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Proceedings of the PSARC Groundfish Subcommittee Meeting, January 18-20, 2005

Compte rendu de la réunion du sous-comité du poisson de fond du CEESP,18-20 janvier 2005

January 18-20, 2005
Nanaimo B.C.

J. Fargo
Groundfish Subcommittee Chair

Fisheries and Oceans Canada
Pacific Scientific Advice Review Committee
Pacifiic Biological Station
Nanaimo, British Columbia V9T 6N7

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PACIFIC SCIENTIFIC ADVICE REVIEW COMMITTEE (PSARC)
GROUNDFISH SUBCOMMITTEE MEETING

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SUMMARY

The Groundfish Subcommittee of the Pacific Scientific Advice Review Committee (PSARC) met to review two Working Papers on January 18-20, 2005 at the Pacific Biological Station, Nanaimo, British Columbia.

Working Paper G2005-01: Sablefish (*Anoplopoma fimbria*) in British Columbia, Canada: Stock Assessment Update for 2004 and Advice to Managers for 2005.

- The Subcommittee noted that positive indicators from the WCVI shrimp trawl survey, U.S. slope and shelf surveys, and the trawl bycatch analysis presented in the working paper were consistent with the view that sablefish recruitment had experienced a recent increase.

- The longer-term 5 year projections were not endorsed by the Subcommittee because they depend to a much larger extent on assumptions about future recruitment than on the current population estimates.

- The Subcommittee recommended the use of the performance measure $P(B_{2007}>B_{2002})$ as the preferred results for formulating management decisions.

- The Subcommittee recommended the Decision Table (Table 1) be used as the basis for management decisions regarding TAC.

Working Paper G2005-02: Assessment of Pacific Cod in Hecate Strait (5CD) and Queen Charlotte Sound (5AB) January, 2005.

- The Subcommittee agreed with the authors that there was insufficient information to provide a stock assessment for the Queen Charlotte Sound stock.

- The Subcommittee recommended that the stock biomass in 1971 be used as a limit reference point for management for the Hecate Strait stock. This is the previous minimum biomass from which the stock has recovered to a level above the long term average.

- The Subcommittee recommended that the Decisions Table from the Fixed *h* model (Table 2) be used as the basis for management decisions regarding TAC for the Hecate Strait stock. Attention should be focused on the probability that the stock biomass will continue to increase and that the biomass after the fishing year will be greater than the biomass in 1971/72, the proposed limit reference point.

- The Subcommittee recommended that the historical tagging results for Pacific cod be reanalyzed with emphasis on re-estimating growth rates. The incorporation of this analysis in the stock assessment model should be investigated. This analysis will also be useful in planning any future tagging experiments.

- The Subcommittee recommended that the original disaggregated catch and effort data be solicited from the USA authorities and analyzed as part of future assessments.

- The Subcommittee recommended that further stock identification work be undertaken for the Queen Charlotte Sound area. An initial project would be to document spawning grounds in the area.

SOMMAIRE

Le sous-comité du poisson de fond du Comité d'examen des évaluations scientifiques du Pacifique (CEESP) s'est réuni du 18 au 20 janvier 2005 à la Station biologique du Pacifique, située à Nanaimo (Colombie-Britannique), pour examiner deux documents de travail.

Document de travail G2005-01 - La morue charbonnière (*Anoplopoma fimbria*) en Colombie-Britannique (Canada) : mise à jour de l'évaluation du stock pour 2004 et avis pour les gestionnaires pour 2005

- Le sous-comité constate que les indicateurs positifs provenant du relevé de la crevette au chalut sur la COIV, des relevés américains des eaux de la pente et de la plate-forme et de l'analyse des prises accessoires au chalut présentés dans le document de travail concordent à la vue à l'effet que le recrutement de la morue charbonnière a récemment connu une augmentation.

- Le sous-comité n'avalise pas les projections à long terme de 5 ans parce qu'elles dépendent dans une trop grande mesure sur des hypothèses sur le recrutement futur plutôt que sur les estimations actuelles des effectifs.

- Le sous-comité recommande qu'il est préférable d'utiliser des mesures de rendement $P(B_{2007} > B_{2002})$ pour formuler des décisions de gestion.

- Le sous-comité recommande que les gestionnaires utilisent le tableau de décision (tableau 1) pour prendre des décisions au sujet du TAC.

Document de travail G2005-02 – Évaluation des stocks de morue du Pacifique du détroit d'Hécate (5CD) et du détroit de la Reine-Charlotte (5AB), janvier 2005

- Le sous-comité souscrit à la conclusion des auteurs à l'effet que l'insuffisance des données ne permet pas de faire une évaluation du stock du détroit de la Reine-Charlotte.

- Le sous-comité recommande que la biomasse du stock en 1971 soit utilisée comme point de référence limite pour prendre des décisions de gestion en ce qui concerne le stock du détroit d'Hécate. Ce niveau est la biomasse minimale à partir de laquelle le stock s'est rétabli jusqu'à un niveau supérieur à la moyenne à long terme.

- Le sous-comité recommande que les gestionnaires utilisent le tableau de décision tiré du modèle du *h* fixé (tableau 2) pour prendre des décisions en ce qui concerne l'établissement du TAC pour le stock du détroit d'Hécate. Ils devraient porter une attention particulière à la probabilité que la biomasse du stock continuera à augmenter et que la biomasse, après la saison de pêche, sera plus élevée que la biomasse en 1971-1972, soit le point de référence limite proposé.

- Le sous-comité recommande que les résultats des études d'étiquetage passées soient analysés à nouveau de sorte à obtenir une nouvelle évaluation des taux de croissance. Il faudrait établir s'il serait utile d'inclure les résultats de cette analyse dans le modèle d'évaluation du stock. Cette analyse servira aussi à planifier les expériences d'étiquetage futures.

- Le sous-comité recommande que des données originales non regroupées sur l'effort et les prises soient demandées aux organismes des pêches américains, puis qu'elles soient analysées dans le cadre d'évaluations futures.

