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Report of the PSARC Groundfish Subcommittee Meeting November 23-26, 1998 and the Steering Committee Meeting December 16, 1998

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PACIFIC STOCK ASSESSMENT REVIEW COMMITTEE

PSARC ADVISORY DOCUMENT 98-6
DECEMBER 1998

GROUNDFISH

I. STEERING COMMITTEE REPORT

Steering Committee met December 16, 1998 at the Pacific Biological Station, Nanaimo, to review the Groundfish Subcommittee report. The report was accepted, with the following comments and recommendations.

Steering Committee noted that for most groundfish stocks yield recommendations do not change from one year to the next. Yield recommendations may change for stocks for which a major stock assessment has been conducted. In 1998 major stock assessments were conducted for sablefish and for Hecate Strait Pacific cod.

Comments on Major Subcommittee Concerns

1. Steering Committee noted the Subcommittee concern about overexploitation of inshore rockfishes. Steering Committee concurred with the Subcommittee that there is an urgent need to implement procedures to address precautionary management in inshore rockfish fisheries.

   Steering Committee supported the Subcommittee recommendation to begin a planning process by forming a multi-branch working group. The working group should develop integrated plans for the assessment and management of inshore rockfishes as soon as possible. The working group should evaluate a variety of management options including large scale area closures, seasonal closures, reduced daily bag limits, catch caps and allocations. With regard to area closures there are data available that may be used to answer questions about the size of closed areas.

   Steering Committee noted that this is a long-term issue since these species live from 40 to over a hundred years.

2. Steering Committee concurred with the Subcommittee recommendation that appropriate effort be directed to complete the work of the groundfish catch data base.

Comments on Additional Subcommittee Discussions

1. Steering Committee noted that discussions on the application of the precautionary approach to groundfish stocks was discussed. The Steering Committee raised the question of whether there was a process in place in DFO for developing operational guidelines for the implementation of the precautionary approach to fisheries management.

2. Steering Committee concurred with the Subcommittee recommendation that closure of the winter fishery operating on the spawning grounds be considered. Spawning aggregations of Pacific cod are very vulnerable to overexploitation.

3. Steering Committee supported the Subcommittee recommendation to compile a history of past groundfish management actions. The Steering Committee suggested that this work be carried out by the Groundfish Management Unit of the Operations Branch.

4. Steering Committee concurred with the Subcommittee recommendation to identify ecosystem approaches suitable for groundfish assessments.

G98-1 Review of hydroacoustic methodology for Strait of Georgia hake

Steering Committee accepted the Subcommittee recommendations and emphasized the need for repeat surveys to address the uncertainties in the estimates of hake biomass.

G98-2 Strait of Georgia Pacific hake stock assessments for 1998 and recommended yield options for 1999.

Steering Committee supported the Subcommittee recommendations, and noted that declines in growth rates has been observed in many other species. The Steering Committee noted that a paper on this issue is being prepared for the next Groundfish Subcommittee meeting.

G98-3 Hecate Strait Pacific cod stock assessments for 1998 and recommended yield options for 1999.

Steering Committee accepted the yield recommendations. Steering Committee noted that biomass and recruitment are low and that stock biomass is likely to decline and recommended that managers use caution in the selection of yield for 1999.

Steering Committee supported the Subcommittee recommendation for additional work on survey design.

G98-4 Flatfish stock assessments for the west coast of Canada for 1998 and recommended yield options for 1999.

Steering Committee accepted yield recommendations, and supported the Subcommittee recommendation that managers use caution in selecting the quota for rock sole in 5A/5B for 1999.

Steering Committee noted that the planned major assessment for 5A/5B rock sole could not be carried out because of a backlog of ageing data. The Steering Committee recommended that this backlog be addressed.

G98-5 Reconstruction of BC sablefish stocks, 1966–97, and catch projections for 1999, using an integrated catch-age mark-recapture model with area and depth movement.

Steering Committee accepted the yield recommendations. However, Steering Committee noted discrepancies between the modeled biomass trajectories using two configurations of tagging data. Because of this uncertainty in the modeled biomass trajectories the Steering Committee recommended caution in the selection of yield options for 1999. Steering Committee supported further investigations into sablefish biology as necessary to resolve the discrepancies between the modeled biomass trajectories. Specifically, research to resolve ageing issues and developing a credible recruitment index should be undertaken.

G98-6 Shelf rockfish stock assessment for 1998 and recommended yield options for 1999.

Steering Committee accepted yield recommendations.

G98-7 Inshore rockfish stock assessment for the west coast of Canada in 1998 and recommendations for 1999/2000.

Steering Committee noted that there are signs of overexploitation in the inshore rockfish fishery. RMEC is advised that managers need to scale back total removals in 1999. Steering Committee recommends that work needs to be initiated quickly to develop precautionary strategies independent of biomass estimation (e.g., large area closures; see comments on major Subcommittee concerns).

G98-8 Slope Rockfish.

Steering Committee accepted yield recommendations.

Steering Committee was unable to determine whether further effort using the methods presented in this paper will result in estimates of abundance for each regulatory area and of slope rockfish species, and if so, whether these estimates could be used for yield recommendations.

II. GROUNDFISH SUBCOMMITTEE REPORT

1. Biological Advice on Management of B.C. Groundfish for 1999

The Subcommittee met at the Pacific Biological Station, Nanaimo, November 23-26, 1998 to review the stock status and develop advice on groundfish resources for the Pacific Region. This advice is based on assessments and recommendations contained in working papers and peer reviews of these papers. This report includes summaries of both the papers and the reviews. There is a synopsis of the conditions of the assessed

stocks and recommendations for management that were based on the working papers and discussions of the Subcommittee.

In 1991, the Groundfish Subcommittee initiated a multi-year schedule for groundfish stock assessments and yield recommendations. This schedule specifies that major updates for most stocks will occur on a staggered basis, with statistical updates (termed Interim Reports) of the fisheries in intervening years. Interim Reports will also provide information on any significant changes in stocks, particularly those that may require more frequent assessment revisions. Recommended yield options will normally remain unchanged between major assessments.

In 1998 major assessments were reviewed on sablefish and Pacific cod. A new document was also submitted reviewing the hydroacoustic methodology used in assessing Strait of Georgia hake stocks (G98-1).

Groundfish staff in the Stock Assessment Division conduct their assessments using a multi-year data base of fishery statistics and biological sampling, and a variety of assessment tools including several catch-at-age models, age-independent biomass dynamic models, and yield-per-recruit models. Stock assessment papers are assigned to reviewers by the Subcommittee chair, and written review comments are provided to the authors prior to the Subcommittee meeting. Reviews for major assessments normally incorporate one external (government or non-government) and one internal reviewer. Assessments and recommended yield options are then reviewed by the Subcommittee, which includes representatives from management and outside reviewers. Beginning in 1997 the assessment meetings also include participants nominated from various sectors of the fishing industry with extensive practical experience in the fishery. These participants are prohibited from acting as industry advocates, but participate in the review as outside experts with considerable practical experience who can provide an additional perspective on the scientific assessments.

In earlier years the Subcommittee was required to reach a consensus on any recommendations presented in assessments before submission to the PSARC Steering Committee. Beginning in 1997 the terms of reference for the Subcommittee were revised, and the requirement for consensus no longer exists; instead the Subcommittee report will be written to reflect both majority and minority viewpoints. There is a standing membership for the Subcommittee, however, non-committee members may also participate in the Subcommittee meetings. A list of participants for the 1998 meeting is appended to the report.

2. 1998 Working Papers and Authors

G98-1. Kieser, R., M.W. Saunders, and K. Cooke. 1998. Review of hydroacoustic methodology and Pacific hake biomass estimates for the Strait of Georgia, 1981 to 1998.

G98-2. Saunders, M.W., and G.A McFarlane. 1998. Pacific Hake - Strait of Georgia stock assessments for 1998 and recommended yield options for 1999.

G98-3. Haist, V., and D. Fournier. 1998. Hecate Strait Pacific cod stock assessment for 1998 and recommended yield options for 1999.

G98-4 Fargo, J. 1998. Flatfish stock assessments for the west coast of Canada for 1998 and recommended yield options for 1999.

G98-5 Haist, V., D. Fournier, and M.W. Saunders. 1998. Reconstruction of BC sablefish stocks, 1966–97, and catch projections for 1999 using an integrated catch-age mark-recapture model with area and depth movement.

G98-6 Stanley, R. 1998. Shelf rockfish stock assessment for 1998 and recommended yield options for 1999.

G98-7 Kronlund, A.R., K.L. Yamanaka, and G.D. Workman. 1998. Inshore rockfish stock assessment for the west coast of Canada in 1998 and recommendations for 1999/2000.

G97-8 Schnute, J., N. Olsen, and R. Haigh. 1998. Slope rockfish.

3. Overview of Current Stock Conditions

PSARC Groundfish Subcommittee overviews on current condition of groundfish species or species groups.

Species or Species Group	**Current Stock Condition**
Pacific Cod	Very Low
Sablefish	Average
Offshore Lingcod	Average to Low
Strait of Georgia Lingcod	Very Low
Offshore Pacific Hake	Average
Strait of Georgia Pacific Hake	Average
Slope Rockfish	Low to Average*
Shelf Rockfish	Low to Average*
Inshore Rockfish	Low to Average*
Walleye Pollock	Low to Average*
Spiny Dogfish	Average
Petrale Sole	Very Low
Rock Sole, English Sole, Dover Sole	Average to High

* depending on specific stock.

4. Yield Options

In the past a number of categories of yield options have been presented, all of which may not be appropriate for a particular species or stock. The five yield options are: (i) zero yield; (ii) low risk yield; (iii) sustainable yield; (iv) high risk yield; (v) unrestricted yield. These levels of risk are qualitative in that they incorporate neither a formal calculation of probability, nor a precise definition of consequence. Rather, they attempt to convey the degree of uncertainty associated with various yield options. For a detailed description of yield options see Stocker (1994).

The Subcommittee also reviewed preliminary work on application of the "Precautionary Approach" to the management of groundfish stocks. There are several major initiatives around the world now developing on the use of the precautionary approach, and a DFO group has also been working to develop advice on the application of these guidelines to the management of Canadian fishery resources.

