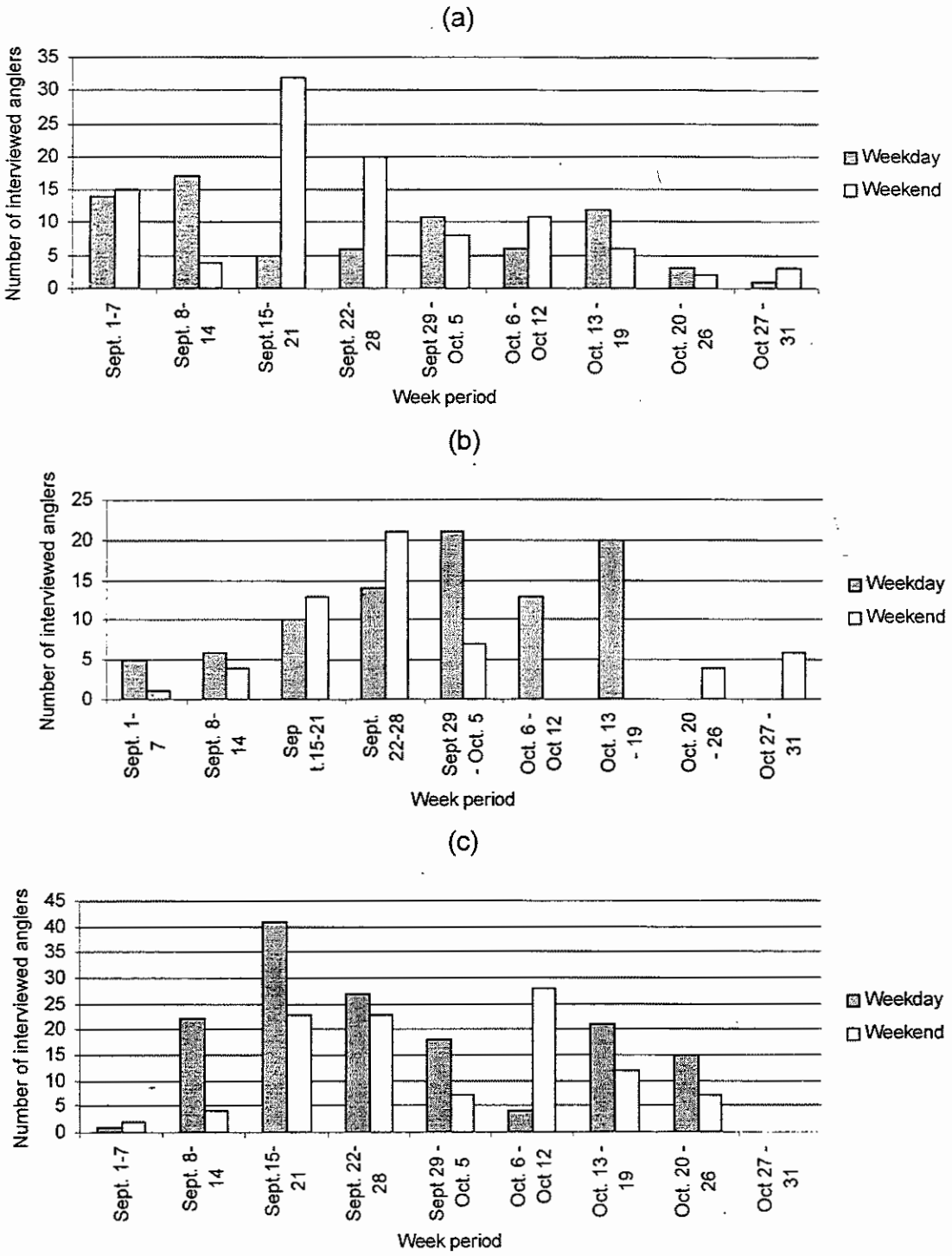


Figure 4: Number of interviewed anglers, weekends and weekdays for (a) local residents (n=176), (b) BC residents (n=145), and (c) Non Canadian residents (n=255).

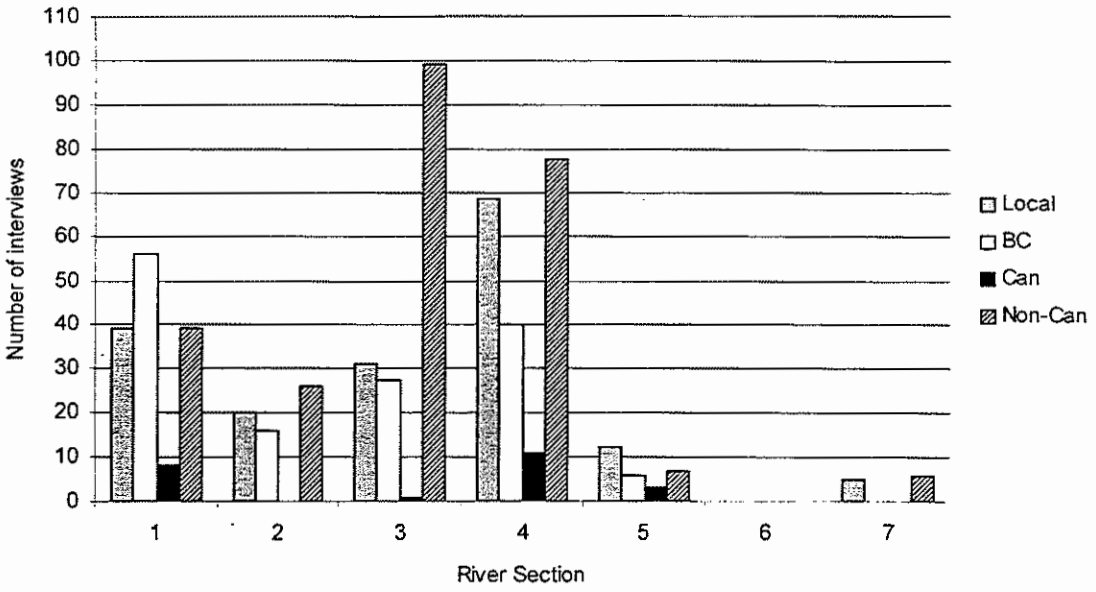


Figure 5: Number of interviews by residency per river section sampled (n=599).

Table 5 : Proportion (bounds on error of estimate in brackets) of angler composition on Bulkley River by river section, September and October, 2000

River Section	Local	BC	Canadian	Non-Canadian
1	0.27 (0.29)	0.39 (0.32)	0.06 (0.16)	0.27 (0.29)
2	0.32 (0.33)	0.26 (0.31)	0 (0)	0.42 (0.35)
3	0.20 (0.31)	0.17 (0.29)	0.01 (0.06)	0.63 (0.37)
4	0.35 (0.31)	0.20 (0.26)	0.06 (0.15)	0.39 (0.32)
5	0.43 (0.69)	0.21 (0.57)	0.11 (0.43)	0.25 (0.60)
6	--	--	--	--
7	0.45 (0.99)	0 (0)	0 (0)	0.55 (0.99)

4.3 GEAR TYPE

In evaluating the entire sample of 599 interviewed fishermen, fly fishers formed the largest component in 2000 (75.2% $\pm$ bound 13.1%) followed distantly by lure anglers (21.1% $\pm$ 5.7%) and those that used both fly and lure (3.7% $\pm$ 3.4%). At the Trout Creek access site, the distribution of gear type was distinctly different over the same time period. Fly anglers composed 33.5 % $\pm$ 3.2% of the total angling population, lure anglers formed 62.5% $\pm$ 3.2%, and those using both fly and lure 4.0% $\pm$ 1.3%. In 1997 the distribution of gear type throughout the river was 81.4% fly and 18.6% "gear" and in 1998 fly fishing comprised 80% of the total equipment, and "gear" 20% (gear in this context is equivalent to all else besides fly tackle). Over surveys done in the past estimates of the proportions of fly and gear have been (from Morten, 1999; see also Figure 6):

- 38% fly to 82% lure (year 1974; Remington, 1975)
- 46% fly to 54% lure (year 1982; O'Neill and Whately, 1984)
- 57% fly to 43% lure (year 1983; O'Neill and Whately, 1984)
- 78% fly to 22% lure (year 1989, Lewynsky and Olmstead, 1990)

Thus it appears there has been a steady increase in the proportion of fly fishermen on the Bulkley River, and consequent decrease in lure anglers, though estimates between 1989 and 2000 suggest that the percentage of fly fishers has leveled off at about 80%.

Looking at a finer scale than the whole season indicated differences in gear type between anglers dependent upon residency and time of season. Table 6 indicates that fly fishing forms a greater component of the angling method among visitors from other parts of Canada and other countries (96%-97% of total interviewed anglers in these categories), than BC residents (75%) and locals (50%). Estimates of proportions of fly and lure anglers from 1997 and 1998 are also included in Table 6 and these estimates are generally quite similar (i.e., within the bounds of the 2000 estimates) to those derived in 2000, though 1997 and the Canadian residence category do contain a number of estimates falling outside these bounds. Chi-square analysis of frequency of gear type (fly only versus non-fly; those that used both gear types were excluded) between residency in 2000 indicates significant difference between residency with respect to angling method ($\chi^2 = 137.21$, df = 3, $p<<<0.001$), indicating that there are statistically significant differences between residency categories with respect to gear used (i.e., Canadians and Non-Canadians use fly gear to a greater degree than BC or local residents).

Over the nine week sampling period in 2000 fly fishing was seen to jump from ~40% of anglers sampled in Week 1 to $\geq$ 70% of sampled anglers for the remaining weeks with the exception of Week 7 (Figure 7). Clearly, angling by fly predominates on the Bulkley River. However, it has been shown above that *i*) local anglers are present in higher proportions on weekends than weekdays (Table 4), and *ii*) locals use lures for angling to a greater proportion than other anglers (Table 6). Therefore, it is of interest to determine if this behaviour by locals affects the proportion of anglers by gear type between weekends and weekdays (estimates provided in Table 7). Chi square analysis indicates that there is significant difference in the proportion of fly fishers between weekdays and weekends ($\chi^2 = 61.45$, df = 8, $p<0.001$) but this is not so for lures ($\chi^2 = 13.11$, df = 8, $0.1<p<0.25$). Thus it appears (not surprisingly) that the increased local angler presence on weekends (using a larger proportion of lures) combined with the fewer fly fishing non-local anglers, results in statistically significant decline in proportion of anglers using fly fishing equipment on weekends.

