

Center of Independent Experts (CIE) Peer Review
SEDAR 63 Gulf of Mexico Menhaden Peer Review Report

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Executive Summary

November 6-7, the Review Workshop for the South-East Data and Assessment SEDAR for Gulf of Mexico Menhaden was held in New Orleans, LA. This was a benchmark review in which this author was part of a team of reviewers called to examine the Beaufort Assessment Model (or BAM), brought forward as a vehicle to provide management advice and determine stock status. To do so, we examined the assessment in using the terms of reference (or TOR), which included: evaluate the data used in the assessment; evaluate the methods used to assess the stock; taking into account the available data, evaluate the assessment findings; consider how uncertainties in the assessment, and their potential consequences, are addressed; consider the research recommendations provided by the Data and Assessment workshop and make any additional recommendations or prioritizations warranted; and provide guidance on key improvements in data or modeling approaches which should be considered when scheduling the next assessment.

Each of the terms of reference was completed during this review and were met by the assessment team. Major uncertainties in this assessment included natural mortality, the lack of reference points or management benchmarks, and the use of the Louisiana (LA) gillnet survey as an adult abundance index. To a lesser extent, the ageing of the commercial samples was also found to be an uncertainty

While we were unable to quantitatively determine stock status due to a lack of reference points, the Panel found it unlikely that this stock was overfished or that overfishing was occurring. This was based on the stock's trajectory as well as auxiliary information provided by an exploratory surplus production model. This reviewer made a number of suggestions for possible reference points, but ultimately suggested a formal MSE (or Management Strategy Evaluation) was perhaps the best way to move forward in the long term. Management should consider historically based reference points, however, in the interim.

Overall the Assessment Team did a lot of work, took a lot of care, and provided a thorough assessment and report. A number of research recommendations were made, but this author suggests that those research recommendations tied to the uncertainties listed above should be considered fully before the next benchmark assessment is attempted.

Background

On November 6-7, 2018, the Review Workshop for the South-East Data and Assessment (SEDAR) for Gulf of Mexico Menhaden was held in New Orleans, LA. This was a benchmark assessment review and included a total of five reviewers, two members from the Assessment Team, and other staff. The meeting was held to evaluate the primary model, constructed using the Beaufort Assessment Model or BAM; its data inputs, configurations, parameterizations, and resultant management advice . A preliminary call to allow for clarifications about some questions was held via webinar on November 1st.

Gulf of Mexico Menhaden (Menhaden throughout) is an important commercial fishery in the Gulf of Mexico. Primary products from this fishery include animal feed, oil, meal, and other products after reduction. It is a high-volume fishery with multiple large “motherships”, but only two companies pursue the fishery. Collectively this large-scale fishery is termed the reduction fishery, as the products come after menhaden are reduced/processed to meal and oil.

In addition to its importance as a commercial fishery, there is also a large ecosystem component. Menhaden play a vital role as forage for other commercially and recreationally important fish species in this region. Additionally, there is also a small bait commercial fishery, presumably for sale to recreational fisheries, as well as the blue crab fishery.

The model put forth by the Assessment Team, BAM, has been in use for many years, for both Gulf of Mexico and Atlantic menhaden. As such it has been reviewed numerous times by SEDAR in the past.

Reviewer’s Role

As a CIE (Center for Independent Experts) reviewer, the author’s role was to read the documents supplied, attend the meeting, ask pertinent questions, and to draw up a report with both individual and Panel findings/recommendations.

The specific tasks included:

1) Review the following background materials and reports prior to the review meeting:

SEDAR 63 Workshop Reports and background documents will be available on the SEDAR website at the link below:

<http://sedarweb.org/sedar-63>

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

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

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

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

Summary of findings

- 1) Evaluate the data used in the assessment, addressing the following:
 - a. Are data decisions made by the Data and Assessment Workshop sound and robust?
 - b. Are data uncertainties acknowledged, reported, and within normal or expected levels?
 - c. Are data applied properly within the assessment model?
 - d. Are input data series reliable and sufficient to support the assessment approach and findings?

The Assessment and Data Workgroups considered a number of biological, fishery independent, and fishery dependent data for this assessment.

For biological data, the working groups considered Gulf of Mexico Menhaden as a single unit stock. The Assessment Workgroup (often referred to as the Assessment Team) also used a time invariant natural mortality (M) which incorporated age varying aspects via a Lorenzen (1996) approach which was then scaled to results from a tagging analysis conducted by Ahrenholz (1981). The groups also used growth, weight-at-age, and ageing data from the fishery dependent sampling conducted by NMFS (National Marine Fisheries Service) Beaufort. As a measure of reproductive potential, the Assessment Team used fecundity as a measure of output rather than the traditional Spawning Stock Biomass (SSB). This use of fecundity is in fact a better representation, biologically, as it weights older and larger females more heavily in the population. Of these, M was possibly the most influential of the uncertainties in the biological data. Plausible alternative M assumptions to the base case were explored as sensitivities and addressed further in TOR 4.

