

Angler Effort and Catch in the 1998 Lower Fraser River Sport Fishery

V. Palermo and A.S. Thompson

Fisheries and Oceans Canada
Science Branch, Pacific Region
100 Annacis Parkway, Unit 3
Delta, British Columbia
V3M 6A2

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by

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Science Branch, Pacific Region
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ABSTRACT

Palermo, V. and A.S. Thompson. 1999. Angler effort and catch in the 1998 lower Fraser River sport fishery. Can. Manuscr. Rep. Fish. Aquat. Sci. 2484: 31 p.

The lower Fraser River mainstem recreational fishery was assessed from 1985 to 1988 and from 1995 to 1997, using an access point/overflight survey design. From May 1 to August 31, 1998, another recreational fishery survey was conducted on the lower Fraser River using the same study design and the data entry and analysis program that was implemented during the 1996 survey. The 1998 survey focused on angler effort and the harvest and release of chinook (*Oncorhynchus tshawytscha*) and sockeye (*O. nerka*) salmon.

Over the course of the survey, 31 overflights and 6,704 angler interviews were conducted. Angler effort was estimated at 360,449 hours. Total harvests of chinook (adults and jacks combined) and sockeye were estimated at 7,181 and 9,655, respectively. Chinook and sockeye released were estimated at 264 and 6,219 (minimum estimate), respectively.

The 1998 July and August chinook catch increased substantially from 1997, due to a higher proportion of effort directed at chinook and increased chinook abundance in the river. Catch rates for sockeye decreased dramatically from 1997 to 1998, due to their decreased abundance in the river and a decreased proportion of angler effort directed at sockeye. July angler effort was higher than in 1997, but August effort was down, probably as a result of closures in the sockeye fishery.

Key Words: lower Fraser River, sport fishery, chinook salmon, sockeye salmon, angler effort, catch, harvest, release.

RÉSUMÉ

Palermo, V. and A.S. Thompson. 1999. Angler effort and catch in the 1998 lower Fraser River sport fishery. Can. Manuscr. Rep. Fish. Aquat. Sci. 2484: 31 p.

La pêche sportive dans le bras principal du cours inférieur du Fraser a fait l'objet d'une évaluation de 1985 à 1988, puis de nouveau de 1995 à 1997, par une méthode combinant les points d'accès et le survol aérien. Du 1^{er} mai au 31 août 1998, un autre relevé de la pêche sportive a été effectué sur le cours inférieur du Fraser par la même méthode et avec le système d'entrée et d'analyse des données mis au point en 1996. L'accent du relevé de 1998 était mis sur l'effort de pêche à la ligne et sur la capture avec graciación du quinnat (*Oncorhynchus tshawytscha*) et du saumon rouge (*O. nerka*).

Dans le cours du relevé, 31 survols ont été effectués, et 6 704 entrevues avec des pêcheurs ont été réalisées. L'effort de pêche a été estimé à 360 449 heures. Les captures totales de quinnats (adultes et jacks combinés) et de saumons rouges ont été estimées respectivement à 7 181 et 9 655. On estime à 264 et 6 219 (estimation minimale) respectivement le nombre de quinnats et de saumons rouges graciés.

Le nombre de captures de quinnat en juillet et août 1998 était sensiblement supérieur à celui de 1997, ce qui est dû à une hausse de l'effort de pêche dirigé vers ce poisson et à l'augmentation de son abondance dans le Fraser. Les taux de capture du saumon rouge ont chuté de façon spectaculaire entre 1997 et 1998, à cause de la diminution de leur abondance dans le Fraser et d'une baisse de l'effort de pêche dirigé vers le saumon rouge. En juillet, l'effort de pêche sportive était plus élevé qu'en 1997, mais il a diminué en août, probablement à cause des fermetures dans le secteur de la pêche du saumon rouge.

Mots clés : cours inférieur du Fraser, pêche sportive, quinnat, saumon rouge, effort de pêche sportive, captures, prélèvements, graciación.

INTRODUCTION

The Fraser River downstream of Hope, British Columbia supports a year round sport fishery that targets all five salmon species (*Oncorhynchus* spp.), and sturgeon (*Acipenser* spp.), as well as steelhead (*O. mykiss*), rainbow (*O. mykiss*) and cutthroat (*O. clarki*) trout. Previous studies describe the lower Fraser River sport fishery as one of the largest in British Columbia (Mosley MS, 1983; DPA Group MS, 1985; Schubert, 1992b).

The lower Fraser River recreational fishery was studied by creel survey from 1985 to 1988. These studies focused on angler effort and catch of salmon and trout in the lower 150 km of the Fraser River, below Hope. In 1995, the lower Fraser River recreational fishery was again studied by creel survey. The focus of the 1995 study was expanded to include angler effort and catch of sockeye (*O. nerka*) and pink (*O. gorbuscha*) salmon, which could not be legally harvested during the 1985 to 1988 creel surveys (Bratty et al., 1998). Assessment of the lower Fraser River recreational fishery continued in 1996 and 1997, with creel surveys focusing on angler effort and catch of chinook (*O. tshawytscha*) sockeye and pink salmon. Pink salmon were not assessed in 1996 because upstream spawning migration of pinks does not occur in the Fraser River in even numbered years (Anon., 1995). The 1998 creel survey focused on the angler effort and catch of chinook and sockeye salmon.

This report describes the methods and procedures of the 1998 survey and details the total angler effort and catch per unit effort (CPUE), including harvest per unit effort (HPUE) and release per unit effort (RPUE), for the lower Fraser River between the Sumas River and Hope, from May 1 to August 31, 1998. The results are compared with previous lower Fraser River recreational fishery surveys. Finally, recommendations are made for future surveys and management of the recreational fishery on the lower Fraser River.

STUDY AREA

The Fraser River is the largest river in British Columbia, draining most of the southern half of the province. From its headwaters in the Rocky Mountains, the Fraser River flows 1,350 km through the central interior, entering the Strait of Georgia near Vancouver, BC.

The final 150 km stretch of the Fraser River below Hope flows through the alluvial floodplain of the Fraser Valley, bounded to the north by the Coast Mountains and to the south by the Cascade Range (Figure 1). The mean daily discharge for the Fraser River in the Hope area is 3,065 m³/s (Water Survey of Canada, pers. comm., 1996 and 1997 mean value). The average width of this section is 600 meters. Maximum freshet width is 5 km in some areas. The Fraser River is tidal as far upstream as the City of Chilliwack, approximately 90 km from the river's outlet.

Schubert (1992b) separated the lower Fraser River into four study regions (Figure 1). The 1998 study focused on the last two regions (Regions 3 and 4) from the outlet of the Sumas River to Hope. This section of the Fraser was chosen as the study area for the 1995 - 1997 Fraser River sport fishery surveys and has historically accounted for the highest harvest of chinook salmon in the lower Fraser River (Schubert, 1992b). In 1996 the area between the Agassiz-Rosedale powerline and Hope was not surveyed, due to budget constraints, and was designated as Region 5. The boundaries of Regions 3 and 4 used in the 1998 study were the same as those used in the 1985-1988, 1995 and 1997 surveys.

Region 3 extended from the outlet of the Sumas River to the outlet of the Harrison River (Figure 1). The region is characterized by many treed islands and mid-channel bars that become exposed as the water level of the Fraser River drops. Angler effort was concentrated at Englebrich bar (locally known as Island 22), Long bar, Grassy Bank bar and Wellington bar. Interviews in Region 3 were conducted at Englebrich bar, which was the main boat launch site for the area;

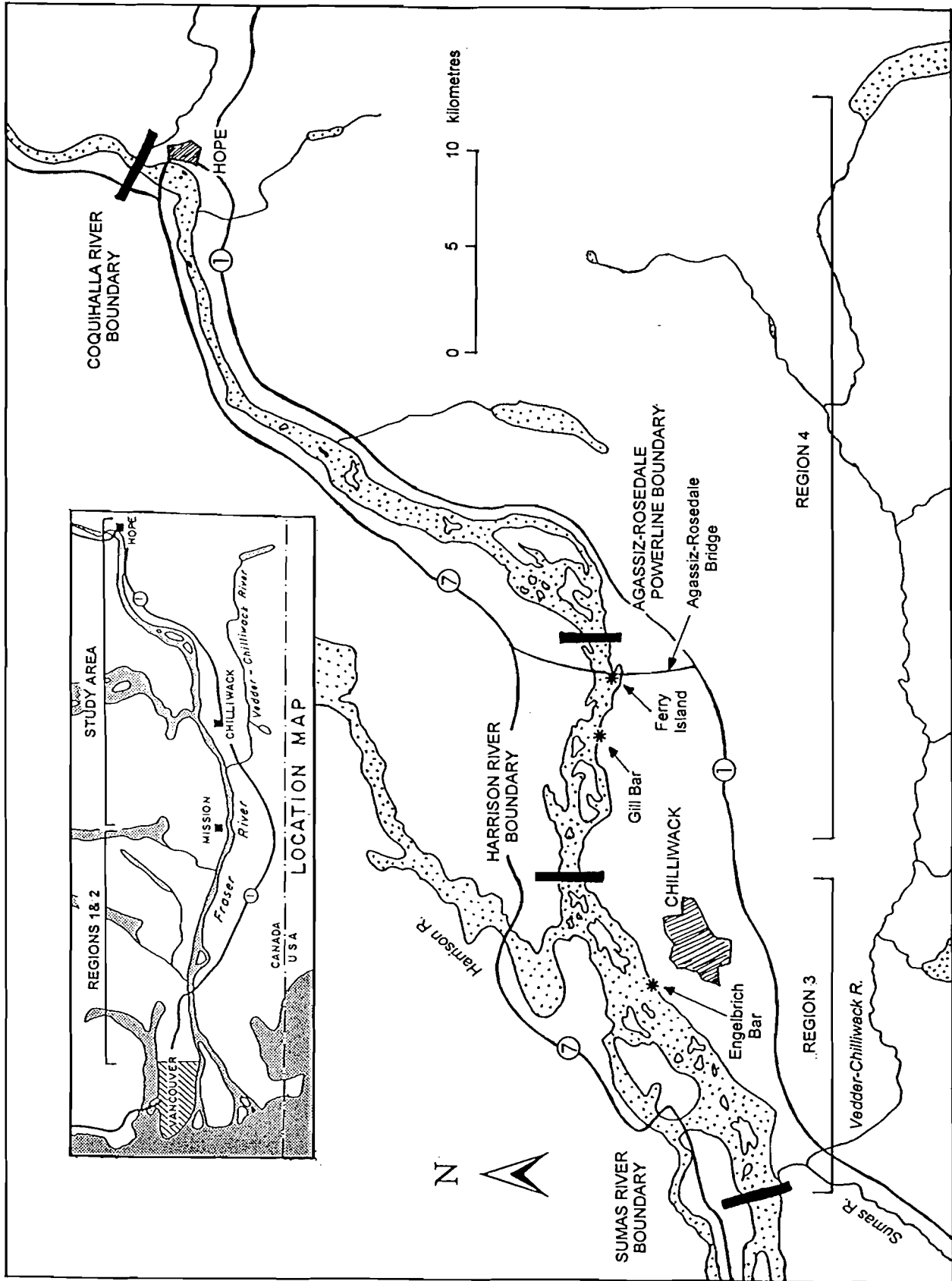


Figure 1. Lower Fraser River sport fishery study area.

by interviewing at this site surveyors were able to get complete trip interviews from a large proportion of anglers fishing in the surrounding area.

