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**Compte rendu 2009/008**

**Proceedings of the Pacific Scientific  
Advice Review Committee (PSARC)  
Invertebrate Subcommittee Meeting:  
Stock Assessment Framework for the  
British Columbia Geoduck Fishery**

**November 26, 2008  
Nanaimo, BC**

**Chairperson,  
Raymond Lauzier**

**Compte rendu de la réunion du  
Sous-comité du CEESP sur les  
invertébrés : Cadre d'évaluation des  
stocks pour la pêche à la panope en  
Colombie-Britannique**

**Le 26 novembre 2008  
Nanaimo, C.-B.**

**Président de réunion,  
Raymond Lauzier**

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

**September 2009**

**Septembre 2009**

## **Foreword**

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

## **Avant-propos**

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

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## SUMMARY

The Pacific Scientific Advice Review Committee (PSARC) Invertebrate Subcommittee met November 26, 2008 at the Pacific Biological Station in Nanaimo. The Subcommittee reviewed one working paper.

### **Working Paper I2008-01 Stock Assessment Framework for the British Columbia Geoduck Fishery**

D. Bureau, C. Hand, W. Hajas

The working paper describes the stock assessment framework for the British Columbia (BC) geoduck fishery, starting with an outline of the early history of assessment and management and bringing up to the present day. The unique biological characteristics of geoducks and their population distribution, structure and dynamics is described to give perspective and background to the stock assessment framework. The actual mechanisms, types and sources of data as well as sources of error in the stock assessment framework are described. Sea otters have a progressively larger impact on the BC geoduck fishery as their range expands. Options to allow the geoduck fishery to co-exist in sea otter areas are discussed. The Limit Reference Point (LRP) currently in use in the BC geoduck fishery is used to close a bed to harvest once the biomass is reduced to 40% of the pre-fishery biomass. An alternative to the current LRP is required and the options are outlined and discussed. An effective conservation measure for geoducks may be a system of reserves. However, estimation of geoduck biomass outside the commercially harvested areas could be undertaken to determine the proportion of the geoduck biomass in BC that already exists in nearby *de-facto* reserves.

There were two reviewers of the working paper, one internal and one external. Both reviewers had concerns on the determination of mean weights and the use of correction factors. Reviewers also raised concerns on show factors and the use of Limit Reference Points (LRP). Both reviewers had suggestions as alternatives to reference points.

There was Subcommittee discussion on the appropriate size of pre-recruit cutoffs and whether they should be used at all. The issue was also raised of not surveying areas < 3 m depth. Another concern expressed was the impact of post-stratification on the overall estimate of density. There was discussion on the term Limit Reference Point that was used in the paper, and it was agreed that it is not the appropriate term. There was discussion on using a minimum density rather than trying to estimate  $B_0$  at a time when there were no sea otters present, and when  $B_0$  would be at historic highs. There was also the suggestion of using simulation scenarios if there are sufficient data in order to more realistically determine the lowest allowable level, taking into consideration the impacts of sea otters as well as sporadic recruitment events. In response to Subcommittee discussion and questions, the authors believe that surveying a greater number of transects would be a better use of time, rather than the show factor plots, which can take up to 25% of the total survey time. There was considerable Subcommittee discussion on how to improve data collection on biological sampling, especially when it came to Recommendation 1 of the working paper. It was agreed by the authors that in the interim, an 11% correction factor would be applied to Queen Charlotte Islands data, and 8% to Prince Rupert data, until further work is completed.

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

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## SOMMAIRE

Le Sous-comité du Comité d'examen des évaluations scientifiques du Pacifique (CEESP) sur les invertébrés a tenu une réunion le 26 novembre 2008 à la Station biologique du Pacifique, à Nanaimo, en C.-B, pour examiner un document de travail.

