

**A Comparison of Steelhead  
Angler Effort and Catch Estimates  
on the Bulkley River  
in 1997 and 1998**

K.L. Morten

Skeena Fisheries Report SK - 123

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## **Abstract**

In 1997 and 1998 the River Guardian program conducted a roving creel survey of Bulkley River steelhead (*Oncorhynchus mykiss*) anglers. Catch and effort estimates and demographic information were summarized for both years of the program. Other independent data sources existed to compare the effort and catch estimates and angler demographics to the River Guardian program. Therefore, comparisons were made between the River Guardian program, the Steelhead Harvest Analysis (SHA), classified waters licenses and guide reports for the 1997 and 1998 classified waters period and steelhead season.

The proportion of guided angler interviews of all non-resident anglers in the River Guardian programs in 1997 and 1998 (28% and 32% respectively) were similar to the proportion of classified waters days sold to guided anglers (34% and 33% respectively). Considering residence, the proportion of Canadian and Non-Canadian non-resident anglers was similar among the River Guardian programs and the classified waters licenses sold. The similarities indicated accurate estimates of residence category proportions in the River Guardian programs and the classified waters license.

Effort and catch analysis indicated SHA results were consistently, drastically higher than River Guardian program results. The draft 1997 SHA effort estimate for all anglers was more than double the 1997 River Guardian program effort estimates. In addition, the draft 1997 SHA catch estimate was almost 1.5 times the River Guardian program catch estimate (a result of double the effort estimates). The consistently higher effort and catch estimates compared to estimates of the River Guardian program suggested that the SHA overestimates the actual effort and catch. Commonly, biases such as non-response, recall, digit preference and avidity bias affect mail surveys. All could inflate effort and catch estimates of the SHA. Other factors that may pertain to the SHA overestimate include: an inaccurate sampling frame, differential bias in residence categories and low response rates.

The River Guardian program guided effort estimates in 1997 were lower than the classified waters days sold to guided anglers. This indicates a probable sampling bias (underrepresentation of guided anglers) in the 1997 River Guardian program. In 1998, the discrepancy in estimates was small. Guide report estimates of effort were larger than River Guardian program estimates. In the 1997 classified waters period, the guides reported 30% more guided angler days than the number of classified waters days sold and 72% more days than estimated by the River Guardian program. In addition, in the 1998 classified waters period, the guides reported 22% more guided angler days than indicated by classified waters licenses and 26% more than River Guardian program estimates.

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## **1.0.0 Introduction**

The Bulkley River in the Skeena Region of northwestern British Columbia is known worldwide for providing a high quality steelhead (*Oncorhynchus mykiss*) recreational fishery. In 1997, the Ministry of Environment, Lands and Parks (MELP) created a River Guardian program to conserve the fishery and protect quality angling opportunities on the Bulkley River. The information collected by the River Guardian program is important to fishery managers and administrators for making resource allocation and management decisions.

The River Guardian program conducted a roving creel survey with on-site interviews of anglers on the Bulkley River in 1997 and 1998. The survey collected information about steelhead angler demographics, catch and effort. Also, aerial counts of anglers were conducted on the Bulkley River to further document the spatial and temporal patterns of angler effort. Effort and catch estimates were established for the 1997 and 1998 steelhead seasons.

Managers require accurate information on which to base management decisions (Connelly and Brown 1995; Pollock *et al* 1994). Other independent data sources existed for comparison to the effort and catch estimates from the River Guardian program. Angler effort and catch were available from the Steelhead Harvest Analysis (SHA), classified waters licenses and angling guide reports. The SHA is a mailback postcard questionnaire sent to a sample of all anglers that purchased a steelhead conservation stamp. The responses enable MELP to estimate angler effort, catch and residence categories for each steelhead river in the province.

In 1990, the Bulkley River was designated as a classified water from September 1 through October 31. Classified waters designation requires that non-resident anglers purchase a day and water specific license. B.C. residents are required to purchase a yearly classified waters license enabling them to fish all classified waters in the province. Classified waters licenses provide a record of the effort that all non-residents expended on the Bulkley River.

Each of the eight angling guides that operate on the Bulkley River were required to submit a yearly guide report. The guides report their angler effort, catch and residence categories for each day they guided on the Bulkley River. The total guided angler effort and catch can be obtained by compiling information from all the guide reports.

There were concerns about the accuracy of the effort and catch estimates obtained from the different methods, which prompted a comprehensive comparison of estimates for Bulkley River steelhead anglers.

The objective was;

- To summarize and compare angler effort and catch by residence category as derived from the 1997 and 1998 River Guardian programs, the 1997 SHA, 1997 and 1998 classified waters licenses and 1997 and 1998 angling guide reports.

## **2.0.0 Study Area**

Morice Lake is the origin of the Bulkley River drainage. From Morice Lake, the Morice River flows for 74 km to meet the Bulkley River near Houston, B.C. (Anonymous 1996). The Bulkley River then flows for 142 km into the Skeena River near Hazelton, B.C. (Figures 1 and 2). The Bulkley watershed is the largest of the Skeena River tributaries and drains 12,173 km<sup>2</sup> (Anonymous 1998b). This study included the Bulkley River from its lowermost reaches at the Suskwa River upstream to its confluence with the Morice River near Houston (142 km). The popular reach of the Morice River from the Bymac campground near Houston downstream to the Bulkley River confluence was also included (4 km).

Highway 16 and the communities of Houston, Telkwa, Smithers, Moricetown and Hazelton are adjacent to the river. There are many access points for angling from shore, power boat or drift boat along the river. The majority of the river is accessible to both power and drift boats and the boating opportunities provide a major feature of the Bulkley River. Of the 146 km of the study area, most (98 km) is relatively heavily fished. Almost all fishing activity occurs in the most navigable water between Trout Creek and Morice River. The area from about 1 km downstream of the Suskwa River to the confluence of the Bulkley and Skeena rivers (about 18 km), the area from Porphyry Creek to Moricetown (about 22 km) and the area between Trout Creek and Moricetown (8 km) are all relatively lightly fished due to access limitations and/or paucity of good angling water.

The Bulkley and Morice rivers are two of about 40 class 2, classified waters in the province (Anonymous 1996). During the classified waters period, angling guides are limited, as is the number of days they can guide. The Bulkley River is restricted to a maximum of eight licensed angling guides and a total of 1,504 guided rod days (Anonymous 1996). The Morice River is restricted to three licensed angling guides, and 433 guided rod days. Both rivers are classified waters between September 1 and October 31. The MELP does not restrict the number of assistant angling guides on any of the classified waters in the province.

Relative to other angling rivers in the Skeena Region, the Bulkley River has good water clarity throughout most of the steelhead angling season (Anonymous 1996). During high runoff from a large rainfall or unusually warm weather, the Telkwa River contributes the majority of turbidity that occurs downstream in the Bulkley River. During these events angling downstream of the confluence of the Telkwa and Bulkley rivers is poor. Most anglers move upstream which concentrates all angling activity upstream of the Telkwa River. During such events it is common for other rivers in the Skeena Region to be highly turbid, therefore adding to the angler concentration on the Bulkley River. The frequency of these events can range from none to four or five per year season, seldom lasting less than three or four days or more than 10 to 12 days.

Angling restrictions in the Bulkley River are published in the B.C. Freshwater Fishing Regulations Synopsis (Anonymous 1998a) and were similar for 1997 and 1998 steelhead seasons. In short, no fishing is permitted from January 1 to June 15. From June 16 to July 31 anglers are permitted to use natural bait, but after July 31 a bait ban is in effect. From June 16 to December 31, there is a single hook only restriction. The regulations state steelhead must be



released and angling from boats is not permitted from the Morice River to the CNR bridge (August 15 - December 31) or in Moricetown Canyon (all year). In the 1997 and 1998 classified waters period, non-resident anglers were required to purchase a classified waters license at \$10.00 per day and B.C. residents were required to purchase a classified waters license at \$10.00 per year. For all anglers, a steelhead stamp was required during the classified waters period and when angling for steelhead outside of the classified waters period. In addition, a new barbless hook regulation came into effect for the whole Skeena Region on August 8, 1998.

