Fisheries and Oceans Canada | Pêches et Océans Canada
Science | Sciences

C S A S | ***S C C S***

Canadian Science Advisory Secretariat | **Secrétariat canadien de consultation scientifique**

Proceedings Series 2004/032 | **Série des compte rendus 2004/032**

Proceedings of the PSARC Salmon Subcommittee Meeting

October 19-20, 2004
Nanaimo, BC

Greg Thomas

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

December 2004

Canada

Proceedings of the PSARC Salmon Subcommittee Meeting

October 19-20, 2004
Nanaimo, BC

Greg Thomas

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

December 2004

ISSN 1701-1272 (Printed / Imprimé)

Published and available free from:
Une publication gratuite de:

Fisheries and Oceans Canada / Pêches et Océans Canada
Canadian Science Advisory Secretariat / Secrétariat canadien de consultation scientifique
200, rue Kent Street
Ottawa, Ontario
K1A 0E6

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

CSAS@DFO-MPO.GC.CA

Printed on recycled paper.
Imprimé sur papier recyclé.

Correct citation for this publication:
On doit citer cette publication comme suit:

DFO, 2004. Proceedings of the PSARC Salmon Subcommittee Meeting, October 19-20, 2004. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2004-032

PACIFIC SCIENTIFIC ADVICE REVIEW COMMITTEE (PSARC)
SALMON SUBCOMMITTEE MEETING

SUMMARY

The Pacific Science Advice Review Committee (PSARC) Salmon Subcommittee met October 19 – 20, 2004 at the Pacific Biological Station, Nanaimo, B.C. to review three working papers.

Working Paper S2004-05: Habitat-based methods to estimate escapement goals for data limited Chinook salmon stocks in British Columbia.

The working paper described a habitat-based approach to generating spawner escapement goals for Chinook salmon in British Columbia. The model is based on a relationship between Chinook production capacity and freshwater habitat area. The method presents a less resource-intensive option for deriving biologically-based escapement goals compared to conventional stock-recruit analysis and is suggested for application in data-limited systems. The subcommittee accepted the working paper, with revisions, concluding the habitat model provides a useful interim measure of Chinook capacity in river systems. The Subcommittee agreed that the method should not replace reference points derived from stock-recruitment analysis where available.

Working Paper S2004-06: A review of biological principles and methods involved in setting minimum population sizes for the September 2004 drafts of the Cultus and Sakinaw Lake sockeye salmon and Interior Fraser coho salmon recovery plans.

The working paper reviewed the basis for setting conservation reference points for Cultus and Sakinaw lake sockeye. The authors concluded that the conservation limits identified in the recovery plans were adequate for these populations and that the recovery objectives were generally consistent with approaches in other North American jurisdictions. The Subcommittee supported the authors' conclusions and emphasized that the values are minimally adequate (ie. a measure of minimal viable population) and that maintenance of positive population growth is crucial to the recovery process.

Update S2004-08: A biologically based escapement goal for Cowichan River fall Chinook Salmon.

This update of a previous working paper presented a revised biologically-based escapement goal for Cowichan River fall Chinook. The subcommittee did not accept the recommended new escapement goal because of unresolved uncertainty in the spawner-recruit analysis and recommended a further analysis be carried out and reported in a future working paper. In addition, the Subcommittee noted the immediate conservation concern for naturally-spawning Cowichan Chinook based on recent poor escapements and survivals reported in the paper. The Subcommittee recommended

that another working paper reviewing the stock status of lower Strait of Georgia chinook be prepared for a future PSARC review.

SOMMAIRE

Le Sous-comité du saumon du Comité d'examen des évaluations scientifiques du Pacifique (CEESP) s'est réuni les 19 et 20 octobre 2004 à la Station biologique du Pacifique, à Nanaimo (C.-B.), pour passer en revue trois documents de travail.

Document de travail S2004-05 : Méthode axée sur l'habitat pour estimer les objectifs d'échappée pour les stocks de saumon quinnat de la Colombie-Britannique pour lesquels les données sont rares.

