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Report of the PSARC Salmon Subcommittee Meeting, February 27-March 2, 2001

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Salmon

SUMMARY

The Pacific Scientific Advice Review Committee (PSARC) Salmon Subcommittee met February 27-March 2, 2001 at the Pacific Biological Station in Nanaimo. The Subcommittee reviewed seven working papers.

Working Paper S2001-01: Trends in abundance and pre-season 2001 stock size forecasts for major sockeye, pink and chum salmon stocks in the central coast of British Columbia

The Subcommittee accepted the central coast B.C. sockeye, pink, and chum forecast probability distributions. The forecasts for Owikeno and Long Lake sockeye are highly uncertain because there is not yet any compelling evidence to choose between the pessimistic "continue like 1996 sea-entry survival" and the optimistic "return to long-term average marine survival" scenarios.

The Subcommittee recommended no or minimal harvests of Owikeno and Long Lake stocks. Even under the optimistic scenario, returns would exceed target escapements to Owikeno only in 2001 and 2002, falling short of the target in 2003 and below the provisional LRP in 2004. Thus, increased returns in 2001 and 2002 provide a rebuilding rather than a fishing opportunity for Owikeno sockeye.

The Subcommittee recommended a cautious approach to the management of Area 8 sockeye stocks and Area 10 pink and chum salmon stocks due to their uncertain status and clear indications that, in recent years, they have shown abundance trends similar to Owikeno and Long Lake sockeye stocks.

Working Paper S2001-02: Pre-season run size forecasts for Fraser River sockeye and pink salmon in 2001

The Subcommittee accepted the forecasts as presented. The Fraser sockeye run size forecast for 2001 based on the 18 stocks considered in the working paper is 12.9 million at the 50% probability level and 6.8 million at the 75% probability level. The Fraser pink run size forecast for 2001 is 5.5 million at the 50% probability level and 4.0 million at the 75% probability level.

The Subcommittee recommended further assessment of the status of the Cultus Lake sockeye stock and small stocks not explicitly included in current forecasts.

The Subcommittee recommended an extremely cautious approach for management of the late summer run stock group in 2001.

The Subcommittee recommended that a PSARC working paper be prepared on the biological and management implications of the "late-run" mortality problem.

The Subcommittee recommended the development of biological reference points to provide a context for interpreting forecast returns of Fraser River sockeye and pink salmon.

Working Paper S2001-03: Pre-season 2001 stock size forecasts for Skeena River and Nass River sockeye salmon

The Subcommittee accepted the smolt model forecast return for Skeena sockeye and the 5-yr average model forecast return for Nass sockeye salmon. The 2001 Skeena sockeye forecast return is 2.8 million at the 50% probability level and 1.7 million at the 75% probability level. The 2001 Nass sockeye forecast return is 741,000 at the 50% probability level and 608,000 at the 75% probability level.

Working Paper S2001-04: Forecast for Southern British Columbia coho salmon in 2001

The Subcommittee accepted the marine survival forecasts, which are expected to remain poor for Strait of Georgia and Fraser-Thompson stocks.

The Subcommittee recommended acceptance of the abundance forecasts. For the West Coast of Vancouver Island coho, the forecast return in 2001 is 460,000 at the 50% probability level and 310,000 at the 75% probability level; for the Strait of Georgia/Fraser River stock aggregate in 2001 the forecast return is 560,000 at the 50% probability level and 430,000 at the 75% probability level; for the Interior-Fraser stock aggregates the forecast return is 24,000 at the 50% probability level and 23,000 at the 75% probability level; and for the Thompson River watershed is 18,000 at the 50% probability level and 12,000 at the 75% probability level.

Working Paper S2001-05: Early returning chinook salmon of the Fraser River watershed

The Subcommittee did not accept the paper. The Subcommittee noted that escapement data, while not indicative of a trend, are highly variable and numbers are small. In the absence of a status assessment, the Subcommittee recommended that expansions of fisheries impacts are highly inadvisable.

Working Paper S2001-06: Forecast for Northern British Columbia coho salmon in 2001

The Subcommittee accepted the Lachmach wild, and Toboggan Creek and Fort Babine hatchery coho marine survival forecasts.

The Subcommittee accepted the abundance forecasts for Lachmach and Toboggan Creek, and the Babine Lake and Area 6 aggregates.

Working Paper S2001-07: Review of 2000 chinook returns to the West Coast Vancouver Island, forecast of the 2001 return to the Stamp/ Robertson Creek hatchery indicator stock, and outlook for other WCVI chinook stocks

The Subcommittee accepted the forecasts of Stamp/Somass chinook salmon to the terminal area of Barkley Sound, determined in the absence of any Canadian fishing mortality. The 2001 forecast return is 13,200 at the 50% probability level and 11,600 at the 75% probability level.

The Subcommittee recommended that fishing mortality on WCVI chinook be minimized in 2001. Low escapements forecast to all WCVI streams represent a serious conservation concern for these populations. The Subcommittee noted that these conservation concerns are likely to persist beyond 2001 with future recovery highly dependent upon the survival projected for the 1998 brood (the return of age 3 chinook in 2001).

INTRODUCTION

The Subcommittee Chair opened the meeting welcoming the participants. During the introductory remarks the objectives of the meeting were reviewed, and the Subcommittee accepted the meeting agenda (Appendix 1).

The Subcommittee reviewed seven working papers. Working paper titles, authors and reviewers are listed in Appendix 2. The Subcommittee noted the attendance of external participants: Mary-Sue Atkinson and Murray Chatwin of the Pacific Fisheries Research Conservation Council, Wayne Harling and Gerry Kristianson of the B.C. Fish and Wildlife Federation; Les Rombough and Jim Jones of the Area D Salmon Gillnet Association; Barry MacPhee from the Heilsuk Tribal Council; Ken Wilson of the Fraser River Aboriginal Fisheries Research Conservation Council and James Walkus from Gwa'sala-'Nakwaxda'xw.

A full list of meeting participants is included as Appendix 3.

WORKING PAPER SUMMARIES, REVIEWS AND DISCUSSION

S2001-01: Trends in abundance and pre-season 2001 stock size forecasts for major sockeye, pink and chum salmon stocks in the central coast of British Columbia

D. Rutherford **Accepted subject to revisions**

Summary

The working paper included 2001 stock size forecasts for four sockeye, four pink, and four chum salmon stocks or stock groupings in the central coast region of British Columbia, statistical areas 7-10 (Table 1). The recommended forecasts

were based on simple models that have been reviewed previously by PSARC.

The recent 5-year average model was used to forecast sockeye salmon returns to the Atnarko River and Kimsquit Lake. For the Owikeno Lake (Rivers Inlet) and Long Lake (Smith Inlet) sockeye salmon stocks, as in 2000, the 5-yr average model was rejected in favour of the "like 1996 sea-entry" model. This model incorporates the measured effects of the recent extremely poor marine survival of these stocks and includes the possibility of continued poor survival. Forecasts of Owikeno and Long Lake sockeye salmon returns based on the alternative scenario of a return to average survival is also presented, however, the "like 1996 sea-entry" model is recommended to guide management decisions in 2001. The non-linear Ricker stock-recruitment model was used to forecast pink salmon returns to statistical areas 7-10. The long-term average model was used to forecast chum salmon returns to statistical areas 7-10.

Subcommittee Discussion

The Subcommittee noted that the forecast returns for Owikeno and Long Lake sockeye stocks for 2001 were updates of projected returns and assessments of these stocks presented in PSARC working paper S2000-20. The Subcommittee recognized that a serious conservation concern exists for central coast sockeye populations. Returns to sockeye populations in Areas 8-10 were at or near record low levels as a consequence of exceptionally poor marine survival in sea-entry years 1996 and 1998.

The most conservative 2001 forecast is the author's "Like 1996 sea-entry" model, that assumes a marine survival for age-four sockeye returning in 2001 similar to that observed for age-four sockeye returning in 1998-2000. The 5-yr mean model forecast for 2001 is only slightly higher because four of the five most recent years have been the lowest on record. However, the Subcommittee agreed with the author that marine survival for sockeye in sea-entry year 1999 may have improved given that the oceanographic and meteorological indicators for the northeast Pacific and coastal British Columbia have returned to near average conditions. If marine survival in 1999 returned to the long-term average, the Owikeno Lake sockeye return will exceed the target escapement in 2001 and 2002 because of the large escapement in 1997. This is not the case for Long Lake sockeye, where escapements have been low since 1995. The Subcommittee cannot advise statistically which of these scenarios is more likely to be correct but noted the asymmetrical consequence of error in in-season assessment and management decisions. Extremely poor returns in 1998-2000 clearly demonstrate the need for extreme caution during 2001. Even under the optimistic scenario, the Owikeno return will be below the target escapement for 2003 and below the provisional limit reference point (LRP) in 2004 due to recent low escapements. The Subcommittee noted that the possibility of relatively large Owikeno returns in 2001 and 2002 should be regarded as a rebuilding rather than a fishing opportunity. Accordingly, the Subcommittee again advised that harvest should remain at minimal levels to avoid compromising long-term recovery of central coast sockeye stocks.

The Subcommittee reiterated its concern about the continuing problem of obtaining reliable indices of abundance for central coast salmon stocks in general. In particular, the Subcommittee was concerned that estimates of pink and chum salmon stock sizes and escapements have been at record low levels since 1997 in Area 10, but not in Areas 7-9. The author speculated that, at least in part, these estimates reflect a reduction in escapement enumeration effort after 1996. Decreased effort or coverage during escapement enumeration will undermine the Department's ability to identify real conservation concerns, evaluate stock status, forecast recruitment, and evaluate various harvest opportunities unless corrected through appropriate calibration. The Subcommittee noted the importance of ensuring that monitoring, assessment, forecasting, and in-season fishery management activities are coordinated to provide information at an appropriate spatial scale.

Subcommittee Recommendations

1. The Subcommittee accepted the central coast B.C. sockeye, pink, and chum forecast probability distributions (Table 1). The forecasts for Owikeno and Long Lake sockeye are highly uncertain because there is not yet any compelling evidence to choose between the pessimistic "continue like 1996 sea-entry survival" and the optimistic "return to long-term average marine survival" scenarios.