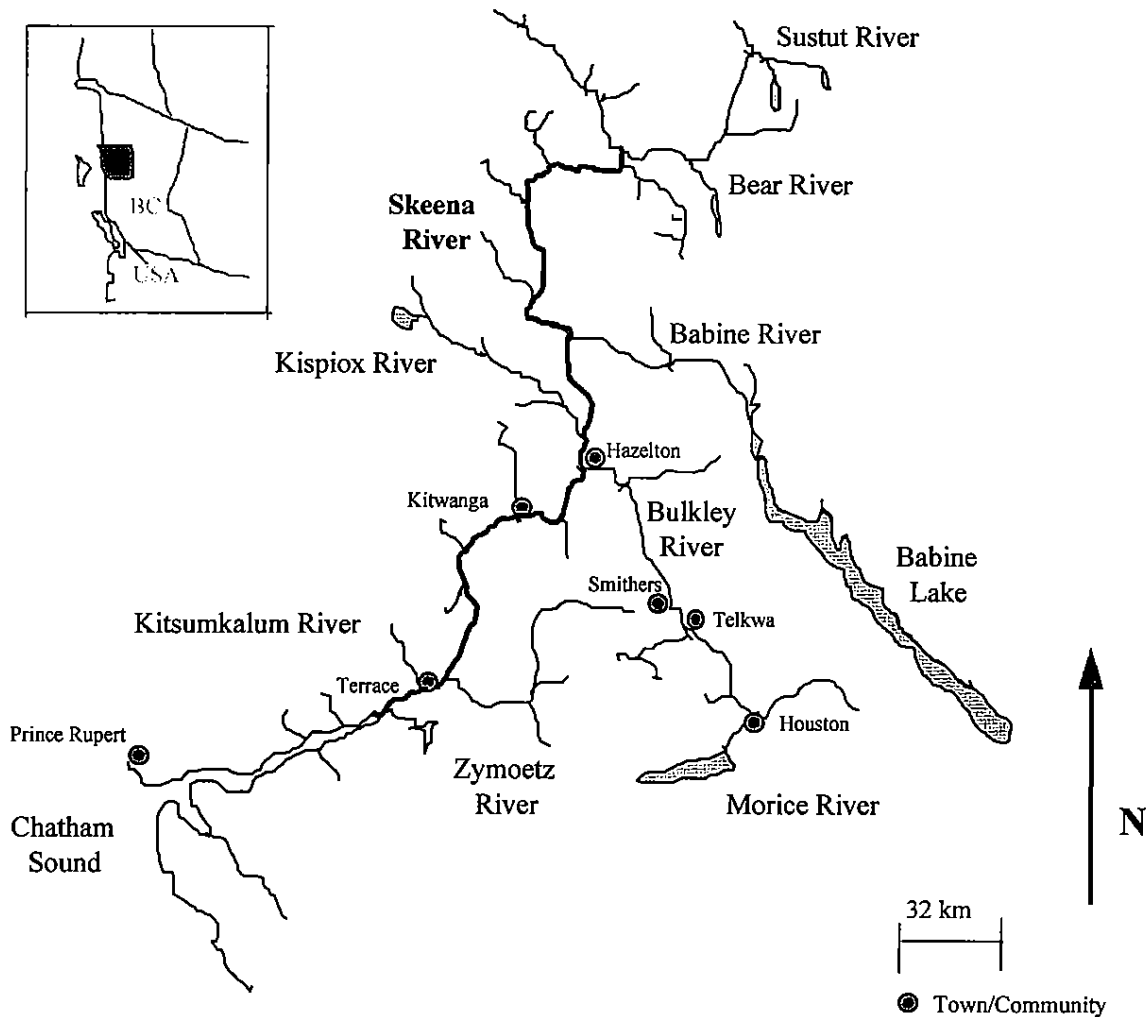


Figure 1. The Skeena River watershed.

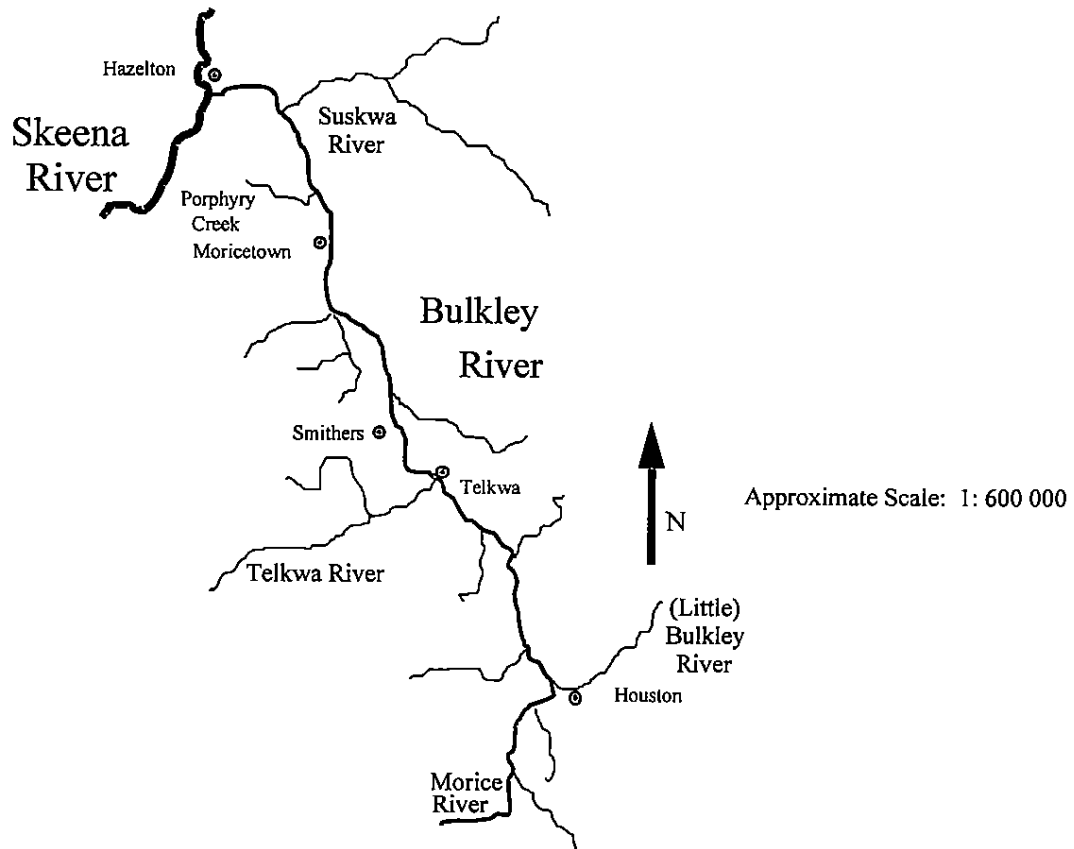


Figure 2. The Bulkley River and surrounding area.

### **3.0.0 Methods**

#### **3.1.0 Data Collection Methods**

##### **3.1.1 River Guardian Program**

In 1997 a 'River Guardian' program was introduced to selected classified waters in the Skeena Region. The primary objective was to provide an 'enforcement presence' and therefore, the province of B.C. hired River Guardians to accompany Conservation Officers in enforcement duties on the Bulkley River. 'Deputy Conservation Officer' status was obtained for each River Guardian, which allowed them to address license violations under the *Wildlife Act*. An agreement between the Conservation Officer Services and the Fisheries Branch of the B.C. Ministry of Environment, Lands and Parks enabled the Fisheries Branch to collect information from steelhead anglers. An on-site roving survey design for interviews was complemented by aerial counts to estimate angler catch and effort.