Region 4 extended from the outlet of the Harrison River to Hope (Figure 1). This region is similar to Region 3, containing many bars and treed islands. Anglers were concentrated at Landstrom bar, Herrling Island, Ferry Island and Gill bar (Figure 1). Interviews in Region 4 were conducted at Gill bar and Ferry Island Provincial Park. As in Region 3, these bars were primary boat launch sites and allowed interviewers to get complete trip interviews from a large proportion of anglers fishing in the surrounding area. No interviews were conducted between the Agassiz-Rosedale powerline and Hope.

FISHERY REGULATIONS

The 1998 lower Fraser River sport fishery was managed by daily and annual catch limits, fish size restrictions, and fishing time restrictions (Table 1). During the survey, the daily catch limit for chinook was 4 per day, 1 of which could be over 50 cm. The annual catch limit for chinook adults over 50 cm was 10. Several sections of the river were closed to angling for all salmon species between July 9 and July 26; these closures are listed with Table 1. The sockeye fishery was open between August 1 and August 10 and again between August 19 and August 26; the limit for sockeye was 2 per day, 30 cm or over. There was no annual catch limit for sockeye. The aggregate harvest limit for all salmon species was 4 per day.

METHODS

STUDY DESIGN

The lower Fraser River sport fishery was assessed from May 1 to August 31, 1998. The study design, which was similar to that of the 1995-1997 lower Fraser River sport fishery surveys, used a combined access point and overflight survey (DPA Group MS, 1985; Bratty et al., 1998; Walter et al., 1998). The access point survey allowed for

a high proportion of complete trip interviews, while the overflight survey effectively covered the whole study area.

The access point/overflight survey design was based on the assumption that either interview sites were representative of the entire study area, or the proportion of angler effort at the interview sites was large enough to make HPUE estimates insensitive to effort occurring at non-interview sites. These assumptions were not believed to have been violated in the 1995 and 1996 surveys, because of the high concentration of angler effort at the interview sites, in proportion to the rest of the survey area (Bratty et al., 1998; Walter et al., 1998). In 1997 these assumptions were also not believed to have been violated because, despite high overflight rod counts at non-survey sites, a high proportion of the anglers exited the river at the access point survey sites; therefore a reasonably high proportion of the total effort was surveyed. In 1998 the assumptions were not believed to have been violated in Region 3, for the same reason as cited above for the 1997 survey. There may have been, however, violation of the assumptions in Region 4, where an increasing proportion of the observed angler effort took place at a non-surveyed and directly accessed bar.

A total of 6,704 angler interviews and 31 overflights were conducted between May 1 and August 31 in the 1998 lower Fraser River sport fishery survey (Table 2).

Access Point Methods

Generally, one interviewer was stationed in each region at a site chosen for maximum expected angling effort. Interviews were conducted from May 13 to August 31, 1998 and were stratified by month into weekday and weekend (including holiday) day types. Interview days were divided into morning and afternoon shifts lasting from 7:00 to 15:00 and from 14:00 to 22:00, respectively. Shifts were scheduled to allow at least two morning shifts and two afternoon shifts per month on both weekends and weekdays, in each region, except in Region 4 during July, as described below.

Table 1. Fraser River (Mission to Hope) non-tidal sport fishery regulations for chinook and sockeye salmon during the 1998 lower Fraser River sport fishery survey.

Location	Species	Openings	Daily Catch Limits	Annual Catch Limits
Mission Br. to Powerline above Agassiz-Rosedale Bridge*	Chinook	May 9 – Sept 1	4 ≥ 30 cm incl. 1 > 50 cm	10 adults > 50 cm
		Sept 2 – Sept 4	4 between 30 and 62 cm	10 adults > 50 cm
		Nov 4 – Dec 31	4 between 30 and 62 cm	10 adults > 50 cm
	Sockeye	Aug 1 – Aug 10	2 ≥ 30 cm	-
		Aug 19 – Aug 26	2 ≥ 30 cm	-
		Nov 4 – Dec 31	2 ≥ 30 cm	-
Powerline to Alexandra Bridge*	Chinook	June 1 – Sept 4	4 ≥ 30 cm incl. 1 > 50 cm	10 adults > 50 cm
		Nov 4 – Dec 31	4 ≥ 30 cm incl. 1 > 50 cm	10 adults > 50 cm
	Sockeye	Aug 1 – Aug 10	2 ≥ 30 cm	-
		Aug 19 – Aug 26	2 ≥ 30 cm	-
		Nov 4 – Dec 31	2 ≥ 30 cm	-

* In addition to the above regulations, the following sections of the mainstem were closed to angling for all salmon species between July 9 and July 26, 1998:

From the northern tip of Herrling Island, downstream to the mouth of Jespersen Slough

From Wahleach Creek, downstream to Peters Reserve #1

From the Highway #1 bridge at Hope, downstream to the gas pipeline crossing near Floods

This fulfilled the minimum monthly effort requirement (Bratty et al., 1998). In Region 3, interviews took place on all but two weekend and holiday days, and on an average of three weekdays per week, beginning May 13. In Region 4 during June and August, interviews were conducted on all but two weekend and holiday days and on an average of 2 weekdays per week; sampling patterns were similar during the latter half of May. Due to angling closures during July, there was no sampling in Region 4 between July 8 and 29. During this period, both interviewers were stationed in Region 3.

Each shift started with interviewers asking anglers to take part in the survey at the end of their fishing trip. Hourly rod counts were then conducted to build effort profiles and all anglers exiting the site were interviewed. Interview questions included: number of anglers in the party, completed or intended length of fishing trip, time blocks fished, target species, fishing gear used, total kept marked or unmarked fish, by species, and total released fish, also by species. With the anglers' permission, any kept fish were inspected by the interviewer to verify species and identify marks. At the end of

the shift an 'incomplete trip' interview was conducted on all anglers that were still fishing at the interview site. Total complete and incomplete interviews were then tallied for the day on an angler count summary form.

Overflight Methods

An average of two overflights per week (one on weekends and one on weekdays) was scheduled for the duration of the survey. With the exception of 2 overflights in July, all overflights covered both Regions 3 and 4.

Overflights were conducted primarily with a Cessna 182 traveling 30 m above the water, at an average speed of 130 kph. All surveys began at 11:30 a.m. and lasted between 1 and 2 hours, depending on the number of regions flown and the amount of angler effort observed.

When conducting overflights, two observers were seated on the same side of the plane. Rod counts and flight times over high effort bars were recorded on a study area map of the lower Fraser River. These maps

were then compiled to build angler effort profiles and to provide mean daily rod counts for the study area, as well as for specific bars and regions.

DATA MANAGEMENT

Historical data management and analytic procedures are thoroughly outlined in Schubert (1992a, 1992b) and Schubert and Whyte (1992). The methodology is reprinted below with relevant modifications.

The use of historical data management programs became increasingly problematic during the 1995 creel survey program, resulting in high rates of input errors and frustration for the data entry staff (R. Diewert, pers. comm.). A review of these programs in 1996 found that the data management and analysis functions were performed by a collection of DOS executable files, with little or no accompanying documentation. In some cases it was impossible to discern what language was used to write the programs, and because the source code was non-existent, it was impossible to perform improvement modifications. For these reasons, we decided that the entire data management and analysis functions would be re-written for the 1996 creel program. This was undertaken with the following specific objectives in mind: 1) the programs would be fully documented with annotated source code and documentation to ease subsequent modification and development; 2) the source language would be a modern generation language, capable of relational database support and running in a Microsoft Windows environment both in 16 and 32 bit versions, taking full advantage of the modern graphical interface design; 3) there would be support for upgrading the database structures to Access and/or Oracle tables when and if necessary, and 4) the system would be modular, allowing greater flexibility for modifications.

The Delphi development system by Borland met all these criteria and was therefore used to develop the database management system for the 1996 creel program. The Delphi language is based on PASCAL rather than C, offering greatly improved annotated code and reduced cryptic

language structures. Three other major features of this system made it very attractive for this project: 1) the Delphi system enables rapid development by tightly integrating the design process with the use of intelligent components, in fact, the entire data entry section was completed and debugged to beta stage within two months; 2) the system produces a native code compiled executable that runs much faster than an interpretative system such as Microsoft's Visual Basic, and 3) Delphi can also compile .OBJ files for integration with C++ and other development systems and exists in two flavours. Delphi 1.0 will compile a 16-bit executable for use on older computers running Windows version 3.x. The 16-bit executable will also run on modern computers with the Windows 95 operating system. Delphi 2.0 produces 32-bit executables which will run on Windows 95 and Windows NT operating systems, virtually without changes in source code. We have produced both 16 and 32 bit versions of the program, with the more extensive analysis components in the 32 bit version, to take advantage of the execution speed increase and memory space increase afforded under the 32 bit version. The 16-bit version is primarily used as a vehicle for data entry and editing functions on machines running Windows versions 3.x. Currently, the program consists of approximately 4200 lines of code and compiles into an executable file 0.6 MB in size.

Delphi also supports modern relational database design, using the Borland Database Engine. Although we originally designed the database using Microsoft Access tables interfaced through an ODBC connection with Delphi, we discovered that using Paradox table formats directly through the BDE proved to be much faster, more efficient, and less prone to error. We were also able to copy the data tables to ASCII, Oracle, and Access formats without difficulty, demonstrating the flexibility of the Delphi/Paradox/BDE combination.

The program is modular in design and presents the user with selection choices for the category of data to input, edit, or analyse. For each main data category, (interview data, overflight data, effort verification) the program

displays visually clear and intelligent forms to aid the entry of the data. Specific mandatory fields are checked for completeness and the entered data is verified for allowable ranges. These design criteria and procedures were proven to be effective in a post-season review of all the data, which indicated data entry error rates of less than 0.5%.