2. The Subcommittee recommended no or minimal harvests of Owikeno and Long Lake stocks. Even under the optimistic scenario, returns would exceed target escapements to Owikeno only in 2001 and 2002, falling short of the target in 2003 and below the provisional LRP in 2004. Thus, increased returns in 2001 and 2002 provide a rebuilding rather than a fishing opportunity for Owikeno sockeye.

3. The Subcommittee recommended a cautious approach to the management of Area 8 sockeye stocks and Area 10 pink and chum salmon stocks due to their uncertain status and clear indications that, in recent years, they have shown abundance trends similar to Owikeno and Long lake sockeye stocks.

S2001-02: Pre-season run size forecasts for Fraser River sockeye and pink salmon in 2001

A. Cass **Accepted subject to revisions**

Summary

Forecasts were made for each of 18 individual sockeye stocks and four timing groups and for Fraser River pink salmon, all spawning populations combined (Table 2). Together the 18 sockeye stocks accounted for 93% of the estimated escapement to the Fraser River in 1997. Forecasts were not provided for a number of small stocks (including Taseko, Momich/Cayenne, Nahatlatch,

Harrison and Widgeon Slough sockeye) for which data quality is poor. Forecasts of adult returns were made using a variety of explanatory variables. For most stocks, forecasts were based on regression models that use spawning escapement to predict adult abundance of age-4 and age-5 sockeye. Additional explanatory variables were available for some stocks based on juvenile abundance estimates. Sibling models were not considered suitable candidate models for forecasting 2001 returns and have recently performed poorly compared to other models. The proportion of age-3 jack returns have undergone dramatic long-term declines that could not be explained by changes in abundance or growth rates.

Model performance was evaluated in a retrospective analysis by comparing the forecasts to the estimated (observed) returns for years that estimates were available. Starting with the most recent year that estimated returns were available (1999), a retrospective forecast for that year was made from the time series of explanatory variables by leaving out the most recent return data. In this way, retrospective forecasts for each year were based only on the time series available prior to the year being forecast. Retrospective comparisons were made for return years 1984-1999 (brood years 1980-1995). Forecast errors were quantified using the root mean square error (RMSE) criteria.

Adult returns of sockeye to the Fraser River on the 2001 cycle line are the highest of the four cycle lines averaging 15.9 million/ year (1980-97) compared to 9.3 million/year for the same period on the other three cycle lines combined. The major stocks on the 2001 cycle line in terms of abundance are Quesnel, Late Stuart and Chilko sockeye. Forecasts are provided at various probability levels of achieving specified run sizes by stock and run-timing group (Table 2). The forecast of sockeye at the 50% level for all stocks combined is 12.9 million fish (420,000 Early Stuart, 202,000 Early Summer, 11.7 million Summer and 530,000 Late Run). The Summer Run forecast accounts for 91% of the total sockeye forecast. The total forecast at the 50% probability level is nearly two times the forecast at the 75% level (6.8 million). For Quesnel and Late Stuart, the two largest stocks anticipated in 2001, the 50% forecast is 1.9 times the 75% level for Quesnel sockeye (7.8 versus 4.1 million) and 2.3 times for Late Stuart sockeye (1.9 million versus 800,000). The 2001 pink forecast at the 50% probability level is 5.5 million fish or about half of the long-term odd-year return of 10.5 million/yr (Table 2). The pink forecast at the 75% probability level is 4.0 million fish.

Reliability of forecasts ultimately depend on survival conditions that prevail in both freshwater and the marine environment. Migratory conditions in the Fraser River for the early-timed sockeye runs in 1997 (i.e. Early Stuart and Early Summer sockeye) were poor as a result of high river discharge rates. The effect of stress on survival of the progeny from those fish that spawned in 1997 is not known. Except for low egg-to-fry survival of Early Stuart sockeye at one of the two sites sampled, there is no evidence of anomalous freshwater conditions that signal low freshwater survival in the egg-to-fry stages where data exist (Early Stuart and Quesnel). There is, however, inadequate sampling throughout the watershed to reliably predict freshwater survival.

The recent intense El Ninos were associated with poor marine survival of Fraser sockeye in ocean entry years 1993 and 1997 and over-forecasts in return years 1995 and 1997. Oceanographic and meteorological conditions in the northeast Pacific returned to near normal values in 1999 (2001 age-4 ocean entry year). Off Vancouver Island, water temperatures were normal to slightly below normal and salinity was near normal or slightly above normal. Normal upwelling conditions prevailed in coastal areas in the summer of 1999. Concentrations of all major zooplankton in 1999 shifted to taxa representative of northern species compared to the period prior to 1998 associated with above average ocean temperatures and southern zooplankton species. There is little evidence based on oceanographic conditions that adverse marine sockeye survival conditions prevailed in ocean-entry-year 1999 of age-4 sockeye returning in 2001.

Fraser River pinks returning to spawn in 2001 entered the ocean as fry in 2000. Based on preliminary information on oceanographic condition that prevailed in 2000, there is no evidence to indicate adverse survival conditions.

Subcommittee Discussion

The Subcommittee noted that the forecast methods were unchanged from previous Fraser sockeye and pink forecasts. The Subcommittee noted that the forecasts for Fraser sockeye and pink salmon were not oriented toward identifying conservation concerns for small stocks. The Subcommittee repeated concerns from previous years that the tabulated list of stocks within timing groups did not have adequate resolution to determine if there were “small-stock” concerns.

Despite the aforementioned comments, the Subcommittee noted that the forecast of Cultus return (800, 50%CI: 400–2000) was only 3% of the long-term cycle mean return of 27,000. The Subcommittee noted that the Cultus population was at one time a significant component of the late summer stock group. There was extensive discussion of how serious the Cultus situation is, whether similar concerns might exist in other small or unproductive populations and what an appropriate recommendation should be from the Subcommittee given the lack of both reference points by population and of recent assessments. The Subcommittee noted that an important technical assessment issue yet to be resolved is how to elucidate stock status in the context of cyclic population sizes. To assist the comparisons of the forecasts with past stock performance, the Subcommittee requested additional information on overall mean returns for at least the forecasted stocks, and that this information be included in a revision and in future forecasts. This issue highlighted the concerns expressed in past forecast meetings of how the Subcommittee might interpret forecasts without the benefits of recent assessments and biological reference points.

The Subcommittee decided that an assessment of Cultus sockeye is required to elucidate, if possible, the reasons for the current critical situation. The Subcommittee noted that Cultus is part of the late summer timing group and is

affected by the unexplained early entry and high mortality problem that has occurred since as early as 1995 in this timing group. The Subcommittee decided that a working paper on management and biological implications of this problem is needed. The Subcommittee noted that those implications are most dire for stocks already depressed, such as Cultus. Further, the Subcommittee decided that a general investigation of the extent of conservation problems in other stocks is required.

Subcommittee Recommendations

1. The Subcommittee accepted the forecasts as presented (Table 2). The Fraser sockeye run size forecast for 2001 based on the 18 stocks considered in the working paper is 12.9 million at the 50% probability level and 6.8 million at the 75% probability level. The Fraser pink run size forecast for 2001 is 5.5 million at the 50% probability level and 4.0 million at the 75% probability level.

2. The Subcommittee recommended further assessment of the status of the Cultus Lake sockeye stock and small stocks not explicitly included in current forecasts should be assessed.

3. The Subcommittee recommended an extremely cautious approach for management of the late summer run stock group in 2001.

4. The Subcommittee recommended that a PSARC working paper be prepared on the biological and management implications of the “late-run” mortality problem.

5. The Subcommittee recommended the development of biological reference points to provide a context for interpreting forecast returns of Fraser River sockeye and pink salmon.

S2001-03: Pre-season 2001 stock size forecasts for Skeena River and Nass River Sockeye salmon

S. Cox-Rogers and L. Jantz **Accepted subject to revisions**

Summary

Run size forecasting is an important component of the management process for Skeena River (Area 4) and Nass River (Area 3) sockeye salmon. Two types of forecasts are used: a) pre-season estimates of total return, and b) in-season estimates of total return. Pre-season forecasts are generated well in advance of the fishing season, and are primarily used for expectation and planning purposes. In-season forecasts are generated during the fishing season, are based on actual return-year data, and are used for active management of the fishery. Of the two forecast types, the in-season estimates are the most important for management as they determine the number of salmon actually available for harvest. Pre-season forecasts provide general expectations, but are

not used for active management of the Area 3 or 4 fisheries.

Pre-season forecasts for Skeena River and Nass River sockeye were generated from simple methods assessed and recommended in previous working papers. The forecasting process is based on three guiding principles. First, the stocks being forecasted must be measurable. That is, forecasts should not be attempted where stock size cannot be measured with reasonable accuracy. Second, the forecasts should specify the probability of all possible run sizes, not just the point estimate. Third, the forecasts should be selected for their predictive power measured in retrospective analysis, not on how well the underlying models fit the historical data.

This working paper presented pre-season forecasts for Skeena River and Nass River sockeye returning in 2001 (Table 3). The basic forecasts developed in this working paper were all based on procedures that performed best in past assessments. Three forecasting models were used to forecast Skeena sockeye returns in 2001, and one forecasting model was used to forecast Nass sockeye returns in 2001. A composite likelihood method, which combines the estimates from the three forecasts for Skeena River returns into a single combined estimate, was also introduced.

Reviewer's Comments

The reviewer recommended the working paper be accepted subject to the authors addressing concerns about the forecast obtained using the new Bayes approach. The reviewer noted that all the other forecasts provided conformed to the required PSARC standards and format established in previous working papers. The reviewer also complimented the authors on a well written paper.

The reviewer agreed with the concept of using a Bayes model forecast and recommended that this method is worth pursuing. The reviewer could not, however, recommend the Bayes forecast to PSARC as the best forecast for 2001. In the written submission and oral presentation the reviewer raised several concerns about the Bayes approach. One concern was the author's assumption that the other three component forecasts that were used in the Bayes model were independent. The reviewer also questioned the assumption of a uniform distribution for the prior distribution required for the Bayes method. The other main concern the reviewer raised was the inclusion of component forecasts (like the 5-year average model forecast) that have already been discredited for other reasons.

