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Proceedings Series 2007/038 / **Compte rendu 2007/038**

Proceedings of the PSARC review on the recovery potential assessments on Speckled Dace, Cultus Pygmy Sculpin, and Okanagan Chinook

Compte rendu de l'examen des évaluations du potentiel de rétablissement du naseux moucheté, du chabot pygmée et du saumon quinnat de l'Okanagan effectué par le CEESP

June 19-20, 2007 / **19-20 juin 2007**

Alan Cass / **Alan Cass**

Fisheries and Oceans Canada
Pacific Biological Station
Nanaimo, BC V9T 6N7

January 2008 / **Janvier 2008**

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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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, 2007. Proceedings of the PSARC review on the recovery potential assessments on Speckled Dace, Cultus Pygmy Sculpin, and Okanagan Chinook, June 19-20, 2007. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2007/038.

PACIFIC SCIENTIFIC ADVICE REVIEW COMMITTEE (PSARC)

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SUMMARY

The Pacific Scientific Advice Review Committee (PSARC) met June 19-20, 2007 at the Coast Bastion Inn in Nanaimo, B.C. Three recovery potential assessment working papers were reviewed.

Working Paper: Recovery Potential Analysis for Chinook Salmon Okanagan Population, *Oncorhynchus tshawytscha*

The efficacy of biologically-based recovery targets and strategies depend on the nature of the population being recovered. Meeting participants agreed that accounts (a-c) are a good representation of alternative hypotheses influencing population structure important for evaluating recovery targets and strategies for Okanagan Chinook.

Participants concluded that the weight of the genetic evidence, albeit based on small sample sizes, supported evidence for account (c); Okanagan Chinook are not demographically isolated nor are they genetically unique as a result of straying from neighbouring and more abundant Similkameen and Wenatchee stocks in the US.

Participants agreed that the Population Viability Analysis (PVA) was well done but were critical of the PVA-based recovery target of 295 spawners because the modeled performance didn't assess outcomes of population projections relative to quasi-extinction values.

Based on the information presented, the PVA indicated that because of the current low population abundance (<50 spawners), recovery of Okanagan Chinook is unlikely without hatchery intervention.

Large-scale hatchery supplementation with US fish will be required to off-set low spawning abundance and high dam mortality for a migratory population traversing the Columbia system. This would likely cause extinction of a demographically isolated and genetically unique Canadian population; cause introgression of an isolated but genetically closely related Canadian and US populations (implying replacement of the Canadian population); and, recover the Canadian population if that population is not demographically isolated and is genetically closely related to US stocks.

Participants concluded that Appendix A in the working paper provided a useful description of habitat but that it wasn't sufficiently synthesized to identify what constitutes habitat important for survival or recovery.

Research to resolve uncertainty in the nature of the Canadian population are a high priority for advising on recovery goals and strategies. To this end, research activities identified during the review are:

- continue otolith ablation work to assess whether adult females sampled in the Okanagan system are offspring of non-anadromous females. This would help to further assess the plausibility of account (a) – isolated demographically; and
- assess the extent of immigration from US natural and hatchery populations to test the hypothesis that the Canadian population is genetically exchangeable with US populations.

There are a number of gaps in the understanding of basic life history characteristics for Okanagan Chinook. In particular, studies to assess the importance of juvenile rearing habitat for the survival or recovery of a Canadian population including the impact of invasive species should be undertaken as resources permit.

Studies to assess the location and importance of groundwater should be done to improve the understanding of factors important for spawning success as resources permit.

Working Paper: Recovery Potential Assessment for the Cultus Pygmy Sculpin (*Cottus sp.*)

Clarification of taxonomic status is important for determining the uniqueness of the species and should be a high research priority given the COSEWIC threatened designation is related to the extreme endemic distribution. Habitat requirements have been inferred through incidental observations and there are conspicuous gaps in all life stages, especially concerning habitat used for reproduction. Participants concluded that critical habitat for Cultus pygmy sculpin is provisionally synonymous with its known distribution.

Numerical recovery targets are not identified in the *proposed recovery strategy* (June 2007). The lack of any direct census data to assess population abundance and trends precludes recommending numerical recovery targets or an evaluation using Population Viability Assessment techniques. Participants supported the recovery strategy of ensuring the long-term viability of the population. The major threat is likely the potential for the introduction of aquatic invasive species.

Participants accepted the recovery strategy of ensuring the long-term persistence of the population. Until basic information on the life history of Cultus pygmy sculpin is acquired, participants accepted that potential critical habitat is synonymous with its known distribution.

Working Paper: Recovery Potential Assessment for the Speckled Dace (*Rhinichthys osculus*)

A target abundance for a healthy population of speckled dace cannot be established without better data to estimate the current abundance and capacity of the system. In the absence of information that indicates the population has declined, the recovery goal should be to maintain the persistence and present range of the population in Canada. Given the low data quality, it is not possible to quantify the importance of specific habitat types. Based on the qualitative information presented, the maintenance of adequate flow regimes in riffle habitat likely is an important strategy for ensuring population persistence. At present, there are insufficient data to quantify potential mortality related to reduced riffle flow.

In light of our poor understanding of the species' biology and natural history, quantitative estimates of its abundance by river reach, as well as studies of its habitat use by life stage and season are required. This information will be necessary to evaluate future population status and the importance (value) of specific habitat for survival and recovery.

SOMMAIRE

Le Comité d'examen des évaluations scientifiques du Pacifique (CEESP) s'est réuni les 19 et 20 juin 2007 au Coast Bastion Inn, à Nanaimo, en Colombie-Britannique, pour examiner trois documents de travail portant sur des évaluations du potentiel de rétablissement.

Document de travail – Évaluation du potentiel de rétablissement de la population de saumon quinnat de l'Okanagan (*Oncorhynchus tshawytscha*)

L'efficacité des objectifs et des stratégies de rétablissement fondés sur des critères biologiques est fonction de la nature de la population que l'on veut rétablir. Les participants conviennent que les points (a, b et c) représentent bien les différentes hypothèses qui influent sur la structure de la population et qui sont importantes pour l'évaluation des objectifs et des stratégies de rétablissement pour le saumon quinnat de l'Okanagan.

Les participants concluent que le poids des preuves génétiques, bien que fondées sur de petits échantillons, appuie les preuves associées au point (c); le saumon quinnat de l'Okanagan n'est pas isolé démographiquement et n'est pas génétiquement unique en raison de la présence d'individus errants provenant des stocks voisins et plus abondants de la Similkameen et de la Wenatchee, aux États-Unis.

