

# Comparison of Scientific Review Processes Used in the Determination of Best Scientific Information Available for Fisheries Management

## Comparación de los Procesos de Revisión Científica Utilizada para la Determinación de la Mejor Información Científica Disponible para la Gestión de la Pesca

### Comparaison de Différentes Méthodes D'examens Scientifiques Employées pour Évaluer les Meilleures Informations Disponibles pour la Gestion des Pêcheries

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#### ABSTRACT

Increasing legal demands in the conservation and management of living marine resources require high quality scientific information that is available in a timely manner. These management decisions must be based on the best scientific information available (BSIA), and scientific peer review is an important process in the determination of BSIA. The need for increased throughput to provide timely information and need for rigorous peer review standards are important considerations in the form of peer review to implement. The standards of scientific peer review and principles of what constitute the best scientific information available must be clearly established, while the degree of how rigorous the peer review depend on whether the science is established, emerging, or highly influential. For example, a routine assessment update should not require the same level of rigorous peer review as a benchmark assessment update or a controversial biological opinion. The Center for Independent Experts (CIE) conducts external peer reviews of scientific information for the National Marine Fisheries Service (NMFS) that satisfy rigorous peer review standards such as independence and lack of conflicts of interest. There are considerations in the form of the peer review, such as desk and panel reviews, in regard to the costs, timeliness, influence, and controversy of the science to be reviewed. The objective of this study is to compare the attributes of various forms of peer review used by selected fishing nations and intergovernmental organizations to provide guidance on how to improve the throughput of peer review processes while ensuring the integrity and credibility of scientific information for management.

KEY WORDS: Fisheries, fishery management, scientific information, peer review

#### INTRODUCTION

Over the past three decades, there have been important developments in environmental legislative requirements to improve scientific information for management decisions. The Marine Mammal Protection Act (1972) and Endangered Species Act (1973) in the United States (USA) were among the first environmental legislations to invoke that management decisions must be based on the “best available science.” The USA Magnuson-Stevens Fishery Conservation and Management Act (MSA) (Department of Commerce 1976) mandated “that the national fishery conservation and management program utilizes, and is based upon, the best scientific information available.” The 1996 reauthorization of the MSA further stated that “Conservation and management measures shall be based upon the best scientific information available.” The United Kingdom report entitled “Use of Scientific Advice in Policy Making” was the first effort to establish standards on scientific transparency to improve public trust (May 1997), and this was adopted by the European Commission (Commission of European Communities 2000). The Canadian report entitled ‘Science Advice for Government Effectiveness’ (SAGE) provided standards for improving the reliability of scientific information (CSTA 1999), and this was adopted the following year by Canadian Department of Fisheries and Oceans (Government of Canada 2000). The most comprehensive peer review standards to date was established by the Office of Management and Budget (OMB) Peer Review Bulletin (2005), authorized by the USA Data Quality Act (2001), which required peer review of influential scientific information disseminated by the USA federal government that affect policy decisions. The USA National Marine Fisheries Service (NMFS) has the MSA mandated responsibility to conserve and management living marine resources within the USA exclusive economic zone, and is presently revising the MSA National Standard 2 to establish national guidelines on the peer review of scientific information which recognizes that there are different forms of peer review.

The need to establish guidelines to improve the reliability and credibility of scientific information for policy decisions are necessary to enact more effective management measures, reduce costly litigation, and improve trust among stakeholders. The Center for Independent Experts (CIE) was established to provide independent peer reviewers to strengthen the science quality assurance of the NMFS scientific products (Figure 1), and the CIE reviewers are selected to meet independent, rigorous peer review standards (Brown et al. 2006). The increasing legal demands to conserve and manage marine living resources require higher quality and more timely scientific information; however, the cost and time associated with conducting peer reviews must not delay the increasing demand for timely delivery of the best scientific information

available for managers (Carmichael and Fenske 2011). For example, recent mandates to establish annual catch limits for all fishery management plans in the USA require an increase in the throughput of reviewing stock assessments (Witherell 2009), while ensuring the reliability and credibility of the best scientific information for policy making. The objective is to evaluate the attributes of various forms of peer review to address limitations in peer review capacity and the ability to produce timely scientific products for management.

