**Report to CIE**

**of**

**Alaska Fisheries Science Center Rockfish Review**
**June 19-23, 2006**
**Seattle, WA**

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**Executive summary**

The Goodman Report of 2002 stated that the harvest strategies for rockfish might be too aggressive. The AFSC staff responded to this assertion at that time, but the issue remains. This review was charged with the broad task of evaluating the assessment, projection and harvest strategies for Alaskan rockfish. The executive summary addresses the three specific items in the terms of reference (ToR), which are listed in Appendix B.

ToR a. Assessments
Although none were explicitly reviewed, the assessments appear to estimate stock status to usual assessment standards. Input and supporting data have been handled with care, especially recently, as is evidenced by the Observer coverage. The GOA and BSAI stocks are analysed with similar but not identical formulations. Stock-recruit relationships are not estimated. Trials leading to standardization should be developed. More attention should be given to the formulation of informative priors and the balance of the likelihood function. The uncertainty is not handled quite so well and more care should be expended in improving this aspect of the generation of biological advice to management.

ToR b. Projections

Projections are produced by separate programs from the assessment model and only uncertainty in the recruitment process is carried into them. Uncertainty in the starting standing stock for the projections as well as key parameters should be carried through to the projection phase. In Tier 3 stocks this could be done by capturing the MCMC replicates or by parametrically approximating key distributions for bootstrapping.

ToR c. Harvest strategies

The harvest strategies are cast in a 6 tier system which range from complete statistical models of the stock and reference points (Tier 1) down to stocks for which there is essentially no data (Tier 6). The rockfish stocks in this review were all Tier 3 or 5. The harvest control rules for the Tier 3, and above, stocks have a constant fishing mortality for stocks that are above Bmsy or proxy with a linearly decreasing ramp as biomass falls, a commonly accepted form. Although setting Bmsy as a limit rather than a target is fairly conservative. Tiers 4-6 do not have a biomass reference point. The tier system is a qualitative attempt to incorporate precautionary considerations as the amount of information decreases. Generation of advice within AFSC framework requires the assessment authors and the Plan Team (an internal review panel) to recommend a buffer between the biologically defined maximum ABC and the advised ABC, apparently using subjective criteria. This sort of ‘precautionary science’ is not permitted in most forums for the generation of harvest advice with which I am familiar. A move to more quantitative and objective linkages between uncertainty and precautionary advice should be developed.

In summary, there was very little indication that the generation of advice and the resultant harvest strategies were too aggressive. It is less clear that they may not be too conservative. Considering the divergence seen in the supporting science for the current proxies for OFL and maxABC, the current values seem appropriately placed.

**Background**

The Terms of Reference for this review (Appendix A) give a brief introduction to the AFSC (Alaska Fisheries Science Center request for a review of their assessments, stock projections and biological advice for resource management. There is a perception held by some (e.g. the report of Goodman et al.(2002) that the rockfish resources in the Gulf of Alaska (GOA) and Bering Sea/Aleutian Islands (BSAI) may be being fished too aggressively. Asymmetrically, there were no suggestions that the approach was too conservative.

Biological advice on harvest levels for the Alaskan rockfish is cast with in a hierarchical system having 6 tiers which reflect the amount of information available for and from the assessment. The most complete is Tier 1 which has "Reliable point estimates of B and $B_{MSY}$ and reliable pdf of MSY". The lowest tier assumes that there is only a knowledge of the catch history. The stocks which were reviewed were either Tier 3 (a fairly complete assessment without posterior distributions) or Tier 5 (reliable estimates of biomass and natural mortality).

The scope of the review was quite broad covering input data, supporting science, analytical methods, projections and harvest strategies. Hundreds of pages of background information were provided on an FTP site. Although 5 days were slated for the meeting, only three were used in presentations. A member of AFSC kindly came in on the morning of the fourth day to report on some requested analysis and answer final questions from the CIE members.

We were asked specifically to consider the following terms of reference (ToR).

a. A statement of the strengths and weaknesses of the input data and analytical approach used to assess stock condition and stock status and methods used for addressing uncertainty in the assessment.
b. A statement of the strengths and weaknesses of the simulation (*taken to mean projection RKM*) models, and the analytical approaches used in estimating future harvest levels.
c. An analysis of current harvest strategies. Specifically do they provide appropriate levels of conservation for Alaskan rockfish fisheries? What harvest control rules might be more appropriate? Are additional spatial management measures required?

The terms of reference were quite wide ranging; any one of them could have filled the week's review. ToR b. is somewhat ambiguous as written and I have interpreted it to pertain to the inputs and models used in stock projections. The parenthetical phrase is mine. We were encouraged by the AFSC representatives to comment in this report on any other topics which we felt might be useful. A sub-section in Recommendations titled "Review" has been added in response to this request.

The Panel and CIE members are as follows:

Phil Rigby - AFSC-Auke Bay Lab, Juneau AK
Jon Heifetz - AFSC-Auke Bay Lab, Juneau AK
Dana Hanselman - AFSC-Auke Bay Lab, Juneau AK
Paul Spencer - AFSC-Seattle
Anne Hollowed - AFSC-Seattle
Martin Dorn - AFSC-Seattle
James Ianelli - AFSC-Seattle
Jennifer Ferdinand - AFSC-Seattle
Dave Somerton - AFSC-Seattle

Mark Wilkins - AFSC-Seattle
Dan Kimura - AFSC-Seattle
Craig Kastelle - AFSC-Seattle
Betty Goetz - AFSC-Seattle
Grant Thompson - AFSC-Seattle
William Stockhausen - AFSC-Seattle
Ben Muse - NMFS Regional Office in Juneau
Jane DiCosimo - North Pacific Fishery Management Council, Anchorage, AK

CIE
Patrick Cordue – Innovative Solutions, NZ
Cynthia Jones – Old Dominion U., USA
Robert Mohn - DFO, Canada

The meeting was rather informal and consisted mostly of a series of presentations. No minutes were taken and either Anne Hollowed or James Ianelli acted as chairs. Staff members, either presenters or other interested personnel, were all most helpful and responsive to our requests.

**Introduction**

After an introduction, each of the terms of reference (See Appendix B) will be discussed in turn. After that a section dealing with various recommendations are discussed. Specifically they are this and future reviews of this sort, technical issues related to assessments, and future methodological considerations.

This review is in response to "numerous requests for review and comment on the harvest strategy currently used for management of Alaskan rockfish". From the various presentations it was revealed that the bulk of these requests were related to concerns that the harvest strategy was too aggressive. Most often mentioned was the report of Goodman et al. (2002). The AFSC responded to this report in 2002, but concerns have remained. Although not ascribed to specific sources, there was mention of the fear of local depletion or depletion of rare species/sub-stocks. These concerns were also heightened because of the over-arching Environmental Impact Study that is underway.

Goodman et al. (2002) reported that F35-40% was too aggressive for rockfish because of low productivity and low resilience. While resilience is well understood in the vernacular as the ability of a strained body to recover, its usage in fisheries science less well defined. In fact several definitions were used during this meeting, one of which was the ability to withstand high levels of exploitation.

The AFSC response agreed that it was reasonable to say that rockfish have different fundamental biology (viviparous, long-lived, asymptotic growth…) but this did not signify that they lacked resilience. They felt that some of the problem might be in confusing west coast rockfish (south of British Columbia, with northern rockfish (Alaskan waters). Alaskan rockfish stocks in the Gulf of Alaska (GOA) and Bering Sea/Aleutian Islands (BSAI) are in prime habitat and have not been overfished to the degree of the West Coast stocks. Recruitment dynamics in the marginal habitat would be expected to be more dependent on random environment effects. Moreover, it was expressed that the northern rockfish were in general better managed as evidenced by the survey coverage, observer coverage and constrained levels of removal.

The case of the AFSC that their assessment-harvest strategy is not too aggressive would have been made more forcefully with a summary of stock histories. See Appendix C for an example of how this could have been done. Certainly the proof of the pudding is in the condition of the stocks. The Recommendations section below will make a number of suggestions on this point.

Recommendations are presented in two ways. Several are made as the terms of reference are discussed. It seemed better to leave them in context. Then a Recommendations section follows. Five appendices including a glossary are included.

**ToR a) A statement of the strengths and weaknesses of the input data and analytical approach used to assess stock condition and stock status and methods used for addressing uncertainty in the assessment.**

Although none were explicitly reviewed, the assessments appear to estimate stock status to usual assessment standards. Input and supporting data have been handled with care, especially recently, as is evidenced by the Observer coverage. The GOA and BSAI stocks are analysed with similar but not identical formulations. Stock-recruit relationships are not estimated. Trials leading to standardization should be developed. More attention should be given to the formulation of informative priors and the balance of the likelihood function. The uncertainty is not handled quite so well and more care should be expended in improving this aspect of the generation of biological advice to management.

