Independent peer review report completed for the Center for Independent Experts

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SEDAR 19 – South Atlantic red grouper and South Atlantic and Gulf of Mexico black grouper Assessment Workshop

St. Petersburg Florida
5th-9th of October 2009

Executive Summary:

The Meeting

The assessment workshop (AW) was held in St. Petersburg, Florida from the 5th to the 9th of October chaired by Julie Neer. The atmosphere in the AW was very positive and open to alternative views. The qualitative input from the industry was particularly important in evaluating the different assessment methodologies and settings. Unfortunately, it was only rarely possible to include this information in a quantitative way and efforts should be made by both industry and scientists to cooperate in future to provide more quantitative information. Scientists from the Beaufort Lab and FWC had carried out a significant amount of work prior to the AW, which meant that it was possible to start with the evaluations of the assessments almost immediately, which significantly increased my ability to contribute to the AW. Overall, these factors as well as the high level of organization made the AW very productive, and in my opinion scientifically sound.

The heavy workload did not allow for the preparation at the AW of a full set of figures and tables as requested by the TORs, but the necessary decision on which to base these outputs were reached at the meeting so that it should be easy to provide this information well in time of the Review Panel.

I have indicated in italics under the relevant sections those issues that were not addressed fully in open plenary, where my opinions differed from those of the panel as a whole, or thoughts I had on some of the topics during the writing of this report.

The topic of quantifying uncertainty in line with the requested TORs sparked a lot of discussion and will require further investigation; however, the problems go further than just these two stocks and it will be a question of managers and scientists to get together on determining an appropriate format for such information.

Red Grouper

The stock status of red grouper was assessed by the AW using a number of assessment models with different assumptions, of which the most realistic was deemed to be the Beaufort Assessment Model (BAM). The model indicated that historically the stock had been substantially overfished and that SSB had dropped well below those levels that would produce maximum yield. However, management actions implemented in the early 1990s had substantially curtailed F and allowed the stock to recover. Current SSB is now just below the level that would attain maximum yield; whether this should classify the stock as overfished is highly dependent on the choice of model settings and parameters such as M and discard mortality, which were not finalized at the AW. The 2008 estimate of F is more uncertain, but it also suggests that overfishing is occurring. However, the additional management measures put in place in the autumn of 2009 to protect gag and red snapper are likely to ensure that F from at least 2010 onwards will fall below the level required to produce the maximum sustainable yield.

The stock assessment appears to reasonably reflect the dynamics of the red grouper stock, and every effort has been made at the AW to examine possible data and process uncertainties as well as address and include industry information wherever quantitatively possible. Nevertheless, this assessment of stock status is still conditional on a number of uncertainties, mainly the precision of landings estimates, the appropriate choice of discard and natural mortalities, and the choice of appropriate selectivity patterns. The AW tried to quantify these uncertainties, but a realistic picture of the absolute uncertainty in this assessment is not possible using the Bayesian approach without independent knowledge of the likely error distributions (priors) of some of a number of the parameter estimates.

In my opinion, the approaches used to assess the red grouper stock at the AW are a good compromise between model complexity and assumptions based on the understanding of the interaction between fish and fishermen. As such, one of the set of model outputs presented at the meeting is likely to provide the best possible scientific basis for advice, given the available information at the time of the AW. No preferred model was presented at the end of the AW, mainly due to the time constraint in developing the full characterization of uncertainty for each of the model set-ups.

Black Grouper

The black grouper assessment is the weaker of the two assessments discussed at the AW, mainly due to the quantity of data, but also due to the uncertainty of the level of landings associated with misidentification of gag grouper. However, the model suggests that the stock abundance has not changed significantly over recent years, and as such, the model is sufficient for managers to assess the stock status as stable, and likely to improve when future management measures designed to protect gag and red grouper come in to force at the end of 2009.

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The work conducted with regards to the terms of reference

Rarely are stock assessments produced in a sequential manner, and a number of the terms of reference, particularly those relating to data and assessments, and assessments and uncertainty are interlinked; thus, it has not been always possible to precisely separate the work out into the different

TORs without repeating significant sections. I have used my best judgment to locate each discussion under the TOR where it is most appropriate, but some jumping between sections of this report is inevitable.

TOR1: 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.

Red Grouper

The discussions regarding red grouper at the AW started by considering the available data provided by the DW in the context of the assessment models to be applied. A number of changes were proposed / implemented with reasons given for the changes. Most of these were readily accepted by the AW without further discussion, and some were discussed in more detail.

Landings data as supplied by the DW was truncated to the period starting in 1976, because precision prior to this period was thought to be poor (being generally recorded as an undefined mixture of groupers) while not contributing significantly to answering current management questions.

All models used required conversion of landings data into whole pounds, rather than the gutted weight provided by the DW.

The plus group was set at 16 for the purpose of the assessment as age information past this age is scarce in the data. At this age, red grouper are well in the asymptotic region of growth so that length induced behaviour changes interacting with selectivities, such as spatial changes to the distribution or effects of gears, are likely to be minimal. In addition, when examining selectivities by fleet at age 16 there was little indication of significant changes in selectivity from ages 15 to 16 so that cumulative errors in the assessment of the plus group beyond 16 would be expected to be insignificant.

Length and age data for both the hand line fisheries were sparse in the data set and did not warrant the additional parameters required by the model in order to consider these separately from the long-line data, given the information content. Summed over all years, the length distributions for the two gears were practically indistinguishable, suggesting that considering these as a single gear would increase the parsimony of the model.

Lengths less than 16cm were considered to be 0-group fish and removed from the length compositions as there was no age based information available for these fish and these were poorly selected by the fisheries independent information. In addition, the data supplied in 1cm bins was converted to 3cm bins with a +group set at a length of 118cm.

This is inconsistent with the choice of +group in terms of age and for models considering length in the minimization could lead to inappropriate contributions to the objective function dependent on how this is implemented. Both the Beaufort (BAM) model and the Stock Synthesis (SS) models are of the latter type, but lengths above 85cm and ages greater then 15 are sufficiently rare in this dataset that this effect would be minimal.

Pooling of the commercial dive trap and 'other' fisheries was necessary because of the low sample sizes available for these fisheries.

Because the proportions of landings contributed by the different fisheries varied over time, pooling these is inappropriate from a modeling perspective, but the only practical solution. Given the small quantities of landings attributed to these fisheries the resultant process error in the model is highly unlikely to have significant impact on the management recommendations based on an assessment with pooled data for these fisheries.

The RVC index represents a visual survey index, so contains length information only. However, the length information available was provided in fork length and scaled up to the population. The data were converted to TL (linear conversion), and spread across length groups on the new scale using normal distributions.

The problem here is two fold, the sampling or raising protocol was not clear to the AW. Lengths appear to be binned in some way, because of the persistent pattern of lengths across years in some length groups and not others. Also it is not clear how many fish were actually encountered in each year, as the numbers have been raised in some way to the population level. The BAM and SS models require effective sample sizes in order to apply the multinomial probabilities in the objective function, but these cannot accurately be reconstructed from these data.

Consistent discard sampling for lengths for the headboat data were available only for the period 2005-2007. The DW provided discard estimates for the period prior to this based on the proportion of catches on the basis of the proportion of catches of other species. Sampling in 2008 was inconsistent with the previous samples. Only the 2005-07 data were used. Discarding in the rest of the period was estimated by the model based on these years and changes in selectivity caused by management measures.

Consequently, historic discard estimates are uncertain, a problem confounded by the uncertainty on the discard mortality rate. The degree of uncertainty is unknown, but it is not possible to assess the level of compounding these errors are subject to. In my opinion this uncertainty with respect to the estimation of current stock status is as large as that introduced by the uncertainty in the choice of M.

The MRFSS data did not contain a measure of the effective sample size as it was anticipated that the length samples are not independent. Rather than using the number of fish measured as part of the multinomial probability in the objective function, an estimate of the number of trips sampled was derived. In addition, the landing data from the MRFSS included an extreme value in 1984. The data were smoothed by cubic spline smoother. There is a problem with this in that either the data point is real, in which case it should be used, or it is unrealistic, in which case it should be excluded entirely. By using a smoother the error is smeared across a number of years to limit the immediate impact, but this only hides the problem rather than curing it. Unfortunately, removal is not an option in the BAM model (other than replacing it with an equally uncertain value), and including it produces unrealistically high values of F. Operationally, the spline smoother seems a reasonable option, but the effects should be considered in detail in the sensitivity analysis.