There is no obvious preferentially angled river section by gear type, each angling method is spread out rather uniformly over the river above Trout Creek (Table 8). Downstream of this point there are insufficient samples to draw conclusions.

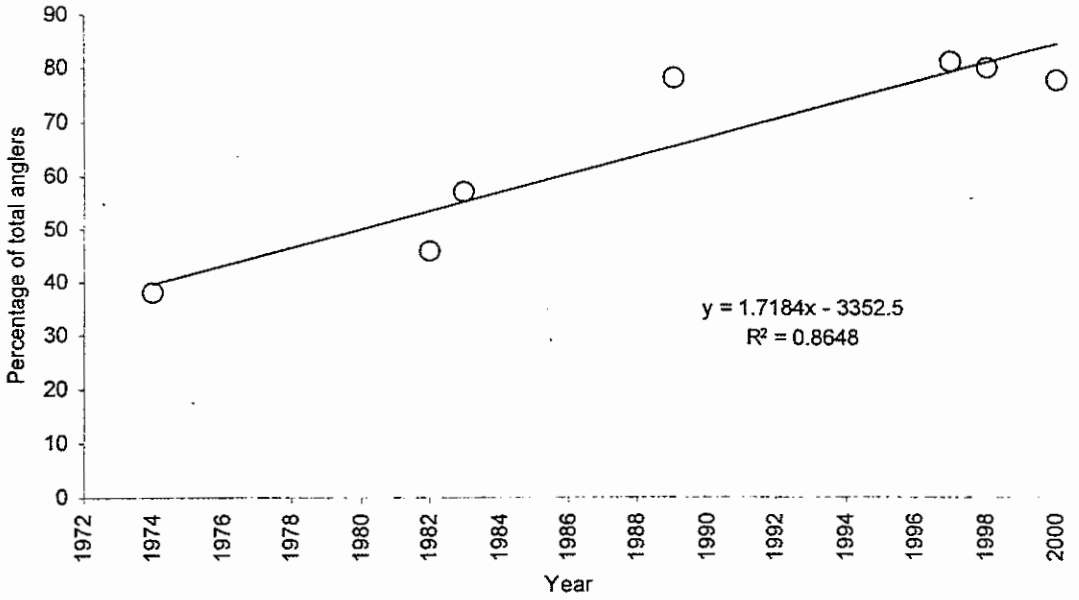


Figure 6: Percentage of fly fishers on Bulkley River over time. For data sources see Table 3.

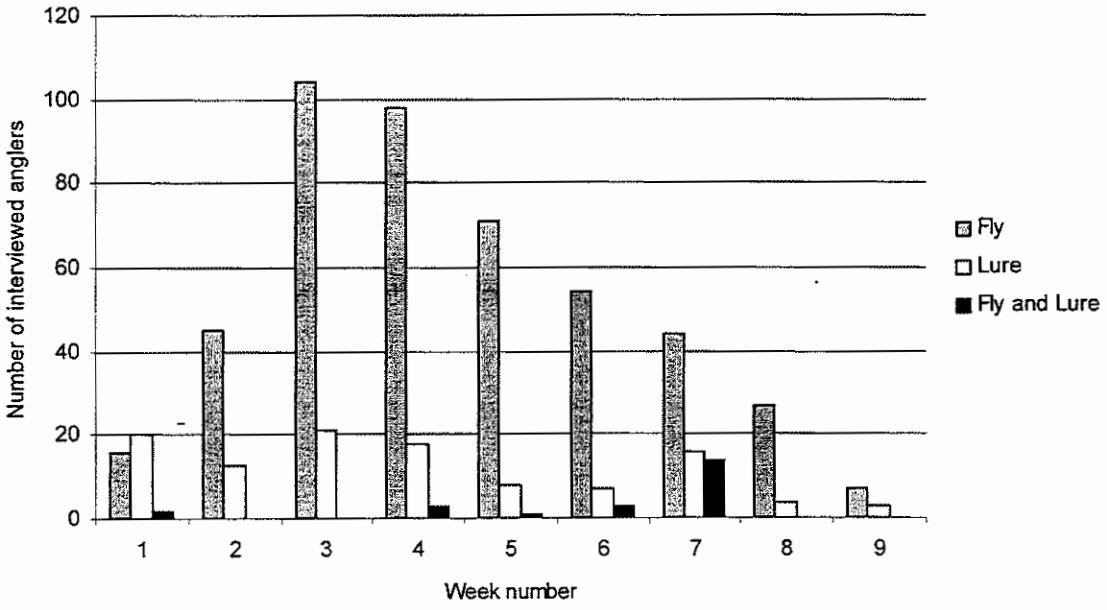


Figure 7: Gear type distribution among interviewed anglers over nine week sampling period in 2000.

Table 6: Distribution of gear type by residency. Numbers represent interviewed anglers, (proportion of total within residence category with bounds presented in brackets). 1997 and 1998 data from Morten (1999).

	Local	BC	Canadian	Non-Canadian
2000				
Fly	88 (0.50 ± 0.12)	109 (0.75 ± 0.11)	22 (0.96 ± 0.05)	247 (0.97 ± 0.04)
Lure	80 (0.45 ± 0.12)	25 (0.17 ± 0.09)	1 (0.04 ± 0.05)	4 (0.02 ± 0.03)
Fly & Lure	8 (0.04 ± 0.05)	11 (0.08 ± 0.06)	0 (0% ± 0%)	4 (0.02 ± 0.03)
Total interviews	176	145	23	255
1998				
Fly	134 (0.60)	357 (0.78)	50 (0.82)	334 (0.94)
Gear	90 (0.40)	101 (0.22)	11 (0.18)	22 (0.06)
Total interviews	224	458	61	356
1997*				
Fly		116 (0.72)	24 (0.86)	130 (90)
Gear		45 (0.28)	4 (0.14)	15 (0.10)
Total interviews		161	25	145

* 1997 BC residents not broken down into locals versus others as in 1998 and 2000

Table 7: Proportion of gear type by week (bound on estimate in brackets).

Week	Fly	Lure	Fly & Lure
1	0.42 (0.26)	0.53 (0.27)	0.05 (0.12)
2	0.78 (0.44)	0.22 (0.45)	--
3	0.83(0.40)	0.17 (0.40)	--
4	0.82 (0.29)	0.15 (0.27)	0.03 (0.12)
5	0.89 (0.17)	0.10 (0.16)	0.01 (0.06)
6	0.84 (0.39)	0.11 (0.33)	0.05 (0.22)
7	0.59 (0.16)	0.22 (0.14)	0.19 (0.13)
8	0.87 (0.57)	0.13 (0.57)	--
9	0.70 (0.71)	0.30 (0.71)	--

Table 8: Proportion of gear type by river section (bound on estimate in brackets).

Section	Fly	Lure	Fly and Lure
1	0.69 (0.11)	0.21 (0.10)	0.10 (0.07)
2	0.87 (0.08)	0.10 (0.07)	0.03 (0.04)
3	0.88 (0.08)	0.13 (0.08)	0.006 (0.02)
4	0.75 (0.11)	0.22 (0.10)	0.03 (0.04)
5	0.79 (0.11)	0.21 (0.10)	0 (0)
6	--	--	--
7	0.54 (0.12)	0.45 (0.12)	0 (0)

4.4 PLANNED FISHING TIME

The planned fishing time was found to differ between anglers based on residency (Table 9, Figure 8), gear type (Figure 9), and sampling week (Figure 10). Local anglers reported significantly shorter trips (Table 9; ANOVA followed by Tukey HSD) than either BC residents or out-of-province anglers. Morten (1999) reports very similar estimates for angling day lengths by residence categories (locals = 4.9 $\pm$ 2.7 (SD) hours, BC residents 7.3 $\pm$ 2.9 hours, Canadians 8.0 $\pm$ 2.2 hours, Non-Canadians 8.2 $\pm$ 2.5 hours). These data suggest different angling strategies by these groups from short trips when time permits for locals to long-term, whole day excursions for the vacationing visitor. As additional support for this concept of differing fishing strategies, and hence time spent per trip, Morten (1999) reports 78% of local anglers interviewed planned on fishing more than 10 days in the 1998 season. Canadian and Non-Canadian anglers, in contrast, fish many fewer days a season (82% of each category planned on fishing fewer than 10 days) while BC residents were between the two (67% planned on fishing fewer than 10 days). These estimates are in keeping with the idea of non-local anglers coming for limited time (i.e., <10 days) and making intense long-duration (> 6 hours) angling trips, while locals, and to some extent other BC residents, fish more days (> 10 days) but for shorter periods (< 5 hours) per trip. The 2000 results (Tukey HSD) indicate that both groups of out-of-province anglers plan on fishing similar length days while the hours spent fishing by locals and those by BC residents are significantly different from all other categories. This, too, is in agreement with Morten (1999) who used a non-parametric analysis and arrived at the conclusion that there are differences in the planned fishing times between the four residence categories.

In addition to differences by residency, planned fishing time was also significantly different between gear types used, with fly fishers planning on spending more time on the water than fly and lure fishermen who plan on more time than lure alone anglers (Table 9, Figure 9). The estimated time spent by fly fishers is very close to the Morten (1999) estimate of 1998 fishermen of 7.5 ($\pm$ 2.8) hours per fisher; the 2000 results for the lure fishermen however, are slightly lower than the 1998 estimate of 5.2 ($\pm$ 2.9) hours. Examination of the planned fishing time by angler (residency and gear types all lumped together) over the weeks of sampling indicate that weeks 1 and 9 have significantly shorter trips planned than weeks 2 to 8 (based on Tukey HSD results), which all have similar length trips (Table 10, Figure 10). This is consistent with a greater proportion of Non-Local anglers during this time period compared with weeks 1 and 9

(Section 4.2). Data presented by Morten (1999) for the 1998 season suggests a similar trend with corresponding times from this study. She found a mean planned trip length of 6.0 to 6.5 hours for the shoulder times and 6.9 to 7.7 hours during the peak season, though in his analysis he did not statistically separate the first and last periods from the intervening weeks as was done here.