Les participants conviennent que l'analyse de la viabilité de la population (AVP) a été bien exécutée, mais critiquent l'objectif de rétablissement de 295 géniteurs fondé sur l'AVP du fait que le rendement modélisé ne nous permet pas d'évaluer les résultats des projections démographiques en fonction de valeurs de quasi-extinction.

D'après l'information présentée, l'AVP indique qu'en raison de la faible abondance actuelle de l'espèce (< 50 géniteurs), le rétablissement du saumon quinnat de l'Okanagan est peu probable sans l'apport de poissons d'écloserie.

Nous devrons procéder à des lâchers à grande échelle de poissons d'écloserie en provenance des États-Unis pour compenser la faible abondance des géniteurs et la mortalité élevée imputable aux barrages de cette population migratrice qui traverse le réseau du fleuve Columbia. Toutefois, cet apport causera probablement l'extinction de la population démographiquement isolée et génétiquement unique du Canada. Il occasionnera également l'introgression de populations isolées, mais étroitement liées sur le plan génétique, en provenance du Canada et des États-Unis (ce qui suppose le remplacement de la population canadienne). Il permettra enfin le rétablissement de la population canadienne si celle-ci n'est pas démographiquement isolée et si elle est étroitement apparentée sur le plan génétique aux stocks américains.

Les participants concluent que l'annexe A du document de travail fournit une description utile de l'habitat, mais que la synthèse effectuée est insuffisante pour que l'on puisse identifier ce qui constitue un habitat important pour la survie ou le rétablissement.

Nous devons réaliser rapidement des recherches pour résoudre l'incertitude entourant la nature de la population canadienne afin de formuler des avis sur les objectifs et les programmes de rétablissement. À cette fin, les activités de recherche relevées pendant l'examen sont les suivantes :

- poursuivre les travaux de cueillette d'otolithes pour évaluer si les femelles adultes prélevées dans le réseau de l'Okanagan sont les filles de femelles non anadromes. On pourrait ainsi mieux évaluer la plausibilité du point (a) – isolement démographique;
- évaluer l'ampleur de l'immigration issue de populations naturelles et d'écloserie des États-Unis pour vérifier l'hypothèse selon laquelle la population canadienne est génétiquement liée à celles des États-Unis.

Il existe un certain nombre de lacunes dans notre compréhension des caractéristiques de base du cycle biologique du saumon quinnat de l'Okanagan. Nous devons notamment entreprendre des études pour évaluer l'importance de l'habitat de croissance des juvéniles pour la survie ou le rétablissement de la population canadienne, y compris l'impact des espèces envahissantes, si les ressources le permettent.

Nous devons aussi entreprendre des études pour évaluer l'emplacement et l'importance des eaux souterraines afin de mieux comprendre les facteurs importants pour le succès de la reproduction, si les ressources le permettent.

Document de travail – Évaluation du potentiel de rétablissement du chabot pygmée (*Cottus* sp.)

Nous devons clarifier le statut taxonomique de l'espèce pour déterminer son caractère unique. Il s'agit d'une importante priorité de recherche étant donné que la désignation attribuée par le COSEPAC, à savoir celle d'« espèce menacée », est liée au caractère extrêmement endémique de la répartition. Nous avons déduit les exigences relatives à l'habitat par des observations fortuites, et nous remarquons l'existence de lacunes au chapitre des connaissances pour tous les stades de développement, particulièrement pour ce qui est de l'habitat de reproduction. Les participants concluent que l'habitat essentiel du chabot pygmée est provisoirement synonyme de sa répartition connue.

Les objectifs numériques de rétablissement ne sont pas définis dans le *programme de rétablissement proposé* (juin 2007). Faute de données directes du recensement de la population pour évaluer l'abondance de l'espèce et les tendances, on ne peut recommander d'objectifs numériques de rétablissement ou une évaluation fondée sur des techniques d'analyse de la viabilité de la population. Les participants soutiennent la stratégie de rétablissement qui consiste à assurer la viabilité à long terme de la population. Le potentiel d'introduction d'espèces aquatiques envahissantes constitue probablement la principale menace.

Les participants approuvent la stratégie de rétablissement qui consiste à assurer la persistance à long terme de la population. En attendant d'avoir en main de l'information de base sur le cycle biologique du chabot pygmée, les participants conviennent que l'habitat essentiel potentiel est synonyme de sa répartition connue.

Document de travail – Évaluation du potentiel de rétablissement du naseux moucheté (*Rhinichthys osculus*)

Nous ne pouvons établir une abondance cible pour une population saine de naseux mouchetés, puisque les données actuelles ne nous permettent pas d'estimer l'abondance actuelle et la capacité du réseau hydrographique. Faute d'information indiquant un déclin de la population, l'objectif de rétablissement doit être d'assurer le maintien de la population et de son aire de répartition actuelle au Canada. Compte tenu de la faible qualité des données, il n'est pas possible de quantifier l'importance des types d'habitat particuliers. D'après l'information qualitative présentée, le maintien de régimes d'écoulement adéquats dans les radiers est vraisemblablement une stratégie importante pour assurer la persistance de la population. Actuellement, les données ne nous permettent pas de quantifier la mortalité potentielle liée à une diminution du débit dans les radiers.

En raison de notre faible compréhension de la biologie et de lhistoire naturelle de l'espèce, nous devons estimer quantitativement l'abondance de l'espèce dans chaque tronçon de cours d'eau ainsi qu'étudier son utilisation de l'habitat selon le stade de développement et la saison. Nous aurons besoin de cette information pour évaluer la situation future de la population et l'importance (valeur) de l'habitat particulier de survie et de rétablissement.

INTRODUCTION

The Pacific Scientific Advice Review Committee (PSARC) met on June 19-20, 2007 at the Coast Bastion Inn in Nanaimo, B.C. to review three Recovery Potential Assessment Working Papers. The meeting Chair, A. Cass welcomed the participants and a round of introductions was completed. Participants included DFO, academics and First Nations. The Chair outlined the purpose of the meeting: to review Recovery Potential Assessments (RPA) for the three papers and to provide advice. The preparation of an RPA is a legal obligation under SARA. The objectives, procedure, and deliverables were also outlined.

