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Proceedings of the PSARC Invertebrate Subcommittee Meeting

Compte rendu de la réunion du sous-comité des invertébrés du CEESP

April 12-14, 2005
Nanaimo, B.C.

J. Boutillier
Invertebrate Subcommittee Chair

Fisheries & Oceans Canada
Pacific Scientific Advice Review Committee
Pacific Biological Station
Nanaimo, B.C. V9T 6N7

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PACIFIC SCIENTIFIC ADVICE REVIEW COMMITTEE (PSARC)

INVERTEBRATE SUBCOMMITTEE MEETING

SUMMARY

The Pacific Scientific Advice Review Committee (PSARC) Invertebrate Subcommittee met April 12-14, 2005 at the Pacific Biological Station in Nanaimo, B.C. The Subcommittee reviewed four working papers.

Working Paper I2005-01: Evaluation of assessment and management frameworks for the British Columbia depuration fishery for intertidal clams
G.E. Gillespie, W.C. Hajas, J.S. Dunham

The Working Paper was written in response to a request to refine and rationalize biological reference points and the management strategy for intertidal clam fisheries. The objectives of the paper were to review the experimental depuration fishery and re-evaluate production models currently used to set harvest thresholds. Population models were also developed to project biomass, abundance and quotas for up to three years following surveys.

Both reviewers found the paper useful, but requested clarification on basic terms, more detail, particularly in the methods and model, and some minor edits. Specific concerns expressed by the reviewers were addressed by the authors and will be corrected in the revision.

The Subcommittee discussed ways to increase survey quality, include natural mortality in the model, and the inability of harvest size limits to ensure conservation of the resource. The Subcommittee agreed with the paper's recommendation to continue the current methods for determining harvest rates and to predict for a *maximum* of three years, if beaches are reviewed and high or unusual mortality rates are incorporated. The Subcommittee emphasized that 1) the model is not packaged for public usage, but is a work in progress 2) the surveyor's efficiency needs further evaluation and, 3) surveys may require qualified surveyors or locals with certified supervision.

The Subcommittee recommended:

- to accept the paper subject to revisions as outlined in the Subcommittee discussion and conclusions and as per the reviews,
- validation of growth ring aging methods be highlighted as we go forward with these types of models,
- quality assurance standards for field and lab work be developed for third party work, and the ageing lab be notified of the expected increase in demands and of the desire to ensure that standards are determined and available to others.
- the model not be made available for public use at this point.

Working Paper I2005-02: Assessment of recruitment forecasting methods for shrimp in selected management areas along the coast of British Columbia

D. Rutherford, H. Nguyen

This paper was written in response to a request to test the relative performance and utility of various recruitment forecasting methods and their application for pre-season forecasting of pink shrimp (*Pandalus jordani* and *P. borealis*) and sidestripe shrimp (*Pandalopsis dispar*). The rationale for the request was to evaluate current and alternative methods, which would enable the managers to develop decision criteria on how to effectively use forecasts in the setting of the pre-season commercial catch ceilings for "pink" and sidestripe shrimp.

Four different biomass forecasting methods were assessed for their relative performance and utility in 11 different Shrimp Management Areas. The methods were tested using retrospective analysis, i.e. by making forecasts for previous years using only the data that would have been available at that time.

Two criteria (the Root Mean Squared Error (RSME) and Mean Absolute Deviation (MAD) were used to evaluate the relative performance of each of the forecasting methods. The authors concluded that none of the methods performed well on a consistent basis. However, the Like Last Year (LLY) model performed slightly better under the RSME criterion, it was simple and required few data. Therefore, this model was used to generate pre-season shrimp biomass forecasts for 2005 and these were summarized for three probability reference points (50%, 25% and 10%). The authors pointed out that the 2005 forecasts in this paper were for illustrative purposes only because the fishing season has already started.

The authors made two recommendations:

1. The Like Last year (LLY) model be used to produce future forecasts for both pink and sidestripe shrimp stocks,
2. The median point estimate of the forecasts be presented along with the 25% and 10% probability levels to ensure the uncertainty bounds associated with the forecasts are simply and effectively conveyed.

The Subcommittee made the following recommendations:

1. Accept the paper with substantial modifications, especially with respect to recommendation #1.
2. Since there was no consensus about which model to use for improved forecasting of shrimp stocks, the Subcommittee recommended further work on investigating optimum methods for forecasting, especially with models that can give an indication of the direction of change, and noted that different models may be needed for different areas and species.
3. Continue data collection to improve model development.

Working Paper I2005-03: Review of the annual sea cucumber fishery and recommendations for a rotational harvest strategy
S.R. Humble, C.M. Hand, W.K. de la Mare

The paper reviewed research and fishery data for sea cucumbers (*Parastichopus californicus*), in response to commercial harvesters' concern that the annual fishery is negatively impacting stocks. Harvest was concentrated in 12% of open areas, by shoreline distance, resulting in average local harvest rates of 30% of estimated biomass. Analysis of market sample, biological sample and survey density data failed to reveal significant impacts of annually-concentrated effort on sea cucumber populations, however sample regimes for estimating animal size distribution were found to be flawed.

Simulation model results suggested that at high local harvest rates, annual harvest leads to smaller and fewer animals while longer rotation periods result in more and larger animals. A new experimental fishing program was described to test rotational harvest and provide more informative short- and long-term data. Recommendations were provided for how a pilot rotational harvest could be conducted within a portion of the open fishery, including changes in data collection that would improve the ability to detect localized fishing effects.

The Subcommittee accepted the paper subject to revisions outlined by the reviewers and agreed upon by the Subcommittee. They noted that this is the first evaluation of the cucumber fishery strategy and it is not a framework paper; it brings up a lot of things that need to be dealt with. The Subcommittee recommended that re-evaluation of the sea cucumber experimental protocol and assessment framework is needed. The Subcommittee also noted that maintaining buffer zones is desirable in any future management regime. The Subcommittee recommended that they be considered in planning changes.

Working Paper I2005-04: Evaluation of abundance based index methods for Dungeness crab, *Cancer magister*, and spot prawn, *Pandalus platyceros*, on small spatial scales
K. H. Fong, G.E. Gillespie

Assessment and management frameworks for Dungeness crab and prawn in BC do not rely on abundance estimates. However, they may be required to meet treaty agreements that guarantee allocation to First Nations (FN) to harvest fish when there is no conservation, public safety, or public health concerns. The paper evaluated the utility of historical catch as a means for delivering allocations for Dungeness crabs and prawns. The paper evaluates the utility of historical catch and abundance-based index models for Dungeness crabs and prawns and describes how allocations can be delivered from abundance indices. The paper also reviewed models for allocation used in Washington State.

