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**Proceedings of the PSARC Salmon Subcommittee Meeting October 16, 2003**

**Compte rendu de la réunion du sous-comité du CEESP sur le saumon tenue le 16 octobre 2003.**

**October 16, 2003
Nanaimo, B.C.**

**Ron Tanasichuk
Salmon Subcommittee Chair**

Fisheries and Oceans Canada
Pacific Scientific Advice Review Committee
Pacific Biological Station
Nanaimo, British Columbia V9T 6N7

**October 2003**

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# PACIFIC SCIENTIFIC ADVICE REVIEW COMMITTEE (PSARC) SALMON SUBCOMMITTEE MEETING

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**SUMMARY**

The Pacific Scientific Advice Review Committee (PSARC) Salmon Subcommittee met October 16, 2003 at the Pacific Biological Station, Nanaimo, B.C. to review one Working Paper.


**Working Paper S2003-16: Pre-season run size forecast for Fraser River sockeye salmon in 2004**

This paper presented forecasts of returns for 18 Fraser River sockeye stocks from four timing groups.  It was not reviewed externally because data and methods used were those which have been accepted previously by PSARC.  The forecasted total return of 5.1 million is 1.13 times greater than the cycle mean of 4.5 million.  The forecast of 216,000 for Early Stuart is 1.14 times the cycle mean.  The forecast for the Early summer run suggests a dramatic increase to 1.1 million which is 2.32 times the mean (474,000); this return is forecast to be dominated by Nadina sockeye.  The forecasted return for Summer run sockeye (3.5 million) is 1.17 times greater than the mean (3.0 million) and is comprised of a below-average return to Chilko, and strong returns of Quesnel and late Stuart fish.  Late Run returns are all below the cycle means, and are forecast to be especially low for the late Shuswap and Cultus Lake runs.  The return to Cultus Lake is forecast to be no more than 500 which is 0.08 of the cycle mean.

The Subcommittee accepted the Working Paper and the forecasts.  It noted that, in the absence of formal assessments for the majority of Fraser River sockeye stocks, this Working Paper provides the only opportunity for the Subcommittee to annually review information on stock status.  Consequently, requested revisions focused on providing more data and providing stock-specific forecasts or abundance trends for as many populations as possible.  The Subcommittee concluded forecasting documents should provide information on stock status that would help identify conservation-based constraints in addition to providing information on harvest opportunities.


**SOMMAIRE**

Le Sous-comité du saumon du Comité d'examen des évaluations scientifiques du Pacifique (CEESP) s'est réuni le 16 octobre 2003 à la Station biologique du Pacifique, située à Nanaimo (C.-B.), pour examiner un document de travail.

**Document de travail S2003-16 : Prévisions des remontes de saumon rouge dans le fleuve Fraser en 2004**

Ce document de travail présente les prévisions des remontes de 18 stocks de saumon rouge du fleuve Fraser appartenant à quatre groupes de montaison. Il n'a pas fait l'objet d'un examen externe étant donné que les données et méthodes utilisées ont déjà été approuvées par le CEESP. La remonte totale devrait se chiffrer à 5,1 millions de saumons, soit 1,13 fois la moyenne (4,5 millions). La remonte de saumons à montaison hâtive dans la rivière Stuart devrait être de 216 000, soit 1,14 fois la moyenne pour ce groupe. La remonte du début de l'été devrait être de 1,1 million, ce qui est

considérablement plus élevé (2,32 fois) que la moyenne pour ce groupe (474 000). Cette remonte devrait être constituée principalement de saumons de la rivière Nadina. La remonte d'été devrait se chiffrer à 3,5 millions, soit 1,17 fois la moyenne pour ce groupe (3,0 millions), et devrait comprendre une remonte inférieure à la moyenne dans la rivière Chilko et des remontes importantes dans les rivières Stuart (montaison tardive) et Quesnel. Les remontes de saumons à montaison tardive sont toutes inférieures aux moyennes et devraient être particulièrement faibles dans la rivière Shuswap et le lac Cultus. La remonte vers le lac Cultus ne devrait pas dépasser 500 saumons, ce qui correspond à 0,08 fois la moyenne pour ce groupe.