The creel database has a modern relational design consisting of related data tables that can be grouped by two main functions: support tables and data tables. Support tables include: 1) the Bar Table consists of uniquely identified river bars and their location by regional association, and is used extensively to identify sampling locations and locations of overflight observations; 2) the Species Table uniquely identifies the species of fish likely to be observed in the survey, and is extensively used to organise information on the basis of unique species groupings; 3) the Periods Table is used to track stint information later used in analysis, and 4) the Region Table lists the unique regions and their identifiers.

Data tables include: 1) the Angler Interview Table set, a group of tables linked together by a unique interview number, which is also linked to an interview sheet for subsequent editing and data verification. The tables in this set are a) the Angler Interview data table, b) the Catch/Release data table, c) the Gear Used table, and d) the Hours Fished by the Angler table. The other data tables are: 2) the Overflight Table, where the information from the unique overflights is recorded, and 3) the Rod count table, where the observed rod counts, later used for effort verification, are recorded by hour. A complete description of these tables, their relationships and the computer programs are documented in Palermo (in prep.).

In 1997, improvements to the program included the division of its input and analysis portions into 2 separate programs. We also made improvements to the data entry portion of the program, based on feedback received in 1996, and the analysis portion was re-written to allow greater analytical flexibility.

In 1998, further improvements were made to facilitate data entry and error detection and to include other study areas. The analytical portion was modified to allow data processing for roving creel designs.

DATA ANALYSIS

Before the analysis algorithms were performed, data were stratified according to region, site, month, day type, hour and stint. Days were divided into three stints: the period of overlap between the a.m. and p.m. shifts, and the a.m. and p.m. shifts outside the overlap period. Stratification allowed the appropriate weighting of interview and overflight data.

The 1998 Canada Day Holiday (July 1) fell on a Wednesday. Although July 1 was the official holiday, many anglers appear to have made the following weekend into a long weekend by taking alternate or additional holiday days. As a result, the river received increased angler effort between July 1 and 5; all 5 days have been classified as weekend/holiday days for the purposes of analysis.

Angler Effort

Angler effort profiles were generated from hourly rod counts at the survey sites. Effort information from outside the survey shifts (prior to 07:00 and after 22:00) was reconstructed from the interview data and used to adjust the daily angler effort profile. Hourly effort was also weighted to compensate for the sampling imbalances resulting from overlapping survey shifts. Mean sample day effort for each stratum (region, month and day type) was the ratio of the mean overflight rod count to the proportion of daily effort occurring during the overflight rod count time block. Total angler effort was the product of the mean daily angler effort and the number of days in the stratum. The mathematical relationships are reported below, with variance calculations detailed in Schubert and Whyte (1992).

- 1) Estimated total rods fishing by hour j and day type h :

$$\hat{R}_{hj} = \sum_i N_h / n_{hij} \sum_k r_{hijk}$$

- 2) Estimated proportion of the daily angler effort occurring during the instantaneous rod count time block, by day type:

$$\bar{P}_{hj^*} = \frac{\hat{R}_{hj^*}}{\sum_j \hat{R}_{hj}}$$

- 3) Estimated mean rod count during the instantaneous rod count time block, by day type:

$$\bar{y}_{hj^*} = \sum_k \frac{y_{hj^*k}}{n_{hj^*}}$$

- 4) Estimated angler effort by day type, in hours:

$$E_h = N_h \frac{\bar{y}_{hj^*}}{\bar{P}_{hj^*}}$$

- 5) Estimated study period angler effort, in hours:

$$E = \sum_h E_h$$

where:

N_h = total study period days of day type h (weekday or weekend);

n_{hij} = number of interview sample days on day type h at site i during hour j ;

r_{hijk} = rod count on day type h at site i at hour j on day k ;

\hat{R}_{hj^*} = estimated total effort (hours) on day type h during the instantaneous count time j^*

y_{hj^*k} = instantaneous rod count on day type h on day k ;

n_{hj^*} = number of instantaneous rod counts on day type h ;

Catch per Unit Effort

CPUE was calculated by region and day type for each species and mark group, using a total ratio estimator (Von Geldern, Jr. and Thomlinson, 1973; Malvestuto, 1983; Hoenig et al., 1997), i.e., the total estimated catch was divided by the total estimated effort (to time of interview). Estimates were derived from interview data weighted by the proportion of stints that were surveyed. CPUE was calculated separately for harvested (HPUE) and released (RPUE) fish. The mathematical relationships are reported below.

- 6) Estimated monthly catch to time of interview at the survey sites by region and day type:

$$\hat{X}_h = \sum_i \sum_l \frac{1}{a_{hil}} \sum_f \sum_q \sum_u \frac{x_{hilfqu}}{a_{hilfq}}$$

- 7) Estimated monthly angler hours to time of interview at the survey sites by region and day type:

$$\hat{T}_h = \sum_i \sum_l \frac{1}{a_{hil}} \sum_f \sum_q \sum_u \frac{t_{hilfqu}}{a_{hilfq}}$$

- 8) Estimated catch per angler hour at the survey sites by region and day type:

$$\bar{C}_h = \frac{\hat{X}_h}{\hat{T}_h}$$

where:

a_{hil} = proportion of monthly stints of type l for site i on day type h which were surveyed;

$ahilfq$ = proportion of anglers leaving in time block q on stint f of stint type l at site i on day type h who were interviewed;

$xhilfq_u$ = catch to time of interview by angler u leaving in time block q on stint f of stint type l at site i on day type h ;

$thilfq_u$ = hours fished to time of interview by angler u leaving in time block q on stint f of stint type l at site i on day type h .

However, before calculating CPUE, the raw interview data were tested for significant differences in CPUE between all interviews and complete trip interviews. The test used, from Cochran (1977) was:

- 9) Estimated variance of the difference between two ratios $Var(\bar{c}_c - \bar{c}_t)$:

$$Var(\bar{c}_c - \bar{c}_t) = Var(\bar{c}_c) + Var(\bar{c}_t)$$

where:

$Var(\bar{c}_c)$ = variance of CPUE from complete trip interviews:

$$\frac{1}{n(n-1)\bar{t}^2} (\sum x_u^2 - 2\bar{c}_c \sum x_u t_u + \bar{c}_c^2 \sum t_u^2)$$

$Var(\bar{c}_t)$ = variance of CPUE from all interviews, calculated as above.

\bar{t} = mean time to interview.

If $(\bar{c}_c - \bar{c}_t) \pm (t\text{-table}, 0.95)$ $Var(\bar{c}_c - \bar{c}_t)$ did not include zero, the difference was significant. In that case, incomplete trip interviews were excluded from the analysis for that site. In the 1998 survey, approximately 1% of all interviews were in-

complete; all of these were excluded from analysis.

Harvest and Release

Monthly regional harvest and release, estimated by species and mark group, was the sum of the weekday and weekend/holiday strata estimates. For each stratum, harvest and release was the product of stratum effort and the corresponding value of HPUE or RPUE.

- 10) Total study period catch (C):

$$C = \sum_h \bar{c}_h E_h$$

Angler Characteristics

Several unweighted angler attributes, including mean angler day length, preferred species, and gear type, were also summarized by site and month (Appendix 1).

RESULTS

The 1998 lower Fraser River sport fishery survey was conducted between May 1 and August 31, 1998. Catches during the two-month study included chinook and sockeye salmon, as well as sturgeon and several trout species. Survey effort, total angler effort, CPUE, HPUE and RPUE estimates by species, and total catch and release by species, are detailed below.

SURVEY EFFORT

The study period included 82 weekdays and 41 weekend/holiday days, of which 82% and 88% were sampled, respectively. The number of interviews conducted per month increased from May (344) to August (2,990). Seventy-five percent of the interviews were conducted at Englebrich bar in Region 3, with the remaining 25% conducted at Gill bar (2%) and Ferry Island (23%) in Region 4.

Six overflights were conducted over Regions 3 and 4 in May, while 8 were conducted in both June and July; two of the July

flights covered Region 3 only, because of mechanical difficulties. Nine overflights were conducted over both regions in August. Mean daily regional rod counts ranged from 8 (Region 4, May) to 200 (Region 4, August) on weekdays and from 25 (Region 4, May) to 300 (Region 4, August) on weekends and holidays (Appendix 2). The peak rod count for the entire study area (874) occurred on August 9. On average, 56% of the anglers in the study area were observed in Region 3, with the remaining 44% observed in Region 4.

ANGLER EFFORT

Daily Profile

The majority of anglers fished during the daylight hours, with peaks in effort generally occurring between 7:00 and 11:30 a.m. (Figures 2a and 2b, Appendices 3a and 3b).

Total Angler Effort

Total estimated angler effort from May 1 through August 31 was 360,449 hours or 63,397 angler days. Angling effort was slightly greater in Region 3 (57% of total effort) than in Region 4 and monthly angling effort ranged from 18,585 hours in May to 140,140 hours in August. Angler effort totals by month and region are presented in Table 2 and Appendices 4a, 4b and 4c.

CATCH PER UNIT EFFORT

CPUEs for adult and jack chinook and sockeye salmon are presented in Figure 3 and, along with HPUEs and RPUEs, in Appendices 5a and 5b. Peak and average CPUEs are described below by month, region and day type. The proportion of harvested fish to total catch is also described.

CPUEs, HPUEs and RPUEs of all other species caught in the study area during the survey are detailed in Appendices 5a and 5b. Following chinook and sockeye, sturgeon and trout species were the most targeted species and had average weekday CPUEs for May through August of 0.0024 and 0.0004, respectively.

Average weekend and weekday CPUEs for adult chinook for the study period were 0.0112 and 0.0241, respectively. Most of the adult chinook catch was harvested, with weekend and weekday HPUEs averaging 0.0108 and 0.0235, respectively. Average weekend and weekday CPUE for jack chinook were both 0.0001. Approximately half of the jack chinook catch was harvested, with weekend and weekday HPUEs averaging 0.0001 and 0.00002, respectively. The peak weekend and weekday CPUEs for adult chinooks both occurred in Region 4 during June (0.0321 and 0.0522, respectively). The peak weekend CPUE for chinook jacks occurred in Region 3 during August (0.0007); the peak weekday CPUE also occurred in Region 3, but during June (0.0003).

Weekend and weekday sockeye CPUEs averaged 0.0444 and 0.0549, respectively for the study period. On average, more than half of the sockeye caught were harvested (weekend and weekday HPUEs averaged 0.0309 and 0.0315, respectively). The peak weekend and weekday CPUEs for sockeye both occurred in Region 4 during August (0.2397 and 0.3213, respectively).

TOTAL CATCH

Total catches of 7,405 adult chinook, 40 chinook jacks, and 15,874 sockeye salmon, representing 94% of the total sport catch, were estimated for the study area from May through August. Monthly harvest and release totals for all species are detailed in Table 2. Harvest and release totals by month and region are detailed in Appendices 4a, 4b and 4c.