**Input Data (survey, Observers, aging)**

The survey has employed 3 vessels of similar size and type. The AFCS does not believe that there is a vessel effect and that a skipper effect is controlled by strict standardization. They found that a great deal of the 'vessel' effect was due to the skipper and the little things they did differently. These protocols took a while to establish and the early data may well need distinct q's and/or selectivities. Probably the only way this can be investigated is by sensitivity runs or perhaps a meta-analytical approach.

A study investigating adaptive cluster sampling for rockfish was reported upon. The adaptive approach did not improve precision much of the same magnitude as placing a few more sets in high variance strata. Although not too promising, it is valuable to have carried out the investigation.

AFSC is to be complimented on the improvements in 2000 to their observer coverage. It would be the envy of many fisheries. All the vessels over 125 ft are covered as well as 1/3 of smaller (60-125 ft) vessels; those under 60 ft, which are just a few longliners, are not covered. As well as the direct benefits to catch sampling and reconstruction, it might provide some catch rate series that even if not used in tuning assessment models could be used to bridge the survey/assessment view of the resource to the fishery perception or CPUE data.

As well as assessing inter-reading precision, age validation using bomb produced radiocarbon was reported on. While most of the data fit the time trend in the atmospheric radiation, four, or about 10%, did not. It was not clear whether these four were aged wrong or for some reason were not exposed to the C14 signal. An examination of when and where these four were caught might give some insight. To resolve this anomaly more sampling is required or perhaps renewed investigation of aging criteria and geo-referenced data on capture locations and depths.

Given the difficulties in aging redfish the AFSC is doing an admirable job. As the rockfish are long-lived, the sampling requirements for supporting an age-based model are considerable. Their attention to detail, quality control precision and accuracy is not exceeded by the labs I have visited over the years. With any move to finer spatial scale management, the demands for aging samples will be increased. Studies would be required to assess the gains in spatial resolution with the loss of precision within each assessment/management unit.

**Stock structure**

Stock structure is an important issue because of the possibility raised of local depletion. The available information on stock structure was very limited. Rockfish are very difficult to tag because they have swim bladders which compromise survival. Spawning locations were not known. Although survey coverage is limited, the Observer program may provide an opportunity for sufficient seasonal sampling to focus in on the spawning of at least the major species. It was reported that saw some difference was seen in growth parameters within a species which could indicate some degree of stock definition.

Genetics studies have led to some improvement in speciation, two rougheyes were identified. In one study (blackspot) it was reported that there was some suggestion that the production areas were smaller than the management areas, but the sampling was insufficient as individual cohorts were not identified.

A request was made if we could comment on the management areas with respect to the population structure implied by the blackspot genetic data. If indeed the stocks are smaller than the management area, local depletion or even more seriously the removal of self-sustaining, units, could occur. The preferred solution is to identify stocks and manage accordingly. This may be difficult to achieve. In the situation of incomplete stock definition, it may be possible to devise strategies (spread over time and area) that are robust to the indeterminedness. I am not aware of any citable references but this problem should be amenable to simulation.

**Natural mortality**

Estimation of natural mortality is a wide spread problem in fisheries assessment and perhaps a bit more serious in rockfish than for shorter lived finfish. In some cases M was estimated in the assessment model and in other cases the oldest age was externally obtained using Hoenig's method. Other regressive methods have been published and investigation of the suite would give a better idea of M and its uncertainty. It is better practice to not define a distribution by its extrema and some sort of Winsorizing should be used. If M is fixed in this way, a variance penalty derived from other assessments (either the additive or multiplicative difference between M estimated and M fixed) should be considered when estimating uncertainty. If M is to be estimated, priors for M should be set at a pre-assessment meeting as a provisional model. This is common problem in assessments and coordination with NWFSC should be beneficial to both groups. Also, with such a long lived species sensitivity to the size of the plus group should be examined. Also, if all the selectivities are domed, the model could generate "phantom fish" which could be a fair proportion of the estimated biomass for rockfish.

**Maturity and reproductive potential**

Many rockfish are relatively late maturing, at ages from 15 -25 years and the requisite data are hard to obtain. The SPR is sensitive to the age of maturity and it may be expected to vary with density or changes to the environmental regime. Fortunately the effects are easy to simulate and

sensitivities runs can assess the probable range of the impact. Until definitive data are available, if ever, it is important that this uncertainty be captured.

A black rockfish study showed that older females have higher than proportional reproductive success. The effect of the maternal age factors of reproductive success were evaluated with respect to biological reference points. When SPR was evaluated, the maternal factors tended to produce more conservative reference values. Thus, if older fish are more valuable, then they should be protected more. However, when stock-recruit functions were included in the analysis, there was a degree of compensation and it was concluded that this should not be a factor. It would be an easy sensitivity run in the Tier 3 models just to get a felling for the impact with the more complete models. (Perhaps this has been done and was not reported.)

An encouraging blood analysis was mentioned that would identify if the fish had ever spawned. This would help to discriminate between resting and immature fish. Improvement to maturity ogives is important because of the sensitivity of SPRs, which are in turn used in the definition of biological reference points.

**Analytical approach**

More care is needed in the definition of the likelihood function. The practice of natural weighting in which the variances and degrees of freedom are matched to the data should be considered. Similarly, the use on weightings (lambdas) in the likelihood should be reserved for sensitivity runs. One specific instance mentioned was the variance for the aging data. AFSC uses the square root of the sample size. Now Zealand uses bootstrap estimates. Mention was made of Chilean who just completed a thesis on this topic. This may not be a major factor, but best to clean it up. The variance on the stock-recruit relationship (often called sigmaR) can be difficult to estimate. See for example M.N. Maunder and R.B. Deriso. (2003. Estimation of recruitment in catch-at-age models. Can. J. Fish. Aquat. Sci. 60:1204-1216.). Uncertainty in the reproductive process is the only uncertainty to be carried through to the projection phase. The only current use the uncertainties from the posteriors appears to be in setting the buffer on ABCs. More rigor and objective procedures need to be incorporated. As mentioned above, similar problems are under consideration by NMFSC.

Although basically similar, a divergence exists between the assessment models used in GOA and BSAI stocks. These differences are shown in Appendix D. It was not mentioned how they came about. In a presentation, three runs were shown in which the same data was used by both models. Read off the graphs, the differences seemed to be on the order of 10-15% mostly in the first few and last few years. A difference of this magnitude in depletion could affect the harvest rate for stocks under Tier 3 with its Bmsy reference.

**Survey catchability, q**

A fair amount of time was spent on problems related to survey catchability; both its magnitude (especially when greater than 1) and to constructing useful priors. This discussion was aided by some submersible work which gave a better understanding to the fraction of ground in each sampling unit (the small squares into which the survey area is divided) which was trawlable. The assumption that the untrawlable bottom has the same density as the trawlable is not in general founded. If the untrawlable bottom has a relatively lower abundance, the q will be biased above 1. When this is coupled with the practice of searching within a sampling unit for trawable bottom, results will be biased. This problem is amenable to modeling and if combined with more submersible data (or possibly high resolution high resolution hydroacoustic data) should be

resolvable. The resultant increased understanding of the distribution of rockfish, their habits and sampling design will aid in the determination of more informative priors for q's in the assessment modeling.

The earlier surveys had longer tow times which may affect the stationarity of q's. Furthermore, it was reported that POP was very evident in echosounder. When skippers select "good bottom" within a sampling unit square they could well be influenced by presence of fish in the sounder. Although they have been trained not to, but they are savvy enough to realise it could have an affect TACs. Also, if the prevalence of this practice has changed in time, it could cause a drift in q's. If data were available to quantify changes to q over time, they should be investigated.

A submersible transect survey for yelloweye rockfish was reported on. As well as a possible (potentially absolute) index for model tuning, it may provide further insight into the performance of the survey gear.

**Ecosystem considerations**

One ecosystem consideration that was discussed was the bycatch of non-target species, so-called technical interactions of rockfish assemblages. Biological interactions, either predator-prey or habitat competition were not discussed. Because there was not strong piscivory among rockfish and it is not a major prey item, it was explained, there was less need to develop MSVPA or food web models.

Although perhaps not a true ecosystem concern, the possibility of local depletion was an issue that arose a number of times. Local depletion need not be caused by fishing and is confounded with the identification of critical habitat. A distinction must be drawn between a contracting stock which appears as sequential loss of local habitat and the less serious local but temporary depletions in an expanding or stable stock. The latter case seems to be more typical of Alaskan rockfish. Detailed analysis survey and commercial catch rate data should be continued to get a better feeling for the nature and extent of local depletion.

