Independent Peer Review of the

Southeast US Hogfish Stock Assessments of the East Florida/Keys and West Florida Shelf

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by

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Executive Summary

Two stock assessments for hogfish (*Lachnolaimus maximus*) were conducted using Stock Synthesis 3: a) the East Florida/Keys (EF/Keys) assessment and b) the West Florida Shelf (WFS) assessment. The following Review examines the efficacy of each of those assessments in terms of specified terms of reference.

Both assessments incorporated commercial and recreational removals, fishery-independent indices of abundance, length-composition and conditional age-at-length data, and biological information appropriate for the protogynous life history of hogfish. The performance of each model was evaluated using an extensive suite of diagnostics and sensitivity analyses.

An important finding of this review was that large uncertainties associated with protogynous hogfish reproductive behavior and their statistical ramifications with the existing data sets for the stocks precluded the determination of a reliable stock recruitment relationship that could be used for management. In the WFS case no stock recruitment relationship could be estimated within the SS3 model. In the EF/Keys case, a stock recruitment relationship was estimated, but with insufficient reliability for management use due to statistical limitations and weak data streams related to the historical catch reconstruction for years 1950 to 86. Thus, it is recommended herein that the EF/Keys alternative model with the 1986 starting year and a steepness of 0.99 be used for the base model. In both assessment cases this implies that the SPR proxy approach is most appropriate for evaluating status criteria.

The accepted assessment models for the two stocks were appropriately configured and applied, and the resulting population estimates were sufficiently reliable and consistent with the available fishery-dependent and fishery-independent data, and the known biology of hogfish. The results indicated that based on existing status criteria, neither stock is overfished or undergoing overfishing.

Status uncertainties were evaluated using posterior distributions of the MCMC analyses, although the EF/Keys results were not available at the Review meeting due to the change in base model.

However, important uncertainties remain regarding stock productivity, the stock recruitment relationship, and several data sources. These qualifications should accompany interpretation and use of the assessment results, but do not alter the two assessment models.

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1. Background

NOAA Fisheries 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). NOAA Fisheries 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.

To that end the **SouthEast Data, Assessment, and Review (SEDAR)** was established as the cooperative process by which stock assessment projects are conducted in NOAA Fisheries' Southeast Region. SEDAR was initiated to improve planning and coordination of stock assessment activities and to improve the quality and reliability of assessments. Through that process a review was requested of the SEDAR 94 assessment of two stocks of Hogfish: the West Florida Shelf Stock and the East Florida/Florida Keys Stock through a review workshop (July 14-17 in Charleston, SC) by a Review Panel including the Center of Independent Experts (CIE). The Review Panel was ultimately responsible for ensuring the scientific basis of the assessment through the SEDAR process.

2. Description of the Individual Reviewer's Role in the Review Activities

I was designated to be a CIE Reviewer for the two hogfish assessments, to be conducted impartially, objectively, and without conflicts of interest. The report herein is my CIE evaluation of these studies in the context of the specific TORs noted below. As such I participated in the Review Panel as a Panel Member (Appendix 3) to ensure that stock assessment was adequate and facilitate the use of this information for management purposes; to provide an independent external review of these stock assessments that meet legal requirements; and to identify research needed to improve the assessment and advice for fishery managers.

3. Summary of Findings for Each Term of Reference (TOR)

The following section begins with a general discussion of the model construction for the two assessments and a detailed discussion of the important use of the stock-recruitment relationship. This discussion provides explanations, conclusions and suggestions that support responses to questions in the TORs listed below. By so doing, I hope to shorten responses to the individual questions and to keep redundancies to a minimum.

3.1 General discussion of EF/Keys and WFS Hogfish assessments.

General Model Construction EF/Keys

The EF/Keys model was constructed using Stock Synthesis 3 (SS3; version 3.30.24) integrating the catch, size, index and life history data to estimate quantities used in management criteria including status criteria and their probabilities that they are being achieved. Originally, the model included a catch reconstruction for 1950 to 86. However, for reasons noted below (section on Stock-Recruitment), it was recommended that modeling feature be dropped and the default stock-recruitment relationship be used (h=0.99), rather than estimating all the parameters of a Beverton-Holt (BH) stock recruitment relationship.

The assessment analyses evaluated a comprehensive suite of diagnostics to support a final set of model alternatives including model convergence using final gradients, Hessian properties, parameter-bound checks, and jitter analyses. Sensitivity analyses and likelihood profiles were also used extensively to examine important model assumptions.

“Super-periods” were used for commercial and recreational length-frequency data to reduce estimation difficulties caused by sparse annual sampling. I view this as a form of a “pooling strategy” which is presently acceptable, but the strengths and weaknesses of super-periods are not sufficiently understood and the Panel recommended additional future methodological research.

The assessment employed an extensive and generally appropriate suite of methods for evaluating uncertainty. These included variance estimates associated with input data, likelihood profiles, sensitivity analyses, jitter analyses, retrospective analyses, asymptotic standard errors, MCMC analyses, and parametric bootstrap analyses.

The assessment estimated a large number of biological, recruitment, catchability, selectivity, retention, and discard-related parameters. Uncertainty associated with input datasets was incorporated into SS3 as appropriate, and likelihood profiles and sensitivity analyses were used to evaluate influential assumptions and model configurations.

The model also used a sum-to-zero constraint on recruitment deviations, in part to reduce retrospective patterns and remove indeterminacy between the scale of the stock-recruit relationship and the mean recruitment deviations. This constraint created difficulties for ADMB MCMC sampling because it restricted efficient exploration of the parameter space. Consequently, MCMC analyses required a proxy model in which the sum-to-zero constraint was removed. This issue was particularly important because the proxy model produced some differences in estimated stock size relative to the corresponding base model. The proxy approach was an acceptable methodological compromise for investigating uncertainty but further research into this issue is needed. Moreover, due to the conversion of the base model from the 1950-2024 data stream with a BH stock recruitment model to the 1986-2024 data stream with h=0.99, the MCMC analyses for ***EF/Keys*** were not conducted at the meeting and was conducted subsequently.

Growth was estimated internally within the model, which provides an effective means of accounting for interactions among growth, length selectivity, and size truncation. Conditional age-at-length information was incorporated to improve estimation of growth and selectivity while reducing biases associated with length-stratified or otherwise size-selective sampling.

The assessment also used the SS3 growth-platoon feature to represent effects of size-selective mortality on the distribution of size at age. The model assumed equivalent growth rates for males and females.

General Model Construction WFS
Stock Synthesis 3 (SS3; version 3.30.24) was used for the assessment of the WFS hogfish stock. A comprehensive set of diagnostics and sensitivity analyses were computed. Model convergence was evaluated using final gradients, Hessian properties, parameter-bound checks, and jitter analyses from dispersed starting values. Likelihood profiles, retrospective analyses, sensitivity runs, parametric bootstrap analyses, and MCMC analyses provided additional evaluation of model behavior and uncertainty.

Steepness was fixed at 0.99 because an informative stock-recruit relationship could not be estimated from the available data. The assessment used super-periods for commercial and recreational length-frequency data to address sparse sampling. A sum-to-zero constraint was applied to recruitment deviations in the base assessment model. The age- and size-structured SS3 model accommodated the available length compositions, CAAL observations, abundance indices, uncertain catch information, and historical changes in fishery regulations. Growth was estimated internally within the model accounting for interactions among growth, length-based selectivity, and size truncation in sampled fish. The model incorporated the SS3 growth-platoon feature to represent the effects of size-selective mortality on the distribution of size at age. The model assumed equivalent growth rates for males and females. Uncertainty was evaluated extensively in the ***WFS*** assessment and the analyses captured many of the important sources of parameter, data, and model uncertainty. The ***WFS*** model estimated a large number of biological, recruitment, catchability, selectivity, retention, and discard-related parameters. Variance estimates associated with input data were incorporated into SS as appropriate, and alternative model configurations and parameter assumptions were evaluated through sensitivity analyses, likelihood profiles, retrospective analyses, jitter analyses, and other standard model diagnostics. In addition to asymptotic uncertainty estimates derived from the covariance matrix, MCMC and parametric bootstrap analyses were conducted. The MCMC analysis produced posterior distributions for model parameters and important derived management quantities permitting probabilistic evaluation of stock status.

