External Independent Peer Review of the

SEDAR 41 South Atlantic Red Snapper and Gray Triggerfish Assessment Review Workshop

Prepared by

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for

The Center for Independent Experts

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Executive summary

The Southeast Data, Assessment, and Review (SEDAR) 41 Review Panel met from 15 to 18 March 2016, in Charleston, SC to review the data and assessments for South Atlantic red snapper and gray triggerfish. The panel consisted of three South Atlantic Fisheries Management Council (SAFMC SSC) members as reviewers, one of whom chaired the meeting, and three Center for Independent Experts (CIE) reviewers. Red snapper was last assessed in 2010 (SEDAR24, 2010) and gray triggerfish was originally to be assessed at SEDAR 32 in 2013, but the discovery of ageing errors delayed the assessment until this meeting. The primary assessment model used was the Beaufort Assessment Model (BAM), a software package that implements a statistical catch-at-age framework. The formulation is an age-structured population model that is fit using standard statistical methods to data available from surveys and commercial and recreational fishing fleets, such as landings, discards, indices of abundance, age compositions, and length compositions. Late in the meeting, corrections had to be made to the age compositions for the Chevron trap survey estimates, which delayed having the complete results for the base case model for red snapper available to the review panel until after the meeting. A follow-up webinar on 8 April 2016 was necessary to continue discussion of projections and finalize the SEDAR 41 Review Workshop process. The results of the age-based model indicated that the red snapper stock was overfished and overfishing was occurring. The results of the stock assessment were judged to be the best scientific information available; however, the increasing reliance on discard data to monitor the amount and size composition of removals will make projections highly uncertain.

The BAM was also used for the South Atlantic gray triggerfish stock with commercial and recreational landings, discards, and length and age compositions. The Chevron trap/video survey was the only abundance index used in the model. The estimates of low abundance at the beginning of the time series due to the high weight given to the Chevron trap/Video survey, and the poor fit to age compositions of the headboat fleet and survey index, especially after the correction of Chevron trap age compositions, led the Review Panel to recommend that further modeling and review was needed before a base case could be accepted for managing this fishery. The Review Panel did not accept the proposed base case model as being appropriate for determining stock status.

Background

The review workshop of the 41st Southeast Data, Assessment, and Review (SEDAR) process was convened in Charleston, SC from March 15 to 18, 2016. The purpose of the workshop was to review stock assessments for South Atlantic red snapper and gray triggerfish. The stocks assessed through SEDAR 41 are within the jurisdiction of the South Atlantic Fisheries Management Council (SAFMC) and the states of Florida, Georgia, South Carolina, and North Carolina. Red snapper was last assessed in 2010 (SEDAR24, 2010) and gray triggerfish was originally to be assessed at SEDAR 32 in 2013, but the discovery of ageing errors delayed the assessment until this meeting.

Description of the Individual Reviewer's Role in the Review Activities

Background information, meeting arrangements and other material were made available to the reviewers either via email or through an ftp site starting on March 2, 2016. I reviewed the two main assessment workshop documents accessing the background information as necessary to get more detail on the data used or analysis that was carried out. On March 11, I participated in a one-hour conference call/webinar with available reviewers and assessment leads hosted by Julia Byrd (SAFMC) and Luiz Barbieri (Review Panel chair) to go over arrangements, agenda, etc., and also to go over any questions or clarifications concerning the assessment documents.

The review meeting was held March 15 to 18 at the Crowne Plaza Charleston Airport Convention Center in Charleston, SC. The first day of the meeting was devoted to the presentation of the material on red snapper and gray triggerfish. The two assessment teams returned on Wednesday with presentations dealing with their responses to issues and questions that the panel had brought up during the original presentations. A problem with the data used to generate the age compositions for the Chevron trap survey estimates was reported on Thursday morning, and both assessment teams spent the day re-running their base model fits and reporting on impact of the age data correction on their results. Late on Thursday, the panel concluded that the age data correction in addition to other issues raised for the gray triggerfish assessment indicated that the current assessment model could not be used for managing the fishery and the assessment panel needed to evaluate the model in context of comments from the review panel. Friday morning was spent clarifying what further material was required from the red snapper team and the timeline for finalizing the review panel report. Industry representatives attended all of the sessions and many presented comments during the Public comment session held at the end of each day.

The Monte Carlo Bootstrap (MCB) evaluations of uncertainty and projections for the red snapper new base case were not available to the panel at the end of the meeting, but were distributed to the panel on March 24. The results were presented to available members of the panel and other participants of the original meeting during a webinar on April 8. At the end of this webinar, the submission date for the panel report was rescheduled to April 15. This change in date in turn led to rescheduling of the date for submission of individual reviews to CIE to April 22.

The panel review chair assigned me to develop text for the review report sections on the assessment findings term of reference (TOR 3), as well as contribute to TOR 4 and 7, based on my notes and those contributed by other panelists. The other CIE and SAFMC SSC panelists were given similar assignments. The chair was responsible for the compiling all of the text into the draft review report. All of the panelists contributed to editing the complete draft report which was submitted on April 15.

Summary of Findings for each ToR

1. Evaluate the data used in the assessment, including discussion of the strengths and weaknesses of data sources and decisions, and consider the following:

Red snapper and gray triggerfish

a) Are data decisions made by the DW and AW sound and robust?

The documentation in support of the data decisions made by the Data Workshop (DW) and Assessment Workshop (AW) were detailed and comprehensive. All of the critiques in the DW report for the different data sets considered for inclusion in the assessment were informative and dealt with limitations and sources of bias. The AW report documented data decisions made after the DW as well as the results of decisions concerning selectivity, abundance indices, age and length compositions, etc. All decisions were well-supported and background supporting documents were also available.

b) Are data uncertainties acknowledged, reported, and within normal or expected levels?

Data uncertainties were discussed in detail in the DW and for those data sets recommended for inclusion in the assessment, measures of data quality such as Coefficients of Variation (CVs), sample size or ranges of plausible parameter values were provided. The AW used these measures to weight different data series in the model and to parameterize the MCB and sensitivity analyses.

c) Are data applied properly within the assessment model?

The application of the data in the Beaufort Assessment Model (BAM) follows common practice and was judged to be sound. The DW and AW thoroughly evaluated a number of issues dealing with what years were to be used, how data was to be weighted in the model and sources of uncertainty were well documented.

d) Are input data series reliable and sufficient to support the assessment approach and findings?

Red snapper

The input data series appear adequate to support the assessment results and findings. While the DW and AW did document the evaluation and decisions for the many different kinds of data used in this assessment, the following issues were noted when discussing the strengths and weaknesses associated with the different kinds of data that were used.

Fishery removals

The current evaluation of stock status, especially in terms of the overfished determination is conditional on the reconstruction of the historical time series of population and catch history including both landings and discards. In this assessment, the time series was started in 1950 to establish a period of stable age structure during a period of time when fishing mortality was expected to be very low. The reconstruction of the removal series since 1950 required considerable work and review by the DW to combine available data, infer historical catches based on recent data and to account for weight conversions, species misidentification, area of capture, etc. Recreational catches recorded in MRFSS from 1981 to 2003 had to be calibrated to be consistent with catches in MRIP from 2004 to the present.

Since the introduction of the moratorium in 2010, removals have consisted of discards and beginning in 2012 limited catches from the commercial handline and recreational fleets during the mini-seasons. The general recreational fleet has accounted for the highest proportion of removals (landings plus discards, 53 to 71%) over the mini-seasons with between 41 to 50% of those removals being assigned to discards. The MRIP program was designed to sample the recreational fishery over the whole year and data from State surveys have been used during the brief (3 to 8 days) mini-seasons where MRIP data were not available or considered to be less reliable. The review panel noted this collaboration and encouraged its continuation. Discards are self-reported in logbooks and recorded by some at-sea observer coverage for commercial handline and headboat fleets, and self-reported by anglers during intercept interviews for the general recreational fleet. Discard estimates are less reliable than landings data, but under the current management regime, discards will likely be the major source of removals in the near future, especially if the apparent strength of the 2013 year class identified in the BAMBAM and preliminary 2015 CVID survey data is confirmed. The Review Panel supports any initiatives to improve the quality of discards and landings estimates to improve the precision and accuracy of estimates of removals.

Length and age compositions

The Review Panel agreed with the recommendation by the AW to only fit to length compositions in the BAMBAM when age compositions were not available. Length compositions only were available for the commercial handline from 1984 to 1992, commercial discards in 2009 and 2013, and headboat discards from 2005 to 2014. Age compositions were fit in the model for handline landings in 1990, 1992, 1994, and 1996 to 2014, headboat landings from 1978 to 2014, general recreational from 2001 to 2014, and CVID for 2010 to 2014.

Relative abundance indices

The rationale for including abundance indices from the fishery-independent combined Chevron trap/video survey (CVID, 2010–2014) and data from three fishery-dependent CPUE series in the BAM stock assessment model were accepted by the review panel. Combining the trap and video data into one CVID index made sense given that the cameras were mounted on the traps. Limiting the handline and headboat catch rate series to 2009 was also accepted, given that fishermen and anglers' behavior would be expected to change during the moratorium. This leaves the headboat discard rate as the only abundance series that spans both the open and closed fishery periods. However, it would seem likely that the discard rate index would also be affected by changing behavior during the moratorium and reduce its effectiveness as an abundance index. Sensitivity runs were conducted to evaluate this index by the AW and presented to the panel (see TOR 3 below).

The fishery dependent (commercial handline catch rates, recreational headboat catch rates and discard catch rates) and independent (CVID survey) abundance indices were modelled using either zero-augmented (fishery dependent) or zero-inflated (fishery independent) Generalized Linear Models (GLM). CVs were developed using bootstrap methods for all models except for the headboat discard index where a jackknife approach was used. The estimated CVs for the handline and headboat catch rates were all less than 0.1 and were set to 0.2 for the BAM base model. The increase in CV to 0.2 reflected arguments made in Francis et al. (2003, SEDAR41-RD72) that CVs estimated for either fishery dependent or independent indices underestimate the true variability for abundance, because they do not include annual variability in catchability. Francis et al. (2003) recommended default CVs between 0.15 and 0.2 for fishery dependent data sets, and 0.2 for trawl survey annual variation based on an analysis of data sets from assessments of New Zealand stocks. The CVs for the discard and the CVID indices ranged from 0.17 to 0.37 and 0.17 to 0.26, respectively and were used as is in the model. This does not mean that estimated CVs closer to 0.2 actually do include variability in catchability instead keeping all of the CVs in the range of 0.2 more or less gives the indices equal first stage weights in the model. However, assuming a constant CV over the whole time series for the handline and headboat catch rates does not reflect variation in sample size or other factors by year.

Evaluation of the validity of the original CV estimates requires information on how the standardized series were calculated, and how the bootstrap or jackknife procedure was implemented. While the descriptions of the modeling approach used were adequately detailed, there was no information on how the standardized time series used in the stock assessment were actually calculated. Information provided by J. Ballenger (SCDNR) after the meeting referred to R software that was developed by E.J. Dick (NMFS, Santa Cruz), and modified by E. Williams (NMFS, Beaufort) and P. Conn (NMFS, Seattle), that calculated the annual index estimates for the zero-augmented models using a marginal means approach. A similar marginal means approach was used for the zero-inflated model using the R function expand.grid.

There were no details on the structure of the bootstrap estimates for the fishery dependent indices in the DW report. J. Ballenger reported that observations were bootstrapped for the CVID index and it is likely that the same was done for the fishery dependent indices. The marginal mean approach to standardization is conditional on having a fixed set of covariates or factor levels to calculate the year effects for the annual index. Bootstrapping observations results in a random sampling of covariate or factor levels and given that on average only 2/3 of the sample size in each bootstrap sample will be unique records or sets, ranges of covariates will vary and factor levels may be missing over these samples. Models computed for each bootstrap sample may not be structured the same if factor levels are missing. In addition, changes in the range of the covariates in the bootstrap samples may not support the original fitted model, especially for coefficients of high degree polynomials. Finally, the bootstrap estimates of variance could also reflect variability in the changing base for the marginal means approach. These problems may be less of an issue for the jackknife if it was structured as a simple "leave-one-out" approach, except in the extreme situations where there was only one observation for a factor level.

As an alternative, bootstrapping of the residuals from the original model fit to the data may more appropriately estimate the variance of the standardized survey index. In this case the residuals (in the appropriate scale) are randomly combined with the predicted values from the original model fit to give new observations that are then used to fit the GLM model for each bootstrap replication. The range of the covariates and levels for the factors will stay the same over all of the bootstrap replications, and the variances of the annual indices will be a function of the variability of the residuals from the fitted model conditional on the standardization approach. I am not aware of any published applications of this kind of model-based bootstrapping for the two-stage type of GLMs used here and there may be some issues that need to be worked out to obtain valid variance estimates.