The reviewer noted that all four forecasts for 2001 for Skeena sockeye were almost identical and so it really would not make much difference which forecast was recommended as the best forecast for 2001. However, the reviewer cautioned that acceptance by PSARC of the Bayes forecast as the preferred forecasting method could set a precedent that would have different and possibly greater implications in future years. The reviewer recommended that additional work was required on several issues (priors distribution, independence of

component forecasts, retrospective performance, etc.) to better understand the Bayes model forecasts before this model is adopted as the preferred forecast model for Skeena sockeye.

Subcommittee Discussion

The Subcommittee noted that the single model used to forecast Nass River sockeye, and three of the four models used to generate forecasts for Skeena River sockeye, all used PSARC-approved methods (Table 3). A fourth forecast for Skeena sockeye was also provided, based on a new Bayesian composite model that was introduced in this working paper. Due to the introduction of the new Bayesian model, a review was requested to provide comments prior to discussion of the working paper by the Subcommittee.

The Subcommittee discussed the working paper and the issues and concerns raised by the reviewer and generally agreed with these concerns. It was noted that the Bayes approach appears to be potentially a useful new approach for developing pre-season forecasts for Skeena River sockeye and encouraged the authors to continue developing and evaluating it. However, the Subcommittee was reluctant to accept this new Bayes model prior to completion of additional work required to investigate the effect and importance of key assumptions. The Subcommittee also wanted to see results from a retrospective analysis of performance of the Bayes model before endorsing it as the preferred forecasting method. After additional discussion it was agreed that this additional work could not be completed in time to allow adequate review by the Subcommittee at this PSARC meeting.

After reaching consensus that the Subcommittee could not endorse the Bayes forecast for Skeena sockeye, the discussion focused on which of the remaining three pre-season forecasts should be recommended. After discussion of the merits and problems associated with each of the alternate forecasts, it was agreed the smolt model forecast was the best forecast for Skeena River sockeye in 2001. The forecast from the 5-year average model was discredited due to the very high variance of the estimate that results from the poor smolt production in 1996 and 1997 from the Babine Lake Development Project due to parasite infections. After eliminating the 5-year average forecast, the Subcommittee agreed that the smolt model forecast was better than the alternate sibling model forecast because it was the lower of the two forecasts, and therefore was preferred as the most risk averse under the precautionary management approach. Concern was also raised that the sibling model forecast may be less reliable for 2001 because the high forecast for 2001 results almost entirely from an extrapolated (record high) projection of age-5 returns based on the strong age-4 return in 2000; in contrast, the forecast for age-4 returns is low because of weak jack returns in 2000.

In recommending the smolt model forecast for Skeena River sockeye in 2001 the Subcommittee agreed with the conclusion of the reviewer that the forecasts from all four models (5-year average, smolt, sibling and Bayes) were all very similar

and the variations between the estimates were not statistically significant. Therefore, the choice of the pre-season forecast for Skeena River sockeye in 2001 likely would not substantially affect either the pre-season planning or in-season management of fisheries that target on Skeena River sockeye in 2001. The Subcommittee accepted the single pre-season forecast for Nass River sockeye.

The Subcommittee also discussed the issue of the appropriateness of the current spatial scale of forecasts for Skeena River and Nass River sockeye, compared to the information required for conservation and management under the precautionary approach. The current pre-season forecasts encompass many stocks distributed over very large geographical areas. The main concern was that although all the pre-season forecasts indicated good overall run sizes for Nass and Skeena sockeye in 2001, the run sizes of some of the individual sockeye populations within these regions may not be as good. The Subcommittee concluded that the data currently available were not sufficient to allow pre-season forecasts for all the populations. However, it was noted that management actions are planned for 2001 to provide additional protection for some of the smaller populations that are currently of particular concern.

Subcommittee Recommendations

1. The Subcommittee accepted the smolt model forecast return for Skeena sockeye and the 5-yr average model forecast return for Nass sockeye salmon. The 2001 Skeena sockeye forecast return is 2.8 million at the 50% probability level and 1.7 million at the 75% probability level. The 2001 Nass sockeye forecast return is 741,000 at the 50% probability level and 608,000 at the 75% probability level.

S2001-04: Forecast for Southern British Columbia coho salmon in 2001

K. Simpson, D. Dobson, J. Irvine, L.B. Holtby, R.W. Tanasichuk
Accepted Subject to revisions

Summary

This working paper documents forecasts of marine survival, abundance and distribution for the coho salmon of southern British Columbia (interior Fraser including the Thompson River, lower Fraser, Strait of Georgia, and West Vancouver Island) for return year 2001.

Marine survival
Recommendations for the marine survival forecast for the five hatchery indicators and two wild coho indicators are given in the following table:

Indicator	Recommended Model	Predicted Survival in 2001 (50% CI)	Change (2001 forecast minus 2000 observed S)
Big Qualicum	LLY	0.020 (0.012-0.031)	0.000
Quinsam	3YRA	0.011 (0.008-0.014)	-0.006
Chilliwack	RAT3	0.014 (0.011-0.019)	-0.009
Inch	3YRA	0.012 (0.006-0.023)	-0.002
Black Creek	3YRA	0.026 (0.021-0.033)	0.004
Robertson:	Sibling, RCH	0.039 (0.026-0.059)	-0.037
	Euphausiid,RCH	0.040 (0.021-0.063)	-0.036
Carnation	Euphausiid,SF85	0.075 (0.052-0.101)	0.027
	Euphausiid, RCH	0.102 (0.066-0.143)	0.054

For populations around the Strait of Georgia, survivals are forecast to change very little. Survival will remain poor throughout southern B.C. and survival of the Black Creek wild stock is forecast to improve only marginally. None of the sibling models performed better than the statistical models. However, all the regressions predict better survivals, particularly in the lower Fraser.

Euphausiid and sibling survival forecasts are presented for Robertson Creek coho on the west coast of Vancouver Island. Bearing in mind that both badly under-forecast the 2000 survival of 7.6%, both predict a survival in 2001 that is similar to the mean 1990s survival and about half of last year's unusually large survival. Using an alternate estimate of Robertson escapements (see below) resulted in larger survivals in the time series, including a larger forecast, but the 2001 forecast remains in the same proportion to last year and the 10 year average. The wild Carnation Creek population has been added to the forecast this year. The forecast survival of 10.2% is a substantial increase over the 4.8% last year and is better than the 1990's average of 8.4%.

Abundance

Without fisheries information, forecasting abundance is highly problematic. Abundance in 2000 was estimated to be 560,000 for populations in the Georgia Basin, which is more than the upper 95% confidence limit for the forecasted abundance of 250,000. This year the best model is the Like Last Year (LLY) model, meaning the authors are forecasting no change in abundance, similar to the forecast for survivals. An abundance of 560,000 is 40% of the long term mean abundance of 1.4 million.

The estimated abundance of the West Coast Vancouver Island (WCVI) aggregate in 2000 (920,000) was extreme compared to the forecast (270,000; upper 99% confidence limit: 900,000). This was attributable to a very large escapement to the hatchery. Although there was also a large relative increase in the escapement to Carnation Creek, all the other escapement data for WCVI indicated only a slight improvement in abundance. This stimulated the authors to examine the effect of using Stamp Falls counts as an alternate estimate of Robertson escapement, which was known to have been underestimated before

2000 but to an unknown degree. Using Stamp Falls data the WCVI abundance estimate for 2000 was slightly higher (1.15 million) but the abundance estimates for 1999 and many preceding years increased even more when this data was used; so the increase in abundance estimates from 1999-2000, although still large, was about half the increase using hatchery escapements. Escapement in 2000 to the Somass system, including Robertson, was obviously large compared to most other WCVI areas. This occurrence highlights the vulnerability of WCVI forecasts, based on only one indicator. The forecast of WCVI abundance in 2001, based on the 3YRA of abundances, is for 460,000 (50% CI: 310,000 – 670,000). The 2000 estimate and 2001 forecast represent 175% and 84% of the long term mean abundances, respectively.

The forecast total abundance of Thompson River watershed coho in 2001 is 18,000, similar to the estimated abundance in the brood year and only about 20% of the long term mean abundance. The overall abundance of Thompson coho has not increased significantly in recent years, but spawner numbers are increasing. Escapements in 2000 and 1999 were both larger than brood year escapements. Greater proportions of fish surviving to maturity are returning to spawn because of the significant reductions in fishing pressure. Thus, assuming marine survivals and fishing pressures remain low, the outlook for Thompson and other interior Fraser coho is for slow but gradual improvement.

Distribution

In the hypothetical circumstance of historical patterns of fishing, the predicted proportion of catch inside the Strait of Georgia (p_{inside}) would be 0.70 (50%CI 0.60-0.78), which is a very strong inside distribution. There is less than a 1% chance of a moderate outside year occurring if that is defined as $p_{inside} < 0.3$.

Reviewers' Comments

The reviewers were generally in agreement and expressed a concern regarding the continued production of abundance estimates and forecast in the absence of significant fishery data. Forecasts using the three previous years were now completely based on the post-97 (fishery closure) data. Abundance estimates were based on hatchery returns, and the assumption that the hatchery-wild ratio was unchanged since some unspecified period over which old (pre-1997) data have been averaged. It seemed conceivable that the proportion of wild fish in the overall coho mix has changed over the last 20 years. If this were the case, then the current abundance estimates would be inaccurate. One reviewer suggested there was little point in making forecasts of quantities that cannot be estimated (especially since the forecasts were based on past abundance of unknown and unknowable quality or accuracy). The estimates of uncertainty for the abundance forecast was also questioned by a reviewer.

Subcommittee Discussion

The Subcommittee accepted the authors' forecast of marine survival rates (Figure 1), abundance (Figures 2 and 3) and distribution (Figure 4) as

summarized below.

