EA3078

Peace River Angling and Recreational-Use Creel Survey 2008-2009

Final Report

Prepared by:

D. Robichaud, M. Mathews, A. Blakley and R. Bocking

LGL Limited

9768 Second Street,

Sidney, BC

V8L 3Y8

Prepared for:

BC Hydro

Vancouver, B.C.

20 February 2010

EXECUTIVE SUMMARY

Sport fishing and river-based recreation are important activities to the communities and economy of the Peace Region and BC Hydro is interested in determining how the potential construction and operation of the Site C dam would change the pattern of river-use. With the aim of establishing a baseline for future assessment, a creel survey was initiated to monitor recreational use (particularly fishing activities) on the Peace and Pine rivers and to interview recreational users in order to quantify the timing, duration, type and location of their recreational activities.

This study focused on the Peace River from Peace Canyon Dam to the Alberta Border (including the lower reaches of tributaries that would be affected by inundation) and parts of the Pine River. The study was conducted from 15 May 2008 to 31 October 2009 for a total of 17.5 months of survey activity. In order to survey a random selection of river users, interviews were conducted at randomly-selected access sites using a randomized work schedule. Over-flights were also conducted on random dates. Flight and interviewing effort were evenly distributed between weekends and weekdays (i.e., 'day types'), and among four geographic river strata. During the study period, 65 over-flights were conducted, and 622 anglers and 5,096 recreational users were interviewed. Data for recreational use, angler effort, catch, and harvests were analyzed to generate monthly, seasonal and annual (12 month) estimates. In generating the annual estimates, data for May - September in each of 2008 and 2009 were combined to generate a pooled estimate for each of those months. Inter-annual variability in recreational use, angler effort and catch was assessed for the June - September summertime period.

The results of the recreational and angling surveys outlined in this report should help inform decisions regarding the potential impacts of the construction and operation of a hydro dam at Site C.

Angling

Angler activity patterns differed by day type and access method. Angler activity was bimodal on weekdays, and was unimodal on weekends; and boat-based activity occurred later in the day, on average, than shore-based angling activity. Angling effort differed significantly among months, among river strata, and between day types, but did not differ significantly between boat and shore anglers. Total annual angling effort was estimated to be 24,622 angler-hours (6,757 angler-days), of which 18,489 hours (5,070 angler-days) were in the Peace River mainstem, and 6,134 hours (1,687 angler-days) were in the Pine River watershed. Within the Peace River, the largest proportion (53%) of the angling activity occurred in the river stratum from Hudson's Hope to Site C.

The annual catch (fish harvested and released) estimates showed that Arctic grayling (2,446 fish, SE = 1,512) and mountain whitefish (2,443 fish, SE = 1,996) were the species that were caught in greatest numbers, the majority of which were caught in the Pine River. The total annual catch of rainbow trout and bull trout, summed across all strata was estimated at 1,883 fish (SE = 1446) and 1,569 fish (SE = 1,220), respectively. Annual catch estimates for the Peace River mainstem indicated that rainbow trout was caught most frequently (1,786 fish, SE = 1,407), followed by bull trout (983 fish, SE = 850) and mountain whitefish (978 fish, SE = 1,009). For certain species (e.g., rainbow trout), the distribution of catch across river strata was strongly skewed

with larger numbers of fish caught in the areas upstream of Site C. No burbot or kokanee were reported as caught during the study period. Typical of creel analyses, estimates have been produced with large standard errors resulting from natural variability in the population and sampling error.

Total annual harvest (retained fish) was dominated by Arctic grayling (284 fish, SE = 234), rainbow trout (224 fish, SE = 223) and mountain whitefish (182 fish, SE = 365). Retention rates were highest for lake trout and northern pike, with 27% and 14% of catch retained, respectively. Despite being a catch and release fishery, bull trout were retained 5% of the time.

Summertime angling effort in 2009 was about half that in 2008; and total species-specific summertime catch in 2009 ranged from 15% (Arctic grayling) to 88% (bull trout) of that in 2008.

Recreational Users

Recreational activity patterns differed by day type and between summer and winter. Summer activities extended later into the day compared to winter activities. In summer, weekday activities peaked in the evenings ('after work'), whereas weekend and holiday activities peaked in the middle of the day. Total annual recreational activity level was estimated to be 144,892 user-hours (15,909 user-days), of which 94,141 hours (10,353 user-days) were in the Peace River mainstem.

The recreational use analysis indicated that camping was the most common activity from May through September, and jet-boating was the most popular in April, October and November. Fishing was a popular activity until October; and hunting was popular in the fall. In the summer months, swimming, camping, picnicking and shoreline leisure were popular activities Fishing and jet-boating were the predominant activities upstream of the potential Site C location, whereas camping and jet-boating were most popular downstream of Site C and in the Pine River. In terms of river access, Peace Island Park was used more than any other site, regardless of day type. Within the Peace River, 28% of the recreational activity occurred in the potential inundation zone from Peace Canyon Dam to Site C.

Summertime recreational activity levels were 14% higher in 2009 than in 2008, with the increase most pronounced between Hudson's Hope and the Alberta border. June to September recreational activity levels declined by 46% in the Pine River between 2008 and 2009.

Recreational Sites

An additional aspect of the study was to identify and describe all recreational use sites located within the Peace River mainstem, potentially inundated tributaries, and the Pine River mainstem. In total 49 sites were identified, 32 of which were found throughout the mainstem Peace River, 2 on the Halfway River and 15 on the Pine River. The majority of these were either some form of campsite, shoreline access or boat launch and the most common types of activities occurring at these sites were camping, fishing and boating. Discussions with local residents and recreational groups were crucial in determining not only the sites but also where and when various activities occur. In total, 29 of the recreational use sites have been documented within the potential inundation zone (from Peace Canyon Dam to Site C) and hence could be directly affected by inundation from Site C.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOS

LIST OF APPENDICES

INTRODUCTION

BC Hydro is considering the Peace River Site C hydroelectric project (Site C) in northeastern British Columbia as an option to help meet BC's future electricity needs. No decision has been made to build Site C (BC Hydro, 2008) and BC Hydro is taking a stage-by-stage approach to the evaluation of Site C. At the end of each stage, BC Hydro will make a recommendation to the provincial government about whether to proceed to the next stage of project planning and development. The Peace River Site C Hydro Project is currently in Stage 2: "Project Definition and Consultation." As part of Stage 2, studies are being conducted to develop an understanding of current Peace River recreational activity patterns. This baseline information will be used to assess the possible future impacts on recreation activities in the Peace River region, should the Site C project proceed. Moreover, knowledge of potential effects on recreation and of potentially new recreational opportunities is important for effective water management planning.

The current study, part of Stage 2 investigations, includes a survey of anglers and recreation users in the region, as well as the identification and mapping of recreational sites and facilities in the region (e.g., formal and informal access areas, day use areas, hiking trails, camping spots, and fishing or hunting areas). A more comprehensive socio-economic study will be conducted as part of Stage 2 investigations.

Sport fishing and river-based recreation are important activities to the communities and economy of the Peace Region. A roving creel census was used in 1985 to estimate that 8,600 anglers fished the Peace River between Peace Canyon Dam and Hudson's Hope between June and October, for a total of 16,890 angler-hours (Hammond 1986). A subsequent exit creel survey (May to October, 1989; and April to June 1990), monitoring a larger geographic area, estimated a total angling effort of 18,500 angler-hours between Peace Canyon Dam and Taylor (including the lower reaches of the Pine, Halfway, and Moberly rivers; DPA 1991). Both creel surveys showed similar patterns of river-use: the majority of fishing effort takes place nearest Peace Canyon Dam, with only a small percentage (6%) occurring downstream of the potential Site C location (DPA 1991). However, the construction and operation of the Site C dam would likely change the pattern of river-use (e.g., a shift from river-based to reservoir-based activities; BC Hydro, 2008), affect angling opportunities (e.g., by changing river and reservoir access); and, therefore modify pressure on sport-fish species.

Previous studies have identified recreational use sites in the Peace River valley (Edwin Reid & Associates Ltd. 1979, DPA 1981a and MacLaren Plansearch Corp. 1991) with regards to potential affects from Site C. A recreation impact assessment was completed in 1979 and identified 13 sites of shoreline features relevant for recreation in addition to 27 shoreline locations with evidence of some type of continuous use (camping or picnicking; Edwin Reid & Associates Ltd. 1979). DPA Consulting Limited (1981a) conducted an inventory of recreational sites in the Peace River valley from Hudson's Hope to Taylor during a recreation survey in 1981, identifying only six significant recreational access sites. In 1990, MacLaren Plansearch Corp (1991) studied the recreation and tourism resources of the area affected by Site C, identifying 24 sites (including 2 sites outside the reservoir area). In 2002, Lions Gate Consulting Inc. et al. conducted a literature review of Site C planning documents and identified four boat launches, one park, five recreation reserves, two river access points, four highway rest stops and numerous rustic campsites from a 1977 inventory of recreational facilities.

This report summarizes research activities that were conducted from mid May 2008 through to the end of October 2009. The report describes Peace River recreational facilities, and summarizes recreational use patterns during the study period. For fishing use patterns, creel data have been analyzed to produce estimates of catch and effort and to describe fishing activity patterns.

SCOPE

The geographic scope of the study is the Peace River, extending from the Peace Canyon Dam to the BC/Alberta border, a distance of 150 km (Figure 1). In addition, the study area includes the Pine River (up to Tumbler Ridge) and two of its tributaries (e.g., lower Murray and lower Sukunka rivers).

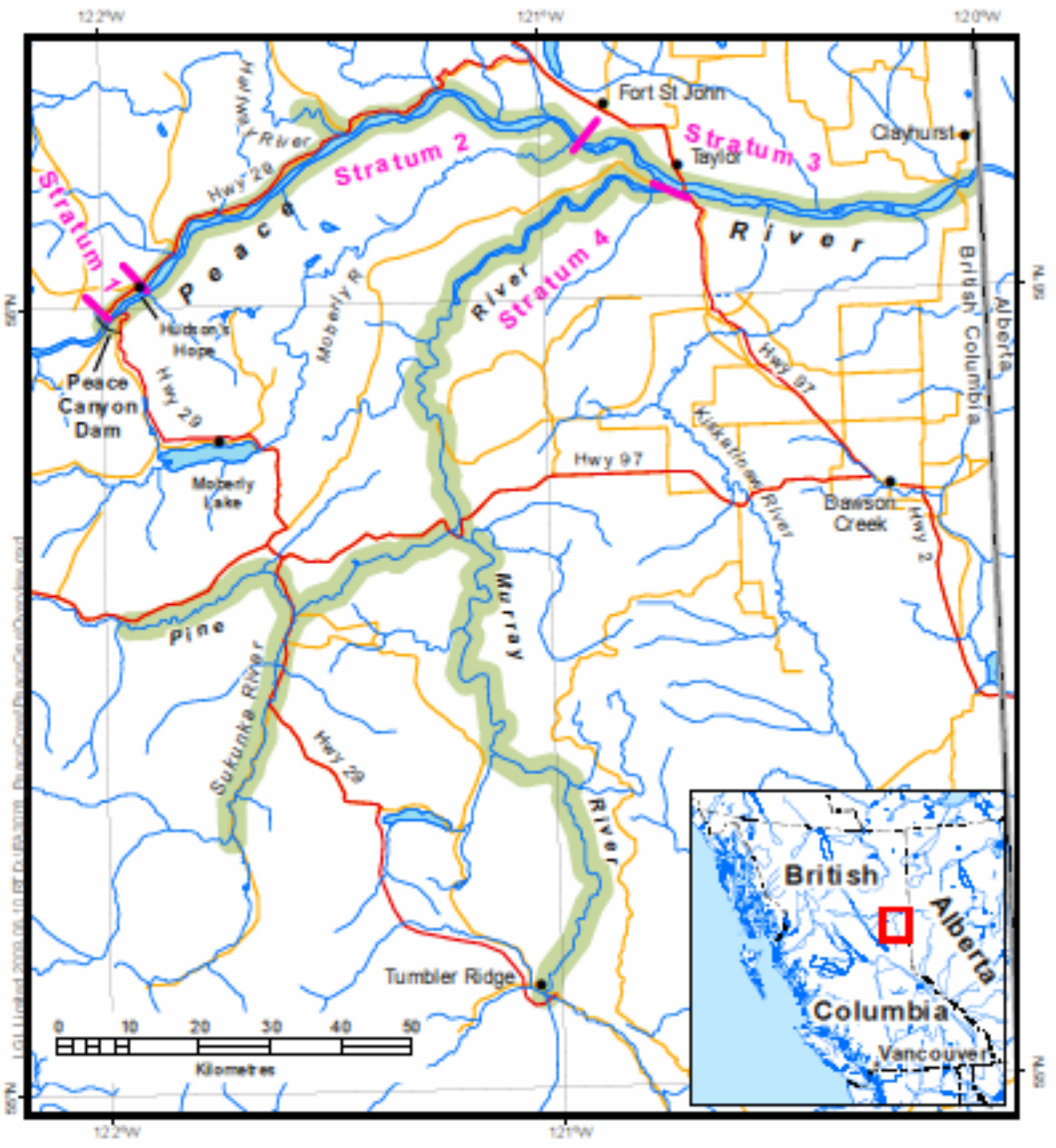


Figure 1. Peace River and its tributaries in northeast British Columbia and northwest Alberta showing study area in green shading and strata.

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

1) Peace Canyon Dam to Hudson's Hope;

2) Hudson's Hope to Site C location. This stratum also includes the lower reaches of the Halfway and Moberly rivers, as well as several smaller tributaries;

3) Site C location to the Alberta Border. This stratum also includes the lower reaches of the Pine and Beatton rivers; and

4) Pine River system (to Tumbler Ridge), including the lower Murray and lower Sukunka rivers.

The Pine River was included in this study because significant recreational fisheries are known to occur throughout the Pine River and its tributaries; and because of the hypothesis that some species of fish inhabiting the Pine (e.g., bull trout) might be migratory into the Peace River, perhaps moving upstream of Site C. This hypothesis is being tested through an extensive radio telemetry study being conducted jointly by LGL Limited and AMEC for BC Hydro.

The temporal scope of the full study was from 15 May 2008 to 31 October 2009, with the angler surveys ending one month earlier (16.5 months of interviews) than the recreational surveys (17.5 months of interviews). Catch, effort, and recreational use surveys were conducted year-round, with elevated sampling effort during the summer months. The data from both years were pooled together in an effort to produce monthly estimates of the highest possible precision. For those months in which comparable data were obtained in both years (June to September) comparisons between years were made.

The study included creel analysis of all major local sportfish species, including the six that were identified by the BC Ministry of Environment as 'indicator species' for the assessment of management objectives (MOE 2009).

OBJECTIVES

There are four primary objectives of this study:

1) Obtain statistically valid, stratified estimates of total angler effort and catch;

2) Review historical use by summarizing previous studies, and document current use patterns by conducting a detailed survey of anglers and recreational users within the study area, including mapping of access points and site amenities;

3) Assemble and present additional information related to assessing the potential effects of Site C on recreational use and angler use; and

4) Collect baseline data to develop empirical relationships linking physical impacts from Site C to factors such as fishing effort, fishing success rate, geographic distribution, species harvested, and catch value.

These objectives have been met through literature reviews, field surveys of angler and recreational use, fixed-wing surveys to estimate angler effort, and shore-based angler interviews to estimate catch per effort. The methodology used during this study is outlined in the following sections.

METHODS

Statistically Valid Estimates of Angler Effort and Catch

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 vectors of effort data by vectors of catch per effort data, for each river stratum, month, day type (weekday vs. weekend), access method (shore vs. boat), and species. This approach is superior to catch reporting calendars in four ways:

1) It is based on first-hand interviews conducted by trained interviewers rather than on the fisherman's memory or diligence in accurately filling out the form;

2) It enables interviewers to interact directly with the fisherman and validate the catch;

3) It provides timely estimates of catch and effort and allows for adaptive control of the sampling procedure; and

4) It allows for computation of statistical confidence in the estimates.

