Center for Independent Experts (CIE) Independent Peer Review of SEDAR 34: Bonnethead Shark and Atlantic Sharpnose Shark Assessments

Prepared for the Center for Independent Experts

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Executive Summary

This desktop review is being undertaken prior to the SEDAR 34 Assessment Review. Stock assessments of Highly Migratory Species Bonnethead and Atlantic Sharpnose Shark were presented at the June (25^{th}-27^{th}) assessment workshop as part of the SEDAR 34 process. This is one report of a three member peer review for the assessment, contracted through the CIE process in September 2013, prior to the consensus summary being drafted. This report should be read in conjunction with the SEDAR 34 assessment reports and the other CIE reviewers' reports.

As a preface to this executive summary I note that the scientific quality of both assessments is, in general, of high quality. Although the assessments adequately fulfilled the terms of reference under which they were contracted, there are problems with the assumptions of stock structure in the assessment terms of reference. While the assessment team addresses the issue of stock structure to varying degrees through sensitivity analysis, the erroneous underlying assumption of one well mixed stock makes direct interpretation of the assessment results difficult.

Both shark species are most often caught as bycatch in the Gulf of Mexico (GOM) and Atlantic shrimp fisheries, though some directed fisheries do exist. Useful data on catch and effort were mostly limited to fishery independent data sources in the GOM and Atlantic Ocean. Significant data gaps were mostly limited to the historical catch in the shrimp fisheries.

Multiple models with different combinations of the input data and parameterizations were run to assess the plausibility of alternate assumptions and their effects on the estimates of stock status. In general this is good, standard practice for bycatch species. Shark assessments are generally difficult to conduct because it is often difficult to construct a catch history (e.g. due to problems of reporting, changes in gear or targeting, discarding and/or species mis-identification) and this uncertainty carries through into the calculation of abundance indices. Often, estimates of biological and life history traits such as growth, natural mortality and the size at maturity are used to help inform and constrain the assessment within plausible population dynamics, because the stock as a whole is limited by its intrinsic rate of growth. This is true for both of these assessments.

Both assessments could benefit from grouping indices and fitting multiple models, using only non-conflicting indices within a model. Allowing a model to include conflicting indices breaks the assumption that the indices represent the population dynamics, and results in poor fit as the model finds a non-optimal solution that is a compromise between the conflicting indices. Both assessments used available length data to estimate selectivity, however the data were used in such a way as to obscure any potential changes in relative abundance in length classes.

I see one major fault with the Bonnethead assessment, namely that two demonstrably distinct stocks (one in the GOM and one in the Atlantic) with different life history characteristics were assessed as one stock. Section 2.2.1.2 of the HMS Bonnethead Assessment Report notes that “Based on tagging and genetic data presented there was a consensus that bonnet heads in the Gulf of Mexico and Atlantic Ocean represent two distinct stocks”. However these stocks were assessed as one stock based on the desire for actionable management advice and the fact that consideration of multiple stocks was beyond the terms of reference for the assessment. This detracts from the quality of any advice based on the Bonnethead shark stock assessment because the basic assumption of a single well mixed stock is demonstrably false. Therefore any inference from this stock assessment may only coincidentally reflect the status of the one, both or neither of the stocks.

It is the reviewer's opinion that this is a problem not related to the scientific merit of the study but rather the overarching process that decided to let the assessment go forward as one stock. From a scientific perspective this was the wrong decision. At the minimum a single stock model for either the Gulf of Mexico or the Atlantic should have been undertaken. Alternatively if a single stock assessment covering the Atlantic and GOM was absolutely needed, a two region model with different life history traits and no mixing should have been undertaken.

The overall findings of this review are that for:

Atlantic Sharpnose Shark

- The total F declining over the last decade was due to reduction in the shrimp bycatch.
- Increasing SSF/SSF_{MSY} (SSF = spawning stock fecundity) since 2002 with current estimates indicate the stock is not overfished.
- The data used, chosen by the Data Workshop, were adequate.
- Quantitative estimates of the stock status based only on the Atlantic and GOM stocks are likely more representative of the stock status than the combined region base case.
- The stock was not overfished and overfishing was not occurring; this conclusion is based on the balance of evidence, across the alternative structural assumptions.
- This assessment is of high scientific quality and represents the best available science.

Bonnethead Shark

- The total F declining over the last decade was due to reduction in the shrimp bycatch.
- The data used, chosen by the Data Workshop, were adequate.
- This assessment is of high scientific quality and fulfills the terms of reference, however historical trajectories (SSF, total biomass, total F) likely represent only the GOM portion of the stock.

- The assessment found that the stock was not overfished and overfishing was not occurring; this conclusion is based on the balance of evidence, across the alternative structural assumptions.
- While it is likely that the combined population and regional stocks are not overfished and not experiencing overfishing, any quantitative estimates are unreliable.
- Projection results are unreliable because there are none based on region specific model runs only.
- The process that recommended this assessment (as a single stock) did not take into account the best scientific information available.

Background

Prior to SEDAR 34, both Bonnethead and Atlantic Sharpnose sharks were last reviewed in 2007 through the SEDAR 13 process. The SEDAR 13 Review panel found that

> *For* **Atlantic sharpnose sharks**, *the Panel concluded that the data used for the analyses were treated appropriately. The assessment does not show the SSF index falling below the threshold over the period considered, but the ratio index shows an almost continuous decline towards it. While it is reasonable to conclude that the stock is not presently overfished, the fact that F is close to, but presently below, Fmsy (i.e. overfishing is not occurring) means that if F is maintained, the stock will continue to decline toward the SSF threshold and will fall below it as F fluctuates around Fmsy. It would therefore be desirable to distinguish between targets and thresholds.*
>
> *In terms of* **bonnethead sharks**, *the Panel accepts the conclusion of the current assessment that it is likely that SSF is greater than SSFmsy, i.e. that bonnethead are not overfished. The estimate of fishing mortality rate in 2005 is less than Fmsy, thus overfishing was not occurring in that year. However, fishing mortality rates in the recent past have fluctuated above and below Fmsy. Thus, there is some probability that fishing mortality rates in 2006 and 2007 have been or will be in excess of Fmsy.*

Multiple changes to the both assessments have been made including new age and growth parameters, new reproductive information, inclusion of new abundance indices, inclusion of live discard mortality and new selectivity functions. Additionally the WinBUGS based estimates of bycatch in the shrimp trawl fishery (responsible for +90% of fishing mortality) could not be reproduced. New WinBUGS based estimates were deemed unreliable and the data workshop panel decided to replace the estimates of shrimp bycatch generated with WinBUGS with the stratified nominal estimates. These have altered the conclusion and retrospective analysis for both stocks.