- Le sous-comité recommande que d'autres travaux d'identification soient entrepris dans la région du détroit de la Reine-Charlotte. La délimitation des frayères serait une première priorité.

INTRODUCTION

The Groundfish Subcommittee met January 18-20, 2005 at the Pacific Biological Station in Nanaimo, British Columbia. External participants from the Canadian Groundfish and Conservation Society (CGRCS) and the Canadian Sablefish Association (CSA) attended the meeting. The Subcommittee Chair, Jeff Fargo, opened the meeting by welcoming the participants. During the introductory remarks, the objectives of the meeting were reviewed, the confidential nature of the discussion was highlighted and the Subcommittee accepted the agenda.

The Subcommittee reviewed two Working Papers. Summaries of the Working Papers are included as Appendix 1. The meeting agenda appears as Appendix 2. A list of meeting participants, observers and reviewers is included as Appendix 3.

DETAILED COMMENTS FROM THE REVIEW

G2005-01: Sablefish (*Anoplopoma fimbria*) in British Columbia, Canada: Stock Assessment Update for 2004 and Advice to Managers for 2005.

V. Haist, A.R. Kronlund and M.R. Wyeth

Paper accepted subject to revisions

Subcommittee Discussion

Two external reviews of the sablefish working paper were tabled. One reviewer asked if the recruits from outside BC could be separated from recruits from BC. The authors responded that current data were not adequate to resolve the source of recruitment.

The authors agreed with a reviewer's statement that fixing the over dispersion parameter in the tagging analysis would influence the variance estimates. However, the Subcommittee agreed with the reviewer that there are likely more important factors in the analysis that would warrant examination before alternative formulations are used for this parameter. The over-dispersion parameter in the tagging model is intended to scale the variance in the tagging data. The over-dispersion parameter effectively reduces the actual numbers of tags released and recovered and thereby decreases the variance in the tagging data.

A reviewer suggested undertaking an analysis based on estimating sablefish habitat in Alaska, B.C. and the continental U.S. to infer biomass in BC based on extrapolation of U.S. biomass densities derived from U.S. stock assessments. The authors noted that would involve substantial data requirements and time which is not available. The work that would have to be done is to define criteria

for “prime sablefish habitat” and then obtain the requisite data from the entire West Coast of North America to be able to do the calculations. To actually ground-truth “prime habitat” would be an extra-ordinary investment of time and money.

The reviewer asked if patterns in movement of fish within B.C., presumably quantified using tag-recovery information, correlated with recruitment to the trap-vulnerable population. The authors responded that they have no year-class recruitment index since “recruitment” is really an increment to the trap-vulnerable biomass from year-classes, immigration and behavioral attraction to trap gear.

One reviewer was uncomfortable with the $B^{0.05}$ reference points. The authors noted this reference point was included in the appendix of the document for continuity with last year’s assessment. However, the authors believed that other reference points include in the working paper are superior. The Subcommittee agreed.

The Subcommittee noted that the scale of biomass estimates, the trend in the estimates, and the uncertainty intervals differ between this year’s assessment and that presented last year. The change in scale of the current estimates stems largely from (1) changes in model structure, and (2) additional data not available for the January 2004 assessment. The current model integrates the 3 abundance indices in a different manner than last year and this contributes to the downwards shift in the posterior distribution. One change relates to differences in weighting the indices in the current integrated model versus the population dynamics model used last year. Additional data have also been added since the January 2004 assessment. The lack of trap fishing after February 2003 and prior to July 31 2003 meant it was not possible to estimate a 2003 tag-recovery index point for the January 2004 assessment. Thus, the posterior distribution of 2003 biomass was dominated by the 2003 trap survey and commercial CPUE in the 2003 assessment. For the January 2005 assessment, fishing after July 31 2003 allowed estimation of a tag-recovery index for 2003. Estimates of January 2004 biomass were also available based on 2004 data. The inclusion of these data contributed to the changes in the posterior distribution of biomasses in the current assessment compared to the previous assessment.

The Subcommittee noted the very high tag reporting rate estimate for 2004. The authors identified this distribution as being unrealistic and a consequence of the model trying to resolve contradictory signals in the indices of trap-vulnerable biomass. Industry participants reported that significant quantities of smaller fish that are coming up in the traps are being released but the tags are being retained. This could result in a downward bias in the trap vulnerable biomass estimate if there is a higher level of discarding in 2004 than previous years.

The quality of discard data recorded in fishery logbooks is likely low and these data are not utilized in calculating total catch. Discards are likely to vary widely over time depending on the prevalent size frequency of the fish. The model attempted to compensate for discards based on adjustments computed from limited observer data and discussed in last year's assessment. A downward bias in the trap-vulnerable biomass could result if there is sufficient unreported catch for the tags recovered, which would in turn reduce the estimated biomass since the model could not know about the unreported catch. This same phenomenon could also result from failure of the basic assumptions of tagging models (random tag application, complete mixing, random recovery) .

The Subcommittee noted that the assessment model has difficulty reconciling conflicting trends in the 2003 and 2004 indices. The trap survey index indicates a large increase in sablefish abundance in 2003 and 2004 while the results from tagging indicate continued low abundance. The model results indicate a more pessimistic view of the trend in biomass than suggested by anecdotal reports from the K-fleet and trawl sector.

The assessment presents two recruitment scenarios, the first based on sampling the long-term 1980 through 2004 recruitments to trap-vulnerable biomass and the second based on the short-term 1994 to 2004 period. The Subcommittee suggested the long-term recruitment scenario is more appropriate for the projections because of a number of positive indicators documented in the working paper and the commentary from industry. In particular, the working paper documented the high trap survey catch rates in 2003 and 2004; the strong catch-rates observed in 2000 and 2001 from the West Coast Vancouver Island shrimp survey, the increase in trawl catch rates of sablefish from area 3CD and 5E since 2001, and the co-occurrence of strong recruitment signals in the U.S. shelf and slope surveys which were attributed to the 1999 and 2000 year-classes.

The Subcommittee noted the continued lack of formal management objectives, for sablefish as well as all other groundfish.