For each river stratum during each month, fishing effort was estimated by counting anglers (both on shore and in boats) from aircraft (Appendix 1); and catch per unit effort was estimated from shore-based interviews (Appendix 2). Interviews were conducted at known access points. At these locations, anglers were interviewed about their catch, effort, and fishing locations. They were also asked about their hourly fishing activity patterns both on the current and previous days. Anglers were also asked 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 bait used;

2) Angler activity – the hours during which angling activity was conducted, both on the day of the interview and on the previous day, and whether or not the trip was 'complete';

3) Fish kept – number of fish caught and kept, by river stratum and by species for the eleven most expected sport fish species: Arctic grayling (*Thymallus arcticus*), burbot (*Lota lota*), bull trout (*Salvelinus confluentus*), lake trout (*S. namaycush*), goldeye (*Hiodon alosoides*), kokanee (*Oncorhynchus nerka*), rainbow trout (*O. mykiss*), lake whitefish (*Coregonus clupeaformis*), mountain whitefish (*Prosopium williamsoni*), northern pike (*Esox lucius*) and walleye (*Sander vitreus*);

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 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.

Interviewing locations were based initially on the access locations identified in DPA (1991), but were later refined to include the twelve locations shown in Table 1. The access points 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) CPE (catch-per-effort) tends to be more variable among fishing parties landing at a single access point than 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 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.

Sampling intensity levels (Table 2) were selected to ensure adequate coverage in all four river strata, on both day types, and to ensure elevated interviewing effort during the summer months, when anglers are more active. Within each river stratum and day type, the sampling dates were selected randomly. Once a date was selected, a site within that stratum was randomly selected, where the probability of selection was based on (approximate) *a priori* expected frequencies of use by anglers and recreational users (Table 1). Interview sampling sessions were 10 hours long (9 AM to 2 PM and 4 PM to 9 PM) from April to September; and were 8 hours long (9 AM to 2 PM and 4 PM to 7 PM) from October to March. In total, 186 shifts were scheduled per year (Table 2), summing to 1,752 hours of effort per year, and with the majority of the interviewing effort focused on the summer months. Because the project start date was mid-month (15 May 2008), only 11 shifts were scheduled for May 2008; and a total of 285 shifts were scheduled from 15 May 2008 to 30 September 2009. Additional shifts were added for crew training, and, in the end, a total of 287 shifts were carried out over the study duration.

Table 1. Twelve shore-based access sites at which angler and recreational-user interviews were conducted. Two to four sites were located in each of the four study strata. For each interviewing session, the location was randomly selected by randomly selecting a stratum. Within a stratum, a site was randomly selected, where the probability of selection was based on (approximate) expected frequencies of use by anglers and recreational users.

Stratum	Site #	Site Name	Prob of selection
1. Peace Canyon Dam to Hudson's Hope	1	Highway 29 Bridge	0.2
	2	Alwin Holland Park	0.5
	3	Hudson's Hope Launch	0.3
2. Hudson's Hope to Site C	4	Lynx Creek Launch	0.3
	5	Lynx Creek RV Park	0.3
	6	Farrell Creek Mouth	0.1
	7	Halfway River Bridge	0.3
3. Site C to Alberta border	8	Peace Island	0.7
	9	Clayhurst	0.3
4. Pine watershed	10	East Pine	0.4
	11	Twidwell Bend	0.3
	12	Sukunka FS Road	0.3

Table 2. Scheduled annual sampling effort (number of interviewer shifts, and interviewer hours), by month and river stratum. Shifts were split evenly between weekday and weekend/holidays.

	Shifts per Stratum				Total	Hours per	Total
Month	PCD-HH	HH-C	C-AB	Pine	Shifts	Shift	Hours
April	6	6	6	4	22	10	220
May	6	6	6	4	22	10	220
June	6	6	6	4	22	10	220
July	6	6	6	4	22	10	220
August	6	6	6	4	22	10	220
September	6	6	6	4	22	10	220
October	3	3	3	0	9	8	72
November	3	3	3	0	9	8	72
December	3	3	3	0	9	8	72
January	3	3	3	0	9	8	72
February	3	3	3	0	9	8	72
March	3	3	3	0	9	8	72
Total per Year					186		1752

PCD = Peace Canyon Dam; HH = Hudson's Hope; C = Site C; AB = Alberta Border

During the winter months, October to March, we altered the above methodology, implementing a roving creel survey format. On random days within these months, interviewers started off at a randomly selected site within a randomly selected river stratum, and moved among the sites within that stratum over the course of the day. The intent was to increase angler contact during the off-peak fishing period.

Angler Activity Patterns

Two weighting factors were used together with the interview-derived angling activity data to estimate the daily fishing activity pattern (DPA 1981b).

The first weighting factor, *W*1, expanded the numbers of days spent interviewing at each site, 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 at site *i*, were consistent for site *i*, even during the days when no interviews occurred. A specific *W*1 was calculated for each site during each month and day type as:

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

where N_{md} was the total number of type *d* days in month *m*; and K_{mdsi} was the number of interview shifts that occurred at site *i*, 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 shift (*k*) at each site during each month and day type as:

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

where L_{mdsik} was the number of anglers observed and A_{mdsik} was the number of anglers interviewed during shift *k*, at interview location *i*, in river stratum *s*, during day type *d*, and month *m*.

The proportion of average daily angling effort (P_{mdsft}) that occurred in each of 16 hourly time-blocks (*t*) was calculated for each month, day type, river stratum, and access method as:

$$P_{mdsft} = \frac{\sum_{i}\left(W1_{mdsi}\cdot\sum_{k}\sum_{q}\left(W2_{mdsik}\cdot A_{mdsikqt}\right)\right)}{\sum_{t}\sum_{i}\left(W1_{mdsi}\cdot\sum_{k}\sum_{q}\left(W2_{mdsik}\cdot A_{mdsikqt}\right)\right)} \qquad \text{(Eqn. 3)}$$

where $A_{mdsikqt}$ was the number of anglers reporting activity during time-block *t*, that were part of the fishing party (*q*) that was interviewed during shift *k*, at site *i*, in river stratum *s*, during month

m, and on day type *d*. 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/holiday'. 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, 192 unique angler activity patterns were to be estimated (i.e., 12 months[1] × 2 day types × 4 river strata × 2 access methods). To reliably describe angler activity, a relatively large number of anglers (~ 60) needed to be interviewed in each of the 192 blocks. In the end, too few interviews were obtained (Table 3). Even after pooling the data from winter months (October to March) together into one temporal period (thus making only 7 "months" and only 112 blocks), there were still too few interviews obtained, and several levels of detail needed to be removed from the analysis of angler activity pattern. To help decide which data to pool, angler activity was plotted by month (Figure 2), by river stratum (Figure 3), by day type (Figure 3), and by access method (Figure 3). The strongest differences in activity pattern were observed between weekday and weekend/holiday anglers, and between shore and boat anglers. Since angler activity was relatively consistent among months and river strata, it was decided to pool activity data over these factors:

$$P_{dft} = \frac{\sum_m \sum_s \sum_i \left(W1_{mdsi} \cdot \sum_k \sum_q \left(W2_{mdsik} \cdot A_{mdsikqt} \right) \right)}{\sum_m \sum_s \sum_t \sum_i \left(W1_{mdsi} \cdot \sum_k \sum_q \left(W2_{mdsik} \cdot A_{mdsikqt} \right) \right)} \qquad \text{(Eqn. 4)}$$

Catch Per Effort Estimation

Catch per effort (and, similarly, harvest per effort) was estimated for each species of fish from interviews of anglers returning with their catch, conducted at the shore-based access sites. 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:

$$CPE_{mdsfri} = \frac{C_{mdsfri}}{\left(A_{mdsfi} \cdot H_{mdsfi} \right)} \qquad \text{(Eqn. 5)}$$

[1] Note that data from 2008 and 2009 were pooled together in order to generate monthly estimates of the highest possible precision, thus we only needed to calculate estimates for 12 months, despite 16.5 months of interview effort.

Table 3. The amount of data (number of anglers) available to estimate angler activity patterns, for all levels of each factor (data from 15 May 2008 to 30 September 2009). No category had adequate sample size to reliably estimate activity, thus data pooling was required.

		Access	River Stratum			
Month	Day Type	Method	PCD-HH	HH-C	C-AB	Pine
January	Weekday	Boat	0	0	0	0
		Shore	0	3	0	0
	Weekend	Boat	0	0	0	0
		Shore	0	3	0	0
February	Weekday	Boat	0	0	0	0
		Shore	0	0	0	0
	Weekend	Boat	0	0	0	0
		Shore	0	0	0	0
March	Weekday	Boat	0	0	0	0
		Shore	4	0	0	0
	Weekend	Boat	0	0	0	0
		Shore	4	0	0	0
April	Weekday	Boat	0	4	13	0
		Shore	6	0	2	0
	Weekend	Boat	0	4	13	0
		Shore	6	0	2	0
May	Weekday	Boat	11	12	0	0
		Shore	16	10	1	0
	Weekend	Boat	0	12	0	0
		Shore	70	6	5	0
June	Weekday	Boat	1	5	6	0
		Shore	61	21	2	0
	Weekend	Boat	1	14	17	0
		Shore	51	15	34	4
July	Weekday	Boat	0	16	33	0
		Shore	11	24	4	0
	Weekend	Boat	0	20	22	4
		Shore	69	48	0	2
August	Weekday	Boat	0	3	30	0
		Shore	21	34	4	6
	Weekend	Boat	0	20	48	0
		Shore	40	18	2	6
September	Weekday	Boat	0	0	7	0
		Shore	21	14	7	4
	Weekend	Boat	0	0	21	0
		Shore	24	39	5	1
October	Weekday	Boat	0	0	0	0
		Shore	6	4	0	0
	Weekend	Boat	0	0	0	0
		Shore	9	6	0	0
November	Weekday	Boat	0	0	0	0
		Shore	0	0	0	0
	Weekend	Boat	0	0	0	0
		Shore	0	0	0	0
December	Weekday	Boat	0	0	0	0
		Shore	0	0	0	0
	Weekend	Boat	0	0	0	0
		Shore	0	0	0	0

PCD = Peace Canyon Dam; HH = Hudson's Hope; C = Site C; AB = Alberta Border

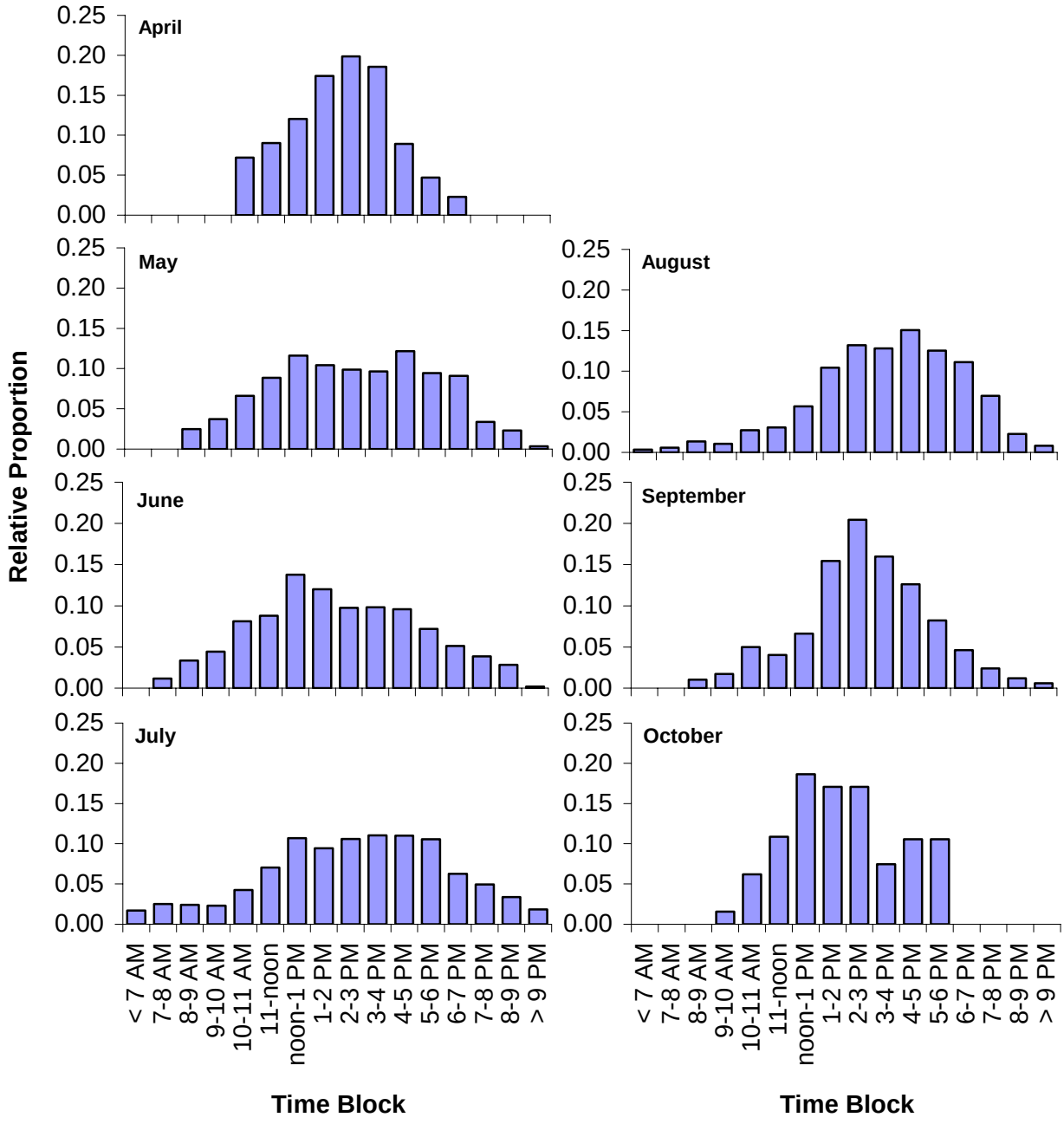


Figure 2. Angler activity patterns, by month (Nov-Mar were data deficient), from interview data collected from 15 May 2008 through 30 September 2009.

