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

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

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

**Proceedings Series 2011/065** | **Compte rendu 2011/065**

**Pacific Region** | **Région du Pacifique**

# Regional Advisory Process on the Review of the Assessment of Inshore Shrimp Stocks and Status Update of Wild Geoduck Stocks

**November 29, 2011**

**Pacific Biological Station**
**Nanaimo, British Columbia**

**Meeting Chairperson:**
**Christopher M. Pearce**

**Editor:**
**Christopher M. Pearce**

# Consultation régionale sur l'examen de l'évaluation des stocks de crevettes côtiers et le point sur les stocks de panopes sauvages

**29 novembre 2011**

**Station de biologie du Pacifique**
**Nanaimo, Colombie-Britannique**

**Président de la réunion :**
**Christopher M. Pearce**

**Éditeur :**
**Christopher M. Pearce**

Fisheries and Oceans Canada / Pêches et Océans Canada
Science Branch / Secteur des Science
3190 Hammond Bay Road
Nanaimo, BC V9T 6N7

**March 2012** | **Mars 2012**

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 contenues dans le présent rapport puissent être inexactes ou propres à induire en erreur, elles sont quand même reproduites aussi fidèlement que possible afin de refléter les échanges tenus au cours de la réunion. Ainsi, aucune partie de ce rapport ne doit être considérée 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.

**Proceedings Series 2011/065**

**Pacific Region**

**Compte rendu 2011/065**

**Région du Pacifique**

# Regional Advisory Process on the Review of the Assessment of Inshore Shrimp Stocks and Status Update of Wild Geoduck Stocks

**November 29, 2011**

**Pacific Biological Station**
**Nanaimo, British Columbia**

**Meeting Chairperson:**
**Christopher M. Pearce**

**Editor:**
**Christopher M. Pearce**

# Consultation régionale sur l'examen de l'évaluation des stocks de crevettes côtiers et le point sur les stocks de panopes sauvages

**29 novembre 2011**

**Station de biologie du Pacifique**
**Nanaimo, Colombie-Britannique**

**Président de la réunion :**
**Christopher M. Pearce**

**Éditeur :**
**Christopher M. Pearce**

Fisheries and Oceans Canada / Pêches et Océans Canada
Science Branch / Secteur des Science
3190 Hammond Bay Road
Nanaimo, BC V9T 6N7

**March 2012**

**Mars 2012**

ISSN 1701-1272 (Printed / Imprimé)
ISSN 1701-1280 (Online / En ligne)

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-sccs/

CSAS-SCCS@DFO-MPO.GC.CA

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

DFO. 2012. Regional Advisory Process on the Review of the Assessment of Inshore Shrimp Stocks and Status Update of Wild Geoduck Stocks; November 29, 2011. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2011/065.

## TABLE OF CONTENTS

## SUMMARY

These Proceedings summarize the relevant discussions and key conclusions that resulted from a Fisheries and Oceans Canada (DFO), Canadian Science Advisory Secretariat (CSAS) Regional Advisory Process meeting on November 29, 2011 at the Pacific Biological Station in Nanaimo, B.C. Two Science Advisory Reports (SARs) were presented for peer review:

- Assessment of inshore shrimp stocks along the coast of British Columbia, 2011
- Status update of wild British Columbia geoduck stocks, 2011

In-person participation included staff from DFO Science and Fisheries Management sectors and external participants from the B.C. government, Parks Canada, and the commercial fishing sector.

The conclusions and advice resulting from this review will be provided in the form of two SARs providing advice to DFO Fisheries Management for shrimp and geoduck fishery planning.

The two SARs will be made publicly available on the CSAS Science Advisory Schedule at http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

## SOMMAIRE

Ces délibérations résument les discussions et les principales conclusions qui découlent de la réunion du 29 novembre 2011 sur le Processus de consultation régionale du Secrétariat canadien de consultation scientifique, tenue par Pêches et Océans Canada à la Station biologique du Pacifique de Nanaimo en C.-B. On a présenté deux Rapports de consultation scientifique (RSC) pour examen par des pairs :

- Évaluation des stocks de crevettes côtiers le long du littoral de la Colombie-Britannique en 2011
- Le point sur l'état des stocks de panopes sauvages de la Colombie-Britannique en 2011

Les participants sur place comprenaient du personnel des secteurs des sciences et de la gestion des pêches du MPO et des membres du gouvernement de C.-B., de Parcs Canada et du secteur de la pêche commerciale.

Les conclusions et conseils qui découlent de cet examen seront présentés dans deux RCS offrant des conseils à la gestion des pêches du MPO sur la planification des pêches à la crevette et à la panope.

Les deux rapports de consultation scientifique (RCS) seront rendus publics dans l'annexe de consultation scientifique du SCCS à l'adresse suivante : http://www.dfo-mpo.gc.ca/csas-sccs/index-fra.htm.

## INTRODUCTION

A Fisheries and Oceans Canada (DFO), Canadian Science Advisory Secretariat (CSAS), Regional Advisory Process (RAP) meeting was held on November 29, 2011 at the Pacific Biological Station in Nanaimo, B.C. to review Science Advisory Reports (SARs) on B.C. inshore shrimp and geoduck clam stocks.

The Terms of Reference (ToR) for the science review (Appendix A) were developed in response to requests for advice from DFO Fisheries Management. Notifications of the science review and conditions for participation were sent to representatives with relevant expertise from First Nations, commercial fishing sectors, other federal government departments, provincial government departments, academia, and environmental non-governmental organizations.

The following two draft SARs were prepared and made available to meeting participants prior to the meeting (summaries provided in Appendix B):

- Assessment of inshore shrimp stocks along the coast of British Columbia, 2011 by Ken Fong and Dennis Rutherford

- Status update of wild British Columbia geoduck stocks, 2011 by Dominique Bureau and Claudia Hand

The meeting Chair, Chris Pearce, welcomed participants and reviewed the meeting agenda (Appendix C). The Head of the Centre for Science Advice Pacific Region, Marilyn Joyce, reviewed the role of CSAS in the provision of peer-reviewed advice and gave a general overview of the CSAS process. She discussed the role of participants, the purpose of the various RAP publications (Science Advisory Report, Proceedings, and Research Document), and the definition and process around achieving consensus decisions and advice. Everyone was invited to participate fully in the discussion and to contribute knowledge to the process, with the goal of delivering scientifically defensible conclusions and advice. It was confirmed with participants that all had received copies of the draft SARs. The Chair then reviewed the ToR for the meeting (Appendix A), highlighting the objectives and identifying the rapporteur for both reviews. The Chair then reviewed the ground rules and process for exchange, reminding participants that the meeting was a science review and not a consultation.