A report was made on 3-dimensional hydrodynamic modeling which uses IBM larvae with diurnal migration. The goal was to identify areas of larval retention to develop inferences of probable stock structure. Also, it could be used to identify areas that are self-recruiting to aid in the definition of potential reserves. The model incorporated the pelagic larval stage (2 months max) but not the pelagic juvenile stage. The model did not have a tidal component, so the interaction between diurnal larvae and the phase of the tide could not be assessed. This was seen to be a major influence in Rothlisberg et al. (Modelling the advection of vertically migrating shrimp larvae. 1983. J. Mar. Res. 41:511-538) but I do not know how important it might be in Alaskan waters.

The Aleutian Islands were more retentive irrespective of surface, depth or diurnal pattern but the author said these were preliminary results. Also, there is the problem that juveniles tend not to live with adults. Having a complex life cycle suggests that you would have to protect all three domains (larval source, juvenile and non-spawning adult) and not just the parturition site. This implies much larger MPAs would need to be considered.

**ToR b). A statement of the strengths and weaknesses of the simulation (taken to mean projection RM) models, and the analytical approaches used in estimating future harvest levels.**

Projections are produced by separate programs from the assessment model and only uncertainty in the recruitment process is carried into them. Uncertainty in the starting standing stock for the projections as well as key parameters should be carried through to the projection phase. In Tier 3 stocks this could be done by capturing the MCMC replicates or by parametrically approximating key distributions for bootstrapping.

The recruitment for projection is from an inverse Gaussian (stationary) model. This approach is insensitive to any trend in recruitment (or recruit per spawner). This may not be too important as rockfish are so long lived.

Projection model is essentially uncoupled from the assessment model, and it does not capture the uncertainty from the posteriors distributions of the model parameters. Unlike the assessment software, the projection software is common between GOA and BSAI assessments. The only difference is that recent recruitment is estimated by GOA and the log mean is used in BSAI projections. The only uncertainty in the projections is in recruitment variability. This practice was justified as it was simpler and more communicable to the Council.

Seven scenarios are routinely carried out in compliance with MSFCMA. They explore a range of F levels that are likely to bound future TACs and catches. It some cases they will be used to assess if an overfished status is anticipated. They are not used to capture uncertainty or risk although within each scenario 1000 recruitment replicates are used. This would of course be an under-representation of uncertainty about future states of the resource.

It was reported that there was an informal group working on improvements to the projection methods and package but it was not reported what their priorities and time-table were. This body should consider the incorporation of uncertainty in the starting standing stock for the projections as well as key parameters should be carried through to the projection phase. In Tier 3 stocks this could be done by capturing the MCMC replicates or done by parametrically approximating key distributions for bootstrapping.

**ToR c). An analysis of current harvest strategies. Specifically do they provide appropriate levels of conservation for Alaskan rockfish fisheries? What harvest control rules might be more appropriate? Are additional spatial management measures required?**

The harvest strategies are cast in a 6 tier system which range from complete statistical models of the stock and reference points (Tier 1) down to stocks for which there is essentially no data (Tier 6). The rockfish stocks in this review were all Tier 3 or 5. The harvest control rules for the Tier 3, and above, stocks have a constant fishing mortality for stocks that are above Bmsy or proxy with a linearly decreasing ramp as biomass falls, a commonly accepted form. Although setting Bmsy as a limit rather than a target is fairly conservative. Tiers 4-6 do not have a biomass reference point. The tier system is a qualitative attempt to incorporate precautionary considerations as the amount of information decreases. Generation of advice within AFSC framework requires the assessment authors and the Plan Team (an internal review panel) to recommend a buffer between the biologically defined maximum ABC and the advised ABC, apparently using subjective criteria. This sort of ‘precautionary science’ is not permitted in most forums for the generation of

harvest advice with which I am familiar. A move to more quantitative and objective linkages between uncertainty and precautionary advice should be developed.

Scientific advice on harvest levels is produced within a tier system which defines rules as a function of the amount of information about the resource. Biologically defined advice on removals is incorporated into four cascading levels OFL, maxABC, ABC and TAC. The highest is OFL and if the OFL is exceeded it may cause the cessation of both directed and by-catch fishing. The next reference is the maximum ABC and it is set somewhat lower than the OFL. This is a limit at which a fishery may be closed rather than a target as it is in some cases. For example in Tier 3 fisheries it is the difference between F35% and F40%. For Tier 5 the reduction is 25%. There is a buffer between the maxABC and the advised ABC which may include qualitative or other information. ABCs may be subdivided into smaller geographical areas. The ABC then is reviewed by the Advisory Panel, which includes NGOs and Industry, and passes on to the Council, where TACs are set. If the TAC is exceeded landings are halted but bycatch (regulatory discards) may continue. During the presentation it was mentioned that some work had been done evaluating the tier system, but it was not made available during the review.

A presentation was made on the limited progress on the development of more objective determination of buffers between OFL and ABC. The four stocks that I looked at in Appendix C showed that on average over the last two years ABC was 84% of OFL, TACs were 75% and catch was 67% of OFL. The OFL-ABC step is fairly well defined while the others are more subjective. Information on maxABC to ABC was not evident in the reporting of these 4 stocks. B40% means the F40% from SPR times recent average recruitment. This is the type of evidence-based summary that, if applied to all the rockfish, would have helped objectively assess how conservative or aggressive the management system is. For the four Tier 3 stocks used for illustration in Appendix C, the ABC/OFL was 84% and TAC/OFL was 75% and Catch/OFL was 67%. I extracted similar data for one Tier 5 stock, the GOA shortraker rockfish. The ABC/OFL was 75% by definition and in 2005 the Catch/OFL was about 50%. Interestingly the TAC was set at the ABC, i.e. no buffer, even though up to 2002 catch met or exceeded the TAC.

In higher number tiers there is no B threshold. If B were falling for several years the discretionary buffer would be invoked by the author/plan team. Presumably this is done on the basis of some subjective criteria of a threshold biomass indicator or proxy.

On a minor note, there appeared to be some confusion amongst the tiers about what biomass was being talked about, SSB, female SSB, Btotal and Bexploitable.

The question of the appropriate BRPs for rockfish is fundamental to this review. Many reports were cited on the determination of appropriate proxies for Fmsy. The Goodman report mentioned Clark (1991, 1993, 2002), Maccall (2002), and Dorn (2002). More recently Hanselman and Spencer and Dorn (2003) have addressed the problem. Iannelli and Heifeitz (1995) found F44% was best for BSAI rockfish Also Ianelli (2002) and Maccall (2002) felt F35 and F40 was too aggressive for WC(?) rockfish. Dorn (2002) found Alaskan stocks tended to have higher h and that F40% was less than Fmsy. Spencer and Dorn (2003) again determined that F40% was less than Fmsy. Most of these felt that F35-45% was appropriate for Alaskan rockfish. For West Coast rockfish the advised F was set considerably lower. While there is variation amongst these sources, the preponderance of evidence supports the current tier's values.

The Goodman report suggests that it is fortunate that rockfish experienced a regime of continuing productivity. No information was presented on how this regime was defined, but it was said to have begun in the late 1970s and has recently (2002) ended. Neither was any indication given,

either in Goodman or other presentations at this review, of the magnitude of its influence. This suggests that even if the harvest strategy is appropriate for current conditions a transition back to 'normal' productivity may be expected to take place. If a transition were to take place how long before it could be detected. Because of the longevity of most rockfish and the low exploitation rates, some time should be available for the detection of the change before things go to far awry. The characteristics and influence of regimes should be evaluated and contingencies drawn up for the appearance of other regimes.

Requests have been made for more conservative alternative (F75 and F60%). In some cases this was because the proponents think they are appropriate for Alaskan rockfish, and in others because it would give another scenario for evaluation of projections. Until there is some justification for such conservative options, these runs added to the current seven seem superfluous. A bigger issue is the need to develop some sort of currency to compare conservation and utilization. Such socio-economic analysis is well beyond my expertise to comment on.

A brief presentation was made on the evaluation of the tier system. The tier system was first put in place in the late 1980s and most of the work done in Tier 1. The higher number tiers then used Clark's work on proxies. Work of evaluation of the rules has seemingly been inhibited by PSEIS and the MSFCMA revision. Tier 6 was specifically mentioned as needing more work and guidance given. However, there are no targeted fish or rockfish currently in Tier 6. This work should be done, even in advance of MSFCMA. Although the tiers may not be able to be changed, having the simulations and analytical tools working and reviewed is valuable in their own right and would allow

The description of the tiers uses the word "reliable" in relation to data and the estimation of various quantities is used in all the tiers. I could not find any definitions for its usage in these contexts. Reliability seems strained for the Tier 5 stocks given the difficulties surround survey q's upon which the biomass is based. It would be useful to tighten up the meaning of reliable, which would presumably be context and tier dependent.