Fisheries and Oceans Canada (DFO) is the lead jurisdiction under SARA and is committed to undertake RPAs of all aquatic species designated as threatened or endangered by COSEWIC. The purpose is to provide rationale for potential incidental harm permitting under SARA (Section 73), advise on science components of Recovery Strategies and Action Plans, provide biological input for subsequent socio-economic analyses and inform the minister on matters related to listing decisions.

The meeting participants reviewed draft RPA working papers for three species designated by COSEWIC as either threatened or endangered. The Terms of Reference for the reviews are in Appendix 1. The summaries of each working paper are summarized in Appendix 2. The meeting agenda appears as Appendix 3. A list of meeting participants and reviewers is included as Appendix 4.

DETAILED COMMENTS FROM THE REVIEW

Recovery Potential Analysis for Chinook Salmon Okanagan Population, *Oncorhynchus tshawytscha*

C. Davis, H. Wright, T. Brown, B. Phillips, R. Sharma, C. Parken

Okanagan Chinook was designated as endangered in an emergency assessment COSEWIC in May 2005 due to the deplete nature of the population (<50 spawners). The status was re-examined in April 2006 and designated as threatened. The more recent assessment was based on genetic data indicating the potential for rescue from populations in adjacent areas of the Columbia River basin. The RPA was prepared under contract between DFO with the Okanagan First Nations Alliance. The working paper contained a main synthesis document and three separate appendices with details on 1) habitat assessment (Appendix A), 2) genetic assessment (Appendix B) and 3) a Population Viability Analysis (PVA) (Appendix C). Three reviewers provide a formal critique of the working paper.

General discussion

Reviewers and participants agreed that the document and the appendices contain a substantial amount of information and several useful analyses relating to the recovery potential assessment of Okanagan Chinook. All reviewers indicated the paper could benefit from significant reorganization of the content that includes a more adequate synthesis of information in the appendices.

Population structure: One reviewer expressed concern that the scope of the main document was not broad enough to inform decision makers on what is at stake (i.e. what is it that is being recovered?). In the reviewer's opinion, the answer to that question has important implications for advising on appropriate recovery goals and strategies to achieve them. A primary concern of the reviewer was that the main document did not adequately resolve questions related to the degree of demographic isolation and genetic uniqueness of the population (i.e. COSEWIC Designatable Unit). This prompted the reviewer to identify three hypotheses (accounts) that have different implications for recovery and therefore need to be considered in the RPA and the provision of advice:

(a) The Canadian population is both demographically isolated and ecologically non-exchangeable with US populations. For example, the Canadian population might have persisted in the face of the dire threats from dams and fisheries because of its adaptations for non-anadromy, either as a largely self-perpetuating resident population, or as a polymorphic anadromous/resident population. If these adaptations are unique, the population should be regarded as *non-replaceable*.

(b) The Canadian population is demographically isolated but genetically closely related and ecologically exchangeable with US populations. On this account, adaptations for residency are not unique or they contribute negligibly to the viability or ecological role of this population in Canada.

(c) The Canadian population is not demographically isolated from US populations. Because at least some reproduction occurs in Canada (fry and residents have been observed from 2 or 3 brood years), the population should be considered a Canadian "wildlife species", but its fate will depend on immigration from the USA.

The reviewer acknowledged that it may be possible to reject one or more of these hypotheses by further analysis of existing data, but thought that more research is required. Account (a) remains plausible only if ecological non-exchangeability can be justified. Its plausibility would be enhanced if a persistent abundance of female residents were discovered or could be inferred (e.g. ablation studies). As noted in the review, preliminary ablation studies to assess if juveniles in freshwater originated from resident parents is suggestive of non-anadromous Okanagan Chinook. Research directed at determining strontium:calcium ratios of females, in particular, could be important for determining whether self-sustainable and isolated non-anadromous populations exist (account a).

Genetic description: One reviewer stated that the genetic description in the main body of the text was confusing and potentially misleading in contrast to Appendix B which he found clear and precise. The reviewer did think however that Appendix B omitted a pertinent discussion of genetic analyses of fry and resident samples; the only samples known to represent successful reproduction in Canada. In the reviewer's opinion, account (c) remains plausible only if persistently high levels of immigration (>10%) from the US can be demonstrated. Further analysis or tagging is warranted to determine whether immigration into Canada from natural spawning sites in the US might exceed 10%. Analyses of neutral (microsatellite) gene frequencies and gene diversity (Appendix B) are most consistent with account (c), but are not, in the opinion of the reviewer, adequate to rule out the other accounts without supplemental knowledge of spawning success of immigrants, and the potential size of a demographically isolated Canadian population.

The reviewer disagreed with the conclusion in the working paper that "the Okanagan population is unlikely to be a long-standing remnant population that is independent from nearby populations in the Okanagan drainage". The reviewer elaborated that the genetic analyses (based on small samples) do indicate that gene flow has been adequate to prevent genetic differentiation or loss of alleles at neutral microsatellite loci in the Canadian spawners. The reviewer cautioned that only a low level of gene flow is required to prevent detectable changes in allele frequencies, and this would not preclude the existence of a small Canadian population that is demographically isolated (account b) with unique adaptations for survival in Canada (account a).

Species status: A reviewer was critical of the organization of the status description in the working paper. The reviewer found the mixed statements about Okanagan Chinook and statements about US populations confusing. Clearly, however, current spawning escapement estimates of <50 individuals represents a severely depleted population compared to historical levels that reportedly once supported a food and economic (trade) fishery prior to non-native settlement.

An observation that 565 spawners entered the system in 2006 based on video counts at Zosel Dam compared to a peak spawning ground count of 30 in the same year was noted in the report. Meeting participants questioned this apparent discrepancy. Participants indicated that it is unlikely that many fish are missed during spawning ground surveys and that fish likely dropped back past the dam after they were counted. Participants agreed that this has a bearing on status and PVA modeling and therefore should be resolved with future research.

Habitat assessment: Reviewers and participants agreed that Appendix A provided a good summary of habitat information. They noted however that the information was not synthesized adequately into the main document nor was there an interpretation of what constitutes critical habitat. One review thought there is enough detail in Appendix A to provide advice on critical habitat. Ultimately the value of particular habitats would depend on the choice of recovery target and the factors affecting the nature of the population (i.e. accounts (a-c)). Protection of spawning habitats are more critical for accounts (a,b) than for account (c). Recognizing that an RPA needs to advise on the biological importance (value) of habitats, one approach discussed is to consider known spawning locations as critical to survival or recovery. Participants acknowledged that assigning values to habitat is difficult given uncertainty about influence of groundwater and freshwater rearing habitat on reproductive success. At present spawning habitat does not appear to be a limiting factor for the few remaining adult spawners.

