



Individual CIE Report

Catch Accounting and Monitoring System (CAMS) Review

Prepared for the Center for Independent Experts

by

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April 2023

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Executive Summary

- This document is the individual Center for Independent Experts (CIE) Reviewer Report of the review of the Catch Accounting and Monitoring System (CAMS). The review was conducted during 17th – 19th January 2023, with the review meetings held between 11.00 to 17.00 (EST) daily and used the Webex virtual platform. The meeting timing was a day later for this reviewer due to the difference in time zone and started at 05.00 NZST on the 18th May. This report represents the sole views of the independent CIE reviewer, Dr Geoff Tingley.
- Comprehensive documents describing CAMS and its predecessor systems, as well as other relevant background documents, were provided in advance of the meeting in a downloadable format posted on a dedicated Webex webpage. The various presentations were made available as pdf and pptx files during the meeting. All documents are listed in [Annex 1](#).
- The CAMS Team fully engaged in the review and were helpful in providing information to the Panel. The Team also engaged in useful discussions and responded to all questions the Panel raised. There was open and informed discussion about all potential issues identified by the Panel, which both greatly assisted the review process and the drafting of appropriately focused recommendations.
- All Terms of Reference of the review were fully addressed.
- During the review process, the CIE reviewers identified a number of issues within the CAMS development and operating regime that would benefit from further consideration and improvement. None of these identified issues were considered a fundamental concern by this reviewer, however, a number were considered to be of more than minor concern and in need of relatively urgent and concerted efforts to address them. These issues have been given the highest priority in terms of recommendations.
- One area needing some development that was not specifically included in the ToR was identified and discussed, that of the need for a Communications and Outreach Plan.
- Recommendations were developed and are arranged in this report by the identified ToR elements. In addition, recommendations have been prioritized and those considered of the highest importance have been identified as such.
- This CAMS project represents a substantive and positive development to improve the consistency across a wide range of fishery-related data used for multiple purposes by different organizations. It is essentially a fit-for-purpose, single source of commercial fishery information, with a few necessary improvements to be made.

Background

The Catch Accounting and Monitoring System (CAMS) is a joint venture between the Greater Atlantic Regional Fisheries Office (GARFO) and the Northeast Fisheries Science Center (NEFSC) to implement a shared data system that offers a single source of fisheries data for the Greater Atlantic Region. The CAMS is a relational database that has been under development since 2019. The contained data support a wide range of usage, principally for quota monitoring and stock assessment purposes, but also for protected resources (e.g., species and habitat) estimation, ecosystem modeling, and other current and future needs of GARFO and the NEFSC. Prior to the development of the CAMS, GARFO and the NEFSC maintained two parallel systems for catch monitoring and accounting purposes. In combining the existing systems into a single, comprehensive source of fisheries data there were multiple goals, including providing a single source of data (avoiding different values being used in different areas of work) and reducing duplication in data processing, data storage, and system maintenance.

At the time of the review, the CAMS had already started being used for some functions by GARFO and the NEFSC.

This review of the Catch Accounting and Monitoring System (CAMS) was conducted as part of an independent review for the Center for Independent Experts (CIE).

All views expressed in this report are solely those of the named, independent CIE reviewer.

Description of Review Activities

This review and reporting was undertaken by Dr Geoff Tingley (Gingerfish Ltd) between mid-January and mid-March 2023. The review meeting was conducted using the Webex software platform, with the Panel Chair and CIE reviewers joining remotely from the east coast USA, Norway and New Zealand. The timing of the hybrid review meeting proceeded as scheduled in the draft [agenda](#) from 11.00 EST 17th January, concluding about 16.30 EST on 19th January 2023. The draft agenda was followed closely, mostly to enable on-line participants to join at appropriate times. The meeting finished a little early on the last day, as there was insufficient time on the final afternoon to make a sensible start on the Panel report and it was agreed we could not make significant progress in the remaining time, after an extensive three-day review, and with reviewers working antisocial hours due to time zone differences.

The supporting documents for the review were provided to the reviewers in downloadable electronic formats on the Webex platform. These resources were provided in advance of the review meeting, and with adequate time to read and adequately consider the material. The documents included previous relevant CIE review reports and PowerPoint presentations on the various components of the CAMS, as well as descriptions of the data structures, analyses conducted, and data processing code. Other material was made available during the meeting as it became clear this was needed, or specifically at the request of the Panel. All documents (but not code files) provided and used are listed in the [Bibliography](#). All documents provided in advance of the meeting were reviewed prior to the start of the meeting, noting the specific Terms of Reference (ToR) provided by the CIE in the [Performance Work Statement](#).

The key documents describing the CAMS and how this was developed from the two separate GARFO and NEFSC data, together with supporting background documents and reports were comprehensive, well written and clearly presented. A large number of CAMS code files were also provided, which were informative but were provided without the necessary identification information and guidance on priority information. The support provided by the local NEFSC and GARFO staff was of a high standard and fully appreciated by the reviewer. The Chair, Cate O’Keefe, provided support and guidance to the CIE reviewers and facilitated the smooth running of the meeting.

The reviewer appreciated the high quality and informative presentations by the various GARFO and NEFSC staff. The various presenters provided clear and informative background on their individual areas of expertise and responsibility for the review Panel. All presenters responded in detail to questions raised by members of the review panel. This CIE reviewer examined the documents and presentations provided prior to the meeting. All CIE reviewers asked questions of clarification, and offered information and alternative approaches where they considered these may be helpful or otherwise informative.

Information relevant to this review is presented in three appendices to this review report, as required by the ToR provided by the CIE. These are, Appendix 1: Bibliography of documents; CIE Performance Work Statement (which includes its own annexes describing (1) the Peer review report requirements, (2) the ToR for the peer review, and (3) the draft agenda for the review meeting; and Appendix 4: Panel membership and other relevant information.

An on-line (Webex) draft agenda was provided in advance of the meeting. At the start of the meeting the agenda was discussed and agreed with no changes. The meeting was conducted in an open, friendly and constructive manner throughout. Presentations were made with questions of clarification asked by all members of the Panel. All discussions were professional and good-natured, being focused on clarification and clarity around the materials under review. Most attendees were GARFO or NEFSC staff, with various industry, NGO and academic. A list of attendees is given in Annex 3.

Responses to panel questions were made available to the reviewers as soon as practicable, either distributed by email or more usually posted to the Webex site. All reviewer requests were responded to before the end of the meeting or by email shortly afterwards. The CAMS Team is to be congratulated on the way requests for additional material were fully and promptly addressed over the three days of the review.

The Summary Report of the Panel was drafted and agreed by correspondence and an additional two-hour virtual Zoom meeting of the Panel held at 13.00 EST on 30th January 2023.

Summary of Findings

The review provided an in-depth understanding of the Catch Accounting and Monitoring System (CAMS), its development and current, and potential applications. The CAMS Team is clearly knowledgeable and highly competent, enabling them to deliver a successful, major change and development program in a relatively short time.

The objective of the CAMS, to provide a single source of fishery data for multiple applications by a range of users, is ambitious but has been delivered well. This review agrees that this an appropriate objective for the specified key uses, supporting both quota management and stock assessment programs, provided that some specific needs are addressed by retaining adequate and appropriate flexibility in the system. The flexibility is required to manage areas of data use where the replacement of incorrect or missing data (by averages or by imputation) would be inappropriate for the mathematical or statistical uses to such those data are put. Specific examples of such areas are provided in the text.

The CAMS was described to have already been in use since 2019 for some key purposes, and apparently without mishap. This review supports the view that the CAMS system is fit for providing data for general use across multiple user groups, provided that some important developments are addressed in a timely manner. These include, for example, the development and implementation of information on version control for users (date stamps, database or data version identifiers, etc.) and the application of a system for uniquely identifying all data from a single vessel trip, a Unique Trip Identifier (UTID), and expanded consideration of user requirements.