Stock-Recruitment:
The stock recruitment model tested in the hogfish assessments was the Beverton-Holt (BH) relationship where recruitment is a function of egg production and Spawning Stock Biomass (SSB), i.e. the mature female biomass, was assumed to be proportional to egg production. The assessment followed the recommendation of Brooks et al. 2008 in which it was recommended that SSB be measured using both male and female SSB. Since there was some reticence at the Review Panel meeting about this decision, I present a quick examination of the underlying models that led to Brooks et al.'s decision. I also look at Per Recruit analyses (based on ***EF/Keys*** life history) and its ramifications for SPR and SSB/R. Although the ***EF/Keys*** assessment estimated all of the parameters of a BH model, the Review Panel rejected this approach (and I concur with that rejection). The following discussion adds some support to that rejection.

The standard BH S-R function using female spawning stock biomass, i.e., $SSB_{Fem|F}$, under a specific fishing mortality regime (F) is

$$R = \frac{A\,SSB_{Fem|F}}{1 + B\;\,SSB_{Fem|F}} = \frac{A\,SSB_{Both|F}}{\frac{SSB_{Fem|F}}{SSB_{Both|F}} + B\;\,SSB_{Both|F}} = \frac{A\,SSB_{Males|F}}{\frac{SSB_{Fem|F}}{SSB_{Males|F}} + B\;\,SSB_{Males|F}} \qquad Eq\{1\}$$

Brooks et al 2008 included a probability of fertilization $f(x|F)$ $term$, modeling it as

$$f(x|F) = \frac{1}{\gamma + \frac{\lambda}{x|F}} \qquad where \quad x|F = \frac{N_{Males|F} / N_{Both|F}}{N_{Males|F=0} / N_{Both|F=0}}$$

leading to

$$R = \frac{A\ SSB_{Fem|F}}{\frac{1}{f(x|F)} + B\ \ SSB_{Fem|F}} = \frac{A\ SSB_{Fem|F}}{\left(\gamma + \frac{\lambda}{x|F}\right) + BSSB_{Fem|F}} = \frac{A\ SSB_{Both|F}}{\left(\gamma + \frac{\lambda}{x|F}\right)\frac{SSB_{Fem|F}}{SSB_{Both|F}} + B\ \ SSB_{Both|F}}$$

Or completing the algebra

$$R_{Brooks\ et\ al} = \frac{A\ SSB_{Both|F}}{\left\{\frac{SSB_{Fem|F}}{SSB_{Both|F}}\right\}\left\{\gamma + \lambda\frac{N_{Males|F=0}}{N_{Both|F=0}}\frac{N_{Both|F}}{N_{Males|F}}\right\} + B\ SSB_{Both|F}} \qquad Eq\{2\}$$

The basic results of the Brooks et al. simulations were that, if you are using SSB as the measure of fertilized egg production and you are not (or cannot) include $f(x|F)$ in the model, then it is better to use

$$R|both = \frac{A\ SSB_{Both|F}}{1 + B\ \ SSB_{Both|F}} \ \ rather\ than\ \ R|Fem = \frac{A\ SSB_{Fem|F}}{1 + B\ \ SSB_{Fem|F}} \quad or\ rather\ than\ R|Male = \frac{A\ SSB_{Males|F}}{1 + B\ \ SSB_{Males|F}}$$

as an approximator of $R_{Brooks\ et\ al}$. "Better" was defined in the context of SPR, SSB at MSY and MSY. Equivalently, their results indicated that assuming $1 \cong \left\{\frac{SSB_{Fem|F}}{SSB_{Both|F}}\right\}\left\{\gamma + \lambda\frac{N_{Males|F=0}}{N_{Both|F=0}}\frac{N_{Both|F}}{N_{Males|F}}\right\}$,

by using the *R|both* model, is better than the alternatives. Thus, $R|both = \frac{A\ SSB_{Both|F}}{1+B\ \ SSB_{Both|F}}$ was examined in the hogfish assessments. Note that the standard 2-parameter BH models implicitly include the notion of a probability of fertilization factor. It's just that the standard models assume that probability is either constant or proportional to SSB and thus, the factor is absorbed into one of the other two parameters. So, from a theoretical S-R standpoint, it is largely irrelevant whether you use SSBmales, females or both when the probability of fertilization is proportional. However, from a practical standpoint it can be important because you are expanding or contracting the x-axis (the SSB measure) based on the choice and the statistical interpretation of any data set might be problematic in highly variable data sets. Additionally, our traditional interpretations of SPR 30% or so being a reasonable proxy of SPRmsy may also be suspect.

I, also, looked at SSB/R analysis of males and females using ***EF/Keys*** parameters (see Table1, but I don't think I got the M at age vector exactly right, but it is close enough to make my point). Selectivity was arbitrarily specified by me.

Table 1. Hogfish life history					
Age	Nat Mort	Selectivity	Maturity	Prob trans	Weight
0.5	0.3105 per 1/2 yr	0	0.0104	0.008314	2.43E+01
1	0.47	0.1	0.2376	0.014619	5.62E+01
2	0.338	0.6	0.5895	0.039967	1.62E+02
3	0.279	0.8	0.9635	0.093103	3.15E+02
4	0.245	1	0.9977	0.186008	4.99E+02
5	0.224	0.8	0.9999	0.321496	6.98E+02
6	0.224	0.7	1	0.486305	9.00E+02
7	0.224	0.6	1	0.653523	1.10E+03
8	0.224	0.5	1	0.79504	1.28E+03
9	0.224	0.5	1	0.894937	1.45E+03
10	0.224	0.5	1	0.953755	1.60E+03
11	0.224	0.5	1	1	1.74E+03
12	0.224	0.5	1	1	1.86E+03
13	0.224	0.5	1	1	1.97E+03
14	0.224	0.5	1	1	2.06E+03
15	0.224	0.5	1	1	2.13E+03
16	0.224	0.5	1	1	2.20E+03
↓	↓	↓	↓	↓	↓ using von Bert and allometric

Table 2. Per-recruit analyses using Table 1 life history. Note that the fishing rate Fmult (F_{age}=Fmult*Sel_{age}) is not the same as the F rate measure used in the hogfish assessments to summarize the annual fishing mortality rate. Also, recruitment is assumed to occur at age 0.5 composed of all females, as in the assessments.

Frmult	# Females	# Males	Ratio M/F	# Mature Females	# Mature Males	Mature Ratio M/F	SSB Females	SSB Males	SSB Ratio M/F	SPR Females	SPR Males	SPR Both
0	2.94	1.02	0.35	1.20	1.01	0.84	454.86	1394.13	3.06	1.00	1.00	1.00
0.1	2.82	0.68	0.24	1.08	0.67	0.62	378.93	836.33	2.21	0.83	0.60	0.66
0.2	2.72	0.48	0.18	0.99	0.47	0.47	320.55	530.95	1.66	0.70	0.38	0.46
0.3	2.65	0.36	0.13	0.91	0.34	0.37	275.11	352.92	1.28	0.60	0.25	0.34
0.4	2.58	0.27	0.11	0.85	0.26	0.31	239.28	243.97	1.02	0.53	0.17	0.26
0.5	2.53	0.22	0.09	0.80	0.20	0.26	210.69	174.62	0.83	0.46	0.13	0.21
0.6	2.48	0.18	0.07	0.75	0.16	0.22	187.59	128.98	0.69	0.41	0.09	0.17
0.7	2.44	0.15	0.06	0.72	0.14	0.19	168.71	98.04	0.58	0.37	0.07	0.14
0.8	2.40	0.13	0.05	0.68	0.12	0.17	153.10	76.52	0.50	0.34	0.05	0.12

Table 2 indicates that one's interpretation of what FSPR% is appropriate as a proxy for Fmsy changes based on whether SSB is in males, or females or both; and that the perceptions are sensitive to the M vector and the probability of sex transition. And since Table 2 results are Per-Recruit, these are independent of the specific SR function. This exemplifies the effect of the male-female SSB choice on the scale being used on the x-axis of a SR curve.