**Recommendations**

This section first looks at the structures and processed that are relevant to this review. The second is on the developmental aspects of assessments and the third is on diagnostics and reporting of the production of assessment advice. Not surprisingly, many of these topics and recommendations are discussed and presented in Courtney et al. (2006) and in Report of the Rockfish Modeling Workshop which was held in May of 2006. The latter source concludes with 10 specific short term recommendation and 13 long term ones.

**Review**

Meetings with agenda of this magnitude are not well matched to independent reviewers. The Goodman team had seven people working together and the assistance of Grant Thompson; they also had several months to complete the task. Although they had more species to cover, they were focused on harvest strategies and ecosystem considerations (See pages 1 and 11 of Goodman et al. 2002). While we only had rockfish, we were responsible from data through to harvest strategies. Also we are working independently so it was not easy to match talents/expertise to topics. The ability of the team exceeds the sum of the individual members. Team efforts like the Goodman 2002 review should be done on a regular schedule, say every 4-6 years. The process should be institutionalised thereby assuring accountability and continuity. Recommendations and progress towards these recommendations would be explicit and publicly available.

Specific to this meeting, it was not well organized up front. There was insufficient focus on specific topics and their resolution. For example it was not obvious to me until well into the meeting the degree of discretion that the authors, Plan Team and SSC had. It would have helped to have had one session that walked through a Tier3 and a Tier 5 assessment from model formulation, diagnostics and run selection through to ABC and any subjective corrections. Emphasis should be placed on diagnostics and any subjective or precautionary interventions. Given the unusually large amount of material, at least compared to most assessment reviews with which I am familiar, just a little structure linking the presentations to documents and issues would have eased the navigational burden.

If the Chair had introduced the meeting with the three (or so) main issues and outlined the approach to be taken for each, the relevant presentations on each could have followed. Instead we received several thousand pages of principle and background material and in some cases fairly broad presentations that were not matched to specific issues.

As well as more focus in the objectives, the data should have been summarised better to provide objective criteria on the science and management of northern rockfish. The only indication we were given was a summary table of depletions which I requested. They do suggest stocks near Bmsy.

| Stock | Depletion |
|---|---|
| GOA Dusky | .54 |
| GOA Dusky | .54 |
| GOA Northern | .50 |
| GOA Pop | .42 |
| GOA Rougheye | .48 |
| BSAI POP | .39 |
| BSAI northern rockfish | .58 |

Appendix C shows a couple of examples of the kinds of summary that would have helped assess performance of the assessments and subsequent management. In the first example, the trajectories of four stocks are superimposed on their harvest control rules, at least to the ability I had at my disposal. This, when done correctly, quickly shows if the science/management has been doing and if they have been too aggressive. The second example in this appendix is getting an indication for the magnitude and frequency of buffers.

The question of an appropriate harvest strategy was presented in an asymmetric manner. It was not was the harvest strategy the best under some stated criteria but rather was it too aggressive or failing to protect some species. Optimality would be hard to defend without extensive analysis and simulation. Stating the criteria for evaluation alone is a daunting task. The one-sided question of being too aggressive is easier to deal with. A sort of Boolean sieve for stocks could have been constructed. First remove all stocks above Bmsy, then those that are recovering under the current harvest strategy. The few stocks that the sieve failed to remove could then be analysed on a case-by-case-basis. Of course, the question of being too conservative still has not been addressed.

The assessment receives a two-stage explicit review in that the author first goes to the Plan Team and then both the author's preferred model, and if different the plan team's, go to an SSC. The SSC provides feedback on the assessment which is incorporated into the final SAFE document. Other jurisdictions have formal (STAR, SEDAR, SAW/SARC) review procedures. The

presentations did not make clear how much external peer review the products were exposed to. Another advantage of formalizing the review is a paper trail of recommendations and their refutation or progress against them. The lack of external review may not be so serious because of strong corporate continuity, every year same teams are doing the same assessments. However, the AFSC is going to a 2 year review cycle. There is some SSC feedback but that seems to be mostly within an assessment cycle.

The presentation did not make clear what opportunities the Industry had to balance the apparent conservatism of the current practices. Although they are on the Advisory Panel, can they make submissions concerning data, changes in fishing practices that could affect the assessment models or any other area in which their experience on the water would give insights? Industry input in conjunction with social and economic considerations could produce a metric on the importance of foregone yield.

**Assessment development**

There are two distinct phases of resource assessment which may be called production and benchmark. In the former, advice is generated for resource management. In the worst case scenario this devolves into the mechanical and dangerous "turning the crank" Benchmark sessions are those in which better tools and techniques are developed and disseminated. It does not work well when both these objectives are attempted at a single meeting.

A number of research initiatives into the assessment process were mentioned during the presentations, new projection software, harvest strategy evaluations, setting priors for q, etc. It was not clear how topics were given priority, who reviewed them or by what criteria they were evaluated. This process should be formalized. SigmaR, natural balancing of the likelihood and diagnostics are obvious topics. The diagnostics should include standardized residuals, likelihood profiles and generalized retrospective analysis. By generalized it is meant that various data windows be explored not just peeling the last few years off the assessment. Given the wealth of talent in the Seattle area, including the AFSC, NWFSC, IPHC and UW, and the commonality of many assessment problems, a collegial approach should be possible. Although significant resources are required, there may be precedents or political obstacles of which I am unaware. This is an 'off' year for NMFSC and I believe a number of workshops are already planned.

The incorporation of uncertainty should be standardized and done in a more objective manner. Uncertainty, at least in qualitative sense, is done by adjusting the maxABC to a lower ABC. The bracketing runs (somewhat inaccurately called "states of nature") used by the NWFSC to incorporate uncertainty have no analog here. The Tier 3 assessments can produce pdf's for parameters and state variable and indeed approximate confidence limits are seen in SAFE document figures, but they are not incorporated in the projections. Nor do they seem to be used to produce any sort of risk plots of management quantities such as the probability of exceeding the target F. All of these comments are predicated on availability of defensible posterior distributions. Although I was critical of the "states of nature" spanning the "dominant dimension of uncertainty" in the NWFSC assessments I reviewed last year because it was incomplete. (A description appears in Anon. 2005. Groundfish stock assessment and review process for 2005-2006). Such an approach could be considered at least as an interim solution as it is more comprehensive and more objective than what is being done now.

As well as topics for development shared with other institutions, some are special to AFSC. The unfished biomass seemed to need some focus. In other assessments it is explicitly estimated as the biomass before fishing, or at least catch data, began, and can be thought of in the sense of the

carrying capacity. This would be SPR (0) times the plateau of the stock-recruit relationship. Using a biomass defined from recent recruitments times SPR(F=0) as Binit could be a problem. It has a built in conservative element in that in most cases it would be less than B0, the unfished or virgin biomass. Similarly, B100% is SPR (F=0) times the average recruitment. But AFSC uses recruitments are from the 1970s to present they certainly are from a stock that has been exploited. They may be neither average nor asymptotic. A brief session looking the appropriate biomass to apply fishing references to would be warranted.

Data workshops probably should be scheduled separately as many of the same people would be involved. There seem to be fewer data issues in the short term that need addressing.

Considerations should be given to the compilation of a couple of simpler models and data summaries to accompany the full Tier 3 or higher model. Either non-parametric (Loess, kernel…) fits to the survey data or the Kalman filter model that Spencer and Ianelli presented would be good candidates. The Kalman filter was a nice example which was used on Tier 5 stocks (catch data and survey indices). As well as single stocks, the authors showed an example where it was used to a two species complex. It also showed a cumulative distribution function of exploitation which is in the standard form of risk analysis. The model was used for some harvest strategy evaluation and comparison with age structured results. Although encouraging, the results seemed preliminary. This model should be further tested with Tier 3 stocks. An operational model using the Kalman filter might also be a useful extension of the approach. It is an intermediary model to simply smoothing abundance indices. Keeping close to the data builds in a sort of ground-truthing.

The evaluation of HCRs within the tier system needs to receive some priority. One concern is the lack of any biomass references in the more data poor tiers, in the rockfish case tier 5. The other is the loss of uncertainty between the assessment process and the projections. And similarly, the apparent separation between quantifiable uncertainty and the degree of precaution advised. Operational models that include stock dynamics, estimation uncertainty and implementation uncertainty would be required. Larger scale initiatives like meta-analysis or hierarchical models represent promising insights as well.

**Assessment production**

As well as for benchmark sessions, complementary models chosen in benchmark sessions should be used in routine assessments as well. With the pressures of more assessments with fewer people to produce and review them, some automation and streamlining will have to be adopted. Standard output formats and a core standard suite of models and diagnostics would help. Too much automation is dangerous and time still needs to be spent thinking about what's being presented.

It would be valuable to institutionalize historical retrospective summaries to complement the windowed retrospective analysis mentioned above. In the situation where time for contemplation during assessment review becomes increasing limited a simple plot of the B-F trajectories from successive assessments quickly spots when a perception has changed. Then the question of parsing out the cause among new data, new analyses or whatever can at least be limited to when it happened and was it sudden or a drift.

