Inseason Forecasting of Skeena River Sockeye Run Size Using Bayesian Probability Theory

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INSEASON FORECASTING OF SKEENA RIVER SOCKEYE RUN SIZE USING BAYESIAN PROBABILITY THEORY

by

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ABSTRACT

Cox-Rogers, S. 1997. Inseason forecasting of Skeena River sockeye run-size using Bayesian probability theory. Can. Manuscr. Rep. Fish. Aquat. Sci. 2412: 43 p.

This report examines the utility of using Bayesian probability theory to combine several inseason estimators of Canadian Area 4 Skeena River sockeye run-size into a single "best" estimate of total return. The inseason estimators were configured in two separate Bayes models, and included Canadian Area 3x cumulative catch per effort (CPE) and catch by statistical week, Area 4 cumulative CPE and catch by statistical week, and the Inshore Run (Area 4 catch plus escapement) by statistical week. Non-linear regressions of Area 4 total return versus each of these predictors were evaluated in a hindcast retrospective analysis for the years 1984-1994. The Bayesian composite forecasts were always more accurate than the least accurate component forecast, and sometimes better than the most accurate component forecast. Confidence intervals, calculated directly from the Bayes posterior distribution, included the true run size for all but the very largest return years. Prior probabilities, expressed as prior five-year average returns, had a variable impact on the Bayes composite forecasts, with some years benefiting form the use of priors, and other years not benefiting from the use of priors. The Mean Absolute Percent Error (MAPE) criterion identified the Bayes model using uniform priors, Area 3 cumulative CPE, Area 4 cumulative CPE, and the cumulative Inshore run, as performing slightly better than any of the other models tested. Forecast performance, for all models tested, improved as the season progressed. The Bayesian approach of using all available data to create a composite run-size forecast appears preferable to single-forecast methodologies.

RÉSUMÉ

Cox-Rogers, S. 1997. Inseason forecasting of Skeena River sockeye run-size using Bayesian probability theory. Can. Manuscr. Rep. Fish. Aquat. Sci. 2412: 43 p.

Le rapport examine l'utilité du recours à la théorie de la probabilité bayésienne pour combiner plusieurs estimateurs en saison de l'effectif de la remonte chez les saumons rouges de la Skeena dans la zone 4, en vue d'établir une seule «meilleure estimation» de la remonte totale. Les estimateurs en saison ont été configurés en deux modèles bayésiens séparés, et comprenaient les CPUE (captures par unité d'effort) cumulatives et les captures par semaine statistique pour la zone 3x, les CPUE cumulatives et les captures par semaine statistique pour la zone 4, et la remonte côtière (captures de la zone 4 plus échappées) par semaine statistique. Les régressions non linéaires de la remonte totale de la zone 4 en regard de chacun de ces prédicteurs ont été évaluées par une analyse rétrospective pour les années 1984-1994. Les prévisions bayésiennes composées étaient toujours plus exactes que la prévision de la moins exacte des composantes, et parfois meilleure que la prévision de la plus exacte des composantes. Les intervalles de confiance, calculés directement à partir des probabilités a posteriori de Bayes, comprenaient l'effectif réel des remontes de toutes les années, sauf celles qui étaient vraiment les plus fortes. Les probabilités a priori, exprimées en remontes moyennes des cinq années antérieures, avaient un effet variable sur les prévisions bayésiennes composées, certaines années bénéficiant de l'emploi des probabilités a priori et d'autres non. Le critère d'erreur moyenne absolue en pourcentage a permis de déterminer que le modèle bayésien utilisant les probabilités a priori uniformes, CPUE cumulatives pour la zone 3, CPUE cumulatives pour la zone 4 et remonte côtière cumulative, donnait des résultats légèrement meilleurs que tous les autres modèles testés. La performance prévue, pour tous les modèles, s'améliorait à mesure que la saison avançait. L'approche bayésienne faisant appel à toutes les données disponibles pour créer une prévision composée de l'effectif de la remonte est préférable aux méthodologies faisant appel à une seule prévision.

INTRODUCTION

Run size forecasting is an important component of the management process for Skeena River sockeye salmon. Two types of forecasts are used: a) pre-season estimates of total return, and b) in-season estimates of total return. Pre-season forecasts are generated well in advance of the fishing season, and are primarily used for expectation and planning purposes. In-season forecasts are generated during the fishing season, and are used for active management of the fishery. Of the two forecast types, the in-season estimates are the most important for managing Skeena River sockeye salmon, as they determine the number of salmon available for harvest (Les Jantz, Fisheries and Oceans Canada, 417 2nd Avenue West, Prince Rupert, British Columbia, V8J 1G8, pers comm).

In-season forecasts for Skeena River sockeye are generated from various "index" sources, such as commercial catch and effort data in specific fishing areas, and escapement enumeration data from test fishing. Walters (Carl Walters, Fisheries Centre, University of British Columbia, Vancouver, B.C. V6T 1Z4, pers comm) notes that the first step in developing an in-season assessment system is to establish historical relationships between the index observations and actual total run sizes. Managers can then update each forecast type as new information becomes available, often using experience and intuition to either choose a single forecast or to subjectively weigh and combine several forecasts to obtain an estimate of run size (Fried and Hilborn 1988). For Skeena River sockeye salmon, the performance (accuracy) of the various individual forecast methods tends to vary within and among seasons. Its also difficult for managers to try and choose the most appropriate forecast when more than one is available.

Fried and Hilborn (1988) identified a similar dilemma for management of the Bristol Bay sockeye fishery. Their problem was to estimate the most likely return of Bristol Bay sockeye based on in-season information from several run size predictors. Their approach was to combine the results of the individual forecast methods into a single "best" forecast using Bayesian probability theory. The concept is appealing for several reasons. First, by using all available information in a Bayesian framework, all of the available data are used to create the forecast. Second, the method is self-weighting, as the effect of any single forecast on the final composite forecast is directly related to its predictive variability. Third, the method is objective rather than subjective, in that the management task of selecting among conflicting forecasts is reduced to a single step.

In this report, I follow the approach of Fried and Hilborn (1988) to assess the utility of using Bayesian logic for in-season run size forecasting of Skeena River sockeye. Skeena River sockeye were chosen for this analysis because an adequate time series of catch, effort, and escapement data were available for the major fisheries impacting this stock.

Fishery Description

Skeena River sockeye are caught throughout July and August in various mixed-stock fisheries in southern Southeast Alaska and northern British Columbia. The run is composed primarily of age 4 and age 5 fish, most of which (>90%) spawn in the Babine Lake system in the upper Skeena River (West and Mason 1987). The major Canadian fisheries for Skeena River sockeye occur in the outer Canadian Area 3x purse seine and gillnet fishery adjacent to Dundas Island, and in the Canadian Area 4 gillnet fishery within Chatham Sound (figure 1). Although pre-season forecasts are made for fish returning through all fisheries, the in-season run size forecasts are made for fish returning to Area 4 alone, as this fishery accounts for about 75% of the Canadian Skeena River sockeye catch, and is actively managed to achieve escapement and harvest rate objectives.

Sockeye run size forecasts are usually provided to industry on a weekly basis. The primary method for estimating Area 4 run size has been division of the Area 4 cumulative catch plus escapement, to date, by the historical cumulative proportion of the Area 4 run to date. Secondary forecast "methods" include the subjective consideration of fishery specific catch and catch-per-effort (CPE) data in Canadian areas 1,3,5 and Southeast Alaska Districts 101-104.fisheries. In recent years, run size has also been estimated using an effort-harvest rate model developed for Area 4 management purposes (Cox-Rogers 1994). Managers often meet daily to discuss new information, evaluate the various run size forecasts, and to formulate decisions about harvest opportunities. Sprout and Kadowaki (1987) describe management of the Area 4 fishery in detail and provide a historic review.

Annual returns of Skeena River sockeye to Area 4 have averaged about 2.1 million (s.d. = 875000) fish for the 1970-1994 time period . The contribution of Skeena River sockeye to various north coast fisheries has been estimated approximately by run-reconstruction and stock identification studies using a wide range of biological markers (Wood et al 1995). In-season escapement estimates for Skeena River sockeye are calculated from a gillnet test fishery located on the lower Skeena River (Jantz et al 1990, Cox-Rogers and Jantz 1993)).

METHODS

Data Sources

All data used to generate the Area 4 run size forecasts in this report are compiled in appendix tables 1 through 5 The data are from spreadsheet files maintained by L. Jantz (FOC, pers comm). The annual Area 4 returns (1970-1994) were calculated by adding a) annual sockeye escapement estimates from the Babine River counting fence and other Skeena tributaries to b) in-river native harvest estimates and c) annual sales-slip catch records from Area 4. The catch and effort data for the Canadian Area 3x and Area 4 fisheries come from the in-season fishery officer "hail" estimates obtained during routine surveys. Here, estimates of average catch per boat (CPE) are obtained by randomly hailing a proportion of the fishing fleet each fishing day. Overflights provide estimates of the total number of boats participating in each fishery. Total catch by day is then estimated by multiplying average daily CPE by daily effort. The daily totals are then summed to provide weekly summaries. Post-season comparisons of hail estimates of catch usually agree well with actual sales slip records (Les Jantz, FOC, pers comm)

Bayesian Forecast Model

The Bayesian forecasting model presented in this report follows the methodology of Fried and Hilborn (1988). Lognormal error structure was assumed for all calculations, after examining frequency histograms of run size before and after log transformation, and after visually examining the various component forecast regressions for evidence of heteroscedasticity before and after log transformation. All parameter estimates were generated using the MGLH modules of SYSTAT (Wilkinson 1990). The Bayes estimator itself was configured in a Lotus 1-2-3 spreadsheet.

The basis for the forecasting technique used in this report is Bayes theorem, described by Hilborn and Walters (1992), pages 222-223, as follows:

$$Pr\{hypothesis|data\} = \frac{Pr\{hypothesis\} \times Pr(data|hypothesis\}}{\sum Pr\{hypothesis\} \times Pr(data|hypothesis\}}$$

"The equation breaks into three parts. Pr{hypothesis|data} is the posterior probability (expressed as an absolute probability between 0.0 and 1.0) of the hypothesis given the data (and prior information). Pr{hypothesis} is the prior probability of the hypothesis before the data are considered. Pr{data|hypothesis} is simply the likelihood of the data if the hypothesis is true. The denominator is exactly the same as

the numerator except summed over all possible hypotheses; it is the total probability of getting the data, over all hypotheses admitted as possibly having produced the data.

To use Bayes theorem to generate a posterior distribution requires three things:

1: A list of all possible hypotheses

2: A prior probability for each hypothesis, normalized so that the sum of all prior probabilities is equal to 1.0

3: A likelihood function to calculate the probability of the data if the hypothesis is true.

In the forecasting framework for this report, Bayes theorem was expressed as:

(Prob. of the run size given the forecasts)

= (prob. of the run size} X (prob. of the forecasts given the run size) / Σ (prob. of the run size} X (prob. of the forecasts given the run size)

eg.

$$P\{R_i|A,B,C,etc\} = \frac{P\{R_i\} \bullet L\{R_i|A,B,C,etc\}}{\sum_{i=1}^{n} P\{R_i\} \bullet L\{R_i|A,B,C,etc\}}$$

where $P\{R_i|A,B,C,etc\}$, the posterior distribution, was the probability of any run size R_i given that various component forecasts A, B, C, etc, were true, $L\{R_i|A,B,C,etc\}$ was the likelihood of getting forecasts A,B,C, etc given that run size R_i was true, and $P\{R_i\}$ was the prior probability of run size R_i occurring at all, based on prior information. The denominator was again the sum of all possible hypotheses.

Requirement #1- A list of all possible hypotheses?

These were the specific run sizes (R_i) considered to be possible in any given year. For Skeena River sockeye $n = 96$ specific run sizes from i =100000 to 4.9 million, in 50000 step increments, were specified.

Requirement #2- Prior probability distribution?

These were the probabilities of obtaining any of the specific run sizes (R_i) prior to the fishing season. For this analysis, Skeena River sockeye returns from 1970-1994 were tabled and mean run sizes and variances were calculated. As run sizes were assumed to be lognormally distributed, the likelihood, $L\{R_i\}$ of each run size (R_i) given these statistics was calculated using log-transformed data in the equation for a normal distribution:

$$L\{R_i\} = \frac{1}{V^{0.5}\sqrt{2\pi}} \exp\left[-(\ln R_i - M)^2 / 2V\right]$$

where R_i = total run size, M= mean run size for past years, and V = variance of run sizes for past years. The individual run size likelihoods ($L\{R_i\}$) were divided by their sum to give the actual prior probabilities ($P\{R_i\}$) of any run size occurring:

$$P\{R_i\} = \frac{L\{R_i\}}{\sum_{i=1}^{n} L\{R_i\}}$$

The run size having the greatest prior probability of being achieved was chosen as the best prior forecast of run size. As noted later in this paper, prior probabilities were treated as preseason estimates of run size, calculated using data for the five years preceding each year evaluated in the retrospective analysis.

Uniform prior probabilities for each run size were also assessed, given the caution by some authors (Walters and Ludwig 1994) about the sensitivity of Bayes estimators to the selection of priors. Uniform priors gave equal prior weight to each possible run size, and were calculated as:

$$P\{R_i\} = L\{R_i\} = \frac{1}{n}$$

where $n = 96$ was again the number of alternative run sizes possible.

Requirement #3- Likelihood function to calculate the probability of the data (forecasts) if the hypothesis (run size) is true

This requirement consisted of two steps. The first step was identifying various forecast methods for predicting Skeena River sockeye run size. The second step was calculating the actual likelihood function itself, and generating the posterior distribution.

Selection of the forecast methods

The inseason management process for Skeena River sockeye begins with a pre-season estimate of run size. Various techniques have been used in the past to establish pre-season forecasts (stock-recruit models, sibling models, etc) with a recent review suggesting that simple 5-year average returns may be the most appropriate (Wood et al 1995). Walters (pers comm) notes that pre-season forecasts can then be updated throughout the season using three types of information (a) catch per effort (CPE) in various index fisheries that have operated consistently over a number of years; (b) total catches in such index fisheries, and (c) indices of abundance based on deliberate test fishing and methods such as echo sounding. Because fish typically pass through the index fisheries with a temporal distribution that is roughly bell-shaped, the index information is usually used in cumulative form (Walters pers comm). Presently, a variation of method (c) is the only forecast method being used to estimate Skeena River sockeye returns in-season, although information from methods (a) and (b) are considered subjectively (L. Jantz, FOC, pers comm).

Following the approach of Fried and Hilborn (1988), I constructed historical regressions relating commercial fishery data to total Area 4 sockeye returns for the years 1970-1994. Five component forecast methods (m), configured in two separate Bayes models, were constructed:

Bayes Model 1: using weekly cumulative CPE data with and without priors

-forecast method (A): total Area 4 return versus Area 3x Gillnet+Seine cumulative CPE by statistical week.

-forecast method (B**):** total Area 4 return versus Area 4 Gillnet cumulative CPE by statistical week,

-forecast method (C): total Area 4 return versus the inshore run by statistical week, where the inshore run = weekly cumulative Area 4 catch + weekly cumulative escapement estimated to pass the Tyee test fishery

Bayes Model 2: using weekly cumulative catch data with and without priors

-forecast method (A): total Area 4 return versus Area 3x Gillnet+Seine cumulative catch by statistical week

-forecast method (B): total Area 4 return versus Area 4 Gillnet cumulative catch by statistical week

-forecast method (C): total Area 4 return versus the inshore run by statistical week, where the inshore run = weekly cumulative Area 4 catch + weekly cumulative escapement estimated to pass the Tyee test fishery

For Bayes Model 1 forecast methods (A) and (B) weekly cumulative CPE was calculated as total catch to date divided by total boat-day effort to date. As effort data for Area 3x were for both purse seines and gillnets, seine boat-day effort was converted to equivalent gillnet boat-day effort by simple ratio conversion (weekly Seine effort in Gillnet boat-days = (Seine cpe/Gillnet cpe) X Seine effort).

Power-function regressions (m) were used to generate weekly forecasts of total Area 4 run size from these historical data:

$$Y_{m,w} = \alpha\left(X_{m,w}\right)^{\beta}$$

solved by linear regression as:

$$\ln Y_{m,w} = \ln\alpha + \beta \ln X_{m,w}$$

where $\ln Y_{m,w}$ = total Area 4 run size estimated from forecast method m for week w, $\ln\alpha$ = y axis intercept, β= slope of the regression line, and $X_{m,w}$= data from forecast method m for week w. (i.e. cumulative Area 3x CPE or catch, cumulative Area 4 CPE or catch, cumulative inshore catch + escapement).

Each of the forecast methods was then used to "hindcast" annual run sizes by week for each year from 1984 -1994. For example, 1994 run size was calculated using 1994 inseason data in each forecast regression calculated using data from 1970-1993, and so on. This form of retrospective analysis, in which only data prior to the year of interest are used to calculate predictive equations, provides a robust measure of how well the various forecasting methods would have worked had they actually been used (Wood et al 1995).

The variance of the hindcasted weekly forecasts was calculated following Fried and Hilborn (1988) as:

$$S_m = S_{r\bullet m}\sqrt{1+\frac{1}{n}+\left[\frac{\left(F_{m,y}-\overline{F}\right)^2}{\sum_{y=1}^{n}\left(F_{m,y}-\overline{F}\right)^2}\right]}$$

where S_m = the standard error of the forecast based on regression method m, $S_{r\bullet m}$ = the standard error of the regression estimate of run size r for regression method m, $F_{m,y}$ = the forecasted run size based on regression method m for year y, and $\overline{F}$ = the mean forecasted run size for all past years based on regression method m.

Calculation of the likelihood function

As regression techniques were used to create the forecasts, a modified normal distribution, using log-transformed data, was used to calculate the likelihood of obtaining each of the 96 total run sizes given any of the forecast methods:

$$L\{R_i|F_m\} = \exp\left[-(\ln R_i - F_m)^2 / 2S_m^2\right]$$

where F_m = the forecasted run size based on regression method m, and S_m = the standard error of the forecast for regression method m. Composite forecast likelihoods ($L\{R_i|A,B,C_i\}$) for each run size were calculated as the product of the individual forecast likelihoods:

$$L\{R_i|A,B,C\} = L\{R_i|A\} * L\{R_i|B\} * L\{R_i|C\}$$

under the assumption that that the individual forecast methods were independent of each other.

Posterior probabilities for each run size were calculated by multiplying each composite run size likelihood by the prior probability of achieving that run size, and then dividing by the sum of all composite likelihoods:

$$P\{R_i|A,B,C\} = \frac{P\{R_i\} \bullet L\{R_i|A,B,C\}}{\sum_{i=1}^{n} P\{R_i\} \bullet L\{R_i|A,B,C\}}$$

Plots of the posterior probability distribution were used to graphically examine the weekly Bayes estimates of total run size for the hindcast simulations. The run size hypothesis associated with the greatest posterior probability (e.g. the mode) was selected as the best Bayesian composite forecast. As the posterior distribution sums to one, run size hypotheses encompassing 47.5% of the probability distribution on either side of the modal value were used to estimate the 95% confidence interval for each weekly forecast.

To compare the accuracy of the Bayesian forecast with each of its component forecasts, Mean Absolute Percent Errors (MAPE) across the years (I = 1,k) for each week were used

$$MAPE = \frac{100}{k} \bullet \sum |A - F|/A$$

where A = the actual run size, and F = the forecasted run size.

RESULTS

Data structure

The frequency histogram of non-transformed and log-transformed sockeye returns to Area 4 from 1970-1994 is shown in Figure 2. Nine potential distributions for the non-transformed data were tested by chi-square analysis (lognormal, logistic, normal, extreme value, gamma, beta, triangular, Weibull, and uniform). The lognormal distribution was found to be the most appropriate (chi-square = 2.01, p = 0.3679). Plots of the various component forecast methods (e.g. run size versus Area 3x CPE, Area 3 catch, Area 4 CPE, Area 4 catch, and Inshore run) for early (Week 071), peak (Week 074), and late (Week 082) season time periods also indicate that log-transformation of the raw data is appropriate (Figures 3 through 7).

Regression fits for all component forecasts improved as the season progressed (Table 1, Appendix Tables 6 and 7), with forecasts for the peak (Week 074) time period being highly significant (F = 25.983 to 42.99, p<0.001). Pre-season forecasts of run size, calculated as prior five-year averages, exhibited considerable variability about the true run size (Tables 2 through 5) a finding also noted by Wood et al (1995).

Retrospective Analysis

The hindcast performance of the individual component forecast methods, as well as the Bayes composite forecasts, varied considerably both among and within years (Tables 2 through 5). Over all hindcast years considered (1984-1994) no single forecast method consistently predicted run size, on average, any better than the other using the MAPE criterion (Table 6), although the lowest MAPE values for the key weeks of the fishing season (Weeks 073 and 074), were achieved for Bayes Model 1 using just Area 3x cumulative CPE, Area 4 cumulative CPE, and Inshore run (MAPE = 18.4% and 17.8% respectively). MAPE values for the individual years generally improved (got lower) as the season progressed.

