Center for Independent Experts (CIE) Independent Peer Review Report for SEDAR 58 Atlantic Cobia Assessment Review

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EXECUTIVE SUMMARY

The SEDAR-58 review of Atlantic Cobia was held in Beaufort, NC on November 19-21, 2019. There were five independent reviewers from ASMFC and CIE. The peer review reviewed the assessment, considered the terms of reference for the review (attached), and provided a draft report of the review.

The Atlantic cobia assessment team (AT) provided the assessment report and presentations. The five reviewers on the review panel (RP) consisted of three CIE reviewers, an ASMFC appointed reviewer, and an ASMFC appointed chair. The AT provided presentations on the background of the stock assessment, sensitivities, and projections. Additionally, the RP requested other sensitivities and ensemble runs that were addressed during the review workshop and are described below. The RP responded to the seven Terms of Reference (TORs) that covered data used, assessment methods, assessment findings and projections, uncertainty, research recommendations, and improvements to data or modelling approaches.

The Data Workshop (DW) assembled data, time series, and the necessary life history information needed for the model; however, the RP did not see a written explanation for some of the data decisions made by the DW (e.g., change in methodology to estimate natural mortality). The uncertainty in data inputs was well described and the RP identified four major sources of data uncertainty: commercial and recreational removals, age compositions for the recreational fishery before 2007, length compositions for the commercial fishery, and the assumed rate of natural mortality. Additionally, the RP recommended further examination of the 1996 and 2015 recreational removals.

Data were used appropriately in the age-structured assessment (Beaufort Assessment Model, BAM) and the methods were scientifically sound, followed accepted scientific practices, were configured appropriately, and were appropriate for the available data. There was no clear stock-recruitment relationship in the data, and hence no stock-recruitment relationship was assumed. The RP asked why the time-block selectivity (i.e., two selectivities, one for the early and one for the late period of the index) was applied to the head-boat index given that the explanation for time-varying selectivity in the targeted fishery would likely not apply to the non-targeted head-boat fishery. The AT agreed and compared age-composition fits with and without time-block selectivity. The time-invariant selectivity for the head-boat index had better fits in recent years and was consistent with the fishery; this model was chosen as the revised base model for Atlantic Cobia.

The modelled population estimates (e.g., abundance, exploitation, and biomass estimates) were reliable given the assessment assumptions and observations. The assessment panel provided reference points of F40% as a proxy for FMSY, SSBF40% as a proxy for SSBMSY, and 75% of F40% and 75%SSB as target reference points. The estimates of SSB and F for Atlantic Cobia show the population has been above SSBF40% and below F40% since the beginning of the modelled period (1986); thus, the stock is not overfished, and overfishing is not occurring. The RP noted that the model estimates of population size, status, and trend were consistent with the known and assumed population parameters, and that the model used the best available science and was adequate to support stock biomass and stock status inferences.

Projections were carried out appropriately using accepted practices given the data available and were appropriate for the assessment model and required outputs. Projections for removals in numbers, F, SSB (mt) and recruits (numbers at age 1) were carried out for the years 2020–2024 at $F = F_{current}$, $F = F_{40\%}$, and $F = 75\%F_{40\%}$. The mean deterministic and median stochastic estimates of SSB were greater than $SSB_{40\%}$ for these years. However, given the uncertainty around inputs, there was a small (12%, $F_{current}$) to moderate (50%, $F = F_{40\%}$) percentage of stochastic simulations that resulted in an overfished status ($SSB < SSB_{F40\%}$). The projection results are informative and robust and are useful to support inferences of future stock status and biomass. The key uncertainties were reflected in projection results.

The key uncertainties within the assessment model were well described by the AT in the assessment document (see SEDAR-58-addendum). The main uncertainty was in estimates of natural mortality (*M*) and less significant uncertainties in the choice of steepness (h) of the stock-recruit relationship and the estimated maturation ogive. Ensemble model bootstraps used estimates of M based on 2x the standard error of the M around the regression line for the estimated mean size of Cobia at age. The RP noted that that while the estimates of M were very uncertain, the outcomes of the assessment showed that the stock was highly unlikely to be below the $SSB_{F40\%}$ reference point.

The following research recommendations should be given high priority because of the importance to the stock assessment model: develop a new index of abundance, increase sample size (such as expanding carcass collection locations and establishing similar programs in other states) of size- and age-compositions in harvested and released fish, improve information on age-at-maturity and annual sex ratios, and use tagging data or other analytical approaches (e.g., meta-analysis, catch-curves, etc.) to ground-truth the estimate of natural mortality. Additionally, the RP recommended that additional research on steepness (h) and a full description of landings changes from SEDAR-28 through SEDAR-58 be conducted.

The assessment has only a single index of abundance (the head-boat CPUE index). Due to recent management closures, this index was not available for years since 2015. The RP noted that if there were future closures, then this index of abundance will not be available in future years. Currently there are no other suitable indices of abundance available. The RP strongly recommended that additional indices of abundance be developed and that, preferably, these be fishery independent.

The RP noted that the SEDAR stock assessment review process would be improved if the Chair of the Data Working Group were to attend the review panel meeting and be available to assist the AT describe decisions relating to the choice of data. The RP recommends that SEDAR request a document or DW report section that summarizes main decisions and descriptions of why those decisions were made at the data workshop. Additionally, a separate document that contains information pertaining to final data streams used in the assessment, including the summary of the rationale for the data choices, would be helpful.

While the AT has proposed $SSB_{40\%}$ and $F_{40\%}$ reference points for this stock, which are based on a long history of use in other locations and for similar stocks, 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 a new assessment is conducted. The reference points proposed are based on MSY proxies and management could consider reference points consistent with levels of risk tolerance.

The RP reached agreement on all its recommendations and conclusions and there was no minority report.

1. BACKGROUND

There were five independent reviewers for the Review Workshop for SEDAR-58 Atlantic cobia stock assessment. The reviewers were Jeff Buckel (Chair) and Gary Nelson (ASMFC appointees), and Alistair Dunn, John Casey, and Matt Cieri (CIE).

As a member of the RP, I reviewed the documents from the Data Workshop (DW) and from the Assessment Team (AT), considered the Terms of Reference (TORs), requested additional analyses from the AT, and discussed the conclusions of the assessment with the AT.

A report of the review is detailed below. All the TORs were addressed by the RP, and recommendations made on the assessment.

The Review Workshop consisted of a summary of the data from the Data Workshop (DW) and reports from the Assessment Team (AT). The Review Workshop was held on November 19-21, 2019 in Beaufort, NC. The Atlantic cobia AT provided an assessment report and presentations that were reviewed by the Review Panel (RP). The AT provided presentations on the background of the stock assessment, sensitivities, and projections. Additionally, the RP requested other sensitivities and ensemble runs that were addressed during the review workshop and are described below.

The RP requested additional analyses and runs during the review, and recommended a revised base case for the assessment, using a single selectivity for the head-boat CPUE indices.

1.1 Summary of recommendations

A brief summary of the recommendations is given here. In subsequent sections of this report, recommendations are highlighted in grey.

- The model estimates of population size, status, and trend were consistent with the known and assumed population parameters, and that the model used the best available science and was adequate to support stock biomass and stock status inferences.
- The AT recommended reference points of $F_{40\%}$ as a proxy for F_{MSY} and $SSB_{F40\%}$ as a proxy for SSB_{MSY} were appropriate for this stock. The AT provided model outcomes based on 75% of $F_{40\%}$ as the target reference point as this provided an uncertainty buffer around the B_{MSY} proxy.
- The AT provided estimates of SSB and F for Atlantic Cobia that showed the population had been above $SSB_{F40\%}$ since the beginning of the modelled period (1986) and had trended up over that time from about 1.5 x $SSB_{F40\%}$ to about 2 x $SSB_{F40\%}$. However, in the most recent three years, the biomass had reduced to about 1.5 x $SSB_{F40\%}$ in the terminal year in 2017.
- The stock is not overfished in relation to the reference point recommended by the AT ($SSB_{F40\%}$).
- Overfishing is not occurring in relation to the reference point recommended by the AT ($F_{40\%}$).
- The projections were carried out appropriately using accepted practices given the data available and were appropriate for the assessment model and required outputs.
- The projection results are informative and robust and are useful to support inferences of future stock status and biomass. The key uncertainties were well described and were reflected in projection results.
- Considerable efforts were made by the AW to address uncertainty in assessment model output through sensitivities and using the ensemble modelling approach. For the ensemble modelling, a total of 4000 simulation runs involving bootstrapping of observed input variables (landings, discard, head-boat index estimates, age and length composition data) and fixed variables (natural mortality, discard mortality and recreational landings and discards) using Monte Carlo sampling with the relevant uncertainties.
- Additional sensitivity runs to investigate uncertainty in the input natural mortality at age, maturity at age, and the assumption of two time blocks for selectivity for the head-boat index were conducted at the review meeting. The sensitivity analyses presented in the assessment report are appropriate, informative, and highlight the sensitivity of model output to *M*-at-age. This result was further confirmed by the additional sensitivity runs carried out during the review meeting. The key uncertainties within the assessment model were well described by the AT in the assessment document, with the main uncertainty on the assessment outcomes were the estimates of natural mortality (*M*), and less significant uncertainties in the choice of steepness (h) of the stock-recruit relationship (see later) and the estimated maturation ogive.
- The choice of abundance indices, the rate of natural mortality (i.e., switching the valuer of *M* from Lorenzen (1996) to Charnov et al. (2013)), and the maturity ogive should be given additional explanation and justification.
- Recommend that the distribution and bounds for *M* for the new base ensemble modelling (co23, see SEDAR-58-Addendum) use the values from the Charnov et al. (2013) regression equation when the equation slope and intercept were adjusted using ±2 standard errors.
- The CVs for the commercial discards appeared unrealistically high and it was noted that the values of these CVs should be reviewed in the future.

- Additional research should be conducted for the next assessment to consider evidence for the choice of *h*, for example from meta-analyses or similar approaches to determine plausible values on *h* to evaluate as sensitivities to the base case model.
- Model fits across ages suggested some small evidence of lack of fit, specifically for ages 4–5 (Figure 8), and it is recommended that the AT consider alternative selectivity shapes that may account for this pattern in future assessments.
- There were concerns about the reliability of recreational removals in the 1996 and 2015 years, as recreational catch estimates for these were unusually high when compared with the neighbouring years. These high catches should be investigated further to determine the underlying cause for the increases.
- As the head-boat index was only for a small proportion of the recreational fishery that did not target Cobia and was unlikely to have changed its fishing pattern over that period, it was recommended that the head-boat index be interpreted using the vulnerable abundance from the pre-2007 selectivity pattern. This revised assessment model is recommended as the base case for the assessment for Atlantic Cobia.
- Additional indices of abundance be developed and that preferably, these be fishery independent.
- The SEDAR stock assessment review process would be improved if the Chair of the Data Working Group were to attend the review panel meeting and be available to assist the AT describe decisions relating to the choice of data.
- The DW report may be improved if summaries of descriptions of the reasons for data choices were provided. In the future, a separate document that contained only information pertaining to final data streams used in the assessment, including the summary of the rationale for the data choices, would be helpful. In this case, with additional detail on what has been done, the workshop documents could be consulted. SEDAR should request a document or DW report section that summarizes main decisions and descriptions of why that decision was made at the data workshop.