The divergence between GOA and BSAI models could be addressed by doing the POP and northern rockfish with both models routinely, with just a base run. More complete analysis of the two should be reserved for a benchmark session. However, if the duplication were done routinely hopefully some conclusions about the superior approach would accrete. A second benefit, if both

models are plausible it gives a limited indication of model uncertainty which could be developed and joined with process and measurement errors to develop a more complete picture of uncertainty.

The question of too conservative versus too aggressive could be put into some perspective by partitioning surplus production into harvest and growth. One way to present this is in the following figure.

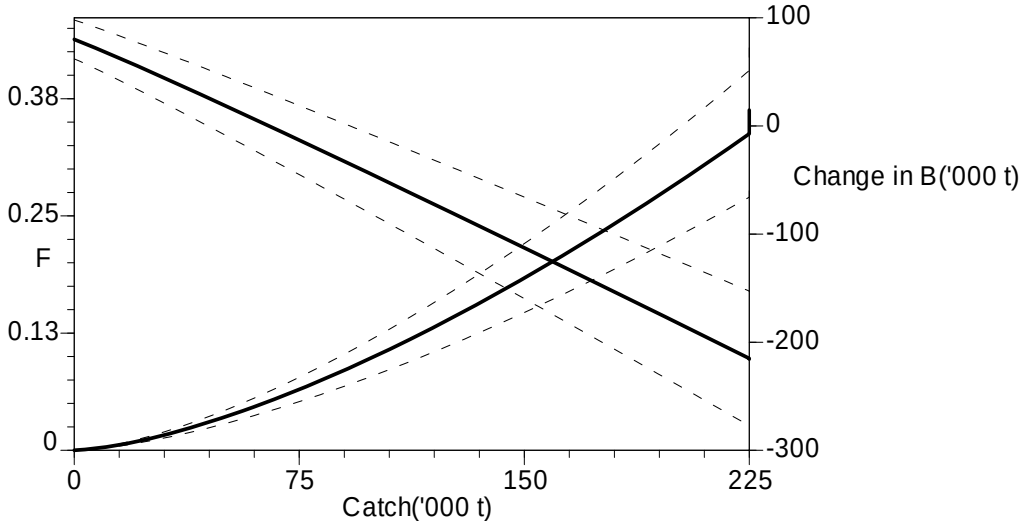


Figure 1. Illustration of the resultant F and change in biomass for a catch in the first year of a projection.

The trade-off in production between catch and biomass accumulation is seen at any harvest level for the next year. There is a continuous scale from conservatism to high exploitation along the x-axis and the two y-axes show the fishing intensity required to get the catch and the cost in terms of gain or loss in biomass. Summarizing over more than one year is possible but requires a few assumptions. Also, partitioning production into biomass growth (g-M) and recruitment factors can illuminate underlying processes with regime change. Of course this assumes that time dependent growth and M can be estimated.

**Other issues**

Resiliency received considerable attention in Goodman et al. (2002) and in the AFSC response (Comments on the 2002 independent scientific review of the harvest strategy currently used n the BSAI and GOA groundfish FMPS, Staff AFSC). The argument was that rockfish might be less resilient than other species and thus B35% was not an appropriate proxy. In the AFSC staff's response a definition was given based on SPR analysis. In the vernacular it would seem that the resilience of a stock would be a measure of how probable it was to recover from a depleted state. This is a very difficult thing to assess unless some stocks are driven low enough so that they do not recover. For at least the major rockfish setting the B limit at the MSY proxy (even if it is a little off) should assure that this would never happen and resiliency is rendered moot. Secondly, SPR arguments would seem to be inadequate to address this issue. They leave out stock-recruit dynamics and ecosystem considerations that may only become apparent at a severely depleted state. Although arbitrary due to the lack of relevant data, the alpha parameters in the Tiers 1-3 would seem to better way to address resilience in the sense of the probability and speed of recovery.

In some instances it appeared that the survey abundance grew too fast to be credible for rockfish. In Tier 3 stocks this information would be balanced by length and age frequency data and constrained by priors and model dynamics. An analysis of residuals and profiles of weighting components of the likelihood should put the abundance data in context. This represents more of a problem for Tier 5 stocks which are based solely on aggregated catch and survey data. If the abundance index is noisy from year to year the situation is not too bad and can be captured in estimation uncertainty. If there are trends or regime-like shifts, we need to know why.

A similar analysis to assess the impact of fishing was reported in which the recruitment series from a stock (WC POP?) was grown out with F=0 instead of the historical fishing pattern and then the resultant population was iterated through a stock-recruitment curve. When this was done the depletion went from 0.2 to 0.4. It was concluded that fishing was not the cause of the stocks poor status. While it may be true, this argument is unconvincing. Taking a single trajectory through time and saying that no other trajectory (except as described above) would or could have happened if F had been 0 seems too speculative to me. Also, as the depletion is so low it is probably a West Coast stock and it is not clear that the conclusions would apply to Alaskan rockfish.

**Conclusions**

The primary issue seems to be whether or not the harvest strategies are sufficiently conservative. In my opinion, they are and indeed may be too conservative. There was not sufficient evidence to evaluate the probability of local depletion. The tier system is unusual but explicitly addresses the issue of what to do with decreasing information. It appears to be meeting its objectives but would benefit from more analysis, including some operational modeling.

Two aspects of precaution are unique, at least in my experience, to the AFSC approach. The first is the institutionalized “precautionary science” which is not only tolerated but required. Although the arguments seem to be lost, the magnitude of the buffer is explicit. The usual approach is to carry unbiased science to the managers and then they add other considerations only at the last stage of setting TACs. The second is that in many systems precaution is predicated on the availability of quantifiable uncertainty. This is not to say which approach is correct but it should be amenable to simulation and would be a good subject for and inter-agency workshop.

In conclusion, the stocks seem to be in the vicinity of, or heading towards, Bmsy. This is an indication of success that would be admired in many fishery management jurisdictions.

**Appendix A. Bibliography of Materials Provided.**

Before the review the Panel was provided with electronic copies of the following documents. The documents were maintained on an FTP site and were available throughout the meeting. (ftp://ftp.afsc.noaa.gov/afsc/public/rockfish/rfwg.html) Handouts were provided during the meeting and they are listed in A.2 Also, the PowerPoint presentation made during the meeting was added to the FTP site and is in A.3 below

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**A.1 Materials made available**

**SAFE Reports**


A'mar, T. et al. The Plan Team for the Pacific Groundfish Fisheries of the Gulf of Alaska. 2005. Appendix B. Stock Assessment and Fisheries Evaluation Report for the Groundfish Resources for the Gulf of Alaska. NPFMC. GOA Introduction 40 p.

Aydin, K. et al. The Plan Team for the Pacific Groundfish Fisheries of the Bering Sea and Aleutian Islands. 2005. Appendix A. Stock Assessment and Fisheries Evaluation Report for the Groundfish Resources for the Bering Sea/ Aleutian Islands Region. NPFMC. BSAI Introduction 30 p.

Clausen, D.M. 2005. Chapter 11 Shortraker and Other Slope Rockfish. NPFMC 42 p.

Gaichais. S. and J. Ianelli. 2005. Chapter 14. Gulf of Alaska Thornyheads. NPFMC 36 p.

Hanselman, D., Heifetz, J., Fujioka, J.T., Ianelli, J.N. 2005. Chapter 8. Gulf of Alaska Pacific ocean perch. 54 p.

Kalei Shotwell, S., Hanselman, D.H., and Clausen, D.M. 2005. Chapter 10. Rougheye Rockfish. GOA Rougheye Rockfish. 44 p.

Lunsford, C.R. Kalei Shotwell, S., Hanselman, D.H., Clausen, D.M., and Courtney, D.L. 2005. Chapter 12. Pelagic Shelf Rockfish. GOA Pelagic Shelf Rockfish. 54 p.

North Pacific Fishery Management Council (The Plan Team). 2005. Stock Assessment and Fishery Evaluation Report for the Groundfish Resources for the Bering Sea Region / Aleutian Islands. 30 p.

O'Connell, V., Brynlinsky, C., and Carlile, D. 2005. Chapter 13. Assessment of the Demersal Shelf Rockfish Stock for 2006 in the Southeast Outside District for the Gulf of Alaska. ADFG Executive Summary. 44 p.

Reuter, R.F., and P.D. Spencer. 2005. Chapter 14. 2005 BSAI Other Rockfish (Executive Summary). 4 p.

Spencer, P.D. Ianelli, J.N. and Lee, Y-W. 2005.Chapter 12. Northern Rockfish. NPFMC Bering Sea and Aleutian Islands SAFE. 42p.