Twelve aerial counts were conducted between August 31 and November 22 (10 in the classified waters period). Aerial counts were planned on days that were most likely to have a high number of anglers on the river and were not randomly selected. Because the primary duty of the River Guardians and Conservation Officers was to provide an enforcement presence, a strict sampling schedule could not be used and therefore, a convenience sample of anglers was collected. Interviews were conducted in the classified waters period from September 1 through October 31, 1997. In addition, several interviews were conducted in the first week of November.

Similar to the 1997 River Guardian program, aerial counts and an on-site roving survey were the two main components of the 1998 program. Unlike 1997, the River Guardians were not officers under the *Wildlife Act* and therefore did not have enforcement powers. Their presence was primarily for data collection.

The aerial counts and roving survey were designed to cover the majority of the steelhead angling season (August 25 through November 22, 1998). The study period was stratified into 12, one week strata and three aerial counts were conducted in each week (36 flights total). Four River Guardians in teams of two were on the Bulkley River on each day selected for aerial counts. As many interviews as possible were conducted in each river section although, all river sections were visited on most days when aerial flights were conducted. While in each river section the River Guardians randomly selected anglers to be interviewed.

##### **3.1.2 Steelhead Harvest Analysis**

The SHA database was established by mailing questionnaires to a sample of anglers who purchased a steelhead conservation stamp throughout the province of B.C. A postcard questionnaire was sent to randomly selected anglers within nine residence categories (seven regions within B.C., Canadian residents and Non-Canadian residents). In 1997, questionnaires

were sent to 79% of anglers that purchased a steelhead license. Steelhead anglers were asked to respond to the following statements (Billings 1989):

1. Did you fish for steelhead between April 1, and March 31, and
2. List the streams fished and, for each, the number of days fished, the number of wild steelhead kept and released, and the number of hatchery steelhead kept and released.

The data returned were analyzed by MELP to determine the total angler effort and the number of hatchery or wild steelhead released and harvested for each steelhead river or stream in the province.

### **3.1.3 Guide Reports**

Each of the eight licensed guides on the Bulkley River was required to submit a guide report to MELP in 1997 and 1998. Guides reported the number of guided anglers, residence of the anglers, and the number of steelhead released by those anglers for each day they guided on the Bulkley River. The data submitted to MELP were entered into a database (SPSS 7.0) and summarized for angler effort, temporal distribution of effort, residence category and catch.

### **3.1.4 Classified Waters Licenses**

All non-residents of B.C. were required to purchase a daily classified waters license and B.C. residents were permitted to purchase a yearly classified waters license. Non-residents were unlimited in the number of classified waters licenses they could purchase although they were only permitted to purchase up to eight days of angling on one classified waters license. Each vendor and licensed guide that sold classified waters licenses were required to submit copies (counterfoils) of the license to MELP (along with their angling guide report) and to their local government agent. The classified waters license counterfoils were sorted to collect information on Bulkley River classified licenses. From each counterfoil, the vendor number, angling license number, date, guided status, guide (if guided), residence category and the number of classified days purchased were recorded and entered into a database (SPSS 7.0).

## **3.2.0 Analysis Methods**

### **3.2.1 Guided Status and Residence**

An estimate of the proportion of guided anglers that fished on the Bulkley River in 1997 and 1998 was available from the River Guardian program and the classified waters licenses. The proportion of guided anglers estimated from the River Guardian program represented angler interviews (anglers were interviewed multiple times). The proportion of guided anglers estimated from classified waters licenses represented the number rod days purchased by non-resident anglers and not the number of classified water licenses purchased. A chi-square test of homogeneity was used to compare the guided status from the River Guardian program and the classified waters licenses.

In 1997 and 1998, estimates of the proportion of anglers in each residence category were available from the River Guardian program, classified waters licenses and guide reports. For guided and non-guided, non-resident anglers, chi-square tests of homogeneity were used to compare the proportions of Canadian and Non-Canadian anglers estimated from the River Guardian program, classified waters licenses and guide reports.

### **3.2.2 Classified Waters Day Purchased**

The number of rod days purchased on each classified waters license was available from the classified waters licenses and the River Guardian program. The number of rod days anglers purchased on classified waters licenses were analyzed by grouping all Canadian and Non-Canadian residents together. B.C. residents were excluded because they bought an annual classified waters license that was not available to non-resident anglers. Using the classified waters licenses, the frequency distribution of rod days purchased per classified waters license was summarized for guided and non-guided anglers in each year and then compared to the River Guardian program results.

### **3.2.3 Temporal Distribution of Effort**

The 1997 and 1998 classified waters licenses and River Guardian program results were used to examine the temporal distribution of non-resident angler effort in the classified waters period. For each year, the non-resident (Canadian and Non-Canadian) angler effort was summarized by day from the classified waters licenses. The temporal distribution of angler effort was compared to the River Guardian program results.

### **3.2.4 Angler Effort and Catch**

In 1997, estimates of angler effort and catch were available from the River Guardian program and the SHA. However for 1998, angler effort and catch were available only from the River Guardian program because the 1998 SHA was not yet available. In 1997, the effort and catch was summarized and compared between the data sources. The SHA included results from the Bulkley and Bulkley/Morice river categories. The methods used to calculate catch and effort and residence statistics in 1997 were described by Morten and Parken (1998) and in 1998 by Morten (1999).

For the 1997 and 1998 classified waters period, angler effort estimates for each residence category were available from the classified waters licenses and the River Guardian program. The 1997 River Guardian program estimates of effort in each residence category was the total effort for the classified waters period multiplied by proportion of residents in each category. Morten (1999) previously calculated the 1998 River Guardian program effort estimates. The non-resident River Guardian effort estimates were compared to the number of rod days sold on classified waters licenses. The 1997 catch estimate was the proportion of effort for each residence category multiplied by the average catch rate for that category. The 1998 classified waters period catch estimates in each residence category were summarized in the River Guardian program information (Morten 1999).

For the whole steelhead season, effort and catch estimates for each residence category were available from the 1997 and 1998 River Guardian program and the draft 1997 SHA, but the 1998 SHA was not available. The 1997 River Guardian program effort estimates in each residence category was the total effort for the season multiplied by proportion of residents in each category. Morten (1999) previously calculated the 1998 River Guardian program estimates of effort. The 1997 catch estimate was the proportion of effort for each residence category multiplied by the average catch rate for that category. The 1998 steelhead season catch estimates in each residence category were summarized in the River Guardian program information (Morten 1999).

### **3.2.5 Guided Angler Effort and Catch**

The 1997 and 1998 guided angler effort estimates for the classified waters period were available from the River Guardian program, classified waters licenses and guide reports. The guided effort was summarized and compared between data sources.

The 1997 and 1998 guided angler effort estimates for the steelhead season were available from the River Guardian program and guide reports. The guided effort and catch was summarized and compared between data sources. In addition, the classified waters licenses and guide reports were used to summarize the 1997 temporal distribution of guided effort. In 1998, the River Guardian project, classified waters licenses and guide reports were used to summarize the temporal guided effort.

The 1997 and 1998 guided catch was available from the River Guardian program and the guide reports for both the classified waters season and the steelhead season. The guided catch was summarized and compared between the data sources.

### **3.3.0 Relevant Definitions**

**B.C. Resident:** The anglers' permanent residence was within B.C. The angler must have resided in B.C. for at least six months during the 12 months immediately prior to purchasing an angling license (Anonymous 1998a).

**Canadian Resident:** The anglers' permanent residence was outside of B.C. but within Canada. The angler resided outside of B.C. for more than six months during the 12 months prior to purchasing an angling license (Anonymous 1998a).

