Center for Independent Experts individual report for SEDAR 58: Atlantic Cobia

November 19-21, 2019

Matthew D. Cieri

Executive Summary

The Review Workshop for Atlantic cobia, termed SEDAR 58, was held at the Beaufort Hotel in Beaufort NC, from November 19th-21st. Reviewers included; Alistair Dunn, John Casey, Gary Nelson, Jeff Buckel (Review Panel Chair) and Matt Cieri (the author of this review report). The approach taken by the Assessment Team was to use a statistical catch at age model (the Beaufort Assessment model, or BAM). The model was configured to use recreational landings in two selectivity time-blocks, commercial landings in one selectivity time block, a head boat recreational CPUE index that initially had two time blocks, a Beverton–Holt recruitment relationship with steepness fixed at 1 (mean recruitment), and natural mortality at age using Charnov et al. (2013). The start year was set at 1986. Proposed reference points were calculated using SSBF40% and F40% in the absence of clear management objectives. Uncertainty was captured using an ensemble approach and through sensitivity analysis.

Results indicated that the stock was not overfished and overfishing was not occurring when using the proposed reference points. Further, the projections indicated a low probability of overfishing/overfished status in the near term using reasonable scenarios of future catch.

The model as configured appeared to be robust and useful for management of the stock. However, a change was made to reduce the time block for the catch per unit effort index to only one, as management changes that induced the selectivity change in the recreational fishery were unlikely to have an impact for the head boat index. As such a new base run was formed at the Review Workshop.

That said, the model had a number of issues; chiefly sensitivity to the use of the Charnov et al. (2013) natural mortality. Additional sensitivities and likelihood profiling suggested that the use of Charnov et al. 2013 was appropriate, however. Other potential areas of sensitivity included commercial and recreational removals, age compositions for the recreational fishery for years prior to 2007, and length compositions for the commercial fishery. These were likely minor, however, when compared to the choice of natural mortality.

A number of research recommendations put forth by the Assessment team and the Data Workshop were reviewed. Of all of these, the most important was the abundance index. Currently, this index stops in 2017 and is fishery dependent. While development of a new fishery independent index would be ideal, some type of fishery independent or dependent index should be made available prior to the next benchmark for the stock to be successfully assessed. An additional recommendation was to have the Data Workshop chair present at the Review Workshop, because at times there seemed to be little justification given for choices on the data used as input to the assessment model. Having the Chair at the Review Workshop would benefit the review process immensely.

Background

SEDAR 58 was convened at the Beaufort Hotel in Beaufort NC, from November the 19th-21st to review the assessment of Atlantic cobia. There were three Center for Independent Experts (CIE) contractors (Alistair Dunn, John Casey, and Matt Cieri) and two Atlantic States Marine Fisheries Commission (ASMFC) appointees (Jeff Buckel and Gary Nelson) that served as reviewers. Jeff Buckel was the chair. In addition, there were other staff from SEDAR (South East Data Assessment and Review) and one from ASMFC as well as two industry observers at this meeting. The meeting was also attended by several personnel from the NMFS Beaufort facility, most importantly Katie Siegfried, who served as lead analyst of the assessment team. A full participant list can be found in Appendix 3.

Role

The author's role during this review was to participate as a panel member, reading documents, providing comments during the meeting, as well as helping to draft the review panel summary report. Additionally, I was also charged with providing my own review of the assessment of Atlantic cobia. The review panel summary report will be made available to SEDAR, CIE, and ASMFC. My individual report comprises much of the rest of this document.

Summary of Findings and Terms of Reference

1. Evaluate the data used in the assessment addressing the following:
- *Are data decisions made by the DW and AW sound and robust?*

Data methods and details were provided in the Data Workshop (DW) report and the Assessment Workshop (AW) report. Both workshops spent much effort to provide the best data and analysis for the cobia Review Workshop (RW). Data sources included: commercial landings; commercial discards; recreational harvest, a recreational fishery catch per unit effort (CPUE) index of abundance; and both length and ages from the state carcass collection program.

Overall, commercial landings and discards were only a small fraction of the overall harvest, averaging approximately 5%. As such, the bulk of the removals were from the recreational sector, which had recently had its methods of harvest estimation calibrated after a change in the methodology. Overall, the Review Panel (RP), including myself, concluded that the methods and results were generally reasonable.

It is noted, however, that a number of decisions made during the DW were not fully justified in the data report. Justification was lacking for potential important life-history parameters including the maturity schedule and the switching from Lorenzen (1996) to Charnov et al. (2013) natural mortality values. Additionally, there was little to no description on the conversion from gutted to whole weight.

- *Are data uncertainties acknowledged, reported, and within normal or expected levels?*

Four major sources of uncertainty were identified during the RW:

1. Uncertainty in commercial and recreational landings and discards;
2. Uncertainty in the age compositions for the recreational fishery for years before 2007 due to small sample sizes;
3. Uncertainty in the length compositions for the commercial fishery due to very small sample sizes; and
4. The assumed rate of natural mortality (*M*).

Both the AW and DW provided uncertainty bounds and Coefficients of variation (CV) for many of the important inputs into the assessment. Almost all of these seemed within plausible ranges with the exception of some of the commercial discard CVs. These in some cases seemed extraordinarily high. While this is something that should be investigated further in future assessments, the commercial discards are a minor portion of the removals overall. As such, large CVs are not problematic.

After examination of the *M* used in the base run of the assessment, it was noted that the ensemble method used the standard error estimates provided in Charnov et al. (2013), which were likely too narrow. After consideration, these were changed to ±2 standard errors from the regression equation slope in Charnov et al. (2013), their Figure 1.

Other than these minor changes, it appeared that the uncertainties in the assessment data were accurately portrayed and reported on.

- *Are data applied appropriately within the assessment model?*

Based on model performance, diagnostics, and output, data appeared to be handled satisfactorily within the modeling framework chosen, the Beaufort Assessment Model (BAM).

- *Are input data series reliable and sufficient to support the assessment approach and findings?*

Overall, the data appeared to support the approach used. However, it was noted that the removals from the recreational sector were higher than surrounding years in 1996 and 2015. Due to concerns about these high values, sensitivity runs which reduced these removals were performed by the Assessment Team (AT). It was seen that these two high years of removals had little influence on the model, and so these concerns were somewhat mitigated. It should be noted, however, that these high removals should be thoroughly investigated in the future to determine if they have a factual basis or an artifact of the re-calibration of the recreational removals.

Currently, there is only one index of abundance used as input for the BAM, a fishery dependent CPUE index derived from the headboat recreational fleet. This index stopped in 2015 because of recreational fishery closures. Should these closures continue, then the feasibility of using this

index in future assessments is low. As there are no other indices currently available for this stock, additional indices of abundance should be developed. Ideally these additional indices should be fishery independent, such as the baited trap-camera time series (SERFS) currently in use.

2. Evaluate the methods used to assess the stock, taking into account the available data.
- *Are methods scientifically sound and robust? Do the methods follow accepted scientific practices?*

The BAM (Williams & Shertzer 2015) implemented through AD-Model Builder was the assessment model chosen for cobia. The BAM is a tried and true method. It has a long history of use in other SEDARs, is publicly available, and has been simulation tested. The AT was well versed in the approach and provided extensive documentation. Additionally, the model code was provided, which highlights transparency. The use of the BAM was scientifically sound, robust, and appropriate for the available data.

For cobia, BAM was configured using estimated removal from two fleets, the commercial and the recreational. An abundance index derived from the recreational headboat CPUE was also used. Inputs included fishery removals, lengths and age compositions, natural morality from Charnov et al. (2013). The model assumed one selectivity time block for the commercial fishery and two selectivity time blocks for the recreational fishery. For the recreational fishery, those two blocks were from 1986-2006 and from 2007-2017, based on changes to management and targeting by a more northerly segment of the fleet. Recruitment was modeled using a Beverton-Holt relationship with a steepness set at 0.99, i.e., essentially mean recruitment with deviations.

The model as configured was found to be very sensitive to the assumed value of M. This was changed from Lorenzen (1996) in the previous cobia assessment to Charnov et al. (2013) during this assessment and produced a large difference in the assessment results. This change was well supported from both external sources as well and internal diagnostics (Figure 1). However, *M* is a critical parameter that produced rather dramatic differences in the model outputs. As such, further exploration of M is suggested in future assessments.