Members were reminded that everyone at the meeting had equal standing as participants and that they were expected to contribute to the review process if they had information or questions relevant to the papers being discussed. In total, 29 people participated in the RAP (Appendix D). Jason Dunham and Reziah Khan were identified as the rapporteurs for the shrimp and geoduck SARs, respectively.

Participants were informed that Dan Clark (DFO) and Nick Duprey (DFO) had been asked before the meeting to provide detailed written reviews for the shrimp and geoduck SARs, respectively, to assist everyone attending the peer-review meeting. Participants were provided with copies of the written reviews prior to the meeting.

The conclusions and advice resulting from this review will be provided in the form of SARs to DFO Fisheries Management to inform the shrimp and geoduck fisheries. The two SARS will be made publicly available on the CSAS Science Advisory Schedule at: http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm

## REVIEW 1

**Science Advisory Report:** Assessment of inshore shrimp stocks along the coast of British Columbia, 2011 by Ken Fong and Dennis Rutherford
**Rapporteur:** Jason Dunham
**Presenter:** Ken Fong

### PRESENTATION OF WORKING PAPER

The status of British Columbia inshore shrimp stocks, as indexed through annual surveys, forms the biological basis upon which DFO's Fisheries and Aquaculture Management branch sets annual area catch ceilings or total allowable catch (TAC). In addition, in 2009, DFO implemented provisional Precautionary Approach (PA) harvest control rules for shrimp stocks (DFO 2009a).

This report and presentation is an update to the 2010 CSAS report on shrimp stock trends (DFO 2011), as indexed through surveys, along with corresponding TACs from inception of surveys in 1997 to 2011 and commercial catch trends from 1987 to 2010. Commercial catch data for 2010 are preliminary except Shrimp Management Area 18/19 where no direct harvest of shrimp occurred. Data for 2011 were not available during the preparation of this report. Furthermore, this report documents the advice on shrimp stock status in relation to the PA, which was provided to fishery managers and industry in-season.

### WRITTEN REVIEWS

**Dan Clark**

There was one formal internal review of this SAR, which was generally positive (Appendix E). The reviewer's comments generally supported the information and advice arising from the SAR. The reviewer questioned why all the assessed shrimp stocks, including offshore stocks, were not included in this document and suggested that a summary of the offshore shrimp stocks, as well as some of the minor species stocks (*e.g.* coonstripe shrimp), should also be included. The reviewer, however, did note the size limitation on the SAR document. See *General Discussion* section below for participants discussion on this point.

The reviewer suggested that the SAR would benefit from adding a little more detail about the PA to this fishery. Specifically, more detail was requested on how the proxy for $B_{msy}$ was established and how the harvest control rules applied to each of the PA zones (*i.e.* Critical, Cautious, Healthy). The reviewer also suggested adding definitions of Limit Reference Point (LRP) and Upper Stock Reference (USR) to the SAR. See *General Discussion* section below for participants discussion on these points.

The reviewer noted that the SAR did not provide forecasts of shrimp stock size for 2012. See *General Discussion* section below for participants discussion on this point.

### GENERAL DISCUSSION

**Discussion on Terms of Reference**

The SAR authors expressed the following concerns with three of the items in the ToR. (1) The ToR specified the inclusion of 2011 commercial catch data. The authors indicated that this was not logistically feasible since the 2011 fishery was ongoing at the time of report preparation and review. The participants agreed.

(2) The ToR did not clearly state that this SAR provides and documents advice on stock status that had been communicated informally to fishery managers and industry in-season.
(3) The last concern was over the second objective in the ToR to "Provide a 2011 fishery performance evaluation…". The authors pointed out that they had documented commercial catch in comparison to TACs, but felt a fishery performance evaluation was outside the scope of this SAR. The participants agreed.

A discrepancy between the ToR and Request for Working Paper (RWP) was also identified. This was attributed to communication and process issues. The SAR generally matched the ToR, but did not include all aspects of the RWP.

**Other Discussion**

Participants discussion was initially framed around the issues raised by the reviewer and was then opened up for discussion of other issues.

The participants also questioned why only inshore pink and sidestripe shrimp stocks were included in the SAR and not offshore and minor species stocks. The authors responded by stating that those were the stocks identified in the ToR and that this SAR was an update to the 2010 SAR that also only included inshore pink and sidestripe stocks (DFO 2011). The authors did recognize that an update on the offshore stocks and some of the minor species should be documented, but given the page limitation of SARs this would have to be a new and separate document. The participants agreed. The authors did agree to add some very general statements to the SAR on why only certain stocks were included in this report.

More clarification was sought from the authors on how the PA reference points (*i.e.* Critical, Cautious, and Healthy zones) were derived. The authors pointed out that all the information is contained in a CSAS document summarizing the results of a national workshop on establishing reference points for shrimp fisheries (DFO 2009a). Authors did recognize that more detail needs to be added to the SAR and they will add more text for clarity. Specifically, they will clarify that the current reference points are provisional and based on $B_{msy}$, where the proxy for $B_{msy}$ was the ln(biomass) over a stable productive period – in most cases, this was the years 1998–2007. Authors will also include the harvest control rules that apply to each of the PA zones.

The reviewer comment and participants discussion on inclusion of 2012 forecasts was responded to by the authors who explained that shrimp stock forecasting is done and provided to managers for inclusion in the shrimp Integrated Fisheries Management Plan. The authors noted, however, that inclusion of these forecasts is outside the scope of this SAR. The participants agreed.