Le Sous-comité accepte le document et les prévisions. Il est souligné qu'en l'absence d'évaluations officielles pour la plupart des stocks de saumon rouge du fleuve Fraser, ce document de travail constitue la seule occasion pour le Sous-comité d'examiner les données sur l'état des stocks à chaque année. Par conséquent, les révisions exigées portent principalement sur la présentation de davantage de données et sur la formulation de prévisions propres aux stocks ou l'établissement de tendances en matière d'abondance pour le plus grand nombre de populations possible. Le Sous-comité conclut que les documents prévisionnels devraient fournir des données sur l'état des stocks qui permettent de cerner les problèmes liés à la conservation et sur les possibilités de récolte.

## INTRODUCTION

The PSARC Salmon Subcommittee met October 16, 2003, at Pacific Biological Station in Nanaimo, British Columbia.  External participants from the Pacific Fisheries Resource Conservation Council, Sierra Club, Pacific Salmon Commission, and the Sport Fishing Advisory Board attended the meeting. A consultant also attended the meeting.  The Subcommittee Chair, R. Tanasichuk, opened the meeting by welcoming the participants. During the introductory remarks, the objectives of the meeting were reviewed, and the Subcommittee accepted the meeting agenda.

The Subcommittee reviewed one Working Paper.  A Summary of the Working Paper is in Appendix 1.  The meeting agenda appears as Appendix 2. A list of meeting participants is included as Appendix 3.


## DETAILED COMMENTS FROM THE REVIEW

### S2003-16: Pre-season run size forecasts for Fraser River sockeye salmon in 2004

M. Folkes and A. Cass   **Accepted subject to revisions**

Data, forecasting models and forecast performance

This paper presented forecasts of returns for 18 Fraser River sockeye stocks from four timing groups.  The data sources and methods used have been accepted previously by PSARC; therefore the paper was not reviewed externally.  Adult abundance data (annual estimates of spawning escapement for 1948-99 and returns for 1952-2001) are maintained by the Pacific Salmon Commission.  Forecasts for most stocks are based on regression models that use spawning escapement (effective female spawner escapement) to predict returns for age-4 and age-5 fish.   There are numerous populations in the Early Summer or Late run timing groups which have no recruitment data.  Effective female escapement estimates were multiplied by the 1980-2001 mean recruits per effective female for the 16 Fraser River sockeye populations which have recruitment data.  Some populations have additional data on fry survivals (Nadina, Gate and Weaver spawning channels) or smolt output (Chilko and Cultus lakes) which were used to test additional models which included estimates of juvenile abundance. The traditional models were  not used to forecast Cultus Lake returns because smolt output has been so low due to apparent high pre-spawning mortality following enumeration of migrating adults at the Sweltzer Creek fence.  Estimates of pre-spawning mortality since the mid-1990s have been as high as 90%.  The Cultus forecast is the estimated number of smolts multiplied by the average 8% smolt-to-adult survival rate.  In general, the model with the lowest root mean-squared error was selected for prediction.   The average absolute percent error for 1990-2003 was 39% for Early Stuart, 48% for Early Summers, 55% for Summers and 82% for Late runs (Fig. 1).

The Subcommittee concluded that forecast documents should provide information on stock status that would help identify conservation-based constraints in addition to providing information on harvest opportunities.  It noted that this Paper is traditionally the only document which presents information on Fraser River sockeye status annually.  The Subcommittee felt that it was essential to tabulate critical data used in the forecasts, and to include abundance data for as many stocks as possible to assess stock status.  This was considered to be especially important for the smaller stocks which are currently grouped in the "Miscellaneous" category.  In addition, forecasts should be presented for as many individual stocks as possible.  The Subcommittee noted that there was no quantitative information presented on how marine environmental conditions affect Fraser River sockeye survival, and suggested that environmental effects should be tested for explicitly.  The Authors noted that the Fisheries Oceanography Working Group is working towards providing indices of ocean conditions which may be useful.  Finally, the Subcommittee noted that the new smolt-based forecasting methodology for Cultus Lake sockeye had not been reviewed.

Stock status and forecasts

Forecasted returns for all ages are presented in Table 1.  The forecasted total return at the 50% probability level is 5.1 million which is 1.13 times greater than the cycle line mean return of 4.5 million.

For Early Stuart sockeye, the 2004 cycle line is the second off cycle following the dominant (2001) and subdominant line (2002) returns.  The spawning escapement in brood year 2000 was impacted by high Fraser River discharges at times during migration in the Fraser Canyon.  Escapement estimates were the highest on the cycle since 1988 (Fig. 2).  Early Stuart returns are forecast to be 216,000.  This is 1.14 times the mean (189,000).