The Subcommittee emphasizes that for some stocks and fisheries, such as inshore rockfish, the biology of the species makes the present approaches to assessment and management inappropriate. Even with significantly greater resources it will remain impossible to provide advice to ensure sustainability with present approaches to estimating abundances and quota management.

5. Major Subcommittee Concerns

(a) The Subcommittee noted that concerns about overexploitation in inshore rockfishes have been expressed in previous years and **recommended** that there is now an urgent need to implement procedures to address precautionary management in these fisheries, particularly because of the long life and low productivity of these stocks. For these reasons, the Subcommittee commented that managers may now wish to evaluate use of large scale area closures as an additional tactic for management of inshore rockfishes. The Subcommittee also supported the recommendation to begin a planning process that should include membership from the Recreational Fisheries Division, the Groundfish Management Group, and client groups.

(b) The Subcommittee is concerned that groundfish catch data are not co-ordinated across fisheries or times, so the data cannot easily be accessed for assessment purposes. The groundfish database concept was well-developed in FMIST, design and testing phases were completed, but the final stages of implementation stalled before it became a useful database for stock assessment. The Subcommittee **recommended** that appropriate effort be directed to complete the remaining work.

6. Additional Subcommittee Discussions

(a) Potential application of the "Precautionary Approach" to Pacific groundfish stocks was discussed during the meeting. The Subcommittee noted that some of the classical

biological reference points may not apply in these complex fisheries. The Subcommittee will continue to review progress on the Precautionary Approach as work in this area continues, and wishes to be kept informed of further work on the development of this approach.

(b) During the meeting, industry participants reported that a very low abundance of Pacific cod had been observed on Area 3C/D (West Coast of Vancouver Island) spawning grounds. The Subcommittee agrees with industry comments that there is potential for a large catch of the Area 3C/D spawning stock unless closure is implemented. As a precautionary measure, the Subcommittee therefore recommended that closure of the winter fishery operating on the spawning grounds be considered in consultation with industry.

(c) The Subcommittee spent considerable time discussing the general concern that interpreting interannual changes in catch, effort and CPUE time series was extremely difficult in light of the impact of changing management strategies. The Subcommittee therefore **recommended** that a history of past management actions be compiled to provide context for interpreting stock indices and landings history. Some of the recent impacts related to individual vessel quotas (IVQs) include increased effort in anticipation of IVQs ("fear" fishing) and increased effort by inexperienced skippers that leads to lower mean CPUE.

(d) The Subcommittee noted the requirement within the *Oceans Act* for multispecies ecosystem assessments. The Subcommittee **recommends** discussions take place to identify ecosystem approaches suitable for groundfish resources.

(e) The Subcommittee notes its concern that the Fisheries Oceanography Working Group has still not been struck. There are remarkable changes in the growth of many groundfish species occurring since 1990 that were discussed during the meeting. These changes indicate that potentially significant changes in the ocean environment are developing. The Subcommittee therefore **recommended** that this Working Group be struck immediately and that collaborative work be encouraged. *(Note: The Subcommittee was subsequently informed after the groundfish meeting that RMEC had approved the formation of the Fisheries Oceanography Working Group).*

7. Summaries of Assessments, Reviewers' Comments and Subcommittee Discussions

G98-1 Review of hydroacoustic methodology for Strait of Georgia hake. R. Kieser, M. Saunders, and K. Cooke.

Accepted Subject to Revision

This paper presents a review of methods used to assess Pacific hake in the Strait of Georgia between 1981 to 1998 and a time series of estimated hake biomass that is based on a single target strength value. The paper includes a description of the evolution

of the acoustic system, data collection, analysis, presentation techniques and sources of uncertainty. In addition a method for calculating biomass based on a target strength-length relation is presented.

Several sources of uncertainty affecting the Pacific hake abundance time series are described in the paper. Recommendations for improving future surveys were also discussed in the paper.

Reviewers' Comments

Reviewer #1

The reviewer was complimentary about the technical aspects of the hydroacoustic survey documented in the paper and commented that the work portrayed a very technically competent and progressive approach that has substantially improved the surveys over the past 2 decades.

Reviewer #1 identified two major concerns. The first involved the possibility that a variable proportion of the hake population might have been encountered and surveyed in different years. The reviewer supported the objective of conducting the survey when the hake were in spawning aggregations, because at that time hake detectability should be greatest and species composition problems minimal. However, it is not clear when hake enter the spawning grounds and when they leave. The reviewer noted that this uncertainty may lead to erroneous conclusions about trends in abundance.

The other major concern identified by the reviewer was that little attention was paid in the review to estimating the uncertainty of the mean estimates of abundance. As a result, it was not easy to judge the results without also addressing this problem. The reviewer felt that at a minimum estimates of uncertainty should be attached to the mean estimates, and the source of the stated uncertainty defined (because not all of the uncertainty is likely to be addressed). The reviewer viewed the estimation of uncertainty as part of the hydroacoustic assessment methodology, and that the authors needed to address these issues directly in a future paper.

Specific Recommendations Identified by Reviewer #1:

1. *Research on target strength at the times and depths of interest across a range of fish sizes, behaviour, and condition (do males and females at spawning differ in TS?).*
2. *Research on target classification (with the goal of making it more objective, so that at least it will be consistent from survey to survey).*
3. *Research on residence time on the spawning grounds (could be done with sonar tags) if absolute biomass estimates are a goal.*
4. *Multiple surveys over several years to determine shape and timing of abundance curve on spawning grounds, if relative estimates are the goal (would be required for absolute estimates as well).*

Reviewer #2

Reviewer #2 also recommended acceptance of the paper, and felt that it was a well-presented paper with all aspects of the acoustic system, data collection, and analysis well described. It was noted that the estimated hake biomass was described by only its point estimate, and that there are several sources of uncertainty from the data acquisition, data processing, and model process errors that were not incorporated into the present analysis. The reviewer felt that abundance estimates would be improved if measurement of the uncertainties could be provided. The reviewer suggested a number of approaches that should be investigated in future work.

Subcommittee Discussion

The Subcommittee agreed with the reviewers' comments that this paper presents a technically competent approach to the use of hydroacoustic methodologies for assessing abundance of Pacific Hake in the Strait of Georgia. Subcommittee discussion focused on the issues surrounding interpretation of the results. Details of survey timing were discussed as key components to evaluating the proportion of hake which may have been encountered and surveyed between years. Specifically, information on differing sex ratios between surveys was identified as a possible source of error. The need for estimation and discussion of the uncertainty of the mean estimates of abundance was identified. The incorporation of an analysis of likely sources of uncertainty, particularly those related to survey design and target strength, was recommended. The Subcommittee agreed that these analyses should be conducted prior to initiating further surveys.

Subcommittee Recommendations

1. The Subcommittee accepted the working paper subject to revision.
2. The Subcommittee **recommended** that analysis of uncertainty be conducted and incorporated in the assessment, in particular, the uncertainty associated with survey design and target strength. This should be submitted in time for next year's Subcommittee meeting.
3. The Subcommittee **recommended** the future work incorporate repeat surveys to examine the appropriateness of survey timing, and exploratory work in shallow water areas and inlets.

G98-2 Strait of Georgia Pacific hake stock assessments for 1998 and recommended yield options for 1999. M. Saunders and G.A McFarlane.

Accepted Subject to Revision

The fishery in the Strait of Georgia increased slightly in 1997 to 7,773 t from 6,582 t in 1997. Age and growth data continue to indicate strong recruitment during the 1990s and a coincidental decline in the mean size-at-age. Preliminary results from a review of hydroacoustic surveys for the Strait of Georgia (G98-1) indicate that the current stock size

is estimated conservatively at 42Kt. A major assessment is required to draw the surveys and updated biological data into an appropriate modelling framework. In the interim, the status quo yield was proposed to be continued, which was calculated in a previous assessment by applying low and high risk rates of fishing mortality generated for the offshore (west coast of Vancouver Island) stock to the current estimate of exploitable biomass for the Strait of Georgia stock (42Kt). The resulting range in yield is 7,554-14,687 t. Due to uncertainty in the current assessment, including evidence of increasing seal predation, the authors recommended that managers choose a quota from the lower half of the yield range.

Reviewers' Comments

Reviewer #1

The reviewer felt that the central issue in this assessment was whether or not there was compelling evidence to support a recommendation to move to a lower, more precautionary exploitation rate. Overall, the reviewer agreed with the technical rationale for a more conservative yield, and felt that concerns resulting from lower size-at-age and increased seal predation are not sufficiently countered by weak evidence for strong recruitment, nor by potential underestimation of biomass by the acoustic survey.

The reviewer identified several major issues in his review:

1. ***Catch not attaining recent quotas*** – In the reviewer's opinion this was not compelling evidence for low stock size and lower recommended harvests; other cited factors had a high likelihood of being responsible for reduced catch.

2. ***Size/age composition data*** – modes of small/young fish do indicate that some recruitment is occurring. However, the absolute magnitude of these recruitments relative to historical or replacement levels cannot be determined. Thus, recent recruitment data are not strong evidence that current or higher harvest rates are sustainable.

3. ***Declines in size-at-age*** – The reviewer commented that the size of this change was a remarkable signal. Although the decline in the early 1980s was well known, the subsequent decline in the 1990s was viewed as a concern because this would reduce the yield per recruit and also reduce the spawning potential for the stock.

4. ***Seal predation*** – The magnitude of this predation appeared sufficient to warrant explicit inclusion in future stock assessment models. The reviewer viewed this issue as an appropriate rationale for reduced expectations for sustainable fishery harvest rates.

Subcommittee Discussion

The Subcommittee accepted the paper and endorsed the author's yield recommendations.

Both the Subcommittee and the reviewers expressed concern about the decline in size-at-age of hake. The change in size-at-age occurred in a step-wise fashion. This suggests that the drop in growth rates were unlikely to be due to competition for food. The Subcommittee **recommended** that the decline in growth rate be investigated further, particularly as there was no compelling evidence for density dependent effects causing the observed drop. The reviewer's comments that seal predation on hake in the Strait of Georgia appeared to be significant and should be incorporated into the population model used in the assessment was **also supported**.

