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Report of the PSARC Groundfish Subcommittee Meeting, November 22-25, 1999

M. Stocker and A. Sinclair (Editors)
Pacific Scientific Advice Review Committee (PSARC)
Pacific Biological Station
Nanaimo, British Columbia V9R 5K6

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PACIFIC SCIENTIFIC ADVICE REVIEW COMMITTEE

PSARC ADVISORY DOCUMENT 99-9
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GROUNDFISH

SUMMARY

Working Paper G99-2: Slope rockfish assessment for the west coast of Canada in 1999

This paper described recent work on developing depth stratified swept area estimates of slope rockfish abundance from commercial and survey data. Methods for estimating fishing reference points were also discussed. This is work in progress and no yield options were recommended. However, continued signs of possible depletion of longspine thornyheads was noted and a recommendation was made regarding additional research for this species.

Working Paper G99-3: Flatfish stock assessment for the West Coast of Canada for 1999 and recommended yield options for 2000

New data on these stocks was presented in an interim assessment. This new information was used in the previously accepted assessment model. No change in yield options was advised.

Working Paper G99-4: Canary rockfish assessment for 1999 and recommended yield options for 2000/01

A major assessment of this species was presented. New yield options were proposed based on average catch levels, observed trends in age composition, catch curve analysis, CPUE trends, and comments from fishers.

Working Paper G99-5: Pacific Cod off BC: Update 99

An analysis of the Hecate Strait groundfish assemblage survey results for this species was presented and comparisons were made with commercial fishing data from the same area. The analysis outlined elements for consideration for developing a new abundance index for this stock. No yield options were proposed.

Working Paper G99-6: Sablefish stock assessment for 1999 and recommended yield options for 2000 and 2001

This working paper described an extensive amount of new modeling work on this stock. While the assessment model is still under development, the results did not suggest a need for changes in yield in the short term. However, the Subcommittee recommended that the differential exploitation rates between the north and south stocks be considered in developing management strategies for this fishery, and cautioned that current removals in the north may not be sustainable.

Working Paper G99-7: Estimate of 1998 recreational halibut catch in British Columbia waters

This paper presented a compilation of recreational halibut catches from the creel survey and recreational logbook programs.

Working Paper G99-8: Pacific Hake, Strait of Georgia stock assessment for 1999 and recommended yield options for 2000

This interim assessment presented a new stock biomass estimate from an acoustic survey. The new observation did not suggest the need to change yield advice for the stock.

Working Paper G99-9: Review of the fisheries and biology of the Pacific Hagfish (*Eptatretus stoutii*) in British Columbia, with recommendations for biological sampling in a developmental fishery

This working paper presented a "phase 0" evaluation of the experimental hagfish fishery that occurred in 1988-92.

Yield options derived from the November 1999 groundfish assessments are given in Table 1. The terms "high and low risk" have been removed from the yield options table because there is no quantitative basis for them. The Subcommittee has recommended a review of current approaches for risk analysis for fisheries management (see section "Risk Analysis" of this report).

Table 1: Summary of yield advice based on advice presented at this meeting.

AREA	SPECIES	1999 YIELD OPTIONS	2000 YIELD OPTIONS
3C/D	Dover sole	Low risk yield 1000 t High risk yield 1500 t	Yield Range 1000 t -1500 t
5C-5E	Dover sole	Low risk yield 800 t High risk yield 1200 t	Yield Range 800 t -1200 t
5C/D	Rock sole	Low risk yield 800 t High risk yield 1100 t	Yield Range 800 t -1100 t
5C/D	English sole	Low risk yield 500 t High risk yield 600 t	Yield Range 500 t -600 t
Coastwide	Sablefish	Yield Range: 2,977 - 5,052 t	Yield Range: 2,977 - 5,052 t
4B, except MSA 19, 20	Pacific hake	Low risk yield 7,554 t High risk yield 14,687t	Yield Range 7,554 t –14,687 t

AREA	SPECIES	1999 YIELD OPTIONS	2000 YIELD OPTIONS
3C/D	Canary rockfish	Low risk yield 350 t High risk yield 525 t	Yield Range 350 - 700 t
5A/B	Canary rockfish	Low risk yield 200 t High risk yield 400 t	Yield Range 175 - 350 t
5C/D	Canary rockfish		Yield Range 50 – 150 t
5E	Canary rockfish		Yield Range 100 - 200 t

INTRODUCTION

The PSARC Groundfish Subcommittee met November 22-25, 1999 at the Pacific Biological Station in Nanaimo. The Subcommittee reviewed eight Working Papers.

The meeting agenda was developed at planning meetings held in July and September. An item on observer coverage levels was added as requested by the Regional Director General (Appendix 1). A second addition was regarding a "phase 0" review of an experimental hagfish fishery (Appendix 2). The meeting agenda and timetable is given in Appendix 3. The Subcommittee Chair reviewed the guidelines for external participation. A list of meeting participants is included as Appendix 4.

The Subcommittee reviewed eight working papers. Working Paper titles, authors and reviewers are listed in Appendix 5.

GENERAL SUBCOMMITTEE DISCUSSION

Historic Yield Table

Table 1 of last year's Subcommittee Proceedings (CSAS Proceedings 98/19) lists catch options for all groundfish stocks on the west coast. For the majority of stocks, the 1999 catch options were based on assessments conducted in previous years. At a planning meeting held in July, 1999, it was agreed to add references to the table to indicate the source of the advice in order to clarify which entries were based on new information and which were carried forward from previous meetings. This has been done and Appendix 6 of this report will become the permanent record of the source of historic yield advice. For future advice, the Subcommittee report will list only advice for stocks assessed during the meeting of record.

Interim Assessments

In the past, the Subcommittee has reviewed what have been called major and interim

assessments. While the terms imply various degrees of coverage and analysis, it is unclear what is gained by making the distinction. There was a general agreement that recommended yield options would normally not be changed by an interim assessment. However, if the major assessment provided an accepted assessment model and new data are provided in an interim assessment, then some Subcommittee members wondered why one would not simply update the input data, run the model, and interpret the results. If the results suggested a change in recommended yield, then these should be used.

Following considerable discussion, the Subcommittee **recommended** that the idea of interim assessments be abandoned. Each assessment document should be reviewed on its merits.

Subcommittee Planning

The sheer number of groundfish assessment units (species and areas) far exceeds the limited resources available to do the work. This is evident from an examination of Appendix 6. There is an urgent need for a coordinated approach to planning the Subcommittees agenda to ensure that stocks in most need of assessments receive the required attention and that the management system is robust to the ability of the assessment process to provide the necessary advice. Consultation and discussion of this issue currently occurs within the groundfish working group, PSARC, and with industry committees. The groundfish working group is scheduled to meet in early January and it is expected that the issue of what assessments are required will be on it's agenda.

It is recommended that the Groundfish Subcommittee meets shortly thereafter to begin discussing its agenda and issues related to cycling stock assessments. However, it is highly unlikely that the assessment requirements can be met with existing resources.

Risk Analysis

In the past, the Groundfish Subcommittee has presented yield advice as bracketing categories intended to identify a range of low and high risk yield options. These yield categories were rarely calculated quantitatively, thus only providing a qualitative opinion of the level of relative risk at each recommended catch level. Such an approach may not be completely consistent with the precautionary approach, which requires that unacceptable outcomes be identified, that the risk of these outcomes be determined, and steps be taken to mitigate them. The Subcommittee recognized that there are a variety of options for calculating and presenting quantitative risk analyses and seeks advice on a range of such options.

Therefore, the Subcommittee recommended the preparation of a discussion paper that examines a range of options for determining and presenting risks so that standard procedures can be identified for application in stock assessments.

WORKING PAPER SUMMARIES, REVIEWS AND DISCUSSION

G99-2 Slope rockfish assessment for the west coast of Canada in 1999

J. Schnute, N. Olsen and R. Haigh **Accepted subject to revisions**

Summary

For assessment purposes, slope rockfish include Pacific ocean perch, yellowmouth rockfish, redstripe rockfish, rougheye rockfish, shortspine/longspine thornyheads (collectively termed “thornyheads”), and shortraker rockfish. In British Columbia (BC), these seven species are managed within six major areas (3C, 3D, 5AB, 5CD, 5ES, 5EN) for a total of 42 species-area combinations called assessment units.

This year’s report does not provide a new assessment, but rather a series of steps essential for future assessments, based on industry sponsored surveys for slope rockfish. The research follows a strategic plan for collaborative work with industry, initiated at a workshop in May, 1998. The report presents the latest available data and makes the following major advancements on past work.

1. Although the 1998 report recognized the key role of depth strata in a multispecies ecology, the assessment team did not have access to technology for a complete bathymetric analysis. This problem has been rectified by developing a bathymetric database using the Geographic Information System software package ArcView (Fig. 1). The coastal bathymetry was partitioned into blocks that are cross-referenced with the observer data. For each 100 m depth interval, bottom area available to fishing was calculated as well as actual bottom areas swept and impacted. Estimates of biomass for each slope rockfish species were provided by extrapolating observed estimates of density (CPUE) at depth to all available coastal bathymetry.

