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Utilizing the Albion Test Fishery as an In-season Predictor of Run Size of the Fraser River Spring and Summer Age 5_2 Chinook Aggregate

Recours à la pêche expérimentale à Albion comme indice, en cours de saison, de la taille de montaison des populations en comigration de saumon quinnat âgées de 5_2 ans dans le fleuve Fraser au printemps et en été

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This paper is dedicated to the late Michael Chamberlain, a creative problem-solver, enthusiastic fish biologist, and friend who inspired his colleagues with his diligence, wit, and intuition.

- *C.K. Parken*

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ABSTRACT

The Albion test fishery provides a long continuous index for measuring Chinook (*Oncorhynchus tshawytscha*) abundance in British Columbia's Fraser River (Figure 1). Following the recommendations of Dempson et al. (1998), Parken et al. (2008) demonstrated that population abundance indices developed from the test fishery were significantly associated with run size at the river mouth in 2000 and 2001. The investigation used cumulative weekly average Catch per Unit Effort (CPUE) from the Albion fishery coupled with genetic stock identification (GSI) data from captured Chinook salmon to develop abundance indices for populations and aggregates of populations by geographic stock structure and migration timing.

Using the same approach as Parken et al. (2008), but in the absence of GSI data, we have re-examined the relationship between the Albion test fishery abundance indices and the aggregate run size for spring- and summer-run age 5_2 populations of Fraser River Chinook (PSC 2008; English et al. 2007). The goal was to examine the feasibility of using the test fishery abundance indices to predict the in-season run size of the aggregate of the spring- and summer-run age 5_2 populations. These predictions could then be used as an in-season tool to design fisheries compatible with the abundance of the aggregated populations.

For the aggregate of the spring- and summer-run age 5_2 populations, we explored the relationship between the Albion test fishery abundance indices and spawning escapement and reconstructed terminal runs at the Fraser River mouth. Regression models were examined for each of ten periods (statistical week 05/3 to statistical week 07/3), where each period was represented by the cumulative weekly average CPUE's from statistical week 05/1 to the end of the individual period. The periods were chosen as they were far enough along into the returning salmon migration to provide a clear signal of the potential run size and early enough to enable managers to use the information to modify fishing plans if necessary.

We found that years with high test fishery abundance indices generally had large terminal runs and spawning escapements. For both terminal run size and spawning escapement data sets, strong relationships were detected as early as period 05/2. Those relationships remained strong until period 07/3. The performance of regression models declines after week 07/2 when the abundance of populations in the Fraser River summer-run age 4_1 stock group increases rapidly.

RÉSUMÉ

La pêche expérimentale à Albion fournit un indice continu qui permet de mesurer l'abondance de saumon quinnat (*Oncorhynchus tshawytscha*) dans le fleuve Fraser en Colombie-Britannique (Figure 1). Suivant les recommandations de Dempson et al. (1998), Parken et al. (2008) ont démontré que les indices d'abondance de populations élaborés à partir de la pêche expérimentale étaient associés de manière significative avec la taille de montaison à l'embouchure du fleuve en 2000 et en 2001. Pour mener l'étude, l'enquête a utilisé la moyenne hebdomadaire cumulative des captures par unité d'effort (CPUE) tirée des activités de pêche à Albion et l'ont associé aux données sur l'identification génétique des stocks (IGS) provenant des saumons quinnat capturés afin d'élaborer des indices d'abondance pour les populations et les populations en comigration en fonction de la structure géographique des stocks et de la période de migration.

Utilisant la même approche que Parken et al. (2008), mais sans les données sur l'IGS, nous avons réexaminé la relation entre les indices d'abondance découlant de la pêche expérimentale à Albion et la taille de montaison printanière et estivale des populations en comigration de saumon quinnat du Fleuve Fraser âgées de 5_2 ans (Commission du saumon du Pacifique 2008; English et al. 2007). L'objectif était d'étudier la faisabilité d'utiliser les indices d'abondance découlant de la pêche expérimentale pour prévoir, en cours de saison, la taille de montaison des populations en comigration de montaison printanière et estivale âgées de 5_2 ans. Ces prévisions pourraient ensuite être utilisées comme outil, en cours de saison, pour concevoir des pêches compatibles avec l'abondance des populations en comigration.

En ce qui concerne la comigration des populations de montaison printanière et estivale âgées de 5_2 ans, nous avons examiné la relation entre les indices d'abondance découlant de la pêche expérimentale à Albion et les échappées de géniteurs et les reconstructions des remontes à l'estuaire à l'embouchure du fleuve Fraser. Nous avons examiné les modèles de régression pour chacune des dix périodes (de la semaine statistique 05/3 à la semaine statistique 07/3). Chaque période était représentée par la moyenne hebdomadaire cumulative des CPUE, de la semaine statistique 05/1 jusqu'à la fin de chaque période. Les périodes ont été choisies parce qu'elles constituaient un point suffisamment avancé dans le cycle de migration de retour du saumon pour fournir un signe clair de la taille potentielle de montaison sans qu'il soit trop tard pour que les gestionnaires utilisent l'information pour modifier les plans de pêche si nécessaire.

Nous avons constaté que les années où les indices d'abondance découlant de la pêche expérimentale sont les plus élevés sont généralement les années où les remontes à l'estuaire et l'échappée de géniteurs sont les plus importantes. Pour les ensembles de données sur les remontes à l'estuaire ainsi que sur l'échappée de géniteurs, des liens très étroits ont été détectés dès la semaine 05/2. Ces liens demeurent importants jusqu'à la semaine 07/3. Le rendement des modèles de régression diminue après la semaine 07/2 lorsque l'abondance des populations de montaison estivale du fleuve Fraser âgées de 4_1 ans connaît une augmentation rapide.

1. INTRODUCTION

The Albion test fishery provides a long continuous index for measuring Chinook salmon (*Oncorhynchus tshawytscha*) in British Columbia's Fraser River (Figure 1). Preliminary summaries of the test fishery data were compiled by Schubert et al. (1988) and Starr and Schubert (1990). Further analyses of the Albion test fishery and its potential to provide estimates of relative abundance of Fraser River Chinook salmon were conducted by Dempson et al. (1998).

Following the recommendations of Dempson et al. (1998), Parken et al. (2008) demonstrated that population abundance indices at the test fishery were significantly associated with run size at the river mouth in 2000 and 2001. The investigation used cumulative weekly average Catch per Unit Effort (CPUE) from the Albion fishery coupled with genetic stock identification (GSI) data from captured Chinook salmon to develop abundance indices for populations and aggregates of populations by geographic stock structure and migration timing. The investigation also described the migration times of Chinook populations into the Fraser River.

Chinook salmon spawn in over 100 locations within the Fraser River watershed and populations have a diverse range of life histories (Candy et al. 2002) and migration times (Parken et al. 2008). In 1985, the Chinook Technical Committee of the Pacific Salmon Commission categorized Chinook Salmon returning to the Fraser as either Fraser-Early or Fraser-late. Fraser Late or fall run Chinook are dominated by the white-fleshed returns to the Harrison and Chilliwack Rivers and various other tributaries of the Lower Fraser to which they have been out-planted. Fraser Early is a "catch-all" for all spring and summer returning Chinook, and is principally comprised of all the Interior populations, plus returns to Maria Slough, Upper Pitt and Birkenhead rivers.

Starting in 1999, escapements to the Fraser Early have been further subdivided into four stock groups based on life history and run-timing (PSC 2002). The stock groups are: Fraser Spring-run Age 4_2; Fraser Spring-run Age 5_2; Fraser Summer-run Age 5_2; and; Fraser Summer-run Age 4_1. These stock groups are closely related to the Conservation Units (CUs) described by Holtby and Ciruna (2007) who after reviewing the biophysical characteristics of Chinook spawning systems in British Columbia, described eight ecotypic CUs within the Fraser River watershed.

This paper focuses on the aggregate run size of the spring- and summer-run age 5_2 Chinook salmon populations. The Fraser River spring-run age 5_2 stock group consists of approximately 31 spawning populations and includes the Birkenhead and upper Pitt Rivers in the lower Fraser, the McGregor and Torpy Rivers in the upper Fraser River and the Salmon and Eagle Rivers in the South Thompson watershed (PSC 2008; PSC 2002; Figure 1). The Fraser River summer-run age 5_2 group consists of approximately 14 spawning populations and includes the Stuart and Nechako rivers upstream of Prince George, Chilko and Quesnel rivers in the mid Fraser and the Clearwater, Blue and Raft Rivers in the North Thompson River watershed (CTC 2008; PSC 2002; Figure 1).

Both groups exhibit a stream-type life history pattern with juveniles remaining in freshwater for one full year after emergence (Healey 1991). Following a year in freshwater the smolts migrate out of the Fraser River, and perhaps follow a similar migration pattern as Fraser Sockeye, moving mainly north out of the Strait Georgia (Healey and Groot 1987). Once out of the Strait they are believed to rear off the continental shelf for three winters prior to returning back to the Fraser River (Healey 1983). Most spawners have spent two, three or four winters in the marine environment (age 4_2, 5_2, and 6_2, respectively). Though varying in proportion from year to year, the 5_2 age classification is the dominant age-at-maturity.

Chinook salmon enter the Fraser River virtually year round, with most populations migrating during the summer and forming a continuum of migration times (Parken et al. 2008). The migration time of the aggregate of spring- and summer-run age 5_2 populations shows the earliest fish passing the Albion test fishery in early April; 21% of the run passing by June 21^{st}; 52% by July 12^{th}; and approximately 93% by August 9^{th} in 2000 and 2001 (data from Parken et. al 2008; Figure 2). The migration times of spring- and summer-run age 5_2 stock groups overlaps with the spring-run age 4_2 and then the summer-run age 4_1 stock groups (Figure 3). During May to mid July, the spring- and summer-run age 5_2 aggregate represents the majority of the test fishery abundance, about 80% in 2000 and 2001 (Figure 4). By late July, the abundance of the summer-run age 4_1 stock group increases and the spring- and summer-run age 5_2 aggregate represents declining proportions of the test fishery abundance.

In 2008, the Department of Fisheries and Oceans (DFO) ‘salmon outlook’ identified the spring-run age 5_2 and summer-run age 5_2 populations as stocks of conservation concern (Appendix 5). Abundance had been declining for both stock groups since the time series high in 2003 (Appendix 1) and conservation concerns were evident for some of the earliest timed populations (DFO 2008, Bailey et al. 2001; Schubert et al. 2007). Low returns were expected for the main year class (age-5) returning in 2008 because extremely low marine survival rates had been observed for southern B.C. salmon smolts that entered the ocean during the same smolt year (2005).

To help inform fishery managers, who were contemplating measures to reduce impacts on the spring- and summer-run age 5_2 stock groups, we employed a similar approach as Parken et. al. (2008) that used simple linear regression models to predict run size from the Albion test fishery abundance indices. However genetic stock identification data was not examined in this analysis because there was insufficient data available over a range of run sizes.

Following 2008, and the trial use of these methods as an in-season run size predictor, DFO Fisheries and Aquaculture Management (FAM) submitted a request for scientific advice to the Pacific Scientific Advice Review Committee (PSARC) seeking a review of the in-season estimation methodology (Appendix 2). Specifically, FAM was looking to review the methods to evaluate their effectiveness in predicting terminal run size (the total number of Chinook returning to the mouth of the Fraser River) and potential escapements to help address management considerations related to First Nations Treaty implementation and negotiation, Wild Salmon Policy implementation and overall improved in-season management of Fraser River Chinook salmon (Appendix 2).

Similar to the methodology developed in 2008 spawning escapement size and terminal run size from an accumulation of CPUE indices over a 2 to 10 week period beginning in May and ending in early July. The strongest relationships explained greater than 74% of the variation in terminal run size and spawning escapements, but with minor alterations to the standardization of prediction decision dates, we have used a classical test fishery data approach to relate CPUE to run size. Through the use of linear regression analysis we are able to provide modestly precise and accurate estimates of both

2 METHODS

2.1 DATA SOURCES

2.1.1 **Albion Test Fishery**

The Albion test fishery is located approximately 50 kilometers upstream from the Fraser River mouth, and has provided the longest continuous index suitable for measuring abundance of Chinook salmon in British Columbia (Dempson et al. 1998). From 1980 to the present, the same individual has operated a vessel which has fished the same location with standardized nets and procedures from April to November (Canada DFO, Delta, British Columbia, unpublished data).

The Albion test fishery fishes the daily high slack tide using standardized gill nets to index abundances of Chinook salmon (mesh size=203 mm; referred to as the “8 inch” net) and chum salmon (*O. keta*) (mesh size=171 mm). Since 1997, a multi-panel gill net has been used on alternate days to index abundance of several species and age-classes (mesh sizes = 127, 152, 178, 203, and 229 mm).

The Albion test fishery is designed to commence on the 1st of April. It begins by alternating daily between fishing the single 8 inch mesh Chinook net and the multi-panel net. On the 1st of September the multi-panel net is replaced with the chum salmon net. The chum net is then alternated with the Chinook salmon 8 inch net until late October, when use of the Chinook net is discontinued and the chum salmon net is used exclusively until late November or early December. The starting dates were delayed in 2007 to 18 June (statistical week 06/4), and again in 2008 to 5 May (statistical week 05/1). The 2007 data were not used as the starting dates missed an important component of the migration. We focused the investigation on the abundance indices from the Chinook net only as it has a longer time series and has been used in all years, whereas the multi-panel net has not been used or has been used inconsistently among time periods for some years.

Catch, effort, and biological data are maintained within the DFO Fishery Operating System database.

2.1.2 **Terminal Run Size and Spawning Escapements**

Spawner abundances are estimated for most Fraser River spring- and summer-run age 5_2 populations using visual surveys and peak count expansion or area-under-the-curve methods (Farwell et al. 1999; Bailey et al. 2000; Parken et al. 2003, NFCP 2005). Individual stream escapement estimates are then summed to provide an annual index of the stock group spawning abundance (Bailey et al. 2000). Spawner abundance indices are developed annually for 28 spring-un age 5_2 and 12 summer-run age 5_2 populations. These indices are used to develop the DFO salmon outlooks (Appendix 5) and they are used by the PSC (2008) to monitor and model Chinook salmon production. Spawner abundance data are maintained by DFO Kamloops and also available through the DFO New Salmon Escapement Data System.

In 2007, English et al. (2007) refined a model to reconstruct the run size of Chinook salmon at the mouth of the Fraser River (terminal run) for individual populations and stock groups. The run reconstruction model uses estimates of in-river catch, spawning escapement, upstream migration rates and arrival timing at the spawning grounds to assign catches to populations. The run reconstruction model uses an in-filling routine for those streams in which no spawning escapement data are available. Given the number of stocks surveyed annually in relation to the number of stocks in the age 5_2 aggregate, in-filling of missing values is generally only completed for streams with low annual escapements (relative to other stocks) or on streams with poor counting conditions (Appendix 1). In 2009 Fraser River Stock Assessment initiated a series of refinements to the model design and its assumptions to better represent catch allocation among fisheries (Canada DFO, Kamloops, British Columbia, unpublished data).

As expected, trends in the run sizes for the 5_2 aggregate were similar to trends in spawning escapements, with peak run sizes (130,000 fish) observed in 2003 and lowest run sizes observed in 2007 (36,684 fish). Terminal run size data are maintained by the Chinook and Coho Program of Fraser River Stock Assessment in Kamloops.

We explored the relationship between the Albion CPUE indices and two Chinook run size data sets for the aggregates:

i. The combined spawning escapement estimates of the spring and summer 5_2 routinely monitored index streams (spawning escapement) and those in-filled using the run reconstruction model, and

ii. The combined spring and summer 5_2 terminal reconstructed runs.

We used only Albion CPUE, terminal run and spawning escapement data from 1995 to 2009, excluding 2007 (due to its delayed start date), in the analysis as the post 1994 escapement data are generally considered to be more reliable and consistent than previous years' estimates (R. Bailey pers. comm.). A quick audit of enumeration data from a subset of streams in both stock groups revealed a pattern of less consistent approaches or unknown methods used to determine spawning escapements in many of the years prior to 1995 supporting the notion of data quality improved post 1994.

2.2 DATA ANALYSIS

For this investigation, abundance (*N*), in terms of terminal run or spawning escapement, was predicted using linear regression analysis (Equation 1), where abundance was regressed against (and predicted from) the cumulative weekly $CPUE_p$ for period *p* for the test fishery. For 2000 and 2001, Parken et al. (2008) reported that an allometric model best described the relationship between run size and test fishery abundance indices because regression models based on untransformed variables yielded residuals with a heteroscedastic distribution. The allometric model:

(1) $$N = a(CPUE_p)^b \exp(e)$$

is log-transformed to

(2) $$\ln N = \ln a + b \ln(CPUE_p) + \varepsilon$$

where $\varepsilon \sim \text{Norm}(0, \sigma^2)$ and linear regression was used to estimate $\widehat{\ln a}$, $\hat{b}$, and $\hat{\sigma}^2$, the regression mean square error. Predicted values for median conditions were calculated from

(3) $$\hat{N} = (CPUE_p)^{\hat{b}} e^{(\widehat{\ln a})}.$$

Predictions were for median instead of average conditions to facilitate reporting predictions in a probabilistic framework consistent with the one used for abundance forecasts of Fraser River sockeye salmon (*O. nerka*; Cass et al. 2006).

CPUE (CPUE in catch/1,000 fathom-minutes; Schubert et al. 1988) was calculated per statistical week (w) as the mean daily catch divided by mean daily test fishing effort (ratio of means estimator; Pollock et al. 1997; Table 1).

