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**Proceedings Series 2007/049**

**Compte rendu 2007/049**

**Proceedings of the PSARC  
Invertebrate Subcommittee Meeting**

**Compte rendu de la réunion du sous-  
comité du CEESP sur les invertébrés**

**November 28, 2007**

**Novembre 28, 2007**

**Ray Lauzier**

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Nanaimo, BC V9T 6N7

**February 2008**

**Février 2008**

## **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  
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Ottawa, Ontario  
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Printed on recycled paper.  
Imprimé sur papier recyclé.

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

DFO, 2008. Proceedings of the PSARC Invertebrate Subcommittee Meeting, November 28, 2007. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2007/049.

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# **PACIFIC SCIENTIFIC ADVICE REVIEW COMMITTEE (PSARC)**

## **INVERTEBRATE SUBCOMMITTEE MEETING**

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## SUMMARY

The Pacific Scientific Advice Review Committee (PSARC) Invertebrate Subcommittee met November 28, 2007 at the Pacific Biological Station in Nanaimo, B.C. The Subcommittee reviewed one working paper.

### **Working Paper I2007-01: An evaluation of fishery and research data collected during the Phase 1 sea cucumber fishery in British Columbia, 1998-2007**

C. Hand, W. Hajas, N. Duprey, J. Lochead, J. Deault, and J. Caldwell

The working paper summarized 10 years of work on a data-limited and conservatively-managed sea cucumber fishery in British Columbia. Commercial harvesting was permitted along 25% of the coastline, and surveys were conducted in six of the commercially-open harvest areas. Four Experimental Fishery Areas (EFA) were established to assess the population responses of harvesting at five different rates (0%, 2%, 4%, 8% and 16%). EFA data were used in a latent productivity model to estimate maximum sustainable harvest rates (MSHR). The lowest of the lower 1 percentile of MSHRs from the four EFAs was 6.8% of the virgin population.

There were two external reviewers of the working paper; both were highly complementary of the sound scientific analysis and the clarity of the writing.

The Subcommittee discussed how the harvest rates were determined in the paper, and agreed with the author's suggested changes to the model that will appear in the revisions. There was detailed Subcommittee discussion on the latent productivity model used in the paper. Similarities to the surplus production model were noted, and drawing upon these similarities could be useful to clarify the latent productivity model. The Subcommittee agreed that the model would be more credible if model parameters could be related to biological processes. Model assumptions and the impact of violating these assumptions on the final analysis were discussed and resolved. There was also Subcommittee discussion on reference points. It was agreed that a target reference point should be established for maximum harvest rate that is equivalent to the lowest of the lower 1 percentile of MSHR (6.8%) of the virgin population and that the limit reference point should be 50%  $B_0$ .

The Subcommittee commended the authors on the high quality of the paper and accepted the paper with revisions. The Subcommittee concluded that the Phase 1 fishery had been completed and recommended proceeding to Phase 2 of the sea cucumber fishery.

## SOMMAIRE

Le sous-comité du Comité d'examen des évaluations scientifiques du Pacifique (CEESP) sur les invertébrés a tenu une réunion le 28 novembre 2007 à la Station biologique du Pacifique, à Nanaimo en C.-B. Le sous-comité a passé en revue un document de travail.

### **Document de travail I2007-01 : Évaluation des données sur la pêche et la recherche recueillies au cours de la phase 1 de la pêche au concombre de mer en Colombie-Britannique – 1998 à 2007**

C. Hand, W. Hajas, N. Duprey, J. Lohead, J. Deault et J. Caldwell

Ce document de travail résume dix années de travaux sur une pêche au concombre de mer en Colombie-Britannique gérée de façon prudente et peu documentée. La pêche commerciale a été autorisée le long de 25 % du littoral. Des relevés ont été effectués dans six des zones ouvertes à la pêche commerciale. Quatre zones de pêche expérimentale (ZPE) ont été établies pour que l'on puisse évaluer la réaction de la population à cinq taux de récolte (0, 2, 4, 8 et 16 %). On a utilisé des données sur les ZPE et un modèle de la productivité latente pour estimer les taux de pêche maximale soutenable (TPMS). Le plus faible 1<sup>er</sup> percentile inférieur du TPMS pour les quatre ZPE était de 6,8 % de la population vierge.

