The trawl surveys conducted by NOAA Fisheries' Northeast Fisheries Science Center provide key fisheries-independent data used for assessing the stocks managed under the Northeast Multispecies Fisheries Management Plan.

The Center for Independent Experts: The National External Peer Review Program of NOAA's National Marine Fisheries Service

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ABSTRACT: Requirements are growing for peer review of the science used for governmental management decisions. This is particularly true for fisheries science, where management decisions are often controversial. The National Oceanic and Atmospheric Administration's National Marine Fisheries Service instituted the Center for Independent Experts (CIE) in 1998 as a national peer-review program. Operations of the CIE, run under a contract with the University of Miami, maintain the independence of reviewers from the agency, and follow strict conflict of interest guidelines. Reviews by the CIE fulfill the requirements of the Information Quality Act and the Office of Management and Budget's Peer Review Bulletin. The CIE completed 101 reviews between 1999 and September 2006. Ninety-eight reviewers have participated in CIE reviews, with 72% of them coming from overseas. Case studies involving groundfish data and stock assessments, and marine-mammal abundance, are described, including the scientific issues, CIE operations, requirements for the reviews, conclusions of the reviewers, and the agency's responses. Impacts of the CIE on the agency's science include improvements to regional stock assessment processes and to stock-assessment and field-survey methods, and reductions in contentious challenges to the agency's science.

INTRODUCTION

Peer review is a vital element of the scientific process, playing a central role in determining research priorities, funding, and publication. It has been defined as "an organized method for evaluating scientific work which is used by scientists to certify the correctness of procedures, establish the plausibility of results, and allocate scarce resources…" (Chubin and Hackett 1990:2), and "a form of deliberation involving an exchange of judgments about the appropriateness of methods and the strength of the author's inferences" (OMB 2004:2). The

American Fisheries Society (AFS) recently commented on the value of independent peer review for fisheries science, including the stimulation of new ideas, clarification of ideas, and increased rigor in analyses and conclusions (Rassam and Geubtner 2006). The AFS also identified peer review as a component of the best available science for fisheries (Sullivan et al. 2006).

Many management agencies base regulatory decisions in part on the work of their own scientists, or on research they receive under contract, which can lead to perceived conflicts of interest and to challenges to the credibility of their science and management decisions. In addition, some agencies have been publicly accused of "gagging" their scientists if their work involves controversial topics (e.g., Revkin 2006). Subjecting agency science to independent peer review is an approach increasingly used to address these problems. For example, the U.S. Environmental Protection Agency (EPA) has adopted a highly detailed process for incorporating peer review into regulatory procedures, including documentation of the results of the review (USEPA 2000). Also, a policy incorporating independent peer reviews into listing and recovery actions under the Endangered Species Act has been in place since 1994 (USFWS and NMFS 1994).

The National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries) has a long tradition of involving outside experts in external peer reviews of the science underlying management decision making and the programs that generate this science. The scope and independence of these reviews varies widely, ranging from informal reviews by colleagues (e.g., an internal report), to peer reviews conducted by scientists from other NOAA Fisheries science centers and academic institutions (e.g., stock assessments used as scientific advice by fishery management councils for setting quotas), to large, complex reviews of topics of national significance, often conducted by the National Research Council. The outside experts providing these reviews typically have been internationally-recognized academics or leading governmental scientists from the United States or other countries. Historically the participation of the reviewers has usually been gratis, with NOAA covering only travel costs. However, due to greatly increasing demands for peer review, and the complexity of the reviews, this situation is changing rapidly for NOAA Fisheries, and for other regulatory agencies as well.

This article provides an overview of the Center for Independent Experts (CIE), NOAA Fisheries' national program for conducting formal peer reviews of the agency's science products. The article covers the role the CIE fills in meeting the agency's needs for peer review, the structure of the program, its operations, and case studies that describe the impacts of CIE reviews on some scientific issues and assessment processes.

ESCALATING PEER-REVIEW REQUIREMENTS

To adapt to the growing emphasis on the use of scientific information in fisheries management decisions, in recent years the federal government, including NOAA Fisheries, has repeatedly sought external advice on how to improve the agency's science, including the role of peer review, and then developed and implemented plans to follow that advice (Table 1).

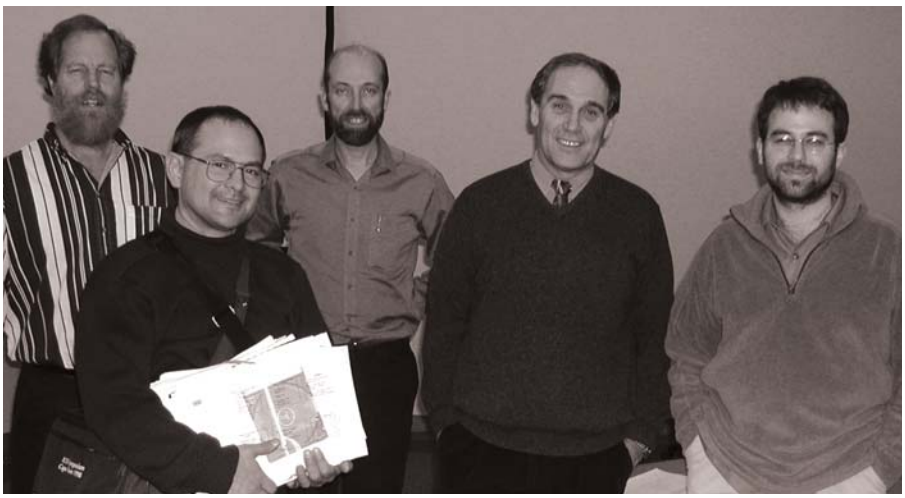
The role of peer review in fisheries management at the national level was addressed by the U.S. Commission on Ocean Policy (USCOP). Recommendation 19-4 in the USCOP's final report (2004) states that NOAA Fisheries, the fishery management councils, and interstate fisheries commissions "should develop a process of independent review of the scientific information relied on by Scientific and Statistical Committees." Three procedures were recognized: a standard annual review to ensure that data and models are correct; an enhanced review conducted on a 3-5 year cycle, which would evaluate models and assessment procedures to assess the state of the art; and an expedited review for highly controversial results. The CIE was specifically mentioned as the type of organization that could provide the enhanced and expedited reviews. The U.S. Administration's response (CEQ 2004) explicitly supports the use of peer-reviewed science in fisheries management.