Forecast Summary

Parameter	Thompson	Georgia Basin	WCVI
Marine survival		Poor (same as last year)	Above average (lower than last year)
Total Abundance	Poor (same as last year)	Poor (same as last year)	About average (lower than last year)
Distribution		Inside (change from last year)	

The Subcommittee expressed concern about the assumptions used to generate the abundance for all aggregates except the Thompson/Interior Fraser aggregate. The Subcommittee requested further assessment of the validity of the key assumptions, methods used to forecast aggregate abundance, and associated measures of uncertainty in revisions of the paper.

The Subcommittee agreed with the reviewers that there are large uncertainties in the forecast abundances of the Strait of Georgia and WCVI aggregates and this concern needs to be examined in detail.

Robertson Creek Hatchery data have been used to generate abundance estimates for the rest of WCVI coho but enumeration related problems have been identified. When returns to the hatchery are large, estimates of the return may be incomplete. This introduces bias in the exploitation and survival rates, particularly in recent years when exploitation was low. There is uncertainty as to the magnitude of the bias and this problem needs to be investigated.

The Subcommittee noted that the forecasts do not provide estimates of hatchery/wild composition. If forecasts of the hatchery contribution are required, this should be identified for future assessments.

The Subcommittee noted that the 2001 abundance forecast of WCVI coho is higher than the 2000 forecast but less than the estimated 2000 abundance. The Subcommittee noted that the WCVI abundance estimates and forecast were based solely on Robertson Creek hatchery estimated returns. The forecast for the WCVI aggregate is less certain because escapements of the wild stocks in 2000 did not increase in the same proportion as the Robertson and Carnation creek stocks.

The Strait of Georgia/Fraser River aggregate forecast abundance for 2001 is the same as 2000 and is at 15% of the mean abundance for the 1984-2000 period. The Subcommittee also noted that the forecast abundance for the Interior-Fraser River stock aggregate (coho originating above Hell's Gate, including the Thompson River) continues to be low and that there is little prospect for improvement based on the marine survival forecast. The Thompson River

forecast abundance is approximately 20% of the mean abundance for the 1984-2000 period.

The Subcommittee noted that the historical relationship between salinity and distribution of coho catches (inside/Georgia Strait vs. outside/WCVI) indicates that the year 2001 will be a strong inside year. Due to lack of catch information for the last three years the model predictions could not be quantitatively assessed but were qualitatively confirmed. It was also noted that a significant proportion of Thompson coho has been caught outside the Strait in years of inside distributions. The Subcommittee noted that the forecast distribution is important to management of coho mortality and that the forecast is markedly different from distributions in the recent past.

Subcommittee Recommendations

1. The Subcommittee accepted the marine survival forecasts, which are expected to remain poor for Strait of Georgia and Fraser-Thompson stocks.

2. The Subcommittee accepted the abundance forecasts. For the West Coast of Vancouver Island coho, the forecast return in 2001 is 460,000 at the 50% probability level and 310,000 at the 75% probability level; for the Strait of Georgia/Fraser River stock aggregate in 2001 the forecast return is 560,000 at the 50% probability level and 430,000 at the 75% probability level; for the Interior-Fraser stock aggregates the forecast return is 24,000 at the 50% probability level and 23,000 at the 75% probability level; and for the Thompson River watershed is 18,000 at the 50% probability level and 12,000 at the 75% probability level.

S2001-05: Early returning chinook salmon of the Fraser River Watershed

R.E. Bailey, J. Irvine, J. Candy, C.K. Parken, S.L. Lemke, M. Sullivan, M. Wetklo **Paper Not Accepted**

Subcommittee Discussion

The Subcommittee was not able to provide advice on the status of the early returning stocks based on the data, analyses, and conclusions of the paper. The Subcommittee did note that the authors presented an informative compendium of information such as recent catch and escapement data. The Subcommittee discussions centered largely on data gaps and the difficulty of drawing conclusions regarding the status of these four stocks.

The Subcommittee concluded that a definitive stock assessment based on available stock and recruitment data is not likely to be achievable. The Subcommittee encouraged the continued development of an alternate approach such as those based on habitat capacity.

Subcommittee Recommendations

The Subcommittee noted that escapement data, while not indicative of a trend, are highly variable and numbers are small. In the absence of a status assessment, the Subcommittee recommended that expansions of fisheries impacts are highly inadvisable.

S2001-06: Forecast for Northern British Columbia coho salmon in 2001

B. Holtby, and B. Finnegan **Accepted subject to revisions**

Summary

This working paper documents forecasts of marine survival and abundance for the coho of selected areas of northern British Columbia including the upper Skeena conservation area.

Marine survival:

In 2001, marine survival at the three northern indicators is expected to be well above the means of their respective periods of observation.

Indicator	model	$\hat{S}_{2001}$	(50% CI)	observed mean and period of observation (year of sea-entry)	
Lachmach	sibling regression	0.29	(0.23–0.35)	0.098	(1987 – 1999)
Toboggan Creek hatchery	from Lachmach	0.09	(0.05–0.14)	0.036	(1987 – 1999)
Fort Babine hatchery	from Lachmach	0.08	(0.04–0.15)	0.023	(1993 – 1999)

The period of observation is short for all three indicators (Figure 5). The survival rate of wild Toboggan Creek coho should be comparable to Lachmach but cannot be reliably forecast.

Abundance forecast:

The forecast total return of Lachmach coho is 3,500 (50%CI: 2,800-4,200) which is above the mean of 2,700 observed over the period 1988 to 2000. Smolt production at Lachmach has remained modest. Estimated smolt production in 2000 of 14,000 was well below the observed mean of 32,000 (1987 – 1999). Therefore, the above average forecast for Lachmach is due to the very high forecast survival rather than to large smolt production. In contrast, the estimated wild smolt production from Toboggan Creek in 2000 was 89,000, indicating high freshwater survival. Assuming that wild survival will be 1.7 times that of the forecast survival for hatchery coho (the same expansion observed for the 2000 return) the total return of wild Toboggan coho could be 13,000, which is well above the 1988-2000 mean of 4,700. Assuming that the exploitation rate in 2001 is unchanged from 2000 the forecast wild escapement to Toboggan is 8,100, which is well above the 1988-2000 mean of 2,000.

After the application of stock-recruitment and time-series models to reconstructions of abundance in the Babine Lake aggregate and the Area 6 average-stream, the authors conclude the following about abundance in 2001 (Figures 6 and 7):

	proportions of observed abundance and escapement less than forecasts‡		
Aggregate	abundance	Escapement	characterization of forecast abundance
Area 6	0.08	0.25	well below average
Babine	0.33	0.49	average

‡ Assuming a log-normal cumulative probability distribution with mean and standard deviation calculated over the observation period 1950 (1946 for Babine) to 2000 (return years).

Caution remains warranted in the conduct of northern B.C. coho fisheries because Area 6 coho continues to be depressed. There are also some indications that high-interior Skeena coho, specifically the Sustut, have not recovered, as has the Babine aggregate. However, with expectations of well above average survivals at the Area 3 indicator, similarly high survivals at the two upper Skeena hatchery indicators and strong forecast returns in all areas but Area 6, we conclude that the conservation concerns of the past decade are considerably reduced.

Subcommittee Discussion

The Subcommittee accepted the forecasts of marine survival and abundance for Area 3, Upper Skeena, the Babine Lake aggregate, and the Area 6 aggregate. The Subcommittee noted however that forecasts produced for the last two years for Statistical Areas 1 to 3, 5, and 7 to 10 were not prepared for 2001 because visual escapement estimates for this year were not available. The Subcommittee was informed by the authors that a paper was in preparation for the next Subcommittee meeting that will consider the stock status for Areas 1 and 2 (Queen Charlotte Islands).

The Subcommittee noted that survival and abundance forecasts were above average for Lachmach (Area 3), well above average for Toboggan (Upper Skeena), average for the Babine aggregate, and well below average for the Area 6 aggregate. The Subcommittee agreed with the authors that caution in management of fisheries was warranted to foster recovery of depressed northern B.C. coho stocks, particularly those in Area 6. The severe conservation concern that the Subcommittee expressed for the previous three years has been reduced for the Skeena stocks due to continuing improvement in returns in 2000 and forecasts of improved marine survival and abundance for 2001. The above average marine survival forecasts were close to or outside of levels previously seen and the Subcommittee suggested caution in their use in the development of fishing plans. In-season assessment, which includes early Alaskan fishery performance, should continue to be used to assess run strength.

The Subcommittee agreed that caution remains warranted in the conduct of northern B.C. fisheries that intercept northern B.C. coho. Exploitation remains high in Alaskan waters, Area 6 coho continues to be depressed, and some high-interior Skeena coho, specifically the Sustut River stock, have not recovered as well as the Babine aggregate.

Subcommittee Recommendations

1. The Subcommittee accepted the Lachmach wild, and Toboggan Creek and Fort Babine hatchery coho marine survival forecasts.

2. The Subcommittee accepted the abundance forecasts for Lachmach and Toboggan Creek, and the Babine Lake and Area 6 aggregates.

S2001-07: Review of 2000 chinook returns to the West Coast Vancouver Island, forecast of the 2001 return to the Stamp/ Robertson Creek hatchery indicator stock, and outlook for other WCVI chinook stocks

B. Riddell, W. Luedke, J. Till, and R. Ferguson **Accepted subject to revisions**

Summary

The intensive assessments and resulting abundance forecasts of the Robertson Creek Hatchery (RCH) and Stamp River chinook are undertaken annually for management of ocean and terminal fisheries, and as an indicator of the expected returns to the naturally spawning chinook populations along the west coast of Vancouver Island (WCVI). Forecasts presented in this paper indicate a continued conservation concern for naturally spawning WCVI chinook in 2001. This situation results from three consecutive years of poor marine survivals for the 1995 through 1997 brood years (Figure. 8). Improved Age-2 male returns to Robertson Creek Hatchery in 2000 indicate improved marine survival for the 1998 brood year.

Review of return of the WCVI chinook in 2000

The 2000 terminal return of chinook to the Stamp River/RCH indicator stock was estimated to be 6,440 adult (age 3 and older) chinook, plus 2,970 age 2 males (jacks). The adult return was an 80% decline from the 1999 terminal return.

