# Precision and Bias of the British Columbia Steelhead Harvest Analysis

by

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# Steelhead Harvest Analysis

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## ABSTRACT

The BC Steelhead Harvest Analysis (SHA) is a province-wide mail survey of steelhead anglers which has been conducted annually since 1967, to obtain estimates of effort and catch stratified by stream and residency. This study reports the compilation and examination of information relating to the accuracy of the survey. Objectives were to assess the capability of available data to reveal the precision and bias of SHA estimates, and to summarize how SHA results compare to steelhead fishery catch and effort parameter estimates from other sources.

Precision of SHA estimates was examined by bootstrap re-sampling of questionnaire responses for approximately 45 fisheries between 1983 and 1995. Precision varied substantially among resident classes, in part due to the higher mail-out proportion applied for non-resident anglers. At a given parameter level, precision also varied substantially between fisheries. Relative precision was highest for estimates of the number of participating anglers, and lowest for catch parameters. Resulting 95% confidence interval widths ranged from approximately twice the estimate value for the lowest estimate values assessed, to roughly one-third the estimate value in the best case for the highest estimates examined.

Bias was assessed through reanalysis of follow-up contact data from 1978/79 and 1982/83, along with preliminary examination of results from an intensive study on the Thompson River in 1984. First-mailing upward bias due to nonresponse was estimated at 24% for number of anglers, 59% for number of successful anglers, and 29% for retained catch, for province-wide aggregate data from the 1978/79 study. In 1982/83, aggregate data from Region 1 re-contact similarly suggested first-mailing upward bias due to nonresponse of 24% for number of anglers but only 33% for number of successful anglers. Water-specific results for 14 fisheries reported in 1978/79 imply first-mailing upward bias due to nonresponse of 20% for number of anglers, 24% for angler days, 29% for retained catch and 27% for released catch, with high variability between fisheries in apparent bias. The Thompson River 1984 study matched individual anglers' field survey results against their SHA questionnaire responses, and suggested that positive recall bias occurs due to angler memory exaggeration of effort and catch as well as angler assignment of activity to the wrong time period. However, rigorous statistical analysis of this dataset is needed to alleviate censoring of the data and allow unbiased estimates of recall effects along with nonresponse bias.

Ninety-five stream-specific annual estimates of one or more steelhead fishery parameters were available from BC provincial and regional fishery reports of field studies. Comparisons from the province-wide dataset show mean upward discrepancy for SHA estimates relative to field results of 42% for number of anglers, 58% for angler days, 83% for retained catch and 109% for released catch. However, most field studies in this dataset have yielded fishery parameter estimates subject to unquantified but substantial downward bias; the data provide a poor basis for assessment of bias in SHA parameter estimates. Dean River field studies from the period 1972-95 show mean upward discrepancy for SHA estimates of 28% for number of anglers, 27% for angler days, 63% for retained catch and 94% for released catch. A restricted dataset of Dean River studies from 1985-95 displays mean upward discrepancy for SHA estimates of 35% for number of anglers, 21% for angler days, 41% for retained catch and 75% for released catch. Although the Dean River data provide approximately unbiased fishery parameter estimates, the comparative dataset probably

provides a poor baseline for quantifying SHA bias. Dean River anglers and angler behavior are highly atypical relative to other BC steelhead anglers and fisheries, in terms of characteristics which are likely to affect both nonresponse and recall bias. Additionally, the range of values displayed by Dean River fishery parameters is narrow relative to BC steelhead fisheries as a group; extrapolation of SHA bias outside of this range would be weakly justified.

Suggestions are offered for improved understanding of the precision and bias of SHA parameter estimates. Complete analysis of the 1984 Thompson River dataset is recommended, along with recovery of raw data from the 1978/79 and 1982/83 follow-up contact studies. The latter data would allow exploration of the possible variation in non-response bias among fisheries and between residency groups. Following consultation with regional fisheries personnel regarding uses of SHA data and desired precision and accuracy, simulation should be used to explore scenarios for modification of the SHA procedure to improve accuracy, probably using initial and follow-up contact by mail and telephone. Precision, freedom from bias, and expense form a three-way tradeoff; reassessment of how the SHA can meet current needs would be desirable given the demonstrated weaknesses and potential misapplication of the current data.

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# 1. INTRODUCTION

Since 1967, the British Columbia Fisheries Branch has utilized an annual mail survey to document trends in steelhead sport fishery effort and catch. Known as the Steelhead Harvest Analysis (SHA), the survey provides the only consistent means for provincial fishery managers to monitor angling activity on the 400+ steelhead streams in British Columbia. Annual voluntary use surveys of anadromous sport fisheries, though not necessarily distributed by mail, have been widely applied in western North America beginning in Washington state in 1947, Oregon in 1952, and Idaho in 1962 (Hicks and Calvin 1964). In other regions, occasional surveys of this type have been used to survey fishery characteristics for all types of freshwater fisheries conducted in the jurisdiction (e.g. New York state; Brown 1991).

In British Columbia, following the end of each angling licence year on March 31, a random sample of the year's steelhead licencees receives a questionnaire requesting information on their steelhead angling activity and catch of the previous licence year. The proportion of licencees sampled varies according to residency. Questionnaires are sent to about half of BC-resident licencees, while all or nearly all out-of-province anglers are selected to ensure an adequate return. Typically, half of the recipients respond. Approximately three-quarters of the respondents have angled for steelhead during the previous licence year. The resulting data set comprises the recollected activity of roughly twenty-five percent of the year's licenced and active BC steelhead angler population. The sample is stratified by residency and computationally expanded, to provide SHA estimates of the total annual activity and success of all anglers for BC steelhead on all waters (Billings 1982).

Inquiry into the accuracy of SHA fishery parameter estimates intensified during the 1970s, when comparable information about British Columbia steelhead fishery parameters from field-based angling use studies began to accumulate. Several creel study report authors noted large discrepancies between analogous fishery parameter estimates (e.g. Hooton 1976). In the previously-mentioned US jurisdictions where extrapolation was made from a survey return rate of roughly 30%, accuracy of harvest estimates was known to suffer from angler nonresponse (Hicks and Calvin 1964). Accordingly, between 1977 and 1983 two distinct methods were applied in British Columbia to formally investigate the accuracy of SHA parameter estimates. The first approach involved broad comparison with creel survey results; the second, follow-up contact with survey non-respondents.

In 1977, 1978 and 1979 creel survey results from studies conducted during the middle 1970s were compiled and summarized with respect to analogous SHA estimates (Narver 1977; Narver 1978; Ford and Narver 1979). Parameters of interest were residency-pooled total annual harvested catch and total annual effort in angler days. Discrepancy between SHA and field results was typically expressed as a percentage of the SHA estimate. Based on data available through 1979 representing 37 fisheries, unweighted mean discrepancy in estimated annual harvested catch was -26.5% for all streams, and -32.1% for streams with angling effort greater than 400 angler days (Ford and Narver 1979). For the same dataset, unweighted mean discrepancy in estimated angling effort was -41.8% for all streams, and -36.3% for streams with angling effort greater than 400 angler days (Ford and Narver 1979). The general implication of these summaries was that SHA estimates were much greater than comparable field survey results, in agreement with early fishery-specific creel survey observations. However, significant doubts remained about downward bias of the field survey estimates, which thus might not provide a valid basis for assessing SHA accuracy.

The second mode of investigation pursued by the British Columbia Fisheries Branch was follow-up contact with survey nonrespondents. Additional mail-outs can reveal the extent of nonresponse bias, by quantifying how the angler population sampled in the first response group differed from those remaining (nonrespondents). Second mailings were made in 1978/79 and 1982/83 (Ford and Narver 1979; Billings 1983). The 1982/83 follow-up survey sampled residents of Vancouver Island only and included telephone contact after the secondary mailing, albeit to a very small sample of nonrespondents (n=52; Billings 1983).

In both years, results of follow-up contact were interpreted by comparing the SHA parameter estimates from the first mailing to those derived from the second mailing alone, as well as estimates obtained by combining the samples. For 1978/79, this interpretation of the results suggested that *"the estimate based on the first mailing was not significantly different from that based on the combined sample. The time and expense of a second mailing appears unwarranted"* (Ford and Narver 1979). In 1982/83, similar interpretation of the results of the follow-up contacts led to the conclusion that "*since the ratio of active and successful anglers remained relatively constant at all response levels, it might be safe to assume that catch estimates from the first mailing are reliable*" (Billings 1983).

Despite the latter conclusions, field-based angler surveys in the 1980s and 1990s have continued to suggest moderate to severe upward bias of SHA parameter estimates. In contrast to most early field-based studies, later surveys have either used statistically defensible designs or achieved near-complete coverage due to the operational details of the fishery, thus providing stronger evidence of bias in SHA estimates.

In the past, managers have treated SHA results as an indicator of general trends in steelhead fishery parameters, an application not necessarily requiring known precision and freedom from bias. However, growth in angling popularity has demanded more exact plans for management of use by steelhead angling sectors. If the SHA is to prove useful in the development and prosecution of management plans, rather than a detriment due to unknown bias and imprecision, an improved understanding of its statistical characteristics is needed. This document attempts to provide such a treatment of the survey, by answering the following questions:

1. What is the typical relationship between steelhead fishery parameters estimated by the SHA and those estimated by other studies of steelhead angling activity?
2. Does existing information allow assessment of the statistical properties, namely bias and precision, which define the accuracy of SHA estimates?
3. If so, what is the bias and precision? If not, what might be done to quantify these properties of the survey?
4. What does existing information suggest about sources of error in the SHA?

To approach the first three questions, British Columbia Ministry of Environment and Parks (BCE) field-based creel surveys of steelhead continue to provide the only available comparison to the SHA. For a few rivers, extensive series of annual studies now exist. Validation of the SHA has been a stated purpose of several field-based surveys, though not necessarily the sole objective. The present province-wide dataset is considerable larger than in 1979, when this type of comparison was last attempted.

Properties of SHA and field data may provide evidence of the causes of bias and imprecision in each, helping to answer the fourth question. In addition, an alternative approach to analysis of the 1978 and 1982 follow-up contact data is relevant. More recent methods for treating such data differ substantially from the approach which was taken at the time of their collection.

To set the stage for this document, the remainder of the introduction reviews the types of inaccuracies typically present in angling use studies of the types conducted in British Columbia. Angler survey errors have been grouped into three general categories: sampling, response and nonresponse errors (Essig and Holliday 1991). Sampling error refers to non-representativeness of the angler sample. Response error describes inaccuracy in the data stemming from angler mis-reporting. Nonresponse error occurs when survey nonrespondents differ systematically from those who do participate. Mail surveys such as the SHA are typically subject to certain types of errors within these three categories. Field surveys also tend to display certain biases, often different than those of mail surveys. Those which appear most applicable to the SHA and comparable field data are discussed briefly in the following sections.

## 1.1. Survey Error

### 1.1.1. Mail Surveys

#### *1.1.1.1 Sampling Error*

Of the recognized types of survey sampling error, undercoverage of the angling population is perhaps most likely to cause bias in the SHA. Because the sample selection is made from angling licencees, certain components of the angling population are not included in the sample frame. Among these are anglers under 16 years of age, status Indians, and others who fail to purchase a steelhead licence. Undercoverage would cause the SHA estimates of total activity and catch to be biased downwards.

#### *1.1.1.2 Response Error*

Survey response errors possibly influencing the SHA include recall bias, rounding bias, prestige bias, and intentional deception. Recall bias refers to memory failure, such that respondents experience difficulty recalling the details of their activity and success during the survey period (Pollock at al. 1994). If memory failure leads to angler responses which tend to be different more often in a particular direction, bias results. For instance, angler memory may be selective such that angling success is recalled moreso than angling failure. Alternatively, the magnitude of effort and/or catch during successful or unsuccessful angling experiences may be exaggerated in memory. Conventional wisdom suggests that angler memory is highly subjective and might tend to magnify the positive; the creel survey literature does not appear to provide evidence to confirm or deny this.

Rounding bias refers to the tendency for anglers to round their reported catch or effort numbers, often upwards. Rounding may occur to the nearest even digit or to a multiple of 5 or 7. This type of error could be expected to create a slight positive bias in SHA estimates.

Prestige bias refers to inflation of response by the angler to enhance their own image, creating a positive bias in resulting estimates (Pollock et al. 1994). No reliable method for differentiating between memory bias and prestige bias is apparent, but the latter seems less likely a widespread factor given the anonymity of the SHA.

Intentional deception could result from anglers concealing or exaggerating activity or catch, possibly to influence fishery management or for other reasons. Again, it is unclear whether this type of error would be likely to create bias in SHA estimates.

#### *1.1.1.3 Nonresponse Error*

Survey nonresponse error, including refusal to answer, is probably the most potentially serious shortcoming of mail surveys. Mail survey nonrespondents are often the less active or successful participants in a fishery (Brown 1991; Pollock et al. 1994). The result of failure to respond is that anglers with greater-than-average activity and/or success are over-represented in the respondent sample, leading to positive estimate bias. Available information suggests that BC steelhead angler success is dominated by a small proportion of the participants. This property of BC steelhead fisheries could be expected to cause particularly harsh estimate bias in the SHA if nonresponse error is as prevalent as for other mail surveys.

### 1.1.2. Field Surveys

British Columbia steelhead fisheries are often spatially and temporally diffuse. Early and late-season angling, as well as activity in less-accessible areas, can be very difficult to quantify. Many field-based steelhead creel studies are not intended only to quantify the absolute magnitude of effort and catch, but also to provide an enforcement presence and to collect biological samples from the catch. Because of these multiple objectives and limited staff resources, surveys have used a broad and eclectic mix of methods. As a result, categorization of survey design types is difficult and an organized description even more so.

Discussion of design and technique is presented in following sections. Design is considered to be the overarching framework for collection and, if needed, computational expansion of information. Technique is then the specific operational methods used to collect the required data. Field-based angler surveys are frequently subject to certain types of recognized biases, though often of unknown magnitude and direction. The biases discussed next are the ones most likely to be introduced by the field techniques commonly used to survey BC steelhead fisheries.

#### *1.1.2.1 Sampling Error*

Avidity bias refers to a survey situation whereby avid anglers (i.e. those that fish more often) are more likely to be sampled, during an access point or roving design survey. More frequent sampling of avid anglers does not necessarily induce bias in catch and effort estimates. Bias results only when avid-angler data is disproportionately represented.

Length-of-stay bias occurs in roving surveys, such that anglers who fish for more hours in a day have a higher probability of being sampled. If those anglers' success rate differs, then estimates of total catch will be biased. Length-of-stay bias is similar to avidity bias, but occurs on a daily rather than seasonal time scale.

##### *1.1.2.2 Response Error*

Prestige bias has already been discussed in the context of mail surveys. Prestige bias seems more likely to cause upward bias in on-site face-to-face interviews. Some anglers may not wish to admit an unsuccessful day of angling to the creel clerk.

Recall bias was also discussed in the context of mail surveys, and might be problematic in certain types of field-based surveys. If data are not collected from anglers at the end of each angling day, but at the end of the trip or after several days, recall may be slightly problematic.

##### *1.1.2.3 Nonresponse Error*

Biased estimates result when anglers refuse to return daily questionnaires or logbooks from field-based surveys, if the anglers who do not respond tend to differ in their effort or catch from those who do respond. As with mail surveys, field survey non-respondents typically are not a random sample with respect to effort and catch, thus causing upward bias when the responding sample is expanded to estimate total effort and catch.

## 1.2. Other Discrepancies Between Field and SHA Parameter Estimates

Field creel data and SHA estimates are not necessarily well-matched spatially or temporally. For instance, discontinuity in the name of the dominant river may cause variability in SHA responses by anglers on a number of river pairs. Examples are the Chilko & Chilcotin, Atnarko & Bella Coola, and Morice & Bulkley. Field creel surveys for the former two systems recognized the spatial continuity of their steelhead fisheries, but Morice & Bulkley data are more problematic.

As well, winter steelhead fisheries often span the March 31 licence year boundary. Angler confusion about reporting may result. It is usually difficult to separate reported field survey results into the appropriate licence years, and impossible to partition SHA results across licence years. Steelhead angling activity may vary greatly from year to year, so rough parity (between an angling season and the nearest-match licence year) cannot necessarily be assumed.

BC steelhead fisheries have occurred within a dynamic regulatory arena, particularly during the last decade. Changes in daily and seasonal retention quotas, tackle restrictions, angling guide regulation and classified waters legislation all have affected the participation and behavior of various sectors. Local resident steelhead anglers may have been less likely to have purchased a steelhead tag during the last decade for angling on non-classified waters, as some steelhead harvest opportunities were suspended for conservation reasons. Anglers who do not purchase a steelhead licence remain unsampled by the SHA procedure.

# 2. METHODS

## 2.1. Conventions

This document considers a steelhead fishery to constitute the steelhead angling activity on a particular named stream within a particular licence year. Angling licence years are often referenced by the second calendar year encompassed. For instance the 1996/97 licence year, which began 1-April-1996 and ended 31-March-1997, is referred to as 1997. This convention can create confusion, particularly since most summer steelhead fisheries no longer occur during the late winter and spring. Thus according to the convention, the 1997 Morice steelhead fishery occurred wholly within the 1996 calendar year, but did exploit 1997 spawners.

## 2.2. General Computational Techniques

Most data manipulations for this study were performed in MS Access®, using software-resident functions. Bootstrapping of standard errors was coded by the author as an MS Access® module, written in Visual BASIC®. Other statistical estimation was performed using the analysis software S-Plus® (Versions 3.3 and 4.5 for Windows). Confidence intervals were 0.95 and alphas were 0.05 unless otherwise stated.

## 2.3. Steelhead Harvest Analysis

### 2.3.1. Data Sources

A digital database (MS Access® platform) of fishery-specific SHA annual effort and catch estimates from 1968 to 1996 was provided by the Licencing and Administration Section, Victoria. Within the database, results from 1981/82 and earlier are not residency-stratified. Forward from 1982/83 inclusive, residency is categorized by BCE region (8 in total) for BC residents, and non-residents are classified as Canadians or non-Canadians, giving a total of ten residency categories. Within the years of residency-stratified data, in 1982/83 a small proportion of the data are residency-unknown, but all data after that licence year are fully categorized by residency.

Annual SHA reports for 1967/68 to 1994/95 (printed copy) available from Skeena Region files were scrutinized for comparable data, particularly pre-1982/83 residency-stratified results not present in the digital database. In some cases, filed printouts summarized results which were not presented in the annual report series --- for instance, effort (angler days) by residency was occasionally available from these sources, though not included in the annual report series.

Individual questionnaire responses, for the period 1983 to 1997 only, were also made available as a distinct digital database (roughly 145,400 records; MS Access®).

### 2.3.2. Characterizing Steelhead Fisheries

From 1967/68 to present, more than 400 British Columbia streams have been identified by SHA questionnaire returns as receiving steelhead angling effort on occasion. A detailed examination of the attributes of BC steelhead fisheries is beyond the scope of this report. However, the residency composition and typical activity of participants in some fisheries may influence SHA estimates differentially. For this reason, an overview of selected fishery characteristics is useful.

In order to characterize steelhead fisheries according to the effort parameters which are estimated by the SHA, annual means were estimated for all fisheries. Thirteen years' data (1984 to 1996) were included, that being the period for which all data were residency-specific. Fisheries were ranked in descending order by the total number of angler days estimated to have been expended during that period. The top 91 fisheries comprised 95% of the total estimated steelhead angling effort in BC, and were selected for further summary calculations.

#### *2.3.2.1 Angler Residency*

For each stream, angler residency was reclassified as local, BC, or non-resident. Local residents (coded L) were those who resided in the BCE region where the stream in question is located. The BC residency class (coded B) included anglers residing in all other regions of BC. Non-residents (coded N) were those anglers residing outside of BC, including non-Canadians. In addition to angler days, mean annual parameters stratified by residency type which were estimated for the popular fisheries included number of anglers, number of days fished per angler, and number of other streams fished in the same year.

Finally, streams were classified by the mean residency composition of the angler-days expended in the steelhead fishery during the time period 1984 to 1996. The residency composition code was created by appending, in order of magnitude, the code for each residency type which comprised more than 20% of the mean annual activity on the stream. For instance, for fishery type "L" only the local component comprised greater than 20% of the effort; for fishery type "NB" both BC residents and non-residents comprised more than 20%, with non-resident effort greater than BC resident effort.

#### *2.3.2.2 Angler Activity and Catch*

To characterize steelhead angler behavior, individual responses were pooled for the 91 most popular fisheries, 1984 to 1996. Considering each individual's annual reported activity and catch on one stream as a single observation, the resulting dataset totaled 134,683 observations. Frequency distributions for angler days, steelhead retained and steelhead released were tallied for the pooled dataset. Cumulative frequency distributions were plotted for the ordered tallies. The ordered tallies were also to generate cumulative proportion - proportion plots for the same parameters of activity, harvested and released catch. For instance, the proportion of anglers who angled *n* days or less per year, was plotted against the proportion of all angler days which such activity represented.

### 2.3.3. Precision of Estimated Parameters

Confidence intervals for SHA fishery parameter estimates were obtained by bootstrap. The bootstrap procedure is a Monte Carlo method which involves randomized re-sampling of the existing data (Sokal and Rohlf 1995). When a large number of re-sampling "runs" are made with the parameter of interest estimated from each run's result,

- the mean of the runs' parameter estimates should approximate the true parameter estimate from the data (this can be used to double check that the re-sampling algorithm is accurate);
- the standard deviation of the parameter estimated from run results should approach the true parameter estimate standard error, thus allowing construction of a confidence interval for the parameter estimate.

The bootstrap algorithm and confidence interval estimation routines are attached as Appendix I. For each estimate, 500 bootstrap runs were made. For each of the residency groups (local, BC, and non-resident), confidence intervals were estimated as ±2 standard deviations of the means of run estimates, for the parameters total angler days, number of anglers, and steelhead retained and released.

Bootstrap estimates could only be made for fisheries for which individual SHA response data were available (e.g. post-1982 data). Intervals were generated for 34 post-1982 fisheries for which field surveys were recorded, to allow examination of whether field survey estimates typically fell within the confidence intervals of SHA parameter value estimates.

To create an additional exploratory dataset, SHA parameter confidence intervals were estimated for 7 Skeena Region streams for 1985, 1990 and 1995, constituting 21 fisheries in total. Intervals for 22 of the field study fisheries were also included in the exploratory dataset giving a total of 43 fisheries. Twelve of 15 Dean River years were excluded from the exploratory dataset to avoid over-influence of that stream's data on more general analyses.

Because bootstrapping is computationally expensive and potentially challenging to implement, it would be desirable to know whether the existing data could be used to develop simple but reasonably precise empirical formulae for generating confidence intervals. To examine the potential of this approach, standard errors were regressed on the associated estimates, after logarithmic transformation of both variables.

Finally, a set of 'rough-and-ready' rules for estimating SHA confidence intervals were obtained from the bootstrapped standard error estimates. For each fishery parameter, the quartiles of the parameter values were calculated. Within each quartile the median standard error, expressed as a percentage of the parameter value, was tabulated.

### 2.3.4. Follow-up Contact

On two documented occasions, follow-up mailings have been made to a portion of SHA non-respondents to assess non-response bias (Ford and Narver 1979; Billings 1983). On the second occasion, a telephone follow-up was made subsequent to the second mailing. Reported results (Ford and Narver 1979 Tables 2 and 3; Billings 1983 Table 8) are reproduced in Appendix II (Table A1 through Table A3).

Sample size for the telephone survey was very small. Angler response may differ depending on contact method, a factor which was not investigated. For these reasons, the telephone results are not given further quantitative consideration in this document.

Tabular results of the follow-up mailings were examined for their utility for re-summarization. The 1978/79 data contain apparent discrepancies which are difficult to explain, particularly in light of the minimal reported methodological detail. Most of the discrepancies occur in the "combined results" or "1st and 2nd" columns. These columns were thus excluded from analyses, and the equivalent combined results obtained by recalculation from the distinct results of the first and second mailings.

Analyses of the initial and follow-up mailing results was made using the method of Filion (1975, 1976) as referenced and applied in Hooton (1985). A conceptual representation of the method is given in Figure 1. In the case of only two mailings linear regression is unnecessary and the final estimate can be obtained by simple geometry. The final parameter estimate is then obtained by multiplying the extrapolated final "parameter per response" value by the number of licencees. In this document, apparent bias is just the ratio of the initial estimate to the final estimate.

Apparent bias might be expected to be correlated with high variance in angler behaviour, since variability in effort and catch is believed to be one component of the non-response bias problem. Individual angler response data were not available for the 1978/79 harvest analysis. Coefficients of variation for angler days and retained and released catch were estimated from the pooled 1983-1995 data for each river, as a surrogate.

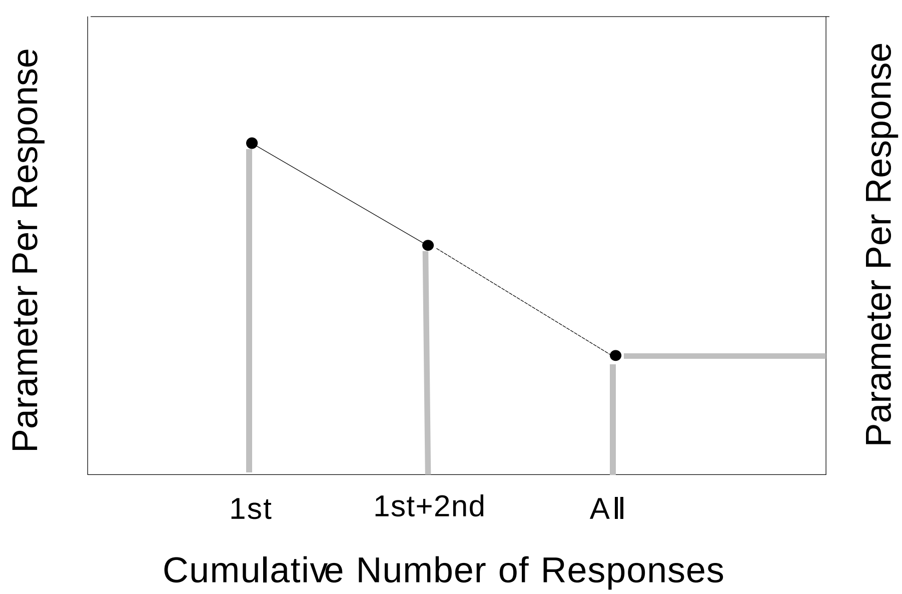



**Figure 1.**—Conceptual representation of the method of Filion (1975) for analysis of multiple-contact survey results. With only two mailings, the computations are simple geometry.

## 2.4. Field Surveys

### 2.4.1. Data Sources

Five BC Environment (BCE) administrative regions manage fisheries for winter or summer steelhead, or both. Staff in each BCE region collected and forwarded photocopies of reports of field-based steelhead creel studies from regional libraries or files. Reports were examined for catch and effort estimates, and other relevant methodological detail, as described in section 2.4.2 below.

Review of the annual SHA report series yielded field creel survey results which were not represented in reports received from the BCE regions. Specifically, Narver (1977; unnumbered table), Narver (1978; unnumbered table) and Ford and Narver (1979; Table 1) provided residency-pooled effort and harvest data for about a dozen additional creel studies in various BCE regions. No additional information about operational detail or techniques was compiled for these studies.

### 2.4.2. Survey Designs, Techniques and Biases

Field study procedures as recorded in the survey reports were examined to tabulate study designs, and to code and tabulate techniques and additional biases for each survey. Techniques commonly applied are listed in Table 2. Biases (Table 1) typically associated with each technique are also given. Study methods are often under-documented or unclear in presentation in the available reports, particularly computational procedures. Assessment of whether full spatial and temporal coverage were achieved was often not possible.

**Table 1.**—Types of error created by angler survey techniques used for BC steelhead fisheries. The column **Code** gives a one-letter code used in other report tables to denote the bias.

| Bias | Code | Notes |
|---|---|---|
| Avidity | **A** | Avid anglers are more likely to be sampled because of the number of days spent angling |
| Length of stay | **L** | Angler probability of being sampled is proportional to length of time fished on a day |
| Memory | **M** | Angler memory (> 1 day) is a significant factor |
| Nonresponse | **N** | Anglers have the opportunity to avoid contributing to the sample |
| Spatially unrepresentative | **S** | Spatial portion of the fishery under-sampled |
| Temporally unrepresentative | **T** | Temporal portion of the fishery under-sampled |
| Design | **D** | Survey design likely to create bias for reasons other than the above factors |

**Table 2.**—Techniques used for field-based creel surveys of BC steelhead fisheries. The column headed **Code** gives the code for the technique, used in other tables in this document. The column headed **Biases** gives the bias code (Table 1) for any biases which are often associated with the technique. Techniques are not necessarily independent or exclusive; for instance, individual tracking subsumes cumulative detail, etc.

| Technique | Code | Biases | Notes |
|---|---|---|---|
| Instantaneous count | **C** | L | Includes angler and vehicle counts or both; may be aerial or surface |
| Roving interview | **R** | L | May include road access points, boat launch sites, or on-river interviews of anglers for effort/catch data |
| Access point | **A** | - | Interviews, only conducted at end-of-trip when angler returns to access point |
| Cumulative detail | **Z** | A, L, M | Tallying of participant catch and effort since last check, without tracking individuals |
| Individual tracking | **I** | A, L, M | Tallying of participant catch and effort since last checked; may include name lists or numbering of angler licences |
| Voluntary questionnaire | **V** | A | Daily; often distributed by roving clerk |
| Logbook | **L** | A, N | Daily totals, maintained for entire season |
| Guide/lodge records | **G** | M, N | Angling guide reports or other records |
| Exit checkpoint | **X** | N | Used when road exit is by a single point |
| Full coverage | **F** | D | Attempt to record all effort and catch |
| Random sampling | **B** | - | Subsampling in units of time (whole day or less than a day), not stratified |
| Spatial stratification | **S** | - | Spatially stratified random sampling |
| Temporal stratification | **T** | - | Temporally stratified random sampling, such as weekday / weekend, AM / PM, or early season / late season |
| Unknown expansion | **E** | D | Survey notes extrapolation or interpolation but does not give operational detail |

### 2.4.3. River Pairs

Several field studies present combined data for two streams. For most parameters of interest (angler-days, catch retained and released) a comparable SHA estimate can be obtained by summing the estimates for the two rivers. However, the number of individual anglers cannot be estimated in this way, because typically there are individuals who have fished both rivers. Summing the SHA estimates of number of individuals who angled each river would thus over-estimate the total number of anglers active on the river-pair. In such cases (primarily the Chilko & Chilcotin), no method was available to adjust for this factor prior to 1983, so this parameter was excluded from further comparison. The digital database of individual responses was used to estimate and adjust for the number of individuals who angled both streams for post-1983 studies.

### 2.4.4. Results Traverse Licence Years

The Atnarko and Bella Coola fisheries of 1976/77 and 1977/78 occurred in both fall and spring within each licence year. Results from studies in each of these years did not cover the entire licence year, but were presented as monthly totals which could be recombined to represent the single complete licence year of 1977/78. An angler use study on Gold River (Vancouver Island) in 1975 and 1976 also spanned two licence years, neither of which received full coverage due to the fall-and-spring nature of the fishery. Accordingly, the study was excluded from analyses.

### 2.4.5. Residency

Angler residency has been categorized by a variety of schema during field-based creel studies of BC steelhead fisheries. In a few cases, residency was recorded exactly as represented by SHA returns. Most often however, the local resident component was defined by residency criteria different than those used by the SHA; for instance, local residents might be considered as those residing within 100 km of the river or in certain nearby towns, rather than those residing in the same MOE region which contains the river. Each such case was evaluated with respect to whether the field estimates could be made reasonably comparable to SHA results, by recalculation if necessary.

## 2.5. Relating Field Estimates to SHA Estimates

### 2.5.1. Expected Relationships

This document does not report tests of specific hypotheses about the relationship between SHA and field creel study fishery parameter estimates. However, an expectation of the possible form of such relationships is necessary as a foundation for any quantitative descriptions. Considering the field data as the independent variable (representing the best available estimates of the true fishery parameters), a parsimonious expectation is that the matching SHA estimates are a linear function of the field data. The linear relationship should have slope greater then one and y intercept greater than zero. A non-zero intercept is expected because anglers cannot report negative values, and on average some reporting of activity which did not occur is anticipated. Slope greater than one is expected if SHA parameter values differ from the comparable field estimate by an absolute amount which increases with the magnitude of the field parameter value. Admittedly there is no *a priori* reason for these relationships to be linear, in other words displaying a constant proportional difference neglecting the intercept. Linearity is offered as a parsimonious model, in the absence of information to the contrary.

### 2.5.2. Quantifying the Relationships

For each fishery parameter, four comparison datasets were compiled: a global dataset of all appropriate values unstratified by residency, a second global dataset of residency-stratified data, and two Dean River datasets of residency-unstratified data. The distinct Dean River datasets were created as a result of the temporally extensive data series for the river, as well as the expectation that the Dean creel surveys are relatively accurate due to the logistics of the fishery. The first Dean dataset contained all available data between 1972 and 1995. The 'restricted' Dean dataset included only data for the years 1984 to 1995, when poorly quantified activity (by sectors such as loggers working in the watershed) had become minimal.

Conventional least squares methods were applied to the various comparison datasets to estimate linear regression coefficients. In addition, robust regression by the "least trimmed squares" approach (Statistical Sciences 1995) was used to explore the sensitivity of the regression coefficients to outliers.

Non-linearity over the available range of parameter values was also considered possible, due to either small sample size and high variance, or a different underlying relationship. As an alternative to the regression approach, for each fishery parameter dataset with sufficient sample size, data were separated into quartiles based on the SHA parameter values. For each data pair, the ratio of the field estimate to the SHA estimate was calculated and for each quartile, the median ratio was tabulated.

# 3. RESULTS

## 3.1. Steelhead Harvest Analysis

### 3.1.1. Characterization of BC Steelhead Fisheries and Anglers

Selected characteristics of popular BC steelhead fisheries are summarized in Table A4 (Appendix III), which presents annual mean values stratified by residency class and arranged by region. Vancouver Island Region supports the highest number of listed fisheries with 37, followed by Skeena Region with 27 (Table 3). A substantial majority of popular fisheries were dominated by local anglers during 1984 to 1996. Of the 91 streams examined, 75 were categorized as type "L" during the period (Table 3). In other words, for only 16 streams did the BC-resident or non-resident sectors, or both independently, contribute more than 20% of estimated angling effort (Table 3).

