Lower Skeena River Angling Creel Survey 2010

Final Report

D. Robichaud and K. K. English

31 March 2011

LGL Limited environmental research associates

EA3243

Lower Skeena River Angling Creel Survey 2010

Final Report

Prepared by:

D. Robichaud and K. K. English

LGL Limited
9768 Second Street,
Sidney, BC
V8L 3Y8

Prepared for:

Kitsumkalum First Nation
Terrace, B.C.

31 March 2011

EXECUTIVE SUMMARY

Catches of Chinook salmon by the Skeena River sport fishery are significant but largely unknown, and attempts to estimate catch have been sporadic. Creel surveys were conducted over most of the Chinook salmon fishing season in 1995, 2001 and 2003. No surveys have been conducted since 2003. The three objectives for this study were: 1) to provide monthly catch estimates (June to September) for all salmon species caught in the sport fishery on the waters of the Skeena River downstream of Terrace; 2) to inspect as many Chinook and coho as possible and record the incidence of adipose fin clips; and 3) to collect DNA and age data of Chinook salmon. The design for the 2010 lower Skeena creel survey was based on similar recreational fishery surveys conducted on the Skeena, Nass and Peace rivers.

Angling effort differed significantly among river strata. Significantly less angling effort occurred in the reach between Lakelse and Exstew (~15,000 angler hours) than in the other two strata (~44,000 angler hours in each). The 2010 surveys produced catch estimates with relatively large standard errors resulting from small catches and high variability in catch rates. Pink salmon was the most abundantly caught fish (3,259 fish, SE = 726), but it was harvested only 5% of the time. Chinook salmon was the second most commonly caught species (2,720 fish; SE = 208), and the species most likely to be harvested (86% of catch was harvested). Scale samples were obtained from 378 of the 437 Chinook observed during angler interviews. The catch estimate for sockeye salmon was 1996 (SE = 383), of which 72% were harvested. In total, 1864 steelhead were caught (SE = 213), but only 1% (~18 fish) were harvested. The steelhead expansion estimate was based on 4 interviews where anglers had retained 5 steelhead, because they were unaware of the regulations or could not distinguish between steelhead and other species. Coho salmon was the least frequently caught species (1690 fish, SE = 234), and 74% were harvested.

The total angler effort estimates for the June-August period in 2010 was 42% of the comparable effort estimate for 2003. Average Chinook CPE was similar to that observed in 2003, however, Chinook catch was likely underestimated in 2010 due to deficiencies in the coverage of boat-based anglers in the Ferry Island to Lakelse stratum. Samples from completed boat trips in this stratum were limited to the period between June 17 and July 2. Chinook CPE for boat-based anglers were 4.3 times higher than those for shore-based anglers during this period.

The survey design included effective methods for obtaining estimates of fishing effort and CPE for the lower Skeena recreational fishery. The collection of information on yesterday line times was an effective method for determining daily fishing activity patterns from a fishery where a large portion of the anglers fish on sequential days. The on-water boat surveys provided complete counts of the number of anglers fishing at specific times and a substantial amount of CPE data from angler interviews on 56% of the days during the monitoring period. All the weaknesses with the 2010 study were associated with survey implementation. Survey schedules included both AM and PM shifts but survey crews worked the same mid-day period each day (8 AM to 5 PM) thus angler interviews did not include CPE information for fishing that occurred after 6 PM. We recommend several changes to program implementation that should improve the quality and quantity of future data obtained through creel surveys conducted on the lower Skeena River.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

INTRODUCTION

Catches of Chinook salmon by the Skeena River sport fishery are significant but largely unknown, and attempts to estimate catch have been sporadic. Creel surveys were conducted over most of the Chinook salmon fishing season in 1995, 2001 and 2003. The estimate of Chinook salmon caught in the Skeena/Kitsumkalum sport fishery exceeded 6,700 fish in 2003 (Tallman 2004). No surveys have been conducted since 2003 and anecdotal information indicates that sport fishing effort has increased, except for 2007 when flooding conditions reduced the fishery to almost nil. Variability in river conditions and salmon abundance can result in high year-to-year variability in Chinook catch and in the catch of other species. The variability in Chinook catch is particularly important for assessing the total harvest of Kitsumkalum Chinook which is the north coast's only exploitation rate indicator stock. Voluntary contributions of CWT heads from the lower Skeena sport fishery are rare and the incidence of adipose fin clips is unknown; thus awareness factors are currently unavailable for this fishery. The implementation of a watershed-wide Chinook radio-telemetry study in 2010 (A. Gottesfeld, Skeena Fisheries Commission, unpublished data) further increased the importance of obtaining a reliable estimated of the number of Chinook caught and released by lower Skeena River anglers in 2010.

The design for the 2010 lower Skeena creel survey was based on similar recreational fishery surveys conducted on the Skeena, Nass and Peace rivers (Tallman 2004; Bocking and English 1994; Robichaud et al. 2009). We used the same spatial strata as the 2003 creel survey program conducted by J.O. Thomas in order to facilitate comparison of the 2010 results with the most recent previous estimates.

This report documents the results from survey efforts conducted from early June to late September 2010. The report describes the methods used to derive estimates of angler activity pattern, catch and fishing effort. The discussion examines how deficiencies in the implementation of the 2010 survey design likely affected the Chinook catch estimates. Recommendations are made to correct these implementation problems in future creel surveys.

SCOPE

The geographic scope of the lower Skeena creel survey study in 2010 was from Ferry Island near Terrace BC to the Kwinitsa boat launch near the mouth of the Skeena River, a distance of 150 km (Figure 1).

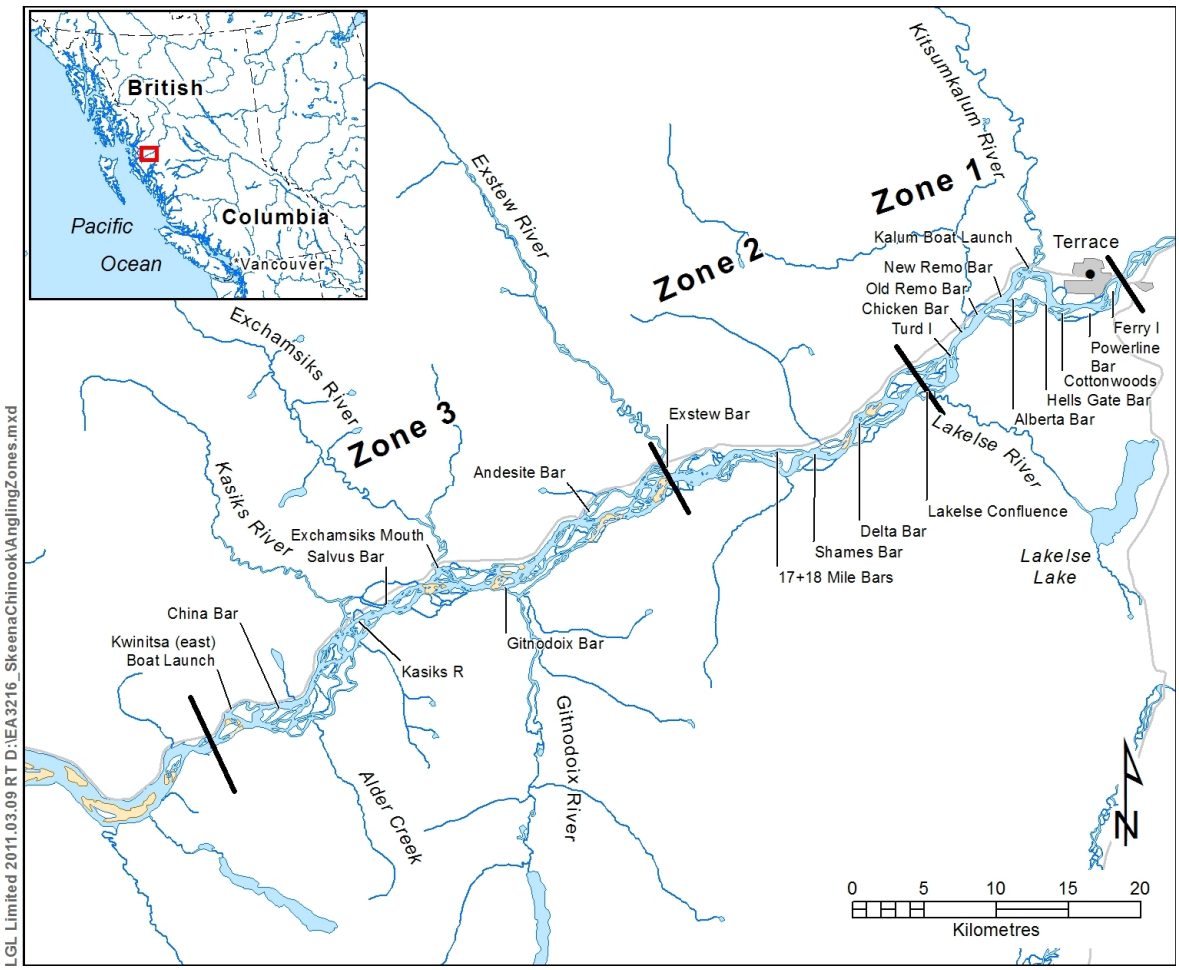

Figure 1. Map of the lower Skeena River showing the major fishing sites and boundaries for the three river zones (strata) used for the 2010 creel survey design.

For the purposes of data collection and analysis, the study area was divided into three geographic strata (called "river zones"), selected to align with previous surveys. These strata were:

1) Terrace to the Lakelse Confluence;

2) the Lakelse Confluence to the Exstew Confluence; and

3) the Exstew Confluence to the Kwinitsa boat launch.

The temporal scope of the full study was from June through September 2010. Survey schedules were designed to provide sufficient data to derive catch and efforts estimates for each month and for each river zone.

The study included creel analysis of all major local sport fish species, including all five salmon species and steelhead.

OBJECTIVES

The three objectives for this study were:

1) to provide monthly catch estimates for all salmon species caught in the sport fishery on the waters of the Skeena River downstream of Terrace;

2) to inspect as many Chinook and coho as possible and record the incidence of adipose fin clips such that awareness factors for the expansion of voluntary CWT head submissions may be developed; and

3) to collect DNA and age data from Chinook salmon.

These objectives were addressed by conducting effort counts and angler interviews throughout the lower Skeena recreational fishery from June through September 2010. The precision goal for the study was to estimate total Chinook catch within 25% of the true value 19 times out of 20. Creel survey strata included temporal separation by month, including week and weekend days. Spatial stratification was similar to past surveys, including three zones (described above). All local fishing areas accessed by bank and boat sport fishers along the Skeena River in these zones were included in our survey design.

Biological samples of DNA, scales and the incidence of adipose fin clips for Chinook and coho were obtained by examining all Chinook and coho observed during angler interviews. Scale samples were collected, stored in scale books and used for both age and DNA analysis.

METHODS

The study area spans a very large geographic area, making it unreasonable to obtain a complete and direct (interview-based) census of the entire catch. Therefore, our approach relied on statistical methods to estimate catch by the multiplication of angler effort estimates by catch per effort estimates, for each river stratum, month, day type (weekday vs. weekend), and species.

For each river stratum during each month, fishing effort was estimated by counting anglers during boat-based river-surveys; and catch per effort was estimated from interviews (see data forms in Appendix 1). Interviews were conducted during effort surveys, and additionally at known access points. During interviews, anglers were asked about their catch, effort, and fishing locations. They were also asked about their hourly fishing activity patterns on the current and previous day, and whether or not they were finished their fishing activity for the day.

Data collected during interviews included:

1) Angler effort – number of anglers, total fishing effort (in angler-hours), fishing location, access location, target species, and gear/bait used;

2) Angler activity – the hours during which angling activity was conducted on the day of the interview if the fishing trip was complete and on the previous day, if fishing occurred;

3) Fish kept – number of fish caught and kept, by river stratum and by species for the five main salmonids types: Chinook (with jacks tallied separately) salmon (*Oncorhynchus tshawytscha*), coho salmon (*Oncorhynchus kisutch*), sockeye salmon (*Oncorhynchus nerka*), pink salmon (*Oncorhynchus gorbuscha*), and steelhead (*Oncorhynchus mykiss*);

4) Fish released – number of fish caught and intentionally released, by species and by river stratum;

5) Whether or not the catch was verified and counted;

6) Whether or not the trip was guided by a professional;

7) Angler demographics – age and community of origin;

8) Angler access methods (shore vs. boat); and

9) Timestamp, including date, month, 'day type' (i.e., weekday vs. weekend/holiday) and time of day.