G98-3 Hecate Strait Pacific cod stock assessments for 1998 and recommended yield options for 1999. V. Haist and D. Fournier

Accepted Subject to Revision

Reconstructions of the Hecate Strait Pacific cod stock were conducted using a catch-at-length model, as in previous assessments. The major modification to this year's assessment was the inclusion of data from the multi-species Hecate Strait survey. While Pacific cod abundance indices from this survey are not precise, the survey has been conducted in a consistent manner since 1984, and should provide information on the general trends in relative abundance.

Stock analyses were conducted under two different assumptions. First, that selectivity for 60 cm fish was constant among commercial fisheries (time periods and fishing quarters), and the other that selectivity for 70 cm fish was constant among the fisheries. The 60 cm assumption is a more restrictive parameterization. Stock trends and estimates of the recruitment time series are shown (see Figure 1) for the two analyses. Both analyses suggest that stock abundance remains near historic low levels, that recruitment of the last 9 year-classes is below the median level, and that the 1998 year-class is the smallest ever. The last result is largely dependent on the length structure observed in the 1998 Hecate Strait survey.

Stock projections were conducted for the years 1999 through 2002 using stochastic simulations, where the stochastic elements were the 1998 number-at-age and the 1999 through 2002 recruitment levels. These stock projections suggest that the spawning stock biomass will continue to decrease through 2001 with a small probability of increase in 2002. Potential yield in 1999, based on target age-5 fishing mortality rates from 0.30 to 0.50, were 600 to 890 tonnes for the common selectivity at 60 cm assumption and 1090 to 1560 tonnes for the common selectivity at 70 cm assumption.

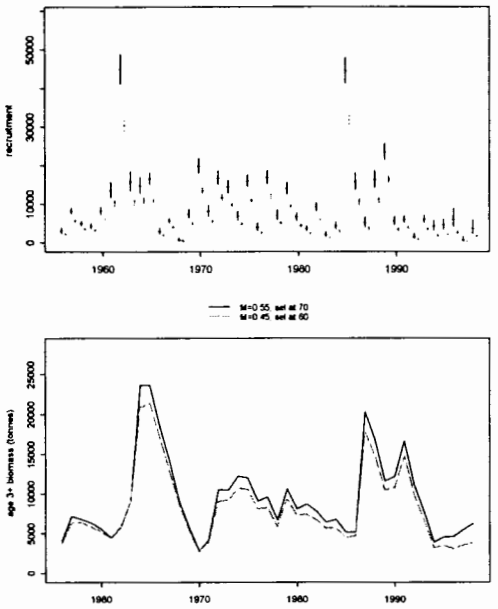


Figure 1. Estimates of the 1956-1998 time series of recruitment and spawning stock biomass from MULTIFAN CL analyses of Hecate Strait Pacific cod assuming either M=0.45 and common fishery selectivity at 60 cm or M=0.55 and common fishery selectivity at 70 cm. The vertical lines on the recruitment figure represent the standard errors of the estimates.

Reviewer's Comments

Reviewer #1

The reviewer complimented the authors on a clearly written and thorough analysis, and noted that they had made significant steps towards rectifying shortcomings identified in last year's assessment. In particular, the reviewer supported the inclusion of data from the Hecate Strait multi-species survey into the model in order to address the high level of uncertainty in the estimates of stock abundance and to identify the causes behind the long-term trends in the abundance of Pacific cod. Second, the inclusion of simulation experiments to assess average levels of catch and spawning stock biomass under different fixed levels of F was considered to be a useful reference for management decisions.

Reviewer #2

The reviewer provided only general comments on the paper and summarized his view of stock status by stating that he did not have a good understanding of stock biomass after reviewing the existing document. The reviewer recommended that in future the authors ignore poor quality data sets and do their analysis using only what they considered to be better quality data sets.

Subcommittee Discussion

Last year, there was considerable uncertainty about recruitment estimates for the stock owing to a recent increase in mesh size used in the commercial fishery. This reduced the catch of smaller recruiting fish. As a result, the indications of future recruitment from commercial catches were lost. This problem was addressed in this year's assessment by the addition of Pacific cod length composition data from the Hecate Strait flatfish surveys. These surveys use small mesh, cover a large portion of Hecate Strait, and contain information on at least 2 age groups not captured in the current commercial fishery. The model estimates of recruitment in this year's assessment had much smaller confidence intervals than those from last year. The Subcommittee considered the addition of this new index to be a large improvement in the assessment.

Several model formulations were considered by the authors and 2 specific runs were retained for catch projections. These had alternative assumptions about natural mortality and the length of maximum selectivity in the fisheries (M = 0.45 and a selectivity at 60 cm, and M = 0.55 and a selectivity at 70 cm). Trends in stock biomass (age 3+) from the 2 runs were very similar. Both indicated that the 1994-96 biomass estimates were close to historic lows and that there was a slight increase in the past 2 years. Recruitment estimates were also low, with the past 9 values being below the long term mean and the longest run of below average recruitment in the time series (1956-1998). Biomass projections therefore indicated that the stock is likely to decline further in the next 2 years. Yield options were presented for a range of fishing mortality from 0.3 – 0.5. Given that biomass declined in all cases considered, the Subcommittee **recommended** that it is prudent to consider lower fishing mortality rates. In addition the Subcommittee felt that it would be informative to see projections of the effect of imposing zero fishing mortality on the analysis. Further, the Subcommittee also noted uncertainties associated with the stability of model estimates and encouraged additional work on aspects of fishery selectivity.

The Subcommittee considers that the use of the Hecate Strait survey results warrants further investigation. This assessment suggests that the survey may provide an index of recruitment for at least 2 age classes not caught in the commercial fishery. The surveys provide 7 years of data on cod recruitment not previously available for the assessment. A continuation of this time series could be of benefit. While having a dedicated cod survey may be the best option, it would take several years before the results could be used in a quantitative manner in the assessment.

Therefore, the Subcommittee **recommended** that additional work on aspects of survey design be completed that may improve the cod estimates while not compromising the main objectives of the survey, (i.e. its use as an index of flatfish abundance). This work should focus on the spatial distribution of Pacific cod catches, the identification of juvenile areas, the possibility of adding more stations and possibly expanding survey coverage. Consultation and dialog with industry on aspects of survey design and the interpretation of results is also **recommended**. The effects of changes in survey design that may affect the consistency of the index need to be carefully considered. It was noted that there was

a large percentage of survey tows that did not catch Pacific cod, and some work on appropriate methods of calculating annual indices in such cases is warranted. Given the relatively short life history of the species, that both recruitment and biomass appear to be very low, and the importance of Pacific cod in the Hecate Strait groundfish fisheries, the Subcommittee encourages further survey work in Hecate Strait. This could be done under the existing Hecate Strait survey or the current observer program. The results should be included in a 1999 assessment.

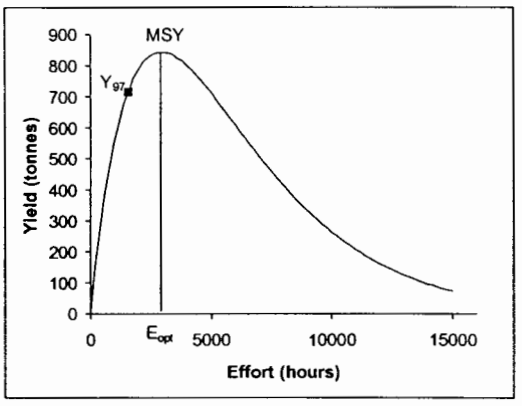
Industry representatives at the meeting expressed the opinion that there has been no change in exploitable biomass in the past year and that recruitment was good. This is based on observations of large schools of cod seen on echo sounders but an inability to catch the fish with current large mesh size. Industry was also concerned that if the assessment relied exclusively on commercial CPUE data that there may be excessive delays in DFO's response to improved recruitment and stock size. The use of research survey to more quickly identify periods of improved recruitment before the animals were large enough to be caught by the commercial fishery and allow their abundance to be assessed by commercial catch data would help address this concern.

Yield options for Hecate Strait Pacific cod range from 600 – 1500 t. The Subcommittee noted that biomass and recruitment are low and that stock biomass is likely to decline for catches in this range. Management may wish to exercise caution in setting catch quotas for 1999 – 2000.

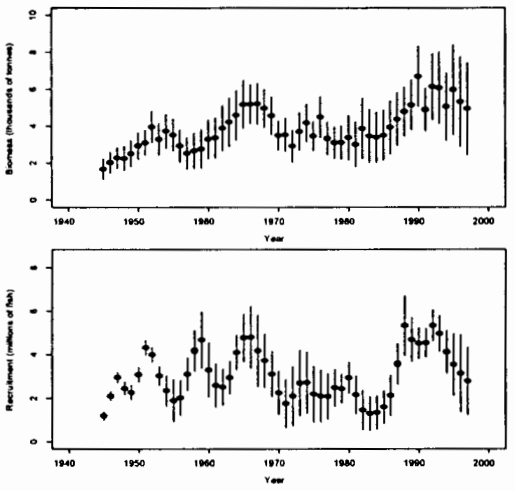
G98-4 Flatfish stock assessments for the west coast of Canada for 1998 and recommended yield options for 1999. J. Fargo

Accepted Subject to Revision

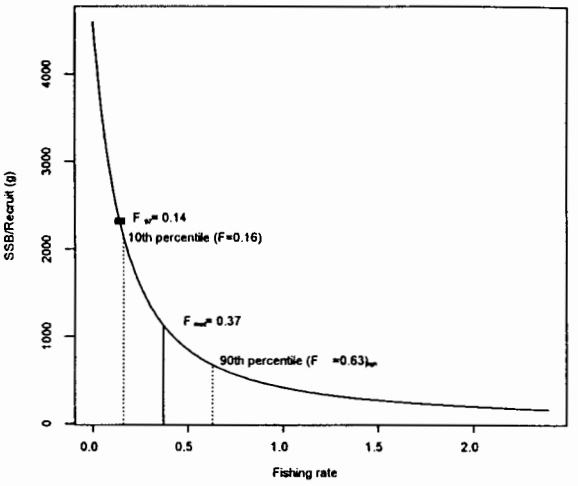
Interim assessments were prepared for the primary stocks of flatfish caught in the B.C. trawl fishery. Yield recommendations for all stocks for 1999 remain unchanged from 1998. There was no new data available for the assessments of Petrale sole, Area 3CD Dover sole or Queen Charlotte Sound Rock sole. Area 5CDE Dover sole were assessed using a dynamic surplus production model. This stock is currently being exploited near the MSY level.



