

***Independent Peer Review of the Gulf Shrimp SEDAR 87
Stock Assessment: Brown, White and Pink Shrimp***

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by

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Executive Summary

A stock assessment of the Gulf shrimp fishery was conducted, culminating in a Review Workshop of the SEDAR 87 Assessment in Tampa on June 23-27. Multiple examinations of the data and previous modeling approaches suggested that methods alternative to traditional methods (SS3 and VPA) would be more appropriate. To that end SEDAR 87 analysts used a three prong modeling approach using catch data and fishery independent surveys as inputs. The three prongs were: (1) using the tool VAST to standardize the indices by handling zero-inflated data and spatial autocorrelation; (2) applying the JABBA Pella-Tomlinson modeling platform to the standardize index and catches, incorporating process error; and 3) implementing the Empirical Dynamic Modeling (EDM) framework to formulate empirical estimates of stock production with limited modeling structure, but incorporating environmental drivers and habitat covariates into the standardization of indices when appropriate. In all three cases a model ensemble approach was taken by developing a matrix of different model configurations for VAST, JABBA, and EDM to test different assumptions about the starting parameters and/or the input data; Bayesian methods were used for parameter estimates (JABBA) and Gaussian Process Bayesian estimation for EDM. While the assessment used two relatively novel models not previously used for Gulf shrimp (JABBA and EDM), the Analyst Team provided sufficient documentation and thorough explanations during the Workshop (see SEDAR87-RD13, SEDAR87-RD15, SEDAR87-RD16, and SEDAR87-RD18). The JABBA and EDM approaches were used to estimate the management quantities of Bmsy, Bcurrent/Bmsy, Fmsy, FCurrent/Fmsy and the trajectories of biomass and fishing rates over the past and projection into the future.

For 1) brown shrimp, the EDM model was size structured (by three size categories) and provided stable estimates of MSY that were similar to one another across numerous model configurations (little variability). Using the mean and standard deviation of the MSY estimates from those model runs that passed the diagnostic tests for brown shrimp could help capture the variability and uncertainty around model configurations. For 2) white shrimp, to capture variability in season and differences in shrimp size, three EDM model configurations were developed: a size class model, a seasonal size class model (which was not used), and one that used a natural log transformation of the CPUE index. The suite of EDM models examined for white shrimp also provided stable estimates of MSY that had little variability in their estimate of MSY across model configurations. For 3) pink shrimp, both JABBA and EDM were insufficient, and no advice was offered for this stock.

A number of suggestions for model improvement, reporting of diagnostics and limitations on interpreting estimates of long term maximum average yield as MSY were noted. Nevertheless, in my opinion the results are robust to the main status determination criteria that harvest rate is much less than that at MSY and that current biomass is much greater than that which would produce MSY for brown and white shrimp.

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1. Background

The 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, and that peer reviewers must be deemed qualified based on the OMB Peer Review Bulletin standards.

The stock assessment for Gulf penaid shrimp provides the scientific basis for the management advice considered and implemented by the Gulf Fisheries Management Council. An independent review of this stock assessment was requested by the SEDAR Steering Committee, for three peer reviewers to attend and participate in the SEDAR 87 Gulf Shrimp Review Workshop.

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

Three Center for Independent Experts (CIE) reviewers were contracted to complete their independent peer review based on the ToRs. Therefore, the CIE-NMFS review and approval process are based on whether the CIE independent reports addressed each Term of Reference (ToRs). The SEDAR requested a CIE review in the months of June/July 2025 to review the SEDAR 87 Gulf shrimp stock assessment.

The goals of this review process are to: 1) ensure that stock assessments represent the best available scientific information and facilitate the use of this information by the Gulf Fishery Management Council; 2) provide an independent external review of this stock assessment that meets the mandates of the Magnuson-Stevens Fisheries Conservation and Management Act (MSA) and other legal requirements; 3) understand and appropriately account for modeling and key data sources of shrimp indices and catch data; and 4) identify research needed to improve the assessment and advice for fishery managers. The review will be to ensure that the stock assessment represents the best available science to date, is statistically sound, and that any deficiencies are identified and addressed. Therefore, I, as a CIE reviewer, conducted a peer review of the current methods based on these goals and the Terms of Reference (TORs) referenced below. This report documents my findings in that regard.

3. Summary of Findings for Each Term of Reference

Preamble to TORs: I begin the discussion of TORs by presenting a general discussion of the modeling and shrimp productivity. After that, the individual TORs are addressed.

Production Functions: In the following I give a couple of generalized approaches to modeling production dynamics expressed in continuous time. I do this to provide some background for comparison of EDM, Pella-Tomlinson (P-T) in the context of Gulf shrimp. Additionally, this allows for future consideration of alternative structures within EDM or P-T.

Consider a generalized dynamic function of biomass (x_t) production:

$$\frac{dx_t}{dt} = x_t(a + bx_t^n + gx_\delta)$$

where x_δ is a value of x at some reference time δ . By selective choices of a , b , n and g , one can obtain the Ricker ($n=1, g<0, x_\delta = x_0, b=0$), Beverton-Holt ($n=1, g=0, a<0, b<0$), Schaeffer ($n=1, g=0, a>0, b<0$) and Pella-Tomlinson models ($g=0, a \times b < 0$). Solving the integral

$$\int \frac{dx_t}{x_t(a + bx_t^n + gx_\delta)} = \frac{1}{(a + gx_\delta)n} \ln \left[\frac{x_t^n}{a + gx_\delta + bx_t^n} \right] = \int dt + C$$

When $t=0$, then $x=x_0$ and $e^C = x_0^n / (a + gx_\delta + bx_0^n)$. Then

$$x_t = x_0 \frac{(a + gx_\delta)^{1/n} e^{(na+gx_\delta)t}}{\{a + gx_\delta + bx_0^n(1 - e^{(a+gx_\delta/n)t})\}^{1/n}}$$

If there is fishing at rate $F_{\Delta t}$, during the time interval Δt , then a is replaced by $a-F$ throughout. Thus, the recursive time equation becomes:

$$x_{t=\Delta t} = x_0 \left\{ -\frac{bx_t^n}{a - F_{\Delta t} + gx_\delta} + \left(1 + \frac{bx_t^n}{a - F_{\Delta t} + gx_\delta} \right) e^{-(a-F_{\Delta t} + \frac{gx_\delta}{n})\Delta t} \right\}^{-1/n}$$

Ultimately, the population production rate is $\ln(x_{\Delta t}/x_0) + f(x)$

$$f(x) = \ln \left\{ -\frac{bx_t^n}{a - F_{\Delta t} + gx_\delta} + \left(1 + \frac{bx_t^n}{a - F_{\Delta t} + gx_\delta} \right) e^{-(a-F_{\Delta t} + \frac{gx_\delta}{n})\Delta t} \right\}^{-1/n}$$

The associated yield ($Y_{\Delta t}$) equation is

$$Y_{\Delta t} = \int_{t=0}^{t=\Delta t} F_{\Delta t} x_t \left\{ -\frac{bx_t^n}{a - F_{\Delta t} + gx_\delta} + \left(1 + \frac{bx_t^n}{a - F_{\Delta t} + gx_\delta} \right) e^{-(a-F_{\Delta t} + \frac{gx_\delta}{n})\Delta t} \right\}^{-1/n} dt$$

where $F_{\Delta t}$ can be found numerically, given the yield and the known production parameters. I don't think there is a closed form solution to the yield integral except for some selected values of n . But, numerical integration should not be very computationally intensive given the recursive equation for x .