The analytical methods used were adapted from those developed and documented for the Georgia Strait Creel Survey (English et al. 2002). The methods used to estimate the

statistical precision associated with creel survey catch and effort estimates are based on those documented in English et al. (2002) and Blakley et al. (2003).

This procedure provides a statistically unbiased estimate of catch per effort, provided the anglers interviewed are representative of the entire fishery. To ensure this, the interview schedule was designed to capture data from representative fishermen in each river stratum, on both day types, and over all time periods of the day.

Shore-based interviewing locations are listed in Table 1. The locations surveyed were selected from all available access points, based on their geographical distribution and the amount of fishing activity that was assumed to be conducted from that site. Within each geographic region, the busiest (i.e., most accessible) access points were selected preferentially in order to obtain the maximum number of interviews. This approach was based on two important observations: 1) the variability in CPE (catch-per-effort) among fishing parties landing at a single access point tends to be as great as the variability in CPE among different access points within a geographic area; and 2) CPE and effort can vary substantially both within and between days at a single site (English et al. 2002). Under these conditions it is better to obtain a large number of interviews covering all temporal strata for a small number of sites than to sample a larger number of sites and obtain fewer interviews and less complete temporal coverage for any specific site. Nevertheless, these access-point interviews were supplemented with boat-based interviews collected opportunistically during the boat-based effort estimation surveys.

Sampling schedules were designed to ensure adequate coverage in all river strata, on both day types (Table 2). Detailed monthly survey schedules are provided in Appendix 2. Complete counts of anglers were conducted during peak fishing periods on most weekend days and usually on three of the five available weekdays each week. Angler interviews were to be conducted for a random sample of the anglers encountered during the roving effort surveys and additional survey effort was scheduled for each of the major angler access points. The roving surveys provided complete coverage of the fishing area, but the data collected was usually for incomplete fishing trips. Surveys at major access points provided more opportunities to interview anglers at the end of their daily fishing trips, especially if surveyors work PM shifts. In order to remove the known fishing effort biases associated with incomplete fishing trips, we used information of fishing activity for the previous day (yesterday line times) to derive fishing activity patterns and estimates of the average number of hours fished each day. Interview sampling sessions were to be separated into AM and PM shifts, with AM shifts occurring between 8:00 and 15:00 and PM shifts from 15:00 to 22:00. Surveyors were allocated 30 minutes at each end of the shift to access the local survey sites and one hour to access the more remote sites. In total, 262 shifts were scheduled (Table 2), including 68 roving boat surveys of the entire study area and 194 access point surveys.

Table 1. Location of seven shore-based access sites and twenty-eight common angler locations where anglers were counted and interviews conducted in 2010.

Zone #	Zone Name	Site #	Site Name	Access Point
1	**Ferry Island to Lakelse Confluence**	1	Upper Ferry Is.	X
		2	Lower Ferry Is.	X
		3	Power Line Bar	
		4	Cottonwoods	
		5	Hells Gate Bar	
		6	Kalum Boat Launch	X
		7	Alberta Bar	
		8	Kraut Bar	
		9	New Remo Bar	
		10	Old Remo Bar	
		11	Chicken Bar	
		12	Turd Island	
		13	Lakelse Confluence	
2	**Lakelse Confluence to Exstew Confluence**	14	Delta Bar	
		15	17 Mile Bar (Shames R. top)	
		16	18 Mile Bar (Shames R. botton	X
		17	Esker Bar	
		18	Shames Bar (Konaham)	
		19	Exstew Bar	
3	**Exstew Confluence to China Bar**	20	Camp Wanahoot	
		21	Gitnadoix Bar	
		22	28 Mile Bar (bottom of Andesite)	
		23	Andesite Bar (river right)	X
		24	Exchansiks Mouth (river left)	
		25	Salvus Bar (river right)	
		26	Kasiks River (Snowbound)	X
		27	China Bar	X

Table 2. Summary of scheduled sampling effort (number of interviewer shifts by shore-based survey site and for boat surveys) by month for AM and PM strata and weekend/holiday (WE) and weekday (WD) strata.

		Ferry Is.*	Kalum*	Andeside	China Bar	Snowbound	Zone 1	Zone 2	Zone 3	Boat Surveys	Total
Jun.	AM	4	7	3	3	3	7		9	8	24
	PM	4	7	3	2	3	7		8	7	22
Jul.	AM	8	8	4	6	3	8		13	10	31
	PM	8	8	2	6	5	8		13	9	30
Aug.	AM	7	7	3	2	3	7		8	9	24
	PM	8	8	3	4	4	8		11	9	28
Sep.	AM	8	8	0	8	0	8		8	8	24
	PM	8	8	0	8	0	8		8	8	24
Jun.	WE	2	8	3	2	1	8		6	8	22
	WD	6	6	3	3	5	6		11	7	24
Jul.	WE	9	9	2	6	1	9		9	10	28
	WD	7	7	4	6	7	7		17	9	33
Aug.	WE	8	8	2	2	2	8		6	9	23
	WD	7	7	4	4	5	7		13	9	29
Sep.	WE	6	6	0	6	0	6		6	6	18
	WD	10	10	0	10	0	10		10	10	30
Total		55	61	18	39	21	61	0	78	68	207

* Ferry Is. and Kalum survey sites were scheduled as split shifts for most days, so Zone 1 total is the maximum scheduled for these two sites.

Angler Activity Patterns

Two weighting factors were used together with the interview-derived angling activity data to estimate the daily fishing activity pattern (English et al. 2002).

The first weighting factor, $W1$, expanded the numbers of days spent interviewing in each river stratum, to account for the total number of days available for sampling. That is, it was assumed that the daily activity pattern recorded during the interview shifts in river stratum s, were consistent for river stratum s, even during the days when no interviews occurred. A specific $W1$ was calculated for each river stratum during each month and day type:

$$W1_{mds} = \frac{N_{md}}{K_{mds}} \qquad \text{(Eqn. 1)}$$

where N_{md} was the total number of type d days in month m; and K_{mds} was the number of days during which interviews occurred in river stratum s, on type d days during month m.

The second weighting factor, *W*2, expanded the numbers of interviews conducted, to account for the anglers that were *not* interviewed. That is, it was assumed that the activity pattern recorded during the interview shifts also held for those anglers that were not interviewed. A specific *W*2 was calculated for each surveying date (*k*) in each river stratum during each month and day type:

$$W2_{mdsk} = \frac{L_{mdsk}}{A_{mdsk}}, \qquad \text{(Eqn. 2)}$$

where L_{mdsk} was the number of anglers observed and A_{mdsk} was the number of anglers interviewed during surveying date *k*, in river stratum *s*, during day type *d*, and month *m*.

We used the term A_{mdskqt} to denote the number of anglers reporting activity during time-block *t*, that were part of the fishing party (*q*) that was interviewed on survey date *k*, in river stratum *s*, during month *m*, and on day type *d* (n_{mdskq} was used to denote the total number of anglers that were part of that fishing party). The two correction factors were applied, and the data were summed over survey dates and fishing parties (within month, day-type, stratum and time-block):

$$A'_{mdst} = W1_{mds} \cdot \sum_{k} \sum_{q} \left(W2_{mdsk} \cdot A_{mdskqt} \right). \qquad \text{(Eqn. 3)}$$

Summing the adjusted number of anglers over the 16 time-blocks gave:

$$T'_{mds} = \sum_{t} A'_{mdst} \,. \qquad \text{(Eqn. 4)}$$

The proportion of anglers (P_{mdst}) that were active during in each of 16 hourly time-blocks (*t*) was calculated for each month, day type and river stratum:

$$P_{mdst} = \frac{A'_{mdst}}{\left(W1_{mds} \cdot \sum_{k} \sum_{q} \left(W2_{mdsk} \cdot \right) n_{mdskq} \right)}. \qquad \text{(Eqn. 5)}$$

For this calculation, 'current day' activity was included only if the anglers said their trip was finished for the day. Regardless, 'prior day' activity was included in the analyses, being careful to assign the data to the correct temporal categories. For example, if an interview was conducted on a Monday, the 'prior day' activity data would be counted under day type = 'weekend'. It should be noted that the ratio of interviewed-to-not-interviewed anglers was not known for the day prior to the interview, thus *W2* weights were assigned a value of 1 when processing 'prior day' activity data.

Using this method, 24 unique angler activity patterns were to be estimated (i.e., 4 months × 2 day types × 3 river strata, see Figure 2 and Figure 3). To reliably describe angler activity, a relatively large number of anglers (~ 60) needed to be interviewed in each of the 24 blocks. In the end, some blocks contained too few interviews (Table 3), so it was decided to pool activity data over month and river stratum. The equation for angler activity was thus

$$P_{dt} = \frac{\sum_{m} \sum_{s} A'_{mdst}}{\sum_{m} \sum_{s} \left(W1_{mds} \cdot \sum_{k} \sum_{q} \left(W2_{mdsk} \cdot n_{mdskq} \right) \right)}, \qquad \text{(Eqn. 6)}$$

Table 3. The amount of data (number of anglers) available to estimate angler activity patterns, for all levels of each factor (data from 1 June to 30 September 2010).

		River Stratum			
Month	Day Type	One	Two	Three	Total
June	Weekday	116	21	29	166
	Weekend	178	21	68	267
July	Weekday	352	213	434	999
	Weekend	449	194	325	968
August	Weekday	136	52	139	327
	Weekend	47	56	105	208
September	Weekday	22	13	199	234
	Weekend	0	0	0	0
Total	Weekday	626	299	801	1726
	Weekend	674	271	498	1443

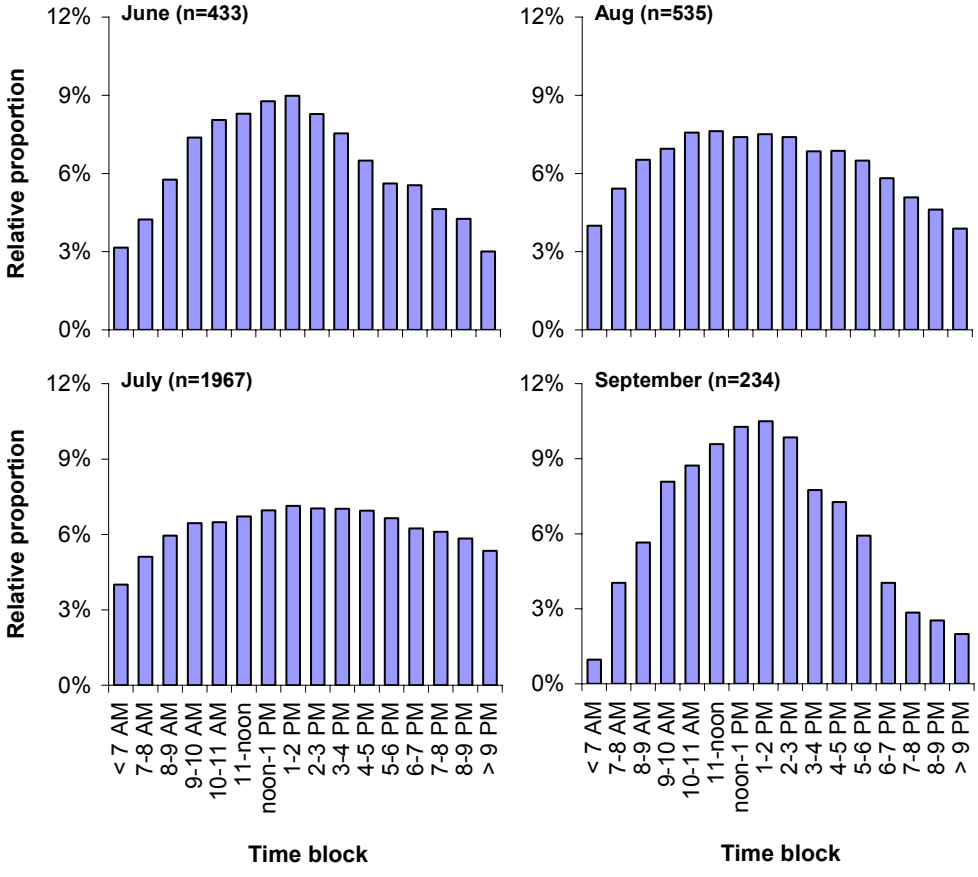

Figure 2. Angler activity patterns, by month, from interview data collected from 1 June to 30 September 2010.

