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Regional Science Advisory Process on the Review of pre-season Fraser River Sockeye forecasts

March 9, 2010
Nanaimo, BC

Chairperson
Michael Chamberlain

Processus de consultation scientifique régional sur l'examen des prévisions d'avant-saison concernant le saumon rouge du fleuve Fraser

Le 9 mars 2010
Nanaimo, Colombie-Britannique

Président de la réunion
Michael Chamberlain

Fisheries & Oceans Canada/Pêches et Océans Canada
3190, route Hammond Bay Road
Nanaimo, BC/C.-B.
V9T 6N7

August 2011 | **Août 2011**

Canada

Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings include research recommendations, uncertainties, and the rationale for decisions made by the meeting. Proceedings also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

Avant-propos

Le présent compte rendu a pour but de documenter les principales activités et discussions qui ont eu lieu au cours de la réunion. Il contient des recommandations sur les recherches à effectuer, traite des incertitudes et expose les motifs ayant mené à la prise de décisions pendant la réunion. En outre, il fait état de données, d'analyses ou d'interprétations passées en revue et rejetées pour des raisons scientifiques, en donnant la raison du rejet. Bien que les interprétations et les opinions contenus dans le présent rapport puissent être inexacts ou propres à induire en erreur, ils sont quand même reproduits aussi fidèlement que possible afin de refléter les échanges tenus au cours de la réunion. Ainsi, aucune partie de ce rapport ne doit être considéré en tant que reflet des conclusions de la réunion, à moins d'indication précise en ce sens. De plus, un examen ultérieur de la question pourrait entraîner des changements aux conclusions, notamment si l'information supplémentaire pertinente, non disponible au moment de la réunion, est fournie par la suite. Finalement, dans les rares cas où des opinions divergentes sont exprimées officiellement, celles-ci sont également consignées dans les annexes du compte rendu.

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SUMMARY

The Centre for Science Advice Pacific (CSAP) Regional Advisory Process (RAP) meeting was held on March 9, 2010 at the Pacific Biological Station, Nanaimo, B.C. One working paper was reviewed.

Working Paper: Pre-season run size forecasts for Fraser River Sockeye salmon (*Oncorhynchus nerka*) in 2010
S.C.H. Grant, C.G.J. Michielsens, E.J. Porszt, A. Cass

A draft research document outlining the methods and results used to generate the 2010 Fraser River Sockeye forecast was presented to Regional Advisory Process participants on 9 March 2010. The document represents an extension of the Scientific Advisory Report (SAR) tabled in November in 2009, in which 2010 Fraser Sockeye forecasts were also presented. The intent of the research document was to allow for the review and approval of forecasting models not included in the 2006 Pacific Scientific Advice Review Committee (PSARC) approved forecasting methodology. The models used in the 2010 forecast for Fraser Sockeye were developed to incorporate recent productivity trends into the forecasting process. Three separate forecasts for all Fraser Sockeye forecasted stocks (found in three forecast tables) were generated and evaluated for the 2010 Fraser River Sockeye Salmon forecast:

- "Long Term Average Productivity" - assumes that the long term productivity trends (1948 to present for most stocks) will persist through to 2010;
- "Recent Productivity" - incorporates recent declining trends (1997 to present) in stock productivity into the methods; and
- "Productivity Equivalent to the 2005 Brood Year" (2009 return year) - assumes that productivity will be similar to that of the 2009 return (lowest on record for a number of stocks).

There were two reviewers of the working paper, one internal and one external. Reviewers concluded that the authors conducted a thorough analysis for forecasting the 2010 adult returns of Fraser River sockeye salmon. The resulting wide probability distributions of the 2010 Fraser Sockeye forecasts and uncertainty regarding future survival represented by three different forecast tables reflect the reality on the west coast of North America generally; namely that forecasts are very uncertain due to many poorly understood processes affecting survival rates. There was recognition and appreciation that the authors applied some new methods to their forecasting work (e.g., Bayesian inference for estimating uncertainties in forecasts and a Kalman filter to estimate time-varying productivity). Most importantly, in some of the 2010 forecast analyses, the author's recognized the substantial decrease in productivity (adult recruits-per-effective-female spawner, or R/EFS) of most of the Fraser River sockeye stocks over the last 20 to 50 years. To reflect this time trend, they developed some new non-parametric models and applied the Kalman filter version of a Ricker model (with a time-varying 'a' parameter). The author's also conducted appropriate sensitivity analyses for various assumptions about changes in productivity.

