

---

# TERMS OF REFERENCE

FOR THE

GROUND FISH AND COASTAL PELAGIC  
SPECIES STOCK ASSESSMENT REVIEW  
PROCESS FOR ~~2015-2016~~2017-2018

---



~~SEPTEMBER, 2014~~JUNE, 2016

---



# TABLE OF CONTENTS

<b>1. INTRODUCTION</b>	<b>2</b>
<b>2. STOCK ASSESSMENT PRIORITIZATION</b>	<b>4</b>
<b>3. STOCK ASSESSMENT REVIEW PROCESS GOALS AND OBJECTIVES</b>	<b>5</b>
<b>4. ROLES AND RESPONSIBILITIES OF STOCK ASSESSMENT REVIEW PROCESS PARTICIPANTS</b>	<b>6</b>
4.1. SHARED RESPONSIBILITIES	6
4.2. STAR PANEL RESPONSIBILITIES	6
4.3. STOCK ASSESSMENT TEAM RESPONSIBILITIES	12
4.4. NATIONAL MARINE FISHERIES SERVICE RESPONSIBILITIES	15
4.5. COUNCIL STAFF RESPONSIBILITIES	15
4.6. MANAGEMENT TEAM RESPONSIBILITIES	16
4.7. ADVISORY PANEL RESPONSIBILITIES	16
4.8. SCIENTIFIC AND STATISTICAL COMMITTEE RESPONSIBILITIES	16
<b>5. DATA-POOR ASSESSMENTS FOR GROUND FISH SPECIES</b>	<b>17</b>
<b>6. DATA-MODERATE ASSESSMENTS FOR GROUND FISH SPECIES</b>	<b>17</b>
<b>7. UPDATE ASSESSMENTS</b>	<b>18</b>
<b>8. CATCH-ONLY PROJECTIONS</b>	<b>19</b>
<b>9. CATCH REPORTS</b>	<b>21</b>
<b>APPENDIX A: 2015 GROUND FISH AND CPS STOCK ASSESSMENT REVIEW CALENDAR</b>	<b>22</b>
<b>APPENDIX B: OUTLINE FOR STOCK ASSESSMENT DOCUMENTS</b>	<b>23</b>
<b>APPENDIX C: TEMPLATE FOR AN EXECUTIVE SUMMARY</b>	<b>29</b>
<b>APPENDIX D: TEMPLATE FOR A DATA-MODERATE ASSESSMENT</b>	<b>30</b>
<b>APPENDIX E: DEFINITIONS OF SPECIES CATEGORIES FOR GROUND FISH AND CPS ASSESSMENTS</b>	<b>31</b>

## 1. INTRODUCTION

The purpose of this document is to outline the guidelines and procedures for the Pacific Fishery Management Council's (Council) groundfish and coastal pelagic species (CPS) stock assessment review (STAR) process and to clarify expectations and responsibilities of the various participants. This document applies to assessments of species managed under the Pacific Coast Groundfish Fishery Management Plan and CPS Management Plan. The STAR process has been designed to provide for peer review as referenced in the 2006 Reauthorization of the Magnuson-Stevens Fishery Conservation and Management Act (RMSA), which states that "the Secretary and each Regional Fishery Management Council may establish a peer review process for that Regional Fishery Management Council for scientific information used to advise the Regional Fishery Management Council about the conservation and management of the fishery (see Magnuson-Stevens Act section 302(g)(1)(E))." National Standard 2 (NS2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (published July 19, 2013) provides guidance and standards to be followed when establishing a peer review process pursuant to MSA section 302(g)(1)(E) including guidance on the timing, scope of work, peer reviewer selection and process transparency. The STAR process follows these standards and is fully compliant with NS2.

Parties involved in the process are Council members, Council staff, members of Council Advisory Bodies, including the Scientific and Statistical Committee (SSC), the Groundfish and CPS Management Teams (GMT and CPSMT), the Groundfish and CPS Advisory Subpanels (GAP and CPSAS), the National Marine Fisheries Service (NMFS), state agencies, and interested persons. The review by the STAR panel is a key element in an overall procedure designed to investigate the technical merits of stock assessments and other relevant scientific information. The review of stock assessments requires a routine, dedicated effort that simultaneously meets the needs of NMFS, the Council, and others. Program reviews, in-depth external reviews, and peer-reviewed scientific publications are used by federal and state agencies to provide quality assurance for the basic scientific methods employed to produce stock assessments. The extended time frame required for such reviews is not suited to the routine examination of assessments that are, generally, the primary basis for harvest recommendations.

This current version of the terms of reference (TOR) reflects recommendations from previous participants in the STAR process, including STAR panel members, the SSC, stock assessment teams (STATs), Council staff, and Council advisory groups. Nevertheless, no set of guidelines can be expected to deal with every contingency, and all participants should anticipate the need to be flexible and address new issues as they arise. This document is included in the Council's Statement of Organization, Practices and Procedures as documentation of the review process that underpins scientific advice from the SSC. The SSC has developed a separate TOR for reviewing new methods that might be used in stock assessments, including methods and tools to incorporate ecosystem processes.

Stock assessments are conducted to assess the abundance and trends of fish stocks, and provide the fundamental basis for management decisions regarding appropriate harvest levels. In most cases, assessments use statistical population models to integrate and simultaneously analyze survey, fishery, and biological data. Environmental and ecosystem data may also be integrated

in stock assessments. Hilborn and Walters (1992)<sup>1</sup> define stock assessments as “the use of various statistical and mathematical calculations to make quantitative predictions about the reactions of fish populations to alternative management choices.” In this document, the term “stock assessment” includes activities, analyses and reports, beginning with data collection and continuing through to scientific recommendations presented to the Council and its advisors. To best serve their purpose, stock assessments ~~should~~must attempt to identify and quantify major uncertainties, balance realism and parsimony, and make best use of the available data.

There are several distinct types of assessment products, which are subject to different review procedures. A “**full (or benchmark) assessment**” is a new assessment or an assessment that may be substantially different from the previously conducted assessment. A full assessment involves a re-examination of the underlying assumptions, data, and model parameters previously used to assess the stock. Full assessments are reviewed via the full STAR process, which includes STAR panel review. Resource limitations constrain the number of full assessments that can be conducted and reviewed during an assessment cycle. Some assessment models have relatively few modeling or data issues and provide relatively stable results as new data are added, such that it is not necessary to develop a completely new assessment every time the species is assessed. In these cases, an “**update assessment**” may be preferable. An update assessment is defined as an assessment that maintains the model structure of the previous full assessment and is generally restricted to the addition of new data to previously evaluated time series that have become available since the last assessment and minor alterations described further in this document. In some cases, an update assessment uses only recent fisheries catch information and generates **catch-only projections** for the stock. Update assessments and catch-only projections are reviewed by the relevant subcommittee of the SSC (Groundfish or CPS) rather than by a STAR panel. A “**data-moderate assessment**” is a third type of assessment that incorporates historical catch data and one or more indices of abundance (or biomass) (e.g., trawl survey or fishery catch per unit effort (CPUE) indices). Data-moderate assessments are limited in that they do not use available compositional data (i.e., length or age data) and have simplified population dynamics (deterministic recruitment), to which makes such assessments less complicated and enables more expeditious review. ~~In 2013, data-moderate assessments were reviewed through the STAR panel review since these assessment methodologies were used for the first time in the Council process. However, in the long term, it may be that~~ Data-moderate assessments will be reviewed by the relevant SSC Subcommittee if an approved standard methodology is proposed to be used. They are reviewed by a STAR panel if a new or non-standard assessment methodology is proposed to be used. A “**data-poor assessment**”, which is the fourth assessment type, relies on catch data and basic life history information about the species to determine the Overfishing Limit (OFL) for the stock. A data-poor assessment differs from a data-moderate assessment in that it does not include any abundance indices. A “**catch report**” is a fifth type of assessment product that tabulates fishery removals over recent years to ensure that they are below the Annual Catch Limits (ACLs). A catch report would be applied-produced when little new information is available about the stock to inform the assessment. Data-poor assessments and catch reports are reviewed by the relevant Subcommittee of the SSC (Groundfish or CPS).

Managed species are assigned to one of the three categories, based on the amount of information available for the species. Assignments are made by the SSC. Category 1 includes the most

---

<sup>1</sup> Hilborn, R., and C. J. Walters. 1992. Quantitative fisheries stock assessment: Choice, dynamics and uncertainty. Chapman and Hall.

robust assessments that have the smallest amount of uncertainty associated with assessment results. Category 2 is primarily for data-moderate assessments, and Category 3 is for data-poor assessments with the largest amount of uncertainty associated with assessment results. Detailed definitions for each of the three categories are provided in Appendix E.