(4)
$$CPUE_w = \frac{\sum_d Catch_{w,d}}{\sum_d Effort_{w,d}}$$

The abundance index for each period ($CPUE_p$) was the cumulative sum of weekly abundance indices ($CPUE_w$). The use of statistical weeks was to standardize the time periods and the time frame for providing advice on estimates of in-season run size. Statistical week 01/1 ended on the first Saturday in January in every year.

We regressed spawning escapements against ten periods (statistical weeks 05/3 07/3), where each period was represented by the cumulative weekly average CPUE's from statistical week 05/1 to the end of the period (Table 2 and Table 3). The periods were chosen as they were far enough along into the returning salmon migration to provide a clear signal of the potential run size and early enough to enable managers to use the information to modify fishing plans if necessary. These periods coincided with those when these stock groups represented the majority of the test fishery abundance index in 2000 and 2001, when GSI data were analyzed to assign catches to populations of origin (Figure 4).

2.3 RETROSPECTIVE PERFORMANCE

To evaluate the performance and sensitivity of the in-season run size model we compared observed (R_t) versus predicted ($\hat{R}_t$) run sizes and escapements calculated using three approaches. The first retrospective analysis was to simply compare predicted versus observed spawning escapements and terminal run sizes for 1995 to 2009, excluding 2007. For this, predicted values and 95% prediction intervals corresponded to the test fishing period with the strongest relationship for spawning escapement or terminal run size.

The second retrospective analysis involved a 'leave one out', cross validation approach where predicted terminal run size was calculated annually from a regression relationship which used all years in the 1995-2009 (excluding 2007) data set, but excluded data from the predicted year. The 'leave-one-out' predictions were compared to the observed terminal run sizes in variable (arithmetic) space for the presentation and performance evaluation. Performance was evaluated through the calculation of the mean absolute percent error (MAPE equation 5).

(5)
$$MAPE = \frac{\sum_{t=1963}^{n} \frac{\left|(\hat{R}_t - R_t)\right|}{R_t}}{n}$$

The third evaluation of model performance and sensitivity was to re-create the regression relationship for the terminal run size predictions using first the early portion of the data set (1995-2001). From this initial relationship we then added an additional year of data (*t+1*) from the remaining years in the time series (2002-2009; excluding 2007) updated the regression equation and used it to calculate the run size prediction for the following year (*t+2*). This was repeated for each remaining year in the time-series. After each iteration, forecast errors, the deviation between the observed and predicted run size, were calculated. The MAPE was calculated for the years 2002-2009 (equation 5).

3. RESULTS

Years with high test fishery abundance indices generally had large terminal runs and escapements; however, variability increased with run size, and the residuals of the linear relationships had a heteroscedastic distribution. To correct for this, we $\log_e$ transformed the abundance indices and run sizes and estimated the allometric model parameters (Table 3).

Log_e(escapement) and Log_e(terminal run) were both positively related to the test fishery abundance index for all periods. The residuals formed a horizontal band with no apparent pattern when plotted against $\log_e$(run size), however 1997 was a large outlier and the residual was greater than two times the standard deviation of the residuals. Fraser River discharge in 1997 was well above average levels (Figure 5), and the low abundance indices at the test fishery were not indicative of low spawning ground escapements or terminal run size.

For estimation of the spawning escapement, the relationship with CPUE increased over time and the strongest relationships were for Period 06/4 (R^2 = 0.76, RMSE= 0.16; P<0.0001) and Period 05/3 (R^2 = 0.75, RMSE= 0.16; P<0.0001) (Appendix 3; Table 4). The same pattern was evident when CPUE was regressed against terminal run size; Period 05/3 was strongest (R^2 = 0.75, RMSE= 0.14; P<0.0001) with Period 05/2 (R^2 = 0.74, RMSE= 0.15; P<0.0001) slightly lower (Appendix 4; Table 4).

For terminal run size and CTC spawning escapement datasets strong relationships were detected as early as period 05/2. Those relationships remained strong until the 07/3 period. The performance of regression models declines after week 07/2 when the abundance of populations in the Fraser River summer-run age 4_1 stock group increase rapidly (Figures 3 and 4). Predictions can be made from the regression relationship for any of the 10 periods though relationships with the highest R^2 values have the highest accuracy and precision.

3.1 RETROSPECTIVE PERFORMANCE

Comparison of spawning escapements (period 06/4) and terminal run size (period 05/3) predicted from the linear regression equation versus the observed spawning and terminal run sizes are presented in Figures 6, and 7, respectively. For all years there were only slight variations in the predicted versus observed values for the two data sets with the observed run sizes falling within the prediction intervals for all years. The MAPE of the spawning escapement and terminal run size predictions were 12% and 11%, respectively. Predictions of terminal run size calculated with the CPUE's to period 05/3 using the 'leave-one-out' approach were similar to the observed terminal run sizes for each corresponding year (Figures 8 and 9; MAPE = 13%) and were nearly identical with those run sizes predicted from the complete test fishery data set.

In general the use of the years 1995-2001, to initialize the regression relationship, resulted in an under estimation of run size than what was observed (Figure 10). Absolute annual forecasting errors ranged from 11% to 17% from the observed terminal runs (Figure 10) and the MAPE for the years 2002-2009 was still low (14%) and consistent with those calculated in the 'leave-one-out' analysis and the complete dataset regression.

4 DISCUSSION

A robust in-season estimator of stock size for the Fraser River spring and summer aged 5_2 aggregate can provide fisheries managers with appropriate information in a timely manner such that fisheries management actions or plans can be implemented in a timely manner. Cumulative weekly average CPUE's from the Albion test fishery 8 inch net provided reliable estimates of the run strength of age 5_2 stocks by late May and early June when less than 25% of the total aggregate run has migrated through the lower Fraser River.

DFO fisheries management requested methodology to provide in-season estimates of the run size of the aggregate of Fraser River spring- and summer-run age 5_2 populations. We developed simple regression models to predict run size and spawning escapements based on cumulative weekly CPUE data collected at the Albion test fishery. Estimates of run size can be generated by late May and early June when less than 25% of the total aggregate run has migrated through the lower Fraser River. The accuracy of run size predictions declines rapidly after week 7/2 in mid July, when populations in the Fraser River Summer 4_1 aggregate rapidly increase in abundance (Figures 3 and 4). The provision of timely run size estimates for the aggregate of spring- and summer-run age 5_2 populations will help design fisheries that are compatible with the aggregate abundance.

We developed modestly precise and accurate relationships between test fishery abundance indices and terminal run size of the aggregate of spring- and summer-run age 5_2 populations for 1995-2008 (R^2 range: 0.59 – 0.75). In comparison, Dempson et al. (1998) reported a much less precise relationship (R^2= 0.41) between the April 1 to July 14, 1981 to 1995 cumulative daily CPUE index and the terminal run size of the aggregate of spring-run age4_2, spring-run age 5_2, and summer-run age 5_2 populations.

Since 1994, there has been an improvement in the quality of spawning escapement estimates for the spring and summer stocks. The methods with which the escapements are estimated (peak live expansions from helicopter visuals) from 1995 to present have not changed significantly from the pre 1995 assessment activities; however there has been improvements and more interannual consistency in the timing of the flights so that they are more likely to coincide with the peak of spawning for each system. This consistency in timing of flights has also been coupled with stability in the personnel performing the enumerations and their levels of training. Annual variation in the timing of flights, but not related to the timing of the peak of spawning would cause biases to the estimates from stream to stream and from year to year which could have reduced the precision of relationships with the Albion test fishery abundance indices. Uncertainty in the escapement enumeration is thought to be reduced in the recent escapement data set, yet the inherent variation in proportion of the population counted among and between rivers annually and forms, at least part of, the unexplained variation in the in-season run size models.

Issues identified in Dempson et al. (1998) related to the applicability of CPUE data as an index of run size are still relevant for this investigation. Variable catch rates of the '8 inch' net are likely affected by environmental conditions (i.e. temperature and discharge; e.g. anomalously high discharge conditions for 1997). These variables can vary daily, weekly, and inter-annually. However we believe that the use of cumulative weekly CPUE's, which reduces the daily variability in catch rates, along with the consistency in the timing of the test fishery in relation to those factors (i.e. rising spring hydrograph), means that inter annual variability in catch efficiency is reduced (Figure 4). Another source of unexplained variation in the predictive relationships is the likely variation in the relative abundance of age 4_2, 5_2 and 6_2 Chinook due to different brood year abundances, inter annual variation in maturation rates, and differences in catchability by age and size.

In 1997 when low cumulative CPUE's did not represent low escapement, it appears that environmental events (Figure 3) can influence the ability of the test fishery to index run size. However, the mechanism that affected the relationship for this year is unclear. High river discharge conditions may have simply reduced the ability of the gill net to intercept migrating Chinook or conversely the climatic conditions which lead to extreme flows altered (delayed) the behavior of Chinook in both stock groups (i.e. the migration timing of the spring and summer Chinook stocks from the ocean into the Fraser River). The protracted nature of both the spring- and summer-run age 5_2 Chinook migrations into the Fraser and the duration of the test fishery data included in the periods would suggest that run timing variations would need to be extensive to be observed in the cumulative CPUE's. Determining the annual aggregate run timing through the use of GSI data will be informative in addressing this question, and may provide managers with options or alternative dataset configurations when environmental variations occur.

Harbour seals (*Phoca vitulina*) are known to target Chinook salmon in the test net. Seals are also known to remove fish from the net prior to them being observed by the test fishing staff. Accounting for fish removed by seals from the net, while based on the expert opinion of the staff at the test fishery, is still difficult to quantify. The effect of seals on CPUE calculations and subsequently run size predictions was insignificant in 2008. When fish removed by seals were added into the total catch for May and June the result was an additional four fish and a negligible increase in the cumulative average CPUE value. Observations of fish removed by seals in 2008 tended to increase as the season went on and as CPUE in the net increased as well.

Regression analysis was conducted on terminal run size and spawning escapement data sets. The strong relationship between CPUE and spawning escapement, without accounting for in-river catch, implies an inherent connection between run size and catch in the in-river fisheries, where in-river harvest rates were proportional to run-size on average from 1995-2008. This pattern reflects the largely consistent approach to managing in-river fisheries during the spring and summer age 5_2 aggregate migration. From a fisheries management perspective, knowledge of terminal run size before in-river fisheries occur will provide greater flexibility to enact management actions consistent with the abundance of the spring and summer age 5_2 aggregate. Predicting terminal run size and subsequently managing harvests level may also decouple the relationship between spawning escapement, but not terminal run, if in-river harvest rates are varied with run size.

Fraser River fisheries for chum salmon are based on a different run size estimation procedure than we have presented for the spring- and summer-run 5_2 Chinook salmon aggregate. For chum salmon, run size estimates are based on a Bayesian procedure that uses cumulative CPUE, migration timing, and pre-season run size data to estimate the in-season run size (Gazey and Palermo 2000). Since Fraser River chum salmon are managed as a single stock, Gazey and Palermo had 22 years of information to characterize variation in migration timing. For spring- and summer-run age 5_2 Chinook salmon, much less information is currently available to characterize the variation in migration timing, as only two years of genetic analyses were presented by Parken et al. (2008). Genetic samples are available for all years of the Chinook salmon test fishery, and genetic samples have been analyzed for stock origin for most years since 2000. Further interpretation of stock origin data and analysis of genetic samples in years prior to 2000 would help characterize the variation in migration and enable the development of alternate models, such as ones that incorporate in-season genetic information to develop population-specific or conservation unit-specific abundance indices. The Bayesian approach developed by Gazey and Palermo can be expanded beyond variables of migration time and pre-season run size to also consider the migration time and pre-season run size of co-migrating populations. Approaches that consider the precision of estimates of catch, spawners, and run size at the river mouth will help to more fully describe the uncertainty in estimates of in-season run size.

The ability of the Albion test fishery to predict the run size of a combination of two stock groups, while beneficial to fisheries management in the near term, should be viewed as a first step towards meeting the needs of management in the future. With the implementation of the Wild Salmon Policy and the management of Chinook conservation units (CU's) as the priority, it is likely that fisheries management will require an in-season tool which can predict the run-size of the individual Fraser River Chinook conservation units. Based on the findings of Parken et al. (2008), GSI methods could be used with test fishery data analysis methods to estimate abundance indices for conservation units. After developing these indices among years, one may be able to develop models to estimate the run size of individual conservation units.

5. RECOMMENDATIONS

- The in-season run size and potential spawning escapement can be estimated for the aggregate of Fraser Spring-run age 5_2 Chinook using these methods until better performing models become available.
- Develop and examine the predictive utility of alternate in-season run size models, such as Bayesian models and models using GSI-based abundance indices for populations, aggregates of populations, and ecotypic conservation units of Chinook salmon.
- Incorporate catch data from the Albion multi-panel net to explore its effect on increasing the precision of the spring and summer aged 5_2 estimate as well as for potential relationships between catch in smaller mesh sizes and the smaller bodied, Spring timed aged 4_2 Fraser Chinook aggregate.

ACKNOWLEDGEMENTS

We thank Al Baker, and the crew of the Witch Doctor for their continued operation of the Albion test fishery over the last twenty-nine years. We also thank Richard Bailey, Lynda Ritchie, Jeff Grout and Erica Grebeldinger for providing data and helpful advice. Dr. Gayle Brown and Jim Cave provided constructive comments on the manuscript.

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TABLES

Table 1. Weekly Catch per Unit Effort (CPUE) in the Albion Test Fishery, 8" net, Statistical Weeks 05/1 to 07/3, 1989-2009.

	Stat. Week										
Year	**05/1**	**05/2**	**05/3**	**05/4**	**06/1**	**06/2**	**06/3**	**06/4**	**07/1**	**07/2**	**07/3**
1989	0.32	0.39	0.96	0.86	0.88	2.50	2.72	1.82	1.21	1.43	1.24
1990	1.16	0.67	0.60	0.68	0.53	1.94	3.46	4.14	2.87	1.50	1.57
1991	0.39	0.50	0.51	1.04	1.71	2.00	3.14	3.04	4.15	2.17	1.90
1992	0.41	0.72	0.85	1.08	0.99	3.15	3.69	4.67	1.84	4.50	2.83
1993	0.20	0.24	0.31	0.64	1.16	2.40	4.25	2.69	3.13	2.91	2.61
1994	0.49	0.41	0.68	0.87	2.04	3.00	3.58	4.13	4.99	3.69	3.19
1995	0.12	0.29	0.86	0.77	1.28	1.57	3.40	3.88	2.96	1.46	1.49
1996	0.37	0.61	0.40	0.93	0.75	2.08	5.20	4.68	4.21	4.71	3.18
1997	0.56	0.09	0.12	0.28	0.11	0.77	0.93	3.06	2.24	0.92	1.26
1998	0.87	0.24	0.65	0.90	1.45	2.10	1.44	1.79	0.89	3.52	0.76
1999	0.23	0.14	0.16	0.12	0.47	0.80	0.54	0.33	2.83	2.39	0.86
2000	0.03	0.25	0.45	0.24	0.58	0.50	0.91	1.84	2.56	2.27	2.84
2001	-	0.25	0.63	1.60	1.54	2.20	2.53	1.33	3.77	2.61	2.42
2002	-	0.33	0.52	0.52	1.42	1.91	0.25	1.36	3.78	4.10	2.58
2003	0.31	0.73	0.72	1.45	3.40	1.62	4.19	6.10	2.69	2.30	0.84
2004	0.14	0.38	0.49	0.58	0.68	0.80	1.90	2.43	1.80	1.44	3.26
2005	0.18	0.00	0.03	0.37	0.13	0.14	0.90	0.93	1.12	0.49	1.05
2006	0.07	0.22	0.11	0.31	0.27	0.48	1.58	0.92	1.15	1.18	2.15
2008	0.03	0.06	0.00	0.09	0.05	0.22	0.73	1.11	1.37	0.68	2.20
2009	0.10	0.12	0.00	0.19	0.08	0.10	0.46	1.26	1.65	0.84	0.48

Table 2. Definition of period designations; where the average Catch per Unit Effort (CPUE) per statistical week are summed together for all weeks in the given period.

Period	**Cumulative Statistical Weeks**
05/2	05/1 05/2
05/3	05/1 05/2 05/3
05/4	05/1 05/2 05/3 05/4
06/1	05/1 05/2 05/3 05/4 06/1
06/2	05/1 05/2 05/3 05/4 06/1 06/2
06/3	05/1 05/2 05/3 05/4 06/1 06/2 06/3
06/4	05/1 05/2 05/3 05/4 06/1 06/2 06/3 06/4
07/1	05/1 05/2 05/3 05/4 06/1 06/2 06/3 06/4 07/1
07/2	05/1 05/2 05/3 05/4 06/1 06/2 06/3 06/4 07/1 07/2
07/3	05/1 05/2 05/3 05/4 06/1 06/2 06/3 06/4 07/1 07/2 07/3

Table 3. Untransformed and Log_e transformed cumulative average weekly Catch per Unit Effort (CPUE) in the Albion Test Fishery by period and year and their corresponding observed spawning escapements and modeled terminal run size 1995-2009 (excluding 2007).

