

REPORT ON THE STOCK ASSESSMENT AND REVIEW

OF BOCACCIO AND BLACK ROCKFISH

APRIL 21–25, 2003

SANTA CRUZ, CALIFORNIA

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EXECUTIVE SUMMARY

Draft bocaccio and black rockfish assessments were reviewed at a STAR Panel meeting from April 21–25, 2003, at NMFS Southwest Fisheries Science Center, in Santa Cruz, California. I fulfilled the role of an “external” member of the Panel. The two assessments were done using a length based version of Stock Synthesis (SS).

With regard to the STAT Teams’ terms of reference (Anon. 2003), the draft assessment documents for both assessments were deficient in several respects. It is hoped that the revised drafts will include full descriptions of the input data (including sample sizes, spatial and temporal coverage) and will tabulate the abundance indices. The “complete” drafts were not finished before the STAR Panel meeting ended and have not been seen by the members of the STAR Panel at the time of writing this report.

A significant amount of time was spent at the STAR Panel meeting correcting problems which could have been identified at pre-assessment meetings. The STAT Teams worked extraordinarily long hours during the meeting but, in part, this was making up for time that would have been better spent on the assessments prior to the meeting.

The draft assessment for black rockfish was implausible. The draft assessment for bocaccio should have included documentation of the effects of the new methods, assumptions, and data on the 2002 assessment results. A quick internal review would probably have identified these problems and saved the STAR Panel and the STAT Teams a considerable amount of time and effort.

The final black rockfish assessment provides a plausible explanation for the data. Sensitivities to model assumptions have been adequately explored. The results are sensitive to the level of early catch history which is not well known. There are the usual sensitivities to steepness and natural mortality.

The final bocaccio assessment has several problems. I agree with the STAR Panel Report (Helsler et al. draft): “. . . the Panel concluded that the bocaccio assessment represents the best available scientific information on stock abundance trends and current stock depletion”. However, that is not to say that it is a “good” assessment; it is the only *available* assessment.

I have recommendations in a number of areas given below. These are in addition to the recommendations in the STAR Panel Reports which I also support.

Assessment software:

- Stock Synthesis (SS) is a flexible package which has done remarkable service, but it is nearing the end of its useful life. Ideally, there should be a managed transition to “new generation” software.
- For bocaccio, there is an urgent need to achieve faster run times. Ways of achieving this should be explored.
- It is desirable to quantify the uncertainty of points estimates within a model run; if SS does not provide adequate means of doing this, then a feature (e.g., bootstrapping) should be added.

Next bocaccio assessment:

- More resources need to be made available to improve the quality of the assessment.
- Much more time needs to be spent on exploring the input data with regard to the model assumptions used in fitting the data.
- The initial conditions in the model should be properly set up. It is important that the model used to fit the data also provides the estimates of virgin spawning output and depletion.

STAR Panel process:

- Pre-assessment meetings should be strongly encouraged.
- A brief internal review of draft assessments should be encouraged.
- Anon (2003), Appendix B: “Outline for groundfish stock assessment documents” should be reviewed. In particular:
 - it should require that full details of survey design be provided, including: sample sizes for abundance indices, and stratification details;
 - it should require that a stock depletion trajectory be provided (to allow assessment of plausibility);
 - there should be a reconsideration of the advice to ignore the estimates of virgin parameters from SS (under 5. Rebuilding parameters).

BACKGROUND

Draft bocaccio and black rockfish assessments were reviewed at a Stock Assessment and Review (STAR) Panel meeting of the Pacific Fishery Management Council from April 21–25, 2003, at NMFS Southwest Fisheries Science Center, in Santa Cruz, California. I was a member of the STAR Panel reviewing the draft assessments presented by the STAT Teams. I fulfilled the role of an “external” member of the Panel (such a member is recommended as part of the process; see Anon. 2003).

The two assessments were done using Stock Synthesis (SS) which has been the standard assessment tool on the West Coast for some years. The software is very flexible and allows the use of many different data types, including length frequencies, age frequencies, and abundance indices (Methot 2000). The software implements fairly standard deterministic population dynamics models in an observation error setting and uses maximum likelihood estimation.