~~In 2011, the RMSA changed the terminology and process for determining harvest levels. The previous Allowable/Acceptable Biological Catch (ABC) was replaced by the Overfishing Limit (OFL). However, the largest allowable harvest level is still the ABC (now “Acceptable Biological Catch”), which is buffered from the OFL based on the risk of overfishing adopted by the Council (which must be less than 50%). The P\* (overfishing probability) approach uses a probability of overfishing (which the Council has set to be less than or equal to 45% or 0.45) and a measure of uncertainty in the assessment of current stock size ( $\sigma$ , the standard error of the biomass estimate in log space) to determine the appropriate buffer with which to reduce the harvest level from the OFL to the ABC (Ralston et al. 2011<sup>2</sup>) to account for scientific uncertainty. The default degree of uncertainty ( $\sigma$ ) varies with species category; it is the smallest for category 1, data rich stocks (Appendix E) and largest for category 3, data poor stocks (Appendix E). The Annual Catch Limit (ACL) is equivalent to what the Council previously called the Optimum Yield (OY). For groundfish species, the upper limit for the ACL is calculated using the 40-10 harvest control rule (and 25-5 rule for flatfish species) while for CPS, each species has a specific control rule to calculate the Harvest Guideline (HG), which is the upper limit for the ACL for CPS. The Annual Catch Target (ACT) is the targeted catch level, representing a possible further reduction from the ACL to account for management/implementation uncertainty. The OFL must be given in the stock assessment (along with, in some cases,  $\sigma$ ). The ABC is determined from the OFL given  $\sigma$  and P\*. For CPS, the assessment reports the application of the HG control rule. The OFL, ABC, ACL, any ACTs, and (for CPS) the HGs are reported in the Council’s Stock Assessment and Fishery Evaluation (SAFE) report or the relevant National Environmental Policy Act (NEPA) analysis of alternative harvest specifications.~~

## 2. STOCK ASSESSMENT PRIORITIZATION

Stock assessments for Pacific sardine are conducted annually, with full assessments occurring every third year, and update assessments during interim years. In June 2013, the Council established a Pacific mackerel management and assessment schedule such that full stock assessments will be conducted every four years, starting in 2015, and catch-only projection estimates (i.e., catch-only updates) will be conducted every four years, starting in 2017. The Council also directed that annual harvest measures for Pacific mackerel be implemented on a biennial basis beginning with the 2015-2016 fishing year. Assessments for groundfish species are conducted every other year as part of the biennial harvest specification cycle. A relatively small number of the more than 90 species in the Council’s Groundfish Fishery Management Plan are selected each cycle for full, update or data-moderate assessments. To implement the RMSA requirements to establish OFLs and ABCs for all species in fishery management plans, catch-only methods (e.g., Depletion-Corrected Average Catch (DCAC)<sup>3</sup>, Depletion-Based Stock

<sup>2</sup> Ralston, S., Punt, A.E., Hamel, O.S., DeVore, J. and R.J. Conser. 2011. An approach to quantifying scientific uncertainty in stock assessment. *Fishery Bulletin* 109: 217-231.

<sup>3</sup> MacCall, A. D. 2009. Depletion-corrected average catch: a simple formula for estimating sustainable yields in data-poor situations. *ICES Journal of Marine Science* 66: 2267-2271.

Reduction Analysis (DB-SRA)<sup>4</sup> and Simple Stock Synthesis (SSS)<sup>5</sup> have been applied to data for the majority of groundfish species. It remains the goal of the Council to substantially increase the number of groundfish stocks with full assessments.

In April 2006, the SSC recommended, and the Council adopted, ~~an new~~ approach to prioritize groundfish species for full and update stock assessments as well as catch reports based on: 1) economic or social importance of the species, 2) vulnerability and resilience of the species, 3) time elapsed since the last assessment (NMFS advises assessments to be updated at least every five years), 4) data availability, 5) potential risk to the stock from the current or foreseeable management regime, and 6) qualitative trends from surveys (when available). It was also recommended that overfished groundfish stocks that are under rebuilding plans be evaluated each assessment cycle to ensure adequate progress towards achieving stock recovery. Recently the Northwest Fisheries Science Center developed a formulaic approach for ranking groundfish stock assessments based on a national framework for stock assessment prioritization described in Methot (2015)<sup>6</sup>. The formal rankings were considered by the Council in June 2016 when the Council adopted the

~~The proposed groundfish stocks for full, update, data moderate assessments, and catch reports should be discussed and finalized by the Council to allow sufficient time to assemble relevant data and arrange STAR panels. The 2015-2017~~ stock assessment plan for groundfish and CPS stocks that is provided in Appendix A.

### **3. STOCK ASSESSMENT REVIEW PROCESS GOALS AND OBJECTIVES**

The goals and objectives of the groundfish and CPS STAR process are to:

- 1) ensure that stock assessments represent the best scientific information available and facilitate the use of this information by the Council to adopt OFLs, ABCs, ACLs, (HG)s, and ACTs;
- 2) meet the mandates of the Magnuson-Stevens Fisheries Conservation and Management Act (MSA) and other legal requirements;
- 3) follow a detailed calendar and fulfill explicit responsibilities for all participants to produce required reports and outcomes;
- 4) provide an independent external review of stock assessments;
- 5) increase understanding and acceptance of stock assessments and peer reviews by all members of the Council family;
- 6) identify research needed to improve assessments, reviews, and fishery management in the future; and
- 7) use assessment and review resources effectively and efficiently.

---

<sup>4</sup> Dick, E. J. and A. D. MacCall. 2011. Depletion-Based Stock Reduction Analysis: A catch-based method for determining sustainable yields for data-poor stocks. *Fisheries Research* 110: 331-341.

<sup>5</sup> Cope, J.M. 2013. Implementing a statistical catch-at-age model (Stock Synthesis) as a tool for deriving overfishing limits in data-limited situations. *Fisheries Research* 142: 3-14.

<sup>6</sup> Methot Jr., R.D. (Editor). 2015. Prioritizing fish stock assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-F/SPO-152, 31 p.

## **4. ROLES AND RESPONSIBILITIES OF STOCK ASSESSMENT REVIEW PROCESS PARTICIPANTS**

### **4.1. Shared Responsibilities**

All parties have a stake in assuring adequate technical review of stock assessments. NMFS, as the designee of the Secretary of Commerce, must determine that the best scientific advice has been used when it approves fishery management recommendations made by the Council. The Council uses advice from the SSC to determine that the information on which it bases its recommendations represents the best available science. Scientists and fishery managers providing technical documents to the Council for use in management need to assure that their work is technically correct.

The Council, NMFS and the Secretary of Commerce share primary responsibility to create and foster a successful STAR process. The Council oversees the process and involves its standing advisory bodies, especially the SSC. For groundfish, NMFS provides a stock assessment coordinator (SAC) to facilitate and assist in overseeing the process, while for CPS a designated SWFSC staff member performs this role. Together NMFS and the Council consult with all interested parties to plan and prepare TOR, and develop a calendar of events with a list of deliverables for final approval by the Council. NMFS and the Council share fiscal and logistical responsibilities and both should ensure that there are no conflicts of interest in the process<sup>7</sup>.

The STAR panels are sponsored by the Council, because the Federal Advisory Committee Act (FACA) limits the ability of NMFS to establish advisory committees. FACA specifies a procedure for convening advisory committees that provide consensus recommendations to the federal government. The intent of FACA is three-fold: to limit the number of advisory committees; to ensure that advisory committees fairly represent affected parties; and to ensure that advisory committee meetings, discussions, and reports are carried out and prepared in full public view. Under FACA, advisory committees must be chartered by the Department of Commerce through a rather cumbersome process. However, the Sustainable Fisheries Act exempts the Council from FACA per se, but requires public notice and open meetings similar to those under FACA.

### **4.2. STAR Panel Responsibilities**

The role of the STAR panel is to conduct a detailed technical evaluation of a full stock assessment to advance the best available scientific information to the Council. The specific responsibilities of the STAR panel are to:

- 1) review draft stock assessment documents, data inputs, and analytical models, along with

---

<sup>7</sup> The final NS2 guidelines state: a “[A] conflict of interest is any financial or other interest which conflicts with the service of the individual on a review panel because it: (A) Could significantly impair the reviewer’s objectivity; or (B) Could create an unfair competitive advantage for a person or organization; (C) Except for those situations in which a conflict of interest is unavoidable, and the conflict is promptly and publicly disclosed, no individual can be appointed to a review panel if that individual has a conflict of interest that is relevant to the functions to be performed. Conflicts of interest include, but are not limited to, the personal financial interests and investments, employer affiliations, and consulting arrangements, grants, or contracts of the individual and of others with whom the individual has substantial common financial interests, if these interests are relevant to the functions to be performed.”

- other pertinent information (e.g., previous assessments and STAR panel reports, when available);
- 2) discuss the technical merits and deficiencies of the input data and analytical methods during the open review panel meeting, work with the STATs to correct deficiencies, and, when possible, suggest new tools or analyses to improve future assessments; and
  - 3) develop STAR panel reports for all reviewed species to document meeting discussion and recommendations.

The STAR panel chair has, in addition, the responsibility to: 1) develop a STAR panel meeting agenda; 2) ensure that STAR panel participants follow the TOR; 3) guide the STAR panel and the STAT to mutually agreeable solutions; and 4) coordinate review of revised stock assessment documents before they are forwarded to the SSC.

Groundfish and CPS STAR panels include a chair appointed from the relevant SSC subcommittee (Groundfish or CPS), and three other experienced stock assessment analysts knowledgeable of the specific modeling approaches being reviewed. Of these three other members, at least one should be appointed from the Center for Independent Experts (CIE) and at least one should be familiar with west coast stock assessment practices. Selection of STAR panelists should be based on expertise, independence, and a balance between outside expertise and in-depth knowledge of west coast fisheries, the data sets available for those fisheries, and the modeling approaches applied to west coast groundfish and CPS. Expertise in ecosystem models or processes, and knowledge of the role of groundfish and CPS in the ecosystem is also desirable, particularly if the assessment includes ecosystem models or environmental processes. For groundfish, an attempt should be made to identify one reviewer who can consistently attend all STAR panel meetings in an assessment cycle. The pool of qualified technical reviewers is limited; therefore, staffing of STAR panels is subject to constraints that can make it difficult to meet the conditions above.