2. REVIEW ACTIVITIES

2.1 Statements addressing the Terms of Reference (TORs)

2.1.1 Evaluate the data used in the assessment, addressing the following:

- **Are data decisions made by the DW and AW sound and robust?**

Details on data processing were provided through Data Workshop (DW) and Assessment Workshop (AW) reports. The DW and AW groups made considerable efforts to provide the best data for use in the assessment. The primary data sources used in the assessment were commercial landings assembled through ACCSP/State records, commercial dead discards derived from standard live discard/landings ratios and a constant discard mortality rate of 55%, the MRIP harvest and dead releases derived from live releases and a constant release mortality rate of 0.05 y^{-1}, and length and age data collected primarily through state carcass collection programs.

Commercial landings were only a small part of the total removals, comprising of about 5% of the total. The RP noted that the AW had low confidence in robustness of data collected prior to 1986, so only data from 1986–2017 were used in the assessment. The decisions made by the DW and AW during data analysis and assembly were reasonable and sound.

However, the justification for some of the data decisions that may have major influences on the assessment results were not as well described as could be. The choice of abundance indices, the rate of natural mortality (i.e., switching the value of *M* from Lorenzen (1996) to Charnov et al. (2013)), and the maturity ogive should be given additional explanation and justification. In a few cases, there were no descriptions of how data were derived (e.g., state gutted to total weight conversion factors).

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

The major sources of data uncertainty were identified by the AT and the DW, and AT had provided adequate information in the data and assessment reports to judge the quality of the data sources. In addition, the DW and AW had provided parameter error bounds for use in the sensitivity and ensemble model runs.

The major sources of uncertainty in the assessment were:

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*).

Coefficients of variation for the commercial landings, recreational landings and discards, and head-boat index were within ranges considered realistic and adequate for assessment purposes. However, CVs for the commercial discards appeared unrealistically high and it was noted that the values of these CVs should be reviewed in the future. The RP noted that the revised base case (run co23, see SEDAR-58-Addendum) applied a maximum cap on the CV for commercial discards of 3.0 in the ensemble modelling analysis. However, the RP noted that due to the small amount of removals associated with commercial discards, that this revision would not have any significant impact on the ensemble modelling outcomes.

The distribution and bounds on the values of the plausible rates of natural mortality (*M*) used in the ensemble modelling were based on the standard error estimates from Charnov et al. (2013) and were likely to be unrealistically narrow. Hence it is recommended that the distribution and bounds for *M* for the new base ensemble modelling (co23, see SEDAR-58-Addendum) use the values from the Charnov et al. (2013) regression equation when the equation slope and intercept were adjusted using ±2 standard errors. This revision was applied in the final base case assessment model.

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

Based on assessment model diagnostics and output, the time series of removals (i.e., catch and discard mortality estimates), length and age composition data, and the head-boat CPUE index of abundance were used appropriately in the BAM model.

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

The data used in the stock assessment were the best available data, and that the working groups satisfactorily characterized removals from all data sources.

There were concerns about the reliability of recreational removals in the 1996 and 2015 years, as recreational catch estimates for these were unusually high when compared with the neighbouring years. A sensitivity run undertaken by the AT at the review, in which the values were replaced with the mean values from the neighbouring four years, showed these values had little influence on the model results. However, these high catches should be investigated further to determine the underlying cause for the increases.

The age composition data appeared sufficient and reliable because several cohorts could be tracked through the data over time.

Only a single index of abundance was available for this assessment (the head-boat CPUE index), and due to recent management closures of the recreational fishery, this index was not available for years since 2015. If there were future closures, then this index of abundance will not be available in future years. Currently, there are no other suitable indices of abundance available.

Additional indices of abundance should be developed and preferably, these should be fishery independent. Potential indices of abundance could include those derived from spatial/temporal analyses of catch and effort data (i.e., using gaussian random fields as, for example, implemented in VAST (Thorson 2019)) to see if they could provide a means to develop an index of abundance using the recreational catch and effort data; and investigation of the baited trap-camera time series (SERFS) that has been carried out in the region to provide an index of abundance.

2.1.2 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 Beaufort Assessment Model (BAM) (Williams & Shertzer 2015) was the primary assessment model, which was implemented with AD-Model Builder software. This model estimated biomass and selectivity parameters using assumed catches and productivity parameters. The estimates were obtained by minimizing an objective function consisting of likelihoods applied to CPUE, age composition data, and length composition data, along with uniform priors on estimated parameters with exception of those that had an assumed functional form. Other commonly applied statistical catch-at-age models are SCAA and SS3. BAM has previously been used in SEDAR assessments, and has been simulation tested. The version of BAM was set up to match the data availability of Atlantic Cobia.

The AT demonstrated they were familiar with the modelling software and were competent in its application. The model was documented in the assessment report (SEDAR-58-addendum) and the AD-Model Builder code was supplied as an appendix to the assessment report. The model was scientifically sound, robust, and appropriate for the available data.

The review considered the base case run (co22), revised base case run (co23, see SEDAR-58-addendum), model diagnostics, model sensitivities, analyses to investigate uncertainties, ensemble models, projections, and some supplementary analyses.

Model observations were a CPUE index from recreational catch and effort for head-boats, comprising of about 5% of the total catch from recreational fishers, age composition data obtained from carcass samples of recreational landings, and length composition data for commercial landings. The head-boat CPUE indices suggested a slight increase in abundance over the time period of the index (1991–2015).

Estimates of removals (landings and discards) were via two fleets: the commercial fleet (comprising of a minority of removals) and the recreational fleet. The model estimated the removals with a very low CV to resolve the Baranov catch equation and not to model the uncertainty in the removals. Estimated removals from the model were almost identical to the observed removals (Figure 1**Error! Reference source not found.**), as would be expected using this approach.

Commercial catch was modelled with a selectivity fitted to the commercial length frequency compositions. The length composition data were an aggregate over the years due to the low annual sample sizes. There were no age data for the commercial catch but given the low level of commercial catch (about 5% of total catch), the use of length composition data was likely adequate for determining the selectivity pattern for the commercial fleet in the assessment model.

Recreational catch was fitted using two selectivity patterns – the first for years between 1986 and 2006, and the second for years since 2007. The head-boat index was initially modelled as the vulnerable abundance using the initial period recreational selectivity for the period up to 2006, and the later period selectivity for the period from 2007. However, as the head-boat index was only for a small proportion of the recreational fishery that did not target Cobia and was unlikely to have changed its fishing pattern over that period, it was recommended that the head-boat index be interpreted using the vulnerable abundance from the pre-2007 selectivity pattern. This revised assessment model is recommended as the base case for the assessment for Atlantic Cobia.

The model convergence for the non-revised base model was good with analyses of the alternative starting values showing no evidence of failure to converge.

While the model was sensitive to the choice of M, the Charnov et al. (2013) approach was supported from both external sources as well and internal diagnostics when compared to lower Lorenzen (1996) estimates. Use of M lower than the current approach resulted in inferior model diagnostics. However, an examination of M should be carried out for future assessments. For this investigation, the 2015 SEDAR data best practices document provides some guidance.

Recruitment was highly variable with no clear stock-recruitment relationship. As such, the use of mean recruitment with deviations was appropriate.

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

The model was configured appropriately and applied consistently with accepted scientific practices after recommended changes were made to the initial base model.

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 appeared appropriate. Changes in management measures and an increase in the VA catch likely increased the targeting of smaller fish since 2007. This change is reflected in the estimated selectivities.

Diagnostics suggested that the model starting year of 1986 was appropriate. 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 wasn't a clear difference when revising the start year back to the SEDAR-28 value of 1950.

The base model case model should have only one selectivity (the 1986–2006 recreational selectivity estimate) to fit the head boat fishery dependent index of abundance. This resulted in a new base case run. When compared to the base run as recommended by the AT, the revised base case had some slight differences in the diagnostics of model fit, but the changes were minor. Further, the revised base case model typically had a lower negative log likelihood for the age composition fits in the most recent years (Table 1).

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

Given that most of the data are 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. Other potential approaches are less likely to be successful given the importance of compositional age data and the lack of a current index of abundance — noting that the head-boat CPUE index of abundance time series ended two years prior to terminal year.

As such, the use of the age data in the assessment seems appropriate and was applied using acceptable methods, especially after moving to the revised base case.

Table 1: Yearly negative log likelihoods for age-composition fits from three runs examining selectivity: co22 (old base case), sens14a (2 time blocks for selectivity with first time block applied to head-boat index of abundance), and sens15 (1 time block for selectivity). Sens14a is the new base case but with likelihood weight on head-boat index from old base case.

	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

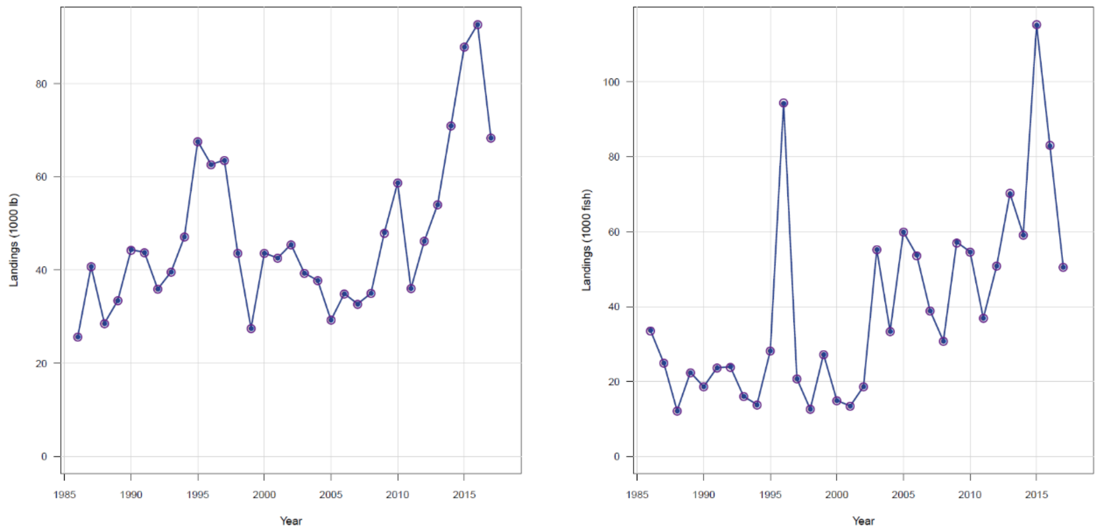


Figure 1: Comparison of estimates versus observed removals for (left) the commercial removals, and (right) the recreational removals. Open circles indicate observed removals and closed circles the estimated removals from the model.