I can also think of more generalized approaches for specifying a production function, such as using polynomials [$f(x) = \ln(\sum b_i x_i^i)$ or $f(x) = \ln(ax_t^n / \sum b_i x_i^i)$]. These alternatives generalize Ricker Pella-Tomlinson even more than the above. I mention them because philosophically, these would be similar to EDM in that they are modeling the production rate very generally. In EDM the "complexity" dimension of the system is defined by the number of lagged observations. In the polynomial, the complexity is defined by the number of polynomial terms.

Generally, I am an advocate of using continuous time models for shrimp in the future for the reason that they match the timing and duration of the catches and the timing of the biological processes. For example, it would be a reasonable hypothesis that all the density-dependence occurs during the post-spawning inshore phase followed by the offshore phase affected only by a density-independent rate. Other combinations of hypotheses might be explored by area, timing, etc., and matched more directly to the

catch durations. To some extent, these options were approached by the EDM explorations of subregions and size-specific models.

In any case, estimation in continuous time models could be expanded to include Bayesian state-space approaches.

Having said all this, would it really make a difference? Taking the brown shrimp as an example: survey data indicate biomass is currently 3-4 times what it was prior to 1990 and current catch is about half of the catches in that previous era (and even less in the last few years). Based on this information alone, without any modeling, one would reasonably conclude that the stock is not overfished and that overfishing has not been recently occurring. Whatever models are chosen they will not “model around” the conclusions based on the data.

But in order to determine the biomass level of the overfished state (B_{msy}) one of two things have to occur: 1) there are data and observations of catch and productivity in an era where $B < B_{msy}$ and/or 2) there is theory (priors) on the biological/ecological structure of where B/K occurs (equivalent to the steepness specification in age-structured models). In both cases, estimates are improved if in fact the stock has been overfished. The P-T JABBA approach takes the latter option.

The P-T model was parameterized as in Winker et al. (2018):

$$\frac{dB_t}{dt} = \frac{r}{m-1} B_t \left(1 - \left(\frac{B_t}{K} \right)^{m-1} \right)$$

Their description of the parameterization denotes that “ r is the intrinsic rate of population increase at time t ”, but it is not. The intrinsic rate is $r/(m-1)$ when $m > 1$ and is infinite if $m < 1$. If $m > 1$, then density dependence (the m exponent) occurs on the biomass loss side of the equation; whereas if $m < 1$ then it occurs on the biomass gain side. Conversely r is more like a mortality rate when $m < 1$. (Note B_{msy}/K is solely dependent on m ; $B_{msy}/K = m^{-1}/(m-1)$ in Winker parameterization). If regular MLE/regression were used for estimation, this makes little difference. However, when priors are specified for r and m , the Winker parameterization obfuscates the specification of prior distributions: what is $r/(m-1)$ in biological terms when the prior distribution for m spans 1? Obviously, I am rather negative about this parameterization. I would opt for the $dB/dt = rB(1 - (B/K)^{m-1})$ specification. I also believe that a more systematic approach would be to separate the prior specification ($m < 1$ vs $m > 1$ and then specify r for each m choice). To some extent the analyst’s exploration of alternative priors on m achieve similar ends, though.

I also have thoughts about the priors for r and m (or B_{msy}/k). It is often repeated (including in these assessment documents) that Gulf shrimp are highly resilient. And often “highly resilient” is defined as a low B_{msy}/K . In typical age structured models, the critical parameter defining density dependence is the steepness of the S-R function. If B_{msy}/K were ~ 0.4 ($m \sim 1$ in the P-T model), then this would imply a steepness of about $h = 0.35$ in an age structured model. Yet in most age-structured models, h is specified to be in excess of 0.6. So yes, my prior (bias?) is that m is less than one for Gulf shrimp. The exploration of alternative priors for the m distribution tends to show the sensitivity of this parameter AND that the data are not very helpful in defining it further.

In “Impacts of the Combined Closures of the Texas Territorial Sea and FCZ on Brown Shrimp Yields Scott Nichols NOAA Technical Memorandum NMFS SEFSC-141”, the instantaneous natural mortality rate (numbers) was ~ 0.28 per month for the months, and the individual VB growth rate (k) was about 0.25/month. And the F current (1981-83) ~ 0.5 /month for the months that fishing occurred. As I recall, the nat mort and VBk were based on tagging, but I could be wrong. In any case, these estimates could become the starting point for defining priors. These would suggest productivity on the high end of the

uncertainty grid for r . The F 's and the associated catches at that time (1981-83) (~100 mt) could be used as a point of comparison for the P-T and EDM results.

I also note that the P-T model suffers from some biological unreality when $m < 1$, as mentioned by Winker et al., and that is that the slope at the origin of the production function is infinite. In a practical sense this will not be a major problem unless there was a period in the data where the stock was heavily overfished. If the stock abundance has always been greater than that at B_{msy} or near the peak, then the optimistic recovery dynamics implied by P-T $m < 1$ will not be a major issue.

The EDM approach as used in Gulf shrimp avoids the parameterized specification inherent in the P-T and similar production models. But implicitly these EDM applications are modeling the production rate: $f(x) = \ln(x_{\Delta t}/x_0)$ as in traditional production models above, but without the biological constraints (guidance?) imposed by fixed parameters. The advantage is that it allows more dynamic estimates of productivity to be made including process variance (ecological/environmental effects on production variability). The disadvantage is that estimates of traditional benchmarks (MSY, B_{msy}/K , etc.) are not driven by parameters of the underlying model, but rather are average behaviors over the history of the data. But then again, given shrimp productivity this may actually be an advantage. Also, the selected models allowed for size structure and seasonal-structure, which is good. Note in my comments above, I believe a more generalized approach to area/time constructions of production functions would be very useful. I think the hierarchical approach taken in these EDMs is very useful.

The final EDM shrimp transformation models (brown and white) were $gr2: f(x) = \ln\left(\frac{x_t}{x_{t-1}-c_{t-1}}\right)$ or in the index scale $gr2(y) = \ln\left(\frac{y_t}{y_{t-1}-qc_{t-1}}\right)$. So, this falls within the generalized production function paradigm that I gave above. In this model, the catch is taken instantaneously at the beginning of the time period and thus all the dynamics (density-dependent, environmental variability, whatever) affects the abundance after that. This is measured by the index data with the implicit imbedding of additional dimensions through the lags in the index data. Essentially, the production rate (the log change in the index) is modeled as a function of the lagged index data. The GP Bayesian process allows for estimation of the process error, correlation between selected parameters and the "inverse length scale" (ϕ) which defines the "wiggleness" of the function. In my jargon, the ϕ values are simply weights applied to the difference in the data in one time period vs in a lagged time period (squared). This process is tantamount to computing semivariograms in kriging, as I remember. The data that provides the scale of abundance is the catch.