This report presents my personal view of the assessments and makes some recommendations with regard to future assessments of these stocks and some aspects of the STAR Panel process. This report is best read in conjunction with the STAR Panel Reports, which contain a more detailed record of the meeting and recommendations concerning the assessments.

REVIEW ACTIVITIES

Meeting Preparation

Prior to the meeting, the supplied background material (Appendix 1) was read and other relevant documents and literature (available on the internet) were consulted. With regard to black rockfish, it became apparent after reviewing the “previous” black rockfish assessment (Wallace et al., draft; Methot et al. 1999) and the current assessment (Ralston, April 10, draft), that the documents described assessments of different black rockfish stocks (Wallace et al. dealt with an essentially Washington stock, while the current assessment was of a California and Oregon stock). During the meeting I obtained a copy of the draft assessment document describing the relevant previous assessment (Ralston et al. draft). I was told that this assessment did not proceed through the STAR Panel, as near the end of that meeting errors were found in the assessment data (and the STAR Panel report was never circulated).

Meeting Attendance

A brief narrative of the meeting (and subsequent emails) is given below. Details of requested analyses and final model runs are provided in the STAR Panel Reports.

21 April

The meeting began with the black rockfish assessment presented by Dr. Stephen Ralston, the single member of the STAT Team. He gave a brief history of the current assessment (its previous presentation, and failure to progress through the STAR Panel meeting because of errors discovered in the input data) and indicated how the assessment had been updated. He worked through the various aspects of the assessment as given in the revised draft assessment document (Ralston, April 21 draft) which was distributed to the meeting. Most of the day was spent on black rockfish and numerous requests for analyses were made of Steve prior to the adjournment of the meeting for the day. Dr Alec McCall, the single member of the STAT Team for bocaccio, requested that the Panel provide him with some suggested analyses before the meeting ended for the day. The panel was able to provide him with several requests in anticipation of his presentation the next day.

22 April

Much of this day was devoted to the bocaccio assessment. Alec presented his new assessment and described how the data and his methods differed from the previous assessment in 2002. New methods had been used to derive recreational CPUE indices, and there had been (minor) changes to the derivation of most time series. There had been a major change in the catch history, and there had also been the addition of new data (from 2002 *and* 2003). Further, there was a revision of the assumed natural mortality (from 0.2 to 0.1), and the use of a new maturity schedule with 50% maturity at age 3 rather than age 5. The Panel made various requests for analyses and, in particular, wanted to see a series of model runs which made incremental changes to the base model run in 2002.

23–25 April

During these days the two STAT Teams reported back to the Panel as requested analyses were completed. When neither of the STAT Teams was available, the Panel worked on the STAR Panel Reports, documenting the requested analyses and identifying the key issues with regard to each assessment.

One analysis of note for bocaccio was a request for Alec to check the maturity codes which had been used in the derivation of the new maturity schedule from port samples. It was discovered that the correct codes had not been used and that when they were used the estimated schedule was very similar to the “old” schedule (Wyllie Echeverria 1987).

The meeting concluded on the afternoon of 25 April. The base run for black rockfish had been presented to the Panel by Steve, and there was general agreement that it gave plausible results and contained a defensible parameterization and assumptions. The same was not true for the bocaccio assessment.

Two base runs for the bocaccio assessment had been requested by the Panel the previous day, and they were presented by Alec on 25 April. There was disagreement between the Panel and Alec as to the relative probabilities which should be assigned to each of the runs. Also, there were several unresolved issues with regard to the assessment. For example, the method used to estimate virgin spawning output and depletion did not use the SS model estimates (as had been done in the black rockfish assessment). Also, a rebuilding plan had not yet been done, and there was concern amongst the Panel as to how exactly this would be implemented.

After the meeting the STAR Panel reports were completed via email as described below.