The trend towards incorporating peer review into regulatory processes has culminated in the Information Quality Act (IQA) of 2000, Section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001 (Public Law 106-554), and the implementing policies established by the Office of Management and Budget in the *Information Quality Bulletin for Peer Review* (PRB; OMB 2004). The PRB establishes minimum standards for federal agencies when peer review is required. Two categories of science are recognized: (1) highly influential scientific assessments, which could have the potential impact > $500 million in any year, or are novel, controversial, precedent-setting, or have significant inter-agency interest; and (2) influential scientific information, which is information an agency can reasonably determine will have a clear and substantial impact on important public policies or private sector decisions. The PRB established requirements for public disclosure of and access to peer review planning; selection of reviewers, including expertise and balance, conflicts of interest, and independence; peer review mechanism (e.g., panel versus letter review); transparency; and management of the peer review process. Although the assessments conducted by NOAA Fisheries may only occasionally reach the level of a highly influential scientific assessment, much of the science routinely conducted by NOAA Fisheries falls into the influential scientific information category. NOAA Fisheries increasingly relies on the CIE for conducting peer reviews that are considered highly influential scientific assessments or influential scientific information.

THE CENTER FOR INDEPENDENT EXPERTS

The CIE provides independent and timely reviews of the science upon which many of NOAA Fisheries' management decisions are based. For fisheries management, the decisions are required under the Magnuson-Stevens Fisheries Conservation and Management Act as amended in 1996. For protected species, the decisions are required under the Endangered Species Act of 1973 as amended or the Marine Mammal Protection Act of 1972 as amended. Compared to reviews conducted by the National Research Council (NRC), CIE reviews are more narrowly focused on specific scientific issues, and are conducted over a shorter timeline, typically two to four months. Consequently, CIE reviews are considerably less costly than NRC reviews. Initiated in 1998, the CIE is now run under a contract with the University of Miami's Cooperative Institute for Marine and Atmospheric Studies (CIMAS; www.rsmas.miami.edu/groups/cie/).

The structure and operation of the CIE have been designed to ensure the quality, relevance, and independence of the reviews. Independence is maintained by eliminating any role for NOAA in selecting or paying the reviewers, or in approving the contents



The CIE panel that participated in the February 2003 workshop on Northeast groundfish assessments (see Case Study1).

of reviewers' reports. Also, strict conflict-of-interest policies are followed. To ensure quality and timeliness, the University of Miami pays CIE reviewers for their work, and requires them to sign contracts with well-defined deliverables and schedules. Most reviews are initiated through requests from the NOAA fisheries science centers, with specific requirements described in a statement of work. Some reviews are initiated as part of a legal settlement, or at the request of NOAA Fisheries, NOAA, or the Department of Commerce.

There is no requirement for the agency to accept or act on the recommendations provided by CIE reviewers, nor is there a comprehensive mechanism that tracks the agency's responses. In some highly sensitive cases (see Case 1 below), the agency does formally respond to CIE reviews.

CIE Reviews and Products

The CIE conducts on-site and correspondence reviews. For on-site reviews, the CIE experts are sent to meetings, workshops, or other fora organized by NOAA Fisheries. They usually participate in a peer-review panel, which may consist only of CIE reviewers, or a mixture of CIE and other reviewers. In some cases, a CIE expert may chair a panel, with responsibilities for coordination and ensuring that the tasks of the panel are completed. In correspondence reviews, the CIE experts conduct all review-related activities from their home location.

Table 1. Recent recommendations to NOAA Fisheries and agency responses relevant to peer review.