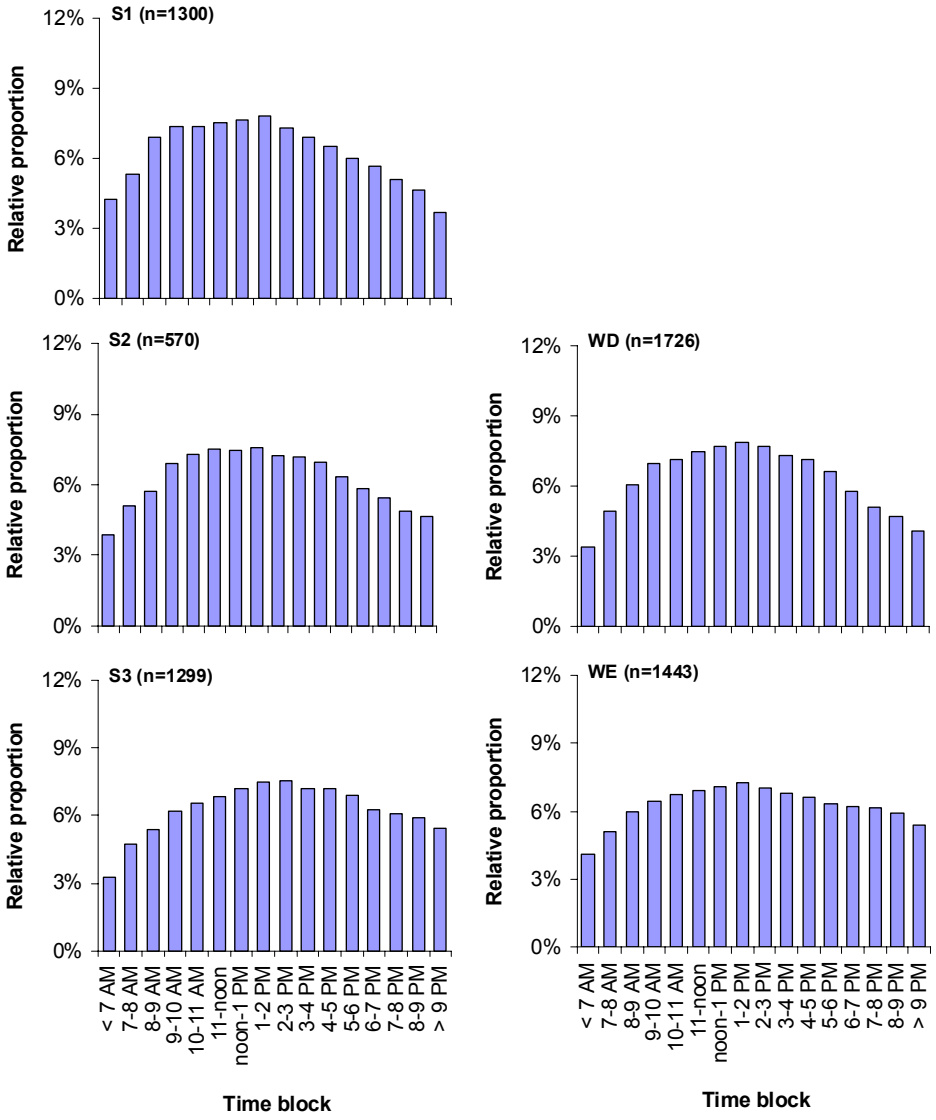

Figure 3. Angler activity patterns, by river stratum (left column) and day type (right column) from interview data collected from 1 June to 30 September 2010.

with its associated variance:

$$S^2_{P_{dt}} = \frac{(K_{dt})(1-K_{dt})}{\sum_m \sum_s \left(W1_{mds} \cdot \sum_k \sum_q \left(W2_{mdsk} \cdot n_{mdskq} \right) \right)}. \quad \text{(Eqn. 7)}$$

The average number of hours fished per angler (G_d) was calculated for each day-type using weighted observations:

$$G_d = \frac{\sum_m \sum_s \left(T'_{mds} \right)}{\sum_m \sum_s \left(W1_{mds} \cdot \sum_k \sum_q \left(W2_{mdsk} \cdot n_{mdskq} \right) \right)}, \quad \text{(Eqn. 8)}$$

but the variance was calculated from the raw interview data (rather than from the weighted values) using the standard formula.

Catch Per Effort Estimation

Catch per effort (and, similarly, harvest per effort) was estimated for each species of fish from interviews of anglers. For each interview (i), the month (m), and day type (d) was recorded, along with the catch (C) of each species (r), the number of anglers (A), and the number of hours spent fishing (H) in each river stratum (s). Using these data, catch per effort was calculated as:

$$CPE_{mdsri} = \frac{C_{mdsri}}{\left(A_{mdsi} \cdot H_{mdsi} \right)}. \quad \text{(Eqn. 9)}$$

Ideally, mean *CPE* would have been calculated for each month, river stratum, day-type and species. However, too few interviews were obtained to provide adequate sample size (n ~3) to reliably estimate *CPE* and its variance for each of the 24 blocks (Table 4). As *CPE* was *expected* to change with month, river stratum, and since no weekend data were collected in September, it was decided to pool interview data by day type.

In most cases, mean *CPE* was calculated by summing the catch for all n_{mds} interviews, pooling over day-type, and dividing by the total number of angler-hours of fishing effort recorded for these interviews:

$$\hat{CPE}_{msr} = \frac{\sum_d \sum_{i=1}^{n_{mds}} C_{mdsri}}{\sum_d \sum_{i=1}^{n_{mds}} \left(A_{mdsi} \cdot H_{mdsi} \right)}. \quad \text{(Eqn. 10)}$$

The variance for the estimate of mean catch per effort was calculated as:

$$S^2_{\hat{CPE}_{msr}} = \frac{\sum_{i=1}^{n_{mds}} (\hat{CPE}^2_{msri}) - \frac{\sum_{i=1}^{n_{mds}} (\hat{CPE}_{msri})^2}{n_{ms}}}{(n_{ms} - 1)}. \quad \text{(Eqn. 11)}$$

The CPE of fish that were harvested and that of fish that were released were calculated by repeating the creel analyses with released or harvested fish excluded from the interview database.

Table 4. The sample size of angler CPE data (i.e., the number of interviewed parties reporting catch and effort) for each river stratum, and for each month and day type (data from 1 June to 30 September 2010).

		River Stratum			
Month	Day Type	One	Two	Three	Total
June	Weekday	122	35	28	185
	Weekend	134	27	39	200
July	Weekday	235	90	232	557
	Weekend	308	113	161	582
August	Weekday	80	38	106	224
	Weekend	32	31	89	152
September	Weekday	24	11	158	193
	Weekend	0	0	0	0
Total	Weekday	461	174	524	1159
	Weekend	474	171	289	934

Angler Effort Estimation

To obtain statistically valid estimates of angler effort, anglers were counted during surveys conducted from a boat traveling through the study area. Table 2 shows the number of boat surveys scheduled for each month and day type. Each survey was supposed to cover the entire study area with the start and end times for angler counts recorded for each of the three spatial zones (Appendix 1). The initial schedule included surveys on every weekend day and usually three of the five weekdays each week.

During survey *o* (conducted during month *m* and on day type *d*), observers tallied the total number of anglers that were actively fishing at time *t* in sub-stratum *u* (within river stratum *s*), V_{mdosut}. These tallies were pooled by substratum. Since angling occurs over the course of the entire day, the number of anglers that were observed at the moment of the survey was divided by the proportion of average daily number of anglers active (P_{dt}) during the time block when the observations were recorded, and multiplied by the average number of hours fished per angler (G_d). These adjusted tallies were summed over the duration of the survey,

to calculate the total number of angler-hours of fishing on the day of the survey, by river stratum, B_{mdso}:

$$B_{mdso} = \sum_{t} \left(\frac{\sum_{u} V_{mdsout}}{P_{dt}} \cdot G_d \right) . \quad \text{(Eqn. 12)}$$

These estimates were then averaged over the number of surveys conducted, n_{mds}, as:

$$\hat{B}_{mds} = \frac{\sum_{o=1}^{n_{mds}} B_{mdso}}{n_{mds}} . \quad \text{(Eqn. 13)}$$

Total monthly fishing effort, was calculated for each day type and river stratum by multiplying the average daily effort by the number days of day type *d* that occurred in month *m*:

$$E_{mds} = \hat{B}_{mds} \cdot N_{md} . \quad \text{(Eqn. 14)}$$

The variance of B_{mdso} was calculated using the standard formulas for combining the variance of products and quotients of two independent random variables (Goodman 1960):

$$\begin{aligned} &\text{if } z = x/y,\ Var(z) = (y^{-2})Var(x) + (x^2 y^{-4})Var(y) \\ &\text{if } z = xy,\ Var(z) = (y^2)Var(x) + (x^2)Var(y) \end{aligned} . \quad \text{(Eqn. 15)}$$

Thus,

$$\begin{aligned} S^2_{V/P} &= (P_{dt}^{-2})S^2_V + (V^2 P_{dt}^{-4})S^2_{P_{dt}} \text{ and} \\ S^2_B &= (G^2)S^2_{V/P} + \left(\frac{V}{P_{dt}}\right)^2 S^2_G , \end{aligned} \quad \text{(Eqn. 16)}$$

where the variance of the observed angler counts S^2_V was calculated from the raw data as:

$$S^2_{V_{mds}} = \frac{\sum_{o=1}^{n_{mds}} V^2_{mdso} - \left(\frac{\sum_{o=1}^{n_{mds}} (V_{mdso})^2}{n_{mds}} \right)}{n_{mds} - 1} \cdot \left[\frac{N_{md} - n_{mds}}{N_{md} - 1} \right] . \quad \text{(Eqn. 17)}$$

The variance of the estimate of the total monthly fishing effort was:

$$S^2_{E_{mds}} = S^2_{\hat{B}_{mds}} \cdot N^2_{md} \quad \text{(Eqn. 18)}$$

The standard error of the estimate of the total monthly fishing effort, after pooling over day types, was:

$$S_{E_{ms}} = \sqrt{\sum_{d} \frac{S^2_{E_{mds}}}{n_{mds}}} \quad \text{(Eqn. 19)}$$

Catch Estimation

Total catch was calculated for each month, river stratum and species by multiplying total angling effort by catch per effort:

$$C_{msr} = \sum_{d} \left(E_{mds} \cdot \hat{CPE}_{msr} \right). \quad \text{(Eqn. 20)}$$

The standard errors for these catch estimates were derived using the Goodman (1960) equation:

$$S_{C_{msr}} = \sqrt{\sum_{d} \left(E_{mds}^2 \frac{S_{CPE_{msr}}^2}{n_{ms}} + CPE_{msr}^2 \frac{S_{E_{mds}}^2}{n_{mds}} + \frac{S_{CPE_{msr}}^2}{n_{msf}} \frac{S_{E_{mds}}^2}{n_{mds}} \right)}. \quad \text{(Eqn. 21)}$$

To estimate the number of fish that were harvested annually, and the annual number of fish that were released after capture, the creel analyses was repeated with released or harvested fish excluded from the interview database.

RESULTS

Angler Interviews

Over the four month study period, 5,121 anglers were surveyed during 2,094 interviews conducted during 128 survey shifts (Table 5, Appendix 2). Completed survey shifts represented 62% of the scheduled survey effort (100% of the scheduled boat surveys and 43% of the shore-based survey effort).

Table 5. Number of complete angler counts from boat surveys and interview shift by zone for each month and day type during the 2010 Skeena creel survey program.