Ce document de travail décrit une approche axée sur l'habitat pour établir les objectifs d'échappée pour le saumon quinnat en Colombie-Britannique. Le modèle repose sur une relation entre la capacité de production du quinnat et la superficie de l'habitat en eau douce. Cette méthode, qui exige moins de ressources pour obtenir des objectifs d'échappée reposant sur des facteurs biologiques en comparaison de l'analyse traditionnelle stock-recrutement, est recommandée dans le cas des réseaux fluviaux pour lesquels les données sont rares. Le Sous-comité accepte le document de travail sous réserve de révisions et conclut que le modèle de l'habitat est une mesure utile provisoire de la capacité de production du quinnat dans des réseaux fluviaux. Il convient que cette méthode ne remplace pas les points de référence dérivés d'une analyse stock-recrutement lorsque ceux-ci sont disponibles.

Document de travail S2004-06 : Examen des principes et des méthodes biologiques utilisés pour fixer les effectifs minimums des populations dans les ébauches de septembre 2004 des plans de rétablissement du saumon rouge des lacs Cultus et Sakinaw et du saumon coho de l'intérieur du Fraser

Le fondement des points de référence de conservation pour le saumon rouge des lacs Cultus et Sakinaw est passé en revue. Les auteurs concluent que les limites propres à assurer la conservation de ces populations, établies dans les plans de rétablissement, étaient adéquates et que les objectifs de rétablissement correspondaient généralement aux approches adoptées par d'autres autorités compétentes en Amérique du Nord. Le Sous-comité accepte les conclusions des auteurs et souligne que les valeurs sont tout juste adéquates (c.-à-d. qu'elles représentent une mesure de la population viable minimale) et que le maintien d'un taux de croissance positif de ces populations est essentiel au processus de rétablissement.

Mise à jour du S2004-08 : Fondement biologique de l'objectif d'échappée d'automne pour le saumon quinnat de la rivière Cowichan

Cette mise à jour d'un document de travail contient un objectif révisé d'échappée d'automne, reposant sur des facteurs biologiques, pour le saumon quinnat de la rivière Cowichan. Le Sous-comité n'accepte pas ce nouvel objectif à cause de l'incertitude non résolue dans l'analyse du recrutement de géniteurs; il recommande qu'une analyse

plus détaillée soit réalisée et les résultats présentés dans un nouveau document de travail. Il prend aussi note des préoccupations à l'endroit de la conservation du quinnat qui se reproduit naturellement dans le lac Cowichan, que soulèvent les faibles échappées et taux de survie récents indiqués dans ce document. Le Sous-comité recommande qu'un autre document de travail sur l'état du stock de saumon quinnat de la partie inférieure du détroit de Georgia soit préparé aux fins d'évaluation future par le CEESP.

INTRODUCTION

DETAILED COMMENTS FROM THE REVIEW

S2004-05 Habitat-based methods to estimate escapement goals for data limited Chinook salmon stocks in British Columbia.
C. Parken, R. McNicol, J. Irvine

Subcommittee Discussion

The Subcommittee agreed that the working paper is an important step forward in the application of habitat models for developing biologically-based escapement targets for chinook salmon where stock-recruitment data are inadequate (data limited). The Subcommittee further agreed that that the limitations of the model need to be more fully acknowledged in revisions to the working paper and in future work. Discussion focused on whether or not the authors had fully considered 1) all sources of uncertainty in their analyses including systematic bias and precision of stock-recruitment reference points and 2) the appropriateness of the rules for including particular stocks, stock aggregates and habitats in the model. These comments were echoed by the two reviewers.

Key concerns and suggestions for future work based on the reviewers' comments and Subcommittee discussion included:

- sensitivity analysis of model performance for individual stocks to uncertainty in the habitat model parameter estimates given the regression is for a suite of stocks ranging from Alaska to Oregon
- sensitivity analysis of model estimates to alternative ways of aggregating the input data:
    - consider separate aggregations for geographically distinct stocks to assess potential confounding effects of spatial differences versus division by stream and ocean type life histories;
    - separately aggregate spawning ground limited habitats versus juvenile rearing limited habitats and the concern that freshwater habitats may not be limiting capacity (i.e. estuaries);
- concern that the model estimates could be biased in favor of the most productive and well studied stocks without accounting for the full range of chinook productivities;
- sensitivity analysis to assess uncertainty associated with measurements of watershed area and habitat quality;
- clarification of the criteria for choosing the modeled stocks and habitats including the rules for determining the size of "accessible" watersheds;
- verification of appropriate bias correction methods.

