Center for Independent Experts (CIE) summary report for the 2006 Alaska rockfish review

This report presents the summary views of Drs. Patrick Cordue, Cynthia Jones, and Robert Mohn on each of three terms of reference, as the reviewers were required to generate under the review statement of work. As such, the report only collates the summary views to generate a concise set of summaries, and it does not otherwise alter the reviewers' text. For a more detailed discussion on each term, the reader should refer to the reviewers' full reports.

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.

<u>Dr. Patrick Cordue</u>

The stock assessment methods used in the rockfish assessments are generally appropriate given the available data.

Strengths:

- The simple stock hypotheses are appropriate given the lack of detailed information.
- Good ageing data are available for estimating growth parameters.
- There is a wealth of trawl survey data.
- There is a strong observer program.
- Assumed population dynamics are consistent with current knowledge.
- Estimation methods are adequate.
- Modeling of uncertainty is adequate.

Weaknesses:

- Stock hypotheses are not well founded as little is known about stock structure.
- Estimation of M is often done using the oldest otolith ever read – better methods are available.
- The trawl surveys have undergone some changes in standardization of gear setup and operation.
- Trawl survey indices take no account of the proportion of untrawlable ground in each stratum (a particular problem for the GOA survey).
- Little is known about migration and distribution patterns associated with mating and parturition – so assumed population dynamics are necessarily simple.
- More sensitivity tests could be done and estimation methods could be refined.

Dr. Cynthia Jones

The quality of input data and the appropriateness of analytical approaches have been reviewed extensively in previous workshops and reports. Nonetheless, the quality of the harvest recommendations rely on good data and methods and additional review can be justified. For the most part, the input data appears to be reliable, although some data collection can be fine-tuned further. The methods used for ageing are well respected and should produce very reliable data. The methods to measure maturity are also standard, but would benefit from surveys timed to evaluate maturity closer to parturition. Estimation of M is notoriously difficult and the methods used are commonplace and accepted, built on reliable ageing. The only suggestion that I offer is that age-distribution be winsorized to test the effects of unusually old fish on “rule of thumb” estimates of M. I am more concerned about the estimates of biomass obtained from the fishery-independent trawl survey because of how density is integrated over untrawlable ground. Dr. Patrick Cordue developed bias estimators from expected values and these showed that there is potential for bias as the survey biomass is now estimated. It is advisable to do a complete review of the trawl-biomass estimators in a workshop or review format where Dr. Cordue’s calculations can be studied further.

Dr. Robert Mohn

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.

b. A statement of the strengths and weaknesses of the simulation models, and the analytical approaches used in estimating future harvest levels.

Dr. Patrick Cordue

The simulation or projection model is used to achieve standardized projection results for all stock assessments (seven standard scenarios are done for each assessment run).

Strengths:

- Standard set of scenarios available for each run in each stock assessment.

- Two of the scenarios provide output for determining stock status according to the current definition of MSST (“overfished” and “approaching overfished”).
- Recruitment variability is incorporated into the projections.

Weaknesses:

- Only recruitment variability is incorporated into the projections despite parameter uncertainty also being available for some assessments (i.e., MCMC runs).
- The population dynamics (e.g., annual cycle) of each stock assessment model must be implemented in the projection model to avoid a mis-match of assumptions (this is a future implementation issue – current dynamics are identical).

<u>Dr. Cynthia Jones</u>

The projection model appears to be providing reasonable evaluations of the impact of harvest targets on long-term sustainable rockfish populations. There is some fine tuning that can improve the projection model, such as estimating parameters within the model rather than providing external-fixed parameters (e.g. M). Moreover, when we were presented with preliminary results based on such fine tuning the new results differed insubstantially.

<u>Dr. Robert Mohn</u>

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.

c. An evaluation of the level of conservatism required to sustain Alaskan rockfish fisheries (e.g. what is the optimal spawning biomass per recruit level? Are additional spatial management measures required?).

<u>Dr. Patrick Cordue</u>

The current harvest strategies for Alaskan rockfish are not fully defined since several subjective choices are involved in setting TACs and, for structural reasons, the subsequent catches will often not reach the TAC. Nevertheless, there are identifiable strengths and weaknesses in the current management system:

Strengths:

- There are multiple and cumulative layers of conservatism in the tier system which will conserve rockfish stocks at high levels of biomass.
- The tier system is comprehensive and familiar.
- Tier 1 is supported by sound research.

Weaknesses:

- The multiple layers of conservatism may result in unnecessarily low yields for groundfish stocks in general.
- Tiers 2-6 are not supported by substantive research.
- Tiers 4-5 require a reliable point estimate of B – for rockfish, such estimates are only available in tier 3 – the assumption that *q* is known *a priori* for a trawl survey is untenable.
- Scientists are required to act as managers since their ABC recommendations limit the level at which the TAC can be set.

With regard to the specific questions in the TOR:

- Current harvest strategies favor conservation over use. If the fishing industry is happy with this circumstance then the strategies do provide an appropriate level of conservatism.
- At the next opportunity the tier structure should be simplified and based on the availability of reliable abundance indices.
- In the long term the tier structure should be tailored to modern stock assessment results (between run and within run uncertainty for multiple runs).
- Current spatial management appears appropriate. Finer scale management is ill-advised until much more is known about stock structure, migration patterns associated with mating and parturition, and the location and stability of any important sources of production.

Dr. Cynthia Jones

Harvest control strategies are best judged in against a statement of management objectives. Without having one for Alaskan rockfish, one can look to the potential results from the stated harvest control rules to comment on their adequacy. For most of the tiers, control rules are quite precautionary when put into practice. The Optimum Yield (OY) was been set conservatively to a level appropriate for the relatively unproductive environment of the 1970's. Next the ABC is set so that it is always below OY. Further TAC is set below ABC for rockfish and in most instances recently catch is well below the TAC. It is not surprising that several species have exhibited biomass increases –where reliable measures of biomass are known as is the case for rockfish. Hence even though there is some evidence to support a harvest control of $F_{50\%}$ or greater for West Coast rockfish, Alaskan stocks appear to be more resilient because of a more productive environment, stock differences, or the built in precautions of the harvest control rules in this region.

Dr. Robert Mohn

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.

REVIEW OF

ALASKAN ROCKFISH

HARVEST STRATEGIES

AND

STOCK ASSESSMENT METHODS

19-22 JUNE, 2006

SEATTLE, WASHINGTON

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EXECUTIVE SUMMARY

A CIE Review Panel considered the current harvest strategies and stock assessment methods for Alaskan rockfish stocks from June 19-22, 2006 at Alaska Fisheries Science Center, Seattle, WA. The motivation for the review was the concern of some stakeholders that rockfish harvest strategies are “too aggressive”. The same tier system and general harvest strategy is applied to all groundfish, including rockfish. For this reason many of my conclusions, with regard to harvest strategies, apply to groundfish stocks in general.

The rockfish team did an excellent job of presenting a wide-array of relevant information. I was impressed by many aspects of the current research programmes, stock assessment methods, and harvest strategies. I find the apparent reason for the review understandable but disappointing. The current rockfish harvest strategies are very conservative and proposals to move to more extreme conservatism are most unfortunate.

My main conclusions are:

- There are multiple and cumulative layers of conservatism in the current groundfish harvest strategies which will conserve rockfish stocks at high levels of biomass.
- The multiple layers of conservatism may result in unnecessarily low yields for groundfish stocks in general.
- Current harvest strategies favor conservation over use. If the fishing industry is happy with this circumstance then the strategies do provide an appropriate level of conservatism.
- Stock assessment scientists are required to make value judgments and, in essence, act as managers since their ABC recommendations limit the level at which the TAC can be set.
- Current spatial management of rockfish appears appropriate. Finer scale management is ill-advised until much more is known about stock structure, migration patterns associated with mating and parturition, and the location and stability of any important sources of production
- Stock assessment methods are generally acceptable but could be improved.
- Stock hypotheses are not well founded as little is known about stock structure.
- Current trawl survey biomass indices could mislead to some extent as they do not take account of the proportion of untrawlable ground in each stratum.

My main recommendations are:

- Consider whether so many cumulative layers of conservatism are really needed.
- At the next available opportunity, update the tier structure so that:
  - a trawl survey index need not be considered to provide “a reliable point estimate of B”
  - the number of tiers is reduced

    - the buffer between F_{OFL} and F_{ABC} is based on some prescribed measure of stock assessment uncertainty
    - and hence, F_{ABC} is prescribed (and stock assessment scientists are not required to make management decisions/value judgments).
- In the long term, plan to replace the tier structure with a system tailored to modern stock assessment results where multiple runs are available, with uncertainty estimated for each run.
- Carefully consider how a much better understanding of stock structure can be achieved (the first step is to obtain data on migration and distribution patterns associated with mating and parturition).
- Reanalyze the trawl survey indices, in particular for the Gulf of Alaska, with regard to the effect of untrawlable ground on the biomass indices.
- Review trawl survey design before the next Gulf of Alaska survey.
- Develop informative priors for the trawl *q*s. Changes in gear setup and operation (e.g., length of trawl, standardization of methods) should be considered for each time series. More than one *q* will probably be needed for each time series.
- Review natural mortality estimates.
- Allow for parameter uncertainty in the projection modeling.

BACKGROUND

A three person CIE Review Panel meet to review Alaskan rockfish harvest strategies and stock assessment methods from June 19-22, 2006 at Alaska Fisheries Science Center, Seattle, WA. The review was motivated by a concern, expressed by some stakeholders, that the harvest strategies for Alaskan rockfish were "too aggressive" given that they are "long lived" and "late maturing".

This report presents my personal view with regard to current Alaskan rockfish harvest strategies and stock assessment methods. This report should be read in conjunction with those of my fellow reviewers Dr Bob Mohn and Dr Cynthia Jones. Although there was no attempt to reach a consensus on any of the issues it was apparent that the Review Panel shared many common views with regard to the current harvest strategies and stock assessment methods.

REVIEW ACTIVITIES

Meeting Preparation

Prior to the meeting I read the main documents and consulted the background material made available on a website (Appendix 1).

Meeting Attendance

A brief narrative of the meeting is given below. There was no designated chair. This duty was shared by Drs Hollowed, Ianelli, and Rigby (on an ad hoc but effective basis).

19 June

The meeting was convened at 9.00 am and began with a round of introductions. Dr Hollowed discussed the purpose of the review and the "charge for the CIE". The main reason for the review was a concern (by the "public" and some NGOs) that the harvest strategy for rockfish was "too aggressive". This belief could perhaps be traced back to a previous review where the use of $F_{40\%}$ as an F_{MSY} proxy was criticized for rockfish (Goodman et al. 2002).

The powerpoint presentations began with an overview of rockfish management in Alaska (Dr Heifetz) which covered the general biology of rockfish, the fisheries, the Council's tier system and harvest strategies, and the 2002 review of groundfish harvest strategies (Goodman et al. 2002).

