Chair Report to the Center of Independent Experts (CIE) on the Atlantic Menhaden and Atlantic Croaker SEDAR Assessment Review Panel held on October 6 to 9, 2003 in Raleigh, North Carolina.

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Summary of Meeting

The **S**outh **E**ast **D**ata, **A**ssessment, and **R**eview (**SEDAR)** process for stock assessment and review is used in the National Marine Fisheries Service-Southeast Fisheries Science Center's (NMFS-SEFSC) area of responsibility. This program provides a framework for independent peer review of stock assessments undertaken jointly by NMFS-SEFSC, three Regional Fishery Management Councils, two Interstate Fishery Commissions, and state fishery agencies. This process involves separate workshops to review the data and then the models used for the stock assessment. The data workshop and assessment workshop were convened by the ASMFC under its established protocols for stock assessment of species managed under the Atlantic Coastal Fisheries Cooperative Management Act. The Commission assessments come to SEDAR in the Review Panel meeting. I represented the Center of Independent Experts as chair for the Peer Review panel held in Raleigh, NC, 6 to 9 October, 2003. The two assessments reviewed by this SEDAR Peer Review Panel were for Atlantic menhaden and Atlantic croaker from the Atlantic States Marine Fisheries Commission's area of jurisdiction.

Panel membership:

Steve Bobko, Old Dominion Universit,y VA
William Goldsborough, CBF, Annapolis MD
Najih Lazar, RI DEM, Jamestown RI
Tom Miller, Chesapeake Biological Laboratory, Solomons MD
Jim Nance, NMFS, Galveston TX
Paul Nitschke, NMFS, Woods Hole MA
Lee Paramore, NC DMF, Wanchese NC
Stephen Smith, DFO, Dartmouth NS (CIE)
Elizabeth Wenner, SC DNR, Charleston SC
Geoffrey White, ASFMC, Washington DC
William T. Windley, MD Saltwater Sportfish Assoc., North East MD

The Review Panel meeting convened at 1:00 pm on Monday 6 October with Doug Vaughn (NMFS-SEFSC) presenting background on the biology of menhaden, the history of the fisheries and the data used in the assessment. While all data sources were discussed by the panel, much of our time was spent on the use of different natural

mortalities (M)-at-age for the Menhaden. Everyone acknowledged that this change from previous assessments where a constant M for all ages was used was definitely more biologically realistic but it was difficult to determine if the relative mortalities at age were realistic for menhaden. These relative mortalities were obtained from a multi-species virtual population analysis (MSVPA) conducted by an ASFMC working group. The results of the MSVPA are currently being peer reviewed and no documentation was available for our review panel.

Erik Williams (NMFS-SEFSC) presented the background and results from a new forward-projecting catch-at-age model for menhaden. Previous assessments had used an un-tuned virtual population model. While many aspects of the model and its underlying assumptions were discussed, panel members and participants returned to the non-constant mortalities-at-age, in particular to the use of very high mortalities for ages 0 and 1 year. These high mortalities were meant to represent the importance of menhaden as a forage fish for many other species of fish, birds and marine mammals.   The stock assessment and the panel's terms of reference were directed toward providing advice for menhaden fisheries only but some members of the panel and other participants expressed frustration with the lack of information presented for broader ecosystem-based issues. In addition, the population model was designed to evaluate stock status on a coast wide basis and therefore could not be used to answer questions about local depletions that were raised during the meeting. All of these concerns were recorded in panel summary report (Appendix 3) with request for direction from ASFMC.

Panel members were concerned about the influence of the large 1958 year class on the model estimates and Erik Williams was asked to run the model based on data from 1965 to the present. Erik gave this presentation on Wednesday morning and the model results appeared to be quite robust to the 1958 year class.

The new population model necessitated a redefinition of the reference points for this stock. Doug Vaughan presented the reasons for changing from spawning stock biomass to population fecundity expressed as the number of maturing or ripe ova and changing from F_{max} to an F-target based on the 75th percentile of fecundity/R_0. In the former case fecundity is related to the size of the fish and this new measure was considered to be a more accurate representation of reproductive capacity than simply using spawning stock biomass. The change in fishing mortality target was required because with the new model and the assumption of different mortalities-at-age, estimates of F_{max} were infinite.

Janaka DeSilva (FLMRI) presented the data section of the Atlantic croaker assessment. There were a number of issues that came up during the presentation that needed to be dealt with. One of the more serious was the use of abundance estimates from the NMFS-NEFSC fall survey for 1982 to 2002. The time series for commercial landings used in the assessment began in 1973. The fall survey began in 1963 and this point was mentioned in the stock assessment but the technical committee had only obtained data for 1982–2002. The technical committee appeared to be unaware of the stratified random design that is used for this survey and opted instead to use a delta-lognormal model to estimate annual abundance. Concerns were expressed about the possible differences

between the delta-lognormal and stratified estimates. Fortunately, Jim Nitschke (NMFS-NEFSC) had brought fall survey data with him from 1973 to the present, so that some of these concerns could be addressed during the meeting.

This was the first time that the Atlantic croaker population has been modeled and because of the lack of age data, a surplus production model had been tried but failed. An age structured production model was constructed for the population with the age structure generated in the model. All of the indices used to tune the model started in the early 1980's while the commercial landings time series started in 1973. Spawning stock biomass in 1973 was assumed to be a constant proportion of virgin spawning stock biomass. A likelihood component for deviations around the recruitment estimates from a Beverton-Holt spawner-recruit was reported as being required for the model to converge. The panel expressed concern about having a landing series starting in 1973 with tuning data series beginning in the 1980s. The lack of dynamic range in the survey indices suggested that the model might get the trend right but would have problems with scaling the population estimates. A new run of the model using the NMFS-NEFSC survey data from 1973 (with stratified estimates) was requested to investigate these concerns.