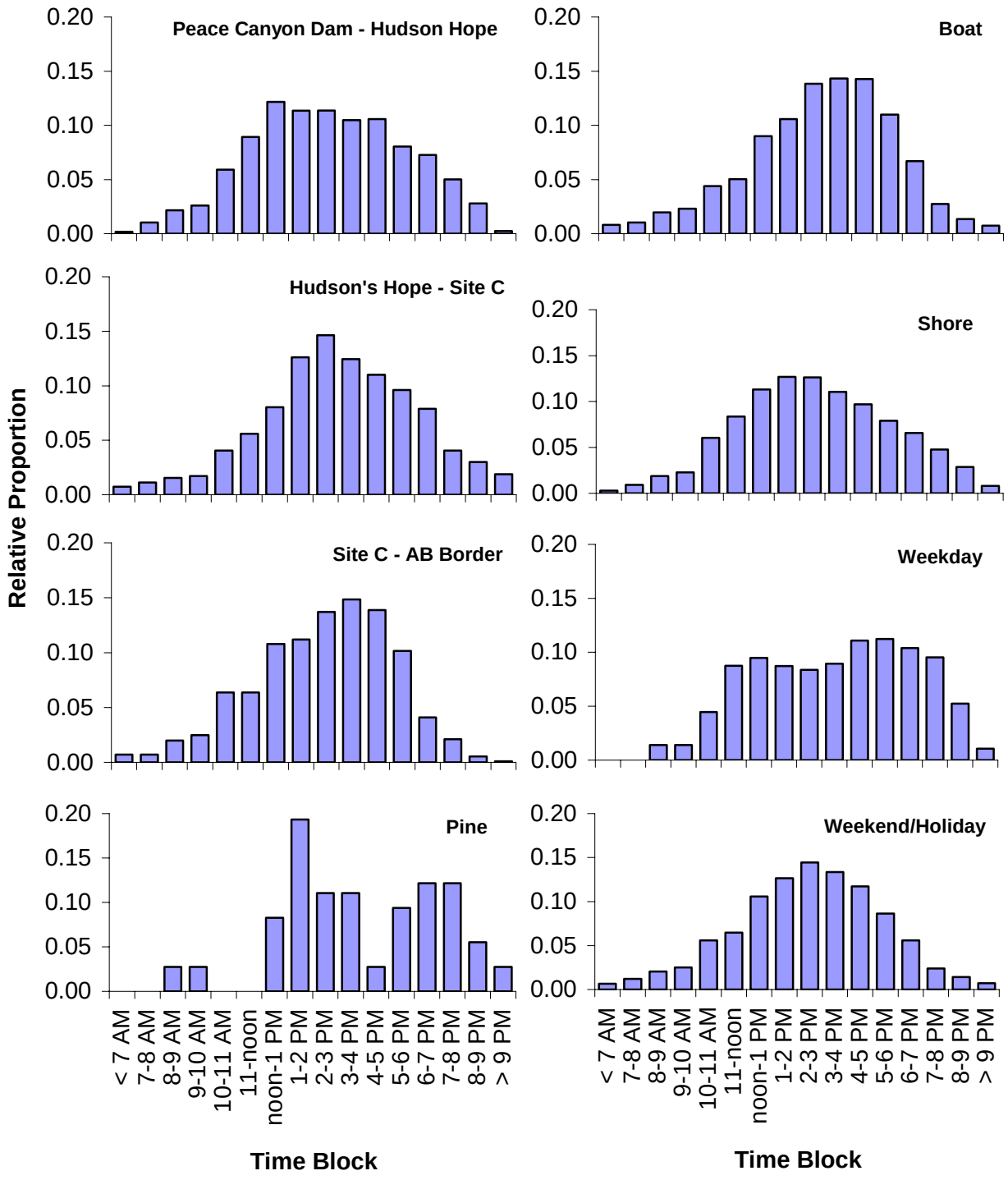


Figure 3. **Angler activity patterns, by river stratum (left column), access method (upper right column), and day type (lower right column) from interview data collected from 15 May 2008 through 30 September 2009.**

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 144 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_{msdf} interviews, pooling over day type, and dividing by the total number of angler-hours of fishing effort recorded for these interviews:

$$\hat{CPE}_{msfr} = \frac{\sum_{d}\sum_{i=1}^{n_{mdsf}} C_{mdsfri}}{\sum_{d}\sum_{i=1}^{n_{mdsf}} \left(A_{mdsfi} \cdot H_{mdsfi}\right)} \qquad \text{(Eqn. 6)}$$

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

$$S^2_{\hat{CPE}_{msfr}} = \frac{\sum_{i=1}^{n_{msdf}} (\hat{CPE}^2_{msfri}) - \frac{\sum_{i=1}^{n_{msdf}} (\hat{CPE}_{msfri})^2}{n_{msf}}}{(n_{msf} - 1)} \qquad \text{(Eqn. 7)}$$

In several instances, the month/access method/river stratum-specific sample size was too low, even after the data were pooled over day type. Due to low interview counts obtained during the winter, data from October through March have also been pooled into one temporal period for all subsequent analyses. Also, all data from the Pine, regardless of month, day type and access method, were pooled into a single CPE estimate for that river stratum.

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.

Angler Effort Estimation

To obtain statistically valid estimates of angler effort, anglers were counted from a fixed-wing aircraft (chartered through Trek Aerial Surveys, Fort St. John) flying over the study area. It took 3 hours to survey the Peace mainstem from Peace Canyon Dam to the Alberta Border (150 km), and an additional hour (from May through September) to survey the Pine River system. Aerial surveys only included the Pine River from April to September. Table 5 shows the number and frequency of over-flights scheduled, by month. The dates of the over-flights were selected randomly within each month, and were equally divided between weekday and weekend/holiday day types. A greater number of over-flights were scheduled during the peak months of June, July and August, and fewer over-flights were scheduled during the winter months.

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 15 May 2008 to 30 September 2009).

Month	Day Type	Access Method	River Stratum			
			PCD-HH	HH-C	C-AB	Pine
April	Weekday	Boat	1	0	3	0
		Shore	2	0	0	0
	Weekend	Boat	2	3	4	0
		Shore	0	5	3	0
May	Weekday	Boat	2	0	0	0
		Shore	7	2	0	0
	Weekend	Boat	6	6	0	0
		Shore	16	3	1	0
June	Weekday	Boat	0	0	0	0
		Shore	14	2	1	0
	Weekend	Boat	1	8	6	0
		Shore	22	6	3	2
July	Weekday	Boat	0	3	4	1
		Shore	4	7	1	0
	Weekend	Boat	3	15	7	8
		Shore	11	21	0	1
August	Weekday	Boat	0	1	1	0
		Shore	4	4	2	5
	Weekend	Boat	0	9	9	0
		Shore	9	11	1	0
September	Weekday	Boat	0	0	2	0
		Shore	8	2	2	0
	Weekend	Boat	0	0	7	1
		Shore	11	16	1	3
Oct-Mar	Weekday	Boat	0	0	0	n/a
		Shore	1	1	0	n/a
	Weekend	Boat	0	0	0	n/a
		Shore	6	5	0	n/a

PCD = Peace Canyon Dam; HH = Hudson's Hope; C = Site C; AB = Alberta Border

Table 5. Number and duration of scheduled aerial surveys, by month. Flights were scheduled to be 4 hours in duration when the Pine system was surveyed, and 3 hours when flights were restricted to the Peace mainstem.

Month	Total Flights	Hours per Flight	Total Hours
April	4	4	16
May	4	4	16
June	6	4	24
July	6	4	24
August	6	4	24
September	4	4	16
October	2	3	6
November	2	3	6
December	2	3	6
January	2	3	6
February	2	3	6
March	2	3	6
Total per Year	42		156

To maximize statistical precision, timing of angler effort surveys should, to the greatest extent possible, correspond to peak hourly angling effort. Initially, the timing of flights (i.e., late afternoon) was based on data from previous summertime creel surveys (e.g., DPA 1991), however, adjustments were required to account for fluctuating daylight hours. Note that monthly over-flights were chartered before collecting the corresponding hourly angling effort data (from interviews), thus flight timing did not always exactly match that of peak angling effort.

During over-flight *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*), $A_{mdosuft}$. 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 over-flight was divided by the proportion of average daily shore and boat-based angling effort (P_{dft}) that occurred during the time block when the observations were recorded. These adjusted tallies were summed over the duration of the over-flight, to calculate the total number of angler-hours of fishing on the day of the over-flight, by river stratum and access method, B_{mdsfo}:

$$B_{mdsfo} = \sum_{t} \frac{\sum_{u} A_{mdosuft}}{P_{dft}} \qquad \text{(Eqn. 8)}$$

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

$$\hat{B}_{mdsf} = \frac{\sum_{o=1}^{n_{mds}} B_{mdsfo}}{n_{mds}} \quad \text{(Eqn. 9)}$$

Total monthly fishing effort, was calculated for each day type, river stratum, and access method by multiplying the average daily effort by $\hat{N}_{md}$:

$$E_{mdsf} = \hat{B}_{mdsf} \cdot \hat{N}_{md} \quad \text{(Eqn. 10)}$$

where $\hat{N}_{md}$ was the mean number days of day type *d* that occurred in month *m*, averaged over all the times that month *m* was surveyed during the study period. Variance of the mean daily effort estimates was:

$$S^2_{\hat{B}_{mdsf}} = \frac{\sum_{o=1}^{n_{mds}} B^2_{mdsfo} - \left(\frac{\sum_{o=1}^{n_{mds}} \left(B_{mdsfo} \right)^2}{n_{mds}} \right)}{n_{mds} - 1} \cdot \left[\frac{N_{md} - n_{mds}}{N_{md} - 1} \right] \quad \text{(Eqn. 11)}$$

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

$$S^2_{E_{mdsf}} = S^2_{\hat{B}_{mdsf}} \cdot \hat{N}^2_{md} \quad \text{(Eqn. 12)}$$

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

$$S_{E_{msf}} = \sqrt{\sum_{d} \frac{S^2_{E_{mdsf}}}{n_{mds}}} \quad \text{(Eqn. 13)}$$

The average number of hours fished per angler-day was calculated by day type and access method, and used to convert angler-hour effort data into angler-days.

Total annual effort was calculated from the monthly effort estimates. Since the data from October to March have been pooled, the creel analysis produced a single 'Oct-Mar' effort estimate, which represents the average effort for each of the six months during that period. As such, the total annual effort was calculated by multiplying the 'Oct-Mar' estimates by six, and then adding the effort estimates for the other six months of the year.

Catch Estimation

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

$$C_{msfr} = \sum_{d} \left(E_{mdsf} \cdot \hat{CPE}_{msfr} \right) \qquad \text{(Eqn. 14)}$$

The standard errors for these catch estimates were derived using the following equation:

$$S_{C_{msfr}} = \sqrt{\sum_{d} \left(E_{mdsf}^2 \frac{S_{CPE_{msfr}}^2}{n_{msf}} + CPE_{msfr}^2 \frac{S_{E_{mdsf}}^2}{n_{mds}} + \frac{S_{CPE_{msfr}}^2}{n_{msf}} \frac{S_{E_{mdsf}}^2}{n_{mds}} \right)} \qquad \text{(Eqn. 15)}$$

which is based on the standard formula for combining the variance of the product of two independent random variables (Goodman 1960). Note that monthly estimates for May - September were each based on two years of data collection (2008 and 2009, pooled), whereas the October - April estimates were based on a single year's data.

Total annual catch was calculated for each species from the monthly catch estimates. Since the data from October to March have been pooled, the creel analysis produced a single 'Oct-Mar' catch estimate, which represents the average catch for each of the six months during that period. As such, the total annual catch was calculated by multiplying the 'Oct-Mar' estimates by six, and then adding the catch estimates for the other six months of the year.

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.

Comparisons between Years

For most of the analyses presented in this report (we call them the "omnibus analyses"), the data from 2008 and 2009 were pooled together an effort to produce monthly estimates of the highest possible precision. However, it was also possible to make comparisons between years for the period of June to September (the months for which comparable data were obtained in both years). To do this, the creel analysis was run two additional times: once using the 2008 data in isolation; and again using the 2009 data.

When the dataset was split by year, reduced sample sizes required additional pooling for the calculation of angler activity patterns. Specifically, the activity pattern data were pooled over month, river stratum *and* access method (whereas the pooling over access method was not required for the omnibus analyses). The use of a different activity pattern affected the effort estimates, which in turn affected the total catch estimates. As a result, the 'by-year' results are not strictly comparable to the omnibus results. Nevertheless the *relative* differences between years should be robust, since both sets of data were treated identically during the two additional creel analyses.

Other than the details described above, the 'by-year' analyses were performed using all the same calculations as those for the omnibus analysis. For this report, the 2008 angler activity pattern, angling effort levels, and total catch by species were compared to those in 2009 for the June to September periods.

The results for the 2008 'by-year' analyses can also be found in Robichaud et al. (2008). However, in that report, the May and June data were combined into a single estimation period. In this report, the May data were not included in the analyses of differences between years, since only half a month of data existed for 2008.

Biosampling

After interviewers collected angler activity and catch per effort data, and when the angler was amenable, catch was inspected. In a subset of cases, interviewers measured fork length, weighed, and took scales from the fish. From 27 August 2008 onwards, fish were also scanned for the presence of a PIT tag.

Angler and Angling Characteristics

The angler interview data were used to describe angler demographic characteristics, including their locality of origin (local, rest of BC, rest of Canada, USA, or other), and their age distribution. In addition, the data were used to calculate the relative use of bait (vs. lures or flies), the relative popularity of certain target species, and the use of guides. Also, the proportion of interviewees who said they had previously fished or planned to fish elsewhere was tabulated by location. The above metrics were calculated using the raw interview data, from both complete and incomplete fishing trips from May 2008 to the end of September 2009.

Recreational Use Patterns

Recreational Site Inventory

To assess current recreational use on the Peace and Pine Rivers, field assessments were conducted of existing facilities throughout the Peace mainstem from the Peace Canyon Dam to the Alberta border, throughout the Pine mainstem from the confluence of the Sukunka to the Peace, and in the lower sections of potentially inundated tributaries. These field studies, conducted in the summers of 2008 and 2009, were aimed at identifying current recreation sites, in particular, the current status of angler access (including locations and conditions) and the current status of amenities for recreational users (including availability and access). Recreational use sites were identified through discussions with local residents, recreational organizations and municipal staff[2].

[2] Local residents, recreational organizations and municipality personnel included: Rick Hopkins of Custom River Adventures, Christine Harwood of Lynx Creek RV Park, Eliza Stanford of the Whiskey Jack Nordic Ski Club, Gloria Baker and Troy Gould of the District of Taylor, Terry Turvey of the District of Hudson's Hope; Scott Ebert provided the map of the River Rats camp sites.

The majority of recreational sites were visited during August and September of 2008, with the exception of 13 Pine River sites and one mainstem Peace site, visited in July of 2009. Data forms were used to record all relevant information pertaining to type of recreational area, confirmed and potential uses, constraints on recreational use, location and status of access and trails and specifics regarding boat launches, types of angling and campsites (Appendix 3). All locations of important site features were recorded on a hand-held GPS unit and photographs were taken of all sites, including any notable features. Specifically, information collected included:

1) Location of the site;

2) Type of recreational area (boat access, shoreline access, campsite, picnic area, trail, cabin);

3) Confirmed and potential recreational area uses in both summer and winter (fishing, hunting, birding, wildlife viewing, jet boating, other boating, canoeing, kayaking, swimming, tubing, plant gathering, rock / fossil hunting, picnicking, camping, hiking, shoreline leisure, ATV driving, snowmobiling, snowshoeing, cross country skiing, dog sledding, and "other");

4) Constraints on recreational use (reasons for difficulties accessing property, seasonal constraints);

5) Access to the site and shoreline (bank trail, boat ramp, bushwhacking);

6) Type of boat ramp (paved, dirt, informal) and size of boat which can be launched;

7) Type of angling (shoreline or boat angling);

8) Potential hazards to users;

9) Type of campground (public, primitive maintained, unmaintained), access, size and facilities available (RV service, washroom, tent pad, fire pit, picnic table, refuse collection, etc);

10) Shoreline type (rocky, sandy beach, etc.); and

11) Bank direction of river access.

Each recreational site was classified according to its primary purpose, such as: boat launch, shoreline access, public campground, primitive maintained campsite, unmaintained campsite, cabin, or scenic location. A description of type of site classification is as follows:

1) Boat launch: access to the shoreline which allows the user to launch a boat;

2) Shoreline access: access to the shoreline which allows the user to participate in activities (i.e., fishing, canoeing, kayaking, swimming, picnicking);

3) Public campground: well maintained campground with regular upkeep that offers facilities such as RV service, washrooms or pit toilets, tent pads, fire pits, picnic tables and refuse collection. Users generally pay during prime months of operation and may reserve sites;

4) Primitive maintained campsite: moderately maintained campsite by the local boaters of the Peace River system which generally has facilities such as an outhouse, fire pit, and picnic table, used on a first come-first served basis;

5) Unmaintained campsite: unmaintained area which often only consists of an obvious clearing in the riparian zone for tents and homemade fire pits. These sites often show evidence of use over years such as obvious bank trails to indicate their location and are used on a first come-first served basis;

6) Cabin: permanent structure that provides shelter. These cabins range from modern structures with several amenities to decrepit structures with very few amenities. Most are left unlocked and may be used by several recreational users; and

7) Scenic location: natural, scenic locations that recreational users would stop to observe, such as a waterfall.

Both during and subsequent to the field assessments, discussions were held with local users and operators of the recreational sites to further determine the extent and types of recreational use as well as additional constraints on use. Discussions were also held with local recreational groups (both winter and summer activities) to determine where and how often some of these activities occur.

Recreational Activity Surveys

For each river stratum during each month, recreational use patterns were documented by counting recreational users from aircraft and by interviewing users at known access points, in conjunction with angler surveys. At these locations, users were interviewed about the nature of their activities, and their location. They were also asked about their hourly activity patterns both on the current and previous days. Users were also asked whether or not they were finished their recreational activity for the day (Appendix 4).