**METHODOLOGY**

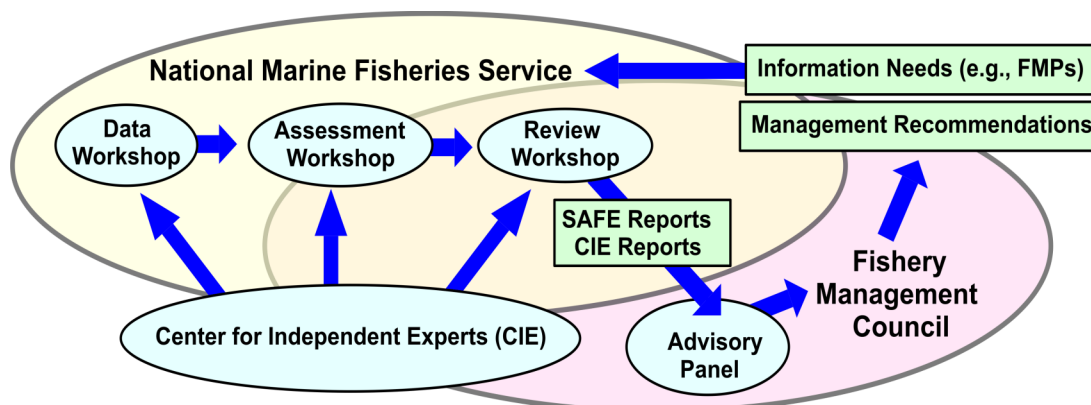
To evaluate the attributes of various forms of peer review, the standards for conducting scientific reviews must be understood. The OMB Peer Review Bulletin (2005) provides the most comprehensive peer review standards to date established for the dissemination of scientific information by the USA federal government that affects policymaking. The proposed MSA National Standard 2 guidelines (Department of Commerce 2009) for scientific information used in the conservation and management of marine living resources in the USA region adopts the OMB peer review standards, and these standards include criteria in the selection of reviewers:

- i) *Expertise and balance* — Peer reviewers must be selected based on scientific expertise and experience relevant to the disciplines of subject matter to be reviewed, including a balance in perspectives. The group of reviewers that constitute the peer review should have sufficiently broad and diverse expertise to represent the range of relevant scientific and technical perspectives to complete the objectives of the peer review.
- ii) *Conflict of interest* — Peer reviewers must not have any conflicts of interest with the scientific information, subject matter, or work product under review. Conflict of interest is any financial

or other interest that significantly impairs the reviewer’s objectivity or creates an unfair competitive advantage for a person or organization. Conflicts of interest include, but are not limited to, the personal financial interests and investments, employer affiliations, lobbying and advocacy activities, and consulting arrangements, grants, or contracts of the individual and of others with whom the individual has substantial common financial interests, if these interests are relevant to the functions to be performed.

- iii) *Independence* — Peer reviewers must not have contributed or participated in the development of the work product or scientific information under review. For peer review of products of higher novelty or controversy, a greater degree of independence is necessary to ensure credibility of the peer review process. Peer reviewer responsibilities should rotate across the available pool of qualified reviewers or among the members on a standing peer review panel to prevent a peer reviewer from repeatedly reviewing that same scientific information, recognizing that, in some cases, repeated service by the same reviewer may be needed because of limited availability of specialized expertise.

It is important to keep in mind that a peer reviewer must be qualified to conduct the review and must not have any conflicts of interest; however the reviewer’s degree of independence from the science may vary depending on the science to be reviewed. It is also important for the purposes of this manuscript that we consider the attribute of independence in regard to the reviewer selection process and the final review of the peer review report. For example, the CIE review process provides an independent reviewer selection process and conducts an independent review and acceptance of the final peer review report.



**Figure 1.** The review of scientific information may include a series of peer reviews that utilize a combination of internal and external experts. The National Marine Fisheries Service, routinely schedule internal reviews as data and methods workshops, external reviews of scientific products, and an evaluation of the science and peer review reports by the scientific advisory panel of the fishery management council for management recommendations.