### **Document de travail I2008-01 : Cadre d'évaluation des stocks pour la pêche à la panope en Colombie-Britannique**

D. Bureau, C. Hand, W. Hajas

Le document de travail décrit le cadre d'évaluation des stocks pour la pêche à la panope en Colombie-Britannique (C.-B.) en commençant avec un aperçu de l'évaluation et de la gestion de cette pêche, depuis ses débuts jusqu'à aujourd'hui. Les auteurs décrivent les caractéristiques uniques de la biologie des panopes ainsi que la répartition, la structure et la dynamique de leur population afin de fournir une perspective et un contexte au cadre d'évaluation des stocks. Les mécanismes qui entrent en jeu, les types et les sources de données ainsi que les sources d'erreur dans le cadre d'évaluation des stocks sont également décrits. En raison de l'expansion de leur aire de répartition, les loutres de mer ont un impact de plus en plus important sur la pêche à la panope en C.-B; aussi discute-t-on des options qui permettraient à la pêche à la panope de subsister dans les zones fréquentées par les loutres de mer. Le point de référence limite (PRL) que l'on utilise pour fermer des gisements à la pêche à la panope en C.-B. correspond à 40 % de la biomasse vierge ( $B_0$ ). Il faut proposer une solution de rechange à ce PRL; à cette fin, les options possibles sont présentées et analysées. Une mesure de conservation efficace, dans le cas de la panope, pourrait être l'établissement d'un système de réserves. Cependant, on pourrait estimer la biomasse de la panope à l'extérieur des zones d'exploitation commerciale afin d'établir la proportion de cette biomasse qui existe déjà en C.-B. dans les réserves de fait situées à proximité.

Deux examinateurs, un de l'interne et l'autre de l'externe, ont passé en revue le document de travail. Tous deux ont soulevé des préoccupations relativement à la détermination des poids moyens et à l'utilisation des facteurs de correction. Ils ont également exprimé des inquiétudes concernant les facteurs d'observation et l'utilisation de points de référence limites (PRL). Tous deux ont proposé des solutions de rechange aux points de référence.

Le Sous-comité a discuté des seuils appropriés concernant la taille des prérecrues et de l'à-propos de tels seuils. On s'est également interrogé sur la nécessité d'effectuer un relevé dans les zones de profondeur inférieure à 3 m. Une autre préoccupation concernait l'impact qu'aurait la stratification *a posteriori* sur l'estimation globale de la densité. Le Sous-comité a discuté du terme « point de référence limite » qui a été utilisé dans le document et a convenu que ce terme n'est pas approprié. On a discuté de la possibilité d'utiliser une densité minimale au lieu d'essayer d'estimer quelle était la  $B_0$  à une époque où les loutres de mer étaient absentes et où cette  $B_0$  avait atteint des sommets historiques. On a également proposé le recours à des scénarios de simulation, si les données le permettaient, afin de déterminer de manière plus réaliste quel serait le niveau le plus faible admissible compte tenu des impacts des loutres de mer ainsi que des événements de recrutement sporadiques. À l'analyse et aux questions du Sous-comité, les auteurs ont répondu qu'ils estimaient que nous occuperions mieux notre temps si nous réalisions des relevés sur un plus grand nombre de transects plutôt que dans les parcelles servant au calcul des facteurs d'observation, cette dernière activité pouvant exiger jusqu'à 25 % du temps total consacré aux relevés. Le Sous-comité a discuté longuement de la façon d'améliorer la collecte de données relatives à l'échantillonnage biologique, en particulier lorsqu'il a été question de la recommandation n° 1 du document de travail. Les auteurs ont convenu d'appliquer provisoirement un facteur de correction de 11 % aux données des îles de la Reine-Charlotte et de 8 % aux données de Prince Rupert en attendant que d'autres travaux soient menés.

Le Sous-comité a félicité les auteurs pour la grande qualité du document et a accepté celui-ci sous réserve que des révisions mineures lui soient apportées.



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## INTRODUCTION

The Pacific Scientific Advice Review Committee (PSARC) Invertebrate Subcommittee met November 26, 2008 at the Pacific Biological Station in Nanaimo to review one working paper, which is summarized in Appendix 1. External participants at the meeting included representatives from the Province of BC, the Haida Nation, and the Underwater Harvesters Association. The Subcommittee Chair, Ray Lauzier, opened the meeting by welcoming 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 in Appendix 3.

## DETAILED COMMENTS FROM THE REVIEWS

**Working Paper I2008-01: Stock Assessment Framework for the British Columbia Geoduck Fishery**  
D. Bureau, C. Hand, W. Hajas  
Presentation by D. Bureau and W. Hajas.