I often look at the choice of an SSBmsy proxy through the SSB at maximum excess recruitment; that is SSB_{MER}, the point on the SR curve where the slope is equal to $1/\phi = R_{|F=0}/SSB_{Fem|F=0}$ or equivalently where $\partial R/\partial\, SSB_{Fem|F} = 1/\phi$. In fact, I am a proponent of using $SPR_{F\ at\ MER}$ as the conservation standard rather than MSY, but then that's a longer story. In any case, for common selectivity patterns like hogfish SPR_{MER} and SPR_{MSY} are usually close. The SPR_{MER} for the standard BH model (Eq {1}) is

$$SPR_{MER} = \sqrt{SPR_{\alpha}} = \sqrt{(1-h_{BH})/4h_{BH}} = \sqrt{(1/A)/\phi} \qquad from\ Eq\{1\}$$

If the SR model includes the probability of fertilization term of the Brooks et al., then we have

$$SPR_{MER} = \sqrt{\{(1/A)/\phi\}\{[(\lambda+\gamma)x|F]/[\lambda+\gamma\ x|F]\}} \qquad from\ Eq\{2\}$$

for a fixed x|F. We can't find an "optimal" x|F for SPR_{MER} without specifying the relationship between the number of males and of females to the ratio of SSB males and SSB of females at a given F. Suffice it to say, that x|F is positively related to SSB_{males}/SSB_{both}. Numerically, this can be derived for a given life history and essentially this was what Brooks et al did in relationship to SPR_{MSY}, rather than SPR_{MER}.

The point of this is that our perceptions of what is a good proxy MSY changes with the f(x|F) model that we choose. Remember that the fertilization rate is basically an instantaneous event at the beginning of the recruitment process. Given that fertilization occurs, one would expect the recruitment process of protogynous larvae to be governed by the standard BH. But it is likely that protogynous fertilization is density-dependent to some unknown degree. We lack an understanding of protogynous reproductive habits and how they relate to the SR function and SSB/R.

An example of this is in Table 2, where the parameterization is close to that used for ***EF/Keys***. The equilibrium sex ratio of mature individuals when there was no fishing was relatively close to 1:1 (Table 2). If this were the case, it suggests that in the "natural" system (where F=0) there were a lot of individual males that don't align with the perception of hogfish reproduction being governed by a single territorial male with a harem of "many" females. If so, with Table 2's parameterization, the natural state would have a large number of unreproductive males presumably without harems and possibly without territories. Again, we just don't know.

Beyond the above theoretical SR arguments above, there are statistical reasons to question the efficacy of the SR in the original ***EF/Keys*** assessment. Generally, the original 1950-2024 ***EF/Keys*** model estimated a large number of SR parameters: R_0, h, ϕ, SigmaR and the constraint that deviations sum to zero. First, the SR is very sensitive to the harvest reconstruction 1950 to 1986 essentially forcing the SR model into a steep decline of male SSB with increased F in the early years, forcing a lower steepness. In particular, recreational catch during the historical period was reconstructed using effort information from the National Survey of Fishing, Hunting, and Wildlife-Associated Recreation together with CPUE inferred from recreational data available for 1982, 1983, and 1985 which assumed catch rates during that period. The associated SR model does not appear to be robust to this reconstruction.

Also, it was argued that the constraint that the sum of the deviations equals zero was imposed to avoid retrospective problems in the most recent years. However, in my opinion the constraint puts undue weight on the notion that the underlying BH SR model is correct.

Also, by estimating a single sigmaR over the entire range of SSBs for a BH SR, one is assuming without much evidence that the variability in recruitment gets smaller at lower SSB. Do we really know how the population responds to a recruitment- ecosystem when in a depleted state? It should be noted that the original 1950-2024 ***EF/Keys*** SR estimated a sigmaR of about 45%, whereas for many stocks sigmaR values imposed are 60 to 100%.

In general, it appears that the original SR model is overspecified. Thus, for all the reasons noted above, it is concluded that the 1950-2024 ***EF/Keys*** data/model did not support reliable estimation of an informative stock-recruit relationship. Thus, it is recommended that the 1986-2024 ***EF/Keys*** model with h=0.99 and an SPR proxy for MSY be used for management purposes. This assumes that the best estimate of recruitment for this stock is obtained **by assuming that h=0.99 over the *observed range of SSB's of 1986-2924*, not that the underlying model is a BH with an h=0.99**. However, given the lack of understanding about hogfish reproductive life history noted in the arguments above, there is sufficient uncertainty about the current Fmsy proxy (F30%SPR) to suggest that a lower F proxy for msy is warranted (i.e. SPR > 30%).

An SR function was not able to be estimated for the ***WFS*** stock. Thus, the default of h=0.99 was appropriately imposed. However, all the arguments above about life history and reproductive behavior AND the suggestion for a lower F proxy for msy pertain to the ***WFS*** stock as well as to the ***EF/Keys*** stock.

The above discussion leads to several of personal recommendations for modeling/simulation exercises to improve future assessments:

- Explore the statistical ramifications of the sum of deviations=0 constraint (this is a broader issue of all assessments not just hogfish or even protogynous fish)
- Explore transition probabilities that are dependent on sex ratio as well as age or length

(rather just age (length) as is done now) and their ramifications on management quantities

Feasibility of estimating sex-ratio related SR parameters and their tradeoff with other parameters

Explore SSB-dependent sigmaR's (this is a broader issue of all assessments not just hogfish or even protogynous fish)

3.2 TOR 1: Evaluate the data used in the assessment, including discussion of the strength and weaknesses of data sources and decisions.

EF/Keys

a) Are data decisions made by the DW and AW panels sound and robust?

Yes, the decisions to aggregate commercial gears into a single commercial fleet, combine SRHS landings and discards with SRFS hook-and-line estimates, and aggregate the recreational fishery into a single fleet were considered sound and robust. However, the reconstructed catches (1950 to 86) were not deemed to be robust because of their undue influence on the SR relationship (see section 3.1). Ultimately, this led to the recommendation to use the 1986-2924 model with steepness set to 0.99 (again see section 3.1).

b) Are data uncertainties acknowledged, reported, and within normal or expected levels?

Data uncertainties are relatively high but acknowledged and expected given the data collection systems. Of particular concern are the recreational spearfishing estimates and MRIP estimates of recreational harvest and discards with high coefficients of variation. Also, note the uncertainty with the 1950 to 86 catch reconstruction and the ensuing decisions (a) and section 3.1).

c) Are input data series reliable and applied properly within the assessment model?

As noted in a) above and in section 3.1 it was recommended that the assessment model not use the 1950 to 86 reconstructed catches and the base model be revised accordingly. The other data series were applied properly in the new base model.

WFS

a) Are data decisions made by the DW and AW panels sound and robust?

Yes, the assessment incorporated the standard data sets of landings (commercial and recreational), fishery-independent abundance indices, length compositions, and age-at-length data. Aggregation of commercial gears into a single commercial fleet was appropriate. Also, combining the relatively small SRHS landings and discards with SRFS hook-and-line estimates was considered reasonable.