Black Grouper

The DW suggested there had been some significant misidentification of gag grouper as black grouper in the Marine Recreational Fisheries Statistics Survey (MRFSS) data prior to the late 1980s. This was based on a large ratio decline in the landings of the two species prior to 1988. The two species look similar at younger ages, and larger individuals are usually identified as black grouper as the species gets larger. At that time misidentification had been noticed and steps taken to educate samplers and fishermen. This likely led to a gradual improvement in the MRFSS and head boat (HB) landings data. The decision was taken to start the assessment period in 1986 and to correct 1986-87 recreational landings data on the basis of the black to gag ratio in subsequent years.

As pointed out at the AW, trying to come up with a precise assessment for black grouper when it is not possible to determine the species-specific landings is very difficult. The assessment team had considerable faith in the data post 1991, and felt they had done the best to correct prior data where necessary. Clearly, this is a less than ideal situation, but given that the age based assessment model used in this assessment tends to go towards an equilibrium initial biomass anyway, I feel that the impact of using an average grouper to gag ratio at the initial period will have a minor impact on the assessment.

The data prior to 1986 indicates much larger catches of black grouper and although we are aware of misidentification at this time, if even a fraction of these were in fact black groupers, one would be left with the feeling that the black grouper stock had declined sharply and the current assessment would likely indicate a much poorer stock status. It is not possible to incorporate the qualitative assessment of misidentification into a quantitative uncertainty analysis, but the review group and future AW need to bear this uncertainty in mind.

A discard mortality of 0.2 per year had been suggested as appropriate for recreational fisheries (MRFSS, HB) by the DW with a range of 0.1-0.3 as plausible values. The AW used 0.2 in the absence of a more precise value estimated from direct observational data in this fishery. Discard mortality is a contentious issue not least because of the ethical considerations; however, it is a very difficult estimate to derive accurately and is highly variable, with the depth at which the fish is captured, the size of the fish, and method by which it is taken all having an effect. The immediate versus the long-term effects of discarding are difficult and costly to assess and the quite different views between fishermen and scientists become apparent.

Unfortunately, quantitative research on the topic is not available for this stock, but even if it were, currently the spatial information regarding all fisheries, but particularly the recreational fishery, is not available. Since discard mortality is likely to vary spatially (by depth), without this depth information future assessments will find it equally difficult to determine accurate estimates of discard deaths.

In my opinion, a discard value of 0.2 is in the lower range of the likely values, but I am not an expert on grouper nor do I think that the assessment will suffer greatly by using a slight under estimate as this will have a tendency to scale recruitment up or down within the assessment if the values are incorrect. More problematic would be using a single value across the whole time series when the regulations have changed (with regards to the size of fish discarded) and the spatial interaction has varied, as this is likely to flatten out the recruitment signal in the assessment.

The DW suggested a higher range of discard mortality for the commercial gear of 0.25 to 0.35. A higher range for this fishery is probably warranted for the long-line gear, because the fishery is situated further offshore (in greater depth) due to changes in regulations, and stress is likely greater on the fish because the gear is not retrieved immediately. Using a value of 0.3 in the AW is consistent with the use of 0.2 for recreational discards, but the bias is equally uncertain.

Choosing a single discard mortality value for the whole period is more problematic for the commercial gears, as there is clear evidence that the fishery has moved offshore over the assessment period in response to regulatory changes. There is a strong distributional offshore gradient in size with larger fish occurring in deeper, offshore waters and smaller ones predominating in shallower inshore areas. Consequently, the interaction between size and depth is likely to have changed the discard mortality over time as the distribution of the fishery has changed. In addition, the black grouper fishery is not a target fishery and the abundance of other species is likely to have a significant impact on the encounter rates and discard rates.

Qualitatively, the evidence of changing discard mortalities is greater for the commercial fishery than the recreational sector, although quantitatively there is no more evidence as the most appropriate choice for either the value or trend in the discard mortality over time. The effects of using a single value are lessened because the encounter rate of the fishery with undersized fish is decreased by the offshore move of the fishery, such that the mortality is applied to fewer fish. Overall, the impact of the choice of discard mortality is most likely to be a scalar effect on recruitment and will tend to obscure the recruitment signal, but the likelihood of covering long term trends in the population as a whole is likely to be minor, given the small number of ages that are discarded compared to the population structure of the stock.

Commercial discards were provided in terms of numbers, with weights provided by the DW based on the average weight of the landed fish, indicating

20lb + fish were being discarded. Using these weights in conjunction with the provided numbers produce significant bias in the estimated weight of discarded mortalities. It is highly unlikely that the average weight of discarded fish is equal to the weight of the average landed fish. Instead, the weight of dead discards was calculated from the lengths of fish smaller than the minimum sizes in earlier years by the fishery. The resultant annual average discard weight suggested a much more realistic average discard weight, around 4lb, which reduced the weights of implied discards by around 80%. The lack of discard weights for the commercial fishery underlines the general data paucity for this stock.

The problem here is that if density dependent changes in weight at age affect the estimates of discarded fish in terms of weight, these will be inconsistent with the numbers at age discarded. For age structured model in general, this is less of a problem than for biomass models; however, in this case, the choice of base model eliminated the age information from the commercial fishery (for other reasons), so that this has the potential to bias the recruitment estimates. Moreover, there is little evidence of density dependent changes in weight at length for the stock overall, and potential biases are much less likely to have significant impacts on the population dynamic estimates associated with stock status than using the average landed weight or other parameter choices, particularly those associated with discard and natural mortality rates.

TOR2: 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.

Red Grouper

Three analyses were presented as alternate assessment approaches. These were catch curve analysis mainly to estimate levels of Z indicating that F over the period was centered around 0.4-0.6. The second was a production model with an aim to verify the population dynamics in the age based assessment models. The third was a Stock Synthesis (SS) model, a potentially more flexible approach to exploring the population dynamics of red grouper. A short overview of the ‘A Stock Production Model Incorporating Covariates’ (ASPIC) and SS3 model results and some of the differences between the models are given below. The final choice of assessment model was the BAM model so the other models are not discussed further beyond their summaries, except where they serve to inform on setting choices or contrast in the assumptions of the BAM model. These models are not further discussed in detail beyond these summaries, but are occasionally referred to in the discussion and comparisons with the preferred assessment and where they contrasted with the results or informed on setting choices for the BAM model.

Alternative assessment approaches

The ASPIC model relied on the landings data from the various fisheries and a combined tuning index based on five sources of information evaluated externally to the model by a Baysian approach described in a working paper. This index relied heavily on the estimates of the CVs for each of the indices used, despite the fact that the CVs were not qualitatively determined. Making these a priori choices does not give the model the ability to compare and contrast the information with the catch data adequately. In addition, there may be differences in the selectivity between the different indices that, once combined, cannot be distinguished by the model.

The attempt to combine the indices described in a working paper originated because of an inability of the BAM model to converge with separate indices. The belief was that the contrast in the index information was causing the problem. In the end, the problem was tracked down to the use of the discard information (on the basis of the findings with regards to incorrect mean discard size, see also black grouper). With this correction, the model was able to converge using the separate indices, and although the overall trends in the stock did not appear to change very significantly, certainly the estimate of the uncertainty on stock size and F decreased. Whether this is realistic or not is another question, but clearly combining the indices does alter the picture. Certainly, using more advanced statistical models capable of evaluating the fit of an index within a model should be strongly preferred to making an a priori decision as to which index contains the most useful information.

In general, the ASPIC model with separate indices gave some reasonable estimates and useful information on trends in SSB and F and a good basis for comparing output from various models. Although it was able to detect a change in the fishery, this did not coincide perfectly with the change in the regulations in 1992, but preceded it by two years starting in 1990. The reasons for this are unclear, but given the precision of the data, in the absence of age information this is a minor problem.

Current management decisions would unlikely be heavily influenced by this inaccuracy, provided they were aimed at being precautionary, particularly as this stock is clearly on its way to recover to a healthy stock status.

The stock synthesis (SS) model was set up as a comparison to the BAM model. The SS model can potentially be set up to be very complex by switching a large number of options. This process has only just started for the Atlantic red grouper stock, and it is not fully understood how these options and assumptions relate to the fishery. Given this uncertainty, a basic model was explored only as a means of exploring the data with regards to options not available in the BAM model and to provide a useful comparison of the output of the other models.