Discussion focused on the issues of recent productivity trends and the effects of model selection and evaluation. Considerable discussion was given to the issues of uncertainty in forecasts and potential approaches to reduce uncertainty in the Fraser Sockeye forecast. Apart from recommendations for future work to explore alternate environmental indicators and sibling ('jack') models to be used as informative priors to the forecasts it was concluded that significant improvements are unlikely to reduce uncertainty in the forecasts.

The group commended the authors on the high quality of the work and accepted the paper subject to minor revisions.

SOMMAIRE

Le 9 mars 2010, une réunion du processus de consultation scientifique régional (PCSR) du Centre des évaluations scientifiques – Pacifique (CESP) a eu lieu à la Station biologique du Pacifique, à Nanaimo, en Colombie-Britannique. Un document de travail a été passé en revue.

Document de travail : Pre-season run size forecasts for Fraser River Sockeye salmon (*Oncorhynchus nerka*) in 2010 (Prévisions d'avant-saison concernant l'importance de la montaison du saumon rouge du fleuve Fraser en 2010)
S.C.H. Grant, C.G.J. Michielsens, E.J. Porszt, A. Cass

Le 9 mars 2010, une ébauche de document de recherche décrivant les méthodes et les résultats utilisés pour produire les prévisions concernant le saumon rouge du fleuve Fraser pour 2010 a été présentée dans le cadre du processus de consultation scientifique régional. Ce document constitue une prolongation de l'avis scientifique (AS) soumis en novembre 2009 et dans lequel on présentait également des prévisions concernant le saumon rouge du Fraser pour 2010. Le but du document de recherche était de permettre l'examen et l'approbation des modèles de prévisions qui n'avaient pas été inclus dans les méthodes de prévision approuvées par le Comité d'examen des évaluations scientifiques du Pacifique (CEESP). Les modèles utilisés pour les prévisions de 2010 concernant le saumon rouge du Fraser intègrent les tendances relatives à la productivité récente dans le processus de prévision. Trois prévisions distinctes ont été évaluées pour l'ensemble des stocks de saumons rouges du Fraser faisant l'objet de prévisions pour 2010 (dans trois tableaux de prévision).

- « Productivité moyenne à long terme » – on suppose que les tendances relatives à la productivité à long terme (de 1948 jusqu'à aujourd'hui, pour la plupart des stocks) se maintiendront jusqu'en 2010.
- « Productivité récente » – on intègre, dans les méthodes, les récentes tendances (de 1997 à aujourd'hui) à la baisse affichées par la productivité des stocks.
- « Productivité équivalente à celle de l'année de ponte 2005 » (année de montaison 2009) – on suppose que la productivité sera semblable à celle de la montaison de 2009 (la plus faible parmi les données pour un certain nombre de stocks).

Une personne de l'interne et une autre de l'externe ont procédé à l'examen du document de travail. Les examinateurs ont conclu que les auteurs ont effectué une analyse approfondie des prévisions concernant la montaison du saumon rouge adulte dans le fleuve Fraser en 2010. Les grandes distributions de la probabilité découlant des prévisions concernant le saumon rouge du Fraser pour 2010 ainsi que l'incertitude entourant sa survie – voir les trois différents tableaux de prévisions – reflètent en général la réalité de la côte ouest de l'Amérique du Nord; c'est-à-dire qu'une grande incertitude entoure les prévisions en raison de la méconnaissance de plusieurs processus affectant les taux de survie. On reconnaît et on apprécie le fait que les auteurs aient utilisé certaines nouvelles méthodes dans leur travail de prévision (p. ex. inférence bayésienne pour estimer les incertitudes dans les prévisions et filtre de Kalman pour estimer la productivité variant dans le temps). Qui plus est, dans certaines analyses des prévisions pour 2010, les auteurs tiennent compte de l'importante diminution de la productivité (recrues adultes par reproductrice ayant frayé) de la plupart des stocks de saumons rouges du fleuve Fraser au cours des 20 à 50 dernières années. Pour refléter cette tendance au fil du temps, ils ont élaboré certains nouveaux modèles non paramétriques et ont utilisé la version du modèle de Ricker avec filtre de Kalman (avec un paramètre « a » variant dans le temps). Les auteurs ont également effectué des analyses de la sensibilité appropriées pour diverses hypothèses sur les changements de productivité.

Au cours de la discussion, on a mis l'accent sur les préoccupations concernant les tendances récentes relatives à la productivité et sur les conséquences du choix et de l'évaluation du modèle. Une importante partie de la discussion a été axée sur les préoccupations concernant l'incertitude entourant les prévisions et sur les approches potentielles pour réduire cette incertitude dans les prévisions sur le saumon rouge du Fraser. En excluant les recommandations concernant des

travaux supplémentaires afin d'examiner d'autres indicateurs environnementaux ainsi que des modèles des classes d'âges jumelles à utiliser en tant que valeurs *a priori* informatives pour les prévisions, on a conclu que l'apport d'améliorations importantes ne réduira probablement pas l'incertitude dans les prévisions.