2. Staff members collaborated with the Canadian Groundfish Research and Conservation Society on a project to develop an industry-sponsored survey of slope rockfish, independent of the fishery. To date, maps have been developed that record fishermen’s impressions of trawl characteristics of the ocean floor. These classifications and preliminary estimates of fish density provide essential prior information in designing a survey that minimizes the variance of biomass estimates for a given level of available resources.

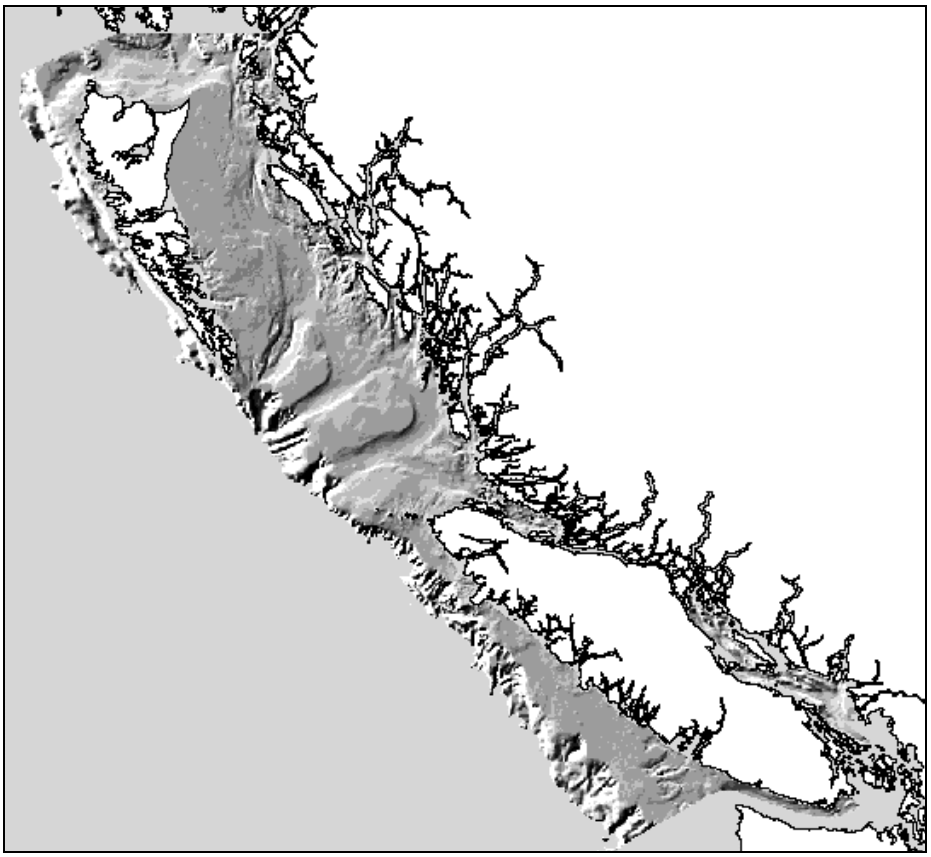
3. Biological data (length, weight, age) were used to calculate rough estimates of key reference points for the slope rockfish species. The report presents the complete mathematical framework for calculating reference point values from underlying biological parameters.

Analyses extended from last year suggest a continuing decline in the density of

longspine thornyheads in the most heavily fished blocks in assessment unit region 3C. Although these results are not definitive, they suggest a cautious approach to the development of a new fishery on this species. In some cases, avoidance fishing or changes among vessels may explain negative CPUE trends in heavily fished blocks.

In response to a request from industry and management, the possible justification for shifting the 5CD/5ES boundary 20 minutes north of its present location at 52°N was examined. If the quota remains unchanged in each area, the impact on quota holders would be minimal. Furthermore, fishing pressure on the Morseby Gully region would be somewhat alleviated if 5CD quota holders shift some of their effort to the region off the southwest Queen Charlotte Islands.

Figure 1. Hillshade view of B.C. coast bathymetry down to 1700 m.



Reviewers' Comments

Reviewer #1

Reviewer 1 suggested an alternative method of estimating exploitation rate. This would be based on estimating the fraction of the area in each depth interval which is swept by

the trawl gear, and estimate of net efficiency, and the distribution of each species by depth interval. This reviewer suggested investigating the use of adaptive sampling design for surveys to the industry surveys of slope rockfish. The work on developing methods for estimating biological reference points for these species was commended, however the reviewer felt it was premature to use the available data to suggest changes in yield options. Further study is required to develop confidence that these swept area estimates of biomass and exploitation rates reflect actual trends rather than changes in fishing tactics.

Reviewer #2

This reviewer noted the authors' analysis of catch rates of longspine thornyheads, the observation that these were declining, and asked what the management implications of this observation is. It was also noted that while the authors do not discuss their use of historic catch data in the 1999 analysis, concerns were expressed regarding misreporting, dumping, and discarding before implementation of the observer program. After identifying these concerns, however, the authors proceeded under the assumption that "reported landed catch represents the actual catch-at-sea". The reviewer suggested consideration of the consequences of specific (i.e. 70%, 90%, 95%) retention rates, or size specific retention rates.

The reviewer commented that the B.C. trawl fishery is comprised of a range of vessels with different sizes and engine powers, and with great variability in gear configuration and fishing strategy. It may be appropriate to classify vessels in the fleet according to such characteristics as horsepower, gear type, fishing strategy, target fishery participation, etc., and, through this process, identify vessels whose catch data are more comparable. This might provide a basis for developing an industry survey based on a standardized configuration.

In addition to the above mentioned concerns which relate primarily to inconsistency and potential bias, the issue of biomass estimator variance merits further attention. As the authors point out, bootstrap methods could be used to assess variance but such methods were not applied during this analysis.

Subcommittee Comments

Both the reviewers and the Subcommittee members agreed that substantial progress had been made in a number of areas including: development of methods for the display of commercial catch data and bathymetry, the development of methods for estimating abundance based on spatial analysis of fishery CPUE and survey planning. As was noted by the reviewers and the authors this is a work in progress and no changes in yield recommendations from the last major assessment were tabled.

Reviewer 1 indicated that adaptive sampling theory could be applied to the analysis of observer data and it was noted that some adaptive sampling of rockfish has been conducted in Alaska and that experience should be reviewed. It was suggested that

research tows be overlaid on commercial tows to evaluate differences between the two data sources. With further reference to the use of expanding swept area catch rates, it was noted also that due to the affiliation of many species to the edge or "break-in-slope" of the continental shelf, the concept of area of bottom habitat does not apply to all species and areas.

The Subcommittee noted that the paper reported statistically significant declines in CPUE within heavily fished blocks off the west coast of Vancouver Island. There was considerable discussion by the Subcommittee on the advice that should be given to management on longspine thornyheads after the question was posed regarding what information is required to allow DFO to identify stock declines in a timely manner. Industry participants indicated that CPUE had declined and that effort was being directed further north to maintain catch rates. Numerous smaller tonnage vessels continue to fish the southern area. It is believed by industry that the stock distribution is continuous along the entire slope and is unexploited over the majority of the coast as well as beyond the depths currently fished by the fishery. They felt that while it would be prudent to be cautious, capping the yield would restrict the fishery to the present grounds and forgo and opportunity to examine the full extent of the stock. The Subcommittee considered whether leaving the fishery at or above the current level of catch was sufficiently precautionary given the declining CPUE and relocation of effort. There were suggestions that the current CPUE could be used to develop a depletion estimate and that experimental management actions could be taken to examine CPUE in previously fished areas and direct effort into unfished areas.

Subcommittee Recommendations

The Subcommittee accepted the paper subject to revision.

Given the concerns raised for longspine thornyheads, the Subcommittee recommended that managers, industry and science collaborate to develop a management and assessment strategy that is structured in a manner to collect the necessary information for a through and directed assessment for this species.

G99-3 Flatfish stock assessment for the west coast of Canada for 1999 and recommended yield options for 2000

J. Fargo **Accepted subject to revisions**

Summary

Interim assessments were prepared for important stocks of flatfish caught in the B.C. trawl fishery. A summary of landing statistics including the observations from the 1997 fishery is presented for all of these. New data was available for only two stocks, Hecate Strait rock sole and Hecate Strait English sole. The catch-age analyses for those two stocks have been updated. There is no change in any of the yield recommendations from last year.

Landings for Area 3C-D and 5C-E Dover sole increased in 1998. Landings for the 3C-D stock were near the low end of the recommended yield range identified last year while 1998 landings for the 5C-E stock were near the upper limit of the recommended yield range identified last year.