**Table 3.**—Categorization of popular BC steelhead fisheries, by BCE region and residency composition of effort. Residency composition types are described on page 8.

| Region | Residency Composition | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | L | LB | LN | LBN | LNB | BL | NB | NL | NBL | |
| **1** | 36 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **37** |
| **2** | 20 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **21** |
| **3** | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | **1** |
| **5** | 1 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | **5** |
| **6** | 18 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | **27** |
| **Total** | **75** | **5** | **1** | **2** | **1** | **2** | **3** | **1** | **1** | **91** |

Components of steelhead angler behavior, as characterized by SHA responses and stratified by residency class, are presented in Table 4 through Table 7. These tables provide descriptions of two types of distributions:

(1) the pooled distribution of responses from *individual anglers* (n = 78,584) who participated in at least one of the most popular BC fisheries as defined previously, and

(2) distributions of *fishery means* (n = 91), which are reported by fishery in Table A4.

The distinction between the two types of distributions and statistics must be emphasized, because the summary statistics are not necessarily comparable.

Residency-stratified angling effort and success are presented in Table 4 and Table 5. On average, local anglers reported expending more effort, in units of angler-days per stream per year, than either non-local BC anglers or non-resident anglers (Table 4; Table 5). Non-resident anglers reported spending a slightly higher number of days per stream angled per year than non-local BC residents. Local anglers also reported harvesting more fish, with non-resident anglers displaying the lowest annual harvest per angler. Non-residents reported releasing the highest number of fish per year per stream angled.

Ratios of variance to mean are much greater than 1, for distributions of both activity and success for all residency classes (Table 4). The implication is that the distributions of reported angler activity and success are clumped or over-dispersed. Reported steelhead angling activity is numerically dominated by anglers who expend relatively little effort per stream per year, and a second group of very avid anglers who expend much more effort per stream per year. This pattern is also true for angler success, and is re-emphasized by the displacement of the medians from the means of these distributions. Despite per-angler mean values of several fish released per stream per year, the median catch (killed or released) for all residencies is either 0 or 1. In other words, steelhead anglers are typically unsuccessful although a minority of anglers are very successful. There are less anglers whose reported behavior is intermediate, than would be expected based on the simplest possible theoretical statistical description of the distributions.

Cumulative frequency distributions (Figure 2 to Figure 4) graphically reinforce the evidence about differences within and between residency groups, in terms of angler behaviour. Cumulative-cumulative plots translate the patterns into their net impact on fishery annual total angling effort and catch (Figure 5 through Figure 7). For all residency classes, the reported effort and catch are concentrated within a relatively minor proportion of the participants. Among residency groups, for all parameters, the concentration is most exaggerated for locals.

**Table 4**.—Characteristics of per-stream angling effort and success by individuals of 3 residency classes. Estimated from a pooled dataset of individual SHA responses for the most popular 91 steelhead fisheries in BC, which comprised 95 % of steelhead effort in the province during 1984 - 96. **Days** gives the number of angler days reported for a licence year; **Retained** gives the number of steelhead reported harvested during a licence year; **Released** gives the number of steelhead reported angled and released alive. **Residency** is categorized as L = Local, B = BC non-local, and N = non-resident of BC. **Max** = maximum reported; **SD** = standard deviation, **S** = variance.

| Parameter | Residency | Mean | Max | Count | SD | S | Median |
|---|---|---|---|---|---|---|---|
| **Days** | B | 3.9 | 180 | 25767 | 5.1 | 26.1 | 3 |
| | L | 7.3 | 300 | 85836 | 11.0 | 121.4 | 4 |
| | N | 5.0 | 186 | 23073 | 4.8 | 22.8 | 4 |
| **Retained** | B | 0.55 | 61 | 25768 | 2.1 | 4.4 | 0 |
| | L | 0.94 | 850 | 85827 | 5.7 | 32.2 | 0 |
| | N | 0.43 | 80 | 23073 | 1.5 | 2.4 | 0 |
| **Released** | B | 2.4 | 207 | 25769 | 6.4 | 41.2 | 0 |
| | L | 3.3 | 866 | 85828 | 10.7 | 115.3 | 0 |
| | N | 4.4 | 161 | 23072 | 7.6 | 58.4 | 1 |

**Table 5**.—Characteristics of distributions of number of days per year per stream angled by individuals of 3 residency classes. Drawn from the fishery means, for the most popular 91 steelhead fisheries in BC, which comprise 95 % of steelhead effort in the province, 1984 - 96.

| **Parameter** | **Local (L)** | **BC Non-local (B)** | **Non-resident (N)** |
|---|---|---|---|
| **Mean** | 5.3 | 3.0 | 3.1 |
| **Standard Error** | 0.23 | 0.13 | 0.15 |
| **Median** | 4.7 | 2.7 | 2.8 |
| **Standard Deviation** | 2.20 | 1.19 | 1.38 |
| **Variance** | 4.83 | 1.41 | 1.91 |
| **Minimum** | 1.7 | 1.0 | 1.0 |
| **Maximum** | 12.4 | 6.6 | 7.0 |
| **Count** | 90 | 89 | 85 |

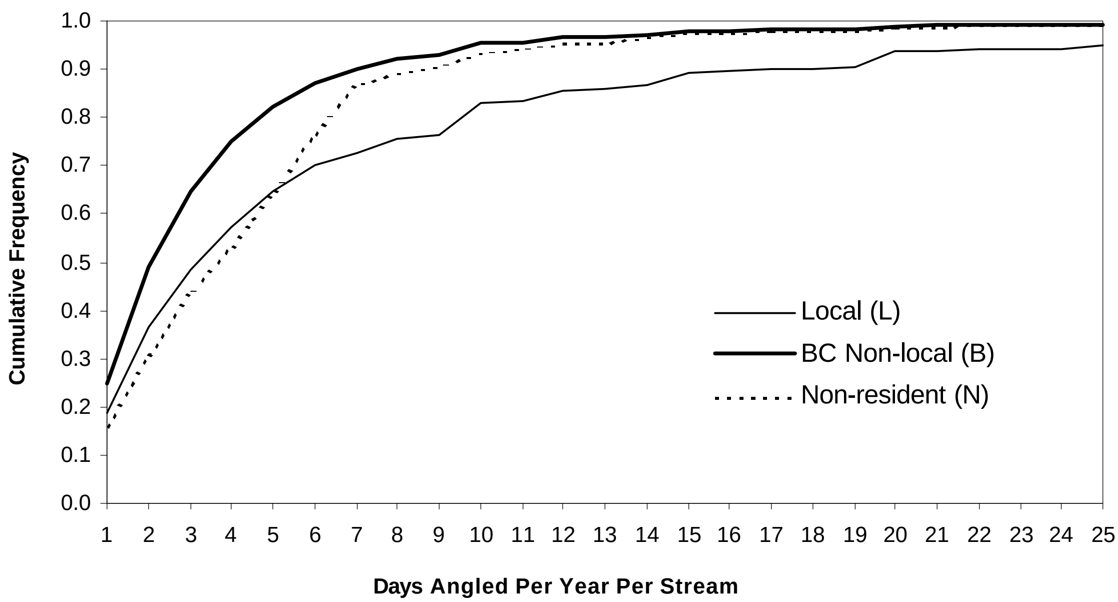



**Figure 2.**—Cumulative frequency distribution, of reported days angled per year per individual angler per stream, for three angler residency classes. Drawn from SHA reports for the 91 most popular fisheries in BC, 1984 to 1996.

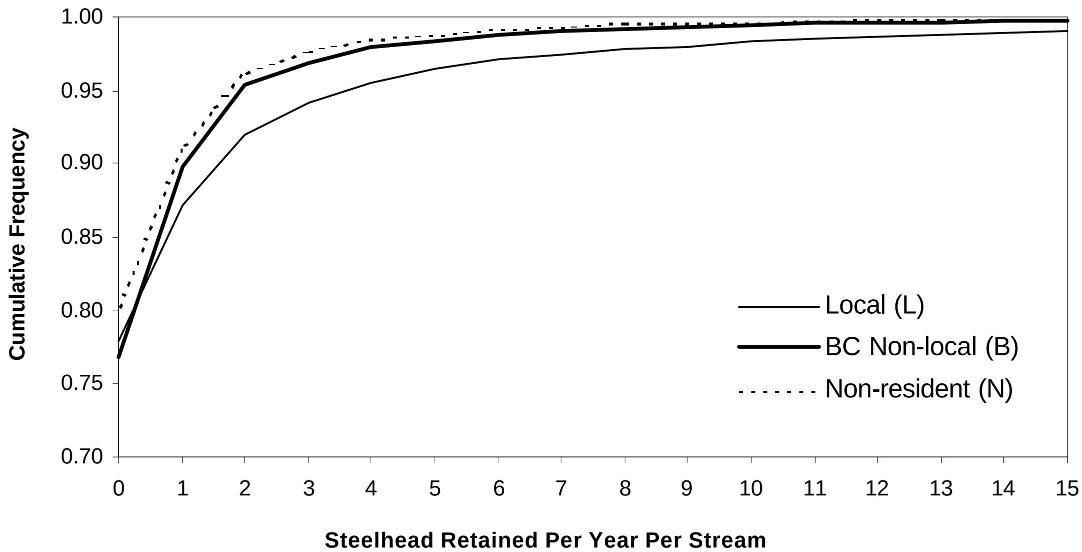



**Figure 3.**—Cumulative frequency distribution, of reported steelhead retained per year per individual angler per stream, for three angler residency classes. Drawn from SHA reports for the 91 most popular fisheries in BC, 1984 to 1996.

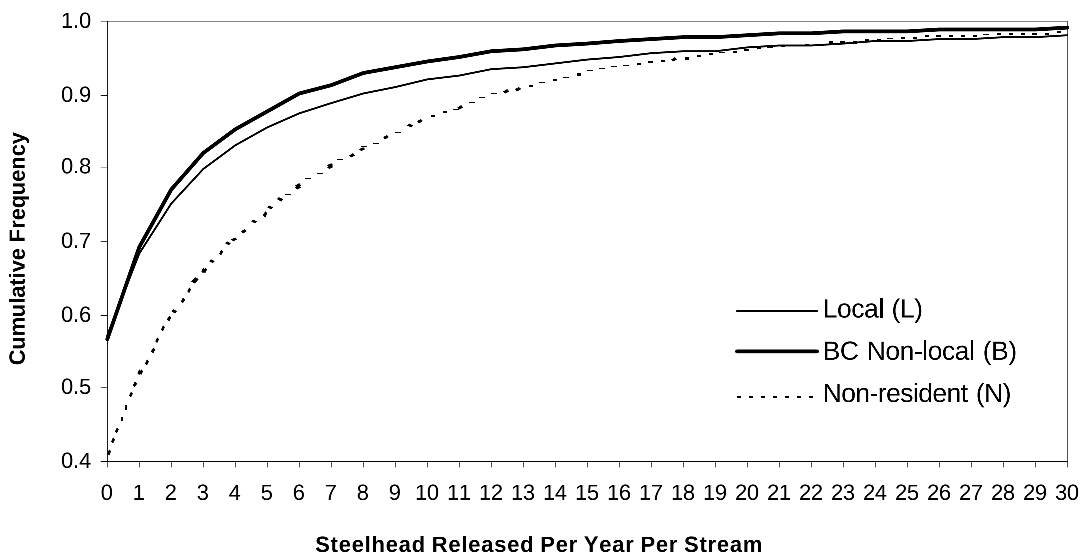



**Figure 4.**—Cumulative frequency distribution of reported steelhead released per year per individual angler per stream, for three angler residency classes. Drawn from SHA reports for the 91 most popular fisheries in BC, 1984 to 1996.

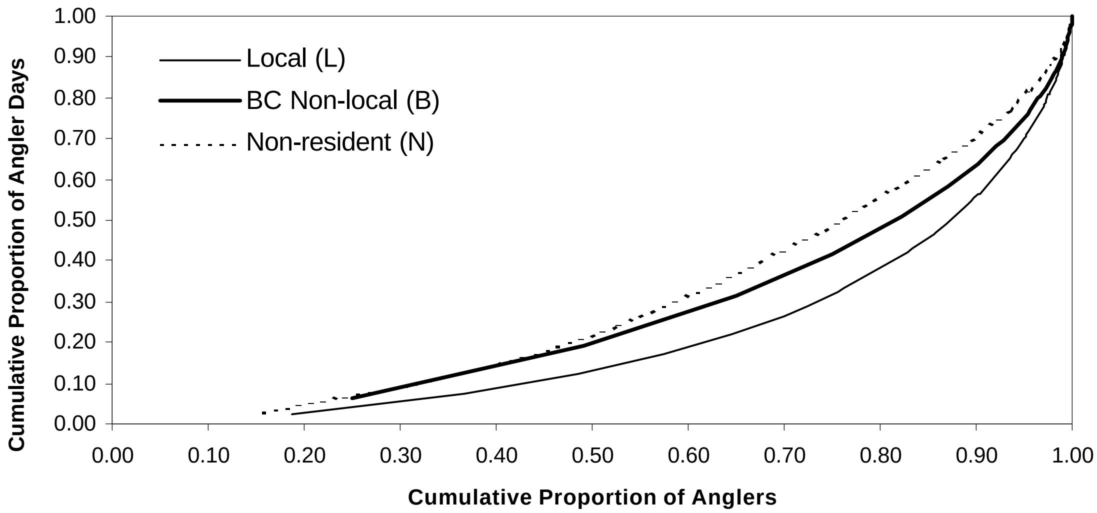



**Figure 5.**—Cumulative proportion of reported days angled, versus the cumulative proportion of anglers who participated, for three angler residency classes. Drawn from SHA reports for the 91 most popular fisheries in BC, 1984 to 1996.

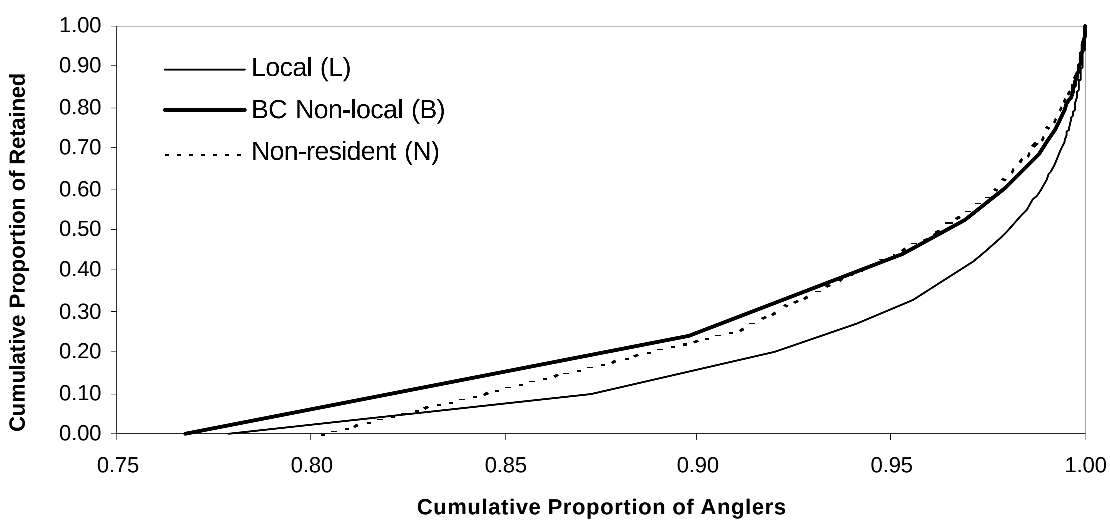



**Figure 6.**—Cumulative proportion of steelhead retained, versus the cumulative proportion of anglers who retained steelhead, for three angler residency classes. Drawn from SHA reports for the 91 most popular fisheries in BC, 1984 to 1996.

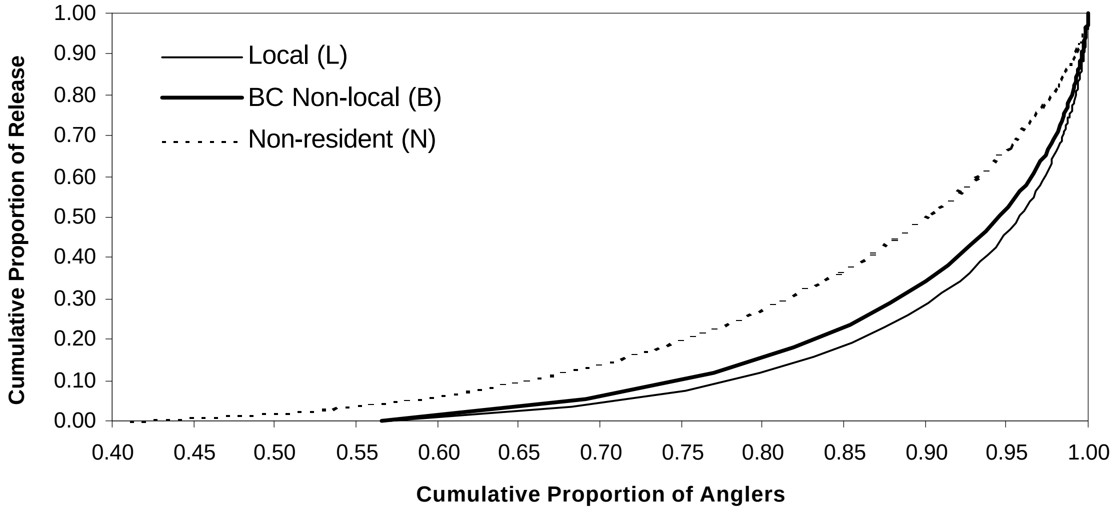



**Figure 7.**—Cumulative proportion of steelhead released, versus the cumulative proportion of anglers who released steelhead, for three angler residency classes. Drawn from SHA reports for the 91 most popular fisheries in BC, 1984 to 1996.

Characteristics of distributions of number of streams angled per SHA respondent are presented in Table 6 and Table 7. The distribution of fishery means (Table 7) provides a description of this component of angler behaviour which is very different than the parameters describing the pooled distribution (Table 6). Anglers who fish a large number of streams per year have a disproportionate effect on the mean of fishery means, because the influence of their high activity appears within the calculation for each of the streams angled. The parameters describing the distribution of fishery means function best as a baseline against which the typicality of the means for individual fisheries (Table A4) can be judged.

Of the angler residency types, non-resident and BC non-local anglers similarly tend to fish the lowest number of BC steelhead streams per year (Table 6). BC resident anglers who fish only waters within their region of residency --- e.g., locals --- tend to fish a greater number of streams per year. However, anglers in the "mixed" category --- e.g., anglers who fish waters both within and outside their region of residency --- display the highest number of streams angled per year, both within their region of residency and outside (Table 6).

**Table 6**.—Characteristics of distributions of the annual number of BC steelhead waters angled by individuals of four **Angler Types**. **Local** anglers are BC residents who fished for steelhead only in streams in their region of residence; **BC Non-local** anglers are BC residents who fished for steelhead only on waters outside of their region of residence; **Mixed** anglers are BC residents who fished for steelhead on waters in and outside their region of residence; **Non-resident** anglers resided outside of BC. The column **# of Local Streams Angled** gives the number of waters reported angled within the angler's region of residence; **# of Other BC Streams Angled** gives the number of waters reported angled outside the angler's region of residence. **Max** = maximum number reported, **S** = variance of the distribution. The dataset includes all (n = 78,584) individual SHA responses from anglers active in the most popular 91 steelhead fisheries in BC during the period 1984 - 96.

| | | # of Local Streams Angled | | | # of Other BC Streams Angled | | |
|---|---|---|---|---|---|---|---|
| **Angler Type** | **N** | **Mean** | **Max** | **S** | **Mean** | **Max** | **S** |
| **Local (L)** | 11,648 | 1.75 | 20 | 1.61 | NA | NA | NA |
| **BC Non-local (B)** | 43,709 | NA | NA | NA | 1.37 | 14 | 0.74 |
| **Mixed** | 6,498 | 2.24 | 17 | 3.17 | 1.69 | 16 | 1.59 |
| **Non-resident (N)** | 16,729 | NA | NA | NA | 1.43 | 23 | 0.92 |

**Table 7**.—Characteristics of distributions of annual number of BC steelhead waters angled by individuals of 3 residency classes. Drawn from the *fishery means* for the most popular 91 steelhead fisheries in BC, which comprised 95 % of steelhead effort in BC during 1984 - 96.

| **Parameter** | **Local (L)** | **BC Non-local (B)** | **Non-resident (N)** |
|---|---|---|---|
| **Mean** | 3.68 | 4.04 | 3.21 |
| **Standard Error** | 0.11 | 0.15 | 0.14 |
| **Median** | 3.74 | 4.21 | 3.00 |
| **Standard Deviation** | 1.06 | 1.44 | 1.31 |
| **Variance** | 1.13 | 2.06 | 1.71 |
| **Minimum** | 1.29 | 1.43 | 1.18 |
| **Maximum** | 5.89 | 7.86 | 7.17 |
| **Count** | 90 | 90 | 85 |

### 3.1.2. Rounding in Angler Reporting

Evidence about the tendency for anglers to round their reported activity is provided graphically in Figure 8. Multiples of 2, 5, 7 and 10 all show some evidence of over-representation, implying that anglers do round their reported activity. For instance, the mean ratio of categories which are multiples of 2 to the average of their lower and upper neighbors is 5.8. Similarly, the mean ratio of categories which are multiples of 5 to the average of their 4 nearest neighbors is 10.7.

However, the true distribution is unknown, and not necessarily typical of any theoretical distribution to which the reports might be compared. For instance, anglers may be more likely to plan trips for certain multiples of days. In addition, no conclusions are possible about whether upward or downward rounding is prevalent, which would determine whether bias would result.

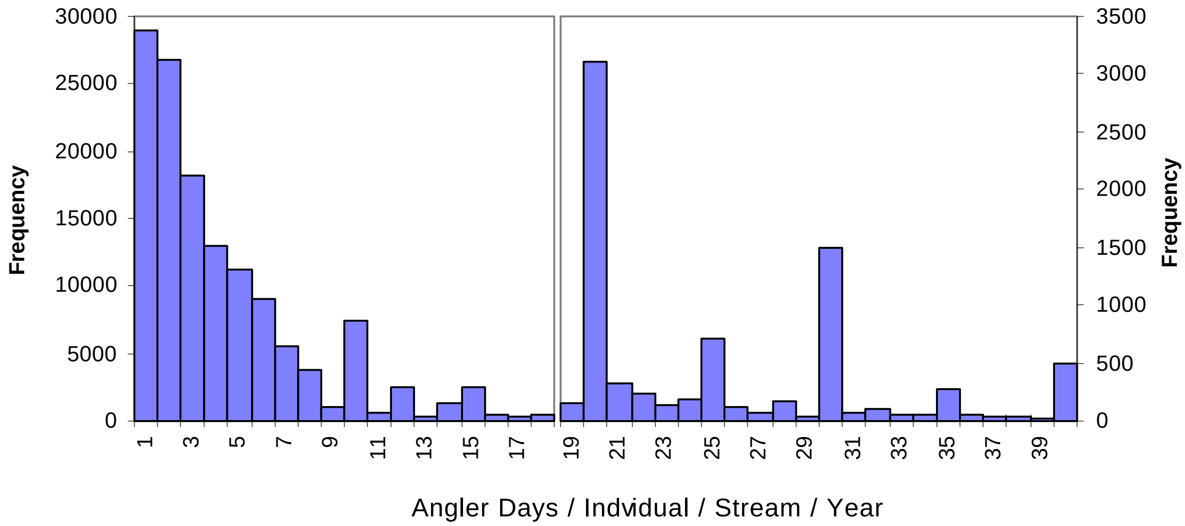



**Figure 8.**—Frequency distribution of reported days angled per stream per licence year. SHA, 1983 to 1996. All residencies pooled. Reported per-stream activity of greater than 40 days is not included. *Note Y-axis scale change midway along X-axis*.

### 3.1.3. Precision of Estimated Parameters

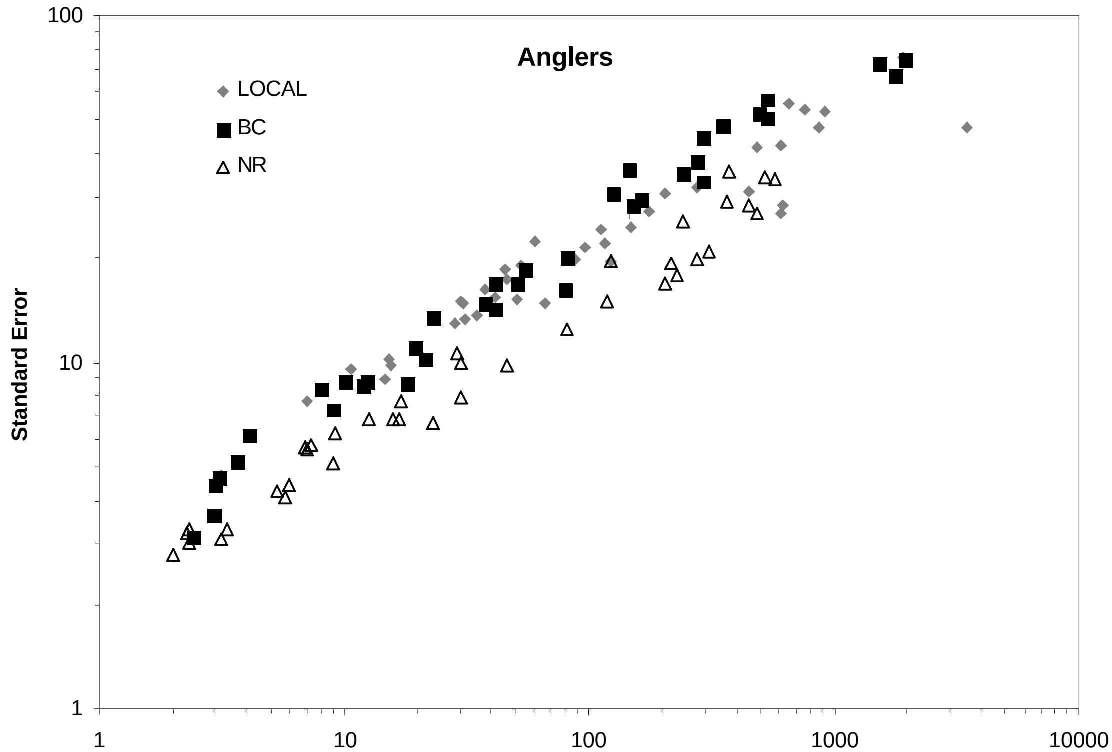
#### *3.1.3.1 Exploratory Dataset*

Bootstrapped standard errors for the exploratory dataset of 43 fisheries are provided in Table A13 (Appendix VII). The values display the relative imprecision of SHA estimates, as well as the variability in imprecision between fisheries. Figure 9a and 9b depict the relationship between estimates and their standard errors. The data are log-log transformed, with the transformations moderately effective in linearizing the relationships. Precision varies substantially among fisheries, at any given parameter level.

Precision also varies substantially among the residency classes (Table 8; Figure 9). Improved precision for non-resident anglers stems from the higher sampling (mail-out) proportion applied to that component of the angler population. For all four parameters of interest, relationships between logged fishery parameter estimates and logged bootstrapped standard errors are roughly linear. Distinction of whether these relationships differ in a statistically or functionally important manner is not offered; the SHA estimates used to derive the regression coefficients were chosen arbitrarily as was the sample size (number of fisheries). Should this type of empirical approach be applied in a broader context, a larger sample of fisheries and more thorough analysis of patterns would be required.

**Table 8.**—Log-log linear regression of bootstrapped standard errors on the associated fishery parameter estimates. Fishery parameters are annual totals, stratified by the residency classes shown; **b** = slope, **a** = intercept; **SE( )** indicates standard error of the regression coefficients.

| Parameter | Residency | b | SE(b) | a | SE(a) |
|---|---|---|---|---|---|
| **Anglers** | BC (B) | 0.462 | 0.012 | 0.438 | 0.022 |
| | Local (L) | 0.364 | 0.016 | 0.593 | 0.035 |
| | NR (N) | 0.422 | 0.011 | 0.334 | 0.019 |
| | **Pooled** | **0.413** | **0.01** | **0.517** | **0.030** |
| **Angler Days** | BC (B) | 0.637 | 0.021 | 0.419 | 0.052 |
| | Local (L) | 0.657 | 0.019 | 0.430 | 0.053 |
| | NR (N) | 0.620 | 0.016 | 0.344 | 0.036 |
| | **Pooled** | **0.634** | **0.018** | **0.433** | **0.055** |
| **Retained** | BC (B) | 0.546 | 0.027 | 0.449 | 0.050 |
| | Local (L) | 0.588 | 0.019 | 0.394 | 0.039 |
| | NR (N) | 0.571 | 0.036 | 0.359 | 0.057 |
| | **Pooled** | **0.564** | **0.017** | **0.429** | **0.038** |
| **Released** | BC (B) | 0.695 | 0.026 | 0.457 | 0.061 |
| | Local (L) | 0.716 | 0.026 | 0.389 | 0.065 |
| | NR (N) | 0.662 | 0.019 | 0.368 | 0.044 |
| | **Pooled** | **0.670** | **0.021** | **0.470** | **0.059** |



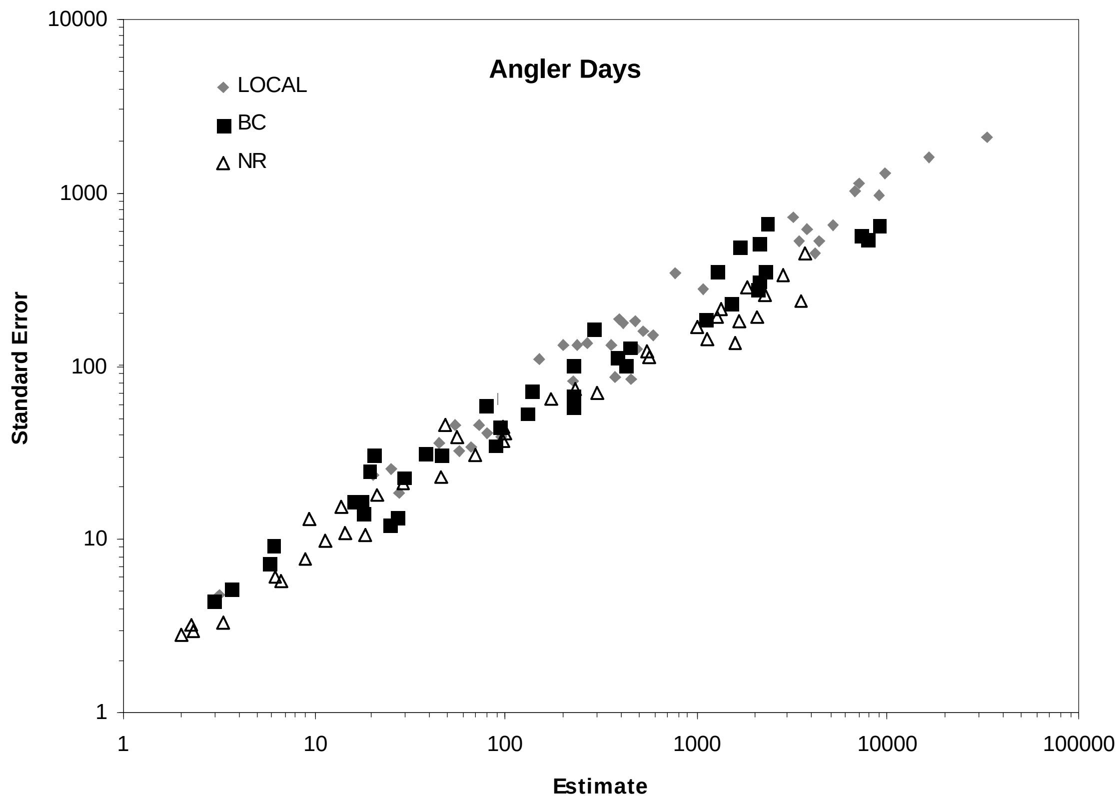




**Figure 9a.**—Log-log relation of annual SHA estimates to their bootstrapped standard errors, anglers and angler days, by residency. Additional explanation is given in the text.

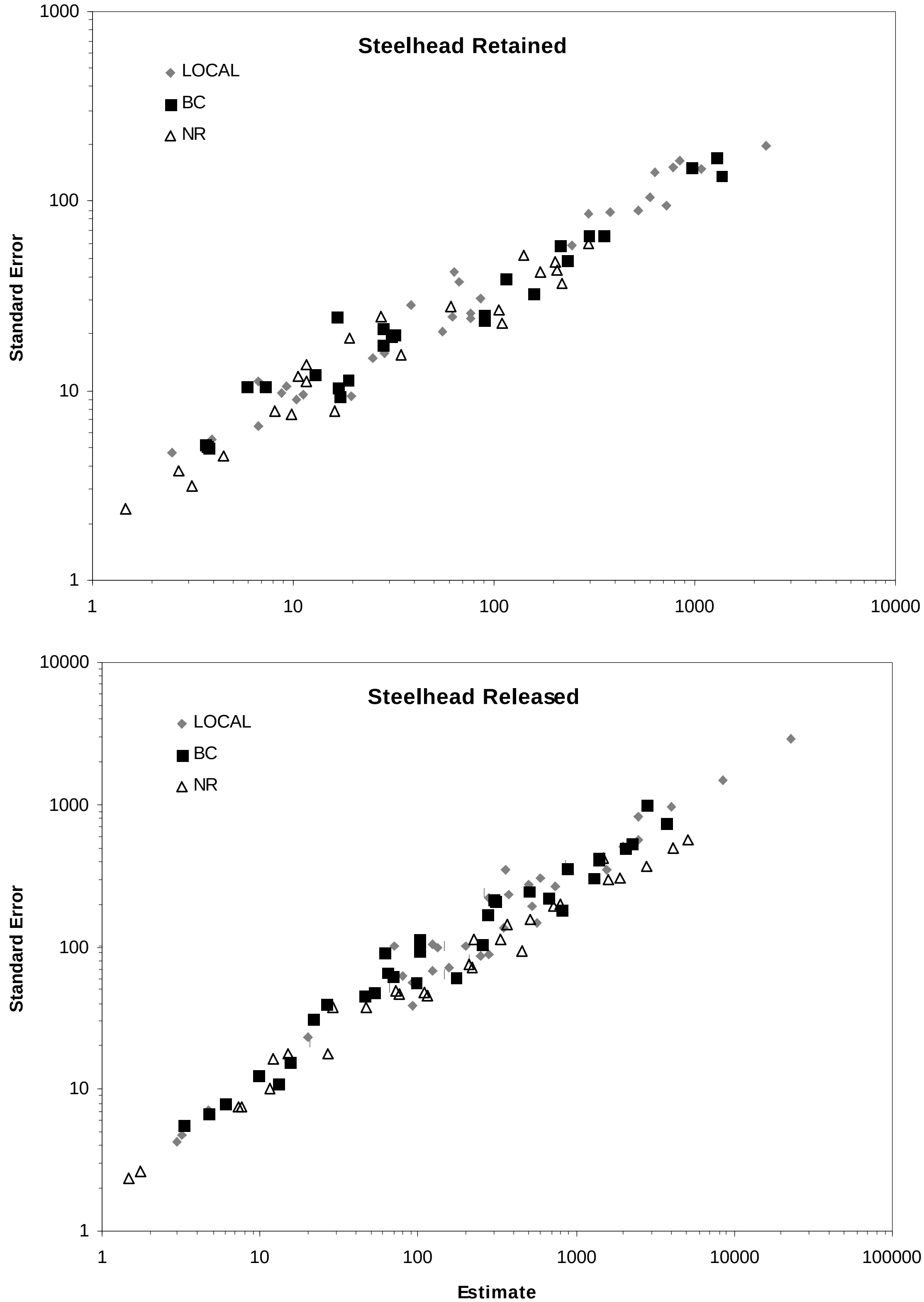



**Figure 9b.**—Log-log relation of annual SHA estimates to their bootstrapped standard errors, catch retained and released, by residency. Additional explanation is given in the text.