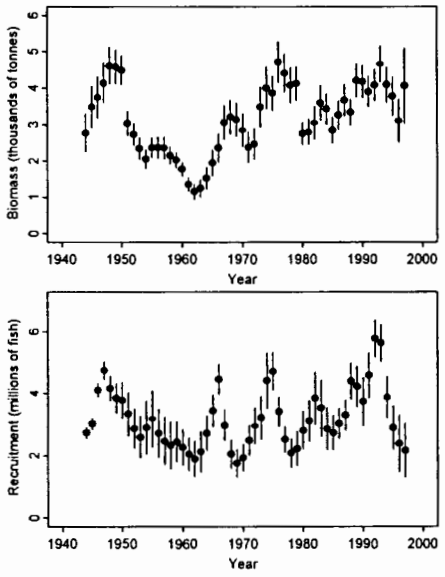
The relationship between yield and fishing effort for Area 5CDE Dover sole. Y_{97} is the yield/effort observation for the 1997 fishery.



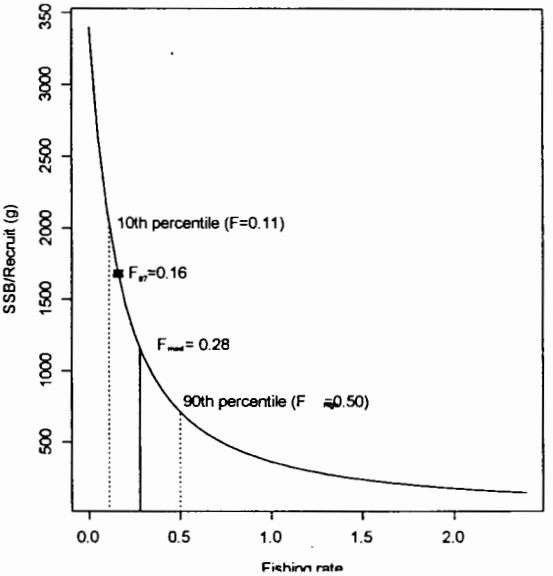
Biomass and recruitment trajectories for Hecate Strait rock sole, 1945-97.



Spawning stock biomass per recruit vs fishing mortality for Hecate Strait Rock sole.



Biomass and recruitment trajectories for Hecate Strait English sole, 1944-97.



Spawning stock biomass per recruit vs fishing mortality for Hecate Strait English sole.

The assessment for Hecate Strait rock sole is based on catch-age analysis updated with data from the 1997 fishery. Rock sole biomass in Areas 5C-D in 1997 was above the long-term average for the last 50 years. However it has been declining over the last four years due to declining recruitment. The estimate of fishing mortality for the stock in 1997, F_{97} =0.14, was below the target fishing reference point F_{low}. The stock has a better than 90% chance of maintaining its spawning stock biomass with fishing mortality at this level.

The assessment for Hecate Strait English sole is based on catch-age analysis updated with data from the 1997 fishery. English sole biomass in Areas 5C-D in 1997 was close to the long term average for the last 50 years. However, recruitment has been declining over the last four years.

The estimate of fishing mortality for the stock in 1997, F_{97}, was 0.16, below the target fishing reference point $F_{0.1}$. The stock has a better than 80% chance of maintaining its spawning stock with fishing mortality at this level.

Reviewers' Comments

Reviewer #1

The reviewer noted that new data on which to base an assessment was very limited and that because of this, the reviewer had little sense after reading the paper of what the status of these stocks truly is. The reviewer noted that the 1997 landings for several species (Rock Sole Area 5A and 5B, for example) appear to be lower than what would have been the low risk yield recommendations. Because CPUE declined at the same time, the reviewer questioned why the current yield recommendations were sustainable. It was also noted that the Subcommittee discussion from last year included a recommendation for a full assessment of Area 5A/B Rock sole which was not done because the age composition data required to complete an assessment are currently being processed.

The reviewer also noted that many of the same concerns identified by last year's reviewer had not been addressed by the authors. For example, justification for the chosen values for the mortality rate, M, and the variance ratio, ρ, were not explained, nor the sensitivity of the model to changes in these parameters. The reviewer also recommended that the various reference points calculated in the paper should be more fully discussed and that the different reference points considered to be sustainable or indicators of overfishing be identified, particularly because the choice of F is probably the most influential factor in determining yields.

Subcommittee Discussion

The Subcommittee accepted the paper subject to modification to address the reviewer's comments, and to allow a clear distinction between uses of research and commercial CPUE described in the paper.

The Subcommittee supports efforts to address the need for survey information for area 5A/5B rock sole and to begin addressing the backlog of ageing data that needed to be processed. In addition, the Subcommittee **recommended** that examination of the effect of changes in gear selectivity on the assessment be addressed in time for next year's analysis and that the ability of the catch-at-age analysis to assess the strength of recruiting year classes be evaluated.

The Subcommittee notes that as this is an interim assessment the yield options for this assessment remain unchanged from 1997. However, in light of declining CPUE noted in the paper and by industry, the Subcommittee **recommended** that managers use caution in selecting the quota for rock sole in 5A/5B.

G98-5 Reconstruction of BC sablefish stocks, 1966–97, and catch projections for 1999, using an integrated catch-age mark-recapture model with area and depth movement. V. Haist, D. Fournier, and M.W. Saunders.

Accepted Subject to Revision

A major assessment was presented for sablefish in this document. The sablefish fishery has been managed under individual vessel quota management (IVQ) since 1990. The fishery has averaged 4,500t annually since 1966, and the catch in 1997 was 4,487t (Figure 2). The assessment was based on an integrated catch-age, mark-recapture model that was stratified by area and depth. The unified approach is a significant improvement over the previous assessment that analyzed catch-at-age and tagging data separately. The model provides a more realistic representation of the complex life history of sablefish. Estimates of available biomass in 1997 range from 43,400 to 51,300t (Figure 3). A recommended yield range of 2,977t-5,052t as developed based on deterministic projections using varying levels of recruitment and target F levels based on the current F ($_{Current}$), $0.8F_{current}$ and $1.2F_{current}$. Under all scenarios with average or below average levels of recruitment the stock is predicted to decline slowly.

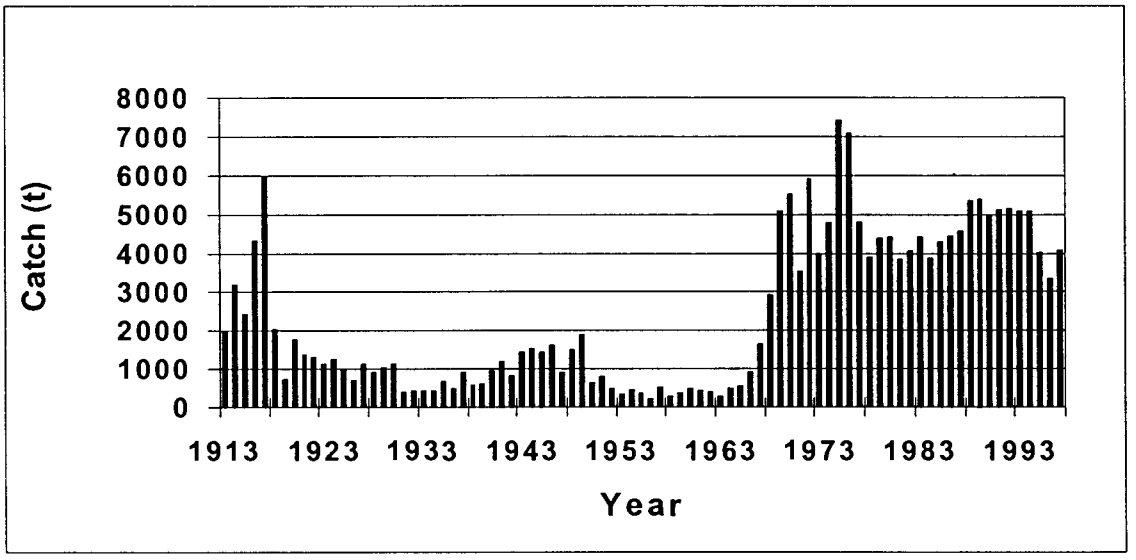


Figure 2. Annual Landings of sablefish 1913-97.

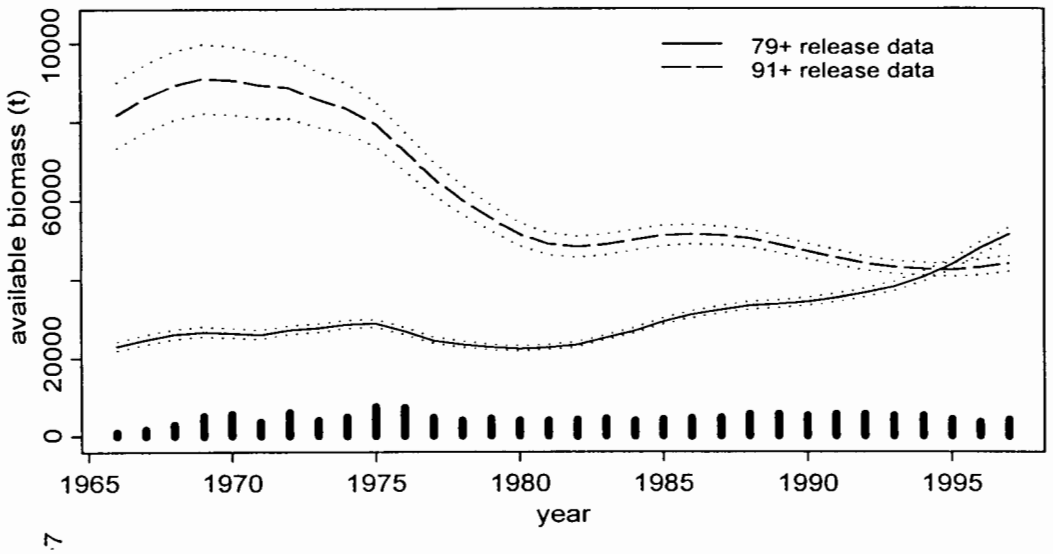


Figure 3. Estimates of available sablefish biomass using two configurations of tagging data. Standard errors of the estimates shown in dotted lines. The B.C. coastwide catch is shown as vertical bars.