Selected reviewers should not have financial or personal conflicts of interest with the scientific information, subject matter, or work product under review, either current to the meeting, within the previous year (at minimum), or anticipated. STAR panel members who are federal employees should comply with all applicable federal ethics requirements. Reviewers who are not federal employees will be screened for conflicts of interest either through existing financial disclosure processes used by the SSC and CIE, or under the NOAA Policy on Conflicts of Interest for Peer Review Subjects.

Reviewers should not have contributed or participated in the development of the work product or scientific information under review, and reviewer responsibilities should rotate across the available pool of qualified reviewers, when possible.

STAR panel meetings also include representatives of the relevant management team (MT) and advisory panel (AP), with responsibilities as laid out in these TOR, and a Council staff member to advise the STAR panel and assist in recording meeting discussions and results. The STAR panel, STATs, the MT and AP representatives, and the public are all legitimate meeting participants who should be accommodated in discussions. It is the STAR panel chair's responsibility to coordinate discussion and public comment so that the assessment review is completed on time.

The STAR is by design a transparent process. STAR panel meetings are open to the public and are announced on the Council's website, through Council meeting notices, and in the Federal Register at least 23 days prior to the STAR panel meeting. The Council (or the SWFCS for CPS) posts background materials on an ftp site prior to the meeting and makes hard copies available upon request. A STAR panel normally meets for four to five days. The number of assessments reviewed per panel should not exceed two, except in extraordinary circumstances if the SSC and NMFS agree that it is advisable, feasible, and/or necessary. When separate assessments are conducted at the sub-stock level by different STATs (~~i.e.e.g.~~, black rockfish), each assessment is considered an independent full assessment for review purposes. Contested assessments, in which alternative assessments are brought forward by competing STATs using different modeling approaches, would typically require additional time (and/or panel members) to review adequately, and should be scheduled accordingly. While contested assessments are likely to be rare, they can be accommodated within the STAR process. The STAR panel should thoroughly evaluate each analytical approach, comment on the relative merits of each, and, when conflicting results are obtained, identify the reasons for the differences. The STAR panel should work with the STATs to come to agreement on a base model that will be reviewed by the SSC to determine its merits for supporting management advice.

#### *STAR Panel Requests for Additional Analyses*

STAR panel meetings are intended as technical reviews of complete assessments rather than not workshops for constructing the assessments. In the course of a meeting, the panel may ask the STAT for a reasonable number of sensitivity runs, request additional details on the proposed base model presented, or ask for further analyses of alternative runs. However, it is not unusual for the review to identify technical problems that would result in a-changes to the assessment resultsinitial base model (given that both the STAR panel and the STAT agree). Resolving technical issues to the mutual satisfaction of the STAR and STAT is an important task of the STAR process. ~~However, t~~The STAR panel is not authorized to conduct an alternative assessment representing its own views that are distinct from those of the STAT, nor can it impose an alternative assessment on the STAT. Similarly, the panel should not impose their preferred methodologies when this is a matter of professional opinion. Rather, if the panel finds an assessment to be inadequate, it should document its opinion and suggest potential remedial measures for the STAT to take to rectify perceived shortcomings of the assessment. For groundfish species, the SSC or SSC Groundfish Subcommittee reviews the STAR panel report and recommends whether an assessment should be further reviewed at the end of the assessment cycle (i.e., mop up review panel) by the SSC's Groundfish ~~subcommittee~~ Subcommittee during a meeting that occurs after all of the STAR panels, primarily to review rebuilding analyses for overfished stocks. Soon after completion of all STAR panels, ~~a meeting of the SSC groundfish Groundfish subcommittee~~ Subcommittee will meet by teleconference or webinar be held to recommend which assessments, if any, will be sent to the mop-up panel and to prioritize further analyses. ~~This recommendation is subject to confirmation by the full SSC at its next scheduled meeting. This teleconference or webinar will be noticed in advance as one where the SSC Groundfish Subcommittee makes the decision which stocks would be subsequently reviewed at the mop-up panel.~~ Since only two assessments can be adequately reviewed in a one-week review panel, the SSC Groundfish Subcommittee will also have the authority to decide which two assessments are reviewed at the mop-up panel in cases where there are more than two candidate assessments for further review. The full SSC and Council can then decide in September whether to schedule a second mop-up panel before the November Council meeting to review any remaining assessments that were not reviewed in the first mop-up panel. For CPS, if an

assessment is found not to be acceptable for use in management, a full assessment would be conducted the following year.

The STAR panels are expected to be judicious in their requests of the STATs. Requests for large changes in data or analytical methods used may often require significant amount of time to complete (e.g., GLMM analysis) and may result in changes to the assessment that cannot be adequately evaluated during the course of the STAR panel meeting. Therefore, caution should be exercised in making such changes. In many cases such changes should be relegated to future research recommendations and/or methodology review. If a groundfish STAR panel agrees that significant changes are necessary, and the assessment is not otherwise acceptable, a recommendation for further examination of the assessment at the mop-up meeting is warranted. Similarly, if the STAR panel agrees that the assessment results strongly indicate that current  $F_{MSY}$  value or management target and threshold are inappropriate, it should identify this in its report and recommend further analysis to support a change to more appropriate values.

STAR panel requests to the STAT for additional model runs or data analyses must be clear, explicit, and in writing. These requests and recommendations should be listed within the STAR panel's report, along with rationale and the STAT response to each request.

To the extent possible, analyses requested by the STAR panel should be completed by the STAT during the STAR panel meeting. It is the obligation of the STAR panel chair, in consultation with other panel members, to prioritize requests for additional analyses. In situations where a STAT arrives with a well-constructed, thoroughly investigated assessment, it may be that the panel finishes its review earlier than scheduled (i.e., early dismissal of a STAT). If follow-up work by the STAT is required after the review meeting (such as MCMC integration of an alternative model created during the STAR panel meeting), this should be completed before the briefing book deadline for the Council meeting at which the assessment is scheduled for review. It is the STAR panel chair's responsibility to track STAT progress. In particular, the chair is responsible for communicating with the STAT to determine if the revised stock assessment document is complete. Any post-STAR drafts of the stock assessment must be reviewed by the STAR panel chair. The assessment document can only be given to Council staff for distribution after it has been endorsed by the STAR panel chair, and when it is accompanied by a complete and approved STAR panel report. Likewise, the final draft that is published in the Council's SAFE document must also be approved by the STAR panel chair prior to being accepted by Council staff.

For some stocks selected for full assessments, the available data may prove to be insufficient to support a category 1 assessment (Appendix E). In such cases, the STAT should consider whether simpler approaches appropriate for a category 2 assessment can be applied. Simpler approaches usually make stronger assumptions and estimate fewer parameters, but are less demanding of data. It is the responsibility of the STAR panel, in consultation with the STAT, to consider the strength of inferences that can be drawn from analyses presented, and identify major uncertainties. If useful results have been produced, the STAR panel should review the appropriateness and reliability of the methods used to draw conclusions about stock status and/or exploitation rates, and either recommend or reject the analysis on the basis of its ability to provide useful information into the management process. If the STAR panel agrees that important results have been generated, it should forward its findings and conclusions to the SSC and the Council for consideration in setting of OFLs, ABCs, and ACLs (for groundfish) and HGs

(for CPS). A key section of the assessment is that on research needed to improve the assessment. Highlighting research priorities should increase the likelihood that future stocks assessments can be raised to category 1.

### *Uncertainty and Decision Tables in Groundfish Stock Assessments*

The STAR panel review focuses on technical aspects of the stock assessment. It is recognized that no model or data set is perfect or issue-free. Therefore, outputs of a broad range of model runs should be evaluated to better define the scope of the accepted model results. The panel should strive for a risk-neutral perspective in its deliberations, and discuss the degree to which the accepted base model describes and quantifies the major sources of uncertainty in the assessment. Confidence intervals for model outputs, as well as other measures of uncertainty that could affect management decisions, should be provided in completed stock assessments and the reports prepared by STAR panels. The STAR panel may also provide qualitative comments on the probability of results from various model runs, especially if the panel does not consider the probability distributions calculated by the STAR capture all major sources of uncertainty. However, as a scientific peer review body, the STAR panel should avoid matters of policy. Assessment results from model runs that are technically flawed or questionable on other grounds should be identified by the panel and excluded from the alternatives upon which management advice is to be developed.

Once alternative models, which capture the overall degree of uncertainty in the assessment, are formulated, a 2-way decision table (alternative models versus management actions) should be developed to illustrate the repercussions of uncertainty to management decisions. The ratio of probabilities of alternative models should be 25:50:25, with the base model being twice as likely as each of the low and high stock size alternatives. There are a number of ways in which the probabilities can be assigned to each model. Probabilities can be assigned to each model through finding the major axis of uncertainty parameter values that correspond to the 12.5% and 87.5% quantiles of the lognormal distribution of the estimated stock size (i.e., taking the natural log of the estimate of stock size from the base model and then adding and subtracting 1.15 times the standard error of the base model estimate in log space), and running the alternative models with those parameters. The 12.5% and 87.5% quantiles of the parameter determining the major axis of uncertainty may also provide reasonable alternative models. Expert judgment may also be used as long as it is fully explained, justified and documented.