Dr Hanselman presented an overview of the available fishery independent data (primarily the RACE groundfish trawl surveys). There was discussion on the potential for vessel effects (given three vessels are used each year, and these vessels change from year to year). It was pointed out that much effort had been put into the standardization of gear setup and operation. Apparent "vessel effects" were actually "skipper and operation effects". However, the standardization was not in effect for the whole duration of each time series.

The observer program was also discussed. I was impressed by the high level of coverage, the real-time supply of data (to managers), the qualifications required of observers, the training program, and the ongoing quality control procedures. Some concern was raised about the potential lack of representativeness of the sampling by *trip* (given that skippers are free to choose, given a minimum level of coverage, which trips observers go on).

Dr Kimura described the ageing procedures and results for rockfish. Dr Kastelle described a validation method (using radiation levels from nuclear bomb tests) which had been used for Pacific ocean perch (POP). The ageing procedures and methods appear to be more than satisfactory. There was discussion on a group of 4-5 outliers in the validation study. The two possible explanations both involved "rogue" fish; they were either badly under-aged or had received very low doses of radiation.

A study of adaptive cluster sampling for POP was briefly presented and discussed (Hanselman et al. 2003). There were problems deciding on appropriate stopping rules. The author suggested using acoustic methods to do this. Given the aggregated nature of the POP schools I suggested that a combined acoustic and trawl survey was the better option.

The Review Panel asked many questions during the presentations. We were aware that slow progress was being made in terms of the original agenda but thought that it was best to fully explore the issues during the presentations. I suggested that we should plan on three days of presentations and a further day for the Review Panel to clarify issues (amongst ourselves) and ask questions of specific presenters if needed.

20 June

The meeting resumed at 9.00 am with presentations on age and growth. Natural mortality estimates were covered. In general they were derived by assuming that the oldest otolith found corresponded to the age attained by 5% of the virgin population. A need for a review of natural mortality estimates was acknowledged. Maturity ogives were briefly discussed as were possible maternal affects on larval viability (older fish having more viable larvae).

Stock structure was discussed after a presentation on genetic investigations. The absence of data on basic migration patterns and mating/parturition distribution was apparent. There appeared to be fine-scale genetic structure, but, as was pointed out by Dr Jones, this was probably due to the "sweep-stakes" effect (different alleles being selected each year purely by chance); no effort had been made, as yet, to compare across areas within cohort (i.e., comparing fish spawned in the same year to rule out the "sweep-stakes" effect).

The recent modeling workshop was briefly discussed before a presentation on the age-structured modeling approach used in tier-3 stock assessments. The methods were described as "quasi Bayesian" as priors were used in the likelihoods and MCMC runs were done. However, it was acknowledged that the priors were formed in an ad hoc manner and were sometimes "tightened" for pragmatic reasons (e.g, to produce sensible estimates of *M*). It was claimed that the mean values of the priors were based on the best *a priori* estimates. The prior mean values for the trawl survey *q*s had been set equal to 1. I pointed out that this was not the best *a priori* estimate as on consideration of the three main factors, areal availability, vertical availability, and vulnerability, one would often arrive at values quite different from 1. We went though the exercise for POP and arrived at a best guess in excess of 1 (which included an additional factor to account for POP's preference for trawlable ground).

The projection model was discussed including the "seven standard scenarios". The last two of these require simulation of fishing at the OFL – it was pointed out that these are needed for determination of stock status according to the current definition of MSST (despite fishing at the OFL being extremely unlikely).

The day finished with an interesting presentation on the use of submarine line-transect data to estimate POP trawl survey catchability. It was concluded that the stock assessment estimates of *q* greater than 1 were not only being driven by herding behaviour but also by POP's preference for trawlable (as opposed to untrawlable) ground (as seen in the submarine data).

21 June

The meeting resumed at 9.00 am with a presentation which I made on a problem with the current RACE trawl survey design. The previous evening I had realized that no allowance had been made in the calculation of the trawl survey indices for the fact that POP (and perhaps other species) had different average densities on trawlable and untrawlable ground. I presented equations showing that the trawl survey indices, as calculated, did not result in a biomass index (in that the expected value of each index divided by biomass was not a constant).

Dr Mohn suggested to me that Canadian trawl surveys may suffer from the same problem (having perhaps 10% of untrawlable ground). The problem is that no account is taken of the proportion of untrawlable ground within each stratum – average stratum densities are scaled-up using the full survey area. During subsequent discussions (during and after the meeting) it was generally agreed that this was a problem for any stratified random trawl survey where untrawlable ground had not been entirely blocked off (i.e., excluded from the survey area). At the time we considered that it did not apply to surveys with fixed stations (this is an error – see Appendix 2). There was no general agreement on whether the magnitude of the problem was of any consequence (i.e., perhaps it could be ignored).

The meeting continued with the agenda items. There was a comparison of the differences between stock assessment models used in the GOA and the BSAI assessments. Tier-5 assessments were discussed. The current method of setting maximum ABCs simply uses trawl survey averages assuming $q = 1$. An alternative method using Kalman filters had been explored – it looked useful, but still assumed $q = 1$, thus defeating any utility it may have had (Spencer and Ianelli 2005).

There was a review of papers relating to the use of $F_{40\%}$ as a proxy for F_{MSY}. The most recent research and that directed specifically at Alaskan rockfish species supported its use (papers cited by Goodman et al. 2002 were less recent and/or dealt with west coast rockfish).

Final topics covered were the evidence for localized depletion, the question of whether spatial management was needed on a finer scale than that already used, a simulation study looking at possible retention areas for rockfish larvae (looking for potential MPAs), and the consequences for reference points if older fish produced more viable larvae than younger fish. Dr Thompson gave the meeting a brief update on current research aimed at improving the tier system. He pointed out that the timing of implementing improvements was problematic because of ongoing/imminent changes to legislation and/or guidelines and/or over-arching studies.

22 June

The Review Panel convened at 9.00 am to identify, discuss, and clarify all relevant review issues. We covered the TOR a.-c. in our SOW (Appendix 3). The Panel appeared to be in agreement on most issues.

Dr Hanselman was also in the meeting room and presented some previously requested stock assessment results. In particular, he presented the current estimates of biomass for the six age-structured stock assessments as a proportion of B_{100} (the “virgin” biomass corresponding to mean recruitment under the current regime). These ranged from 0.39 to 0.58. He also presented the BSAI POP and GOA POP biomass trajectories, as a proportion of B_{40}, for the two different stock assessment models (the “GOA” model and the “BSAI” model). For BSAI there was little difference in the trajectories, but for GOA, one model estimated current biomass at approximately B_{40}, while the other model estimated it at 0.6 B_{40}.

We ended our formal discussions at noon (to attend a lunchtime seminar on GOA ecosystem modeling).

Post Meeting Activities

Prior to and during my return journey to New Zealand I considered several review issues. In particular, I further developed the equations relating to the trawl survey indices and considered how the current indices could be corrected and what data would be needed to do this. The Panel had further informal discussions which proved useful in further clarifying some issues.

SUMMARY OF FINDINGS

This section is organized according to the TOR provided in the SOW (Appendix 3). As required, each section is prefaced with an "executive summary" (being the bullet points).

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.

The stock assessment methods used in the rockfish assessments are generally appropriate given the available data.

Strengths:

- The simple stock hypotheses are appropriate given the lack of detailed information.
- Good ageing data are available for estimating growth parameters.
- There is a wealth of trawl survey data.
- There is a strong observer program.
- Assumed population dynamics are consistent with current knowledge.
- Estimation methods are adequate.
- Modeling of uncertainty is adequate.

Weaknesses:

- Stock hypotheses are not well founded as little is known about stock structure.
- Estimation of M is often done using the oldest otolith ever read – better methods are available.
- The trawl surveys have undergone some changes in standardization of gear setup and operation.
- Trawl survey indices take no account of the proportion of untrawlable ground in each stratum (a particular problem for the GOA survey).
- Little is known about migration and distribution patterns associated with mating and parturition – so assumed population dynamics are necessarily simple.
- More sensitivity tests could be done and estimation methods could be refined.

Stock hypotheses

There appears to have been little research done on the movement and migrations of rockfish in the GOA and BSAI. Apparently, little is know about where mating and parturition occur. Because of this, life cycle information is general rather than stock specific. The stock hypotheses are not well formed – two stocks (GOA and BSAI) are usually assumed. This is a viable default position, but is far from ideal for the stocks which are assessed through age-structured stock assessment models. A basic assumption of these models is that the data relate to a single biological stock. Violation of this assumption can lead to misinterpretation of abundance data and unreliable stock assessments.

Fixed biological parameters

Growth parameters and length-weight relationships are estimated outside the models using standard methods. Natural mortality is usually estimated from maximum age assumptions using the oldest otolith ever aged. It appears that the standard assumption is that 5% of the virgin population attain this age. In general this will be a conservative assumption, but it depends on how many otoliths have been aged and how they were selected. Estimation of M is problematic, whether it is via a maximum age assumption, an early catch-curve, or is estimated within a stock assessment model. How ever it is done, the objective should be to attain a “best” estimate of M – not a conservative estimate of M.

Estimation of the maturity ogive is done outside the model. Histological data are available for some species and this would generally be preferable to macroscopic staging data. However, the key determinant in obtaining reliable estimates of maturity ogives is the representativeness of the fish sampling. Clearly, the sampling needs to be unbiased with regard to maturity (e.g., sampling only from mating fish or predominately mating fish due to a migration to a “mating ground” would introduce bias). However, this is very hard to guarantee, especially if little is known about stock structure and mating/parturition related migrations and distribution.

The distinction between “proportion mature at age” and “proportion *maturing* at age” is not particularly relevant for rockfish (since fishing is not especially targeted at mature fish). However, it should be noted that the proportion mature at age is not constant as it must depend on fishing exploitation rates (which are not constant). If there is a constant with regard to maturity it will be the proportion of immature fish at age which mature.

Recruitment variability can either be estimated in the stock assessment model or fixed. Current attempts to estimate it in the model have been technically incorrect; to do it properly involves hyper-distributions when it is used as the parameter of another prior (recruitment deviations). An alternative to fixing it (and then, if necessary, iterating to make sure that the standard deviation of the estimated recruitment deviations is consistent with the assumed value) is to use an uninformed prior on the recruitment deviations (see Appendix 2).

Fishery independent data

There are three sources of fishery independent data used in the current assessments: trawl surveys; longline surveys; and submarine line transect surveys. I have not reviewed the longline or submarine data in any depth. They were briefly covered in presentations and the methods appear appropriate. The same is true for the methods used to obtain at-age and at-length data from the trawl surveys.

The RACE trawl survey which uses a random stratified design is somewhat unusual in the selection of random grids within a stratum prior to the allocation of a single trawl station in each selected grid. This is not a particular problem, but it introduces an extra level of complexity which interacts with a problem for all trawl surveys where the untrawlable ground is not excluded from the survey area (see Appendix 2). Because of the potential for some species to preferentially inhabit either trawlable or untrawlable ground, and because of the relatively large proportion of untrawlable ground in some strata of the GOA survey, the GOA trawl survey data need to be analyzed further.