Fishery dependent data, including landings and sample information, are excellent for this fishery. While the bait fleet is not well characterized in some aspects, its relatively low landings compared to the reduction fleet makes this uncertainty rather negligible. Overall there is good landings and sampling information from the primary reduction fleet. One important issue brought up during the Review Workshop was the veracity and uncertainty of ageing. The data and assessment working groups explored ageing error and bias, both within and between readers, appropriately. Model sensitivities were examined to frame the effects and an ageing error matrix was developed (See TOR 4).

The base model included two fishery independent indices; a juvenile seine index from LA, MS and AL, and a LA gillnet index of adult abundance. The Data and Assessment Workgroups considered a number of other indices for menhaden including ones based on seine, gillnet, and trawl gears. These were, however, not used given various issues. Both the Assessment and Data Workgroups explained the rationale for not choosing these in detail and the Review Panel agreed with their conclusions.

Of the indices used, the adult gillnet index was perhaps the most problematic. This index has a high influence in the model, yet conflicts with some of the other inputs. As detailed in TOR 4, this leads to

some level of retrospective uncertainty. Additionally, this index lacks ageing data (though otoliths are available), and as outlined in TOR 5, a recommendation was made to explore age compositions rather than using length compositions for this index. The issues of this index were acknowledged by the working groups, and sensitivities of model results to leaving this index out as well as removing the standardization were explored (see TOR 4).

The Review Panel concluded, and this author agreed, that this TOR was met. Data decisions were found to be sound and robust. Uncertainties were acknowledged, were within a reasonable range, were well explained, and in some cases, drove further analysis as to impact on the assessment. Overall the data included supported the assessment and its conclusions.

- 2) Evaluate the methods used to assess the stock, taking into account the available data.
 - a. Are methods scientifically sound and robust?
 - b. Are assessment models configured properly and used consistent with standard practices?
 - c. Are the methods appropriate for the available data?

The current approach to the assessment of menhaden uses the Beaufort Assessment model (BAM). This is largely an age-structured approach incorporating fishery dependent, fishery independent, and biological data to produce management advice and to predict stock trajectory through time. The BAM is used extensively in SEDAR, having been used for a number of different stocks including Atlantic menhaden.

The current formulation is extensively documented in the Assessment Report. Further, the analysts provided clear explanations during the Review Workshop. Because this model was developed by the analysts it was not a “black box”; analysts had the ability to change and explore configurations during the Review Workshop at the request of the Reviewers. This is perhaps one of BAM’s greatest strengths; its flexibility and transparency of operations.

The base case model has a few issues. Chief among them is the conflict between the adult gillnet index and the other information in the model. This translates into a minor retrospective bias. Additionally, as outlined in TOR 4, many parameters are input as fixed values from external analyses, making estimates of uncertainty difficult to interpret.

In addition to BAM, a surplus production model (A Stock Production Model Incorporating Covariates or ASPIC) was also conducted with many of the same input data and parameters. The results of this “biomass” modeling approach further supported the findings and conclusions derived from BAM; as it gave a very similar trend.

After discussion, the Review Panel and this author concluded that this TOR was met. The BAM analysis put forth was sound and robust. Additionally, the model was configured properly and results matched a preliminary surplus production model’s results at least in trend. Further it was concluded that the model was indeed appropriate given the data available. As such all the Panel members agreed that the BAM run as configured represented the best available information on

which to base management advice.

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

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

As discussed above in TOR 2, the modeling approach to menhaden was to use the BAM. Model results for F and SSB (as fecundity) are shown below.