The participants felt that just providing annual commercial catch in comparison to TACs may lead some readers to make incorrect assumptions, particularly since many of the TACs are not reached. Readers could interpret this as TACs being too high for the given shrimp stock sizes. The authors pointed out that there are several explanations for this, the main one being that this is a multi-species fishery so if a TAC is reached for one species in a management area the area closes to all species. In addition, the economic situation is poor, so fishing effort is very low. The authors agreed to add some text to the SAR to address this participants concern.

There was discussion on whether the shrimp SAR should contain a table of 2011 shrimp biomass estimates as only graphs were provided in the document. The participants

agreed to not include a table of 2011 biomass since the main focus of the SAR is the long-term trend information. A table of all biomass estimates would be too cumbersome and long for the SAR (given page number restrictions) and a table of 2011 biomass estimates was already provided in-season in the shrimp bulletins. Managers present at the meeting indicated that they would not find the table a useful addition to the SAR.

Sources of uncertainty were not addressed by the authors and this needs to be included in the document. The authors agreed to add this as a new section.

## CONCLUSIONS

The SAR was accepted with minor revisions.

The ToR objectives were primarily met except for Objective 2 which, as pointed out by the authors (and agreed upon by the participants), was outside the scope of the SAR.

Shrimp biomass is highly variable within and between SMAs and among years. In 2011, nine of the 14 shrimp stocks assessed in this report were in the Healthy zone (*i.e.* above the USR); three stocks, SMA 14 and GSTE pink shrimp and SMA 18 sidestripe shrimp, were between the USR and LRP and in the Cautious zone; two stocks, SMA 18 and SMA 19 pink shrimp, were below the LRP and in the Critical zone. SMA 12IN shrimp stocks were not assessed in 2011. The current assessment concludes that shrimp stocks show high annual variation in stock size and all shrimp stocks were relatively unchanged or decreased from 2010 levels except SMA FR sidestripe which was at a record high.

## RECOMMENDATIONS & ADVICE

(1) The participants recommended acceptance of the SAR, with minor revisions.

(2) The participants recommends that other stocks of shrimps not dealt with in this report (*i.e.* offshore stocks and some of the minor species stocks) should be addressed in another SAR.

(3) The participants recommended the following changes to the text of the SAR:
(a) Clarification as to why only certain stocks were addressed in this report.

(b) Clarification on how the current reference points (LRP, USR) are generated and how the harvest control rules apply to each of the PA zones.

(c) Clarification as to why there are differences between the TACs and annual commercial catch with the mention that this is a multi-species fishery.

(d) Addition of a section on sources of uncertainty.

## REVIEW 2

**Science Advisory Report:** Status update of wild British Columbia geoduck stocks, 2011 by Dominique Bureau and Claudia Hand
**Rapporteur:** Reziah Khan
**Presenter:** Dominique Bureau

### PRESENTATION OF WORKING PAPER

Geoduck clam (*Panopea generosa*) populations occur in discrete beds of soft substrate, distributed throughout the coast of British Columbia (BC). The individual beds are connected by means of planktonic larvae, thereby forming meta-populations.

The BC geoduck fishery is managed with a TAC, individual vessel quotas, and scheduled openings and area quotas. The fisheries in the North and Inside Waters regions are on a three-year rotation, while the West Coast of Vancouver Island is fished annually. All landings are validated at designated ports by a third-party service provider.

Stock assessment and management of the fishery are conducted on the spatial scale of individual geoduck beds. A LRP of 40% of estimated virgin biomass ($B_0$) is established and implemented by individual geoduck bed. The assessment framework was described in 2002 (Hand and Bureau 2011) and updated in 2008 (Bureau et al. 2011). Assessment frameworks are modified as warranted by new information or analytical approaches, or as requested by DFO's Fisheries Management branch. Biomass estimates are updated annually with new data on population densities, mean geoduck weights, and bed area. This report provides updated estimates of geoduck stock biomass in BC and estimates of stock index relative to the LRP.

### WRITTEN REVIEWS

**Nick Duprey**

There was one formal internal review of this SAR, which was generally positive (Appendix E, which also includes the authors' rebuttal to the reviewer's concerns). Suggestions were provided for improvement in text clarity, the majority of which the authors will make in the revised draft. In responding to comments regarding the confusion around definitions of 'beds' and 'sub-beds', it was concluded that the area of geoduck beds is a more meaningful measure of abundance and coastal distribution than the number of beds. A new table will be added to the revised report to list estimates of geoduck bed area by region, harvestable status, and impact by otters.

The reviewer questioned why the full range of estimated geoduck biomass was not provided rather than just the lower 90% confidence bound to the mean and the participants agreed that the full range should be included in the paper as it provides information on data uncertainty that fishery managers should have. The authors agreed to add in the upper confidence bound to the revised paper.

The reviewer questioned whether sections on *Fallback Quota Options* and *New Developments* should be included as they are not relevant to information being presented on stock status. The participants agreed that the SAR should focus on science issues and the delivery of advice and requested that the sections that described management actions be removed. The authors agreed to make these revisions.

The reviewer expressed concern over the seemingly interchangeable use of the terms TAC and quota in the report. The authors agreed to clarify their definitions of these terms in the revised draft.

For a complete list of reviewer concerns and the authors' rebuttal, please see Appendix E.

## GENERAL DISCUSSION

There was discussion on the SAR sections describing geoduck enhancement and aquaculture and it was agreed that the focus of the paper should remain on the status of wild geoduck stocks rather than aspects that affect the commercial fishery. The participants recommended that these sections be removed and any pertinent points regarding these areas summarized briefly under the section *Other Considerations*. The authors agreed to make these revisions.

It was questioned whether the definition of healthy, cautious, and critical zones for geoduck stocks made appropriate use of the suggestions provided in the DFO decision-making framework and agreed that the LRP in place for geoduck is provisional only. The participants agreed that further work needs to be done to evaluate the effectiveness of the LRP, to examine possible alternatives given the problems outlined in the paper, and to develop a PA-compliant LRP and USR. It was agreed by the participants that the paragraph on PA and LRP in the *Conclusions* section should be deleted and the authors agreed to this.