The paper made two recommendations:

1. Improve and develop catch monitoring programs for all Dungeness crab and prawn fisheries (commercial, recreational and First Nation FSC).
2. Multiple programs should be initiated, developed and tested to determine which methods are most appropriate in each area.

The Subcommittee accepted the paper's recommendations, if reworded to qualify "if abundance methods are used", and if the second was revised to clarify the need to get more information on the methods considered and to test them before committing to use them in treaties.

The Subcommittee emphasized that ultimately the goal is to set a TAC (total allowable catch) for FN each year and to manage to it. If abundance methods are used, we need to know the steps to go from abundance to a TAC. Since Washington State uses a combination of pre-season forecasting with in-season adjustments, maybe the paper should identify what is required pre-season and in-season for each approach.

The majority of the Subcommittee accepted the paper with the revisions discussed by the Subcommittee, including a discussion of spatial scales in the context of biology of each animal and a rewording of the title in reference to "evaluation" and "small spatial scales".

The Subcommittee recognized that other tools could be used by management besides the abundance indexes presented in the paper and that accurate information on total catch is needed to be able to use the models presented. It was recommended that abundance based models be piloted before being entrenched in treaties.

The Subcommittee encouraged developing a plan in cooperation with treaties, managers, and science to discuss how to deal with some of the issues raised here, including the appropriate place to discuss broader measures to move forward with regard to treaty settlements.

SOMMAIRE

Le Sous-comité des invertébrés du Comité d'examen des évaluations scientifiques du Pacifique (CEESP) s'est réuni du 12 au 14 avril 2005 à la Station biologique du Pacifique, située à Nanaimo (C.-B.), et a examiné quatre documents de travail.

Document de travail I2005-01 - Évaluation des cadres d'évaluation et de gestion de la pêche aux palourdes intertidales en vue de leur dépuration en Colombie-Britannique

G.E. Gillespie, W.C. Hajas et J.S. Dunham

Ce document de travail fait suite à une demande de perfectionnement et de justification des points de référence biologiques et de la stratégie de gestion de la pêche aux palourdes intertidales. Le document vise à examiner la pêche expérimentale pour dépuration et à réévaluer les modèles de production qui servent à établir les seuils de récolte. Des modèles de population ont été élaborés pour prédire la biomasse, l'abondance et les quotas jusqu'à trois ans après les relevés.

Les deux examinateurs jugent que le document est utile, mais ils demandent aux auteurs d'éclaircir des éléments de base et d'apporter des précisions, particulièrement sur les méthodes et les modèles, ainsi que des modifications mineures. Les auteurs abordent les points soulevés par les examinateurs et apporteront les corrections pertinentes dans la nouvelle version.

Le Sous-comité discute de façons de rehausser la qualité des relevés et d'inclure la mortalité naturelle dans le modèle, ainsi que du fait que les limites sur le taux d'exploitation ne permettent pas de conserver la ressource. Le Sous-comité accepte la recommandation du document qui préconise de continuer d'établir les taux d'exploitation selon les méthodes actuelles et les prévisions sur un *maximun* de trois ans, si les plages sont étudiées et que l'on tient compte des taux de mortalité élevés ou inhabituels. Le Sous-comité relève les points suivants : 1) le modèle n'est pas adapté pour être utilisé par le public étant donné que celui-ci est en cours de développement; 2) les besoins en matière d'efficacité du personnel de relevé doivent être mieux évalués; 3) les relevés devraient être effectués par des spécialistes qualifiés ou par des résidents locaux sous la supervision de spécialistes.

Voici les recommandations du Sous-comité :
- accepter le document sous réserve des modifications demandées dans la discussion et les conclusions du Sous-comité et par les examinateurs;
- insister sur la validation des méthodes de détermination de l'âge selon les anneaux de croissance pour l'application de ces modèles

- établir des normes d'assurance de la qualité du travail de terrain et de laboratoire effectué par de tierces parties; aviser le laboratoire de détermination de l'âge de la hausse prévue des demandes et de la volonté d'établir des normes et de les mettre à la disposition d'autres parties;
- à cette étape-ci, le modèle ne sera pas mis à la disposition du public.

Document de travail I2005-02 - Évaluation des méthodes de prévision du recrutement des crevettes dans certaines zones de gestion le long de la côte de la Colombie-Britannique
D. Rutherford et H. Nguyen

Ce document de travail fait suite à une demande d'évaluation de la performance et de l'utilité de diverses méthodes de prévision du recrutement et de leur application présaison aux crevettes roses (*Pandalus jordani* et *P. borealis*) et à la crevette à flanc rayé (*Pandalopsis dispar*). Il s'agissait de comparer la méthode actuellement utilisée et de nouvelles méthodes qui permettraient aux gestionnaires d'élaborer des critères décisionnels pour bien appliquer les prévisions à l'établissement avant la saison de plafonds de prises commerciales de ces crevettes.

La performance et l'utilité de quatre méthodes de prévision de la biomasse ont été évaluées dans 11 zones de gestion de la crevette par analyse rétrospective, c'est-à-dire en faisant des prévisions pour des années passés seulement à partir données qui auraient alors été disponibles.

Deux critères, soit l'erreur quadratique moyenne (EQM) et l'écart absolu moyen (EAM), ont servi à comparer la performance des méthodes de prévision. Les auteurs ont conclu qu'aucune des méthodes ne donnait toujours de bons résultats. Toutefois, selon le critère de l'EQM, le modèle LLY (« L*ike Last Year* ») est légèrement supérieur aux autres; de plus, il est simple et nécessite peu de données. Par conséquent, ce modèle a servi à prévoir avant la saison la biomasse de crevette en 2005 pour trois point de référence probabilistes (50 %, 25 % et 10 %). Les auteurs font remarquer que les prévisions de 2005 ne sont présentées dans le document qu'à titre indicatif, car la saison de pêche est déjà commencée.

Les auteurs ont fait les deux recommandations suivantes :
3. utiliser le modèle LLY (« L*ike Last Year* ») pour prévoir la taille des stocks de crevettes roses et à flanc rayé;
4. présenter l'estimation au point médian et les niveaux de probabilité à 25 % et à 10 % afin de définir simplement et efficacement les limites d'incertitude des prévisions.

Voici les recommandations du Sous-comité :
1. accepter le document sous réserve de modifications importantes, surtout en ce qui a trait à la recommandation 1 des auteurs;

2. comme les membres du Sous-comité ne s'entendent pas sur le modèle à utiliser pour améliorer les prévisions des stocks de crevettes, le Sous-comité recommande de poursuivre les travaux pour déterminer les méthodes de prévisions optimales, en particulier les modèles qui peuvent indiquer la direction des changements, et fait remarquer que différents modèles pourraient être nécessaires selon la zone et l'espèce;
3. poursuivre la collecte de données pour améliorer la mise au point des modèles.