	Cumulative average CPUE										**Escapement**	
Year	**Period 05/2**	**Period 05/3**	**Period 05/4**	**Period 06/1**	**Period 06/2**	**Period 06/3**	**Period 06/4**	**Period 07/1**	**Period 07/2**	**Period 07/3**	**Spawning Escapement**	**Terminal Run**
1995	0.41	1.27	2.04	3.32	4.89	8.28	12.16	15.12	16.58	18.07	84,786	102,355
1996	0.98	1.38	2.31	3.06	5.13	10.33	15.01	19.22	23.93	27.11	99,669	116,167
1997	0.65	0.77	1.05	1.15	1.92	2.85	5.91	8.16	9.08	10.34	102,937	124,828
1998	1.11	1.76	2.66	4.11	6.21	7.65	9.43	10.33	13.85	14.60	92,687	114,120
1999	0.37	0.53	0.65	1.12	1.93	2.47	2.80	5.63	8.02	8.88	53,458	71,383
2000	0.28	0.73	0.97	1.55	2.05	2.96	4.79	7.36	9.63	12.47	61,568	79,467
2001	0.25	0.88	2.48	4.02	6.21	8.74	10.07	13.84	16.45	18.87	75,186	96,410
2002	0.33	0.85	1.38	2.80	4.71	4.96	6.32	10.10	14.20	16.78	89,428	107,345
2003	1.04	1.76	3.21	6.61	8.24	12.42	18.53	21.22	23.51	24.36	118,566	141,696
2004	0.52	1.01	1.59	2.27	3.07	4.97	7.40	9.20	10.64	13.90	83,797	117,172
2005	0.18	0.21	0.58	0.71	0.85	1.74	2.67	3.79	4.28	5.33	52,187	68,103
2006	0.30	0.40	0.71	0.99	1.47	3.05	3.97	5.13	6.31	8.45	54,414	69,804
2008	0.09	0.09	0.17	0.23	0.45	1.18	2.28	3.66	4.33	6.54	43,007	55,431
2009	0.23	0.23	0.42	0.49	0.59	1.06	2.31	3.96	4.89	5.28	61,624	81,711

	Log_e (Cumulative average CPUE)										**Log_e(Escapement)**	
Year	**Period 05/2**	**Period 05/3**	**Period 05/4**	**Period 06/1**	**Period 06/2**	**Period 06/3**	**Period 06/4**	**Period 07/1**	**Period 07/2**	**Period 07/3**	**Spawning Escapement**	**Terminal Run**
1995	-0.90	0.24	0.71	1.20	1.59	2.11	2.50	2.72	2.81	2.89	11.35	11.54
1996	-0.02	0.32	0.84	1.12	1.64	2.34	2.71	2.96	3.18	3.30	11.51	11.66
1997	-0.44	-0.27	0.05	0.14	0.65	1.05	1.78	2.10	2.21	2.34	11.54	11.73
1998	0.11	0.57	0.98	1.41	1.83	2.03	2.24	2.33	2.63	2.68	11.44	11.65
1999	-1.00	-0.64	-0.43	0.12	0.66	0.90	1.03	1.73	2.08	2.18	10.89	11.18
2000	-1.29	-0.32	-0.03	0.44	0.72	1.08	1.57	2.00	2.26	2.52	11.03	11.28
2001	-1.40	-0.13	0.91	1.39	1.83	2.17	2.31	2.63	2.80	2.94	11.23	11.48
2002	-1.11	-0.16	0.32	1.03	1.55	1.60	1.84	2.31	2.65	2.82	11.40	11.58
2003	0.04	0.56	1.17	1.89	2.11	2.52	2.92	3.05	3.16	3.19	11.68	11.86
2004	-0.65	0.01	0.46	0.82	1.12	1.60	2.00	2.22	2.36	2.63	11.34	11.67
2005	-1.72	-1.55	-0.54	-0.34	-0.16	0.56	0.98	1.33	1.45	1.67	10.86	11.13
2006	-1.22	-0.90	-0.34	-0.01	0.38	1.12	1.38	1.63	1.84	2.13	10.90	11.15
2008	-2.45	-2.45	-1.76	-1.49	-0.80	0.16	0.83	1.30	1.47	1.88	10.67	10.92
2009	-1.49	-1.49	-0.87	-0.70	-0.52	0.06	0.84	1.38	1.59	1.66	11.03	11.31

Table 4. Linear regression summary statistics for models estimating spawning escapement or terminal run size for ten CPUE summary periods (1995-2009; excluding 2007).

Escapement Data Set	Period									
	05/2	05/3	05/4	06/1	06/2	06/3	06/4	07/1	07/2	07/3
Spawning Escapement										
Slope	0.36	0.30	0.32	0.27	0.27	0.30	0.38	0.45	0.44	0.46
Intercept	11.56	11.34	11.17	11.07	10.96	10.79	10.53	10.26	10.18	10.06
R^2	0.74	0.75	0.73	0.67	0.66	0.63	0.76	0.74	0.71	0.63
RMSE*	0.16	0.16	0.17	0.18	0.19	0.20	0.16	0.16	0.17	0.19
P	<.0001	<.0001	0.0001	0.0004	0.0004	0.0008	<.0001	<.0001	0.0002	0.0007
Terminal Run Size										
Slope	0.33	0.27	0.28	0.24	0.24	0.27	0.33	0.39	0.39	0.40
Intercept	11.76	11.56	11.41	11.32	11.22	11.07	10.85	10.61	10.54	10.44
R^2	0.74	0.75	0.73	0.66	0.64	0.59	0.71	0.69	0.66	0.59
RMSE*	0.15	0.14	0.15	0.17	0.17	0.18	0.15	0.16	0.17	0.19
P	<.0001	<.0001	0.0001	0.0004	0.0006	0.0013	0.0001	0.0002	0.0004	0.0014

*Root Mean Square Error (RMSE)

FIGURES

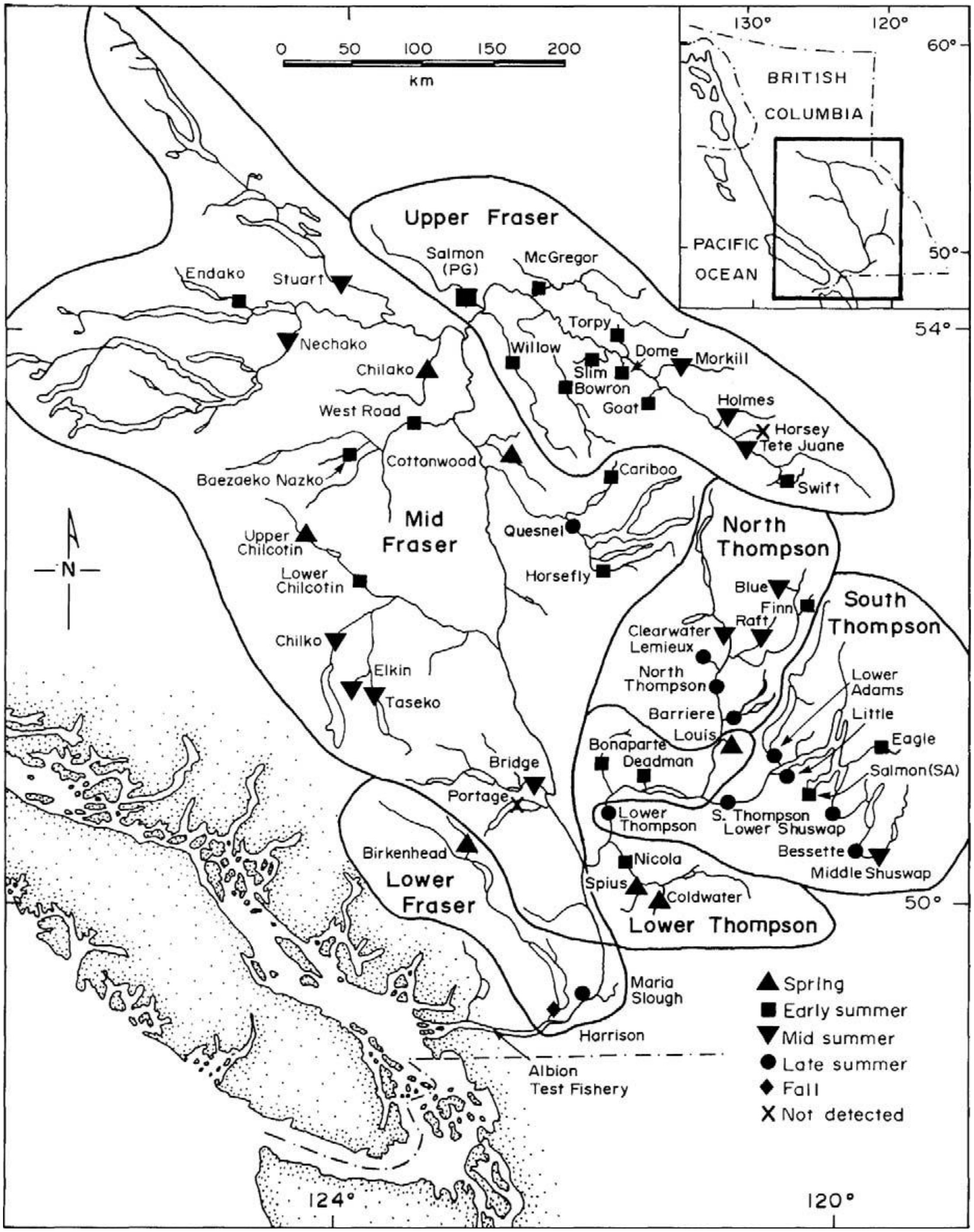


Figure 1. Locations of Chinook salmon populations within six regional reporting aggregates in the Fraser River watershed, British Columbia, and their migration periods (see legend) (From Parken et al. 2008).

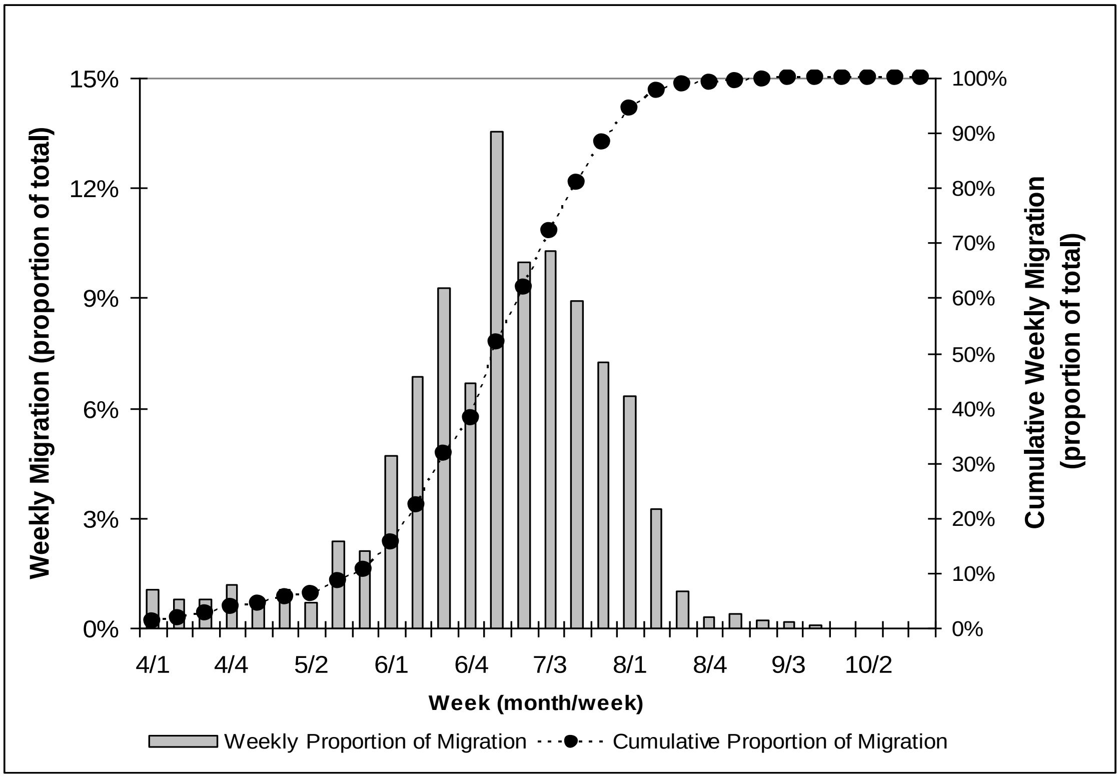


Figure 2. *Migration timing for the aggregate of Fraser River spring and summer age 5_2 populations at the Albion test fishery.*

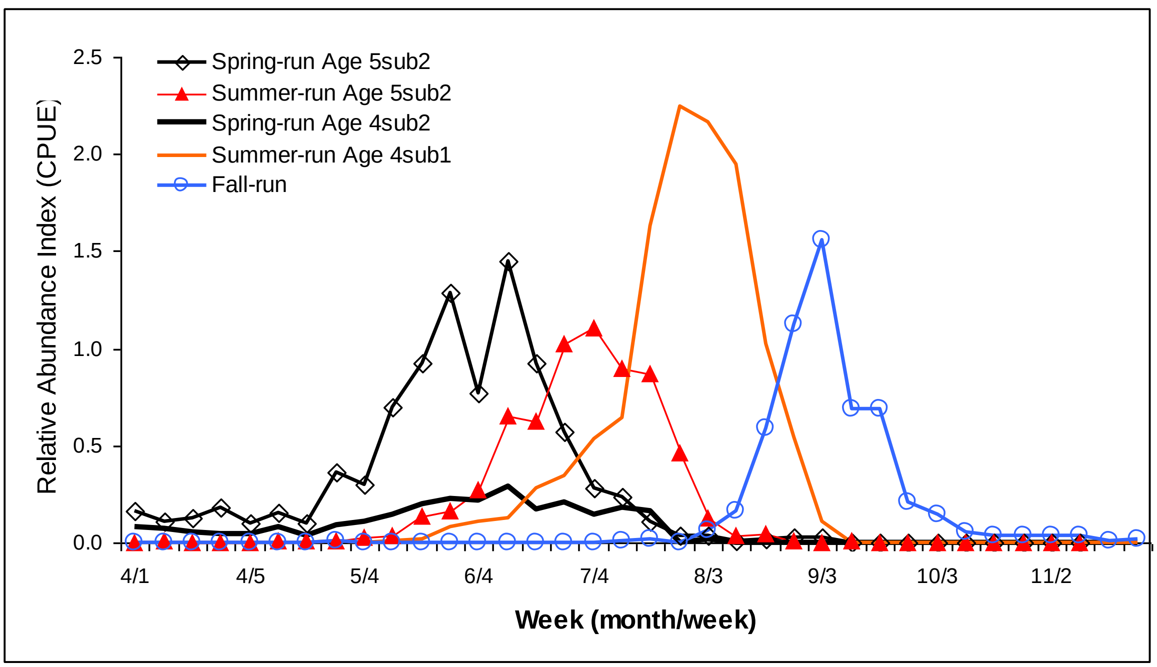


Figure 3. *Migration timing of the five Fraser River Chinook stock groups at the Albion test fishery (data from Parken et al. 2008).*

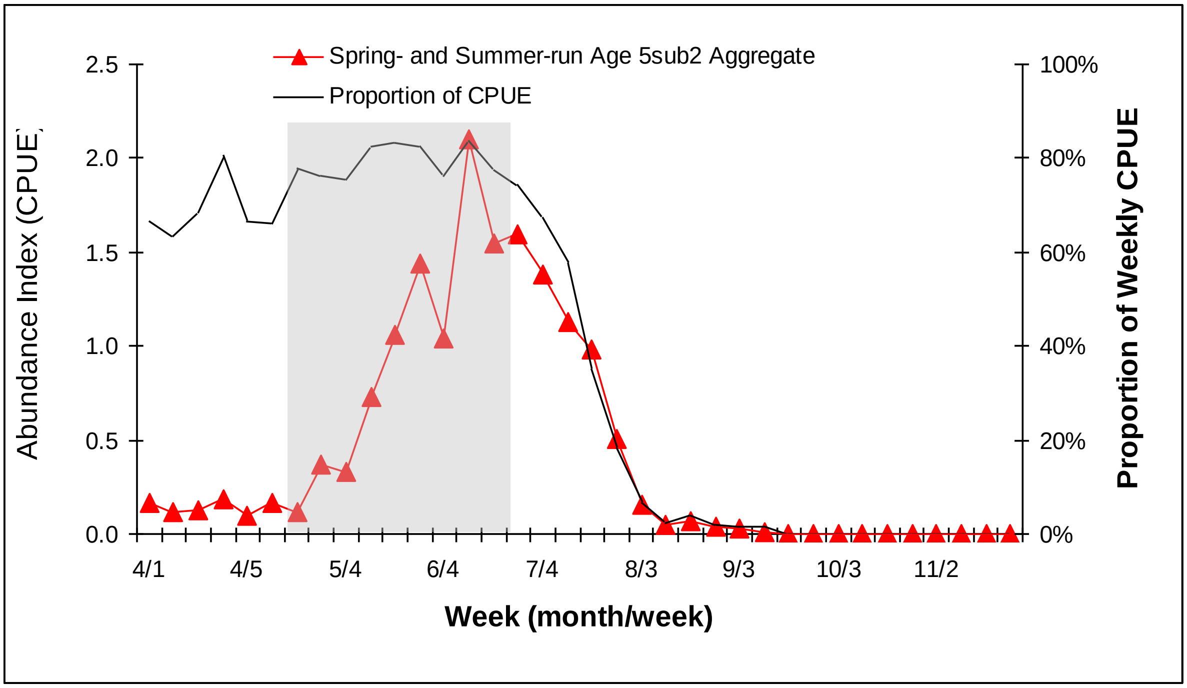


Figure 4. *Migration timing of the aggregate of Fraser River age 5_2 populations and their relative proportion of the total weekly CPUE from the Albion test fishery 2000 and 2001 (data from Parken et al. 2008). The shaded area represents the periods corresponding to the models described in Table 4.*

