Summary Report of the Longfin Inshore Squid Research Track Stock Assessment Peer Review

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Marine Biological Laboratory, Woods Hole, Massachusetts

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Introduction

The Northeast Region Coordinating Council (NRCC)[1] has developed an enhanced stock assessment process to improve the quality of assessments. The process involves two tracks of assessment work: 1) a Management Track (MT) that includes routine updates of previously approved assessment methods to support regular management actions (e.g., annual catch limits), and 2) a Research Track (RT) that allows comprehensive research and development of improved assessments on a stock-by-stock or topical basis. The RT assessment process allows for a more thorough review of information available and for the evaluation of different assessment approaches than would be possible in a standard stock assessment process where the results are immediately needed for management advice. RT assessments are followed by MT assessments; occasionally, there is the ability to improve a RT assessment before or during a subsequent MT assessment. This Peer Review Panel (hereafter Panel) reviewed the RT Assessment for the Longfin Inshore Squid stock in United States waters.

The Panel reviewed the Research Track Stock Assessment for the Longfin Inshore Squid (*Doryteuthis pealeii*), which developed and evaluated two alternative assessment approaches, a Seasonal Production Assessment Model (SPAM) and a State-Space Length Structured Assessment Model (SSLAM), for estimating stock status, biological reference points, and future population dynamics. The assessment considered the full range of available fishery-dependent and fishery-independent information, including commercial catch and effort data, Northeast Fisheries Science Center (NEFSC), states and regional survey indices, biological sampling, and environmental information where appropriate. Particular emphasis was placed on evaluating whether either assessment approach provides a scientifically defensible basis for management advice under the species' short life span, highly variable recruitment, and environmentally driven population dynamics.

[1] Atlantic States Marine Fisheries Commission (ASFMC), Greater Atlantic Regional Fisheries Office (GARFO), Mid-Atlantic Fishery Management Council (MAFMC), New England Fishery Management Council (NEFMC), and Northeast Fisheries Science Center (NEFSC).

The Peer Review Panel (Panel) met at the NEFSC, Woods Hole, Massachusetts from August 3-7, 2026 to evaluate the assessment with respect to the approved Terms of Reference. Online option via Google Meet was also available for other attendees who wanted to attend the review remotely. The Panel consisted of three independent reviewers appointed through the Center for Independent Experts (CIE), Dr. Klaas Hartmann, Dr. Alexei Sharov, and Dr. Ruben Roa Ureta, together with an independent Panel Chair, Dr. Yong Chen (Stony Brook University and member of the Scientific and Statistical Committee of the Mid-Atlantic Fisheries Management Council). Throughout the review, the Panel received presentations from the Working Group (WG), questioned the WG, evaluated supporting analyses, and discussed the strengths, weaknesses, assumptions, and uncertainties associated with assessment models, input data, fisheries, ecosystems, and assessment results.

The WG Assessment Report, supporting Working Papers, model documentation, input datasets, diagnostic analyses, and presentation materials were made available to the Panel at https://apps-nefsc.fisheries.noaa.gov/saw/sasi.php two weeks before the review meeting. These materials included complete model descriptions, diagnostic results, sensitivity analyses, retrospective analyses, projection analyses, and comparisons between the two candidate assessment models. Throughout the review, WG members responded to questions, clarified analytical approaches, and provided additional supporting information and conducted additional model runs and analyses, requested by the Panel.

Individual Panel members assumed primary responsibility for drafting specific sections of this Summary Report according to the assigned Terms of Reference. The Panel Chair coordinated report preparation, integrated the individual sections into a single report, and ensured that the report accurately reflected the consensus of the Panel and the scientific discussions during the review. The WG reviewed the draft report solely to identify factual errors or request clarification of Panel findings; the scientific conclusions and recommendations presented herein remain entirely those of the independent Peer Review Panel. In addition to this Summary Report, each CIE reviewer will prepare an independent reviewer report in accordance with CIE requirements. CIE Peer Review Reports will be made available at https://www.st.nmfs.noaa.gov/science-quality-assurance/cie-peer-reviews/peer-review-reports.

The Panel recognized that longfin squid presents significant assessment challenges because of its annual life cycle, rapid growth, strong seasonality in life history and fishery, highly variable recruitment, environmentally mediated population dynamics, and limited age information. These characteristics increase structural uncertainty and place greater demands on assessment models than for most finfish stocks. Consequently, the Panel placed particular emphasis on evaluating model assumptions, parameter estimability, model diagnostics, model performance, sensitivity analyses, uncertainty characterization, and the robustness of scientific advice under alternative model structures.

The Panel concluded that the WG successfully achieved the objectives of the Research Track by developing and thoroughly evaluating two complementary assessment models and a biologically appropriate framework for estimating biological reference points for the longfin squid. The SSLAM and SPAM represent different but complementary approaches to assessing this highly dynamic, short-lived species. SSLAM provides a biologically realistic, process-based framework

that explicitly models recruitment, growth, mortality, and seasonal population dynamics, whereas SPAM offers a simpler, robust seasonal biomass-dynamics approach that is computationally efficient and operationally practical. Despite their different structures and assumptions, both models provide scientifically credible representations of stock dynamics and generally lead to consistent conclusions regarding stock status and management. After careful evaluation of the available data, model diagnostics, sensitivity analyses, retrospective analyses, and supporting simulations, the Panel concluded that both assessment models are scientifically sound and suitable for providing management advice. The availability of two independently developed assessment approaches can strengthen confidence in stock assessment by providing complementary lines of evidence and allowing structural uncertainty to be explicitly evaluated.

The Panel further concluded that the proposed biological reference points represent a substantial scientific advancement over previous approaches and are consistent with the biology and life history of longfin squid. The WG appropriately recognized that conventional equilibrium reference points developed for long-lived finfish are not well suited for a short-lived, highly seasonal cephalopod and developed a biologically informed framework supported by extensive simulation analyses and sensitivity testing. Nevertheless, the Panel concluded that the biological reference points derived from both assessment models remain subject to uncertainty associated with biomass estimation, recruitment variability, model structure, and other underlying assumptions. Consequently, the Panel considers the proposed biological reference points to be provisional. While they provide the best available scientific basis for current management decisions, their continued application should be accompanied by additional evaluation and refinement as new biological information becomes available and/or catches substantially increase. In particular, further testing through future assessments, simulation analyses, and, where feasible, Management Strategy Evaluation will be important to evaluate their robustness and long-term performance under a broader range of biological and observational uncertainties.

The Panel commends the WG for conducting a rigorous, comprehensive, and transparent assessment. Developing two independent assessment models, assembling and integrating diverse biological and fishery datasets, and conducting extensive diagnostic evaluations, sensitivity analyses, retrospective analyses, and simulation testing represent a substantial scientific achievement. Throughout the review, the WG responded openly and constructively to Panel questions and provided additional analyses and clarifications whenever requested, greatly facilitating the review process. The Panel recognizes the inherent challenges of assessing a short-lived species with highly variable recruitment and strong seasonal dynamics, and believes that the WG has developed a scientifically robust assessment framework that substantially advances the assessment and management of longfin squid.

Overall, the Panel concludes that this Research Track provides NOAA Fisheries with two scientifically defensible assessment models that are appropriate for supporting current management advice and relevant biological reference points that represent the best available science but should be further evaluated during future assessments. The Panel believes that this Research Track establishes a strong scientific foundation for future assessments and adaptive management while identifying a clear roadmap for continued refinement of the assessment models and biological reference points as additional scientific information becomes available.

The Panel's evaluation of each Term of Reference is presented in the following sections of this report. Each section summarizes the scientific evidence reviewed by the Panel, evaluates the extent to which the Working Group addressed the specific objectives of the Term of Reference, identifies major strengths and concerns, and provides recommendations for future assessment development and management application.

TOR 1. Ecosystem

Identify relevant ecosystem and climate influences on the stock. Characterize the uncertainty in the relevant sources of data and their link to stock dynamics. Consider findings, as appropriate, in addressing other TORs. Report how the findings were considered under impacted TORs.

The Panel concluded this TOR was met.

The Panel concluded that the WG completed a comprehensive review of the available information describing the environmental and ecosystem processes affecting longfin inshore squid. The review synthesized current knowledge of the species' distribution, seasonal migration, habitat use, temperature dependence, growth, life history, and trophic ecology, and evaluated multiple environmental datasets that could potentially inform assessment development.
The Panel concluded that the TOR is substantively addressed, with transparent acknowledgment of the limitations and explicit reporting of how ecosystem and climate findings influenced the other relevant TORs. The Panel agreed that the review provides an excellent synthesis of current ecological knowledge and establishes a strong scientific foundation for future ecosystem-informed assessments. The Panel identified several important strengths. First, the WG conducted one of the most comprehensive syntheses to date of the ecology and environmental drivers affecting longfin squid throughout the Northwest Atlantic. The review integrates fishery-independent surveys, environmental observations, published literature, and recent analyses into a coherent description of the species' seasonal dynamics. Second, the analyses clearly demonstrate that temperature plays a fundamental role in growth, seasonal distribution, migration timing, and habitat occupancy. Incorporating temperature-dependent growth into SSLAM represents an important methodological advance and improves biological realism relative to previous assessment approaches. Third, the application of VAST provides a modern framework for standardizing survey indices while accounting for changes in spatial distribution and sampling intensity. The Panel considered this an important improvement over traditional design-based indices for a highly mobile species. Finally, the WG appropriately recognized that environmental processes should be incorporated only where supported by data and biological understanding, rather than adding complexity without demonstrated benefit.

The WG identified key ecosystem and climate influences, discussed major sources of uncertainty, and explicitly explained where these findings informed other Terms of Reference (TORs). However, the WG also acknowledged that the work was scaled back due to factors outside the WG's control and that several ecosystem-climate relationships could not be incorporated quantitatively into the assessment.

With respect to the identification of relevant ecosystem and climate influences, the WG reviewed in detail life history, trophic ecology, predator-prey interactions, environmental drivers, temperature effects on growth, oceanographic influences on movement, and stakeholder perspectives. The WG also developed a snapshot Ecosystem and Socioeconomic Profile (ESP)

when a full ESP was not possible. The WG repeatedly highlighted uncertainty surrounding lifespan, spawning timing and location, life history, environmental relationships, and ecological linkages. It explained that these uncertainties limited quantitative incorporation into the assessment.

The WG explicitly identified where TOR 1 findings informed other work, including temperature-dependent growth in SSLAM (TOR 4), discussion of growth in SPAM (TOR 8), use of trawl efficiency estimates in SPAM sensitivity analyses (TOR 8), and spatiotemporal species distribution modeling used to develop abundance indices (TOR 3). The Executive Summary clearly documents how ecosystem and climate findings were incorporated into TORs 3, 4, and 8, providing a direct crosswalk between TOR 1 and later assessment components.

The WG completed this TOR to a high standard. The main strengths of the WG's report are that it identifies the major ecosystem and climate drivers affecting longfin squid, explicitly discusses important biological and environmental uncertainties, and clearly documents how ecosystem findings informed subsequent assessment components.