Canadian Sablefish Industry Perspective

The CSA presented reports from a number of sablefish longline and trap fishermen regarding sablefish abundance observed in the latter part of 2004. All of the opinions presented indicated high abundance of sablefish, and in particular small sablefish. Some commented that the abundance was the highest ever observed.

The CSA presentation suggested there were problems with the tag return estimates of stock size in 2003-2004 because these estimates do not agree with the trends indicated by the trap survey, commercial CPUE, and fishermen's observations. They also noted that the commercial CPUE index has been

reduced by the introduction of escape rings and stated that the efficiency of trap gear has been reduced in recent years due to the high abundance of small fish.

An invited expert with experience in the trawl fleet indicated that sablefish have become more abundant in recent years to an extent where it is becoming increasingly difficult to avoid catching them. Further, if sablefish abundance continues to increase at a rate faster than the rate of increase in the TAC, it will become even more problematic for the trawl fishery to catch its full range of quotas for other species.

Subcommittee Conclusions

The Subcommittee accepted the working paper subject to revisions.

The Subcommittee noted that positive indicators from the WCVI shrimp trawl survey, U.S. slope and shelf surveys, and the trawl bycatch analysis presented in the working paper were consistent with the view that sablefish recruitment had experienced a recent increase.

The longer-term 5 year projections were not endorsed by the Subcommittee because they depend to a much larger extent on assumptions about future recruitment than on the current population estimates.

Subcommittee Recommendations

1. The Subcommittee recommended the use of the performance measure $P(B_{2007}>B_{2002})$ as the preferred results for formulating management decisions.

2. The Subcommittee recommended the Decision Table (Table 1) be used as the basis for management decisions regarding TAC.

Table 1. Decision Table for sablefish showing the expected probability P for 2-year catch projections where recruitment values are drawn from the historic time series.

Total Annual Catch (t) 2005-2009	Expectation $P(B_{2007}>B_{2002})$
0	0.72
3500	0.67
4500	0.66
5500	0.65
7500	0.63
10000	0.59

G2005-02: Assessment of Pacific Cod in Hecate Strait (5CD) and Queen Charlotte Sound (5AB) January, 2005.

A. F. Sinclair and P.J. Starr

Paper accepted subject to revisions

Subcommittee Discussion

The Subcommittee requested a more detailed graphical treatment of diagnostics to explore the potential for over parameterization in the model. The Subcommittee also endorsed one reviewer's request that more information on the choice of Bayesian priors be added to the final document.

The reviewer noted the poor fit between predicted and observed mean weight. The authors responded that the mean weight observations conflict with the estimates of catch. Since there was more confidence in the catch data, they weighted the catch data more heavily than the mean weight data. This resulted in the large residuals around the mean weight observations. However, the mean weight data are retained because they are necessary to the estimation of *M*.

The authors agreed with the reviewer that one of the weaknesses in the analysis is the assumption of constant catchability, but the authors and Subcommittee agreed that there were no obvious means for resolving this. Catchability has undoubtedly changed over time due to the influences of technological change, introduction of IVQ's, quota variation and changing management regulations but these influences cannot be quantified.

The Subcommittee endorsed the reviewer's suggestion that the description of how future recruitment was included in the catch forecast be clarified in the document.

The authors agreed with the reviewer that simulation testing of proposed management options on these stocks could be useful. The Subcommittee noted the high sensitivity of model-based estimates of target and limit reference points (e.g. B_{MSY}, F_{MSY}) to minor changes in model formulation. The reviewer agreed with the use of observation based reference point but noted the problems of using long-term average biomass or harvest rates.

The other reviewer's comments were mostly complimentary. He suggested use of a length based analysis such as Multifan. The authors noted that this methodology had been used in earlier assessments of this stock. They suggest that the current analysis is better than a length-based approach.

The Subcommittee noted the inclusion of recorded discards from GFCatch, the groundfish trawl catch database for 1954 -1995 (with no observers). The Subcommittee suggested that these data seriously underestimated the discards

during this period and they should not be used to index the amount of discards over time. The Subcommittee agreed with the authors that there was no need for a re-analysis after removing these data because the amount of recorded discards is small and would not significantly change the catch. The Subcommittee suggested that future assessments do not attempt to utilize discard information from GFCatch. The authors agreed to emphasize the inaccuracy of these data in the text and captions.

There was general discussion about the choice between the "fixed *h*" model or "estimate *M, h*" model. The Subcommittee agreed with the authors' basis for recommending that management be based on results of the fixed *h* version but noted that the estimate *M, h* version provided a more pessimistic view. The Subcommittee requested that a figure be added to the document which compared the two results.

The Subcommittee noted that the first recommendation for the Hecate Strait population required elaboration with respect to the "relative" aspect of the 1971/72 reference point.

The Subcommittee concurred with the author's conclusion that there was a substantial amount of Pacific cod catch reported in Canadian waters by vessels from the USA in the years prior to the extension of fisheries jurisdiction.

Subcommittee Conclusions

The Subcommittee accepted the Working Paper with revisions.

The Subcommittee concluded that advice to fishery managers be based on results from the model with the fixed *h* parameter.

The Subcommittee agreed with the authors that there was insufficient information to provide a stock assessment for the Queen Charlotte Sound stock.

The Subcommittee concluded that the original disaggregated catch and effort data be solicited from the USA authorities and analyzed as part of future assessments, particularly for Queen Charlotte Sound.

Subcommittee Recommendations

1. The Subcommittee recommended that the stock biomass in 1971 be used as a limit reference point for management for the Hecate Strait stock. This is the previous minimum biomass from which the stock has recovered to a level above the long term average.

2. The Subcommittee recommended that the Decisions Table from the Fixed *h* model (Table 2) be used as the basis for management decisions regarding TAC for the Hecate Strait stock. Attention should be focused on the probability that the stock biomass will continue to increase and that the biomass after the fishing year will be greater than the biomass in 1971/72, the proposed limit reference point.