One of the participants provided a detailed review of the SAR on behalf of the Underwater Harvesters Association. This person suggested the following:
(1) Adding in areas of beds affected by sea otters and listing of otter effects under *Ecosystem Considerations* section.
(2) Adding in areas of beds that have been designated for aquaculture use.
(3) Re-wording section on high-grading.
(4) Recognizing the detail that goes into conducting dive surveys including the experience of the divers doing the density surveys and the fact that there are third party requirements for confirming density estimates.
The authors agreed to make all of these suggested revisions.

## CONCLUSIONS

The SAR was accepted with minor revisions and the ToR objectives were met.

The following summarizes the conclusions and recommendations arising from this assessment:

- The area of harvestable geoduck beds in BC is estimated to be 18,067 ha. The overall mean estimated current density of all surveyed beds is 1.7 geoducks/$m^2$ while the mean weight of all geoducks is estimated to be 1.11 kg.
- Geoduck biomass in harvestable beds on the BC coast is estimated at 178,352 t (95% CB: 92,668 t – 339,582 t).
- For all harvestable beds in BC, the sums of the low 95% and low 90% annual harvest options are 1,427 t and 1,590 t, respectively, while the sum of maximum harvest options, according to the management decision rules, is 2,986 t.
- The decrease in TAC for 2012 can mostly be attributed to predation by sea otters and the associated loss of harvest opportunities, and to the reallocation of beds to geoduck subtidal aquaculture.
- More research is planned for 2012 to investigate the effects of biological sample handling practices on mean weight estimates.
- A provisional LRP is established for the geoduck fishery, however, it has not been evaluated nor is there a USR in place (DFO 2009b). In addition, because of the

issues associated with back-calculating original biomass ($B_0$) and the difficulty in monitoring recovery of closed beds, the development of an alternative LRP and USR, that are compliant with DFO's PA, is desired.

## RECOMMENDATIONS & ADVICE

(1) The participants recommended acceptance of the SAR, with minor revisions.

(2) The participants agreed that further work needs to be done to evaluate the effectiveness of the LRP, to examine possible alternatives given the problems outlined in the paper, and to develop a PA-compliant LRP and USR.

(3) The participants recommended the following changes to the text of the SAR:

(a) Defining ‘bed’ and ‘sub-bed’ more clearly.

(b) Adding in estimates of geoduck bed area by region, harvestable status, and impact by otters.

(c) Adding in upper 95% confidence bounds for mean biomass estimates.

(d) Deleting sections on *Fallback Quota Options* and *New Developments*.

(e) Clarification of the terms TAC and quotas.

(f) Deleting sections on *Geoduck Enhancement* and *Geoduck Aquaculture*, but summarizing any pertinent points regarding these areas briefly under the section *Other Considerations*.

(g) Deleting the paragraph on PA and LRP in the *Conclusions* section.

## ACKNOWLEDGEMENTS

I would like to thank the two official reviewers, Dan Clark and Nick Duprey, for providing thoughtful and in-depth reviews of the two SARs; the two rapporteurs, Jason Dunham and Reziah Khan, for taking detailed notes during the meeting; and Ken Fong, Claudia Hand, and Dennis Rutherford for post-meeting input into the proceedings. Grant Dovey, of the Underwater Harvesters Association, is thanked for his detailed review of the geoduck SAR.

## REFERENCES

Bureau, D., C.M. Hand and W Hajas. 2012. Stock assessment framework for the British Columbia geoduck fishery, 2008. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/121. v + 79p.

DFO. 2009a. Proceedings of the precautionary approach workshop on shrimp and prawn stocks and fisheries; November 26-27, 2008. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2008/031.

DFO. 2009b. A fishery decision-making framework incorporating the precautionary approach. http://www.dfo-mpo.gc.ca/fm-gp/peches-fisheries/fish-ren-peche/sff-cpd/precaution-eng.htm

DFO. 2011. Assessment of inshore shrimp stocks along the coast of British Columbia. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2010/079.

Hand, C.M., and D. Bureau. 2012. Stock Assessment Framework for the British Columbia GeoduckFishery, 2002. DFO. Can. Sci. Advis. Sec. Res. Doc. 2011/120: vi + 33 p.

## APPENDIX A: TERMS OF REFERENCE

# Terms of Reference

*Status Update of British Columbia Geoduck Stocks, 2011; and Assessment of Inshore Shrimp Stocks along the Coast of British Columbia, 2011*

## Pacific Regional Advisory Process

**November 29, 2011**
**Nanaimo, British Columbia**

Chairperson: Chris Pearce

This Regional Advisory Process (RAP) will review two Science Advisory Reports (SARs) for three species of marine invertebrates. The context and objectives for each review are outlined below.

***REVIEW 1: Status Update of British Columbia Geoduck Stocks, 2011***

**Context**
The British Columbia geoduck fishery is managed with a Total Allowable Catch (TAC), individual vessel quotas (IVQs), along with scheduled openings and area quotas. The fishery in the North and Gulf regions is a three-year rotational fishery while the West Coast of Vancouver Island (WCVI) is fished annually. Stock assessment and management of the fishery are conducted on a by-geoduck-bed spatial scale. The Limit Reference Point (LRP) is set at 40% of estimated virgin biomass ($B_0$). Biomass estimates are updated annually with new data from population density surveys, mean weights, and bed areas. An updated stock assessment framework was reviewed and accepted in November 2008, which provided details of geoduck biomass estimation methods (Bureau et al., Stock Assessment Framework for the British Columbia Geoduck Fishery, 2008. Unpublished Manuscript). The purpose of this status update is to provide an updated range of geoduck biomass estimates using the 2008 framework.

**Objectives**
The objective of this SAR is to provide an assessment of geoduck stock status in British Columbia using the assessment framework developed in 2008: Specifically, the SAR will:

1. Provide estimates of harvestable area, geoduck density, mean weight, and range of geoduck biomass estimates in British Columbia;
2. Provide estimates of stock index in relation to the current LRP;
3. Identify issues that may impact geoduck populations and the commercial fishery in the future; and
4. Identify research priorities.