Gray Triggerfish

Fishery removals

Prior to 1980s, Gray Triggerfish were not heavily exploited as they were not considered a desirable species. The first year for the assessment was set to be 1988 to coincide with when interest in catching Gray Triggerfish developed and when data on discards, length and age composition became available. The same kinds of data sources that were used for red snapper were used here to reconstruct the landings and discard history for gray triggerfish. As such, all of the same caveats, including those concerning the reliability of the discard data equally apply as well.

Length and age compositions

Recently, age in gray triggerfish has been successfully determined using increments in dorsal spines, because of the difficulty in obtaining increment data from other hard structures including otoliths. Results from fitting von Bertalanffy growth curves to the length and age data indicated that there was a very broad distribution of length at age relative to the annual increase in length by age. This in turn can make it difficult to estimate annual age compositions and track cohorts by BAM through fits to sample length compositions. The AW had recommended that both length and age compositions for headboats and the CVID be included in the model, but this raised concerns by the Review Panel that these data were in sense being double-counted in the model, and therefore receiving more weight in the model than the separate length and age compositions available for the other data series (e.g., landings, discards). The Review Panel requested a sensitivity run of BAM omitting length compositions where age compositions were available. Removal of the length composition data resulted in poorer fits to the associated age compositions suggesting possibly that sampling for age may have been inadequate for those cases, especially given the broad distribution of length at age noted above.

Relative abundance indices

Initially, three fishery dependent abundance indices, a headboat index (1995–2009), a general recreational index (1993–2009), and a commercial handline index (1993–2009) along with the CVID index for the period 1990 to 2014, were included in the BAMBAM. The CVID index was based on Chevron trap catches for the period up to 2010 after which the video camera index was combined with the trap index. The AW recommended dropping the three fishery dependent indices because of conflicts between the commercial index and the two recreational indices, and the conflict between all three and the CVID index. The version presented to the Review Panel only included the CVID index.

Similar to the case for red snapper, the gray triggerfish CVID survey data was modeled using a Zero inflated Negative Binomial model, and CVs were calculated based on bootstrapping the survey observations, refitting the model and calculating a standardized index using the R function expand.grid. The issues raised above with this approach for estimating bootstrap CVs for red snapper apply equally to gray triggerfish.

The possibility of gear saturation effects for the Chevron traps was also raised by the results of Bacheler et al. (2013; SEDAR41-RD79) who show that catch rates of Gray Triggerfish reached an asymptote once a moderate number (between 50 and 100 individuals) of all species were caught in the trap.

2. Evaluate and discuss the strengths and weaknesses of the methods used to assess the stock, taking into account the available data, and considering the following:

Red snapper

a) Are methods scientifically sound and robust?

The BAMBAMincorporated data from a wide range of sources to form an integrated view of population dynamics for the South Atlantic red snapper stock. A number of assumptions had to be made concerning incomplete coverage with respect to time, space, and fisheries. This assessment evaluated the robustness of the stock status determinations to the data decisions, assumptions, and alternative model configurations through extensive sensitivity analyses and Monte-Carlo Bootstrap analyses. The methods used for this assessment were judged to be scientifically sound and robust.

b) Are assessment models configured properly and used consistent with standard practices?

The BAM is the approved assessment method for many stocks in the South Atlantic Snapper-Grouper complex, and allows for incorporating fishery dependent and independent indices, as well as life history information into the stock assessment. This model is also well suited for dealing with removals from a variety of sources, such as commercial fisheries, recreational fisheries, and discards. The model for this stock assessment was highly complex with many assumptions and data sources, and its application was consistent with standard practices. The configuration was thoroughly evaluated with respect to the determination of stock status.

In addition to the BAM, two production models and a catch curve analysis were applied to the data. All of these models were applied to the data according to standard practices.

c) Are the methods appropriate for the available data?

The two production models ignored the length and age composition data that were used in the BAMBAM. While the modeling of the length and age composition data can be complex due to the need to assume different forms of selectivity for indices and removals, the review panel agreed with the conclusions of the AW that these data are an important source of information for understanding the stock population dynamics. The catch curve method assumes that the population age structure was stable due to constant recruitment and mortality, neither of which conditions hold for red snapper. In addition, selectivities for the catch curve analysis were all assumed to be flat-topped unlike the most of those used in the BAM.

The BAM base model configuration was agreed to be the most appropriate for determining stock status given the information available. The base configuration presented at the AW had to be updated during the review panel meeting to correct the age compositions for the Chevron trap surveys. This updated version differed from the original base case with respect to providing slightly more optimistic status determination measures, although stock status remained the same.

Removal of the CVID index resulted in more optimistic stock status measures although stock status determinations remained the same as the base case (S4). A flat-topped selectivity function for ages 4+ was assumed for the CVID catches, implying that the relative abundance of older fish was represented by this survey. Public comment submitted before or presented during the panel review suggested that the larger older red snapper would not be as vulnerable to the Chevron traps as younger fish, due to behavior or habitat specific differences including depth. However, studies on red snapper available to the review panel did not find evidence for length/depth relationships (SEDAR41-RD34) or the lack of larger fish in chevron traps (SEDAR31-RD36, SEDAR31-DW28). The panel noted that some of the largest and oldest fish in the length/age samples were from the CVID survey. The panel concluded that there was insufficient evidence to reject the flat-topped selectivity curve for the CVID survey.

Prior to the moratorium the selectivity for the general recreational landings were assumed to be domed shape similar to the landings from the headboat fleet. During the moratorium, the domed shaped curve was continued to be used for the headboat fleet, but a flat-topped selectivity was assumed for the general recreational landings to reflect the larger size and older age compositions seen in the samples during the mini-seasons. The assessment team conducted a sensitivity study at the panel's request, where the domed shape selectivity for the headboat fleet was used for the general recreational fleet. This modification did not result in any change of stock status determination from the base case, although there was some degradation in the fits to the age composition data.

General recreational discards were estimated from angler interview data and no size composition information was available. The size and age composition of these discards was assumed to be the same as the headboat discards, even though the general recreational fishery was assumed to be targeting larger/older fish than the headboats during the mini-seasons, as represented by the flat-topped selectivity curve used for this fishery. Estimated general recreational discards accounted for 56% of the removals by numbers in 2014, and will continue to be a major source of information as the moratorium continues. Estimates of these discards are also the most uncertain component of the removals data. The assessment team was unable to fit the BAMBAM assuming error in landings, and in the base model all removal data was fit assuming a CV of 0.05. Sensitivity runs assuming higher or lower total discards did not result in in any appreciable changes to stock status (S19, S20).

Gray Triggerfish

a) Are methods scientifically sound and robust?

The BAM was used for the South Atlantic gray triggerfish stock assessment with data sources similar to those used for the red snapper assessment. This model and the associated sensitivity analyses are considered scientifically sound and robust.

b) Are assessment models configured properly and used consistent with standard practices?

The base model only included the CVID survey as an index of abundance and used six times up-weighting to improve the fit of the survey in the model. The base model estimated very low levels of abundance in the initial years of 1988 and 1989 at a time when exploitation was expected to be quite low. Sensitivity runs determined that a combination of fitting the model closely to the low 1990 CVID point by using six times up-weighting and the assumed selectivity for the CVID resulted in low abundance and recruitment in the first two years. Fitting the CVID without up-weighting essentially resulted in no appreciable trend over the time series although the fit was contained within the confidence intervals for all the survey points.

The base configuration of the BAM from the Assessment Workshop was revised with corrected age compositions of the CVID survey during the Review Workshop. Although the determination of stock status was not influenced by the correction, results from the corrected base model were somewhat different. The Review Panel requested and reviewed two revised models to resolve apparent difficulties in fitting to the survey and associated estimates of abundance in the first year of the assessment series. An alternative BAM configuration with a starting year of 1974 estimated a series of low recruitments to explain the low survey index in 1990. The extremely low estimates of abundance in the first year of the assessment may result from an unusual survey observation in the first year of the survey, rather than overfitting the entire survey series. An exploratory analysis that removed the 1990 survey observation produced estimates of abundance in the first year of the assessment that was similar to the rest of the time series. The Chevron trap survey began in 1988, but the protocol was being refined in 1988 and 1990. There have been no changes to the design of the survey since 1990. However, Hurricane Hugo was 7-8 months prior to the 1990 survey. A study of Jamaican reef fish found changes in abundance, behavior, and distribution a year after Hurricane Allen (Kaufman 1983).

The Review Panel was also concerned that the need to up-weight the survey may result from using composition samples twice (as age compositions and length compositions). An exploratory analysis that removed length compositions for fleets with age compositions, with no up-weighting of the survey, still did not fit the survey well.

c) Are the methods appropriate for the available data?

Based on the magnitude of changes to the data, results and model diagnostics from the Assessment Workshop base model, as well as concerns about overfitting the survey, the

Review Panel recommends that further modeling is needed to model the corrected data appropriately.

3. Evaluate the assessment findings and consider the following:

Red snapper

a) Are abundance, exploitation, and biomass estimates reliable, consistent with input data and population biological characteristics, and useful to support status inferences?

The Review panel accepted the new base model with the corrected age compositions for the CVID survey index as the best available model to provide advice for the South Atlantic red snapper fishery. However, the review panel did have concerns which are discussed below.

The reliability of model estimates of abundance, biomass, and exploitation depend on how well the monitoring indices included in the model track the population trends over time. In this assessment, fishery dependent catch rates were used for the pre-moratorium period and were replaced by the CVID survey index for 2010 to the present. The MRIP annual red snapper discard rate from the headboat fleet for 2005 to the present was the only index that spanned the two time periods.

The consistency of the stock status determinations for this combination of monitoring indices was evaluated through a series of sensitivity runs. These runs indicated that the determination of stock status was actually fairly insensitive to changes such as using the longer time series for the CVID (S9), removing the CVID (S4), up-weighting the fishery dependent indices (S3), dropping the headboat discard index for 2010 to the present (S12), dropping the headboat discard index altogether (S16), or only using the CVID (S23). All indices were well fit by the data, except for the headboat discard rate in the most recent years.

All of these results suggest that the population trends in the model results probably have as much or more to do with the very close fit of the model to the landings, discard data, and associated age compositions as they do with the trends in the monitoring data. CVs were set to 0.05 for the landings and discards, which seems unreasonably low for the MRIP estimates of the latter in the case of the recreational fishery, but a higher CV of 0.20 for discards was investigated in MCB study, and the results did not indicate a change in stock status from the base case.

b) Is the stock overfished? What information helps you reach this conclusion?

The estimated abundance for 2014 was at levels not seen in the model since the mid-1960s; however, the 2014 population mainly consisted of ages 1–4 years (96% by number). Despite these high abundance levels, the stock is overfished by biomass as $SSB_{2014}/SSB_{F30\%}$ =0.16 due to the lack of older fish in the population.

c) Is the stock undergoing overfishing? What information helps you reach this conclusion?

The review panel could not find any evidence against the overfishing determination in the assessment, but did have a number concerns that are discussed below. The panel also reflected on issues with using apical fishing mortality to monitor the impact of the fishery on the stock over time (see item e below).

The current determination that overfishing is occurring while the fishery is under moratorium generated much discussion during the panel review. The moratorium has not resulted in a complete closure as there have been landings from mini-seasons in 2012–2014 and removals due to discards during these seasons and throughout all of moratorium years for recreational fisheries. The estimated fishing mortalities reflect the large decrease expected with the introduction of the moratorium in 2010. However, since 2010 fishing mortalities have increased from this low point mainly due to discard mortalities and catches from the general recreational fishery. A comparison of F at ages 1, 2, 3, 4, and 5+ indicates that while fishing mortality was greatly reduced on all age groups in 2010, fishing mortality greatly increased on the older age 4 and 5+ group by 2014 while the Fs for the younger group ages level continued to be lower. The moratorium appears to have been a benefit to the younger fish but not so for fish 4 years and older, as interpreted by the selectivity curves used for the moratorium years.

The determination of overfishing in the assessment relies on the geometric mean of apical F summed across fleets each year over 2012–2014 period. Currently, $F_{2012\text{-}2104}/F_{30\%}$=2.52. The retrospective analysis indicated that there was a substantial increase in apical F for 2010 to 2013 with the addition of the 2014 data. The individual results for the different runs were not presented and it is not known whether the ages at which the apical Fs occurred changed with the addition of 2014 data. Given the retrospective pattern, it is likely that had the red snapper assessment been done a year ago, evidence for overfishing would have been much weaker than presented here. The main change between 2013 and 2014 was that landings and discards by the general recreational fleet were much higher in 2014 compared to 2013 by about 3.7 times for numbers landed and 3.4 times for discard numbers. Estimated increase in weight landed by the general recreational fleet was 3.4 times the 2013 landings. Fishing mortalities associated with general recreational landings and discards make up 78% of the 2014 apical F estimate. The mini-season in 2014 was longer than in previous years, and recruits in 2014 were the highest in the time series.