Pre-season (prior) information had a variable impact on the calculation of the Bayes posterior distribution, with some years benefiting from the inclusion of priors, and others not benefiting (Tables 2 through 5). Over all hindcast years, the use of priors did not improve average forecast success for either Bayes model 1 or 2 (Table 6), although the inclusion of priors did not significantly alter forecast success either. The variable impact of non-uniform priors on the Bayes composite forecasts reflects the high variability associated with actual returns versus preceding 5-year average run sizes. The 1984-1994 average MAPE value for prior run size was 32.6%, the highest of all component forecasts.

The Bayesian composite forecasts, for both Bayes models 1 and 2, were always more accurate than the least accurate of their component forecasts (Tables 2 through 5, Table 6). In general, the Bayes composite forecasts were closer to the most accurate individual forecast than they were to the least accurate individual forecast. The confidence intervals for the Bayes composite forecasts were quite wide for some weeks in some years (Tables 2 through 5) and generally improved as the season progressed. For the retrospective analysis, there was also a tendency for the Bayes composite forecasts to underestimate the very large run sizes (1985) and overestimate the very small ones (1986). For both Bayes models 1 and 2, the 95% confidence intervals included the correct run size for all years except 1985 and 1993, the two largest return years to Area 4.

Figure 8 compares the Bayes posterior distribution with its component forecasts for Bayes model 1 using priors (Week 074 in 1994). This particular example illustrates how the various component forecasts, all of which predict different run sizes, combine to generate the Bayes composite forecast.

DISCUSSION

This report outlines a Bayesian procedure for combining various in-season forecast methods into a single weighted composite estimate of Skeena River sockeye run size each week of the fishing season. The forecast methods presented in this report are based on the types of data fishery managers obtain inseason. Other in-season "index" data not considered in this report may also prove useful for incorporation into the same Bayesian framework (e.g. in-river native fishery data, Southeast Alaska fishery data, etc.). The Bayesian method could be also be applied to other north coast salmon stocks where reliable catch, effort, and escapement data exist (Nass River sockeye, Smith Inlet sockeye, Area 8 pink, Area 8 chum, etc.).

The various Bayes models examined in this report all performed similarly for the key weeks of the fishing season from mid-late July. Bayes Model 1 (using uniform prior probabilities of run size, Area 3x cumulative catch per effort, Area 4 cumulative catch per effort, and the Inshore run) had slightly lower Mean Absolute Percent Error values than Bayes Model 1 using non-uniform priors (pre-season run size estimates based on the preceding five-year average), or Bayes model 2 (Area 3x cumulative catch, Area 4 cumulative catch, Inshore run) with or without priors. Given that catch-per-effort (CPE) forecasts consider the effects of effort on catch, its tempting to give preference to the Bayes models incorporating CPE data. However, CPE models can be vulnerable to changing catchability over time (Walters and Ludwig 1994), and so further sensitivity testing should be conducted prior to choosing any one specific Bayes model over the other. Sensitivity testing could also include a comparison of the Bayes results with those from other methodologies, such as multivariate regression analysis and simple averaging of all estimation procedures.

A useful feature of the Bayesian approach is the ability to incorporate pre-season "expectations" about run size into the inseason forecast through the use of non-uniform prior probability distributions. Walters and Ludwig (1994) discuss the selection of prior probability distributions at length. They stress caution when developing priors because the posterior distributions can be very sensitive to the form of the prior used. In this report, non-uniform priors were represented as pre-season run size expectations based on preceding five-year average returns. The pre-season expectations performed variably for all of the models tested. This reflects the large uncertainty inherent in pre-season forecasting of Skeena River sockeye salmon. It is unclear if pre-season expectations offer any real utility for inseason forecasting purposes. Although some of the Bayes composite forecasts were enhanced by the use of pre-season expectations, many were not, and some performed worse than those models using simple uniform priors. Further work is required to better assess the influence of various non-uniform priors on the Bayes models presented in this report.

The accuracy and reliability of the Bayesian approach outlined in this report is clearly dependent upon the catch, effort, and escapement data used to construct the historical forecast regressions. Catch and effort data for the various fisheries impacting

Skeena River sockeye are from fishery officer surveys, which usually agree relatively well with annual sales slip figures tallied at the end of the year. Still, the area-specific catch data used in this report may need to be calibrated against more sophisticated run- reconstructions being developed (Gazey and English 1996). The in-season test fishery escapement data used for the inshore component forecast tends to underestimate true escapement each year (Cox-Rogers and Jantz 1993). Ongoing studies are attempting to qualify and improve the accuracy of inseason test fishery escapement estimates. Other data concerns include the effect that changing fishery regimes may have on the forecasting methods outlined in this report. Inseason forecasting relies upon index fisheries and assessment programs that have operated in a consistent manner over a number of years. There is some potential for fundamental changes to north coast index fisheries as a result of ongoing fleet rationalization initiatives in the Pacific Region. The impact of these changes, on the forecasting process, needs to be identified and evaluated.

The advantages of using Bayesian forecasting, as opposed to maintaining the single-forecast methodology now being used for Skeena River sockeye, are intriguing. First, the composite Bayes forecast eliminates the need for managers to try and pick the "best" forecast from among the several available. Although the Bayes estimate is not always more accurate than its component forecasts, it is always more accurate than the least accurate component forecast. Second, the Bayes forecast utilizes all available information in a self-weighting, self-updating format as the season progresses. Third, the Bayes posterior distribution conveys forecast uncertainty in a graphical form easily understood by managers and industry. The posterior distribution also provides managers with a graphical interface for implementing various management strategies. For example, a simple "risk averse" run size estimate can be made from the posterior distribution by reducing the modal (maximum likelihood) Bayes composite run size estimate "downwards" by some designated standard deviation unit.

CONCLUSIONS

1) Bayesian forecast techniques offer an objective and consistent framework for inseason run size forecasting of Skeena River sockeye , and should be considered as a replacement to current single-method forecasts. Where feasible, Bayesian approaches should also be considered for other north coast salmon stocks where reliable data exist (e.g. Nass River sockeye, Smith Inlet sockeye, Area 8 pink, Area 8 chum, etc.).

2) The Bayesian approach outlined in this report utilizes catch, effort, and escapement data from fisheries that have operated in a consistent manner over a number of years. The sensitivity of the Bayesian approach to changing fishery regimes (Area licensing, effort transfer, etc.) in future years needs to be understood and evaluated.

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Forecast Method		Wk 071	Wk 074	Wk 082
3x CPE	F	7.841	38.309	36.153
	p	0.019	<0.001	<0.001
	r^2	0.439	0.625	0.606
3x Catch	F	1.796	25.983	26.847
	p	0.210	<0.001	<0.001
	r^2	0.152	0.553	0.561
4 CPE	F	3.136	27.483	83.589
	p	0.102	<0.001	<0.001
	r^2	0.207	0.544	0.814
4 Catch	F	0.339	39.388	124.846
	p	0.571	<0.001	<0.001
	r^2	0.028	0.642	0.850
Inshore	F	1.773	42.999	125.684
	p	0.196	<0.001	<0.001
	r^2	0.072	0.652	0.845

Table 1. 1970-1994 summary regression statistics for Area 4 run size versus Area 3x cumulative CPE, Area 3x cumulative catch, Area 4 cumulative CPE, Area 4 cumulative catch, and Inshore run for early season (Week 071), peak season (Week 074), and late season (Week 082) forecast regression models (log-transformed data).

NO PRIORS

Year	Method	83	84	71	72	73	74	75	81	82
1994	CPE 3x	0	1437178	1790178	1924569	2144653	2365650	2338559	2532565	2546253
	CPE 4	0	0	0	1580778	1543676	1054068	1116037	1205302	1390123
	Inshore	1681478	1880026	1761171	1725838	1737595	1530329	1601877	1537552	1634157
	lower	900000	1000000	1100000	1150000	1250000	1150000	1150000	1250000	1300000
	BAYES	1850000	1550000	1800000	1700000	1800000	1600000	1600000	1600000	1700000
	upper	4350000	2650000	3100000	2700000	2600000	2150000	2150000	2050000	2100000
	Actual Run	1784363	1784363	1784363	1784363	1784363	1784363	1784363	1784383	1784383
1993	CPE 3x	0	2188392	2115586	2344405	2509551	2745754	2590379	2473111	2492393
	CPE 4	0	0	2496023	2694695	2580834	2858394	2854007	3303686	3586320
	Inshore	1913063	1926180	1998877	2074529	2202379	2556088	2618254	2930994	3188062
	lower	950000	1550000	1450000	1600000	1750000	2000000	2000000	2250000	2500000
	BAYES	1900000	2150000	2150000	2400000	2450000	2700000	2700000	2900000	3150000
	upper	4350000	3900000	3800000	3700000	3700000	3650000	3650000	3700000	3950000
	Actual Run	3637895	3637895	3637895	3637895	3637895	3637895	3837895	3837895	3837895
1992	CPE 3x	0	0	2619539	2463249	2705336	3066319	2863630	2999155	2972059
	CPE 4	0	0	2270572	2209652	2090701	2227099	2242371	2292121	2456094
	Inshore	1665958	1797640	1919307	2083946	2241832	2500737	2438669	2461136	2484913
	lower	850000	900000	1550000	1500000	1650000	1900000	1850000	1950000	2050000
	BAYES	1650000	1800000	2300000	2250000	2350000	2600000	2450000	2550000	2550000
	upper	4000000	4200000	3650000	3500000	3350000	3500000	3250000	3200000	3200000
	Actual Run	3201553	3201553	3201553	3201553	3201553	3201553	3201553	3201553	3201553
1991	CPE 3x	0	0	1741990	2176063	2618721	2633874	2546256	2757011	2763115
	CPE 4	0	0	2113685	2212036	2096004	1950065	1927560	2031263	2165959
	Inshore	1666320	1726170	1864373	2102301	2315370	2496123	2451808	2324752	2355452
	lower	950000	850000	1200000	1450000	1650000	1750000	1700000	1800000	1850000
	BAYES	1850000	1750000	1850000	2150000	2350000	2350000	2300000	2350000	2350000
	upper	4300000	4100000	2950000	3400000	3350000	3200000	3050000	2950000	2950000
	Actual Run	2380598	2380598	2380598	2380596	2380596	2380596	2380596	2380596	2380596
1990	CPE 3x	0	0	1632775	1951069	1842514	2027300	2055335	1576266	1479524
	CPE 4	0	1369965	1498753	1157690	1619140	1552891	1551812	1594417	1684908
	Inshore	1793894	1753682	1714893	1595532	1676002	1680545	1651835	1610486	1605105
	lower	900000	950000	1050000	950000	1200000	1250000	1250000	1200000	1250000
	BAYES	1800000	1500000	1600000	1500000	1700000	1750000	1700000	1600000	1600000
	upper	4250000	2550000	2650000	2350000	2500000	2400000	2250000	2050000	2000000
	Actual Run	1970004	1970004	1970004	1970004	1970004	1970004	1970004	1970004	1970004
1989	CPE 3x	0	0	1515162	1817746	1923238	1876978	1725125	1735645	1761655
	CPE 4	0	1292601	1741514	1995109	1753661	1550967	1589375	1566822	1615009
	Inshore	1934793	1941510	2008456	2342760	2203753	2032481	1921379	1792697	1729746
	lower	950000	900000	1100000	1350000	1350000	1300000	1300000	1300000	1300000
	BAYES	1950000	1500000	1700000	2050000	1950000	1800000	1750000	1700000	1700000
	upper	4400000	2500000	2900000	3300000	2850000	2500000	2350000	2200000	2100000
	Actual Run	1909221	1909221	1909221	1909221	1909221	1909221	1909221	1909221	1909221

MAPE

Year	Method	83	84	71	72	73	74	75	81	82
1994	CPE 3x	—	18.5	1.5	9.1	21.6	34.1	32.5	43.5	44.3
	CPE 4	—	—	—	10.4	12.5	40.3	36.7	31.7	21.2
	Inshore	5.5	5.4	0.2	2.2	1.5	13.3	9.2	12.9	7.4
	BAYES	4.9	12.1	2.0	3.8	2.0	9.3	9.3	9.3	3.8
1993	CPE 3x	—	39.8	41.8	35.6	31.0	24.5	28.8	32.0	31.5
	CPE 4	—	—	31.4	25.9	29.1	21.4	21.5	9.2	1.4
	Inshore	47.4	47.1	45.1	43.0	39.5	29.7	28.0	19.4	12.4
	BAYES	47.8	40.9	40.9	34.0	32.7	25.8	25.8	20.3	13.4
1992	CPE 3x	—	—	18.2	23.4	16.5	4.2	10.6	8.3	7.2
	CPE 4	—	—	29.1	31.0	34.7	30.4	30.0	28.4	23.3
	Inshore	48.0	43.8	40.1	34.9	30.0	21.9	23.8	23.1	22.4
	BAYES	48.5	43.8	28.2	29.7	28.8	18.8	23.5	20.4	20.4
1991	CPE 3x	—	—	26.2	7.9	10.9	11.6	7.9	16.8	17.1
	CPE 4	—	—	10.5	6.3	11.2	17.4	18.3	14.0	8.2
	Inshore	20.9	26.9	21.0	10.9	1.9	5.7	3.9	1.5	0.2
	BAYES	21.6	25.9	21.6	8.9	0.4	0.4	2.8	0.4	0.4
1990	CPE 3x	—	—	17.1	1.0	6.5	2.9	4.3	20.0	24.9
	CPE 4	—	30.5	23.9	41.2	17.6	21.2	21.2	19.1	14.5
	Inshore	8.9	11.0	12.9	19.0	14.9	14.7	16.2	18.2	18.5
	BAYES	8.8	23.9	18.8	23.9	13.7	11.2	13.7	18.8	18.8
1989	CPE 3x	—	—	20.6	4.8	0.7	1.7	9.6	9.1	7.7
	CPE 4	—	32.3	8.8	4.5	8.1	18.8	16.8	17.9	15.4
	Inshore	1.3	1.7	5.2	22.7	15.4	6.5	0.6	6.1	9.4
	BAYES	2.1	21.4	11.0	7.4	2.1	5.7	8.3	11.0	11.0

Table 2. 1984-1994 retrospective forecasts of Area 4 Skeena River sockeye returns by statistical week for Bayes Model 1 (no priors) , for three independent forecasts and the Bayesian composite forecast. Corresponding absolute percent error (APE) values for each forecast are reported by year for each statistical week.

Year		63	64	71	72	73	74	75	81	82
1988	CPE 3x	0	0	0	2058483	2157458	2180795	1402687	1669367	1722068
	CPE 4	0	0	1460333	2004298	2038102	1909391	1999347	2707681	2919359
	Inshore	1673297	1617879	1766017	2055318	2303163	2426215	2558572	3036666	3228987
	lower	600000	800000	900000	1350000	1500000	1600000	1500000	1900000	2100000
	BAYES	1650000	1600000	1600000	2050000	2150000	2150000	2000000	2450000	2700000
	upper	4100000	4000000	3250000	3250000	3150000	3100000	3200000	3100000	3350000
	Actual Run	3064832	3064832	3064832	3064832	3064832	3084832	3064832	3064832	3084832
1987	CPE 3x	0	0	0	0	1977625	1789299	1794578	1903111	1922380
	CPE 4	0	0	0	2042358	2510492	2290439	2285071	1845671	1792142
	Inshore	1696826	1709381	1628604	1633949	1693178	1530517	1497674	1416063	1380380
	lower	800000	650000	800000	1150000	1400000	1350000	1350000	1250000	1250000
	BAYES	1700000	1700000	1650000	1850000	2050000	1850000	1800000	1650000	1600000
	upper	4200000	4150000	4100000	3300000	3050000	2550000	2350000	2100000	1950000
	Actual Run	1982906	1982906	1982906	1982906	1982906	1982906	1982906	1982906	1982906
1986	CPE 3x	0	0	0	2371108	1614845	1721393	1786328	1802471	1847672
	CPE 4	0	0	0	1749817	1982367	2389219	2293312	2214049	2033019
	Inshore	1537466	1571636	1589693	1465980	1506129	1436186	1335886	1246009	1250847
	lower	700000	750000	750000	1150000	1150000	1400000	1300000	1300000	1250000
	BAYES	1550000	1550000	1600000	1800000	1700000	1900000	1750000	1700000	1600000
	upper	4050000	4050000	4100000	2950000	2550000	2550000	2300000	2100000	1950000
	Actual Run	1322044	1322044	1322044	1322044	1322044	1322044	1322044	1322044	1322044
1985	CPE 3x	0	0	0	1878070	2439853	3242096	3055215	2795410	2785844
	CPE 4	0	0	1460336	2429383	2473840	3119353	3401823	3644937	3764096
	Inshore	1766434	1655409	1797072	2013231	2442985	3108727	3570130	4001681	4603615
	lower	900000	950000	1000000	1400000	1750000	2350000	2600000	2750000	3050000
	BAYES	1750000	1850000	1600000	2100000	2450000	3150000	3350000	3450000	3800000
	upper	4100000	4200000	2800000	3300000	3550000	4200000	4350000	4300000	4600000
	Actual Run	4419879	4419679	4419679	4419679	4419679	4419679	4419679	4419679	4419679
1984	CPE 3x	0	0	0	2023420	2183604	1752462	1565488	1575926	1311568
	CPE 4	0	0	0	2211154	2450780	2207285	2154708	2056909	2051075
	Inshore	1771382	1868826	1785727	2007600	2411432	3081965	3575846	4000903	4686940
	lower	900000	950000	900000	1350000	1650000	1700000	1650000	2000000	2250000
	BAYES	1750000	1850000	1900000	2100000	2350000	2300000	2400000	2500000	2800000
	upper	4150000	4250000	4200000	3350000	3450000	3150000	3200000	3100000	3350000
	Actual Run	1992484	1992484	1992484	1992484	1992484	1992484	1992484	1992484	1992484

Year		63	64	71	72	73	74	75	81	82
1988	CPE 3x	—	—	—	32.8	29.6	28.8	54.2	45.5	43.8
	CPE 4	—	—	52.4	34.6	33.5	37.7	34.8	11.6	4.7
	Inshore	45.4	47.2	42.4	32.9	24.9	20.6	16.5	0.9	5.4
	BAYES	46.2	47.8	47.8	33.1	29.8	29.8	34.7	20.1	11.9
1987	CPE 3x	—	—	—	—	0.3	9.8	9.5	4.0	3.1
	CPE 4	—	—	—	3.0	26.6	15.5	15.2	6.9	9.6
	Inshore	14.4	13.8	17.9	17.6	14.6	22.8	24.5	28.6	30.4
	BAYES	14.3	14.3	16.8	6.7	3.4	6.7	9.2	16.8	19.3
1986	CPE 3x	—	—	—	79.4	22.1	30.2	35.1	36.3	39.8
	CPE 4	—	—	—	32.4	49.9	80.7	73.5	67.5	53.8
	Inshore	16.3	18.9	20.2	10.9	13.9	8.6	1.0	5.8	5.4
	BAYES	17.2	17.2	21.0	36.2	29.6	43.7	32.4	28.6	21.0
1985	CPE 3x	—	—	—	57.5	44.8	26.6	30.9	36.8	37.0
	CPE 4	—	—	67.0	45.0	44.0	29.4	23.0	17.5	14.8
	Inshore	60.0	58.0	59.3	54.4	44.7	29.7	19.2	9.5	4.2
	BAYES	60.4	58.1	63.8	52.5	44.6	28.7	24.2	21.9	14.0
1984	CPE 3x	—	—	—	1.6	9.6	12.0	21.4	20.9	34.2
	CPE 4	—	—	—	11.0	23.0	10.8	6.1	3.3	2.9
	Inshore	11.1	6.2	10.4	0.8	21.0	54.7	79.5	100.8	135.2
	BAYES	12.2	7.2	9.7	5.4	17.9	15.4	20.5	25.5	40.5
All Years MAPE	CPE 3x	—	29.2	20.9	23.0	17.5	17.0	22.3	24.7	26.4
	CPE 4	—	31.4	31.8	22.3	28.4	29.4	27.2	20.6	15.5
	Inshore	25.4	25.5	25.0	22.7	20.2	20.8	20.2	20.6	22.8
	BAYES	25.8	28.4	25.6	21.9	18.4	17.8	18.6	17.5	15.9

Table 2. continued.