MSY and B_{msy} are determined as "average yield and biomass" over the years where harvest rate is fixed. Then, searching over increments of U , U_{msy} is the harvest rate that maximizes the average yield and B_{msy} is the related biomass. As I understand it, since catch occurs instantaneously at the beginning of a time interval, the imposed harvest rate being searched over will not necessarily be related to the estimated production rate of any particular year. Thus, the projected production and the imposed U are not directly related. Thus, it is important to note that B_{msy} and MSY are not necessarily measures of maximum possible production, but rather a measure of the long-term maximum average. Nor does EDM attempt to estimate carrying capacity.

An important note is that the catch is being modeled as occurring at a particular instant in time and the harvest rate is $U = \text{Catch}/\text{Biomass}$ at that instant. Thus, the harvest rate so defined is more like an F . I do not believe the conversion rate of $F = -\ln(1-U)$ is appropriate. F will be a function of the biomass and production characteristics which are very dynamic and likely large (see yield equations above). This creates some anomalies. Normally, we think with a production function that $MSY = F_{msy} \times B_{msy}$. With the brown shrimp EDM results in $MSY = U_{msy} \times B_{msy}$ ($215.07 = 0.531 \times 405.39$) not $MSY = F_{msy} \times$

Bmsy (215.07 does not equal 0.617×405.39). ***I recommend that harvest rate be used in lieu of F and that reports should just use Ucurrent/Umsy, etc.***

EDM P-T Comparisons. I examined the EDM results by comparing the production estimates to what they imply if the underlying dynamics were actually P-T. I used the brown shrimp slide page 138 which plots yield versus harvest rate with the associate MSY and Umsy. I overlaid a P-T model with the same MSY and Umsy (I used $U=F$ in the P-T model). The goal in this experiment was to mimic the equilibrium biomass and yield trends especially when $B > B_{msy}$ $U < U_{msy}$ (Fig 1A). The associated P-T surplus production curve is in Fig 1B.

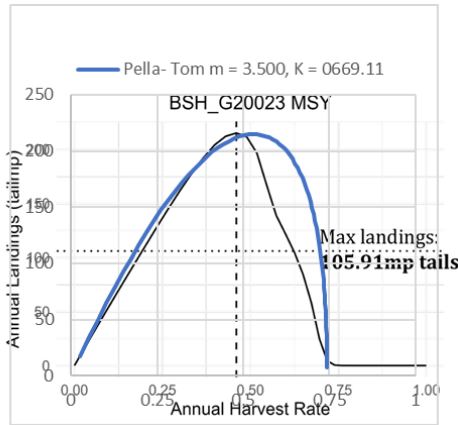


Fig 1A

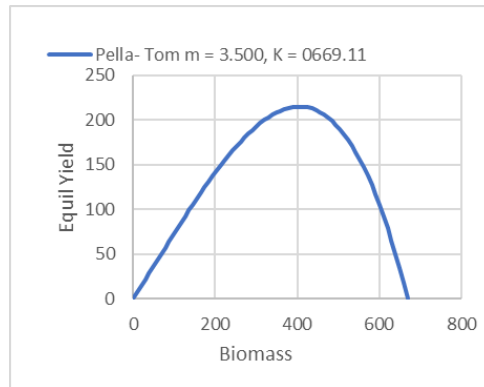


Fig 1 B

Note that the B_{msy}/K is very large with this P-T ($m=3.5$). Conversely, I overlaid if the P-T m was specified as 0.5 then

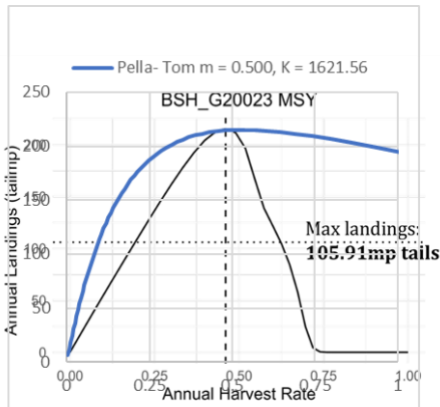


Fig 1 C

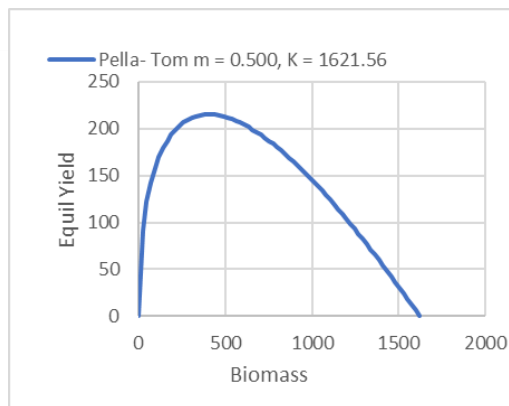


Fig 1 D

The conclusion is that perceptions that $m < 1$ and that $K \sim 700$ mp are probably incompatible. The EDM is estimating current biomass of ~ 2000 mp. An obvious reason for such an incompatibility is that population productivity has increased over time. I can think of some long-standing hypotheses about why that might be occurring (e.g., land loss creates more “edge” for the land-water interface, increasing production; land loss means more edge ... until it doesn’t). The EDM results do not address K directly, so increased productivity is an interpretation. However, this emphasizes the ambiguity of what is meant by MSY and B_{msy} in the context of dynamic shrimp productivity.

3.1 TOR: Evaluate the degree to which the terms of reference from the Data and Assessment processes were addressed

The selection of data sources was conducted via a thorough and comprehensive process that can be considered best practice and appropriate during the Data and Assessment Workshops, respectively. The data/modeling decisions were justified and reasonable given the TOR and the immediate goals of estimating historical stock conditions and estimating status determination criteria. Some minor questions and uncertainties are mentioned below under specific themes.

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

Data potentially used in the stock assessment includes fishing effort, catch, depth, time, environmental drivers, potential abundance indices (CPUE and fishery independent surveys) and social and economic information. However, three fishery independent abundance indices and catch were the only data used in principal model runs.

Commercial fishing effort and CPUE data show gross trends that informed discussions but are difficult to interpret and were not used in modeling or reference point calculations. Difficulties include changes in fishery operations over time, nonlinear stock size relationships, recent low prices and a new procedure for calculating effort by species.

Catch data are collected by all five Gulf states using a variety of processes that have changed over time. The Data Workshop concluded that the accuracy of the data has changed and recommended a set of assumed CVs for landings data in JABBA assessment models (20% during 1960-1983, 10% during 1984-2015 and 5% during 2016-2022). The Review Panel noted that CVs $\leq 10\%$ imply more accuracy than typically assumed. The Assessment Team suggested that the recommended values were based on expert discussions and capture the trend of increasing accuracy over time due to improvements in data collection systems. They suggested other uncertainties about the overall precision of the landings data would probably have little effect on assessment results. It was suggested by the Review Panel that a sensitivity analysis be conducted in which landings are perturbed to understand the sensitivity of the models to these assumptions.