Participants agreed that the value of juvenile freshwater rearing habitat cannot be determined from the data. The distribution of juveniles, their numbers, residency time, and densities are unknown. The movement patterns of Chinook fry and juveniles following emergence is poorly understood. The availability or capacity of freshwater rearing habitat therefore cannot be estimated.

A reviewer pointed out that the fate of naturally spawning Okanagan Chinook rests with land use in the watershed. In his view, there could be as many as a million people living in the Okanagan valley by 2050. From a land-use planning perspective, the reviewer thought it desirable to know how planning of the Okanagan watershed integrates with what is happening in the rest of the Columbia watershed. An example cited by the author is the heavy predation by pikeminnows at Wells and McIntyre dams that in his view wasn't accounted for in model. He further commented that there is a need for basic biological investigations on this population, particularly for juveniles.

One reviewer noted that the working paper lacked any discussion on potential climate change impacts particularly on freshwater survival. The population exists within arid conditions where climate change impacts could create more demand for water use and adversely affect spawning and rearing survival conditions

Recovery goals: Each account of what is to be recovered suggests a different recovery goal, with different implications for the target abundance and recovery strategy. In one reviewer's opinion, given the genetic evidence for recent (and likely continuing) gene flow with the larger US population, recovery targets on any account probably do not need to meet the abundance criterion (N_e>1000) for maintaining genetic diversity in a closed population over the longer term. However, targets would have to be larger for accounts (a) and (b) than for account (c). If the Canadian population is demographically isolated, then recovery will not occur unless threats to spawning and rearing in Canada are addressed; this might be desirable but would not be essential on account (c).

Reviewers and meeting participants agreed that the PVA in Appendix B was well done. The results indicate that sustainable populations are highly improbable without large-scale hatchery supplementation given the current low abundance and high dam mortality. As one reviewer pointed out, large-scale hatchery supplementation with US fish would likely cause extinction of the isolated Canadian population on account (a), introgression of the Canadian and US populations (implying replacement of the Canadian population) on account (b), and recovery of the Canadian deme on account (c). A potential short-coming of the PVA is that it was based on the account (b) scenario. One reviewer questioned why scenarios that included captive brood-stock supplementation to preserve genetic integrity under accounts (a,b) weren't considered to in the PVA. He noted, however, that scenarios with captive brood supplementation wouldn't be useful for account (c). Given the evidence for account (c), some reviewers and participants argued for a PVA model that assesses the effect of straying levels on recovery. The PVA analyst stated that a straying option could be included in the model but, based on initial trials, thought the results would be similar to scenarios that included hatchery supplementation. One reviewer indicated that data sources used in the VPA should be explicitly identified. The authors agreed to clarify this issue in revisions to the paper.

A reviewer noted that the PVA did not include explicit consideration of risk due to demographic stochasticity or genetic changes. He further stated that typically, these risks are modelled indirectly, by setting a quasi-extinction threshold above which these risks can safely be ignored. The "process error" estimated from residuals likely includes measurement error as well as environmental stochasticity. Measurement error should not be propagated in a PVA, but in practice, it is difficult to estimate and remove. The likely overestimation of environmental process error that includes measurement error might compensate for underestimation of other sources of uncertainty (demographic stochasticity and structural model error). For these reasons, the reviewer did not consider this a serious deficiency, but thought the issue should be acknowledged in the working paper.

In one reviewer's opinion, given uncertainty regarding the nature of population isolation and uniqueness (i.e. answering the question: what is being recovered?), the recovery targets remain uncertain. The PVA results based on the account (b) scenario produced what was described in the paper as a "minimum population size" value of 295 spawners (produced from 1.75 million smolts). The reviewer questioned where the 295 spawner target came from because it wasn't based on a quasi-extinction level to evaluate what is acceptable or unacceptable from a risk-based perspective.

Meeting participants agreed that if Okanagan Chinook are not demographically isolated and not genetically unique then recovery in Canada could be addressed through hatchery supplementation without concern for preserving genetic uniqueness (accounts (a,b)).

Human-induced mortality and scope for allowable mortality: Dam-passage mortality of juvenile Upper Columbia River Chinook is recognized as the single most important source of direct human-induced mortality. A dam mortality rate of 57% has been estimated for juveniles from surrogate populations compared to 15-20% for adult migrants. Fishery impacts on Okanagan Chinook cannot be measured directly but are estimated for more abundance US hatchery populations. Harvest rates have varied in recent years from 18% in 1991 to more that 70% in 1999. Less quantifiable mortality occurs from water withdrawals, habitat destruction, and potential competition and predation by invasive species.

The results of the PVA, based on the account (b) scenario, indicates that juvenile and adult mortality by dams limits population persistence. Ocean survival impacts also affected persistence. The authors pointed out that the PVA scenarios included a period when ocean survival were among the highest observed. Population trajectories presented in the working paper would therefore be more optimistic than in the presence of low ocean survival rates resulting from future climate change impacts. While fishing mortality also contributes to the declines in population projections, even in the absence of harvest the stock would not recover under account (b) given the low spawning abundance and high dam mortality. Given the results of the PVA, there was no consideration given in the paper for allowable harm.

Conclusions

- The efficacy of biologically-based recovery targets and strategies depend on the nature of the population being recovered. Meeting participants agreed that accounts (a-c) are a good representation of alternative hypotheses influencing population structure important for evaluating recovery targets and strategies for Okanagan Chinook.

- Participants concluded that the weight of the genetic evidence, albeit based on small sample sizes, supported evidence for account (c); Okanagan Chinook are not demographically isolated nor are they genetically unique as a result of straying from neighbouring and more abundant Similkameen and Wenatchee stocks in the US.

- Participants agreed that the Population Viability Analysis (PVA) was well done but were critical of the PVA-based recovery target of 295 spawners because the modeled performance didn't assess outcomes of population projections relative to quasi-extinction values.

- Based on the information presented, the PVA indicated that because of the current low population abundance (<50 spawners), recovery of Okanagan Chinook is unlikely without hatchery intervention.

- Large-scale hatchery supplementation with US fish will be required to off-set low spawning abundance and high dam mortality for a migratory population traversing the Columbia system. This would likely cause extinction of a demographically isolated and genetically unique Canadian population; cause introgression of an isolated but genetically closely related Canadian and US populations (implying replacement of the Canadian population); and, recover the Canadian population if that population is not demographically isolated and is genetically closely related to US stocks.

