Individual CIE Report

SEDAR 20 Atlantic Croaker and Atlantic Menhaden.

Prepared for the Centre for Independent Experts

By

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COMMERCIAL IN CONFIDENCE

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Executive Summary

- This document is the individual CIE Reviewer report of the SEDAR 20 Atlantic croaker and Atlantic menhaden review.

- This report solely represents the views of the independent reviewer (Dr Geoff Tingley).

- This reviewer fully agrees with all of the findings reported in the SEDAR 20 Atlantic croaker and Atlantic menhaden Summary Report (*Summary Report*). Findings that are fully reported in the *Summary Report* are not necessarily repeated in this individual report although much is repeated. This report also presents clarifications of elements in the summary report plus some additional views of the individual reviewer that may not have been fully discussed by the Panel or at the meeting.

- A principal finding is that the technical assessment team for menhaden met all of their review terms of reference and that the assessment team for croaker met all of their important terms of reference.

- The assessment outputs for menhaden were robust and minor adjustments to the assessment and input data yielded improved fits. Model outputs were suitable for providing management advice.

- The assessment outputs for croaker were somewhat less robust and, largely due to the lack of data to define the level of by-catch in the shrimp fisheries, estimates of biomass were unavailable. Fishing mortality estimates were available and suitable for providing some useful management advice.

- This reviewer believes that there are some significant data issues that need to be addressed in order to improve the quality and reliability of the future assessment of both Atlantic croaker (by-catch in the shrimp fisheries) and Atlantic menhaden (fishery independent indices).

- The assessment methodology for menhaden is mature and currently needs little core development. However, changing some of the input data (i.e. the catch data fleet structure within the model) should yield improved fits and is recommended for future assessments.

- The assessment methodology for croaker is relatively immature and requires considerable core development and testing together with addressing some fundamental input data issues, each of which is subject to its own recommendation.

- Recommendations aimed at improving the current approach to stock assessment through additional research are made. Readers should refer to the main text for discussion.

Introduction

This SEDAR Panel met as intended and focused on reviewing and providing support to the development of the best approaches to assessment for management purposes of these important species during the review process.

All presenters provided clear and informative material and were constructive and helpful in providing clarifications. The overall tone of the meeting was positive and constructive.

The *Summary Report* of the SEDAR 20 Review Panel was well drafted and this report draws heavily on the wording in the *Summary Report*. All views expressed in this report are, however, those of this reviewer.

Description of review activities

This review was undertaken by Dr Geoff Tingley in Charleston, South Carolina over the period 8th-10th March 2010 as part of the SEDAR 20 Review Panel for Atlantic Croaker and Atlantic menhaden. Relevant documents (see Bibliography, Appendix 1) were made available between one and two weeks prior to the meeting via a link to an ftp server. The documentation so provided was reviewed prior to the meeting.

During the week prior to the meeting, a conference call for Panel members was held with the agenda presented in Appendix 3.

The Panel was comprised of individuals with a wide variety of skills and experience and worked well as a team. The Panel was well chaired.

During the meeting, all presentations, additional material and requests made by the Panel were uploaded onto the ftp server for common access by all participants, which was extremely useful.

The background information and assessment of Atlantic croaker were principally presented by Laura Lee and Katie Drew, supported by Linda Barker and Eric Robillard. The quality of all presentations was high.

The background information and assessment of Atlantic menhaden was principally presented by Erik Williams, Joe Smith and Doug Vaughan, supported by Rob Latour, Matt Cieri and Brad Spear. The quality of all presentations was very high and the use of graphic spatial mapping material was particularly helpful.

Dale Theiling from SEDAR and Patrick Campfield from ASMFC provided excellent co-ordination of the meeting and report preparation, ably supported by other staff from ASMFC.

Industry participants were present throughout most of the meeting but their involvement was minimal.

Background information relevant to this review is presented in a series of appendices, including a Bibliography (A1); the CIE Statement of Work (A2) (which includes (i) the Format and Contents of the CIE Peer Review Report, (ii) Terms of Reference for the Peer Review, and (iii) Tentative Agenda SEDAR 20 Atlantic Menhaden and Atlantic Croaker Review), and the Agenda of a Pre-meeting Conference Call (A3).

Comments are provided against the specific terms of reference (ToR) given in Appendix 2 and are those of the reviewer.

Summary of findings

The assessment teams should be commended for their thorough and professional approach to developing and applying the models to provide the best advice to managers on these two species. The openness of the discussions and breadth of information presented during the review greatly aided the review process. A summary of findings and recommendations from this reviewer for each species are presented below.

The findings of this reviewer are reported within relevant sections, addressing each of the Terms of Reference (ToR) as set out in Appendix 2.

Where no recommendations are made against a specific ToR, this is because the reviewer believes that the *Summary Report* of the Panel has made the appropriate recommendations in full or that none are required.

Overall findings

The reviewer fully agrees with all of the findings reported in the *Summary Report*. Findings that are fully reported in the *Summary Report* are not necessarily repeated in this individual report, although many are. This report focuses on clarifications of elements in the summary report plus some additional views of the individual reviewer that may not have been fully discussed by the meeting or the Panel.

The principal finding is that all key terms of reference were met.

1. Atlantic Menhaden Terms of Reference

Summary

- The results from the menhaden base run appear to be sound. The model results and the status determination are robust.
- The 2008 point estimate of fishing mortality (F) was below the estimated F threshold, the status determination is that overfishing was not occurring. The 2008 point estimate of fecundity was above both the fecundity threshold and target, i.e. the stock is not overfished.
- Although the 2008 F estimate was above the threshold, it was very close to it. Thus, as there is a degree of uncertainty associated with the point estimate, there is a significant probability that overfishing occurred in 2008. Indicative of a future need to take corrective action.
- The use of F_{med} and associated fecundity as reference points gives rise to a concern as there is no information on the relationship of the target or threshold fecundity in relation to virgin levels. From projections requested by the Panel, estimates of annual fecundity since 1998 were only 5 to 10% of the virgin fecundity
- It was recommended that a model specification similar to the Panel's reference run be considered for future assessments. This includes (i) capping effective sample size at 200, (ii) allow gaps in the pound net index and bait fishery age composition where data are not available, (iii) modification of the fleets structure from 'reduction' and 'bait' fleets to 'northern' and 'southern' fleets, and (iv) use time-varying domed selectivity for the southern region.
- The assessment team did a thorough and highly professional job of presenting and discussing the fishery-dependent and fishery-independent input data, the model design and the various outputs and diagnostics of the assessment.

Comments on Individual Terms of Reference: Menhaden

1. *Evaluate precision and accuracy of fishery-dependent and fishery-independent data used in the assessment:*

The wording in the *Summary Report* fully reflects the position of this fishery. In brief, there are excellent landings data of different quality for different elements of the fishery over different time periods. These are supported by considerable biological data sampled from, particularly, the reduction fishery.

Modelling the Atlantic menhaden as a single stock on the east coast is the correct approach based on the currently available information.

A number of fishery independent (i.e. independent of the menhaden fishery) indices have been developed over the years, including an adult index developed from the Potomac River Fisheries Commission (PRFC) pound net survey, and a juvenile abundance index (JAI) developed from regional beach seine information.

Recreational harvest and discards were estimated through the Marine Recreational Fisheries Statistical Survey (MRFSS).

Growth, weight, and maturity at age were obtained from both fishery-dependent and independent sources, while age and time variant natural mortality were estimated using a multi-species virtual population analysis.

The use of cohort specific weight and length at age to account for apparent density-dependent growth was a valid approach. Maturity was re-examined at the recommendation of the 2004 Peer Review Panel. New estimates of maturity were based on scale collections in 2004 and 2008. The results were similar to previous studies except for a high percent of mature age 1 fish, which the Assessment Team assumed was due to a low sample size (n=11). There may be an issue of maturity being confounded by the spatial and temporal movement of mature fish. The Assessment Team noted that samples for all the maturity work have been collected in the fall off North Carolina to account for spatial and temporal variability. Fecundity was estimated using length-specific fecundity data.

The PRFC adult CPUE index was used in the model, including the estimated values to fill in data gaps. Since the model can handle missing data, the Panel recommended leaving the gaps in the data as filling the gaps underestimates uncertainty.