Although the ecological review is comprehensive, the Panel noted that relatively few environmental relationships have yet been translated into quantitative components of the assessment. Most ecosystem analyses remain descriptive rather than predictive. Temperature has been linked to growth which has been incorporated into SSLAM, but environmental drivers have not yet been linked quantitatively to other potentially important processes, including recruitment variability, migration, seasonal availability, and natural mortality, in the assessment of population dynamics.

The Panel also noted that evidence supporting environmentally driven recruitment remains limited. While several environmental variables appear correlated with recruitment and distribution, the analyses presented do not yet demonstrate stable predictive relationships suitable for operational assessment use. Similarly, the Panel found limited evaluation of uncertainty associated with environmental covariates. The consequences of uncertainty in environmental covariates were not explicitly incorporated propagated into assessment estimates, projections, or biological reference points.

Another principal limitation is that the WG explains that the intended scope of TOR 1 had to be reduced because the loss of the TOR 1 lead prevented completion of the planned full Ecosystem and Socioeconomic Profile and species distribution modeling effort. Consequently, ecosystem and climate information is used primarily to inform the assessment rather than being fully integrated quantitatively into the stock assessment models.

The Panel recommends that future work should focus on (1) identifying and quantitatively validating relationships between environmental conditions and recruitment, movement, and seasonal availability; (2) continuing development of climate-informed assessment approaches while ensuring that added complexity results in measurable improvements in model performance; and (3) maintaining ecosystem analyses as an active area of research, with incorporation into operational assessments only after sufficient evidence demonstrates improved predictive skill and management relevance.

TOR 2. Catch

Estimate catch from all sources including landings and discards. Describe the spatial and temporal distribution of landings, discards, and fishing effort. Characterize the uncertainty in these sources of data.

The Panel concluded this TOR was met.

The Panel concluded that the WG conducted a comprehensive evaluation of the fishery-dependent information available for longfin inshore squid. The WG compiled and synthesized commercial landings, discards, fishing effort, fishery-independent biological sampling, commercial length composition data, and spatial and seasonal characteristics of the fishery. Recreational catch estimates are not available and the WG considered that recreational catches are negligible. The Panel concurred with this view given the scale of commercial catch and stock status. The catch estimates included all U.S. commercial catch north of Cape Hatteras and covered both landings and discards.

With respect to the catch time series length, the WG described temporal trends in landings for 1963–2023, with emphasis on 1996–2023, as well as seasonal patterns in catch associated with migrations, spatial distributions of landings, discards, and fishing effort, and identified areas with the highest monthly landings. It also reported directed fishing trips and days at sea.

The WG identified commercial landings (1996–2023) as the most reliable component of total catch. Evidence supporting relatively low uncertainty in reported landings includes the following factors:

- Landings are based on mandatory commercial reporting.
- Historical landings were reviewed from 1963 onward, with the assessment focusing on 1996–2023.
- Spatial distributions were reconstructed using vessel-reported location data.
- Multiple independent biological sampling programs (port sampling, observer sampling, processor sampling, SQUIBS) as well as data from processors were available to characterize the biological composition of catch.

The WG did not identify major concerns regarding the accuracy of landings estimates, suggesting they are considered a robust input to the assessment.

With respect to commercial discards the WG defined them as noticeably more uncertain according to the following:

- Discards were estimated and generally represented only about 4% of total landings.
- Observer data were used to characterize discarded squid, implying that discard estimation depends on sampling rather than complete reporting.
- Because discard estimates rely on observer coverage and extrapolation rather than census data, their uncertainty is inherently greater than that of landings.

The WG suggests that uncertainty in total commercial catch during 1996–2023 is relatively limited because:

- Landings dominate the catch (approximately 96% of total commercial catch).
- Discards comprise only about 4% of landings, so even moderate uncertainty in discard estimates has a relatively small influence on total catch estimates.

The WG report fully satisfied the requirement to describe fishing effort. It provided a thorough description of the temporal and spatial distribution of commercial fishing effort and linked those patterns to catch per unit effort (CPUE) standardization and stock assessment. Specifically, the report described:

- Long-term trends in fishing effort over the 1996–2023 assessment period.
- Directed fishing effort, including the number of directed fishing trips.
- Fishing effort measured as days-at-sea (DAS), allowing comparison of effort through time.
- Seasonal and spatial distributions of fishing activity, identifying where and when effort was concentrated.
- Spatial patterns that were used to support the development of fishery-dependent CPUE indices.

The characterization of commercial fishing effort is comprehensive and is one of the strongest aspects covered in TOR 2, although explicit discussion of uncertainty in effort estimates is relatively limited.

With respect to the size frequency distribution of the catch, the WG compiled multiple independent sampling programs, evaluated their representativeness, developed standardized annual size compositions, and used them directly as inputs to the stock assessment models.

The spatial distribution of commercial discards and fishing effort is described well. The WG describes and map where discarding occurs using Northeast Fishery Observer Program data. Specifically, the report mapped the spatial distribution of commercial discards, compared discard patterns with commercial landings; identified areas where discarding is concentrated; and used observer data to characterize the size composition of discarded squid. However, the report does not identify strong geographic "hot spots" of discarding or provide extensive analysis of why discard rates differ among regions.

During the review the importance of the size-composition data obtained from processors was noted. The SSLAM model did not converge in the absence of this dataset. Concerns were raised that provision of this dataset is not mandated and this may affect future assessments. However the WG noted that i) the key processors had all provided letters of support for ongoing provision of this data and that ii) methods are being developed to streamline data provision including consideration of an electronic reporting system.

Fishing efforts received a more comprehensive treatment. The working group report mapped the spatial distribution of commercial fishing effort; described where directed fishing effort is concentrated; presented effort in terms of directed trips and days at sea (DAS); examined seasonal shifts in fishing locations associated with squid migrations; and used spatial effort information to develop standardized fishery-dependent CPUE indices. The report also identified the regions with the highest monthly landings and effort, providing a clear picture of how the fishery shifts through space and time. Overall, the fishing effort was very well described, with

detailed spatial and temporal analyses that directly support CPUE standardization and stock assessment.

Compared with previous assessments, the WG made substantial progress in documenting the historical fishery, evaluating the quality and limitations of available fishery-dependent datasets, and assembling the information necessary to support development of both SSLAM and SPAM. The Panel considered the fishery data review to be comprehensive and appropriate for supporting assessment development.

Although the fishery-dependent data are extensive, several uncertainties remain that may influence assessment results. The Panel noted that discard estimation continues to represent an important source of uncertainty. Observer coverage varies among years and fleets and estimates of discard rates and discard mortality remain limited. While discards appear to represent a relatively small proportion of total removals in most years, uncertainty surrounding discard estimation should be more explicitly incorporated into future assessment analyses where feasible. The Panel also noted that commercial biological sampling may not always be representative of the entire exploited population. Commercial catches reflect fisher behavior, market demand, gear selectivity, and spatial targeting rather than random sampling of the stock. Consequently, commercial length and sex compositions should continue to be interpreted with appropriate caution, particularly during periods of strong aggregation or localized fishing. Fishing effort remains difficult to standardize because of changes in fleet behavior, technology, market conditions, regulations, and targeting practices over time. These factors limit the usefulness of LPUE and other commercial catch rates as direct indicators of abundance. The Panel agreed with the WG's decision not to rely on fishery-dependent abundance indices as primary inputs to the assessment. The Panel further noted that uncertainties remain regarding the temporal allocation of catches within seasons and the correspondence between commercial removals and the biomass represented by fishery-independent surveys. Because longfin squid are short-lived and highly seasonal, the timing of removals relative to recruitment, migration, and survey observations may influence assessment estimates.

The Panel recommends the following research activities.

High priority (not listed in order of priority)

- Continue improving discard estimation through expanded observer coverage and evaluation of discard mortality.
- Continue collecting standardized biological sampling from commercial catches across seasons and geographic regions to improve representation of the exploited population.
- Further evaluate the timing of seasonal catches relative to recruitment, migration, and survey observations to improve alignment between removals and modeled population dynamics.
- Develop a streamlined approach for collecting size-composition data from processors.

Long-term research (important, but cannot be done within a short time period)

- Continue investigating methods for standardizing commercial LPUE while recognizing the influence of targeting behavior, technological change, market conditions, and spatial redistribution of fishing effort.
- Evaluate whether additional fishery-dependent information, including electronic monitoring and high-resolution fishery data, can improve future assessments without introducing additional bias.
- Continue developing cooperative research programs to improve biological sampling, discard estimation, and understanding of fleet dynamics.
- Periodically reassess the role of commercial fishery data as assessment models evolve and additional information becomes available.

TOR 3. Surveys

Present the survey data used in the assessment (e.g., indices of relative or absolute abundance, recruitment, state surveys, age-length data, application of catchability and calibration studies, etc.) and provide a rationale for which data are used. Describe the spatial and temporal distribution of the data. Characterize the uncertainty in these sources of data.

The Panel concluded this TOR was met.

The TOR required presentation of the survey data used in the assessment, a rationale for why it was used, and a characterization of the temporal and spatial scope of the data and its uncertainty. The WG undertook a comprehensive approach to this TOR by initially collating longfin squid data from a broad range of institutions along the USA and Canadian East Coast. This included NEFSC, all state agencies from Maine to North Carolina, and Fisheries and Oceans Canada (DFO). A total of fifteen fisheries-independent bottom-trawl survey time series were collated. The Panel was impressed by the amount of available data and the work undertaken in compiling the datasets.

The Panel queried the practicality of updating the datasets on an ongoing basis, given the amount of work this would require and the feasibility of being able to continue to compile the data (particularly outside of a research track), to support regular assessments. The WG indicated that there is a robust working relationship between the collaborating organizations and ongoing data sharing is straightforward. The response satisfied the Panel.

The suitability of the time series for informing the assessment was considered and a structured data filtering approach was developed. This approach operated at two levels, firstly whether each individual data source was suitable for inclusion and secondly a data filter applied to each data source.

Selection criteria for data sources were: i) temporal coverage - minimum of 5 years, ii) spatial coverage (minimum 1000 km^2), and iii) prevalence (longfin squid in at least 5% of tows). This left a total of nine surveys for consideration. These datasets were further filtered by i) removing cruise periods in which squid occurred at fewer than 5% of the sampling sites and ii) removing individual strata with encounter rates below 5%. This nested approach matched the remaining datasets with the spatial and temporal distribution of squid.

The Panel agreed that the data compilation, selection and filtering process was appropriate.

Four approaches utilizing these datasets to produce indices suitable for model inclusion were developed:

1. Individual-survey model-based indices - delta-GAMs (binomial + positive-catch components) standardizing CPUE per survey/cruise period, with covariates chosen to address catchability rather than density.
2. Individual-survey design-based indices - stratified means with associated uncertainty.
3. Multi-survey univariate Vector Autoregressive Spatio-Temporal (VAST) biomass indices (spring/fall) — the primary input to SPAM (TOR 8).
4. Multi-survey multivariate VAST abundance and length-composition index (fall) and the model-based indices for NEFSC and NEAMAP for the spring - the input to SSLAM (TOR 4).