The initial base case (termed co22) used two selectivity time blocks for the headboat CPUE index of abundance, based on the overall recreational fleet selectivity (above). However, it was noted that this index was derived from a smaller (~5%) segment of the recreational fleet and that this segment was not targeting cobia. As such, the rationale for changing the recreational fleet selectivity was not valid. After discussion during the RW it was decided to change the base run to have only one selectivity time block for the head boat index (co23).

Recruitment was highly variable with no clear stock-recruitment relationship (Figure 2). As such the use of a Beverton-Holt relationship with a steepness set at 0.99, essentially mean recruitment with deviations, was appropriate.

After this change to the base model run, the BAM was sound and robust and adhered to the best scientific practices when applied to cobia.

- *Are assessment models configured appropriately and applied consistent with accepted scientific practices?*

The use of two fleets with a time block of selectivity for the recreational fleet at 1986- 2006 and a second time block 2007-2017 was well supported. Changes in management measures and an increase in the VA catch likely increased the targeting of smaller fish 2007-present. This change is reflected in the estimated selectivities (Figure 3).

Diagnostics suggested that the appropriate start years were used. Data prior to 1986 are likely unreliable. Further sensitivity analysis supported the AT's use of 1986 as a start year for the assessment as there was no clear difference when pushing the start year back to the SEDAR 28 value of 1950 (Figure 4).

During the RW it was suggested to change the base model to one which had only one block for selectivity in the head boat fishery dependent index of abundance. This resulted in a revised base run which was consistent as it is unlikely that management changes would affect the headboat index given it is not targeting cobia. When compared to the base run as recommended by the AT, this new run had some differences in diagnostics, but these were minor. Further, this run shows lower negative log likelihoods in the most recent years (Table 1).

- *Are the methods appropriate for the available data?*

Given that most of the data is catch-at-age composition data, a statistical catch-at-age approach, such as the BAM, which fully utilizes these data, is likely the best approach. The potential use of other approaches was discussed, but these were even less likely to be successful given the importance of compositional age data and the lack of an index of abundance in the most recent years.

As such, the use of the age data in the assessment seems appropriate and acceptable methods were applied, especially after moving to the revised base case as recommended by the RP.

3. Evaluate the assessment findings with respect to the following:

- *Are population estimates (model output – e.g. abundance, exploitation, biomass) reliable, consistent with input data and population biological characteristics, and useful to support status inferences?*

Results from the BAM indicated that the stock has been above $SSB_{F40\%}$ since the start of the model in 1986. There was an upward trend in the SSB from about 1.5 times $SSB_{F40\%}$ to 2 times $SSB_{F40\%}$. Recent reductions in SSB have been seen, however, with the SSB dropping to its current 1.5 times $SSB_{F40\%}$ (Figure 5).

These trends in BAM were mostly consistent with the only index of abundance, the head-boat index. With little residual patters to suggest any major inconsistencies (Figure 6).

Fits to the recreational catch age composition data were decent over the time period where these data were available and there was no evidence of systematic trends in the annual age composition fits (Figure 7). Model fits across ages suggested some lack of fit, specifically for ages 4-5 (Figure 8), and it is suggested that selectivity be further investigated in future assessments.

It should be noted that there is only one index of relative abundance in this model, the fishery dependent recreational head-boat index. There was no other suitable index of abundance for use in the BAM. Due to recent management changes that closed portions of the recreational fishery, this index was deemed unreliable after 2015.

Because of this, it was generally accepted at the RW that this assessment needs an index of abundance. In fact, a strong recommendation is made to develop a fishery independent survey for this stock. One promising index would be the use of baited cameras already in use (SERFS) reanalyzing this data for cobia might prove useful in development of such an important data stream. Alternatively, a rigorous spatial/temporal analysis of catch and effort data (i.e., using gaussian random fields as, for example, implemented in VAST Thorsen (2019)) may provide a means to develop an index of abundance using recreational data if the baited camera index work does not prove useful.

Overall, the major sources of uncertainty were natural mortality, and to a lesser extent the choice of steepness for the stock recruitment relationship and the maturity ogive used. Despite this, model estimates of population size, status, and trend were consistent with the known and assumed population parameters, and the model used the best available science and was adequate to support stock biomass and stock status inferences.

- *Is the stock overfished? What information helps you reach this conclusion?*

Reference point have not been currently provided by the management body for this review. However, the AT did put forth $SSB_{F40\%}$ as a recommended biomass reference point. $SSB_{F40\%}$ has a long history of use in other stocks around the world and, given a lack of clear management objectives, is a good placeholder for biomass status.

Given this and the fact that there is a very low probability that the stock is below $SSB_{F40\%}$ suggest that this stock is not overfished in 2015 to 2017 (Figure 9). Additionally, the projections likewise indicate that it was highly unlikely that the stock was overfished in 2017 to 2019.

- *Is the stock undergoing overfishing? What information helps you reach this conclusion?*

Like with SSB, managers have not provided management objectives from which fishing mortality reference points can be derived. However, the AT recommended using $F_{40\%}$ as the

fishing mortality reference point. $F_{40\%}$ like $SSB_{F40\%}$ has a long history of use around the world for stock management. As such, it is a good placeholder in the interim until more meaningful management objectives can be crafted.

Like with $SSB_{F40\%}$, the BAM indicates that the probability of the stock experiencing overfishing is highly unlikely in the most recent years (2017-2019) (Figure 9).

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

Unfortunately, the stock recruitment relationship for this stock is highly variable, which results in the use of a steepness close to 1 and essentially mean recruitment. This has implications for the stock assessment as it prevents the use of MSY-based reference points. The use of mean recruitment, however, does not preclude the use of stock projections, and so these projections are therefore adequate for short-term management of the stock.

It should be noted that the choice of steepness, while not impactful to stock status, could affect the value of target reference points for this stock, and hence status relative to those targets. Further research and analysis are recommended to examine the choice of steepness values in future assessments.

- *Are the quantitative estimates of the status determination criteria for this stock appropriate for management use? If not, are there other indicators that may be used to inform managers about stock trends and conditions?*

Quantitative reference points for this stock are appropriate, however, managers have not yet defined the management objectives for this stock, and so the AT proposed a series of reference points based on a meta-analysis of other stocks with similar life histories. These included: 75% $SSB_{F40\%}$ (as biomass threshold), $SSB_{F40\%}$ (as biomass target), and $F_{40\%}$ (as fishing mortality threshold). The use of $SSB_{F40\%}$ and $F_{40\%}$ has a long history for use in other stocks/species. As such they are appropriate proxies for the more familiar MSY-based reference points.

4. Evaluate the stock projections, addressing the following:

- *Are the methods consistent with accepted practices and available data?*
- *Are the methods appropriate for the assessment model and outputs?*

Projections for landings in number (000's), F, SSB (000 mt) and recruits (000's at age 1) were carried out for the years 2020-2024 under 3 different scenarios:

- *Scenario 1: F = $F_{current}$, (where $F_{current}$ is computed as the geometric mean F2015-2017)*
- *Scenario 2: F = $F_{40\%}$,*
- *Scenario 3: F = 75% $F_{40\%}$,*

As the assessment ended in 2017, the projections required an initialization period (2018 and 2019) for which total removals in weight were the mean removals in weight observed for the years 2015-2017.

Deterministic and stochastic projections were performed for each scenario. Population numbers at ages 2+ in 2018 were derived from the assessment base run. For deterministic projections the value for numbers at age 1 was the arithmetic mean recruitment. For stochastic projections, age 1 recruits were drawn from the lognormal distribution of recruitment values.

Projections appeared to be carried out appropriately using accepted practices and were appropriate for the assessment model, data on hand, and required outputs. The results for the projections can be found in Table 2.

- *Are the results informative and robust, and useful to support inferences of probably future conditions?*
- *Are key uncertainties acknowledged, discussed, and reflected in projection results?*

Overall, the projections were robust and based on the best available data. It is noteworthy that these projections assume constant recruitment in keeping with the mean recruitment implied from the BAM.