***REVIEW 2: Assessment of Inshore Shrimp Stocks along the Coast of British Columbia, 2011***

**Context**
The status of British Columbia inshore shrimp stocks, as indexed through annual surveys, forms the biological basis upon which the Department of Fisheries and Oceans (DFO) Fisheries and Aquaculture Management (FAM) branch sets annual area catch ceilings, referred to in this report as total allowable catch (TAC). In addition, in 2009, DFO implemented provisional Precautionary Approach (PA) harvest control rules (HCR) for shrimp stocks (DFO 2009a). This report provides an update to the 2010 Canadian Science Advisory Secretariat Science Advisory Report on shrimp stock trends (DFO 2011), as indexed through surveys from inception of surveys in 1997 to

2011, along with commercial catch trends from 1987 to 2011. This report documents the advice on stock status, in relation to the PA, which provided to fishery managers and industry in-season.

**Objectives**
The objective of this SAR is to document the advice with respect to the management and assessment of the shrimp trawl fishery by Shrimp Management Area (SMA) along the coast of British Columbia. Specifically, the SAR will:

1. Provide estimates of biomass for pink and sidestripe shrimp in 2011, resulting from the annual area-swept fishery independent surveys in selected SMAs; and
2. Provide a 2011 fishery performance evaluation, in selected SMAs, of catch in comparison to the recommended catch ceilings.

**Expected Publications**

- CSAS Science Advisory Report (2)
- RAP Proceedings (1)

**Participation**
Participants will include internal DFO representatives and potentially participants from the Province of British Columbia, academia, First Nations, NGOs, and industry.

**References Cited**
DFO. 2011. Assessment of Inshore Shrimp Stocks Along the Coast of British Columbia. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2010/079.

DFO. 2009. Proceedings of the Precautionary Approach Workshop on Shrimp and Prawn Stocks and Fisheries; November 26-27, 2008. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2008/031.

## APPENDIX B: SUMMARIES OF THE SCIENCE ADVISORY REPORTS

### (1) Assessment of inshore shrimp stocks along the coast of British Columbia, 2011

- The coast of British Columbia is divided up into 36 Shrimp Management Areas (SMA's).

- Shrimp stock size is indexed through annual swept-area fishery independent surveys in selected SMA's.

- In 2011, nine of the fourteen shrimp stocks assessed in this report were in the Healthy Zone i.e. above the Upper Stock Reference (USR); three stocks, SMA 14 and GSTE pink shrimp and SMA 18 sidestripe shrimp, were between the USR and Limit Reference Point (LRP) and in the Cautious zone; two stocks, SMA 18 and SMA 19 pink shrimp, were below the LRP and in the Critical zone. SMA 12IN shrimp stocks were not assessed in 2011.

- The current assessment concludes that shrimp stocks show high annual variation in stock size and all shrimp stocks were relatively unchanged or decreased from 2010 levels except SMA FR sidestripe which was at a record high.

### (2) Status update of wild British Columbia geoduck stocks, 2011

- The area of harvestable geoduck beds in BC is estimated to be 18,065 ha. The overall mean estimated current density on surveyed beds is 1.7 geoducks/$m^2$ while mean weight is estimated at 1,111g.

- More research is planned to investigate the effects of biological sample handling practices on mean weight estimates.

- The estimated current geoduck biomass in harvestable beds ranges from 101,764 tons (224,349,590 lbs) (low 90% confidence bound) to 180,204 tons (397,277,979 lbs) (mean estimate).

- The Total Allowable Catch (TAC) for the BC geoduck fishery was set at 1,497 tons (3,300,000 lbs; 60,000 lbs per licence) for 2012, down from 1,559 tons (3,437,500 lbs; 62,500 lbs per licence) in place from 2005 to 2011.

- The expansion of sea otter (*Enhydra lutris*) populations (size and range) in BC poses a threat to the geoduck fishery and will likely lead to further reductions in TAC in the future.

- Increased interest in geoduck aquaculture in BC may result in the allocation of existing geoduck beds (or portions of beds) to aquaculture, which will lead to in a decrease in bed area available to the fishery and likely a decreased TAC.

- An alternative to the Limit Reference Point (LRP) that is based on a proportion of estimated current biomass to estimated virgin biomass is required, due to the uncertainties associated with estimating virgin biomass and because of violations of many of the inherent assumptions.

## APPENDIX C: AGENDA

# Regional Advisory Process (RAP)

**Centre for Science Advice Pacific**

# AGENDA

## Assessment of Inshore Shrimp Stocks along the Coast of British Columbia, 2011

## Status Update of British Columbia Geoduck Stocks, 2011

**November 29, 2011**

**PBS Seminar Room, Taylor Building, Rooms 227A&B**
**Pacific Biological Station**
**3190 Hammond Bay Road, Nanaimo, British Columbia V9T 6N7**

**Chairperson: Chris Pearce**

| | | |
|---|---|---|
| 9:00 | Welcome & Introductions | Chris Pearce |
| 9:15 | Review Agenda & Housekeeping | Chris Pearce |
| 9:30 | CSAS Overview & Meeting Procedures | Marilyn Joyce |
| 9:45 | Review of Terms of Reference | Chris Pearce |
| 10:00 | Presentation of Shrimp SAR | Ken Fong |
| **10:30** | ***Break*** | |
| 10:45 | Reviewer Presentation & Author Response | Dan Clark |
| 11:15 | Group Discussion to Identify Issues and Topics Needing Further Discussion | RAP Participants |
| **12:15** | ***Lunch Break*** | |
| 1:15 | Presentation of Geoduck SAR | Dominique Bureau |
| 1:45 | Reviewer Presentation & Author Response | Nick Duprey |
| 2:15 | Group Discussion to Identify Issues and Topics Needing Further Discussion | RAP Participants |
| **3:15** | ***Break*** | |
| **3:30** | Discussion and Resolution - Issues & Topics | RAP Participants |
| **4:30** | ***Adjournment*** | |

