Reviewer Report to the Center for Independent Experts on the Gulf of Mexico and South Atlantic Goliath Grouper Review Workshop (SEDAR 23) held November 15-17, 2010 in Key West, Florida.

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Executive Summary

This document contains my independent reviewer report of review activities and findings for the 23rd Southeast Data, Assessment and Review (SEDAR 23) Review Workshop, held November 15-17, 2010 at the Marriott Beachside Hotel in Key West, Florida. An assessment for goliath grouper, including the findings of the data and assessment workshops, and the status of the stock, were reviewed at the meeting.

The current distribution of goliath grouper in the USA is from North Carolina to Texas and in the USA Caribbean. Goliath grouper in the USA were treated as a single stock during this assessment. While there is genetic information that can be used to show that goliath grouper in USA waters differ from those in other areas, there is little information that can be used to evaluate finer scale stock structure.

Information about life history, commercial and recreational fisheries and abundance indices for goliath grouper were compiled for this assessment, including descriptions of uncertainties associated with this information, providing a comprehensive overview of what is known about this stock. A catch-free model was used to assess the status of goliath grouper. The catch-free model has the advantage that it does not rely on landings data (a major source of uncertainty in this assessment) when estimating abundance, with the disadvantage that only estimates of relative biomass can be provided from the model. The model was implemented in AD Model Builder (ADMB), and Bayesian methods implemented within ADMB were the primary method used to quantify uncertainty in the resulting estimates. The implementation of the model was technically sound, but some issues with the underlying assumptions and uncertainties in some data inputs led the review panel to question whether the resulting abundance and fishing mortality time series were adequate to form the basis for management advice. Key sources of uncertainty in the assessment include the commercial and recreational landings, maximum age and the status of the population at the start of the time period used in the model.

Notwithstanding these issues, the abundance indices do show increases that are likely indicative of an increase in the overall abundance for this stock. However, given the very rapid rate of increase in some of the indices, as well as the issues of fitting a model to these indices, in my opinion the extent to which the indices reflect the true change in abundance is not known. Additionally, assuming that fishing mortality was the primary cause of the abundance decline for goliath grouper, it does appear from the abundance increase that the moratorium has been effective in reducing fishing mortality.

Table of Contents

1.0. Background

This document contains my independent reviewer report of review activities and findings for the 23rd Southeast Data, Assessment and Review (SEDAR 23) Review Workshop, held November 15-17, 2010 at the Marriott Beachside Hotel in Key West, Florida. An assessment for goliath grouper, including the findings of the data and assessment workshops, and the status of the stock, were reviewed at the meeting. Prior to the meeting, the review committee (Appendix 1), was provided with a Statement of Work (Appendix 2), including the Terms of Reference (TOR) for the assessment as well as for the review panel (RP). Assessment documents and background material (Appendix 3) were provided via a website and/or by email during the three weeks prior to the meeting. During the meeting there was a general consensus among the RP for most of the main discussion points and findings of the panel as outlined in the Review Workshop Report. This document contains a summary of those findings as well as my own opinions about this assessment.

2.0. Individual Reviewer Activities

Prior to the meeting I reviewed the assessment and background documents provided for the workshop. I participated in the Review Workshop in Key West, Florida, November 15-17, 2010. This workshop benefited from the participation of both managers and fisheries representatives who were able to provide both background and personal experience with respect to goliath grouper. The assessment leaders from the stock assessment workshop presented the assessment results. The structure was fairly informal with a lot of discussion during each presentation, an approach that worked well in this case. During the meeting, I actively participated as member of the meeting review panel and questioned several aspects of the assessment. These issues are expanded upon in the next section.

After the review workshop, I prepared this individual, independent report and assisted in writing the Review Workshop Report. As outlined in Appendix 3, this independent report is intended to summarize review activities completed during the panel review meeting, including providing a detailed summary of findings, conclusions, and recommendations for each TOR. The following section in this document contains my findings for the goliath grouper assessment.

3.0. Summary of Findings, Conclusions and Recommendations in Accordance with the TOR's

3.1. Evaluate the adequacy, appropriateness, and application of data used in the assessment.

The RP reviewed the Data Workshop Report, the revisions to the data inputs described in the Assessment Workshop Report, and the supporting documentation. Together, these documents provided a comprehensive overview of the information available for the assessment of goliath grouper. The Assessment Team (AT) thoroughly documented the available information relating to stock structure, life history, commercial and recreational landings, and abundance indices; as well as an evaluation of the uncertainties associated with this information. While the utility of some the data for the assessment was questioned during the review, the limitations are mostly

due to the nature of the data themselves rather than the way the data were analyzed, presented and used by the AT.

A fundamental question in any assessment is the selection of appropriate stock units. The AT provided information on the distribution of goliath grouper in the USA: they are known to occur from North Carolina to Texas and in the USA Caribbean. Their distribution is patchy, with adults using high relief habitat and juveniles utilizing estuarine and fringing red mangrove habitat. This patchy distribution contributes to the difficulty assessing the stock. Additionally, the quantity of habitat has likely changed during the time period covered by the assessment (potentially having increased via the creation of artificial reefs and decreased as a result of the loss of mangrove habitat). It was not clear in the assessment how changing habitat quantity would affect either goliath grouper population dynamics or benchmarks such as B_0.

USA Goliath grouper were treated as a single stock during this assessment. While, as was described by the AT, there is genetic information that can be used to show that goliath grouper in USA waters differ from those in other areas, there is little information that can be used to evaluate finer scale stock structure. However, tagging information does show movement on scales typically less than 200 km; extirpations of spawning aggregations have been documented; and survey data show different adult trends on the Atlantic coast and in the Gulf of Mexico; all of which is potentially suggestive of finer scale population structuring. However, current information does not appear to be sufficient for more than a single stock to be delineated.

There was relatively limited discussion on stock structure during the review meeting, at least in part due to the limited information available. However, this remains a fundamental issue in any assessment because, if a finer scale population structuring does exist, less productive populations could potentially become overfished if harvested in mixed population fisheries at levels consistent with the average productivity (see Research Recommendations).

The AT thoroughly documented and evaluated the available life history information including size-at-age and associated growth models, maturity and reproduction, maximum age and natural mortality. The growth model developed by the AT combined data from a couple of sources, a decision that was justified particularly given that goliath grouper was being treated as a single stock. However, information about size-at-age comes from relatively few individuals and is not sufficient to characterize annual variability in growth, an issue that could be important when length information is used to estimate proportions-at-age, an important input into many assessment models. Little information was available for maturity and reproduction. Males are thought to mature around ages 4 to 6, and females around ages 6 to 7. Spawning is known to occur during late summer and early fall, but spawning frequency is not known. Fisheries models often include a spawning biomass per recruit component. Both age-at-maturity and spawning frequency are inputs into these models, although the latter can be subsumed into the spawner-recruit function if data are sufficient to estimate this relationship (which is not the case for goliath grouper). Maximum age for goliath grouper is not well known. The oldest observed age is 37 years, although as an estimate of the maximum age it is likely low given the heavy fishing pressure that occurred during the 1980's. The AT thoroughly investigated the effect of the assumed maximum age on the assessment, and demonstrated that the conclusions that would be

drawn from the catch-free model with respect to the magnitude of recovery are very sensitive to this parameter. This is a key source of uncertainty in this assessment.