Bracketing of the base model for which the geometric mean of the final biomass levels from the high and low stock size alternative models approximates the base model biomass level (indicating that it is evenly distributed in log space) would be an ideal option. In this case, stock size in log space should be used because the distribution of possible stock sizes is necessarily bounded at the low end, while the right tail can extend much further from the point estimate, and thus the probability density is more log-normal than normal. If the bracketing models are far from this option (e.g., if the base model is closer to the upper bracketing model in absolute terms than to the lower bracketing model), the three levels should be reconsidered and either one or more of them adjusted. In certain cases, if there is a great deal of confidence in the bracketing models, the base model could be reconsidered, or a justification for the severely non-lognormal structure of alternatives be given, and/or justification for an adjustment to the 25:50:25 probabilities be provided. Similarly, if more than one dimension is used to characterize uncertainty, resulting in, for example, a 3-by-3 decision table, careful consideration and justification of how the complete table brackets the uncertainty should be undertaken.

### *Areas of Disagreement*

STATs and STAR panels are required to make an honest attempt to resolve any areas of disagreement during the meeting. Occasionally, fundamental differences of opinions may remain between the STAR panel and STAT that cannot be resolved during the STAR panel meeting. In such cases, the STAR panel must document the areas of disagreement in its report. While identifying areas of disagreement, the following questions should be discussed at the meeting:

- 1) Are there any differences in opinion about the use or exclusion of data?
- 2) Are there any differences in opinion about the choice of the base model?
- 3) Are there any differences in opinion about the characterization of uncertainty?

The STAT may choose to submit a supplemental report supporting its view, but in that case, an opportunity must be given to the STAR panel to prepare a rebuttal. These documents would then be appended to the STAR panel report as part of the record of the review meeting. In some cases STAR panel members may have fundamental disagreements among themselves that cannot be resolved during the review meeting. In such cases, STAR panel members may prepare a minority report that would also become part of the record of the review meeting. The SSC would then review all information pertaining to STAR panel and STAR panel/STAT disputes, and issue its recommendation.

### *STAR Panel Report*

The STAR panel report should be developed and approved by the full panel shortly after the STAR panel meeting. The STAR panel chair appoints members of the panel to act as rapporteurs and draft the report (or specific sections thereof) according to the STAR panel chair guidance on format and level of detail. The STAR panel chair is responsible for preparing the final draft of the panel report, obtaining panel approval, providing a copy for STAT review and comment, and submitting it to the Council in a timely fashion (i.e., by briefing book deadline).

The STAR panel report should include:

- Summary of the STAR Panel meeting:
  - Names and affiliations of STAR panel members, STAT and STAR panel advisors;
  - Brief overview of the meeting (where the meeting took place, what species was assessed, what was the STAR panel recommendation, etc.);
  - Brief summary of the assessment model and the data used;
  - List of analyses requested by the STAR panel, the rationale for each request, and a brief summary of the STAT response to the request;
- Description of the base model and, for groundfish species, the alternative models used to bracket uncertainty;
- Comments on the technical merits and/or deficiencies in the assessment and recommendations for remedies;
- Areas of disagreement regarding STAR panel recommendations:
  - Between the STAR panel and STAT(s).

- Among STAR panel members (including concerns raised by MT and AP representatives);
- Unresolved problems and major uncertainties, e.g., any special issues that complicate the assessment and/or interpretation of results;
- Management, data, or fishery issues raised by the MT or AP representatives during the STAR panel; and
- Prioritized recommendations for future research and data collection, including methodology and ecosystem considerations for the subsequent assessment.

For groundfish species, the STAR panel also makes a recommendation on whether the next assessment of the species should be full or update, and explain reasons for its recommendation.

The STAR panel report should be made available for review by the STAT with adequate time prior to the briefing book deadline (i.e., a week in most circumstances, but at minimum a full 24 hours, in cases when the time between the STAR panel and the deadline is particularly compressed) so that the STAT can comment on issues of fact or differences in interpretation. If differences of opinion come up during review of the STAR panel report, the STAR panel and STAT should attempt to resolve them. Otherwise, the areas of disagreement must be documented in the STAR panel report.

The chair will also solicit comment on the draft report from the STAT and the MT and AP representatives. The purpose of this is limited to ensuring that the report is technically accurate and reflects the discussion that occurred at meeting, and should not be viewed as an opportunity to reopen debate on issues. The STAR panel chair is the final arbiter on wording changes suggested by STAT and the MT and AP representatives as the report is the panel's report of the meeting. Any detailed commentary by MT and AP representatives should be drafted separately, reviewed by the full advisory body, and included in the briefing book.

The STAR panel chair is responsible for providing the Council staff with the final version of the STAR panel report. The STAR panel chair is also expected to attend the SSC meeting and, if requested, MT meetings and the relevant portions of the Council meetings, where stock assessments and harvest projections are discussed, explain the reviews, and provide technical information and advice. The final STAR panel reports are posted on the Council's website.

### **4.3. Stock Assessment Team Responsibilities**

The STAT is responsible for conducting a complete and technically sound stock assessment that conforms to accepted standards of quality, and in accordance with these TOR.

The STAT is responsible for preparing three versions of the stock assessment document:

- 1) a "draft" for discussion during the STAR panel meeting;
- 2) a "revised draft" for presentation to the SSC, the Council, and relevant MT and AP; and
- 3) a "final version" to be published in the Council's SAFE document or posted on the Council's web site.

The draft assessment document should follow the outline in Appendix B with an executive summary as in the template in Appendix C. In the draft document, the STAT should identify a

candidate base model, fully-developed and well-documented, for the STAR panel to review. A draft assessment document should be submitted by the STAT to the STAR panel chair, Council staff, and the NMFS Stock Assessment Coordinator (SAC, for groundfish) three full weeks prior to the STAR panel meeting, to determine whether the document is sufficiently complete to undergo review. If the draft assessment is judged complete, the draft assessment and supporting materials would be distributed to the STAR panel and relevant MT and AP representatives two weeks prior to the STAR panel meeting. If the assessment document does not meet minimum criteria of the TOR, the review would be postponed to a subsequent assessment cycle or to the review at the mop-up meeting. There ~~is~~ are no CPS mop up panels – assessments which do not meet the minimum criteria are deferred to the next year. The mop up panel generally is not able to review more than two assessments. Therefore, the review options are limited for assessments not completed on time.

The STAT is also responsible for ~~bringing~~ providing model files and data (in digital format) to the STAR panel meeting so that they can be analyzed on site. For assessments conducted with Stock Synthesis the set of files provided by the STAT should include all files needed to run the model as well as the standard set of r4ss output files.

In most cases, the STAT should produce a revised draft of the assessment document within three weeks of the end of the STAR panel meeting. The revised draft must include a point-by-point response of the STAT to each of the STAR panel's recommendations. The revised draft must be finalized before the briefing book deadline for the Council meeting at which the assessment is scheduled for review. Post-STAR drafts must be reviewed and approved by the STAR panel chair prior to being submitted to Council staff. This review is limited to editorial issues, verifying that all required elements are included, and confirming that the document reflects the discussion and decisions made during the STAR panel.

The final version of the assessment document is produced after the assessment has been reviewed by the SSC. Other than changes recommended by the SSC, only editorial and other minor alterations should be made to the revised draft for the final version. Electronic versions of the final assessment document, model files, and key output files should be submitted by the STATs to Council staff (for CPS) and to Council staff and the SAC (for groundfish) for inclusion in a stock assessment archive. Any tabular data that are inserted into the final documents in an object format should also be submitted in alternative forms (e.g., spreadsheets), which allow selection of individual data elements.

A STAT for which no base model was endorsed by a STAR panel should, in most cases, provide the pre-STAR draft assessment (or corrected/ updated version thereof, as agreed upon with the STAR panel) to the Council by the briefing book deadline. If the STAR panel, nonetheless, recommends using outputs of certain sensitivity runs to bracket uncertainty in the assessment, the results of those runs should be appended to the draft assessment and provided to the Council and its advisory bodies.

STATs are strongly encouraged to develop assessments in a collaborative environment by forming working groups, holding pre-assessment workshops, and consulting with other stock assessment and ecosystem assessment scientists. STATs are encouraged to evaluate alternative models and analyses that incorporate ecosystem considerations and cross-FMP interactions that may affect stock dynamics. When new data sources or methods, which could be used in many

assessments or are likely contentious, are planned for inclusion in the assessment, they should ideally be reviewed by a methodology panel. STATs should identify whether such new data sources or methods will be proposed for inclusion in assessments as early as feasible so that it is possible to hold a methodology review panel if one is needed. Irrespective of whether a methodology review panel takes place, the STAR panel should be provided with model runs with and without the new data sources so that it can evaluate the sensitivity of model outputs to these data sources.

STATs should coordinate early in the process with state representatives and other data stewards to ensure timely availability of data. For assessments of stocks that have not previously been assessed or stocks for which the STAT plans to use a data source not used in a previous assessment, the STAT should hold a data workshop with state representatives and other data stewards and interested parties to discuss which data will be used and which will be excluded, and how the assessment model will use the data. Final data must be provided to the STATs at least seven weeks in advance of the STAR panel meeting, to allow sufficient time for data processing, assessment model development, and assessment document preparation. STATs are not obliged to use data provided after the deadline. STATs are also encouraged to organize independent meetings with industry and interested parties to discuss data and issues. The STAT should initiate contact with the AP representative early in the assessment process, keep the AP informed of the data being used and respond to any concerns that are raised. The STAT should also contact the MT representative early in the process for information about changes in fishing regulations and spatial management issues associated that may influence model structure and the way data are used in the assessment. The latter is particularly important for nearshore stocks, for which each state has different regulatory histories. The STAT should be well represented at the STAR panel meeting to ensure timely completion of the STAR panel requests. Barring exceptional circumstances, STAT members who are not attending the STAR panel meeting should be available remotely to assist with responses when needed. Each STAT conducting a full assessment should appoint a representative to attend the Council meeting where the assessment is scheduled to be reviewed and give presentations of the assessment to the SSC and other Council advisory bodies. In addition, the STAT should be prepared to respond to MT requests for model projections for the MT's to develop ACL alternatives.