**Non-Canadian Resident:** The anglers' permanent residence was outside of Canada. The angler resided outside of Canada for more than six months during the 12 months prior to purchasing an angling license (Anonymous 1998a).

**Non-Resident:** The angler resided outside of B.C. Non-residents consisted of one group of Canadian and Non-Canadian residents.

**Classified Waters Period:** The Bulkley River is classified water between August 31 and October 31.

**Steelhead Season:** The length of the whole steelhead season varies and is weather dependant. The steelhead season usually starts during the last week in August and in 1997, the Bulkley River did not freeze over before the season ended on December 31 (Morten and Parken 1998). Similarly, in 1998, angling was possible until early December (Morten 1999).

## **4.0.0 Results**

### **4.1.0 Responses**

#### **4.1.1 River Guardian Program**

In 1997, 469 anglers were observed and 374 (80%) were approached for an interview by River Guardians. Of those that were approached for an interview, eight (2%) refused to complete the interview and five (1%) were not angling. The remaining 361 surveys were at least partially completed. Fifteen (4%) of those anglers did not know enough English to understand all of the questions and 40 anglers (13%) replied they had already completed the interview. A non-response bias check indicated there were more Non-Canadian residents that did not complete the survey (because they could not speak English) than B.C. residents or Canadian residents.

In 1998, the River Guardians observed 2,265 anglers and interviewed 1,199 (53%) of them. Of the anglers approached for an interview, 1,197 anglers agreed to complete the interview while one angler did not know enough English to complete the whole interview and one angler refused to complete the interview. This yielded a non-response of less than one percent and angler non-response bias was not an issue. Of the 1,199 anglers that were approached for an interview, 693 (58%) were interviewed for the first time while 506 (42%) had been interviewed previously.

#### **4.1.2 Steelhead Harvest Analysis**

In 1997, 19,814 anglers purchased a steelhead license. Of those anglers, 87% (17,178) were B.C. residents, 2% (351) were Canadian residents and 11% (2,285) were Non-Canadian residents. Of all steelhead licensees, 15,667 (79%) were mailed a SHA questionnaire (Table 1). Eighty-one percent (13,993) of B.C. residents, 89% (312) of Canadian residents and 60% (1,362) on Non-Canadian residents were sent a questionnaire. Twenty-eight percent (3,927) of B.C. residents responded while 30% (93) of Canadian and 31% (381) of Non-Canadian residents responded, which yielded an overall response rate of 28% (4,234 questionnaires) after correction for non-deliverable questionnaires.

There were 2,554 Skeena Region anglers that purchased a steelhead license. Of those, 82% (2,091) were sent a SHA questionnaire and 624 responded (30% response rate). The response rate for Skeena region anglers was typical in relation to other regions.

In 1996, the SHA response rate was 39% and it ranged from 46 to 55% between 1968/69 and 1996 (Table 1). The response rate has declined significantly in the past two years of record.



Table 1. The number of licensees, questionnaires mailed, number of respondents and response rate for recent years of the SHA.

Year(s) <sup>1</sup>	Licensees	Questionnaires Mailed	Respondents	Response Rate (%)
1997/98	19,814	15,667	4,401	28.4
1996/97	19,608	16,335	6,272	39.0
1995/96	23,044	15,625	7,430	48.4
1994/95	23,061	16,732	7,630	46.4
1993/94	27,482	12,903	5,887	46.8
1992/93	23,625	13,526	6,655	54.7
1991/92	25,588	13,513	5,227	48.4
1985/86-90/91	29,983	mean = 16,505	mean = 8,108	mean = 54.5
1968/69-84/85	29,269	mean = 17,497	mean = 7,913	mean = 51.1

### 4.1.3 Guide Reports

In 1997, guide reports indicated guided anglers fished for 1,098 rod days on the Bulkley River. All but one of those rod days were used in the classified waters period. On average, 18.3 guided anglers fished per day on the Bulkley River between September 1 and November 1, and the guides reported a maximum of 48 guided anglers on any one day (September 29).

In 1998, guide reports indicated that guided anglers fished 1,183 rod days on the Bulkley River. Ninety-nine percent (1,172) of those rod days were used in the classified waters period. Rod days were used between August 23 and November 4 and on average, 16.9 guided anglers fished per day between these dates. The guides reported a maximum of 37 guided anglers on any one day (October 5).

### 4.1.4 Classified Waters License Sales

In 1997, 37 vendors sold classified waters licenses to non-resident anglers. Non-resident Bulkley River anglers purchased 2,470 rod days on 1,185 classified waters licenses. On average, there were 2.1 days of classified waters angling purchased on each license.

In 1998, 45 vendors sold classified waters licenses to non-resident anglers. Non-resident Bulkley River anglers purchased 2,768 classified waters days on 1,276 licenses. On average, there were 2.2 days of classified waters angling purchased on each license.

### 4.2.0 Guided Status and Residence

An estimate of the proportion of guided anglers that fished on the Bulkley River in 1997 and 1998 was available from the River Guardian program and the classified waters licenses. In the 1997 River Guardian program 15% (43) of all angler interviews and 28% of non-resident angler interviews were guided. Thirty-four percent (843) of classified waters days were sold to guided anglers. The proportion of non-resident guided anglers interviewed by River Guardians was similar to the proportion of non-residents that purchased classified waters days (chi-square  $\chi^2 = 2.8$ ,  $df = 3$ ,  $P \leq 0.09$ ).

Similarly, 15% (165 anglers) of all angler interviews by River Guardians in 1998 were guided and 32% of non-resident angler interviews were guided. Thirty-three percent (938) of classified waters days were sold to guided anglers. The proportion of non-resident, guided anglers interviewed by River Guardians was similar to the proportion that purchased classified waters licenses (chi-square  $\chi^2=0.63$ ,  $df=3$ ,  $P \leq 0.23$ ).

In 1997 and 1998, estimates of the proportion of anglers in each residence category were available from the River Guardian program, classified waters licenses and guide reports. In 1997, the River Guardian program estimated 57% of non-guided anglers were B.C. residents while 43% were non-residents. The River Guardian program and the classified waters licenses both indicated that of non-guided, non-residents, about 20% were Canadian residents and 80% were Non-Canadian residents (Table 2). The proportion of Canadian and Non-Canadian residents was similar between the River Guardian interviews and the classified waters licenses sold (chi-square  $\chi^2=0.72$   $df=3$ ,  $P \leq 0.13$ ; Table 2). The proportion Canadian and Non-Canadian residents among guided anglers was similar between data sources although sample sizes were too small to test statistically. Guided anglers were almost all Non-Canadian residents.

Table 2. The residency composition of non-resident, guided and non-guided anglers by each data source in 1997.

	Percentage (n) of Non-Resident Anglers		
	Interviewed by River Guardians	Classified Waters Licenses	Guide Reports
Non-Guided			
Canadian	22 (25)	21 (337)	NA
Non-Canadian	78 (88)	79 (1,290)	NA
Guided			
Canadian	0 (0)	1 (12)	3 (6)
Non-Canadian	100 (43)	99 (820)	97 (217)

Of all 1998 non-guided River Guardian program angler interviews, 70% were B.C. residents while 30% were non-residents. Of non-residents, the proportion of Canadian and Non-Canadian residents was similar between the River Guardian program and the classified waters licenses (chi-square  $\chi^2=1.9$   $df=3$ ,  $P \leq 0.17$ ; Table 3). The proportion Canadian and Non-Canadian residents among guided anglers was similar between data sources although sample sizes were too small to test statistically. Similar to 1997, few Canadian residents used the services of a guide to fish on the Bulkley River in 1998.

Table 3. The residency composition of non-resident, guided and non-guided anglers by each data source in 1998.

