

# **SCIENTIFIC PEER REVIEW**

## **Guidance and Recommendations for the California Department of Fish and Wildlife**

California Ocean Science Trust

**Supported by**  
The California Ocean Protection Council

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## California Ocean Science Trust

Ocean Science Trust is an independent, non-profit organization that brings together governments, scientists, and citizens to build trust and understanding in ocean and coastal science issues. We empower participation in the decisions that are shaping the future of our oceans. We were established by the California Ocean Resources Stewardship Act to support managers and policymakers with sound science. For more information, visit our website at [www.oceansciencetrust.org](http://www.oceansciencetrust.org).

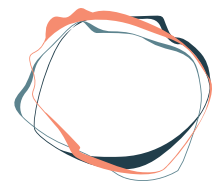
## Acknowledgements

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## About this Document

This project was developed for consideration by the California Department of Fish and Wildlife (CDFW) to help inform the State's process to amend the Marine Life Management Act (MLMA) Master Plan. All final products from this project have been submitted to CDFW for review and may be integrated, in full or in part, into a draft Master Plan Amendment. Additional information about the amendment process, including key resources and opportunities for stakeholder engagement, is available at <https://www.wildlife.ca.gov/Conservation/Marine/Master-Plan>.

## Management Context and Request

The MLMA of 1999 identifies science as a primary tool to be used in making management decisions in order to ensure the conservation, restoration and sustainable use of California's marine living resources. Scientific peer review (hereafter, "peer review") is a vital component to meeting these goals and certifying that fisheries management is supported by the best readily available science. CDFW and external practitioners coordinate peer reviews of science-based work products supporting State marine fisheries management (e.g., fishery management plans (FMPs), FMP amendments, interim research or management protocols, and marine resource and fishery research plans) as guided by initial provisions in the MLMA and existing Master Plan for Fisheries. However, the scope, process, rigor and independence of these reviews have varied widely in the past, and have ranged from individual written reviews to complex panel workshops. Given increasing demands for and complexity of fishery peer reviews in California, there is an opportunity to standardize existing procedures and continue to build out these practices into a rigorous fisheries peer review program for the State.

Through 2018, CDFW and its partners are amending the MLMA Master Plan for Fisheries in order to consider advancements in understanding of the status of California's marine resources, as well as new and emerging tools in the field of fisheries science and management. As part of the amendment, CDFW, with funding provided by the Ocean Protection Council, asked Ocean Science Trust to provide guidance to the State on ways to further standardize and streamline their peer review process, building on best practices on the use of peer review in natural resource management from California and elsewhere, lessons learned from past implementations, and existing policy guidance in California. CDFW requested recommendations and a suite of review options that can be widely applied to meet California's existing and future fishery management needs, with a focus on review of science supporting fishery management plans (FMPs).

## Report Scope

The project scope was developed in consultation with CDFW staff, the MLMA planning team, and OPC. Specifically, this report aims to:

- Summarize scientific peer review best practices that draw on lessons learned



from past CDFW reviews, as well as peer review models implemented by federal and international natural resource management practitioners

- Provide recommendations and a suite of review options that can meet current and future peer review needs on behalf of State managed marine fisheries
- Provide considerations and guidance on:
  - » Definitions and characteristics of peer review options, including potential strengths and weaknesses
  - » The level/type of review process most appropriate for a given work product, including recommendations for a minimum acceptable level of review to meet legal requirements or policy intent
  - » Timing of the peer review process
  - » When scientific information or documents should be subject to (or exempt from) scientific peer review
  - » Mechanisms that could be used to incorporate stakeholder engagement in the peer review process

Recommendations, guidance and considerations in this report were developed by Ocean Science Trust in discussion with an advisory group of the Ocean Protection Council Science Advisory Team (OPC-SAT). The advisory group was composed of an OPC-SAT member and other experts to provide input throughout the project, as well as final review of this report. Members include:

- **Christopher Costello**, Professor of Environmental and Resource Economics, Bren School of Environmental Science & Management, OPC-SAT member
- **E.J. Dick**, Research Fishery Biologist, Fisheries Ecology Division, NOAA Southwest Fisheries Science Center
- **Manoj Shivlani**, Lead Coordinator, Center for Independent Experts

CDFW staff Tom Barnes and Pete Kalvass, as well as members of the MLMA Planning Team, served as advisors to the project to ensure that guidance provided aligns with State needs.

## Looking Forward

The guidance within this report is intended to support cost-effectiveness, consistency, predictability, and transparency in the implementation of future fisheries peer reviews on behalf of CDFW, including the upcoming review of the Pacific herring and red abalone FMPs which will be administered by Ocean Science Trust in 2017.

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# 1. Introduction to Fisheries Peer Review in California

## 1.1. What is peer review?

Scientific and technical peer review (hereafter, “peer review” or “review”) is widely applied across numerous technical disciplines to assure products are of high quality, reflect solid scholarship, and that the information contained is accurate and based on rigorous, sound science (OST 2016). Peer review is a process where experts assess the extent to which a work product presents credible, defensible scientific conclusions. Review processes can vary widely depending on the practitioner, from academic journals which are charged with assessing the scientific validity of manuscripts submitted for publication, to federal agencies like the Office of Management and Budget (OMB) or the Environmental Protection Agency (EPA) which employ highly systematic processes for ensuring the validity of science informing decision-making (OMB 2005, EPA 2015). A standard peer review typically follows eight common steps (Figure 1) (OST 2016). However, the level of review and details of an individual process will depend on the review request, complexity of the materials under review, timelines and available resources, among other factors.

For California marine fisheries management, peer review is a vital component of meeting the goals of the Marine Life Management Act (MLMA) and ensuring that new science, models, methods and other scientific and technical work products developed by an on behalf of the California Department of Fish and Wildlife (CDFW), and presented to the California Fish and Game Commission (FGC), are defensible and meet high scientific quality standards. Peer review can help to enhance the credibility, integrity, and scientific rigor of a product, which is especially valuable when scientific information is controversial, highly influential or may inform costly decision-making. Often, when scientific information is the primary reason for making a difficult or unpopular management decision, the science can be highly criticized or challenged (NRC 2004). Thus, review that is perceived as independent and/or unbiased can increase confidence of the community (including scientists, managers and stakeholders) in the findings presented in a scientific work product (NRC 2004).

Management and policy elements are outside the scope of scientific peer reviews. Decision-making for fisheries matters beyond the scientific deliberation can involve stakeholder consultations, trade-offs, and compromises (all of which fall outside the purview of scientific peer review). For clarity and shared understanding, we define some commonly used terms throughout this report in Box 1.