The Panel agreed that the approaches were suitable and the presented work was conducted appropriately, noting that further development and refinement of the models remains important; particularly as new data become available.

Recruitment indices using paralarval abundance and egg mop presence/absence data from both fishery dependent and independent datasets were investigated. These analyses supported the WG's understanding of the spawning cycle and life-history narrative. However due to data availability and a range of data quality concerns they were not utilized as input for SSLAM. The Panel supported this finding.

Overall, a comprehensive range of datasets were collated, thoroughly investigated and analyzed. This sets the stage for having appropriate and well understood/characterized data inputs for model development; thereby meeting the requirements and intent of this TOR.

The Panel recommends the following priorities to simplify and reduce the workload associated with assessment updating:

- Continued streamlining / automation of data collation and quality control processes.
- Development of a workflow utilizing high performance computing facilities to simplify the VAST index calculations.

The Panel recommends the following priorities for future assessment development.

- Conduct studies to improve understanding of survey catchability, including gear efficiency, behavioral responses, vertical distribution, and seasonal availability of longfin squid.
- Evaluate the sensitivity of assessment results to alternative assumptions regarding effective survey catchability and biomass scaling.
- Continue refining VAST model development through evaluation of alternative spatial structures, observation models, and model diagnostics.
- Quantify and propagate uncertainty associated with survey standardization into assessment estimates, biological reference points, and projections.

- Improve understanding of seasonal migration and availability to fishery-independent surveys through integration of survey observations, fishery information, and movement studies.
- Continue evaluating consistency among multiple survey programs and identify opportunities for survey calibration where appropriate.
- Expand analyses of fishery-independent biological sampling to strengthen estimation of recruitment, growth, and seasonal population structure.
- Investigate independent approaches for estimating survey catchability, including comparative fishing experiments, acoustic methods, optical surveys, and integrated modeling approaches.

TOR 4. Model

Use the appropriate assessment approach to estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series, and estimate their uncertainty. Compare the time series of these estimates with those from the previously accepted assessment(s). Evaluate a suite of model fit diagnostics (e.g., residual patterns, sensitivity analyses, retrospective patterns), and (a) comment on likely causes of problematic issues, and (b), if possible and appropriate, account for those issues when providing scientific advice and evaluate the consequences of any correction(s) applied.

The Panel concluded this TOR was met.

SSLAM (State-Space Length-structured Assessment Model) is a length- and sex-specific, state-space population model coded in RTMB. It features a monthly time step and tracks abundance by 1-cm length bin and sex. Growth follows a stochastic increment-based sex specific and temperature dependent Gompertz model, natural mortality is length-dependent (Lorenzen), and fishing mortality combines follows a random-walk over time with estimated selectivity. Recruitment follows an estimated mean-monthly pattern scaled by AR1 process-error deviations and spread over length by a fixed recruit-length distribution. It is fitted to catch, fishery and survey length/sex compositions, the commercial CPUE index, and survey indices.

The Panel considered the model structure and mathematical description appropriate given the life-history and characteristics of the fishing fleet. Substantial uncertainty remains regarding spatial stock structure and life-history characteristics; however the model structure matches current scientific knowledge.

Candidate models were identified on the basis of convergence, objective function values, residuals and biological plausibility. A broad range of configurations were explored covering aspects including recruitment parameterization, growth, natural mortality, data treatment and combinations of datasets. Monthly time steps were used to capture the rapid seasonal changes in abundance and life-history characteristics.

The Panel found that appropriate methods were used for assessing model convergence, stability and assessing model fits. On the Panel's request, documents with comprehensive model diagnostics were provided for key model runs facilitating comparison between models. Overall the Panel agreed that an appropriate approach had been taken for identifying a base case.

The Panel found that whilst a broad range of sensitivity analyses had been conducted, these weren't comprehensive. In particular, the Panel was concerned about sensitivity to natural mortality given the highlighted uncertainty regarding the life-history. Consequently, additional model runs were requested during the review, these were reduced natural mortality scenarios:

- Constant natural mortality at M = 0.3 and M = 0.38
- Constant natural mortality estimated within the model
- Lorenzen natural mortality magnitude fitted within the model.

The results of these additional analyses were provided promptly by the WG. The impact of the reduced mortality was consistent across the scenarios: as natural mortality was decreased, the fitted biomass increased and the VAST selectivity curve shifted left (decreased for larger sizes) to maintain the fit to this index. This demonstrated robustness of the model based estimates and allayed the WG's concerns about the magnitude of the biomass index.

Simulation testing for SSLAM was conducted (WP17). Datasets were generated using a simulation model following the same equations and assumptions as SSLAM. Two different scenarios were tested, a base case with information availability mimicking the real datasets and a higher information dataset with reduced CVs and higher effective sample sizes. The assessment model includes penalties to stabilize parameter estimation and the test here demonstrated that this results in an attenuation of the annual cycle, which was reduced under the higher information scenario. Whilst this result is to be expected, quantifying this effect aids in understanding model dynamics in particular when contrasting SSLAM and SPAM.

The simulation testing demonstrated that the results are approximately median unbiased and confirmed that the implementation is correct (or at least consistent between the simulation and assessment models). However it also demonstrates the challenges in reconstructing the biomass time series, given the high proportion of months with no data. This is unsurprising and a significant challenge resulting from the population dynamics.

The Panel considered that this was an appropriate simulation test which validated model performance, however the opportunity exists to explore other key assumptions such as the impact of mis-specified catchability for the fall VAST index.

Although substantial progress has been achieved, several important research priorities remain. The Panel recommends the following priorities for future research and assessment development.

- Quantify and propagate uncertainty associated with survey standardization into assessment estimates, biological reference points, and projections.
- Consider alternative approaches that address the inherent dampening of the seasonal biomass fluctuations as a function of data availability.
- Continue refining model development through evaluation of alternative model structures (such as a single sex model), data utilization and model diagnostics.
- Conduct sensitivity testing to the data weighting (CVs and ESS) assumptions.

- Ongoing work for characterizing model performance including broader sensitivity testing. For sensitivity testing, alternative output plots should be developed that contrast multiple runs in a single figure (e.g., median biomass in terminal year vs Lorenzen M scaling factor).
- Development of a workflow utilizing high performance computing facilities to facilitate more comprehensive model exploration.
- Explore the tension in input L-F data sources by producing L-F residual plots that are averaged across data sources to identify consistent residual patterns.
- From a communication perspective, reporting the sum of the monthly biomass values can be confusing and is an arbitrary scale dependent on the choice of model time step. The WG suggested that the mean monthly value may be more appropriate. This provides a value that is more comparable to the magnitude of the VAST index and to SPAM biomass estimates. Note that this is simply a scaling factor to aid interpretation/communication and doesn't change the interpretation of any results.
- Consider a more complex configuration of the SSLAM model where recruitment depends on relevant environmental variables.

TOR 5. Biological Reference Points

Update or redefine Biological Reference Points (BRPs; point estimates or proxies for BMSY, BTHRESHOLD, FMSY and MSY reference points) and provide estimates of those criteria and their uncertainty, along with a description of the sources of uncertainty. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for reference points. For illustrative purposes, where feasible and appropriate, compute the ratios of the RT assessment's terminal year stock size and fishing mortality to existing, and any redefined, BRPs.

The Panel concluded this TOR was met.

The Panel concluded that the WG completed a well-reasoned evaluation of biological reference points (BRPs) for longfin inshore squid using both SSLAM and SPAM. Recognizing the limitations of applying conventional equilibrium reference points to a short-lived, highly seasonal species, the WG developed and evaluated alternative reference points based primarily on spawning potential ratio (SPR) and escapement biomass. The proposed framework represents a conservative approach and reflects current understanding of the species' biology.

BRPs for stocks of short-lived animals that experience fluctuations in population dynamics under fishing are scarce and those applied to long-lived stocks with smooth dynamics may not be applicable due to their dependence on single equilibrium points of abundance and/or biomass for their derivation.

Stocks with fluctuating dynamics are fairly common in fisheries (Hsieh et al., 2006; Poot-Salazar et al., 2024; Hilborn et al., 2022) and arise in discrete time models when perturbed by disturbances such as fishing. They do not have a single equilibrium point but instead they may have a stable cycle, irregular fluctuations, or quasi-chaotic dynamics (May 1975). So the use of BRPs that are useful for stocks with smooth dynamics to stocks with fluctuating dynamics may lead to over-estimated harvest rates (Poot-Salazar et al., 2024), and incorrect fishing mortality and biomass BRPs, in particular when using single-equilibrium concepts such as MSY (F_{MSY} and

B_{MSY}). The WG considered this aspect of the squid dynamics as crucial in their proposals for BRP both in SSLAM and SPAM.

SSLAM

In connection with the SSLAM model, the WG presented $F_{75\%SPR}$ and $SSB_{75\%SPR}$ as the rate of change and state BRPs, respectively, to be used for determination of the stock status of the longfin inshore squid in any year (annual time steps) when assessed to determine annual statistics representing fishing mortality and stock biomass. SPR-based BRPs are equilibrium concepts, so they have the risk of being inadequate for use with a stock with rapid and large fluctuating dynamics. The inadequacy of equilibrium BRP for stocks with fluctuating dynamics leads to non-conservative estimates of fishing mortality and biomass BRP.

For other relevant reasons, namely the important ecological role of the longfin inshore squid as an abundant forage species, the WG decided to determine a very high SPR BRP, at the level of 75% of the unfished condition. This high value for the SPR with respect to the unfished condition, essentially eliminates the risk posed by the recourse to equilibrium BRP for a stock that is clearly experiencing fluctuations at the intra-annual and inter-annual scales, as demonstrated by results of the SSLAM model. Therefore, the panel of reviewers concluded that the proposed BRP presented by the WG to be applied in conjunction with the SSLAM stock assessment model, namely $F_{75\%SPR}$ and $SSB_{75\%SPR}$, are technically appropriate.

In connection with the BRP to judge the status of the stock from results of the SSLAM model, the review panel presents the following caveats for consideration by the WG:

- 75% SPR, although conservative and safe, is an arbitrary point that is disconnected with the population dynamics modelled in SSLAM.
- SPR is a single equilibrium point concept while the population dynamics of the squid is characterized by fluctuations and cycles.

SPAM

In connection with the SPAM model, the WG decided to set up a similarly conservative escapement biomass BRP: the fishing mortality level that would let 75% of the biomass of squids of 5 months of age or older (fully recruited) survive fishing, which corresponds to $F_{75\%esc}$=0.58 month-1. This is a fishery mortality level much higher than any fishing mortality estimated by SPAM even when assuming that survey catchability was 1.