None of the panel reported having any fundamental concerns about the CAMS during the three days of the meeting or while preparing the Summary Report of the Panel.

Unsurprisingly, for such a large and complex information technology development, there are a number of areas where improvement could be made. These are described in some detail in the text of the report and are mostly focused on improvements to existing approaches and processes.

Recommendations have been developed for all identified areas where improvement could be made and all recommendations are prioritized.

There are a number of areas of improvement that were identified as warranting a very high priority. This was partly driven by the uses to which the CAMS output data were already being put, coupled with the potential impacts that improvements in these areas could have on the functioning and effectiveness of the CAMS. These areas were:

- (i) a rapid development and implementation of a Unique Trip Identifier (UTID);
- (ii) increase the period of time over which comparative testing with previous systems has been done from just 2019;
- (iii) development of a program of user experience (UX) testing and research to better define the requirements and expectations of all potential users. The outcomes of the UX testing and research would be expected to be critical in planning the future

- development of how the CAMS responds to user groups in terms of providing output data and other relevant information;
- (iv) review the current approach to managing information privacy and electronic security; and
 - (v) development of a communications and outreach plan.

The four members of the Review Panel generally showed a high level of agreement in their understanding of the issues, and also in their consideration of recommendations and priorities.

Addressing the Terms of Reference (ToR) for the Peer Review

Detailed findings and recommendations are presented below, as required by the ToR for the review. Text in italics is taken directly from the requirements of the review defined in the ToR.

Catch Accounting and Monitoring System (CAMS)

1. *Comment on the ability of CAMS to provide a single source of commercial fishery data for users in both GARFO and NEFSC (e.g., for quota monitoring, stock assessment, socio-economic analysis, ecosystem assessment, protected species bycatch assessment, and research). Consider the following aspects in your review:*

a. Documentation at both the conceptual and technical levels

The current position regarding documentation is considered fairly typical for a technical application of this kind, some of the documentation is fully developed, some is partially developed, and some is largely absent.

The conceptual documentation describing the system is fairly well developed, is currently in use and appears fit-for-purpose. However, it is not clear that there is an effective process to ensure the documentation remains up-to-date with respect to future changes to the system.

Substantial technical documentation and requirements for the system developers have been written. These appear to meet the principal technical needs but some further consideration of how and where to store and access such documentation may be advisable. Key future needs will include tracking of historical system developments (enabling bug and error checking), checking of historical output (system compatibility), and future access to key documentation (legacy and current).

Support documentation for end-users of CAMS outputs appears to be pretty much embryonic, at least for some user groups, and what is available is somewhat minimal. As CAMS is likely to proceed rapidly into more mainstream use, this aspect of documentation covering all identifiable actual and potential end-users, needs to be addressed urgently, so as to provide informative and accessible documentation for technical, less-technical and non-technical users. End-users of CAMS outputs will include a wide-range of individuals and organizations, including, for example, data source organisations and their data stewards through to fishers and fishers organizations, and appropriate documentation needs to provide inclusive accessibility to all.

b. Data source contributions, including the smaller and harder to track data sources (e.g., state of Maine herring data)

The sources of data for principal data components are clearly defined and well understood. Data considered “smaller” or “harder to track” necessarily make up a small proportion of the data stored or to be stored in CAMS but have a disproportionately large processing requirement and possibly a wider range of data providers and stakeholders to align. In the development of CAMS, these smaller and harder to track datasets have understandably not been prioritized to date, which is completely appropriate.

As the handling of the principal data are further automated, more resources should become available and should be used to address the incorporation of the smaller and harder to track

data sources. This is a continuation of the path to deliver a single source of commercial fishery data that lies behind the CAMS. Addressing the needs of systematizing these lesser datasets will continue to need appropriate on-going review and prioritization.

Description of data from core data sources (e.g., vessel trip reports, Vessel Monitoring System (VMS) data, dealer reports, observer data) are well developed. Additional effort is probably required to adequately describe data from other, non-core data sources, including the smaller and harder to track datasets.

The CAMS is clearly capable of bringing together both major and minor data components as has been envisaged, although much of the work to incorporate the minor data sources remains to be done. To assist in this more complex and challenging task of addressing the minor data sources, development of a specific, time-bound implementation plan is advisable. This plan may need to be updated periodically.

c. Processes to combine data sources

The processes for combining the main data sources as inputs to the CAMS have been developed from existing data processing for the previous, separate GARFO and NEFSC systems. As described in the review, these processes are both well-understood and substantially robust for this context. Processes to incorporate some additional data sources into the CAMS have been specifically developed, and others will need to be so in the future. Provided the development of these processes follows the existing pattern, is effectively planned, and well-documented, there should be low risk of appreciable process-related issues in handling data from the various different sources. For third-party data sources, appropriate data and information privacy and electronic security issues may need to be addressed prior to integration of such data.

There were some clear issues in effective data matching and imputation output errors that implied some process limitations. Much of this could be solved by the development and implementation of a Unique Trip Identifier (UTID). This report addresses the issue of UTID development in greater detail [elsewhere](#).

One of the observations of this review relates to data checking and validation, specifically the adequacy of comparing the CAMS outputs to those from the GARFO and NEFSC predecessors. Existing comparative checks have principally been restricted to comparison of data from a single year and, as discussed below ([ToR 1d](#)), are considered minimal. As and when new processes are developed, the amount and quality of checking against previous output datasets needs to be considerably strengthened, with an effective procedure put in place. This should form a core part of any new data process development (see [ToR 1d](#) below).

d. Comparisons of CAMS outputs with landings and discards provided from previous quota monitoring and stock assessment approaches

A number of detailed comparisons between CAMS outputs and the previous GARFO quota-monitoring and NEFSC stock assessment data-systems have been conducted. These have shown a broad level of agreement between the historic systems and the CAMS outputs. However, there were two substantive issues identified for consideration during this review.

The first and most important issue relates to the very limited time period over which comparisons have been made, which is restricted to a single year, 2019. The second relates to the numbers and scales of observed differences between the various outputs.

It is important to note that landings data in the CAMS showed a reasonable match to both the previously used Area Allocation tables used in developing stock assessment input data, and the DMIS system for monitoring quota for the period compared (2019 only).

As reported to the review meeting, current comparisons between the CAMS and the GARFO and DMIS data outputs have been restricted to the 2019 dataset, which could mean that some types of inconsistencies or errors in data-matching may not have been picked up. It is understood that conducting comparisons on data after 2019 is not possible as some of the components of the earlier systems ceased to be supported after 2019, with switching to use of CAMS outputs. In hindsight, this was a mistake with respect to enabling adequate testing as it significantly constrains evaluation of whether CAMS has been performing as expected.

Specifically, comparisons covering a single year are unable to evaluate the robustness of the system to inter-annual variations that are typical in fisheries and fisheries data. For example, between-year variations in stock abundance, catch and effort limits, environmental drivers, fisher behavior (e.g., driven by fuel price change, market forces), fish behavior, and fish location would all be expected to occur. The implications of these types of changes on the quality and comparability of the CAMS outputs cannot be evaluated from a single year's comparison.

Landings data exist in the CAMS at least as far back as 2005. It is understood, however, that although doing comparisons between CAMS and the systems it is replacing for years prior to 2019 is possible, this is increasingly problematic for earlier years. The CAMS Team indicated they thought it possible to do such comparisons for 2018 and probably 2017 as well. It would, therefore, be prudent to extend such comparative analyses back at least to 2018 and preferably to 2017.

The more recently developed discard component of the CAMS did not fare so well in comparative testing, with some potentially important discrepancies evident between the CAMS and previous discard handling approaches. For example, there were clearly some issues in some gear and spatial reallocations that required more investigation. Further efforts to explore the underlying reasons for differences in comparisons, including the use of statistical methods on results of comparisons, are required.