Rock sole biomass in Areas 5C-D in 1998 declined slightly from 1997 but remains above the long-term average for the last 50 years. The estimate of fishing mortality for the stock in 1998, was F =0.13, below $F_{0.1}$ (F=0.22). With fixed exploitation at this level there is a 0.91 probability that the stock will maintain its spawning biomass and ensure the recruitment necessary to sustain itself in the future.

English sole biomass in Areas 5C-D in 1998 declined from 1997 to a level near the long-term average for the last 50 years. The estimate of fishing mortality for the stock in 1998 was F=0.16, below $F_{0.1}$ (F=0.25). With fixed exploitation at this level there is a 0.88 probability that the stock will maintain its spawning biomass and ensure the recruitment necessary to sustain itself in the future.

Reviewers' Comments

Reviewer #1

Upon noting that this was an "interim" assessment, this reviewer was concerned that the criteria for providing advice in such a situation were arbitrary and poorly defined (this issue was discussed for all assessments, and is reported in the Interim Assessments section of the report).

This reviewer expressed concern that the change in regulated mesh size in the trawl fishery that occurred in 1995 has had a significant effect on the selectivity of flatfish species but that this change has not been accounted for in the assessment. The reviewer felt that this has probably resulted in an underestimation of recruitment. It was also noted that changes in selectivity will affect fishery reference points (i.e. $F_{0.1}$, F_{med}, etc.), and these should be recalculated based on the current fishery selectivity.

Based on the observation that few male English sole in Hecate Strait attain commercial size, the reviewer suggested that sex specific catch-age analyses should be conducted for this species and that fishing reference points should be calculated for each sex. Special attention should be paid to female spawning biomass as it may be more susceptible to fishing effects than male spawning biomass.

The reviewer suggested that there is potentially more than one rock sole stock in Hecate Strait and the catch-age analysis uses age-composition data from only one area (Butterworth/Two Peaks) and catch (landings) data from the entire Hecate Strait region. Does the age-composition in other areas of Hecate Strait differ from the Butterworth/Two Peaks area, and if so, are there potential biases in the catch-age analysis from using data from only the one area?

The reviewer asked that diagnostics be presented for the catch-age analyses (i.e. fits to age-composition and the survey indices) and that a description of how the survey indices and their associated variances were calculated be provided.

Reviewer #2

This reviewer expressed similar concerns about the meaning of the term “interim” assessments. Several comments were made about the technical aspects of the catch-age analysis.

Similar comments were made for Rock sole and English sole in Hecate strait. The reviewer questioned the use of a constant selectivity function for the entire time period given that there had been an increase in the regulated mesh size. The reviewer asked if there were data to support the use of an autoregressive lognormal recruitment process for the stock and whether it is necessary to assume process error in recruitment at all. The reviewer noted that the author assumed that the survey and commercial selectivity at age were assumed to be the same and asked if the length frequency data from these two sources supports this assumption. It was suggested that age composition data from the surveys may provide a useful index of recruitment and should be used in future assessments. The assumptions about selectivity, weight at age, and recruitment that were made in yield projections to 2001 should be stated. The adequacy of the model fit or the model assumptions cannot be evaluated with the output provided.

The reviewer noted the following for Dover sole in areas 5CD. Yield and effort since 1992 appear to be above MSY levels yet F is estimated at about $F_{0.1}$. Is $F_{0.1}$ for this stock lower or higher relative to F_{MSY} and how should this be interpreted with regards to harvest strategy? CPUE in the 1990s appears lower than any period since 1970. Given the increased landings and effort, should this trend raise some concern?

Subcommittee Discussion

Dover Sole

The author provided clarification that CPUE was used in the area 5CDE Dover sole assessment, but the area 3CD assessment was based on results from a 1995 biomass survey. The Subcommittee discussed the merits of adopting a constant harvest rate strategy instead of the current constant catch policy, pointing out that constant catch policies may forgo yield, or over-harvest when stocks are at low levels of abundance. It was suggested that the impetus for a change in harvest policy should come from the managers and industry rather than stock assessment. It was noted that adoption of a constant harvest rate policy would increase the demand for major assessments of flatfish stocks.

The author provided clarification that the catch rate index used for 5CDE Dover sole utilized data from the targeted Dover sole fishery at Dundas Island, a single-species

fishery. General discussion ensued on the changes in fishing behavior that impact catch rate data following the adoption of a quota fishery management system.

Concern was voiced over the lack of analysis for area 5E where CPUE is high. The author indicated that limited biological data were available for this area. The general level of biological sampling for flatfishes was queried, but the author responded that current sampling levels were adequate for size composition, but it remains to be seen if sufficient otoliths will be collected for age composition.

Rock sole

The change in selectivity due to the new mesh regulation in 1995 was acknowledged, but the author pointed out that the terminal biomass estimate is largely based on cohorts recruiting prior to 1995. The rate of recruitment decline is probably not as severe as indicated in the analysis. The effect of not accounting for the change in selectivity is that biomass is underestimated. A suggestion was made to note the change in selectivity in recent years in the text of the assessment, and that the selectivity be accounted for in a subsequent assessment. The author pointed out that the selectivity function should be size-based rather than age-based. The author agreed to provide the details on the auto-regressive recruitment function and model likelihood function in the technical appendix, as requested by reviewers.

The possibility was raised that the increased mesh size prevented information on new recruits from being collected. Furthermore, the fleet was excluded from areas which may support new recruits due to crab closures and Pacific cod closures. The author pointed out that area closures do not affect the fishing index grounds used for this analysis. Rock sole landings increased in the early 1980s and 1990s which implies that high biomass must have existed, but survey CPUE shows a different trend than commercial CPUE. The author pointed out that the commercial CPUE index does not appear to be reliable because of changing management tactics over time, but the Hecate Strait survey index used in the assessment does appear to capture changes in abundance.

English sole

The author provided clarification that the catch-at-age analysis was conducted for female English sole only, but results are extrapolated to total catch. The author agreed that simulations could be done for the next assessment to examine the target spawning stock biomass policy. Commercial CPUE is not used in the catch-at-age analysis for English sole. It was noted that the same comments with respect to the effects of the selectivity function on rock sole assessment apply to the English sole assessment.

The adoption of the 50^{th} percent quantile (of computed biomass) as “high risk” was questioned; it was suggested that the 25^{th} percent quantile is “precautionary” and that the 50^{th} percent quantile is “average” risk, and that the 75^{th} to 90^{th} percent quantile could be considered “high risk”. The current “risk” approach used in Groundfish

assessments does not show the consequences of harvest policy. It was suggested that the 75th percent quantile be added to the range of yield options, and that a note be added to clarify how biomass yield ranges were derived. It was pointed out that $F_{0.1}$ has uncertainty associated with it, which is not considered in the current assessment.

Subcommittee Recommendations

The Subcommittee accepted the paper subject to revisions and agreed that no change in flatfish yield options is necessary.

The selectivity function should be revised in the next assessment to accommodate the regulated change in mesh size that occurred in 1995. This may involve adopting a size-based rather than an age-based selectivity function.

An analysis of the probability of exceeding target reference points should be conducted, along with simulations to examine downstream effects of the harvest policy.

G99-4 Canary rockfish assessment for 1999 and recommended yield options for 2000

R. Stanley **Accepted subject to minor revisions**

Summary

This document provides an analysis of the available stock assessment information on canary *rockfish (Sebastes pinniger*) and harvest recommendations for the 2000/2001 fishing year. For Areas 3C+3D (west coast of Vancouver Island), minimum and maximum harvests of 350 and 700 t are proposed, an increase from the 350-550 range proposed the previous year. A range of 175-350 t is proposed for Areas 5A+5B (Queen Charlotte Sound) down slightly form the 200-400 t range proposed a year earlier. There is little basis for determining optimal harvest levels for Areas 5C+5D (Hecate Strait) or 5E, (west coast of the Queen Charlotte Islands). However, for Areas 5C+5D, a harvest range of 50-150 t is suggested. This brackets historical landings. A harvest range of 100-200 t for Area 5E is suggested, but the hook-and-line fishery is providing significant landings from this area. A summary of Canadian and U.S. landings and the management and assessment history for canary rockfish is provided.

Assessment methodologies continue to follow recommended procedures for “data poor” stocks. Historical mean harvests are evaluated as quota guidelines subject to: observed trends in age composition, catch curve analysis, CPUE trends and comments from fishers. We include a discussion of the information content of each data source. Also included is a brief review of a canary rockfish assessment provided by Walters and Bonfil (1999) and incorporation of those authors’ concerns in the quota recommendations. Yield recommendations are discussed relative to current perceptions of decadal scale variation in groundfish recruitment trends.

Reviewers' Comments

Reviewer #1

This reviewer suggested that future assessments of this species should consider additional work on identifying appropriate stock units for management, and suggested plotting tow-by-tow catch data to examine their continuity along the shelf. The reviewer also noted the possibility that canary rockfish distribution may be influenced by recent environmental changes and asked if the recent increase in canary rockfish in Canadian waters may be related to northward shifts from U.S. waters.