The SPAM model has no density-dependence and therefore no predictive capacity to project the stock mechanistically. So it was necessary to formulate an additional phenomenological input coming into the stock as an exogenous stimulus to control the projection of biomass of the stock under a fishing scenario with $F_{75\%esc}$=0.58 month^{-1}, thus determining $B_{75\%esc}$. Stochasticity in projections was achieved by generating random starting points from a normal distribution parameterized by values estimated by the SPAM model with historical data. The projection was run for 50 generations to generate a burn in period and recover the stabilized results.

The Panel supported the adoption of the fishing mortality reference point that would let 75% of the biomass from a cohort of squid 5 months and older survive fishing, $F_{75\%esc}$, on grounds similar to those to support $F_{75\%SPR}$ for the SSLAM model, but at the same time had substantial concerns about the conceptual idea of exogenous inputs of aggregated somatic growth and recruitment. While recruitment could be and is considered as exogenous inputs in models for the assessment of squids and other short-lived species (e.g., SSLAM model, Roa-Ureta, 2012), somatic growth seems internal to the population.

Nevertheless, two considerations led the Panel to deem the methodology as acceptable. First, somatic growth could be conceptualized as an external input from the ecosystem in the form of prey for squids, such as zooplankton and ichthyoplankton biomass. Second, the resulting biomass reference points (112,120 mt for the fall and 32,502 mt for the spring) were biologically reasonable. Therefore, the Panel concluded that the proposed BRP presented by the WG to be applied in conjunction with the SPAM stock assessment model, namely $F_{75\%esc}$ and $B_{75\%esc}$, are technically appropriate.

In connection with the BRP to determine the status of the stock from results of the SPAM model, the Panel presents the following caveats for consideration by the WG:

- 75% escapement biomass, although conservative and safe, is an arbitrary point that is disconnected with the biomass dynamics modelled in SPAM.
- The WG presents $F_{75\%esc}$ and $B_{75\%esc}$ as proxies of F_{MSY} and B_{MSY}, respectively, yet the latter are applicable to single equilibrium point stocks and the squid stock has a dynamics of fluctuations and cycles.
- To conduct stochastic projections to find the values of biomass reference points for the fall and the spring, the WG used a 3-parameters (plus variance) SPAM model while the AIC best supported SPAM model (when fitted to historical biomass estimates from surveys) was a 4-parameters (plus variance) variant, which included different slopes because of a slope offset for the fall biomass.
- The SPAM model may need to be substantially upgraded or replaced if annual catches start to increase, which means that its proposed BRPs are deemed technically appropriate, conditional on the low magnitudes of catches that are prevalent presently.

The Panel recommends the following long-term research topics for future development of biological reference points:

- Continue evaluating the robustness of the proposed BRPs under alternative assumptions regarding survey catchability, biomass scaling, natural mortality, and recruitment.
- Continue comparing SSLAM- and SPAM-derived reference points to better understand the influence of model structure on management quantities.
- Evaluate the sensitivity of stock status determination to alternative assumptions regarding biomass scaling and population availability.
- Continue improving biological information on maturation, natural mortality, and reproductive dynamics to strengthen future estimation of SPR-based reference points.

- Reassess candidate BRPs periodically as additional survey information, assessment refinements, and management experience become available.
- Conduct Management Strategy Evaluation (MSE) to examine the performance of candidate reference points across a broad range of biological and observational uncertainties.
- Investigate methods for incorporating environmental variability into future evaluations of biological reference points where supported by sufficient evidence.

TOR 6. Projections

Define appropriate methods for producing short-term projections; provide justification for assumptions of fishery selectivity, weights at age, maturity, and recruitment; and comment on the reliability of resulting projections considering the effects of uncertainty and sensitivity to projection assumptions.

The Panel concluded this TOR was met.

The Panel concluded that the WG developed a scientifically appropriate framework for producing short-term population projections using both the SSLAM and the SPAM. The projection methods developed for the SSLAM and SPAM are internally consistent with the assessment models. In particular, the SSLAM explicitly accounts for the seasonal life history, rapid growth, annual recruitment, and short life span of longfin inshore squid. The WG clearly documented the assumptions underlying the projections and evaluated their implications for forecast performance.

The Panel agreed that the SSLAM projection methodology appropriately reflects current biological understanding of the species. SPAM projections also incorporate some of the key stock characteristics but are more limited. Both models provide a reasonable basis for short-term management advice. Given the highly variable recruitment and environmental conditions affecting longfin squid, the WG acknowledged the increasing uncertainty associated with longer-term forecasts. The Panel also recognized that the reliability of projections depends fundamentally on the quality of the underlying assessment and on assumptions regarding future recruitment, natural mortality, fishing patterns, and stock availability. Consequently, uncertainty associated with the assessment propagates directly into projection results and should be clearly communicated when providing management advice.

The Panel identified several important strengths. First, the projection framework, especially the one based on SSLAM, is well aligned with the biology of longfin squid. Unlike projection methods developed for long-lived species, the proposed approach explicitly recognizes the annual life cycle, rapid turnover, and strong seasonal dynamics characteristic of this species. Second, projection assumptions are clearly documented and are internally consistent with the biological processes represented in SSLAM and SPAM. In SSLAM, recruitment, growth, mortality, and fishing dynamics are treated in a manner that reflects current biological understanding and maintains consistency between assessment and forecasting. Third, the WG appropriately emphasized short-term projections rather than attempting long-term forecasts that would be difficult to justify biologically for a species with highly variable annual recruitment. The Panel considered this to be scientifically appropriate, although the 5-year projection horizon used in the projection is still too long for this short-lived species. Fourth, the projection analyses

include stochastic components and uncertainty estimates, allowing managers to evaluate risk associated with alternative harvest scenarios rather than relying solely on deterministic forecasts. Finally, the WG openly discussed the assumptions and limitations of the projection framework associated with SSLAM and SPAM, providing transparency regarding the appropriate interpretation of forecast results.

Although the projection framework for both models is scientifically appropriate, several limitations should be recognized. The Panel noted that future recruitment remains the dominant source of uncertainty in projected population trajectories. Because recruitment is highly variable and only partially predictable, projection performance is inherently limited regardless of assessment complexity. The Panel also noted that projection uncertainty reflects not only recruitment variability but also uncertainty in biomass estimation, survey catchability, natural mortality, and structural assumptions inherited from the assessment models. These sources of uncertainty should be clearly recognized when interpreting projected stock status and harvest scenarios. The Panel further observed that assumptions regarding future fishing patterns, selectivity, and seasonal distribution may not fully capture changes in fleet behavior or environmental conditions. While these assumptions are reasonable for short-term forecasting, their reliability decreases as projection horizons increase. The Panel believes that projections extending beyond the near term should be interpreted cautiously, particularly under changing environmental conditions or when recruitment differs substantially from historical patterns. Forecast uncertainty should therefore be emphasized in management advice. Finally, although the WG conducted sensitivity analyses, additional evaluation of projection skill through retrospective forecasting and hindcasting would provide valuable information regarding the predictive performance of the proposed framework.

The Panel concluded that the WG developed scientifically sound and biologically appropriate projection frameworks that is consistent with the assessment models and reflects the unique life history of longfin inshore squid. The projection methodology for both SSLAM and SPAM models provide an appropriate basis for supporting short-term management advice and appropriately recognize the increasing uncertainty associated with longer-term forecasts. The Panel concluded that the proposed projections should be interpreted as probabilistic forecasts rather than precise predictions. Their utility depends upon recognition of the substantial uncertainty associated with future recruitment and other biological processes that cannot be reliably predicted.

The Panel recommends the following priorities for future projection development for both the SSLAM and SPAM.

High priority (not listed in order of priority)

- Continue emphasizing short-term projections that are consistent with the annual life cycle and biological characteristics of longfin squid.
- Clearly communicate uncertainty associated with recruitment, biomass estimation, natural mortality, and model structure when presenting projection results for management advice.
- Continue evaluating alternative recruitment assumptions and their influence on projected stock trajectories and harvest outcomes.

- Develop standardized procedures for routinely evaluating projection performance through retrospective forecasting and hindcasting.

Long-term research

- Investigate environmentally informed recruitment scenarios where sufficient empirical support exists.
- Continue comparing projection results from SSLAM and SPAM to better understand the influence of model structure on forecast uncertainty.
- Evaluate the sensitivity of projections to assumptions regarding future fishing patterns, seasonal availability, and selectivity.
- Develop Management Strategy Evaluation frameworks that incorporate the proposed projection methodology to evaluate the long-term performance of alternative harvest strategies.
- Continue improving understanding of environmental drivers of recruitment and seasonal population dynamics that may ultimately improve projection skill.
- Reassess projection methods periodically as additional biological information and operational experience become available.

TOR 7. Research Recommendations

Review, evaluate, and report on the status of research recommendations from the last assessment peer review, including recommendations provided by the prior Research Track Working Group, peer review panel, and SSC. Identify new recommendations for future research, data collection, and assessment methodology. If any ecosystem influences from TOR 1 could not be considered quantitatively under that or other TORs, describe next steps for development, testing, and review of quantitative relationships and how they could best inform assessments. Prioritize research recommendations.

The Panel concluded this TOR was met.

The Panel concluded that the WG made substantial progress in addressing the recommendations from previous benchmark and peer-review assessments. Many of the major scientific priorities identified during earlier reviews have been addressed through the development of new assessment models, improved treatment of fishery-independent surveys, expanded biological analyses, and provided a more comprehensive understanding of the ecology and population dynamics of longfin inshore squid.

The most significant accomplishments include development of the SSLAM and SPAM, implementation of VAST for survey standardization, incorporation of seasonal population dynamics and temperature-dependent growth, development of biologically appropriate reference points, and a greatly expanded evaluation of fishery-dependent and fishery-independent datasets. Collectively, these efforts represent a major advancement in the scientific foundation supporting assessment and management of longfin squid.

The Panel also concluded that the Research Track successfully identified the principal scientific uncertainties that remain and provided a clear roadmap for future research. Most remaining recommendations relate to improving biological understanding, reducing uncertainty, and

strengthening confidence in management quantities rather than addressing fundamental deficiencies in the assessment framework.

The Panel identified several notable accomplishments. First, the WG successfully developed an integrated state-space assessment model that addresses one of the principal recommendations arising from previous assessments. SSLAM represents a substantial advancement in biological realism and provides a modern framework for future assessment development. The WG developed and thoroughly evaluated two complementary assessment models and a biologically appropriate framework for estimating biological reference points for the longfin squid. The SSLAM and SPAM represent different but complementary approaches to assessing this highly dynamic, short-lived species. SSLAM provides a biologically realistic, process-based framework that explicitly models recruitment, growth, mortality, and seasonal population dynamics, whereas SPAM offers a simpler, robust seasonal biomass-dynamics approach that is computationally efficient and operationally practical. Despite their different structures and assumptions, both models provide scientifically credible representations of stock dynamics and generally lead to consistent conclusions regarding stock status and management.

Second, implementation of VAST substantially improved the treatment of fishery-independent survey data and addressed previous concerns regarding spatial variability and survey standardization.