The AT devoted considerable effort to deriving age-specific natural mortality (M) estimates, using a combination of Hoenig's method to derive a single value of M, and Lorenzen's model for deriving estimates of M at age. Given the paucity of species-specific information, the RP agreed with the AT that the use of Hoenig's method was appropriate, but had concerns with the use of Lorenzen's model for deriving age-specific estimates of M. First, Lorenzen's model has not been tested for this specific application and there are species and population assemblages for which mortality is higher for older/larger animals than for younger/smaller animals. One case in point is Atlantic salmon. For salmon in Canada's inner Bay of Fundy region, annual survival of parr (roughly 10-15 cm in length and ages 1-3) in fresh water has been estimated to be roughly 40% annually, whereas survival in the marine environment one year later is less than 20% (Gibson et al. 2008). Similarly, Fu et al. (2001) estimated that age-specific mortality of Atlantic cod on the Scotian Shelf changed during the 1990's such that the mortality of mature cod exceeded that of immature cod. As a third example, Swain et al. (2006) showed that mortality (apparently reflective of natural mortality) of winter skate in NAFO areas 4T and 4VW has changed, with decreases in juvenile mortality and increases in adult mortality. Application of Lorenzen's model to these species would not be appropriate. In addition, as pointed out by Dr. Hoenig during the review meeting, the Hoenig method provides estimates of natural mortality that are old enough to be exploited. If used, the Lorenzen method would be most suited for adjusting the mortality of juvenile fish upward, rather than to rescale mortality of all age classes to have an overall rate equation to Hoenig's M, as was done in this assessment. In summary, the AT thoroughly investigated the effects of maximum age and natural mortality on the assessment results, and used methods that are more or less appropriate. However, given that there is variability in age-specific mortality rates among species, whether the method applied here is better than a single estimate of M remains (at least to me) unclear. The use of AIC applied to the assessment model using different mortality functions as inputs, might be one way to choose an appropriate form for the mortality curve.

The AT also provided thorough descriptions of the data used to derive abundance indices, including the EMP creel survey, the REEF survey (Southeast and Southwest), the MRFFS survey and the DeMaria survey. The REEF and DeMaria surveys are fishery independent. Of these, the DeMaria survey ends in 2002 and does not cover the peak abundances in the mid-2000's, whereas the REEF survey begins in 1994 and does not cover the decline in mid 1980's. The EMP creel survey is the longest time series and is considered to be indicative mostly of the abundance of juveniles, but not adults. As with any fishery-based CPUE time series, changes in fisher behavior (potentially resulting from how anglers perceive the quality of fishing, information exchange, targeting, etc.), gear or other technological changes, or other factors can affect the resulting time series. Although industry representatives at the review workshop spoke about changes in the recreational fishery, it was not clear during the review meeting whether these changes were affecting these abundance indices. As shown in Figure 3.3.5 of the assessment report, the last 7 residuals of the fit of the catch-free model to the EMP creel survey series and 4 of the last 6 residuals of the fit to the MRFSS series were positive, indicating that the recent rapid increase in abundance was not consistent with the parameter values estimated with this model. The EMP index increased by a factor of roughly five between 2002 and 2007.

The AT did a thorough job when standardizing the indices. In the case of the EMP series, the AT used a delta-lognormal modeling approach including the variables year, angler skill, area and season. The resulting standardized abundance time series was roughly similar to the un-standardized series, indicating that changes in these variables were not a significant determinant of abundance. I would have liked to have seen time series of the residuals for skill level to see whether the pattern for skilled and unskilled anglers was the same (changes in fishing practices might be expected to affect skilled and unskilled anglers differently), but these were not available at the meeting.

The REEF index is comprised of observations of volunteer divers trained in the roving diver technique. After each dive, they assign an abundance category to each species: (1) a single fish, (2) 2-10 fish, (3) 11-100 fish, or (4) >100 fish. It was not clear that this logarithmic scaling could capture smaller increases in abundance, an issue that could be tested via simulation. Additionally, the data were heavily filtered (34,143 surveys at 1,700 dive sites, down to 11,663 surveys at 77 sites) based on the number of years the site was sampled and whether goliath grouper were ever encountered there. It is unclear how this thinning would affect the overall abundance index. These data were also standardized to correct for differences in sites, visibility, etc. between years. As pointed out by the AT, the southwest and southeast REEF indices show very different patterns. Although abundance is higher in the southwest, most of the increases are occurring in the southeast. If these indices are intended to be indicative of an overall trend of a single stock, there remains the issue of how to weight these indices in an assessment. Personally, if goliath grouper are being considered as a single stock, I would prefer to see a single index derived from this wide-spread survey rather the split that was used which resulted to two time series showing different trends. Although the data report recommends more surveys from more sites in the southwest to improve the index in this region (considered the centre of abundance), particularly if habitat use and distribution are density dependent, a single survey that encompasses the range of this goliath grouper stock might provide a better overall picture of abundance trends for this stock.

The DeMaria index is of particular interest because these data were initially used to highlight the abundance decline. It is also the only adult index to cover the decline in the early 1980's. A key issue with this index is that it has limited spatial coverage. As such it could represent a local depletion and recovery. Additionally, as highlighted in Porch and Eklund (2004), these sites were offshore and may have been some of the last known aggregations. Because they may not have been depleted by decades of fishing, their higher abundance in the early 1980's may not have represented the depleted state of the stock. This is an important issue when considering how to include this index in the model.

The AT also provided a thorough description of the reported commercial landings, highlighting the uncertainty resulting from under- and over-reporting. The AT did not attempt to correct for unreported or under-reported landings because of the lack of an objective criterion to make this adjustment. The AT did modify the commercial landings to adjust for inflated landings by a seafood dealer in Lee County. While the RP did not have good criteria for assessing or critiquing this adjustment, it did note that the adjusted Florida-wide time series showed reported landings remaining roughly stable from the mid-1960's to mid-1980's, whereas the unadjusted time series showed a decrease in the reported landings from the mid-1970's to the mid-1980's that

intuitively appeared more consistent with the idea that abundance was in decline during that time. No recommendation is made on how to resolve this question, but if these data are used in a model including catch, evaluation of the robustness of conclusions to the adjustment would be warranted.

Another source of uncertainty in this assessment is mortality associated with the recreational fishery (both harvests and hook-and-release mortality). Preliminary recreational landings were compiled after the data workshop, but were not needed for the catch-free model and could potentially be used in an assessment model that uses landings. Hook-and-release mortality remains a source of uncertainty as well. A value of 5% was assumed for juvenile fish, but whether this value is appropriate for older goliath grouper remains unclear, particularly given the issues of barometric trauma and injuries that can result if these fish are removed from the water (as described at http://myfwc.com/rulesandregs/Saltwater_Regulations_GoliathGrouperCatchRelease.htm).

3.2. Evaluate the adequacy, appropriateness, and application of methods used to assess the stock.

Two assessment models were presented at the review workshop: the catch-free model modified and updated from SEDAR 6, and a preliminary stock reduction analysis (SRA). The latter model had not been reviewed by the AT and the review panel was instructed at the review meeting not to consider its output when evaluating the catch-free model. The catch-free model has the advantage that it does not rely on landings data (a major source of uncertainty in this assessment) when estimating abundance, with the fundamental disadvantage that only estimates of relative biomass are provided. As such, the model cannot easily be used to evaluate the effects of management regulations, for example whether or not the population would be expected to increase in size at a given TAC. The stock reduction analysis does rely on landings data to scale to biomass, but does provide estimates of the actual, not relative abundance, and is therefore more useful for providing management advice. With the caveat that I don't know that a complete version of the stock reduction analysis would have been accepted, my personal preference would have been to see the stock reduction analysis as the primary model, with some coarse sensitivity analyses with respect to the landings providing alternate states of nature. Further work with the SRA model is a research recommendation of mine. Although the catch-free model has limits for providing specific advice for fisheries management, the catch-free model could be a very valuable tool for evaluating the results of other assessment models, particularly those where the landings are uncertain, by comparison of the relative trends produced by the two models.

Notwithstanding the issue of only providing relative estimates, the decision to use the catch-free model is not unreasonable given the limited information available about the catch. The AT thoroughly investigated the model, providing a continuity run a proposed base run, and multiple runs to evaluate the sensitivity of the model to assumptions about maximum age, assumptions about the starting year in the model and assumptions about the effectiveness of the moratorium. The effectiveness was included in the model as a prior probability density based on Data Workshop participants' opinions. During the Review Workshop, the AT also ran the model with an uninformative prior for this parameter, and found that the model converged to a higher effectiveness than with the prior. Based on the thorough analyses provided in the assessment

report as well as the behavior of the model during further exploratory runs at the assessment workshop, in my opinion the model itself appears to be technically sound in the sense that it does what is expected. Most of the issues leading to the non-acceptance of the model output have to do with assumptions and data inputs for the model, and their potential influence on the model output. These are elaborated upon below.