Reviewer #2

The reviewer endorsed the author's approach of assessing individual shelf rockfish species on a 3-4 year cycle rather than attempting to assess all of them at once. This implies that the yield options for such a cycle would have to apply for the same period of time, in this case the canary rockfish yields would apply until the 2003/2004 fishing year inclusive. The reviewer suggested the use of population dynamics simulations to examine whether the observed stability of age compositions is sufficient reason to accept the average yield as a basis for yield options.

Subcommittee Discussion

The Subcommittee noted that using average historical catch in each area as a maximum yield recommendation for these areas may be over-optimistic since many of the early catches came from accumulated biomass and not recent production of the stock. However, the Subcommittee also noted that catches to date do not appear to be associated with other signs of overfishing, such as truncated age compositions.

The Subcommittee discussed the low estimates of natural mortality (M) from the analysis and noted these estimates are not consistent with the age composition data presented (i.e. few fish older than 45 yrs). Further insight on M of canary rockfish may be gained by examination of age compositions in the lightly fished areas west of the Queen Charlotte Islands. It was noted that this area is generally unsuitable for bottom trawl gear, but that sampling with hook and line or midwater gear may be possible.

Although insufficient information is available to examine recruitment levels (trends) for canary rockfish in the 1990s, it was suggested that declines in recruitment levels for canary and widow rockfish in U.S. waters to the south could indicate a similar trend in recruitment levels for Canary rockfish in British Columbia waters.

Subcommittee Recommendations

The Subcommittee accepted the paper subject to minor modifications requested by the reviewers.

The Subcommittee endorsed the authors recommendations for cycling assessments of shelf rockfish species. A three to four year cycle for canary rockfish is recommended. The frequency of assessments for other shelf rockfish species should be evaluated separately.

G99-5 Pacific Cod off BC: Update 99

A. Sinclair **Accepted subject to revisions**

Summary

The working paper reviewed aspects of the Hecate Strait groundfish assemblage survey design that may improve Pacific cod estimates while not compromising the main objectives of the survey. This included an analysis of past surveys and commercial fisheries data from the 1996-99 observer program. Consultation were held with Pacific cod fishermen on aspects of survey design and the interpretation of results.

There are advantages to conducting bottom trawl surveys at times when the target species are dispersed throughout the survey area, to avoid seasons when the fish are highly aggregated, and to avoid periods when they have migrated out of the survey area. Cod spawning is reported in Hecate Strait between January and March. Commercial catch rates decline in the September - December period indicating that Pacific cod availability in Hecate Strait may be reduced then. It would appear that the month of June, when the survey has been conducted, is a good choice for this survey.

Less than half the area of Hecate Strait is covered by the survey. A crab fishery occurs over a large portion of the Strait east of the Queen Charlotte Islands and the bottom conditions there are unfavorable for trawling. It would be illustrative to examine the fish by-catch in the crab traps for Pacific cod. If cod are present in significant numbers, then it may be worthwhile having the crab traps lifted at the time of the survey to allow fishing there.

It would be useful to consider modifying the survey design where fewer strata are used and station selection is randomized. For Pacific cod, there does not appear to be a significant amount of inter-annual spatial correlation in distribution. Thus, little gain is expected in using a fixed station design over an annual random station selection design. The basis for stratification should be further examined, taking into consideration other species for which the survey is now used (e.g. flatfish). Consideration should be given to trade-offs in station allocation and stratification.

The current surveys have between 80 - 100 fishing sets. Increasing the number of sets would be expected to reduce the standard deviation of the mean in proportion to the square root of the number of observations. Roughly speaking, doubling the number of sets may result in a 30% reduction in the standard deviation.

It is strongly recommended that length frequencies be taken for all Pacific cod catches made on the groundfish assemblage survey. Filling in for missing length frequencies

introduces unnecessary uncertainties to the survey results.

Reviewers' Comments

Reviewer #1

The reviewer noted that the development of a long-term, risk-averse harvest strategy for this stock would be challenging given the high level of uncertainty associated with the CPUE and survey indices. While this often prompts stock assessment scientists to defer development of a long-term strategy until greater certainty can be achieved, an alternative would be to develop a long-term strategy that incorporates the existing level of certainty as well as provisions for adapting to future improvements in this level.

Reviewer #2

This reviewer supported the use of an area-weighted stratified mean for calculating abundance indices from the Hecate Strait groundfish assemblage survey. It was suggested that additional analyses be undertaken to examine annual trends in the abundance of Pacific cod by depth intervals. The reviewer suggested that a GIS-based analysis be used to examine the possibility of using bottom type in addition to depth as a basis for stratification and that future surveys use random station selection. The reviewer compared changes in catch of cod in the Hecate Strait area with variations in the survey CPUE index, and found some similarities which suggest the survey index may be useful for measuring changes in stock size. The lack of an increase in catch in 1999, following a strong survey index in 1998, may be due to restrictive quotas and that the cod have not yet recruited to the commercial size range.

The reviewer questioned the observation from the last assessment that the abundance of Pacific cod in the Hecate Strait area is very low. The similarities in catch trends in areas 3CD, 5AB, and 5CD were noted, as was the high survey index in area 5CD in 1998. A detailed analyses of the available observer data to confirm if the apparent increase in recruitment predicted by the 1998 survey is being replicated in the commercial catch was suggested.

Subcommittee Discussion

The Hecate Strait groundfish assemblage survey was designed for flatfish which are amenable to swept-area estimations. Pacific cod can be highly aggregated and periodically "disappear" from the survey area. There was no consensus on where the cod disappear to but it was ruled out that they simply disaggregate and become less catchable. Two other drawbacks to the survey were highlighted: (i) sampling is non-random because the choice of tow location is left to the discretion of the fishing master, (ii) the time frame is limited to a single period. Problems in using survey data to estimate Pacific cod abundance result in variance estimates so large that 1996 and 1998 biomass estimates were not statistically different from each other even though the latter was three times the former.

It was stressed that a completely random sampling regime is inappropriate for Hecate Strait because there is more untrawlable bottom than trawlable. It was suggested that elements of the survey could be randomized, for instance, random sampling could be done in areas of suitable bottom type similar to those presented in the slope rockfish assessment (G99-2). Another way to minimize variance would be to tow for a set amount of distance rather than time.

At present, the survey is used for input to catch-at-length analysis and not for evaluating changes in biomass from year to year. There was much discussion on whether this survey should be used as a relative index of abundance for Pacific cod. Some thought that the variance was too large to be useful as an abundance index but could be used to detect signals in the population. It was thought that there is little more that can be done on post-stratification or analysis of existing data to reduce the variance. It would be of greater benefit to either make changes to the existing survey design to optimize sampling or to develop a separate survey directed specifically at Pacific cod.

While some thought that there was no further information for quota recommendations others flagged the high index value for 1998. If Pacific cod abundance does increase in Hecate Strait, this will likely result in individual vessel quotas being caught at a faster rate during the fishing season and consequently causing quota problems for other fisheries. Until a more reliable index of Pacific cod abundance can be developed, the most effective monitoring tool may be the cod by-catch in other trawl fisheries.

Subcommittee Recommendations

The paper was accepted subject to revisions. The following recommendations were made.

Continue to use the relative abundance of Pacific cod in the groundfish assemblage surveys to flag potential concerns. However, it must be recognized that the survey results will be highly variable and their interpretation will be difficult.

The survey estimate in 1998 may be a signal of high abundance and quotas may need adjusting in the near future.

In-season monitoring of catch and size composition should be implemented.

Discussions with fishermen should be continued to alert assessment staff of potential changes in Pacific cod population dynamics.

G99-6 Sablefish stock assessment for 1999 and recommended yield options for 2000 and 2001

V. Haist, R. Hilborn, and M. Saunders **Accepted subject to revisions**

Summary

This document represents a major assessment for B.C. sablefish. The principle data source on trends in abundance is the tagging program, and in particular the percentage of tags returned in the year following tagging. Coastwide, this percentage remained steady at 10-11% from 1991 to 1997, but rose to 14% in 1998.

Analytical stock assessments are conducted using an integrated catch-age mark-recapture model. The stock reconstructions suggest that from 1972 to 1998 the available biomass of sablefish decreased by 50% in northern B.C. and by 48% in southern B.C. The 1998 female spawning stock biomass (SSB) is estimated at 50-67% of the virgin level for the southern B.C. stock, and from 38-48% of the virgin level for the northern B.C. stock. These SSB levels are well above “high risk” levels, hence, there are no short-term conservation concerns for these stocks.

Deterministic stock projections are conducted for the 2000 to 2008 period at three levels of fixed harvest. Stock projections suggest that current removals in the north are not sustainable, and that in the next 8 years considerable reduction in removals from the north may be required if recruitment does not increase. Recent reductions in trawl by-catch and reduced mortality of small sablefish from escape rings may result in increased recruitment.