The panel asked for a sensitivity run to investigate the impact of the flat topped selectivity curve assumed for the general recreational fishery by substituting the domed curve used for headboats for 2010–2014. The domed selectivity did not result in any substantial change in stock status from the base case. The fishing mortalities-at-age were not presented by gear, so it was not possible to see which age corresponded to apical F for the general recreational landings or discards for either selectivity curve.

d) Is there an informative stock recruitment relationship? Is the stock recruitment curve reliable and useful for evaluation of productivity and future stock conditions?

The stock recruitment curve was not informative and inference was based on setting steepness to 0.99 and assuming average recruitment. Mean annual recruitment was assumed and lognormal deviations around that mean were estimated in the model.

Recruitment is typically not well estimated in the last year of stock assessments, because there is little information to inform the estimate. The estimate of strong recruitment in the last year of the assessment is supported by the high CVID index, as well as the length composition of the headboat fleet. Review Workshop participants reported continued signals of strong recruitment in 2015 fishery and survey data. The Review Panel recognizes that projections are largely dependent on the estimate of recent recruitment, but the estimates of abundance at age from the base model is the most reliable basis for stock status determination and projection.

e) Are the quantitative estimates of the status determination criteria for this stock reliable? If not, are there other indicators that may be used to inform managers about stock trends and conditions?

Alternative Metrics of Fishing Mortality

Evaluating trends in F over time requires a metric that is comparable among years and reflects exploitation across a range of ages. Apical F (maximum F at age, Figure 1) is based on a different range of ages among years, because of changing fleet contributions and changes in fleet selectivities. Apical F also does not reflect F for partially selected ages.

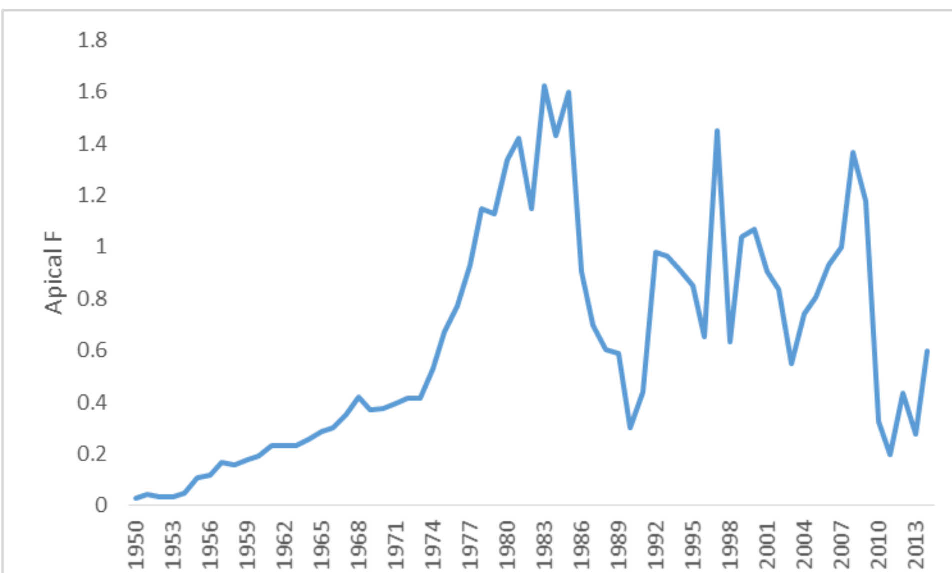

Figure1. Maximum fishing mortality (F) at age for South Atlantic red snapper

Deciding on a more appropriate metric of F for Red Snapper is challenging because of the complexity of patterns in estimated F at age (Figure 2):

- Age-1 F has one peak in 2004. F was negligible until the mid-1990s, peaked at 0.4 in 2004, then decreased to around 0.1 since 2010.
- Age-2 F had one peak at 1.0 in 1985. F decreased to around 0.1 in the late 1990s, increased to 0.2-0.3 from 1999 to 2010, then decreased to around 0.1 since 2010.
- Age-3 F also had a major peak at 1.6 in the early 1980s, decreased to 0.3-0.5 in the early 1990s, increased to a minor peak of 0.8 in 2008 and decreased to 0.2-0.3 since 2010.
- Age-4 F had three peaks at >1.0 in the early 1980s, 1.5 in 1997 and 1.4 in 2008, then increasing from 0.2 in 2010 to 0.5 in 2014.
- Ages 5 and older have similar patterns in F (three peaks in the early 1980s, 1997 and 2008-2009, then increasing from 2010 to 2014). For most of the time series F decreases with age, but since 2010, F at ages 5+ is similar, increasing from approximately 0.2 in 2010 to 0.5 in 2014.

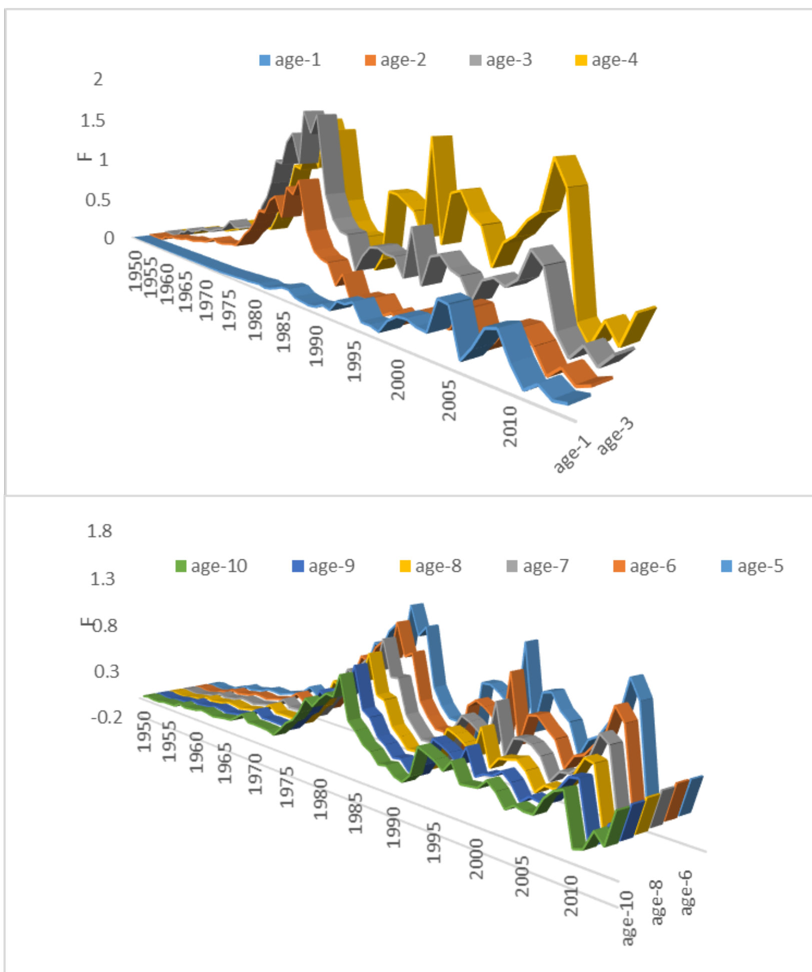

Figure 2. Fishing mortality (F) at age for South Atlantic red snapper.

Alternative metrics of F will reflect these patterns differently. Simple average F at age can reflect trends for similar ages (e.g., ages 2–3, ages 4+), and show different recent trends. During the moratorium, F remained low for ages 1–3, but more than tripled for ages 4+ (Figure 3).

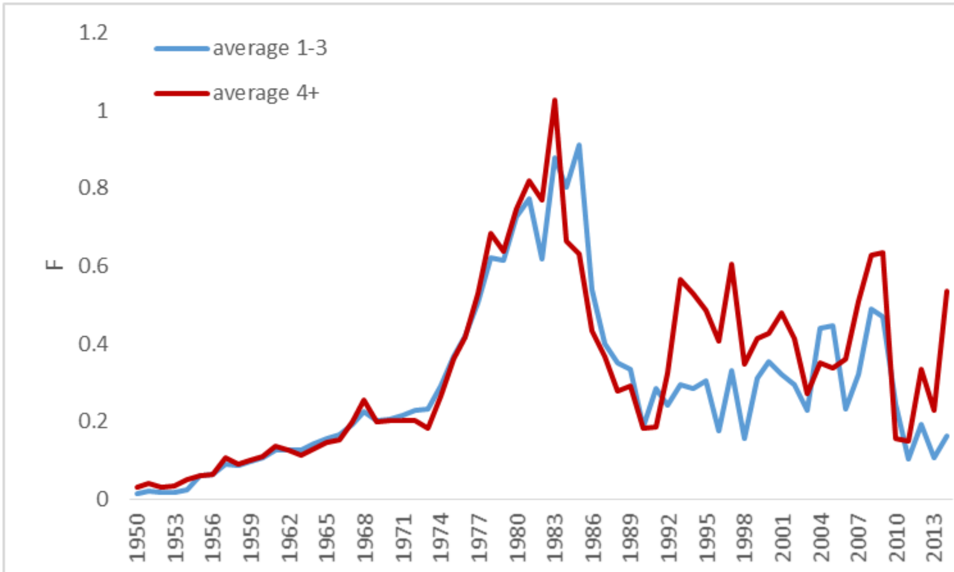

Figure 3. Average fishing mortality (F) for age groups 1-3 and 4+ for South Atlantic red snapper.

Average F can be weighted by abundance at age or biomass at age to measure the average F exerted on the entire stock (Figure 4). With young ages typically having greater abundance, abundance weighted average F reflects patterns of F at young ages. Biomass peaks at different ages over the assessment time series (age-20 in 1950, age-2 in 2014), so biomass weighted average F reflects a varying age range.

Average F can also be weighted by exploitable abundance (the product of abundance at age and selectivity at age) or exploitable biomass (the product of biomass at age and selectivity at age) to measure the average F exerted on the exploitable stock (Figure 5). The two exploitable stock average F's are similar, but the exploitable biomass weighted F reflects older ages (e.g., more than doubles during the moratorium) and the exploitable abundance weighted F reflects younger ages (e.g., remains low during the moratorium).

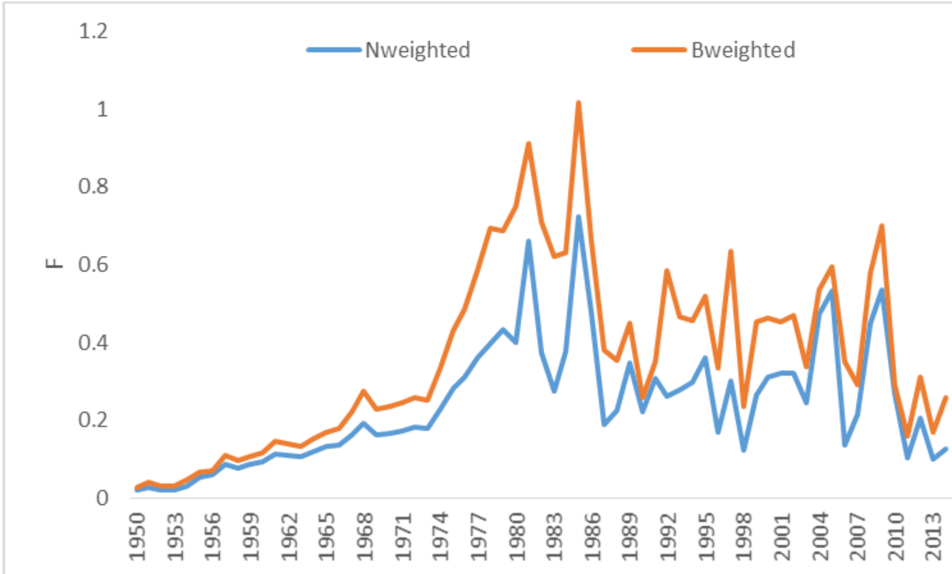

Figure 4. Average fishing mortality (F) at age weighted by estimated numbers (Nweighted) or estimated biomass (Bweighted) for South Atlantic red snapper.

