
Report on the 2010 assessment of South Atlantic Red Snapper

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Reviewed by:

Approved for release by:

Executive Summary

The 2010 assessment of the South Atlantic stock of red snapper *Lutjanus campechanus* is being conducted for the South Atlantic Fishery Management Council in a series of three workshops known collectively as SEDAR 24. This report provides an independent peer review of the assessment, after the Data and Assessment Workshops, but before the Review Workshop.

This assessment, which was generally well documented, was done in four parts: population modelling (with the Beaufort Assessment Model), estimation of population benchmarks and management parameters, projection of future population status, and characterization of uncertainty. The methods used in all four parts were sound. However, some aspects of the application of these methods could be improved. These improvements are likely to make significant changes to the assessment, and increase the estimated uncertainty associated with it.

I recommend that all four parts of the assessment be redone after

- the weighting of data in the base model has been adjusted (this includes omitting much of the length composition data),
- the assumptions concerning population initialization and steepness have been reconsidered,
- support for the base model has been more closely examined,
- the reliability of the estimated the spawner-recruit relationship has been reconsidered (to determine whether a per-recruit proxy for F_{MSY} should be used), and
- steepness has been included in the set of parameters subject to Monte Carlo sampling.

Three topics suggested for further research are

- further development of the Beaufort Assessment Model,
- the development and use of a fishery-independent biomass index, and
- the quantification and understanding of assessment uncertainty.

1. Background

The 2010 stock assessment of the South Atlantic stock of red snapper *Lutjanus campechanus* is being conducted by the Southeast Fisheries Center of the National Marine Fisheries Service for the South Atlantic Fishery Management Council (SAFMC). SEDAR 24 is a series of workshops addressing that assessment (see <http://www.sefsc.noaa.gov/sedar/Index.jsp> for more information about the SEDAR process). The first two steps in SEDAR 24 were a Data Workshop (DW) held May 24-28 2010 in Charleston, SC, to evaluate the assessment data, and an Assessment Workshop (AW), held as a series of webinars, to develop the assessment model. The present report reviews the stock assessment, as described in reports produced during these workshops.

The final step in SEDAR 24 will be the Review Workshop, to be held October 12-14 2010 in Savannah, GA.

2. Reviewer's Role

The reviewer's role is described by the Statement of Work (see Appendix 2) provided by the Center for Independent Experts, which commissioned this report. In general terms this role involves providing an independent peer review of the stock assessment prior to the Review Workshop, with the proviso that the term review is to be applied broadly, so that "the reviewer may suggest additional analyses, error corrections and sensitivity runs of the assessment models". Detailed Terms of Reference (TORs) for the review are given in Annex 2 of Appendix 2.

The reviewer did not participate in either the Data Workshop or the assessment webinars, but was provided with the draft Assessment Report (AR), some documents prepared for, and after, these meetings, and other reference documents (see Appendix 1).

3. Findings

My findings are given under five headings corresponding to the first five TORs (see Appendix 2, Annex 2, and note that the sixth and final TOR is simply to prepare this report).

I did not feel well equipped to address all of the TORs of this review, partly because of limited expertise (I have no specialist knowledge about red snapper, its fishery, or

the legislative and administrative environment in which it is monitored and managed, and I note that this knowledge is not specified amongst the Requirements for the Reviewer in Appendix 2), and partly because of limited time. For that reason I focussed on those TORs for which I thought I had most to contribute.

3.1 TOR 1: Data

My ability to comment on the data used in the assessment is very limited because I have no specialist knowledge about this fishery (including the agencies involved in monitoring it, and their data collection and management practices). Where I do have relevant expertise (in the construction of model inputs, such as age and length compositions and catch-per-unit-effort [CPUE] indices, from raw data) there was little for me to comment on. The methods used seem appropriate, but very little detail, and no diagnostics, were presented. For example, I assume that age compositions were constructed in the usual fashion using age-length keys, but this was not clear from the Data Report.

There is clearly a high degree of uncertainty about all three types of data: landings and discards; age and length compositions; and CPUE indices. It is the last data type that is of greatest importance, because this is what drives the assessment. A major component of the uncertainty concerning the CPUE indices is the extent to which they are proportional to biomass.

3.2 TOR 2: Assessment methods

Three assessment methods were described: the Beaufort Assessment Model (BAM) (Section 3.1), a catch curve analysis (Section 3.1.1.5), and a surplus production model (Section 3.2). I will restrict my comments to the first of these because I believe it is greatly superior to the other two, whose results made up only a small part of the AR, and did not in any way qualify my perception of the status of the red snapper stock.

The BAM seems to me to be a good tool. It is written using a well-tested modern package (ADMB), uses generally sound statistical and modelling principles, and is fairly well documented. My main comments on the assessment concern four aspects of the application of this tool: data weighting, population initialization, support for the base model, and the treatment of steepness. These are covered in Sections 3.2.1–3.2.4, with lesser matters discussed in Section 3.2.5.

3.2.1 Data weighting

There are two important aspects of data weighting. First, the *relative* weights assigned to different data sets can have a profound effect on key model outputs (e.g., estimated stock and fishery status). Second, the *absolute* data weights affect estimates of uncertainty (i.e., doubling all the data weights will not affect estimated stock status, but it will reduce the estimated uncertainty about stock status). I will argue that there are problems with both the relative and absolute weights used in this assessment, and that these are demonstrable using simple diagnostics. However, before discussing these diagnostics there is another data-weighting issue to be addressed.

I think that it was wrong to use both age and length compositions for the same fishery in the same year. This is double dipping; because the length composition information (which is used in creating the associated age compositions) was used twice in the model. The effect of this duplication is to give undue weight to the composition data. Since the age composition data contain more information, the length composition data should be dropped wherever there is corresponding age composition data.

In this assessment, no effort seems to have been made to check whether the assumed data weights (CVs [coefficients of variation] for CPUE, and ESSs [effective sample sizes] for composition data) were correct. When we assign a weight to a piece of data we are, roughly speaking, telling the model how big we expect the residuals will be (residuals are the differences between the observed value of each datum and the value estimated by the model). If the residuals are much larger (or smaller) than was implied by our data weights, then these weights are too small (or large) and should be adjusted appropriately. A simple diagnostic statistic that allows us to check that the residuals for each data set are about the right size is the standard deviation of the normalised residuals, or SDNR, which should have a value near 1. I calculated SDNRs for the base model (see Appendix 3 for computation details) and found that, for most data sets, there were markedly greater than 1 (Table 1A), indicating that data weights were much too high. I also calculated correction factors (see Appendix 3) for each data set, which are estimates of how much we might need to change the initial data weights to obtain SDNRs near 1 (the initial weights should either be divided [for CVs] or multiplied [for ESSs] by these factors). Most of these factors were much less than 1 (Table 1B).

Some comments on these statistics. They are only well estimated for the larger data sets (CPUE and composition data for head boat and commercial line landings). Thus, it might be sensible, when correcting the weights for a smaller data set (e.g., the length compositions for the head boat discards), to use correction factors for similar, but larger, data sets. For the composition data sets, the sample size for each SDNR is the

number of years of data (thus those for the dive data are not well estimated) because the composition SDNRs are based on residuals for mean length or age, rather than the individual residuals. This is because there are strong correlations amongst the residuals for the individual proportions at length or age in each year, as is obvious in the residual plots (see AR Figures 3.4–3.13, and note that residuals for adjacent length or age bins are usually of the same sign). These correlations are caused both by correlations in catch samples (fish from the same catch tend to be of similar size and age – see, e.g., Pennington and Vølstad 1994) and process error (e.g., year-to-year variations in natural mortality or selectivity). A useful diagnostic plot for the composition data compares observed and expected mean lengths (or ages), with 95% confidence intervals for the observed values being based on the assumed ESSs. For the BAM base model, this plot provides a clear visual demonstration that the composition data were over-weighted, because many of the confidence intervals do not include the expected values (Figure 1).