3. The Subcommittee recommended that the historical tagging results for Pacific cod be reanalyzed with emphasis on re-estimating growth rates. The incorporation of this analysis in the stock assessment model should be investigated. This analysis will also be useful in planning any future tagging experiments.

4. The Subcommittee recommended that the original disaggregated catch and effort data be solicited from the USA authorities and analyzed as part of future assessments.

5. The Subcommittee recommended that further stock identification work be undertaken for the Queen Charlotte Sound area. An initial project would be to document spawning grounds in the area.

**SEE ERRATUM ON PAGE 20 FOR CORRECT TABLE 2 **

Table 2. Decision Table with probabilities associated with five performance measures for the "Fixed *h* "model resulting from the range of simulated catch levels applied in 2005 based on 100,000,000 MCMC draws sampled every 50,000 iterations where *U* = CPUE and *B* = biomass.

Catch (t)	$U_{2005} > U_{avg}$	$U_{2006} > U_{avg}$	$B_{2006} > B_{2005}$	$B_{2006} > B_{1971}$	$B_{2006} > B_{2001}$
0	1.00	0.00	0.98	0.90	1.00
50	1.00	0.00	0.98	0.89	1.00
100	1.00	0.00	0.98	0.89	1.00
150	1.00	0.00	0.98	0.88	1.00
200	1.00	0.00	0.98	0.88	1.00
250	1.00	0.00	0.97	0.87	1.00
300	1.00	0.00	0.97	0.86	1.00
350	1.00	0.00	0.97	0.85	1.00
400	1.00	0.00	0.96	0.84	1.00
450	1.00	0.00	0.95	0.83	1.00
500	1.00	0.00	0.94	0.83	1.00
550	1.00	0.00	0.93	0.81	1.00
600	1.00	0.00	0.91	0.80	1.00
650	1.00	0.00	0.90	0.79	1.00
700	1.00	0.00	0.87	0.78	1.00
750	1.00	0.00	0.85	0.78	1.00
800	1.00	0.00	0.83	0.77	1.00
850	1.00	0.00	0.80	0.76	1.00
900	1.00	0.00	0.75	0.75	1.00
950	1.00	0.00	0.69	0.74	1.00
1000	1.00	0.00	0.63	0.73	1.00
1050	1.00	0.00	0.55	0.71	1.00
1100	1.00	0.00	0.46	0.70	1.00
1150	1.00	0.00	0.36	0.69	1.00
1200	1.00	0.00	0.26	0.68	1.00
1250	1.00	0.00	0.18	0.67	1.00
1300	0.99	0.00	0.12	0.65	1.00
1350	0.98	0.00	0.07	0.64	1.00
1400	0.97	0.00	0.05	0.62	1.00
1450	0.94	0.00	0.03	0.61	1.00
1500	0.91	0.00	0.02	0.60	1.00
1550	0.85	0.00	0.02	0.59	1.00
1600	0.79	0.00	0.02	0.57	1.00
1650	0.72	0.00	0.01	0.56	1.00
1700	0.64	0.00	0.01	0.55	1.00
1750	0.55	0.00	0.01	0.53	1.00
1800	0.47	0.00	0.00	0.52	1.00
1850	0.38	0.00	0.00	0.51	1.00
1900	0.31	0.00	0.00	0.49	1.00
1950	0.26	0.00	0.00	0.48	1.00
2000	0.20	0.00	0.00	0.46	1.00
2050	0.15	0.00	0.00	0.45	1.00
2100	0.12	0.00	0.00	0.44	1.00
2150	0.09	0.00	0.00	0.43	1.00
2200	0.07	0.00	0.00	0.42	1.00
2250	0.05	0.00	0.00	0.41	1.00
2300	0.04	0.00	0.00	0.39	1.00
2350	0.03	0.00	0.00	0.39	1.00
2400	0.02	0.00	0.00	0.37	1.00
2450	0.01	0.00	0.00	0.36	1.00
2500	0.01	0.00	0.00	0.34	1.00

APPENDIX 1. Working Paper Summaries

G2005-01: Sablefish (*Anoplopoma fimbria*) in British Columbia, Canada: Stock Assessment Update for 2004 and Advice to Managers for 2005.

V. Haist, A.R. Kronlund and M.R. Wyeth

Sablefish (*Anoplopoma fimbria*) stock status in British Columbia for 2004 was updated and advice provided to managers for the 2005/2006 fishing year. Four stock abundance indices were evaluated including (1) trap survey catch rates, (2) trap-vulnerable biomass estimates derived from tag-recovery data, (3) standardized catch rates based on commercial trap fishing logbooks, and (4) nominal catch rates based on commercial trap fishing landings and logbooks. Non-tagging based indices of abundance were integrated into a monthly tagging model to conduct stock biomass projections. Performance measures were summarized in decision tables to allow the projected stock biomass to be compared at different levels of total annual catch.

There has been agreement among the stock indices over most of the overlap in the time series; however the 2003 and 2004 indices have diverged. The indices suggest sablefish vulnerable to trap gear experienced a decrease in abundance from higher levels in the early 1990s to low levels in the mid 1990s. The rate of decline slowed in the mid 1990s in both the north and south areas. For the north area, a period of relative stability occurred in the mid 1990s until 2001 when historically low commercial CPUE and survey results were observed. The decline in commercial trap and survey indices for the south area was more gradual through the mid 1990s and continued through 2002. Survey catch rates in the north increased modestly in 2002 and then increased substantially in 2003 and this increase was maintained in 2004. Significant improvement of the 2003 survey index was observed for the south area and this improved level continued in 2004. Coast-wide standardized commercial trap catch rates also increased substantially in 2003 then declined approximately 20 percent in 2004. The pattern of tagging model estimates of trap-vulnerable biomass was generally consistent with trends in the other indices through 2002 but remained at a low level in 2003 and 2004 (Figure 1).

