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Proceedings of the PSARC Salmon Subcommittee Meeting

Compte rendu de la réunion du sous-comité du CEESP sur le saumon

December 13, 2005
Nanaimo, B.C.

Greg Thomas
PSARC Salmon Subcommittee Chair

Fisheries and Oceans Canada
Pacific Scientific Advice Review Committee
Pacific Biological Station
Nanaimo, B.C. V9T 6N7

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200, rue Kent Street
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K1A 0E6

http://www.dfo-mpo.gc.ca/csas/

CSAS@DFO-MPO.GC.CA

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PACIFIC SCIENTIFIC ADVICE REVIEW COMMITTEE (PSARC)
SALMON SUBCOMMITTEE MEETING

SUMMARY

S2005-03: A Biologically-based Escapement Goal for Cowichan River Fall Chinook Salmon (Oncorhynchus tshawytscha)

A. Tompkins, B. Riddell and D.A. Nagtegaal

The paper presents a revised escapement goal for Cowichan River Chinook. The new goal was not significantly different from previous estimates, therefore the Subcommittee recommended the goal remain unchanged at 7400 Chinook. Given the low status of Cowichan River Chinook, it was recommended that exploitation in marine fisheries be reduced below the estimated maximum sustained level (70%). It was also recommended that development of a Cowichan Chinook stock status paper be expedited.

S2005-04: Pre-season Run Size Forecasts for Fraser River Sockeye for 2006

A.Cass, M. Folkes, C. Parken, C. Wood

This paper provides recommended 2006 pre-season forecasts for nineteen Fraser River sockeye stocks which comprise the four stock timing groups. Additional forecasts were made for “miscellaneous” stocks with limited data quality. The paper presents 2006 forecasts for Fraser River sockeye totaling 17.4 million at the 50% p-level forecast. The Subcommittee supported the rationale for the forecasts using retrospective analysis to select the best forecasts model.

SOMMAIRE

S2005-03 : Objectif d’échappées fondé sur des paramètres biologiques pour le saumon quinnat de la rivière Cowichan (*Oncorhynchus tshawytscha*)

A. Tompkins, B. Riddell et D.A. Nagtegaal

Présentation d’un objectif d’échappées révisé pour le saumon quinnat de la rivière Cowichan. Comme le nouvel objectif n’est pas très différent des estimations antérieures, le sous-comité recommande que l’objectif de 7 400 saumons quinnats soit maintenu. Étant donné le piètre état des stocks de saumons quinnat de la rivière Cowichan, on recommande que l’exploitation en mer soit réduite en dessous du niveau soutenu maximal estimé de 70 %. On recommande également la production d’un document sur l’état des stocks de saumon quinnat de la rivière Cowichan.

S2005-04 : Prévisions d’avant saison concernant les montaisons de saumon rouge du fleuve Fraser pour 2006

A.Cass, M. Folkes, C. Parken, C. Wood

Présentation des prévisions d’avant saison recommandées pour dix-neuf stocks de saumon rouge du fleuve Fraser en 2006, lesquels stocks comprennent les quatre groupes de migration. Des prévisions supplémentaires ont été effectuées pour « divers » stocks à partir de données de qualité limitée. Le document présente aussi

les prévisions pour 2006 concernant le saumon rouge du fleuve Fraser, qui se chiffrent à 17.4 millions d'individus, avec un seuil de probabilité de 50 %. Le sous-comité appuie le recours à l'analyse rétrospective pour choisir les meilleurs modèles de prévision.

INTRODUCTION

DETAILED COMMENTS FROM THE REVIEW

S2005-03: A Biologically-based Escapement Goal for Cowichan River Fall Chinook Salmon *(Oncorhynchus tshawytscha)*

A. Tompkins, B. Riddell, and D.A. Nagtegaal

"Accepted with minor revisions"

Subcommittee Discussion

This paper follows on a review of Cowichan River Chinook stock status, provided to PSARC in 2000, which recommended a biologically-based escapement goal of 7400 chinook. The paper provides a re-analysis of the previously reviewed biological data that has been verified and corrected. As well, new escapement data compiled in the interim period from 2000 to present and juvenile production information has been incorporated in the analysis.

