Center for Independent Experts (CIE) Independent Peer Review Report

on

SEDAR 51 Gulf of Mexico Gray Snapper Assessment Review

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I. Executive Summary

The Center for Independent Experts (CIE) review for SEDAR 51's Gulf of Mexico (GOM) Gray Snapper stock assessment, held in Tampa, FL from March 20-22, 2018, was aimed to evaluate a benchmark stock assessment including input data, stock assessment model configuration, stock assessment outputs, model projection, and uncertainty associated with the assessment, and make recommendations for the improvement of the stock assessment and assessment process. Using fishery-dependent and fishery-independent data recommended by the Data Workshop and an integrated statistical catch-at-age model implemented in Stock Synthesis (SS) 3 (v. 3.24S) and configured and parameterized in the Assessment Workshop, SEDAR 51 is the first quantitative stock assessment for the Gulf of Mexico Gray Snapper. This review is the first CIE review for the Gray Snapper. Southeast Fisheries Science Center (SEFSC), SEDAR and Gulf of Mexico (GOM) Fisheries Management Council provided all the necessary logistics support, documentation, data, and background information I requested. The stock assessment analysts involved in the process were open to suggestions, provided additional information upon request, and conducted additional model runs for more sensitivity analyses identified by the Review Panel during the review. The SEFSC analysts accommodated all the requests I had made for different test runs and extra information. The whole process was very open and constructive, and all materials were sent to me in a timely manner. As a CIE reviewer, I am charged to evaluate the GOM Gray Snapper stock assessment with respect to the Terms of Reference.

I would like to commend the NOAA SEFSC stock assessment analysts' efforts in the GOM Gray Snapper review for providing necessary information on the stock assessment model configuration and parameterization, control files, and input data including life history parameters, landings and discards, fishery-dependent and fishery-independent abundance indices. I was impressed by the breadth of expertise and experience of the participants in SEDAR 51, the amount of effort spent to compile all the data for the model, the considerations of plausible scenarios for sensitivity analyses, the openness of discussion for considering alternative approaches and suggestions, and the constructive dialogues between the Review Panel and stock assessment analysts and other participants during the review.

Overall, based on the materials presented and additional runs conducted during the review I believe the GOM Gray Snapper stock assessment provides rather robust assessment results regarding various uncertainties in data and models. SEDAR 51 concludes that the Gulf of Mexico Gray Snapper is currently undergoing overfishing and has been undergoing overfishing in most years since 1976, but is currently not overfished. The assessment is scientifically sound and adequately addresses management needs. However, I believe some important questions still need to be addressed and there is still room for improving the current stock assessment.

My specific recommendations/comments are to (1) present biological/monitoring/management/background information on the Gulf of Mexico Gray Snapper at the beginning of the Review Workshop; (2) have at least one reviewer (either CIE reviewer or SSC reviewer) participate in all the process including Data Workshop, Assessment Workshop, and Review Workshop; (3) improve communications and research between various groups within the SEFSC to improve the data and assessment products; (4) provide a comprehensive evaluation of possible spatio-temporal variability and possible issues associated with age data in SS; (6) spend more effort on

model diagnoses to identify whether the model assumptions, implicit and explicit, have been violated in all the data analyses; (7) better understand stock structure and possible impacts on stock assessment of metapopulation structure; (8) outline potential habitat maps in the Gulf of Mexico by conducting habitat suitability modeling to identify suitable habitats for the Gray Snapper and evaluate whether monitoring programs cover main suitable habitat area for the Gray Snapper; (9) explore robust likelihood functions to reduce impacts of outliers in size composition and survey abundance index; (10) explore some competitive models at different complexities for comparison with SS; (11) explore Bayesian approaches to fully incorporate uncertainty in the assessment; (12) improve efforts to collect discard-related information for commercial and recreational fisheries including discard rates, discard size composition, spatio-temporal distribution of discards, and mortality of discarded catch; (13) conduct an extensive computer simulation study based on the data collected in the past to evaluate the effectiveness of the current sampling/reporting system in yielding catch and abundance index estimates; (14) evaluate quality of age data and potential spatio-temporal variability before they are used in SS; (15) evaluate the effectiveness of individual monitoring program in capturing overall population dynamics in the assessment; (16) explore the dynamic binning approach to reduce the impacts of zero observation in the two ends of size distribution matrices (given the dominance of size distributional data in the stock assessment, this may be very important); (17) evaluate effectiveness of CPUE standardization process in removing impacts of factors other than stock biomass/abundance; (18) identify possible temporal pattern in selectivity in a more subjective way; (19) better quantify and exhibit retrospective errors; (20) evaluate the performance of the projection in achieving the management objectives; (21) keep the assessment model structure and configuration relatively stable over time and run future new models in parallel to the old model to identify changes in stock assessment results resulting from changes in model configurations; (22) better quantify differences in the assessment results between the base case and sensitivity scenarios; and (23) continue research to improve estimation and understanding of recruitment dynamics.

Further general and specific comments and recommendations can be found in Section V of this report.

II. Background

The Gray Snapper, *Lutjanus griseus*, or sometimes referred to Mangrove Snapper, is recreationally and commercially important in the Gulf of Mexico. From off the coast of Massachusetts and Brazil, to the Gulf of Mexico and the Caribbean Sea, the Gray Snapper is widely distributed across the western Atlantic Ocean. They can be found in a wide variety of habitats, including brackish and fresh waters, as well as at depths ranging from 5 to 180 m, although they are most abundant at less than 50 m waters.

The Gulf of Mexico Gray Snapper is managed by the Gulf of Mexico Fishery Management Council based on the Reef Fish Fishery Management Plan, which was implemented in November 1984 with Addenda 1, 4, 5, 9, 11, 12, 14, 17, 18A, 19, 20, 21, 24, 25, 27, and 31. The regulations were developed for rebuilding declining reef fish stocks.

The stock structure of Gray Snapper in the Gulf of Mexico is still not well defined. Genetics studies have indicated three units: Western Gulf, Central/Eastern Gulf, and East Florida, and this difference may be the result of distance and isolation. However, relatively low sample sizes were used in the study, and more sampling over the whole stock area is needed to further test this stock structure. Otolith microchemistry studies found regional signatures, also indicating possible existence of local stocks (Gerard and Muhling 2010). *However,* there is limited information from these studies to delineate stock structure, as these studies were mainly focused on juveniles with limited linkages to adults.

Tagging and movement studies indicated that there is little movement by adult fish. Recent FWC tagging data also indicate little long distance movement. One study noted that there was a disconnection between years of peaks in abundance of juveniles along the two coasts of Florida; this finding may indicate a lack of connectivity between the regions. There is evidence that adults move from inshore to offshore reefs to form spawning aggregations but the direction is still unknown. Various studies suggest that the Gray Snapper tends to have large spatial variability in key life history parameters within their distribution. Latitudinal differences in growth along both Florida's west and east coasts have been found (Allman and Goetz 2009).

Most studies done tend to support that the Gray Snapper has a complex stock structure. SEDAR 51 recommends that Gulf of Mexico and South Atlantic should not be combined into one assessment because genetic studies indicate differences between the Gulf of Mexico and the South Atlantic as well as limited movement of adult fish shown in tagging studies. SEDAR 51 also recommends that all Monroe County data be included in the Gulf, because of different pulses in juvenile recruitment on the East and West coast of Florida*,* genetics information, small home ranges*,* lack of additional information to confirm the need for a single stock assessment, and insufficient evidence to depart from the previous recommendation. SEDAR 51 also discussed possible splits between the East/West Gulf of Mexico and decided there is insufficient information to support splitting Gulf of Mexico into East/West assessments because little biological information exists for the western region, with few landings in the western Gulf of Mexico. Most Gray Snapper in Texas are believed to come from the Gulf of Mexico, although there is no information on recruitment from Mexican waters.

Before SEDAR 51, the stock exploitation status and biomass status were undefined for the Gulf of Mexico Gray Snapper. SEDAR 51, which is the first formal quantitative stock assessment for the Gulf of Mexico Gray Snapper, consists of a Data Workshop held April 24-28, 2017 in Tampa, Florida, an Assessment Workshop conducted via a series of webinars June 2017 - January 2018, and a Review Workshop (this one) held March 20-22, 2018 in Tampa, FL.

Commercial Gray Snapper landings data were compiled from records in the NOAA Southeastern Fisheries Science Center's (SEFSC) Accumulated Landings System (ALS). The ALS includes landings beginning in 1962. Landings data from 1945 to 1961 were estimated based on a constant CPUE assumption. The first and terminal years for the SEDAR 51 baseline assessment are set as 1945 and 2015, respectively.

The SEDAR 51 Data Workshop agrees that the landing data used in this stock assessment include both the regular Gulf of Mexico landings where north of US 1 and the South Atlantic portion of Monroe county landings south of US1. The SEDAR 51 Data Workshop has also decided that landings should be classified as three-gear groupings perceived to have different size selectivities including (1) vertical hand lines and diving or spear; (2) nets and traps; and (3) longline and other gears.