The purpose of random station allocation within a stratum is to ensure an unbiased estimate of the average density within the stratum so that scaling-up to the stratum area provides an unbiased estimate of stratum biomass. However, if a stratum has a proportion of untrawlable ground and the average density (for a particular species) differs between the trawlable and untrawlable ground then a stratum biomass estimate will be biased. If such a bias were consistent from year to year it would not be a problem if the data were used to provide *relative* abundance indices (it would be if they were used as *absolute* abundance indices). However, fish distribution is unlikely to stay constant from year to year and a shift in distribution combined with differing biases across strata could well introduce a trend in trawl survey indices which is not related to a change in biomass.

The relevant equations are developed in Appendix 2. Without a detailed analysis of the GOA trawl survey data it is not possible to determine whether recalculation of the trawl survey indices is necessary. For POP it is known that they have a preference for trawlable ground (from submarine data). I doubt that there are any species where it is *certain* that they do not have a preference for the trawl-ability of the ground. Ideally, data on the proportion of trawlable ground in each stratum should be compiled/collected and the trawl survey indices recalculated. Alternatively, it may be possible to establish that such a recalculation will not result in any substantive changes to the indices and is therefore not necessary. The problem needs to be addressed in the short-term.

Fishery dependent data

The observer sampling program appears well-founded. The sampling methods are appropriate and well documented. Considerable effort goes into training and quality control. Scientists are aware of possible non-representativeness in sampling at the trip level for vessels where skippers can choose which trips observers participate in.

CPUE indices are used in some BSAI assessments (but are down-weighted relative to other indices). With the wealth of available trawl survey data there may appear to be little need to consider abundance indices derived from a fishery. However, for species which have a preference for untrawlable ground, it may be that the trawl survey indices are unreliable. Certainly, trawl survey indices do ***not*** provide reliable estimates of *absolute* biomass, and so it is prudent to consider what other data may aid in the reliable estimation of biomass. CPUE indices should be considered for all of the age-structured stock assessments.

Assessment models

The population dynamics of the models are very simple which is consistent with the absence of detailed information on stock structure and migrations. When more detailed information is collected, it may be necessary to consider spatially explicit models. The use of two-sex models should be considered for any species where there are large growth differences between the sexes and/or there is preferential targeting of males or females, and/or there are sex imbalances in the survey data.

The plus-group at 25 years is at a relatively young age compared to the maximum age of some of the species. Provided that the mean weight in the plus-group is adjusted when calculating virgin/unfished biomass it should not present a problem. However, it would be worthwhile to do some runs with an older plus group to make sure it does not make a difference. When estimating M within the model, the age of the plus group should be increased (as should the plus-group age in the at-age data) – though this may not make a difference either.

Estimation methods

The current estimation methods were described as “quasi-Bayesian”. The estimates are derived by minimizing a negative log-likelihood modified by some prior distributions. The methods are acceptable but should be improved. The full Bayesian tools are available to the stock assessment authors and they should be endeavoring to use them. The likelihood components need to be formed with more care as do the prior distributions.

For example, the likelihood for abundance indices assumed to have lognormal errors should correspond to mean unbiased indices; currently it corresponds to median unbiased indices (see Appendix 2). This is a common assumption which is not generally justifiable (as many surveys are designed to be mean unbiased). The multinomial assumption for at-age and at-length data should be investigated – it is very unlikely to be appropriate for all data sets. The current method of calculating effective sample sizes is ad hoc. Bootstrap estimates of variance should be obtained and used to calculate effective sample sizes (e.g., Bull and Dunn 2002).

The formation of priors should be done with some care. For trawl survey qs, the first step is to derive an equation for q in terms of parameters about which beliefs can be expressed (either using expert opinion or based on data which is not otherwise fitted in the stock assessment model). Bounds and best guesses for each component – together with the equation – can be used to obtain bounds and best guesses for *q*. These can then be used to determine an informed prior for *q*, e.g., equate the best guess to the median and the bounds to 99% of a lognormal distribution, (Cordue, in prep. a.).

As already described, the recruitment variance can be dealt with in three ways: fixed (possibly with some iteration); estimated using hyper-distributions and used in the prior on recruitment deviations; or uncoupled from the prior on recruitment deviations and estimated as the standard deviation of the recruitment deviations (Appendix 2).

Estimation of *M* is difficult. However, if it is to be done in the model then the informed prior should be realistic in terms of what is know about *M a priori*. If the results using this approach provide unrealistic estimates of *M*, then simply fix *M* and do sensitivity runs with lower and higher values. The same approach should be adopted with other parameters where the runs with appropriate priors produce unrealistic estimates. One of the benefits of forming priors correctly is that the relationship of the posteriors (or point estimates) to the priors can be used as a diagnostic (if the beliefs about a parameter have not been formalized it is difficult to justify statements like "the estimated *q* is too low").

The initial conditions of the model can affect the stock assessment results (and so should be explored in sensitivity runs). There are three (main) options: equilibrium age structure at virgin biomass (B_0); equilibrium age structure with the biomass allowed to differ from B_0; and non-equilibrium age structure (i.e., estimate initial numbers at age). In the first option the full catch history would be specified; in the second option the full catch history can be specified (in which case an extra parameter is introduced: $B_{initial}$ = biomass just before fishing), or a constant annual historical catch can be given; the third option should probably only be used if the early catch history is unavailable.

The full biomass trajectory should always be considered in terms of $\%B_0$ or $\%B_{100}$ to check its plausibility. The GOA POP assessment has an initial biomass (before fishing) of only 30% B_{100} – this could well be implausible depending on the estimated recruitment variability.

The calculation of standardized residuals should be routine. As a starting point, the standard deviation of the standardized residuals (SDSR) of each time series should be approximately equal to 1. If they are not, then the statistical assumptions of the model are violated. It is (almost) standard practice in New Zealand to re-weight indices (by adjusting their c.v.s) until the SDSR of all time series are approximately equal to 1. These are the termed the "natural weights" of the indices. Indices may be re-weighted for the final runs (e.g., if a trend in a primary biomass time series is not well fitted) but there must be a compelling reason to depart from the "natural weights".

Modeling of uncertainty

The "art of stock assessment" is in capturing an appropriate level of uncertainty so that assessment results are realistic in terms of the "true" uncertainty but still useful for management purposes. My impression of the rockfish assessments is that an appropriate level of uncertainty is captured at the stock assessment level. However, more sensitivity runs could perhaps be done, certainly with regard to some of the biological parameters (e.g., alternative maturity ogives). Also, more effort should be made to explore alternative formulations and model structures and parameterizations – assessment authors should be looking for plausible and defensible alternative assumptions which may alter the perception of stock status (ideally this is done by using alternative methods, data, or structure, rather than low, medium, and high values of a single parameter). Ideally all runs presented to management should be taken through to the MCMC stage (and have properly formed priors).

b. A statement of the strengths and weaknesses of the simulation models, and the analytical approaches used in estimating future harvest levels.

The simulation or projection model is used to achieve standardized projection results for all stock assessments (seven standard scenarios are done for each assessment run).

Strengths:

- Standard set of scenarios available for each run in each stock assessment.
- Two of the scenarios provide output for determining stock status according to the current definition of MSST ("overfished" and "approaching overfished").
- Recruitment variability is incorporated into the projections.

Weaknesses:

- Only recruitment variability is incorporated into the projections despite parameter uncertainty also being available for some assessments (i.e., MCMC runs).
- The population dynamics (e.g., annual cycle) of each stock assessment model must be implemented in the projection model to avoid a mis-match of assumptions (this is a future implementation issue – current dynamics are identical).

The current implementation of the projection model does not capture parameter uncertainty even if is available from the stock assessment. In some assessments this could be a major component of uncertainty which is currently ignored. That said, it remains to be seen whether incorporation of such uncertainty would alter the *mean* projection results (nevertheless, this area should be tidied up).

In future stock assessments it is likely that the population dynamics of the models will become more complex (e.g., spatially explicit). The current projection model software would then have to be modified to accommodate the new dynamics (i.e., offer them as an option). This involves the duplication of code since the stock assessment model already has the dynamics coded. An alternative to a separate projection program is to write a C++

projection class. It would incorporate all of the standard scenarios as member functions which would be called within each stock assessment program. The stock assessment program would supply its own dynamics (i.e., the address of the annual cycle function). This is only an efficiency issue. Since C++ is being used, it makes sense to use its full capability.

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 current harvest strategies for Alaskan rockfish are not fully defined since several subjective choices are involved in setting TACs and, for structural reasons, the subsequent catches will often not reach the TAC. Nevertheless, there are identifiable strengths and weaknesses in the current management system:

Strengths:

- There are multiple and cumulative layers of conservatism in the tier system which will conserve rockfish stocks at high levels of biomass.
- The tier system is comprehensive and familiar.
- Tier 1 is supported by sound research.

Weaknesses:

- The multiple layers of conservatism may result in unnecessarily low yields for groundfish stocks in general.
- Tiers 2-6 are not supported by substantive research.
- Tiers 4-5 require a reliable point estimate of B – for rockfish, such estimates are only available in tier 3 – the assumption that *q* is known *a priori* for a trawl survey is untenable.
- Scientists are required to act as managers since their ABC recommendations limit the level at which the TAC can be set.

With regard to the specific questions in the TOR:

- Current harvest strategies favor conservation over use. If the fishing industry is happy with this circumstance then the strategies do provide an appropriate level of conservatism.
- At the next opportunity the tier structure should be simplified and based on the availability of reliable abundance indices.
- In the long term the tier structure should be tailored to modern stock assessment results (between run and within run uncertainty for multiple runs).
- Current spatial management appears appropriate. Finer scale management is ill-advised until much more is known about stock structure, migration patterns

associated with mating and parturition, and the location and stability of any important sources of production.

What is a "harvest strategy"?

The current harvest strategies for Alaskan rockfish are perhaps better defined than most harvest strategies used in managed fisheries. Nevertheless they are not fully defined. This is because the method of setting a TAC involves at least four subjective decisions by different groups of individuals (also, for various complex reasons, the subsequent catch is often well below the TAC). First, the assessment author must recommend an ABC (after choosing a run on which to base it). Then the Plan Team must recommend an ABC, which may differ from the assessment author's recommendation. Next, the SSC makes an ABC recommendation (another subjective choice), and finally the Council accepts one of the ABC recommendations and then sets a TAC at a level up to the ABC.

Without knowing how each of these decisions is made it is not possible to fully define the harvest strategy. Without a fully defined harvest strategy and an *explicit* statement of management objectives it is not possible to *accurately* assess whether a harvest strategy is appropriate or not. That said, it is possible to make some general statements about the tier structure and the general management regime and culture.

Multiple levels of conservatism

The "harvest strategies" for Alaskan rockfish provide an ultra-conservative fisheries management regime. There are some components of the tier structure which may not be conservative in their operation – but that is accidental. On the whole, the management regime provides multiple and *cumulative* layers of conservatism.