Review Activities

As this was a desktop review the reviewer's role consisted of reviewing the background material, and conducting a review of the assessments, including the writing of this report. Assessment documents (including pre-assessment webinars, working papers, reference documents and assessment reports) were made available through the SEDAR FTP site. I downloaded and reviewed the material, and subsequently wrote the assessment reviews.

Summary of Findings by Term of Reference

The stock assessment structure, data provenance and methodological components varied only slightly across the two stock assessments. Therefore, unless noted, the comments on methodology, data and process reflect my findings for both assessments.

[TOR #1]. Evaluate the data used in the assessment

a. Are data decisions made by the assessment panel sound and robust?
b. Are data uncertainties acknowledged, reported, and within normal or expected levels?
c. Are data applied properly within the assessment model?
d. Are input data series reliable and sufficient to support the assessment approach and findings?

[Reviewer's Comments]

Of all the terms of reference in this review, this (TOR #1) is the most difficult to answer because the decision made by the assessment panel to conduct a single stock assessment for bonnethead sharks heavily influence the inputs, the robustness of the assessment, and any management advice derived from it.

In light of the terms of reference given the assessment team, this review finds that in general the data uncertainties were acknowledged, being well documented through the SEDAR process, and that the data were properly applied through the assessment model. In general sufficiently reliable input data series exist to support the assessment approach and were applied properly under the Terms of Reference delivered to the assessment panel. The uncertainties associated with some of the sources of information were addressed by the assessment team via sensitivity analysis. Specific comments on the data follow.

Stock Units:
[Bonnethead]

Section 2.2.1.2 of the HMS Bonnethead Assessment Report notes that "Based on tagging and genetic data presented there was a consensus that bonnetheads in the Gulf of Mexico and Atlantic Ocean represent two distinct stocks". However these stocks were assessed as one stock based on the desire for actionable management advice and the fact that consideration of multiple stocks was beyond the terms of reference for the assessment. The assessment panel "also provided a strong recommendation that the next assessment for this species be a benchmark assessment treating bonnetheads in the Gulf of Mexico and the

Atlantic Ocean as separate stocks." From a scientific perspective doing a combined assessment was the wrong decision. At the minimum a single stock model for either the Gulf of Mexico or the Atlantic should have been undertaken. Alternatively if a single stock assessment covering the Atlantic and GOM was absolutely needed, a two region model with different life history traits and no mixing should have been undertaken.

[Sharpnose]

The assessment report notes that "Four working papers were presented which examined the movements of Atlantic sharpnose sharks between the Atlantic Ocean and the Gulf of Mexico based on tag-recapture data (SEDAR34-WP-04, SEDAR34-WP-25, SEDAR34-WP-31, SEDAR34-WP-33). There was no evidence of movement between the Atlantic Ocean and the Gulf of Mexico. However, based on restriction fragment length polymorphism analysis of mitochondrial DNA, Heist et al. (1996) concluded that there was no genetic difference between Atlantic sharpnose sharks in the Atlantic Ocean and the Gulf of Mexico." However this places the weight of evidence on a paper that notes

> "The lack of genetic divergence among Atlantic and Gulf of Mexico Sharpnose sharks cannot prove that separate stocks do not exist. An exchange rate of a small number (<20) of females per generation between isolated breeding populations is enough to prevent drift from establishing significant heterogeneity....... The only way, however, to determine the current level of gene flow in this species may be through a tag and recapture program. This information is necessary to determine whether regional exploitation of this species will be compensated by immigration from other regions. (Heist et al 1996)"

In practice the definition of stocks ranges from qualitative to highly technical, and in general stocks should be defined groups that are similar enough (e.g. life history and population dynamics) to be managed together. In this case the life history characteristics and fishery interactions in the GOM and Atlantic are similar enough for this to be the case. The tagging work suggests little compensation occurring to either portion of the stock if one were depleted. For stock assessment purposes a significant issue is the correlation of population dynamics. If there is no significant exchange then the stocks are effectively separate, and so should be assessed as separate stocks. The assessment team did conduct sensitivity analyses based on separate stocks that were informative.

Life History Parameters:

In general the life history information was used appropriately. I have reservations about how the limited age and length data were used to derive selectivity's for various fisheries and surveys; Appendix 3 notes "If fulcrum age=1 (fully selected), fit a double exponential curve by eye by manipulating parameter values to ensure coverage of all ages represented in the sample." While fitting 'by eye' may work out 'well enough', it is not a practice that would be considered robust.

Further it would be better to including length data and a growth model or age-length key in the assessment model so abundance-at-age and selectivity can be estimated simultaneously.

Life History Parameters - Bonnethead
Given the differences in life history traits from the GOM and Atlantic, it was necessary to pick between them. The resulting choices represented neither stock's data completely, which can only be justified by saying that it was in accordance with the Terms of Reference for the stock assessment.

Abundance Indices:
The provenance of the abundance indices was well documented though no comprehensive data workshop report was provided. Conflicting trends in abundance exist for both species in each region. Accepted statistical standardization techniques were unable to remove some large fluctuations in the abundance indices that were not biologically plausible. Expert opinion was used to rank the abundance indices for use in weighting the indices in the model runs. A worksheet outlining the strengths and weaknesses was provided, however no summary of the discussion regarding the weighting of the indices was provided. Many of the indices were short relative to the life span and exploitation history of the stocks under assessment. Many indices exhibited annual variability that exceeds what might be expected for these stocks, while several did not span the full geographic distribution of the stocks. Some of the indices used incorrectly grouped Atlantic and GOM datasets.

Landings and Removals:
In this assessment, as with many shark assessments, overall removals (catch) needed to be partially estimated because only a small percentage of the overall removals is reported as commercial landings.

Issues normally associated with the estimation of (largely unobserved) bycatch, such as under-reporting, species identification, low- spatial coverage, low-temporal coverage, and historical landings being estimated, were encountered in this assessment. Reliable estimates of overall removals for multiple fisheries were calculated and well documented through the data workshop process. The majority of the estimated removals come from the shrimp fisheries bycatch, and are highly uncertain.

The assessments evaluated the effects of having overestimated landings by running a low catch scenario, with the assumption that the catch from the base case is a high case/upper bound. Based on the fact that bycatch in the shrimp fishery constitutes the majority of the overall removals for both species, looking at sensitivities in the other components of the overall fishing mortality would be of little use. The assessment Panel recommended scaling the mean of the SEDAR 13 values by the effort exerted by the shrimp fleet to produce low catch estimates.

This approach assumes that the issues with bycatch in the shrimp fishery have been common over the entire time period, which may or may not be true. In general the utility in exploring alternate catch histories lies in the trend more than the magnitude, if catches are scaled by a factor of 2, usually the biomass will scale by the same factor. In this case the assessment team scaled only the estimates from 1972 onward, which effectively changed the whole trend. This is an adequate attempt at exploring the assumption of the catch trend and magnitude.