Le groupe a souligné la grande qualité du travail des auteurs et a accepté le document, sous réserve de révisions mineures.

INTRODUCTION

The Centre for Science Advice Pacific (CSAP) Regional Advisory Process (RAP) meeting was held on March 9, 2010 at the Pacific Biological Station, Nanaimo, B.C. to review one working paper, which is summarized in Appendix 1. There was good representation from industry, universities, First Nations, and NGO's. During the introductory remarks, the objectives of the meeting were reviewed and the participants accepted the meeting agenda. The meeting participants reviewed the working paper which is summarized in Appendix 1. The meeting agenda appears as Appendix 2. A list of meeting participants and reviewers is included as Appendix 3.

DETAILED COMMENTS FROM THE REVIEW

Working Paper: Pre-season run size forecasts for Fraser River Sockeye salmon (*Oncorhynchus nerka*) in 2010

S.C.H. Grant, C.G.J. Michielsens, E.J. Porszt, A. Cass

*** Paper accepted subject to minor revisions***

Rapporteur: J. Scroggie

DISCUSSION

A draft working paper outlining the methods and results used to generate the 2010 Fraser River Sockeye forecast was presented. The document represents an extension of the CSAS Science Advisory Report tabled in November in 2009, in which 2010 Fraser Sockeye forecasts were also presented. The intent of the research document was to allow for the review and approval of forecasting models not included in the 2006 PSARC approved forecasting methodology. The models were developed to incorporate recent productivity trends into the forecasting process.

There were two reviewers for the paper, one internal and one external. Both reviewers and participants agreed that the authors conducted a reasonably thorough analysis for forecasting the 2010 adult returns of Fraser River sockeye salmon. The authors were congratulated by the reviewers for applying new methods for their forecasting work reporting on the substantial decrease in productivity (adult recruits-per-effective-female-spawner, or R/EFS) of most of the Fraser River Sockeye stocks over approximately the last 20-60 years. The authors were also clear to illustrate the exceptions to this trend; including the Late Shuswap stock group (a stock that has not exhibited long-term systematic trends in productivity), which is expected to be the largest component of the 2010 total return.

The authors and participants spent considerable time discussing the causes and effects of uncertainty in pre-season forecasts with the recognition that pre-season forecasts of salmon abundance are generally highly uncertain due the combination of historical variability in annual survival rates (stochastic uncertainty) and uncertainty regarding future survival rates. There was also a recognition that Fraser River Sockeye Salmon (Fraser Sockeye) forecasts in 2010 are especially uncertain given the decreasing trends in productivity for most stocks in recent years and, in particular, the unexpectedly poor returns in 2009.

Connected to the discussions around uncertainty was the shift in the most appropriate means to communicate forecast probabilities. In the 2010 forecast research document, the forecast distribution has been changed from the probability of exceeding the forecast to the probability of being lower that the forecast. For example, there would be a one in four chance at the 25% probability level that the actual number of returning Sockeye will be at or below the forecasted value given the assumptions about future survival. This was presented in both the CSAS research document and in the meeting presentation and marks a shift from previous years when the 25% probability level forecast indicated a one in four chance that the actual number of returning Sockeye would meet or exceed the forecasted value. Participants agreed that this change makes sense from a conservation perspective.

There was consensus that the use of alternative scenarios to address assumptions about future survival (productivity) was an improvement over previous forecasting documents. In 2010, three alternative scenarios were presented and evaluated to characterize the potential productivity of spawners in the 2006 brood year (returning as age 4 recruits in 2010). Discussion occurred over the appropriate labeling of the three scenarios with the final agreed to descriptions being:

- "Long Term Average Productivity" - assumes that the long term productivity trends (1948 to present for most stocks) will persist through to 2010;
- "Recent Productivity" - incorporates recent declining trends (1997 to present) in stock productivity into the methods; and
- "Productivity Equivalent to the 2005 Brood Year" (2009 return year) - assumes that productivity will be similar to that of the 2009 return (lowest on record for a number of stocks).

There was clarification that the stock productivity calculations for 2009 used to calculate age-4 recruits for the "Recent Productivity" and age-4 and age-5 recruits for the "Productivity Equivalent to the 2009 Return Year" were to be considered preliminary and incomplete.