Reviewers' Comments

Reviewer #1

The reviewer was complimentary, and stated that the proposed model nicely integrated a complex data set into a single framework from which stock abundance could be estimated by Bayesian methods. The reviewer stated that for technical reasons he did not completely understand the model being used but thought that the difficulties he had found could easily be addressed by fixing a number of typographic errors or adding some explanatory material. As a general point, he noted that the assessment did not clearly distinguish between parameters to be estimated and the input data, and that this distinction needed to be clearly specified. The reviewer also noted that the results include estimates that are sometimes based on comparisons with survey abundance estimates. The model, however, is not stated in a manner that shows how such comparisons would be made.

The reviewer stated that with such a complex model it would be helpful to have some intuitive discussion of the results. In particular, two subsets of data give two remarkably different biomass trajectories in Fig. 9 of the working paper (See Fig. 3 of this document). Narrow and mutually exclusive confidence bands seem to emphasize the difference between these trajectories. Additional ambiguities can be seen in Fig. 10 of the working paper, depending on whether or not index data are included in the analysis. The reviewer concluded by noting that without a clear biological interpretation, the model acts like a black box that could be adjusted to infer either an increasing or decreasing population.

Reviewer #2

The reviewer stated that in his opinion, the reported work did not provide a convincing case that we know what the biomass or potential yield of sablefish are. In the reviewer's opinion, the results of the analyses/model are difficult to judge because there are a number of assumptions and procedures that are not well explained. These included a lack of explanation of how tags were allocated between recovery regions based on partial information, little indication of what "reasonable" properties are for the model, and no supporting evidence that model assumptions are valid, and the strong likelihood in his opinion that the assumption that fish movement is independent of previous movement is likely incorrect. As a general point, the reviewer stated that it was not clear how important these assumptions or procedures were to determining the outcomes from the model.

1. The reviewer noted that a key problem with the analyses is that there are very different outcomes depending on which set of tagging data are used. The reviewer recommended that the earlier tagging data should not be considered to be of the same quality as the later data because it is clear that the early part of these series cannot be well determined using all of the reported tagging data. He recommended that the better data should be used to make the stock size estimates (1991 onwards).
2. In the reviewer's opinion, the downward sloping CPUE index was a sign of stock decline unless there was extenuating circumstances. The reviewer noted that the model should be at least compatible with such a trend, and that only the model based on the later tagging data was.
3. The reviewer suggested that a section be added to the paper describing the use of both the tagging data and the catch and age data for this model. The reviewer felt that the question of whether or not these data were adequate for use in the model was best addressed directly by the authors.

Subcommittee Discussion

The Subcommittee notes that the assessment model is highly complex and that the current document does not adequately detail it's workings. For example, the data sources used as input to the model and the quantities being estimated are not clearly identified and that there was not adequate justification given for some of the technical details used. The authors agree to address these concerns during the revision process.

The Subcommittee notes the large discrepancy between the model results produced by the two sets of tagging data and feels that the authors need to clearly identify the causes of this disparity. Although the authors viewed the discrepancy as being of minor importance, there are a number of issues that lead to a greater confidence in the output than is, as yet, warranted. For example, the authors pointed out that the focus of the model was on describing the current stock reality, and not the reconstruction of historic biomass or future projections. They noted that the older tagging data are not very reliable and that prior to the 1980s, only catch data exist. Therefore, little is known of past biomass. The authors also noted that the unrealistically tight confidence bounds on the biomass trajectories are because no process error is accounted for in the tag return data. However, these results lead to the conclusion that the true level of uncertainty in the

model output is not well-defined by the model as currently formulated, and that some model inputs may be inappropriate for the uses to which they are put.

There is some consensus among Subcommittee members that the current levels of exploitation and biomass described by the model are stable and this is corroborated by the experience of fishermen. Despite these assertions, some Subcommittee members remain concerned that the model may not be capturing key biological information and that this might at least partially explain the disparity between some of the model results. For example, the lack of males detected in the northern area (but not explained by the model) is noted. During the meeting observers from industry suggested that the lack of males in the northern area is likely due to the slower growth of males relative to females and because males are found at shallower depths. They observed that the larger females are selectively targeted in the fishery and that the males are discarded at a higher rate.

During the Subcommittee discussion it was noted that there is some evidence, not presented in the assessment document, that indicates that recruitment has improved in recent years. The available age compositions and larval survey work provide evidence of an above average year class around 1990. Studies of juvenile by-catch in the trawl fishery and anecdotal reports from sablefish fishers indicate that the 1997 year-class may be above average.

Given the agreement by fishermen at the meeting that the discrepancies can be explained by known aspects of the biology of sablefish, plus industry experience that sablefish biomass is currently stable, the Subcommittee **recommended** acceptance of the assessment subject to revisions taking into account reviewer's comments. A yield option of 2,977 tonnes – 5,052 tonnes is recommended.

G98-6 Shelf rockfish stock assessment for 1998 and recommended yield options for 1999. R. Stanley

Accepted Subject to Revision

An interim assessment was presented for shelf rockfish in this document, however, some new information on stock abundance was also provided based on an acoustic survey of the winter aggregation of widow rockfish near Triangle Island. The purpose of the survey was to estimate the abundance of a mid-winter aggregation which trawl fishers had suggested might be large enough to indicate that current yields are too conservative. Survey methodology appears to have been successful in generating robust estimates of biomass on this aggregation. Estimated biomass of the Triangle Island aggregation ranged from 852-2366 t, 88% of which was widow rockfish. Attempts to expand the area coverage could not locate any additional significant aggregations.

Deterministic calculations of the biomass necessary to support a 1,000-3,000 t fishery (the current yield recommendation) given two estimates of widow rockfish natural mortality range from 7,300- 42,900 t. The author argued that because there were no concurrent reports from Industry to indicate the presence of other aggregations on the

coast, the survey provided no basis for raising the current recommended yield range. The previous recommended yield range of 1,000 – 3,000 t is continued for 1999/2000.

Reviewer's Comments

Reviewer #1

Reviewer 1 noted widow rockfish were impossible to survey by net and difficult to survey acoustically because of habitat bathymetry. The reviewer concluded that the application of acoustic techniques was good, but pointed out several general problems. These problems include difficulty in interpretation of the acoustic signal due to the speed of the survey, acoustic detectability of the fish with regard to the bottom, and the variability attributable to biology, light cycle, tidal cycle, and other factors. The reviewer suggested attempting to quantify the systematic variability of the data and highlighted the possibility of sub-sampling the unusually intense survey data to explore sampling alternatives. In view of the bias in acoustic measurements, he concluded that the estimates from the survey are likely to underestimate the true biomass.

Reviewer #2

The reviewer stated that in his view the 10 years of age data now available for widow rockfish should provide a sufficient place to begin stock assessment modelling despite the short history of reliable data and that the age data alone may be sufficient to evaluate biomass, or minimally, variability in year-class strength. The reviewer also noted that reported landings of widow rockfish have fallen abruptly in the last two years such that landings in 1997 are half the landings in 1995. Substantive declines in landing began first in statistical area 5B (1991), then 3D (1992) and more recently in 5A (1995). Although treated as one coast-wide stock, the sequential decline in landings from different statistical area creates at least the appearance of local depletion of this resource.

The reviewer further noted in this context that overall yield recommendations are based on a policy choice that can be characterized as "best guess". Consequently, the biomass estimate from Triangle Island could not be put into a context relative to the total coast-wide biomass. In his view, the absence of a coast-wide biomass estimate in combination with a harvest policy based on historical catch and a declining trend in recent landings made the maintenance of the current yield recommendations seem overly optimistic.

Subcommittee Discussion

The Subcommittee accepted this interim assessment and noted that the 1998 yield recommendations for shelf rockfishes are therefore also adopted for 1999.

During the Subcommittee discussion, the quality of the acoustic measurements made by the author was thought to be good, with little signal loss due to adsorption in very dense schools. The problem of bottom separation was also discussed. The author suggested that it would be possible to resolve the issue for widow rockfish using a submersible or

drop-camera to directly observe off-bottom behaviour. It was pointed out that landings of widow rockfish are highly variable and do not reflect abundance; the reduction in landings in 1997/98 were in part due to poor winter weather and due to the delayed fishing resulting from the implementation of IVQs. Management restrictions such as trip limits affected landings in the early 1990s. Discussion on the viability of swept-area surveys for shelf rockfishes ensued; it was concluded that shelf species were not amenable to swept-area surveys. However, the author did comment that yellowtail rockfish might also be candidates for acoustic surveys.

G98-7 Inshore rockfish stock assessment for the west coast of Canada in 1998 and recommendations for 1999/2000. A.R. Kronlund, K.L. Yamanaka, and G.D. Workman

Accepted Subject to Revision

This document contains an interim update on the status of inshore rockfishes, with updated time series of commercial catch and effort in the directed fishery, and bycatch in other fisheries. Recreational landings were updated where data were available, and ongoing work to collate and archive inshore rockfish data was described. The status of research projects undertaken in collaboration with industry was also reported.

No new data or analyses sufficient to identify sustainable harvest targets for inshore rockfishes were presented. Because harvest targets were not identified or estimated, there is no basis for quantifying risk or for providing yield options. The ability to assess stock status for inshore rockfishes on a coastwide basis is poor, and is likely to remain so pending cost-effective solutions to the problem of abundance estimation. In spite of the inability to estimate sustainable harvest targets, the authors' opinion is that inshore rockfishes are at best fully utilized, and likely over-utilized in the Strait of Georgia and locally elsewhere. This conclusion is based on the implications of rockfish life history on harvest potential, declining catch per unit effort indices for the lower Strait of Georgia management region, and anecdotal information provided by fishers. Reasons for this situation were reviewed, and recommendations provided for inshore rockfishes subject to constraints on assessment capabilities.

The authors propose that the Groundfish Management Unit, Recreational Fish Division, Aboriginal Fish Division, and Stock Assessment Division develop integrated plans for the assessment and management of inshore rockfishes. Precautionary strategies, independent of biomass estimation, were advocated (e.g. area closures). The authors' stressed that all sectors should be consulted to identify geographic areas with conservation concerns and to evaluate management options (e.g. area closures, seasonal closures, reduced daily bag limits, catch caps, and allocations).