In general the results were very similar to the other assessment models based on trends in the SSB and F and stock status; however, the period of changing management was better estimated for 1992 in terms of the selectivities *compared to the ASPIC model. There was an increased lag in the reduction in F compared to the BAM model after 1992, suggesting F remained high for a period while management measures were being implemented; also, increasing the minimum landing size reduced the effective effort of the long line fishery by excluding that fleet from inshore waters. This difference could at least in part be explained by the fact that the BAM model estimates discard selectivities separately from the retained proportion, whilst the SS model retains the same gear selectivity, but applies a varying retention ration. In this case, the gear selectivity changed at the same time as the retention.*

The BAM model was chosen as the best option, because it was easier to set up, better understood concerning how the options related to changes in the fishery and stock, and because the model output seemed to better match up with the known trends in the fishery and management. Consequently, changing settings and determining uncertainty was investigated only in the BAM model, as previously described in the selectivity section. The final choice was to use dome shaped selectivities for all commercial and recreational gears except the long line fishery, where a flat topped curve was used. Fisheries independent information consisting of the RVC and micro chevron trap surveys were modeled as only declining selectivities.

A detailed description and code for the BAM model was presented. Essentially the model represents a forward projecting, separable VPA model with the ability to model landings, length composition, and age data, with the aid of length and / or age based index information.

A base run was chosen based on the data and recommendations provided by the DW and the following discussions.

<u>Index information</u>

A logistic curve was assumed for the long-line data. Following a discussion on why one would a priori assume a double logistic for the trap fishery and not the long-line fishery, using a dome-shaped selection for this fishery was investigated. The overall length frequency distributions of the two gears differed, with the long-line taking a relatively larger proportion of the older fish than the trap fishery. Model diagnostics also pointed to a more parsimonious model and one potentially risked the assessment accumulating large numbers of fish at the older ages for which there would be little or no evidence. Indications from the industry indicated that from a gear perspective traps should be as capable of capturing older and large individuals as long-line, but conceded that spatial differences in the distribution of the two fisheries in relation to spatial differences in the distribution of the population could contribute to differences, although no data were available to substantiate this.

Having the fishery which takes the majority of fish at the older ages with a dome-shaped selection pattern presents the assessment with a problem. It represents a reduced capability of the assessment to monitor the older part of the population, and it should be avoided unless there is a clear indication that there is an unfished part of the stock contributing to the SSB beyond the *reach of the gear. Even when justified, it represents a problem for the assessment when including a link between SSB and recruitment within the model, because of the uncertainty in SSB. Consequently, diagnostics will be poorer in such instances.*

The final selection of selectivity curves seemed the most appropriate, and the residual diagnostics of the model were acceptable; however, there remains a problem with the choice of a logistic function in general. The function is fundamentally symmetrical, where at least gear selectivities tend to be asymmetrical (although often modeled as logistic) with a larger curvature radius in the lower part of the curve and a much sharper change in the rate of the slope at the higher probability.

This deviation from the model assumption is reflected in the q-residuals by predominantly negative residuals for some ages with other ages indicating predominantly positive values. Overall, this tends to average out over the lifespan of the cohort, but not for incomplete cohorts. Effects of this process error on historic information are thus insignificant so that stock productivity estimates are only marginally affected. However, current stock status estimates and forecast predictions based on incomplete cohorts will vary more from year to year than for models fitting a q for each age separately. This is especially true for large or small cohorts. This effect will not be well reflected in the uncertainty estimates from the MCMC analysis.

The RVC visual census was assumed to have a logistically declining selectivity although, given its protocol, one might have assumed it to be less selective for the smallest individuals. Model parsimony indicated that this was not justified. The index is quite noisy and, as is (see data section), does not fit the data very well. The scale of the variation seems to more than mask any possible declining selectivity at the youngest age.

The micro chevron trap index was assumed to have a declining selectivity and the same choice was made for the trap fishery, although this was adjusted by the fact that catches at the youngest ages would be discarded by the fishery under the most recent management regime. The a priori choice of a declining selectivity for the trap gears versus the flat topped selectivity chosen for the line gears was questioned by the industry, on the basis that the former gear is no more or less size selective than a line gear. However, the available length information does suggest that there are differences in the selectivities of the gears, with traps taking a larger proportion of smaller fish and fewer of the larger fish. This was later confirmed within the BAM model by examining fits to different selectivity options.

An a priori choice of a selectivity function on the basis of gear characteristics alone is difficult, as there may be spatial effects in the distribution of gear and fish that interact. Spatial information on the operations by this fishery is sparse at best and, where available, is usually on the scale of management units and not on scales of biologically meaningful effects. In lieu of detailed spatial information, and the fact that the BAM model indicated a significantly better fit to the data using the divergent selectivity patterns for the two gears, the best *option is to go with the a priori choice, although it was fruitful to investigate the uncertainty in the assessment with regards to this choice.*

The model had originally been set up to closely match landings information by using a small CV (0.01) as an estimate of the uncertainty in this data source, with higher variation allowed for length and age information as well as the tuning information. This seemed unreasonable for two reasons. First, given our understanding of the uncertainty in the estimates coming from the MRFSS data, which make up the largest proportion of the landings, such a small CV does not seem justified because variances are regularly approaching the size of the mean and a correction was already implemented for the 1984 data point. Second, the fisheries dependent tuning index, constructed from essentially the same data, was fit with much less certainty, which makes the model internally inconsistent.

One could argue that the uncertainty of the CPUE information is derived solely from the effort estimation, but this seems unlikely; so an attempt was made to release the constraint on the landings CV. Large values greater than 0.05 precluded model convergence and values greater than 0.1 provided unrealistic results. The reason for this is not clear, but must stem from some colinearities in the parameter estimates. Because uncertainty could not be investigated by the MCMC approach in the absence of model convergence, it was decided to use the maximum possible value for the landings CV whilst not sacrificing convergence.

The landings CV was set to 0.05, although realistically it is likely to be higher at least for the MRFSS data. Further investigations near the point of loss of convergence should be investigated for model stability in the future and to determine the parameters that cause the lack of convergence at higher CVs. The higher value of 0.1 gave more weighting to the RVC data making some gains in its contribution to the objective function; but, this was ultimately done at the cost of reducing the fit to the other data sources so that there was not much of a change to the overall picture.

It is difficult to determine the CVs of any of the data sources in the absence of independent data. One approach is to weakly constrain all data sources and often this is described as the best approach. However, when some data sources are more variable than others, giving them essentially the same weight will tend to drag the assessment away from the real solution, so inevitably the answer will remain slightly subjective.

The constraint on the model provided, investigated here as the 'base model', shows quite tight confidence limits even in the MCMC approach. The estimate of 2008 landings is higher than previous estimates with little explanation of why this should be in terms of changes in effort, gear or spatial effects. I would expect this value to be an overestimate similar to the 1984 value and it is likely that levels will return to more usual levels in 2009. This is also the reason why in the estimation of stock status, the AW decided to use the three-year average for the estimates of F instead of the 2008 value. In short, I would expect the confidence bands for the 2008 F estimate to at least include the *value of the average F for previous years, which it does not seem to, suggesting on the basis of current knowledge that the uncertainty is underestimated by the MCMC approach. Alternatively the uncertainty may merely be incorrectly distributed in time, as we would also expect the most recent years to have the largest uncertainty because of the incomplete cohort problem.*

Time- or abundance-dependent q was investigated, with the process being much simpler than for the black grouper assessment because the BAM model allows for this within the model, rather than having to change the input data sets. Comparison of the model output from runs assuming constant q versus a 2% year on year increase in q for fisheries dependent indices indicated that there was little to chose between the options in terms of the overall penalty function, despite the fact that the time-dependent q would suggest the estimation of an additional parameter (here fixed at 0.02/annum). Furthermore, when the model was allowed to perform a random walk in terms of catchability, the variation was not correlated either with the time or the estimated density.

This does not necessarily preclude the presence of a q-trend, but it does suggest that data variability is such that it at least cannot be detected. As in the black grouper model, the AW felt that it had considered the possibility of trends in q, as required by the TORs, and found there to be no evidence of such trends. Equally, the AW found it difficult to prove the absence of such trends, so the appropriate choice of model is really dependent on what is set as the null hypothesis. From a parsimony perspective, I feel one should consider the lack of trend as the starting point as fitting other values would increase model freedom without a significant gain in the reduction of the objective function.