The SEDAR 51 stock assessment uses Stock Synthesis (SS) 3 (v. 3.24S) as a modeling platform for assessing the Gulf of Mexico Gray Snapper. The following data were compiled for the SS model in the assessment: life history data (e.g., age and growth, natural mortality, length-specific maturity, length-specific fecundity); landings that include commercial fisheries (e.g., landings for vertical line, trap and other gear for Monroe County, Florida from 1945-2015; landings for vertical line, trap and other gear for all counties except Monroe County, Florida only from 1945-2015; landings for commercial longline, all counties from 1980-2015); landings from recreational fisheries (e.g., recreational private from 1945-2015; recreational headboats and charterboats, 1945-2015; and recreational shore, 1945-2015); discards in the commercial and recreational fisheries; length composition of commercial and recreational landings; five fishery-independent survey abundance indices (i.e., SEAMAP Groundfish Trawl: 2010-2015, FWRI Age-0 1998-2015, FWRI-Age-1 1996-2015, Combined video: 1993-1997, 2004-2015, NMFS Visual Survey 1997-2014); three fishery-dependent abundance indices (i.e., commercial handline CPUE 1993-2015, recreational private CPUE (MRFSS) 1981-2015, and recreational shore CPUE (MRFSS) 1981-2015); and discard mortality for commercial and recreational fisheries. The stock assessment time period set for SEDAR 51 is from 1945 to 2015.

A base case scenario was developed during the SEDAR 51 Assessment Workshop. Multiple scenarios were developed for sensitivity analyses with respect to discard mortality for recreational and commercial fisheries, lower/higher natural mortality rates, different size lambda, discard lambda, and Jackknifing abundance index.

Length-based selectivity and retention patterns and the assumed discard mortality rates were estimated for each fishing fleet and survey programs. Selectivity estimated in this assessment includes both gear selectivity and fishery availability due to limited spatial coverage of fish and fishing fleet. Selectivity patterns were assumed to be constant over time for each fishery and survey (except Commercial Handline not Monroe County). Regulations of managing the Gray Snapper fisheries have experienced changes during the period covered by this stock assessment. These changes in management regulations were assumed to influence the retention patterns. Thus, time-varying retention patterns were used and discards were modeled explicitly. Changes in the management regulations for all fleets include the implementation of a 10 and 12 inch total length (25.6 and 30.48 cm) size limit from 1990. Such a change in the size limit might change the retention patterns. The fishery-independent surveys size selectivity patterns were fixed based on either observed or assumed size composition, or set to mirror specific fleets for which they were derived. The SEAMAP fall groundfish survey was used as a proxy of spawning stock biomass in the previous year. Selectivity of other indices mirrored the selectivity of their associated fleets. Logistic and double normal distributional functions were used for the selectivities.

SPR30% was selected as an MSY-proxy, and used to determine exploitation and stock status. Following the generic rule in the Gulf of Mexico Fisheries Management Council reef fish FMP, the minimum stock size threshold (MSST) is set at 50% of SSB_SPR 30, and the maximum fishing mortality threshold (MFMT) is set at F30%SPR. The exploitation and stock status were determined based on a comparison of current deterministic fishing mortality and stock biomass estimates versus MFMT and MSST, respectively.

This review is the first CIE review for this fishery because no formal quantitative stock assessments have been done for the Gulf of Mexico Gray Snapper stock before this assessment. I was provided with all the necessary logistics support, documentation, data, and background information. The stock assessment analysts involved in the process were open for suggestions and provided additional information upon request. Dr. Jeff Iselu and Dr. Shannon Clay-Cass of NOAA SEFSC presented the Gray Snapper stock assessment, and worked hard to accommodate all the requests the Review Panel made for different test runs and extra information. The whole process was very open and constructive.

As a CIE reviewer, I am charged with evaluating the GOM Gray Snapper stock assessment with respect to the Terms of Reference. This report includes an executive summary (Section I), a background introduction (Section II), a description of my role in the review activities (Section III), my comments on each item listed in the Terms of Reference (ToRs, Section IV), a summary of my comments and recommendations (Section V), and references (Section VI). The final part of this report (Section VII) includes a collection of appendices, including the Statement of Work (SoW).

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

My role as a CIE independent reviewer is to conduct an impartial and independent peer review of the GOM Gray Snapper stock assessment with respect to the defined Terms of Reference.

I received the relevant working papers and background materials two weeks prior to the review workshop in the GOM Fisheries Management Council in Tampa, FL, and received the GOM Gray Snapper stock assessment report one week prior to the workshop. I also received all relevant files for the base case runs, including SS3 input data files, control files, report files and other relevant files compiled for the base case.

I have read the GOM Gray Snapper stock assessment report, research recommendations suggested by the Data Workshop and Assessment Workshop, and all the working papers, information papers and other relevant documents that were sent to me (see the list in the Appendix I). I have also searched, collected and read references relevant to the topics covered in the reports and the SoW prior to my trip to the GOM Gray Snapper stock assessment.

The Review Workshop was held from March 20 to March 22, 2018 in the GOM Fisheries Management Council in Tampa, FL (see Appendix II for the schedule). The three days of review were attended by SEFSC fisheries stock assessment scientists, Council representatives, three GOM Fisheries Management Council SSC members who are on the review panel, three CIE reviewers, and a commercial-recreational fisherman (only in the first day) (see the List of Participants in Appendix III).

Presentations were given during the Review Workshop to provide reviewers with stock assessment input data, information on model configuration and parameterization, fisheries management, stock assessment modeling outputs and results, sensitivity analysis scenario settings and results, results of additional model runs identified during the Review Workshop, and model projections (see the list of presentations in Appendix I). I actively involved myself in the discussion during the Review Workshop by (1) questioning and asking for clarification on monitoring/sampling program designs, statistical analyses, stock assessment configuration, assumptions, uncertainties of various sources, and interpretations; (2) commenting on the assessment and review processes; (3) making constructive comments and suggestions for alternative approaches and additional analyses; (4) interpreting the assessment results and potential issues; and (5) contributing to the Review Panel report. I had also been interacting with relevant scientists and other panel members regarding issues raised during the review process for further clarifications and discussion during the breaks and after the review.

During the Review Workshop, the Review Panel worked with the NOAA SEFSC to develop a series of scenarios to evaluate the impacts of various model configurations on the stock assessment. The scenario design follows the following principle: changing one variable at a time so that we can ensure that changes observed in modeling can be solely attributed to the change we made. The following additional analyses or plots were conducted during the Review Workshop:

- Evaluate the model with the effects of length and indices of abundance weighted at 0 to attempt a better fit to the discards;
- Add a retrospective analysis of F and Recruitment;
- Produce a Kobe plot of SSB and F;
- Add a plot of the "jitter" analysis;
- Add a plot of Spawning Stock Biomass (SSB) with confidence intervals;
- Compare model recruitment estimates to the predicted values of the FWRI_Age-0 recruitment index;

- Provide Projections;
- Provide a retrospective analysis relative to SSB_{virgin} for the Gulf of Mexico Gray Snapper stock assessment;
- Provide a sensitivity analysis of the base model without recreational indices or length effects relative to virgin Spawning Stock Biomass compared to the base model for the Gulf of Mexico Gray Snapper stock assessment;
- Provide sensitivities for the Gulf of Mexico Gray Snapper stock assessment comparing alternative data weighting (McAllister and Ianelli 1997) to the base model.

These additional plots and analyses were done to further improve our understanding of model fitting, impacts of uncertainty in data and models, robustness of the assessment results, and/or better presentation of the results of the stock assessment.

I was actively involved in developing additional sensitivity scenarios, discussing outputs and their implications, and identifying issues related to sensitivity runs. I also discussed relevant issues with the fellow reviewers.

IV. Summary of Findings

My detailed comments on each item of the ToRs are provided under their respective subtitles from the ToRs (see below).

1. 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?

In general, I have not identified any significant issues that may change the stock assessment results. Given the limitation in the quantity and quality of the data used in the SEDAR 51 stock assessment, data decisions made by the Data Workshop and Assessment Workshop are sound and robust. The process of data preparation, compilation, evaluation, and analysis is transparent and well documented, and the decisions were well justified biologically and/or statistically. The determination of stock assessment area (and subsequent catch data compilations) seems to be appropriate. The methods used to analyze the data before they were used in SS (e.g., CPUE standardization) are appropriate.

Having said the above, for future Gulf of Mexico Gray Snapper assessments, I recommend that the following issues be considered in data analyses:

- The SS framework allows for the incorporation of both age and length composition data of both commercial, recreational and survey catches as part of input data. The age composition data were not included in this study because of potential quality issues. Instead, the von Bertalanffy growth parameters were estimated outside of the SS model and used as input data. This may reduce the model flexibility in modeling the data and lose the information on cohort strength which may be better reflected in age composition data. Future analyses may explore the use of age composition data and estimate the von Bertalanffy growth parameters internally in the SS model to improve the model fitting (and diagnostics).

- Survey catchability is supposed to be constant (with random variation) over time, which forms the base for using the design-based abundance index as a reliable stock abundance index. Usually, a design-based abundance index can be derived from a well-designed survey program. However, the SEDAR 51 Data Workshop applied modeling procedures to standardize survey abundance indices. The fact that all the surveys included in SEDAR 51 require abundance index standardization suggests that the design of these surveys may be inappropriate. An in-depth analysis may be needed to evaluate the effectiveness of the designs for the fishery-independent monitoring programs.

- A few surveys only cover very limited areas. Given the complex stock structure, lack of evidence for strong movement by the Gray Snapper in the Gulf of Mexico, and possible weak connectivity among estuaries and regions, the surveys with limited spatial coverage are unlikely to be representative of the overall stock abundance/biomass. The effectiveness of these surveys in quantifying overall stock dynamics should be carefully evaluated.