Chinook were caught throughout the study period; the adult catch peaked in Region 3 during June (29% of the total survey adult chinook catch). On average, 58% of adult chinook and 100% of jacks were caught in Region 3. A total of 97% of the combined chinook catch was harvested.

Seventy-two percent of the sockeye caught were in Region 4 during August. Ninety-five percent of all sockeye caught in the study area were caught during August.

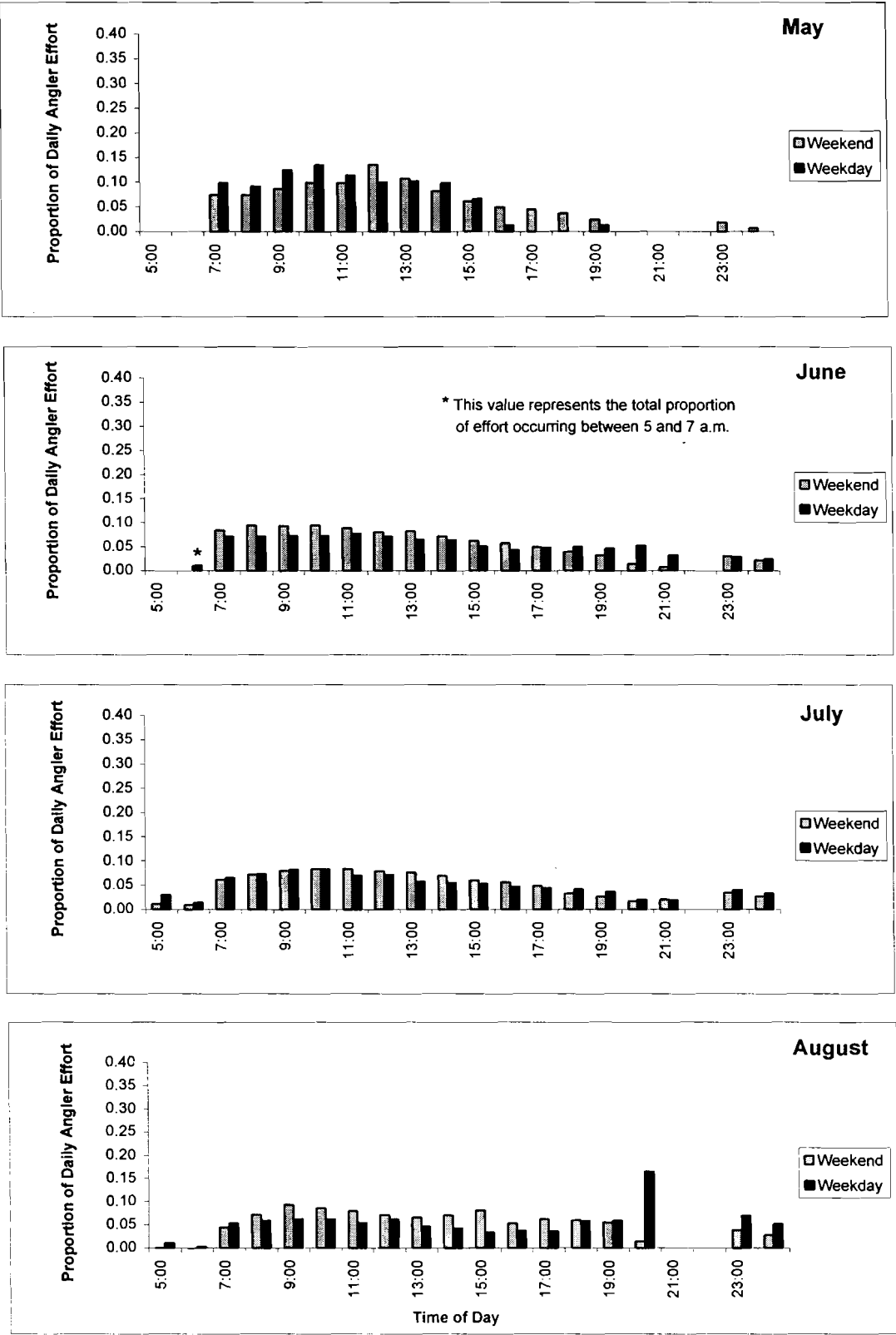


Figure 2a. Hourly effort profiles by month and day type in the 1998 lower Fraser River sport fishery, Region 3.

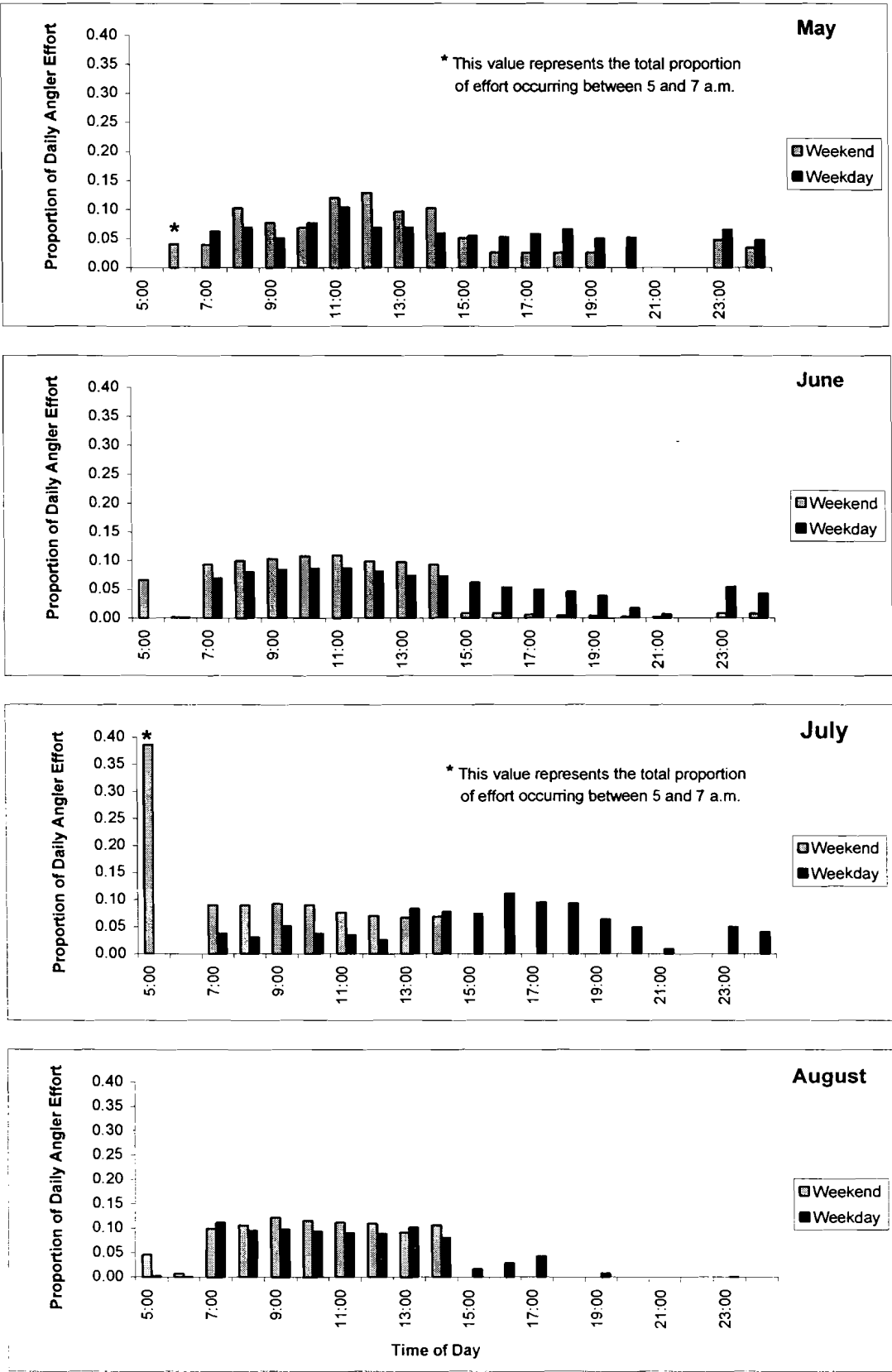
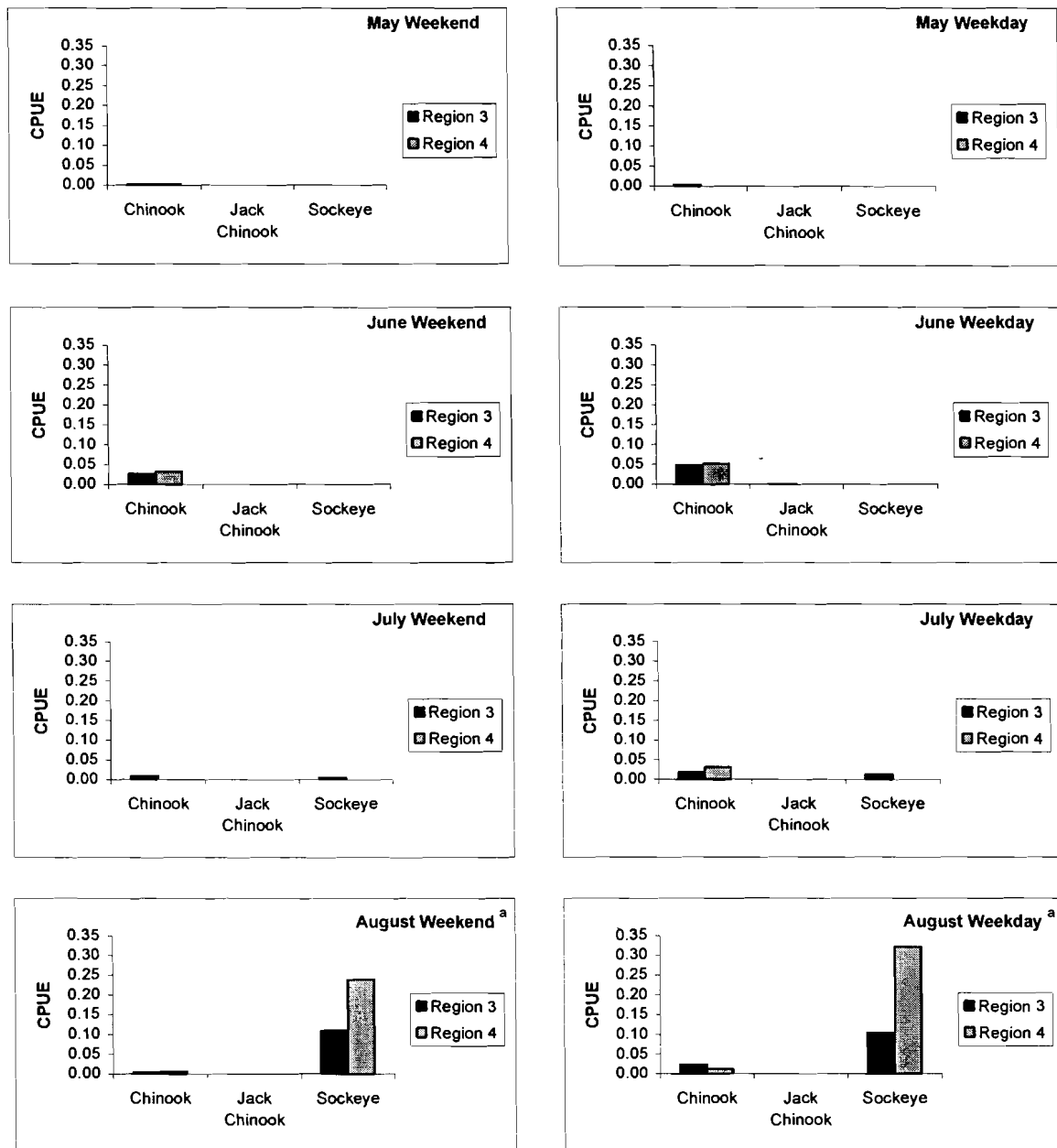


Figure 2b. Hourly effort profiles by month and day type in the 1998 lower Fraser River sport fishery, Region 4.