The forecasted return for the Early Summer run timing group is 1.1 million which is 2.32 times greater than the mean return of 474,000.  The forecasted return is dominated by Nadina sockeye.  The forecast for this stock is based on fry production.  The fry estimates are beyond the observed range which increases the uncertainty of the forecast (Fig. 3).  The forecast (342,000) is similar to the maximum return (450,000) which was observed in 2000.

The forecasted return of 3.5 million for Summer run sockeye is 1.17 times greater than the mean (3.0 million).  Chilko escapement in 2000 was the eighth highest on record but survival to the smolt stage was lower than average (Fig. 4).  The forecast for Chilko (1.2 million) is 0.57 of the mean for this stock.  Quesnel spawning escapement on the 2004 cycle line has increased continuously from 300 in 1980 to 63,000 in 2000, and is forecast to be 611,000 in 2004.  Spawning escapement has also increased continuously for Late Stuart sockeye.  Spawning escapement reached a record high (455,000) in 2000 and is forecast to be 989,000 in 2004; the mean return is 221,000.  The return of Stellako sockeye is forecast as 737,000 which is 1.13 of the cycle mean.

Late Run returns are all below the cycle means, and are forecast to be especially low for the late Shuswap and Cultus Lake runs.  High en-route mortality, inferred from differences between Mission acoustic estimates and estimates of spawning escapement

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plus catches up-river of Mission, has been implicated as the cause of the decline in escapement to the Late Shuswap stock and other Late run stocks in 2000.  For Late Shuswap fish, the forecast of 10,000 is 0.23 of the cycle mean.  In 2002, Cultus Lake sockeye were emergency-listed by COSEWIC as "Endangered".  The forecasted return of 454 would be the lowest on record and be less than 2% of the cycle mean (since 1952).  The forecast of 11,000 for Portage Creek is 0.41 of the cycle mean and the forecast of 56,000 for Weaver Creek channel sockeye is 0.14 of the cycle mean.  Returns to the Birkenhead River are forecast to be 172,000 which is 0.53 of the cycle mean.

## Subcommittee Conclusions

The Working Paper was accepted with revisions. The Subcommittee requested the following revisions, which are also to be included routinely in future forecasts:

1) Time series of all data used in the forecasts should be tabulated and either presented in the paper or made readily available to the Subcommittee in a standardized format;
2) Data are to be disaggregated into individual stocks to the extent possible. This request applies in particular to the miscellaneous stock groups;
3) Performance measures used in model selection are to be presented for all stocks;
4) The graphical presentations (Figs. 6 to 11 in the Working Paper) are to be expanded to include all stocks where feasible. In particular, the Subcommittee would appreciate the opportunity to examine trends in escapement, recruitment, productivity (R/S), and residuals of predictive models for all stocks;
5) The performance of forecast models should be tabulated and show the model used, the observed run size and the probability level of the observed return.  A critical examination of model performance should be included in all future forecasts.

The Subcommittee noted that the low forecast for Cultus Lake sockeye is a result of low smolt production, and emphasized that the forecast is for the lowest return on record.  In addition, the status of the miscellaneous non-Shuswap populations is unknown but these small populations should be considered "at-risk" pending further investigation.  The status of Weaver Creek, Portage and Late Shuswap populations should also be investigated.

## Subcommittee Recommendations

The Subcommittee recommended that formal assessments of Fraser River sockeye populations be expedited.  The assessments should begin with those stocks most vulnerable to irreversible damage because of small stock size, low productivity (inherent or environmentally caused) or admixture with the stocks targeted in commercial fisheries.

The objectives of future forecasting documents should be assessed. Emphasis on the status of small stocks and impending conservation concerns should increase to identify stocks of potential concern.

**S2003-16: Pre-season run size forecast for Fraser River sockeye salmon in 2004**

M. Folkes and A. Cass

There is no dominant run in either the Summer or Late run timing aggregates in the 2004 cycle line.  The summer run is expected to contribute 3.5 million to the total expected return of 5.1 million.  Within the summer run, the non-cyclic Chilko Lake stock is expected to have the highest return (1.2 million).  This is 23% of the total forecasted return while, on average, Chilko sockeye account for 47% of the total sockeye returns on the cycle since 1980.  Average sockeye returns for all stocks on the cycle were 4.5 million sockeye/yr compared to an all-year average of 10.2 million fish/yr (1980-2002). Forecasts are made for each of 18 individual sockeye stocks and four run timing groups (Table 1).  Together the 18 sockeye stocks accounted for 96% of the estimated escapement to the Fraser River in brood year 2000.  Escapement estimates for the remaining 4% are extrapolated based on mean recruits-per-spawner for combined stocks with escapement and recruitment data to forecast total returns for all spawning populations.