Returns to another 22 WCVI streams that were monitored for chinook spawning escapements also declined considerably from 1999 levels. Over all these systems, the decline averaged 60%. The overall age composition was very similar to that in the Stamp River/RCH terminal run.

Forecast for the 2001 terminal return of the WCVI chinook

The forecasting methods applied have been reviewed and accepted previously by PSARC. For 2001, the forecasted total return of Stamp River/RCH chinook to

the terminal area of Barkley Sound and Alberni Inlet is estimated to be 14,200 based on averaging the forecast models. The mean absolute percent error in the average forecast (1985-2000 returns) has increased to 15%. The age structure of the 2001 return is projected to be 78% Age 3, 9% Age 4, and 13% Age 5 with an expected sex ratio of 20% females. At this time, the forecast only assumes fishing mortality in Southeast Alaska (SEAK). Harvest rate factors in SEAK were based on the Pacific Salmon Treaty agreements and we initially used a harvest rate scalar of 0.5 in SEAK troll fishery. The remaining cohort is identified as the expected terminal run assuming no fishing mortality on this stock in Canada. A comparison of the 2000 forecast, observed terminal run in 2000, and the forecast for 2001 is presented in Table 4. A slightly more conservative terminal run is predicted if the forecast is expressed as a cumulative probability distribution. Based on the annual deviations from forecasts observed between 1988 and 2000, the 50% value of the cumulative distribution is 13,200 chinook in the terminal run and the 50% confidence interval is 11,600 to 15,100 adult chinook.

Overall, returns are expected to increase by more than double relative to 2000, due to the expected large Age-3 component. However, the number of females, and resulting eggs, will decrease by an expected 25% from the 2000 level. The resulting level of egg deposition to the Stamp River/RCH will be substantially below the base period level (approximately 20% of base). The expected number of eggs would be the lowest on record since 1985, when the indicator stock program began.

The more serious concern for conservation is the expected run size to the naturally spawning chinook populations along the WCVI. The 2001 outlook in the WCVI indicator streams assumes a 120% increase from 2000 levels and expected 20% female component in the total return. The results indicate that many chinook populations along the WCVI will have less than 100 females (Table 5) in the 2001 spawning escapement.

Subcommittee Discussion

The Subcommittee noted that the total chinook forecast return (if realized) to the Stamp/Somass river system in 2001, expressed in terms of eggs potentially available for incubation, would be the lowest on record since 1985. Assuming no fishing mortality in Canada on this stock, the predicted 2001 terminal run to the Stamp River/RCH is 13,200 chinook. The age structure of the return is projected to be 78% age 3, 9% age 4, and 13% age 5. The Subcommittee noted that while the forecast indicates the 2001 Stamp River/RCH will be more than double the 2000 return, only 20% will be females. The resulting number of females will actually decrease about 25% relative to 2000 returns of females. This is due to the poor returns of two consecutive age classes, age 4 (1997 brood) and age 5 (1996 brood). However, the decrease would be much larger if not for a good return of age 3 chinook, of which about 7% is female.

The Subcommittee emphasized the serious conservation concern for the naturally spawning chinook populations along the WCVI. Escapements

averaged over all the naturally spawning indicator stocks declined about 60% from 1999 to 2000. Declines in the extensive escapement indicators generally reflected returns in the Stamp River indicator. The Subcommittee noted the 2001 outlook in selected WCVI indicator streams assumes a 120% increase from 2000 levels and expected 20% female component in the total return. The results show many chinook populations along the WCVI with less than 100 females. The Subcommittee noted the future recovery of these stocks will be highly dependent upon the survival projected for the 1998 brood (the return of age 3 chinook in 2001). Improved survival is forecast based on jack returns to the Stamp/RCH; however, jacks are very difficult to enumerate in natural systems.

Subcommittee Recommendations

1. The Subcommittee accepted the forecasts of Stamp/Somass chinook salmon to the terminal area of Barkley Sound, determined in the absence of any Canadian fishing mortality. The 2001 forecast return is 13,200 at the 50% probability level and 11,600 at the 75% probability level.

2. The Subcommittee recommended that fishing mortality on WCVI chinook be minimized in 2001. Low escapements forecast to all WCVI streams represent a serious conservation concern for these populations. The Subcommittee noted that these conservation concerns are likely to persist beyond 2001 with future recovery highly dependent upon the survival projected for the 1998 brood (the return of age 3 chinook in 2001).

APPENDIX 1: PSARC SALMON SUBCOMMITTEE MEETING AGENDA FEBRUARY 27-MARCH 2, 2001

PSARC Salmon Subcommittee Meeting
Re: Return Forecasts/Assessments
Feb 27 – Mar 2, 2001
Seminar Room, PBS, Nanaimo

Tuesday Feb 27, 13:00

Introductions and procedures
Fraser River Sockeye (A. Cass)
Central Coast Sockeye, Pink, and Chum (D. Rutherford)

Wednesday Feb 28, 10:30

Skeena and Nass Sockeye (S. Cox-Rogers and L. Jantz)
Northern B.C. Coho (B. Holtby et al)
Southern B.C. Coho (K. Simpson et al)
Review of rapporteur reports

Thursday Mar 1, 09:00

Early Returning Fraser Chinook (R. Bailey et al)
West Coast Vancouver Island Chinook (B. Riddell et al)
Review of rapporteur reports

Friday Mar 2, 08:30

Review of rapporteur reports

APPENDIX 2: PSARC SALMON WORKING PAPERS FOR FEBRUARY 27-MARCH 2, 2001

Paper #	Title	Authorship
S2001-01	Trends in abundance and pre-season 2001 stock size forecasts for major sockeye, pink and chum salmon stocks in the central coast of British Columbia	D. Rutherford
S2001-02	Pre-season run size forecasts for Fraser River Sockeye and pink salmon in 2001	A. Cass
S2001-03	Pre-season 2001 stock size forecasts for Skeena River and Nass River sockeye salmon	S. Cox-Rogers L. Jantz
S2001-04	Forecast for Southern British Columbia coho salmon in 2001	K. Simpson D. Dobson J. Irvine B. Holtby R.W. Tanasichuk
S2001-05	Early returning chinook salmon of the Fraser River watershed	R.E. Bailey J. Irvine J. Candy C.K. Parken S.L. Lemke M. Sullivan M. Wetklo
S2001-06	Forecast for Northern British Columbia coho salmon in 2001	B. Holtby B. Finnegan
S2001-07	Review of 2000 chinook returns to the west coast Vancouver Island, forecast of the 2001 return to the Stamp / Robertson Creek Hatchery indicator stock, and outlook for other WCVI chinook stocks	B. Riddell W. Luedke J. Till R. Ferguson

List of Reviewers

M. Bradford	DFO, Simon Fraser University, MEHS
L. Godbout	DFO, PBS, Stock Assessment
M. Folkes	DFO, PBS, Stock Assessment
W. Luedke	DFO, South Coast, Stock Assessment
C. Wood	DFO, PBS, Stock Assessment

APPENDIX 3: PARTICIPANTS AT THE SALMON SUBCOMMITTEE MEETING, FEBRUARY 27-MARCH 2, 2001

Subcommittee Chair: Allan Macdonald
PSARC Chair: Max Stocker

DFO Participants	**Tues**	**Wed**	**Thurs**	**Fri**
* Subcommittee Members				
Anderson, D.*	✓			
Bradford, M.*	✓	✓		
Candy, J.			✓	
Cass, A. *	✓			
Cook, R.	✓			
Cox-Rogers, S.	✓	✓	✓	
Gjernes, T.			✓	
Goudbout, L.	✓	✓	✓	
Hargreaves, B.*	✓	✓		✓
Holtby, B.*	✓	✓	✓	✓
Irvine, J.*	✓	✓	✓	✓
Jantz, L.*	✓	✓	✓	
Johnston, T for A. Tautz*	✓	✓	✓	
Lemke, S.		✓	✓	
McNicol, R.			✓	
Meerburg, D.*	✓	✓	✓	✓
Nagetaal, D.		✓	✓	
Parken, C.	✓	✓	✓	
Riddell, B.*	✓	✓	✓	✓
Rutherford, D.	✓	✓	✓	
Sullivan, M.*	✓	✓	✓	✓
Wood, C.*	✓	✓	✓	
External Participants:				
Atkinson, M.		✓	✓	
Chatwin, M.	✓			
Harling, W.	✓		✓	
Jones, J.	✓	✓	✓	
Kristianson, G.		✓		
MacPhee, B.	✓	✓		
Rombough, L.	✓			
Walkus, J.	✓	✓		
Wilson, K.	✓	✓	✓	
Observers:				
Blackbourn, D.	✓	✓	✓	
Cardinal, N.	✓	✓	✓	
Chow, S.	✓		✓	
Scarfo, C.	✓	✓	✓	
Webb, L.	✓			

TABLES AND FIGURES

Table 1 . Summary of pre-season stock size forecasts for 2001. Bold print is used to flag stock size forecasts that are well below escapement targets in stocks whose status has been reviewed previously by PSARC.

Species	Statistical Area	River or Lake	Escapement Target	Forecasts for reference probabilities[a] 25%	50%	75%	90%	Forecasting Model
Sockeye	8	Atnarko	75,000	40,400	29,700	21,800	15,600	5-yr average
	8	Kimsquit	30,000	16,000	6,800	2,900	1,200	5-yr average
	9	Owikeno	200,000	124,600	**39,000**	12,300	3,500	5-yr average
	9	Owikeno	200,000		240,000			Optimistic
	9	Owikeno[c]	200,000		**5,600**			Like 1996 sea-entry
	10	Long	200,000	58,600	**16,600**	4,700	1,200	5-yr average
	10	Long	200,000		**27,000**			Optimistic
	10	Long[c]	200,000		**1,800**			Like 1996 sea-entry
Pink	7	all	440,720	602,000	370,000	227,000	144,000	Ricker[b]
	8	all	1,475,400	1,498,000	1,394,000	866,000	558,000	Ricker[b]
	9	all	342,450	291,000	180,000	111,000	71,000	Ricker[b]
	10	all	65,600		<1,000			Ricker[b]
Chum	7	all	311,950	551,000	373,000	252,000	176,000	average
	8	all	267,450	647,000	434,000	291,000	201,000	average
	9	all	150,700	75,000	43,000	25,000	15,000	average
	10	all	98,500	61,000	34,000	18,000	11,000	average

[a] probability that the actual stock size will exceed the specified forecast

[b] NLSRESC model of Wood et. al. (1995)

[c] recommended forecast for management decisions.