- Participants concluded that Appendix A in the working paper provided a useful description of habitat but that it wasn't sufficiently synthesized to identify what constitutes habitat important for survival or recovery.

Recommendations

1) Research to resolve uncertainty in the nature of the Canadian population are a high priority for advising on recovery goals and strategies. To this end, research activities identified during the review are:
   - continue otolith ablation work to assess whether adult females sampled in the Okanagan system are offspring of non-anadromous females. This would help to further assess the plausibility of account (a) – isolated demographically; and
   - assess the extent of immigration from US natural and hatchery populations to test the hypothesis that the Canadian population is genetically exchangeable with US populations.

2) There are a number of gaps in the understanding of basic life history characteristics for Okanagan Chinook. In particular, studies to assess the importance of juvenile rearing habitat for the survival or recovery of a Canadian population including the impact of invasive species should be undertaken as resources permit.

3) Studies to assess the location and importance of groundwater should be done to improve the understanding of factors important for spawning success as resources permit.

Recovery Potential Assessment for the Cultus Pygmy Sculpin (*Cottus sp)*
B. Harvey

Cultus pygmy sculpin (CPS) was designated as threatened by COSEWIC (2000) and is listed as threatened in Schedule 1 of SARA, mainly because it is an extreme endemic. A *Proposed Recovery Strategy* (June 2007) provides recovery goals and strategies. The species was discovered in 1934 and much of what is known about the population is contained in a singe research paper (Ricker, W.E. 1980). CPS is believed to occupy the greater part of Cultus Lake from surface to bottom, excluding only a poorly defined littoral (shoreline) fringe where it has not so far been observed. The recovery strategy focuses on the goal of ensuring the long-term viability of the population. Three reviews of the paper were presented.

General Discussion

All three reviewers indicated that the working paper was a good treatment of a data limited species. One reviewer stated that there was not enough known to make informed decisions on critical habitat, abundance, and population targets for recovery. The reviewer indicated that CPS may not be unique and its habitat may not be threatened. He further postulated that under the right set of environmental conditions, other similar populations might independently develop a pelagic existence (i.e. neotony) and perhaps these populations may exist in the many coastal lakes. One review indicated that revisions to the paper should consider the broad uncertainties about Cultus pygmy sculpin and not make definitive statements when information is not available. The author agreed to revise the text accordingly based on the comments provided by the reviewer.

Genetic description: Participants acknowledged that the proposed recovery strategy identifies taxonomic research as a high priority. Participants noted that a study of the pygmy sculpin's phylogenetic relationships with neighbouring coast range sculpin populations is under way at the University of British Columbia.

Species status: Reviewers and participants acknowledged that the species is very data limited and that there are no reliable trend data or estimates of abundance. Most of what is known is based on the limited observations of Ricker (1960) and on collections made during acoustic and mid-water trawl surveys targeting juvenile sockeye since 1975.

Participants acknowledged that the range trajectory is likely unchanged since glaciation and unlikely to change in the near future given the static shape and volume of the lake. The working paper reports a slight but statistically insignificant decline in the incidental CPUE data over time but participants acknowledged the data may not be representative of CPS abundance trends given surveys were never designed to sample CPS. One review questioned that since the only information available is from night surveys in the pelagic zone: was the fish truly nocturnal and pelagic (neotonic) or was this only a sampling artifact? Participants agreed that the lack of sampling elsewhere represented a substantial knowledge gap in assessing the distribution within the lake. This is especially true for evaluating the relationships between the littoral zone, milfoil, CPS reproduction, and early life history.

Habitat assessment: A reviewer stated that in his opinion, critical habitat for this species could be defined as the current, known distribution given uncertainty in life history traits and therefore the value of specific habitat contributing to the persistence of CPS. Another reviewer noted the critical habitat is a mosaic that changes over time and we should not simply be looking for a weak link. As reported by COSEWIC (2006), existing analysis of trends in the limnetic habitat of Cultus Lake indicate little change over the past six decades. Benthic habitat, however, has not been stable in Cultus Lake since the introduction of Eurasian water milfoil in the late 1970s.

Recovery goals: Participants acknowledged that CPS was designated by COSEWIC as threatened because it is an "extreme endemic" and that the draft *Recovery Strategy* does not set quantitative recovery targets. The recovery goal in the strategy of ensuring the long-term viability of the species was therefore considered appropriate by meeting participants.

Human-induced mortality and scope for allowable mortality: Participants noted that the only known human-induced mortality on CPS is from occasional bycatch in the sockeye midwater trawl surveys. Participants agreed that the greatest threat is the potential for the introduction of invasive species into Cultus Lake such as yellow perch, bass, bullhead and pumpkinseed. Potential for either negative or positive effects of milfoil in the nearshore lake habitat has not been determined. Hatchery supplementation and enhanced freshwater survival of Cultus Lake sockeye could impact the abundance of CPS through competitive species interactions. Eutrophication through human-induced nutrient loading, contamination or reduction of groundwater and recreational use of the lake were other potential threats noted in the review. Participants agreed that the total allowable mortality the species can withstand in order to maintain persistence is not known. The scope for allowable mortality, therefore, cannot be determined from available information. Participants noted, however, that given the population of CPS appears stable, the current level of mortality likely is not limiting population persistence. One participant indicated that an expert opinion methodology has been used in the Central and Arctic Region to assess threats for data limited freshwater species assessed there.

Conclusions

- Clarification of taxonomic status is important for determining the uniqueness of the species and should be a high research priority given the COSEWIC threatened designation is related to the extreme endemic distribution.

- Habitat requirements have been inferred through incidental observations and there are conspicuous gaps in all life stages, especially concerning habitat used for reproduction. Participants concluded that critical habitat for Cultus pygmy sculpin is provisionally synonymous with its known distribution.

- Numerical recovery targets are not identified in the *proposed recovery strategy* (June 2007). The lack of any direct census data to assess population abundance and trends precludes recommending numerical recovery targets or an evaluation using Population Viability Assessment techniques. Participants supported the recovery strategy of ensuring the long-term viability of the population.

- The major threat is likely the potential for the introduction of aquatic invasive species.

Recommendations

1. The catch-per-unit-effort data for Cultus pygmy sculpin from sockeye trawl surveys should be included in the revision to the working paper.