Reference	Key statement on peer review
	Recommendations
NRC 1998a:116	The committee recommends that NOAA Fisheries conduct (at reasonable intervals) in-depth, independent peer review of its fishery management methods to include (1) the survey sampling methods used in the collection of fishery and fishery-independent data, (2) stock assessment procedures, and (3) management and risk-assessment strategies.
NRC 1998b:75	Ensure that a greater number of independent scientists from academia and elsewhere participate in the Stock Assessment Review Process [with respect to the Northeast groundfish stock assessments]…
NRC 2000:156	NOAA Fisheries, in conjunction with the regional councils, should review all aspects of its data collection activities, on a fixed, publicly-announced schedule including all types of fishery-dependent and fishery independent data. Such reviews should include both a scientific peer review and a stakeholder review.
NRC 2000:165	A greater degree of independence in the peer-review process is needed in order to maintain the integrity and scientific credibility of the NOAA Fisheries assessments….every assessment should be externally reviewed on a regular basis, for example, every three to five years.
NRC 2002:5	NOAA Fisheries should continue to use and seek advice and review from independent sources. In the past, NOAA Fisheries has been criticized for the lack of independent review of its stock assessments….Hence, independent review should be a fundamental component of developing stock assessments.
NRC 2004:7	NOAA Fisheries should establish an explicit and standardized peer review process for all documents that contain scientific information used in the development of fishery management plans.
U.S. COP 2004:235	Recommendation 19-4. The National Marine Fisheries Service, working with the Regional Fishery Management Councils and the interstate fisheries commissions, should develop a process for independent review of the scientific information relied on by Scientific and Statistical Committees.
	Responses and planning documents
U.S. DOC 2001:25	The CIE provides a mechanism for accessing a worldwide pool of highly-qualified fisheries scientists, statisticians, and other experts.
U.S. DOC 2004a:44	Objective 1.5: Use stock assessment workshops, peer reviews, and other fora to ensure that our information and advice are developed through an open and collaborative process.
U.S. DOC 2004b:2	Scientific peer review depicted in conceptual model of stock assessment process for protected species.
CEQ 2004:19	The Administration supports the use of peer-reviewed science in resource management decisions. …the President directs NOAA to establish guidelines and procedures for the development and application of scientific advice for fisheries management decisions, in consultation with the Regional Fishery Management Councils, Interstate Fishery Commissions, stakeholders, and other agencies as appropriate.

The CIE generally requires that reviewers complete reports that describe the review activities, present all relevant findings, and draw conclusions and recommendations. Each reviewer usually provides a separate, independent report. Sometimes CIE reviewers also contribute to panel reports, though these are not considered CIE products. In a few recent projects, one of the reviewers, typically a panel chair, has provided a summary report, which consolidates the views of each individual report. This is not developed as a consensus document, since there has been no process for reaching consensus. On points where all panelists agree, this is noted. Where opinions diverge, each viewpoint is summarized. The individual reviewer reports are appended to the summary report, ensuring that all detailed information is provided.

CIE STRUCTURE

The CIE operates in a dynamic environment, in that it reviews, modifies, and accelerates its operating procedures as required for the reviews needed by NOAA Fisheries, while maintaining its core independence. The CIE structure consists of a coordination team and a steering committee, which work together in developing and updating CIE operating procedures, identifying and selecting reviewers, and reviewing background material, review reports, and other related documents. The coordination team consists of a primary and an external coordinator, a manager, and an intern, as well as ancillary personnel that provide support in contracts and accounting. The steering committee, comprising three senior scientists, provides scientific oversight.

The CIE coordination team is responsible for daily operations. The manager and intern identify and contact experts in various marine science fields to maintain a reviewer database, work with the coordinators in developing reviewer candidate lists, interface with the steering committee in selecting reviewers, draft contracts and related legal material as part of contracting experts to serve as CIE reviewers, and handle review logistics. The primary coordinator oversees daily operations, serving as the official CIE contact with NOAA Fisheries, reviewers, and others; directing reviewer identification and selection; and working with the manager and intern on other operational matters. The primary coordinator also acts as the main liaison with the steering committee, providing them with review and process-related developments, and serving as the point of contact between the steering committee and NOAA Fisheries. The external coordinator acts on behalf of the primary coordinator on reviews, processes, and issues on which the primary coordinator may be perceived to possess a conflict of interest. Currently, the CIE coordination team is set up such that the primary coordinator, whose primary research interest is in the Atlantic, manages all West Coast-based reviews, and the external coordinator, whose primary research is in the Pacific, manages all East Coast-based reviews.

Comprising three senior scientists, the CIE steering committee is responsible for selecting reviewers, making final decisions concerning conflict of interest, and determining all other CIE-related issues that could not be resolved by the coordination team. Steering committee members serve three-year terms, and are replaced on a staggered schedule, thereby ensuring continuity. The steering committee collectively possesses expertise on fishery stock assessment, marine mammals and protected marine species, and ecology and ecosystem science.

CONFLICT OF INTEREST

To ensure that the CIE maintains the highest level of independence, the CIE and NOAA Fisheries developed a strict conflict of interest policy, which has been designed to be consistent with OMB (2004) requirements. Prior to participating in any CIE review, every expert is required to sign a conflict of interest (COI) statement (www.rsmas.miami.edu/groups/cie/ciecoi.htm). This statement outlines the conditions under which an expert is considered to be free from any conflict that would preclude participation in a CIE review. Reviewers are required to sign this statement for every review in which they participate, and are required to provide the CIE with any materials relevant to a potential conflict, such as a curriculum vitae and published articles and opinions. The CIE evaluates these materials before offering a review to an expert.

NOAA Fisheries participates in the COI evaluation only to the extent that the agency can provide additional information, which may have been unavailable to the CIE, that could affect an expert's eligibility. In such cases, NOAA Fisheries may request that the CIE revisit the eligibility of an expert, but NOAA Fisheries does not have a decision-making role regarding the expert's selection as a CIE reviewer. Additionally, NOAA Fisheries cannot request rejection of an expert based on the expert's view of the agency, and can only provide information that is germane to the issues in the COI statement.

Many of the COI requirements involve financial conflicts. An expert may not participate as a CIE reviewer if he/she has received funds in the past three years or is seeking funds and/or employment from sources with vested interests in resources for which NOAA Fisheries has stewardship responsibilities. These sources include industry or environmental groups, non-governmental organizations, foundations, and any entity involved in relevant litigation. Additionally, an expert is considered to have a conflict if they have received or are seeking sole-source or non-competitive funding from NOAA Fisheries or interested state or local governments. These restrictions also apply to immediate family members of potential CIE reviewers.