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 all sources of uncertainty in the population, data sources, and assessment methods.*

The AT made a considerable effort in providing concise and intelligible estimates of uncertainty. This was done using the ensemble approach. This approach ran 4000 individual simulations that bootstrapped input variables as well as fixed estimates using Monte Carlo techniques. The results of this work can be found in Figure 9.

Additionally, a number of sensitivities were performed to look at model behavior under different assumptions. These analyses indicated that natural mortality is the most sensitive aspect of the BAM. As such, the choice on natural mortality can affect the outcome of the model results, and more importantly impact status determination.

Other runs were requested during the RW. These included natural mortality at age, maturity at age, and the assumption of two time blocks for selectivity for the head-boat index (see below). While informative, these also highlighted the sensitivity of the model to the choice of natural mortality.

- *Are the implications of uncertainty in technical conclusions clearly stated?*

Overall, 97% of ensemble runs indicate that the stock of Atlantic cobia is not overfished and 96.7% runs indicated that overfishing was not taking place (Figure 9). The small percentage of runs that indicated overfished or overfishing occurred when natural mortality was assumed to be at lower than plausible. Given this and the graphical representations of the sensitivities of stock and fishing morality status relative to reference points, these uncertainties were clearly stated for both the RP and other interested parties.

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

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

During the RW the list of research recommendations from both the AW and the DW (Data Workshop) were examined in detail. From the discussions, four major areas of research were identified as priority. These included:

1. Because the fishery-dependent index ended in 2015, the development of a new index, either fishery-dependent or preferably fishery-independent, should be given top priority. Without an index of abundance, it is unlikely that stock status would be able to be estimated with any reliability in the future. The RP recommends exploring other fisheries-dependent CPUE sources if available, developing fisheries-independent surveys such as egg/larvae surveys or close-kin methods, expanding analysis of the ten-year SERFS baited trap-video survey for cobia, or exploring the use of tag-data as potential indices of abundance.
2. Given that age composition data are an important source of information for the assessment model, methods to increase the sample size (such as expanding carcass collection locations and establishing similar programs in other states) should be implemented. In addition, the development of sampling programs to collect size and age information on fish released in the recreational fishery should be a priority.
3. The uncertainty in the stock status would be improved if better information on age-at-maturity and annual sex ratios were collected.
4. Natural mortality is an important parameter that affects model estimates of recruitment and spawning stock biomass. The RP recommends that estimates of natural mortality be made using tagging data or other analytical approaches (e.g., meta-analysis, catch-curves, etc.) for use in the model or to ground-truth the life-history invariant method used currently.

- *Provide recommendations on possible ways to improve the SEDAR process.*

During the RW it seemed as though there was often a disconnect between the DW, AW and the RW. Often the AT was unable to explain some of the rationales behind the choices made during the DW, some of which impact model results quite heavily. Further, the issues were often not well described in the text of the DW report. An example of this was the choice between the Lorenzen and Charnov approaches to estimating natural mortality. As such, it would be a good idea if the Chair of the Data Working Group were to attend the review panel meeting and be available to describe decisions relating to the choice of data.

Further, the DW report and RW process could be vastly improved by providing a summary of the main decisions and the justification for those as a separate document for the RW.

7. Provide suggestions on improvements in data or modeling approaches which should be considered when scheduling the next assessment.

The $SSB_{F40\%}$ and $F_{40\%}$ reference points, as proposed for this stock, are based on a long history of use in other locations and for similar stocks. However, further work with fishery managers on goals and objectives is advised prior to conducting a new benchmark. Proposed reference points could then be fully evaluated while the new assessment is constructed. The reference points proposed are based on MSY proxies and management could consider reference points consistent with levels of risk tolerance or by examining past fishery performance.

There were some inconsistencies with recreational landings; particularly in 1996 and 2015. After further examination during the RW, it was unclear if this was the result of the MRIP calibration or the result of other changes in the recreational catch. Prior to the next assessment, a full description of landings changes from SEDAR-28 through SEDAR-58 should be conducted. This examination should be fully and completely documented before the next benchmark.

Work on an appropriate fishery-dependent or independent abundance index should be a priority before the next review. The current head-boat index as formulated through 2015 may not be useful after SEDAR-58. Additionally, the development of a fishery-independent index is preferred. Lack of an appropriate index would likely prevent a quantitative assessment of this stock from moving forward.

Stock status is highly sensitive to assumptions of natural mortality. As such, a more thorough examination of natural mortality, complete with a range of possible analyses (Lorenzen, Charnov, etc.), should be conducted. The choice of natural mortality should be rigorously justified.

Given the recent break in the head-boat index, an additional three years of the head-boat index would be required to produce a robust assessment using only that index. This implies that if the head-boat index were to re-commence in 2020, the next assessment would be in 2024 at the earliest. However, the Atlantic Cobia assessment could be done sooner if other information (low recruitment, change in catch) points to issues with the stock.

A bridging analysis that describes consequential model changes and resulting stock status estimates between assessments is valuable. This would allow for the examination of potentially major effects in a step-by-step fashion and the potential to remove confounding effects.

Uncertainty in the maturity ogive should be included in future ensemble modeling prior to another assessment. It could be a major source of uncertainty in the future and should be captured.

8. Prepare a Peer Review Summary of the Panel's evaluation of the stock assessment, addressing each Term of Reference. Develop a list of tasks to be completed following the

workshop. Complete and submit the Peer Review Summary Report in accordance with project guidelines.

This report serves as a portion of this term of reference.

Other Requests made during the Workshop

Model sensitivities and exploration

1. Undertake a comparison between Lorenzen and Charnov estimates of M using the new population-level VBGF parameters for Lorenzen. Two Lorenzen M versus age curves (SEDAR-28 and with SEDAR-58 VBGF size at age) and the Charnov estimated M versus age with SEDAR-58 VBGF parameters were provided to the RP.
2. Evaluate uncertainty in maturity; 75% of age-3 and 100% of age-4 for life history incremental analysis. This sensitivity run gave a similar result to the revised base case model.
3. Examine PSEs for recreational landings and discards; captured in ensemble models.
4. Provide a raw time series of F40 and SSB40 (instead of those values relative to benchmarks). RP agreed that R0 values in Table 7 provide the scaling differences between the various sensitivity runs and met requests.
5. Provide the CVs of the head-boat index. The AT provided these as pre- and post-weighted values (and given in Table 5.5 of AW report).
6. Provide boxplots and bubble plots of absolute and Pearson residuals for age composition data for the previous (SEDAR-28), and the SEDAR-58 base case, and revised base case models; the RP did not find any major concerns resulting from consideration of the diagnostic plots.
7. Undertake a model run using a single selectivity for the head-boat index. The AT provided this sensitivity and it was decided by RP and AT that this should be the base case run. Further details are provided in RP report sections addressing the TORs above.
8. Provide CPUE index and catch-at-age residual patterns for original and revised base case models.
9. Undertake a sensitivity of model results to the relative weighting of the age composition data for the revised base model, by multiplying the Dirichlet N's by 0.5 and 2.0 as sensitivity runs.
10. Provide a likelihood profile for R0 and M.
11. Provide boxplots of the age composition residuals to provide information on whether a robustified distribution (e.g., robust multinomial) would be appropriate to model the age composition data.
12. Provide information on if the 1996 spike in estimated recreational catch was the result of MRIP calibration.
13. Provide a plot of the distribution of M when the standard error of the Charnov regression estimated model slope and intercept was doubled from that provided by Charnov et al. (2013).

Projection comments and requests

1. Describe the assumption of current landings for the first two years relative to constant F; any means to determine which is best. Given closures, are the current landings justified? Time series of historic F projected F and time series of historic catch and projected catch.
2. Provide tables on the probability of stock status being above and below targets in the projection period.
3. Provide a description of the assumptions on future recruitment used for projections.
4. Question on targets. Is there a threshold level for ASMFC? Varies by species.
5. Is F40% appropriate?
6. Provide analyses to check that SSB goes below target because of low recruitment in 2014; this resulting in the identification of an error in the projections where the bias correction was not applied to the future recruitment deviations; this was corrected by the AT for the projections described in this report.

Comments and Final Thoughts

This section is usually included in my CIE reports to comment on issues outside the Terms of References and to convey thoughts on the process as well as overarching issues of the assessment.