^a August values are for the sockeye retention periods only because CPUE for sockeye cannot be calculated for the sockeye non-retention periods.

Figure 3. Chinook, jack chinook and sockeye CPUEs by month, day type and region in the 1998 lower Fraser River sport fishery.

Table 2. Angler effort and harvest and release by species and month in the 1998 lower Fraser River sport fishery, Regions 3 and 4.

	May	June	July	August ^a	August ^b	Total
# of interviews	344	1,607	1,763	2,501	489	6,704
# of overflights	6	8	8	5	4	27
ANGLER EFFORT						
Estimated effort (hours)	18,585	78,868	122,856	74,553	65,587	360,449
Estimated effort (days)	3,177	12,240	19,433	14,076	14,471	63,397
Average angler day (hours)	5.85	6.44	6.32	5.30	4.53	5.69
ESTIMATED HARVEST						
Chinook	48	3,054	2,317	834	907	7,160
Jack Chinook	0	0	0	13	8	21
Coho	0	0	0	0	0	0
Chum	0	0	0	0	0	0
Pink	0	0	0	0	0	0
Sockeye	0	0	0	9,655	0	9,655
Steelhead	0	0	0	0	0	0
Trout	0	0	0	4	2	6
Sturgeon	0	0	0	0	0	0
Other	0	0	0	0	0	0
ESTIMATED RELEASE						
Chinook	8	56	17	78	86	245
Jack Chinook	0	10	5	3	1	19
Coho	0	0	0	0	0	0
Chum	0	0	0	0	0	0
Pink	0	0	0	0	0	0
Sockeye	0	5	735	5,479	-	6,219 ^c
Steelhead	0	44	23	0	0	67
Trout	0	0	138	48	28	214
Sturgeon	19	101	399	349	282	1,150
Other	18	13	0	0	0	31

^a For the period when the fishery was open for sockeye retention: August 1 – 10 and August 19 - 26

^b For the period when the fishery was closed to sockeye retention: August 11 – 18 and August 27 - 31

^c This value is an underestimate, since it is not possible to calculate the number of sockeye released during the sockeye non-retention period.

- Value cannot be calculated

A total of 61% of the sockeye catch was harvested.

MARKED CATCH

Of the 6,661 fish examined during the study, only 4 (0.1%) were marked with an adipose fin clip or any other mark. Marked fish estimates are presented in Table 3. Interview staff did not record mark data for released fish, as angler mark recognition was not considered reliable.

ANGLER CHARACTERISTICS

Weekly and site-specific angler characteristics are detailed in Appendix 1. Anglers changed their fishing location, as well as target species, in accordance with changes in river conditions, species composition, species abundance and fishery openings.

The majority of anglers in the 1998 lower Fraser River sport fishery fished from shore, or from mid-channel gravel bars, as

they became exposed. Many anglers launched boats at the access points and traveled to other bars, where they fished from shore. Some fished directly from their boats, particularly during the early part of the season when the water was high.

Ninety-nine percent of the anglers interviewed were targeting either adult chinook or sockeye salmon. From May through July, between 97% and 99% of the anglers targeted adult chinook, with almost no anglers targeting sockeye. In August, the proportion of anglers targeting adult chinook dropped to 14% and 84% of the anglers targeted sockeye.

Ninety-eight percent of the anglers interviewed (6,570) used lures as their gear type, with 1.8% using bait (118), and the other 0.2% using either bait and lure combinations (11) or flies (5). Mean angler trip length over the study period was 5.7 hours. On average, trips were longer in June (6.38 hours) than in any other month (Table 2).

Table 3. Estimated marks by species and month in the 1998 lower Fraser River sport fishery, Regions 3 and 4.

	May	June	July	Aug.	Total
Chinook	0	28	0	0	28
Jack					
Chinook	0	0	0	0	0
Coho	0	0	0	0	0
Chum	0	0	0	0	0
Pink	0	0	0	0	0
Sockeye	0	0	0	0	0
Steelhead	0	0	0	0	0
Trout	0	0	0	3	3
Sturgeon	0	0	0	0	0
Other	0	0	0	0	0

DISCUSSION

The lower Fraser River sport fishery was closed to sockeye retention between August 11 and 18 and also between August 27 and 31. No sockeye were reported harvested during the non-retention periods; the sockeye harvest is assumed to be zero during these times. The number of sockeye released during the 13 non-retention days cannot be calculated, therefore any sockeye catch numbers reported in this paper do not

include sockeye released during the non-retention periods. Because only 12% of anglers targeted sockeye during the August closures, the missing release numbers are not likely to be very large.

The 1997 lower Fraser River sport fishery survey only covered July and August of that year. As a result, any comparisons involving the 1997 fishery can involve July and August only.

MIGRATION TIMING AND ABUNDANCE

In the 1998 lower Fraser River sport fishery survey, monthly and regional catch patterns, along with effort, were associated with salmon migration timing and abundance.

The 1998 test fishery index indicated that the chinook run peaked between early July and late August (Figure 4). In the sport fishery, however, chinook CPUEs peaked during June; 42% of the season total chinook catch occurred during June. 1998 July and August chinook catches were up to 4,269 from 1,870 in 1997, despite lower test fishery index values in 1998. Based on final escapement numbers, the test fishery is believed to have significantly underestimated chinook abundance in the river. For example, the 1998 Harrison River mark-recapture estimates indicated that adult chinook escapement was the highest recorded since 1984, and significantly greater than in 1997 (R. Semple, pers. comm). The increased chinook catch in 1998 can therefore be attributed in part to increased chinook abundance in the river. It can also be attributed to an increased proportion of angler effort directed at chinook; 45% of anglers targeted chinook in July and August 1998, while only 15% of anglers targeted chinook during the same months in 1997. Environmental conditions may also have played a part in the increased chinook catch; see the discussion below.

Sockeye catch peaked in August, accounting for 85% of the total sport catch for that month. The July sockeye catch (735) was down dramatically from 1997 (15,003), which was a peak year for the Fraser River

sockeye stocks. The lower catch in 1998 was the result of lower numbers of sockeye in the river and a decreased proportion of effort directed at sockeye. Sixty-four percent of anglers targeted sockeye in July 1997, while only 0.1% targeted sockeye in 1998. August sockeye catch (15,134) was also down from 1997 (36,219); the proportion of anglers targeting sockeye dropped from 95% in 1997 to 84% in 1998 as a result of the sockeye non-retention periods.

Changes in species abundance also affected angling effort distribution on the lower Fraser River. In May and June, approximately 73% of the effort within the study area occurred in Region 3, which contained prime chinook angling sites (i.e., Wellington bar). In July and August, the proportion of effort occurring in Region 3 decreased to approximately 51%, as effort began to shift to Region 4. The increase in Region 4 effort during July may have occurred because anglers in Region 4 were experiencing better CPUEs for chinook (0.0320 in Region 4 on weekdays, compared with 0.0184 in Region 3 on weekdays). In August, the increasing number of sockeye in the lower Fraser River and the opening of the sockeye fishery maintained the increased proportion of angler effort in Region 4, which contains sites known to produce high numbers of sockeye salmon, such as Gill bar and Ferry Island. The proportion of anglers fishing in Region 4 during August 1998 (55%) was less than in 1997 (65%); this decrease was likely the result of the sockeye closures in August when many anglers targeted chinook. The proportion of anglers targeting adult chinook dropped from 99% in July to 14% in August; conversely, the proportion of anglers targeting sockeye rose from 0.1% to 84%.

ENVIRONMENTAL CONDITIONS

Interannual variation in environmental conditions can also impact the effectiveness of a fishery. Schubert and Whyte (1992) have shown that river level can affect both angler effort and success. High river levels flood the most effective fishing sites, making them inaccessible to anglers. Also, the proportion of a run that is vulnerable to a fishery

is affected by river discharge, since river discharge affects migration timing.

Palermo and Thompson (1999) felt that the high water levels in 1997 may have deterred anglers and resulted in the decrease in angling effort from July 1996 to July 1997. The river level was much lower in 1998 than in 1997, particularly during June and July (Figure 4) and angling effort during July 1998 was up to 122,856 hours from 85,636 hours in 1997. The lower water levels likely produced better angling conditions, which resulted in the increased angling effort.

Low water may have made the chinook in the river more vulnerable to anglers. Walters et al. (1998) found that chinook HPUEs for June and July were significantly lower in 1996 than in 1995, and attributed this to the high water levels in 1996. In contrast, the low water levels in 1998 may have resulted in a greater proportion of the chinook run being vulnerable to anglers targeting chinook.

August water levels were low enough to expose prime fishing bars during peak sockeye migration. These conditions resulted in a highly effective sockeye fishery, with weekday HPUEs for Region 3 and Region 4 of 0.1041 and 0.3213, respectively. While July effort was up from 1997, August effort decreased by approximately 13% (from 175,238 hours in 1997 to 140,141 hours in 1998), probably as a result of the 13-day sockeye closure.

FISHERY REGULATIONS

Angling effort was also affected by openings and closures in the fishery. For example, overflight rod counts increased substantially when the sockeye fishery opened (162 rods counted in Region 3 on Saturday, July 25, before the sockeye fishery, compared to 273 rods on Sunday, August 2, during the sockeye fishery). Schubert (1992a) noted increased angler effort at the initiation of special fisheries as well.