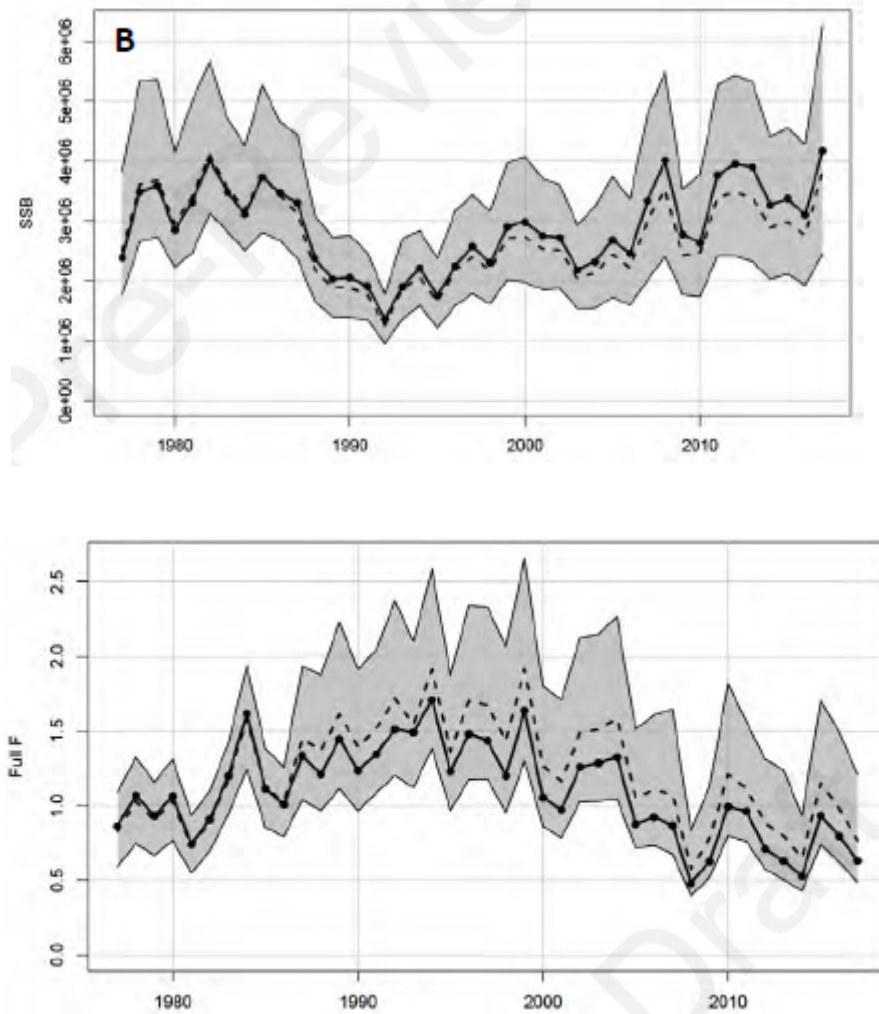


Figure 1. BAM estimates of SSB (as fecundity) in the top panel. Estimates from the same model for fishing mortality in the bottom panel. For both, the dashed lines are medians, the solid black lines are the estimates, and the shaded regions are the 90% confidence intervals.

Overall, the results were consistent with both the data inputs as well as the stock biology. Additionally, these results were consistent with the findings of the surplus production model, which further supported the findings.

In addition to the major sources of uncertainty of natural mortality, ageing, and fishery independent indices, the shape of the stock recruitment curve is perhaps the most difficult for this term of reference. The base model assumed a Beverton-Holt model in which steepness was fixed at 0.99. In practice, the underlying recruitment was effectively constant across the biomasses observed and with variations around this constant as shown below.

