TERMS OF REFERENCE

FOR THE

GROUNDFISH STOCK ASSESSMENT REVIEW PROCESS FOR 2023-2024

JUNE 2022

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1. SUMMARY OF MAJOR CHANGES FROM THE 2021 TERMS OF REFERENCE

1. Addition of *a priori* criteria and guidance on how to determine stock assessment and management units. (This topic will be discussed at the March at PFMC SSC meeting, a workshop to better define these criteria may be considered.)

2. The requirement that the state provide approval and/or confirm the final catch histories to be used in assessments to the STAT before the data deadline.

3. The requirement that the GFSC attend and document modeling decisions agreed upon in the report for the pre-assessment workshop, including the spatial strata for assessments, via the pre-assessment meeting workshop report.

4. The current TOR requirement that regulatory histories for stock assessments be provided by Council staff has been updated to include consultation with the States and the use of a regulatory history database that can be queried at the appropriate spatial scale.

5. The STAR panel Chair is responsible for presenting a summary of the STAR panel and stock assessment results to the GFSC, with any subsequent issues raised by the GFSC being addressed by the STAT, who will be present at the meeting. If there is a conflict between the STAR panelists and the STAT then both sides will present to the GFSC, and the conflict resolution mechanisms in the current TOR will be followed.

6. Provide at least a week for the GFSC to review catch-only projection documents.

7. If feasible within the modeling platform as determined by the SS development team, guidance on how to best address separate weighting of retained and discarded catch, where appropriate, noting this capability is currently not available in Stock Synthesis (e.g., version 3.30.19 and earlier).

8. Require the identification of states of nature and removal assumptions for decision tables during the STAR panel, then allow the decision table to be completed in time for the assessment document submitted for review at either the May or August GFSC meeting, or the June or September PFMC meetings, or November for those assessments going to mop-up panel review.

9. Change references to data-poor assessments to data-limited to apply consistent language with that most frequently used terminology in the SAFE document.

10. Sections pertaining to the Coastal Pelagic Species were removed from the Groundfish Stock Assessment Review Process TOR under the proposed division of the respective TORs for the 2023-2024 process and thereafter.

Recommendations for the Stock Assessment Terms of Reference

Introduction

The purpose of this document is to outline the guidelines and procedures for the Pacific Fishery Management Council's (Council's) groundfish and 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. 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. An overview of the STAR panel process for groundfish, including the timing and participation by Council and panel bodies is provided in Appendix H.

Parties involved in the process are Council members, Council staff, members of Council Advisory Bodies, including the Scientific and Statistical Committee (SSC), the Groundfish Management Team (GMT), the Groundfish Advisory Panel (GAP), 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 the 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 and resources required for such reviews limits the number of assessments reviewable at a given time, thus requiring a stock assessment prioritization and balance of assessment types to review each cycle.

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, as well as a separate TOR for rebuilding analyses for groundfish stocks.

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) 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 must attempt to identify and quantify major uncertainties, balance realism and parsimony, and make best use of the available data. Data availability produces a continuum of approaches that are outlined below:

There are several distinct types of assessment products, which are subject to different review procedures.

1. **Full/Benchmark assessment**: The least restricted assessment type is a **"full (or benchmark) assessment",** which makes greater use of data than other assessment types. A full assessment can be applied to a stock that has not been previously assessed or re-applied to a previously assessed stock, in which case the 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. The STAR Panel reviewers are encouraged to convey issues they are concerned with to the STAT during the two-week review period prior to the STAR panel to make them aware and provide as much lead time as possible for them to address them.

2. **Update assessment**: Resource limitations constrain the number of full assessments that can be conducted and reviewed during an assessment cycle. For assessment models that have relatively few outstanding modeling or data issues and provide relatively stable results as new data are added, an "update assessment" may be preferable when more current information is desired and there are other priorities for full assessments. An update assessment is defined as an assessment that maintains the model structure of the previous full assessment, with additions generally restricted to data that have become available since the last assessment added to previously evaluated time series, along with limited allowable minor alterations (described further in section 7 of this document). Authors are encouraged to incorporate sections by reference to the previous full assessment where methods do not differ appreciably. Update assessments are reviewed by the relevant subcommittee of the SSC rather than by a STAR panel. The review of update assessments for groundfish stocks should take place by June to provide sufficient time for issues that may arise to be addressed prior to the mop-up STAR Panel (if necessary) in the fall.