Document de travail I2005-03 – Examen de la pêche annuelle au concombre de mer et recommandations pour une stratégie de récolte par rotation
S.R. Humble, C.M. Hand et W.K. de la Mare

Ce document passe en revue les données de recherche et les données de pêche sur le concombre de mer *Parastichopus californicus*, pour donner suite aux préoccupations des pêcheurs qui croient que la pêche annuelle nuit aux stocks de cet animal. Cette pêche a été concentrée sur 12 % des zones ouvertes, selon la distance à la côte, ce qui a donné des taux d'exploitation locaux moyens de 30 % de la biomasse estimée. L'analyse des données recueillies sur des échantillons de la pêche commerciale et des échantillons biologiques, ainsi que des données de densité obtenues dans le cadre de relevés, n'ont révélé aucun impact significatif de l'effort de pêche annuel sur les populations de concombres de mer, mais on a trouvé que les régimes d'échantillonnage pour estimer la structure de tailles des populations sont déficients.

Les résultats du modèle de simulation suggèrent que le nombre et la taille des concombres sont réduits lorsqu'une pêche annuelle est pratiquée à des taux d'exploitation locaux élevés et qu'ils augmentent lorsque les périodes de rotation sont plus longues. Le document décrit un nouveau programme de pêche expérimentale visant à tester la récolte par rotation et à obtenir de meilleures données à court et à long terme. Les auteurs font des recommandations sur la pratique d'une pêche pilote par rotation dans le cadre de la pêche ouverte, préconisant notamment des changements dans la collecte de données pour accroître la capacité de déceler des effets localisés de la pêche.

Le Sous-comité accepte le document sous réserve des révisions suggérées par les examinateurs et entérinées par le Sous-comité. Le Sous-comité remarque qu'il ne s'agit pas d'un document cadre, mais de la première évaluation de la stratégie de pêche au concombre de mer, laquelle soulève de nombreux aspects qui doivent être abordés. Le Sous-comité recommande de réévaluer le protocole de pêche expérimentale et le cadre d'évaluation et indique que tout régime de gestion devrait maintenir des zones tampons, qui devraient être prises en compte dans la planification des changements.

Document de travail I2005-04 - Évaluation de méthodes de gestion à petites échelles spatiales du crabe dormeur (*Cancer magister*) et de la crevette tachetée (*Pandalus platyceros*) fondées sur des indices d'abondance
K. H. Fong et G.E. Gillespie

Les cadres d'évaluation et de gestion du crabe dormeur et de la crevette tachetée de la C.-B. ne dépendent pas d'estimations de leur abondance. Toutefois, ces estimations peuvent être nécessaires pour respecter les traités qui assurent des allocations de pêche aux Premières nations en l'absence de risques pour la conservation ou la santé et la sécurité du public. Le document évalue l'utilité des données de captures historiques du crabe dormeur et de la crevette tachetée et celle des modèles fondés sur des indices d'abondance, notamment pour établir les quotas de pêche de ces invertébrés. Le document passe aussi en revue les modèles utilisés pour établir les quotas dans l'État du Washington.

Les auteurs du document ont fait les deux recommandations suivantes :

1) Améliorer ou élaborer des programmes de surveillance des captures pour toutes les pêches au crabe dormeur et à la crevette tachetée (pêches (commerciales, pêches récréatives et pêches autochtones à des fins alimentaires, sociales et rituelles).
2) Lancer, élaborer et tester plusieurs programmes pour déterminer les méthodes qui conviennent le mieux dans chaque zone.

Le Sous-comité accepte les recommandations si elles sont modifiées de façon à qualifier « si des méthodes axées sur l'abondance sont utilisées » et si la seconde recommandation est révisée pour éclaircir le besoin d'obtenir plus d'information sur les méthodes envisagées et de les mettre à l'essai avant de s'engager à les utiliser dans le cadre des traités.

Le Sous-comité souligne que le but ultime est d'établir chaque année un TAC (total autorisé des captures) pour les Premières nations et de gérer en conséquence. Si des méthodes axées sur l'abondance sont utilisées, nous devons connaître les étapes de l'établissement d'un TAC à partir des données d'abondance. Comme l'État du Washington utilise une combinaison de prévisions présaison et d'ajustements en saison, le document devrait peut-être déterminer les données nécessaires avant et pendant la saison pour chaque méthode.

La majorité des membres du Sous-comité acceptent le document sous réserve des révisions abordées par le Sous-comité, notamment une discussion sur les échelles spatiales dans le contexte de la biologie de chaque espèce et une modification du titre en ce qui concerne les termes « évaluation » et « petites échelles spatiales ».

Le Sous-comité reconnaît que les gestionnaires pourraient utiliser des outils autres que les indices d'abondance présentés dans le document et que l'utilisation des modèles présentés nécessite des données exactes sur le total des captures. Il recommande de mettre à l'essai les modèles axés sur l'abondance avant de les inscrire dans des traités.

Le Sous-comité encourage l'élaboration d'un plan de concert avec les responsables des traités, les gestionnaires et les scientifiques pour aborder certaines des questions soulevées ici, notamment celle de la bonne tribune où discuter des mesures générales pour conclure des ententes dans le cadre des traités.

INTRODUCTION

The PSARC Invertebrate Subcommittee met April 12-14, 2005 at the Pacific Biological Station in Nanaimo, British Columbia to review four working papers which are summarized in Appendix 1. External science reviews of the papers were obtained from New Caledonia, Alaska, and other regional DFO Science sections and programs. External participants at the meeting included representatives from Simon Fraser University, Sport Fish Advisory Board, and the Pacific Prawn Fishermen's Association. The Subcommittee Chair, J. Boutillier, opened the meeting by welcoming the participants, reviewing the objectives and protocols of the meeting and reviewing the agenda.

The meeting agenda appears in Appendix 2, while a list of meeting participants and reviewers is included as Appendix 3. The rapporteur responsibilities for the meeting were carried out by Barbara Lucas, Brenda Waddell, Julie Deault, Miriam O, and Dominique Bureau. Barbara provided the overall coordination of all the notes and the general meeting minutes for agenda while each of the others were responsible for one working paper.

DETAILED COMMENTS FROM THE REVIEWS

Working Paper I2005-01: Evaluation of assessment and management frameworks in the British Columbia depuration fishery for intertidal clams

G.E. Gillespie, W.C. Hajas, J.S. Dunham

The working paper was written in response to a request to refine and rationalize biological reference points and the management strategy for intertidal clam fisheries. The objectives of the paper were to review the experimental depuration fishery and re-evaluate production models currently used to set harvest thresholds. Population models were also developed to project biomass, abundance and quotas for up to three years following surveys.

Subcommittee Discussion

Both reviewers said that the purpose of the paper was clearly stated, the advice incorporated uncertainties in data and analyses, and it would be useful for fisheries management. However, some basic terms and methods need to be explained in more detail. Both reviewers listed minor edits to tables and graphs.