## 1.2. Existing Peer Review Requirements

California Fish and Game Code<sup>1</sup>, the Marine Life Management Act (MLMA)<sup>2</sup>, the Master Plan for Fisheries<sup>3</sup>, and the CDFW Science Institute<sup>4</sup> provide general guidance and requirements for peer review of CDFW work products that contain scientific and technical information. Existing guidance is provided on the following topic areas:

- Documents that are subject to review
- Organizations who can perform external reviews
- Who can participate as reviewers
- How results from a review are considered

In order to support the development of a robust program, we summarize existing State guidance and requirements grouped by topic below, and identify opportunities and recommendations to build these out into a comprehensive program.

### What requires peer review?

Fish and Game Code states that CDFW may submit to *external* review, documents that include, but are not limited to:

- Fishery management plans (FMPs) and FMP amendments
- Interim research or management protocols
- Marine resource and fishery research plans

Additional guidance from CDFW's Policy for Quality in Science and Key Elements of Scientific Work (CDFW 2008) states that any "high profile proposals or work that has a substantial management impact or large expenditure of funds will be subject to formal independent peer review." While CDFW has requested reviews of data collection efforts, methods and models that support management and FMP development, these are not mentioned specifically as requiring review, but would likely fall under high profile work with substantial management impact, and should be subject to external review.



**Figure 1. Flow chart of general peer review process steps (OST 2016).**

<sup>1</sup> <http://codes.findlaw.com/ca/fish-and-game-code/>

<sup>2</sup> <https://www.wildlife.ca.gov/Conservation/Marine/MLMA>

<sup>3</sup> <https://www.wildlife.ca.gov/Conservation/Marine/Master-Plan>

<sup>4</sup> <https://www.wildlife.ca.gov/Science-Institute>

## BOX 1. Peer Review Definitions

To support shared understanding given the broad applications for peer review, we define some commonly used terms associated with California fishery reviews, drawing from existing legal and policy documents, where available. We also provide recommendations and identify where more clarity is needed.

**Peer review:** CDFW does not have a formal definition for peer review, although it may consider adopting the NRC definition: "Review in science is one of the more important processes to which a body of scientific work is exposed. It is the process through which practitioners with technical expertise in a particular field provide objective, constructive criticism on the validity of a body of work to ensure its compliance with scientific methods. The review process uncovers scientific problems of method, interpretation, approach, or failure to provide sufficient detail to reproduce analytical results." (NRC 2004).

It is important to separate peer review of scientific and technical work products, from review of the management decisions they inform. Often, management and policy recommendations within a work product are closely intertwined with scientific information. While it is critical that participating experts understand the policy and management context of the issue at hand, and how the final product is to be used in decision-making, management and policy elements are outside the scope of scientific peer reviews. In addition, a peer review process should not be used as a delay tactic, and should acknowledge that decisions need to be made in a timely fashion with available information despite recognized data gaps (NRC 2004).

**Internal peer review:** Internal review can have several meanings. Internal review can be generally defined as a review of a work product by qualified scientists within the institution producing the product who are not directly involved in the development of the product under review. Internal reviews may also be defined as reviews coordinated by the institution producing the product, with a panel of external reviewers not directly involved in the development of the work product under review. While both of these processes are valuable and can reduce costs and time associated with a review, they may be perceived as biased or lacking in independence. Thus, some experts suggest that internal reviews should not be conflated with the formal definition of "peer review" (NRC 1997). It may be valuable for CDFW to consider more narrowly defining the various types of review, and developing criteria for determining which type of review is appropriate (see section 2).

**External peer review:** External peer review is typically defined as a review led by a body outside the institution producing the product and including reviewers not involved in the production of the work product under review, and free from conflict of interest.

**Best available science:** California marine fisheries management is to be based on the best available science that CDFW or the Fish and Game Commission possesses or receives, per the goals of the MLMA. However, there are no state or federal guidelines that explicitly describe what constitutes "best available science," though the existing Master Plan for Fisheries does provide information about the types of scientific information that should be included in an FMP. The MLMA also states that lack of scientific information should not greatly delay taking action. In federal fisheries management, numerous lawsuits have challenged the use of "best scientific information available," leading to a National Research Council Committee on Defining Best Available Science for Fisheries Management to explore whether the term required further explanation or definition (NRC 2004). The committee determined that a statutory definition of what constitutes "best scientific information available" was inadvisable because it could impede the incorporation of new types of scientific information. However, they suggested the establishment and adherence to 6 guidelines:

- Relevance
- Inclusiveness
- Objectivity
- Transparency and Openness
- Timeliness
- Peer Review

Regional fishery management councils in the federal fisheries management process (NOAA Fisheries) generally interpreted "best available science" as the most recent and relevant information available to them at the time of FMP development. CDFW should consider balancing the emphasis on both the quality (best) and timeliness (available) of scientific information.

**Credible science:** "Credible science" means the best available scientific information that is not overly prescriptive due to the dynamic nature of science, and includes the evaluation principles of relevance, inclusiveness, objectivity, transparency, timeliness, verification, validation, and peer review of information as appropriate. Credible science also recognizes the need for adaptive management as scientific knowledge evolves (FGC §33).



Products subject to *internal* review by CDFW or CDFW-selected professions with relevant experience include:

- Written proposals or reports
- Data sets
- Manuscripts (for submittal to a scientific journal)

For additional considerations for determining what level of review is appropriate for a work product, see section 2.2 below.

### **Exempting Work Products from Peer Review**

According to the Master Plan for Fisheries, "The Commission, with advice from [CDFW], shall adopt criteria to determine whether any MLMA document may be exempt from peer review" (FGC §7075(c)). Currently, no criteria exist for exempting documents from peer review. Thus, if exemption criteria have not been adopted, "all MLMA related documents must be peer reviewed" (CDFW 2001).

Reviewing all scientific documents may be cumbersome, redundant, and/or result in limited resources allocated to peer reviews of work products that contain routine analyses or have already gone through some level of scientific vetting or review. It is important that CDFW develop transparent criteria that managers can consider as they determine whether a work product should be exempt from peer review without compromising the scientific integrity of work products supporting decision-making. CDFW may consider adopting criteria from box 2, which were developed based on exemption criteria applied to reviews by the EPA, OMB Peer Review Bulletin, National Oceanic and Atmospheric Administration (NOAA) Fisheries, and National Research Council (NRC).