3. **Catch-only or catch and climate-only projection**: In some cases, only recent fisheries catch or catch and climate information are added to an existing, approved stock assessment model to generate catch-only or catch and climate-only projections for the stock. The latter case is applicable only to benchmark assessments that include a relationship between environmental variables and environmental parameters, in which case the projections should consider these relationships. Catch-only and catch and climate-only projections are reviewed by the relevant subcommittee of the SSC rather than by a STAR panel. The review of catch-only and catch and climate-only projections for groundfish stocks should take place by September to allow incorporation of new total catch estimates in the Groundfish Expanded Mortality Multi-year (GEMM) product.

   Catch-only projection documents are short, but still require careful review, including ensuring catches are correctly distributed among fleets in fixed and forecasted years. Improved catch-only projection reviews would require a longer time for review, with additional metrics presented, and/or specifically assigned reviewers. The GFSC Chair and NMFS should make plans that ensure sufficient review.

4. **Data-moderate assessment**: A continuum of "data-moderate assessment" methods exist between data-limited methods relying on catch data alone to fully integrated stock assessments incorporating a range of data types including up-to-date age data. Council-approved methods for data-moderate assessments are limited in that they do not use age data (directly), even if available, and often have simplified population dynamics (deterministic recruitment), which leads to more fixed parameters requiring sensitivity analyses. Two approaches have been developed to conduct data-moderate assessment with historical catch data and 1) one or more indices of abundance (or biomass) (e.g., survey data or fishery catch per unit effort [CPUE] indices) referred to as extended DB-SRA (XDB-SRA) using stand-alone programming and extended Simple Stock Synthesis (XSSS) using Stock Synthesis; 2) catch and length-based data-moderate stock assessment methods conducted in Stock Synthesis (SS-CL). Methods incorporating catches, lengths, and indices of relative abundance from fishery-independent surveys in Stock Synthesis have also been adopted by the Council for use in management (SS-CL+Index). Methods using length data do have the potential to estimate recruitment, thus adding more dynamics and complexity to the assessment and the review. Data-moderate assessments can be reviewed by a STAR panel or the SSC Groundfish Subcommittee if an approved standard methodology is proposed to be used. They should be reviewed by a STAR panel if a new or non-standard assessment methodology is proposed to be used or if other considerations discussed during the stock assessment prioritization necessitate additional review.

5. **Data-limited assessment**: A **"data-limited assessment"** relies on catch data and basic life history information about the species to determine an overfishing limit (OFL) for the stock. A data-limited assessment does use a catch history but differs from a data-moderate assessment in that it does not include any abundance indices or length data, and assumes relative stock status. Given relative stock status is an input, these methods only produce estimates of OFL. Data-limited assessments are reviewed by the relevant Subcommittee of the SSC. Three "catch-only" methods have been developed to conduct data-limited

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assessments: Depletion-Corrected Average Catch (DCAC), Depletion-Based Stock Reduction Analysis (DB-SRA), and Simple Stock Synthesis (SSS).

6. **Catch Report**: A **"catch report"** tabulates fishery removals over recent years to ensure that they are below specified annual catch limits (ACLs). A catch report would be produced when little new information is available about the stock to inform the assessment. Catch reports are reviewed by the relevant Subcommittee of the SSC.

Stock assessment products are assigned to one of three categories based on the amount of information available for the species and subsequent uncertainty measured in the stock assessments. Assignments are made by the SSC based on the recommendations from the STAR Panels. Category 1 includes the most robust assessments that have the smallest number of fixed parameters leading to a better characterization of uncertainty. Category 2 is primarily for data-moderate assessments but can also be used to categorize full assessments that are constrained by data quality, resulting in more fixed parameters and unrealistically small variance around key management quantities (e.g., $SB_{current}$), and/or make unusual simplifying assumptions (e.g., no recruitment deviations), and Category 3 is primarily for data-limited assessments with the largest number of fixed parameters and underestimates of uncertainty associated with assessment results, but can also be used to categorize data-moderate assessments constrained by data quality. Detailed definitions for each of the three categories are provided in Appendix F.

2. STOCK ASSESSMENT PRIORITIZATION

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 100 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 acceptable biological catches (ABCs) for all species in fishery management plans, catch-only methods 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 and data-moderate assessments.