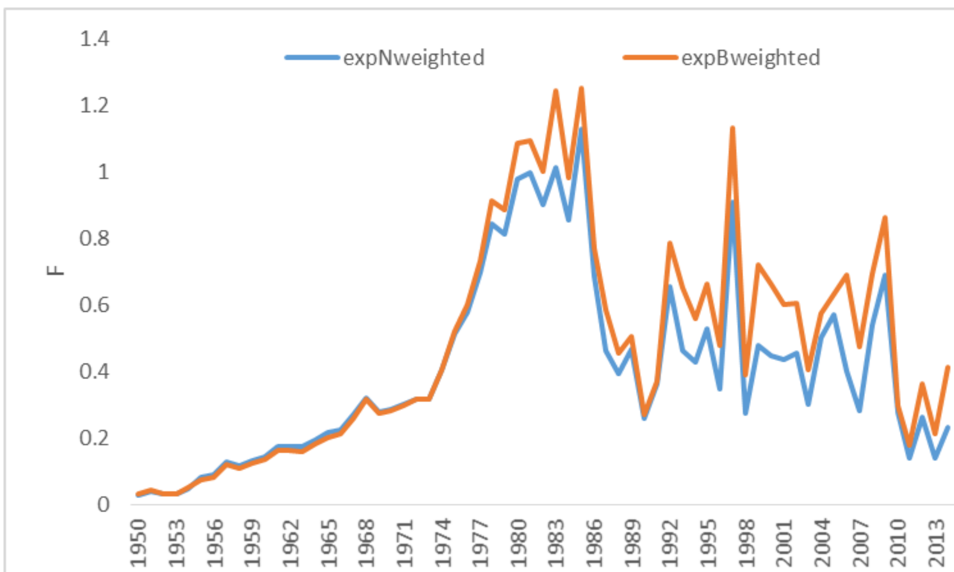

Figure5. Average fishing mortality (F) at age weighted by exploitable numbers (expNweighted) or exploitable biomass (expBweighted) for South Atlantic red snapper.

The overfishing limit ($F_{30\%SPR}$) can be expressed in the same currency as the measure of F from the stock assessment. $F_{30\%}$ is currently expressed as Apical F, assuming the average selectivity for the last three years of the stock assessment, which peaks at age-5 (e.g., $F_{30\%}$ expressed as age-5 F is 0.15). All forms of $F_{30\%SPR}$ expressed as an average F are less than age-5 F, because they include some partially recruited ages. According to all of the alternative F metrics considered, overfishing is occurring, but to varying degrees.

Metric	2012–2014 Geo.Mean	F30%	F/F30%
F(age-5)	0.43	0.15	2.8
F(ages 1–3)	0.15	0.06	2.7
F(age-4+)	0.35	0.12	2.8
F(Nwtd)	0.14	0.08	1.8
F(Bwtd)	0.24	0.11	2.1
F(expNwtd)	0.20	0.10	2.0
F(expBwtd)	0.31	0.12	2.5

Gray Triggerfish

a) Are abundance, exploitation, and biomass estimates reliable, consistent with input data and population biological characteristics, and useful to support status inferences?

An issue was identified with inclusion of both age and length compositions in the fitting process, which was explored after the CVID age compositions had been corrected for errors discovered late in the week. Additional runs to establish a base case with the corrected age compositions and removing length compositions when age compositions resulted in poor fits to the headboat and CVID age compositions. At this point, the review panel concluded that given these problems and those identified for fitting the CVID index, there wasn't enough time left in the meeting to establish a base case for gray triggerfish. The assessment panel needed to review the findings to date and work with the assessment team to develop a new base case.

b) Is the stock overfished? What information helps you to reach this conclusion?

Without an accepted base case from the BAM, the review panel was unable to determine if the stock was overfished with respect to the standard reference points. Abundance in 2014 from the CVID survey was at 82% of the maximum abundance in the time series. Based on the information available to the review panel there was no evidence that the stock is overfished at this time.

c) Is the stock undergoing overfishing? What information helps you reach this conclusion?

Without an accepted base case from the BAM, the review panel was unable to determine if overfishing was occurring with respect to the standard reference points. In 2014 total removals have declined by 38% from the landings in 2009, which represented the highest landings in the 1988 to 2014 time series. The CVID survey index indicates that abundance has been increasing since 2010. Based on the information presented to the review panel, there was no evidence that current levels of removals have resulted in overfishing.

d) Is there an informative stock recruitment relationship? Is the stock recruitment curve reliable and useful for evaluation of productivity and future stock conditions?

The stock recruitment curve was not informative as there was little evidence for low recruitment at low stock size. Inference was based on setting steepness to 0.99 and mean annual recruitment was assumed. Lognormal deviations around the mean were estimated in the model.

e) Are the quantitative estimates of the status determination criteria for this stock reliable? If not, are there other indicators that may be used to inform managers about stock trends and conditions?

Without a reliable base case, quantitative estimates of status determination were not available.

4. Evaluate the stock projections, including discussing strengths and weaknesses, and consider the following:

Red Snapper

a) Are the methods consistent with accepted practices and available data?

The projection method used in this assessment was consistent with those used widely in SEDAR assessments based on statistical models such as BAM and Stock Synthesis, and was consistent with the available data. The method used stochastic projections that extended the Monte Carlo/ Bootstrap (MCB) fits of the assessment model with added stochasticity in recruitment, and hence the propagation of uncertainty from the assessment into the projection period is internally consistent.

b) Are the methods appropriate for the assessment model and outputs?

The Review Panel concluded that the red snapper stock projections provided for SEDAR 41 are appropriate for the BAM assessment model and outputs.

c) Are the results informative and robust, and are they useful to support inferences of probable future conditions?

The projections provide the information needed to develop management advice, showing projections for F=0; $F=F_{CURRENT}$ (geometric mean of the last 3 years); $F=F_{30\%}$; $F=F_{TARGET}$; $F=F_{REBUILD}$ (max exploitation that rebuilds in greatest allowed time; 2044). An additional projection was carried out with F from discards only. Each projection shows the 10th and 90th percentiles of the replicate projections allowing an evaluation of the probability of overfishing occurring, or the stock being overfished, for each year in the rebuilding time frame up to 2044. The projections are robust in terms of propagating realistic levels of uncertainty from the accepted base model run.

The Review Panel recognizes that the perception of current selectivity used to derive reference points and projections is conditional on recent fishing behavior, and projections of alternative management scenarios should consider alternative selectivity assumptions that are consistent with each scenario. For example, alternatives that do not allow recreational landings (e.g., moratoria with no mini-seasons) should not assume the status quo composite selectivity that includes a flat-topped selectivity for general recreational landings.

d) Are key uncertainties acknowledged, discussed, and reflected in the projection results?

Key uncertainties in the projections are acknowledged, discussed, and reflected in the projection results. The MCB runs included ranges of values of natural mortality, discard mortality and fecundity at age agreed to by the assessment working group, together with bootstrap selection of data using well-justified error distributions and additional random process error in recruitment conditional on the fitted stock recruit pattern with steepness fixed at 0.99. Initial age structure at the start of 2015 was computed by the assessment model, and fishing rates for the projection started in 2017 following an initialization period in 2015–2016, where fishing mortality rates were derived to represent the management measures in place.

In addition, the stock assessment report was quite clear on the fact that it is unrealistic to assume that the current fishing patterns including effort by fleet, discard trends, and selectivity patterns will continue as the stock recovers. Management actions in response to strong or weak year classes will affect these patterns and in turn, the current projections based on them.

Gray Triggerfish

Since the base BAM for gray triggerfish was not accepted by the Review Panel projections, results were only reviewed in terms of the methodological approaches used— i.e., projections results were not considered as providing plausible scenarios and, therefore, were not investigated in detail. The projection method used is consistent with those used widely in SEDAR assessments based on statistical models such as BAM and Stock Synthesis, and is consistent with the available data. Further, the method described for the stochastic projections that extended the Monte Carlo/ Bootstrap (MCB) fits of the assessment model with added stochasticity in recruitment, and hence the propagation of uncertainty from the assessment into the projection period is internally consistent.

5. Consider how uncertainties in the assessment, and their potential consequences, are addressed.

Red Snapper

a) Comment on the degree to which methods used to evaluate uncertainty reflect and capture the significant sources of uncertainty in the population, data sources, and assessment methods.

A thorough evaluation of convergence and model sensitivity is necessary, but difficult to do for a complex model like BAM because of the large number of parameters. Uncertainties in the assessment were thoroughly explored through (1) a mixed Monte Carlo and bootstrap (MCB) analysis of quantify random errors in the assessment output; (2) sensitivity analysis around the base BAM run; and (3) the use of alternative assessment models. The Monte Carlo Bootstrap procedure also explored many combinations of alternative data and model assumptions. In the bootstrapping of observed data on landings, information from the headboat program was used to specify a decreasing CV by time blocks (i.e. CV = 0.15 for 1981–1995, CV = 0.1 for 1996–2007, and CV = 0.05 thereafter). These CVs reflect random errors. However, landings from the headboat fishery are monitored through mandatory logbooks, and thus should in principle have zero sampling errors for the vessels in the sampling frame. The CVs may reasonably reflect random errors in reporting. However, various sources of systematic errors (bias) are not reflected through these CVs. It is known that under-reporting of trips does occur, that catch data may not always be 100% accurate (for example, due to recall bias if logbooks are not filled in immediately after each trip), and that other variations in reporting likely occur. Because the distribution of such systematic errors is unknown, it is not possible to quantify the magnitude of the resulting uncertainty in the landings.

Bootstrapping methods were used extensively to estimate CVs for abundance indices based on resampling original records or observations, and then re-fitting standardization models. As discussed in TOR 2, the purpose of standardization is to derive an index for a fixed set of covariates, but resampling observations will introduce variation associated with covariates and the standardization process, which will not appropriately capture the variation in the standardized index. Model-based bootstrapping should be considered as an alternative approach to capturing the variability of the standardized index.

The input data on catch composition and abundance indices by cohort are obtained from multi-stage sampling programs where fishing trips typically are the primary sampling units (PSUs) for fisheries data, and locations/standardized trap catches (90 min soak time) are the PSUs for the chevron trap. Substantial correlations can be expected in age or length composition data sets that are constructed from samples/sub-samples from multiple catches (whether from fisheries-independent surveys or fisheries, e.g., Aanes and Vølstad 2015). The BAM itself and the MCB is not likely to realistically account for complex error structure in data weighting without prior estimates of the actual variance-covariance matrices for the input data. The robust multinomial approach with number of PSU's as proxy effective sample sizes employed in the uncertainty evaluation of the BAM can only partly reflect the complex error structure. Ideally, one would run bootstrap resampling on the PSU's to create replicated BAM runs that reflect the complexity in input data, but given the complexity and configuration of BAM this is not possible. The Review Panel therefore considers the uncertainty in the assessment to be appropriately addressed given these restrictions.

The sensitivity analyses were used to explore a wide range of data decisions, model assumptions and model configurations to examine the robustness of stock status determination. The model was run for a plausible range of values for each factor. The Review Panel noted that the sensitivity testing by alternating one factor at a time, although commonly done, may not fully reflect the uncertainty in model outputs from a complex model such as BAM with a large number of parameters, where many are likely to be correlated (e.g., Saltelli and Annoni 2010). Global sensitivity analysis (Saltelli et al. 2008) may be used to untangle the contribution of single factors/parameters and interactions between parameters to the overall variability in model output. Anderson et al. (2011) provide an excellent overview of the literature, and many examples of applications of global sensitivity analysis to Integrated Assessment Models in climate research, and some of these are likely to be applicable to the BAM.

Model uncertainty was mainly explored by running an alternative Stock Production Model Incorporating Covariates (ASPIC software Version 7.03, SEDAR41-RD74) that relies on length-age aggregated catch and CPUE indices, with no compositional catch being included. The difference between the ASPIC and the BAM results can, however, be explained by the fact that ASPIC does not take into account the age-structure of the catches and the stock. The BAM base configuration is therefore considered to provide the most appropriate basis for status determination, despite many sources of uncertainty.

b) Ensure that the implications of uncertainty in technical conclusions are clearly stated.

The Review Panel agreed that the implications of uncertainty in the technical conclusions were clearly stated and evaluated.

6. Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations or prioritizations warranted.

   a) Clearly denote research and monitoring that could improve the reliability of, and information provided by, future assessments.

Red Snapper

- Given the concerns expressed by industry about the assumptions for the asymptotic selectivity of red snapper to the CVID traps, it would be useful to have another fishery independent source of abundance and size composition data. A longline survey is used for the Gulf of Mexico red snapper stock, and this survey is assumed to represent the older fish in that population. The possibility of initiating a longline survey for the South Atlantic was discussed during the review panel meeting, and it is recommended that such a longline survey should be implemented as soon as possible.