In addition to considering exempting entire work products from review, managers may consider requesting review of only subsections of a document where new scientific information, analyses, or data are used or applied. For example, draft FMPs contain sections on management and policy, as well as biological information that has been widely accepted by the scientific community. In such cases, the scope of the review may be constrained to new methods, data and analyses. The process and purpose for exempting components for review should be clearly noted to communicate to both reviewers and interested stakeholders that the exempted sections were purposefully omitted from peer review based on predetermined criteria.

CDFW should also allow for review of work products that contain confidential information. To handle this, reviewers could be asked to sign non-disclosure agreements, and any review reports made available to the public should appropriately aggregate any confidential data.

#### **BOX 2. Potential criteria to consider when determining whether to exempt work products (or portions of work products) from scientific review.**

- The product does not contain scientific or technical information from which decisions are based
- The work product has already been subject to a prior adequate peer review within a reasonable time period
- A peer review process would significantly interfere with the need for promptness in decision-making or secrecy of information
- Routine data, information and analyses to compute standard indicators and trends performed using properly applied, scientifically accepted methods
- Information disseminated in the course of an individual adjudication or permit proceeding
- Information involving a health or safety issue where dissemination is time-sensitive
- Accounting, budget, actuarial and financial information

## Review Coordinating Bodies

According to Fish and Game Code §7062(b), CDFW “may enter into an agreement with one or more outside entities that are significantly involved with researching and understanding marine fisheries and are not advocacy organizations.” The peer review coordinator is responsible for the scientific integrity of the peer review process, and may include, but is not limited to the following entities (FGC §7076(b)): The existing provisions list the following entities:

- Sea Grant program of any state
- University of California
- California State University
- Pacific States Marine Fisheries Commission
- Any other entity approved by the commission to select and administer peer review panels

Any external review coordinating body should be free from conflict of interest, and should maintain neutrality in the outcomes from a review. While the external review coordinating body should maintain a certain level of independence from CDFW throughout the course of the review, it may still be valuable to have two-way interactions between CDFW staff and reviewers. For example, CDFW staff may be asked to present on model methods, inputs and usability at the start of a review while still allowing time for reviewers to convene independently.

## Review Participants

As detailed in Fish and Game Code §7076(b), peer review panels shall meet the following criteria:

1. Panels must be composed of individuals with technical expertise specific to the document to be reviewed
2. Panel members cannot be employees or officers of the CDFW or the commission
3. Panel members cannot have participated in the development of the document to be reviewed

CDFW's Science Institute provides additional guidelines for convening science advisory committees (SAC) (CDFW 2012), which may also be applied to convening of review panels:

- CDFW may specify required areas of scientific expertise among SAC members, but the review appointing agency will identify such experts and have final appointing authority for members
- Members will be selected based on scientific expertise in relevant discipline(s), and ability and time to fully participate in SAC activities
- Potential members must disclose any potential conflicts of interest and cannot have financial conflicts of interest

In addition to the above criteria for determining whether an expert is appropriately qualified for participating in a review, we suggest also considering objectivity, fairness, and neutrality in the outcome. When assembling a review team, practitioners should consider convening experts from multiple affiliations (e.g., academic institutions, independent or non-governmental and non-advocacy organizations, and state/federal agency scientists) to deliver balanced feedback and multiple perspectives (OST 2016). In order to fulfill federal requirements and maintain the impartiality and independence of peer reviews of National Marine Fisheries Service (NMFS) science, as well as broaden the pool of outside experts available to participate in reviews, NOAA Fisheries instituted the Center for Independent Experts (CIE) in 1998 (Brown et al., 2006). CIE reviewers participate in both in-person and remote reviews alongside other NOAA-selected experts, and follow strict conflict of interest guidelines. The CIE is administered by an outside consultancy, and eliminates any role for NOAA in selecting reviewers, or in approving the contents of review reports. CDFW may choose to consider a similar model as the complexity and need for peer review grows in California.

Fish and Game Code §7076(b) allows peer reviewers to be compensated for their participation.

## Product Produced from a Peer Review

According to Fish and Game Code, an external peer review entity “shall provide the department with the written report of the peer review panel that contains an evaluation of the scientific basis of the document. If the report finds that the department has failed to demonstrate that a scientific portion of the document is based on sound scientific knowledge, methods, and practices, the report shall state that finding, and the reasons for the finding” (FGC §7062).

In the past, review reports have varied from individual written reports, to higher-level consensus recommendations. In order to provide consistency across reviews, it may be useful to develop a suggested template for review reports based on the category of review selected (i.e., methodology review, stock assessment review), similar to what is included in the Pacific Fishery Management Council (PFMC) Terms of Reference documents (Appendix A).

## Using Results from a Review

According to Fish and Game Code, CDFW may “accept the finding, in whole or in part, and may revise the scientific portions of the document accordingly” (FGC §7062). Disagreements with any aspect of the findings require a written explanation of reasoning for arriving at such a determination, to be included as part of a record to be included for the adoption of the final document (Box 3). The peer review report shall be submitted to the FGC with any peer-reviewed document that is to be adopted or approved. CDFW should also include information in any final work product that appropriately describes the external review process and how the results were considered.

For past external reviews on behalf of CDFW, a review process typically ended after the final review report has been delivered to CDFW and other partners. However, a review coordinating body may consider hosting a results sharing briefing with CDFW to walk through some of the more technical recommendations, as well as facilitate discussion among reviewers and CDFW staff as they consider review feedback and revise the work product.

### **BOX 3. Dealing with disagreements among reviewers or conflicting reviews**

While it is not the goal of peer review to achieve consensus among reviewers, contrasting viewpoints or recommendations about major components of the subject matter can be difficult to resolve. This may occur more frequently during written reviews where experts do not communicate with one another during the process. However, panel workshops may also produce conflicting recommendations.

While any review output should appropriately represent any dissenting or contrasting views, it is not the role of a review coordinating body to resolve or prescribe which recommendation to consider or accept over another. This role could be deferred to the review committee chair, or depending on the level and subject of disagreement, CDFW or the review coordinating body may choose to consult with an outside expert.

As noted here, CDFW is required to provide written explanation if they disagree with any aspect of the review findings. A written response and justification could also be appropriate when responding to conflicting reviews. The review committee chair, outside expert, or the Fish and Game Commission could serve as moderator to make a final determination of whether an issue was reasonably addressed.