The other COI requirements address conflicts arising from a history of advocacy or perceptions. A potential reviewer with a well-formed position or history of advocacy for a specific viewpoint relevant to the fishery, or a perceived conflict of interest relevant to the specific issue or fishery being reviewed, is considered ineligible. These types of conflicts may only be relevant to a specific issue. In such cases an expert may be eligible for other reviews.

REVIEW PROCESS

To begin the annual cycle of CIE reviews, the NOAA Fisheries project manager compiles a list of proposed reviews prior to the beginning of the fiscal year. This list is updated as needs change during the fiscal year. The list includes details on the topic, type of review, number of reviewers, expertise required, level of effort, location, and schedule. The list is used by NOAA Fisheries for scheduling and prioritizing reviews, and by both the agency and the CIE for planning, coordination, and budget management. NOAA Fisheries has instituted a prioritization process to ensure maximum benefit from the expenditures for CIE peer reviews (Table 2). At the beginning of a fiscal year, the prioritization factors are applied to the initial list of proposed reviews by the NOAA Fisheries project manager. These priorities are reviewed and approved by the NOAA fisheries science center directors and the chief scientist, and are re-evaluated as circumstances evolve over the course of the fiscal year.

A typical CIE review requires two to four months from initiation to delivery of final review reports (Figure 1). This pro-

As is typical of peer reviews, the scientists involved with the Northeast groundfish reviews focused intently on technical issues.

cess can be expedited if necessary. A review is initiated by NOAA Fisheries by selecting a high-priority review from the annual list of proposed reviews. The NOAA Fisheries project manager and the CIE develop a statement of work and cost estimate, which are entered into a work order, the legal document that formally assigns a review to the CIE under the contract. The statement of work provides background information and specifies requirements for the number and expertise of reviewers and the activities required of the reviewers, such as documents that must be read, meetings that must be attended, and the outline for any report that each reviewer must produce. It also covers budget and schedule.

Once the CIE receives a draft statement of work, the coordination team searches for potential candidates for that review, based on the expertise required. To ensure independence from NOAA Fisheries, the agency has no role in this process. The coordinator and manager consider candidates from the pool of experts that the CIE retains for this purpose, and may also search online databases and journals for additional candidates. Once suitable candidates have been identified, the coordination team contacts each expert to determine interest and availability and evaluates potential conflicts of interest. The final list of candidates, along with curricula vitae, is placed on the CIE's restricted-access website, from which the steering committee selects the final reviewer(s).

Following approval of the reviewers, the CIE manager develops contracts and organizes logistics. The contracts are between the University of Miami and each reviewer. NOAA is not a party to these contracts. Logistics include providing reviewer contact information to NOAA Fisheries, and setting up travel arrangements. The agency must provide all background material to the CIE and the reviewers well in advance of review activities. All correspondence between reviewers and NOAA Fisheries is copied to the CIE to ensure transparency.

In contrast to the anonymity of reviewers maintained in most academic peer review processes, information on the iden-

Table 2. Factors considered by NOAA Fisheries in prioritizing proposed CIE reviews. These factors are considered in the order given.

1. High economic impact, controversy, or potential for establishing a precedent with wide-ranging implications.
2. Benchmark assessments prompted by a new fishery or protected resource management action, or by a major change in a stock assessment model or input data that will have a major impact on stock status determination.
3. The scientific information to be reviewed provided new or innovative research results, or used new or innovative methods, with clear application to fisheries or protected resource management.
4. The scientific information or assessment has not undergone independent peer review within the past five years, and new data or methods may be needed to improve the scientific basis for management.
5. The scientific information to be reviewed has significant interagency interest.
6. The assessment is an annual update of an existing assessment with the addition of a new year of data, but no change in the assessment model.
7. The purpose of the review is to improve NOAA Fisheries's scientific operations.

Figure 1. Steps of the CIE review process.

Step	Responsible party	Duration
1. Peer review requested	NOAA Fisheries client (science center, regional office, or headquarters office)	
2. Statement of work/work order developed	NOAA Fisheries headquarters and CIE	1–3 months
3. Reviewers selected, brought under contracts	CIE	
4. Review activities completed	Reviewers contracted to CIE	2–3 weeks
5. Reports submitted to CIE	Reviewers contracted to CIE	
6. Reports reviewed, approved, submitted to NOAA Fisheries	CIE	2–3 weeks
7. Reports accepted, sent to NOAA Fisheries client	NOAA Fisheries headquarters	

tities of CIE reviewers is not restricted. Most of the reviews that include workshops attended by CIE reviewers are open to the public. In some cases, the names of the reviewers are posted on the Internet (e.g., the South East Data Assessment and Review [SEDAR] web site, maintained by the South Atlantic Fisheries Management Council). Also, the names of CIE reviewers can be obtained from NOAA Fisheries upon request. The time-course of CIE reviews is too short to routinely post this information on the Peer Review Bulletin web site, which is updated only every six months.

The statement of work contains deadlines for when the reviewers must submit draft review reports to the CIE, and for when the CIE must provide the final review reports to NOAA Fisheries. Many reviews involve panel meetings or workshops. Some panels consist only of CIE reviewers, while others are a mixture of CIE and other reviewers. In some of these cases, the CIE also provides a panel chair. The chair does not provide a review report, but rather provides independent leadership of the panel and facilitates its functioning. The chair may also contribute to panel reports, which may or may not be CIE products. Generally, reviewers have two weeks following any offsite meeting to produce draft reports, and the CIE has another two weeks for internal review and approval. In extraordinary conditions, the CIE completes expedited reviews, providing reports to NOAA Fisheries in one week or less after receipt. When CIE reviewers are required to contribute to panel reports in addition to producing their own review report, they must do so in accordance with the panel's schedule.