Foremost, this was a well-performed Assessment and Review Workshop. The other reviewers on the panel performed admirably and provided many comments and improvements to the work. They were a real pleasure to work with. Jeff did a wonderful job with the report in the final days of our working together. Likewise, the SEDAR staff was very organized and put us in a good direction right from the start of the process. Having staff from ASMFC was also very helpful as we navigated through the past management changes as well as providing some insight into management objectives.

As always, Katie and the rest of the staff from Beaufort were very accommodating. They provided all the sensitivity analyses requested and were very interested in how to improve the model. Having the AT at the RP was very helpful as questions on the formulation of BAM for cobia, as well as general knowledge of BAM in a broad sense was key to a good review process. Overall, they produced a thorough assessment that is useful for management decisions.

Additionally, the Beaufort Hotel is a lovely place to hold a meeting of this sort. Very comfortable and very beautiful. Though it is a bit far from local restaurants and grocery/convenience stores for those of us without cars.

There are, however, several concerns. As stated above the potential lack of an index of abundance in the future is troubling. The current fishery dependent index, while adequate for this assessment, is unlikely to remain adequate in subsequent benchmarks. More importantly, it is subject to management measures and other issues stemming from it being fishery dependent. A better approach is to find a fishery independent data source.

There are some issues with communication between Data Workshop, Assessment Workshop, and Review Workshop. It was often difficult at the Review Workshop to pin down how decisions were made on inputs to the model. At times the Assessment Team did not seem clear on the justification for decisions. I think our suggestions of having Data Workshop participation at the Review Workshop and the recommendation to have better justification in the Data Workshop report will help.

There are not, at present, clear management objectives for this stock. While the $SSB_{F40\%}/F_{40\%}$ proposed reference points are a good placeholder, it can not replace well thought out fishery management objectives and harvest control rules. As this stock moves from federal to ASMFC

management, this is a good opportunity for thoughtful management objectives to be developed together with stakeholders. Those objectives can then form the base for target and limit reference points, as well as harvest control rules to meet stock management goals.

Overall, this was a fun and thought-provoking workshop. I look forward to seeing the results and working more with the SEDAR and other review processes.

References

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Tables and Figures

Table 1. Yearly negative log-likelihoods from the three runs considered for the base case; co22 =old base sens14a =2 time blocks, Head Boat index of abundance using only the first time block, sens15 = 1 time block for selectivity.

	co22	sens14a	sens15
1986	44.778	44.803	43.831
1987	36.087	36.098	38.667
1989	137.910	138.060	137.870
1990	141.306	141.483	138.400
1991	26.599	26.586	27.256
1992	28.823	28.849	29.101
1995	23.531	23.544	24.596
1996	60.886	60.993	61.464
1997	30.925	30.769	30.523
1999	249.833	250.169	251.431
2000	240.678	240.981	242.119
2001	99.538	99.776	98.903
2002	54.123	54.248	55.387
2005	95.815	96.362	99.389
2006	137.570	137.730	137.547
2007	341.990	342.178	342.064
2008	410.445	410.879	410.493
2009	484.010	484.044	485.065
2010	627.468	627.281	628.063
2011	469.958	469.662	469.736
2012	507.673	507.711	508.450
2013	749.187	748.787	749.533
2014	805.321	805.013	804.939
2015	848.079	848.063	847.913
2016	663.435	663.177	663.284
2017	490.955	490.818	491.071

Table 2. The proportion of stochastic projections where $SSB<SSB_{F40\%}$ under three fishing scenarios: fishing at $F_{40\%}$, at 75% $F_{40\%}$, and at the current F.

	F40	75% F_{40}	$F_{current}$
2018	0.19	0.07	0.07
2019	0.23	0.11	0.11
2020	0.3	0.14	0.12
2021	0.4	0.23	0.11
2022	0.46	0.31	0.09
2023	0.49	0.34	0.08
2024	0.5	0.35	0.08

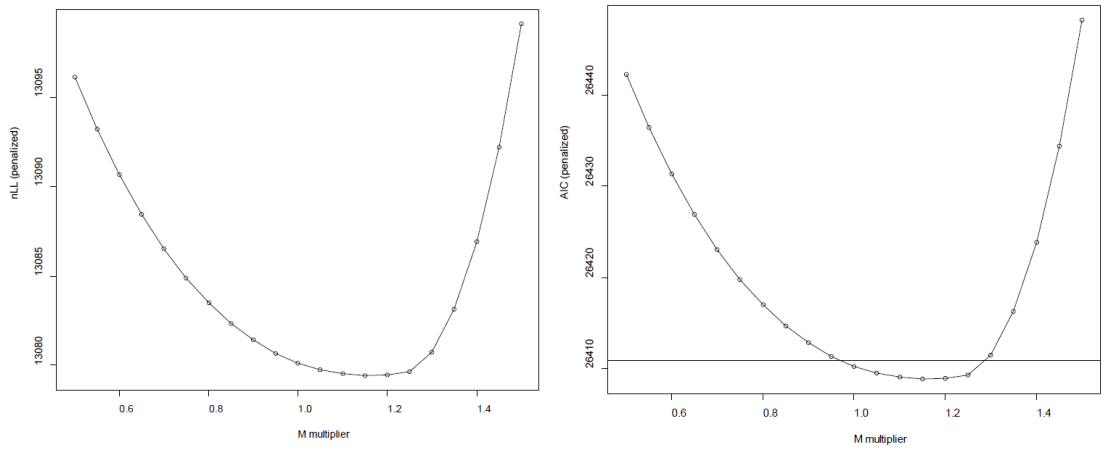

Figure 1. Negative Log-likelihood and AIC at various values of natural mortality, shown as a multiplier on the value of M.

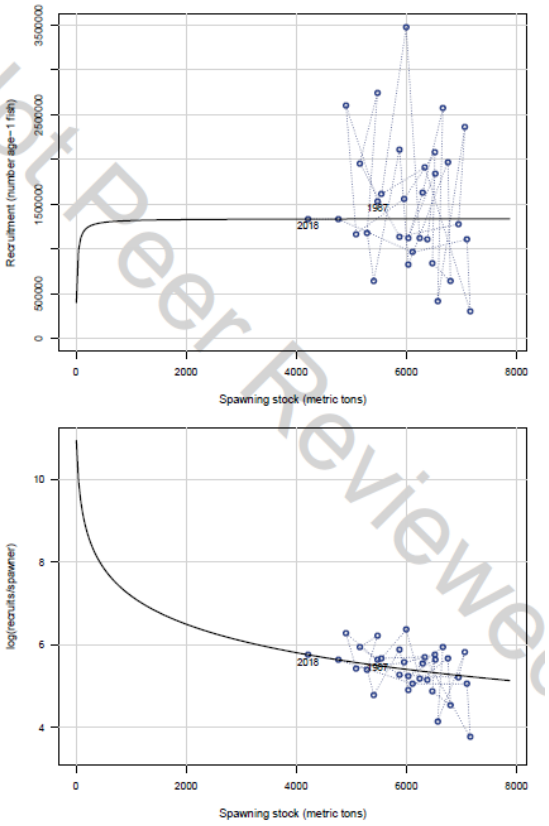

Figure 2. Top panel: Spawner-recruit relationship. The expected curve was used for computing management benchmarks. Years within the panel indicate the year of recruitment generated from spawning biomass. Bottom panel: log of recruits (number age 1) per spawner as a function of spawners.