The choice of M was more complex than in the black grouper assessment, because the catch curve analysis indicated a higher Z, leaving a wider choice for M. The DW suggested an age-dependent M with high mortalities at the younger ages, but averaging out to 0.14 over all ages. The AW considered this a good choice, but decided to explore values from 0.1 to 0.3. The results suggested similar trends in F and SSB, with the absolute levels varying expectedly. Unfortunately, estimation of stock status differed, so that the uncertainty in M, although not particularly worrisome, did imply significantly different management actions. For most of the reasonable levels of M, the model suggested that F and SSB were below and above possible management F and SSB targets respectively, and in all cases close to the desired levels.

Black Grouper

The aim of this AW was to develop more complex assessment methodologies for black grouper than had been possible in the past, given significant advances in our understanding of the biology of the species and the fisheries exploiting it.

Alternative assessment approaches

A first attempt was to examine whether trends in the landings and fisheries independent indices were sufficient to determine the population dynamics in the stock. The ASPIC model was applied to the available landings information in conjunction with fisheries independent and fisheries dependent indices of abundance. Model convergence indicated that there was sufficient information available to warrant further investigation of the age structure in an attempt to develop an age based assessment model. However, age based information was scarce for the various fisheries, while length based information was sufficient to suggest grouping the data into a long line fishery and a fishery for all other gear types, including hook and line catches together. The available age data summed over all years supported these groupings as the long line catches were distinct in that they contained significant numbers of older fish (over age 30) not seen in the landings of other gear types.

The ASPIC model described a generally stable stock status based mainly on landings information, with SSB and F reflective of the stock only, but unlikely to descriptive of the absolute levels. Abundance indices also were fit poorly. It seems likely that F and SSB have been relatively flat following an initial decline in abundance, so there is little information in the model to resolve to, mostly describing a near equilibrium condition. Recruitment and selectivity parameters are thus difficult to resolve and likely lead to a poor model fit to indices.

Length based information appeared to be more representative of the catches than the age information so an attempt was made to invert the von Bert function to determine the probability of a fish of a specific age having a specific length. To do this, ten von Bert curves were developed covering the time period of the fishery. The advantage was that age information not coming from the fishery (different selectivities) could be used to inform the model on age. Model output indicated that there was little contrast in the yearclass information provided by this methodology for the longline fishery. The main reason for this is likely the fact that fish older than 15 are virtually impossible to distinguish on the basis of length, and without weighting the probability of an individual being a specific age by the size of the population at that age, all ages were virtually equally represented in catches.

Trends in the assessment following the commencement of the long line fishery appeared to be driven entirely by trends in landings, rather than the age structure with recruitment estimated to be almost flat. Although recruitment does not have to be variable, my understanding of the stochastic processes involved in recruitment dynamics suggests that such a constant recruitment scenario is unlikely. Consequently, I feel the estimation of recruitment is rather poor for this assessment; however, the fishery in general is not recruitment driven so that the influence on the accuracy of forecasts should be minor and, assuming there is no long-term trend in recruitment, estimation of productivity parameters based on equilibrium conditions should be negligible.

The catch curve analysis indicates Z estimated from the fisheries other than long line is around 0.5, which would make the older ages rarer than the numbers encountered in the long line fishery, suggesting that the selectivity for those fisheries is dome shaped. Without the long line information, there are no data for the model to determine the selectivity of the hook and line fishery. Consequently, it would be desirable to include the long line ages in the assessment. Using the ages for the long line fishery directly provided no better estimates, mainly because of the large number of zero catches in the catch-at-age matrix.

In other words, the model would have to try to create fish from nothing. In the end, the long line fishery contributed landings information only, and the selectivity of the other fisheries was forced to be dome shaped by applying a double logistic function. Age information was used directly in the hook and line fishery, rather than using probabilistic aging based on length, although judging by the results (a direct comparison between the two methodologies) either could have been used because lengths at age were sufficiently discrete to allow reasonable aging based on length for the ages encountered.

Discussions at the AW considered whether this approach would be worthy of a more detailed investigation. Although I agree in general that this approach would be of some use, it seems for black grouper above the age of about 12, mean and variance at age are such that it is not possible to distinguish ages, so that the approach is unsuitable. Future efforts should concentrate on collecting more age information from the long line fishery to enable one to determine cohort abundance either directly or by use of annual age-length-keys.

With better age data assessments could be attempted that model age as a multinomial probability multiplied by the estimate of n-at-age internal to the model rather than trying to determine probabilities external to the model.. Given that there appears to be little information on year class trends, there seems to be little point in trying to apply the current data to models such as BAM and SS as the only long line data informative to the model at this time is the fact that older ages persist in the stock past the ages captured by the other fisheries. It would still be interesting to see how these models would interpret the age information in the absence of a clear cohort signal.

Using the direct ageing for the long line fishery for the assessment caused unrealistic jumps in F-estimates and suggested an almost flat trend in stock biomass with a short sharp decline in the middle of the period. Recruitment showed slightly more variation than when using the probabilistic aging but mainly in a short period prior to the start of the long line age data, which suggests a discontinuity in the assessment parameterization rather than a true decline in recruitment.

Allowing the model to change selectivities at the same point in time that the long line data series began probably allowed the model to confuse the regulatory changes that the model was designed to accommodate with a sudden temporary decline in recruitment.

Having made the choice of omitting the age information for the long line fishery from the assessment, possible choices for the selectivities profiles for the different fisheries were examined. The longline fishery was set to a flat topped selectivity, because there was no reason to assume that selectivities would decline at older ages based on the gear or the spatial distribution of the fishery. In any case, given that this fishery takes the oldest fish, it is unlikely that the model could distinguish between a decline in the abundance of a cohort from a decrease in the selectivity in the absence of a strong cohort signal. This is also the more precautionary approach as the risk to the stock is smaller than when choosing a dome shaped pattern, and this could potentially result in an accumulation of older fish in the assessment that may or may not be present in the stock as they are poorly monitored.

A dome shaped selectivity was assumed for the hook and line fishery as described earlier, because the older ages taken by the long line were mostly absent from this fishery. Although larger fish may be harder to catch with hook and line gear due to the weakness of the line, a more likely reason for this decline in selectivity is the tendency for larger black grouper to be found further off shore out of the reach of the more coastally based hook and line fishery. The information contained in the data was investigated, by allowing the selectivity at age to vary freely for the hook and line fishery. The results indicated a dome shaped selectivity with some noise, justifying the choice of a double logistic selectivity pattern in the final model. The same assumption was made for the headboat and MRFSS data as the age information also suggested that few older fish were caught in these fisheries.

Although the information in the data here was relatively clear cut, the choice of a double logistic pattern is problematic because following an initial decline in the data, the selectivity is forced to go to 0 at older ages. Often there may be a decline in selectivity, but in reality a decline to 0 is theoretically unlikely because there will always be fishers that target the largest individuals, particularly in the recreational fishery. In this case, the model seems appropriate mainly because black grouper is not the main target species and pursuit of the largest individuals would forego significant catches of other species in the hook and line fishery, whilst the long line fishery is excluded from these higher catch rates through regulatory mechanisms.

Fisheries independent index information used in the assessment was limited to the RVC and VS visual information. The area covered by the surveys means that these largely monitor the younger ages of black grouper, so that the choice of selectivity was one of a declining selectivity commensurate with the offshore migration of older fish. The data did not support a dome shaped selectivity as might be expected with smaller individuals being harder to spot and identify.

In general, the indices fitted the model rather poorly, in my opinion mainly due to the inability of the model to track cohort strength well in the fishery. Assuming that the visual census information (RVC and VS) is largely a *recruitment index, the poorer fit is thus inevitable. See also comments in the section on length information.*

The final choice was to use the age based model, as the hook and line (H&L) data were deemed to provide significant additional information to the assessment especially with regards to changes in cohort strength. The model provided a reasonable basis for assessing the status of the stock and provided a reasonable approach to determine stock productivity, although further information is urgently required to determine this more precisely. There is some concern that due to the sparse availability of age information, the real contrast in cohort strength is likely to be less precisely reflected than the general biomass trends. This will greatly decrease the precision of projections, when strong or weak year classes are encountered at the end of the time series.

The most convincing age based assessment suggested that the black grouper stock is neither overfished, nor is overfishing occurring. The results indicated that the stock abundance has not changed significantly over recent years, and as such the model is sufficient for managers to assess the stock status as stable, and likely to improve when future management measures designed to protect gag and red grouper come in to force at the end of 2009.