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

### Subcommittee Discussion

There were two reviewers for the paper, one internal and one external. Both reviewers had concerns with the determination of mean weights and the use of correction factors. The first reviewer provided a detailed review outlining major concerns (definition of precision; mean weight comparisons and correction factor; survey design and analysis of survey data; Limit Reference Points) and minor concerns (geoduck density; show factor; equations and notations; tables and figures). It was suggested by this reviewer and agreed to by the Subcommittee that using ratios was likely not the best comparator of density survey precision (Table 4 in paper), and the coefficient of variation or some other statistical value such as standard deviation would be more appropriate. The same reviewer suggested designing a simulation study to evaluate changes in study design (current vs. core area vs. index sites) for geoducks. This reviewer also had major concerns with the terminology and use of Limit Reference Points (LRP). This led to subcommittee discussion on using simulation scenarios, if there are sufficient data, in order to more realistically determine the lowest level allowable, taking into consideration the impacts of sea otters as well as sporadic recruitment events.

The second reviewer outlined concerns about the mean weight estimates, but agreed that extrapolating mean weights to nearby areas would be reasonable if the substrate type and depth were similar. This reviewer also outlined concerns as to how the show factor plots were flagged, and suggested that not using show factors at all was conservative as well as less costly. This reviewer was doubtful the discretization method would provide realistic estimates of geoduck populations on unsurveyed beds due to sporadic recruitment and the patchy and unpredictable distribution of geoducks. This reviewer also outlined the benchmarks or reference points used in Washington State for the geoduck fishery, where geoduck beds are closed when 65% of the pre-fishing surveyed biomass is reached or the average density drops below 0.04 geoducks/ft<sup>2</sup>.

After the authors responded to the reviewers' specific comments and concerns, the subcommittee discussed the effect of the presence of small clams on the estimate of mean weight and biosampling. Small clams are typically missed using a stinger and not all are seen on transects. It was suggested that sampling using a Venturi dredge might give an unbiased

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estimate of mean weight. The pros and cons were discussed about using a Venturi dredge. However the negative aspects seem to outweigh the positive: it is time consuming; it can't use it on a large scale; there is a great deal of bed variability; and finally it only samples a small part of the population. It was agreed that the effect small clams in the biosamples have on weight estimates should be determined, as they would not be seen by divers doing surveys. There was an identified need to determine the minimum size (weight) of geoduck that can be seen by survey divers and use that as a cut-off in mean weight comparisons. There was the identified issue that all "shows" should be sampled, but in the process of collecting geoducks, other smaller clams pop up, and they may be counted and weighed, which necessitates the correction factor. There was Subcommittee discussion on whether pre-recruit cutoffs should be used at all, and if they were used, whether 300 g. geoduck juveniles would be more appropriate rather than 462 g. geoduck juveniles. The authors agreed that mean weight comparisons in the paper could be done using this smaller size (300g.) cut-off.

There was considerable Subcommittee discussion on the use of mean weight and how mean weights were derived. It was pointed out that the mean weight values used in quota calculations has not changed much over the years, and a great deal of time has been spent trying to decrease the variability, yet it has not changed much. The questions were raised as to whether greater focus be put on parameters other than weight and whether or not estimating mean weight from logbook data is sufficiently accurate. It was pointed out that logbook data may be more representative than biosample data with regards to size selectively during fishing because harvesters sample more of the bed.

There was Subcommittee discussion on which weight measurement is most representative of geoducks counted on dive surveys. It was suggested future research might include a review of past data to review past changes in weight over time. This could indicate changes in oceanographic productivity of area.

There were concerns expressed about the magnitude of the correction factors. It was suggested that a correction factor should be applied to density, rather than mean weight, but it was pointed out that this also creates problems. It was suggested that a correction factor be applied only to beds where fishers harvest a part of a bed and where biosamples were obtained from another part of the same bed. Correction factors should not be applied where the entire bed area is harvested.

The value of show factor information was discussed as compared to the benefits obtained from surveying more transects. The authors pointed out that increasing the number of transects surveyed is believed to yield better density estimates and sampling time might be better spent doing more transects rather than surveying show plots. The authors also pointed out their show factor estimates have been consistently in the 90-95% range, suggesting that applying a fixed conservative show factor value would be appropriate. There was concern expressed by the subcommittee about applying correction factor more than 5% regionally. There was Subcommittee discussion about differences in Washington State show factor results as compared to show factors from BC. It was suggested that Washington State methods could be tried here.

There was considerable Subcommittee discussion on the method of biomass extrapolation to unsurveyed beds (discretization method). It was agreed that further clarification of the methodology was required. It was suggested that comparisons of extrapolated biomass estimates, with and without density categorization, be done for surveyed beds to evaluate the effectiveness of density categorization in providing more accurate biomass estimates.