### 1.3. CDFW Peer Review Practices

CDFW, with support from external practitioners, requests both internal and external peer reviews of science work products supporting California's marine fisheries management. Because of the diverse needs and practical interests of the State's many marine fisheries, there has not been a "one-size-fits-all" process for review of the scientific work products informing their management. Thus, the scope, process, level of rigor and independence of these reviews varied widely in the past, ranging from individual written reviews to complex multi-day panel workshops (Table 1). Work products submitted for independent review have included stock assessments, survey methodologies, new tools and models, and draft FMPs.

As CDFW considers a new framework for MLMA-based management as part of the Master Plan for Fisheries amendment process through 2018 and considers new management approaches and innovative science-based tools, the complexity of scientific peer review may grow. In addition, Fish and Game Code stipulates that CDFW "shall establish a program for external peer review of the scientific basis of marine living resources management documents" (FGC §7062). There is a need for the development of a robust but streamlined program that can meet the State's current and future needs. However, beyond general guidance, little direction is given on the structure of such a program. As we discuss in more detail in the following sections, there exist a wealth of resources and existing fishery peer review programs from which to draw from as CDFW continues to refine its peer review practices.

## 2. Determining an Appropriate Level and Mode of Review

### 2.1. Planning for Peer Review in the FMP Development Process

Based on need and resources, peer review may occur at multiple points within an FMP development timeline, from evaluating emerging methods and data collection (e.g., is sampling developed in a way that is informative and defensible?), to after the development of the draft FMP (e.g., are the proposed fishery reference points scientifically sound and supported by the best available science?) (Figure 2). Appendix B includes a checklist that can be used by CDFW and review coordinating bodies to plan for an upcoming peer review process. It is recommended that review of technical models included in and supporting an FMP or other management documents should be reviewed prior to and independently from review of a full draft. That way, any technical elements in the models have been assessed and revised before they are applied.

In any review process, CDFW should identify items that would benefit from periodic review (i.e., formalize a process to periodically re-review science within a work product as new information or analyses become available, or if issues come to light after a program has been in place over a period of time). Models and new methods often require continual refinement to ensure that they are effectively meeting management goals. This may be considered as part of adaptive management within an FMP.

CDFW project managers should budget for and build in adequate time for review at the outset of a scientific project that expects the need for peer review. It is recommended that CDFW notify an external review coordinating body of a review request several months to a year prior to delivering the draft documents to allow for contracts to be put in place, as well as internal resource and logistical planning on the contractor's end. Time should be budgeted for reviewers to familiarize themselves with the review materials, as well as for drafting, reviewing and finalizing the summary report. Additional data, analyses, or document requests from the client, as well as including a public component (if necessary) to the review will also add time to the process. The cost for conducting a scientific and technical review will vary depending on the number of experts required, the complexity of the review, and whether reviewers are required to meet in person. See Ocean Science Trust's peer review guide for approximate budget ranges based on the review mode selected (OST 2016).

**Table 1. Summary of scientific peer reviews of California Department of Fish and Wildlife work products from the period of 2001 – 2017. Note: statutory program reviews are omitted.**

Work product	Review Year	Review Type	Coordinating Entity	Review Format	Stakeholder Involvement	Number of Reviewers	Review Output
Draft Nearshore FMP	2001	FMP	California Sea Grant Extension Program	1-day workshop	none	6	Individual written reports, consolidated report
Draft White Sea Bass FMP	2001	FMP	California Sea Grant Extension Program	1-day workshop	none	4	Individual written reports, consolidated report
Draft Market Squid FMP	2002	FMP	California Sea Grant Extension Program	2-day workshop	none	5	Compiled summary report written by review panel (internal)
Draft Abalone Recovery and Management Plan	2002	FMP	California Sea Grant Extension Program	2-day workshop	none	4	Compiled summary report from CASG (internal)
Model Supporting the Herring Stock Assessment	2003	Methodology	California Sea Grant Extension Program	2 day workshop	none	3	Report <a href="#">available here</a>
Sheephead Stock Assessment	2004	Stock Assessment	CDFW	Meeting	unknown	3	Report <a href="#">available here</a>
California Halibut Assessment	2011	Stock Assessment	CDFW	3-day workshop	Workshop open to public with public comment	3	Report <a href="#">available here</a>
Spiny Lobster Stock Assessment	2011	Stock Assessment	CDFW	2-day workshop	none	3	Report <a href="#">available here</a>
Abalone Density Estimation Method	2014	Methodology	Ocean Science Trust	Multiple remote webinars, 1-day workshop	Multiple remote webinars open to public with public comment	6	<a href="#">Executive summary</a> and <a href="#">full report</a>
Draft Spiny Lobster FMP	2015	FMP	Ocean Science Trust	Multiple remote webinars	none	4	Report <a href="#">available here</a>
White Seabass Stock Assessment	2016	Stock Assessment	P.I.E.R.	2-day workshop	Workshop open to public with public comment	2	Summary report <a href="#">available here</a>
Pacific Herring Stock Assessment	2016/17	Stock Assessment	CDFW	2-day workshop	none	3	In progress