28 April – 2 May

After the meeting I worked on two points which had concerned me with regard to the bocaccio assessment. First, I attempted to clarify exactly how the estimates of virgin spawning output and depletion (stock status) from SS were related to the estimates that Alec had used (they differ by a constant factor – see Appendix 2). Second, I was greatly concerned that the reported SS estimates of virgin total biomass were

inconsistent with the depletion in 1951 (the first model year). A 2000 t historical catch (taken out annually) had apparently caused a 1 000 000 t virgin total biomass to decline to less than 5% of its value in 1951. In an email to the Panel members on 28 April, I hypothesized that this must have been caused by an unstable virgin equilibrium (i.e., that somehow an implied steepness of less than 0.2 was being used in the model, so that the spawner-recruit curve was below the replacement line).

Subsequent investigations by Panel members (and a response by SS creator Rick Methot) revealed that the bocaccio SS input files were such that the reported estimates of virgin biomass and spawning output were not linked with the model used to fit the data. That is, it appears that they are essentially “random” numbers (though the spawners per recruit can presumably be correctly calculated from them).

On 29 April, the Panel was alerted by Alec, through the Chair, that he was planning to do a new base run which he would use in the rebuilding analysis. The run was to use all data sources despite the advice of the Panel to exclude contradictory data from the same model run. Also, a new method of estimating recruits was to be used.

On 30 April, Panel members were alerted by Alec, through the Chair, that he had accidentally used the “new” (and incorrect) maturity schedule in the final runs (rather than the agreed “old” schedule). Summary output of the corrected base model runs were received later the same day (and the results were not substantially different from the earlier versions).

There were several further exchanges of comments on the two draft reports, and these were reduced to simple editorial remarks by 2 May.

Conduct of the Meeting

There are several aspects of the meeting and the STAR Panel process on which I wish to comment.

First, I must say that both Alec and Steve worked extremely hard during the course of this meeting, putting in extraordinarily long hours. They were responsive to the panel’s requests for analyses and were generally compliant with regard to our suggestions. I believe that this STAR Panel perhaps “pushed the boundaries” with regard to the level of direction it “imposed” on the STAT Teams. Alec, in fact, remarked that we had “behaved like a STAT Team”. The reason for the Panel’s behaviour in this regard stems from the draft assessments which were provided to us.

In the case of both draft assessments the details of survey design and implementation (e.g., when, where, how, how much) were missing for most time series used in the assessment models. Also, for both assessments it was apparent that there had been too little investigation of the input data. For example, in the case of black rockfish, it was found that the Oregon sport fishery data prior to 1990 had been sampled from only one port, and that black rockfish landed at this port were typically larger than fish from other Oregon ports. In the case of bocaccio, Alec stated early in his presentation that he had only had “one day to spend on each data component”.

The draft black rockfish assessment had one other deficiency which was striking. The results appeared to be inconsistent with the abundance indices. In the base run, the spawning output was estimated to be at 27% of the virgin level (Ralston, April 21 draft). This was despite the fact that the fishery did not really “take off” until 1978 and that the CPUE indices used in the model showed flat trends since this time. The decline had apparently occurred before there was substantial fishing.

In the draft bocaccio assessment, the most striking feature of the document was the absence of any attempt to link the new assessment to the previous 2002 assessment. There had been numerous changes, both in methods, assumptions, and data. Further, the “tone” of the assessment was quite different: the virtual collapse of the stock depicted in the 2002 assessment was replaced with a much more optimistic outlook in

the 2003 assessment. This made it more surprising that there had not been an attempt to explain what changes in the method, assumptions, and/or data had led to the new results.

The Panel members all had substantial experience in stock assessment and were committed to an attempt to get sensible and defensible final assessments out of the review process. The deficiencies in the draft assessments caused us to take a more “hands on” role than many other STAR Panels may have adopted in the past.

The STAR Panel process appeared very worthwhile in this case, and the assessments have been greatly improved by the process. However, I believe that better assessments could have been achieved had the process proceeded somewhat differently.

I note in the document describing the process (Anon. 2003), that a pre-assessment meeting could have been held for each species. Properly structured, and with the right participants, such meetings could have avoided several of the problems that the STAR Panel encountered. For example, in black rockfish, a pre-assessment meeting would have identified the sampling problem with the Oregon sport fishery data. In bocaccio, the problem with the new maturity schedule might have been identified, and any proposal to make numerous changes to the assessment methods and assumptions may have prompted a reminder to systematically document the effect of the changes.