Data collected during interviews included:

1) Number of users and the total hours spent on both shore-and boat-based recreational activities;

2) The location of the recreational activity, and the river access location;

3) Recreational activity pattern – the hours during which the user participated in the recreational activity, both on the day of the interview and on the previous day, and whether or not the trip was ‘complete’;

4) The type of activity (fishing, hunting, birding, wildlife viewing, jet boating, other boating, canoeing, kayaking, swimming, plant gathering, rock/fossil hunting, picnicking, camping, hiking, shoreline leisure, other);

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

6) User demographics – age and community of origin; and

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

To minimize bias, the interview schedule was designed to capture data from representative recreational users in each river stratum, on both day types, and over all time periods of the day. As such, recreational use interviews were conducted concurrently with creel (fishing activity) interviews. Further methodological details of the interviews (sampling intensity levels, coverage, and randomization) can be found above.

For this report, the total number of interview respondents was tallied by month. The percentage of people interviewed who said they were participating in each activity and using each access site was calculated and tabulated by month, river stratum and access method.

Recreational Activity Patterns

Recreational activity patterns were determined from interview data using the same methods as described for angling activity patters (see "Angler Activity Patterns", above). Users whose activity included only fishing were included in the creel analysis (above), and were excluded from analyses of recreational activity patterns.

Recreational Activity Levels

Monthly and annual recreational activity levels were calculated from recreational activity pattern and over-flight data, using the same estimation methods as described for angler effort (see "Angler Effort Estimation", above). There were two details to note: 1) "water" and "land" recreational activity levels were pooled for these calculations because recreational 'access method' was not distinguished during over-flights; and 2) during over-flights, users who were not fishing were tallied as 'recreational users', thus analyses of recreational activity levels include only non-fishing activities.

Comparisons between Years

For most of the analyses presented in this report (the 'omnibus analyses'), the data from 2008 and 2009 were pooled together in order to produce monthly estimates of the highest possible precision. However, it was also possible to make comparisons between years for the period of June to September (the months for which comparable data were obtained in both years). To do this, the recreational activity analysis was run two additional times: once using the 2008 data in isolation, and again using the 2009 data. For each of these additional analyses, all calculations were identical to those for the omnibus analysis.

For this report, the 2008 recreational activity pattern and activity levels were compared to those in 2009 for the June to September periods.

Recreational User Characteristics

The recreational user interview data were used to describe user demographic characteristics, including their locality of origin (local, rest of BC, rest of Canada, USA, or other), and their age distribution. Also, the proportion of interviewees who said they had previously recreated or planned to recreate elsewhere was tabulated by location. The above metrics were calculated using the raw interview data, from both complete and incomplete trips from May 2008 to the end of October2009.

Supporting Businesses

In the autumn of 2008, businesses which support recreational use in the project area were identified from the City of Fort St. John business listings, the Fort St. John 2008 Visitor Guide and the business directories on the District of Hudson's Hope and District of Taylor websites. Supporting businesses were then categorized as accommodation, service or transportation and totaled for each municipality.

RESULTS

Estimates of Angler Effort and Catch

Angler Interviews

Over the 16.5 month study period, 622 anglers were surveyed during 291 interviews. Of these, 29 anglers said they were angling both from boats and from shore during the same fishing trip. For these anglers, half were randomly selected and entered as 'boat', and the other half as 'shore'. Of the 622 anglers interviewed, 501 reported complete trips, including 323 that fished from shore, and 178 that fished from a boat (the remaining 121 anglers had not completed their trips). Of the 622 anglers interviewed, 93 anglers (55 from shore, and 38 boat-based) reported their previous-day's fishing activity. Creel analyses in this report were based on data from 594 anglers, including 'same-day' data from 501 anglers, and 'previous-day' data from 93 anglers.

Angler Activity Patterns

As described in the Methods Section (above), low sample sizes required interview data to be pooled across years, months and river strata, resulting in sample sizes of 42, 114, 160 and 278 for weekday boat anglers, weekday shore anglers, weekend/holiday boat anglers, and weekend/holiday shore anglers, respectively.

Angler activity patterns differed by day type and fishing access method (Figure 4): There was proportionally more shore-based angling activity during morning hours, as compared to boat-based angling activity. Shore-based angler activity was distinctly bimodal on weekdays, with peaks occurring around noon and again in the late afternoon; whereas weekend/holiday shore-angling was unimodal, with the largest proportions of fishing occurring between noon and 3 PM. Boat-based angling was strongly skewed towards evening activity on weekdays, and was more evenly distributed over the afternoon on weekends/holidays.

Catch Per Effort Estimates

In order to obtain adequate sample sizes for CPE estimation, interview data were pooled over year and over day type, the October to March data were pooled, and all Pine River data were pooled together. In most cases, the pooled number of interviews was >= 3 (Table 4). The exceptions were: the August boat anglers in River Stratum 1 (n=0; CPE for Stratum 2 was assumed); the September boat anglers in River Strata 1 and 2 (n=0; CPE for Stratum 3 was assumed); shore anglers in October-March in River Stratum 3 (n=0; CPE for Stratum 2 was assumed); and boat anglers in October-March (n=0; CPE for September was assumed).

After pooling (as described above), CPE estimates were calculated for each species by month, river stratum and access method (Table 6). Month had a strong effect on CPE of mountain whitefish (Table 7; $\chi^2_6 = 14.1$, $P = 0.03$), which had highest catch rates in the October-March period, and lowest rates in April. The only strong effect of access method was for Arctic grayling (Table 7; $\chi^2_1 = 4.5$, $P = 0.03$), which was caught more readily by boat than from shore. River stratum was a strong factor influencing CPE of northern pike ($\chi^2_3 = 10.4$, $P = 0.01$), and walleye ($\chi^2_3 = 15.8$, $P = 0.001$). However, after adjusting α for the number of tests performed

(i.e., using the Bonferroni adjustment), the only effect that was statistically significant was that of river stratum on walleye CPE.

The CPE retention rates (i.e., the proportion of total CPE that was harvested) are shown for each species by month, river stratum and access method in Table 8. Mountain whitefish, Arctic grayling and rainbow trout were the most commonly retained species. Despite it being a catch and release fishery, bull trout were retained a portion of the time. Goldeye and lake whitefish were never noted as retained during the study period.

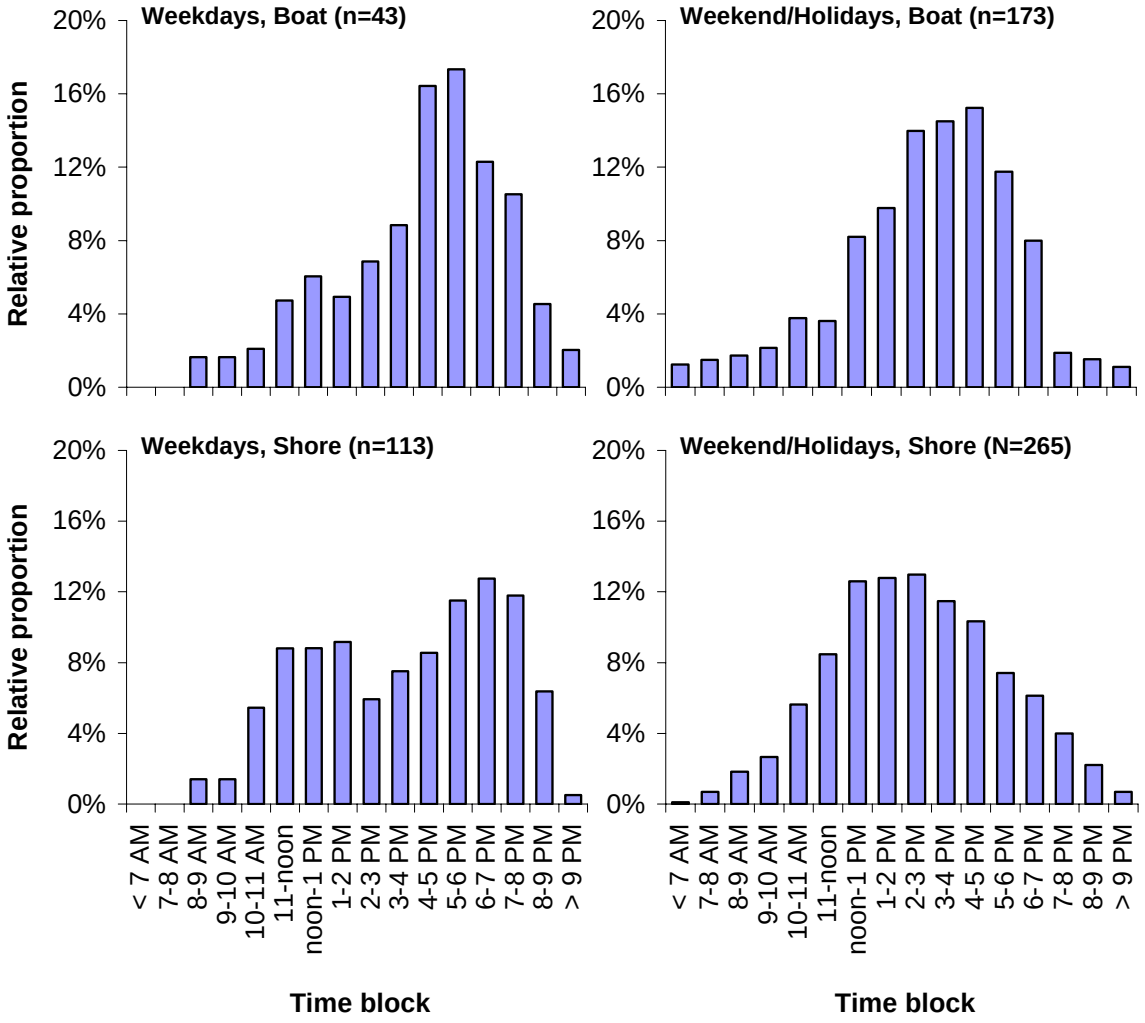


Figure 4. Activity patterns of Peace River shore and boat-based anglers on weekdays and weekends/holidays from 15 May 2008 to 30 September 2009. Bars show the relative proportion of the anglers fishing during any one time block.

Angler Effort Estimates

Over the 16.5 month study period, a total of 65 over-flights were conducted, including 33 on weekdays, and 32 on weekend/holidays. During the spring/summer months (April to

September), the average flight duration was 3.19 hours, and ranged from 1.5 to 4.7 hours. In winter (October to March), flights averaged 1.1 h as they were often cut short due to inclement weather. Some scheduled flights had to be cancelled altogether, and some could not be rescheduled. As a result, adequate sample sizes for effort calculations were obtained by pooling flight data from October to March.

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

			Species							
River Stratum	Month	Access Method	Arctic Grayling	Bull Trout	Burbot	Goldeye	Mountain Whitefish	Northern Pike	Rainbow Trout	Walleye
PCD-HH	April	Boat	0	0.41 (0.026)	0	0	0.09 (0.027)	0	0.05 (0.005)	0
	May	Boat	0	0.16 (0.019)	0	0	0.02 (0.000)	0	0.24 (0.160)	0
	June	Boat	0.10 (0.049)	0.08 (0.022)	0	0	0.03 (0.002)	0	0.26 (0.121)	0
	July	Boat	0	0.10 (0.021)	0	0	0.05 (0.006)	0	0.15 (0.068)	0
	August	Boat	0.05 (0.006)	0.02 (0.001)	0	0	0.01 (0.003)	0.02 (0.003)	0.18 (0.062)	0
	September	Boat	0	0	0	0.11 (0.160)	0.05 (0.082)	0.04 (0.018)	0.04 (0.001)	0.07 (0.071)
	Oct-Mar	Boat	0	0	0	0.11 (0.160)	0.05 (0.082)	0.04 (0.018)	0.04 (0.001)	0.07 (0.071)
	April	Shore	0	0	0	0	0	0	0	0
	May	Shore	0	0.02 (0.001)	0	0	0.02 (0.024)	0	0.10 (0.151)	0
	June	Shore	0.01 (0.000)	0.06 (0.009)	0	0	0.03 (0.010)	0.01 (0.001)	0.50 (0.744)	0
	July	Shore	0	0.08 (0.037)	0	0	0.05 (0.025)	0	0.12 (0.032)	0
	August	Shore	0	0.01 (0.019)	0	0	0	0	0.09 (0.062)	0
	September	Shore	0	0.03 (0.023)	0	0	0.03 (0.009)	0	0.37 (0.562)	0
	Oct-Mar	Shore	0	0.11 (0.022)	0	0	0.11 (0.188)	0.03 (0.143)	0.16 (0.537)	0
HH-C	April	Boat	0	0.07 (0.037)	0	0	0	0	0	0
	May	Boat	0.18 (0.067)	0	0	0	0	0	0.45 (0.241)	0
	June	Boat	0.11 (0.056)	0.08 (0.025)	0	0	0.03 (0.003)	0	0.27 (0.129)	0
	July	Boat	0.10 (0.124)	0.10 (0.063)	0	0	0.05 (0.099)	0.01 (0.000)	0.12 (0.028)	0
	August	Boat	0.05 (0.006)	0.02 (0.001)	0	0	0.01 (0.003)	0.02 (0.003)	0.18 (0.062)	0
	September	Boat	0	0	0	0.11 (0.160)	0.05 (0.082)	0.04 (0.018)	0.04 (0.001)	0.07 (0.071)
	Oct-Mar	Boat	0	0	0	0.11 (0.160)	0.05 (0.082)	0.04 (0.018)	0.04 (0.001)	0.07 (0.071)
	April	Shore	0	0	0	0	0	0	0	0
	May	Shore	0	0	0	0	0.04 (0.022)	0	0.04 (0.050)	0
	June	Shore	0	0	0	0	0	0.07 (0.007)	0.01 (0.003)	0
	July	Shore	0.08 (0.099)	0.10 (0.062)	0	0	0.19 (0.861)	0	0.15 (0.128)	0
	August	Shore	0	0.13 (0.048)	0	0	0.01 (0.004)	0	0.04 (0.071)	0
	September	Shore	0	0.04 (0.099)	0	0	0.07 (0.036)	0	0.28 (1.585)	0
	Oct-Mar	Shore	0	0.03 (0.007)	0	0	0.13 (0.033)	0	0	0
C-AB	April	Boat	0	0.02 (0.003)	0	0	0	0.04 (0.006)	0	0.02 (0.003)
	May	Boat	0.18 (0.067)	0	0	0	0	0	0.45 (0.241)	0
	June	Boat	0.14 (0.042)	0	0	0.04 (0.019)	0	0.04 (0.003)	0.11 (0.023)	0
	July	Boat	0	0.02 (0.000)	0	0	0	0.12 (0.269)	0	0.08 (0.160)
	August	Boat	0.02 (0.006)	0.02 (0.007)	0	0	0.01 (0.006)	0.07 (0.016)	0.04 (0.032)	0.01 (0.001)
	September	Boat	0	0	0	0.11 (0.160)	0.05 (0.082)	0.04 (0.018)	0.04 (0.001)	0.07 (0.071)
	Oct-Mar	Boat	0	0	0	0.11 (0.160)	0.05 (0.082)	0.04 (0.018)	0.04 (0.001)	0.07 (0.071)
	April	Shore	0	0	0	0	0	0	0	0
	May	Shore	0	0	0	0	0.04 (0.019)	0	0.04 (0.042)	0
	June	Shore	0	0	0	0	0	0.02 (1.000)	0	0
	July	Shore	0.08 (0.096)	0.10 (0.060)	0	0	0.18 (0.833)	0	0.15 (0.125)	0.01 (0.034)
	August	Shore	0	0	0	0	0	0.13 (0.037)	0	0
	September	Shore	0.20 (0.053)	0.60 (0.480)	0	0	0	0.20 (0.053)	0	1.20 (1.920)
	Oct-Mar	Shore	0	0.03 (0.007)	0	0	0.13 (0.033)	0	0	0
Pine	pooled	pooled	0.33 (0.646)	0.10 (0.067)	0	0	0.24 (0.367)	0.02 (0.003)	0.02 (0.000)	0.02 (0.003)

PCD = Peace Canyon Dam; HH = Hudson's Hope; C = Site C; AB = Alberta Border

The over-flight data were pooled over the two years and the total angling effort was estimated for each month, day type, river stratum, and access method (Table 9). There was no statistically significant effect of access method on angler effort (Table 10; $\chi^2_1 = 1.9$, $P = 0.17$). Total effort was strongly influenced by month ($\chi^2_6 = 18.0$, $P = 0.006$), river stratum ($\chi^2_3 = 13.3$, $P = 0.004$) and day type ($\chi^2_1 = 10.0$, $P = 0.002$; Figure 5). After adjusting α for the number of tests performed (i.e., using the Bonferroni adjustment), the effects month, river stratum and day type remained statistically significant (Table 10; Figure 5).