Table 1: Data-weighting diagnostic statistics for the main data sets in the base model: A, SDNRs (standard deviations of normalised residuals) and B, weighting correction factors. An SDNR much greater than 1 indicates that a data set was given too much weight. To correct the data weightings the initial weights should either be multiplied (for CVs) or divided (for ESSs) by the correction factors.

Data type	<u>Head boat</u>		<u>Commercial landings</u>	
	<u>landings</u>	<u>discards</u>	<u>line</u>	<u>dive</u>
A: SDNRs				
CPUE	6.1	1.4	5.7	–
Length composition	4.0	2.0	3.2	0.7
Age composition	2.9	–	2.8	1.0
B: Correction factors				
CPUE	0.16	0.71	0.17	–
Length composition	0.061	0.26	0.098	2.0
Age composition	0.12	–	0.13	1.0

I have not discussed data weightings for the landings and discards which, in the BAM, are treated as data observed with error. This is because this treatment is purely a matter of computational convenience (to avoid having to solve the Baranov equation iteratively – which is complex when there are multiple fisheries), with the intention being to fit the landings and data ‘closely’ (AR, p. 5). All that is needed is to set the CVs for landings and discards sufficiently low that a close fit is achieved. This was clearly done (see AR Figures 3.14–3.20).

Some final comments about data weighting in stock assessment models. This is inevitably an iterative procedure: we set some initial weights, run the model, and then adjust the weights (as described above). The last two steps may need to be repeated. If we subsequently make significant changes to the base model assumptions we may

need to re-check the weights. When composition data are combined across years (as with the private recreational length compositions) they should be down-weighted. Whatever you do, do not allow composition data to prevent a good fit to abundance indices.

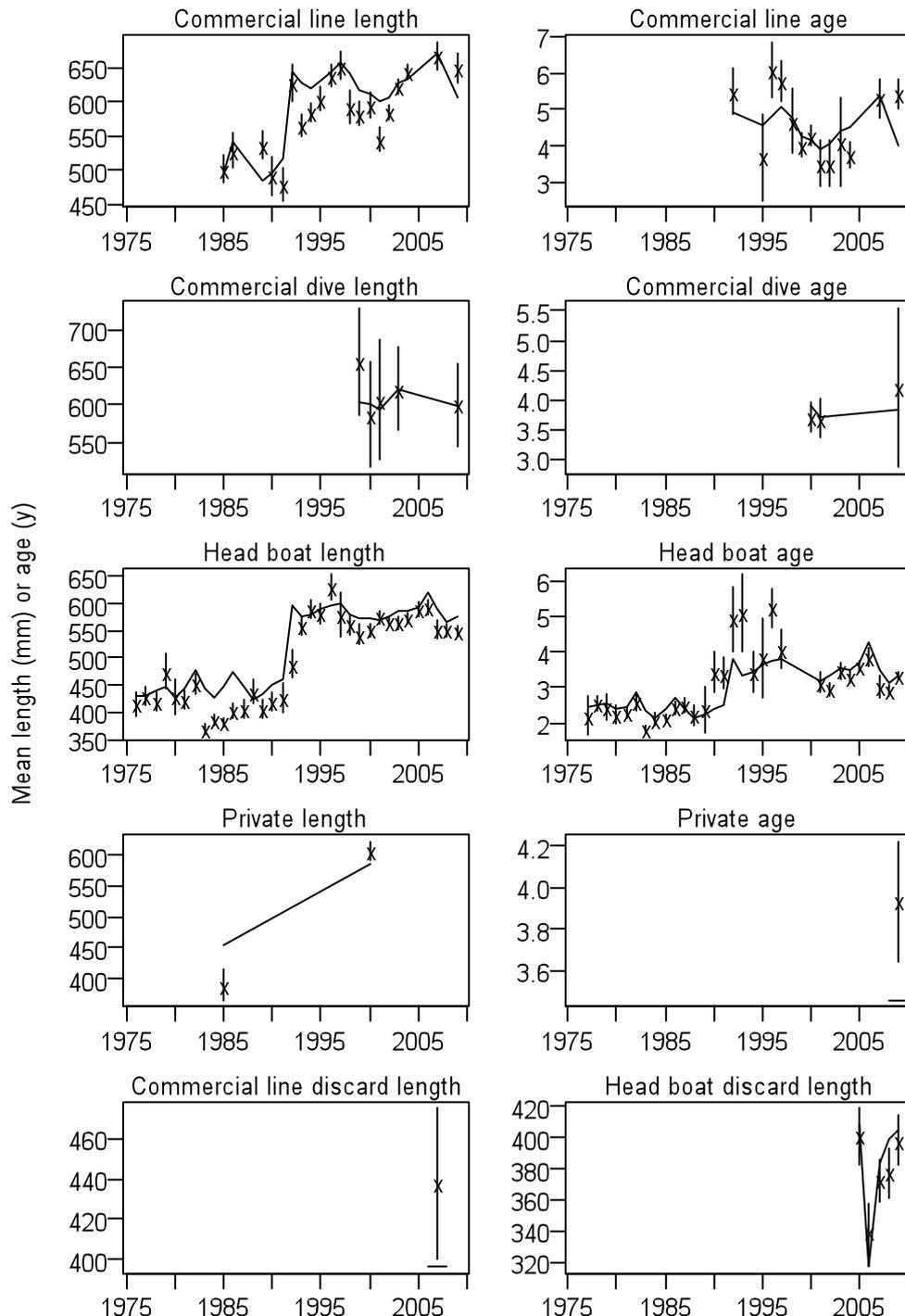


Figure 1: Observed ('x', with 95% c.i.s as vertical lines) and expected (lines) mean lengths or ages for all composition data. Expected values are from the base BAM model; confidence intervals are based on the sample sizes assumed in that model.

3.2.2 Population initialization

An important assumption of this assessment concerns the state of the red snapper population in 1955, the first modelled year. As far as I understand, it is assumed that the numbers at age in this year are what would be expected from a population with deterministic recruitment that had been fished for many years with fishing mortality equal to F_{init} , the fishing mortality estimated for 1955. I was concerned that I saw no discussion of the grounds for this very strong assumption. I will describe the specific aspect of this assumption that concerns me, why this is important (i.e., how it might affect our view of stock status), and what might be done to investigate and modify it.

The initialization assumption determines two aspects of the initial state: the population proportions at age, and the depletion (i.e., $B_{\text{init}}/B_{\text{unfished}}$). It is only the latter aspect that is of concern. Now, consider the chain of logic associated with the initialization. Given the estimated F_{init} (0.181 – this, and the figures which follow, come from AR Table 3.4), together with the 1955 landings, it is easy for the model to calculate B_{init} (11 300 t). Also, given the biological parameters for this species and the composite fishery selectivity, a simple simulation shows that long-term fishing at $F = 0.181$ will produce a depletion of 0.28. Thus, the initialization assumption implies that B_{unfished} is 40 300 t. The key point to notice is that, once B_{unfished} is known, the model can calculate R_0 (the mean recruitment in the unfished population), which scales the expected recruitment in 1955 and all subsequent years, and B_{MSY} . This raises two points of concern: bias and uncertainty. If the actual depletion caused by pre-1955 fishing was markedly different than 0.28, the assessment will be biased. Also, by assuming that F_{init} determines the exact degree of depletion in 1955 we are ignoring an important source of uncertainty.

It is easy to investigate the possibility of bias, though it does require some guesswork. What is needed is to construct a complete pre-1955 catch history for this stock, then to run a simple model, with deterministic recruitment and an initial biomass of 40 300 t, to see whether this predicts a 1955 biomass near 11 300 t. As a starting point, I suggest using the catches in the right-hand column of Table 3.1 of the Data Report, filling in the gaps by simple interpolation, and adding an allowance for recreational catch (as was done for the post-1955 catches). A possible way of dealing with the pre-1927 period would be to choose a plausible starting year for the fishery and assume a linear increase in catches from then until 1927. It would be sensible to consider several alternative scenarios, and produce several possible pre-1955 catch histories. The aim of the game is to see whether a 1955 depletion of 0.28 is plausible.