Length and Age Data:
Limited catch at length data of both shark species were available from observer programs, fishery independent surveys and recreational sampling programs. In general the quality of the observations was high, though some data sets were limited in their practical utility by low sample size. The assessment team converted the catch at length data to estimated catch at age data for use in the model.

The conversion of lengths to ages is problematic for a number of reasons. For relatively long lived species like most sharks, the difference in mean length can be quite small across a range of age classes, especially when the theoretical maximum length (L_∞) is attained relatively early in the lifespan. In populations like these there can be relatively small changes in mean size of individuals in the catch, but they can reflect significant changes in the mean age of the catch. Because of this, back calculating ages based on observed lengths at or near the L_∞ can be problematic because the range of ages represented by a particular length class can be quite broad. The estimation process also assumes that all age classes beyond the 'fully selected' age class experience approximately the same fishing and natural mortality. This is likely untrue for a population that has seen its removals fall by approximately 50% in the last decade.

Furthermore, apparent temporal trends in length data in multiple data sets were obscured through the calculation of a single selectivity curve for each fishery. Changes in observed catch at length data usually indicate a change in selectivity (due to targeting, regulation or gear change) or a change in the relative proportions of the length classes within the stock.

It is strongly recommended that the length data not be converted to age estimates, unless an age-length key is available for the appropriate temporal-spatial strata. This will require stock assessment methods that can fit to length data and estimate length-based selectivity.

[TOR #2]. Evaluate the methods used to assess the stock, taking into account the available data.

a. Are methods scientifically sound and robust?
b. Are assessment models configured properly and used consistent with standard practices?
c. Are the methods appropriate for the available data?

[Reviewer's Comments]
Both assessments used the state-space age-structured production model (SSASPM) framework for the assessment and conducted projections in R. Overall this is appropriate for the assessment of both species and an improvement over the initial assessments (2002 BSP model).

The down weighting of the reconstructed catches (1950 to 1994 for the commercial BLL, GN, and HL catches; 1950-1980 for the recreational catches; and 1950-1971 for the shrimp bycatch series) is an appropriate way to overcome the lack of information from this period, and although there are multiple potential weighting schemes for individually down weighting specific series or combinations of series, this is likely sufficient given the timeframe of the assessment, and the relative improvement in the catch information in the last two decades.

Overall the catch weighting scheme is likely to be less important than the overall CV multipliers on catches, indices and effort. In the Bonnethead assessment these multipliers were set at unity, whilst in the Atlantic sharpnose assessment the indices were given a value of 3 times the catch CV multiplier, with the catch and effort CVs set at 1. The justification for this was that it was what was done in 2007 and (in the case of Sharpnose) necessary for the model to fit. The justification given in the SEDAR 13 (2007 assessment) report for setting the overall model CV's to 1 for Bonnethead was that the data workshop had chosen equal weighting for the base case and that the λg's were not estimable. Given that the inverse CV weighting was chosen as the base case (for both current Bonnethead and Sharpnose assessments) this decision is curious, but a fine point on an otherwise scientifically sound and robust assessment methodology. I would comment that the SEDAR 13 report on Atlantic Sharpnose (page 109) mentions only that

"Given the data workshop decision to use equal weighting, between indices for the base model run, all $\omega_{i,y}$ were fixed to 1.0 and the same λg was applied to all indices"

and not the magnitude of the overall CV, and commend the assessment team for including this information.

The overall CV's are difficult to estimate, and fixing them is fine. I agree with the assessment author that placing less certainty in the indices is justified because of a lack of signal and high (biologically unrealistic) viabilities. I would note that overall, given the inverse CV weighting (choice for $\omega_{i,y}$), variable-specific multiplier (λg), and the state-space parameterization of the model, it is difficult to see what the effect of weighting the abundance index by 3 was. In the future, a higher and lower value or a likelihood profile on this parameter would help inform the choice of the overall CV (λg). In addition I would recommend calculating the overall weights on the CPUE indices, especially looking at the relative observation errors on the CPUE and the catch indices. It is unclear whether there are trends in the deviates on catch, CPUE or effort because there are no diagnostic plots or tables.

If possible it would be good to estimate the overall CV's, though the assessment report noted that the CV on the CPUE index hit the upper bound, likely due to high interannual variability and indices with similar selectivity and conflicting trends. The assessment did undertake model runs with only increasing or decreasing trends, as sensitivity analyses.

In practice this is a significant issue relating to model mis-specification resulting from the inclusion of conflicting trends. The conflicting trends presume alternate states of nature in conflict, because either the stock will be going up, or down, not both. Inclusion of both increasing and decreasing trends will force the model towards non-optimal solutions (Schnute and Hilborn 1993). The estimate of the stock status will be entirely dependent on the relative weighting of the indices.

Aside from the problems associated with the conversion and use of the length data, the inclusion of conflicting trends and (or) the combining of separate stocks in the base case, I would note that the models were for the most part properly configured.

[TOR #3]. Evaluate the assessment findings with respect to the following:

a. Are abundance, exploitation, and biomass estimates reliable, consistent with input data and population biological characteristics, and useful to support status inferences?
b. Is the stock overfished? What information helps you reach this conclusion?
c. Is the stock undergoing overfishing? What information helps you reach this conclusion?
d. Is there an informative stock recruitment relationship? Is the stock recruitment curve reliable and useful for evaluation of productivity and future stock conditions?
a. Are the quantitative estimates of the status determination criteria for this stock reliable? If not, are there other indicators that may be used to inform managers about stock trends and conditions?

[**Sharpnose**]
The abundance, exploitation, and biomass estimates were consistent with the input data and population biology, and were useful to support status inferences for the regional populations as reflected in the Atlantic and GOM stocks estimates (pg. 124, Table 3.5.18). I note that the reliability of these estimates is non-optimal and their uncertainty is likely underestimated given the inclusion of conflicting trends in the abundance indices.

With respect to the terms of reference the assessment was carried out under, the combined population is most likely not experiencing overfishing based on: the weight of evidence from all the models run; the estimated reduction in catch over the last decade; and the evidence of increasing CPUE. Only one model resulted in an overfished population. This run relied on the decreasing indices of abundance only. The importance of this run cannot be overlooked when considering the results from the increasing index and the results of the regional stock runs.