Juvenile indices (JAI) were produced using two methods: (i) a single coastwide juvenile index assuming that each survey represents a component of the coastal juvenile relative abundance (this was as used in the base run); and (ii) a combination of relative abundance data from groups of states according to the similarity of trends in the state-specific time series (additive approach). The second approach, effectively giving regional indices, is preferable as it may capture spatial patterns of juvenile abundance.

a. Discuss data strengths and weaknesses (e.g. temporal and spatial scale, gear selectivities, aging accuracy, sampling intensity).

Strengths:
(i) the accurate long time-series of commercial landings data.
(ii) consistent aging of samples over time.

Weaknesses:
(i) Use of a product based fleet structure (reduction and bait), as this has little to do with the biology of the species or the approach to fishing. Switching to a northern and southern fleet structure was recommended as this captures aspects of the distribution and age structure in the population.
(ii) Incomplete validation of ageing.

(iii) Missing years in the Potomac River Fisheries Commission (PRFC) pound-net index filled with estimated values. Re-instatement of the gaps was recommended.
(iv) There are some concerns about the appropriateness of the length-based cut offs for age-0 juveniles from the state specific seine surveys which do not age menhaden. Raw data were not available at the Review to explore those concerns.

b. Report metrics of precision for data inputs and use them to inform the model as appropriate.

A re-aging program was conducted in 2009 to determine precision of aging. The standard deviations associated with age estimates were used to provide the error associated with the age composition data, which was assumed constant over time.

Error levels for the fishery catch at age were based on the number of sampling trips (effective sample size). The Panel thought the effective sample size on the age composition data was too high, and recommended capping at 200.

c. Describe and justify index standardization methods.

The Assessment Team had developed several adult and juvenile abundance indices for potential use in the model, with detailed methodology and justification. An alternative approach was recommended that would use an alternative regional JAI (see discussion above). There was also discussion about developing an alternative coast-wide adult index

d. Justify weighting or elimination of available data sources.

The Assessment Team made several adjustments or weighting to account for size-variable migration (topping off adjustment, weighted mean weights and length at age). The judgment of the Assessment Team not to include adult effort-based indices from the reduction fishery was correct. For the PRFC adult index, it was recommended to remove the estimated values and run the model with the data gaps (discussed in a).

2. Evaluate models used to estimate population parameters (e.g., F, biomass, abundance) and biological reference points.

The Beaufort Assessment Model (BAM), a well tested model framework, was the only model used to produce final assessment results. This is a statistical forward-projection model with separable selectivities using the Baranov catch equation. Catch histories, catch-at-age, juvenile and adult abundance indices were all fitted in the model assuming two fisheries (reduction and bait). Constant selectivities were estimated for the fisheries but fixed at assumed values for both the juvenile and adult indices. Catchability parameters were estimated for both indices. Lognormal likelihoods were assumed for the catch histories and indices, with multinomial likelihoods for the catch-at-age data.

The MSVPA-X model was used to estimate age and year specific natural mortality from 1982-2008 for use in the BAM. The estimates were then assumed known in the base BAM run in those years with the average at-age estimates applied to the years 1955-1981. The MSVPA-X model was peer reviewed in 2005 and recommended for use in estimating natural mortality but not as a full assessment model. The Panel did not revisit this recommendation. There were mixed views within the Panel on the appropriateness of using these estimates in the base model. All members agreed that, in reality, natural mortality was age and year specific. However, there was some concern that the natural mortality estimates were unreliable because of the difficulties of modelling the complexity of the Atlantic ecosystem as it relates to menhaden mortality. However, it was noted that the assessment results are not sensitive to the choice between age-specific natural mortality or age-and-year specific natural mortality.

a. Did the model have difficulty finding a stable solution?

The Panel requested some jittered starting values. Twenty five runs were performed and all runs converged to the same solution.

b. Were sensitivity analyses for starting parameter values, priors, etc. and other model diagnostics performed?

An extensive set of sensitivity runs were performed for the base model. The only result of note was that leaving out the juvenile abundance index resulted in an over-fishing status in 2008. It was found that this index supported a higher recruitment in the last three years than other data sets. Removal of this index was sufficient to move the point estimate of 2008 F just above the overfishing threshold.

c. Have the model strengths and limitations been clearly and thoroughly explained?

These were discussed in the assessment document and were also considered by the Panel and reported on in the *Summary Report* and above.

d. Have the models been used in other peer reviewed assessments? If not, has new model code been verified with simulated data?

The BAM has been peer-reviewed in several assessments.

e. Compare and discuss differences among alternative models.

The Panel formulated an alternative BAM run which addressed the main problems identified with the base run. Given the other uncertainties, the differences in the assessment results between the two models are relatively minor (see above).

3. Evaluate the potential for conducting assessments at a sub-regional level (e.g. Chesapeake Bay).

Data are available that would probably support sub-regional level assessments. However, all information points towards a single coast-wide menhaden stock and there would be no merit from either a biological or management perspective to assess the stock at a finer scale. Also a sub-regional assessment approach would certainly generate significant problems in dealing with both age/size dependent migration between areas in the same fishing period and expansion and contraction of the range of the stock (a feature of the biology of menhaden).

4. State and evaluate assumptions made for all models and explain the likely effects of assumption violations on model outputs, including:

Discussed under ToR 2 above.

a. *Calculation of M.*

Discussed at ToR2 b.

b. Choice to incorporate constant or time-varying M and catchability.

Year and age-specific M were estimated in the MSVPA-X model for use in the BAM base run. Sensitivity runs with higher and lower M and age-specific but time-invariant M did not change the status determination.

c. Choice of selectivity patterns.

Fishery selectivities were estimated in the base run although domed-selectivities were not allowed. The potential impact of mis-specification was investigated by allowing domed-selectivities in some runs, which did not change the status determination.

d. Choice of time steps in models.

The model had a simple annual cycle and assumed that all fisheries were operating year-round. This is a significant departure from reality but it is unlikely to have a major impact on assessment results. Changing the model to reflect the timing of the fisheries more accurately, particularly as the timing of some of them has changed in recent years, would be sensible.

e. Error in the catch-at-age matrix.

The catch at age data is assumed to follow a multinomial distribution in each year with effective sample sizes equal to the number of trips sampled. This is a mathematically convenient and commonly made assumption which is almost certainly violated. In this particular case, the effective sample sizes appear to be too high as the model residuals are much more variable than they should be given the assumed sample sizes. Also, there were obvious patterns in the residuals for the reduction fishery. Lower sample sizes and alternative splits of the fisheries, together with alternative selectivities alleviated these problems to some extent. Different point estimates were obtained but stock status determination was unaltered.

f. Choice of a plus group for age-structured species.

A plus group was used at an appropriate age.

g. Constant ecosystem (abiotic and trophic) conditions.

Ecosystem conditions are unlikely to have been constant over the period for which the stock was modelled. The model does attempt to deal with changing conditions in terms of year-specific natural mortality and cohort-specific growth. The reference points used assume that the time period modelled is representative of a single constant regime. This is a reasonable approach as without a full understanding of the processes involved it is not possible to know how long a "regime shift" might last (or even if it has occurred). There is some evidence of a "regime shift" in 1992 to lower productivity. This was considered by the Panel when calculating unfished fecundity (two alternatives: 1992-present or 1955-present). There was some brief discussion about the changing status of Chesapeake Bay over time, especially with regard to nutrient loading and declining water quality and the potential impacts that this might have on spawning success and recruitment.

h. Choice of stock-recruitment function.

There appears to be very little relationship between population fecundity and recruitment (i.e., steepness is close to 1). There is no evidence for a relationship between the model estimates of fecundity and recruitment. However, recruitment is quite variable and there could be a stock-recruit relationship which is not discernable for this reason. The current reference points are independent of steepness, so this assumption has no consequences for status determination.

i. Choice of reference points (e.g. equilibrium assumptions).

The use of F_{MED} based reference points is of concern. It appears that the stock has been at low levels of population fecundity for many years and yet the current reference points (and the F_{MED} reference points of previous years) provide a determination of "not overfishing" and "not overfished". The Panel recommended that more appropriate reference points be considered and selected on the basis of providing better protection for the SSB or population fecundity relative to the unfished level.