The reference points were the standard fishing mortality and biomass thresholds used for other stocks. Two separate models were developed for the fishery from North Carolina and points north (mid-Atlantic model), and from South Carolina to Florida (south Atlantic model). While there was a great deal of discussion on splitting the population this way, the panel did not have enough information to evaluate this approach. Stock status was only reported for the mid-Atlantic model.

The panel reviewed a comparison of abundance estimates from the NMFS-NEFSC survey using delta lognormal and stratified estimates. There was enough difference between the two approaches to recommend that more work needs to be done to understand these differences. In addition, the results of running the mid-Atlantic model with NMFS-NEFSC survey data back 1973 suggested that there were enough differences between population estimates from this run and the original run based on data from 1982 to warrant concern.

During the panel's second pass through the terms of reference on Wednesday afternoon, it was discovered that the commercial landings did not include catch from the scrap or bait fishery. These data were not available in the original stock assessment but data from the North Carolina scrap fishery were presented by Janaka DeSilva. It was determined that prior to 1996, landings from the scrap fishery in North Carolina were between 10 and 50 percent of the total commercial landings. While it was unknown how significant landings from these scrap or bait fisheries were in other states, the problem was serious enough for the panel to conclude that the removals from the croaker stock used in the stock assessment were inadequate for the determination of stock status.

Meeting Process

All relevant documents were supplied to the chair the week of 22 September in the form of paper copies of the two main assessment reports (ASFMC 2003a,b) in addition to electronic copies on CD of all of the documents in Appendix 2.

The first three terms of reference (Appendix 1) were used to structure the meeting into separate presentations on the data, models and the technical committee's recommendation on stock status for each of the species reviewed. Each presentation was followed by comments from the panel, followed by comments from the other participants. After the first pass through the assessment, requests for additional analyses were discussed making sure that these analyses were focused on answering a particular question and did not constitute an alternate assessment. Once the results of these analyses had been presented and discussed, there was a second pass through the first three terms of reference. The chair summarized the points from the previous discussion for each term of reference and then directed the panel and participants to reach conclusions on the adequacy and appropriateness of the material presented and the recommendations that were made. Notes made by the chair and ASFMC staff during these discussions were used to construct the draft report of the peer review panel's evaluation. Research recommendations were identified during this time as well. Printed copies of the draft report including the research recommendations were supplied to all panel members before being discussed.

Monday afternoon and Tuesday morning were dedicated to the presentation and discussion of the menhaden assessment. We spent Tuesday afternoon reviewing research recommendations for menhaden and then dismissed the panel in the late afternoon so that the chair and ASFMC staff could write a draft summary report. This draft was printed out and made available to panel members late Tuesday evening.

The croaker presentation began on Wednesday morning. While the panel did evaluate all aspects covered in the first three terms of reference, problems with the survey series and landings led to the conclusion that the stock assessment would not be useful for management purposes. The chair and ASFMC staff spent Wednesday afternoon and early evening, drafting up the croaker summary report and research recommendations. Printed copies were made available late Wednesday evening.

On Thursday morning, the croaker report and research recommendations were reviewed by the panel and remedial measures for the stock assessment were drawn up. There was enough time to also review the menhaden summary report. The panel completed all of this work by 11:00 am.

ASFMC staff distributed edited versions of the summary reports and research recommendations by email to panel members by Friday 10 October. Draft Advisory reports were distributed by email on Wednesday 15 October with a request for comments on these and the summary reports back to ASFMC staff by 17 October. New versions of the documents were sent out to panel members on Monday 20 October and a conference

call on Thursday 23 October was used to address outstanding issues. I chaired the conference call and the few outstanding issues were resolved with most of the panel members attending. ASFMC staff revised the reports and distributed the new versions electronically by late afternoon Thursday. All members were requested to get any last minute edits back to ASFMC staff by noon Friday (EDT) 24 October. Final versions were distributed on 30 October (Appendix 3).

Overall, the panel review workshop was a success. ASFMC council staff did an excellent job of providing meeting support and the panel members worked well together reviewing the information provided. The technical committee members provide very lucid presentations that summarized very well the material from the large stock assessment documents.

I would like to make two observations about possible improvements in the future. The issues about the NMFS-NEFSC survey for the croaker assessment raise questions about the membership of the technical committees. As far as I could tell, no one on the croaker committee was familiar with this survey. Many problems could have been avoided if the data had arrived at the meeting along with an expert from Woods Hole.

We also had the sense that the croaker technical committee did not have enough time to do justice to the assessment. There was some discussion about changes in membership during the process. Neither of these problems was conducive to ensuring a quality product no matter how dedicated the remaining individuals in the committee are.

Other observations

A meeting chair should act as an impartial guide and facilitator. However, I found that there were many times when I had to act as a technical reviewer as well. These two roles can be in conflict because as chair, one would like to achieve a degree of balance between opinions expressed while a technical reviewer will tend to want to make sure that their opinion is noted and responded to. Future meetings should specifically include reviewers capable of dealing with technical aspects of the stock assessment so that the chair is free to concentrate on his/her required role.

Acknowledgements

I would like to thank Lisa Kline, Geoff White, Nancy Wallace and Laura Lee (Menhaden only) for all of their assistance with meeting notes and preparation of drafts during the meeting. We would not have been able to complete the work in the time allotted without their help. I would also like to thank the panel members and the participants for their contributions to this panel review. Everyone's dedication to the tasks at hand made my job as chair that much easier.

Appendix 1.