There is an informative stock recruitment trend presented, however a recruitment time series is not. Annual deviates from the stock recruitment relationship are not estimated, and the recruits at virgin biomass (R0) and pup survival are given prior pdfs. The base model estimated higher virgin recruitment (and SSF) and a more productive stock than the 2007 assessment. The reasons given for this include; “the magnitude of the shrimp bycatch series increased ca. six-fold; an additional selectivity function and slight changes to some of those previously used were introduced; there are now 15 indices of relative abundance in the base run (vs. 16 in 2007), but five of them were not used in 2007 and all (except PC LL) were re-analysed and include six more years of data; there are new biological parameters, including a new maximum age of 18 yr (vs. 12), a maternal length vs. litter size relationship is used (vs. a fixed fecundity of 4.1), and there are new estimates of natural mortality at age (0.23 vs. 0.36 to 0.24)” (page 96).

This configuration of recruitment and mortality takes into account the best available science on stock recruitment and mortality by age, and is a major improvement on the biological realism of the model over the previous assessment. I would note that R0 is the number of Age-1 individuals and the estimated S0 is the estimated survival at low density. However, based on the information provided, it is unclear how the fisheries mortality (selectivity) on Age-0 individuals is estimated within this context.

The quantitative estimates of the stock status are reliable only with respect to the given terms of reference. I would recommend the region specific model runs for any management advice due to the differences in removals, life history and indices by region. As evidenced by the runs with only increasing and decreasing indices, the inclusion of indices of abundance with conflicting trends impacts the estimates of stock status. Therefore the region specific stock status estimates must be treated as uncertain.

[**Bonnethead**]
The fundamental flaw with the Bonnethead assessment is the combining of two populations with important differences in the life history together in one assessment. However, based on the terms of reference, the abundance, exploitation, and biomass estimates are consistent with the input data and input population biological characteristics, and useful to support status inferences for the population. The reliability of any quantitative estimates is low based on the fact that the assumptions regarding stock structure and shared populations dynamics are wrong, the inclusion of conflicting indices of abundance, and ‘compromise’ life history parameters.

The stock is not overfished based on the base case, but more importantly, taken as a whole the assessment shows decreasing catches and reliable increasing trends. There are decreasing indices and examining the assessment with just these indices, the combined biology and combined removals found that the stock was overfished but that overfishing was not occurring. Based on the weight of evidence, the stock is not overfished nor is overfishing occurring.

There is an informative stock recruitment trend presented, however a recruitment time series is not. Annual deviates from the stock recruitment relationship are not estimated, and the recruits at virgin biomass (R0) and pup survival are given prior pdfs. The method in which recruitment is modeled is sufficient to evaluate future stock conditions and is useful for evaluation of productivity. However, the underlying assumptions regarding a combined stock and differences in life history limit the utility of the stock recruitment relationship for evaluation of productivity.

The reliability of any quantitative estimates is low based on the fact that the assumptions regarding stock structure and shared populations dynamics are wrong, the inclusion of conflicting indices of abundance, and 'compromise' life history parameters. However, the decrease in landings and reliable increasing trends indicate that the assumption that the stock is not over fished and not experiencing overfishing is valid.

[TOR #4]. Evaluate the stock projections, rebuilding timeframes, and generation times, addressing the following:

a. Are the methods consistent with accepted practices and available data?
b. Are the methods appropriate for the assessment model and outputs?
c. Are the results informative and robust, and useful to support inferences of probable future conditions?
d. Are key uncertainties acknowledged, discussed, and reflected in the projection results?

[Reviewer's Comments]
The key uncertainties in both assessments revolve around stock structure (and to a certain extent removal) rather than the biology. Although the projection methods are appropriate and consistent with the accepted practice given the available data and terms of reference, they are likely not useful to support inferences of probable future conditions due to the projections on the combined stock, the exception being for the Sharpnose region specific projections.

[TOR #5]. Consider how uncertainties in the assessment, and their potential consequences, are addressed.

- Comment on the degree to which methods used to evaluate uncertainty reflect and capture the significant sources of uncertainty in the population, data sources, and assessment methods
- Ensure that the implications of uncertainty in technical conclusions are clearly stated.

[Reviewer's Comments]
The key uncertainties in both assessments revolve around stock structure (and to a certain extent the removals due to the shrimp bycatch). This was noted by the assessment team, which used alternative 'states of nature' to characterize this uncertainty. In practice this consisted of separate stocks in the case of Atlantic sharpnose shark and the impact of alternate biological parameterization (belonging to the Atlantic and GOM portions) for the bonnethead shark assessment. These methods adequately capture the uncertainty within the structure of the assessments given the terms of reference.

Uncertainty in the data (removals and the indices) was handled in much the same way, with alternative runs undertaken (i.e. lower removals, increasing and decreasing scenarios). In addition, retrospective analyses were used to evaluate the impact of additional data on the parameter and stock status estimates. As noted above, the inclusion of indices of abundance with conflicting trends introduces uncertainty into the model and estimates.

Within-model uncertainty was evaluated with estimated CVs and 'profile likelihoods' to characterize the uncertainty in the derived quantities and parameter estimates. Comparison of the prior and posterior distributions for the directly estimated parameters (R_0 and S_0) showed the influence of the data and model structure on these parameters.

Due to the importance of the structural sensitivity analysis, future assessments should include more than one change to the assessment, for example using the region specific biology and region specific increasing (or decreasing) indices.

The implications of the major source of uncertainty in technical conclusions (with respect to stock status) are for:

[Atlantic Sharpnose]:
The major uncertainty for the Atlantic sharpnose shark stock assessment rests with the definition of the stock; to this end the separate model runs based only on the Atlantic and GOM stock were undertaken. These shows the stock to be in better and worse condition (Atlantic and GOM respectively), though neither showed that the stock was over fished or that over-fishing was occurring. Across the alternative structural uncertainties considered, only the 'decreasing indices' model showed a stock status that was highly divergent from the base case (Figure 1: Atlantic Sharpnose Assessment Figure 3.6.45. Phase plot of Atlantic sharpnose shark stock status). In general the implications of the evaluation of these multiple sources of uncertainty show that the stock status conclusions are robust to the structural uncertainty. However, the uncertainty in the estimates is likely underestimated due to the inclusion of conflicting trends in abundance.