There was a general discussion and agreement about the recreational fisheries and the fact that the hook-and-line component has recently increased such that separate components of spearfishing and hook and line were modeled.

b) Are data uncertainties acknowledged, reported, and within normal or expected levels?

Data uncertainties are relatively high but acknowledged and expected given the data collection systems. Of particular concern are the recreational spearfishing estimates and MRIP estimates of recreational harvest and discards with high coefficients of variation.

c) Are input data series reliable and applied properly within the assessment model?
Yes, the data inputs and their treatment in the WFS assessment were applied properly recognizing the uncertainty estimating recreational spear catches and landings.

3.3 TOR 2: Evaluate and discuss the strengths and weaknesses of the methods used to assess the stock, taking into account the available data

EF/Keys

a) Are methods scientifically sound and robust?

Yes (see section 3.1 ***General Model Construction EG/Keys*** and ***Stock-Recruitment***)
Uncertainty analyses were especially important for evaluating the influence of the reconstructed historical catches and assumptions regarding initial conditions and stock-recruit dynamics. While the model framework was scientifically sound, it was recommended that an alternative base model be used that would be more robust.

Stock Synthesis 3 (SS3; version 3.30.24) is a scientifically sound and robust framework for assessing this Hogfish stock. A strength of this application of SS3 was the extensive suite of diagnostics during model development. These analyses were particularly important for evaluating the influence of the reconstructed historical catches and assumptions regarding initial conditions and stock-recruit dynamics. These analyses supported the recommendation for the alternative base-model configuration.

b) Are assessment models configured properly and consistent with standard practices?
The alternative base model (1986-2024, h=0.99) was appropriately configured and consistent with accepted assessment practices. Of particular importance was the examination of the stock recruitment model (section 3.1) leading to the alternative base.

Super-periods were used for commercial and recreational length-frequency data to reduce estimation difficulties caused by sparse annual sampling. This is acceptable but there is a need for further evaluation of this method.

The sum-to-zero constraint created difficulties for ADMB MCMC sampling because it restricted efficient exploration of the parameter space. Consequently, MCMC analyses required a proxy model in which the sum-to-zero constraint was removed. This issue was particularly important because the proxy model produced some differences in estimated stock size relative to the corresponding base model. The proxy approach was an acceptable method for investigating uncertainty but further research is needed.

c) Are the methods appropriate for the available data?
Yes, the methods were appropriate for the available data (see section 3.1)

The age- and size-structured SS3 framework appropriately accommodated the available catch data, intermittent length compositions, conditional age-at-length observations, abundance indices, and changes in fishery size limits and other regulations.

Growth was estimated internally within the model, which provides an effective means of accounting for interactions among growth, length selectivity, and size truncation. Conditional age-at-length information was incorporated to improve estimation of growth and selectivity while reducing biases associated with length-stratified or otherwise size-selective sampling.

Additional sensitivity analyses of growth-platoon assumptions are recommended because this component of SS3 is less familiar.

WFS

a) **Are methods scientifically sound and robust?**

Yes (see section 3.1 ***General Model Construction WFS*** and ***Stock-Recruitment***)

b) **Are assessment models configured properly and consistent with standard practices?**

Yes, (Section 3.1)

Super-periods were used for commercial and recreational length-frequency data to reduce estimation difficulties caused by sparse annual sampling. This is acceptable but there is a need for further evaluation of this method.

The sum-to-zero constraint created difficulties for ADMB MCMC sampling because it restricted efficient exploration of the parameter space. Consequently, MCMC analyses required a proxy model in which the sum-to-zero constraint was removed. This issue was particularly important because the proxy model produced some differences in estimated stock size relative to the corresponding base model. The proxy approach was an acceptable method for investigating uncertainty, but further research is needed.

c) **Are the methods appropriate for the available data?**

Yes, the methods were appropriate for the available data (see sections 3.1 and 3.2)

3.4 TOR 3: Evaluate the assessment findings.

EF/Keys

I have reordered the questions of TOR 3 to begin with the stock-recruitment question since answers to the other questions flow from the stock-recruitment analyses.

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

No, the BH model as tested in the 1950 to 2024 model structure was not sufficiently reliable and useful for evaluation of productivity and future stock conditions. This conclusion is based on the extensive discussion and analyses in section 3.1 ***Stock Recruitment***. Thus, it is recommended that the alternative base model with 1986-2024 data (h=0.99) and an SPR proxy for msy (referred to as RW-Base)

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

The RW Base model is sufficiently reliable and useful for stock-status inference. Hence, that conclusion is based on the uncertainty of catch reconstruction, uncertainty of protogynous hogfish reproductive behavior and statistical issues (section 3.1) which led to the conversion to RW Base as the acceptable model.

Despite the difference in starting years between the original 1950–2024 model and the revised 1986–2024 model, the two configurations produced broadly similar temporal trends in spawning stock biomass and fishing mortality. This consistency provided some reassurance that the principal recent stock trajectory was robust.

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

Based on RW Base model and the applicable SPR-based biomass reference point, the current SSB is greater than the SSB at that reference point, indicating by that criterion the stock is not overfished.

Note that MCMC and parametric bootstrap analyses corresponding specifically to RW Base were not available during the Review Workshop. Consequently, it was not possible to evaluate the probabilistic robustness of this status determination using posterior distributions for the final revised model during the workshop.

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

Based on RW Base model and the applicable SPR-based fishing mortality rate reference point, the current fishing mortality rate is less than the FSPR reference point, indicating by that criterion the stock is not undergoing overfishing.

As with the biomass determination, this conclusion is based on SPR proxies and did not rely on MCMC and bootstrap analyses. The associated probabilistic characterization of uncertainty for the revised model remained to be completed before subsequent consideration by the SSC.

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

It is concluded that SPR-based status determination criteria are appropriate for the RW Base model because an informative stock-recruit relationship could not be reliably estimated. Nevertheless, there are ample arguments there is unknown uncertainty in the appropriate specification of the proxy (section 3.1 ***Stock Recruitment***). The SSC and Council should therefore recognize this structural uncertainty when interpreting assessment-derived management quantities.

WFS

I have reordered the questions of TOR 3 to begin with the stock-recruitment question since answers to the other questions flow from the stock-recruitment analyses.

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

No, the base WFS model was not able to estimate a stock recruitment relationship. Thus, the SPR proxy method for msy was used. The arguments about SR use noted in the extensive discussion and analyses in section 3.1 ***Stock Recruitment*** are still extant.

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

The population estimates generated by the ***WFS*** Base model were sufficiently reliable, consistent with the available data and known biology, and appropriate for supporting stock-status inferences.

c) Is the stock overfished? What information helps you reach this conclusion?

Based on WFS Base and the applicable SPR-based biomass reference point, the current SSB is greater than the SSB at that reference point, indicating by that criterion the stock is not overfished.

Current spawning stock biomass, was estimated at approximately 1,086 mt, substantially greater than the minimum stock size threshold (MSST) of approximately 259 mt based on the SPR30% reference point. The uncertainty analysis strongly supported this conclusion. The posterior distribution from the MCMC analysis for the ratio of current SSB to MSST was entirely above 1. Thus, the conclusion that the stock is not overfished was robust to the parameter uncertainty represented by the MCMC analysis.

d) Is the stock undergoing overfishing? What information helps you reach this conclusion?

Based on RW Base model and the applicable SPR-based fishing mortality rate reference point, the current fishing mortality rate is less than the FSPR reference point, indicating by that criterion the stock is not undergoing overfishing.