Council decisions on groundfish stock assessment priorities are aided by a formulaic approach for ranking groundfish stock assessments developed by the Northwest Fisheries Science Center based on a national framework for stock assessment prioritization described in Methot (2015). The formal rankings were considered by the Council in June 2022 when the Council adopted the 2023 stock assessment plan for groundfish that is provided in Appendix A. Additionally, the Council decided preliminary priorities for 2025 groundfish stock assessments to allow agencies more time to prepare for future stock assessments (e.g., focus on ageing collected structures, biological sampling, etc.). Final decisions on 2023 groundfish stock assessment priorities will be made in June 2022.

3. STOCK ASSESSMENT REVIEW PROCESS GOALS AND OBJECTIVES

The goals and objectives of the groundfish 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, harvest guidelines (HGs), and annual catch targets (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 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.

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 scientific information available (BSIA) as defined by criteria described under National Standard 2 of the Magnuson-Stevens Act. The STAT and STAR panel reviewers should be aware of the criteria and strive to create a final assessment that reflects the BSIA. These BSIA criteria include inclusiveness, transparency, and openness in communication, which may be hindered by implicit bias. In order to increase awareness of implicit bias in the course of the review, each panel member is encouraged to participate in training (https://implicit.harvard.edu/implicit/). 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. A NMFS Science Center staff member will be assigned as the Point of Contact (POC) to facilitate and assist Council staff in overseeing the stock assessment process. Together, NMFS and the Council consult with all interested parties to plan and prepare the 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[1].

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[1] 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."

4.2. STAR Panel Responsibilities

The role of the STAR panel is to conduct a detailed technical evaluation of full stock assessments and other assessments as determined during the stock assessment prioritization process to advance the best scientific information available to the Council. Types of stock assessment other than full do not necessarily undergo review by a STAR panel. The specific responsibilities of the STAR panel are to:

1) be familiar with the Terms of Reference, the *Accepted Practices Guidelines* (for groundfish assessments), and most recent Methodology Review reports;

2) review draft stock assessment documents, data inputs, and analytical models, along with other pertinent information (e.g., previous assessments and STAR panel reports, when available) before the STAR panel;

3) 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

4) develop STAR panel reports for all reviewed species-area assessments to document meeting discussion and recommendations.

Groundfish STAR panels include a chair appointed by the SSC and three other experienced stock assessment analysts knowledgeable of the specific modeling approaches being reviewed. Details of the Chair's responsibilities are provided in a separate section below. 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. Expertise in ecosystem models or processes, and knowledge of the role of groundfish in the ecosystem is also desirable, particularly if the assessment includes ecosystem models or environmental processes. An attempt should be made to identify one reviewer who can consistently attend all STAR panel meetings during 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 GMT and GAP, 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 GMT and GAP 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 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.

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 prior to the STAR panel meeting. The Council (or the Southwest Fisheries Science Center) posts background materials on an accessible site (e.g., ftp) prior to the meeting and makes hard copies available upon request. A STAR panel normally meets for four to five days.

The number of groundfish assessment models reviewed per panel should ideally be two, except in extraordinary circumstances if the SSC and NMFS agree that it is advisable, feasible, and/or necessary, taking into account multiple area models per species or the potential for also reviewing data-moderate assessments in the STAR panel. If a STAR Panel reviews only one assessment, the panel chair should schedule the meeting to give the STAT adequate time to respond to requests for additional analyses/information. When separate area assessments are conducted for the same species by different STAT members or other analysts (e.g., black rockfish in 2015), 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 and assumptions, would typically require additional time (and/or panel members) to review adequately, and should be scheduled accordingly. Historically, the occurrence of contested assessments have been rare; however, there are mechanisms in place to accommodate them within the STAR process. In all cases, competing assessment models should not be proposed to the SSC if they have not undergone a STAR panel review.

During interim periods, new data collection efforts, research surveys, and/or analytical methods in support of stock assessments may be reviewed through the Council's Methodology Review Process for Groundfish (Council Operating Procedure 25). This process provides an independent peer review process of new methods in advance of the STAR Panel process to ensure the best scientific information available is used in stock assessments. The decisions and guidelines documented in endorsed methodology review panel reports are used to inform the Accepted Practices Guidelines for Stock Assessments. The *Guidelines* are intended to provide groundfish STATs with default approaches they should use for dealing with certain stock assessment data and modeling issues. STATs may diverge from the *Guidelines* if they provide adequate justification for doing so. Accepted practices endorsed by the SSC should not be re-evaluated during STAR Panel, unless there have been changes in the approach or method previously reviewed, or under other extenuating circumstances.