2. Revisions should consider the life history information supplied by one reviewer.

3. Accept the recovery strategy of ensuring the long-term persistence of the population.

4. Until basic information on the life history of Cultus pygmy sculpin is acquired, accept that potential critical habitat is synonymous with its known distribution.

Recovery Potential Assessment for the Speckled Dace (*Rhinichthys osculus)*

B. Harvey

Speckled dace are common in the western United States. Its geographic range protrudes into Canada within the Kettle-Granby River drainage in the west Kootenay area of southern British Columbia. Speckled dace have been observed in approximately 300 km of river in Canada. Speckled dace were designated by COSEWIC as *Endangered* because of its isolation in a single drainage basin and the low potential rescue effect after a catastrophic event because of a natural barrier between Canada and US populations. Speckled dace is not listed under *SARA*.

General discussion

Reviewers and participants agreed the RPA was well written and the author had done a commendable job with the limited information available.

Genetic description: One reviewer commented that there maybe potential for more than one population of speckled dace in the Canadian system and noted that this should be investigated. Genetic data for speckled dace in the US indicated the existence of genetic divergence between basins. Another reviewer observed that populations at the edge of their range are potentially genetically unique.

Species status: Meeting participants acknowledged the poor data quality available for the species but recognized that the population is numerically abundant and roughly in the range of 11,500 to 23,100 individuals. Participants agreed that the population appears to be stable and at no immediate conservation risk. Participants supported the stated "recovery" target of a self-sustaining population.

Habitat assessment: As a stream-dwelling species that occupies fast-water riffle habitat, the species potentially can be affected by long-term changes in water volume and velocity. A reviewer pointed out that the riffle areas may only be used for shelter during the day and that these animals most probably exhibit nocturnal foraging activity. In the reviewer's opinion, the importance of riffle habitat is unclear given that the morphological characteristics of speckled dace are not those of an animal that lives in fast water. In addition, the reviewer noted that as a species dace are exceedingly versatile with the capacity to adapt to considerable environmental variability. The reviewer noted that there is no solid information on what they eat or where they spawn though it is likely that they spawn on a declining hydrograph with increasing temperatures.

Participants agreed that not enough is known about speckled dace habitat requirements to describe critical habitat. A schedule of studies to determine this will need to be included in the recovery strategy. Based on studies on US populations, spawning appears to occur over clean gravel and may include preparation of a nest site by males. If such site preparation occurs, it implies a residence requirement for the duration of spawning, and perhaps during larval development as well. The latter has implication for SARA given the need to protect places of residence.

Recovery goals: Participants agreed that a quantitative abundance recovery target speckled dace cannot be established without better data. The working paper presented rationale for two abundance-based conservation limits: 1) 2,500 individuals when applying COSEWIC's small-population risk criteria threshold equal to 10% of the carrying capacity of the environment; and 2) a 5,000 – 7,000 minimum viable population size adopted for listed vertebrate species based on theoretical considerations to guard against genetic and other potential depensatory factors that increase mortality at low abundances. Participants noted however that the state of the speckled dace population relative to any benchmark requires quantitative survey data.

Participants noted that an appropriate distribution target for recovery should, in the absence of any evidence that distribution has changed significantly, reflect the need to maintain the status quo, namely to preserve the species' current distribution.

Human-induced mortality and scope for allowable mortality: COSEWIC (2006) speculated on the cumulative effects of agricultural and mining development, as well as the construction of the railroad and a number of dams in the region. A reviewer commented that a major threat to the species is surface or groundwater extraction and that the control and management of this threat would be challenging. Participants acknowledged that instream flow rates based on a percentage of mean annual discharge have been proposed for BC rivers to conserve riffle habitat in the Kettle River, but there are insufficient data to determine the expected harm to dace at different flow rates. Participants recognized that ensuring adherence to any flow benchmark is complicated by unlicensed withdrawal of ground water and a poor understanding of the connection between surface water and aquifers. A flow of 10% Mean Annual Discharge (MAD) has been proposed as the minimum necessary for maintenance of riffle width in B.C. streams. The working paper reported that, based on previous literature, flows near 20% MAD are thought to be required to maintain riffle depth and velocity. Participants discussed whether the 10% MAD might not be appropriate noting that emulation of the natural hydrograph would be a better flow regime for protecting the species. Participants noted that management triggers in Alberta are invoked at 20% loss of flow and 15 % loss of habitat. Participants acknowledged that climate change impacts likely would exacerbate water withdrawal effects on flow regimes and hence survival.

Participants acknowledged that other cumulative impacts include potential sedimentation from road building for pine beetle salvage. A reviewer stated that the long term approach to forest management, in the area, needed to be reviewed. Participants thought GIS maps detailing land use would be useful for all SARA species affected by land-use practices.

<u>Conclusions</u>

- A target abundance for a healthy population of speckled dace cannot be established without better data to estimate the current abundance and capacity of the system.

- In the absence of information that indicates the population has declined, the recovery goal should be to maintain the persistence and present range of the population in Canada.

- Given the low data quality, it is not possible to quantify the importance of specific habitat types. Based on the qualitative information presented, the maintenance of adequate flow regimes in riffle habitat likely is an important strategy for ensuring population persistence.

- At present, there are insufficient data to quantify potential mortality related to reduced riffle flow.

Recommendations

In light of our poor understanding of the species' biology and natural history, quantitative estimates of its abundance by river reach, as well as studies of its habitat use by life stage and season are required. This information will be necessary to evaluate future population status and the importance (value) of specific habitat for survival and recovery.

APPENDIX 1: Working Paper Summary

Recovery Potential Analysis for Chinook Salmon Okanagan Population, *Oncorhynchus tshawytscha*

C. Davis, H. Wright, T. Brown, B. Phillips, R. Sharma, C. Parken

The Chinook Okanagan population is the last remaining Columbia basin stock within Canada and is geographically and genetically distinct from other Chinook populations in Canada. They consist of anadromous salmon that migrate to and from the Pacific Ocean through the Columbia River, to the area bounded by McIntyre Dam at the outlet of Vaseux Lake. Ancestral Columbia River Chinook salmon population have been estimated at 2-4 million fish with the historic abundance in the Upper Columbia in the hundreds of thousands. Historically the Okanagan Chinook population was large enough to support an important food and commercial/economic trade fishery prior to non-native human settlement. However, downstream fishing combined with high inter-dam mortalities for migrating salmon has led to declines in numbers. Rapid human development in the river basin has led to wide spread degradation of habitat. Habitat decline has also been attributed to irrigation and water withdrawal, logging, mining, transportation corridors and other human activities, which have reduced the quantity, quality, and capacity of spawning and rearing areas. The current population is less than 50 adults.