A key assumption of the catch-free model is that abundance is near virgin size at the start of the time series in 1950. This assumption is likely violated given the history of exploitation that dates back to at least the late 1800's (the history of this fishery is well described in the Data Workshop report). It was not clear during the review that the extent that the stock had recovered to some biomass-based reference level (e.g. $B_{50\%SPR}$), would not be largely determined by the assumed stock size at the start of the time series.

Information about the maximum lifetime reproductive rate is input into the model via a prior, and this parameter is then estimated in the model. The prior (shown in Porch et al. 2006) appears reasonable (based on the data used to derive the prior) and has a mode of less than 10 spawners produced per spawner throughout its life. The point estimates in nearly all model runs are greater than 20 spawners/spawner. The value of 22 spawners/spawner estimated by the base model run is towards the upper end of the range for any species based on the meta-analysis by Myers et al. (1999). This higher value likely results from fitting to the indices showing rapid increases in the early 2000's (note that the continuity run provides an estimate of 8.8 spawners/spawner). Additionally, at the request of the RP, the AT produced a time series of recruitment residuals that showed mostly negative values early in the time series, with mostly positive residuals during the period of rapid increase. This pattern further highlights the difficulty the model has fitting the abundance increases shown in some surveys during the early and mid 2000's.

Selectivity is estimated outside the model. One of the methods uses an assumed F to adjust for unequal cohort sizes. As pointed out by Sven Kupschus, this is somewhat circular. A value of F is assumed to estimate selectivity, and the resulting selectivity curve is used to estimate relative F. I think the only way to address this issue would be to estimate the selectivity in the model, although it is not clear that the data would support this.

While the catch-free model does not require landings, it uses either effort or a proxy for effort as an input. In this assessment, the census population size to 1980 is used as a proxy (it is not clear to me that the assumption that fishing mortality is proportional to human population size is an improvement over using the reported landings, either adjusted or unadjusted, together with the existing recreational data and some assumptions about this fishery in the past). The effect of this assumption is evident in the smooth increase in relative F from 1950 to 1980, after which the indices become informative about relative F. Fishing mortality estimates spike very rapidly in the early 1980's, likely in an attempt to fit the rapid decrease in the DeMaria index. As mentioned, this decrease may be a local event representing the loss of a few remaining spawning aggregations in an already depleted stock rather than being indicative of an overall trend. After the moratorium is imposed in 1990, estimates of relative F are largely the result of the prior on the effectiveness of the moratorium coupled with the high rate of increase in some indices. The high rate of increase contributes to both high estimates of the effectiveness as well as high estimated productivity.

Another assumption of this catch free model is that the underlying population dynamics remain unchanged during the time period over which the stock is being assessed. If the amount of either juvenile or adult habitat has changed during this time period, then the degree to which density dependence governs recruitment would also be expected to have changed. In addition to uncertainty as to the degree that the stationarity assumption has been violated in this assessment, changes in habitat quantity also raise questions about the selection of appropriate benchmarks: i.e., whether the benchmarks should be based on past conditions (habitat amount), present conditions, or future potential conditions. This is more of a management than an assessment issue, but guidance on this topic might be beneficial for future assessments.

Finally, the AT did a very thorough job of investigating the effect of the assumed maximum age on the assessment results, and clearly showed that if the remainder of the assessment is accepted, the status of the population relative to $B_{50\%SPR}$ is determined by this assumed value. The base model run (maximum age of 37 y) indicates that the 2009 biomass is 96% of this reference level, whereas at an assumed maximum age of 60 y, the 2009 biomass is 59% this level.

Given the issues with the model discussed above, combined with some issues with the data inputs discussed in the previous section, I was not able to accept that the model output sufficiently characterized fishing and biomass trajectories for this goliath grouper stock. Specifically, given the uncertainty in biomass reference levels arising from the assumption that the population was near an unfished equilibrium at the start of the time series, I was not willing to accept that this stock had recovered to $B_{50\%SPR}$.

3.3. Recommend appropriate estimates of stock abundance, biomass, and exploitation.

Although the catch-free model can provide relative estimates of biomass and exploitation, and is therefore useful for estimating abundance trends, because it is not scaled to the absolute population size it is not suitable for providing estimates of the stock abundance or, in its current form, exploitation (but see comments in Section 3.4).

For the reasons above, I cannot recommend appropriate estimates of stock abundance, biomass and exploitation based on this assessment at this time. However, it does appear clear from the abundance indices that the abundance of this stock (or stock aggregate) is increasing, although in my opinion, based on the issues when fitting to these indices discussed in Sections 3.1 and 3.2, the extent to which these indices reflect the true change in abundance is not known. Additionally, assuming that fishing mortality was the primary cause of the abundance decline for goliath grouper, it does appear from the abundance increase that the moratorium has been effective in reducing fishing mortality.

3.4. Evaluate the methods used to estimate population benchmarks and management parameters (e.g., MSY, Fmsy, Bmsy, MSST, MFMT, or their proxies); recommend appropriate management benchmarks and provide estimated values for management benchmarks, and declarations of stock status.

The AT used the catch-free model to estimate relative fishing mortality and biomass compared to the benchmarks $F_{50\%SPR}$ and $B_{50\%SPR}$. Because, these are relative estimates, absolute estimates were not provided. Additionally, SPR-based reference points are sensitive to the assumed maximum age, particularly if the maximum age is used to determine and re-scale natural mortality as was done in this assessment. The appropriateness of other levels of %SPR were not discussed at the workshop, but given that the mode of the prior for the maximum lifetime reproductive rate (used to reflect belief) used as an input in the model and its resulting estimate by the model (at least partially determined by the rapid recent increase in the abundance indices) show very different levels of productivity, it is unlikely that a strong case for an alternative level could have been made. At this time, appropriate benchmarks or associated values based on this assessment cannot be provided.

Although not discussed at the Review Workshop, it is not clear to me that estimates of annual fishing mortality could not be obtained from this model. With the understanding that the inputs are sensitive to assumptions about maximum age, the values required to calculate %SPR for a given F (vulnerability-at-age, natural mortality-at-age, biomass-at-age, maturity-at-age) are available as inputs, so a value for a reference level such as $F_{50\%SPR}$ could be calculated. If this value is known and annual estimates of F relative to this value are known, then absolute estimates of the annual fishing mortality rates could be calculated. Similarly, if a Beverton-Holt model is used as the spawner-recruit relationship, as it was in the catch-free model, then I believe that for a given set of SPR inputs the estimate of the slope at the origin (in terms of recruits per unit spawner biomass produced annually) should map one-to-one to F_{MSY}. If true, then a comparison of F_{MSY} with the $F_{\%SPR}$ values might help to address the issue of selecting an appropriate %SPR level to use as a benchmark.

3.5. Evaluate the adequacy, appropriateness, and application of the methods used to project future population status; recommend appropriate estimates of future stock condition (e.g., exploitation, abundance, biomass).

The AT provided projections of relative biomass and relative fishing mortality using methods that are relatively standard in assessment models. Projections were made based upon the state of the population and the relative fishing mortality rate in the final year of the assessment (2009). The spawner-recruit relationship and natural mortality were also used in the projections. Projections were made deterministically, and parameter uncertainty was carried forward into the projection model via MCMC. This method ensures that the uncertainty in the current stock biomass and current fishing mortality, including covariance in the estimated model parameters, is carried forward throughout the projections. Further uncertainty could have been added by including random variability in the fishing mortality, natural mortality and spawner-recruitment processes, thereby adding (at least the illusion of) greater realism to the projections. While inclusion of factors such as implementation uncertainty, episodic sources of mortality (e.g. cold kills) or good and bad recruitment years, would increase the uncertainty in future years, in my opinion the data presented in the assessment are not sufficient to derive the underlying sampling distributions for these processes. For this reason, in my opinion the methods used were sufficient for this assessment.