The authors also recommended continuing the development of alternative methods for the estimation of rockfish abundance. Thus research on habitat classification in conjunction with rockfish composition and density was viewed as having application in both the assessment and evaluation of area closures. Completion of the analyses using

research charter data collected from areas with contrasting exploitation histories may lead to the evaluation of reference points for exploited rockfish populations.

Reviewers' Comments

Reviewer #1

The reviewer stated that he found the summary information on data sources and current assessment work extremely useful. He also agreed with the authors that there are fundamental problems underlying assessments for this group of fishes and that providing "traditional" harvest based assessments on a "reef" or "reef-group" basis was virtually impossible given current resources. He supported the co-operative research approaches being developed, as in his view they may provide the basics for alternative assessment and management programs.

The reviewer supported the authors' view that despite an inability to estimate sustainable harvest targets inshore rockfishes are at best fully utilised and likely "overutilised" in some areas. He supported the recommendation that the coast wide total be reduced, but felt that it was incumbent on the authors to provide some guidance on what the level of reduction should be.

Subcommittee Discussion

The paper was accepted.

The Subcommittee supported the authors' view that traditional stock assessment procedures requiring an abundance estimate are inappropriate for inshore rockfish. Approaches that do not require biomass estimation (i.e. area closures) need to be developed. The Subcommittee noted that there are signs of overexploitation in the fishery and that there needs to be a measurable reduction in harvests. Action taken to reduce harvests should consider all fisheries that harvest rockfish. The Subcommittee noted that very limited information on landings is currently available for sport and aboriginal fisheries.

The Subcommittee also noted that the impact of overfishing rockfish can be very long-term. The combination of rockfish life history characteristics and the fact that much of the landings of inshore rockfish result from bycatches, and thus are difficult to reduce when required. This implies that once stocks are depleted recovery time can be prolonged.

G98-8 Slope Rockfish. J. Schnute, N. Olsen and R. Haigh

Accepted Subject to Revision

For assessment purposes, slope rockfish include seven species: Pacific ocean perch, yellowmouth rockfish, redstripe rockfish, rougheye rockfish, shortspine/longspine thornyheads, and shortraker rockfish. These are managed within six major areas (3C, 3D, 5AB, 5CD, 5ES, 5EN), giving a total of 42 species-area combinations. Historically, these

42 assessment units have been managed with reference to a benchmark stock of Pacific ocean perch in Area 5AB. A catch-at-age analysis of this stock occupied a central role in the assessment. This assessment differed from past reports in three principal respects:

1. A new trawl observer database was used to examine abundance ratios among species and areas.
2. Information gathered from experienced members of the industry was used in the stock assessment, and some of their concerns included in the analysis.
3. No new data are available to alter substantially the 1997 analysis, so a new catch-at-age analysis of the benchmark stock was not conducted in this interim analysis. The 1998 yield options were therefore extended to 1999 (Table 2).

The new database was found to offer significant information about the trawl fishery in each of the 42 assessment units. Major conclusions from the analysis include the following:

1. As stated by industry members, CPUE varies substantially with depth. Spatial stratification can be used to qualify tows by depth in each assessment unit. (Fig. 4).
2. Commercial slope rockfish tows that occur in similar times and places as research survey tows give similar profiles of CPUE in relation to depth, as least according to limited data currently available.
3. Analysis of heavily fished blocks shows little evidence of localised stock depletion, except possibly for the thornyhead species.
4. Industry abundance estimates conform more closely to recent yield and quota recommendations than to various indices computed here, based on effort qualification and spatial stratification.

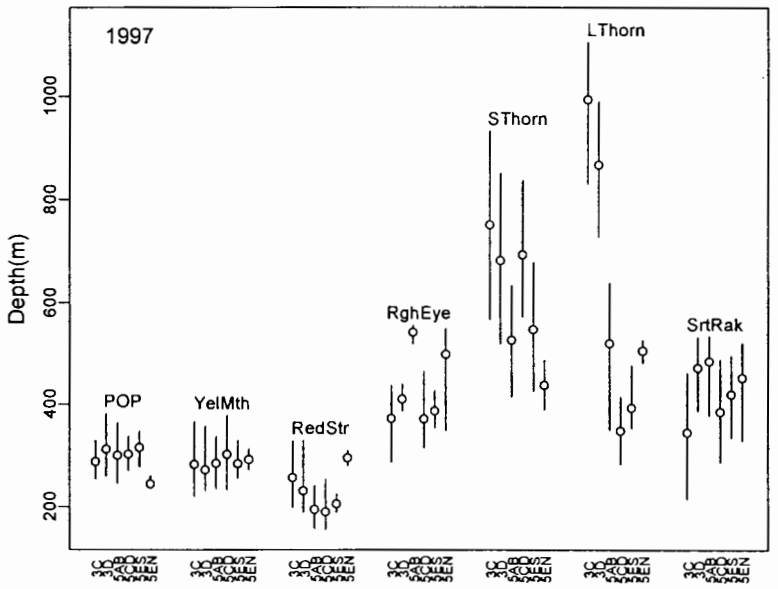


Figure 4. Depth ranges (25% to 75% quantiles) with the 50% quantile point for each assessment unit (species-area combination), based on 1997 observer data.

Reviewers' Comments

Reviewer #1

The reviewer commented that the data description and preliminary analysis of the 1996-98 observer database provides a useful first step in tackling this extensive new source of information. It was noted that the analysis focused mainly on species distribution (location and depth) and that the work is presumably moving toward developing an index of stock size and trends in abundance. As a general point, the reviewer recommended that some theoretical background on the use of fine scale catch and effort data for these purposes would be useful, as it was unclear from the existing document what the main points of the analyses were.

The reviewer raises a number of questions which would be useful to address in revisions to the paper. The reviewer noted that interviews with fishermen were designed to gather information on relative abundance of the species among areas (within species), and that the qualitative evaluations of relative abundance agreed best with the existing quotas and catches. It would be useful to have some comments on how the quotas were set originally. Were they based on independent estimates of stock abundance or on fishermen's opinions? Alternatively, do existing quotas influence the fishermen's opinions? The reviewer also noted that it was interesting that allocation of fishing effort among areas was also in close agreement with opinions of relative abundance. This suggests that trends in qualified fishing effort may be a more useful index of stock size than catch rates. Is it possible to use the interview results to rank species in relative abundance (inter species comparisons)?

The reviewer noted that there was very little analysis of stock status or trends in this paper, because it was an interim assessment directed mainly at exploratory analysis of the observer data. The only trend analysis concentrated on a low number of small blocks (1' latitude x 2' longitude) for each species which did not provide any new information on stock status and, consequently, recommended 1999 catches. The reviewer further recommended that it would be useful to summarize comparisons of two different surveys that were mentioned in the paper and to compare their tow-by-tow results to commercial CPUE for future reference.

The reviewer spent considerable time at the meeting discussing the broader scale problems with slope rockfish assessments. It was noted that a qualitative examination of the catch rate trends over the past 10-20 years for Pacific ocean perch, yellowmouth rockfish, redstripe rockfish, and rougheye rockfish all indicate a downward trend. The Pacific ocean perch and yellowmouth rockfish quotas are the largest ever. And, of seven species, 5 of the quotas were not fully taken in 1998 with shortfalls of 10% – 15%. In the reviewer's opinion, new management measures such as individual vessel quotas might

influence catch rates and thus limit their utility as stock size indicators in the short term, but were unlikely to explain the longer term downward trends. This raises the question of whether or not all of the slope rockfish species might be in a state of decline, and whether existing management measures have been put in place to reverse the trend.

Reviewer #2

The reviewer was complimentary, and noted that the slope rockfish assessment and management process has been plagued by a lack of data. Historically, the quotas for 7 stocks in 6 areas have been set based only upon the Pacific Ocean Perch assessment, using catch histories in areas to adjust quotas for other species and other areas. In the reviewer's opinion, a revised management process using new data is called for, and the current paper provides a very interesting approach to using both fishermen's experience and the observer data to remedy this problem and to provide an ongoing monitoring program.

In the reviewer's opinion, the thrust of the paper is the desire to use either fishermen's opinion and/or observer data to provide an estimate of abundance for each species and regulatory area, and then use these estimates of abundance to set quotas.

The reviewer suggested two revised methods might be considered, the first of which would calculate relative quotas for different stocks in each area by calculating appropriate yields after taking into account the amount of available habitat, as indicated by the observer database or fishermen's opinion. This method would proceed as follows:

1. Establish area 5AB (Goose Island Gully) as a reference site. By taking the ratio of CPUE in area 5AB to the other areas would provide an estimated mean density relative to the density in 5AB.
2. Next multiply by the relative habitat area of the two management areas. This would then provide an estimate of the relative abundance.
3. Now multiply times the absolute abundance estimate in area 5AB.
4. Then multiply the estimated abundance times the reference harvest rate ... perhaps 5%. This would then provide a quota for other areas.

The reviewer noted that these calculations could be made from the existing document if the habitat area of each management area were calculated, and could be done quickly. He recommended that the estimates should be presented to the PSARC final review for the different indices computed in the existing table 4.4.1

The reviewer also identified a second approach:

1. Calculate the average catch per area swept from the observer data
2. Determine an estimate of the gear efficiency (q) by estimating (a) the vertical availability of the species, (b) the efficiency of the net in terms of herding, escape under and around the net, and out-swimming of the net by fish, (c) the relative

abundance in trawlable and untrawlable ground and (d) the abundance of the species of interest outside the survey area.
3. Calculate the total abundance of the species in an area by A=(area*density)/q
4. Multiply total abundance times a reference point as in step 4 above.

The reviewer commented that both of these methods can be followed, but that it is important to note that they both abandon any attempt to use the tradition time series modelling approaches of biomass dynamics models, VPA or statistical catch at age models. It would be possible to stop with the total stock biomass estimates (step 3 of the 1st and 2nd methods), and plug these into traditional models.

The reviewer noted that it would be very useful if we could treat the observer data as if it were research survey data. Figure 4.2.10 in the existing document suggests that this might be possible as there is a close correspondence between the cpue at depth between survey data and observer data. However, the reviewer also presented a preliminary analysis (see Figure 5, below) plotting the average CPUE vs depth for the two methods that suggest this correspondence may not particularly good.