PRIORS

Year	Method	83	84	71	72	73	74	75	81	82
1994	Preseason	2528781	2528781	2528781	2528781	2528781	2528781	2528781	2528781	2528781
	CPE 3x	0	1437178	1790176	1924569	2144653	2365650	2338559	2532565	2546253
	CPE 4	0	0	0	1580778	1543676	1054068	1116037	1205302	1390123
	Inshore	1861478	1860026	1761171	1725838	1737595	1530329	1601877	1537552	1634157
	lower	1550000	1400000	1500000	1450000	1500000	1350000	1350000	1400000	1450000
	BAYES	2350000	1950000	2100000	2000000	2000000	1800000	1750000	1750000	1800000
	upper	3750000	2800000	3100000	2600000	2700000	2300000	1350000	2200000	2200000
	Actual Run	1784363	1784363	1784363	1784363	1784363	1784363	1784363	1784363	1784363
1993	Preseason	2443557	2443557	2443557	2443557	2443557	2443557	2443557	2443557	2443557
	CPE 3x	0	2188392	2115586	2344405	2509551	2745754	2590379	2473111	2492393
	CPE 4	0	0	2496023	2694895	2580834	2858394	2854007	3303686	3586320
	Inshore	1913063	1926180	1998877	2074529	2202379	2558088	2618254	2930994	3188062
	lower	1600000	1700000	1700000	1800000	1850000	2050000	2050000	2250000	2400000
	BAYES	2300000	2250000	2300000	2400000	2450000	2600000	2600000	2800000	3000000
	upper	3450000	3900000	3800000	3700000	3700000	3600000	3600000	3600000	3600000
	Actual Run	3637895	3637895	3637895	3637895	3637895	3637895	3637895	3637895	3637895
1992	Preseason	2220295	2220295	2220295	2220295	2220295	2220295	2220295	2220295	2220295
	CPE 3x	0	0	2619539	2453249	2705336	3066319	2863630	2999155	2972059
	CPE 4	0	0	2270572	2209652	2090701	2227099	2242371	2292121	2456094
	Inshore	1665956	1797840	1919307	2083946	2241832	2500737	2438669	2461136	2484913
	lower	1550000	1550000	1700000	1700000	1750000	1900000	1900000	1950000	2000000
	BAYES	2100000	2150000	2250000	2250000	2250000	2450000	2350000	2400000	2450000
	upper	3500000	3500000	3400000	3400000	3400000	3200000	3200000	3200000	2950000
	Actual Run	3201553	3201553	3201553	3201553	3201553	3201553	3201553	3201553	3201553
1991	Preseason	1977223	1977223	1977223	1977223	1977223	1977223	1977223	1977223	1977223
	CPE 3x	0	0	1741990	2175063	2618721	2633874	2548258	2757011	2763115
	CPE 4	0	0	2113685	2212036	2096004	1950065	1927580	2031283	2165959
	Inshore	1866320	1726170	1864373	2102301	2315370	2496123	2451808	2324752	2355452
	lower	1250000	1250000	1350000	1500000	1650000	1700000	1700000	1800000	1850000
	BAYES	1950000	1900000	1900000	2100000	2200000	2250000	2200000	2250000	2300000
	upper	3100000	3050000	2700000	2950000	3000000	2950000	2850000	2800000	2600000
	Actual Run	2380598	2380596	2380596	2380596	2380596	2380596	2380596	2380596	2380596
1990	Preseason	2324022	2324022	2324022	2324022	2324022	2324022	2324022	2324022	2324022
	CPE 3x	0	0	1632775	1951069	1842514	2027300	2055335	1576266	1479524
	CPE 4	0	1369965	1498753	1157890	1619140	1552891	1551812	1594417	1684908
	Inshore	1793894	1753882	1714893	1595532	1676002	1880545	1651835	1610488	1605105
	lower	1200000	1100000	1200000	1100000	1300000	1350000	1300000	1250000	1300000
	BAYES	2050000	1700000	1750000	1650000	1600000	1800000	1750000	1650000	1650000
	upper	3900000	2600000	2700000	2400000	2500000	2400000	2300000	2050000	2050000
	Actual Run	1970004	1970004	1970004	1970004	1970004	1970004	1970004	1970004	1970004
1989	Preseason	2344372	2344372	2344372	2344372	2344372	2344372	2344372	2344372	2344372
	CPE 3x	0	0	1515162	1617746	1923238	1876976	1725125	1735645	1761655
	CPE 4	0	1292601	1741514	1995109	1753661	1550967	1589375	1566822	1615009
	Inshore	1934793	1941510	2008456	2342760	2203753	2032481	1921379	1792697	1729746
	lower	1250000	1100000	1250000	1450000	1450000	1400000	1350000	1350000	1350000
	BAYES	2150000	1650000	1850000	2100000	2000000	1900000	1650000	1750000	1750000
	upper	4050000	2600000	2900000	3200000	2850000	2500000	2400000	2200000	2150000
	Actual Run	1909221	1909221	1909221	1909221	1909221	1909221	1909221	1909221	1909221

MAPE

Year	Method	83	84	71	72	73	74	75	81	82
1994	Preseason	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3
	CPE 3x	—	18.5	1.5	9.1	21.6	34.1	32.5	43.5	44.3
	CPE 4	—	—	—	10.4	12.5	40.3	36.7	31.7	21.2
	Inshore	5.5	5.4	0.2	2.2	1.5	13.3	9.2	12.9	7.4
	BAYES	33.2	10.5	19.0	13.4	13.4	2.0	0.6	0.6	2.0
1993	Preseason	32.8	32.8	32.8	32.8	32.8	32.8	32.8	32.8	32.8
	CPE 3x	—	39.8	41.8	35.8	31.0	24.5	28.8	32.0	31.5
	CPE 4	—	—	31.4	25.9	29.1	21.4	21.5	9.2	1.4
	Inshore	47.4	47.1	45.1	43.0	39.5	29.7	28.0	19.4	12.4
	BAYES	38.8	38.2	38.8	34.0	32.7	28.5	28.5	23.0	17.5
1992	Preseason	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6
	CPE 3x	—	—	18.2	23.4	15.5	4.2	10.6	8.3	7.2
	CPE 4	—	—	29.1	31.0	34.7	30.4	30.0	28.4	23.3
	Inshore	48.0	43.8	40.1	34.9	30.0	21.9	23.8	23.1	22.4
	BAYES	34.4	32.8	29.7	29.7	29.7	23.5	28.8	25.0	23.5
1991	Preseason	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2
	CPE 3x	—	—	26.2	7.9	10.9	11.6	7.9	16.8	17.1
	CPE 4	—	—	10.5	6.3	11.2	17.4	18.3	14.0	8.2
	Inshore	20.9	26.9	21.0	10.9	1.9	5.7	3.9	1.5	0.2
	BAYES	17.4	19.5	19.5	11.0	6.8	4.7	8.8	4.7	2.8
1990	Preseason	16.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0
	CPE 3x	—	—	17.1	1.0	6.5	2.9	4.3	20.0	24.9
	CPE 4	—	30.5	23.9	41.2	17.8	21.2	21.2	19.1	14.5
	Inshore	8.9	11.0	12.9	19.0	14.9	14.7	16.2	18.2	18.5
	BAYES	4.1	13.7	11.2	16.2	8.8	8.8	11.2	16.2	16.2
1989	Preseason	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8
	CPE 3x	—	—	20.6	4.8	0.7	1.7	9.6	9.1	7.7
	CPE 4	—	32.3	8.8	4.5	8.1	18.8	16.8	17.9	15.4
	Inshore	1.3	1.7	5.2	22.7	15.4	6.5	0.8	8.1	9.4
	BAYES	12.6	13.6	3.1	10.0	4.8	0.5	3.1	8.3	8.3

Table 3. 1984-1994 retrospective forecasts of Area 4 Skeena River sockeye returns by statistical week for Bayes Model 1 (with priors) , for three independent forecasts and the Bayesian composite forecast. Corresponding absolute percent error (APE) values for each forecast are reported by year for each statistical week.

Year	Method	63	64	71	72	73	74	75	81	82
1988	Preseason	1981513	1981513	1981513	1981513	1981513	1981513	1981513	1981513	1981513
	CPE 3x	0	0	0	2058483	2157458	2180795	1402887	1669367	1722068
	CPE 4	0	0	1460333	2004296	2038102	1909391	1999347	2707881	2919359
	Inshore	1873297	1817879	1786017	2055318	2303163	2426215	2558572	3036866	3228987
	lower	1050000	1050000	1050000	1350000	1500000	1600000	1500000	1900000	2100000
	BAYES	1800000	1800000	1750000	2000000	2150000	2150000	2000000	2400000	2650000
	upper	3550000	3450000	3450000	3350000	3300000	3250000	3300000	3200000	3000000
	Actual Run	3084832	3084832	3084832	3084832	3084832	3084832	3084832	3084832	3084832
1987	Preseason	2158373	2158373	2158373	2158373	2158373	2158373	2158373	2158373	2158373
	CPE 3x	0	0	0	0	1977625	1789299	1794578	1903111	1922380
	CPE 4	0	0	0	2042358	2510492	2290439	2285071	1845671	1792142
	Inshore	1896828	1709381	1628604	1633949	1693178	1530517	1497874	1416063	1380380
	lower	1050000	1100000	1050000	1250000	1450000	1400000	1350000	1300000	1250000
	BAYES	1900000	1900000	1850000	1900000	2050000	1900000	1800000	1700000	1600000
	upper	3800000	3800000	3750000	3150000	3000000	2550000	2350000	2100000	2000000
	Actual Run	1982906	1982906	1982908	1982906	1982906	1982908	1982908	1982906	1982908
1986	Preseason	2557906	2557906	2557906	2557906	2557906	2557906	2557906	2557906	2557906
	CPE 3x	0	0	0	2371108	1614845	1721393	1786328	1802471	1847672
	CPE 4	0	0	0	1749817	1982367	2389219	2293312	2214049	2033019
	Inshore	1537488	1571638	1589693	1465980	1506129	1436186	1335886	1246009	1250847
	lower	1150000	1200000	1200000	1350000	1300000	1450000	1400000	1350000	1300000
	BAYES	2050000	2050000	2050000	1950000	1850000	1950000	1850000	1750000	1850000
	upper	3900000	3900000	3950000	3000000	2650000	2600000	2350000	2150000	2000000
	Actual Run	1322044	1322044	1322044	1322044	1322044	1322044	1322044	1322044	1322044
1985	Preseason	1908804	1908804	1908804	1908804	1908804	1908804	1908804	1908804	1908804
	CPE 3x	0	0	0	1878070	2439853	3242096	3055215	2795410	2785844
	CPE 4	0	0	1460336	2429383	2473840	3119353	3401823	3644937	3764096
	Inshore	1788434	1855409	1797072	2013231	2442985	3108727	3570130	4001681	4603615
	lower	1050000	1100000	1100000	1450000	1700000	2250000	2500000	2650000	2950000
	BAYES	1850000	1900000	1850000	2050000	2350000	3000000	3200000	3300000	3650000
	upper	3500000	3550000	2850000	3100000	3300000	3950000	4150000	4150000	4450000
	Actual Run	4419679	4419679	4419679	4419679	4419679	4419879	4419879	4419879	4419679
1984	Preseason	2004775	2004775	2004775	2004775	2004775	2004775	2004775	2004775	2004775
	CPE 3x	0	0	0	2023420	2183604	1752462	1565488	1575928	1311568
	CPE 4	0	0	0	2211154	2450780	2207285	2154708	2058909	2051075
	Inshore	1771382	1868826	1785727	2007600	2411432	3081965	3575848	4000903	4886940
	lower	1100000	1100000	1100000	1400000	1650000	1700000	1800000	1950000	2250000
	BAYES	1850000	1950000	1900000	2050000	2300000	2250000	2400000	2450000	2750000
	upper	3650000	3750000	3650000	3150000	3250000	3050000	3100000	3050000	3300000
	Actual Run	1992484	1992484	1992484	1992484	1992484	1992484	1992484	1992484	1992484

Year		63	64	71	72	73	74	75	81	82
1988	Preseason	35.3	35.3	35.3	35.3	35.3	35.3	35.3	35.3	35.3
	CPE 3x	—	—	—	32.8	29.6	28.8	54.2	45.5	43.8
	CPE 4	—	—	52.4	34.6	33.5	37.7	34.8	11.6	4.7
	Inshore	45.4	47.2	42.4	32.9	24.9	20.8	16.5	0.9	5.4
	BAYES	41.3	41.3	42.9	34.7	29.8	29.8	34.7	21.7	13.5
1987	Preseason	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8
	CPE 3x	—	—	—	—	0.3	9.8	9.5	4.0	3.1
	CPE 4	—	—	—	3.0	26.8	15.5	15.2	6.9	9.6
	Inshore	14.4	13.8	17.9	17.6	14.6	22.8	24.5	28.6	30.4
	BAYES	4.2	4.2	8.7	4.2	3.4	4.2	9.2	14.3	19.3
1986	Preseason	93.5	93.5	93.5	93.5	93.5	93.5	93.5	93.5	93.5
	CPE 3x	—	—	—	79.4	22.1	30.2	35.1	36.3	39.8
	CPE 4	—	—	—	32.4	49.9	80.7	73.5	67.5	53.8
	Inshore	16.3	18.9	20.2	10.9	13.9	8.6	1.0	5.8	5.4
	BAYES	55.1	55.1	55.1	47.5	39.9	47.5	39.9	32.4	24.8
1985	Preseason	56.8	56.8	56.8	56.8	56.8	56.8	56.8	56.8	56.8
	CPE 3x	—	—	—	57.5	44.8	26.6	30.9	36.8	37.0
	CPE 4	—	—	67.0	45.0	44.0	29.4	23.0	17.5	14.8
	Inshore	60.0	58.0	59.3	54.4	44.7	29.7	19.2	9.5	4.2
	BAYES	58.1	57.0	82.7	53.8	48.8	32.1	27.8	25.3	17.4
1984	Preseason	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	CPE 3x	—	—	—	1.6	9.6	12.0	21.4	20.9	34.2
	CPE 4	—	—	—	11.0	23.0	10.8	8.1	3.3	2.9
	Inshore	11.1	8.2	10.4	0.8	21.0	54.7	79.5	100.8	135.2
	BAYES	7.2	2.1	4.8	2.9	15.4	12.9	20.5	23.0	38.0
All Years MAPE	Preseason	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6
	CPE 3x	—	29.2	20.9	23.0	17.5	17.0	22.3	24.7	26.4
	CPE 4	—	31.4	31.8	22.3	28.4	29.4	27.2	20.6	15.5
	Inshore	25.4	25.5	25.0	22.7	20.2	20.8	20.2	20.6	22.8
	BAYES	27.7	26.2	26.5	23.4	21.0	17.7	19.0	17.7	16.7

Table 3. continued.

NO PRIORS

Year	Method	63	64	71	72	73	74	75	81	82
1994	catch 3x	0	921870	1664053	2033131	2125141	1799440	1840108	1825452	1869652
	catch 4	0	0	0	1892468	1913956	1610373	1652834	1608567	1597257
	Inshore	1861478	1860026	1761171	1725838	1737595	1530329	1601877	1537552	1634157
	lower	900000	700000	1000000	1200000	1300000	1200000	1250000	1250000	1300000
	BAYES	1850000	1100000	1700000	1650000	1900000	1650000	1650000	1600000	1650000
	upper	4350000	1700000	3250000	3050000	2850000	2200000	2150000	2000000	2050000
	Actual Run	1764363	1764363	1764363	1764363	1764363	1764363	1764363	1764363	1764363
1993	catch 3x	0	2380781	1955686	2151238	2443088	2494272	2700834	2769141	2770307
	catch 4	0	0	2043290	2430612	2597397	2981830	3023541	3101795	3148810
	Inshore	1913063	1926180	1998877	2074529	2202379	2556088	2618254	2930994	3188062
	lower	950000	1600000	1250000	1450000	1650000	2000000	2150000	2350000	2500000
	BAYES	1900000	2300000	2000000	2200000	2400000	2700000	2800000	2950000	3100000
	upper	4350000	3350000	3350000	3550000	3550000	3850000	3650000	3750000	3850000
	Actual Run	3837895	3837895	3837895	3837895	3837895	3837895	3837895	3837895	3837895
1992	catch 3x	0	0	1456306	1966564	2322288	2308649	2380660	2330193	2338628
	catch 4	0	0	1664464	2214051	2222669	2523303	2586102	2592241	2634938
	Inshore	1665956	1797640	1919307	2083948	2241632	2500737	2438689	2481136	2484913
	lower	650000	900000	1100000	1350000	1550000	1800000	1900000	1950000	2000000
	BAYES	1650000	1800000	1700000	2100000	2250000	2450000	2500000	2500000	2550000
	upper	4000000	4200000	2700000	3350000	3350000	3350000	3200000	3150000	3150000
	Actual Run	3201553	3201553	3201553	3201553	3201553	3201553	3201553	3201553	3201553
1991	catch 3x	0	0	1646012	1904184	2347069	3065965	2982448	3064403	3071026
	catch 4	0	0	1879730	2124301	2316036	2510265	2586148	2454734	2459498
	Inshore	1686320	1726170	1664373	2102301	2315370	2496123	2451808	2324752	2355452
	lower	950000	850000	1150000	1350000	1800000	1950000	2000000	1950000	1950000
	BAYES	1650000	1750000	1750000	2050000	2300000	2850000	2800000	2500000	2500000
	upper	4300000	4100000	2650000	3350000	3500000	3650000	3400000	3150000	3100000
	Actual Run	2360596	2360596	2360596	2360596	2360596	2360596	2360596	2360596	2360596
1990	catch 3x	0	0	1543256	1870840	1634857	1210099	1224851	1382551	1420366
	catch 4	0	1666917	1693166	1694060	1624565	1648888	1833957	1839870	1835794
	Inshore	1793894	1753882	1714893	1595532	1676002	1680545	1651835	1610488	1605105
	lower	900000	1100000	1050000	1100000	1150000	1150000	1200000	1250000	1300000
	BAYES	1800000	1700000	1650000	1700000	1700000	1600000	1600000	1650000	1650000
	upper	4250000	2750000	2750000	2800000	2600000	2150000	2100000	2100000	2050000
	Actual Run	1970004	1970004	1970004	1970004	1970004	1970004	1970004	1970004	1970004
1989	catch 3x	0	0	1424269	1888593	2072908	1699337	1649797	1657370	1864705
	catch 4	0	1597183	1847533	2307115	2195875	1967567	1841379	1800301	1672355
	Inshore	1934793	1941510	2008456	2342760	2203753	2032481	1921379	1792697	1729746
	lower	950000	1050000	1050000	1400000	1450000	1350000	1350000	1350000	1300000
	BAYES	1950000	1700000	1700000	2200000	2150000	1900000	1850000	1750000	1700000
	upper	4400000	2950000	2900000	3650000	3300000	2650000	2400000	2250000	2100000
	Actual Run	1909221	1909221	1909221	1909221	1909221	1909221	1909221	1909221	1909221

MAPE

Year	Method	63	64	71	72	73	74	75	81	82
1994	catch 3x	—	47.8	5.7	15.2	20.4	2.0	4.3	3.5	6.0
	catch 4	—	—	—	7.3	8.5	8.7	6.3	8.8	9.5
	Inshore	5.5	5.4	0.2	2.2	1.5	13.3	9.2	12.9	7.4
	BAYES	4.9	37.7	3.6	4.9	7.7	6.5	6.5	9.3	6.5
1993	catch 3x	—	34.6	46.2	40.9	32.8	31.4	25.8	23.9	23.8
	catch 4	—	—	43.8	33.2	28.8	18.0	16.9	14.7	13.5
	Inshore	47.4	47.1	45.1	43.0	39.5	29.7	28.0	19.4	12.4
	BAYES	47.8	36.8	45.0	39.5	34.0	25.6	23.0	18.9	14.8
1992	catch 3x	—	—	54.5	38.6	27.5	27.9	25.6	27.2	27.0
	catch 4	—	—	41.8	30.8	30.6	21.2	19.2	19.0	17.7
	Inshore	48.0	43.8	40.1	34.9	30.0	21.9	23.8	23.1	22.4
	BAYES	48.5	43.8	46.9	34.4	29.7	23.5	21.9	21.9	20.4
1991	catch 3x	—	—	30.3	19.3	0.6	29.9	26.3	29.8	30.1
	catch 4	—	—	20.4	10.0	1.9	6.3	9.6	4.0	4.2
	Inshore	20.9	26.9	21.0	10.9	1.9	5.7	3.9	1.5	0.2
	BAYES	21.6	25.9	25.9	13.2	2.6	12.3	10.1	5.9	5.9
1990	catch 3x	—	—	21.7	5.0	17.0	38.6	37.8	29.8	27.9
	catch 4	—	15.4	3.9	14.0	7.4	6.2	6.9	6.6	6.8
	Inshore	8.9	11.0	12.9	19.0	14.9	14.7	16.2	18.2	18.5
	BAYES	8.6	13.7	16.2	13.7	13.7	18.8	18.8	16.2	16.2
1989	catch 3x	—	—	25.4	1.1	8.6	11.0	13.6	13.2	12.8
	catch 4	—	16.3	3.2	20.8	15.0	3.1	3.6	5.7	12.4
	Inshore	1.3	1.7	5.2	22.7	15.4	6.5	0.6	6.1	9.4
	BAYES	2.1	11.0	11.0	15.2	12.6	0.5	3.1	8.3	11.0

Table 4. 1984-1994 retrospective forecasts of Area 4 Skeena River sockeye returns by statistical week for Bayes Model 2 (no priors) , for three independent forecasts and the Bayesian composite forecast. Corresponding absolute percent error (APE) values for each forecast are reported by year for each statistical week.