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The Subcommittee recognized that marine protected areas could be used to protect stocks. However, natural refugia probably already exist in shallow (<3m), deep (>20 m) unharvested areas which are adjacent to harvested geoduck beds as well as in existing parks. The Subcommittee identified the need to assess whether deep water (>20m) populations are reproductive and contribute to overall recruitment. It was recognized that additional data are needed from closed areas, and discussion arose as to who was going to collect this data. It was suggested that future research might include oceanographic circulation modeling for refugia areas.

There was considerable Subcommittee discussion on the term Limit Reference Point (LRP) used in the paper, and that it was not an appropriate use of the term. One suggestion was made to use the term commercial fishery cut-off, or a comparable term. The subcommittee agreed that there should be a consistent use of terms found in recent DFO publications to be consistent with the National direction (DFO 2006. CSAS SAR 2006/023).

One of the points made in the paper and recognized by the Subcommittee was using the current LRP will ultimately lead to closure of the fishery in the future. It was recognized by the Subcommittee that there are problems with the term virgin biomass ( $B_0$ ) which was developed when sea otters were absent and geoduck stocks at historically high levels. One reviewer suggested using a minimum density rather than trying to estimate  $B_0$  at a time when there were no sea otters present, and when  $B_0$  would be at historic highs. It is unknown what  $B_0$  would be in the presence of sea otters that feed intensively on geoducks and other shellfish. The Subcommittee agreed that reference points in otter inhabited areas should not be ignored, as the increased mortality due to otter predation needs to be taken into account, in addition to any fishing mortality.

The Subcommittee recognized that recruitment needs to be considered in any future analysis and that in order to maintain or sustain populations, all sources of mortality needs to be balanced with recruitment. Therefore a long-term recruitment estimate should be considered a priority. The Subcommittee agreed that using long-term recruitment and mortality information to achieve a sustainable balance would be a preferable alternative to using an LRP.

The Subcommittee agreed there is a need to clarify the purpose and definition of reference points, and the need for a recovery potential analysis with the derived reference points. However, it was recognized that this is probably the subject of a future paper. It was agreed that new information will be based on density and reproductive potential, resulting in the need to look at classifying geoduck beds in terms of reproductive success. It was suggested that reference points be used to target beds for enhancement and used as a management tool. There was also the suggestion of using simulation scenarios if there are sufficient data available, in order to more realistically determine the lowest allowable level, taking into consideration the impacts of sea otters as well as sporadic recruitment events. The Subcommittee advised reducing the LRP discussion in the paper as there are identified valid alternatives. The point was made that there are limitations with the current framework, and more research is needed for a new approach.

There was Subcommittee discussion on errors in bed area estimation, particularly with beds having a portion shallower than 5 m, and sites where the banks are steep. These beds are currently probably not being entirely mapped, although fishing might occur to 3 m depth, resulting in stock biomass being slightly underestimated. However, substrate mapping is not the only source of data used in estimating bed areas: harvest locations, dive surveys and harvester

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comments should indicate where beds extend shallower than substrate mapping. Since other methods are used for bed area estimates, the degree of bed area under-estimates due to substrate mapping shallow depth limitations should not be very important. Another concern expressed was that post-stratification would result in a higher density over a smaller area, therefore boosting the value for the fishery. It was explained that in reality, the opposite effect was happening.

There was Subcommittee discussion on the estimation of exploitation rates and how it could be improved. The authors pointed out that currently cross dating for ages is being done which will likely give a more precise estimate of recruitment history. It was suggested that Zane Zhang's exploitation rate model could be rerun with the new data, but the required sample size or how long it would take to collect the new data was unknown in order to estimate revised exploitation rates. The question was also raised as to how often the exploitation rate model should be run using new cross-dating information as it becomes available.

A number of issues were raised in the Subcommittee discussion on survey methods. It was suggested that there are likely important data not yet analyzed from repeat surveys. It was recognized that more research is needed into optimal sampling frequency (#quadrats per hectare), possibly focusing on a few beds and using different numbers of transects and different spacing between transects. More time could be allocated during surveys to look at substrate types to determine the location and extent of the real fishable areas. In general it was agreed that fewer beds could be surveyed in a season, but they would be surveyed more intensely to collect new information.