Furthermore, the proposed National Standard 2 guidelines on peer review emphasize the importance of:

- i) *Transparency* — A transparent process is one that ensures that background documents and reports from peer review are publicly available, with exception of confidentiality requirements, and allows the public full and open access to peer review panel meetings. Names and organizational affiliations of reviewers also should be publicly available.
  - ii) *Timing* — The peer review should be conducted early in the process of producing scientific information or a work product, to the extent practicable, so peer review reports are available for the policy decision process.
  - iii) *Scope of work* — The scope of work or charge (sometimes called the terms of reference) of any peer review should be determined in advance of the selection of reviewers. The scope of work contains the objectives of the peer review, evaluation of the various stages of the science, and specific recommendations in improvements of the science. The scope of work should be carefully designed, with specific technical questions to guide the peer review process; it should ask peer reviewers to ensure that scientific uncertainties are clearly identified and characterized, it should allow peer reviewers the opportunity to offer a broad evaluation of the overall scientific or technical product under review, as well as to make recommendations regarding areas of missing information, future research, data collection, and improvements in methodologies, and it must not change during the course of the peer review.
  - iv) *Form of process* — The peer review process may take many forms, including individual letter or written reviews, and panel reviews, which are appropriate for a specific information product.
- i) *Internal reviews* — Reviews that are routinely conducted, mainly within the organization, on the established operational aspects of scientific information (data, methods) or scientific products that are considered as routine updates to established science. Internal reviews are often conducted as workshops that benefit from a balance of expertise and perspective from a combination of local and external expertise, but may also be conducted as desk reviews of scientific products. Due to intra-organizational involvement in internal reviews, such reviews do not require a high degree of independence.
  - ii) *External reviews* — Reviews of scientific products that utilize new research or emerging science and science considered as influential science that may significantly affect policy decisions. External reviews are most appropriate for benchmark updates involving significant changes in the science and may not be necessary for routine updates of established science. External reviews may also be required to address issues where local and agency expertise is contested or considered biased. External reviews tend to require rigorous peer review standards including a high degree of independence. The external and internal reviews of scientific products are often conducted as panel reviews or desk reviews.
    - *Panel reviews* — Reviews conducted during a panel review meeting during which reviewers participate in discussions on the scope and context of the science.
    - *Desk reviews* — Reviews conducted of science products, such as reports and background documents, during which a reviewer is typically not required to travel to a review meeting.
  - iii) *Ad hoc reviews* — Reviews to specifically address problems, typically not considered to be routinely scheduled. Ad hoc reviews typically are required to address controversial issues, and these may often require a high degree of independence. Ad hoc reviews can be conducted as internal reviews (within an organization), but are more often conducted as external reviews (using expertise from outside the organization) when addressing controversial issues.

The form of the peer review can vary considerably, and may even involve a series of stages in the peer review process that utilizes different forms. For example, a peer review process may utilize a series of workshops, desk reviews, and panel review meetings involving a combination of internal and external expertise. Determination of the appropriate form of the review will often depend on the science to be reviewed, whether the science is established or emergent, degree of influence or controversy, frequency of updates and review, and time and cost considerations. These factors will influence the requirements for reviewers, such as the balance in expertise and perspectives. The degree of independence is another important attribute that may vary with the form of peer review. For the purpose of evaluating the key attributes of various forms of the peer review, we have grouped the various forms of peer review into the following general categories:

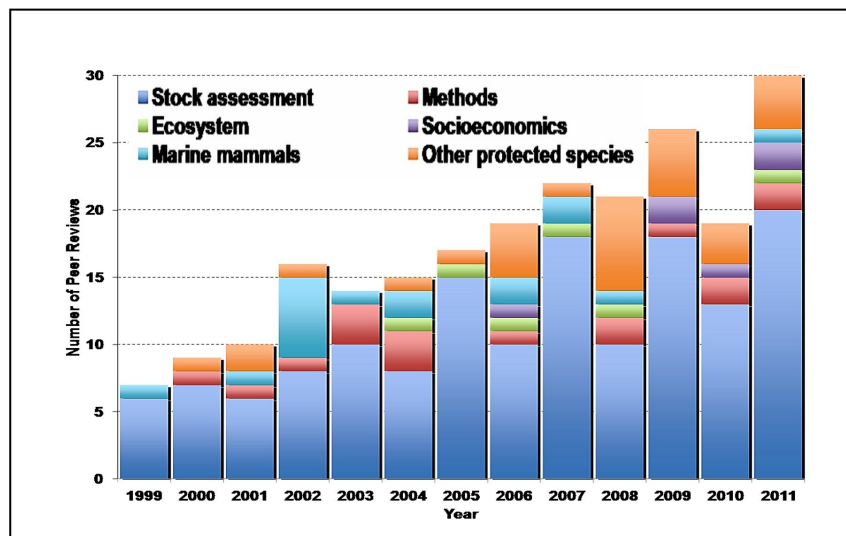
These categories allow us to make some generalizations concerning key attributes to consider when determining the appropriate form of peer review to implement, recognizing there are hybrid examples that may utilize a combination of the above categories. It is the trade-offs between cost, time, and quality of the review mechanism with the complexity, novelty, and importance of the science to be reviewed that must be considered to optimize throughput of the review process for policy makers.

The CIE peer review process produced 528 independent peer review reports from different types of reviews during 1999 - 2011, including internal workshops on routine updates and review of emergent science, external panel review meetings, ad hoc reviews of highly influential and controversial science, and desk reviews (Figures 2 and 3). These CIE reviews comprise a range of science pertinent to conserving and managing marine living resources, such as the review of stock assessments, data and methodologies, biological opinions, recovery plans, and ecosystem research. The CIE performance based on the cost, quality and timeliness of the CIE products and client satisfaction surveys provided insight into the key attributes to consider for selecting the appropriate form of peer review:

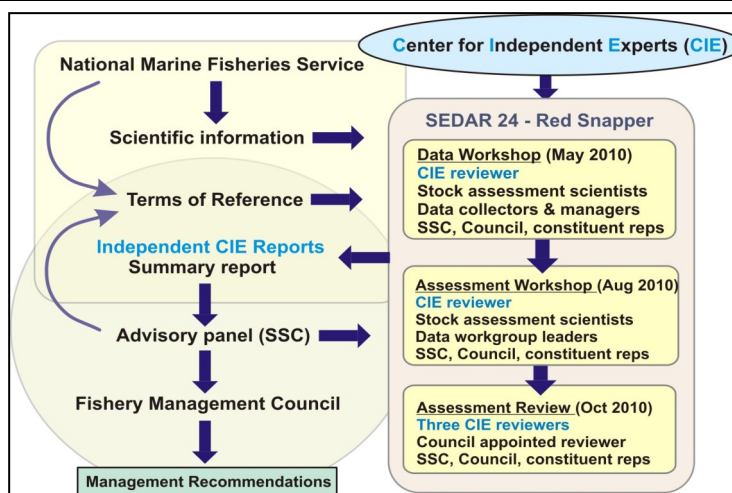
- i) *Importance* — The importance of the science to be reviewed is a critical factor in selecting the appropriate form of review. The degree of independence and conflicts of interest are critical requirements in the selection of reviewers, therefore external reviewers that meet rigorous peer review standards are necessary when reviewing influential, complex, novel, or controversial science. Internal reviewers with local knowledge provide appropriate balance and perspective to ensure the science addresses regional issues.
- ii) *Scope and purpose* — The use of the peer review product is determined by the scope and objectives defined by the terms of reference (ToRs) of the review. For example, the ToRs of a methods workshop can task reviewers to evaluate new research and emerging analytical approaches early

in the scientific process that might require a balance in perspectives from a combination of internal and external expertise. Such a review can be an early step in a series of reviews in the determination of best scientific information available. External review are appropriate of a scientific products used by managers that affect policy decisions.