Spencer, P.D. Ianelli, J.N. and Zenger, H. 2004. Chapter 11 Pacific ocean perch. NPFMC Bering Sea and Aleutian Islands SAFE. 72p.

Spencer, P.D., and R.F. Reuter. 2004. Chapter 13. Shortraker and Rougheye Rockfish. NPFMC Bering Sea and Aleutian Island SAFE. 30 p.


**Workshop Reports**


Rockfish Modeling Workshop: May 23rd – May 25th 2006. 7 p.

Rockfish Modeling Workshop Agenda May 23rd – May 25th 2 p.

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## General Supplemental Material

NMFS AFSC and NPFMC Reports and other Documents


Anonymous. 2003. Discussion paper of 2003 management of BSAI rockfish species. AFSC. 10 p.

Courtney, D.L., Ianelli, J.N., Hanselman, D., and Heifetz. No Date. Selected Results from Stock Assessments of Rockfish (*Sebastes* ssp) Populations in the North Pacific with AD Modelbuilder Software. AFSC report (no number), 33p.

DiCosimo, J., Spencer, P., Hanselman, D., Reuter, R., Stockhausen, B., and others. 2005. Bering Sea/Aleutian Islands and Gulf of Alaska Rockfishes, their fisheries and management: Focus on Pacific ocean perch, rougheye and dusky rockfishes. AFSC document, 72 p

Dorn, M.W. 2002.Advice on West Coast Rockfish Harvest Rates from Bayesian Meta-analysis of Stock Recruit Relationships. N. Amer. J. Fish Manag. 22: 280-300.

Funk.F, Gunderson, D., Mayo, R.,Richards, L.,and Roger. J. 1997. Rockfish Stock Assessment Review. AFSC Report .9p.

Gharrett, A., Matala, A.P., Peterson, E.L., Gray, A.K., Li, Z., and Heifetz, J. No date. Chapter III. Distribution and population structure of sibling species of rougheye rockfish based on microsatellite and mitochondrial variation. No publication source listed. 33 p..

Goodman, D., Mangel, M., Parkes, G., Quinn, T., Restrepo, V., Smith, T., Stokes, K. (with help from G. Thompson). 2002. Scientific Review of the Harvest Strategy Currently Used in the BSAI and GOA Groundfish Fisheries Management Plans. Draft Report Prepared for the NPFMC. 138 p.

Hanselman, D. Spencer, P., Shotwell, K., and Reuter, R. In. Press. Localized depletion of three rockfish species. No journal indicated. 24 p.

Hanselman, D.H., and Quinn II, T.J. Performance of modern age-structured stock assessments with large survey measurement errors. AFSC draft document.

Ianelli, J., and Spencer, P. 2006. An evaluation of using commercial fisheries data to estimate northern rockfish biomass in the Eastern Bering Sea. AFSC Draft document 6/7/06. 11 p.

NPFMC (Oliver, C). 2006 North Pacific Fishery Management Council Research Priorities. 7 p plus letter.

Restrepo, V. R., Thompson, G.G., Mace, P.M., Gabriel, W,L., Low, L.L., MacCall, A.D., Methot, R.D., Powers, J.E., Taylor, B.L., Wade, P.R., and Witzig, J.F. 1998. Technical Guidance on the Use of Precautionary Approaches to Implementing National Standard 1 of the Magnuson-Stevens Fishery Conservation and Management Act. NOAA Technical Memorandum NMFS-F/SPO-##.

Spencer, P. and Dorn. M. No Date. Evaluation of Bering Sea/Aleutian Islands Pacific ocean perch management parameters using Bayesian stock-recruit analysis. Draft Document. AFSC.

Spencer, P., Hanselman, D., and Dorn, M. In Press. The effect of maternal age of spawning on estimation of $F_{msy}$ for Pacific ocean perch. No journal listed. 30 p.


Recent relevant publications

Berkely, S. A., Chapman, C. and Sogard, S.M. 2004. Maternal age as a determinant of larval growth and survival in a marine fish, *Sebastes melanops*. Ecology 85(5): 1258-1264.

Bobko, S.J. and Berkely, S.A. 2004. Maturity, ovarian cycle, fecundity, and age-specific partuition of black rockfish (Sebastes melanops). Fish. Bull. 102: 418-429.

Clausen, D.M. and Heifetz, J. Date? The Northern rockfish, Sebastes polyspinis, in Alaska: commercial fishery, distribution, and biology. Mar. Fish. Rev. 64(4): 1-28.

Ianelli, J.N. 2002. Simulation analysis testing the robustness of productivity determinations from West Coast Pacific ocean perch stock assessment data. N. Amer. J. Fish. Manag. 21: 301-310.

Hanselman, D. H., Quinn II, T.J., Lunsford, C, Heifetz, J. and Clausen, D. 2003. Applications in adaptive cluster sampling of Gulf of Alaska rockfish. 2003. Fish. Bull. 101: 501-513.

Hanselman, D.H., and Quinn II, T.J. 2004. Chapter 14: Sampling rockfish populations:Adaptive sampling and hydroacoustics. Pp 271-296. Rest of citation missing.

Hawkins, S.L., Heifetz, J., Kondzela, C.M., Pohl, J.E., Wilmot, R.L., Katugin, O.N, and Tuponogov, V.N. 2005. Genetic variation of rougheye rockfish (*Sebastes aleutianus*) and shortraker rockfish (*S. borealis*) inferred from allozymes. Fish. Bull. 103: 524-535.

Kendall, Jr., A.W. 2000. An Historical Review of *Sebastes* Taxonomy and Systematics. Marine Fish. Rev. 62(2):1-23.

Krieger, K., Heifetz, J., and Ito, D. 2001. Rockfish assessed acoustically and compared to bottom-trawl catch rates. Alaska Fishery Research Bulletin 8(1): 71-77.

Matata, A.P., Gray, A.K., Heifetz, J., and Gharrett, A. J. 2004. Population structure of Alaskan shortraker rockfish, *Sebastes borealis*, inferred from microsatellite variation. Environ. Bio. Fishes 69: 201-210.

Miller, J.A., and Shanks, A.L. 2004. Evidence for limited larval dispersal in black rockfish (*Sebastes melanops*): implications for population structure and marine-reserved design. Can. J. Fish. Aquat. Sci. 61: 1723-1735.

Orr, J.W. and Blackburn, J.E. 2004. The dusty rockfishes (Teleostei: Scorpaeniformes) of the North Pacific Ocean: resurrection of Sebastes variabilis (Pallas, 1814) and a redescription of Sebastes ciliatus (Tilesius, 1813). Fish. Bull. 102:328-348.

Spencer, P.D., and Ianelli, J.N. 2005. Application of a Kalman filter method to a multi-species complex. Pp 613-634. In Fisheries Assessment and Management in Data-limited Situations. Alaska Sea Grant Program. AK-SG-05-02.

Other regions' rockfish assessments

Hamel, O.S. 2005. Status and future prospects for the Pacific ocean perch resource in waters off Washington and Oregon as assessed in 2005. NWFSC. 76 p.

Schnute, J.T., Haigh, R., Krishka, B.A., and Starr, P. 2001. Pacific ocean perch assessment for the west coast of Canada in 2001. Canadian Science Advisory Secretariat. Research Doc. 2001/138.96 p.

Björnsson, H. and Sigurdsson, T. 2003. Assessment of Golden Redfish (*Sebastes mentella, L*) in Icelantic waters. Scient. Mar. 67 (suppl 1):301-314.

**A.2 Other materials supplied in hardcopy during the meeting.**

Anon. 2005. Developments on the population projection model used for Alaskan groundfish. Alaska Fisheries Science Center. 34 p.

Anon. 2006. North Pacific Fishery Management Council research priorities. SSC document and letter from NPFMC to NOAA Fisheries – Alaskan region. 8 p.

Gharrett, A.J. et al. 2006. Do genetically distinct rougheye rockfish sibling species differ phenotypically? *Transactions of the American Fisheries Society 135*: 792-800.

Ianelli, J.N. 2002. Simulation analyses testing the robustness of productivity determinations from west coast Pacific ocean perch stock assessment data. *North American Journal of Fisheries Management 22*: 301-310.

Kimura, D.K.; Ander, D.M. 2005. Quality control of age data at the Alska Fisheries Science Center. *Australian Journal of Marine and Freshwater Research 56*: 783-789.

Smoker, A.; Furuness, M. 2005. Alaska region groundfish harvest specification and inseason management overview. 4 p.

Thompson, G.G. 1998. Environmental assessment and regulatory impact review for Amendment 56 to the FMP for the groundfish fishery of the Bering Sea and Aleutian Islands area and Amendment 56 to the FMP for the groundfish fishery of the GOA. Public review draft. 27 p.

Thompson, G.G. 1999. Optimizing harvest control rules in the presence of natural variability and parameter uncertainty. *In*: *NOAA Tech. Memo. NMFS-F/SPO-40*:124-145.