The CIE coordination team and steering committee are both responsible for reviewing draft review reports. The steering committee reviews them for accuracy, relevance, and quality, and assesses whether they meet the requirements of the statement of work. The coordination team also comments on these issues, but focuses mainly on formatting and editing. The CIE manager submits final reports to NOAA Fisheries, and the agency's project manager makes a final determination as to whether the reports meet the statement of work requirements. At this point NOAA Fisheries can require revisions to address specific shortcomings, such as missing items identified in the statement of work, but cannot request changes in content or conclusions.

Publication of Reviews

Completed review reports are the property of NOAA Fisheries. The reports are provided to the entity within the agency that originally requested the review. They are not considered privileged information, so the reports are generally available upon request. Some reports of high public interest are published on the Internet (see Case 1 below).

CHALLENGES ENCOUNTERED WITH CIE REVIEWS

Occasional difficulties have occurred during or following CIE reviews. During reviews, problems can occur when the requirements in the statement of work are not clear, when the process followed during a review workshop deviates from the process outlined in the statement of work, or when additional information is provided that was not available when the statement of work was written. In such cases, reviewers might produce reports that do not meet their contractual requirements, which may necessitate revisions to the reports and cause delays in their delivery. Care in designing and implementing a review process and in writing the statement of work with well-defined and appropriate products can minimize these occurrences.

Despite having well-crafted statements of work and smoothly implemented review workshops, some reviewers' reports may not contain appropriate or useful analysis or recommendations. Contracts between the CIE and the reviewers provide some measure of quality control, but the purpose of CIE reviews is to obtain the freely expressed opinions of the individual reviewers. The reviewer's comments are accepted as long as they have addressed the specific elements identified in the statement of work. Because of this, some reviews have contained comments that are inappropriate or are not feasible to implement. Reviews of this nature represent a lost opportunity, and could sometimes put the agency in the awkward position of ignoring the advice that it had sought.

There are some topics that remain controversial, even after an independent peer review. A few interested parties have challenged the agency or the CIE itself over the credibility of a review. These challenges have focused on review processes, rather than the scientific issues that were the subjects of the reviews. A point of contention has been the perceived conflict of interest on the part of a reviewer, such as whether or not a reviewer has a history of advocacy for a specific viewpoint.

