New England Fishery Management Council
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Daniel Salerno, *Chair* | Cate O'Keefe, PhD, *Executive Director*

MEMORANDUM *(typo correction on p.5)*

DATE: April 2, 2026 *(revised 4/20/26)*

TO: Cate O'Keefe, Ph.D., Executive Director

FROM: Scientific and Statistical Committee Subpanel

SUBJECT: Response to Terms of Reference for review of methods for developing monkfish catch per unit effort indices

A subpanel of the Scientific and Statistical Committee (SSC) met on March 13, 2026, via webinar to review two separate research projects that developed standardized CPUE indices. These projects were conducted by 1) the University of Massachusetts Dartmouth School for Marine Science & Technology in collaboration with the Cape Cod Commercial Fishermen's Alliance, and 2) the Northeast Fisheries Science Center Cooperative Research Branch. The researchers collaborated and shared findings throughout the process.

The subpanel provided feedback and guidance to the project team and the Council, suggesting modifications that could be made to the methods and models while also commenting on the utility of the products for informing future monkfish stock assessments and fisheries management decisions.

SSC subpanel members in attendance: Conor McManus (panel chair), Lisa Kerr, and Jason McNamee.

TERMS OF REFERENCE (TORS)

A. Evaluate the strengths and weaknesses of the methods and summary products of the two projects to develop standardized monkfish catch per unit effort (CPUE) indices. Provide suggestions for improvements to the methods and/or summary products where appropriate. Topics to consider include, but are not limited to, the following:
    a. Do the projects clearly define and describe the data sources, methods, and assumptions with a level of detail sufficient to assess results and applicability to monkfish assessment and management?
    b. Do the projects characterize trends in monkfish catches by gear type and monkfish management area?
        i. Are there additional data sources, aggregations, resolutions, etc. that should be considered?
        ii. Are key areas of uncertainty identified and addressed?
    c. Are the conclusions regarding the trawl and gillnet CPUE comparisons to the NEFSC bottom trawl surveys scientifically robust?

B. Evaluate utility of the project outcomes and what project modifications would improve their utility. Topics to consider include, but are not limited to, the following:
    a. Whether project outcomes should be used individually or if they can also be used in combination given the differences in methods and assumptions.
    b. Whether and how project outcomes could inform future monkfish stock assessments.
    c. Whether and how project outcomes could inform management approaches, such as how monkfish days-at-sea (DAS) and monkfish trip possession limits are determined?

The subpanel received presentations from project participants outlining the background of monkfish science and management, motivations for the projects, and details of the projects' objectives, methods, outcomes, and discussion of the Terms of Reference.

GENERAL COMMENTS

Two projects developing CPUE indices for monkfish were reviewed by the SSC subpanel. Project 1 derived CPUE indices using vessel logbooks and trip reports. The strength of this dataset is that it represents catch from the entire or nearly entire fleet (trawl and gillnet federally permitted harvesters), but some data fields are not recorded at the fine scale or resolution that would be desirable for CPUE modeling exercises. Project 1 was informed by the industry through five semi-structured workshops starting in summer 2024. The workshops included in-person formats where standard questions about catch rates and how to interpret data were posed, as well as a virtual workshop once standardization methods were drafted. Project 2 used NEFSC Study Fleet and Northeast Fisheries Observer Program data from gillnet, trawl and scallop dredge harvesters to derive CPUE indices. This project applied a randomized subsampling approach and then applied a similar statistical approach to Project 1 (i.e., Generalized Additive Models) to derive indices. The researchers assessed concordance of these novel CPUE series with the traditional fishery-independent time series based on the bottom trawl survey. The subpanel thanks the project teams for their research, and the industry's engagement throughout the work and participation in the subpanel meeting.

SPECIFIC RESPONSES TO TERMS OF REFERENCE

TOR A.a.

A. Evaluate the strengths and weaknesses of the methods and summary products of the two projects to develop standardized monkfish catch per unit effort (CPUE) indices. Provide suggestions for improvements to the methods and/or summary products where appropriate. Topics to consider include, but are not limited to, the following:
    a. Do the projects clearly define and describe the data sources, methods, and assumptions with a level of detail sufficient to assess results and applicability to monkfish assessment and management?

The subpanel found that the projects adequately described the data sources, methods and assumptions used in deriving the CPUE indices. The project teams used the most appropriate fishery-dependent data available, and the complementary nature of the two projects allows for understanding tradeoffs with each dataset. The subpanel had feedback and recommendations on the CPUE indices that applied to both project teams as well as recommendations specific to individual teams.