Although I believe the methods used to project future stock abundance are adequate and appropriate, appropriate estimates of future stock conditions cannot be provided for the reasons discussed in Section 3.1 and 3.2.

3.6. Evaluate the adequacy, appropriateness, and application of methods used to characterize uncertainty in estimated parameters. Provide measures of uncertainty for estimated parameters. Ensure that the implications of uncertainty in technical conclusions are clearly stated.

The AT used two basic approaches to characterizing uncertainty in the estimated parameters: via the provision of measures of precision (standard errors and posterior distributions) associated with model outputs, and via sensitivity analyses to key model assumptions. I believe both approaches were implemented appropriately and thoroughly.

The decision by the AT to implement the model in ADMB facilitated characterizing the uncertainty in the estimated parameters. As part of its standard output, ADMB provides standard errors (based on normal approximations and the delta method) for estimated parameters and derived values. Additionally, ADMB can produce posterior probability distributions for parameters of interest via Markov Chain Monte Carlo (MCMC) methods implemented using the Metropolis Hastings algorithm. Both methods were used by the AT. Of the two methods, I prefer MCMC because it produces estimates of the marginal posterior probability distributions that constrain the resulting confidence intervals to be within the parameter bounds, and additionally parameter covariance is preserved when the model estimates the posterior probability density. The methods used in this assessment to choose an appropriate burn-in period and thinning level appeared appropriate. MCMC also has the advantage that the cumulative probability distributions can be used to assess the probability the management benchmarks would be met or exceeded, an approach appropriately used by the AT for each model run.

In addition to assessing the uncertainty associated with parameter estimates from a single model fit, there is additional uncertainty that results from decisions about data inputs and model structure. As discussed in Section 3.2, the AT thoroughly investigated the effect of the assumption about maximum age on the assessment results. These analyses provided by the AT were helpful in reviewing this assessment.

While I believe the methods used by the AT to characterize uncertainty were adequate, estimates of the uncertainty associated with parameter estimates cannot be provided because the parameter estimates are not accepted.

3.7. Ensure that stock assessment results are clearly and accurately presented in the Stock Assessment Report and that reported results are consistent with Review Panel recommendations.

This TOR is ongoing at the time of writing of this independent reviewer report (this report is due before the Summary Report).

3.8. Evaluate the SEDAR Process as applied to the reviewed assessments and identify any Terms of Reference which were inadequately addressed by the Data or Assessment Workshops.

Even though the final assessment model results were not accepted by the RP, I believe the SEDAR process has, overall, led to a comprehensive compilation of information about this goliath grouper stock. The data workshop and assessment workshop reports were very good summaries and sufficient detail was provided in the background material. I particularly appreciated the flexibility afforded to the reviewers by the workshop chair when allowing us to spend a lot of time on topics that we considered to be important. During the meeting, I did request a time series of residuals from the GLM used to standardize an abundance index, but it could not be made available during this review. While it would not have changed the outcome of this assessment, it might have helped with me to better understand this data series and future reviews might be improved if these types of requests can be addressed.

My comments on the extent to which specific TORs for the Data and Assessment Workshops were addressed are:

Data workshop:

1. Characterize stock structure and develop a unit stock definition. Provide maps of species and stock distribution.

    This TOR was addressed. Further comments with respect to stock structure are provided in Section 3.1.

2. Review, discuss and tabulate available life history information (e.g., age, growth, natural mortality, reproductive characteristics); provide appropriate models to describe growth, maturation, and fecundity by age, sex, or length as applicable. Evaluate the adequacy of available life-history information for conducting stock assessments and recommend life history information for use in population modeling.

    This TOR was thoroughly addressed in the Data Workshop Report and updated in the Assessment Workshop Report. Further comments with respect to life history information are provided in Section 3.1.

3. Provide measures of population abundance that are appropriate for stock assessment. Consider and discuss all available and relevant fishery dependent and independent data sources. Document all programs evaluated, addressing program objectives, methods, coverage, sampling intensity, and other relevant characteristics. Provide maps of survey coverage. Develop CPUE and index values by appropriate strata (e.g., age, size, area, and fishery); provide measures of precision and accuracy. Evaluate the degree to which available indices adequately represent fishery and population conditions. Recommend which data sources are considered adequate and reliable for use in assessment modeling.

    This TOR was fully addressed. Considerable detail about the abundance indices was available in the background documentation as well as the Data Workshop report.

4. Characterize commercial and recreational catch, including both landings and discard, in pounds and number. Provide estimates of discard mortality rates by fishery and other strata as appropriate or feasible. Evaluate and discuss the adequacy of available data for accurately characterizing harvest and discard by species and fishery sector. Provide length and age distributions if feasible. Provide maps of fishery effort and harvest.

This TOR was addressed to the extent possible in the Data Workshop Report. Although considerable uncertainty remains with respect to both the landings and discards, this uncertainty was well documented by the AT. I found the historical description of the fisheries to be very informative.

5. Provide recommendations for future research in areas such as sampling, fishery monitoring, and stock assessment. Include specific guidance on sampling intensity (number of samples including age and length structures) and appropriate strata and coverage.

This TOR was addressed. My specific comments on these recommendations are provided in Section 3.9 of this report.

6. Develop a spreadsheet of assessment model input data that reflects the decisions and recommendations of the Data Workshop. Review and approve the contents of the input spreadsheet by June 1.

A spreadsheet of data inputs was provided for the Review Workshop

7. Prepare the Data Workshop report providing complete documentation of workshop actions and decisions (Section II. of the SEDAR assessment report). Develop a list of tasks to be completed following the workshop.

The Data Workshop report was prepared, including documentation of actions and decisions as well as tasks to be completed after the workshop.

Assessment workshop:

1. Review any changes in data following the data workshop and any analyses suggested by the data workshop. Summarize data as used in each assessment model. Provide justification for any deviations from Data Workshop recommendations.

This TOR was addressed in the Assessment Workshop Report.

2. Develop population assessment models that are compatible with available data and recommend which model and configuration is deemed most reliable or useful for providing advice. Document all input data, assumptions, and equations.

This TOR was addressed in the Assessment Workshop Report (see Section 3.2 for further discussion about this TOR).

3. Provide estimates of stock population parameters (fishing mortality, abundance, biomass, selectivity, stock-recruitment relationship, etc); include appropriate and representative measures of precision for parameter estimates.

> This TOR was addressed to the extent possible in the Assessment Workshop Report. As discussed here in Sections 3.2 and 3.3, the catch-free model only provides estimates of relative biomass and fishing mortality.

4. Characterize uncertainty in the assessment and estimated values, considering components such as input data, modeling approach, and model configuration. Provide appropriate measures of model performance, reliability, and 'goodness of fit'.

> This TOR was well addressed in the Assessment Workshop Report (further discussion of this TOR is provided in Sections 3.2 to 3.5 of this reviewer report).

5. Provide yield-per-recruit, spawner-per-recruit, and stock-recruitment evaluations, including figures and tables of complete parameters.

> This TOR was reasonably addressed in the Assessment Workshop Report (further discussion of this TOR is provided in Sections 3.2 to 3.5 of this reviewer report).

6. Provide estimates for SFA criteria consistent with applicable FMPs, proposed FMPs and Amendments, other ongoing or proposed management programs, and National Standards. This may include: evaluating existing SFA benchmarks, estimating alternative SFA benchmarks; and recommending proxy values.

> The Review Workshop Report provided assessments relative to several SPR based benchmarks.

7. Provide declarations of stock status relative to SFA benchmarks.

> This TOR was addressed in the Assessment Workshop Report.

8. Perform a probabilistic analysis of proposed reference points and provide the probability of overfishing at various harvest or exploitation levels.

> This TOR was addressed to the extent possible in the Assessment Workshop Report. The model used does not allow evaluation of various harvest levels.