Overall, the black grouper assessment was weaker than the red grouper assessment, mainly due to the quantity of data, but also due to the uncertainty of the level of landings associated with misidentification of gag grouper. The uncertainty in the model conditional upon the data (MCMC bootstrap) was likely a substantial underestimate of the true uncertainty, but there were technical and time constraints at the AW, which limited our ability to fully investigate the process error in the assessment. A number of models with different parameter settings were investigated and although in some scenarios (very high M estimates) the estimate of stock status indicated a more problematic situation, they did not differ in their assessment of the stock being in a stable condition.

TOR3: 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.

Red and Black Grouper

Trends in the stock population parameters were described in the assessment section of the report and were available graphically in presentations provided by the assessment scientists. Tables of the absolute estimates and their precision were not available at the time of writing, but these will be provided as part of the full report produced for the AW.

TOR4: 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'.

Red Grouper

Steepness as in the case of black grouper was poorly defined, but for red grouper, there was some evidence from the data that levels above 0.75 (the starting point) were justified. The model converged to a value of 0.9, although it was difficult to see much justification for values much less than 1 from the stock recruit plot. In general, we know that recruitment will be limited when SSB drops below some critical value, but determining this point is very difficult.

Given that this stock has seen some variation in SSB and the stock is now at much healthier levels, it seems unlikely with proper management that the stock will return to levels where recruitment is impaired. As such the estimation of steepness is unlikely to be critical for future management from a precautionary perspective, but it does significantly affects the estimation of stock productivity; hence, stock status is considered important from a sustainability point of view. The AW decided to stick with a value of 0.9 as a conservative estimate determined by the model, rather than making a more subjective choice of a lower value, and in preference of a proxy.

Consequently, as with black grouper, the uncertainty in steepness should not significantly impact the ability of managers to set suitable ABCs, but it will make it more difficult to determine long-term productivity levels.

In addition to the discussion on steepness, the AW considered the appropriate measure of SSB, because red grouper are protogenous hermaphrodites, turning to males at older ages. There is the potential of sperm limitation at low stock levels, unless there is some biological flexibility in the age of sex change. The AW had little to go on as neither female nor male SSB provided a reasonable stock recruit relationship.

From a theoretical standpoint, neither can be appropriate over the whole range of SSB. Unless the level of male SSB at which sperm availability become limiting is known, either physically or behaviorally this uncertainty will remain. Although given the poorly defined stock recruit relationship, this would appear to be of little consequence to short-term management at current levels of SSB, and this can have significant impacts on the estimation of productivity of the stock and hence complicates estimation of stock status.

The industry indicated that there was evidence that the red grouper stock consisted of two sub-populations based on the fact that the fisheries and the fisheries independent information in the north and south indicated different trends. The panel came to the conclusion that it was not possible to estimate rates of migration between the different stocks independently, so that a spatial model would suffer from having to fit additional unconstrained parameters that were impossible to verify and as such were likely to over-fit known processes. In addition, the various data sources were of insufficient density to allow age *based separation of the two components for the fisheries dependent information.*

Biologically, there is little information to justify such a split as recruitment is likely to come from a single spawning pool directed spatially by prevailing environmental conditions. The fact that the model cannot accurately mimic the interaction of spatio-temporally heterogeneous recruitment with spatially explicit selectivities does present an additional uncertainty, but one which in the absence of independent information is currently not possible to estimate quantitatively. This uncertainty is not included in the quantitative information, but its effect on stock productivity estimates and stock status estimation is thought to be small in relation to the more prominent uncertainties associated with this assessment referred to in the above discussion.

In terms of providing sound management advice for red grouper, the provision of the uncertainty analysis seems unlikely to provide significant improvements in the quality of the advice. Given that previous management appears to have had the desired effect of increasing SSB at current levels of F (with the exception of 2008), it is suggested that the stock is likely to recover further still in the absence of further management.

Given that current levels of the stock and F are only slightly below and above possible management targets based on Fmsy, and further management action in the form of a 4 month seasonal closure to protect spawning aggregations of gag and an area closure to protect red snapper, it seems unlikely that it will be possible to exploit the stock at levels beyond those recommended without a considerable influx of effort from other areas or fisheries. However, no management measure is likely to be fully effective, with a possible redistribution of effort or retargeting of other gear types possibly reducing the effectiveness, so requiring future reevaluation of the situation.

Black Grouper

The estimated uncertainty internal to the model (based on bootstrapping residuals) gives some indication of some of the uncertainties in the data, but is unlikely to present the full gamut of uncertainty, particularly as it has not been possible to include the age structure of the long line fishery. Estimation of possible process error for this stock was limited at the AW to examination of different values of M and possible changes in the catchability of the commercial fleets.

Using different values for the estimate of M changes the absolute level of abundance estimates, but does not significantly alter the trends in SSB or F except at M= 0.3, levels thought to be unlikely given the Z-estimates from the catch curve analysis. Significant changes in the stock perception are possible by forcing the selectivity curve for the hook and line fishery to be flat topped. Again this is an unlikely scenario, given the substantial portion of the long line caches at older ages.

A 2% increase in efficiency of the fleets, as suggested by the DW, was modeled by decrementing the fisheries dependent CPUE data by 2% as a correction since the Age Structured Assessment Program (ASAP2) model does not allow for a CPUE correction factor. The maximum likelihood analysis indicated that this had little impact on the model fit. Taking no change in catchability, the more parsimonious model, as the null hypothesis, one would conclude that there is no evidence of an increase in catchability. However there were some discussions at the AW whether the SSC assumed H0 to be that there was likely an increase of 2% in catchability. In the latter case, the interpretation would be that there was no evidence of a constant catchability.

The latter would in my opinion be difficult to justify, but more so the interpretation, i.e. if it is not constant, what is the rate of change? In any case, the assessment period was divided into management periods for which different selectivities were estimated. Commensurate with the management periods, the model re-estimates q, so that it is reset to the center of each management period were there to be a trend in q. Consequently, the type 2 error would be relatively small given the relatively short management periods.

Estimates of the steepness of the stock recruit curve were heavily constrained in order to aid model convergence. The sensitivity of the model to this constraint is substantial and the value of steepness is highly uncertain as there appears to be little contrast in either SSB or recruitment over the assessment period. Assuming the SSB does not change significantly in the short term, particularly a reduction in SSB, the uncertainty in the estimate of steepness is unlikely to reduce the ability to manage the stock effectively.

Given the healthy stock status, determination of ABCs is less critical than in cases of poor stock status. On the basis of the current assessment setting, ABCs should be possible without endangering in the stock so long as targets are not set to increase fishing mortality. However, there was insufficient time at the AW to investigate specific scenarios that would satisfy the criterion.

In contrast, the determination of management targets based on stock productivity, such as Fmsy, is heavily reliant on a precise estimates of M and steepness. Given the uncertainty in landings, long line age compositions, M and steepness, it is advisable to use proxies based on ratios such as F30, for example, which relies only on the better known estimation of growth and selectivity, as these advise on productivity on a per recruit basis.

This differs from the conclusions made for red grouper in this AW. The red grouper stock had declined significantly in abundance and was now returning to higher levels so that a reasonable range of SSB had been experienced; the model converged to a value of steepness of 0.9 despite a prior probability of 0.75, suggesting there was some evidence in the data to estimate steepness. By contrast, the black grouper stock appeared to have experienced little variation in the SSB, especially at the lower end of the range where one would expect to see the most significant impact on recruitment. Consequently, in the absence of information, the estimates of steepness *converged to the starting value (0.7), identical to using an uninformed fixed value without variation.*

Current management requires the estimation of uncertainty in association with the best estimates of central tendencies. During the AW, two types of uncertainty were discussed and evaluated. Variance can be estimated from the model and basically represents the deviances of the input data in the final optimization. Redistributing the deviance in a MCMC process gives some indication of the sensitivity of certain parameters within the model. In my opinion, the model setup chosen for either stock seemed to underestimate the true uncertainty, as they used smaller CVs for the landings data than were warranted. MRFSS data for red grouper for example was corrected using a cubic spline smoother, because it was felt that the value was too high, and there the likely misidentification of some gag as black grouper landings similarly indicates that the quality of the data is more suspect than implied by a CV of 0.01. In other words, the apparently quantitative results of the MCMC process are subject to process bias even in the absence of process error in the deterministic assessment of the stock.