Subcommittee Conclusions

- The Subcommittee accepted the paper subject to revisions including an overview of the uncertainties and effects of those uncertainties on estimates of capacity parameters.
- The Subcommittee concluded that the model is correlative with limited biological information and cannot replace estimates of capacity where sufficient biological data are available.
- The Subcommittee concluded that model provides acceptable interim measures of capacity for establishing management targets but agreed that it should be applied with caution given potential for imprecision and systematic bias.
- Future development of the model is required before the application can be fully accepted including: 1) an evaluation of parameter sensitivity to factors affecting uncertainty and potential bias including uncertainty in the habitat variable. 2) an assessment of bias correction methods in the stock-recruitment and regression analysis.

Subcommittee Recommendations

1. The Subcommittee recommended that the authors continue to develop the method. In particular, that the authors continue work to:
   a) as soon as is reasonable, provide a full discussion of all the uncertainties associated with the model and effects of those uncertainties on escapement goals that the model is producing;
   b) determine whether or not Smsy and Srep values predicted by the model are systematically biased;
   c) Develop clearly stated rules for inclusion or exclusion of upstream and downstream habitats, inclusion or exclusion of stocks and aggregation or disaggregation of stocks, in the model.

2. The Subcommittee recommended that the model should not replace stock-recruitment approaches to determine escapement targets where sufficient valid stock-recruit data are available.

3. The Subcommittee recommended that subject to satisfactory investigation of the uncertainty and potential bias associated with the model, the model could be applied in the interim with caution to estimate escapement targets for data limited chinook stocks.

S2004-06 A review of biological principles and methods involved in setting minimum population sizes for the September 2004 drafts of the Cultus and Sakinaw Lake sockeye salmon and Interior Fraser coho salmon recovery plans.
M. Bradford, C. Wood.

Subcommittee Discussion

Both reviewers of the working paper concluded that the paper was technically sound and represented a 'state of the art' examination of the scientific basis and best practice for the numerical minimum viable population size (MVP) proposed in the recovery plans. Reviewers and Subcommittee members agreed with the authors' suggestion that the salmon recovery teams have been consistent in interpretation of the MVP in that it represents the abundance at the lower range of the spectrum of values they might have considered and also that it is well below the habitat carrying capacity.

Reviewers of the paper and Subcommittee members expressed some confusion over the subject of the working paper. The intent of the paper was to review the scientific basis for certain numerical objectives proposed in the recovery plans. During Subcommittee discussion, the authors agreed to change the title to better reflect that the intent of the paper was to review biological principles and methods for assessing viable population size of salmon.

Differences between recovery plans in the role of enhancement were described by the authors. Reviewers and Subcommittee members discussed some of the implications concerning the differences between recovery plans. The Subcommittee acknowledged that a thorough examination of the role of enhancement in the recovery plans was beyond the scope of the current working paper. The authors stated, however, that the calculation of a parameter *Ne*, representing the effective population abundance per generation given adverse genetic consequences, is complicated by enhancement activity. The effects of enhancement are complex and could act to either increase or decrease *Ne* depending on hatchery practices. The Subcommittee acknowledged that supplementation is only one of several threats to recovery including fisheries management. The Subcommittee discussed approaches for technical evaluation of the impacts of hatchery supplementation on "wild" salmon recovery. They concluded that if the populations are not listed under SARA, then the question defaults to the more general question: "What are the impacts of hatcheries in resource management?"

The authors reviewed evidence for depensatory mortality in Cultus Lake on juvenile sockeye salmon and agreed with the recovery team that reduced smolt per female at low spawner density could inhibit recovery. The spawner density of 1000 averaged over a four year period recommended by the recovery team as that required to ensure genetic integrity is considerably below the level at which depensatory mortality was

indicated (<7000). The Subcommittee agreed with the authors' assertion that fishery management should consider the evidence for depensatory mortality in setting management targets.