Year	Method	63	64	71	72	73	74	75	81	82
1988	catch 3x	0	0	0	1796882	1956952	2222813	2361253	2497331	2505211
	catch 4	0	0	1736204	2097478	2306353	2584389	2584931	3127743	3298877
	Inshore	1673297	1617679	1766017	2055318	2303163	2426215	2558572	3036866	3228987
	lower	800000	800000	1000000	1250000	1500000	1750000	1900000	2300000	2500000
	BAYES	1650000	1800000	1750000	2000000	2200000	2400000	2550000	2950000	3150000
	upper	4100000	4000000	3650000	3350000	3350000	3350000	3350000	3850000	3950000
	Actual Run	3064832	3064832	3064832	3064832	3064832	3064832	3064832	3064832	3064832
1987	catch 3x	0	0	0	0	1569207	1693074	1540822	1562268	1609058
	catch 4	0	0	0	1538857	1543920	1280935	1247018	1318436	1302043
	Inshore	1896826	1709381	1628604	1633949	1693178	1530517	1497674	1416063	1380380
	lower	800000	850000	800000	900000	1050000	1050000	1050000	1050000	1050000
	BAYES	1700000	1700000	1850000	1800000	1600000	1500000	1400000	1400000	1350000
	upper	4200000	4150000	4100000	3000000	2500000	2050000	1800000	1750000	1650000
	Actual Run	1982908	1982906	1982906	1982906	1982906	1982908	1982906	1982908	1982906
1986	catch 3x	0	0	0	0	1569207	1693074	1540822	1562268	1609058
	catch 4	0	0	0	1538857	1543920	1280935	1247018	1318436	1302043
	Inshore	1537468	1571636	1589693	1465980	1506129	1436186	1335886	1246009	1250847
	lower	800000	850000	800000	900000	1050000	1050000	1050000	1050000	1050000
	BAYES	1700000	1700000	1850000	1800000	1600000	1500000	1400000	1400000	1350000
	upper	4200000	4150000	4100000	3000000	2500000	2050000	1800000	1750000	1650000
	Actual Run	1322044	1322044	1322044	1322044	1322044	1322044	1322044	1322044	1322044
1985	catch 3x	0	0	0	1710609	1734856	2616319	2545612	2542562	2549012
	catch 4	0	0	1423472	1645783	2166970	2690072	3060443	3171613	3403301
	Inshore	1766434	1855409	1797072	2013231	2442985	3108727	3570130	4001681	4603615
	lower	900000	950000	950000	1200000	1450000	2050000	2400000	2650000	3000000
	BAYES	1750000	1650000	1550000	1850000	2100000	2800000	3100000	3350000	3700000
	upper	4100000	4200000	2700000	3000000	3100000	3900000	4050000	4250000	4550000
	Actual Run	4419879	4419679	4419879	4419679	4419679	4419679	4419679	4419679	4419679
1984	catch 3x	0	0	0	1699760	1840654	1766062	1676907	1668467	1703742
	catch 4	0	0	0	1647928	1916448	1867482	1856700	1792282	1759990
	Inshore	1771382	1888826	1785727	2007600	2411432	3081965	357848	4000903	4686940
	lower	800000	800000	650000	1100000	1250000	1250000	1300000	1250000	1250000
	BAYES	1800000	1550000	1650000	1700000	1800000	1750000	1700000	1800000	1550000
	upper	3950000	3850000	4000000	2800000	2750000	2450000	2200000	2000000	1850000
	Actual Run	1994284	1994284	1994284	1994284	1994284	1994284	1994284	1994284	1994284

Year		63	64	71	72	73	74	75	81	82
1988	catch 3x	—	—	—	41.4	36.1	27.5	23.0	18.5	18.3
	catch 4	—	—	43.4	31.6	24.7	15.7	15.7	2.1	7.6
	Inshore	45.4	47.2	42.4	32.9	24.9	20.8	16.5	0.9	5.4
	BAYES	46.2	47.8	42.9	34.7	28.2	21.7	16.8	3.7	2.8
1987	catch 3x	—	—	—	—	20.9	14.6	22.3	21.2	18.9
	catch 4	—	—	—	22.4	22.1	35.4	37.1	33.5	34.3
	Inshore	14.4	13.8	17.9	17.6	14.6	22.8	24.5	28.6	30.4
	BAYES	14.3	14.3	16.8	19.3	19.3	24.4	29.4	29.4	31.9
1986	catch 3x	—	—	—	—	16.7	28.1	16.5	18.2	21.7
	catch 4	—	—	—	16.4	16.8	3.1	5.7	0.3	1.5
	Inshore	16.3	18.9	20.2	10.9	13.9	8.6	1.0	5.8	5.4
	BAYES	28.6	28.6	24.8	21.0	21.0	13.5	5.9	5.9	2.1
1985	catch 3x	—	—	—	61.3	60.7	40.8	42.4	42.5	42.3
	catch 4	—	—	67.8	58.2	51.0	39.1	30.8	28.2	23.0
	Inshore	60.0	58.0	59.3	54.4	44.7	29.7	19.2	9.5	4.2
	BAYES	60.4	58.1	64.9	58.1	52.5	36.6	28.9	24.2	16.3
1984	catch 3x	—	—	—	14.8	7.7	11.4	15.9	16.4	14.6
	catch 4	—	—	—	17.4	3.9	6.4	6.9	10.1	11.7
	Inshore	11.2	6.3	10.5	0.7	20.9	54.5	82.1	100.6	135.0
	BAYES	19.8	22.3	17.3	14.8	8.7	12.2	14.8	19.8	22.3
All Years MAPE	catch 3x	—	41.2	30.6	21.6	22.8	23.9	23.1	22.2	22.1
	catch 4	—	15.9	32.0	23.8	19.1	14.8	14.4	12.1	12.9
	Inshore	25.4	25.5	25.0	22.7	20.2	20.7	20.5	20.6	22.8
	BAYES	27.5	30.9	28.7	24.4	21.0	17.8	16.4	14.9	13.6

Table 4. continued.

PRIORS

Year	Method	83	84	71	72	73	74	75	81	82
1994	Preseason	2528781	2528781	2528781	2528781	2528781	2528781	2528781	2528781	2528781
	catch 3x	0	921670	1664053	2033131	2125141	1799440	1840108	1825452	1869652
	catch 4	0	0	0	1892468	1913958	1610373	1652834	1608567	1597257
	Inshore	1881478	1860026	1761171	1725838	1737595	1530329	1601877	1537552	1634157
	lower	1550000	1100000	1450000	1500000	1550000	1400000	1400000	1400000	1400000
	BAYES	2350000	1550000	2150000	2150000	2100000	1850000	1800000	1750000	1750000
	upper	3750000	2150000	3200000	3050000	2900000	2400000	2300000	2150000	2150000
	Actual Run	1764383	1764383	1764383	1764383	1764383	1764383	1764383	1764383	1764383
1993	Preseason	2443557	2443557	2443557	2443557	2443557	2443557	2443557	2443557	2443557
	catch 3x	0	2380781	1955868	2151238	2443088	2494272	2700834	2769141	2770307
	catch 4	0	0	2043290	2430612	2597397	2981830	3023541	3101795	3146810
	Inshore	1913083	1928180	1998877	2074529	2202379	2558088	2618254	2930994	3188062
	lower	1600000	1750000	1600000	1700000	1800000	2000000	2150000	2300000	2400000
	BAYES	2300000	2350000	2250000	2350000	2400000	2600000	2700000	2850000	2950000
	upper	3450000	3100000	3100000	3200000	3200000	3350000	3350000	3450000	3550000
	Actual Run	3837895	3837895	3837895	3837895	3837895	3837895	3837895	3837895	3837895
1992	Preseason	2220295	2220295	2220295	2220295	2220295	2220295	2220295	2220295	2220295
	catch 3x	0	0	1456306	1966584	2322288	2308649	2380880	2330193	2338828
	catch 4	0	0	1884464	2214051	2222669	2523303	2586102	2592241	2634938
	Inshore	1665958	1797840	1919307	2083948	2241832	2500737	2438689	2461136	2484913
	lower	1550000	1550000	1500000	1850000	1700000	1850000	1900000	1950000	2000000
	BAYES	2100000	2150000	2000000	2150000	2250000	2350000	2400000	2400000	2450000
	upper	2950000	3000000	2600000	2850000	2900000	2950000	2900000	2900000	2900000
	Actual Run	3201553	3201553	3201553	3201553	3201553	3201553	3201553	3201553	3201553
1991	Preseason	1977223	1977223	1977223	1977223	1977223	1977223	1977223	1977223	1977223
	catch 3x	0	0	1648012	1904184	2347069	3065965	2982448	3064403	3071026
	catch 4	0	0	1879730	2124301	2316036	2510265	2588146	2454734	2459498
	Inshore	1666320	1726170	1864373	2102301	2315370	2496123	2451808	2324752	2355452
	lower	1250000	1250000	1300000	1450000	1600000	1850000	1900000	1900000	1950000
	BAYES	1950000	1900000	1850000	2000000	2200000	2450000	2450000	2400000	2400000
	upper	3100000	3050000	2850000	2900000	3000000	3200000	3100000	2950000	2950000
	Actual Run	2380596	2380598	2380598	2380596	2380596	2380596	2380598	2380598	2380598
1990	Preseason	2324022	2324022	2324022	2324022	2324022	2324022	2324022	2324022	2324022
	catch 3x	0	0	1543256	1870840	1634857	1210099	1224651	1382551	1420366
	catch 4	0	1666917	1893188	1694060	1824565	1848886	1833957	1839870	1835794
	Inshore	1793894	1753882	1714893	1595532	1676002	1880545	1651835	1610488	1605105
	lower	1200000	1250000	1200000	1250000	1250000	1200000	1250000	1300000	1350000
	BAYES	2050000	1600000	1800000	1650000	1800000	1850000	1700000	1700000	1700000
	upper	3900000	2800000	2800000	2800000	2600000	2250000	2150000	2150000	2100000
	Actual Run	1970004	1970004	1970004	1970004	1970004	1970004	1970004	1970004	1970004
1989	Preseason	2344372	2344372	2344372	2344372	2344372	2344372	2344372	2344372	2344372
	catch 3x	0	0	1424269	1888593	2072908	1699337	1849797	1857370	1864705
	catch 4	0	1597183	1847533	2307115	2195875	1967567	1841379	1800301	1872355
	Inshore	1934793	1941510	2008458	2342780	2203753	2032461	1921379	1792697	1729746
	lower	1250000	1250000	1200000	1500000	1650000	1450000	1400000	1400000	1350000
	BAYES	2150000	1850000	1850000	2250000	2200000	1950000	1900000	1800000	1750000
	upper	4050000	2950000	2900000	3450000	3200000	2650000	2450000	2300000	2150000
	Actual Run	1909221	1909221	1909221	1909221	1909221	1909221	1909221	1909221	1909221

MAPE

Year	Method	83	84	71	72	73	74	75	81	82
1994	Preseason	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3
	catch 3x	—	47.8	5.7	15.2	20.4	2.0	4.3	3.5	6.0
	catch 4	—	—	—	7.3	8.5	8.7	6.3	8.8	9.5
	Inshore	5.5	5.4	0.2	2.2	1.5	13.3	9.2	12.9	7.4
	BAYES	33.2	12.1	21.9	21.9	19.0	4.9	2.0	0.8	0.8
1993	Preseason	32.8	32.8	32.8	32.8	32.8	32.8	32.8	32.8	32.8
	catch 3x	—	34.6	48.2	40.9	32.8	31.4	25.8	23.9	23.8
	catch 4	—	—	43.8	33.2	28.6	18.0	18.9	14.7	13.5
	Inshore	47.4	47.1	45.1	43.0	39.5	29.7	28.0	19.4	12.4
	BAYES	38.8	35.4	38.2	35.4	34.0	28.5	25.8	21.7	18.9
1992	Preseason	30.6	30.6	30.8	30.8	30.8	30.8	30.6	30.8	30.6
	catch 3x	—	—	54.5	38.6	27.5	27.9	25.6	27.2	27.0
	catch 4	—	—	41.8	30.8	30.8	21.2	19.2	19.0	17.7
	Inshore	48.0	43.8	40.1	34.9	30.0	21.9	23.8	23.1	22.4
	BAYES	34.4	32.8	37.5	32.8	29.7	28.8	25.0	25.0	23.5
1991	Preseason	18.2	18.2	18.2	16.2	16.2	16.2	16.2	16.2	16.2
	catch 3x	—	—	30.3	19.3	0.6	29.9	26.3	29.8	30.1
	catch 4	—	—	20.4	10.0	1.9	6.3	9.6	4.0	4.2
	Inshore	20.9	26.9	21.0	10.9	1.9	5.7	3.9	1.5	0.2
	BAYES	17.4	19.5	21.6	15.3	8.8	3.8	3.8	1.7	1.7
1990	Preseason	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0
	catch 3x	—	—	21.7	5.0	17.0	38.6	37.8	29.8	27.9
	catch 4	—	15.4	3.9	14.0	7.4	6.2	6.9	6.6	6.8
	Inshore	6.9	11.0	12.9	19.0	14.9	14.7	16.2	18.2	18.5
	BAYES	4.1	8.6	8.8	6.1	8.8	18.2	13.7	13.7	13.7
1989	Preseason	22.8	22.8	22.8	22.6	22.8	22.8	22.8	22.8	22.8
	catch 3x	—	—	25.4	1.1	8.8	11.0	13.6	13.2	12.8
	catch 4	—	18.3	3.2	20.8	15.0	3.1	3.6	5.7	12.4
	Inshore	1.3	1.7	5.2	22.7	15.4	6.5	0.6	6.1	9.4
	BAYES	12.8	3.1	3.1	17.8	15.2	2.1	0.5	5.7	8.3

Table 5. 1984-1994 retrospective forecasts of Area 4 Skeena River sockeye returns by statistical week for Bayes Model 2 (with priors) , for three independent forecasts and the Bayesian composite forecast. Corresponding absolute percent error (APE) values for each forecast are reported by year for each statistical week.

Year		63	64	71	72	73	74	75	81	82
1988	Preseason	1981513	1981513	1981513	1981513	1981513	1981513	1981513	1981513	1981513
	catch 3x	0	0	0	1796882	1956952	2222813	2361253	2497331	2505211
	catch 4	0	0	1736204	2097478	2306353	2564389	2584931	3127743	3298877
	Inshore	1673297	1617879	1766017	2055318	2303163	2426215	2558572	3036866	3228987
	lower	1050000	1050000	1100000	1300000	1500000	1750000	1900000	2250000	2400000
	BAYES	1800000	1800000	1850000	2000000	2150000	2350000	2450000	2900000	3050000
	upper	3550000	3450000	3250000	3100000	3150000	3200000	3200000	3650000	3800000
	Actual Run	3064832	3064832	3064832	3064832	3064832	3064832	3064832	3064832	3064832
1987	Preseason	2158373	2158373	2158373	2158373	2158373	2158373	2158373	2158373	2158373
	catch 3x	0	0	0	0	1569207	1693074	1540822	1562268	1609058
	catch 4	0	0	0	1538857	1543920	1280935	1247016	1318436	1302043
	Inshore	1696826	1709361	1628604	1633949	1693178	1530517	1497674	1416063	1380380
	lower	1050000	1100000	1050000	1100000	1150000	1100000	1100000	1100000	1100000
	BAYES	1900000	1900000	1850000	1750000	1700000	1550000	1450000	1450000	1400000
	upper	3800000	3800000	3750000	2950000	2500000	2100000	1850000	1750000	1700000
	Actual Run	1982908	1982906	1982908	1982908	1982908	1982908	1982908	1982908	1982906
1986	Preseason	2557906	2557906	2557908	2557906	2557906	2557906	2557906	2557906	2557906
	catch 3x	0	0	0	0	1569207	1693074	1540822	1562268	1609058
	catch 4	0	0	0	1538857	1543920	1280935	1247016	1318436	1302043
	Inshore	1537466	1571636	1589693	1465960	1506129	1436186	1335886	1246009	1250847
	lower	1250000	1250000	1200000	1200000	1200000	1150000	1100000	1150000	1100000
	BAYES	2100000	2100000	2050000	1850000	1750000	1600000	1500000	1450000	1400000
	upper	4000000	3950000	3900000	3100000	2600000	2150000	1900000	1800000	1700000
	Actual Run	1322044	1322044	1322044	1322044	1322044	1322044	1322044	1322044	1322044
1985	Preseason	1908804	1908804	1908804	1908804	1908804	1908804	1908804	1908804	1908804
	catch 3x	0	0	0	1710809	1734856	2616319	2545612	2542562	2549012
	catch 4	0	0	1423472	1845783	2166970	2690072	3060443	3171613	3403301
	Inshore	1766434	1855409	1797072	2013231	2442985	3108727	3570130	4001681	4603615
	lower	1050000	1100000	1050000	1250000	1450000	2000000	2300000	2550000	2900000
	BAYES	1850000	1900000	1850000	1850000	2050000	2700000	3000000	3250000	3600000
	upper	3500000	3550000	2600000	2850000	2950000	3650000	3850000	4050000	4400000
	Actual Run	4419679	4419679	4419879	4419679	4419679	4419679	4419679	4419679	4419879
1984	Preseason	2004775	2004775	2004775	2004775	2004775	2004775	2004775	2004775	2004775
	catch 3x	0	0	0	1699760	1840654	1766082	1676907	1666487	1703742
	catch 4	0	0	0	1647928	1916448	1867482	1856700	1792282	1759990
	Inshore	1771382	1866826	1785727	2007600	2411432	3081965	357848	4000903	4686940
	lower	1050000	1000000	1050000	1150000	1300000	1300000	1300000	1250000	1250000
	BAYES	1800000	1750000	1800000	1750000	1850000	1800000	1700000	1600000	1550000
	upper	3500000	3400000	3550000	2700000	2650000	2450000	2200000	2000000	1850000
	Actual Run	1994284	1994284	1994284	1994284	1994284	1994284	1994284	1994284	1994284

Year		63	64	71	72	73	74	75	81	82
1988	Preseason	35.3	35.3	35.3	35.3	35.3	35.3	35.3	35.3	35.3
	catch 3x	—	—	—	41.4	36.1	27.5	23.0	18.5	18.3
	catch 4	—	—	43.4	31.6	24.7	15.7	15.7	2.1	7.6
	Inshore	45.4	47.2	42.4	32.9	24.9	20.8	16.5	0.9	5.4
	BAYES	41.3	41.3	39.8	34.7	29.8	23.3	20.1	5.4	0.5
1987	Preseason	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8
	catch 3x	—	—	—	—	20.9	14.6	22.3	21.2	18.9
	catch 4	—	—	—	22.4	22.1	35.4	37.1	33.5	34.3
	Inshore	14.4	13.8	17.9	17.6	14.6	22.8	24.5	28.6	30.4
	BAYES	4.2	4.2	8.7	11.7	14.3	21.8	28.9	26.9	29.4
1986	Preseason	93.5	93.5	93.5	93.5	93.5	93.5	93.5	93.5	93.5
	catch 3x	—	—	—	—	18.7	28.1	16.5	18.2	21.7
	catch 4	—	—	—	16.4	16.8	3.1	5.7	0.3	1.5
	Inshore	16.3	18.9	20.2	10.9	13.9	8.6	1.0	5.8	5.4
	BAYES	58.8	58.8	55.1	39.9	32.4	21.0	13.5	9.7	5.9
1985	Preseason	56.8	56.8	56.8	56.8	56.8	56.8	56.8	56.8	56.8
	catch 3x	—	—	—	61.3	60.7	40.8	42.4	42.5	42.3
	catch 4	—	—	67.8	58.2	51.0	39.1	30.8	28.2	23.0
	Inshore	60.0	58.0	59.3	54.4	44.7	29.7	19.2	9.5	4.2
	BAYES	58.1	57.0	62.7	58.1	53.8	38.9	32.1	28.5	18.5
1984	Preseason	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	catch 3x	—	—	—	14.8	7.7	11.4	15.9	16.4	14.6
	catch 4	—	—	—	17.4	3.9	6.4	6.9	10.1	11.7
	Inshore	11.2	6.3	10.5	0.7	20.9	54.5	82.1	100.6	135.0
	BAYES	9.7	12.2	9.7	12.2	7.2	9.7	14.8	19.8	22.3
All Years MAPE	Preseason	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6
	catch 3x	—	41.2	30.6	21.6	22.8	23.9	23.1	22.2	22.1
	catch 4	—	15.9	32.0	23.8	19.1	14.8	14.4	12.1	12.9
	Inshore	25.4	25.5	25.0	22.7	20.2	20.7	20.5	20.6	22.8
	BAYES	28.2	25.9	27.7	26.0	22.8	17.9	16.2	14.3	13.0

Table 5. continued.