Typical percent-wise standard errors of SHA fishery parameter estimates unstratified by residency are provided in Table 9. To apply this table, simply find the parameter of interest, select the value range which contains the desired estimate value, and read the percentage from the final column. For instance, for the Zymoetz River in 1990, the SHA estimate of 426 anglers results in a percent-wise standard error from Table 9 of 9% and thus an absolute standard error of 38. The 95% confidence interval would then be 426 ± 77, or 349 to 503 anglers. Note that in this case, the approximate method under-estimates the bootstrapped standard error of 48 for the 1990 Zymoetz fishery (Table A13). As noted previously, at a given parameter value there remains large variability between fisheries in the apparent precision of estimates, which renders this approach as very approximate. An alternate approach would use the log-log regression equations (Table 8) to estimate the standard error for each residency class, for the parameter of interest. Re-transformation and summing of confidence intervals would give the all-residency confidence interval. Both methods are only empirical approximations drawn from the bootstrap results, which in turn were generated from a very small proportion of SHA data collected to date. In all cases, the best estimate of a confidence interval for the parameter estimate would be provided by applying the bootstrap procedure to the raw data.

Although only an approximate summary, Table 9 provides a basis for expectation about the magnitude of standard errors and thus confidence intervals for SHA results. First, estimates of retained and released steelhead catch are typically subject to much higher relative imprecision at all levels than are the corresponding estimates of effort. Second, in terms of activity, only the upper two quartiles display typical confidence interval widths less than the parameter values themselves, in other words percent-wise standard errors less than 25%. Almost all of the fisheries used to derive the Table 9 standards were drawn from the uppermost quartile, in terms of activity, of the 400+ steelhead fisheries in BC. The typical width of confidence intervals for SHA fishery parameter estimates for the remaining fisheries will thus be similar to those for the lowest value range for each parameter in Table 9. This implies typical confidence interval width of two or more times the parameter value.

**Table 9.**—Rough 'rule-of-thumb' standards for estimating standard errors of SHA parameters for a given value. Methods explained in the text. Approximate confidence intervals are calculated as the value of the estimate ± *z* standard errors, where *z* is the value of the *z* distribution at df = 8.

| Parameter | Quartile | Value Range | Standard Error (expressed as %) |
|---|---|---|---|
| Anglers | 1 | 6 - 40 | 46 |
| | 2 | 41 - 162 | 30 |
| | 3 | 163 - 970 | 9 |
| | 4 | 971 - 3666 | 4 |
| Angler Days | 1 | 6 - 122 | 52 |
| | 2 | 123 - 599 | 39 |
| | 3 | 600 - 6696 | 15 |
| | 4 | 6697 - 33485 | 9 |
| Steelhead Retained | 1 | 3 - 15 | 108 |
| | 2 | 16 - 78 | 58 |
| | 3 | 79 - 768 | 20 |
| | 4 | 769 - 2292 | 12 |
| Steelhead Released | 1 | 3 - 124 | 73 |
| | 2 | 125 - 570 | 62 |
| | 3 | 571 - 3216 | 22 |
| | 4 | 3217 - 23262 | 16 |

### 3.1.4. Follow-up Contact

#### *3.1.4.1 Aggregate Estimates*

Estimates from re-analysis of the province-wide secondary mailing in 1978/79, and Vancouver Island (Region 1) follow-up contact in 1982/83, are presented in Table 10. These aggregate (provincial or regional) totals are essentially weighted means not corresponding directly to other fishery parameter estimates presented in this report, which are usually water-specific or unweighted mean parameter estimates. Nevertheless, all aggregate results suggest that SHA estimates made from a single mailing and the typical response rate are substantially higher than would be obtained from a complete (100%) response to the same mailing. Expressed as a percent of the final estimate, initial mailing estimates appear biased upward due to nonresponse by 24 to 29% for two of the parameters usually examined (number of active anglers and retained catch; Table 10). The number of successful anglers may be overestimated by 33 to 59% due to nonresponse.

**Table 10.**—Comparison of single-mailing SHA fishery parameter estimates to multiple-mailing estimates, 1978/78 provincial total and 1982/83 Region 1. The column headed **Initial** gives the estimate obtained from the results of the Initial mailing; **Final** gives the estimate obtained from all mailings by the method of Filion; **Bias** is **Initial ÷ Final**. Data are from Ford and Narver (1979) and Billings (1983).

| | **1978/79 British Columbia** | | | **1982/83 Vancouver Island** | | |
|---|---|---|---|---|---|---|
| **Parameter** | **Initial** | **Final** | **Bias** | **Initial** | **Final** | **Bias** |
| **Anglers** | 15,788 | 12,694 | **1.24** | 2,887 | 2,331 | **1.24** |
| **Successful Anglers** | 6,746 | 4,241 | **1.59** | 1,856 | 1,390 | **1.33** |
| **Total Retained** | 14,700 | 11,422 | **1.29** | N/A | N/A | **N/A** |

#### *3.1.4.2 Water-Specific Estimates*

Table 11 and Table 12 present re-analysis of water-specific results of the provincial follow-up mailing in 1978/79. Ford and Narver (1979) provide data for only 14 waters, the majority of which lie on Vancouver Island or in the lower mainland. As with the aggregate parameters, the water-specific results suggest that SHA estimates made from a single mailing accompanied by the prevailing response rate are typically substantially higher than would be obtained from a full response to the same mailing. Expressed as a percentage of the final estimate, initial mailing estimates appear biased upward on average by 17 to 38%, depending on the measure of central tendency applied (Table 11).

Although the typical apparent bias of initial results is in the order of 20 to 30%, the results display considerable variability as evidenced by the range (Table 11) and scatter (Table 12, Figure 11) of the estimates. Of 56 initial estimates (4 parameters for 14 waters), 13 were lower than the re-estimated results. Variability in apparent bias is particularly high for the catch parameters, as might be expected given the high variability in reported catch from angler responses to the questionnaire. Relationships between initial and final estimates for the four parameters are depicted graphically in Figure 10, with standard least-squares regressions of initial on final estimates displayed in the same figure and coefficients provided in Table 11. The variability in apparent bias causes the regression coefficients to be poorly determined (see slope and intercept confidence intervals in Table 11). Although y-intercepts appear positive for all parameters, there is no strong indication of slope differing from one for this limited dataset.

Figure 11 displays the relationships between CV and apparent bias for these parameters. It should be re-emphasized that the CV's are surrogate values estimated from 1983-95 angler report. The data suggest a possible weak positive relationship between CV and bias in angler days, but for the catch parameters no pattern is evident.

**Table 11.** —Summary of apparent biases from re-analysis of 14 water-specific results of the provincial follow-up mailing in 1978/79. Coefficients for the regression of the initial estimate (dependent variable) on the final estimate (independent variable) are provided in the lower rows of the table. For each regression coefficient, the 95% confidence interval is provided in parentheses. Regressions are depicted graphically in Figure 11.

| | **Fishery Parameter** | | | |
|---|---|---|---|---|
| **Description of Bias** | **Anglers** | **Angler Days** | **Catch Retained** | **Catch Released** |
| **Range** | 0.94 to 1.37 | 0.88 to 1.56 | 0.71 to 2.52 | 0.44 to 2.14 |
| **Unweighted Mean** | 1.20 | 1.24 | 1.29 | 1.27 |
| **Weighted Mean** | 1.18 | 1.18 | 1.17 | 1.10 |
| **Median** | 1.20 | 1.24 | 1.38 | 1.17 |
| **Slope** | **1.12** (1.01, 1.22) | **0.99** (0.76, 1.22) | **0.86** (0.66, 1.05) | **0.68** (0.11, 1.25) |
| **Intercept** | **46** (-40, 132) | **819** (-341, 1978) | **116** (18, 215) | **224** (-123, 572) |

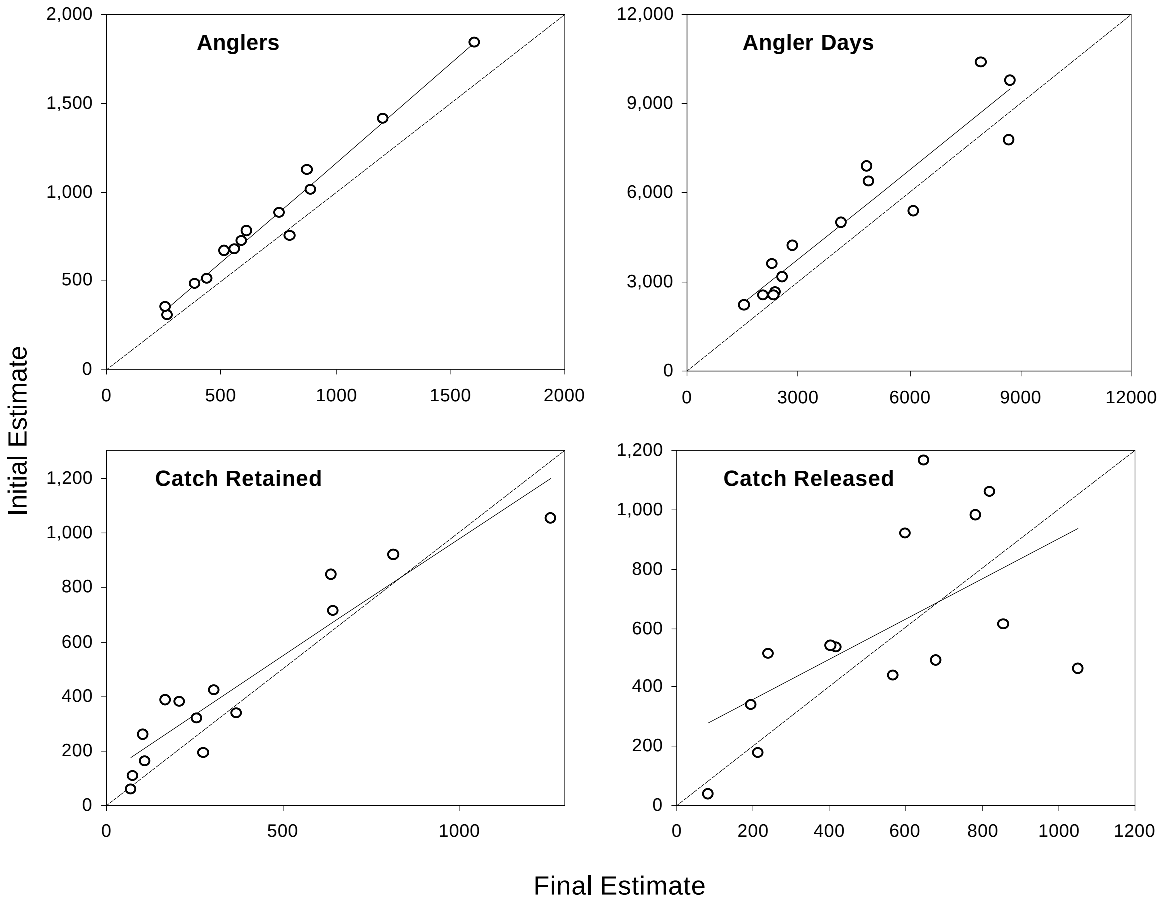



**Figure 10.**— Comparison of single-mailing SHA fishery parameter estimates to multiple-mailing estimates, for 14 rivers, 1978/79. Regression coefficients are provided in Table 11. The dashed lines indicate Initial = Final, e.g. an unbiased initial estimate.

**Table 12.**— Comparison of single-mailing SHA fishery parameter estimates to multiple-mailing estimates, for 14 rivers, 1978/79. The column headed **Initial** gives the estimate obtained from the results of the first mailing; **Final** gives the estimate obtained from all mailings; **Bias** is simply Initial ÷ Final. Data obtained from Ford and Narver 1979; estimation methods explained in the text.

| **River** | **Anglers** | | | **Angler Days** | | | **Catch Retained** | | | **Catch Released** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Initial** | **Final** | **Bias** | **Initial** | **Final** | **Bias** | **Initial** | **Final** | **Bias** | **Initial** | **Final** | **Bias** |
| **Big Qualicum** | 777 | 613 | **1.27** | 3,599 | 2,311 | **1.56** | 384 | 167 | **2.30** | 513 | 240 | 2.14 |
| **Campbell** | 670 | 515 | **1.30** | 4,239 | 2,850 | **1.49** | 258 | 102 | **2.52** | 534 | 419 | 1.28 |
| **Cowichan** | 1,413 | 1,205 | **1.17** | 10,371 | 7,951 | **1.30** | 921 | 817 | **1.13** | 1,060 | 820 | 1.29 |
| **Gold** | 510 | 441 | **1.16** | 2,647 | 2,364 | **1.12** | 426 | 305 | **1.40** | 490 | 677 | 0.72 |
| **Nanaimo** | 730 | 592 | **1.23** | 6,900 | 4,878 | **1.41** | 711 | 641 | **1.11** | 921 | 596 | 1.55 |
| **Stamp** | 306 | 266 | **1.15** | 2,206 | 1,518 | **1.45** | 380 | 206 | **1.84** | 539 | 404 | 1.33 |
| **Englishman** | 481 | 384 | **1.25** | 2,529 | 2,033 | **1.24** | 321 | 256 | **1.25** | 440 | 567 | 0.78 |
| **Cheakamus** | 680 | 558 | **1.22** | 3,164 | 2,581 | **1.23** | 161 | 106 | **1.53** | 342 | 193 | 1.77 |
| **Fraser** | 751 | 797 | **0.94** | 7,751 | 8,685 | **0.89** | 196 | 275 | **0.71** | 40 | 81 | 0.50 |
| **Seymour** | 356 | 260 | **1.37** | 2,564 | 2,349 | **1.09** | 111 | 75 | **1.48** | 176 | 214 | 0.82 |
| **Vedder/Chilliwack** | 1,130 | 878 | **1.29** | 6,381 | 4,880 | **1.31** | 62 | 67 | **0.92** | 1,164 | 647 | 1.80 |
| **Squamish** | 1,018 | 892 | **1.14** | 4,993 | 4,174 | **1.20** | 339 | 367 | **0.92** | 612 | 855 | 0.72 |
| **Thompson** | 1,841 | 1,610 | **1.14** | 9,797 | 8,723 | **1.12** | 1,050 | 1,261 | **0.83** | 466 | 1,050 | 0.44 |
| **Bella Coola** | 884 | 758 | **1.17** | 5,375 | 6,132 | **0.88** | 849 | 639 | **1.33** | 983 | 783 | 1.26 |

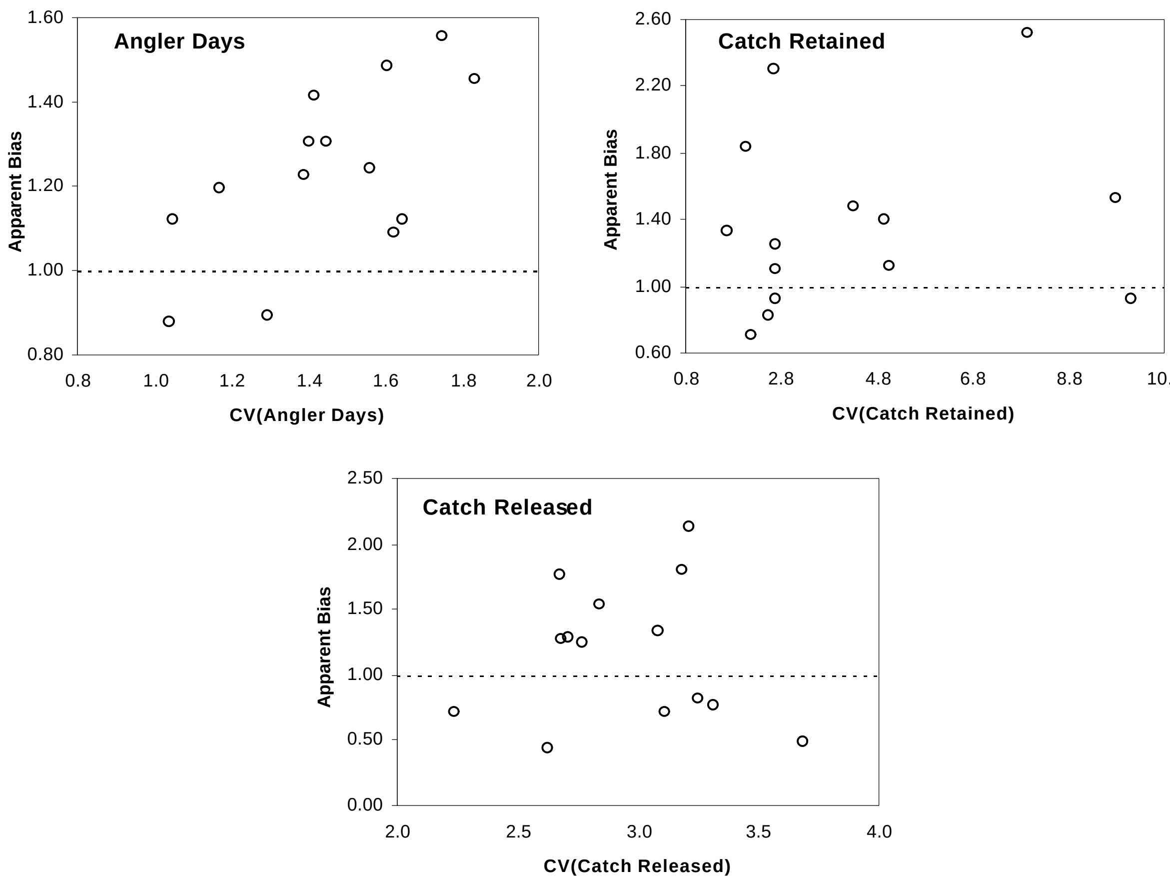



**Figure 11.**—Coefficients of variation (CV's) for steelhead fishery parameters in relation to the apparent bias displayed by analysis of follow-up contact in 1978/79, for 14 rivers. Parameter CV's estimated for each river from all individual response data, 1983 to 1995. Dashed lines show the position of an unbiased estimate.

## 3.2. Comparison of SHA and Field Survey Estimates

### 3.2.1. Characteristics of the Field Survey Dataset

Approximately 97 field-based angling use studies were available for examination. Two studies (Remington 1974; Kier 1980) were rejected immediately as insufficient in scope. Of the remaining 95 studies, 92 yielded one or more parameter estimates comparable to SHA estimates for the same parameter (Table A5; Table A7). The resulting dataset draws from surveys conducted on 26 rivers or river pairs, but is numerically dominated by surveys of three rivers: the Dean (n = 26), Chilko & Chilcotin (n = 12), and Thompson (n = 8).

#### *3.2.1.1 Biases*

Sampling designs with known statistical properties have infrequently been used for BC steelhead angler studies. The majority of surveys, especially prior to 1985, sought full coverage within the time period and area judged to include most of the effort and catch. Arbitrary adjustments to compensate for unsampled anglers were occasionally made, based on subjective observations of creel clerks or supervisors. The accuracy of estimates obtained by these techniques is impossible to evaluate in retrospect. Although some techniques used to achieve full coverage can create upward bias in the survey parameter estimates, the net (design) bias associated with full coverage is certainly downward for activity and catch parameters. Simply put, most such studies do not enumerate all of the effort and catch. In attempting only to do so, they fail to provide a means of assessing what has been missed.

Studies which do not attempt full coverage must apply some form of sampling design, if total effort and catch are to be obtained by systematic expansion. The majority of these attempted full coverage on randomly selected days which were stratified according to weekday/weekend, month of the year, or another temporal unit. Again, arbitrary adjustments were sometimes made to alleviate under-sampling. Full coverage even on a single day was still likely unachievable on average, so these estimates are also probable to display a net downward bias of unknown but variable magnitude.

Very occasionally, more complex designs have been applied (Table 13). These designs admit that complete coverage of activity, even for a single day, is impractical for most BC steelhead fisheries. Unlike full-coverage studies, these sampling designs provide a means for assessing the variability in the data and thus uncertainty in parameter estimates. No net design biases are apparent but even among these studies failure to sample the entire season has occurred in many cases, and differentiation of steelhead anglers from individuals pursuing other species is also problematic for some.

**Table 13.**—BC steelhead angler surveys using documented designs other than full-coverage, licence years 1997 and earlier.

| Study | River | Year |
|---|---|---:|
| Hooton 1976 | Gold | 1976 |
| Hooton and Lewynsky 1985 | Big Qualicum | 1976 to 81 |
| Carswell et al. 1986 | Campbell; Quinsam | 1976 to 80 |
| Clark and Facchin 1986 | Chilliwack | 1984 |
| Scott and Lewynsky 1985 | Chilliwack | 1985 |
| Lewynsky and Olmsted 1990 | Lower Skeena, Zymoetz, Kispiox, Bulkley | 1990 |
| Tallman 1997 | Kispiox | 1997 |

### 3.2.2. Relationship Between Parameter Estimates

#### *3.2.2.1 Residency Pooled*

For the 5 fishery parameters of interest, 32 to 82 comparable data pairs were available to examine the relationships of field to SHA estimates. The fishery parameter relationships do not appear to arise from single set of coefficients (ANOVA, F=2870, df = 1 & 310, $p \approx 0$ ), though pairwise comparisons were not made. Sample sizes, and coefficients for the linear regressions describing these relationships, are given in Table 14. The variability in the data and the linear regressions which describe the relationships are depicted graphically in Figure 12. Figure 13 provides greater detail near the origin, where most of the data lie. As anticipated, for all of the parameter relationships, estimated slopes are greater than one with positive y intercepts (Table 14).

However, as indicated by the relatively large standard errors of regression coefficients for several of the parameters, the relationships are poorly defined due to the variability of the data. This is apparent from the plotted data, and the degree to which the robust regression coefficients differ from the conventional least squares regression coefficients (Table 14).

**Table 14.**—Conventional least squares and robust least trimmed squares regression coefficients describing the relationships between field creel study estimates (independent variable) and comparable SHA estimates (dependent variable), for five steelhead fishery parameters. All fisheries included. **SE()** indicates the standard error of the indicated parameter; **N** is the sample size. Least trimmed squares estimates are in italics.

| Parameter | N | Slope | SE(slope) | Intercept | SE(intercept) |
|---|---|---|---|---|---|
| **Anglers** | 32 | 1.323 | 0.381 | 58.1 | 302.4 |
| | *17* | *0.947* | | *91.1* | |
| **Angler Days** | 82 | 1.545 | 0.042 | 170.5 | 171.0 |
| | *42* | *1.058* | | *324.2* | |
| **All Catch** | 64 | 1.901 | 0.069 | 112.5 | 183.5 |
| | *33* | *1.749* | | *134.1* | |
| **Retained** | 74 | 1.676 | 0.404 | 44.9 | 167.1 |
| | *38* | *1.267* | | *16.7* | |
| **Released** | 60 | 1.984 | 0.083 | 133.9 | 174.3 |
| | *31* | *2.634* | | *87.9* | |

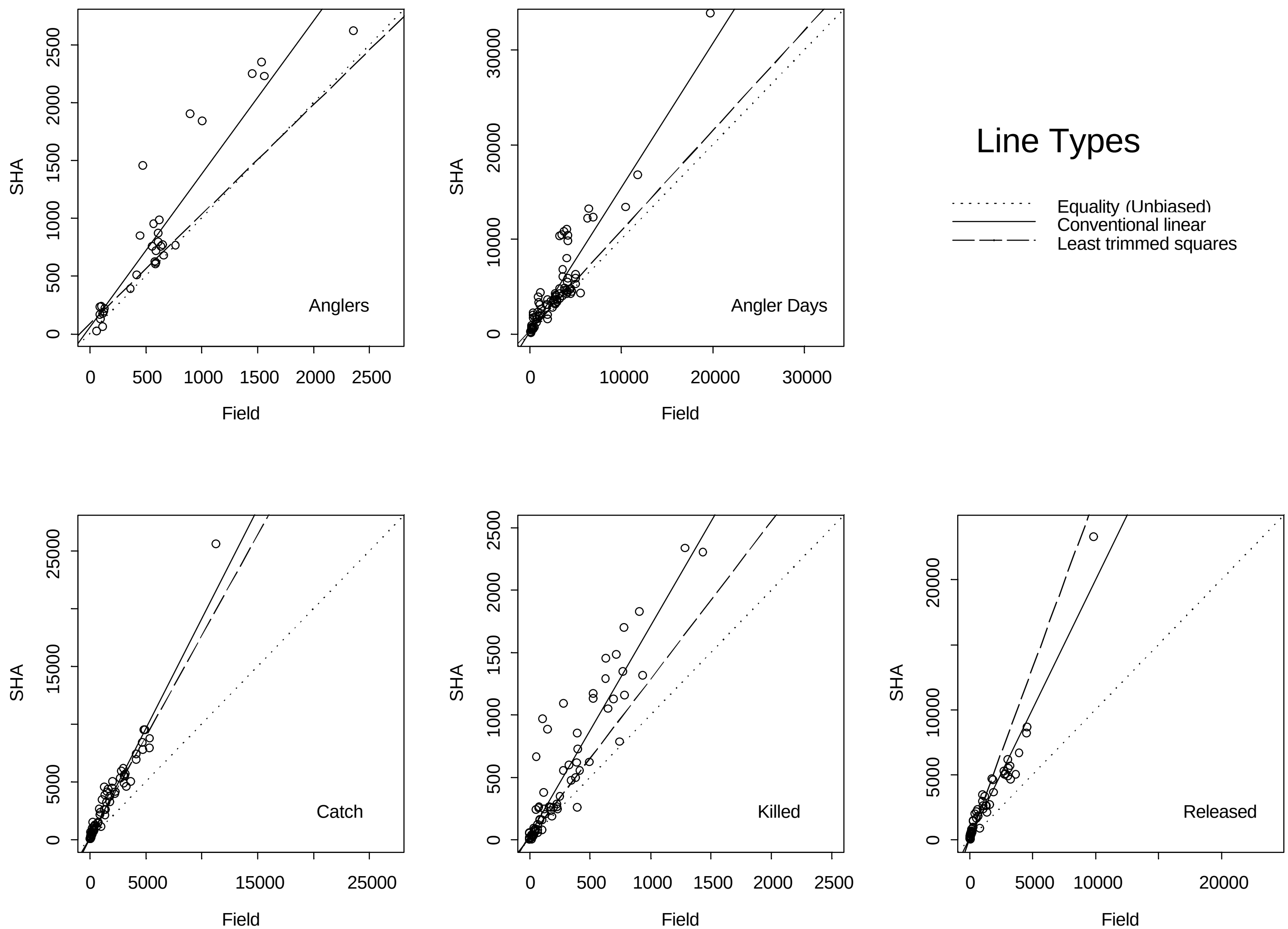



**Figure 12.**—Comparison of field creel study and SHA estimates for 5 fishery parameters. Depicted regressions include conventional least squares, and a method robust to outliers (least trimmed squares regression). All relevant data are displayed.

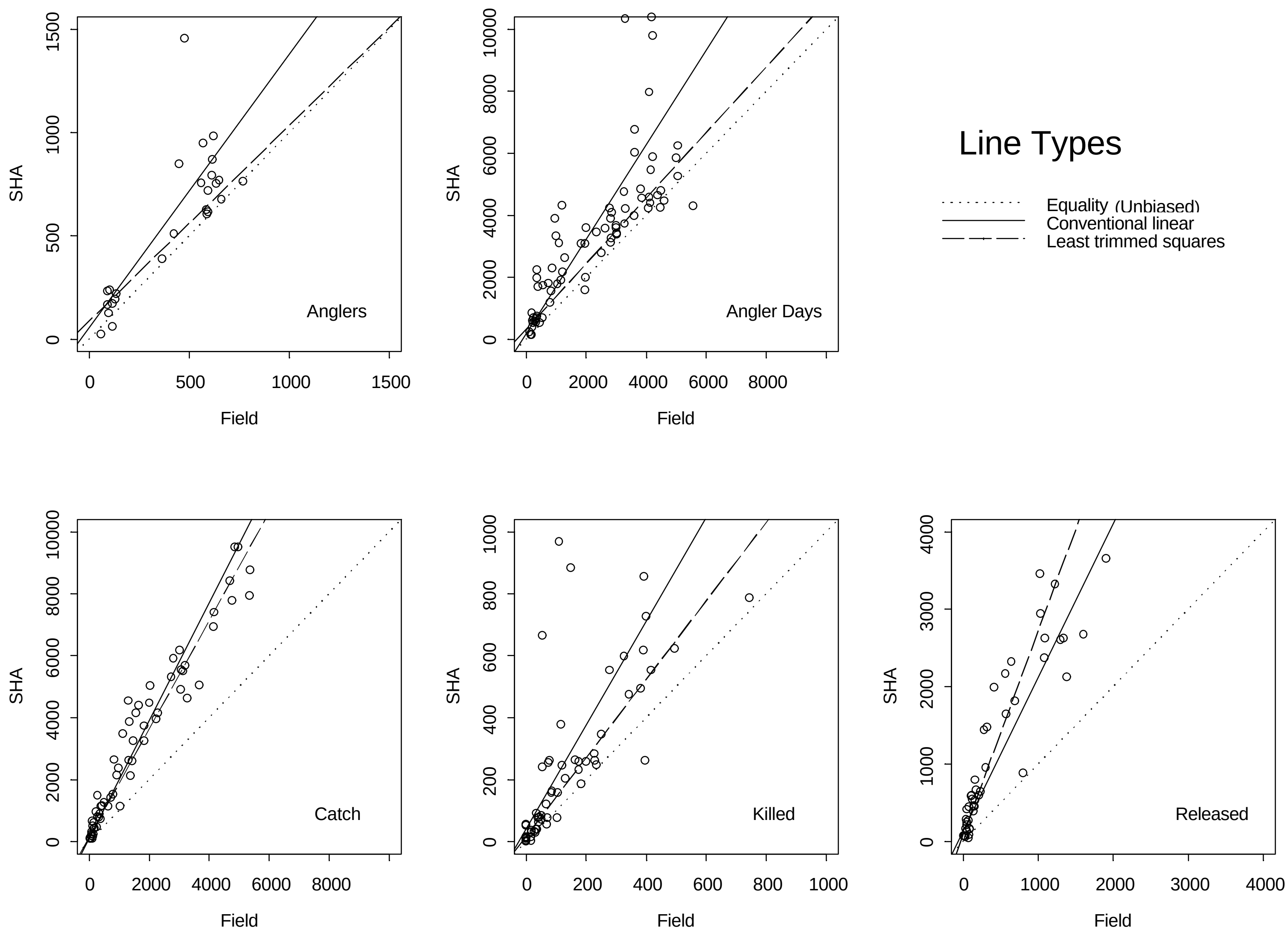



**Figure 13.**—Comparison of field creel study and SHA estimates for 5 fishery parameters. Data and relationships depicted are the same as for Figure 12, but these panels are scaled differently to provide greater detail in the plot regions where most data lie.

As an alternative to the regression analyses, median ratios of field study estimates to SHA estimates are tabulated in Table 15. Variability is high and the data do not display any obvious relationship between the magnitude of the estimate and the typical discrepancy ratio. Median ratios for quartiles which are dominated by Dean River data (e.g. the second quartile of the number of anglers data and the third quartile of angler days data ---Table 15) are quite different than neighboring quartiles. For these reasons, the median ratio for **All** data points, given in bold for each parameter, is the best general estimate.

**Table 15.**—Median ratios of field study estimates to comparable SHA estimates, for quartiles of available data for five fishery parameters. Methodological detail provided in the report text. For each parameter the number of data pairs, in each quartile and total, is given as **N**.

| Parameter | N | Quartile | SHA Value Range | Median Ratio of Field to SHA ( as %) | Median Ratio of SHA to Field ( as %) |
|---|---|---|---|---|---|
| **Anglers** | 8 | 1 | 24 - 233 | 68 | 147 |
| | 8 | 2 | 237 - 720 | 94 | 106 |
| | 8 | 3 | 754 - 949 | 76 | 132 |
| | 8 | 4 | 985 - 2,620 | 64 | 156 |
| | **32** | **All** | **24 - 2620** | **72** | 139 |
| **Angler Days** | 21 | 1 | 141 - 1780 | 51 | 196 |
| | 20 | 2 | 1,807 - 3,599 | 62 | 161 |
| | 20 | 3 | 3,664 - 4,788 | 86 | 116 |
| | 21 | 4 | 4,851 - 33,877 | 51 | 196 |
| | **82** | **All** | **141 - 33,877** | **62** | 161 |
| **Catch** | 16 | 1 | 88 - 736 | 41 | 244 |
| | 16 | 2 | 792 - 2,600 | 42 | 238 |
| | 16 | 3 | 2,631 - 5,026 | 45 | 222 |
| | 16 | 4 | 5,044 - 25,572 | 56 | 179 |
| | **64** | **All** | **88 - 25,572** | **49** | 204 |
| **Retained** | 19 | 1 | 6 - 63 | 56 | 179 |
| | 18 | 2 | 76 - 255 | 57 | 175 |
| | 18 | 3 | 258 - 727 | 70 | 143 |
| | 19 | 4 | 786 - 2,335 | 49 | 204 |
| | **74** | **All** | **6 - 2,335** | **57** | 175 |
| **Released** | 15 | 1 | 48 - 416 | 27 | 370 |
| | 15 | 2 | 446 - 1,475 | 26 | 385 |
| | 15 | 3 | 1,646 - 3,652 | 38 | 263 |
| | 15 | 4 | 4,597 - 23,270 | 56 | 179 |
| | **60** | **All** | **48 - 23,270** | **36** | 278 |

#### *3.2.2.2 Residency-Specific Comparisons*

Residency-specific data were available for field and SHA comparisons of at least one fishery parameter from 43 studies. For a relatively large number of early field studies with residency-specific estimates, matching residency-specific SHA results were not available from either reports or available digital databases. Two types of residency-class contrasts are presented in the following sections: BC residents compared to non-residents, and local residents compared to non-local BC residents.