Catch data was assumed accurate in Gaussian-Process EDM models although uncertainty in escapement (basically survey data minus catch) was assumed in model fitting. JABBA incorporates uncertainty in catch data (specification of a catch CV) and index data (specification of standard errors), while also allowing for the estimating or fixing of process variance and estimating additional observation variance.

All fishery index data used in the assessment (SEAMAP, Texas Gulf Survey, Louisiana Trawl Survey) is collected and recorded spatially. Furthermore, these data contain a relatively large proportion of zero values, about 70%, 40%, 80% for brown, white and pink shrimp, respectively. Such data requires a unique model structure (e.g., delta-linear model) as provided by VAST which is a spatial delta-

generalized linear mixed model. This model structure can also incorporate habitat and catchability covariates which can lead to more precise estimates of abundance. This standardization method was used to produce a time-series of abundance for JABBA.

Are data decisions made by the Data and Assessment processes justified?

Clear selection criteria were used to define the appropriateness of the available data associated with temporal range, spatial range, consistent survey design (e.g., fixed sampling sites, stratified random, etc.), standardized sampling methodology (e.g., gear, vessels, effort, etc.), and size groups represented.

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

As always, there were data limitations and ad hoc adjustments were made to limit effects on important analyses. For example, missing SEAMAP COVID year data were filled by averaging prior year and later year summer SEAMAP estimates. An alternative would be to use the summer/fall relationship. Also, the JABBA structure allows for inclusion of catch CVs.

Is the appropriate model(s) applied properly to the available data?

The short answer is yes, but with caveats about limitations and how to interpret the results. This was discussed in the Preamble above and is discussed again in TOR 3.3.

Are input data series sufficient to support the assessment approach?

Identifying environment drivers of productivity from changes in catch rates, requires the composition of the catch to align with the correct time lag. In most months of the year, there exist multiple cohorts of shrimp, with each cohort being derived from a different period in the estuarine environment. A single cohort needs to be identified and modeled using VAST to examine environmental drivers of shrimp productivity.

The reference point procedure for EDM affected data decisions because long term projections are difficult when future conditions are unknown. JABBA is not programmed to accommodate environmental information directly. However, the JABBA model uses the VAST index standardization which does allow for environmental covariates. Thus, one can argue (loosely) that JABBA reference points involve environmental data.

JABBA implements a Bayesian state-space surplus production model and is specifically designed for data-moderate stock assessments based on landings and an index of abundance. It offers a flexible framework for estimating stock status and generating reproducible results. JABBA has been used successfully in other jurisdictions to conduct stock assessments on short-lived species including Penaeids (shrimp/prawns).

EDM is new to most fisheries biologists and can accommodate many types of data. MSY reference points from EDM were calculated by long term deterministic projections over a range of constant catch levels.

EDM has been used to investigate stock dynamics in other fisheries, but not to the extent conducted by the assessment team.

The quality of the data (appropriate for shrimp, standardized, fishery-independent and spatially extensive) is appropriate. When subset by species (spatial truncation), the data available for brown and white shrimp appear sufficient to support the assessment approach. The length of the time series for pink shrimp, however, currently seems too short to support the assessment approaches employed during this review.

3.3 TOR: Evaluate and discuss the strengths and weaknesses of the methods used to assess the stock, given the available data.

The VAST analyses are designed to standardize survey and index data by predicting density across space and year separately, modeling encounter probability and positive catch rates using delta-models or zero-inflated binomial models. Unmeasured processes are approximated through spatial and spatio-temporal random effects (assuming two points in space are more strongly correlated if they are neighbors). In addition, VAST allows specification of either density or catchability covariates. VAST “controls for” catchability covariates when calculating an index (i.e., removes their estimated effect) while “conditioning on” density/habitat covariates when calculating an index (i.e., uses them to improve interpolated/extrapolated predictions of density). These are accounted for by fitting year as a fixed effect (separate intercept for each year), ensuring that estimates of abundance are independent for each modeled year.

Spatial variation is estimated as a random effect. Additionally, covariates may be included, such as habitat covariates (e.g., depth, substrate, temperature and salinity) and can be integrated, as can Catchability covariates (e.g., time of day, vessel) to explain changes in catchability over space and time. The resulting spatiotemporal index standardization can provide a more precise abundance index than the design-based estimator or other conventional standardization models by explaining spatial variation in densities.

A large number of modeling options were implemented and evaluated using multiple criteria. The resulting VAST indices were recommended to be carried forward in the assessment:

Brown Shrimp: use SEAMAP (summer and fall) + TPWD monthly surveys over the years 1987-2022. The recommended VAST model used Delta-lognormal numbers per tow with an effort offset (fish time). Additionally, spatial and spatiotemporal random effects (anisotropy) and catchability covariates (time of day, survey and month) were included.

White Shrimp: use the LDWF survey over the years 1980-2022. The recommended VAST model used Delta-lognormal numbers per tow. Additionally, spatial and spatiotemporal random effects (anisotropy) and the catchability covariate (month) were included.

Pink Shrimp: use SEAMAP (summer and fall) survey over the years 2010-2022. The recommended VAST model used zero-inflated negative binomial numbers per tow. Additionally, spatial random effects (anisotropy) (no spatiotemporal RE) and the catchability covariate (time of day) were included.

The Pella-Tomlinson production model was implemented using the state-space formulation of Just Another Bayesian Biomass Assessment (JABBA); where $\text{Surplus Production}_t = r/(m-1) B_t (1 - (B_t/K)^{(m-1)})$, where K is the carrying capacity and r and m are parameters. Most notable is the shape parameter, m , which defines the management quantity $B_{\text{msy}}/K = m^{1/(1-m)}$. In these JABBA implementations additional parameters were implemented: q the catchability coefficient associated with the VAST index; ψ , the initial biomass depletion at the start of catch time series; the process variance (σ^2 ; fixed or estimated); the observation variance (τ^2 ; fixed or estimated); and input observation error plus year-to-year variation in catchability.

Prior distributions were assigned for key parameters which were common for all three stocks. These parameters were: K (mean 10x maximum catch, $CV=1$), B_{msy}/K (mean 0.4, $CV=0.3$); process error variance ($1/\text{gamma}(4,0.01)$). Additionally, an uncertainty grid of priors was assigned for r [medium, high and very high priors (very high was used for brown shrimp, only)], ψ [low ($\text{lognormal}(\mu=0.9, CV=0.25)$), high $\text{lognormal}(\mu=0.25, CV=0.5)$] and additional index observation error [none versus $1/\text{gamma}(0.001,0.001)$]. Model fits were conducted for all combinations of the uncertainty grid and the results evaluated using criteria for model convergence, model fit, model consistency and the DIC. Posterior distributions were estimated for the parameters and from these the management quantities and their posterior probability distributions were calculated.

The brown shrimp model selected was based upon the uncertainty grid of high r , low initial depletion and additional process error estimated (using catch time series starting in 1960). The white shrimp model selected was based upon the uncertainty grid of medium r , low initial depletion and no additional process error estimated (using catch time series starting in 1960). The pink shrimp model selected was based upon the uncertainty grid of medium r , high initial depletion and no additional process error estimated (using catch time series starting in 1960). However, in all three cases several alternative model structures provided similar results.