The posterior distribution of the fishing mortality status ratio was entirely below 1, with a posterior median of approximately 0.28. The available uncertainty analyses therefore provide strong evidence that recent fishing mortality is below the applicable maximum fishing mortality threshold.

e) Are the quantitative estimates of the status determination criteria for this stock reliable? If not, are there other indicators that may be used to inform managers about stock trends and conditions?

It is concluded that SPR-based status determination criteria are appropriate for the ***WFS*** Base model because an informative stock-recruit relationship could not be reliably estimated. Nevertheless, there are ample arguments there is unknown uncertainty in the appropriate specification of the proxy (section 3.1 ***Stock Recruitment***). The SSC and Council should therefore recognize this structural uncertainty when interpreting assessment-derived management quantities.

3.5 TOR 4: Evaluate the stock projections, including discussing strengths and weaknesses

EF/Keys

a) Are the methods consistent with accepted practices and available data?

The projection methodology was consistent with accepted practices and appropriate for the available data. The Allocation-Forecasting framework developed by the SEFSC provides an established mechanism for conducting forecasts using SS3 assessment results and allocating catches among fleets. The methodology can accommodate alternative recruitment assumptions, fishing mortality targets, catch limits, and fleet allocations and can provide projected SSB, allowable catches, and stock-status metrics.

b) Are the methods appropriate for the assessment model and outputs?

Yes, see a) above

c) Are the results informative and robust, and useful to support inferences of probable future conditions?

Final projections corresponding to the RW Base model were not available for evaluation during the Review Workshop. These projections should be completed prior to presentation of the assessment to the SSC. While the projection methodology is acceptable, projection results were unavailable for this review.

d) Are key uncertainties acknowledged, discussed, and reflected in the projection results?

The projections are deterministic and do not propagate assessment uncertainty from the terminal year into future stock trajectories. Likewise, using average recruitment in future years does not represent interannual recruitment variability. Although selection of long-term or recent average recruitment is a standard forecasting approach, actual future recruitment will vary around those expectations. Therefore, probabilistic projections that propagate relevant parameter and state uncertainty and, where appropriate, future recruitment variability would be useful. Such projections could provide explicit probabilities of future biomass falling below applicable thresholds or fishing mortality exceeding reference points.

WFS

a) Are the methods consistent with accepted practices and available data?

The projection methodology was consistent with accepted practices and appropriate for the available data. The Allocation-Forecasting framework developed by the SEFSC provides an established mechanism for conducting forecasts using SS3 assessment results and allocating catches among fleets. The methodology can accommodate alternative recruitment assumptions, fishing mortality targets, catch limits, and fleet allocations and can provide projected SSB, allowable catches, and stock-status metrics.

Deterministic projections under multiple fishing mortality/reference-point scenarios were presented. Long-term equilibrium projections used average recruitment over 1986–2024, whereas short-term projections used the more recent 2020–2024 average given the model structure with no SR relationship.

b) Are the methods appropriate for the assessment model and outputs?

The projection methods were appropriate for the ***WFS*** assessment model and its outputs. The projections were based on accepted model estimates and reference points and appropriately reflected the recruitment assumptions required by the model configuration.

c) Are the results informative and robust, and useful to support inferences of probable future conditions?

The projections were considered informative and sufficiently useful for evaluating probable future stock conditions and developing management advice. However, the degree of robustness to alternative biological assumptions could not be fully evaluated because projections were not accompanied by sensitivity analyses for all potentially important inputs, such as natural mortality, discard mortality, and other externally specified parameters. In other words, standard practices for projections do usually include the evolution of uncertainty into the future. Nevertheless, sensitivity analyses might provide useful information regarding the dependence of projected outcomes on key fixed assumptions.

d) Are key uncertainties acknowledged, discussed, and reflected in the projection results?

Important projection assumptions and uncertainties were acknowledged, including assumptions of constant fleet selectivity and allocation, growth, natural mortality, stock-recruitment parameters, other fixed quantities, terminal-year recruitment, and future recruitment. A limitation is that the projections were deterministic and therefore did not propagate parameter uncertainty forward through time. Although multiple management scenarios were considered, the projections did not directly estimate probabilities of future biomass or fishing mortality crossing management reference points.
The MCMC analyses provide a potential mechanism for incorporating this uncertainty. Future assessments should consider propagating posterior parameter draws through projections to estimate the probability of future stock conditions under alternative fishing scenarios. Such stochastic projections could provide managers with a more explicit representation of risk in future assessments.

3.6 TOR 5: Consider how uncertainties in the assessment, and their potential consequences, are addressed.

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

EF/Keys and WFS

The assessments employed an extensive set of methods for evaluating uncertainty. These included variance estimates associated with input data, likelihood profiles, sensitivity analyses, jitter analyses, retrospective analyses, asymptotic standard errors, MCMC analyses, and parametric bootstrap analyses.

The assessments estimated a large number of biological, recruitment, catchability, selectivity, retention, and discard-related parameters. Uncertainty associated with input datasets was incorporated into SS3 as appropriate, and likelihood profiles and sensitivity analyses were used to evaluate influential assumptions and model configurations. However, in the case of ***EF/Keys***, the MCMC and bootstrap analyses were not available at the meeting due the selection of a new base RW Base.

For both ***EF/Keys and WFS***, the need to use a proxy model for MCMC analysis introduces an additional methodological qualification. The sum-to-zero constraint on recruitment deviations used in the base assessment interferes with efficient MCMC exploration and therefore must be removed in the proxy configuration. Because the proxy model produced some differences in estimated stock size additional research is warranted to understand the consequences of this modification and to evaluate alternative approaches to posterior sampling.

In the ***WFS*** case, in addition to asymptotic uncertainty estimates derived from the covariance matrix, MCMC and parametric bootstrap analyses were conducted. These analyses represented a substantial strength of the assessment because they provided alternative means of characterizing uncertainty beyond standard asymptotic approximations. The MCMC analysis produced posterior distributions for model parameters and important derived quantities, including current SSB and fishing mortality relative to their respective status thresholds. This permitted direct probabilistic evaluation of stock status and clearly demonstrated the strength of evidence supporting the conclusions that the stock is neither overfished nor undergoing overfishing.

In the ***WFS*** case, some qualifications apply to the MCMC analysis. Two of eight chains did not satisfy the selected convergence diagnostic and were excluded from inference. The six retained chains showed acceptable convergence according to other diagnostics, but the reason for failure of the two excluded chains was not fully determined. Further investigation of trace behavior, posterior geometry, and alternative sampling algorithms would help distinguish between inefficient sampling and more substantive features such as posterior multimodality.

The ***WFS*** parametric bootstrap provided an additional evaluation of uncertainty associated with the observed data and potential model instability. A substantial fraction of bootstrap replicates produced at least one parameter estimate at a parameter-space bound, indicating that model behavior under resampled datasets was less stable than suggested by the convergence characteristics of the base model alone. However, the resulting distributions of key parameters and derived quantities were generally consistent with the base-model and MCMC estimates. The different uncertainty approaches therefore did not indicate materially different conclusions regarding stock status.

The implications of parameter uncertainty need to have been clearly communicated, particularly for the stock-status criteria. The posterior distributions associated with current biomass and fishing mortality effectively conveyed the degree of risk relative to the management thresholds. Nevertheless, not all forms of uncertainty were propagated through every component of the analysis. In particular, the deterministic projections did not propagate parameter uncertainty into future stock trajectories. Future assessments should consider whether stochastic projections based on posterior parameter distributions could provide a more complete characterization of management risk.

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

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

Provide recommendations on possible ways to improve the SEDAR process.