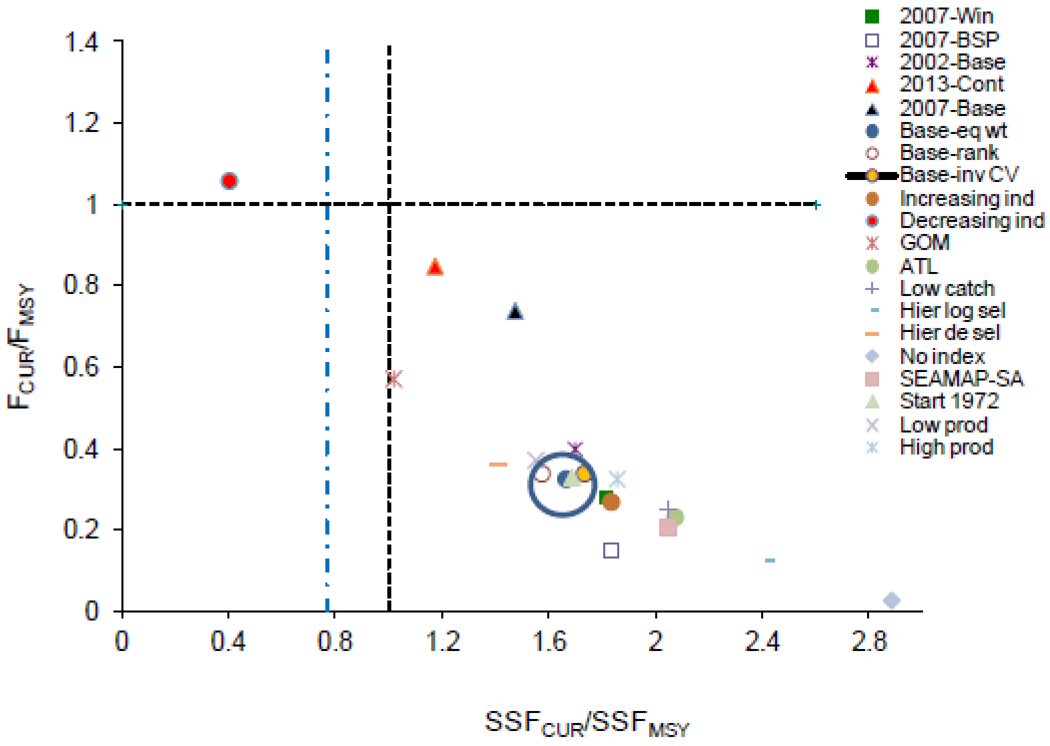

Figure 1: Atlantic Sharpnose Assessment Figure 3.6.45. Phase plot of Atlantic sharpnose shark stock status.

[Bonnethead]:

Similar to the Atlantic sharpnose shark stock assessment, the major uncertainty in the bonnethead shark assessment rests with the definition of the stock, and to a certain extent the indices and catch data. Separate model runs based only on the Atlantic and GOM stock biology were undertaken. However, no analyses based on regional abundance indices and landings were undertaken. Interpretation of these model runs is not straight forward because the main data inputs (catches and indices) are not separated, though they show the stock to be in worse and better condition (Atlantic and GOM respectively), than the base case.

The balance of evidence, across the alternative structural assumptions, showed that the stock was not over fished, nor was over fishing occurring. (Figure 2: Bonnethead Assessment Figure 3.6.42. Phase plot of bonnethead shark stock status). In general the implications of the evaluation of these multiple sources of uncertainty show that the stock status conclusions are robust to the structural uncertainty, given the terms of reference. However, the uncertainty in the estimates is likely underestimated due to the inclusion of conflicting trends in the abundance indices.

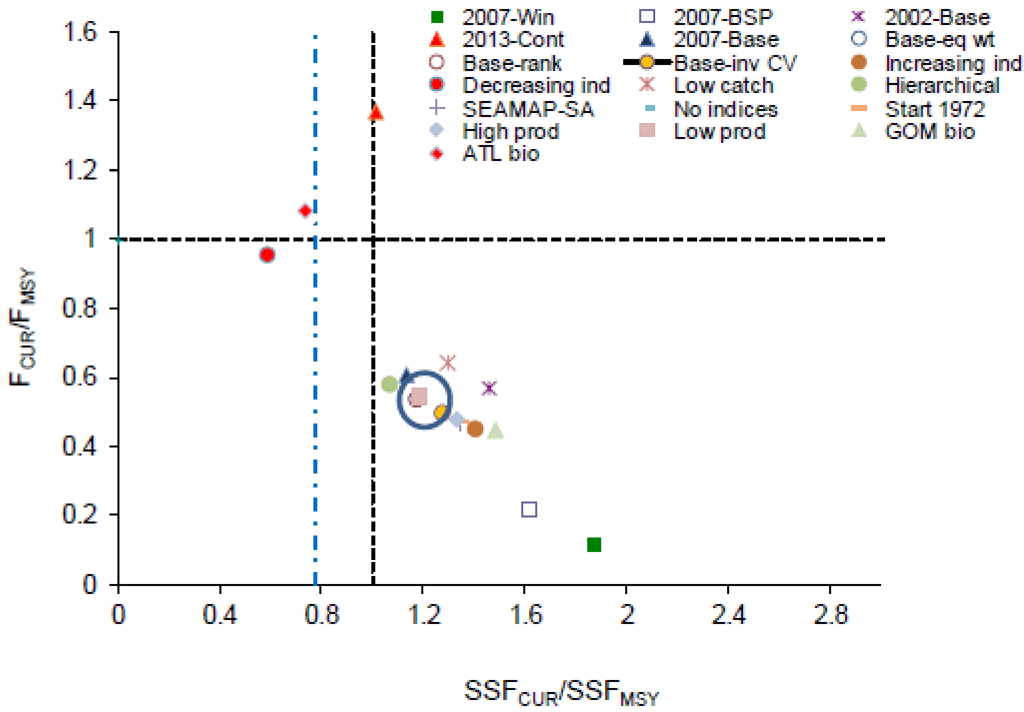

Figure 2: Bonnethead Assessment Figure 3.6.42. Phase plot of bonnethead shark stock status

TOR # 6. Consider the research recommendations provided and make any additional recommendations or prioritizations warranted.

- Clearly denote research and monitoring that could improve the reliability of, and information provided by, future assessments.
- Provide recommendations on possible ways to improve the SEDAR process.

[Reviewer's Comments]

There are sufficient data for further development of these assessments using sex-structured models that estimate selectivity inside an assessment model, fitting to size data, not length data converted to age. The assessment team mentioned that this is a desirable framework for the next assessment. Specific recommendations for research priorities include:

- To develop region specific indices of abundance. I note that this had been done, alongside the combined indices.
- Ensuring information about sex, length and age is collected in each fishery, throughout with respect to the spatial/temporal nature of the fishery.
- Research that improves the understanding of historical landings in the shrimp fishery, both in the modern and historical period and to support the assumptions about when stocks are at virgin biomass if this assumption is carried forward in future assessments.
- Research into the change in selectivity resulting from regulatory or gear changes (e.g. TEDs).

With respect to the overall SEDAR process, it is apparent that the some aspect of the process failed. The major issue detracting from the quality of any advice based on the bonnethead shark stock assessment is that it does not represent the status of either of the regional stocks.

TOR # 7. Provide guidance on key improvements in data or modeling approaches which should be considered when scheduling the next assessment.