Empirical Dynamic Modeling (EDM) uses lags of time series data to reconstruct the state-space of a system. This form of modeling is particularly useful for short-lived species with highly variable population dynamics where drivers are often not observed directly, yet the information is embedded within the time series of abundance. Lags of abundance indices are used to reconstruct the full dynamics of the system without needing data on variables impacting abundance or specifying model form. Gaussian Process EDM (GP-EDM) was used to fit the SEAMAP survey data aggregated at several defined levels. The inclusion of economic and environmental variables as covariates were tested as well.

In a broad sense and in the context of shrimp, EDM predicts an index of abundance based upon observations of the index in the previous year and an unknown function that incorporates unknown drivers. Takens Theorem shows these drivers can be modeled through a series of index observations lagged over a number of years. The number of lagged years and covariate drivers define the embedded dimension of the system. Incorporation of catch data scaled by a catchability q converts the catch data into the index scale. Several options were evaluated to transform the index observations in the model with no transformation estimate parameters defining the predicted index. Then, imposing alternative harvest rates into a time series of predictions defines the relationship of abundance to fishing rates and, thus, management quantities B_{msy} and F_{msy} . These models (and their full description) were developed through a series of workshops and reports documented though SEDAR).

The shrimp data were stratified by area: Gulf fishing areas 1-10, 11-17, 18-21, size categories “Small”, “Medium”, “Large”; >67, 67-31, <=30 shrimp tails per pound; =167mm total length; seasonal categories: Winter (JFMA), Summer (MJJA), Fall (SOND); and years duration: 1987-2022. These were modeled as “populations” within a hierarchical model with options where populations were modeled independently with no shared parameters, with a degree to which the dynamics are correlated and quantifies the similarity of population responses across predictor space and hierarchical models with shared parameters. These were explored through a factorial design. All models were evaluated using multiple criteria.

The final selected brown shrimp model was size structured (Large, Medium, Small), with shared catchability, seasonal time steps, an embedded dimension of 5 and the gr2 transformation of the index observations minus q times catch. It was felt that this provided a robust model that captured brown shrimp dynamics and provided stable estimates of maximum sustainable yield and management quantities.

The final selected white shrimp model was size structured (Large, Medium, Small), with separately estimated catchability, annual time steps, an imbedded dimension of 4 and the gr2 transformation. This parameterization was similar to the next best model, but had a smaller embedding dimension and fewer degrees of freedom. It was felt that this provided a robust model that captured white shrimp dynamics and provided stable estimates of maximum sustainable yield and management quantities.

No pink shrimp models passed the selection criteria and none were recommended for evaluation of management quantities.

The strengths and weaknesses of the methods used to assess the stock, given the available data were evaluated through the response to the following questions:

Are priority modeling issues clearly stated and addressed?

The priority modeling issues are clearly stated and addressed. The goal of the modeling was to provide estimates of shrimp productivity and biomass over past history and to estimate the management quantities of Bmsy, Fmsy, Bcurrent/Bmsy and Fcurrent/Fmsy. With the exception of pink shrimp this was done. Additionally, the goal was to incorporate environmental covariates or their surrogates into the production estimation models and evaluate their efficacy for inclusion in the models. This was done.

Are the methods appropriate for the available data?

The data was discussed in detail above. Essentially, these data were: catch histories by size class and survey data from SEAMAP and State surveys. Since shrimp productivity is quite volatile both in space and time, so too are the survey and catch data. The VAST standardization framework is designed to address the volatility, especially spatially. The modeling frameworks (JABBA, EDM) were chosen because of precisely those characteristics: high volatility, limited auxiliary data. So, yes, the methods are appropriate for the available data.

Are assessment models configured properly and used in a manner consistent with standard practices?

The VAST analyses were extensive, exploring a large number of model configurations and then evaluated through a suite of selection criteria. This process was well documented. The VAST modeling goes beyond standard practices in its detail.

The JABBA/Pella-Tomlinson model was configured in a manner consistent with standard practices established in Winker et al. (2018). However, the parameterization of Pella-Tomlinson used in Winker affects the interpretation of the parameter “r” when defining priors for r. Also, the structure of Pella-Tomlinson shifts when the parameter “m” is above or below 1. For that reason, alternative priors on m were explored at the meeting. Results indicated the sensitivity of that parameter.

EDM was configured consistently with standard practices established for EDM generally, but standard practices for fisheries applications have yet to be established. Nevertheless, the EDM analyses were rigorous in their construction and evaluation consistent with good scientific practices. However, because the methods are not as well-known as other approaches, continued effort is needed to show results in a manner consistent with standard assessment presentations and to compare results to more standard models.

Are methods scientifically sound and robust?

While this assessment used two relatively novel approaches not previously used for the assessment of Gulf shrimp (JABBA and EDM platforms), the Analyst Team provided sufficient documentation prior to the workshop for the Review Panel to familiarize themselves with these methods, in addition to answering any questions with insightful and thorough explanations during the Workshop. These methods appear justified and scientifically sound and robust.

The analyst’s conclusions were that the JABBA P-T brown and white models were not sufficiently robust to rely on that method for status determination criteria, instead relying on EDM. I agree that the EDM is sufficiently robust to conclude that $B \gg B_{msy}$ and $U \ll U_{msy}$. The EDM has estimated a long-term average sustainable catch that can be defined as a surrogate for MSY. However, as noted by the analysts and a slew of Gulf penaid shrimp experts over the last half century, further thought (modeling?) is needed to obtain a reference point that is more useful for management (see preamble).

3.4 TOR: 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.

Both the EDM and JABBA methods expand variance estimation beyond just observation error into process error. Improvements might be made to both methods to include other sources of observation error, other sources of fishery-dependent data and time/space dependent productivity parameters. As noted above, a more general production framework using continuous time might be useful. Nevertheless, the existing approaches seem to capture the uncertainties in data and assessment methods.

Comment on the likely relationship of this variability with possible ecosystem or climate factors and possible mechanisms for including this into management reference points.

As noted above, the basic brown shrimp abundance index indicates a large increase over the last several decades. One possibility is that productivity has changed over the years. Future assessment work should be structured to evaluate (by simulation and other methods), the ability to detect such changes.

3.5 TOR: Provide, or comment on, recommendations to improve the assessment

Consider the research recommendations provided by the Data and Assessment processes in the context of overall improvement to the assessment, and make any additional research recommendations warranted.

If applicable, provide recommendations for improvement or for addressing any inadequacies identified in the data or assessment modeling. These recommendations should be described in sufficient detail for application, and should be practical for short-term implementation (e.g., achievable within ~6 months). Longer-term recommendations should instead be listed as research recommendations above.

Simulation work should be explored with EDM Gulf Shrimp to understand how well we are estimating q and how well the MSY projections are performing, how much they depend on the history of exploitation of the stock and basic data limitations (number of years of data, missing annual data). Such tests could be done routinely in real stock assessments or to develop general rules.

It might be possible to use fishery dependent data to a greater extent to improve short-term projections with EDM. EDM makes predictions based on lagged data which are “nearby” in time (e.g., 3-4 year lags). The emphasis on recent data may alleviate problems using fishery dependent data with properties that change slowly over time.