##### *BC Residents Compared to Non-Residents*

Nine to 25 data pairs were available to examine relationships between field and SHA parameter estimates, from results which could be grouped as BC residents and non-residents. Sample sizes and coefficients for the linear regressions describing these relationships are given in Table 16. The variability in the data and the least squares linear regressions which describe the relationships are depicted graphically in Figure 14 through Figure 16. Similar to the residency-pooled data, variability is extreme. Slopes for BC resident data are greater than those for non-residents for all four fishery parameters considered, though none of the differences are statistically significant (Table 16). For three of the four parameters, y-intercepts for the resident group are also greater than for the non-resident class. The implication is that either the upward bias of the SHA estimates is greater for BC residents as a group than for non-residents, or the downward bias of field results is greater for the non-resident group. The data do not allow distinction between these alternatives, though the former hypothesis appears more plausible given other evidence about differences between typical behaviour of resident and non-resident anglers.

**Table 16.**—Residency-specific least squares regression coefficients describing the relationship between field creel study estimates (independent variable) and comparable SHA estimates (dependent variable). **Int** = intercept, **SE()** indicates the standard error of the indicated parameter; **N** is sample size. **Residency** classes: **R** = all BC residents, **N** = non-residents of BC. For each parameter, the final row gives the results of an F-test for equality of slopes of the regressions : $\mathbf{F_s}$ = F statistic, **df** = degrees of freedom, and **p** = p-value for the test.

| Parameter | Residency | N | Slope | SE(slope) | Int | SE(Int) |
|---|---|---|---|---|---|---|
| **Anglers** | **R** | 14 | 1.328 | 0.14 | 48.2 | 81.8 |
| | **N** | 14 | 1.087 | 0.11 | 24.3 | 28.4 |
| **$F_s$ = 0.586, df = 1 & 24, p = 0.45** | | | | | | |
| **Angler Days** | **R** | 17 | 1.611 | 0.21 | 464.5 | 710.7 |
| | **N** | 17 | 1.108 | 0.07 | 197.1 | 132.9 |
| **$F_s$ = 2.086, df = 1 & 30, p = 0.16** | | | | | | |
| **Retained** | **R** | 25 | 1.846 | 0.06 | 11.3 | 17.2 |
| | **N** | 25 | 1.633 | 0.15 | 7.9 | 6.2 |
| **$F_s$ = 0.454, df = 1 & 46, p = 0.50** | | | | | | |
| **Released** | **R** | 9 | 2.332 | 0.41 | -68.7 | 297.3 |
| | **N** | 9 | 1.697 | 0.29 | 133.5 | 590.6 |
| **$F_s$ = 0.810, df = 1 & 14, p = 0.38** | | | | | | |

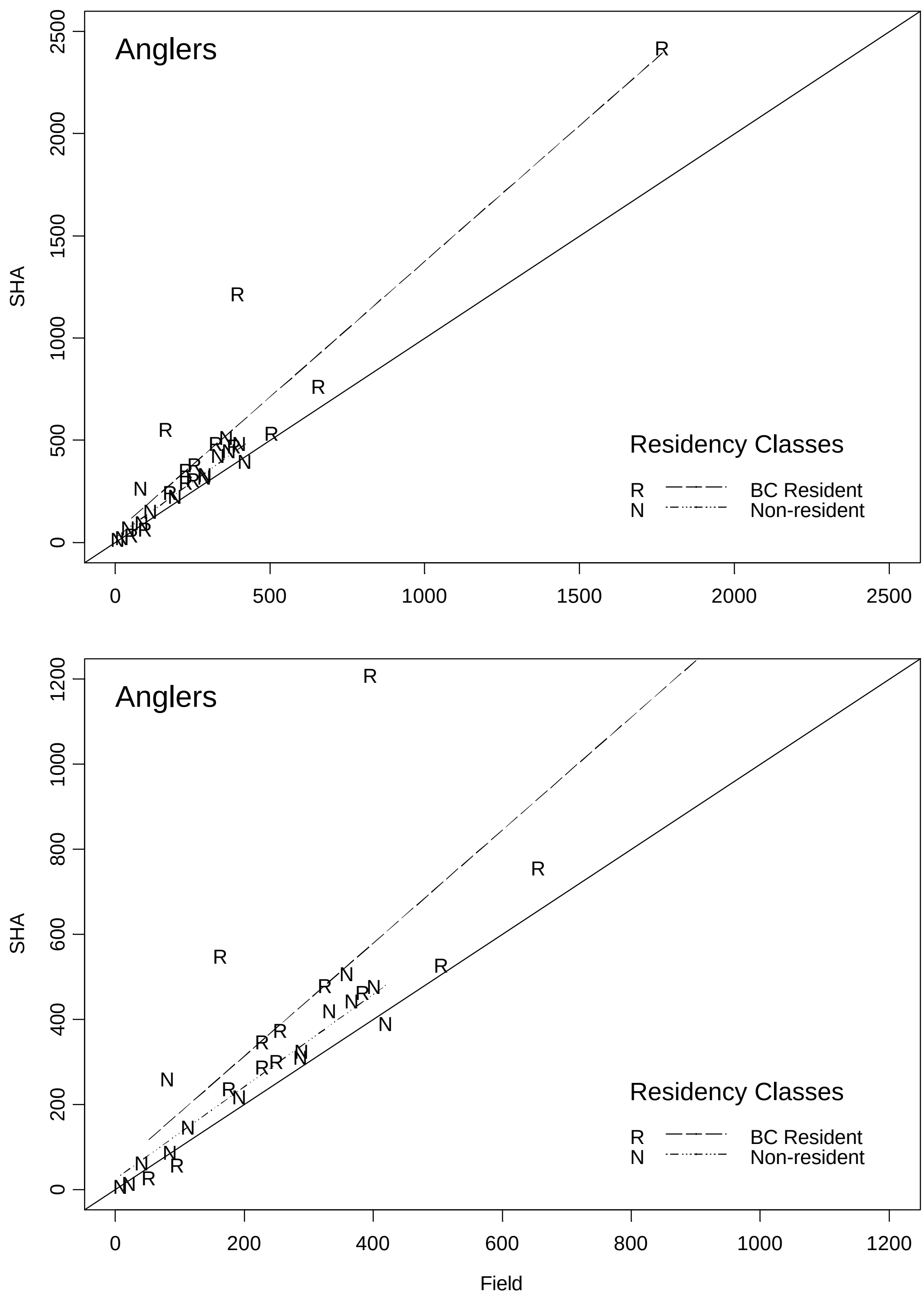



**Figure 14.**—Comparison of field creel study and SHA estimates of annual number of anglers, BC residents and non-residents. The upper plot shows all available data pairs; the lower plot displays only the region near the origin. Regression coefficients are provided in Table 16. The solid diagonal line depicts equality of field and SHA estimates.

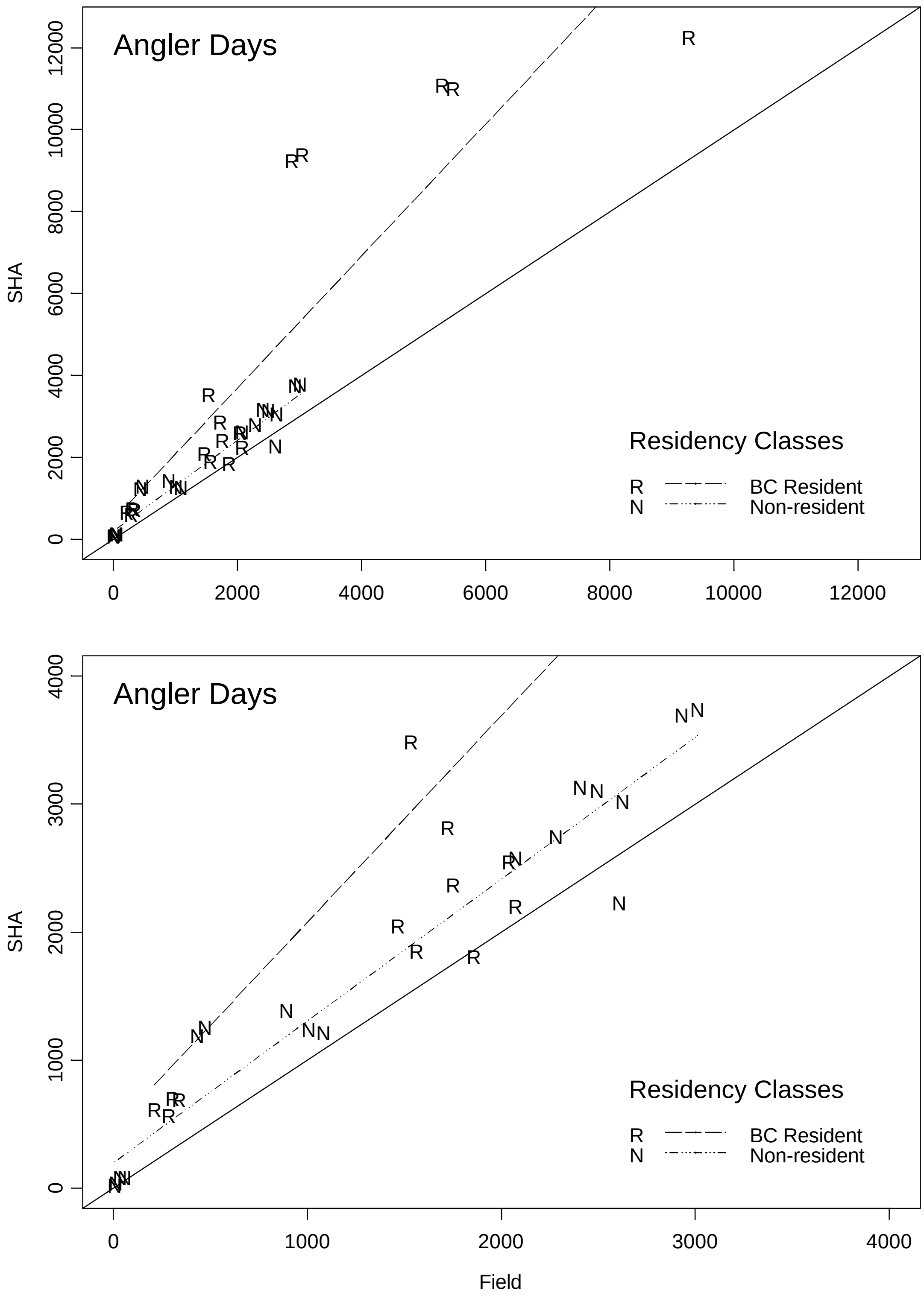



**Figure 15.**—Comparison of field creel study and SHA estimates of annual number of angler days, BC residents and non-residents. Upper plot shows all available data pairs; lower plot displays only the region near the origin. Regression coefficients are provided in Table 16. The solid diagonal line depicts equality of field and SHA estimates.

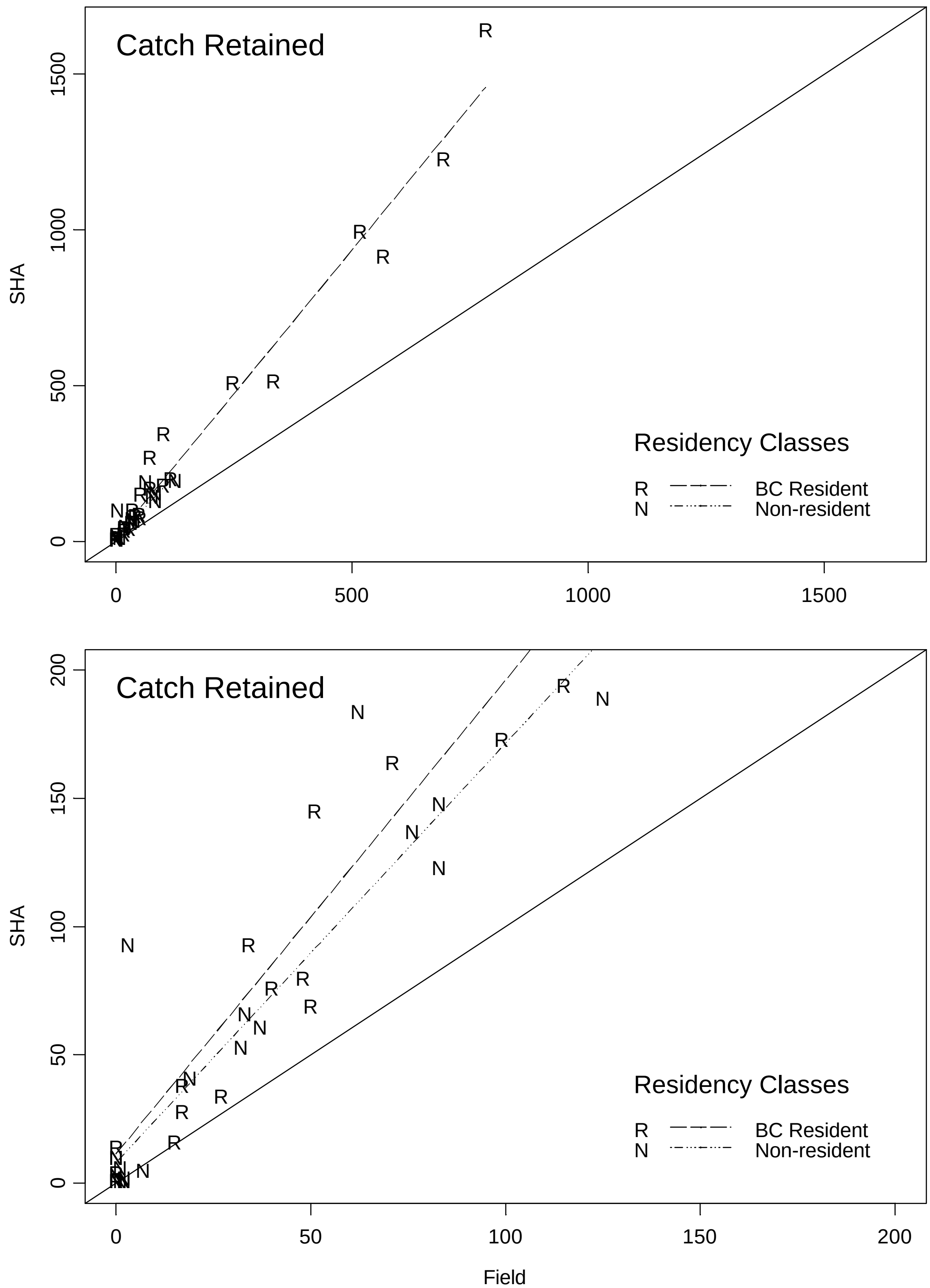



**Figure 16.**—Relation of field creel study to SHA estimates of annual number of steelhead retained, BC residents and non-residents. Upper panel shows all available data; lower panel displays only the region near the origin. Regression coefficients are provided in Table 16. The solid diagonal line depicts equality of field and SHA estimates.

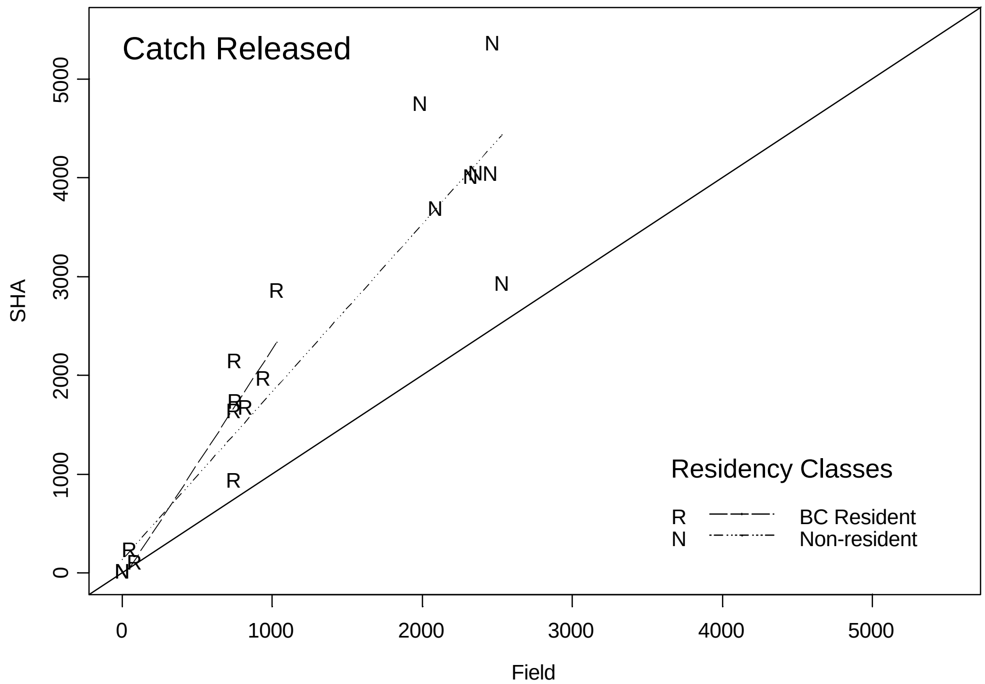



**Figure 17.**—Comparison of field study and SHA estimates of annual number of steelhead released, BC residents and non-residents. Regression coefficients provided in Table 16. The solid diagonal line depicts equality of field and SHA estimates.

### *Local Residents Compared to BC Non-Local Residents*

Field and SHA results which could be grouped as local residency and BC non-local residency were uncommon in the available datasets (Table 17). The linear regressions which describe the relationships are depicted graphically in Figure 18 and Figure 19. Small sample sizes and high variability prevent any type of conclusion about differences between these residency groups in terms of possible bias of SHA parameter estimates.

**Table 17.**—Residency-specific least squares regression coefficients describing the relation of field creel study estimates (independent variable) to comparable SHA estimates (dependent variable), for local (**L**) and non-local BC (**B**) resident classes. Abbreviations as for Table 16.

| Parameter | Residency | N | Slope | SE(slope) | Int | SE(Int) |
|---|---|---|---|---|---|---|
| **Anglers** | **L** | 7 | 1.114 | 0.40 | 15.3 | 97.9 |
| | **B** | 7 | 1.220 | 0.06 | 54.6 | 33.3 |
| **$F_s$ = 0.100, df = 1 & 10, p = 0.76** | | | | | | |
| **Retained** | **L** | 8 | 2.193 | 0.77 | -1.35 | 25.8 |
| | **B** | 8 | 2.157 | 0.53 | -4.49 | 7.6 |
| **$F_s$ = 0.001, df = 1 & 12, p = 0.97** | | | | | | |

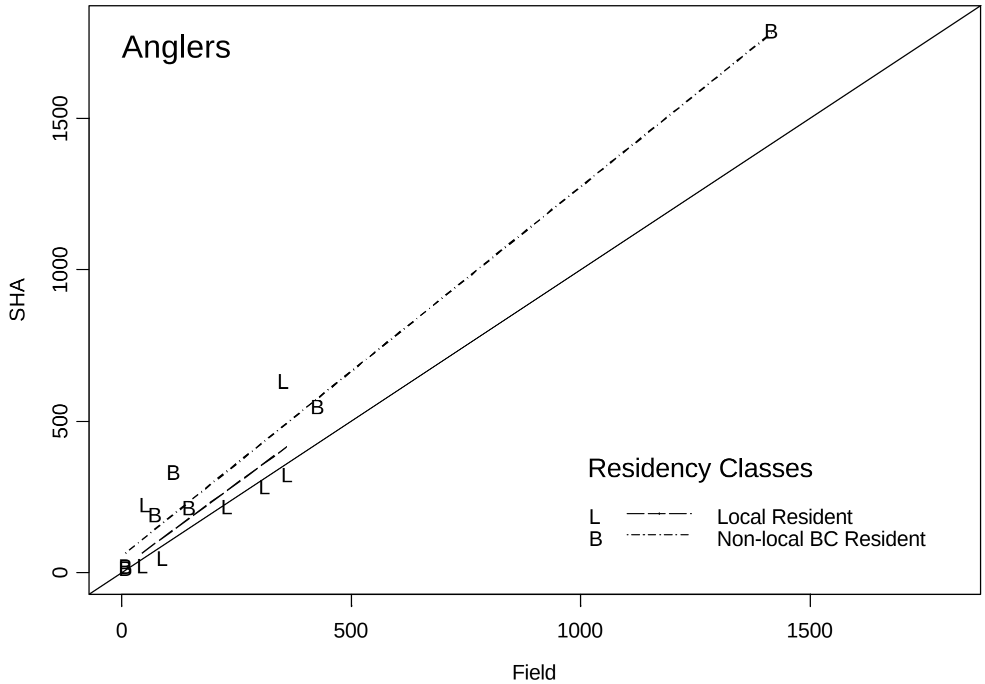



**Figure 18.**—Relation of field creel study to SHA estimates of annual number of steelhead anglers, local and non-local BC residents. Regression coefficients provided in Table 17.

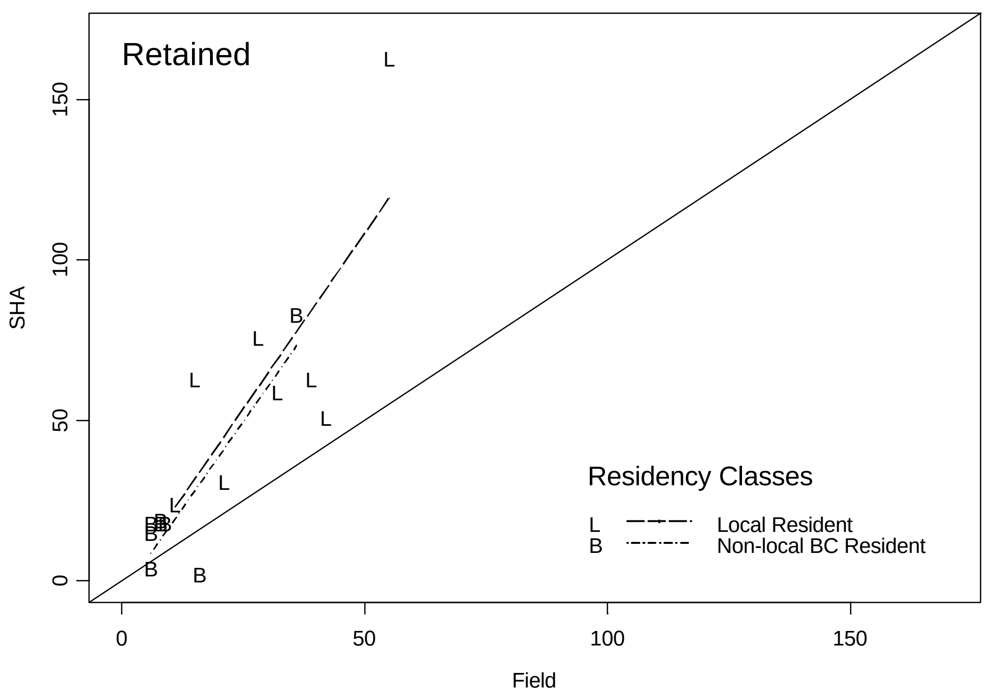



**Figure 19.**—Relation of field creel study to SHA estimates of annual number of steelhead retained, local and non-local BC residents. Regression coefficients are provided in Table 17.

## 3.3. Dean River

### 3.3.1. Characteristics of the Fishery

Characteristics of the Dean River steelhead fishery and angler population are provided in Table A4 (Appendix III). Selected characteristics of the fishery and anglers, and how the values compare to other popular BC steelhead fisheries, appear in Table 18. For each characteristic, the percentile provides a relative placement of the value, in comparison to other fisheries. Percentiles range between 0 and 100; a greater percentile indicates the value is high relative to other fisheries.

The Dean River fishery displays the lowest proportion of local anglers and angler days of the popular fisheries considered. The proportions of angler and angler days contributed by non-local BC residents and non-residents are among the highest of all fisheries. For each residency class, the mean number of days fished per angler are in the top quartile, with the values for non-local BC anglers and non-residents among the highest for all fisheries. Finally, for all residency classes, Dean River anglers fish fewer other streams on average than anglers in almost all other popular BC steelhead fisheries.

**Table 18.**—Selected characteristics of the Dean River steelhead fishery and anglers, relative to other popular BC steelhead fisheries.

| Characteristic | Residency | Value | Percentile |
|---|---|---|---|
| Percentage of anglers | Local (L) | 9.2 | 1 |
| | BC Non-local (B) | 34.6 | 97 |
| | Non-resident (N) | 56.2 | 97 |
| Percentage of angler days | Local (L) | 9.9 | 1 |
| | BC Non-local (B) | 36.1 | 94 |
| | Non-resident (N) | 54.0 | 98 |
| Days per angler | Local (L) | 6.8 | 77 |
| | BC Non-local (B) | 6.6 | 100 |
| | Non-resident (N) | 6.1 | 96 |
| Number of streams angled | Local (L) | 1.7 | 3 |
| | BC Non-local (B) | 1.9 | 3 |
| | Non-resident (N) | 1.2 | 0 |

### 3.3.2. Relationship Between Field and SHA Parameter Estimates

The full Dean River dataset provides 11 to 23 comparable data pairs for examination of the relationships of field to SHA parameter estimates. Sample sizes and coefficients for the linear regressions describing these relationships are given in Table 19. The variability in the data and the linear regressions which describe the relationships are depicted graphically in Figure 20. For 4 of the 5 parameter relationships, estimated slopes are greater than one; 3 display positive y intercepts (Table 19). Similar to the province-wide dataset, however, the relatively large standard errors of regression coefficients indicate that relationships are poorly defined. Variability of the SHA estimates is high, relative to the range (spread) of field values. This is apparent from the plotted data, and the degree to which the robust regression fits differ from the conventional least squares regression coefficients (Table 19, Figure 20). Only for the total and released catch parameters do the coefficients appear well-determined and plausible.

**Table 19.**—Conventional least-squares and robust LTS regression coefficients describing the relationships between field creel study estimates (independent variable) and comparable SHA estimates (dependent variable), Dean River 1972-1995. LTS coefficients are shown in *italics*.

| Parameter | N | Slope | SE(slope) | Intercept | SE(Intercept) |
|---|---|---|---|---|---|
| **Anglers** | 11 | 1.292 | 1.988 | -9.7 | 1181.7 |
| | *7* | *1.484* | | *-133.7* | |
| **Angler Days** | 23 | 0.915 | 0.099 | 1201.8 | 347.3 |
| | *13* | *0.703* | | *1618.2* | |
| **All Catch** | 23 | 1.428 | 0.082 | 1193.8 | 263.7 |
| | *13* | *1.462* | | *845.0* | |
| **Retained** | 19 | 1.674 | 0.425 | -13.3 | 184.2 |
| | *11* | *1.276* | | *9.6* | |
| **Released** | 19 | 1.457 | 0.108 | 1053.9 | 261.5 |
| | *11* | *1.606* | | *644.7* | |

The restricted Dean River dataset (1985 to 1995) provides reduced sample sizes (number of data pairs), but reflects refined field procedures and presumably more accurate estimates than those obtained during the 1970s. Sample sizes and coefficients for the linear regressions describing the field / SHA estimate relationships are given in Table 20. The variability in the data and the linear regressions which describe the relationships are depicted graphically in Figure 21. However, as for the previously-considered Dean dataset, variability of the SHA estimates is high relative to the moderate spread of field values. The Dean River fishery has been relatively stable during the period represented by the restricted dataset. Only for the ‘retained catch’ parameter does the field data provide a wide range of values, and this is an artifact of institution of a mandatory release regulation on the river during the late 1980s.

**Table 20.**—Conventional least-squares and robust LTS regression coefficients describing the relationships between field creel study estimates (independent variable) and comparable SHA estimates (dependent variable), Dean River 1985-1995. LTS coefficients are shown in *italics*..

| Parameter | N | Slope | SE(slope) | Intercept | SE(Intercept) |
|---|---|---|---|---|---|
| **Anglers** | 7 | 0.409 | 7.80 | 563.3 | 4698.1 |
| | *5* | *0.857* | | *210.0* | |
| **Angler Days** | 11 | 0.468 | 0.38 | 3247.9 | 1678.0 |
| | *6* | *1.086* | | *58.7* | |
| **All Catch** | 11 | 1.662 | 0.21 | 306.8 | 835.4 |
| | *6* | *1.285* | | *1777.2* | |
| **Retained** | 7 | 1.266 | 2.66 | 7.5 | 266.2 |
| | | *NA* | | *NA* | |
| **Released** | 7 | 1.654 | 0.39 | 311.6 | 1347.1 |
| | | *1.613* | | *880.9* | |

Mean and median ratios of field study estimates to SHA estimates for Dean River datasets are tabulated in Table 21, as an alternative to the regression approach. For both datasets, means and medians for each parameter tend to agree closely. For most parameters, means or medians tend to be higher for the 1985-95 dataset, perhaps reflecting improved accuracy of the recent field estimates. Retained catch estimate ratios are of low utility due to the zero values for recent years. No immediate explanation is available for the increased discrepancy between field and SHA estimates of the number of anglers, for the 1985-95 dataset.

**Table 21.**—Ratios (as percentages) of field study estimates to comparable SHA estimates, for 5 fishery parameters, Dean River 1972 - 95 and 1985 - 95. **N** gives the number of data pairs; **Med** = median ratio; **Mean =** unweighted mean ratio; **Range** = minimum and maximum ratio.

| | **1972 - 1995 (%)** | | | | **1985 - 1995 (%)** | | | |
|---|---|---|---|---|---|---|---|---|
| **Parameter** | **N** | **Med** | **Mean** | **Range** | **N** | **Med** | **Mean** | **Range** |
| **Anglers** | 11 | 83 | 80 | 60 - 98 | 7 | 74 | 76 | 60 - 97 |
| **Angler Days** | 23 | 81 | 78 | 49 - 96 | 11 | 85 | 84 | 60 - 96 |
| **All Catch** | 23 | 55 | 53 | 38 - 71 | 11 | 58 | 58 | 49 - 67 |
| **Retained** | 19 | 66 | 52 | 0 - 87 | 7 | 0 | 25 | 0 - 78 |
| **Released** | 19 | 51 | 50 | 35 - 71 | 7 | 56 | 58 | 49 - 71 |

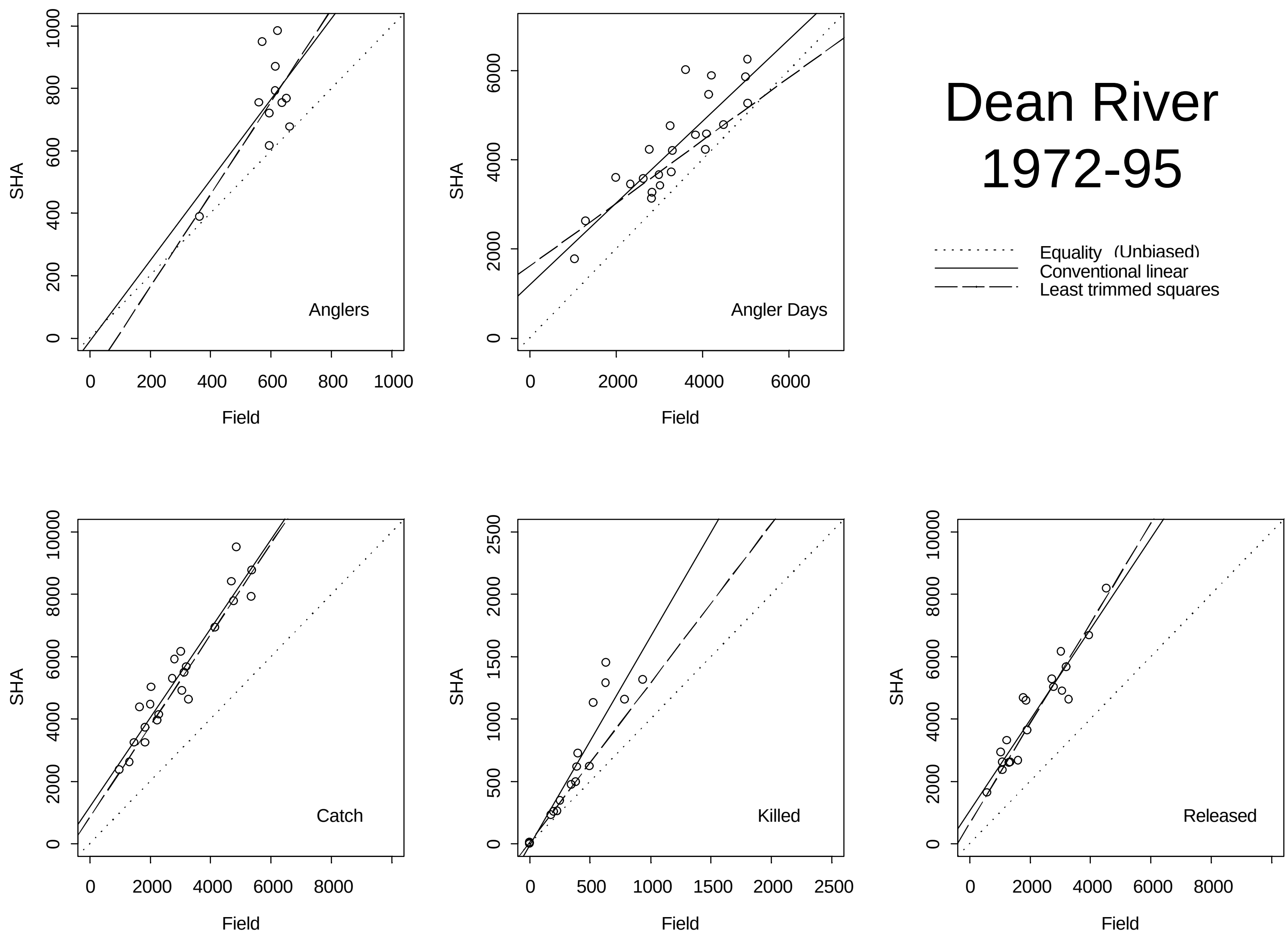



**Figure 20.**—Comparison of field creel study and SHA estimates for 5 fishery parameters, Dean River 1972 - 95. Depicted regressions are conventional least squares, and a method robust to outliers (least trimmed squares regression). Coefficients are given in Table 19.