I can think of two alternatives to the current initialization assumption: either initialize the population at B_{unfished} and use a complete catch history, or stick with the post-1955 catch history and make B_{unfished} (or, equivalently, R_0) a free parameter.

3.2.3 Support for the base model

When a stock assessment is presented, as with the current one, as a base model and a set of sensitivity analyses, it is very common that any consequent management actions will depend strongly on results from the base model alone, regardless of any qualifying comments made by the assessment team (e.g., “The AW did not consider [the base model] to represent reality better than all other possible configurations”, p. 5 in the AR). For that reason it is important that the assessment team closely examine all evidence in support (or otherwise) of the assumptions of the base model. This is normally done in two stages. First, a combination of expert judgement and examination of all available information is used to formulate initial assumptions; then a model using these assumptions is run, and model diagnostics are used to determine whether there are any grounds to reconsider any assumptions. I’m sure the assessment team was diligent in stage one, but the AR contains no evidence of stage two investigations (though, of course, they may have been done, but not reported).

I will describe some diagnostics that I think could have been examined to check support for three base model assumptions. The first two assumptions (concerning asymptotic selectivity and natural mortality) are clearly identified by the sensitivity analyses (S23–S30 and S1–S2) as influential. Thus it is important to be sure that there is no evidence in support of alternative assumptions. The third one (to do with growth) may not be so important if my suggestion to drop most of the length composition data (see above) is followed. By recommending that some effort be made to check support for these three assumptions I do not mean to imply that I think they may be wrong. Rather, I am offering a way of showing readers of the AR what support there is for them.

In the base model, the asymptotic values for the selectivities for the commercial line and both recreational fisheries (i.e., parameters `selpar_min_cl` and `selpar_min_HB`) were fixed at 0.5 and 0.3, respectively, with alternative pairs of values being examined in sensitivities S25–S30. I think I understand why this was done (because these parameters were difficult to estimate), and I support the use of expert judgement to fix such parameters. However, it is useful to examine the extent to which this judgement is supported by the data, and this is easily done using the profile feature of ADMB. This provides a simple way of examining the fits of a series of models that are identical in all ways except for the fixed value of the parameter being profiled. We

can learn several things from a profile on, say, `selpar_min_cL`. First, which value of this parameter is best fitted by the data? This might lead us to reconsider the value assumed in the base model. Second, if the total objective function value (Λ , in the notation of SEDAR 24-RW-01) varies substantially across the profile we can examine the various components of this function (i.e., Λ_1 – Λ_{11} on pp. 10-12 of SEDAR 24-RW-01) to find which is driving this variation. If Λ does not vary much then we may want to consider extending the range of `selpar_min_cL` values that is considered in the sensitivity analyses.

A profile could be used in a similar way to examine the range of natural mortality assumptions spanned by the base model and sensitivities S1–S2. As the model is currently written, the profile would need to be constructed manually (preferably adding some values of the scaling constant that are intermediate between the three values currently used: 0.05, 0.08, and 0.12). Alternatively, the model code could easily be rewritten so that this scaling constant becomes a model parameter, from which the values of M at age are calculated (actually, there appears to be some vestigial [i.e., commented-out] code on p. 27 of SEDAR 24-RW-01 which does just that). Then an ADMI profile could be constructed on the scaling constant.

The third model assumption that I thought could be evaluated (though not quite as easily as the others) is the growth model (i.e., the von Bertalanffy parameters together with the assumption that the standard deviation (SD) of length – parameter `len_sd_val` – does not vary with age). My experience is that length composition data can be very misleading if these assumptions are wrong. Here’s how they can be checked. For each year of each age composition data set, there is an age-length key which may be thought of as a matrix A , where A_{ij} is the estimated proportion of the fish in the i th length bin that are also in the j th age class (so the rows of A sum to 1). Given a length composition vector, C_L , we construct the corresponding age composition by first multiplying the i th row of A by $C_{L,i}$, for all i , to produce the matrix A^+ , and then summing the columns of A^+ . The columns of A^+ can also be used to provide estimates of the mean and SD of length at each age. For example, the estimated mean length for the j th age class is simply $(\sum_i A^+_{ij} l_i) / (\sum_i A^+_{ij})$, where l_i is the mid-length of the i th length bin. Let’s denote these estimated means and SDs as $_{obs}\mu_{fya}$ and $_{obs}\sigma_{fya}$, where f indexes the fisheries, y the years, and a the ages. The idea is to compare these observed means and SDs with those expected by the model, which we might write as $_{exp}\mu_{fya}$ and $_{exp}\sigma_{fya}$ (NB we need the subscript f because these means and SDs apply to the (selected) catch from the fishery, not the whole population). I would do this with two plots: one of $_{obs}\mu_{fya} / _{exp}\mu_{fya}$ against a for all f and y , and the other the corresponding plot for the SDs. If the growth model is appropriate, both plots will show a scatter of points centred on the horizontal line at value 1, and showing no upward or downward trend with increasing age. If the SD plot shows a linear trend then this can easily be fixed by

adding one more parameter to the model (replacing `len_sd_val` by `len_sd_val1` and `len_sd_val2`, which are the length SDs at the first and last age classes).

Note that the analyses described in this sub-section should be done *after* the data weightings have been adjusted (to see why, try constructing one of the above profiles both before and after reweighting the data).

3.2.4 The treatment of steepness

I was not happy about the treatment of h , the steepness of the spawner-recruit relationship, in this assessment. This important parameter effectively describes how the expected recruitment from a population at low spawning biomass compares to that from an unfishery population. I maintain that the available data contain very little information about h because the only recruitment estimates are from a very narrow range of population sizes (between about 1% and 8% of B_{unfished} , according to AR Table 3.4). Thus, to attempt to estimate h is to extrapolate well beyond the range of the available data. It is a bit like trying to estimate the overall height of an unknown quadruped from the height of its ankle.

I know it seems as if one can estimate h well in this assessment. This might be inferred from the narrow range of h estimates in the sensitivity analyses (AR Table 3.15) and the estimated probability density for h (AR Figure 3.38). However, these results are misleading because they are conditional on the model assumption that the spawner-recruit relationship is Beverton-Holt, and the available data provide no means for checking that assumption. That assumption allows the model to estimate what the recruitment would be in the unfishery population, even though all the estimated recruitments in the assessment are from when the population was believed to be a small fraction of that size. My point might be clearer if I describe an analogous situation. It is generally believed that the growth of most fish species is asymptotic, i.e., the mean length at age tends towards an asymptotic value, commonly denoted L_{∞} . Now imagine the problem of estimating L_{∞} for red snapper using only observations of fish of ages less than 4 y. To make such an estimate is to extrapolate well beyond the range of the data. We can certainly estimate L_{∞} using these data if we are prepared to assume a mathematical form for the red snapper growth curve (e.g., von Bertalanffy) but that estimate may be badly wrong if this assumption is wrong. Further, these data do not allow us to test this assumption.

A better way to treat steepness might be to fix it at the mean (or median) of the prior distribution (see SEDAR 24-AW06) in the base model, and include sensitivity runs with high and low values of steepness from this prior.

3.2.5 Other comments

I am slightly bothered by the parametric form used for domed selectivity, because this requires that the age of full selection be “fixed for each model run” (AR, p. 3), presumably by trial and error. That’s not a problem for the base model, but it certainly will be for the MCB (Monte Carlo bootstrap) runs, and possibly also for the sensitivity runs, (assuming that the base model fixed values are used throughout). There are plenty of parametric forms for domed selectivity that do not require fixing the age of full selection (or even assuming that this is an integer age). See, for example, table 2 and figure 3 of Bull et al. (2008).