A short-term recommendation (mentioned in the preamble) is that I believe the harvest rate U should be reported rather than the transformation to F . This is because the harvest rate that is being estimated is in fact instantaneous and it more directly relates to the MSY and B_{msy} estimates.

A longer-term research objective is a generalized framework of spatial (estuarine?) variability, with associated catches and indices estimated with hierarchical and phase-dependent models would be useful (see preamble). Additionally, incorporating fishery-dependent effort and CPUE would be useful for understanding fleet/catch dynamics and may provide useful predictions for management.

3.6 TOR: Provide recommendations on possible ways to improve the Research Track Assessment process

This assessment utilized novel approaches for estimating the management quantities of B_{msy} , $B_{current}/B_{msy}$, F_{msy} , $F_{current}/F_{msy}$ for Gulf shrimp, and their trajectories of biomass and fishing rates over the past and projection into the future. While far removed from a “traditional” Research Track Assessment under typical SEDAR operations, these methods proved to be sound as well as robust for determining basic status determination criteria (SDCs), at least for brown and white shrimp. The caveat being the following. Despite the known relationships between Gulf shrimp species and environmental conditions in the estuaries during their post-larval, juvenile, and sub-adult stages (particularly water

temperature in the spring when initial recruitment begins for brown shrimp), none of the environmental data series were ultimately included in assessment. The same can be said for the socioeconomic factors that have been shown to drive much of the effort of the fleet (diesel price, consolidation of the fleet, massive recent influx of foreign imports and its effect on dockside prices, etc.). The structure of EDM models may provide opportunities in this regard. A more general framework of spatial (estuarine?) variability, with associated catches and indices estimated with hierarchical and phase-dependent models would be useful (see preamble). Additionally, incorporating fishery-dependent effort and CPUE would be useful for understanding fleet/catch dynamics and may provide useful predictions for management.

3.7 TOR: Prepare a Review Workshop Summary Report describing the Panel's evaluation of the Research Track stock assessment and addressing each Term of Reference

The Summary Report was prepared and submitted.

4. Conclusions and Recommendations

The assessment documents and explanations were quite useful in providing background for this review. I wish to thank the assessment authors and the SEFSC and the SEDAR staff for their guidance. This was especially important in that the EDM approaches include some non-standard jargon and major improvements since I was initially exposed to imbedded dimensions in models, i.e., there was a learning curve. However, I feel that the documentation was sufficient to provide this learning and allow me to appropriately compare EDM methods with alternative approaches and to suggest improvement to the modeling structure that might be used to explore alternative ecological and environmental hypotheses.

As noted in multiple places in the above comments on TORs, I feel the EDM methods are robust to the key questions of MSY reference points. So EDM is a useful tool. I am a proponent of more generalized production modeling frameworks incorporating the timing of catches, the timing of density-dependence processes and spatial (estuarine?) variability. The spatial hierarchical approach used in EDM is a positive step in that direction.

Appendix 1: Bibliography of materials provided for review

Document #	Title	Authors	Date Submitted
Documents Prepared for the Data Workshop			
SEDAR87-DW-01	Estimation of Commercial Shrimp Effort in the Gulf of Mexico	Kyle Dettloff	30 August 2023 Updated: 27 Sept 2023 Updated: 7 Nov 2023 Updated: 14 December 2023 Updated: 2 April 2024 Updated: 17 May 2024 Updated: 20 August 2024
SEDAR87-DW-02	Social Dimensions of the Gulf of Mexico Shrimp Fishery: Overview	David Griffith	31 August 2023
SEDAR87-DW-03	Commercial Landings of Gulf of Mexico Shrimp Self-Reported Survey 2005-2020	Rebecca Smith, Alan Lowther, J. Williams	5 September 2023
SEDAR87-DW-04	Vessel and Gear Characterizations of Gulf of Mexico Shrimp Self-Reported Survey 2005-2020	Rebecca Smith, Alan Lowther, J. Williams	5 September 2023
SEDAR87-DW-05	Gulf of Mexico Brown, Pink, and White Shrimp Weight-Length Regression using SEAMAP Data	Molly H. Stevens	1 September 2023
SEDAR87-DW-06	Commercial Shrimp Landings of Gulf of Mexico Final Title: Gulf of Mexico Commercial Brown, Pink and White Shrimp Landings	Jade Chau, Alan Lowther, and Kimberley Johnson Final Document Authors: Sarina Atkinson, Alan Lowther, Kyle Dettloff, and Steven Smith	1 September 2023 Updated: 6 Nov 2023 Updated: 5 February 2024 Updated: 13 June 2024

SEDAR87-DW-07	<i>Economics of the Federal Gulf of Mexico Shrimp Fishery</i>	Christopher Liese	1 September 2023
SEDAR87-DW-08	General Economic Measures for Fuel Price Trend, Inflation Adjustment, and Discounting	Christopher Liese	1 September 2023
SEDAR87-DW-09	Gulf of Mexico Spatial-Temporal Environmental Data	Holden Harris	14 September 2023
SEDAR87-DW-10	Shrimp Import Data	Alan Lowther	18 September 2023
SEDAR87-DW-11	Indices of relative abundance for Pink Shrimp, and summary of data availability for Pink, Brown, and White Shrimp, from inshore surveys of Florida's Gulf coast estuaries	Dwayne D. Edwards, Derek M. Tremain, Meagan N. Schrandt, and Theodore S. Switzer	21 September 2023 Updated: 30 November 2023
SEDAR87-DW-12	Inshore brown and white shrimp relative abundance in Louisiana	Office of Fisheries, Louisiana Department of Wildlife and Fisheries	1 November 2023 Updated: 4 January 2024
SEDAR87-DW-13	Brown, White and Pink Shrimp Abundance Indices from SEAMAP Groundfish Surveys in the Northern Gulf of Mexico	Adam G. Pollack and David S. Hanisko	18 Oct 2023
SEDAR87-DW-14	Summary of the Gulf of Mexico Shrimp Effort Data Collection	Alan Lowther	6 Nov 2023 Updated 5 January 2024
SEDAR87-DW-15	Social Dimensions of Gulf of Mexico Shrimping	David Griffith, Christopher Liese, Mike Travis, Matt Freeman, David Records	29 November 2023
SEDAR87-DW-16	SEDAR 87 Commercial Fishery Landings and Effort Figures for White, Pink, and Brown Shrimp in the US Gulf of Mexico, 1960–2021	<i>Jo A. Williams, Kimberley Johnson, and Alan Lowther</i>	12 February 2024 Updated: 4 October 2024
Documents Prepared for the Assessment Process			