A further argument for extending the period of comparison further back in time than just 2019 relates to the process for identifying problems in comparative CAMS and earlier system data. This process appears to (be relatively *ad hoc* and) rely on differences in the compared data being relatively large. There is clearly some risk that important issues could have been missed because, in the 2019 dataset, key differences are relatively small and are not recognized as significant, when in another year the differences could be substantive.

e. Methods for imputing effort, area, and gear when such data are missing

The approaches to imputing missing data (principally area, effort, and gear type) used for the CAMS are appropriate for application in quota management – but may not be adequate for use in stock assessments. While there is a reasonably large component of imputation at present, most of this will be made redundant when a UTID is introduced.

Where ratios are used, including drawing on data from previous years, to understand bycatch and discards, alternative modelled approaches exist and have been found to be superior. For example, the use of modelled relationships allowed additional covariates and are preferred to the use of ratios (Finucci et al., 2019). This is not a new issue as Zhou (2016) also recommended using modelling, including with Bayesian inference, in an earlier CIE review. It is perhaps worth revising this issue to ensure that the best approaches are used.

f. Approaches to handle conflicts across data sources (e.g., area 514 reported on vessel trip report (VTR) but observer on the trip reports areas 514, 521, and 525)

The handling of data conflicts between different data sources was well-described and the approaches were considered largely appropriate. One area of minor concern was that the CAMS approach to correcting some data, such as for misreported fishing areas, had the potential to introduce some bias into the final datasets. This was considered a minor issue given the approach to data quality control, plus the number of such errors appears to be relatively small. A review of the range of data conflict types, including for accidental miscoding vs intentional misreporting (e.g., in area), is needed. Future developments in electronic reporting may lead to a reduction of such errors.

The correction of missing area information currently uses a limited range of data, and while reasonable effective, including a wider range of data types should be able to both reduce the amount of missing area data and improve the accuracy of the areas allocated under the current system. A range of other data types are used to correct missing or misreported areas in other jurisdictions, and some of these may work here too. For example, consider including and comparing the missing or misreported area with:

- (i) areas fished on other trips by the same vessel adjacent in time;
- (ii) other vessels fishing the same target at the same time and also landing at the same port; and
- (iii) VMS data for the same and/or other vessels fishing the same target at the same time and also landing at the same port, on the same or adjacent days.

There are processes to trap reporting errors. It was unclear whether these processes were expressly used to identify numbers of errors by type (e.g., fishery, fleet, gear-type, location) in such a way as to be able to both monitor performance and for use in driving improvement in reporting accuracy. If done well, such an initiative could progressively reduce the scale and importance of reporting errors, thereby improving data quality and potentially reducing the cost of error correction. In a similar vein, it may be appropriate to set a goal of continuing reduction in the quantity of imputed data over time. This would result in measurable improvement in reporting quality, reflecting general improvement in data entry and checking processes, and with reduced effort needed in the imputation of missing or mismatched data. Such a process would require appropriate, probably annual, monitoring data to be collected and reported.

g. Utility of CAMS outputs for operational use, particularly for the primary uses – quota monitoring and stock assessment

In summary, while there remain reservations about the adequacy of the comparative testing (ToR 1d), it is concluded that implementation of CAMS as a single source of fisheries data for stock assessment and quota management for the NEFSC and GARFO is the most appropriate course of action at this time.

The overall goal of the CAMS implementation, to deliver a single, unified source of fisheries related data for multiple organisations, has many positive aspects and is fully supported by this reviewer, provided sufficient flexibility in delivering output data is retained to enable bespoke analyses and allow species specific data sets to be created and accessed. To put this another way, having a common data source is a great idea and a completely appropriate objective, with the following provisos:

- (i) users understand how, where and which data have been estimated or imputed; and
- (ii) users have the option of not using the common source data but extracting other, raw data from CAMS to support analyses and methodological development.

An example of an analysis type that may need to avoid using estimated, average or imputed data would be in the provision of data to develop a commercial CPUE as a biomass index, where using imputed data would not be appropriate.

The CAMS is still in its developmental phase and this should be recognized in the way it is implemented, noting that changes to the system and data outputs are likely to be more frequent in the early stages of implementation than later on. Further, extensive and detailed comparative testing should be explicitly incorporated into the implementation program for the CAMS.

The methodologies for combining and imputing missing data, and approaches to handle conflicting data, are clear and well described. The appropriateness of these processes depends on how the end data are to be employed. For example, some imputed data would be inappropriate for use in stock assessments (e.g., CPUE, see above). Thus, all altered, amended or imputed data must be described and clearly identifiable within the data structure and their use in aggregate output data clearly flagged to ensure end users can select and use only the appropriate data for their specific needs.

Parts of the CAMS are likely to require more development than others in future. This may be particularly true of those components that are yet to be developed, incorporating small and harder to track datasets. Provided that the same careful approach to development that has been used to date is followed in future, this should not create any untoward difficulties.

The eventual utility of the CAMS is, in part, dependent on end users having sufficient knowledge of the system and being able to access user group-appropriate documentation. Currently, there appears to have been limited effort to identify all potential user groups or to engage with user groups outside of the core project. To meet an objective of wide uptake of what should be a highly valuable resource, more effort needs to be directed identifying potential user groups and engaging with them.

Operational application of a single CAMS dataset across a range of uses is clearly beneficial for a number of reasons. However, some applications will have specific needs that may not be so well matched to the single data source. The need for scope to do different things in preparing data for stock assessments and not to have to use imputed data has already been flagged. A similar issue is likely to arise when dealing with some protected species data, where, for example, there may be a need to use a very specific measure of fishing effort when considering some protected species interactions with longline gear. An example of this would be the need to use hook numbers per event, hour, day or trip, rather than just days (or hours) fished when considering seabird and marine turtle captures. The key message here is to seek to retain sufficient flexibility to support multiple users' requirements, but where such needs cannot be met, make it absolutely clear that the CAMS may not be the best source of data for some user purposes. This issue could be mitigated with some *in situ* content on the CAMS, written in plain language, that explains any limitations or exceptions and, where appropriate, redirects users to alternative data sources or help.

2. Recommend future enhancements for CAMS noting whether each is an immediate need or a longer-term project. Consider the following aspects in your review:

a. Change management and version control

The CAMS Team provided detailed information about the approach to version control currently employed and described an outline concept for a Change Control Board, probably located within the NEFSC, intended to oversee future development of the CAMS. The Review Panel noted the high quality of information provided by the CAMS Team and used to engage in a discussion with the Review Panel about possible future system developments. The current version control of CAMS from a technical developer perspective has been well set-up, using systems such as Jira, but lacks transparency and does not extend sufficiently to other users.

It was recognized that key challenges in system change management are implementation and the need to respond quickly to requests for change, noting that not all requests should be met, and not all requests for change will be of equal importance. It is particularly noted that there are strong links between this ToR and that pertaining to the reproducibility of results ([ToR 2h](#)).

As described, the Control Board appears to be an excellent approach to managing the demands of system change, while managing the inherent associated risks of the on-going development of a complex information technology system. The CAMS Team recognized the importance of the function of a Control Board, but there did not appear to be a timeline for setting up this function.

Some thought had been directed at the possible composition of the Control Board (or equivalent) by the CAMS Team, but this is in need of completion and implementation and would benefit from a consideration of drawing the membership from a wider constituency.

There are some additional risks associated with the CAMS that should also be considered, and in the context of system change management both GARFO and, to a less extent, NESFC may

have been, and will likely need to continue, to operate in areas that are not their core businesses. This is particularly true for some components, such as stakeholder engagement and communication. Managing these activities will likely need more resources and expertise in the immediate future, including the development of some form of communications plan to engage with both internal (mostly technical) and external (output) users.

Many users will need to be able to easily find the version identifier reference so that they can reference this directly in output data and analyses. This will be essential for at least some purposes, including for stock assessments and other science publication applications. System changes and data changes have immediate and on-going implications for users and in enabling reproducibility of results. It is, therefore, necessary for users to be able to add a data output date stamp and CAMS data version number to all data drawn from the system. User and data source partner requirements in this area need better definition.