		Shore-based Surveys								Shore-based Surveys		
		Ferry Island	Kalum	Kalum-Lakelse	Zone 1	Zone 2	Zone 3	Boat Surveys	Total[2]	Worked	Scheduled	% of Scheduled[1]
Jun.	MD[1]	7	7	0	7	0	2	18	27	9	31	29%
Jul.	MD	11	1	8	19	16	18	23	60	37	42	88%
Aug.	MD	3	0	2	5	6	8	14	27	13	34	38%
Sep.	MD	0	0	0	0	1	1	13	14	1	32	3%
Jun.	WE	4	4	0	4	0	1	8	13	5	14	36%
	WD	3	3	0	3	0	1	10	14	4	17	24%
Jul.	WE	5	0	4	9	7	8	10	27	17	18	94%
	WD	6	1	4	10	9	10	13	33	20	24	83%
Aug.	WE	1	0	0	1	0	3	4	8	4	14	29%
	WD	2	0	2	4	6	5	10	19	9	20	45%
Sep.	WE	0	0	0	0	0	0	0	0	0	12	0%
	WD	0	0	0	0	1	1	13	14	1	20	5%
Total		21	8	10	31	23	29	68	128	60	139	43%
% of Scheduled[2]		38%	13%		51%		37%	100%	62%			

[1] MD - mid-day from 8 am to 5 pm

[2] Zone 2 not included in total because Zone 1 and 3 shifts include Zone 2 coverage

Only 29% of the scheduled shore-based shifts for June were worked due to personnel and training issues. Shore-based coverage improved in July with 88% of the total scheduled effort worked but coverage of the Kalum boat launch was very poor (implications discussed below). Shore-based survey effort dropped to 38% in August because of mechanical problems with one of the Kitsumkalum fisheries vehicles. Concerns regarding project funding resulted in field crews being limited to boat-based surveys during mid-week days in September. These deficiencies were partially mitigated for by interviewing virtually every

angler encountered during the boat-based surveys. However, the crew inflexibility regarding survey timing resulted in virtually no interviews of anglers after 6 PM. Our use of fishing effort information from the pervious day (yesterday line-times) helped account for fishing effort that occurred after 6 PM. Of the 5,121 anglers interviewed, 3,087 (60.3%) anglers reported their previous-day's fishing activity. However, the lack of CPE estimates for trips that included evening fishing was definitely problematic. Information on yesterday line-times from interviews conducted between 8 AM and 6 PM indicated that fishing effort after 6 PM accounts for 20% of the daily fishing effort.

Angler Activity Patterns

As described in the Methods Section (above), low sample sizes required interview data to be pooled across months and river strata, resulting in sample sizes of 1,726 and 1,443 for weekday and weekend/holiday anglers, respectively. Angler activity patterns differed by day type (Figure 3): There was proportionally more angling activity during evening hours on weekend/holiday days, as compared to weeknights.

Catch Per Effort Estimates

In order to obtain adequate sample sizes for CPE estimation, interview data were pooled over day type. In all cases, the pooled number of interviews was >= 3 (Table 4). After pooling, CPE estimates were calculated for each species by month and river stratum (Table 6).

Month had a strong and statistically significant effect on CPE of Chinook, pink and steelhead (Table 7; $\chi^2_3 > 17.6$, $P > 0.001$). CPE of Chinook salmon was highest in June and July when Chinook retention was permitted in all areas and Chinook abundances in the lower river were highest. The July Chinook CPE estimates were likely biased low due to the poor coverage of the Kalum boat launch site and the tendency for boat-based anglers to have higher Chinook CPE than shore-based anglers. Fishers were not permitted to retain Chinook in the Ferry Island to Lakelse strata after 7 August, and increasing abundances of other salmon species resulted in low Chinook CPE for all strata in August. No Chinook were observed or reported caught in September. CPE of pink salmon and steelhead was highest in August, and lower in all other months. CPE of pink salmon and steelhead was zero in June.

Month also had an effect on CPE of coho and sockeye salmon (Table 7), though the effects were not statistically significant after adjusting α for the number of tests performed (i.e., using the Bonferroni adjustment). CPE of Coho was highest in August and September, very low in July, and was zero in June. CPE of sockeye salmon was highest in August, lower in July and September, and zero in June.

There was an effect of river stratum on CPE of sockeye salmon (Table 7), though the effects were not statistically significant after the Bonferroni adjustment ($\chi^2_2 = 7.7$, $P = 0.021$). CPE of sockeye salmon was higher in river reach between Ferry Island and Lakelse, as compared to the other surveyed areas.

Table 6. Catch per effort (CPE) estimates (fish per angler-hour) for six fish taxa, by month and river stratum. Variance in parentheses.

		Fish Species					
Month	River Stratum	Chinook	Coho	Sockeye	Pink	Steelhead	Other
June	Ferry Island to Lakelse	0.079 (0.024)	0	0	0	0	0.001 (0.000)
	Lakelse to Exstew	0.102 (0.020)	0	0	0	0	0
	Exstew to Kwinitsa	0.037 (0.007)	0	0	0	0	0.017 (0.180)
July	Ferry Island to Lakelse	0.041 (0.035)	0	0.012 (0.044)	0.001 (0.000)	0.002 (0.007)	0.000 (0.000)
	Lakelse to Exstew	0.038 (0.070)	0.000 (0.048)	0	0	0.007 (0.001)	0
	Exstew to Kwinitsa	0.025 (0.004)	0.001 (0.000)	0.000 (0.000)	0.002 (0.000)	0.011 (0.003)	0.001 (0.000)
August	Ferry Island to Lakelse	0.004 (0.003)	0.042 (0.019)	0.129 (0.076)	0.208 (0.397)	0.061 (0.016)	0.003 (0.001)
	Lakelse to Exstew	0.004 (0.000)	0.024 (0.006)	0.007 (0.015)	0.121 (0.564)	0.062 (0.015)	0
	Exstew to Kwinitsa	0.003 (0.000)	0.032 (0.011)	0.001 (0.000)	0.024 (0.004)	0.047 (0.016)	0.001 (0.000)
September	Ferry Island to Lakelse	0	0.036 (0.007)	0.024 (0.004)	0.012 (0.003)	0.012 (0.005)	0
	Lakelse to Exstew	0	0	0	0.013 (0.009)	0	0.025 (0.333)
	Exstew to Kwinitsa	0	0.050 (0.030)	0	0	0.013 (0.004)	0

Table 7. Statistical tests of the effect of month and river stratum on median catch per effort (CPE) estimates for the 6 taxa surveyed. *P*-values that are underlined are less than 0.05, but only those in bold are statistically significant after the Bonferroni adjustment.

	Month		River Stratum	
Species	χ_3^2	*P*	χ_2^2	*P*
Chinook	20.5	**0.000**	1.5	0.461
Coho	13.0	<u>0.005</u>	2.7	0.262
Pink	17.6	**0.001**	0.8	0.678
Sockeye	10.7	<u>0.014</u>	7.7	<u>0.021</u>
Steelhead	18.3	**0.000**	0.6	0.724
Other	0.5	0.915	2.2	0.339

The retention per effort rates (i.e., the proportion of total CPE that was harvested) are shown for each species by month and river stratum in Table 8. For the most part, retention per effort patterns were similar to those for total CPE, except that pink salmon and steelhead were infrequently kept.

Angler Effort Estimates

Over the 4 month study period, a total of 71 effort surveys were conducted on 68 separate days, including 49 on weekdays, and 22 on weekend/holidays (Appendix 3). The total angling effort was estimated for each month, day type and river stratum (Table 9).

Table 8. Retention per effort (CPE of harvested fish) rates for six fish taxa, by month and river stratum. Variance in parentheses.

		Fish Species					
Month	River Stratum	Chinook	Coho	Sockeye	Pink	Steelhead	Other
June	Ferry Island to Lakelse	0.059 (0.018)	0	0	0	0	0.001 (0.000)
	Lakelse to Exstew	0.080 (0.010)	0	0	0	0	0
	Exstew to Kwinitsa	0.037 (0.007)	0	0	0	0	0.014 (0.063)
July	Ferry Island to Lakelse	0.038 (0.035)	0	0.008 (0.015)	0.000 (0.000)	0	0.000 (0.000)
	Lakelse to Exstew	0.034 (0.023)	0	0	0	0	0
	Exstew to Kwinitsa	0.022 (0.003)	0.001 (0.000)	0.000 (0.000)	0.000 (0.000)	0.001 (0.000)	0.001 (0.000)
August	Ferry Island to Lakelse	0.003 (0.002)	0.026 (0.018)	0.092 (0.050)	0.006 (0.003)	0	0
	Lakelse to Exstew	0.004 (0.000)	0.022 (0.005)	0.004 (0.015)	0.009 (0.002)	0.002 (0.001)	0
	Exstew to Kwinitsa	0.002 (0.000)	0.020 (0.008)	0	0.004 (0.002)	0	0
September	Ferry Island to Lakelse	0	0.036 (0.007)	0.024 (0.004)	0	0	0
	Lakelse to Exstew	0	0	0	0	0	0.013 (0.083)
	Exstew to Kwinitsa	0	0.040 (0.010)	0	0	0	0

Table 9. Effort estimates (angler-hours per month), by month, day type and river stratum. Standard errors in parentheses.

		River Stratum			
Month	Day Type	Ferry Island to Lakelse	Lakelse to Exstew	Exstew to Kwinitsa	Total
June	Weekday	4,627 (2,033)	1,888 (879)	1,994 (963)	8,509 (2,415)
	Weekend	2,289 (817)	1,127 (421)	1,874 (758)	5,290 (1,191)
July	Weekday	11,343 (3,606)	4,543 (1,548)	13,033 (4,067)	28,919 (5,652)
	Weekend	9,575 (2,334)	3,451 (930)	6,157 (1,504)	19,183 (2,928)
August	Weekday	7,644 (2,541)	1,362 (519)	4,708 (1,781)	13,713 (3,147)
	Weekend	4,839 (3,663)	1,487 (1,061)	3,449 (2,737)	9,775 (4,695)
September	Weekday	2,553 (855)	646 (276)	7,506 (2,101)	10,704 (2,285)
	Weekend*	1,839 (616)	465 (199)	5,407 (1,514)	7,712 (1,646)
Overall Total		44,709 (6,651)	14,968 (2,392)	44,129 (6,138)	103,806 (9,361)

* estimated from September weekday effort, and the June-August ratio of weekend:weekday effort

There was a strong statistically significant effect of river stratum on angler effort (Table 10; $\chi^2_2 = 9.4$, $P = 0.009$). Significantly less angling effort occurred in the reach between Lakelse and Exstew (~15,000 angler hours) than in the other two strata (~44,000 angler hours in each). Total effort was strongly influenced by month (Table 10; $\chi^2_3 = 8.1$, $P = 0.045$), with 46% of the effort observed in July, but the effect was not statistically significant after adjusting α for the number of tests performed (i.e., using the Bonferroni adjustment). There was no statistically significant effect of day-type on angler effort ($\chi^2_1 = 1.0$, $P = 0.33$).

Table 10. Statistical tests of the effect of month, day type and river stratum on median effort estimates during the study period. *P*-values that are underlined are less than 0.05, but only those in bold are statistically significant after the Bonferroni adjustment.

Effect Test	χ^2	df	*P*
Month	8.1	3	0.045
Day Type	1.0	1	0.326
River Stratum	9.4	2	**0.009**

Catch Estimates

Estimates of total monthly catch (Table 11) were generated by calculating E × CPE, and then summing over day types. Pink salmon was the most abundantly caught fish (~ 3260 fish). Chinook salmon was the second most commonly caught species (~ 2,720 fish), followed by sockeye salmon (~ 2,000 fish), steelhead (~1,860 fish), and then coho salmon (~1,690 fish).

For no species did catch vary significantly with river stratum (Table 12; $\chi^2_3 < 3.7$, $P > 0.16$).

Chinook salmon catch was highest in July (60% of Chinook total catch, ~1,600 fish), lower in June (37% of total Chinook catch, ~1,000 fish), negligible in August and zero in September. ($\chi^2_3 = 9.6$, $P = 0.022$). For pink salmon, 96% of the total catch was observed in August (>3000 fish), with comparatively little catch in July and September, and none in June ($\chi^2_3 = 8.2$, $P = 0.042$). For steelhead, 71% of the total catch was observed in August (~1,300 fish), with comparatively little catch in July and September (200-300 fish), and none in June ($\chi^2_3 = 8.4$, $P = 0.039$). The monthly effects described for these three species were not statistically significant after the Bonferroni adjustment.

For coho salmon, 98% of the catches were made in August and September (vs. 2% in June and July). For sockeye salmon, 82% of the total catch was observed in August (vs. 13% in July, 5% in September). Nevertheless the data for these two species were variable enough that the monthly differences were not statistically significant, even prior to the Bonferroni adjustment.

Table 11. Estimated catch (harvest + release) of six fish taxa in three geographic strata, by month. Catches are rounded to the closest whole number. Standard errors in parentheses.