Strengths and Weaknesses in Assessment Methods and Advice

Black rockfish

The Panel and the STAT Team developed a base model with the following primary components: recruitment estimated from 1978–1998; sex-specific natural mortality, including an increase in age-specific natural mortality for females; and a two time-period selectivity curve for the California sport fishery. To bracket the assessment uncertainty, sensitivity to the assumed early catch history was presented with two base case sensitivity runs (one assumed lower early catches, the other, higher early catches). The Panel and the STAT Team were satisfied that this presented a risk neutral assessment of the stock based on the best available data and methods.

The assessment has several merits:

- It provides a plausible explanation of the data,
- All of the assessment estimates are derived from the single, internally consistent model used to fit the data.
- Some innovative and more widely applicable methods of CPUE analysis were used.
- Only one equilibrium assumption was needed in the model as a full catch history was provided (i.e., it was not necessary to assume equilibrium in the first model year, but only in the virgin stock).

There are still some deficiencies:

- It is moot if any of the CPUE indices are actually indexing abundance and, even if they are, they are very noisy.
- A fuller analysis and documentation of the data inputs is desirable.
- If a GLM approach is to be used for CPUE indices they should be constructed using *stepwise* regression methods and full diagnostics should be considered (and presented).
- There should be some quantification of the uncertainty associated with the estimates from each model run (i.e., within runs as well as across runs).

Bocaccio

The bocaccio assessment is much more complex than that for black rockfish. There are more data sources and some of the time series appear to be contradictory. The STAT Team was also severely hampered because the model runs took about 3 hours to converge (compared to 10-20 minutes for black rockfish). Below is a summary of the two base runs and the rationale for their use.

The triennial trawl survey time series appears to be contradictory to the RECFIN CPUE indices. Following Schnute & Hilborn (1993), the Panel recommended that they not be used in the same run. Arguments can be made for the use or exclusion of either set of indices. On one hand, fishery dependent CPUE indices are suspect because they are fishery dependent (e.g., catch rates maintained because of changes in fisher behaviour). On the other hand, the triennial trawl survey may be less efficient at low stock abundance because under such conditions a larger proportion of bocaccio may occupy untrawlable habitat (i.e., varying q with stock abundance).

Separation of these sets of indices gave rise to two models with the following features in common:

- Catch history as in Ralston et al. (1996) with the addition of foreign catches of bocaccio reported in Rogers (2003), and 2000 t of historical catch prior to 1950.
- Updated length composition and abundance indices with revised methods for calculation.
- No recruitment indices. (The Panel was concerned the recruitment indices were not sufficiently comprehensive spatially to provide a reliable index of year-class strength.)
- Maturity schedule as in the 2002 assessment based on Wyllie Echeverria (1987).
- Natural mortality equal to 0.15 as recommended in Ralston et al. (1996).
- Selectivity patterns parameterized as in the 2002 assessment.

Base model 1: RECFIN CPUE indices with bag limit adjustment, remove triennial survey (biomass index and length composition). Estimate recruitment freely from 1960–2001, but use constant background recruitment in 1950–1959.

Base model 2: Use triennial survey, remove RECFIN CPUE indices. Use triennial survey length frequency from 1989 onwards because of irregular survey coverage for earlier years. Estimate recruitment freely from 1970–2001, but use constant background recruitment in 1950–1969

As well as the difference in data inputs, there is a difference between the two runs in the number of freely estimated recruits. The rationale for allowing free recruit parameters from 1960 is that the large increase in the CalCOFI index in the mid 1960s is a true reflection of increased spawning biomass (and so it is desirable to allow the model to adequately fit this increase). If instead one were to adopt the more traditional approach and only allow recruits to be freely estimated when there are adequate cohort specific observations, then recruits should not be estimated until about 1970 (note, “cohort specific” observations are available for young bocaccio from the length data because of early fast growth).

The assessment has some merits:

- Data from a wide variety of sources are used.
- Some innovative and more widely applicable methods of CPUE analysis were used,
- Within each run, data sources show relatively consistent trends.