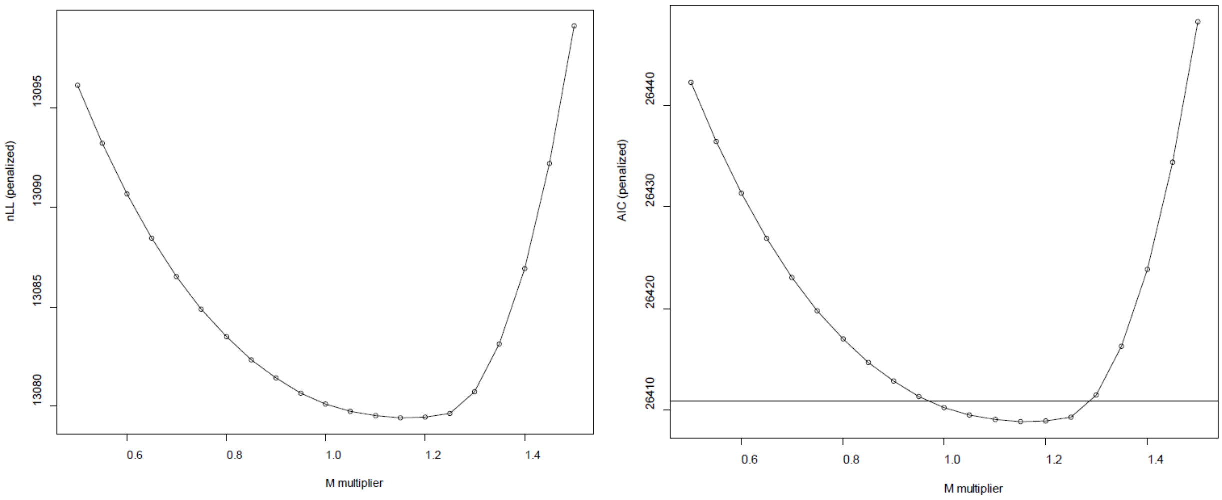
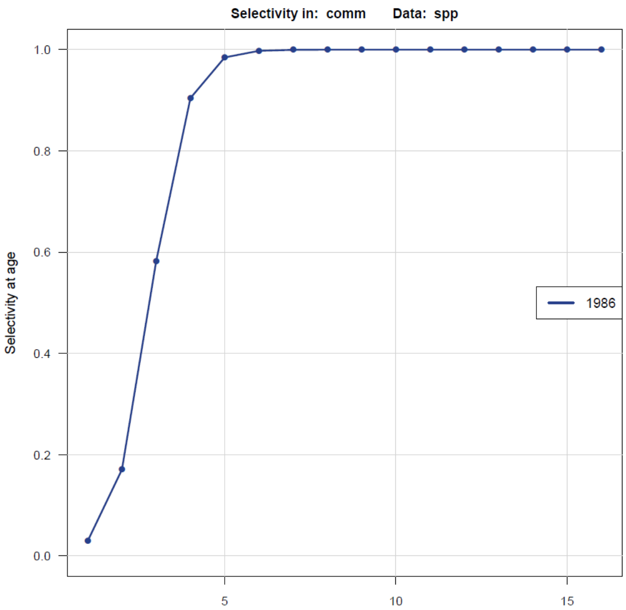


Figure 2: Negative Log likelihood and AIC at various values of natural mortality, shown as a multiplier on the value of M



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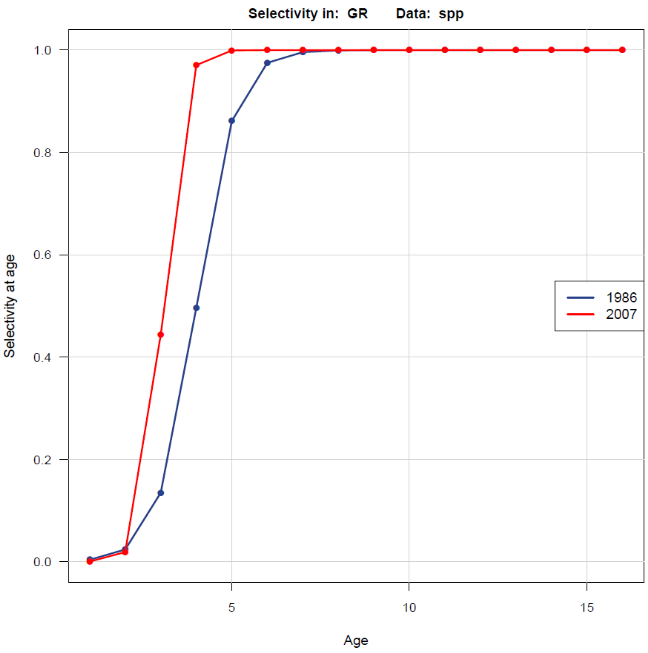

Figure 3: Selectivity curve for the commercial (top) and recreational fishery (bottom). Note that two time blocks on fishery selectivity are used 1986-2006 (blue) and 2007-2017 (red).

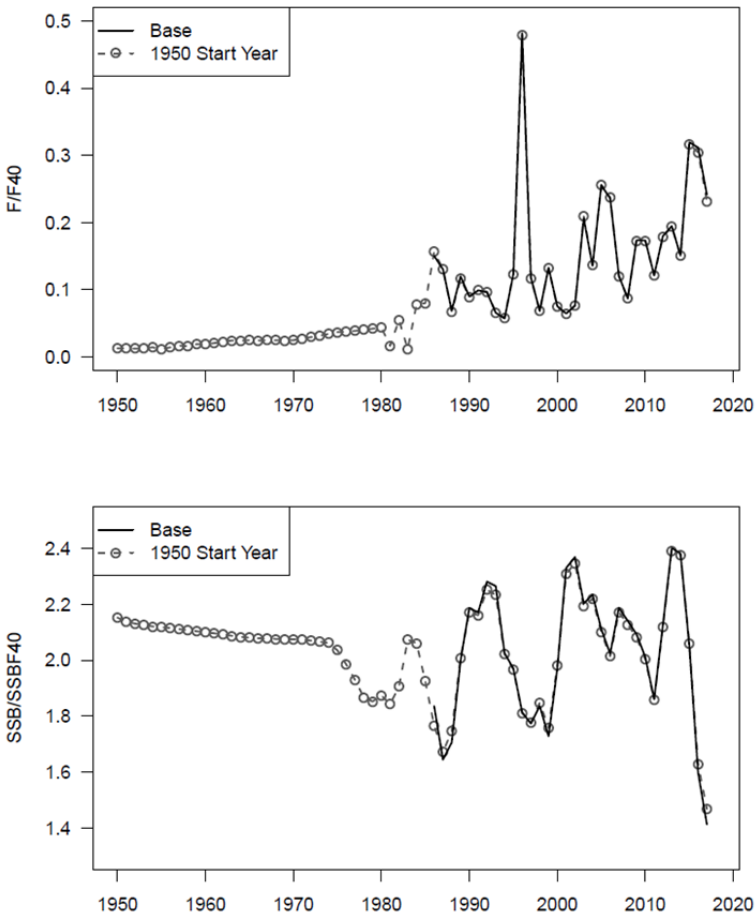

Figure 4: Start year value sensitivity. ratio of F to F40% (top), ratio of SSB to SSBF40% (bottom)

2.1.3 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?**

The modelled population estimates (e.g., abundance, exploitation, and biomass estimates) were reliable given the assessment assumptions and observations.

The AT recommended reference points of $F_{40\%}$ as a proxy for F_{MSY} and $SSB_{F40\%}$ as a proxy for SSB_{MSY} were appropriate for this stock. The AT provided model outcomes based on 75% of $F_{40\%}$ as the target reference point as this provided an uncertainty buffer around the B_{MSY} proxy.

The AT provided estimates of SSB and F for Atlantic Cobia showed that the population had been above $SSBF_{40\%}$ since the beginning of the modelled period (1986) and had trended up over that time from about 1.5 x $SSB_{F40\%}$ to about 2 x $SSB_{F40\%}$. However, in the most recent three years the biomass had reduced to about 1.5 x $SSB_{F40\%}$ in the terminal year 2017 (Figure 5 and Figure 6).

The biomass estimates were consistent with the head-boat index with no evidence of departure from the assumptions of constant variance or trend in residuals (Figure 6).

Model fits to the recreational catch age composition data were adequate over the time period where these data were available and there was no evidence of systematic trend in the annual age composition fits (Figure 7). Model fits across ages suggested some small evidence of lack of fit, specifically for ages 4-5 (Figure 8), and it is recommended that the AT consider alternative selectivity shapes that may account for this pattern in future assessments.

There was only a single index of abundance for this fishery (the head-boat CPUE index), and due to recent management closures of the recreational fishery, this index was not available for years since 2015. If there were to be future closures, then this index of abundance will not be available in future years. Currently, there are no other suitable indices of abundance available. Additional indices of abundance should be developed and, preferably, these be fishery independent.

The 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.

The key uncertainties within the assessment model were well described by the AT in the assessment document, with the main uncertainty on the assessment outcomes from the estimates of natural mortality (*M*), and less significant uncertainties in the choice of steepness (*h*) of the stock-recruit relationship (see later) and the estimated maturation ogive.

Estimates of *M* were age-dependent, based on the life-history invariant assumptions using the regressions in Charnov et al. (2013). Ensemble model bootstraps used estimates of *M* based on 2x the standard error of the *M* around the regression line for the estimated mean size of Cobia at age. While the estimates of *M* were very uncertain within the assessment model, the outcomes of the assessment showed that the stock was highly unlikely to be below the $SSB_{F40\%}$ reference point.

The RP noted that the estimates of the maturation ogive in the model were uncertain but noted that a sensitivity that used a slightly right-shifted ogive showed that the model outcomes were relatively insensitive to the choice of the maturity ogive.