The following is the list of research priorities as in our summary report to which I generally concur. I have added personal comments where appropriate. Also, unless otherwise specified, the list pertains to both ***EF/Keys and WFS***

Improve understanding and modeling of protogynous hermaphroditic population dynamics.
Investigate the recruitment and reproductive dynamics of protogynous, harem-forming species and evaluate how social structure affects sex transition. The current assessment represents sex transition primarily as an age-dependent process, whereas hogfish sex change may also depend strongly on the local abundance or density of males. Research should evaluate whether the probability of female-to-male transition changes with male density and how fishing-induced changes in population sex ratio affect reproductive output. Simulation studies and explicitly sex-structured population models could be particularly useful for evaluating these processes and the implications of size-selective harvest regulations for protogynous species. Investigate the potential for sperm limitation or male limitation and the prevalence of skip spawning. These processes could influence the relationship between conventional measures of spawning biomass and realized reproductive output and may help explain why a conventional stock-recruit relationship is difficult to estimate for this species.

Improve life-history, age, length, and discard information.
Improving and updating basic biological and fishery information should remain a high priority. Better age and length information would strengthen estimation of growth, selectivity, mortality, and population age structure.

For ***EF/Keys*** specifically, obtaining a more reliable estimate of maximum age is recommended. Maximum age provides important information for evaluating natural mortality-at-age assumptions, and improved information would help validate the natural mortality vector used in future assessments.

Discard information also remains limited and should be improved, particularly where sample sizes are insufficient to characterize discard magnitude, composition, and mortality reliably.

Improve recreational fishery information.
Recreational harvest and discard estimates, particularly for the spear sector, remain relatively uncertain because of low positive-trip interception rates and correspondingly high sampling variability. Improved sampling approaches or supplemental data collection could reduce uncertainty in these removals.

The historical catch reconstruction considered during SEDAR 94 also demonstrates the importance of developing and maintaining reliable recreational fishery information. Future historical reconstructions should explicitly characterize uncertainty in both effort and CPUE assumptions and evaluate how those uncertainties affect population-scale and productivity estimates before such data are used to inform initial stock conditions.

Evaluate fishery-independent survey coverage and data gaps.
All available fishery-independent indices, including those excluded during the Data Workshop, should be evaluated systematically for geographic and habitat coverage, sample size, and availability of age and length information.

The differences in selectivity among surveys considered during SEDAR 94 illustrate the importance of understanding survey depth distributions, habitat coverage, fish availability, and spatial patterns of fishing pressure when interpreting fishery-independent indices.

Evaluate uncertainty estimation methods.
Future research should compare uncertainty distributions obtained from MCMC, parametric bootstrap, and asymptotic normal approximations. Comparisons on both arithmetic and log scales could help determine when conventional covariance-based uncertainty estimates provide adequate inference and when computationally intensive MCMC or bootstrap methods materially improve characterization of uncertainty.

Particular attention should be given to the MCMC proxy-model issue identified during SEDAR 94. The statistical consequences of removing the recruitment-deviation sum-to-zero constraint should be investigated, as should alternative methods that permit posterior sampling without requiring changes to the base-model configuration.

Alternative MCMC algorithms, including Hamiltonian Monte Carlo and related approaches, should be investigated where feasible to determine whether they improve convergence and posterior exploration relative to the current Metropolis-Hastings implementation.

Additional consideration should also be given to assessment frameworks capable of incorporating random effects or state-space processes, including time-varying fishing mortality where appropriate.

Evaluate Stock Synthesis implementation choices that are not well understood.
Additional research should examine the statistical properties and consequences of using super-periods to address sparse composition data. Sensitivity analyses should also evaluate the specification of growth platoons, given the limited experience of many assessment practitioners and reviewers with this feature.

Sensitivity analyses should also be conducted for the SS3 growth-platoon specification to identify whether alternative platoon assumptions materially influence growth, selectivity, population scale, or status estimates.

The implications of removing the recruitment-deviation sum-to-zero constraint for MCMC proxy models should also be examined further. The current workaround was considered acceptable for the WFS assessment, but a better understanding of the statistical consequences would benefit future applications.

Investigate sex-specific growth.
Although available residual diagnostics supported the assumption of equal male and female growth for the current assessment, further biological and modeling work should evaluate whether sex-specific growth differences are important for hogfish assessment results.

Evaluate environmental effects and stressors.
Future research should investigate environmental influences on natural mortality, recruitment, movement, and habitat use. Potential factors include red tides and other harmful algal blooms, cold events, oil spills, and other disturbances that could affect hogfish population dynamics independently of fishing.

Develop stochastic projections that propagate assessment uncertainty.
The MCMC framework provides an opportunity to propagate parameter uncertainty into future projections. Stochastic projections could quantify probabilities of SSB falling below biomass thresholds or fishing mortality exceeding applicable reference points under alternative management scenarios. Incorporating such approaches more routinely into the SEDAR process could improve communication of management risk and make fuller use of the uncertainty analyses already conducted as part of the assessment.

Revisit the Review Workshop Terms of Reference and alignment among SEDAR stages.
The structure and wording of the Review Workshop TORs should be revisited to improve clarity regarding the Reviewer's expected role. In particular, TORs requiring evaluation of the robustness of projection results may be difficult to address when final projections change following Review Workshop recommendations or when the SSC is expected to request alternative projection scenarios.

Additionally, the TORs should be examined for elimination of redundancy.

Greater alignment among Data Workshop, Assessment Workshop, and Review Workshop TORs would also be beneficial. Important Assessment Workshop tasks, such as bridge analyses between previous and current assessments, should be reflected explicitly in Review Workshop TORs when evaluation of those analyses is expected.

3.8 TOR 7: Consider whether the stock assessment is consistent with and represents best scientific information available (BSIA) using the following criteria as appropriate: relevance, inclusiveness, objectivity, transparency, timeliness, verification, validation, and peer review of fishery management information.

The ***EF/Keys and WFS*** hogfish stock assessments are scientifically sound, use the available data appropriately, and provide a suitable basis for management advice.

3.9 TOR 8: Provide suggestions on key improvements in data or modeling approaches that should be considered when scheduling the next assessment

Scheduling of a future assessment is not dependent on the completion of any of the research recommendations provided for TOR 6.

Revisions and recalibration of MRIP fishing effort may warrant that a new assessment be scheduled.

However, in my opinion if a new assessment is scheduled the following simulation research should be conducted prior to that assessment: evaluate whether the probability of female-to-male transition changes with male density and how fishing-induced changes in population sex ratio affect reproductive output. Simulation studies and explicitly sex-structured population models could be particularly useful for evaluating these processes and the implications of size-selective harvest regulations for protogynous species. Investigate the potential for sperm limitation or male limitation and the prevalence of skip spawning. These processes could influence the relationship between conventional measures of spawning biomass and realized reproductive output and may help explain why a conventional stock-recruit relationship is difficult to estimate for this species.

Explore the statistical ramifications of the sum of deviations=0 constraint (this is a broader issue of all assessments not just hogfish or even protogynous fish).

Explore transition probabilities that are dependent on sex ratio as well as age or length (rather just age (length) as is done now) and their ramifications on management quantities.

Explore the feasibility of estimating sex-ratio related SR parameters and their tradeoff with other parameters

Explore SSB-dependent sigmaR values (this is a broader issue of all assessments not just hogfish or even protogynous fish)

3.10 TOR 9: 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.

The Peer Review Summary was drafted using input from all Review Panel members and then revised as appropriate by Panel members to comprise a final Summary. The final Summary Report is to be submitted Aug 7, 2026, which is subsequent to the submission date required for my CIE report. Nevertheless, I consider that this task (to complete and submit the Peer Review Summary Report in accordance with project guidelines) has been fulfilled.

4. Conclusions and Recommendations

The Review Meeting for the two stock hogfish assessments was informative, productive and useful for making progress in the assessment modeling and subsequent management of the two protogynous stocks. The assessment too was especially responsive and communicated with great clarity about the detail of these complex and detailed models.

