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Lower Skeena River Angling Creel Survey 2011

Final Report

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EXECUTIVE SUMMARY

Catches of Chinook salmon by the Lower Skeena River sport fishery can be substantial. Chinook catch was estimated to have exceeded 6,700 fish in 2003, but appeared to have dropped to 2,700 fish in 2010. Fishing effort in 2010 was estimated to be half of that reported in 2003. This report documents the results from survey efforts conducted from June to September, 2011. 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 as possible and record the incidence of adipose fin clips; and 3) to collect length and age data of Chinook salmon. The design for the 2011 lower Skeena creel survey was similar to that in 2010, and was based on similar recreational fishery surveys conducted on the Skeena, Nass and Peace rivers.

The 2011 creel survey 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 (7,006 fish, SE = 954), but it was harvested only 6% of the time. Steelhead was the second most commonly caught species (3,499 fish, SE = 363), and was the least frequently harvested species, with only 23 fish harvested (1%). The steelhead harvest estimate was based on 5 interviews during which 9 anglers reported a total of 6 retained steelhead, likely because they were unaware of the regulations or could not distinguish between steelhead and other species. Sockeye salmon was the third most commonly caught species (3,302 fish, SE = 100), followed by Chinook salmon (2,540 fish, SE = 263), and then by coho salmon (2,066 fish, SE = 180). Sockeye, Chinook and coho salmon were harvested 65-68% of the time. Angling effort, CPE and catch differed significantly among months.

Average Chinook CPE was similar in 2003, 2010 and 2011. However, total anger effort estimates for the June-August period in 2010 and 2011 were only 42% of the comparable effort estimate for 2003. As a result, thus total catches in 2010 and 2011 were considerably reduced in comparison to that reported for 2003. The additional interview data collected from launch ramp interviews of boat-based anglers in 2011 indicated that our 2010 estimates Chinook catch were likely biased low by 20%.

The additional resources to support a local creel survey program supervisor resulted in the successful implementation of most of the recommendations that were proposed following the 2010 survey. These included greater adherence to the survey schedule, more consistent recording of interview data, and improved data form completion. Despite the general improvements in survey implementation, there were concerns regarding Chinook biosampling and survey interview coverage in September 2011.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

INTRODUCTION

Catches of Chinook salmon by the Lower Skeena River sport fishery can be substantial when conditions are favorable for anglers. Estimates of the catch of Chinook salmon by the sport fishery in the Skeena were sporadic prior to 2010. Creel surveys were conducted over most of the Chinook salmon fishing season in 1995, 2001, and 2003. The catch of Chinook salmon in the Lower Skeena sport fishery was estimated to have exceeded 6,700 fish in 2003 (Tallman 2004). In 2010, the PSC Northern Fund supported the development and implementation of a new series of creel surveys and angling effort counts to provide reliable estimates of angler catches of salmon and steelhead between early June and late September each year, with emphasis on the Chinook catch. Surveys conducted in 2010 documented a substantial reduction in fishing effort (103,806 angler-hours) from that estimated for 2003 (203,587 angler-hours), which may have been the result of poorer fishing conditions and a lower abundance of Chinook. The resulting Chinook catch estimate for 2010 was 2,720 (Robichaud and English 2011).

In 2011, another creel study was conducted. The 2011 survey was based on the 2010 study design, with improvements to the study design that resulted in better coverage of all types of angling effort (shore and boat based angling). In 2010-11, we used the same spatial strata as the 2003 creel survey program conducted by J.O. Thomas in order to facilitate comparisons between the current and results and those from or before 2003.

This report documents the results from survey efforts conducted from early June to late September 2011. The report describes the methods used to derive estimates of angler activity pattern, catch and fishing effort.

SCOPE

The geographic scope of the lower Skeena creel survey study in 2011 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).

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 2011. 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.

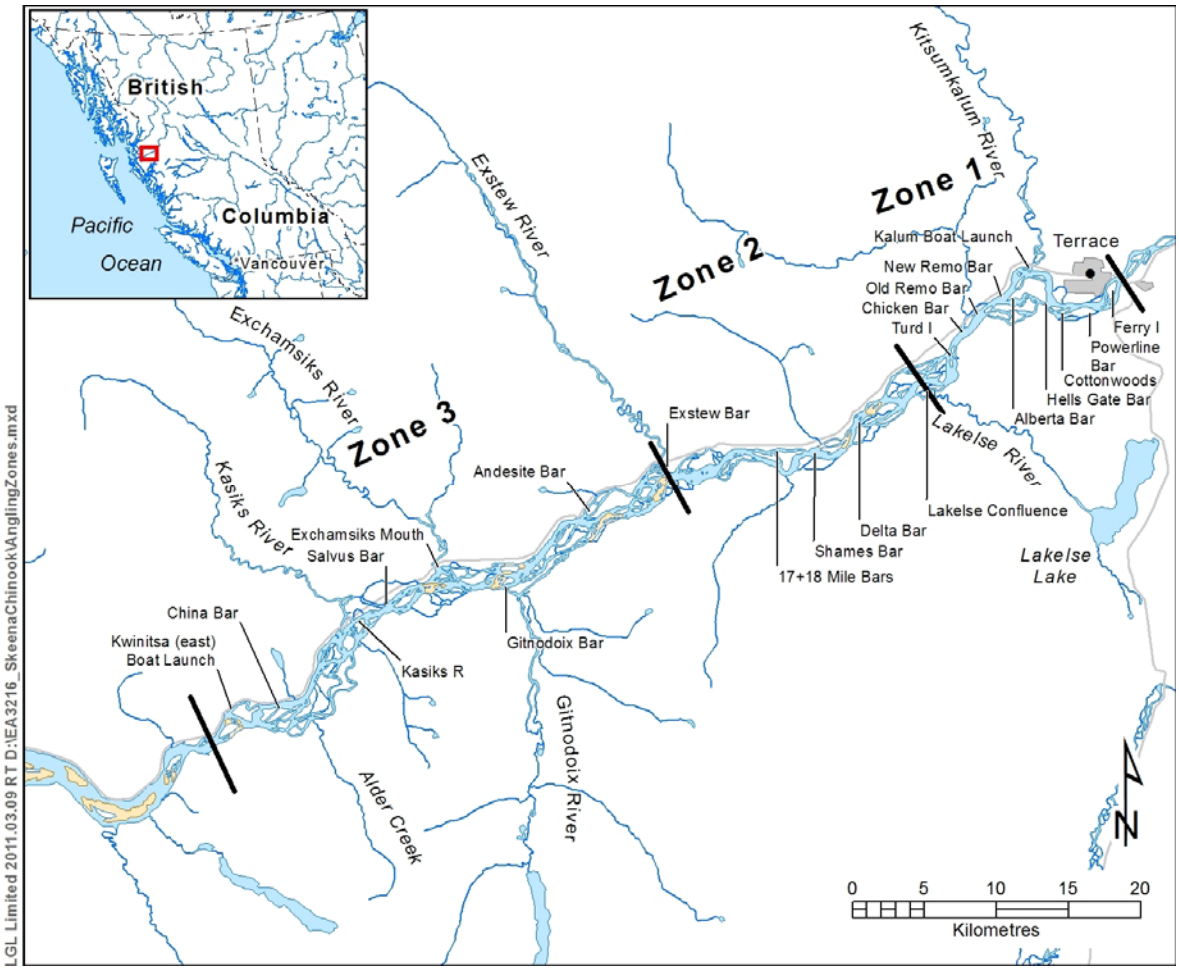

Figure 1. Map of the lower Skeena River showing the major fishing sites and boundaries for the three river zones (strata) used for the 2011 creel survey design.

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 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 length 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 2011. 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.

The incidence of adipose fin clips for Chinook and coho were obtained by examining fish during angler interviews. Scale samples were collected from Chinook, stored in scale books and used for age 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 at known access points, and also from a boat (after conducting the effort surveys). 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 following 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, 154 shifts were scheduled (Table 2), including 76 roving boat surveys and 78 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 2011.

Zone #	Zone Name	Site #	Site Name	Shore Survey
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. bottom)	
		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.

		Boat Survey					Shore Survey					
		Kwinitsa		Kalum			Terrace		China Bar			Grand
Month	Daytype	AM	PM	AM	PM	Total	AM	PM	AM	PM	Total	Total
June	WD	0	5	0	6	11	4	4	4	0	12	23
	WE	0	4	0	4	8	3	3	2	0	8	16
July	WD	0	5	1	5	11	4	7	3	0	14	25
	WE	1	4	1	5	11	3	3	3	0	9	20
August	WD	0	6	0	6	12	4	6	2	0	12	24
	WE	0	4	0	4	8	3	3	2	0	8	16
September	WD	0	4	0	3	7	3	3	1	0	7	14
	WE	0	4	0	4	8	3	4	1	0	8	16
Total		1	36	2	37	76	27	33	18	0	78	154

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, *W*1, 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 *W*1 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 $A_{mdsfkqt}$ 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*, with access method *f*, during month *m*, and on day type *d* (n_{mdsfkq} 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, access method and time-block):

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

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

$$T'_{mdsf} = \sum_{t} A'_{mdsft} \cdot \quad \text{(Eqn. 4)}$$

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

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

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, 48 unique angler activity patterns were to be estimated (i.e., 4 months × 2 day types × 3 river strata× 2 access methods, see Figure 2, Figure 3 and Figure 4). To reliably describe angler activity, a relatively large number of anglers (~ 60) needed to be interviewed in each of the 48 blocks. In the end, some blocks contained too few interviews (Table 3), so it was decided to pool activity data over month and day type. The equation for angler activity was thus

$$P_{sft} = \frac{\sum_{m}\sum_{d} A'_{mdsft}}{\sum_{m}\sum_{d}\left(W1_{mds} \cdot \sum_{k}\sum_{q}\left(W2_{mdsk} \cdot n_{mdsfkq}\right)\right)}, \quad \text{(Eqn. 6)}$$

with its associated variance:

$$S^2_{P_{sft}} = \frac{(P_{sft})(1 - P_{sft})}{\sum_{m}\sum_{d}\left(W1_{mds} \cdot \sum_{k}\sum_{q}\left(W2_{mdsk} \cdot n_{mdsfkq}\right)\right)}. \quad \text{(Eqn. 7)}$$

The average number of hours fished per angler (G_{sf}) was calculated for each stratum / access method combination using weighted observations:

$$G_{sf} = \frac{\sum_{m}\sum_{d}\left(T'_{mdsf}\right)}{\sum_{m}\sum_{d}\left(W1_{mds} \cdot \sum_{k}\sum_{q}\left(W2_{mdsk} \cdot n_{mdsfkq}\right)\right)}, \quad \text{(Eqn. 8)}$$

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

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 2011).