STATEMENT OF WORK

Consulting Agreement between the University of Miami and Dr. Stephen Smith

September 15, 2003

Introduction

The **S**outh **E**ast **D**ata, **A**ssessment, and **R**eview (**SEDAR)** process for stock assessment and review is used in the NMFS- Southeast Fisheries Science Center's area of responsibility. This program provides a framework for independent peer review of stock assessments undertaken jointly by NMFS-SEFSC, three Regional Fishery Management Councils, two Interstate Fishery Commissions, and state fishery agencies. The SEDAR process uses a three-phase approach: a data workshop, an assessment workshop, and a peer review panel workshop. The peer review panel is composed of stock assessment experts, other scientists, and representatives of the Councils/ Commissions, the fishing interests, and non-governmental conservation organizations. The communication elements of SEDAR include a stock assessment report from the Assessment Workshop, a review panel report evaluating the assessment(s) (drafted during the Review Panel Workshop), presentation of the peer reviewed assessment results to the Council(s)/Commission(s) and public, and publication of collected documents for stock assessments in that cycle of SEDAR.

The 2 assessments to be reviewed by this SEDAR Peer Review Panel are for Atlantic menhaden and Atlantic croaker from the Atlantic States Marine Fisheries Commission's area of jurisdiction. The data workshop and assessment workshop were convened by the ASMFC under its established protocols for stock assessment of species managed under the Atlantic Coastal Fisheries Cooperative Management Act. The Commission assessments come to SEDAR in the Review Panel meeting. The SEDAR Review Panel for Atlantic menhaden and Atlantic croaker assessments will include up to 12 members: a senior assessment scientist from NMFS, a Commission/Council Staff scientist, up to 4 assessment scientists from the ASMFC member states, a commercial or recreational fisherman from the respective species Advisory Panel, a scientist representative from a non-governmental organization, and a Chairperson from the Center for Independent Experts (CIE). Scientists from the ASMFC Technical Committee and Stock Assessment subcommittee will present the assessments and be available during the meeting to provide supplemental information as requested by the review panel.

SEDAR Assessment Review Panel Tasks-

The Panel will evaluate the Atlantic menhaden and Atlantic croaker assessments, the input data, assessment methods, and model results as put forward in the Atlantic States Marine Fisheries Commission (ASMFC) stock assessment reports.

Specifically, the Review Panel will:

1. Evaluate the adequacy and appropriateness of fishery-dependent and independent data used in the assessments (i.e. was the best available data used in the assessment).
2. Evaluate the adequacy, appropriateness and application of models used to assess these species and to estimate population benchmarks.
3. Evaluate the adequacy and appropriateness of the Technical Committee's recommendations of current stock status based on biological reference points.
4. Develop recommendations for future research for improving data collection and the assessment.
5. Draft a report summarizing the Peer Review Panel's evaluation of the stock assessments. (Drafted during the Review Workshop, Final report due two weeks after the workshop.)
6. Draft a summary stock status report including research considerations. (Drafted during the Review Workshop, Final report due two weeks later.)

It is emphasized that the Panel's primary duty is to review the existing assessment. In the course of this review, the Chair may request a reasonable number of sensitivity runs, additional details of the existing assessment, or similar items from the technical staff. However, the Review Panel is not authorized to conduct an alternative assessment, or to request an alternative assessment from the technical staff present. To do so would invalidate the transparency of the SEDAR process. If the Review Panel finds that the assessment does not meet the standards outlined in points 1 through 3, above, the Panel shall outline in its report the remedial measures that the Panel proposes to rectify those shortcomings.

The Review Panel Report is a product of the overall Review Panel, and is NOT a CIE product. The CIE will not review or comment on the Panel's report, but shall be provided a courtesy copy, as described below under "Specific Tasks." The CIE product to be generated is the Chair's report, also discussed under Specific Tasks.

Specific Tasks

The CIE shall provide one member of the SEDAR Stock Assessment Review Panel: a Chair. The Review Panel will convene at the **Holiday Inn Brownstone Hotel in Raleigh, NC, during the week of October 6-9, 2003.** The Panel meeting will begin mid-day on October 6, and conclude early afternoon on October 9, 2003. The Panel will review stock assessments provided for Atlantic menhaden and Atlantic croaker in the area of jurisdiction of the Atlantic States Marine Fisheries Commission.

The NMFS-SEFSC/ASMFC SEDAR coordinator shall provide the CIE with copies of the following documents for distribution to the Chair. Individual Panel members will receive the same documents.

Report of Atlantic menhaden stock assessment.
Report of Atlantic croaker stock assessment.
Other reports and documents that may follow (to be finalized).

Chair's Tasks

It is estimated that the Chair's duties will occupy a total of 17 working days – several days prior to the Review Panel meeting for document review; four days at the SEDAR meeting; several days following the meeting to ensure that the final Peer-Review Panel Report and Summary Stock Status Report are completed, and several days to complete the Chair's report for the CIE.

Roles and responsibilities:

1. Prior to the Review Panel meeting the Chair will be provided with the stock assessment workshop reports. The Chair shall read and review these documents to gain an in-depth understanding of the stock assessment itself and the resources and information considered in the assessment.
2. During the Review Panel meeting, the Chair shall control and guide the meeting, including the coordination of presentations and discussions, and document flow.
3. The Chair shall facilitate the preparation and writing of the Review Panel Report (item 5 above) and a Draft Summary Stock Status Report (item 6 above). Review panel members, ASMFC/SEFSC staff, and stock assessment scientists present will assist the Chair as needed. The Chair shall be responsible for the editorial content of the two review workshop reports. These reports shall be drafted during the Review Workshop, with the final reports due to the recipients listed below in item #4 two weeks after the workshop. These reports are products of the Review Panel meeting, and are not CIE products.
4. The Review Panel Report and the Draft Summary Stock Status Report, which are not CIE products, shall be provided to Dr. Nancy Thompson, NMFS-SEFSC, 75 Virginia Beach Drive, Miami, FL 33149 (e-mail, Nancy.Thompson@NOAA.GOV); Dr. John Merriner, NOAA Beaufort Laboratory, 101 Pivers Island Road, Beaufort, NC 28516 (e-mail, John.Merriner@NOAA.GOV; and Dr. Lisa Kline, ASMFC, 1444 Eye Street NW, Sixth Floor, Washington, DC 20005 (e-mail, lkline@asmfc.org); Dr. David Sampson of the CIE shall also be provided a courtesy copy of these documents via e-mail at david.sampson@oregonstate.edu.
5. The ASMFC assessment workshop Chairs and SEDAR Coordinator will assist the Review Panel Chair prior to, during and after the meeting to ensure that final documents/results are distributed in a timely fashion.