I commend the authors of BAM for creating a very useful stock assessment package, but would like to point out one drawback which they might like to consider. I first assumed that BAM was a flexible, and reasonably stable, software package comparable to Stock Synthesis (<http://nft.nfsc.noaa.gov/SS3.html>) or CASAL (Bull et al. 2008). The strength of such packages is that the computer code is well tested (because it has been used in many assessments) and any assessment using such a package is completely documented by the combination of the program manual and the assessment input files. From a comparison between SEDAR 24 documents AW02 and RW01, I saw that BAM is not quite like these packages. Rather, it is a corpus of computer code that can be modified to suit the requirements of each individual assessment. A drawback to this approach to modelling is that each time the code is modified, there is potential for error, and there is a real danger that corresponding changes will not be made to the documentation. When the documentation is wrong, there is a possibility that the model will not be doing what the user (and a reviewer, like me) thinks that it’s doing. Without looking very hard I found three places where the equations in the BAM documentation (SEDAR 24-RW01) differed from the ADMB code: the variation in length at age is assumed to have a constant SD, not CV; the equations for linear increase in catchability (here the AR description is wrong too – the slope is $0.02q_{\text{initial}}$, not 0.02); and the prior distributions. These sorts of documentation problems can be reduced if you try to move towards a well-documented program with which users can modify their model assumptions simply by changing their input files, rather than modifying the ADMB code.

Though many useful plots and tables were presented in the Assessment Report, there was relatively little in the way of useful interpretation of these model outputs. For example, if we ignore text which is no more than a repetition of plot or table captions, the output from 36 sensitivity/retrospective runs – 11 figures and 1 table – is discussed in just two short sentences. Also, what does it mean to say (p. 12) that fits to the composition and CPUE data (illustrated in AR Figures 3.3 and 3.21–3.23) were ‘reasonable’? And how are we to interpret the angular deviation plots (lower panels

in AR Figures 3.4–3.13)? (e.g., what would such a plot need to look like to suggest cause for concern?).

3.3 TOR 3: Population benchmarks and management parameters

The methods used to estimate population benchmarks (e.g., MSY, F_{MSY} , SSB_{MSY}) and management parameters (MSST and MFMT) appeared to be standard and sound. Current estimates of these quantities may not be reliable because of issues discussed above in Sections 3.2.1–3.2.4.

I note the comment that the per-recruit benchmarks $F_{30\%}$, $F_{40\%}$, and $F_{50\%}$ “may serve as proxies for F_{MSY} , if the spawner-recruit relationship cannot be estimated reliably” (AR p. 8). For reasons given above, my view is that this relationship was not reliably estimated in this assessment. However, I do not know what criteria, or conventions, may exist within the SAFMC to judge reliability in this setting.

3.4 TOR 4: Projections, uncertainty, and workshop TORs

The method used to project future population status in this assessment is standard and appears adequate, appropriate, and well applied (assuming that the range of scenarios considered (AR, p. 11) is appropriate for the red snapper management environment).

Uncertainty in this assessment, for both the main assessment results and the projections, was characterized mainly using the MCB (Monte Carlo bootstrap) method, which is quite adequate and appropriate. [I believe that a slightly better method, if it proved practicable, would be a fully Bayesian assessment, using Markov Chain Monte Carlo (MCMC) methods to characterize uncertainty. ADMB is set up to facilitate this approach. However, I acknowledge that this approach is not always practicable because of convergence problems and a heavy computational load.] There was one detail of the data bootstrapping which I think could be improved (unless I have misunderstood Section 3.1.1.8.1, which was not quite clear), and that is that the bootstrapped data should be obtained by adding random error to the model’s *expected* value for the data, not the *observed* value (which already includes error).

I believe that the application of the MCB method in this assessment underestimated uncertainty because (a) most data weightings were much too high (see Section 3.2.1 above), and (b) steepness was assumed to be well estimated (see Section 3.2.4). Steepness should be included in the set of parameters subject to Monte Carlo sampling (see AR Section 3.1.1.8.2). I thought that the uncertainty that *was* estimated was well communicated in a series of figures and tables, except that I was surprised to see no

uncertainty in the plots of future landings associated with the projections (lower right panels in AR Figures 3.61–3.68).

For reasons given above (at the beginning of Section 3) my focus in this review was on the stock assessment, rather than on the processes that generated it. For that reason I am unable to offer any comments, beyond those given above, on the extent to which the DW and AW met their TORs.

3.5 TOR 5: Research recommendations

Most of the research recommendations from the DW, and many from the AW, concern technical issues relating to the red snapper fishery and thus are beyond my expertise. I will comment on the following four recommendations from the AW.

- Fishery independent surveys of reef fishes in the Southeast were expanded in 2010. These data should be available for future assessments of red snapper.
- More detailed spatial and temporal resolution of fishing effort for each fleet would likely improve assessments.
- Methods to characterize uncertainty in assessment results deserve further consideration. For avoiding overfishing, characterizing uncertainty is more than an academic exercise, particularly when relying on probabilistic methods to set catch levels.
- Depth appears to be important component of population and fishery dynamics for red snapper. Spatial assessment models might be able to address depth explicitly, if migration rates among strata were better understood.

With regard to the first of these, any fishery-independent index of biomass would be of great value to future assessments of this stock as long as it was reasonably precise and reliably indexed the whole stock (or at least a large fraction of it). What priority should be given to this recommendation depends on the feasibility of obtaining such an index at an acceptable cost.

I strongly support the third of these recommendations, but suggest a wider interpretation of the phrase “characterize uncertainty” than was perhaps meant by the AW. In the SEDAR setting, this phrase seems to refer primarily to the *quantification* of uncertainty, as achieved in this assessment using the MCB method. On this front I would encourage exploration of full Bayesian estimation, using MCMCs, which I

believe is more sound, theoretically, than MCB (though I acknowledge that the latter method is an acceptable, and pragmatic, alternative when the former method is not practicable). I would also encourage more use of the sorts of diagnostic and exploratory techniques described above in Section 3.2.2, one aim of which is to increase *understanding* of uncertainty in the assessment.

I am less sure about the second and fourth recommendations. The former could certainly be useful if it is aimed at improving the standardisation of CPUE indices. However, I am dubious about any gains to be made by adding spatial structure to the assessment model. Additional structure means more parameters, and these will add little to the assessment unless there are sufficient data to estimate them well. They may make the model structure slightly closer to that of the real world, but they are unlikely to improve estimates of stock and fishery status.

4. Conclusions and Recommendations

My conclusions and recommendations are grouped by TORs 1–5.

4.1 TOR 1: Data

I conclude that there is great uncertainty about all three types of data used in this assessment but have no recommendations to make on this subject.

4.2 TOR 2: Assessment methods

The general approach used in this assessment, involving the Beaufort Assessment Model, was sound. I believe the assessment could be improved if some attention was paid to the questions of data weighting, population initialization, support for the base model, and the treatment of steepness, as discussed in Section 3.2.

I recommend that the assessment be redone after

- the weighting of data in the base model has been adjusted (this includes omitting much of the length composition data),
- the assumptions concerning population initialization and steepness have been reconsidered, and
- support for the base model has been more closely examined.

4.3 TOR 3: Population benchmarks and management parameters

The methods used to estimate population benchmarks and management parameters for red snapper were sound but the current estimates may change substantially once the above changes in the assessment are implemented and the reliability of the estimated the spawner-recruit relationship has been reconsidered (see Section 3.3).

I recommend that the population benchmarks and management parameters be recalculated after

- the assessment has been redone (see Section 4.2), and
- the reliability of the estimated the spawner-recruit relationship has been reconsidered.