Deux examinateurs externes se sont penchés sur le document de travail; les deux ont été fortement impressionnés par l'objectivité de l'analyse scientifique et la clarté du texte.

Le sous-comité a discuté de la façon dont les taux de capture ont été déterminés dans le document et est d'accord avec les changements suggérés par l'auteur pour le modèle et qui apparaîtront dans les versions révisées. Le sous-comité discute en détail du modèle de la productivité latente utilisé dans le document. On note des similitudes avec le modèle de la production excédentaire et on souligne qu'il pourrait être intéressant d'utiliser ces similitudes pour clarifier le modèle de la productivité latente. Le sous-comité reconnaît que le modèle serait davantage crédible si ses paramètres pouvaient être associés à des processus biologiques. On discute aussi des hypothèses établies avec le modèle et de l'impact du non-respect de ces hypothèses sur l'analyse finale. Le sous-comité discute également des points de référence. On convient qu'un point de référence cible doit être établi pour le taux de capture maximal et que ceci doit être équivalent au plus faible 1<sup>er</sup> percentile inférieur du TPMS (6,8 %) pour la population vierge et que le point de référence limite devrait être de 50 % de  $B_0$ .

Le sous-comité félicite les auteurs pour la qualité élevée de leur document et accepte celui-ci après y avoir apporté quelques modifications. Le sous-comité conclut que la phase 1 de la pêche au concombre de mer est terminée et recommande que la phase 2 soit mise en œuvre.



## **INTRODUCTION**

The PSARC Invertebrate Subcommittee met November 28, 2007 at the Pacific Biological Station in Nanaimo, British Columbia to review one working paper, which is summarized in Appendix 1. External participants at the meeting included representatives from the Government of B.C. and the Pacific Sea Cucumber Harvesters Association. The Subcommittee Chair, R. Lauzier opened the meeting by welcoming the participants, reviewing the objectives and protocols of the meeting and reviewing the agenda.

The meeting agenda appears in Appendix 2, while a list of meeting participants and reviewers is included as Appendix 3.

## **DETAILED COMMENTS FROM THE REVIEWS**

### **Working Paper I2007-01: An evaluation of fishery and research data collected during the Phase 1 sea cucumber fishery in British Columbia, 1998-2007**

C. Hand, W. Hajas, N. Duprey, J. Lohead, J. Deault and J. Caldwell

**\*\*Paper accepted subject to revisions.\*\***

#### **Subcommittee Discussion**

There were two reviewers for the paper. Both reviewers complemented the authors on quality of the research and analysis. One reviewer felt that it was the best study he had seen for any species of commercially-harvested sea cucumber, and the other reviewer felt that it provided a sound basis for the sustainable management of sea cucumbers that would likely have relevance to adjacent jurisdictions outside of British Columbia.

One reviewer considered the purpose of the paper was clearly stated, that the data and methods were adequate to support the conclusions and recommendations, and especially noted that the paper gains validity from the long time frame (10 years) studied. He noted that several complementary yet independent analytical methods were used to verify the conclusions of the paper and that uncertainty was well addressed. The reviewer felt that the Experimental Fishing Area (EFA) approach was an excellent method for recommending sustainable harvest rates, and that this was likely one of the most important sections of the paper. The reviewer requested clarification of what the harvest rate (as a percentage) was applied to, and the authors agreed to clarify this in the revisions.