Third, the WG significantly improved understanding of the species' biology through expanded analyses of growth, recruitment, seasonal dynamics, environmental influences, and population structure. These analyses provide a much stronger scientific foundation for future assessments.

Fourth, the proposed biological reference point framework reflects the unique life history of longfin squid and represents an important step toward more biologically appropriate management advice.

Finally, the WG clearly documented remaining uncertainties throughout the assessment and identified numerous opportunities for continued improvement. The Panel viewed this transparency as an important strength of the Research Track process.

Although substantial progress has been achieved, several important research priorities remain, many of which are described under each TOR. The Panel recommends (and reiterates) the following priorities for future research and assessment development.

High priority (not listed in order of priority)

- Improve understanding of survey catchability and seasonal population availability through empirical studies and additional sensitivity analyses.
- Continue research on longfin squid aging to confirm applicability of statoliths as source of reliable age determination. Improve existing techniques to reduce uncertainty in age readings. Explore consequences of improved age determination techniques on estimation of natural mortality, growth and maturation.
- Continue refining estimation of recruitment, natural mortality, and movement using additional biological information and expanded simulation testing.

- Conduct Management Strategy Evaluation to evaluate the robustness of proposed biological reference points under biological and observational uncertainty.
- Evaluate the performance of the SSLAM and SPAM projections, including during periods of heightened recruitment as occurred in recent years.

Long-term research

- Continue improving environmental analyses and investigate quantitative incorporation of environmental drivers where supported by sufficient evidence.
- Further develop efficient operational versions of SSLAM suitable for future Management Track assessments (including TOR 4 recommendations).
- Continue improving biological sampling programs and fishery-independent monitoring to strengthen future assessments.
- Investigate independent estimates of survey catchability using acoustic surveys, comparative fishing experiments, optical technologies, or integrated observation systems.
- Continue evaluating alternative assessment frameworks, including comparison between SSLAM and SPAM, to improve understanding of structural uncertainty.
- Periodically review assessment performance as additional survey information, biological data, and management experience become available, allowing continued refinement of assessment methods and reference points.

TOR 8. Alternative Approach

Develop an alternative assessment approach to providing scientific advice to managers, including providing BRPs if possible. The alternative approach could be used if the primary assessment approach is not feasible (e.g., due to data or resource limitations), or if it does not pass peer review either now or in a future Management Track assessment.

The Panel concluded this TOR was met.

The WG developed an aggregate biomass model running at semester time steps and lacking density dependence, SPAM (Seasonal Production Assessment Model). Essentially, SPAM is an exponential rise/decay model with a time-varying (by semester) rate parameter, decomposed into positive and negative sub-rates. These rates were for somatic growth and recruitment aggregated on the positive side (G), and separate fishing (F) and natural (M) mortality rates on the negative side. This rate can be called $Q=G-F-M$.

The model produced seasonal fluctuations by design, in order to account for the usually larger fall biomass and smaller spring biomass. The model can be considered as a surplus production model that lacks any control by the carrying capacity of the environment. So in SPAM, the control of growth or decay is achieved by making the rate parameter Q time-dependent and importantly, switching the sign of Q depending on seasonal changes in the predominance of positive and negative contributions to Q.

Observations of biomass to fit the SPAM model come from fall and spring biomass estimates from surveys in the corresponding season. The survey biomass estimates are for point months inside semesters so the SPAM model assumes that the estimated biomass is different across the two intra-annual seasons but constant inside each season.

The SPAM model is unique in the class of surplus production models because it does not take into account density-dependence, relying instead on controls on the exponential rise and decay by the semester-varying rate parameter.

Since the SPAM model is a simple exponential biomass dynamics model in discrete time, with a semester-varying rate parameter, taking logarithms upon a recursive reconstruction over an arbitrary number of time steps demonstrates that the log of biomass at any season is a linear function of

- the unconditional intercept of the rate of change in biomass in the fall
- the conditional rate of change in biomass in the spring
- the unconditional slope of the rate of change in the spring
- the conditional slope of the rate of change in the fall

Finally, considering this model as the process model, the statistical model is completed with a variance parameter representing the observations of biomass. The documents provided by the WG do not specify the likelihood function, but presumably, since the model is estimated as a linear regression, the likelihood function corresponds to the adjusted profile likelihood (minimum squares). Parameters and time series of interest were obtained in natural units from algebraic back-transformations.

Results were diagnosed with numerical and statistical criteria yielding acceptable diagnostics. In addition, the robustness of results were analyzed for retrospective patterns, yielding some slightly excessive Mohn's rho values. Although bootstrap simulation on the biomass observations using their VAST standard errors was conducted to have a qualitative idea of the impact of uncertainty in biomass observations, analytical incorporation of VAST standard errors of biomass into the estimation process of SPAM was not undertaken.

Biological reference points designed for examination of SPAM results in terms of biomass were described under TOR 5 and are repeated here for convenience of the reader.

Similar to SSLAM, the WG decided to set up a very conservative escapement biomass BRP: the fishing mortality level that would let 75% of the biomass of squids of 5 months of age or older (fully recruited) survive fishing, which corresponds to $F_{75\%esc}$=0.58 month^{-1}. This is a fishery mortality level much higher than any fishing mortality estimated by SPAM even when assuming that survey catchability was 1.

The SPAM model has no density-dependence and therefore no predictive capacity to project the stock mechanistically. So it was necessary to formulate an additional phenomenological input coming into the stock as an exogenous stimulus to control the projection of biomass of the stock under a fishing scenario with $F_{75\%esc}$=0.58 month^{-1}, thus determining $B_{75\%esc}$. Stochasticity in projections was achieved by random starting points generated from a normal distribution parameterized by values estimated by the SPAM model with historical data. The projection was run for 50 generations to generate a burn in period and recover the stabilized results.

The Panel supports the adoption of the fishing mortality reference point that would let 75% of the biomass from a cohort since 5 months of age survive fishing, $F_{75\%esc}$, on grounds similar to those to support $F_{75\%SPR}$ for the SSLAM model, but at the same time had substantial concerns

about the conceptual grounds of the idea of exogenous inputs of aggregated somatic growth and recruitment. While recruitment could be and is considered an exogenous input in models for the assessment of squids and other short-lived species (e.g. SSLAM model, Roa-Ureta, 2012), somatic growth seems internal to the population.

Nevertheless, two considerations led the Panel to deem these BRP as acceptable. First, somatic growth could be conceptualized as an external input from the ecosystem in the form of prey for squids, such as zooplankton and ichthyoplankton biomass. Second, the resulting biomass reference points (112,120 mt for the fall and 32,502 mt for the spring) were reasonable.

Comparisons of SPAM and SSLAM results for the biomass time series allowed interpretation of SPAM results as follows. SPAM biomass estimates were consistently lower than SSLAM biomass estimates. Thus, by virtue of its use of multiple sources of biological composition data in addition to survey biomass indices and catches, SSLAM is capable of estimating the total biomass of the stock. This is done in the SSLAM model by raising the biomass estimates from surveys in the fall and spring, assuming catchability of 1 for fall survey and estimating catchability for the spring survey, to total biomass. On the other hand, SPAM is not capable of raising biomass from survey indices to total biomass because of its structural simplicity and limited capacity to model the population dynamics, which forces it to assume constant catchabilities equal to 1. Nevertheless, the fluctuation pattern between fall and spring seasons of the biomass estimates from SSLAM and SPAM is consistent.

The Panel considered that, given (a) the above interpretation of the estimated time series of biomass from SPAM, as an under-estimation that achieves the capture of a sufficient part of the fluctuating dynamics and (b) good numerical and statistical properties, the SPAM model is technically appropriate in a provisional manner.

The following caveats are highlighted for the WG to consider in connection with further use of the SPAM model to determine stock status and other management oriented quantities and criteria:

- Reasons expressed by the WG to rule out other possible alternative assessment models, which have much more support worldwide for the assessment of cephalopod stocks, are rather simplistic and could be counter-argued conceptually and by examples.
- The SPAM model has a simple mathematical structure that forces the fluctuating dynamics rather than discovering it from the model-data combination.
- The SPAM model is unable to capture the full dynamics of the stock and produces cyclical dynamics that appear overly deterministic, as if the stock were a simple mechanical system instead of a complex biological system immersed in an ecosystem.
- The SPAM model assumes a fixed value of the natural mortality rate instead of discovering its value from the model-data combination.
- The SPAM model underestimates uncertainty in biomass time series and parameters in the model by not accounting for the uncertainty of VAST biomass estimates inside the model.
- The WG selected a 3-parameter version of the SPAM whereas the 4-parameter version had more support (AIC difference greater than 2 AIC units in favor of the 4-parameter version).

- 75% escapement biomass, although conservative and safe, is an arbitrary point that is disconnected from the biomass dynamics modelled in SPAM.
- The WG presents $F_{75\%esc}$ and $B_{75\%esc}$ as proxies of FMSY and BMSY, respectively, yet the latter are applicable to single equilibrium point stocks and the squid stock has a dynamics of fluctuations and cycles.
- To conduct stochastic projections to find the values of biomass reference points for the fall and the spring, the WG used a 3-parameters (plus variance) SPAM model while the AIC best supported SPAM model (when fitted to historical biomass estimates from surveys) was a 4-parameters (plus variance) variant, which included different slopes because of a slope offset for the fall biomass.
- The SPAM model may need to be substantially upgraded or replaced if annual catches start to increase, which means that its BRP are deemed technically appropriate conditional on the low magnitudes of catches that are prevalent presently.

The Panel provided the following qualitative comparisons between SSLAM and SPAM.

Aspect	**SSLAM**	**SPAM**
Philosophy	Process-based	Biomass dynamics
Time step	Monthly	Spring/Fall
Population	Sex & length structured	Total biomass
Recruitment	Explicit	Implicit in production
Growth	Explicit	Implicit
Natural mortality	Explicit	Implicit
Movement	Not explicit (absorbed indirectly)	Implicit in production
Selectivity	Explicit	Not explicit
Survey	Predicts observations	Uses biomass index
Parameters	Many	Few
Complexity	High	Moderate
Operational	Moderately complex	Relatively simple
Biological realism	High	Low to moderate

Size and sex structure	Yes	No
Data requirements	Very high	Moderate
Model transparency	Moderate to low	High
Computational burden	High	Low
Parameter identifiability	Lot of parameters, and likely confounding	Fewer parameters, but structural confounding
Biomass scaling	Depends critically on VAST q and model structure	Depends directly on VAST q = 1
Diagnostics	Extensive, and complex	Generally straightforward
Reference-point maturity	Some simulation work, but still provisional	Some simulation work, but still provisional
Projection reliability	Limited by recruitment, low fishing mortality, M and population closure	Limited by stationarity, low fishing mortality, and absence of density dependence
Near-term role	Able to provide management advice	Able to provide management advice

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Roa-Ureta, R. H. 2012. Modelling in-season pulses of recruitment and hyperstability-hyperdepletion in the Loligo gahi fishery around the Falkland Islands with generalized depletion models. ICES Journal of Marine Science, 69: 1403 – 1415.