4.4 TOR 4: Projections, uncertainty, and workshop TORs

The methods used in this assessment to project future population status and characterize uncertainty were sound, but their application was compromised by decisions made in the construction of the base model and the choice of parameters for Monte Carlo sampling.

I recommend that

- the projections and characterization of uncertainty be redone after the assessment has been redone (see Section 4.2), and
- steepness should be included in the set of parameters subject to Monte Carlo sampling.

4.5 TOR 5: Research recommendations

As discussed above in Sections 3.2.5 and 3.5, I recommend three areas for future research

- further development of the Beaufort Assessment Model,
- the development and use of a fishery-independent biomass index, and

- the quantification and understanding of assessment uncertainty.

5. Acknowledgments

I am grateful to Kyle Shertzer for providing me with an advance copy of the model description (SEDAR 24-RW01) and the data (in a very convenient format) that allowed me to create Table 1 and Figure 1.

6. References

- Bull, B.; Francis, R.I.C.C.; Dunn, A.; McKenzie, A.; Gilbert, D.J.; Smith, M.H.; Bian, R. (2008). CASAL (C++ algorithmic stock assessment laboratory): CASAL User Manual v2.20-2008/02/14. NIWA Technical Report 130. 275 p. (may be downloaded from <http://www.niwa.co.nz/our-science/fisheries/tools/casal>).
- Pennington, M.; Vølstad, J.H. (1994). Assessing the effect of intra-haul correlation and variable density on estimates of population characteristics from marine surveys. *Biometrics* 50: 725-732.

APPENDIX 1: Materials Provided for the Review

The reviewer was provided with access to the following documents on the SEDAR website (<http://www.sefsc.noaa.gov/sedar/Index.jsp>).

1. SEDAR 24 Assessment Report Draft-August 26, 2010 (This was the main source document for this review. It included the reports of the data and assessment workshops and the combined research recommendations from the two workshops)
2. SEDAR24-RW01 (containing a description of the main assessment model – the Beaufort Assessment Model – including the source code and the input file for the base run).
3. Some supplemental documents (CIE DW Reviewer Report – Stokes; SEDAR 24 Document List; SEDAR 24 Project Schedule; SEDAR 24 South Atlantic Red Snapper FINAL Terms of Reference)
4. The following additional documents

Document #	Title	Authors
Documents Prepared for the Data Workshop		
SEDAR24-DW01	Discards of Red Snapper Calculated for Vessels with Federal Fishing Permits in the US South Atlantic	K. McCarthy 2010
SEDAR24-DW02	SEDAR 24 South Atlantic Red Snapper Management Summary	J. McGovern 2010
SEDAR24-DW03	Standardized catch rates of U.S. Atlantic red snapper (<i>Lutjanus campechanus</i>) from headboat data	Sustainable Fisheries Division, NMFS 2010
SEDAR24-DW04	Standardized catch rates of U.S. Atlantic red snapper (<i>Lutjanus campechanus</i>) from commercial logbook data	Sustainable Fisheries Division, NMFS 2010
SEDAR24-DW05	Red snapper standardized catch rates from the Marine Recreational Fisheries Statistics Survey for the U.S. Atlantic Ocean, 1981-2009	Indices Group MRFSS 2010
SEDAR24-DW06	Distribution of red snapper catches from headboats operating in the South Atlantic	Sustainable Fisheries Division, NMFS 2010
SEDAR24-DW07	Georgia Headboat Red Snapper Catch & Effort Data, 1983-2009	S. Amick, K. Knowlton 2010
SEDAR24-DW08	Sampling Procedures Used in the Trip Interview Program (TIP)	Sustainable Fisheries Division, NMFS 2010
SEDAR24-DW09	Pre-Data Workshop Development of Commercial Landings for the Red Snapper Fishery	D. Vaughan, D. Gloeckner 2010

SEDAR24-DW10	Age Workshop for Red Snapper	J. Potts, editor 2009
SEDAR24-DW11	Review and Analysis of Methods to Estimate Historic Recreational Red Snapper Landings in the South Atlantic	SEDAR24 Historic Rec Catch Group 2010
SEDAR24-DW12	Red Snapper Discard Mortality Working Paper	SEDAR24 Discard Mortality Group 2010
SEDAR24-DW13	South Atlantic Red Snapper Marine Recreational Fishery Landings: FHS-conversion of Historic MRFSS Charter Boat Catches	T. Sminkey 2010
SEDAR24-DW14	Marine Resources Monitoring, Assessment and Prediction Program: Report on Atlantic Red Snapper, <i>Lutjanus campechanus</i> , for the SEDAR 24 Data Workshop	MARMAP 2010
SEDAR24-DW15	Red Snapper Length Frequencies and Condition of Released Fish from At-Sea Headboat Observer Surveys, 2004 to 2009.	B. Sauls and C. Wilson 2010
Documents Prepared for the Assessment Workshop		
SEDAR24-AW01	Assessment History of Red Snapper (<i>Lutjanus campechanus</i>) in the U.S. Atlantic	Sustainable Fisheries Branch, NMFS 2010
SEDAR24-AW02	The Beaufort Assessment Model (BAM) with application to red grouper1: mathematical description, implementation details, and computer code	Sustainable Fisheries Branch, NMFS 2010
SEDAR24-AW03	Standardized discard rates of U.S. Atlantic red snapper (<i>Lutjanus campechanus</i>) from headboat at sea observer data.	Sustainable Fisheries Branch, NMFS 2010
SEDAR24-AW04	Additional age data of south Atlantic red snapper (<i>Lutjanus campechanus</i>) from Florida Fish and Wildlife's dependent monitoring program	J. Tunnell, 2010
SEDAR24-AW05	Selectivity of red snapper in the southeast U.S. Atlantic: dome-shaped or flat-topped?	Sustainable Fisheries Branch, NMFS 2010
SEDAR24-AW06	Spawner-recruit relationships of demersal marine fishes: Prior distribution of steepness for possible use in SEDAR stock assessments	Sustainable Fisheries Branch, NMFS 2010
SEDAR24-AW07	Red snapper: Regression and Chapman-Robson estimators of total mortality from catch curve data	Sustainable Fisheries Branch, NMFS 2010
SEDAR24-AW08	Overviews of NMFS fishery-dependent data source surveys referenced in the SEDAR 24 data workshop report	SEDAR 2010, Compiled by J. Carmichael
SEDAR24-AW09	Vulnerability to Capture of Red Snapper (<i>Lutjanus campechanus</i>) in the Fisheries of the Southeast United States - a Preliminary look	F. Hester and D. Nelson, 2010