		Fish Species					
Month	River Stratum	Chinook	Coho	Sockeye	Pink	Steelhead	Other
June	Ferry Island to Lakelse	546 (75)	0	0	0	0	4 (5)
	Lakelse to Exstew	309 (51)	0	0	0	0	0
	Exstew to Kwinitsa	144 (32)	0	0	0	0	66 (144)
July	Ferry Island to Lakelse	851 (131)	0	242 (135)	15 (9)	49 (55)	5 (1)
	Lakelse to Exstew	305 (108)	3 (88)	0	0	58 (16)	0
	Exstew to Kwinitsa	473 (54)	24 (8)	9 (4)	39 (11)	218 (39)	15 (14)
August	Ferry Island to Lakelse	54 (46)	526 (149)	1615 (354)	2595 (695)	762 (164)	36 (26)
	Lakelse to Exstew	13 (4)	69 (24)	19 (31)	344 (202)	175 (46)	0
	Exstew to Kwinitsa	26 (9)	261 (65)	5 (1)	199 (45)	383 (87)	5 (6)
Sept	Ferry Island to Lakelse	0	158 (53)	105 (43)	53 (33)	53 (44)	0
	Lakelse to Exstew	0	0	0	14 (22)	0	28 (133)
	Exstew to Kwinitsa	0	649 (132)	0	0	164 (44)	0
Overall Total		2720 (208)	1690 (234)	1996 (383)	3259 (726)	1864 (213)	160 (198)

Table 12. Statistical tests of the effect of month and river stratum on median catch (harvest + release) estimates for six fish taxa surveyed. *P*-values that are underlined are less than 0.05, but only those in bold are statistically significant after the Bonferroni adjustment.

	Month		River Stratum	
Species	χ_3^2	*P*	χ_3^2	*P*
Chinook	9.6	<u>0.022</u>	0.7	0.690
Coho	6.4	0.093	1.5	0.475
Pink	8.2	<u>0.042</u>	0.8	0.675
Sockeye	4.9	0.178	3.7	0.158
Steelhead	8.4	<u>0.039</u>	1.1	0.575
Other	0.6	0.901	1.8	0.411

Harvest (Retention) Estimates

Estimates of total monthly harvest are shown in Table 13. Pink salmon, which was the most abundantly caught fish, was retained only 5% of the time (~ 150 fish harvested). Steelhead was the least frequently harvest species, with only 18 fish harvested (1% of total steelhead catch). The steelhead expansion estimate was based on 4 interviews where anglers had retained 5 steelhead, because they were unaware of the regulations or could not distinguish between steelhead and other species. Chinook salmon was the most harvested species (~ 2,350 fish harvested) and the species that was least likely to be released after capture (86% of total Chinook catch harvested). Sockeye and coho salmon were harvested 72-74% of the time.

The temporal and geographical pattern of harvest was similar to that of catch. Thus, the statistical effects of river stratum and month on harvest were similar to those on catch (Table 14).

Table 13. Estimated harvest of six fish taxa in three geographic strata, by month. Numbers are rounded to the closest whole number. Standard errors in parentheses.

		Fish Species					
Month	River Stratum	Chinook	Coho	Sockeye	Pink	Steelhead	Other
June	Ferry Island to Lakelse	406 (61)	0	0	0	0	4 (5)
	Lakelse to Exstew	242 (38)	0	0	0	0	0
	Exstew to Kwinitsa	144 (32)	0	0	0	0	54 (85)
July	Ferry Island to Lakelse	802 (128)	0	168 (79)	10 (6)	0	5 (1)
	Lakelse to Exstew	271 (63)	0	0	0	0	0
	Exstew to Kwinitsa	422 (51)	24 (8)	9 (4)	9 (4)	12 (5)	12 (14)
August	Ferry Island to Lakelse	36 (42)	327 (130)	1143 (270)	73 (53)	0	0
	Lakelse to Exstew	13 (4)	63 (21)	13 (31)	25 (11)	6 (6)	0
	Exstew to Kwinitsa	15 (4)	164 (49)	0	31 (20)	0	0
Sept	Ferry Island to Lakelse	0	158 (53)	105 (43)	0	0	0
	Lakelse to Exstew	0	0	0	0	0	14 (67)
	Exstew to Kwinitsa	0	511 (78)	0	0	0	0
Overall Total		2350 (176)	1246 (170)	1438 (286)	147 (58)	18 (8)	89 (109)

Table 14. Statistical tests of the effect of month and river stratum on median harvest estimates for six fish taxa surveyed. *P*-values that are underlined are less than 0.05, but only those in bold are statistically significant after the Bonferroni adjustment.

	Month		River Stratum	
Species	χ_3^2	*P*	χ_3^2	*P*
Chinook	10.1	<u>0.018</u>	0.5	0.776
Coho	6.6	0.085	2.2	0.336
Pink	9.5	<u>0.024</u>	0.6	0.733
Sockeye	3.2	0.359	4.4	0.114
Steelhead	2.2	0.530	1.1	0.573
Other	2.8	0.417	0.6	0.733

Bio-sampling

Scale samples were obtained from 378 (86%) of the 437 Chinook observed during angler interviews. Of these scales samples, 299 provided complete age data, 67 provided partial ages and 12 were not readable. Using the Gilbert-Rich convention, the three major age groups were: age 6_2 at 27.1%, 5_2 at 35.5% and 4_2 at 30.4%. The remainder of the Chinook samples were: age 3_2 at 3.0%, 5_1 at 1.7%, 3_1 at 1.3% and 7_2, 4_1 and 5_3 each at 0.3%.

DISCUSSION

Comparison of the catch and fishing effort estimates derived from the 2003 creel survey data with those derived for a similar period in 2010 revealed some substantial differences (Table 15). The total anger effort estimates for the June-August period in 2010 was 42% of the comparable effort estimate for 2003. Average Chinook CPE was similar to that observed in 2003, however, Chinook catch was likely underestimated due to deficiencies in the coverage of boat-based anglers in the Ferry Island to Lakelse stratum and evening fishing effort in all strata (discussed further below). Coho catch and CPE was much higher in 2010, as a result of a strong return for summer-run stocks. The sockeye and steelhead catches were similar in total but the spatial distribution of the catch was very different between the two years. The total catch of pink salmon in 2010 was only 16% of that estimates in 2003.

Table 15. Comparison of the catch and effort estimates for the 2003 and 2010 creel surveys for the same spatial strata and fishing periods.

			Fish Species				
Month	River Stratum	Angler-hours	Chinook	Coho	Sockeye	Pink	Steelhead
June-August 2010							
	Ferry Island to Lakelse	40,317	1,452	526	1,857	2,610	812
	Lakelse to Exstew	13,857	626	72	19	344	234
	Exstew to Kwinitsa	31,216	643	285	14	239	602
	Total	85,390	2,720	883	1,890	3,192	1,647
June-August 2003							
	Ferry Island to Lakelse	106,717	2,910	177	1,631	2,145	685
	Lakelse to Exstew	55,996	2,477	253	122	12,036	488
	Exstew to Kwinitsa	40,875	1,342	127	108	5,282	241
	Total	203,588	6,729	557	1,861	19,463	1,414
% of 2003 Estimates							
	Ferry Island to Lakelse	38%	50%	297%	114%	122%	118%
	Lakelse to Exstew	25%	25%	28%	15%	3%	48%
	Exstew to Kwinitsa	76%	48%	224%	13%	5%	250%
	Total	42%	40%	159%	102%	16%	116%

The 2010 estimates of angler effort and Chinook catch in the Ferry Island to Lakelse stratum were likely biased low because of deficiencies in the survey coverage of boat-based fishing effort. Samples from completed boat trips in this stratum were limited to the period between 17 June and 2 July. Chinook CPE for boat-based anglers were 4.3 times higher than those for shore-based anglers during this period. This combined with the complete lack of CPE data for anglers that landed after 7 PM has certainly resulted in an underestimate of the number of Chinook caught by boat-based anglers in the Ferry Island to Lakelse stratum. The reliance on CPE data from incomplete fishing trips could also result in an underestimation bias in Chinook CPE because the daily bag limit was 1 adult Chinook per angler and roving surveys were more likely to miss anglers or angler groups that had filled their bag limits quickly than those that were less successful and were still fishing when the survey crew arrived at their fishing site (Pollock et al. 1994).

While the estimate of angler effort was substantially lower in 2010 than 2003, this is consistent with the observed effort during the extensive on-water surveys conducted in both years. Based on the data presented in Tallman (2004), we estimate that the average number of anglers fishing each day during the 2003 study period was 2-3 times that observed in 2010. The average number of anglers observed fishing in 2010 over all strata was 103 anglers per day (Table 16) compared to 2003 when daily counts of shore-based frequently exceeded 250 anglers on a single day. Unfortunately, a precise estimate of the average number of anglers observed each day in 2003 cannot be readily derived from the Tallman (2004) report because activity patterns were not provided, and the reported average trip length (4.5 h), derived from their access point surveys, was likely biased low. If this value was correct, the average number of anglers fishing each day in 2003 would have been 595 for the 76 day study period to produce their effort estimate of 203,587 angler-hours. Data from 2010 revealed that the average trip length estimated from interviews for completed trips (5.0 h) was substantially shorter than that estimated from yesterday line times (8.7 h). If the average trip length in 2003 was similar to that in 2010, an average of 308 anglers per day would be required to produce the effort estimate reported in Tallman (2004). Angler counts were also conducted between 9 July and 1 August 2006 by the Kitsumkalum catch monitoring crew and the average of 18 complete counts of the study area was 276 anglers per day (Kitsumkalum Fisheries 2006). Therefore, it appears that the number of anglers participating in the lower Skeena recreational fishery in 2010 was substantially lower than in 2003 and 2006.

Table 16. Estimates of the average length of a fishing trip and average number of anglers fishing each day by river stratum and month in 2010.

Average trip length (h)	River Stratum			
Month	Ferry Island to Lakelse	Lakelse to Exstew	Exstew to Kwinitsa	Total
June	6.5	6.1	8.0	6.7
July	8.1	9.5	10.6	9.2
August	8.3	9.6	9.1	8.9
September	5.2	4.6	8.4	7.7
Overall Total	7.7	9.1	9.7	8.7

Average anglers/day	River Stratum			
Month	Ferry Island to Lakelse	Lakelse to Exstew	Exstew to Kwinitsa	Total
June	35	17	16	68
July	83	27	58	168
August	48	10	29	87
September	28	8	51	87
Average	49	16	39	103

Precision of the Results

Typical of creel surveys, this creel analysis produced estimates with a relatively low level of precision. The imprecision clouds statistical analyses, and reduces our ability to confidently draw strong conclusions from the results. For example, coho catch varied drastically among months, as would be expected based in its run-timing, yet variances were high enough to render the statistical test inconclusive. To understand the imprecision, it is important to know that the variance in the catch estimates result from two factors: 1) large variability in CPE; and 2) the sampling error. In the present study, both factors played important roles in generating uncertainty in the estimates, and each is discussed below.

When sample sizes are large, the main factor affecting the precision of the catch estimate is the variability in CPE. Catch rates tend to follow a negative binomial distribution, where most catches are of zero fish; and the larger the catch the rarer the event. If the fish were uniformly distributed and anglers had equal experience and ability, there would be considerably less variability in the CPE estimates. However, day-day changes in abundance of the target species, fishing effort and weather conditions typically results in a wide range of outcomes for each fishing event. This variability translates into wide confidence limits around the catch estimates for each species.

Sampling error is the other main source of estimation error. As with any sampling program, the confidence you have in your final estimate is greater when a larger proportion of population has been sampled. With catches expected to be widely variable, it follows that the precision of estimates drawn from a sample of small n would be low. One solution is to pool data among categories, but this is not ideal since we know *a priori* that catch rates differ among months and river strata. The other solution is to increase interviewing and survey effort. However, personnel and budget limitations restrict most recreational creel surveys to sample less than 20% of the total fishing effort.

Accuracy of the Results

The accuracy of our creel methodology is only as good as that of the data provided by the anglers to the interviewers. In this study, 72% of the 816 salmon and steelhead reported as kept during angler interviews were recorded as observed by the interviewer. However, it is likely that most of the reported catch was observed because most of the interviews were conducted at the fishing site and anglers tended to tether the fish close to the river bank until their fishing trip was complete. Incomplete data forms or misunderstandings associated with how to complete the data forms accounted for most of the remaining catch recorded on interview forms. For example: 122 of the kept fish were on data forms for which the "Catch Seen" field was blank; and 100 of the 103 kept fish on data forms with "N" in the "Catch Seen" field were attributable to the surveyor who initially thought that the "Catch Seen" field was related to biosampling Chinook for scales and thus entered "N" when fish were not sampled.