At the top level, there is an OFL defined by F_{MSY} or an F_{MSY} proxy. It is defensible, in my opinion, to use F_{MSY} based reference points as a target. However, in the U.S. these are used as limit reference points. This is the first level of conservatism. In the National Standard 1 guidelines Restrepo et al. (1998) recommend a default MSY control rule which allows for fluctuations of biomass around (including below) B_{MSY} before there is a reduction in F_{OFL}. However, in the Alaskan tier structure F_{OFL} is reduced at B_{MSY} or its proxy (in tier 3, it is actually reduced above the B_{MSY} proxy). This is the second level of conservatism.

The maximum ABC is always less than the OFL – this is the third level of conservatism. However, the maximum ABC need not be recommended. It appears that if assessment authors, the Plan Team, or the SSC are concerned that the maximum ABC might not be "sustainable" that they will recommend a lower value. Since the ABC limits the TAC, this is the fourth level of conservatism. Next is the TAC setting by the Council. They cannot set the TAC above the ABC, it can only go lower – the fifth level of conservatism. But what is actually caught? The Review Panel were told that (in-season) managers will try to manage the fishery to the TAC and will certainly try to avoid any catch in excess of the ABC. There will be no directed fisheries on a stock after its TAC has been exceeded. Fisheries on one stock can be closed if the bycatch on another stock would cause the TAC of the bycatch stock to be exceeded. This effect is only in one direction – a potential under-catch of a TAC – the sixth level of conservatism.

I will only briefly address the concern of Goodman et al. (2002) that, for rockfish, $F_{40\%}$ is not a good proxy for F_{MSY} and therefore not conservative. I did not find their arguments compelling. On the contrary, I found the arguments of the "response document" (Anon. 2002) more appealing. It does not matter that rockfish are "long lived" and "late maturing"; this is accounted for in the calculation of $F_{40\%}$. There does not appear to be any evidence that Alaskan rockfish stocks lack "resilience" – they appear to have had some of their best recruitment at relatively low stock sizes (see SAFE reports). In any case, whether $F_{40\%}$ is a good proxy for F_{MSY} is somewhat beside the point since the harvest strategy is such that levels as high as $F_{40\%}$ are very unlikely to be achieved.

Separation of science and management

In New Zealand there is a clear separation between the assessment of stock status and the determination of TACs. Scientists perform the stock assessment. Managers set the TAC. A stock assessment is aimed at providing an unbiased assessment of current stock status and the likely (biological) consequences of alternative TACs (obtained through projections at different catch levels). At no stage are scientists required to or allowed to recommend a TAC. Stock assessment choices (e.g., which runs to take forward) are made on "best scientific" judgment. The objective is to provide a realistic and unbiased assessment of the current state of knowledge. In the New Zealand setting, stock assessment choices should never be based on possible consequences for TACs. It is for managers (and politicians), not scientists, to make value judgments about the level of conservatism which should be exercised when managing a stock.

The Alaskan rockfish setting is very different from that in New Zealand. The recommendation of an ABC, be it at the maximum or not, limits the TAC which can be set. Scientists are required to make value judgments. They have the best understanding of the limitations of the assessment and the consequent uncertainties, but they do not perhaps have the best understanding of the political, social, and economic consequences of their choices.

Spatial management

Currently, the GOA and BSAI stocks are managed spatially in relatively large areas. TACs are management-area specific for some stocks. There are suggestions that smaller scale management is needed. In the absence of detailed information on stock structure and migration patterns related to mating and parturition any such attempts are extremely unlikely to have beneficial consequences.

The apparent fine scale genetic structure is not compelling. It could easily be due to the "sweepstakes effect" on individual cohorts. Given that rockfish larvae have a drift phase, followed by a "swimming" pelagic phase, it is hard to conceive of a mechanism for fine scale stock structure. Even if there were a large number of "distinct stocks" how important can any particular stock be? Yes, do protect important habitat using closed areas. Yes, do protect important and stable sources of productivity – but find them first.

Simplify and modernize

The current tier structure has six levels based on different levels of available information. However, apart from tier 1 (Thompson 1999), there is no substantive research supporting the use of the tiers or the definitions of F_{OFL} or F_{ABC} within each tier. I think that the system has been successful in conserving fish stocks. I am not convinced that it needs to be so conservative or so detailed. Certainly, there is a problem with some of the wording: "reliable point estimates of B".

In tier 3 these "reliable estimates" come from an age-structured stock assessment. That is defensible. Tier 4 is problematic. There is a reliable estimate of B, but not of B_{40} – apparently because mean recruitment cannot be reliably estimated. In that case, I assume that the "reliable" estimate of B is coming from a trawl survey. The same must be true in tier 5. The problem is that a trawl survey does not provide reliable estimates of biomass, according to any defensible definition of "reliable".

I understand that there is a long history, in the U.S. and in Alaska, of using trawl survey estimates to provide absolute biomass estimates. That does not make it defensible. It will require a difficult cultural change, but, with strong leadership, I am sure that such a change can be made.

At the next opportunity to update the tier system it should be simplified. Tier 1 is fine, but other tiers (perhaps just two more) should be based on whether there are reliable abundance indices available or not. Also, the buffer between OFL and ABC should to be based on the uncertainty in the assessment – the recent work of Dr Thompson should be useful here. The ABC should be prescriptive and not left to a value judgment on the behalf of scientists (at least not on a case by case basis – the initial formulation may require a value judgment). In the long term, the tier system should be replaced by a system which is tailored to modern stock assessments: between-run and within-run uncertainty (i.e., multiple MCMC runs) with a suite of performance indicators calculated for each run.

RECOMMENDATIONS

My recommendations are organized according to the three TOR (with abbreviated headings):

a. Input data and stock assessment methods

- Carefully consider how a much better understanding of stock structure can be achieved (the first step is to obtain data on migration and distribution patterns associated with mating and parturition).
- The trawl survey indices, in particular for the GOA, should be analyzed with regard to the effect of untrawlable ground on the biomass indices (at the same time, any potential effects from different vertical availability or vulnerability by stratum could also be considered – see Appendix 2).
- Trawl survey design should be reviewed before the next GOA survey.
- Informative priors should be developed for trawl *q*s. Changes in gear setup and operation (e.g., length of trawl, standardization of methods) should be considered for each time series. More than one *q* will probably be needed for each time series. Common factors between the *q*s within a time series can be accounted for by putting a prior on the ratio of pairs of *q*s (see Cordue in prep.).
- The use of catch and effort data to develop abundance indices should be considered for more species (descriptive analyses of catch and effort data should be done routinely; on an annual basis for major stocks).
- Natural mortality estimates should be reviewed. Informative priors could be developed at the same time.
- Likelihood equations should be briefly reviewed. In particular, use one of the three suggested options for recruitment variability, and use a likelihood corresponding to mean unbiased abundance indices (see Appendix 2).
- Implement alternative initial conditions for model biomass and age structure.
- Routinely calculate standardized residuals and "natural weights" for time series.
- Always examine biomass trajectories as $\%B_0$ or $\%B_{100}$, checking for plausibility.
- Do more sensitivity runs, looking for the assumptions which really do make a difference (e.g., structural, statistical, assumed fixed parameters, priors used).

b. Projection model

- Include parameter uncertainty in the projections.
- Plan for the future by implementing a C++ projection class (the separate projection software will still be needed for multi-species projections, but that is a separate application from production-line stock assessment).

c. Harvest strategies

- Consider whether so many cumulative layers of conservatism are really needed. Are *all* stakeholders happy with this?

- At the next available opportunity, update the tier structure so that:
    - a trawl survey index need not be considered to provide "a reliable point estimate of B"
    - the number of tiers is reduced
    - the buffer between F_{OFL} and F_{ABC} is based on some a prescribed measure of stock assessment uncertainty
    - and hence, F_{ABC} is prescribed (and stock assessment scientists are not required to make management decisions/value judgments).
- In the long term, plan to replace the tier structure with a system tailored to modern stock assessment results where multiple runs are available, with uncertainty presented for each run.

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APPENDIX 1: MATERIAL PROVIDED

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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, but these have not been included 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 F_{OFL} and maxF_{ABC} 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)
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Spencer,P. & J. Ianelli. Application of the Kalman filter to Bering Sea-Aleutian Island rockfish. (Kalman filter.ppt)

APPENDIX 2: TECHNICAL DETAILS

This appendix contains three sections. The first section deals with potential problems for stratified random trawl surveys. The issue of untrawlable ground is particularly relevant to the GOA survey. More details, on the general problems, will appear in Cordue (in prep. b.). The remaining two sections are very similar to appendices in some of my other CIE reports. They contain technical details on lognormal likelihood components and the treatment of recruitment variability.

A. RANDOM STRATIFIED TRAWL SURVEY INDICES

The ideal random stratified trawl survey design has all untrawlable ground blocked-off from the survey strata. In practice, this is not usually possible (as not all untrawlable ground is identified *a priori*) and a survey design will include contingencies if a random station is in an untrawlable location. If most strata have little untrawlable ground this should not present a problem. However, when there are some strata with a large proportion of untrawlable ground and/or many strata with some untrawlable ground there is a potential problem: the trawl survey proportionality constant, q, may not be constant.

We shall first look at the equations for the ideal random stratified trawl survey and then we will consider the equations for the RACE trawl surveys which sample random grids within strata.

Consider a stratified random trawl survey with all untrawlable ground blocked-off from the survey strata.

Let,

C_{ij} = catch rate of the jth tow in the ith stratum
a_i = area of ith stratum
n_i = number of random trawls in ith stratum
b_i = biomass in ith stratum
d_i = average density in ith stratum

The biomass index is:

$$X = \sum_i a_i \bar{C}_i$$

where

$$\bar{C}_i = \frac{1}{n_i} \sum_j C_{ij}$$

Let,

u_a = areal availability (the proportion of the total biomass which is in the survey area)
u_v = vertical availability (the average proportion of the biomass in the water column, which is in front of the net after vertical herding)
v = vulnerability (the average proportion of the biomass in front of the net, before horizontal herding, which is actually caught)

Assume, for the moment, that u_v and v are the same for all strata. Then, within strata, the C_{ij} are independent and identically distributed:

$$\mathrm{E}(\bar{C}_i) = \mathrm{E}(C_{ij}) = u_v v d_i$$

and

$$\mathrm{E}(X) = \sum_i a_i u_v v \frac{b_i}{a_i} = u_v v \sum_i b_i$$

Let,

B = total biomass
q = trawl survey proportionality constant

Then,

$$q = \frac{\mathrm{E}(X)}{B} = u_v v \frac{\sum_i b_i}{B} = u_v u_a v$$

which is the usual expression assumed for q.

Now consider the RACE trawl survey design and initially just consider a single stratum. It is divided up into equal sized grids. Some grids have no trawlable ground, and if they are initially selected a replacement grid will be chosen. For selected grids a single trawl station is allocated within the grid. Label the grids:

trawlable: $1, \ldots, g$
untrawlable: $g+1, \ldots, m$.