- Historical catches from 1945 to 1961 were estimated based on a rather unrealistic assumption (i.e., constant CPUE). This assumption may need to be evaluated, and alternative approaches may be explored for alternative estimates of historical catch. However, this is not expected to change the assessment results.

(a) **Are data uncertainties acknowledged, reported, and within normal or expected levels?**

Uncertainties associated with both the input data and fixed parameters in the SS are acknowledged, evaluated, justified, and reported. Coefficients of variation (CVs) were provided for all datasets and appear to represent the best available information and be appropriate. The uncertainty associated with both the data quality and quantity has been acknowledged. Uncertainty associated with most data is within normal or expected levels; however, uncertainty associated with the following data may be beyond the normal/expected levels:

- Discard mortality may vary greatly over space, time/seasons, gear types and fishermen's behavior, the current mortality rates were estimated from a study with limited spatio-temporal coverage and relatively small sample sizes. The extrapolation of such a study to the whole stock area is questionable.

- The quality of discard estimates may also be questionable because of limited observer coverage. There is lack of biological information on the discards. For example, there are no length composition data for discards.

- Age data were not explicitly used in the SS in SEDAR 51 because of concerns about the model performance after the age data were incorporated in the model. A comprehensive study should be done to evaluate possible spatio-temporal variability and possible issues associated with age data in the SS model.

- Catch data, including both landed catch and discards, are estimated from different sources (e.g., observers, industry logbook reports). Although various efforts have been made to yield a high quality of total catch estimates, it is clear that the catch estimates are still subject to large errors. Because of the complexity of the Gray Snapper fishery in the Gulf of Mexico with large spatial coverage, multiple gears, management regulations, and different fishing fleets, the level of the error in catch estimates may vary by area, year, season and gear. The current error levels assigned to catch may be underestimated. I suggest estimating uncertainty associated with catch estimates to develop a plausible range of catch estimates, which can be used to evaluate impacts of uncertainty associated with catch estimates on stock assessment.

- Natural mortality rate is commonly fixed in stock assessments because it is almost inseparable from fishing mortality and stock biomass estimates. The current M of 0.15/yr was estimated from Hoenig (1983) function based on a maximum age of 28. Natural mortality estimates varied greatly among studies ranging from 0.14 to 0.43 (Burton 2001), 0.17 to 0.36 (Allman and Goetz 2009), and 0.15 to 0.5 (Fischer 2005). The two sensitivity runs were conducted to evaluate possible impacts of different levels of M on the assessment results. However, this cannot formally incorporate the uncertainty in M in the stock assessment. In the future, if a Bayesian approach is used in the assessment, I recommend that informative priors be derived for M using M values estimated with different methods. Similar approach may be also considered for steepness parameter h, which was given a fixed value in SEDAR 51.

(b) **Are data applied properly within the assessment model?**

Overall, I believe the data available were carefully evaluated and justified for application in the assessment model, representing the use of best available information in the assessment, given the constraints in the quality and quantity of the data available to SEDAR 51. The model can be run by others with control files and input data files and the results are reproducible. A series of sensitivity analyses were conducted to evaluate impacts of uncertainty-associated model input parameters. High and low historical catch scenarios were not constructed and recorded in SEDAR 51 because they were expected to have little impact on model results based on previous assessments.

The current stock assessment re-scales sample size for size composition so that the average sample size in a year is approximately 300. For almost all runs effective sample sizes estimated from the model tended to be higher than the input sample sizes, suggesting that the model believes that the size-composition data have higher quality than that suggested by the input sample sizes. However, no information was available to evaluate differences in stock biomass estimates derived from the input effective sizes and model-internally calculated effective sample sizes. Dynamic binning may potentially reduce the effective sample size, but no test run was done during the Review Workshop due to time constraints.

Log-scale standard deviations for survey abundance data were inputted in the model. However, the variation calculated for the abundance indices were derived from their standardizations, which may not necessarily represent their true variability correctly because the current calculation of standard error can be readily influenced by the CPUE standardization model structure (e.g., with or without interaction terms). Future assessment may want to focus on the diagnostic analyses for model fitting in the CPUE standardization process and evaluation of possible impacts of different levels of variability in standardized CPUEs on the assessment results. Some sort of cross-validation study in developing CPUE standardization models should also be conducted to evaluate the CPUE standardization models.

Several abundance indices were derived from monitoring programs with limited spatio-temporal coverage. Given the complex stock structure and limited connections and movement of Gray Snapper in the Gulf of Mexico, the representation of certain local monitoring programs should be evaluated before they are assumed to be representative of the dynamics of whole stock in SS.

Fishery CPUE data are often considered not to be representative of population abundance and are unreliable in terms of abundance index (Hilborn and Walters 1992) for reasons such as non-randomness of fishing process, temporal changes in catchability, and limited spatial coverage. Even if they were standardized, the fishery CPUE data may still not produce a reliable abundance index.

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

Available fishery-dependent and independent data as well as biological information for SEDAR 51 were compiled and evaluated in the SEDAR 51 Data Workshop and Assessment Workshop for their suitability for the Gulf of Mexico Gray Snapper stock assessment. The data are generally reliable and sufficient to support the SS-based stock assessment and conclusions about the status of the Gulf of Mexico Gray Snapper stock and exploitation. However, the SS assessment lacks biological information (e.g., length composition data) for discards of both commercial and recreational fisheries, and the level of discards and mortality of discarded fish also have large uncertainty values, which may have a major impact on the assessment results.

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:
a) Are methods scientifically sound and robust?

SS has been widely used in fisheries stock assessment in the USA and many other countries. It is a very open and flexible stock assessment framework that can be configured for different fisheries. The performance of the model has been evaluated for different fisheries. Given the quality and quantity of data available to SEDAR 51, I conclude that the assessment models used are scientifically sound and robust.

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

The SS model is very complicated with many built-in constraints and "tricks" in configurations, which may have significant impacts on the assessment results. However, this is difficult to evaluate given the short time period for the review workshop. With the control files and input data, the models can be run by others with reproducible results for the base case and sensitivity runs. I also believe the model was configured in a manner so it was easy to explore the data, test hypotheses and apply appropriate diagnostics. Although I conclude that the assessment models used in SEDAR 51 are configured properly and consistent with standard practice, I would like to make the following suggestions for future studies to better understand the model performance.

Various selectivity functions are available in SS. They provide a flexible framework to assign different selectivity functions for different gears. Choice of selectivity functions and the subsequent shape of selectivity curves with length/age can greatly influence the stock assessment results. Selectivity function choices tend to be highly flexible to let model fitting process decide the selectivity curves, although in some cases, selectivity is forced to follow the curves. In some cases, there is lack of justification for the choice of a particular selectivity function for a fishery. I believe relevant hypotheses should be developed to explain the derived selectivity curves. This has not been done explicitly in the stock assessment report.

The choice of current time block for selectivity (i.e., no time block) is rather arbitrary. I believe that a random walk over years may be a better choice. Once a model is run with random-walk selectivity over years, the temporal trend of selectivity plots needs to be examined closely to identify any temporal pattern. The identified temporal pattern can be used in the future to decide a time block for selectivity. For multiple fleets, I believe we need to evaluate one fleet at a time for its temporal trend while holding others constant.

Natural mortality, growth parameters, and steepness parameters are key parameters in driving the dynamics of a fish stock. All these parameters were fixed in this assessment, which may determine the stock dynamics and result in an under-estimation of uncertainty associated with the stock dynamics.

c) Are the methods appropriate for the available data?

SS is a very flexible stock assessment modeling framework. It can be configured for various levels of data quantity and quality. Thus, for SEDAR 51, the choice of using SS is appropriate for the available data. However, because of its complexity and many built-in constraints, it may not be straightforward to evaluate the performance of the model in fitting the data. Models of lower complexity (statistical age- or length-structured models) may need to be explored and compared with the SS in the Gulf of Mexico Gray Snapper. Because discards, which might be related to the size and/or bag limits, play an important role in this fishery, a model incorporating length composition information is necessary. Bayesian statistics may be considered for the next assessment to better facilitate the incorporation of uncertainties associated with various model parameters.

3. 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?

Based on the evaluation of the base scenario and all of the sensitivity runs conducted before and during the Review Workshop, I conclude that although the absolutes may vary, trends in exploitation levels and stock abundance and biomass were rather robust. The conclusion about the status of stock and exploitation also tends to be robust with respect to plausible scenarios examined before and during the Review Workshop.

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

Based on the base case and all of the sensitivity runs conducted before and during the review workshop, I conclude that the Gulf of Mexico Gray Snapper stock considered in SEDAR 51 is unlikely to be overfished using the current Minimum Stock Size Threshold (MSST) definition. This conclusion tends to be sound and robust with respect to uncertainty in data and models.

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

Based on the results derived for the base case and sensitivity runs conducted before and during the Review Workshop, I would conclude that the Gulf of Mexico Gray Snapper stock is undergoing overfishing, because the current estimated fishing mortality tended to be higher than the current Maximum Fishing Mortality Threshold (MFMT). This conclusion tends to be sound and robust with respect to uncertainty in data and models.

The stock assessment further suggests that the stock has been undergoing overfishing for most years since 1976. This conclusion, however, may be questionable. It implies that the Gulf of Mexico Gray Snapper has been fished at a rate higher than the MFMT, yet the stock is still not overfished even after almost four decades of overfishing. Thus, I believe the appropriateness and consistency of the current MFMT and/or MSST should be carefully evaluated.