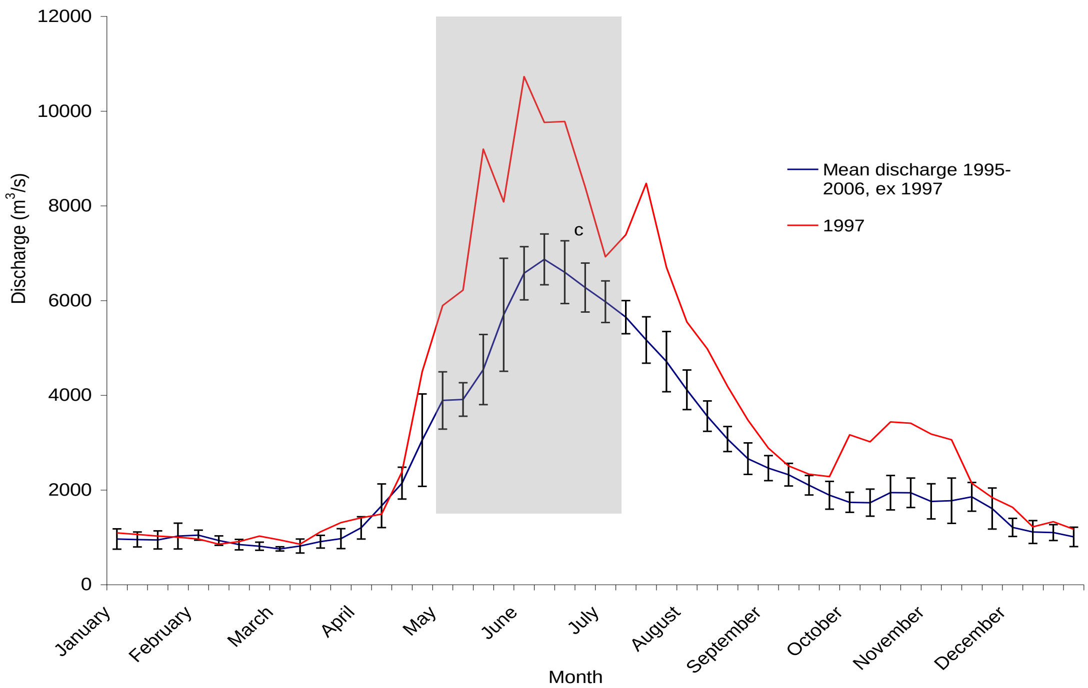


Figure 5 *Mean daily flow (m^3/s) and confidence intervals (±2 SD) for the Fraser River (Hope Station WSC 08MF005), 1995-2006 (excluding 1997) and 1997 only. The shaded area represents periods corresponding to the models described in Table 4.*

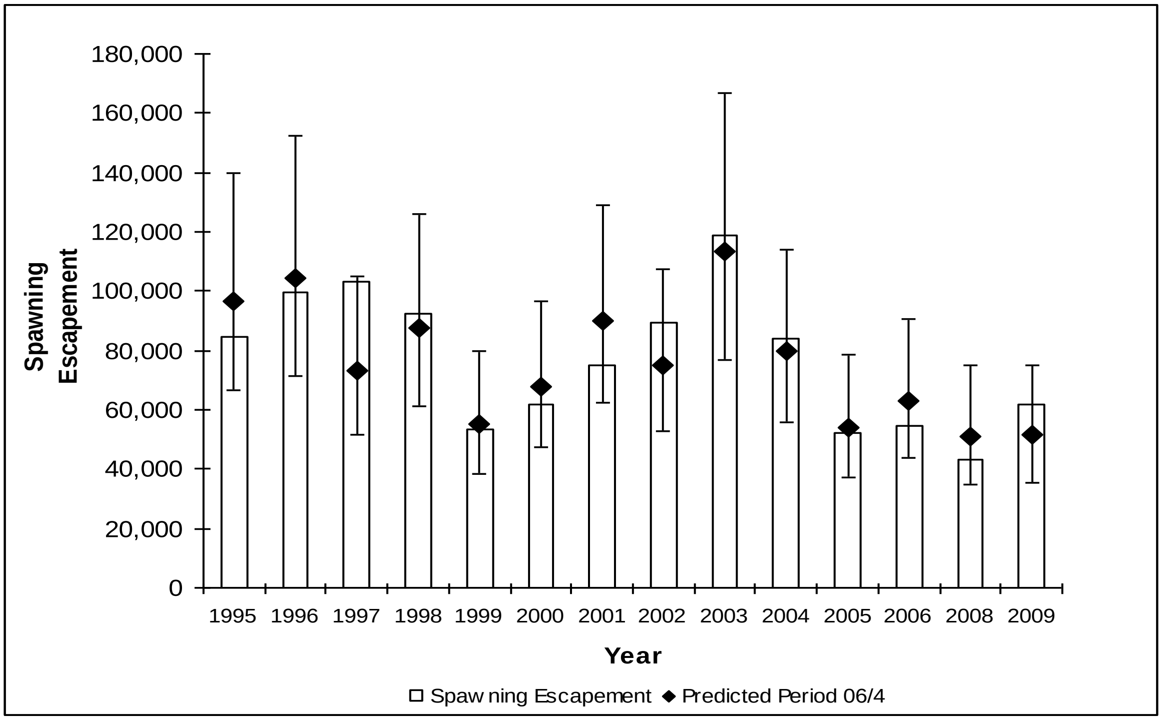


Figure 6. *Predicted versus observed spawning escapement from the Albion test fishery cumulative CPUE to Period 06/4 for the Fraser River spring and summer age 5_2 aggregate, 1995–2009 (excluding 2007). Error bars represent 95% prediction intervals.*

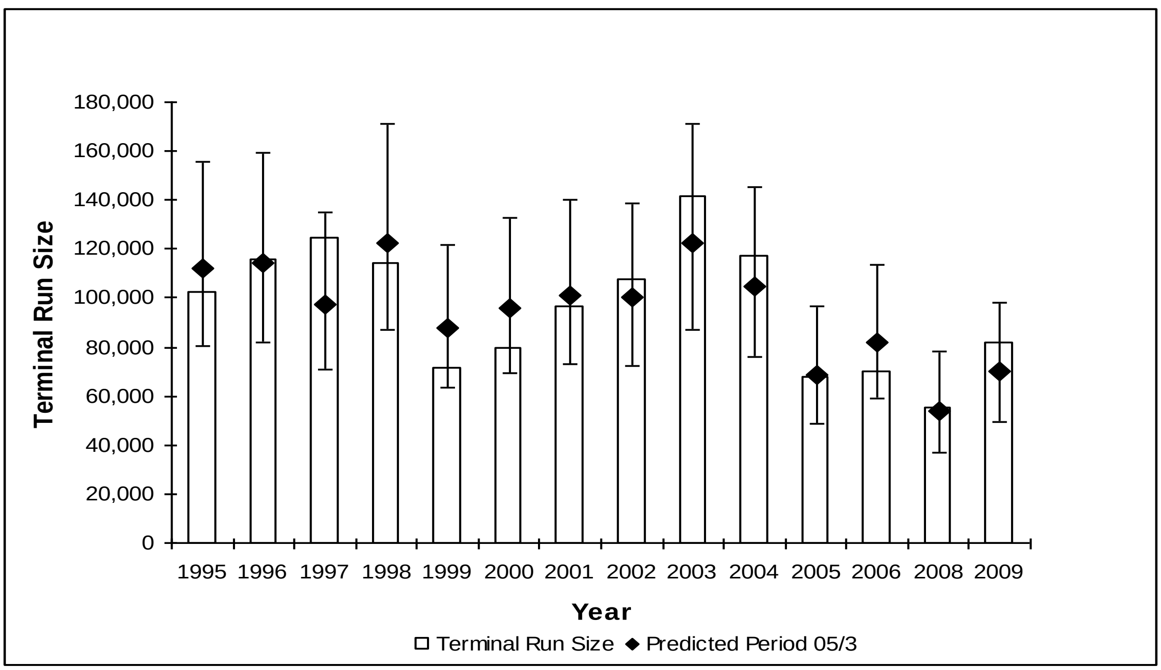


Figure 7. *Predicted versus observed terminal run size from the Albion test fishery cumulative CPUE to Period 05/3 for the Fraser River spring and summer age 5_2 aggregate, 1995–2009 (excluding 2007). Error bars represent 95% prediction intervals.*

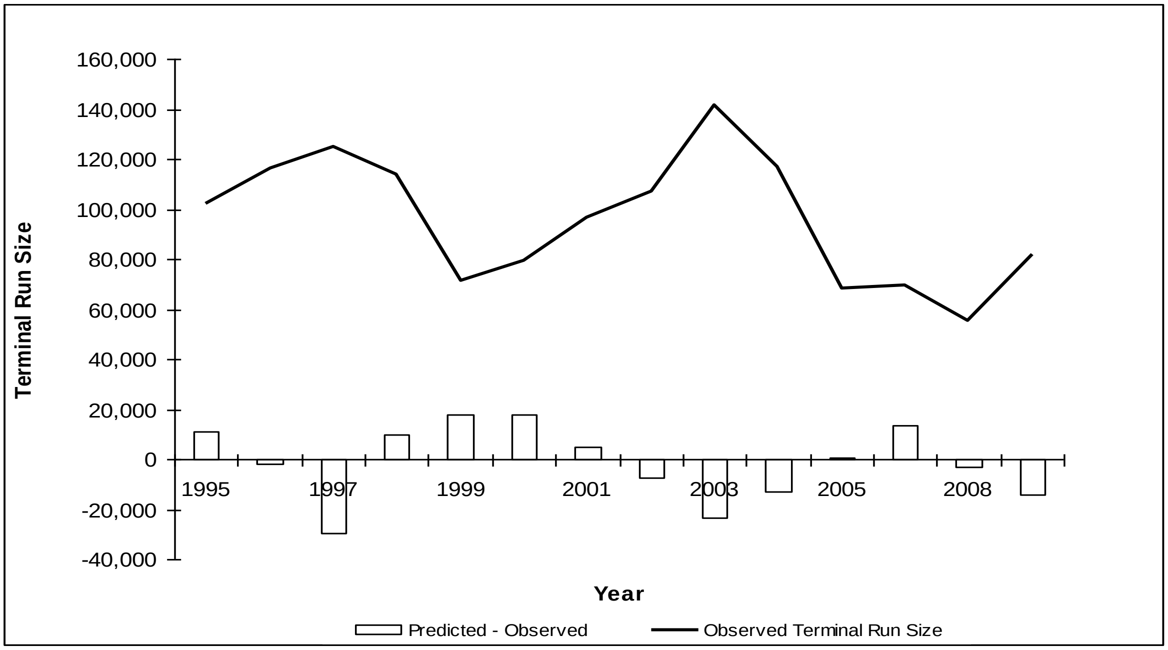


Figure 8. *Differences in the terminal run size of Spring and Summer aged 5_2 Chinook between those predicted and those observed using the 'leave-one-out' analysis for Period 05/3.*

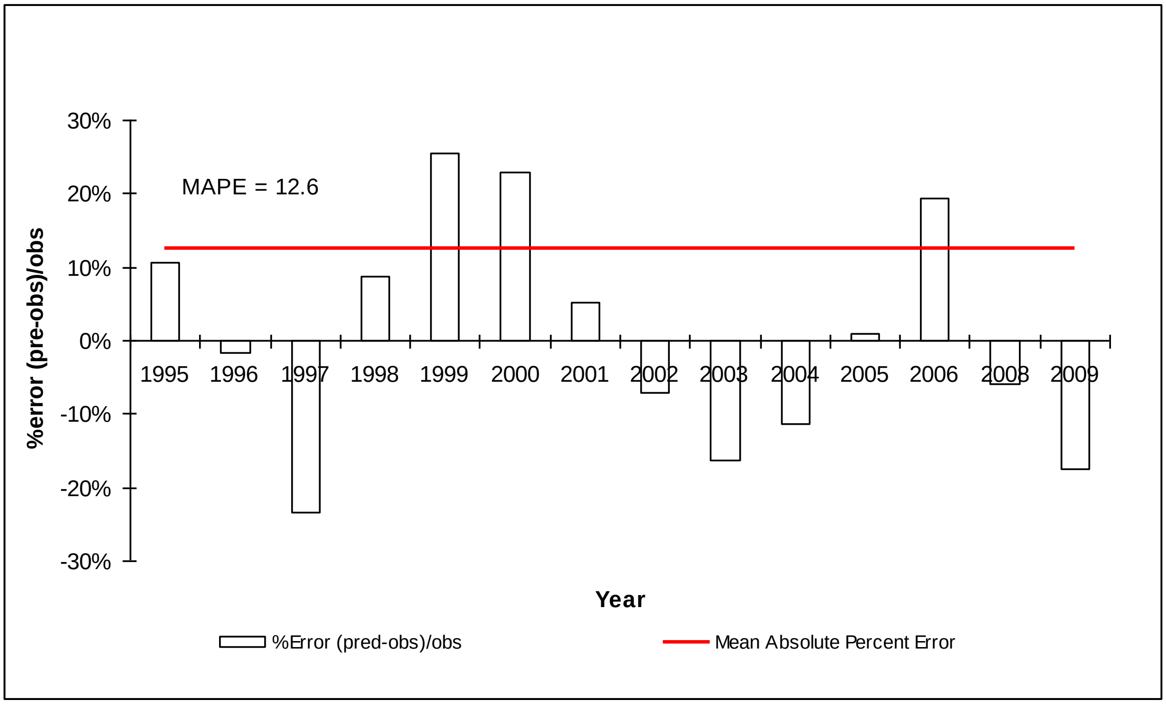


Figure 9. *Annual percent error and mean absolute percent error (MAPE) of the predicted terminal run size calculated from the 'leave-one-out' estimates (Period 05/3) and the observed terminal run size. Error is expressed as the deviation from the observed terminal run.*

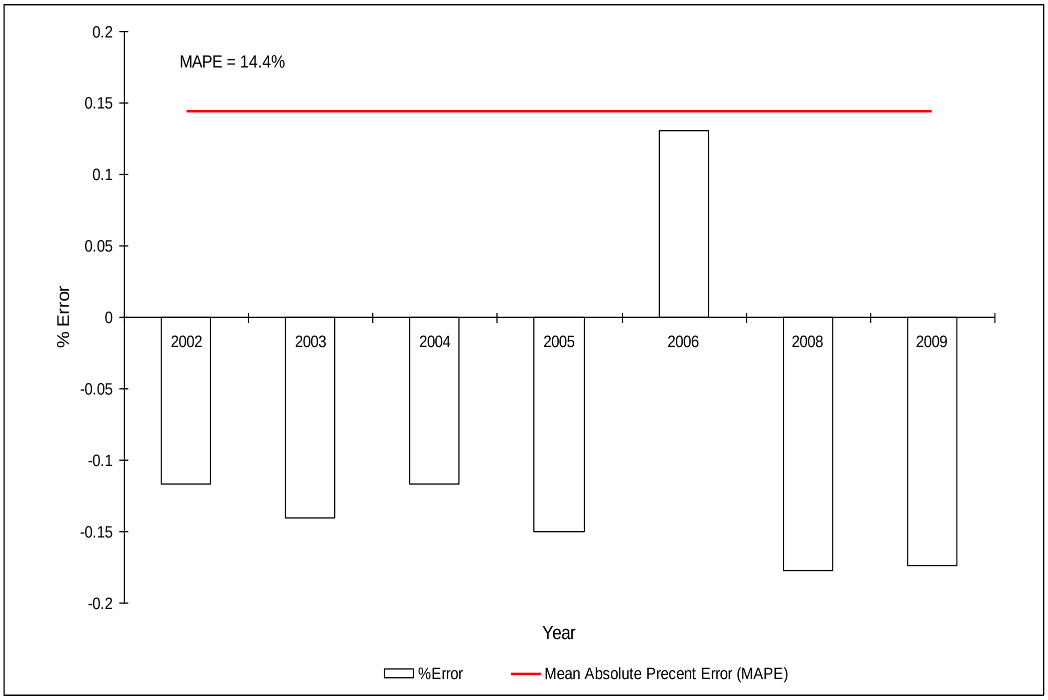


Figure 10. *Annual percent error in the terminal run size of Spring and Summer aged 5_2 Chinook when predicted through an annually updated linear regression relationship (Period 05/3). The Mean Absolute Percent Error (MAPE) is also shown.*

APPENDICES

Appendix 1 Spawning escapements by stream population for Fraser River spring and summer-run age 5_2 populations, 1995-2009. Shaded areas identify situations when streams were not surveyed and spawner estimates were derived indirectly using the methods described by English et al. (2007).