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

The reference points were not provided by the current management body to determine stock status. However, $SSBF_{40\%}$ was recommended as a reference point by the assessment panel. SSBF40% is commonly used in this region and globally as an appropriate management reference point.

The results of the assessment model showed that the stock was highly unlikely to be below the $SSBF_{40\%}$ reference point for the period 2015 to 2017 (i.e., the terminal years of the model) (Figure 10). The assessment model stock projections (see later) also showed that it was highly unlikely that the stock was below the $SSBF_{40\%}$ reference point in the most recent years (2017—2019).

The stock is not overfished in relation to the reference point recommended by the assessment panel ($SSB_{F40\%}$).

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

The reference points were not provided by the current management body to determine stock status. $F_{40\%}$ was recommended from the assessment panel. $F_{40\%}$ is commonly used in this region and globally as an appropriate management reference point.

The assessment model showed that it was highly unlikely that fishing on the stock was above $F_{40\%}$ reference point for the period 2015 to 2017 (i.e., the terminal years of the model) (Figure 10). The assessment model stock projections (see later) also showed that it was highly unlikely that fishing on the stock was above $F_{40\%}$ reference point in the most recent years (2017–2019).

Overfishing is not occurring in relation to the reference point recommended by the assessment panel ($F_{40\%}$).

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

The revised base case assessment model (run co23) and all sensitivities assumed a steepness of h=1 (i.e., no relationship between spawning stock abundance and the mean number of recruits). There was no available information to support estimation of the value of h in the model, as stock size had remained high over the modelled period. Further, given the stock status, the choice of h was unlikely to affect the stock status estimates in the model nor the projections given the current and historical stock status. However, the choice of steepness would affect the value of the target reference points and hence the stock status relative to the targets.

Additional research should be conducted for the next assessment to consider evidence for the choice of h, for example from meta-analyses or similar approaches to determine plausible values on h to evaluate as sensitivities to the base case model.

- **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?**

The quantitative estimates of the status determination criteria for this stock were appropriate for management, but there were no defined and approved management targets or thresholds by the current management body. However, the AT used a proposed reference point of 75% $SSB_{F40\%}$ and $F_{40\%}$, and that $SSB_{F40\%}$ and $F_{40\%}$ were appropriate choices as proxies for B_{MSY} and MSY, with 75% $SSB_{F40\%}$ and $F_{40\%}$ were likely to be appropriate proxies for management targets.

Additional work by the AT on catch curve analyses (using regression estimators, Chapman-Robson estimators, and Poisson regression estimators) showed a similar pattern of a slight increase in total mortality Z (i.e., $F + M$) over time with values that were consistent with the assessment modelling results (Figure 11).

There were no other status indicators considered that may be appropriate to inform managers.

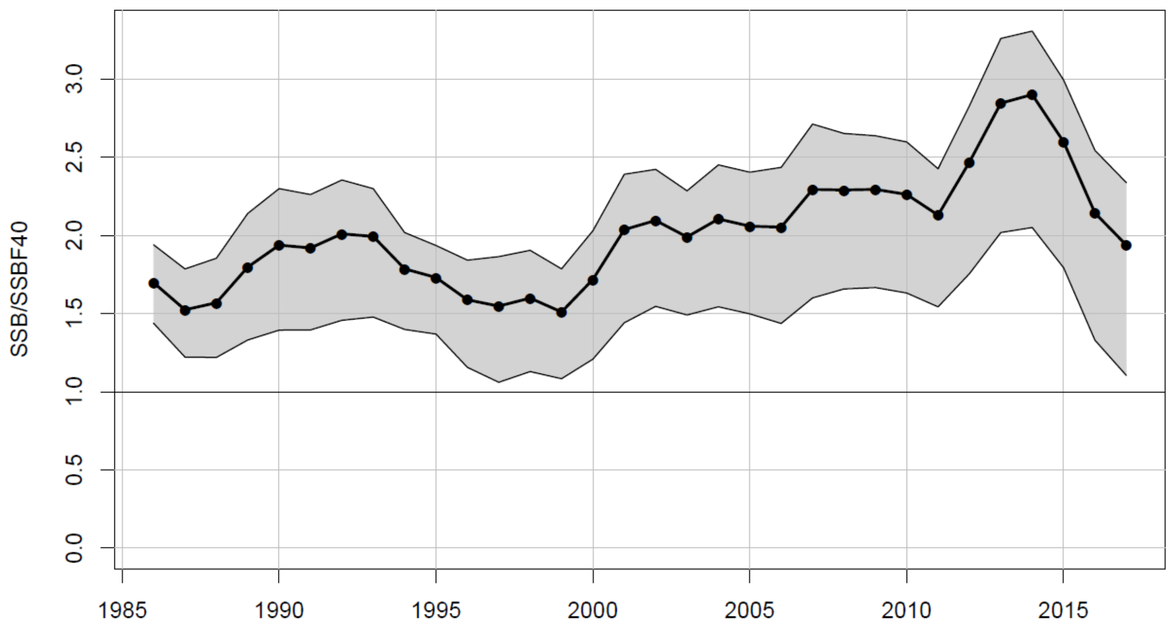

Figure 5: The 95% range for the estimates of SSB/SSBF40 from the ensemble models (grey shaded region) with the revised base case (co23, solid line) for the assessment model for 1986-2017.

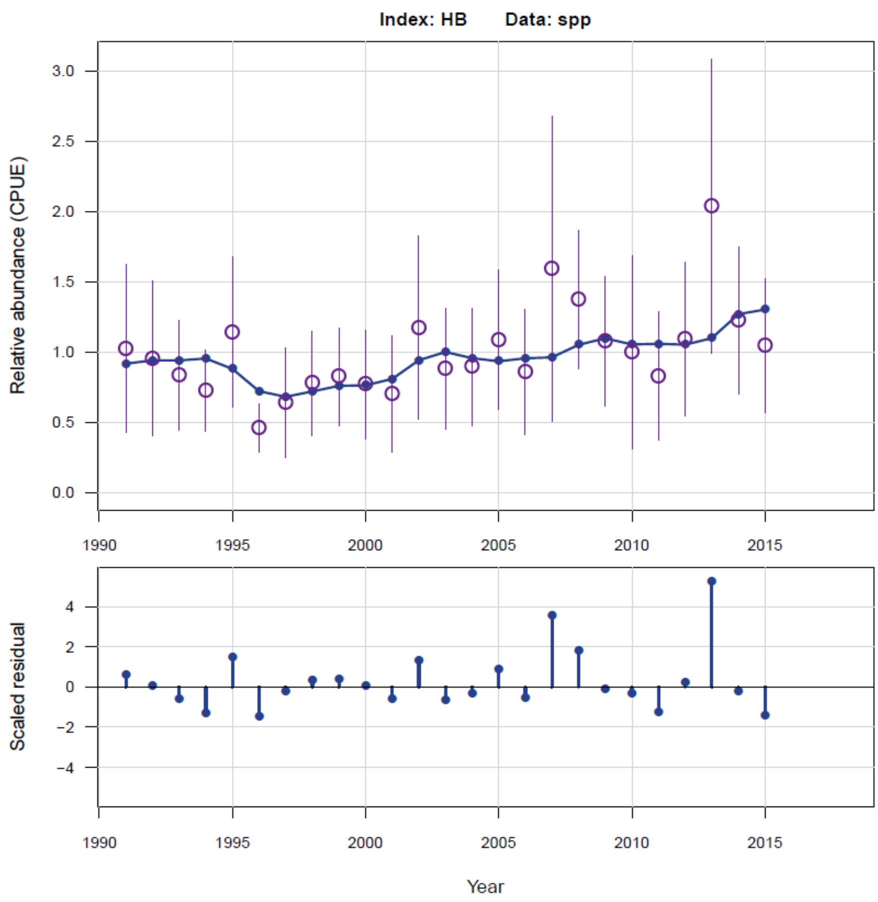

Figure 6: Revised base case model (co23) fits (top) and residuals (bottom) to the head-boat CPUE index of abundance for 1991-2015.

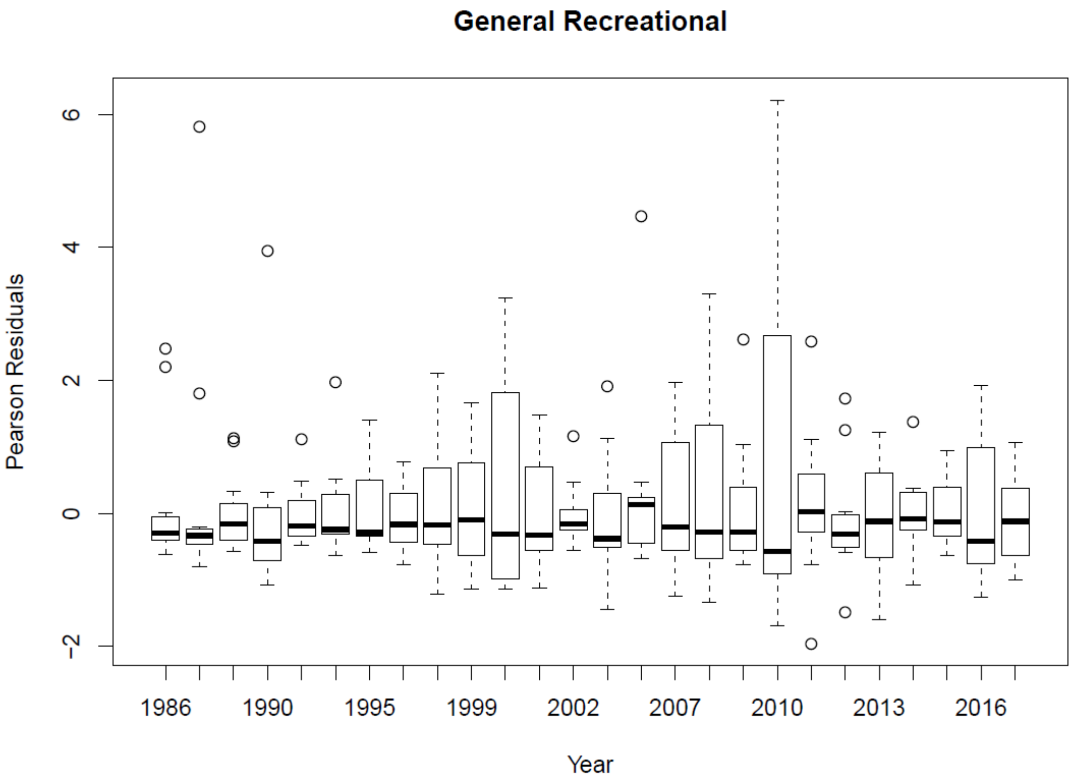

Figure 7: Pearson residuals for the age composition fits for years 1986-2017 for the revised base case model (co23).