When developing an assessment model the STAT should follow accepted best practices. However, for some technical issues there is not yet general agreement on what constitutes best practice. To produce greater consistency among assessments in the approaches taken to common technical problems, the STATs should follow accepted guidelines that will be developed by the SSC and distributed to the STATs and STAR Panels following the November 2016 meeting. The STATs may diverge from the guidelines if they provide adequate justification to the STAR panel and in the assessment document.

For stocks that are estimated to be below overfished thresholds (or those previously declared overfished and not yet rebuilt), the STAT must complete a rebuilding analysis according to the SSC's TOR for Rebuilding Analyses and prepare a document that summarizes the analysis results. Groundfish rebuilding analyses are reviewed at the mop-up panel.

Finally, STATs are responsible to conduct model runs requested by the MTs for use in the harvest specification process. STATs are also responsible to update assessment model projections upon the Council's request for use in ecosystem, socioeconomic, or other related

analyses.

#### **4.4. National Marine Fisheries Service Responsibilities**

The NMFS Northwest Fisheries Science Center (NWFSC) and the Southwest Fisheries Science Center (SWFSC) assist in organizing stock assessment reviews of groundfish and CPS, respectively. For groundfish, NMFS provides a stock assessment coordinator (SAC) to facilitate and assist in overseeing the STAR process. For CPS, the SWFSC provides a staff member to facilitate and assist in the STAR process.

NMFS (through the SAC for groundfish and a designated SWFSC staff member for CPS) works with the STATs and other STAR process participants to develop a proposed list of stocks to be assessed for ~~the~~ consideration by the Council. NMFS also develops a draft STAR panel schedule for the Council review. NMFS identifies STAR panel members based on criteria for reviewer qualifications, and, for groundfish, makes every effort to designate one independent reviewer who can attend all STAR panel meetings to provide consistency among reviews. The costs associated with these reviewers are borne by NMFS. NMFS also helps organize STAR panel meetings and develops meeting schedules.

NMFS (along with the Council staff and the STAR panel chair) coordinates with the STATs to facilitate delivery of required materials by scheduled deadlines and in compliance with the TOR. NMFS also assists Council staff in a pre-review of assessment documents to assure they are complete, and in a post-STAR review of the revised assessment document for consistency with the TOR.

#### **4.5. Council Staff Responsibilities**

The role of Council staff is to coordinate, monitor, and document the STAR process to ensure compliance with these TOR.

Council staff coordinates with the STAR panel chair and NMFS (the SAC in the case of groundfish; a designated SWFSC staff member for CPS) in a pre-review of assessment documents, to assure they are complete. If an assessment document is not in compliance with the TOR, Council staff returns the assessment document to the STAT with a list of deficiencies, a notice that the deadline has expired, or both. Council staff also coordinates with the STAR panel chair, STAT, and NMFS in a post-STAR review of the revised assessment document for consistency with the TOR. When inconsistencies are identified, the STAT is requested to make appropriate revisions in time for briefing book deadlines.

Council staff attends and monitors all STAR panel meetings to ensure continuity and adherence to the TOR and the independent review requirements of Council Operating Procedure 4. If inconsistencies with the TOR occur during STAR panel meetings, Council staff coordinates with the STAR panel chair to develop solutions to correct the inconsistencies. Council staff also attends and monitors the SSC review of stock assessments to ensure compliance with the TOR.

Council staff is responsible for timely issuance of meeting notices and distribution of stock assessments and other appropriate documents to relevant groups. Council staff also collects and maintains electronic copies of assessment documents and relevant reports from the STAR panel, SSC, MT, and AP and CIE reports reviewers, as well as letters from the public and any

other relevant documents. These documents are typically published in the Council's SAFE document or posted on the Council's web site.

#### **4.6. Management Team Responsibilities**

The MT is responsible for identifying and evaluating potential management actions based on the best available scientific information. Particularly, the MT uses stock assessment results and other information to make ACL, HG (for CPS) and ACT recommendations to the Council.

A MT representative, usually appointed by the MT chair, is responsible to attend the STAR panel meeting and serve as advisor to the STAT and STAR panel on changes in fishing regulations that may influence data used in the assessment and the nature of the fishery in the future. The MT representative does not serve as a member of the STAR panel.

Successful separation of science (e.g., STAT and STAR panels) from management (e.g., MT) depends on assessment reviews being completed by the time the MT meets to discuss preliminary ACL, HG (for CPS) and ACT recommendations. The MT should not seek revision or additional review of the stock assessments after they have been endorsed by the STAR panel. The MT chair should communicate any unresolved issues to the SSC for consideration. The MT, however, can request additional model projections from the STAT, to fully evaluate potential management actions.

For reviews of groundfish assessments the GMT representative, in collaboration with the Council staff, is responsible for providing the STAT with the information needed to conduct projections, including the default harvest control rules, the  $\sigma$  and P\* values needed for the default projections, and specifications for any additional projection requests.

#### **4.7. Advisory Panel Responsibilities**

An AP representative, usually appointed by the AP chair, is responsible to attend the STAR panel meeting and serve as advisor to the STAT and STAR panel. The AP representative should review the data sources being used in the assessment prior to development of the stock assessment model and ensure that industry concerns regarding the adequacy of data used by the STAT are communicated and addressed early in the assessment process. The AP representative does not serve as a member of the STAR panel, but, as a legitimate meeting participant, may provide appropriate information and advice to the STAT and STAR panel during the meeting.

The AP representative (along with STAT and STAR panel chair, if requested) is expected to attend the MT meeting at which preliminary ACL and ACT recommendations are developed. The AP representative is also expected to attend subsequent MT and Council meetings where the relevant harvest recommendations are discussed.

#### **4.8. Scientific and Statistical Committee Responsibilities**

The Council's SSC plays multiple roles within the STAR process and provides the Council and its advisory bodies with technical advice related to the stock assessments and the STAR process. The SSC provides guidelines with accepted practices for data and modeling approaches for developing stock assessments. The SSC assigns a member of its relevant subcommittee (Groundfish or CPS) to act as the STAR panel chair. The STAR panel chair attends the assigned

STAR panel meeting and fulfills responsibilities described in the section “STAR Panel Responsibilities”.

The STAR panel chair presents the STAR panel report at the SSC and Council meetings at which stock assessments are reviewed. If requested, the STAR panel chair also attends the MT meeting, at which preliminary ACL, HG (for CPS) and ACT recommendations are developed, to discuss the STAR panel report and assist with interpreting the assessment results.

The full SSC conducts a final review of the stock assessment. This review should not repeat the detailed technical review conducted by the STAR panel. The SSC also reviews the STAR panel recommendations and serves as arbitrator to resolve disagreements between the STAT and the STAR panel if such disagreements occurred during the review meeting. The SSC is responsible for reviewing and endorsing any additional analytical work requested from the STAT by the MT after the stock assessment has been reviewed by the STAR panel. To insure independence in the SSC review, the SSC members who served on the STAT or STAR panel for the stock assessment being reviewed are required to recuse themselves; their involvement in the review being limited to providing factual information and answering questions.

The SSC is responsible for making OFL recommendations to the Council. The SSC is also responsible for assigning species managed by the Council to a specific category based on definitions of species categories in Appendix E. It is also the SSC’s responsibility to determine when it is appropriate to make changes to proxies or the use of estimated values of  $F_{MSY}$  and  $B_{MSY}$ .

## **5. DATA-POOR ASSESSMENTS FOR GROUND FISH SPECIES**

Data-poor assessment methods to assess groundfish species were adopted by the Council in 2011 to inform harvest specifications for category 3 stocks (Appendix E). These adopted methods include: 1) Depletion Corrected Average Catch (DCAC), 2) Depletion Based Stock Reduction Analysis (DB-SRA), and 3) Simple Stock Synthesis (SSS).

DCAC provides estimates of sustainable yield on long lived species based on catches and associated number of years, as well as the relative reduction in biomass during that period, the natural mortality rate ( $M$ ), and the assumed ratio of MSY fishing rate ( $F_{MSY}$ ) to  $M$  (MacCall 2009). DB-SRA combines DCAC and stock reduction analysis to produce probability distributions of management reference points concerning yield and biomass (Dick and MacCall 2011). DB-SRA is based on estimates of historical annual catches, natural mortality rate ( $M$ ) and age at maturity. A production function is specified based on the relative location of maximum productivity and the ratio of  $F_{MSY}$  to  $M$ . Unfished biomass, the only unknown parameter, is then calculated based on a designated relative depletion level near the end of the time series. Uncertainties in natural mortality, stock dynamics, optimal harvest rates, and recent stock status are incorporated using Monte Carlo exploration. SSS utilizes a similar approach as DB-SRA using the Stock Synthesis modeling platform (Cope 2013).

## **6. DATA-MODERATE ASSESSMENTS FOR GROUND FISH SPECIES**

Data-moderate assessments for groundfish species are a refinement over the adopted data-poor methods. Data-moderate assessments are used for category 2 stocks; the defining distinction between category 2 and category 3 stocks is that abundance trend information is incorporated in

a category 2 assessment enabling an estimate of stock status (Appendix E).