The other reviewer thought the introduction provided background for the research and analysis, but could have more directly identified the objectives outlined in the Request for Working Paper. The reviewer felt that the sampling design for the

EFA was a substantial effort, considering the constraints on collecting data from a dive fishery, and that it was well executed. He was complementary of the description of the latent productivity model methods and appreciated the clear discussion on model assumptions. He found the data analysis generally sound and the descriptions of the survey methods, biomass measures and geographic analysis complete and easy to follow. The reviewer expressed concern that the recommended maximum harvest rate may seem high compared to the current harvest, but recognized that it is still precautionary given that it is applied to a conservative of the population size, and that surveys will be conducted prior to harvests. The reviewer thought the recommendations of the paper were clear, straightforward and mostly well supported. He suggested additional recommendations, including: elimination of exposed, low productivity sites from population estimates as they are not targeted by the fleet; and establishing a minimum density threshold as a limit reference point in each area. The reviewer commented specifically on the analysis of 'harvested' vs. 'unharvested' transects and suggested a different approach to analysis, which the authors agreed to do. He also pointed out a need to present sea cucumber weight data in terms of densities for weight intervals, rather than frequency, to facilitate the comparison of effects across years and sites.

The Subcommittee discussed how harvest rates in the Experimental Fishing Areas (EFAs) were modeled, a concern also raised by one of the reviewers. The authors explained that experimental quotas were fixed to proportions of the estimated virgin population size, as determined in the first survey conducted in each area, resulting in a higher effective harvest rate in later years as populations declined. It was agreed that the data should be analyzed in terms of the actual harvest rate in the future rather than a fixed quota. Furthermore, the harvest rate should be expressed as a proportion of the estimated biomass rather than population number, and the authors agreed to include modifications to the model in the revisions to the paper.

In the areas open to commercial harvest, the harvest rate was based on the current estimated biomass from the latest survey. The harvest rate applied in this fishery was based on Washington State unpublished data and has always been recognized as being very conservative. The new recommended harvest rate in the paper was derived from the EFA analysis, and the Subcommittee agreed that this was still conservative. It was agreed that there should be more elaboration in the general discussion of the paper on the conservative aspects of the harvest rates and how they are applied (proxy to virgin or current biomass estimate).

The lack of depth analysis in the paper was noted by one reviewer which led to Subcommittee discussion on how the actual maximum depth feasible for harvesting (gauge depth or datum depth) should be determined. The authors agreed to add some depth information in the revised paper. It was concluded that 60 feet datum depth was feasible with the use of dive computers, and this will be standardized in future assessment efforts.

There was some discussion on the appropriate size of the no-take zones or refuge areas, and how they should be distributed. It was noted that there isn't very much data available to assist in the design of these no-take zones, but they need to be large enough to indicate trends with the virgin populations and the sites need to be large enough so that surveys can be conducted with appropriate accuracy.

There was lengthy and detailed Subcommittee discussion on the Latent Productivity model presented in this paper. It was not clear from the paper whether the model parameters have biological meaning, and that to clarify how the model links back to biology would strengthen the presentation and increase its credibility. Parentage for the Latent Productivity model could be provided by drawing on first principles and showing an evolution from traditional Surplus Production models. The Latent Productivity model allows the productivity level to vary relative to the biomass, in comparison to the Schaffer model where MSY happens at 50% population level. It was pointed out that the slope is fairly consistent and that truncation due to lack of data may hide some of the possible biological significance. The Subcommittee agreed that this is a new type of model and it would be worthwhile expanding and clarifying the model and how it links to biology. The Subcommittee discussed the limitations of the model assumptions and how violations of assumptions may result in an inflated Maximum Sustainable Harvest Rate (MSHR). It was remarked that, although the input data are quite variable, the results and distributions for MSRH are very precise. Latent productivity seems to keep increasing beyond the range of available data (lower abundance) and it was thus concluded that the recommended 6.8% harvest rate is likely very precautionary.

Due to the biology of sea cucumbers, conventional estimates of recruitment are not possible. The Subcommittee recognized that recruitment can vary between years due to environmental variation, and agreed with the suggestion in the paper to set up settlement monitoring stations to evaluate interannual recruitment.