6. No later than October 24, 2003, the Chair shall submit a written Chair's Report[1] addressed to the "University of Miami Independent System for Peer Review," and sent to Dr. David Sampson, via email to David.Sampson@oregonstate.edu, and to Mr. Manoj Shivlani, via email to mshivlani@rsmas.miami.edu. Contents and outline of the Chair's Report are summarized in Annex I.

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[1] The written report will undergo an internal CIE review before it is considered final. After completion, the CIE will create a PDF version of the written report that will be submitted to NMFS and the consultant.

ANNEX I: Contents of Chair Report

1. Synopsis/summary of the meeting – to provide context for the comments rather than to rewrite the summary report, which is a product of the meeting, and is not a CIE product.

2. Views on the meeting process, including recommendations for improvements on:
> The meeting process itself;
> The outcome(s) of the meeting;
> Materials provided for the meeting, including their timeliness, relevance, content, and quality;
> The guidance provided to run the meeting.

3. Other observations on the meeting process.

4. Appendices, including:
> Statement of Work;
> Bibliography of the materials provided for the meeting;
> Summary report (if available at the time of report submission).

Appendix 2.

Bibliography

Anon. 2003. A preliminary assessment of Atlantic croaker on the Atlantic coast of the United States. Report for the Atlantic croaker technical committee, Atlantic States Marine Fisheries Commission. 81 pp.

Atlantic States Marine Fisheries Commission. 2003a. Atlantic Menhaden 2003 Stock Assessment Report. Draft Document. 159 pp.

Atlantic States Marine Fisheries Commission. 2003b. Atlantic Croaker 2003 Stock Assessment Report. Draft Document. 146 pp.

National Marine Fisheries Service. 1995. Instructions for menhaden sampling program. National Marine Fisheries Service, Beaufort Laboratory, 101 Pivers Island Road, Beaufort, North Carolina. 20 pp. (Supplied on CD).

Vaughan, D. S., M. H. Prager and J. W. Smith. 2002a. Consideration of Uncertainty in Stock Assessment of Atlantic Menhaden. *In* Incorporating uncertainty into fishery models. J.M. Berkson, L.L. Kline, and D.J. Orth (eds.). American Fisheries Society Symposium. 27: 83–112.

Vaughan, D.S., J.W. Smith, E. H. Williams. 2002b. Analyses on the Status of the Atlantic Menhaden Stock. Report for the Atlantic Menhaden Technical Committee, Atlantic States Marine Fisheries Commission. 60 pp.

Appendix 3:

Summary Reports.

Terms of Reference for the Atlantic Menhaden Peer Review

1. Evaluate the adequacy and appropriateness of fishery-dependent and independent data used in the assessments (i.e., was the best available data used in the assessment).

The commercial fisheries for Atlantic menhaden consist primarily of a directed purse seine fishery for reduction and a fishery that provides bait for other fisheries. Landings for the menhaden reduction plants have been reported since 1940 and biostatistical samples of the catches have been collected continuously since 1955. The directed bait fishery for menhaden has grown in importance in recent years and landings from 1985–2002 are included in the current model. Recreational fishermen also catch Atlantic menhaden as bait for various game fish; however, the quantities removed are believed to be minimal and are currently not quantified. By-catch of other species in these fisheries has been shown to be minimal. Fishery-independent data sources for Atlantic menhaden exist primarily as seine survey data collected by various states. In most cases, menhaden is not the target species of these surveys and thus the survey design may not be optimal for assessing the menhaden stock.

The Panel accepted the accuracy and suitability of the landings for the reduction and bait fishery. Information on the recreational fishery was minimal and omitted from the assessment model. The Panel did not believe that this was a serious issue.

The Potomac River pound net survey, which covers a limited geographical area, provided the only adult index used in the assessment. The Panel suggested that an adult abundance index would be helpful to tune the population model. There was a very strong relationship between the purse seine effort series and landings in the reduction fishery. The CPUE index derived from these data was not used in the assessment and no justification was presented in the stock assessment report. The Panel recommended the evaluation of commercial purse seine fishery effort (vessel/weeks) data as a possible index of adult abundance. As an alternative, the Panel recommended data collected in the Captain's Daily Fishing reports be evaluated for use as an adult abundance index. If the data from these reports are not useful as adult abundance indices, then the Panel recommended that the Commission explore the utility of a commercial fishery-based adult index, developed jointly with the fishermen, for future assessments.

The seine survey data included in the assessment are juvenile indices only. A composite index was developed from seine surveys conducted in North Carolina, Virginia, Connecticut, Maryland, and Rhode Island. While the North Carolina, Virginia, and Maryland surveys had similar trends, they showed different trends from those exhibited

by the Connecticut and Rhode Island surveys. The surveys were weighted individually by a measure of relative productivity that dates back to the 1970s. Due to the survey weighting, the coast wide series mainly reflects the trends in the Maryland survey. However, the relative productivities of menhaden nursery areas coast wide in recent years are unknown. The Panel recommended investigation of existing studies that could assist in evaluating current productivity and development of protocols to quantify contribution of different nursery areas to the adult stock. Moreover, the Panel recommended that new research be initiated to quantify the relative contributions of different potential nursery areas to the adult stock. The panel discussed a variety of techniques involving the use of natural tags (genetic and otolith microchemical tags) that could fulfill this need.