Let,

a = area of each grid
b_j = biomass in grid j
t_j = proportion of trawlable ground in grid j
d_j = average density on trawlable ground in grid j
e_j = average density on untrawlable ground in grid j

then

$$b_j = a\left[t_j d_j + (1-t_j)e_j\right]$$

Assume that n trawlable grids are chosen at random with replacement (a convenient and reasonable approximation – assuming there is a large number of grids in the stratum).

Let,

C_{j_k} = catch rate in grid j_k $k = 1, \ldots, n$

Then the biomass estimate for the stratum is

$$Y = ma\overline{C}$$

To obtain the expected value of each C_{j_k} we use conditional expectation on the random grid selection:

$$\mathrm{E}(C_{j_k}) = \mathrm{E}[E(C_{j_k} \mid j_k)] = \mathrm{E}\left[u_v v d_{j_k}\right]$$

Since there is an equal probability of selecting any of the trawlable grids, it follows that

$$\mathrm{E}(C_{j_k}) = \frac{1}{g}\sum_{j=1}^{g} u_v v d_j = u_v v\overline{d}$$

and hence,

$$\mathrm{E}(Y) = ma u_v v\overline{d}$$

Now, the biomass in the stratum is:

$$B = \sum_{j=1}^{m} b_j = \sum_{j=1}^{g} a\left[t_j d_j + (1-t_j)e_j\right] + \sum_{j=g+1}^{m} b_j$$

If we add and subtract d_j inside the square brackets, we get:

$$B = \sum_{j=1}^{m} b_j = ag\overline{d} + a\sum_{j=1}^{g}(1-t_j)(e_j - d_j) + \sum_{j=g+1}^{m} b_j$$

Let

$$f_j = (1-t_j)(d_j - e_j)$$

and define p as the proportion of stratum biomass on trawlable ground, so that,

$$\sum_{j=g+1}^{m} b_j = (1-p)B$$

Then we have,

$$\bar{d} = \bar{f} + \frac{pB}{ag}$$

and hence,

$$\mathrm{E}(Y) = \frac{m}{g} u_v v p B + m a u_v v \bar{f}$$

If the average densities on trawlable and untrawlable ground are equal then the second term in the above equation is zero. However, if they are not, then the biomass estimate is not proportional to the stratum biomass.

Let us extend the above equation to the full survey area. Assume now that there are *n* strata (with n_i trawls in each stratum) and let Y_i be the biomass estimate for the *i*th stratum. Let the index for a given year be *X*:

$$X = \sum_{i=1}^{n} Y_i$$

Then,

$$\mathrm{E}(X) = \sum_i \mathrm{E}(Y_i) = \sum_i \left(\frac{m_i}{g_i} u_i v_i p_i B_i + m_i u_i v_i a \bar{f}_i \right)$$

where the previous notation has been generalized for the *i*th stratum (and the subscript *v* has been dropped from u_v). For generality we are no longer assuming that vertical availability and vulnerability are constant across strata. We are working towards a general expression for the annual trawl survey proportionality “constant”.

Let,

$$r_i = \frac{p_i}{\left(\frac{g_i}{m_i} \right)}$$

and

$$s_i = r_i u_i v_i = \frac{m_i}{g_i} p_i u_i v_i$$

The reason for distinguishing r_i is because it is the proportional of biomass on the trawlable grids divided by the proportion of trawlable grids. We then have,

$$\mathrm{E}(X) = \bar{s}\sum_i B_i + \sum_i \left(s_i - \bar{s}\right)B_i + \sum_i a_i u_i v_i \bar{f}_i$$

where $a_i = am_i$ is the area of the ith stratum.

Let B denote the total stock biomass and let,

$$B_i = h_i B$$
$$\sum_i B_i = wB$$

then

$$\mathrm{E}(X) = \left[\bar{s}w + \sum_i \left(s_i - \bar{s}\right)h_i\right]B + \sum_i a_i u_i v_i \bar{f}_i$$

and

$$q = \frac{\mathrm{E}(X)}{B} = \bar{s}w + \sum_i \left(s_i - \bar{s}\right)h_i + \frac{\sum_i a_i u_i v_i \bar{f}_i}{B}$$

As a quick check on the equation, notice that if vertical availability and vulnerability are constant across strata and the fish have the same average density on trawlable and untrawlable ground, then the last two terms are zero, and we have the usual expression for q (as the product of areal availability (w), vertical availability, and vulnerability.

Finally, let us generalize the above equation to a multi-year time series indexed by y:

$$q_y = \frac{\mathrm{E}(X_y)}{B_y} = \bar{s}_y w_y + \sum_i \left(s_{yi} - \bar{s}_y\right)h_{yi} + \frac{\sum_i a_i u_{yi} v_{yi} \bar{f}_{yi}}{B_y}$$

The only parameters in the above equation which cannot vary annually are the stratum areas (assuming the same survey area and stratification).

The last term in the equation is present because of the grid design and will be non-zero for any species which has a preference for trawlable or untrawlable ground. Unless there is a major distributional change in biomass which interacts with the strata which contain grids with a high proportion of untrawlable ground, there is unlikely to be much annual variation in the term. Nevertheless, its variability and magnitude needs to be considered on a case-by-case basis for each survey (and each species). In particular, is its magnitude significant compared to the other terms and could there be a trend in this term, as opposed to just some extra noise.

The second term is non-zero when there is stratum variation in the vertical availability or vulnerability, or the ratio of the proportion of biomass on trawlable grids to the proportion of trawlable grids. This term will be present whether a grid design is used or not (if not, the ratio will be the proportion of biomass on trawlable ground to the proportion of trawlable ground). The potential magnitude and variability of this term also needs to be investigated on a case-by-case basis.

To recalculate existing biomass indices so that they exclude non-random error structure requires that average stratum catch rates are calculated from weighted averages of individual station catch rates. The weights are intuitively obvious and can easily be derived (simply hypothesis them and check that they give unbiased biomass estimates – see Cordue in prep. b.) It should be feasible to collect information on the proportion of untrawlable ground in each stratum and this will probably be adequate to correct the trawl survey indices (to allow for any preferences that species may have for trawlable or untrawlable ground).

B. LIKELIHOOD AND LOGNORMAL ERRORS

For biomass indices it is usually appropriate to assume in a stock assessment that the indices are “mean unbiased” rather than “median unbiased”. When a lognormal error structure is assumed the likelihood should be derived with some care.

Consider a biomass index X_i:

$$X_i = qB_i\varepsilon_i$$

where B_i is the biomass (in year i), q is the proportionality constant, and ε_i is the error (in year i). Suppose that the errors are lognormal: $\log(\varepsilon_i) \sim \mathrm{N}(\mu_i, \sigma_i^2)$. It then follows that,

$$\log(X_i) \sim N(\log(qB_i) + \mu_i, \sigma_i^2)$$

and the negative log-likelihood (ignoring constants) is

$$\frac{1}{2}\sum_i \left[\log(\sigma_i^2) + \frac{(\log(X_i) - \log(qB_i) - \mu_i)^2}{\sigma_i^2} \right]$$

If the variances are assumed known, then the first term in the square brackets in the above equation can be ignored. It is not uncommon to assume, in every year, that $\mu_i = 0$. However, under this assumption it follows that:

$$\mathrm{E}(X_i) = qB_i\mathrm{E}(\varepsilon_i) = qB_i e^{\frac{\sigma_i^2}{2}} = qB_i\sqrt{cv_i^2 + 1}$$

where cv_i is the specified c.v. in year *i*.

When the c.v.s are relatively small (< 0.35), there is a very small bias in the indices. However, by definition, they are no longer indices in the usual sense. The assumption is consistent with "median" unbiased indices, in that there is a 50% probability that an index will be above or below the true value (qB_i). This would be acceptable if the random variables in question could be expected to have this property. However, this would not generally be true and it would be preferable to use "mean" unbiased indices:

$$\mathrm{E}(X_i) = qB_i\mathrm{E}(\varepsilon_i) = qB_i$$

This requires $\log(\varepsilon_i) \sim N(-0.5\sigma_i^2, \sigma_i^2)$ and for known variance the negative log-likelihood (ignoring constants) is:

$$\frac{1}{2}\sum_i \left[\frac{(\log(X_i) - \log(qB_i) + \frac{\sigma_i^2}{2})^2}{\sigma_i^2} \right]$$

When the likelihood is expressed as a function of *q* and differentiated one can derive a formula for the *q* which minimizes the negative log-likelihood for given biomass:

$$\frac{dL(q)}{dq} = \frac{-1}{q}\sum_i \left[\frac{\log(X_i) - \log(qB_i) + \frac{\sigma_i^2}{2}}{\sigma_i^2} \right] = 0$$

Which implies:

$$\log(q) = \frac{\frac{n}{2} + \sum_i \frac{\log\left(\frac{X_i}{B_i}\right)}{\sigma_i^2}}{\sum_i \frac{1}{\sigma_i^2}}$$

This formula can be used to speed up the minimization if an uninformed prior is specified for *q* (of course, when an informed prior is used, *q* must remain as one of the estimated parameters).

C. ALTERNATIVE PRIOR FOR YEAR CLASS STRENGTH

It is common in stock assessment models for the recruitment variability σ_R (the s.d. of the log-deviations) to be used as the s.d. of a lognormal prior on the recruitment deviations (or year class strengths (YCS) if recruitments are parameterized as multipliers of expected recruitment – or average recruitment in the absence of a stock-recruit relationship).

Such a formulation requires that σ_R is specified despite there generally being information in the data with regard to recruitment variation. It could be useful to allow alternative priors to be specified for the recruitment deviations, or the YCS, and to estimate σ_R as a derived parameter (i.e., being the s.d. of the estimated YCS).

Since each YCS is a multiplier, the natural uninformed prior for a YCS is a uniform on log(YCS) with E(YCS) = 1. A method for specifying this type of prior is given below.

Let $Y = \log(X) \sim \mathrm{U}(a, b) : \mathrm{E}(X) = 1$. The specified expectation requires:

$$\mathrm{E}(X) = \frac{e^b - e^a}{b - a} = 1$$

The problem is to find bounds on YCS, e^a, e^b which are sensible and also satisfy the above equation. The bounds should be wide because we are looking for an uninformed prior. There is no analytical solution to the above equation for a given upper (or lower) bound. However, for given b, e^b the following equation quickly converges to a solution (with starting value $a_0 = 0$):

$$a_{n+1} = e^{a_n} - e^b + b$$

A sample table of solutions is given below:

a	b	e^a	e^b
-7.70	2.30	4.54×10^{-4}	10
-4.19	1.79	1.51×10^{-2}	6
-3.36	1.61	3.49×10^{-2}	5

The pdf for X is:

$$f_X(x) = \frac{1}{(b-a)x} \quad \text{for} \quad e^a \le x \le e^b$$

If $X_1, \ldots, X_n$ (being n YCS) are given identical independent priors as above, then the negative log likelihood (ignoring constants) is:

$$\sum_i \log(X_i)$$

Because of this, MPD (mode of posterior distribution) estimates will tend to e^a if there is little or no information for an estimated YCS in the data. However, for such cases in MCMC runs the posterior will tend to the prior which sensibly has a mean of 1. If these priors were to be used for MPD estimates then it might be sensible to impose a penalty encouraging the estimated YCS to average to 1.