There is a high degree of interrelatedness between all fish found within the Okanagan River. A close familial relationship among Okanagan Chinook implies strong evidence of successful out migration, return and survival of Okanagan Chinook. The high level of genetic diversity in the small population and recovery of a few tagged fish indicates that it is currently receiving strays from a larger population. The lack of significant differentiation in allele frequency between the Similkameen and Okanagan River samples indicates that the Similkameen population is likely the source of strays.

The amount of area available for spawning and rearing within the Canadian portion of the Okanagan River is estimated at 16km^2. Anadromous species may use the Columbia River for rearing, and must use it as a migration corridor. Juveniles rear and grow to adults in the Pacific Ocean. Adults spawn over a patchy range of habitat. Total spawning capacity estimates range from 2,440 to 8,680 fish with a defensible estimate of 1460 spawning pairs. These estimates are based on watershed areas and habitat and behavioural characteristics of Okanagan Chinook. The northern portion of the Okanagan River contains reaches that are suitable for spawning and rearing. The naturalised upper sections contain a variety of habitats, while the lower channelized section lacks habitat complexity as it has no backwater pools, primary pools, undercut banks, pool tailout glides, and has little groundwater influence. The exact rearing locations of Okanagan Chinook fry are unknown following their emergence in April or May. We suspect they rear in the Okanagan River and Osoyoos Lake, but they may also rear in the mainstem of the Columbia River.

The life history of the Canadian portion of the Okanagan Chinook population has never been examined as a unique entity. We suspect their life history is similar to the life history of other Upper Columbia River summer stocks that have been examined in more detail. Juvenile Chinook move downstream through the Columbia River throughout the year and pass through the estuary to the ocean. Fish may remain in the estuary for periods ranging from weeks to months.

Chinook in Canada have been adversely impacted by human induced changes in the environment. These threats include; water withdrawals, construction of dams that limit and exclude passage or entrain/harm migrating fish, channel modification and introduction of non-native fish species. American Columbia River habitat impacts can be severe. These alterations have resulted in reductions in habitat complexity, slower water velocities and higher water temperatures with the Columbia and Okanagan Rivers.

We employed a parameter estimation and sensitivity analysis, using stochastic and deterministic elements to evaluate population trajectories under baseline conditions and explored the potential impacts of multiple management alternatives (Appendix C). Our model strongly indicates that juvenile survival downstream through the hydro-power system limits population persistence. The same is true for adult survival, which is likewise constrained by upstream passage through the hydro-power system. Ocean survival is another influential parameter, but values used in our simulations were derived from a period when ocean survivals were among the highest recorded (i.e., the late 1990's). Thus, it is likely that observed rates of decline would exceed those observed in our simulations. While fishing mortality also contributes to the decline, even complete cessation of harvest and corresponding reduction in mortality was found to be insufficient to recover the stock.

Given the uncertainty that managers can dramatically improve juvenile and adult survival through the gauntlet of American hydro dams and reservoirs it appears that the only alternative that can feasibly forestall extirpation in the near-term is via hatchery production. However, the magnitude of artificial production required to meet escapement goals would require a large program (approximately 1.75 million smolts annually). A program of that magnitude would be accompanied by its own array of risks.

The target should secure the long-term viability of Chinook within the Okanagan Basin. The short-term objective should be to maintain a run of Chinook in the Canadian portion of the Okanagan River through hatchery supplementation. The longer-term objective would be viable naturally spawning Chinook population.

The minimum population size based on the population viability analysis is an average of 295 individuals over four brood years that can be achieved by 2050. Immediate action needs to be taken to prevent the Canadian population from being extirpated. First and foremost would be the implementation of a hatchery program to supplement the current population. Second would be investigation into provisions for fish passage at facilities currently limiting access. Third is determining and mitigating the impacts of predation/competition with exotics fish species is required. Fourth, reducing fisheries impacts should be investigated. Lastly, investigation into how Canada can contribute to improve downstream survival through mainstem hydroelectric dams should be conducted. To support the existing wild population, measures should be taken to ensure that the required habitat features are maintained, enhanced, or restored in the Canadian portion of the Okanagan.

Recovery Potential Assessment for the Cultus Pygmy Sculpin (*Cottus sp.)*

B. Harvey

Cultus pygmy sculpin is a pelagic/pygmy form of the coast-range sculpin *Cottus aleuticus.* The coast-range sculpin is common in lakes and rivers along most of the Pacific coast of North America; whereas the pygmy form has only been found in Cultus Lake. That unique population is listed as *Threatened* in Schedule 1 of *SARA*, mainly because it is an extreme endemic; that is, it occurs in only one location that is not connected to other suitable locations. A *Proposed Recovery Strategy for Cultus Pygmy Sculpin,* prepared prior to the present Recovery Potential Assessment (RPA), details recovery objectives and approaches to meeting them.

We know very little about the natural history of the Cultus pygmy sculpin, the habitat requirements of its different life stages (and which habitats may be limiting), causes of mortality, or environmental factors that affect abundance. For this reason, the present RPA can only provide the 'best advice with the information available,' while noting the many information gaps. An absolute risk analysis is impossible.

The Cultus pygmy sculpin is believed to occupy the greater part of Cultus Lake from surface to bottom, excluding only a poorly defined littoral (shoreline) fringe where it has never been observed. Critical habitat for Cultus pygmy sculpin is synonymous with its known distribution. Listing of the Cultus pygmy sculpin is not based on any trend in the number of individuals because there are not enough data to show whether there is a trend, nor are there enough data to estimate the current population size. Until a directed enumeration program for Cultus pygmy sculpin is mounted, the recovery target must remain 'a healthy, self-sustaining population;' the distribution target should be 'to maintain its current distribution in limnetic areas of the lake.'

Neither critical habitat nor ecosystem relationships in the lake currently limit the long term viability of Cultus pygmy sculpin. The likelihood of critical habitat becoming limiting is low. The primary human-caused threat to Cultus pygmy sculpin is introduction of an exotic fish species, which could increase predation, introduce diseases, or cause changes in habitat and food supply that are detrimental to survival. The precautionary way to reduce this risk is to mount and continue a campaign including signage, brochures, advertisements, spot inspections and insertions in school curricula that reduce the likelihood of introduction. It is believed that incidental capture of sculpin in midwater trawls for juvenile sockeye enumeration is allowable harm.