There were other concerns with regard to accuracy and completeness of the interview and effort survey data forms. Some of these problems were expected given that this was the first year that the surveyors had used these data forms and project funding for field supervision

was extremely limited. Interviewers completed their survey forms in interesting and inconsistent ways, and considerable effort was required to massage their data into a workable format. The most of these problems were resolved through meetings and telephone conversations with the surveyors to review data forms, fill in missing fields or discard interviews with unreliable information.

The major issues associated with the accuracy of the 2010 creel survey results were: 1) the poor coverage of boat-based anglers; and 2) the lack of adherence to the sampling schedule. The poor coverage of boat-based anglers was directly related to the surveyor's failure to work the scheduled shifts at the Kalum boat launch site after 2 July, and refusal to work evening shifts at the Ferry Island and Kalum boat launch sites. Apparently, a large portion of the daily boat-based fishing trips return to these boat launch sites after 6 PM, yet no interviews were conducted after 5 PM at the Kalum boat launch site.

RECOMMENDATIONS

The 2010 shore-based and on-water surveys produced a substantial amount of information on the magnitude, timing and location of angling effort and catches in the lower Skeena fishery. Detailed analysis of the 2010 data has revealed both strengths and weaknesses in the study design and implementation. The survey design included effective methods for obtaining estimates of fishing effort and CPE for the lower Skeena recreational fishery. If the initial survey schedule had been followed there would have been complete coverage of the study area through boat-based surveys and monitoring shifts at the major access points for anglers. The collection of information on yesterday line times was an effective method for determining daily fishing activity patterns from a fishery where a large portion of the anglers fish on sequential days. The on-water boat surveys provided complete counts of the number of anglers fishing at specific times and a substantial amount of CPE data from angler interviews on 56% of the days during the monitoring period. All the weaknesses with the 2010 study were associated with survey implementation. Survey schedules included both AM and PM shifts but survey crews preferred to work the same mid-day period (8 AM to 5 PM) thus angler interviews did not include CPE information for fishing that occurred after 6 PM. The initial budget for this project did not include sufficient funds to cover all the costs associated with project management, training, four months of data collection, vehicle and jet-boat rental, supervision of field crews as well as data management, analysis and reporting. Costs associated with project management and supervision of field crews were minimized by asking creel survey field crews to report to the supervisor responsible for the 2010 lower Skeena Chinook radio-tagging crew during the period when both studies overlapped (June through mid-July 2010). This approach was fairly effective once the initial problems associated with survey personnel were resolved in mid-June but the lack of daily supervision and data verification in the later half of the creel survey program resulted in significant divergence from the survey schedule and more incomplete data forms. Even during the period when the Chinook radio-tagging supervisor was on-site, supervision time for creel survey personnel was limited due the time and effort being expended to capture and radio-tag the desired number of Chinook. Consequently, most of our recommendations for improvements to the lower Skeena creel survey program are related to program supervision, training and implementation, specifically:

1. ensure that a local program supervisor is available to direct field survey crews and review the data collected on a daily basis for the first three weeks of the field program and on a weekly basis for the remainder of the study period.

2. hire individuals with previous creel survey experience and conduct a training course in May to explain the survey methods and reasons for the creel survey design and work schedule.

3. ensure field crews work the times and locations defined in the creel survey schedule which will include evening hours at all the key access sites (e.g., Kalum boat launch).

4. a larger portion of the survey effort should be allocated to access sites where anglers can be interviewed at the end of their daily fishing trip.

5. periodic trailer and vehicle counts should be conducted as a cross check for the boat survey angler counts and activity patterns from angler interviews.

6. information on yesterday's catch should be collected along with information on yesterday's line times so CPE estimates from incomplete trips, completed trips and yesterday's data can be compared.

7. each data form should be submitted d checked within 24 hours of collection to ensure that all data fields are complete and accurate.

8. all the data collected in a week should be entered into structured databases by the end of the following week and these data provided to the project analyst for verification.

9. catch and effort estimates should be stratified by shore-based and boat-based anglers, as initially planned for 2010, but which was not possible due to the limited coverage of boat-based fishing effort.

10. data analysis and reporting systems described in this report should be used to derive preliminary monthly estimates of catch and effort within 2 weeks of the end of each month.

11. The stratified catch and effort estimates from the proposed 2011 lower Skeena creel surveys should be used to estimate the magnitude of the underestimation bias associated with the 2010 estimates. These data can be used to produce a revised estimate for 2010 that accounts for this suspected bias.

ACKNOWLEDGEMENTS

We would like to thank William Bolan, Russ Bolton, and David Nelson who conducted the on-water angler counts, angler interviews and biosampling for this project and the many anglers that provided information on their catch and fishing effort. We also thank Steve Roberts and Jim Roberts for help with the administration of the project through the Kitsumkalum First Nation. We thank Elmar Plate, Jason Smith, Megan Mathews and Anita Blakley with LGL Limited for their assistance with training and periodic field supervision of field sampling efforts. We thank Anita Blakley, Lucia Ferreira, Dawn Keller, Joanne Dovey and Hannah English for their assistance with data entry and verification. We thank Mark Reagan, Ivan Winther and Dave Peacock with Fisheries and Oceans Canada for their assistance in initial planning for this project, and Ivan Winther for his constructive comments on the final report.

Funding for this project was provided through the Pacific Salmon Commission (PSC) Northern Endowment Fund. We thank Victor Keong for project oversight and administration on behalf of the PSC.

LITERATURE CITED

Blakley, A. C., J. McKenzie, T. Joe, K. K. English, and W. B. Griffiths. 2003. Yukon River drainage basin harvest study, 2002. Report prepared for the Yukon River Basin Harvest Study Steering Committee, Council of Yukon First Nations, and Fisheries and Oceans, Canada, Whitehorse, Yukon.

Bocking, R. C. and K. K. English. 1994. Nass River Sport Fishery Catch Monitoring Program, 1993. Report prepared for Nisga'a Tribal Council, New Aiyansh, BC. Nisga'a Fisheries Report No. NF93-04.

English, K. K., G. F. Searing, and D. A. Nagtegaal. 2002. Review of Georgia Strait recreational creel survey, 1983-1999. Canadian Technical Report of Fisheries and Aquatic Sciences 2414: 81 p.

Goodman, L. 1960. On the exact variance of products. Journal of the American Statistical Association 55: 708-713.

Kitsumkalum Fisheries. 2006. Sport Fishing Effort Count. Data report prepared by Kitsumkalum Fisheries, Terrace, BC. 7 p.

Pollock, K. H., C. M. Jones, and T. L. Brown. 1994. Angler survey methods and their applications in fisheries management. American Fisheries Society Special Publication 25.

Robichaud, D., M. Mathews, A. Blakley and R. Bocking. 2009. Peace River angling and recreational-use creel survey 2008-2009. Report prepared by LGL Limited, Sidney, B.C. for BC Hydro, Vancouver, B.C., November, 2009.

Tallman, D. C. 2004. Lower Skeena River Sport Fishery Survey Summary 2003. Report prepared by J.O. Thomas & Associates Ltd. for Fisheries and Oceans Canada, Prince Rupert BC. 66 p. plus appendices.

APPENDICES

Appendix 1. Data forms

Lower Skeena River Creel Survey 2010 Form:

Surveyor: Zone #: Year 2010

Location of Int: Date:

Day Type: Time:

Anglers (Lines) in Today's Party:

Residence: Skeena Watershed B.C. Rest of Canada U.S. Other

Type of Fishing: Boat Shore Guided: Y / N

Method: Botton Bouncing Fly Casting Spin Casting Still Fishing Other

Gear Type: Spin+Glow SG+Bait Fly Spoon Spinners Wool Bait Other

Times lines were in the water ** TODAY

	Before 7		10 - 10:59		2 - 2:59		6 - 6:59
	7 - 7:59		11 - 11:59		3 - 3:59		7 - 7:59
	8 - 8:59		12 - 12:59		4 - 4:59		8 - 8:59
	9 - 9:59		1 - 1:59		5 - 5:59		After 9

	Site 1	Site 2	Site 3
Zone Fished:			
River Location Fished:			
Hours Fished:			

Today's Catch:	Kept	Rel.	Kept	Rel.	Kept	Rel.
Chinook						
Coho						
Sockeye						
Pink						
Steelhead						
Other						

Target Species: CN CO SK PK STHD

Completed Trip? : Y or N Catch seen? : Y or N or N/A

Times lines were in the water ** YESTERDAY Yesterday's Zone:

	Before 7		10 - 10:59		2 - 2:59		6 - 6:59
	7 - 7:59		11 - 11:59		3 - 3:59		7 - 7:59
	8 - 8:59		12 - 12:59		4 - 4:59		8 - 8:59
	9 - 9:59		1 - 1:59		5 - 5:59		After 9

Do you plan to fish tomorrow? Y / N

Comments:

Lower Skeena River Angling Effort Survey Form - 2010

Surveyor (s): _____ **Form #:** _____

Weather _____

Date: _____ * Be sure to record the number of anglers separately:

	Shore Anglers		Boat Anglers		Total	Start	End
	Total	Int.	Total	Int.	Boats	Time	Time
(Zone 1) - Ferry Island to Lakelse Confluence							
Upper Ferry Is.							
Lower Ferry Is.							
Power Line Bar							
Cottonwoods							
Hells Gate Bar							
Alberta Bar							
Kraut Bar							
New Remo Bar							
Old Remo Bar							
Chicken Bar							
Turd Island							
Lakelse Confluence							
(Zone 2) - Lakelse Confluence to Exstew Confluence							
Delta Bar							
17 Mile Bar (Shames R. top)							
18 Mile Bar (Shames R. bottom)							
Esker Bar							
Shames Bar (Konaham)							
Exstew Bar							
(Zone 3) - Exstew Confluence to China Bar							
Camp Wanahoot							
Gitnadoix Bar							
28 Mile Bar (bottom of Andesite)							
Andesite Bar (river right)							
Exchansiks Mouth (river left)							
Salvus Bar (river right)							
Kasiks River							
China Bar							

Comments: _____

Lower Skeena River Creel Survey - Daily Tally Form Date: _____

Surveyor: _____

Landing site: _____ Survey Period: Start: _____ End: _____

Interview Location 1: Boats Landing

Completed Interviews	Not Interviewed		Completed Interviews	Not Interviewed		Completed Interviews	Not Interviewed		Completed Interviews	Not Interviewed	
		Before 7			10 - 10:59			2 - 2:59			6 - 6:59
		7 - 7:59			11 - 11:59			3 - 3:59			7 - 7:59
		8 - 8:59			12 - 12:59			4 - 4:59			8 - 8:59
		9 - 9:59			1 - 1:59			5 - 5:59			After 9

Comments: _____

Landing site: _____ Survey Period: Start: _____ End: _____

Interview Location 2: Boats Landing

Completed Interviews	Not Interviewed		Completed Interviews	Not Interviewed		Completed Interviews	Not Interviewed		Completed Interviews	Not Interviewed	
		Before 7			10 - 10:59			2 - 2:59			6 - 6:59
		7 - 7:59			11 - 11:59			3 - 3:59			7 - 7:59
		8 - 8:59			12 - 12:59			4 - 4:59			8 - 8:59
		9 - 9:59			1 - 1:59			5 - 5:59			After 9

Comments: _____

Appendix 2. Proposed survey schedule and actual shifts worked.

Appendix Table 2-1. June Lower Skeena Creel Schedule - proposed versus actual.