	Percentage (n) of Non-Resident Anglers		
	Interviewed by River Guardian	Classified Waters Licenses	Guide Reports
Non-Guided			
Canadian	21 (58)	18 (320)	NA
Non-Canadian	79 (222)	82 (1,508)	NA
Guided			
Canadian	2 (3)	1 (6)	0.0 (0)
Non-Canadian	98 (132)	99 (932)	100.0 (245)

#### 4.3.0 Classified Waters Days Purchased

The number of rod days purchased on each classified waters license was available from the classified waters licenses and the River Guardian program. In 1997, 68% of classified waters licenses sold to non-guided anglers were one-day licenses. Fewer anglers purchased two, three or greater than four days of angling in one block (Figure 3). In contrast, guided anglers purchased more five-, six- or seven-day licenses than non-guided anglers. The distribution of days purchased on each classified waters license was similar to the distribution observed by the River Guardian program (Morten and Parken 1998).

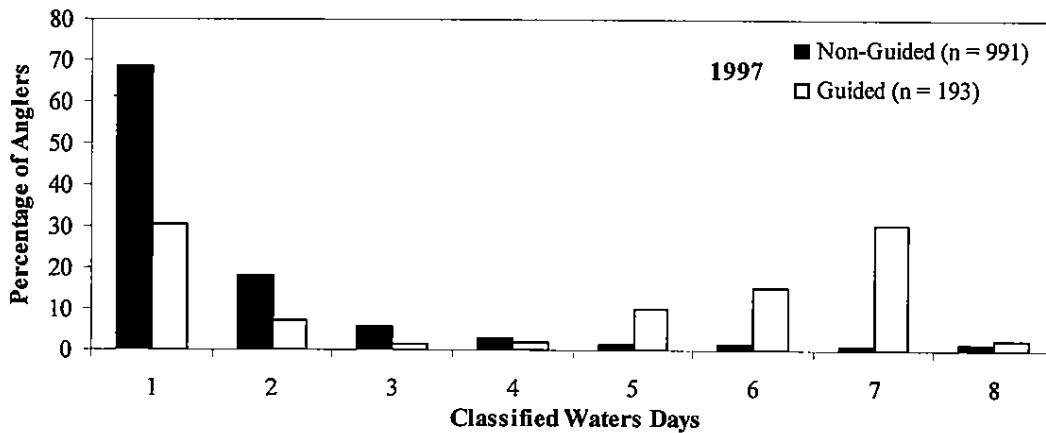


Figure 3. The percentage of non-guided and guided anglers that purchased classified waters licenses in blocks of one through eight days, 1997 (Canadian and Non-Canadian residents only).

In 1998, non-guided anglers purchased mainly one-day licenses while guided anglers purchased more six- and seven-day licenses (Figure 4). Sixty-three percent of licenses sold to non-guided anglers were one-day licenses whereas only 34% of classified waters licenses sold to guided anglers were one-day licenses. The River Guardian program observed a similar distribution where 40% of non-guided anglers purchased a one-day license and 13% of guided anglers purchased a one-day license (Morten 1999).

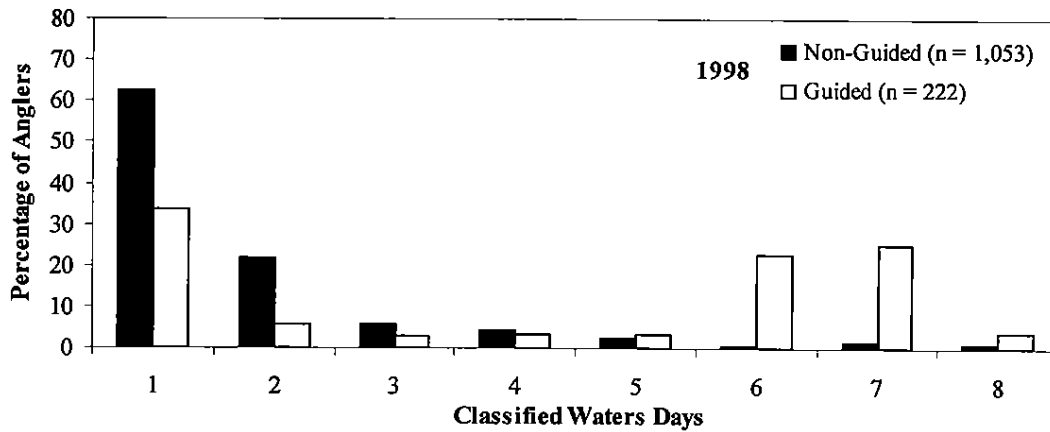


Figure 4. The percentage of non-guided and guided anglers that purchased classified waters licenses in blocks of one through eight days, 1998 (Canadian and Non-Canadian residents only).

#### 4.4.0 Temporal Distribution of Effort

Classified waters licenses were used to examine the temporal distribution of non-resident angler effort in the classified waters period. In 1997, the distribution of non-resident angler effort was normal or bell-shaped (Figure 5). The peak daily non-resident effort (99 rod days) was on September 29. A similar bell-shaped or normal distribution of angler effort was also found in the River Guardian program (Morten and Parken 1998). A comparison of the non-resident angler effort during the classified waters period (2,470 rod days, classified waters days) to the non-resident angler effort during the steelhead season from the SHA (3,279 rod days) suggested 25% of the non-resident angler effort occurred outside of the classified waters period (Table 5). This contradicted the temporal distribution of angler effort determined by classified waters licenses, indicating the SHA overestimated non-resident angler effort.

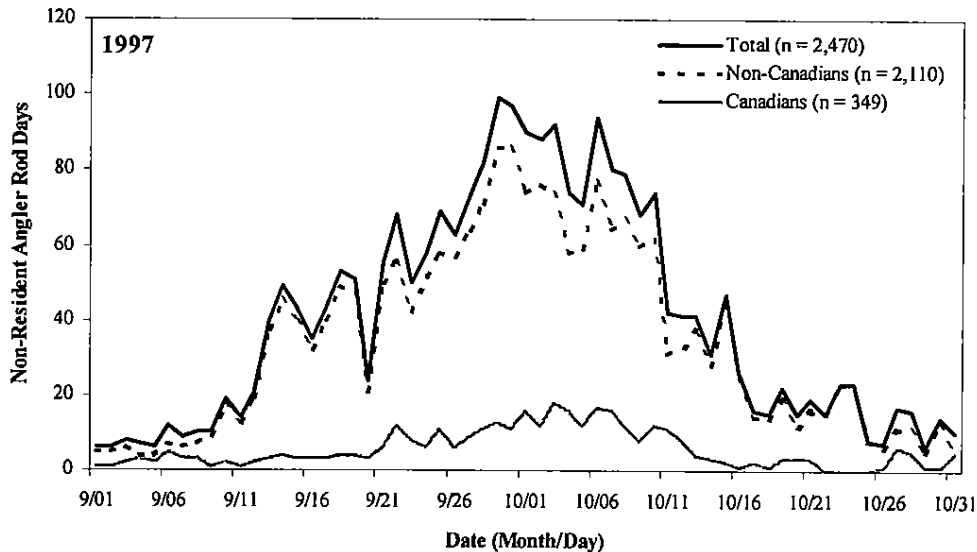


Figure 5. Daily non-residents (Total), Canadian and Non-Canadian resident effort determined from classified waters licenses in 1997. Eleven classified waters licenses were missing residence information.

In 1998, the distribution of non-resident angler effort, determined from classified waters licenses, followed a normal or bell-shaped distribution (Figure 6). The peak non-resident angler effort (101 rod days) occurred on October 2. A similar bell-shaped or normal distribution of angler effort was also found in the River Guardian program (Morten 1999).