Forecasts of returns are made using a variety of explanatory variables.  For most stocks, forecasts are based on regression models that use spawning escapement to predict returning age-4 and age-5 sockeye in 2004.  Additional explanatory variables are available for some stocks and include smolt and fry data.  Model performance was evaluated in a retrospective analysis by comparing forecasts to estimated (observed) run sizes for years that estimates are available.  The root-mean-square error criteria was used to select the best model from several candidate models.

Forecasts are provided at various probability levels of achieving specified run sizes by stock and run-timing group. The forecast of sockeye at the 50% level for all stocks combined is 5.1 million fish (216,000 Early Stuart, 1.1 million Early Summer, 3.5 million Summer and 318,000 Late run).  The Summer Run forecast accounts for 68% of the total forecast with Chilko and Late Stuart stocks in nearly equal proportion at 1.2 and 1 million sockeye respectively.  The remainder is shared equally between the early summer aggregate and Quesnel and Stellako of the summer aggregate.

Forecasts are associated with high uncertainty.  Although forecasts are presented as probability distributions, they are based on models that for most stocks assume average survival conditions.  Improvements to pre-season abundance forecasts are unlikely without a better understanding of environmental factors affecting survival.  Reliability of forecasts ultimately depend on understanding processes that affect survival in both freshwater and the marine environment.  Where they are assessed, all but one of the indicators of sockeye freshwater survival for the brood were slightly above average. Lower than average freshwater survival to the smolt stage is evident in the two sockeye populations where smolts are enumerated (Chilko and Cultus).  Cultus sockeye have experienced long-term declines exasperated by the recent high pre-spawning mortality of Late-timed runs.

Oceanographic and meteorological conditions in the northeast Pacific and coastal British Columbia in 2001 presented moderate La Niña conditions which changed to moderate El Niño conditions in the second half of 2002.  These years are the main ocean entry years for age-5 and age-4 sockeye returning in 2004.  Correlations of survival and specific oceanographic variables, however, have not been demonstrated.

**PSARC Salmon Subcommittee Meeting**
**October 16, 2003**
**Seminar Room, PBS, Nanaimo**

Thursday, October 16, 9:00-12:00

  9:00 –   9:30  Introduction and procedures
  9:30 – 11:00  Fraser River Sockeye forecast
11:00 – 12:00  Subcommittee Discussion and Recommendations

## APPENDIX 3:  List of Attendees

Subcommittee Chair:          Ron Tanasichuk
PSARC Chair:                Al Cass

| DFO Participants | |
|---|---|
| * denotes Subcommittee Members | |
| Brown, Gayle* | |
| Cass, Al* | |
| Cook, Roberta* | |
| Dobson, Diana | |
| Folkes, Michael | |
| Holtby, Blair* | |
| Ionson, Bert* | |
| Irvine, Jim* | |
| McNicol, Rick* | |
| Meerburg, Dave* | |
| Parken, Chuck* | |
| Simpson, Kent* | |
| Tanasichuk, Ron* | |
| Thomas, Greg | |
| Tompkins, Arlene* | |
| Wood, Chris* | |
| Yockey, Cindy* | |
|  |  |
| **External Participants:** | **Affiliation** |
| Blackbourn, David | Consultant |
| Chow, Sharon | Sierra Club of BC |
| Gable, Jim | Pacific Salmon Commission |
| Guthrie, Ian | Pacific Salmon Commission |
| Kritianson, Gerry | Sport Fishing Advisory Board |
| Riddell, Brian | Pacific Fisheries Resource Conservation Council |

Reviewers for the PSARC papers presented at this meeting are listed below, in alphabetical order.  Their assistance is invaluable in making the PSARC process work.

| Bradford, Mike | Fisheries and Oceans |
|---|---|
| Parken, Chuck | Fisheries and Oceans |