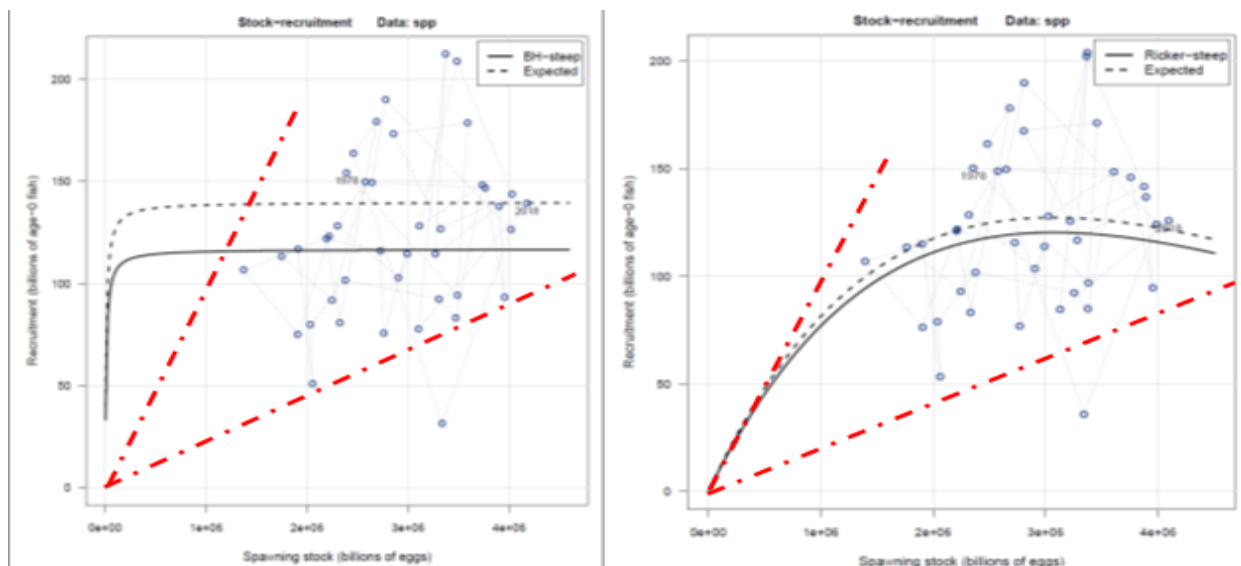


Figure xx. Stock-Recruit data: left panel from the base case with a Beverton-Holt function with steepness fixed at 0.99; right panel is with a Ricker function. The red diagonals are approximate replacement lines with no fishing (diagonal with smaller slope) and the replacement line at 25% SPR (larger slope).

Figure 2. Stock-Recruit data: Left panel from the base-case with a Beverton-Holt function with $h = 0.99$; right panel is a Ricker function. Red dashed lines are approximate replacement lines with no fishing (lines with smaller slope) and at 25% SPR (lines with larger slope). Note 1: Dashed grey line is Beverton-Holt on the left, Ricker on the right, with expected as a solid grey line in both panels. Note 2: Figure adapted from review panel consensus report.

While the use of this type of Beverton-Holt model is acceptable, it doesn't lend itself to estimates of MSY-based reference points as there is no maximum recruitment. Additionally, the use of SPR based reference points gave non-suitable results as outlined in the Assessment Workgroup report. These two factors together prompted the Assessment Team to suggest fishing reference points based on $F = M$ or some derivation. Such reference points are problematic for menhaden, as there is a large uncertainty around M , and the abundant literature which suggests $F = M$ may not be

sustainable for forage fisheries (Pikitch et al., 2012). During the Review Workshop the use of the Ricker stock recruitment relationship was tested, but the preliminary results suggested an SPR of 25% was not sustainable, in contrast to the stock's biology.

Two other possible alternatives suggested at the Review Workshop, hockey-stick and non-parametric approaches, were suggested for future exploration (See TOR 5). Additional suggestions based on historical performance were also made. All these suggestions made thus far, either in the assessment report or made during the Review Workshop, likely require extensive simulation testing, management input, and/or formal Management Strategy Evaluation (MSE). Reference points, no matter the stock, usually require some acknowledgment of trade-off, risks, and management goals for the stock in question.

To examine the status of the stock, the Review Panel examined the results of the surplus production model (ASPIC). Results from this analysis suggested $F_{2017}/F_{MSY}=0.31$ and $B_{2018}/B_{MSY}=1.53$. This coupled with observation that the stock has not experienced SPR less than 25% supported the Panel's conclusion that the stock is not likely overfished and is unlikely to be experiencing overfishing.

Overall the Review Panel concluded, and this author agreed, that the abundance, biomass, fishing mortality outputs from the BAM were reliable and consistent with both the input data and the biology of the stock. As such this TOR was met. While exact status relative to reference points cannot be ascertained, it is unlikely that the stock is overfished or that overfishing is occurring, given the trends and information/discussion presented elsewhere in this TOR. The stock recruitment relationship was found not to be informative in supplying status determination as currently formulated, as further work and MSE are needed to define management relevant reference points. In short, reliable information on stock trajectory, scale, and exploitation are available and reliable, but quantified measures for reference points are not. As such the qualitative status estimates mentioned above are based on ASPIC results and stock trajectory.

As experienced elsewhere in fisheries management and science, lack of defined biologically and management relevant reference points can be highly problematic. In the short term this author recommends the use of historically based reference points, with short term management centered around keeping the stock at or close to recent exploitation/ biomass. More moderate or long-term reference points should come from simulation as well as MSE. For both short and long-term, reference points cannot be derived without active management/stakeholder engagement, and specification of clear goals and objectives for this stock.

It is important to note that this is a vital forage stock for the Gulf of Mexico ecosystem. As such, any reference points selected, either short or long-term, should account for this important role of menhaden explicitly if the reference points are to be considered precautionary.

- 4) Consider how uncertainties in the assessment, and their potential consequences, are addressed.

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

The assessment of Gulf menhaden used two approaches to capture uncertainty, the use of sensitivity analysis and a Monte Carlo Bootstrap (MCB) procedure.

Sensitivity analysis is useful in two respects. It can be used to explore plausible states of nature, and to examine model behavior. The Assessment Team used a number of different runs to explore both aspects, including runs to examine ageing error, fecundity, indices, growth, natural mortality, steepness, index weightings, selectivity, and start year. A retrospective analysis was also performed to probe the influence of terminal year estimates of F and fecundity to examine bias.