## APPENDIX D: ATTENDEES

| Last Name | First Name | Affiliation |
|---|---|---|
| **DFO Participants** | | |
| Barton | Leslie | DFO |
| Bureau | Dominique | DFO |
| Clark | Dan | DFO |
| Davies | Sandra | DFO |
| Davies | Sarah | DFO |
| Dunham | Jason | DFO |
| Ennevor | Bridget | DFO |
| Fong | Ken | DFO |
| Gillespie | Graham | DFO |
| Hajas | Wayne | DFO |
| Hand | Claudia | DFO |
| Joyce | Marilyn | DFO |
| Khan | Reziah | DFO |
| Lessard | Joanne | DFO |
| Nguyen | Hai | DFO |
| Parker | Guy | DFO |
| Pearce | Chris | DFO |
| Perry | Ian | DFO |
| Ridings | Pauline | DFO |
| Rogers | Juanita | DFO |
| Rutherford | Dennis | DFO |
| Waddell | Brenda | DFO |
| Wylie | Erin | DFO |
| Zhang | Zane | DFO |
| | | |
| **External Participants** | | |
| Atkins | Mike | Trident Biological Consulting |
| Chalmers | Dennis | Province of BC |
| Dovey | Grant | Underwater Harvesters Association |
| Holmes | Heather | Parks Canada |
| Tomascik | Tomas | Parks Canada |

## APPENDIX E: WRITTEN REVIEWS

### (1) Assessment of inshore shrimp stocks along the coast of British Columbia, 2011

Regional Advisory Process Reviewer's Comments

**Review of Science Advisory Report:** Assessment of Inshore Shrimp Stocks along the Coast of British Columbia, 2011
Dan Clark, Fisheries and Oceans Canada, South Coast Area, Resource Management

This Science Advisory Report (SAR) summarizes the state of the primary inshore shrimp stocks that are indexed through annual surveys with descriptors (unchanged, decreased, or record high e.g.) and the data is summarized in graphs which show the trends from historical calculations. The stock status for each of the pink and sidestripe shrimp stocks for 2011 is defined following the Precautionary Approach (Critical, Cautious, or Healthy zone). It shows how the pink and sidestripe shrimp stocks can vary over time.

Graphs of catch ceilings and landings history for each of the Shrimp Management Areas (SMA) are included, sometimes with species combined, as per the history of each area.

One small edit was provided to the author.

With respect to the 5 standard questions:
1. Is the purpose of the SAR clearly stated?

Yes, the context box provides background on the purpose of the SAR and gives references to more background on the Precautionary Approach – if a reader wants to know more about how the Critical, Cautious and Healthy zones are defined, they can go to the source document (although might it be possible to briefly include how the LRP, USR are defined in the Fishery summary section (LRP is 40% of Ln(average biomass); USR 80% of the Ln(average biomass)?).

2. Are the data and methods adequate to support the conclusions?

Yes, there are graphs that show the current indexes and the trends.

3. Are the data and methods explained in sufficient detail to properly evaluate the conclusions?

Since this is a summary document, I think sufficient detail is provided.

4. If the document presents advice to decision makers, are the recommendations provided in a useable form, and does the advice reflect the uncertainty in the data, analysis or process?

The advice is provided on the current Precautionary Approach zone (Critical, Cautious or Healthy) and there are 95% confidence intervals on the most recent data. No advice with respect to future biomass is provided (would it be possible to say why it is not?).

5. Can you suggest additional areas of research that are needed to improve our assessment abilities?

No, not in terms of the scope of this document in defining stock trends in comparison to past biomass indexes.

Comments/questions
Q1. Limitation to inshore SMA's - With respect to the Request for advice (I was not sure if I found the correct version and since this is an annual assessment, there may not be one) – the request did not appear to be limited to inshore stocks only and mentioned that there was a pre-2005 Stock Status Report that needed to be updated. This SAR has been limited to the inshore shrimp stocks and the offshore stocks that are assessed annually are not included. A previous Stock Status Report (C6-08(1999)) that covers the West Coast shrimp stocks is out of date. While it may be unfair to ask, but since this SAR is an update of a previous one on the inshore stocks, why not include the offshore stocks as well to give an overview of all BC pink and sidestripe shrimp stocks and therefore update/replace C6-08 at the same time?

Q2. Decision rules – setting catch ceilings – this SAR provides the history of catch ceilings and landings but does not specifically repeat the decision rules for how those were defined, although there is reference to the publication that does define the decision rules. Would it not be useful to repeat them in the Fishery summary section? Even to say that in general, when a stock biomass index is in the Critical zone, the harvest rate is 0%, in the Cautious zone, a catch ceiling is set using a harvest rate of 0% to 35% and in the Healthy zone the catch ceiling is defined using a harvest rate of 35%). The graph of catch ceiling and landings shows how the landings have been limited to catch ceilings in most years by management actions.

Q3. One question/clarification I had was the source of the landings – from hails or logbooks. If from logbooks that would explain why the 2010 landings are preliminary. If from hails, the 2010 landings are as given in-season, and therefore do not get updated.

Q4. Coonstripes - There is a species with no LRP or USR defined (coonstripe shrimp) but a biomass index is defined in most years for SMA 18 and SMA 19 and harvest opportunity may be limited by this species. I wondered why it was not included (although there is a limit to the length of the document so I realize it might not be included but a general comment about the bulletins providing more complete information might cover this off).

The author has summarized a huge amount of work in 11 pages and this will be useful for managers, fish harvesters and resource managers who are interested in how pink and sidestripe shrimp populations fluctuate. It is a valuable reference document.

Thank you for letting me provide this review.

## (2) Status update of wild British Columbia geoduck stocks, 2011

Canadian Science Advisory Secretariat
Centre for Science Advice Pacific

Regional Advisory Process Reviewer's Comments

**Reviewer:** Nicholas M.T. Duprey, Fisheries and Oceans Canada
**Science Advisory Report**: Status Update of British Columbia Geoduck Stocks, 2011

## REVIEWER COMMENTS

**Status Update of British Columbia Geoduck Stocks, 2011**
Pacific Regional Advisory Process
November 29, 2011
Pacific Biological Station, Nanaimo, BC

**Reviewer**
Nicholas M.T. Duprey
Sea Cucumber Research Biologist
Fisheries and Oceans Canada, Nanaimo, BC

**Science Advisory Report**
Status Update of British Columbia Geoduck Stocks, 2011

Thank-you for the opportunity to review this paper, this Science Advisory Report (SAR) was very well laid out, with defined sections that were easy to follow and covered all the basic information required in a status update. The Report made good use of tables and figures to supplement the written text and main points being presented. The goal of the paper appears to be an update on the current status of the British Columbia geoduck stock with a brief description on how stock estimates are calculated. The brief history of the biology of geoduck followed by a brief history of the fishery is concise and provides the information required for a stock update (please see comments on the biology section and CPUE discussion below and minor editorial comments embedded in document). My main comments on the paper are listed below in point form to make their presentation and discussion easier at the CSAP meeting. Unfortunately I will not be able to attend the meeting as I will be in the field, please contact me before November 25 if you need any points clarified.