Stock Name	Aggregate	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Swift	Spring 5_2	1700	1500	1200	1098	375	486	982	1535	835	520	335	643	328	422	747
Fraser	Spring 5_2	6000	4100	2935	2586	2081	2262	4976	3913	3048	2062	2535	2412	1021	1858	3194
Horsey	Spring 5_2	120	20	75	57	14	128	78	308	288	62	34	146	22	59	111
Nevin	Spring 5_2	131	116	130	161	46	62	57	132	385	238	77	174	42	20	174
Holmes	Spring 5_2	2600	2775	3203	2362	523	1795	1018	3740	4110	1376	821	1458	758	454	2187
McKale	Spring 5_2	45	39	44	20	22	32	9	81	49	68	78	11	17	18	118
Twin	Spring 5_2	88	78	88	88	43	52	49	73	160	102	70	100	20	49	196
Goat	Spring 5_2	400	440	354	302	89	212	411	820	569	172	151	158	114	440	308
Morkill	Spring 5_2	407	567	550	2398	1152	926	860	1152	1343	1122	355	549	408	166	1257
Walker	Spring 5_2	101	426	122	392	206	252	177	382	543	277	103	234	166	189	494
Torpy	Spring 5_2	1590	1055	1042	2293	1819	1468	1755	2565	4457	2730	1027	1221	903	941	1966
Dome	Spring 5_2	550	571	625	400	309	271	385	450	444	208	224	248	181	226	272
Slim	Spring 5_2	4634	2268	3130	2664	1235	2112	2876	3021	3676	2278	2161	2204	638	1389	2029
Bowron	Spring 5_2	8316	4577	7334	7618	3455	3233	5491	8719	10059	8682	4074	3876	1821	3740	4222
McGregor	Spring 5_2	2412	3461	2505	4471	1870	2449	2168	4003	3740	2722	1310	1333	963	1260	2622
Willow	Spring 5_2	817	1612	1961	2041	717	1314	893	1033	1980	1887	1012	1206	377	666	1009
Salmon (PG)	Spring 5_2	901	1054	1200	1362	823	634	478	463	2395	1170	668	544	269	447	731
Endako	Spring 5_2	125	167	43	191	171	160	275	292	263	172	252	118	26	300	162
Chilako	Spring 5_2	200	624	186	39	115	20	7	229	249	106	202	168	76	123	171
Blackwater	Spring 5_2	6050	4615	7206	3827	984	1600	1924	1620	2966	1366	846	1052	461	961	978
Cottonwood	Spring 5_2	2100	1750	3329	2592	641	1208	781	1352	1555	1241	646	740	378	225	520
Horsefly	Spring 5_2	185	400	115	43	137	174	281	404	246	375	509	345	46	98	200
Chilcotin Upper	Spring 5_2	262	735	360	617	285	229	243	523	678	220	97	158	78	240	232
Chilcotin Lower	Spring 5_2	3480	2285	4000	1636	2896	2971	1574	2092	3396	967	1509	1027	368	2018	998
Elkin	Spring 5_2	786	1250	806	651	417	394	458	423	1038	493	323	340	177	268	391
Bridge	Spring 5_2	851	1900	1968	626	898	769	198	969	948	1101	183	109	138	103	12
Finn	Spring 5_2	810	1569	725	632	524	1511	1115	650	45	426	185	157	32	97	91
Eagle	Spring 5_2	700	780	915	1055	624	1085	1397	1469	1583	867	427	521	334	655	574
Salmon (ST)	Spring 5_2	700	727	252	284	350	355	1362	1003	89	439	307	554	173	535	308
Nahatlatch	Spring 5_2	101	10	101	10	49	40	97	100	89	73	48	50	26	39	17
Birkenhead	Spring 5_2	162	293	573	565	147	404	624	463	427	180	1425	1250	1968	206	625
Pitt	Spring 5_2	402	356	401	367	196	245	281	276	171	288	341	220	100	198	90
Blue	Spring 5_2	35	113	128	110	11	235	88	480	329	152	60	212	117	142	63
	Total Spring 5_2	**47,761**	**42,233**	**47,607**	**43,558**	**23,224**	**29,088**	**33,368**	**44,735**	**52,154**	**34,141**	**22,395**	**23,538**	**12,546**	**18,553**	**27,068**
Stuart	Summer 5_2	3730	7415	6221	4645	3875	1920	1954	4789	6943	5430	3302	3607	1742	2730	3576
Nechako	Summer 5_2	1689	2040	1954	1868	1917	3794	9331	3296	5100	5189	3217	7376	1441	4643	2289
Stellako	Summer 5_2	57	85	81	15	18	51	67	69	100	79	231	52	25	40	52
Quesnel	Summer 5_2	3073	3100	3185	4906	1620	1718	2418	5509	5265	3477	3230	2665	1772	1383	1944
Cariboo	Summer 5_2	817	1850	1800	936	573	744	503	1097	2565	250	526	949	532	449	1264
Chilko	Summer 5_2	10461	17000	16272	14549	8920	9171	10891	10731	21625	16287	7668	5201	4160	5186	8548
Taseko	Summer 5_2	5231	8500	8136	7275	4460	4586	5446	5366	10813	8144	3834	2601	2080	2593	4274
Portage	Summer 5_2	172	300	246	18	200	46	248	445	158	103	86	248	51	217	156
Seton	Summer 5_2	74	111	105	93	64	66	87	6	5	102	62	68	33	51	67
Mahood	Summer 5_2	130	415	260	341	91	245	172	155	929	317	269	217	100	52	194
Clearwater	Summer 5_2	5100	7780	7830	7007	3837	4563	5051	6215	6234	4616	3519	3768	1894	3307	5980
Raft	Summer 5_2	1371	870	1230	309	712	936	237	443	311	741	109	141	38	395	194
Barriere	Summer 5_2	21	189	180	160	110	77	362	357	131	306	220	216	100	101	37
North Thompson	Summer 5_2	5100	7780	7830	7007	3837	4563	5051	6215	6234	4616	3519	3768	1894	3307	5980
	Total Summer 5_2	**37,025**	**57,436**	**55,331**	**49,129**	**30,234**	**32,480**	**41,818**	**44,693**	**66,413**	**49,656**	**29,792**	**30,876**	**15,862**	**24,454**	**34,556**
	Total Spring and Summer	**84,786**	**99,669**	**102,937**	**92,687**	**53,458**	**61,568**	**75,186**	**89,428**	**118,566**	**83,797**	**52,187**	**54,414**	**28,408**	**43,007**	**61,624**

Appendix 2 Request for PSARC Working Paper.

Data

Fisheries and Oceans Canada | Pêches et Océans Canada

REQUEST FOR SCIENCE INFORMATION AND/OR ADVICE

PART 1: DESCRIPTION OF THE REQUEST – TO BE FILLED BY THE CLIENT REQUESTING THE INFORMATION/ADVICE

Date *(when initial client's submission is sent to Science)*:

Directorate, Branch or group initiating the request and category of request	
Directorate/Branch/Group	Category of Request
☒ Fisheries and Aquaculture Management	☐ Stock Assessment
☐ Oceans & Habitat Management and SARA	☐ Species at Risk
☐ Policy	☐ Human impacts on Fish Habitat/ Ecosystem components
☐ Science	☐ Aquaculture
☐ Other (please specify):	☐ Ocean issues
	☐ Invasive Species
	☐ Other (please specify):

Initiating Branch Contact:	
Name: A. Lester Jantz	Telephone Number: (250) 851-4948
Email: lester.jantz@dfo-mpo.gc.ca	Fax Number: (250) 851-4873

Issue Requiring Science Advice (i.e., "the question"):

Issue posed as a question for Science response.

The utility of Albion Test Fishery chinook catch information to predict the terminal run size and potential escapement of Fraser River Spring and Summer yearling chinook. A review of the methodology developed in 2008 is requested.

Rationale for Advice Request:

What is the issue, what will it address, importance, scope and breadth of interest, etc.?

This tool is required to provide the ability to predict terminal run size and potential escapement for Fraser chinook stocks in order to address management considerations related to First Nations Treaty implementation and negotiation (e.g. abundance based allocations), Wild Salmon Policy implementation and overall improved in-season management of Fraser River chinook stocks. Management impacts affect all South Coast fisheries.

Possibility of integrating this request with other requests in your sector or other sector's needs?

As mentioned above this tool could be useful in the delivery of First Nations Treaty obligations (e.g. abundance based allocation) as well as addressing Wild Salmon Policy implementation (e.g. abundance relative to stock reference points).

Intended Uses of the Advice, Potential Impacts of Advice within DFO, and on the Public:

Who will be the end user of the advice (e.g. DFO, another government agency or Industry?). What impact could the advice have on other sectors? Who from the Public will be impacted by the advice and to what extent?

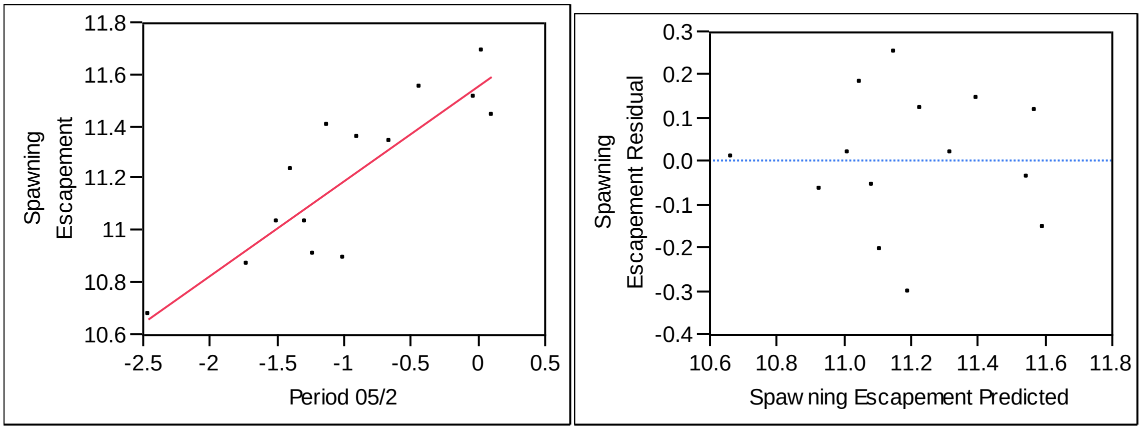
DFO will be the end user of this advice. Benefits from this tool could be utilized to improve fisheries management by all sectors (First Nations, commercial and recreational).

Date Advice Required:

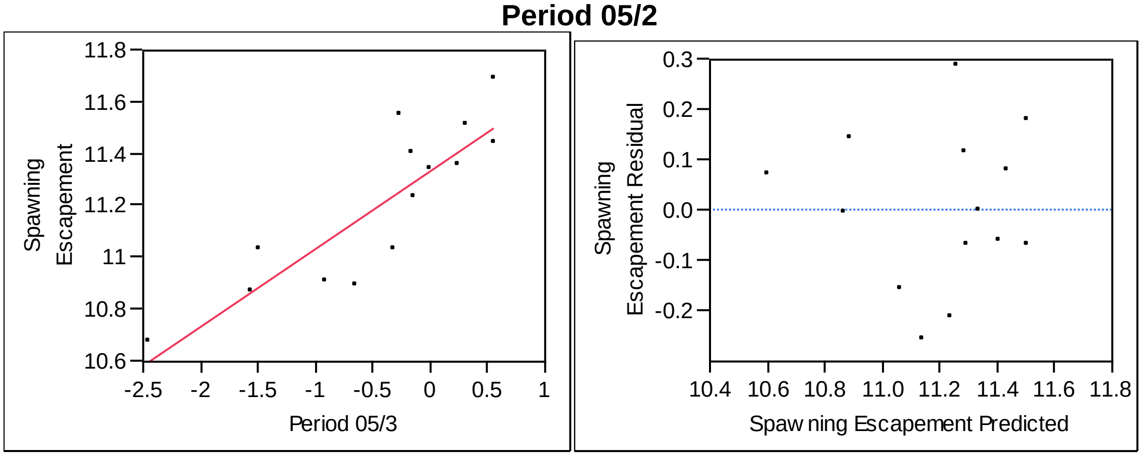
Latest possible date to receive Science advice: 2009-03-31

Rationale justifying this date: This paper is required prior to the development of management approaches for the 2009 season and prior to entry of spring/summer Fraser chinook in May.

Appendix 3 Linear regression relationships of Log$_e$(Spawning Escapement) versus Log$_e$(CPUE) and the corresponding plot of residuals by predicted values, by period, from the Albion test fishery 8" inch net, 1995–2009, 2007 excluded.



Period 05/2



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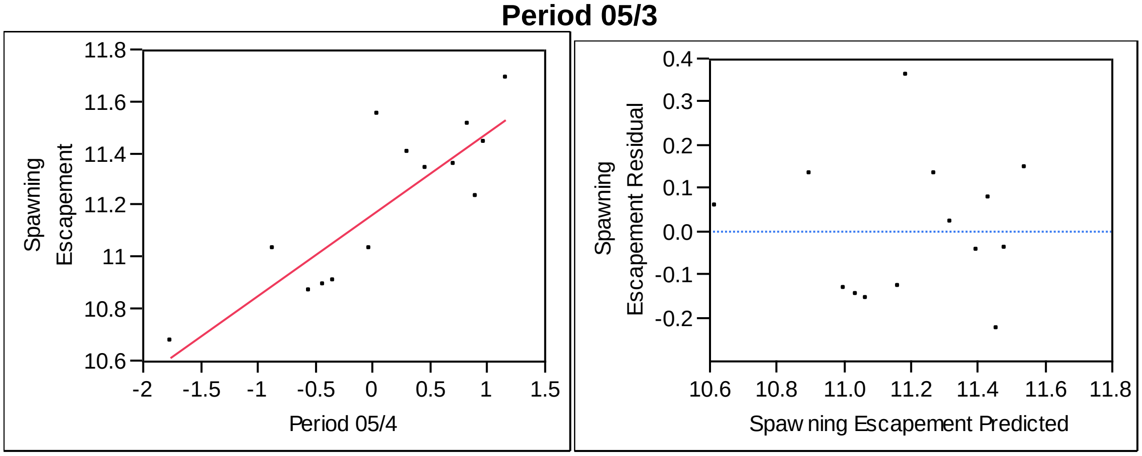

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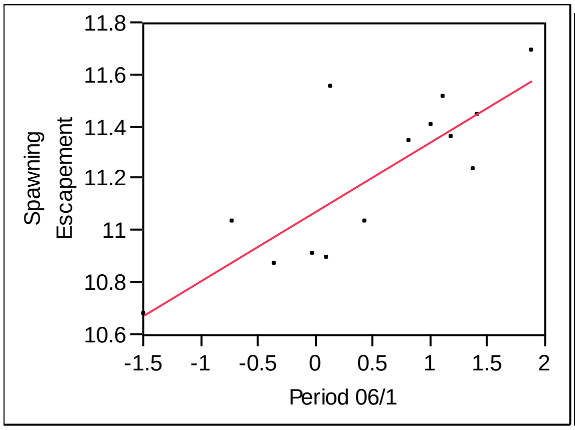

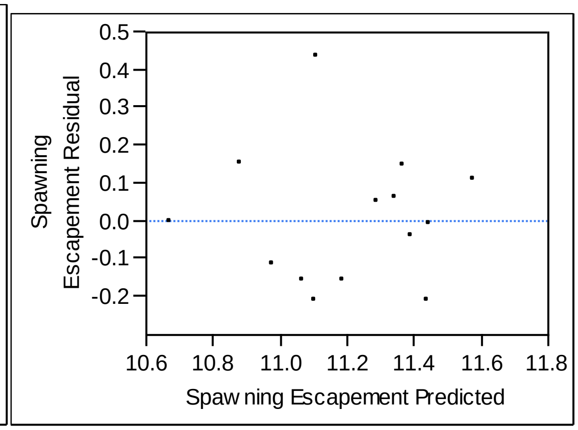

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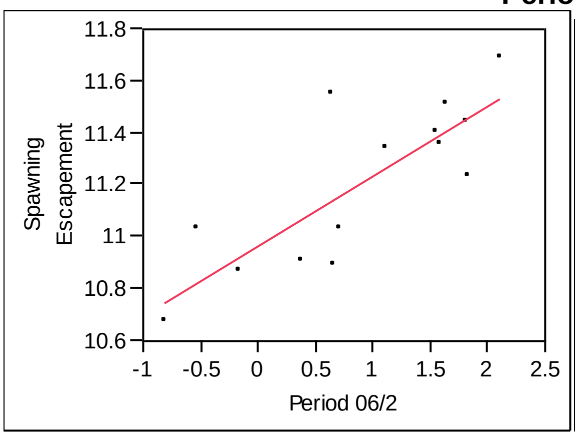

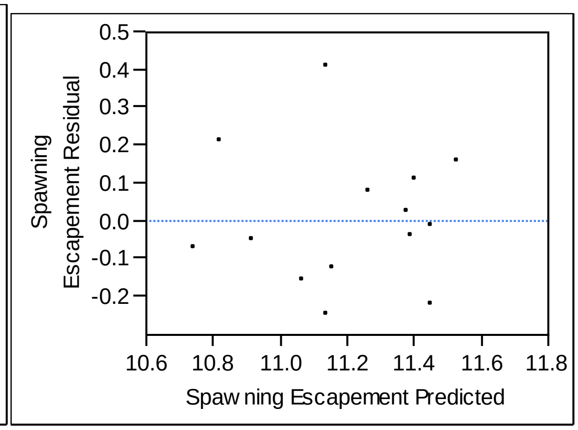

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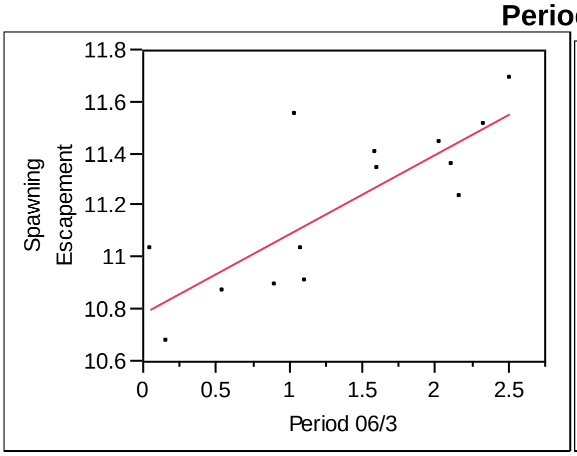