5. Evaluate uncertainty of model estimates and biological or empirical reference points.

Sensitivity runs were discussed under ToR 2.b. Almost all sensitivity runs gave the same stock status determination as the base run. However, from the bootstrap analysis of the base run, it is clear that there is considerable uncertainty with regard to the overfishing status of the stock in 2008 (with 37% of the runs indicating that overfishing was occurring). The Panel noted that uncertainty is underestimated in the bootstrap analysis as the assumed effective sample sizes are too high.

a. *Choice of weighting likelihood components.*

The likelihood components were each given equal weight which, along with incorporated estimates or assumed CVs for each component, attempts to provide relative influence on the objective function that reflects knowledge about the quality of the inputs. However, correct weighting procedures seems to be an open question.

6. *Perform retrospective analyses, assess magnitude and direction of retrospective patterns detected, and discuss implications of any observed retrospective pattern for uncertainty in population parameters (e.g., F, SSB), reference points, and/or management measures.*

A retrospective analysis was performed by the Assessment Team for the base model. There were no retrospective patterns of any consequence.

7. *Recommend stock status as related to reference points.*

This is fully discussed in the *Summary Report.* The Panel supported the view of the Assessment Team that the stock status determination is "not overfished" and there is "no overfishing", relative to the current reference points. Further, the Panel also agrees with the Assessment Team that the uncertainties in the assessment are such that there could have been overfishing in 2008 (removal of the juvenile abundance index from the base model gave that determination and many bootstrap runs also fell in the overfishing zone).

An issue of the use of full Fs rather than number-weighted Fs in status determination is fully presented in the Summary Report. The Panel agreed that full F should be used.

8. *Develop detailed short and long-term prioritized lists of recommendations for future research, data collection, and assessment methodology. Highlight improvements to be made by next benchmark review.*

The research recommendations in the menhaden assessment report were largely sensible, however, additional short and long-term research recommendations were identified by the Panel. The short and long-term recommendations are in priority order.

The data and model run requests made by the Panel or suggested by the Assessment Team are fully detailed in the *Summary Report* and are not reproduced in this individual report.

Menhaden Recommendations

Short-term recommendations (for completion for the next benchmark review).

Menhaden recommendation 1.

The Panel recommended that model specifications similar to the Panel's reference run be considered for future assessments. This has embedded the following sub-recommendations:

(i) capping the effective sample size at 200;
(ii) allow the gaps in the pound net index and bait fishery age composition where data are not available;
(iii) modification of the fleet structure in the model from the current approach of a reduction fleet and a bait fleet to northern and southern fleets (see below); and
(iv) permit time-varying domed selectivity for the southern region.

The Panel's reference run included a model specification that combined information from the bait and reduction fisheries occurring together regionally because they are essentially using the same gear. Removing the estimated age composition and indices for years where data are absent is desirable because the data from years where it is available is providing the correct amount of information, from a statistical perspective, to the assessment model. Allowing domed selectivity in the southern region fishery allows for the lack of availability of older fish in that region when the fishery is occurring. The reduction of effective sample sizes is intended to better reflect the actual information content of the age composition data (the residuals in the base model were inconsistent with the large assumed effective sample sizes). Also, the time-varying selectivity in the southern region had the best AIC of comparable runs and reduced the undesirable pattern of residuals in the southern fishery.

As indicated above, a reworking of the menhaden fishery into northern and southern fleets should be explored to support the assessment. This approach is based on the idea of capturing structure in the biology and distribution of the fish as seen in the age structure of the catch in these two areas given that the gear type is essentially the same (purse seine). This exploration should consider the spatial patterns of both the stock and the fishery as the stock range and fishery have expanded and contracted over time, and may be expected to continue to do so in future and thus setting an appropriate fixed boundary (or fixed criteria to define a movable boundary) may be critical.

Menhaden recommendation 2.

Fishing mortality should be calculated as full F. The number-weighted fishing mortalities relative to the number-weighted F-reference points do not provide correct interpretation with regard to overfishing.

Menhaden recommendation 3.

The Panel has concerns about the use of F_{MED} and the fecundity associated with it as reference points. The concern is that no information on the relationship of the target and threshold fecundity in relation to virgin fecundity levels was available. Projections were run to examine this, and the estimated fecundity since 1998 was less than 10% of the virgin fecundity for the base model. We recommend examination of alternative reference points which provide more protection to the SSB or fecundity than F_{MED}.

Menhaden recommendation 4.

Examine weighting of datasets in the model. As a starting point, some experts assert that the input variance assumptions should be consistent with the estimated variance of residuals. Deviations from this weighting pattern may be desirable but the weightings ultimately used need to be justified. In the base model, the effective sample sizes for catch-at-age data were far too high and consequently estimates of uncertainty too low.

Menhaden recommendation 5.

The Panel recommends the Assessment Team's alternative use of the juvenile indices: combining relative abundance data from groups of adjacent states according to the similarity of trends in the state-specific time series; and cumulatively-combining these indices within the model. This allows for different regional patterns of recruitment to provide a stock-wide recruitment pattern.

Menhaden recommendation 6.

Examine the timing of fisheries and indices in the model. Many of the fisheries are seasonal and need to be timed appropriately with the abundance indices. Incorrect timing may affect model fits.

Long-term recommendations

Menhaden recommendation 7.

Develop a coast-wide adult menhaden survey, which should preferably be independent of the fishery. Possible methodologies include (i) an aerial (spotter plane) survey, (ii) a hydro-acoustic survey (research vessel or industry vessel-based with scientific observer support). Whatever approach were to be taken, a sound statistical design is essential (achievable by involving survey design statisticians throughout the development and review of the design; pilot survey programs may be necessary).

It is the view of this reviewer that an annual aerial over-flight survey would be the best approach to developing an adult survey. This is based on the biology of the fish (surface schooling), independence from the fishery, the relative ease of design, long experience of the use of spotter planes in the fishery with estimation of school size, and cost effectiveness (light aircraft will be able to cover the range of the stock at a much lower cost than ship-based acoustics).

Pilot surveys could be easily implemented, with industry co-operation, by providing a GPS logger to each existing spotter aircraft, permitting the flight transect to be digitally recorded. With school counts and school size estimation this would provide data to enable a provisional transect-based adult abundance estimate. Some additional flights to cover the range of the stock may be either advantageous or necessary.

Alternative options for aerial surveying are also available through, for example, the use of digital video recording linked to GPS loggers from light aircraft, with post-flight school counting and estimation of size by scientific staff. If video recording pilots proved successful, other vehicles could be used to do the survey, such as pilotless drones aircraft which might prove to be more cost effective.

2. Atlantic Croaker Terms of Reference

Summary

- The Panel correctly concluded that in 2008 overfishing was probably not occurring. Data compiled for the stock assessment appears to show an upward trend in biomass since the 1980s and a decreasing trend in F (since commercial catches have been fairly constant since the mid 1990s). There has also been an expansion in age classes in the catch and indices, which is consistent with increasing biomass and decreasing F.

- It is not possible to be confident with regard to the overfished status until the discards from the shrimp fisheries are properly incorporated into the stock assessment.

- All Panel members were very concerned about the lack of adequate estimates of Atlantic croaker by-catch in the shrimp fisheries. Rough estimates of by-catch indicate it could be as large as or larger than the directed harvest in some years. The Panel made a number of separate recommendations to correct this serious issue.

- The Panel requested a number of changes to the base model run, but without a defensible discard history for the shrimp fisheries, or a major restructuring of the model, an adequate base model could not be developed. There are also problems with the definition of Fmsy and Bmsy that will need to be addressed for the next assessment.

- Based on the data and analyses presented, the stock of croaker is unlikely to be in trouble. Biomass has been trending up, commercial catches have been fairly stable, and discards from the shrimp fishery have been lower at the more recent sampling occasions than earlier (three points estimates from actual data: 1970: 11,600 t; 1992-1994: 13,000-15,000 t annually; 2007-08: 5,500 t annually).