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

In the SEDAR 51 assessment recruitment was assumed to be independent of spawning biomass for the Gulf of Mexico Gray Snapper. Such a lack of stock-recruitment relationship over the whole stock area may not necessarily imply that there is no stock-recruitment relationship for the Gulf of Mexico Gray Snapper. The Gulf of Mexico Gray Snapper tend to have a complex spatial structure with many spawning areas, and recruitment may be more likely related to local spawning stock biomass. Thus, the stock-recruitment relationship may need to be examined in a finer spatial scale (Chang et al. 2016).

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?

Although the quantitative estimates of current stock biomass and fishing seem reliable and robust to various uncertainties in the sensitivity analyses, the biological reference points (i.e., MFMT and/or MSST) used to determine the status of stock and exploitation were not evaluated for the Gulf of Mexico Gray Snapper stock. Overfishing has occurred most years over the last four decades, yet the stock is still not overfished. This inconsistency between overfished and overfishing status suggests some incompatibility between MFMT and MSST.

4. Evaluate the stock projections, including discussing strengths and weaknesses, and consider the following:
a) Are the methods consistent with accepted practices and available data?

SEDAR 51 uses built-in functions in the SS software to make the projection. This method has been used and evaluated in other assessments. The projection seems to be consistent with normal accepted practices and available data.

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

Some modifications were done after the Review Workshop to the projection function to resolve an issue with the SS projection, which yielded some strange projections that were identified during the Review Workshop. The current projection seems to be appropriate for the assessment model and outputs derived for the base case scenario.

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

The results are informative and sufficient for providing management advice. However, I am not sure if this projection supports inferences of probable future conditions that are not projected in SEDAR 51.

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

Yes, the projection uses the results (including both means and variances) for the base case scenario in making prediction of stock dynamics given the current harvest control rules. The key uncertainties were acknowledged, discussed and reflected in the projection results. However, the use of 80% confidence intervals seems to be inconsistent with 95% confidence intervals used in reporting uncertainty for other key model outputs.

5. 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

In order to address the uncertainty associated with the data and models, the SEDAR 51 Data Workshop and Assessment Workshop developed sensitivity analyses, estimated confidence intervals for key model estimates, conducted a retrospective analysis for possible retrospective errors, and conducted diagnostic analyses.

The SEDAR 51 Data Workshop and Assessment Workshop have considered uncertainties of multiple sources in the data, assumptions on life history parameters and assessment methods. The Assessment Workshop has identified the needs for the information on the discard length composition to better quantify the discard data, which are a major driving force in the dynamics of the Gulf of Mexico Gray Snapper stock. The Assessment Workshop has also realized that the discard mortality estimated from a study with limited spatio-temporal coverage may not be representative of discard mortality over all stock area and different fisheries, and explored a range of discard mortality rates in the assessment sensitivity runs. A large coefficient of variation (e.g., CV =0.5) was also assigned to discard rates for some years, reflecting perceived uncertainty associated with the information on the discard rates. Natural mortality rates estimated in different studies varied greatly among studies. Although M of 0.15 was used in the base case scenario, a lower value and an upper value of M were also used in the sensitivity analysis. Various levels of CVs were also used for the growth model parameters to quantify the variability associated with the growth for the Gulf of Mexico Gray Snapper.

The uncertainty associated with abundance indices was quantified with the CV scaled for each index to an overall average of 0.2, but inter-annual variability for each index retained within the model. The uncertainty associated with size composition data for the recreational and commercial fisheries and survey programs was quantified with effective sample sizes for each data set, which were then iteratively adjusted based on the estimated effective sample sizes.

The uncertainty of the above sources was considered in the SEDAR 51 DW and AW, but spatio-temporal variability that may be associated with the dynamics of Gulf of Mexico Gray Snapper was not explicitly considered. Given the complex spatial structure of the Gray Snapper stock in the Gulf of Mexico and possible temporal changes in the environment, I believe it may be necessary to evaluate possible spatial-temporal variability in some key life history parameters, especially in growth parameters.

Age data, although available, were not used in the base model, as the age-length keys contained some unusual features (e.g., bi-modal distributions for some years) and produced spurious results in initial model configurations. This was explicitly acknowledged during the Review Workshop. This issue needs to be further evaluated and the data may be included in future assessments to better reflect the possible variability in growth over time and space.

The limited spatial coverage of some data (e.g., some local monitoring programs) may also result in uncertainty when used as an abundance index to describe the overall stock dynamics in SS. Although the SEDAR DW and AW considered possible conflicts of these abundance indices by jackknifing the abundance indices in the sensitivity analysis, this may not be sufficient. More careful evaluation regarding possible local dynamics of Gray Snapper in the Gulf of Mexico and possible conflicts among different areas may be needed.

Possible spatial dynamics of the Gray Snapper stock in the Gulf of Mexico may need to be evaluated for possible impacts on the stock assessment.

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

Overall, the sensitivity analyses and alternative model runs conducted before and during the Review Workshop suggest that the status of stock and exploitation tended to be robust with regard to uncertainty associated with the data and models.

The uncertainties associated with both the current stock biomass and fishing mortality were estimated, but not included in the report. They were plotted during the Review Workshop, which helps understand possible implications of uncertainty in determining the status of stock and exploitation for the Gulf of Mexico Gray Snapper.

The retrospective analysis, although included in the analysis, was only presented in a plot, which is not very informative (see my recommendation below). I would suggest calculating Mohn's rho to better quantify the retrospective errors and making retrospective error adjustment for the current stock biomass and fishing mortality when they are compared with biological reference points, which can evaluate possible implications of uncertainty resulting from retrospective errors in the determination of stock and exploitation status. Whether the current stock biomass and fishing mortality need to be adjusted for retrospective errors in determining the stock and exploitation status and making the projection also needs to be 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**

The SEDAR 51 Data Workshop and Assessment Workshop have made some important recommendations for improving future stock assessment. I support their recommendations. In addition to their recommendations, I suggest the following recommendations to improve stock assessment data and models:

- A careful evaluation of existing monitoring programs in order to identify possible issues that may influence data quality and conduct a simulations study to evaluate their effectiveness (e.g., Cao et al. 2014; Li et al. 2015);
- Identification and improvement of potential information gaps in spatial and temporal coverages of the monitoring programs;
- Improve biological sampling of catch and discards (e.g., length composition, discard rates);
- Improved quantification of discard mortality rates over a large range of environmental conditions (e.g., over a wide range of depths);
- Collection of catch and discard data at a finer spatial scale;
- Evaluation of the age and length discrepancies identified during the assessment process.

More general and specific recommendations can be found in the next section.

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

SEDAR 51 Data, Assessment and Review Workshops were held in sequence. The Review Panel only attended the Review Workshop. Although relevant working papers and the reports of both Data and Assessment Workshops provide a good summary of relevant processes and outcomes, there is still a lack of full understanding of how certain conclusions/recommendations regarding data/model configurations were made because no member of the Review Panel attended all three workshops and none of the scientists who had attended the Data Workshop were present at the Review Workshop. For the sake of consistency, it would be very beneficial to have a Review Panel member attend all three workshops.

The Review Panel members from outside the region may not be familiar with the SEDAR process, and it would make the review process more effective if the Review Panel is provided with descriptions of the SEDAR and Council processes. This can provide the Review Panel a better understanding of various decisions made about stock assessment data and model configurations as well as potential usage and implications of the stock assessment results.

Input data, model control files and stock assessment results were presented to the Review Panel at SEDAR 51. I recommend that the basic biology of the species being assessed, information on the relevant ecosystems, a comprehensive description of the fishery, and fishery management history be presented to the Review Panel before stock assessment materials are presented. Doing so will help the Review Panel better understand the stock assessment.

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.

In general, I would conclude that the SEDAR 51 stock assessment uses the best available information and best available methods in a transparent and constructive way, yielding important information that can help guide the development of management advice, given the time constraints and the limitation of data quality and quantity. This suggests that the SEADR 51 stock assessment constitutes the best scientific information available.

Relevance: The compilation of a large body of biological, population, ecosystem, and fisheries information from various sources and configuration and parametrization of SS in SEDAR 51 is highly relevant for the development of stock assessment that uses the best available scientific information in the evaluation of Gray Snapper stock and exploitation status and identification of potential management strategies for the Gulf of Mexico Gray Snapper.

Inclusiveness: Overall, the SEDAR 51 Data and Assessment Workshops explored a great diversity of data from fishery-dependent and fishery-independent monitoring programs and different configurations and parameterizations of the SS model for determining the stock and exploitation status and providing management advice. This includes data from almost all sources (i.e., directly measured data from state and federal monitoring programs and secondary data obtained from the literature including biological information for similar species). The analytic team was also very willing and open to include the suggestions suggested by the Review Panel at the Review Workshop.

Objectivity: The SS software is a widely used and well tested stock assessment modeling platform with great flexibility. The SEDAR 51 Data and Assessment Workshops have used highly objective and structured protocols to evaluate data quality and identify appropriate methods in developing abundance indices and key biological parameters for the SS model. These protocols are well documented and reviewed through the SEDAR Data and Assessment process. Possible exceptions are assumptions made for the data and methods, such as temporal and spatial variation in life history parameters and the exploitation history (prior to 1962). However, given the limited information, I understand these assumptions had to be made in a subjective way for the assessment. The analytic team improved this by conducting many runs of sensitivity analyses regarding these assumptions

Transparency: All the materials presented in the SEDAR 51 Data, Assessment and Review Workshops were fully documented and publicly available. The discussions at the Review Workshop were recorded and open to public. The quality and quantity of all input data sets were well evaluated and documented. The choice of the input parameters for the SS, sensitivity scenarios, and subsequent results were all well documented and publicly available. The whole review process was also very open and transparent and the analytic team responded to all the requests made by the Review Panel at the Review Workshop.