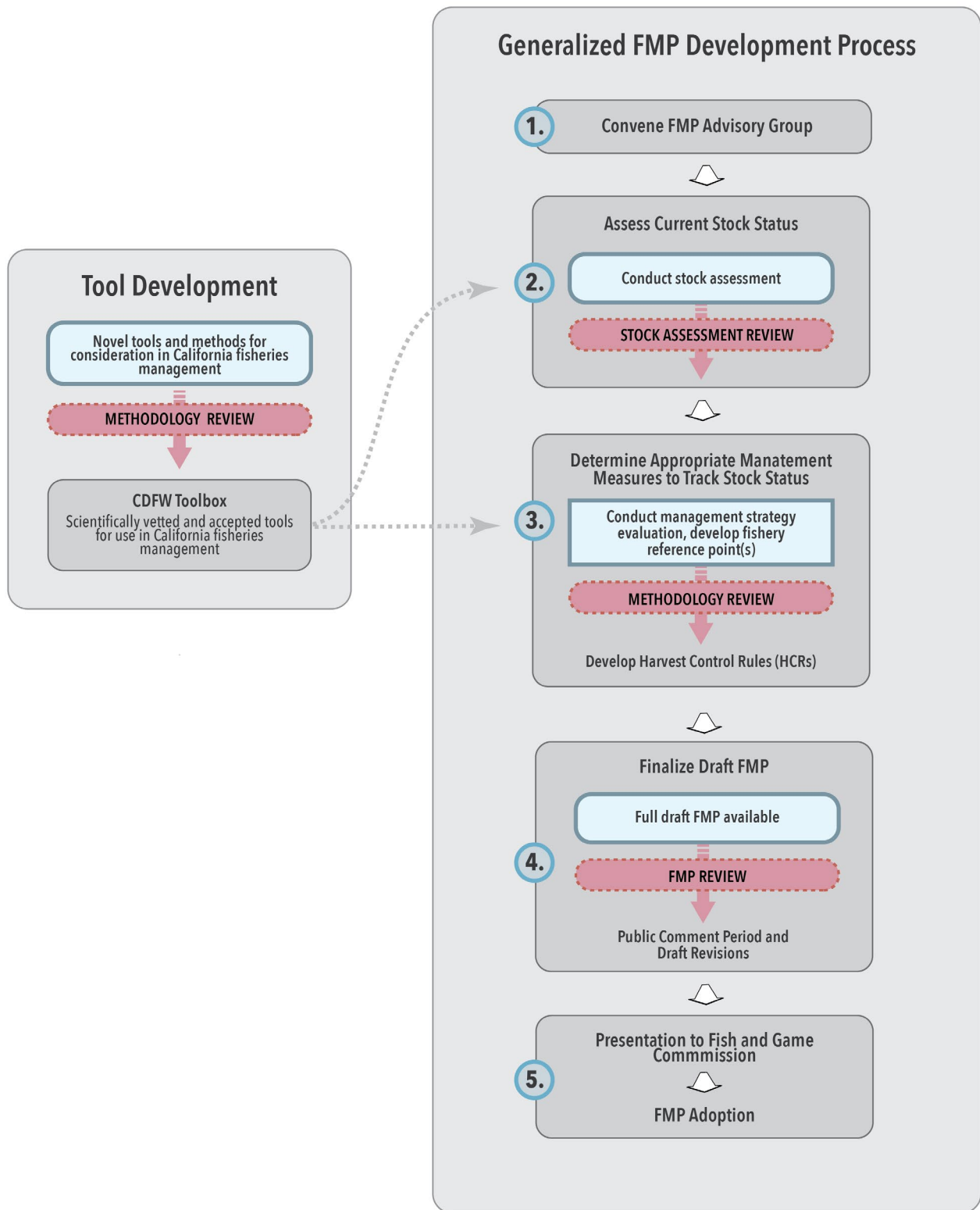


Figure 2: Suggested checkpoints for scientific peer review in a generalized fishery management plan development process.

## 2.2. General Modes of Peer Review

Most scientific review processes supporting California marine fisheries management will fall into four main “modes.” Below, we describe the modes of review, circumstances where a mode may be most appropriate, and some benefits and challenges of each (Table 2). We then discuss criteria that CDFW may consider when determining an appropriate level of review.

1. **Independent expert written review** – a process that calls upon multiple experts to produce independent written assessments of the work product; reviewers do not typically interact with one another.
2. **Panel review (remote)** – this type of process typically convenes experts in multiple group discussions that occur remotely.
3. **Panel workshop review (in-person)** – a panel or committee of experts participate collaboratively in a review during an in-person workshop.
4. **Journal peer review** – a process by which a manuscript is reviewed by experts selected by a scientific journal editor before it is published in scientific literature.

These general modes of review may be combined in different ways throughout the FMP development process. For example, in some instances a journal review could be in addition to or in place of some of the above modes.

## 2.3. Selecting an Appropriate Level of Review

First, CDFW must first determine whether a work product should be (a) coordinated *internally* by CDFW with reviewers comprised of CDFW scientists not involved in the production of the work product, (b) coordinated *internally* by CDFW with *external* independent reviewers, or (c) led entirely by an *external* contractor. An internal review can be rigorous, but may not have the same level of actual and perceived independence and potential buy-in of the review outputs. An external review may be advisable when one or a combination of the following circumstances applies (NRC 2004; Shivilani, personal communication):

- Questions exceed the expertise of the internal review team
- There is substantial scientific uncertainty
- The findings are controversial
- There are a range of scientific opinions regarding the proposed action
- There are concerns that the internal review will not be perceived as sufficiently independent, regardless of whether it is or not

Currently, CDFW does not have formalized criteria for determining an appropriate level of peer review for a work product informing California marine fisheries management. For external coordinated reviews, the decision has often been determined by the CDFW project team and management in consultation with the peer review coordinating body. The driving force for the level of review should be the application. Peer review serves the purposes of providing the best available science and reducing distrust, and if that requires a more extensive process, then the benefits should be weighted accordingly. Based on practices adopted by other review programs and in consultation with review experts, we developed criteria to consider when determining an appropriate level of review (Box 4).

These criteria should be appropriately balanced when determining the level of review. For example, while a fishery research plan developed for a low-value fishery with minor management implications may typically fall to a written review process, a more involved review may be appropriate (e.g., panel review) if it is the first application of a new model or analyses (i.e., a precedent setting circumstance). Thus, more attention and rigor may be given to such a work product whereas subsequent similar reviews may not require the same level of scrutiny.

**Table 2. A breakdown of four modes of review and considerations for each.**

<b>Review mode</b>	<b>Example applications</b>	<b>Potential work product</b>	<b>Benefits</b>	<b>Challenges</b>
<b>Expert written review</b>	<p>Products of short to moderate length, and low to moderate complexity</p> <p>Work products that are unlikely to have highly significant management implications</p>	Status of the fisheries reports, fishery research protocols, draft FMP of low to moderate complexity	<p>Quick, less costly</p> <p>Multiple independent reviews offers diverse viewpoints</p>	<p>No group discussion or deliberation</p> <p>Reviewers may have contrasting or opposing views</p>
<b>Panel review (remote)</b>	<p>Moderately complex methodologies, models or data analyses that require group discussion and participation of agency staff</p> <p>Reviews requiring international participants</p> <p>Work products that are likely to have moderately to highly significant management implications</p>	Draft FMPs or methodologies of moderate to high complexity	<p>Allows for deliberation among reviewers and managers</p> <p>Relatively easy to accommodate public participation</p>	<p>Moderately costly, moderately time-intensive</p> <p>Does not allow for in-depth group working sessions</p>
<b>Panel workshop review (in-person)</b>	<p>Complex methodologies, models or data analyses that require group discussion and participation of agency staff</p> <p>Newly applied methodologies (first application in California fisheries management)</p> <p>Reviews requiring additional analyses or model runs</p> <p>Work products that are likely to have moderately to highly significant management implications</p>	<p>Stock assessment, complex or highly complex draft FMP or methodology</p> <p>Highly controversial reviews</p>	<p>Allows for deliberation among reviewers and managers, real-time analysis, discovery and back and forth deliberation.</p> <p>Some formats allow workshops to be open to the public which may increase buy-in</p>	<p>Requires extensive pre-workshop planning</p> <p>Costly, time intensive</p>
<b>Journal peer review</b>	<p>Complex methodologies, models or data analyses, and novel science</p> <p>Decisions or scientific information that would benefit from highly rigorous scientific vetting</p> <p>Scientific information that could be built upon or would benefit the wider academic community</p> <p>Controversial findings or results inform influential or costly management decisions</p>	Varied; Methodology, models, new data, analyses	Ensures product meets high standards of scientific quality	<p>Not reviewed in a transparent manner, may not allay public concerns</p> <p>Time-intensive – may not be appropriate for time-sensitive findings or conclusions; Manuscript must align with journal publication timelines</p> <p>Competitive process</p>