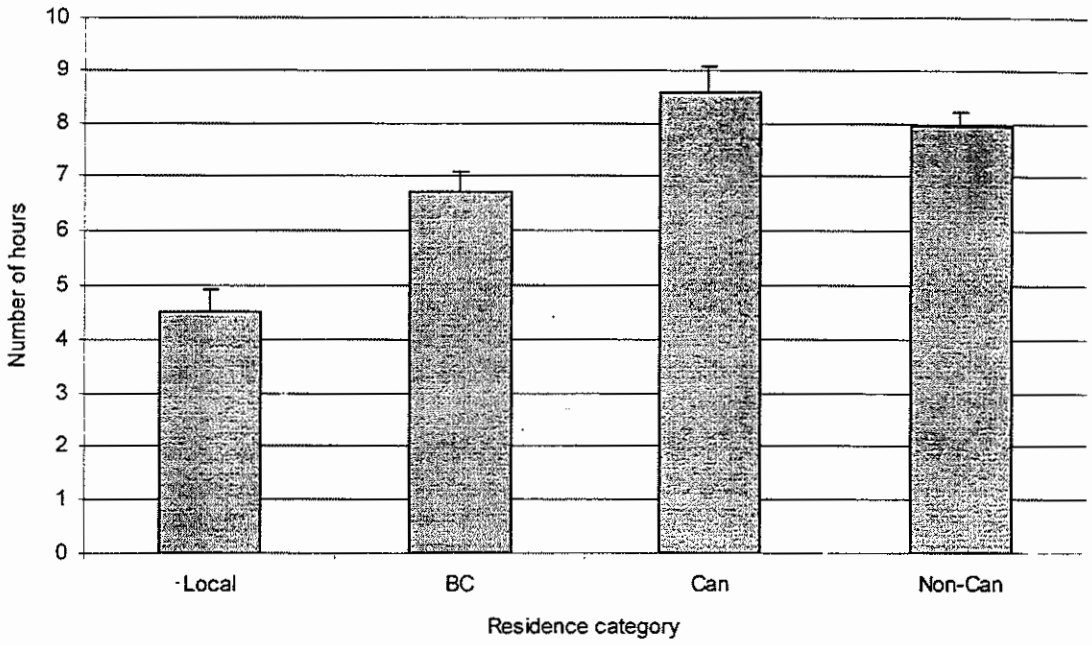


Figure 8: Planned length of fishing trip based on residency category. Error bars are 95% confidence intervals.

Table 9: Summary statistics of planned fishing time (hours) by residency and gear type.

	Mean	SD	n	Analysis of Variance
Residency				
Local	4.50	2.83	176	F=83.14, df=595, p<<<0.001
BC	6.71	2.20	145	Tukey: Can = Non-Can
Canadian	8.59	1.19	23	Local ≠ BC, Can or Non-Can
Non-Canadian	7.95	2.02	255	BC ≠ Local, Can, or Non-Can
Gear Type				
Fly	7.31	2.44	466	F=76.32, df=596, p<<<0.001
Fly and Lure	5.52	2.89	23	Tukey: Fly ≠ Lure ≠ Fly & lure
Lure	4.15	2.40	110	

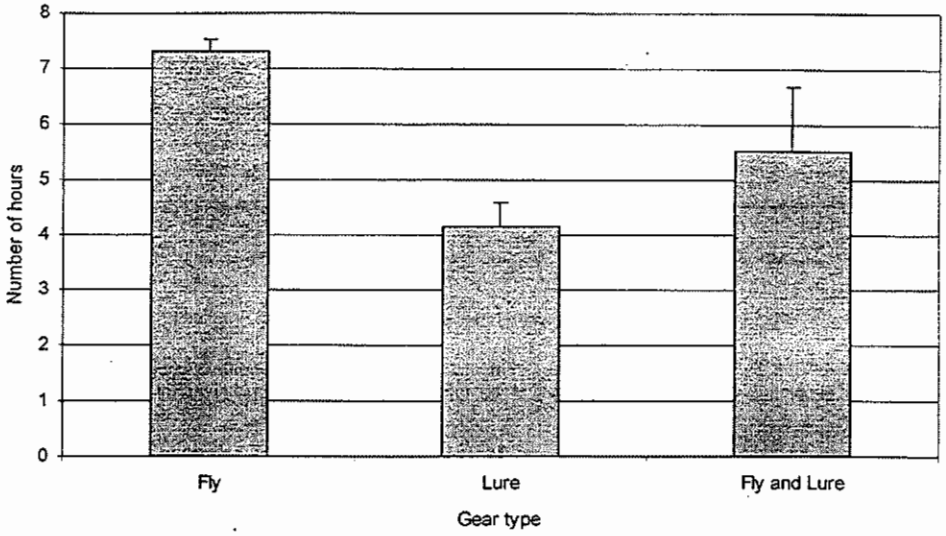


Figure 9: Planned length of fishing trip based on gear type. Error bars are 95% confidence intervals.

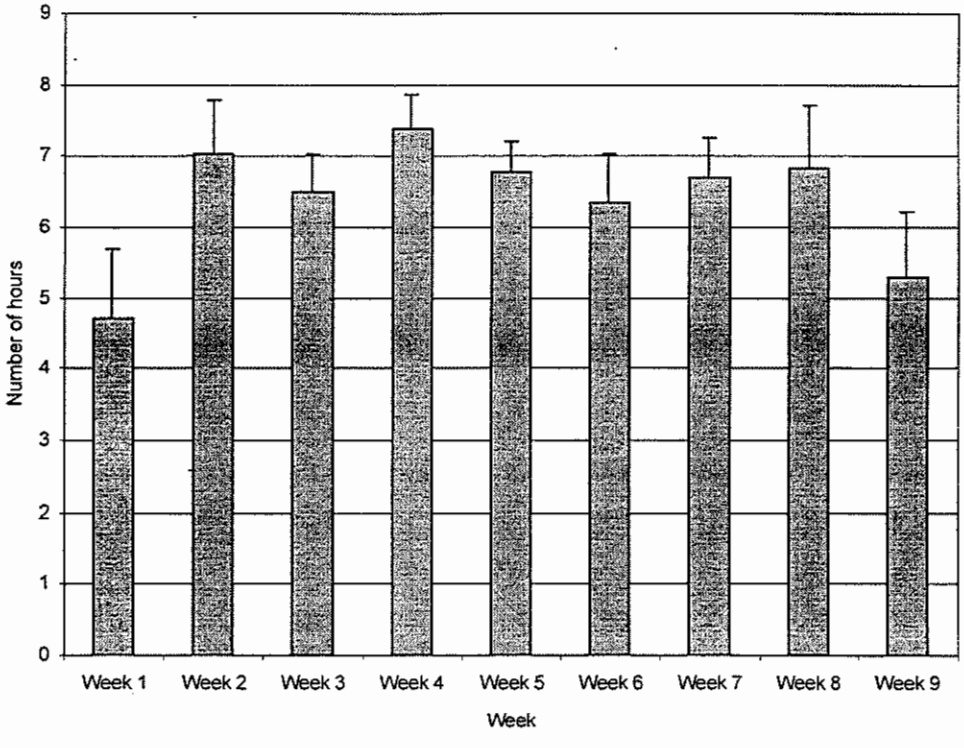


Figure 10: Planned length of fishing trip based on week of the season. Error bars are 95% confidence intervals.

Table 10: Planned fishing time (hours) by week, and broken down as weekday and weekend for the Bulkley River, September and October, 2000. Values are presented as mean (standard deviation); sample size.

Week	Total for week	Weekday	Weekend
1	4.71 (3.09); 38	4.2 (2.12);20	5.28 (3.59); 18
2	7.03 (2.92); 58	6.78 (3.04); 46	8.0 (2.26); 12
3	6.52 (3.02); 125	7.69 (2.38); 56	5.56 (3.16); 69
4	7.39 (2.68); 119	7.84 (2.33); 52	7.04 (2.89); 67
5	6.78 (2.01); 80	7.06 (1.94); 54	6.173 (2.05); 26
6	6.36 (2.78); 64	6.28 (3.38); 14	6.38 (2.62); 50
7	6.70 (2.42); 74	6.39 (2.38); 56	7.67 (2.35); 18
8	6.84 (2.5); 31	7.0 (2.89); 18	6.61 (1.9); 13
9	5.30 (1.48); 10	2.0 (-); 1	5.67 (0.97); 9
ANOVA	F=4.25, df=590, p<0.001		

For 2000, the differences in planned fishing trip lengths between weekends and weekdays (Figure 11) were also compared. Weeks 1 and 9 were pooled (they were statistically the same mean as indicated above) and the mean planned fishing time on weekdays (4.09 $\pm$ 2.12 hours) hours was found to be similar to the planned fishing time on the weekends (5.40 $\pm$ 3.19 hours; t =-1.70, df=45, p=0.09) based on Students t-test (unequal variance). For weeks 2-8 there was significant difference in trip length between weekends and weekdays (t=2.677, df=517, p=0.008) with weekends (mean trip length = 6.49 $\pm$ 2.81 hours) being significantly less than weekdays (mean trip length = 7.10 $\pm$ 2.53 hours). A caveat is required however, in this comparison. For weeks 1 and 9 the sample size is small (n=47) relative to weeks 2-8 (n=519) resulting in the two tests being of unequal sensitivity. The "non-significant" difference for weeks 1 and 9 (difference of 1.3 hours) is actually twice that difference during weeks 2 to 8 (0.6 hours). The large difference in sample size (order–of–magnitude) creates a statistical difference that is of questionable practical difference. Due to this it is premature to conclude that there actually was a difference in planned length of trip between weekends and weekdays during 2000.

These results suggest that planned trip lengths vary according to who is fishing (residency), how they are fishing (gear type) and when they are fishing (time of season). The consequence of this is that an "angler-day" does not necessarily exist; various fishermen will fish for significantly different periods of time. In estimating effort on the Bulkley River in the past, Parken and Morten (1998) used a rod-day of 8 hours and Morten (1999) used 7 hours, and the weighted grand mean for 2000 is 6.52 hours. These values apply quite well to BC, Canadian and Non-Canadian fly fishers (together these formed about 65% of the anglers [24% BC * 75% fly + 4% Canadian + 43% Non-Canadian]) but will result in an overestimate of effort if applied to local anglers who only fish on average 4.5 hours a day. The rod-day has been used extensively for management purposes (e.g., Ānonymous, 1998) and is reported in surveys but it appears from these result to be an arbitrary unit of effort. The results presented here and in Morten (1999)

suggest that estimation and allocation of effort using rod-hours would more closely approximate what is really occurring.