The first reviewer noted discrepancies in abundance of sub-legal and legal clams between density data and biosamples. He requested a description of how biosamples were taken and of sample sizes, so that readers may better appreciate the discrepancies. The authors note that the discrepancies with Wall beach abundance have been resolved and agree to include a better description of how biosamples were taken.

The reviewer also noted that the assumptions of size at age and vulnerability in the model could cause over-estimating the abundance of sub-legal clams, which would have 1-3 years of repercussions to the projection results. The authors agreed, but pointed out that they could just as likely be under-estimating.

When questioned on the form of SSQ used in the paper, the authors responded that they actually used a maximum likelihood approach. They will change this in the paper and include a reference.

The reviewer said it seems that available information (age, age frequency distribution and survey year) was not sufficient to partition the standard error for mortality into three parts, and asked that it be described in more detail or references be provided on how to do it. The authors explained that there are three components used for the partition. Relative cohort strength could also be used to partition. Cohort strength is estimated for every cohort in the series, but these values don't get used in this kind of projection, because they have the complete age-structure for the population.

The reviewer wondered why standard error estimated from the model was used rather than one calculated from the data. The authors will clarify in the paper how year and abundance error parameters were used differently than survey-derived standard errors.

The reviewer also questioned the need for the assumption that settlement rate is zero when the model was used as a predictive tool when the projections are only three years, and clams do not reach legal size until 3.5 years. The authors agree, because although the projections were originally going to be longer, finally they were only for three years. The authors will clarify why zero recruitment was used in the model.

Most questions from the second reviewer relate to information from the survey manual cited in the document. However, some additional detail will be added to the paper by the authors.

The reviewer wondered whether it has been demonstrated that growth rings are annuli in Manila clams, and if a reference could be cited. The authors responded that there are no references available for this species, only for butter clams based on work done by Dr. Neil Bourne. Dr. Bourne's work is not published, but the authors are confident that the rings are yearly growth marks.

The Subcommittee agreed with the reviewer that growth ring ageing of Manila clams is important. They questioned quality assurance, how few people are qualified to age them, and the limited capacity in house, especially as demand increases and new relationships with the industry develop.

The Subcommittee discussed the variable survey quality, due to differences between crews' experience, objectives, and language barriers. Perhaps trained professionals will have to start collecting this data, or be present on all surveys to provide quality assurance. Alternatively, if industry crews continue, more data may need to be collected, such as screening quadrants after sampling.

The Subcommittee wondered if any highly unusual natural mortality was encountered in these experiments and if the model was able to measure such an event. The authors did see some winter mortality due to freezing, and a large fresh-water event that killed clams but such events are unpredictable and thus cannot be incorporated into the model. The authors agreed to incorporate a discussion about these high natural mortality events into the paper as a factor that needs to be considered when using the model results within the prescribed management decision rules. If an unusually high mortality event were seen, managers could then assume that the model results will not be correct, and the area could be re-surveyed or harvest suspended to allow recovery.

The Subcommittee emphasized a point raised in the document that size limits alone do not guarantee conservation.

Subcommittee Conclusions

The Subcommittee agreed with the paper's first recommendations to continue using the biologically based threshold and limit reference points to determine harvest rates to manage the depuration fishery for intertidal clams.

The Subcommittee agreed with the paper's second recommendation to use probabilistic projection models to predict stock size, density and resulting harvest rates and quotas for a number of years from a single survey, with the inclusion of decisions rules that provide a review of the beaches and incorporate high and unusual mortality rates. It should also be more clearly stated that parameters should only be projected for a *maximum* of three years.

The Subcommittee emphasized that the model is not packaged and documented to the extent required for public usage, but is a work in progress. Additional funding would be required to further develop the programming and documentation model.

The Subcommittee discussed the paper's recommendation regarding training for and quality during industry surveys (such as screening quadrates after sampling or using consultants for surveys). In some cases, groups may prefer using their own people and having qualified supervision. In other fisheries, a third-party biologist needs to be involved. The Subcommittee concluded that the goal should be to have the local capacity along with certified supervision.

The authors offered to delete the paper's last recommendation. The Subcommittee agreed, since the sample size has recently been increased to 500 from 200 and methodology has been developed to compare the biological sample to the overall survey samples and continue sampling in an abundance adaptive manner to minimize differences in the two data sets.

Subcommittee Recommendations

1. The Subcommittee accepted the paper subject to revisions as outlined in the Subcommittee discussion and conclusions and as per the reviews.

2. The Subcommittee recommended that validation of growth ring ageing methods be highlighted as we go forward with these types of models.

3. The Subcommittee recommended that quality assurance standards for field and lab work be developed for third party work. Since capacity is limited in the ageing lab, and as industry requires more and more ageing, we need to ensure that standards are determined and available to others.

4. The Subcommittee recognized that the model is not at the point where it can be handed over for public use. However, they acknowledged that the model cannot be further developed at this time without additional funding support.

Working Paper I2005-02: Assessment of recruitment forecasting methods for shrimp in selected shrimp management areas along the coast of British Columbia

D.T. Rutherford, H. Nguyen

The paper assessed four different models in their ability to accurately forecast pink and sidestripe shrimp biomasses in 11 different Shrimp Management Areas (SMA's) using retrospective analysis (i.e., by making forecasts for past years using only the data that would have been available at that time). Two different criteria, root mean square error (RSME) and mean absolute deviation (MAD), were used to evaluate which model performed the best. None of the models proved to be superior; however, the Like Last Year (LLY) model performed the best most frequently. This model was used to generate 2005 pre-season pink and sidestripe biomass forecasts for 2005 and these were summarized for 50%, 25% and 10% probability reference points.

Subcommittee Discussion

Both reviewers found the data were limited, especially when considering the significantly high recruitment variability for these species. They agree with the authors that there is considerable uncertainty with forecasting shrimp biomass which is presented in "a form useful for making management decisions". However, both reviewers note (and the authors concur) there was a mistake in

recommendation #1 of the submitted Working Paper and the forecast model recommendation should read Like Last Year (LLY) for 3-yr running average (RNAVG).

The first reviewer recommended rejecting this paper due to the limited amount of data, or that the authors revise the paper by evaluating additional models, especially ones with environmental components and using "a broader array of evaluation criteria". He also suggested that additional clarification needed to be made as to how the models were evaluated using the RMSE and MAD. This reviewer had extensive comments and questions as well as several editorial suggestions.

The second reviewer questioned the uncertainty around the yearly estimates of biomass, whether the methodologies used to estimate the management area biomasses changed over the time-series, and asked if the LLY model assumes no error structure, or if the error structure would be normally distributed? In addition to giving several specific editorial comments, the second reviewer offered the following suggestions for improving future research; conduct more research into forecast models that use environment parameters, maintain and expand the data collection to extend the time series, consider aggregating management areas to assess broad scale forecasting, which may improve prediction abilities, focus assessment research on in-season estimation of biomass, not preseason forecasting, and review the biological and socio-economic implications associated with using the LLY forecasting model using simulations of various management scenarios.