The appropriate management and control of the data change process within the CAMS for this ToR is directly linked to ToR 2h (reproducibility of results).

b. Test environment

The current testing environment was fully described and appears to be effective in informing on implications of system change, as well as being able to analyse and investigate innovations in data processing prior to full incorporation into the CAMS.

This is a necessary function, and the processes need to be fast and efficient, noting that other, downstream systems and functions will rely of the quality and integrity of the CAMS-sourced data. There will be an on-going need to prevent growth in unnecessary bureaucracy and running costs.

Challenges in testing include the scale (quantity) of the data, complexity of the databases, and the incorporation of new data streams.

Overall, the test environment described appeared appropriate in scale and scope, and robust to the current and immediate future needs. And it should be continued with occasional review of fitness for purpose.

c. Inclusion of a Universal Trip Identifier once it has been developed and implemented

The various agencies involved with the management of fisheries data have been considering options around developing a Universal Trip Identifier (UTID) that would provide a unique code for each fishing trip. Even though both GARFO and NEFSC fully recognize the benefits such a development would bring, this appears to have been a very long-term issue for NOAA and has been under consideration for some years.

The advantages of having a UTID are substantive and clear. These include simplifying the matching processes and improving the ability to link and cross-check all fishery-dependent

data as they arrive into any system, including CAMS. The CAMS Team reported that the CAMS is ready to use a UTID when one becomes available.

It is recognized that there are substantive challenges in developing a UTID system that will be broadly acceptable, that everyone can use, does not create insurmountable issues in other systems, and in eventually implementing the UTID. However, it is also clear that not having such a system in place for the CAMS is driving considerable processes of data checking, correction, substitution and imputation, that are costly, inefficient and leads directly to lower quality fishery dependent data than would be achieved with a UTID.

Implementation of a UTID is by far the most far reaching and urgent improvement need identified in this review.

Other fishery jurisdictions are already moving beyond trip identification to individual fishing event identification that enable tow-by-tow or set-by-set analyses. This finer level of identification also allows for easier and more precise linkage between different components of some of the fishery-dependent data. For example, a unique fishing event identifier would enable linking an observer-derived age- or length frequency to a specific fishing event and location. Such improvements offer potentially considerable advantages when combined with new approaches such as some of the spatial analyses that can now be applied to fishery dependent data. While hopefully delivering a UTID for these fisheries, it may be advantageous to consider the practicality of developing, in tandem or at a later date, a unique fishing event identifier and preparing the CAMS for use of such a development. Should there be a consideration of developing a unique fishing event identifier, this should in no way be allowed to delay the introduction of a UTID, which is urgently needed.

The innovation brought by a UTID (and a unique fishing event identifier), linked to an ability to access some relevant parts of the fishery-dependent data (e.g., fisher access to data from their own fishing activities) may also be of interest to some other potential user groups. These would likely include, fishers and the seafood supply chain, in order to support their growing requirements to demonstrate provenance and transparency.

d. New sources of data

The CAMS already draws data from multiple sources and has managed to incorporate new data sources with relative ease but not without issues, including recently, length data derived from electronic monitoring.

The pace of on-going technological development, including in the fields of digital imaging, artificial intelligence, and machine learning, continues to accelerate and will likely produce new types and sources of data over coming years. This was fully recognized by the CAMS Team, who also noted the difficulty of predicting what was coming and preparing for it in advance.

It is clear that new types and sources of data will continue to appear. Some of these will be difficult to predict or prepare for, others less so. In order to manage this in the future, the CAMS will need to retain a certain degree of flexibility while not compromising its existing

strong, core functionality. There are clearly several factors to be addressed in considering new sources of data:

- (i) identifying potential new data sources;
- (ii) determining whether such new data sources have any interest to the CAMS or the CAMS user groups; and
- (iii) if of interest, how and on what timescale should they be incorporated into the CAMS?

The proposed Control Board is clearly the most appropriate body to manage (ii) and (iii), and should also be placed to oversee but not necessarily deliver (i), which may be more appropriate to a development of the small, probably virtual, technical horizon scanning group.

In trying to address the challenges in this area, the existing team structure and approach appears relatively well suited to the task. However, noting that seeing change coming has been identified as something of a weakness, some other avenues may warrant consideration, including the small, virtual, technical horizon scanning group suggested above to support the Control Board.

Management systems may also need adjustment as new data and analyses come on-stream, or as advice structures and needs change but the CAMS will have some limitations on what change it can both drive and accommodate.

There was some discussion about the overall scope of the CAMS, and limits to data inclusivity into the system. The principal concern was one of a potential overexpansion of CAMS to include increasingly wide data sources and, in so doing, permit mission-creep. There was specific discussion about some environmental data sources, including state of the ecosystem data¹. It was agreed that these types of data should not be included into the CAMS, and that this has already been recognized is probably sufficient protection to prevent such data being brought in in future. As discussed, it is expected that this issue will, in future be overseen and managed by the Control Board function and no recommendation is provided.

e. User tables or interfaces

There is already a large number of user groups accessing data from the CAMS, some of whom will have substantively different data requirements. Not all users will want to link multiple tables in the CAMS, with some users will just requiring a simple table of results or a simple way to get the piece of information they need. Other users will want to dive deeply into the available data, including data drawn and cross-matched from numerous, different data sources.

Some of these user outputs (tables) are already known and understood; others are yet to be defined, and there will likely be a continued need to innovate to meet new, and changes in existing, user requirements.

¹ <https://www.fisheries.noaa.gov/new-england-mid-atlantic/ecosystems/state-ecosystem-reports-northeast-us-shelf>

Finding a balance between providing simple tables and having users enabled to extract data themselves may be challenging. Any move to enable more access will raise issues of control and management of access, security and liability. There are plenty of examples, both good and bad, of managing access to a mix of confidential and non-confidential data held in a single database, that can be drawn on to ensure a practical, low-risk, workable system is designed.

There needs to be a focused effort to understand user requirements and expectations, informed through user-experience (UX) research. It is likely that having a public, user-accessible library of table types and the code to generate such tables will be necessary (a key area for UX testing). All new users should be supported to engage with and benefit from the CAMS development, specifically including fishers, their representative bodies, and the seafood product supply chain.

f. Data dictionary and entity relationship diagrams

Users need to know what data are held in the CAMS (especially new users), what is in the standardly produced output tables, how key data and tables relate to each other, etc.

The existing Data Dictionary and Entity Relationship Diagrams provide such help for internal users already. Providing access to similar material but in a more user-friendly form (UX informed), will be of great assistance to external users and will almost certainly benefit uptake of the CAMS.

The existing Data Dictionary is pretty well developed; the Entity Relationship Diagrams need further development. To date this task has not been completed due to the necessity of many changes to table structures during development. Keeping these important resources up to date will become less problematic as the CAMS structure becomes more established.

It would be appropriate to keep all of this material, including legacy and replaced material, on-line, for reasons of efficiency and cost control. This should be considered soon, prior to the loss of any such information.

This material appears to be relatively well understood within CAMS, although there is a need to formalize for public and user access, specifically considering simpler presentation and language for less technical users.

g. Feedback to data providers to improve overall accuracy and utility of data

Bringing together all the data sources in the CAMS allows cross-checking between multiple data sources. QA/QC checks already exist and are in place or can be quickly implemented. The key challenge with QA/QC is to determine the correct values and modify the incorrect data quickly and efficiently when conflicts are found, ensuring that all original data are also kept for back checking.