**Table 1.  Pre-season sockeye salmon forecasts for 2004 by stock/timing group and probability level.**

| Sockeye stock/timing group | Forecast model | Meanc Run Size[b] | | Probability of Achieving Specified Run Sizes[a] | | | | |
|---|---|---|---|---|---|---|---|---|
| | | all cycles | 2004 cycle | 0.25 | 0.5 | 0.75 | 0.8 | 0.9 |
| **Early Stuart** | Power | **362,000** | **189,000** | **341,000** | **216,000** | **137,000** | **122,000** | **90,000** |
| **Early Summer** | | **488,000** | **474,000** | **2,030,000** | **1,104,000** | **594,000** | **513,000** | **336,000** |
| Fennell | Ricker | 26,000 | 37,000 | 72,000 | 39,000 | 22,000 | 19,000 | 12,000 |
| Bowron | Ymean | 23,000 | 26,000 | 52,000 | 28,000 | 15,000 | 13,000 | 9,000 |
| Raft | Power | 25,000 | 50,000 | 213,000 | 119,000 | 66,000 | 57,000 | 39,000 |
| Gates | R/S | 64,000 | 155,000 | 334,000 | 194,000 | 112,000 | 98,000 | 68,000 |
| Nadina | Fry | 76,000 | 110,000 | 669,000 | 342,000 | 175,000 | 148,000 | 94,000 |
| Pitt | Power | 53,000 | 48,000 | 110,000 | 66,000 | 40,000 | 35,000 | 25,000 |
| Seymour | Cmean | 159,000 | 42,000 | 44,000 | 29,000 | 18,000 | 17,000 | 12,000 |
| Scotch | Power | 62,000 | 6,000 | 34,000 | 15,000 | 6,000 | 5,000 | 3,000 |
| Misc[c] | R/S | - | - | 502,000 | 272,000 | 140,000 | 121,000 | 74,000 |
| **Summer** | | **5,884,000** | **3,023,000** | **6,152,000** | **3,501,000** | **2,078,000** | **1,834,000** | **1,335,000** |
| Chilko | Pooled | 1,883,000 | 2,099,000 | 1,609,000 | 1,164,000 | 842,000 | 777,000 | 627,000 |
| Quesnel | Power | 2,585,000 | 51,000 | 1,136,000 | 611,000 | 329,000 | 281,000 | 187,000 |
| Stellako | Ricker | 542,000 | 652,000 | 1,144,000 | 737,000 | 475,000 | 425,000 | 318,000 |
| Late Stuart | Power | 874,000 | 221,000 | 2,263,000 | 989,000 | 432,000 | 351,000 | 203,000 |
| **Late** | | **3,470,000** | **811,000** | **584,000** | **318,000** | **171,000** | **146,000** | **97,000** |
| Birkenhead | Power | 512,000 | 324,000 | 307,000 | 172,000 | 96,000 | 83,000 | 57,000 |
| Late Shuswap | Ricker | 2,422,000 | 44,000 | 18,000 | 10,000 | 5,000 | 4,000 | 3,000 |
| Cultus | Power | 21,000 | 6,000 | <500 | <500 | <500 | <500 | <500 |
| Portage | R/S | 65,000 | 27,000 | 24,000 | 11,000 | 5,000 | 4,000 | 2,000 |
| Weaver | R/S | 450,000 | 410,000 | 108,000 | 56,000 | 29,000 | 24,000 | 16,000 |
| Misc Shuswap[d] | R/S | - | - | 7,000 | 4,000 | 2,000 | 2,000 | 1,000 |
| Misc. non-Shusw | R/S | - | - | 120,000 | 65,000 | 34,000 | 29,000 | 18,000 |
| **TOTAL** | | **10,204,000** | **4,497,000** | **9,107,000** | **5,139,000** | **2,980,000** | **2,615,000** | **1,858,000** |