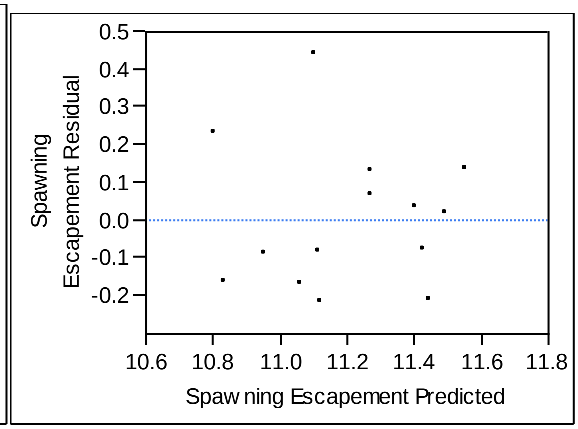

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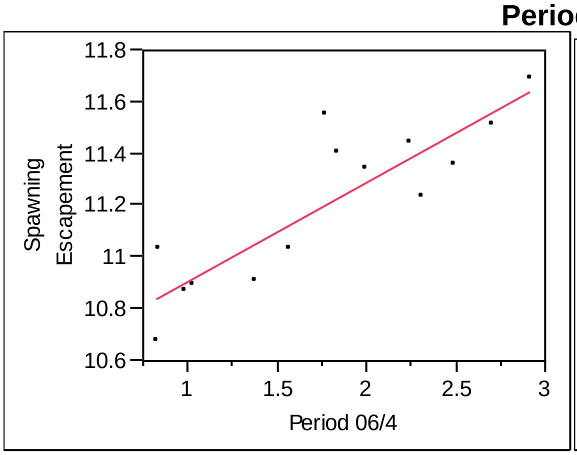

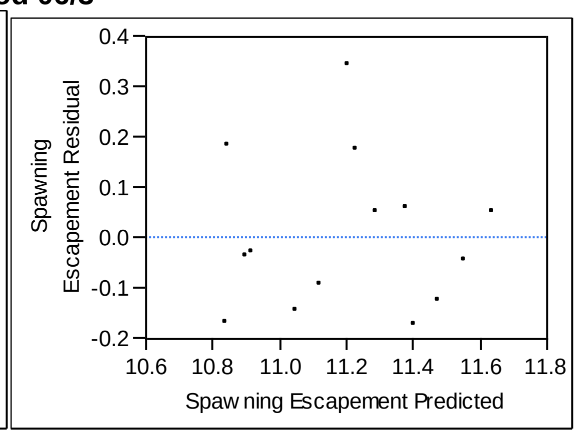

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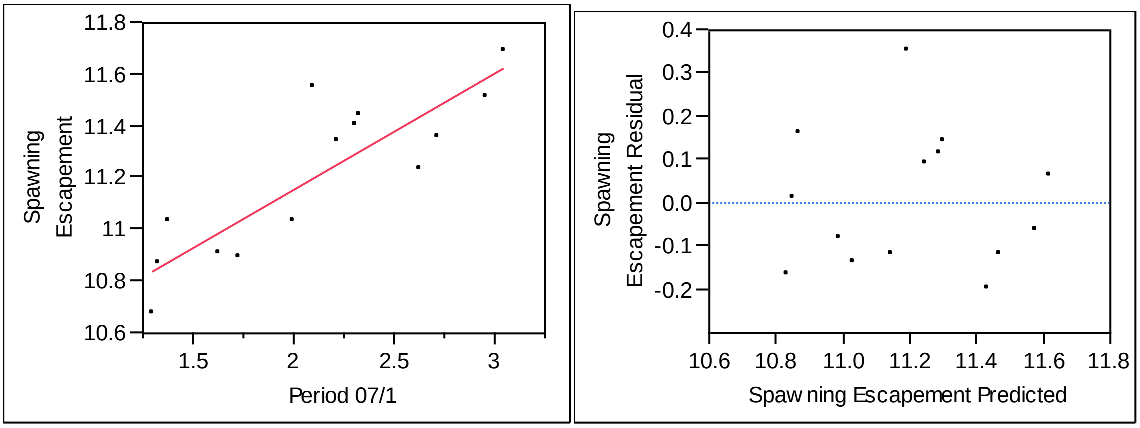
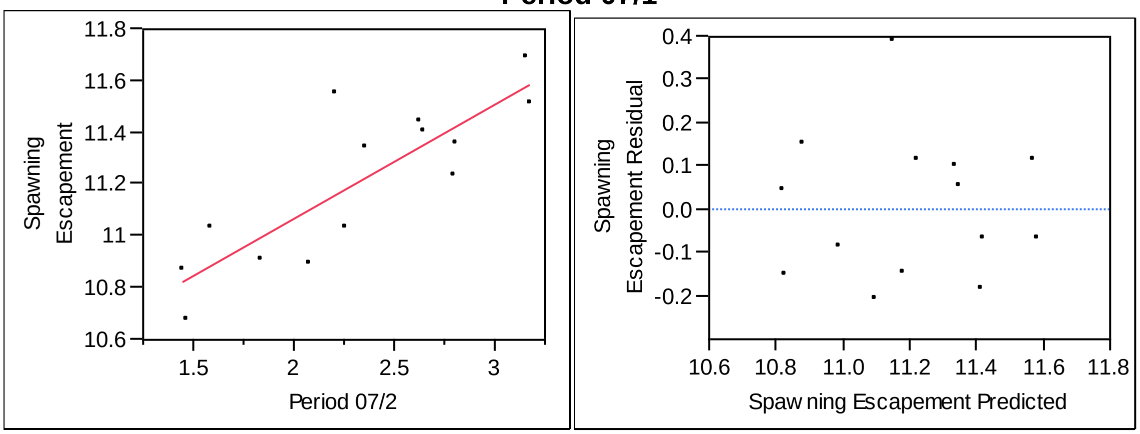


Period 07/1



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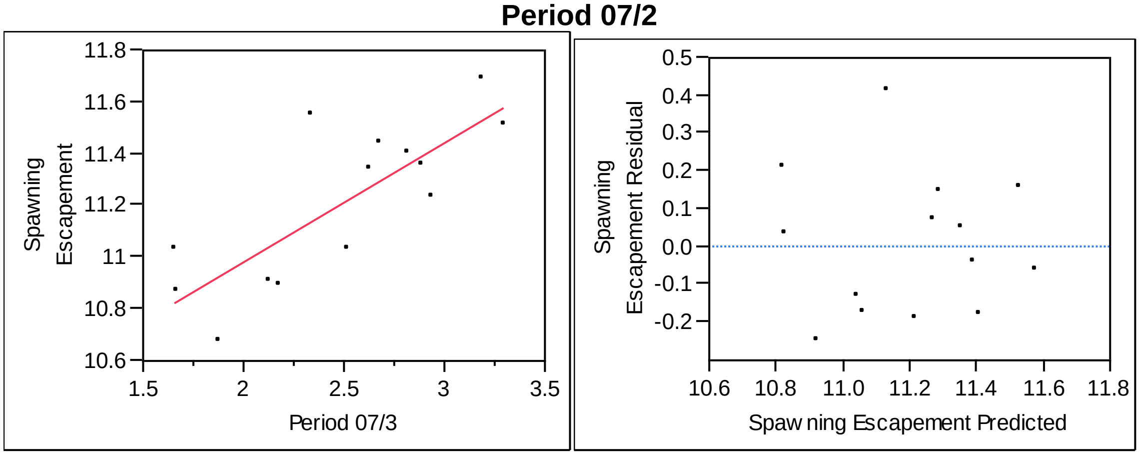
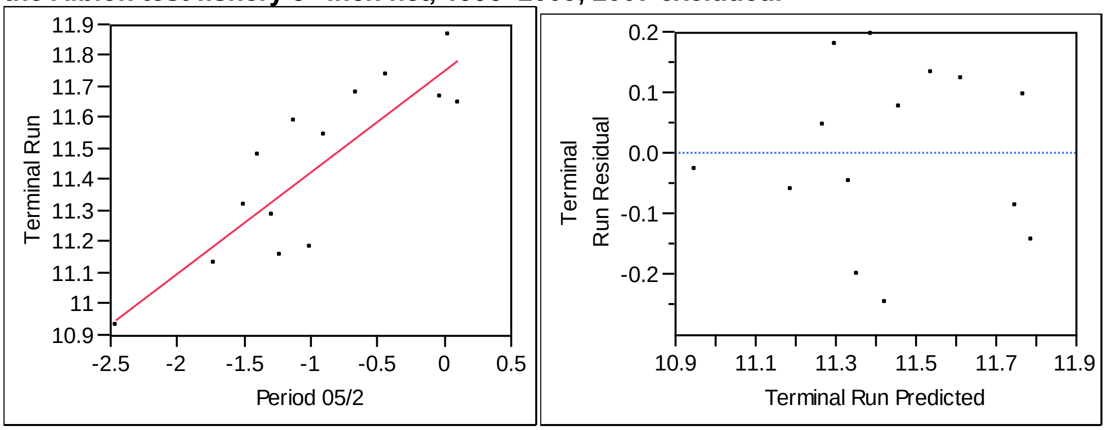


Period 07/3

Appendix 4 Linear regression relationships of Log$_e$(Terminal Run Size) versus Log$_e$(CPUE) and the corresponding plot of residuals by predicted values, by period, from the Albion test fishery 8” inch net, 1995–2009, 2007 excluded.



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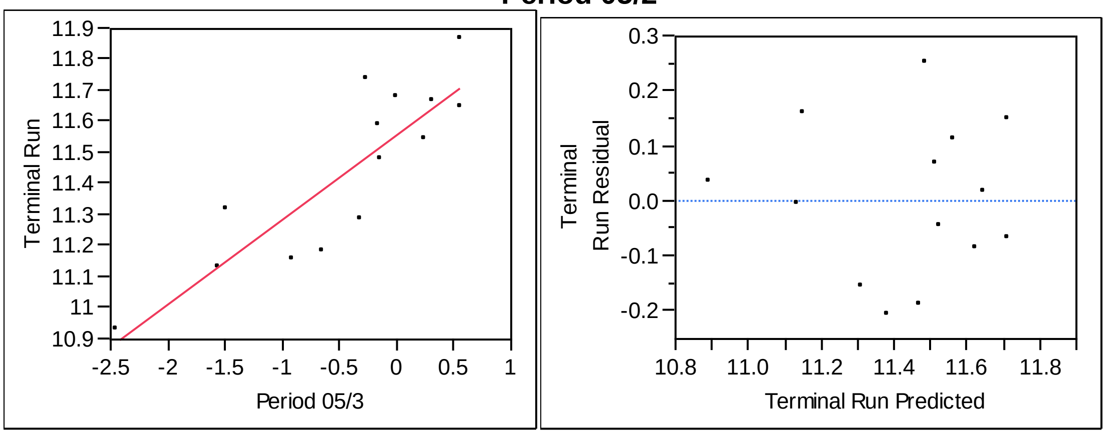

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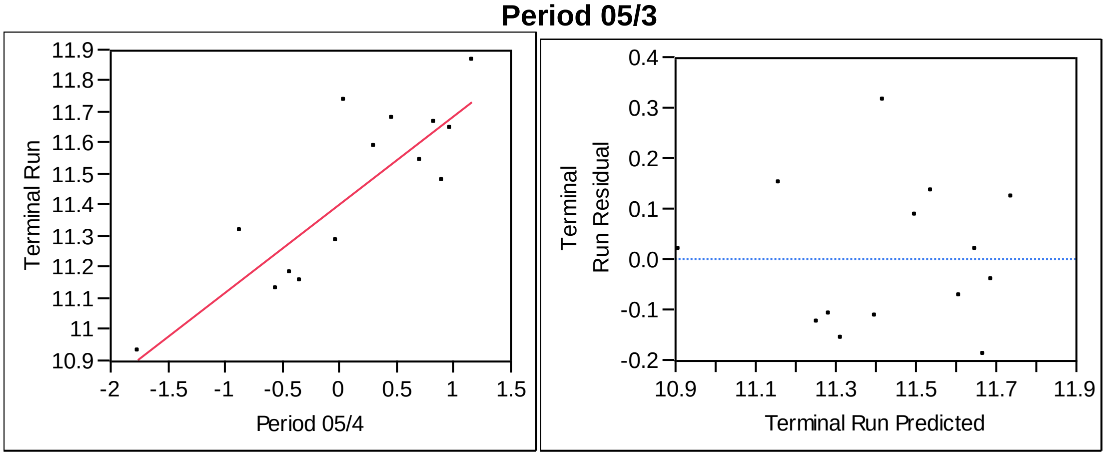

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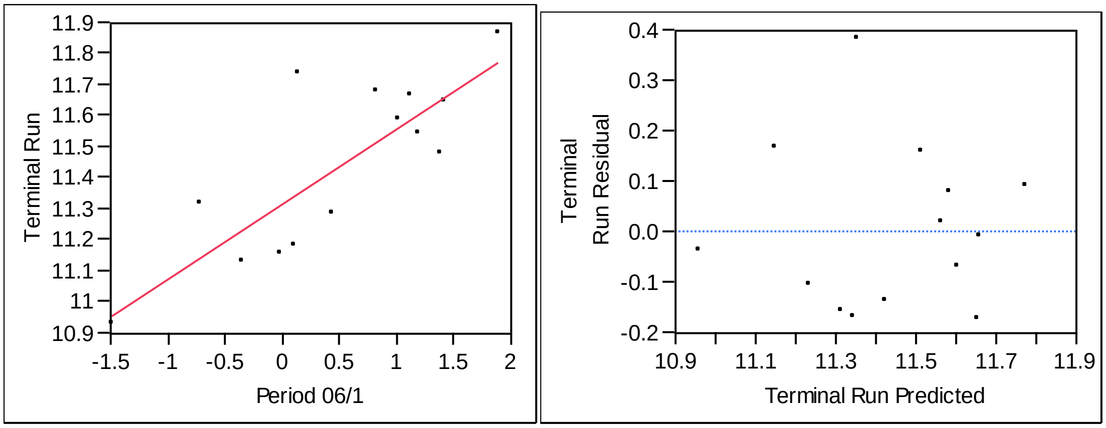

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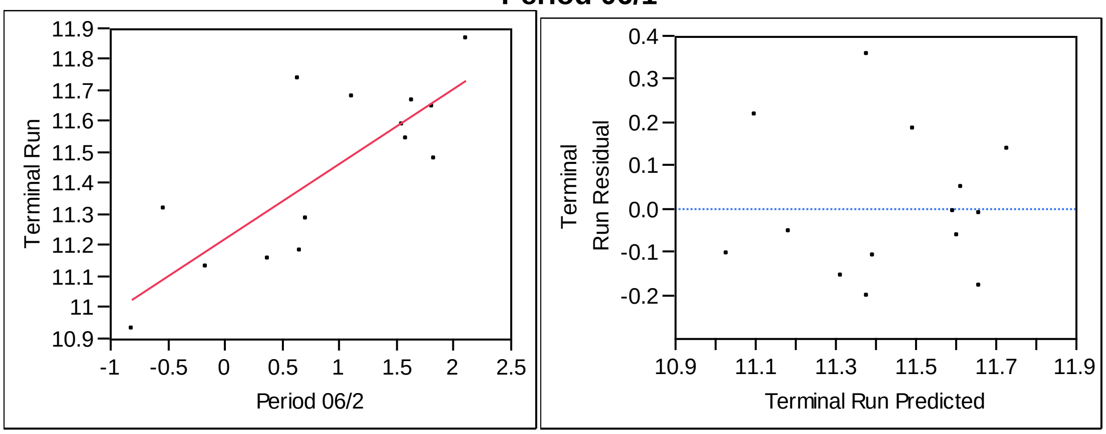

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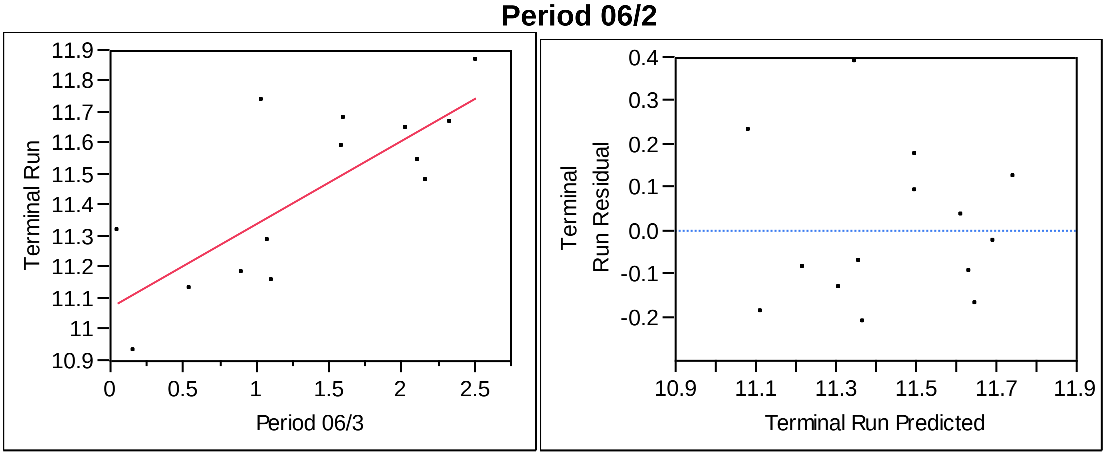