The assessment is deficient in the following ways:

- The method used to estimate virgin spawning output and depletion is inconsistent with the model used to fit the data and is also internally inconsistent (see Appendix 2).
- Two equilibrium assumptions are required: one in the virgin state, and another in the first model year.

- In the second base run, the estimated selectivity for the triennial trawl survey is implausible.
- It is moot if any of the CPUE indices are actually indexing abundance and, even if they are, they are very noisy.
- It is moot if the CalCOFI index is actually indexing spawning biomass.
- A fuller analysis and documentation of the data inputs is desirable.
- Indices constructed using regression methods should use *stepwise* regression and full diagnostics should be considered (and presented).
- There should be some quantification of the uncertainty associated with the estimates from each model run (i.e., within runs as well as across runs).

SUMMARY OF FINDINGS

With regard to the STAT Teams' terms of reference (Anon. 2003) the draft assessment documents for both assessments were deficient in several respects. It is hoped that the revised drafts will include full descriptions of the input data (including sample sizes, spatial and temporal coverage) and will tabulate the abundance indices. The "complete" drafts were not finished prior to the STAR Panel meeting's conclusion and have not been seen by the members of the STAR Panel at the time of writing this report.

A significant amount of time was spent at the STAR Panel meeting correcting problems which could have been identified at pre-assessment meetings. The STAT Teams worked extraordinarily long hours during the meeting, but in part this was necessary because inadequate time had been spent on the assessments prior to the meeting. This is not necessarily the fault of the STAT Teams. There may be a resourcing issue for management to consider.

The draft assessment for black rockfish was implausible. The draft assessment for bocaccio should have included documentation of the effects of the new methods, assumptions, and data on the 2002 assessment results. A quick internal review would probably have identified these problems and saved the STAR Panel and the STAT Teams a considerable amount of time and effort. Again, there is a resourcing and management issue here: the draft assessments would need to be completed well in advance of the STAR Panel meeting to allow time for a brief internal review and additional work to be done if needed.

The final black rockfish assessment provides a plausible explanation for the data. Sensitivities to model assumptions have been adequately explored. The results are sensitive to the level of early catch history which is not well known. There are the usual sensitivities to steepness and natural mortality. A more thorough exploration of the input data is needed, with more consideration paid to whether the CPUE indices are actually indexing abundance. A quantification of the uncertainty associated with point estimates within runs would be desirable.

The final bocaccio assessment has several problems. I agree with the STAR Panel Report: "... the Panel concluded that the bocaccio assessment represents the best available scientific information on stock abundance trends and current stock depletion". However, that is not to say that it is a "good" assessment; it is the only *available* assessment. Much more time needs to be spent on exploring the input data with regard to the model assumptions used in fitting the data. This requires both an analysis of the data outside the model and a careful study of residual patterns under different model assumptions. The initial conditions in the model need to be properly set up. It is important that the model used to fit the data also provides the estimates of virgin spawning output and depletion. Much of this work is hampered by the fact that SS takes about 3 hours to converge for each run. There is a strong incentive to move to "new generation" software which is far quicker than SS (though again, this raises the question of available resources).

CONCLUSIONS AND RECOMMENDATIONS

My conclusions with regard to the assessments are:

- The black rockfish and bocaccio assessments were much improved by the STAR Panel process.
- The black rockfish assessment is relatively straight forward, and it provides a reasonable assessment on which to base management advice.
- The bocaccio assessment provides the best currently available scientific information on the status of the stock.

I have recommendations in a number of areas given below. These are in addition to the recommendations in the STAR Panel Reports which I also support.

Assessment software:

- SS is a flexible package which has done remarkable service but it is nearing the end of its useful life. Ideally, there should be a managed transition to “new generation” software.
- For bocaccio, there is an urgent need to achieve faster run times. Ways of achieving this should be explored.
- It is desirable to quantify the uncertainty of points estimates within a model run; if SS does not provide adequate means of doing this then a feature (e.g., bootstrapping) should be added.

Next bocaccio assessment:

- More resources need to be made available to improve the quality of the assessment.
- Much more time needs to be spent on exploring the input data with regard to the model assumptions used in fitting the data.
- The initial conditions in the model should be properly set up. It is important that the model used to fit the data also provides the estimates of virgin spawning output and depletion.