Data filtering for both projects was well documented but differed considerably between projects; the subpanel recommended making sure the documented data filtering is coded in a manner that allows for ease in reproducibility to update time series moving forward. The subpanel appreciated the effort to use semi-structured, qualitative interview data with the industry to inform quantitative modeling efforts. The subpanel requested future reporting include more information on the model selection process and the model performance and diagnostics of the various tested models via tables. Doing so would allow for better understanding of the variables tested and eventually used, the significance of the covariates in and across the models, the overall model variance explained for tested models, and additional model diagnostics that helped inform the final model selection. Other items to explicitly report out are partial effect plots for each gear type and index, the associated diagnostics for those plots, and deviance explained for the various models.

The subpanel supported the effort metrics used by the project teams in development of indices using gillnet (days at sea) and trawl (tow duration) data. The project teams noted other effort metrics were evaluated (e.g., vessel horsepower, tonnage and length) but ultimately were not included. There was interest from the subpanel for more precise effort metrics for the gillnet fishery (e.g., number and mesh of panels), but the project teams noted this was challenging as such data are not consistently reported in harvesters' logbooks. The subpanel recommended additional outreach to the monkfish fleet on the value of such information for CPUE index development and perhaps requesting this information be consistently recorded in the future. This concept was also voiced during the public comment period.

The development of both projects allowed for understanding potential differences that can arise when using larger census dataset with coarser spatial resolution (Project 1) compared to that of a subset of the fleets but with greater spatial resolution (Project 2). Given the finer scale data available in Project 2, the subpanel recommended as a future consideration to test more advanced analytical methods (e.g. VAST, sdmTMB) to model CPUE. These tools can better account for spatial correlation in the data and treat fleets or individual harvesters as random effects (features often sought when developing indices using multiple data sources).

ToR A.b.

b. *Do the projects characterize trends in monkfish catches by gear type and monkfish management area?*
    i. *Are there additional data sources, aggregations, resolutions, etc. that should be considered?*
    ii. *Are key areas of uncertainty identified and addressed?*

Overall, the subpanel concluded that both projects effectively characterized trends in monkfish catches by gear type and management area. In addition, the subpanel noted that the project teams identified and tried to address some of the key areas of uncertainty. The subpanel made recommendations regarding additional considerations for future improvements to the indices.

The subpanel discussed the representativeness and robustness of the fishery-dependent indices and recommended that formal practices and guidelines for CPUE model or index evaluation be adopted for application in the management of NEFMC stocks. The subpanel noted that criteria for model performance and diagnostics (e.g. model variance explained, standardized procedures for testing autocorrelation and collinearity in variables across models and processes for removing variables autocorrelated, collinear, or insignificant) would be useful guidance in adoption of CPUE indices for NEMFC-managed stocks. The project teams noted that other institutions have developed criteria (e.g., International Commission for the Conservation of Atlantic Tunas (ICCAT) and the Southeast Data, Assessment, and Review (SEDAR)) and this guidance informed the project team's evaluation of their CPUE indices. Adoption of criteria for CPUE indices that are to be used to inform management decisions would be useful for this region.

The subpanel noted and appreciated the efforts made to incorporate skate fishery dynamics in the Project 1 models given the hypothetical impact of skates on catch rates of monkfish in the gillnet fishery. The subpanel recommended future work to explore the feasibility of accounting for the influence of skates on gillnet indices and consider additional fisheries management or market elements for the fishery that have been documented by the industry and have metrics available to inform modeling. Two suggestions brought forth were to more explicitly incorporate price per pound and use market or management time period categories (akin to selectivity blocks).

The subpanel commented on concerns that could challenge the assumption that catchability is constant for deriving CPUE indices. For example, the focus of fleets on high spatial densities of monkfish could lead to hyperstability of indices, whereby catch rates remain stable while total biomass is declining. Alternatively, interaction with the skate fishery might lead to hyperdepletion, whereby catch rates decline faster than biomass due to technical interactions. Furthermore, changing ocean conditions have been linked to shifts in monkfish distribution (northward and deeper) that could impact the availability of fish within stock areas. These shifts have not been explicitly accounted for in these efforts and would be useful to consider when interpreting trends between southern and northern indices. Inclusion of environmental variables in the model may allow for addressing this to an extent. Project Team 1 noted future work could include hyperstability being more formally tested (similar to what has been done for ICCAT managed species assessments that use CPUEs), which the subpanel supported.