I recommend that a benchmark assessment be completed for both species where the GOM and Atlantic stocks are modeled separately. In practice this is a recommendation that four stock assessments be conducted. Specific recommendations are:

- Development of a length based model that estimates fishery and survey selectivity's within the assessment model.
- Development of a two sex model.
- Fit the model to either length or age data.
- Exploration of models that do not require an assumption that the population is at virgin levels at some point in time.
- Simulation tests (management strategy evaluation) to test the performance of alternative assessment methods, recruitment parameterizations, harvest control rules, assessment frequency and data collection.
- Fit the model to each abundance index (one at a time) this will allow the direct comparison of their impacts.
- Include only increasing or decreasing indices when indices are run in aggregate.
- Use region specific indices of abundance.

TOR # 8. Prepare a Peer Review Report summarizing the Reviewer's evaluation of the stock assessment and addressing each Term of Reference.

This document is the independent peer review report based on the terms of reference.

Conclusions and Recommendations in accordance with the Terms of Reference.

Both assessments are of high scientific quality though neither adequately assesses the populations, due to a lack of region specific populations and the inclusion of conflicting trends in abundance. The Atlantic sharpnose assessment came close to conducting valid region specific assessments. However, the inclusion of conflicting indices of abundance produced lack of fit by the model, most notably in the Atlantic only sensitivity.

The major consequence of using one stock for the base case is that the quantitative estimates of reference points for the base case are unreliable for the stock as a whole. Nevertheless, the weight of evidence suggests that neither species is over fished and that over fishing is not occurring. This finding is in concert with the estimated exploitation history and reliable increasing abundance trends.

Overall the data, methods and stock status determinations (not over fished, no overfishing for both stocks) are sound under the assumptions and terms of reference for these stock assessments. The major sources of uncertainty were addressed in the model through sensitivity runs, retrospective analysis and direct estimations of uncertainty.

Appendix 1: Bibliography of materials provided for review

SEDAR 34

HMS Atlantic Sharpnose and Bonnethead Sharks

Workshop Document List

Documents Prepared for the Assessment Process		
SEDAR34-WP-01	Standardized catch rates of Atlantic sharpnose sharks (*Rhizoprionodon terraenovae*) in the U.S. Gulf of Mexico from the Shark Bottom Longline Observer Program, 1994-2011	John Carlson and Simon Gulak
SEDAR34-WP-02	Standardized catch rates of bonnetheads from the Everglades National Park Creel Survey	John K. Carlson and Jason Osborne
SEDAR34-WP-03	Standardized Catch Rates of Bonnethead and Atlantic Sharpnose Shark from the Southeast Shark Drift Gillnet Fishery: 1993-2011	John Carlson, Alyssa Mathers and Michelle Passerotti
SEDAR34-WP-04	Tag and recapture data for Atlantic sharpnose, *Rhizoprionodon terraenovae*, and bonnethead shark, *Sphyrna tiburo*, in the Gulf of Mexico: 1999-2011	Dana Bethea and Mark Grace
SEDAR34-WP-05	Relative abundance of bonnethead and Atlantic sharpnose sharks based on a fishery-independent gillnet survey off Texas	Walter Bubley and John Carlson
SEDAR34-WP-06	Update to maximum observed age of Atlantic sharpnose sharks (*Rhizoprionodon terraenovae*) in the western North Atlantic Ocean based on a direct age estimate of a long term recapture	Bryan S. Frazier and Joshua K. Loefer
SEDAR34-WP-07	Validated age and growth of the bonnethead (*Sphyrna tiburo*) in the western North Atlantic Ocean	Bryan S. Frazier, Douglas H. Adams, William B. Driggers III, Christian M. Jones, Joshua K. Loefer, Linda A. Lombardi
SEDAR34-WP-08	A preliminary review of post-release live-discard mortality rate estimates in sharks for use in SEDAR 34	Dean Courtney
SEDAR34-WP-09	Standardized catch rates of Atlantic sharpnose (*Rhizoprionodon terraenovae*) and bonnethead (*Sphyrna tiburo*) sharks collected during a gillnet survey in Mississippi coastal waters, 1998-2011	Eric R. Hoffmayer, Glenn R. Parsons, Jill M. Hendon, Adam G. Pollack, and G. Walter Ingram, Jr.
SEDAR34-WP-10	Standardized catch rates of Atlantic sharpnose sharks (*Rhizoprionodon terraenovae*) collected during a bottom longline survey in Mississippi coastal waters, 2004-2011	Eric R. Hoffmayer, Jill M. Hendon, and Adam G. Pollack
SEDAR34-WP-11	Standardized catch rates of Atlantic sharpnose sharks (Rhizoprionodon terraenovae) collected during bottom longline surveys in Mississippi, Louisiana, Alabama, and Texas coastal waters, 2004-2011	Eric Hoffmayer, Adam Pollack, Jill Hendon, Marcus Drymon, and Mark Grace
SEDAR34-WP-12	Atlantic Sharpnose Shark: Standardized index of relative abundance using boosted regression trees and generalized linear models	John Froeschke and J. Marcus Drymon