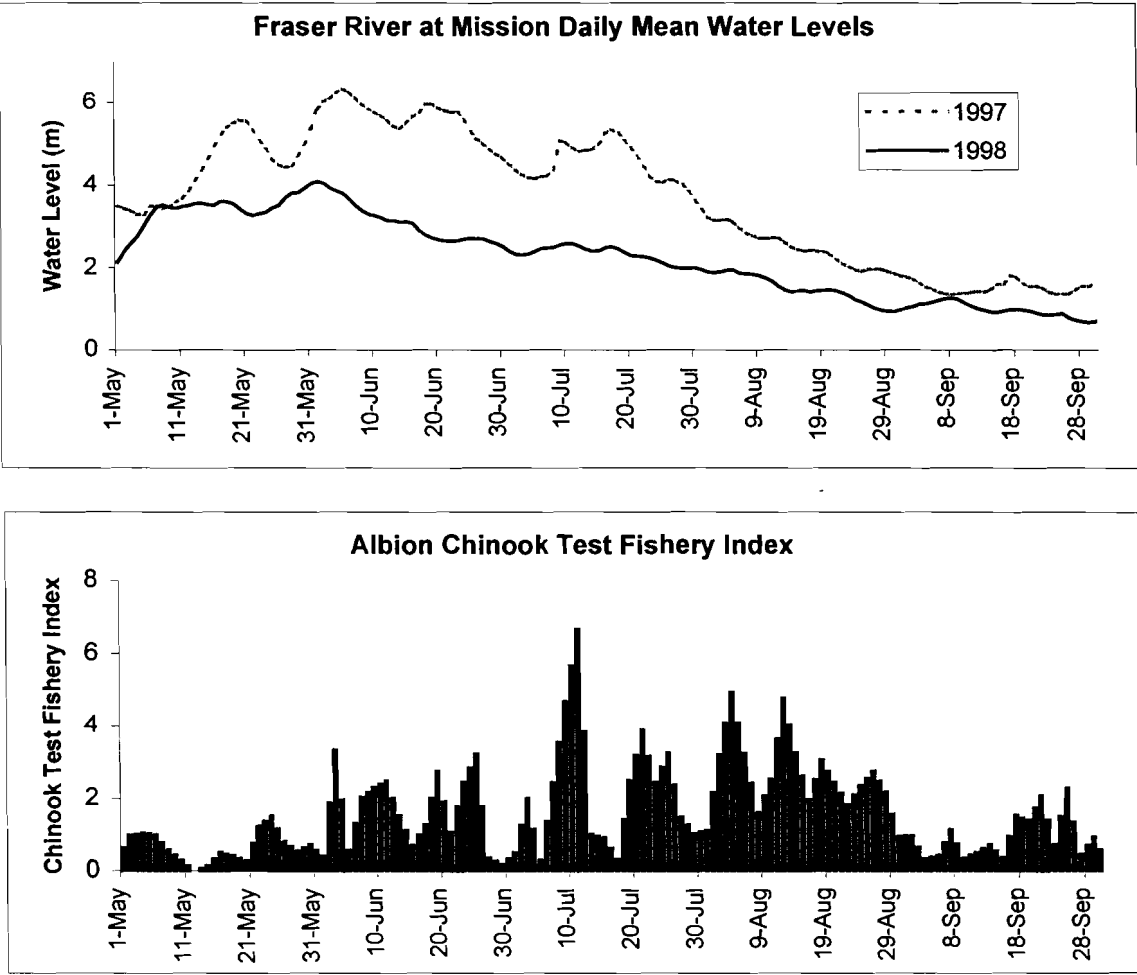


Figure 4. 1997 and 1998 Fraser River water levels at Mission and the 1998 Albion chinook test fishery index, May through September.

Most of the top half of Region 4, above the Agassiz-Rosedale powerline, was closed to angling for all salmon species between July 9 and 26. As a result, most of the effort recorded in Region 4 during July occurred in the first part of the month. The regular Region 4 interviewer was stationed in Region 4 between July 1 and 7 and on July 30. Because of budget constraints and a large amount of effort at Englebrich bar in Region 3, the interviewer was stationed in Region 3 for the remainder of July.

The opening of the sockeye fishery in August prompted the majority of anglers to change their target species from chinook to sockeye. Prior to August 1, approximately 99% of Region 3 anglers were targeting chinook, with less than 1% targeting sockeye;

between August 1 and 10 and August 19 and 26, 97% of Region 3 anglers targeted sockeye. During the August sockeye non-retention periods (August 11-18 and 27-31), 12% of anglers targeted sockeye, and 70% targeted chinook.

PROPORTION OF ANGLERS AT SURVEY SITES AND SURVEY EFFICIENCY

In previous lower Fraser River sport fishery surveys, the proportion of anglers at survey sites was assessed to determine whether the assumption that either the interview sites were representative of the entire study area, or the proportion of angler effort occurring at the interview sites was sufficient to make HPUE estimates insensitive to effort occurring at non-interview sites was satisfied

(Schubert 1992a, 1995). It has been suggested that if the interview sites account for a large proportion (>50%) of the total angler effort, the difference between survey sites and the remainder of the fishery would have to be large to appreciably affect effort estimates (Schubert, 1995). Bratty et al. (1998) found that effort at survey sites during the 1995 survey was high in June and July (68% and 56%, respectively) and somewhat lower during August (42%) and concluded that there may have been more error associated with the August estimate than with the June and July estimates. Walters et al. (1998) chose not to evaluate effort distribution for the 1996 survey, since the study design and methodology were consistent with those of the 1995 survey.

Palermo and Thompson (1999) did not attempt to quantify the proportion of effort occurring at non-survey sites during the 1997 survey. They found that using over-flight rod counts to determine effort distribution was misleading and would underestimate the proportion of effort essentially occurring at survey sites, since many anglers used boats to access and fish at other bars, but entered and exited the river via the access point survey areas. This was particularly common in Region 3, and the assumptions associated with the study design were not believed to have been violated in this region. In Region 4, however, an unexpectedly high proportion of effort took place at Landstrom bar, which was a directly accessed and non-surveyed site. They found that more error may therefore have been associated with the Region 4 estimates, particularly during August, when Region 4 received a greater proportion of the total study area effort.

In 1998, Landstrom bar again received a significant proportion of the Region 4 effort. Budget constraints prevented the placement of an interviewer at Landstrom bar; as in 1997, more error may have been associated with the Region 4 estimates, particularly during August, when Region 4 received a greater proportion of the total study area effort.

Survey efficiency (the proportion of the total estimated effort that was interviewed) has averaged between 9% and 11% in previous lower Fraser River sport fishery surveys, comparing favourably to surveys in other systems (Bratty et al., 1998). In 1998, survey efficiency averaged 10.6%.

EFFORT DISTRIBUTION

Effort distribution was not examined during the 1998 survey. Effort distribution has been examined during past surveys and in each case it was determined that the majority of effort took place within, rather than outside, the study area (Palermo and Thompson, 1999; Bratty et al., 1998).

RECOMMENDATIONS

Due to increased population levels in the Lower Mainland, there is a common belief that sport fishing has substantially increased in the lower Fraser River area. Therefore, we recommend that the survey be extended to cover areas and species currently not covered. Specifically:

1. Extend the survey coverage to include the area below the confluence of the Sumas River to the mouth of the Fraser River.
2. Extend the survey coverage to include the months May through November in order to estimate sport catch of chinook, coho, sockeye, pink and steelhead.
3. Add an additional interviewer at Landstrom bar in Region 4, if it remains accessible to anglers in future years.

Further recommendations regarding the general evaluation of recreational fisheries are discussed by Schubert (1995).

SUMMARY

1. The 1998 July and August chinook catch was up considerably from 1997, due to increased chinook abundance in the river, an increased proportion of effort directed at chinook and envi-

ronmental conditions in 1998 which favoured the chinook fishery. In July and August 1998 a total of 4,269 chinook were caught, compared with 1,870 chinook caught in the same months of 1997.

2. Catch rates for sockeye decreased dramatically from 1997 to 1998, due to their decreased abundance in the river and a decreased proportion of angler effort directed at the species. The sockeye catch for July and August 1998 was estimated at a minimum of 15,869, compared with 51,222 sockeye caught in the same months in 1997.
3. July angler effort increased from 1997 with 122,856 angler hours expended, compared with 85,636 hours in 1997. In contrast, August angler effort was down in August 1998 with 140,141 angler hours expended, compared to 175,238 hours in 1997. The proportion of angler effort directed at chinook increased from 1997 to 1998. In 1998, 99% and 15% of anglers targeted chinook in July and August, respectively, compared with 35% and 4% targeting chinook in the same months of 1997.

ACKNOWLEDGMENTS

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REFERENCES

Anon. 1995. Fraser River pink. Prepared by Fraser River Action Plan, Fishery Management Group, Fisheries and Oceans Canada.

Bratty, J.M., R.E. Diewert, J.R. Irvine, V. Palermo and A.S. Thompson. 1998. Angler effort and catch in the 1995 lower Fraser River sport fishery. Can. Manuscr. Rep. Fish. Aquat. Sci. 2469: 39p.

Cochran, W.G. 1977. Sampling techniques, 3rd edition. John Wiley & Sons, New York.

DPA Group Inc. MS 1985. The Fraser River bar sport fishery design study. Prepared for the Dept. of Fisheries and Oceans, New Westminster. 63 p.

Hoenig, J.M., C.M. Jones, K.H. Pollock, D.S. Robson and D.L. Wade. 1997. Calculation of catch rate and total catch in roving surveys of anglers. Biometrics 53: 306-317.

Malvestuto, S.P. 1983. Sampling the recreational fishery, p.397-419 *In* Neilsen, L.H. and D.L. Johnson [eds.]. Fisheries techniques. American Fisheries Society, Bethesda, Maryland.

Mosley, T. MS 1983. Creel survey of the Fraser River bar fishery, 1982. Prepared for the Dept. of Fisheries and Oceans, New Westminster. 97 p.

Palermo, V. and A.S. Thompson. Angler effort and catch in the 1997 lower Fraser River sport fishery. Can. Manuscr. Rep. Fish. Aquat. Sci. (in press).

Schubert, N.D. 1992a. Angler effort and catch in five Fraser River chinook salmon fisheries, 1989. Can. Manuscr. Rep. Fish. Aquat. Sci. 2128: 69 p.

Schubert, N.D. 1992b. Angler effort and catch in the 1985 - 1988 lower Fraser River sport fishery. Can. Manuscr. Rep. Fish. Aquat. Sci. 2170: 140 p.

Schubert, N.D. and I.W. Whyte. 1992. Angler effort and catch in five Fraser River chinook salmon sport fisheries, 1990. Can. Manuscr. Rep. Fish. Aquat. Sci. 2142: 58 p.