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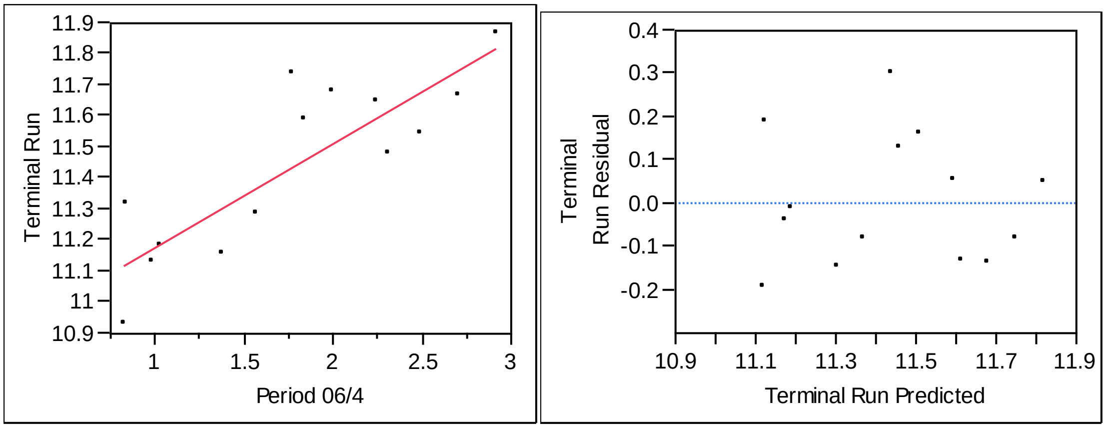

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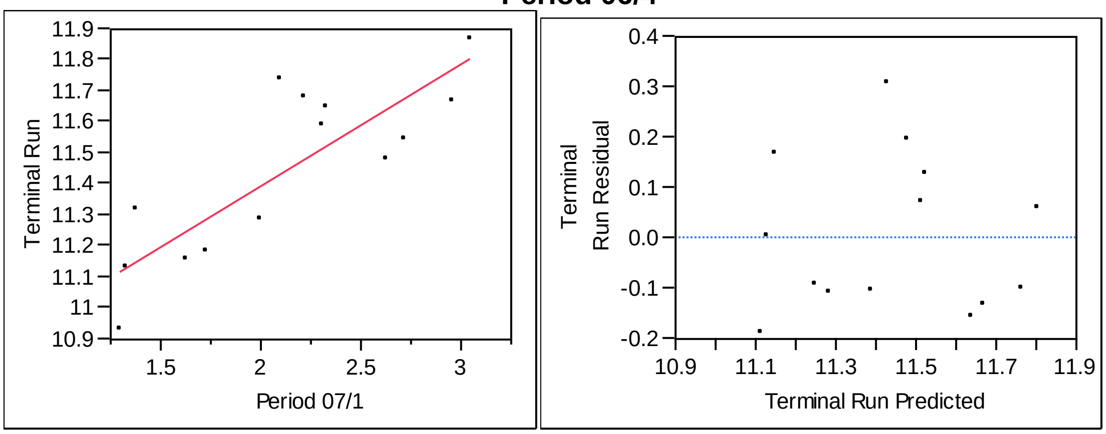

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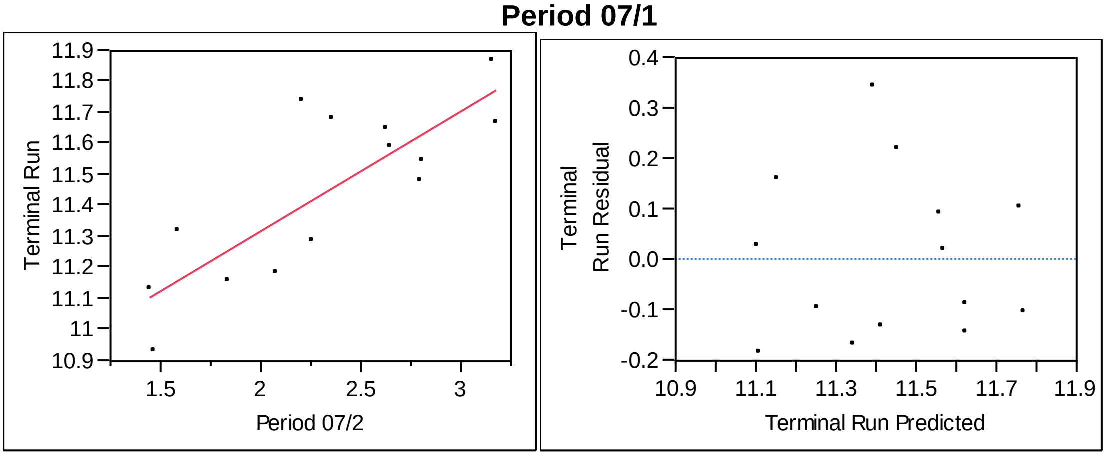

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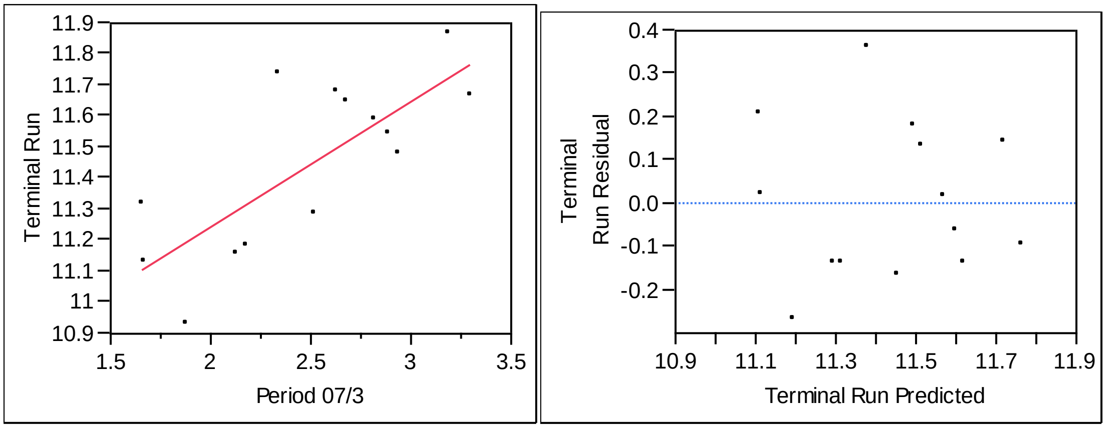
11.9
11.8
11.7
11.6
11.5
11.4
11.3
11.2
11.1
11
10.9
Terminal Run
1.5
2
2.5
3
3.5
Period 07/3
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
Terminal
Run Residual
10.9
11.1
11.3
11.5
11.7
11.9
Terminal Run Predicted

Period 07/3

Appendix 5 2008 DFO Salmon outlook.

2008 SALMON STOCK OUTLOOK

DFO Stock Assessment has developed a categorical outlook for salmon stock status since 2002. It's intended to provide an objective and consistent context within which to initiate fisheries planning. In particular, the outlook provides a preliminary indication of potential fishing opportunities and the stocks of concern around which fisheries might be shaped.

For each stock group, a status outlook is provided on a categorical scale of 1 to 4 (please see the following Table). The category reflects interpretation of available quantitative and qualitative information and forecasts as well as expert opinion of status. In many cases, stock targets have not been formally described and for those cases targets were either historical levels or expert opinion.

Stock status implies consequences to fisheries where the stock group is caught directly or incidentally. In the context of this outlook the probable fishery consequences associated with each of the four status categories are identified in the following table. Stock groups forecast in category "2" are considered "sensitive" and in general, fisheries will be planned to reduce impacts on these groups where possible.

Status Category	Category Definition	Criteria	Fishery Consequences
1	Stock of concern	Stock is (or is forecast to be) less than 25% of target or is declining rapidly.	Directed fisheries are unlikely and there may be a requirement to avoid indirect catch of the stock.
2	Low	Stock is (or is forecast to be) well below target or below target and declining.	Directed fisheries are uncertain and likely to be small if permitted. Allocation policy will determine harvest opportunities.
3	Near Target	Stock is (or is forecast to be) within 25% of target and stable or increasing.	Directed fisheries subject to allocation policy.
4	Abundant	Stock is (or is forecast to be) well above target.	Directed fisheries subject to allocation policy.

It is important to note that the fishery consequences implied by any of the status categories do not include interactions with other stocks. Consequently, conservation requirements for stocks in status categories 1 and 2 may limit fishing opportunities for stock groups for which there are no concerns. Where possible the comments associated with each stock identify such potential constraints. A range of status categories indicates significant geographic variation in status within the stock group and fisheries may be shaped in response to that variation.

The outlook should be regarded as very preliminary and is subject to change as more information becomes available and as statistical forecasts and assessments are completed and reviewed.

Salmon outlook for 2008

A total of **93** stock groups were considered and outlooks were provided for **89** of them. **Thirty-four (34)** stock groups are likely to be at or above target abundance (category 3-4), while **34** are expected to be of some conservation concern (category 1, 2, 1/2). The remaining **21** stock groups had mixed status levels (1/4, 2/3, 2/4). For clarity some adjacent stock groups have been grouped in the following table where their outlooks were similar. Overall, the outlook for 2008 for each species is not as positive as in recent years.

Species/Stock	Outlook status	Comments
Sockeye		
Okanagan	3	Survival rates for Okanagan sockeye salmon have exhibited substantial variation over the past 4 years (i.e. range of returns per spawner from 0.75 to 2.09). The majority of Okanagan sockeye salmon return in their 4th year of life so applying the recent 4-year average return per spawner value (1.25) to 2004 brood-year adults suggests total returns in 2008 on the order of 97,000 adult sockeye at Wells Dam (i.e. 58,000 on the grounds in the Okanagan R. at Oliver). These values assume virtually no harvest in U.S. portions of the migratory route as has been the practice in recent years in order to protect ESA listed Redfish Lake sockeye that co-mingle with Wenatchee and Okanagan sockeye salmon stocks returning to the Columbia River.
Early Stuart	1	The forecast is for a return of 35,000 sockeye, Cycle year escapements have decreased by 90% over the last three generations. The 2004 brood year escapement (9,300) was only 10% of the 2000 escapement (90,000) and 24% of the long term cycle average escapement (38,000).
Early Summer – North Thompson	2.5	The forecast is for a return of 77,000 sockeye to the Raft, Fennell and the North Thompson. The 2004 brood year escapement (10,000) was the lowest observed on this cycle since 1968. It was only 12% of the 2000 record cycle escapement (89,000) and 43% of the long term cycle average (24,000). Above average rainfall in the North Thompson system in 2004 led to poor counting conditions at several streams, therefore the 2004 system escapement is likely biased low. Prior to 2004, cycle year escapements to this system had been trending upwards, increasing by 78% over the previous three generations.
Early Summer – South Thompson	2	The forecast is for a return of 25,000 sockeye. The 2004 brood year escapement (3,900) was the fourth lowest observed on this cycle. It was only 3% of the 2000 record cycle escapement (126,000) and 20% of the long term average (20,000). Above average rainfall in the South Thompson system in 2004 led to poor counting conditions at several streams, therefore the 2004 system escapement is likely biased low. Prior to 2004, cycle year escapements to this system had been trending upwards over the previous three generations.
Early summer – upper Fraser	1.5	The forecast is for a combined total return of 171,000 sockeye to the Gates, Nadina and Bowron systems. Brood year (2004) escapements decreased significantly relative to the brood in all three systems (90%, 89% and 93%, respectively) and fell below the recent cycle line (1984-2000) averages by 84%, 53% and 90%, respectively. Bowron is a very small populations returning in the 2008 cycle.
Early Summer – lower Fraser	3	The forecast is for a return of 75,000 sockeye. The 2004 brood year escapement (102,000) was the largest on record for this cycle line. It was almost double the 2000 escapement (56,000) and well above the long term cycle average (44,000). Record escapements were observed at both the Upper Pitt River (61,000) and Chilliwack Lake system (40,000).
Summer – Chilko	3	The forecast is for a return of 885,000 sockeye. The 2004 brood year escapement (92,000) was the lowest on record for this cycle. It was only 12% of the 2000 escapement (759,000) and 18% of the long term cycle average (500,000).
Summer – Late Stuart	2	The forecast is for a return of 355,000 sockeye. The 2004 brood year escapement (83,000) was only 18% of the 2000 escapement (454,000) and 75%

Species/Stock	Outlook status	Comments
		of the recent cycle year average of 111,000. Prior to 2004, cycle year escapements had been trending upwards, increasing by 100% over the previous six generations.
Summer – Nechako	3	The forecast is for a return of 477,000 sockeye. The 2004 brood year escapement (88,000) was only 23% of the 2000 escapement (373,000) and 36% of the recent cycle average (247,000).
Summer – Quesnel	2	The forecast is for a return of 93,000 sockeye. Returns in 2008 represent the second off-cycle year in this system. Similar to the other cycle lines, the 2008 cycle experienced remarkable growth through the 1990's. The 2004 brood year escapement (10,000) was only 16% of the 2000 escapement (64,000) and 35% of the recent cycle average (30,000). Similarly, recent returns on the dominant (2005), sub-dominant (2006) and first off-cycle (2007) have also declined substantially relative to the respective brood. This has raised concerns with respect to juvenile rearing capacity limitation in Quesnel Lake as a result of the large annual escapements since 1993.
Fall – Cultus	1	The forecast is for a return of 5,000 sockeye. The 2004 brood year escapement (90) was the lowest on record; it was only 7% of the 2000 escapement (1,227) and only a small fraction of the long tern cycle year average (13,000). Identified threats to this population are harvest, habitat alteration in Cultus Lake, environmental fluctuations, and impacts related to parasites (early migration) and predators (freshwater predation). Recovery activities will be on ongoing in 2008.
Fall – Portage	1.5	The forecast is for a return of 15,000 sockeye. The 2004 escapement (1,300) was similar to the 2000 escapement but fell short of the recent cycle average (2,100) by 39%. Cycle line escapements have been relatively steady since 1972, ranging between 1,300-3,800 spawners. Portage sockeye continue to be a concern as they are impacted by early Fraser River entry mortality exhibited by Late Run stocks since 1995.
Fall – South Thompson	1.5	The forecast is for a return of 17,000 sockeye. These stocks are in their first off-cycle year in 2008. The 2004 escapement (3,000) was well above the 2000 escapement (855), but only 57% of the recent cycle average (7,200). Concerns continue with entry timing related mortality for all Fraser Late Run stocks.
Fall – Birkenhead	3	The forecast is for a return of 238,000 sockeye. The 2004 brood year escapement (38,000) was the almost four times greater than the 2000 escapement (14,000), but only 44% of the long term cycle year average (86,000). Prior to 2004, cycle line escapements were on a downward trend, decreasing by 94% over the previous three generations.
Fall – lower Fraser	3	The forecast is for a return of 140,000 sockeye to Harrison River & tributaries and 290,000 sockeye to Weaver Creek. The 2004 brood year escapement to the Weaver Creek system (25,000) was over four times greater than the 2000 escapement (6,600) but 80% of the long term cycle year average (32,000), while escapement to the Harrison (2,100) was only 48% of the 2000 escapement and 27% of the long term cycle average (7,800).
Somass	1.5	Expectations for 2008 are well below the long term average of approximately 760,000 combined return to Great Central and Sproat Lake. Of continued concern is the extremely low production so far resulting from the 2003 brood year. We expect a very poor return of 5_2 year old fish in 2008. Normally, this age group contributes to about 35% of the return.
Henderson	1	Recent escapements to Henderson are very low, although preliminary assessement of the 2007 return is encouraging and shows improvement. However, there were low numbers of spawners from two brood years (2003 and 2004) that will contribute to the 2008. As well, marine survival rates experienced by the 2003 brood were likely also very low.

Species/Stock	Outlook status	Comments
WCVI-other	1.5	Assessment data are not available for Hobiton and others systems; however, Kennedy and Jantzen Lake stocks are depressed.
Area 11-13	1.5	For many of the small Johnstone Strait stocks, assessment data are sparse, but most systems surveyed appear to be low to stable (Quatse River and Heydon Creek). Returns to Village Bay have be non existent in 4 of the last 5 years with a high likelihood that this stock is extinct in that watershed. Preliminary information for 2007 escapement to Nimpkish are below expectations. Nimpkish in 2008 will likely contribute another low return based on the fairly week week 2003 and 2004 brood years and continued poor marine survival. 2008 expectations are for low and stable abundances with some stocks of concern.
Sakinaw	1	Three fish entered the lake in 2003, 100 in 2004, 27 in 2005, and 1 female in 2006. Only 11 smolts were counted in spring 2005. In 2006, 8,351 hatchery-origin and 2,926 wild-origin smolts were enumerated at the weir. The field operations ran successfully throughout the 2007 summer and, as forecast based on 2005 smolt production, there were no sockeye salmon returns to Sakinaw Lake.
Area 7-10	1.5	The outlook is uncertain and final forecasts are not yet available. 2006 and 2007 returns indicated extremely poor survivals from brood year escapements in Area 8, 9 and 10. Returns to Areas 7 and 8 were variable with some stocks showing improvement while others continue to be depressed.
Coastal 3/6	3	Status is uncertain. Very limited assessment data for evaluation.
Babine Lake enhanced	3	Modest forecast for age-4 fish based on 2007 jack returns. Well below average age-5 return expected from very poor age-4 returns in 2007.
Skeena wild		Non-Babine sockeye status continues to be variable.
Nass	2/4	Average returns are expected. Stock specific status of non-Meziadin sockeye uncertain.
QCI	2/4	Status uncertain for some systems.
Alsek	3	An above average run is expected based on brood year escapements and the historical stock-recruitment relationship. However, both early and late runs have been below expectations recently and survivals appear to have been below average.
Stikine-wild	3/4	Stikine sockeye production has varied dramatically since 1985. Low production periods occurred in the mid 1980(s) to early 1990(s). Since 2003 production has been relatively good which may have been due to improved marine survival. The Tahltan Lake component is predicted to return in abundant numbers, whereas the mainstem component is expected to return in average numbers. A more restrictive fishing regime may be implemented during the overlap with the latter part of the Tahltan run and early segment of the mainstem run.
Taku-wild	3	Although the principle brood year escapement was record high, production is expected to be below average based on stock-recruitment. Fishing opportunities are expected within the confines of conservation and PST requirements. Special measures may be needed to achieve the egg-take goal for Tatsamenie enhancement.