Factors external to the four stock indices bear on the status of B.C. sablefish as well. Gulf of Alaska sablefish abundance is considered to be at a moderate level with the 1997 year-class comprising 23 percent of the projected 2005 spawning biomass. The 2000 year-class may be above average but more data are required to confirm its relative contribution to stock abundance. Projected 2005 spawning biomass is estimated to be 37 percent of unfished biomass and is projected to decline under the U.S. adjusted $F_{40\%}$ harvest policy. In continental U.S. waters relatively strong 1999 and 2000 year-classes were observed by the U.S. triennial shelf survey, and the 2001 shelf survey results were the highest in

the 1980 to 2001 series. These signs that the 1999 and 2000 year-classes may be very strong in the waters off the continental U.S. follows poor recruitment through the 1990s and a concurrent decline in sablefish spawning stock biomass off the continental U.S. over the same period. The west coast Vancouver Island shrimp survey, which intercepts juvenile sablefish, has been conducted since 1975 at shallow depths (50 to 200 m) in management areas 124 and 125. Sablefish catch rates increased markedly in 2001 and 2002, and subsequently declined after 2002. These results are consistent with the increase in sablefish catch rates attributed to the 1999 and 2000 year-classes and reported from the continental U.S. shelf and slope surveys and bycatch rates in the U.S. Pacific hake (*Merluccius productus*) fishery. Trends in B.C. trawl catch rates of sablefish off the west coast Vancouver Island are consistent with the other indicators of strong 1999 and 2000 year-classes, although there are insufficient size data to determine which year-classes are captured. In waters shallower than 550 m off the West Coast of Vancouver Island sablefish catch rates by trawl gear increased beginning in 2001 through 2004 relative to previous years. In waters deeper than 311 m off the Queen Charlotte Islands, sablefish catch rates have increased since 2000 relative to the 1996 to 1999 period.

For this stock assessment, the monthly tagging model was extended to integrate fitting to the non-tagging based abundance indices. While this modification eliminated the need for a separate biomass dynamics model, it also introduced a higher weighting of the tagging data relative to other abundance indices. The tagging model assumed constant rates of natural mortality and emigration from the B.C. trap-vulnerable population. Recruitment parameters are estimated for each year and these represent all additions to the trap-vulnerable biomass in B.C. including immigration, recruiting year-classes, and behavioral recruitment to trap gear. A Bayesian approach, based on the Markov Chain Monte Carlo (MCMC) algorithm (Gelman et al. 1995), was used to estimate the joint posterior distribution of model parameters. Although presented as distributions of absolute biomass estimates, the absolute values are highly dependent on assumptions integral to the tagging analysis. These assumptions correspond to the treatment of tag reporting rates, tagging induced fish mortality, and a constant rate of emigration. Abundance trends are likely better determined than are absolute abundance values (Figure 2).

Stock projections were conducted under two scenarios with respect to recruitments to the trap-vulnerable biomass over the projection period. For the first scenario, recruitments were re-sampled from those estimated over the 1980 through 2004 time series including large recruitments estimated from the 1980s and early 1990s and low recruitments estimated from the mid-1990s onward. The second scenario arises from re-sampling from the more recent and shorter-term, 1994 to 2004 time series. As in previous sablefish assessments, a number of performance measures were calculated for each projection to assist in the selection of short-term TACs. The performance statistics depend on a number of factors: (1) results are highly sensitive to what recruitments occur over the

projection period, and this has greater influence on the probabilities than does the selection of TAC level within the 3500 to 10000 t range evaluated, (2) the end-year statistics are consistently lower than the beginning-year statistics and the differences increase with higher TAC levels, and (3) the influence of the TAC level on the performance measure is less pronounced when looking at stock biomass after two years than when looking at stock biomass after five years.