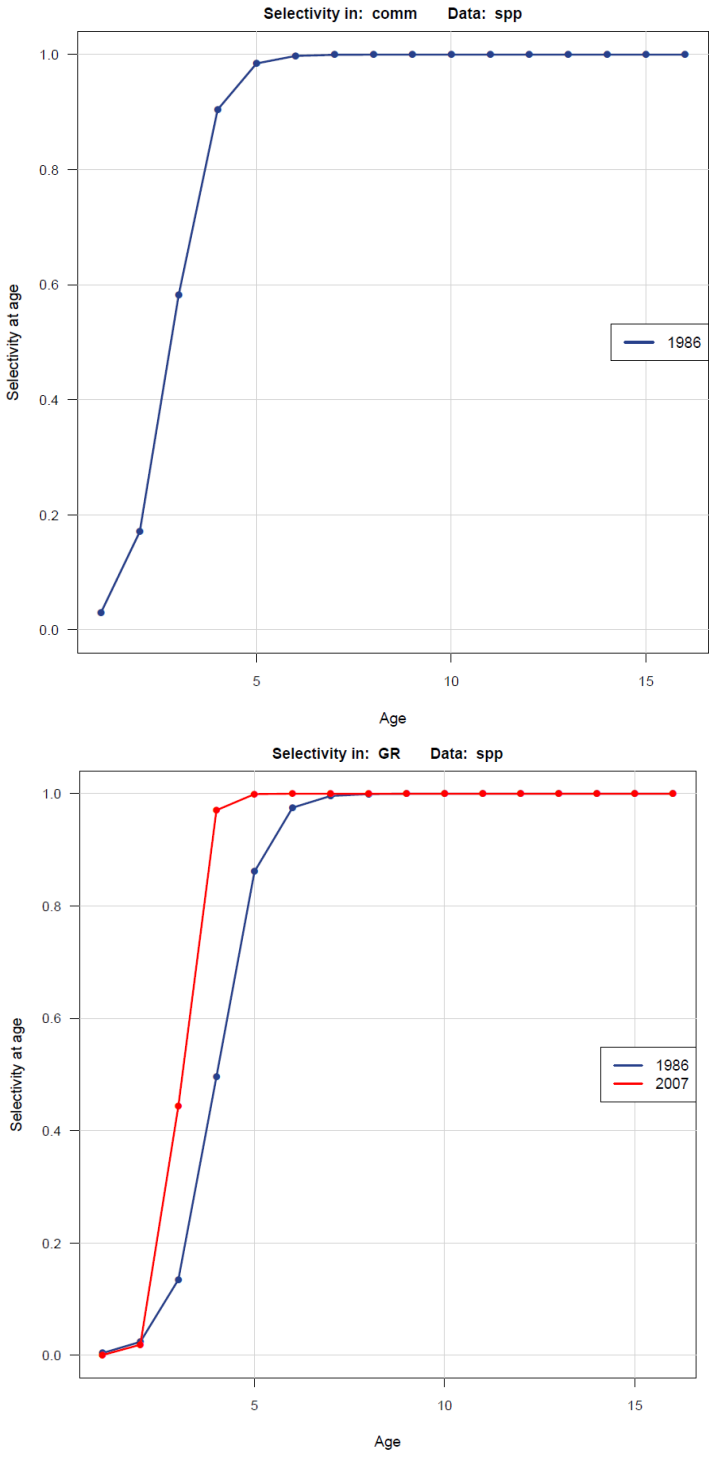

Figure 3. Selectivity curve for the commercial (top) and recreational fishery (bottom). Note two time blocks on fishery selectivity are used 1986-2006 (blue) and 2007-2017 (red).

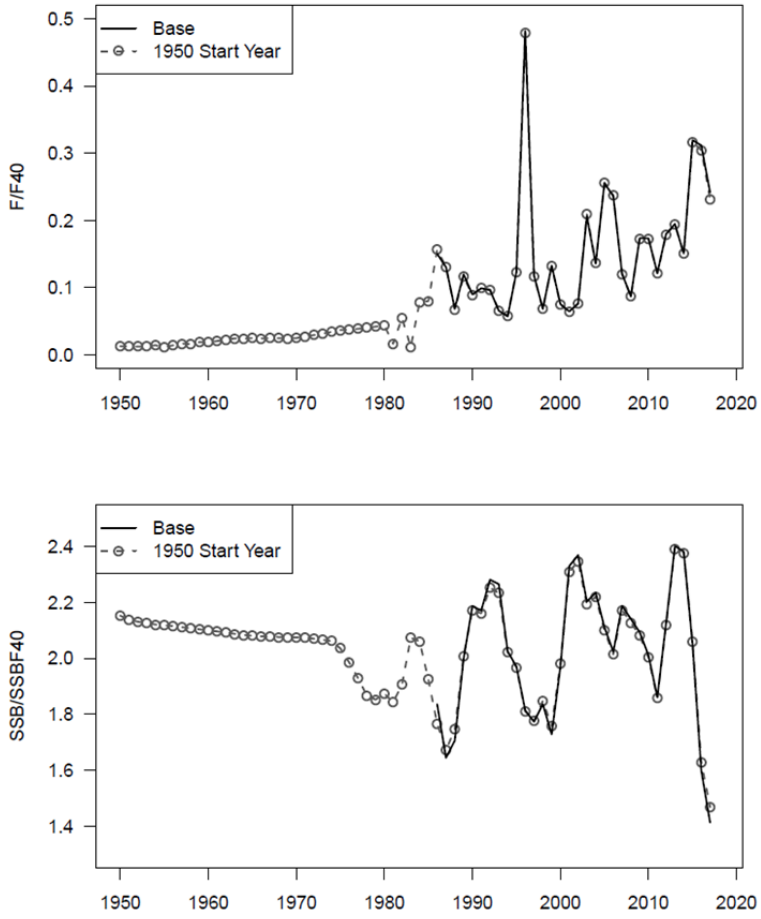

Figure 1. Start year value sensitivity. ratio of F to $F_{40\%}$ (top), ratio of SSB to $SSB_{F40\%}$ (bottom).

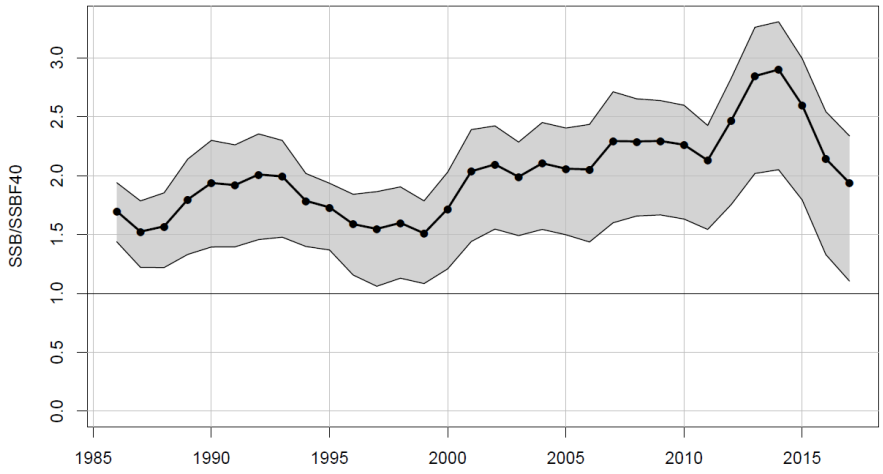

Figure 2. The 95% range for the estimates of SSB/$SSB_{F40\%}$ from the ensemble models (grey shaded region) with the revised base case (co23, solid line) for the assessment model for 1986-2017.

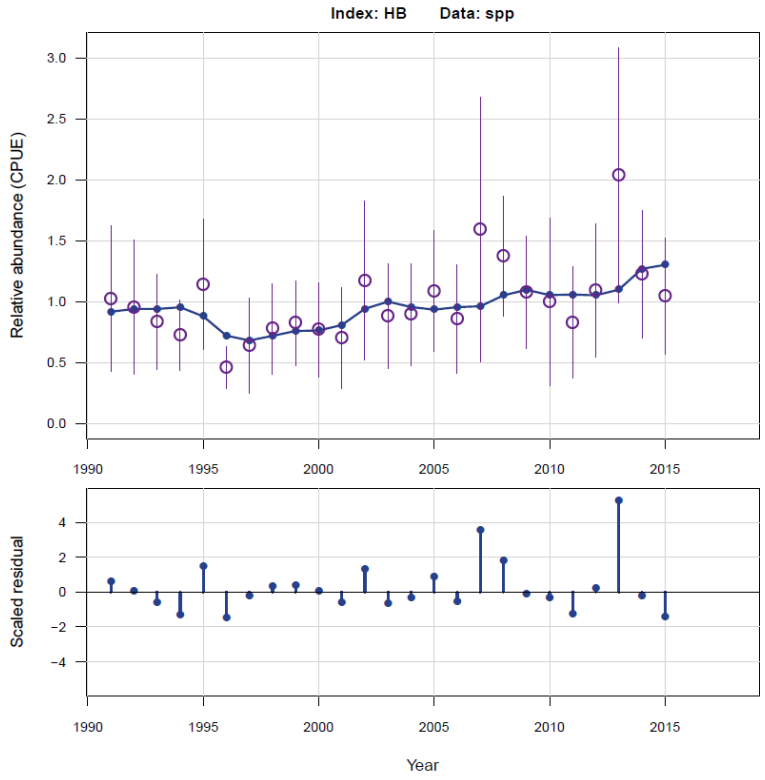

Figure 3. Revised base case model (co22) fits (top) and residuals (bottom) to the head-boat CPUE index of abundance for 1991-2015.