1. Biology section:
    a. You state geoducks generally reach max size by age 20. But aren't growth rings used to age animals? So how are they not growing over the next 80 years but still putting on growth rings? Seems counterintuitive.

       Asymptotic size reached around 20 years for all populations. After that there is only a slight increase in weight due to thickening of the shell over time.

    b. You state that animals are "recruited to the fishery at age 4, fully recruited at 6-12 years". Really? Does this mean that 4 year old animals are being harvested in the fishery?

       Harbo et al. 1983 found some 4 year olds in Market Samples.

       Does this mean other fisheries like aquaculture can expect harvestable animals at age 4?

       At age 4, shells are thin and brittle resulting in much breakage. Since there is a no-discard policy in the geoduck fishery, if a young geoduck is harvested, it has to be landed. It is unlikely that aquaculturists would want to harvest at age 4 since most product would end up on processed instead of live market due to shell breakage. Price of processed product

is approx 25% of live product.

c. You state “recruitment was at a coastwide high around 1950...” a citation is required for this.

   Added.

2. Fishery
   a. Your last sentence before Figure 3. “In 1996, a 50-year time horizon was…” this is a complicated correction factor that would be very hard to explain in a few sentences. I suggest simply mentioning it and giving a source to follow and get all the information about this calculation. I don’t think it warrants too much discussion as it was discontinued in 2007 (as mentioned later, although I would mention it here).
      i. Perhaps a sentence like “Between 1995 and 2007 an Amortization Factor was to reduce quotas and evenly distribute $0.5B_0$ into future fishing years (somebody and somebody 1995).

         Will reword.

   b. CPUE. Your sentence “Overall CPUE has increased slightly since 1998…” CPUE appears to be decreasing since 1995 in Haida Gwaii and Central Coast, thoughts on this as you don’t mention it? (Figure 4) Rupert appears to be making the overall north CPUE look good.

      True, decrease in CC may be due to otters. Decrease in QCI might be due to having progressively higher quotas up North over time forcing harvest in less desirable beds.
      I can add a sentence if needed.

3. Ecosystems Considerations: Great section. However, Pearce et al is not published and therefore cannot be cited here. Perhaps change to personnel communication.

   Pearce et al. should be published before SAR is ready for publication.

4. In the Assessment sections the terms bed and sub-bed are at times confusing. I would like to see the number of beds and sub-beds that are harvestable included.

   Clarification on definition of beds and sub-beds: Approximately 2,400 geoduck beds have been identified along the BC coast. Some beds comprise more than one polygon in the GIS bed maps, each individual polygon is defined as a sub-bed, which number around 4,800.

   I realize these numbers change annually, as mentioned in the paper, but I believe bed counts (both “beds” and “sub-beds”, harvestable and un-harvestable) should be presented with a date stamp to clarify future discussions later in the paper.

Amount of Area is more relevant than number of beds. Added new table for bed area:

| Licence Area | Bed Area (Ha) | | | | | |
|---|---|---|---|---|---|---|
| | Total | Closed | Otters | Harvestable | Below LRP | Open |
| North | 7,184 | 111 | 598 | 6,475 | 115 | 6,359 |
| Gulf | 8,898 | 638 | 0 | 8,260 | 527 | 7,733 |
| WCVI | 5,457 | 321 | 1,803 | 3,333 | 559 | 2,774 |
| Total | 21,538 | 1,070 | 2,401 | 18,067 | 1,201 | 16,867 |

Also care should be taken to clarify when “beds” and “sub-beds” are being discussed. I became confused in at times whether the author(s) where presenting numbers and results about beds or sub-beds.

All results presented clearly state that they refer to beds in the table captions and table themselves. Table 4 modified to refer to beds.

5. Assessment
    a. Page 5: “Approximately 2,400 beds have been identified…”
        i. So some beds have 2+ sub-beds, but not all of them? Correct
        ii. How are sub-beds defined?

            Different polygons in GIS belonging to the same bed code.

            And how can they merge?

            If fishing happens between two sub-beds then they can become a single polygon and therefore “merge” into a single sub-bed.

        iii. Also how many of the 2,400 beds and/or 4,800 sub-beds are harvestable?

            See new table above. Area is more meaningful than number of beds.

        iv. A table might be best here with harvestable and un-harvestable as columns OR better yet add un-harvestable to Table 3 (this would also give readers a good idea how much un-harvestable biomass is out there that is not used in harvestable biomass calculations.

            Providing harvestable biomass on un-harvestable beds is dubious since very few (if any) are surveyed and many have been impacted to an un-quantified degree by otters. Biomass on those beds would be extrapolated from surveyed beds (mostly not impacted by otters).

6. Mean weight
    a. Table 1: I am guessing you use the most current weight estimate to calculate a beds biomass if you have multiple samples from a single bed? If there is some other way weight data is drawn for this analysis please be clear about that here (which years take precedence, when is enough data achieved to use, is data actually bed specific).

        This is described in detail in 2008 Assessment Framework and there is no

room to discuss this in the SAR.

b. Table 1. Does this mean you have 2,140 beds of 2,400 beds with sample weights that are used for biomass estimations? If so that is really good and should be highlighted.

   Not exactly. For biomass calculations we only use beds where the number of landings is 10 or more. This table includes all beds for which we have landings irrespective of the number of landings. To add sentence to clarify.