- The application of model-based (re-sampling of residuals) bootstrapping for calculation of CVs of standardized abundance indices should be investigated to avoid varying the basis for standardization at each bootstrap replication.
- The headboat discard rate index is the only fishery-dependent index that was used during the moratorium years. While retaining or removing this index did not appear to alter the determination of stock status for the BAM, it was not clear how this index reflects the abundance of red snapper, particularly the younger fish at a time when anglers are supposed to be avoiding them. Further work is required to evaluate the reliability of discard data as an abundance index by improving knowledge of private recreational fisherman behavior before and during the moratorium.
- Discards, particularly those from the general recreational fleet are a major source of removals from this fishery while under moratorium. Currently, the size compositions of the discards from the general recreational are unknown and assumed to be equal to those estimated for the headboats. Knowledge of the discard size composition will become increasingly more important to determine the strength of the apparently strong 2013 year-class. Alternative methods need to be developed to obtain size information for discards from the general recreational fleet. One possibility that could be considered is having a "text-a-picture" of the "one that got away" contest. Participants could take a picture of the red snapper they caught next to something of known length with their smartphone before discarding the fish, and then text the picture to an address with information on date, time, and rough location when they return to shore. Prizes could be awarded based on some criterion. These samples will not be random samples per se, but they will at least provide a range of sizes that may allow for evaluating the assumption that the general recreation size compositions can be represented by the headboat age compositions. These pictures may also give some information on the accuracy of species identification.
- Public comment during the Panel Review suggested larger fish were not being adequately represented by the Chevron traps as they do not associate with the younger fish and may occupy different depth ranges. A research program should be initiated to determine the spatial distribution (horizontal and vertical) of red snapper by size using tracking and telemetry.
- The current estimate of age of sexual maturity used in the assessment is younger than expected compared to other Lutjanids. Has this always been the case for red snapper in the South Atlantic or is it reflective of a compensatory response to heavy exploitation? Further investigations into possible historical trends in the age at sexual maturity should be initiated.
- The current assessment assumed that batch fecundity did not vary over time. Studies should be conducted to evaluate the validity of this assumption.

Gray triggerfish

- Length-at-age had a wide range when compared with the expected increase in length with age. This makes it difficult to estimate annual age compositions and track cohorts by BAM through fits to sample length compositions. This broad range of length-at-age may be due to ageing issues, and the DW has recommended a validation study to refine and improve age determination. In addition, the broad range may also represent spatial variability in growth characteristics. If length/age samples are available by location (e.g., Chevron sets) then a non-linear mixed effects model version of the von Bertalanffy model could be used to investigate the possibility of such patterns with the grouping variable set to location. Random effects by location could be mapped out to investigate for spatial patterns in growth.
- Bubble plots or some other informative display should be added as a diagnostic to evaluate how well the CVID survey tracks cohorts.
- Further modeling is needed to fit the corrected CVID age composition data and to resolve the fit to the survey. In addition, the validity of the 1990 survey observation should be evaluated to consider possible effects from Hurricane Hugo or other possible reasons for it appearing to be abnormally low.
- Given the evidence for trap saturation, the CVID index should be re-evaluated with respect the catch rate with and without sets, where total catch was greater than 50 fish. Temporal trends in numbers of traps with >50 total catch should also be investigated.
- The application of model-based (re-sampling of residuals) bootstrapping for calculation of CVs of standardized abundance indices should be investigated to avoid varying the basis for standardization at each bootstrap replication.
- More research to better understand the life history is needed, including natural mortality, maturity, and reproductive potential, particularly for the youngest ages.
- Research on the effects of environmental variation on the changes in recruitment or survivorship.

b) Provide recommendations on possible ways to improve the SEDAR process.

The red snapper and gray triggerfish assessments were both very complex with respect to fishery composition, data sources, and models. Both assessments were supported by many documents from the associated Data and Assessment workshops. The Panel review for both stocks should have been a full week instead of three and half days to accommodate all of this material. Under normal circumstances this could have allowed for time to develop the first draft of the Panel Review group report before the end of the meeting. For our particular meeting, the discovery of errors in the CVID age composition data would have still been as disruptive, but the five day time frame may have allowed for more time to complete model runs, etc., before the end of the meeting.

7. Consider whether the stock assessment constitutes the best scientific information available using the following criteria as appropriate: relevance, inclusiveness, objectivity, transparency, timeliness, verification, validation, and peer review of fishery management information.

The assessment for red snapper constitutes the best scientific information available, and fulfils the following criteria:

Relevance: The SEDAR 41 assessment is highly relevant as the red snapper stock is depleted and undergoing rebuilding under a moratorium with limited landings permitted and most catches being discarded. The data and assessment provide the best means of establishing the rate of recovery of the stock, determining if measures are preventing overfishing, and providing information that can be used to adjust management actions where appropriate.

Inclusiveness: The SEDAR 41 assessment includes all data that have been quality assured and proved adequate for use in the assessment. This includes data from State, as well as Federal, sampling schemes where needed, for example to estimate discards during the mini-season where MRIP sampling is too limited for such a short season length.

Objectivity: The SEDAR 41 BAMBAM is a highly objective procedure based on well-tested assessment modeling principles, and using data sets and assumptions that have been rigorously documented and reviewed through the SEDAR data, assessment and peer-review process. Where fully objective decisions are difficult to make, such as some decisions on scenarios for historic catches where evidence is lacking, the uncertainties around the decisions made have been explored and included in sensitivity analyses and the Monte Carlo Bootstrap evaluation of assessment uncertainty.

Transparency: All outputs of the data, assessment and review workshops in SEDAR 41 are fully documented and publicly available. The discussions at the review workshop are also recorded for record. All data sets are thoroughly explored and the quality of data on which the assessment is based is documented and transparent, as are all decisions related to the choice of assessment model, how it is implemented, and the results of the base run and sensitivity and uncertainty analyses.

Timeliness: The SEDAR process in general is arranged to provide timely fishery management advice where it is needed, and to ensure that assessments are benchmarked and reviewed at appropriate intervals.

Verification: The SEDAR 41 assessment process and deliverables comply with legal requirements under the Magnuson Stevens Act (2007) for developing and monitoring of fishery management plans and providing information on stock status.

Validation: The SEDAR 41 process is designed to meet the needs of fishery managers for peer-reviewed stock assessments and associated advice on stock status and future catches, and the process is open and fully transparent to the fishery managers and to stakeholders from commercial and recreational fisheries, conservation groups or others with a stake in the outcomes and who have opportunity to give their views on record.

Peer review: The SEDAR 41 process includes full peer-review by experts appointed by the Center for Independent Experts (CIE) and by reviewers from the SAFMC SSC. The review panel report and the independent CIE reviews are publicly available.

The Review Panel concluded that, as configured, the SEDAR 41 gray triggerfish stock assessment model could not be considered the best scientific information available.

8. Compare and contrast assessment uncertainties between the Gulf of Mexico and South Atlantic stocks.

Red snapper

Both the South Atlantic and Gulf of Mexico red snapper stock assessments have multiple uncertainties. The table below summarizes the significant sources of assessment uncertainty in the population, data sources, and assessment methods for both stocks.

Sources of Uncertainty	South Atlantic (SEDAR 41)	Gulf of Mexico (SEDAR 31)
Population	• Juvenile life history, including the location of juveniles before they recruit to the fishery • Spatial distribution (horizontal and vertical) of large adult Red Snapper • Variability in batch fecundity and spawning frequency with size and age • Effects of environmental variation on changes in recruitment • Density-dependent changes in growth, reproduction, and natural mortality	• Population structure and connectivity between eastern and western Gulf (for both adults and juveniles) • The use and effect of artificial reef structures on red snapper population abundance, age and length composition, and spatial distribution effects of environmental variation on changes in recruitment • Density-dependent changes in growth, reproduction, and natural mortality
Data Sources	• Limited fishery independent indices of abundance • No fishery independent index of abundance for early juveniles • Changes in selectivity, catch, and discard data due to changes in fisher behavior within and outside the mini-season	• Limited fishery independent index of abundance for early juveniles • Limited information on the magnitude, size, and age composition of discards • Poorly-informed selectivity functions for most fleets

	• Poor information on the magnitude, size, and age composition of discards • Poorly-informed selectivity functions for most fleets	
Assessment Methods	• Uninformative Stock-Recruitment relationship (had to use proxy reference points) • Uncertainty for certain parameters and data inputs was fixed to chosen values that could be considered arbitrary (e.g., CV for landings and discards set = 0.05) • Model uncertainty was mainly explored by running an alternative Stock Production Model	• Uninformative Stock-Recruitment relationship (had to use proxy reference points) • Uncertainty for certain parameters and data inputs was fixed to chosen values that could be considered arbitrary (e.g., CV for landings set = 0.05 and for discards = 0.5) • Model uncertainty was not explicitly explored by the use of different models

It was not possible to complete this ToR for gray triggerfish because the SEDAR 41 stock assessment could not be successfully completed (i.e., many of the assessment uncertainties could not be fully evaluated).

9. Provide guidance on key improvements in data or modeling approaches which should be considered when scheduling the next assessment.

Red snapper

In addition to the results from the research recommendations (TOR 6), additional information should be provided on how removals and fishing mortality are distributed by age for both landings and discards across the different commercial and recreational fleets. This kind of information may provide insight into possible ontogenetic spatial patterns that could be useful for assessing the impact of mini-seasons and other management actions on the population. If patterns are discernable, they may provide possible alternatives for weighting the different fishery dependent abundance indices associated with the landings or discards.

Gray triggerfish

The major key improvement that will be required for the next assessment is an understanding of how the CVID survey tracks abundance. The research recommendations (TOR 6) list a number of potential research areas that may offer insights into the relationship between South Atlantic gray triggerfish and this survey.

10. Prepare a Peer Review Summary summarizing the Panel's evaluation of the stock assessment and addressing each Term of Reference. Develop a list of tasks to be completed following the workshop. Complete and submit the Peer Review Summary Report in accordance with the project guidelines.

    The summary group report for the Review Panel was submitted on April 15, 2016. This independent peer review report was submitted on April 21, 2016.

Conclusions and Recommendations

The results of the age-based model for South Atlantic Red Snapper indicate that the stock is overfished and overfishing is occurring. While the current levels of abundance are at the highest since the mid-1960s, the population in 2014 consisted mainly of ages 1–4 years (96% by number). As a result, the current population biomass is less than expected at $SSB_{F30\%}$ due to the lack of older fish. The finding for overfishing was made despite the fact that the fishery has been under moratorium since 2010. However, the moratorium has not resulted in a complete closure as there have been limited openings or mini-seasons in 2012, 2013 and 2014. In addition, a large portion of the removals since 2010 have been due to discards especially in the general recreational fishery. Annual fishing mortality has been monitored by apical F which will be based on different ages over time as a function of the differing contribution of fleets and fleet selectivities. Apical F definitely shows a large decrease in fishing mortality from 2009 to 2010, corresponding to the setting of the moratorium; however, fishing mortality increases thereafter to where it is now exceeding $F_{F30\%}$ in 2014. This increase in fishing mortality appears to be confined to ages 4+ only as the fishing mortality for the younger ages remains low. Population estimates for older fish were indexed by the CVID survey and the assumed flat-topped selectivity curve. Research recommendations were made to investigate the spatial distribution of red snapper by size to determine if the larger fish were vulnerable to being caught by the traps. Also, the addition of a longline survey to sample a broad size range of fish was also recommended. Under the current management regime, discards will continue to be as or more important than landings as removals from the population; however, discard data provide less reliable estimates than landing data. Research recommendations were made to improve the size composition estimates for the discards, in particular for the general recreational discards for which no direct size compositions estimates were available.

The Review Panel reviewed the BAM base model for gray triggerfish. The base model estimated very low levels of abundance in the initial years of 1988 and 1989 at a time when exploitation was expected to be quite low. This behavior appeared to be a consequence of the close fit to the low 1990 CVID survey point, due to the six times up-weighting along with the assumed selectivity for the CVID. Additional runs to establish a base case with the corrected CVID age compositions and removing length compositions when age compositions were available resulted in poor fits to the headboat and CVID age compositions. The Review Panel recommends that further modeling is needed to model the corrected data appropriately given the magnitude of changes to the data, results and model diagnostics from the Assessment Workshop base model, as well as concerns about overfitting the survey. Research recommendations were provided to explore for possible spatial reasons for the weak relationship between age and length, as well as further investigation of the CVID survey series with respect to the 1990 observation, evidence for tracking cohorts and the possible effects of gear saturation.