APPENDIX 3: STATEMENT OF WORK

Consulting Agreement between the University of Miami and Patrick Cordue

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, non-consensus report that should include:

    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 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?

    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.

[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.

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.

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

Report to the Center for Independent Experts
On the Review of Rockfish Stock Assessments and Current Harvest Strategy
Workshop held June 19-23, 2006 in Seattle, WA

By
Cynthia M. Jones, Ph.D.
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Portsmouth, VA 23701

Executive Summary – The NMFS Alaska Fisheries Science Center (AFSC) requested a review of management strategies for Gulf of Alaska (GOA) and Bering Sea/Aleutian Island rockfish (*Sebastes* and *Sebastolobus*) from the Council of Independent Experts (CIE). See the statement of work in Appendix 1. Concerns about the management and conservation of Pacific rockfish has grown since Clark (2002) determined that rockfish on the U.S. west coast had a low resilience to harvest and were not maintaining biomass under the $F_{40\%}$ policy. That same year Dorn (2002) published a paper showing that $F_{50\%}$ was risk-neutral and a better proxy for F_{msy} for West Coast rockfish. Meanwhile the North Pacific Fishery Management Council (NPFMC) requested an evaluation and primer of stock assessment and harvest management policies for its groundfish stocks. The subsequent report by Goodman et al. (2002) stated that $F_{40\%}$ policies for Alaska rockfish were not sufficiently conservative. Most recently, Berkeley et al. (2004) showed in the laboratory that black rockfish (*Sebastes melanops*) larval viability increased with maternal age.

On June 19th to June 22nd 2006, a workshop was convened at the AFSC in Seattle with NMFS scientific staff and three scientists representing CIE to review data, modeling, and management of Alaskan rockfish with specific attention to Acceptable Biological Catch (ABC) and Overfishing Level (OFL).

Stock assessments for Alaskan rockfish are single-species, following ecosystem-based approaches and relying on $F_{40\%}$ reference points. Rockfish fall under Tier3-5 management based on varying level of available data with which to reliably estimate biomass. Although $F_{40\%}$ references are widely thought to provide insufficient conservation for West Coast stocks, their implementation for Alaskan stocks have resulted in stable or increasing biomass for many of the species under management. The Tier structure provides several layers of precaution, resulting in catches that are almost always below TAC, which itself is conservative. Beyond this, rockfish stocks in Alaska appear to be more resilient to harvest than do those on the U.S. West Coast, possibly because of a more productive environment. However, should the environment become less productive, then the current harvest strategies may not be sufficiently conservative for these stocks.

The quality of input data and the appropriateness of analytical approaches have been reviewed extensively in previous workshops and reports. Nonetheless, the quality of the harvest recommendations rely on good data and methods and additional review can be

justified. For the most part, the input data appears to be reliable, although some data collection can be fine-tuned further. However, questions were raised during the workshop concerning the estimation of biomass from trawl surveys in regions where the amount of untrawlable ground is significant.

Task-specific executive summaries, findings, conclusions, and recommendations follow in order.

Specific Activities – Prior to the workshop in Seattle, I was provided with copies of stock assessment documents through an ftp site. These included documents listed in Appendix 2. I read as many of these reports as I could before the workshop, given that I was given the ftp site one week prior to the meeting. Formal presentations with AFSC staff lasted three days and the list of these presentations is in Appendix 3. During the formal meeting, CIE scientists were also given additional reports as listed in Appendix 4. We meet informally on Thursday June 22 with AFSC staff to seek clarification of issues raised during the formal presentations. We also heard a seminar by Sarah Gaichas on ecosystem-based management. Upon my return from Seattle, I finished my review of all bibliographic materials and meeting notes, obtained some additional supporting literature, and wrote my report.

Statement of Work Task 1. Include 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.

<u>Executive Summary Task 1</u> – The quality of input data and the appropriateness of analytical approaches have been reviewed extensively in previous workshops and reports. Nonetheless, the quality of the harvest recommendations rely on good data and methods and additional review can be justified. For the most part, the input data appears to be reliable, although some data collection can be fine-tuned further. The methods used for ageing are well respected and should produce very reliable data. The methods to measure maturity are also standard, but would benefit from surveys timed to evaluate maturity closer to parturition. Estimation of M is notoriously difficult and the methods used are commonplace and accepted, built on reliable ageing. The only suggestion that I offer is that age-distribution be winsorized to test the effects of unusually old fish on "rule of thumb" estimates of M. I am more concerned about the estimates of biomass obtained from the fishery-independent trawl survey because of how density is integrated over untrawlable ground. Dr. Patrick Cordue developed bias estimators from expected values and these showed that there is potential for bias as the survey biomass is now estimated. It is advisable to do a complete review of the trawl-biomass estimators in a workshop or review format where Dr. Cordue's calculations can be studied further.

<u>Background</u> – At the time of the Goodman et al (2002) report, eight species or species complexes were managed under Tier 3-4, while seven rockfish species or complexes were managed under Tier 5. Currently of the 34 species of rockfish that are managed currently, four GOA species are managed under Tier 3 with age-structured models, two under Tier 4, and 28 under Tier 5. The four under Tier 3 species include Pacific ocean perch (*Sebastes alutus*), northern rockfish (*S. polyspinis*), dusky rockfish (*S. variabilis*), and rougheye rockfish (*S. aleutianus*). In the Bering Sea/ Aleutian Island region 12 rockfish species are under management, two species (POP and northern rockfish) are managed with statistical catch-at-age models under Tier 3, 10 under Tier 5, while rougheye/shortraker (*S. borealis*) complex is managed with a production model.

Biomass estimates – Biomass estimates come from two sources, fisheries-dependent (catch cpue data, observer data) and fisheries independent surveys (Trawls, longlines, and submersibles). These will be discussed below.

Ageing – The ageing laboratory at the AFSC is recognized for the high quality of its ageing (see for example Kimura and Anderl 2005 for the QA/QC procedures). From 2001 to 2006, the laboratory aged over 30,000 rockfish. This laboratory has relied on radiometric ageing of fishes with high terminal ages and these procedures are excellent in validating ages. In one part of the presentation, radiometric ages and otolith-read ages diverged. The explanation for this was that fish that diverged had been exposed to different radioisotopes. During the Power Point presentation it was stated that rockfish ages were done by the break and burn method. Even though this method works well in general, thin-sectioning is a more reliable method even though more time consuming, especially when underageing is possible.

It is difficult to do age-based stock assessments of long-lived fish because of the large sample requirements for ageing. Long-lived fish with relatively high mean ages require more collections to get enough samples into age categories to build a sufficient age-length key that can be used in stock assessments. Beyond this, long-lived fish can be difficult to age. For example, POP is moderately difficult to age. To validate POP ages, the AFSC ageing group has attempted to validate otoliths with bomb carbon. In the validation, 15-30 fish were pooled for each radiometric age group. The results of bomb carbon analysis, showed a tendency to underage. Four or five out of 35 samples were younger based on bomb carbon. The explanation given by staff was that these otoliths may also have been from exposure to less bomb carbon. They do not have a reference standard from POP juveniles (1 yo) and so do not have a direct comparison with the same species and must use the reference standard from another species. However, the parsimonious explanation is that these fish were incorrectly aged, albeit with seemingly normal annuli. Because the divergence accounted for about 10% of the radiometrically-aged fish, it is not inconsequential and should be investigated further.

Maturity – Age of maturity for rockfishes is from 10-22 years depending on the species. Maturity stage is typically assessed by macroscopic examination of rockfish ovaries. However, when a microscopic examination of ovaries was made by Chilton, different maturities were seen for northern rockfish. Note that these microscopic results were not available at the CIE workshop. My experience in measuring maturation stage and fecundity does not include ovoviviparous fishes, so I must rely on my experience with oviparous fishes. In my experience, macroscopic gonad examination does provide a fairly reliable indicator of age-at-first maturity for the production of maturity ogives. Macroscopic examination is less precise for measuring fecundity and this is best done with microscopic examination. Beyond the issues of fecundity and maturity, Bobko and Berkley (2004) and Berkley et al. (2004) have identified enhanced maternal contribution of older females, something seen earlier in striped bass (*Morone saxatilis*; Monteleone and Houde, 1990). AFSC modelers have begun to evaluate the effect of maternal age effects on their rockfish stocks but at the time of the workshop, they had inconclusive results.

Several other issues arose during the discussion of maturity. One was the timing of fishing and the fisheries-independent trawl survey. The trawl survey is not being done during the spawning parturition period and female rockfish sexual maturity and fecundity is not assessed at or close to parturition when the best estimates can be obtained. The other problem is that few females are caught relative to the data needed on maturity. Because of this data on the proportion mature is more uncertain. There is a possibility that the otolith transition area (from wide to narrow increments) might be a potential proxy for age at first maturity, but must first be validated and then used carefully.

Natural mortality (M) – This is a notoriously difficult parameter to estimate. The AFSC has used widely respected methods based on maximum age to provide a point estimate or to constrain estimates of M. For some species, the estimate is more ad hoc, where M is derived from the oldest fish using a rule of thumb or Hoenig's method to estimate M. The method of using maximum age is commonly used in data poor situations. When estimating M based on oldest age, it is advisable to determine whether the estimate is sensitive to an extreme outlier. For this reason, scientists often compare estimates from Winsorized data (e.g. truncate at upper 95th percentile of age) to those using a single maximum age. As I understood, this has not been done yet, but is an important step to test for sensitivity of the methods used to obtain estimates of M.

Stock Structure – The knowledge of stock structure is fundamental to evaluating the spatial dynamics of a metapopulation and to assessment metapopulation dynamics and persistence (Jones 2006). However, the stock structure of Alaskan rockfish is not well understood, even for its most abundant species. As recently as this year, research was published to show genetic evidence of the existence of sibling species that were formerly considered phenotypic morphs of the same species (Gharrett et al. 2006). As modern techniques are applied to rockfish, more spatially discrete stocks may be discerned upon which to base spatial-explicit management strategies.

One concern that was raised during the workshop was development of rockfish management at finer scale to address stock structure and localized depletion. The species of concern for localized depletion are POP, dusky and northern rockfish. Currently, there is a dearth of information about the genetic structure of most rockfish other than POP and even with POP more research is needed. POP stock structure has been analyzed with allozymes and microsatellites and results have shown quite a bit of structure north and south, and two populations within Queen Charlotte Sound. While genetics provide the most definitive answer to questions of population structure, tagging studies may also be useful. Because many rockfish species will not survive applied-tag procedures (barotrauma), natural tags (e.g. otolith chemistry) may provide useful data. Ashford et al. (2005) have shown that natural tags can be useful in evaluating population structure in polar fish. Tags will show the rate of dispersal and the potential of gene intromission. Another promising development was discussed by Jim Ianelli who stated that the Japanese have a new in-situ marking device that can be used for tagging rockfish. If this proves effective, then traditional mark-recapture studies may be possible in the future.