For a species like Cultus pygmy sculpin, where so little is known of basic biology, habitat use and abundance, identifying alternatives to human activities that cause harm to it or to its critical habitat is an exercise in common sense. No quantitative predictions can be made; these have to await mathematical models based on real-life abundance data. A population viability analysis for Cultus pygmy sculpin is presently impossible because of the lack of data on abundance, habitat use and recruitment. Midwater trawls and hydroacoustic surveys presently used to enumerate juvenile sockeye could be modified to count Cultus pygmy sculpin and thus provide some quantitative basis for a model.

Recovery Potential Assessment for the Speckled Dace (*Rhinichthus osculus)*

B. Harvey

Speckled dace *Rhinichthys osculus* is a small, bottom-living, minnow-like river fish. While common in the western United States, its geographic range protrudes into Canada in one place only: the Kettle-Granby River drainage in the west Kootenay area of southern British Columbia. Speckled dace have been observed in approximately 300 km of river here; availability of suitable riffle or other fast water habitat has been identified as the main factor limiting its abundance. COSEWIC lists the species as *Endangered* because of its isolation in a single drainage basin and the impossibility of re-colonization after a catastrophic event. It is not listed under the *Species at Risk Act* (*SARA*).

Given the serious knowledge gaps concerning habitat use by speckled dace in Canada, all aquatic habitat in the Kettle, West Kettle and Granby rivers, and in their tributaries, should be considered critical for the species. Abundance is poorly known; best estimates range from 11,546 to 23,092 fish. Lack of any consistent census means we have no knowledge of trends in abundance, which appears to vary dramatically depending on time of year and water flow. Because the population appears to be stable and at no immediate risk, an appropriate "recovery" target is the maintenance of a self-supporting population. To set a generic lower benchmark when a population is not necessarily declining may ignore the purpose of recovery targets. A quantitative target abundance for a healthy population of speckled dace cannot be established without better census data.

As a stream-dwelling species that prefers fast-water riffle habitat, the speckled dace can potentially be affected by long-term changes in water volume and velocity. Concerns have been raised that increasing withdrawal for irrigation may affect the population. Instream flow rates based on a percentage of mean annual discharge have been proposed to conserve habitat such as that preferred by speckled dace in the Kettle River, but there are insufficient data to allow us to quantify the expected harm to dace at different flow rates. Ensuring adherence to any benchmark is complicated by unlicensed withdrawal of ground water and a poor understanding of the connection between surface water and aquifers. Licensing of groundwater extraction, further research to determine the connection between surface and ground waters in the basin, and alternative agricultural practices, including trickle irrigation, are proposed.

A proposal for a 25-megawatt run-of-river hydroelectric generation project at Cascade Falls on the Kettle River was approved in 2006 after modification to reduce potential fish habitat impacts. A qualitative risk assessment supported by a quantitative population viability model concluded that the project posed a negligible risk to the speckled dace population. The procedure followed in determining its potential impact on speckled dace could be applied to any subsequent proposed activities on the river that could disrupt fish habitat.

Infestation by mountain pine beetle (*Dendroctonus ponderosae*) could degrade stream habitat through collapse of dead trees (reducing stream canopy and allowing understory vegetation to increase), as well as through salvage logging. Logging damage to stream habitat can be minimized in various ways that reduce runoff, maintain diversity of cover and avoid sensitive terrain.

In interior B.C. streams, climate change is expected to increase the number and severity of droughts. For flow-sensitive species like speckled dace, such alterations are of concern.

A quantitative model developed to allow contemplation of various scenarios for removal of speckled dace habitat by the Cascade Falls hydropower project demonstrated that it was possible to make some quantitative predictions for a data-poor species like speckled dace. Development of alternative models for dace population viability depends on better knowledge of abundance, spatial distribution, habitat availability and recruitment.

APPENDIX 2: PSARC Meeting Agenda, June 19-20, 2007

PACIFIC SCIENTIFIC ADVICE REVIEW COMMITTEE
RECOVERY POTENTIAL ASSESSMENTS

JUNE 19-20, 2007
COAST BASTION INN, NANAIMO, B.C.
- agenda -

TUESDAY – June 19	
Introduction and procedures	9:00 – 9:15
Recovery Potential Analysis for Chinook Salmon Okanagan Population *Oncorhynchus tshawytscha*	9:15 – 12:00
Lunch Break	*12:00 – 1:00*
Okanagan Chinook Continued. **Reviewers comments and formulation of advice**	1:00 – 4:00
WEDNESDAY – June 20	
Recovery potential assessment for the Cultus Pygmy sculpin (*Cottus sp.*)	9:00-12:00
Lunch Break	*12:00 – 1:00*
Recovery potential assessment for the speckled dace (Rhinichthys osculus).	1:00-4:00

APPENDIX 3: List of Attendees

Subcommittee Chair: Al Cass

External Participants	
Name	**Affiliation**
Argue, Sandy	Ministry of Environment
Davies, Carla	Okanagan Nation Alliance
Hartman, Gordon	Emeritus, DFO
Harvey, Brian	Consultant
McPhail, Don	Emeritus, UBC
Phillips, Brent	Okanagan Nation Alliance
Richardson, John	UBC
Sharma, Rishi	Okanagan Nation Alliance
Woodruff, Patricia	UBC
Wright, Howie	Okanagan Nation Alliance
DFO Participants	
Bailey, Richard	
Bradford, Mike	
Brown, Tom	
Candy, John	
Cass, Al	
Druce, Courtenay	
Franzin, Bill	
Godbout, Lyse	
Holtby, Blair	
Irvine, Jim	
Lauzier, Ray	
Lynch, Cheryl	
McNicol, Rick	
Parken, Chuck	
Riddell, Brian	
Schubert, Neil	
Schweigert, Jake	
Stockwell, Margot	
West, Kim	
Withler, Ruth	
Wood, Chris	

The reviewers for the PSARC paper presented at this meeting are listed below. Their assistance is invaluable in making the PSARC process work.

Hartman, Gordon	Emeritus, Fisheries and Oceans Canada
McPhail, Don	Emeritus, University of British Columbia
Richardson, John	University of British Columbia
Schubert, Neil	Fisheries and Oceans Canada
Wood, Chris	Fisheries and Oceans Canada