Comments on Individual Terms of Reference: Croaker

1. *Evaluate precision and accuracy of fishery-dependent and fishery-independent data used in the assessment, including the following but not limited to:*

The Atlantic croaker fishery was modeled as one east coast stock. The Atlantic Croaker Stock Assessment Subcommittee (Assessment Team) used commercial and recreational landings, and discards at age from the east coast of the United States, a single fishery-dependent index developed from the Marine Recreational Fishery Statistical Survey (MRFSS), and four fishery-independent indices including the National Marine Fisheries Service (NMFS) bottom trawl survey, Virginia Institute of Marine Science (VIMS) survey, SEAMAP-South Atlantic survey, and North Carolina 195 survey. In addition growth, weight, maturity, and natural mortality at age were developed using both fishery dependent and independent information.

The Assessment Team did a thorough job of presenting and discussing the fishery-dependent and fishery-independent data used in the assessment. Commercial landings data by gear were available from 1950 to 2008 from Florida (FL) to New Jersey (NJ), which spans the range of the stock. These data were collected by NMFS and State agencies at various reporting levels over the time series. The commercial landings data from 1981 through 2008 from FL to NJ were used in the assessment to conform to the years where recreational landings are available. Daily or trip-level data are currently collected in most states in the Atlantic States Marine Fisheries Commission (ASMFC) management region. A weakness in the data is that data collection methods have changed over time for a number of states. Data may not be comparable throughout the time series before and after the change in these states. The bulk of the landings come from Virginia (VA) and North Carolina (NC). The Panel was concerned about the CVs used for the

commercial landings data. Other Panel members suggested it would be better to develop reasonable bounds on the catch history and to explore sensitivities to alternative catch histories. The Panel had questions about the use of gillnets, which has been a significant and growing part of the fishery in recent years. The main concern was about changes in fishery selectivity. The current effort data by gear are not adequate to examine changes.

There are three major types of commercial discard; scrap, finfish, and shrimp. Information on the amount of discards by year and area is more uncertain than landings.

The scrap fishery is one in which the fish species that are unmarketable as food, are sold unsorted, usually for bait in other fisheries. NC initiated a scrap fishery sampling program in 1986, which was used to estimate the proportion of croaker in the unsorted landings. Atlantic croaker is a major component of the NC scrap fishery. There was concern that there are no data to estimate landings from the scrap fisheries in other states. Different gears are used in other states with scrap landings, so the NC data would not be appropriate to use. Estimates of scrap landings have declined by an order of magnitude since the early part of the assessment time period. This decline may be due to the enactment of various gear related regulations along the coast.

A variety of gears used to catch finfish along the coast also have a by-catch of Atlantic croaker. NMFS observer data were used to estimate the by-catch in gillnets and otter trawls. The Assessment Team estimated croaker by-catch using the method recommended for scup during the 2009 data poor workshop. The Panel considered that this method is unreliable for croaker, due to the low number of trips which landed croaker.

Atlantic croaker is also a by-catch in the southeastern Atlantic shrimp fishery. The Assessment Team developed rough by-catch estimates using the ratio of croaker catch to shrimp catch. These estimates indicated that in some years the by-catch was larger than the directed harvest. The Panel was concerned that this gives more a reflection of shrimp landings than croaker by-catch.

Recreational landings and discards were provided through MRFSS from 1981 through 2008. The majority of the harvest was in VA (62%), with FL, NC and Maryland (MD) next in importance. MRFSS harvest estimates for croaker were fairly reliable with low proportional standard errors. The Panel inquired about the use of 10% discard mortality for the recreational fishery. There are no discard mortality studies on Atlantic croaker; the 10% is based on rates used for red drum and weakfish (other sciaenids). Given the magnitude of the recreational catch, assuming a 10% mortality adds a significant additional uncertainty.

Biological sampling data for length, weight and age for the commercial fishery were available from a number of states over differing time frames. NC (1979 to 2008) and VA (1989 to 2008) had the longest sampling programs, with NC being the only state that sampled over the whole of the assessment time series. NC initiated a biological sampling program for the scrap fishery in 1986, and is the only program along the coast. The information collected from the scrap fish sampling is used to estimate the proportion of croaker in the fishery and the size structure. There are no long term programs for collecting biological data on the by-catch of croaker in the shrimp fishery, but historical work indicates that nearly all the discarded by-catch were age 0. Recreational length information was collected in the MRFSS intercept survey. Croaker ageing was originally determined using scales, but switched to otoliths in 1996. NC's biological sampling collected paired samples of scales and otoliths from 1996 – 1999 which were used to develop a scale-otolith transition matrix. The matrix was used to convert scale based age-length keys (ALK). The 2005 Peer Review Panel had concerns about ageing protocols, so an ASMFC ageing workshop was conducted in 2008. New ageing protocols were developed. The Panel had concerns that length, weight and maturity at age might be mismatched with cohort due to the new ageing protocol and the protracted spawning period. The Assessment Team reviewed the length and weight at age and found that they were cohort based. The Panel continued to have concerns

about the maturity at age, since new maturity estimates have a much higher percentage of mature age 0's compared to the past. The Panel concurs with the development and use of age varying M.

A fishery-dependent and four fishery-independent indices were developed. Recreational catch per unit effort (CPUE) indices were developed using two methods; directed trips and that of Stephens and MacCall (2004). The Panel was concerned about using the directed trips method, and thought it may under represent trips with no croaker. The Assessment Team was concerned that the Stephens and MacCall (2004) method resulted in some unrealistic species associations. The Panel believes the unrealistic species associations were probably due to use of the full data set without stratification by, for example latitude, area or depth. The Panel recommended using the Stephens and MacCall (2004) approach with the coast divided into sub-areas based on expected species associations.

The NMFS Northeast Fisheries Science Center (NEFSC) multi-species trawl survey was used to develop a fishery-independent index. The survey uses a stratified random design based on 3 depth strata. On examination, the Panel found that the inshore strata were not consistently sampled, and there was also concern about using numbers per tow rather than swept-area (swept-area estimates enable the estimated trawl-survey proportionality constant to be used as a model diagnostic). The Panel recommended dropping the inshore depth strata, development of a depth by latitude based stratification using the mid and offshore depth strata and estimating the index using area swept approach). The Assessment Team also developed fishery-independent indices using data from the Virginia Institute of Marine Science (VIMS) Juvenile Trawl Survey, the Southeast Area Monitoring and Assessment Program (SEAMAP) South Atlantic Coastal Survey, and NC Survey 195 which catches young of the year (YOY) croaker.

a. *Discuss the effects of data strengths and weaknesses (e.g. temporal and spatial scale, gear selectivities, aging accuracy, sample size, standardization of indices) on model inputs and outputs.*

Strengths:

- Landings data were available from all states in the range of Atlantic croaker distribution, and biological samples are available from states with the major fishery (88 to 99%).
- Paired scale/otolith collections were used to develop a scale-otolith transition matrix and applied to the scale based age-length keys.
- The ASMFC held an ageing workshop in 2008 which developed standardized ageing protocols following a recommendation of the 2005 Peer Review Panel.

Weaknesses:

- No adequate estimates of by-catch in the shrimp fisheries exist or can be made from existing data.
- Collection of landings data have changed over time and may not be comparable before and after the changes.
- The method used to estimate the finfish fishery by-catch using NMFS observer data is unreliable.
- There is no information available to estimate landings in the VA scrap fishery.
- Age as determined from otoliths has not been validated with known age samples.
- Protracted spawning may be causing difficulties in age determination and the maturity at age proportions. It was recommended that the maturity at age schedule be determined using a definition of cohorts based on the spawning season in the mid-Atlantic region (Chesapeake Bay).
- Using only one ALK may not be adequate, due to year-round fisheries operations, fast growth and a protracted spawning season.

- The use of the directed trips method to estimate a recreational CPUE index may not be appropriate. The Panel recommended using the Stephens and MacCall (2004) method based on sub-areas.
- The NMFS survey inshore depth stratum was sampled inconsistently between years. The Panel recommended an alternative stratification scheme (see above).

b. Report standard errors of inputs and use them to inform the model if possible.