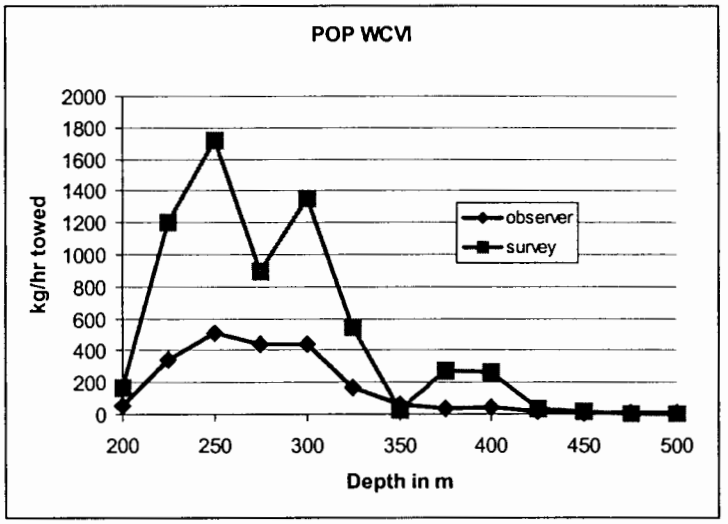


Figure 5. The graph shows the WCVI survey CPUE using only observer data taken within the same time frame as the research survey.

The reviewer noted that although in the assessment document it looked as if the observer data and the survey data were reasonably similar, the graph was deceptive because the data was plotted on a logarithmic scale, so that the weight of the high survey points are visually underestimated, while the zero catches were not plotted, which reduces the average. The reviewer concluded that this graph suggests that the survey CPUE is considerably higher than the observer, and that the fishermen are somehow avoiding Pacific ocean perch, even in the appropriate depth strata for this species. He recommended that this discrepancy needed further exploration.

The reviewer suggested that the following further steps be considered for future research.

1. Obtain the amount of area by depth in each management area.
2. Estimate spawning biomass per recruit reference points for each species
3. Further explore the relationship between observed CPUE and survey CPUE.
4. Continue discussion with fishermen about fishing behaviour and targeting to understand the types of differences seen in the graph above.
5. Initiate a program to estimate the gear efficiency (q) of both the survey and commercial gear – including vertical efficiency and relative densities in trawlable and untrawlable ground.
6. Design and evaluate an industry based survey system – that is having commercial vessels do some scientifically designed tows as part of normal fishing operations that would allow them to keep everything caught and not count as part of their IVQ. The data suggest such tows should be as or more profitable than their commercial operations and thus there should be, in effect, no cost to this type of survey.

The current management system tries to manage each stock at or near its biological optimum. There may be large economic costs to this approach. Alternative management strategies should be explored that would maximize economic value rather than try to maximize biological yield.

Subcommittee Discussion

The paper was accepted, and the Subcommittee noted that this interim assessment provides no basis for any changes to current yield recommendation for slope rockfish. The Subcommittee notes that this work was done jointly with industry and encourages continuation of this collaboration.

The Subcommittee **supported** the suggestions of Reviewer 2 for further work, particularly the development and evaluation of an industry based survey system. The Subcommittee also noted the need for a program to estimate gear efficiency (q) of both the survey and commercial gear and consider including available habitat as an additional parameter in estimating biomass.

The Subcommittee highlighted the fact that there is some evidence for a decline in longspine thornyhead abundance. Given the longevity of this species, plus preliminary evidence for localized depletion and the fact that the current quota exceeds the recommended the yield level, some restrictions on catch may be appropriate now as a precautionary measure. The Subcommittee encourages continued dialogue and collaboration with industry, researchers and managers in developing useful, credible assessments.

Table 1. Summary of recommended yield options for 1996 and 1997, and the new yield options presented for 1998. Yield recommendations are held constant between major assessments; for this reason most of the recommendations for 1999 are the same as those for 1998, except for sablefish and Area 3C/D Pacific cod.

AREA	SPECIES	1996 YIELD OPTIONS	1997 YIELD OPTIONS	1998 YIELD OPTIONS	1999 YIELD OPTIONS
4B	Lingcod	Zero yield (no options proposed)	Zero yield (no options proposed)	Zero yield (no options proposed)	Zero yield (no options proposed)
3C	Lingcod	Low risk yield 1400 t High risk yield 2800 t	Low risk yield 1400 t High risk yield 2800 t	950 t	950 t
3D	Lingcod	Low risk yield 400 t High risk yield 800 t	Low risk yield 400 t High risk yield 800 t	Low risk yield 400 t High risk yield 800 t	Low risk yield 400 t High risk yield 800 t
5A/B	Lingcod	Low risk yield 1100 t High risk yield 2200 t	Low risk yield 1100 t High risk yield 2200 t	Low risk yield 1100 t High risk yield 2200 t	Low risk yield 1100 t High risk yield 2200 t
5C/D	Lingcod	Low risk yield 1000 t	Low risk yield 1000 t	Low risk yield 1000 t	Low risk yield 1000 t
4B	Pacific cod	No options proposed	No options proposed	No options proposed	No options proposed
3C/D	Pacific cod	Low risk yield no fishery Sustainable yield 694 t High risk yield 916 t	Low risk yield no fishery Sustainable yield 694 t High risk yield 916 t	Low risk yield no fishery Sustainable yield 694 t High risk yield 916 t	No Recommendation See Additional Subcommittee Discussion
5A/B	Pacific cod	No options proposed	No options	No change	No change
5C/D	Pacific cod	No fishery	No directed fishery	No change	600-1,500 t
5E	Pacific cod	No options proposed	No options proposed	No change	No change
Coastwide	Petrale sole	No options proposed	No options proposed	No change	No change
4B	Flatfish	No options proposed	300 t	300 t	300 t
3C/D	Dover sole	Low risk yield 1300 t High risk yield 2000 t	Low risk yield 1000 t High risk yield 1500 t	Low risk yield 1000 t High risk yield 1500 t	Low risk yield 1000 t High risk yield 1500 t

AREA	SPECIES	1996 YIELD OPTIONS	1997 YIELD OPTIONS	1998 YIELD OPTIONS	1999 YIELD OPTIONS
5A	Rock sole	Low risk yield 250 t High risk yield 500 t	Low risk yield 250 t High risk yield 500 t	Low risk yield 250 t High risk yield 500 t	Low risk yield 250 t High risk yield 500 t
5B	Rock sole	Low risk yield 250 t High risk yield 600 t	Low risk yield 250 t High risk yield 700 t	Low risk yield 250 t High risk yield 700 t	Low risk yield 250 t High risk yield 700 t
5C/D	Rock sole	Low risk yield 1200 t (350 t revised 1996) High risk yield 1850 t (700 t revised 1996)	Low risk yield 800 t High risk yield 1100 t	Low risk yield 800 t High risk yield 1100 t	Low risk yield 800 t High risk yield 1100 t
5C/D	English sole	Low risk yield 800 t (300 t revised 1996) High risk yield 1300 t (500 t revised 1996)	Low risk yield 500 t High risk yield 600 t	Low risk yield 500 t High risk yield 600 t	Low risk yield 500 t High risk yield 600 t
5C-5E	Dover sole	Low risk yield 800 t High risk yield 1200 t	Low risk yield 800 t High risk yield 1200 t	Low risk yield 800 t High risk yield 1200 t	Low risk yield 800 t High risk yield 1200 t
Coastwide	Sablefish	Low risk yield 690 t High risk yield 2580 t	Yield Range: 3,100 - 4,600 t	Yield Range: 3,457 - 4,777 t	Yield Range: 2,977 - 5,052 t
South Stock North Stock	Sablefish	Low risk yield 275 t High risk yield 1000 t Low risk yield 465 t High risk yield 1580 t	Yield Range: S: 1,700 - 2,500 t N: 1,400 - 2,100 t	Yield Range: S: 2,307 - 3,185 t N: 1,150 - 1,592 t	Yield Range: No Recommendation on geographic split
4B, except MSA 19, 20	Pacific hake	Low risk yield 8000 t High risk yield 14000 t	Low risk yield 10300 t High risk yield 20100 t	Low risk yield 7,554 t High risk yield 14,687t	Low risk yield 7,554 t High risk yield 14,687t

AREA	SPECIES	1996 YIELD OPTIONS	1997 YIELD OPTIONS	1998 YIELD OPTIONS	1999 YIELD OPTIONS
Coastwide (including U.S. waters)	Spiny dogfish	Low risk yield 9000 t High risk yield 15000 t	Low risk yield 9000 t High risk yield 15000 t	Low risk yield 9000 t High risk yield 15000 t	Low risk yield 9000 t High risk yield 15000 t
4B (Strait of Georgia)	Spiny dogfish	Low risk yield 4000 t High risk yield 6000 t	Low risk yield 4000 t High risk yield 6000 t	Low risk yield 4000 t High risk yield 6000 t	Low risk yield 4000 t High risk yield 6000 t
4B	Walleye pollock	Low risk yield 630 t High risk yield 2350 t	Low risk yield 470 t High risk yield 1760 t	Low risk yield 470 t High risk yield 1760 t	Low risk yield 470 t High risk yield 1760 t
5C/D	Walleye pollock	Low risk yield 440 t High risk yield 1760 t	Low risk yield 330 t High risk yield 1320 t	Low risk yield 330 t High risk yield 1320 t	Low risk yield 330 t High risk yield 1320 t
Area 12	Walleye pollock	Low risk yield 1000 t High risk yield 2450 t	Low risk yield 1000 t High risk yield 2580 t	Low risk yield 1000 t High risk yield 2580 t	Low risk yield 1000 t High risk yield 2580 t
Coastwide (Area 3C to 5E)	Pacific ocean perch	Low risk yield 3400 t High risk yield 5700 t	Low risk yield 4060 t High risk yield 7210 t	Low risk yield 3330 t High risk yield 7030 t	Low risk yield 3330 t High risk yield 7030 t
5A/B	Pacific ocean perch	Low risk yield 350 t High risk yield 1800 t	Low risk yield 1760 t High risk yield 2340 t	Low risk yield 1200 t High risk yield 2400 t	Low risk yield 1200 t High risk yield 2400 t
5C/D	Pacific ocean perch	Low risk yield 1500 t High risk yield 3400 t	Low risk yield 1500 t High risk yield 3400 t	Low risk yield 1500 t High risk yield 3400 t	Low risk yield 1500 t High risk yield 3400 t
Coastwide (Area 3C to 5E)	Redstripe rockfish	Low risk yield 950 t High risk yield 2570 t	Low risk yield 490 t High risk yield 870 t	Low risk yield 910 t High risk yield 1810 t	Low risk yield 910 t High risk yield 1810 t
Coastwide (Area 3C to 5E)	Yellowmouth rockfish	Low risk yield 1100 t High risk yield 1850 t	Low risk yield 1540 t High risk yield 2740 t	Low risk yield 1380 t High risk yield 2870 t	Low risk yield 1380 t High risk yield 2870 t
Coastwide (Area 3C to 5E)	Rougheye rockfish	Low risk yield 500 t High risk yield 900 t	Low risk yield 500 t High risk yield 900 t	Low risk yield 520 t High risk yield 950 t	Low risk yield 520 t High risk yield 950 t