		Access	River Stratum		
Month	Day Type	Method	One	Two	Three
June	Weekday	Boat	7	0	0
		Shore	23	0	0
	Weekend	Boat	0	0	0
		Shore	24	0	0
July	Weekday	Boat	111	11	43
		Shore	519	65	20
	Weekend	Boat	156	35	34
		Shore	386	45	60
August	Weekday	Boat	110	22	20
		Shore	352	28	44
	Weekend	Boat	141	11	6
		Shore	340	33	48
September	Weekday	Boat	47	0	0
		Shore	57	2	21
	Weekend	Boat	7	0	0
		Shore	96	1	14

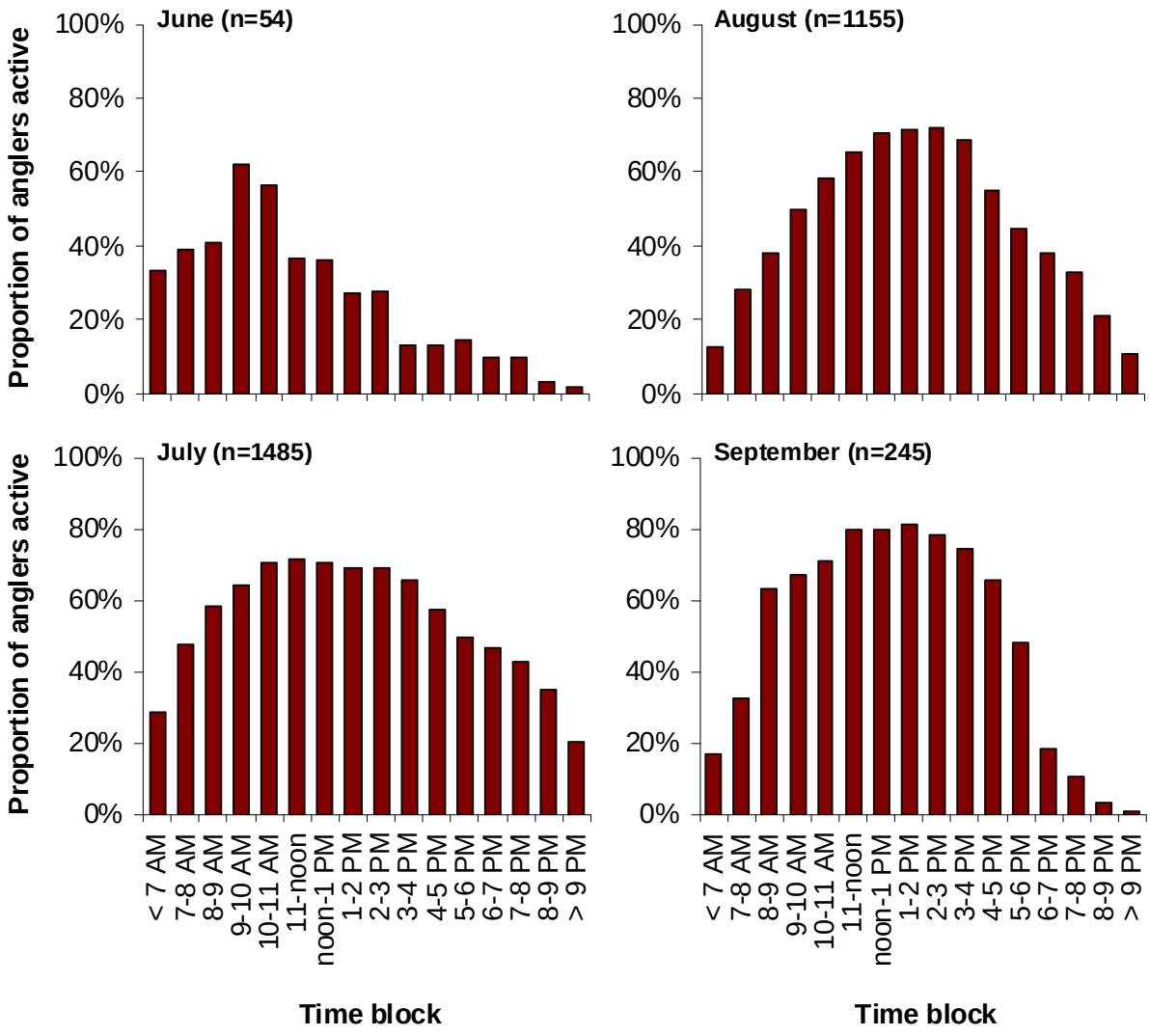

Figure 2. Angler activity patterns, by month, from interview data collected from 1 June to 30 September 2011.

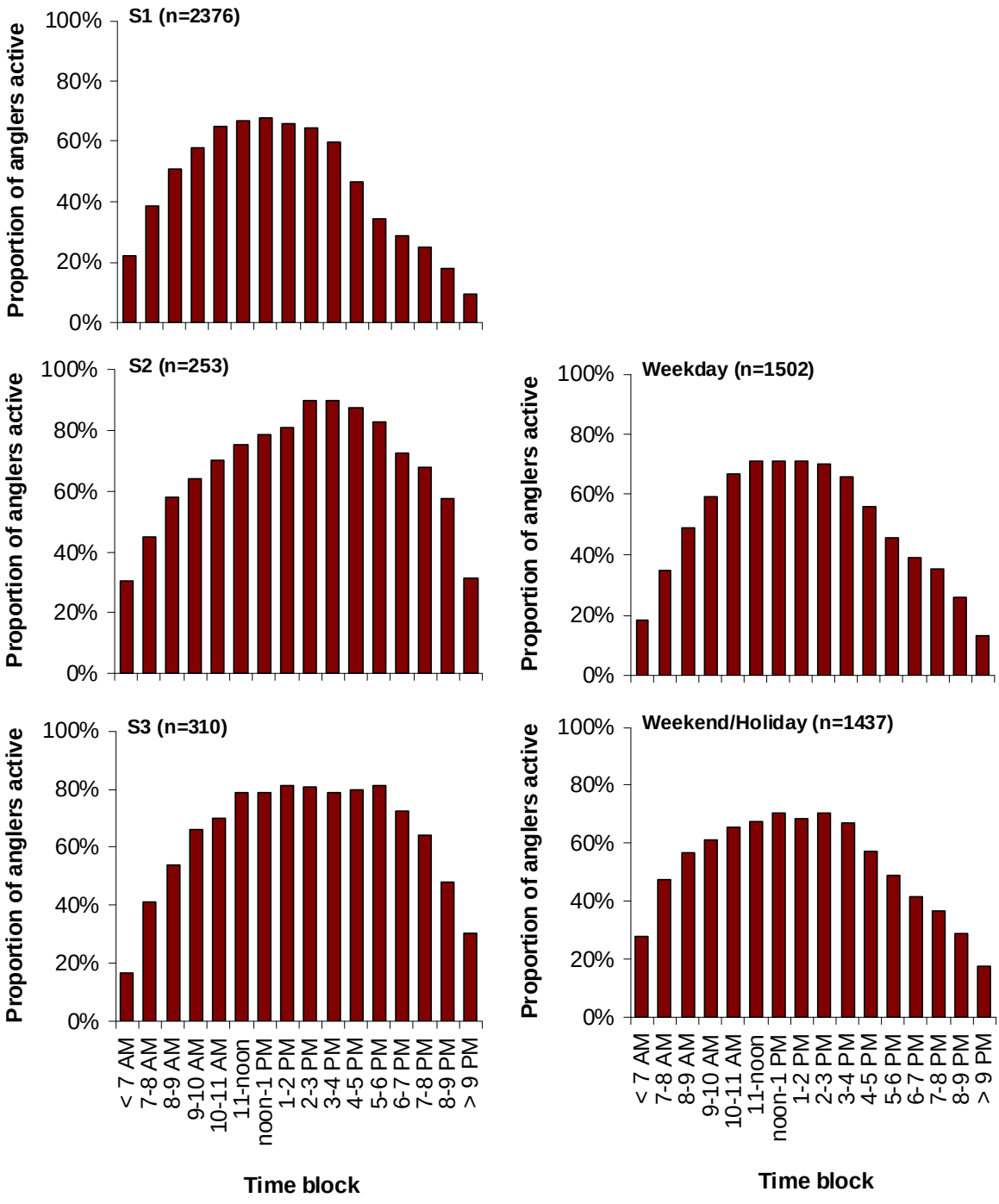

Figure 3. Angler activity patterns, by river stratum (left column) and day type (right column) from interview data collected from 1 June to 30 September 2011.

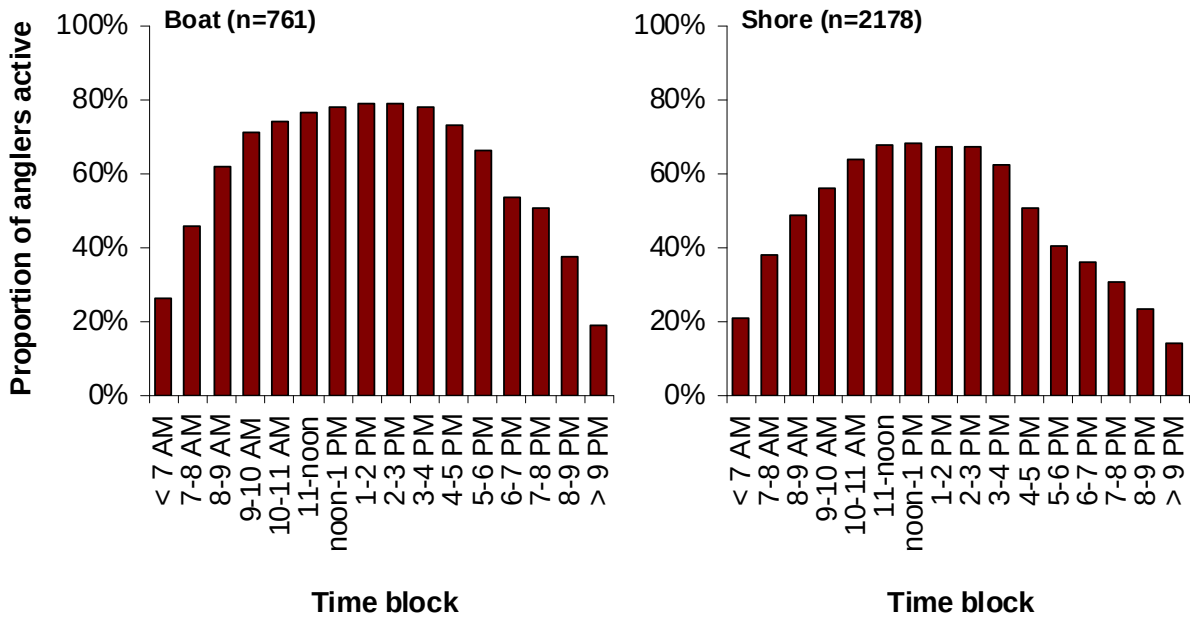

Figure 4. Angler activity patterns, by access method, from interview data collected from 1 June to 30 September 2011.

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*), day type (*d*) and access method (*f*) 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:

$$CPE_{mdsfri} = \frac{C_{mdsfri}}{\left(A_{mdsfi} \cdot H_{mdsfi}\right)}. \qquad \text{(Eqn. 9)}$$

Ideally, mean *CPE* would have been calculated for each month, river stratum, day type, access method 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 48 blocks (Table 4). As *CPE* was *expected* to change with month, river stratum and access method, it was decided to pool interview data by day type.

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

$$\hat{CPE}_{msfr} = \frac{\sum_{d}\sum_{i=1}^{n_{mdsf}} C_{mdsfri}}{\sum_{d}\sum_{i=1}^{n_{mdsf}}\left(A_{mdsfi} \cdot H_{mdsfi}\right)}. \qquad \text{(Eqn. 10)}$$

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

$$S^2_{\hat{CPE}_{msfr}} = \frac{\sum_{i=1}^{n_{mdsf}} (\hat{CPE}^2_{msfri}) - \frac{\sum_{i=1}^{n_{mdsf}} (\hat{CPE}_{msfri})^2}{n_{mdsf}}}{(n_{mdsf} - 1)}. \quad \text{(Eqn. 11)}$$

In several instances, the month/access method/river stratum-specific sample size was too low, even after the data were pooled over day type (Table 4). Due to low interview counts obtained from boats in September, two adjustments were made: 1) the September boat CPE for Stratum One was used as the September boat CPE for both Stratum One and Two; and 2) the September boat CPE for Stratum Three was based on September boat data from all three strata combined. Also, the June shore CPE for Stratum 2 was CPE was based on June shore data from stratum One and Two combined.

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, day type, and access method (data from 1 June to 30 September 2011).

			River Stratum		
Month	Day Type	Access	One	Two	Three
June	Weekday	Boat	3	3	2
		Shore	37	1	0
	Weekend	Boat	2	0	1
		Shore	20	1	5
July	Weekday	Boat	39	5	13
		Shore	276	48	33
	Weekend	Boat	82	12	10
		Shore	240	34	38
August	Weekday	Boat	43	10	8
		Shore	153	34	52
	Weekend	Boat	45	9	7
		Shore	122	36	34
September	Weekday	Boat	13	0	1
		Shore	29	4	21
	Weekend	Boat	4	0	0
		Shore	37	6	13

For each interview, CPE was calculated. These interview-level CPE data were used to examine the effects of landing time, by comparing CPE among hour-bins. For this analysis, data were restricting to those from completed trips, collected by shore-based crews.