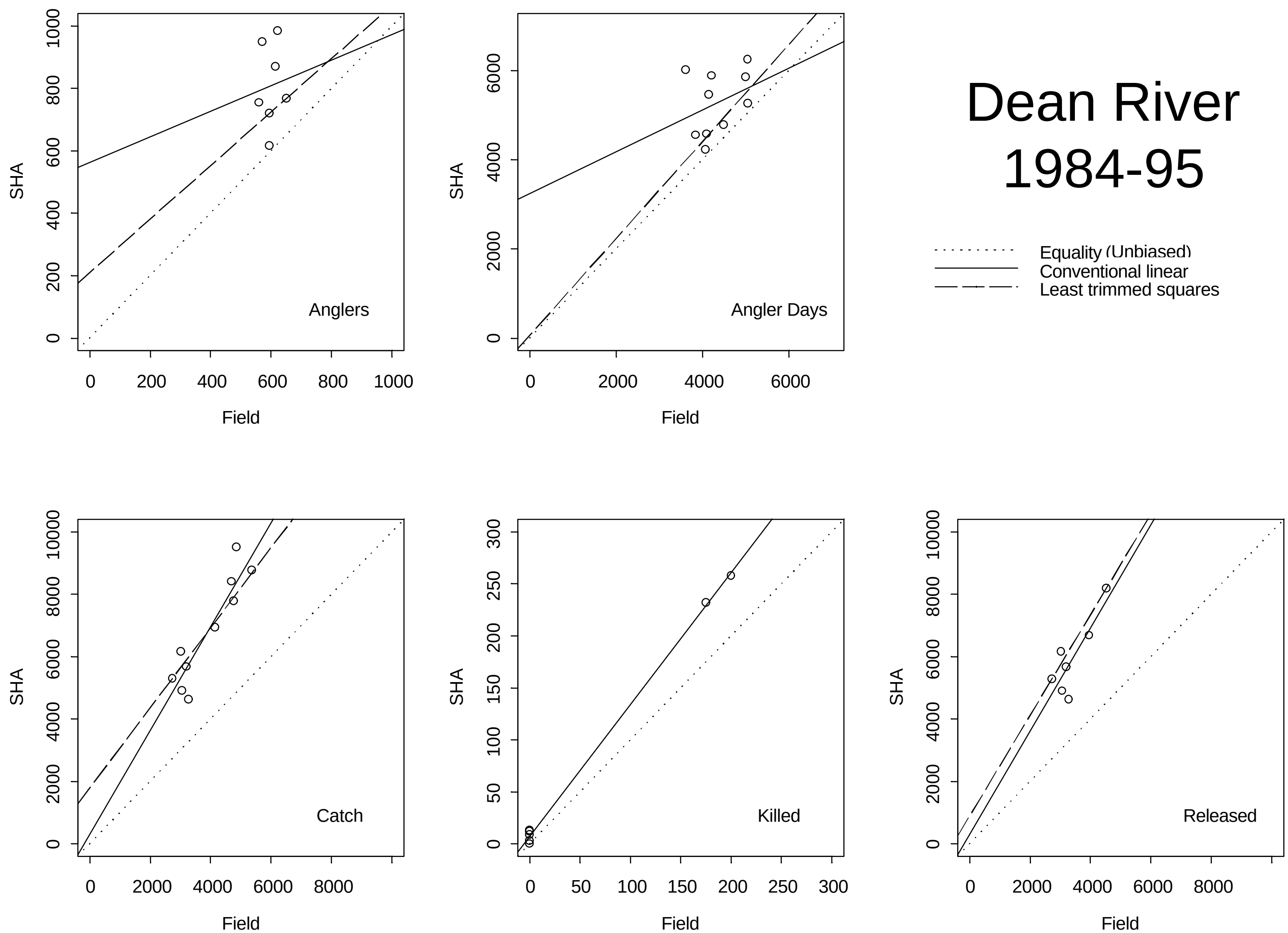



**Figure 21.**—Comparison of field creel study and SHA estimates for 5 fishery parameters, Dean River 1985-95. Depicted regressions include conventional least squares, and a method robust to outliers (least trimmed squares regression). Coefficients given in Table 20.

Finally, mean SHA and field estimates for the parameters of interest, for each of the 3 residency-pooled datasets, are given in Table 22. The conventional least squares regressions pass through the mean of the independent and dependent variable observations, so the means represent the ‘centre’ of the data and regression for each parameter. The ratio of the SHA to field estimate at the centre point is one measure of the mean discrepancy for the dataset. This constitutes a weighted mean, and if the relationship is linear with a non-zero intercept, the ratio is only valid at the centre itself. The mean discrepancies are presented as a simplified depiction of the typical difference in discrepancy between the three datasets. As expected, the province-wide dataset typically displays the highest discrepancy and the recent Dean dataset the lowest. Only for number of anglers does the complete Dean dataset present the lowest discrepancy. If the recent Dean field data are as accurate as believed, the mean discrepancies represent the approximate bias of the SHA-estimated Dean fishery parameters under current conditions.

**Table 22.**—Mean SHA and field estimates and weighted mean discrepancy for five fishery parameters. Results for 3 datasets are presented: **Province**-wide data, and the complete Dean and recent Dean data. Columns are: **SHA** = mean value of SHA estimates; **Field** = mean value of field estimates; **D** = weighted mean discrepancy, calculated as SHA/Field.

| | **Province** | | | **Dean 1972-95** | | | **Dean 1985-95** | | |
|---|---|---|---|---|---|---|---|---|---|
| | **SHA** | **Field** | **D** | **SHA** | **Field** | **D** | **SHA** | **Field** | **D** |
| **Anglers** | 866 | 611 | **1.42** | 752 | 590 | **1.28** | 809 | 601 | **1.35** |
| **Angler Days** | 4602 | 2904 | **1.58** | 4275 | 3358 | **1.27** | 5148 | 4263 | **1.21** |
| **Total Catch** | 3474 | 1769 | **1.96** | 5420 | 2960 | **1.83** | 6911 | 4044 | **1.71** |
| **Retained** | 492 | 269 | **1.83** | 548 | 336 | **1.63** | 75 | 54 | **1.41** |
| **Released** | 2592 | 1239 | **2.09** | 4225 | 2177 | **1.94** | 5930 | 3397 | **1.75** |

# 4. DISCUSSION

## 4.1. Precision of SHA Parameter Estimates

Imprecision in fishery parameter estimates from the SHA results from three main factors which interact in a variable manner:

1. response samples constitute a relatively small proportion of the angler population,
2. reported participation and success vary greatly among individual anglers, and
3. many fisheries are conducted by a relatively small number of individuals, with total activity and catch dominated by an even smaller number of anglers.

Random re-sampling of individual response data gave standard errors for SHA parameter estimates whose relative magnitude was inversely correlated with the estimated value of the parameter, as would be expected for such an estimator. Resulting 95% confidence interval widths varied from two times the parameter estimate for values at the lower margin of the range of estimate sizes, to roughly one-third the estimate at the upper margin. Precision varies substantially among the parameters and residency classes. Highest precision is achieved for non-resident estimates because of the higher sampling proportion applied. Of the directly estimated parameters, precision is lower for the catch parameters than for those related to effort, mainly due to higher underlying variance in the catch data.

The acceptability of an estimator's precision can only be judged with reference to its intended use. As far as could be determined, explicit consideration of the intended precision of SHA estimates has not been recorded in reports which document the survey. Assessment of whether the SHA is achieving the desired precision is therefor not possible. Precision is clearly correlated with sample size, and the trade-off with increased cost has always been an important factor in angler survey design. To the present, management application of SHA results by the Fisheries Branch has been relatively non-quantitative. In the current management arena, the desire to apply SHA estimates alongside statistics which are presumed more precise (e.g. Bulkley River AUP 1998) requires reconsideration of the precision of SHA results. Randomized re-sampling offers the opportunity to estimate SHA precision, as well as explore how precision might change under a different sampling regime. At a minimum, precision should be explicitly considered and discussed in a quantitative manner in any steelhead fishery management plan which proposes to apply SHA estimates for any purpose, be it trend-monitoring or otherwise. In reality, the issue of precision of SHA estimates will continue to be secondary to concerns about bias, which are discussed next.

## 4.2. Bias of SHA Parameter Estimates

Two types of biases have been repeatedly documented to affect the results of jurisdiction-wide mail angler surveys covering multiple months' activity: nonresponse bias and recall bias (Brown 1991). Limited evidence about how each of these sources of bias may influence SHA estimates is currently available. Follow-up contact results from 1978/79 and 1982/83 were reanalyzed for nonresponse bias, and a discussion of the implications is given in subsequent paragraphs of this section. Material is also available for assessing recall bias, in the form of a unique study conducted on the Thompson River in 1984. Results of the study are not presented under this cover, but the implications for recall bias gained by preliminary review of the dataset are discussed below.

### 4.2.1. Recall Bias

Long recall periods for mail and phone surveys typically result in overestimates of effort and catch (Brown 1991). Anglers experience difficulty referencing which time period their trips fell within, and they err on the side of including trips that fell outside a given time period (Brown 1991). Preliminary analysis of data from a unique study on the Thompson River in 1984 suggests that this is a factor which contributes substantially to upward bias of SHA results. During an intensive creel survey, angler licence numbers were recorded along with the data describing their activity on-river. Individual SHA responses could then be compared to on-site "real-time" data. Unfortunately, the field data are truncated or censored, meaning that potential activity after the final field check of an angler is unknown. A statistically valid adjustment for this factor was beyond the scope of this study, and prevented the summary and presentation of the comparative data here. As well, no means are available for assessing the effect of multiple-contact field studies such as the Thompson angler survey on the representativeness of corresponding SHA responses. Repeated questioning by creel survey technicians might be expected to influence anglers' ability to accurately recall their angling experience, but there is no evidence to confront this conjecture. However, the number of SHA respondents who reported angling the Thompson River in 1984 but were never detected by the creel survey was much higher than could have occurred by chance. The implication is that a significant number of anglers incorrectly recalled having angled the Thompson in 1984. It is clear that angler recall is a factor in the bias of SHA estimates, and it suggested that complete analysis of the 1984 Thompson dataset would provide a starting point for further investigation.

### 4.2.2. Nonresponse Bias

Reanalysis of follow-up contact data suggests that the typical nonresponse bias of SHA parameter estimates obtained by a single mailing tends to lie within the range of + 20 to + 30 %. Aggregate results from 1978/79 and 1982/83, as well as a limited set of water-specific results for 1978/79, display apparent first-result biases of this magnitude. Water-specific results displayed a wide range of apparent nonresponse bias. Individual response data were not available for either secondary-contact dataset, so no method was available for constructing confidence intervals for the apparent bias. Given the known variance in response data, the variability in apparent bias estimated from such data appears plausible. Recovery of the raw data from the 1978/79 study would allow estimation of the precision of water-specific results by simulation, as well as extension of the analysis to a larger number of individual waters than the 14 reported in the study. It might also allow investigation of whether nonresponse bias varies among residency groups, which could cause differential bias between rivers given the wide variation in residency composition of BC steelhead fisheries.

Survey bias stemming from the reduced tendency for less active and successful anglers to respond to voluntary questionnaires has been well documented in the fisheries management literature (Brown 1991). Although some studies have reported that respondent and non-respondent groups did not appear to differ with respect to the parameters of interest (Brown

1991), the balance of evidence suggests that nonresponse bias must be considered in any voluntary survey of angling activity and success. The follow-up contact reanalysis reported here confirms that the SHA estimates are subject to substantial nonresponse effects, and diverges from the original interpretation of the follow-up data which concluded that secondary contact indicated minimal nonresponse bias in the SHA (Ford and Narver 1979; Billings 1983). The original interpretation implicitly assumed that the secondary response data were representative of the entire population of nonrespondents to the first contact. The present analysis assumes that the results of secondary response are indicative of a trend in per-respondent parameter values, which would continue to change in a linear manner if the sample could be extended to all survey recipients. The interpretations are thus based on very different underlying models of angler behaviour and/or response probability. The unstated model of angler behaviour assumed by the original interpretation is easily rejected as unlikely. The model implied by the re-analysis (Filion's method) is also unstated, but is computational rather than statistical or probabilistic and may itself be no more plausible than the original one. In fact, the Filion estimator is unlikely to be unbiased, even were its implicit model accurate. The available data are derived from a single follow-up contact and thus do not allow assessment of linearity in per-respondent parameter values implied by Filion's method, which would require at least two follow-ups. Regardless, apparent linearity is still no guarantee of an accurate estimate. There are superficial similarities to the Leslie removal estimator of population size; removal data often appear quite linear while severely underestimating population size. The fact that the reanalyzed data provide estimates of SHA bias which are similar to other subjective ideas about bias, should not be interpreted as implying that the re-estimates are themselves accurate.

This discussion of apparent bias may seem to belabour the possible weaknesses of follow-up contact methods. Follow-up contact is certainly worthwhile, and could be used to generate SHA estimates which would be typically less biased than by the current method, without completely redesigning the SHA procedure or abandoning the perceived value of a time series of initial-contact SHA estimates as a long-term index of steelhead fishery characteristics. However, such an approach will do little to clarify the characteristics of the angler population which lead to such severe non-response bias, leaving unanswered the question of the remaining inaccuracy including recall bias. Sampling nonrespondents by an alternative contact method, such as by telephone, has been suggested as "the only sound method of estimating non-response bias" (Pollock et al. 1994). This approach neglects the possible effect of the contact method itself. It is easy to envision that some anglers might respond differently to an anonymous postal questionnaire than to a person-to-person telephone survey. A factorial design for initial and follow-up contact could alleviate this problem, and might be needed only occasionally to maintain an aggregate adjustment factor. In summary, a thorough review of the social science literature concerning the design of mail survey follow-up contact would be useful before an attempt to estimate or reduce bias in the SHA is undertaken by this method. Recovery of the raw data from the 1978/79 follow-up study would allow Monte Carlo simulation to be used to examine the precision of any proposed approach.

## 4.3. Net Bias: Comparison to Field Studies

Comparison of SHA estimates to field-based angler survey results was a prime motivator for this study. Such comparisons have typically documented large differences in fishery parameter estimates between the two methods. Compilation of all such comparative data was viewed as one potential approach to 'calibration' of the net bias from all sources for SHA estimates. In particular, the Dean River dataset was viewed as potentially providing an accurate standard for assessing SHA bias. For reasons discussed next, neither the Dean River dataset nor the province-wide dataset appear to be suited to assessment of SHA estimate bias.

### 4.3.1. Dean River

The Dean River series superficially appears to be the field survey dataset most suited to comparison with the SHA. The logistics of the fishery allow a near-complete tallying of effort and catch, with more than 25 years data compiled to the present and typical downward bias in the neighborhood of 5% or less. Data from early years of the full 1972-1995 dataset may have been less complete, due to unquantified activity by loggers and some guided anglers. However, since the mid-1980s, virtually all steelhead angling on the Dean has been tabulated. Weighted mean upward discrepancy of SHA to field estimates for the 1985-95 dataset (35% for number of anglers, 21% for number of angler days, 71% for total catch, 41% for retained catch, and 75% for released catch) might be interpreted as the best available estimates of SHA bias.

However, the Dean River series does not appear to provide an adequate calibration for the bias of SHA results for other provincial steelhead fisheries. Dean River fishery participants are not typical of provincial steelhead anglers, either in terms of their activity on the Dean or other factors which might affect their SHA responses, such as participation in other BC steelhead fisheries. The Dean River fishery lacks a substantial local angler component, which may reduce the severity of non-response bias. The majority of Dean participants angle steelhead in BC only on the Dean River in any one licence year. Most Dean River anglers make a single discrete trip to the river in a given year. As well, every angler completes a survey form at the end of a Dean River visit. Each of the latter 3 factors could serve to anchor the trip details more firmly in anglers' memories, easing recall bias. Finally, steelhead fisheries in British Columbia are highly variable, in terms of the effort and catch parameters estimated by the SHA. The relative stability of the Dean fishery limits the range of values it has displayed; the range is insufficient relative to the spread for other fisheries in British Columbia. In other words, extension of Dean results to other fisheries would require extrapolation far beyond values displayed by the Dean dataset. Such extrapolation would be statistically invalid and potentially dangerous by any standard of analysis.

### 4.3.2. Province-wide Dataset

In most cases across the province, SHA estimates of effort and catch are substantially greater than those resulting from field studies. The proportional discrepancy is higher for catch than effort, so the mean catch per effort (CPE) estimate from the SHA is typically higher than for field studies as well. This pattern was noted immediately and repeatedly in specific studies during the first decade of the SHA (e.g. Hemus 1974; Hooton 1976), and additional examples have been compiled to the present (e.g. Wilders 1995). The current report compiles all data available to present, and supports conclusions reached by previous authors.

The clear difficulty is that nearly all field-based surveys of BC steelhead fisheries have utilized techniques and designs which tend to create downward bias in their estimates of angling effort and catch. The methods used for such studies have not typically allowed estimation of the magnitude of the underestimation, which thus remains unknown and presumably quite variable. As a result, existing field survey data offer a poor baseline for assessing bias in the SHA. Simply put, SHA estimates are certainly biased upward, but field survey results have been predominantly biased downward, likely in an inconsistent fashion. Reality is somewhere between, but difficult to locate with any confidence by using the existing data.

More recently, BC steelhead angler surveys have tended to use designs with precision which is statistically well defined as long as sampling assumptions are met. Even among these studies, however, angling during the "shoulders" of the steelhead angling season or on less-utilized reaches has often remained unquantified, and distinction of anglers targeting other species has been problematic. Both factors limit their utility as a true baseline for comparison to the SHA. Only the collection of full-season spatially complete data limited to steelhead anglers will allow field studies to provide a convincing basis for assessment of SHA estimate bias.

## 4.4. Summary

Mail surveys are simple and relatively inexpensive for their breadth of scope (Brown 1991; Pollock et al. 1994). No other affordable method would be capable of providing regular and consistent information about the hundreds of spatially and temporally diffuse recreational fisheries for steelhead in British Columbia. The SHA has provided an ongoing time series of effort and catch estimates which has been a helpful reference for provincial fishery managers.

Even when biased, estimates of population parameters can be used as indices of the relevant parameter if bias is consistent (stable or stationary) with respect to time or other varying conditions. Available information provides minimal basis for assessing the validity of the SHA as a stable index of effort and catch. Recent evidence has failed to confirm one hypothesized time-linked source of downward bias, a decline in the proportion of steelhead anglers purchasing annual species licences. However, observations which address this issue (Tallman 1996; Morten and Parken 1998) have been made on classified waters, where possession of a steelhead stamp is required in order to obtain the mandatory classified water licence. These data thus do not confront the hypothesis that a declining proportion of local resident participants in unclassified steelhead fisheries are purchasing steelhead stamps.

Notwithstanding the previous discussion, the value of the SHA as a trend index cannot be judged in isolation from other (mis)uses of the survey parameter estimates. The SHA estimate series now represents the "best available information" about activity and harvest which have occurred during previous years. Maintaining such an information base without establishing its limitations is a potentially hazardous policy for any management agency. Brown (1991) is worth quoting extensively on this point:

> " *¼ the use of (annual single contact) data for trend purposes is a classic rationalization. The problem is that cheap, biased data are not cheap. They are barely affordable ¼ Socioeconomic data are most in demand when a policy issue, conflict or significant environmental impact occurs. In general, effort, harvest, expenditures or other economic valuation data are wanted immediately¾ there is neither time nor money for a new study. In this case, estimates from statewide mail surveys are used for want of anything better. Indeed, during a crisis, they may be regarded as numerically accurate. ¼ This is an example of the abuse of mail survey data.*"

The current steelhead fishery management arena offers three examples where application of upward-biased SHA parameter estimates could prove misleading or even damaging. First, use of SHA effort estimates to establish acceptable levels of activity on a particular water would be valid only under very restricted conditions, whereby SHA results would be understood to constitute an index only, with periodic assessment of stability of the index a necessity. Second, if SHA estimates were used alongside guide reports to establish the proportion of all angling activity conducted by guided anglers, this type of application must also be understood to provide a very rough index only and not an absolute proportion. In both cases, estimates of total activity obtained by methods other than the SHA could not be substituted. Third, SHA estimates of steelhead harvests sustained during the past would provide a badly unbalanced and potentially damaging standard for resumption of harvest in BC recreational steelhead fisheries. The general implication is that abandonment of the SHA time-series without attempting to address the issues of its bias and accuracy could prove even more destructive than a continuance of the present methodology, given the potential misuses of the data.

# 5. RECOMMENDATIONS

1. The Ministry of Fisheries and Ministry of Environment should reassess the desired accuracy of SHA estimates and the three-way tradeoff of cost, bias and precision. Regional staff should be consulted as to the potential applications for SHA data and the needs in terms of accuracy. Existing data and costs per questionnaire could then be used to examine scenarios for decreasing bias by including follow-up contact as an ongoing component of the SHA. Allocation of funding to follow-up contact could require lowering the first-mailing sample proportion, but the reduced precision might be acceptable when balanced against reduced bias.

2. SHA parameter estimates should be reported with their standard errors or confidence intervals. Standard errors could be most easily obtained by Monte Carlo methods such as the bootstrap, although an analytical approach might also be possible.

3. Data from the 1978/79 and 1982/83 follow-up contact should be recovered and subjected to complete re-analysis. Assessment of nonresponse bias for a large number of fisheries would provide a better basis for understanding this component of SHA inaccuracy. The data would also provide a basis for designing future follow-up contact to alleviate nonresponse bias.

4. Data from the 1984 Thompson River study should be thoroughly analyzed, for the understanding that it will provide about both recall bias and nonresponse bias. A statistically rigorous approach to alleviating truncation or censoring of the field data will be necessary.

5. A province-wide follow-up contact study should be conducted, using multiple contact methods within a factorial design, to more thoroughly assess the extent and properties of nonresponse bias. Design of the follow-up study should utilize the existing dataset to provide expectations of the statistical distributions involved, and explicitly-stated objectives for study power and estimate precision. The follow-up study should be conducted concurrently with at least one field-based study where angler activity and success can be matched with individual angler responses to the SHA.

6. SHA estimates of harvest and catch should be explicitly labeled as indices when cited in management contexts, until the (in)accuracy of the SHA is more fully understood. Particular care should be taken when SHA estimates are provided alongside effort and catch data from other sources.

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## APPENDIX I. BOOTSTRAP SOURCE CODE

```
Function SHABootstrap()

‘ get array of estimates (stream and year) to be made
SelStr = "SELECT DISTINCTROW [Estimates].[Year], [Estimates].[Stream] FROM [Estimates]"
Set dbs = CurrentDb
Set Datasets = dbs.OpenRecordset(SelStr, dbOpenSnapshot)
Fisheries = Datasets.GetRows(5000)
estimates = UBound(Fisheries, 2)
Set dbs = Nothing
Set Responses = Nothing

For dataset = 0 To estimates

  EYear = Fisheries(0, dataset): EStream = Fisheries(1, dataset)
  SelStr = "SELECT DISTINCTROW [SortedRawData].[RES_AREA], [SortedRawData].[DAYS],  [SortedRawData].[KILL],
[SortedRawData].[REL] FROM [SortedRawData]"
  WherePart = "WHERE [SortedRawData].[YEAR] = " & EYear & " AND [SortedRawData].[STREAM] = '" & _
      EStream & "'"
  SelStr = SelStr & WherePart

  Set dbs = CurrentDb
  Set Responses = dbs.OpenRecordset(SelStr, dbOpenSnapshot)
  records = Responses.GetRows(5000)
  NumRet = UBound(records, 2)
  Set dbs = Nothing
  Set Responses = Nothing

  '0 is RES_AREA, 1 is DAYS, 2 is KILL, 3 is REL
  'resampling by residency; next code looks at the sample, counts up lines in each res class
  Erase allres(): Erase allmeans(): Erase resRA(): ct = 0
  Erase sdRA(): Erase estRA(): Erase datRA(): Erase redatRA()

  resRA(0, 1) = 1: resRA(0, 2) = 0
  resRA(0, 0) = records(0, 0)
  For i = 1 To NumRet
    If records(0, i) <> records(0, i - 1) Then
      ct = ct + 1
      resRA(ct, 0) = records(0, i)
```

```
    resRA(ct, 2) = i
  End If
  resRA(ct, 1) = resRA(ct, 1) + 1
Next i

Lcl = DLookup("[REGION CODE]", "Lookup Stream Codes", "[STREAM CODE] = '" & EStream & "'")

'go through the res classes and make each estimate
For j = 0 To 9

  'col 0 is res type, col 1 is sample, col 2 is start line
  'Debug.Print j, resRA(j, 0), resRA(j, 1), resRA(j, 2)
  If resRA(j, 1) > 0 Then
    'if there are residents in this slot
    licences = DLookup("[LICENSEES]", "QUESTIONNAIRE STATISTICS", "[YEAR] = " & EYear & " AND [RES_AREACD]
             = '" & resRA(j, 0) & "'")
    respond = DLookup("[RESPONSES]", "QUESTIONNAIRE STATISTICS", "[YEAR] = " & EYear & " AND [RES_AREACD]
             = '" & resRA(j, 0) & "'")
    active = DLookup("[R_ACTIVE]", "QUESTIONNAIRE STATISTICS", "[YEAR] = " & EYear & " AND [RES_AREACD] =
             '" & resRA(j, 0) & "'")
    undelivered = DLookup("[UNDELIVERD]", "QUESTIONNAIRE STATISTICS", "[YEAR] = " & EYear & " AND
             [RES_AREACD] = '" & resRA(j, 0) & "'")
    mailed = DLookup("[MAILED]", "QUESTIONNAIRE STATISTICS", "[YEAR] = " & EYear & " AND [RES_AREACD] = '"
             & resRA(j, 0) & "'")

    'probabilistic approach to how many responses to generate
    ProbResp = respond / (mailed - undelivered)
    ProbActive = active / respond
    ProbRiver = resRA(j, 1) / active

    For k = 1 To numruns: ' for each simulation run
      expand = 0: responders = 0: activeresponders = 0
      For m = 1 To (mailed - undelivered)
        Randomize Timer
        If Rnd < ProbResp Then
          'response occurs
          responders = responders + 1
          Randomize Timer
          If Rnd < ProbActive Then
            'responder was active
            activeresponders = activeresponders + 1
```

```
            Randomize Timer
            If Rnd < ProbRiver Then
               Randomize Timer
               pick = Int(Rnd * (resRA(j, 1)))
               For n = 1 To 3
                 datRA(j, k, n) = datRA(j, k, n) + records(n, pick + resRA(j, 2))
               Next n
               datRA(j, k, 4) = datRA(j, k, 4) + 1
            End If
          End If
        End If
      Next m
     expand = licences / responders
     For n = 1 To 4
       datRA(j, k, n) = datRA(j, k, n) * expand
     Next n
    Next k: ' next sim run
  End If
Next j: 'next residency class

'reclassify residency and create totals
 For j = 0 To 9
    If resRA(j, 0) = Lcl Then
       resclass = 1: 'local
    ElseIf resRA(j, 0) = "9" Or resRA(j, 0) = "0" Or resRA(j, 0) = "A" Then
       resclass = 3: 'non-resident
    Else
       resclass = 2: 'BC-resident
    End If


    For k = 1 To numruns
      For m = 1 To 4: 'for each parameter
        redatRA(resclass, k, m) = redatRA(resclass, k, m) + datRA(j, k, m)
        redatRA(0, k, m) = redatRA(0, k, m) + datRA(j, k, m)
      Next m
    Next k
 Next j

     'tally each parameter
     For h = 0 To 3: 'for each res class
```

```
        For k = 1 To numruns: 'for each run result
          For m = 1 To 4: 'for each parameter
            'add to res class tally
            estRA(h, m) = estRA(h, m) + redatRA(h, k, m)
          Next m
        Next k
      Next h

      'loop thru parameters & res classes, estimate means
      For k = 0 To 3: 'for each res class
        For m = 1 To 4: ' for each parameter
            estRA(k, m) = estRA(k, m) / numruns
        Next m
      Next k

      'loop thru parameters & res classes & runs, estimate variance
      For k = 0 To 3: 'for each res class, including pooled
        For m = 1 To 4: ' for each parameter
            For n = 1 To numruns
              sdRA(k, m) = sdRA(k, m) + (redatRA(k, n, m) - estRA(k, m)) ^ 2
            Next n
        Next m
      Next k

      'loop thru parameters & res classes, estimate sd
      For k = 0 To 3: 'for each res class, including pooled
        For m = 1 To 4: ' for each parameter
           sdRA(k, m) = (sdRA(k, m) / numruns) ^ 0.5
        Next m
      Next k

‘write to output file code would be here

Next dataset

End Function
```

## APPENDIX II. FOLLOW-UP CONTACT

**Table A1.**—Reported results of follow-up contact in 1978/79, all waters combined. Reproduced from Table 2, Ford and Narver 1979. Total number of steelhead licences sold in 1978/79 was 24,599.

| Feature Compared | Mailings | | |
|---|---|---|---|
| | 1st | Combined 1st and 2nd | 2nd |
| Questionnaires mailed (less those returned undelivered) | 14,164 | 13,931 | 6,562 |
| Total response | 7,387 | 10,317 | 2,302 |
| Percent response | 52% | 74% | 35% |
| Percent of total licences sampled | 30% | 42% | 9% |
| Estimated number of anglers | 15,788 | 15,254 | 13,452 |
| Estimated number of successful anglers | 6,746 | 6,406 | 5,206 |
| Estimated number of fish killed | 14,700 | 14,190 | 12,268 |

**Table A2.**—Reported results of follow-up contact in 1978/79. Reproduced from Table 3, Ford and Narver 1979. Total number of steelhead licence sold in 1978/79 was 24,599. Only selected rivers' results were given in the original document.

| | Estimated no. anglers | | | Estimated days fished | | |
|---|---|---|---|---|---|---|
| **River** | **1st** | **2nd** | **1st & 2nd** | **1st** | **2nd** | **1st & 2nd** |
| Big Qualicum | 777 | 564 | 715 | 3,599 | 1,829 | 3,120 |
| Campbell | 670 | 466 | 625 | 4,239 | 2,345 | 3,851 |
| Cowichan | 1,413 | 1,160 | 1,347 | 10,371 | 7,191 | 9,538 |
| Gold | 510 | 428 | 512 | 2,647 | 2,333 | 2,827 |
| Nanaimo | 730 | 554 | 669 | 6,900 | 4,171 | 5,952 |
| Stamp | 306 | 259 | 298 | 2,206 | 1,272 | 1,943 |
| Englishman | 481 | 356 | 449 | 2,529 | 1,893 | 2,328 |
| Cheakamus | 680 | 526 | 623 | 3,164 | 2,424 | 2,855 |
| Fraser | 751 | 850 | 760 | 7,751 | 9,451 | 8,097 |
| Seymour | 356 | 227 | 325 | 2,564 | 2,348 | 2,474 |
| Vedder/Chilliwack | 1,130 | 801 | 1,036 | 6,381 | 4,406 | 5,984 |
| Squamish | 1,018 | 871 | 981 | 4,993 | 3,976 | 4,668 |
| Thompson | 1,841 | 1,571 | 1,788 | 9,797 | 8,594 | 9,670 |
| Bella Coola | 884 | 732 | 852 | 5,375 | 6,717 | 5,668 |

**Table A2** continued.—Reported results of follow-up contact in 1978/79.

| | Estimated kill | | | Estimated released | | |
|---|---|---|---|---|---|---|
| **River** | **1st** | **2nd** | **1st & 2nd** | **1st** | **2nd** | **1st & 2nd** |
| Big Qualicum | 384 | 77 | 308 | 513 | 128 | 420 |
| Campbell | 258 | 37 | 244 | 534 | 384 | 518 |
| Cowichan | 921 | 803 | 890 | 1,060 | 746 | 968 |
| Gold | 426 | 263 | 491 | 490 | 788 | 684 |
| Nanaimo | 711 | 636 | 659 | 921 | 475 | 773 |
| Stamp | 380 | 137 | 313 | 539 | 360 | 475 |
| Englishman | 321 | 237 | 317 | 440 | 647 | 471 |
| Cheakamus | 161 | 85 | 136 | 342 | 134 | 278 |
| Fraser | 196 | 322 | 219 | 40 | 102 | 51 |
| Seymour | 111 | 62 | 95 | 176 | 239 | 184 |
| Vedder/Chilliwack | 62 | 72 | 62 | 1,164 | 442 | 997 |
| Squamish | 339 | 395 | 347 | 612 | 998 | 682 |
| Thompson | 1,050 | 1,406 | 1,155 | 466 | 1,353 | 663 |
| Bella Coola | 849 | 571 | 765 | 983 | 725 | 914 |

**Table A3.**—Reported results of follow-up contact in 1982/83. Only Vancouver Island (Region 1) anglers received follow-up sampling. There were 4,532 steelhead licencees in the region; of these, 2624 were sent a questionnaire.

| | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| | **Response** | **Reported active** | **Active anglers % (C/B)** | **Estimated active anglers (AD)** | **Reported successful anglers** | **Successful anglers % (F/C)** | **Estimated successful anglers (EG)** |
| **1st mailing** | 1,046 | 666 | 64 | 2,887 | 428 | 64 | 1856 |
| **2nd mailing** | 470 | 244 | 52 | 2,352 | 146 | 60 | 1406 |
| **Telephone survey** | 52 | 32 | 62 | 2,787 | 22 | 69 | 2917 |
| **Combined results** | 1,568 | 942 | 60.1 | 2,724 | 596 | | 1724 |

## APPENDIX III. CHARACTERISTICS OF SELECTED STEELHEAD FISHERIES

**Table A4.**—Characteristics of 92 steelhead fisheries (streams) which experienced 95% of the steelhead effort in British Columbia during 1983/84 to 1995/96, as estimated by the SHA. **Reg** = BCE administrative region; **Type** refers to the composition of the fishery in terms of residency, coded as described in the report text; **Anglers** gives the estimated number of individuals who angled the stream, per year, by residency; **Angler Days** gives the estimated average annual total number of days of steelhead angling effort expended on the stream, by residency; **Anglers** gives the estimated average annual number of individuals who angled the stream, by residency; **Days Per Angler** gives the estimated average annual number of days angled per individual who angled the stream, by residency; **Streams Angled** gives the estimated average annual total number of streams angled by individuals who angled the stream, by residency. Residency classes are: **L** = (Local) resident of the same region in which the stream is located; **B** = British Columbia resident, not of the same region in which the stream is located; **N** = non-resident of British Columbia.