Two data-moderate assessment methods have been endorsed since the 2013-14 assessment cycle: 1) extended DB-SRA (XDB-SRA) and 2) extended Simple Stock Synthesis (XSSS). In both cases, abundance trend information (e.g., survey or fishery CPUE indices) is included in the assessment.

XSSS assumes that recruitment is related deterministically to the stock-recruitment relationship and allows index data to be used within a Bayesian framework. The Markov chain Monte Carlo (MCMC) or Sample Importance Resample (SIR) algorithm (perhaps implemented using Adaptive Importance Sampling) is used to quantify uncertainty for XSSS-based assessments. XDB-SRA is implemented within a Bayesian framework, with the priors for the parameters updated based on index data. The additional parameters in XDB-SRA compared with DB-SRA include the catchability coefficient ( $q$ ), and the extent of observation variance additional to that inferred from sampling error ( $a$ ). The priors for these parameters are a weakly informative log-normal and a uniform distribution, respectively.

Comparison of alternative methods (XDB-SRA and XSSS) is encouraged, but it is acceptable to present an assessment using a single modeling approach. The STAR panel can make requests of the STATs for additional runs, but should not impose an alternative method if STATs consider this is not appropriate for the stock concerned. In the event that more than one model is presented, the panel should recommend adoption of a preferred model, if one can be identified, for use in management.

Data-moderate stock assessment reports should follow the template in Appendix D.

## **7. UPDATE ASSESSMENTS**

For sardine, update assessments typically occur during two years out of every three. For mackerel, update catch-only assessments occur every four years, alternating with full assessments. For groundfish, the initial recommendation whether the next assessment should be full or update is made by the STAR panel during the STAR panel meeting. The final recommendation is made by the SSC.

An update assessment is generally restricted to the addition of new data that have become available since the last full assessment. It must carry forward the fundamental structure of the last full assessment reviewed and endorsed by a STAR panel, the SSC, and the Council. Assessment structure here refers to the population dynamics model, data sources used as inputs to the model, the statistical platform used to fit model to the data, and how the management quantities used to set harvest specifications are calculated. Particularly, when an update assessment is developed, with the exceptions noted below, no substantial changes should be made to:

- 1) the particular sources of data used. It is not uncommon that data sources are updated to correct data entry errors or include additional historical data. It is acceptable to use the most up-to-date data from the sources used in the original assessment.
- 2) the software used in programming the assessment. It is acceptable to use a newer version of Stock Synthesis (or other assessment software used). A comparison should be provided to illustrate the newer software version produces adequately similar results when using with the same model files as in the original assessment.
- 3) the assumptions and structure of the population dynamics model underlying the stock assessment.
- 4) the statistical framework for fitting the model to the data and determining goodness of fit.
- 5) the analytical treatment of model outputs in determining management reference points.

Major changes to the assessment should be postponed until the next full assessment. Alterations to the assessment can be considered as long as the update assessment clearly documents and justifies the need for such changes and provides a step-by-step transition (via sensitivity analysis) from the last full assessment to an update assessment under review.

Alterations are allowed when there are clear and straightforward improvements in the input data and/or how it is processed and analyzed for use in the model. It is acceptable to use the newer versions of software to process input data (e.g., software for GLMM analysis of survey catch data), with comparison provided between results generated from the same dataset using old and new software versions. It is also allowed to follow a model selection process used in the original assessment for model inputs (e.g., GLMM) rather than using the model selected in the original assessment. It is acceptable to use the updated parameter priors as long as comparison of model results is provided while using old and new priors.

Examples of other allowable alterations include: 1) the weighting of the various data components (including the use of methods for tuning the variances of the data components); when data weightings in the assessment were chosen based on a repeatable process, it is allowed to repeat this same process rather than to use identical weighting as in the original assessment; 2) changes in the time periods for the selectivity blocks; 3) correcting data entry errors; and 4) bug fixes in software programming. This list is not meant to be exhaustive, and other alterations can be considered if warranted. Ideally, improved data or methods used to process and analyze data would be reviewed by the SSC prior to being used in assessments.

## ~~8.1. CATCH-ONLY PROJECTIONS~~

~~In some circumstances, a STAT may be asked to produce an update assessment using only recent fisheries catch information and generate catch-only projections for the stock. Such update assessments do not include the most recent survey abundance index estimates and have no new data to inform the stock-recruitment relationship in the model. The catch-only projections become more uncertain as the length of the projection period increases. This is particularly an issue for short-lived CPS species, for which recruitment is highly variable, and predictive power of catch-only projections is particularly low. Additional requests can also be made to the STAT if the amount of uncertainty associated with assessment results (e.g., due to highly variable recruitment) should be evaluated further. Catch-only projections are initially reviewed by the relevant SSC subcommittee with public notice, and subsequently reviewed by the full SSC.~~

Update assessments are reviewed by members of the relevant SSC subcommittee (Groundfish or CPS), during a single meeting. Review typically requires one or two days with an option of early dismissal of a STAT. The STAT is responsible for producing the update assessment document and submitting it to Council staff in a timely manner, before the relevant SSC subcommittee reviews the assessment. The document should follow the outline in Appendix B. The STAT, however, can reference the last full assessment (or other relevant documentation) for description of methods, data sources, stock structure, etc., given that they have not been changed. Any new information to the assessment must be presented in sufficient detail for the subcommittee to determine whether the update meets the Council's requirement to use the best available scientific information.

The document must include a retrospective analysis illustrating the model performance with and without the most recent data (new to the update assessment) and discuss whether the new data and update assessment results are sufficiently consistent with those from the last full assessment. The assessment document should include a detailed step-by-step transition from the last full assessment to the update under review. The updated decision table, if there is one, should be of the same format as in the last full assessment; it should highlight differences among alternative models defined using the same axes of uncertainty as those in the last full assessment.

In addition to the update assessment document, Council staff will also provide the subcommittee with a copy of the last full stock assessment reviewed via the STAR process and the associated STAR panel report. The chair of the subcommittee designates a lead reviewer from the subcommittee members for each update assessment to document the meeting discussion, produce a review report, and ensure that each review is conducted according to the TOR. MT and AP representatives also participate in the review.

The review of update assessments is not expected to require additional model runs or extensive analytical requests during the meeting, although changes in assessment outputs may necessitate some model exploration. The review focuses on two main questions:

- 1) Does the assessment meet the criteria of a stock assessment update?
- 2) Can the results of the update assessment form the basis of Council decision making?

If the answer to either of these questions is negative, a full stock assessment for the species would typically be recommended for the next assessment cycle (for groundfish) or the next year (for CPS). For groundfish, if the subcommittee agrees that the update assessment results require additional, but limited exploration before being endorsed for management use, further review at the mop up meeting could be recommended. In cases like this, the subcommittee needs to develop a list of requests for the STAT to address before the mop-up meeting.

Shortly after the meeting, the subcommittee issues a review report that includes: 1) comments on the technical merits and/or deficiencies of the update assessment; 2) explanation of areas of disagreement between the subcommittee and STAT (if any); and 3) recommendations on the adequacy of the update assessment for use in management. The report may also include subcommittee recommendations for modifications that should be made when the next full assessment is conducted.

The report is reviewed by the full SSC at the appropriate Council meeting. If the subcommittee

review concludes that it is not possible to use the update assessment, the SSC is responsible for evaluating all model runs examined during the review meeting and providing recommendations on an appropriate fishing level to the Council.

## **8. CATCH-ONLY PROJECTIONS**

In some circumstances, a STAT may be asked to produce an update assessment using only recent fisheries catch information and generate catch-only projections for the stock. Such update assessments do not include the most recent survey abundance index estimates and have no new data to inform the stock-recruitment relationship in the model. The catch-only projections become more uncertain as the length of the projection period increases. This is particularly an issue for short-lived CPS species, for which recruitment is highly variable, and predictive power of catch-only projections is particularly low. Additional requests can also be made to the STAT if the amount of uncertainty associated with assessment results (e.g., due to highly variable recruitment) should be evaluated further. Catch-only projections are initially reviewed by the relevant SSC subcommittee with public notice, and subsequently reviewed by the full SSC.

## **9. CATCH REPORTS**

In certain cases (e.g., cowcod in 2011) only limited new data are available to inform the assessment. In such cases, it is appropriate for the STAT to provide a catch report, which documents recent removals and compares them to the ACLs established for the stock. For a catch report, if the estimated removals of a species are near the value projected by the previous assessment/rebuilding analysis, the STAT does not need to conduct model runs since no new insight would be obtained by rerunning the assessment model.

Catch reports are reviewed by the relevant SSC subcommittee (Groundfish or CPS) during a single meeting (that during which update assessments are reviewed). The STAT is responsible for producing the catch report and submitting it to Council staff in a timely manner, before the relevant subcommittee reviews it. The report should be brief, but provide enough details on how total removals were estimated. It should provide only essential information about the stock and refer to the last assessment (or other relevant documentation) for full description of methods, data sources, model structure, etc. used to estimate the status of the stock and generate projections.

In common with a review of an assessment update, Council staff will provide the subcommittee with the catch report, along with a copy of the last full stock assessment reviewed via the STAR process, and the associated STAR panel report. The chair of the subcommittee will designate a lead reviewer from the subcommittee members for each catch report to document the meeting discussion, produce a review report, and ensure that each review is conducted according to the TOR. The report is reviewed by the full SSC at the next Council meeting. The MT and AP representatives also participate in the review.