Rockfish catch histories:

- Develop appropriate methods to estimate historical rockfish catch and apply the methods across rockfish complexes to obtain the “best” estimates of the catch. The idea is that this should be done once and done properly.

STAR Panel process:

- Pre-assessment meetings should be strongly encouraged.
- A brief internal review of draft assessments should be encouraged.
- Anon (2003), Appendix B: “Outline for groundfish stock assessment documents” should be reviewed. In particular:
 - It should require that full details of survey design be provided, including: sample sizes for abundance indices, and stratification details;
 - It should require that a stock depletion trajectory be provided (to allow assessment of plausibility);
 - There should be a reconsideration of the advice to ignore the estimates of virgin parameters from SS (under 5. Rebuilding parameters).

REFERENCES

(see Appendix 1 for further references)

Helser, T. et al. (draft): Bocaccio STAR Panel Report 2003. 12 p.

Method R. D. 2000: Technical description of the stock synthesis assessment program. U.S. Dept. Commer., NMFS-NWFSC-43. 46 p.

Ralston, S., Ianelli, J.N., Miller, R.A., Pearson, D.E., Thomas, D., & Wilkins, M.E.. 1996: Status of bocaccio in the Conception/Monterey/Eureka INPFC areas in 1996 and recommendations for management in 1997. In: Status of the Pacific Coast Groundfish fishery through 1996 and recommended acceptable biological catches for 1997, stock assessment and fishery evaluation, Appendix B. Pacific Fishery Management Council, 7700 NE Ambassador Place, Suite 200, Portland, Oregon 97220.

Rogers, J.B. 2003: Species allocation of *Sebastes* and *Sebastolobus* sp.caught by foreign countries off Washington, Oregon, and California, U.S.A. in 1965-1976. NOAA Tech.Memo.

Schnute, J. T. & Hilborn, R. 1993: Analysis of contradictory data sources in fish stock assessment. Canadian Journal of Fisheries and Aquatic Sciences 50: 1916-1923

Wyllie Echeverria, T. 1987: Thirty-four species of California rockfishes: maturity and seasonality of reproduction. Fish. Bull., U.S. 85:229-250.

APPENDIX 1: MATERIAL PROVIDED

Documents provided before the meeting:

- Anon. 2003: Groundfish stock assessment and review process during 2003. Draft document describing the groundfish stock assessment review process. 18 p.
- MacCall, A. (draft): Status of bocaccio off California in 2003. Draft Stock Assessment Document (April 6, 2003). 31 p. Supplementary material. 4 p.
- MacCall, A. 2002: Status of bocaccio off California in 2002. Final draft Stock Assessment Document. 41 p.
- Methot, R. et al. 1999: Black rockfish STAR Panel Report 1999. 4 p.
- Ralston, S. (draft): The status of black rockfish (*Sebastes melanops*) off Oregon and Northern California in 2003. Draft Stock Assessment Document (April 10, 2003). 41 p.
- Stauffer, G. et al. 2002: Bocaccio STAR Panel Report 2002. 5 p.
- Wallace, F., Hoffmann, A., & Tagart, J. (draft): Status of the black rockfish resource in 1998. Draft Stock Assessment Document (May 12, 1999). 72 p.

Documents provided during the meeting:

- *Gunderson, D., & Sample, T. 1980: Distribution and abundance of rockfish off Washington, Oregon, and California during 1977. Marine Fisheries Review, Mar-Apr 1980.
- Medley, P. 2002: Consultant report on STAR Panel for coastwide bocaccio and canary rockfish, April 15-19, 2002, NWFSC Montlake Laboratory, Washington. 15 p.
- Ralston, S. (draft): The status of black rockfish (*Sebastes melanops*) off Oregon and Northern California in 2003. Draft Stock Assessment Document (April 21, 2003). 53 p.
- Ralston, S., MacCall, A., & Pearson, D. (draft): The status of black rockfish (*Sebastes melanops*) off Oregon and California in 2001. Draft Stock Assessment Document (undated). 29 p.
- Wallace, F., Hoffmann, A., & Tagart, J. 1999: Status of the black rockfish resource in 1999. Final draft Stock Assessment Document (October 1, 1999). 83 p.
- *Weinberg, K. 1994: Rockfish assemblages of the middle shelf and upper slope off Oregon and Washington. Fishery Bulletin 92: 620–632.
- *Wilkins, M. (unknown): Long term trends in abundance: Results of triennial bottom trawl surveys of West Coast groundfish resources between 1977 and 1995. Appendix F in unknown document.