Process error in the form of constraints on parameters, such as landings or steepness as well as fixed parameters such as M were also examined. For M, for example, a number of different M's were examined, and it is planned for red grouper to perform a full MCMC analysis using some distributional, but relatively uninformative prior. Nevertheless, whether a symmetrical, non-symmetrical or uniform distribution or a range of plausible values is used, the choice of prior will invariably affect the posterior likelihood. Without prior, independent scientific evidence the results remain subjective and can at best be used qualitatively rather than quantitatively. That is not to say that such investigations are not worthwhile, but scientists and managers will need to discuss how one might describe such results in order to avoid different interpretations.

Interpretation provided further difficulty as some of the parameters were not symmetrically susceptible to changes in the data. In some cases, the resultant probability distribution for parameters was neither consistent with the mode (the most likely outcome) or the 50% percentile. Trying to estimate the likelihood of F/Fmsy < 1, for example, can provide inconsistent answers, with the deterministic outcome (the most likely scenario given the actual data) indicating F < Fmsy, whilst the MCMC process might indicate that the likely hood of F< Fmsy is significantly less than 50%. The degree to which this occurred when only redistributing the residuals in the data was mostly of minor significance in terms of management (it did not result in different interpretation of stock status for either red or black grouper), but relaxing constraints or varying initially fixed parameters such as M with prior distributions significantly increased the problem. Further work needs to be carried out with managers to better understand their needs and to evaluate such uncertainty more consistently.

For a more in-depth discussion on the general provision of quantitative uncertainty information, see also the quantitative uncertainty in the following assessment section.

General uncertainty concerns

Incorporating all the sources of uncertainty in a quantitative manner individually is difficult enough, but trying to assess all the interactions between the different uncertainties is even more difficult. From a practical approach, assessing the uncertainty interactions should not require much more than allowing the CVs of the input values to change, however individual runs are exponentially less likely to converge as we increase the uncertainty in several parameters, as seen by the release of the landings CV alone. Providing an interpretation useful to manager of such a complex analysis in an attempt to provide entirely objective advice, when the choice of input variability is subjective itself, seems to me to be no less misleading than providing a single scenario with the caveat that given the data it is the most likely scenario. Consequently, I find it difficult to suggest a quantitative way forward in evaluating these uncertainties and would suggest that a more qualitative approach using guided experts may be a more honest solution. I feel as experts the AW has been open and honest as to their feeling of where the weaknesses are in the data and the models and one should be able to come up with sound management solutions from the information provided without having to resort to quantitative analysis of the uncertainty. The complex interaction of all sources of uncertainty may imply that we know very little about the stock, and this may be true from a quantitative perspective, but qualitative information and an expert understanding of the biological and fisheries processes involved can guide model choice and reduce uncertainty much below the levels indicated by a full Bayesian analysis with uninformative priors.

Despite the problems described above with the full evaluation of the uncertainty, the TORs for the AW requested such information. In reality, the true uncertainty can only be defined as somewhere between the variance described by the single assessment, and the almost complete uncertainty taking account of all possible values for all possible input parameters. The AW discussed limiting the number of possible uncertainties to exploration of various rates of discard mortality, natural mortality, but wisely shied away from dealing with such difficult issues as the historic discard rate in the recreational fishery, which in a full uncertainty analysis should be included due to the heavy impact of the recreational sector on the stock. Assessments were run with various settings of the natural and discard mortality to explore the range of possible answers, but for a full MCMC analysis some agreement had to be reached on the prior distribution. The choice of this prior distribution is likely to have a significant impact on the estimates of uncertainty, and the group found it difficult to agree on an appropriate way forward. Uniform priors seem to rely too heavily on the more unlikely extremes of the range of plausible values.

In the end, there was insufficient time to run the full MCMC analysis at the AW, having only completed a small number of runs on a subset of possible *options. However, I believe the limiting of the choice of possible options, as well as the difficulty in coming up with a realistic set of prior distributions, underline our inability to actually provide a true quantitative assessment of the uncertainty in the assessment. Assuming it is possible to complete this analysis by the time the RG meets, quantitative data will be provided; but given the limited extent of the full probability space examined, the results are likely to be interpreted differently by different experts. I do not think that these particular analyses yield much in the way of benefit for managers, and in certain circumstances could actually hinder effective management of the fisheries. For example if the uncertainty estimates cover all possibilities, no matter how unlikely, then the likely outcome is that any catch is likely too large. Even if scientists are able to provide a realistic subset of the critical uncertainties and a reasonable quantitative measure of the likely qualitative prior distributions, these decisions are going to be very difficult to defend in a legal sense, as by definition the assessment of uncertainty should include all possible scenarios, not just the most likely ones. Consequently, management action based on the most likely state of nature type analysis may be severely impaired by legal actions aimed at introducing further possibilities not considered as plausible or relevant in the initial assessment. The same is true of the conditional probability of the assessment, i.e. it holds only if the model assumptions are reflected in the processes, but the conditional probability given the data is more honest in the sense that it does not claim to be all knowing.*

The difficulties with regards to the examination of the uncertainty have been entirely theoretical as clearly it is possible to evaluate a set of uncertainties. However, during the AW it also became apparent that it was unclear as to how management could / would interpret the data. One problem for example was having developed an assessment and an uncertainty distribution of that assessment, which do we base management on? Basing it on the distribution of possible outcomes based on the MCMC essentially denies that fact that the data which were collected exist. In contrast basing it on only the assessment denies that there is uncertainty around the values.

The problem for management arises, when the most likely state of nature given the data differs from the most likely unconditional probability, i.e. the actual assessment is found in the extremes of the overall probability distribution. Clearly both are right given their theoretical basis, but the differences greatly complicate management. Managers will need to understand what they are asking for and relate to the assessment scientist in which format they wish to interpret the data in order that effective management can be applied. The problem of how to interpret the assessment information is beyond the scope / time available at the AW and should ideally be taken up at a separate SEDAR workshop that includes managers in order to derive a consistent approach across all assessments.

TOR5: Provide yield-per-recruit, spawner-per-recruit, and stock-recruitment evaluations, including figures and tables of complete parameters.

Red & Black Grouper

Yield-per-recruit evaluations were largely based on the partial F and the selectivity patterns of the different fleets. These patterns changed sequentially through out the assessment period due to the introduction of management measures, which in conjunction with the paucity of age data made a detailed analysis of the YPR and spawner-per-recruit tenuous in either stock. Despite this, figures and tables are provided in the final report of the AW, but were not available for inclusion at the time of writing this report.

Stock recruitment parameters were evaluated internal to the model for both stocks. The relationship is central to the evaluation of productivity as well important in determining assessment fit. The main issue is the difficulty in estimating steepness. Because the discussions were important in the choice of model and setup these have been included and values given in the previous section. In general neither stock seemed to respond strongly to changes in SSB, although SSB for black grouper has not changed significantly over the assessment period so in this case there is even less information available. Figures and tables are provided in the final report of the AW, but were not available for inclusion at the time of writing this report.

TOR6: 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.

A. **In addition, for black grouper, the Gulf Council requests that the Panel specify OFL, and recommend a range of ABCs for review by its SSC.**

Red and Black Grouper

Benchmarks were discussed at some length at the AW, concentrating on the principals of the type of benchmark to be used. For red grouper, given that there was some information available to provide an estimate of steepness, it was felt that it was appropriate to use MSY based benchmarks. In contrast, the black grouper stock assessment contained very little information on steepness, so here it was deemed more appropriate to used SPR proxies.

Having decided on the nature of the benchmarks, and given that for these stocks there are currently no FMP, a range of options would need to be evaluated to determine the suitability in use by management. There was insufficient time at the meeting to produce a final table of options for either stock, but given the assessments the determination of such information will be completed following the meeting.

TOR7: Provide declarations of stock status relative to SFA benchmarks.

Red Grouper

The BAM model indicated that red grouper had been substantially overfished historically, and that SSB had dropped well below those levels that would produce maximum yield. However, management actions implemented in the early 1990s had substantially curtailed F and allowed the stock to recover. Current SSB is now just below the level that would attain maximum yield. The 2008 estimate of F is more uncertain, but also suggests that overfishing may be occurring. However, the additional management measures put in place in the autumn of 2009 to protect gag and red snapper are likely to ensure that F from at least 2010 onwards falls below the level required to produce the maximum sustainable yield. No final assessment of current stock status has been undertaken at this point, and no final decision has been made as to the choice of some of the parameter settings such as M and discard mortality, all of which have some bearing on the definition of stock status when SSB < SSBmsy.