While data inputs were relatively sparce and suffered from intermittent sampling, the assessment used them within appropriate limitations. However, inevitably in these situations, the resulting uncertainties were relatively large.

A particular limitation in these assessments was the lack of obtaining reliable stock recruitment relationships for use in evaluating status criteria. This is common to many (most?) assessments but is compounded with hogfish where reproductive behavior colors our perceptions of SPR status criteria (section 3.1). To that end a major recommendation is to evaluate whether the probability of female-to-male transition changes with male density and how fishing-induced changes in population sex ratio affect reproductive output. Simulation studies and explicitly sex-structured population models could be particularly useful for evaluating these processes and the implications of size-selective harvest regulations for protogynous species. Investigate the potential for sperm limitation or male limitation and the prevalence of skip spawning. These processes could influence the relationship between conventional measures of spawning biomass and realized reproductive output and may help explain why a conventional stock-recruit relationship is difficult to estimate for this species. This should include: exploration of the statistical ramifications of the sum of deviations=0 constraint (this is a broader issue of all assessments not just hogfish or even protogynous fish); exploration of transition probabilities that are dependent on sex ratio as well as age or length (rather than just age (length) as is done now) and their ramifications on management quantities; feasibility of estimating sex-ratio related SR parameters and their tradeoff with other parameters; exploration of SSB-dependent sigmaR values (this is a broader issue of all assessments not just hogfish or even protogynous fish); and evaluation of the ramifications of the sum to zero deviations in the stock recruitment data. These should be addressed before the next assessment.

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Appendix 1: Bibliography of materials provided for review

SEDAR 94 Data Workshop Report: https://sedarweb.org/documents/sedar-94-florida-hogfish-data-workshop-report/

SEDAR 94 Assessment Process Report: https://sedarweb.org/documents/sedar-94-florida-hogfish-assessment-process-report/

Reference Documents		
SEDAR94-RD03	Modeling protogynous hermaphrodite fishes workshop	Gary Shepherd, Kyle Shertzer, Jessica Coakley, Megan Caldwell
SEDAR94-RD04	Stock assessment of protogynous fish: evaluating measures of spawning biomass used to estimate biological reference points	Elizabeth N. Brooks, Kyle W. Shertzer, Todd Gedamke, and Douglas S. Vaughan

Appendix 2: Performance Work Statement (PWS)

National Oceanic and Atmospheric Administration (NOAA)
NOAA Fisheries
Center for Independent Experts (CIE) Program
External Independent Peer Review

SEDAR 94 Florida Hogfish Assessment: West Florida Shelf Stock and East Florida/Florida Keys Stock
July 14- 17, 2026

Background
NOAA Fisheries 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). NOAA Fisheries 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. Specifically, science products that the agency can reasonably determine that will have, when disseminated*, "a clear and substantial impact on important public policies or private sector decisions*." Additionally, peer reviewers must be deemed qualified based on the OMB Peer Review Bulletin standards[1].

Scope

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

SEDAR 94 will be a CIE assessment review conducted for two stocks of Hogfish: the West Florida Shelf Stock and the East Florida/Florida Keys Stock. The review workshop provides an independent peer review of SEDAR stock assessments. The term review is applied broadly, as the review panel may request additional analyses, error corrections and sensitivity runs of the assessment models provided by the assessment panel. There will be two models to be reviewed during the workshop. The review panel is ultimately responsible for ensuring the scientific basis of the assessment through the SEDAR process. The specified format and contents of the individual peer review report are found in **Annex 1**. The Terms of Reference (ToRs) of the peer and review are included in **Annex 2**. The tentative agenda of this virtual panel review and process review meetings is included in **Annex 3**.

Requirements

NOAA Fisheries requires three reviewers to conduct an impartial and independent peer review in accordance with this Performance Work Statement (PWS), OMB Guidelines, and the ToRs below. Modifications to this Performance Work Statement (PWS) and ToRs cannot be made during the peer review, and the Contracting Officer's Representative (COR) and the CIE contractor shall approve any modifications prior to the peer review. All ToRs must be addressed in each reviewer's report.

The reviewers shall have a working knowledge in stock assessment, statistics, fisheries science, and marine biology sufficient to complete the primary task of providing peer-review advice in compliance with the workshop Terms of Reference fisheries stock assessment. Expertise with the Stock Synthesis modeling platform, and the associated model diagnostics would be helpful. Experience with assessments of reef-associated species, particularly those exhibiting complex life histories (e.g., hermaphrodism), and familiarity with evaluating length-and-age composition data, selectivity patterns, and model diagnostics in data-moderate or data-limited contexts is preferred.

The chair, who is in addition to the panel of three reviewers, will not be provided by the CIE. Although the chair will be participating in this review, the chair's participation (e.g., labor and travel) is not covered by this contract.

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[1] https://www.whitehouse.gov/wp-content/uploads/legacy_drupal_files/omb/memoranda/2005/m05-03.pdf

Tasks for Reviewers
Each CIE reviewer shall complete the following tasks in accordance with the PWS and Schedule of Milestones and Deliverables herein.

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

Documents to be provided to the CIE reviewers prior to this review include:

S94 Data Workshop Report (https://sedarweb.org/documents/sedar-94-florida-hogfish-data-workshop-report/)

S94 Assessment Process Report (to be provided two weeks prior to review)

S94 Working papers and Reference documents (https://sedarweb.org/assessments/sedar-94-florida-hogfish/)

Panel Review Meeting: The CIE reviewers shall conduct the independent peer review in accordance with the PWS and ToRs and shall not serve in any other role unless specified herein. The CIE reviewers shall attend and actively participate in a professional and respectful manner as members of the meeting review panel, and their peer review tasks shall be focused on the ToRs as specified herein. The NOAA Fisheries Project Contact is responsible for any meeting arrangements (e.g., conference room reservations, video conferencing logistics, etc.).

Chair Summary Report: The reviewers shall assist the Chair of the meeting with contributions to the summary report.

Contract Deliverables - Independent CIE Peer Review Report: The CIE reviewers shall complete an independent peer review report in accordance with this PWS. Reviewers are not required to reach a consensus. The CIE reviewer shall complete the independent peer review according to required format and content as described in **Annex 1**. The CIE reviewer shall complete the independent peer review addressing each ToR as described in **Annex 2**. The tentative agenda of the panel review meeting is attached in **Annex 3**.

Foreign National Security Clearance
When reviewers participate during a panel review meeting at a government facility, the NOAA Fisheries 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 Project Contact for the purpose of their security clearance, and this information shall be submitted at least two weeks in advance. For additional information, please see the following link: https://www.commerce.gov/osy/programs/foreign-access-management. All CIE reviewers must have a REAL ID-compliant form of identification to access Federally owned or leased facilities The contractor is required to use all appropriate methods to safeguard Personally Identifiable Information (PII).

Place of Performance
The place of performance shall be the Charleston, SC.

Period of Performance
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:

Schedule	**Milestones and Deliverables**
Within two weeks of award	Contractor secures participation of the CIE reviewers.
At least two weeks prior to the panel review meeting	Pre-review documents are provided to the reviewers.
July 14- 17, 2026	The reviewers participate and conduct an independent peer review during the panel review meeting.
Approximately 2 weeks later	Contractor receives draft reports
Within 3 weeks of receiving draft reports	Contractor submits final reports to the Government

* The Peer Review Summary Report will not be submitted to, reviewed, or approved by the Contractor.

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 in **Annex 1**; (2) The reports shall address each ToR as specified **Annex 2**; 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 (Travel resources | GSA), and all contractor travel must be approved by the COR prior to the actual travel. Any travel conducted prior to the receipt of proper written authorization from the COR will be done at the Contractor's own risk and expense. International travel is authorized for this contract. Travel is not to exceed 17,000.