**Box 4. Recommended criteria\* to consider when determining an appropriate level of review required for a work product:**

- **Complexity** - Nature and complexity of scientific information in models, analyses, method. However, there is often no relationship between the level of review conducted, and the amount of data available for a fishery
- **Uncertainty** - Level of scientific uncertainty surrounding a body of scientific knowledge
- **Level of previous review** - Level of previous scientific review or vetting
- **Precedent** - whether science is regarded as “precedent setting,” particularly novel, or is the first application of a new tool or model
- **Management implications** - Significance of information and decision-making implications
- **Controversy** - Level of controversy associated with an issue or fishery
- **Socioeconomics** – social and/or economic value of the fishery and economic impacts of decisions that will be informed by the scientific information; cost-benefit analysis of additional review
- **Author** – Both the expertise and reputation of the author/contractor who completed the work
- **Group discussion** - Benefits to be gleaned from group deliberations

*\*Note: Criteria are not listed in priority rank or order of importance.*

Review processes should also accommodate shifting priorities and political climates. For example, the level of controversy for a work product could be low initially (and thus the product would receive a lighter review) but may become controversial in the future. This type of situation may necessitate a more careful review in the future should the State’s priorities shift.

While criteria in box 3 are currently qualitative, CDFW may consider development of a “cost-benefit” model as a semi-quantitative metric for screening a work product to determine an appropriate level of review (Costello, personal communication). While we have not seen this approach formalized elsewhere, it builds on the concept of the value of information. When making decisions under uncertainty, one must weigh the benefits versus the costs of information. The benefits of a more extensive peer review derive from making better-informed decisions of particular social relevance. The costs of a more extensive peer review might arise, for example, from needing to assemble larger panels with more scarce expertise on a particular topic. In principle, these effects should be balanced in the selection of the rigor of a peer review.

## **2.4. Suggested categories for peer review of science supporting Fishery Management Plans**

Based on the various categories of CDFW work products and practices undertaken by the PFMC, most fishery peer review work products fall into four general categories:

- A. Draft FMP reviews**
- B. Stock assessment and/or Management Strategy Evaluation reviews**
- C. Methodology reviews**
- D. Review of science supporting focused rulemaking or routine management measures**

We provide suggested “checkpoints” for scientific peer review of science in a generalized fishery management plan development process (Figure 2). Each FMP development process will vary, thus not every checkpoint will be

necessary, nor will every checkpoint require the same level of review each time. For example, if a Management Strategy Evaluation (MSE) determined that a simple control rule (as opposed to a stock assessment) could provide adequate protections and yield for a stock, effort controls based on monitoring could require less review than a stock assessment with dozens of data inputs. Likewise, if stock assessment and methodology reviews have been undertaken during the development of an FMP, the intensity of peer review of the final draft FMP (that considers information from all of these tools) can be reduced.

In addition to the four modes above, CDFW has also has the need for program reviews (e.g., Ocean Resources Enhancement and Hatchery Program, 2015-2017; MLMA Implementation, 2011) and management reviews. While many of the concepts and recommendations in this report may be relevant and pertain to these types of reviews, they are outside the scope of this report and not discussed in detail here.

Currently, there is no transparent, systematic approach for each of category of review undertaken on behalf of CDFW work products. CDFW may consider developing protocols and responsibilities for each category that can be made publicly available, similar to what is included in PFMC "Terms of Reference" reports (Appendix A). Below, we describe some best practices and recommendations for each category of review.

## **A. Draft Fishery Management Plan Review**

According to Fish and Game Code §7075(a), all FMPs and FMP amendments are subject to external peer review (unless CDFW determines that peer review of the plan or plan amendment may be exempted<sup>5</sup>). Review of a draft FMP should occur late in development when a full high quality draft is completed (reviewers should not be used as FMP development teams/advisory committees), and preferably before public comment so that the science has been reviewed, and any issues addressed, before a draft is released to the public. Review processes of methodologies, complex models, or stock assessments supporting an FMP should occur separately from review of a full draft FMP (Figure 2). Thus, any draft FMP review can focus on how the models or methods have been applied, and less on the mechanics of the models themselves.

Based on operating procedures of the PFMC, an FMP peer review should evaluate "statistical, biological, economic, social, and other scientific information, analyses, analytical methodologies, literature, research, and other information" relevant to decision-making (PFMC 2016a). Rather than a line-by-line assessment, an FMP review may consider addressing the following questions<sup>6</sup>:

- *Do the scientific and technical components within and supporting FMP form a rigorous framework that can support sound fishery management decisions?*
- *Are there critical discussions or literature that should be factored into the FMP that would substantially strengthen the document?*
- *Are the models' interpretations technically sound, appropriate and supported by the best available data?*
- *Are the proposed reference points scientifically sound and supported by the best available data (as presented in the FMP and additional CDFW presentations/materials)? Are the thresholds sufficient and appropriate for identifying important changes/trends in stock status?*
- *Are research and monitoring needs comprehensive to allow CDFW to collect and maintain essential fishery information necessary to achieve management targets for the stock? Are there any priority gaps in research and monitoring that should be addressed or included?*

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<sup>5</sup>Note: In order for CDFW to consider exempting work products from peer review, the Fish and Game Commission must first "adopt criteria to be applied in determining whether a plan or plan amendment may be exempted from peer review" (FGC §7075(c)).

<sup>6</sup>Questions in section A through C were modified from Ocean Science Trust review instructions for past reviews as well as PFMC TOR documents.

If the FMP is at the high quality draft stage and the supporting models and methods have already been reviewed, it is likely best to consider a written review. Considering the level of previous review of the individual components of the FMP, the full draft may not necessitate a highly processed technical review. However, if enough concern were to emerge, then a follow-up webinar and/or workshop review could be conducted.