Appendix 1: Bibliography of materials provided for review

SEDAR 41
South Atlantic Red Snapper and Gray Triggerfish
Workshop Document List

Document #	Title	Authors
Documents Prepared for the Data Workshop (DW)		
SEDAR41-DW01	**UPDATED:** Georgia Headboat Red Snapper Catch and Effort Data, 1983-2013	Amick and Knowlton 2014
SEDAR41-DW02	**UPDATED:** Georgia Red Snapper Catch & Effort Collection during Mini-Seasons, 2012-2014	Knowlton 2015
SEDAR41-DW03	Standardized video counts of Southeast U.S. Atlantic gray triggerfish (*Balistes capriscus*) from the Southeast Reef Fish Survey ****See SEDAR41-DW44 for index updated through 2014**	Purcell et al. 2014
SEDAR41-DW04	Standardized video counts of Southeast U.S. Atlantic red snapper (*Lutjanus campechanus*) from the Southeast Reef Fish Survey ****See SEDAR41-DW45 for index updated through 2014**	Purcell et al. 2014
SEDAR41-DW05	Gray Triggerfish Fishery-Independent Indices of Abundance in US South Atlantic Waters Based on a Chevron Trap Survey ****See SEDAR41-DW52 for index recommended from 2015 DW**	Ballenger et al. 2014
SEDAR41-DW06	Red Snapper Fishery-Independent Indices of Abundance in US South Atlantic Waters Based on a Chevron Trap Survey ****See SEDAR41-DW53 and SEDAR41-DW54 for index recommendations from 2015 DW**	Ballenger et al. 2014
SEDAR41-DW07	Age Truncation and Reproductive Resilience of Red Snapper (*Lutjanus campechanus*) Along the East Coast of Florida **(has since been published – see SEDAR41-RD57)**	Lowerre-Barbieri et al. 2014
SEDAR41-DW08	The utility of a hooked gear survey in developing a fisheries-independent index of abundance for red snapper along Florida's Atlantic coast	Guenther et al. 2014
SEDAR41-DW09	Size and age composition of red snapper, *Lutjanus campechanus*, collected in association with fishery-independent and fishery-dependent projects off of Florida's Atlantic coast during 2012 and 2013	Switzer et al. 2014

SEDAR41-DW10	Overview of Florida's Cooperative East Coast Red Snapper Tagging Program, 2011-2013	Brodie et al. 2014
SEDAR41-DW11	Habitat models for Gray Triggerfish collected in fishery-independent trap surveys off the southeastern United States	Muhling et al. 2014
SEDAR41-DW12	**UPDATED:** Preliminary standardized catch rates of Southeast US Atlantic red snapper (*Lutjanus campechanus*) from headboat logbook data	SFB-NMFS 2015
SEDAR41-DW13	**UPDATED:** Preliminary standardized catch rates of Southeast US Atlantic gray triggerfish (*Balistes capriscus*) from headboat logbook data	SFB-NMFS 2015
SEDAR41-DW14	**UPDATED:** Standardized catch rates of red snapper (*Lutjanus campechanus*) from headboat at-sea-observer data	SFB-NMFS 2015
SEDAR41-DW15	Standardized catch rates of gray triggerfish (*Balistes capriscus*) from headboat at-sea-observer data	SFB-NMFS 2014
SEDAR41-DW16	**UPDATED:** Report on Life History of South Atlantic Gray Triggerfish, *Balistes capriscus*, from Fishery-Independent Sources	Kolmos et al. 2015
SEDAR41-DW17	**UPDATED:** Estimates of Historic Recreational Landings of Red Snapper in the South Atlantic Using the FHWAR Census Method ****See SEDAR41-AW07 for updated 2015 Addendum**	Brennan 2015
SEDAR41-DW18	**UPDATED**: South Carolina Red Snapper Catch and Biological Data Collection during Mini-Seasons, 2012-2014	Dukes & Hiltz 2015
SEDAR41-DW19	**UPDATED**: Standardized catch rates of red snapper (*Lutjanus campechanus*) in the southeast U.S. from commercial logbook data	SFB-NMFS 2015
SEDAR41-DW20	**UPDATED**: Standardized catch rates of gray triggerfish (*Balistes capriscus*) in the southeast U.S. from commercial logbook data	SFB-NMFS 2015
SEDAR41-DW21	North Carolina Division of Marine Fisheries Red Snapper Carcass Collections, 2012-2013	NCDMF 2014
SEDAR41-DW22	SEDAR 41 Red snapper stock assessment must utilize "direct" estimates of gear selectivity	Barile and Nelson 2014
SEDAR41-DW23	Atlantic Red Snapper (*Lutjanus campechanus*) Fishing History Timeline	Hudson 2014
SEDAR41-DW24	Atlantic Red Snapper (*Lutjanus campechanus*) Historical Fishing Pictures	Hudson 2014

SEDAR41-DW25	Historical For-Hire Fishing Vessels: South Atlantic Fishery Management Council, 1930's to 1985	Hudson 2014
SEDAR41-DW26	SEDAR 41 Atlantic Red Snapper and Gray Triggerfish Data Workshop Historical Photographs of For-Hire Vessels 1930's to 1985	Hudson 2014
SEDAR41-DW27	Red snapper mini season ad-hoc working group report	Red Snapper Mini Season Ad-hoc Group 2014
SEDAR41-DW28	Red Snapper *Lutjanus campechanus* in Gulf of Mexico versus southeast US Atlantic Ocean waters: gaps in knowledge and implications for management	Rindone et al. 2014
SEDAR41-DW29	Discards of red snapper (*Lutjanus campechanus*) for the headboat fishery in the US South Atlantic ****See SEDAR41-AW01 for updated HB discards WP**	FEB-NMFS 2014
SEDAR41-DW30	Discards of gray triggerfish (*Balistes capriscus*) for the headboat fishery in the US South Atlantic ****See SEDAR41-AW02 for updated HB discards WP**	FEB-NMFS 2014
SEDAR41-DW31	Red Snapper Preliminary Genetic Analysis Temporal Genetic Diversity Trends in the South Atlantic Bight	O'Donnell and Darden 2014
SEDAR41-DW32	SCDNR Charterboat Logbook Program Data, 1993-2013	Hiltz 2014
SEDAR41-DW33	**UPDATED:** Size Distribution, Release Condition, and Estimated Discard Mortality of Red Snapper Observed in For-Hire Recreational Fisheries in the South Atlantic	Sauls et al. 2015
SEDAR41-DW34	**UPDATED:** Size Distribution, Release Condition, and Estimated Discard Mortality of Gray Triggerfish Observed in For-Hire Recreational Fisheries in the South Atlantic	Sauls et al. 2015
SEDAR41-DW35	**UPDATED:** Marine Resources Monitoring, Assessment and Prediction Program: Report on Atlantic Red Snapper, *Lutjanus campechanus*, Life History for the SEDAR 41 Data Workshop	White et al. 2014 Wyanski et al. 2015
SEDAR41-DW36	**UPDATED:** Discards of Red Snapper Calculated for Commercial Vessels with Federal Fishing Permits in the US South Atlantic	McCarthy 2015
SEDAR41-DW37	**UPDATED:** Calculated Discards of Gray Triggerfish from US South Atlantic Commercial Fishing Vessels	McCarthy 2015
SEDAR41-DW38	Historic catch of red snapper by headboats through historic photograph analysis	Gray et al. 2014

SEDAR41-DW39	Index report cards	Index Working Group 2014
SEDAR41-DW40	Problems with Headboat Index of Abundance Confounds Use in SEDAR 41 Red Snapper	Nelson et al. 2014
SEDAR41-DW41	Commercial Fishing Targeting Changes	Fex 2014
SEDAR41-DW42	**NEW:** South Atlantic Red Snapper (*Lutjanus campechanus*) monitoring in Florida: Revised recreational private boat mode estimates for 2012 and 2013 mini-seasons, and new private boat mode estimates for the 2014 mini-season	Sauls 2015
SEDAR41-DW43	**NEW:** Hook Selectivity in gray triggerfish observed in the for-hire fishery off the Atlantic coast of Florida	Gray and Sauls 2015
SEDAR41-DW44	**NEW:** Standardized video counts of Southeast U.S. Atlantic gray triggerfish (*Balistes capriscus*) from the Southeast Reef Fish Survey	Ballew et al. 2015
SEDAR41-DW45	**NEW:** Standardized video counts of Southeast U.S. Atlantic red snapper (*Lutjanus campechanus*) from the Southeast Reef Fish Survey	Ballew et al. 2015
SEDAR41-DW46	**NEW:** Headboat Data Evaluation	NMFS-SEFSC 2015
SEDAR41-DW47	**NEW:** Development of an ageing error matrix for U.S. gray triggerfish *(Balistes capriscus)*	SFB-NMFS 2015
SEDAR41-DW48	**NEW:** Development of an ageing error matrix for U.S. red snapper *(Lutjanus campechanus)*	SFB-NMFS 2015
SEDAR41-DW49	**NEW:** Estimates of reproductive activity in red snapper by size, season, and time of day with nonlinear models	Klibansky 2015
SEDAR41-DW50	**NEW:** Hook Selectivity in red snapper observed in the for-hire fishery off the Atlantic coast of Florida	Gray and Sauls 2015
SEDAR41-DW51	**NEW:** SERFS Chevron Trap Red Snapper Index of Abundance: An Investigation of the Utility of Historical (1990-2009) Chevron Trap Catch Data	Ballenger 2015
SEDAR41-DW52	**NEW:** Gray Triggerfish Fishery-Independent Index of Abundance in US South Atlantic Waters Based on a Chevron Trap Survey (1990-2014)	Ballenger and Smart 2015
SEDAR41-DW53	**NEW:** Red Snapper Fishery-Independent Index of Abundance in US South Atlantic Waters Based on a Chevron Trap Survey (2005-2014)	Ballenger and Smart 2015
SEDAR41-DW54	**NEW:** Red Snapper Fishery-Independent Index of Abundance in US South Atlantic Waters Based on a Chevron Trap Survey (2010-2014)	Ballenger and Smart 2015
Documents Prepared for the Assessment Workshop		

SEDAR41-AW01	Addendum to SEDAR41-DW29: Discards of red snapper (*Lutjanus campechanus*) for the headboat fishery in the US South Atlantic	FEB-NMFS 2015
SEDAR41-AW02	Addendum to SEDAR41-DW30: Discards of gray triggerfish (*Balistes capriscus*) for the headboat fishery in the US South Atlantic	FEB-NMFS 2015
SEDAR41-AW03	South Atlantic U.S. red snapper (*Lutjanus campechanus*) age and length composition from the recreational fisheries	FEB-NMFS 2015
SEDAR41-AW04	South Atlantic U.S. gray triggerfish (*Balistes capriscus*) age and length composition from the recreational fisheries	FEB-NMFS 2015
SEDAR41-AW05	Commercial age and length composition weightings for Atlantic Red Snapper (*Lutjanus campechanus*)	SFB-NMFS 2015
SEDAR41-AW06	Commercial age and length composition weightings for Atlantic Gray Triggerfish (*Balistes capriscus*)	SFB-NMFS 2015
SEDAR41-AW07	Addendum to SEDAR41-DW17: Estimates of Historic Recreational Landings of Red Snapper in the South Atlantic Using the FHWAR Census Method	Brennan 2015
SEDAR41-AW08	South Atlantic U.S. red snapper (*Lutjanus campechanus*) catch curve analysis	SFB-NMFS 2015
Documents Prepared for the Review Workshop		
SEDAR41-RW01	Addendum to SEDAR41-DW16: Report on Life History of South Atlantic Gray Triggerfish, *Balistes capriscus*, from Fishery-Independent Sources: UPDATE on analyses of maturity, spawning fraction, and sex ratio	Kolmos et al. 2016
SEDAR41-RW02	Age structured production model (ASPM) for U.S. South Atlantic Red Snapper (*Lutjanus campechanus*)	SFB-NMFS 2016
SEDAR41-RW03	Age structured production model (ASPM) for U.S. South Atlantic Gray Triggerfish (*Balistes capriscus*)	SFB-NMFS 2016
SEDAR41-RW04	Red Snapper: Additional BAM diagnostics, analyses, and code	SFB-NMFS 2016
SEDAR41-RW05	Model Diagnostics and Source Code for SEDAR 41 Gray Triggerfish (*Balistes capriscus*) Benchmark Stock Assessment	SFB-NMFS 2016
SEDAR41-RW06	SEDAR 41: Public Comments	Various Authors
Final Assessment Reports		

SEDAR41-SAR1	Assessment of Red Snapper in the US South Atlantic	To be prepared by SEDAR 41
SEDAR41-SAR2	Assessment of Gray Triggerfish in the US South Atlantic	To be prepared by SEDAR 41
	Reference Documents	
SEDAR41-RD01	List of documents and working papers for SEDAR 32 (South Atlantic Blueline Tilefish and Gray Triggerfish) – all documents available on the SEDAR website.	SEDAR 32
SEDAR41-RD02	List of documents and working papers for SEDAR 9 (Gulf of Mexico Gray Triggerfish, Greater Amberjack, and Vermilion Snapper) – all documents available on the SEDAR website.	SEDAR 9
SEDAR41-RD03	2011 Gulf of Mexico Gray Triggerfish Update Assessment	SEDAR 2011
SEDAR41-RD04	List of documents and working papers for SEDAR 24 (South Atlantic red snapper) – all documents available on the SEDAR website.	SEDAR 24
SEDAR41-RD05	List of documents and working papers for SEDAR 31 (Gulf of Mexico red snapper) – all documents available on the SEDAR website.	SEDAR 31
SEDAR41-RD06	List of documents and working papers for SEDAR 15 (South Atlantic red snapper and greater amberjack) – all documents available on the SEDAR website.	SEDAR 15
SEDAR41-RD07	2009 Gulf of Mexico red snapper update assessment	SEDAR 2009
SEDAR41-RD08	List of documents and working papers for SEDAR 7 (Gulf of Mexico red snapper) – all documents available on the SEDAR website.	SEDAR 7
SEDAR41-RD09	SEDAR 24 South Atlantic Red Snapper: management quantities and projections requested by the SSC and SERO	NMFS - Sustainable Fisheries Branch 2010
SEDAR41-RD10	Total removals of red snapper (*Lutjanus campechanus*) in 2012 from the US South Atlantic	NMFS - Sustainable Fisheries Branch 2013
SEDAR41-RD11	Amendment 17A to the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region	SAFMC 2010
SEDAR41-RD12	Amendment 28 to the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region	SAFMC 2013
SEDAR41-RD13	Total removals of red snapper (*Lutjanus campechanus*) in 2013 from the U.S. South Atlantic	NMFS - Sustainable Fisheries Branch 2014