The Subcommittee acknowledged the brief discussion of target and limit reference points in the paper and agreed that recommended reference points need to be formalized and more detailed discussion in the paper is warranted. After much discussion, a maximum harvest rate of 6.8% was identified as a target reference point, with a range of 4.2 – 6.8% harvest rate to ensure sustainability. A suggested target range was thought to be more useful to resource managers. It was agreed that 50%  $B_0$  would be an appropriate limit reference point. Since 5 cucumbers/ meter shoreline is the surrogate density in the absence of estimated biomass from surveys, then 2.5 cucumbers/ meter shoreline will be the limit reference point in the absence of estimated biomass. The Subcommittee recognized that data available to date does not show how low

the population would have to go to reach the no-recovery point and agrees that more work is needed to explore the lower bounds of recoverable populations.

The Subcommittee discussed the issue of rotational harvests and whether it should form part of the recommendations of the paper, especially when the topic had not been developed within this working paper. The harvesters already practice a form of rotational harvesting, and there is a previous Working Paper (Humble et al. 2005) which directly addresses rotational harvests. The Subcommittee recognized that recommendations from this paper, as well as from the previous paper, will help form a new management plan for a Phase 2 fishery and that a rotational harvest strategy does not need to be recommended in this paper.

The Subcommittee provided several suggestions for changes to the recommendations of the paper, to which the authors agreed. In terms of the first recommendation in the paper to open up the coast, the Subcommittee suggested that since the Phase 1 of the fishery has been successfully completed, there is sufficient information available to ensure a sustainable fishery, and precautionary reference points have been determined; then the next step is to re-open the BC Coast to a Phase 2 fishery. The Subcommittee supported the revised Recommendation 1 in the paper.

In a new Recommendation 2 in the paper, it was agreed that the recommended harvest rate in the paper should be in terms of biomass, with the necessary conversion of 6.8% of virgin population size to an equivalent rate of the biomass. The Subcommittee recognized that there are problems in applying the target and limit reference points to estimates of virgin stocks in currently open areas and acknowledged that using estimates of current biomass is more precautionary. Managers, industry and science need to work out process to address these issues with the aim to get consistent decision rules across the coast. In the absence of an initial survey in a new area, the use of a surrogate density of 5 cucumbers/ meter shoreline is acceptable to use in calculating a baseline biomass estimate. The Subcommittee supported the new and revised Recommendation 2 in the paper.

After discussion on the high precision obtained from the surveys and power of pair-wise comparisons, the Subcommittee supported the re-numbered Recommendation 3 of the paper to maintain sampling intensity at current levels for future surveys.

The Subcommittee, as well as one of the reviewers, supported Recommendation 4 of the paper to continue surveying control sites in the Experimental Fishery Areas, as well as fishing and surveying the 8% and 16% sites. Continuing to monitor these sites will assist in determining how far down from the virgin biomass the sea cucumber populations can be fished and still recover to a sustainable level.

The Subcommittee supported Recommendation 5 in the paper of no-take zones in the newly-opened fishing areas and also supported establishment of no-take zones in the current fishing areas, as suggested by one of the reviewers.

The Subcommittee suggested an additional recommendation in the working paper to eliminate areas of high exposure or unfishable shoreline from estimates of fishable biomass.

### **Subcommittee Conclusions**

The Subcommittee noted that in 10 years, the assessment team has been able to move from using no data from B.C. to using exclusively data from B.C. The Subcommittee agreed that the Phase I sea cucumber fishery has been completed, and commended the authors and Industry for a well executed research program and working paper. The working paper was accepted with suggested revisions.

### **Subcommittee Recommendations**

1. The Subcommittee considers the Phase 1 Giant Red Sea Cucumber (*Parastichopus californicus*) fishery to be complete and should now move to a Phase 2 implementation of the fishery.
2. The Subcommittee recommended a Target Reference Point (TRP) of a maximum harvest rate on the virgin biomass equivalent to 6.8% of the virgin population size. The Subcommittee recommended a Limit Reference Point (LRP) of 50%  $B_0$ , with continued monitoring of 16% experimental sites to assist in determining population response below 50%.
3. The Subcommittee recommended establishing no-take areas throughout all fishing areas, and surveying the no-take areas to monitor natural population fluctuations and processes.
4. The Subcommittee recommended conducting surveys to a standard depth in relation to chart datum in new areas, e.g 50 or 60 feet, in order to alleviate some of the needs for truncation.
5. The Subcommittee recommended that the results of this working paper be used in conjunction with the 2005 working paper on rotational fisheries to establish a new assessment and management plan for Phase 2 implementation of the sea cucumber fishery.