Appendix 1 - Terms of Reference for the Longfin Inshore Squid Research Track Stock Assessment

1. Identify relevant ecosystem and climate influences on the stock. Characterize the uncertainty in the relevant sources of data and their link to stock dynamics. Consider findings, as appropriate, in addressing other TORs. Report how the findings were considered under impacted TORs.
2. Estimate catch from all sources including landings and discards. Describe the spatial and temporal distribution of landings, discards, and fishing effort. Characterize the uncertainty in these sources of data.
3. Present the survey data used in the assessment (e.g., indices of relative or absolute abundance, recruitment, state surveys, age-length data, application of catchability and calibration studies, etc.) and provide a rationale for which data are used. Describe the spatial and temporal distribution of the data. Characterize the uncertainty in these sources of data.
4. Use the appropriate assessment approach to estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series, and estimate their uncertainty. Compare the time series of these estimates with those from the previously accepted assessment(s). Evaluate a suite of model fit diagnostics (e.g., residual patterns, sensitivity analyses, retrospective patterns), and (a) comment on likely causes of problematic issues, and (b), if possible and appropriate, account for those issues when providing scientific advice and evaluate the consequences of any correction(s) applied.
5. Update or redefine Biological Reference Points (BRPs; point estimates or proxies for B_{MSY}, $B_{THRESHOLD}$, F_{MSY} and MSY reference points) and provide estimates of those criteria and their uncertainty, along with a description of the sources of uncertainty. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for reference points. For illustrative purposes, where feasible and appropriate, compute the ratios of the RT assessment's terminal year stock size and fishing mortality to existing, and any redefined, BRPs.
6. Define appropriate methods for producing short-term projections; provide justification for assumptions of fishery selectivity, weights at age, maturity, and recruitment; and comment on the reliability of resulting projections considering the effects of uncertainty and sensitivity to projection assumptions.
7. Review, evaluate, and report on the status of research recommendations from the last assessment peer review, including recommendations provided by the prior Research Track Working Group, peer review panel, and SSC. Identify new recommendations for future research, data collection, and assessment methodology. If any ecosystem influences from TOR 1 could not be considered quantitatively under that or other TORs, describe next steps for development, testing, and review of quantitative relationships and how they could best inform assessments. Prioritize research recommendations.
8. Develop an alternative assessment approach to providing scientific advice to managers, including providing BRPs if possible. The alternative approach could be used if the primary assessment approach is not feasible (e.g., due to data or resource limitations), or if it does not pass peer review either now or in a future Management Track assessment.

Appendix 2 - Longfin Inshore Squid Research Track Assessment Peer Review Meeting Agenda

Longfin Inshore Squid Research Track Assessment Peer Review Meeting
August 3 - 7, 2026

Marine Biological Laboratory, Starr Building, Room 209, Woods Hole, MA

Google Meet joining info: https://meet.google.com/wdu-ghyv-qbn
Or dial: (US) +1 929-266-2650
PIN: 685 019 997#

AGENDA* (v. 7/15/2026)
**All times are approximate at the discretion of the Review Panel Chair. The meeting is open to the public; however, during the closed panel writing sessions we ask that the public refrain from engaging in discussion with the Peer Review Panel.*

Monday, August 3, 2026

Time	Topic	Presenter(s)	Notes
9 a.m.	Welcome, Introductions, Agenda, Logistics	Chair Brian Hooper	
9:15 a.m.	Research Track Process Overview	Kristan Blackhart	
9:30 a.m.	Overview of Longfin Inshore Squid Research Track	Amy Schueller	
10 a.m.	Historical and Current Management	Jason Didden	
10:30 a.m.	BREAK		
10:45 a.m.	Life History	John Manderson	
12 p.m.	LUNCH		
1 p.m.	Term of Reference (TOR) 1 - Ecosystem and Socioeconomic Report Card	Stephanie Owen	Ecosystem
1:45 p.m.	TOR 1 - Predation	Jim Gartland	Ecosystem

Time	Topic	Presenter(s)	Notes
2:15 p.m.	TOR 1 - Stakeholder Summit and Perspectives	John Manderson	Ecosystem
3 p.m.	BREAK		
3:15 p.m.	TOR 2	Daniel Hocking Jessica Blaylock	Catch
4:10 p.m.	Public Comment	Public	
4:20 p.m.	Discussion/ Summary	Review Panel	Conclusions, Recommendations, & Final Wrap-up for TOR 1 and 2
5 p.m.	ADJOURN		

Tuesday, August 4, 2026

Time	Topic	Presenter(s)	Notes
9 a.m.	Welcome, Logistics, Agenda	Chair Brian Hooper	
9:05 a.m.	TOR 3	Jim Gartland	Surveys
10:30 a.m.	BREAK		
10:45 a.m.	TOR 4 - State-Space Length Structured Assessment Model (SSLAM)	Mike Wilberg Jessica Blaylock Cameron Hodgdon	Model
12 p.m.	LUNCH		
1 p.m.	TOR 4, continued	Mike Wilberg Jessica Blaylock Cameron Hodgdon	Model
2:45 p.m.	BREAK		
3 p.m.	TOR 8 - Seasonal Production Assessment Model (SPAM)	Paul Rago	Model
4 p.m.	Public Comment	Public	

Time	Topic	Presenter(s)	Notes
4:10 p.m.	Discussion/Summary	Review Panel	Conclusions, Recommendations, & Final Wrap-up for TOR 3 and 4
5 p.m.	ADJOURN		

Wednesday, August 5, 2026

Time	Topic	Presenter(s)	Notes
9 a.m.	Welcome, Logistics, Agenda	Chair Brian Hooper	
9:05 a.m.	Review Homework	Chair	If Needed
10 a.m.	TOR 8 - SPAM, continued	Paul Rago	Model
10:30 a.m.	BREAK		
10:45 a.m.	TOR 5 - SSLAM	Cameron Hodgdon Mike Wilberg	Biological Reference Points (BRPs)
12 p.m.	LUNCH		
1 p.m.	TOR 5 - SPAM	Paul Rago	BRPs
1:45 p.m.	TOR 6 - SSLAM	Cameron Hodgdon Mike Wilberg	Projections
3 p.m.	BREAK		
3:15 p.m.	TOR 6 - SPAM	Paul Rago	Projections
4 p.m.	Public Comment	Public	
4:10 p.m.	Discussion/Summary	Review Panel	Conclusions, Recommendations, & Final Wrap-up for TORs 5, 6, and 8
5 p.m.	ADJOURN		

Thursday, August 6, 2026

Time	Topic	Presenter(s)	Notes
9 a.m.	Welcome, Logistics, Agenda	Chair Brian Hooper	
9:05 a.m.	Review Homework	Chair	If Needed
10:30 a.m.	BREAK		
10:45 a.m.	TOR 7	Jason Didden	Research Recommendations
12 p.m.	LUNCH		
1 p.m.	Comparison of SSLAM and SPAM	Jessica Blaylock Amy Schueller	
2 p.m.	Revisit Any Remaining Questions	Chair	
3 p.m.	BREAK		
3:15 p.m.	Review Any Additional Homework	Chair	
4 p.m.	Public Comment	Public	
4:15 p.m.	Discussion/Summary	Review Panel	Conclusions, Recommendations for TOR 7, & Final Wrap-up
5 p.m.	ADJOURN		

Friday, August 7, 2026

Time	Topic	Presenter(s)	Notes
9 a.m.	Welcome, Logistics, Agenda	Chair Brian Hooper	
9:05 a.m.	Review Any Remaining Homework; Answer Any Additional Questions	Chair	If Needed (Else Closed Panel Writing Session
10 a.m.	Closed Panel Writing Session	Review Panel	
5 p.m.	ADJOURN		

Appendix 3 - Longfin Inshore Squid Research Track Assessment Peer Review Attendees (August 3-7)

ASMFC - Atlantic States Marine Fisheries Commission
GARFO - Greater Atlantic Regional Fisheries Office
MAFMC - Mid-Atlantic Fisheries Management Council
NEFMC - New England Fisheries Management Council
NEFSC - Northeast Fisheries Science Center

Yong Chen, MAFMC Science and Statistical Committee (Review Panel Chair)
Klaas Hartmann, Center for Independent Experts
Ruben Roa-Ureta, Center for Independent Experts
Alexei Sharov, Center for Independent Experts

Amy Schueller, Southeast Fishery Science Center (Working Group Chair)
Jessica Blaylock, NEFSC (Assessment Lead)
Jason Didden, MAFMC
James Gartland, Virginia Institute of Marine Science
Daniel Hocking, GARFO
Cameron Hodgdon, NEFSC
John Manderson, Open Ocean Research
Michael Wilberg, University of Maryland Center for Environmental Science

Larry Alade, NEFSC
Samantha Alaimo, Rutgers University
Katie Almeida, The Town Dock
David Bank, Marine Biological Laboratory
Olive Bender, NEFSC
Kristan Blackhart, NEFSC
Jason Boucher, NEFSC
Conner Buckley, NEFMC
Steve Cadrin, University of Massachusetts School of Marine Science & Technology
Kiersten Curti, NEFSC
Jonathan Deroba, NEFSC
Greg DiDomenico, Lund's Fisheries
Maria Fenton, GARFO
Corrin Flora, North Carolina Department of Marine Resources
Madison Hall, NEFSC
Alex Hansell, NEFSC
Brian Hooper, NEFSC
Kimberly Hyde, NEFSC

Andrew Jones, NEFSC
Emily Liljestrand, NEFSC
Robyn Linner, Stony Brook University
Andrew Lipski, NEFSC
Jeff Kaelin, Lund's Fisheries
Anna Mercer, NEFSC
Timothy Miller, NEFSC
Mary Munley, NEFSC
Stephanie Owen, NEFSC
Paul Rago, NEFSC retired
Christopher Roebuck, Commercial fisherman
Sarah Salois, NEFSC
Burton Shank, NEFSC
Bridget St Amand, NEFSC
Samuel Truesdell, NEFSC
Abigail Tyrell, NEFSC
Paulo Veiga
Kristopher Winiarski, GARFO
Anthony Wood, NEFSC

Appendix 4 - Materials provided or referenced during the Longfin Inshore Squid Research Track Stock Assessment Peer Review meeting

Working papers and presentations are available on a NEFSC website (https://apps-nefsc.fisheries.noaa.gov/saw/sasi.php) by selecting the species and year of assessment.