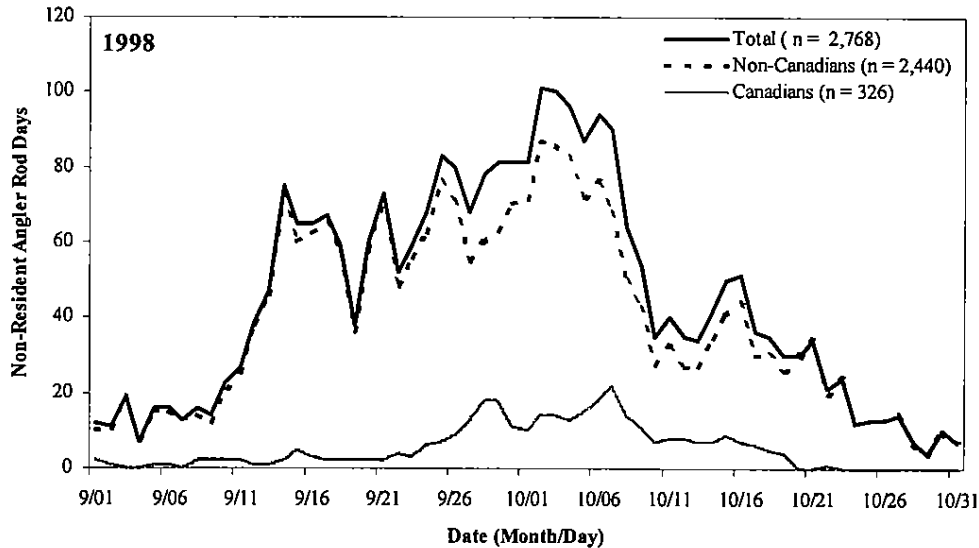


Figure 6. Daily non-residents (Total), Canadian and Non-Canadian resident effort determined from classified waters licenses in 1998. Two classified waters licenses were missing residence information.

#### 4.5.0 Angler Effort and Catch

In 1997, estimates of angler effort and catch were available from the River Guardian program and the SHA. However for 1998, angler effort and catch were available only from the River Guardian program because the 1998 SHA was not available. The draft 1997 SHA effort estimate for all anglers was more than double the 1997 River Guardian program effort estimates (Table 4,9). In addition, the draft 1997 SHA catch estimate was almost 1.5 times the River Guardian program catch estimate (a result of double the effort estimates; Morten and Parken 1998). In 1998, the River Guardian program effort and catch estimates were higher than the estimates in 1997 (Table 4).

Table 4. The angler catch and effort estimates for the steelhead season from the 1997 and 1998 River Guardian program and the 1997 draft SHA results.

Project	1997		1998	
	Effort Estimate (rod day)	Catch Estimate (steelhead)	Effort Estimate (rod day)	Catch Estimate (steelhead)
River Guardian	4,317 ± 324	6,364 ± 6,650	6,116 ± 442	8,956 ± 1,466
SHA <sup>1</sup>	9,148	9,105	NA	NA

1. The SHA includes results from the Bulkley and Bulkley/Morice river categories.

For the 1997 and 1998 classified waters period, angler effort estimates for each residence category were available from the classified waters licenses and the River Guardian program.

In 1997, the classified waters licenses indicated 2,470 classified waters days were purchased by non-residents. Non-Canadian residents purchased most days (86%), while 14% were purchased by Canadian residents (Table 5,9). The River Guardian program effort estimates for Canadian and Non-Canadian residents were smaller than the actual number of classified waters license rod days sold. In fact, for all non-residents, the classified waters licenses indicated there were 24% more rod days of non-resident angler effort than estimated by the River Guardian program.

In 1998, 2,768 classified waters days were purchased by non-residents during the classified waters period (Table 5,9). Similar to 1997, the majority of rod days were purchased by Non-Canadian residents (88%). Also, the classified waters licenses indicated there were 29% more rod days of non-resident angler effort than estimated by the River Guardian program.

For the whole steelhead season, effort estimates for each residence category were available from the 1997 and 1998 River Guardian program and the draft 1997 SHA. In 1997, the River Guardian program estimated less effort for B.C. and Non-Canadian residents than the SHA (Table 5,9). The SHA estimated that B.C. residents fished for almost three times more rod days than estimated by the River Guardian program. Also, the SHA effort estimate for Non-Canadian residents was 76% more than the River Guardian estimate. In contrast, the River Guardian effort estimate for Canadian residents was 49% more than the SHA estimate. The end result was the SHA non-resident effort estimate was 58% higher than the River Guardian program effort estimate.

Table 5. The 1997 and 1998 angler effort estimates in each residence category for the River Guardian program, the draft 1997 SHA results and the classified waters licenses in the classified waters period and the whole steelhead season.

	Classified Waters Period Effort (rod days) <sup>1</sup>		Steelhead Season Effort (rod days) <sup>1</sup>	
	River Guardian	Classified Waters <sup>2</sup> Licenses	River Guardian	SHA <sup>1</sup>
<b>1997</b>				
B.C.	1,992 ± 227	NA	2,075 ± 229	5,869
Canadian	323 ± 91	349	336 ± 92	226
Non-Canadian	1,669 ± 208	2,110	1,739 ± 210	3,053
<b>Total Non-Resident</b>	<b>1,992</b>	<b>2,470</b>	<b>2,075</b>	<b>3,279</b>
<b>1998</b>				
B.C.	3,265 ± 52	NA	3,766 ± 64	NA
Canadian	281 ± 6	326	343 ± 18	NA
Non-Canadian	1,873 ± 74	2,440	2,006 ± 60	NA
<b>Total Non-Resident</b>	<b>2,154</b>	<b>2,768</b>	<b>2,349</b>	<b>NA</b>

1. The SHA includes results from the Bulkley and Bulkley/Morice river categories.

2. The total non-resident rod days are more than the sum of Canadian and Non-Canadian rod days because some classified waters licenses were missing the residence category information.

Considering the whole steelhead season, the 1997 River Guardian catch estimates for B.C. and Non-Canadian residents were less than the SHA catch estimates (Table 6,9). The SHA estimated B.C. residents caught more than one and a half times the number of steelhead than the River Guardian program estimated. Also, the SHA catch estimate for Non-Canadian

residents was higher than the River Guardian catch estimate. In contrast, the River Guardian program catch estimate for Canadian residents was more than the SHA catch estimate.

Table 6. The 1997 and 1998 angler catch estimates in each residence category for the River Guardian program, the draft 1997 SHA results for the Classified Waters Period and the whole steelhead season.

	Classified Waters Period Catch (steelhead) River Guardian	Steelhead Season Catch (steelhead)	
		River Guardian	SHA <sup>2</sup>
<b>1997<sup>1</sup></b>			
B.C.	2,749 ± 4,299	3,182 ± 5,409	5,627
Canadian	445 ± 696	515 ± 876	155
Non-Canadian	2,303 ± 3,602	2,667 ± 4,532	3,736
<b>1998</b>			
B.C.	4,792 ± 5,728	5,294 ± 5,840	NA
Canadian	312 ± 630	312 ± 631	NA
Non-Canadian	2,257 ± 2,460	2,435 ± 2,510	NA

1. The 1997 catch for each residence category was calculated by taking the total catch and multiplying by the proportion of each residence category. Catch rates were equal among all residence categories and instead were specific to each time period.
2. The SHA includes results from the Bulkley and Bulkley/Morice river categories.

#### **4.6.0 Guided Angler Effort and Catch**

Guided angler effort estimates were available from the River Guardian program, classified waters licenses and guide reports for the classified waters season. In 1997, the River Guardian program estimated 637 guided rod days, the classified waters licenses indicated 843 guided rod days whereas the guide reports indicated 1,093 guided rod days in the classified waters period (Table 7,9). Overall, the guides reported 30% more guided angler days than the number of classified waters days sold and 72% more days than estimated by the River Guardian program. For the steelhead season, the River Guardian program and the guide reports provided estimates of guided effort. The guide reports estimated 65% more rod days than the River Guardian program estimated.