The Subcommittee discussed the quality of data available for the stock/recruit (S/R) analysis used to estimate the spawner abundance that produces maximum sustained yield (Smsy). One reviewer indicated that the escapement data suffered from having been derived from varying survey methods over time. It was also noted that there was considerable uncertainty associated with estimates of wild smolt abundance (based on hatchery smolt survivals) and in the downstream estimates of fry abundance. However the reviewers suggested, and the Subcommittee agreed, that the data presentation and treatment was thorough and the S/R analysis had been extended as far is practicable.

The reviewers also identified a discrepancy in estimates of hatchery and wild Chinook spawners derived independently from coded wire tag (CWT) and otolith assessment methods. The Subcommittee discussed further experimental work, such as thermal marking of fry that could resolve the lack of agreement.

The Subcommittee identified that the majority of available Chinook escapements were clustered at levels at or below the current estimated level of Smsy so that any potential density dependent effect could not be demonstrated in the analysis. A recommendation from a previous paper to examine this relationship by managing for escapements in excess of Smsy was reiterated and approaches to meet this goal, such as harvest rate management, were discussed.

In this paper the authors recommended that the escapement goal for Cowichan River Chinook be revised to 6500 spawners. The Subcommittee supported the authors assessment of the available data but suggested that the new goal is not significantly different than the current level of 7400 chinook.

Information provided in the paper indicates that the productivity (survival and escapement) of the naturally spawning population of Cowichan River Chinook continues to decline and that rates of exploitation have increased in recent years to the level estimated to be the maximum sustainable (70%). The cause(s) of the population decline was not examined in the paper, though it was observed that the increased hatchery outputs in recent years appear to be correlated with low survivals.

The Subcommittee voiced considerable concern about the low status and relatively high fishery exploitation rate of the Cowichan River Chinook stock, particularly given this stock is an indicator under the Pacific Salmon Treaty. It was noted that management action has been taken in 2005 to limit impacts in Stait of Georgia recreational fisheries, commercial fisheries in Johnstone Strait and in offshore troll fisheries, but the outcome cannot yet be assessed. The Subcommittee emphasized the need to expedite the development of a review of lower Georgia Strait stock status for PSARC review in the spring of 2006.

Subcommittee Conclusions

1. The paper was accepted with minor revisions. The revisions are to include clarification of expansions applied to escapement data provided in the appendices.
2. The Subcommittee complimented the authors on data presentation and analysis. The Subcommittee also commended the authors for making data available to reviewers and it was recommended that this practice be continued.
3. The Subcommittee concluded that the revised estimate of Smsy for Cowichan River Chinook provided in this paper was not significantly different than previous estimates. As a result it was recommended that the escapement goal remain at 7400 Chinook[1].

Subcommittee Recommendations

1. Intensive Chinook escapement and CWT monitoring programs should be continued in the Cowichan River, especially because of the current stock concern.
2. Given the low stock status, management action should be taken to limit fishery exploitation of Cowichan River Chinook to a level less than observed in the 2000 brood year (ie. to levels less than the maximum sustainable at Smsy).
3. It is recommended that a paper reviewing the status of lower Georgia St. Chinook be prepared for review by the Subcommittee in the spring. This paper will provide the basis for deliberations on the cause of observed stock declines and impacts of hatchery production, which will lead to recommendations for mitigating the stock declines.

[1] The previous estimate of S_{msy} (7400) was based on the mean from a bootstrap analysis, not the model estimate (6600). In the recent analysis, the revised goal (6500) was based on the preferred model estimate rather than the bootstrap mean (7900). This issue will be tabled at the next Salmon Subcommittee meeting to review the rationale and re-state Canada's escapement goal for Cowichan Chinook.

4. The Subcommittee recommended that a paper be developed for PSARC which reviews current salmon mass marking methodologies and estimation of enhancement contributions to fisheries and spawner returns.
5. The Subcommittee recommended that future PSARC papers contain a summary of recommendations contained in previous papers on the same topic.

S2005-04 Pre-season run size forecasts for Fraser River sockeye for 2006

A. Cass, M. Folkes, C. Parken, C. Wood

Subcommittee Discussion

This paper provides recommended 2006 pre-season forecasts for twenty-two (22) Fraser River sockeye stocks (including miscellaneous stock groupings) that comprise the four stock timing groups under which the return is managed. The recommended forecasts are based on an assessment of a suite of biological and naïve models against a number of standard performance measures. The assessment involves a retrospective analysis, that is, a comparison of forecast model estimates to observed abundances. Consistent with past practice, the recommended forecasts are presented as distributions of adult returns at a range of probabilities (10%, 25%, 50%, 75%, 90%).