Panel members expressed concern about the CVs used for the commercial landings data. Some of the Panel suggested it would be better to develop reasonable bounds (tighter for years with more certain data, and wider for less certain years) and then evaluate sensitivity within those bounds rather than assuming CVs.

Alternative methods of developing empirical uncertainty estimates of the scrap fishery discards should be investigated.

The Panel was concerned that the effective sample size on the commercial landings at age was too high. They recommend that the effective sample size be based on the number of biological samples.

c. Justify weighting or elimination of available data sources.

The Panel was concerned about the estimation method for the recreation index. The Panel recommended dropping the index in the short-term until it was possible to re-estimate it using the Stephens and MacCall (2004) approach with appropriate spatial stratification in the future.

2. *Evaluate models used to estimate population parameters (e.g., F, biomass, abundance) and biological reference points.*

The structure used for the assessment model is based on a well established age structured production model (ASPM) - forward VPA combination that has been applied for many assessment analyses. The model structure was considered appropriate for fitting a population model to the available information, however, a number of concerns were raised about some of the assumptions made when constructing the input data sets, the fit function formulation and derivation of the diagnostic output.

The various strengths and weaknesses of the croaker assessment are given in full in the *Summary Report*.

Specific concerns about the model structure and coding issues, which were discussed and reviewed with the Assessment Team, include:

- The coding of several parts of the model which did not follow standard formulations e.g. the multinomial assumption on proportions at age and the scaling of the selection pattern used within the estimation of Fmsy.
- The assumption of a population age structure at equilibrium in the first year when strong year class effects were apparent throughout the available catch at age data.
- The use of aggregated indices from the NFMS and SEAMAP surveys when age structure information was available.
- The inclusion of the recreational CPUE data set, which appears to indicate no change in stock status for the majority of the time series. Either the data set is uninformative or the modeling assumptions used to fit the data set were inappropriate.
- The use of the shrimp by-catch data which is based on a raising procedure that results in croaker by-catch being directly proportional to shrimp landings rather than the effort expended and incoming croaker year class strength.

a. *Did the model have difficulty finding a stable solution? Were sensitivity analyses for starting parameter values, priors, etc. and other model diagnostics performed?*

Sensitivity analyses were presented within the assessment report and during the review. The dominant sensitivities in model estimates are not dependent on the model structure or starting values but derive from the data sets to which the model is fitted and assumptions concerning the biological characteristics of the stock, specifically the shrimp by-catch and maturity of the age 0 croaker.

b. *Have the model strengths and limitations been clearly and thoroughly explained?*

Model strengths and weaknesses were reviewed with the Assessment Team and are fully presented in the S*ummary Report.*

c. *If using a new model, has it been tested using simulated data?*

This model has not been adequately tested.

d. *Has the model theory and framework been demonstrated and documented in the stock assessment literature?*

The model theory and framework has been documented as described above.

2. *State and evaluate assumptions made for all models and explain the likely effects of assumption violations on synthesis of input data and model outputs. Examples of assumptions may include (but are not limited to):*

a. *Calculation of M.*

The assessment used instantaneous natural mortality rates which decline with age and are constant over all years. The values are averaged across values derived from a series of methodologies applied to historical growth data and, although the analyses showed a range of values, the Panel agreed that the appropriate selections had been made and appropriate structure applied within the model.

b. *Choice to use (or estimate) constant, time-varying, or age-varying M and catchability.*

See discussion in 3.a above.

c. *No error in the catch-at-age or catch-at-length matrix.*

Multinomial error was modeled for the fit to the catch at age data from the commercial, recreational and survey time series. As noted within ToR 1 the original formulation of the error model was incorrect, following a review with the Assessment Team this was corrected and the appropriate formulation derived.

d. *Choice of a plus group.*

This was modeled appropriately.

e. *Population is at equilibrium.*

This is also addressed in ToR 2, model structure. The assumption of a population age structure at equilibrium in the first year was considered inappropriate, when strong year class effects were apparent throughout the available catch at age data. Following discussions with the Assessment Team the starting populations for each cohort present within the first year were estimated, improving the fit of the model.

f. *Constant ecosystem (abiotic and trophic) conditions.*

Changes in ecosystem conditions are not considered within the assessment model. However, discussions did note anecdotal reports relating to environmental conditions in Chesapeake Bay that could impact on the population dynamics of this species and might warrant further investigation.

g. Choice of stock-recruitment function.

A Beverton and Holt stock-recruitment (S-R) relationship is estimated by fitting to derived estimates of spawning stock size (S) and recruitment at age 0 within the model. Due to a lack of information the relationship at low stock size, the curve is conditioned on a fixed slope at the origin (steepness). This was considered appropriate.

h. Choice of proxies for MSY-based reference points.

The method used to calculate the MSY-based biomass and fishing mortality thresholds and targets are considered appropriate. However, sensitivity resulting from the inclusion or omission of the shrimp by-catch ensured that stock status relative to reference levels could not be determined, as described above.

i. Determination of stock structure.

The assessment of croaker assumes a single population with mixing. Although alternative hypotheses of multiple stocks have been suggested, the information available for deriving separate assessments is too sparse and therefore the current level of aggregation is considered appropriate.

j. *Maturity.*

Maturity for age 0 was initially modeled at 43% mature. All Panel members considered this unlikely for a species that spawns primarily in the autumn and winter. A review of the species spawning and growth patterns established that there is potential for uncertainty as to which year class (as required by the assessment model) a fish counted as 0 group is derived from. Fish from the previous year class could potentially be included within the new maturity ogive applied in the assessment. It was established that this was unlikely to be the case for the catch at age data, for which the adjustment was made when reading and compiling the otolith data. Following a review with the Assessment Team the maturity ogive from the previous assessment, which assumes that 0 group are not mature, was applied within the assessment formulation.

4. *Evaluate uncertainty of model estimates and biological or empirical reference points.*

Confidence intervals for the estimated stock metrics were provided and sufficient to determine that the base model estimated trends in biomass and fishing mortality were well determined (given the model assumptions). Sensitivity runs gave similar trends in stock metrics as those from the base run apart from when shrimp by-catch estimates were included in the catch data. The uncertainty of model estimates and biological and empirical reference points is therefore dominated by the catch data set to which the model is fitted rather than the estimation procedure or model structure.

5. *Perform retrospective analyses, assess magnitude and direction of retrospective patterns detected, and discuss implications of any observed retrospective pattern for uncertainty in population parameters (e.g., F, SSB), reference points, and/or management measures.*

Retrospective analyses of the model were conducted and illustrated a tendency of under-estimation of stock biomass and over-estimation of fishing mortality across the time series of estimates. The retrospective bias does not affect the perception of the trends in the assessment estimates, biomass has an upwards trend and fishing mortality has recently been declining. The sensitivity of stock status relative to reference levels is marginal compared to the sensitivity to the inclusion or exclusion of the by-catch of croaker in the shrimp fisheries as discussed earlier, and, therefore, the retrospective pattern was not considered further.

6. *Recommend stock status as related to reference points:*

In 2008 overfishing was probably not occurring. There has been an upward trend in biomass since the 1980s and a decreasing trend in F. There has also been an expansion in age classes in the catch and indices, which is consistent with increasing biomass and decreasing F.

It is of note, however, that the evaluation of stock status relative to reference points could not be made as a result of the uncertainty introduced by the lack of appropriate information on the by-catch of croaker in the shrimp fisheries.

Studies have established that the by-catch of croaker in the shrimp fisheries could constitute a substantial number of 0 group fish. When estimates of the by-catch are included in the assessment, there is a marked revision in the estimated 0 group recruitment level, time series structure and mortality rate, and the stock status relative to reference points is revised substantially.

a. Biomass threshold and target and *b. F threshold and target.*
The method used to calculate the biomass and fishing mortality thresholds and targets is considered appropriate. However, sensitivity resulting from the inclusion or omission of the by-catch of croaker in the shrimp fisheries ensured that stock status relative to reference levels could not be determined, as described above.

7. *Compare trends in population parameters and reference points with current and proposed modeling approaches. If outcomes differ, discuss potential causes of observed discrepancies.*
Comparisons were made with an alternative age structured production model and with a biomass dynamic model. Both models gave similar perceptions of increasing biomass levels and decreasing mortality rates. Lack of information on by-catch in the shrimp fisheries prevented determination of reference levels and the relative stock status, as above.