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. The study area was split into two subsections, the first comprising River Strata One and Two, and the second being equivalent to River Stratum Three. On any given survey day, anglers were enumerated in one of the two study area subsections. Table 2 shows the number of boat surveys scheduled for each month and day type. Each survey was supposed to cover the entire subarea with the start and end times for angler counts recorded for each of the River Strata surveyed (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 (boating and shore-based counted separately, *f*) that were actively fishing at time *t* in sub-stratum *u* (within river stratum *s*), $V_{mdsfout}$. 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 shore and boat-based anglers active (P_{sft}) during the time block when the observations were recorded, and multiplied by the average number of hours fished per angler (G_{sf}). 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 and access method, B_{mdsfo}:

$$B_{mdsfo} = \sum_{t} \left(\frac{\sum_{u} V_{mdsfout}}{P_{sft}} \cdot G_{sf} \right) . \qquad \text{(Eqn. 12)}$$

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

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

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

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

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

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

Thus,

$$S^2_{V/P} = (P_{sft}^{-2})S^2_V + (V^2 P_{sft}^{-4})S^2_{P_{sft}} \text{ and}$$
$$S^2_B = (G^2_{sf})S^2_{V/P} + \left(\frac{V}{P_{sft}}\right)^2 S^2_{G_{sf}}, \quad \text{(Eqn. 16)}$$

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

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

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

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

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

$$S_{E_{msf}} = \sqrt{\sum_d \frac{S^2_{E_{mdsf}}}{n_{mds}}} \quad \text{(Eqn. 19)}$$

Catch Estimation

Total catch was calculated for each month, river stratum and species by multiplying total angling effort by catch per effort, and then summing over day type and access method:

$$C_{msr} = \sum_f \sum_d \left(E_{mdsf} \cdot \hat{CPE}_{msfr}\right). \quad \text{(Eqn. 20)}$$

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

$$S_{C_{msr}} = \sqrt{\sum_f \sum_d \left(E^2_{mdsf} \frac{S^2_{CPE_{msfr}}}{n_{msf}} + CPE^2_{msfr} \frac{S^2_{E_{mdsf}}}{n_{mdsf}} + \frac{S^2_{CPE_{msfr}}}{n_{msf}} \frac{S^2_{E_{mdsf}}}{n_{mdsf}}\right)}. \quad \text{(Eqn. 21)}$$

Because the Chinook fishery was closed on 7 August, it made the most sense to include the first week of August in with July, and to treat the last three weeks of August separately. As a result, it was necessary that comparisons of catch among months, river strata and access method be made using 'catch per day' in lieu of 'catch per month'. Catch per day was calculated by diving the 'monthly' catch estimates by the number of days included in each period (30, 37, 25, and 30 days for the four 'months', respectively).

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, 3,715 anglers were questioned during 1,581 interviews. Of the 3,715 anglers interviewed, 1,208 (32.5%) reported on completed fishing trips, and 1,732 (46.6%) reported their previous-day's fishing activity. Interviews were conducted during 139 survey shifts (Table 5, Appendix 2). Completed survey shifts represented 90% of the scheduled survey effort (104% of the shore-based effort, and 76% of the boat-based effort). The difference between the scheduled and actual survey effort can almost entirely be attributed to the fact that the boat-based survey crew stopped conducting interviews as of 26 August. After this date, the crew would leave work after conducting their effort counts (instead of interviewing anglers, the crew went to work on another project doing creek walks to count chum).

Table 5. Summary of observed 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.

		Boat Survey					Shore Survey					
		Kwinitsa		Kalum			Terrace		China Bar			Grand
Month	Daytype	AM	PM	AM	PM	Total	AM	PM	AM	PM	Total[1]	Total
June	WD	1	6	0	5	12	6	6	4	6	12	24
	WE	0	3	0	3	6	4	3	4	1	7	13
July	WD	0	6	1	5	12	8	5	2	2	13	25
	WE	1	5	1	4	11	7	3	2	0	10	21
August	WD	0	5	0	5	10	4	8	3	1	12	22
	WE	0	3	0	4	7	4	4	1	1	8	15
September[2]	WD	0	0	0	0	0	8	3	3	0	11	11
	WE	0	0	0	0	0	4	4	2	0	8	8
Total		2	28	2	26	58	45	36	21	11	81	139
% of Scheduled						76%					104%	90%

[1] All surveys at China Bar were conducted on the same day as surveys in the Terrace area.

[2] Boat survey crew stopped conducting interviews as of 26 August

Angler Activity Patterns

As described in the Methods Section (above), low sample sizes required interview data to be pooled across months and day types, resulting in the six angler activity patterns estimates (3 river strata × 2 access methods) shown in Figure 5. Angler activity patterns in River Stratum One (Ferry Island to Lakelse) differed markedly from those in the rest of the study area, with fewer anglers active in the early afternoon and evening. In general, boat anglers were active for a greater portion of the day than shore anglers.

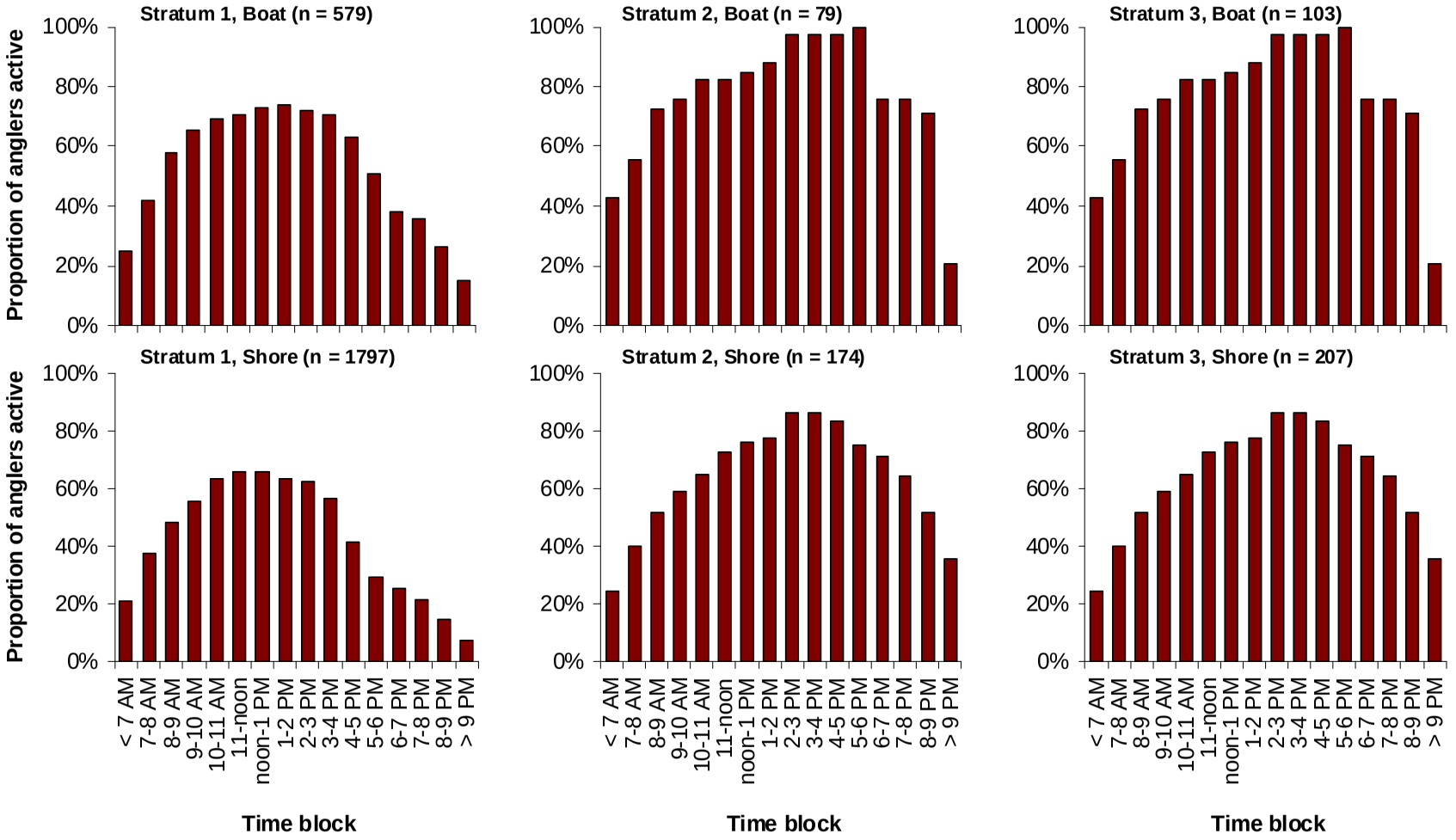

Figure 5. Angler activity patterns, by river stratum and access method, from interview data collected from 1 June to 30 September 2011.

Catch Per Effort Estimates

In order to obtain adequate sample sizes for CPE estimation, interview data were pooled over day type. In most cases, the pooled number of interviews was >= 3 (Table 4). The exceptions were: the June shore CPE in River Stratum 2 (n = 2; CPE was calculated from data for Stratum 1 and 2, combined); the September boat CPE in River Stratum 2 (n = 0; CPE for Stratum 1 was assumed); and the September boat CPE in River Stratum 3 (n = 1; CPE was calculated from data for Stratum 1 and 3, combined).

After pooling (as described above), CPE estimates were calculated for each species by month, river stratum and access method (Figure 6). Month had a strong effect on CPE for all species, which was statistically significant for steelhead and for coho and pink salmon (Table 7). No coho, pink, sockeye or steelhead were caught in June (Figure 6). CPE of coho and steelhead increased from month to month (Figure 6), although the differences between August and September were not statistically significant. CPE of pink salmon was significantly higher in August and September relative to other months (Figure 6). CPE of Chinook salmon was highest in July and the first week of August, lower in the last three weeks of August, and virtually zero in September (Figure 6).

There were no significant effects of river stratum or access method on CPE for any species (Table 7). To highlight similarities in Chinook CPE between access methods, the CPE estimates for the primary Chinook fishing period (1 July to 6 August) are shown in Figure 7.

Interview-level CPE data varied significantly with landing time (Figure 8, $\chi^2 = 26.8$, df = 12, $P = 0.008$).

The retention per effort rates (i.e., the rate of fish harvest, with units of 'fish per unit effort', where released fish were excluded) 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 (compare with Table 6), except that pink salmon and steelhead were infrequently kept.

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

Boat anglers		Fish Species					
Month	River Stratum	Chinook	Coho	Sockeye	Pink	Steelhead	Other
June	Ferry Island to Lakelse	0	0	0	0	0	0
	Lakelse to Exstew	0	0	0	0	0	0
	Exstew to China Bar	0	0	0	0	0	0
1 July - 6 Aug	Ferry Island to Lakelse	0.047 (0.015)	0.005 (0.003)	0.018 (0.009)	0.008 (0.007)	0.003 (0.000)	0.001 (0.000)
	Lakelse to Exstew	0.040 (0.014)	0.003 (0.000)	0.003 (0.000)	0.020 (0.034)	0.009 (0.001)	0
	Exstew to China Bar	0.019 (0.003)	0.005 (0.000)	0.008 (0.004)	0.027 (0.002)	0.006 (0.000)	0
7-31 Aug	Ferry Island to Lakelse	0.012 (0.000)	0.033 (0.005)	0.144 (0.093)	0.069 (0.030)	0.066 (0.058)	0.001 (0.001)
	Lakelse to Exstew	0.025 (0.002)	0.099 (0.009)	0.022 (0.007)	0.329 (0.126)	0.149 (0.029)	0.003 (0.000)
	Exstew to China Bar	0.009 (0.003)	0.037 (0.001)	0	0.174 (0.052)	0.041 (0.010)	0.009 (0.000)
September	Ferry Island to Lakelse	0	0.068 (0.033)	0.064 (0.008)	0.181 (1.288)	0.106 (0.089)	0.004 (0.000)
	Lakelse to Exstew	0	0.068 (0.033)	0.064 (0.008)	0.181 (1.288)	0.106 (0.089)	0.004 (0.000)
	Exstew to China Bar	0	0.068 (0.031)	0.064 (0.007)	0.181 (1.226)	0.105 (0.085)	0.004 (0.000)

Shore anglers		Fish Species					
Month	River Stratum	Chinook	Coho	Sockeye	Pink	Steelhead	Other
June	Ferry Island to Lakelse	0.092 (0.032)	0	0	0	0	0.004 (0.018)
	Lakelse to Exstew	0.088 (0.031)	0	0	0	0	0.004 (0.017)
	Exstew to China Bar	0	0	0	0	0	0
1 July - 6 Aug	Ferry Island to Lakelse	0.044 (0.101)	0.003 (0.001)	0.053 (0.261)	0.007 (0.020)	0.002 (0.008)	0.000 (0.000)
	Lakelse to Exstew	0.035 (0.005)	0.003 (0.000)	0.008 (0.004)	0.011 (0.006)	0.009 (0.001)	0
	Exstew to China Bar	0.023 (0.017)	0.009 (0.001)	0.001 (0.000)	0.038 (0.031)	0.008 (0.004)	0
7-31 Aug	Ferry Island to Lakelse	0.008 (0.004)	0.037 (0.087)	0.146 (0.339)	0.150 (0.283)	0.031 (0.125)	0.003 (0.002)
	Lakelse to Exstew	0.024 (0.002)	0.010 (0.004)	0.008 (0.002)	0.565 (1.177)	0.052 (0.091)	0.006 (0.006)
	Exstew to China Bar	0.006 (0.001)	0.030 (0.013)	0.001 (0.000)	0.052 (0.018)	0.059 (0.028)	0.005 (0.002)
September	Ferry Island to Lakelse	0.003 (0.001)	0.042 (0.012)	0.034 (0.011)	0.278 (1.924)	0.118 (0.107)	0.006 (0.001)
	Lakelse to Exstew	0	0.104 (0.108)	0	0.015 (0.000)	0.089 (0.073)	0
	Exstew to China Bar	0	0.037 (0.007)	0	0.015 (0.032)	0.136 (0.268)	0.015 (0.005)