| | | | Anglers | | | Angler Days | | | | Days Per Angler | | | Streams Angled | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **STREAM** | **Reg** | **Type** | **L** | **B** | **N** | **L** | **B** | **N** | **Total** | **L** | **B** | **N** | **L** | **B** | **N** |
| AMOR DE COSMOS R | 1 | L | 53.9 | 5.5 | 2.5 | 118 | 9 | 4 | 130 | 2.2 | 1.7 | 1.4 | 4.9 | 6.5 | 5.7 |
| ASH R | 1 | L | 41.0 | 3.6 | 1.0 | 122 | 9 | 2 | 133 | 3.0 | 2.4 | 1.6 | 3.9 | 4.5 | 7.2 |
| BIG QUALICUM R | 1 | L | 460.2 | 158.9 | 15.6 | 2629 | 343 | 62 | 3034 | 5.7 | 2.2 | 4.0 | 3.6 | 4.7 | 3.2 |
| CAMPBELL R | 1 | L | 320.2 | 143.9 | 95.0 | 2212 | 608 | 286 | 3105 | 6.9 | 4.2 | 3.0 | 4.2 | 4.4 | 2.4 |
| CHEMAINUS R | 1 | L | 77.8 | 10.5 | 1.0 | 242 | 25 | 3 | 270 | 3.1 | 2.4 | 2.9 | 4.7 | 4.7 | 2.9 |
| CHINA CR | 1 | L | 54.3 | 9.1 | 0.8 | 205 | 17 | 1 | 223 | 3.8 | 1.9 | 1.6 | 4.4 | 6.4 | 2.6 |
| CLUXEWE R | 1 | L | 99.7 | 13.2 | 3.8 | 432 | 32 | 10 | 474 | 4.3 | 2.4 | 2.7 | 4.6 | 5.1 | 3.7 |
| COWICHAN R | 1 | L | 980.2 | 170.7 | 31.2 | 7936 | 491 | 99 | 8526 | 8.1 | 2.9 | 3.2 | 2.6 | 4.0 | 2.7 |
| ENGLISHMAN R | 1 | L | 341.3 | 90.0 | 8.4 | 1999 | 215 | 32 | 2246 | 5.9 | 2.4 | 3.8 | 3.9 | 5.5 | 3.6 |
| EVE R | 1 | L | 41.8 | 6.0 | 4.2 | 101 | 10 | 7 | 118 | 2.4 | 1.6 | 1.8 | 5.4 | 7.9 | 4.9 |
| GOLD R | 1 | LB | 410.5 | 222.7 | 85.6 | 1975 | 687 | 229 | 2890 | 4.8 | 3.1 | 2.7 | 4.0 | 4.7 | 2.7 |
| GOODSPEED R | 1 | L | 27.2 | 4.5 | 0.5 | 171 | 10 | 1 | 183 | 6.3 | 2.2 | 2.4 | 4.5 | 6.6 | 4.0 |
| HARRIS CR | 1 | L | 116.8 | 9.2 | 1.4 | 418 | 18 | 2 | 438 | 3.6 | 2.0 | 1.6 | 3.9 | 4.5 | 4.6 |
| HEBER R | 1 | L | 24.0 | 5.2 | 7.5 | 87 | 9 | 13 | 109 | 3.6 | 1.8 | 1.8 | 5.6 | 5.6 | 3.9 |
| KEOGH R | 1 | L | 124.8 | 29.2 | 2.4 | 521 | 73 | 5 | 600 | 4.2 | 2.5 | 2.3 | 4.5 | 4.7 | 4.5 |
| KOKISH R | 1 | L | 37.4 | 4.2 | 1.9 | 129 | 6 | 9 | 145 | 3.5 | 1.5 | 4.7 | 4.8 | 4.4 | 4.2 |

**Table A4** continued.—Characteristics of 92 steelhead fisheries (streams) which experienced 95% of the steelhead effort in British Columbia during 1983/84 to 1995/96, as estimated by the SHA.

| | | | Anglers | | | Angler Days | | | | Days Per Angler | | | Streams Angled | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **STREAM** | **Reg** | **Type** | **L** | **B** | **N** | **L** | **B** | **N** | **Total** | **L** | **B** | **N** | **L** | **B** | **N** |
| KOKSILAH R | 1 | L | 48.7 | 1.3 | 0.3 | 213 | 6 | 1 | 219 | 4.4 | 4.4 | 1.8 | 3.6 | 3.4 | 2.0 |
| LITTLE QUALICUM R | 1 | L | 512.8 | 198.5 | 14.9 | 3374 | 542 | 49 | 3965 | 6.6 | 2.7 | 3.3 | 3.7 | 4.9 | 3.8 |
| MAHATTA CR | 1 | L | 31.4 | 4.5 | 1.2 | 53 | 8 | 2 | 62 | 1.7 | 1.7 | 1.3 | 5.0 | 4.4 | 7.0 |
| MARBLE R | 1 | L | 63.2 | 17.5 | 10.6 | 253 | 49 | 23 | 325 | 4.0 | 2.8 | 2.2 | 5.7 | 5.7 | 3.8 |
| NAHMINT R | 1 | L | 34.0 | 4.6 | 0.9 | 75 | 11 | 1 | 87 | 2.2 | 2.4 | 1.6 | 4.4 | 5.1 | 6.5 |
| NAHWITTI R | 1 | L | 63.0 | 17.1 | 2.0 | 208 | 34 | 4 | 246 | 3.3 | 2.0 | 1.8 | 5.4 | 5.3 | 4.9 |
| NANAIMO R | 1 | L | 389.2 | 69.7 | 8.5 | 3394 | 161 | 15 | 3570 | 8.7 | 2.3 | 1.8 | 3.4 | 4.9 | 3.2 |
| NIMPKISH R | 1 | L | 117.0 | 30.2 | 7.5 | 650 | 63 | 14 | 728 | 5.6 | 2.1 | 1.9 | 5.4 | 6.0 | 5.5 |
| NITINAT R | 1 | L | 56.5 | 8.1 | 1.9 | 137 | 11 | 4 | 153 | 2.4 | 1.4 | 2.0 | 4.7 | 7.3 | 3.5 |
| OYSTER R | 1 | L | 246.8 | 47.0 | 12.7 | 1178 | 119 | 29 | 1327 | 4.8 | 2.5 | 2.3 | 4.4 | 5.5 | 4.4 |
| PUNTLEDGE R | 1 | L | 99.8 | 15.0 | 2.6 | 685 | 45 | 4 | 734 | 6.9 | 3.0 | 1.6 | 4.5 | 5.0 | 4.2 |
| QUATSE R | 1 | L | 195.8 | 51.3 | 5.8 | 1476 | 204 | 23 | 1703 | 7.5 | 4.0 | 4.0 | 3.8 | 4.4 | 4.0 |
| QUINSAM R | 1 | L | 491.5 | 133.5 | 26.7 | 4543 | 475 | 88 | 5105 | 9.2 | 3.6 | 3.3 | 3.5 | 4.6 | 3.3 |
| SALMON R | 1 | L | 173.0 | 36.8 | 22.0 | 628 | 119 | 56 | 803 | 3.6 | 3.2 | 2.5 | 4.9 | 5.0 | 3.9 |
| SAN JUAN R | 1 | L | 92.8 | 7.5 | 3.5 | 273 | 10 | 8 | 291 | 2.9 | 1.3 | 2.4 | 4.0 | 5.0 | 5.3 |
| SARITA R | 1 | L | 44.8 | 5.1 | 1.2 | 117 | 8 | 1 | 126 | 2.6 | 1.5 | 1.1 | 4.5 | 4.4 | 4.0 |
| SOMASS R | 1 | L | 267.8 | 70.7 | 17.8 | 2294 | 221 | 50 | 2566 | 8.6 | 3.1 | 2.8 | 3.0 | 3.4 | 2.1 |
| SOOKE R | 1 | L | 73.8 | 4.3 | 0.8 | 321 | 8 | 4 | 332 | 4.3 | 1.9 | 4.3 | 3.6 | 5.1 | 2.6 |
| SPROAT R | 1 | L | 120.4 | 21.8 | 5.7 | 687 | 41 | 15 | 743 | 5.7 | 1.9 | 2.6 | 3.5 | 5.3 | 2.4 |
| STAMP R | 1 | L | 917.0 | 537.4 | 97.2 | 6776 | 1750 | 307 | 8832 | 7.4 | 3.3 | 3.2 | 3.0 | 3.6 | 2.2 |
| WAUKWAAS CR | 1 | L | 61.6 | 4.2 | 1.2 | 159 | 7 | 2 | 168 | 2.6 | 1.7 | 1.9 | 5.0 | 5.9 | 7.0 |
| ALOUETTE R | 2 | L | 572.5 | 7.1 | 0.6 | 5062 | 18 | 2 | 5082 | 8.8 | 2.6 | 2.9 | 3.3 | 4.0 | 3.3 |
| ASHLU CR | 2 | L | 62.2 | 1.5 | - | 165 | 2 | 0 | 167 | 2.7 | 1.5 | - | 5.9 | 6.4 | - |
| CAMPBELL R | 2 | L | 178.2 | 2.2 | 1.1 | 1642 | 7 | 4 | 1654 | 9.2 | 3.1 | 3.9 | 2.8 | 2.3 | 2.4 |
| CAPILANO R | 2 | L | 443.4 | 4.4 | 2.1 | 3160 | 15 | 8 | 3184 | 7.1 | 3.5 | 4.0 | 4.0 | 4.6 | 3.4 |
| CHAPMAN CR | 2 | L | 31.5 | 1.4 | - | 208 | 9 | 0 | 217 | 6.6 | 6.6 | - | 3.6 | 2.5 | - |

**Table A4** continued.—Characteristics of 92 steelhead fisheries (streams) which experienced 95% of the steelhead effort in British Columbia during 1983/84 to 1995/96, as estimated by the SHA.

| | | | Anglers | | | Angler Days | | | | Days Per Angler | | | Streams Angled | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **STREAM** | **Reg** | **Type** | **L** | **B** | **N** | **L** | **B** | **N** | **Total** | **L** | **B** | **N** | **L** | **B** | **N** |
| CHEAKAMUS R | 2 | L | 426.4 | 16.5 | 3.8 | 1751 | 60 | 8 | 1818 | 4.1 | 3.6 | 2.0 | 4.6 | 5.6 | 3.0 |
| CHEHALIS R | 2 | L | 1202.7 | 30.0 | 9.0 | 6441 | 68 | 32 | 6542 | 5.4 | 2.3 | 3.6 | 3.1 | 4.0 | 2.4 |
| CHILLIWACK R | 2 | L | 4732.0 | 166.6 | 89.7 | 46226 | 666 | 570 | 47462 | 9.8 | 4.0 | 6.4 | 2.2 | 2.8 | 1.8 |
| COQUIHALLA R | 2 | L | 194.9 | 19.0 | 6.0 | 709 | 42 | 12 | 763 | 3.6 | 2.2 | 2.0 | 3.7 | 3.9 | 2.2 |
| COQUITLAM R | 2 | L | 110.8 | 1.2 | 0.5 | 711 | 3 | 1 | 715 | 6.4 | 2.3 | 2.8 | 4.3 | 4.3 | 4.3 |
| FRASER R | 2 | L | 716.5 | 49.8 | 15.4 | 8876 | 315 | 72 | 9263 | 12.4 | 6.3 | 4.7 | 1.9 | 2.0 | 1.8 |
| HARRISON R | 2 | L | 43.0 | 2.2 | 0.5 | 193 | 10 | 1 | 203 | 4.5 | 4.3 | 2.0 | 3.9 | 2.8 | 3.0 |
| KANAKA CR | 2 | L | 113.6 | 2.6 | 0.2 | 670 | 7 | 0 | 677 | 5.9 | 2.7 | 1.0 | 4.6 | 5.3 | 3.0 |
| MAMQUAM R | 2 | L | 68.6 | 2.3 | 0.2 | 228 | 9 | 0 | 237 | 3.3 | 3.9 | 2.0 | 5.8 | 5.3 | 5.0 |
| NAHATLATCH R | 2 | LB | 39.3 | 11.0 | 0.5 | 99 | 26 | 0 | 125 | 2.5 | 2.4 | 1.0 | 4.4 | 3.2 | 2.0 |
| NICOMEKL R | 2 | L | 94.5 | - | - | 696 | 0 | 0 | 696 | 7.4 | - | - | 3.2 | 3.5 | - |
| NORRISH CR | 2 | L | 58.6 | 0.8 | - | 189 | 1 | 0 | 189 | 3.2 | 1.0 | - | 4.8 | 7.3 | - |
| SEYMOUR R | 2 | L | 531.9 | 14.7 | 2.2 | 3922 | 37 | 16 | 3974 | 7.4 | 2.5 | 7.0 | 3.9 | 4.3 | 4.2 |
| SILVERHOPE CR | 2 | L | 77.8 | 4.5 | 1.1 | 297 | 10 | 2 | 309 | 3.8 | 2.2 | 1.6 | 4.7 | 5.8 | 2.8 |
| SQUAMISH R | 2 | L | 448.5 | 17.5 | 8.8 | 1493 | 39 | 25 | 1557 | 3.3 | 2.3 | 2.8 | 4.3 | 5.8 | 3.0 |
| STAVE R | 2 | L | 68.3 | 2.4 | 0.5 | 341 | 5 | 1 | 346 | 5.0 | 2.1 | 1.3 | 4.3 | 4.3 | 3.3 |
| THOMPSON R | 3 | BL | 330.5 | 1200.9 | 231.9 | 2007 | 5347 | 1262 | 8615 | 6.1 | 4.5 | 5.4 | 1.3 | 2.7 | 1.8 |
| ATNARKO R | 5 | LB | 70.5 | 47.8 | 24.1 | 307 | 165 | 91 | 564 | 4.4 | 3.5 | 3.8 | 2.0 | 2.5 | 1.9 |
| BELLA COOLA R | 5 | LB | 211.9 | 144.3 | 75.6 | 1200 | 723 | 388 | 2311 | 5.7 | 5.0 | 5.1 | 1.6 | 1.8 | 1.4 |
| CHILCOTIN R | 5 | L | 117.8 | 43.5 | 7.5 | 411 | 107 | 21 | 538 | 3.5 | 2.5 | 2.7 | 1.8 | 2.6 | 2.3 |
| CHUCKWALLA R | 5 | NB | 1.8 | 13.2 | 27.2 | 11 | 66 | 85 | 162 | 5.7 | 5.0 | 3.1 | 2.8 | 2.2 | 1.7 |
| DEAN R | 5 | NB | 73.8 | 276.0 | 448.6 | 501 | 1827 | 2735 | 5063 | 6.8 | 6.6 | 6.1 | 1.7 | 1.9 | 1.2 |
| BABINE R | 6 | NBL | 85.2 | 103.2 | 278.2 | 540 | 541 | 1571 | 2652 | 6.3 | 5.2 | 5.6 | 2.8 | 2.5 | 1.5 |
| BULKLEY R | 6 | LNB | 552.1 | 391.0 | 398.0 | 4804 | 1705 | 1976 | 8485 | 8.7 | 4.4 | 5.0 | 2.1 | 2.5 | 2.0 |
| COPPER CR | 6 | L | 49.7 | 21.2 | 7.3 | 306 | 60 | 23 | 389 | 6.2 | 2.8 | 3.1 | 3.0 | 3.8 | 3.5 |
| CRANBERRY R | 6 | BL | 72.0 | 82.9 | 22.9 | 229 | 261 | 81 | 572 | 3.2 | 3.2 | 3.5 | 3.7 | 2.2 | 2.3 |
| DEENA CR | 6 | LB | 30.7 | 17.9 | 3.2 | 99 | 48 | 9 | 155 | 3.2 | 2.7 | 2.8 | 3.9 | 3.3 | 3.3 |

**Table A4** continued.—Characteristics of 92 steelhead fisheries (streams) which experienced 95% of the steelhead effort in British Columbia during 1983/84 to 1995/96, as estimated by the SHA.

| | | | **Anglers** | | | **Angler Days** | | | | **Days Per Angler** | | | **Streams Angled** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **STREAM** | **Reg** | **Type** | **L** | **B** | **N** | **L** | **B** | **N** | **Total** | **L** | **B** | **N** | **L** | **B** | **N** |
| HONNA R | 6 | L | 35.4 | 6.5 | - | 143 | 15 | 0 | 158 | 4.0 | 2.3 | - | 3.1 | 2.7 | - |
| ISHKHEENICKH R | 6 | L | 45.8 | 10.5 | 3.2 | 156 | 36 | 7 | 199 | 3.4 | 3.4 | 2.1 | 4.1 | 2.9 | 4.8 |
| KISPIOX R | 6 | NL | 146.5 | 130.0 | 296.6 | 687 | 441 | 1646 | 2773 | 4.7 | 3.4 | 5.5 | 3.1 | 3.4 | 2.3 |
| KITEEN R | 6 | L | 26.8 | 6.8 | 2.7 | 63 | 13 | 9 | 85 | 2.3 | 1.9 | 3.5 | 4.2 | 2.3 | 2.9 |
| KITIMAT R | 6 | L | 626.0 | 194.2 | 68.8 | 5765 | 774 | 319 | 6858 | 9.2 | 4.0 | 4.6 | 2.0 | 2.3 | 2.2 |
| KITSUMKALUM R | 6 | L | 420.4 | 92.8 | 29.1 | 2937 | 295 | 110 | 3342 | 7.0 | 3.2 | 3.8 | 3.0 | 3.1 | 2.5 |
| KLOIYA R | 6 | L | 68.2 | 13.2 | 0.3 | 632 | 82 | 1 | 715 | 9.3 | 6.2 | 4.0 | 2.6 | 3.7 | 4.3 |
| KWINAMASS R | 6 | L | 26.8 | 6.4 | 4.1 | 86 | 21 | 15 | 122 | 3.2 | 3.3 | 3.7 | 3.3 | 2.3 | 1.5 |
| LAKELSE R | 6 | L | 306.3 | 102.5 | 42.2 | 2077 | 345 | 200 | 2622 | 6.8 | 3.4 | 4.7 | 3.2 | 3.1 | 2.9 |
| MAMIN R | 6 | L | 54.3 | 8.8 | 2.2 | 238 | 19 | 5 | 262 | 4.4 | 2.1 | 2.2 | 2.9 | 4.5 | 2.5 |
| MEZIADIN R | 6 | L | 27.5 | 6.2 | 3.5 | 103 | 12 | 13 | 129 | 3.8 | 2.0 | 3.6 | 3.3 | 3.0 | 2.9 |
| MORICE R | 6 | LBN | 255.9 | 218.1 | 160.3 | 1878 | 932 | 729 | 3538 | 7.3 | 4.3 | 4.5 | 2.0 | 2.2 | 2.2 |
| NASS R | 6 | LBN | 41.8 | 23.0 | 17.9 | 154 | 71 | 65 | 290 | 3.7 | 3.1 | 3.6 | 3.5 | 2.3 | 2.3 |
| PALLANT CR | 6 | L | 39.2 | 13.4 | 5.8 | 233 | 42 | 15 | 290 | 5.9 | 3.1 | 2.6 | 3.5 | 4.2 | 3.1 |
| SKEENA R | 6 | L | 713.1 | 372.9 | 327.0 | 6923 | 1772 | 2162 | 10857 | 9.7 | 4.8 | 6.6 | 2.3 | 1.9 | 1.7 |
| SUSKWA R | 6 | LN | 29.7 | 18.2 | 20.2 | 126 | 39 | 46 | 211 | 4.2 | 2.2 | 2.3 | 3.7 | 4.2 | 4.1 |
| SUSTUT R | 6 | NB | 11.7 | 46.2 | 64.2 | 68 | 165 | 366 | 600 | 5.9 | 3.6 | 5.7 | 3.8 | 1.4 | 1.4 |
| TAHLTAN R | 6 | L | 32.2 | 7.2 | 5.3 | 120 | 19 | 15 | 154 | 3.7 | 2.6 | 2.8 | 1.6 | 1.7 | 1.5 |
| TLELL R | 6 | L | 82.7 | 19.1 | 4.4 | 387 | 45 | 8 | 440 | 4.7 | 2.4 | 1.7 | 2.6 | 3.1 | 3.3 |
| TSEAX R | 6 | L | 75.9 | 26.0 | 15.4 | 247 | 69 | 45 | 361 | 3.3 | 2.7 | 2.9 | 4.3 | 3.2 | 3.1 |
| YAKOUN R | 6 | L | 314.5 | 112.6 | 21.5 | 2129 | 388 | 84 | 2601 | 6.8 | 3.4 | 3.9 | 2.1 | 2.6 | 2.1 |
| ZYMOETZ R | 6 | L | 263.4 | 100.2 | 73.5 | 1550 | 294 | 302 | 2146 | 5.9 | 2.9 | 4.1 | 3.4 | 3.5 | 2.9 |

## APPENDIX IV. FIELD SURVEY DETAILS

**Table A5.**—Additional detail from steelhead angler survey reports. **Year** gives the licence year of the survey.

| Water | Year | Temporal details | Spatial and other survey details | Reference |
|---|---|---|---|---|
| Atnarko & Bella Coola | 76/77 | Daily checks 1-Nov-76 to 31-Jan-77; two weekdays and both weekend days each week during Feb and most of Mar, daily checks from late Mar through May. Results traverse licence year bound but could be partitioned. | Chinook anglers not separated from steelhead anglers. Subjective upward adjustment of 10% for Apr and 30% for May. | Wilkinson 1978a |
| Atnarko & Bella Coola | 77/78 | 15-Oct to 5-Dec-77 and 23-Mar to 31-May-78, daily checks. Results traverse licence year break, but could be partitioned. | May chinook anglers not separated from steelhead anglers. Subjective upward adjustment of 10% for Apr 1 to 15, 15% for Apr 16 to 30, and 30% for May. Total of 3355 days directly censused. | Wilkinson 1978b |
| Babine | 76/77 | Unknown | Unknown | Narver 1978 |
| Big Qualicum | 76/77 | 1-Dec-76 to 30-Apr-77. Unclear if full season coverage. | 447 respondents; did not enumerate all anglers so cannot extrapolate to total. | Hooton and Lewynsky 1985 |
| Big Qualicum | 77/78 | 1-Dec-76 to 30-Apr-77. Unclear if full season coverage. | Survey methodology described in report (Hooton 1977) not available ATP. Count of all observed angler days was 2856. | Hooton and Lewynsky 1985 |
| Big Qualicum | 78/79 | 1-Dec-78 to 30-Apr-79. Unclear if full season coverage. Results traverse licence year bound but could be partitioned. | Survey methodology described in report (Hooton 1977) not available ATP. Count of all observed angler days was 2990. Response 80%. Extrapolation of hours, kill and release not made. | Hooton and Lewynsky 1985 |

**Table A5.** continued**.—**Additional detail from steelhead angler survey reports. **Year** gives the licence year of the survey.

| **Water** | **Year** | **Temporal details** | **Spatial and other survey details** | **Reference** |
|---|---|---|---|---|
| Big Qualicum | 79/80 | 1-Dec-79 to 30-Apr-80. Unclear if full season coverage. Results traverse licence year bound but could be partitioned. | Survey methodology described in Hooton (1977)not available ATP. Count of all observed angler days was 1974; response 70%. Extrapolation of hours, kill and release not made. | Hooton and Lewynsky 1985 |
| Big Qualicum | 80/81 | 1-Dec-80 to 30-Apr-81. Unclear if full season coverage. | Survey methodology described in Hooton (1977) not available ATP. Total of 203 respondents, no count of other observed angler days so cannot extrapolate to complete estimate. | Hooton and Lewynsky 1985 |
| Bulkley | 69/70 | Oct and Nov 69. Total of 12 days checked. | | Pinsent 1970 |
| Bulkley | 74/75 | | Mainly an opinion survey. | Remington 1974 |
| Bulkley | 82/83 | Temporal coverage undocumented. Weekday/weekend stratification. | Skeena confluence to Mile 3 on Morice River by jet boat. 701 angler days actually checked. This year's study is poorly documented in the report. No attempt to extrapolate to total catch. | O'Neill and Whately 1984 |
| Bulkley | 83/84 | 26-Aug-83 to 20-Nov-83. Weekday/weekend stratification. | Chicken Creek to Mile 3 on Morice River by jet boat, exclusive of Quick to Walcott. 2676 angler-days checked. Unclear how final totals were calculated. | O'Neill and Whately 1984 |
| Bulkley | 89/90 | 1-Sep to 31-Oct-89. | | Lewynsky and Olmsted 1990 |
| Campbell | 75/76 | 1-Dec-75 to 18-Apr-76. Did not cover the entire season. Season stratified into 10 periods. Day stratified into 2-hr periods; sampled 14 days per month, with 2 or 3 randomly-selected periods sampled on each day. | Assumption of angler day as 2 hr based on subsampling, unknown validity. | Carswell et al. 1986 |

**Table A5.** continued**.—**Additional detail from steelhead angler survey reports. **Year** gives the licence year of the survey.

| Water | Year | Temporal details | Spatial and other survey details | Reference |
|---|---|---|---|---|
| Campbell | 76/77 | 17-Nov-76 to 31-Mar-77. Did not cover the entire season. Season stratified into 10 periods. Day stratified into 2-hr periods; sampled 20 days per month, 4 periods between 08:00 and 17:00 on each day. | Assumption of angler day as 2 hr based on subsampling, unknown validity. | Carswell et al. 1986 |
| Campbell | 77/78 | 15-Nov-77 to 31-Mar-78. Did not cover the entire season. Season stratified into 10 periods. Day stratified into 2-hr periods; sampled 20 days per month, 4 periods between 08:00 and 17:00 on each day. | Assumption of angler day as 2 hr based on subsampling, unknown validity. | Carswell et al. 1986 |
| Campbell | 78/79 | 17-Nov-78 to 31-Mar-79. Did not cover the entire season. Season stratified into 10 periods. Day stratified into 2-hr periods; sampled 20 days per month, 4 periods between 08:00 and 17:00 on each day. | Assumption of angler day as 2 hr based on subsampling, unknown validity. | Carswell et al. 1986 |
| Campbell | 79/80 | 15-Nov-79 to 31-Mar-80. Did not cover the entire season. Season stratified into 10 periods. Day stratified into 2-hr periods; sampled 16 days per month, 4 periods between 08:00 and 17:00 on each day. | Assumption of angler day as 2 hr based on subsampling, unknown validity. | Carswell et al. 1986 |
| Chilko & Chilcotin | 72/73 | Fall and spring, 5 to 8 randomly selected days per month; weekend/weekday strata. | Between TH Ranch and the Chilko-Taseko junction. | Spence 1978 |
| Chilko & Chilcotin | 73/74 | Spring only, 5 to 8 randomly selected days per month; weekend/weekday strata. | Between TH Ranch and the Chilko-Taseko junction. | Spence 1978 |

**Table A5.** continued.—Additional detail from steelhead angler survey reports. **Year** gives the licence year of the survey.

| Water | Year | Temporal details | Spatial and other survey details | Reference |
|---|---|---|---|---|
| Chilko & Chilcotin | 75/76 | Spring only, 5 to 8 randomly selected days per month. Weekend/weekday strata. | Between TH Ranch and the Chilko-Taseko junction. | Spence 1978 |
| Chilko & Chilcotin | 76/77 | Fall and spring; 5 to 8 randomly selected days per month in Mar and 5 days per week in Apr; weekend/weekday strata. | Between TH Ranch and the Chilko-Taseko junction. | Spence 1978 |
| Chilko & Chilcotin | 77/78 | 3-Oct to 17-Nov-77; weekend/weekday strata. | Between TH Ranch and the Chilko-Taseko junction. | Spence 1978 |
| Chilko & Chilcotin | 78/79 | 7-Oct to 12-Nov-78 (rivers closed 31 Dec); twice-daily coverage of Chilcotin; Chilko every second day. | Entire Chilcotin; between mouth and Siwash Bridge on the Chilko. Reconciled logbooks with on-site activity checks. | Bell 1979 |
| Chilko & Chilcotin | 79/80 | 6-Oct to 12-Nov-79 with spot checks until 24-Nov; closed 31-Dec. Weekend coverage on Chilko; twice-daily coverage on the Chilcotin. | Chilko from its mouth to Chilko-Taseko junction; Chilcotin between Hanceville Bridge and the mouth of the Chilko. Reconciled logbooks with on-site checks. | Bell 1980 |
| Chilko & Chilcotin | 80/81 | 4-Oct to 15-Nov-80, cursory checks until 22-Nov; river closed 31-Dec. Once or twice-daily coverage 3 weekdays and 2 weekend days per week on Chilcotin, weekend coverage on Chilko. | Chilko from its mouth to Chilko-Taseko junction; Chilcotin between Hanceville Bridge and the mouth of the Chilko. Reconciled logbooks with on-site activity checks. | Bell 1981 |
| Chilko & Chilcotin | 81/82 | 4-Oct to 6-Dec-81, river closed 31-Dec. Once or twice-daily coverage 3 weekdays and 2 weekend days per week; Chilko weekend coverage only during same period. | Chilko from its mouth to Chilko-Taseko junction; Chilcotin between Hanceville Bridge and the mouth of the Chilko. Reconciled logbooks with on-site activity checks. | Bell and Kirsebom 1982 |
| Chilko & Chilcotin | 82/83 | 9-Oct to 27-Nov-82 (river closed 31-Dec). Once or twice-daily coverage 3 weekdays and 2 weekend days per week. | Reconciled logbooks with on-site activity checks. | Evans 1983a |

**Table A5.** continued**.—**Additional detail from steelhead angler survey reports. **Year** gives the licence year of the survey.

| Water | Lic Yr | Temporal details | Spatial and other survey details | Reference |
|---|---|---|---|---|
| Chilko & Chilcotin | 83/84 | 6-Oct to 4-Dec-83, on 'a few randomly selected' weekdays, one or two weekend days per week (river closed 31-Dec). | | Evans and Van Dyk 1984 |
| Chilko & Chilcotin | 84/85 | 10-Oct to 28-Nov-84, on 'a few randomly selected' weekdays and one or two weekend days per week (river closed 31-Dec). | | Evans and Van Dyk 1985 |
| Chilliwack | 83/84 | 7-Jan to 23-Apr-84. Strata were season (day length), time of day (AM/PM). Extrapolated to extend period to 1-Jan to 30-Apr, but do not include December (est. ~10%). Results do not allow partitioning across licence year break. | Difficult to evaluate other biases in design. | Clark and Facchin 1986 |
| Chilliwack | 84/85 | 1-Dec-84 to 30-Apr-85. Fishery likely began in November. Strata were seasonal (day length) and time of day. Results would allow partitioning across licence year break. | About 1/4 of anglers during December claimed species other than ST as target. | Scott and Lewynsky 1985 |
| Clore | 78/79 | 1-Sep to 29-Oct-78, fishery well underway in Aug and terminated about 1-Nov due to heavy rains. | | Chudyk and Whately 1980 |
| Clore | 79/80 | 18-Aug to 13-Dec-79; fishery likely continued until Clore closed on 15-Jan. | | Chudyk and Whately 1980 |
| Coquitlam | 76/77 | Unknown | Unknown | Narver 1978 |
| Dean | 71/72 | 12-Jul to 19-Sep-71. | Estimated 90% efficiency. No data for James' guide camp or loggers. | Leggett and Prediger 1972 |
| Dean | 72/73 | 15-Jun to 9-Sep-72. | Data exclude loggers. | George and Leggett 1982 |

**Table A5.** continued.—Additional detail from steelhead angler survey reports. **Year** gives the licence year of the survey.

| Water | Year | Temporal details | Spatial and other survey details | Reference |
|---|---|---|---|---|
| Dean | 73/74 | 1-Jun to 24-Sep & 24-Oct to 5-Nov-73; angling likely terminated on ~ 5-Nov. | Data include loggers. | Hemus 1974 |
| Dean | 74/75 | 2-Jun to 15-Sep-74. | Est efficiency 95%. Data exclude loggers. | Leggett and Westover 1976 |
| Dean | 75/76 | 1-Jun5 to 20-Sep-75. | Data exclude loggers. | Leggett and Narver 1976 |
| Dean | 76/77 | 2-June to 7-Sep-76. | Data exclude loggers. Est efficiency 95% | Leggett et al. 1977 |
| Dean | 77/78 | 2-Jun to 30-Sep-77. | Data exclude loggers. Est efficiency 95% | Leggett et al. 1978 |
| Dean | 78/79 | 1-Jun to 24-Sep-78. | Data exclude loggers. | Bell and Leggett 1979 |
| Dean | 79/80 | 1-Jun to 24-Sep-79. | No data for Upper Dean Lodge or loggers. | Dolighan 1981 |
| Dean | 80/81 | 1-Jun to 21-Sep-80. | No data for Upper Dean Lodge or loggers. | George 1981; George and Leggett 1982 |
| Dean | 81/82 | 1-Jun to 23-Sep-81. | Data exclude loggers. | George 1982; George and Leggett 1982 |
| Dean | 82/83 | 1-Jun to 26-Sep-82. | | Evans 1983b |
| Dean | 83/84 | 1-Jun to 12-Jul-83; terminated early. | | Evans 1984 |
| Dean | 84/85 | 1-Jun to early/mid Sep-84. | | Wilders 1995 |
| Dean | 85/86 | 1-Jun to early/mid Sep-85. | | Wilders 1995 |
| Dean | 86/87 | 1-Jun to early/mid Sep-86. | | Wilders 1995 |
| Dean | 87/88 | 1-Jun to early/mid Sep-87. | | Wilders 1995 |
| Dean | 88/89 | 1-Jun to early/mid Sep-88. | Applied % retained from digital database to Wilders' total catch figure, for retained. | Wilders 1995 |
| Dean | 89/90 | 1-Jun to early/mid Sep-89. | Applied % retained from digital data. | Wilders 1995 |
| Dean | 90/91 | 1-Jun to early/mid Sep-90. | | Wilders 1995 |

**Table A5.** continued.—Additional detail from steelhead angler survey reports. **Year** gives the licence year of the survey.

| Water | Year | Temporal details | Spatial and other survey details | Reference |
|---|---|---|---|---|
| Dean | 91/92 | 1-Jun to early/mid Sep-91. | | Wilders 1995 |
| Dean | 92/93 | 1-Jun to early/mid Sep-92. | | Wilders 1995 |
| Dean | 93/94 | 1-Jun to early/mid Sep-93. | | Wilders 1995 |
| Dean | 94/95 | 1-Jun to early/mid Sep-94. | | Wilders 1995 |
| Dean | 95/96 | 1-Jun to early/mid Sep-95. | | Anonymous 1998 |
| Dean | 96/97 | 1-Jun to early/mid Sep-96. | | Anonymous 1998 |
| Gold & Gold | 75/76 | 1-Dec-75 to 30-Jun-76; total of 68 days chosen at random: 10 per month, of which at least four were weekend days. | Windshield survey. Not possible to accurately partition between 75/76 and 76/77. No matching data in previous or subsequent year. | Hooton 1976 |
| Keogh | 75/76 | Unknown | Unknown | Narver 1978 |
| Keogh | 76/77 | Unknown | Unknown | Narver 1978 |
| Keogh | 77/78 | Unknown | Unknown | Narver 1978 |
| Kispiox | 69/70 | Oct and Nov 69. 12 days checked in total. | | Pinsent 1970 |
| Kispiox | 75/76 | Terminated end of Oct-75, fishery effectively terminated end of first week of Nov; angling closure from 1-Mar to 31-May. | Total number of anglers "an educated guess only but considered to be within +/-10%"; method of extrapolation not documented. Censused 219 anglers who retained 114 and released 389. | Whately 1977 |
| Kispiox | 89/90 | 1-Sep to 31-Oct-89. | Skeena confluence to Cullen confluence. | Lewynsky and Olmsted 1990 |
| Kispiox | 96/97 | 15-Sep to 31-Oct-96; fishery initiated in early Sep or earlier, and likely continued sporadically into Nov. | Sweetin confluence to Kispiox village. Does not provide an estimate of angler days. | Tallman 1997 |

**Table A5.** continued**.**—Additional detail from steelhead angler survey reports. **Year** gives the licence year of the survey.