Additional runs were also requested by the Review Panel including:

- Using a Ricker stock recruitment curve
- To use the nominal rather than the standardized index for the adult gillnet survey
- To set the gillnet survey start year at 1996 to coincide with the available length frequency data

The model appeared to be sensitive to three different configurations or parametrizations; natural mortality, ageing error, and inclusion/weight of the gillnet index. Natural mortality and ageing error, while having predictable results, highlight the general uncertainty with model scale. Ageing error, however, is something that can be readily addressed with more analysis and more study. Natural mortality, however, is more problematic, as it is likely to be changeable under various environmental conditions.

Of the sensitivities list above, inclusion of the gillnet index is perhaps the most problematic. While its inclusion in the model is appropriate, the results of the sensitivity analysis suggest that it changes the stock's trajectory as show below.

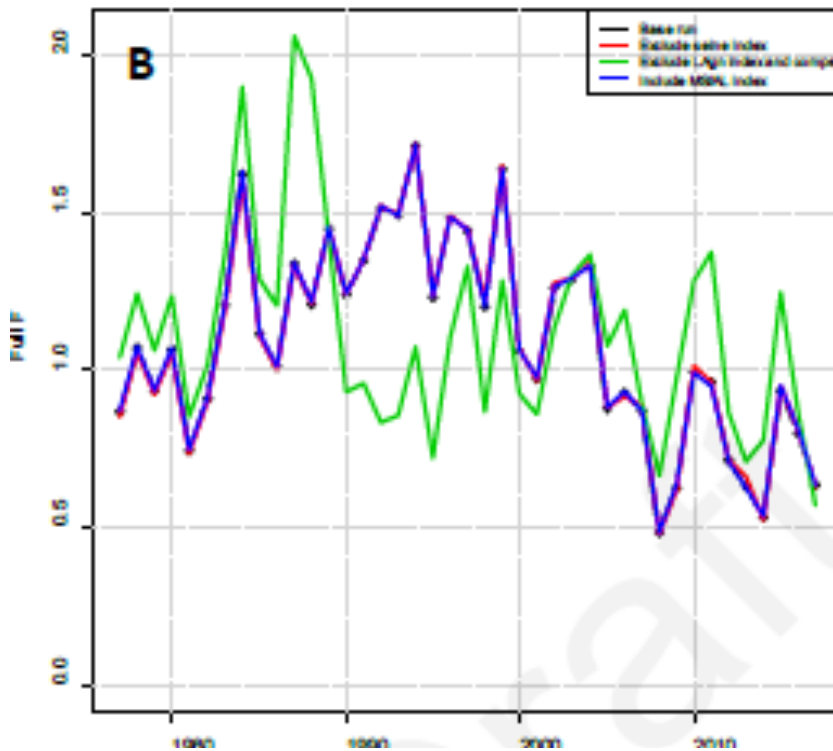


Figure 3. Sensitivity analysis around indices. The blue line is the base run, the red line excludes the juvenile seine index, the green line excludes the LA adult gillnet index, the dark blue line includes the MS/AL index. Note: except for the green line, most overlap and are hard to see.

Further examination during the Review Workshop suggests that this sensitivity is not the product of the length data, but rather the index for catch per unit effort. The small retrospective pattern seen with the BAM is a product of this index's conflict with the other data sources in the model.

The second way uncertainty is captured in the analysis is using MCB. The approach simulates different observations along with fixed model parameters to quantify uncertainties and derive confidence intervals. However, this approach can lead to problematic interpretations. Because many parameters are externally derived, they are confounded by other parameters in the model. For example, ageing error can affect selectivity and natural mortality. This could lead to a "double counting" of uncertainty. Additionally, using a uniform distribution for possible draws for natural mortality and selectivity, ignores the likelihood profile information which indicates that some values are more plausible than others. Alternatively, some important fixed parameters were not bootstrapped over (growth and likelihood weightings), while others were assigned a subjective level of uncertainty from the base run. Both of which could lead to under-estimations of uncertainty. While it's possible that these may cancel each other out, it is more appropriate to suggest that the estimates of uncertainty are uncertain themselves as it is unclear what they are truly measuring and if they are independent of each other.

This MCB is therefore best described as a combination of boot strap and sensitivity analysis. Despite its flaws, however, it is likely the best estimation of uncertainty available. Estimating uncertainty by only bootstrapping over the observations would underestimate uncertainty given the number of fixed parameters. However, some caution is advised in interpreting the results. Future research by this and other Assessment Teams is needed to fully capture uncertainty when using both fixed parameters and observations. It's an interesting subject worth serious work and review by all in the field.