The stock assessment model used a new maturity vector based on the published work of Lewis et. al (1987). The Panel accepted the new maturity vector as the best available information.

In past menhaden stock assessments, a constant natural mortality rate (M) of 0.45 over all ages and years had been assumed. In the current stock assessment, different M values for each age were introduced based on results from the Commission's Multispecies VPA (MSVPA). The menhaden assessment model estimated a mortality scalar that was applied to a constant proportional mortality at age vector based on the MSVPA for 1981–1999. The most drastic change in predicted mortality that resulted was for age-0 and age-1 menhaden, for which M's were estimated to be 4.31 and 0.98 for age-0 and age-1 fish, respectively. The Panel agreed that the change to an age-specific M was a substantial improvement over the constant M assumption. The assessment used the only quantitative information available (i.e., MSVPA M estimates). Targets should be distinguishable from the limits and represent societal goals (such as menhaden's ecological function). However, the Panel noted that it was difficult to judge whether this approach represented use of the best available data, given that the MSVPA was not available for review. The Commission is currently in the process of conducting a formal peer review of the MSVPA. The Panel questioned the validity of the assumptions that age-specific M was constant for the time period 1981–1999 and that such data could be further expanded to apply to the period from 1955–1980. The Panel recommended that the application of results from the MSVPA to the 1955–1980 period be validated. The Panel suggested that the documentation for developing the vector of age-dependent proportional M from basic theory through use of the MSVPA be more fully developed. The Panel recommended that the MSVPA be enhanced by inclusion of all the key predators and prey in the MSVPA. The Panel recommended that assessment of key sources of predation mortality for menhaden be conducted so that temporal patterns in these sources can be determined and included in the MSVPA assessment to yield time-dependent, age-specific mortality rates.

Spawning stock biomass (SSB) was expressed as potential population fecundity estimated from fecundity at size based on studies conducted in the 1980s and earlier. The Panel accepted that the change to potential population fecundity from SSB as an index of spawning potential and recognized that the fecundity-based index will be more sensitive to changes in the underlying population structure. The Panel recommended that the fecundity-at-size estimates and maturity ogives be updated.

There have been large changes in size-at-age over the 1955–2002 period. These trends are not a problem for the model but could have an impact on future forecasts. The Panel recommended the evaluation of historical change in size (weight and length) at age using existing data (e.g., scale incremental widths).

2. Evaluate the adequacy, appropriateness and application of models used to assess these species and to estimate population benchmarks.

A new forward-projecting statistical catch-at-age model was used as the assessment tool for Atlantic menhaden in 2003. Previous stock assessment analyses of Atlantic menhaden have used untuned virtual population analysis (VPA) methods. The Panel approved of the use of this new model to assess Atlantic coast menhaden stocks. The model uses weighted likelihoods for the major time series of data in the model to adjust population rates so that the overall model likelihood is minimized. Briefly, the likelihood components express the probability of observing the data given model parameters. The Panel agreed that the weightings used in the model appropriately reflected the degrees of belief in the different time series input to the model. The Panel noted that the weightings chosen for the model force a high degree of agreement between observed and predicted catches. The model fit the juvenile abundance indices fairly well, but fit the bait fishery and the Potomac River pound net index less well. No consensus was reached to explain the discrepancies in index fits. The Panel noted that the forward projection model did not exhibit any retrospective patterns. However, strong retrospective patterns typically seen in a VPA would not be expected in a forward projection model.

The menhaden stock assessment model presented assumed a unit stock. The Panel recommended that stock structure be assessed using natural tags such as otolith microchemistry and/or genetic markers. This research should seek to elucidate the potential for stock structure and the potential presence of latitudinal or other spatial variability in the stock.

The Panel noted the higher Ms on age-0 and age-1 menhaden assumed for this model resulted in much larger population sizes for those ages than in previous assessments. This does not have an impact on stock status because these population increases are removed due to high M values prior to their full recruitment to the fishery. Consequently, estimated Ms for the adult animals (age-2+) are similar to those assumed for model runs assuming constant M across all age groups. The Panel recommended that the constant pattern of M at age over time should be re-evaluated for each assessment, and that the best available estimates be used. This concern is particularly relevant should the model be used to project the population into the future.

Both a Ricker and a Beverton-Holt stock-recruitment model were used to relate recruits to spawning stock biomass. There was very little difference between model results using these two different relationships. The Panel noted that at present the lack of difference is

not of concern, but the structure of the stock recruitment relationship could become an issue in a rebuilding situation.

The Panel requested a sensitivity analysis to evaluate the impact of the large 1958 year class on the estimates. This involved re-running the Ricker base model with data from 1965 to the present (as compared to 1955 to the present). Re-running the model for this time frame resulted in truncation of the reduction landings, reduction age compositions, and composite juvenile index. Overall, the magnitude and trends in the population did not change. The Panel was encouraged by these results. The Panel noted that the model resulted in patterns in residuals of numbers at age for commercial catch. The Panel recommended investigation of the source of this pattern in the residuals that should include the potential roles of whether the selectivity model, spatial changes in fishing pattern, or fish distribution are causing this observed residual pattern.

The Panel also noted that it was difficult to distinguish degrees of belief in alternative models. The Panel recommended the development of measures (goodness of fit/complexity) to screen multiple models.

The control plot determination of overfishing/overfished was based on point estimates only. Variances were directly available from the model output. However, these variances were based on the underlying Hessian matrix, and accordingly are believed to be underestimates. The Panel recommended the development of uncertainty measures or risk analysis for future control plots such as through bootstrap analysis involving resampling of the input distributions.

3. Evaluate the adequacy and appropriateness of the Technical Committee's recommendations of current stock status based on biological reference points.