Observer Program – Observers provide validation of catch composition, bycatch, effort, location, and obtain biological metrics and collections. For the GOA and BS/AI regions, boats longer than125 ft always carry an observer or two - it takes two observers to monitor every haul. Boats between 60 to125 ft carry an observer on 30% of their trips with one event being an entire trip. Boats under 60 ft have no observers. At least one "basket sample" with a total of 300 kg is sampled throughout the haul in which the entire catch in the basket is identified to species and biological samples are taken. A subset is taken of predominant species for length and age. Observations are done mostly on trawls, but also are done for bycatch on longline vessels. In this way, incidental catch is sampled. Note that shortraker and rougheye rockfish are counted on the longline as a group because they are hard to tell apart on the line. These data are obtained largely electronically (85%). Observers make a rough estimate of the discard. However, these data are only obtained for vessel catches and not for processor discard.

The AFSC is aware of problems with observer honesty. They provide three weeks of training prior to going to sea. However, observers are not hired directly by NMFS but rather by outside companies. Observers must be licensed by NMFS and are paid by the fishing industry. The AFSC cannot easily track that observers take random samples for age, but there is some ability to check to see it basket is chosen randomly.

One important issue to note is that observer trips may not be representative. The vessel captain can choose which days and trips are observed. The observed trips can occurred at the end of the season or in areas that are close to port and short, and may not be representative of the true catch.

Catchability (q) – There was considerable discussion about how q was estimated. Dr. Patrick Cordue provided a brief review of how these calculations were made at NIWA. For POP, q ranged from 1.27-2.1. For other species q was: Sharpchin rockfish=0.12, Shortspine thornyhead=0.34, Rougheye rockfish=0.89, and Pacific ocean perch=2.08 based on a comparison between trawl and submersible estimates of density done by the AFSC.

Fishery-independent surveys – The fishery-independent trawl survey is conducted with three vessels. The AFSC has shown that there is no vessel effect, but rather a skipper effect. Further, they use standardized gear and operation. Trawls are done in random grid positions in places that have been found to be towable. This raises an important issue of how untrawlable ground is handled. There is quite a bit of untrawlable habitat and some of it is clustered. Whether this untrawlable ground is habitable and what densities exist on it appears to be species specific, but is largely unknown. Trawls for some species result in lots of variability in the density estimates that are unlikely for a long-lived fish. How biomass is estimated became an issue of concern during the meeting. Patrick Cordue presented an analysis of potential sources of bias based on the method of estimating biomass from trawlable to total area within grids that have varying amounts of untrawlable ground. I leave it to his report to present this source of bias fully. I agree that this is a major issue that must be addressed because considerable bias may be introduced into biomass estimates.

Results from the trawl survey show that catch distributions are higher and broader for POP than for other species and this indicates that their biomass may be estimated well with trawls.

Survey catches for northern were presented that show that these rockfish are getting bigger and are slightly older. Some scientists have interpreted this as less recruitment. This explanation doesn’t make sense because the area under the graphs (number) becomes greater and this can’t happen without recruitment unless there has been a significant change in gears or catchability over time, for which there is no evidence.

AFSC has conducted a submersible survey for yelloweye in which they use traditional approaches to provide a detection function but then only use the lower 10% to estimate density. This will provide a lower-bound estimate of yelloweye abundance – a very conservative and precautionary approach. The submersible survey has considerable value to the AFSC in evaluating the density of rockfish on untrawlable ground.

Beyond this, the AFSC has conducted acoustic surveys to obtain an independent estimate of rockfish biomass to compare with bottom-trawl catch rates (Krieger et al. 2001). They found a significant relation between acoustic estimate and trawl cpue for Pacific ocean perch, thus indicating that acoustic survey hold promise for at least this species.

Stock Assessment Methods – I can comment on the stock assessments methods, but am less familiar with the Bayesian methods used at the AFSC than the other CIE reviewers. The methods that are used are widely accepted in the U.S. The one question that arose was that some of the parameter estimates, e.g. M or maturity, are estimated outside the model and thus, the impact of uncertainty in their estimation is lost to the model. The maturity schedules for many of the rockfish have greater uncertainty than is recognized for reason stated previously and this can have a potentially large impact on SPR and F_{40} calculations. For this reason, systematic procedures to evaluate uncertainty should be part of each assessment.

Statement of Work Task 2. Include a statement of the strengths and weaknesses of the simulation models, and the analytical approaches used in estimating future harvest levels.

<u>Executive Summary Task 2</u> – The projection model appears to be providing reasonable evaluations of the impact of harvest targets on long-term sustainable rockfish populations. There is some fine tuning that can improve the projection model, such as estimating parameters within the model rather than providing external-fixed parameters (e.g. M). Moreover, when we were presented with preliminary results based on such fine tuning the new results differed insubstantially.

Background – To meet the needs of the Programmatic Supplemental Environmental Impact Statement (PSEIS), the stock-assessment scientists at the AFSC have developed a population projection model for Alaskan groundfish (AFSC 2005) that uses a multispecies technical interaction model that supplies overall catch levels for use in single-species stock projections. Projections begin with the current year vector of parameters from the current assessment. The projections are then run forward, based on fishing mortality as determined by spawning stock biomass generated each year, with biomass determined by recruitment drawn from maximum likelihood estimates based on the time series of recruitments from 1976 to the current year, weight and maturity schedules. Total catch is evaluated from the fishing control rules and the simulation is run 1,000 times to produce a frequency distribution of possible outcomes.

One issue that has been addressed by the AFSC staff was the use of recruitment time series versus specific biomass-driven recruitment into the projection model. During the workshop, the point was raised that the time series would result in a more optimistic outcome because it is less responsive to decline in spawning stock biomass. This is particularly true for a long-lived fish such as rockfish.

After reviewing the analytic methods it became clear that there was no set way to incorporate uncertainty into the models, especially in how uncertainty is presented to managers. The stock assessment author can come forward with recommendations on the ABC based on assessment uncertainty. However, the Plan Team may not agree with the stock assessment author and may pick another output but must justify its selection of a specific run. It appeared that runs were picked based on management implications. The stock assessment author does this when he/she sees something outside the model that isn't being taken into account by the model itself but would alter the model output. A more formal way to handle uncertainty and to present it to managers may be needed.

Statement of Work Task 3. Include an analysis of current harvest strategies. Specifically do they provide appropriate levels of conservation for Alaska rockfish fisheries? What harvest control rules might be more appropriate? Are additional spatial management measures required?

Executive Summary Task 3 – Harvest control strategies are best judged in against a statement of management objectives. Without having one for Alaskan rockfish, one can look to the potential results from the stated harvest control rules to comment on their adequacy. For most of the tiers, control rules are quite precautionary when put into practice. The Optimum Yield (OY) was been set conservatively to a level appropriate for the relatively unproductive environment of the 1970's. Next the ABC is set so that it is always below OY. Further TAC is set below ABC for rockfish and in most instances recently catch is well below the TAC. It is not surprising that several species have exhibited biomass increases –where reliable measures of biomass are known as is the case for rockfish. Hence even though there is some evidence to support a harvest control of $F_{50\%}$ or greater for West Coast rockfish, Alaskan stocks appear to be more resilient because of a more productive environment, stock differences, or the built in precautions of the harvest control rules in this region.

It is very difficult to address which harvest control rules would be more appropriate without a clear and precisely worded management objective as my goal. However, some improvements can be made in the practice of stock assessments by better incorporating uncertainty in the estimates of acceptable ABCs and TACs. I do not feel that I can offer much advice here.

Although spatial management measures are valuable when species are spatially structured in their population dynamics, spatial management requires thorough knowledge of movement, dispersal, and genetic structure to be effective. These data do not exist in the most part for rockfish and fine-scale spatial management to achieve goals such as protecting genetic heterogeneity are premature. Nonetheless, spatial closures based on exploitation practices will be effective in curtailing localized depletion.

Background – Harvest control strategies operate under a system of six tiers in the North Pacific Fisheries Management Council. These tiers 1-6 reflect the amount and quality of data obtained for each stock, from rich to poor data. The harvest control rules begin with the determination of the OY which was set in this region soon after the Magnuson Act of 1976 during a period thought now to be relatively unproductive in Alaskan waters (Goodman et al. 2002). Based on this, the Council set the OY range for the BSAI at between 1.4-2.0 mmt in 1984, which was 85% of MSY. The OY for the GOA was set at 116-800 mmt in 1987 (Goodman et al. 2002). These are now thought to be low in the current environment and, thus, provide a precautionary, conservative limit on harvest.

Initially the management approach was a constant catch strategy, but was soon replaced with a constant F strategy where for most stocks the $F_{ms}y$ has been set at $F_{35\%}$-$F_{40\%}$. The harvest control rules now set ABC to below OFL, thus providing a buffer between them. This adds another level of precaution to potential overharvest. Typically ABCs are 75%

of OFL, and TAC are set lower still, again adding a level of precaution. For rockfish, total catch has been lower still than the TAC frequently.

In 2005, the BSAI for POP OFL=17,300, ABC=14,600, TAC=12,600, and total catch was 10,360 or 30% below the ABC. For 2005 the GOA POP OFL=16,266, ABC=13,575, TAC=13,575, and total catch was 11,357 or 17% below ABC. In reviewing the stock assessments this was a consistent trend, that catches were conservative. Female spawning stock has been increasing for POP in the GOA and this also indicates that this stock is rebuilding and resilient to the current actual F. One strong concern for GOA POP is the potential for local depletion in so far as the area east of 140^o is closed to trawling and POP are taken almost exclusively in trawls in the remaining area.

In the GOA, the biomass of POP, rougheye, northern and dusky rockfish are above targets, while the biomass of the other rockfish is unknown (GOA Stock Assessments 2005).

Ecosystem-based approaches – Two approaches are trophic interactions (e.g. Ecosim) or using proxy by carefully choosing environmental indices. To be effective, trophic approaches are best done in data-rich situations, where in data-poor situations such as with rockfish, environmental indices may provide the best insights. However, note Dorn's comments (2002) that such proxies may be misleading when incorporated into single species stock assessments. During the workshop, Grant Thompson presented preliminary results from a decision-theoretic framework and this approach may be promising. After the workshop, I attended a seminar given by Dr. Sarah Gaichas that presented other interesting approaches to ecosystem-based management that may hold promise.