## **B. Methodology Reviews**

Methodology reviews are appropriate when a major data source is introduced, when a new tool is developed for consideration in management, or when a major change is made to a method or model (PFMC 2016b). Ideally, the scientific and technical merits of a new methodology proposed for use should be reviewed prior to and separately from application to help ensure any issues are worked out in the tool before it is applied in an FMP or other management work product. A reviewed model can then slot into an "accepted" toolbox for use in fishery management, and any subsequent application may not need the same level of review (Figure 2).

A methodology review scope will vary depending on the work product under review, but may consider addressing the following questions:

- *Are the analytical methods used appropriate and technically sound?*
- *Are the research, data collection, and analyses supporting the methodology comprehensive and representative of the best available science?*
- *If it is a new methodology proposed for use, how does it improve on existing approaches, and how can it be applied in support of management targets for the stock? Were alternative methods considered, and if so, why were they rejected?*
- *What research and/or monitoring are needed to improve the methodology in the future?*

The modes of peer review most appropriate for methodologies are remote panel reviews, panel workshops, and/or journal peer review. The methods tend to be novel, untested, and can be subject to controversy.

## **C. Stock Assessment and Management Strategy Evaluation Reviews**

Stock assessments use fishery dependent and independent data to describe past and current status of a fish population or stock to help managers make predictions about how a fishery will respond to current and future management measures (NOAA Fisheries<sup>7</sup>). Management Strategy Evaluations (MSE) are simulations that compare among different combinations of data collection efforts, methods of analysis and subsequent management actions in order to identify an appropriate strategy, or to understand the effectiveness of an existing management strategy (Punt et al. 2014). Several MSEs are currently under development, and stock assessments have only been completed for a handful of state-managed marine species in California due to the resource-intensive nature of the exercise and the data required for a fishery. However, as more data-poor, rapid stock assessment and MSE methods become available, CDFW will likely conduct more frequent assessments and evaluations that require peer review.

A stock assessment and/or MSE review may consider posing the following questions to the review team:

- *Are the underlying assumptions, data inputs, model parameters, and other pertinent information scientifically sound and appropriate?*
- *Are additional sensitivity runs, analyses, or data required to support the peer review process?*
- *Does the stock assessment or MSE represent the best available scientific information to inform the development of harvest control rules? Are there any deficiencies in the input data or analytical methods?*
- *What additional research and monitoring are needed to improve the assessment and fishery management in the future?*
- *What data sets were considered but rejected for the final model, and why were they rejected?*

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<sup>7</sup>[http://www.nmfs.noaa.gov/stories/2013/06/science\\_stock\\_assessments.html](http://www.nmfs.noaa.gov/stories/2013/06/science_stock_assessments.html)

The mode of peer review most appropriate for a stock assessment or MSE is a panel workshop because of the need for group discussion and additional data analyses. In addition to reviewers, stock assessment and MSE review workshops often include the FMP management team and CDFW scientists, as well as additional stock assessment and MSE experts. Stock assessment review processes have been well established for federal fisheries management. Groups like South East Data, Assessment and Review (SEDAR) and PFMC Stock Assessment Review (STAR) Panels may provide informative examples of successful approaches that vary in detail and level of time and analyses required.

#### **D. Review of Science Supporting Focused Rulemaking or Routine Management Measures**

Routine management measures are those that are likely to be adjusted annually or more frequently, and may include changes to conservation area boundaries and trip limits, and bag and size limits, among other measures. Often, the science supporting these measures has been previously reviewed or relies on expert judgment. Given the need for timeliness, the mode of peer review most appropriate for science supporting focused rulemaking or routine management measures may vary, but will likely fall under internal review or external expert written review depending on the significance and implications of the rulemaking. Where there is an advanced knowledge that the issue may be controversial, it should be determined (e.g., using a cost-benefit analysis, as stated above) whether the benefits of a panel or remote panel review with public, stakeholder, and agency input may mitigate the costs of the more extensive process.

### **3. Additional Considerations**

#### **3.1. Options for Considering Stakeholders in a Review Process**

Stakeholder buy-in of a review process and outputs may be of particular importance for highly controversial or sensitive fisheries. Understanding who key stakeholders are, and how they are likely to react to a review, can help identify the best ways to engage them in the process. CDFW should consider whether a transparent process is consistently applied across all reviews, or whether stakeholder involvement is determined on a case-by-case basis depending on the needs of a review. Pacific Fishery Management Council review panel meetings are all open to the public and announced on the Council's website, and all background materials are made available online. However, in an analysis of past CDFW reviews from 2001-2004, it was recommended that outside stakeholders should not attend or participate in the peer review panel meetings (Deweese et al., 2004). While these groups or individuals will not be directly involved in conducting the review or assessment, their larger role in the review process can be considered. This can take many forms, including:

- Advertising/publicizing panel reviews for public attendance
- Allowing for public comments over designated periods at a panel review
- Sharing review materials and final review reports online
- Sending review status updates to a stakeholder email distribution list
- Implementing a public reviewer nomination process
- Making reviewer identities and expertise publicly available, either at the outside or upon completion of a review
- Hosting public information-sharing meetings or webinars with time for public comment

Guidance on how stakeholders may participate as well as how their input will be utilized should be made clear at the outset of a review.

### 3.2. Convening a Standing Scientific Committee

CDFW Marine Region may consider convening a standing committee to provide ongoing expert scientific and technical advice to inform management decisions, similar to the Science and Statistical Committee of the Pacific Fishery Management Council. Such a body would play a number of different roles that go beyond scientific review, though it could also consider assisting with planning and coordination of marine fishery peer reviews by:

- Providing scientific information, recommendations and advice to inform the development of FMPs
- Developing procedures and protocols for the various categories of peer review
- Serving as a source for internal reviewers, chair and participate in panels, or provide reviewer recommendations
- Helping CDFW managers and the FGC evaluate scientific information
- Making scientific recommendations for the composition of FMP development

Long-term funding and staff support of such a committee would need to be considered.

### 3.3. Review of Independently Produced Science to Inform Management

Some examples of independently produced science include studies, data collection and approaches led or conducted by fishing cooperatives, citizen scientists, local and traditional ecological knowledge, NGO funded fishery research, and independent academic-produced research. It is often easier for CDFW to consider work that has been peer reviewed via traditional journal review. However, unpublished data and methods should be held to (at a minimum) the same standard as internally-derived products. Criteria in Box 3 would be equally applicable to independently produced science. If this information (say, a novel approach to assessing data poor stocks) were used in major decision-making processes that lead to shifts in management, then more peer review would be needed to:

- Ensure that the approach represents the best available science, regardless of its pedigree
- Make certain that approach is most suitable for the management decision in question

Aside from the level of review required for this type of science, there is no clear pathway for integrating novel, independently produced science in California fisheries management. A standing committee, as proposed in 3.2 above, could potentially be a "gatekeeper" for the applicability of such work in addition to a formal process for gathering and considering work developed by independent groups.