Reviewers’ Comments

Both reviewers of this paper commended the authors for their treatment of the existing data and the development of the assessment model. However, both also made several suggestions for future work.

<u>Reviewer #1</u>

The first reviewer recommended that, in addition to the integrated migration and catch-age analysis presented in the working paper, a simplified model should be developed in parallel, and provided suggestions for what such an approach could include. The reviewer noted that cooperation between the US and Canada sablefish scientists is critical in developing an assessment for the B.C. sablefish stock given the relatively high number of returns of Canadian tagged sablefish in US waters. It was suggested that the procedure for estimating the initial population size and the catch-at-age likelihood should be changed. Where available, data on the length and age of tagged and recaptured fish should be incorporated into the model, and the tagging program should collect these data regularly. The reviewer noted that checking for programming errors in a complex model such as this one is difficult and suggested ways to achieve verification

by having the model coded by independent researchers and using two different programming languages. It was suggested that it is unlikely that the sablefish population will collapse in the next two years, and that during this time emphasis should be placed on developing the assessment procedures and data collection methods rather than on full annual assessments.

Reviewer #2

The reviewer expressed concern for the apparent downward trend in population biomass, low recruitment estimates in recent years, and the low estimates of surplus production and asked what is necessary to reduce quotas for this stock. It was suggested that the authors undertake an analysis of the data requirements for unambiguous estimation of the large number of parameters used in the assessment model. While the working paper presented an improved description of the basic data used in the analysis, this reviewer suggested that a series of graphs depicting the inputs should be provided. There is also a need for these inputs to be available in machine-readable form. The reviewer noted the lack of statistical justification for the definitions of the negative log likelihood and Bayes prior components of the model objective function and the form of the movement component of the model.

Subcommittee Discussion

General discussion following the reviews addressed a variety of issues.

- The age structured model uses age data up to 1996. Recruitment projections were based on year-classes from the mid-1970s to 1993. The lack of recent age data make future projections very uncertain.
- The practice of retaining small tagged fish and not retaining untagged fish of similar size could potentially result in a biased biomass estimate. Because of this bias, the current biomass estimate is considered a minimum estimate.
- The male/female ratio available to the fishery varies significantly during the year. The main source of sex ratio data used in the model is the November pot survey. However, additional data from the fishery exists. Further investigation of this issue is warranted.
- Industry noted that both reviewers expressed concern with the model's uncertainty. The authors acknowledged that the model itself helps to identify reasons for our limited knowledge of the sablefish stocks and that the lack of U.S. data remains one of the most serious limitations.
- The Subcommittee also discussed ways to estimate recruitment. Science and industry are cooperatively investigating methods to estimate relative year-class strength.

In conclusion, Subcommittee members gave cautious endorsement to the analysis in this paper. The model itself is taken as a work in progress, a substantial first step in which some important scientific issues remain to be addressed.

Subcommittee Recommendations

The Subcommittee accepted this paper subject to revisions.

There is no evidence in the current analysis to alter the 1999 yield recommendations for 2000.

The Subcommittee recommended that the differential exploitation rates between the north and south stocks be considered in developing management strategies for this fishery, and caution that current removals in the north may not be sustainable.

G99-7 Estimate of 1998 recreational halibut catch in British Columbia waters

J. King and T. Gjernes **Accepted subject to revisions**

Summary

The 1998 recreational catch of Canadian landed Pacific halibut was estimated using information from creel surveys and logbook records. The 1998 catch estimate is 38,100 pieces. This estimate should be considered a minimum estimate since it does not include any correction or expansion for non-coverage in certain months by creel survey or for non-submission of logbook records in some areas. However, large portions of the catch are estimated with reliable sources of information. An attempt was made to correct for the shortcomings in coverage by creel survey and logbook programs and an expanded estimate is 44,400 pieces. The International Pacific Halibut Commission is presently using information from a 1995 angler response survey program (The National Survey) to estimate the British Columbia 1998 recreational halibut catch. It was suggested that the 1998 estimate presented in the paper is the best estimate of Canadian landings of recreationally caught halibut.

Reviewers' Comments

Reviewer #1

This reviewer found that using data from creel surveys and logbooks to estimate recreational halibut catch was an improvement over the old National survey. It was pointed out that a number of lodges and resorts record halibut catch and weight data for their own purposes. These data may be available upon request and augment the limited average weight data used in the paper. Error estimates for the Strait of Georgia creel survey are made and should be included in the analysis. It was pointed out that the closure of many recreational salmon fishing areas in 1998 resulted in a shift of recreational effort toward halibut. Consequently, the 1998 estimated halibut catch would not be typical of previous years. It would be worthwhile to estimate halibut catches in other years for comparative purposes and to replace estimates that were based on the National survey.

Reviewer #2

The second reviewer found it inappropriate to use the creel survey estimates of halibut recreational catch at face value and could not recommend that the paper be accepted in its current form. The reviewer noted that it was necessary to guess catches in several fisheries for which there were no data. Substantial components of the estimates depended on a number of unsubstantiated assumptions used to impute halibut catches at times when there was no creel survey coverage. The reviewer also noted that the creel survey estimates were used without a critical evaluation of the fact that the surveys were optimised for salmon fisheries. The reviewer found the presentation of the basic data was insufficient to fully understand the validity of the analyses and conclusions. The use of an average weight from a single lodge to convert the piece estimate of catch into a catch weight was not accepted.

Subcommittee Discussion

The Subcommittee commended the authors for their efforts to compile data from an array of recreational catch programs conducted on the coast. This is the first attempt at estimating the total recreational catch of halibut in British Columbia.

The Subcommittee agreed with the authors and the reviewers that there are several limitations to the current logbook and creel programs. Specific problems with the current programs include:

1. The creel survey program, while designed to cover recreational activity may be biased toward the collection of salmon data in that;
    i) timing of the data collection is over the peak salmon season
    ii) location of the survey points may not reflect fishing times and areas.

    Of particular concern is the lack of data from any areas during the October to May period when targeted groundfish fishing may occur.
2. The logbook program is not a complete census of all lodges and charter operators; and,
3. There has been no attempt to increase compliance and coverage of the logbook program or determine the accuracy of the data collected.

The Subcommittee questioned the authors' application of mean weights, obtained from a single lodge in the north, to the estimate of total catch in pieces to determine a total catch weight. There is considerable variation in the size of halibut caught along the coast and current data are insufficient to describe this variation. Therefore, no total weight estimate should be provided.

The Subcommittee suggested that total piece counts be presented and that separate tables be formulated to represent the estimated catch from each data source (creel surveys and logbook programs) and to indicate extrapolations from the data and/or any additional antedotal information collected.

Subcommittee Recommendations

The Subcommittee accepted the paper, with revisions, as a best estimate of recreational halibut catch given the available data. The Subcommittee recommended that existing error estimates from the creel surveys be included in the revised document.

The Subcommittee noted that the concerns expressed regarding the existing recreational catch monitoring programs apply equally to other non-salmon fisheries. Further, to improve the estimates for Canadian recreational halibut, the Subcommittee supported the authors' recommendations and further recommended the following:

- A review of the existing creel programs be conducted to assess whether program design meets the requirements for non-salmon catch estimation;
- Creel survey coverage should be expanded to cover periods in which halibut are targeted;
- Error estimates for catch and effort in all creel survey programs be calculated;
- Weight and length data should be collected from all major recreational halibut catch areas;
- Measures to ensure complete coverage and compliance of the logbook program for lodges and charter operations be initiated; and
- Random checks or other measures are instituted to validate the accuracy of the data submitted through the logbook program.

G99-8 Pacific Hake, Strait of Georgia stock assessment for 1999 and recommended yield options for 2000

M. Saunders and G.A. McFarlane **Accepted subject to revisions**

Summary

The fishery in the Strait of Georgia decreased substantially to 3,996t in 1998 from 6,561t in 1997, a result of low demand. Age and growth data continue to indicate strong recruitment during the 1990s and a coincidental decline in the mean size-at-age. Yield options remain unchanged from the previous assessment with a range of 7,554-14,687 t. Due to uncertainty in the current assessment, including evidence of increasing seal predation it is recommend that managers choose a quota from the lower half of the yield range.

Reviewers' Comments

Reviewer #1

The reviewer found this interim assessment to be acceptable but suggested that there were sufficient data to warrant an updated sequential population analysis of the stock. It was also suggested that an integrated model would be useful to explore alternative assumptions about the comparability of acoustic estimates, the effects of seal predation,

selectivity, and stock recruitment dynamics. The reviewer thought this system provides a rare opportunity to examine trophic interactions within a tuned catch-at-age analysis – somebody should be putting this together, perhaps Ecopath/Ecosim would help. The reviewer disagreed with the authors' inference that recruitment was strong based on catch proportions at age. A suggested alternative interpretation was that the apparent stability in biomass, in spite of decreased growth, implies increased recruitment in recent years.