* Single copies supplied in response to my request for some details about the west coast triennial groundfish surveys.

APPENDIX 2: DEFINITION AND ESTIMATION OF B_0 AND STOCK STATUS

In the black rockfish and bocaccio assessments B_0 was used to denote virgin spawning output in units proportional to total population egg production (the preferred option recommended in the 1999 Safe report). However, in the two assessments the Stock Synthesis (SS) model output was used differently to derive estimates of B_0 and associated levels of stock status (B_i/B_0) in each year.

In the black rockfish assessment the estimate of B_0 was taken directly from the SS output file. Stock status (or “depletion”) in each year was estimated as the spawning output in each year (B_i) divided by B_0 . This is the obvious method to use and it provides estimates of B_0 and stock status which are consistent with the population model used to fit the data.

The method in the PFMC’s document “Groundfish stock assessment and review process during 2003, Appendix B: 5. Rebuilding parameters” was used in the bocaccio assessment. As written in the document it reads “determine B_0 as the product of spawners per recruit (SPR) in [the] unfished state multiplied by the average recruitment expected while the stock is unfished. This typically is estimated as the average recruitment during [the] early years of [the] fishery”. In this method, a time frame for the determination of average recruitment must be chosen. The SS recruitment estimates over the time frame are then averaged and multiplied by the SS estimate of SPR to obtain the B_0 estimate. Stock status is then determined by dividing the SS estimates of spawning output in each year by the B_0 estimate.

There is a simple relationship between the estimates obtained from the two methods.

Let,

B_* = SS estimate of virgin spawning output

B_i = SS estimate of spawning output in the i th year

$B_{\#}$ = “SPR” estimate of virgin spawning output (i.e., using the alternative method)

R_0 = SS estimate of virgin recruitment

R_{av} = average of SS recruitment estimates used to obtain $B_{\#}$

D_i = SS stock status in the i th year

$D_{i\#}$ = “SPR” stock status in the i th year.

Then,

$$SPR = B_* / R_0 \quad \text{and} \quad B_{\#} = SPR * R_{av} = B_* * R_{av} / R_0$$

and

$$D_{i\#} = B_i / B_{\#} = B_i * R_0 / (B_* * R_{av}) = D_i * R_0 / R_{av}.$$

It is apparent that if $R_0 = R_{av}$ then the two methods will yield identical estimates. However, if $R_{av} < R_0$ then $B_{\#} < B_*$ and $D_{i\#} > D_i$. Also, if $R_{av} > R_0$ then $B_{\#} > B_*$ and $D_{i\#} < D_i$. In either of these cases (i.e., $R_0 \neq R_{av}$) the estimates of virgin spawning output and stock status are inconsistent with the model used to fit the data (i.e., $B_{\#} \neq B_*$).

In the bocaccio assessment it was discovered after the STAR Panel meeting that the SS input file had been set up in such a way that the “background” recruitment parameter (rather than the virgin recruitment parameter) was used to establish the initial equilibrium conditions. This meant that the reported estimates of virgin spawning output were ignored by the model (and so were essentially meaningless, except in the calculation of SPR). However, the ratio of background recruitment to the average recruitment used in the SPR calculation of B_0 , can presumably be used to obtain what should have been the reported SS estimates of B_0 and depletion (though there may be some intricacies involved with steepness not accounted for).

When these ratios are calculated for the two base runs and applied to the SPR estimates they increase the estimates of stock status for both runs (by a factor of 1.6 for the RECFIN run and by a factor of 1.1 for the triennial run).