8. *If a minority [stock assessment] report has been filed, explain majority reasoning against adopting approach suggested in that report. The minority report should explain reasoning against adopting approach suggested by the majority.*
No minority report was submitted for review.

9. *Develop detailed short and long-term prioritized lists of recommendations for future research, data collection, and assessment methodology. Highlight improvements to be made by next benchmark review.*
The data and model run requests made by the Panel or suggested by the Assessment Team are fully detailed in the *Summary Report* and are not reproduced in this individual report.

Croaker Recommendations

The Atlantic croaker assessment research recommendations are sensible. Additional short and long-term research recommendations were made by the Panel and are detailed below. The short and long-term recommendations are in priority order.

Short-term recommendations (for completion for the next benchmark review).

Croaker recommendation 1.
Develop a time series of effort for the shrimp fishery for use in modeling the by-catch of Atlantic croaker within the stock assessment model. Rough estimates of croaker by-catch in the shrimp fishery indicate it could be as large as, or larger than, the directed harvest in some years. These estimates are based on the ratio of croaker catch to shrimp landings (in three short time periods), and therefore, within each time period, they tend to track shrimp catch rather than croaker by-catch and so cannot be used directly. Instead of trying to estimate croaker by-catch outside the model it is better to do it internally to allow for changes in croaker recruitment. The suggested approach is to develop an effort time series and supply it as input data to the model together with the observations from the three studies (i.e., as catch per unit of shrimp effort).

An appropriate time series of effort data from the shrimp fisheries effort would support a similar approach for modelling by-catch mortality of a number of species in the shrimp fisheries, as well as enabling a better understanding the shrimp fisheries themselves.

Croaker recommendation 2.

The effect of protracted spawning on age determination and the maturity at age proportions is unclear and of direct interest in providing good assessment results. The Panel therefore recommended that the maturity at age schedule be determined using a definition of cohorts based on the spawning season in the mid-Atlantic region (Chesapeake Bay).

Croaker recommendation 3.

Due to an apparent inability to distinguish some portions of age 0 and age 1 cohorts for croaker and onset of maturity during this period, it would be beneficial to explore a method of calculating spawning biomass in the assessment model that uses a length-based maturity ogive along with predicted yearly length composition.

Croaker recommendation 4.

Re-examine development of recreational CPUE index using the Stephens and MacCall (2004) method with the coast divided into sub-areas based on expected species association with Atlantic croaker by area.

Croaker recommendation 5.

The estimation method for croaker discards using observer data is unreliable. Although the method was applied for the scup assessment, the numbers of trips observed that landed croaker is very small in many years for both gillnet and otter trawl gears. The geometric mean is not recommended with low sample sizes nor would the ratio-type estimators in the Standardized Bycatch Reporting Methodology (Wigley *et al*., 2006) be recommended under these conditions. As such, a better approach would be to use a ratio-type estimator examined by Wigley *et al*., (2006) with observed landings of a larger aggregation of species in the denominator and corresponding total landings for expansion. There will be more variability of the discard of croaker from trip to trip (with a large number of zero observations), but the much larger sample size will help overcome this variability. Furthermore, this methodology provides estimates of uncertainty corresponding to annual discard estimates that can be used in the assessment model.

Croaker recommendation 6.

Due to poor information on stock and recruitment, there is little ability to estimate steepness within the model. An examination of alternative types of reference points that do not rely on a defined stock–recruitment relationship is advised. SPR based reference points should be considered. An appropriate level of SPR can be determined for croaker by considering the trade-off between yield and SSB over a range of plausible levels of steepness. This evaluation can be done using models with deterministic recruitment or stochastic recruitment.

Croaker recommendation 7.

Carefully consider how to best determine F-based reference points (e.g., F_{MSY} or $F_{\%SPR}$) given the presence of the croaker by-catch in the shrimp fisheries. The current approach uses a single average selectivity (from the recent time period combined across all fisheries) in conjunction with a single F. Manipulation of F to achieve a particular target (MSY or some %SPR) therefore involves scaling the effort in all fisheries up or down by the same proportion. This makes little sense given the independence of the shrimp fisheries and the directed croaker fisheries. A better approach would be to scale the effort in the directed fisheries while holding the shrimp effort constant.

Croaker recommendation 8.

The gillnet fishery has been a significant part of the fishery in recent years (⅓ - ½ of the landings) and has been increasing in relative terms. More information is needed on this fishery to estimate

any changes in selectivity. Explore commercial fishery landings reports for gillnet information directed at Atlantic croaker and other species that may also catch croaker.

Croaker recommendation 9.
Investigate alternative methods of developing empirical uncertainty estimates of the scrap fishery discards. Perhaps a model for estimating the proportion of croaker in the scrap fishery could be derived to provide variance estimates for this proportion and estimated total croaker scrap landings.

Long-term recommendations

Croaker recommendation 10.
Atlantic croaker ageing using otoliths has not been validated with known ages. The Panel recommends development of an age validation program. The program could be based on otolith marking (e.g. tetracycline), conventional tagging, or tank studies.

Croaker recommendation 11.

Develop and implement compatible and co-ordinated sampling programs for state-specific commercial scrap and shrimp fisheries in order to monitor the relative importance of Atlantic croaker in these fisheries.

Croaker recommendation 12.
Estimates of catch-at-age for a year-round fishery may not be reliably estimated from a length frequency and a *single* age-length key if some of the vulnerable fish are growing significantly during the fishing season (because age proportions at given length keep changing). If this is a problem for some of the croaker catch-at-age data, there are two alternative methods for avoiding the problem that should be investigated:

a. Development of separate age-length keys for different times of year;
b. Directly sample for age (otoliths) year round.

Croaker recommendation 13.
Given the number of issues identified in the Atlantic croaker assessment, I would recommend that additional testing of the model and new/amended input data for Atlantic croaker be undertaken. This could either be done internally, via workshop of with a more formal review.

Conclusions

The Panel was unanimous in its final evaluations of the presented base models for both species and selection of preferred versions. There were no significant disagreements within the Review Panel or between the Review Panel and either of the technical stock assessment teams.

Both stock assessments were able to provide outputs suitable for basing management advice on, although in the case of croaker, this was less complete.

The stock assessments for both Atlantic menhaden and Atlantic croaker can be improved by uptake of recommendations made by the Review Panel.

Most, but not all, of the recommendations presented in this individual report also appear in the *Summary Report*.

Appendix 1: Bibliography

SEDAR 20
Atlantic Menhaden and Atlantic Croaker
ASMFC and SEDAR 20 Workshops Document List

Document #	Title	Authors
Documents Prepared for the Data Workshops		
SEDAR20-ASMFC_DW01	History of Assessments of the Atlantic Menhaden Stock along the U.S. Atlantic Coast	D. Vaughan, April 2009
SEDAR20-ASMFC_DW02	Reconstructing Historical Commercial Landings of Atlantic Menhaden	D. Vaughan, June 2009
SEDAR20-ASMFC_DW03	Life-History Based Estimates of Natural Mortality for Atlantic Menhaden	D. Vaughan, M. Cieri, G. Nesslage, 2009
SEDAR20-ASMFC_DW04	Growth and Reproduction of Atlantic Menhaden	D. Vaughan, J. Smith, E. Williams, 2009
SEDAR20-ASMFC_DW05	Commercial Harvest and Catch-at-Age for Atlantic Menhaden	J. Smith, D. Vaughan, & J. Brust, 2009
SEDAR20-ASMFC_DW06	Estimating the size and age composition of the B–2 fish (caught and released alive) in the recreational fishery for red drum and spotted seatrout in South Carolina	C. J. McDonaugh, C.A. Wenner, 2009
SEDAR20-ASMFC_DW07	Croaker and Red Drum Aging Workshop Proceedings	SCDNR, 2008
SEDAR20-ASMFC_DW08	Ageing Atlantic croaker (*Micropogonias undulatus*) using otolith transverse cross-sections	Center for Quantitative Fisheries Ecology & VA Marine Res Comm, undated
SEDAR20-ASMFC_DW09	Documentation and reduction of bycatch in North Carolina fisheries	K. Brown, 2009
SEDAR20-ASMFC_DW10		
SEDAR20-ASMFC_DW11		
SEDAR20-ASMFC_DW12		
SEDAR20-DW17		
SEDAR20-DW18		
Documents Prepared for the Assessment Workshop		
SEDAR20-AW01		
SEDAR20-AW02		
SEDAR20-AW03		
SEDAR20-AW04		
SEDAR20-AW05		
SEDAR20-AW06		
SEDAR20-AW07		
Documents Prepared for the Review Workshop		
SEDAR20-RW01		