SEDAR34-WP-13	Atlantic Sharpnose Abundance Indices from SEAMAP Groundfish Surveys in the Northern Gulf of Mexico	Adam G. Pollack and G. Walter Ingram, Jr.
SEDAR34-WP-14	Bonnethead Abundance Indices from SEAMAP Groundfish Surveys in the Northern Gulf of Mexico	Adam G. Pollack and G. Walter Ingram, Jr.
SEDAR34-WP-15	Atlantic Sharpnose and Bonnethead Abundance Indices from NMFS Bottom Longline Surveys in the Western North Atlantic and Northern Gulf of Mexico	Adam G. Pollack and G. Walter Ingram, Jr.
SEDAR34-WP-16	Continuity Runs for Atlantic Sharpnose and Bonnethead SEAMAP Groundfish Surveys and NMFS Bottom Longline Surveys	Adam G. Pollack and G. Walter Ingram, Jr.
SEDAR34-WP-17	Variability in the Reproductive Biology of the Atlantic Sharpnose Shark in the Gulf of Mexico	Eric R. Hoffmayer, Jill M. Hendon, William B. Driggers III, Lisa M. Jones, and James A. Sulikowski
SEDAR34-WP-18	Shrimp Fishery Bycatch Estimates for Atlantic Sharpnose and Bonnethead Sharks in the Gulf of Mexico, 1972-2011	Xinsheng Zhang, Brian Linton, Enric Cortés and Dean Courtney
SEDAR34-WP-19	Standardized catch rates of Atlantic sharpnose and bonnethead sharks from the SEAMAP-South Atlantic Shallow Water Trawl Survey	Enric Cortés and J. Boylan
SEDAR34-WP-20	Updated catches of Atlantic sharpnose and bonnethead sharks	Enric Cortés and Ivy Baremore
SEDAR34-WP-21	Dead discards of Atlantic sharpnose sharks in the shark bottom longline fishery	John Carlson, Kevin J. McCarthy and Simon J.B. Gulak
SEDAR34-WP-22	Preliminary data on the reproductive biology of the bonnethead (*Sphyrna tiburo*) from the southeast U.S. Atlantic coast	Bryan Frazier, Jim Gelsleichter, and Melissa Gonzalez De Acevedo
SEDAR34-WP-23	Interannual site fidelity of bonnetheads (*Sphyrna tiburo*) to two coastal ecosystems in the western North Atlantic Ocean	William B. Driggers III, Bryan S. Frazier, Douglas H. Adams, Glenn F. Ulrich and Eric R. Hoffmayer
SEDAR34-WP-24	Size composition and indices of relative abundance of the Atlantic sharpnose shark (*Rhizoprionodon terraenovae*) in coastal Virginia waters	Robert J. Latour, Christopher F. Bonzek, and J. Gartland
SEDAR34-WP-25	Mark/Recapture Data for the Atlantic Sharpnose Shark (*Rhizoprionodon terranovae)*, in the Western North Atlantic from the NEFSC Cooperative Shark Tagging Program	Nancy E. Kohler, Danielle Bailey, Patricia A. Turner, and Camilla McCandless
SEDAR34-WP-26	Mark/Recapture Data for the Bonnethead (*Sphyrna tiburo)*, in the Western North Atlantic from the NEFSC Cooperative Shark Tagging Program	Nancy E. Kohler, Elizabeth Sawicki, Patricia A. Turner, and Camilla McCandless
SEDAR34-WP-27	Preliminary mtDNA assessment of genetic stock structure of the bonnethead, *Sphyrna tiburo*, in the eastern Gulf of Mexico and northwestern Atlantic	Píndaro Díaz-Jaimes, Douglas H. Adams, Nadia S. Laurrabaquio-Alvarado, Elena Escatel-Luna
SEDAR34-WP-28	Standardized Catch Rates of Bonnethead and	John Carlson, Alyssa

	Atlantic Sharpnose Shark from the Southeast Sink Gillnet Fishery: 2005-2011	Mathers and Michelle Passerotti
SEDAR34-WP-29	Relative abundance of Atlantic sharpnose and bonnethead shark from the northeastern Gulf of Mexico	John K. Carlson, Dana M. Bethea, Eric Hoffmayer, John Tyminski, Robert Hueter, R. Dean Grubbs, Matthew J. Ajemian, and George H. Burgess
SEDAR34-WP-30	Reproductive parameters for Atlantic sharpnose sharks (*Rhizoprionodon terraenovae*) from the western North Atlantic Ocean	William B. Driggers III, Eric R. Hoffmayer, John K. Carlson and Joshua Loefer
SEDAR34-WP-31	Tag-recapture results of bonnethead (*Sphyrna tiburo*) and Atlantic sharpnose (*Rhizoprionodon terraenovae*) sharks in the Gulf of Mexico and Florida Coastal Waters	John P. Tyminski, Robert E. Hueter, John Morris
SEDAR34-WP-32	Standardized catch rates of bonnethead (*Sphyrna tiburo*) from the South Carolina Department of Natural Resources trammel net survey	Bryan S. Frazier and Camilla T. McCandless
SEDAR34-WP-33	Tag and recapture data for Atlantic sharpnose, *Rhizoprionodon terraenovae*, and bonnethead, *Sphyrna tiburo*, sharks caught in the northern Gulf of Mexico from 1998-2011	Jill M. Hendon, Eric R. Hoffmayer, and Glenn R. Parsons
SEDAR34-WP-34	Standardized indices of abundance for Atlantic sharpnose sharks from the Georgia Department of Natural Resources red drum longline survey	C.T. McCandless, C.N. Belcher
SEDAR34-WP-35	Standardized indices of abundance for bonnethead and Atlantic sharpnose sharks from the Georgia Department of Natural Resources ecological monitoring trawl surveys	C.T. McCandless, J.Page, C.N. Belcher
SEDAR34-WP-36	Standardized indices of abundance for bonnethead and Atlantic sharpnose sharks caught during the South Carolina Department of Natural Resources red drum longline and Cooperative Atlantic States Shark Pupping and Nursery gillnet surveys	C.T. McCandless, B.S. Frazier
SEDAR34-WP-37	Standardized indices of abundance for bonnethead and Atlantic sharpnose sharks caught during the Cooperative Atlantic States Shark Pupping and Nursery longline surveys from South Carolina to northern Florida	C.T. McCandless, C.N. Belcher, B.S. Frazier, M. McCallister, R. Ford, J. Gelsleichter
SEDAR34-WP-38	Standardized indices of abundance for Atlantic sharpnose sharks from the University of North Carolina bottom longline survey	Frank Schwartz, Camilla McCandless, and John Hoey
SEDAR34-WP-39	A Summary of Evaluation Worksheets of abundance indices for Atlantic sharpnose shark and bonnethead shark	SEDAR 34 Panel
	Final Stock Assessment Reports	
SEDAR34-SAR	Atlantic Sharpnose Sharks	SEDAR 34 Panel
SEDAR34-SAR	Bonnethead Sharks	SEDAR 34 Panel

Reference Documents		
SEDAR29-RD01	SEDAR 13 (SCS) Final Stock Assessment Report	SEDAR 13 Panels
SEDAR29-RD02	Abundance Indices Workshop: Developing protocols for submission of abundance indices to the SEDAR process	SEDAR Procedural Workshop I
SEDAR29-RD03	Characterization of the U.S. Gulf of Mexico and South Atlantic Penaeid and Rock Shrimp Fisheries Based on Observer Data	ELIZABETH SCOTT-DENTON, PAT F. CRYER, MATT R. DUFFY, JUDITH P. GOCKE, MIKE R. HARRELSON, DONNA L. KINSELLA, JAMES M. NANCE, JEFF R. PULVER, REBECCA C. SMITH, and JO A. WILLIAMS
SEDAR29-RD04	Effects of Turtle Excluder Devices (TEDs) on the Bycatch of Three Small Coastal Sharks in the Gulf of Mexico Penaeid Shrimp Fishery	Scott W. Raborn, Benny J. Gallaway, John G. Cole, William J. Gazey & Kate I. Andrews

Additional Documents

Heist, E.J., J.A. Musick, and J.E. Graves. 1996. Mitochondrial DNA diversity and divergence among sharpnose sharks, Rhizoprionodon terraenovae, from the Gulf of Mexico and mid-Atlantic Bight. Fish. Bull. 94:664-668.