9. Project future stock conditions (biomass, abundance, and exploitation) and develop rebuilding schedules if warranted; include estimated generation time. Stock projections shall be developed in accordance with the following:

A) If stock is overfished:
F=0, F=current, F=Fmsy, Ftarget (OY),
F=Frebuild (max that rebuild in allowed time)
B) If stock is overfishing

F=Fcurrent, F=Fmsy, F= Ftarget (OY)
C) If stock is neither overfished nor overfishing
F=Fcurrent, F=Fmsy, F=Ftarget (OY)

This TOR was addressed to the extent reasonable in the Assessment Workshop Report. Projections were carried out using the current year F which is appropriate given the nature of the catch-free model.

10. Provide recommendations for future research and data collection (field and assessment); be as specific as practicable in describing sampling design and sampling intensity and emphasize items which will improve future assessment capabilities and reliability.

Research recommendations with respect to future research and data collection were provided.

11. Prepare an accessible, documented, labeled, and formatted spreadsheet containing all model parameter estimates and all relevant population information resulting from model estimates and any projection and simulation exercises. Include all data included in assessment report tables and all data that support assessment workshop figures.

This TOR was addressed and updated at the Review Workshop.

12. Complete the Assessment Process Report (Section III of the SEDAR Stock Assessment Report), prepare a first draft of the Summary Report, and develop a list of tasks to be completed following the workshop.

This TOR was addressed.

3.9. Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations or prioritizations warranted. Clearly denote research and monitoring needs that could improve the reliability of future assessments. Recommend an appropriate interval for the next assessment, and whether a benchmark or update assessment is warranted.

Research recommendations were provided from some of the working groups. My comments with respect to these recommendations are below. In my opinion, research that addresses stock structure, addresses uncertainties in life history in the context that it is used in the assessment model, and research that improves the usefulness of the existing data are priorities.

DATA WORKSHOP RESEARCH RECOMMENDATIONS

LIFE HISTORY WORKING GROUP

Stock Definition:

- D. Jones has new MARFIN funding to use otolith microchemistry (laser ablation) to determine if there are distinct subpopulations based on geographic differences in chemical signatures. Juvenile habitat would be represented at the origin of otolith, adult habitat at the margins (SA and/or Gulf) ***goliath grouper were not originally considered in this MARFIN proposal, but could easily be added with availability of otoliths and moderate time resources.*

  Although I cannot comment on this specific proposal, this method has been useful for delineating stock structure for some species and thus warrants further consideration (see next comment).

- Koenig referenced the availability of goliath grouper eggs from the SA and GOM which could be used for genetic population structure analysis. Eggs will be sampled for Dr Matthew Craig (U Puerto Rico) who has done the most extensive work on goliath grouper population genetics (Craig et al. 2009).

  I fully support research that will help identify population structure. Further research using methods such as tagging, morphometrics and microchemistry (analogous to the otolith work that has been done for American shad, if appropriate structures to be sampled can be identified) is recommended, in addition to finer scale genetic research. An emphasis on sampling in ways that both identify populations (sampling mature fish when spawning) and when populations are mixed (to identify the amount of mixing) is important. While genetic research has proven useful for identifying relatively large groupings (e.g. ESU's), it is not clear to me that it is as useful for examining population structure, particularly if divergence has been recent (as would be the case with re-colonization) or when there are low levels of straying among populations. In my personal opinion, genetic research coupled with other studies may be most useful.

- Description of larval stages of goliath grouper is part of an ongoing MARFIN project by Koenig and Coleman.

  While certainly of interest, I don't believe this recommendation will lead to an improved assessment.

- Limited recent drifter studies along the US South Atlantic coast have shown the potential for wide distribution patterns along the coast from Cape Hatteras to the Florida Keys (Lesher and Sedberry, SEDAR 10-DW-06). With location and timing of spawning now known, it would be a good opportunity to initiate additional drifter studies in the SA and GOM.

  While certainly of interest, I don't believe this recommendation will lead to an improved assessment unless it can be demonstrated to be informative about population structuring.

- Ongoing research (Koenig and Coleman) will verify known SPAGS and suspected SPAGS. It will also determine the size structure of spawning fish, their residency time on the SPAGS, and size-related fecundity. With more known SPAGS, there is the potential to assess the abundance of reproductive adults based on numbers present at SPAGS and knowing the geographical range of the participating spawners.

  I do not fully understand this recommendation.

Age and Growth:

- A directed effort to collect hard parts from large, old fish to validate these methods for old individuals.

  Maximum age is a major source of uncertainty in this assessment and this recommendation has the potential to help establish maximum age.

- More detailed information on maximum age and size is needed. There are no new data available for maximum age or maximum size since Bullock et al. 1992. There is reason to suspect that maximum age is a low estimate due to the small number of large, old fish sampled. Additionally, there is concern over whether or not the asymptote is fully represented due to the low number of samples represented at the oldest ages (Fig.1). However, this maximum age does fall within the values observed for other epinephelines [i.e., *E. fuscoguttatus* (42 y for females and 40y for males; Pears, 2006), *E. morio* (29 y; Lombardi-Carlson et al., 2006), *E.*), *H. nigitus* (41 y; Manooch, 1987), *E. striatus* (29 y; Sadovy and Eklund 1999)]. However, the best species for comparison (due to similar size, tropical/subtropical distribution and ecological role) are the Indo-Pacific *E. lanceolatus* and *E. tukula*; data on maximum size, age and growth rate are still being sought at the time of writing the present report.

  I agree that better information about maximum age would help to inform the assessment, but it is not clear to me what is being proposed here.

- As suggested during the last SEDAR (SEDAR6, 2004): "The panel recommended continued work on ageing. Ages should be standardized to a calendar year, so that information on a year class is treated consistently throughout the year."

  I agree that age data used in the assessment should be standardized, if it is not already.

Reproduction

- Ongoing research (Koenig and Coleman, MARFIN) will evaluate fecundity, sexual pattern, SPAG distribution, size structure and sex ratio within SPAGS, and mating system using non-lethal methods.

  This research will likely be informative with respect life history, but as a research recommendation with respect to a stock assessment, linkages to a new assessment method should be developed to ensure that data are collected in a way that is most informative for the assessment process.

Habitat and Movement:

- We need spatially-explicit models. Due to microhabitat preferences and site attachment in both juvenile and adult goliath groupers, density values (as number of individuals per unit area or length of coastline) should be used with caution in population estimates and modeling; it is essential to contrast densities in high quality habitats versus low quality habitats, and not use a single density value which could results in over-estimates of total population levels. Future modeling efforts should also account for the known (or unknown) statewide spatial distribution of both juveniles and adults.

  This kind of research can be informative about population structuring (see next comment).

- We need a state-wide evaluation of habitat quality integrating habitat structure and water quality. Including this knowledge in our goliath grouper assessments will allow us to expand population models into ecosystem-based management.

As a research scientist that works with endangered salmon populations, I certainly support research that allows assessments to provide advice beyond fisheries management, and that places fisheries in a larger context as only one of the human activities that impact on fish populations. Assessing habitat quality and quantity is an important step towards ecosystem-based management.

- What is the extent of high quality mangrove habitat, and where is it located in Florida? There is a need for a state-wide assessment of mangroves as fish habitat, to evaluate potential high quality sites that are the nurseries, not only for juvenile goliath grouper but also for juveniles of a diverse group of other fish and invertebrate species.

  As above.

- When evaluating high quality habitat (both in mangroves and reefs), in addition to evaluating the structural characteristics, what is the water quality of each habitat? There is a need to quantify, state-wide in real time and 24/7 the water quality (salinity, temperature, dissolved oxygen) of mangroves, and coastal reefs. This research question applies not only to goliath grouper but also to all estuarine and coastal species that use mangroves and reefs (coral reefs, reef ledges) during their life history.

  As above.

- What are the biological corridors used during the ontogenetic migrations (from juvenile mangrove habitat to reef adult habitat) and the spawning migrations (from resident habitat to spawning aggregation sites)? We don't know if goliath grouper use a specific path or network (=biological corridor) during their two major migratory events (ontogenetic and reproductive).

  I support this research recommendation to the extent that it may be informative about population structuring and habitat use.