Table 7. Statistical tests of the effect of month, river stratum, and access method 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		Access Method	
Species	χ_3^2	*P*	χ_2^2	*P*	χ_1^2	*P*
Chinook	11.3	0.0103	2.5	0.290	1.1	0.286
Coho	20.9	**0.0001**	0.1	0.943	0.2	0.663
Pink	17.9	**0.0005**	0.1	0.944	0.4	0.541
Sockeye	9.6	0.0218	4.3	0.117	0.9	0.343
Steelhead	20.7	**0.0001**	0.2	0.891	0.1	0.793
Other	10.0	0.0183	0.4	0.820	1.0	0.313

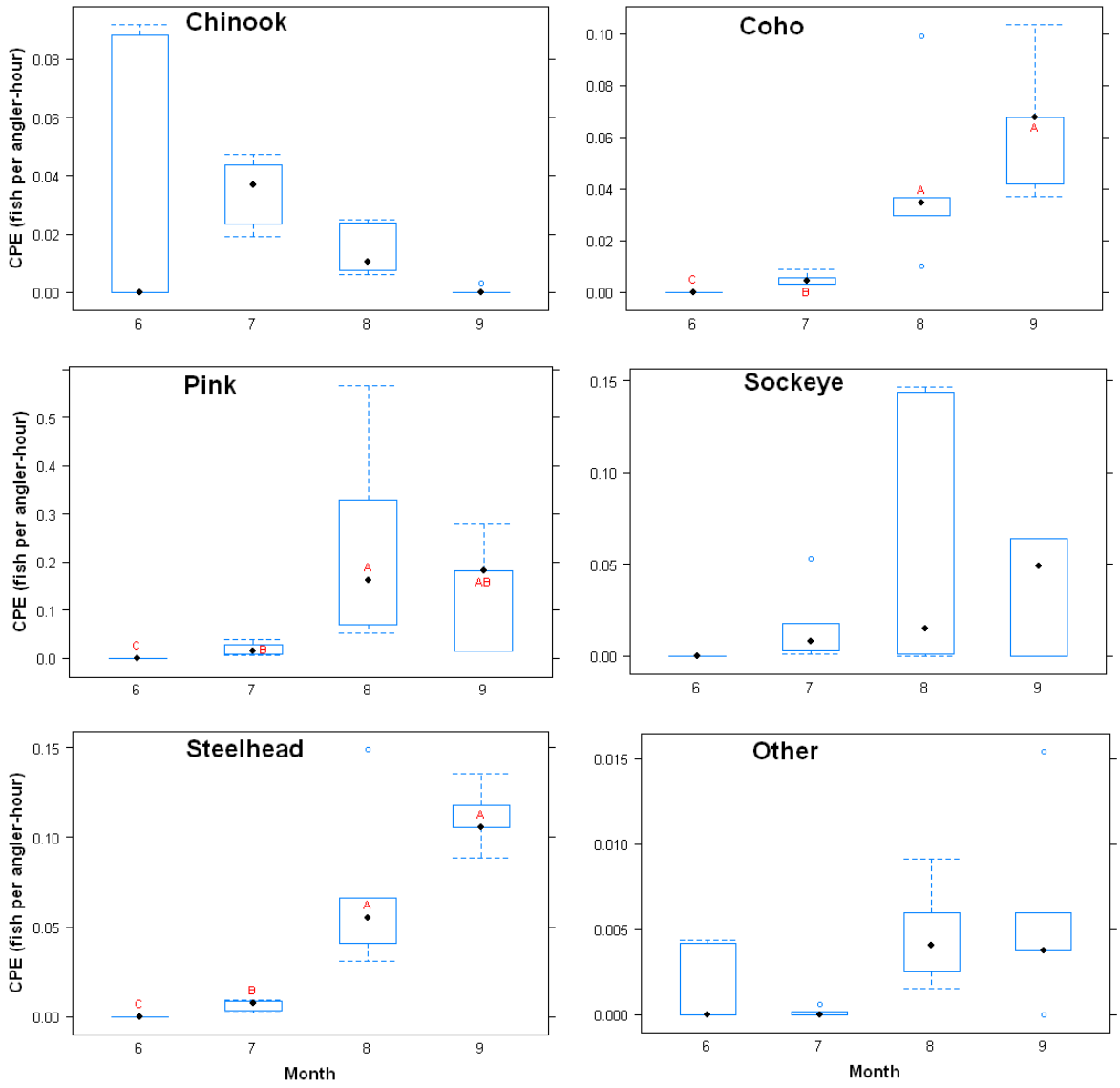

Figure 6. **Box-whisker plots showing the distribution of CPE estimates for each month, by species. Within a species, letters indicate statistically significant differences among months (i.e., months that share a letter in common are not significantly different).**

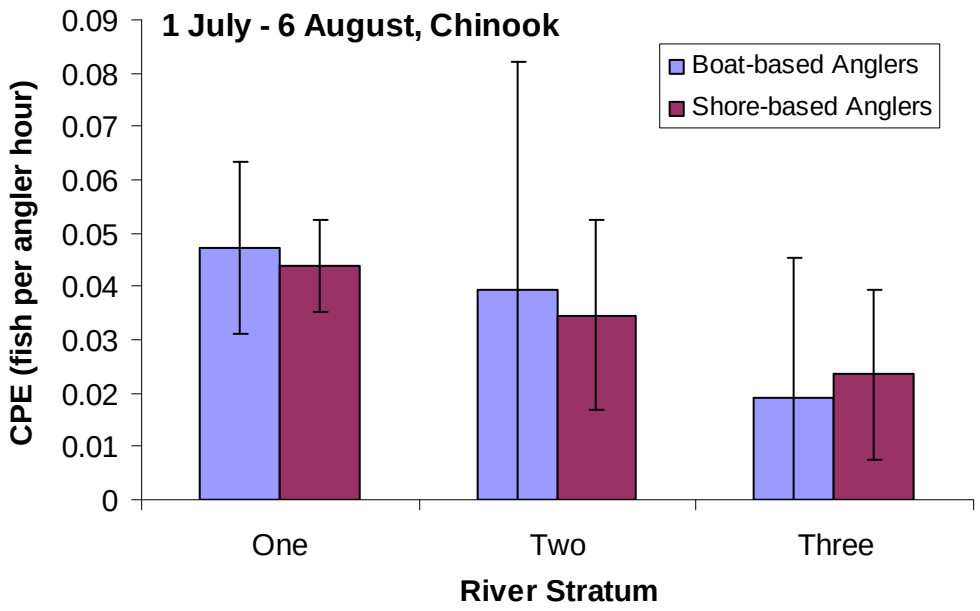

Figure 7. CPE for Chinook, by access method and river stratum, 1 July to 6 August, 2011.

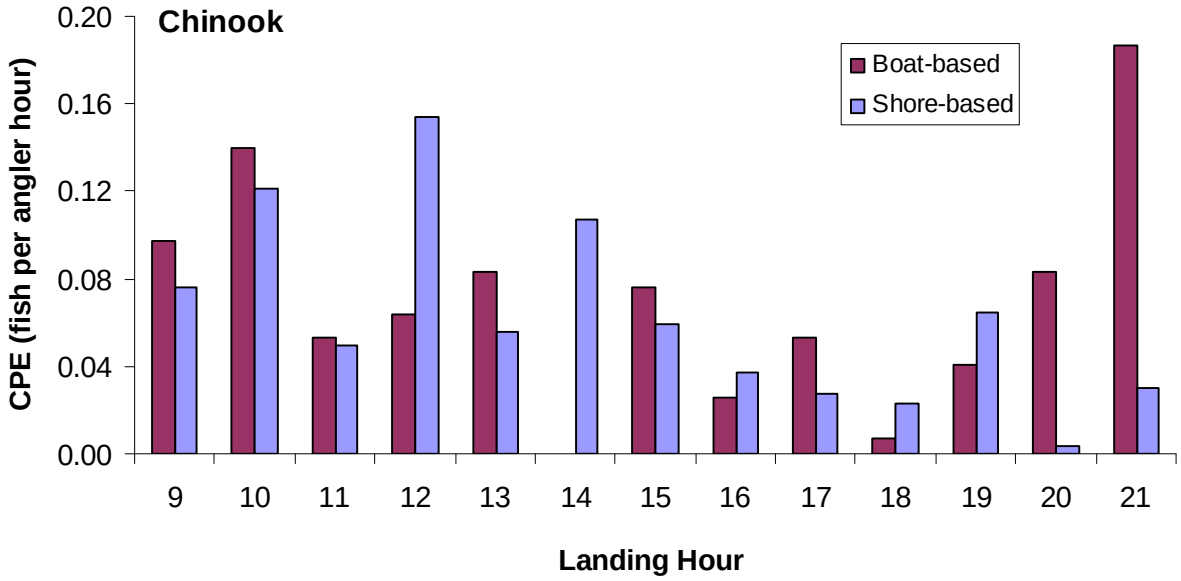

Figure 8. Average interview-level CPE, by hour of landing time, for complete trips surveyed at access sites by shore-based interviewers, 1 June to 30 September 2011.

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

Boat anglers		Fish Species					
Month	River Stratum	Chinook	Coho	Sockeye	Pink	Steelhead	Other
June	Ferry Island to Lakelse	0	0	0	0	0	0
	Lakelse to Exstew	0	0	0	0	0	0
	Exstew to China Bar	0	0	0	0	0	0
1 July - 6 Aug	Ferry Island to Lakelse	0.032 (0.009)	0.003 (0.003)	0.015 (0.009)	0.001 (0.000)	0.000 (0.000)	0.001 (0.000)
	Lakelse to Exstew	0.030 (0.004)	0.003 (0.000)	0.003 (0.000)	0	0	0
	Exstew to China Bar	0.016 (0.001)	0.004 (0.000)	0.003 (0.000)	0.008 (0.001)	0	0
7-31 Aug	Ferry Island to Lakelse	0.006 (0.000)	0.022 (0.005)	0.108 (0.087)	0.003 (0.003)	0	0.001 (0.001)
	Lakelse to Exstew	0.003 (0.000)	0.037 (0.003)	0.009 (0.001)	0.003 (0.000)	0	0
	Exstew to China Bar	0.009 (0.003)	0.023 (0.001)	0	0	0	0
September	Ferry Island to Lakelse	0	0.041 (0.005)	0.019 (0.004)	0	0	0
	Lakelse to Exstew	0	0.041 (0.005)	0.019 (0.004)	0	0	0
	Exstew to China Bar	0	0.041 (0.005)	0.019 (0.003)	0	0	0

Shore anglers		Fish Species					
Month	River Stratum	Chinook	Coho	Sockeye	Pink	Steelhead	Other
June	Ferry Island to Lakelse	0.009 (0.001)	0	0	0	0	0.004 (0.018)
	Lakelse to Exstew	0.008 (0.001)	0	0	0	0	0.004 (0.017)
	Exstew to China Bar	0	0	0	0	0	0
1 July - 6 Aug	Ferry Island to Lakelse	0.035 (0.052)	0.003 (0.000)	0.044 (0.238)	0.003 (0.002)	0.000 (0.000)	0
	Lakelse to Exstew	0.029 (0.003)	0.002 (0.000)	0.001 (0.000)	0.003 (0.003)	0	0
	Exstew to China Bar	0.016 (0.013)	0.009 (0.001)	0.001 (0.000)	0.015 (0.002)	0.001 (0.001)	0
7-31 Aug	Ferry Island to Lakelse	0.000 (0.000)	0.020 (0.015)	0.098 (0.103)	0.009 (0.001)	0.001 (0.001)	0
	Lakelse to Exstew	0.018 (0.002)	0.010 (0.004)	0.008 (0.002)	0.002 (0.000)	0.002 (0.001)	0.002 (0.005)
	Exstew to China Bar	0.004 (0.001)	0.027 (0.013)	0.001 (0.000)	0.016 (0.007)	0	0
September	Ferry Island to Lakelse	0	0.025 (0.009)	0.024 (0.009)	0	0	0
	Lakelse to Exstew	0	0.030 (0.029)	0	0	0	0
	Exstew to China Bar	0	0.037 (0.007)	0	0	0	0.006 (0.004)

Angler Effort Estimates

Over the 4 month study period, a total of 80 effort surveys were conducted, covering River Stratum One, Two and Three a total of 39, 42 and 44 times, respectively. Of the 80 surveys, 49 were conducted on weekdays, and 31 on weekend/holidays (Appendix 3). The total angling effort was estimated for each month, day type, river stratum and access method (Table 9).