Model	Method	063	064	071	072	Key Management Weeks 073	074	075	081	082
Bayes 1 no priors	CPE 3x	—	29.2	20.9	23.0	17.5	17.0	22.3	24.7	26.4
	CPE 4	—	31.4	31.8	22.3	26.4	29.4	27.2	20.6	15.5
	Inshore	25.4	25.5	25.0	22.7	20.2	20.8	20.2	20.6	22.8
	BAYES	25.8	28.4	25.6	21.9	18.4	17.8	18.6	17.5	15.9
Bayes 1 no priors	Prior	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6
	CPE 3x	—	29.2	20.9	23.0	17.5	17.0	22.3	24.7	26.4
	CPE 4	—	31.4	31.8	22.3	26.4	29.4	27.2	20.6	15.5
	Inshore	25.4	25.5	25.0	22.7	20.2	20.8	20.2	20.6	22.8
	BAYES	27.7	26.2	26.5	23.4	21.0	17.7	19.0	17.7	16.7
Bayes 2 no priors	catch 3x	—	41.2	30.6	21.6	22.8	23.9	23.1	22.2	22.1
	catch 4	—	15.9	32.0	23.8	19.1	14.8	14.4	12.1	12.9
	Inshore	25.4	25.5	25.0	22.7	20.2	20.7	20.5	20.6	22.8
	BAYES	27.5	30.9	28.7	24.4	21.0	17.8	16.4	14.9	13.6
Bayes 2 with priors	Prior	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6
	catch 3x	—	41.2	30.6	21.6	22.8	23.9	23.1	22.2	22.1
	catch 4	—	15.9	32.0	23.8	19.1	14.8	14.4	12.1	12.9
	Inshore	25.4	25.5	25.0	22.7	20.2	20.7	20.5	20.6	22.8
	BAYES	28.2	25.9	27.7	26.0	22.8	17.9	16.2	14.3	13.0

Table 6. A summary of the 1984-1994 retrospective forecast mean absolute percent error (MAPE) values of Area 4 Skeena River sockeye returns by statistical week for Bayes Model 1 with and without priors, and Bayes Model 2 with and without priors for three independent forecasts and the Bayesian composite forecast.

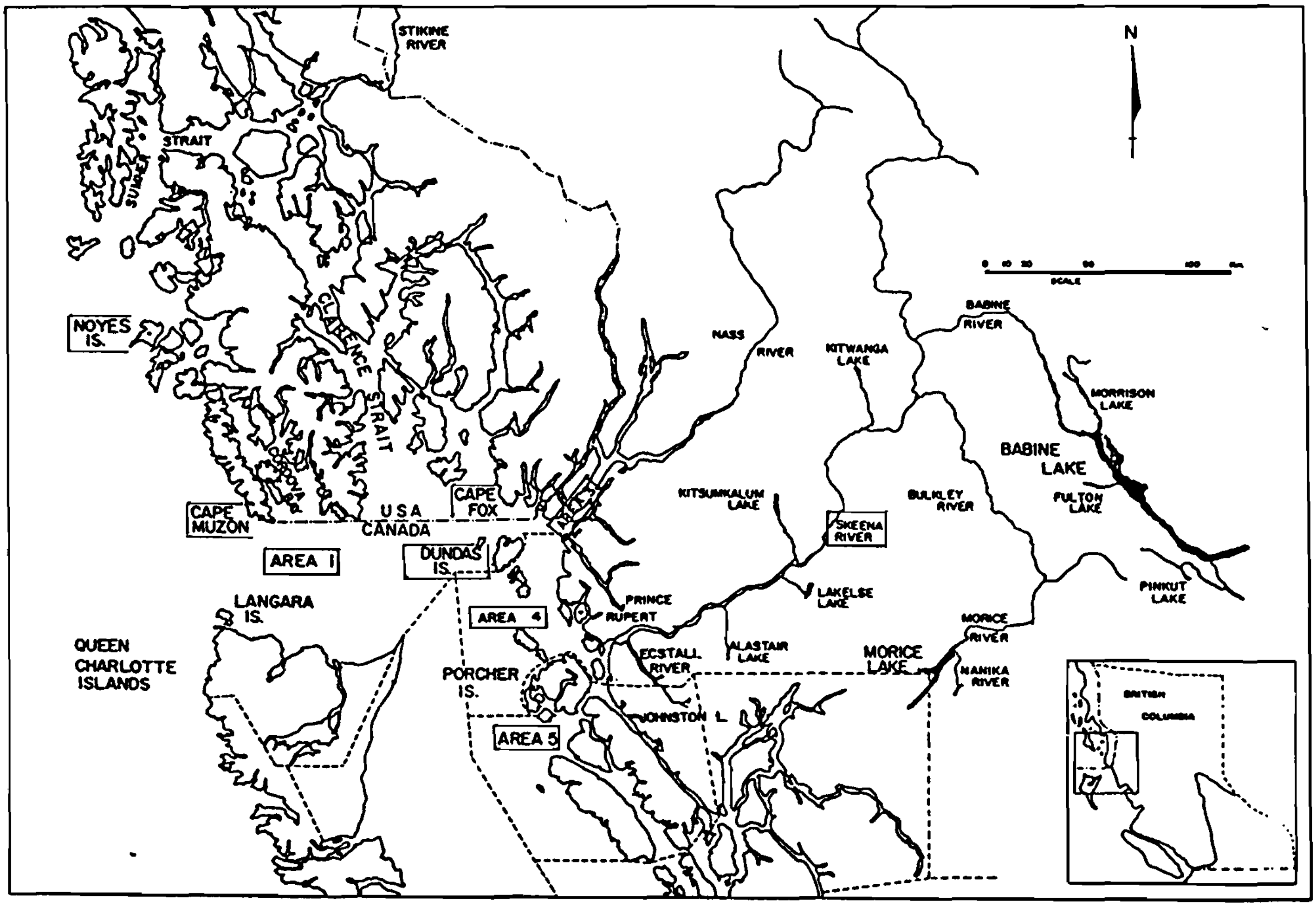

Figure 1. Major Canadian interception fisheries of Skeena River sockeye salmon.

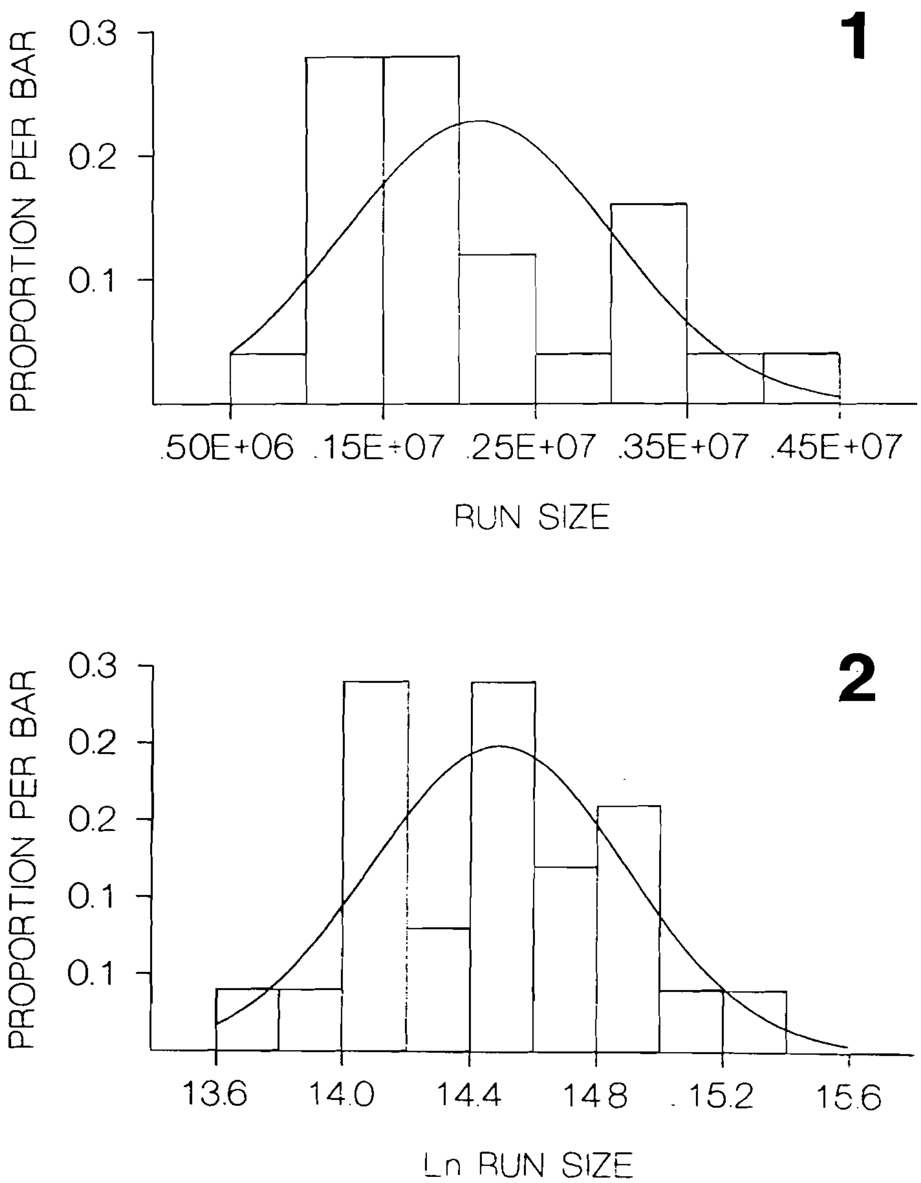

Figure 2. Frequency histograms of 1970-1994 Area 4 Skeena River sockeye returns: (1) non-transformed data, (2) log-transformed data.

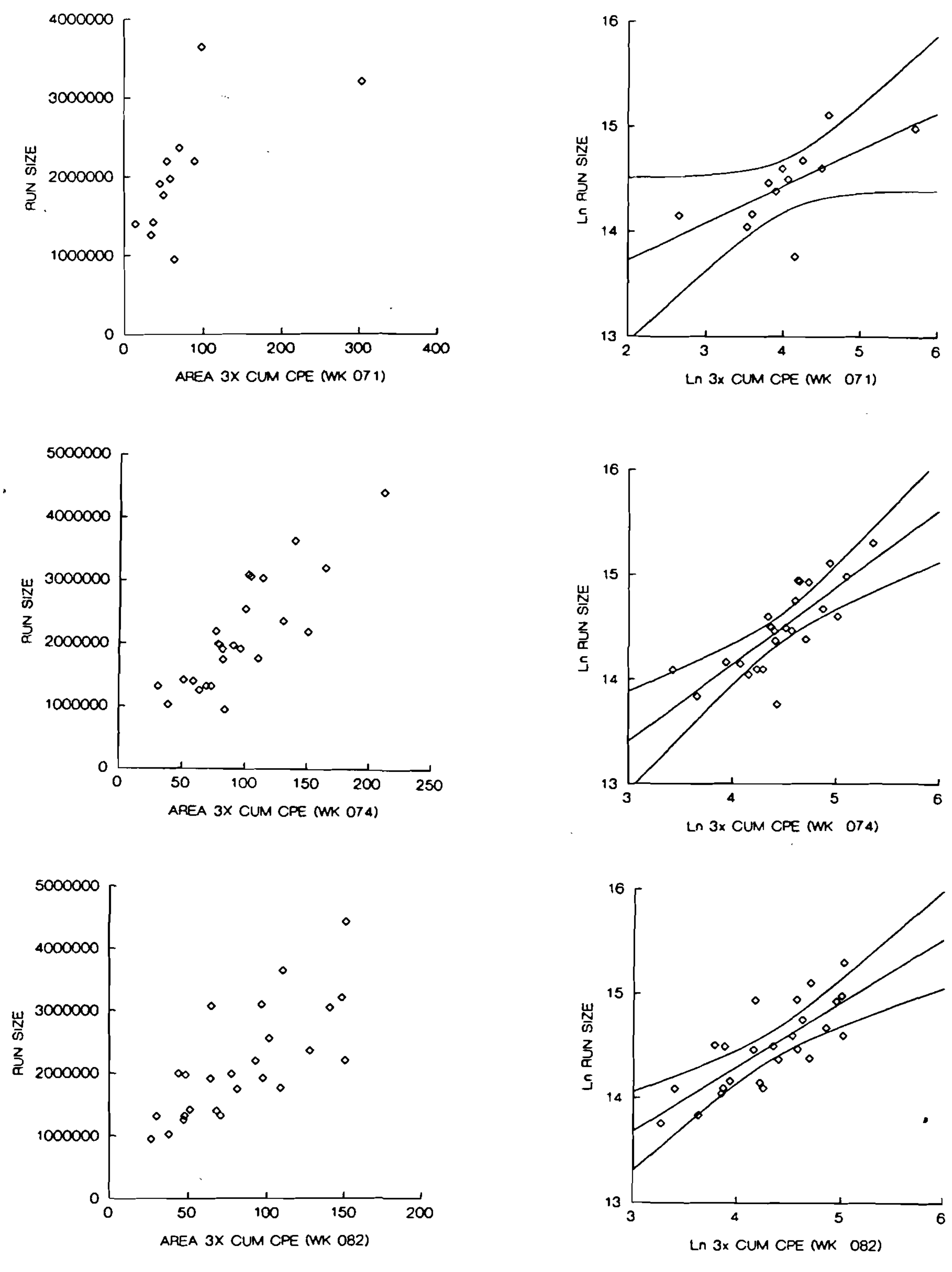

Figure 3. Non-transformed and log-transformed comparisons of Area 4 Skeena River sockeye run-size versus cumulative Area 3x CPE for statistical weeks 071, 074, and 082, for the years 1970-1994.

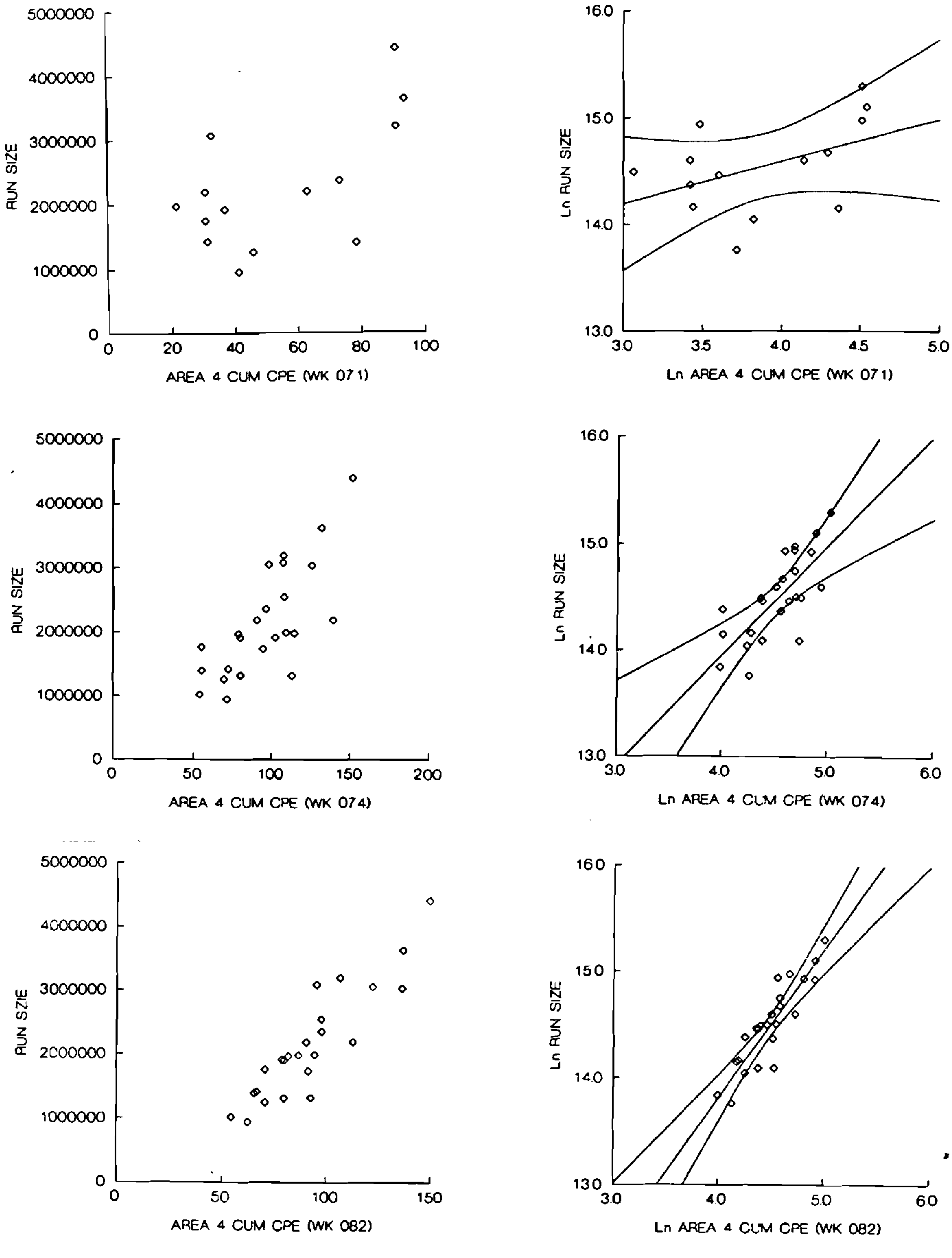

Figure 4. Non-transformed and log-transformed comparisons of Area 4 Skeena River sockeye run-size versus cumulative Area 4 CPE for statistical weeks 071, 074, and 082, for the years 1970-1994.

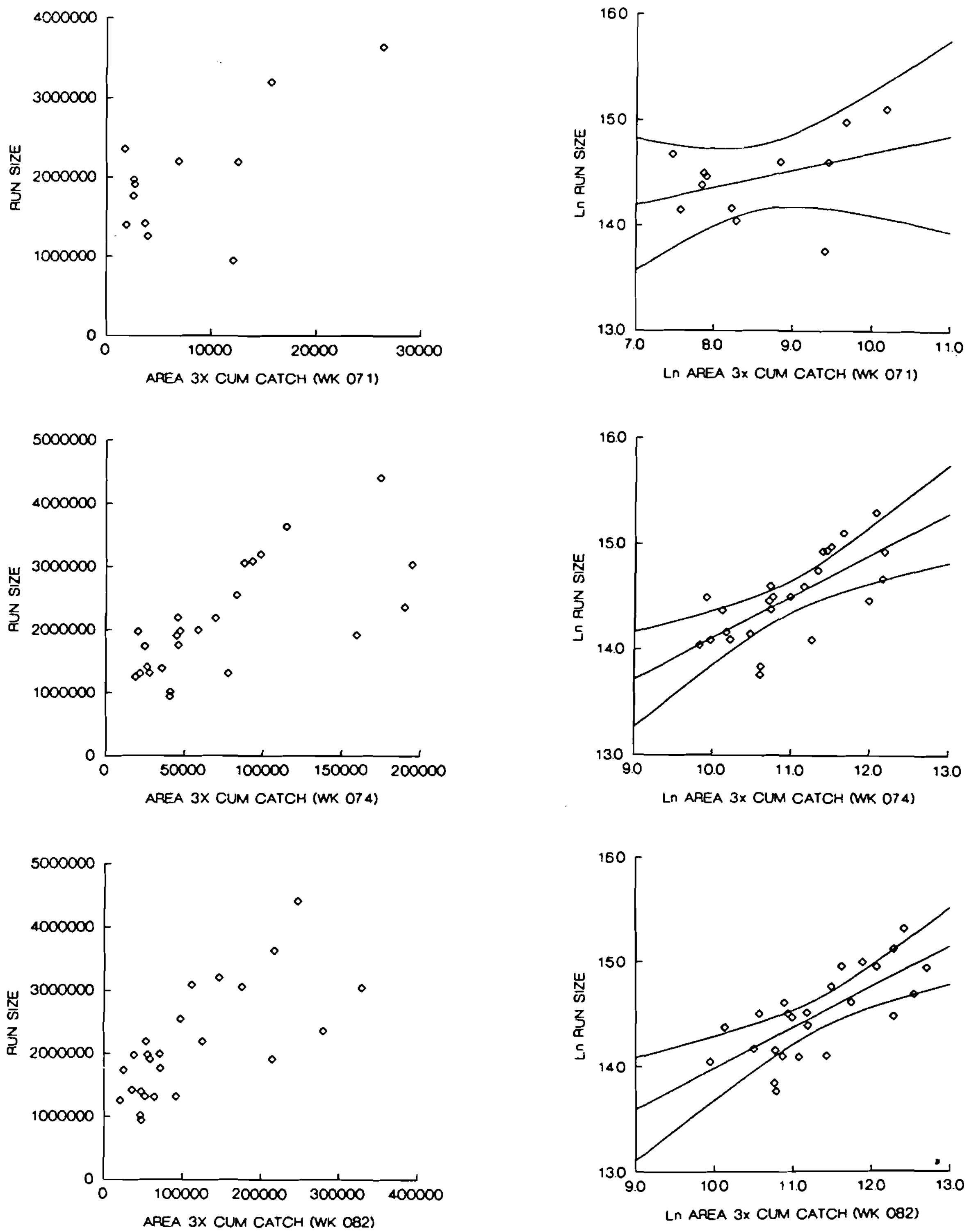

Figure 5. Non-transformed and log-transformed comparisons of Area 4 Skeena River sockeye run-size versus cumulative Area 3x catch for statistical weeks 071, 074, and 082, for the years 1970-1994.