- What are the maximum distances that can be covered by juveniles in ontogenetic migrations towards the adult habitat, and by adults in their spawning migrations? These data are needed to understand the ontogenetic and spawning connectivity within the goliath grouper population.

  As above.

COMMERCIAL AND RECREATIONAL STATISTICS WORKING GROUP

- The prohibition on any harvest of goliath grouper precludes any fishery dependent research other than that conducted by on-board observers or recorded in fishermen's logbooks. Continued collection of size, frequency in the catches by gear, and observed release condition is important for obtaining release mortality estimates and possibly an estimate of numbers caught by gear, fishing area, and depth. It is expected that as the abundance of this species increases, so too will the frequency of encounter with fishing gears. Brusher and Schull's (2009) study that goliath grouper have a reasonably good chance of surviving the encounter with fishing gear at least in shallower waters. Capture-recapture studies could be designed to examine the effects of releases from the recreational fishery. With the apparent increase in numbers of goliath grouper reported by anglers, it is inevitable that more encounters with fishing gear will occur and this seems to be borne out by reports from angler surveys such as the ENP Angler Creel Survey and the MRFSS. Surveys of spawning aggregations are needed to extend the usefulness of Don DeMaria's earlier surveys and to monitor population trends of adults.

  Release mortality, particularly for larger animals, is a source of uncertainty in this assessment and warrants further research.

REVIEW PANEL RESEARCH RECOMMENDATIONS

I endorse the review panel draft recommendations as listed below.

Stock Definition:

- Goliath grouper should be genetically sampled from as many areas in the South Atlantic and Gulf of Mexico as possible to allow for a more thorough examination of the current single stock definition.

- Examination of spawning aggregations over the entire distribution range should include seasonality, sex ratios, and individual fidelity.

Long-term monitoring:

- Basic reproductive data are lacking throughout the species distribution, including: size and age at maturity for each sex, sexual sequence with size and age for each sex, and fecundity.

- As described in the above research recommendations by the Life History Working Group, research on age structure, and locations of suitable juvenile and adult habitat, discard and discard mortality rates should be accomplished throughout the species distribution.

Economic impact:

- Because of the relatively small size of a potentially reopened consumptive fishery for goliath grouper, a socio-economic evaluation of the relative benefits of consumptive versus non-consumptive uses would be beneficial. There may be greater long-term economic benefit to development of sustainable non-consumptive eco-tourism venues than would be possible from a consumptive fishery [jg: this does not preclude the need for an assessment].

OTHER RESEARCH RECOMMENDATIONS

- In my own research and assessments for diadromous fish, I deal regularly with index data including counts of fish by divers, salmon redd counts, recreational fishery CPUE, and juvenile fish densities obtained by electrofishing. I've found that in some, but not all cases, the utility of the data can be considerably improved with relatively few annual population estimates that can be used to establish the relationships between the index and population size. I recommend that, if possible, population estimates (possibly split by habitat type to obtain juvenile and adult estimates) be obtained using mark-recapture or some method, and if possible, at a couple of abundance levels. While I appreciate that this can be expensive and is not easy, it could go a long way towards improving the usefulness of the index data, both from the past and in the future, particularly if it proves to be impossible to scale the assessment to abundance using fisheries data. An example of a model I've used to

scale indices to abundance can be found in the appendix of Gibson and Bowlby (2009) and in Gibson and Amiro (2003). Both are available online. See also Rago (2001), who makes a similar recommendation for some salmon assessments.

- In my personal opinion, I work like to see further assessment work using the SSRA model, or a similar model that provides estimates of abundance, to fully explore the data limitations associated with uncertainty in the catch. Further work with this model would help to establish whether fisheries management advice could be provided using the existing data, or whether a completely new assessment method, including new data collections is necessary if an assessment for this stock that provides abundance estimates is to be completed.

With respect to the next assessment, given the issues with this assessment, a benchmark assessment is warranted, however recommendation of an appropriate time period for the next assessment is problematic given the questions raised during this process. The timing depends on progress made to address these questions, as well as the management requirements for advice. My opinion on this may differ somewhat from other review panel members in that, as mentioned above, I would like to see further work with the SSRA (or a similar model that provides estimates of abundance) as a first step towards a new assessment. If further work with the SSRA model produces results that are reliable then an assessment could potentially take place in the near term, whereas if further data collection is required (as identified from further analysis) then the next assessment could be considerably delayed as the data collection occurs. If further work with the SSRA (or a similar) model does not lead to reliable advice given the uncertainty in the landings, then it does not appear likely that an assessment will be possible until sufficient new data have been collected. Given that this species was considered by the IUCN to be critically endangered throughout its range, is known to be vulnerable to random events such as cold kills and habitat loss is known to have occurred, in my opinion development of a sound assessment methodology is warranted.

3.10 Prepare a Peer Review Summary summarizing the Panel's evaluation of the stock assessment and addressing each Term of Reference. Develop a list of tasks to be completed following the workshop. Complete and submit the Summary Report within 3 weeks of workshop conclusion.

This TOR is also ongoing at the time of writing of this independent reviewer report. Writing tasks for the Peer Review Summary were assigned to the RP members at the meeting, and a schedule was developed to ensure the Summary Report would be completed on time. At the time of writing of this independent report, the Summary Report appears to be on schedule.

4.0. Acknowledgments

Overall, I believe that this assessment review meeting provided a thorough review of the status of goliath grouper as a result of the hard work of many people. Thanks go to to Luiz Barbieri for an excellent job in chairing the meeting, particularly for providing the RT the latitude for long discussions on some issues arising during the review. Joe O'Hop (assessment team lead) and

Joseph Munyandorero presented the assessment and carried out further analysis during the review meeting. Their efforts greatly helped this review. I also wish to thank the other panel members, Barbara Dorf, John Hoenig, Shannon Calay, Kevin Stokes, Sven Kupschus, for stimulating discussions both during and around the meeting; and Manoj Shivlani for his work coordinating the review on behalf of CIE and his assistance with travel arrangements. Julie Neer provided coordination around the meeting and ongoing guidance about the overall SEDAR process.

5.0. References

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6.0. Appendices

Appendix 1: Panel Membership
Appendix 2: CIE Statement of Work
Appendix 3: Bibliography of Materials Provided for Review

Appendix 1: Review Panel Membership.

Review Panel Membership

Member	Primary Affiliation	Role
Luiz Barbieri	Florida Fish and Wildlife Conservation Commission, USA	Chair
Barbara Dorf	Texas Parks and Wildlife Department, USA	Reviewer
John Hoenig	Virginia Institute of Marine Science, USA	Reviewer
Shannon Cass-Calay	Southeast Fisheries Science Center, USA	Reviewer
Kevin Stokes	Stokes.net.nz Ltd, New Zealand	Reviewer; CIE
Sven Kupschus	Centre for Fisheries and Aquaculture Science, England	Reviewer; CIE
Jamie Gibson	Bedford Institute of Oceanography, Canada	Reviewer; CIE

Appendix 2: CIE Statement of Work.

Attachment A: Statement of Work for Dr. Jamie Gibson

External Independent Peer Review by the Center for Independent Experts

SEDAR 23 Gulf of Mexico and South Atlantic Goliath Grouper Review Workshop

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

Project Description: SEDAR 23 will be a compilation of data, a benchmark assessment of the stock, and an assessment review conducted for Gulf of Mexico and South Atlantic Goliath Grouper. The review workshop provides an independent peer review of SEDAR stock assessments. The review panel is ultimately responsible for ensuring that the best possible assessment is provided through the SEDAR process. The stocks assessed through SEDAR 23 are within the jurisdiction of the Gulf of Mexico and South Atlantic Fishery Management Councils and the states of Texas, Louisiana, Mississippi, Alabama, Florida, Georgia, South Carolina, and North Carolina. The Terms of Reference (ToRs) of the peer review are attached in **Annex 2**. The tentative agenda of the panel review meeting is attached in **Annex 3**.