Spatial management – Finer-scale spatial management can address issues of mixed stocks, stock structure, and localized depletion. Although a laudable goal, spatial management is difficult to undertake when there is a dearth of data, as in the rockfish fisheries of Alaska. For example, there is virtually no information on rockfish movement aside from work done on the U.S. West Coast (e.g. limited larval dispersal paper by Miller and Shanks 2003). This is exacerbated by sparse sampling over a wide area, small sample size, and limitations on methods such as mark-recapture which are inappropriate for rockfish due to barotrauma. Hence the dispersal rate over larvae and adult is virtually unknown for most rockfish species.

Scientists at the PML have developed a three-dimensional hydrodynamic model for the North East Pacific to help in siting marine reserves that has been used to model rockfish dispersal. Although not well known for rockfish, in general spawning areas with high local retention are good areas to site reserve. The model was set up with simple day/night behavior. Moreover, because rockfish parturate, there is no dispersal egg stage, larvae are weak swimmers with little evidence for vertical migration, although juveniles are more competent to move. The results of this model showed few areas of rockfish retention with most being swept along the Aleutian chain.

There is some evidence for localized depletion as shown in the result of Leslie depletion estimates for three species of rockfish (POP, dusky, and northern) in graphs shown by Dr. Dana Hanselman during the workshop. He found a few areas where there were significant declines. Hence, dispersal is not so high as to ameliorate heavy fishing in specific locations, although these effects are not thought to be lasting.

There is also a dearth of information on rockfish stock structure aside for a few species (see for example shortraker rockfish, Matala et al. 2004). Some data has been collected on blackspotted and rougheye rockfish to show some spatial structuring in a presentation by Dr. Jon Heifetz. Further, there is evidence of structuring in POP. However, in general little is known about the other rockfish species and what is known is based on small sample size.

The goal of such spatial management is to develop area closures for species that they think are more stationery and thus reduce localized depletion. Recent area closures have occurred for other unrelated issues and include: an Eastern GOA trawl closure; recent coral closures; Stellar Sea Lion closures; Atka Mackerel, cod, crab no trawl closures. Area closures also include Marine Protected Areas (MPAs). The goals of MPAs as stated in the workshop are to "Protect genetic diversity, Rehabilitate from overfishing, Increase fishery productivity by protecting source production of recruits, Habitat restoration". Again, however laudatory these goals, MPAs must be sited correctly especially if there are locations that are as sources for recruitment. To site MPAs correctly, managers must know a great deal about stock structure and dispersal at all life stages. Clearly, these data do not exist and the value of MPAs for rockfish is unknown.

Appendix 1. Statement of Work

STATEMENT OF WORK
June 15, 2006

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 consultants is requested for this review. The panel should 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. It would be beneficial to receive a summary report that documents the areas of agreement and disagreement among the reviewers.

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:

   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 models, and the analytical approaches used in estimating future harvest levels.
   c. An evaluation of the level of conservatism required to sustain Alaskan rockfish fisheries (e.g. what is the optimal spawning biomass per recruit level? 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-d) 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 center and a copy of the statement of work.
4. Individuals shall be provided with an electronic version of a bibliography of background materials sent to all reviewers. Other material provided directly by the center must be added to the bibliography that can be returned as an appendix to the final report.

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

[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.

Appendix 2. Bibliography for CIE Rockfish Review, June 19-22, 2006

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.

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

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Workshop Reports

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

.

General Supplemental Material

NMFS AFSC and NPFMC Reports and other Documents

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Courtney, D.L., Inaelli, 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

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Appendix 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 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 4. Materials that were made available in hard copy during the workshop

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.

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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.
Bearing 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.

Report to CIE

of

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

R. K. Mohn
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Canada

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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.

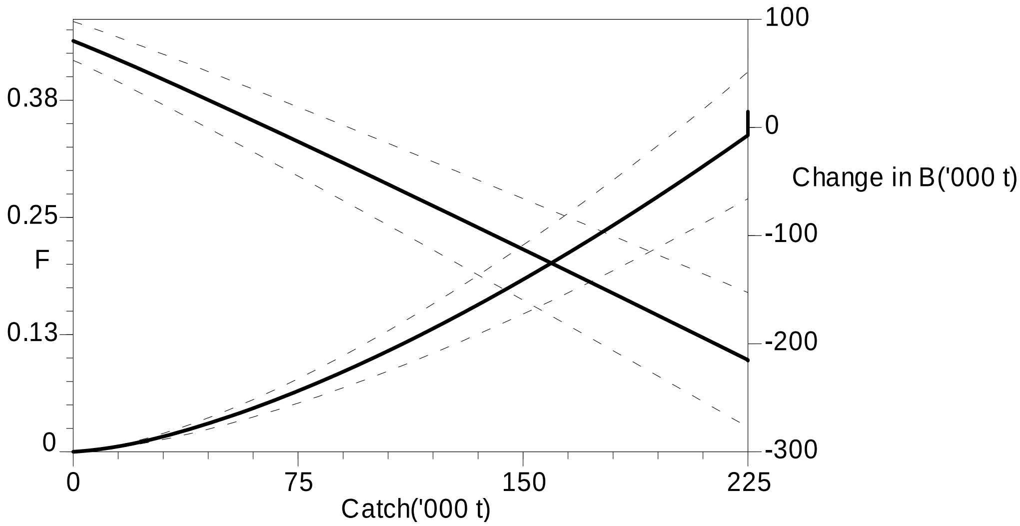

Figure 1. Illustration of the resultant F and change in biomass for a catch in the first year of a projection.

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.

.

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.

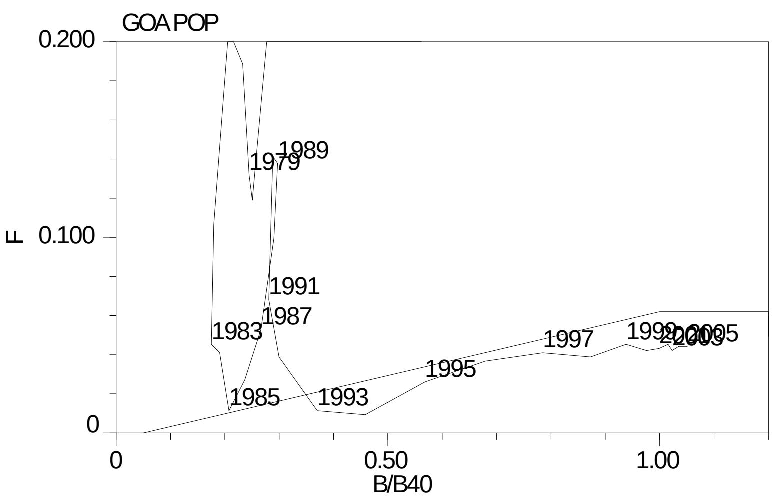

Figure C.1 GOA POP

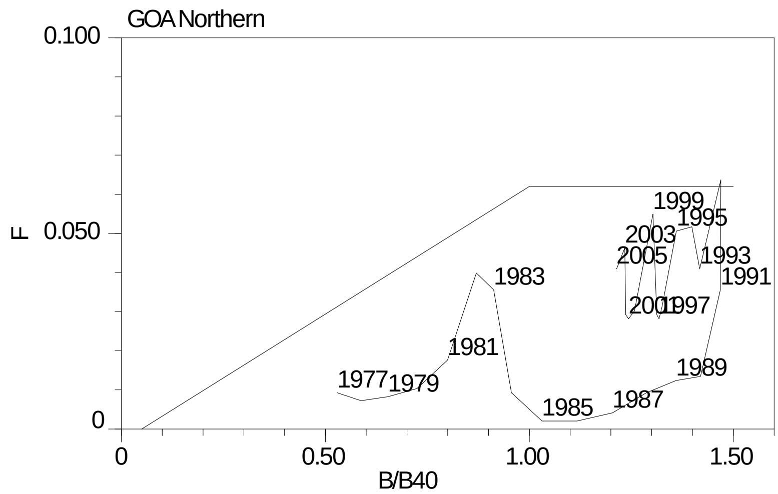

Figure C.2 GOA northern rockfish.

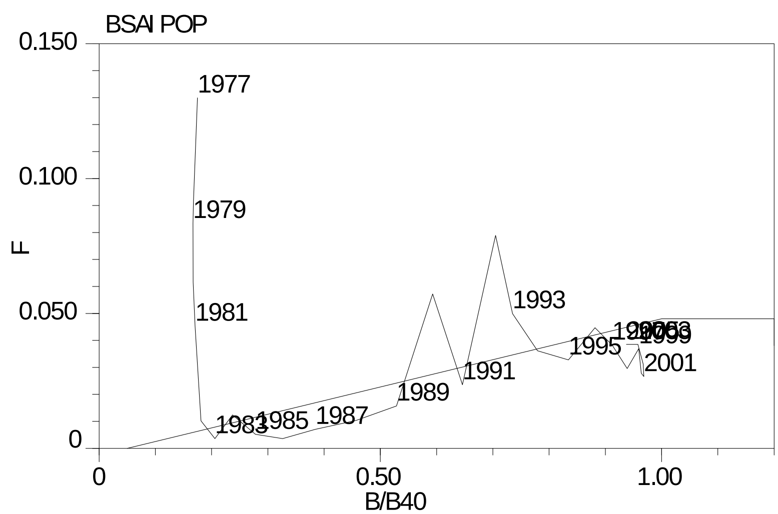

Figure C.3 BSAI POP.

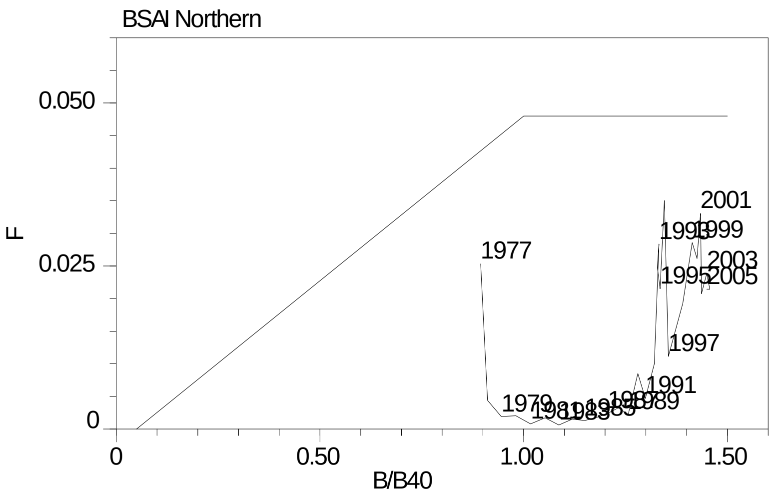

Figure C.4 BSAI northern rockfish.

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	$L_{10} = \lambda_{10}\left[\frac{1}{2*\sigma_r^2}\sum_y \tau_y^2 + n_y*\ln(\sigma_r)\right]$	$L_{10} = \lambda_{10}\left[\frac{1}{2*\sigma_r^2}\sum_y \left(\tau_y + 0.5\sigma_r^2\right)^2 + n_y*\ln(\sigma_r)\right]$
Early recruitment	Log mean recruitment	Rzero before fishery starts log-mean recruitment after
Selectivity	By Age	Logistic
σ_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