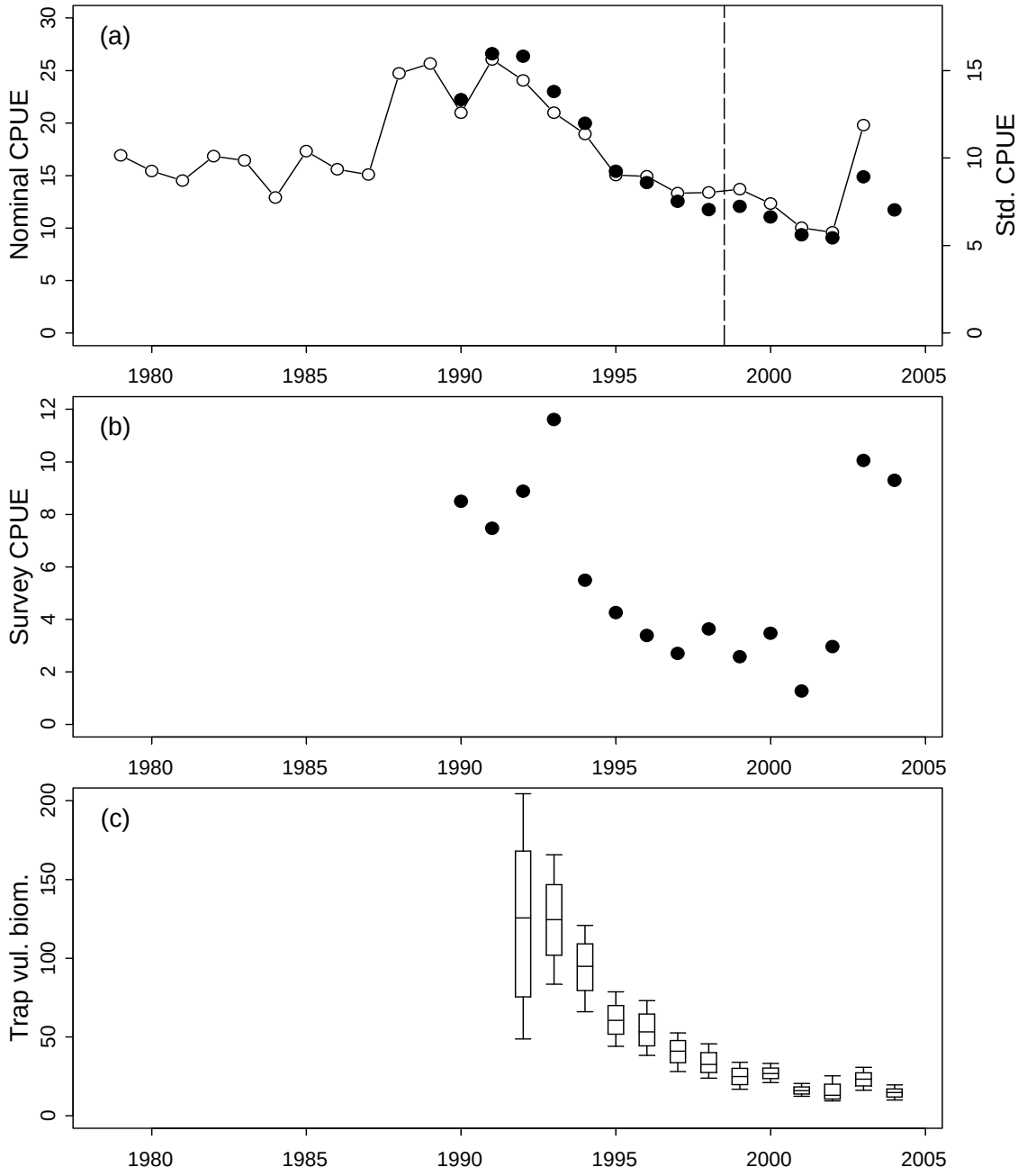

Figure 1 Coast-wide stock indices: (a) B.C. trap fishery nominal index (open circles) and standardized (filled circles) indices (kg/trap), (b) B.C. survey index (numbers/trap), and (c) B.C. trap-vulnerable biomass (1,000 t) posterior distributions for tagging data only. The dashed vertical line in panel (a) indicates the inception of trap escape rings in the B.C. trap fishery.

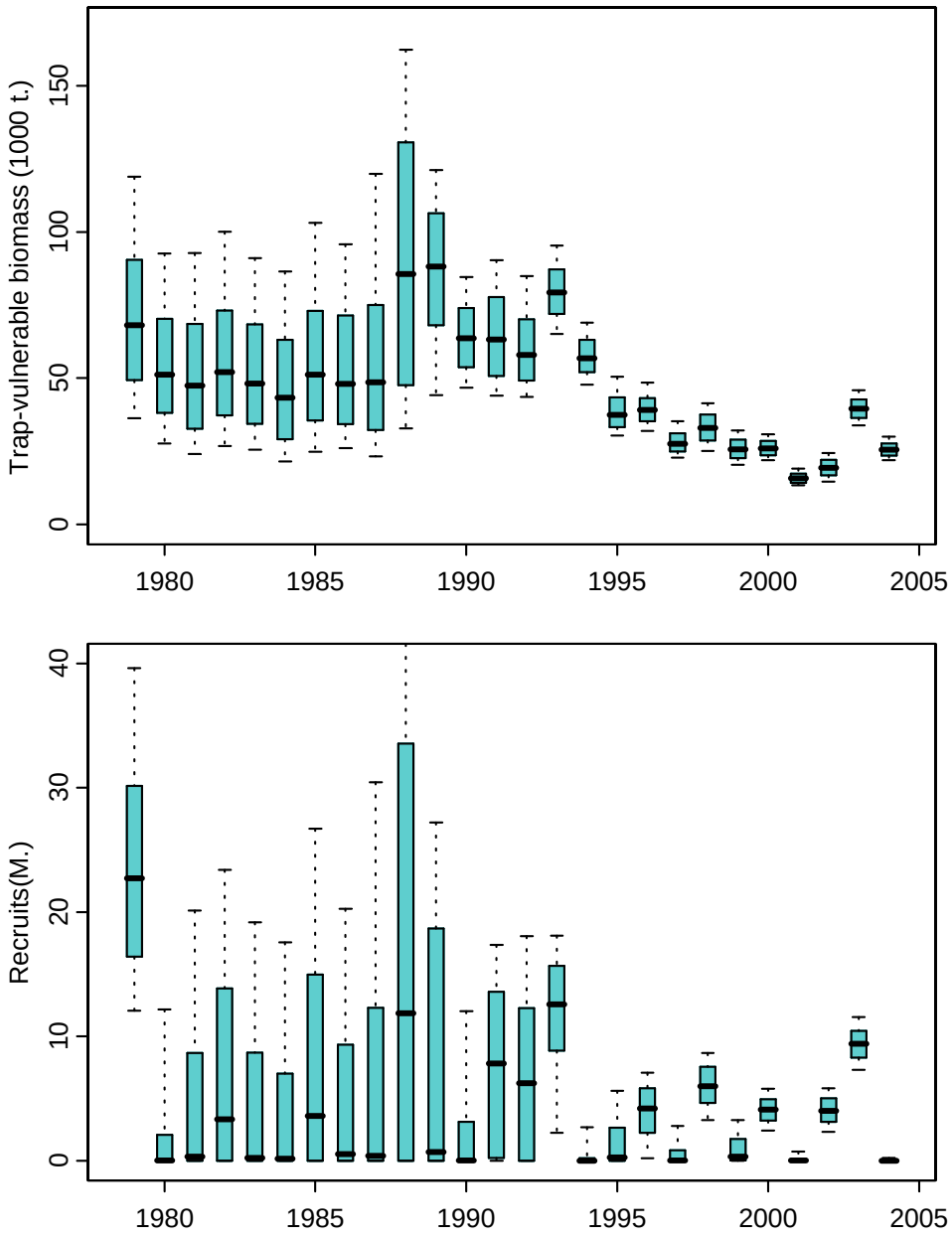

Figure 2 Quantile plots of the marginal posterior distributions of (a) trap-vulnerable biomass (1,000 t, upper panel) and (b) recruitments (millions, lower panel). The median is shown by heavy horizontal lines, the inter-quartile range by the shaded boxes, and the 5th and 95th percentiles by the whiskers.

G2005-02: Assessment of Pacific Cod in Hecate Strait (5CD) and Queen Charlotte Sound (5AB) January, 2005.