SEDAR87-AP-01	Development of estuarine environmental indices for SEDAR 87 Gulf of Mexico White, Pink, and brown shrimp stock assessment	Brendan Turley, Lisa Ailloud, and Molly Stevens	25 July 2024
SEDAR87-AP-02	Price Indices for Shrimp Imports and Gulf of Mexico Shrimp Landings by Size and Season	Christopher Liese	18 December 2024
SEDAR87-AP-03	Developing a fishery-independent index of relative abundance for Gulf of Mexico Brown Shrimp using VAST	Lisa Ailloud, Molly Stevens, Brendan Turley, Adam Pollack, and David Hanisko	31 January 2025
SEDAR87-AP-04	Developing a fishery-independent index of relative abundance for Gulf of Mexico Pink Shrimp using VAST	Lisa Ailloud, Molly Stevens, Brendan Turley, Adam Pollack, and David Hanisko	31 January 2025
SEDAR87-AP-05	Developing a fishery-independent index of relative abundance for Gulf of Mexico White Shrimp using VAST	Lisa Ailloud, Molly Stevens, Brendan Turley, Adam Pollack, and David Hanisko	31 January 2025
Documents Prepared for the Review Workshop			
SEDAR87-RW-01	State Management History - Texas	Council & State Staff	28 May 2025
SEDAR87-RW-02	State Management History - Louisiana	Council & State Staff	28 May 2025
SEDAR87-RW-03	State Management History - Mississippi	Council & State Staff	28 May 2025
SEDAR87-RW-04	State Management History - Alabama	Council & State Staff	28 May 2025
SEDAR87-RW-05	State Management History - Florida	Council & State Staff	28 May 2025
SEDAR87-RW-06	Brown, White, and Pink Shrimp Life History in the Gulf: A Primer	Gulf Council Staff	18 June 2025
Final Stock Assessment Reports			
SEDAR87-SAR1	Gulf Council White Shrimp	SEFSC	
SEDAR87-SAR2	Gulf Council Pink Shrimp	SEFSC	
SEDAR87-SAR3	Gulf Council Brown Shrimp	SEFSC	

Reference Documents		
SEDAR87-RD01	SEAMAP Trawl Shrimp Data and Index Estimation Work Group Report	
SEDAR87-RD02	The Annual Economic Survey of Federal Gulf Shrimp Permit Holders: Implementation and Descriptive Results for 2008	Christopher Liese and Michael D. Travis
SEDAR87-RD03	Mississippi Department of Marine Resources and University of Southern Mississippi Gulf Coast Research Laboratory Inshore Trawl Monitoring Programs: Sampling and Lab Protocols	
SEDAR87-RD04	Marine Fisheries Crustacean Section - Independent Sampling Activities: Field Manual	Louisiana Wildlife and Fisheries
SEDAR87-RD05	Fisheries Assessment and Monitoring Program (FAMP)	Alabama Marine Resources Division
SEDAR87-RD06	AL FAMP Assessment Sampling - Standard Operating Procedures	Alabama Marine Resources Division
SEDAR87-RD07	TPWD's Gulf Trawl Sample Design	Texas Parks and Wildlife Division
SEDAR87-RD08	Commercial brown, white, and pink shrimp tail size: total size conversions	Susan L. Brunenmeister
SEDAR87-RD09	Final Report: U.S. Gulf of Mexico Commercial Shrimp Conversion Factors Validation 2020	GSMFC
SEDAR87-RD10	Conversion of "whole" and "headless" weights in commercial Gulf of Mexico shrimps	Joseph H. Kutkuhn (1962)
SEDAR87-RD11	Brown, White and Pink Shrimp Life History Summaries	Jen Leo
SEDAR87-RD12	JABBA: Just Another Bayesian Biomass Assessment	Henning Winker, Felipe Carvalho, Maia Kapur
SEDAR87-RD13	Empirical dynamic modeling for sustainable benchmarks of short-lived species	Cheng-Han Tsai, Stephan B. Munch, Michelle D. Masi, and Molly H. Stevens
SEDAR87-RD14	Recent developments in empirical dynamic modelling	Stephan B. Munch, Tanya L. Rogers, George Sugihara
SEDAR87-RD15	Comparing estimates of abundance trends and distribution shifts using single- and multispecies models of fishes and biogenic habitat	James T. Thorson and Lewis A. K. Barnett
SEDAR87-RD16	The Texas Shrimp Fishery	Texas Parks and Wildlife

Appendix 2: Performance Work Statement
Performance Work Statement (PWS)
National Oceanic and Atmospheric Administration (NOAA)
NOAA Fisheries
Center for Independent Experts (CIE) Program
External Independent Peer Review

SEDAR 87 Gulf of Mexico White, Pink, and Brown Shrimp
June 23-27, 2025

Background

The 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, and that peer reviewers must be deemed qualified based on the OMB Peer Review Bulletin standards¹.

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.

The SEDAR 87 review workshop will be a CIE assessment review of the Benchmark Assessment of Gulf of Mexico white, pink, and brown shrimp. 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 additional runs of the

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

assessment models provided by the assessment panel. The review panel is ultimately responsible for providing advice to ensure the assessment is appropriate for use by fishery managers.

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

Requirements

NOAA Fisheries requires three reviewers to conduct an impartial and independent peer review in accordance with the Performance Work Statement (PWS), OMB guidelines, and the ToRs below. The reviewers shall have a working knowledge in stock assessment, statistics, and fisheries science sufficient to complete the primary task of providing peer-review advice in compliance with the workshop Terms of Reference fisheries stock assessment. Expertise in the usage of at least two of the three of the following: surplus production models, EDM (Empirical Dynamic Modeling), and VAST (Vector Autoregressive Spatio-Temporal Model) modeling approaches and the associated diagnostics is necessary.

The chair, who is in addition to the 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. Each reviewer will write an individual review report in accordance with the PWS, OMB Guidelines, and the TORs below. Modifications to the PWS and TORs cannot be made during the peer review, and any PWS or TORs modifications prior to the peer review shall be approved by the Contracting Officer's Representative (COR) and the CIE contractor. All TORs must be addressed in each reviewer's report.

Tasks for Reviewers

- 1) Pre-review Background Documents: Review the following background materials and reports prior to the review:

Completed Data and Assessment reports, along with all working papers and reference documents, will be available on the SEDAR website no later than two weeks prior to the in-person review workshop:

<https://sedarweb.org/assessments/sedar-87-gulf-of-mexico-white-pink-and-brown-shrimp/>

- 2) Attend and participate in an in-person review meeting. The meeting will consist of presentations by NOAA and other scientists, stock assessment authors and others to facilitate the review, to answer any questions from the reviewers, and to provide any additional information required by the reviewers.

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

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 30 days in advance. For additional information, please see the following link: <https://www.commerce.gov/osy/programs/foreign-access-management>. The contractor is required to use all appropriate methods to safeguard Personally Identifiable Information (PII).

Place of Performance

The place of performance shall be Tampa, Florida

Period of Performance

The period of performance shall be from the time of award through August 15, 2025. Each reviewer’s duties shall not exceed **14** days to complete all required tasks.

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

Schedule	Milestones and Deliverables
Within 2 weeks of award	Contractor selects and confirms reviewers
Approximately 2 weeks prior to the review	Contractor provides the pre-review documents to the reviewers
June 23-27, 2025	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 (2) The reports shall address each ToR as specified (3) The reports shall be delivered as specified in the schedule of milestones and deliverables.

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).

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 \$12,000.00.