- iii) *Cost* — The travel expenses and stipends for the service of external reviewers will exceed the costs of internal reviews. Internal reviews are less expensive depending on the need to balance the expertise and perspectives of local and external reviewers. Reducing costs by using regional experts would be appropriate for the reviews of established science undergoing routine updates. Desk reviews that can be accomplished on scientific products such as reports that do not involve travel costs are less expensive than the cost of external reviewers attending panel review meetings, yet the additional expense of panel reviews are necessary when the science is complex requiring discussions to understand the scope and context of the science.
- iv) *Time* — In contrast to internal reviews, external reviews require more time due to travel logistics and related matters. Therefore, increasing the throughput of a review process should utilize internal workshops and reviews when established science is undergoing routine updates. The additional time for external reviews is necessary for the review of influential or controversial scientific products, and it is equally important to



**Figure 2.** The demand for external peer reviews through the Center for Independent Experts (CIE) has increased during recent years. The CIE peer review process provides highly qualified external reviewers that meet rigorous peer review standards to independently review the science of the National Marine Fisheries Service.



**Figure 3.** The flowchart of the red snapper stock assessment review shows a three step review of the data, assessment methods, and stock assessment product. External CIE reviewers are incorporated in each of these reviews because this assessment was considered to be influential and controversial.

have external review of emergent or complex science early in the process such as methods workshops.

- v) *Frequency* — The frequency of review is a consideration in selecting the form of peer review, and is a function of the importance, cost, and quality of the science. Updates of established science will only require frequent reviews if the science is considered influential or controversial by significantly impacting policy decisions.
- vi) *Independence* — The degree of independence can vary considerably within and between various forms of reviews. A high degree of independence is necessary for the review of influential, complex, novel, or controversial science. External reviewers with a high degree of independence typically incur additional costs associated with travel and stipends, and may not be necessary for internal reviews. For example, it may be appropriate for internal reviews to include local expertise that have an understanding of the regional issues that the science must address.
- vii) *Reviewer selection* — Another important aspect of independence is the reviewer selection process. For example, the CIE process provides a high degree of independence by ensuring the reviewers are independent from the science to be reviewed, are independently selected, and their reports are independently reviewed and accepted. External reviewers with a high degree of independence can be difficult to recruit due to the limited availability of specialized expertise, and this typically

requires the travel costs of foreign national experts. Furthermore, the CIE process rotates experts to prevent a reviewer from being involved in work that was previously reviewed by the same expert.

## DISCUSSION

Improving linkages between science, policy, and the confidence of stakeholders requires the strengthening of science quality assurance through scientific peer review. The increasing demand of the best scientific information available for the conservation and management of living marine resources results in the need to balance peer review capability with throughput of reviewing science. Case studies and lessons learned from scientific peer review suggest that there are key attributes to consider when selecting the appropriate form of peer review. Approaches for increasing the throughput of reviewing scientific information for policy makers include trade-offs between the importance of the science with the cost and time for the form of peer review (Figure 4). Based on consideration of key attributes of peer reviews, the following recommendations for selecting the appropriate form of peer review are:

- i) *Internal reviews* should be conducted for routine updates of established science. Internal reviews can be conducted as workshops that benefit from a combination of local and external expertise that provide a balance of perspective to address regional issues. Due to intra-organizational involvement in internal reviews, such reviews do not require a high degree of independence.

- ii) *External reviews* should be conducted on influential scientific products that may affect policy decisions and stakeholders. External reviews are also most appropriate for benchmark updates involving significant changes in the science or emerging science and new research. External reviews tend to require rigorous peer review standards including a high degree of independence. The external reviews are not recommended for routine updates of established science because of the additional cost and time associated with external reviewers.
- iii) *Panel reviews* should be conducted for controversial or complex science that requires reviewer participation during discussions at a panel review meeting to understand the scope and content of the science to be reviewed. Panel reviews may include a combination of external and local expertise depending on the degree of importance and need to address issues at the regional or national level.
- iv) *Desk reviews* should be conducted of science products, such as reports and background documents, during which a reviewer is typically not required to travel to a review meeting. Desk reviews are not recommended when the science is sufficiently complex and reviewer might not obtain the necessary insight on the scope and context of the issues to be addressed by simply reading the reports.

Furthermore, the lessons learned from case studies and various forms of peer review indicate the success of the peer review is dependent not only on the appropriate form of peer review, but also dependent on well defined and predetermined ToRs. ToRs, when properly defined, ensure the objectives of peer review are achieved, and thus must be considered as a key component in the process.

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