SEDAR24-AW10	South Atlantic Red Snapper Fishery – A Fisherman’s Perspective	D. Nelson, 2009
SEDAR24-AW11	Additional information for red snapper selectivity	F. Hester, 2010
SEDAR24-AW12	Selectivity of red snapper in the South Atlantic More than Just Depth	D. Nelson, 2010
Reference Documents		
SEDAR24-RD01	Age, Growth, And Reproduction Of The Red Snapper, <i>Lutjanus Campechanus</i> , From The Atlantic Waters Of The Southeastern U.S.	D. B. White, S. M. Palmer 2004
SEDAR24-RD02	Age and growth of red snapper, <i>Lutjanus Campechanus</i> , from the southeastern United States	S. McInerny 2007
SEDAR24-RD03	Commercial catch composition with discard and immediate release mortality proportions off the southeastern coast of the United States	J. A. Stephen, P. J. Harris 2010
SEDAR24-RD04	The 1960 Salt-Water Angling Survey, USFWS Circular 153	J. R. Clark c.1962
SEDAR24-RD05	The 1965 Salt-Water Angling Survey, USFWS Resource Publication 67	D. G. Deuel, J. R. Clark 1968
SEDAR24-RD06	1970 Salt-Water Angling Survey, NMFS Current Fisheries Statistics Number 6200	D. G. Deuel 1973
SEDAR24-RD07	Lecture Notes on Coastal and Estuarine Studies, #10 Fisheries Management, Ch VII Marine Sport Fisheries	J. L. McHugh 1984
SEDAR24-RD08	Survey of Offshore Fishing in Florida	M. A. Moe, Jr. 1963
SEDAR24-RD09	Geographic Comparison of Age, Growth, Reproduction, Movement, and Survival of Red Snapper off the State of Florida	K. M. Burns, N. J. Brown-Peterson, R. M. Overstreet 2006
SEDAR24-RD10	Regional Differences in Florida Red Snapper Reproduction	N. J. Brown-Peterson, K. M. Burns, R. M. Overstreet 2008
SEDAR24-RD11	Evaluation of the Efficacy of the Minimum Size Rule in the Red Grouper and Red Snapper Fisheries With Respect to J and Circle Hook Mortality and Barotrauma and the Consequences for Survival and Movement	K. M. Burns 2009
SEDAR24-RD12	Survival of Released Red Snapper progress Report	R. O. Parker, Jr. 1985
SEDAR24-RD13	Survival of Released Reef Fish—A Summary of Available Data (Preliminary)	R. O. Parker, Jr. 1991
SEDAR24-RD14	Incorporating Mortality from Catch and Release into Yield-per-Recruit Analyses of Minimum-Size Limits	J. R. Waters, G. R. Huntsman 1986

SEDAR24-RD15	Modified hooks reduce incidental mortality of snapper (<i>Pagrus auratus</i> : Sparidae) in the New Zealand commercial longline fishery	T. J. Willis, R. B. Millar 2001
SEDAR24-RD16	Key principles for understanding fish bycatch discard mortality	M. W. Davis 2002
SEDAR24-RD17	Indirect Estimation of Red Snapper (<i>Lutjanus campechanus</i>) and gray Triggerfish (<i>Balistes capriscus</i>) Release Mortality	W. F. Patterson, III, G. W. Ingram, Jr., R. L. Shipp, J. H. Cowan, Jr. 2002
SEDAR24-RD18	Red Snapper Discards in Texas Coastal waters-a Fishery Dependent Onboard Survey of Recreational Headboat Discards and Landings	B. A. Dorf 2003
SEDAR24-RD19	Partitioning Release Mortality in the Undersized Red snapper Bycatch: Comparison of Depth vs. Hooking Effects	K. M. Burns, N. F. Parnell, R. R. Wilson, Jr. 2004
SEDAR24-RD20	Catch-and-release science and its application to conservation and management of recreational fisheries	S. J. Cooke, H. L. Schramm 2007
SEDAR24-RD21	Discard composition and release fate in the snapper and grouper commercial hook-and-line fishery in North Carolina, USA	P.J. Rudershausen, J. A. Buckel, E. H. Williams 2007
SEDAR24-RD22	Evaluating the physiological and physical consequences of capture on post-release survivorship in large pelagic fishes	G. B. Skomal 2007
SEDAR24-RD23	Release Mortality of Undersized Fish from the Snapper–Grouper Complex off the North Carolina Coast	A. S. Overton, J. Zabawski, K. L. Riley 2008
SEDAR24-RD24	Capture depth related mortality of discarded snapper (<i>Pagrus auratus</i>) and implications for management	J. Stewart 2008
SEDAR24-RD25	Linking “Sink or Swim” Indicators to Delayed Mortality in Red Snapper by Using a Condition Index	S. L. Diamond, M. D. Campbell 2009
SEDAR24-RD26	Does Venting Promote Survival of Released Fish?	G. R. Wilde 2009
SEDAR24-RD27	Field Experiments on Survival Rates of Caged and Released Red Snapper	G. R. Gitschlag, M. L. Renaud 1994
SEDAR24-RD28	Red Snapper in the Northern Gulf of Mexico: Age and Size Composition of the Commercial Harvest and Mortality of Regulatory Discards	D. L. Nieland, A. J. Fischer, M. S. Baker, Jr., C. A. Wilson, III 2007
SEDAR24-RD29	Factors Affecting Catch and Release (CAR) Mortality in Fish: Insight into CAR Mortality in Red Snapper and the Influence of Catastrophic Decompression	J. L. Rummer 2007
SEDAR24-RD30	Evaluation of The Efficacy of the Current Minimum Size Regulation for Selected Reef Fish Based on Release Mortality and Fish	K. M. Burns, N. J. Brown-Peterson, R. M. Overstreet

	Physiology	2008
SEDAR24-RD31	American Fishes - A Popular Treatise upon the Game and Food Fishes of North America with Especial Reference to Habits and Methods of Capture	G. B. Goode, T. Gill 1903
SEDAR24-RD32	Proceedings: Colloquium on Snapper-Grouper Fishery Resources of the Western Central Atlantic Ocean	H. R. Bullis, Jr., A. C. Jones 1976
SEDAR24-RD33	Growth and Mortality of Red Snappers in the West-Central Atlantic Ocean and Northern Gulf of Mexico	R. S. Nelson, C. S. Manooch, III 1982
SEDAR24-RD34	Yield Per Recruit Models of Some Reef Fishes of the U. S. South Atlantic Bight	G. R. Huntsman, C. S. Manooch, III, C. B. Grimes 1983
SEDAR24-RD35	Population Assessment of the Red Snapper, <i>Lutjanus campechanus</i> , from the Southeastern United States	C. S. Manooch, III, J. C. Potts, D. S. Vaughan, M. L. Burton 1997
SEDAR24-RD36	Executive Summary: Review of Recreational Fisheries Survey Methods	National Research Council 2006
SEDAR24-RD37	Spawning Locations for Atlantic Reef Fishes off the Southeastern U.S.	G. R. Sedberry, O. Pashuk, D. M. Wyanski, J. A. Stephen, P. Weinbach 2006
SEDAR24-RD38	More Red Snapper Discussion	J. H. Cowan, Jr. 2009
SEDAR24-RD39	A Perspective of the Importance of Artificial Habitat on the Management of Red Snapper in the Gulf of Mexico	R. L. Shipp, S. A. Bartone 2009
SEDAR24-RD40	National Survey of Fishing and Hunting	Dept Interior 1955
SEDAR24-RD41	National Survey of Fishing and Hunting 1960	Dept Interior 1960
SEDAR24-RD42	FMP, Regulatory Impact Review, and Final Environmental Impact Statement for the SG Fishery of the South Atlantic Region	SAFMC 1983
SEDAR24-RD43	Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Gulf of Mexico) – Red Snapper	D. Morgan 1988
SEDAR24-RD44	Evaluation of Multiple Factors Involved in Release Mortality of Undersized Red Grouper, Gag, Red Snapper and Vermilion Snapper	K. M. Burns, C. C. Koenig, F. C. Coleman 2002
SEDAR24-RD45	Physiological Effects of Swim Bladder Overexpansion and Catastrophic Decompression on Red Snapper	J. L. Rummer, W. A. Bennet 2005
SEDAR24-RD46	A Review of Movement in Gulf of Mexico Red Snapper: Implications for Population Structure	W. F. Patterson, III 2007
SEDAR24-RD47	J and Circle Hook Mortality and Barotrauma	K. M. Burns 2009