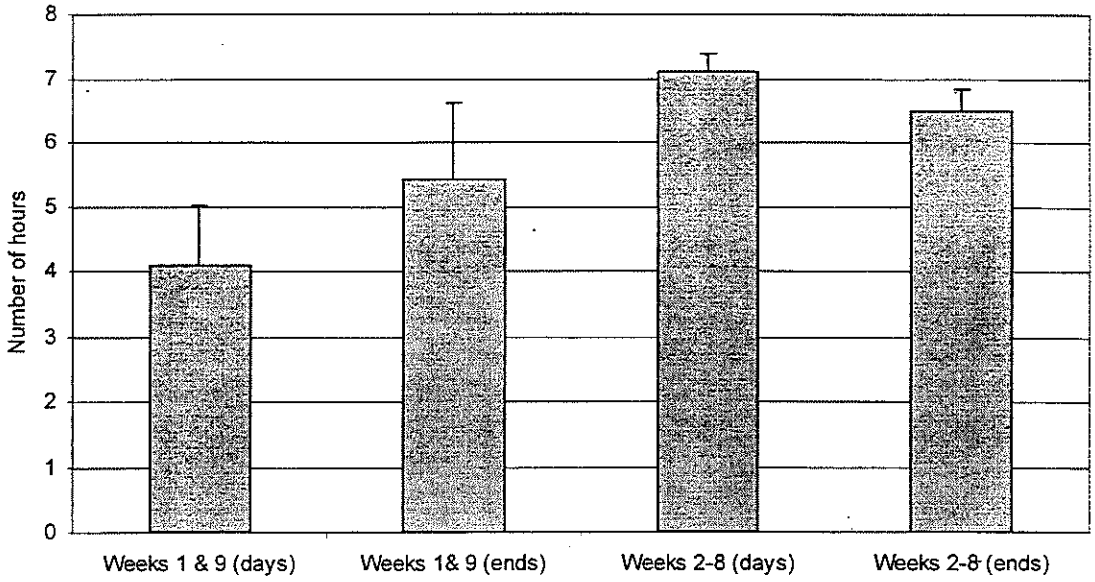


Figure 11: Planned length of fishing trip based on weekends vs weekdays. Error bars are 95% confidence intervals.

4.5 CATCH

One hundred and fourteen of the 599 interviewed anglers (19.03%) of the roving survey reported catching fish (Table 11). Angler success in pursuing steelhead was analyzed by residence (steelhead alone was analyzed as all other species were represented by very small sample sizes) to determine if there was differential success based upon where anglers were from. Of 176 interviewed local anglers, 41 (23.3%) were successful at catching one or more steelhead, 23 of 145 BC anglers (15.9%), 3 of 23 Canadian anglers (13.0%) and 37 of 255 Non-Canadian anglers (14.5%) reported successful catches of steelhead. These frequencies were tested to determine whether the proportions of catch were equivalent between residence categories and found to be not significantly different from one another (χ^2=6.219, df=3, 0.1<p<0.25) indicating that no single residence category is more successful than the others.

Results from the access point survey indicate 341 fish captured between Sept. 1 and Oct. 31, 2000. Of these steelhead formed 52.5% (179 fish), coho 36.6% (125 fish), pink salmon 7.3% (25 fish), rainbow trout and Dolly Varden each 1.5% (5 fish each), and whitefish <1.0% (2 fish captured). Catch per unit estimates were also derived at this site, based on total effort of 2,314.5 hours, for the period from August 21st to October 31 and result in estimates of 0.088 steelhead per hour (203 fish), 0.069 coho per hour (159 coho), and 0.015 pinks per hour (35 pink salmon). This steelhead CPUE is about one-half previous estimates. Morten and Parken (1998) estimated a CPUE of 0.157 steelhead per hour in 1997 and Morten (1999) reported an estimate of 0.19 steelhead per hour for the

1998 survey; both of the latter estimates are based on roving surveys. Care must be exercised in comparing these values however, as the estimates were generated by two different methodologies and the access point site does not appear to be representative of the Bulkley River as a whole (Section 4.8). Thus a CPUE one half of previous estimates is not to be taken necessarily as a reduction in success per unit effort, but is only presented as an order-of-magnitude estimate of success at Trout Creek relative to the entire Bulkley system.

Table 11: Captures of fish by anglers recorded during roving survey, Bulkley River, September-October, 2000.

Species	Total reported catch	Number of anglers reporting catch	Mean number of captures per successful angler (SD)	Species proportion of all fish captured (95% CI)
Steelhead	158	103	1.53 (1.06)	0.73 (0.06)
Rainbow trout	8	6	1.33 (0.82)	0.04 (0.02)
Coho salmon	5	5	1 (0)	0.03 (0.02)
Pink salmon	6	3	2 (1.73)	0.03 (0.01)
Bull trout	2	1	2 (-)	0.01 0.02)
Cutthroat trout	4	3	1.33 (0.58)	0.02 (0.02)
Mountain whitefish	3	2	1.5 (0.71)	0.01 (0.02)
Dolly Varden	31	10	3.1 (2.23)	0.14 (0.05)
Totals	217	133*		

* Total number of anglers reporting catch (column 3) not equal to total number of fishermen catching a fish (114) due to some angler catching more than one species on a trip

4.6 TRANSIENCY

One of the primary aims of this survey was to attempt to quantify the degree of transiency of anglers (i.e., the proportion of anglers moving between sites within a single day) on the Bulkley River. Of 598 responses (one angler no response to this question) to the query of whether the angler was going to fish elsewhere within the Bulkley River that day, 53 (8.9% $\pm$ 10.8%) said they would be. This was one-half the estimate from the Trout Creek access survey (18.1% $\pm$ 2.4%). These responses are broken down in Table 12. The frequency of transience by angler residency over the 9 week period was tested by chi-square analysis ($\chi^2 = 25.54$, df=12, $0.025>p>0.01$) and found to be significantly different between the three residency categories of local, BC and Non-Canadians (No Canadian residence reported transiency). However, a similar chi square analysis on the frequency of transients by residency across the whole season (values from Table 12) indicate no significant difference in proportion of transiency between residence categories ($\chi^2 = 2.784$, df=2, $p \approx 0.25$) when the season is treated as a whole. These results suggest that the rate of transiency is overall similar between different residencies but variable from week to week. The frequency of anglers transient on weekends (Table 13) was found to be significantly different from the frequency during weekdays (χ^2 =

28.78, df = 8, $p<0.001$). However, there is no consistent pattern of increase in one period over the other and, together with the relatively large number of periods reporting no transiency (four weekdays, three weekends), this precludes clear determination of a trend of changes between periods.

Table 12: Transiency of anglers by residency, gear type and week of the season for the Bulkley River, September-October, 2000.

	Number in group transient (total interviewed)	Proportion transient (bound on estimate)
By Residency		
Local	12 (176)	0.07 (0.04)
BC	12 (145)	0.08 (0.04)
Non-Canadian	29 (255)	0.11 (0.04)
By Gear Type		
Fly	44 (466)	0.09 (0.03)
Lure	5 (110)	0.05 (0.04)
Fly and Lure	4 (23)	0.17 (0.13)
By Week		
1	5 (38)	0.13 (0.11)
2	14 (58)	0.24 (0.11)
3	2 (125)	0.02 (0.02)
4	10 (129)	0.08 (0.04)
5	6 (80)	0.07 (0.05)
6	6 (64)	0.094 (0.07)
7	10 (74)	0.135 (0.07)
8	0 (31)	0 (0)
9	0 (10)	0 (0)

This movement of anglers from one site to another, in combination with different trip lengths by residency, has implications for the estimation of the number of anglers on the river as not all anglers are equally likely to be counted. Local anglers are on the river for shorter periods, therefore, their probability of being counted on a given day will depend on the time of the survey. The Non-Canadian component will be more likely to be counted irrespective of time of survey, since they are on the river for so much longer. All groups will, further, have a component (~10%) of anglers for whom the fishing effort will not be uniform (an assumption of effort estimates based on number of anglers multiplied by hours spent fishing; Pierce and Bindman, 1994). This effort is not uniform because an angler must stop fishing for a period to move between sites. Due to the probability of angler interception in a roving survey being proportional to trip length, those anglers that move alter their probability from proportional to trip length, to the sum of individual probabilities for each fishing site they visit (each of relatively short

duration) minus the time spent travelling when the probability of interception is zero. This must result in lower probability than if the angler had remained in place. The effect of these two influences (transiency and differential planned trip lengths) on estimates of fishing effort are unknown, and whether 10% of anglers being transient significantly affects estimated number of anglers requires further, directed, research. In addition, not knowing the "direction" of transiency of the anglers (i.e., whether they will be moving into or out of a survey river section, or which sections they have previously fished that day) prevents a more detailed understanding of this dynamic on the counts. It is unknown whether transiency would involve a net loss of anglers from a given section over a day compared with an instantaneous count, net gain, or some form of equilibrium. This aspect of angler behaviour, and its role in the estimation of the number of anglers, requires future work.

Table 13: Number of transients (total interviewed in brackets), and proportion (bound on estimate in brackets) for weekday and weekend anglers on Bulkley River, September-October, 2000.