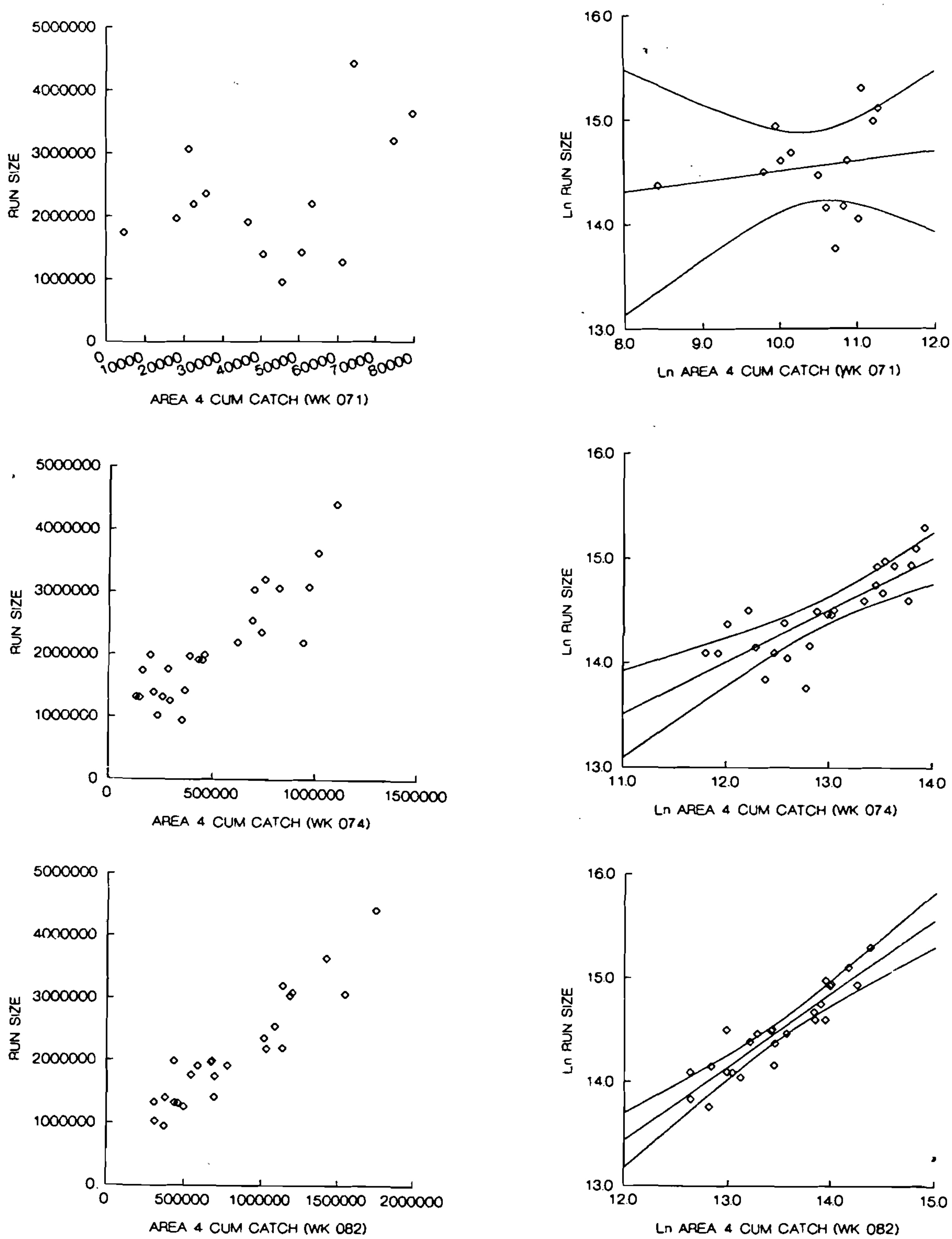

Figure 6. Non-transformed and log-transformed comparisons of Area 4 Skeena River sockeye run-size versus cumulative Area 4 catch for statistical weeks 071, 074, and 082, for the years 1970-1994.

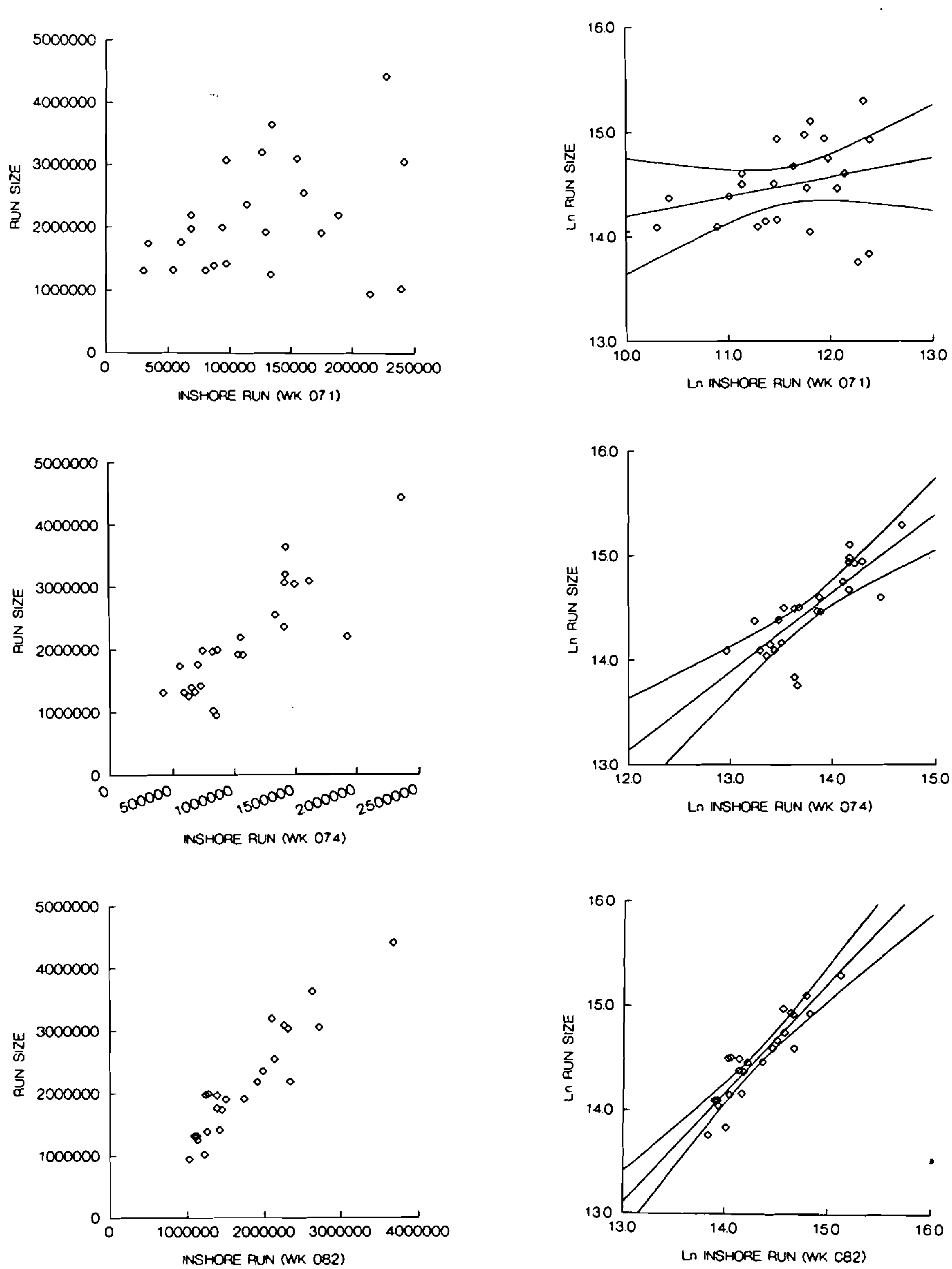

Figure 7. Non-transformed and log-transformed comparisons of Area 4 Skeena River sockeye run-size versus cumulative Inshore run for statistical weeks 071, 074, and 082, for the years 1970-1994.

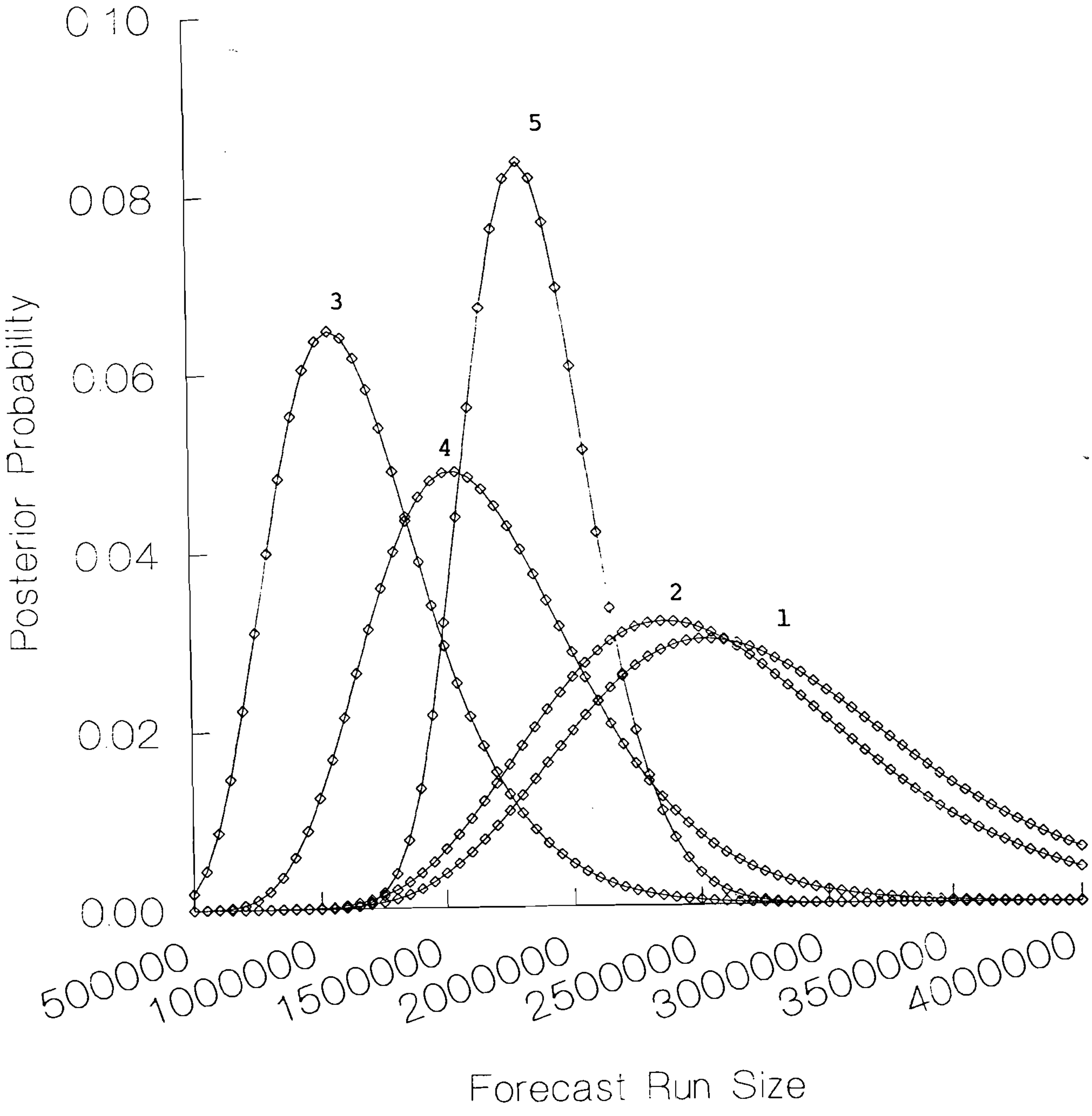

Figure 8. Retrospective posterior probability distributions for four independent forecasts and the Bayesian composite forecast of total 1994 Area 4 Skeena River sockeye run size made in statistical week 074. (1) Preseason estimate (2528781), (2) Area 3x cumulative CPE estimate (2365650), (3) Area 4 cumulative CPE estimate (1054068), (4) Inshore run estimate (1530329), and (5) the Bayes composite estimate (mode 1800000). The actual 1994 return was 1764363.

APPENDICES

Appendix Table 1. Cumulative Skeena River sockeye Area 3x purse-seine + gillnet catch-per-effort by statistical week from 1970-1994.

year	actual a4 run	week 63	week 64	week 71	week 72	week 73	week 74	week 75	week 81	week 82	week 83	week 84
1970	1257261	0.0	28.3	34.2	44.2	54.1	63.7	63.7	47.0	47.0	46.4	46.0
1971	1742581	0.0	0.0	0.0	64.0	60.8	82.0	82.0	82.0	80.9	80.9	80.9
1972	1417151	0.0	54.9	36.5	42.4	48.8	51.3	53.3	51.3	50.8	50.6	50.6
1973	2193566	0.0	87.6	89.8	96.4	159.5	149.8	152.5	150.6	150.6	150.6	150.6
1974	2189694	0.0	0.0	53.8	58.4	67.9	76.4	92.2	92.2	92.2	92.2	92.2
1975	1396490	0.0	0.0	14.1	21.6	21.6	58.8	68.6	68.3	67.7	67.7	67.7
1976	1314915	0.0	0.0	0.0	33.1	37.3	30.7	29.7	29.8	29.8	29.8	29.8
1977	1917023	0.0	0.0	0.0	92.1	104.1	96.1	97.8	98.4	97.0	96.9	96.9
1978	946623	0.0	0.0	63.1	91.3	94.1	83.9	68.0	26.3	26.1	25.5	25.5
1979	2548640	0.0	0.0	0.0	48.6	101.3	99.7	101.4	101.4	101.4	90.9	90.9
1980	1022760	0.0	0.0	0.0	66.7	60.5	38.8	38.9	38.9	37.5	37.5	37.4
1981	3090557	0.0	0.0	0.0	75.1	101.8	101.9	96.1	96.1	96.1	96.1	96.1
1982	3040538	0.0	0.0	0.0	87.9	107.3	113.1	132.4	141.3	140.6	139.7	138.0
1983	1322082	0.0	0.0	0.0	0.0	35.9	69.1	62.0	60.6	47.7	46.3	46.3
1984	1994284	0.0	0.0	0.0	105.0	127.6	77.9	65.8	60.6	43.8	42.6	42.6
1985	4419679	0.0	0.0	0.0	80.2	178.2	210.8	184.5	151.2	151.0	151.0	151.0
1986	1322044	0.0	0.0	0.0	127.0	57.6	73.2	76.6	70.1	70.1	70.1	70.1
1987	1982906	0.0	0.0	0.0	0.0	90.0	78.9	78.9	77.8	77.0	71.9	71.9
1988	3064832	0.0	0.0	0.0	113.0	107.6	103.8	56.0	64.5	64.7	63.8	63.8
1989	1909221	0.0	0.0	45.0	59.7	81.5	81.5	69.3	65.0	63.9	63.9	63.9
1990	1970004	0.0	0.0	58.0	75.9	74.9	90.5	89.7	55.7	48.3	48.3	48.3
1991	2360596	0.0	0.0	70.1	112.4	148.2	129.9	125.1	127.4	127.4	127.4	127.4
1992	3201553	0.0	0.0	303.3	165.7	162.3	163.7	151.3	148.8	148.1	147.3	147.3
1993	3637895	0.0	103.5	98.4	123.7	134.7	139.0	127.0	109.8	109.8	109.7	109.7
1994	1764363	32.3	40.8	49.4	65.6	95.3	110.3	105.8	109.4	108.4	106.8	106.8

Appendix Table 1. Cumulative Skeena River sockeye Area 3x purse-seine + gillnet catch-per-effort by statistical week from 1970-1994.

Appendix Table 2. Cumulative Skeena River sockeye Area 3x purse-seine + gillnet catch by statistical week from 1970-1994.

year	actual a4 run	week 63	week 64	week 71	week 72	week 73	week 74	week 75	week 81	week 82	week 83	week 84
1970	1257261	0	1303	3963	6607	13792	18804	18804	20955	20955	20965	20967
1971	1742581	0	0	0	320	3887	24812	24812	24812	25196	25196	25196
1972	1417151	0	824	3711	8721	20363	26260	35136	35747	36285	36302	36302
1973	2193566	0	4005	6891	8651	27413	45710	53371	53606	53606	53606	53806
1974	2189694	0	0	12598	33213	52851	69641	125256	125256	125256	125256	125256
1975	1396490	0	0	1938	6370	6370	35527	47560	47744	47749	47749	47749
1976	1314915	0	0	0	2521	3359	21580	37126	64668	64668	64668	64668
1977	1917023	0	0	0	19069	106616	159561	197346	212931	214320	214321	214321
1978	946623	0	0	12190	33549	35622	40458	45668	48340	48350	48545	48545
1979	2548640	0	0	0	3081	67873	83155	97214	97214	97214	97736	97736
1980	1022760	0	0	0	17385	30510	40752	46765	46765	47162	47162	47164
1981	3090557	0	0	0	25494	79584	93348	111309	111309	111309	111309	111309
1982	3040538	0	0	0	44896	158268	194759	285001	326353	327917	328077	328397
1983	1322082	0	0	0	0	6030	77525	84560	85175	91645	92989	92989
1984	1994284	0	0	0	5460	36480	58880	62985	65945	71345	71975	71975
1985	4419679	0	0	0	5133	26159	174621	216596	245842	246591	246591	246591
1986	1322044	0	0	0	3048	13974	27612	47426	52666	52666	52666	52666
1987	1982906	0	0	0	0	11835	47168	47168	51933	56161	57701	57701
1988	3064832	0	0	0	5424	38513	88148	134869	170509	174165	175199	175199
1989	1909221	0	0	2700	11526	44968	44968	53104	57782	59299	59299	59299
1990	1970004	0	0	2610	7210	12559	20413	24571	35445	38779	38779	38779
1991	2360596	0	0	1753	15405	86239	190063	243107	278554	278904	278904	278904
1992	3201553	0	0	15770	41934	83127	98488	138372	143406	145578	148163	148163
1993	3637895	0	5897	26367	62949	89218	115017	185901	216264	216264	216464	216464
1994	1764363	0	470	2550	11504	39974	45982	62387	66617	72307	73274	73274
		1680	12147	32293	76361	131706	335119	423330	476238	500855	506069	506069

Appendix Table 2. Cumulative Skeena River sockeye Area 3x purse-seine + gillnet catch by statistical week from 1970-1994.