The history of the Hecate Strait Pacific cod fishery is one of pulse fishing with wide variations in harvest rate coinciding with large variations in stock size. There have been three distinct episodes of substantial increases in stock size which followed periods when the harvest rate was low. These increases in stock size were then tracked with an increasing harvest rate. Inevitably the harvest rate peaked after the peak in stock size and the continued high harvest rates exacerbated the subsequent decline in stock size. Of particular note is the period of very high harvest rate in the early 1990s which was followed by the lowest biomass on record during the late 1990s and early 2000s. There are clear indications of recent increases in stock biomass in Hecate Strait. The reduced TAC for the stock and a shift in fishing pattern has resulted in a reduction in exploitation rate. The increased monitoring effort associated with the Hecate Strait Pacific cod monitoring survey has indicated an increase in stock size between 2002-2004. This is corroborated by an increase in catch per unit effort in the commercial fishery and by the many reports of increased abundance from the fishing industry. The size composition data from the monitoring survey and the commercial fishery are consistent, showing a good abundance of 1-year old fish in 2002 and 2003, which in turn contributed to an increase in spawning stock size. However, the abundance of young fish in 2004 was lower than in the previous 2 years, suggesting that recruitment to the commercial sizes in 2005/06 may be lower. While there has been an increase in stock size, it has not yet reached the long term average biomass level.

One of the objectives of the working paper was to propose candidate limit reference points for this fishery. We have extended this discussion to include both target and limit reference points and examined a number of alternatives. Traditional model-based reference points such as B_{msy} and F_{msy} as well as reference points derived from a stock recruitment relationship (e.g. BH_{50}) were shown to be very sensitive to minor changes in model formulation or assumptions and thus were too unstable to be of practical use to provide consistent management advice. Pragmatic observation-based reference points based on estimates taken from the historical reconstruction of the stock, such as the average biomass (B_{avg}), the average harvest rate (H_{avg}), and the minimum biomass from which the stock has recovered ($B_{recovery}$), were shown to be more robust to changes in model assumptions and thus could provide more consistent management advice. These reference points have an intuitive appeal since they are based on empirical observations which can be easily explained to managers and industry.

It is also evident from the time series of biomass and harvest rates that stock conditions have varied considerably but there has been no long term trend. This argues in favor of using historical reference levels to guide current management. A possible caveat to this approach is the fact that the extended period of low

biomass in the recent years followed a period of very high harvest rates in the early 1990s. Thus, it would seem prudent to manage the TAC so that harvest rates stay away from the high levels observed in the 1990s.

A desirable state (target) would be to have stock biomass near the long term average. This would buffer against potentially dangerous stock declines during periods of poor recruitment and should result in higher production from the stock. The previous minimum biomass from which the stock has recovered to above the long term average occurred in 1971. The estimated stock biomass in 1971 was sensitive to the model formulation. However, the observation that the minimum biomass from which the stock recovered occurred in 1971 was robust to model formulation. The stock reached an historic low in 2001. While there has been some stock growth since then, the population has yet to reach the long term average. Thus, it would be premature to conclude that the stock has recovered from the low biomass in 2001. Based on these observations, we suggest that the biomass in 1971 be used as a candidate limit reference point for this stock. We recommend against using a fixed biomass as the limit since this number will change depending on the assessment model formulation. Rather, we recommend using the biomass in 1971 as the limit from whatever model formulation is used.

How the decision table is used to inform a management decision on the TAC for this stock in 2005/06 will depend on the management objectives and risk tolerance. The limit reference point specifies a stock biomass below which serious harm to the stock may result. In principle, a management decision regarding a limit reference point should be made in a risk averse manner. In other words, the probability that the stock biomass will remain above the limit should be well above 50%. No standard has been set for how high this probability should be. A reasonable short term objective for this stock would be to promote stock rebuilding, given that the current biomass is still below the long term average. The probability that stock size will increase should be above 50% in order to achieve this objective and the rate of rebuilding will be faster with higher rebuilding probabilities.

It was not possible to produce a stock assessment for Pacific cod in Queen Charlotte Sound (5AB). We used a similar modeling approach and input data for this stock as was used for Hecate Strait but numerous attempts to produce a credible result failed. The reasons for this result are unclear at present. One observation is that the time series of catch and catch per unit effort for this stock do not follow a normal pattern for fish stocks. In particular, there was considerable variation in the annual catch during the first 30 years of the time series, but the estimated fishing effort was relatively constant during this period. It is possible that the commercial catch per unit effort time series is biased because we were not able to properly identify those fishing events which were the most likely to indicate variation in cod abundance. There was also a substantial catch by vessels from the USA for which we have no effort data so

the Canadian CPUE series was used to estimate the effort. Essentially we were forced to assume that the Canadian and USA CPUE were the same. However, if the USA CPUE was higher during those years, then the effort estimates would be biased. The new bottom trawl survey in Queen Charlotte Sound may provide a useful index of cod abundance in the area for future assessments. A second problem is that the stock structure in Queen Charlotte Sound is not well known. There have been no tagging experiments conducted in the area nor have any spawning areas been identified. While there are similarities in CPUE and total catch trends among all three offshore management areas, this is not sufficient to warrant grouping Queen Charlotte Sound with either of the other two.