Total annual effort, summed across all strata was estimated to be 24,622 angler-hours per year (Table 9). The months with the greatest angling effort (over 5,000 angler hours per month) were August and September, followed by July (~3,500 angler hours), June (~3,000 angler hours), April and May (~2,000 angler-hours per month). On average, there was ~560 hours of angling effort per month from October to March (Table 9).

Angling effort was distributed unequally over the entire study area (Table 9), with 12% occurring in the relatively small stratum from Peace Canyon Dam and Hudson's Hope, 40% occurring from Hudson's Hope to Site C, 23% between Site C to the Alberta Border, and 25% in the Pine River watershed. For all river strata, angling effort was dominated by shore-based activity. This was especially true between Peace Canyon Dam and Hudson's Hope (83% shore-based). In the other three river strata, 61%, 66%, and 72% of angling activity was shore-based (Table 9).

Table 7. Statistical tests of the effect of month, river stratum and access method on median catch per unit effort (CPE) estimates for the 11 sport fish species 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_6^2	*P*	χ_3^2	*P*	χ_1^2	*P*
Arctic grayling	6.7	0.350	5.9	0.114	4.5	<u>0.033</u>
Bull trout	7.5	0.277	6.5	0.090	0.3	0.563
Burbot	0.0	1.000	0.0	1.000	0.0	1.000
Goldeye	5.5	0.477	4.1	0.249	2.7	0.098
Kokanee	0.0	1.000	0.0	1.000	0.0	1.000
Lake trout	6.2	0.397	4.0	0.260	0.0	0.891
Lake whitefish	8.3	0.217	0.8	0.840	1.5	0.228
Mountain whitefish	14.1	<u>0.028</u>	6.6	0.087	0.4	0.513
Northern pike	7.5	0.279	10.4	<u>0.015</u>	0.8	0.377
Rainbow trout	9.8	0.133	7.0	0.073	1.8	0.183
Walleye	7.5	0.280	15.8	**0.001**	1.6	0.205

Table 8. CPE retention rates for eight sport fish, by month, access method and river stratum.

River Stratum	Month	Access Method	Species: Arctic Grayling	Bull Trout	Burbot	Goldeye	Mountain Whitefish	Northern Pike	Rainbow Trout	Walleye
PCD-HH	April	Boat	-	0%	-	-	0%	-	0%	-
	May	Boat	-	0%	-	-	0%	-	8%	-
	June	Boat	0%	0%	-	-	0%	-	30%	-
	July	Boat	-	0%	-	-	0%	-	67%	-
	August	Boat	33%	0%	-	-	0%	0%	0%	-
	September	Boat	-	-	-	0%	100%	0%	0%	0%
	Oct-Mar	Boat	-	-	-	0%	100%	0%	0%	0%
	April	Shore	-	-	-	-	-	-	-	-
	May	Shore	-	0%	-	-	100%	-	42%	-
	June	Shore	0%	0%	-	-	83%	0%	8%	-
	July	Shore	-	0%	-	-	0%	-	0%	-
	August	Shore	-	0%	-	-	-	-	38%	-
	September	Shore	-	50%	-	-	50%	-	13%	-
	Oct-Mar	Shore	-	0%	-	-	0%	0%	0%	-
HH-C	April	Boat	-	0%	-	-	-	-	-	-
	May	Boat	100%	-	-	-	-	-	0%	-
	June	Boat	0%	0%	-	-	0%	-	30%	-
	July	Boat	23%	0%	-	-	14%	0%	25%	-
	August	Boat	33%	0%	-	-	0%	0%	0%	-
	September	Boat	-	-	-	0%	100%	0%	0%	0%
	Oct-Mar	Boat	-	-	-	0%	100%	0%	0%	0%
	April	Shore	-	-	-	-	-	-	-	-
	May	Shore	-	-	-	-	100%	-	0%	-
	June	Shore	-	-	-	-	-	0%	100%	-
	July	Shore	0%	0%	-	-	0%	-	6%	-
	August	Shore	-	44%	-	-	0%	-	67%	-
	September	Shore	-	0%	-	-	0%	-	6%	-
	Oct-Mar	Shore	-	0%	-	-	0%	-	-	-
C-AB	April	Boat	-	0%	-	-	-	0%	-	0%
	May	Boat	100%	-	-	-	-	-	0%	-
	June	Boat	0%	-	-	0%	-	0%	0%	-
	July	Boat	-	0%	-	-	-	13%	-	0%
	August	Boat	50%	0%	-	-	0%	17%	0%	0%
	September	Boat	-	-	-	0%	100%	0%	0%	0%
	Oct-Mar	Boat	-	-	-	0%	100%	0%	0%	0%
	April	Shore	-	-	-	-	-	-	-	-
	May	Shore	-	-	-	-	100%	-	0%	-
	June	Shore	-	-	-	-	-	0%	-	-
	July	Shore	0%	0%	-	-	0%	-	6%	100%
	August	Shore	-	-	-	-	-	100%	-	-
	September	Shore	0%	0%	-	-	-	0%	-	0%
	Oct-Mar	Shore	-	0%	-	-	0%	-	-	-
Pine	pooled	pooled	10%	0%	-	-	0%	0%	0%	0%

PCD = Peace Canyon Dam; HH = Hudson's Hope; C = Site C; AB = Alberta Border

The average number of hours fished per angler-day was calculated by day type and access method. Averages were 2.95 hours for 'weekdays from shore', 3.51 hours for 'weekends/holidays from shore', 4.40 hours for 'weekdays from boats, and 4.82 hours for 'weekend/holidays from boats'. Using these averages, total annual effort summed across all strata was estimated to be 6,757 angler days per year, including 1,727 angler-days from boats and 5,030 angler-days from shore.

Table 9. Effort estimates (angler-hours per month), by month, day type, access method and river stratum. Standard errors in parentheses. 12-month totals were calculated by adding the sum of the April to September estimates with 6 × the Oct-Mar estimate (since there are 6 months in the Oct-Mar period). Abbreviations are as shown in previous tables.

		Access	River Stratum			
Month	Day Type	Method	PCD-HH	HH-C	C-AB	Pine
April	Weekday	Boat	113 (156)	663 (290)	339 (156)	0
		Shore	266 (366)	0	0	0
	Weekend	Boat	0	139 (90)	102 (48)	107 (143)
		Shore	116 (154)	218 (290)	0	0
May	Weekday	Boat	0	241 (402)	0	0
		Shore	0	0	0	0
	Weekend	Boat	26 (42)	104 (112)	0	0
		Shore	823 (944)	457 (303)	175 (283)	0
June	Weekday	Boat	20 (46)	64 (100)	0	0
		Shore	154 (231)	93 (214)	0	0
	Weekend	Boat	79 (120)	411 (272)	65 (134)	21 (43)
		Shore	510 (389)	610 (482)	522 (534)	376 (380)
July	Weekday	Boat	67 (154)	201 (354)	156 (231)	0
		Shore	43 (99)	480 (487)	43 (99)	583 (624)
	Weekend	Boat	0	186 (204)	26 (53)	73 (126)
		Shore	61 (125)	735 (676)	15 (30)	823 (721)
August	Weekday	Boat	0	140 (231)	19 (44)	86 (126)
		Shore	0	455 (394)	39 (89)	435 (498)
	Weekend	Boat	84 (180)	653 (535)	232 (261)	283 (326)
		Shore	196 (267)	941 (948)	403 (349)	1781 (930)
September	Weekday	Boat	0	151 (291)	30 (58)	773 (1202)
		Shore	184 (354)	182 (351)	0	0
	Weekend	Boat	120 (218)	633 (790)	962 (1654)	363 (377)
		Shore	61 (110)	935 (813)	377 (369)	430 (267)
Oct-Mar	Weekday	Boat	0	0	0	n/a
		Shore	0	92 (222)	351 (576)	n/a
	Weekend	Boat	0	50 (107)	0	n/a
		Shore	18 (40)	50 (107)	0	n/a
12-Month Total			3032 (4192)	9843 (11248)	5613 (7848)	6134 (6330)

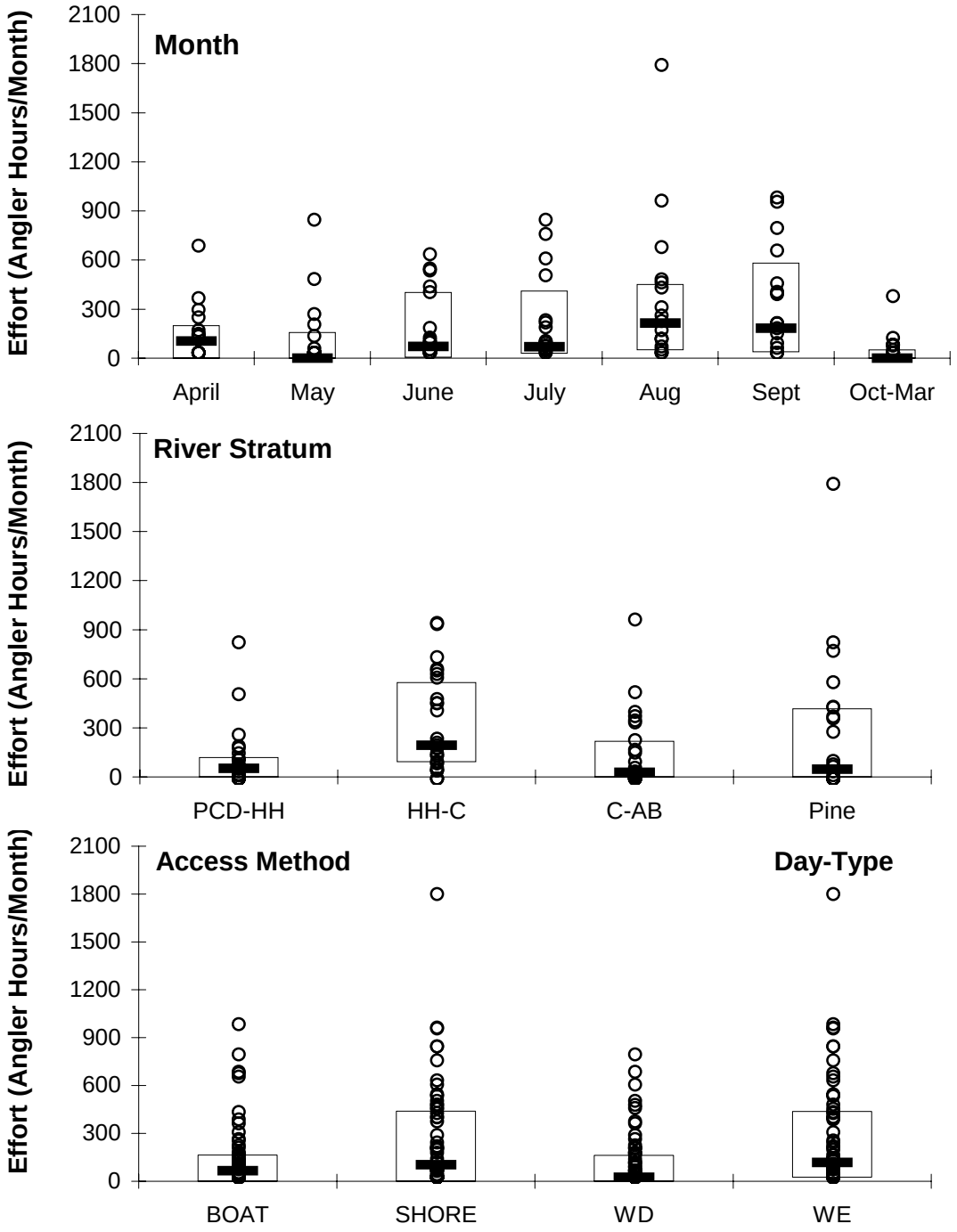


Figure 5. Total effort estimates (angler-hours per month) by month (upper panel), river stratum (middle panel), access method (lower panel), and day type (lower panel). Boxes bound the 25th to 75th percentile values; and bold horizontal lines show median values. Abbreviations are as shown in previous figures.

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	18.0	6	**0.006**
Day Type	10.0	1	**0.002**
River Stratum	13.3	3	**0.004**
Access Method	1.9	1	0.169

Catch Estimates

Estimates of total monthly catch were generated by calculating E × CPE, and then summing over day types. Depending on the species, estimated monthly catches varied by month, river stratum (Table 11) or access method. However, after adjusting α for the number of tests performed (i.e., using the Bonferroni adjustment), no differences were statistically significant (Table 12). Nevertheless, *P*-values from the unadjusted statistical tests are provided below in order to show the magnitude of each of the differences.

Arctic grayling and mountain whitefish were the species that were caught in greatest numbers (~2,400 fish per year). For both of these species, catches were greater in the Pine River than in the other river strata (84% of the Arctic grayling, $\chi^2_3 = 14.1$, $P = 0.003$; 60% of the mountain whitefish, $\chi^2_3 = 9.6$, $P = 0.02$). Most of these fish were caught in the summer months: 88% of the Arctic grayling ($\chi^2_6 = 13.6$, $P = 0.03$), and 75% of the mountain whitefish ($\chi^2_6 = 11.9$, $P = 0.07$) were caught from July to September. No grayling were caught during the October to March period, partly because the Pine River was not surveyed during that period.

The total annual catch of rainbow trout, summed across all strata, was estimated at ~1900 fish (Table 11). The distribution of catch estimates across river strata was strongly skewed to the areas upstream of Site C (91% of annual catch, Figure 6, $\chi^2_3 = 11.8$, $P = 0.008$). Catches of rainbow trout varied among months ($\chi^2_6 = 18.8$, $P = 0.004$). Catches were highest in June and September (27% in each), followed by May, July and August (14-15% each). Nominal catches occurred from October to March.

The total annual catch of bull trout, summed across all strata, was estimated at ~1,550 fish (Table 11). Differences among months and among river strata were not statistically significant (month: $\chi^2_6 = 11.2$, $P = 0.08$; river stratum: $\chi^2_3 = 4.7$, $P = 0.20$). Nevertheless, there was a trend for catches to be higher in the summer (76% caught from July-September), and higher in Pine River (37% of the catch) and in River Stratum 2 (Hudson's Hope to Site C: 33% of the catch).

Month and river stratum were both strong factors influencing catch of northern pike (month: $\chi^2_6 = 18.3$, $P = 0.006$; river stratum:$\chi^2_3 = 7.8$, $P = 0.050$) and walleye (month: $\chi^2_6 = 16.0$, $P = 0.014$; river stratum:$\chi^2_3 = 13.9$, $P = 0.003$), but not of goldeye, lake trout, or lake whitefish (Table 11).

Goldeye was the only species for which a strong effect of access method was observed (χ^2_1 = 5.4, P = 0.02), as it was never caught by shore-based anglers. Goldeye were caught in all three Peace River mainstem strata, and were mostly caught in September.

No kokanee or burbot were reported as caught during the study period.

Harvest (Retention) Estimates

Depending on the species, estimated monthly harvest varied by month, river stratum or access method (Table 13). After adjusting α for the number of tests performed (i.e., using the Bonferroni adjustment), the only effect that was statistically significant was the effect of stratum on Arctic grayling harvest (Table 14). Nevertheless, *P*-values from the unadjusted statistical tests are provided below in order to show the magnitude of each of the differences.

Arctic grayling was the species that was harvested in greatest numbers (~284 fish per year; Table 13). There was a statistically significant effect of river stratum on harvest of Arctic grayling (χ^2_3 = 20.6, $P < 0.0001$; Table 14). Harvest was significantly greater in the Pine River (63% of annual harvest) than in two of the other river strata (Peace Canyon Dam to Hudson's Hope: 0% of annual harvest, χ^2_1 = 12.6, P = 0.0004; Site C to Alberta border: 1% of annual harvest, χ^2_1 = 12.2, P = 0.0005), though post-hoc pairwise tests showed that harvest differences between the Pine River stratum and that between Hudson's Hope and Site C did not differ significantly (χ^2_1 = 5.7, P = 0.017, Bonferroni-adjusted α = 0.0083). Of the total catch of Arctic grayling, 12% was estimated to have been harvested.