Schnute, J.T., Hilborn, R. 1993. Analysis of Contradictory Data Sources in Fish Stock Assessment. Canadian Journal of Fisheries and Aquatic Sciences, Vol. 50, No. 9 : pp. 1916-1923 (doi: 10.1139/f93-214)

Appendix 2: Statement of Work for Dr. Joel Rice (SPC)

External Independent Peer Review by the Center for Independent Experts

SEDAR 34: Highly Migratory Species Bonnethead Shark and Atlantic Sharpnose Shark Assessment Desk Review

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

Project Description SEDAR 34 will be a compilation of data, a standard assessment of the stock, and CIE assessment review conducted for HMS Bonnethead and Atlantic sharpnose sharks. The desk review provides an independent peer review of SEDAR stock assessments. The review is responsible for ensuring that the best possible assessment is provided through the SEDAR process and will provide guidance to the SEFSC to aid in their review and determination of best available science, and to HMS when determining if the assessment is useful for management. The stocks assessed through SEDAR 34 are within the jurisdiction of the Highly Migratory Species Division of NOAA Fisheries and the states of Texas, Louisiana, Mississippi, Alabama, Florida, Georgia, South Carolina, North Carolina, Virginia, Maryland, Delaware, Pennsylvania, New Jersey, New York, Connecticut, Rhode Island, Massachusetts, New Hampshire, and Maine. The Terms of Reference (ToRs) of the peer review are attached in **Annex 2**.

Requirements for CIE Reviewers: Three CIE reviewers shall have the necessary qualifications to complete an impartial and independent peer review in accordance with the statement of work (SoW) tasks and terms of reference (ToRs) specified herein. The CIE reviewers shall have expertise in stock assessment, statistics, fisheries science, and marine biology sufficient to complete the tasks of the peer-review described herein. Each CIE reviewer's duties shall not exceed a maximum of 10 days to complete all work tasks of the peer review described herein.

Location of Peer Review: Each CIE reviewer shall participate and conduct an independent peer review as a desk review, therefore travel will not be required.

Statement of Tasks: Each 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 contact information to the COR, who forwards this information to the NMFS Project Contact no later the date specified in the Schedule of Milestones and Deliverables. The CIE is responsible for providing the SoW and ToRs to the CIE reviewers. The NMFS Project Contact is responsible for providing the CIE reviewers with the assessment and other pertinent background documents for the peer review. Any changes to the SoW or ToRs must be made through the COR prior to the commencement of the peer review.

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

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

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

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

1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review.
2) Conduct an impartial and independent peer review in accordance with the tasks and ToRs specified herein, and each ToRs must be addressed (**Annex 2**).
3) No later than October 7, 2013, each CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Mr. Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and CIE Regional Coordinator, via email to Dr. David Sampson david.sampson@oregonstate.edu. Each CIE report shall be written using the format and content requirements specified in **Annex 1**, and address each ToR in **Annex 2**.

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

10 September 2013	CIE sends reviewer contact information to the COR, who then sends this to the NMFS Project Contact
17 September 2013	NMFS Project Contact sends the CIE Reviewers the assessment report and background documents
18 September through 02 October 2013	Each reviewer conducts an independent peer review as a desk review
07 October 2013	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
21 October 2013	CIE submits CIE independent peer review reports to the COR
28 October 2013	The COR distributes the final CIE reports to the NMFS Project Contact and regional Center Director

Modifications to the Statement of Work: This 'Time and Materials' task order may require an update or modification due to possible changes to the terms of reference or schedule of milestones resulting from the fishery management decision process of the NOAA Leadership, Fishery Management Council, and Council's SSC advisory committee. A request to modify this SoW must be approved by the Contracting Officer at least 15 working days prior to making any permanent changes. The Contracting Officer will notify the COR within 10 working days after receipt of all required information of the decision on changes. The COR can approve changes to the milestone dates, list of pre-review documents, and ToRs within the SoW as long as the role and ability of the CIE reviewers to complete the deliverable in accordance with the SoW is not adversely impacted. The SoW and ToRs shall not be changed once the peer review has begun.

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

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

(1) The CIE report shall completed with the format and content in accordance with **Annex 1**,

(2) The CIE report shall address each ToR as specified in **Annex 2**,

(3) The CIE reports shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

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

Support Personnel:

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Key Personnel:

NMFS Project Contact:

Julie Neer, SEDAR Coordinator
4055 Faber Place Drive, Suite 201
North Charleston, SC 29405
Julie.Neer@safmc.net Phone: 843-571-4366

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

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

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

   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

Annex 2 – Terms of Reference
SEDAR 34: Atlantic Sharpnose and Bonnethead Shark Assessment Review

1. Evaluate the data used in the assessment, addressing the following:
   a) Are data decisions made by the assessment panel sound and robust?
   b) Are data uncertainties acknowledged, reported, and within normal or expected levels?
   c) Are data applied properly within the assessment model?
   d) Are input data series reliable and sufficient to support the assessment approach and findings?
2. Evaluate the methods used to assess the stock, taking into account the available data.
   a) Are methods scientifically sound and robust?
   b) Are assessment models configured properly and used consistent with standard practices?
   c) Are the methods appropriate for the available data?
3. Evaluate the assessment findings with respect to the following:
   a) Are abundance, exploitation, and biomass estimates reliable, consistent with input data and population biological characteristics, and useful to support status inferences?
   b) Is the stock overfished? What information helps you reach this conclusion?
   c) Is the stock undergoing overfishing? What information helps you reach this conclusion?
   d) Is there an informative stock recruitment relationship? Is the stock recruitment curve reliable and useful for evaluation of productivity and future stock conditions?
   e) Are the quantitative estimates of the status determination criteria for this stock reliable? If not, are there other indicators that may be used to inform managers about stock trends and conditions?
4. Evaluate the stock projections, rebuilding timeframes, and generation times, addressing the following:
   a) Are the methods consistent with accepted practices and available data?
   b) Are the methods appropriate for the assessment model and outputs?
   c) Are the results informative and robust, and useful to support inferences of probable future conditions?
   d) Are key uncertainties acknowledged, discussed, and reflected in the projection results?
5. Consider how uncertainties in the assessment, and their potential consequences, are addressed.
   - Comment on the degree to which methods used to evaluate uncertainty reflect and capture the significant sources of uncertainty in the population, data sources, and assessment methods
   - Ensure that the implications of uncertainty in technical conclusions are clearly stated.
6. Consider the research recommendations provided and make any additional recommendations or prioritizations warranted.

- Clearly denote research and monitoring that could improve the reliability of, and information provided by, future assessments.
- Provide recommendations on possible ways to improve the SEDAR process.

7. Provide guidance on key improvements in data or modeling approaches which should be considered when scheduling the next assessment.
8. Prepare a Peer Review Report summarizing the Reviewer's evaluation of the stock assessment and addressing each Term of Reference.