There were two reviews provided for this paper. The data used for the forecasts were similar to previous years, although one reviewer identified a potential data problem relating to fry abundances for stocks with spawning channels. The authors agreed to examine the reason for the discrepancies and to revise the forecasts accordingly. The larger issue of corporate responsibility for data management was discussed. The Subcommittee agreed that there needs to be one accepted database to avoid inconsistencies in data sets used in assessments.

The forecast models recommended in the paper are stock specific, and include both biological and naïve models. Naïve models (such as, like last cycle year return) performed best for seven stocks including Quesnel (Summer Run) and Late Shuswap (Late Run), which are forecast to dominate 2006 returns. One reviewer expressed concern regarding the use of naïve models given the importance of the estimates. The reviewer presented an analysis which indicated that naïve models may underforecast both abundance and the variability associated with the estimate. He argued that, although a naïve model might provide the most statistically defensible forecast in the long term, consideration should be given to brood year abundances to derive the best estimate in a given year. Based on this view, he recommended fry based models be used to forecast returns for the critically important Quesnel and Late Shuswap stocks. The second reviewer however expressed support for the naïve model based on the recent comprehensive analysis on forecasting methods conducted by researchers at Simon Fraser University. The better performance of the simpler model is explained by the increased chance for error associated with parameter estimation in the more complex biological models. In discussing this issue, the Subcommittee concluded that justification for a forecast should be provided by

retrospective model performance. It was agreed however that the recommended forecasts should be qualified with biological information. The authors agreed to include these qualifiers as footnotes in the table of forecasts in cases where naïve models do not account for large deviations in brood year escapements.

The implications of establishing Conservation Units under the Wild Salmon Policy to current run timing aggregates was discussed. The Subcommittee noted that future stock forecasts will need to be developed by Conservation Units once they become established.

Subcommittee Conclusions

1. The paper was accepted with minor revisions.
2. The Subcommittee accepted the 2006 Fraser River Sockeye forecasts, totaling 17.4 million sockeye at the 50% probability level, presented in the paper. However, the Subcommittee noted that extremely small fry size observed in the brood year suggests Quesnel forecasts may be biased high.

Subcommittee Recommendations

1. The Subcommittee accepted the pre-season forecasts (Table 1).
2. Corporate data management practices within the department should be examined to ensure that inconsistencies in data are avoided.

Table 1: Pre-season Forecast for Fraser River Sockeye for 2006

Sockeye stock/timing group	Forecast model[b]	Mean Run Size[c]		Probability of Achieving Specified Run Sizes[a]				
		all cycles	2006 cycle	0.1	0.25	0.5	0.75	0.9
Early Stuart	fry	**362,000**	**129,000**	**175,000**	**124,000**	**84,000**	**55,000**	**38,000**
Early Summer		**492,000**	**586,000**	**4,545,000**	**2,412,000**	**1,303,000**	**721,000**	**435,000**
Bowron	Ricker-pi	35,000	21,000	85,000	54,000	34,000	22,000	15,000
Fennell [f]	TSA	25,000	13,000	692,000	140,000	24,000	4,000	1,000
Gates [g]	power	58,000	21,000	50,000	31,000	20,000	11,000	7,000
Nadina	fry	82,000	24,000	94,000	54,000	29,000	16,000	9,000
Pitt	power	67,000	56,000	292,000	194,000	124,000	75,000	51,000
Raft	power	29,000	14,000	172,000	109,000	71,000	43,000	28,000
Scotch	R1C	49,000	119,000	567,000	319,000	168,000	89,000	50,000
Seymour	Ricker-cyc	147,000	318,000	1,039,000	656,000	393,000	253,000	166,000
Misc[d]	R/S	-	-	1,553,630	854,554	439,831	208,412	108,115
Summer		**4,669,000**	**3,943,000**	**23,240,000**	**13,052,000**	**7,158,000**	**4,020,000**	**2,484,000**
Chilko	smolt-esc	1,636,000	1,597,000	3,110,000	2,257,000	1,689,000	1,215,000	932,000
Late Stuart	R1C	686,000	305,000	2,017,000	803,000	288,000	104,000	41,000
Quesnel [h]	R1C	1,824,000	1,538,000	16,786,000	9,104,000	4,613,000	2,338,000	1,268,000
Stellako	R1C	523,000	503,000	1,327,000	888,000	568,000	363,000	243,000
Late		**3,196,000**	**8,143,000**	**28,586,000**	**16,314,000**	**8,812,000**	**4,734,000**	**2,726,000**
Cultus	smolt-jack	28,000	28,000	18,000	11,000	5,800	3,000	1,000
Harrison [i]	TSA	35,000	45,000	184,000	90,000	41,000	19,000	9,000
Late Shuswap [j]	RAC	2,206,000	6,745,000	21,605,000	12,359,000	6,644,000	3,572,000	2,043,000
Portage	Ricker	52,000	80,000	269,000	134,000	67,000	34,000	18,000
Weaver	fry	384,000	594,000	1,117,000	656,000	411,000	259,000	175,000
Birkenhead	power	491,000	651,000	1,120,000	713,000	433,000	274,000	183,000
Misc Shuswap[e]	R/S	-	-	3,819,395	2,100,807	1,081,266	512,352	265,786
Misc. non-Shuswap[e]	R/S	-	-	454,052	249,745	128,542	60,909	31,597
TOTAL		**8,719,000**	**12,801,000**	**56,546,000**	**31,902,000**	**17,357,000**	**9,530,000**	**5,683,000**