7. Density
   a. "The Coefficient of variation of mean survey density estimates…" How was CV actually calculated? In Bureau et al. unpublished it is not clear.
      i. Was this the mean of all the mean survey density estimates? Yes
      ii. Or did you pool all transects surveyed between 2003 – 2008 and calculate a mean and CV? No
         1. If you did this then I don't think it serves your purpose here
         2. You want to show that density estimates are precise for a surveyed bed. You therefore need a CV for each analyzed area. And should indicate the range of CVs you have calculated from all surveys conducted.
         3. This is assuming you are trying to show that the precision of your surveys are good and compare them to one another. If you are trying to show that overall geoduck transect density does not vary much throughout BC this CV is appropriate, but you contradict this later in the following paragraph.
      iii. You appear to have calculated CV using the following equation (found in Bureau et al unpublished – Table 5)
         1. CV = (mean – LCB 90%)/mean which ~= sd*2/mean
         2. I believe CV should be calculated as CV = sd/mean
         3. Why did you use the equation in #1?

            Mean density and confidence bounds are estimated using non-parametric methods (bootstrapping) and therefore we do not have SD.

8. Exploitation rate: This section is clear and concise. However, I believe that the exploitation rate is adjusted in rotated areas (HG, NC, CC, and Gulf). The presented annual exploitation rates should also be presented as the value recommended for use when using a three year rotation (I believe, but I am not certain, it is HG=4.8%; NC/CC/Gulf =5.4%).

   Added following sentence: "The annual exploitation rates are multiplied by three for regions harvested under three year rotation, so that the average exploitation rate over a rotation period is equal to the annual harvest rate."

9. Estimated Geoduck biomass in BC
   a. Why do you range the biomass from the lower 90% CB to the mean? Why not present the whole 90% confidence bound with the mean? In fact why not present the whole range of confidence bounds (75%, 90%, 95%).

The upper 95% is un-trustworthy in my opinion and therefore not worth mentioning. Not convinced that presenting all confidence bounds is necessary. I'll probably add the low 95%.

b. Are the numbers presented here the real TACs? Or are these the numbers managers shrink down to allow for a Fallback Quota? I think only the real (whole) numbers should be presented here. As they are the recommended total amount that can be removed.

   TAC now defined at beginning of document as: "Total Allowable Catch (TAC) in the context of this report refers to the annual catch ceiling, established by fishery managers, for the BC wild geoduck fishery."

   "Harvest Options" is what Science provides to Managers.

c. After reading this more carefully I realise there is no discussion about where in the range of means and confidence bounds does science recommend managers choose their biomass estimate for TAC calculations. There is only a total biomass, and then the current management total quota allocations. Does science have a recommended biomass value to offer managers; either on a coastwide basis or bed-to-bed? This should be in either the Sources of Uncertainty section or here in the Biomass section.

   There has not been a recommendation from Science as to which level of confidence managers should use in establishing quotas from the harvest options provided by Science. Current management rules are that: 1- if a bed has been dive surveyed, managers can assign a bed quota up to the mean harvest option; 2- if a bed has not been surveyed, managers can assign a quota up to the mean value between the lower 95% and mean estimate of quota options.

   For reference in other fisheries:
   BC sea cucumbers uses Low 90%
   SE Alaska geoducks uses Low 90%
   Washington geoducks uses mean

d. I would present this section as… "The current 2011 estimated mean geoduck biomass in BC is ## tons (## tons - ## tons 90% CB), due to uncertainties presented earlier it is believed that the real biomass of the coastwide BC geoduck stock lies closer to the lower 90% confidence bound. The 55 BC Geoduck licences were allocated ## tons annually between 2005 and 2011, and ## tons for 2012. Currently the fishery, overall, is managed more conservatively than the lower 90% confidence bound."

   Not sure about the "it is believed that the real biomass…" part. We are MORE CONFIDENT that the biomass is at least the low 90 (vs. for example the mean) but I am not sure we can honestly say anything about the "real" biomass.

10. As this is a SAR I do not feel sections "Fallback Quota Options" and "New Developments" should be included. They do not appear to have any relevance

on the question being presented “status update on geoduck stocks”. I would remove these from the paper as they only discuss management actions and have no bearing on the geoduck stock; they would fit better in the IFMP. The fact that the calculated TAC is not being fully used (We do NOT calculate a TAC, managers do that) is already discussed later in conclusions, which covers the important parts of “Fallback Quota Options”. “The New Development” section has nothing to do with stock assessment.

Those sections are perhaps more related to a “fishery update” possibly than a “status update”. They are however an important part of how the fishery is run. Also, the request for working paper contains the following in the “intended uses of the advice…” section: “The document will provide timely information on stock status, **fishery history and management actions**…” Both these sections would fall under fishery history and/or management actions.

Wrong use of TAC here. TAC is defined by most agencies worldwide as what managers allow to come out of the ocean and does NOT refer to stock assessment estimates. TAC is a management tool.

Update at meeting: Take those sections out.

11. Geoduck Enhancement: This section needs more detail. How many beds were enhanced? How often? Is it considered effective? What does the term map-reserve mean?

    Will add more detail.

    Aquaculture section. Add in lost ground estimates.

12. The use of Total Allowable Catch (TAC) and quota seems to be used interchangeably throughout the document. These terms are not interchangeable and I would recommend carefully reviewing their use. Science should be advising on the total biomass of geoduck populations and what are appropriate harvest rates. This would then result in Total Allowable Catch options (NO, TAC is a management tool and a set number, not a range of options), not quota options. I feel it is important to recognize these differences and not muddle the boundaries between advice to managers and presenting final quotas for IFMPs, as many more considerations, other than total sustainable take (≠TAC), goes into allocating a quota to a licence.

    This has been clarified in the document.
    TAC is what managers allow to come out of the ocean and does NOT refer to stock assessment estimates.
    Following sentence was added: “In this report, advice provided by science to fishery managers is referred to as “Harvest Options”, while “Quota” refers to a portion of the TAC, i.e., IVQ or area quota or bed quota, as assigned by fishery managers, so that the sum of quotas is equal to the TAC.”
    Advice from Science to Managers we have now renamed “Harvest Options” instead of “Quota Options” to eliminate confusion between science advice and assigned quota.

13. Citations: I would like to see this SAR published after all the cited documents have been published: Bureau etal, Hand and Bureau, and Pearce etal. Without

these documents I don’t think this SAR can be published as is. These three documents hold much of the background and thorough explanations of methods, equations, findings, results and discussions that are critical to the status update presented here.

Agreed, and we are working on it.