The total annual harvest of rainbow trout, summed across all strata, was estimated at ~224 fish (Table 13). Harvest was restricted to river strata upstream of Site C (χ^2_3 = 13.3, P = 0.004), and all harvest occurred between May and September. Of the total catch of rainbow trout, 12% was estimated to have been harvested.

The total annual harvest of mountain whitefish summed across all strata, was estimated at ~182 fish (Table 13). No harvest occurred in the Pine River stratum (χ^2_3 = 9.6, P = 0.022). Of the total catch of mountain whitefish, 7% was estimated to have been harvested.

The total annual harvest of bull trout, summed across all strata, was estimated at ~82 fish (Table 13). Bull trout are a catch and release species in the Peace River system, but were nonetheless retained 5.3% of the time. All bull trout harvest occurred from August to September in river strata upstream of Site C.

The total annual harvest of northern pike, summed across all strata, was estimated at ~61 fish (Table 13). Harvest occurred from July to August, and was restricted to the Peace River mainstem downstream of Site C (χ^2_3 = 8.9, P = 0.031). Of the total catch of northern pike, 14% was estimated to have been harvested.

A total harvest of ~12 lake trout was estimated across all strata. These fish were harvested from June to July in the river stratum between Hudson's Hope and Site C. Of the total catch of lake trout, 27% was estimated to have been harvested.

During the study period, no goldeye, walleye, burbot, kokanee (Table 13) or lake whitefish were estimated to be harvested.

Comparisons between Years

Activity patterns were similar between years (Figure 7).

Summertime (June to September) angler effort levels were 51% lower in 2009 than in 2008 (Figure 8). Boat angling declined more from summer 2008 to summer 2009 (62% decline) than did shore-based angling (43% decline). A proportional decline was observed for both weekday and weekend/holiday day types (51% each), as expected given the similarity in activity patterns between years (Figure 7). Total species-specific summertime catch in 2009 ranged from 15% (Arctic grayling) to 88% (bull trout) of that in 2008.

Table 11. Estimated catch (harvest + release) of eight sport fish in four geographic strata in the Peace River watershed, by month. Catches are rounded to the closest whole number. Standard errors in parentheses. Annual (12-month) totals were calculated by adding the sum of the omnibus April to September estimates with 6 × the omnibus October to March estimate (since there are 6 months in the Oct-Mar period). Abbreviations are as shown in previous tables.

		Fish Species							
River Stratum	Month	Arctic Grayling	Bull Trout	Burbot	Goldeye	Mountain Whitefish	Northern Pike	Rainbow Trout	Walleye
PCD-HH	April	0	46 (47)	0	0	10 (18)	0	5 (8)	0
HH-C	April	0	56 (80)	0	0	0	0	0	0
C-AB	April	0	8 (8)	0	0	0	17 (12)	0	8 (7)
Pine	April	36 (43)	10 (13)	0	0	26 (31)	2 (2)	2 (2)	2 (2)
PCD-HH	May	0	22 (17)	0	0	13 (34)	0	88 (104)	0
HH-C	May	63 (58)	0	0	0	18 (33)	0	175 (180)	0
C-AB	May	0	0	0	0	7 (15)	0	7 (21)	0
Pine	May	0	0	0	0	0	0	0	0
PCD-HH	June	14 (10)	46 (20)	0	0	23 (13)	3 (3)	355 (140)	0
HH-C	June	51 (38)	39 (26)	0	0	13 (8)	47 (24)	138 (77)	0
C-AB	June	9 (11)	0	0	2 (5)	0	13 (286)	7 (8)	0
Pine	June	133 (96)	38 (30)	0	0	95 (71)	6 (6)	6 (3)	6 (6)
PCD-HH	July	0	15 (17)	0	0	8 (10)	0	22 (26)	0
HH-C	July	129 (93)	163 (82)	0	0	245 (202)	3 (2)	230 (105)	0
C-AB	July	4 (5)	8 (7)	0	0	11 (13)	22 (31)	9 (8)	14 (26)
Pine	July	495 (253)	141 (78)	0	0	353 (188)	24 (16)	24 (8)	24 (16)
PCD-HH	August	4 (5)	4 (10)	0	0	1 (2)	1 (2)	33 (34)	0
HH-C	August	39 (21)	190 (90)	0	0	26 (32)	13 (12)	202 (150)	0
C-AB	August	6 (7)	6 (7)	0	0	3 (7)	72 (64)	11 (15)	3 (3)
Pine	August	864 (435)	247 (137)	0	0	617 (325)	41 (28)	41 (13)	41 (28)
PCD-HH	September	0	8 (11)	0	13 (25)	14 (25)	4 (8)	96 (87)	9 (16)
HH-C	September	0	39 (79)	0	86 (113)	121 (134)	29 (38)	343 (353)	57 (75)
C-AB	September	75 (67)	226 (201)	0	108 (192)	54 (129)	112 (131)	36 (32)	525 (530)
Pine	September	524 (372)	150 (113)	0	0	374 (273)	25 (22)	25 (14)	25 (22)
PCD-HH	Oct-Mar	0	2 (2)	0	0	2 (5)	0 (4)	3 (8)	0
HH-C	Oct-Mar	0	5 (6)	0	5 (11)	21 (24)	2 (4)	2 (2)	4 (7)
C-AB	Oct-Mar	0	11 (16)	0	0	45 (44)	0	0	0
Pine	Oct-Mar	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
12 Month Total (Peace)		395 (314)	983 (850)	0	242 (398)	978 (1109)	350 (655)	1786 (1407)	638 (701)
12 Month Total (Pine)		2051 (1198)	586 (371)	0	0 (0)	1465 (887)	98 (74)	98 (40)	98 (74)
12 Month Total (All)		2446 (1512)	1569 (1220)	0	242 (398)	2443 (1996)	448 (729)	1883 (1446)	736 (774)

Table 12. Statistical tests of the effect of month, river stratum and access method on median catch (harvest + release) estimates for the 11 sport fish species surveyed. *P*-values that are underlined are less than 0.05, but none are statistically significant after the Bonferroni adjustment.

	Month			River Stratum			Access Method		
Species	χ_6^2	df	*P*	χ_3^2	df	*P*	χ_1^2	df	*P*
Arctic grayling	13.6	6	0.034	14.1	3	0.003	0.8	1	0.360
Bull trout	11.2	6	0.083	4.7	3	0.196	0.5	1	0.461
Burbot	0.0	6	1.000	0.0	3	1.000	0.0	1	1.000
Goldeye	11.7	6	0.068	2.1	3	0.553	5.4	1	0.020
Konanee	0.0	6	1.000	0.0	3	1.000	0.0	1	1.000
Lake trout	5.1	6	0.537	5.4	3	0.147	0.2	1	0.692
Lake whitefish	10.0	6	0.125	2.2	3	0.525	2.0	1	0.153
Mountain whitefish	11.9	6	0.064	9.6	3	0.022	0.7	1	0.401
Northern pike	18.3	6	0.006	7.8	3	0.050	0.8	1	0.361
Rainbow trout	18.8	6	0.004	11.8	3	0.008	0.0	1	0.867
Walleye	16.0	6	0.014	13.9	3	0.003	2.2	1	0.138

The drop in summertime effort was largest in the stratum from Site C to the Alberta border (64% decline) and in the Pine River (61% decline). In the river stratum from Site C to the Alberta border, summertime catches of bull trout, walleye and Arctic grayling declined by 57%, 100%, and 89% from 2008 to 2009, respectively (Figure 9). In the Pine River stratum, summertime catches of bull trout, mountain whitefish and Arctic grayling declined by 28%, 82%, and 76% from 2008 to 2009, respectively (Figure 9).

The summertime angling effort in the stratum from Hudson's Hope to Site C declined by 46% from 2008 to 2009 (Figure 8). Meanwhile, summertime catches of rainbow trout declined by 58%. Surprisingly, summertime catches of bull trout and mountain whitefish increased in this river stratum by 60% and 86%, respectively.

There was no decline in summertime angling effort between years in the stratum from Peace Canyon Dam to Hudson's Hope (Figure 8). Nevertheless, summertime catch of rainbow trout in this river stratum declined by 51% (Figure 9).

Biosampling

Interviewers were not very successful in inspecting, measuring or weighing catch during the study period. Over the 16.5 month period, with 501 anglers reporting on complete trips, interviewers were only permitted to biosample a total of 30 fish of seven species (Table 15). This represents only 3.6% of the 833 total fish harvested during the study period. Rainbow trout was the most commonly biosampled fish (n=16), followed by mountain whitefish (n=8). PIT tags that have been applied to fish in the study area as part of the Peace River Fish Indexing program were not detected in any of the scanned fish. Accordingly, too few fish were biosampled to permit any detailed analyses. The complete biosampling dataset is included in Appendix 8.

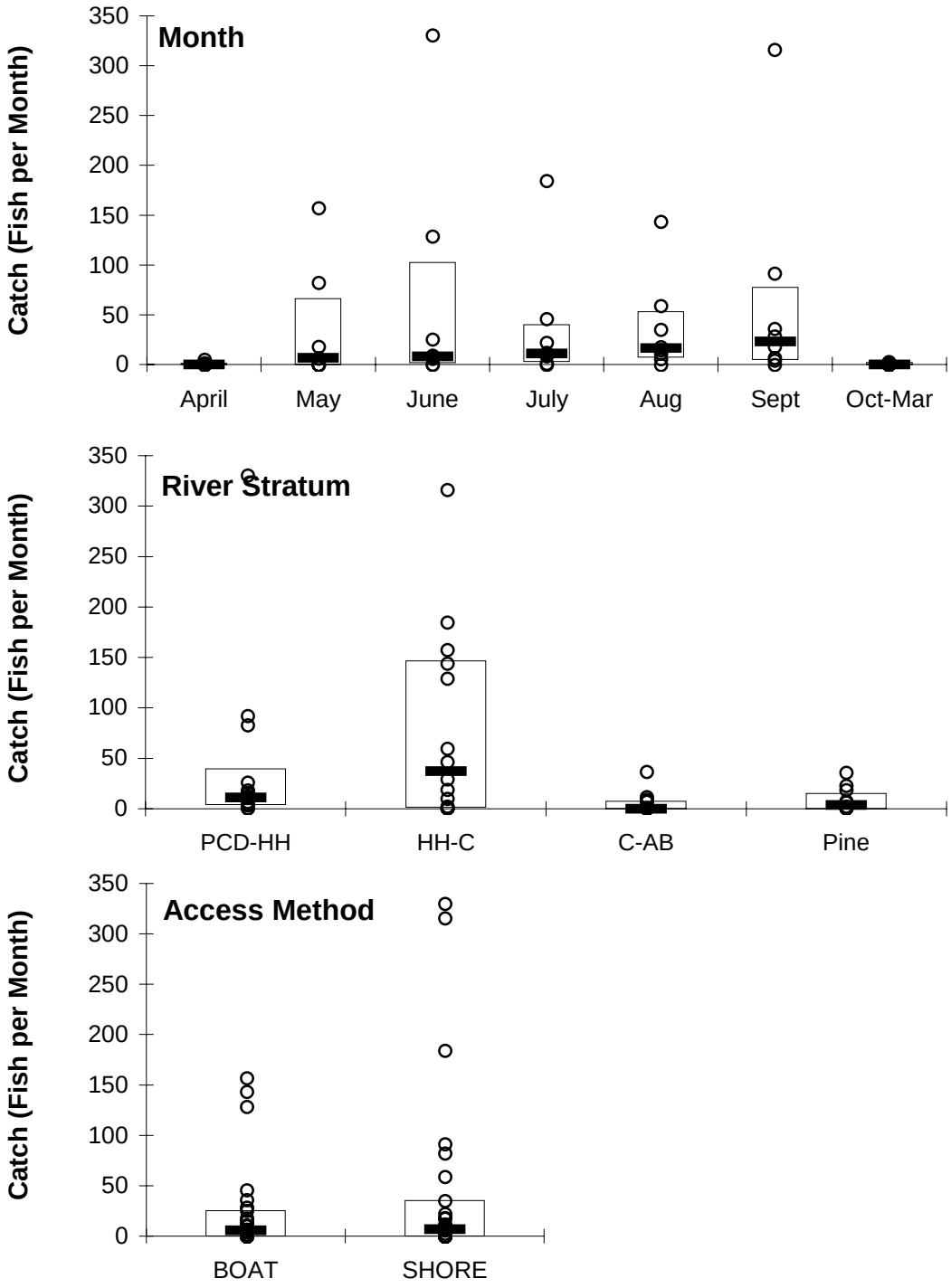


Figure 6. **Rainbow trout catch estimates (number of fish per month) by month (upper panel), river stratum (middle panel), and access method (lower panel). Boxes bound the 25th to 75th percentile values; and bold horizontal lines show median values. Abbreviations are as shown in previous figures.**

Table 13. Estimated harvest of eight sport fish in four geographic strata in the Peace River watershed, by month. Numbers are rounded to the closest whole number. Standard errors in parentheses. Annual (12-month) totals were calculated by adding the sum of the omnibus April to September estimates with 6 × the omnibus Oct-Mar estimate (since there are 6 months in the Oct-Mar period). Abbreviations are as shown in previous tables..

		Fish Species							
River Stratum	Month	Arctic Grayling	Bull Trout	Burbot	Goldeye	Mountain Whitefish	Northern Pike	Rainbow Trout	Walleye
PCD-HH	April	0	0	0	0	0	0	0	0
HH-C	April	0	0	0	0	0	0	0	0
C-AB	April	0	0	0	0	0	0	0	0
Pine	April	3 (5)	0	0	0	0	0	0	0
PCD-HH	May	0	0	0	0	13 (33)	0	35 (43)	0
HH-C	May	63 (58)	0	0	0	18 (33)	0	0	0
C-AB	May	0	0	0	0	7 (15)	0	0	0
Pine	May	0	0	0	0	0	0	0	0
PCD-HH	June	0	0	0	0	17 (10)	0	35 (24)	0
HH-C	June	0	0	0	0	0	0	48 (69)	0
C-AB	June	0	0	0	0	0	0	0	0
Pine	June	13 (12)	0	0	0	0	0	0	0
PCD-HH	July	0	0	0	0	0	0	7 (17)	0
HH-C	July	9 (12)	0	0	0	3 (3)	0	22 (18)	0
C-AB	July	0	0	0	0	0	3 (2)	0 (1)	0 (2)
Pine	July	47 (31)	0	0	0	0	0	0	0
PCD-HH	August	1 (2)	0	0	0	0	0	7 (4)	0
HH-C	August	13 (12)	79 (39)	0	0	0	0	39 (28)	0
C-AB	August	3 (2)	0	0	0	0	58 (58)	0	0
Pine	August	82 (56)	0	0	0	0	0	0	0
PCD-HH	September	0	4 (3)	0	0	10 (23)	0	11 (12)	0
HH-C	September	0	0	0	0	43 (77)	0	20 (9)	0
C-AB	September	0	0	0	0	54 (129)	0	0	0
Pine	September	50 (44)	0	0	0	0	0	0	0
PCD-HH	Oct-Mar	0	0	0	0	0	0	0	0
HH-C	Oct-Mar	0	0	0	0	3 (7)	0	0	0
C-AB	Oct-Mar	0	0	0	0	0	0	0	0
Pine	Oct-Mar	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
12 Month Total (Peace)		88 (86)	82 (42)	0	0 (0)	182 (365)	61 (60)	224 (223)	0 (2)
12 Month Total (Pine)		195 (147)	0 (0)	0	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
12 Month Total (All)		284 (234)	82 (42)	0	0 (0)	182 (365)	61 (60)	224 (223)	0 (2)

Table 14. Statistical tests of the effect of month, river stratum and access method on median harvest estimates for the 11 sport fish species surveyed. *P*-values that are underlined are less than 0.05, and those that are statistically significant after the Bonferroni adjustment are in bold font.