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

Month	Day Type	Access Method	River Stratum: Ferry Island to Lakelse	River Stratum: Lakelse to Exstew	River Stratum: Exstew to China Bar	Total
June	Weekday	Boat	517 (353)	552 (261)	117 (38)	1,186 (440)
		Shore	781 (557)	0	0	781 (557)
	Weekend	Boat	627 (466)	50 (26)	50 (27)	728 (468)
		Shore	670 (544)	0	151 (100)	821 (553)
1 July - 6 Aug	Weekday	Boat	10,425 (5,085)	1,602 (663)	3,281 (1,343)	15,308 (5,301)
		Shore	7,241 (3,702)	4,050 (1,901)	4,758 (2,269)	16,050 (4,740)
	Weekend	Boat	6,708 (3,133)	1,852 (728)	1,527 (608)	10,087 (3,273)
		Shore	5,176 (2,324)	3,713 (1,661)	3,879 (1,757)	12,768 (3,354)
7-31 Aug	Weekday	Boat	4,968 (2,450)	3,076 (1,511)	1,794 (961)	9,838 (3,035)
		Shore	2,111 (1,063)	1,023 (524)	5,634 (3,487)	8,769 (3,683)
	Weekend	Boat	2,997 (2,097)	636 (497)	629 (477)	4,261 (2,207)
		Shore	1,245 (887)	1,517 (1,297)	2,620 (1,985)	5,383 (2,532)
September	Weekday	Boat	1,823 (1,016)	961 (407)	1,208 (631)	3,991 (1,264)
		Shore	794 (378)	410 (254)	1,909 (1,297)	3,112 (1,375)
	Weekend	Boat	2,003 (1,623)	445 (345)	157 (109)	2,605 (1,663)
		Shore	527 (470)	282 (218)	1,055 (1,057)	1,865 (1,177)
Overall Total			48,615 (8,490)	20,170 (3,507)	28,769 (5,557)	97,554 (10,735)

There was a strong statistically significant effect of month on angler effort (Table 10). The greatest observed angling effort occurred in July, then August, and September (Figure 9). Significantly less fishing effort was observed in June (Figure 9). There were no significant effects of day type, river stratum or access method on fishing effort (Table 10).

Table 10. Statistical tests of the effect of month, day type, river stratum and access method on median effort estimates during the study period. *P*-values that are in bold are statistically significant after the Bonferroni adjustment.

Effect Test	χ^2	df	*P*
Month	32.0	3	< **0.0001**
Day Type	1.4	1	0.232
River Stratum	4.6	2	0.099
Access Method	0.03	1	0.853

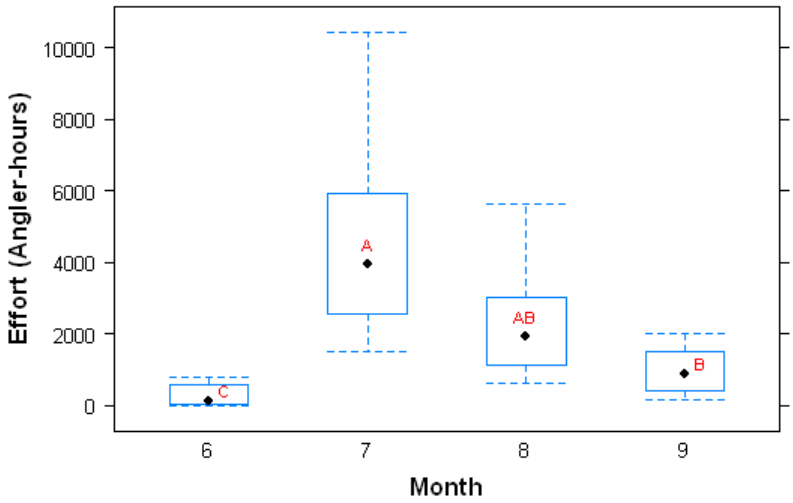

Figure 9. Box-whisker plot showing the distribution of effort estimates for each month. Letters indicate statistically significant differences among months (i.e., months that share a letter in common are not significantly different).

Catch Estimates

Estimates of total monthly catch (Table 11) were generated by calculating E × CPE, and then summing over day types and access methods. Pink salmon was the most abundantly caught fish (7006 fish, SE = 954). Steelhead was the second most commonly caught species (3499 fish, SE = 363), followed by sockeye salmon (3302 fish, SE = 100), Chinook salmon (2540 fish, SE = 263), and then coho salmon (2066 fish, SE = 180).

For no species did catch per day vary significantly with river stratum or access method (Table 12).

There were strong effects of month on catch per day for all species, and, after the Bonferroni adjustment, the effect was statistically significant for all species except sockeye salmon (Table 12, Figure 10). For Chinook salmon, the highest catch rate was in July and the first week of August (when 81% of the total Chinook catch was caught), followed by the last three weeks of August (14%), and then by June (5%). Chinook catches were negligible in September (4 fish). Steelhead and coho, sockeye and pink salmon catch rates were highest in the last three weeks of August (when 53-65% of the species-specific catches were made), were intermediate in July and September, and were zero in June (Figure 10). For steelhead and coho and pink salmon, catch rates in September were higher than in July and the first week of August (though the level of significance varied among species, Figure 10).

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	133 (47)	0	0	0	0	6 (20)
	Lakelse to Exstew	0	0	0	0	0	0
	Exstew to China Bar	0	0	0	0	0	0
1 July - 6 Aug	Ferry Island to Lakelse	1356 (214)	129 (58)	967 (236)	218 (97)	85 (40)	12 (15)
	Lakelse to Exstew	404 (83)	34 (15)	71 (36)	151 (109)	101 (22)	0
	Exstew to China Bar	295 (97)	104 (27)	47 (43)	459 (127)	101 (44)	0
7-31 Aug	Ferry Island to Lakelse	121 (29)	386 (102)	1638 (405)	1052 (246)	629 (271)	20 (25)
	Lakelse to Exstew	153 (48)	394 (105)	101 (73)	2656 (656)	684 (198)	27 (23)
	Exstew to China Bar	74 (43)	335 (112)	10 (3)	852 (218)	583 (187)	63 (35)
Sept	Ferry Island to Lakelse	4 (3)	315 (146)	291 (91)	1060 (839)	560 (241)	22 (8)
	Lakelse to Exstew	0	167 (76)	90 (28)	265 (303)	210 (95)	5 (3)
	Exstew to China Bar	0	202 (72)	87 (31)	292 (339)	546 (254)	51 (31)
Overall Total		2540 (263)	2066 (266)	3302 (488)	7006 (1219)	3499 (532)	207 (64)

Table 12. Statistical tests of the effect of month, river stratum and access method on median catch-per-day (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		Access Method	
Species	χ_3^2	*P*	χ_3^2	*P*	χ_1^2	*P*
Chinook	16.9	**0.001**	1.9	0.389	0.4	0.510
Coho	18.7	**0.000**	0.6	0.753	0.4	0.541
Pink	18.6	**0.000**	0.5	0.794	0.2	0.663
Sockeye	10.0	0.018	5.3	0.070	0.7	0.406
Steelhead	20.0	**0.000**	0.01	0.998	0.0	0.884
Other	14.7	**0.002**	2.0	0.371	0.02	0.881

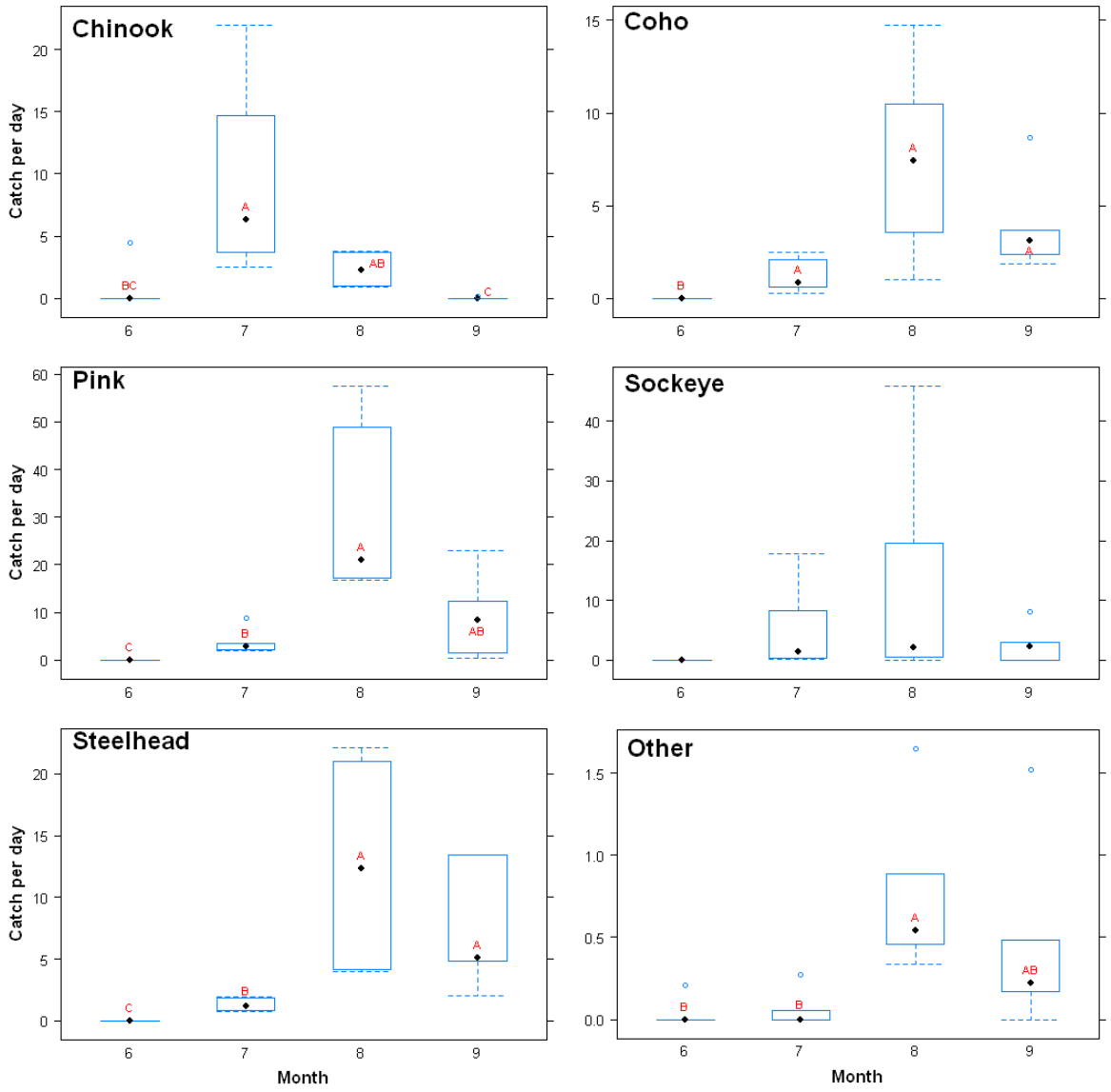

Figure 10. Box-whisker plots showing the distribution of catch estimates (harvest + release) for each month, by species. Within a species, letters indicate statistically significant differences among months (i.e., months that share a letter in common are not significantly different).

Harvest (Retention) Estimates

Estimates of total monthly harvest are shown in Table 13 and Figure 11. Pink salmon, which was the most abundantly caught fish, was retained only 6% of the time (450 fish harvested). Steelhead was the least frequently harvested species, with only 23 fish harvested (1% of total steelhead catch). The steelhead expansion estimate was based on 5 interviews during which 9 anglers reported a total of 6 retained steelhead, likely because they were unaware of the regulations or could not distinguish between steelhead and other species. Sockeye, Chinook and coho salmon were harvested 65-68% of the time. Despite a fishery closure, our analysis estimated that 49 Chinook were harvested in Stratum One (Ferry Island to Lakelse) on or after 7 August. This number resulted from the expansion of 2 interviews conducted the day

after the fishery closed (7 Aug), during which 16 anglers reported a total of 5 retained Chinook in Stratum One, likely because they were unaware of the regulations. No Chinook were reported as harvested after 7 August in Stratum One.