The term 'Feedback' in the ToR comes across as a bit heavy handed, especially within a federal-state relationship. Developing a partnership approach with data stewards, so as to enable and

support a dialogue that seeks cross-the-board improvement in data quality is likely a better working framework. For example, it would be better to seek to develop a partnership aimed at improving the quality of input and output data, for all data providers and users working with the CAMS. Data providers will have suggestions to improve problem areas. The review found that this was already happening to some extent.

h. Enhancements for reproducibility of results and/or enhanced utility in assessments, quota monitoring, and research

Weekly updates of data mean that downloading data or output tables at different times can produce different results, especially with respect to quota management functions. While this is not necessarily a problem for quota management, as this is the norm with these data types, it is more likely that this could be an issue for other users. Reproducibility is a high priority for stock assessment work and scientific publishing.

Most users will want to be able to reproduce results easily (for scientific and legal reasons) or at least be able to understand and explain why there are differences. Key challenges in this area are the sheer size of data holdings and the speed at which data come in, undergo QA/QC, are modified, and updated.

There is a raft of issues to consider, including that data from some sources may not always be available to recreate historic datasets and the scale of data is growing rapidly. For example, digital image data from camera-based electronic monitoring systems generates more raw data than can be stored in the medium- or long-term. The CAMS systems need to be robust to these types of issues in an open and transparent way.

In addition, how far back in time users may require access to data will vary with the user and the use to which the data are put.

The onus need not solely be on the CAMS to address these issues. The end users also have the responsibility to support their own requirements and already do so. For example, stock assessments frequently, as part of best practice, archive the data sets used in each assessment. The key is for the CAMS to understand their users' requirements and, where these cannot be met, that a dialogue takes place to enable the user and/or the CAMS to take appropriate actions. This would be difficult to achieve without adequate understanding of user needs, which would be best addressed through UX research.

Clearly, standard, established database management approaches should continue to be followed. Keeping original data, or at least sufficient information, to enable data reconstruction is strongly advisable. There are technologies that can assist with these types of issues to minimize data storage requirements (e.g., smart back-up systems that only back-up changed data); this was not specifically discussed during the review.

There are clear links here to [ToR2a](#) (Change management and version control).

Other identified issues

Communication and outreach

The review found that consideration of outreach and communication had been considered during the development of CAMS, but had gotten lost as the pace of development quickened as the project moved towards conclusion and use. The CAMS Team recognized that this was an obvious need and would need to be readdressed for the next phases of development, when more external engagement was expected. The Team notes their appreciation for a number of suggestions in this area made during the review, and these suggestions are reflected in the recommendations. The CAMS Team did acknowledge the challenge of how best to address these issues, especially given limited resources.

One possible route is to provide useful and usable output to a range of users (including fishers and the seafood supply chain), enabling these users to become proactive in engaging with the CAMS Team. Use of existing routes, including through the State and Council structures, should be continued and expanded where necessary. There should be a focus on online tools, including social media, to manage costs, but piggybacking on other meeting opportunities should not be overlooked.

The key missing component is an adequate understanding of who all of the potential users are and what their user requirements are, and what are the best methods of engaging with them. To adequately address this, UX research will be required and probably fairly urgently, specifically including seeking information about how current users and potential users would wish to be communicated with, and about what aspects of the CAMS they are interested in.

In summary, a new look at who (users, public, funders) to communicate with, about what aspects of the CAMS, how frequently, and the mode of communications should be conducted is urgently needed. This research should then, clearly, drive the development of a communications plan.

Recommendations

The following recommendations for the Catch Accounting and Monitoring System are those considered by this CIE peer reviewer to be appropriate.

In addressing the need to prioritize recommendations, as required by the ToR, I have broadly followed the approach developed by the Review Panel for the Panel Report. This was considered an approach that is appropriate to the need. It is described in Table 1.

Table 1. Prioritization of recommendations by importance and urgency of implementation.

Rating	Description and timescale
--------	---------------------------

Immediate – critical or high priority	Essential to support an operational CAMS; ≤1 year
Near-term – important priority	Needed to improve CAMS in near-term; 1-2 years
Longer-term – strategic priority	Important but not urgent, as CAMS evolves; 2-5 years

Highest priority IMMEDIATE recommendations

1. Implement a Unique Trip Identifier (UTID). This will greatly simplify the necessary cross-matching of fisheries data, will reduce the resources needed for replacing missing data by imputation and other means, and will improve the overall quality of the data. This is the highest priority recommendation made in this review, noting that delivering this outcome is unlikely to be within sole control of the CAMS project. Linked to recommendations [Tor 1e \(i\)](#) and [Tor 2c \(i\)](#).
2. Extend the period of comparative testing between the CAMS and the legacy GARFO and NEFSC databases back to at least 2018, and preferably to 2017, to evaluate potential interannual differences in data comparisons. Linked to [Tor 1d](#).
3. Review the current approach to the management of data and information privacy, and electronic security, especially for third-party data sources in preparation for the wider integration of such data. Linked to [Tor 1c](#).
4. Develop a focused program to improve the understanding of all current and potential user requirements and expectations, informed through user-experience (UX) research to support current and future CAMS developments. This cuts across many of the identified ToRs in this review, including ToRs [1a \(ii\)](#), [1g \(iv\)](#), [2e \(ii, iii and v\)](#), [2f \(ii\)](#), [2h \(i\)](#) and [Communications and Outreach \(i\)](#).
5. Develop a detailed Outreach and Communications Plan, using the outputs from recommendation 4 above. This cuts across many of the identified ToRs in this review.

Recommendations against each ToR

ToR 1: Comment on the ability of CAMS to provide a single source of commercial fishery data for users in both GARFO and NEFSC (e.g., for quota monitoring, stock assessment, socio-economic analysis, ecosystem assessment, protected species bycatch assessment, and research).

a. Documentation at both the conceptual and technical levels

- (i) Improvements to the tracking and documentation of system changes should be made. These should include full documentation of historical and future system developments (enabling bug and error checking), checking of historical outputs (system compatibility), and planned access to key documentation (legacy and current) by users. [NEAR-TERM]
- (ii) Support documentation for all identifiable end user groups needs to be developed, supported by UX testing. [NEAR-TERM]

b. Data source contributions, including the smaller and harder to track data sources (e.g., state of Maine herring data)

- (i) Develop a specific, time-bound implementation plan for incorporating data from new data sources, including smaller and harder to track data sources. [NEAR-TERM]

c. Processes to combine data sources

- (i) Review the current approach to data and information privacy and electronic security, especially for third-party data sources in preparation for the wider integration of such data. [IMMEDIATE]

d. Comparisons of CAMS outputs with landings and discards provided from previous quota monitoring and stock assessment approaches

- (i) Extend the period of comparative testing between the CAMS and the legacy GARFO and NEFSC databases back to at least 2018, and preferably to 2017, to evaluate potential interannual differences in data comparisons. [IMMEDIATE]
- (ii) Further explore the discard component comparison of the CAMS and legacy systems to better understand and define what could be potentially important discrepancies evident between the CAMS and previous discard handling approaches. [IMMEDIATE]

e. Methods for imputing effort, area, and gear when such data are missing

- (i) Implement a Unique Trip Identifier (UTID). This will greatly reduce the resources needed for replacing missing data by imputation and other means and will improve the overall quality of the data. [IMMEDIATE] linked to [ToR 2c](#).
- (ii) Review alternative approaches to using ratios to inform on estimation of bycatch and discards when missing, so as to ensure that the best available approaches continue to be used. [NEAR-TERM]

f. Approaches to handle conflicts across data sources (e.g., area 514 reported on vessel trip report (VTR) but observer on the trip reports areas 514, 521, and 525)

- (i) Review the range of data conflict types, including accidental miscoding vs intentional misreporting (e.g., in fishing area) and quantify the risk of introducing bias into corrected datasets in the way that data are currently corrected. [LONGER-TERM]
- (ii) Explore using a wider range of data sources to correct possible erroneous or missing location data, including, for example, (a) areas fished on other trips by the same vessel adjacent in time; (b) other vessels fishing the same target at the same time and also landing at the same port; and (c) VMS data for the same and/or other vessels fishing the same target at the same time and also landing at the same port, on the same or adjacent days. [LONGER-TERM]

g. Utility of CAMS outputs for operational use, particularly for the primary uses – quota monitoring and stock assessment