Reviewer #2

This reviewer felt that interim assessments are conducted when new data are obtained and can be easily incorporated into the assessment model to provide updated yield estimates. In the case of Strait of Georgia hake, the new acoustic biomass estimate for 1998 should be used to produce new yield options in the same way as the 1997 acoustic estimate was used to produce the current yield options. Alternatively, if no advice is to be produced from an interim assessment, then there is no need for an assessment paper. The reviewer also commented that the problems associated with using F_{opt} estimated from the outside stock and applying it to the inside stock and the timing of the acoustic survey were of greater concern in this assessment than the influence of climate change and seal predation on the hake population in the Strait. A discussion on climate change and seal predation is best deferred for further discussion around mortality rates for the Strait of Georgia stock.

Subcommittee Discussion

This interim assessment presents updated information on biomass estimates using recent acoustic survey work. The acoustic survey work is considered 'work in progress' but is still useful information. The authors noted that the biomass estimates were likely underestimates, since the sex ratio observed and the maturity stages of the fish indicated that the survey was not capturing the total spawning biomass. The authors felt that potential overestimation of biomass in early years and the underestimation of biomass in recent years means that data in the time series are not directly comparable.

It was noted that the optimum fishing mortality applied to the biomass estimate for the Strait of Georgia hake was inappropriate since it was derived for the offshore stock. It was also noted that the apparent decrease in mean size-at-age might indicate a change in productivity. The authors felt that the apparent decline in size-at-age was not likely a reflection of overexploitation but was a response to changing environmental conditions. Irrespective of the cause of the apparent change in size at age, it would be prudent to include the most recent data in estimates of optimum fishing mortality for the inshore stock.

The Subcommittee agreed that a new yield option based on the 1998 acoustic biomass estimate should be presented in the revised paper, and that the reasons why this was not used in this assessment be clearly described with supporting evidence (i.e. sex ratios, maturity stage, and availability).

Subcommittee Recommendations

The paper was accepted subject to revisions.

The Subcommittee recommended the same yield range as last year.

The Subcommittee recommended that the next major assessment needs to incorporate a population dynamics model and can not depend on acoustic surveys as an unbiased estimate of biomass. The Subcommittee recommended that the next major assessment uses an optimum fishing mortality derived for the inshore stock that also accounts for the apparent decrease in productivity.

G99-9 Review of the fisheries and biology of the Pacific Hagfish (*Eptatretus stoutii*) in British Columbia, with recommendations for biological sampling in a developmental fishery

K.D. Leask and R.J. Beamish **Accepted subject to revisions**

Summary

A review of the biology of hagfish in general and *Eptatretus stoutii* in particular is presented. Hagfish are one of the most studied fishes in the laboratory, but one of the least studied in its natural environment. Food and commercial fisheries in Asia and North America are described and historical landings presented. The fishery and associated biological sampling program that took place in British Columbia from 1988 to 1992 is reviewed. Fishing hagfish at harvest levels similar to those in the earlier fishery are considered to be possible, provided adequate monitoring and assessment are carried out.

Reviewers' Comments

Reviewer #1

This reviewer expressed some concern that the use of CPUE as an index of hagfish abundance during the initial fishery was not validated and wondered if there was a possibility of serial depletion of fishing sites and compensation for reduced catch rates by moving to new locations. While the results of the biological sampling program were described, the reviewer requested more detail on how to improve sampling and information content. Further exploration is needed on the implications of on-deck sorting and the size of release ports on a future fishery. Similarly, further discussion was requested on the implications of specific size limits.

Regarding recommendations for management of future fisheries, the reviewer found few specifics on methods or discussion of the relative importance in pursuing alternative approaches. A list of recommendations are provided at the end of the paper that suggest continued experimental fishing with more controlled and standardised fishing,

better monitoring and biological sampling. It is made clear that the methods will not provide an estimate of absolute abundance or biomass and no alternative management approach was suggested. This leaves only the CPUE approach to provide information on the response of the population to a period of no fishing. No details on the kinds of responses that should be measured were provided.

The reviewer recommended that this paper be accepted and that the authors follow through with more explanation of the procedures to collect specific information and present a clearer direction on the value of pursuing specific techniques so managers can prioritise activities.

Reviewer #2

This reviewer found that while the paper described the results of the earlier experimental fishery for hagfish, it lacked specific recommendations for what additional information is required to develop a management plan specific to this fishery. It was pointed out that managers should consider a suite of potential management tactics when developing a fishery. Typically these include sex limitation (primarily for crustacean fisheries), size limits, TACs, direct effort limitation (licence limitation, gear limits), and time or area closures. These might be used proactively, or as in-season adaptive measures. The paper should include a discussion of the relative applicability of each tactic to hagfish biology and fisheries, and available or attainable assessment data.

The reviewer also stated that a major part of fisheries assessment is determining the success of each management tactic in addressing management objectives. Specific data will be required to enact management actions (i.e., size at maturity for size limits, estimates of stock size to set TACs) and assess the effectiveness of each tactic (i.e., time series of stock estimates to evaluate stock response to exploitation rates), and the assessment program should be structured to provide this information. Often the data required to develop and assess management tactics are not available. In these cases, directed research is required to obtain this information before a fishery can be considered.

The reviewer questioned whether collecting more of the same data in further experimental fisheries would improve future assessments. An experimental fishery should be a structured fishery-based survey to establish distribution and indices of initial abundance in areas proposed for fishing. It should follow a scientifically-structured survey design, to explore stock characteristics after a recovery period, to provide baseline information for the assessment of future fishery impacts, and to obtain assessment information required to develop management strategies and tactics. Given the possible pattern of relatively rapid depletion of stocks in the previous fishery, effort levels should be a fraction of previous levels until the response of stocks to fishing is better understood. Catch and effort might be adequately captured with harvest logs and sales slips, although confirmation from observer coverage or landing validation may be required. Using controlled fishing experiments would likely be very beneficial.

Subcommittee Discussion

An experimental fishery for hagfish was proposed for the west coast. A previous fishery occurred between 1988-92. That fishery collapsed due to market problems but there were suggestions at the time that the stocks in the area fished were depleted. Managers were reluctant to allow another as indications were that effort was too high.

A phased approach similar to that used in developing shellfish fisheries was suggested. This should be structured as a survey to collect additional information required to establish an effective management strategy for a full scale commercial fishery, i.e. Phase 1 of the phased approach. The Subcommittee noted, however, that additional work is required to identify the specific information requirements.

Managers expressed concern about monitoring the fishery and suggested that regular biological samples be collected and that this and monitoring should be paid for by the fishers. There was discussion about how much fishing effort should be allowed and suggestions were that it be only a fraction of that in the 1988-92 fishery. The Subcommittee questioned how size-selective the fishery could be relative to the age of maturity of the species and how the fishery could be assessed.

Subcommittee Recommendations

The paper was accepted subject to revisions.

The Subcommittee recommended that if there is interest in further development of a hagfish fishery that a “Phase 1” approach (Perry et al. 1999) is needed. An experimental fishery should be designed as a survey to collect additional data thought necessary for future management.

Update on Precautionary Approach Workshop

Presentation Summary

The second workshop of the national High Priority Project on the Precautionary Approach was held at PBS from November 1 – 5, 1999. The project was designed to use a number of case studies to investigate aspects of what might constitute a Canadian flavour of the precautionary approach. This is the final year of the project. Results of the first workshop are available in Rice et al. (1998) and the second report will be published soon in the CSAS Proceedings Series.

The legal context for the precautionary approach has been drawn from several international agreements including the UN Convention on the Law of the Sea (1982), the Rio Declaration (1992), the FAO Code of Conduct for Responsible Fisheries (1995), the UN Fisheries Agreement (1995), and the Canada Oceans Act (1997). Canada became a signatory to the UN Fisheries Agreement this year, and while it applies

specifically to straddling and highly migratory stocks, it is also likely to have an influence on management policy for domestic marine fisheries. Some of the highlights of the UN Fisheries Agreement are:

- States shall be more cautious when information is uncertain, unreliable or inadequate. The absence of adequate scientific information shall not be used as a reason for postponing or failing to take conservation and management measures.
- In implementing the precautionary approach, States shall: improve decision-making by using the best scientific advice available, using improved techniques for dealing with risk and uncertainty, and determine stock-specific reference points and the action to be taken if they are exceeded.
- Fishery management strategies shall ensure that the risk of exceeding limit reference points is very low and target reference points are not exceeded on average.
- The fishing mortality rate that generates maximum sustainable yield should be regarded as a minimum standard for limit reference points.
- For overfished stocks, the biomass which would produce maximum sustainable yield can serve as a rebuilding target.
- When information for determining reference points for a fishery is poor or absent, provisional reference points shall be set. Provisional reference points may be established by analogy to similar and better-known stocks.