Although the working paper had 8 listed recommendations, it was pointed out that there are really about 13. The Subcommittee agreed with the need to prioritize the working paper recommendations, with issues surrounding the LRP as a high priority. The Subcommittee also agreed that the paper would be improved by highlighting what research and work are required to resolve issues raised in the paper as well as subsequent Subcommittee discussions, and additional work would be required to produce any recommended changes. This would help to outline research programs and prioritize any changes.

Recommendation #1 of the working paper was accepted by the Subcommittee, but modified:

*1. Regional correction factors should be applied to mean weight estimates from logbook data. A 10% correction factor should be applied to QCI and 8% to Prince Rupert until further work is conducted.*

Currently correction factors are not used, but would be incorporated into the fishery in 2010. There was Subcommittee discussion on the appropriate numbers. It was agreed there is a need to improve the correction factors, although they are conservative. There was much discussion on how to improve estimates, such as the minimum weight of animals seen by divers. However this work would be the subject of another paper.

Additional research is required to determine regional correction factors using a 300 g cut-off instead of 462 g and how to improve the collection of biological samples. Ultimately managers could be given options with and without cut-offs and they would choose the most appropriate measure.

Recommendation #2 of the working paper was accepted, but modified:

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*2. Use regional average show factor values until a thorough analysis of all show factor data collected to date are conducted.*

It was suggested that regional averages (around 92-96%) could be used and these regional values should be presented in the paper. Due to the time required to survey show factor plots, time would be better spent on doing more transects in the future to improve density estimates.

The original Recommendation #3 of the working paper was removed, and subsequent recommendations of the working paper are re-numbered.

Recommendation #4 of the working paper was accepted, but modified and re-numbered:

*3. Continue using Run 4 estimates for surveyed beds until further analysis have been conducted to determine the potential benefits of quadrat post stratification in calculating geoduck density estimates.*

Recommendation #5 of the working paper was accepted and renumbered:

*4. Use Run 4 survey results for extrapolation to unsurveyed beds that have been substrate mapped.*

Recommendation #6 of the working paper was accepted, but modified and re-numbered:

*5. Efforts should be made to quantify geoduck biomass outside of commercially harvested beds to help assess the amount of biomass that resides in de-facto reserves.*

The Subcommittee agreed that the original recommendation could not stand by itself if the reproductive capacity of deep water stocks was unknown, and the original recommendation was considered incomplete or too simple. There was a recognized need to look for geoduck biomass outside of commercial beds (in shallow and deep water and in protected areas). During Subcommittee discussion the question arose whether deep water stocks are reproductive and able to contribute to stocks in harvested areas. Spawning might be temperature dependent and deep water stocks might not be able to spawn. An experiment was suggested to determine whether deep water geoducks can be induced to spawn. It was also suggested that an examination of oceanographic data showing water temperature below 20 m would be useful.

The question was raised of who would do the survey work. Industry might not be willing or they may be reluctant to undertake this extra work as direct benefits of such surveys is not readily apparent to them. Industry would be encouraged to contribute and participate, as they would directly benefit from results that might positively impact reference points if big reproductive stocks are found to exist outside the fishery.

Recommendation #7 of the working paper was removed.

Recommendation #8 of the working paper was accepted, but modified and re-numbered:

*6. Alternative LRP or other conservation measures need to be considered as alternatives to the current LRP for the BC geoduck fishery. The 40% Bo LRP should continue to be used until an alternative LRP or similar conservation measure can be developed, except in experimental areas.*

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The Subcommittee suggests that LRP term might be changed to reference point or have an alternative term. The Subcommittee realizes that geoduck stocks in otter areas are currently below their viability as defined by the current LRP so no anthropogenic impacts should occur in these areas. The Subcommittee noted that time series of data are already being collected where sea otters are present (Mission Group and Rolling Roadstead) and agreed that more research could be done. For all beds north of Tofino, including those already at LRP, this research could be undertaken on an experimental basis using the commercial fishery, and collecting information through bed questionnaires. Limitations must be applied. For example, the "new bed" protocol defined in the annual fishing plan permits harvest of up to 1500 lb. before a harvester is required to move to a different site. Providing this opportunity, for 2009 only, gives MEAD and resource managers opportunity to gather information and make more sound decisions for the future of these areas.

There was Subcommittee discussion as to whether 40% of  $B_0$  was a valid reference point in terms of defining the risk of extinction. The present term and framework might not be relevant for geoducks, but this needs to be confirmed by further experimental work and additional research in assessing the role and impact of long-term recruitment.