The technical committee presented F-based and biomass-based reference points that together define the conditions of overfishing and overfished. In past assessments, the target fishing mortality was based on F_{max} and SSB was used as the biomass measure. In this assessment, SSB has been replaced with population fecundity (number of maturing or ripe ova as a function of fish size). The Panel agreed that this change represents an improved measure of reproductive capacity. F_{MED} continues to be used to represent F_{REP} as the F-threshold. However, in the current forward projection model, F_{max} was infinite, possibly due to varying M at age and other aspects of the model. Therefore, the F-target is based on the 75th percentile of fecundity/R_0. The Panel noted that the proposed F-target, though arbitrary, was not capricious and yielded a target that was sufficiently lower than the threshold so that deviations of F from the target will not result in overfishing. The Panel agreed with the definition of these new benchmarks. Based on these benchmarks the menhaden stock in 2002 is considered not overfished and overfishing is not occurring. The Panel accepted the conclusion on stock status on a coast wide basis.

The Panel noted the lack of any clear relationship between estimates of F and stock spawning potential apparent in the control plots. This will become of concern should the population be assessed as overfished and/or overfishing is occurring as it suggests that management action to control F may have little impact on population abundance and spawning potential.

The stock assessment document referred to the ecological role of menhaden, although no new data or analyses were presented. Nevertheless, there was considerable discussion at the meeting about the need for information on the role of menhaden as a forage fish for other species such as bluefish, striped bass, marine mammals, and birds. Some participants expressed frustration with the lack of ecosystem-based information in the stock assessment. In particular, there was concern that while the stock assessment tracked status on a coast wide basis it would not detect localized depletion and reduced ecological function that could occur when the fishery is concentrated in one part of the coast. The terms of reference for this panel were limited to evaluating the data, model and stock status for the menhaden fishery. The previous stock assessment for this stock in 1999 did include a term of reference directed toward understanding the ecological role menhaden. At that time, the panel concluded that "until management had specified an allocation goal for menhaden as a forage fish or filter feeder, it will not be possible to develop a reference point to conserve menhaden's ecological function". The current Panel recommends that management objectives be established before it can be determined what kind of scientific information will be useful for ecosystem-based management decisions.

4. Develop recommendations for future research for improving data collection and the assessment.

1. Issue: There is no adult abundance index to tune the population model.
   - Evaluate commercial purse seine fishery effort (vessel/weeks) series as a possible tuning index in the model. Evaluate any measure of effort contained in this or other data series.
   - Evaluate the data collected in the Captain's Daily Fishing reports for an adult abundance index. If these data are not useful, explore the utility of a commercial fishery-based adult index, developed jointly with the fishermen, for future assessments.

2. Issue: Recent relative productivities of menhaden nursery areas coast wide are unknown.
   - Investigate if there are any existing studies that could assist in evaluating current productivity.
   - Develop protocols to quantify contribution of different nursery areas to the adult stock.

3. Issue: M-at-age is an improvement over constant M assumption. However, there is concern that not all key sources of mortality have been accounted for and little is known about the temporal patterns of mortality.
- Identify key sources of non-fishing mortality for menhaden.
- Enhance the coverage of the MSVPA to more predator and prey species.
- Determine if there are temporal patterns in these sources.
- Validate assumptions about applying results from MSVPA to the 1955–1980 period.

4. Issue: There have been large changes in size-at-age over the 1955–2002 period. These trends are not a problem for the model but could have an impact on forecasts.
- Evaluate historical change in size (weight and length) at age using existing data (e.g., scale incremental widths).

5. Issue: There are patterns in residuals of numbers at age for commercial catch estimated by the model.
- Investigate if the selectivity model is causing this pattern.
- Look at spatial changes in fishing pattern as well as fish distribution.

6. Issue: Current fecundity estimates are from studies in the 1980's and earlier.
- Update the fecundity-at-size estimates and maturity ogives.

7. Issue: Cannot address local depletion questions with the current model.
- Investigate methods to determine the proportion of the stock that may reside in a particular area in any one season and whether regional reference points can be developed to address local depletion.
- Extend these methods to track changes in distribution over time.

8. Issue: Control plot determination of overfishing/overfished is based on point estimates only.
- Develop uncertainty measures or risk analysis for control plots.

9. Issue: It is difficult to distinguish between results of different models and model assumptions.
- Develop measures (goodness of fit/complexity) to screen multiple models.

10. Issue: The assessment model assumes a unit stock.
- Test this assumption using otolith microchemistry and/or genetic markers.

Terms of Reference for the Atlantic croaker Peer Review

1. **Evaluate the adequacy and appropriateness of fishery-dependent and independent data used in the assessments (i.e. was the best available data used in the assessment).**

The Atlantic croaker stock assessment used commercial and recreational landings data, the National Marine Fisheries Service (NMFS) Northeast Fisheries Science Center (NEFSC) bottom trawl indices, Marine Recreational Fisheries Statistics Survey (MRFSS) CPUE index, and Southeast Area Monitoring and Assessment Program (SEAMAP) nearshore trawl survey indices.

The commercial landings data used in the assessment did not include landings from aggregate, unculled ("scrap") bait fisheries nor were discard data estimated. Unculled bait landings data are only available from North Carolina and indicated that this fishery could account for a substantial amount (2–50%) of additional landings not accounted for in the directed fishery landings, particularly prior to 1996. The Panel expressed concern both over whether unculled bait landings data are available from other states and the magnitude of these landings for other states. The Panel recommends that the North Carolina unculled bait fishery data be evaluated and the landings updated to include these landings. The possibility of applying the North Carolina proportions to other states to estimate their unculled fish landings should also be explored. The unculled bait fishery consists of primarily small fish compared to other commercial landings and may require a revised or new selectivity curve in the model. The Panel also recommends that at-sea observer data be evaluated for inclusion of discard/bycatch data in the model.