	Weekdays		Weekend	
Week	Number interviewed	Proportion transient	Number interviewed	Proportion transient
1	12 (20)	0.6 (0.17)	3 (18)	0.17 (0.13)
2	10 (46)	0.22 (0.14)	4 (12)	0.33 (0.16)
3	0 (56)	0 (0)	2 (69)	0.03 (0.06)
4	0 (52)	0 (0)	10 (67)	0.15 (0.12)
5	6 (54)	0.11 (0.11)	0 (26)	0 (0)
6	2 (23)	0.09 (0.10)	4 (41)	0.10 (0.10)
7	8 (56)	0.14 (0.12)	2 (18)	0.11 (0.11)
8	0 (18)	0 (0)	0 (13)	0 (0)
9	0 (1)	0 (0)	0 (9)	0 (0)

4.7 NUMBER OF ANGLERS and EFFORT

The 15 flights along the Bulkley River (including the one on August 27, prior to the Classified Waters period) provided instantaneous counts of anglers ranging from 22 (October 31) to 158 (September 30), with a total of 1,314 anglers and a mean of 87.6 $\pm$ 33.1 anglers per flight (Table 14). Jet boat counts ranged from four (October 31) to 25 (September 18 and September 30) and drift boats from one (September 1) to 29 (September 18). These flights were intended to provide an instantaneous picture of the number of anglers using the river and then this value to be used in calculation of fishing effort. However, the previous discussion of transient anglers and differential planned trip lengths between residence categories suggests that this instantaneous count may not accurately reflect a day's total activity on the river as short-trip or highly mobile anglers may be missed. As an evaluation of the accuracy of these aerial counts, a comparison of flight counts with drift counts was conducted. Drifts were deliberately timed to occur concurrently with flights on flight days to allow this comparison of the aerial count against the drift count within a river section. A paired *t*-test approach indicated the mean

number of anglers per section estimated by each method were not significantly different (t=0.255, df=13, p>0.4, Pearson correlation coefficient = 0.788). A plot of numbers of anglers counted per section from the air versus on-river (drift) counts, however, indicates substantial differences (i.e., off the 1:1 line) between the two counts (Figure 12; roving survey). At low angler densities (i.e., <15 anglers per section) the two methods agree reasonably well, but above this, aerial flights tend to underestimate the on-river counts. Morten's (1999) analysis of 1998 data included a similar comparison (36 flights) and she found a similar correlation (r=0.73). In contrast to the results presented here, in 1998 the aerial counts were found to slightly exceed the river counts conducted by the Guardians. This discrepancy may be due to methodology. In 1998 river counts were conducted on flight days over six sections (Bymac Creek to Chicken Creek), taking much more time than the aerial count and allowing time for significant changes in angler number (i.e., anglers to leave a section) between time of flight and on river interviews. In 2000, this temporal separation of flight and on-river interview, was much reduced by only drifting one section during the flight.

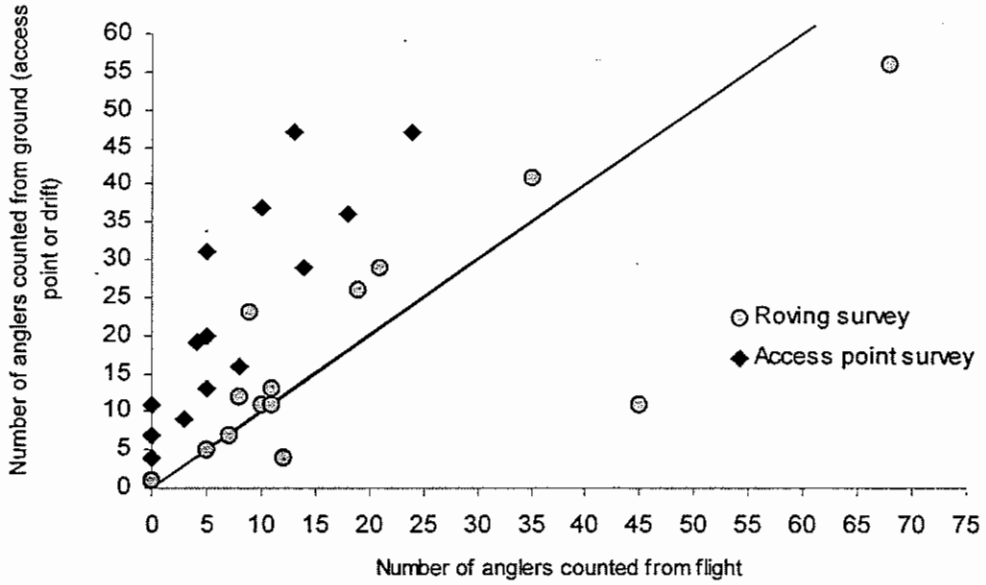


Figure 12: Comparison of number of observed anglers between aerial flights and drift counts (roving survey) and aerial counts at Trout Creek and access point ground counts. Line is 1:1 correspondence line.

As an additional assessment of the correspondence between aerial and drift counts, anglers were asked by the drift team whether they were on the river as the plane flew over. The premise of this question is that the number of anglers observed within a section from the plane should be approximately equal to the number of anglers that in turn saw the plane as it went over. The number of anglers who reported not being on the river as the plane passed provides some estimate of new anglers who have begun fishing since the plane passed. The proportion of drift counted anglers who claimed to be present when the flight occurred ranged from 0 to 1.0 with a mean of 0.54 $\pm$ 0.28 (Table 15), which suggests that there is considerable influx of new anglers in the short time period

between the flight and the drift contact (maximum 4-6 hours). Taken at face value this finding implies that only 54% of the anglers interviewed on the drifts were observed by the aerial count, the remainder of them not being present at that time. It is possible that a proportion of the anglers did not take notice of the plane, or did but had forgotten its passage, and so to assume an angler turnover of almost 50% in such a short period may be an overestimate. It is also probable that had the drifts been at a time period farther removed from the flights that the turnover rate may have been even greater. At any rate, it is safe to assume that static aerial counts only indicate the absolute minimum number of anglers present on the river on the day of the flight.

Table 14: Number of anglers, jet boats, and drift boats counted along the length of the Bulkley River during each flight of 2000. Also included are the number of anglers counted at Trout Creek during that flight.

	Number of Anglers	Jet boats	Drift boats	Number of anglers observed at Trout Creek (aerial)	Number of anglers observed at Trout Creek (access)	Ratio aerial/access
27-Aug	72	9	3	21	49	0.43
1-Sep	45	12	1	13	47	0.28
3-Sep	111	21	4	24	47	0.51
4-Sep	90	16	11	14	29	0.48
10-Sep	65	19	11	5	31	0.16
11-Sep	80	14	17	18	36	0.5
18-Sep	119	25	29	0	11	0.0
23-Sep	110	18	19	10	37	0.27
30-Sep	158	25	27	5	20	0.25
5-Oct	115	24	26	5	13	0.38
13-Oct	93	16	21	4	19	0.21
15-Oct	93	12	18	8	16	0.5
18-Oct	74	15	22	0	7	0.0
21-Oct	67	20	12	3	9	0.33
31-Oct	22	4	6	0	4	0
Total[a]	1314	250	227	130	375	
Mean[a]	87.60	16.67	15.13	8.67	25.0	0.29
SD[a]	33.10	6.00	9.09	7.76	15.5	0.18

a = includes single flight outside the Classified Waters period.

Table 15: Comparison of aerial and drift counted anglers on the Bulkley River, September and October, 2000.

Date	Section assessed	Anglers counted		Claimed to be on river during flight	Proportion of drift counted anglers seen by aerial count
		Drift	Aerial		
1-Sep	3	4	12	3	0.75
3-Sep	4	11	45	4	0.36
4-Sep	2	7	7	5	0.71
10-Sep	1	12	8	4	0.33
11-Sep	4	29	21	24	0.83
18-Sep	3	56	68	45	0.80
23-Sep	1	26[a]	19	7	0.27
30-Sep	1	41[a]	35	20	0.49
5-Oct	2	11	10	11	1.00
13-Oct	1	23	9	10	0.43
15-Oct	7	11	11	4	0.36
18-Oct	2	5	5	2	0.40
21-Oct	3	13	11	11	0.85
31-Oct	2	1	0	0	0.00
Mean		15.25	18.64	10.71	0.54
SD		15.02	18.63	12.0	0.28

[a] = Sept 23 saw additional 3 anglers not interviewed so total here greater than reported for interviews
[a] = Sept 30 saw additional 15 anglers not interviewed so total here greater than reported for interviews

A final aerial-ground truth comparison was made using the aerial counts of the number of anglers observed at Trout Creek (not over the section, but at the Trout Creek access site alone) with the access point results (Table 14). The access point count includes anglers throughout the day while the aerial flight is an instantaneous count, but this comparison is useful as indicative of how representative instantaneous counts are of daily activities. The mean number of anglers counted by the aerial method, excluding single August flight for consistency with previous analysis, (mean = 7.8 anglers $\pm$ SD 7.2; n=14) was significantly different (t= -6.376, df=13, p<<0.001) from the access point count (mean 23.3 anglers $\pm$ SD 14.5; n=14) using a paired Students t-test. Figure 12 illustrates that all of the access point counts are above the 1:1 line of flight counts and also that the discrepancy between the two counts increases with increasing density (anglers per section). Trout Creek is not representative of the Bulkley River as a whole (see Section 4.8) so these results must be interpreted with caution, but it is quite evident (and intuitive) that the instantaneous aerial flight does not capture a significant proportion of the anglers present during a day, and at this intensively fished site may regularly underestimate the total number of anglers by well over 100% (Table 14 and Figure 12).

The outcome of these comparisons of aerial and on-river counts is that aerial counts appear to do an adequate job of estimating mean number of anglers per section over relatively short time periods (i.e., 4-6 hours; the length of a drift), but are biased low at angler densities greater than about 15 anglers per section and over longer time periods (e.g., a day). There is some evidence of considerable angler transition between aerial

counts and river drift counts, but this is not conclusive. Finally, aerial counts do not capture the whole days angling activity and appear to significantly underestimate the total number of anglers in a given day. In wildlife surveys, aerial counts are known to be biased with many animals missed (Marsh and Sinclair, 1989; Sutherland, 1996). It is common that many animals are missed by aerial reconnaissance, Caughley (1974) estimated only 23% to 89% of individuals were seen on 17 different aerial surveys of large terrestrial mammals. Therefore, the suggestion here that the aerial counts significantly underestimate total angler usage is consistent with the experience of wildlife censusing.

Using the results reported here to calculate angler effort (rod hours and rod days, where a rod day is simply an observed angler; i.e., he is assumed to angle for a full day) and emphasizing that in using aerial counts the following are minimum estimates as the flights underestimate angler numbers by some unquantified amount, the 2000 estimates of angler effort are 38,471 $\pm$ 11,418 rod hours and 5,917 $\pm$ 1,493 rod days. See Table 16 for detailed breakdown by angler residency and week. In 1998 total angler effort from late August to mid-November was estimated at 6,116 ($\pm$ 442 95% confidence intervals) rod days and for the period September 1 through October 31 was 5, 422 ($\pm$ 389) rod days (Morten, 1999; this includes 262 rod days in a section not included in this 2000 project). In 1997 the total angler effort for the whole season was estimated at 4,317 ($\pm$ 324 95% confidence intervals) rod days and from September 1 to October 31 was 3,983 ($\pm$282) rod days (Morten, 1999).