It was also recognized that methods used to forecast Fraser River Sockeye abundance were the most up to date methods used for salmon on the west coast of Canada. Along with that recognition was considerable discussion regarding the incorporation of environmental indicators to help reduce uncertainty in the predictions. Environmental variables used quantitatively in forecasts have not significantly improved forecast performance. Qualitative environmental indicators were not included in the 2010 Forecast CSAS Research Document since currently the suite of indicators explored to date have not been effective for predicting Fraser Sockeye productivity.

There was discussion regarding the utility of 'sibling' forecasts or the incorporation of 'jack' returns into the forecast selection process. While sibling forecasts are more uncertain than the other forecast models presented, observations of large (or small) catches of jacks in the previous year may highlight support for picking one productivity scenario over another. The group recommended work on jack models should be conducted, specifically:

- looking to see if there are any patterns in the residuals (directional bias)
- the appropriateness of linear models (perhaps use a step function)

perform a retrospective analysis on the jack data. If you are missing jack data there are other approaches such as Dr. Randall Peterman's hybrid sibling model.

There was discussion regarding which performance measures managers see as being important for forecast model selection. It was suggested that in future years consultation with fisheries managers could take place prior to the initiation of future forecasting documents to ensure they have input into which performance measures are most appropriate.

Reviewers communicated that the paper was in need of a more thorough copy editing revision to improve the clarity of the information being communicated including the standardizing of key definitions and figure labeling. Improved descriptions of the methods used in the forecasting document were also recommended. This suggestion was tempered by the recognition that the forecasting methods were the most up to date being used on the west coast of Canada.

CONCLUSIONS AND RECOMMENDATIONS

- Participants and reviewers agreed that the methods employed to produce the forecasts were suitable and appropriate for these stocks.
- The trends observed in Fraser sockeye productivity have been addressed within the forecasting methods.
- Regardless of the inclusion of the new modeling approaches, there remains a high degree of uncertainty in the annual Fraser River Sockeye salmon forecasts and while recommendations were presented to improve the forecasting performance, significant improvements are unlikely to reduce uncertainty.
- Consensus was reached that all three forecasts will be provided with more weight to be placed on the “Recent Productivity” scenario given recent trends in Fraser Sockeye productivity.
- There was a reviewer recommendation to conduct an extensive edit on the text of the research document. The edit would help clarify the methods and results and ensure that definitions were consistent throughout the paper.

APPENDIX 1 : WORKING PAPER SUMMARY

Pre-season run size forecasts for Fraser River Sockeye salmon (*Oncorhynchus nerka*) in 2010

S.C.H. Grant, C.G.J. Michielsens, E.J. Porszt, A. Cass

- Pre-season forecasts of salmon abundance are generally highly uncertain due the combination of historical variability in annual survival rates (stochastic uncertainty) and uncertainty regarding future survival rates. Fraser River Sockeye Salmon (Fraser Sockeye) forecasts in 2010 are especially uncertain given the decreasing trends in productivity for most stocks in recent years and, in particular, the unexpectedly poor returns in 2009.
- Uncertainty that is attributed to stochastic (random) variability in annual Fraser Sockeye survival is communicated in the 2010 forecast paper through a series of forecasted values that correspond to standardized cumulative probabilities (10%, 25%, 50%, 75%, 90%) (Figure 10). For example, there would be a one in four chance at the 25% probability level that the actual number of returning Sockeye will be at or below the forecasted value given the assumptions about future survival.
- Uncertainty about future Fraser Sockeye survival is communicated in this paper through the presentation of three alternative cases (forecast tables) to characterize stock productivity for the 2010 returns:
  - **Case 1.** "Long Term Average Productivity" assumes that average stock productivity (across entire stock-recruitment time series) will persist through to 2010 (Table 2). Methods and model ranks were identical to the 2009 forecast (DFO 2009).
  - **Case 2.** "Recent Productivity" assumes that recent productivity trends will persist through to 2010 (Table 3). To forecast age-4 recruits, this case includes the addition of three new models that consider recent productivity. Model performance was evaluated in recent years only (brood years 1997-2004). Age-5 recruits were forecast using preliminary productivity for the 2005 brood year (2009 returns).
  - **Case 3.** "Productivity Equivalent to the 2005 Brood Year (2009 Returns)" assumes this low productivity will re-occur in 2010 (Table 5). Age-4 and age-5 recruits were forecast using preliminary productivity for the 2005 brood year (2009 returns),
  - At the time of this paper, the 2005 brood year productivity data used to forecast age-5 recruits in the Case 2 forecast and age-4 and age-5 recruits in the Case 3 forecast were preliminary and also do not include the age-5 recruits that will return in 2010.
- The forecast with the greatest degree of belief (as recommended by the March 9, 2010 Canadian Science Advisory Secretariat (CSAS) Regional Advisory Process (RAP)) was Case 2 ("Recent Productivity"). For this case, the number of returning Fraser Sockeye in 2010 will range from 7.0 million-18.3 million at the 25% to 75% probability levels. The same probability range each of the four run timing groups are as follows: Early Stuart Run: 26,000-66,000; Early Summer Run: 374,000-1.6 million; Summer Run: 1.6 million-4.3 million; and Late Run: 5.0 million-12.3 million (Figure 11 and Table 3).
- For Case 1 ("Long-Term Average Productivity"), the forecast range is from 8.4 million to 23.5 million at the 25% to 75% probability levels (Figure 11 and Table 2).
- For Case 3 ("Productivity Equivalent to the 2005 Brood Year (2009 Return)), the forecast range is from 1.6 million to 7.9 million at the 25% to 75% probability levels (Figure 11 and Table 5).