Sensitivities and MCB aside, the most pressing problem for this assessment is a lack of management defined reference points. Given that MSY and SPR based reference points cannot, at this time, be developed, ad hoc methods are likely to be the most plausible in the short-term. While the Assessment Team and the Review Panel examined and discussed numerous options, by the end of the Review Workshop it was not possible to settle on a path forward. This is to be expected; reference points are based in large part on management objectives. To this end a key recommendation to resolving the uncertainty surrounding quantification of stock status is to have both managers and scientists work together for a solution. In the short-term, one possible avenue could be to examine reference points based on historical performance, while longer-term a more formal MSE approach with simulation, or simulation based around the use of a Ricker curve might be most useful. Regardless of when the process starts and how it proceeds, the role of menhaden as a forage species should be taken well into account, if sustainable reference points are the goal.

Overall the Panel concluded, and this reviewer agreed, that this TOR was well met. The Assessment Team spent considerable time and effort into selecting sensitivity analyses and interpreting the implications, performing the MBC, and explaining and presenting the results. All of this is clearly spelled out in the document.

- 5) Consider the research recommendations provided by the Data and Assessment workshop and make any additional recommendations or prioritizations warranted.
 - a. Clearly denote research and monitoring that could improve the reliability of, and information provided by, future assessments.
 - b. Provide recommendations on possible ways to improve the SEDAR process.

The Review Panel discussed the research recommendations from the Assessment Panel in detail. As stated above, the main sources of uncertainty included 1) the sensitivity of the model to inclusion of the adult gillnet survey and associated length data, 2) natural mortality, 3) lack of reference points or management benchmarks. Considering the main sources of uncertainty in this assessment, the Review Panel re-prioritized the Assessment Panel's list and made a few additions, as outlined below.

DATA ELEMENT	RECOMMENDATION	Priority
Tagging Analysis	Reevaluation of tag based natural mortality estimates including evaluation of tag data from Ahrenholz's original work.	High

Stock Status Benchmarks	Use simulations of potential stock recruitment relationships, coupled with MSE, to examine single species reference points or management approaches.	High
Modeling	Further explore alternative models, particularly ASPIC, and compare with the current model.	High
Modeling	Explore finer time resolution (e.g. quarterly) on the model.	High
Ageing	Continue to explore the effects of ageing error and ageing bias in the model.	High
Ageing	In cooperation with state agencies, implement ageing of fish caught in independent sampling to allow for the use of ages in modeling.	High
Genetics and Stock Structure	Improve species identifications at the periphery of the Gulf menhaden's range in Texas and Alabama/Florida waters for juveniles and adults.	Med
Tagging Study	Conduct Gulf menhaden tag/recovery study for better estimates of natural mortality, migration, growth, etc., which are inputs for the stock assessment. After achieve data analyzed.	Med
Modeling	Explore further diagnostics and presentation of model uncertainty.	Med
Predator/Prey	Expand understanding of diets of potential Gulf Menhaden predators using a variety of tools including traditional stomach analysis, DNA barcoding, and fatty acid profiles Gulf wide.	Med
Fishery-Independent Adult Index	Collect and age Gulf menhaden scales from fishery-independent gears (e.g., gill nets) to determine selectivity. Expand efforts to age menhaden by state agencies.	Med
Predator/Prey	Expand understanding of diets of potential Gulf Menhaden predators using a variety of tools including traditional stomach analysis, DNA barcoding, and fatty acid profiles Gulf wide.	Med
Fishery-Independent Juvenile Index	Design and implement a survey dedicated to determining menhaden recruitment in the coastal rivers and upper bays of the northern Gulf of Mexico.	Low
Genetics and Stock Structure	Identify menhaden-specific nuclear DNA markers (preferably microsatellites or SNPs) using lab-based DNA library screening techniques. Evaluate these markers for use in genetic studies of Gulf menhaden.	Low
Legacy Data (Fishery-Dependent Surveys)	Process and analyze samples that address the homogeneity of the catch in the hold of the reduction fishery vessels.	Low

While the Panel did not make detailed recommendations as to what should be improved in the SEDAR process (the individual CIE review reports contained some information), the Panel did agree that the recommendation to improve model diagnostics and presentation would be useful for this assessment, and that standardization of this type of presented information could improve other SEDAR assessments.

- 6) Provide guidance on key improvements in data or modeling approaches which should be considered when scheduling the next assessment.

Research recommendations highlighted above should be considered and, at least, explored prior to commencing the next assessment. These recommendations are specifically targeted at the main areas of uncertainty, including the adult gillnet survey and associated length structure, natural mortality, and lack of reference points or management benchmarks. The Review Panel agreed that

progress on these would be important prior to the next benchmark.