Timeliness: The SEDAR 51 Data, Assessment and Review Workshops were arranged in a timely manner for the assessment and management of the Gulf of Mexico Gray Snapper stock. This is the first quantitative stock assessment for the Gulf of Mexico Gray Snapper. All the materials were made available and all our requests for additional analyses were addressed in a timely fashion.

Verification: The SEDAR 51 process and deliverables comply with legal requirements under the Magnuson-Stevens Act (2007) for developing and monitoring of fishery management plans.

Validation: The SEDAR 51 Data, Assessment, and Review Workshops were conducted to provide management advice. The biological realisms were always checked for choice of the model parameters and modeling results were validated if empirical information was available. The process is open and fully transparent to stakeholders.

Peer review: The SEDAR 51 includes the Review Workshop, at which the outcomes of the Data and Assessment Workshops were fully peer-reviewed by a Review Panel consisting of experts appointed from the Center for Independent Experts (CIE reviewers) and members of the GMFMC SSC. The Review Panel report and the independent CIE reviews are publicly available.

8. Provide suggestions on key improvements in data or modeling approaches that should be considered when scheduling the next assessment.

Overall, I believe that the data compilation, evaluation and analysis in SEDAR 51 and the application of SS have provided critical and quantitative information for the determination of stock and exploitation status and management advice that was previously unavailable for the Gulf of Mexico Gray Snapper. In terms of providing management advice based on a quantitative stock assessment for the Gulf of Mexico Gray Snapper, SEDAR 51 is a significant step forward. There is room for improvement in every aspect of the Gulf of Mexico Gray Snapper stock assessment. My major and specific recommendations for improvements in data and modeling approach can be found in Section V.

9. Prepare a Peer Review Summary summarizing the Panel's evaluation of the stock assessment and addressing each Term of Reference.

A separate Peer Review Summary Report was prepared to summarize the Panel's evaluation of the stock assessment with respect to each Term of Reference.

V. Conclusions and Recommendations

I would like to commend all participants in the SEDAR 51 Gray Snapper Data and Assessment Workshops for compiling background information on the Gulf of Mexico Gray Snapper life history parameters, commercial and recreational fisheries data, monitoring data, genetic data, microchemical and tagging work on stock structure and fish movement, and management issues. I was impressed by the breadth of expertise and experience shown in the working papers and Data Workshop and Assessment Workshop reports provided, as well as the amount of effort spent to collect, evaluate, and compile the data. I appreciate the openness of discussion during the Review Workshop in considering alternative approaches/suggestions, and the constructive dialogues between the reviewers and stock assessment analysts throughout the review. Materials were sent to me in a timely manner, and almost all of my requests for extra information and additional analyses requested during the Review Workshop were addressed promptly.

Overall, I believe the Gulf of Mexico Gray Snapper stock assessment provides robust assessment results, in particular with regard to temporal trends. The assessment appears to be scientifically sound and adequately addresses management requirements. The SEDAR 51 Data workshop and Assessment Workshop and NOAA stock assessment analysts were particular keen in sourcing, assessing and addressing uncertainty in the data and assessment and in exploring alternative model configurations. However, some important questions still need to be addressed, and I believe there is still room to improve the current stock assessment. I have made the following general comments and specific recommendations.

General comments

The SEDAR 51 Review Workshop did not provide a presentation on the background information on the Gulf of Mexico Gray Snapper, such as its basic biology and ecology, environment and ecosystems, and history of recreational and commercial fisheries and management. Although some background papers and working papers include some of the information, it was not introduced in a systematic and structured manner. The review process would be much more effective if such background information is presented at the beginning of the Review Workshop.

The SEDAR 51 Review Workshop did not have the necessary expertise and background for many questions about the quality and quantity of various data. Someone who is familiar enough with the data to answer questions from reviewers should attend the Review Workshops. I also suggest that at least one reviewer (either CIE reviewer or SSC reviewer) participate in all processes, including the Data workshop, Assessment Workshop, and Review Workshop. Doing so will allow reviewers in the Review Workshop to better understand how decisions were made in the Data Workshop and Assessment Workshop.

There seemed to be a disconnection between the groups that collect the data and those that use the data for the assessment. Fully understanding the data and their associated biological and statistical properties is very important for stock assessment scientists. Doing so will allow stock assessment scientists to properly use the data in SS and assume its appropriate statistical property in developing objective functions for model parameter estimations. I would encourage improvement between communications and research groups within SEFSC, which will improve data and assessment products

Even for the base case scenario, some choices of model configurations may influence stock assessment results. An important issue that needs to be addressed is how the final model can be determined for the development of management regulations. I see limited discussion on this topic in the current stock assessment report. I suggest that the following criteria be considered in the selection of the final model: (1) full use of the information available; (2) statistically justified model structures; (3) sufficiently parsimonious models; and (4) derivation of plausible estimates of stock biomass, recruitment and fishing mortality. These measures may be good indicators of model performance, although they are qualitative and may be subjective.

Age data were not explicitly used in SEDAR 51 although a large quantity of age data are available as a result of concerns about poor model performance after age data were incorporated in the model. A comprehensive study should be done to evaluate possible spatio-temporal variability and possible issues associated with age data in SS.

An in-depth analysis should be conducted to identify possible sources of uncertainty for a given set of data, and relevant analysis should be done to reduce the uncertainty and improve data quality *before* the data are used in the stock assessment model. Trying to resolve all uncertainties within the SS model may complicate parameter estimation, resulting in difficulty in the model converging.

Given the flexibility and many choices that SS provides for functions quantifying life history and fishery processes, one needs to use background information on the collection of fishery and survey data, fish life history theory and local ecosystem to develop hypotheses to explain choices and resultant estimates.

Current efforts were focused on accommodating many sensitivity analyses for different assumptions on some key model parameters. More effort should be spent on model diagnoses to identify if model assumptions, implicit and explicit, have been violated. This involves evaluating residual patterns for distributional assumptions, CVs of each estimated parameters to identify if an estimated parameter is significant, and the variance-covariance matrix to identify possible correlations between different parameters (and then to see if such a correlation can be justified biologically).

Although the existing studies for the Gulf of Mexico Gray Snapper stock structure are not conclusive, there is evidence of limited movement and mixture of the stock, which is likely to result in large variabilities in key life history parameters. Thus, I would hypothesize that the Gray Snapper may have a metapopulation structure in the Gulf of Mexico. This stock spatial structure may call for consideration of spatial variability in the assessment.

A habitat suitability modeling approach (e.g., Chang et al. 2010, Tanaka and Chen 2015, 2016) can be used to identify suitable habitats for the Gray Snapper to outline potential habitat maps in the Gulf of Mexico and evaluate whether monitoring programs cover main suitable habitat area for the Gray Snapper. Such an approach can also be used to project possible changes in Gray Snapper spatial distributions if key habitat variables (e.g., temperature) change. The estimated spatial distribution from such a study can also help improve designs of monitoring programs to ensure the coverage of major habitat for the Gray Snapper in the Gulf of Mexico.

Outliers are likely to exist in input data used in the assessment, given that the data are derived from different sources and are subject to different levels of errors. They may bias parameter estimation in stock assessment. Robust likelihood functions can reduce impacts of outliers in size composition and survey abundance index (Chen et al. 2000, 2003).

Although SS3 is very flexible and has been tested and used in the assessment of many fish stocks, the results derived still need to be cross-validated to enhance confidence in the assessment. I believe some competitive models at different complexities should be developed for comparison with SS. A comparative study of stock assessment, begot from different models, can help improve understanding of fish population dynamics modeled by SS.

A Bayesian approach has not been fully incorporated in the Gulf of Mexico Gray Snapper stock assessment. Thus, uncertainty in the assessment has not been fully incorporated in the assessment and stock projection under different harvest strategies. I would encourage future assessment to fully utilize this function in SS.

SEDAR 51 has fixed values for steepness parameter h, natural mortality M, and von Bertalanffy growth parameters for the Gulf of Mexico Gray Snapper. This has essentially fixed the intrinsic growth of fish stock. The implication of fixing key life history parameters on the assessment needs to be evaluated.

Specific recommendations

Although I have provided detailed comments and recommendations under each TOR, I would like to re-iterate the following recommendations.

No systematic study has ever been done to evaluate and quantify errors associated with catch estimates. Low CVs were assigned to the landing data, but the values are rather arbitrarily determined with limited justifications. The current program has some overlaps in catch reporting from different sources, data from different sources can be compared and cross-validated. Such a study can yield some insights about potential errors in catch estimates from different sources. Given the importance of catch data in the assessment, I suggest conducting an extensive computer simulation study based on the data collected in the past to evaluate the effectiveness of current sampling/reporting system in yielding catch estimates in order to evaluate potential error sources and levels of catch estimates, and to identify alternative sampling/reporting program designs.

The discarded catch is very important for the Gulf of Mexico Gray Snapper stock assessment; however, information on discards is limited. Monitoring programs and studies need to be developed to improve the estimation of discard rate, length composition of discarded catch in the commercial and recreational fisheries, and mortality of discarded Gray Snapper over a wide range of depths.

I suggest improving efforts to collect discard-related information for commercial and recreational fisheries including discard rates, discard size composition, spatio-temporal distribution of discards, and mortality of discarded catch.