Black Grouper

The most convincing age based assessment suggested that the black grouper stock is neither overfished, nor is overfishing occurring. The results indicated that the stock abundance has not changed significantly over recent years, and as such the model is sufficient for managers to assess the stock status as stable, and likely to improve when future management measures designed to protect gag and red grouper come in to force at the end of 2009.

TOR8: Perform a probabilistic analysis of proposed reference points and provide the probability of overfishing at various harvest or exploitation levels.

Red and Black Grouper

No analyses providing probabilistic results of proposed reference points were provided at the meeting. In general, this is a more or less deterministic calculation from standard stock assessment output, once assessment and uncertainty have been characterized. No tables were produced at the AW. I feel the time at the AW was probably more effectively spent examining the assessment and uncertainty surrounding it than the production of tables, and I have no doubt that the final report will produce suitable information based on the most appropriate models and their variance, i.e. the uncertainty given the data. However, given the problems in quantifying the process uncertainty (see TOR 4), it seems unlikely that it will be possible to provide useful estimates of the overall probability for either stock.

TOR9: 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)

Red Grouper

In terms of providing a forecast (ABCs) for implementation in 2010, the AW decided to use the average F for the last three years as Fcurrent, use the geometric mean of recruitment (in the absence of a discernable stock recruit relationship), and use the stock numbers in the terminal year. The problem is that this does not take account of the likely impacts of the management measures to protect gag and red snapper to be implemented in 2010. The effects of these measures are likely to be beneficial to red grouper, but the AW could not provide a realistic estimate of the effect. Instead, it was agreed to provide a table of likely catches, given various reductions in fishing mortality compared to current levels.

$F_{current}$

1) $F_{current}$ 2009, 2010
2) $F_{current}$ in 2009, 75% $F_{current}$ 2010
3) $F_{current}$ in 2009, 50% $F_{current}$ 2010
4) $F_{current}$ in 2009, 25% $F_{current}$ 2010

F_{msy}

65% F_{msy}
75% F_{msy}
85% F_{msy}

$F_{rebuild}$

1) $F_{current}$ 2009, 2010
2) $F_{current}$ in 2009, 75% $F_{current}$ 2010
3) $F_{current}$ in 2009, 50% $F_{current}$ 2010
4) $F_{current}$ in 2009, 25% $F_{current}$ 2010.

The levels chosen and the forecast parameters are shown above, but there was insufficient time at the AW to provide the results of these runs.

Black Grouper

The assessment output for black grouper was examined, but no clear cut decision was made at the workshop on how best to move that forward.

TOR10: Evaluate the results of past management actions and, if appropriate, probable impacts of current management actions with emphasis on determining progress toward stated management goals.

Red Grouper

Management action for red grouper, after initial failings, appears to have been successful in increasing the SSB of the stock from a low in 1992 almost back to sustainable levels due in a large part to a decrease in the fishing mortality, which is now also close to sustainable levels. The management actions relate to the introduction of a minimum landings size, but more importantly an inshore exclusion zone for the commercial long line fishery.

Although the change in selectivity associated with the increase in the minimum landing size is likely to have improved stock status, the results are heavily dependent on the assumption of discard mortality. The impact on selectivity and catchability of the longline fishery by essentially being excluded from waters shallower than 50 fathom is likely to have had a much more dramatic impact than the effect of a change in selectivity, despite the fact that most of the catches in this fishery come from the recreational sector, which is unaffected by the spatial regulation.

Black Grouper

The age based grouper model gave some indication that fishing mortality and selectivity had changed twice over the period, commensurate with two rises in the minimum landing size for black grouper. In addition, a number of management measures for other species seem to have had a beneficial impact on the stock status of black grouper, but these measures appeared to have been of a preventative nature. In other words the status of the stock never deteriorated so that assessment of the adequacy of the measures can only be measured by the fact that the stock status never deteriorated, rather than by a positive improvement in stock status.

The model was set up to reflect these changes in selectivity, so it is not entirely clear whether the model was interpreting the pattern based on the additional freedom given to the model by the introduction of additional parameters, or whether this reflected actual information in the data. From a parsimony point of view, it appeared that two management periods would suffice to reflect the changes in the data. This was thought to be consistent with the fact that there had already been a state (Florida) minimum landing size, with Florida accounting for the majority of catches, prior to the introduction of a federal minimum landing size. In any case, the stock is quite hard to manage given that this is almost entirely a by-catch fishery, unless discard mortalities are low, management of black grouper will be mostly be dependent on management of the target fisheries. Given the status of the stock as estimated by the AW the stock is neither overfished, nor is overfishing occurring, so that one can only conclude that management appears to have been successful. Management regulations coming into force *at the end of 2009, designed to protect gag and red snapper, are likely to further reduce the fishing mortality on black grouper resulting in exploitation of the stock below management targets, such as maximum sustainable yield with a commensurate increase in B >> Bmsy.*

TOR11: Provide recommendations for future research and data collection (field and assessment); be as specific as practicable in describing sampling design and sampling intensity.

Red Grouper

There are a number of key questions regarding the red grouper assessment that in the opinion of experts contribute significantly to the uncertainty in the assessment and hence reduce the ability to manage the stock more effectively.

1) Determination of the discard mortality for red grouper. In this research it is important to consider the effects of size of fish and depth of capture and how this interacts with the fisheries that discard red grouper. Ideally, discard information and fisheries information should be made available spatially in order to determine an appropriate rate of discarding. Furthermore, it would be useful to differentiate between primary and secondary discard mortality, as the primary is easy to determine and is usually what fishermen see, whereas the secondary mortality is the source of the major uncertainty.
2) A more detailed analysis of the available discard information should be sought, as there were only three years (2005-7) of suitable information available. Once better estimates of discard mortality are available better data on discard rates are essential to avoid having to essentially freely estimate these in the assessment. The inclusion of 2008 and future discard estimates collected under a new sampling design will require future research to concentrate on making this consistent with historic discard data collection.
3) More information on the spatio-temporal distribution of fisheries would also be useful to determine the likely effects of the management measures coming into effect in 2010 with regards to the seasonal closure, and this should be considered when deciding on future management options.
4) Better estimates of natural mortality rates and possible density dependent variation would decrease the uncertainty in the assessment and improve the estimates of stock productivity.
5) Tagging information should be collected / examined to determine the degree of mixing between populations in the current management unit. Such data would also be one way to collect independent information on mortality rates.

Black Grouper

The data on black grouper are sparse in general and uncertain with regards to landings information in the early assessment period. Although the assessment represents the best available information at this time, future work should focus on:

1) Collecting additional age information, particularly for the long line fishery, as length information seems inappropriate to assess cohort strength and hence fishing mortality at the older ages. These ages represent a significant portion of SSB, but are only partially selected due to spatial constraints and hence are poorly monitored by the current sampling program compared to the younger ages in the H&L fishery.
2) With additional age information an attempt should be made to see if it is possible to better assess the stock using multinomial probabilities within a model (as in the BAM or SS3 models), rather than trying to determine the probability of a fish having an age given a length externally as was attempted unsuccessfully at this AW.
3) If possible an attempt should be made to investigate quantitatively if more certain estimates can be attained of black grouper landings in the early part of the time series, given the known problems with identification. This should include an investigation of the effects that possible uncertainties have on the estimated historic stock trends and the proposed management benchmarks.
4) Discard rates and discard data are unlikely to be as critical to the current stock assessment, but as the assessment improves with additional data these are likely to represent some of the biggest uncertainties as is the case in the current red grouper assessment. Given that this stock is largely a by-catch fishery, having a time series of reliable information will be essential and work should start as soon as possible to provide a useful time series, or to highlight weaknesses in the current sampling design.

TOR 12 and 13 were not part of the CIE independent expert responsibility as they pertained to the summarization and documentation of the agreed findings with regards to the final outcome of the assessment to be put forward to the SSC.

Appendix 1: Bibliography

Paul B. Conn, **SEDAR 19-AW-01**. A hierarchical analysis of south Atlantic red grouper CPUE indices

Sustainable Fisheries Branch, **SEDAR 19−AW−02**. Red grouper: Regression and Chapman−Robson estimators of total mortality from catch curve data

Sustainable Fisheries Branch, **SEDAR 19–AW03**. Additions and Updates to Red Grouper data since the SEDAR 19 Data Workshop

Sustainable Fisheries Branch, **SEDAR 19–AW04**. Red Grouper: Predecisional Surplus–production Model Results

Robert G. Muller, **SEDAR19-AW-05**. A non-equilibrium surplus production model of black grouper (*Mycteroperca bonaci*) in southeast United States waters

Robert G. Muller, **SEDAR19-AW-06**, Catch curves from two periods in the black grouper fishery.