The reviewers and Subcommittee members agreed with the authors that population growth rate is a crucial component in the recovery process. Population growth rate is part of the recovery objectives in the recovery plans and the Subcommittee agreed that it be taken into account in fishery management plans. The targets for number of spawners could be viewed as short-term goals for fishery management but they are not appropriate as long term goals due to the need for positive population growth. Most risk concerns are met or exceeded at the MVP size (i.e., the minimally adequate "safe" population level) but not all. The more uncertainty that exists in population productivity, the greater the margin should be between the MVP (considered as a floor) and the management target. A recommended approach for managers would be to act to minimize the probability of falling below the MVP level.

The Subcommittee agreed with the authors' assertion that levels of both freshwater and marine survival-related factors need to be monitored and taken into account in setting fishery management targets.

The decision was made by the Interior Fraser coho recovery team to consider five separate populations in the Designatable Unit (DU). The decision to include five populations separately in the DU has not been reviewed by the authors or the Subcommittee. The Subcommittee recognized that the choice was guided within the recovery plans by both science and policy issues. This decision may have long-term implications for fisheries management under the PST. The authors agreed to clarify the scientific basis for five populations in the DU and their inference in the viability of the DU.

Subcommittee Conclusions

The working paper was accepted with revisions.

The Subcommittee accepted the minimum viable spawning population sizes presented in the Working Paper and agreed that most risk concerns are met at the MVPs (i.e., the minimally adequate "safe" population level) but not all. The more uncertainty that exists in population productivity, the greater the margin should be between the MVP (considered as a floor) and the management target.

A Positive population growth rate, in addition to establishing MVPs, is a crucial component in the recovery process. The MVPs should be viewed as short-term recovery targets for fishery management but they are not in themselves appropriate in the long term. .

The Subcommittee concluded that the importance of both freshwater and marine productivity should be emphasized in recovery planning and implementation.

Subcommittee Recommendations

1. The Subcommittee recommended that the principles and methods for establishing the minimum viable populations sizes presented in the paper be accepted and that fisheries management minimize the probability of spawning populations falling below the prescribe lower limit identified in the recovery plans.

2. Maintaining a positive population growth rate is part of the objectives in the recovery plans and the Subcommittee recommended that in addition to maintaining effective spawning populations above the MVP, managing for positive population growth rates is crucial and that it be taken into account in fishery management plans.

3. The Subcommittee agreed with the authors' assertion that levels of both freshwater and marine survival-related factors need to be monitored and taken into account in setting fishery management targets.

S2004-08 A biologically based escapement goal for Cowichan River fall Chinook Salmon – Update.
A. Tompkins, B. Riddell, D. Nagtegaal.

Subcommittee Discussion

The assessment was an update of existing methodology using data available to 2003. In keeping with the PSARC terms-of-reference dealing with updates, no pre-meeting reviews were obtained. An interim escapement goal of 7,400 (95% C.I. 4,185-18,915) was accepted by PSARC in May 2000 based on available stock-recruitment data. Consistent with the original report, the present analysis used spawning stock size and two covariates (marine survival and hatchery contribution to the natural spawners) to assess impacts on recruitment and recommended an escapement goal of 8,600 spawners (90% CI=5,004-28,386).

The review by the Subcommittee identified two concerns with the present analysis. First, an alternative analysis of the data was suggested that includes CWT estimates of smolt-to-adult survival directly in the estimate of recruitment rather than as a covariate. This would allow an evaluation of the effect of the hatchery covariate independent of potential density-dependant marine effects. Since 1990, the enhanced contribution to the naturally-spawning population has averaged 35% but ranged as high as 70% (2002) based on the incidence of coded wire tagged chinook recovered in the escapement.

Second, the Subcommittee identified a statistical issue that needs to be resolved when estimating point estimates of S_{msy} from stock-recruitment analysis with log-normal errors. The working paper estimate of the mean S_{msy} based on the standard back-transformation to correct for bias was 8,600 spawners. The mean of the distribution of S_{msy} based on bootstrapped sampling of the residuals was 12,000 spawners. The Subcommittee could not conclude which method was superior and suggested that this needs to be resolved before acceptance of the proposed S_{msy} target. Some Subcommittee members argued for establishing guidelines for conducting stock assessments that would deal with these sorts of statistical issues and, more generally, the relevance of advice based on the median or mean of parameter estimates.