JUNE - Proposed														JUNE - Actual													
Date	Day	AM	PM	BS	F	K	A	C	S	Mgr	WB	RB	DH	Date	Day	MD	BS	F	K	Z1	Z2	Z3	Mgr	WB	RB	DH	DN
1	**T**													**1**	**T**												
2	**W**	**X**			**A**					EP	O		F	**2**	**W**								EP				
3	**Th**	**X**		**D**		**A**		**A**		EP	B	B	C	**3**	**Th**								EP				
4	**F**		**X**		**P**	**P**				EP	F		K	**4**	**F**								EP				
5	**Sa**	**X**		**D**		**A**	**A**			EP	B	B	A	**5**	**Sa**	**X**	**D**						EP	B	B		
6	**Su**		**X**	**U**		**P**			**P**	JS	B	B	S	**6**	**Su**	**X**	**D**						JS	B	B		
7	**M**									JS				**7**	**M**								JS				
8	**T**	**X**		**U**			**A**			JS	B	B	A	**8**	**T**	**X**	**D**						JS	B	B		
9	**W**		**X**		**P**					JS	F			**9**	**W**	**X**	**D**						JS	B	B		
10	**Th**		**X**						**P**	JS	B	B	S	**10**	**Th**	**X**	**D**						JS	B	B		
11	**F**		**X**		**P**					JS			F	**11**	**F**								JS				
12	**Sa**		**X**	**D**		**P**	**P**			JS	B	B	A	**12**	**Sa**	**X**	**D**						JS	B	B		
13	**Su**		**X**	**U**		**P**		**P**		JS	B	B	C	**13**	**Su**	**X**	**D**						JS	B			
14	**M**	**X**				**A**				JS				**14**	**M**								JS				
15	**T**									JS				**15**	**T**								JS				
16	**W**	**X**			**A**	**A**			**A**		F		S	**16**	**W**	**X**	**D**							B	B		
17	**Th**		**X**	**D**			**P**				B	B	A	**17**	**Th**	**X**	**D**							B	B		B
18	**F**	**X**		**D**					**A**		B	B	S	**18**	**F**	**X**	**D**							B	B		
19	**Sa**		**X**	**U**		**P**		**P**		EP	B	B	C	**19**	**Sa**	**X**	**D**	**X**	**X**				EP	B	B		FK
20	**Su**	**X**		**D**	**A**	**A**				EP	B	B	F	**20**	**Su**	**X**	**D**	**X**	**X**			**X**	EP	B	B		FK and zone 3
21	**M**									EP				**21**	**M**								EP				
22	**T**									EP				**22**	**T**								EP	O			O
23	**W**	**X**			**A**				**A**	EP	F		S	**23**	**W**	**X**	**D**	**X**	**X**			**X**	EP	B	B		FK and zone 3
24	**Th**	**X**						**A**		EP	B	B	C	**24**	**Th**	**X**	**D**	**X**	**X**				EP	B	B		FK
25	**F**		**X**			**P**	**P**		**P**	EP	A		S	**25**	**F**	**X**	**D**	**X**	**X**				EP	B	B		FK
26	**Sa**		**X**	**U**	**P**	**P**				EP	B	B	F	**26**	**Sa**	**X**	**D**	**X**	**X**				EP	B	B		FK
27	**Su**	**X**		**D**		**A**	**A**			EP	B	B	A	**27**	**Su**	**X**	**D**	**X**	**X**				EP	B	B		FK
28	**M**									EP				**28**	**M**								EP				
29	**T**									EP				**29**	**T**								EP				
30	**W**	**X**				**A**		**A**		EP	B	B	C	**30**	**W**	**X**	**D**						EP	B	B		
	AM	11		5	4	7	3	3	3						MD	18	18	0	7	7	0	0	2	26	19	17	0	9
	PM		11	7	4	7	3	2	3		21	15	21														

Shift Type (O=Office, B=Boat Survey, A=AM shift, P=PM shift, MD=mid-day shifts from 8 AM to 5 PM)

Boat Survey Direction (U=Upstream, D=Downstream)

Personnel (EP=Elmar Plate, JS=Jason Smith, JR=Jim Roberts, WB= William Bolan, RB=Russ Bolton, DN=David Nelson, DH=Duane Horner)

Angler Access Sites (F=Ferry Island, K=Kalum launch ramp, A=Andesite, C=China Bar, S=Snowbound, Z1= Zone 1; Z2 = Zone 2; Z3 = Zone 3)

Appendix Table 2-2. July Lower Skeena Creel Schedule - proposed versus actual.

JULY - proposed															JULY-actual														
Date	Day	AM	PM	BS	F	K	A	C	S	Mgr	WB	RB	DH	DN	Date	Day	MD	BS	F	K	Z1	Z2	Z3	Mgr	WB	RB	DH	DN
1	**Th**	**X**		**D**	**A**	**A**				EP	B	B		FK	**1**	**Th**	**X**	**D**	**X**					EP	B	B		F
2	**F**		**X**		**P**	**P**				EP	B	B		FK	**2**	**F**	**X**	**D**	**X**	**X**			**X**	EP	B	B	KC	FK and zone 3
3	**Sa**	**X**		**D**	**A**	**A**		**A**		EP	B	B	C	FK	**3**	**Sa**	**X**	**D**	**X**				**X**	EP	B	B	C	F and zone 3
4	**Su**		**X**	**D**	**P**	**P**		**P**		EP	B	B		FK	**4**	**Su**	**X**	**D**	**X**				**X**	EP	B	B		FC
5	**M**		**X**												**5**	**M**												
6	**T**		**X**						**P**	EP			K		**6**	**T**								EP				
7	**W**	**X**		**D**	**A**	**A**				EP	B	B		FK	**7**	**W**	**X**	**D**			**X**	**X**	**X**	EP	B	B	C	all three zones
8	**Th**	**X**			**A**	**A**	**A**	**A**		EP	FK	FK	C	A	**8**	**Th**	**X**	**D**	**X**			**X**		EP	B	B	C	Ferry Island/18 mile
9	**F**		**X**						**P**	EP	B	B		S	**9**	**F**	**X**	**D**	**X**					EP	B	B	C	F
10	**Sa**		**X**	**D**	**P**	**P**				EP	B	B	K	FK	**10**	**Sa**	**X**	**D**			**X**	**X**	**X**	EP	B	B		all three zones
11	**Su**	**X**		**D**	**A**	**A**			**A**	EP	B	B		FK	**11**	**Su**	**X**	**D**			**X**	**X**	**X**	EP	B	B		all three zones
12	**M**	**X**													**12**	**M**												
13	**T**		**X**					**P**		EP					**13**	**T**								EP				
14	**W**	**X**						**A**					C		**14**	**W**	**X**						**X**				C	
15	**Th**		**X**	**D**	**P**	**P**	**P**			EP	B	B		FK	**15**	**Th**	**X**	**D**	**X**			**X**	**X**	EP	B	B		F/18 mile/C
16	**F**	**X**		**D**					**A**	EP	B	B	K	S	**16**	**F**	**X**	**D**	**X**			**X**	**X**	EP	B	B		F/18 mile/C
17	**Sa**		**X**	**D**	**P**	**P**		**P**		EP	B	B	C	FK	**17**	**Sa**	**X**	**D**				**X**	**X**	EP	B	B		F/18 mile/C
18	**Su**	**X**		**D**	**A**	**A**	**A**	**A**		EP	C			FK	**18**	**Su**	**X**	**D**	**X**			**X**	**X**	EP	B			F/18 mile/C
19	**M**		**X**				**P**				B	B		A	**19**	**M**	**X**	**D**			**X**	**X**	**X**		B	B		all three zones
20	**T**														**20**	**T**												
21	**W**		**X**						**P**		B	B		S	**21**	**W**	**X**	**D**	**X**			**X**	**X**		B	B		F/18 mile/C
22	**Th**		**X**		**P**	**P**		**P**			B	B	C	FK	**22**	**Th**	**X**	**D**			**X**	**X**	**X**		B	B		all three zones
23	**F**		**X**		**P**	**P**		**P**	**P**		FK	FK		C	**23**	**F**	**X**	**D**			**X**	**X**			B	B		zone 1 and 2
24	**Sa**		**X**	**D**				**P**			B	B		C	**24**	**Sa**	**X**	**D**	**X**			**X**	**X**		B	B		F/18 mile/C
25	**Su**	**X**		**D**	**A**	**A**	**A**	**A**			B	B	C	FK	**25**	**Su**	**X**	**D**			**X**	**X**	**X**		B	B		all three zones
26	**M**														**26**	**M**												
27	**T**		**X**						**P**						**27**	**T**												
28	**W**	**X**									B	B			**28**	**W**	**X**	**D**							B	B		
29	**Th**	**X**		**D**			**A**	**A**	**A**		KF	KF	C	S	**29**	**Th**	**X**	**D**					**X**		B	B		C
30	**F**		**X**		**P**	**P**					B	B		FK	**30**	**F**	**X**	**D**				**X**	**X**		B	B		18 mile/C
31	**Sa**	**X**		**D**	**A**	**A**					B	B	K	FK	**31**	**Sa**	**X**	**D**			**X**	**X**			B	B		zone 1 and 2
	AM	13		0	8	8	4	6	3							MD	24	23	11	1	8	16	18	15	23	22	6	22
	PM		16	14	8	8	2	6	5	15	23	22	11	22														

Shift Type (O=Office, B=Boat Survey, A=AM shift, P=PM shift, MD=mid-day shifts from 8 AM to 5 PM)
Boat Survey Direction (U=Upstream, D=Downstream)
Personnel (EP=Elmar Plate, JS=Jason Smith, JR=Jim Roberts, WB= William Bolan, RB=Russ Bolton, DN=David Nelson, DH=Duane Horner)
Angler Access Sites (F=Ferry Island, K=Kalum launch ramp, A=Andesite, C=China Bar, S=Snowbound, Z1= Zone 1; Z2 = Zone 2; Z3 = Zone 3)

Appendix Table 2-3. August Lower Skeena Creel Schedule - proposed versus actual.

AUGUST - proposed														AUGUST-actual												
Date	Day	AM	PM	BS	F	K	A	C	S	Mgr	WB	RB	DN	Date	Day	MD	BS	F	K	Z1	Z2	Z3	Mgr	WB	RB	DN
1	**Su**		**X**	**D**	**P**	**P**			**P**		B	B	FK	**1**	**Su**	**X**					**X**	**X**		zone 2 and 3		
2	**M**													**2**	**M**											
3	**T**		**X**				**P**							**3**	**T**											
4	**W**	**X**			**A**	**A**					B	B	FK	**4**	**W**	**X**	**D**							B	B	B
5	**Th**		**X**				**P**		**P**		B	B	A	**5**	**Th**	**X**	**D**							B	B	B
6	**F**	**X**							**A**		B	B	S	**6**	**F**	**X**				**X**	**X**	**X**		all three zones		
7	**Sa**	**X**		**D**	**A**	**A**					B	B	FK	**7**	**Sa**	**X**					**X**			18 mile		
8	**Su**		**X**	**D**	**P**	**P**		**P**			B	B	FK	**8**	**Su**	**X**	**D**							B	B	
9	**M**	**X**												**9**	**M**											
10	**T**		**X**						**P**					**10**	**T**	**X**	**D**									B
11	**W**	**X**			**A**	**A**					A	A	FK	**11**	**W**	**X**	**D**			**X**	**X**	**X**		zone 2 and 3		B
12	**Th**		**X**	**D**			**P**		**P**		B	B	S	**12**	**Th**	**X**					**X**	**X**		zone 2 and 3		
13	**F**	**X**		**D**	**A**	**A**					B	B	FK	**13**	**F**	**X**	**D**							B	B	B
14	**Sa**		**X**	**D**	**P**	**P**					B	B	FK	**14**	**Sa**	**X**					**X**	**X**		zone 2 and 3		
15	**Su**	**X**		**D**			**A**	**A**			B	B	A	**15**	**Su**	**X**	**D**							B	B	
16	**M**													**16**	**M**											
17	**T**		**X**					**P**						**17**	**T**											
18	**W**		**X**					**P**			S	S	C	**18**	**W**	**X**	**D**							B	B	B
19	**Th**	**X**			**A**	**A**	**A**				B	B	FK	**19**	**Th**	**X**	**D**							B	B	B
20	**F**		**X**		**P**	**P**		**P**			FK	FK	C	**20**	**F**	**X**	**D**							B	B	B
21	**Sa**		**X**	**D**	**P**	**P**					B	B	FK	**21**	**Sa**	**X**	**D**							B	B	B
22	**Su**	**X**		**D**	**A**	**A**			**A**		B	B	FK	**22**	**Su**	**X**	**D**							B	B	B
23	**M**													**23**	**M**											
24	**T**													**24**	**T**	**X**		**X**				**X**				FC
25	**W**		**X**		**P**	**P**					B	B	FK	**25**	**W**	**X**	**D**							B	B	
26	**Th**	**X**		**D**				**A**	**A**		B	B	S	**26**	**Th**	**X**	**D**	**X**				**X**	B			FC
27	**F**		**X**		**P**	**P**					B	B	FK	**27**	**F**											
28	**Sa**	**X**		**D**	**A**	**A**	**A**				B	B	FK	**28**	**Sa**	**X**		**X**				**X**				FC
29	**Su**		**X**		**P**	**P**					B	B	FK	**29**	**Su**											
30	**M**													**30**	**M**											
31	**T**													**31**	**T**											
	AM	11		0	7	7	3	2	3						MD	21	14	3	0	2	6	8	1	17	11	13
	PM		14	11	8	8	3	4	4	0	21	21	21													

Shift Type (O=Office, B=Boat Survey, A=AM shift, P=PM shift, MD=mid-day shifts from 8 AM to 5 PM)
Boat Survey Direction (U=Upstream, D=Downstream)
Personnel (EP=Elmar Plate, JS=Jason Smith, JR=Jim Roberts, WB= William Bolan, RB=Russ Bolton, DN=David Nelson, DH=Duane Horner)
Angler Access Sites (F=Ferry Island, K=Kalum launch ramp, A=Andesite, C=China Bar, S=Snowbound, Z1= Zone 1; Z2 = Zone 2; Z3 = Zone 3)

Appendix Table 2-4. September Lower Skeena Creel Schedule - proposed versus actual.