SEDAR41-RD14	South Atlantic red snapper (*Lutjanus campechanus*) monitoring in Florida for the 2012 season	Sauls et al. 2013
SEDAR41-RD15	South Atlantic red snapper (*Lutjanus campechanus*) monitoring in Florida for the 2013 season	Sauls et al. 2014
SEDAR41-RD16	A directed study of the recreational red snapper fisheries in the Gulf of Mexico along the West Florida shelf	Sauls et al. 2014
SEDAR41-RD17	Using generalized linear models to estimate selectivity from short-term recoveries of tagged red drum *Sciaenops ocellatus*: Effects of gear, fate, and regulation period	Bacheler et al. 2009
SEDAR41-RD18	Direct estimates of gear selectivity from multiple tagging experiments	Myers and Hoenig 1997
SEDAR41-RD19	Examining the utility of alternative video monitoring metrics for indexing reef fish abundance	Schobernd et al. 2014
SEDAR41-RD20	An evaluation and power analysis of fishery independent reef fish sampling in the Gulf of Mexico and U.S. South Atlantic	Conn 2011
SEDAR41-RD21	Consultant's Report: Summary of the MRFSS/MRIP Calibration Workshop	Boreman 2012
SEDAR41-RD22	2013 South Atlantic Red Snapper Annual Catch Limit and Season Length Projections	SERO 2013
SEDAR41-RD23	Southeast Reef Fish Survey Video Index Development Workshop	Bacheler and Carmichael 2014
SEDAR41-RD24	Observer Coverage of the 2010-2011 Gulf of Mexico Reef Fish Fishery	Scott-Denton and Williams
SEDAR41-RD25	Circle Hook Requirements in the Gulf of Mexico: Application in Recreational Fisheries and Effectiveness for Conservation of Reef Fishes	Sauls and Ayala 2012
SEDAR41-RD26	GADNR Marine Sportfish Carcass Recovery Project	Harrell 2013
SEDAR41-RD27	Catch Characterization and Discards within the Snapper Grouper Vertical Hook-and-Line Fishery of the South Atlantic United States	Gulf and South Atlantic Fisheries Foundation 2008
SEDAR41-RD28	A Continuation of Catch Characterization and Discards within the Snapper Grouper Vertical Hook-and-Line Fishery of the South Atlantic United States	Gulf and South Atlantic Fisheries Foundation 2010
SEDAR41-RD29	Continuation of Catch Characterization and Discards within the Snapper Grouper Vertical Hook-and-Line Fishery of the South Atlantic United States	Gulf and South Atlantic Fisheries Foundation 2013
SEDAR41-RD30	Amendment 1 and Environmental Assessment and Regulatory Impact Review to the Fishery	SAFMC 1988

	Management Plan for the Snapper Grouper Fishery of the South Atlantic Region	
SEDAR41-RD31	Final Rule for Amendment 1 to the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region	Federal Register 1989
SEDAR41-RD32	Population Structure and Genetic Diversity of Red Snapper (Lutjanus campechanus) in the U.S. South Atlantic and Connectivity with Red Snapper in the Gulf of Mexico	Gold and Portnoy 2013
SEDAR41-RD33	Oogenesis and fecundity type of Gulf of Mexico gray triggerfish reflects warm water environmental and parental care	Lang and Fitzhugh 2014
SEDAR41-RD34	Depth-related Distribution of Postjuvenile Red Snapper in Southeastern U.S. Atlantic Ocean Waters: Ontogenetic Patterns and Implications for Management	Mitchell et al. 2014
SEDAR41-RD35	Gray Triggerfish Age Workshop	Potts 2013
SEDAR41-RD36	Age, Growth, and Reproduction of Gray Triggerfish *Balistes capriscus* Off the Southeastern U.S. Atlantic Coast	Kelly 2014
SEDAR41-RD37	Assessment of Genetic Stock Structure of Gray Triggerfish (*Balistes capriscus*) in U.S. Waters of the Gulf of Mexico and South Atlantic Regions	Saillant and Antoni 2014
SEDAR41-RD38	Genetic Variation of Gray Triggerfish in U.S. Waters of the Gulf of Mexico and Western Atlantic Ocean as Inferred from Mitochondrial DNA Sequences	Antoni et al. 2011
SEDAR41-RD39	Characterization of the U.S. Gulf of Mexico and South Atlantic Penaeid and Rock Shrimp Fisheries Based on Observer Data	Scott-Denton et al. 2012
SEDAR41-RD40	Does hook type influence the catch rate, size, and injury of grouper in a North Carolina commercial fishery	Bacheler and Buckel 2004
SEDAR41-RD41	Fishes associated with North Carolina shelf-edge hardbottoms and initial assessment of a proposed marine protected area	Quattrini and Ross 2006
SEDAR41-RD42	Growth of grey triggerfish, *Balistes capriscus*, based on growth checks of the dorsal spine	Ofori-Danson 1989
SEDAR41-RD43	Age Validation and Growth of Gray Triggerfish, *Balistes capriscus*, In the Northern Gulf of Mexico	Fioramonti 2012
SEDAR41-RD44	A review of the biology and fishery for Gray Triggerfish, *Balistes capriscus*, in the Gulf of Mexico	Harper and McClellan 1997

SEDAR41-RD45	Stock structure of gray triggerfish, *Balistes capriscus*, on multiple spatial scales in the Gulf of Mexico	Ingram 2001
SEDAR41-RD46	Evaluation of the Efficacy of the Current Minimum Size Regulation for Selected Reef Fish Based on Release Mortality and Fish Physiology	Burns and Brown-Peterson 2008
SEDAR41-RD47	Population Structure of Red Snapper from the Gulf of Mexico as Inferred from Analysis of Mitochondrial DNA	Gold et al. 1997
SEDAR41-RD48	Successful Discrimination Using Otolith Microchemistry Among Samples of Red Snapper *Lutjanus campechanus* from Artificial Reefs and Samples of *L.campechanus* Taken from Nearby Oil and Gas Platforms	Nowling et al. 2011
SEDAR41-RD49	Population Structure and Variation in Red Snapper (Lutjanus campechanus) from the Gulf of Mexico and Atlantic Coast of Florida as Determined from Mitochondrial DNA Control Region Sequence	Garber et al. 2003
SEDAR41-RD50	Population assessment of the red snapper from the southeastern United States	Manooch et al. 1998
SEDAR41-RD51	Otolith Microchemical Fingerprints of Age-0 Red Snapper, *Lutjanus campechanus*, from the Northern Gulf of Mexico	Patterson et al. 1998
SEDAR41-RD52	Implications of reef fish movement from unreported artificial reef sites in the northern Gulf of Mexico	Addis et al. 2013
SEDAR41-RD53	Evaluating the predictive performance of empirical estimators of natural mortality rate using information on over 200 fish species	Then et al. 2014
SEDAR41-RD54	Length selectivity of commercial fish traps assessed from in situ comparisons with stereo-video: Is there evidence of sampling bias?	Langlois et al. 2015
SEDAR41-RD55	MRIP Calibration Workshop II – Final Report	Carmichael and Van Vorhees (eds.) 2015
SEDAR41-RD56	Total Removals of red snapper (*Lutjanus campechanus*) in 2014 from the U.S. South Atlantic	SEFSC 2015
SEDAR41-RD57	Assessing reproductive resilience: an example with South Atlantic red snapper *Lutjanus campechanus*	Lowerre-Barbiere et al. 2015
SEDAR41-RD58	Overview of sampling gears and standard protocols used by the Southeast Reef Fish Survey and its partners	Smart et al. 2014
SEDAR41-RD59	MRIP Transition Plan for the Fishing Effort Survey	Atlantic and Gulf Subgroup of the MRIP Transition Team 2015

SEDAR41-RD60	Technical documentation of the Beaufort Assessment Model (BAM)	Williams and Shertzer 2015
SEDAR41-RD61	Stock Assessment of Red Snapper in the Gulf of Mexico 1872-2013, with Provisional 2014 Landings: SEDAR Update Assessment	Cass-Calay et al. 2015
SEDAR41-RD62	Excerpt from the December 2013 SAFMC SEDAR Committee Minutes (pages 11-21 where SEDAR 41 ToR were discussed)	SAFMC SEDAR Committee
SEDAR41-RD63	Population structure of red snapper (*Lutjanus campechanus)* in U.S. waters of the western Atlantic Ocean and the northeastern Gulf of Mexico	Hollenbeck et al. 2015
SEDAR41-RD64	SEDAR31-AW04: The Effect of Hook Type on Red Snapper Catch	Saul and Walter 2013
SEDAR41-RD65	SEDAR31-AW12: Estimation of hook selectivity on red snapper (*Lutjanus campechanus*) during a fishery independent survey of natural reefs in the Gulf of Mexico	Pollack et al. 2013
SEDAR41-RD66	Effect of Circle Hook Size on Reef Fish Catch Rates, Species Composition, and Selectivity in the Northern Gulf of Mexico Recreational Fishery	Patterson et al. 2012
SEDAR41-RD67	Effect of trawling on juvenile red snapper (*Lutjanus campechanus*) habitat selection and life history parameters	Wells et al. 2008
SEDAR41-RD68	SEDAR24-AW05: Selectivity of red snapper in the southeast U.S. Atlantic: dome-shaped or flat topped?	SFB-SEFSC 2010
SEDAR41-RD69	Hierarchical analysis of multiple noisy abundance indices	Conn 2010
SEDAR41-RD70	Data weighting in statistical fisheries stock assessment models	Francis 2011
SEDAR41-RD71	Corrigendum to Francis 2011 paper	Francis
SEDAR41-RD72	Quantifying annual variation in catchability for commercial and research fishing	Francis et al. 2003
SEDAR41-RD73	Evolutionary assembly rules for fish life histories	Charnov et al. 2012
SEDAR41-RD74	User's Guide for ASPIC Suite, version 7: A Stock-Production Model Incorporating Covariates and auxiliary programs	Prager 2015
SEDAR41-RD75	Standing and Special Reef Fish SSC, September 2015 Meeting Summary (see pages 4-7 for SEDAR 43 review)	Gulf of Mexico Standing and Special Reef Fish SSC
SEDAR41-RD76	Standing and Special Reef Fish SSC, January 2016 Meeting Summary (see pages 2-7 for SEDAR 43 review)	Gulf of Mexico Standing and Special Reef Fish SSC

SEDAR41-RD77	SEDAR 43 Gulf of Mexico Gray Triggerfish Stock Assessment Report	SEDAR 43
SEDAR41-RD78	Review of 2014 SEDAR 31 Gulf of Mexico Red Snapper Update Assessment	Gulf of Mexico Standing and Special Reef Fish SSC
SEDAR41-RD79	Influence of soak time and fish accumulation on catches of reef fishes in a multispecies trap survey	Bacheler et al. 2013

Additional papers:

Aanes, S., and J. H. Vølstad. 2015. Efficient statistical estimators and sampling strategies for estimating the age composition of fish. Canadian Journal of Fisheries and Aquatic Sciences, 72: 938–953.

Anderson, B., E. Borgonovo, M. Galeotti and R. Roson. 2011. Uncertainty in integrated assessment modelling: Can global sensitivity analysis be of help? Working Paper Series. Working Paper 52. ISSN 1973-0381. IEFE - The Center for Research on Energy and Environmental Economics and Policy at Bocconi University. This paper can be downloaded at www.iefe.unibocconi.it

Kaufman, L. S. 1983. Effects of Hurricane Allen on reef fish assemblages near Discovery Bay, Jamaica. Coral Reefs. 2: 43–47.

Saltelli, A., and P. Annoni. 2010, How to avoid a perfunctory sensitivity analysis. Environmental Modelling & Software 25: 1508–1517.

Saltelli, A., M. Ratto, T. Andres, F. Campolongo, J. Cariboni, D. Gatelli, M. Saisana, and S. Tarantola. 2008. Global Sensitivity Analysis - The Primer. John Wiley & Sons. Chichester.