Appendix Table 3. Cumulative Skeena River sockeye Area 4 gillnet catch-per-effort by statistical week from 1970-1994.

year	actual a4 run	week 63	week 64	week 71	week 72	week 73	week 74	week 75	week 81	week 82	week 83	week 84
1970	1257261		44.50	45.88	50.83	54.62	69.64	69.64	67.88	70.49	65.08	60.64
1971	1742561	0.43	0.43	30.65	34.00	52.29	94.85	100.04	96.13	91.41	85.64	77.07
1972	1417151	0.75	28.49	31.23	32.38	62.11	72.23	80.20	73.54	66.57	63.84	62.32
1973	2193566		68.65	63.00	146.51	161.21	139.63	130.33	118.88	112.71	112.71	111.28
1974	2189694			30.54	86.84	94.05	90.96	94.86	90.26	90.26	89.24	89.24
1975	1396490			78.49	44.72	44.72	55.25	71.59	71.78	65.22	54.15	62.97
1976	1314915				30.92	35.09	79.96	88.10	84.49	79.67	79.67	79.67
1977	1917023				43.74	100.60	102.45	97.29	87.15	78.64	74.32	71.12
1978	946623			41.25	70.60	78.40	71.37	71.37	67.55	62.44	60.15	59.16
1979	2548640				94.76	109.77	106.23	99.03	99.51	97.43	97.43	97.43
1980	1022760				51.19	54.10	54.09	54.53	54.53	54.53	54.53	54.53
1981	3090557				85.49	112.34	107.72	102.63	99.68	95.28	91.53	91.53
1982	3040538				65.92	126.87	128.27	135.39	139.04	135.93	135.93	135.93
1983	1322062					38.94	80.43	90.75	88.42	79.86	71.45	69.41
1984	1994284				105.75	136.41	109.45	107.66	99.70	94.29	92.69	92.08
1985	4419679			91.22	140.05	148.49	151.60	154.96	153.28	148.97	144.37	144.37
1986	1322044				57.06	90.34	113.42	110.51	103.49	92.66	84.66	78.58
1987	1982906				79.27	137.07	114.77	113.81	93.17	86.52	80.24	78.74
1988	3064832			32.68	77.04	101.35	98.30	103.85	122.88	122.13	116.58	114.64
1989	1909221		29.72	36.77	72.21	76.43	80.06	85.53	82.00	79.80	78.43	77.59
1990	1970004		19.58	21.40	26.93	66.45	79.02	83.25	82.43	81.71	80.68	79.94
1991	2360596			73.33	89.60	99.77	96.41	97.74	97.78	97.49	95.78	94.98
1992	3201553			91.19	88.31	98.71	107.87	109.20	106.16	106.40	108.19	107.36
1993	3637895			93.97	126.50	132.75	132.19	128.79	135.71	136.52	136.69	136.17
1994	1764363				41.94	58.65	55.12	63.97	66.39	70.53	70.53	70.53

Appendix Table 3. Cumulative Skeena River sockeye Area 4 gillnet catch-per-effort by statistical week from 1970-1994.

Appendix Table 4. Cumulative Skeena River sockeye Area 4 gillnet catch by statistical week from 1970-1994.

year	actual a4 run	week 63	week 64	week 71	week 72	week 73	week 74	week 75	week 81	week 82	week 83	week 84
1970	1257261	0	23720	61250	102072	145410	296047	296047	387127	495391	498897	499775
1971	1742581	34	34	4597	8025	32577	163434	346539	469031	691326	733264	748345
1972	1417151	67	16693	50720	75567	187636	366728	516378	639027	688767	692524	693252
1973	2193566		26980	53362	162622	718343	941944	1088929	1129791	1134583	1134583	1134634
1974	2189694	0	0	22505	171330	394360	617965	950345	1025888	1025888	1028443	1028443
1975	1395490			40502	72886	72886	216579	312267	360994	374818	377461	377781
1976	1314915				21119	37789	150489	370984	444528	458269	458269	458269
1977	1917023	0	0	0	22527	206433	432749	634735	749773	773227	777205	778175
1978	946623			45537	211950	292985	353801	353801	361013	366466	367107	367181
1979	2548640				83953	339081	689132	634070	1052491	1081748	1081748	1081748
1980	1022760				86768	194742	237790	308408	308408	308408	308408	308408
1981	3090557				180552	655632	965668	1103315	1171474	1199465	1205409	1205409
1982	3040538				108907	450766	695349	1038710	1159317	1184509	1184609	1184509
1983	1322082					17250	133761	204557	243053	306333	324320	326145
1984	1994284				29504	342523	450889	598889	643446	673970	677288	677925
1985	4419679			64035	377152	705940	1098780	1437990	1610094	1744344	1806124	1806124
1986	1322044				15350	59352	260073	369210	388512	434763	462269	472787
1987	1982906				21798	95809	200275	305797	395409	431986	451174	452623
1988	3064832			21176	192908	539813	819855	972495	1423253	1539973	1604873	1611678
1989	1909221		10403	36517	275859	400471	450187	538100	567818	584136	586663	587469
1990	1970004		7677	18062	35012	177698	390110	532825	613799	667344	672865	674943
1991	2360596			25739	174452	497162	736174	925848	971986	1013247	1035814	1038265
1992	3201553			74686	225443	433153	749075	933753	1067607	1134811	1205185	1207578
1993	3637895			79499	344329	752933	1010821	1173835	1351816	1419490	1445188	1452122
1994	1764363				58968	194194	284962	441724	494708	542639	542639	542639

Appendix Table 4. Cumulative Skeena River sockeye Area 4 gillnet catch by statistical week from 1970-1994.

Appendix Table 5. Cumulative Skeena River sockeye inshore run (Area 4 catch plus Tyee escapement) by statistical week from 1970-1994.

year	actual a4 run	week 63	week 64	week 71	week 72	week 73	week 74	week 75	week 81	week 82	week 83	week 84
1970	1257261	8981	54519	133536	275888	442233	632340	743156	973424	1128428	1139621	1141103
1971	1742581	6359	11204	33400	70020	497589	580273	853704	1121610	1441332	1529802	1554256
1972	1417151	2806	50880	97006	134840	262339	732262	945161	1299926	1415547	1429248	1432639
1973	2193566	36190	102012	188479	831196	1553761	1926425	2241863	2326247	2341983	2341983	2341983
1974	2189694	21106	31387	68788	234606	683484	1056558	1624686	1839564	1906656	1928862	1930124
1975	1396490	21106	31387	86785	136162	362010	655172	986628	1174670	1255586	1277880	1279462
1976	1314915	9917	21430	29774	64773	119284	426322	824803	1040067	1107280	1134492	1139795
1977	1917023	21072	43099	129347	231779	553250	1033056	1437181	1672515	1729881	1738429	1740011
1978	946623	44520	76433	214528	501377	666859	853445	923817	993198	1019337	1030860	1030934
1979	2548640	62838	103449	160059	351892	779822	1341153	1721114	2056746	2131178	2131178	2131178
1980	1022760	60342	127657	239444	460293	680770	830275	1071191	1159853	1212781	1225206	1228112
1981	3090557	16204	70196	154416	494575	1119042	1615920	1976265	2196301	2257396	2268353	2268353
1982	3040538	33486	120849	241186	425135	1108045	1498035	2001874	2240270	2310789	2335003	2342963
1983	1322082	17855	37802	80197	156627	320425	592828	851612	985191	1087512	1117003	1129231
1984	1994284	8475	23409	93752	311099	543254	867406	1084369	1189979	1268929	1307703	1318221
1985	4419679	42326	134351	227151	806423	1605290	2366740	2957975	3340982	3681252	3824198	3824198
1986	1322044	3714	22734	53875	107123	371256	684438	895559	1020286	1124011	1172816	1172816
1987	1982906	11854	40102	68739	173959	500278	748657	1019236	1161816	1231758	1271162	1277561
1988	3064832	9010	28005	96651	444152	1025167	1419038	1853302	2446304	2718546	2826190	2859062
1989	1909221	28602	66074	174532	628151	868223	1073652	1320975	1423955	1492250	1508219	1514300
1990	1970004	11679	35096	68658	147457	470592	828544	1112138	1273612	1376137	1408419	1427006
1991	2360596	18856	28748	113777	454904	980688	1415934	1722667	1852053	1987133	2041959	2077309
1992	3201553	4564	32685	126338	403437	914743	1425225	1724770	1967712	2100549	2212678	2246212
1993	3637895	16001	48967	134266	372656	829847	1428653	1833885	2299119	2629451	2739044	2782442
1994	1764363	3887	28562	60353	171592	474748	711540	1048544	1199901	1376422	1405447	1421684

Appendix Table 5 Cumulative Skeena River sockeye inshore run (Area 4 catch plus Tyee escapement) by statistical week from 1970-1994.

Appendix table 6. Hindcast regression statistics for Run Size versus Area 3x cum CPE, Area 4 cum CPE, and Inshore run by statistical week for the years 1994 through 1984.

for year	data used	Area	week	63	64	71	72	73	74	75	81	82	83	84
94	1970-93	3x CPE	Constant		11.453	13.033	12.864	12.088	11.140	11.418	11.857	11.781	11.779	11.777
			Std Err of Y Est		0.275	0.318	0.388	0.296	0.250	0.282	0.244	0.251	0.253	0.252
			R Squared		0.783	0.438	0.197	0.602	0.645	0.547	0.640	0.642	0.637	0.637
			X Coefficient(s)		0.735	0.350	0.384	0.547	0.752	0.697	0.879	0.840	0.835	0.836
		4 CPE	Constant		14.228	13.011	12.353	11.538	9.161	8.195	8.011	8.046	8.220	8.401
			Std Err of Y Est		0.273	0.403	0.333	0.295	0.265	0.253	0.218	0.169	0.177	0.170
			R Squared		0.005	0.207	0.369	0.506	0.600	0.635	0.734	0.797	0.822	0.836
			X Coefficient(s)		0.035	0.395	0.514	0.866	1.174	1.378	1.428	1.433	1.404	1.370
		Inshore	Constant	14.098	13.287	12.323	11.119	8.251	3.919	1.311	-0.046	-0.733	-0.803	-0.809
			Std Err of Y Est	0.418	0.413	0.405	0.370	0.309	0.248	0.207	0.180	0.184	0.157	0.165
			R Squared	0.007	0.031	0.069	0.222	0.458	0.655	0.756	0.815	0.846	0.859	0.863
			X Coefficient(s)	0.041	0.112	0.187	0.269	0.468	0.766	0.936	1.021	1.064	1.067	1.067
93	1970-92	3x CPE	Constant		12.409	13.179	13.044	12.196	11.263	11.551	11.653	11.844	11.873	11.871
			Std Err of Y Est		0.168	0.286	0.384	0.293	0.249	0.280	0.237	0.244	0.247	0.248
			R Squared		0.835	0.433	0.189	0.462	0.826	0.526	0.861	0.840	0.633	0.633
			X Coefficient(s)		0.472	0.302	0.337	0.518	0.722	0.864	0.653	0.814	0.609	0.610
		4 CPE	Constant		14.228	13.281	12.498	11.879	9.371	8.432	8.126	8.067	8.191	8.365
			Std Err of Y Est		0.273	0.409	0.336	0.293	0.267	0.255	0.220	0.193	0.181	0.173
			R Squared		0.005	0.134	0.323	0.481	0.570	0.608	0.707	0.774	0.802	0.818
			X Coefficient(s)		0.035	0.319	0.477	0.631	1.125	1.324	1.402	1.429	1.411	1.378
		Inshore	Constant	14.077	13.277	12.489	11.274	8.472	4.324	1.765	0.360	-0.443	-0.559	-0.590
			Std Err of Y Est	0.405	0.400	0.394	0.359	0.297	0.240	0.201	0.179	0.166	0.160	0.158
			R Squared	0.008	0.034	0.063	0.220	0.466	0.651	0.756	0.806	0.833	0.846	0.850
			X Coefficient(s)	0.040	0.111	0.171	0.255	0.450	0.738	0.903	0.992	1.043	1.050	1.052
92	1970-91	3x CPE	Constant		12.409	13.407	13.236	12.271	11.291	11.620	11.687	11.881	11.909	11.906
			Std Err of Y Est		0.168	0.302	0.390	0.298	0.255	0.286	0.242	0.250	0.252	0.252
			R Squared		0.835	0.174	0.107	0.445	0.594	0.489	0.634	0.611	0.603	0.603
			X Coefficient(s)		0.472	0.240	0.289	0.499	0.715	0.647	0.645	0.605	0.600	0.601
		4 CPE	Constant		14.228	13.575	12.583	11.738	9.514	8.597	8.282	8.222	8.329	8.492
			Std Err of Y Est		0.273	0.418	0.335	0.286	0.262	0.249	0.214	0.190	0.181	0.173
			R Squared		0.005	0.067	0.308	0.490	0.572	0.612	0.715	0.775	0.796	0.812
			X Coefficient(s)		0.035	0.235	0.452	0.613	1.090	1.284	1.364	1.391	1.378	1.348
		Inshore	Constant	13.576	13.03	12.588	11.439	8.693	4.629	2.084	0.702	-0.094	-0.223	-0.262
			Std Err of Y Est	0.393	0.39	0.388	0.356	0.295	0.24	0.197	0.175	0.162	0.157	0.155
			R Squared	0.037	0.051	0.06	0.209	0.457	0.639	0.756	0.809	0.837	0.846	0.849
			X Coefficient(s)	0.089	0.132	0.16	0.241	0.432	0.713	0.879	0.967	1.018	1.026	1.028
91	1970-90	3x CPE	Constant		12.409	13.580	13.275	12.224	11.236	11.583	11.616	11.812	11.836	11.833
			Std Err of Y Est		0.168	0.307	0.401	0.305	0.260	0.293	0.248	0.254	0.256	0.256
			R Squared		0.835	0.116	0.094	0.439	0.590	0.482	0.634	0.611	0.603	0.604
			X Coefficient(s)		0.472	0.166	0.279	0.511	0.729	0.656	0.663	0.623	0.619	0.620
		4 CPE	Constant		14.288	13.662	12.600	11.757	9.531	8.611	8.310	8.250	8.352	8.510
			Std Err of Y Est		0.273	0.439	0.343	0.292	0.265	0.252	0.217	0.194	0.185	0.178
			R Squared		0.005	0.048	0.298	0.486	0.575	0.617	0.716	0.773	0.794	0.810
			X Coefficient(s)		0.035	0.210	0.447	0.608	1.084	1.279	1.356	1.384	1.372	1.343
		Inshore	Constant	13.583	12.842	12.599	11.497	8.709	4.561	2.033	0.718	-0.091	-0.232	-0.289
			Std Err of Y Est	0.399	0.394	0.394	0.364	0.303	0.246	0.202	0.179	0.166	0.161	0.159
			R Squared	0.036	0.064	0.060	0.199	0.447	0.634	0.752	0.806	0.834	0.844	0.647
			X Coefficient(s)	0.087	0.146	0.158	0.235	0.431	0.718	0.683	0.966	1.018	1.026	1.030
90	1970-89	3x CPE	Constant		12.409	13.648	13.278	12.221	11.233	11.577	11.857	11.718	11.749	11.745
			Std Err of Y Est		0.168	0.327	0.414	-0.313	0.268	0.301	0.248	0.253	0.256	0.256
			R Squared		0.835	0.091	0.093	0.439	0.590	0.482	0.849	0.635	0.625	0.626
			X Coefficient(s)		0.472	0.162	0.279	0.511	0.730	0.658	0.675	0.642	0.637	0.638
		4 CPE	Constant		13.348	13.295	12.164	11.704	9.414	8.450	6.220	6.208	8.329	8.496
			Std Err of Y Est		0.287	0.459	0.334	0.296	0.267	0.253	0.217	0.196	0.188	0.161
			R Squared		0.175	0.075	0.372	0.497	0.591	0.634	0.729	0.780	0.798	0.813
			X Coefficient(s)		0.263	0.302	0.546	0.618	1.108	1.306	1.374	1.392	1.376	1.345
		Inshore	Constant	13.857	12.797	12.495	11.355	8.637	4.482	1.927	0.556	-0.256	-0.392	-0.433
			Std Err of Y Est	0.410	0.404	0.404	0.371	0.309	0.250	0.204	0.178	0.164	0.159	0.157
			R Squared	0.038	0.066	0.065	0.211	0.455	0.641	0.761	0.818	0.847	0.856	0.858
			X Coefficient(s)	0.090	0.151	0.167	0.246	0.436	0.723	0.890	0.977	1.029	1.037	1.040
89	1970-88	3x CPE	Constant		12.409	13.641	13.268	12.221	11.233	11.559	11.845	11.709	11.742	11.739
			Std Err of Y Est		0.168	0.350	0.427	0.322	0.276	0.309	0.254	0.259	0.263	0.263
			R Squared		0.835	0.091	0.094	0.439	0.590	0.485	0.651	0.836	0.827	0.627
			X Coefficient(s)		0.472	0.155	0.280	0.511	0.730	0.661	0.676	0.643	0.638	0.639
		4 CPE	Constant		12.400	13.242	12.161	11.693	9.316	8.393	8.126	8.148	8.290	8.489
			Std Err of Y Est		0.279	0.490	0.344	0.304	0.271	0.256	0.219	0.196	0.190	0.184
			R Squared		0.548	0.079	0.372	0.499	0.604	0.644	0.741	0.769	0.804	0.817
			X Coefficient(s)		0.493	0.313	0.548	0.619	1.127	1.323	1.393	1.404	1.383	1.350
		Inshore	Constant	13.552	12.792	12.481	11.169	8.648	4.457	1.925	0.542	-0.293	-0.439	-0.480
			Std Err of Y Est	0.422	0.415	0.416	0.379	0.316	0.257	0.210	0.183	0.167	0.161	0.160
			R Squared	0.038	0.066	0.065	0.222	0.461	0.642	0.761	0.820	0.850	0.660	0.661
			X Coefficient(s)	0.090	0.152	0.170	0.262	0.443	0.725	0.890	0.978	1.031	1.040	1.042
88	1970-87	3x CPE	Constant		12.409	13.641	13.468	12.306	11.327	11.211	11.457	11.649	11.684	11.682
			Std Err of Y Est		0.168	0.350	0.431	0.321	0.272	0.257	0.216	0.228	0.232	0.232
			R Squared		0.835	0.091	0.059	0.425	0.588	0.631	0.739	0.711	0.700	0.700
			X Coefficient(s)		0.472	0.155	0.222	0.487	0.704	0.731	0.689	0.650	0.644	0.645
		4 CPE	Constant		12.400	12.522	12.217	11.761	9.365	8.505	8.254	8.203	6.364	6.542
			Std Err of Y Est		0.279	0.453	0.340	0.298	0.254	0.243	0.223	0.203	0.196	0.189
			R Squared		0.548	0.201	0.375	0.505	0.640	0.670	0.722	0.770	0.787	0.801
			X Coefficient(s)		0.493	0.480	0.528	0.599	1.111	1.293	1.383	1.391	1.366	1.333
		Inshore	Constant	13.274	12.351	12.341	11.415	8.823	4.788	2.242	0.684	-0.465	-0.713	-0.797
			Std Err of Y Est	0.409	0.400	0.407	0.379	0.318	0.259	0.212	0.188	0.171	0.165	0.163
			R Squared	0.066	0.109	0.078	0.199	0.435	0.625	0.749	0.803	0.836	0.648	0.651
			X Coefficient(s)	0.116	0.190	0.178	0.240	0.421	0.700	0.867	0.975	1.043	1.059	1.065