Because the current program may have some overlap in catch reporting from different sources, data from different sources can be compared and cross-validated. Such a study can yield some insights about potential errors in catch estimates from different sources.

Given the importance of the catch data in the assessment and possible error sources, I suggest conducting an extensive computer simulation study based on the data collected in the past to evaluate the effectiveness of the current sampling/reporting system in yielding catch estimates, potential error sources and levels of catch estimates in addition to identifying alternative sampling/reporting program designs.

I suggest estimating uncertainty associated with catch estimates to develop a plausible range of catch estimates, which can then be used to evaluate impact of uncertainty associated with catch estimates on stock assessment.

The quality of age data and potential spatio-temporal variability should be carefully evaluated before they are used in SS.

Data collected from a monitoring/survey program should be analyzed using methods consistent with the design, and spatio-temporal coverage and limitation of the monitoring/survey programs should be considered when they are applied in the stock assessment. Assumptions should be explicitly described if a spatio-temporal limited monitoring program has to be used in the assessment.

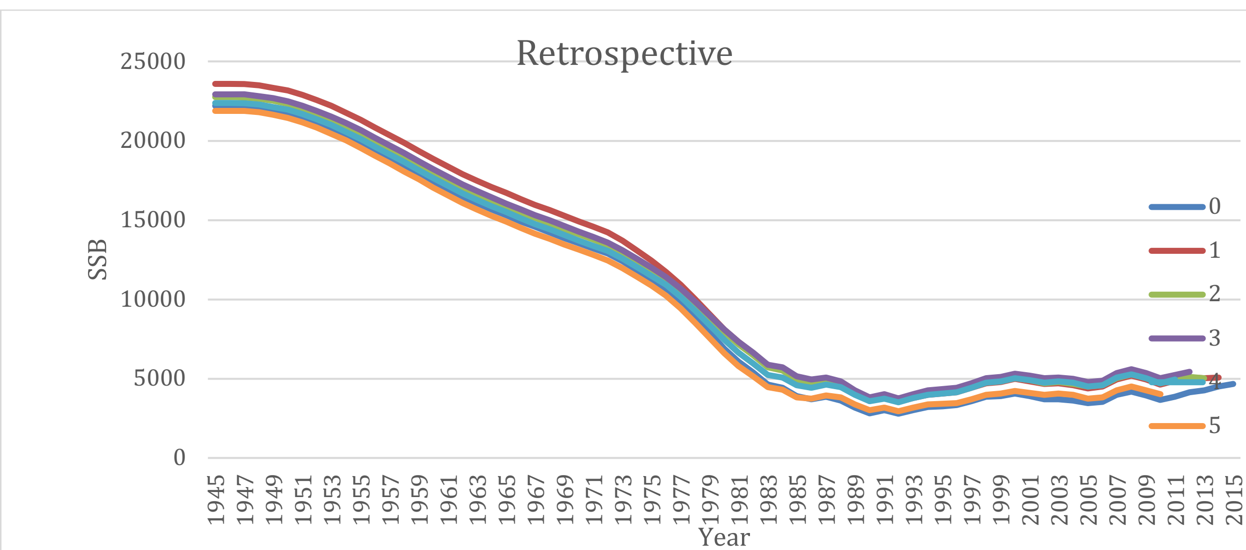
More study needs to be done to explore the dynamic binning approach to reduce the impacts of zero observation in the two ends of the size distribution matrices.

All CPUE indices, whether developed from a fishery-dependent or fishery-independent monitoring program, were standardized. This process, if done properly, can remove factors other than stock abundance/biomass that influence catchability. However, I would like to see some studies evaluating the effectiveness of such a standardization process. Statistical models developed for the CPUE standardization may need to be cross-validated.

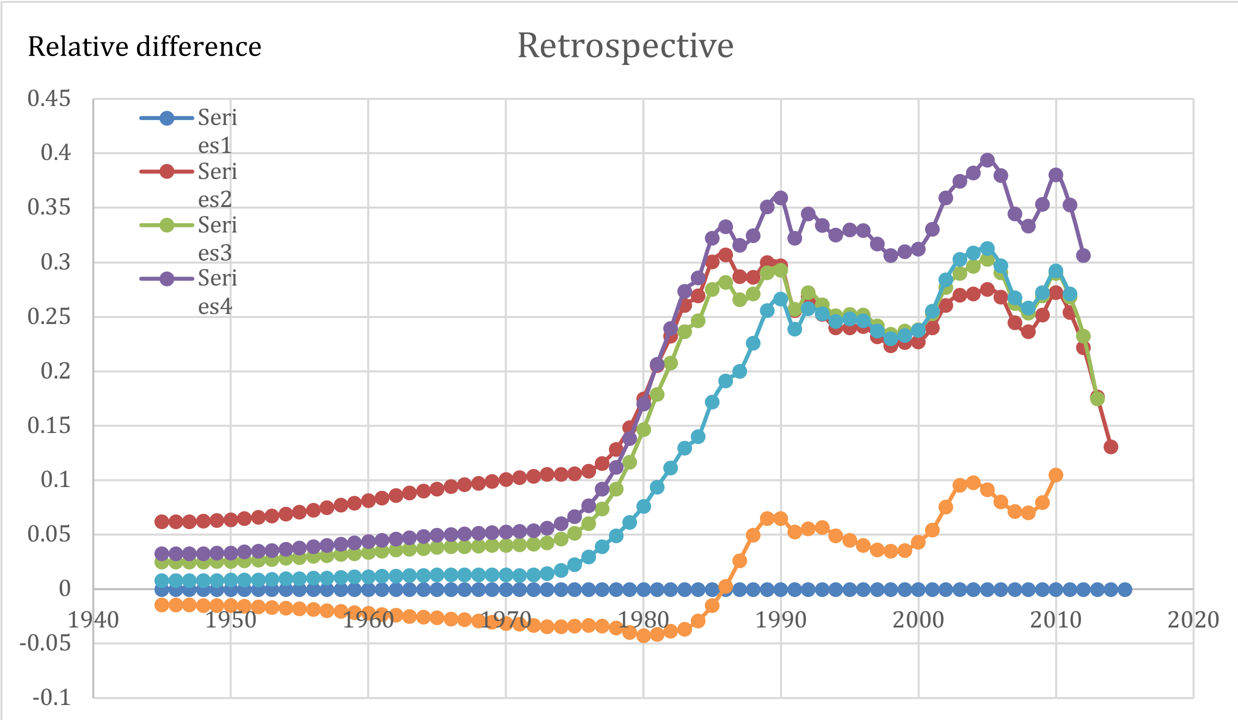
The choice of time block for selectivity is rather arbitrary. I believe that a random walk over a defined set of years may be a better choice. Once a model is run with random-walk selectivity over a defined set of years, the temporal trend of selectivity plots needs to be examined closely to identify any temporal pattern. The identified temporal pattern can be used in the future to decide the time block for selectivity. For multiple fleets, I suggest evaluating one fleet at a time for its temporal trend while holding others constant.

I suggest that more effort be put towards model diagnosis and residual analysis.

Retrospective errors may result in large errors in estimates of current stock biomass. The retrospective errors should be carefully evaluated for estimates of stock biomass, fishing mortality, and recruitment. However, SEDAR 51 only presents the following plot to describe retrospective error, which is not only difficult to read, but also may be misleading.



I would suggest the NOAA guideline to present retrospective errors be followed (Legault 2008). For example, if we use the relative difference to quantify the retrospective errors, the above plot becomes the following plot, which suggests a pretty high retrospective error.



Mohn's rho value (Mohn 1999) should also be calculated to quantify the retrospective errors.

This assessment also incorporates model projection. I recommend that the performance of the projection done in this assessment be evaluated in two to three years, to evaluate their performance in achieving management objectives.

I suggest that the assessment model structure and configuration be kept relatively stable over time. If a new model needs to be developed in the future, it should be run parallel to the old model to identify changes in stock assessment results resulting from changes in model configurations.

Recruitment dynamics were estimated with steepness parameter h being set at 0.99, which essentially assumes that recruitment is independent of spawning stock biomass. Large annual variability in the estimated recruitment over time for the base case may not be biologically plausible, and perhaps indicate model overfitting. More studies are needed to improve our understanding of the estimated recruitment dynamics.

Size composition data were grouped into 2-cm size bins in the assessment. A factorial experiment may be needed to evaluate impacts of different bin widths. A fine size bin can yield more accurate representations of length distributions of fisheries and survey catches. However, particularly for large and small sizes of fish, fine binning may result in a large number of bins without observation, forcing the model to fit these 0 observations on both sides of the size distribution tails. This may be done at the cost of other size classes, resulting in a misfit of other size classes that tend to have more reliable and informative information.