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

Location of Peer Review: Each CIE reviewer shall conduct an independent peer review during the panel review meeting scheduled in Key West, Florida during 15-17 November 2010.

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

Prior to the Peer Review: Upon completion of the CIE reviewer selection by the CIE Steering Committee, the CIE shall provide the CIE reviewer information (full name, title, affiliation,

country, address, email) to the COTR, who forwards this information to the NMFS Project Contact no later the date specified in the Schedule of Milestones and Deliverables. The CIE is responsible for providing the SoW and ToRs to the CIE reviewers. The NMFS Project Contact is responsible for providing the CIE reviewers with the background documents, reports, foreign national security clearance, and other information concerning pertinent meeting arrangements. The NMFS Project Contact is also responsible for providing the Chair a copy of the SoW in advance of the panel review meeting. Any changes to the SoW or ToRs must be made through the COTR prior to the commencement of the peer review.

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

Panel Review Meeting: Each CIE reviewer shall conduct the independent peer review in accordance with the SoW and ToRs, and shall not serve in any other role unless specified herein. **Modifications to the SoW and ToRs can not be made during the peer review, and any SoW or ToRs modifications prior to the peer review shall be approved by the COTR and CIE Lead Coordinator.** Each CIE reviewer shall actively participate in a professional and respectful manner as a member of the meeting review panel, and their peer review tasks shall be focused on the ToRs as specified herein. The NMFS Project Contact is responsible for any facility arrangements (e.g., conference room for panel review meetings or teleconference arrangements). The NMFS Project Contact is responsible for ensuring that the Chair understands the contractual role of the CIE reviewers as specified herein. The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements, including the meeting facility arrangements.

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

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

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

Appendix 2: CIE Statement of Work.

1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review.
2) Participate during the panel review meeting in Key West, Florida during 15-17 November 2010.
3) During 15-17 November in Key West, Florida as specified herein, conduct an independent peer review in accordance with the ToRs (**Annex 2**).
4) No later than 1 December 2010, each CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Mr. Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and CIE Regional Coordinator, via email to David Sampson david.sampson@oregonstate.edu. Each CIE report shall be written using the format and content requirements specified in Annex 1, and address each ToR in **Annex 2**.

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

11 October 2010	CIE sends reviewer contact information to the COTR, who then sends this to the NMFS Project Contact
1 November 2010	NMFS Project Contact sends the CIE Reviewers the pre-review documents
15-17 November 2010	Each reviewer participates and conducts an independent peer review during the panel review meeting
1 December 2010	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
15 December 2010	CIE submits CIE independent peer review reports to the COTR
22 December 2010	The COTR distributes the final CIE reports to the NMFS Project Contact and regional Center Director

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

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

Appendix 2: CIE Statement of Work.

Applicable Performance Standards: The contract is successfully completed when the COTR provides final approval of the contract deliverables. The acceptance of the contract deliverables shall be based on three performance standards:
(1) each CIE report shall completed with the format and content in accordance with **Annex 1**,
(2) each CIE report shall address each ToR as specified in **Annex 2**,
(3) the CIE reports shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

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

Support Personnel:

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Key Personnel:

NMFS Project Contact:

Julie A Neer, SEDAR Coordinator

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Julie.neer@safmc.net Phone: 843-571-4366

Appendix 2: CIE Statement of Work.

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

1. The CIE independent report shall be prefaced with an Executive Summary providing a concise summary of the findings and recommendations, and specify whether the science reviewed is the best scientific information available.

2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each ToR in which the weaknesses and strengths are described, and Conclusions and Recommendations in accordance with the ToRs.

   a. Reviewers should describe in their own words the review activities completed during the panel review meeting, including providing a brief summary of findings, of the science, conclusions, and recommendations.

   b. Reviewers should discuss their independent views on each ToR even if these were consistent with those of other panelists, and especially where there were divergent views.

   c. Reviewers should elaborate on any points raised in the Summary Report that they feel might require further clarification.

   d. Reviewers shall provide a critique of the NMFS review process, including suggestions for improvements of both process and products.

   e. The CIE independent report shall be a stand-alone document for others to understand the weaknesses and strengths of the science reviewed, regardless of whether or not they read the summary report. The CIE independent report shall be an independent peer review of each ToRs, and shall not simply repeat the contents of the summary report.

3. The reviewer report shall include the following appendices:

   Appendix 1: Bibliography of materials provided for review
   Appendix 2: A copy of the CIE Statement of Work
   Appendix 3: Panel Membership or other pertinent information from the panel review meeting.

Appendix 2: CIE Statement of Work.

Annex 2: Tentative Terms of Reference for the Peer Review

SEDAR 23 Gulf of Mexico and South Atlantic Goliath Grouper Review Workshop

1. Evaluate the adequacy, appropriateness, and application of data used in the assessment.
2. Evaluate the adequacy, appropriateness, and application of methods used to assess the stock.
3. Recommend appropriate estimates of stock abundance, biomass, and exploitation.
4. Evaluate the methods used to estimate population benchmarks and management parameters (*e.g., MSY, Fmsy, Bmsy, MSST, MFMT, or their proxies*); recommend appropriate management benchmarks and provide estimated values for management benchmarks, and declarations of stock status.
5. Evaluate the adequacy, appropriateness, and application of the methods used to project future population status; recommend appropriate estimates of future stock condition (e.g., exploitation, abundance, biomass).
6. Evaluate the adequacy, appropriateness, and application of methods used to characterize uncertainty in estimated parameters. Provide measures of uncertainty for estimated parameters. Ensure that the implications of uncertainty in technical conclusions are clearly stated.
7. Ensure that stock assessment results are clearly and accurately presented in the Stock Assessment Report and that reported results are consistent with Review Panel recommendations.
8. Evaluate the SEDAR Process as applied to the reviewed assessments and identify any Terms of Reference which were inadequately addressed by the Data or Assessment Workshops.
9. Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations or prioritizations warranted. Clearly denote research and monitoring needs that could improve the reliability of future assessments. Recommend an appropriate interval for the next assessment, and whether a benchmark or update assessment is warranted.
10. Prepare a Peer Review Summary summarizing the Panel's evaluation of the stock assessment and addressing each Term of Reference. Develop a list of tasks to be completed following the workshop. Complete and submit the Summary Report within 3 weeks of workshop conclusion.

The review panel may request additional sensitivity analyses, evaluation of alternative assumptions, and correction of errors identified in the assessments provided by the assessment workshop panel; the review panel may not request a new assessment. Additional details regarding the latitude given the review panel to deviate from assessments provided by the assessment workshop panel are provided in the *SEDAR Guidelines* and the *SEDAR Review Panel Overview and Instructions*.

** The panel shall ensure that corrected estimates are provided by addenda to the assessment report in the event corrections are made in the assessment, alternative model configurations are

recommended, or additional analyses are prepared as a result of review panel findings regarding the TORs above.**

Appendix 2: CIE Statement of Work.

Annex 3: Tentative Agenda

SEDAR 23 Gulf of Mexico and South Atlantic Goliath Grouper Review Workshop

Key West, Florida during 15-17 November 2010

Monday

10:00 a.m.	**Convene**	
10:00 – 10:30	**Introductions and Opening Remarks**	**Coordinator**
	- Agenda Review, TOR, Task Assignments	
10:30 – 11:30	**Assessment Presentation**	**TBD**
11:30 a.m. – 1:00 p.m.	**Lunch Break**	
1:00 p.m. – 3:30 pm	**Continue Presentation/Discussion**	**Chair**
3:30 – 4:00	**Break**	
4:00 – 6:00	**Continue Presentation/Discussion**	**Chair**

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

Tuesday

8:30 a.m. – 11:30 a.m.	**Panel Discussion**	**Chair**
	- Assessment Data & Methods	
	- Identify additional analyses, sensitivities, corrections	
11:30 a.m. – 1:00 p.m.	**Lunch Break**	
1:30 p.m. – 3:30 p.m.	**Panel Discussion**	**Chair**
	- Continue deliberations	
	- Review additional analyses	
3:30 p.m. – 4:00 p.m.	**Break**	
4:00 p.m. – 6:00 p.m.	**Panel Discussion/Panel Work Session**	**Chair**
	- Recommendations and comments	

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

Wednesday

8:30 a.m. – 11:30 a.m.	**Panel Discussion**	**Chair**
	- Final sensitivities reviewed.	
	- Projections reviewed.	**Chair**
11:30 a.m. – 1:00 p.m.	**Lunch Break**	
1:30 p.m. – 3:30 p.m.	**Panel Discussion or Work Session**	**Chair**
	- Review Reports	
4:00 p.m.	**ADJOURN**	

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

Appendix 3: Bibliography of Materials Provided for Review.