[a] probability that the actual run size will exceed the specified projection
[b] see text for model descriptions
[c] 1970-2004 mean
[d] unforecasted miscellaneous Early Summer stocks
[e] unforecasted miscellaneous Late stocks

[f] Fennell performance measures of TSA and RAC models were nearly indistinguishable. Brood effective females (4800) were nearly double the cycle line average (2680) and 25% greater than the time series average (3861). This lends weight to the choice of the TSA model which forecasts double that of the RAC model.

[g] Gates Power model ranked third in the MAE measure, because the Fry and MRS models tied for the first rank. This influenced the average rank of the Power model. However, because the Power model is virtually the same or superior on all measures and has narrower bounds on the forecast it was the model chosen.

[h] Fry based models for Quesnel ranked third, with much greater RMSE (uncertainty) than the top two models. The fry model forecast was 6.2M (1.4M - 27M). Additionally, the top three models were all "naive", outperforming all escapement based models. While Quesnel escapement was near the historic maximum, productivity has been low relative to historic values - even during years of low escapement. Extremely small fry size resulting from large escapements in the brood year may negatively impact survival. This lends support to the low returns per spawner implied by the naïve model forecast and suggests that forecasts based on biological models would tend to be biased high.

[i] Harrison brood escapement exceeds the historical range. Use of any escapement based model would be invalid. The best ranking naïve model was chosen.

[j] The RAC model outperformed all fry models for Late Shuswap. Fry models still have great uncertainty because of their short time series (forecast 9M intervals ranging 3M to 39M). Brood escapement was 1.6x the historic maximum. Any escapement based forecast would be outside the predictive range of the model, making it invalid. Therefore only naive models were considered.

Model definitions: TSA (Time series average of recruitment); R1C (recruitment like last generation); RAC(Average recruitment on the cycle line); Ricker-pi (Ricker function with Pine Island SST covariate); Ricker-cyc (Ricker function using cycle line data only); Smolt-esc (multiple linear relation between smolt production, escapement, and recruitment);

APPENDIX 1: Working Paper Summaries

S2005-03: A Biologically-based Escapement Goal for Cowichan River Fall Chinook Salmon (*Oncorhynchus tshawytscha*)

A.Tompkins, B. Riddell, D.A. Nagtegaal

This assessment incorporates spawner recruit data available to 2004 and provides a revised biologically-based escapement goal for Cowichan River fall chinook, a naturally-spawning population in the lower Strait of Georgia.

Based on the Ricker stock recruit model, excluding the 1981-1984 and 1986-1987 brood years, with the survival rate to age 2 as a covariate (log transformed) the biologically-based escapement goal for adult fall chinook in the Cowichan River was estimated to be 6,514 (90% CI = 4159, 14962). The associated maximum sustainable exploitation rate at S_{msy} was estimated to be 0.69 (90% CI = 0.52, 0.80).