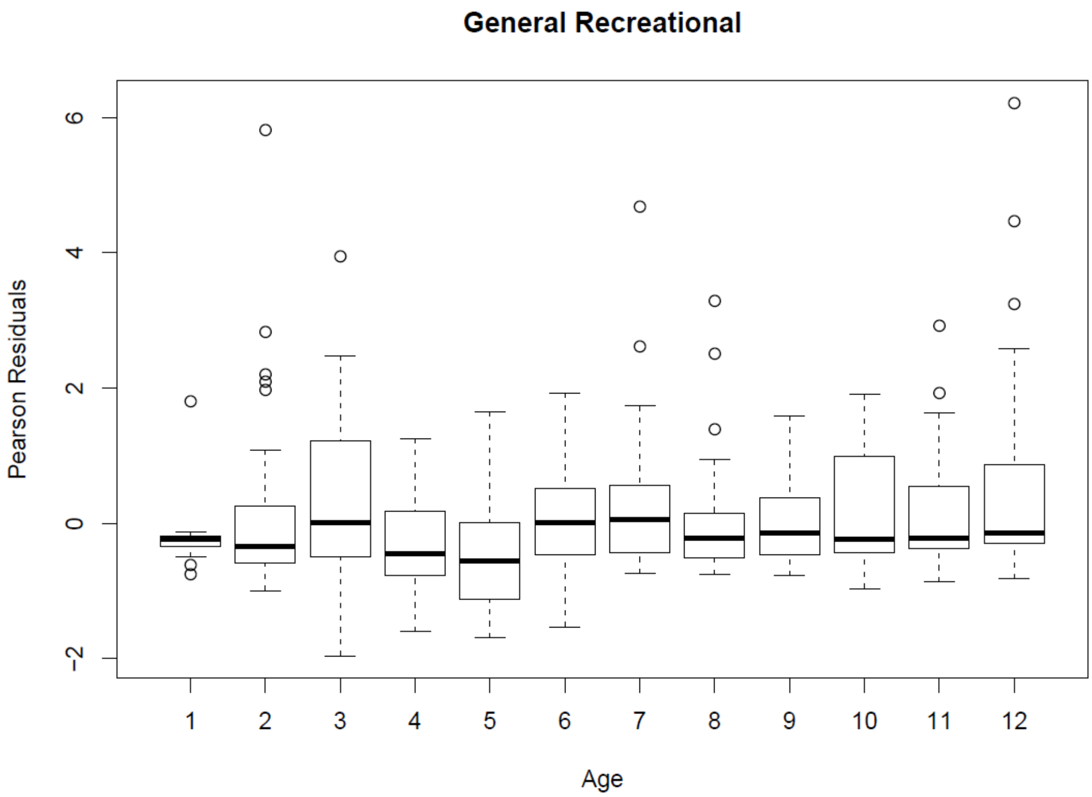

Figure 8: Pearson residuals for the age composition fits for ages 1-12 over the years 1986-2017 for the revised base case model (co23).

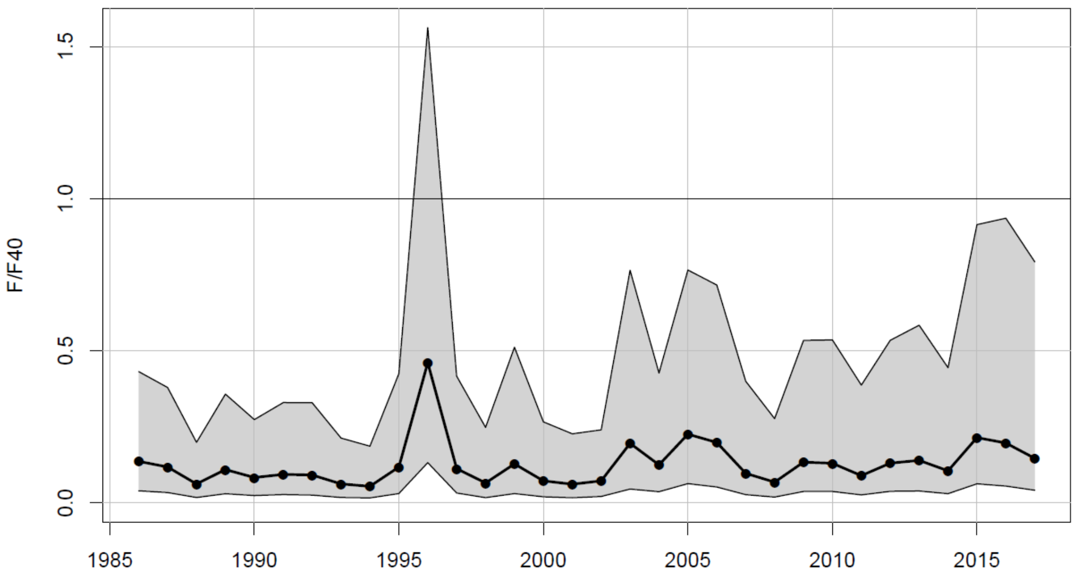

Figure 9: The 95% range for the estimates of F/F40 from the ensemble models (grey shaded region) with the revised base case (co23, solid line) for the assessment model for 1986-2017.

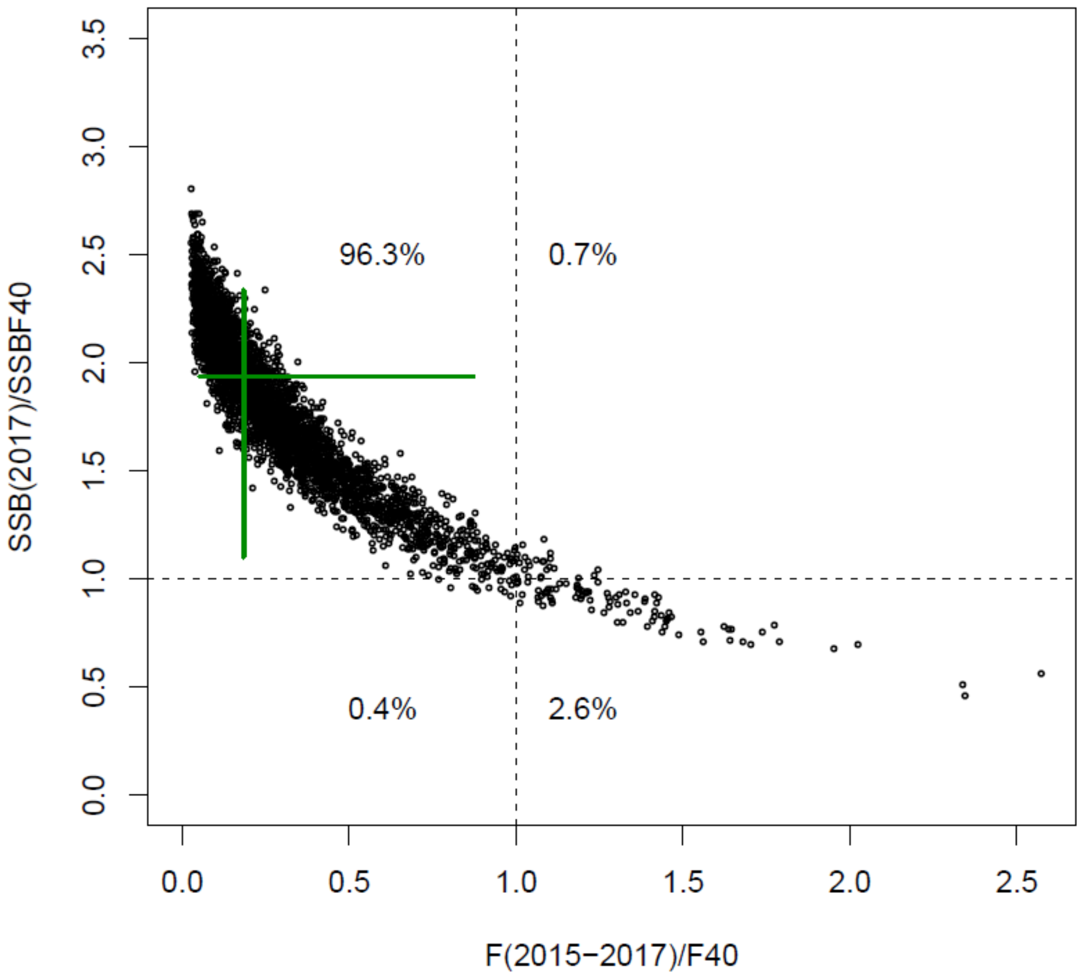

Figure 10: Ensemble model estimates of SSB(2017)/SSBF40 versus F(2015-2017)/F40 showing the proportion of ensemble model runs above and below the potential over-fishing and overfished reference points for Atlantic Cobia from the revised base case model (co23).