The authors agreed to revise the paper as suggested by the reviewers, with the following exceptions:

- The authors did not feel that using the 2 or 4 yr running average model would significantly improve forecasting ability.
- The error structure or variability around the length-weight relationship in the BIOL model cannot be included because the original data were not available. The authors also noted that the variability attributed to the length-weight relationship is likely only a very small component of the overall variability and that further refinements of this parameter would result in little or no improvement to forecasts using the biological model.
- The authors truncated the data in the evaluation component because the evaluation criteria are sensitive to the magnitude of the difference between the observed and forecasted biomass. Using an equal number of years for the comparison would bias the results. The authors will clarify in the paper why they chose to compare only years where all data were available.
- The authors found that using different models in different areas is more work than is necessary, given that no model is markedly better than others.
- The authors were unable to identify which parameters would have the greatest influence on improving forecasts. They stated that the variation is due to "unknown random processes". The authors pointed out that biological

relationships underlying the forecasts for salmon stocks are often well measured and understood however the amount of unexplained residual variation is so large that these relationships are often not very useful for forecasting abundance.

The Subcommittee discussed at length the lack of a clearly superior model, noting the inherent limitations associated with each model and that a χ^2 test on the results in Table 12 in the Working Paper would likely show that the differences between the models are random. If the LLY model is used when there is a spike in shrimp biomass, this model will over predict the biomass for the following year. However, one member supported the LLY model because *numerically* it performed the best, even if it wasn't *statistically* better, and because changes in natural mortality may be better shown by the LLY model than by long term average models. Although the biological model did not perform any better than the non-biological models, it can give an indication of directionality (an increase or decrease) and several members thought that predicting this change was the most important consideration. However, further investigation needs to be made on the biological model to address its short-comings and some questionable forecasts in the paper. The Subcommittee questioned whether it was reasonable to have one model for all species and all areas, and suggested separate models may be needed. The Subcommittee also suggested that using more than one model and taking the median result may be better because of the possibility of over forecasting with a single model when there are in spikes in the shrimp biomass. Alternatively, a suite of models could be presented to managers to choose a forecast to start the season.

The Subcommittee suggested an extra paragraph be added to the introduction to explain that in some areas surveys are done fairly soon after the fishery starts, and in other areas it takes longer before there is an estimate of actual biomass.

Subcommittee Conclusions

The Subcommittee commended the authors for taking the initiative for writing this paper.

The Subcommittee was reluctant to support the use of just one model, (paper's recommendation #1). They suggested other models or variations be considered, such as the median prediction of all models, an ensemble method, predicting 2 years ahead, obtaining more information from the RSME and MAD results, and research towards enabling calculating confidence intervals for the biomass estimates.

The Subcommittee agreed with the paper's second recommendation, to present the median point estimate along with the 25% and 10% probability levels, but said uncertainty estimates should be incorporated into all models used in the future.

Although the authors did not find a single model for predicting shrimp biomass that significantly performed best, the Subcommittee noted that the paper was very useful for science and managers.

Subcommittee Recommendations

1. The Subcommittee accepted the paper with substantial modifications, especially with respect to recommendation 1 in the Working Paper.

2. The Subcommittee found there was no consensus about which model to use for improved forecasting of shrimp stocks. The Subcommittee recommended further work on investigating optimum methods for forecasting, especially with models that have the ability to forecast directional change in biomass, and noted that different models may be needed for different areas and species.

3. The Subcommittee recommended that data collection continue.

Working Paper I2005-03: Review of the current annual sea cucumber fishery in British Columbia and recommendations for a rotational harvest strategy

S.R. Humble, C.M. Hand, W.K. de la Mare

The paper provided a focused review of research and fishery data for sea cucumbers (*Parastichopus californicus*), in response to commercial harvesters' concern that the annual fishery is negatively impacting stocks. Examination of the spatial distribution of effort found harvest was concentrated yearly in approximately 12% of open areas, by shoreline distance, resulting in average local harvest rates of 30% of estimated biomass. Analysis of market sample, biological sample and survey density data failed to reveal significant impacts of annually-concentrated effort on sea cucumber populations, however sample regimes for estimating animal size distribution were found to be flawed.

Simulation model results suggested that at high local harvest rates, annual harvest leads to decline in animal size and population density while longer rotation periods result in larger animals and higher spawning densities. A new experimental fishing program was described to test rotational harvest and provide more informative short and long-term data. Recommendations were provided for how a pilot rotational harvest could be conducted within a portion of the open fishery, including changes in data collection that would improve the ability to detect localized fishing effects.

Subcommittee Discussion

The first reviewer believed the paper to be useful and informative, making an important contribution to sea cucumber fishery management. He provided corrections, comments and suggestions on a copy of the paper.

He found the paper lacked detail in sections; the sampling procedure used was complex and prone to several sources of error, and the density units ("cucumbers/meter of shoreline") should be explained better or should be modified.

The reviewer pointed out that the management strategy relies on good information on population abundance and mean size, and that insufficient attention was given to this in the paper. A detailed method on how to obtain the required information should be provided in the paper.

The authors agreed to add more details where required, but pointed out that the objective of this paper was as a guideline toward developing experiments on a rotational fishery, not to set out a complete sampling protocol for new experiments. They will clarify the density unit and why it is used, and note that others (e.g., density per square meter) could be evaluated in the future. The unit used does not affect the model results.

The second reviewer concluded the "analyses provide useful information for consideration in modifying harvest strategies. Despite a few technical issues, the results appear robust and explained with sufficient acknowledgment of uncertainties in the available data and the analyses. The simulation of rotational harvests is especially well conceived and presented. The recommendations appear to be useful to fishery managers, although the costs of the suggested research program may be high." He suggested reducing the number of treatments and habitat types, and tagging to monitor sea cucumber migration.

The reviewer found the quantitative results the most interesting and important findings, but questioned why the model used 25% and 50% harvest rates instead of the reported 30%. He suggested that alternatives to spatial rotation be considered for reducing high local harvest rates. He cautioned that the "harvest then adjust" strategy could allow harvesting even if the population was not recovered.

The authors accepted most of the reviewer's suggestions, but commented on some aspects. For the market samples, the data from the portions of the coast fished annually were not separated from the rest of the data. Since only a small portion of the coast is fished, and an even smaller portion that was fished annually (at least three years in a row), it would not have made much of a difference in the results. It would be very labour intensive to obtain these results and it would not add to what was found.