The statistical effects of month, river stratum and access method on harvest were similar to those on catch (Table 14, Figure 11).

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	13 (6)	0	0	0	0	6 (20)
	Lakelse to Exstew	0	0	0	0	0	0
	Exstew to China Bar	0	0	0	0	0	0
1 July - 6 Aug	Ferry Island to Lakelse	971 (156)	86 (51)	805 (221)	50 (20)	7 (13)	10 (15)
	Lakelse to Exstew	331 (56)	24 (13)	20 (12)	23 (28)	0	0
	Exstew to China Bar	219 (81)	96 (27)	21 (12)	172 (40)	8 (17)	0
7-31 Aug	Ferry Island to Lakelse	49 (15)	245 (80)	1189 (351)	55 (56)	3 (6)	12 (24)
	Lakelse to Exstew	57 (22)	163 (58)	55 (33)	17 (10)	5 (9)	5 (21)
	Exstew to China Bar	53 (38)	282 (109)	10 (3)	134 (72)	0	0
Sept	Ferry Island to Lakelse	0	192 (68)	104 (49)	0	0	0
	Lakelse to Exstew	0	79 (36)	27 (17)	0	0	0
	Exstew to China Bar	0	166 (51)	26 (18)	0	0	18 (24)
Overall Total		1694 (190)	1333 (183)	2256 (420)	450 (106)	23 (24)	52 (47)

Table 14. Statistical tests of the effect of month, river stratum and access method on median harvest-per-day 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		Access Method	
Species	χ_3^2	*P*	χ_3^2	*P*	χ_1^2	*P*
Chinook	21.2	< **0.0001**	0.3	0.873	0.1	0.808
Coho	17.8	**0.001**	1.2	0.538	0.1	0.749
Pink	15.0	**0.002**	0.7	0.693	1.1	0.302
Sockeye	10.1	0.018	6.1	0.049	0.5	0.477
Steelhead	6.4	0.093	1.26	0.533	2.1	0.143
Other	0.6	0.898	1.9	0.379	0.17	0.684

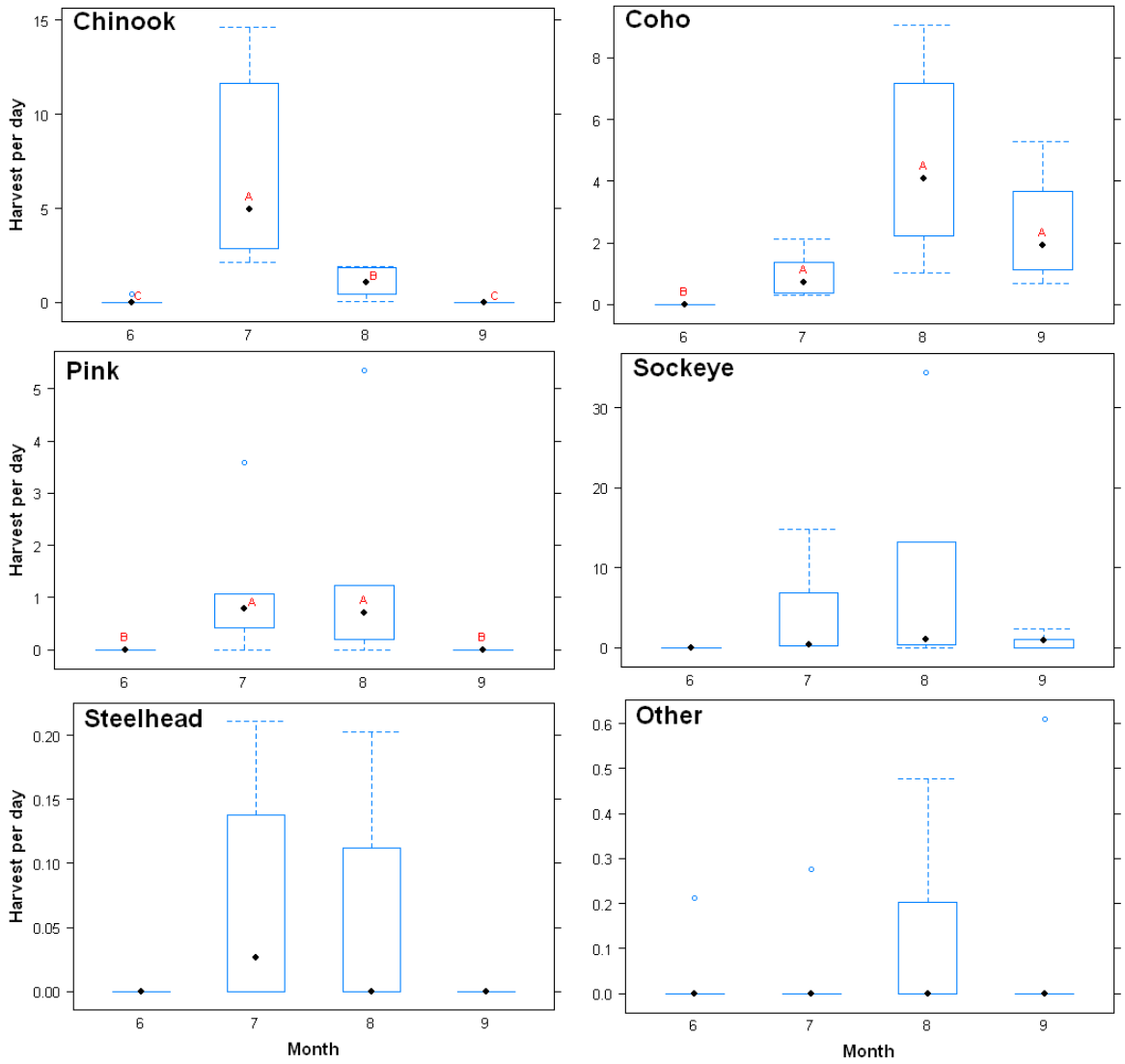

Figure 11. Box-whisker plots showing the distribution of harvest estimates for each month, by species. Within a species, letters indicate statistically significant differences among months (i.e., months that share a letter in common are not significantly different).

Bio-sampling

Scale samples were obtained from 39 (27%) of the 147 Chinook observed during angler interviews. Of these scales samples, only 17 were delivered to the DFO analysis lab. Of these, one was wet, one was resorbed and 3 were regenerate, thus there are only complete ages for 12 fish (8% of the 147 observed). The relative proportions of each age group (using the Gilbert-Rich convention), in order of decreasing abundance, were: age 6_2 at 41.7%, age 5_2 at 25.0%, age 5_3 at 16.7%, and 4_2 and 6_3 each at 8.3%. Due to small sample sizes, further analyses were not conducted.

No Chinook or coho that were observed by the field surveyors had their adipose fin clipped.

DISCUSSION

Comparison of the catch and fishing effort estimates derived from the 2003 creel survey data (Tallman 2004) with those derived for a similar period in 2010 (Robichaud and English 2011) and 2011 revealed some substantial differences (Table 15, Table 16). The total angler effort estimates for the June-August period in 2010 and 2011 were remarkably similar, both only 42% of the comparable effort estimate for 2003.

Chinook CPE was similar in all three years. In our 2010 report (Robichaud and English 2011), we hypothesized that 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). In 2011, coverage of boat-based anglers from June to August was improved relative to 2010, as was the coverage of evening fishing.

Coho catch and CPE was higher in 2011 than it was in 2010, and both were greater than observed in 2003, possibly as a result of increased returns of the Upper Skeena stocks. Sockeye and steelhead CPEs have also increased in each study year, relative to the previous. The CPE of pink salmon in 2010 and 2011 was only 39% and 66% of the 2003 estimate, respectively.

Table 15. Comparison of the catch and effort estimates for the 2003, 2010 and 2011 creel surveys for the same spatial strata and fishing periods.

		Catch by Fish Species				
Period/ River Stratum	Angler-hours	Chinook	Coho	Sockeye	Pink	Steelhead
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 China Bar	40,875	1,342	127	108	5,282	241
Total	203,588	6,729	557	1,861	19,463	1,414
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 China Bar	31,216	643	285	14	239	602
Total	85,390	2,720	883	1,890	3,192	1,647
June - August 2011						
Ferry Island to Lakelse	43,468	1,610	515	2,605	1,270	714
Lakelse to Exstew	18,071	557	427	171	2,808	785
Exstew to China Bar	24,441	368	440	58	1,311	684
Total	85,980	2,536	1,381	2,834	5,389	2,183

Table 16. Comparison of the average CPE estimates (derived from values in Table 15) for the 2003, 2010 and 2011 creel surveys for the same spatial strata and fishing periods.

	CPE by Fish Species				
Period/ River Stratum	Chinook	Coho	Sockeye	Pink	Steelhead
June - August 2003					
Ferry Island to Lakelse	0.027	0.002	0.015	0.020	0.006
Lakelse to Exstew	0.044	0.005	0.002	0.215	0.009
Exstew to China Bar	0.033	0.003	0.003	0.129	0.006
Total	0.033	0.003	0.009	0.096	0.007
June - August 2010					
Ferry Island to Lakelse	0.036	0.013	0.046	0.065	0.020
Lakelse to Exstew	0.045	0.005	0.001	0.025	0.017
Exstew to China Bar	0.021	0.009	0.000	0.008	0.019
Total	0.032	0.010	0.022	0.037	0.019
June - August 2011					
Ferry Island to Lakelse	0.037	0.012	0.060	0.029	0.016
Lakelse to Exstew	0.031	0.024	0.009	0.155	0.043
Exstew to China Bar	0.015	0.018	0.002	0.054	0.028
Total	0.029	0.016	0.033	0.063	0.025

The estimate of angler effort was substantially lower in 2010 (Robichaud and English 2011) and 2011 as compared to 2003 (Tallman 2004). The average number of anglers observed fishing in 2011 over all strata was 101 anglers per day (Table 17). This is similar to the average of 103 anglers/day observed in 2010 but markedly lower than in 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. Using Tallman's (2004) reported average trip length (4.5 h; likely biased low), and his reported effort estimate of 203,587 angler hours, we calculated that, on average, 595 anglers would have been fishing each day over the 76 day study period in 2003. Even if the average trip length in 2003 was similar to that in 2011, over 300 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 and 2011 was substantially lower than in 2003 and 2006.

Table 17. Estimates of the average length of a fishing trip and average number of anglers fishing each day by river stratum and month in 2011.

Average trip length (h)	River Stratum			
Month	Ferry Island to Lakelse	Lakelse to Exstew	Exstew to China Bar	Total
June	5.3	-	-	5.3
July	8.5	10.9	12.4	9.4
August	7.2	9.0	9.4	7.9
September	8.5	8.7	8.1	8.5
Overall Total	8.0	10.2	10.8	8.7

Average anglers/day	River Stratum			
Month	Ferry Island to Lakelse	Lakelse to Exstew	Exstew to China Bar	Total
June	16	4*	2*	16
July	94	28	29	151
August	63	28	46	137
September	20	8	18	46
Average	48	21	31	101

* used average trip length for Stratum One, since no data were available for Strata Two or Three

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, sockeye catch varied markedly among months, as would be expected based in its run-timing, yet variances were high enough to render the statistical test inconclusive. In this study, any statistically significant results that were observed are therefore very conclusive, as these effects were strong enough to be observed above-and-beyond the inherent variance.

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-to-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, 457 (32%) of the 1426 salmon and steelhead reported as kept during angler interviews were recorded as observed by the interviewer. Incomplete data forms or misunderstandings associated with how to complete the data forms accounted for a notable portion of the 'unobserved' catch. For example: 226 (16%) of the kept fish were on data forms for which the "Catch Seen" field was blank.

There were other concerns with regard to accuracy and completeness of the interview and effort survey data forms. Although much improved over the previous year, interviewers completed their survey forms in interesting and inconsistent ways, and some effort was required to massage their data into a workable format. 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.

In 2010, we had deficiencies in the survey coverage of boat-based fishing effort in Stratum 1 (Ferry Island to Lakelse) due to lack of survey effort at the launch ramps near the mouth of the Kitsumkalum River (Fisherman's Park and Kalum boat launch). In 2011, boat-based survey coverage was much improved, as crews conducted 531 interviews at these launch ramps, and they worked later in the day to intercept boat anglers returning from their trips. In 2011, 20.7% of interviews were conducted after 6 PM, up from ~5% in 2010. In 2011, we found that anglers' daily CPE varied with landing time (Figure 8), thus highlighting the importance of sampling randomly and throughout the entire day.