[a]  probability that the actual run size will exceed the specified projection
[b]  1980-2002 mean
[c]  unforecasted miscellaneous Early Summer stocks
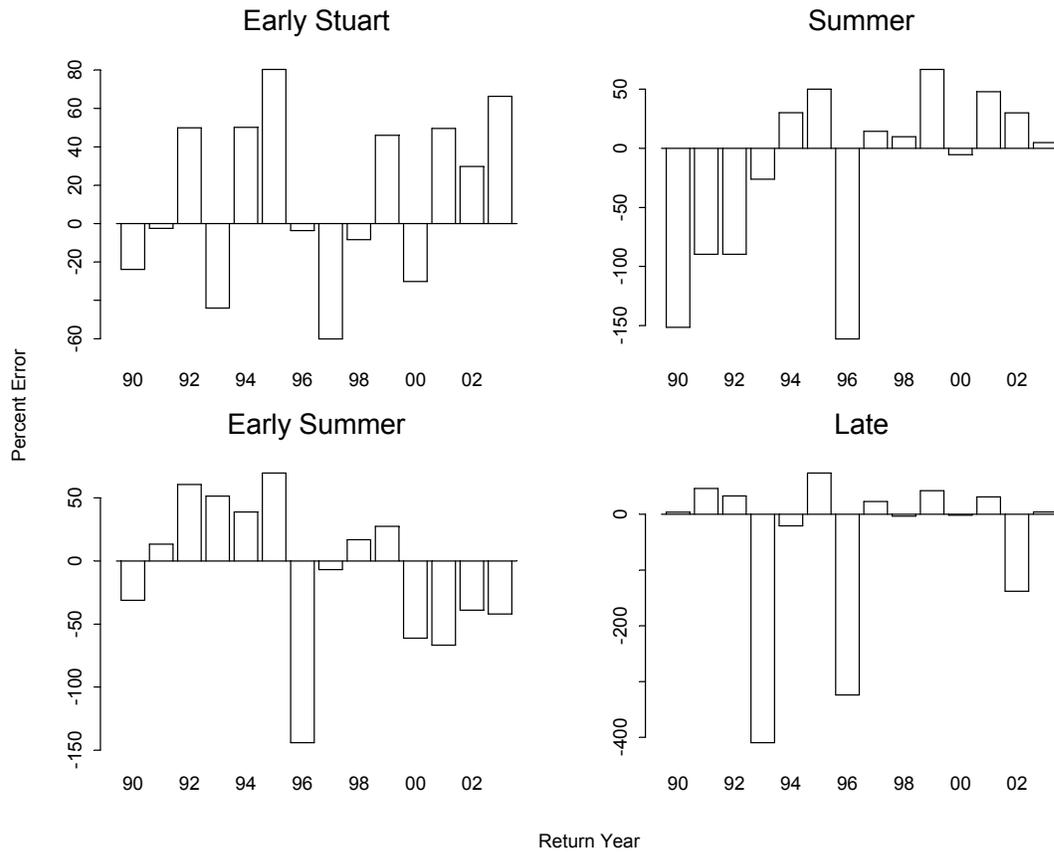[d]  unforecasted miscellaneous Late stocks