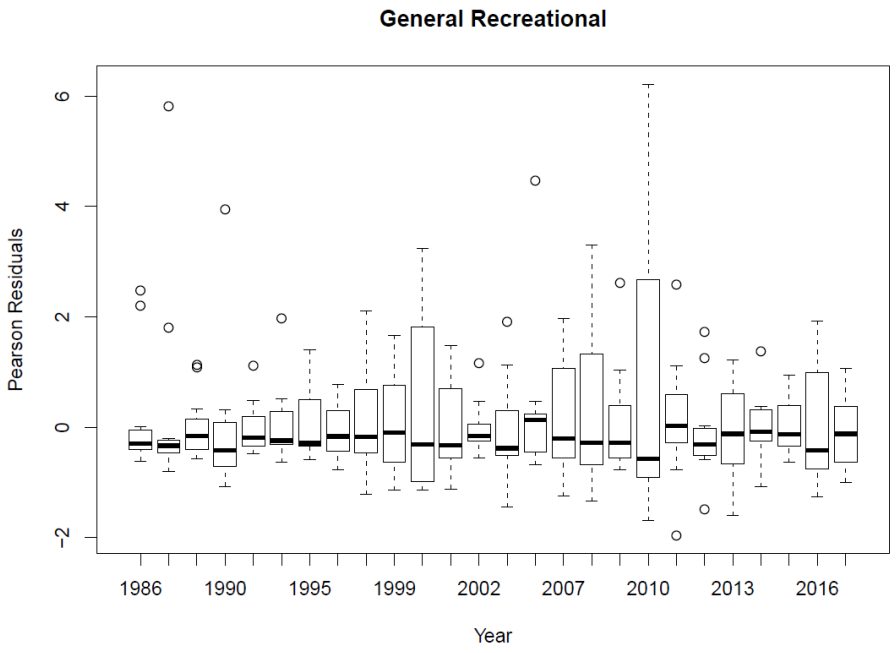

Figure 4. Pearson residuals for the age composition fits for years 1986-2017 for the revised base case model (co23).

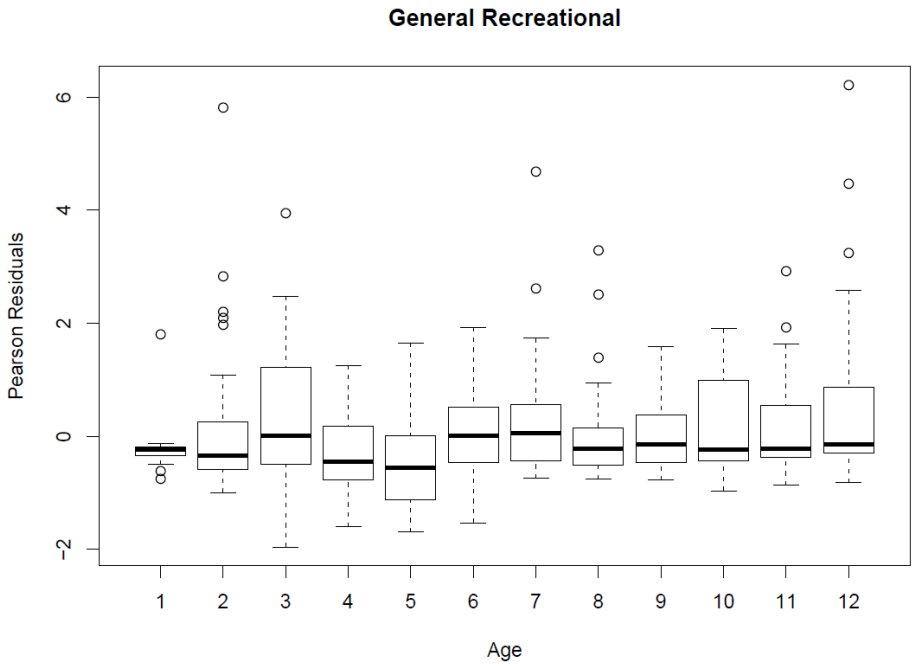

Figure 5. Pearson residuals for the age composition fits for ages 1-12 over the years 1986-2017 for the revised base case model (co23).

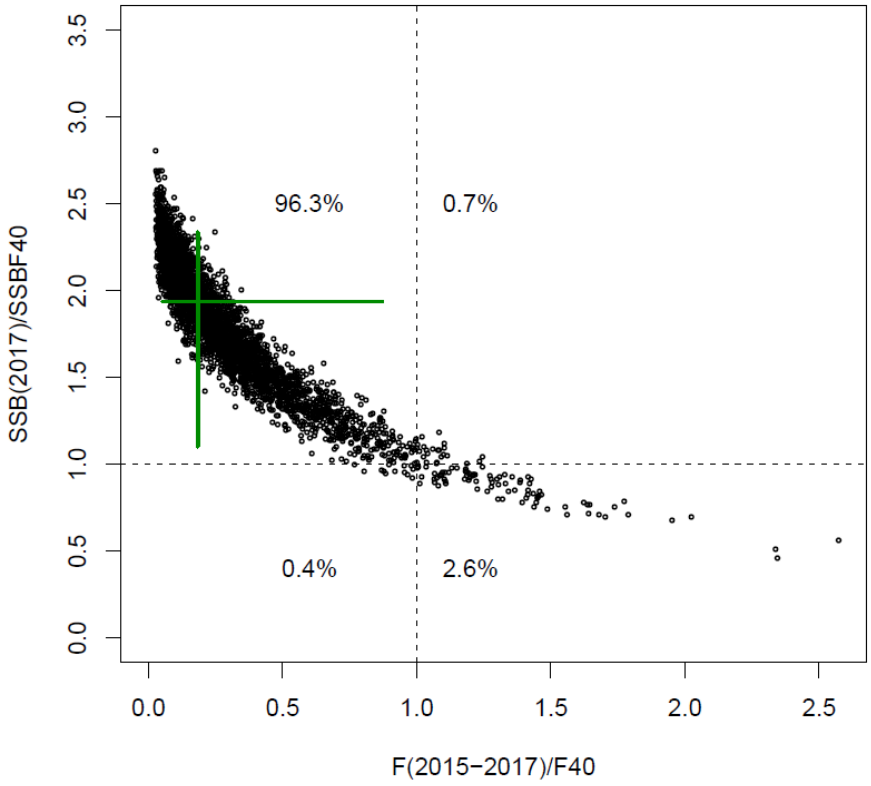

Figure 9. Ensemble model estimates of SSB (2017)/SSBF40% versus F (2015-2017)/F40 showing the proportion of ensemble model runs above and below the potential over-fishing and overfished reference points for Atlantic Cobia from the revised base case model (co23).