- 7) Prepare a Peer Review Summary summarizing the Panel's evaluation of the stock assessment and addressing each Term of Reference. Develop a list of tasks to be completed following the workshop. Complete and submit the Peer Review Summary Report in accordance with the project guidelines.

This report, and participation by this reviewer in writing parts of the summary consensus report, fulfills the requirements of this TOR.

Concluding remarks

As always, this reviewer tries to wrap up the review report with some personal comments and observations that do not tend to fit in directly with the TOR. This was a most enjoyable review from my perspective. The Assessment Team was professional and thorough, SEDAR staff were helpful and managed the process well, and my fellow reviewers were well prepared and made some of the best suggestions and comments I've seen in years.

The Assessment Team produced a complete and thorough report. While I would have liked there to be consistency between the use of fecundity and SSB, the rest of it was clear and concise. Clearly, they put a lot into the report and the assessment work behind it. Their presentations were equally clear, and the Team were very amenable to tweaking the model and producing alternate runs on the fly. It was clear they were knowledgeable and experienced in both menhaden and the process.

The SEDAR staff were equally professional and helpful. Things were well organized, reports and presentations were available prior to the meeting, and the other parts of the meeting ran very well. The TORs were clear and to the point.

The other reviewers were simply brilliant. Each brought different ideas and views to the table, challenged me personally to re-think positions, and in the end made huge contributions to improving the assessment through their suggestions. Our chair kept people on task and generally on-time, without rushing or cutting people off.

The only main detraction for the meeting was the venue. While the hotel was nice and amendable to working meetings, the location was less so. Between being on Bourbon Street in New Orleans and the resulting construction outside, it was noisy to say the least. This was true both during the meeting and while trying to sleep after. A suggestion to have future venues not be directly on Bourbon Street is perhaps best. Though I do have to admit that the food in the general area, as well as the historic nature of New Orleans, in some ways outweighed this one failing.

Of final note: the public comments by D. Butterworth were on point and gave the reviewers, myself included, some clarity as we discussed reference points. His input, though brief, was helpful.

Literature Cited

Ahrenholz, D.W. 1981. Recruitment and exploitation of Gulf menhaden, *Brevoortia patronus*. Fishery Bulletin 79(2):325-335.

Lorenzen, K. 1996. The relationship between body weight and natural mortality in juvenile and adult fish: A comparison of natural ecosystems and aquaculture. Journal of Fish Biology 49:627-647.

Pikitch, E., Boersma, P.D., Boyd, I.L., Conover, D.O., Cury, P., Essington, T., Heppell, S.S., Houde, E.D., Mangel, M., Pauly, D., Plagányi, É., Sainsbury, K., and Steneck, R.S. 2012. Little Fish, Big Impact: Managing a Crucial Link in Ocean Food Webs. Lenfest Ocean Program. Washington, DC. 108 pp.

Appendix 1: Bibliography of materials provided for review

SEDAR 63
Gulf Menhaden Workshop
Document List

Document #	Title	Authors
Final Assessment Report		
SEDAR63-SAR1	Assessment of Gulf Menhaden	To be prepared by
Reference Documents		
SEDAR63-RD01	Genetic Population structure of the Gulf Menhaden (<i>Brevoortia patronus</i>) Presentation from SFFMC Menhaden Advisory	Anderson 2016
SEDAR63-RD02	The Selection and Role of Limit Reference Points for Pacific Herring (<i>Clupea pallasii</i>) in British	Canadian Science Advisory Secretariat
SEDAR63-RD03	Data weighting in statistical fisheries stock	Francis 2011
SEDAR63-RD04	A Review of Biological Reference Points in the Context of the Precautionary Approach	Gabriel and Mace 1999
SEDAR63-RD05	A new role for MSY in single-species and ecosystem approaches to fisheries stock assessment and management	Mace 2001
SEDAR63-RD06	NPFMC Groundfish Species Profiles 2015	NPFMC 2015
SEDAR63-RD07	Fisheries for small pelagic species: an empirical	Patterson 1992
SEDAR63-RD08	Status of the Pacific Coast Groundfish Fishery: Stock Assessment and Fishery Evaluation	PFMC 2016
SEDAR63-RD09	A spatial model for fishery age-selection at the population level	Sampson & Scott
SEDAR63-RD10	GDAR 02: Gulf Menhaden Stock Assessment - 2016 Update	Schueller 2016
SEDAR63-RD11	Model-based estimates of effective sample size in stock assessment models using the Dirichlet-multinomial distribution	Thorson et al. 2017
SEDAR63-RD12	The Gulf Menhaden Fishery of the Gulf of Mexico: A Regional Management Plan, 2015 Revision	VanderKooy and Smith 2015