**APPENDIX A: 2015-2017 GROUND FISH AND CPS STOCK ASSESSMENT REVIEW CALENDAR**

<b>Review Meeting</b>	<b>Initial Review Deadline</b>	<b>Document Distribution Dates</b>	<b>STAR Panel Dates</b>	<b>Location</b>	<b>Species</b>
TBD					

## APPENDIX B: OUTLINE FOR STOCK ASSESSMENT DOCUMENTS

This is a general outline of elements that should be included in stock assessment reports for groundfish and CPS managed by the Pacific Fishery Management Council. Not every item listed in the outline is relevant (or available) for every assessment. Therefore, this outline should be considered a flexible guideline on how to organize and communicate stock assessment results. Items with asterisks (\*) are optional for draft assessment documents prepared for STAR panel meetings but should be included in the final document.

A. Title page and list of preparers – the names and affiliations of the stock assessment team either alphabetically or as first and secondary authors.

1. The back of the title page should include text on how to cite the assessment document, based on the following example.

This report may be cited as:

Stewart, I.J., Thorson, J.T., Wetzell, C., 2011. Status of the U.S. Sablefish Resource in 2011. Pacific Fishery Management Council, Portland, OR. Available from <http://www.pcouncil.org/groundfish/stock-assessments/>

A-B. Executive Summary (should follow the template in Appendix C). **Not required in draft assessment undergoing review.**

B-C. Introduction

1. Scientific name, distribution, the basis for the choice of stock structure, including regional differences in life history or other biological characteristics that should form the basis of management units.
2. A map showing the scope of the assessment and depicting boundaries for fisheries or data collection strata.
3. Important features of life history that affect management (e.g., migration, sexual dimorphism, bathymetric demography).
4. Ecosystem considerations (e.g., ecosystem role and trophic relationships of the species, habitat requirements/preferences, relevant data on ecosystem processes that may affect stock or parameters used in the stock assessment, and/or cross-FMP interactions with other fisheries). This section should note if environmental correlations or food web interactions were incorporated into the assessment model. The length and depth of this section would depend on availability of data and reports from the IEA, expertise of the STAT, and whether ecosystem factors **are informational to** contribute quantitative information to the assessment.
5. Important features of current fishery and relevant history of fishery.
6. Summary of management history (e.g., changes in mesh sizes, trip limits, or other management actions that may have significantly altered selection, catch rates, or discards).
7. Management performance, including a table or tables comparing Overfishing Limit (OFL), Annual Catch Limit (ACL), Harvest Guideline (HG) [CPS only], landings, and catch (i.e., landings plus discard) for each area and year
8. Description of fisheries for this species off Canada, Alaska and/or Mexico, including references to any recent assessments of those stocks.

#### D. Data

Description of all data and sources, which are used in the assessment; if not all data sources are used, provide the rationale for excluding particular data sources; report on consulting with AP and MT representatives regarding the use of various data sources.

1. Fishery-dependent data: Commercial fisheries landings by state, year and gear (PacFIN is the standard source for recent domestic commercial landings), historical catch estimates, discards, recreational fisheries catches, foreign removals; sample size information for length and age composition data by state, year and gear, including both the number of trips and fish sampled. Include complete tables and figures and date of data extraction.
2. Fishery-independent data: Description of surveys used in the assessment, description of methods to estimate abundance indices, sample size information for length and age composition data by survey and year, including both the number of tows and fish sampled. Include complete tables and figures and date of data extraction.
3. Sources used to estimate biological parameters (e.g., natural mortality, growth, maturity schedules, etc.)
4. Environmental or ecosystem data used. If environmental or ecosystem data are incorporated, report of consultations with technical teams that evaluated ecosystem data or methodologies used in the assessment.

#### E. Model

1. History of modeling approaches used for this stock
2. Response to STAR panel recommendations from the most recent previous assessment.
3. Description of new modeling approaches and changes made from the last assessment, with rationale.
4. General model specifications:  
Assessment program and its version used for the assessment (i.e., date executable program file was compiled), description of model structure, definitions of fleets and areas. Description of how the first year that is included in the model was selected and how the population state at the time is defined (e.g.,  $B_0$ , stable age structure, etc.).
5. Model parameters: estimated and fixed parameters, constraints on parameters, selectivity assumptions, natural mortality, treatment of age reading bias and/or imprecision, and other fixed parameters, description of stock-recruitment constraints or components, critical assumptions and consequences of assumption failures.

#### F. Base model(s) selection and evaluation

1. Evidence of search for balance between model realism and parsimony. Key model assumptions and structural choices (e.g., asymptotic vs. domed selectivities, constant vs. time-varying selectivities). Summary of alternate model configurations that were examined but rejected.
2. Evaluation of model parameters. Likelihood profile for the base model over key parameters (e.g., natural mortality, stock-recruit steepness, survey catchability). The profile should indicate all likelihood values for individual components (e.g., indices by survey, compositional data for each type and fleet). Are parameter estimates (e.g., survey catchability) consistent with estimates for related stocks?

3. Residual analysis for the base-run configuration e.g., residual plots, time series plots of observed and predicted values, etc.
4. Convergence status and convergence criteria for the base-run model (or proposed base-run). Randomization run results or other evidence of search for global best estimates.

G. Point-by-point response to the STAR panel recommendations.\* Not required in draft assessment undergoing review.

H. Base-model(s) results

1. Table listing all explicit parameters in the stock assessment model used for base model, their purpose (e.g., recruitment parameter, selectivity parameter) and whether or not the parameter was actually estimated in the stock assessment model.
2. Population numbers at age  $\times$  year  $\times$  sex (if sex-specific M, growth, or selectivity) (May be provided as a text or spreadsheet file).\* **Not required in draft assessment undergoing review.**
3. Time-series of total, 1+ (if age 1s are in the model), summary, and spawning biomass (and/or spawning output), depletion relative to B<sub>0</sub>, recruitment and fishing mortality or exploitation rate estimates (table and figures).
4. Selectivity estimates (if not included elsewhere).
5. Stock-recruitment relationship.
6. OFL, ABC and ACL (and/or ABC and OY or HG) for recent years.
7. Clear description of units for all outputs.
8. Description of how discard is included in yield estimates.
9. Description of environmental or ecosystem data if included in the assessment.

I. Evaluation of uncertainty in model results.

1. Sensitivity to assumptions about model structure, i.e., model specification uncertainty.
2. Sensitivity to data set choice and weighting schemes (e.g., emphasis factors), which may also include a consideration of recent patterns in recruitment.
3. Parameter uncertainty (variance estimation conditioned on a given model, estimation framework, data set choice, and weighting scheme), including likelihood profiles for important assessment parameters (e.g., natural mortality). This also includes expressing uncertainty in derived outputs of the model and estimating CVs using appropriate methods (e.g., bootstrap, asymptotic methods, Bayesian approaches, such as MCMC). Include the CV of spawning biomass in the first year for which an OFL has not been specified (typically end year +1 or +2).
4. Retrospective analysis, where the model is fitted to a series of shortened input data sets, with the most recent years of input data being dropped.
5. Historical analysis (plot of actual estimates from current and previous assessments).
6. If a range of model runs is used to characterize uncertainty it is important to provide some qualitative or quantitative information about relative probability of each. If no statements about relative probability can be made, then it is important to state that all scenarios (or all scenarios between the bounds depicted by the runs) are equally likely
7. If possible, ranges depicting uncertainty should include at least three runs: (a) one judged most probable; (b) at least one that depicts the range of uncertainty in the direction of lower current biomass levels; and (c) one that depicts the range of uncertainty in the direction of higher current biomass levels. The entire range of uncertainty should be carried through stock projections and decision table analyses.

#### J. Harvest control rules (CPS only)

The OFL, ABC and HG harvest control rules for actively managed species apply to the U.S. (California, Oregon, and Washington) harvest recommended for the next fishing year and are defined as follows:

- $OFL = BIOMASS * F_{MSY} * U.S. \text{ DISTRIBUTION}$
- $ABC = BIOMASS * BUFFER * F_{MSY} * U.S. \text{ DISTRIBUTION}$
- ACL LESS THAN OR EQUAL TO ABC
- $HG = (BIOMASS-CUTOFF) * FRACTION * U.S. \text{ DISTRIBUTION}$
- ACT EQUAL TO HG OR ACL, WHICHEVER VALUE IS LESS

where  $F_{MSY}$  is the fishing mortality rate that maximizes catch biomass in the long-term.

#### **Implementation for Pacific Sardine**

1. BIOMASS is the estimated stock biomass (ages 1+) at the start of the next year from the current assessment,
2. CUTOFF (150,000 mt) is the lowest level of estimated biomass at which harvest is allowed,
3. FRACTION is an environment-based percentage of biomass above the CUTOFF that can be harvested by the fisheries. Given that the productivity of the sardine stock has been shown to increase during relatively warm-water ocean conditions, the following formula has been used to determine an appropriate (sustainable) FRACTION value:

$$FRACTION = 0.248649805(T_2) - 8.190043975(T) + 67.4558326,$$

where T is the running average sea-surface temperature at Scripps Pier, La Jolla, California during the three preceding years. Under the harvest control rule, FRACTION is constrained and ranges between 5% and 15% depending on the value of T.

4. U.S. DISTRIBUTION is the percentage of BIOMASS in U.S. waters (87%).

NOTE: at its April 2014 meeting, the Council adopted a new FRACTION formula and SST index for immediate use in calculating the sardine OFL, and for future use in calculating the HG, after the Council takes final action. The new FRACTION formula is  $Emsy = -18.46452 + 3.25209T - 0.19723T^2 + 0.0041863T^3$ , with the Temperature term (T) derived from the CalCOFI SST index.