Draft Assessment Reports		
S20-CroakerDraft SAR	ASMFC Atlantic Croaker Draft Assessment Report	ASMFC Croaker TC and SAS
S20- Menhaden Draft SAR	ASMFC Atlantic Menhaden Draft Assessment Report	ASMFC Menhaden TC and SAS
Final Assessment Reports		
S20-ASMFC-SAR01	Assessment of the Atlantic Croaker Stock	To be prepared following Review Workshop
S20-SAR02-ASMFC	Assessment of the Atlantic Menhaden Stock	To be prepared following Review Workshop
Reference Documents		
	Population dynamics and potential of fisheries stock enhancement: practical theory for assessment and policy analysis. Philosophical Transactions of the Royal Society of London, Series B 360 (1453):171-189.	Lorensen, K. (2005).
	A multispecies approach to subsetting logbook data for purposes of estimating CPUE. Fisheries Research (Amsterdam) 70(2-3):299-310.	Stephens, A., and MacCall, A. (2004).
	The analytic component to the standardized bycatch reporting methodology omnibus amendment: sampling design and estimation of precision and accuracy. NMFS/NEFSC, Reference Document 06-22.	Wigley, S. E., Rago, P. J., Sosebee, K. A. and Palka, D. L. (2006).
	Synchronous multidecadal fish recruitment patterns in Chesapeake Bay, USA. Can. J. Fish. Aquat. Sci. 66:496-508.	Wood, R. J. and Austin, H.M. (2009)
SEDAR20-RD01		
SEDAR20-RD02		
SEDAR20-RD03		
SEDAR20-RD04		

ACRONYMS

AW Assessment Workshop
DW Data Workshop
RD Research Document
RW Review Workshop
SAR Stock Assessment Report
SAS Stock Assessment Subcommittee
TC Technical Committee

Some additional, particularly graphic, material was presented during the meeting, either at the request of the Panel or because the technical teams considered that it would be helpful to address a specific issue. This material was all efficiently placed on the ftp server for the Panel and workshop participants to access.

Appendix 2: Statement of Work

Attachment A: Statement of Work for Dr. Geoff Tingley (CEFAS)

External Independent Peer Review by the Center for Independent Experts

SEDAR 20 Atlantic Menhaden and Atlantic Croaker Review

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

Project Description: SEDAR 20 will be peer reviews of assessments of Atlantic menhaden and Atlantic croaker stocks conducted by the respective stock assessment subcommittees of the Atlantic States Marine Fisheries Commission (ASMFC). The Southeast Data, Assessment and Review (SEDAR) process will coordinate the peer reviews during a single workshop. SEDAR peer reviews typically involve a panel composed of one NOAA/NMFS chair, one reviewer selected by the resource management agency, and three CIE reviewers. The lead assessment agency is the Atlantic States Marine Fisheries Commission with consultation by the Southeast Fisheries Science Center, NMFS. Peer reviews of the Atlantic menhaden and Atlantic croaker stock assessments are approved items of the SEDAR Steering Committee assessment schedule. Atlantic menhaden is an important industrial and bait fishery resource and contributes to commercial fisheries in portions of its range. It is also recognized as a vital ecological resource as a prey species. The most recent assessment of Atlantic menhaden was the 2006-update of a full assessment conducted in 2003. Atlantic croaker is an important recreational fishery resource and contributes significant commercial landings throughout its range on the Atlantic coast. The most recent assessment of Atlantic croaker status was in 2004 and presents stock status for the mid-Atlantic region. The Terms of Reference (ToRs) of the peer review are attached in **Annex 2**. The tentative agenda of the panel review meeting is attached in **Annex 3**.

Requirements for CIE Reviewers: Three CIE reviewers shall conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. CIE reviewers shall have working knowledge and recent experience in the application of stock assessment, statistics, fisheries science, and marine biology to complete their primary task of conducting an impartial and independent peer review report in accordance with the Terms of Reference to determine if the best available science is utilized for fisheries management decisions. Each

CIE reviewer's duties shall not exceed a maximum of 14 days to complete all work tasks of the peer review described herein.

Location of Peer Review: Each CIE reviewer shall conduct an independent peer review during the panel review meeting scheduled in North Charleston, South Carolina during 8-12 March 2010.

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

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

Foreign National Security Clearance: When CIE 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 CIE reviewers who are non-US citizens. For this reason, the CIE 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/sponsor.html).

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

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

Chair understands the contractual role of the CIE reviewers as specified herein. The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements, including the meeting facility arrangements.

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

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

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

1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review.
2) Participate during the panel review meeting in North Charleston, South Carolina during 8-12 March 2010.
3) In North Charleston, South Carolina during 8-12 March 2010 as specified herein, conduct an independent peer review in accordance with the ToRs (**Annex 2**).
4) No later than 26 March 2010, submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Mr. Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and David Sampson, CIE Regional Coordinator via email to david.sampson@oregonstate.edu. Each CIE report shall be written using the format and content requirements specified in Annex 1, and shall address each ToR in **Annex 2**.

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

1 February 2010	CIE sends reviewer contact information to the COTR, who then sends this to the NMFS Project Contact
22 February 2010	NMFS Project Contact sends the CIE Reviewers the pre-review documents
8-12 March 2010	Each reviewer participates and conducts an independent peer review during the panel review meeting
26 March 2010	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
8 April 2010	CIE submits CIE independent peer review reports to the COTR
15 April 2010	The COTR distributes the final CIE reports to the NMFS Project Contact and regional Science Center Director

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

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

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

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

Key Personnel:

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

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

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

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

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

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

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

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

3. The reviewer report shall include the following appendices:

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

Annex 2: Terms of Reference for the Peer Review

SEDAR 20 Atlantic Menhaden and Atlantic Croaker Review

Atlantic Menhaden

- Evaluate precision and accuracy of fishery-dependent and fishery-independent data used in the assessment:
  - Discuss data strengths and weaknesses (e.g. temporal and spatial scale, gear selectivities, aging accuracy, sampling intensity).
  - Report metrics of precision for data inputs and use them to inform the model as appropriate.
  - Describe and justify index standardization methods.
  - Justify weighting or elimination of available data sources.
- Evaluate models used to estimate population parameters (e.g., F, biomass, abundance) and biological reference points.
  - Did the model have difficulty finding a stable solution?
  - Were sensitivity analyses for starting parameter values, priors, etc. and other model diagnostics performed?
  - Have the model strengths and limitations been clearly and thoroughly explained?
  - Have the models been used in other peer reviewed assessments? If not, has new model code been verified with simulated data?
  - Compare and discuss differences among alternative models.
- Evaluate the potential for conducting assessments at a sub-regional level (e.g. Chesapeake Bay).
- State and evaluate assumptions made for all models and explain the likely effects of assumption violations on model outputs, including:
  - Calculation of M.
  - Choice to incorporate constant or time-varying M and catchability.
  - Choice of selectivity patterns.
  - Choice of time steps in models.
  - Error in the catch-at-age matrix.
  - Choice of a plus group for age-structured species.
  - Constant ecosystem (abiotic and trophic) conditions.
  - Choice of stock-recruitment function.
  - Choice of reference points (e.g. equilibrium assumptions).
- Evaluate uncertainty of model estimates and biological or empirical reference points.
  - Choice of weighting likelihood components.
- Perform retrospective analyses, assess magnitude and direction of retrospective patterns detected, and discuss implications of any observed retrospective pattern for uncertainty in population parameters (e.g., F, SSB), reference points, and/or management measures.
- Recommend stock status as related to reference points.
- Develop detailed short and long-term prioritized lists of recommendations for future research, data collection, and assessment methodology. Highlight improvements to be made by next benchmark review.