- (i) While there remain some reservations about the adequacy of the comparative testing ([ToR 1d](#)), addressed with recommendation [ToR 1d \(i\)](#), it is recommended that implementation of CAMS as a single source of fisheries data for stock assessment and quota management for the NEFSC and GARFO is progressed at this time. [IMMEDIATE]
- (ii) Conducting further, extensive and detailed comparative testing should be explicitly incorporated into the implementation program for the CAMS as per recommendation [ToR 1d \(i\) and \(ii\)](#). [IMMEDIATE]
- (iii) While developing the CAMS as a single source of commercial fisheries data for the Greater Atlantic Region, seek to retain sufficient flexibility to support multiple users' requirements, especially where the use of replaced or imputed data would be inappropriate. [NEAR-TERM or IMMEDIATE]
- (iv) Work to proactively identify all potential user groups to facilitate engagement, definition of output requirements, and the conducting of UX testing. [NEAR-TERM]

ToR 2: Recommend future enhancements for CAMS noting whether each is an immediate need or a longer-term project.

a. Change management and version control

- (i) A Control Board (or equivalent function) to oversee the process of system change for the CAMS should be set up as a matter of urgency. [IMMEDIATE]
 - As part of setting up a Control Board, the following components should be explicitly addressed:
 - consider whether an organizational or a fully independent Chair would deliver the best outcomes for change management and a robust system;
 - consider whether the membership of the Control Board should be drawn not only from GARFO and NEFSC but from a wider constituency, including for example, other end users, fishers (or their representative organisations), and public good organisations (e.g., NGOs, academia).
 - The need for specialist support groups (e.g., for new data scanning, recommendation [ToR 2d](#)).
- (ii) Develop a communications plan to engage with all the CAMS output users, this will include internal (likely mostly technical) and external users. Link to Communication and Outreach [Plan](#). [IMMEDIATE]
- (iii) Improve the understanding of user and data source partner requirements with respect to the CAMS. This could be part of a larger UX work package. Links to multiple ToRs. [IMMEDIATE]

b. Test environment

- (i) The current approach to a test environment is appropriate and should continue to be applied, with on-going or occasional review of fitness for purpose. [IMMEDIATE]

c. Inclusion of a Universal Trip Identifier once it has been developed and implemented

- (i) Implement a Unique Trip Identifier (UTID). This will greatly reduce the resources needed for replacing missing data by imputation and other means and will improve the overall quality of the data. [IMMEDIATE] linked to the recommendation under ToR 1e.
- (ii) As the introduction of a UTID will increase the usability and value of some of the fishery data to fishers and the seafood supply chain, it is recommended that consideration be given to how such data may be made easily accessible to potential users (given appropriate permissions and authorities).[NEAR-TERM]
- (iii) Consider the value of developing, in tandem with the UTID or at a later date, a unique fishing event identifier, and also preparing the CAMS for use of such a development. [NEAR- or LONGER-TERM]

d. New sources of data

- (i) Consider the need for the development of a small, probably virtual, technical horizon scanning group to support the Control Board in identifying potential new data sources. [IMMEDIATE or NEAR-TERM]

e. User tables or interfaces

- (i) Develop, in collaboration with other federal, state and regional agencies, industry, and other organizations, lists of current and potential end users and their anticipated access and data requirements. [IMMEDIATE]
- (ii) Develop a focused program to improve the understanding of all current and potential user requirements and expectations, informed through user-experience (UX) research to support current and future CAMS developments. [IMMEDIATE]
- (iii) Develop a public, user-accessible library of table types, contents descriptions and the code to generate such tables, informed through user-experience (UX) research. Links to multiple ToRs. [IMMEDIATE]
- (iv) Develop an approach for a public user registration and login system for controlled access to appropriate parts of the CAMS data. [NEAR-TERM]
- (v) Actions to support all new users to engage and benefit from the CAMS development should be developed. This should specifically include fishers, their representative

bodies, and the seafood product supply chain. This process should be informed by UX research. Links to multiple ToRs. [NEAR–TERM]

- (vi) Develop strategies for on-going engagement between users and the CAMS systems to proactively monitor changes in user requirements (see recommendations for [ToR 1a](#)). [LONGER–TERM]

f. Data dictionary and entity relationship diagrams

- (i) Continue to develop and update the existing Data Dictionary and Entity Relationship Diagrams. [NEAR–TERM]
- (ii) Develop similar material to the Data Dictionary and Entity Relationship Diagrams for non-technical, particularly external users, and do so in a more user-friendly, plain English form (informed by UX research). [NEAR–TERM]
- (iii) Plan to keep all information on legacy and replaced material, updates and version control available on-line, to enable back-checks to be conducted by all users. [IMMEDIATE]

g. Feedback to data providers to improve overall accuracy and utility of data

- (i) Ensure that the current approach to monitoring and improving data quality further develops as a partnership between the CAMS and those providing and using the data, especially with the data stewards. [NEAR–TERM TO LONGER–TERM]

h. Enhancements for reproducibility of results and/or enhanced utility in assessments, quota monitoring, and research

- (i) Develop guidance for all users on when and how the CAMS data are updated or changed, including replacement of erroneous data and imputation of missing data. The immediate priority should be to support the key data users, and so this guidance should focus on quota management and stock assessment functions in the first instance, being expanded to cover other users progressively. See also recommendations for [ToR 2a](#). [IMMEDIATE to NEAR TERM]

Other identified issues

- **Communications and outreach**

- (i) Develop a comprehensive Communications and Outreach Plan covering all current and potential users, clarifying what the CAMS does and does not do. This should also address user requirements and expectations of, with whom, the mode, what information, and how frequently communications are made. Link to recommendations for [ToR 2a](#). [IMMEDIATE]

Appendix 1: Bibliography

CAMS Review Documents

Greater Atlantic Regional Fisheries Office (GARFO). 2022. Length Frequency Distributions.

Hocking, D., Lanning, J.M., Galuardi, B., Linden, D., McAfee, B. 2023. MAPS: Production system for matching and monitoring catch at the Greater Atlantic Regional Fisheries Office. R package version 0.5.1-9000.

Legault, C., Adams, C., Boucher, J., Burgess, L., Chute, T., Hu, L., Lucey, S., Wigley, S. 2022. CAMS Discards Comparison.

Linden, D. and Legault, C. 2022. Exploring Contamination of Discard Estimates.

Northeast Fisheries Science Center (NEFSC) Review of CAMS Landings, Value, and Effort. February 2022; 234p.

Northeast Fisheries Science Center Review (NEFSC) of CAMS Discards. November 2022; 22p.

Background Documents

Discard Methodology: <https://www.fisheries.noaa.gov/new-england-mid-atlantic/science-data/discard-methodology>

Northeast Fisheries Science Center Data Collection Program Review:

<https://www.fisheries.noaa.gov/national/about-us/noaa-fisheries-science-program-review>

Standardized Discard Reporting Methodology:

<https://www.fisheries.noaa.gov/resource/data/annual-discard-reports-northeast>

Lanning, J.M., Hermsen, J., McAfee, B., Linden, D., Sullivan, J., Caless, D., Galuardi, B., Carbonneau, W. 2018. Data Matching and Identification System (DMIS). 32p.

Linden, D. 2021. A predictive model of discarded catch that leverages self-reporting and electronic monitoring on commercial fishing vessels. 23p.

Northeast Fisheries Science Center. 2008. Appendix to the Report of the 3rd Groundfish Assessment Review Meeting (GARM III): Assessment of 19 Northeast Groundfish Stocks through 2007. Northeast Fisheries Science Center, Woods Hole, MA, August 4-8, 2008. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 08-16; 1056p.