| Water | Year | Temporal details | Spatial and other survey details | Reference |
|---|---|---|---|---|
| Kitimat | 77/78 | | Casual survey, not intended to quantify all effort and catch. Effort not total but daily to time of interview, recorded in hours, so CPE is estimable only per hour | Eccles et al. 1977 |
| Little Campbell | 77/78 | Unknown | Unknown | Narver 1978 |
| Morice | 69/70 | Oct / Nov 69. Total of 10 days checked. | | Pinsent 1970 |
| Morice | 76/77 | 4-Sep to 13-Dec-76; fishery initiated in late Aug and closed by regulation 15-Jan. | Included 4 miles of the Bulkley, from Morice confluence to Barrett Station. Second vehicle entry/exit point vie Owen Lakes, which was monitored only on holiday weekends. | Morris et al. 1977 |
| Morice | 77/78 | 15-Aug to 30-Nov-77; fishery initiated in late Aug, closed by regulation 15-Jan. | Included 4 miles of the Bulkley, from Morice confluence to Barrett Station. There is another vehicle entry/exit point vie Owen Lakes, which was monitored on holiday weekends. | Whately et al. 1978 |
| Nicomekl | 77/78 | Unknown | Unknown | Narver 1978 |
| Quinsam | 75/76 | 1-Dec-75 to 18-Apr-76. Did not cover entire season. Season stratified into 10 periods. Day stratified into 2-hr periods; sampled 14 days per month, 2 or 3 randomly-selected periods each day. | Assumption of angler day as 2 hr based on subsampling, unknown validity. | Carswell et al. 1986 |
| Quinsam | 76/77 | 17-Nov-76 to 31-Mar-77. Did not cover the entire season. Season stratified into 10 periods. Day stratified into 2-hr periods; sampled 20 days per month, 4 periods between 8:00 & 17:00 each day. | Assumption of angler day as 2 hr based on subsampling, unknown validity. | Carswell et al. 1986 |

**Table A5.** continued**.—**Additional detail from steelhead angler survey reports. **Year** gives the licence year of the survey.

| Water | Year | Temporal details | Spatial and other survey details | Reference |
|---|---|---|---|---|
| Quinsam | 77/78 | 15-Nov-77 to 31-Mar-78. Did not cover the entire season. Season stratified into 10 periods. Day stratified into 2-hr periods; sampled 20 days per month, 4 periods between 8:00 & 17:00 each day. | Assumption of angler day as 2 hr based on subsampling, unknown validity. | Carswell et al. 1986 |
| Quinsam | 78/79 | 17-Nov-78 to 31-Mar-79. Did not cover the entire season. Season stratified into 10 periods. Day stratified into 2-hr periods; sampled 20 days per month, 4 periods between 8:00 & 17:00 each day. | Assumption of angler day as 2 hr based on subsampling, unknown validity. | Carswell et al. 1986 |
| Quinsam | 79/80 | 15-Nov-79 to 31-Mar-80. Did not cover the entire season. Season stratified into 10 periods. Day stratified into 2-hr periods; sampled 16 days per month, 4 periods between 8:00 & 17:00 each day. | Assumption of angler day as 2 hr based on subsampling, unknown validity. | Carswell et al. 1986 |
| Salmon | 77/78 | Unknown | Unknown | Narver 1978 |
| Serpentine | 77/78 | Unknown | Unknown | Narver 1978 |
| Skeena | 89/90 | 1-Aug to 15-Oct-89. | Zymoetz confluence to Kasiks confluence. Cannot distinguish salmon and steelhead anglers | Lewynsky and Olmsted 1990 |
| South Alouette | 76/77 | Unknown | Unknown | Narver 1978 |
| Squamish | 77/78 | Unknown | Unknown | Narver 1978 |
| Suskwa | 69/70 | Oct / Nov 69. Total of 5 days checked. | | Pinsent 1970 |
| Thompson | 76/77 | 1-Oct-76 to 31-Mar-77. .Fishery may start before 1-Oct. | Difficult to evaluate methods of expansion of sample to total effort and catch. Est 80% sampling efficiency. Unknown effort occurs u/s of Lytton to Martel sampled area. | Antifeau 1977 |

**Table A5.** continued**.** —Additional detail from steelhead angler survey reports. **Year** gives the licence year of the survey.

| Water | Year | Temporal details | Spatial and other survey details | Reference |
|---|---|---|---|---|
| Thompson | 77/78 | Oct-77 through Mar-78. Fishery may start before 1-Oct. | Unknown effort occurs u/s of Lytton to Martel sampled area. Checked 2943 angler days. | Dolighan 1978 |
| Thompson | 78/79 | Oct-78 through Mar-79. Fishery may start before 1-Oct. | Methodology unclear. Unknown effort occurs u/s of the Lytton to Martel sampled area. | Dolighan 1979 |
| Thompson | 80/81 | Oct through Dec-80 (river closed 1-Jan to 31-May). Fishery may start before 1-Oct. | Unknown method of interpolation. Unknown effort occurs u/s of Lytton to Martel sampled area. Checked 1996 angler days' catch was only 239 fish (much lower success rate than claimed for all days). | Caverly 1981 |
| Thompson | 81/82 | 28-Sep through Dec-81, entire river. | 2 persons checking the river most days. Checked 3632 angler days (56% of total), remainder reported as days fished since last check. Number of sample days unrecorded. | Caverly 1982 |
| Thompson | 82/83 | 26-Sep through 28-Nov-82, entire river, weekends only for much of the period. | Unexplained discrepancy between 3905 and 4507 as total angler days. | Moore 1983 |
| Thompson | 83/84 | 26-Sep through 31-Dec-83. | Number of sample days unrecorded. Report very brief, discrepancy between two figures for total angler days (6362 and 6971) is unexplained. | Moore 1984 |
| Thompson | 84/85 | 1-Oct to 31-Dec-84; sampled 79 days of 92 calendar days during the period. | | Moore and Olmsted 1985 |
| Zymoetz | 78/79 | 1-Sep to 29-Oct-78; fishery well underway in August and terminated about 1-Nov due to heavy rains. | | Chudyk and Whately 1980 |

**Table A5** continued.—Additional detail from steelhead angler survey reports. **Year** gives the licence year of the survey.

| Water | Year | Temporal details | Spatial and other survey details | Reference |
|---|---|---|---|---|
| Zymoetz | 79/80 | 18-Aug to 13-Dec-79; fishery continued through winter due to warm dry conditions --- whether spring closure was in place is unknown. | | Chudyk and Whately 1980 |
| Zymoetz & Clore | 89/90 | 15-Aug to 15-Oct-89. | Skeena confluence to Clore confluence, and including Clore River. | Lewynsky and Olmsted 1990 |

**Table A6.**—Additional detail about residency-stratified data from steelhead angler survey reports. **Year** gives the licence year of the survey. Report references are provided in Table A5.

| Water | Year | Residency details |
|---|---|---|
| Dean River | 71/72 | Categories: resident and non-resident (assumed Provincial but may be Canadian); Angler days appear to exclude one guide camp (James) and loggers |
| Chilko & Chilcotin Rivers | 72/73 | Categories: local residents (Region 5); other BC; non-residents |
| Dean River | 72/73 | Categories: BC, Canadian and non-resident alien |
| Chilko & Chilcotin Rivers | 73/74 | Categories: local residents (Region 5); other BC; non-residents |
| Dean River | 73/74 | Categories: BC, Canadian and non-resident alien |
| Dean River | 74/75 | Categories: BC, Canadian and non-resident alien |
| Dean River | 75/76 | Angler days and catch not categorized by residency |
| Kispiox River | 75/76 | Categories as per SHA |
| Chilko & Chilcotin Rivers | 76/77 | Categories: local residents (Region 5); other BC; non-residents |
| Morice River | 76/77 | Catch, effort summarized by non-corresponding criteria: western Region 6 anglers considered non-local |

**Table A6** continued.—Additional detail about residency-stratified data from steelhead angler survey reports.

| Water | Year | Residency details |
|---|---|---|
| Thompson River | 76/77 | Categories: local residents --- considered those residing "along the Thompson R" so cannot compare to SHA local category (region 3); other BC; other Canada; and USA. Kill/release not broken down by residency. |
| Atnarko & Bella Coola Rivers | 77/78 | Categories : "Valley residents", other BC, non-residents of BC; 792 Angler days of unknown residency |
| Chilko & Chilcotin Rivers | 77/78 | Categories: local residents (Region 5); other BC; non-residents |
| Morice River | 77/78 | Catch, effort summarized by non-corresponding criteria: western Region 6 anglers considered non-local |
| Thompson River | 77/78 | Categories: BC, Canada and USA |
| Chilko & Chilcotin Rivers | 78/79 | Categories: local residents (Region 5); other BC; non-residents |
| Clore River | 78/79 | Categorized anglers by SHA residence, but summarized Angler days and catch by non-corresponding criteria (local = Terrace, PR and Kitimat only) which necessitated recalculation |
| Thompson River | 78/79 | Categories: local residents --- considered "those residing within 100 km of Thompson R" so cannot compare to SHA local category (region 3); other BC; other Canada; and USA. |
| Zymoetz River | 78/79 | Categorized anglers by SHA residence, but summarized Angler days and catch by non-corresponding criteria (local = Terrace, PR and Kitimat only) which necessitated recalculation |
| Chilko & Chilcotin Rivers | 79/80 | Categories: local residents (Region 5); other BC; non-residents |
| Clore River | 79/80 | Categorized anglers by SHA residence, but summarized Angler days and catch by non-corresponding criteria (local = Terrace, PR and Kitimat only) which necessitated recalculation |
| Zymoetz River | 79/80 | Categorized anglers by SHA residence, but summarized Angler days and catch by non-corresponding criteria (local = Terrace, PR and Kitimat only) which necessitated recalculation |
| Chilko & Chilcotin Rivers | 80/81 | Categories: local residents (Region 5); other BC; non-residents |
| Thompson River | 80/81 | Categories: local residents --- considered "those residing within 100 km of Thompson R" so cannot compare to SHA local category (region 3); other BC; other Canada; and USA. |
| Chilko & Chilcotin Rivers | 81/82 | Categories: local residents (Region 5); other BC; non-residents |

**Table A6** continued.—Additional detail about residency-stratified data from steelhead angler survey reports.

| Water | Year | Residency details |
| --- | --- | --- |
| Thompson River | 81/82 | Categories: local residents --- considered "those residing within 100 km of Thompson R" so cannot compare to SHA local category (region 3); other BC; other Canada; and USA. |
| Chilko & Chilcotin Rivers | 82/83 | Categories: local residents (Region 5); other BC; non-residents |
| Thompson River | 82/83 | Categories: local residents --- considered "those residing within 100 km of Thompson R" so cannot compare to SHA local category (region 3); other BC; other Canada; and USA. |
| Bulkley River | 83/84 | Within-BC residence areas do not correspond to SHA categories |
| Chilko & Chilcotin Rivers | 83/84 | Categories: local residents (Region 5); other BC; non-residents |
| Thompson River | 83/84 | Categories: local residents --- considered "those residing within 100 km of Thompson R" so cannot compare to SHA local category (region 3); other BC; other Canada; and USA. |
| Chilko & Chilcotin Rivers | 84/85 | Categories: local residents (Region 5); other BC; non-residents |
| Thompson River | 84/85 | Categories: local -- MOE Region 3 residents south of and including Kamloops so not comparable to Region 3 SHA result; other BC; other Can; US; other NR |
| Dean River | 87/88 | Categories: BC, Canadian and non-resident alien |
| Dean River | 88/89 | Categories: BC, Canadian and non-resident alien |
| Dean River | 89/90 | Categories: BC, Canadian and non-resident alien |
| Dean River | 90/91 | Categories: BC, Canadian and non-resident alien |
| Dean River | 91/92 | Categories: BC, Canadian and non-resident alien |
| Dean River | 92/93 | Categories: BC, Canadian and non-resident alien |
| Dean River | 93/94 | Categories: BC, Canadian and non-resident alien |
| Dean River | 94/95 | Categories: BC, Canadian and non-resident alien |
| Dean River | 95/96 | Categories: BC, Canadian and non-resident alien |
| Dean River | 96/97 | Categories: BC, Canadian and non-resident alien |

## APPENDIX V. COMPARABLE FIELD AND SHA ESTIMATES

**Table A7.**—Unadjusted data available for comparison of **SHA** estimates to **Field** angler survey estimates. **River** : name of river or river-pair; **Year** : licence year; **Type** : steelhead population type, where W = Winter-run, S = Summer-run, WS = both types; **Kill** = total number of steelhead retained; **Rel** : total number of steelhead released; **Tech** : techniques utilized in the field survey -- each letter corresponds to a single technique as coded in **Table 2**; **Add Bias** : additional biases (above and beyond those associated with the utilized techniques) associated with the field survey where each letter corresponds to a single bias as coded in Table 1; **CAdj** : upward adjustment factor for catch recommended in the survey report; **EAdj** : upward adjustment factor for effort recommended in the survey report. ‡ indicates field survey data were excluded from analyses due to incompleteness or unsuitability.

| | | | SHA | | | | Field | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **River** | **Year** | **Type** | **Anglers** | **Days** | **Kill** | **Rel** | **Anglers** | **Days** | **Total Catch** | **Kill** | **Rel** | **Tech** | **Add Bias** | **CAdj** | **EAdj** |
| Atnarko & Bella Coola | 77/78 | WS | 228 & 871 | 6773 | 1177 | 1149 | NA | 3614 | NA | NA | NA | RFGIE | TDY | | |
| Chilko & Chilcotin | 72/73 | S | 215 & 613 | 3329 | 967 | 322 | NA | 999 | NA | 110 | NA | RT | ST | | |
| Chilko & Chilcotin ‡ | 73/74 | S | 143 & 483 | 2679 | 504 | 180 | NA | 653 | NA | 58 | NA | RT | ST | | |
| Chilko & Chilcotin | 75/76 | S | 236 & 560 | 3902 | 884 | 259 | NA | 957 | NA | 149 | NA | RT | ST | | |
| Chilko & Chilcotin | 76/77 | S | 234 & 796 | 4325 | 665 | 96 | NA | 1202 | NA | 55 | NA | RT | ST | | |
| Chilko & Chilcotin | 77/78 | S | 101 & 528 | 2236 | 255 | 157 | NA | 368 | NA | 161 | NA | RT | ST | | |
| Chilko & Chilcotin | 78/79 | S | 19 & 148 | 527 | 37 | 76 | 92 | 232 | 25 | 18 | 7 | RILF | ST | | |
| Chilko & Chilcotin | 79/80 | S | 53 & 184 | 651 | 85 | 166 | 104 | 316 | 85 | 50 | 35 | RILF | ST | | |
| Chilko & Chilcotin | 80/81 | S | 16 & 110 | 739 | 33 | 142 | 98 | 362 | 77 | 27 | 50 | RILF | ST | | |
| Chilko & Chilcotin | 81/82 | S | 36 & 157 | 549 | 40 | 48 | 130 | 331 | 108 | 36 | 72 | RILF | ST | | |
| Chilko & Chilcotin | 82/83 | S | 159 | 582 | 71 | 165 | 118 | 289 | 135 | 50 | 85 | RILF | ST | | |
| Chilko & Chilcotin | 83/84 | S | 215 | 690 | 77 | 87 | 135 | 353 | 121 | 40 | 81 | RILF | ST | | |
| Chilko & Chilcotin | 84/85 | S | 233 | 594 | 92 | 217 | 92 | 217 | 83 | 34 | 49 | RILF | ST | | |
| Zymoetz & Clore | 89/90 | S | 441 | 1807 | 52 | 1440 | NA | 749 | 279 | 0 | 279 | XT | T | | |
| Gold ‡ | 75/76 | WS | 846 | 5009 | 991 | 1084 | NA | 3255 | 2056 | 867 | 1189 | VTC | YL | | |
| Babine | 76/77 | S | 275 | 1185 | 157 | 977 | NA | 800 | NA | 84 | NA | U | U | | |
| Big Qualicum | 76/77 | W | 414 | 1656 | 253 | 520 | NA | NA | NA | NA | NA | VTC | AT | | |

**Table A7** continued.—Data available for comparison of **SHA** estimates to **Field** angler survey estimates. All residency classes pooled.

| | | | SHA | | | | Field | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **River** | **Year** | **Type** | **Anglers** | **Days** | **Kill** | **Rel** | **Anglers** | **Days** | **Total Catch** | **Kill** | **Rel** | **Tech** | **Add Bias** | **CAdj** | **EAdj** |
| Big Qualicum | 77/78 | W | 661 | 4085 | 786 | 1814 | NA | 2856 | 1437 | 744 | 693 | VTC | AT | | |
| Big Qualicum | 78/79 | W | 777 | 3599 | 384 | 513 | NA | 2990 | NA | NA | NA | VTC | AT | | |
| Big Qualicum | 79/80 | W | 394 | 2005 | 206 | 866 | NA | 1974 | NA | NA | NA | VTC | AT | | |
| Big Qualicum | 80/81 | W | 390 | 3082 | 327 | 2246 | NA | NA | NA | NA | NA | VTC | AT | | |
| Bulkley | 69/70 | S | 1128 | 4490 | 1244 | 0 | NA | 369 | NA | 220 | NA | RB | DST | | |
| Bulkley | 82/83 | S | 1451 | 10816 | 1385 | 3269 | NA | 3794 | NA | 116 | NA | RIT | S+ | | |
| Bulkley | 83/84 | S | 1457 | 10349 | 1091 | 3455 | 476 | 4304 | 1309 | 280 | 1029 | RIT | S | | |
| Bulkley | 89/90 | S | 1311 | 7977 | 55 | 5488 | NA | 4105 | 3067 | 0 | 3067 | HST | ST | | |
| Bulkley | 97/98 | | | | | | NA | 4317 | 5497 | 0 | 5497 | | | | |
| Bulkley | 98/99 | | | | | | NA | 6116 | 8956 | 0 | 8956 | | | | |
| Campbell | 75/76 | W | 777 | 4640 | 598 | 666 | NA | 4376 | 498 | 326 | 172 | RT | DT | | |
| Campbell | 76/77 | W | 734 | 4468 | 284 | 452 | NA | 4592 | 379 | 227 | 152 | RT | DT | | |
| Campbell | 77/78 | W | 620 | 3900 | 264 | 544 | NA | 2819 | 283 | 163 | 120 | RT | DT | | |
| Campbell | 78/79 | W | 670 | 4239 | 258 | 534 | NA | 4478 | 336 | 175 | 161 | RT | DT | | |
| Campbell | 79/80 | W | 575 | 3383 | 246 | 642 | NA | 3014 | 350 | 120 | 230 | RT | DT | | |
| Chilliwack | 83/84 | W | 2007 | 16811 | 855 | 8656 | NA | 11798 | 4960 | 393 | 4567 | STCR | T | | |
| Chilliwack | 84/85 | W | 3744 | 33877 | 2302 | 23270 | NA | 19749 | 11311 | 1434 | 9877 | STCR | T | | |
| Clore | 78/79 | S | 24 | 231 | 15 | 73 | 60 | 117 | 37 | 17 | 20 | XRIF | T | | |
| Clore | 79/80 | S | 61 | 141 | 32 | 62 | 117 | 184 | 49 | 18 | 31 | XRIF | T | | |
| Coquitlam | 76/77 | W | 266 | 1694 | 56 | 37 | NA | 390 | NA | 69 | NA | U | U | | |
| Dean | 71/72 | S | 389 | 1780 | 1288 | 2677 | 364 | 1041 | 2231 | 629 | 1602 | RGF | T | 0.11 | 0.11 |
| Dean | 72/73 | S | 456 | 2627 | 1452 | 2940 | NA | 1296 | 1661 | 631 | 1030 | RGF | T | | |
| Dean | 73/74 | S | 626 | 3600 | 1316 | 4597 | NA | 1994 | 2810 | 937 | 1873 | RGF | T | | |
| Dean | 74/75 | S | 712 | 3453 | 1132 | 2604 | NA | 2338 | 1827 | 529 | 1298 | RGF | T | 0.05 | 0.05 |
| Dean | 75/76 | S | 793 | 3579 | 1156 | 3320 | 614 | 2636 | 2012 | 785 | 1227 | RGF | T | | |

**Table A7** continued.—Data available for comparison of **SHA** estimates to **Field** angler survey estimates. All residency classes pooled.

| | | | SHA | | | | Field | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **River** | **Year** | **Type** | **Anglers** | **Days** | **Kill** | **Rel** | **Anglers** | **Days** | **Total Catch** | **Kill** | **Rel** | **Tech** | **Add Bias** | **CAdj** | **EAdj** |
| Dean | 76/77 | S | 754 | 3263 | 727 | 1646 | 636 | 2841 | 972 | 399 | 573 | RGF | T | 0.05 | 0.05 |
| Dean | 77/78 | S | 677 | 3419 | 623 | 2628 | 661 | 3025 | 1832 | 495 | 1337 | RGF | T | 0.05 | 0.05 |
| Dean | 78/79 | S | 718 | 4204 | 617 | 2626 | NA | 3305 | 1478 | 391 | 1087 | RGF | T | | |
| Dean | 79/80 | S | 567 | 3129 | 262 | 2369 | NA | 2825 | 1311 | 229 | 1082 | RGF | T | | |
| Dean | 80/81 | S | 670 | 4226 | 495 | 3652 | 538 | 2779 | 2285 | 381 | 1904 | RGF | T | | |
| Dean | 81/82 | S | 722 | 4762 | 346 | 4680 | 614 | 3263 | 2035 | 251 | 1784 | RGF | T | | |
| Dean | 82/83 | S | 660 | 3664 | 475 | 5023 | NA | 2996 | 3132 | 343 | 2789 | RGF | T | | |
| Dean | 84/85 | S | 652 | 3727 | 470 | 7457 | NA | 3278 | NA | 5347 | NA | RGF | T | | |
| Dean | 85/86 | S | 757 | 4580 | 547 | 8221 | NA | 4102 | NA | 5368 | NA | RGF | T | | |
| Dean | 86/87 | S | 946 | 5264 | 530 | 7249 | NA | 5057 | NA | 4768 | NA | RGF | T | | |
| Dean | 87/88 | S | 994 | 5886 | 372 | 9134 | NA | 4218 | NA | 4848 | NA | RGF | T | | |
| Dean | 88/89 | S | 985 | 5858 | 258 | 6679 | 623 | 5005 | 4150 | 200 | 3950 | RGF | T | | |
| Dean | 89/90 | S | 949 | 6247 | 232 | 8181 | 571 | 5052 | 4700 | 175 | 4525 | RGF | T | | |
| Dean | 90/91 | S | 870 | 5462 | 3 | 5675 | 615 | 4156 | 3200 | 0 | 3200 | RGF | T | | |
| Dean | 91/92 | S | 720 | 4554 | 12 | 5290 | 595 | 3846 | 2733 | 0 | 2733 | RGF | T | | |
| Dean | 92/93 | S | 755 | 6023 | 13 | 6157 | 560 | 3613 | 3026 | 0 | 3026 | RGF | T | | |
| Dean | 93/94 | S | 768 | 4788 | 9 | 4907 | 651 | 4494 | 3063 | 0 | 3063 | RGF | T | | |
| Dean | 94/95 | S | 616 | 4234 | 0 | 4623 | 595 | 4076 | 3280 | 0 | 3280 | RGF | T | | |
| Dean | 95/96 | S | 626 | 4851 | 15 | 5029 | 586 | 3826 | 3674 | 0 | 3674 | RGF | T | | |
| Dean | 96/97 | S | 649 | 4961 | 0 | 7210 | 576 | 3983 | 4391 | 0 | 4391 | RGF | T | | |
| Keogh | 75/76 | W | 198 | 692 | 77 | 118 | NA | 550 | NA | 70 | NA | U | U | | |
| Keogh | 76/77 | W | 126 | 537 | 40 | 65 | NA | 540 | NA | 36 | NA | U | U | | |
| Keogh | 77/78 | W | 104 | 386 | 29 | 157 | NA | 206 | NA | 31 | NA | U | U | | |
| Kispiox | 69/70 | S | 1319 | 5349 | 772 | 0 | NA | 1363 | NA | 362 | NA | RB | DST | | |
| Kispiox | 75/76 | S | 848 | 4396 | 247 | 887 | 450 | 4137 | 1035 | 234 | 801 | REV | TD | | |

**Table A7** continued.—Data available for comparison of **SHA** estimates to **Field** angler survey estimates. All residency classes pooled.

| | | | SHA | | | | Field | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **River** | **Year** | **Type** | **Anglers** | **Days** | **Kill** | **Rel** | **Anglers** | **Days** | **Total Catch** | **Kill** | **Rel** | **Tech** | **Add Bias** | **CAdj** | **EAdj** |
| Kispiox | 89/90 | S | 785 | 3994 | 4 | 2122 | NA | 3605 | 1384 | 0 | 1384 | HST | ST | | |
| Kispiox | 96/97 | S | 615 | 2705 | 9 | 1852 | NA | NA | 637 | 0 | 637 | RST | T | | |
| Little Campbell | 77/78 | W | 186 | 1739 | 186 | 120 | NA | 557 | NA | 183 | NA | U | U | | |
| Morice | 69/70 | S | 1136 | 4997 | 1464 | 0 | NA | 645 | NA | 175 | NA | RB | DST | | |
| Morice | 76/77 | S | 764 | 3087 | 553 | 595 | NA | 1971 | 394 | 279 | 115 | XRF | TS+ | | |
| Morice | 77/78 | S | 892 | 3836 | 630 | 952 | 769 | 1833 | 627 | 416 | 211 | XRIF | TS+ | | |
| Nicomekl | 77/78 | W | 120 | 694 | 79 | 24 | NA | 241 | NA | 43 | NA | U | U | | |
| Quinsam | 75/76 | W | 433 | 1545 | 240 | 416 | NA | 834 | 104 | 54 | 50 | RT | DT | | |
| Quinsam | 76/77 | W | 460 | 2178 | 158 | 272 | NA | 1219 | 174 | 105 | 69 | RT | DT | | |
| Quinsam | 77/78 | W | 380 | 1907 | 163 | 446 | NA | 1164 | 165 | 86 | 79 | RT | DT | | |
| Quinsam | 78/79 | W | 347 | 1584 | 76 | 391 | NA | 1956 | 240 | 103 | 137 | RT | DT | | |
| Quinsam | 79/80 | W | 441 | 2789 | 204 | 954 | NA | 2512 | 430 | 130 | 300 | RT | DT | | |
| Salmon | 77/78 | W | 242 | 852 | 121 | 213 | NA | 188 | NA | 67 | NA | NA | NA | | |
| Serpentine | 77/78 | W | 34 | 144 | 3 | 0 | NA | 152 | NA | 17 | NA | U | U | | |
| Skeena [‡] | 89/90 | S | 1962 | 15242 | 643 | 2190 | NA | 16683 | 568 | 210 | 358 | HST | D | | |
| South Alouette | 76/77 | W | 368 | 1972 | 63 | 22 | NA | 366 | NA | 41 | NA | U | U | | |
| Squamish[1] | 77/78 | W | NA | 8830 | 501 | NA | NA | 5572 | NA | 396 | NA | U | U | | |
| Suskwa | 69/70 | S | 116 | 300 | 146 | 0 | NA | 425 | NA | 91 | NA | RB | DST | | |
| Thompson | 76/77 | S | 2011 | 11038 | 1127 | 287 | NA | 5073 | 733 | 694 | 39 | RFC | ST | 0.25 | |
| Thompson | 77/78 | S | 2078 | 10391 | 1345 | 798 | NA | 5016 | 1110 | 924 | 186 | RFC | ST | | |
| Thompson | 78/79 | S | 1841 | 9797 | 1050 | 466 | 1207 | 5059 | 949 | 779 | 170 | RFI | ST | | |
| Thompson | 80/81 | S | 1904 | 10449 | 1170 | 1475 | 1078 | 3517 | 843 | 580 | 263 | RFI | STD | 0.20 | |
| Thompson | 81/82 | S | 2351 | 13232 | 1698 | 2166 | 1539 | 6492 | 1342 | 780 | 562 | RFI | ST | | |

[1] Squamish SHA totals for 1977/78 are given as reported in Narver (1978), and do not coincide with digital database totals.

**Table A7** continued.—Data available for comparison of **SHA** estimates to **Field** angler survey estimates. All residency classes pooled.

| | | | SHA | | | | Field | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **River** | **Year** | **Type** | **Anglers** | **Days** | **Kill** | **Rel** | **Anglers** | **Days** | **Total Catch** | **Kill** | **Rel** | **Tech** | **Add Bias** | **CAdj** | **EAdj** |
| Thompson | 82/83 | S | 2249 | 12176 | 1826 | 2325 | 1453 | 6310 | 1355 | 795 | 560 | RFI | DT | 0.40 | 0.40 |
| Thompson | 83/84 | S | 2228 | 12308 | 1482 | 1989 | 1560 | 6971 | 1130 | 717 | 413 | RFI | DT | | |
| Thompson | 84/85 | S | 2620 | 13395 | 2335 | 5065 | 2356 | 10490 | 4155 | 1289 | 2866 | RFI | T | 0.20 | 0.20 |
| Zymoetz | 78/79 | S | 605 | 3104 | 378 | 588 | 590 | 1093 | 227 | 117 | 110 | XRIF | T | | |
| Zymoetz | 79/80 | S | 511 | 2302 | 262 | 250 | 424 | 874 | 127 | 78 | 49 | XRIF | T | | |

## APPENDIX VI. RESIDENCY-SPECIFIC COMPARABLE FIELD AND SHA ESTIMATES

**Table A8.**—Data available for comparison of the estimated number of participating anglers, stratified by residency, from **Field** studies and the **SHA**. **Local** = anglers resident in the BCE region enclosing the stream; **other BC** = BC anglers residing in a region other than that containing the stream; **all BC** = all BC anglers; **NR** = non-residents of BC. NA = value not estimable from available results. The # symbol indicates that field and SHA values are not strictly comparable, usually due to varying residency definitions by field studies.

| | | SHA | | | | Field | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Stream** | **Year** | **Local** | **other BC** | **all BC** | **NR** | **Local** | **other BC** | **all BC** | **NR** | **Unknown** |
| Dean River | 75/76 | 128 | 345 | 473 | 320 | NA | NA | 325 | 289 | 0 |
| Kispiox River | 75/76 | 218 | 324 | 542 | 306 | 50 | 113 | 163 | 287 | 0 |
| Morice River | 77/78 | 211 | 540 | 751 | 141 | 229 | 427 | 656 | 113 | 0 |
| Clore River | 78/79 | 16 | 6 | 22 | 2 | 44 | 8 | 52 | 8 | 0 |
| Zymoetz River | 78/79 | 317 | 205 | 522 | 83 | 359 | 146 | 505 | 85 | 0 |
| Clore River | 79/80 | 39 | 13 | 52 | 9 | 88 | 8 | 96 | 21 | 0 |
| Zymoetz River | 79/80 | 276 | 182 | 458 | 57 | 311 | 72 | 383 | 41 | 0 |
| Bulkley River | 83/84 | 669 | 534 | 1203 | 254 | NA | NA | 395 | 81 | 0 |
| Thompson River | 84/85 | 625 | 1783 | 2408 | 212 | 351 | 1416 | 1767 | 192 | 0 |
| Dean River | 90/91 | 54 | 314 | 368 | 502 | NA | NA | 256 | 359 | 0 |
| Dean River | 91/92 | 41 | 241 | 282 | 438 | NA | NA | 228 | 367 | 0 |
| Dean River | 92/93 | 52 | 289 | 341 | 414 | NA | NA | 228 | 332 | 0 |
| Dean River | 93/94 | 55 | 241 | 296 | 472 | NA | NA | 250 | 401 | 0 |
| Dean River | 94/95 | 64 | 167 | 231 | 385 | NA | NA | 176 | 419 | 0 |
| Dean River | 96/97 | | | | | NA | NA | 156 | 430 | 0 |

**Table A9.**—Data available for comparison of the estimated number of angler days, stratified by residency, from **Field** studies and the **SHA**. **Local** = anglers resident in the BCE region enclosing the stream; **other BC** = BC anglers residing in a region other than that containing the stream; **all BC** = all BC anglers; **NR** = non-residents of BC. NA = value not estimable from available results. The # symbol indicates that field and SHA values are not strictly comparable, usually due to varying residency definitions by field studies.

| | | SHA | | | | Field | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Stream** | **Year** | **Local** | **other BC** | **all BC** | **NR** | **Local** | **other BC** | **all BC** | **NR** | **Unknown** |
| Dean River | 71/72 | NA | NA | NA | NA | NA | NA | 150 | 787 | 0 |
| Chilko & Chilcotin Rivers | 72/73 | NA | NA | NA | NA | 582 | 343 | 925 | 71 | 0 |
| Dean River | 72/73 | NA | NA | NA | NA | NA | NA | 354 | 942 | 0 |
| Chilko & Chilcotin Rivers | 73/74 | NA | NA | NA | NA | 440 | 199 | 639 | 14 | 0 |
| Dean River | 73/74 | NA | NA | NA | NA | NA | NA | 1339 | 1378 | 0 |
| Dean River | 74/75 | NA | NA | NA | NA | NA | NA | 796 | 1425 | 0 |
| Dean River | 75/76 | NA | NA | NA | NA | NA | NA | 1309 | 1327 | 0 |
| Kispiox River | 75/76 | NA | NA | NA | NA | 350 | 452 | NA | 3335 | 0 |
| Chilko & Chilcotin Rivers | 76/77 | NA | NA | NA | NA | 538 | 296 | 834 | 105 | 0 |
| Morice River | 76/77 | NA | NA | NA | NA | 497 | 804 | 1301 | 202 | 0 |
| Thompson River | 76/77 | NA | NA | NA | NA | #211 | #1764 | 1975 | 205 | 139 |
| Atnarko & Bella Coola Rivers | 77/78 | NA | NA | NA | NA | 757 | 1894 | 2651 | 415 | 546 |
| Chilko & Chilcotin Rivers | 77/78 | NA | NA | NA | NA | 226 | 82 | 308 | 44 | 0 |
| Morice River | 77/78 | NA | NA | NA | NA | 555 | 681 | 1236 | 191 | 0 |
| Thompson River | 77/78 | NA | NA | NA | NA | NA | NA | 3762 | 376 | 42 |
| Chilko & Chilcotin Rivers | 78/79 | NA | NA | NA | NA | 112 | 87 | 199 | 33 | 0 |
| Clore River | 78/79 | NA | NA | NA | NA | 84 | 33 | 117 | 12 | 0 |
| Thompson River | 78/79 | NA | NA | NA | NA | #652 | #2642 | 3294 | 431 | 113 |
| Zymoetz River | 78/79 | NA | NA | NA | NA | 599 | 305 | 904 | 182 | 0 |
| Chilko River | 79/80 | NA | NA | NA | NA | 233 | 43 | 276 | 57 | 0 |
| Clore River | 79/80 | NA | NA | NA | NA | 147 | 25 | 172 | 11 | 0 |
| Zymoetz River | 79/80 | NA | NA | NA | NA | 673 | 123 | 796 | 75 | 0 |
| Chilko & Chilcotin Rivers | 80/81 | 313 | 365 | 678 | 61 | 204 | 101 | 305 | 57 | 0 |
| Thompson River | 80/81 | 3052 | 6278 | 9330 | 1236 | #304 | #2735 | 3039 | 473 | 0 |