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VII-1. Appendix 1: Bibliography of materials provided for review

(1) **Documents received prior to the review**

SEDAR 51 Stock assessment report for Gulf of Mexico Gray Snapper

Document #	Title	Authors	Date
SEDAR 51	Stock assessment report for Gulf of Mexico Gray Snapper	SEDAR	March 2018
Base case stock assessment files	Stock synthesis (SS) data, control, and result files for the base case for Gulf of Mexico Gray Snapper	SEDAR	January 2018
Documents Prepared for the Data Workshop			
SEDAR51-DW-01	Brief Summary of FWRI-FDM Tag-Recapture Program and Brief Summary of FWRI-FIM Tag-Recapture Data	Rachel Germeroth, Kerry Flaherty- Walia, Beverly Sauls, Ted Switzer	4 Nov 2016
SEDAR51-DW-02	Summary of length and weight data for gray snapper (*Lutjanus griseus*) collected during NMFS and SEAMAP fishery- independent surveys in the Gulf of Mexico	David S. Hanisko and Adam Pollack	20 March 2017
SEDAR51-DW-03	Gray Snapper Abundance Indices from SEAMAP Groundfish Surveys in the Northern Gulf of Mexico	Adam G. Pollack, David S. Hanisko and G. Walter Ingram, Jr	7 April 2017 Updated: 12 June 2017
SEDAR51-DW-04	Length frequency distributions for gray snapper length and age samples collected from the Gulf of Mexico	Ching-Ping Chih	9 April 2017
SEDAR51-DW-05	Gray snapper *Lutjanus griseus* Findings from the NMFS Panama City Laboratory Camera Fishery-Independent Survey 2005-2015	C.L. Gardner, D.A. DeVries, K.E. Overly, and A.G. Pollack	7 April 2017
SEDAR51-DW-06	Reproductive parameters for the Gulf of Mexico gray snapper, *Lutjanus griseus,* 1991-2015	G.R. Fitzhugh, V.C. Beech, H.M. Lyon, and P. Colson	13 April 2017
SEDAR51-DW-07	SEAMAP Reef Fish Video Survey: Relative Indices of Abundance of Gray Snapper	Matthew Campbell et al.	10 April 2017
SEDAR51-DW-08	Description of age data and estimated growth of Gray Snapper from the northern Gulf of Mexico: 1982-1983 and 1990-2015	L.A. Thornton, L.A. Lombardi, and R.J. Allman	14 April 2017
SEDAR51-DW-09	SEDAR 51 Stock ID Working Paper	S51 Stock ID Working Group	February 2017
SEDAR51-DW-10	Indices of abundance for Gray Snapper (*Lutjanus griseus*) from the Florida Fish and Wildlife Research Institute (FWRI)	Kevin A. Thompson, Theodore S. Switzer, and Sean F. Keenan	21 April 2017

	video survey on the West Florida Shelf		
SEDAR51-DW-11	Gray Snapper Abundance Indices from Inshore Surveys of Northeastern Gulf of Mexico estuaries	Kerry E. Flaherty-Walia, Theodore S. Switzer, and Amanda J. Tyler- Jedlund	24 April 2017 Updated: 27 April 2017
SEDAR51-DW-12	Standardized Catch-Per-Unit Effort Index for Gulf of Mexico Gray Snapper *Lutjanus griseus* Commercial Handline Fishery (1993 – 2015)	Matthew W. Smith	26 April 2017
SEDAR51-DW-13	Commercial Landings of Gray or Mangrove Snapper (*Lutjanus griseus*) from the Gulf of Mexico	Refik Orhun and Beth Wrege	Not Recieved
SEDAR51-DW-14	Standardized Reef Fish Visual Census index for Gray Snapper, *Lutjanus griseus*, for the Florida reef track from Biscayne Bay through the Florida Keys for 1997- 2016	Robert G. Muller	6 June 2017
SEDAR51-DW-15	Indices of abundance for Gray Snapper (*Lutjanus griseus*) using combined data from three independent video surveys	Kevin A. Thompson, Theodore S. Switzer, Mary C. Christman, Sean F. Keenan, Christopher Gardner, Matt Campbell, Adam Pollack	15 June 2017
Documents Prepared for the Review Workshop			
SEDAR51-RW-01	Commercial Landings of Gray or Mangrove Snapper (*Lutjanus griseus*) from the Gulf of Mexico	Refik Orhun and Beth Wrege	5 March 2018
Final Stock Assessment Reports			
SEDAR51-SAR1	Gulf of Mexico Gray Snapper	SEDAR 51 Panels	
Reference Documents			
SEDAR51-RD01	Short-Term Discard Mortality Estimates for Gray Snapper in a West-Central Florida Estuary and Adjacent Nearshore Gulf of Mexico Waters	Kerry E. Flaherty-Walia, Brent L. Winner, Amanda J. Tyler-Jedlund & John P. Davis	
SEDAR51-RD02	Regional Correspondence in Habitat Occupancy by Gray Snapper (*Lutjanus griseus*) in Estuaries of the Southeastern	Kerry E. Flaherty & Theodore S. Switzer & Brent L. Winner & Sean F. Keenan	

	United States	
SEDAR51-RD03	Improved Ability to Characterize Recruitment of Gray Snapper in Three Florida Estuaries along the Gulf of Mexico through Targeted Sampling of Polyhaline Seagrass Beds	Kerry E. Flaherty-Walia, Theodore S. Switzer, Brent L. Winner, Amanda J. Tyler-Jedlund & Sean F. Keenan
SEDAR51-RD04	Conservation Genetics of Gray Snapper (*Lutjanus griseus*) in U.S. Waters of the Northern Gulf of Mexico and Western Atlantic Ocean	John R. Gold, Eric Saillant, N. Danielle Ebelt, and Siya Lem
SEDAR51-RD05	Developmental patterns within a multispecies reef fishery: management applications for essential fish habitats and protected areas	Kenyon C. Lindeman, Roger Pugliese, Gregg T. Waugh, and Jerald S. Ault
SEDAR51-RD06	Age, growth, and mortality of gray snapper, *Lutjanus griseus*, from the east coast of Florida	Michael L. Burton
SEDAR51-RD07	Ingress of transformation stage gray snapper, *Lutjanus griseus (*Pisces: Lutjanidae) through Beaufort Inlet, North Carolina	Mimi W. Tzeng, Jonathan A. Hare, and David G. Lindquist
SEDAR51-RD08	Biological response to changes in climate patterns: population increases of gray snapper (*Lutjanus griseus*) in Texas bays and estuaries	James M. Tolan and Mark Fisher
SEDAR51-RD09	Returns from the 1965 Schlitz tagging program including a cumulative analysis of previous results	Dale S. Beaumariage
SEDAR51-RD10	Recruitment dynamics and otolith chemical signatures of juvenile gray snapper, *Lutjanus griseus,* among West Florida estuarine and coastal marine ecosystems	Cecelia Lounder
SEDAR51-RD11	Reproductive biology of gray snapper (*Lutjanus griseus*), with notes on spawning for other Western Atlantic snappers (Lutjanidae)	M.L. Domeier, C. Koenig, and F. Colman
SEDAR51-RD12	Climate-related, decadal-scale assemblage changes of seagrass-associated fishes in the northern Gulf of Mexico	F. Joel Fodrie, Kenneth L. Heck, Jr., Sean P. Powers, William M. Graham, and Kelly L. Robinson
SEDAR51-RD13	Response of coastal fishes to the Gulf of Mexico oil disaster	F. Joel Fodrie and Kenneth L. Heck Jr.
SEDAR51-RD14	Variation in the isotopic signatures of juvenile gray snapper (*Lutjanus griseus*)	Trika Gerard and Barbara Muhling

	from five southern Florida regions	
SEDAR51-RD15	Temporal and spatial dynamics of spawning, settlement, and growth of gray snapper (*Lutjanus griseus*) from the West Florida shelf as determined from otolith microstructures	Robert J. Allman and Churchill B. Grimes
SEDAR51-RD16	Regional variation in the population structure of gray snapper, *Lutjanus griseus,* along the West Florida shelf	R.J. Allman and L.A. Goetz
SEDAR51-RD17	Evaluating juvenile thermal tolerance as a constraint on adult range of gray snapper (Lutjanus griseus): A combined laboratory, field and modeling approach	Mark J. Wuenschel, Jonathan A. Hare, Matthew E. Kimball, and Kenneth W. Able
SEDAR51-RD18	Growth variation, settlement, and spawning of gray snapper across a latitudinal gradient	Kelly Denit and Su Sponaugle
SEDAR51-RD19	Age, growth, mortality, and radiometric age validation of gray snapper (Lutjanus griseus) from Louisiana	Andrew J. Fischer, M. Scott Baker, Jr., Charles A. Wilson, and David L. Nieland
SEDAR51-RD20	Southeast Florida reef fish abundance and biology: Five year performance report	Luiz R. Barbieri and James A. Colvocoresses
SEDAR51-RD21	Larval ecology of a suite of snappers (family: Lutjanidae) in the Straits of Florida, western Atlantic Ocean	E. K. D'Alessandro, S. Sponaugle, and J. E. Serafy
SEDAR51-RD-22	Multidecadal otolith growth histories for red and gray snapper (Lutjanus spp.) in the northern Gulf of Mexico, USA	Bryan A. Black, Robert J. Allman, Isaac D. Schroeder, and Michael J. Schirripa
SEDAR51-RD-23	Investigations on the Gray Snapper, Lutjanus griseus	Walter A. Starck II and Robert E. Schroede
SEDAR51-RD-24	Age-size Structure of Gray Snapper from the Southeastern United States: A Comparison of Two Methods of Back- calculating Size at Age from Otolith Data	A.G. Johnson, L.A. Collins, and C.P. Keim

(2) **Documents received during the review**

- SEDAR 51, Gulf of Mexico Gray Snapper. SECTION I: Introduction

(3) **Presentations at the review**

- Review Workshop: DATA, Gulf of Mexico Gray Snapper Benchmark Assessment by Dr. Jeff Isely, NOAA SEFSC Miami
- Review Workshop: CONTROL, Gulf of Mexico Gray Snapper Benchmark Assessment by Dr. Jeff Isely, NOAA SEFSC Miami
- Review Workshop: RESULTS, Gulf of Mexico Gray Snapper Benchmark Assessment by Dr. Jeff Isely, NOAA SEFSC Miami

VII-2. Appendix 2: Statement of Work for Dr. Yong Chen

National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) Center for Independent Experts (CIE) Program External Independent Peer Review

SEDAR 51 Gulf of Mexico Gray Snapper Assessment Review

Background

The National Marine Fisheries Service (NMFS) is mandated by the Magnuson-Stevens Fishery Conservation and Management Act, Endangered Species Act, and Marine Mammal Protection Act to conserve, protect, and manage our nation's marine living resources based upon the best scientific information available (BSIA). NMFS science products, including scientific advice, are often controversial and may require timely scientific peer reviews that are strictly independent of all outside influences. A formal external process for independent expert reviews of the agency's scientific products and programs ensures their credibility. Therefore, external scientific peer reviews have been and continue to be essential to strengthening scientific quality assurance for fishery conservation and management actions.