	and the Consequences for Red Snapper Survival	
SEDAR24-RD48	Procedural Guidance Document 2 - Addressing Time-Varying Catchability	SEDAR 2009
SEDAR24-RD49	Final Report on Bioeconomic Analysis of the Red Snapper Rebuilding Plan and Transferable Rights Policies in the Gulf of Mexico <u>with</u> Supplementary Technical Document to the Final Report	W. L. Griffin, R. T. Woodward 2009
SEDAR24-RD50	Comments On SPR-Based Benchmarks For Red Snapper Stocks in the Southeastern USA	R. Methot, P. Rago, G. Scott 2009
SEDAR24-RD51	The Recreational fishery in South Carolina: The Little River Story	V. G. Burrell 2000
SEDAR24-RD52	Southeastern U.S. Deepwater Reef Fish Assemblages, Habitat characteristics, Catches, and Life History Summaries	R. O. Parker, R. W. Mays 1998
SEDAR24-RD53	American Game and Food Fishes pp 410-412	D. S. Jordan, B. W. Evermann 1908
SEDAR24-RD54	Comparison of two approaches for estimating natural mortality based on longevity.	D. A. Hewitt, J. M. Hoenig 2005.
SEDAR24-RD55	Notes on the red snapper fishery	J. W. Collins 1886
SEDAR24-RD56	Southeast Region Headboat Survey Program Description	K. Brennan 2010
SEDAR24-RD57	Biological-Statistical Census of the Species Entering Fisheries in the Cape Canaveral Area	W. W. Anderson, J. W. Gehringer 1965
SEDAR24-RD58	Abundance Indices Workshop: Developing protocols for submission of abundance indices to the SEDAR process. SEDAR Procedures Workshop 1	SEDAR 2008
SEDAR24-RD59	Source Document for the Snapper-Grouper Fishery of the South Atlantic Region	SAFMC 1983
SEDAR24-RD60	Projected Combined Effects of Amendments 13C, 16, and 17A Regulations on south Atlantic Red Snapper Removals.	SERO v Jan 2010
SEDAR24-RD61	Catch Characterization and Discards within the Snapper Grouper Vertical Hook-and-Line Fishery of the South Atlantic United States	Gulf & SA Fisheries Foundation 2008
SEDAR24-RD62	Returns from the 1965 Schlitz Tagging Program Including a Cumulative Analysis of Previous Results	D. S. Beaumariage 1969
SEDAR24-RD63	Length of Recall Period and Accuracy of Estimates from the National Survey of Fishing, Hunting, and Wildlife-Associated Recreation	W. L. Fisher, A.E. Grambsch, D.L. Eisenhower, D.R. Morganstein 1991
SEDAR24-RD64	Shelf -edge and upper slope reef fish assemblages in the South Atlantic Bight:	C. M. Schobernd, G. R. Sedberry

	habitat characteristics, spatial variation, and reproductive behavior	2009
SEDAR24-RD65	A survey of the number of anglers and of their fishing effort and expenditures in the coastal recreational fishery of Florida	Ellis et al., 1958
Previous SEDARs Documents of Interest		
SEDAR7-DW13	The steepness stock-recruit parameter for red snapper in the Gulf of Mexico (<i>Lutjanus campechanus</i>): what can be learned from other fish stocks?	M. K. McAllister 2004
SEDAR7-DW19	Estimating Catches and fishing Effort of the Southeast United States Headboat Fleet, 1972-1982	R. L. Dixon, G. R. Huntsman, Undated Draft
SEDAR7-AW16	Estimates of Historical Red Snapper Recreational Catch Levels Using US Census Data and Recreational Survey Information	G. P. Scott 2004
SEDAR7-SAR1	Stock Assessment Report Gulf of Mexico Red Snapper, SEDAR7 Assessment Report 1	SEDAR 2005
SEDAR17-RD18	The summer flounder chronicles: Science, politics, and litigation, 1975-2000.	M. Teceiro 2002
SEDAR17-RD20	Comparing 1994 angler catch and harvest rates from on-site and mail surveys on selected lakes.	B. Roach, J. Trial, and K. Boyle 1999.
SEDAR17-RD23	Effects of recall bias and nonresponse bias on self-report estimates of angling participation.	M. A. Tarrant, M. J. Manfredo, P. B. Bayley, R. Hess 1993
SEDAR19-DW05	Evaluation of the 1960, 1965, and 1970 U.S. Fish and Wildlife Service salt-water angling survey data for use in the stock assessment of red grouper (Southeast US Atlantic) and black grouper (Southeast US Atlantic and Gulf of Mexico)	R. Cheshire, J. O'Hop 2009
SEDAR7-DW51	MSY, Bycatch and Minimization to the "Extent Practicable"	J. E. Powers 2004
SEDAR19-RD27	The Natural Mortality Rate of Gag Grouper: A Review of Estimators for Data-Limited Fisheries.	T. J. Kenchington

APPENDIX 2: Statement of Work

This appendix contains the Statement of Work that formed part of the consulting agreement between Northern Taiga Ventures Inc. and the author.

External Independent Peer Review by the Center for Independent Experts

SEDAR 24 Red Snapper Pre-Review Workshop Review

Scope of Work and CIE Process: The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of NMFS scientific projects. The Statement of Work (SoW) described herein was established by the NMFS Project Contact and Contracting Officer's Technical Representative (COTR), and reviewed by CIE for compliance with their policy for providing independent expertise that can provide impartial and independent peer review without conflicts of interest. CIE reviewers are selected by the CIE Steering Committee and CIE Coordination Team to conduct the independent peer review of NMFS science in compliance the predetermined Terms of Reference (ToRs) of the peer review. Each CIE reviewer is contracted to deliver an independent peer review report to be approved by the CIE Steering Committee and the report is to be formatted with content requirements as specified in **Annex 1**. This SoW describes the work tasks and deliverables of the CIE reviewer for conducting an independent peer review of the following NMFS project. Further information on the CIE process can be obtained from www.ciereviews.org

Project Description: SEDAR 24 will be a benchmark assessment of the status of the US South Atlantic red snapper stock conducted by the Southeast Fisheries Science Center (SEFSC) of the National Marine Fisheries Service (NMFS) (agency). The assessment will be conducted for the South Atlantic Fishery Management Council (SAFMC), which has responsibility for management of the South Atlantic snapper/grouper complex fishery, of which red snapper is a member. The Southeast Data, Assessment and Review (SEDAR) process will coordinate the three components of the assessment, those being data evaluation, assessment model development, and final assessment peer review.

The desk review will provide an independent peer review of SEDAR stock assessment prior to the panel Review Workshop. The term review is applied broadly, as the reviewer may suggest additional analyses, error corrections and sensitivity runs of the assessment models provided by the assessment workshop panel. In providing peer review advice during this pre-review workshop comment period, the independent expert can improved the overall assessment process by advising the analysts regarding issues that might become points of contention in the formal peer review workshop—at which time it would be too late to revise the actual assessment (assessment data decisions, assumptions, models, modifications, etc. are confined to the assessment process before the peer review workshop). The Terms of Reference (ToRs) of the peer review are attached in **Annex 2**.

Requirements for the CIE Reviewer: One CIE reviewer shall conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. The CIE

reviewer shall have expertise, background, and recent experience in stock assessment, statistics, fisheries science, and marine biology sufficient to complete the primary tasks of reviewing stock assessment model(s) developed for this assessment and presenting the review in writing. The CIE reviewer's duties shall not exceed a maximum of 10 days to complete all work tasks of the peer review described herein.

Location of Peer Review: The CIE reviewer shall conduct an independent peer review as a desk review, therefore no travel is required.

Statement of Tasks: The CIE reviewer shall complete the following tasks in accordance with the SoW and Schedule of Milestones and Deliverables herein.

Prior to the Peer Review: Upon completion of the CIE reviewer selection by the CIE Steering Committee, the CIE shall provide the CIE reviewer information (full name, title, affiliation, country, address, email) to the COTR, who forwards this information to the NMFS Project Contact no later the date specified in the Schedule of Milestones and Deliverables. The CIE is responsible for providing the SoW and ToRs to the CIE reviewer. The NMFS Project Contact is responsible for providing the CIE reviewer with the background documents, reports, and other pertinent information. Any changes to the SoW or ToRs must be made through the COTR prior to the commencement of the peer review.