Table 2. Pre-season sockeye and pink salmon run size forecasts for 2001 by stock/timing group and probability level.

stock/timing group	mean run size[b]		Probability of Achieving Specified Run Sizes[a]				
	all cycles	2001 cycle	25%	50%	75%	80%	90%
Early Stuart	**341,000**	**918,000**	**682,000**	**420,000**	**258,000**	**229,000**	**167,000**
Early Summer	**410,000**	**322,000**	**392,000**	**202,000**	**107,000**	**89,500**	**61,000**
Fennell	20,000	14,000	50,000	26,000	14,000	12,000	8,000
Bowron	44,000	28,000	39,000	22,000	13,000	11,000	8,000
Raft	25,000	19,000	42,000	21,000	11,000	9,000	6,000
Gates	44,000	40,000	62,000	32,000	17,000	14,000	10,000
Nadina	45,000	82,000	23,000	12,000	6,000	5,000	3,000
Pitt	67,000	89,000	113,000	62,000	34,000	29,000	20,000
Seymour	128,000	27,000	16,000	9,000	5,000	4,500	3,000
Scotch	37,000	23,000	47,000	18,000	7,000	5,000	3,000
Mid Summers	**3,653,000**	**6,885,000**	**22,560,000**	**11,714,000**	**6,159,000**	**5,262,000**	**3,489,000**
Chilko	1,418,000	861,000	2,465,000	1,578,000	1,010,000	904,000	676,000
Quesnel	1,219,000	3,908,000	14,974,000	7,839,000	4,104,000	3,496,000	2,292,000
Stellako	454,000	245,000	733,000	424,000	245,000	214,000	150,000
Late Stuart	562,000	1,871,000	4,388,000	1,874,000	800,000	648,000	372,000
Late Summer	**2,852,000**	**943,000**	**1,026,000**	**528,000**	**273,000**	**232,000**	**152,000**
Birkenhead	375,000	324,000	444,000	247,000	138,000	119,000	81,000
Late Shuswap	2,061,000	29,000	11,000	6,000	3,000	2,000	2,000
Cultus	64,000	27,000	2,000	800	400	300	200
Portage	40,000	43,000	189,000	86,000	40,000	33,000	20,000
Weaver	312,000	520,000	382,000	188,000	93,000	78,000	49,000
TOTAL	**7,256,000**	**9,068,000**	**24,660,000**	**12,864,000**	**6,797,000**	**5,812,500**	**3,869,000**
PINKS	**-**	**10,467,000**	**7,384,000**	**5,468,000**	**4,049,000**	**3,759,000**	**3,090,000**

[a] probability that the actual run size will exceed the specified projection

[b] cycle line means are computed over the range of the time series except for stocks with spawning channel supplemention. Channel startup years were Nadina (1968), Gates (1973) and Weaver (1965).

Table 3. Summary of pre-season forecasts for Skeena River sockeye salmon stock size in 2001 from the three alternative models, and the composite Bayesian estimate. The target escapement is 1,159,000 sockeye. The recommended forecast is the Smolt estimate.

Model	Brood Year	Forecasts for reference probabilities (1) 5%	10%	25%	**50%**	75%	90%	95%
5-yr mean	All Combined	14,927,614	9,094,959	4,719,787	**2,556,634**	1,384,888	718,681	437,871
Smolt	1996				1,727,459			
	1997				1,081,847			
	1996+1997	9,513,929	7,185,329	4,575,394	**2,809,306**	1,724,923	1,098,377	829,542
Sibling	1996				3,545,029			
	1997				196,336			
	1996+1997	10,197,771	8,099,574	5,589,160	**3,741,364**	2,504,456	1,728,215	1,372,634
Bayes		9,585,988	7,457,367	4,937,183	**3,140,000**	1,997,009	1,322,129	1,028,543

(1) probability (chance) that the actual stock size will meet or exceed the specified forecast

Table 4. Forecast and terminal run to Robertson Creek Hatchery and Somass River chinook salmon in 2000 and for 2001 (forecasts are not made for Age 2 chinook).

	2000 Forecast	2000 TermRun	2001 Forecast
Age 2	na	2,970	na
Age 3	*1,330*	*990*	11,000
Age 4	*5,100*	*3,040*	1,350
Age 5+	*3,500*	*2,420*	1,850
Total	*9,930*	*6,450*	14,200

Table 5. Forecast for 2001 total escapement and female spawners in selected WCVI indicator streams assuming changes equal to the Robertson Creek indicator stocks (a 120% increase from 2000 levels and expected 20% female component) in the total return.

AREA	RIVER	2000 adults	2001 adults	2001 females
20	San Juan River	370	820	160
21	Gordon River	19	40	10
22	Nitinat River	8685	19,190	3,840
23	Sarita River	301	670	130
23	Nahmint River	68	150	30
23	Toquart River	100	220	40
24	Bedwell River	143	320	60
24	Megin River	160	350	70
24	Moyeha River	94	210	40
25	Burman River	212	470	90
25	Gold River	500	1,110	220
25	Conuma River	9970	22,030	4,410
25	Leiner River	182	400	80
25	Tahsis River	1320	2,920	580
25	Zeballos River	200	440	90
26	Kaouk River	105	230	50
26	Artlish River	75	170	30
26	Tashish River	391	860	170
27	Marble River	2575	5,690	1,140
27	Colonial / Cayeghle	600	1,330	270

Figure 1. Marine survivals vs. return year for six coho indicators in southern British Columbia. Robertson survival is calculated only from CWT returns to the hatchery. Forecasts for 1999 to 2001 are shown with associated 50% confidence intervals

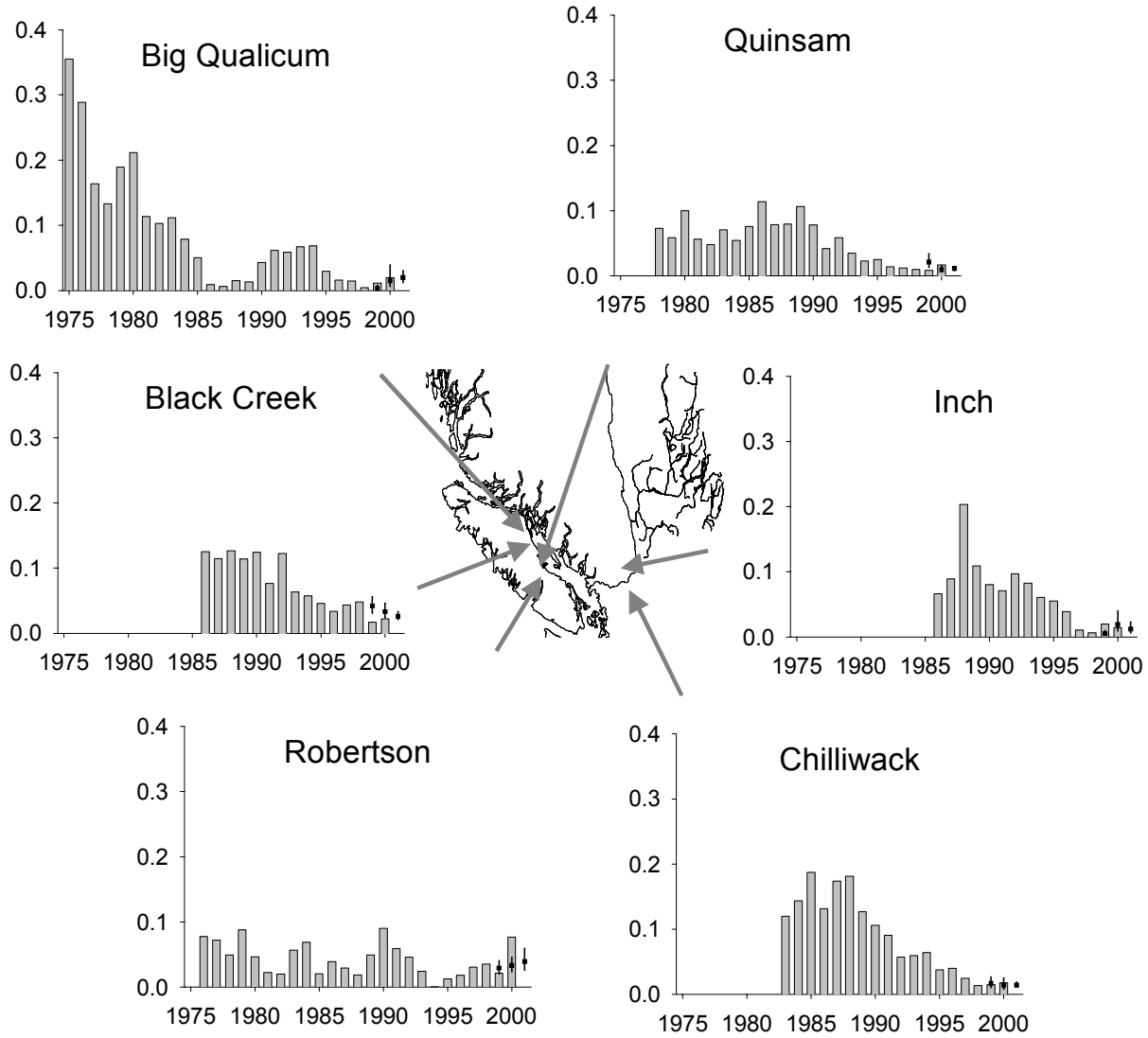
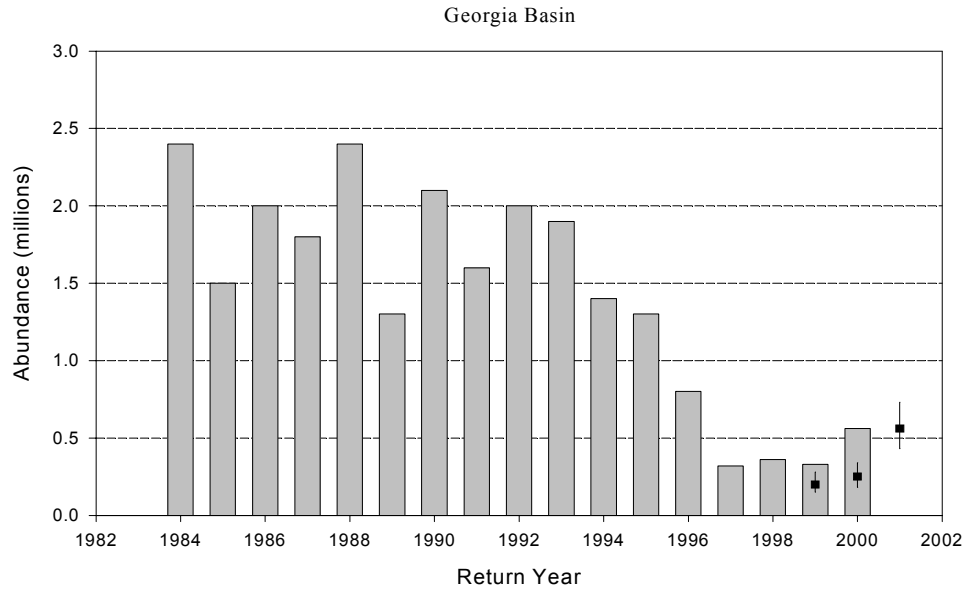