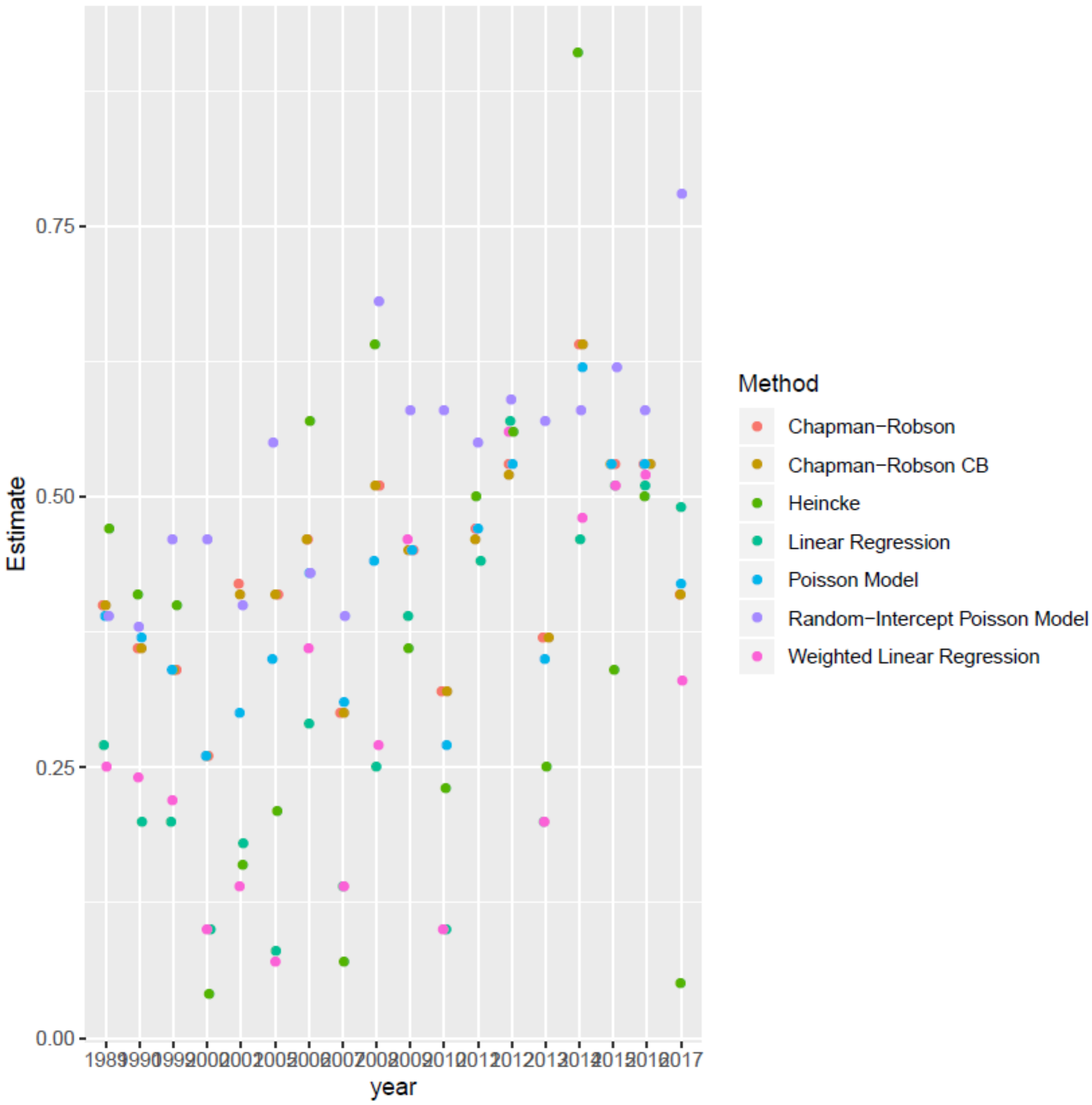

Figure 11: Catch curve estimates for 1989-2017 using regression Chapman-Robson, and Poisson regression estimators for Atlantic Cobia.

2.1.4 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?**

The projections were carried out appropriately using accepted practices given the data available and were appropriate for the assessment model and required 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:

1. Scenario 1: $F = F_{current}$, (where F current is computed as the geometric mean $F_{2015\text{-}2017}$)
2. Scenario 2: $F = F_{40\%}$,
3. Scenario 3: $F = 75\%\ F_{40\%}$,

Because the assessment period ended in 2017, the projections required an initialisation period (2018 and 2019) for which it was assumed that total removals in weight were the mean removals in weight observed for the years 2015-2017. Given this mean removal in weight, the projection code determined the removal in numbers for 2018 and 2019 based on population attributes using the same equations used in the base model. Thus, there is a slight increase in the number of removals in 2019 relative to 2018 because the age- and size-structure of the population differed between the two years. For each scenario, deterministic and stochastic projections were performed.

Population numbers at ages 2 and older in 2018 were derived from the assessment base run. For deterministic projections the numbers at age 1 was the arithmetic mean recruitment. For stochastic projections the age 1 recruits were drawn from the lognormal distribution of recruitment values.

- **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?**

The projection results are informative and robust and are useful to support inferences of future stock status and biomass. The key uncertainties were well described and were reflected in projection results.

Results of projections are given in Figure 12-Figure 14.

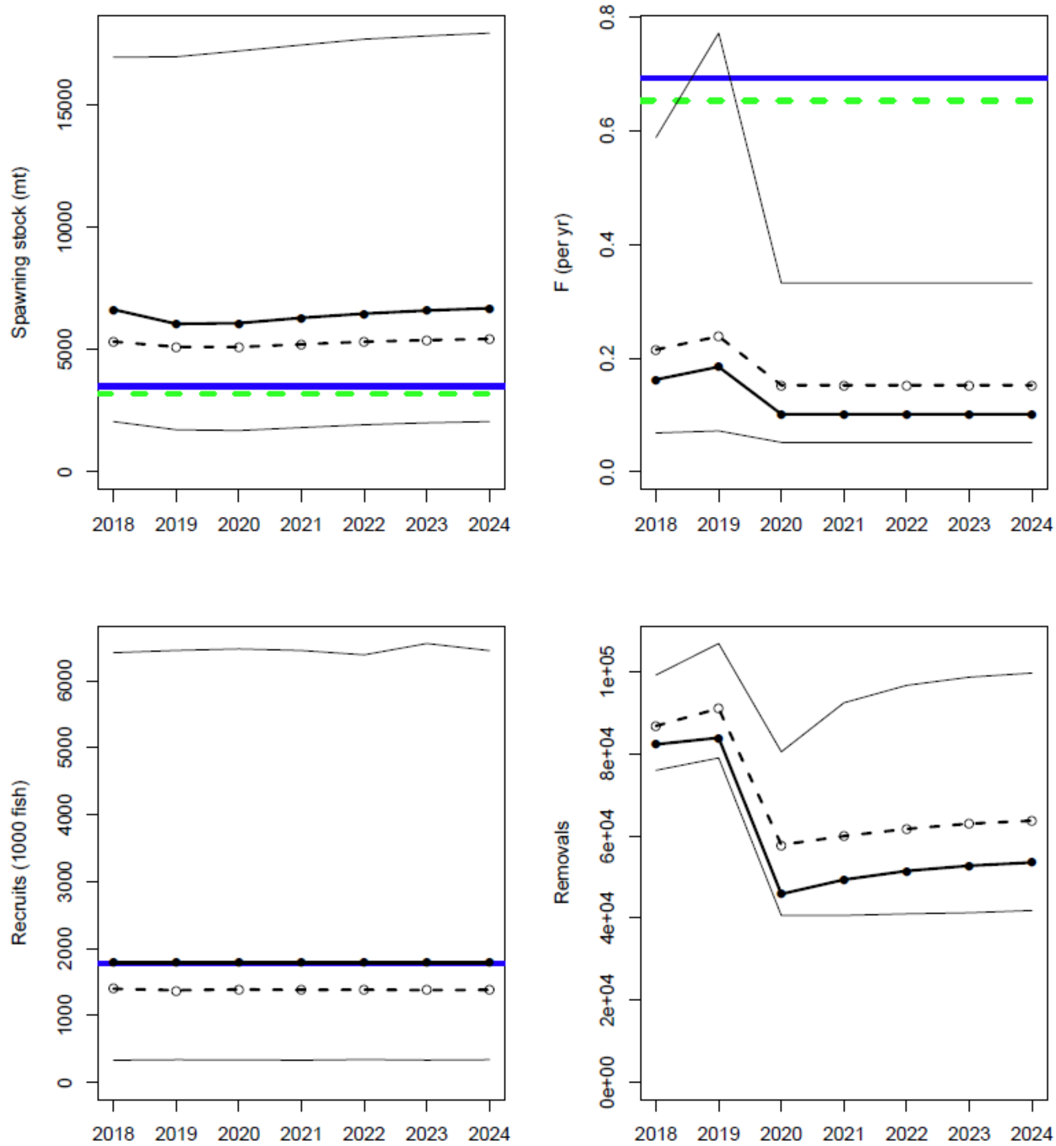

Figure 12: Results of projections for Scenario 1. Solid black line = deterministic projection; dashes black line = median of stochastic simulations; thin black lines = lower (5%) and upper (95%) confidence intervals; green and blue horizontal lines = stochastic and deterministic reference levels respectively.

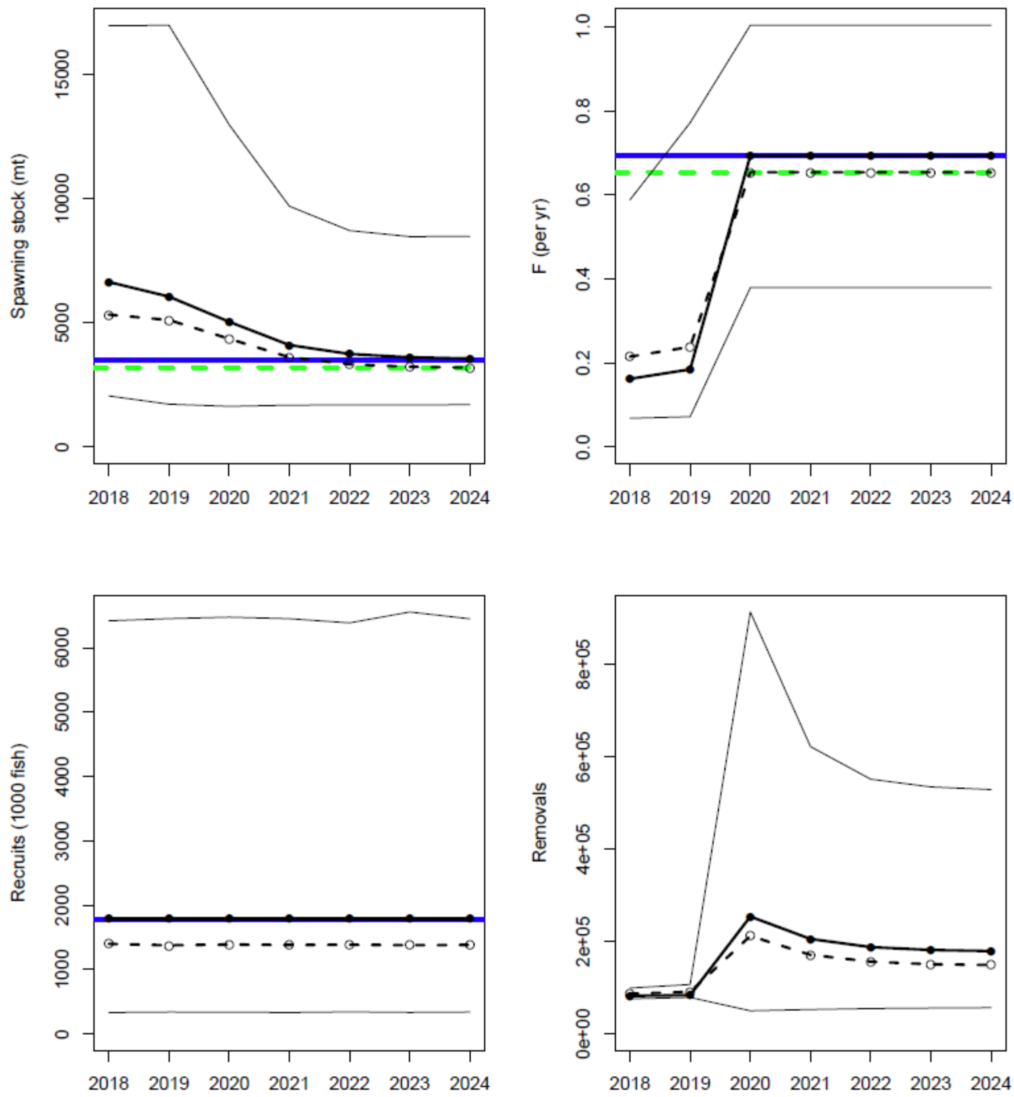

Figure 13: Results of projections for Scenario 2. Solid black line = deterministic projection; dashes black line = median of stochastic simulations; thin black lines = lower (5%) and upper (95%) confidence intervals; green and blue horizontal lines = stochastic and deterministic reference levels respectively.