APPENDIX 2: AGENDA

CENTRE FOR SCIENCE ADVICE PACIFIC
SALMON SUBCOMMITTEE MEETING

March 9, 2010

Pacific Biological Station
Seminar Room
Nanaimo, BC

Tuesday, March 9	
Introduction and procedures	9:00 - 9:15
Review of Pre-season Fraser River Sockeye abundance forecast for 2010	9:15 -12:00
Lunch Break	12:00 -1:00
Continued review of Pre-season Fraser River Sockeye abundance forecast for 2010	1:00 - 4:00
Adjournment	4:00

APPENDIX 3: ATTENDEES AND REVIEWERS

First Name	Last name	Affiliation
EXTERNAL PARTICIPANTS		
Atkinson	Mary-Sue	Pacific Fisheries Resource Conservation Council
Blackbourn	Dave	Consultant
Graves	Gary	Northwest Indian Fisheries Commission
Harling	Wayne	Sport Fish Advisory Board
Lapointe	Mike	Pacific Salmon Commission
Michielsens	Catherine	Pacific Salmon Commission
Murray	John	Fraser Panel
Pestal	Gottfried	Solve Consulting
Peterman	Randall	Simon Fraser University
Seaweed	Reg	Quatsino First Nation
Staley	Mike	Consultant
Wilson	Ken	Watershed Watch Salmon Society
DFO PARTICIPANTS		
Brahniuk	Randy	
Candy	John	
Cass	Al	
Chamberlain	Mike	
Godbout	Lyse	
Grant	Sue	
Hargreaves	Brent	
Holt	Carrie	
Holtby	Blair	
Huang	Ann-Marie	
Irvine	Jim	
Johansen	Jeff	
Joyce	Marilyn	
Kristmanson	James	
McHugh	Diana	
Mortimer	Matt	
Portz	Erin	
Rosenberger	Barry	
Ryall	Paul	
Saunders	Mark	
Tompkins	Arlene	
Whitehouse	Timber	
REVIEWERS		
Peterman	Randall	Simon Fraser University
Wood	Chris	Fisheries and Oceans Canada

APPENDIX 4: TERMS OF REFERENCE

Terms of Reference

Regional Advisory Meeting

Pre-season Fraser River sockeye abundance forecasts for 2010

Pacific Scientific Advice Review Committee (PSARC)
9 March 2010
Pacific Biological Station
Nanaimo, BC

Chairperson: Michael Chamberlain

Context

The PSARC Salmon Subcommittee meets routinely to conduct peer reviews of scientific information in support of management decision making. A peer review of the Fraser River sockeye abundance forecasts for 2010 is planned for March 9, 2010.

Objectives

2010 Fraser River sockeye abundance forecasts:

Fraser River sockeye abundance forecasts are requested annually by Fisheries and Aquaculture Management for pre-season fisheries planning activities. Quantitative abundance forecasts have been produced and peer reviewed annually by DFO since the mid-1990s. A framework describing the methodology was reviewed by PSARC in 2006.

The objective of the March 2010 meeting is to review those changes in forecasting methodology, identified in the November 2009 review, which are new to the 2010 document and were included in the 2006 methodology. A recommendation as to the appropriate forecast for the 2010 return year will also be sought.

Products

- CSAS Proceedings document summarizing the discussion (1)
- CSAS Science Advisory Report (1)
- CSAS Research Document (1)

Location and Date

Pacific Biological Station, Nanaimo, BC, March 9, 2010

Participants

Participants will include internal DFO representatives and potentially participants from the Province of British Columbia, academia, First Nations, NGO's and industry.