Scientific peer review is defined as the organized review process where one or more qualified experts review scientific information to ensure quality and credibility. These expert(s) must conduct their peer review impartially, objectively, and without conflicts of interest. Each reviewer must also be independent from the development of the science, without influence from any position that the agency or constituent groups may have. Furthermore, the Office of Management and Budget (OMB), authorized by the Information Quality Act, requires all federal agencies to conduct peer reviews of highly influential and controversial science before dissemination, and that peer reviewers must be deemed qualified based on the OMB Peer Review Bulletin standards. (http://www.cio.noaa.gov/services_programs/pdfs/OMB_Peer_Review_Bulletin_m05-03.pdf). Further information on the CIE program may be obtained from www.ciereviews.org.

Scope

SEDAR 51 will be a compilation of data, an assessment of the stock, and CIE assessment review conducted for Gulf of Mexico Gray Snapper. 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 stock assessed through SEDAR 51 is within the jurisdiction of the Gulf of Mexico Fisheries Management Council and the states of Florida, Mississippi, Alabama, Louisiana, and

Texas.

Requirements
NMFS requires three (3) CIE reviewers to conduct an impartial and independent peer review in accordance with the SoW, OMB guidelines, and the TORs below. The CIE reviewers shall have 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.

Tasks for Reviewers

1) Review the following background materials and reports prior to the review meeting.
    a. Working papers, reference documents, and the Data Workshop and Assessment Process Reports will be available on the SEDAR website: http://sedarweb.org/sedar-51

2) Attend and participate in the panel review meeting. The meeting will consist of presentations by NOAA and other scientists, stock assessment authors and others to facilitate the review, to answer any questions from the reviewers, and to provide any additional information required by the reviewers.

3) After the review meeting, reviewers shall conduct an independent peer review report in accordance with the requirements specified in this SoW, OMB guidelines, and TORs, in adherence with the required formatting and content guidelines; reviewers are not required to reach a consensus.

4) Each reviewer should assist the Chair of the meeting with contributions to the summary report.

5) Deliver their reports to the Government according to the specified milestones dates.

Foreign National Security Clearance
When 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 reviewers who are non-US citizens. For this reason, the 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/ and http://deemedexports.noaa.gov/compliance_access_control_procedures/noaa-foreign-national-registration-system.html. The contractor is required to use all appropriate methods to safeguard Personally Identifiable Information (PII).

Place of Performance
The place of performance shall be at the contractor's facilities, and at Tampa, FL.

Period of Performance
The period of performance shall be from the time of award through March 31, 2018. The CIE chair and each reviewer's duties shall not exceed 14 days to complete all required tasks.

Schedule of Milestones and Deliverables: The contractor shall complete the tasks and deliverables in accordance with the following schedule.

Within two weeks of award	Contractor selects and confirms reviewers
Approximately 2 weeks later	Contractor provides the pre-review documents to the reviewers
February 13-15, 2018	Panel review meeting
Approximately 2 weeks later	Contractor receives draft reports
Within 2 of receiving draft reports	Contractor submits final reports to the Government

Applicable Performance Standards
The acceptance of the contract deliverables shall be based on three performance standards: (1) The reports shall be completed in accordance with the required formatting and content; (2) The reports shall address each TOR as specified; and (3) The reports shall be delivered as specified in the schedule of milestones and deliverables.

Travel
All travel expenses shall be reimbursable in accordance with Federal Travel Regulations (http://www.gsa.gov/portal/content/104790). International travel is authorized for this contract. Travel is not to exceed $10,000.

Restricted or Limited Use of Data

The contractors may be required to sign and adhere to a non-disclosure agreement.

Project Contact:

Julie A. Neer, Ph.D.
SEDAR Coordinator Science and Statistics Program
South Atlantic Fishery Management Council
4055 Faber Place Drive, Suite 201, North Charleston, SC 29405
(843) 571-4366 *Julie.neer@safmc.net*

Annex 1: Peer Review Report Requirements

1. The report must 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 report must contain a background section, description of the individual reviewers' roles 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 must describe in their own words the review activities completed during the panel review meeting, including 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, but especially where there were divergent views.

   c. Reviewers should elaborate on any points raised in the summary report that they believe 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 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 report shall represent the peer review of each TOR, and shall not simply repeat the contents of the summary report.

3. The report shall include the following appendices:

   Appendix 1: Bibliography of materials provided for review
   Appendix 2: A copy of this 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 51 Review Workshop Terms of Reference

1. 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?
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:
   a) Are methods scientifically sound and robust?
   b) Are assessment models configured properly and consistent with standard practices?
   c) Are the methods appropriate for the available data?
3. 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?
4. 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 useful to support inferences of probable future conditions?

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

5. Consider how uncertainties in the assessment, and their potential consequences, are addressed.
   - 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
   - Ensure that the implications of uncertainty in technical conclusions are clearly stated
6. Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations or prioritizations warranted.
   - Clearly denote research and monitoring that could improve the reliability of, and information provided by, future assessments
   - Provide recommendations on possible ways to improve the SEDAR process
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.
8. Provide suggestions on key improvements in data or modeling approaches that should be considered when scheduling the next assessment.
9. Prepare a Peer Review Summary summarizing the Panel's evaluation of the stock assessment and addressing each Term of Reference.

Annex 3: AGENDA

SEDAR 51 Gulf of Mexico Gray Snapper Assessment Review
March 20-22, 2018
Tampa, FL

Tuesday

9:00 a.m.	**Introductions and Opening Remarks** *- Agenda Review, TOR, Task Assignments*	**Coordinator**
9:30 a.m. – 11:30 a.m.	**Assessment Presentations** **-** *Assessment Data & Methods* *- Identify additional analyses, sensitivities, corrections*	**Analytic Team**
11:30 a.m. – 1:00 p.m.	**Lunch Break**	
1:00 p.m. – 6:00 p.m.	**Assessment Presentations (continued)** **-** *Assessment Data & Methods* *- Identify additional analyses, sensitivities, corrections*	**Analytic Team**
6:00 p.m. – 6:30 p.m.	**Public comment**	**Chair**

Tuesday Goals**:** Initial presentations completed, sensitivity and base model discussion begun

Wednesday

- **8:00 a.m. – 11:30 a.m.**	**Panel Discussion** **-** *Assessment Data & Methods* *- Identify additional analyses, sensitivities, corrections*	**Chair**
- **11:30 a.m. – 1:00 p.m.**	**Lunch Break**	
1:00 p.m. – 6:00 p.m.	**Panel Discussion/Panel Work Session** *- Continue deliberations* *- Review additional analyses* *- Recommendations and comments*	**Chair**

Wednesday Goals**:** sensitivities and modifications identified, preferred models selected, projection approaches approved, Report drafts begun

Thursday

8:00 a.m. – 11:30 a.m.	**Panel Discussion** *- Final sensitivities reviewed.* *- Projections reviewed.*	**Chair** **Chair**
11:30 a.m. – 1:00 p.m.	**Lunch Break**	
1:00 p.m. – 5:30 p.m.	**Panel Discussion or Work Session** - *Review Reports*	**Chair**
- **5:30 p.m. – 6:00 p.m.**	**Public comment**	**Chair**
6:00 p.m.	**ADJOURN**	

Thursday Goals: Complete assessment work and discussions, final results available. Draft Reports reviewed.

VII-3. Appendix III: List of Participants

Review Workshop Panel

Dr. Kai Lorenzen, Chair..Chair, GMFMC SSC (Univ. of FL)
Dr. Luiz Barbieri...GMFMC SSC (FWRI)
Dr. Yong Chen... CIE Reviewer (Univ. of Maine)
Bob Gill.. GMFMC SSC
Dr. Laurence Kell .... CIE Reviewer (Hempstead, UK)
Dr. Peter Stephenson...CIE Reviewer (Perth, SU)

Analytic Representation

Dr. Jeff Isely (Lead)..SEFSC, Miami
Dr. Shannon Cass-Calay ....SEFSC, Miami

Appointed Observers

Ed Walker...Industry Representative

Observers

Beth Wrege...SEFSC, Miami

Staff

Dr. Julie Neer...SEDAR
Steven Atran...GMFMC
Doug Gregory...GMFMC
Karen Hoak...GMFMC
Ryan Rindone...GMFMC
Charlotte Schiaffo...GMFMC

GMFMC = Gulf of Mexico Fisheries Management Council, SSC = Scientific and Statistical Committee, SEFSC = Southeast Fisheries Science Center, SEDAR = Southeast Data, Assessment, and Review