The Panel agreed that the MRFSS recreational landings for the period 1981 to present were the best available data. The Panel noted that as the ratio of commercial to recreational landings for the period 1981–present was used to hindcast earlier recreational landings, changes in the commercial removals (see above) will require re-estimation of recreational landings for the 1973 to 1980 time period. The Panel agreed with the validity of the recreational landings and the method of extending these data back to 1973.

The model used NMFS NEFSC fall bottom trawl survey indices from 1982 to the present. The survey is a stratified random survey design extending back to 1963. The assessment used a survey index derived from the application of a delta lognormal model to the NEFSC bottom trawl data, as opposed to stratified mean estimates. A comparison of the delta lognormal estimates with stratified mean estimates on assessment results indicated substantial differences. The Panel noted that these differences were not addressed in the assessment report and was not confident in the use of the Delta lognormal model. The Panel recommends that the time series be extended back to 1973 and an evaluation be conducted to better understand the differences between the lognormal and stratified mean estimates.

The Panel accepted the SEAMAP nearshore trawl data and the MRFSS CPUE index as the best data available. The Panel accepted the definition of croaker trips as consisting of a suite of species.

The final stock assessment model did not include trawl survey data from the Virginia Institute of Marine Science (VIMS). The VIMS trawl survey is believed to reflect dynamics of young croaker. The Panel noted that although the inclusion of the VIMS trawl survey might not be appropriate in an unstructured surplus production model, the VIMS time series may provide important information for the current assessment model. The Panel recommends further investigation of the inclusion of the VIMS trawl survey in the model since this survey covers the full time period and areas not covered by other survey indices included in the model.

The assessment model uses a growth curve derived only from North Carolina data and applies this growth curve to all areas included in the model. The Panel agrees that the North Carolina growth curve is the best available. However, the Panel expressed concern that the North Carolina growth parameters were being applied across the entire latitudinal range of the stock and over the entire period of the assessment. Given the wide latitudinal range of this species, and the wide range of abundances observed in the stock, the Panel recommends the investigation of spatial and interannual variability in growth.

Several different methods of calculating natural mortality (M) were evaluated in the stock assessment. The model used a constant M of 0.3 from the mid-point of the range of estimates. The Panel accepted the approach for calculating M as the best available, but recommends the development of age-specific mortality estimates.

The Atlantic croaker stock assessment is not an age based method. Work is currently being conducted to standardize ageing methods for Atlantic croaker. The Panel recommends that the Commission conduct an ageing workshop to develop approved standard ageing protocols to improve coast wide consistency in ageing data. The Panel also support continued collection of age samples from fisheries-independent surveys and length samples from the MRFSS in order to improve future Atlantic croaker assessments.

2. Evaluate the adequacy, appropriateness and application of models used to assess these species and to estimate population benchmarks.

The model used was a forward projection age-structured production model with the age structure generated by the model and not included as input data to the model. The model was run separately for the mid-Atlantic region (North Carolina and north) and the south Atlantic region (South Carolina to Florida). The regions were separated due to a lack of observations of older fish (age 3+) in the southern region and differences in the temporal patterns in fishery independent survey indices in the southern area, which indicated that dynamics may be different in the two regions. The Technical Committee indicated that performance of the mid-Atlantic model was acceptable, whereas that of the south Atlantic model was not wholly acceptable. There was extensive Panel discussion of the

justification and implications of the separation of croaker into two management units. One view suggested the separation reflected a recognition of a lack of knowledge regarding the dynamics of croaker in the southern part of the species range. An extension of this view implies that the separation reflects a "culling" of the data so that the strength of the signal in the mid-Atlantic is not masked by differences in indices in the southern portion of the range. An alternative view is that there is indeed some functional stock structure that underlies the decision to develop separate models. An extension of this view implies the potential for different reference points in the two components. Overall, the Panel did not believe that data were available to support either view. The Panel recommends investigation of the distribution and movement of croaker by age and season, and a comparison of life history parameters over the full distribution of croaker to address these uncertainties and provide full justification for a spatially explicit model. The Panel recommends tagging (artificial tags or natural tags such as otolith microchemistry/genetics) studies be conducted to address the justification for regional assessments.

The model for the Mid-Atlantic region used commercial and recreational landings from 1973 to the present, while the survey indices used in the model only extended back to 1982. The Panel expressed concerns with starting the model in 1973 with landings data only and not taking advantage of the available survey tuning indices. During the review, the Panel requested a comparison model run using the NMFS NEFSC bottom trawl survey data from 1973 to the present. This analysis provided some indication of differences in scale between the full series and the partial series used in the assessment. The Panel recommends re-running the model using the full series of NMFS NEFSC fall bottom survey data. The Panel also recommends the evaluation and possible inclusion of the VIMS trawl survey data.

The base model assumed that the SSB in 1973 was equal to 0.75 SSB (virgin biomass) from the Beverton-Holt analysis. The Panel was concerned about the validity of this assumption. The Panel recommends that the assessment readdress this assumption once the full time series of survey data is included in the model.

The model assumes that the fisheries-independent survey indices are more precise than the fisheries-dependent data and recruitment deviation estimates and, therefore, provided higher weights to these surveys. The Panel did not find compelling evidence to support the weightings applied. The Panel noted that these weighting factors may not be optimum and could strongly impact model results. The Panel recommended an exploration of the consequences of different weighting factors.

The assessment included an age structured production model only. This required development of an algorithm to generate an age structure for the population. The Panel recommends a comparison of non-age assessment models, such as the Collie-Sissenwine catch-survey and a delay difference model, to understand the implications of this age structure on derived reference points and stock advice.

The Panel accepted selectivity curves used for both commercial and fisheries-independent indices as the best available. The Panel recommends the evaluation of culling the larger fish out of the survey indices to better match the assumed selectivity.