The authors note the model does not include a sporadic recruitment option, but it could be added, along with the figures and summary statistics suggested. The recruitment does match the one of red sea urchins, a species that has a life cycle similar to sea cucumbers. A range of recruitment was used, but maybe not as wide as the reviewer suggests.

The authors do not feel that re-sampling the same location year after year would affect the biosample size as sea cucumbers are known to be able to move a few meters a day. The “harvest then adjust” strategy was modeled and showed that even when a population is harvested before it has recovered, it will still recover to the desired level if left unharvested for a longer period.

The Subcommittee discussed the parameters entered in the sea cucumber population recovery model. The authors stated that since no information is available on growth rate and recruitment age, they were estimated and the model was made robust to their uncertainty. The model can be adjusted to precautionary thresholds for parameters, therefore avoid getting the population down to a critical density. In the simulations presented in the paper, size of the animals and density were used, but other parameters could be used. If the adaptive strategy is used, it can be decided what the indicators that will be used to allow re-fishing of an area are. A new assessment framework would be required if new indicators are desired.

This paper aimed to be a discussion paper to address the issues and the questions raised by the present management of this fishery and to explore the possibility of moving toward a rotational fishery. The questions of growth rate and recovery rates need to be addressed.

The Subcommittee questioned if the “harvest then adjust” strategy would take a long time to establish a harvest pattern. The authors felt it would be constantly adapted and sensitive to changes in the system. Yet, since harvesters target the best areas, there is always a risk of over harvesting.

Another topic discussed by the Subcommittee was the utility of the market samples and the protocol used to collect them. Market samples are collected from loads of cucumbers which have been selected for bigger size and cannot always be linked to the fishing location. Therefore, the data are not likely to show if size changed due to harvest. It may be possible to work with industry to get spatially certain samples. The Subcommittee pointed out that the changes in sea cucumber size could reflect a recruitment event, or a high density could be reflected in a lower mean size of cucumbers, and vice versa.

The Subcommittee pointed out that the paper demonstrated that only 12% of the shoreline is fished in the open area and that there are cucumbers in areas that are not fished. So it seems there would be enough room to implement a

rotational fishery in the open coast that could be monitored by the industry. They acknowledge that in the future, the industry would like to see the closed area be reopened on a rotational basis. Management commented that all the fisheries are going to a smaller management scale, with more monitoring, and higher costs.

Subcommittee Conclusions

The Subcommittee agreed with the paper's first recommendation, to discontinue the collection of market sample data. The paper provided good evidence that the market samples do not provide the intended information.

The Subcommittee agreed with the paper's second recommendation, with slight rewording to clarify concerns. Transects should be placed in areas that are regularly fished in order to detect potential changes in cucumber size, and in unfished locations to take into account natural variability.

The Subcommittee disagreed with the paper's third recommendation as stated. The Subcommittee did however support it on a pilot basis in areas open to the fishery and/or in experimental fishing areas. It was concluded that more details are needed before it can be implemented. The pilot fishery is proposed to determine the challenges of implementing that type of management for this fishery.

The Subcommittee supported the paper's fourth recommendation with rewording to show these would be new experiments in experimental fishing areas (EFAs) to set up recovery monitoring. The authors should also clarify what the proposed changes are, including that this experiment is designed to be done in the 25% of the coast open to scientific experiments, and they will be designed to measure the ability of a sea cucumber population to recover as in the commercial fishery.

The Subcommittee concluded that there is not enough evidence in the paper to support the fifth recommendation. Fifty percent of the coast needs to remain closed to act as a reserve while a sustainable fishery is determined in the open portion. There is not enough evidence presented to open the fishery to the whole coast and there is enough room in the 50% of the coast that is currently open areas and or allocated to EFAs (note all the EFA's have not been allocated) to establish a rotational fishery. Industry input and cooperation is required to avoid the increased costs associated with managing on a smaller scale.

Subcommittee Recommendations

The Subcommittee accepted the paper subject to revisions outlined by the reviewers and agreed upon by the Subcommittee.

The Subcommittee recommended that re-evaluation of the sea cucumber experimental protocol and assessment framework is needed.

The Subcommittee noted that maintaining buffer zones is desirable in any future management regime. The Subcommittee recommended that they be considered in planning changes.

Working Paper I2005-04: Evaluation of abundance based index methods for Dungeness crab, *Cancer magister*, and spot prawn, *Pandalus platyceros*, on small spatial scales

K.H. Fong, G.E. Gillespie

Subcommittee Discussion

Dungeness crab and prawns are economically and socially important species, therefore, they are especially subject to allocation issues. Assessment and management frameworks for these two species in BC do not rely on abundance estimates. However, they may be required to meet treaty agreements that guarantee allocation to First Nations (FN) to harvest fish when there are no conservation, public safety, or public health concerns. The paper evaluated the utility of historical catch as a means for delivering allocations for Dungeness crab and prawn. The paper presented abundance-based index models for Dungeness crabs and prawns and describes how allocations can be delivered from abundance indices. The paper also reviewed models for allocation used in Washington State for Dungeness crabs and prawns. Models for allocation of Dungeness crab and prawn used in Washington State were also reviewed. The authors described how allocations could be delivered from abundance indices. Other abundance estimation models such as change-in-ratio, tagging and video assessment were also presented. Catch information for Dungeness crab and prawn were found to be incomplete. The paper recommended improvements in catch monitoring / reporting programs, and initiation, development, and testing of methods to determine the most appropriate method for estimating abundance.

One of the reviewers questioned if PSARC was the right forum for this kind of paper, as it presented no new data or analyses. Both reviewers thought that a relative cost analysis of the different options presented would be helpful to managers for prioritizing options to test. Reviewers noted that the importance of spatial scale needed to be expanded upon, and that assessing which approach might work better under different spatial scales would be helpful. One reviewer pointed out the need to review the implications of having different assessment

and/or management regimes in different parts of the coast (stemming from different treaty settlements) and how it could complicate fishery management.

Both reviewers also suggested a number of editorial changes and identified sections that needed clarification. One reviewer asked for clarification between catch reporting and catch monitoring. One reviewer pointed out that there is no easy mechanism to change allocation once it is set in a treaty. One reviewer questioned if the assumption of no immigration was valid in crab fisheries. One reviewer pointed out that FN may want access to crab and prawns year round and that FN may wish to fish using traditional methods; both will have to be considered when selecting a possible management regime.

The authors agreed to make the editorial changes suggested, expand certain sections to better support the conclusions of the paper, describe the current monitoring programs used in the commercial fishery of each species, include the sports catch and gear limits for Dungeness crabs and prawns, and discuss logbook problems. The authors agreed that management could get very complex if different assessment / management systems are used in different portions of the coast. They recognized that the difference in fishing efficiencies between FN gear and commercial gear will have to be taken into account when setting allocation. The authors also hoped to have further discussions with fishery managers from Washington State to see how well their approach works and include that in the revisions.