Chinook

Early spring – upper & mid-Fraser, North Thompson	1	Populations of concern are upper and lower Chilcotin, Westroad, Cottonwood, and Chilako rivers. Very poor escapements observed in 2007 with escapements averaging ~22% of brood escapements. Very poor survivals have been observed for of Fraser salmon that went to sea in 2005. These fish will form the bulk of returns in 2008. No indicator stock.
Late summer –	3	Indicator is Lower Shuswap. Returns in 2007 were generally above brood year

Species/Stock	Outlook status	Comments
South Thompson		escapements, although mid and lower Shuswap were below brood. South Thompson and Lower Adams were both strong.
Spring – upper & mid-Fraser, North Thompson	1	Returns throughout range in 2007 were poor, averaging only 25% of brood year escapements. Very poor survivals have been observed for of Fraser salmon that went to sea in 2005. These fish will form the bulk of returns in 2008. No indicator stock.
Summer – upper & mid-Fraser, North Thompson	1	No indicator. Returns throughout range in 2007 were poor. Escapements averaged only 29% of brood escapements. Very poor survivals have been observed for of Fraser salmon that went to sea in 2005. These fish will form the bulk of returns in 2008.
Spring – lower Thompson	1	Indicator is Nicola. Extremely poor returns in 2005 to 2007. Continued major decline in escapements from brood year. Returns averaged 10% of brood year escapements in 2003.
Fall – lower Fraser natural	2	Four year old returns expected to be poor, however, large jack returns in 2007 predict strong returns of 3 year-olds in 2008.
Fall – lower Fraser hatchery		Although there are significant hatchery releases of Harrison fall-run chinook stock into the Harrison & Stave Rivers, lower Fraser River fall-run hatchery chinook consists mainly of Chilliwack Hatchery releases. 2007 adult spawning escapements indicated weaknesses in 3 year-olds. Forecasts for 4 year-old returns in 2008 are poor, however, strong returns of 3 year-olds are predicted.
Early spring – lower Fraser	2	Birkenhead River escapement (~1,000 adults) is significantly greater than brood year 2002 (512 adults) and greater than the previous 10-year average. Previous to past three years, the trend in escapement was down. Returns in 2008 will be predominately from the 2003 escapement of about 427 adults. A major flood in the Birkenhead drainage may also have adversely affected recruitment from the 2003 brood. Very poor survivals have been observed for of Fraser salmon that went to sea in 2005 (2003 brood). These fish will form the bulk of returns in 2008. No indicator stock.
Summer – lower Fraser	2	Maria Creek escapements in 2007 (650 adults) were slightly lower than the brood year (823). Big Silver escapement was only 70. Expectations are for near target abundance levels, however, returns in 2008 will have mostly gone to sea in 2005, and may have experienced poor survival.
WCVI-hatchery	3	2007 returns were below forecast expectations. . For 2008, returns are expected to be lower than 2007 based on anticipated low returns of age-4 fish resulting from poor survival of the 2004 brood.
WCVI-wild	1	Escapements appear to have decreased in 2007 relative to 2006. Final escapements and age compositions are currently unavailable. However, returns are expected to decrease in 2008 and females may be limited in small populations.
Johnstone Strait area including mainland inlets	2/3	Preliminary 2007 returns to the Quinsam River hatchery indicator show a continued stabilization of the return. Escapement monitoring is ongoing at this time and expect to meet 6000 escapement target. Preliminary estimate of returns to the Campbell River indicates ~300 adults. A similar return is expected for 2008.
Georgia Strait Fall (wild and small hatchery operations)	1	Outlook is for a stock of concern. The 2007 Cowichan River return was estimated to be 1450 jacks and 2413 adult chinook. Of these, 51 jacks and 315 adults were collected for broodstock and 132 jacks and 238 adults were caught in a Food, Social and Ceremonial fishery by Cowichan Tribes Returns to Chemainus are thought to be extremely low, probably less than 50. The return to Nanaimo was estimated to be 2322 adult 1973 jack chinook which is 65% higher than the 1995-2005 average.

Species/Stock	Outlook status	Comments
Georgia Strait Fall (large hatchery operations)	4	Returns to rivers with major hatcheries (Big Qualicum, Little Qualicum and Puntledge) have been very strong with record numbers in recent years. In contrast, stocks with smaller hatchery operations have had less abundant returns. Early 2007 indications are similar returns as 2006.
Georgia Strait Spring and Summer	2	Returns to Nanaimo (spring and summer) and Puntledge (summer) hatcheries are at or above 2005 levels, but are still below target escapements. Rebuilding efforts are continuing.
Area 7-8	3/4	Dean River brood year escapements were good and an average return is expected. Bella Coola/Atnarko enhanced returns and production for the modest brood year escapements are expected to provide a return similar to last year.
Area 9-10	2/3	Wannock River returns are from relatively poor brood years, which may result in a below average return. The spring-run stocks including the Owikeno tributary stocks and Chuckwalla/Kilbella are expected to be below average as brood year escapements were poor.
Coastal Areas 3 to 6	2/3	Stocks generally depressed but stable and this pattern is expected to continue. Poor quality assessments except at Kwinamass and Khutzeymateen rivers.
Nass	3/4	Below average return expected based on poor ocean survival of chinook that went to sea in 2005.
QCI	3/4	Stock appears stable at relatively high levels.
Skeena	3/4	Below average return expected based on poor ocean survival of chinook that went to sea in 2005.
Alsek	2/3	Brood year escapements were within what is considered to be the optimal range. Based on the historical stock recruitment relationship, an above average run is expected. However, , it should be noted the brood year escapements are similar to those which produced the 2006 and 2007 returns which were the lowest and second lowest respectively on record due to poor survival. Hence there is much uncertainty over the 2008 run outlook.
Stikine	3	This stock was subjected to directed commercial fisheries in 2005 through 2007 as a result of a Canada/U.S. agreement reached in 2005 under the Pacific Salmon Treaty. Brood year escapements for 2008 were within/above the target range. The 2008 Transboundary Technical Committee sibling-based forecast of approximately 46,100 large chinook suggests production may be average to below average but above the trigger for conducting a directed fishery. Under the new fishing regime, a directed Canadian commercial fishery will occur again in 2008. Once inseason projections become available (likely starting the third week in May), the fishery will continue providing run projections are greater than 24,500 large chinook salmon.
Taku	2	Although brood year escapements were within the target range, the Transboundary Technical Committee pre-season forecast of 39,400 large chinook, based on sibling analysis, is below the threshold for conducting directed chinook fisheries, i.e.42,400 large chinook. At this time, it appears that only a very limited assessment fishery will be conducted initially to gather data upon which to base inseason run size projections. If in-season projections exceed 42,400 large chinook salmon, directed fisheries may be allowed. In-season projections are not expected to be available until after May 18. As on the Stikine River, management will be directed by the terms of the Canada/U.S. agreement reached in 2005 under the PST.
Yukon	2/3	A total run of 80,000-111,000 Canadian-origin Yukon River chinook salmon is expected in 2008, a below average run. Until 2007, as a result of increased marine survival and more precautionary management particularly in Alaska, spawning escapements generally recovered from the poor runs observed from 1998 to 2000. The estimates of the total upper Yukon spawning escapements

Species/Stock	Outlook status	Comments
		from 2001 to 2003, the three primary brood years contributing to the 2008 run, were close to, or exceeded, the upper end of the escapement goal range for rebuilt stocks of 33,000-43,000 chinook salmon. However, total production has not yet returned to the levels observed prior to 1998. The 2007 run was unexpectedly weak and conservation measures were required- i.e. there were no commercial or domestic fishery openings and Chinook retention was varied to zero in the recreational fishery. If the factors that contributed to the weak 2007 run persist, fishing opportunities may also be limited in 2008.
Coho		
Mid/upper-Fraser	1	2007 returns were better than recent levels, and mainly exceeded brood escapement levels. Rebuilding will continue to be affected by marine survival, which continues to be poor but may be improving.
Thompson	1	2007 returns were similar to brood escapement levels in the North Thompson, but failed to meet brood levels in other areas. Rebuilding will continue to be affected by marine survival, which continues to be poor but may be improving.
Lower Fraser	1/2	Escapements in 2007 were poor to fair even with the improved marine conditions in 06-07. Rebuilding will continue to be affected by marine survival, which continues to be poor but may be improving. The 2007 hatchery marine survival was higher than forecast. The 2008 marine survival is forecast to be the same as 2007 at 1.3%
WCVI	2	2007 returns were less than forecast but higher than the 2006 return. Hatchery and wild marine survivals were 2.0% and 2.2%, respectively. Forecast marine survival for 2008 is 0.7% (hatchery) and 3.8% (wild).. Due to continuing low marine survivals the Outlook status has been decreased from category 3 to category 2.
Area-12	2/3	Preliminary marine survival (4%) at Keogh River indicates a slight improvement in marine survival over 2007. In 2007, Keogh smolt production was slightly higher than 2007 and close to the historic average production. Expectations are for returns similar to the last 3 years.
Area-13 North	2	Preliminary data for 2007 shows a significant improvement in survival from 2006. Abundance remains low and expectations are for levels similar to the past 3 years.
Georgia Strait	1	2007 returns were higher than forecast but still at low levels. Marine survivals for hatchery stocks ranged from 0.3% to 0.7%. Marine survival for the wild indicator (Black Creek) was 2.6%. These survival rates are at replacement level over the brood year. The 2008 forecast, using time series models, is for a decrease in marine survival from 2007. Hatchery stock marine survivals are forecast to decrease to 0.2% to 0.3% and wild stocks are forecast to decrease to 1.7%
Area-7-10	2/4	The outlook is very uncertain, survivals have been poor for the last two years. Management plans will rely on in-season abundance data.
Area 5/6	2/4	Stocks continue to rebuild in Area 6. Area 5 not assessed (no data).
Area-3	3/4	Average return is expected.
QCI-E	3/4	Assessments poor since 2002, outlook status based on previous assessments.
QCI-N	3/4	Assessments poor since 2002, outlook status based on previous assessments.
QCI-W	3/4	Assessments poor since 2002, outlook status based on previous assessments.
Skeena	3/4	Outlook is good for the middle and upper Skeena stocks, as they continue to around a higher abundance in recent years. Outlook for lower Skeena tributaries is uncertain, based on poor quality assessments.

Species/Stock	Outlook status	Comments
Skeena – high Interior	2/3	Stocks continue to fluctuate around a higher abundance in recent years.
Alsek	2/3	A below average run is expected based on low weir counts in in the Klukshu River 2004 and 2005 and recent poor survivals.
Stikine	3	An ABM regime has not yet been developed for this stock. Under the current PST arrangements, Canada is permitted to harvest 5,000 coho in a directed fishery. Reliable brood year escapement data is limited and available information is contradictory – extrapolated test fishing indices were above average, yet results from limited aerial surveys were below average. Marine survival of coho salmon in other nearby locations (Taku River, SEAK Hatcheries) was well below average in 2007. If this continues in 2008, a below average run can be expected
Taku	2/3	Excluding 2007, favorable marine survival combined with low exploitation resulted in large in-river run sizes and spawning escapements since 2000. However in 2007, the run was well below average as a result of marine survival being at the lowest level recorded (smolt-to-adult survival of 3.7% compared to 8.7% average). For 2008, a below average run of approximately 111,500 coho is expected based on the estimated smolt abundance in 2007 (1.3 million which was below average), combined with recent smolt-adult survival data. If marine survival observed in 2007 continues in 2008, the run size may be less than half this prediction. Under the current PST, Canada is permitted to harvest 3,000-10,000 Taku coho salmon in a directed fishery.
Yukon	ND	Little is known about the stock status within Canadian portions of the Yukon River drainage. Harvest data from the U.S. portion of the drainage indicates spawning abundance decreased since 1984-91 but has recently been increasing. The general sense in Alaska is that exploitation is low and has been influenced by conservation actions to protect co-migrating fall chum particularly during 1998-2004.
Pink		
Fraser – Even	ND	There is no Fraser Pink salmon run in even years, with the exception of small numbers of pinks of unknown origins. Therefore, no quantitative forecast is available.
Squamish - Even	ND	No qualitative assessment information is available.
WCVI-Even	ND	No quantitative assessment information is available for this stock.
Area-11/13-even	2/3	2007 returns appear similar to improved over the brood returns in 2005.. 2008 is typically the dominant cycle run and returns in 2006 were depressed throughout the area and likely attributed to poor survival in the 2005 outmigration which affect pink, coho and sockeye on a more region wide basis. The Parental Brood in 2006 was the second lowest return in recent cycle years and well below the historic average escapement... Historically, the mainland inlets populations have been highly variable, with expectations of low to near target abundance in 2008.
Georgia Strait-west	2/3	Low to near target returns expected. Good brood year escapement (2005) to Puntledge 75,000 and Englishman 5,000. Few systems surveyed. 2007 Tsolum River pink return was less than brood year
Georgia Strait - east	2	Lang and Sliammon (enhanced systems) appear stable at low abundances (<1,000), and Deserted Creek was 2,500.
Area-7/10 Even	3	2006 brood year escapements were generally poor. Expect below average return.
North Coast Areas-3/6 Even	3	2006 brood year escapements were generally poor. Expect below average return.

Species/Stock	Outlook status	Comments
QCI- Even	3	2006 brood year escapements were generally poor. Expect below average return.
Chum		
Fra ser River	3	Quantitative forecasts are not prepared for Fraser chums (catch-by-stock and escapement info is extremely limited). The largest contributing chum age class is 4 years (~70%). The 2004 brood year (age-4) escapement for assessed populations (2.6 M) was above the recent average (1998-2007 average: 2.1 M). Since chum are immediate migrants, poor ocean conditions in 2005 should result in reduced marine survival and below average returns of age-4 chum. Age-3 and -5 y brood year escapements are ~50% below average, respectively, in 2005 (1.3 M) and 2003 (1.5 M).
WCVI	2/3	Brood year (2003) escapements were average or above average in most areas. Assessment ongoing, but most returns appear lower than expected.. Nitinat returns are under the escapement target and chum escapement to NWVI rivers was extremely poor.
Johnstone Strait area and mainland inlets (Area-11-13)	3	2007 returns appear below average. The dominant year class (4 year old) associated with study area chum contributing to the 2008 return outmigrated to the ocean in 2005. Information on coho and pink (2006 returns) and sockeye (2007 returns) have demonstrated that marine survival in 2005 may have been compromised. Taking that into account along with lower than average 3-year old catch composition in the Johnstone Starit fisheries (preliminary results) abundance to the Studay Area may be blow average to average for 2008. 2007 summer-run returns demonstrated low returns in both Area 12 Mainland Inlets (Ahnuhati and Viner) and Bute Inlet (Orford River, Area 13). Summer run parental brood returns were low except for the year that would contribute to the 3-year old components. Those factors contribute to the below average expectations assigned to summer run chum in Area 12 and 13 for 2008.
Georgia Strait	3	Brood year (2004) escapements were low. Survival rates appear lower than average, and preliminary 2007 returns were low and variable. A below average return is forecasted, however, chum forecasts remain highly uncertain. Limited fishing opportunities are expected.
Coastal Areas 5/6	1/4	Low returns expected to areas other than Kitimat. Long term widespread decline among small and medium wild stocks. Good return of enhanced fish expected at Kitimat as well as 'wild' chum from a strong brood year escapement
QCI	2/4	Variable brood year escapements may result in local surpluses.
Skeena-Nass	1/2	Poor returns expected. Brood year escapements relatively poor, coupled with expected poor ocean survivals from juveniles going to sea in 2005. Long term widespread decline among wild stocks.
Area-7-10	3/4	A modest return is expected from average to abundant brood year escapements for areas 7 -10, tempered by expected poor ocean survivals from juveniles going to sea in 2005.
Yukon	3	This stock group includes upper Yukon River populations (excluding Porcupine drainage stocks). Spawning escapements have exceeded the targets since 2002; this has been attributed to reduced in-river exploitation and improved marine survival. Escapements in 2003 and 2004, the principle brood years contributing to the 2008 run, were well above the minimum goal established for a rebuilt stock. Based on the excellent brood year escapements, an above average run is expected.

Species/Stock	Outlook status	Comments
Porcupine (Yukon)	3	This stock group includes all stocks located within the Porcupine River drainage, a major tributary of the Yukon River. The principle stock, the Fishing Branch River which is annually assessed via an enumeration weir, had depressed runs from 1997 to 2003. The 2004-2006 runs exceeded preseason outlooks and escapements having been rebuilding. As a result, an average to above average run is expected. The Yukon River Panel has recommended an interim management escapement goal range for Fishing Branch chum salmon of 22,000-49,000 for 2008.
Taku	2	The stock has been depressed since 1991, although little information is available. The inriver run abundance index for the primary brood year was low but similar to the recent 10-year average. Non-retention provisions are expected to continue.