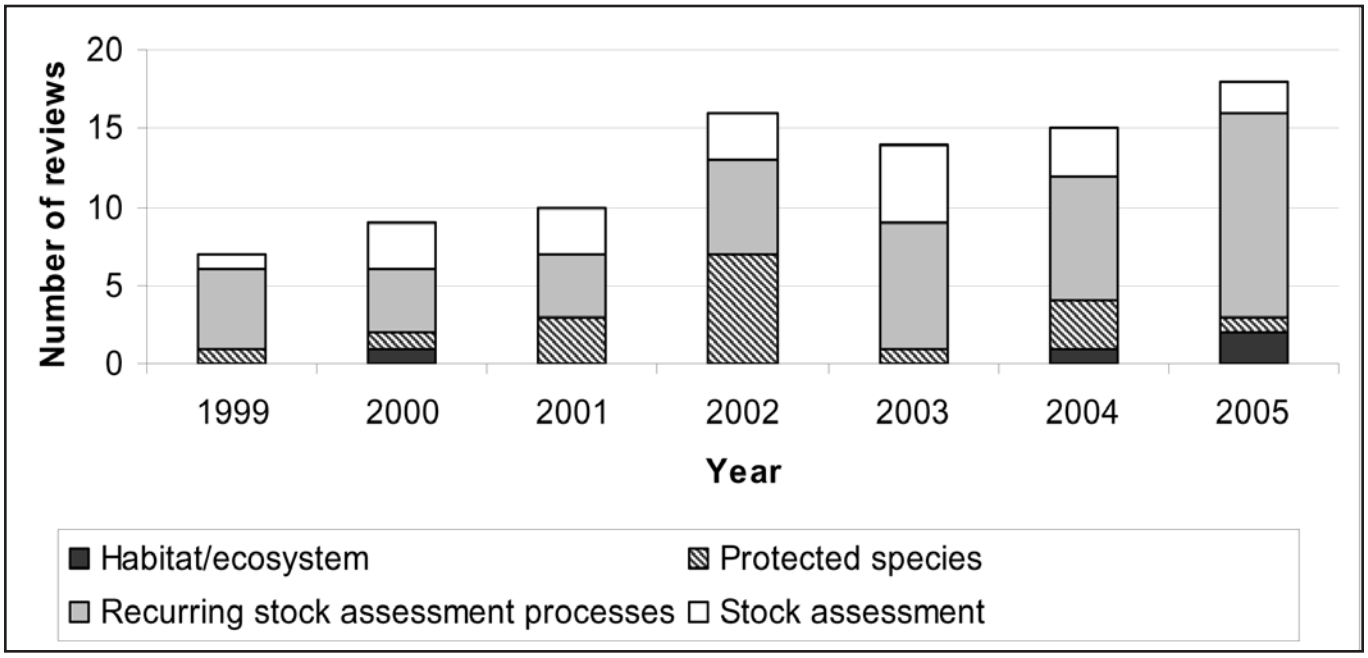
PROFILE OF CIE REVIEWS AND REVIEWERS

The CIE completed 101 reviews between 1999 and September 2006, averaging about 13 reviews per year. The number of reviews per year has increased over time, reaching 18 in 2005 (Figure 2). Most reviews have covered recurring fish stock assessment meetings and workshops, other fish stock assessments, essential fish habitat, ecosystem health and function, and impacts of habitat alteration. Over time there has been an increase in the number of reviews for recurring stock assessment processes: the Stock Assessment Review Committee (SARC) for the Northeast; the South East Data Assessment and Review (SEDAR) for the Southeast, Gulf of Mexico and Caribbean; and the Stock Assessment and Review (STAR) for the Pacific Coast. These recurring processes now all depend on reviewers from the CIE. A substantial portion of CIE reviews has involved protected species of marine mammals, sea turtles, and anadromous fishes, covering topics such as population structure, abundance estimates, and impacts of fishing and other anthropogenic factors. The CIE has provided experts in other fields as diverse as veterinary science, physiology, animal behavior, genetics, biochemistry, toxicology, geomorphology, oceanography, economics, and hydrology.

NOAA Fisheries pays the CIE for the reviews. The costs include payments made by the University of Miami to the reviewers and the university's costs for the running the program. For the 2006 schedule, costs per review ranged from $18,600 for a desk review, involving three reviewers working for a total of 15 days with no travel, to $98,500 for a review panel involving international travel and four reviewers working for a total of 61 days.

Over the 1999-September 2006 period, the CIE contracted a total of 98 reviewers. CIE experts have participated in an average of 2.2 reviews, with a maximum of 19. To ensure that experts are not perceived as being part of recurring or other assessment

Figure 2. Numbers and types of CIE reviews, 1999-2005. Recurring stock assessment processes are those incorporated into regional assessment processes (SARC, SEDAR, and STAR).



processes, the CIE generally does not allow participation by the same experts in consecutive reviews or in more than one review that addresses a particular issue. This promotes independence and diversity of input, and prevents development of potential conflicts of interest.

Primarily because of conflict of interest concerns, 72% of the CIE reviewers have come from outside the United States (Figure 3). In addition to avoiding even the perception of a conflict of interest, reviewers from overseas often provide a fresh point of view and a greater sense of independence. The tradeoff is that foreign reviewers generally lack local knowledge and familiarity with U.S. laws and management priorities. These factors are compensated for by requiring reviewers to prepare for their reviews by reading an extensive set of background documents.

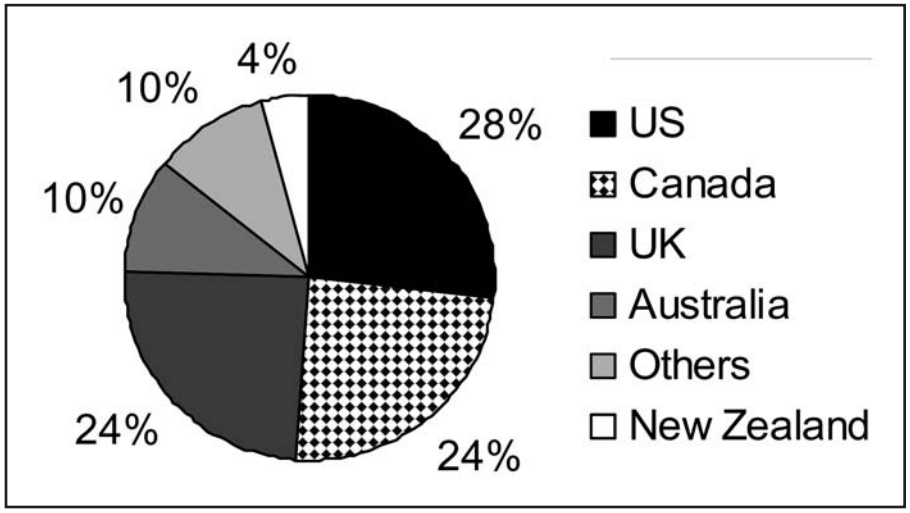
CASE STUDIES

The case studies described below illustrate successful CIE reviews, including the circumstances surrounding the reviews, the activities and deliverables required of the reviewers, and the impacts of their reviews. Case Study 1 describes a crisis in a key agency science program, which the CIE helped to resolve, and which had lasting impacts on both CIE and agency operations. Case Study 2 describes a comparatively routine scientific review, in which the recommendations of the reviewers provided useful guidance for improving a specific project.

Case 1: "Trawlgate," Amendment 13, and the Groundfish Assessment Review Meeting

Twenty groundfish stocks are managed under the Northeast Multispecies Fishery Management Plan (FMP). These stocks have been traditional mainstays of the commercial fishing sector in New England. Their decline has been widely reported in the scientific literature (e.g., NRC 1998b) and in other media for the broader public (e.g., Fordham 1996). In 2001 estimates of fishing mortality rates (or proxies) were available for 19 of the 20 stocks. Of those 19 stocks, fishing mortality rates declined between 1994 and 2001 for 15, and increased for only 4, and biomass estimates had increased for 19 of the 20 stocks since 1995 (US DOC 2002). Nonetheless, based on stock assessments derived in large part from data generated by standardized trawl surveys conducted using the Northeast Fisheries Science Center's (NEFSC's) *Albatross IV*, the rebuilding rates were determined to be below rebuilding targets. To comply with rulings of the U.S. District Court, in 2002

Figure 3. Nationalities of CIE reviewers, 1999 through September 2006.



the New England Fishery Management Council proposed Amendment 13 of the FMP, which required major cuts in commercial fishing. The public debate over Amendment 13 became highly contentious and politicized.