Figure 1. Percent error of forecasts from observed run size by run-timing group for Fraser River sockeye (1990-2003). Deviations in 1990-2002 are based on post-season estimates of run size. Deviations in 2003 are based on final in-season estimates and are therefore very preliminary.
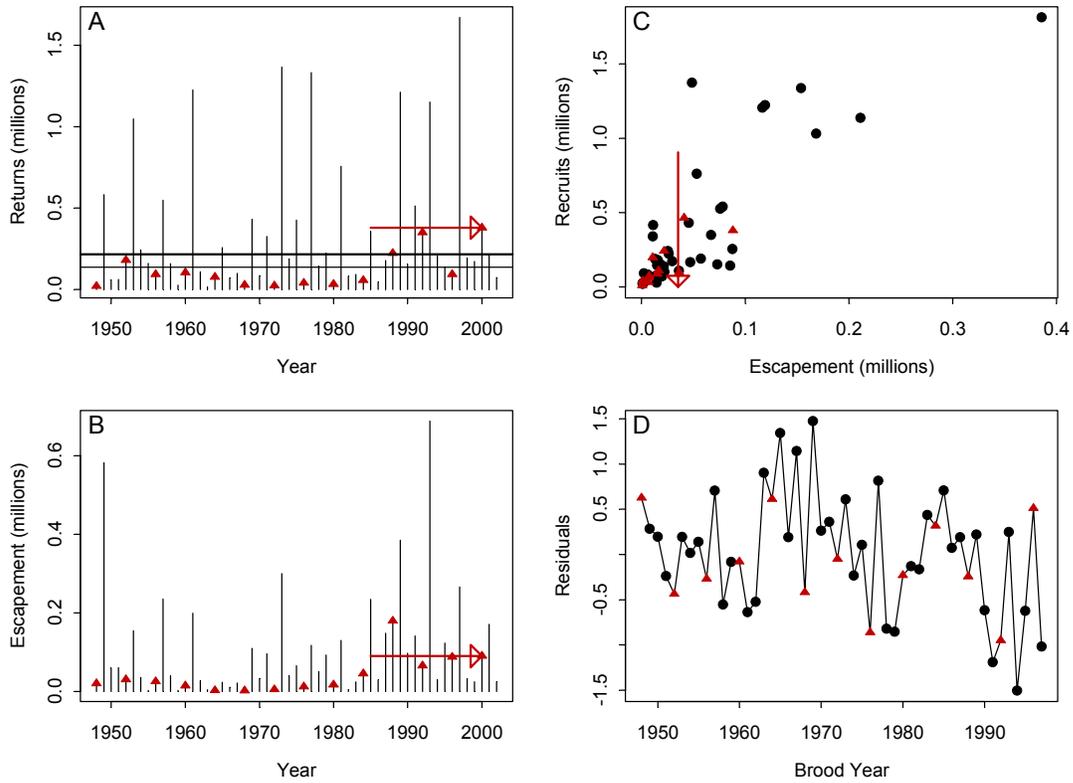
Figure 2. A) Trend in Early Stuart sockeye adult returns. Horizontal lines show the 2004 forecast at the 50% (upper) and 75% (lower) probability level. B) Trends in adult spawners, C) recruit-effective female escapement relationship and D) residual trend ($\log_e$ scale) from the fit of the power model to the relationship in C. Arrows depict 2000 data. Triangles (red) depict the 2004 cycle line data points.
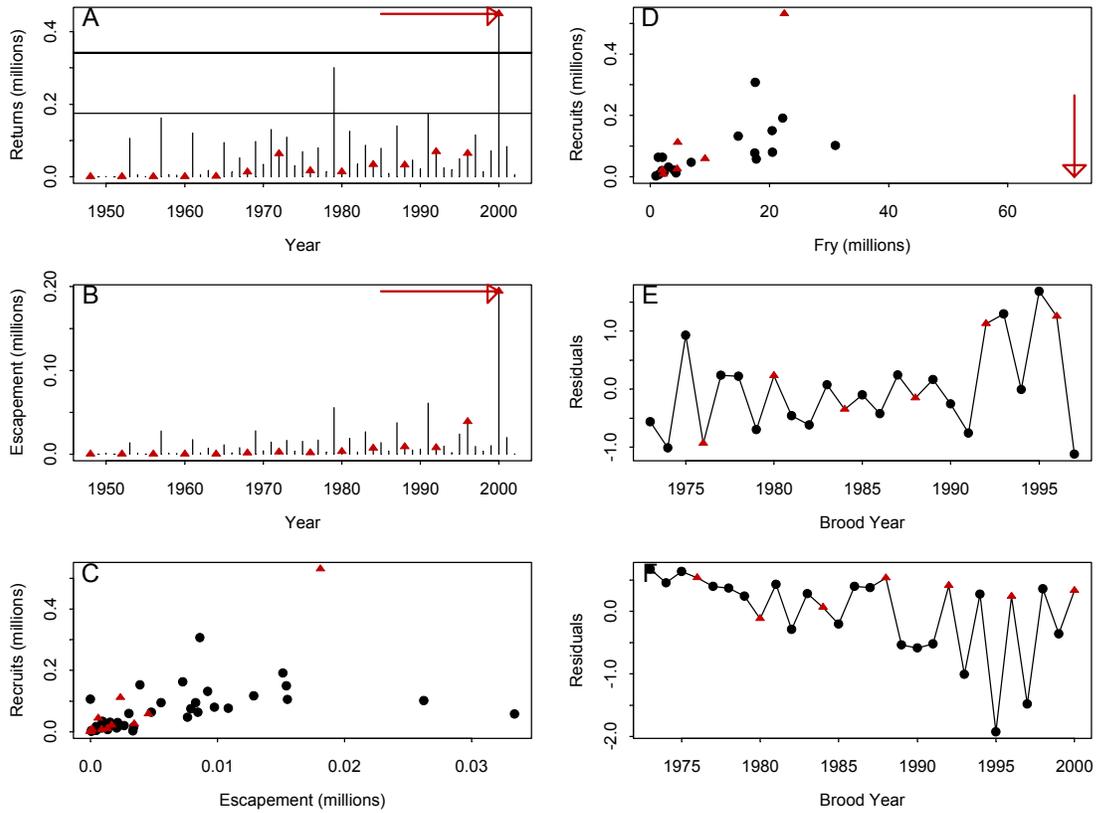
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Nadina