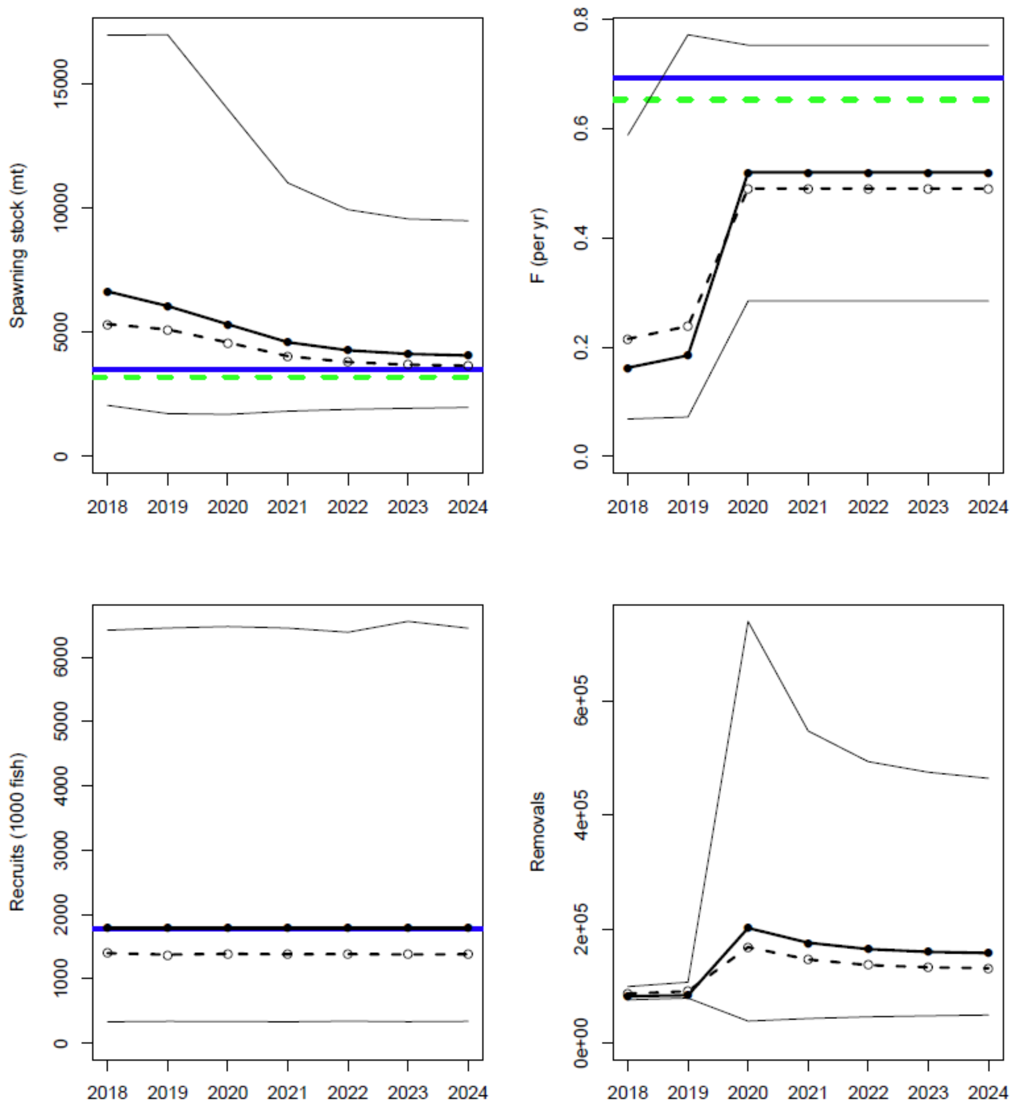

Figure 14: Results of projections for Scenario 3. Solid black line = deterministic projection; dashes black line = median of stochastic simulations; thin black lines = lower (5%) and upper (95%) confidence intervals; green and blue horizontal lines = stochastic and deterministic reference levels respectively.

The apparent increase in removals in numbers from 2018–2019 arose from the conversion of the fixed weight for these two years into numbers.

Results of deterministic and median estimates from stochastic projections were broadly similar although the 95% confidence intervals on stochastic estimates were relatively large indicating the uncertainty associated with the projection results. Such uncertainty was primarily driven by future recruit estimates being drawn from the historical variation about the mean recruitment because of an absence of a meaningful stock/recruit relationship. Nevertheless, examination of the proportion of stochastic projections runs where SSB falls below the $SSB_{F40\%}$ reference point indicated that,

1. If $F=F_{current}$, the probability of the SSB falling below the biomass corresponding to $SSB_{F40\%}$ between 2020 and 2024 was less than 12%.
2. If $F=75\%F_{40\%}$, the probability of the SSB falling below the biomass corresponding to $SSB_{F40\%}$ between 2020 and 2014 was less than 3.5%.
3. If $F = F_{40\%}$, the probability of the SSB falling below the biomass corresponding to $SSB_{F40\%}$ tended to 50% by 2024.

*Table 18. Projection results with fishing mortality rate fixed at $F = F_{\text{current}}$ starting in 2020. R = number of age-1 recruits (in 1000s), F = fishing mortality rate (per year), S = spawning stock (mt), L = landings expressed in numbers (n, in 1000s) or whole weight (w, in 1000*lb*). The extension* b *indicates expected values (deterministic) from the base run; the extension* med *indicates median values from the stochastic projections.*

Year	R.b	R.med	F.b	F.med	S.b(mt)	S.med(mt)	L.b(n)	L.med(n)	L.b(w)	L.med(w)
2018	1796	1399	0.16	0.22	6647	5333	82	87	2820	2908
2019	1796	1377	0.19	0.24	6060	5117	84	91	2820	2908
2020	1796	1389	0.10	0.15	6089	5112	46	58	1479	1817
2021	1796	1382	0.10	0.15	6306	5225	49	60	1553	1857
2022	1796	1385	0.10	0.15	6478	5327	51	62	1612	1905
2023	1796	1380	0.10	0.15	6606	5394	53	63	1653	1944
2024	1796	1383	0.10	0.15	6697	5443	54	64	1683	1967

Table 19. Projection results with fishing mortality rate fixed at $F = f_{40\%}$ starting in 2020. R = number of age-1 recruits (in 1000s), F = fishing mortality rate (per year), S = spawning stock (mt), L = landings expressed in numbers (n, in 1000s) or whole weight (w, in 1000 lb*). The extension* b *indicates expected values (deterministic) from the base run; the extension* med *indicates median values from the stochastic projections.*

Year	R.b	R.med	F.b	F.med	S.b(mt)	S.med(mt)	L.b(n)	L.med(n)	L.b(w)	L.med(w)
2018	1796	1399	0.16	0.22	6647	5333	82	87	2820	2908
2019	1796	1377	0.19	0.24	6060	5117	84	91	2820	2908
2020	1796	1389	0.69	0.65	5046	4361	254	212	8041	6507
2021	1796	1382	0.69	0.65	4109	3618	205	171	5945	4980
2022	1796	1385	0.69	0.65	3751	3338	188	156	5141	4315
2023	1796	1380	0.69	0.65	3616	3234	181	151	4836	4082
2024	1796	1383	0.69	0.65	3566	3201	179	149	4722	3981

Table 20. Projection results with fishing mortality rate fixed at $F = 75\% F_{40\%}$ starting in 2020. R = number of age-1 recruits (in 1000s), F = fishing mortality rate (per year), S = spawning stock (mt), L = landings and Discards combined expressed in numbers (n, in 1000s) or whole weight (w, in 1000 lb*). The extension* b *indicates expected values (deterministic) from the base run; the extension* med *indicates median values from the stochastic projections.*

Year	R.b	R.med	F.b	F.med	S.b(mt)	S.med(mt)	L.b(n)	L.med(n)	L.b(w)	L.med(w)
2018	1796	1399	0.16	0.22	6647	5333	82	87	2820	2908
2019	1796	1377	0.19	0.24	6060	5117	84	91	2820	2908
2020	1796	1389	0.52	0.49	5326	4591	202	168	6426	5188
2021	1796	1382	0.52	0.49	4602	4041	176	147	5222	4341
2022	1796	1385	0.52	0.49	4277	3804	165	137	4680	3921
2023	1796	1380	0.52	0.49	4132	3697	160	133	4437	3739
2024	1796	1383	0.52	0.49	4069	3656	158	131	4329	3659

Table 2: Proportion of stochastic projections where $SSB<SSB_{F40\%}$.

	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

2.1.5 Consider how uncertainties in the assessment, and their potential consequences, are addressed.

Considerable efforts were made by the AW to address uncertainty in assessment model output through sensitivities and using the ensemble modelling approach. The ensemble modelling was based on a total of 4000 simulation runs involving bootstrapping of observed input variables (landings, discard, head-boat index estimates, age and length composition data) and fixed variables (natural mortality, discard mortality and recreational landings and discards) using Monte Carlo sampling with the relevant uncertainties.

Sensitivity runs were performed to investigate responses in model output to changes in inputs and to investigate model behaviour. Ten alternative sensitivity runs were initially presented. Most of the model runs had a similar status as the base run presented in the assessment report. The sensitivity and ensemble analyses showed that the results were most sensitive to the choice of natural mortality (*M*). While uncertainty in the value of *M* did not significantly impact the status of the stock with regard to reference points, the choice of *M* is important as the stock status will be sensitive to its value.

Additional sensitivity runs to investigate uncertainty in the input natural mortality at age, maturity at age, and the assumption of two time blocks for selectivity for the head-boat index were conducted at the review meeting. The sensitivity analyses presented in the assessment report are appropriate, informative, and highlight the sensitivity of model output to *M* at age. This result was further confirmed by the additional sensitivity runs carried out during the review meeting.