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Wigley, S. Hersey, P., Palmer, J. 2008. A description of the allocation procedure applied to the 1994 to 2007 commercial landings data. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 08-18; 61p. <http://www.nefsc.noaa.gov/nefsc/publications/>

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Zhou, S. (2016) Report for Review of Cumulative Discard Methodology. CIE Review Report. 21pp. <https://www.st.nmfs.noaa.gov/science-quality-assurance/cie-peer-reviews/cie-review-2016>

Finucci, B.; Edwards, C.T.T; Anderson, O.F.; Ballara, S.L. (2019). Fish and invertebrate bycatch in New Zealand deepwater fisheries from 1990–91 until 2016–17. New Zealand Aquatic Environment and Biodiversity Report No. 210. 77 p.
<https://fs.fish.govt.nz/Doc/24680/AEBR-2019-210-Bycatch-in-deepwater-fisheries.pdf.ashx>

Appendix 2: 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**

***Catch Accounting and Monitoring System (CAMS)
January 17-19, 2023***

Background

Prior to the development of the Catch Accounting and Monitoring System (CAMS) project, the Northeast Fisheries Science Center (NEFSC) and the Greater Atlantic Regional Fisheries Office (GARFO) developed and maintained two parallel systems for catch monitoring and accounting. Mission needs for quota monitoring led to GARFO operating one system, while the mission needs for stock assessments and other research activities led to the NEFSC operating the other system. The two systems each integrate data across a wide array of fishery information systems, and each approaches integration and record matching slightly differently, resulting in different outputs that have raised and continue to raise internal and external stakeholder concerns. Additionally, the two independent systems require significant maintenance and upgrading as regulations and data streams change; which illustrates the maintenance of two systems is an inefficient use of resources and is no longer an effective tool to provide the best information for science and management actions.

To address both sets of mission needs and remove system siloes and duplicative operational costs, the NEFSC and GARFO jointly sponsor the development and implementation of the CAMS project. The envisioned end-state of the project is a single comprehensive source for all U.S. northeast commercial fisheries catch (landings and discards) for quota monitoring, stock assessments, protected resources estimation, ecosystem modeling, and other needs of GARFO and NEFSC in a fully documented relational database with appropriate user views and tables. The logic and algorithms supporting CAMS build from previous knowledgebase, while incorporating updated matching and linking processes across the various fishery data sources.¹² The outputs of CAMS are an integral asset to the processes and analyses of NEFSC and GARFO missions; therefore, a formal scientific peer review is requested of CAMS components and products to ensure credibility and relevance. External scientific peer reviews have been and continue to be essential to strengthening scientific quality assurance for fishery conservation and management actions.

¹ Northeast Fisheries Science Center, "Appendix to the Report of the 3rd Groundfish Assessment Review Meeting (GARM III)," Northeast Fisheries Science Center reference document ; 08-16, 2008, <https://repository.library.noaa.gov/view/noaa/5210>

² Northeast Fisheries Science Center, "Summary Report: Northeast Fisheries Science Center Science Data Collection Program Review," Stock Assessment Data Collection Program Review, August 5-8, 2013, https://apps-nefsc.fisheries.noaa.gov/nefsc/program_review/pdfs/nefsc_reviewer_summary_report.pdf

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

Scope

The formal scientific peer review of CAMS is recommended to follow the same procedures as research track assessment peer reviews, which include 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 (NRCC) stock assessment process. The process includes assessment development and report preparation, assessment peer review, public presentations, and document publication. The results of the requested peer review will be incorporated into future CAMS development iterations as well as inform stock assessments that serve as the basis for developing fishery management recommendations.

The purpose of this CIE review is an external peer review of the CAMS components: data integration across multiple sources, new methods developed for the project, and documentation of the system. This performance work statement (PWS) provides additional details and clarification of peer review requirements in the following sections: **Annex 1:** CAMS landings and discards Terms of Reference, which are the responsibility of the analysts; **Annex 2:** a draft meeting agenda; **Annex 3:** individual independent review report requirements; and **Annex 4:** peer reviewer summary report requirements.

Requirements

Pursuant to CIE standards, NMFS requires three reviewers to participate in the panel review. Either the New England or Mid-Atlantic Fishery Management Council's Science and Statistical Committee will provide the review panel chair, who is in addition to the three reviewers. Although the chair will be participating in the review, the chair's participation (i.e. labor and travel) is not covered by this CIE review engagement.

Each reviewer will write an individual review report in accordance with the PWS, OMB Guidelines, and the provided terms of reference (TOR). Modifications to the PWS and TORs cannot be made during the peer review, and the Contracting Officer's Representative (COR) and the CIE contractor shall approve any modifications prior to the peer review. All TORs must be addressed in each reviewer's report. The reviewers shall have expertise and experience with developing large-scale databases that require merging of multiple component databases. In addition, the reviewers should have working knowledge and recent experience in the use and application of fishery-dependent data in stock assessment or quota monitoring.

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

Tasks for Reviewers

- Review the background materials and reports prior to the review meeting
 - Two weeks before the peer review, the project contacts 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 scientists to facilitate the review, to provide any additional information required by the reviewers, and to answer any questions from reviewers
- Conduct an independent peer review in accordance with the requirements specified in this PWS and TORs, 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 panel's summary report.
- Each reviewer shall assist the 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
- Individual and panel reports each should explain whether each CAMS landings and discards TOR was or was not completed successfully during the peer review meeting, using the criteria specified below in the "Tasks for Peer Review Panel."
- During the meeting, additional questions that are not in the TORs, but that are directly related to the CAMS 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 TORs or on additional questions raised during the meeting.

Tasks for Review panel

- During the peer review meeting, the panel is to determine whether each TOR was or was not completed successfully. 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 CAMS data outputs are developed and implemented appropriately, processes and assumptions involved in CAMS are scientifically valid, the resulting data provided are high quality, and the data are provided in a format that is appropriate for use in stock assessments and quota monitoring. Where possible, the Peer Review Panel chair shall identify or facilitate agreement among the reviewers for each TOR.
- 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 CAMS working group report, CAMS Landings and Discards, and CAMS documentation.

The 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 TOR and whether their opinions can be summarized into a single conclusion for all, or only for some of the TORs 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 be submitted directly to NEFSC and GARFO; it will not be submitted, reviewed, or approved by the contractor.

The contractor is required to use all appropriate methods to safeguard Personally Identifiable Information (PII).

Place of Performance

The place of performance shall be hybrid at the contractor’s facilities, the Northeast Fisheries Science Center in Woods Hole, Massachusetts, and the Greater Atlantic Regional Fisheries Office in Gloucester, Massachusetts, via WebEx video conferencing.

Period of Performance

The period of performance shall be from the date of award through March 2023. 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.

Milestone Date	Description
Within 2 weeks of award	Contractor selects and confirms reviewers
Approximately 2 weeks later	Contractor provides the pre-review documents to the reviewers
January 17-19, 2023	Panel review meeting
Approximately 2 weeks later	Contractor receives draft reports
Within 2 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.

Travel

No travel is necessary, as this meeting is being held remotely.

