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.
144 Yorkshire Ct
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.

Executive Summary Task 1 – 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.

Background – 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.

Executive Summary Task 2 – 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.

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

<u>NMFS AFSC and NPFMC Reports and other Documents</u>

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

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

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. <u>Localized depletion</u> 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.

Additional References Obtained By Jones

Jones, C.M. 2006. "Chapter 4: Estuarine and diadromous species", in Marine Metapopulations. J.P. Krtizer and P.F. Sale Editors. Academic Press.

Monteleone, D. M. and Houde, E. D. 1990. Influence of Maternal Size on Survival and Growth of Striped Bass Morone-Saxatilis Walbaum Eggs and Larvae. J. Exper. Mar. Biol. Ecol. 140: 1-11.

O'Farrel, M.R. and Botsford, L.W. 2006. Estimating The Status Of Nearshore Rockfish (Sebastes SPP.) Populations With Length Frequency Data. Ecological Applications 16 (3): 977-986.

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.

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 Alaska 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.
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.