	Month			River Stratum			Access Method		
Species	χ_6^2	df	*P*	χ_3^2	df	*P*	χ_1^2	df	*P*
Arctic grayling	9.0	6	0.176	20.6	3	**0.000**	2.3	1	0.133
Bull trout	4.8	6	0.564	1.9	3	0.595	2.0	1	0.153
Burbot	0.0	6	1.000	0.0	3	1.000	0.0	1	1.000
Goldeye	0.0	6	1.000	0.0	3	1.000	0.0	1	1.000
Konanee	0.0	6	1.000	0.0	3	1.000	0.0	1	1.000
Lake trout	4.8	6	0.564	5.8	3	0.121	0.0	1	0.979
Lake whitefish	0.0	6	1.000	0.0	3	1.000	0.0	1	1.000
Mountain whitefish	11.8	6	0.066	4.4	3	0.225	0.0	1	0.970
Northern pike	8.7	6	0.189	8.9	3	0.031	0.3	1	0.586
Rainbow trout	9.0	6	0.173	13.3	3	0.004	1.7	1	0.189
Walleye	5.8	6	0.452	2.9	3	0.414	1.0	1	0.317

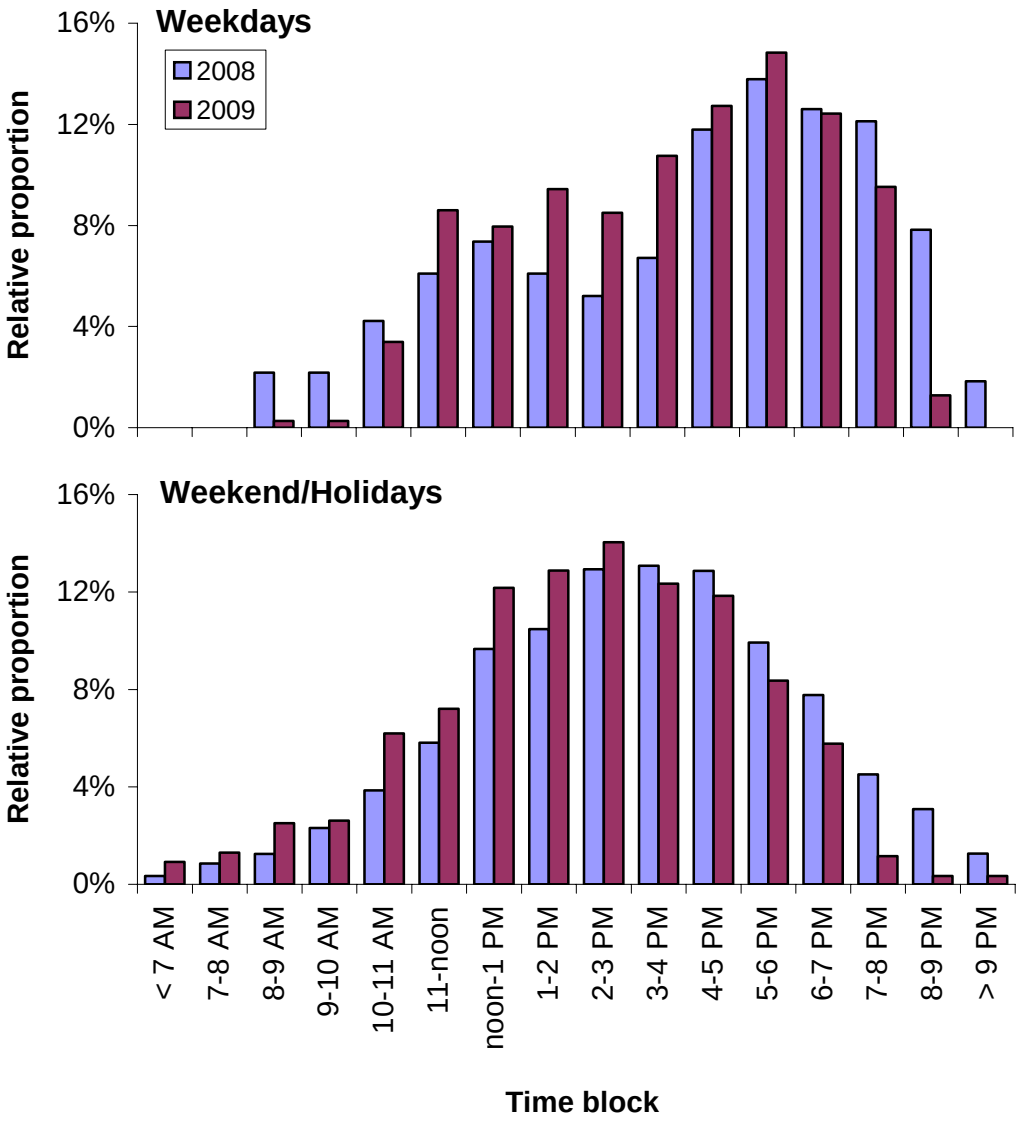


Figure 7. Comparison between 2008 and 2009 of activity patterns of Peace River anglers on weekdays and weekends/holidays.

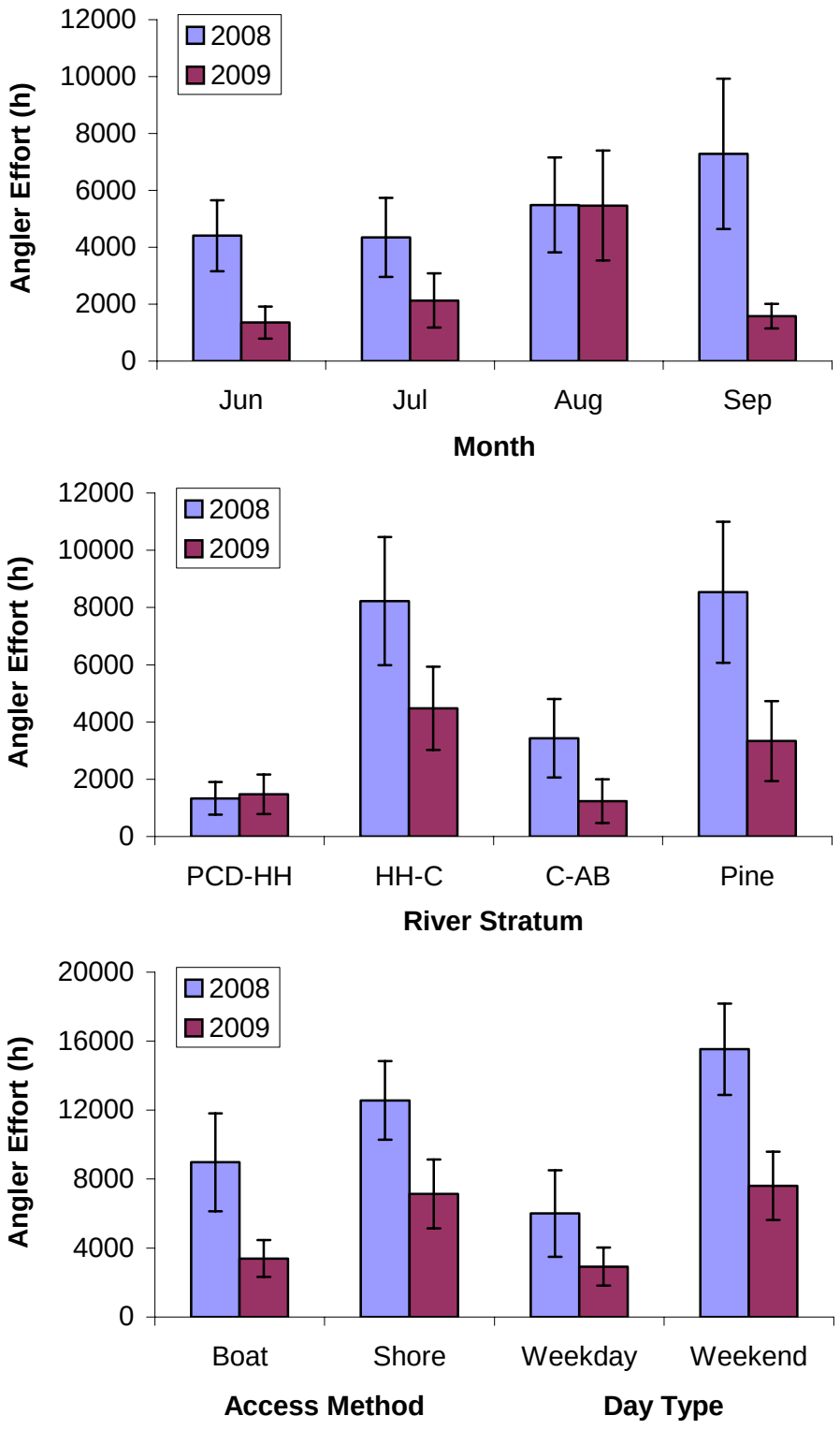


Figure 8. Comparison between 2008 and 2009 of angler effort by month (upper panel), river stratum (middle panel), access method (lower panel, left) and day type (lower panel, right). Data include June to September effort only.

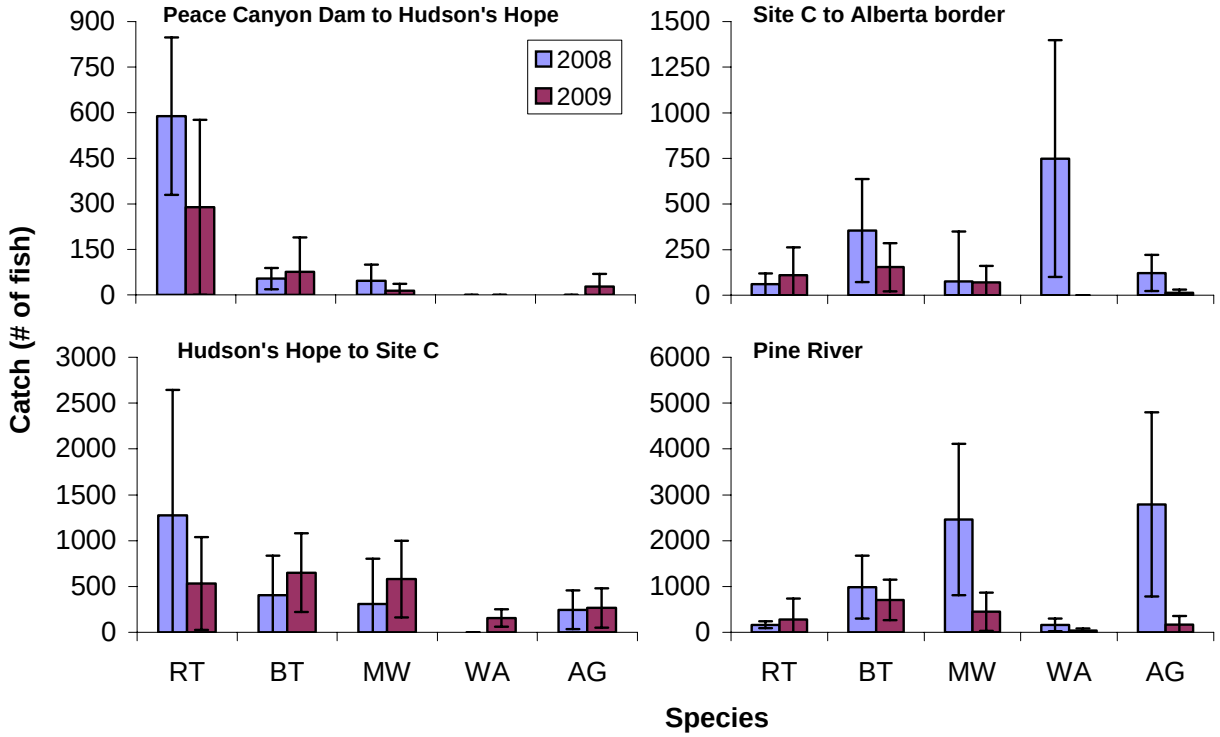


Figure 9. **Comparison between 2008 and 2009 of annual catch for 5 common sport fish species, by river stratum. Data include June to September catch only. RT = rainbow trout; BT = bull trout; MW = mountain whitefish; WA = walleye; AG = Arctic grayling.**

Table 15. **Summary of average weights and lengths of fish that were caught by anglers and biosampled from 15 May 2008 to 30 September 2009, by species.**

Species	Sample Size	Average Fork Length (cm)	Average Weight (g)
Rainbow Trout	16	36.5	447.8
Mtn. Whitefish	8	34.7	348.8
Bull Trout	2	45.5	840.0
Arctic Grayling	1	32	369
Lake Trout	1	46	780
Northern Pike	1	67	2060
Walleye	1	39	530

Angler and Angling Characteristics

The anglers interviewed were overwhelmingly from the local area (Table 16), especially during the winter. Overall, 87% of anglers were from the Peace River area, 8% were from the rest of

BC, and 4% were from the rest of Canada. The average age of anglers was 35 years. 11% of respondents were under the age of 16 years. Overall, 69% of respondents were between the ages of 20 and 49 (Figure 10). Of all the interviewed anglers, none were being guided by a professional, regardless of location of origin or age.

The largest portion of respondents (46%; Table 16) said they were fishing with lures (including spoons, spinners and jigs), 20% were fishing with flies, and 10% said they were using bait (including worms, fish eggs, and various arthropods).

The most popular target species was rainbow trout (34% of respondents; Table 16). Bull trout was second in popularity (10%), followed by Arctic grayling (8%), lake trout (7%), walleye (6%) and whitefish (4%).

Interviewees were also asked where else they have previously been or planned to go to fish. The top 10 responses (accounting for nearly 80% of the choices) were all within the Peace region and included: the Peace region,; the Peace River; Charlie ,Dinosaur and Williston lakes; Beatton and Halfway rivers; and the Pine, Sukunka and Moberly rivers (Table 17).

Table 16. Characteristics of anglers interviewed from 15 May 2008 to 30 September 2009, by month. Within a column, fishing methods and species targeted can sum to more than 100% since some anglers used more than one gear type, and some targeted more than one species.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Overall
Number of Anglers	3	3	2	42	75	131	144	124	84	14	0	0	622
% led by Guide	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%			0%
Residence													
% Peace Area	100%	100%		90%	81%	85%	93%	94%	81%	64%			87%
% Rest of BC			100%	10%	13%	14%	1%	2%	11%	21%			8%
% Rest of Canada					4%	2%	6%	4%	6%	14%			4%
% US													0%
% Other					1%				2%				0.5%
Fishing Method													
% Using Bait		100%			3%	18%	12%	3%	11%	50%			10%
% Using Lures	100%		100%	62%	43%	35%	65%	37%	45%				46%
% Using Flies				14%	15%	21%	22%	21%	26%	21%			20%
Species Targetted													
% Arctic Grayling				12%	7%	8%	13%	4%	5%	14%			8%
% Bull Trout	100%	100%		5%	8%	13%	6%	6%	17%	21%			10%
% Goldeye						2%			1%	14%			1%
% Kokanee					3%	4%			1%	14%			2%
% Lake Trout			100%	7%	17%	7%	7%	3%	1%	14%			7%
% Northern Pike				7%		4%	1%		1%	14%			2%
% Rainbow Trout				21%	25%	37%	33%	38%	42%	50%			34%
% Walleye				24%		4%	6%	5%	5%	14%			6%
% Whitefish	100%				7%	6%			4%	36%			4%

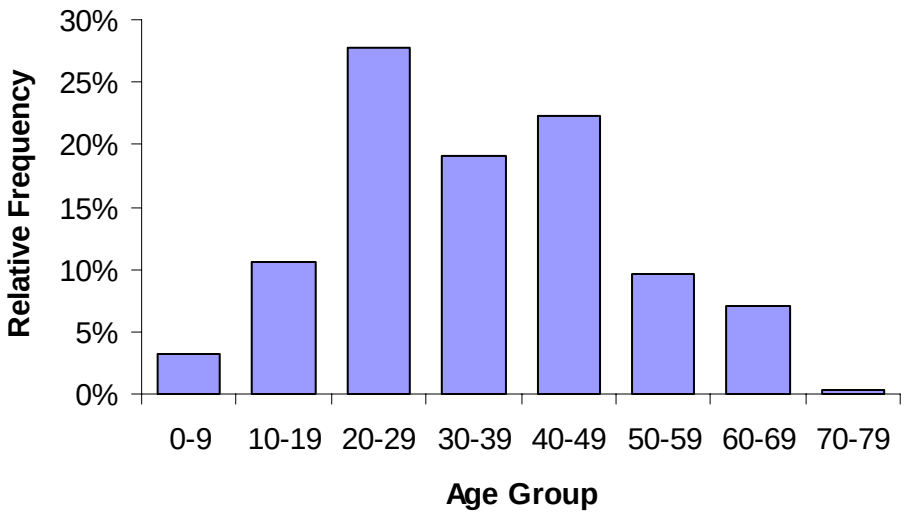


Figure 10. The age distribution of anglers interviewed from 15 May 2008 to 30 September 2009.