Project Contacts

Kate Siegfried – NOAA Fisheries Project Contact
Chief, Gulf Fisheries Branch
Sustainable Fisheries Division
Southeast Fisheries Science Center

Julie Neer - SEDAR Program Manager
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Annex 1: Peer Review Report Requirements

1. The independent Peer Reviewer report shall be prefaced with an Executive Summary providing a concise summary of whether they accept or reject the work that they reviewed, with an explanation of their decision (strengths, weaknesses of the analyses, etc.).
2. The report must contain a background section, description of the individual reviewers' roles in the review activities, summary of findings for each ToR, in which the weaknesses and strengths are described, and conclusions and recommendations in accordance with the TORs.
 - a. Reviewers must describe in their own words the review activities completed during the panel review meeting, including a brief summary of findings, of the science, conclusions, and recommendations.
 - b. Reviewers should discuss their independent views on each ToR even if these were consistent with those of other panelists, but especially where there were divergent views.
 - c. Reviewers should elaborate on any points raised in the summary report that they believe might require further clarification.
 - d. Reviewers shall provide a critique of the agency review process, including suggestions for improvements of both process and products.
 - e. The report shall be a stand-alone document for others to understand the weaknesses and strengths of the science reviewed, regardless of whether or not they read the summary report. The report shall represent the peer review of each ToR, and shall not simply repeat the contents of the summary report.
3. The report shall include the following appendices:
 - Appendix 1: Bibliography of materials provided for review
 - Appendix 2: A copy of this Performance Work Statement
 - Appendix 3: Panel membership or other pertinent information from the panel review meeting.

Annex 2: Terms of Reference for the Peer Review

SEDAR 87 Gulf of Mexico White, Pink, and Brown Shrimp June 23-27, 2025

Review Workshop Terms of Reference

1. Evaluate the degree to which the terms of reference from the Data and Assessment processes were addressed.
2. Evaluate the data used in the assessment, including discussion of the strengths and weaknesses of data sources and decisions. Consider the following:
 - Are data decisions made by the Data and Assessment processes justified?
 - Are data uncertainties acknowledged, reported, and within normal or expected levels?
 - Is the appropriate model(s) applied properly to the available data?
 - Are input data series sufficient to support the assessment approach?
3. Evaluate and discuss the strengths and weaknesses of the methods used to assess the stock, given the available data. Consider the following:
 - Are methods scientifically sound and robust?
 - Are priority modeling issues clearly stated and addressed?
 - Are the methods appropriate for the available data?
 - Are assessment models configured properly and used in a manner consistent with standard practices?
4. 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.
 - Comment on the likely relationship of this variability with possible ecosystem or climate factors and possible mechanisms for including this into management reference points.
5. Provide, or comment on, recommendations to improve the assessment
 - Consider the research recommendations provided by the Data and Assessment processes in the context of overall improvement to the assessment, and make any additional research recommendations warranted.
 - If applicable, provide recommendations for improvement or for addressing any inadequacies identified in the data or assessment modeling. These recommendations should be described in sufficient detail for application, and should be practical for short-term implementation (e.g., achievable within ~6 months).

Longer-term recommendations should instead be listed as research recommendations above.

6. Provide recommendations on possible ways to improve the Research Track Assessment process.
7. Prepare a Review Workshop Summary Report describing the Panel's evaluation of the Research Track stock assessment and addressing each Term of Reference.

Annex 3: Tentative Agenda

SEDAR 87 Gulf of Mexico White, Pink, and Brown Shrimp Review June 23 – 25, 2024 Tampa, Florida

Monday

1:00 pm – 6:00 pm	Introductions and Opening Remarks <i>- Agenda Review, TOR, Task Assignments</i> Assessment Presentations <i>- Background</i> <i>- Assessment Data & Methods</i>	Coordinator Analytic Team
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Tuesday

9:00 am – 12:00 pm	Assessment Presentations (continued) <i>- Assessment Data & Methods</i>	Analytic Team
12:00 pm – 1:30 pm	Lunch Break	
1:30 pm – 4:30 pm	Assessment Presentations (continued) <i>- Assessment Data & Methods</i> <i>- Identify additional analyses, sensitivities, corrections</i>	Analytic Team
4:30 pm – 5:00 pm	Wrap Up/Public Comment	Chair
5:00 pm - 6:00 pm	Panel Work Session	Chair

Tuesday Goals: Initial assessment presentations completed, sensitivities and modifications identified.

Wednesday

8:30 a.m. – 11:30 pm	Assessment Presentations (continued) <i>- Assessment Methods</i> <i>- Identify additional analyses, sensitivities, corrections</i>	Analytic Team
11:30 a.m. – 1:00 pm	Lunch Break	
1:00 pm – 5:30 pm	Panel Discussion <i>- Review additional analyses, sensitivities</i> <i>- Recommendations and comments</i>	Chair
5:30 pm - 6:00 pm	Public Comment	Chair

Wednesday Goals: Presentations completed, additional sensitivities identified, preferred models selected, projection approaches approved, Summary report drafts begun.

Thursday

8:30 a.m. – 11:30 pm	Panel Discussion <i>- Review additional analyses, sensitivities</i> <i>- Recommendations and comments</i>	Chair
11:30 a.m. – 1:00 pm	Lunch Break	
1:00 pm – 5:30 pm	Panel Discussion	Chair

- *Final sensitivities reviewed.*
- *Projections reviewed.*

5:30 pm - 6:00 pm

Public Comment

Chair

Thursday Goals: Review final sensitivities, complete assessment work, and finalize discussions.

Friday

9:00 a.m. – 1:00 pm

Panel Discussion or Work Session

Chair

- *Review Summary Reports*

Friday Goals: Final results available. Draft Summary Report reviewed.

Appendix 3: Panel membership or other pertinent information from the panel review meeting.

List of Participants.....	<i>Review Panel</i>
Jim Tolan (Chair)	GMFMC Appointee
Simon DeLestang	CIE Reviewer
Larry Jacobson	CIE Reviewer
Erik Lang	LDWF/GMFMC Appointee
Joe Powers	CIE Reviewer
Steven Saul.....	GMFMC SSC

Analytic Team

Lisa Ailloud	NMFS SEFSC
Molly Stevens	NMFS SEFSC
Katie Siegfried	NMFS SEFSC

Appointed Observers

Fernando Martinez-Andrade	TXPWD
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Staff

Julie A Neer	SEDAR
Matt Freeman	GMFMC Staff
John Froeschke.....	GMFMC Staff
Ryan Rindone.....	GMFMC Staff
Charlotte Schiaffo	GMFMC Staff

Workshop Observers

Leann Bosarge	Shrimp Industry
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Workshop Observers via Webinar

Jason Adriance	LADWF
Jesse Buntin	NOAA
Peyton Cagle	LADWF
Judd Curtis	SAFMC Staff
Tricia Kimball.....	
Dominique Lazarre	SERO
Richard Malinowski.....	NOAA
Jessica Marchant	AL DCNR
Michelle Masi	SERO
Steve Munch	SWFSC
Emily Ott.....	SEDAR
Jason Saucier.....	MS DMR
Rebecca Smith	NOAA
John Walter	SEFSC