However, having presented these values as direct calculations, there is evidence that these estimates are underestimating angler effort by as much as 50%. Each year a mail out questionnaire, the Steelhead Harvest Analysis (SHA) is used to estimate the steelhead fishing effort; the estimates of rod days of effort from this source for 1997 and 1998 are provided in Table 17 (unfortunately, SHA data for 2000 was not available as this report was being prepared). In addition, Non-Canadian anglers have been required to identify the waters they intend to fish when they purchase a Classified Waters fishing license. The "counter-foils" (i.e., vendors receipts) have been collated by the Ministry of Environment, Lands and Parks and these too are presented in Table 17. A comparison of these independently derived estimates of the number of Non-Canadian anglers (via counter-foils) and the number of rod-days (via SHA) suggest that previous surveys have underestimated numbers of anglers and effort by between 44% and 80%. There is no reason not to think that the same applies to 2000. Indeed, the previous discussion on transiency and differential fishing times are consistent with estimates based directly on flights being significant underestimates. For these reasons, the 2000 estimates are corrected by a factor of 1.60 (1/0.625) for total effort (this factor is the mean of the counterfoil and SHA ratio estimates in Table 17). There is evidence that 50% to 60% of wildlife populations within the flight transect are missed by aerial surveys (Caughley, 1977 cited in Marsh and Sinclair, 1989), and thus the correction factor of 1.6 is very reasonable. As further support, the counterfoil data for 2000 which were not available for the first draft of this report may be used to validate the factor 1.6. Table 17 shows the uncorrected estimate of 2,332 Non-Canadian angling days. The counterfoils data records 3,204 Non-Canadian angler days. Multiplying 2,332 by 1.6 yields 3731 Non Canadian angler days. This overestimates the counterfoil estimate by 15%. However, this is better than the non-corrected value for which the estimate is only 62% of that indicated by the counterfoils. It is realized that this value of 1.6 is based on limited data, however, all

Table 16: Uncorrected (a) and Corrected (b) angling effort estimates for the Bulkley River 2000 Classified Waters period from the 2000 Bulkley River Creel Survey.

(a) Uncorrected

		Proportion of Anglers				Effort(hours)				Effort (Days)				Total Effort	
Week	# anglers	Local	BC	Can	NC	Local	BC	Can	NC	Local	BC	Can	NC	Hours	Days
1	45	0.83	0.06	0	0.11	168.08	18.09	0.00	39.35	37.35	2.70	0.00	4.95	225.52	45
1	111	0.83	0.06	0	0.11	414.59	44.62	0.00	97.07	92.13	6.66	0.00	12.21	556.28	111
1	90	0.7	0.25	0	0.05	283.50	150.75	0.00	35.78	63.00	22.50	0.00	4.50	470.03	90
2	65	0.33	0.33	0	0.33	96.53	143.72	0.00	170.53	21.45	21.45	0.00	21.45	410.77	64.35
2	80	0.37	0.13	0.02	0.48	133.20	69.68	13.74	305.28	29.60	10.40	1.60	38.40	521.90	80
3	119	0.09	0.18	0	0.73	96.39	287.03	0.00	1381.23	21.42	42.84	0.00	173.74	1764.65	238
4	110	0.3	0.31	0.04	0.34	148.50	228.47	37.80	297.33	33.00	34.10	4.40	37.40	712.10	108.9
5	158	0.31	0.27	0.15	0.27	220.41	285.82	203.58	339.15	48.98	42.66	23.70	42.66	1048.96	158
5	115	0.2	0.39	0.07	0.33	103.50	300.50	69.15	301.70	23.00	44.85	8.05	37.95	774.85	113.85
7	93	0.21	0.36	0.05	0.38	87.89	224.32	39.94	280.95	19.53	33.48	4.65	35.34	633.10	93
7	93	0.33	0	0	0.67	138.11	0.00	0.00	495.36	30.69	0.00	0.00	62.31	633.47	93
7	74	0.21	0.36	0.05	0.38	69.93	178.49	31.78	223.55	15.54	26.64	3.70	28.12	503.76	74
8	67	0.15	0.31	0	0.54	45.23	139.16	0.00	287.63	10.05	20.77	0.00	36.18	472.02	67
9	22	1	0	0	0	99.00	0.00	0.00	0.00	22.00	0.00	0.00	0.00	99.00	22
Mean						150.35	147.90	28.29	303.92	33.41	22.08	3.29	38.23	630.46	97.01
SD						98.17	108.28	54.95	339.76	21.82	16.16	6.40	42.74	398.84	52.20
Total						9171.05	9022.05	1725.42	18539.29	2038.01	1346.58	200.86	2331.99	38471.28	5917.44
Variance						1.97E+06	2.40E+06	6.18E+05	2.36E+07	9.75E+04	5.35E+04	8.38E+03	3.74E+05	3.26E+07	5.58E+05
Bound						2809.63	3099.02	1572.63	9724.04	624.36	462.54	183.08	1223.15	11418.24	1493.89

Table 16 (con't)

(b) Corrected by 1.60 factor

		Proportion of Anglers				Effort(hours)				Effort (Days)				Total Effort	
Week	# anglers	Local	BC	Can	NC	Local	BC	Can	NC	Local	BC	Can	NC	Hours	Days
1	72	0.83	0.06	0	0.11	268.92	28.94	0.00	62.96	59.76	4.32	0.00	7.92	360.83	72.00
1	177.6	0.83	0.06	0	0.11	663.34	71.40	0.00	155.31	147.41	10.66	0.00	19.54	890.04	177.60
1	144	0.7	0.25	0	0.05	453.60	241.20	0.00	57.24	100.80	36.00	0.00	7.20	752.04	144.00
2	104	0.33	0.33	0	0.33	154.44	229.94	0.00	272.84	34.32	34.32	0.00	34.32	657.23	102.96
2	128	0.37	0.13	0.02	0.48	213.12	111.49	21.99	488.45	47.36	16.64	2.56	61.44	835.05	128.00
3	190.4	0.09	0.18	0	0.73	77.11	229.62	0.00	1104.99	17.14	34.27	0.00	138.99	1411.72	190.40
4	176	0.3	0.31	0.04	0.34	237.60	365.55	60.47	475.73	52.80	54.56	7.04	59.84	1139.35	174.24
5	252.8	0.31	0.27	0.15	0.27	352.66	457.32	325.73	542.64	78.37	68.26	37.92	68.26	1678.34	252.80
5	184	0.2	0.39	0.07	0.33	165.60	480.79	110.64	482.72	36.80	71.76	12.88	60.72	1239.76	182.16
7	148.8	0.21	0.36	0.05	0.38	140.62	358.91	63.91	449.52	31.25	53.57	7.44	56.54	1012.96	148.80
7	148.8	0.33	0	0	0.67	220.97	0.00	0.00	792.58	49.10	0.00	0.00	99.70	1013.55	148.80
7	118.4	0.21	0.36	0.05	0.38	111.89	285.58	50.85	357.69	24.86	42.62	5.92	44.99	806.01	118.40
8	107.2	0.15	0.31	0	0.54	72.36	222.65	0.00	460.21	16.08	33.23	0.00	57.89	755.22	107.20
9	35.2	1	0	0	0	158.40	0.00	0.00	0.00	35.20	0.00	0.00	0.00	158.40	35.20
Mean						235.04	220.24	45.26	407.35	52.23	32.87	5.27	51.24	907.89	141.61
SD						161.62	160.99	87.92	299.50	35.91	24.03	10.23	37.67	394.27	54.37
Total						14337.68	13434.79	2760.68	24848.28	3186.15	2005.19	321.38	3125.57	55381.43	8638.30
Variance						5.35E+06	5.31E+06	1.58E+06	1.84E+07	2.64E+05	1.18E+05	2.15E+04	2.91E+05	3.18E+07	6.05E+0
Bound						4625.53	4607.56	2516.21	8571.90	1027.90	687.70	292.92	1078.23	11284.16	1556.07

evidence points to previous creel surveys (and this one) underestimating the number of anglers and effort, and this expansion factor may be viewed as a preliminary estimate. Even the counter-foils may be low estimates of Non Canadian resident participation in the fishery as not every Non-Canadian angler purchases a Classified Waters license (i.e., angles illegally). The extent of this is unknown at this time but even based on the low estimate of 1.3% of Non-Canadian anglers fishing illegally (estimate from Parken and Morten, 1998 and Morten, 1999) results in an underestimate of 28 anglers (1997) and 32 anglers (1998) based on counterfoil receipts. Based on Table 16 in Morten (1998) it appears ~50% of Non-Canadian anglers plan to fish approximately 6 days. So, multiplying the uncounted anglers by 6 days results in underestimating by ~ 170-200 angler days.

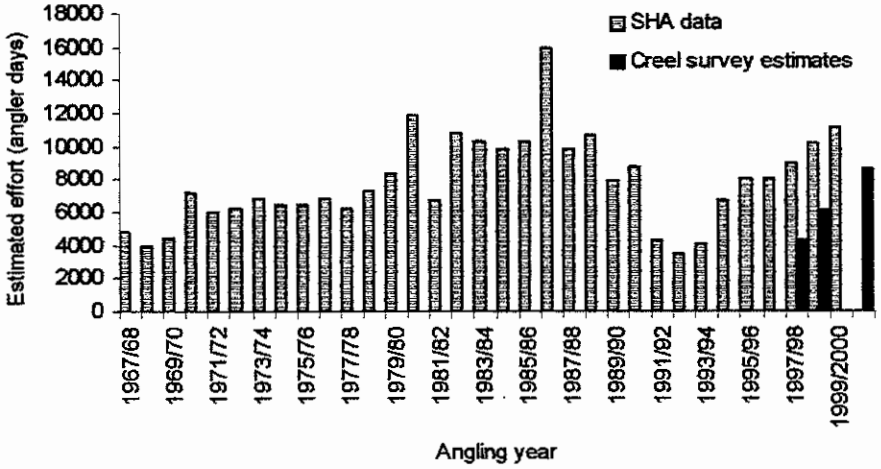
Using this estimated expansion factor of 1.6, the estimate of effort on the Bulkley River during the 2000 Classified Waters period is 8,638 $\pm$ 1,556 rod days or 55,381 $\pm$ 11,284 rod hours (see Table 16). Historic fishing effort, as determined via SHA (data in Appendix 2), is presented in Figure 13, along with recent creel survey estimates. This illustrates the long term trend of steelhead fishing effort on the Bulkley River and also the increasing prevalence of Non-Canadian anglers over time (similar to Figure 2 but using independent data). If the results from 1997 and 1998 are similarly underestimated due to reliance on the aerial counts, then correcting those estimates by 1.6 yields 6,373 angler days in 1997 and 8,675 in 1998. Using the respective percentage of Non-Canadians reported for those years, the reported counterfoils estimates, and including a factor of 200 angler days for illegal fishing (add this to the counterfoil estimates to account for those anglers not included there), these new estimates yield estimates of Non-Canadian fishing effort for these years within 15% (1997) and 8% (1998) of the counterfoil estimates. One implication of this underestimation of effort in 1997 and 1998 is that their reported CPUE (Section 4.5) would be overestimated. Assuming that these revised estimates are more accurate, the CPUE would then be more similar to that reported at Trout Creek for 2000.