### **Subcommittee recommendations**

**Recommendation 1.** The Subcommittee recommends accepting the working paper "Stock Assessment Framework for the British Columbia Geoduck Fishery" subject to minor revisions.

**Recommendation 2.** The Subcommittee recommends comparing the discretization method with and without density categorization, for surveyed beds, to measured survey estimates to ascertain the effectiveness of density categorization in providing more accurate estimates of biomass.

**Recommendation 3.** The Subcommittee recommends that small clams (pop-ups) collected during the collection of biological samples should be handled and processed separately in the biological sampling.

**Recommendation 4.** The Subcommittee considers evaluating alternative reference points for geoducks as a high priority due to the potential impact of sea otters on harvested beds on the West Coast of Vancouver Island.

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## Appendix 1: Working Paper Summary

### Working Paper I2008-01: Stock Assessment Framework for the British Columbia Geoduck Fishery

D. Bureau, C. Hand, W. Hajas

The stock assessment framework for the British Columbia (BC) geoduck fishery is described, starting with an outline of the early history of assessment and management and bringing up to the present day. The unique biological characteristics of geoducks and their population distribution, structure and dynamics is described to give perspective and background to the stock assessment framework. The actual mechanisms, types and sources of data as well as sources of error in the stock assessment framework are described.

Quota calculations rely on estimates of current biomass and use regional harvest rates. Biomass is calculated as the product of geoduck bed area, density and mean weight. The sources of data and of uncertainties are discussed for each parameter. Density categorization, based on the qualitative information on geoduck bed densities provided by harvesters and On-Ground Monitors, is now used to extrapolate densities to unsurveyed beds.

Sea otters have a progressively larger impact on the BC geoduck fishery as their range expands. Options to allow the geoduck fishery to co-exist in sea otter areas are discussed. The Limit Reference Point (LRP) currently in use in the BC geoduck fishery is used to close a bed to harvest once the biomass is reduced to 40% of the pre-fishery biomass. The calculation of the pre-fishery biomass is fraught with a number of problems, including the presence or absence of sea otters, as well as the difficulty in realistically estimating the pre-fishery biomass with the underlying uncertainties.

An alternative to the current LRP is required and the options are outlined and discussed. An effective conservation measure for geoducks may be a system of reserves. However, estimation of geoduck biomass outside the commercially harvested areas could be undertaken to determine the proportion of the geoduck biomass in BC that already exists in nearby *de-facto* reserves.

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

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**AGENDA  
PSARC INVERTEBRATE SUBCOMMITTEE MEETING  
November 26, 2008  
Pacific Biological Station  
Nanaimo, BC  
Wednesday, November 26**

9:15 - Introductions and Opening Remarks.

9:15-10:20 Stock Assessment Framework for the British Columbia Geoduck Fishery

10:20-10:35 *Health Break*

10:35-12:20 Stock Assessment Framework for the British Columbia Geoduck Fishery

12:20-1:20 *Lunch*

1:20-4:00 Stock Assessment Framework for the British Columbia Geoduck Fishery



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### APPENDIX 3: List of Attendees and Reviewers

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Subcommittee Chair: Ray Lauzier

PSARC Chair: Al Cass

| <b>External Participants</b> | <b>Affiliation</b>                   |
|------------------------------|--------------------------------------|
| Adkins, M.                   | Underwater Harvesters Association    |
| Dovey, G.                    | Underwater Harvesters Association    |
| Heath, B.                    | BC Ministry of Agriculture and Lands |
| Jones, R.                    | Haida Nations Fisheries Program      |
| Morrison, J.                 | BC Ministry of the Environment       |

| <b>DFO Participants</b> |
|-------------------------|
| Boutillier, J.          |
| Bureau, D.              |
| Cass, A.                |
| Clark, D.               |
| Cleary, J.              |
| Davies, S.              |
| Dunham, J.              |
| Duprey, N.              |
| Ennevor, B.             |
| Gillespie, G.           |
| Hajas, W.               |
| Hand, C.                |
| Lauzier, R.             |
| Lessard, J.             |
| Lothead, J.             |
| Marcus, K.              |
| Mylchreest, R.          |
| Perry, I.               |
| Rogers, J.              |

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

|              |  |
|--------------|--|
| Cleary, J.   | DFO, Marine Environments and Aquaculture Division, PBS |
| Sizemore, R. | Washington State Department of Fish and Wildlife       |