Table 7. The River Guardian program and guide report effort estimates for guided anglers in the classified waters period and the whole steelhead season, 1997 and 1998.

Year	Classified Waters Period (rod days)			Steelhead Season (rod days)	
	River Guardian Estimate	Classified Waters Licenses	Guide Reports	River Guardian Estimate	Guide Reports
1997	637 ± 129	843	1,093	664 ± 130	1,098
1998	906 ± 38	938	1,145	910 ± 39	1,183

In the 1998 classified waters period, the River Guardian program estimated 906 guided rod days, the classified waters licenses indicated 938 guided rod days whereas the guide reports indicated 1,145 guided rod days (Table 7,9). Overall, the guides reported 22% more guided angler days than indicated by classified waters licenses and 26% more than River Guardian program estimates. Similar to 1997 results, the guided effort estimated from guide reports was consistently higher than the guided effort estimated from classified waters licenses and the River Guardian program. It is important to note that guides and assistant guides were not

included in the guided angler effort in any of the data collection methods in 1997 or 1998. From a fisheries management perspective, the effort associated with guides/assistant guides and their clients may be about 50% more than guided angling effort, considering the approximate guide to client ratio of 1:2.

The temporal distribution of guided angler effort was available from the classified waters licenses and the guide reports. In 1997, the majority of effort occurred in the classified waters period. The River Guardian program estimated 96% of guided effort occurred during the classified waters period while the guides reported 99.5% of guided effort occurred during the classified waters period (Figure 7). The guided angler effort followed a normal or bell-shaped curve throughout the classified waters period. The 1997 River Guardian program reported a similar distribution of guided angler effort (Morten and Parken 1998).

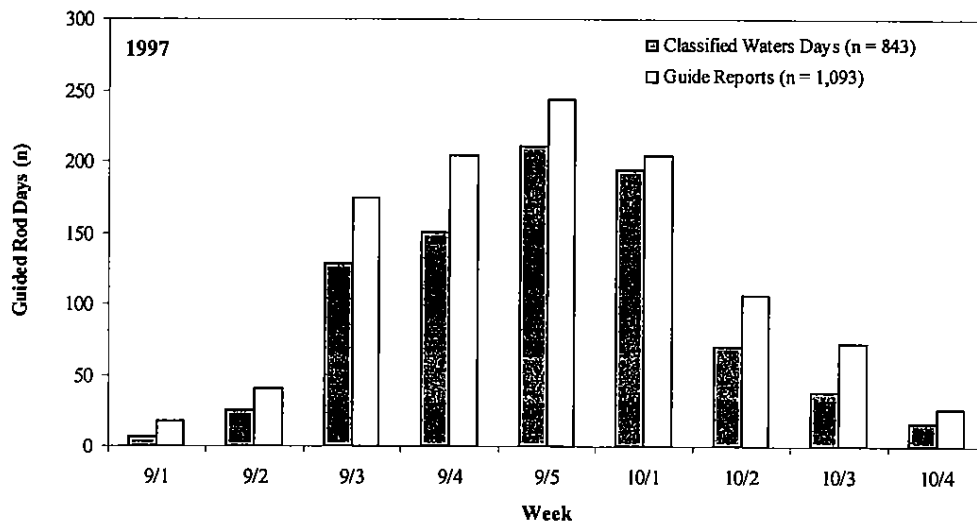


Figure 7. The guided classified waters days sold and the rod days reported by the guides for each week in the 1997 classified waters period.

In 1998, the majority of guided effort occurred in the classified waters period. The River Guardian program estimated 99.5% of guided effort occurred during the classified waters period while the guides reported 97% of effort occurred during the classified waters period. Most guided effort outside the classified waters period occurred in the last week of August or early November.



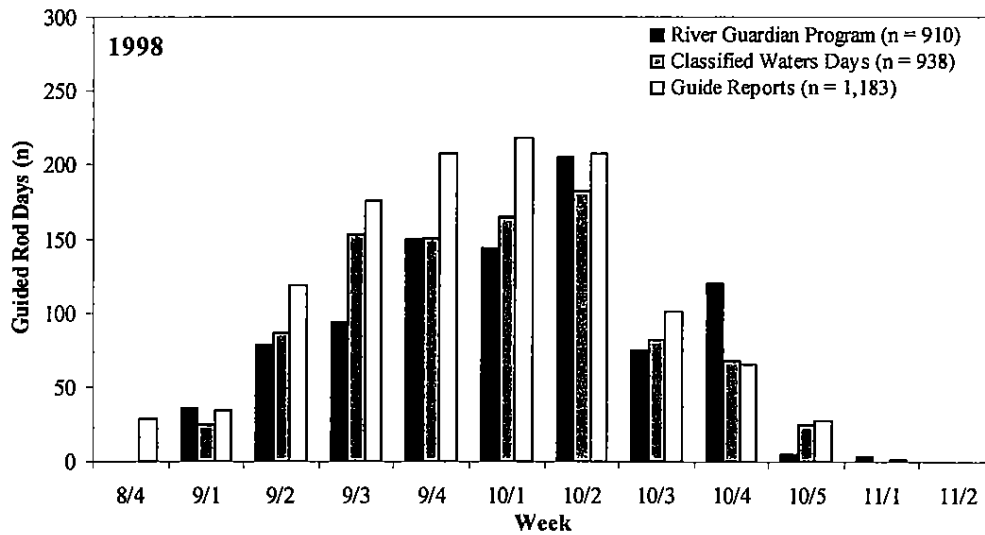


Figure 8. The guided classified waters days sold and the rod days reported by the guides for each week in the 1998 steelhead season.

In the 1997 classified waters period, the guides reported 1,553 steelhead were landed whereas, 832 steelhead were estimated landed by the River Guardian program (Table 8,9). Overall, the guides reported 86% more steelhead were caught in the classified waters period than the estimates from the River Guardian program. Also, the guides reported that no steelhead were landed outside the classified waters period.

The guides reported that 1,709 steelhead landed in the 1998 classified waters period which was 42% more than the River Guardian program estimate. The discrepancy between the guide reports and the River Guardian program catch estimates is larger when the whole steelhead season is considered. The guides reported their clients caught 46% more steelhead than what was estimated in the River Guardian program.

Table 8. The River Guardian program and guide report catch estimates for guided anglers in the classified waters period and the whole steelhead season, 1997 and 1998.

Year	Classified Waters Period		Steelhead Season	
	River Guardian Estimate	Guide Reports	River Guardian Estimate	Guide Reports
1997	832 ± 2,638	1,553	867 ± 2,748	1,553
1998	1,201 ± 1,638	1,709	1,201 ± 1,638	1,748

Table 9. A summary of the 1997 and 1998 angler effort and catch for B.C. residents, Non-Residents and guided and non-guided anglers from the Guardian Program, SHA, Guide Reports and Classified Waters Licenses.