Table 17: Comparison of 1997 and 1998 creel surveys with independent data sources. The 2000 results are presented as validation data for estimates based on the 1.6 factor determined from the previous two years efforts.

	1997	1998	2000
Est. angler days (Creel Surveys)	3983	5422	5917[a]
% of angler as Non-Canadians	43	33	39.4
Est # Non-Canadians	1713	1789	2332
# Non-Canadians from counter-foils	2152	2436	3204
Ratio Est. #Non- Canadians to counter-foils	0.796	0.734	0.727
SHA # angler days	8997	10252	Not available
Ratio Est. angler days/SHA angler days	0.442	0.529	

[a] = uncorrected estimate

(a)



(b)

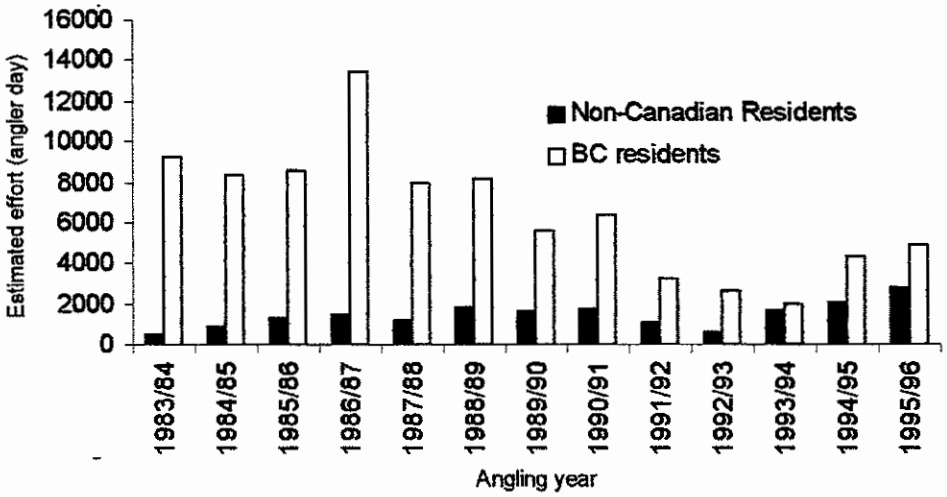


Figure 13: (a) Historic trend of total angling effort on Bulkley River, 1967-2000, based on SHA data. Also included are recent creel survey estimates. (b)Historic estimated angling effort by BC residents and Non-Canadian residents on the Bulkley River, 1983-1996. Data from SHA.

In attempting to assess the distribution of the angling effort along the length of the river, the mean percentage of total anglers on the river from the flight data was calculated for each section, this is presented individually and on a cumulative basis in Figure 14. Despite the flight estimates being underestimates of numbers, it is assumed (and the small confidence intervals provide some support) that these data may provide valid relative

estimates (e.g., proportions/percentages). It is seen that the majority (i.e., 59%) of the effort occurs in sections 3 to 5 (Quick Bridge to Trout Creek). The site of the access point survey, Trout Creek, with its estimated 1,315 angler days during the Classified Waters period (Struthers, 2001) accounts for 15.2% (using corrected total effort estimate of 8638 angler days) to 22.0% (using uncorrected 5917 angler days) of the total river effort when proportion is estimated using total effort. These estimates are very high and all of river section 5 (including the Trout Creek access point site) only represents 6% of the observed anglers on flights (this flight estimate is reasonable as the flights appear to do a relatively good job of counting anglers over short periods and so the percentages of anglers by section are likely representative). This 6% estimate based on observation suggests that the proportional calculation using total effort (angler days) are inflated and this may be because the access point survey (the numerator) is biased high, or the total river estimate (the denominator) is biased low. All previous evidence (transiency, short angling trips by locals, and illegal fishing, as well as the much greater precision in the access point survey relative to the roving survey (see Section 4.8)) that the inflation of the estimate is probably due to the latter cause – the total river effort estimate is likely low.

The Bulkley River Angling Use Plan (Anonymous, 1999) recommends a total of 10,500 rod days divided up as 7,140 rod days (68%) for BC residents, 630 days (6%) for Canadians and 2,730 rod days (26%) for Non-Canadian residents. Results from 2000 suggest that BC residents (locals and non-local) account for 60.1% of total rod days, Canadians for 3.7% and Non-Canadians for 36.2% (Values derived from Table 16). When broken down by rod-hour, local and BC anglers account for 50.1% of the rod hours, Canadians form 5.0% and Non-Canadian anglers 44.9% of total rod hours fished in 2000. Compared to targets set by Anonymous (1999), BC residents appear to be underrepresented and Non-Canadians over-represented in effort.

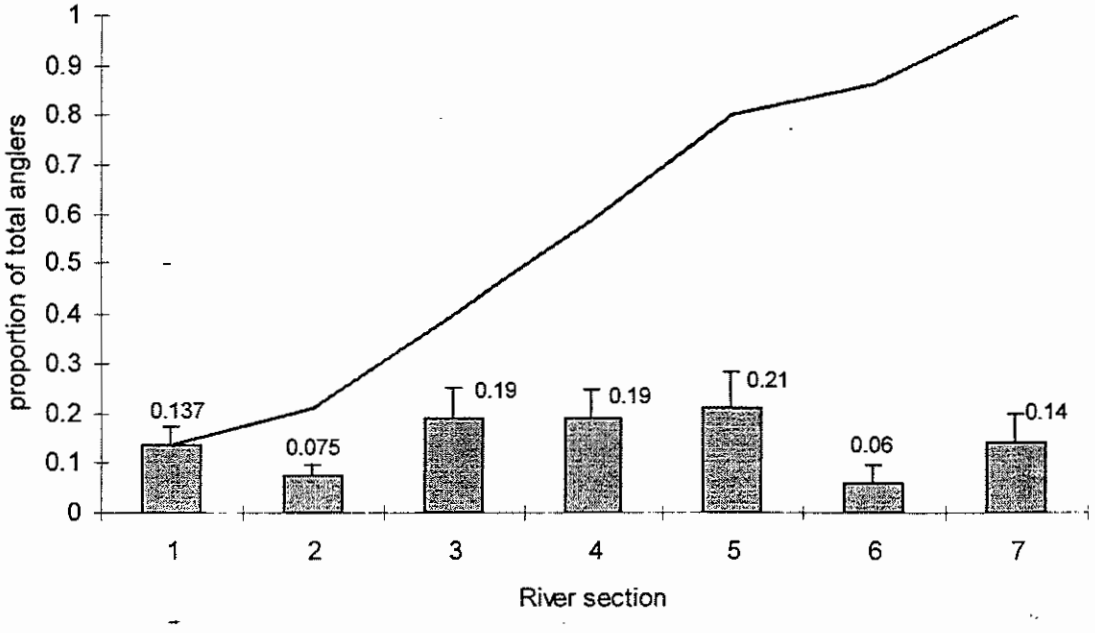


Figure 14: Mean proportion (error bars are 95% confidence intervals) of total anglers per section, with cumulative proportion.

4.8 COMPARISON OF ROVING AND ACCESS SURVEYS

Not surprisingly considering the level of survey effort, the access point survey provides much more precise (i.e., smaller bounds on estimate) estimates of angler characteristics than the roving survey. The access point estimates are typically ± 2-5% while the roving survey are in the range of ± 15-50%. The question becomes can the higher precision access point results be applied to the larger scale of the Bulkley River as a whole. By residency there were differences in angler composition for local residents between these two surveys (32.5% in roving, 42.3% at access) and Non-Canadians (39.4% in roving, 22.6% at access). This, together with the very different use of gear types (75.1% fly in roving, 33.5% fly in access), CPUE (access point estimates are one-half previous roving survey estimates), and rates of transiency (8.9% in roving, 18.1% at access), though not tested statistically, suggest that anglers sampled by the two methods represent two different groups. Therefore, results from one (including CPUE) should not be extrapolated to the other. The Trout Creek anglers are largely highly mobile, local and BC residents using non-fly gear and fishing for relatively short periods of time. The anglers throughout the river, in contrast, are composed of a greater proportion of Non-Canadians, use fly gear to a much greater degree, and fish for longer periods of time. However, the reported much shorter planned fishing time by locals relative to other groups means that they have a lesser probability of being encountered in the roving survey, while at the access point survey their probability of interview is the same as everyone else. Therefore, the roving survey estimates may be biased low for local residence due to this shorter time on the river. This may account for the observed difference between roving and access point survey results. That noted, however, until future data indicates otherwise, the results from this complementary survey provides pictures of two different populations of anglers rather than providing detailed information on a sub-group of the larger river population. On such a system as the Bulkley, with numerous access points, a truly representative access point survey of the general population may not be practical; the required cost and manpower to appropriately sample a sufficient number of access sites may be prohibitive. However, the Trout Creek access survey has provided important information on a sub-group of the angling population which may have been missed in the standard roving creel surveys conducted alone.

4.9 SHORTCOMINGS OF THE SURVEY

As with any attempt to gather information on a large population from a small sample, the 2000 survey included several shortcomings that need to be considered in interpreting the results. There was no mechanisms included to determine the rate of repeat interviews such as was included by Morten (1999). The repeated interviewing of the same angler, while likely not occurring to a large percentage of the interviews will affect the derived estimates as that angler has disproportionate influence on the results. Future surveys should include a method of uniquely identifying every individual sampled, or at the very least inquire as to whether the angler was previously interviewed.

The spatial emphasis on sampling the Bulkley River above Trout Creek means that the results reported here are applicable only to this area, not the entire Bulkley. The

angler characteristics and effort downstream of Trout Creek cannot be determined with any degree of accuracy from the limited sampling which took place there in 2000.