Figure 2. Abundance estimates for the Strait of Georgia+Fraser aggregates and the West Coast of Vancouver Island aggregate of southern British Columbia coho. Two methods of estimating WCVI abundances are shown. 1994 WCVI estimates are obviously wrong (escapements and catch were near zero that year) and this year was not included in time series analyses. The forecast abundances for 1999 to 2001 with associated 50% CI's are shown for both aggregates.



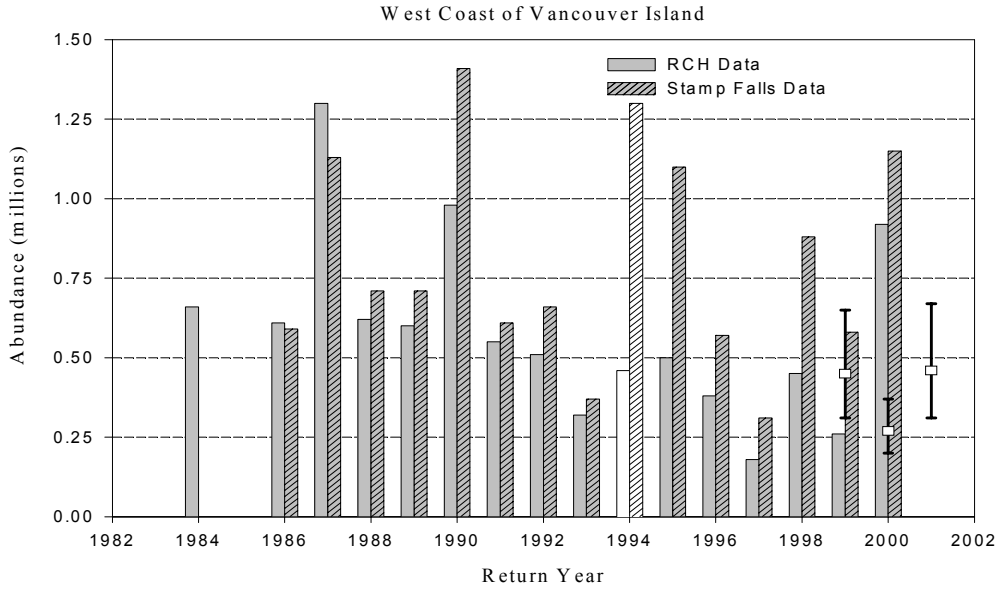


Figure 3. Estimated total abundance of Thompson River watershed coho from 1984 to 2000. The forecast for 2001 with associated 50% CI are shown.

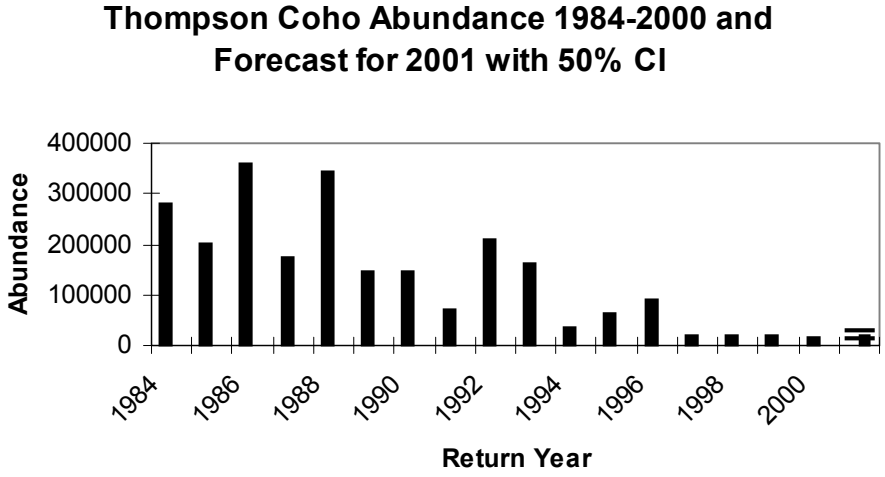


Figure 4. Predicting p_{inside} for 2001 using average Chrome Island and the Sisters February salinities. The lower panel is the predictive relationship. The upper panel is the probability distribution for the point predictions. A February salinity of 29.5 was used.

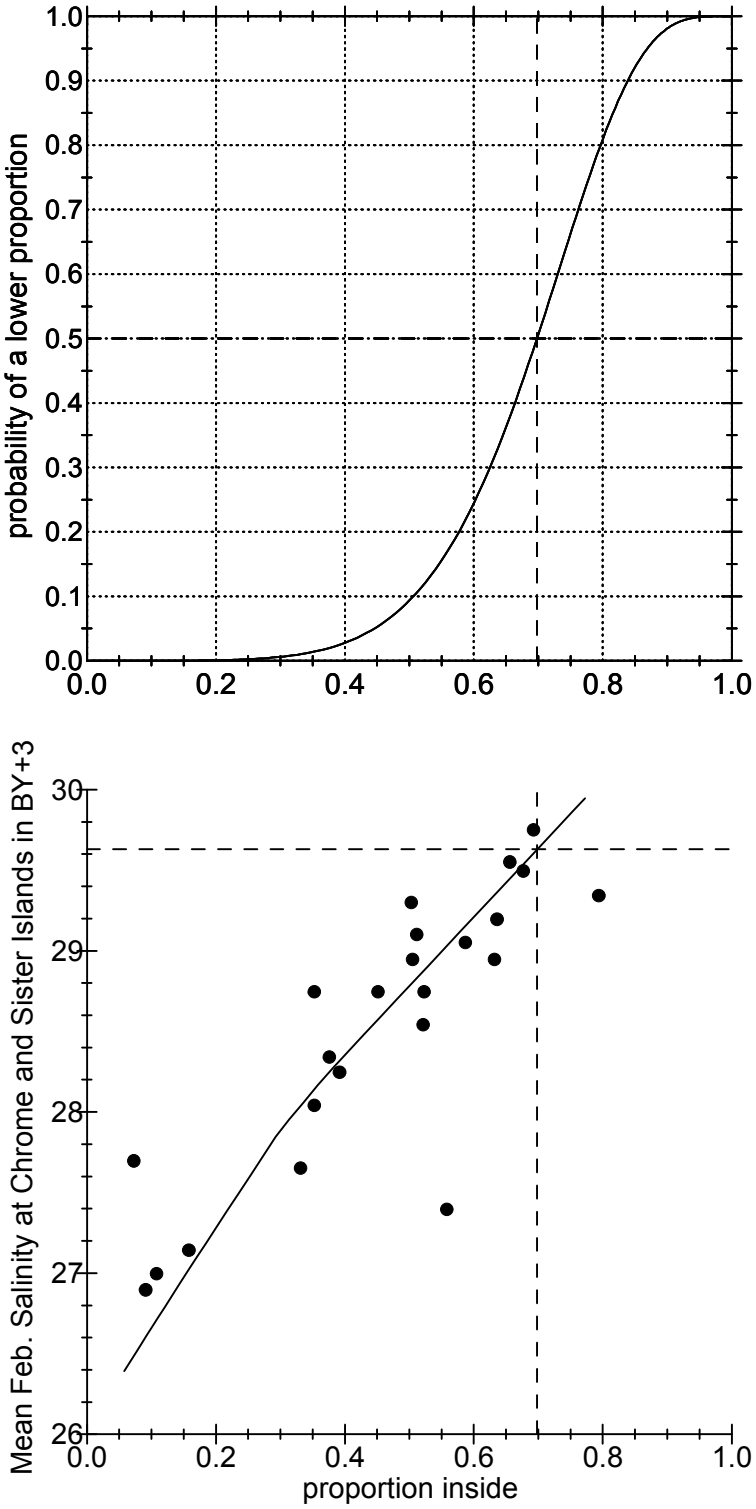


Figure 5. Time series of standardized survivals for three northern B.C. coho indicators. Forecast survivals for 2001 are shown with 50% confidence intervals to the right of the plot.