Confidentiality and Data Privacy

This contract may require that services contractors have access to Privacy Information. Services contractors are responsible for maintaining the confidentiality of all subjects and materials and may be required to sign and adhere to a Non-disclosure Agreement (NDA).

NOAA Fisheries Project Contact:

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Annex 1: Peer Review Report Requirements

1. The CIE independent report shall be prefaced with an Executive Summary providing a concise summary of the findings and recommendations as specified in the ToR.

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

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

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

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

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

3. The reviewer report shall include the following appendices:

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

Annex 2: Terms of Reference for the Peer Review

SEDAR 94 Hogfish Assessment: West Florida Shelf Stock and East Florida/Florida Keys Stock

CIE reviewers are contracted to complete their independent peer review based on the ToRs. Therefore, the CIE-NOAA Fisheries review and approval process is based on whether the CIE independent reports addressed each of the ToRs.

Review Workshop Terms of Reference

1. Evaluate the data used in the assessment, including discussion of the strengths and weaknesses of data sources and decisions, and consider the following:
   a) Are data decisions made by the Data Workshop (DW) and Assessment Workshop (AW) panels sound and robust?
   b) Are data uncertainties acknowledged, reported, and within normal or expected levels?
   c) Are input data series reliable and applied properly within the assessment model?
2. Evaluate and discuss the strengths and weaknesses of the methods used to assess the stock, taking into account the available data, and considering the following:
   a) Are methods scientifically sound and robust?
   b) Are assessment models configured properly and consistent with standard practices?
   c) Are the methods appropriate for the available data?
3. Evaluate the assessment findings and consider the following:
   a) Are population estimates (model output – e.g. abundance, exploitation, biomass) reliable, consistent with input data and population biological characteristics, and useful to support status inferences?
   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 reliable? If not, are there other indicators that may be used to inform managers about stock trends and conditions?
4. Evaluate the stock projections, including discussing strengths and weaknesses, and consider the following:
   a) Are the methods consistent with accepted practices and available data?

b) Are the methods appropriate for the assessment model and outputs?

c) Are the results informative and robust, and useful to support inferences of probable future conditions?

d) Are key uncertainties acknowledged, discussed, and reflected in the projection results?

5. Consider how uncertainties in the assessment, and their potential consequences, are addressed.
   - Comment on the degree to which methods used to evaluate uncertainty reflect and capture the significant sources of uncertainty in the population, data sources, and assessment methods
   - Ensure that the implications of uncertainty in technical conclusions are clearly stated.
6. Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations or prioritizations warranted.
   - Clearly denote research and monitoring that could improve the reliability of, and information provided by, future assessments.
   - Provide recommendations on possible ways to improve the SEDAR process.
7. Consider whether the stock assessment is consistent with and represents best scientific information available (BSIA) using the following criteria as appropriate: relevance, inclusiveness, objectivity, transparency, timeliness, verification, validation, and peer review of fishery management information.
8. Provide suggestions on key improvements in data or modeling approaches that should be considered when scheduling the next assessment.
9. 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.

Reviewers must provide details on the basis of their responses to the review questions.

Annex 3: Tentative Agenda for SEDAR 94 Florida Hogfish Assessment Review: West Florida Shelf Stock and East Florida/Florida Keys Stock

July 14-17, 2026

Charleston, South Carolina

Tuesday:

8:30 a.m.	**Introductions and Opening Remarks**	**Coordinator**
	- Agenda Review, TOR, Task Assignments	
9:00 a.m. – 12:00 p.m.	**Assessment Presentations**	**Analytic Team**

	- *Assessment Data & Methods*	
	- Identify additional analyses, sensitivities, corrections	
12:00 p.m. – 1:30 p.m.	**Lunch Break**	
1:30 p.m. – 4:30 p.m.	**Assessment Presentations (continued)**	**Analytic Team**
	- *Assessment Data & Methods*	
	- Identify additional analyses, sensitivities, corrections	
4:30 p.m. – 5:30 p.m.	**ToR Review and Daily wrap up**	**Chair**
5:30 p.m. – 6:00 p.m.	**Public comment**	**Chair**

Tuesday Goals**:** Initial presentations completed, sensitivity and base model discussion begun.

Wednesday:

8:30 a.m. – 12: p.m.	**Panel Discussion**	**Chair**
	- *Assessment Data & Methods*	
	- Identify additional analyses, sensitivities, corrections	
12:00 p.m. – 1:30 p.m.	**Lunch Break**	
1:30 p.m. – 5:00 p.m.	**Panel Discussion/Panel Work Session**	**Chair**
	- Continue *deliberations*	
	- Review additional analyses	
	- Recommendations and comments	
5:00 p.m. – 5:30 p.m.	**ToR Review and Daily wrap up**	**Chair**
5:30 p.m. – 6:00 p.m.	**Public comment**	**Chair**

Wednesday Goals**:** sensitivities and modifications identified, preferred models selected, projection approaches approved, Report drafts begun.

Thursday

9:00 a.m. – 12: p.m.	**Panel Discussion**	**Chair**
	- *Assessment Data & Methods*	

	- *Identify additional analyses, sensitivities, corrections*	
12:00 p.m. – 1:30 p.m.	**Lunch Break**	
1:30 p.m. – 4:30 p.m.	**Panel Discussion/Panel Work Session**	**Chair**
	- Continue *deliberations*	
	- *Review additional analyses*	
	- *Recommendations and comments*	
4:30 p.m. – 5:00 p.m.	**ToR Review and Daily wrap up**	**Chair**
5:30 p.m. – 6:00 p.m.	**Public comment**	**Chair**

Thursday Goals: sensitivities and modifications identified, preferred models selected, projection analysis reviewed, Report draft continued

Friday

8:30 a.m. – 11:30 a.m.	**Panel Discussion or Work Session**	**Chair**
	- *Final sensitivities reviewed.*	
	- *Projections reviewed.* **Chair**	
	- *Review Reports*	
11:30 a.m. – 12:00 p.m.	**Public comment**	**Chair**
12:00 p.m.		**ADJOURN**

Friday Goals: Complete assessment work and discussions, final base configuration available. Draft Reports reviewed.

Appendix 3: Panel Membership

Review Panel

Luiz Barbieri (Chair) .... SAFMC/GFMC SSC
Lisa Chong .... CIE Reviewer
Noel Cadigan .... CIE Reviewer
Challen Hyman .... GFMC SSC
Joe Powers .... CIE Reviewer
Marcel Renchert .... SAFMC SSC
Alexei Sharov .... SAFMC SSC
Steve Saul (via webinar) .... GFMC SSC

Analytic Team

Chris Swanson .... USF/FWC-FWRI
Dustin Addis .... FWC-FWRI
Heather Christiansen .... FWC-FWRI

Staff

Julie A Neer .... SEDAR
Chip Collier .... SAFMC Staff
Leonardo Eguia .... GFMCC Staff
Emily Ott .... SEDAR
Ryan Rindone .... GFMC Staff
Rachael Silvas .... SAFMC Staff

Council Representative

CJ Sweetman .... Gulf & South Atlantic Council

Workshop Observers

Chris Bradshaw .... FWC-FWRI

Workshop Observers via Webinar

Shanae Allen .... USF/FWC-FWRI
Manuel Coffill-Rivera ....
Alena Figueroa .... FWC-FWRI
Sarah Gardiner .... GFMC Staff
Bob Hillard .... Recreational Fisherman
Jennifer Loch .... REEF
Danielle Morley .... FWC-FWRI
Robert Muller .... FWC-FWRI
Roldan Muñoz .... NOAA
Hallie O'Farrell .... FWC-FWRI
Tia Offner .... FWC-FWRI

Jack Olsen.. FWC-FWRI
Chloe Ramsay.. FWC-FWRI
Ted Switzer .... FWC-FWRI