**Table A9** continued.—Data available for comparison of the estimated number of angler days, stratified by residency, from **Field** studies and the **SHA**.

| | | SHA | | | | Field | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Stream** | **Year** | **Local** | **other BC** | **all BC** | **NR** | **Local** | **other BC** | **all BC** | **NR** | **Unknown** |
| Chilko & Chilcotin Rivers | 81/82 | NA | NA | NA | NA | 193 | 79 | 272 | 59 | 0 |
| Thompson River | 81/82 | NA | NA | NA | NA | #1003 | #4766 | 5769 | 723 | 0 |
| Chilko & Chilcotin Rivers | 82/83 | 447 | 100 | 547 | 61 | 221 | 65 | 286 | 35 | 0 |
| Thompson River | 82/83 | 3646 | 7375 | 11021 | 1219 | #500 | #3284 | 3784 | 720 | 0 |
| Bulkley River | 83/84 | 6793 | 2387 | 9180 | 1169 | NA | NA | 2873 | 431 | 0 |
| Chilko & Chilcotin Rivers | 83/84 | 579 | 90 | 669 | 21 | 289 | 51 | 340 | 13 | 0 |
| Thompson River | 83/84 | 3428 | 7515 | 10943 | 1365 | #1018 | #4453 | 5471 | 891 | 0 |
| Chilko & Chilcotin Rivers | 84/85 | 488 | 102 | 590 | 4 | 169 | 42 | 211 | 6 | 0 |
| Thompson River | 84/85 | 4195 | 8006 | 12201 | 1194 | #1694 | #6036 | 7730 | 904 | 0 |
| Dean River | 87/88 | 799 | 1999 | 2798 | 3088 | NA | NA | 1724 | 2494 | 0 |
| Dean River | 88/89 | 432 | 1749 | 2181 | 3677 | NA | NA | 2074 | 2931 | 0 |
| Dean River | 89/90 | 231 | 2296 | 2527 | 3720 | NA | NA | 2040 | 3012 | 0 |
| Dean River | 90/91 | 535 | 1815 | 2350 | 3112 | NA | NA | 1751 | 2405 | 0 |
| Dean River | 91/92 | 201 | 1628 | 1829 | 2725 | NA | NA | 1563 | 2283 | 0 |
| Dean River | 92/93 | 398 | 3067 | 3465 | 2558 | NA | NA | 1535 | 2073 | 0 |
| Dean River | 93/94 | 380 | 1407 | 1787 | 3001 | NA | NA | 1858 | 2625 | 0 |
| Dean River | 94/95 | 509 | 1517 | 2026 | 2208 | NA | NA | 1468 | 2608 | 0 |
| Dean River | 95/96 | 407 | 2227 | 2634 | 2217 | NA | NA | NA | NA | 0 |
| Dean River | 96/97 | NA | NA | NA | NA | NA | NA | 1048 | 2778 | 0 |

**Table A10.**—Data available for comparison of the estimated catch (retained and released), stratified by residency, from **Field** studies and the **SHA**. **Local** = anglers resident in the BCE region enclosing the stream; **other BC** = BC anglers residing in a region other than that containing the stream; **all BC** = all BC anglers; **NR** = non-residents of BC. NA = value not estimable from available results. The # symbol indicates that field and SHA values are not strictly comparable, usually due to varying residency definitions by field studies.

| | | SHA | | | | Field | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Stream** | **Year** | **Local** | **other BC** | **all BC** | **NR** | **Local** | **other BC** | **all BC** | **NR** | **Unknown** |
| Chilko & Chilcotin Rivers | 72/73 | NA | NA | NA | NA | 56 | 49 | 105 | 0 | 0 |
| Chilko & Chilcotin Rivers | 73/74 | NA | NA | NA | NA | 38 | 14 | 52 | 0 | 0 |
| Kispiox River | 75/76 | NA | NA | NA | NA | 105 | 109 | 214 | 821 | 0 |
| Chilko & Chilcotin Rivers | 76/77 | NA | NA | NA | NA | 38 | 10 | 48 | 0 | 0 |
| Morice River | 76/77 | NA | NA | NA | NA | NA | NA | 340 | 54 | 0 |
| Thompson River | 76/77 | NA | NA | NA | NA | #79 | #432 | 511 | 70 | 5 |
| Chilko & Chilcotin Rivers | 77/78 | NA | NA | NA | NA | 60 | 44 | 104 | 57 | 0 |
| Morice River | 77/78 | NA | NA | NA | NA | NA | NA | 465 | 162 | 0 |
| Thompson River | 77/78 | NA | NA | NA | NA | NA | NA | 790 | 85 | 50 |
| Chilko & Chilcotin Rivers | 78/79 | NA | NA | NA | NA | 13 | 6 | 19 | 6 | 0 |
| Clore River | 78/79 | NA | NA | NA | NA | NA | NA | 34 | 3 | 0 |
| Thompson River | 78/79 | NA | NA | NA | NA | #128 | #557 | 685 | 96 | 10 |
| Zymoetz River | 78/79 | NA | NA | NA | NA | NA | NA | 173 | 56 | 0 |
| Chilko & Chilcotin Rivers | 79/80 | NA | NA | NA | NA | 49 | 17 | 66 | 19 | 0 |
| Clore River | 79/80 | NA | NA | NA | NA | NA | NA | 48 | 1 | 0 |
| Zymoetz River | 79/80 | NA | NA | NA | NA | NA | NA | 115 | 12 | 0 |
| Chilko & Chilcotin Rivers | 80/81 | NA | NA | NA | NA | 36 | 9 | 45 | 32 | 0 |
| Thompson River | 80/81 | NA | NA | NA | NA | #53 | #570 | 624 | 79 | 0 |
| Chilko & Chilcotin Rivers | 81/82 | NA | NA | NA | NA | 63 | 9 | 72 | 36 | 0 |
| Thompson River | 81/82 | NA | NA | NA | NA | #178 | #976 | 1154 | 187 | 0 |
| Chilko & Chilcotin Rivers | 82/83 | NA | NA | NA | NA | 102 | 8 | 110 | 25 | 0 |
| Thompson River | 82/83 | NA | NA | NA | NA | #101 | #842 | 943 | 164 | 0 |
| Chilko & Chilcotin Rivers | 83/84 | 139 | 23 | 162 | 2 | 109 | 12 | 121 | 0 | 0 |
| Thompson River | 83/84 | 512 | 2411 | 2923 | 548 | #103 | #789 | 892 | 238 | 0 |

**Table A10** continued.—Data available for comparison of the estimated catch (retained and released), stratified by residency, from **Field** studies and the **SHA**.

| | | SHA | | | | Field | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Stream** | **Year** | **Local** | **other BC** | **all BC** | **NR** | **Local** | **other BC** | **all BC** | **NR** | **Unknown** |
| Chilko & Chilcotin Rivers | 84/85 | 240 | 69 | 309 | 0 | 71 | 11 | 82 | 1 | 0 |
| Thompson River | 84/85 | 1299 | 5096 | 6395 | 1005 | #407 | #2670 | 3077 | 482 | 0 |
| Dean River | 88/89 | 331 | 1815 | 2146 | 4791 | NA | NA | 1063 | 2015 | 0 |
| Dean River | 89/90 | 280 | 2730 | 3010 | 5403 | NA | NA | 1128 | 2502 | 0 |
| Dean River | 90/91 | 284 | 1375 | 1659 | 4019 | NA | NA | 820 | 2453 | 0 |
| Dean River | 91/92 | 226 | 1402 | 1628 | 3674 | NA | NA | 743 | 2084 | 0 |
| Dean River | 92/93 | 274 | 1867 | 2141 | 4029 | NA | NA | 744 | 2356 | 0 |
| Dean River | 93/94 | 169 | 748 | 917 | 3999 | NA | NA | 743 | 2320 | 0 |
| Dean River | 94/95 | 232 | 1483 | 1715 | 2908 | NA | NA | 751 | 2529 | 0 |
| Dean River | 96/97 | NA | NA | NA | NA | NA | NA | 538 | 3136 | 0 |

**Table A11.**—Data available for comparison of the estimated number of steelhead retained, stratified by residency, from **Field** studies and the **SHA**. **Local** = anglers resident in the BCE region enclosing the stream; **other BC** = BC anglers residing in a region other than that containing the stream; **all BC** = all BC anglers; **NR** = non-residents of BC. NA = value not estimable from available results. The # symbol indicates that field and SHA values are not strictly comparable, usually due to varying residency definitions by field studies.

| | | SHA | | | | Field | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Stream** | **Year** | **Local** | **other BC** | **all BC** | **NR** | **Local** | **other BC** | **all BC** | **NR** | **Unknown** |
| Kispiox River | 75/76 | 62 | 82 | 144 | 103 | 15 | 36 | 51 | 183 | 0 |
| Morice River | 76/77 | 93 | 408 | 501 | 52 | NA | NA | 247 | 32 | 0 |
| Chilko & Chilcotin Rivers | 77/78 | 162 | 1 | 163 | 92 | 55 | 16 | 71 | 3 | 0 |
| Morice River | 77/78 | 152 | 356 | 508 | 122 | NA | NA | 333 | 83 | 0 |
| Thompson River | 77/78 | 384 | 837 | 1221 | 136 | NA | NA | 654 | 72 | 44 |
| Chilko & Chilcotin Rivers | 78/79 | 23 | 14 | 37 | 0 | 11 | 6 | 17 | 1 | 0 |
| Clore River | 78/79 | 12 | 3 | 15 | 0 | NA | NA | 15 | 2 | 0 |

**Table A11** continued.—Data available for comparison of the estimated number of steelhead retained, stratified by residency, from **Field** studies and the **SHA**.

| | | SHA | | | | Field | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Stream** | **Year** | **Local** | **other BC** | **all BC** | **NR** | **Local** | **other BC** | **all BC** | **NR** | **Unknown** |
| Thompson River | 78/79 | 348 | 558 | 906 | 147 | #122 | #437 | 559 | 82 | 8 |
| Zymoetz River | 78/79 | 212 | 126 | 338 | 40 | NA | NA | 100 | 19 | 0 |
| Chilko & Chilcotin Rivers | 79/80 | 62 | 17 | 79 | 1 | 39 | 9 | 48 | 2 | 0 |
| Clore River | 79/80 | 21 | 6 | 27 | 5 | NA | NA | 17 | 1 | 0 |
| Zymoetz River | 79/80 | 186 | 76 | 262 | 4 | NA | NA | 71 | 7 | 0 |
| Chilko & Chilcotin Rivers | 80/81 | 30 | 3 | 33 | 0 | 21 | 6 | 27 | 0 | 0 |
| Thompson River | 80/81 | 301 | 686 | 987 | 183 | #48 | #383 | 431 | 52 | 0 |
| Chilko & Chilcotin Rivers | 81/82 | | | | | 32 | 4 | 36 | 0 | 0 |
| Thompson River | 81/82 | | | | | #142 | #528 | 670 | 110 | 0 |
| Chilko & Chilcotin Rivers | 82/83 | 50 | 18 | 68 | 0 | 42 | 8 | 50 | 0 | 0 |
| Thompson River | 82/83 | 531 | 1103 | 1634 | 188 | #83 | #476 | 559 | 89 | 0 |
| Chilko & Chilcotin Rivers | 83/84 | 58 | 17 | 75 | 2 | 32 | 8 | 40 | 0 | 0 |
| Chilko & Chilcotin Rivers | 84/85 | 75 | 17 | 92 | 0 | 28 | 6 | 34 | 0 | 0 |
| Dean River | 88/89 | 34 | 159 | 193 | 65 | NA | NA | 115 | 33 | 0 |
| Dean River | 89/90 | 21 | 151 | 172 | 60 | NA | NA | 99 | 37 | 0 |
| Dean River | 90/91 | 3 | 0 | 3 | 0 | NA | NA | 0 | 0 | 0 |
| Dean River | 91/92 | 3 | 0 | 3 | 9 | NA | NA | 0 | 0 | 0 |
| Dean River | 92/93 | 0 | 13 | 13 | 0 | NA | NA | 0 | 0 | 0 |
| Dean River | 93/94 | 0 | 0 | 0 | 9 | NA | NA | 0 | 0 | 0 |
| Dean River | 94/95 | 0 | 0 | 0 | 0 | NA | NA | 0 | 0 | 0 |
| Dean River | 96/97 | | | | | NA | NA | 0 | 0 | 0 |

**Table A12.**—Data available for comparison of the estimated number of steelhead released, stratified by residency, from **Field** studies and the **SHA**. **Local** = anglers resident in the BCE region enclosing the stream; **other BC** = BC anglers residing in a region other than that containing the stream; **all BC** = all BC anglers; **NR** = non-residents of BC. NA = value not estimable from available results. The # symbol indicates that field and SHA values are not strictly comparable, usually due to varying residency definitions by field studies.

| | | SHA | | | | Field | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Stream** | **Year** | **Local** | **other BC** | **all BC** | **NR** | **Local** | **other BC** | **all BC** | **NR** | **Unknown** |
| Kispiox River | 75/76 | NA | NA | NA | NA | 90 | 73 | 163 | 638 | 0 |
| Morice River | 76/77 | NA | NA | NA | NA | NA | NA | 93 | 22 | 0 |
| Chilko & Chilcotin Rivers | 77/78 | NA | NA | NA | NA | 5 | 28 | 33 | 54 | 0 |
| Morice River | 77/78 | NA | NA | NA | NA | NA | NA | 132 | 79 | 0 |
| Thompson River | 77/78 | NA | NA | NA | NA | NA | NA | 138 | 8 | 9 |
| Chilko & Chilcotin Rivers | 78/79 | NA | NA | NA | NA | 2 | 6 | 8 | 5 | 0 |
| Clore River | 78/79 | NA | NA | NA | NA | NA | NA | 19 | 1 | 0 |
| Thompson River | 78/79 | NA | NA | NA | NA | #6 | #120 | 126 | 14 | 2 |
| Zymoetz River | 78/79 | NA | NA | NA | NA | NA | NA | 73 | 37 | 0 |
| Chilko & Chilcotin Rivers | 79/80 | NA | NA | NA | NA | 10 | 8 | 18 | 17 | 0 |
| Clore River | 79/80 | NA | NA | NA | NA | NA | NA | 31 | 0 | 0 |
| Zymoetz River | 79/80 | NA | NA | NA | NA | NA | NA | 44 | 5 | 0 |
| Chilko & Chilcotin Rivers | 80/81 | NA | NA | NA | NA | 15 | 3 | 18 | 32 | 0 |
| Thompson River | 80/81 | NA | NA | NA | NA | #5 | #187 | 193 | 27 | 0 |
| Chilko & Chilcotin Rivers | 81/82 | NA | NA | NA | NA | 31 | 5 | 36 | 36 | 0 |
| Thompson River | 81/82 | NA | NA | NA | NA | #36 | #448 | 484 | 78 | 0 |
| Chilko & Chilcotin Rivers | 82/83 | NA | NA | NA | NA | 60 | 0 | 60 | 25 | 0 |
| Thompson River | 82/83 | NA | NA | NA | NA | #18 | #366 | 384 | 75 | 0 |
| Chilko & Chilcotin Rivers | 83/84 | 81 | 6 | 87 | 0 | 77 | 4 | 81 | 0 | 0 |
| Chilko & Chilcotin Rivers | 84/85 | 165 | 52 | 217 | 0 | 43 | 5 | 48 | 1 | 0 |
| Dean River | 88/89 | 297 | 1656 | 1953 | 4726 | NA | NA | 938 | 1982 | 0 |
| Dean River | 89/90 | 259 | 2579 | 2838 | 5343 | NA | NA | 1029 | 2465 | 0 |
| Dean River | 90/91 | 281 | 1375 | 1656 | 4019 | NA | NA | 820 | 2453 | 0 |
| Dean River | 91/92 | 223 | 1402 | 1625 | 3665 | NA | NA | 743 | 2084 | 0 |

**Table A12** continued.—Data available for comparison of the estimated number of steelhead released, stratified by residency, from **Field** studies and the **SHA**.

| | | SHA | | | | Field | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Stream** | **Year** | **Local** | **other BC** | **all BC** | **NR** | **Local** | **other BC** | **all BC** | **NR** | **Unknown** |
| Dean River | 92/93 | 274 | 1854 | 2128 | 4029 | NA | NA | 744 | 2356 | 0 |
| Dean River | 93/94 | 169 | 748 | 917 | 3990 | NA | NA | 743 | 2320 | 0 |
| Dean River | 94/95 | 232 | 1483 | 1715 | 2908 | NA | NA | 751 | 2529 | 0 |
| Dean River | 96/97 | NA | NA | NA | NA | NA | NA | 538 | 3136 | 0 |

## APPENDIX VII. BOOTSTRAPPED STANDARD ERROR ESTIMATES

**Table A13.**—Bootstrapped standard errors for SHA fishery parameters. Forty-three fisheries, each comprising the estimated activity on a single **Stream** in a single licence **Year**, were selected for analysis. For each parameter the mean of 500 bootstrap run **Estimates** is given, along with the estimated **Standard Error**, which is the standard deviation of run results. Parameters are: **AD** = angler days, **K** = steelhead retained, **R** = steelhead released, **A** = individual anglers. The results are stratified by angler residency.

| | | Local Resident Anglers | | | | | | | | Other BC Anglers | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Estimate | | | | Standard Error | | | | Estimate | | | | Standard Error | | | |
| Year | Stream | AD | K | R | A | AD | K | R | A | AD | K | R | A | AD | K | R | A |
| 1984 | Chilliwack R | 16441 | 835 | 8574 | 1927 | 1590 | 162 | 1467 | 76 | 128 | 17 | 100 | 55 | 54 | 10 | 94 | 19 |
| 1985 | Chilliwack R | 32836 | 2251 | 22850 | 3470 | 2076 | 194 | 2900 | 48 | 420 | 31 | 274 | 151 | 103 | 19 | 170 | 28 |
| 1983 | Thompson R | 4367 | 599 | 279 | 604 | 529 | 105 | 89 | 27 | 9034 | 1280 | 2041 | 1946 | 647 | 170 | 497 | 75 |
| 1984 | Thompson R | 3397 | 294 | 210 | 447 | 523 | 85 | 83 | 31 | 7265 | 957 | 1283 | 1530 | 565 | 151 | 303 | 72 |
| 1985 | Thompson R | 4161 | 728 | 571 | 620 | 443 | 96 | 147 | 28 | 7805 | 1345 | 3692 | 1769 | 546 | 136 | 732 | 67 |
| 1983 | Chilcotin River | 478 | 62 | 125 | 112 | 181 | 25 | 105 | 24 | 136 | 28 | 26 | 41 | 71 | 17 | 40 | 17 |
| 1984 | Chilcotin River | 493 | 56 | 66 | 147 | 126 | 21 | 51 | 27 | 88 | 19 | 6 | 37 | 35 | 12 | 8 | 15 |
| 1985 | Chilcotin River | 451 | 77 | 158 | 175 | 85 | 24 | 72 | 27 | 92 | 17 | 53 | 42 | 44 | 9 | 47 | 14 |
| 1983 | Chilko R | 28 | 4 | 0 | 16 | 19 | 6 | | 10 | 18 | 0 | 0 | 10 | 17 | | | 9 |
| 1984 | Chilko R | 91 | 0 | 3 | 20 | 65 | | 4 | 11 | 0 | 0 | 0 | 0 | | | | |
| 1985 | Chilko R | 55 | 4 | 0 | 15 | 46 | 5 | | 9 | 6 | 0 | 0 | 3 | 9 | | | 5 |
| 1985 | Dean R | 772 | 77 | 729 | 116 | 348 | 26 | 266 | 22 | 1114 | 231 | 2264 | 241 | 188 | 49 | 530 | 35 |
| 1990 | Dean R | 226 | 19 | 371 | 51 | 82 | 9 | 231 | 15 | 2351 | 157 | 2792 | 291 | 674 | 33 | 986 | 44 |
| 1995 | Dean R | 523 | 0 | 246 | 66 | 160 | | 86 | 15 | 1680 | 0 | 1395 | 162 | 483 | | 420 | 29 |
| 1983 | Bulkley R | 9020 | 1083 | 2458 | 870 | 970 | 147 | 560 | 47 | 2263 | 354 | 881 | 535 | 355 | 66 | 354 | 51 |
| 1984 | Bulkley R | 6693 | 632 | 2006 | 655 | 1013 | 141 | 513 | 56 | 2121 | 296 | 668 | 533 | 310 | 66 | 221 | 57 |
| 1990 | Bulkley R | 3742 | 11 | 2493 | 485 | 616 | 10 | 828 | 41 | 2097 | 32 | 1380 | 354 | 512 | 20 | 404 | 48 |
| 1990 | Clore R | 25 | 0 | 5 | 11 | 26 | | 7 | 10 | 0 | 0 | 0 | 0 | | | | |
| 1985 | Cranberry River | 353 | 87 | 350 | 88 | 133 | 31 | 135 | 20 | 228 | 89 | 257 | 79 | 59 | 25 | 103 | 16 |
| 1990 | Cranberry River | 268 | 0 | 499 | 53 | 137 | | 274 | 19 | 286 | 0 | 68 | 55 | 164 | | 62 | 19 |
| 1995 | Cranberry River | 95 | 0 | 279 | 41 | 39 | | 219 | 15 | 27 | 0 | 46 | 18 | 14 | | 46 | 9 |

**Table A13** continued.—Bootstrapped standard errors, SHA fishery parameters, for 43 British Columbia steelhead fisheries. Values are for local residents and BC residents.

| | | Local Resident Anglers | | | | | | | | Other BC Anglers | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Estimate | | | | Standard Error | | | | Estimate | | | | Standard Error | | | |
| Year | Stream | AD | K | R | A | AD | K | R | A | AD | K | R | A | AD | K | R | A |
| 1985 | Damdochax Cr | 0 | 0 | 0 | 0 | | | | | 0 | 0 | 0 | 0 | | | | |
| 1990 | Damdochax Cr | 20 | 0 | 20 | 7 | 23 | | 23 | 8 | 0 | 0 | 0 | 0 | | | | |
| 1995 | Damdochax Cr | 0 | 0 | 0 | 0 | | | | | 19 | 0 | 10 | 2 | 25 | | 12 | 3 |
| 1985 | Gitnadoix R | 3 | 0 | 3 | 3 | 5 | | 5 | 5 | 3 | 0 | 0 | 3 | 4 | | | 4 |
| 1990 | Gitnadoix R | 199 | 2 | 146 | 38 | 131 | 5 | 103 | 16 | 4 | 4 | 0 | 4 | 5 | 5 | | 5 |
| 1995 | Gitnadoix R | 45 | 0 | 71 | 15 | 36 | | 101 | 10 | 6 | 0 | 0 | 3 | 7 | | | 4 |
| 1985 | Ishkheenickh R | 80 | 25 | 132 | 31 | 41 | 15 | 100 | 15 | 38 | 13 | 65 | 9 | 31 | 12 | 65 | 7 |
| 1990 | Ishkheenickh R | 58 | 29 | 358 | 30 | 32 | 16 | 352 | 15 | 21 | 16 | 62 | 4 | 31 | 25 | 92 | 6 |
| 1995 | Ishkheenickh R | 66 | 9 | 124 | 29 | 34 | 10 | 67 | 13 | 0 | 0 | 0 | 0 | | | | |
| 1990 | Kispiox R | 375 | 0 | 144 | 124 | 87 | | 65 | 20 | 225 | 0 | 96 | 82 | 69 | | 56 | 20 |
| 1997 | Kispiox R | 593 | 10 | 92 | 149 | 150 | 9 | 38 | 25 | 444 | 0 | 311 | 126 | 130 | | 209 | 31 |
| 1985 | Kitimat R | 3191 | 382 | 524 | 277 | 719 | 87 | 194 | 32 | 223 | 28 | 13 | 51 | 100 | 21 | 11 | 17 |
| 1990 | Kitimat R | 6991 | 778 | 3962 | 763 | 1136 | 152 | 960 | 53 | 1264 | 114 | 496 | 276 | 352 | 39 | 244 | 38 |
| 1995 | Kitimat R | 5230 | 522 | 2475 | 605 | 652 | 89 | 563 | 42 | 1498 | 212 | 810 | 294 | 228 | 58 | 182 | 33 |
| 1990 | Skeena R | 9659 | 245 | 1573 | 914 | 1295 | 59 | 345 | 53 | 2053 | 90 | 171 | 492 | 277 | 24 | 61 | 52 |
| 1985 | Tseax R | 395 | 64 | 199 | 95 | 187 | 42 | 102 | 21 | 46 | 7 | 22 | 19 | 31 | 10 | 31 | 11 |
| 1990 | Tseax R | 235 | 9 | 93 | 60 | 134 | 11 | 56 | 22 | 79 | 4 | 5 | 23 | 59 | 5 | 7 | 13 |
| 1995 | Tseax R | 73 | 0 | 21 | 31 | 45 | | 21 | 13 | 25 | 0 | 0 | 21 | 12 | | | 10 |
| 1990 | Zymoetz R | 1072 | 39 | 853 | 203 | 277 | 28 | 379 | 31 | 379 | 4 | 302 | 145 | 112 | 5 | 217 | 36 |
| 1985 | Pallant Cr | 410 | 67 | 587 | 46 | 179 | 38 | 304 | 17 | 29 | 6 | 101 | 12 | 23 | 11 | 112 | 9 |
| 1990 | Pallant Cr | 97 | 7 | 80 | 45 | 42 | 7 | 63 | 19 | 16 | 0 | 3 | 8 | 17 | | 6 | 8 |
| 1995 | Pallant Cr | 150 | 7 | 262 | 35 | 109 | 11 | 241 | 14 | 18 | 0 | 15 | 12 | 14 | | 15 | 9 |

**Table A13** continued.—Bootstrapped standard errors of SHA fishery parameters, for 43 British Columbia steelhead fisheries. Values are for non-residents, and all residencies totaled.

| | | Non-Residents of BC | | | | | | | | Total, All Residencies | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Estimate | | | | Standard Error | | | | Estimate | | | | Standard Error | | | |
| **Year** | **Stream** | **AD** | **K** | **R** | **A** | **AD** | **K** | **R** | **A** | **AD** | **K** | **R** | **A** | **AD** | **K** | **R** | **A** |
| 1984 | Chilliwack R | 56 | 12 | 12 | 17 | 39 | 14 | 16 | 8 | 16625 | 863 | 8686 | 1999 | 1589 | 163 | 1471 | 78 |
| 1985 | Chilliwack R | 229 | 10 | 109 | 46 | 74 | 8 | 48 | 10 | 33485 | 2292 | 23233 | 3668 | 2074 | 195 | 2901 | 57 |
| 1983 | Thompson R | 1279 | 204 | 331 | 228 | 190 | 47 | 111 | 18 | 14679 | 2083 | 2651 | 2778 | 864 | 210 | 524 | 81 |
| 1984 | Thompson R | 1326 | 170 | 364 | 215 | 214 | 43 | 145 | 19 | 11987 | 1421 | 1856 | 2192 | 843 | 190 | 349 | 80 |
| 1985 | Thompson R | 1141 | 217 | 728 | 206 | 142 | 37 | 195 | 17 | 13107 | 2290 | 4991 | 2595 | 711 | 173 | 778 | 72 |
| 1983 | Chilcotin River | 48 | 0 | 29 | 9 | 45 | | 37 | 5 | 662 | 89 | 180 | 162 | 196 | 30 | 117 | 29 |
| 1984 | Chilcotin River | 18 | 3 | 0 | 13 | 11 | 3 | | 7 | 599 | 78 | 72 | 197 | 135 | 24 | 52 | 32 |
| 1985 | Chilcotin River | 3 | 0 | 0 | 3 | 3 | | | 3 | 547 | 94 | 211 | 220 | 93 | 25 | 84 | 30 |
| 1983 | Chilko R | 7 | 0 | 0 | 5 | 6 | | | 4 | 52 | 4 | 0 | 31 | 24 | 6 | | 13 |
| 1984 | Chilko R | 2 | 0 | 0 | 2 | 3 | | | 3 | 94 | 0 | 3 | 23 | 65 | | 4 | 11 |
| 1985 | Chilko R | 0 | 0 | 0 | 0 | | | | | 61 | 4 | 0 | 18 | 47 | 5 | | 10 |
| 1985 | Dean R | 1597 | 110 | 4155 | 275 | 134 | 23 | 489 | 20 | 3482 | 418 | 7149 | 631 | 417 | 60 | 758 | 45 |
| 1990 | Dean R | 3541 | 61 | 5069 | 577 | 237 | 28 | 559 | 34 | 6118 | 237 | 8232 | 919 | 728 | 45 | 1155 | 60 |
| 1995 | Dean R | 2090 | 0 | 2788 | 365 | 192 | | 365 | 29 | 4293 | 0 | 4429 | 592 | 529 | | 569 | 43 |
| 1983 | Bulkley R | 1668 | 205 | 789 | 307 | 182 | 43 | 200 | 21 | 12951 | 1642 | 4128 | 1711 | 1042 | 169 | 668 | 74 |
| 1984 | Bulkley R | 1014 | 106 | 517 | 242 | 168 | 27 | 156 | 25 | 9828 | 1035 | 3191 | 1430 | 1080 | 153 | 569 | 85 |
| 1990 | Bulkley R | 2278 | 19 | 1888 | 452 | 256 | 19 | 305 | 28 | 8117 | 62 | 5761 | 1291 | 821 | 28 | 947 | 70 |
| 1990 | Clore R | 0 | 0 | 0 | 0 | | | | | 25 | 0 | 5 | 11 | 26 | | 7 | 10 |
| 1985 | Cranberry River | 97 | 16 | 8 | 30 | 37 | 8 | 7 | 8 | 678 | 191 | 615 | 198 | 149 | 41 | 171 | 26 |
| 1990 | Cranberry River | 97 | 0 | 47 | 30 | 45 | | 37 | 10 | 651 | 0 | 614 | 138 | 234 | | 284 | 29 |
| 1995 | Cranberry River | 2 | 0 | 0 | 2 | 3 | | | 3 | 125 | 0 | 326 | 61 | 41 | | 221 | 18 |
| 1985 | Damdochax Cr | 69 | 27 | 75 | 16 | 31 | 25 | 46 | 7 | 69 | 27 | 75 | 16 | 31 | 25 | 46 | 7 |
| 1990 | Damdochax Cr | 99 | 0 | 72 | 17 | 41 | | 49 | 7 | 119 | 0 | 92 | 24 | 47 | | 55 | 10 |
| 1995 | Damdochax Cr | 173 | 0 | 225 | 29 | 65 | | 113 | 11 | 193 | 0 | 234 | 31 | 70 | | 115 | 11 |

**Table A13** continued.—Bootstrapped standard errors of SHA fishery parameters, for 43 British Columbia steelhead fisheries. Values are for non-residents, and all residencies totaled.

| | | Non-Residents of BC | | | | | | | | Total, All Residencies | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Estimate | | | | Standard Error | | | | Estimate | | | | Standard Error | | | |
| **Year** | **Stream** | **AD** | **K** | **R** | **A** | **AD** | **K** | **R** | **A** | **AD** | **K** | **R** | **A** | **AD** | **K** | **R** | **A** |
| 1985 | Gitnadoix R | 0 | 0 | 0 | 0 | | | | | 6 | 0 | 3 | 6 | 6 | | 5 | 6 |
| 1990 | Gitnadoix R | 2 | 0 | 0 | 2 | 3 | | | 3 | 205 | 6 | 146 | 43 | 132 | 7 | 103 | 18 |
| 1995 | Gitnadoix R | 0 | 0 | 0 | 0 | | | | | 51 | 0 | 71 | 18 | 37 | | 101 | 11 |
| 1985 | Ishkheenickh R | 14 | 1 | 1 | 6 | 15 | 2 | 2 | 4 | 132 | 39 | 198 | 45 | 52 | 19 | 117 | 17 |
| 1990 | Ishkheenickh R | 9 | 0 | 0 | 2 | 13 | | | 3 | 88 | 45 | 419 | 36 | 46 | 29 | 361 | 17 |
| 1995 | Ishkheenickh R | 0 | 0 | 0 | 0 | | | | | 66 | 9 | 124 | 29 | 34 | 10 | 67 | 13 |
| 1990 | Kispiox R | 1838 | 12 | 1491 | 373 | 283 | 11 | 423 | 35 | 2438 | 12 | 1730 | 579 | 300 | 11 | 435 | 43 |
| 1997 | Kispiox R | 2860 | 0 | 1596 | 484 | 337 | | 300 | 27 | 3897 | 10 | 1999 | 759 | 386 | 9 | 361 | 47 |
| 1985 | Kitimat R | 46 | 11 | 27 | 23 | 23 | 12 | 18 | 7 | 3460 | 421 | 563 | 351 | 728 | 90 | 195 | 38 |
| 1990 | Kitimat R | 563 | 141 | 114 | 119 | 111 | 51 | 45 | 15 | 8819 | 1033 | 4573 | 1158 | 1197 | 167 | 991 | 67 |
| 1995 | Kitimat R | 546 | 35 | 221 | 122 | 122 | 16 | 72 | 19 | 7274 | 769 | 3506 | 1022 | 715 | 108 | 599 | 57 |
| 1990 | Skeena R | 3694 | 296 | 452 | 522 | 446 | 60 | 93 | 34 | 15405 | 631 | 2197 | 1929 | 1391 | 88 | 371 | 83 |
| 1985 | Tseax R | 14 | 0 | 2 | 6 | 11 | | 3 | 4 | 455 | 71 | 222 | 121 | 190 | 43 | 108 | 25 |
| 1990 | Tseax R | 29 | 0 | 0 | 9 | 21 | | | 6 | 343 | 13 | 98 | 92 | 145 | 11 | 57 | 27 |
| 1995 | Tseax R | 9 | 0 | 7 | 7 | 8 | | 7 | 6 | 107 | 0 | 28 | 60 | 48 | | 23 | 18 |
| 1990 | Zymoetz R | 304 | 3 | 212 | 81 | 70 | 4 | 75 | 12 | 1756 | 45 | 1367 | 429 | 302 | 29 | 442 | 48 |
| 1985 | Pallant Cr | 6 | 0 | 15 | 3 | 6 | | 18 | 3 | 445 | 73 | 704 | 61 | 180 | 39 | 328 | 19 |
| 1990 | Pallant Cr | 21 | 8 | 11 | 7 | 18 | 8 | 10 | 6 | 134 | 15 | 94 | 61 | 49 | 10 | 64 | 21 |
| 1995 | Pallant Cr | 11 | 5 | 0 | 7 | 10 | 5 | | 6 | 179 | 11 | 277 | 54 | 112 | 12 | 243 | 18 |