SEDAR 23
South Atlantic and Gulf of Mexico Goliath Grouper
Workshop Document List –November 10th, 2010

Document #	Title	Authors
SEDAR23-DW-01	Bottom longline fishery bycatch of Goliath Grouper (*Epinephelus itajara*) from observer data	Loraine Hale
SEDAR23-DW-02	Monitoring changes in the catch rates and abundance of juvenile goliath grouper using the ENP creel survey, 1973-2009	Shannon L. Cass-Calay
SEDAR23-DW-03	Goliath grouper surveys and samples: A summary of recent work by the Fish and Wildlife Research Institute (2006 -2010)	Angela Collins & Luiz Barbieri
SEDAR23-DW-04	Calculated Goliath grouper discards from commercial vertical line and longline fishing vessels in the Gulf of Mexico and US South Atlantic	Kevin McCarthy
Documents Prepared for the Assessment Workshop		
SEDAR23-AW-01	Standardized visual counts of goliath grouper off south Florida	Clay Porch
SEDAR23-AW-02	Analysis of Headboat Data for Goliath Grouper	Walter Ingram
SEDAR23-AW-03	Standardized proportion of private vessel trips with catches of goliath grouper from the Marine Recreational Fisheries Statistics Survey in south Florida, 1991-2009	Joe O'Hop
Documents Prepared for the Review Workshop		
SEDAR23-RW-01	Application of Stock Reduction Analysis to goliath grouper (*Epinephelus itajara*) off southeastern U.S.A, 1918 – 2009	Joseph Munyandorero
Final Stock Assessment Reports		
SEDAR23-SAR	Goliath Grouper	

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Reference Documents		
Document #	Title	Authors
SEDAR23-RD01	Age, growth, and reproduction of jewfish, *Epinephelus itajara* in the eastern Gulf of Mexico	L.H. Bullock, M.D. Murphy, M.F. Godcharies, and M.E. Mitchell
SEDAR23-RD02	Monitoring changes in the catch rates and abundance of juvenile goliath grouper using the ENP creel survey, 1973-2006	Shannon L. Cass-Calay and Thomas W. Schmidt
SEDAR23-RD03	How many species of goliath grouper are there? Cryptic genetic divergence in a threatened marine fish and the resurrection of a geopolitical species	M. T. Craig, R. T. Graham, R. A. Torres, J. R. Hyde, M. O. Freitas, B. P. Ferreira, M. Hostim-Silva, L. C. Gerhardinger, A. A. Bertoncini, D. R. Robertson10
SEDAR23-RD04	Habitat affinities of juvenile goliath grouper to assess estuarine conditions	Anne-Marie Eklund
SEDAR23-RD05	A stepwise approach to investigating the movement patterns and habitat utilization of goliath grouper, *Epinephelus itajara*, using conventional tagging, acoustic telemetry and satellite tracking	Anne-Marie Eklund and Jennifer Schull
SEDAR23-RD06	Activity patterns of three juvenile goliath grouper, *Epinephelus itajara*, in a mangrove nursery	Sarah Frias-Torres, Pedro Barroso, Anne-Marie Eklund, Jennifer Schull, and Joseph E. Serafy
SEDAR23-RD07	Mangroves as essential nursery habitat for goliath grouper (*Epinephelus itajara)*	Christopher C. Koenig, Felicia C. Coleman, Anne-Marie Eklund, Jennifer Schull, and Jeffrey Ueland
SEDAR23-RD08	Early life history stages of goliath grouper *Epinephelus itajara* (Pisces: Serranidae) from Ten Thousand Islands, Florida	Monica R. Lara, Jennifer Schull, David L. Jones, Robert Allman
SEDAR23-RD09	Goliath grouper *Epinephelus itajara* sound production and movement patterns on aggregation sites	David A. Mann, James V. Locascio, Felicia C. Coleman, Christopher C. Koenig
SEDAR23-RD10	Documenting Loss of Large Trophy Fish from the Florida Keys with Historical Photographs	Loren McClenachan
SEDAR23-RD11	Status report on the continental United States distinct population segment of the goliath grouper (*Epinephelus itajara*)	NMFS

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Document #	Title	Authors
SEDAR23-RD12	A catch-free stock assessment model with application to goliath grouper (Epinephelus itajara) off southern Florida	Clay E. Porch, Anne-Marie Eklund, and Gerald P. Scott
SEDAR23-RD13	A Preliminary Discussion of Acceptable Harvest Levels for Scientific Sampling of Goliath Grouper in the U.S. South Atlantic and Gulf of Mexico	Clay E. Porch and Luiz R. Barbieri
SEDAR23-RD14	Range-wide status and conservation of the goliath grouper *Epinephelus itajara*: Introduction	Kevin L. Rhodes and Rachel T. Graham
SEDAR23-RD15	Synopsis of biological data on the Nassau grouper, *Epinephelus striatus* (Bloch, 1792), and the jewfish, *E. itajara* (Lichtenstein, 1822)	Yvonne Sadovy and Anne-Marie Eklund
SEDAR23-RD16	Complete Stock Assessment Report of SEDAR 6 – Goliath Grouper	SEDAR 3 DW participants/ SEDAR 6 RW participants
SEDAR23-RD17	Habitat use of juvenile goliath grouper *Epinephelus itajara* in the Florida Keys, USA	Sarah Frias-Torres
SEDAR23-RD18	Standardized visual counts of goliath grouper off south Florida and their possible use as indices of abundance	Clay E. Porch and Anne-Marie Eklund
SEDAR23-RD19	Population density, demographics, and predation effects of adult goliath grouper	Christopher C. Koenig and Felicia C. Coleman
SEDAR23-RD20	The role of dispersal and demography in determining the efficacy of marine reserves	Gerber LR, Heppell SS, Ballantyne F, Sala E.
SEDAR23-RD21	Spawning aggregations and reproductive behavior of reef fishes in the Gulf of California	Sala E, Aburto-Oropeza O, Paredes G, Thompson G.
SEDAR23-RD22	American Fisheries Society Position Statement. Long-lived reef fishes: the grouper-snapper complex	Coleman, F.C., C.C. Koenig, G.R. Huntsman, J.A. Musick, A.M. Eklund, J.C. McGovern, R.W. Chapman, G.R. Sedberry, and C.B. Grimes
SEDAR23-RD23	Preliminary Investigations of Reproductive Activity of the Jewfish, Epinephelus itajara (Pisces: Serranidae)	Colin, P.L.

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Document #	Title	Authors
SEDAR23-RD24	Grouper Stocks of the Western Central Atlantic: The Need for Management and Management Needs	Sadovy, Y.
SEDAR23-RD25	Hypothermal mortality in marine fishes of southcentral Florida	Gilmore RG, Bullock LH, Berry FH
SEDAR23-RD26	Evaluation of finrays as a non-lethal ageing method for protected goliath grouper *Epinephelus itajara*	Murie DJ, Parkyn DC, Koenig CC, Coleman FC, Schull J, Frias-Torres S.
SEDAR23-RD27	Mercury concentrations in the goliath grouper of Belize: an anthropogenic stressor of concern	Evers DC, Graham RT, Perkins CR, Michener R, Divoll T.
SEDAR23-RD28	Behavior, Habitat, and Abundance of the Goliath Grouper, *Epinephelus itajara*, in the Central Eastern Gulf of Mexico	Angela B. Collins and Luiz R. Barbieri