Schubert, N.D. 1995. Angler effort and catch in four Fraser River chinook salmon sport fisheries, 1994, and a retrospective on nine years of upper Fraser River sport fishery management and assessment. Can. Manuscr. Rep. Fish. Aquat. Sci. 2275: 93 p.

Von Geldern, Jr., C.E. and P.K. Thomlinson. 1973. On the analysis of angler catch rate data from warmwater reservoirs. Calif. Fish and Game 59(4): 281-292.

Walter, A.R., V. Palermo, K.J. Scott and A.S. Thompson. Angler effort and catch in the 1996 lower Fraser River sport fishery. Can. Manuscr. Rep. Fish. Aquat. Sci. 2470: 26p.

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APPENDICES

Appendix 1a. Month-specific interview responses in the 1998 lower Fraser River sport fishery, Region 3.

		May	June	July	August ^a	August ^b	Total
Number of Interviews		245	1,128	1,641	1,704	387	5,105
Mean Angler Day Length							
- All Anglers		5.7	6.5	6.2	5.2	5.4	5.8
- Complete Trip Interviews	Number	245	1,119	1,635	1,701	387	5,087
	Hours	5.7	6.4	6.2	5.2	5.4	5.8
- Incomplete Trip Interviews	Number	0	9	6	3	0	18
	Hours	N/A	10.3	10.3	17.5	N/A	11.5
Target Species	None	0	1	0	0	0	1
	Chinook	237	1,113	1,619	41	270	3,280
	Coho	0	0	0	0	0	0
	Chum	0	0	0	0	0	0
	Pink	0	0	0	0	0	0
	Sockeye	0	0	1	1,655	48	1,704
	Steelhead	0	0	0	0	0	0
	Trout	0	0	1	0	3	4
	Sturgeon	8	14	20	8	65	115
	Jack Chinook	0	0	0	0	0	0
	Other	0	0	0	0	1	1
Gear	Bait	8	15	25	0	60	108
	Lure	237	1,113	1,614	1,704	314	4,982
	Bait and Lure	0	0	2	0	9	11
	Fly	0	0	0	0	4	4
Inspection of Catch	Inspected	245	1,128	1,625	1,704	387	5,089
	Number Correct	245	1,128	1,613	1,704	387	5,077

^a For the period when the fishery was open for sockeye retention: August 1 – 10 and August 19 - 26

^b For the period when the fishery was closed to sockeye retention: August 11 – 18 and August 27 – 31

Appendix 1b. Month-specific interview responses in the 1998 lower Fraser River sport fishery, Region 4.

		May	June	July	August ^a	August ^b	Total
Number of Interviews		99	479	122	797	102	1,599
Mean Angler Day Length							
- All Anglers		6.5	6.3	6.5	4.2	4.8	5.2
- Complete Trip Interviews	Number	72	450	116	797	102	1,537
	Hours	5.4	6.0	6.4	4.2	4.8	5.0
- Incomplete Trip Interviews	Number	17	29	6	0	0	52
	Hours	9.3	10.2	7.8	N/A	N/A	9.6
Target Species	None	1	0	0	0	0	1
	Chinook	98	479	122	0	101	800
	Coho	0	0	0	0	0	0
	Chum	0	0	0	0	0	0
	Pink	0	0	0	0	0	0
	Sockeye	0	0	0	797	1	798
	Steelhead	0	0	0	0	0	0
	Trout	0	0	0	0	0	0
	Sturgeon	0	0	0	0	0	0
	Jack Chinook	0	0	0	0	0	0
	Other	0	0	0	0	0	0
Gear	Bait	1	1	0	8	0	10
	Lure	98	478	122	788	102	1,588
	Bait and Lure	0	0	0	0	0	0
	Fly	0	0	0	1	0	1
Inspection of Catch	Number	99	452	122	797	102	1,572
	Number Correct	99	452	122	797	102	1,572

^a For the period when the fishery was open for sockeye retention: August 1 – 10 and August 19 - 26

^b For the period when the fishery was closed to sockeye retention: August 11 – 18 and August 27 - 31

Appendix 2a. Daily angler counts from overflights during May and June in the 1998 lower Fraser sport fishery survey.

Month	Day	Day of Week	Region 3	Region 4	Regions 3 & 4 Total
May	14	Thursday	28	6	34
	17	Sunday	55	13	68
	21	Thursday	31	9	40
	23	Saturday	93	31	124
	28	Thursday	29	8	37
	31	Sunday	66	31	97
	weekday	mean	29.3	7.7	37.0
		%	29.1	23.5	27.8
	weekend	mean	71.3	25.0	96.3
		%	70.9	76.5	72.3
Month	Day	Day of Week	Region 3	Region 4	Regions 3 & 4 Total
June	4	Thursday	33	20	53
	7	Sunday	144	57	201
	9	Tuesday	110	52	162
	13	Saturday	253	158	411
	17	Wednesday	145	54	199
	20	Saturday	321	152	473
	23	Tuesday	132	51	183
	28	Sunday	296	217	513
	weekday	mean	105.0	44.3	149.3
		%	29.3	23.3	27.2
	weekend	mean	253.5	146.0	399.5
		%	70.7	76.7	72.8

Appendix 2b. Daily angler counts from overflights during July and August in the 1998 lower Fraser sport fishery survey.

Month	Day	Day of Week	Region 3	Region 4	Regions 3 & 4 Total
July	1 ^a	Wednesday	316	196	512
	4	Saturday	210	224	434
	9 ^b	Thursday	118	19	137
	12 ^b	Sunday	239	5	244
	19 ^{b,c}	Sunday	130	-	130
	21 ^b	Tuesday	129	1	130
	25 ^b	Saturday	162	2	164
	27 ^{b,c}	Monday	78	-	78
	weekday	mean	108.3	10.0	115.0
		%	23.5	4.5	18.9
	weekend	mean	211.4	106.8	296.8
		%	76.5	95.5	81.1
Month	Day	Day of Week	Region 3	Region 4	Regions 3 & 4 Total
August	2	Sunday	273	339	612
	5	Wednesday	139	285	424
	9	Sunday	383	491	874
	13 ^d	Thursday	55	51	106
	16 ^d	Sunday	49	182	231
	18 ^d	Tuesday	53	116	169
	22	Saturday	116	287	403
	25	Tuesday	191	347	538
	30 ^d	Sunday	115	197	312
	weekday	mean	109.5	199.8	309.3
		%	31.9	34.8	33.7
	weekend	mean	187.2	299.2	486.4
		%	68.1	65.2	66.3

^a Canada Day holiday

^b Most of the section of Region 4 upstream of the Agassiz-Rosedale powerline was closed to angling for all salmon species.

^c The overflight did not cover Region 4, due to mechanical difficulties.

^d The fishery was closed to retention of sockeye salmon.

Appendix 3a. Mean hourly proportion of angler effort by region and day type during May and June in the 1998 lower Fraser River sport fishery survey.

Region 3					
Hour	May		June		
	Weekend	Weekday	Weekend	Weekday	
5:00	0.00000	0.00000	0.00000	0.01044	
6:00	0.00000	0.00000	0.00000	0.00000	
7:00	0.07396	0.09868	0.08355	0.07132	
8:00	0.07396	0.09150	0.09424	0.07195	
9:00	0.08629	0.12447	0.09327	0.07322	
10:00	0.09862	0.13456	0.09424	0.07227	
11:00	0.09862	0.11438	0.08841	0.07766	
12:00	0.13560	0.10092	0.08064	0.07195	
13:00	0.10786	0.10227	0.08209	0.06500	
14:00	0.08218	0.09868	0.07189	0.06358	
15:00	0.06164	0.06728	0.06283	0.05078	
16:00	0.04931	0.01346	0.05732	0.04336	
17:00	0.04520	0.00000	0.04987	0.04850	
18:00	0.03698	0.00000	0.03918	0.04964	
19:00	0.02465	0.01346	0.03174	0.04622	
20:00	0.00000	0.00000	0.01425	0.05230	
21:00	0.00000	0.00000	0.00738	0.03138	
22:00	0.00000	0.00000	0.00000	0.00000	
23:00	0.01890	0.00000	0.03065	0.02895	
24:00	0.00687	0.00000	0.02098	0.02387	

Region 4					
Hour	May		June		
	Weekend	Weekday	Weekend	Weekday	
5:00	0.04082	0.00000	0.06620	0.00132	
6:00	0.00000	0.00000	0.00177	0.00000	
7:00	0.03864	0.06260	0.09287	0.06947	
8:00	0.10304	0.06956	0.09936	0.08028	
9:00	0.07728	0.05101	0.10301	0.08413	
10:00	0.06870	0.07651	0.10747	0.08645	
11:00	0.12022	0.10434	0.10950	0.08722	
12:00	0.12881	0.06956	0.09896	0.08105	
13:00	0.09660	0.06956	0.09693	0.07352	
14:00	0.10304	0.05962	0.09287	0.07333	
15:00	0.05152	0.05565	0.00811	0.06183	
16:00	0.02576	0.05286	0.00811	0.05372	
17:00	0.02576	0.05843	0.00608	0.04979	
18:00	0.02576	0.06678	0.00406	0.04631	
19:00	0.02576	0.05008	0.00406	0.03890	
20:00	0.00000	0.05217	0.00203	0.01760	
21:00	0.00000	0.00000	0.00203	0.00695	
22:00	0.00000	0.00000	0.00000	0.00000	
23:00	0.04762	0.06573	0.00794	0.05439	
24:00	0.03401	0.04695	0.00794	0.04254	

Appendix 3b. Mean hourly proportion of angler effort by region and day type during July and August in the 1998 lower Fraser River sport fishery survey.