#### **Implementation for Pacific Mackerel**

1. BIOMASS is the estimated stock biomass (ages 1+) at the start of the next year from the current assessment,
2. CUTOFF (18,200 mt) is the lowest level of estimated biomass at which harvest is allowed,
3. FRACTION (30%) is the fraction of biomass above CUTOFF that can be taken by fisheries, and
4. U.S. DISTRIBUTION (70%) is the average fraction of total BIOMASS in U.S. waters.

The CUTOFF and FRACTION values applied in the Council's harvest policy for mackerel are based on simulations published by MacCall et al. in 1985.

K. Reference points (groundfish only)

1. Unfished spawning stock biomass, summary age biomass, and recruitment, along with unfished spawning stock output.
2. Reference points based on  $B_{40\%}$  for rockfish and roundfish and on  $B_{25\%}$  for flatfish (spawning biomass and/or output, SPR, exploitation rate, equilibrium yield).
3. Reference points based on default SPR proxy (spawning biomass and/or output, SPR, exploitation rate, equilibrium yield).
4. Reference points based on MSY (if estimated) (spawning biomass and/or output, SPR, exploitation rate, equilibrium yield).
5. Equilibrium yield curve showing various  $B_{MSY}$  proxies.

L. Harvest projections and decision tables (groundfish only) \* Not required in draft assessment undergoing review.

1. Harvest projections and decision tables (i.e., a matrix of alternative models (states of nature) versus management actions) should cover the plausible range of uncertainty about current stock biomass and a set of candidate fishing mortality targets used for the stock. See section “*Uncertainty and Decision Tables in Groundfish Stock Assessment*” (this document, pp.12-13) on how to define alternative states of nature. Management decisions in most cases represent the sequence of catches including estimate of OFL based on  $F_{MSY}$  (or its proxy) and those obtained by applying the Council 40-10 harvest policy to each state of nature; however other alternatives may be suggested by the GMT as being more relevant to Council decision making. OFL calculations should be based on the assumption that future catches equal ABCs and not OFLs.
2. Information presented should include biomass, stock depletion, and yield projections of OFL, ABC and ACL for ten years into the future, beginning with the first year for which management action could be based upon the assessment. An example template for a table of harvest projections is provided below. << TO BE COMPLETED.

M. Regional management considerations.

- Discussion of whether there is biological evidence for a regional management approach. If a regional management approach is desirable for the stock, but there are insufficient data for it, what are the research and data needs to address this issue?
- For stocks where current practice is to allocate harvests by management area, a recommended method of allocating harvests based on the distribution of biomass should be provided. The MT advisor should be consulted on the appropriate management areas for each stock.

N. Research needs (prioritized).

- O. Acknowledgments: include STAR panel members and affiliations as well as names and affiliations of persons who contributed data, advice or information but were not part of the assessment team. \* **Not required in draft assessment undergoing review.**

P. Literature cited.

- Q. An appendix-Separate text files with the complete parameter and data in the native code of

the stock assessment program. ~~(For a draft assessment undergoing review, these listings can be provided as text files or in spreadsheet format.)~~

## APPENDIX C: TEMPLATE FOR AN EXECUTIVE SUMMARY

Items with asterisks (\*) are optional for draft assessment documents prepared for STAR panel meetings but should be included in the final document.

<b>Stock</b>	Species/area, including an evaluation of any potential biological basis for regional management.
<b>Catches</b>	Trends and current levels - include table for last ten years and graph with long term data.
<b>Data and assessment</b>	Date of last assessment, type of assessment model, data available, new information, and information lacking.
<b>Stock biomass</b>	Trends and current levels relative to virgin or historic levels, description of uncertainty-include table for last 10 years and graph with long term estimates.
<b>Recruitment</b>	Trends and current levels relative to virgin or historic levels-include table for last 10 years and graph with long term estimates
<b>Exploitation status</b>	Exploitation rates (i.e., total catch divided by exploitable biomass, or the annual SPR harvest rate) - include a table with the last 10 years of data and a graph showing the trend in fishing mortality relative to the target (y-axis) plotted against the trend in biomass relative to the target (x-axis).
<b>Ecosystem considerations</b>	A summary of reviewed environmental and ecosystem factors that appear to be correlated with stock dynamics, e.g., variability in the physical environment that directly or indirectly affects the vital rates (growth, survival, productivity/recruitment) of fish stocks, and/or trophic interactions that affect predators and prey. Note what, if any, ecosystem factors are used in the assessment and how.
<b>Reference points (groundfish)/ Harvest control rules (CPS)</b>	<u>Groundfish</u> : Management targets and definition of overfishing, including the harvest rate that brings the stock to equilibrium at $B_{40\%}$ (the $B_{MSY}$ proxy) and the equilibrium stock size that results from fishing at the default harvest rate (the $F_{MSY}$ proxy). Include a summary table that compares estimated reference points for SSB, SPR, Exploitation Rate and Yield based on SSB proxy for MSY, SPR proxy for MSY, and estimated MSY values. <u>CPS</u> : Results of applying the control rule to compute the harvest guideline, including specification of each of the quantities on which the harvest guideline is based (BIOMASS, CUTOFF, FRACTION, U.S. DISTRIBUTION)
<b>Management performance</b>	Catches in comparison to OFL, ABC, HG, and OY/ACL values for the most recent 10 years (when available), overfishing levels, actual catch and discard. Include OFL (encountered), OFL (retained) and OFL (dead) if different due to discard and discard mortality.
<b>Unresolved problems and major uncertainties</b>	Any special issues that complicate scientific assessment, questions about the best model scenario, etc.
<b>Decision table (groundfish only)*</b>	Projected yields (OFL, ABC and ACL), spawning biomass, and stock depletion levels for each year. OFL calculations should be based on the assumption that future catches equal ABCs and not OFLs.
<b>Research and data needs</b>	Identify information gaps that seriously impede the stock assessment.
<b>Rebuilding Projections*</b>	Reference to the principal results from rebuilding analysis if the stock is overfished. For groundfish, see Rebuilding Analysis terms of reference for detailed information on rebuilding analysis requirements.

## **APPENDIX D: TEMPLATE FOR A DATA-MODERATE ASSESSMENT**

1. Title page and list of preparers – the names and affiliations of the stock assessment team (STAT).
2. Introduction: Scientific name, distribution, basic biology (growth, longevity, ecology), the basis for the choice of stock unit(s) (no more than 1-2 paragraphs).
3. Development of indices (used and rejected). Novel approaches should be fully documented.
4. Survey of other data available for assessment: sample sizes by year and source of lengths, and ages (read and unread)--in case there is interest in conducting a full assessment in the future.
5. Selection of method (XSSS or XDB-SRA; authors “encouraged” to do both).
6. Assessment model
  - a. Specification of priors / production function (defaults OK)
  - b. Initial runs using catch-only methods (DB-SRA or SSS (or both))
  - c. Diagnostics
    - i. Evaluation of convergence
    - ii. Residual plots
    - iii. Posterior predictive intervals (if Bayesian)
    - iv. Time-trajectories of biomass, depletion, etc.
    - v. Sensitivity analyses using alternative catch streams, alternative priors for depletion, etc.
7. Estimates of OFL (median of the distribution), and
8. Estimates of stock status.

**APPENDIX E: DEFINITIONS OF SPECIES CATEGORIES FOR GROUND FISH AND CPS ASSESSMENTS**

<p><b>Category 3: Data poor.</b> OFL is derived from historical catch.</p>	<b>a</b>	No reliable catch history. No basis for establishing OFL.
	<b>b</b>	Reliable catches estimates only for recent years. OFL is average catch during a period when stock is considered to be stable and close to BMSY equilibrium on the basis of expert judgment.
	<b>c</b>	Reliable aggregate catches during period of fishery development and approximate values for natural mortality. Default analytical approach DCAC.
	<b>d</b>	Reliable annual historical catches and approximate values for natural mortality and age at 50% maturity. Default analytical approach DB-SRA.
<p><b>Category 2: Data moderate.</b> OFL is derived from model output (or natural mortality).</p>	<b>a</b>	M*survey biomass assessment (as in Rogers 1996).
	<b>b</b>	Historical catches, fishery-dependent trend information only. An aggregate population model is fit to the available information.
	<b>c</b>	Historical catches, survey trend information, or at least one absolute abundance estimate. An aggregate population model is fit to the available information.
	<b>d</b>	Full age-structured assessment, but results are substantially more uncertain than assessments used in the calculation of the P* buffer. The SSC will provide a rationale for each stock placed in this category. Reasons could include that assessment results are very sensitive to model and data assumptions, or that the assessment has not been updated for many years.
	<b>e</b>	Assessments of a complex of species cannot be designated as a category 1 assessment unless there is good evidence that the component species have very similar life-history characteristics and similar rates of biological productivity.
<p><b>Category 1: Data rich.</b> OFL is based on <math>F_{MSY}</math> or <math>F_{MSY}</math> proxy from model output. ABC based on P* buffer.</p>	<b>a</b>	Reliable compositional (age and/or size) data sufficient to resolve year-class strength and growth characteristics. Only fishery-dependent trend information available. Age/size structured assessment model.
	<b>b</b>	As in 1a, but trend information also available from surveys. Age/size structured assessment model.
	<b>c</b>	Age/size structured assessment model with reliable estimation of the stock-recruit relationship.