Appendix 2: CIE Statement of Work

External Independent Peer Review by the Center for Independent Experts

SEDAR 41 South Atlantic Red Snapper and Gray Triggerfish Assessment Review Workshop

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 41 will be a compilation of data, an assessment of the stocks, and CIE assessment review conducted for South Atlantic red snapper and gray triggerfish.
The review workshop provides an independent peer review of SEDAR stock assessments. The term review is applied broadly, as the review panel may request additional analyses, error corrections and sensitivity runs of the assessment models provided by the assessment panel. The review panel is ultimately responsible for ensuring that the best possible assessment is provided through the SEDAR process. The stocks assessed through SEDAR 41 are within the jurisdiction of the South Atlantic Fisheries Management Council and the states of Florida, Georgia, South Carolina, and North Carolina. The Terms of Reference (ToRs) of the peer review are attached in **Annex 2**. The tentative agenda of the panel review meeting is attached in **Annex 3**.

Requirements for CIE Reviewers: Three CIE reviewers shall conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. CIE reviewers shall have working knowledge expertise in stock assessment, statistics, fisheries science, and marine biology sufficient to complete the primary task of providing peer-review advice in compliance with the workshop Terms of Reference. Each CIE reviewer's duties shall not exceed a maximum of 14 days to complete all work tasks of the peer review described herein.

Location of Peer Review: Each CIE reviewer shall conduct an independent peer review during the panel review meeting scheduled in Charleston, SC **during March 15-18, 2016**.
Statement of Tasks: Each CIE reviewers 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 reviewers. The NMFS Project Contact is responsible for providing the CIE reviewers with the background documents, reports, foreign national security clearance, and other information concerning pertinent meeting arrangements. The NMFS Project Contact is also responsible for providing the Chair a copy of the SoW in advance of the panel review meeting. Any changes to the SoW or ToRs must be made through the COTR prior to the commencement of the peer review.

Foreign National Security Clearance: When CIE reviewers participate during a panel review meeting at a government facility, the NMFS Project Contact is responsible for obtaining the Foreign National Security Clearance approval for CIE reviewers who are non-US citizens. For this reason, the CIE reviewers shall provide requested information (e.g., first and last name, contact information, gender, birth date, passport number, country of passport, travel dates, country of citizenship, country of current residence, and home country) to the NMFS Project Contact for the purpose of their security clearance, and this information shall be submitted at least 30 days before the peer review in accordance with the NOAA Deemed Export Technology Control Program NAO 207-12 regulations available at the Deemed Exports NAO website: http://deemedexports.noaa.gov/
http://deemedexports.noaa.gov/compliance_access_control_procedures/noaa-foreign-national-registration-system.html

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 reviewers 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. CIE reviewers are responsible only for the pre-review documents that are delivered to the reviewer in accordance to the SoW scheduled deadlines specified herein. The CIE reviewers shall read all documents in preparation for the peer review.

Panel Review Meeting: Each 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.** Each CIE reviewer shall actively participate in a professional and respectful manner as a member of the meeting review panel, and their peer review tasks shall be focused on the ToRs as specified herein. The NMFS Project Contact is responsible for any facility arrangements (e.g., conference room for panel review meetings or teleconference arrangements). The NMFS Project Contact is responsible for ensuring that the Chair understands the contractual role of the CIE reviewers as specified herein. The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements, including the meeting facility arrangements.

CIE reviewers shall conduct an impartial and independent peer review of the assessment in accordance with the SoW and ToRs herein.

A description of the SEDAR Review process can be found in the SEDAR Policies and Procedures document:
http://sedarweb.org/docs/page/SEDARPoliciesandProcedures_Oct14_FINAL.pdf

The CIE reviewers may contribute to a Summary Report of the Review Workshop produced by the Workshop Panel.

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

Other Tasks – Contribution to Summary Report: Each CIE reviewer may assist the Chair of the panel review meeting with contributions to the Summary Report, based on the terms of reference of the review. Each CIE reviewer is not required to reach a consensus, and should provide a brief summary of the reviewer's views on the summary of findings and conclusions reached by the review panel in accordance with the ToRs.

Specific Tasks for CIE Reviewers: The following chronological list of tasks shall be completed by each 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) Participate during the panel review meeting at the **Charleston, SC during March 15-18, 2016**.
3) Participate at the review meeting in **Charleston, SC during March 15-18, 2016** as specified herein, and conduct an independent peer review in accordance with the **ToRs (Annex 2).**
4) No later than April 11 2016, each CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Dr. Manoj Shivlani, CIE Lead Coordinator, via email to mshivlani@ntvifederal.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.

February 9, 2016	CIE sends reviewer contact information to the COTR, who then sends this to the NMFS Project Contact
March 1, 2016	NMFS Project Contact sends the CIE Reviewers the pre-review documents
March 15–18, 2016	Each reviewer participates and conducts an independent peer review during the panel review meeting
April 11, 2016	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
April 25, 2016	CIE submits CIE independent peer review reports to the COTR
May 2, 2016	The COTR distributes the final CIE reports to the NMFS Project Contact and regional Center Director

Modifications to the Statement of Work: This 'Time and Materials' task order may require an update or modification due to possible changes to the terms of reference or schedule of milestones resulting from the fishery management decision process of the NOAA Leadership, Fishery Management Council, and Council's SSC advisory committee. A request to modify this SoW must be approved by the Contracting Officer at least 15 working days prior to making any permanent changes. The Contracting Officer will notify the COTR within 10 working days after receipt of all required information of the decision on changes. 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 reviewers 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 (Allen Shimada at allen.shimada@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) The CIE report shall completed with the format and content in accordance with **Annex 1**,
(2) The 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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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.
    a. Reviewers should describe in their own words the review activities completed during the panel review meeting, including providing a brief summary of findings, of the science, conclusions, and recommendations.
    b. Reviewers should discuss their independent views on each ToR even if these were consistent with those of other panelists, and especially where there were divergent views.
    c. Reviewers should elaborate on any points raised in the Summary Report that they feel might require further clarification.
    d. Reviewers shall provide a critique of the NMFS review process, including suggestions for improvements of both process and products.
    e. The CIE independent report shall be a stand-alone document for others to understand the weaknesses and strengths of the science reviewed, regardless of whether or not they read the summary report. The CIE independent report shall be an independent peer review of each ToRs, and shall not simply repeat the contents of the summary report.
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
Appendix 3: Panel Membership or other pertinent information from the panel review meeting.

Annex 2: Terms of Reference for the Peer Review

SEDAR 41 South Atlantic Red Snapper and Gray Triggerfish Assessment Review Workshop

11. Evaluate the data used in the assessment, including discussion of the strengths and weaknesses of data sources and decisions, and consider the following:
    a) Are data decisions made by the DW and AW sound and robust?
    b) Are data uncertainties acknowledged, reported, and within normal or expected levels?
    c) Are data applied properly within the assessment model?
    d) Are input data series reliable and sufficient to support the assessment approach and findings?
12. Evaluate and discuss the strengths and weaknesses of the methods used to assess the stock, taking into account the available data, and considering the following:
    a) Are methods scientifically sound and robust?

b) Are assessment models configured properly and used consistent with standard practices?
c) Are the methods appropriate for the available data?

13. Evaluate the assessment findings and consider the following:
    a) Are abundance, exploitation, and biomass estimates reliable, consistent with input data and population biological characteristics, and useful to support status inferences?
    b) Is the stock overfished? What information helps you reach this conclusion?
    c) Is the stock undergoing overfishing? What information helps you reach this conclusion?
    d) Is there an informative stock recruitment relationship? Is the stock recruitment curve reliable and useful for evaluation of productivity and future stock conditions?
    e) Are the quantitative estimates of the status determination criteria for this stock reliable? If not, are there other indicators that may be used to inform managers about stock trends and conditions?
14. Evaluate the stock projections, including discussing strengths and weaknesses, and consider the following:
    a) Are the methods consistent with accepted practices and available data?
    b) Are the methods appropriate for the assessment model and outputs?
    c) Are the results informative and robust, and are they useful to support inferences of probable future conditions?
    d) Are key uncertainties acknowledged, discussed, and reflected in the projection results?
15. Consider how uncertainties in the assessment, and their potential consequences, are addressed.
    a) Comment on the degree to which methods used to evaluate uncertainty reflect and capture the significant sources of uncertainty in the population, data sources, and assessment methods.
    b) Ensure that the implications of uncertainty in technical conclusions are clearly stated.
16. Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations or prioritizations warranted.
    a) Clearly denote research and monitoring that could improve the reliability of, and information provided by, future assessments.
    b) Provide recommendations on possible ways to improve the SEDAR process.
17. Consider whether the stock assessment constitutes the best scientific information available using the following criteria as appropriate: relevance, inclusiveness, objectivity, transparency, timeliness, verification, validation, and peer review of fishery management information.
18. Compare and contrast assessment uncertainties between the Gulf of Mexico and South Atlantic stocks.
19. Provide guidance on key improvements in data or modeling approaches which should be considered when scheduling the next assessment.
20. Prepare a Peer Review Summary summarizing the Panel's evaluation of the stock assessment and addressing each Term of Reference. Develop a list of tasks to be completed following the workshop. Complete and submit the Peer Review Summary Report in accordance with the project guidelines.

Annex 3: Tentative Agenda

SEDAR 41 South Atlantic Red Snapper and Gray Triggerfish Assessment Review Workshop

Charleston, SC

March 15-18, 2016

<u>*Tuesday*</u>

8:30 a.m.	**Convene**	
8:30a.m. – 9:00a.m.	**Introductions and Opening Remarks** *- Agenda Review, TOR, Task Assignments*	**Coordinator** **Chair**
9:00a.m. – 12:00p.m.	Assessment Presentation and Discussion (RS*)	**TBD**
12:00p.m. – 1:30p.m.	**Lunch Break**	
1:30 p.m. - 3:30 p.m.	**Panel Discussion** *- Assessment Data & Methods* *- Identify additional analyses, sensitivities, corrections*	**Chair**
3:30p.m. – 3:45 p.m.	**Break**	
3:30 p.m. - 5:00 p.m.	**Panel Discussion** *-Continue deliberations*	**Chair**
5:00p.m. – 6:00p.m.	**Panel Work Session**	**Chair**

Tuesday Goals: Initial RS* presentation completed, sensitivities and modifications identified.

<u>*Wednesday*</u>

<u>*Tuesday*</u>

8:30a.m. – 12:00 p.m.	**Assessment Presentation and Discussion (GTF**)**	**TBD**
12:00p.m. – 1:30p.m.	**Lunch Break**	
1:30 p.m. - 3:30 p.m.	**Panel Discussion** *- Assessment Data & Methods* *- Identify additional analyses, sensitivities, corrections*	**Chair**
3:30p.m. – 3:45 p.m.	**Break**	
3:30 p.m. - 5:00 p.m.	**Panel Discussion** *-Continue deliberations*	**Chair**
5:00p.m. – 6:00p.m.	**Panel Work Session**	**Chair**

Wednesday Goals: Initial GTF** presentation completed, sensitivities and modifications identified.

Thursday

8:30a.m. – 12:00 p.m.	**Panel Discussion** *- Review additional analyses, sensitivities*	**Chair**
12:00p.m. – 1:30p.m.	**Lunch Break**	
1:30 p.m. - 3:30 p.m.	**Panel Discussion** *- Continue deliberations*	**Chair**
3:30p.m. – 3:45 p.m.	**Break**	
3:45 p.m. - 5:00 p.m.	**Panel Discussion** *- Consensus recommendations and comments*	**Chair**
5:00p.m. – 6:00p.m.	**Panel Work Session**	**Chair**

Thursday Goals: Final sensitivities identified, preferred models selected, projection approaches approved, Summary report drafts begun.

Friday

8:30a.m. – 10:30 a.m.	**Panel Discussion** *- Review additional analyses, final sensitivities* *- Projections reviewed.*	**Chair**
10:30 a.m. – 10:45 a.m.	**Break**	
10:45 a.m. - 1:00 p.m.	**Panel Discussion or Work Session** *- Continue deliberations*	**Chair**
3:30p.m. – 3:45 p.m.	**Break**	
3:30 p.m. - 5:00 p.m.	**Panel Discussion** *- Review Consensus Reports*	**Chair**
1:00 p.m.	**ADJOURN**	

Friday Goals: Complete assessment work and discussions. Final results available. Draft Summary Report reviewed.

* RS = South Atlantic red snapper **GTF = South Atlantic gray triggerfish

Appendix 3: Panel Membership

Appointee	Function	Affiliation
Luiz Barbieri	Review Panel Chair	SAFMC SSC
Steve Cadrin	Reviewer	SAFMC SSC
Churchill Grimes	Reviewer	SAFMC SSC
Mike Armstrong	Reviewer	CIE
Stephen Smith	Reviewer	CIE
Jon Helge Volstad	Reviewer	CIE