A generic precautionary approach framework for the project case studies was developed and is shown in Figure 2. This would allow practitioners to classify their stock according to its current status (i.e. biomass, abundance) and removal rate.

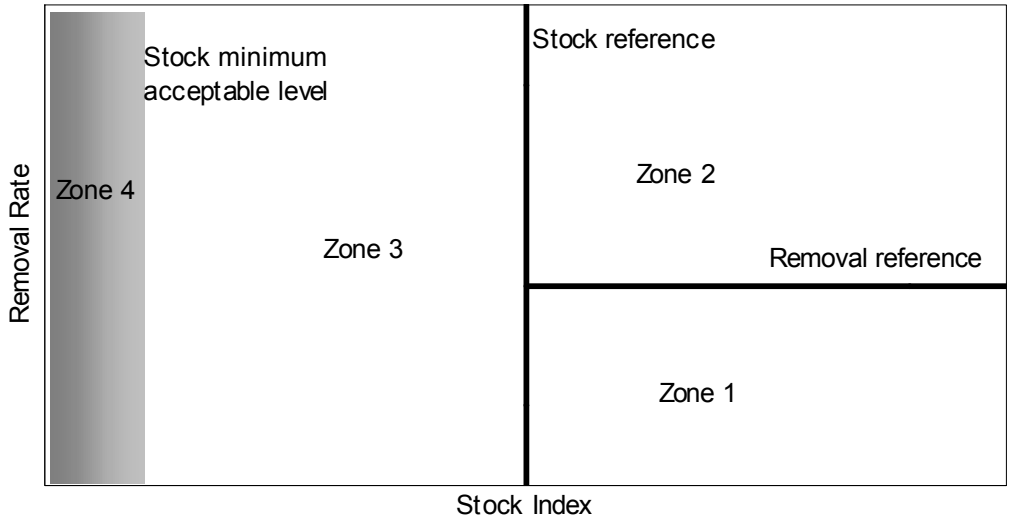


Figure 2: A generic precautionary approach framework.

Zone 1: the desired state

The stock is above the Stock reference level and removals are below the Removal reference level – status quo is acceptable. This zone identifies the "desired" state in terms of exploitation and stock size.

Zone 2: Overexploitation state
The stock is above the Stock reference level but removals are above the Removal reference level – removals should be reduced to below the Removal reference level. This zone is characterised by removal rates exceeding the reference and, as such, would identify an "overexploitation" state.

Zone 3: Overexploited state
The stock is below the Stock reference level – removals should be restricted to allow a high probability of moving to Zone 1. In this zone, the stock is overexploited in relation to the stock reference and the stock would be considered to be in an "overexploited" state.

Zone 4: Unacceptable state
The stock is below the Stock minimum acceptable level – removals should be kept to the lowest possible level. In this zone, the stock has been reduced to a very low level and would be considered to be in an "unacceptable" state.

It was recognised that consultation among stakeholders (fishing industry, first nations, environmental groups, managers, and scientists) is essential to the successful implementation of a precautionary approach. One workshop participant pointed out that "A precautionary approach which is not accepted, and therefore not used, is not precautionary". It is necessary to keep the conceptual framework and associated discussions as simple and straightforward as possible. Consultation is likely to be the most time consuming part of the process.

The language of the UN Fisheries Agreement presents many challenges to practitioners. The theory of stock production and maximum sustainable yield is front and centre but there is much debate of the utility of the concept, the estimability of its reference points, and the application of the results. There are clearly multispecies and environmental effects that will affect stock production and current single species methods are inadequate to take these into account. These concepts are also difficult to explain and understand thus presenting additional challenges. Strong leadership will be required to implement any associated changes.

Subcommittee Discussion

Subcommittee discussion focussed on two issues. Firstly, it was noted that the Canadian program concentrated on the biological component of the approach. Recent FAO discussions identified that for the approach to be successfully implemented, it must extend beyond the biology and view the issue at the system level and incorporate, for example, the socio-economic context.

Secondly, the Subcommittee expressed the concern over whether a formalized approach would limit flexibility and force managers to ignore specific contextual issues. For example, a manager may wish to adopt different strategies for two similar stock status scenarios because of different expectations over the ability to monitor the impact

of their management actions.

Observer Coverage Summary

In a memorandum dated September 30, 1999, the Regional Director General asked the PSARC Groundfish Subcommittee to provide advice on minimum standards for observer coverage in the groundfish trawl fishery (Appendix 1).

The current level of observer coverage is an important part of the management system developed for the highly complex multi-species fisheries for B.C. groundfish. The management system provides for maintenance of TAC's on a stock specific basis (i.e. by species and area) and uses observers to ensure that total catch information (by area and species), including discards, are properly estimated and reported. Observers also collect biological samples and the observer data are used in stock assessments and scientific research.

While it is likely that 100% coverage is not necessarily cost effective for strictly scientific reasons, the Subcommittee is unable to identify minimum levels separate from the management requirements for the diverse assessment issues that can be addressed with these data. The current level of observer coverage allows all involved to have considerable confidence in the data produced. Reduced coverage would require additional effort and expense directed towards the reconciliation of data between observed and unobserved trips. It is almost certain that the presence of an observer on a vessel will influence the fishing practices of the skipper and crew. It would be potentially misleading to infer the fishing practices of unobserved vessels from data collected from observed vessels. The lower the level of observer coverage, the less confidence there will be in the data, and the more work needed to check and validate the information.

The observer data is an extremely valuable source of information which will provide the opportunity for improved stock assessments, not only for the Groundfish trawl fishery, but for other fisheries and broader ecosystem analysis. If Fisheries and Oceans Canada had to directly acquire similar biological samples and resource information through research charters, the costs would be significant.

The Subcommittee questioned that there may be opportunities to reduce some of the administrative and data processing costs associated with the program. It was noted that the Groundfish Trawl Advisory Committee (GTAC) Observer Subcommittee, which includes representatives from management, science, industry, and the observer contractor, are considering various options. Additional representation from science and industry will be needed.

Appendix 1: Request for advice on Observer Coverage

Fisheries and Oceans / Pêches et Océans

PSARC RECEIVED OCT 12 1999

MEMORANDUM NOTE DE SERVICE

Security Classification - Classification de sécurité	**UNCLASSIFIED**
Our file - Notre référence	
Your File - Votre référence	
Date	**SEP 3 0 1999**

To / A: Dr. M. Stocker
PSARC Secretariat

From / De: Director General
Pacific Region

Subject / Object: **GROUNDFISH OBSERVER PROGRAM**

It has come to my attention that the issue of 100% observer coverage in certain segments of the groundfish trawl fishery is very complicated and difficult to justify. Although sampling at some level lower than 100% should, in my opinion, provide us with the necessary information to manage the fishery in a precautionary manner, the groundfish industry maintains that 100% coverage is important to continue managing the fishery in the current manner.

I understand that the Groundfish Subcommittee of PSARC will be meeting in the next few months. While time for a full scale analysis of this issue is likely not possible for that meeting, I would appreciate some advice from PSARC with regard to setting minimum standards for observer coverage in the groundfish trawl fishery.

It is clear that there are a variety of reasons for the observer program, including, but not limited to, collecting data for stock assessment and for management, as well as for enforcement and monitoring. I would like advice regarding the minimum level of coverage required for each component, for areas that are within Fisheries and Oceans mandate so that we can attempt to determine to what level we should fund this program.

Thank you.

D. M. Petrachenko

cc: Laura Richards
T. A. Tebb

Canada

Appendix 2: Request for advice on Hagfish

Fisheries and Oceans / Pêches et Océans

MEMORANDUM NOTE DE SERVICE

To / À: Alan Sinclair

From / De: Richard Beamish

Security Classification - Classification de sécurité **UNCLASSIFIED**
Our file - Notre référence
Your File - Votre référence
Date **November 8, 1999**

Subject / Object: **PACIFIC HAGFISH MANUSCRIPT**

As requested by Bruce Adkins and Marilyn Joyce we have attached the 'phase 0' assessment of the potential for a hagfish fishery. We believe that this is the first 'phase 0' report submitted to the Groundfish subcommittee, however, several have been reviewed by the shellfish subcommittee.

Possible reviewers are Chrys Neville and Marylyn Joyce.