The loss of flights due to weather resulted in an inability to use a stratified random estimate on effort and due to this the error associated with the estimate is relatively large (i.e., $\pm$ ~40%). Ensuring more than one flight per week would allow estimates of weekly variance, allow for the use of a stratified estimator, and thus reduce the variance associated with the estimate.

6. CONCLUSIONS

The following conclusions may be drawn from the 2000 creel survey and the previous (1997, 1998) studies.

5.1 ANGLER RESIDENCY

Between 1997 and 2000 the angler composition appears to have remained relatively constant with local anglers forming approximately one-third of the angling population, BC residents (including locals) between 50% and 60%, Canadians less than 10% and Non-Canadians 35-45% of the total. There are differences in angler composition over the season with Non-Canadians forming the majority of the angling population through the central period and locals and BC residents forming majority at beginning and end of the season. There are differences in angler composition between weekends and weekdays with, generally speaking, local anglers being more prevalent on weekends, and Non-Canadians on weekdays. Due to the under-representation of BC anglers compared with AUP targets, and the importance of weekends to local anglers, the maintenance or protection of this time period for this group may become warranted.

5.2 GEAR TYPE

Fly fishers form the dominant gear type (approximately 80% of anglers) with differences in the prevalence of this angling method with residency and through the angling season. The combination of increased local angler presence on weekends (using a larger proportion of lures) results in a different angling community between weekdays (fly fishing non-locals) and weekends (lure fishing locals). There are also significant differences between the Trout Creek fishing community and the remainder of the anglers on the river with respect to gear type.

5.3 PLANNED FISHING TIME

Planned fishing time varies between anglers based upon residency, gear type and time of the season with out-of-province anglers spending considerably longer times fishing than BC residents and fly fishers longer than lure fishermen. There were good similarities in estimates of this characteristic between 1998 and 2000. This difference in angling times raises the question of the validity of a rod day among the different anglers.

5.4 TRANSIENCY

The transiency of anglers may be a significant aspect affecting estimates of numbers of anglers fishing as the probability of interception by survey personnel is decreased relative to stationary anglers. The estimated proportion of transient anglers was ~10% via roving and ~20% via access point estimate and thus represents a sizable fraction of the total angling population.

5.5 NUMBER OF ANGLERS AND EFFORT

Aerial counts appear to do an adequate job of estimating mean number of anglers per section over relatively short time periods (i.e., 4-6 hours; the length of a drift), but are biased low at angler densities greater than about 15 anglers per section. There is some evidence of considerable angler transition between aerial counts and river drift counts, but this is not conclusive. Finally, aerial counts do not capture the whole day's angling activity and significantly underestimate the total number of anglers in a given day.

Uncorrected estimated angling effort in 2000 was 5,917 rod days or 38,471 rod hours, corrected estimates were 8,638 rod days and 55,381 rod-hours. Based on the distribution of these times between the various residency categories, it appears that the allocation targets as set out in the Bulkley River AUP (Anonymous, 1999) are being approached in total effort, and exceeded in effort by Non-Canadians.

6. RECOMMENDATIONS

Based on the findings from the 2000 Creel Survey, the following recommendations are made:

Effort estimates based on aerial counts appear to significantly underestimate "true effort' when compared with SHA and counter-foils. Validation of the expansion factor of 1.60 is required once 2000 SHA and counter-foils become available.

The counter-foils appear to be a valuable, and likely quite accurate, count of the number of Non-Canadian anglers on the Bulkley River. If the processing of these receipts to provide total estimates of Non-Canadian angling effort could be conducted in a timely manner, then this estimate; together with a simple in-season, on-river angler survey determining angler place of residency (for proportion of total formed by Non-Canadians) and days spent fishing/planned fishing; would provide an accurate, inexpensive and simple method of estimating angling effort. Such an approach would be extremely valuable in not being subject to the pitfalls of the aerial counts (i.e., transiency and differential fishing times between residency groups).

There is a need for a mechanism of determining repeat interviews. By uniquely identifying each angler (e.g., ask name), or asking if they have been interviewed previously in this season it will be possible to identify and eliminate repeat interviews and so prevent them influencing the results.

There is a need to better assess transiency. To meet this end suggested questions to determine angler movement are:

- Have they fished elsewhere in that day as well as are they planning to?,
- Where they will be going/have been (sections)?,
- How long they spent at each site?, How many different areas they have fished that day?

The significance of the bias introduced by transiency should be examined. This aspect of the creel survey is not well reported in the literature and the assumption of uniform effort necessary to estimate angling effort is not being met by these anglers. The role and extent of the influence of this on the final estimates should be evaluated.

During 2000 it was suggested not to have extra flights in the event of cancelled aerial counts as this would interfere with the random selection of days and times of the flights. However, a second random selection of backup flight times within each week would be appropriate in order to ensure more than one flight per week to allow use of the more precise stratified estimator.

The roving survey resulted in large bounds on the estimates. If higher precision estimates are required for management, an increased frequency of drift surveys and aerial flights will be required.

More intensive sampling of river section 7 is required in order to determine angler characteristics and behaviour along the river below Moricetown Canyon.

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APPENDICES

Appendix 1: Sample survey forms used in 2000 Bulkley River Creel Survey

2000 UPPER SKEEN RIVER CREEL SURVEY
ANGLER CATCH & SURVEY FORM – TROUT CREEK INDEX SITE

Monitors Name: _____ **Date/Time:** _____
Weather: _____ **Turbidity:** _____

ANGLER INFORMATION

Angler #	Angler Origin	Gear Type	Angling Time (observed by you)	Estimated Daily Effort	Do you plan or did you fish at site on the Bulkley River today answer & location.
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

OBSERVED LANDED CATCH

Angler #	Wild Coho		Hatchery Coho		Steelhead		Pink Salmon		Other	
	Kept	Released	Kept	Released	Kept	Released	Kept	Released	Kept	Rele
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

EFFORT / CATCH OBSERVED DURING STINT

Total Angler Hours Observed: _____
Total Observed Landed Catch:

_____

DNA Samples Taken From **Wild** Coho: _____

TAG DATA RECOVERED

(Record tag colour, origin, number and species - if tag is reported clearly mark!)

_____ _____

_____ _____

MAKE SURE FORMS ARE FILLED OUT COMPLETELY BEFORE THE END OF THE STINT

2000 UPPER SKEENA RIVER CREEL SURVEY
DRIFT SURVEY DATA SHEET

Monitors Name:_____ Date: _____ Time:_____
(start of drift)

Drift Section:_____ Did an overview flight occur today?____ Total # Anglers Counted:_____
(from where to where)

Introduction:

Hello, I am conducting an angler count on the Bulkley River for Fisheries renewal B.C. The purpose of this survey is to ensure that there continues to be quality angling opportunities on this river and to assist fisheries managers with the management of this fishery. Would you mind answering a few short questions?

	Anglers residency (write in home town)	**Gear type (fly, lure, both)**	**How long do you plan on fishing for today?**	**Landed catch**	**Have you or do you plan on fishing at another site on the Bulkley River today?** (If the angler was on a different river section during the flight clearly mark that section on the sheet)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					

NOTES (use back of sheet if necessary):_____

2000 UPPER SKEENA RIVER CREEL SURVEY
FLIGHT SURVEY DATA SHEET

Monitors name: _____ Date: _____
Pilots Initials: _____ Time:

Section	Number of Anglers	Number of jet boats	Number of drift boats
Bulkley/Morice Confluence to Walcott Bridge			
Walcott Bridge to Quick Bridge			
Quick Bridge to Telkwa Bridge			
Telkwa Bridge to Chicken Creek			
Chicken Creek to Trout Creek			
Trout Creek to Moricetown Canyon			
Moricetown Canyon to Suskwa River Confluence			
TOTALS			

Notes:

Appendix 2: Number of anglers as estimated by Steelhead Harvest Analysis (1967-2000)

Angling Year	# of Anglers Non-Can	Canadian	BC Res (excl. Local)	BC Res (total)	Local	TOTAL ALL ANGLERS
1967/68						1078
1968/69						893
1969/70						1128
1970/71						1376
1971/72						1140
1972/73						1070
1973/74						1163
1974/75						922
1975/76						950
1976/77						993
1977/78						1021
1978/79						1149
1979/80						1307
1980/81						1696
1981/82						1161
1982/83						1451
1983/84	123	131	534	1203	669	1457
1984/85	160	140	428	1089	661	1389
1985/86	215	134	426	1152	726	1501
1986/87	313	191	683	1799	1116	2303
1987/88	277	138	465	1175	710	1590
1988/89	394	174	474	1210	736	1778
1989/90	342	127	351	842	491	1311
1990/91	309	105	450	1024	574	1438
1991/92	242		192	502	310	744
1992/93	139	18	129	409	280	565
1993/94	336	81	278	466	188	883
1994/95	432	73	337	683	346	1188
1995/96	480	100	336	706	370	1286
1996/97						1264
1997/98						1478
1998/99						1726
1999/2000						1764

Appendix 2: Number of days fished as estimated by Steelhead Harvest Analysis (1967-2000)

	# days Fished					
Angling Year	Non-Can	Canadian	BC Res (excl. Local)	BC Res (total)	Local	TOTAL DAYS FISHED
1967/68						4805
1968/69						3950
1969/70						4490
1970/71						7232
1971/72						6000
1972/73						6215
1973/74						6841
1974/75						6476
1975/76						6505
1976/77						6855
1977/78						6248
1978/79						7341
1979/80						8433
1980/81						11936
1981/82						6734
1982/83						10816
1983/84	513	556	2387	9180	6793	10349
1984/85	891	609	1669	8309	6640	9809
1985/86	1228	611	2025	8499	6474	10338
1986/87	1500	984	3207	13435	10228	15919
1987/88	1203	685	1839	7910	6071	9798
1988/89	1867	715	2060	8114	6054	10698
1989/90	1683	721	1874	5573	3699	7977
1990/91	1783	565	1742	6377	4635	8706
1991/92	1044		793	3273	2480	4317
1992/93	612	154	392	2699	2307	3466
1993/94	1711	361	1088	2007	919	4079
1994/95	2022	379	1508	4360	2852	6761
1995/96	2704	507	1582	4882	3300	8093
1996/97						8069
1997/98						8997
1998/99						10252
1999/2000						11129