AREA	SPECIES	1996 YIELD OPTIONS	1997 YIELD OPTIONS	1998 YIELD OPTIONS	1999 YIELD OPTIONS
Area 3C to 5E	Shortraker rockfish	Average of 1993 and 1994 catches	Low risk yield 100 t High risk yield 180 t	Low risk yield 110 t High risk yield 200 t*	Low risk yield 110 t High risk yield 200 t
Area 3C to 5E	Shortspine thornyhead rockfish	Average of 1993 and 1994 catches	Low risk yield 490 t High risk yield 870 t	Low risk yield 490 t High risk yield 870 t*	Low risk yield 490 t High risk yield 850 t
Area 3C to 5E	Longspine Thornyhead rockfish	Average of 1993 and 1994 catches	Low risk yield 250 t High risk yield 440 t	Low risk yield 245 t* High risk yield 425 t*	Low risk yield 245 t High risk yield 425 t
3B-3C (Combined U.S. and Canadian quota)	Yellowtail rockfish	Low risk yield 1000 t High risk yield 2000 t	Low risk yield 500 t High risk yield 2000 t	Low risk yield 1100 t High risk yield 2400 t	Low risk yield 1100 t High risk yield 2400 t
3D-5E	Yellowtail rockfish	Low risk yield 2750 t High risk yield 5100 t	Low risk yield 2750 t High risk yield 5100 t	Low risk yield 2000 t High risk yield 4025 t	Low risk yield 2000 t High risk yield 4025 t
Coastwide	Widow rockfish	Low risk yield 1100 t High risk yield 3000 t	Low risk yield 1100 t High risk yield 3000 t	Low risk yield 1100 t High risk yield 3000 t	Low risk yield 1100 t High risk yield 3000 t
3C/D	Silvergray rockfish	Low risk yield 150 t High risk yield 425 t	Low risk yield 150 t High risk yield 425 t	Low risk yield 150 t High risk yield 425 t	Low risk yield 150 t High risk yield 425 t
5A/B	Silvergray rockfish	Low risk yield 350 t High risk yield 700 t	Low risk yield 350 t High risk yield 700 t	Low risk yield 350 t High risk yield 700 t	Low risk yield 350 t High risk yield 700 t
5C/D	Silvergray rockfish	Low risk yield 125 t High risk yield 400 t	Low risk yield 125 t High risk yield 400 t	Low risk yield 125 t High risk yield 400 t	Low risk yield 125 t High risk yield 400 t
5E	Silvergray rockfish	No options proposed	Low risk yield 175 t High risk yield 300 t	Low risk yield 175 t High risk yield 300 t	Low risk yield 175 t High risk yield 300 t

* *There were several small errors in the recommended yield options listed in the 1997 PSARC Groundfish Report last year. High risk yield options for Shortraker rockfish and Shortspine Thornyhead rockfish were incorrectly listed in the 1997 PSARC report as 120 t and 850 t, respectively. Low and High risk yield options for Shortspine Thornyhead rockfish were incorrectly listed in the 1997 PSARC report as 250 t and 425 t. The numbers presented in this table for the 1998 Yield Option have been corrected to reflect the original assessment advice.*

AREA	SPECIES	1996 YIELD OPTIONS	1997 YIELD OPTIONS	1998 YIELD OPTIONS	1999 YIELD OPTIONS
3C/D	Canary rockfish	Low risk yield 350 t High risk yield 525 t	Low risk yield 350 t High risk yield 525 t	Low risk yield 350 t High risk yield 525 t	Low risk yield 350 t High risk yield 525 t
5A/B	Canary rockfish	Low risk yield 200 t High risk yield 400 t	Low risk yield 200 t High risk yield 400 t	Low risk yield 200 t High risk yield 400 t	Low risk yield 200 t High risk yield 400 t

Table 2. Recommended slope rockfish yield options for 1997, 1998, and 1999, based on the methodology described in last year's PSARC Document G97-8. The yield recommendation is held constant between major assessments; for this reason the recommendation for 1999 is the same as that for 1998.

Area	Species	1997 Yield Options		1998 & 99 Yield Options	
Coastwide (3C-5E)	Pacific ocean perch	4060 -	7210	3330 -	7030
3C		250 -	500	80 -	110
3D		100 -	300	100 -	300
5AB		1760 -	2340	1200 -	2400
5CD		1500 -	3400	1500 -	3400
5ES		300 -	500	170 -	300
5EN		150 -	170	280 -	520
Coastwide (3C-5E)	Redstripe rockfish	1020 -	1800	910 -	1810
3C				120 -	190
3D				70 -	150
5AB				370 -	790
5CD				190 -	400
5ES				140 -	200
5EN				20 -	80
Coastwide (3C-5E)	Yellowmouth rockfish	1540 -	2740	1380 -	2870
3C				130 -	260
3D				190 -	390
5AB				460 -	980
5CD				390 -	830
5ES				100 -	210
5EN				110 -	200
Coastwide (3C-5E)	Rougheye rockfish	500 -	900	520 -	950
3C				70 -	130
3D				40 -	70
5AB				60 -	110
5CD				90 -	160
5ES				210 -	380
5EN				50 -	100
Coastwide (3C-5E)	Shortraker rockfish	100 -	180	110 -	200
3C				20 -	40
3D				20 -	40
5AB				10 -	20
5CD				30 -	50
5ES				20 -	30
5EN				10 -	20

Table 2. (Cont'd)

Coastwide (3C-5E)	Shortspine thornyhead	490 -	870	490 -	850
3C				310 -	540
3D				80 -	140
5AB				20 -	30
5CD				50 -	90
5ES				10 -	20
5EN				20 -	30
Coastwide (3C-5E)	Longspine thornyhead	250 -	440	250 -	440

Appendix 1 Participants at the Groundfish Subcommittee Meeting held 23-26 November 1998 at the Pacific Biological Station, Nanaimo, B.C.

Subcommittee Chair: David Welch
PSARC Chair: Max Stocker

DFO Participants	Mon	Tues	Wed	Thurs
* Subcommittee Members				
R.Beamish*				
P. Eveson	✓	✓		
J. Fargo*	✓	✓	✓	✓
M. Joyce*	✓	✓	✓	✓
R. Kronlund*	✓	✓	✓	✓
D. Trager*	✓		✓	✓
S. McFarlane*	✓	✓	✓	✓
N Olsen*	✓	✓	✓	✓
R. Kadowaki	✓p.m.		✓ a.m.	
M. Saunders*	✓			
R. Stanley*	✓	✓	✓	✓
J. Schnute *	✓	✓	✓	✓
L. Yamanaka*	✓	✓	✓	✓
B. Ackerman*	✓	✓	✓	✓
K. Rutherford	✓	✓	✓	✓
A. Sinclair*	✓	✓	✓	✓
K. Cooke	✓p.m	✓		
R. Kieser	✓p.m	✓		
R. Haigh		✓		
G. Workman		✓		
M. Cornthwaite	✓	✓	✓	
T. Gjernes*		✓	✓	
N. Venables*		✓	✓	
S. Morin	✓		✓	
S. Hardy*		✓	✓	

External Participants:

B. Fraumani			✓	
G. Rose	✓	✓	✓	
D. March	✓	✓		
B. Turris	✓	✓	✓	
B. Mose	✓	✓	✓	
B. Dickens	✓	✓	✓	✓
J. Koolman	✓	✓	✓	
B. Humphreys	✓	✓	✓	
R. Hilborn		✓	✓	
V. Haist			✓	
B. Atkinson			✓	

8. Appendix 2. List of reviewers of working papers presented at the Groundfish Subcommittee Meeting 23-26 November 1998

No.	Title	Authors	Reviewers
G98-1	Review of hydroacoustic methodology and Pacific hake biomass estimates for the Strait of Georgia, 1981 to 1998.	Kieser, R., M.W. Saunders, and K. Cooke.	G. Rose D. Chen
G98-2	Pacific Hake - Strait of Georgia stock assessments for 1998 and recommended yield options for 1999.	Saunders, M.W., and G.A. McFarlane.	R. Methot
G98-3	Hecate Strait Pacific cod stock assessment for 1998 and recommended yield options for 1999.	Haist, V., and D. Fournier	N.Olsen G. Rose
G98-4	Flatfish stock assessments for the west coast of Canada for 1998 and recommended yield options for 1999.	Fargo, J.	P. Eveson
G98-5	Reconstruction of BC sablefish stocks, 1966–97, and catch projections for 1999 using an integrated catch-age mark-recapture model with area and depth movement.	Haist, V., D. Fournier, and M.W. Saunders.	J. Schnute, G. Rose
G98-6	Shelf rockfish stock assessment for 1998 and recommended yield options for 1999.	Stanley, R.	G. Rose J. Tagart
G98-7	Inshore rockfish stock assessment for the west coast of Canada in 1998 and recommendations for 1999/2000.	Kronlund, A.R., K.L. Yamanaka, and G.D. Workman	G. Rose S. McFarlane
G98-8	Slope rockfish	Schnute, J., N. Olsen, and R. Haigh.	A. Sinclair R. Hilborn