Dr. R.J. Beamish

Appendix 3: PSARC Groundfish Subcommittee Meeting Agenda, November 22-25, 1999

Agenda

Date/Time	Item	Authors	WP
Mon-Nov-22-1999			
10:00	Introduction		
10:30	Rock Sole, English Sole, Dover Sole	Fargo	G99_03
12:30	Lunch		
13:30	Shelf Rockfish	Stanley	G99_04
15:00	Coffee		
15:30	Update on Precautionary Approach Workshop	Schnute/Sinclair	
16:00	Source of Catch Advice in Table 1	Various	
Tue-Nov-23-1999			
09:00	Strait of Georgia Hake	Saunders	G99_08
10:30	Coffee		
11:00	Halibut Sport Catch	King/Gjernes	G99_07
12:00	Lunch		
13:00	Slope Rockfish	Schnute/Olsen/Haigh	G99_02
15:00	Coffee		
15:30	Hagfish	Leask/Beamish	G99_09
Wed-Nov-24-1999			
09:00	Observer Coverage	Sinclair	G99_05
10:30	Coffee		
11:00	Sablefish	Haist/Hilborn	G99_06
12:00	Lunch		
13:00	Sablefish con't		
15:00	Coffee		
15:30	Sablefish con't		
Thu-Nov-25-1999			
09:00	Pacific Cod		
11:00	Report Review		
15:00	Meeting adjourned		

Appendix 4: Participants at Groundfish Subcommittee Meeting, November, 1999

DFO Participants	Association	Mon.	Tues.	Wed.	Thurs.
* Subcommittee Members					
Ackerman, B.*	Operations	✓p.m.	✓	✓	
Bedard, T.	Operations	✓	✓	✓	
Clark, D.	Operations	✓	✓		
Fargo, J.*	Science	✓	✓	✓	✓
Gillespie, G.	Science		✓p.m.		
Gjernes, T.*	Operations	✓	✓	✓	✓
Haigh, R.	Science	✓	✓	✓	✓
Haist, V.*	Science			✓	✓
Hardy, S.	Science	✓	✓	✓	
Joyce, M.*	Operations	✓	✓	✓	✓
King, J.*	Science	✓	✓	✓	✓
Kronlund, R.*	Science	✓	✓	✓	✓
McFarlane, S.*	Science	✓	✓	✓	✓
Moores, J.*	Science (Ottawa)	✓	✓	✓	✓
Nagtegaal, D.	Science		✓a.m.		
Rutherford, K.	Science	✓	✓	✓	✓
Saunders, M.*	Science	✓	✓	✓	✓
Schnute, J.*	Science	✓	✓	✓	✓
Sinclair, A.* (Chair)	Science	✓	✓	✓	✓
Stanley, R.*	Science	✓	✓	✓	✓
Stocker, M. (PSARC Chair)	Science	✓	✓	✓	✓
Trager, D.*	Operations	✓p.m.	✓	✓	
Venables, N.	Science	✓	✓	✓	
Yamanaka, L.*	Science	✓	✓	✓	✓
External Participants					
Asp, B.	Fisherman		✓		
Dickens, B.	CGRCS[1]			✓	✓
Fraumani, B	PBCFA [2]			✓	
Greba, L.	Kitassoo Band Council			✓	
Healy, D.	Hook and Line Advisory Council	✓	✓		
Heggelund, H.	Hook and Line Advisory Council	✓	✓	✓	
Henshaw, T.	Halibut Advisory Board		✓		
Hilborn, R.	CGRCS and PBCFA	✓	✓	✓	
Humphreys, B.	Groundfish Development Authority	✓			
Koolman, J.	Hook and Line Advisory Council	✓	✓	✓	
McPhee, B.	Heiltsuk Tribal Council	✓	✓		
March, D.	CGRCS	✓	✓	✓	
Mose, B.	CGRCS	✓	✓	✓	✓
Pearl, G.	PBCFA	✓	✓	✓	
Sporer, C.	Halibut Advisory Board	✓			
Starr, P.	CGRCS	✓	✓	✓	✓
Turris, B.	CGRCS and PBCFA	✓	✓	✓	✓
Technical Expert					
Menzies, C	UBC		✓		

[1]CGRCS – Canadian Groundfish Research and Conservation Society
[2]PBCFA – Pacific Black Cod Fisherman's Association

Appendix 5: PSARC Groundfish Working Papers and Reviewers for November, 1999

No.	Title	Authors	Reviewers
G99-2	Slope rockfish assessment for the west coast of Canada in 1999	J. Schnute N. Olsen R. Haigh	1. R. Hilborn 2. W. Karp
G99-3	Flatfish stock assessment for the West Coast of Canada for 1999 and recommended yield options for 2000	J. Fargo	1. V. Haist 2. S. Gavaris
G99-4	Canary Rockfish assessment for 1999 and recommended yield options for 2000/01	R. Stanley	1. M. Saunders 2. R. Kronlund
G99-5	Pacific Cod off B.C.: Update 99	A. Sinclair	1. G. Thompson 2. P. Starr
G99-6	Sablefish stock assessment for 1999 and recommended yield for 2000/01	V. Haist R. Hilborn M. Saunders	1. M. Maunder 2. J. Schnute
G99-7	Estimate of 1998 recreational halibut catch in British Columbia waters	J. King T. Gjernes	1. D. Nagtegaal 2. N. Schubert
G99-8	Pacific Hake, Strait of Georgia Stock Assessment for 1999 and recommended yield options for 2000	M. Saunders G.A. McFarlane	1. R. Stanley 2. L. Yamanaka
G99-9	Review of the fisheries and biology of the Pacific Hagfish (*Eptatretus stoutii*) in British Columbia, with recommendations for biological sampling in a developmental fishery	K.D. Leask R.J. Beamish	1. D. Clark 2. G. Gillespie

Appendix 6: Summary of recommended yield options for 1996 to 1999 and their sources.

AREA	SPECIES	1996 YIELD OPTIONS	1997 YIELD OPTIONS	1998 YIELD OPTIONS	1999 YIELD OPTIONS	SOURCE
4B	Lingcod	Zero yield (no options proposed)	Zero yield (no options proposed)	Zero yield (no options proposed)	Zero yield (no options proposed)	Richards and Hand 1990
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	Leaman and McFarlane 1997
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	Richards and Hand 1989
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	Richards and Hand 1989
5C/D	Lingcod	Low risk yield 1000 t	Low risk yield 1000 t	Low risk yield 1000 t	Low risk yield 1000 t	Richards and Yamanaka 1992
4B	Pacific cod	No options proposed	No options proposed	No options proposed	No options proposed	Stocker 1987
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	Stocker and Welch 1998
5A/B	Pacific cod	No options proposed	No options	No change	No change	Stocker 1987
5C/D	Pacific cod	No fishery	No directed fishery	No change	600-1,500 t	Haist and Fournier 1998 Stocker 1998
5E	Pacific cod	No options proposed	No options proposed	No change	No change	Stocker 1987
Coastwide	Petrale sole	No options proposed	No options proposed	No change	No change	Fargo 1991

AREA	SPECIES	1996 YIELD OPTIONS	1997 YIELD OPTIONS	1998 YIELD OPTIONS	1999 YIELD OPTIONS	SOURCE
4B	Flatfish	No options proposed	300 t	300 t	300 t	Fargo and Kronlund 1996 Rice et al. 1997
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	Fargo and Kronlund 1996 Rice et al. 1997
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	Fargo 1989
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	Fargo and Kronlund 1996 Rice et al. 1997
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	Fargo and Kronlund 1996 Rice et al. 1997
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	Fargo and Kronlund 1996 Rice et al. 1997
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	Fargo 1990
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	Haist et al. 1999

AREA	SPECIES	1996 YIELD OPTIONS	1997 YIELD OPTIONS	1998 YIELD OPTIONS	1999 YIELD OPTIONS	SOURCE
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	Haist et al. 1999 Haist et al. 1999
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	Saunders and McFarlane 1997
3C	Pacific Hake	Joint arrangements with U.S.	Joint Arrangements wit h U.S.	Joint Arrangements with U.S.	Dorn et al. 1999	Stocker et al. 1999
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	Saunders 1994
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	Thompson 1994 Rice et al. 1995
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	Saunders and Andrews 1996 Rice et al. 1997
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	Saunders and Andrews 1996 Rice et al. 1997
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	Saunders and Andrews 1995 Rice et al. 1996

AREA	SPECIES	1996 YIELD OPTIONS	1997 YIELD OPTIONS	1998 YIELD OPTIONS	1999 YIELD OPTIONS	SOURCE
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	Richards et al. 1997
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	Richards et al. 1997
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	Richards et al. 1997
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	Richards et al. 1997
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	Richards et al. 1997
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	Richards, et al. 1997
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[1]	Low risk yield 110 t High risk yield 200 t	Richards et al. 1997
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	Richards et al. 1997

[1] *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	SOURCE
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	Richards et al. 1997
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	Stanley and Haist 1997 Stocker and Welch 1997
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	Stanley and Haist 1997 Stocker and Welch 1997
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	Stanley 1993 Humphreys et al. 1994
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	Stanley 1991 Irvine et al. 1992
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	Stanley 1994 Rice et al. 1995
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	Stanley 1994 Rice et al. 1995
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	Stanley 1996 Rice et al. 1997
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	Stanley 1995 Rice et al. 1996
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	Stanley 1995 Rice et al. 1996
Coastwide	Inshore rockfish	Rice et al. 1996	Rice et al. 1997	No options proposed	No options proposed	Kronlund et al. 1999

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