The issue that became known as "Trawlgate" burst onto the scene in this already highly charged atmosphere in the autumn of 2002 (Daley and Cook 2003; Van Zile 2003). Commercial fishermen speculated that the cables connecting the net to the winches on the *Albatross IV* were not properly marked, leading to uneven cable lengths on port and starboard and potentially skewing the net while fishing. The offset ranged from less than one inch at 100 meters of deployed cable, to just under 6 feet at 300 meters of deployed cable. This apparent defect perhaps caused the nets to be towed asymmetrically during eight bottom-trawl surveys conducted between 2000 and 2002. Acrimonious challenges to the credibility of the surveys, the resultant stock assessments, and Amendment 13 immediately followed.

These events required rapid and credible responses from NOAA Fisheries (www.nefsc.noaa.gov/survey_gear/). The NEFSC conducted gear performance experiments and detailed analyses of the degree to which the surveys in question had affected the groundfish stock assessments. A public workshop, termed the Groundfish Assessment Review Meeting (GARM), was held in October 2002 to present the results of these studies. A second public peer-review workshop was held in February 2003 to review the results of the GARM and for broader discussions of the trawl surveys, groundfish assessments, biological reference points for Amendment 13, and stock rebuilding projections. In addition, the NOAA Administrator ordered all of the fisheries science centers around the coasts of the United States to develop and implement written protocols for conducting their trawl surveys.

Three independent peer reviews conducted by the CIE were critical to establishing the scientific credibility of these responses. The first of these reviews was of the October GARM, which was attended by two CIE reviewers. Their reports concurred with the NEFSC's analyses showing that the trawl offsets did not have a major effect on the survey data, and that the data could be used in the assessments underlying Amendment 13 (Darby 2002; Volstad 2002). The CIE provided a panel of four reviewers plus a panel chair for the February peer-review workshop. The four panelists each provided an individual review report. The chair provided a report summarizing the views expressed in the four panelist reports (Payne 2003), which was a new type of CIE product at the time. These reports concluded that the sensitivity tests carried out by the NEFSC scientists had demonstrated that the survey data could be used unadjusted in the groundfish stock assessments, and made numerous technical recommendations regarding the surveys and assessments. The NEFSC compiled a point-by-point response to the reviews from the February peer-review workshop (www.nefsc.noaa.gov/groundfish/response.pdf), and committed in a letter to the New England Fishery Management Council to follow up on the major points raised by the reviewers (www.nefsc.noaa.gov/groundfish/cover.pdf). These reviews and follow-up actions effectively put an end to the Trawlgate matter (S. Murawski, NOAA Fisheries, personal communication). Subsequently, the council adopted Amendment 13. Finally, the trawl protocols developed by NOAA Fisheries were reviewed by two CIE (Godo 2003; Walsh 2003) and four other reviewers, including two commercial fishermen. Protocols requir-

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ing frequent, precise re-measurements are now in place in all NOAA fishery science centers. A positive aspect of this episode is that these protocols ensure more standardized and repeatable sampling.

Case 2: *Abundance of the coastal bottlenose dolphin in U.S. continental shelf waters between New Jersey and Florida during winter and summer 2002*

After massive die-offs of bottlenose dolphins in the late 1980s, NOAA Fisheries declared the Atlantic stocks of coastal bottlenose dolphin (*Tursiops truncates*) to be depleted, and created a Coastal Bottlenose Dolphin Take Reduction Team (TRT), consisting of scientists, recreational and commercial fishermen, and representatives from the environmental community. The TRT was responsible for recommending policies to reduce incidental takes of bottlenose dolphin by gill-net fisheries. Because most of the available estimates of dolphin abundance were speculative, the NOAA Southeast Fisheries Science Center (SEFSC) undertook research to estimate bottlenose dolphin abundance in the U.S. Atlantic coastal waters. Several aerial surveys were conducted over the continental shelf between New Jersey and Florida, and extensive skin-biopsy samples were collected during 2001 and 2002 to enable genetic identification of coastal versus offshore morphotypes and to describe their spatial distributions. A report on these activities, entitled "Abundance of the Coastal Morphotype of Bottlenose Dolphin, *Tursiops truncates*, in U.S. Continental Shelf Waters Between New Jersey and Florida During Winter and Summer 2002" (Garrison et al. 2003), was the subject of a CIE review during February 2003.

The CIE selected a panel of three internationally recognized scientists, with expertise in stock assessment, genetics, and marine mammalogy, to review this report by correspondence. The statement of work for the review specified that the reviewers evaluate: (1) the appropriateness of the design, execution, and analysis of the aerial surveys; (2) the appropriateness of the statistical methodologies used to distinguish the spatial distributions and habitats of the coastal versus offshore morphotypes; (3) the appropriateness of the resulting abundance estimate for coastal bottlenose dolphins; and (4) whether potential biases had been adequately identified and appropriate measures of statistical uncertainty had been included in the resulting abundance estimates.