Atlantic Croaker

1. Evaluate precision and accuracy of fishery-dependent and fishery-independent data used in the assessment, including the following but not limited to:
    a. Discuss the effects of data strengths and weaknesses (e.g. temporal and spatial scale, gear selectivities, aging accuracy, sample size, standardization of indices) on model inputs and outputs.
    b. Report standard errors of inputs and use them to inform the model if possible.
    c. Justify weighting or elimination of available data sources.
2. Evaluate models used to estimate population parameters (e.g., F, biomass, abundance) and biological reference points.
    a. Did the model have difficulty finding a stable solution? Were sensitivity analyses for starting parameter values, priors, etc. and other model diagnostics performed?
    b. Have the model strengths and limitations been clearly and thoroughly explained?
    c. If using a new model, has it been tested using simulated data?
    d. Has the model theory and framework been demonstrated and documented in the stock assessment literature?
3. State and evaluate assumptions made for all models and explain the likely effects of assumption violations on synthesis of input data and model outputs. Examples of assumptions may include (but are not limited to):
    a. Calculation of M.
    b. Choice to use (or estimate) constant, time-varying, or age-varying M and catchability.
    c. No error in the catch-at-age or catch-at-length matrix.
    d. Choice of a plus group.
    e. Population is at equilibrium.
    f. Constant ecosystem (abiotic and trophic) conditions.
    g. Choice of stock-recruitment function.
    h. Choice of proxies for MSY-based reference points.
    i. Determination of stock structure.
4. Evaluate uncertainty of model estimates and biological or empirical reference points.
5. Perform retrospective analyses, assess magnitude and direction of retrospective patterns detected, and discuss implications of any observed retrospective pattern for uncertainty in population parameters (e.g., F, SSB), reference points, and/or management measures.
6. Recommend stock status as related to reference points:
    a. Biomass threshold and target.
    b. F threshold and target.
7. Compare trends in population parameters and reference points with current and proposed modeling approaches. If outcomes differ, discuss potential causes of observed discrepancies.
8. If a minority [stock assessment] report has been filed, explain majority reasoning against adopting approach suggested in that report. The minority report should explain reasoning against adopting approach suggested by the majority.
9. Develop detailed short and long-term prioritized lists of recommendations for future research, data collection, and assessment methodology. Highlight improvements to be made by next benchmark review.

Annex 3: Tentative Agenda SEDAR 20 Atlantic Menhaden and Atlantic Croaker Review

SEDAR 20 REVIEW WORKSHOP

Atlantic Menhaden and Atlantic Croaker

Hilton Garden Inn – Charleston
5265 International Blvd., North Charleston, South Carolina

TENTATIVE AGENDA

TBN, Chair
Mr. Dale Theiling, SEDAR Coordinator

Monday, March 8, 2010

1:00pm – 5:30pm	**Afternoon Session**	
	Convene	Chair
	Introductions and Opening Remarks	Chair and SEDAR Coordinator
	Agenda Review	Chair
	TOR Review	Chair
	Task Assignments	Chair
	Croaker Data Presentation	Linda Barker
	Croaker Assessment Presentation	Laura Lee Katie Drew
	Croaker Assessment Discussion	Review Panel and Analysts

Tuesday, March 9, 2010

8:00am - 11:30am	**Morning Session**	
	Croaker Assessment Discussion	Review Panel
12:00nn Lunch		
2:00pm – 5:30pm	**Afternoon Session**	
	Menhaden Management History	Brad Spears
	Menhaden Data Presentation	Doug Vaughan (data) Rob Latour (indices) Matt Cieri (MSVPA and M)
	Menhaden Assessment Presentation	Doug Vaughan (model selection) Erik Williams (Beaufort Assessment Model) Behzad Mahmoudi (complementary model)
	Menhaden Assessment Discussion	Review Panel and Analysts

Wednesday, March 10, 2010

8:00am - 11:30am	**Morning Session**	
	Menhaden Assessment Discussion	Review Panel and Lead Analyst

2:00pm – 5:30pm **Afternoon Session**
Stock Topical Discussions as needed Review Panel

Thursday, March 11, 2010

8:00am - 11:30am **Morning Session**
Complete Croaker Topical Discussions Review Panel
Croaker Review Workshop Report Review Panel

12:00nn **Lunch**

2:00pm – 5:30pm **Afternoon Session**
Complete Menhaden Topical Discussions Review Panel
Menhaden Review Workshop Report Review Panel
Croaker Assessment Summary Report Panel, Stock Leader, Coordinator
Menhaden Assessment Summary Report Panel, Stock Leader, Coordinator

Friday, March 12, 2010

8:00am - 11:30am Morning Session
Final Review of Panel Documents Chair

12:00nn Adjournment Chair

Discussion Topics

Evaluation of data and their preparation and presentation
Choice and utilization of assessment models and methods
Continuity run from previous assessment(s)
Alternative assessment approaches
Identification of additional analyses, sensitivities, and corrections
Review of additional analyses and sensitivities
Initial Review Workshop recommendations and comments
Review of Data and Assessment Workshop research recommendations
Identify Review Panel research recommendations
Improvement of the SEDAR process
Assure all Terms of Reference are addressed
Develop and review draft Review Panel Report sections
Finalize workshop recommendations
Finalize Review Panel Report
Post-Review Workshop tasks and products due Chair and CIE

The timing of particular events is tentative, and the Chair may modify this schedule during the workshop as needed to complete stated tasks. However, to accommodate travel planning the workshop will start as scheduled and will conclude no later than the stated time.
SEDAR is a public process, and the public is welcome to attend SEDAR workshops. Although no formal public comment period is scheduled, the workshop Chair will allow opportunity during the meeting for the public in attendance to comment on discussion items.

Appendix 3: Conference Call Agenda

SEDAR 20 Review Panel – 2/25/2010 1pm EST Conference call

1. Introductions

2. Any Travel issues?

3. ftp site problems?

4. Review Panel responsibilities
    a. Panelist
        i. Responsibilities
        ii. Volunteers for assessment leader for each stock to work with chair
    b. CIE additional responsibilities

5. Review Panel Report – determine report writing assignments
    a. Discussion addressing and responses to each TOR
        i. **TOR 1**: Evaluate precision and accuracy of fishery-dependent and fishery-independent data used in the assessment:
        ii. **TOR 2**: Evaluate models used to estimate population parameters (e.g., F, biomass, abundance) and biological reference points.
        iii. TOR (3 menhaden): Evaluate the potential for conducting assessments at a sub-regional level (e.g. Chesapeake Bay).
        iv. **TOR (3 croaker / 4 menhaden)** State and evaluate assumptions made for all models and explain the likely effects of assumption violations on model outputs, including:
        v. **TOR (4 croaker / 5 menhaden)** Evaluate uncertainty of model estimates and biological or empirical reference points.
        vi. **TOR (5 croaker / 6 menhaden)** Perform retrospective analyses, assess magnitude and direction of retrospective patterns detected, and discuss implications of any observed retrospective pattern for uncertainty in population parameters
        vii. **TOR (6 croaker / 7 menhaden)** Recommend stock status as related to reference points.
        viii. TOR (7 croaker) Compare trends in population parameters and reference points with current and proposed modeling approaches. If outcomes differ, discuss potential causes of observed discrepancies.
        ix. TOR (8 croaker) *If a minority [stock assessment] report has been filed, explain majority reasoning against adopting approach suggested in that report. The minority report should explain reasoning against adopting approach suggested by the majority.*
            1. No minority opinions for croaker (or menhaden)
        x. **TOR (9 croaker/ 8 menhaden)** Develop detailed short and long-term prioritized lists of recommendations for future research, data collection, and assessment methodology. Highlight improvements to be made by next benchmark review

b. Summary Report for each assessment which summarizes the primary assessment findings and Review Panel recommendations.

c. Summary results of analytical requests (sensitivities, corrections, additional analyses, etc.)
   i. Review panel analytical requests and the replies must be documented in the Review Panel Report.
   ii. For extensive replies, an addendum may be developed.

6. Other?