Pre-review Background Documents: Two weeks before the peer review, the NMFS Project Contact will send (by electronic mail or make available at an FTP site) to the CIE reviewer the necessary background information and reports for the peer review. In the case where the documents need to be mailed, the NMFS Project Contact will consult with the CIE Lead Coordinator on where to send documents. The CIE reviewer is responsible only for the pre-review documents that are delivered to the reviewer in accordance to the SoW scheduled deadlines specified herein. The CIE reviewer shall read all documents in preparation for the peer review.

Desk Review: The CIE reviewer shall conduct the independent peer review in accordance with the SoW and ToRs, and shall not serve in any other role unless specified herein. **Modifications to the SoW and ToRs can not be made during the peer review, and any SoW or ToRs modifications prior to the peer review shall be approved by the COTR and CIE Lead Coordinator.** The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements.

Contract Deliverables - Independent CIE Peer Review Reports: The CIE reviewer shall complete an independent peer review report in accordance with the SoW. The CIE reviewer shall complete the independent peer review according to required format and content as described in Annex 1. The CIE reviewer shall complete the independent peer review addressing each ToR as described in Annex 2.

Specific Tasks for the CIE Reviewer: The following chronological list of tasks shall be completed by the CIE reviewer in a timely manner as specified in the **Schedule of Milestones and Deliverables**.

- 1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review.
- 2) Conduct an independent peer review in accordance with the ToRs (**Annex 2**).

- 3) No later than 7 September 2010, the CIE reviewer shall submit an independent peer review report addressed to the “Center for Independent Experts,” and sent to Mr. Manoj Shivilani, CIE Lead Coordinator, via email to shivilanim@bellsouth.net, and Dr. David Sampson, CIE Regional Coordinator, via email to david.sampson@oregonstate.edu. Each CIE report shall be written using the format and content requirements specified in Annex 1, and address each ToR in **Annex 2**.

Schedule of Milestones and Deliverables: CIE shall complete the tasks and deliverables described in this SoW in accordance with the following schedule.

11 August 2010	CIE sends reviewer contact information to the COTR, who then sends this to the NMFS Project Contact
18 August 2010	NMFS Project Contact sends the CIE Reviewer the background documents
26 August 2010	NMFS Project Contact sends CIE reviewer the report to be peer reviewed
26 August - 7 September 2010	CIE reviewer conducts an independent peer review as a desk review
7 September 2010	CIE reviewer submits draft CIE independent peer review report to the CIE Lead Coordinator and CIE Regional Coordinator
14 September 2010	CIE submits the CIE peer review report to the COTR
16 September 2010	The COTR distributes the final CIE report to the NMFS Project Contact and regional Center Director

Modifications to the Statement of Work: Requests to modify this SoW must be approved by the Contracting Officer at least 15 working days prior to making any permanent substitutions. The Contracting Officer will notify the COTR within 10 working days after receipt of all required information of the decision on substitutions. The COTR can approve changes to the milestone dates, list of pre-review documents, and ToRs within the SoW as long as the role and ability of the CIE reviewer to complete the deliverable in accordance with the SoW is not adversely impacted. The SoW and ToRs shall not be changed once the peer review has begun.

Acceptance of Deliverables: Upon review and acceptance of the CIE independent peer review reports by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, these reports shall be sent to the COTR for final approval as contract deliverables based on compliance with the SoW and ToRs. As specified in the Schedule of Milestones and Deliverables, the CIE shall send via e-mail the contract deliverables (CIE independent peer review reports) to the COTR (William Michaels, via William.Michaels@noaa.gov).

Applicable Performance Standards: The contract is successfully completed when the COTR provides final approval of the contract deliverables. The acceptance of the contract deliverables shall be based on three performance standards:

- (1) each CIE report shall be completed with the format and content in accordance with **Annex 1**,
- (2) each CIE report shall address each ToR as specified in **Annex 2**,
- (3) the CIE reports shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

Distribution of Approved Deliverables: Upon acceptance by the COTR, the CIE Lead Coordinator shall send via e-mail the final CIE reports in *.PDF format to the COTR. The COTR will distribute the CIE reports to the NMFS Project Contact and Center Director.

Support Personnel:

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Key Personnel:

NMFS Project Contact:

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4055 Faber Place Drive, Suite 201, North Charleston, SC 29405
Kari.fenske@safmc.net Phone: 843-571-4366

Annex 1: Format and Contents of CIE Independent Peer Review Report

1. The CIE independent report shall be prefaced with an Executive Summary providing a concise summary of the findings and recommendations, and specify whether the science reviewed is the best scientific information available.
2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each ToR in which the weaknesses and strengths are described, and Conclusions and Recommendations in accordance with the ToRs.
3. The reviewer report shall include the following appendices:

Appendix 1: Bibliography of materials provided for review

Appendix 2: A copy of the CIE Statement of Work

Annex 2: Terms of Reference for the Peer Review

SEDAR 24 Red Snapper Assessment Model Development Evaluation

1. Evaluate the adequacy, appropriateness, and application of data used in the assessment.
2. Evaluate the adequacy, appropriateness, and application of methods used to assess the stock.
3. Evaluate the methods used to estimate population benchmarks and management parameters (*e.g.*, *MSY*, *F_{msy}*, *B_{msy}*, *MSST*, *MFMT*, or their proxies); comment on the reliability of the estimated benchmarks..
4. Evaluate the adequacy, appropriateness, and application of the methods used to project future population status; Evaluate the adequacy, appropriateness, and application of methods used to characterize uncertainty in estimated parameters. Comment on the degree to which uncertainties are identified and evaluated, and implications of uncertainties stated. Identify any Terms of Reference which are inadequately addressed by the Data or Assessment Workshops.
5. Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations or prioritizations warranted. Clearly denote research and monitoring needs that could improve the reliability of future assessments.
6. Prepare a Peer Review Report documenting findings pertaining to these Terms of Reference.

APPENDIX 3: Calculation of SDNRs and correction factors

In this Appendix I give details of the calculation of the SDNRs and correction factors presented in Table 1.

To calculate an SDNR, we first calculate a “normalised” residual, which is a residual that is scaled (and transformed, if necessary) so that its expected distribution is normal (at least approximately) with standard deviation 1, given the error assumptions of the model. For CPUE, the normalised residual for year y is given by $r_y = \log(U_{\text{obs},y}/U_{\text{exp},y})/\sigma_y$, where $U_{\text{obs},y}$ and $U_{\text{exp},y}$ are the observed and expected values of CPUE, c_y is the assumed CV for the former, and $\sigma_y = \sqrt{\log[1+c_y^2]}$. For the composition data, let $P_{\text{obs},iy}$ be the observed proportion of fish in the i th length (or age) bin in year y , with associated length (or age) x_i . Then the normalised residual for year y is $r_y = (\mu_{\text{obs},y} - \mu_{\text{exp},y})/\text{s.e.}(\mu_{\text{obs},y})$, where $\mu_{\text{obs},y}$ is the observed mean length (or age), calculated as $\mu_{\text{obs},y} = \sum_i x_i P_{\text{obs},iy}$, $\mu_{\text{exp},y}$ is the corresponding expected mean, $\text{s.e.}(\mu_{\text{obs},y}) = \sqrt{[\sum_i (x_i - \mu_{\text{obs},y})^2 P_{\text{obs},iy}]/N_y}$, and N_y is the assumed sample size. For each type of observation, the SDNR is just the standard deviation of the set of normalised residuals.

The correction factor, w , is designed to represent how much we have to up-weight (if $w > 1$) or down-weight (if $w < 1$) a data set so that its SDNR will be equal to 1. For composition data this is straightforward: set $w = 1/\text{SDNR}^2$. For CPUE, we can't solve for w analytically, but it's straightforward to calculate an acceptable approximate value as follows. For each of a set of trial values, w_1, w_2, \dots , let S_j be the adjusted SDNR calculated when each c_y is replaced by c_y/w_j , and then interpolate to find the value of w that makes the adjusted SDNR equal to 1.