87	1970-86	3x CPE	Constant		12.409	13.641	13.488	12.306	11.322	11.207	11.459	11.650	11.684	11.681
			Std Err of Y Est		0.168	0.350	0.431	0.332	0.279	0.265	0.223	0.235	0.239	0.239
			R Squared		0.835	0.091	0.059	0.423	0.590	0.632	0.739	0.711	0.700	0.700
			X Coefficient(s)		0.472	0.155	0.222	0.487	0.704	0.731	0.689	0.649	0.644	0.644
		4 CPE	Constant		12.400	12.522	12.212	11.641	9.280	8.418	8.257	8.199	8.336	8.519
			Std Err of Y Est		0.279	0.453	0.352	0.302	0.260	0.249	0.230	0.208	0.198	0.191
			R Squared		0.548	0.201	0.374	0.521	0.646	0.675	0.722	0.772	0.794	0.808
			X Coefficient(s)		0.493	0.480	0.530	0.629	1.131	1.315	1.361	1.390	1.370	1.336
		Inshore	Constant	13.228	12.306	12.187	11.314	8.778	4.570	1.962	0.156	-1.008	-1.219	-1.301
			Std Err of Y Est	0.421	0.411	0.417	0.388	0.326	0.260	0.207	0.178	0.153	0.146	0.145
			R Squared	0.070	0.113	0.087	0.209	0.441	0.646	0.774	0.837	0.878	0.888	0.890
			X Coefficient(s)	0.119	0.193	0.190	0.248	0.424	0.715	0.886	1.003	1.080	1.093	1.099
86	1970-85	3x CPE	Constant		12.409	13.641	13.027	12.357	11.362	11.233	11.481	11.663	11.693	11.69
			Std Err of Y Est		0.168	0.35	0.423	0.339	0.281	0.263	0.217	0.227	0.231	0.231
			R Squared		0.835	0.091	0.125	0.417	0.8	0.651	0.762	0.739	0.73	0.73
			X Coefficient(s)		0.472	0.155	0.341	0.478	0.698	0.729	0.688	0.651	0.646	0.647
		4 CPE	Constant		12.400	12.522	12.264	11.604	8.924	8.096	8.013	8.103	8.334	8.566
			Std Err of Y Est		0.279	0.453	0.357	0.295	0.223	0.216	0.198	0.185	0.185	0.185
			R Squared		0.548	0.201	0.376	0.560	0.749	0.765	0.802	0.826	0.827	0.828
			X Coefficient(s)		0.493	0.480	0.522	0.643	1.218	1.392	1.422	1.418	1.375	1.329
		Inshore	Constant	13.399	12.482	12.427	11.430	8.890	4.678	1.976	0.020	-1.147	-1.297	-1.393
			Std Err of Y Est	0.434	0.423	0.429	0.401	0.336	0.268	0.215	0.182	0.157	0.151	0.149
			R Squared	0.044	0.092	0.066	0.184	0.428	0.636	0.767	0.833	0.875	0.884	0.887
			X Coefficient(s)	0.103	0.178	0.170	0.239	0.416	0.707	0.885	1.013	1.090	1.099	1.105
85	1970-84	3x CPE	Constant		12.409	13.641	13.297	12.769	11.733	11.614	11.782	11.955	11.986	11.983
			Std Err of Y Est		0.168	0.350	0.372	0.320	0.283	0.258	0.194	0.206	0.211	0.211
			R Squared		0.835	0.091	0.103	0.306	0.457	0.548	0.746	0.713	0.699	0.699
			X Coefficient(s)		0.472	0.155	0.262	0.374	0.609	0.636	0.610	0.575	0.570	0.571
		4 CPE	Constant		12.4	14.474	12.756	11.996	9.485	8.635	8.426	8.436	8.702	8.917
			Std Err of Y Est		0.279	0.333	0.339	0.268	0.215	0.215	0.2	0.189	0.187	0.187
			R Squared		0.548	0.006	0.252	0.513	0.686	0.687	0.728	0.759	0.764	0.762
			X Coefficient(s)		0.493	-0.062	0.394	0.545	1.089	1.27	1.328	1.34	1.289	1.247
		Inshore	Constant	13.969	13.548	13.489	12.584	10.022	5.894	2.885	0.556	-1.379	-1.872	-1.991
			Std Err of Y Est	0.383	0.380	0.381	0.369	0.317	0.266	0.217	0.187	0.163	0.156	0.154
			R Squared	0.009	0.020	0.017	0.081	0.321	0.520	0.680	0.764	0.821	0.836	0.840
			X Coefficient(s)	0.039	0.075	0.074	0.142	0.328	0.617	0.819	0.975	1.106	1.139	1.147
84	1970-83	3x CPE	Constant		12.409	13.641	13.287	12.720	11.737	11.551	11.738	11.762	11.783	11.781
			Std Err of Y Est		0.168	0.350	0.388	0.333	0.293	0.260	0.191	0.181	0.186	0.186
			R Squared		0.835	0.091	0.093	0.300	0.459	0.571	0.770	0.793	0.781	0.781
			X Coefficient(s)		0.472	0.155	0.265	0.387	0.606	0.648	0.617	0.615	0.612	0.612
		4 CPE	Constant		12.400	14.474	12.684	11.851	9.400	8.566	8.403	8.419	8.676	8.880
			Std Err of Y Est		0.279	0.333	0.353	0.274	0.222	0.223	0.208	0.196	0.194	0.195
			R Squared		0.548	0.006	0.249	0.525	0.687	0.886	0.725	0.756	0.761	0.76
			X Coefficient(s)		0.493	-0.062	0.413	0.582	1.109	1.286	1.333	1.345	1.296	1.256
		Inshore	Constant	13.812	13.260	13.421	12.622	10.009	5.856	2.678	0.000	-2.117	-2.552	-2.650
			Std Err of Y Est	0.394	0.391	0.394	0.382	0.326	0.273	0.215	0.17	0.134	0.127	0.126
			R Squared	0.015	0.034	0.019	0.077	0.325	0.530	0.708	0.818	0.886	0.897	0.900
			X Coefficient(s)	0.054	0.100	0.079	0.139	0.328	0.619	0.833	1.012	1.156	1.185	1.192

Appendix Table 7. Hindcast regression statistics for Run Size versus Area 3x cum catch, Area 4 cum catch, and Inshore run by statistical week for the years 1994 through 1984.

for year	data used	Area	week	63	64	71	72	73	74	75	81	82	83	84
94	1970-93	3x Catch	Constant		10.787	13.007	13.749	12.323	10.173	10.307	10.219	10.156	10.164	10.164
			Std Err of Y Est		0.233	0.391	0.418	0.348	0.297	0.294	0.291	0.290	0.290	0.290
			R Squared		0.844	0.151	0.057	0.312	0.498	0.508	0.517	0.522	0.522	0.522
			X Coefficient(s)		0.479	0.168	0.083	0.212	0.394	0.373	0.378	0.383	0.383	0.383
		4 Catch	Constant		14.420	13.648	12.575	11.384	7.924	5.999	5.506	4.856	4.786	4.772
			Std Err of Y Est		0.236	0.446	0.374	0.316	0.249	0.203	0.177	0.165	0.159	0.180
			R Squared		0.008	0.028	0.206	0.434	0.847	0.768	0.821	0.845	0.856	0.855
			X Coefficient(s)		-0.007	0.095	0.171	0.253	0.507	0.640	0.870	0.714	0.719	0.719
		Inshore	Constant	14.098	13.287	12.323	11.119	8.251	3.919	1.311	-0.046	-0.733	-0.803	-0.809
			Std Err of Y Est	0.418	0.413	0.405	0.370	0.309	0.246	0.207	0.180	0.184	0.157	0.155
			R Squared	0.007	0.031	0.069	0.222	0.458	0.655	0.756	0.815	0.846	0.859	0.863
			X Coefficient(s)	0.041	0.112	0.187	0.269	0.468	0.766	0.936	1.021	1.064	1.067	1.067
93	1970-92	3x Catch	Constant		11.922	13.906	14.018	12.486	10.383	10.514	10.424	10.363	10.360	10.360
			Std Err of Y Est		0.195	0.377	0.414	0.348	0.294	0.295	0.293	0.291	0.291	0.291
			R Squared		0.777	0.017	0.021	0.278	0.478	0.476	0.482	0.487	0.488	0.488
			X Coefficient(s)		0.318	0.057	0.051	0.195	0.373	0.354	0.359	0.364	0.364	0.364
		4 Catch	Constant		14.420	14.169	12.804	11.563	8.147	6.229	5.716	5.060	4.986	4.971
			Std Err of Y Est		0.236	0.438	0.374	0.316	0.251	0.204	0.179	0.166	0.160	0.161
			R Squared		0.008	0.003	0.160	0.398	0.618	0.749	0.807	0.833	0.845	0.844
			X Coefficient(s)		-0.007	0.032	0.149	0.237	0.489	0.622	0.654	0.899	0.703	0.704
		Inshore	Constant	14.077	13.277	12.489	11.274	8.472	4.324	1.765	0.360	-0.443	-0.559	-0.590
			Std Err of Y Est	0.405	0.400	0.394	0.359	0.297	0.240	0.201	0.179	0.166	0.160	0.158
			R Squared	0.008	0.034	0.063	0.220	0.466	0.651	0.756	0.806	0.833	0.846	0.850
			X Coefficient(s)	0.040	0.111	0.171	0.255	0.450	0.736	0.903	0.992	1.043	1.050	1.052
92	1970-91	3x Catch	Constant		11.922	15.158	14.247	12.619	10.536	10.870	10.577	10.516	10.515	10.515
			Std Err of Y Est		0.195	0.323	0.412	0.348	0.293	0.295	0.292	0.291	0.291	0.291
			R Squared		0.777	0.066	0.004	0.243	0.465	0.457	0.467	0.472	0.472	0.472
			X Coefficient(s)		0.318	-0.100	0.023	0.180	0.358	0.339	0.344	0.349	0.349	0.349
		4 Catch	Constant		14.420	14.820	12.971	11.681	8.343	8.435	5.912	5.262	5.168	5.154
			Std Err of Y Est		0.236	0.432	0.375	0.314	0.252	0.204	0.178	0.165	0.161	0.181
			R Squared		0.008	0.004	0.131	0.365	0.602	0.741	0.803	0.830	0.839	0.838
			X Coefficient(s)		-0.007	-0.034	0.133	0.226	0.473	0.606	0.638	0.683	0.689	0.690
		Inshore	Constant	13.578	13.03	12.588	11.439	8.893	4.629	2.064	0.702	-0.094	-0.223	-0.262
			Std Err of Y Est	0.393	0.39	0.388	0.356	0.295	0.24	0.197	0.175	0.162	0.157	0.155
			R Squared	0.037	0.051	0.06	0.209	0.457	0.639	0.756	0.809	0.837	0.846	0.849
			X Coefficient(s)	0.089	0.132	0.16	0.241	0.432	0.713	0.879	0.967	1.018	1.026	1.028
91	1970-90	3x Catch	Constant		11.922	14.523	14.286	12.623	10.244	10.419	10.264	10.223	10.224	10.224
			Std Err of Y Est		0.195	0.326	0.421	0.357	0.295	0.299	0.295	0.293	0.293	0.293
			R Squared		0.777	0.004	0.003	0.230	0.473	0.462	0.475	0.481	0.481	0.481
			X Coefficient(s)		0.318	-0.028	0.018	0.180	0.386	0.362	0.371	0.376	0.376	0.376
		4 Catch	Constant		14.420	14.731	13.012	11.691	8.292	8.344	5.876	5.229	5.129	5.115
			Std Err of Y Est		0.236	0.450	0.364	0.322	0.259	0.208	0.182	0.169	0.165	0.165
			R Squared		0.008	0.003	0.121	0.374	0.596	0.739	0.800	0.827	0.836	0.835
			X Coefficient(s)		-0.007	-0.028	0.129	0.226	0.477	0.613	0.641	0.686	0.692	0.693
		Inshore	Constant	13.583	12.842	12.599	11.497	8.709	4.561	2.033	0.718	-0.091	-0.232	-0.289
			Std Err of Y Est	0.399	0.394	0.394	0.364	0.303	0.246	0.202	0.179	0.166	0.161	0.159
			R Squared	0.036	0.064	0.060	0.199	0.447	0.634	0.752	0.806	0.834	0.844	0.847
			X Coefficient(s)	0.087	0.148	0.158	0.235	0.431	0.718	0.883	0.966	1.018	1.026	1.030
90	1970-89	3x Catch	Constant		11.922	14.155	14.282	12.561	9.729	9.934	10.012	9.993	9.991	9.992
			Std Err of Y Est		0.195	0.343	0.434	0.364	0.284	0.288	0.292	0.292	0.292	0.292
			R Squared		0.777	0.001	0.003	0.239	0.537	0.523	0.511	0.511	0.511	0.511
			X Coefficient(s)		0.318	0.012	0.018	0.185	0.431	0.404	0.394	0.395	0.395	0.396
		4 Catch	Constant		14.407	14.689	12.951	11.685	8.289	6.339	5.869	5.223	5.122	5.107
			Std Err of Y Est		0.258	0.477	0.394	0.330	0.265	0.213	0.186	0.173	0.168	0.169
			R Squared		0.013	0.002	0.127	0.375	0.597	0.740	0.801	0.828	0.838	0.837
			X Coefficient(s)		-0.009	-0.024	0.133	0.226	0.477	0.613	0.642	0.686	0.693	0.694
		Inshore	Constant	13.557	12.797	12.495	11.355	8.637	4.482	1.927	0.558	-0.256	-0.392	-0.433
			Std Err of Y Est	0.410	0.404	0.404	0.371	0.309	0.250	0.204	0.178	0.184	0.159	0.157
			R Squared	0.036	0.066	0.065	0.211	0.455	0.641	0.761	0.818	0.847	0.856	0.858
			X Coefficient(s)	0.090	0.151	0.167	0.246	0.436	0.723	0.890	0.977	1.029	1.037	1.040
89	1970-88	3x Catch	Constant		11.922	13.624	14.263	12.641	9.696	9.888	9.968	9.951	9.949	9.949
			Std Err of Y Est		0.195	0.363	0.448	0.374	0.291	0.295	0.299	0.299	0.299	0.299
			R Squared		0.777	0.024	0.003	0.241	0.541	0.529	0.516	0.517	0.517	0.517
			X Coefficient(s)		0.318	0.069	0.016	0.187	0.434	0.407	0.397	0.398	0.398	0.398
		4 Catch	Constant		14.404	14.692	12.836	11.635	8.283	6.337	5.884	5.168	5.057	5.041
			Std Err of Y Est		0.295	0.810	0.404	0.338	0.273	0.219	0.190	0.175	0.169	0.170
			R Squared		0.030	0.002	0.137	0.381	0.597	0.740	0.804	0.834	0.845	0.844
			X Coefficient(s)		-0.013	-0.025	0.145	0.230	0.477	0.813	0.643	0.690	0.697	0.698
		Inshore	Constant	13.652	12.792	12.461	11.169	8.548	4.457	1.925	0.542	-0.293	-0.439	-0.480
			Std Err of Y Est	0.422	0.416	0.416	0.379	0.316	0.257	0.210	0.183	0.167	0.161	0.160
			R Squared	0.038	0.066	0.065	0.222	0.461	0.642	0.761	0.820	0.850	0.860	0.861
			X Coefficient(s)	0.090	0.152	0.170	0.262	0.443	0.725	0.890	0.978	1.031	1.040	1.042
88	1970-87	3x Catch	Constant		11.922	13.624	14.178	12.818	9.866	10.068	10.141	10.124	10.121	10.122
			Std Err of Y Est		0.195	0.363	0.443	0.371	0.290	0.298	0.304	0.304	0.304	0.304
			R Squared		0.777	0.024	0.006	0.234	0.532	0.506	0.483	0.483	0.483	0.483
			X Coefficient(s)		0.318	0.069	0.026	0.177	0.417	0.390	0.381	0.382	0.382	0.382
		4 Catch	Constant		14.404	14.168	13.035	11.787	8.474	6.534	5.603	5.034	4.863	4.842
			Std Err of Y Est		0.295	0.507	0.407	0.342	0.276	0.222	0.196	0.180	0.173	0.174
			R Squared		0.030	0.001	0.105	0.349	0.568	0.724	0.786	0.820	0.833	0.832
			X Coefficient(s)		-0.013	0.020	0.125	0.217	0.462	0.597	0.646	0.700	0.712	0.713
		Inshore	Constant	13.274	12.351	12.341	11.416	8.823	4.786	2.242	0.684	-0.445	-0.713	-0.797
			Std Err of Y Est	0.409	0.400	0.407	0.379	0.318	0.259	0.212	0.188	0.171	0.165	0.163
			R Squared	0.066	0.109	0.076	0.199	0.435	0.625	0.749	0.603	0.836	0.848	0.851
			X Coefficient(s)	0.116	0.190	0.174	0.240	0.421	0.700	0.867	0.975	1.043	1.059	1.065

87	1970-86	3x Catch	Constant		11.922	13.624	14.178	12.531	9.833	9.954	10.038	10.048	10.054	10.055
			Std Err of Y Est		0.195	0.363	0.443	0.378	0.296	0.301	0.309	0.310	0.310	0.310
			R Squared		0.777	0.024	0.006	0.249	0.539	0.525	0.500	0.496	0.495	0.495
			X Coefficient(s)		0.318	0.069	0.026	0.185	0.419	0.399	0.389	0.388	0.387	0.387
		4 Catch	Constant		14.404	14.168	12.858	11.692	7.996	5.940	5.367	4.529	4.399	4.376
			Std Err of Y Est		0.295	0.507	0.416	0.348	0.267	0.199	0.176	0.154	0.148	0.149
			R Squared		0.030	0.001	0.122	0.366	0.626	0.792	0.837	0.876	0.885	0.884
			X Coefficient(s)		-0.013	0.020	0.139	0.223	0.497	0.641	0.677	0.736	0.745	0.746
		Inshore	Constant	13.228	12.306	12.187	11.314	8.778	4.570	1.962	0.156	-1.008	-1.219	-1.301
			Std Err of Y Est	0.421	0.411	0.417	0.388	0.326	0.260	0.207	0.176	0.153	0.146	0.145
			R Squared	0.070	0.113	0.087	0.209	0.441	0.646	0.774	0.837	0.878	0.888	0.890
			X Coefficient(s)	0.119	0.193	0.190	0.248	0.424	0.715	0.886	1.003	1.080	1.093	1.099
86	1970-85	3x Catch	Constant		11.922	13.624	14.318	12.6	9.853	10.035	10.121	10.131	10.138	10.138
			Std Err of Y Est		0.195	0.363	0.452	0.388	0.307	0.308	0.316	0.49	0.318	0.318
			R Squared		0.777	0.024	0.001	0.239	0.523	0.518	0.494	0.317	0.488	0.488
			X Coefficient(s)		0.318	0.069	0.013	0.179	0.417	0.393	0.383	0.381	0.381	0.381
		4 Catch	Constant		14.404	14.168	12.996	11.733	8.081	6.000	5.352	4.510	4.421	4.413
			Std Err of Y Est		0.295	0.507	0.431	0.360	0.275	0.206	0.182	0.159	0.153	0.154
			R Squared		0.030	0.001	0.092	0.345	0.617	0.786	0.832	0.872	0.881	0.881
			X Coefficient(s)		-0.013	0.020	0.128	0.220	0.491	0.636	0.678	0.737	0.743	0.744
		Inshore	Constant	13.399	12.482	12.427	11.430	8.890	4.678	1.976	0.020	-1.147	-1.297	-1.393
			Std Err of Y Est	0.434	0.423	0.429	0.401	0.336	0.268	0.215	0.182	0.157	0.151	0.149
			R Squared	0.044	0.092	0.066	0.184	0.428	0.636	0.767	0.833	0.875	0.884	0.887
			X Coefficient(s)	0.103	0.178	0.170	0.239	0.416	0.707	0.885	1.013	1.090	1.099	1.105
85	1970-84	3x Catch	Constant		11.922	13.624	14.062	12.566	10.613	10.757	10.876	10.890	10.897	10.897
			Std Err of Y Est		0.195	0.363	0.390	0.314	0.291	0.289	0.299	0.300	0.300	0.300
			R Squared		0.777	0.024	0.014	0.334	0.428	0.434	0.396	0.393	0.391	0.391
			X Coefficient(s)		0.318	0.069	0.034	0.177	0.345	0.325	0.312	0.311	0.310	0.310
		4 Catch	Constant		14.404	15.386	13.979	12.259	8.963	6.838	6.166	5.253	5.112	5.107
			Std Err of Y Est		0.295	0.316	0.391	0.326	0.258	0.194	0.171	0.152	0.148	0.149
			R Squared		0.030	0.108	0.008	0.279	0.548	0.745	0.802	0.844	0.851	0.85
			X Coefficient(s)		-0.013	-0.11	0.035	0.173	0.42	0.571	0.616	0.681	0.691	0.691
		Inshore	Constant	13.969	13.548	13.489	12.584	10.022	5.894	2.885	0.556	-1.379	-1.872	-1.991
			Std Err of Y Est	0.383	0.380	0.381	0.369	0.317	0.266	0.217	0.187	0.163	0.156	0.154
			R Squared	0.009	0.020	0.017	0.081	0.321	0.520	0.680	0.764	0.821	0.836	0.840
			X Coefficient(s)	0.039	0.075	0.074	0.142	0.328	0.617	0.619	0.975	1.106	1.139	1.147
84	1970-83	3x Catch	Constant		11.922	13.624	14.019	12.578	10.628	10.741	10.853	10.884	10.893	10.893
			Std Err of Y Est		0.195	0.363	0.404	0.326	0.301	0.297	0.307	0.309	0.309	0.309
			R Squared		0.777	0.024	0.017	0.328	0.428	0.441	0.404	0.397	0.395	0.395
			X Coefficient(s)		0.318	0.069	0.036	0.175	0.342	0.325	0.313	0.310	0.309	0.309
		4 Catch	Constant		14.404	15.386	13.621	12.274	8.989	6.865	6.187	5.268	5.125	5.120
			Std Err of Y Est		0.295	0.316	0.405	0.339	0.268	0.201	0.175	0.154	0.15	0.15
			R Squared		0.030	0.108	0.015	0.271	0.544	0.744	0.805	0.85	0.857	0.857
			X Coefficient(s)		-0.013	-0.11	0.048	0.172	0.418	0.569	0.614	0.679	0.689	0.689
		Inshore	Constant	13.612	13.260	13.421	12.622	10.009	5.856	2.678	0.000	-2.117	-2.552	-2.650
			Std Err of Y Est	0.394	0.391	0.394	0.382	0.326	0.273	0.215	0.17	0.134	0.127	0.126
			R Squared	0.015	0.034	0.019	0.077	0.325	0.530	0.708	0.818	0.886	0.897	0.900
			X Coefficient(s)	0.054	0.100	0.079	0.139	0.328	0.619	0.633	1.012	1.156	1.185	1.192