Appendix 1: Bibliography of materials provided for review

Documents Prepared for the Review Workshop		
SEDAR58-RW01	An Age Structured Production Model for Atlantic Cobia	Siegfried, 2019
SEDAR58-RW02	Public Comment Forum	SEDAR 2019
Final Assessment Reports		
SEDAR58-SAR1	Assessment of Atlantic Cobia	To be prepared by SEDAR 58
Reference Documents		
SEDAR58-RD01	SEDAR 28 South Atlantic Cobia Stock Assessment	SEDAR 28

	Report	
SEDAR58-RD02	SEDAR 28 Gulf of Mexico Cobia Stock Assessment Report	SEDAR 28
SEDAR58-RD03	List of documents and working papers for SEDAR 28 (South Atlantic Cobia and Spanish Mackeral) – all documents available on the SEDAR website.	SEDAR 28
SEDAR58-RD04	Managing A Marine Stock Portfolio: Stock Identification, Structure, and Management of 25 Fishery Species along the Atlantic Coast of the United States	McBride 2014
SEDAR58-RD05	Chapter 22: Interdisciplinary Evaluation of Spatial Population Structure for Definition of Fishery Management Units (excerpt from Stock Identification Methods – Second Edition)	Cadrin et al. 2014
SEDAR58-RD06	Mitochondrial DNA Analysis of Cobia *Rachycentron canadum* Population Structure Uisng Restriction Fragment Length Polymorphisms and Cytochrome B Sequence Variation	Hrincevich 1993
SEDAR58-RD07	Population Genetic Comparisons among Cobia from the Northern Gulf of Mexico, U.S. Western Atlantic, and Southeast Asia	Gold et al. 2013
SEDAR58-RD08	Population genetics of Cobia (*Rachycentron canadum*): implications for fishery management along the coast of the southeastern United States	Darden et al. 2014
SEDAR58-RD09	Growth, mortality, and movement of cobia (*Rachycentron canadum*)	Dippold et al. 2017
SEDAR58-RD10	Assessment of cobia, *Rachycentron canadum*, in the waters of the U.S. Gulf of Mexico	Williams, 2001
SEDAR58-RD11	Life history of Cobia, *Rachycentron canadum* (Osteichthyes: Rachycentridae), in North Carolina waters	Smith 1995
SEDAR58-RD12	A review of age, growth, and reproduction of cobia *Rachycentron canadum*, from US water of the Gulf of Mexico and Atlantic ocean	Franks and Brown-Peterson, 2002
SEDAR58-RD13	An assessment of cobia in Southeast US waters	Thompson 1995
SEDAR58-RD14	Reproductive biology of cobia, *Rachycentron canadum*, from coastal waters of the southern United States	Brown-Peterson et al. 2001
SEDAR58-RD15	Age and growth of cobia, *Rachycentron canadum*, from the northeastern Gulf of Mexico	Franks et al. 1999

SEDAR58-RD16	Synopsis of biological data on the cobia *Rachycentron canadum* (Pisces: Rachycentridae)	Shaffer and Nakamura 1989
SEDAR58-RD17	Age, growth, and reproductive biology of greater amberjack and cobia from Louisiana waters	Thompson et al. 1991
SEDAR58-RD18	Cobia (*Rachycentron canadum*) stock assessment study in the Gulf of Mexico and in the South Atlantic	Burns et al. 1998
SEDAR58-RD19	Gonadal maturation in the cobia, *Rachycentron canadum*, from the northcentral Gulf of Mexico	Lotz et al. 1996
SEDAR58-RD20	Length-weight relationships, location and depth distributions for select Gulf of Mexico reef fish species	Pulver & Whatley 2016
SEDAR58-RD21	Inshore spawning of cobia (*Rachycentron canadum)* in South Carolina	Lefebvre & Denson 2012
SEDAR58-RD22	Determining the stock boundary between South Atlantic and Gulf of Mexico managed stocks of Cobia, *Rachycentron canadum*, through the use of telemetry and population genetics	Perkinson et al. 2018
SEDAR58-RD23	SAFMC Mackerel Cobia Advisory Panel and Cobia Sub-Panel Cobia Fishery Performance Report April 2017	SAFMC Mackerel Cobia AP & Cobia Sub-Panel 2017
SEDAR58-RD24	Spawning of the Cobia, *Rachycentron canadum*, in the Chesapeake Bay Area, with Observations of Juvenile Specimens	Joseph et al. 1964
SEDAR58-RD25	SEDAR28-DW02: South Carolina experimental stocking of Cobia *Rachycentrom canadum*	Denson 2012
SEDAR58-RD26	Applying network methods to acoustic telemetry data: Modeling the movements of tropical marine fishes	Finn et al. 2014
SEDAR58-RD27	Developing a deeper understanding of animal movements and spatial dynamics through novel application of network analyses	Jacoby et al. 2012
SEDAR58-RD28	Status of the South Carolina Fisheries for Cobia	Hammond 2001
SEDAR58-RD29	Dynamic ocean management increases the efficiency and efficacy of fisheries management	Dunn et.al. 2016
SEDAR58-RD30	Using Pop-off Satellite Archival Tags To Monitor and Track Dolphinfish and Cobia	Hammond 2008
SEDAR58-RD31	Cusk (Brosme brosme) and climate change: assessing the threat to a candidate marine fish species under the US Endangered Species Act	Hare et al 2012

SEDAR58-RD32	Dynamic habitat suitability modelling reveals rapid poleward distribution shift in a mobile apex predator	Hill et. al. 2016
SEDAR58-RD33	Seasonal forecasting of tuna habitat for dynamic spatial management	Hobday et. al. 2011
SEDAR58-RD34	Near real-time spatial management based on habitat predictions for a longline bycatch species	Hobday et. al. 2006
SEDAR58-RD35	Seasonal forecasting for decision support in marine fisheries and aquaculture	Hobday et. al. 2016
SEDAR58-RD36	Changing spatial distribution of fish stocks in relation to climate and population size on the Northeast United States continental shelf	Nye et.al. 2009
SEDAR58-RD37	Projecting changes in the distribution and productivity of living marine resources: A critical review of the suite of modelling approaches used in the large European project VECTORS	Peck et. al. 2016
SEDAR58-RD38	Climate Change Affects Marine Fishes Through the Oxygen Limitation of Thermal Tolerance	Portner and Knust 2007
SEDAR58-RD39	Effects of water temperature and fish size on growth and bioenergetics of cobia (Rachycentron canadum)	Sun and Chen 2014
SEDAR58-RD40	Effect of temperature on growth and energy budget of juvenile cobia (Rachycentron canadum)	Sun et. al. 2006
SEDAR58-RD41	Managing living marine resources in a dynamic environment: The role of seasonal to decadal climate forecasts	Tomoassi et. al. 2017
SEDAR58-RD42	Model-estimated conversion factors for calibrating Coastal Household Telephone Survey (CHTS) charterboat catch and effort estimates with For-Hire Survey (FHS) estimates in the Atlantic and Gulf of Mexico with application to red grouper and greater amberjack	Dettloff & Matter 2019

SEDAR58-RD43	Understanding the Virginia Cobia Stock Through Analysis of Trophy Fish	Weng et. al. 2019
SEDAR58-RD44	Technical Documentation of the Beaufort Assessment Model	Williams and Shertzer, 2015
SEDAR58-RD45	Evolutionary assembly rules for fish life histories	Charnov et.al. 2013
SEDAR58-RD46	The relationship between body weight and natural mortality in juvenile and adult fish: a comparison of natural systems and aquaculture	Lorenzen, 1996
SEDAR58-RD47	Bias in common catch-curve methods applied to age frequency data from fish surveys	Nelson, 2019

Appendix 2: Performance Work Statement

Background

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

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

Further information on the CIE program may be obtained from www.ciereviews.org.

Scope

The **SouthEast Data, Assessment, and Review (SEDAR)** is the cooperative process by which stock assessment projects are conducted in NMFS' Southeast Region. SEDAR was initiated to improve planning and coordination of stock assessment activities and to improve the quality and reliability of assessments.

SEDAR 58 will be a CIE assessment review conducted for Atlantic Cobia. The review workshop provides an independent peer review of SEDAR stock assessments. The term review is applied broadly, as the review panel may request additional analyses, error corrections and sensitivity runs of the assessment models provided by the assessment panel. The review panel is ultimately responsible for ensuring that the best possible assessment is provided through the

SEDAR process. The stocks assessed through SEDAR 58 are within the jurisdiction of the Atlantic States Marine Fisheries Commission and the states of Georgia, South Carolina, North Carolina, Virginia, Maryland, Delaware, Pennsylvania, New Jersey, New York, Connecticut, Rhode Island, Massachusetts, New Hampshire, and Maine. The specified format and contents of the individual peer review reports are found in **Annex 1**. The Terms of Reference (TORs) of the peer review are listed in **Annex 2**. Lastly, the tentative agenda of the panel review meeting is attached in **Annex 3**.