Assessment Report:
Final_Longfin Squid RTSA WG Report_REVISED_31Jul2026.pdf

Working Papers and Background Documentation:
WP01_Owen 2026a.pdf
WP02_Mercer et al 2026a.pdf
WP03_Mercer et al 2026b.pdf
WP04_Richardson 2025.pdf
WP05_Schueller and Gartland 2026.pdf
WP06_Hodgdon and Blaylock 2026a.pdf
WP07_Richardson and Peoples 2026.pdf
WP08_Gartland et al 2026a.pdf
WP09_Manderson and Salois 2024.pdf
WP10_Gartland and Latour 2024.pdf
WP11_Owen_2026b.pdf
WP12_Gartland and Wilberg 2026a.pdf
WP13_Jones 2026.pdf
WP14_Gartland et al 2026b.pdf
WP15_Gartland and Wilberg 2026b.pdf
WP16_Wilberg et al 2026a.pdf
WP17_Wilberg et al 2026b.pdf
WP18_Hodgdon and Blaylock 2026b.pdf
WP19_Manderson 2026 with Table 1.pdf
WP20_Rago et al 2026a.pdf
WP21_Rago et al 2026b.pdf
WP22_Rago et al 2026c.pdf

Presentations:
DOR_Presentation_Comparison of SSLAM and SPAM.pdf
DOR_Presentation_Historical and Current Management.pdf
DOR_Presentation_Life History.pdf
DOR_Presentation_Overview of Longfin Squid Research Track.pdf
DOR_Presentation_Research Track Process Overview.pdf
DOR_Presentation_TOR1_ESP.pdf
DOR_Presentation_TOR1_Predation.pdf
DOR_Presentation_TOR1_Stakeholder Summit.pdf
DOR_Presentation_TOR2.pdf
DOR_Presentation_TOR3_Surveys.pdf

DOR_Presentation_TOR4_ SSLAM.pdf
DOR_Presentation_TOR5_ SSLAM BRPs.pdf
DOR_Presentation_TOR6 SSLAM Projections.pdf
DOR_Presentation_TOR7_Research Recommendations.pdf
DOR_Presentation_TOR8 and SPAM v3.pdf

Additional Materials Provided During Peer Review Meeting
DOR_HOMEWORK_CVs and ESS for Base.pdf
DOR_HOMEWORK_Comparison of SPAM and SSLAM Estimates_v2.pdf
DOR_HOMEWORK_Comparison of Sensitivity Analyses That Estimated Lorenzen M.pdf
DOR_HOMEWORK_Comparison of Sensitivity Analyses That Estimated M.pdf
DOR_HOMEWORK_Diagnostic Comparison.pdf
DOR_HOMEWORK_Retrospective Forecasts SSLAM.pdf
DOR_HOMEWORK_SSLAM Runs and VAST Ratios.pdf

Appendix 5 - CIE Performance Work Statement

Performance Work Statement (PWS)

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

Longfin Inshore Squid Research Track Peer Review
August 3-7, 2026

Background

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

Scientific peer review is defined as the organized review process where one or more qualified experts review scientific information to ensure quality and credibility. These expert(s) must conduct their peer review impartially, objectively, and without conflicts of interest. Each reviewer must also be independent from the development of the science, without influence from any position that the agency or constituent groups may have. Furthermore, the Office of Management and Budget (OMB), authorized by the Information Quality Act, requires all federal agencies to conduct peer reviews of highly influential and controversial science before dissemination, and that peer reviewers must be deemed qualified based on the OMB Peer Review Bulletin standards[2].

Scope

The Research Track Peer Review meeting is a formal, multiple-day meeting of stock assessment experts who serve as a panel to peer-review tabled stock assessments and models. The Research Track Peer Review is the cornerstone of the Northeast Region Coordinating Council stock assessment process, which includes assessment development, report preparation, and public presentations (done by the Research Track Working Group or Atlantic States Marine Fisheries Commission (ASMFC) technical committees), assessment peer review (done by the Peer Review Panel), and document publication. The results of this peer review will be incorporated into future Management Track assessments, which serve as the basis for developing fishery management recommendations.

The purpose of this meeting will be to provide an external peer review of the Longfin Inshore Squid Research Track assessment. The requirements for the peer review follow. This PWS also includes: **Annex**

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

1: Terms of Reference (TORs) for the research track, defined to guide the work of the Research Track Working Group; **Annex 2:** a draft meeting agenda; **Annex 3:** Individual Independent Review Report Requirements; and **Annex 4:** Peer Reviewer Summary Report Requirements.

Requirements

NMFS requires three reviewers under this contract, subject to CIE standards for reviewers, to participate in the panel review. The Peer Review Panel Chair, who is in addition to the three reviewers, will be provided by either the New England or Mid-Atlantic Fishery Management Council's Science and Statistical Committee; although the Chair will be participating in this review, the Chair's participation (i.e., labor and travel) is not covered by this contract.

Each CIE reviewer will write an individual review report in accordance with the PWS, OMB Guidelines, and the peer review tasks below. Modifications to the PWS and peer review tasks cannot be made during the peer review, and any PWS or peer review task modifications prior to the peer review shall be approved by the Contracting Officer's Representative (COR) and the CIE contractor. All tasks must be addressed in each reviewer's report. Peer reviewers shall have working knowledge and recent experience in at least one but ideally several of the following areas: the development and application of length-structured stock assessment models; the development and application of data-moderate stock assessment models (e.g., mass balance models, production models); the development and application of state space assessment methods; the implementation of spatio-temporal models (e.g., Vector Autoregressive Spatio-Temporal model); and specific expertise in fisheries for invertebrates, preferably cephalopods. Reviewers shall also have familiarity with interpreting model diagnostics from population models and how catch advice is developed from stock assessment models.

Tasks for Reviewers

- Review the background materials and reports prior to the review meeting.
    - Two weeks before the peer review, the Assessment Process Lead will electronically disseminate all necessary background information and reports to the CIE reviewers for the peer review.
- Attend and participate in the panel review meeting.
    - The meeting will consist of presentations by NMFS and other scientists, including stock assessment authors, to facilitate the review, provide any additional information required by the reviewers, and answer any questions from reviewers.
- Conduct an independent peer review in accordance with the requirements specified in this PWS and peer review task list, in adherence with the required formatting and content guidelines.
- Reviewers are not required to reach a consensus. Individual reviewer perspectives should be provided in their individual reports, and any lack of consensus should be clearly described in the Peer Review Panel's Summary Report.
- Each reviewer shall assist the Peer Review Panel Chair with contributions to the Peer Review Panel's Summary Report.
- Deliver individual Independent Reviewer Reports to NMFS according to the specified milestone dates.

- This report should explain whether each Research Track TOR was "met," "partially met," or "not met" during the peer review meeting, using the criteria specified below in the "Tasks for Peer Review Panel."
- If any existing Biological Reference Points (BRPs) or their proxies are considered inappropriate, the Independent Report should include recommendations and justification for suitable alternatives. If such alternatives cannot be identified, then the report should indicate that the existing BRPs are the best available at this time.
- During the meeting, additional questions that were not in the Research Track TORs but that are directly related to the assessments and research topics may be raised. Comments on these questions should be included in a separate section at the end of the Independent Report produced by each reviewer.
- The Independent Report can also be used to provide greater detail than the Peer Reviewer Summary Report on specific Research Track TORs or on additional questions raised during the meeting.

Tasks for Peer Review Panel

- During the peer review meeting, the Panel is to determine whether each Research Track TOR was "met," "partially met," or "not met". To make this determination, panelists should consider whether the work provides a scientifically credible basis for developing fishery management advice. Criteria to consider include: whether the data were adequate and used properly, the analyses and models were carried out correctly, and the conclusions are correct/reasonable. Where possible, the Peer Review Panel Chair shall identify or facilitate agreement among the reviewers for each Research Track TOR.
- For the Longfin Inshore Squid Research Track assessment, the Panel will review two proposed models under TORs 4, 5, 6, and 8. The Panel will evaluate the strengths and weaknesses of each model and associated model assumptions. Then, for each model, the Panel will recommend if the scientific approach should be adopted for use in developing fishery management advice.
- If the Panel rejects any of the current BRP or BRP proxies (for B_{MSY} and F_{MSY} and MSY), the Panel should explain why those particular BRPs or proxies are not suitable, and the Panel should recommend suitable alternatives. If such alternatives cannot be identified, then the Panel should indicate that the existing BRPs or BRP proxies are the best available at this time.
- Each reviewer shall complete the tasks in accordance with the PWS and Schedule of Milestones and Deliverables below.

Tasks for Peer Review Panel Chair and reviewers combined:

Review the Report of Longfin Inshore Squid Research Track Working Group.

The Peer Review Panel Chair, with the assistance from the reviewers, will write the Peer Reviewer Summary Report. Each reviewer and the Chair will discuss whether they hold similar views on each Research Track TOR and whether their opinions can be summarized into a single conclusion for all or only for some of the TOR of the peer review meeting. For terms where a similar view can be reached, the Peer Reviewer Summary Report will contain a summary of such opinions.

The Chair's objective during this Peer Reviewer Summary Report development process will be to identify or facilitate the finding of an agreement rather than forcing the Panel to reach an agreement. Again, the CIE reviewers are not required to reach a consensus. The Chair will take the lead in editing and completing this report. The Chair may express their opinion on each research track TOR, either as part of the group opinion, or as a separate minority opinion. The Peer Reviewer Summary Report will not be submitted, reviewed, or approved by the Contractor.

Place of Performance
The place of performance shall be in person at the Northeast Fisheries Science Center's Woods Hole Science Aquarium, Clark Conference Room, 166 Water Street, Woods Hole, MA 02532.

Period of Performance
The period of performance shall be from the time of award through August 2026. 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.

Within 2 weeks of award	Contractor selects and confirms reviewers
2 weeks prior to Peer Review meeting	Contractor provides the pre-review documents to the reviewers
August 3-7 2026	Peer 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 Reviewer 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 (http://www.gsa.gov/portal/content/104790), 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 $12,500.00.

NMFS Project Contact
Brian Hooper, Assessment Process Lead
Northeast Fisheries Science Center
166 Water Street, Woods Hole, MA 02543
brian.hooper@noaa.gov

Annex 1. Longfin Inshore Squid Research Track Terms of Reference

1. Identify relevant ecosystem and climate influences on the stock. Characterize the uncertainty in the relevant sources of data and their link to stock dynamics. Consider findings, as appropriate, in addressing other TORs. Report how the findings were considered under impacted TORs.

2. Estimate catch from all sources including landings and discards. Describe the spatial and temporal distribution of landings, discards, and fishing effort. Characterize the uncertainty in these sources of data.

3. Present the survey data used in the assessment (e.g., indices of relative or absolute abundance, recruitment, state surveys, age-length data, application of catchability and calibration studies, etc.) and provide a rationale for which data are used. Describe the spatial and temporal distribution of the data. Characterize the uncertainty in these sources of data.

4. Use appropriate assessment approach to estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series, and estimate their uncertainty. Compare the time series of these estimates with those from the previously accepted assessment(s). Evaluate a suite of model fit diagnostics (e.g., residual patterns, sensitivity analyses, retrospective patterns), and (a) comment on likely causes of problematic issues, and (b), if possible and appropriate, account for those issues when providing scientific advice and evaluate the consequences of any correction(s) applied.