The authors noted that a cost analysis would be difficult, as it would depend on the program's spatial scale, which has not been provided. The authors did not give specific examples as they felt it would be inappropriate to discuss allocation issues in this paper. The authors felt that whether the assumption of no immigration is valid would depend on the spatial scale at which a species is managed. The authors pointed out that this paper is the first step in the process and, because of this, it is too early to implement some of the changes the reviewers wanted to see such as cost analysis.

The Subcommittee recognized that the paper is useful, but not all were convinced that PSARC was the right forum for this kind of paper. Nevertheless, such papers should be reviewed and evaluated in an open forum. The paper was described as a summary document and literature review, similar to a Phase 0 paper, although it does not deal with a new fishery. The Subcommittee discussed whether a new Request for Working Paper (RFWP) should request the paper be re-written as a Phase 0 (major revisions) with additional information, and then reviewed again. A Phase 0 would look at how other jurisdictions deal with allocation issues in crab and prawn fisheries.

The Subcommittee emphasized that the paper did not address spatial scale. They would prefer the paper discuss which approach might work better at what spatial scale, including examples that reflect small or large scales. It was

suggested that the scope of the (RFWP) might have been too limited. The Subcommittee identified the need to relate the spatial scale of treaty allocations to the spatial scale of biological processes of the species in question (e.g., stock-recruitment relationships).

The Subcommittee discussed forecasting, management, and allocation methods. They noted inherent difficulties in using historical catch and the possibility of other methods of forecasting abundance. They identified the need for the paper to describe what is and is not working in the current allocation processes in each fishery, and considered the potential of using current methods such those that provide allocation for sports fisheries. It was recognized that other tools could be used by management besides the abundance indexes and should be reflected in the paper.

The Subcommittee was informed that abundance-based allocation can be written in treaties based on estimates, but many thought it would be difficult, since abundance estimates are not used in either fishery. The Subcommittee cautioned that once you look at abundance, a whole suite of other questions arises, such as exploitation rates. Abundance is not the final result; more work is needed to test exploitation.

The Subcommittee recognized that that the purpose of the paper was to present abundance based options that could be used in these fisheries, not to determine which option to use, or to determine quotas.

Subcommittee Conclusions

The Subcommittee accepted the paper's first recommendation, if reworded to qualify "if abundance methods are used".

The Subcommittee accepted the paper's second recommendation, with revision to clarify the need to get more information on the methods considered and to test them before committing to use them in treaties, and to qualify "if abundance methods are used."

The Subcommittee emphasized that ultimately the goal is to set a TAC (total allowable catch) for FN each year and to manage to it. If abundance methods are used, we need to understand the steps to go from abundance to a TAC. Since Washington State uses a combination of pre-season forecasting with in-season adjustments, maybe the paper should include what is required pre-season and in-season for each approach.

Subcommittee Recommendations

The Subcommittee accepted the paper with the revisions discussed by the Subcommittee, including a discussion of spatial scales in context of biology of

each animal and a rewording of the title to better reflect the “evaluation” and “small spatial scales”.

The Subcommittee recognized that abundance indices are one of several tools available to managers and treaty negotiators for defining an allocation. The Subcommittee noted that accurate information on total catch from all sectors is needed to be able to use the models presented in the paper. It was recommended that abundance based models be piloted before being entrenched in treaties.

The Subcommittee encouraged developing a plan in cooperation with treaties, managers, and science to discuss how to deal with some of the issues raised here, including the appropriate place to discuss broader measures to move forward with regard to treaty settlements.

APPENDIX 1: Working Paper Summary

Working Paper I2005-01: Evaluation of assessment and management frameworks in the British Columbia depuration fishery for intertidal clams.
G.E. Gillespie, W.C. Hajas, J.S. Dunham

We reviewed the experimental program in the depuration fishery for intertidal clams in British Columbia. The program consisted of beaches that were regularly surveyed between harvests to evaluate the effectiveness of various harvest rates in ensuring sustainable populations and harvest opportunities. Five beaches were evaluated: three unharvested controls (Mill Bay, Royston and Wall Beach) and two harvested beaches (Booth Bay and Goldstream). Two other beaches, China Cloud Bay and Long Bay, were afforded unrestrained harvest opportunities followed immediately by surveys to establish harvest rates in non-quota clam fisheries. Simple production models currently used to set harvest thresholds were re-evaluated, and population models were used to project biomass, abundance and quotas for several years following surveys.

Population responses to experimental harvest rates changed little from the previous evaluation. Booth Bay remained a highly productive beach even at high harvest rates (25-53%). Population levels and production at Goldstream remained relatively stable at harvest rates of 10-20%. The controls exhibited a range of responses, with a declining trend at Wall Beach and increasing trends at Mill Bay and Royston. None of the new information suggested that target and threshold limits currently used to set harvest rates required changing. Information from China Cloud and Long Bays indicated that harvest rates were approximately 11-13%, considerably less than previous estimates of unrestrained harvest rates.

Relatively low vulnerability of small clams to survey methods was noted from industry surveys, and vulnerability and sampling error required reconciliation of survey data before the population model was used. The population model could be used to project quotas for approximately three years. Only the use of the median values (0.50 quantiles) of the projected populations yielded practical projections; more precautionary quantiles (0.05 and 0.25) resulted in rapid reductions in quotas. Our opinion is that the model allows for at least one year of projected quota in most cases before declines in quotas would motivate Industry to re-survey.

The paper recommended that current reference points for setting harvest rates be maintained, that the population model can be used to project population characteristics and quotas, that issues surrounding vulnerability of small clams in Industry surveys be further evaluated and rectified, and that the potential benefits of larger biological samples be examined.

Working Paper I2005-02: Assessment of recruitment forecasting methods for shrimp in selected shirmp management areas along the coast of British Columbia.
D.T. Rutherford, H. Nguyen

The relative performance and utility of four procedures for forecasting shrimp recruitment was assessed for pink and sidestripe shrimp in Shrimp Management Areas PRD, 3IN, 124OFF, 125OFF, 23&21OFF, 23IN, 14, GSTE, 16, and FR. These areas were selected because adequate time series data were available on shrimp abundance. The forecasting models provided forecasts of shrimp abundance one year in advance and were evaluated through retrospective analysis. The analysis involved hindcasting biomass in previous years using only the data that would have been available at that time. This type of retrospective analysis provides a robust measure of how well the various forecasting models would have worked had they actually been used.

The root mean square error and the mean absolute deviation were used as criteria to measure model performance. None of the models performed well on a consistent bases; however, the Like Last Year (LLY) model scored the best in the retrospective evaluation. The LLY model was used to forecast shrimp biomass in 2005 and forecasts are documented as cumulative probability distributions to specify the probability of all possible shrimp biomasses within a Shrimp Management Area.