Figure 10 summarizes the results of ensemble runs with respect to the reference points for *F* and SSB. 97% of ensemble runs indicate that the stock of Atlantic cobia is not overfished with respect to the proxy reference point for B_{MSY} ($SSB_{F40\%}$) and 96.7% indicate that with respect to the F_{MSY} proxy ($F_{40\%}$) that overfishing is not taking place (Figure 10). The small percentage of runs that indicated overfished or overfishing occurred when natural mortality was assumed to be at the very low end of its plausible range.

2.1.6 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.**

The list of research recommendations made by the DW and AW groups were reviewed. The following DW and AW research recommendations should be given high priority because of the importance to the stock assessment model:

1. Because the fishery-dependent index ended in 2015, 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 sample size (such as expanding carcass collection locations and establishing similar programs in other states) should be implemented. In addition, 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.**

The SEDAR stock assessment review process would be improved if the Chair of the Data Working Group were to attend the review panel meeting and be available to assist the AT describe decisions relating to the choice of data.

The DW report may be improved if summaries of descriptions of the reasons for data choices were provided. In the future, a separate document that contained only information pertaining to final data streams used in the assessment, including the summary of the rationale for the data choices, would be helpful. In this case, where additional detail is needed on what has been done, then the workshop documents could be consulted. SEDAR should request a document or DW report section that summarizes main decisions and provides descriptions of why each decision was made at the data workshop.

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

While the AT has suggested $SSB_{F40\%}$ and $F_{40\%}$ reference points for this stock, based on a long history of use in other locations and for similar stocks, 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 a new assessment is being conducted. The reference points proposed are based on MSY proxies and management could consider reference points consistent with levels of risk tolerance.

During the review, it was noted that there are some inconsistencies with regards to recreational landings; most notably the 1996 and 2015 catch. Further examination by the AT during the workshop provided no clear answers as to whether this was the result of the MRIP calibration or the result of other changes in the recreational catch stream. Prior to the next assessment, a full description of landings changes from SEDAR-28 through SEDAR-58 should be conducted. This examination should be in time for the next benchmark.

Work on an appropriate fishery-dependent or independent abundance index should be a priority. The current head-boat index as formulated through 2015 may not be useful after SEDAR-58. Additionally, 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.

The assessment method used, and thus stock status, is highly sensitive to assumptions of M. As such, a full suite of potential values of M, either based on life history or other approaches, should be investigated and fully documented in future assessments.

Given the recent break in the head-boat index an additional three years of 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.

Bridging analyses that described model changes and the consequential changes in stock status estimates between assessments would be valuable to allow future reviews to identify those components of the analysis that resulted in changes in stock status between assessments.

Uncertainty in the maturity ogive should be included in future ensemble modelling.

2.1.8 Summary results of analytical requests (sensitivities, corrections, additional analyses etc.,)

The review panel for SEDAR-58 made several requests for additional graphs and tables of input data, additional model sensitivity and ensemble runs, and modified projections during the workshop. The requests are listed below along with summaries when appropriate. The AT fulfilled these requests during the workshop and the results were instrumental in reaching the conclusions summarised in this report.

2.2 List of requests for AT

2.2.1 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 as the revised base case model.
3. Examine PSEs for recreational landings and discards; captured in ensemble models).
4. Provide a raw time series of $F_{40\%}$ and $SSB_{40\%}$ (instead of those values relative to benchmarks). The RP agreed that R_0 values provide the scaling differences between the various sensitivity runs and met the request.
5. Provide the CVs of the head-boat index. The AT provided these as pre- and post-weighted values (and they are 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 the RP and AT that this should be the base case run. Further details are provided in the RP report sections addressing the TORs.
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 R_0 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 the 1996 spike in estimated recreational catch if it was a result of the 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).
14. Provide the proportion of total catch that was head-boat catch. It was less than about 1% in most years, with the highest in any one year of about 3%.
15. Describe the numbers of vessels and locations that made up the head-boat index. The vessels and locations are in Table 4.11.3 in the DW report; the number of cobia are in Table 4.11.15 in the DW report; All modes are in Table 4.11.19 in the DW report; Year and state level summaries are in Table 4.11.20 in the DW report; and the head-boat index values are in Table 5.3 in the DW report.
16. Update the ensemble models with revised base case.
17. Cap the commercial discard CV at 3.0 for the ensemble modelling.
18. Show the values of the observation and prior likelihood components for the revised base case and the old base case (i.e., for the choice of one vs two selectivity blocks to fit the head-boat index).

2.2.2 Projection comments and requests

1. Describe the assumption of current landings for first two years relative to constant F; any means to determine which is best. Given closures then current landings is justification for landings. 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 $F_{40\%}$ 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.

2.3 Additional comments (if necessary, to address issues or discussions not encompassed above)

No additional comments were made by the RP.

2.4 Submitted Comment

The following statements were submitted to the review as comments.
Comments from Bill Gorman (1 of 2):

Hello, I would like to start out by expressing my disappointment in being unable to attend the review workshop due to illness. I have spent a long time waiting for this processes and truly enjoyed being a part of the stock ID workshop. Being an observer at the stock ID workshop I must voice my objection to parts of the summary documents. For example in the genetics work groups they concluded that "the current stock boundary or one that came as a result of SEDAR28 could not be refuted." When reviewing the rational for the current stock boundary, that ultimately being "...for ease of management, and there was no tagging or life history to dispute.." However, it goes on to clearly disclose that genetic did not "prove" nor narrow down the area in that location of the FL/GA boarder. I contend that the current stock ID CAN be refuted with new tagging from VA, both Atags and Sat tags both have fish going into NEFL with a 3rd making it's was prior to a premature release in South GA. Two different studies, both with yes limited samples, but if it were such a small fraction to went and wintered off NEFL than two studies with extremely small samples shouldn't have captured these fish in back to back years. That is BEST AVAILABLE SCIENCE, you cannot tell me nor will anyone accept that these tagged fish are merely "strayers" and are to be overlooked and labeled "it's low sample size" when two UNSEEN fish can account for over 400,000lb of catch, resulting to federal waters being closed the following year and further restricting citizens access to their public resource. This migration pattern is also consistent with Spanish. The NEFL area accounts for the largest area of commercial catch and up to 45% of the EFL annual catch. I agree for ease of management it is likely best to keep the boundary where it is, however, I strongly believe science shows what we fishermen have known, NY to NEFL should be assessed as one management group and even when SC and GA Atag fish go off radar, the fishery in NEFL picks up, and it is shown again in the timing of the VA fish. If fish are leave one fishery and enter into another, they should either be managed or assessed together.

Comment from Bill Gorman (2 of 2):

Reviewers Please take note of the MRIP 2015 and or 2016 catch totals. They were discussed, and addressed in the data workshop report section 4.3.1 (page 73-74, specifically in the catch estimates section), and graphs in section 4.12.1-3 (pg. 104 - 106). However, these data points are important on two ends, if you recall there was one year GA had zero or next to zero reported landings, that is as troubling as catch estimates that reflect daily effort in one day that isn't practical. Reviewers should also recognize that VMRC took over the surveying from subcontractors during this time period. These are important notes, since this assessment is working with extremely limited data, catch data will play a larger roll than one with more data such as independent surveys and or consistent caucus/age sampling across the entire management range. Thank you for your time Bill Gorham

Comment from Collins Doughtie:

I am very sorry for missing this event but hopefully my comments about cobia, and that fishery itself, will finally be taken to heart. I realize some of you rely on your job compiling statistics and such but being out on the ocean as much as I am plus being heavily involved in the cobia research that has, and is, being done here at the Waddell Mariculture Center in Bluffton, SC, I feel the solution to insure healthy cobia populations for the future starts with one change. That is an across the board limit revision. For example, right here in SC there is a six fish per boat, per day limit. With the ever growing coastal population and popularity of cobia, this insanely liberal limit is unsustainable. I realize many of you are not fisherman but one cobia can feed a lot of folks. The yield per fish is substantial. I have caught a whole lot of cobia over the years and though I have pretty much gone to catch and release now, a two fish per boat per day limit is all anyone needs to satisfy those onboard. I know that a three fish limit has floated out there and that would be a good start but it has to be for all our Atlantic coastal states. My comments here are not based on statistics but rather observation and many years of catching these wonderful creatures. I have watched what over fishing has done to our area and unless changes are made quite quickly, I fear the rest of you will experience this very sad scenario in the not so distant future. Thank you for being involved!

3. COMMENTS ON THE NMFS PROCESS

The NMFS review process review process was organised and conducted well. Other than the comments made by the review panel on the SEDAR process (Section 2.1.7 above), I have no additional comments on the NMFS review process.

4. REFERENCES

Charnov, E.L.; Gislason, H.; Pope, J.G. (2013). Evolutionary assembly rules for fish life histories: Natural mortality in fish life-history evolution. Fish and Fisheries 14, 213–224. https://doi.org/10.1111/j.1467-2979.2012.00467.x

Lorenzen, K. (1996). The relationship between body weight and natural mortality in juvenile and adult fish: a comparison of natural ecosystems and aquaculture. Journal of Fish Biology 49, 627–642. https://doi.org/10.1111/j.1095-8649.1996.tb00060.x

Thorson, J.T. (2019). Guidance for decisions using the Vector Autoregressive Spatio-Temporal (VAST) package in stock, ecosystem, habitat and climate assessments. Fisheries Research. https://doi.org/10.1016/j.fishres.2018.10.013

Williams, E.H.; Shertzer, K.W. (2015). Technical documentation of the Beaufort Assessment Model (BAM). NOAA Technical Memorandum NMFS-SEFSC-671. U.S. Department of Commerce, Springfield, VA 2216, 43 p. https://doi.org/10.7289/V57M05W6

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 Report	SEDAR 28
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, 2019	Panel review meeting
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:

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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 panellists, 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 of SEDAR 58 Atlantic Cobia Assessment

1. 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?
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?
    - Are assessment models configured appropriately and applied consistent with accepted scientific practices?
    - Are the methods appropriate for the available data?
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?
    - 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 reliable 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?
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?
    - 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?
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.
    - Are the implications of uncertainty in technical conclusions clearly stated?
6. Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations or prioritizations warranted.
    - Clearly denote research and monitoring that could improve the reliability of, and information provided by, future assessments.
    - Provide recommendations on possible ways to improve the SEDAR process.
7. Provide suggestions on improvements in data or modelling approaches which should be considered when scheduling the next assessment.
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.

Annex 3: Tentative Agenda - 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.

APPENDIX 3: PANEL MEMBERSHIP OR OTHER PERTINENT INFORMATION FROM THE PANEL REVIEW MEETING

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.