5. Update or redefine Biological Reference Points (BRPs; point estimates or proxies for B_{MSY}, $B_{THRESHOLD}$, F_{MSY} and MSY reference points) and provide estimates of those criteria and their uncertainty, along with a description of the sources of uncertainty. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for reference points. For illustrative purposes, where feasible and appropriate, compute the ratios of the RT assessment's terminal year stock size and fishing mortality to existing, and any redefined, BRPs.

6. Define appropriate methods for producing projections; provide justification for assumptions of fishery selectivity, weights at age, maturity, and recruitment; and comment on the reliability of resulting projections considering the effects of uncertainty and sensitivity to projection assumptions.

7. Review, evaluate, and report on the status of research recommendations from the last assessment peer review, including recommendations provided by the prior assessment working group, peer review panel, and SSC. Identify new recommendations for future research, data collection, and assessment methodology. If any ecosystem influences from TOR 2 could not be considered quantitatively under that or other TORs, describe next steps for development, testing, and review of quantitative relationships and how they could best inform assessments. Prioritize research recommendations.

8. Develop an alternative assessment approach to providing scientific advice to managers, including providing BRPs if possible. The alternative approach could be used if the primary assessment approach is not feasible (e.g., due to data or resource limitations), or if it does not pass peer review either now or in a future Management Track assessment.

Research Track TORs:

General Clarification of Terms that may be Used in the Research Track Terms of Reference

Guidance to Peer Review Panels about "Number of Models to include in the Peer Reviewer Report":

In general, for any TOR in which one or more models are explored by the Working Group, give a detailed presentation of the "best" model, including inputs, outputs, diagnostics of model adequacy, and sensitivity analyses that evaluate robustness of model results to the assumptions. In less detail, describe other models that were evaluated by the Working Group and explain their strengths, weaknesses and results in relation to the "best" model. If selection of a "best" model is not possible, present alternative models in detail, and summarize the relative utility of each model, including a comparison of results. It should be highlighted whether any models represent a minority opinion.

On "Acceptable Biological Catch" (DOC Nat. Stand. Guidelines. Fed. Reg., v. 74, no. 11, 1-16-2009):

Acceptable biological catch (ABC) is a level of a stock or stock complex's annual catch that accounts for the scientific uncertainty in the estimate of Overfishing Limit (OFL) and any other scientific uncertainty…" *(p. 3208) [In other words, OFL ≥ ABC.]*

ABC for overfished stocks. For overfished stocks and stock complexes, a rebuilding ABC must be set to reflect the annual catch that is consistent with the schedule of fishing mortality rates in the rebuilding plan. *(p. 3209)*

NMFS expects that in most cases ABC will be reduced from OFL to reduce the probability that overfishing might occur in a year. (p. 3180)

ABC refers to a level of ‘‘catch’’ that is ‘‘acceptable’’ given the ‘‘biological’’ characteristics of the stock or stock complex. As such, Optimal Yield (OY) does not equate with ABC. The specification of OY is required to consider a variety of factors, including social and economic factors, and the protection of marine ecosystems, which are not part of the ABC concept. (p. 3189)

On “Vulnerability” (DOC Natl. Stand. Guidelines. Fed. Reg., v. 74, no. 11, 1-16-2009):

“Vulnerability. A stock’s vulnerability is a combination of its productivity, which depends upon its life history characteristics, and its susceptibility to the fishery. Productivity refers to the capacity of the stock to produce Maximum Sustainable Yield (MSY) and to recover if the population is depleted, and susceptibility is the potential for the stock to be impacted by the fishery, which includes direct captures, as well as indirect impacts to the fishery (e.g., loss of habitat quality).” (p. 3205)

Participation among members of a Research Track Working Group:

Anyone participating in peer review meetings that will be running or presenting results from an assessment model is expected to supply the source code, a compiled executable, an input file with the proposed configuration, and a detailed model description in advance of the model meeting. Source code for NOAA Toolbox programs is available on request. These measures allow transparency and a fair evaluation of differences that emerge between models.

Annex 2. Draft Review Meeting Agenda

Longfin Inshore Squid Research Track Assessment Peer Review Meeting
August 3 - 7, 2026

Clark Conference Room, Woods Hole Science Aquarium, Woods Hole, MA

Google Meet joining info: https://meet.google.com/wdu-ghyv-qbn
Or dial: (US) +1 929-266-2650
PIN: 685 019 997#

AGENDA* (v. 2/17/2026)
**All times are approximate at the discretion of the Review Panel Chair. The meeting is open to the public; however, during the closed panel writing sessions we ask that the public refrain from engaging in discussion with the Peer Review Panel.*

Monday, August 3, 2026

Time	Topic	Presenter(s)	Notes
9:00 a.m.	Welcome, Introductions, Agenda, Logistics	Chair Brian Hooper	
9:15 a.m.	Research Track Process Overview	Kristan Blackhart	
9:30 a.m.	Overview of Longfin Inshore Squid Research Track	Amy Schueller	
10:00 a.m.	Historical and Current Management	Jason Didden	
10:30 a.m.	BREAK		
10:45 a.m.	Life history including longfin squid biological sampling program (SQUIBS)	Amy Schueller John Manderson Jessica Blaylock	
12:00 p.m.	LUNCH		
1:00 p.m.	Term of Reference (TOR) 1 - Ecosystem and Socioeconomic Report Card	Stephanie Owen	Ecosystem
1:45 p.m.	TOR 1 - Predation	Jim Gartland	Ecosystem

2:15 p.m.	TOR 1 - Stakeholder summit and perspectives	John Manderson	Ecosystem
3:00 p.m.	BREAK		
3:15 p.m.	TOR 2	Daniel Hocking	Catch
4:10 p.m.	Public Comment	Public	
4:20 p.m.	Discussion/ Summary	Review Panel	Conclusions, Recommendations, & Final Wrap-up for TOR 1 and 2
5:00 p.m.	ADJOURN		

Tuesday, August 4, 2026

Time	**Topic**	**Presenter(s)**	**Notes**
9:00 a.m.	Welcome, Logistics, Agenda	Chair Brian Hooper	
9:05 a.m.	TOR 3	Jim Gartland	Surveys
10:30 a.m.	BREAK		
10:45 a.m.	TOR 4 - Length structured model	Mike Wilberg	Model
12:00 p.m.	LUNCH		
1:00 p.m.	TOR 4 - Continued	Mike Wilberg	Model
2:45 p.m.	BREAK		
3:00 p.m.	TOR 8 - Surplus production model	Paul Rago	Model
4:00 p.m.	Public Comment	Public	
4:10 p.m.	Discussion/Summary	Review Panel	Conclusions, Recommendations, & Final Wrap-up for TOR 3 and 4
5:00 p.m.	ADJOURN		

Wednesday, August 5, 2026

Time	**Topic**	**Presenter(s)**	**Notes**

9:00 a.m.	Welcome, Logistics, Agenda	Chair Brian Hooper	
9:05 a.m.	Review Homework	Chair	If needed
10:00 a.m.	TOR 8 - Surplus production model continued	Paul Rago	Model
10:30 a.m.	BREAK		
10:45 a.m.	TOR 5 - Length structured model	Jessica Blaylock	Biological Reference Points (BRPs)
12:00 p.m.	LUNCH		
1:00 p.m.	TOR 5 - Surplus production model	Jessica Blaylock	BRPs
1:45 p.m.	TOR 6 - Length structured model	Cameron Hodgdon	Projections
3:00 p.m.	BREAK		
3:15 p.m.	TOR 6 - Surplus production model	Paul Rago	Projections
4:00 p.m.	Public Comment	Public	
4:10 p.m.	Discussion/Summary	Review Panel	Conclusions, Recommendations, & Final Wrap-up for TORs 5, 6, and 8
5:00 p.m.	ADJOURN		

Thursday, August 6, 2026

Time	Topic	Presenter(s)	Notes
9:00 a.m.	Welcome, Logistics, Agenda	Chair Brian Hooper	
9:05 a.m.	Review Homework	Chair	If needed
10:30 a.m.	BREAK		
10:45 a.m.	TOR 7	Jason Didden	Research recommendations
12:00 p.m.	LUNCH		

1:00 p.m.	Comparison of length structured model and surplus production model	Jessica Blaylock Amy Schueller	
2:00 p.m.	Revisit any remaining questions	Chair	
3:00 p.m.	BREAK		
3:15 p.m.	Review any additional homework	Chair	
4:00 p.m.	Public Comment	Public	
4:15 p.m.	Discussion/Summary	Review Panel	Conclusions, Recommendations for TOR 7, & Final Wrap-up
5:00 p.m.	ADJOURN		

Friday, August 7, 2026

Time	**Topic**	**Presenter(s)**	**Notes**
9:00 a.m.	Welcome, Logistics, Agenda	Chair Brian Hooper	
9:05 a.m.	Review any remaining homework; answer any additional questions	Chair	
10:00 a.m.	Closed panel writing session	Review panel	
5:00 p.m.	ADJOURN		

Annex 3. Individual Independent Peer Reviewer 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 Term of Reference in which the weaknesses and strengths are described, and conclusions and recommendations in accordance with each Term of Reference being "met," "partially met," or "not met". The independent report shall be an independent peer review, and shall not simply repeat the contents of the Peer Reviewer Summary Report.

    a. Reviewers should describe in their own words the review activities completed during the panel review meeting, including a concise summary of whether they accept or reject the work that they reviewed, and explain their decisions (strengths, weaknesses of the analyses, etc.), conclusions, and recommendations.

    b. Reviewers should discuss their independent views on each Term of Reference 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 Peer Reviewer Summary Report that they believe might require further clarification.

    d. The report may include recommendations on how to improve future assessments.

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 4. Peer Reviewer Summary Report Requirements

1. The main body of the report shall consist of an introduction prepared by the Research Track Peer Review Panel chair that will include the background and a review of activities and comments on the appropriateness of the process in reaching the goals of the peer review meeting. Following the introduction, for each assessment /research topic reviewed, the report should address whether each Research Track Term of Reference was "met," "partially met," or "not met". It should also include whether they accept or reject the work that they reviewed, with an explanation of their decision (strengths, weaknesses of the analyses, etc.)

   To make this determination, the peer review panel chair and reviewers should consider whether or not the work provides a scientifically credible basis for developing fishery management advice. If the reviewers and peer review panel chair do not reach an agreement on a Term of Reference, the report should explain why. It is permissible to express majority as well as minority opinions.

   The report may include recommendations on how to improve future assessments.

2. If any existing Biological Reference Points (BRPs) or BRP proxies are considered inappropriate, include recommendations and justification for alternatives. If such alternatives cannot be identified, then indicate that the existing BRPs or BRP proxies are the best available at this time.

3. The report shall also include the bibliography of all materials provided during the peer review meeting, and relevant papers cited in the Peer Reviewer Summary Report, along with a copy of the CIE Performance Work Statement.

   The report shall also include as a separate appendix the assessment Terms of Reference used for the peer review meeting, including any changes to the Terms of Reference or specific topics/issues directly related to the assessments and requiring Panel advice.