The coherence in the project teams' indices provided confidence in the observed trends being representative of the exploitable monkfish stock in each management area. The subpanel did ask the project teams about reconciling differences in the effects of the variables across models that, in theory, should be consistent based on the species life history. For example, the effect of depth on CPUE varied across the models. An understanding of whether this is data driven, a function of the GAMs smoothing functions, or a true difference in depth preference of monkfish or effort by management area would be useful. This is particularly relevant if models are maintained into the future and additional years' data change our inferences on the relationship between CPUE and predictor variables.

Both project teams noted the longstanding concern with technology creep and its impact on the interpretation of CPUE indices over time. Project 2 explored scenarios in which CPUE trends could be impacted by linearly increasing but compounding impacts of technology creep. The similarity in trends and impacts on terminal years was informative, but the subpanel noted that differences in scale can be meaningful depending on the application of the index. For example, in an analytical assessment, changes in overall index scale may have less of an impact on final

management outcomes as the model uses the trend and can internally adjust other parameters to get at the correct population scale relative to the index value. However, our current use of indices in the I-smooth approach may have a more direct effect on the management advice than analytical assessments, as the index values are used directly. More informed technology creep scenarios related to the evolution or advancement of the monkfish fishery over time would be another useful sensitivity analysis.

TOR A.c.

> *c. Are the conclusions regarding the trawl and gillnet CPUE comparisons to the NEFSC bottom trawl surveys scientifically robust?*

The project teams provided visual comparisons and correlation analysis between the trawl and gillnet CPUE indices and the NEFSC bottom trawl survey indices to assess their concordance. The subpanel and project teams discussed how to interpret agreement or discrepancies between the fishery dependent CPUE indices and the indices derived from the NEFSC bottom trawl surveys. Both the project teams and the subpanel cautioned against using significant positive correlation with fisheries independent surveys as a metric for performance or as a reason to use in assessments, as the CPUE trends inherently could capture features missed by fishery-independent surveys and thus provide new insight. This was a key motivation for this work and a sentiment shared by industry via public comment during the review. The subpanel thought it would be informative to compare the CPUE model-based coefficients of variations (CVs) to the NEFSC bottom trawl survey CVs as well to understand the precision in the indices.

TOR B.a.

> *B. Evaluate utility of the project outcomes and what project modifications would improve their utility. Topics to consider include, but are not limited to, the following:*
>
> *a. Whether project outcomes should be used individually or if they can also be used in combination given the differences in methods and assumptions.*

The subpanel discussed the robustness and utility of the project outcomes for use in assessment and management decisions. In addition, the project teams themselves provided recommendations for the use of the CPUE products. The subpanel agreed with the project team's recommendation that the following list of specific indices could inform future assessments and fisheries management deliberations:

- Southern gillnet observer index
- Southern gillnet Study Fleet-observer index
- Southern gillnet logbook index
- Northern trawl observer index (with early years removed)
- Northern trawl Study Fleet-observer index

The subpanel noted the inconsistent trend in the northern trawl indices, which may reflect multiple factors, including characteristics of the northern trawl fishery, changes in management strategies, and differences in the strengths and limitations of observer versus logbook data in this area. Thus, the subpanel did not recommend its use for assessment purposes at this time. The subpanel did not recommend abandoning this index completely as

it could be useful for certain applications once some of the contradictory effects seen in the current version of the indices are further investigated. The subpanel noted that whether one or multiple indices are used will depend on both the application (e.g., stock assessment, see TOR B.b) and how the indices are developed further based on the subpanel feedback.

TOR B.b.

> b. *Whether and how project outcomes could inform future monkfish stock assessments.*

The indices present various tradeoffs, in particular the balance between a larger census of the fleet versus more fine-scale data with additional fields of information available. The subpanel felt that the list of indices from the previous section could be used in future analytical assessments, and in current assessment and management processes. Based on the index tradeoffs presented by the project teams, of those listed above, the subpanel did not identify specific indices that should be solely used for assessment or management applications. How exactly the individual index is used would likely be predicated on its application (stock assessment, informing days-at-sea, etc.). The subpanel suggested prioritizing the development of observer-based indices for use in assessment in the short term due to the quality of the data and the fact that both northern and southern indices are available from a consistent data source.

The subpanel recommended the project teams and scientists using these indices for assessments or management further consider additional metrics or rubrics for determining whether to use these indices. For example, there was discussion on what would qualify for an index to be removed or added to an assessment or management process over time, and whether differences in time series should be considered when looking to use one or multiple indices. Further, it would be informative to compare the CPUE model-based coefficients of variations (CVs) to the NEFSC bottom trawl survey CVs, and further, examine the length frequency distributions between the two data sources to ensure that the indices are examining approximately the same size compositions of the population.