Region 3			August	
Hour	July		Weekend	Weekday
	Weekend	Weekday		
5:00	0.01125	0.03059	0.00050	0.01138
6:00	0.01004	0.01451	0.00067	0.00243
7:00	0.06100	0.06580	0.04410	0.05366
8:00	0.07191	0.07377	0.07166	0.05943
9:00	0.08034	0.08321	0.09371	0.06191
10:00	0.08332	0.08292	0.08544	0.06191
11:00	0.08381	0.07065	0.07992	0.05425
12:00	0.07985	0.07259	0.07166	0.06191
13:00	0.07683	0.05754	0.06614	0.04623
14:00	0.06993	0.05506	0.07074	0.04265
15:00	0.06036	0.05275	0.08150	0.03302
16:00	0.05611	0.04763	0.05315	0.03715
17:00	0.04889	0.04475	0.06284	0.03632
18:00	0.03316	0.04220	0.05994	0.05778
19:00	0.02636	0.03708	0.05512	0.05916
20:00	0.01726	0.02092	0.01434	0.16510
21:00	0.02083	0.01918	0.00000	0.00000
22:00	0.00000	0.00000	0.00000	0.00000
23:00	0.03495	0.04161	0.03852	0.07038
24:00	0.02711	0.03287	0.02725	0.05218

Region 4			August	
Hour	July		Weekend	Weekday
	Weekend	Weekday		
5:00	0.38636	0.00000	0.04577	0.00217
6:00	0.00000	0.00000	0.00692	0.00036
7:00	0.09016	0.03711	0.09964	0.11187
8:00	0.09016	0.03016	0.10623	0.09469
9:00	0.09172	0.05103	0.12187	0.09756
10:00	0.09016	0.03711	0.11481	0.09373
11:00	0.07617	0.03480	0.11152	0.08991
12:00	0.06995	0.02552	0.10964	0.08838
13:00	0.06685	0.08351	0.09129	0.10184
14:00	0.06840	0.07732	0.10650	0.07996
15:00	0.00000	0.07423	0.00000	0.01683
16:00	0.00000	0.11134	0.00000	0.02946
17:00	0.00000	0.09511	0.00000	0.04208
18:00	0.00000	0.09279	0.00000	0.00000
19:00	0.00000	0.06379	0.00000	0.00842
20:00	0.00000	0.04871	0.00000	0.00000
21:00	0.00000	0.00928	0.00000	0.00000
22:00	0.00000	0.00000	0.00000	0.00000
23:00	0.00000	0.04885	0.00000	0.00036
24:00	0.00000	0.04023	0.00000	0.00000

Appendix 4a. Estimated angler effort, harvest and release by region during May and June in the 1998 lower Fraser River sport fishery.

	May			June		
	Region 3	Region 4	Total	Region 3	Region 4	Total
# of interviews	245	99	344	1,128	479	1,607
# of overflights	6	6	6	8	8	8
ANGLER EFFORT						
Estimated effort (hours)	14,705	3,880	18,585	56,970	21,898	78,868
Estimated effort (days)	2,580	597	3,177	8,765	3,476	12,240
Average angler day (hours)	5.7	6.5	5.85	6.5	6.3	6.44
ESTIMATED HARVEST						
Chinook	38	10	48	2,140	914	3,054
Jack Chinook	0	0	0	0	0	0
Coho	0	0	0	0	0	0
Chum	0	0	0	0	0	0
Pink	0	0	0	0	0	0
Sockeye	0	0	0	0	0	0
Steelhead	0	0	0	0	0	0
Trout	0	0	0	0	0	0
Sturgeon	0	0	0	0	0	0
Other	0	0	0	0	0	0
ESTIMATED RELEASE						
Chinook	8	0	8	44	12	56
Jack Chinook	0	0	0	10	0	10
Coho	0	0	0	0	0	0
Chum	0	0	0	0	0	0
Pink	0	0	0	0	0	0
Sockeye	0	0	0	5	0	5
Steelhead	0	0	0	44	0	44
Trout	0	0	0	0	0	0
Sturgeon	19	0	19	72	29	101
Other	18	0	18	6	7	13

Appendix 4b. Estimated angler effort, harvest and release by region during July in the 1998 lower Fraser River sport fishery.

	July		
	Region 3	Region 4	Total
# of interviews	1,641	122	1,763
# of overflights	8	6	8 ^a
ANGLER EFFORT			
Estimated effort (hours)	71,501	51,355	122,856
Estimated effort (days)	11,532	7,901	19,433
Average angler day (hours)	6.20	6.50	6.32
ESTIMATED HARVEST			
Chinook	1,062	1,255	2,317
Jack Chinook	0	0	0
Coho	0	0	0
Chum	0	0	0
Pink	0	0	0
Sockeye	0	0	0
Steelhead	0	0	0
Trout	0	0	0
Sturgeon	0	0	0
Other	0	0	0
ESTIMATED RELEASE			
Chinook	17	0	17
Jack Chinook	5	0	5
Coho	0	0	0
Chum	0	0	0
Pink	0	0	0
Sockeye	735	0	735
Steelhead	23	0	23
Trout	138	0	138
Sturgeon	399	0	399
Other	0	0	0

^a Two of the overflights did not cover Region 4, due to aircraft difficulties

Appendix 4c. Estimated angler effort, harvest and release by region during August in the 1998 lower Fraser River sport fishery.

	August ^a			August ^b			August
	Region 3	Region 4	Total	Region 3	Region 4	Total	Total
# of interviews	1,704	797	2,501	387	102	489	2,990
# of overflights							
ANGLER EFFORT							
Estimated effort (hours)	33,966	40,587	74,553	28,742	36,845	65,587	140,140
Estimated effort (days)	6,532	7,544	14,076	6,795	7,676	14,471	28,547
Average angler day (hours)	5.20	5.38	5.30	4.23	4.80	4.53	4.91
ESTIMATED HARVEST							
Chinook	435	398	834	518	389	907	1,741
Jack Chinook	13	0	13	8	0	8	20
Coho	0	0	0	0	0	0	0
Chum	0	0	0	0	0	0	0
Pink	0	0	0	0	0	0	0
Sockeye	2,484	7,171	9,655	0	0	0	9,655
Steelhead	0	0	0	0	0	0	0
Trout	4	0	4	2	0	2	5
Sturgeon	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0
ESTIMATED RELEASE							
Chinook	33	46	78	25	61	86	164
Jack Chinook	3	0	3	1	0	1	4
Coho	0	0	0	0	0	0	0
Chum	0	0	0	0	0	0	0
Pink	0	0	0	0	0	0	0
Sockeye	1,165	4,313	5,479	-	-	-	5,479 ^c
Steelhead	0	0	0	0	0	0	0
Trout	48	0	48	28	0	28	76
Sturgeon	349	0	349	282	0	282	632
Other	0	0	0	0	0	0	0

^a For the period when the fishery was open for sockeye retention: August 1 – 10 and August 19 - 26

^b For the period when the fishery was closed to sockeye retention: August 11 – 18 and August 27 - 31

^c This value is an underestimate, since it is not possible to calculate the number of sockeye released during the sockeye non-retention period.

- Value cannot be calculated

Appendix 5a. Mean monthly HPUE, RPUE and CPUE by month, day type and species in the 1998 lower Fraser River sport fishery survey, Region 3.

Weekend											
	Month	Chinook	Jack chinook	Coho	Chum	Pink	Sockeye	Steelhead	Trout	Sturgeon	Other
HPUE	May	0.00184	0	0	0	0	0	0	0	0	0
	June	0.02594	0	0	0	0	0	0	0	0	0
	July	0.00987	0	0	0	0	0	0	0	0	0
	August	0.00380	0.00056	0	0	0	0.07385	0	0.00020	0	0
RPUE	May	0.00092	0	0	0	0	0	0	0	0.00092	0.00076
	June	0.00091	0	0	0	0	0.00017	0.00046	0	0.00263	0.00023
	July	0.00022	0	0	0	0	0.00471	0.00045	0.00115	0.00943	0
	August	0.00110	0.00014	0	0	0	0.03650	0	0.00223	0.01107	0
Total (CPUE)	May	0.00276	0	0	0	0	0	0	0	0.00092	0.00076
	June	0.02685	0	0	0	0	0.00017	0.00046	0	0.00263	0.00023
	July	0.01009	0	0	0	0	0.00471	0.00045	0.00115	0.00943	0
	August	0.00490	0.00070	0	0	0	0.11035	0	0.00243	0.01107	0
Weekday											
	Month	Chinook	Jack chinook	Coho	Chum	Pink	Sockeye	Steelhead	Trout	Sturgeon	Other
HPUE	May	0.00384	0	0	0	0	0	0	0	0	0
	June	0.04828	0	0	0	0	0	0	0	0	0
	July	0.01814	0	0	0	0	0	0	0	0	0
	August	0.02334	0.00016	0	0	0	0.07232	0	0	0	0
RPUE	May	0	0	0	0	0	0	0	0	0.00192	0.00192
	June	0.00063	0.00035	0	0	0	0	0.00105	0	0	0
	July	0.00024	0.00012	0	0	0	0.01395	0.00024	0.00244	0.00305	0
	August	0.00080	0	0	0	0	0.03177	0	0.00048	0.00936	0
Total (CPUE)	May	0.00384	0	0	0	0	0	0	0	0.00192	0.00192
	June	0.04891	0.00035	0	0	0	0	0.00105	0	0	0
	July	0.01838	0.00012	0	0	0	0.01395	0.00024	0.00244	0.00305	0
	August	0.02414	0.00016	0	0	0	0.10409	0	0.00048	0.00936	0

Appendix 5b. Mean monthly HPUE, RPUE and CPUE by month, day type and species in the 1998 lower Fraser River sport fishery survey, Region 4.

Weekend											
	Month	Chinook	Jack chinook	Coho	Chum	Pink	Sockeye	Steelhead	Trout	Sturgeon	Other
HPUE	May	0.00433	0	0	0	0	0	0	0	0	0
	June	0.03211	0	0	0	0	0	0	0	0	0
	July	0	0	0	0	0	0	0	0	0	0
	August	0.00820	0	0	0	0	0.17350	0	0	0	0
RPUE	May	0	0	0	0	0	0	0	0	0	0
	June	0	0	0	0	0	0	0	0	0	0
	July	0	0	0	0	0	0	0	0	0	0
	August	0	0	0	0	0	0.06625	0	0	0	0
Total (CPUE)	May	0.00433	0	0	0	0	0	0	0	0	0
	June	0.03211	0	0	0	0	0	0	0	0	0
	July	0	0	0	0	0	0	0	0	0	0
	August	0.00820	0	0	0	0	0.23975	0	0	0	0
Weekday											
	Month	Chinook	Jack chinook	Coho	Chum	Pink	Sockeye	Steelhead	Trout	Sturgeon	Other
HPUE	May	0	0	0	0	0	0	0	0	0	0
	June	0.05116	0	0	0	0	0	0	0	0	0
	July	0.03200	0	0	0	0	0	0	0	0	0
	August	0.01124	0	0	0	0	0.17948	0	0	0	0
RPUE	May	0	0	0	0	0	0	0	0	0.00192	0.00192
	June	0.00106	0	0	0	0	0	0	0	0.00264	0.00066
	July	0	0	0	0	0	0	0	0	0	0
	August	0.00212	0	0	0	0	0.14182	0	0	0	0
Total (CPUE)	May	0.00000	0	0	0	0	0	0	0	0.00192	0.00192
	June	0.05222	0	0	0	0	0	0	0	0.00264	0.00066
	July	0.03200	0	0	0	0	0	0	0	0	0
	August	0.01336	0	0	0	0	0.32130	0	0	0	0