The Panel noted that the assessment model relies on a single renewal function — specifically a Beverton and Holt stock-recruit function. The Panel noted that there has been dramatic variation in croaker abundance over the time period. In weakfish, a related sciaenid fish, similar variation in abundance has induced density-dependent changes in fecundity. If similar biological changes, or environmentally induced changes to potential stock productivity have occurred in croaker, the assumption of a constant renewal function may be questionable. The Panel recommended an evaluation of changes in maturity and fecundity within the stock.

3. Evaluate the adequacy and appropriateness of the Technical Committee's recommendations of current stock status based on biological reference points.

The Atlantic Croaker Technical Committee had concerns with recommending and evaluating reference points for the south Atlantic model at this time. Given the lack of data to estimate movement between the two regions, and the poor model fits, estimates of Fmsy and SSBmsy for the South Atlantic may be incorrect. The Panel accepted this conclusion regarding the southern region.

The benchmarks for the mid-Atlantic region listed in the stock assessment report were corrected as follows:

F threshold - Fmsy
Biomass threshold - 0.7 SSBmsy
F target - 0.75 Fmsy
Biomass target - SSBmsy

These benchmarks are based on Restrepo et al. (1998) and are standard for other managed species. The Panel noted that these benchmarks are appropriate given the model.

Stock status determination was only provided for the Mid-Atlantic region, with F2001 = 0.98 Fmsy, and SSB2001 = 1.76 SSBmsy. Based upon the recent trends in survey indices, many members of the Panel accepted that the stock was not overfished; however, full consensus was not reached. However, given the lack of precision associated with the F estimates and the problems noted earlier with the model and landings data the Panel could not determine if overfishing is occurring. The Panel recommends that if the high degree of uncertainty in current F's continues, a more conservative target be evaluated so that management action to meet the target F may not place the stock in danger of simultaneously exceeding the limit F.

Given the major concerns with the landings data and abundance indices used in the model, the Panel expressed concern with use of the current Atlantic croaker stock assessment for management purposes. The Panel recommends that the Atlantic Croaker Technical Committee resolve the issues in research recommendations 1–7 and update the assessment.

4. Develop recommendations for future research for improving data collection and the assessment.

The Panel recommends that the Atlantic Croaker Technical Committee resolve the issues in research recommendations 1–7 during the development of an updated assessment.

1. Issue: Commercial landings did not include all removals from the population.
   - Evaluate North Carolina unculled bait ("scrap") fishery data and include in the commercial landings.
   - Evaluate the potential of applying the North Carolina unculled bait fishery data to other states.
   - Consider at-sea observer data for discards and bycatch.

2. Issue: The model used catch data from 1973 to the present but tuning indices were only used from 1981 to the present.
   - Extend the NMFS NEFSC bottom trawl survey data to 1973 for inclusion in the model.
   - Evaluate the difference between the Delta lognormal and stratified mean estimates from NMFS NEFSC bottom trawl survey.
   - Evaluate the VIMS survey data for possible inclusion in the model.

3. Issue: The base model assumed that the SSB in 1973 was equal to 0.75 SSB (virgin biomass) from the Beverton-Holt analysis.
   - Re-evaluate after inclusion of the full time series of NMFS NEFSC and VIMS trawl survey data.

4. Issue: The model assumes that the fisheries-independent survey indices are more precise than the fisheries-dependent data and model recruitment estimates and, therefore, provided higher weights to these surveys.
   - Evaluate the consequences of alternative weighting schemes.
   - Provide detailed justification for the final choice of weighting scheme.

5. Issue: Separate models were developed for the mid-Atlantic (North Carolina and north) and South Atlantic (South Carolina to Florida).
   - Investigate the distribution and movement of croaker by age and season.
   - Compare life history parameters over the full distribution of croaker.

6. Issue: The assessment included an age structured production model only. This required development of an algorithm to generate an age structure for the population.

- Compare non-age assessment models, such as the Collie-Sissenwine catch-survey and a delay difference model, to understand the implications of this age structure on derived reference points and stock advice.

7. Issue: Determination of overfishing/overfished were based on point estimates only.

- Estimate the error distribution for current estimates of F, and reference points.
- Determine whether, given error distributions determined above, target F and threshold F could be distinguished from estimates derived from the assessment model.
- Consider revising F target reference point relative to the previous bullet.

The following research recommendations are lower priority, long-term research issues. These recommendations will provide improvements to future assessments.

8. Issue: Separate models were developed for the mid-Atlantic (North Carolina and north) and South Atlantic (South Carolina to Florida).

- Conduct tagging and otolith microchemistry studies to address the justification for regional assessments.

9. Issue: Difficult to understand what component of the population the surveys were tracking.

- Include maps of fishery and survey areas in future reports.

10. Issue: A single growth curve based on data from North Carolina was applied over all years and for whole area.

- Evaluate the applicability of the North Carolina growth curve to all areas (spatial variability).
- Investigate interannual variability in growth.

11. Issue: A single natural mortality estimate was used for all ages and years.

- Develop age-specific M for inclusion in the model.

12. Issue: Trends in the recruitment deviations may indicate temporal bias in the recruitment model.

- Assess whether changes in potential population reproductive capacities have changed by quantifying patterns in the maturity ogive and size- and age-dependent fecundity.
- Assess whether density dependent shifts in age- or condition-dependent timing of age at maturity have occurred as in other sciaenids.
- Assess whether temporal patterns in recruitment slope or asymptote have occurred.

13. Issue: There are no standard protocols for ageing of Atlantic croaker.
- Conduct a workshop to develop and approve ageing standards for Atlantic croaker.
- Continue collection of coastwide age samples from fisheries-independent surveys and length samples from the MRFSS.

14. Issue: Selectivity curves were used for both commercial and fisheries-independent indices.
- Evaluate culling of the larger fish out of the survey indices to better match the assumed selectivity.

Appendix 4: Menhaden Peer Review and Croaker Peer Review Reports

1. 2003 Menhaden Peer Review Report

2. 2003 Croaker Peer Review Report