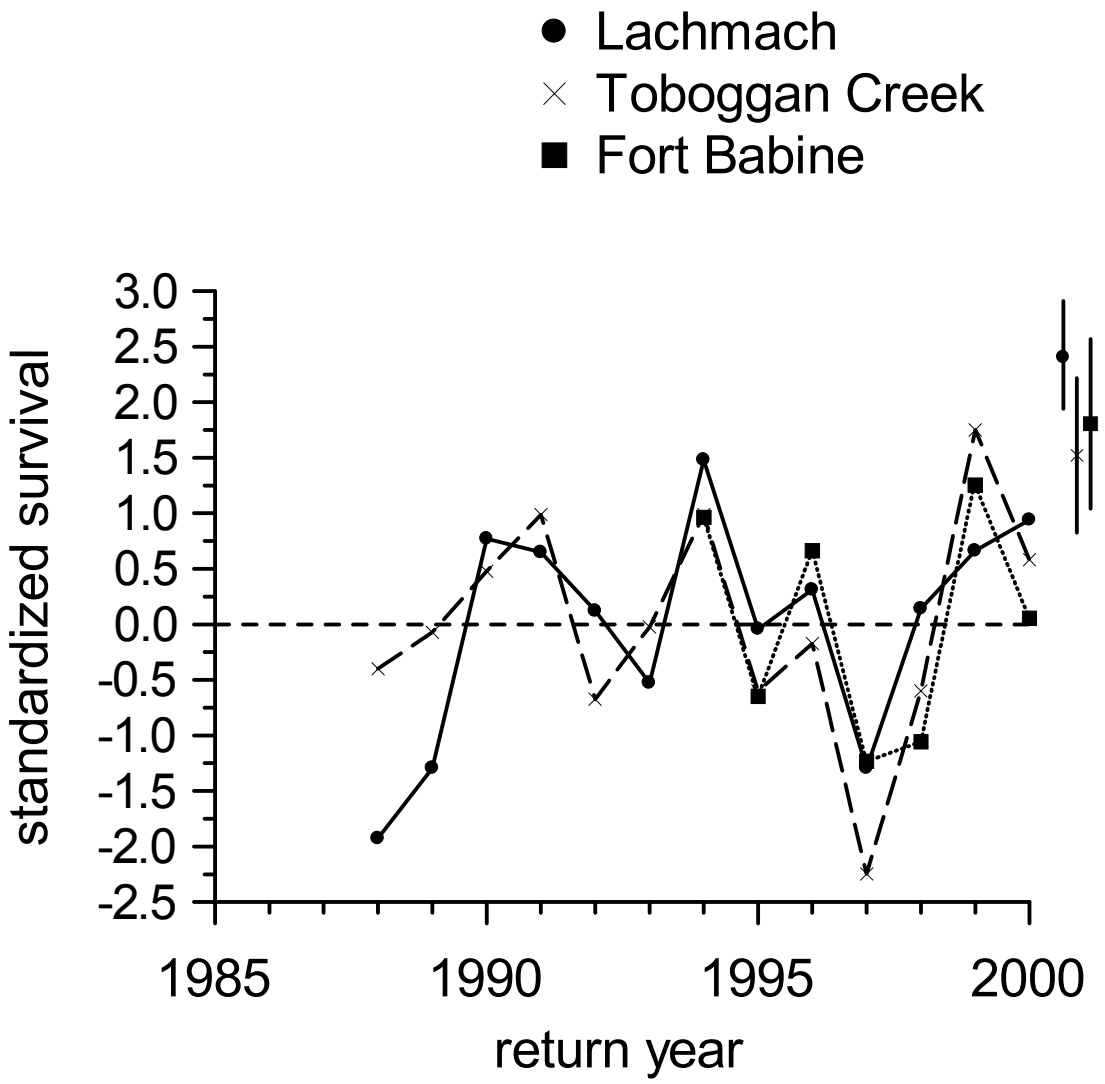


Figure 6. Forecast of total return of the Babine Lake coho aggregate in 2001. The S-R and 3YRA forecasts with 50% CI are shown to the right of the graph.

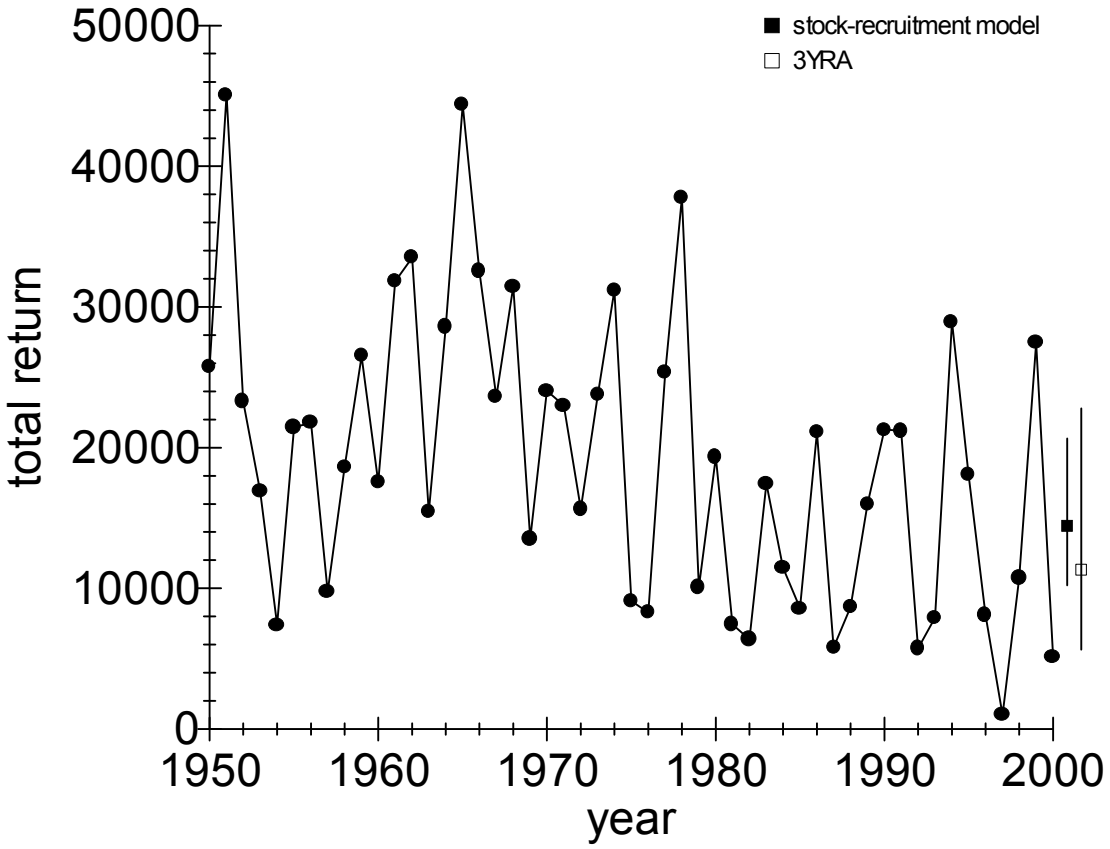


Figure 7. Total return to the average stream in Area 6. The S-R and 3YRA forecasts for 2001 with associated 50% CI are shown to the right of the graph.

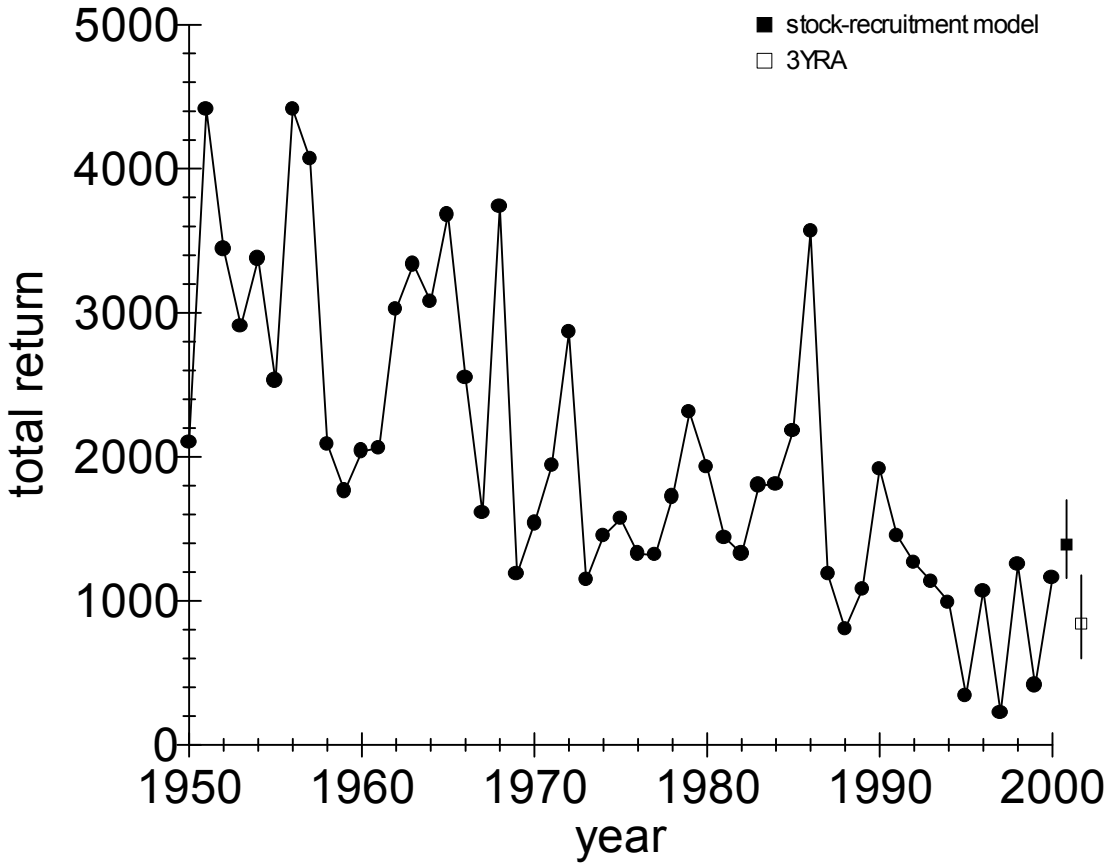


Figure 8. Time series of marine survival estimates for chinook smolts released from Robertson Creek Hatchery, 1983 –1998 brood years. Survival is estimated to Age-2 pre-fishery recruitment.