Recreational Use Patterns

Recreational Site Inventory

A total of 49 recreational use sites were identified in the project area. Of these sites, 32 occurred on the mainstem Peace River between the Peace Canyon Dam and the Alberta border, 15 occurred on the mainstem Pine River between the Sukunka and Peace River confluences, and 2 occurred within the inundation zone of the Halfway River. No sites were identified within the inundation zones of any other potentially affected tributaries. Extensive descriptions of each individual site are provided in Appendix 5.

For these 49 sites, the totals of all types of recreational sites in each stratum are documented in Table 18. The area from Hudson's Hope to Site C was the River Stratum that contained the most recreational use sites (24 sites identified). The most abundant types of recreational use sites were 'unmaintained campsite' and 'primitive maintained campsite'; a total of 13 and 12 of each were located in the study area, respectively. 'Shoreline access' was one of the next most common types of recreational use site with 10 located. Also, eight 'boat launches' were documented, three of which were part of a 'public campground' and one was part of an 'unmaintained campsite'. An additional 'public campground' (without a boat launch) was also identified. A total of four 'cabin' sites were documented throughout the Pine mainstem only and a single 'scenic location,' consisting of a small waterfall, was documented on the mainstem Peace. All 29 sites located between Peace Canyon Dam and Site C (5 sites in River Stratum One; 24 sites in River Stratum Two) could be directly affected by, or fall within the inundation zone of Site C. All site locations have been mapped indicating the type of recreational use site (Figure 11).

Table 17. The number of respondents who indicated that they had previously been, or planned to go elsewhere for angling or recreational activity, by location. Top ten choices are shaded in gray.

	Angling		Recreation	
Location	Count	Percent	Count	Percent
Alberta	5	1.0%	46	2.5%
Alaska	0	0.0%	6	0.3%
Yukon	1	0.2%	8	0.4%
United States	0	0.0%	4	0.2%
Ontario	0	0.0%	2	0.1%
Manitoba	0	0.0%	2	0.1%
Saskatchewan	0	0.0%	4	0.2%
Northern BC	13	2.5%	48	2.6%
Southern BC	3	0.6%	41	2.3%
Peace Region	72	13.7%	236	13.0%
Peace River	91	17.4%	228	12.5%
Alwin Holland Park	0	0.0%	7	0.4%
Beatton River	15	2.9%	24	1.3%
Blackfoot Park	0	0.0%	29	1.6%
Boot Lakes	0	0.0%	1	0.1%
Burnt River	4	0.8%	3	0.2%
Cameron Lake	1	0.2%	6	0.3%
Carbon Creek	4	0.8%	4	0.2%
Carp Lake	5	1.0%	8	0.4%
Charlie Lake	31	5.9%	87	4.8%
Chinnamon Lake	5	1.0%	0	0.0%
Chowade River	2	0.4%	0	0.0%
Dinosaur Lake	42	8.0%	80	4.4%
Halfway River	31	5.9%	128	7.0%
Graham River	6	1.1%	15	0.8%
Gwillim Park	3	0.6%	25	1.4%
Inga Lake	10	1.9%	9	0.5%
Jones Lake	1	0.2%	0	0.0%
Kchiecwa River	1	0.2%	1	0.1%
Kiskatinaw River	1	0.2%	20	1.1%
Kunuses Falls	1	0.2%	1	0.1%
Lynx Creek	7	1.3%	9	0.5%
Moberly Lake/River	24	4.6%	72	4.0%
Murray River	13	2.5%	59	3.2%
Misichinka	1	0.2%	0	0.0%
One Island Lake	7	1.3%	17	0.9%
Peace Island Park	5	1.0%	196	10.8%
Pine River	59	11.3%	240	13.2%
Pine Lake	2	0.4%	3	0.2%
Sukunka River	27	5.2%	43	2.4%
Sundance Lake	2	0.4%	2	0.1%
Swan Lake	1	0.2%	14	0.8%
Williston Lake	24	4.6%	72	4.0%
Wolverine	1	0.2%	0	0.0%
Other Miscellaneous Areas	3	0.6%	19	1.0%
Total	524	100%	1819	100%
Top 10	416	79%	1398	77%

All 49 recreational sites described in detail are accessible to the public by boat. Although many are accessible by both boat and road most were accessed by boat during the current surveys. Of those sites also accessible by road, the access roads to two of the Peace River sites cross private land (Confluence of Maurice Creek and Unmaintained Campsite E). Of those recreational sites which are maintained, public campgrounds and some boat launches are either maintained by the municipalities or private owners while the primitive maintained campsites are maintained by local users such as the River Rats boating club. The unmaintained campsites, shoreline access sites, scenic location and some boat launches are not actively maintained (other than occasionally by local users). Details regarding access and maintenance can be found in the individual site descriptions (Appendix 5).

Many types of recreational activities have been confirmed at the identified sites. Camping and fishing were the most popular types of activities as they have been found to occur at 39 and 15 of the 49 recreation sites assessed, respectively (Table 19). Shoreline leisure occurred at eight of the sites, boating at seven sites, picnicking and hunting at six sites, and swimming and canoeing at five of the sites. Tubing, hiking and snowshoeing have each occurred at two of the sites; and birding, cross-country skiing and dog sledding were all known to occur at one of the recreational use sites.

Discussions with local recreational groups suggested that activities are occurring in many areas along both the Peace River mainstem and the Halfway River, not necessarily at specific sites. The Whiskey Jack Nordic Ski Club, which has 85 members, indicated the Peace Island Park cross country trails are posted for their members. This club estimates there are approximately

Table 18. Total number of recreational-use sites on the mainstem of the Peace River, mainstem of the Pine River, or potentially inundated tributaries, by site type and river stratum. Abbreviations are as shown in previous tables.

	River Stratum				
Type of Recreational Use Site	PCD - HH	HH - C	C - AB	Pine	Total
Public Campground & Boat Launch		1	2		3
Boat Launch & Un-maintained Campsite				1	1
Boat Launch (only)	1	3			4
Public Campground (only)	1				1
Primitive Maintained Campsite		8	1	3	12
Un-maintained Campsite (only)	1	7	1	4	13
Cabin				4	4
Shoreline Access	2	4	1	3	10
Scenic Location		1			1
Total	5	24	5	15	49

Table 19. The total number of sites (49 recreation sites assessed) where each particular activity occurs.

Recreational Activity	No. Rec Sites Where Activity is Confirmed
Fishing	15
Hunting	6
Birding	1
Wildlife Viewing	0
Boating (Jet and Other)	7
Canoeing	5
Kayaking	0
Tubing	2
Swimming	5
Plant Gathering	0
Rock / Fossil Hunting	0
Picnicking	6
Camping	39
Hiking	2
Shoreline Leisure	8
ATV Driving	0
Snowmobiling	0
Snowshoeing	2
Cross Country Skiing	1
Dog Sledding	1

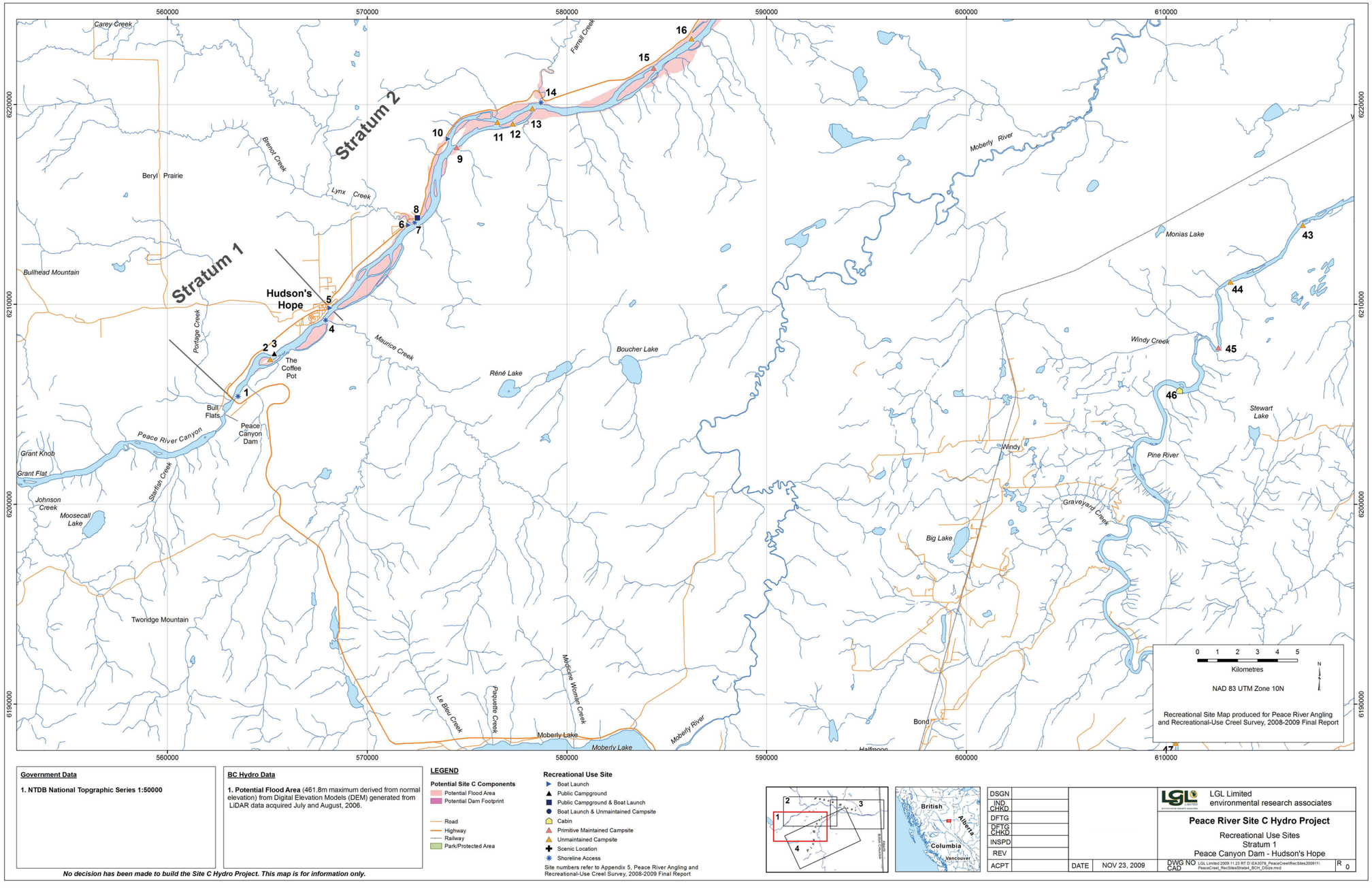
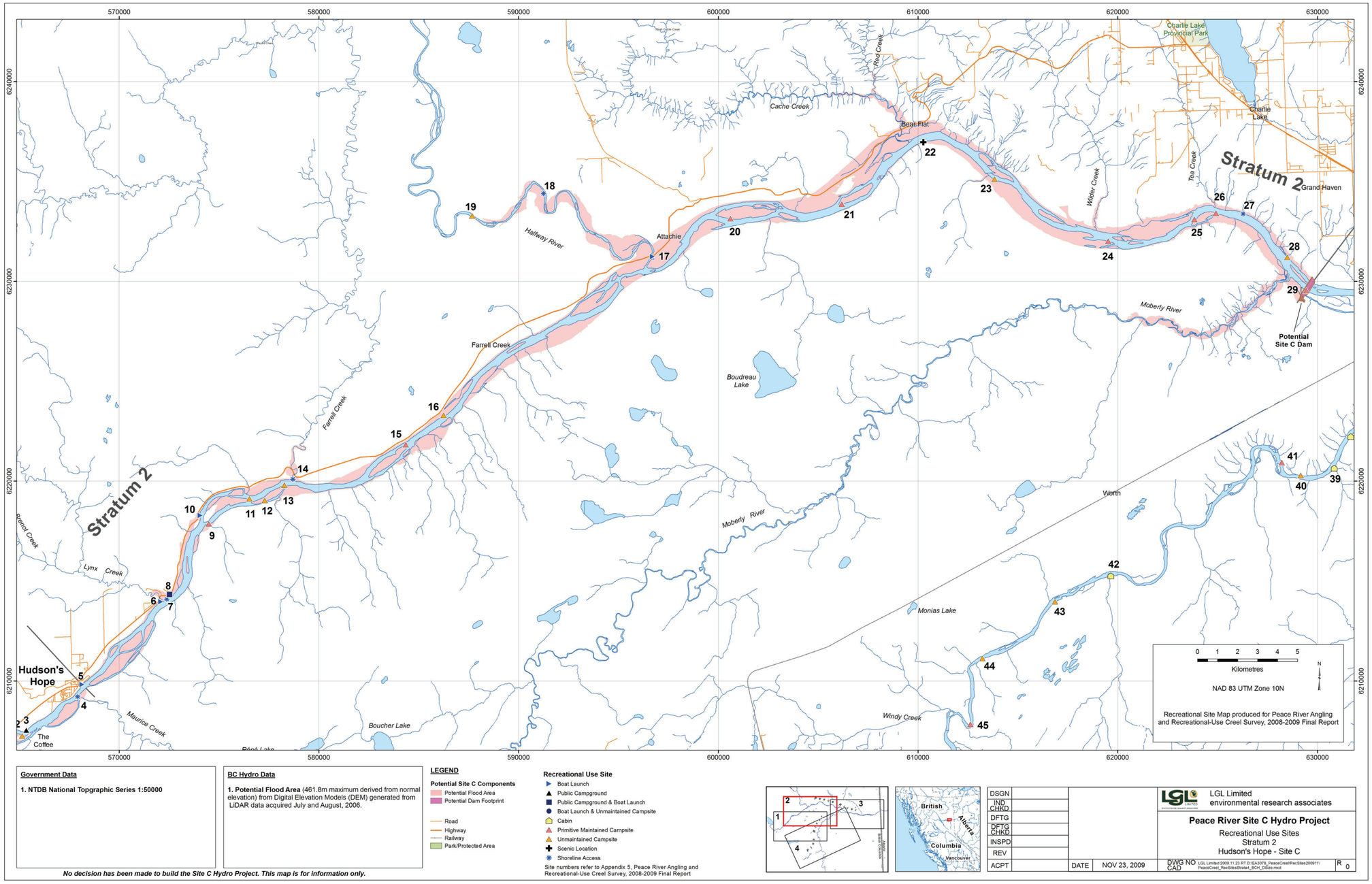


Figure 11. Recreational use sites, classified by type, identified throughout the study area.



Government Data

1. NTDB National Topgraphic Series 1:50000

BC Hydro Data

1. **Potential Flood Area** (461.8m maximum derived from normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July and August, 2006.

No decision has been made to build the Site C Hydro Project. This map is for information only.

LEGEND

Potential Site C Components
- Potential Flood Area
- Potential Dam Footprint

- Road
- Highway
- Railway
- Park/Protected Area

Recreational Use Site
- Boat Launch
- Public Campground
- Public Campground & Boat Launch
- Boat Launch & Unmaintained Campsite
- Cabin
- Primitive Maintained Campsite
- Unmaintained Campsite
- Scenic Location
- Shoreline Access

Site numbers refer to Appendix 5, Peace River Angling and Recreational-Use Creel Survey, 2008-2009 Final Report

DSGN				LGL Limited environmental research associates
IND CHKD				**Peace River Site C Hydro Project**
DFTG				Recreational Use Sites
DFTG CHKD				Stratum 2
INSPD				Hudson's Hope - Site C
REV				
ACPT		DATE	NOV 23, 2009	DWG NO CAD: LGL Limited 2009.11.23 RT D:\EA3078_PeaceCreel\RecSites2009\11\PeaceCreel_RecSitesStratum4_BCH_DSize.mxd — R 0

Figure 11 (continued).