		Effort and Catch for the Steelhead Season (Classified Waters Period)			
	Guardian Program	SHA	Guide Reports	Classified Waters Licenses	
<b>1997</b>					
<b>Angler Effort (Rod Days)</b>					
B.C. Residents	2,075 (1,992)	5,869 (NA)	NA (NA)	NA (NA)	
Non-Residents	2,075 (1,992)	3,279 (NA)	NA (NA)	NA (2,470)	
Guided	664 (637)	NA (NA)	1,098 (1,093)	NA (843)	
Non-Guided	3,486 (3,346)	NA (NA)	NA (NA)	NA (1,627)	
<b>Catch (Steelhead)</b>					
B.C. Residents	3,182 (2,749)	5,627 (NA)	NA (NA)	NA (NA)	
Non-Residents	3,182 (2,748)	3,891 (NA)	NA (NA)	NA (NA)	
Guided	867 (832)	NA (NA)	1,553 (1,553)	NA (NA)	
Non-Guided	3,855 (3,700)	NA (NA)	NA (NA)	NA (NA)	
<b>1998</b>					
<b>Angler Effort (Rod Days)</b>					
B.C. Residents	3,766 (3,265)	NA (NA)	NA (NA)	NA (NA)	
Non-Residents	2,349 (2,154)	NA (NA)	NA (NA)	NA (2,768)	
Guided	910 (906)	NA (NA)	1,183 (1,145)	NA (938)	
Non-Guided	5,205 (4,512)	NA (NA)	NA (NA)	NA (1,830)	
<b>Catch (Steelhead)</b>					
B.C. Residents	5,294 (4,792)	NA (NA)	NA (NA)	NA (NA)	
Non-Residents	2,747 (2,569)	NA (NA)	NA (NA)	NA (NA)	
Guided	1,201 (1,201)	NA (NA)	1,748 (1,709)	NA (NA)	
Non-Guided	6,576 (5,862)	NA (NA)	NA (NA)	NA (NA)	

## **5.0.0 Discussion**

Among non-resident anglers, the proportions of guided angler interviews in the River Guardian programs in 1997 and 1998 (28% and 32% respectively) were similar to the proportions of classified waters days sold to guided anglers (34% and 33% respectively). Considering residence, the proportions of Canadian and Non-Canadian non-resident anglers were similar among the River Guardian programs and the classified waters licenses sold. The similarities indicated the estimates of residence category and guided status proportions in the River Guardian programs were accurate. B.C. residents were not included in the comparison because they were not required to purchase date and river specific classified waters licenses and very few were reported as guided in the guide reports. Also, the SHA was not included in the comparison because it does not have an estimate of effort in the classified waters period or an estimate of guided angler effort.

The classified waters days obtained on the classified waters licenses showed most non-guided, non-resident anglers purchased one day of classified waters angling at a time. Conversely, guided anglers purchased multiple days of angling on one classified waters license. These results helped clarify the understanding that non-guided, non-resident anglers purchase their classified waters license in one or two day blocks. The anglers may want to fish on different classified waters or do not want to take the chance of being 'rained out' and wasting their license investment. Conversely, guided anglers pre-pay for one-week trips and are committed to angling on the Bulkley River and therefore, purchase multiple classified waters days on one classified waters license.

Effort and catch analysis indicated SHA results consistently exceeded the River Guardian program results. Commonly, mail surveys are affected by biases such as non-response, recall, digit preference and avidity bias (Tarrant and Manfredo 1993, Pollock *et al.* 1994, Westat Inc 1989 cited by Frechtling 1994, Degisi 1999). All could inflate effort catch estimates of the SHA. Other factors that may pertain to the SHA overestimate include: an inaccurate sampling frame, differential bias in residence categories and low response rates.

The SHA sampling frame was established from anglers who purchased a steelhead conservation stamp. Since 1997, it has been mandatory for steelhead anglers to purchase a steelhead conservation stamp during the classified waters period on the Bulkley River. There is some concern that some steelhead anglers did not purchase a steelhead stamp when angling prior to 1997 and also currently outside of the classified waters period (Morten and Parken 1998). It is unknown if anglers who purchased a steelhead conservation stamp had a different rate of participation than those who do not purchase a steelhead conservation stamp. The percentage of anglers that did not have a steelhead conservation stamp was low in 1997 and 1998 (2% and <1% of anglers interviewed, respectively; Morten and Parken 1998; Morten 1999) which indicated the potential bias was small. It is recognized, however, that the presence of the River Guardian program probably had positive affect on angler compliance. In addition, the SHA sampling frame does not include anglers under 16 and status First Nations neither of whom require licenses (De Gisi 1999). Therefore, the SHA results were only representative of those anglers that purchased a steelhead conservation stamp, adults and non-First Nations anglers.

Angler attributes vary between residence categories which probably influences the susceptibility to biases. The discrepancy between the SHA and River Guardian program estimates was largest for B.C. residents. The proportion of each residence category was similar between the classified waters licenses and the River Guardian program estimates, which indicated the SHA effort estimates for B.C. residents are inflated. B.C. residents and non-guided, non-residents who fish in the Skeena Region for extended periods may be more susceptible to recall bias and digit preference bias (Brown and Wilkins 1978). They participate in more trips in one season making it harder to recall each specific rod day fished. In contrast, non-resident guided anglers or non-resident, non-guided anglers who fish for only a few days may be less susceptible to recall, avidity and digit preference bias because angling in the Bulkley River is an infrequent event and their angling experience is likely to be vivid in their memory. Non-resident anglers are also required to record days fished and catch on their license and this may assist recall accuracy.

The SHA response rate has declined in the past several years to a low of 28% in 1997. The low response rate likely enhances non-response bias and when combined with recall, digit preference and avidity bias it could produce the SHA overestimate. Further investigations are necessary before the overestimation can be quantified accurately.

River Guardian program effort estimates for non-residents were also consistently lower than the number of rod days sold on classified waters licenses in the classified waters period. Several factors could account for this discrepancy. First, aerial flights estimating effort were conducted during midday (1:30 p.m.) which represented when most anglers were on the Bulkley River in a previous study (Lewynski and Olmsted 1990). Future surveys should investigate the daily trend in angling to determine if midday is still the busiest part of the angling day. Second, the classified waters licenses were only indicative of days that were purchased, not the days fished. Anglers could have purchased a day of classified water angling and not used it. The effect of not using classified waters days already purchased is probably small because non-resident anglers make a significant monetary investment in angling during the classified waters season and the majority of classified waters licenses are purchased for one day of angling.

The River Guardian program guided effort estimates in 1997 were lower than the amount of classified waters days sold to guided anglers. This indicated a possible sampling bias (underrepresentation of guided anglers) in the 1997 River Guardian program. In 1998, the discrepancy in estimates was small. In contrast, guide reports of effort were at least 22% larger than River Guardian program estimates in the classified waters period and the whole steelhead season. Also, angling guides indicated 30% and 26% more days fished on their mandatory guide reports in 1997 and 1998 respectively than they accounted for in mandatory but separate returns of classified waters license. In both years, most of the discrepancy was accounted for by the same guides, which raises serious concerns about the credibility of some guide reports. These results raise questions about the quality of information on which angling use decisions have been based.

In 1997 and 1998 the guide reports of guided catch was higher than the River Guardian program estimates. The difference in effort estimates probably accounted for the majority of differences in catch estimates. The River Guardian program estimates could be lower than estimates from the guide reports because a steelhead was only determined caught if it was landed in the River Guardian program. It was unclear if the guides reported steelhead that were hooked but lost as caught.

## **6.0.0 Recommendations**

1. MELP should continue to evaluate the accuracy and precision of the SHA. It is clear there is a substantial positive bias in the effort and catch estimates and that this bias may be increasing over time. Caution should be used in application of SHA data in the meantime.
2. On the non-resident classified waters licenses, specific dates and times for the days purchased were not completed by some vendors. If classified waters license counterfoils continue to be used as estimates of angler effort, MELP should increase the education available to the vendors to ensure all classified waters licenses are date and river specific. Increased vendor education will lead to more accurate estimates of angler effort within the classified waters period.
3. MELP should endeavor to establish an electronic licensing system. An electronic system would ensure a fast and efficient way of distributing the SHA questionnaires (less recall bias), ensure classified waters licenses are completed correctly and provide almost an immediate and accurate estimate of angler effort.
4. The large discrepancy between the angler effort reported by guides and the effort estimated by the River Guardian programs and classified waters license counterfoils should be further investigated.
5. MELP should ensure guides record and report steelhead landed and not hooked. Specific instructions should be placed on the guide report data forms. Also, guided angler catch could be separated by residence category currently it is grouped for all categories.

## **7.0.0 Acknowledgments**

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