Sustainable Fisheries Branch, **SEDAR 19-AW-07**. A statistical catch-age model for red grouper: mathematical description, implementation details, and computer code.

Robert G. Muller, **SEDAR19-AW-08**. Assessment history of black grouper (*Mycteroperca bonaci*) in the southeast U. S. waters.

Annex 2: Statement of Work for Dr. Sven Kupschus (CEFAS)

External Independent Peer Review by the Center for Independent Experts

SEDAR 19 – South Atlantic red grouper and South Atlantic and Gulf of Mexico black grouper Assessment 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. The CIE reviewer is 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. The 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.com.

Project Description: SEDAR 19 will be a compilation of data, a benchmark assessment of the stock, and an assessment review for conducted South Atlantic red grouper and South Atlantic and Gulf of Mexico black grouper under the SEDAR (Southeast Data, Assessment and Review) process. This proposal is for a CIE expert to be appointed to participate as a CIE independent peer reviewer on the Assessment Panel during the assessment process.

SEDAR assessments typically involve an assessment panel composed of assessment analysts named by the lead SEDAR cooperator, fishery scientists as SSC members, and fishery managers. This proposal is based in part on a recent SEDAR assessment panel recommendation that the assessment panel include an independent expert peer review person to serve as a workshop panelist during the process leading to an Assessment Review Workshop. While the independent expert will not contribute to the production of science products, he or she can be valuable by providing peer review advice regarding technical details of the methods used in SEDAR assessments and decisions related to model configuration during the workshop. In providing peer review advice during the assessment workshop, the independent expert can improved the overall assessment process by advising the analysts regarding issues that might become points of contention in the formal peer review workshop—at which time it would be too late to revise the actual assessment (assessment data decisions, assumptions, models, modifications, etc. are confined to the assessment process before the peer review workshop).

The Terms of Reference (ToRs) of the peer review are attached in **Annex 2**. The tentative agenda of the panel review meeting is attached in **Annex 3**.

Requirements for CIE Reviewer: One CIE reviewer shall conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. CIE reviewer shall have working knowledge and recent experience in the application of stock assessment, statistics, fisheries science, and marine biology sufficient to complete the task of participation in discussions of technical details of the data and methods used for this SEDAR assessment and decisions related to model configuration in compliance with the workshop's Terms of Reference. The 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: The CIE reviewer shall conduct an independent peer review during the panel review meeting scheduled in St. Petersburg, Florida during 5-9 October 2009.

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

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

Foreign National Security Clearance: When CIE reviewer 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 the CIE reviewer if a non-US citizen. For this reason, the CIE reviewer 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/sponsor.html).

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

Panel Review Meeting: The CIE reviewer shall conduct the independent peer review in accordance with the SoW and ToRs, and shall not serve in any other role unless specified herein. **The CIE reviewer serves only as a peer reviewer in accordance with the SoW, and shall not serve as an analyst during the workshop. Modifications to the SoW and ToRs can not be made during the peer review, and any SoW or ToRs modifications prior to the peer review shall be approved by the COTR and CIE Lead Coordinator. The CIE reviewer shall actively participate in a professional and respectful manner as a member of the meeting review panel, and the CIE reviewer's peer review tasks shall be focused on the ToRs as specified herein, to the extent possible where the tasks represent peer review and not analysis.** 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 reviewer 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 Report: The CIE reviewer shall complete an independent peer review report in accordance with the SoW. The CIE reviewer shall complete the independent peer review according to required format and content as described in Annex 1. The CIE reviewer shall complete the independent peer review addressing each ToR as described in Annex 2.

Other Tasks – Contribution to Summary Report: The 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. The 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 Reviewer: The following chronological list of tasks shall be completed by the CIE reviewer in a timely manner as specified in the **Schedule of Milestones and Deliverables**.

1) Conduct necessary pre-review preparations, including the review of background material and report provided by the NMFS Project Contact in advance of the peer review.
2) Participate during the panel review meeting at the St. Petersburg, Florida during 5-9 October 2009.
3) During the review meeting in St. Petersburg, Florida during 5-9 October 2009 as specified herein, and CIE reviewer shall conduct an independent peer review in accordance with the ToRs (**Annex 2**).
4) No later than 23 October 2009, the 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 David Sampson, CIE Regional Coordinator, via email to david.sampson@oregonstate.edu. The 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.

30 August 2009	CIE sends reviewer contact information to the COTR, who then sends this to the NMFS Project Contact
21 September 2009	NMFS Project Contact sends the CIE Reviewer the pre-review documents
5-9 October 2009	The reviewer participates and conducts an independent peer review during the panel review meeting
23 October 2009	CIE reviewer submit draft CIE independent peer review report to the CIE Lead Coordinator and CIE Regional Coordinator
5 November 2009	CIE submits CIE independent peer review report to the COTR
12 November 2009	The COTR distributes the final CIE report to the NMFS Project Contact and regional Center Director

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

Acceptance of Deliverables: Upon review and acceptance of the CIE independent peer review report by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, these report 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 report) to the COTR (William Michaels, via William.Michaels@noaa.gov).

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

COTR. The COTR will distribute the CIE report to the NMFS Project Contact and Center Director.

Support Personnel:

William Michaels, Contracting Officer's Technical Representative (COTR)
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Key Personnel:

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

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

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

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

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

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

3. The reviewer report shall include the following appendices:

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

Annex 2: SEDAR 19 Assessment Workshop Terms of Reference

South Atlantic red grouper and South Atlantic and Gulf of Mexico black grouper

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.

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.

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.

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'.

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

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.
   B. In addition, for black grouper, the Gulf Council requests that the Panel specify OFL, and recommend a range of ABCs for review by its SSC.

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

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

10. Evaluate the results of past management actions and, if appropriate, probable impacts of current management actions with emphasis on determining progress toward stated management goals.

11. Provide recommendations for future research and data collection (field and assessment); be as specific as practicable in describing sampling design and sampling intensity.

12. 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.

13. Complete the Assessment Workshop 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.

Annex 3: Tentative Agenda

SEDAR 19 – South Atlantic red grouper and South Atlantic and Gulf of Mexico black grouper Assessment Workshop

St. Petersburg, Florida during 5-9 October 2009

Monday

1:00 p.m.	**Convene**
1:00 – 1:30	**Introductions and Opening Remarks** **Coordinator**
1:30 – 3:30	**Panel discussions** **Panel**
3:30 – 4:00	**Break**
4:00 – 6:00	**Continue Discussion** **Panel**

Monday Goals: *Final data decisions, assign roles & tasks*

Tuesday

8:30 a.m. – 11:30 a.m.	**Panel Discussions** **Panel**
11:30 a.m. – 1:30 p.m.	**Lunch Break**
1:30 p.m. – 3:30 p.m.	**Panel Discussion** **Panel**
3:30 p.m. – 4:00 p.m.	**Break**
4:00 p.m. – 6:00 p.m.	**Panel Discussion** **Panel**

Tuesday Goals: *Base configuration, sensitivity/uncertainty run list*

Wednesday

8:30 a.m. – 11:30 a.m.	**Panel Discussion** **Panel**
11:30 a.m. – 1:30 p.m.	**Lunch Break**
1:30 p.m. – 3:30 p.m.	**Panel Discussion** **Panel**
3:30 p.m. – 4:00 p.m.	**Break**
4:00 p.m. – 6:00 p.m.	**Panel Discussion** **Panel**

Wednesday Goals: *Preferred models, Consensus Discussion, Stock Status*

Thursday

8:30 a.m. – 11:30 a.m.	**Panel Discussion** **Panel**
11:30 a.m. – 1:30 p.m.	**Lunch Break**
1:30 p.m. – 3:30 p.m.	**Panel Discussion or Work Session** **Panel**
3:30 p.m. - 4:00 p.m.	**Break**
4:00 p.m. - 6:00 p.m.	**Panel Work Session** **Panel**

Thursday Goals: *Projections, Consensus Text.*

Friday

8:30 a.m. – 12:00 p.m.	**Panel Work Session** **Panel**
12:00 p.m.	**ADJOURN**

Friday Goals: Draft AW report, All files on server