We recommend that a management plan be established to investigate production potential from escapements exceeding this point and to explore the effect of enhancement on wild stock productivity.

This assessment indicates that productivity and marine survival of the naturally-spawning population has continued to decline while the proportion of hatchery fish in the natural spawning population has increased substantially. At the same time ocean fishery exploitation rates have increased to 70%. Present population sizes are an immediate conservation concern. In 2004, natural escapement was 2226 adult chinook (2721 total escapement), a similar level only experienced during 1986 -1987 (previous conservation concerns) when survival rates were three to eight times higher.

S2005-04: Pre-season Run Size Forecasts for Fraser River Sockeye for 2006

A. Cass, M. Folkes, C. Parken, and C. Wood

Forecasts of salmon returns were made using a variety of models depending on data availability. For all stocks the data included spawning escapement estimates that date back to the late 1940s. Nineteen stocks have paired escapement and recruitment data. A subset of stocks have juvenile abundance data in addition to escapement data. Several small populations only have escapement data. A suite of biological and naïve models were assessed retrospectively against standard performance measures. The biological models include models relating recruitment to predictor variables (escapement, fry, smolts, and age-3 (jack) siblings in the case of Cultus Lake sockeye). We also investigated whether some environmental variables would improve model performance. These included Fraser River discharge, sea surface temperature (SST) data and the Pacific Decadal Oscillation index (PDO). Uncertainty in forecasts for 2006 were captured using Bayesian statistical inference. In keeping with past practice, forecasts are presented as distributions of age 4 + age 5 returns given data uncertainty.

Most of the forecasts were associated with large uncertainty. This is consistent with previous Fraser sockeye forecast PSARC reviews and recent research on coast-wide salmon stocks ranging from Alaska to BC. Biological models outperformed naïve models for 12 of 19 stocks. Biological models that included juveniles out-performed other models in 4 of 8 stocks, the 8 stocks for which juvenile data were available. The inclusion of environmental variables did not improve the performance of biological models that considered only stock (or fry) and recruitment. A Ricker cycle-line model performed best for only one (Seymour) of the 10 stocks considered to have sufficient data (1950-present).

APPENDIX 2: PSARC Salmon Subcommittee Meeting Agenda, December 13, 2005

PSARC Salmon Subcommittee Agenda
December 13, 2005
Seminar Room, Pacific Biological Station
Nanaimo BC

December 13

9:00	Introductions and Overview of the agenda
9:30	Review of Working Paper – *Fraser Sockeye Forecast Abundance*
11:00	Formulation of Subcommittee conclusions and recommendations
12:00	Lunch
1:00	Review of Working Paper – *Cowichan Chinook Escapement Goals*
3:00	Formulation of Subcommittee conclusions and recommendations
4:00	Adjournment

APPENDIX 3: List of Attendees

Subcommittee Chair: Greg Thomas
PSARC Chair: Al Cass

NAME	
EXTERNAL PARTICIPANTS	
Argue, Sandy	BC Ministry of Agriculture, Food and Fisheries
Atkinson, Mary-Sue	Pacific Fisheries Research Conservation Council
Blackbourn, David	Consultant
Gottesfeld, Allen	Skeena Fisheries Committee
Harling, Wayne	Sport Fish Advisory Board
Lapointe, Mike	Pacific Salmon Commission
Rombough, Les	Pacific Salmon Harvester's Society
Wilson, Ken	Fraser River Aboriginal Fishery Society
DFO MEMBERS	
Bailey, Richard	
Brown, Gayle	
Cass. Al (PSARC Chair)	
Cook, Roberta	
Folkes, Michael	
Grout, Jeff	
Holtby, Blair	
Hop Wo, Leroy	
Hyatt, Kim	
Irvine, Jim	
Jantz, Les	
McNicol, Rick	
Riddell, Brian	
Samaha, Cindy	
Schubert, Neil	
Spencer, Kent	
Tanasichuk, Ron	
Thoulton, Nicole	
Tutty, Brian	

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.

Grout, Jeff	Fisheries and Oceans Canada
Hyatt, Kim	Fisheries and Oceans Canada
Lapointe, Mike	Pacific Salmon Commission
Sawada, Joel	Fisheries and Oceans Canada