APPENDIX 2: PSARC Groundfish Subcommittee Meeting Agenda

PSARC Groundfish Subcommittee
18-20 January 2005
Pacific Biological Station – Nanaimo, B.C.
Seminar Room

Tuesday 18 January

1. Opening remarks and introductions	9:00	Jeff Fargo
2. Pacific cod	9:30	
Lunch Break	*11:30*	
Pacific cod (cont'd)	13:00	
Adjournment	*16:30*	

Wednesday 19 January

3. Sablefish	9:00	
Lunch Break Canadian Sablefish Association Presentation 4. Formulation of Subcommittee Conclusions and Recommendations *Adjournment*	*12:00* 13:00 *14:30* *16:30*	

*Due to time constraints in developing the Lingcod Management Framework paper, it will not be tabled at this meeting

Thursday, January 20

Formulation of Subcommittee Recommendations 9:00

APPENDIX 3. List of Attendees

Subcommittee Chair: Jeff Fargo
PSARC Chair: Al Cass ,

Name	Affiliation	Jan. 18	Jan. 19	Jan. 20
External Participants				
Alvin Sewid	Kwakiutl Fisheries Commission	✓		
Brian Mose	CGRCS	✓	✓	✓
Bruce Turris	CGRCS	✓	✓	✓
Kelly Andersen	CGRCS	✓	✓	
Paul Starr	CGRCS	✓	✓	✓
Sean Cox	Simon Fraser University		✓	
Steve Martell	UBC		✓	
Bob Fraumeni	CSA		✓	
Eric Olsen	CSA		✓	
Chris Acheson	CSA		✓	
Eric Wickham	CSA		✓	✓
Vivian Haist	CSA		✓	✓

UBC – University of British Columbia
CGRCS – Canadian Groundfish Research Conservation Society
CSA – Canadian Sablefish Association

Internal Participants		Jan. 18	Jan. 19	Jan. 20
Jon Schnute	PBS	✓	✓	
Barry Acherman	DFO Vancouver	✓	✓	✓
Rick Stanley	PBS	✓		
Jim Kristmanson	DFO Ottawa	✓		
Alan Sinclair	PBS	✓	✓	✓
Dan Clark	DFO	✓		
Norm Olsen	PBS		✓	
Al Cass	PBS, PSARC Chair	✓	✓	✓
Jeff Fargo	PBS, Subcommittee Chair	✓	✓	✓
Rowan Haigh	PBS	✓	✓	
Brian Krishka	PBS	✓	✓	
Jackie King	PBS	✓	✓	
Rob Kronlund	PBS	✓	✓	✓
Diana Trager	DFO	✓	✓	
Greg Workman	PBS	✓	✓	
Kate Rutherford	PBS	✓	✓	
Malcolm Wyeth	PBS	✓	✓	✓
Ed Choromanski	PBS	✓	✓	
Karina Cooke	PBS	✓	✓	
Sun-Do Hwang	PBS		✓	

Schon Acheson	PBS	✓	✓	
Kris Castle	PBS	✓	✓	
Ted Perry	PBS		✓	

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

Dana Hanselman	NOAA
James Ianelli	NOAA
Max Stocker	Pacific Biological Station
Sean Cox	Simon Fraser University

ERRATUM

Erratum: DFO. 2005. Proceedings of the PSARC Groundfish Subcommittee Meeting, January 18-20, 2005. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2005/003

Replace page 8, Table 2 with information below.

Table 2. Decision table with probabilities associated with five performance measures for the "Fixed h"model resulting from the range of simulated catch levels applied in 2005 based on 100,000,000 MCMC draws sampled every 50,000 iterations where *U* = harvest rate and *B* = biomass.

Catch (t)	$U_{2005} < U_{avg}$	$B_{2006} > B_{avg}$	$B_{2006} > B_{2005}$	$B_{2006} > B_{1971}$	$B_{2006} > B_{2001}$
0	1.00	0.00	0.98	0.90	1.00
50	1.00	0.00	0.98	0.89	1.00
100	1.00	0.00	0.98	0.89	1.00
150	1.00	0.00	0.98	0.88	1.00
200	1.00	0.00	0.98	0.88	1.00
250	1.00	0.00	0.97	0.87	1.00
300	1.00	0.00	0.97	0.86	1.00
350	1.00	0.00	0.97	0.85	1.00
400	1.00	0.00	0.96	0.84	1.00
450	1.00	0.00	0.95	0.83	1.00
500	1.00	0.00	0.94	0.83	1.00
550	1.00	0.00	0.93	0.81	1.00
600	1.00	0.00	0.91	0.80	1.00
650	1.00	0.00	0.90	0.79	1.00
700	1.00	0.00	0.87	0.78	1.00
750	1.00	0.00	0.85	0.78	1.00
800	1.00	0.00	0.83	0.77	1.00
850	1.00	0.00	0.80	0.76	1.00
900	1.00	0.00	0.75	0.75	1.00
950	1.00	0.00	0.69	0.74	1.00
1000	1.00	0.00	0.63	0.73	1.00
1050	1.00	0.00	0.55	0.71	1.00
1100	1.00	0.00	0.46	0.70	1.00
1150	1.00	0.00	0.36	0.69	1.00
1200	1.00	0.00	0.26	0.68	1.00
1250	1.00	0.00	0.18	0.67	1.00
1300	0.99	0.00	0.12	0.65	1.00
1350	0.98	0.00	0.07	0.64	1.00
1400	0.97	0.00	0.05	0.62	1.00
1450	0.94	0.00	0.03	0.61	1.00
1500	0.91	0.00	0.02	0.60	1.00
1550	0.85	0.00	0.02	0.59	1.00
1600	0.79	0.00	0.02	0.57	1.00
1650	0.72	0.00	0.01	0.56	1.00
1700	0.64	0.00	0.01	0.55	1.00
1750	0.55	0.00	0.01	0.53	1.00
1800	0.47	0.00	0.00	0.52	1.00
1850	0.38	0.00	0.00	0.51	1.00
1900	0.31	0.00	0.00	0.49	1.00
1950	0.26	0.00	0.00	0.48	1.00
2000	0.20	0.00	0.00	0.46	1.00
2050	0.15	0.00	0.00	0.45	1.00
2100	0.12	0.00	0.00	0.44	1.00
2150	0.09	0.00	0.00	0.43	1.00
2200	0.07	0.00	0.00	0.42	1.00
2250	0.05	0.00	0.00	0.41	1.00
2300	0.04	0.00	0.00	0.39	1.00
2350	0.03	0.00	0.00	0.39	1.00
2400	0.02	0.00	0.00	0.37	1.00
2450	0.01	0.00	0.00	0.36	1.00
2500	0.01	0.00	0.00	0.34	1.00