The panelists independently concluded that the aerial survey had followed an appropriate design and used adequate methods for data analysis, had used appropriate statistical methods for distinguishing coastal from offshore dolphins, and had produced reasonable estimates of coastal bottlenose dolphin abundance. In addition, the reviewers made several recommendations that subsequently resulted in modifications to the process of surveying coastal bottlenose dolphins. For example, concerns about potential changes in dolphin abundance and inter-annual variability in distribution led SEFSC personnel to schedule surveys in winter 2003 and summer 2004 that filled data gaps left by the biopsy sampling during 2002. Other issues raised by the reviewers were considered by NOAA Fisheries, but not acted on. One reviewer noted that the research report did not consider the estuarine dolphin populations, whose presence in the survey area could have influenced the coastal dolphin abundance estimates.

IMPACTS OF THE CIE ON NOAA FISHERIES' SCIENCE

The CIE has had significant impacts on the science conducted by NOAA Fisheries. Perhaps the most tangible impacts have been at the scale of the recurring regional stock assessment and review processes: the SARC for the Northeast; SEDAR for the Southeast, Gulf of Mexico, and Caribbean; and STAR for the Pacific. CIE reviewers are now integral to all three of these processes, because of the benefits their presence provides. Recent SARC review panels have been composed entirely of CIE reviewers. Based on the experiences from the February 2003 groundfish peer-review panel, SARC review panels now have a chair provided by the CIE. In addition to running the panel, the chair provides a report summarizing the comments of the other reviewers, which is a product more easily used by the clients. SEDAR panels are now a mix of CIE and other reviewers. The SEDAR reviews typically utilize a chair supplied by the CIE. The STAR panels are also a mix of CIE and other reviewers. Although these recurring processes differ somewhat in detail, all involve the peer review of stock assessments that have been developed by NOAA Fisheries, and the products of these processes, including the CIE reviews, are provided as management advice to the regional fisheries management councils.

Many of the tangible impacts of CIE reviews are at the scale of the specific projects, such as constructive criticisms leading to modifications to stock assessments, field methods, and applied research projects. The case studies described above are examples. The tuna/dolphin issue in the Eastern Tropical Pacific provides an ongoing example of CIE reviews impacting a high-profile NOAA Fisheries science program. In the yellowfin tuna purse-seine fishery, nets are deployed around dolphin schools that associate with the tuna and are easier to detect. Historically this fishery killed up to 350,000 dolphins per year (U.S. DOC 2000). With the passage of the Marine Mammal Protection Act in 1972 and subsequent legislation, such as the International Dolphin Conservation Program Act in 1997, direct, observed mortality caused by fishing operations has been greatly reduced. The dolphins are still encircled by the nets, but most are released alive. Nonetheless, the affected dolphin populations have not recovered. The CIE has conducted a total of eight peer reviews on aspects of this problem between 1999 and 2006. The seven reviews conducted between 1999 and 2002 addressed ecosystem carrying capacity, physiological, and behavioral changes caused by the stress of encirclement by the purse seines, and stock assessment methods for determining dolphin populations. After the 2002 reviews, NOAA Fisheries developed a new research plan for determining why the populations are still not recovering (US DOC 2006). The 2006 CIE review evaluated this plan, providing constructive criticisms of the scope, organization, and proposed methods.

Although the benefits are not easily quantified, the CIE has also had intangible impacts on NOAA Fisheries' science and the management that depends on it. CIE reviews have quelled controversy when the agency's science has been challenged, as described in the Trawlgate case study. In reference to the CIE, the U.S. Commission on Ocean Policy (2004) stated, "Although the center's experts

have examined a number of controversial topics, their reviews have so far been less subject to challenge than internal NMFS peer reviews." Even when reviewers report legitimate shortcomings in the science, the very fact that the agency has brought in independent reviewers is a key first step in identifying and solving the problems and bolstering science quality and credibility over the long term.

FUTURE IMPROVEMENTS

Quality assurance for the reviewers and the review process, and assessment of the impacts of reviews on the agency's science, are issues that may receive attention in the future. These types of information could be useful for improving the quality of the products delivered to NOAA Fisheries and improving how reviews are conducted, as well as for eliminating individuals from the reviewer pool who do not perform adequately. Questionnaires have been drafted to address some of these issues, but they have not been fully developed or used, and there has been no substantive consideration of performance metrics. Currently the quality of reviews is assessed informally by the CIE's coordination team and steering committee. There is no formal mechanism for obtaining feedback from NOAA Fisheries on the quality or relevance of the reviews. There is some risk in providing a forum for the agency to evaluate the reviewers, as it could compromise the independence of the reviewer selection process. Other than through the contents of their reports, there is no mechanism by which reviewers can provide feedback to the CIE about the reviews in which they participate.

CONCLUSIONS

The CIE has proven to be a successful approach for obtaining independent peer reviews of NOAA Fisheries' science products. Where the science has been of high quality, the CIE's reviews have generally provided independent confirmation. This outcome has bolstered the credibility of the agency's science to a wide range of stakeholders, and helped to reduce the contentiousness that can accompany management decision making in the face of competing economic and societal values. Where reviewers have identified shortcomings, their recommendations have often provided valuable guidance for improvements. As such, the CIE could be a model for other natural resource and environmental agencies.

It can be anticipated that the need for peer review will continue to increase in the foreseeable future. Demand from within NOAA Fisheries for CIE reviews is continuing to grow, fueled in part by the requirements of the Information Quality Act and the OMB Peer Review Bulletin. As fisheries management begins to transition from the current single-species focus to ecosystem-based approaches, the underlying science and management decisions will become more complex, which will likely lead to an increased need for independent peer review. It is probable that other regulatory agencies at all levels of government will experience similar growth in the need for peer review. Thus, entities that can meet this need, like the CIE, will likely become more common as time goes on.

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