## 4. Conclusion

As we discuss throughout this report, there exist a wealth of resources to draw from - both policy guidance and lessons learned from previous reviews - as California continues to refine its peer review practices for State marine fisheries management. While scientific review can be a resource and time-intensive process, it can help to demonstrate that fishery management decisions are based on valid and defensible science. A transparent process can also demonstrate a commitment to objectivity and help build relationships with stakeholders. Many of the recommendations contained in this report simply require standardizing and formalizing existing practices and processes to ensure consistency across review implementations. Similar to the iterative process of adaptive management, a successful peer review program should aim to improve over time as we learn from the outcomes of future fishery peer reviews.

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# Appendix A: Terms of Reference and Sample Report Template

The Pacific Fishery Management Council (PFMC) establishes Terms of Reference (TOR) documents that lay out general procedures and responsibilities that contributors should aim to adhere to when conducting a formal process such as developing and peer-reviewing a work product. A TOR is typically developed for each type of review (e.g., stock assessment review, methodology review) and for each fishery management sector (e.g., groundfish, coastal pelagic species), and revisited and updated on a regular basis based on feedback and recommendations from the previous year. TOR documents detail the objectives, approaches, reporting requirements, and responsibilities of participants. For transparency, they are made publicly available. Each individual review will likely have unique requirements that can be defined in a Specific Terms of Reference or scope of work which conform to the more general terms.

A TOR can include information on:

- Review process goals and objectives
- Roles and responsibilities of participants
- Structure and qualifications of the review panel participants
- Structure of meetings and/or workshops
- Process for requesting additional data or analyses
- Guidelines for dealing with uncertainty and areas of disagreement
- Guidance on structure of the review report (see below)
- Calendar or timeline for upcoming reviews within a given year

## Suggested Template for Methodology Review Panel Report

The following suggested template has been adapted from Terms of Reference for the Methodology Review Process for Groundfish and Coastal Pelagic Species, 2017-2018.<sup>1</sup>

- Summary of the Methodology Review Panel meeting, containing:
  - » Names and affiliations of panel members
  - » Topic(s) being reviewed
  - » List of analyses requested by the Panel, the rationale for each request, and a brief summary the responses to each request
- Comments on the technical merits and/or deficiencies of the methodology and recommendations for remedies. Comments should address each of the following issues:
  - » What are the data requirements of the methodology?
  - » What are the situations/stocks for which the methodology is applicable?
  - » What are the assumptions of the methodology?
  - » Is the methodology correct from a technical perspective?
  - » How robust are results to departures from the assumptions of the methodology?
  - » Does the methodology provide estimates of uncertainty? How comprehensive are those estimates?
  - » Will the new methodology or data set result in improved stock assessments or management advice?

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<sup>1</sup> Available at: [http://www.pcouncil.org/wp-content/uploads/2017/01/Methodology\\_ToR\\_CPSGF-2017-18.pdf](http://www.pcouncil.org/wp-content/uploads/2017/01/Methodology_ToR_CPSGF-2017-18.pdf)

- Areas of disagreement regarding panel recommendations:
  - » Among panel members
  - » Between the panel and proponents
- Unresolved problems and major uncertainties (e.g., any issues that could preclude use of the methodology)
- Management, data, or fishery issues raised by the public and other representatives during the panel review
- Prioritized recommendations for future research and data collection

#### **Sample TOR reports:**

- Terms of Reference for the Groundfish and Coastal Pelagic Species Stock Assessment Review Process for 2017-2018 (June 2016)
- Terms of Reference for the Methodology Review Process for Groundfish and Coastal Pelagic Species for 2017-2018 (June 2016)
- All CIE reports append the review scope/statement of work, which includes the TOR. These are available by year and title at: <https://www.st.nmfs.noaa.gov/science-quality-assurance/cie-peer-reviews/peer-review-reports>



# Appendix B: General Fisheries Peer Review Checklist

Below is a checklist that can be used by CDFW and review coordinating bodies to plan for an upcoming peer review process. Note that timelines often shift, so review coordinators should maintain a high level of flexibility (given that end products are often time sensitive).

## PEER REVIEW SCOPING

*9-12 months prior to start of a review*

### CDFW

- Using criteria from box 2, determine whether product is subject to or exempt from review
- If review is required, determine whether review is **internal** or **external**
- If external, contract with an appropriate review coordinating body

*2-3 months prior to start of external review*

### CDFW

- Deliver draft outline or preliminary draft to review coordinating body to assist with peer review scoping

### Review Coordinating Body

- Work with CDFW to develop a "Specific Terms of Reference" or scope of work indicating:
  - Mode and level of review, selected based on criteria from box 3
  - Roles and responsibilities of all parties involved in the review
  - Process, timeline, and budget
  - Level of stakeholder involvement
  - Required reviewer expertise and appropriate number of reviewers
  - Product(s) from the review
- Select and convene reviewers
- Have reviewers complete and sign a conflict of interest policy and a non-disclosure agreement (if required)
- Develop review instructions based on draft report and "Specific Terms of Reference"
- Develop collateral (e.g., webpage, communication materials, stakeholder listserve)

*Prior to start of external review*

### CDFW

- Deliver draft report to review coordinating body

## CONDUCT PEER REVIEW

*Reviews take from 6 weeks to several months*

### Review Coordinating Body

- Distribute Specific Terms of Reference, review materials, and review instructions to reviewers
- Administer review based on mode selected (e.g., individual written reviews, panel workshop, etc.)
- Gather and submit additional data and analyses requests to CDFW
- Develop draft product(s)
- Manage reviewers approve of/sign-off on final product
- Deliver product to CDFW for a management preview prior to public release
- When appropriate, conduct a results briefing with the client and/or stakeholders
- Post final report online and distribute to interested partners and stakeholders

## PEER REVIEW FOLLOW-UP

*Revisions to the product under review may occur from several weeks to several months after delivery of the review report*

### Review Coordinating Body

- Facilitate discussions between reviewers and CDFW as they consider review feedback and revise the work product
- Where appropriate, present results of review in a public meeting (e.g., FGC public meeting)
- Work with CDFW to develop text to include in the final work product that appropriately represents the review process and outcomes



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