Restricted or Limited Use of Data

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

NEFSC Project Contact

Chris Legault, NEFSC Assessment Process Lead
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GARFO Project Contact

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Annex 1. CAMS Landings and Discards Terms of Reference

1. Comment on the ability of CAMS to provide a single source of commercial fishery data for users in both GARFO and NEFSC (e.g., for quota monitoring, stock assessment, socio-economic analysis, ecosystem assessment, protected species bycatch assessment, and research). Consider the following aspects in your review:
 - a. Documentation at both the conceptual and technical levels
 - b. Data source contributions, including the smaller and harder to track data sources (e.g., state of Maine herring data)
 - c. Processes to combine data sources
 - d. Comparisons of CAMS outputs with landings and discards provided from previous quota monitoring and stock assessment approaches
 - e. Methods for imputing effort, area, and gear when such data are missing
 - f. Approaches to handle conflicts across data sources (e.g., area 514 reported on vessel trip report (VTR) but observer on the trip reports areas 514, 521, and 525)
 - g. Utility of CAMS outputs for operational use, particularly for the primary uses – quota monitoring and stock assessment

2. Recommend future enhancements for CAMS noting whether each is an immediate need or a longer-term project. Consider the following aspects in your review:
 - a. Change management and version control
 - b. Test environment
 - c. Inclusion of a Universal Trip Identifier once it has been developed and implemented
 - d. New sources of data
 - e. User tables or interfaces
 - f. Data dictionary and entity relationship diagrams
 - g. Feedback to data providers to improve overall accuracy and utility of data
 - h. Enhancements for reproducibility of results and/or enhanced utility in assessments, quota monitoring, and research

Annex 2. Draft Review Meeting Agenda
 {Final Meeting agenda to be provided at time of award}

CAMS Peer Review Meeting
January 17-19, 2023
 WebEx link: TBD
DRAFT AGENDA*

**All times are approximate Eastern Standard Time, and may be changed at the discretion of the review panel chair. The meeting is open to the public; however, during the report writing sessions we ask that the public refrain from engaging in discussion with the peer review panel.*

Tuesday, January 17, 2023

Time	Topic	Presenter(s)	Notes
9 a.m. - 9:15 a.m.	Welcome/Logistics Introductions/Agenda/Conduct of Meeting	Review Panel Chair, CAMS NEFSC Sponsors	
9:15 a.m. - 9:30 a.m.	Introductions		
9:30 a.m. - 10:30 a.m.	High-level Overview	Chris Legault	
10:30 a.m. - 10:45 a.m.	Break		
10:45 a.m. - 12:15 p.m.	Data Sources and Processes	Michael Lanning	
12:15 p.m. - 1:15 p.m.	Lunch		
1:15 p.m. - 3 p.m.	Data Sources and Processes (Continued)	CAMS Program Team	
3 p.m. - 3:15 p.m.	Break		
3:15 p.m. - 4:45 p.m.	Data Conflict Management	CAMS Program Team	
4:45 p.m. - 5 p.m.	Public Comment	Public	
5 p.m.	Adjourn		

Wednesday, January 18, 2023

Time	Topic	Presenter(s)	Notes
9 a.m. - 9:05 a.m.	Welcome/Logistics	Review Panel Chair	
9:05 a.m. - 9:20 a.m.	Follow-up from Day 1	Review Panel	

Time	Topic	Presenter(s)	Notes
9:20 a.m. - 10:50 a.m.	CAMS Stock Assessment Comparisons	CAMS Program Team	
10:50 a.m. - 11:05 a.m.	Break		
11:05 a.m. - 12:15 p.m.	CAMS Quota Monitoring Comparisons	CAMS Program Team	
12:15 p.m. - 1:15 p.m.	Lunch		
1:15 p.m. – 2:15 p.m.	New Estimations	CAMS Program Team	
2:15 p.m. - 3:15 p.m.	Operationalizing CAMS	CAMS Program Team	
3:15 p.m. - 3:30 p.m.	Break		
3:30 p.m. - 4:45 p.m.	TOR 1 Discussion	Review Panel	
4:45 p.m. - 5 p.m.	Public Comment	Public	
5 p.m.	Adjourn		

Thursday, January 19, 2023

Time	Topic	Presenter(s)	Notes
9 a.m. - 9:05 a.m.	Welcome/Logistics	Review Panel Chair	
9:05 a.m. - 9:20 a.m.	Follow-up from Day 2	Review Panel	
9:20 a.m. - 11:15 a.m.	Future of CAMS	CAMS Program Team	
11:15 a.m. - 11:30 a.m.	Break		
11:30 a.m. - 12:00 p.m.	Key Findings	Review Panel	
12:00 p.m. - 1:00 p.m.	Lunch		
1:00 p.m. - 5 p.m.	Report Writing	Review Panel	
5 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 TOR in which the weaknesses and strengths are described, and conclusions and recommendations in accordance with the TORs. 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 TOR even if these were consistent with those of other panelists, but especially where there were divergent views.
 - c. Reviewers should elaborate on any points raised in the 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

The main body of the report shall consist of an introduction prepared by the 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 research topic reviewed, the report should address whether or not each Term of Reference was completed successfully. For each Term of Reference, the Peer Reviewer Summary Report should state why that Term of Reference was or was not completed successfully. 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 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.

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

ASMFC - Atlantic States Marine Fisheries Commission
 CIE – Center for Independent Experts
 GARFO - Greater Atlantic Regional Fisheries Office
 MADMF - Massachusetts Division of Marine Fisheries
 MAFMC - Mid Atlantic Fisheries Management Council
 NEFMC - New England Fisheries Management Council
 NEFSC - Northeast Fisheries Science Center
 SEFSC - Southeast Fisheries Science Center
 SMAST - University of Massachusetts School of Marine Science and Technology

Panel and participant membership

As provided by NOAA hosting staff.

Name	Role / Affiliation
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Cate O’Keefe	Panel Chair (Independent)
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Edvin Fuglebakk	CIE Reviewer (Norway)
Steven Holmes	CIE Reviewer (New Zealand)
Geoff Tingley	CIE Reviewer (New Zealand)

Alex Dunn - NEFSC	Dan Hennen - NEFSC
Alex Hansell - NEFSC	Dan Linden - NEFSC
Amy Martins - NEFSC	Daniel Caless - GARFO
Andy Jones - NEFSC	Daniel Hocking - GARFO
Angela Forristall - NEFMC	David Gouveia - GARFO
Anna Webb - MADMF	David McCarron - NEFMC
Ashley Ascii - GARFO	Debra Duarte - NEFSC
Ben Duffin - SEFSC	Erich Druskat - MADMF
Ben Levy - NEFSC	Erin Kupcha - NEFSC
Benjamin Galuardi - GARFO	Geoff White - ASMFC
Brad Schondelmeier - MADMF	George Lapointe - George Lapointe Consulting
Brant McAfee - NEFSC	Heather Baertlein - SEFSC
Brian Linton - NEFSC	Holly McBride - NEFSC
Bridget Harner - NEFSC	J. Michael Lanning - GARFO
Cory Endres - NEFSC	Jamie Cournane - NEFMC
Cameron Day - NEFSC	Jason Boucher - NEFSC
Charles Adams - NEFSC	Jeff Kaelin - Lund’s Fisheries
Charles Perretti - NEFSC	Jenny Couture - NEFMC
Chris Legault - NEFSC	Jonathon Peros - NEFMC
Chris McGuire - The Nature Conservancy	Jose Montanez - MAFMC
Chris Tholke - NEFSC	Joshua Lee - NEFSC
Connor Buckley - NEFMC	Julie Beaty - ASMFC

Julie DeFilippi Simpson - ASMFC	Paul Nitschke - NEFSC
Karson Cisneros - MAFMC	Robin Frede - NEFMC
Kathy Sosebee - NEFSC	Russ Brown - NEFSC
Kiersten Curti - NEFSC	Sam Asci - NEFMC
Kristin Precoda - NEFSC	Sara Turner - GARFO
Kristopher Winiarski - GARFO	Sarah Cierpich - NEFSC
Larry Alade - NEFSC	Scott Schaffer - SMAST
Lee Benaka - NOAA S&T	Stephanie Weiss - NEFSC
Leona Burgess - NEFSC	Steve Cadrin-SMAST
Libby Etrie - Northeast Sector Service Network, Inc.	Susan Wigley - NEFSC
Maggie Ball - NEFSC	Tara Dolan - MADMF
Mark Terceiro - NEFSC	Taylor Compton - GARFO
Mary Hughes - NEFSC	Toni Chute - NEFSC
Michael Simpkins - NEFSC	Tony Hooper - Fish Resourcing
Michele Traver - NEFSC	Tony Wood - NEFSC
Nick Buchan - MADMF	Tori Luu – NEFSC

Other pertinent information from the panel review meeting

The draft Agenda (TOR Annex 3) was followed closely to enable on-line participants to join at appropriate times.