SEPTEMBER-proposed													SEPTEMBER-actual										
Date	**Day**	AM	PM	BS	F	K	A	C	S	WB	RB	DN	**Date**	**Day**	MD	BS	F	K	Z1	Z2	Z3	WB	RB	DN
1	W		**X**	**D**	**P**	**P**		**P**		B	B	FK	**1**	W	**X**	**D**						B	B	B
2	**Th**	**X**		**D**	**A**	**A**		**A**		B	B	FK	**2**	**Th**	**X**	**D**				**X**	**X**	B	B	zone 2 and 3
3	**F**		**X**	**D**	**P**	**P**		**P**		B	B	FK	**3**	**F**	**X**	**D**						B	B	B
4	**Sa**	**X**		**D**	**A**	**A**		**A**		B	B	FK	**4**	**Sa**										
5	**Su**												**5**	**Su**										
6	**M**												**6**	**M**										
7	**T**												**7**	**T**										
8	**W**		**X**	**D**	**P**	**P**		**P**		B	B	FK	**8**	**W**	**X**	**D**						B	B	
9	**Th**	**X**		**D**	**A**	**A**		**A**		B	B	FK	**9**	**Th**										
10	**F**		**X**	**D**	**P**	**P**		**P**		B	B	FK	**10**	**F**	**X**	**D**						B	B	B
11	**Sa**												**11**	**Sa**										
12	**Su**	**X**		**D**	**A**	**A**		**A**		B	B	FK	**12**	**Su**										
13	**M**		**X**	**D**	**P**	**P**		**P**		B	B	FK	**13**	**M**										
14	**T**	**X**		**D**	**A**	**A**		**A**		B	B	FK	**14**	**T**	**X**	**D**						B	B	B
15	**W**												**15**	**W**	**X**	**D**						B	B	B
16	**Th**												**16**	**Th**	**X**	**D**						B	B	B
17	**F**		**X**	**D**	**P**	**P**		**P**		B	B	FK	**17**	**F**	**X**	**D**						B	B	B
18	**Sa**	**X**		**D**	**A**	**A**		**A**		B	B	FK	**18**	**Sa**										
19	**Su**		**X**	**D**	**P**	**P**		**P**		B	B	FK	**19**	**Su**										
20	**M**												**20**	**M**	**X**	**D**						B	B	B
21	**T**												**21**	**T**	**X**	**D**						B	B	B
22	**W**												**22**	**W**	**X**	**D**						B	B	B
23	**Th**	**X**		**D**	**A**	**A**		**A**		B	B	FK	**23**	**Th**	**X**	**D**						B	B	B
24	**F**		**X**	**D**	**P**	**P**		**P**		B	B	FK	**24**	**F**										
25	**Sa**	**X**		**D**	**A**	**A**		**A**		B	B	FK	**25**	**Sa**										
26	**Su**												**26**	**Su**										
27	**M**												**27**	**M**										
28	**T**												**28**	**T**										
29	**W**												**29**	**W**										
30	**Th**												**30**	**Th**										
	AM	8		0	8	8	0	8	0					MD	13	13	0	0	0	1	1	13	13	12
	PM		8	16	0 8	8	0	8	0	16	16	16												

Shift Type (O=Office, B=Boat Survey, A=AM shift, P=PM shift, MD=mid-day shifts from 8 AM to 5 PM)
Boat Survey Direction (U=Upstream, D=Downstream)
Personnel (EP=Elmar Plate, JS=Jason Smith, JR=Jim Roberts, WB= William Bolan, RB=Russ Bolton, DN=David Nelson, DH=Duane Horner)
Angler Access Sites (F=Ferry Island, K=Kalum launch ramp, A=Andesite, C=China Bar, S=Snowbound, Z1= Zone 1; Z2 = Zone 2; Z3 = Zone 3)

Appendix 3 Boat-based angler counts and survey times for each survey day.

Day		Zone 1		Zone 2		Zone 3		Angler Counts			
Type	DATE	Start	End	Start	End	Start	End	Zone 1	Zone 2	Zone 3	Total
WE	5 Jun 2010	8:30	9:00	9:00	10:00	10:00	11:40	2	0	4	6
WE	6 Jun 2010	8:15	9:30	9:30	11:00	11:00	15:00	4	0	9	13
WD	8 Jun 2010	9:20	11:00	11:00	12:00	12:00	13:00	11	3	2	16
WD	9 Jun 2010	12:50	15:00	12:00	12:50	9:00	12:00	0	2	2	4
WD	10 Jun 2010	12:00	13:00	13:00	14:00	14:00	14:45	3	0	0	3
WE	12 Jun 2010	10:30	12:25	12:25	13:00	13:00	14:15	13	0	4	17
WE	13 Jun 2010	11:00	16:15	12:00	13:00	15:20	15:30	9	0	3	12
WD	16 Jun 2010	8:35	10:15	10:15	11:15	11:15	12:10	7	2	1	10
WD	17 Jun 2010	9:15	14:35	14:35	15:20	15:20	18:00	10	4	2	16
WD	18 Jun 2010	8:20	13:30	14:00	14:30	14:30	15:00	43	0	4	47
WE	19 Jun 2010	12:45	15:50	15:50	16:45	16:45	17:40	34	14	0	48
WE	20 Jun 2010	8:45	10:15	10:15	11:50	11:50	14:00	15	18	19	52
WD	23 Jun 2010	8:30	12:48	12:48	14:00	14:00	16:50	23	10	11	44
WD	24 Jun 2010	9:10	11:45	11:45	13:15	13:15	15:00	23	13	12	48
WD	25 Jun 2010	11:35	13:10	13:10	14:45	14:45	17:00	14	15	20	49
WE	26 Jun 2010	10:30	15:35	15:35	17:00	17:00	18:08	68	17	26	111
WE	27 Jun 2010	8:30	10:05	10:05	12:00	12:00	15:00	15	28	66	109
WD	30 Jun 2010	11:40	13:30	13:30	14:45	15:38	17:55	21	18	13	52
WE	1 Jul 2010	8:45	11:40	11:40	13:45	13:45	17:00	51	35	42	128
WD	2 Jul 2010	9:30	14:00	14:00	15:40	15:40	17:45	66	45	82	193
WE	3 Jul 2010	7:30	11:25	11:25	13:20	13:20	15:00	48	45	50	143
WE	4 Jul 2010	10:45	13:40	13:40	14:15	14:15	16:15	51	7	41	99
WD	7 Jul 2010	8:55	11:30	11:30	13:30	13:30	17:00	33	23	77	133
WD	8 Jul 2010	7:30	10:00	10:00	10:30	10:30	12:55	21	5	59	85
WD	9 Jul 2010	10:00	13:40	13:40	15:05	15:05	17:30	47	25	52	124
WE	10 Jul 2010	11:35	14:40	14:40	16:05	16:05	16:50	63	37	54	154
WE	11 Jul 2010	8:35	10:47	10:47	11:40	11:40	14:15	35	4	63	102
WD	15 Jul 2010	9:30	13:45	13:45	14:58	14:58	17:00	45	16	45	106
WD	16 Jul 2010	7:30	10:40	10:40	11:50	11:50	13:55	48	20	62	130
WE	17 Jul 2010	11:30	13:25	13:25	15:15	15:15	16:30	41	46	27	114
WE	18 Jul 2010	7:15	11:45	11:45	12:45	12:45	14:00	106	12	25	143
WD	19 Jul 2010	11:20	13:10	13:10	13:50	13:50	16:05	57	26	17	100
WD	21 Jul 2010	12:40	14:25	14:25	15:00	15:00	16:50	36	2	30	68
WD	22 Jul 2010	11:06	14:05	14:05	14:40	14:40	17:00	83	24	67	174
WE	24 Jul 2010	12:00	14:25	14:25	15:25	15:25	16:55	94	14	44	152
WE	25 Jul 2010	8:34	9:40	9:40	10:15	10:15	13:00	86	27	65	178
WD	23 Jul 2010	16:31	16:33	14:40	16:00	16:00	16:30	57	15	0	72
WD	28 Jul 2010	8:00	10:10	10:10	10:51	10:51	13:05	1	0	59	60
WD	29 Jul 2010	13:30	14:30	9:25	10:45	10:45	12:00	30	12	4	46
WD	30 Jul 2010	8:00	10:10	15:00	17:00	12:10	15:00	0	3	45	48
WE	31 Jul 2010	8:40	12:00	10:10	13:00	13:00	14:30	79	14	14	107

Day		Zone 1		Zone 2		Zone 3		Angler Counts			
Type	DATE	Start	End	Start	End	Start	End	Zone 1	Zone 2	Zone 3	Total
WD	4 Aug 2010	11:10	14:16	12:48	12:48	13:40	14:02	45	4	14	63
WD	5 Aug 2010	9:30	11:00	11:00	12:00	12:00	12:15	40	12	15	67
WE	8 Aug 2010	12:00	14:00	14:00	14:16			35	6		41
WD	10 Aug 2010					11:00	13:00			25	25
WD	11 Aug 2010	9:00	11:00					30			30
WD	13 Aug 2010	9:00	12:00	12:00	12:50	10:00	12:31	48	10	22	80
WE	15 Aug 2010	7:05	8:50	8:50	10:20			30	9		39
WD	18 Aug 2010	9:45	9:52					22			22
WD	19 Aug 2010	13:50	13:50			10:50	11:45	21		19	40
WD	19 Aug 2010	9:37	12:45	12:45	13:35			39	5		44
WD	20 Aug 2010			14:00	15:00	15:00	17:15		15	58	73
WD	20 Aug 2010	9:15	10:55	10:55	10:55	0:00	0:00	38	3	0	41
WE	21 Aug 2010			12:45	12:58	8:50	12:05		13	38	51
WE	22 Aug 2010	9:30	10:15	10:15	11:30	11:30	13:05	57	13	59	129
WD	25 Aug 2010	8:50	10:00	10:00	10:30	10:30	13:05	14	0	34	48
WD	26 Aug 2010	7:20	11:05	11:05	13:20	13:20	17:35	24	11	14	49
WD	1 Sep 2010	13:30	14:30	14:30	14:45	12:30	13:30	12	15	18	45
WD	1 Sep 2010	9:50	14:00	11:31	12:00			28	4		32
WD	2 Sep 2010	10:15	11:54	11:54	11:56			15		0	15
WD	3 Sep 2010	10:20	12:25	12:25	12:45	12:45	13:45	20	0	21	41
WD	8 Sep 2010	8:40	10:00	10:00	10:40	10:40	11:26	14	1	30	45
WD	10 Sep 2010	8:45	9:45	9:45	11:42	11:42	13:00	11	4	36	51
WD	14 Sep 2010	11:55	12:30	12:30	13:45	13:45	14:45	3	3	41	47
WD	15 Sep 2010	11:50	12:00	12:00	13:45	13:45	14:30	1	2	47	50
WD	16 Sep 2010	9:15	10:00	10:00	10:55	10:55	14:20	5	0	50	55
WD	17 Sep 2010	9:00	11:10	11:10	12:00	12:00	13:30	2	2	34	38
WD	20 Sep 2010	10:45	11:11	11:11	11:25	11:25	14:05	7	0	32	39
WD	21 Sep 2010	12:30	12:45	12:45	13:15	13:15	14:40	6	2	32	40
WD	22 Sep 2010	13:00	13:20	13:25	13:40	13:40	14:38	3	0	26	29
WD	23 Sep 2010	11:30	12:00	12:00	12:20	12:20	14:00	0	0	23	23
June				18				17.5	8.0	11.0	36.5
July				23				51.2	19.9	44.5	115.6
August				16				34.1	8.4	27.1	52.6
September				14				9.1	2.5	30.0	39.3
Total				71				30.3	11.1	29.4	66.3