SEDAR63-RD13	Technical documentation of the Beaufort Assessment Model (BAM)	Williams and
SEDAR63-RD14	Fishery Models	Shertzer et al. 2014
SEDAR63-RD15	Gulf menhaden (<i>Brevoortia patronus</i>) fishery-	West and Zhang 2018

Appendix 2: Statement of Work

Performance Work Statement (PWS)

National Oceanic and Atmospheric Administration (NOAA)

National Marine Fisheries Service (NMFS)

Center for Independent Experts (CIE) Program

External Independent Peer Review

SEDAR 63 Gulf of Mexico Menhaden Review

Background

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

Scientific peer review is defined as the organized review process where one or more qualified experts review scientific information to ensure quality and credibility. These expert(s) must conduct their peer review impartially, objectively, and without conflicts of interest. Each reviewer must also be independent from the development of the science, without influence from any position that the agency or constituent groups may have. Furthermore, the Office of Management and Budget (OMB), authorized by the Information Quality Act, requires all federal agencies to conduct peer reviews of highly influential and controversial science before dissemination, and that peer reviewers must be deemed qualified based on the OMB Peer Review Bulletin standards¹. Further information on the Center for Independent Experts (CIE) program may be obtained from www.ciereviews.org.

Scope

The SouthEast Data, Assessment, and Review (SEDAR) is the cooperative process by which stock assessment projects are conducted in NMFS' Southeast Region. SEDAR was initiated to

¹ http://www.cio.noaa.gov/services_programs/pdfs/OMB_Peer_Review_Bulletin_m05-03.pdf

improve planning and coordination of stock assessment activities and to improve the quality and reliability of assessments. SEDAR 63 will be a CIE assessment review conducted for GSMFC Gulf of Mexico Menhaden. The Review Workshop will provide an independent review of the Gulf of Mexico Menhaden stock assessment. The term review is applied broadly, as the review panel may request additional analyses, error corrections and sensitivity runs of the assessment models provided by the assessment panel. The review panel is ultimately responsible for ensuring that the best possible assessment is provided through the SEDAR process.

The stock assessed through SEDAR 63 is within the jurisdictions of the Gulf States Marine Fisheries Commission and the states of Florida, Alabama, Mississippi, Louisiana, and Texas.

The specified format and contents of the individual peer review reports are found in Annex 1. The Terms of Reference (TORs) of the peer review are listed in Annex 2. Lastly, the tentative agenda of the panel review meeting is attached in Annex 3.

Requirements

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

Tasks for Reviewers

1) Review the following background materials and reports prior to the review meeting:

SEDAR 63 Workshop Reports and background documents will be available on the SEDAR website at the links below.

<http://sedarweb.org/sedar-63>

<http://sedarweb.org/sedar-63-review-workshop->

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

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

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

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

Foreign National Security Clearance

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

Place of Performance

The place of performance shall be at the contractor's facilities, and in New Orleans, LA.

Period of Performance

The period of performance shall be from the time of award through January 2019. The CIE reviewers' duties shall not exceed 14 days to complete all required tasks.

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

Within two weeks of award	Contractor selects and confirms reviewers
No later than Oct. 23, 2018	Contractor provides the pre-review documents to the reviewers
November 6 - 7, 2018	Panel review meeting
Approximately 4 weeks later	Contractor receives draft reports
Within 2 weeks of receiving draft reports	Contractor submits final reports to the Government

Applicable Performance Standards

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

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

Travel

All travel expenses shall be reimbursable in accordance with Federal Travel Regulations (<http://www.gsa.gov/portal/content/104790>). International travel is authorized for this contract. Travel is not to exceed \$10,000.

Restricted or Limited Use of Data

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

Project Contacts:

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Appendix 3: Panel membership

Review Workshop Participant List

REVIEW PANEL

- Will Patterson Review Panel Chair GSMFC Appointee
- Joe Powers Reviewer GSMFC Appointee
- Matt Cieri CIE Reviewer CIE
- Anders Nielsen CIE Reviewer CIE
- Kevin Stokes CIE Reviewer CIE

ANALYTICAL REPRESENTATIVES

- Amy Schueller Lead analyst SEFSC Beaufort
- Robert Leaf Assessment Team GCRL
- Ray Mroch Assessment Team SEFSC Beaufort

COUNCIL AND COMMISSION STAFF

- Julia Byrd Coordinator SEDAR
- Kimberly Cole Admin SEDAR/SAFMC
- Steve VanderKooy IJF/Aquaculture Coordinator GSMFC