Working Paper I2005-03: Review of the current annual sea cucumber fishery in British Columbia and recommendations for a rotational harvest strategy.
S.R. Humble, C.M. Hand, W.K. de la Mare

The sea cucumber (*Parastichopus californicus*) fishery in British Columbia is in Phase 1 of development, according to the nationally-adopted protocol for new or data-limited fisheries, wherein profit-based fisheries are held at conservative levels while the necessary stock assessment data are collected. Since 1997, the fishery has been restricted to 25% of the coast and management areas are harvested annually at 4.2% of estimated biomass. Commercial harvesters have expressed concern that the annual fishery is negatively impacting stocks.

A focused review of research and fishery data was undertaken to evaluate the annual harvest regime and to identify any potential conservation concerns. The spatial distribution of harvest was examined to estimate localized harvest rates in this dive fishery. Harvest effort was found to be concentrated in approximately 12% of open areas, by shoreline distance, resulting in average local harvest rates of 30% of estimated biomass. Analysis of market sample, biological sample and survey density data failed to reveal significant impacts of annually-concentrated effort on sea cucumber populations, however sample regimes for estimating animal size distribution were found to be flawed.

A simulation model is presented, which uses estimated local harvest rates to evaluate risks and benefits of annual versus rotational harvest strategies. Model results suggest that a high local harvest rates, annual harvest leads to decline in animal size and population density while longer rotation periods result in larger animals and higher spawning densities. This paper describes a new program of experimental fishing designed to test rotational harvest and provide more informative data for management decisions in both the short-term and the long-term. Recommendations are provided for how a pilot rotational harvest could be conducted within a portion of the open fishery, including changes in data collection that would improve the ability to detect localised fishing effects.

Working Paper I2005-04: Evaluation of abundance based index methods for Dungeness crab, *Cancer magister*, and spot prawn, *Pandalus platyceros*, on small spatial scales.
K.H. Fong, G.E. Gillespie

Allocation issues are especially prevalent for Dungeness crabs (*Cancer magister*) and prawns (*Pandalus platyceros*) because they are economically and socially important species. Periodically, DFO resource managers receive undefined requests from First Nations for improved access to shellfish for food, social and ceremonial purposes. Often, requests are met through effort limitations of the commercial fishing industry such as commercial area closures, seasonal closures or gear limitations. The current management and assessment frameworks for Dungeness crab and prawn fisheries in British Columbia do not rely on abundance estimates. However, final treaty agreements between First Nations and the governments of Canada and British Columbia will guarantee allocations to First Nations to harvest fish or aquatic plants when there are no conservation, public safety or public health concerns.

For comparative purposes, we reviewed the Washington State models for allocation of Dungeness crab and prawn resources.

This paper evaluates the utility of historical catch as a means for delivering allocations for Dungeness crabs and prawns. We also evaluate fishery dependent and fishery independent CPUE (catch per unit effort) as indices of abundance and describe how allocations can be delivered from abundance indices for Dungeness crabs and prawns. Other abundance estimation models such as change-in-ratio, index-removal, mark-recapture and video assessment are presented.

We conclude that historical catch information for Dungeness crabs and prawns are incomplete. We also conclude that final determination of the most successful approach will depend largely on the spatial scale, stock characteristics, dynamics of each fisheries sector, testing of assumptions and cost.

We provide the following recommendations:

1) Improve and develop catch monitoring programs for all Dungeness crab and prawn fisheries (commercial, recreational and First Nation FSC).
2) Multiple programs should be initiated, developed and tested to determine which methods are most appropriate in each area.

APPENDIX 2: PSARC Invertebrate Subcommittee Meeting Agenda

PSARC Invertebrate Subcommittee Agenda
April 12-14, 2005
PBS Nanaimo Seminar Room

April 12:

1:00-4:30	Evaluation of assessment and management frameworks for the British Columbia depuration fishery for intertidal clams. – G. Gillespie, W. Hajas, J. Dunham.

April 13:

9:00-12:00	Assessment of recruitment forecasting methods for shrimp in selected shrimp management areas along the coast of British Columbia. – D.T. Rutherford, H. Nguyen
12:00	Lunch
1:00-3:30	Review of the current annual sea cucumber fishery and recommendations for a rotational harvest strategy. – S.R. Humble, C.M. Hand, W.K. de la Mare
3:30-4:30	Further discussion as required.

April 14:

9:00-12:00	Evaluation of abundance based index methods for Dungeness Crab, *Cancer magister,* and spot prawn, *Pandalus platyceros*, on spatial scales. – K.H. Fong, G.E. Gillespie
2:00	Lunch
1:00-4:00	Discussion of agenda items for the November Invertebrate Subcommittee Meeting.

APPENDIX 3: List of Attendees & Reviewers

Subcommittee Chair: J. Boutillier
PSARC Chair: Al Cass

DFO Participants * Subcommittee Members	**April 12**	**April 13**	**April 14**
L. Barton		√	√
J. Boutillier*	√	√	√
D. Bureau	√	√	√
A. Campbell*	√	√	√
D. Clark		√	√
J. Deault		√	
J. Dunham	√		√
B. Ennevor		√	√
K. Fong			√
G. Gillespie*	√	√	√
W. Hajas	√	√	
C. Hand*	√	√	√
R. Harbo*	√	√	√
B. Koke			√
R. Lauzier*	√	√	√
J. Lessard		√	
B. Lucas	√	√	√
R. Mylchreest*	√	√	√
J. Nener			√
H. Nguyen	√	√	√
M. O	√	√	
G. Parker*	√	√	√
B. Pechter*	√	√	√
I. Perry*	√	√	√
A. Phillips		√	√
J. Rogers*	√	√	√
D. Rutherford		√	√
B. Spence	√		
T. Therriault		√	
B. Waddell		√	
R. Webb	√		√
K. West			√
E. Wylie		√	
Z. Zhang*	√	√	√

	April 12	April 13	April 14
External Participants:			
William de la Mare (delamare@sfu.ca)		√	
Chris Sporer (ppfa@telus.net)		√	
Wayne Harling, SFAB (harling@island.net)			√
Sylvia Humble (shumble@sfu.ca)		√	
Ken Ridgeway, PSCHA		√	
Luc Anfray, DFO Coop Student		√	
Thomas Binet, DFO Coop Student		√	
Kevin Erikson			√
Barb Snyder			√

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

Jennifer Whitney	Washington Department of Fish & Game
Zane Zhang	DFO Shellfish
Tom Therriault	DFO Pelagics
Pieter Van Will	DFO Salmon
Beth Pechter	DFO Resource Management North Coast
Jennifer Nener	DFO Treaty and Aboriginal Policy
Warwick Nash	World Fish Center- Pacific Noumea, New Caladonia
Doug Woodby	Alaska Dept of Fish and Game, Juneau, Alaska