Thompson, G.G. 2004. Report on the first Management Strategy Evaluation Working Group meeting. 4 p.

Extracts (date and source generally unknown)

Development of Alaska's fisheries management programme. 2 p.

Precautionary approach. 1 p.

Conservative catch limits. 1 p.

Bycatch and discards. 4 p.

Effective monitoring and enforcement. 1 p.

Alternatives 1-5 for setting TACs. 1 p.

GOA trawl survey results, east, west and central, 1984-2005. 1 p.

Proposed rule to Amendment 68. Federal Register 71: 33040-33043.

An NGO's recommendations for the EIS. 2 p.

GOA dark rockfish. NPFMC, April 2006. 1 p.

Bering Sea habitat conservation, NPFMC, June 2006. 1 p.

Estimation procedures for bycatch and discards in the Alaska region. 4p.

A decision theoretic approach to ecosystem-based fishery management. Abstract.1 p.

**A.3 Presentations made during the review.**

The authors (if identified) and title are from the first slide. The name of the PowerPoint file follows in brackets. Sometimes the file name at the FTP site will not agree with the PowerPoint name, however these have not been included in an attempt to reduce confusion.

Anon. Age and growth information for Alaska rockfish. (age and growth.ppt)

Anon. Conservation of harvest policy. (conservation of harvest policy.ppt}

Anon. General age-structured modeling methodology. (Tier 3 methods.ppt)

Anon. Genetics and stock delineations. (Genetics and stock structure.ppt)

Anon. How our models differ (Tier 3 age-structured models). (ModelContrasts.ppt)

Anon. Rockfish modeling workshop. (Natural mortality-maturity.ppt)

Anon. Spatial management. (Spatial-management.ppt)

Anon. Survey overview. (Survey overview2.ppt)

Anon. Tier 5. (Tier 5.ppt)

Anon. Why isn't the buffer between FOFL and maxFABC explicitly tied to uncertainty. (Uncertainty.ppt)

Hanselman,D. Stock assessment workshop review. (WORKSHOP_REVIEW.ppt)

Hanselman, D., K. Shotwell, P. Spencer & R. Reuter Short-term localized depletion and longer-term localized population changes for Alaskan rockfish. (Depletion.ppt)

Heifetz, J. Overview of rockfish biology and management in Alaska. (HISTORY_CIE_.ppt)

Kastelle, C., D. Kimura. B. Goetz. Age validation of Pacific ocean perch (*Sebasetes alutus)* using bomb produced radiocarbon. (POP C!$ CIE.ppt)

Kimura, D. Rockfish age data at the Alaska Fisheries Science Center. (Age_Determination.ppt)

Spencer, P., D. Hanselman and M. Dorn. The effect of maternal age of spawning on estimation of Fmsy for Alaskan Pacific ocean perch. (maternal effect.ppt)

Spencer,P. & J. Ianelli. Application of the Kalman filter to Bering Sea-Aleutian Island rockfish. (Kalman filter.ppt)

**Appendix B**

**Consulting Agreement between the University of Miami and Dr. Robert Mohn**

## STATEMENT OF WORK

### General

The Alaska Fisheries Science Center (AFSC) requests review of rockfish (*Sebastes* and *Sebastolobus*) stock assessments and the current harvest strategy used to set Acceptable Biological Catch (ABC) and the Overfishing Level (OFL). The North Pacific Fishery Management Council (NPFMC) has received numerous requests for review and comment on the harvest strategy currently used for management of Alaskan rockfish. In response to these inquiries, NOAA Fisheries solicits a thorough review of Alaskan rockfish assessments and their associated harvest strategies.

There are currently 12 rockfish species managed under the Bering Sea and Aleutian Islands Fisheries Management Plan and 32 rockfish species managed under the Gulf of Alaska Fisheries Management Plan. Of these, three species are targeted by commercial fisheries: Pacific ocean perch, northern rockfish, and dusky rockfish. Although some other species are commercially important, the remaining rockfish species groups are captured incidentally during target fisheries for other groundfish and they are managed as bycatch only. Single-species assessments of rockfish indicate that stock status is "not overfished" and "not overfishing." While these stocks appear to be above threshold biological reference points, some stakeholders contend that the harvest policy is too aggressive and that further conservation is warranted.

### CIE Panel

A panel of three experts shall be provided for this review. Each reviewer shall spend a maximum of 16 days working on their review, so that the maximum number of reviewer days for the project shall not exceed 48. The panel shall include representatives with broad range of expertise. Important areas of expertise should include: analytical stock assessment, including population dynamics, age/length based stock assessment models, Bayesian analysis/uncertainty, rebuilding analyses, estimation of biological reference points, harvest strategy modeling, and fisheries biology.

### Specific Activities and Products

1. Prior to the review, AFSC will provide copies to reviewers of the stock assessment documents, groundfish overfishing definitions, a description of the simulation model used to project future stock levels, and the AD Model Builder code used to estimate stock status.

2. The reviewers will convene in a panel with scientists from the Alaska Fisheries Science Center and the Alaska Department of Fish and Game from June 19 to June 23, 2006, in Seattle, Washington.

3. Each reviewer is to generate a written, nonconsensus report that should include:

    d. A statement of the strengths and weaknesses of the input data and analytical approach used to assess stock condition and stock status and methods used for addressing uncertainty in the assessment.
    e. A statement of the strengths and weaknesses of the simulation models, and the analytical approaches used in estimating future harvest levels.
    f. An analysis of current harvest strategies. Specifically do they provide appropriate levels of conservation for Alaskan rockfish fisheries? What harvest control rules might be more appropriate? Are additional spatial management measures required?

    Within the main body, the report is to contain an executive summary paragraph of the reviewer's findings and conclusions for each of the terms of reference (a-c) listed above, followed by the detailed comments for each term.

4. No later than July 7, 2006, all three reviewers are to submit their reports[1] consisting of the findings, analysis, and conclusions to Dr. David Die, via email to ddie@rsmas.miami.edu, and to Mr. Manoj Shivlani, via email to mshivlani@rsmas.miami.edu. See Annex 1 for additional details on the report contents and organization.

5. The CIE shall provide a summary report documenting the areas of agreement and disagreement among the three reviewers. This report shall contain the information provided by each reviewer in the "executive summary paragraph" for each term of reference, as detailed under item 3 above.

## ANNEX I: REPORT GENERATION AND PROCEDURAL ITEMS

1. The report should be prefaced with an executive summary of findings and/or recommendations.

2. The main body of the report should consist of a background, description of review activities, summary of findings, and conclusions/recommendations.

3. The report should also include as separate appendices the bibliography of materials provided by the Center for Independent Experts and the Alaska Fisheries Science Center and a copy of the statement of work.

[1] Every report will undergo an internal CIE review before it is considered final. After completion, the CIE will create a PDF version of each report that will be submitted to NMFS and the reviewer.

Please refer to the following website for additional information on report generation: http://www.rsmas.miami.edu/groups/cimas/Report_Standard_Format.html

**Appendix C. Summaries of extracted data from SAFE documents.**

Spawning biomass data and catch/biomass (6+) ratios were cut from summary tables in the GOA POP and Northern rockfish SAFE documents. The C/B ratios were converted to F's by iteratively solving the catch equation. The 6+ ratio corresponds fairly well to fully recruited ages for POP, but less well for the northern rockfish which means that the F plotted will be lower than fully recruited F. These data were plotted with the harvest strategy for each (B40 and F40)

Spawning biomass data for these two species were also taken from the BSAI documents. They did not have the C/B ratio summaries so the total biomass was divided into the catch and then converted to F's. These F's will be considerably under fully recruited F's, but the B/B40 should be unbiased. Comparison to Figure 11.11 in the POP assessment suggests about a factor of ½. Also, comparison to Figure 8-14 suggests that the data were cut and pasted accurately. On the other hand, comparison to Figure 12.10 suggests that the northern fully recruited F is fairly close to the one estimated here.