Consider the instructions for estimating B_0 using the SPR method (in relationship to the two base runs). Average recruitment is meant to be estimated “while the stock is unfished”. This is in fact R_0 and if it were used this method would provide the same estimates as SS. The “average recruitment during the early years of the fishery” is a proxy for recruitment from an unfished stock. According to the models used to fit the data (SS estimates) the spawning output in the first year of each model (1951) is at 40% (RECFIN) or 60% (triennial) of the virgin level. These are not unfished stocks. Also, the recruitments estimated (from 1951 onwards) are conditional on the fact that the spawning output is at 40% or 60% of the virgin level in 1951.

If the inconsistency of switching to the SPR estimates of stock status is ignored, the use of recruitment estimates from 1951 onwards still does not make sense in relation to the instructions associated with the SPR method. At 26% (RECFIN) or 54% (triennial) of the virgin output, these recruits do not approximate the recruitment expected from the “unfished stock”. To be consistent with this interpretation it would be necessary to assume that biomass was near to its virgin level in 1951 (depending on assumed levels of steepness).

In general, the use of the SS estimates of B_0 and stock status is technically sound and the alternative SPR method is flawed, at least in terms of the given instructions. It is perhaps technically legitimate to use the SPR method, but the interpretation must be modified to something similar to that used when an initial non-equilibrium age structure is fitted in the first year of a model. Perhaps there is another mode that SS can be run in to do this type of estimation. The use of the SS feature of a constant historical catch (used to set up the initial equilibrium age structure prior to the first year of the model) would be redundant in such a mode, as an initial equilibrium would not be established.

In such models, estimates of B_0 often become highly dependent on the period over which recruitment is averaged and there is little justification for choosing a period near the start of the fishery. In fact, periods of recent recruitment are often chosen to model future recruitment in projections. Such models are apparently more useful for estimating current spawning output relative to a spawning output in the modelled timeframe rather than relative to B_0 .

Given that management decisions are based on estimates of stock status (relative to B_0) it would seem better to use the SS estimates of B_0 and stock status rather than estimates from the SPR method (even if non-equilibrium initial conditions can be used).

APPENDIX 3: STATEMENT OF WORK

Consulting Agreement Between The University of Miami and Patrick Cordue

May 30, 2003

General

The consultant will participate in the Stock Assessment and Review (STAR) Panel of the Pacific Fishery Management Council (PFMC) from April 21-25, 2003, in Santa Cruz, California. The STAR panel will review the Bocaccio and Black Rockfish stock assessments and will provide the basis for management of both fisheries.

The consultant's duties shall not exceed a maximum total of 14 days: Several days prior to the meeting for document review; the five-day meeting; and several days following the meeting to complete the written report. The report is to be based on the consultant's findings, and no consensus report shall be accepted.

The consultant will be provided with the following documents:

1. Draft Bocaccio and Black Rockfish assessment reports for 2003;
2. Most recent prior Bocaccio and Black Rockfish assessment reports;
3. Any prior STAR panel reports on Bocaccio and Black Rockfish assessments;
4. An electronic copy of the data, the parameters, and the model used for the assessment (if requested).

Specific

- 1) Become familiar with the current Bocaccio and Black Rockfish stock assessments and background materials;
- 2) Participate in the STAR Panel to be held in Santa Cruz, California, from April 21-25, 2003;
- 3) Understand the primary sources of uncertainty in the assessments;
- 4) Comment on the strengths and weaknesses of current approaches;
- 5) Recommend alternative model configurations or formulations as appropriate during the STAR panel;
- 6) No later than May 9, 2003, submit a written report¹ consisting of the findings, analysis, and conclusions, addressed to the "University of Miami Independent System for Peer Review," and sent to Dr. David Die, via email to ddie@rsmas.miami.edu, and to Mr. Manoj Shivlani, via email to mshivlani@rsmas.miami.edu.

Signed _____

Date _____

¹ The written report will undergo an internal CIE review before it is considered final. After completion, the CIE will create a PDF version of the written report that will be submitted to NMFS and the consultant.

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, conclusions/recommendations, and references.
3. The report should also include as separate appendices the bibliography of all materials provided and a copy of the statement of work.