The subpanel noted that the application of these indices would depend on the future assessment approach for monkfish. The current approach to monkfish assessment uses an empirical method (i.e., I-Smooth). This stock used to be assessed using an age-structure analytical model, but this model was rejected due to issues with the accuracy of ageing methodologies for this species. Future exploration of a length-based analytical assessment has been recommended for this stock. In an analytical assessment framework, the CPUE indices could be used to track the relative abundance of exploitable biomass. Deriving size compositions would be challenging given that fish length is not always reported for landed monkfish (i.e., when not landed whole) and would need further consideration. One idea to consider for this challenge is the potential use of market category as a proxy for length.

Decisions would need to be made as to which indices to include in an analytical model and how to weight them if multiple indices are used. Goodness-of-fit tests could help inform this. In the current assessment approach (I-smooth), one or multiple CPUE indices could be included through methods such as averaging normalized indices prior and an averaged index with a loess smoother. However, more thought is required on the various decision points needed for doing so, including but not limited to weighted averages for indices and time

series lengths. Such considerations would need to be vetted through a formal assessment and peer review process.

Holistically, application of these new CPUE indices should be done in a systematic manner to ensure a thoughtful and transparent transition from the current data sources such that any changes to catch advice can be easily understood. Adoption of formal criteria for both the inclusion and removal of CPUE indices in stock assessments would be helpful to ensure that the indices are used in a systematic, unbiased manner. There are some methods used for systematic approaches for vetting multiple indices, so those could be a good starting point for developing this systematic process (example, see section 5.1, page 77 in the 2020 Atlantic Menhaden Benchmark Assessment.)

The subpanel emphasized that, when incorporating multiple indices, care should be taken to avoid duplicative information that could overweight models sharing the same underlying signal. Because fleet dynamics can shift over time, certain indices may better reflect species abundance during specific periods, but be less informative during others. Further, methods that allow for the CPUEs to be adaptable to changing stock boundaries are ideal. Genetic research has indicated that the monkfish management areas may represent a single stock, and thus a single index may be more accurate or useful for tracking stock dynamics than individual northern and southern management indices. While spatial stock structure and management units do not have to align, single spatial indices such as those presented as part of Project 2 may be useful.

Irrespective of their inclusion in a stock assessment model, the subpanel noted that these indices would be valuable both for SSC deliberations for catch advice and fisheries management applications. For several years during SSC deliberations, the plan development team (PDT) and industry members have suggested that caution be used when interpreting catch trends and using that information as a guide for setting catch advice given changes in markets and other fleet dynamics that impact catch rates unrelated to abundance changes. Because these types of models can explicitly account for some of these factors, these indices would be valuable in informing the catch advice deliberations of the SSC. Having these indices as part of data updates or management track assessments would provide the needed synthesis of these other types of information often referenced by the PDT and members of industry.

TOR B.c.

c. *Whether and how project outcomes could inform management approaches, such as how monkfish days-at-sea (DAS) and monkfish trip possession limits are determined?*

The subpanel affirmed that regardless of inclusion in stock assessment models or methods, the CPUE indices would be useful for informing fisheries management decisions, specifically DAS deliberations. Depending on the units of the CPUE indices, the indices in concert with projected fishing effort could be informative for estimating DAS for the management units. The current state of the indices, which are in catch per unit effort, would directly relate to these sorts of management decisions. The subpanel pondered whether the fishery-dependent data could be revised in a fashion that could allow for a smaller lag between assessment terminal year and management action. If so, that would also prove to be a powerful tool for fisheries management decision making.

DOCUMENTS

To address the TORs, the subpanel considered the following information:

1. Introductory presentation: Monkfish project context, management, and assessment background (M. Sanderson, S. Cadrin)
2. Project 1: Incorporating Fishermen's Knowledge into Standardized Catch-Per-Unit-Effort Indices for the Commercial Monkfish Fishery
    a. Project team presentation
    b. Project technical report (Richardson, Cadrin)
3. Project 2: Examining High-Resolution Monkfish CPUE Indices Across Gillnet, Trawl, and Scallop Dredge Fisheries
    a. Project team presentation
    b. Project technical report (Jones, Legault)
4. Presentation: Monkfish project team recommendations and responses to TORs (S. Cadrin)
5. Past SSC Reports on Monkfish OFL/ABC:
    a. Monkfish OFL/ABC 2023-2025, November 21, 2022
    b. Monkfish OFL/ABC 2023-2025, January 23, 2023 (Remand)
    c. Monkfish OFL/ABC 2026-2030, August 31, 2025