The potential bias in the 2010 estimates was assessed by removing all interview data obtained from the Fisherman's Park and Kalum boat launches in 2011 and comparing these partial survey results with those derived using all of the 2011 interview data. Excluding interview data from these launch ramps resulted in a decrease in the total Chinook catch estimate by 532 fish (20%), despite an increase of 7000 angler hours (7%) in our estimate of total effort. Anglers landing at these boat launches had substantially higher catch per effort and lower daily fishing effort (7.6 hours/day) than boat-based anglers interviewed elsewhere along the Skeena River (12.0 hours/day). Since a substantial portion of the boat-based fishers in the Terrace area access the Skeena River via the Kalum boat launches, the 2010 effort estimate for Stratum 1 was probably biased high and the Chinook catch estimate was

biased low, as previously expected. Catch estimates for other species were also affected by the removal of the Kalum launch ramp interview data. However, it is difficult to make any meaningful inferences regarding the potential bias in the 2010 catch estimates for sockeye, coho, pink and steelhead because most of the interview data for these species was obtained from surveys at the Kalum launch ramps in 2011.

RECOMMENDATIONS

In 2011, specific efforts were undertaken to address each of the recommendations that arose from the 2010 surveys. Specifically:

1. Additional funding was obtained to ensure that a local program supervisor was 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. We hired individuals with previous creel survey experience and conducted a training course in May to explain the survey methods and reasons for the creel survey design and work schedule.

3. The local program supervisor monitored the activities of the field crews and ensured that they worked the times and locations defined in the creel survey schedule, which included evening hours at all the key access sites (e.g., Kalum boat launch).

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

5. During the first few weeks of the 2011 survey, field crews conducted periodic trailer and vehicle counts as a cross-check for the boat angler counts and activity patterns from angler interviews.

6. Information on yesterday's line times was more complete and consistently collected in 2011 than in 2010.

7. During the first weeks of the 2011 survey, data forms were submitted to the local program supervisor and checked within 24 hours of collection so any problems could be identified early in the field season.

8. After the first three weeks of the 2011 survey, field crews were told to submit all the data collected in a week by Monday afternoon of the following week so the data could be entered into structured databases and provided to the project analyst for verification. Field crew compliance with this reporting requirement was not consistent throughout the 2011 program and further measures will be required in future years to achieve the goal of weekly data transmission and verification.

9. In 2011, catch and effort estimates were stratified by shore-based and boat-based anglers, as initially planned for 2010, but was not possible in 2010 due to the limited coverage of boat-based fishing effort.

10. The data analysis and reporting systems described in the 2010 report were used to derive preliminary monthly estimates of catch and effort within 2-3 weeks of the end of each month.

11. The improvements in survey coverage of boat-based fishing effort in 2011 allowed us to estimate the magnitude of the underestimation bias associated with the 2010 estimate of Chinook catch for the lower Skeena recreational fishery.

Recommendations resulting from the 2011 Lower Skeena Creel Survey Program are to continue the implementation of the above actions and ensure that effort surveys and anglers interviews are conducted in a consistent and reliable manner throughout the survey period. The reduction in angler interviews conducted by the boat survey crews in late August and September 2011 resulted in reduced samples sizes and greater uncertainty in the catch and effort estimates for this later portion of the creel survey period.

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APPENDICES

Appendix 1. Data forms.

Lower Skeena River Creel Survey 2011 Form:

Surveyor: Zone #: Year 2011

Location of Int: Date: Month/Day

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 adult						
Chinook jack						
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 - 2011

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

Weather _____

Date: _____

	# shore anglers observed	# boat anglers observed	# Boats observed	Start Time	End Time
(Zone 1) - Ferry Island to Lakelse Confluence					
Upper Ferry Is.					
Lower Ferry Is.					
Power Line Bar					
Cottonwoods					
Hells Gate Bar					
Alberta Bar (below mouth of Kalum)					
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					
Gitnadoix Bar					
28 Mile Bar (bottom of Andesite)					
Andesite Bar (river right)					
Exchamsiks Mouth (river left)					
Salvus Bar (river right)					
Kasiks River					
China Bar					

Comments: _____

_____

_____

Lower Skeena River Boat-based Interview Tally Form - 2011

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

Weather _____

Date: _____

	Shore Anglers		Boat Anglers	
	# anglers observed	# anglers interviewed	# anglers observed	# anglers interviewed
(Zone 1) - Ferry Island to Lakelse Confluence				
Upper Ferry Is.				
Lower Ferry Is.				
Power Line Bar				
Cottonwoods				
Hells Gate Bar				
Alberta Bar (below mouth of Kalum)				
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				
Gitnadoix Bar				
28 Mile Bar (bottom of Andesite)				
Andesite Bar (river right)				
Exchamsiks 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

# Anglers Interviewed	# Anglers Not Interviewed		# Anglers Interviewed	# Anglers Not Interviewed		# Anglers Interviewed	# Anglers Not Interviewed		# Anglers Interviewed	# Anglers 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

# Anglers Interviewed	# Anglers Not Interviewed		# Anglers Interviewed	# Anglers Not Interviewed		# Anglers Interviewed	# Anglers Not Interviewed		# Anglers Interviewed	# Anglers 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: _____

Lower Skeena River Creel Survey: Biosampling Form 2011

Form#:

Date yy/mm/dd	Zone No.	Site Name	Interview No.	Species	Fish Fork Length cm	Adipose Clipped Y / N	External Tag Y / N	Tag No.	Scale Book No.	Fish No. 1-5	Comments

Appendix 2. Proposed survey schedule and actual shifts worked.

June -proposed															June-actual													
		Boat Survey				Shore Survey									Boat Survey				Shore Survey									
		Kwinitsa		Kalum		Terrace		China Bar		Survey Team					Kwinitsa		Kalum		Terrace		China Bar		Survey Team					
Date	Day	AM	PM	AM	PM	AM	PM	AM	PM	DR	DN	RB	WB	RM	AM	PM	AM	PM	AM	PM	AM	PM	DR	DN	RB	WB	RM
1	W																											
2	Th																											
3	F		B							F	B	B											F					
4	Sa		B				FK			F	B	B	S	S									F					
5	Su				B	FK				F	B	B	S	S									F					
6	M							C		F			S	S				B		FK		C	F	B	B	S	S
7	T						FK						S	S	B					FK		C		B	B	S	S
8	W																			FK		C				S	S
9	Th		B							O	B	B				B				FK		C	O	B	B	S	S
10	F				B	FK				F	B	B	S	S				B		FK			F	B	B	S	S
11	Sa		B			FK				F	B	B	S	S				B	FK				F	B	B		
12	Su				B			C			B	B	S	S		B					C			B	B		
13	M		B				FK				B	B	S	S		B				FK				B	B	S	S
14	T							C		O			S	S					FK		C		O			S	S
15	W																		FK		C					S	S
16	Th				B					O	B	B				B			FK		C		O	B	B	S	S
17	F		B							O	B	B				B			FK		C		O	B	B	S	S
18	Sa				B	FK				F	B	B	S	S				B	FK		C		F	B	B	S	S
19	Su		B				FK				B	B	S	S		B			FK		C			B	B	S	S
20	M				B	FK				O	B	B	S	S				B	FK				O	B	B	S	S
21	T	Aboriginal Day						C		O			S	S	Aboriginal Day								O				
22	W						FK						S	S						FK		C				S	S
23	Th		B					C		O	B	B	S	S		B							O	B	B		
24	F				B					O	B	B						B					O	B	B		
25	Sa		B				FK			F	B	B	S	S		B				FK		C	F	B	B	S	S
26	Su				B			C			B	B	S	S				B	FK		C			B	B	S	S
27	M						FK						S	S		B				FK		C		B	B	S	S
28	T				B	FK				O	B	B	S	S					FK				O			S	S
29	W					FK				O			S	S									O				
30	Th				B					O	B	B						B					O	B	B		
Weekday			5		6	4	4	4	0						1	6		5	6	6	4	6					
Weekend			4		4	3	3	2	0	19	19	19	20	20	0	3		3	4	3	4	1	19	18	18	18	18

Appendix 2 continued.

JULY - Proposed																July-actual													
		Boat Survey				Shore Survey										Boat Survey				Shore Survey									
		Kwinitsa		Kalum		Terrace		China Bar		Survey Team						Kwinitsa		Kalum		Terrace		China Bar		Survey Team					
Date	Day	AM	PM	AM	PM	AM	PM	AM	PM	DR	DN	RB	WB	RM		AM	PM	AM	PM	AM	PM	AM	PM	DR	DN	RB	WB	RM	
1	F				B			C			B	B	S	S			B			FK					B	B	S	S	
2	Sa		B				FK				B	B	S	S					B		FK				B	B	S	S	
3	Su				B	FK					B	B	S	S			B			FK					B	B	S	S	
4	M				B			C		O	B	B	S	S					B	FK				O	B	B	S	S	
5	T						FK			O			S	S						FK				O			S	S	
6	W									O														O					
7	Th		B							O	B	B					B							F	B	B			
8	F				B	FK				O	B	B	S	S					B	FK				O	B	B	S	S	
9	Sa		B			FK					B	B	S	S			B			FK					B	B	S	S	
10	Su				B			C			B	B	S	S					B	FK		C			B	B	S	S	
11	M		B				FK			O	B	B	S	S			B				FK			O	B	B	S	S	
12	T							C		O			S	S						FK		C		O			S	S	
13	W									O														O					
14	Th				B						B	B							B						B	B			
15	F		B				FK			O	B	B	S	S			B				FK			O	B	B	S	S	
16	Sa			B		FK					B	B	S	S				B		FK					B	B	S	S	
17	Su	B					FK				B	B	S	S		B				FK					B	B	S	S	
18	M			B		FK				O	B	B	S	S				B		FK				O	B	B	S	S	
19	T							C		O			S	S						FK		C		O			S	S	
20	W						FK			O			S	S							FK		C	O			S	S	
21	Th		B							O	B	B					B							O	B	B			
22	F				B					O	B	B							B					O	B	B			
23	Sa		B				FK				B	B	S	S			B				FK				B	B	S	S	
24	Su				B			C			B	B	S	S					B	FK		C			B	B	S	S	
25	M		B				FK			O	B	B	S	S			B				FK			O	B	B	S	S	
26	T					FK				O			S	S						FK				O			S	S	
27	W						FK			O			S	S							FK		C	O			S	S	
28	Th																B								B	B			
29	F				B						B	B							B						B	B			
30	Sa				B	FK					B	B	S	S					B	FK					B	B	S	S	
31	Su		B				FK				B	B	S	S			B				FK				B	B	S	S	
	Weekday	0	5		4	4	7	3	0							0	6	1	5	8	5	2	2						
	Weekend	1	4		6	3	3	3	0	17	22	22	23	23		1	5	1	4	7	3	2	0	17	23	23	23	23	

Appendix 2 continued.

SEPTEMBER- proposed															September-actual													
		Boat Survey				Shore Survey									Boat Survey				Shore Survey									
		Kwinitsa		Kalum		Terrace		China Bar		Survey Team					Kwinitsa		Kalum		Terrace		China Bar		Survey Team				
Date	Day	AM	PM	AM	PM	AM	PM	AM	PM	DR	DN	RB	WB	RM	AM	PM	AM	PM	AM	PM	AM	PM	DR	DN	RB	WB	RM
1	Th		B					C		O	B	B	S	S			B*		FK		C		O	B	B		S
2	F		B				FK			O	B	B	S	S	B*					FK			O	B	B		S
3	Sa				B	FK					B	B	S	S			B*		FK		C			B	B		S
4	Su		B				FK				B	B	S	S						FK						S	S
5	M				B	FK					B	B	S	S													
6	T									O													O				
7	W									O													O				
8	Th		B				FK			O	B	B	S	S						FK			O			S	S
9	F				B	FK				O	B	B	S	S	B*				FK				O	B	B	S	S
10	Sa		B				FK				B	B	S	S		B*				FK				B	B	S	S
11	Su				B			C			B	B	S	S			B*		FK		C			B	B	S	S
12	M		B			FK					B	B	S	S	B*				FK					B	B	S	S
13	T				B		FK			O	B	B	S	S			B*			FK			O	B	B	S	S
14	W									O													O				
15	Th																										
16	F									O							B*						O				
17	Sa				B	FK					B	B	S	S			B*		FK					B	B	S	S
18	Su		B				FK				B	B	S	S	B*					FK				B	B	S	S
19	M				B					O	B	B					B*		FK		C		O	B	B	S	S
20	T														B*				FK					B	B	S	S
21	W																										
22	Th																										
23	F					FK				O			S	S									O				
24	Sa		B				FK				B	B	S	S			B*			FK				B	B	S	S
25	Su																		FK							S	S
26	M									O							B*		FK				O			S	S
27	T									O					B*				FK				O			S	S
28	W									O					B*				FK		C		O			S	S
29	Th																										
30	F																										
	Weekday		4		3	3	3	1	0						5	0	5	0	8	3	3	0					
	Weekend		4		4	3	4	1	0	14	15	15	15	15	2	1	4	0	4	4	2	0	14	13	13	16	19

* Boat crew conducted effort surveys, but did not interview anglers

Appendix 2 continued.