## **APPENDIX 1: Working Paper Summary**

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### **Working Paper I2007-01: An evaluation of fishery and research data collected during the Phase 1 sea cucumber fishery in British Columbia, 1998-2007**

C. Hand, W. Hajas, N. Duprey, J. Lochead, J. Deault and J. Caldwell

Investigations have been underway since 1998 to fill some of the knowledge gaps in the giant red sea cucumber fishery that were originally identified in 1996. The current annual harvest regime conducted in 25% of the British Columbia coast and the experimental fishing have allowed a thorough study of the effects of harvesting on the density and size of sea cucumbers.

Surveys were conducted in six commercially-open harvesting areas and all had a decline in density ranging between 10-23% between 1998 and 2007. There was a decline in the mean weight of sea cucumbers in four of the six open areas ranging from 12% to 17%.

Four experimental fishery areas (EFAs) were developed to study the effects of various harvest levels on density and sea cucumber size. Five sites (no harvest, 2%, 4%, 8%, and 16% harvest rate) were created in each EFA and were harvested annually, based on virgin population estimated at the beginning of the study. The sites with higher harvest rates, 8% and 16%, showed large decreases in density between the first and last year of study. Lower harvest rates (control, 2% and 4%) did not show the same levels of decline. The mean weight of sea cucumbers also declined during this time period, significantly in approximately half of the 20 EFA sites and by up to 37%. The declines in mean split weight were not entirely the result of harvesting levels as size also declined in control sites.

A latent productivity model was used to estimate the maximum sustainable harvest rate, using the 10 years of data from the experimental fishery areas. The model indicated that we can be 99% confident that maximum sustainable harvest rate is 6.8%, or higher, of the virgin population.

A total of 7.7% of the shoreline available for fishing was targeted by harvesters in 2005. The fleet does not target the same pieces of shoreline repeatedly and they appear to harvest different areas from year to year. As was expected, the amount of shoreline targeted by harvesters increased with quota levels, but natural reserves with high densities of sea cucumbers still persisted.

**APPENDIX 2: PSARC Invertebrate Subcommittee Meeting  
Agenda**

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PSARC Invertebrate Subcommittee Agenda  
November 28, 2007  
Coast Bastion Inn  
*(venue moved to Pacific Biological Station due to  
power outage at Coast Bastion Inn)*  
Nanaimo, BC

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Wednesday, November 28:

9:00	Introduction and Overview of the agenda
9:15	Review of working paper, -“An evaluation of fishery and research data collected during the Phase 1 sea cucumber fishery in British Columbia, 1998-2007”
12:00	LUNCH
1:00	Review of working paper, -“An evaluation of fishery and research data collected during the Phase 1 sea cucumber fishery in British Columbia, 1998-2007” cont’d
4:00	Adjournment

### APPENDIX 3: List of Attendees & Reviewers

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Subcommittee Chair: R. Lauzier  
 PSARC Chair: A. Cass

<b>External Participants:</b>	<b>Affiliation</b>
Heath, B.	Ministry of Agriculture and Lands
Ridgway, K.	Pacific Sea Cucumber Harvesters Assoc.

<b>DFO Participants</b>
Bassett, S.
Boutillier, J.
Bureau, D.
Campbell, A.
Cass, A.
Deault, J.
Ennevor, B.
Gillespie, G.
Hajas, W.
Hand, C.
Lessard, J.
Leus, D.
MacDougall, L.
Mylchreest, R.
Perry, I.
Ridings, P.
Rogers, J.
Rusch, B.
Waddell, B.
Zhang, Z.

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

Bradbury, A.	Washington Department of Fish and Wildlife
Woodby, D.	Alaska Dept. of Fish and Game