Figure 3.  A) Trend in Nadina sockeye adult returns.  Horizontal lines show the 2004 forecast at the 50% (upper) and 75% (lower) probability level.  B) Trends in adult spawners, C) recruit-effective female escapement relationship, D) recruit-fry relationship, E) residual trend ($\log_e$ scale) from the fit of the power model to the relationship in C and F) residual trend ($\log_e$ scale) from the fit of the recruit-fry power model to the relationship in D.  Arrows depict 2000 data.  Triangles (red) depict the 2004 cycle line data points.
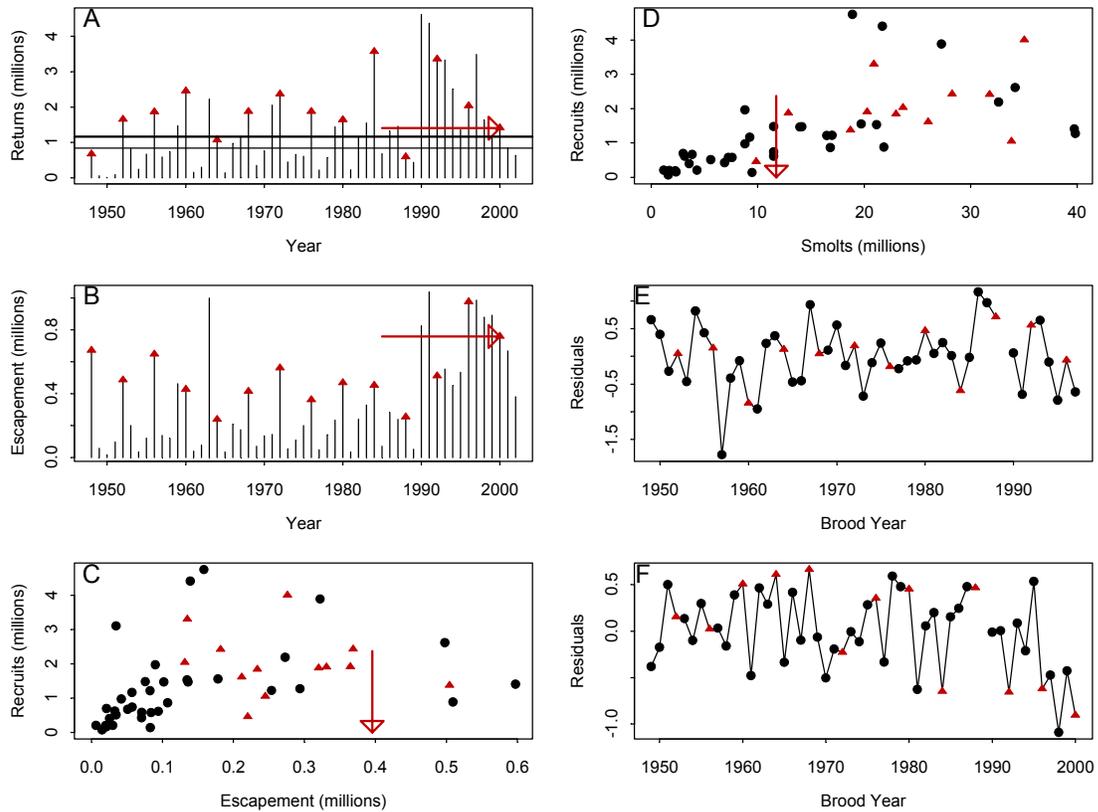
Chilko



Figure 4.  A) Trend in Chilko sockeye adult returns.  Horizontal lines show the 2004 forecast at the 50% (upper) and 75% (lower) probability level.  B) Trends in adult spawners, C) recruitment-effective female escapement relationship, D) recruitment - smolt relationship, E) residual trend ($\log_e$ scale) from the fit of power model to the relationship in D and F) residual trend ($\log_e$ scale) from the fit of power model to the relationship in C.  Arrows depict 2000 data. Triangles (red) depict the 2004 cycle line data points.