Although the analysis was not a report on stock status, the data presented in the paper showed that recent wild chinook escapement estimates have dropped to near record lows and exploitation rate estimates have concurrently increased. The Subcommittee concluded that based on the information in the paper, the status of Cowichan chinook is poor. One meeting participant with a habitat perspective argued that spawning success of chinook entering the Cowichan River might be improved through flow regulation of the river. The Subcommittee noted that the Cowichan River stock is a prominant component of the Lower Strait of Georgia (LSG) indicator and

warrants a priority assessment of the stock status of LSG chinook. The Subcommittee further noted that the last LSG assessment was done in 1998.

Subcommittee Conclusions

- The revised escapement goal provided in the Update was not accepted.
- The Subcommittee concluded that a re-analysis of the stock-recruitment data be undertaken to decouple density dependent ocean survival effects from potential hatchery effects.
- The statistical issue identified by the Subcommittee for estimating point estimates of S_{msy} or other metrics derived from log-normal distributions should be resolved.
- Although the Update was not a report on stock status of Cowichan River chinook, the recent historical low escapements are cause for conservation concern.
- The present CWT and escapement monitoring should continue.

Subcommittee Recommendations

1. The Subcommittee recommended that a new stock-recruitment analysis that allows a direct assessment of hatchery effects on natural production be carried out and reported in a future PSARC working paper.

2. The Subcommittee recommended that the request for advice include input from the Ocean - Habitat Sector to consider alternative habitat-based mitigation methods for increasing spawning success such as water flow management.

3. The Subcommittee recommended that the stock status of Lower Strait of Georgia chinook be undertaken as soon as possible given the recent historical low chinook escapement to the Cowichan River.

APPENDIX 1: Working Paper Summaries

S2004-05 Habitat-based methods to estimate escapement goals for data limited Chinook salmon stocks in British Columbia.

C. Parken, R. McNicol, J. Irvine

DFO requires escapement goals for Chinook salmon stocks to evaluate status and achieve objectives established by international agreements and domestic policy. However, the stock-specific data typically needed to establish these 'goals' are, for the most part, lacking. The resources required to establish biologically-based goals using a conventional spawner-recruit approach for even a small number of stocks are prohibitive. Here we describe a habitat-based approach developed to generate escapement goals.

A relationship between productive capacity and freshwater habitat area was developed based on a meta-analysis of 25 Chinook stocks ranging from central Alaska to northern Oregon, representing a broad range of environments and life history. We developed an allometric model to predict Smsy and Srep (spawners required to produce maximum sustained yield and replacement) from the accessible watershed area and assessed the model's performance. The model adequately predicted the Smsy and Srep for an independent data source and out-performed the interim method applied to BC Key Streams. We applied the habitat-based approach to seven BC case study examples and found the approach performed adequately for most data limited stocks, yet overestimated the productive capacity of stocks with unusually small spawning areas for the watershed size.

The habitat-based method can generate biologically-based escapement goals, rooted in fish-production relationships, for data limited stocks over a broad range of environments. This simple approach requires easily acquirable data and makes few assumptions. However, spawner escapements of known accuracy and reliability are required, which may impede implementation for some systems. The approach is well-suited for most data limited stocks in BC and can be tested and refined as new stock-recruitment data become available. Since the habitat-based method was more accurate than the interim method for BC Key Streams, we recommend applying the habitat-based method for data limited stocks in BC to establish escapement goals until more stock-specific data are available.

S2004-06 A review of biological principles and methods involved in setting minimum population sizes for the September 2004 drafts of the Cultus and Sakinaw Lake sockeye salmon and Interior Fraser coho salmon recovery plans.
M. Bradford, C. Wood.

The purpose of this paper is to review the scientific basis for the recovery objectives contained in the September 2004 draft recovery plans for Cultus and Sakinaw Lake sockeye salmon and Interior Fraser coho salmon. First, a brief review of recovery objectives for a variety of other North American salmonid recovery plans was conducted, and we concluded that the objectives of the 3 plans were consistent with current practice; the main difference was that the objectives were more quantitative than was usual in other jurisdictions. Next, objectives that were developed for the purpose of conserving genetic resources in the endangered populations were compared to the recent literature and were found to be minimally adequate. In a review of population viability analysis (PVA) and its application to setting conservation targets, we concluded that demographically-based conservation goals in the order of 1,000 annual spawners was only adequate if there was an additional objective of maintaining positive population growth. We detailed and reviewed the evidence for depensatory mortality in Cultus Lake on juvenile sockeye salmon and concurred with the recovery team that there was reason to be concerned that at low spawner abundance reduced smolt production rates could inhibit recovery. Lastly, we documented the evidence used to develop a total escapement estimate for Interior Fraser coho salmon that would meet recovery objectives for individual populations and sub-populations.