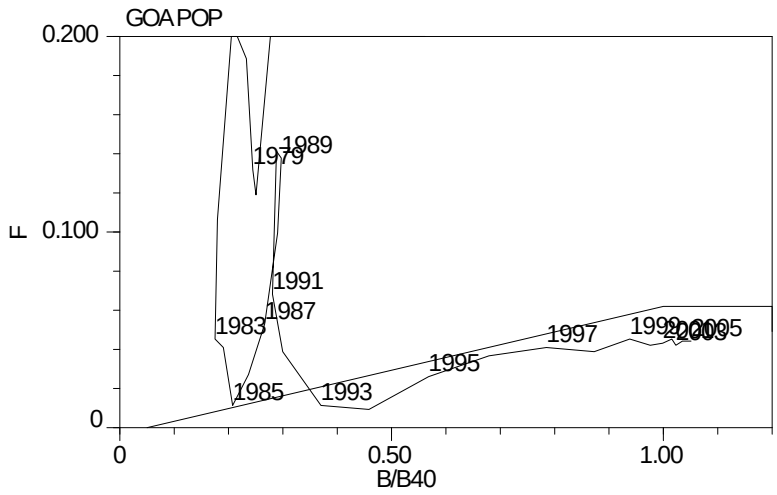


Figure C.1 GOA POP

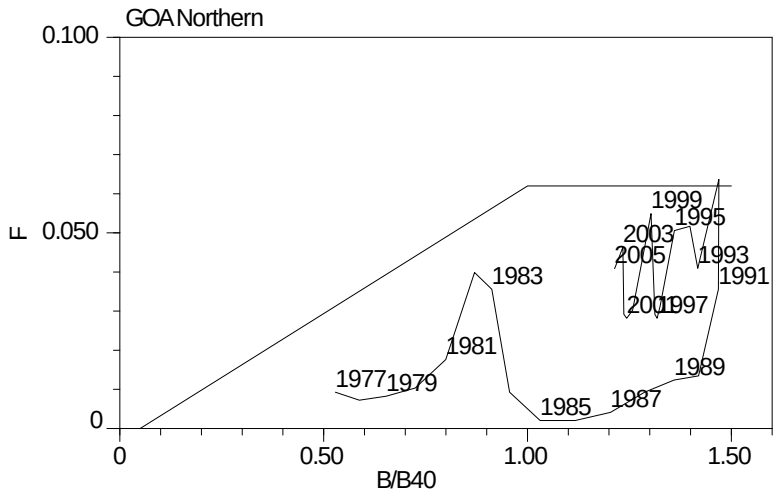


Figure C.2 GOA northern rockfish.

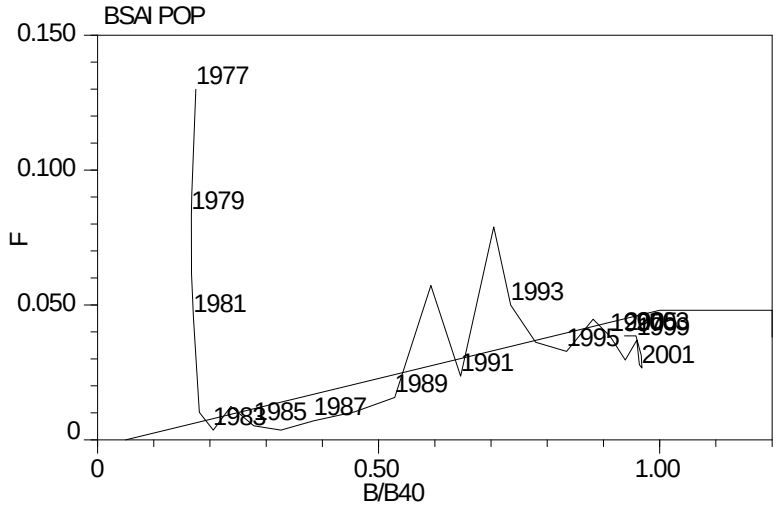


Figure C.3 BSAI POP.

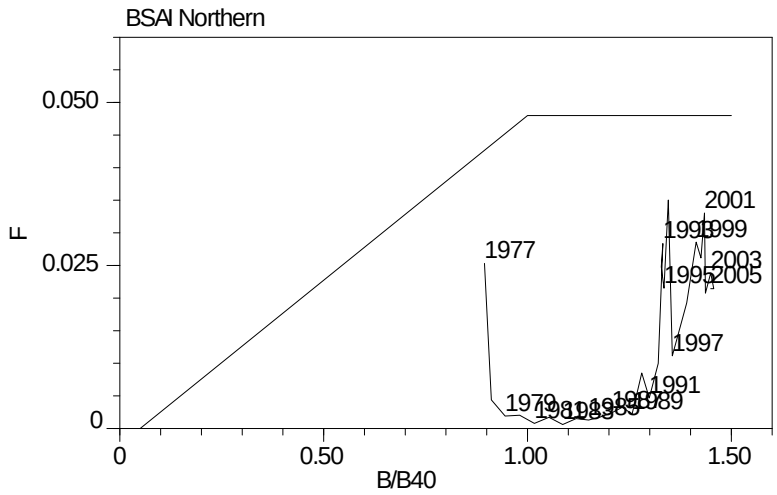


Figure C.4 BSAI northern rockfish.

Although care was taken in developing the data for these plots, errors from being unfamiliar with the assessments could have happened. Nonetheless provisional conclusions will be made. Figure C.1 shows a resource brought under control and currently in the vicinity of MSY while being fished at levels the HCR. Figure C.2 for GOA northern rockfish shows a resource which was fished conservatively and is well above BMSY.

| | GOA POP B1+ | | GOA Nor B1+ | | BSAI POP B3+ | | BSAI Nor B3+ | | Ave |
|---|---|---|---|---|---|---|---|---|---|
| | 2004 | 2005 | 2004 | 2005 | 2004 | 2005 | 2004 | 2005 | |
| B | 285066 | 286367 | 104438 | 108274 | 349000 | 379000 | 142000 | 200000 | |
| OFL | 15840 | 16266 | 5790 | 6050 | 15800 | 17300 | 8140 | 9810 | |
| ABC | 13340 | 13575 | 4870 | 5093 | 13300 | 14600 | 6880 | 8260 | |
| TAC | 13340 | 13575 | 4870 | 5093 | 12220 | 12600 | 5000 | 5000 | |
| Catch | 11528 | 11357 | 4783 | 4778 | 11883 | 10360 | 4683 | 3959 | |
| OFL/B | 0.06 | 0.06 | 0.06 | 0.06 | 0.05 | 0.05 | 0.06 | 0.05 | |
| ABC/OFL | 0.82 | 0.86 | 0.84 | 0.84 | 0.84 | 0.84 | 0.85 | 0.84 | 0.84 |
| TAC/OFL | 0.84 | 0.86 | 0.84 | 0.84 | 0.77 | 0.73 | 0.61 | 0.51 | 0.75 |
| Catch/OFL | 0.73 | 0.72 | 0.83 | 0.79 | 0.75 | 0.60 | 0.58 | 0.40 | 0.67 |
| Catch/B | 0.04 | 0.04 | 0.05 | 0.04 | 0.03 | 0.03 | 0.03 | 0.02 | 0.04 |

Table C.1 Summary of harvest levels and related estimates for four stocks, GOA POP and northern rockfish and BSAI POP and northern rockfish.

**Appendix D. Slide of differences in GOA and BSAI assessment models.**

| ***Difference*** | ***GOA*** | ***BSAI*** |
|---|---|---|
| Survey error | Normal | Lognormal |
| Fishery CPUE | Not Used | Lognormal |
| Biased ages | Not used | Used, with bias correction |
| Rec_Like | $L_{10} = \lambda_{10}\left[\frac{1}{2*\sigma_r^2}\sum_y \tau_y^2 + n_y * \ln(\sigma_r)\right]$ | $L_{10} = \lambda_{10}\left[\frac{1}{2*\sigma_r^2}\sum_y (\tau_y + 0.5\sigma_r^2)^2 + n_y * \ln(\sigma_r)\right]$ |
| Early recruitment | Log mean recruitment | Rzero before fishery starts log-mean recruitment after |
| Selectivity | By Age | Logistic |
| $\sigma_r^2$ | Estimated (with prior) | Fixed |
| *M* | Estimated (with prior) | Fixed |
| Recent Recruitment | Estimated | Fixed at LMR |
| *q* | Estimated (with prior) | Estimated (with bounds) |

Table D.1. Summary from presentation from Anon. How our models differ (Tier 3 age-structured models)

**Appendix E. Glossary.**

This is not meant to be an exhaustive glossary but rather those used in this review. I will not bother with the more commonly used terms, MSY, SSB, etc.

| | |
|---|---|
| ABC | Allowable biological catch |
| AFSC | Alaska Fisheries Science Center |
| AP | Advisory Panel (reports to the Council in process of setting TACs) |
| BRP | Biological reference point |
| BSAI | Bering Sean and Aleutian Islands |
| HCR | Harvest control rule |
| Ibm | individual based model |
| maxABC | Maximum allowable biological catch |
| MCMC | Monte Carlo Markov Chain |
| MSFCMA | Magnuson-Stevens Conservation and Management Act |
| NPFMC | North Pacific Fisheries Management Council (also just Council) |
| OFL | Overfishing limit |
| pdf | probability distribution function |
| PSEIS | Programmatic supplemental environmental impact statement |
| q | survey catchability |
| S-R | stock-recruit |
| SAFE | Stock assessment and fishery evaluation. |
| SPR | Spawning potential ration |
| SSC | Statistical and scientific committee |
| TAC | Total allowable catch |