Requirements

NMFS requires three (3) reviewers to conduct an impartial and independent peer review in accordance with the Performance Work Statement (PWS), OMB guidelines, and the TORs below. The reviewers shall have a working knowledge in stock assessment, statistics, fisheries science, and marine biology sufficient to complete the primary task of providing peer-review advice in compliance with the workshop Terms of Reference fisheries stock assessment.

Tasks for Reviewers

1) Two weeks before the peer review, the Project Contacts 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 Project Contacts will consult with the contractor 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 PWS scheduled deadlines specified herein. The CIE reviewers shall read all documents in preparation for the peer review.

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

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

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

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

Foreign National Security Clearance

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

Place of Performance

The place of performance shall be at the contractor's facilities, and in Atlantic Beach, NC.

Period of Performance

The period of performance shall be from the time of award through January 2020. Each CIE reviewer's duties shall not exceed 14 days to complete all required tasks.

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

Within two weeks of award	Contractor selects and confirms reviewers
2 weeks prior to the panel review	Contractor provides the pre-review documents to the reviewers
November 19-21,	Panel review meeting

2019	
Approximately 3 weeks later	Contractor receives draft reports
Within 2 weeks of receiving draft reports	Contractor submits final reports to the Government

Applicable Performance Standards

The acceptance of the contract deliverables shall be based on three performance standards:

(1) The reports shall be completed in accordance with the required formatting and content; (2) The reports shall address each TOR as specified; and (3) The reports shall be delivered as specified in the schedule of milestones and deliverables.

Travel

All travel expenses shall be reimbursable in accordance with Federal Travel Regulations (http://www.gsa.gov/portal/content/104790). International travel is authorized for this contract. Travel is not to exceed $12,000.

Restricted or Limited Use of Data

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

Project Contacts:

Larry Massey – NMFS Project Contact
150 Du Rhu Drive, Mobile, AL 36608
(386) 561-7080
larry.massey@noaa.gov

Kathleen Howington - SEDAR Coordinator
SEDAR Coordinator
Science and Statistics Program
South Atlantic Fishery Management Council
4055 Faber Place Drive, Suite 201
North Charleston, SC 29405
Kathleen.howington@safmc.net

Annex 1: Peer Review Report Requirements

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

2. The report must contain a background section, description of the individual reviewers' roles in the review activities, summary of findings for each TOR in which the weaknesses and strengths are described, and conclusions and recommendations in accordance with the TORs.

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

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

   c. Reviewers should elaborate on any points raised in the summary report that they believe might require further clarification.

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

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

3. The report shall include the following appendices:

Appendix 1: Bibliography of materials provided for review

Appendix 2: A copy of this Performance Work Statement

Appendix 3: Panel membership or other pertinent information from the panel review meeting.

Annex 2: Terms of Reference for the Peer Review

SEDAR 58 Atlantic Cobia Assessment
Review Workshop Terms of Reference

9. Evaluate the data used in the assessment addressing the following:
    - Are data decisions made by the DW and AW sound and robust?
    - Are data uncertainties acknowledged, reported, and within normal or expected levels?
    - Are data applied appropriately within the assessment model?
    - Are input data series reliable and sufficient to support the assessment approach and findings?
10. Evaluate the methods used to assess the stock, taking into account the available data.
    - Are methods scientifically sound and robust? Do the methods follow accepted scientific practices?
    - Are assessment models configured appropriately and applied consistent with accepted scientific practices?
    - Are the methods appropriate for the available data?
11. Evaluate the assessment findings with respect to the following:
    - Are population estimates (model output – e.g. abundance, exploitation, biomass) reliable, consistent with input data and population biological characteristics, and useful to support status inferences?
    - Is the stock overfished? What information helps you reach this conclusion?
    - Is the stock undergoing overfishing? What information helps you reach this conclusion?
    - Is there an informative stock recruitment relationship? Is the stock recruitment curve realiable and useful for evaluation of productivity and future stock conditions?
    - Are the quantitative estimates of the status determination criteria for this stock appropriate for management use? If not, are there other indicators that may be used to inform managers about stock trends and conditions?
12. Evaluate the stock projections, addressing the following:
    - Are the methods consistent with accepted practices and available data?
    - Are the methods appropriate for the assessment model and outputs?
    - Are the results informative and robust, and useful to support inferences of probably future conditions?
    - Are key uncertainties acknowledged, discussed, and reflected in projection results?
13. 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 all sources of uncertainty in the population, data sources, and assessment methods.
- Are the implications of uncertainty in technical conclusions clearly stated?

14. Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations or prioritizations warranted.
    - Clearly denote research and monitoring that could improve the reliability of, and information provided by, future assessments.
    - Provide recommendations on possible ways to improve the SEDAR process.
15. Provide suggestions on improvements in data or modeling approaches which should be considered when scheduling the next assessment.
16. Prepare a Peer Review Summary of the Panel's evaluation of the stock assessment, addressing each Term of Reference. Develop a list of tasks to be completed following the workshop. Complete and submit the Peer Review Summary Report in accordance with project guidelines.

Appendix 3: Panel membership, Attendee list, Agenda.

Appointee	Function	Affiliation
REVIEW PANEL		
Jeff Buckel	Review Panel Chair	ASMFC Appointee
Gary Nelson	Reviewer	ASMFC Appointee
Alistair Dunn	CIE Reviewer	CIE
John Casey	CIE Reviewer	CIE
Matt Cieri	CIE Reviewer	CIE
APPOINTED OBSERVERS		
Collins Doughtie*	Fisherman – SC	SAFMC Mack/Cobia AP
Bill Gorham	Fisherman – NC	SAFMC Mack/Cobia AP
Wes Blow	Fisherman – VA	SAFMC Mack/Cobia AP
ANALYTICAL REPRESENTATIVES		
Katie Siegfried	Lead analyst	SEFSC Beaufort
Kyle Shertzer	Assessment Team	SEFSC Beaufort
Erik Williams	Assessment Team	SEFSC Beaufort
Rob Cheshire	Assessment Team	SEFSC Beaufort
COUNCIL AND AGENCY STAFF		
Kathleen Howington	Coordinator	SEDAR
Cierra Graham	Admin	SAFMC
Mike Schmidtke	ASMFC lead	ASMFC
Other		
Jie Cao	NC State	Morehead City, NC
Erik Fitzpatrick	NOAA	Beaufort, NC
Amy Scheuller	NOAA	Beaufort, NC
Matt Damiano	NC State	Morehead City, NC
Riley Gallagher	NC State	Morehead City, NC
Joseph W. Smith	NMFS Retired	Morehead City, NC
Amanda Tong	NCDMF	Morehead City, NC
Chris Batsavage	NCDMF	Morehead City, NC

*Appointees with an asterisk were unable to attend the workshop.

SEDAR 58 Atlantic Cobia Assessment Review

Atlantic Beach, NC

November 19-21, 2019

Tuesday

8:00 – 8:30	**Introductions and Opening Remarks**	**Coordinator**
	- Agenda Review, TOR, Task Assignments	
8:30 a.m. – 11:30 a.m.	**Assessment Presentations**	**TBD**
11:30 a.m. – 1:00 p.m.	**Lunch Break**	
1:00 p.m. – 5:00 p.m.	**Panel Discussion**	**Chair**
	- *Assessment Data & Methods*	
	- Identify additional analyses, sensitivities, corrections	
	- Review additional analyses	
	Take Breaks as needed	
5:00 p.m. - 6:00 p.m.	**Panel Work Session**	**Chair**

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

Wednesday

8:00 a.m. – 11:30 a.m.	**Panel Discussion**	**Chair**
	- Review additional analyses, sensitivities	
	- Consensus recommendations and comments	
11:30 a.m. – 1:00 p.m.	**Lunch Break**	
1:00 p.m. – 5:00 p.m.	**Panel Discussion**	**Chair**
5:00 p.m. - 6:00 p.m.	**Panel Work Session**	**Chair**

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

Thursday

8:00 a.m. – 11:30 a.m.	**Panel Discussion**	**Chair**
	- Final sensitivities reviewed.	

	- Projections reviewed.	
11:30 a.m. – 1:00 p.m.	**Lunch Break**	
1:00 p.m. – 6:00 p.m.	**Panel Discussion or Work Session**	**Chair**
	- Review Consensus Reports	

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