A comparison of the recovery objectives with recent historical abundances indicates that the recovery targets for the 3 salmon populations are all less than one third of recent maxima. Thus the teams have been consistent in interpreting recovery as an abundance at the lower range of the spectrum of values they might have considered, well below the carrying capacity of their habitats. We conclude that there is a need to develop plans to maintain population productivity to ensure persistence at the proposed recovery targets.

S2004-08 Biologically based escapement goal for Cowichan Chinook Salmon – Update.

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

This assessment incorporates spawner recruit data available to 2003 and provides a revised biologically-based escapement goal for Cowichan River fall chinook, a naturally-spawning population in the lower Strait of Georgia. Present population sizes are an immediate conservation concern. In 2003, natural escapement was 1843 adult chinook (2813 total escapement), a similar level only experienced during 1986 -1987 (previous conservation concerns) when survival rates were three to eight times higher. 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 60%.

We recommend that the escapement goal for Cowichan River fall chinook should be increased to 8600 adult chinook, and 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.

APPENDIX 2: PSARC Salmon Subcommittee Meeting Agenda, October 19-20, 2004

AGENDA
PSARC SALMON SUBCOMMITTEE MEETING
October 19-20, 2004, Ramada on Long Lake
Nanaimo, BC

Tuesday October 19, 2004

9:00	Introductions and Opening Remarks.
9:30-12:00	Habitat based escapement targets for Chinook salmon
12:00	Lunch
1:00-2:00	Habitat based escapement targets for Chinook salmon continued
2:00-4:00	Biologically based escapement goal for Cowichan Chinook salmon

Wednesday October 20, 2004

9:00-12:00	Technical basis for biological limit reference points for salmon
12:00	Lunch
1:00-4:00	Technical basis for biological limit reference points for salmon continued

APPENDIX 3: List of Attendees

Subcommittee Chair: Greg Thomas
PSARC Chair: Al Cass

NAME	Tuesday (19)	Wednesday (20)
EXTERNAL PARTICIPANTS		
Argue, Sandy	✓	✓
Atkinson, Mary-Sue	✓	
Blackbourn, Dave	✓	✓
Chamberlain, Mike	✓	✓
Dunlop, Roger	✓	
Harling, Wayne	✓	
Rickard, Paul	✓	
Wilson, Ken	✓	✓
DFO MEMBERS		
* Subcommittee Members		
Adkins, Bruce	✓	
Bailey, Richard	✓	✓
Bailey, Steve		✓
Bonnell, Greg		✓
Bradford, Mike		✓
Brown, Gayle*	✓	✓
Cass, Al*	✓	✓
Cook, Roberta*	✓	✓
Davies, Shawn	✓	✓
Eros, Carol	✓	✓
Folkes, Michael	✓	✓
Godbout, Lyse		✓
Grout, Jeff*	✓	✓
Hargreaves, Brent	✓	✓
Holtby, Blair	✓	✓
Hyatt, Kim	✓	✓
Ionson, Bert	✓	✓
Ionson, Bert	✓	✓
Irvine, James*	✓	✓
McNicol, Rick*	✓	✓
Murburg, Dave	✓	✓
Nagtegaal, Dick	✓	
Parken, Chuck*	✓	✓

NAME	Tuesday (19)	Wednesday (20)
Sawada, Joel	✓	✓
Simpson, Kent*	✓	✓
Thomas, Greg*	✓	✓
Tompkins, Arlene*	✓	✓
Trouton, Nicole	✓	✓
Tutty, Brian	✓	
Van Will, Pieter	✓	✓
Wood, Chris*	✓	✓
Yockey, Cindy	✓	✓

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.

MacIssac, Erland	DFO
McElhany, Paul	NOAA