SEPTEMBER- proposed															September-actual													
		Boat Survey				Shore Survey									Boat Survey				Shore Survey									
		Kwinitsa		Kalum		Terrace		China Bar		Survey Team					Kwinitsa		Kalum		Terrace		China Bar		Survey Team				
Date	Day	AM	PM	AM	PM	AM	PM	AM	PM	DR	DN	RB	WB	RM	AM	PM	AM	PM	AM	PM	AM	PM	DR	DN	RB	WB	RM
1	Th		**B**					**C**		O	**B**	**B**	**S**	**S**			**B***		**FK**		**C**		O	**B**	**B**		**S**
2	**F**		**B**				**FK**			O	**B**	**B**	**S**	**S**	**B***					**FK**			O	**B**	**B**		**S**
3	**Sa**				**B**	**FK**					**B**	**B**	**S**	**S**			**B***		**FK**		**C**			**B**	**B**		**S**
4	**Su**		**B**				**FK**				**B**	**B**	**S**	**S**						**FK**						**S**	**S**
5	**M**				**B**	**FK**					**B**	**B**	**S**	**S**													
6	**T**									O													O				
7	**W**									O													O				
8	**Th**		**B**				**FK**			O	**B**	**B**	**S**	**S**						**FK**			O			**S**	**S**
9	**F**				**B**	**FK**				O	**B**	**B**	**S**	**S**	**B***				**FK**				O	**B**	**B**	**S**	**S**
10	**Sa**		**B**				**FK**				**B**	**B**	**S**	**S**		**B***				**FK**				**B**	**B**	**S**	**S**
11	**Su**				**B**			**C**			**B**	**B**	**S**	**S**			**B***		**FK**		**C**			**B**	**B**	**S**	**S**
12	**M**		**B**			**FK**					**B**	**B**	**S**	**S**	**B***				**FK**					**B**	**B**	**S**	**S**
13	**T**				**B**		**FK**			O	**B**	**B**	**S**	**S**			**B***			**FK**			O	**B**	**B**	**S**	**S**
14	**W**									O													O				
15	**Th**																										
16	**F**									O							**B***						O				
17	**Sa**				**B**	**FK**					**B**	**B**	**S**	**S**			**B***		**FK**					**B**	**B**	**S**	**S**
18	**Su**		**B**				**FK**				**B**	**B**	**S**	**S**	**B***					**FK**				**B**	**B**	**S**	**S**
19	**M**				**B**					O	**B**	**B**					**B***		**FK**		**C**		O	**B**	**B**	**S**	**S**
20	**T**														**B***				**FK**					**B**	**B**	**S**	**S**
21	**W**																										
22	**Th**																										
23	**F**					**FK**				O			**S**	**S**									O				
24	**Sa**		**B**				**FK**				**B**	**B**	**S**	**S**			**B***			**FK**				**B**	**B**	**S**	**S**
25	**Su**																		**FK**							**S**	**S**
26	**M**									O							**B***		**FK**				O			**S**	**S**
27	**T**									O					**B***				**FK**				O			**S**	**S**
28	**W**									O					**B***				**FK**		**C**		O			**S**	**S**
29	**Th**																										
30	**F**																										
			4		3	3	3	1	0						5	0	5	0	8	3	3	0					
	Total		4		4	3	4	1	0	14	15	15	15	15	2	1	4	0	4	4	2	0	14	13	13	16	19

* Boat crew conducted effort surveys, but did not interview anglers

Appendix 3. Boat-based effort data, including angler counts and survey dates and times.

		Survey Timing and Duration						Angler Counts								
		Zone 1		Zone 2		Zone 3		Zone 1		Zone 2		Zone 3		Boat	Shore	Overall
Day Type	Date	Start	End	Start	End	Start	End	Boat	Shore	Boat	Shore	Boat	Shore	Total	Total	Total
WD	20 Jun					14:40	15:05					0	0	0	0	0
WD	23 Jun					14:42	15:11					0	0	0	0	0
WD	27 Jun					16:00	16:20					0	0	0	0	0
WD	30 Jun	14:20	14:55	14:56	15:39	15:40	16:00	4	5	8	0	2	0	14	5	19
WD	6 Jun	13:11	13:59	14:00	14:25			0	0	0	0			0	0	0
WD	7 Jun					11:25	12:00					0	0	0	0	0
WD	9 Jun					15:10	16:10					0	0	0	0	0
WD	10 Jun	17:10	17:59	18:00	18:15			0	0	0	0			0	0	0
WE	11 Jun	13:37	15:04	15:05	15:37	15:38	16:00	0	0	0	0	0	0	0	0	0
WE	12 Jun			16:01	16:10	15:00	16:00			0	0	0	0	0	0	0
WD	13 Jun					14:10	14:40					0	0	0	0	0
WD	16 Jun			15:16	15:30	14:15	15:15			0	0	0	0	0	0	0
WD	17 Jun			16:21	16:30	15:20	16:20			0	0	0	0	0	0	0
WE	18 Jun	14:15	15:24	15:25	16:00			10	7	0	0			10	7	17
WE	19 Jun					14:38	16:17					0	0	0	0	0
WD	24 Jun	14:10	15:34	15:35	16:11	16:12	16:45	4	8	4	0	2	0	10	8	18
WE	25 Jun					15:02	19:15					2	6	2	6	8
WE	26 Jun	13:55	15:06	15:07	15:41			10	16	2	0			12	16	28
WE	1 Jul					14:45	14:55					0	3	0	3	3
WE	2 Jul	14:10	16:19	16:20	17:10			23	33	10	4			33	37	70
WE	3 Jul					14:50	15:35					0	5	0	5	5
WD	4 Jul	15:10	16:51	16:52	17:00			24	19	2	0			26	19	45
WD	7 Jul					15:15	17:45					0	20	0	20	20
WD	8 Jul	15:11	17:37	17:38	19:02			35	36	0	8			35	44	79
WE	9 Jul					15:18	17:50					0	8	0	8	8
WE	10 Jul	13:48	16:52	16:53	17:45			31	29	18	15			49	44	93
WD	11 Jul					15:10	18:18					10	15	10	15	25
WD	14 Jul	15:31	16:56	16:56	17:30			2	10	6	0			8	10	18
WD	15 Jul					8:47	11:07					15	4	15	4	19
WE	16 Jul	8:00	10:02	10:03	12:03			26	29	10	21			36	50	86
WE	17 Jul					9:30	13:48					5	33	5	33	38
WD	18 Jul	10:25	13:56	13:57	14:12			43	3	7	0			50	3	53
WD	21 Jul					17:13	19:01					18	12	18	12	30
WD	22 Jul	12:50	13:43	13:43	14:15			48	42	4	29			52	71	123
WE	23 Jul					16:35	18:20					23	26	23	26	49
WE	24 Jul	12:52	13:43	13:43	14:10			67	28	8	32			75	60	135
WD	25 Jul					14:26	16:00					15	18	15	18	33
WD	28 Jul					15:48	14:25					9	12	9	12	21
WD	29 Jul	12:57	13:46	13:46	14:28			60	30	9	28			69	58	127
WE	30 Jul	13:00	14:35	14:35	15:15			49	39	8	33			57	72	129
WE	31 Jul					14:10	15:35					29	39	29	39	68
WE	1 Aug	12:55	13:55	13:55	14:30			68	53	12	30			80	83	163
WD	2 Aug					15:47	17:04					4	26	4	26	30
WD	3 Aug	12:50	13:43	13:43	14:31			42	23	9	30			51	53	104
WE	6 Aug					14:10	15:32					6	54	6	54	60

continued…

Appendix 3 continued.

		Survey Timing and Duration						Angler Counts								
		Zone 1		Zone 2		Zone 3		Zone 1		Zone 2		Zone 3		Boat	Shore	Overall
Day Type	Date	Start	End	Start	End	Start	End	Boat	Shore	Boat	Shore	Boat	Shore	Total	Total	Total
WE	7 Aug	12:48	13:55	13:55	14:10			41	18	14	35			55	53	108
WD	8 Aug					15:00	16:12					7	28	7	28	35
WD	11 Aug	16:30	17:16	17:16	18:18			17	0	5	7			22	7	29
WD	12 Aug					12:57	14:20					17	36	17	36	53
WE	13 Aug	11:56	12:45	12:45	13:34			37	19	4	15			41	34	75
WE	14 Aug					13:16	14:32					13	45	13	45	58
WD	18 Aug					13:54	15:14					4	44	4	44	48
WD	15 Aug	13:12	14:03	14:03	15:05			39	18	13	7			52	25	77
WD	19 Aug	12:03	12:54	12:54	13:47			29	15	9	1			38	16	54
WE	21 Aug	11:54	12:43	12:43	13:41			33	14	3	3			36	17	53
WD	22 Aug					14:10	15:31					0	6	0	6	6
WE	20 Aug					13:22	14:41					2	24	2	24	26
WD	23 Aug	12:41	13:31	13:31	14:20			14	6	32	0			46	6	52
WD	26 Aug	13:51	14:35	14:35	15:20			18	10	8	2			26	12	38
WE	27 Aug					9:59	11:14					5	19	5	19	24
WD	30 Aug	9:48	10:36	10:36	11:35			22	17	9	9			31	26	57
WD	31 Aug					10:12	11:20					9	11	9	11	20
WD	1 Sep	9:48	10:43	10:43	11:30			24	8	7	0			31	8	39
WD	2 Sep					10:45	12:05					11	12	11	12	23
WE	3 Sep	9:27	10:17	10:17	11:05			29	9	2	6			31	15	46
WD	9 Sep	9:15	10:04	10:04	11:01			1	0	0	0			1	0	1
WE	10 Sep					10:01	11:15					0	2	0	2	2
WE	11 Sep	9:30	10:20	10:20	11:02			10	1	0	0			10	1	11
WD	12 Sep					11:12	12:35					5	4	5	4	9
WD	13 Sep	11:08	11:57	11:57	12:46			7	3	4	0			11	3	14
WD	16 Sep	9:00	10:20	10:20	11:15			11	7	2	1			13	8	21
WE	17 Sep	9:40	10:35	10:35	11:20			13	5	8	0			21	5	26
WE	18 Sep					10:35	11:55					4	20	4	20	24
WD	19 Sep	10:40	11:35	11:35	12:27			6	6	9	9			15	15	30
WD	20 Sep					10:30	11:45					6	17	6	17	23
WD	23 Sep	9:40	10:40	10:40	11:35			0	0	0	0			0	0	0
WE	24 Sep					10:35	11:55					0	5	0	5	5
WD	26 Sep	11:08	12:01	12:01	12:50			0	0	0	0			0	0	0
WD	27 Sep					10:25	11:00					0	2	0	2	2
WD	28 Sep					10:10	10:40					0	0	0	0	0

				Average Angler Counts								
	Number of Surveys Performed			Zone 1		Zone 2		Zone 3		Boat	Shore	Overall
Date Range	Zone 1	Zone 2	Zone 3	Boat	Shore	Boat	Shore	Boat	Shore	Total	Total	Total
1 - 30 June	7	10	14	4.0	5.1	1.4	0.0	0.4	0.4	5.8	5.6	11.4
1 July - 6 Aug	13	13	14	39.8	28.8	7.9	17.7	9.6	19.6	57.3	66.1	123.4
7 - 31 Aug	9	9	8	27.8	13.0	10.8	8.8	7.1	26.6	45.7	48.4	94.1
1 - 30 Sept	10	10	8	10.1	3.9	3.2	1.6	3.3	7.8	16.6	13.3	29.8
Total	39	42	44	23.0	14.5	5.9	7.7	5.1	12.6	33.9	34.9	68.8