STAR Panel Requests for Additional Analyses

STAR panel meetings are intended as technical reviews of complete assessments rather than 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 changes to the assessment results. Resolving technical issues to the mutual satisfaction of the STAR and STAT is an important task of the STAR process. 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. Differences of opinion often may best be addressed by future research, and thus are appropriate to include in the "Future Research Recommendations" sections of the assessment and STAR panel report.

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 a significant amount of time to complete (e.g., GLMM or VAST 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 a mop-up meeting is warranted. Similarly, if the STAR panel agrees that the assessment results strongly indicate that the 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. 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. All groundfish assessments not going to a mop-panel review that have been endorsed by the SSC and adopted by the Council need to be finalized and posted on the Council's web site by the November briefing book deadline. Those groundfish assessments requiring subsequent review at a mop-up panel need to be substantively complete (especially the 10-year projections of harvest specifications under default and, if requested by the Council, alternative harvest control rules) by the November briefing book deadline to facilitate a final SSC review in November. These assessments, if endorsed by the SSC and adopted by the

Council, need to be finalized and posted on the Council's web site as soon after the November Council meeting as practicable.

For some stocks selected for full assessments, the available data may prove to be insufficient to support a category 1 assessment (Appendix F). In such cases, the STAT should consider whether simpler approaches appropriate for a category 2 or category 3 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). A key section of the assessment is 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 Stock Assessments

The STAR panel review focuses on technical aspects of full stock assessments. 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 STAT 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. While the basis for the decision tables including states of nature under the primary axes of uncertainty, recommended category designation, associated sigma value and catch projection assumptions should be determined at the STAR panel, the tables themselves are not expected to be completed by the end of the STAR review and can be provided soon thereafter and included in the subsequent draft. The decision table is to be completed for the final document adoption shortly after either the June or September PFMC meetings, or November for those assessments going to mop-up panel review, while changes thereafter should be provided as addenda.

Once alternative models, which capture the overall degree of uncertainty in the assessment, are formulated, a two-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 several ways in which the

probabilities can be assigned to each model. One method bases uncertainty in management quantities for the decision table on the asymptotic standard deviation for the OFL in the final year of the model from the base model. Specifically, the current year spawning biomass for the high and low states of nature are given by the base model mean plus or minus 1.15 standard deviations (i.e., the 12.5th and 87.5th percentiles). A search across fixed values of lnR_0 are then used to attain the current year spawning biomass values for the high and low states of nature.   Another method to provide reasonable alternative models uses the 12.5% and 87.5% quantiles of the likelihood profile of an estimated parameter (the value of 0.66 reflects the chi square distribution with one degree of freedom) to determine the major axis of uncertainty.   Expert judgment may also be used as long as it is fully explained, justified, and documented.

Assessments can categorize uncertainty by using the model estimated uncertainty, sigma, or the default category sigma value (Wetzel and Hamel 2019; Privitera-Johnson and Punt 2020) if greater than the model estimate to create the low and high alternative states of nature. The above approaches may be an improved representation of the total uncertainty in the model, rather than the uncertainty within a specific model parameter. Secondly, the uncertainty expressed through the decision table is often symmetric. However, the actual uncertainty of a parameter or the spawning biomass is often not symmetric. Development of future decision tables should consider non-symmetric uncertainty in parameter and model uncertainty. Assessments could also explore uncertainty using MCMC. Using MCMC to express the probability of future population states given alternative harvest levels could be informative for the PFMC. Historically MCMC has been challenging for West Coast groundfish stock assessments due to long run times and the STAR Panel process that requires sub-daily turnaround of exploratory model results. The STAR panel may request that MCMC runs on the final model are run to account for uncertainty more fully account for uncertainty.

Bracketing of the base model for which the geometric mean of the current year 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) is an option that corresponds well to the assumption of a lognormal uncertainty distribution inherent in the current PFMC approach to determining scientific uncertainty buffers. This approach is based on the recognition that 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. Explanation and justification of severely non-lognormal structure of alternatives should be given. 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. Guidance on approaches for constructing decision tables will be provided in the *Accepted Practices Guidelines for Stock Assessments*.

There should be text explaining the major uncertainties addressed in the decision table. In addition to a description of the major axis of uncertainty and differences in the catch scenarios evaluated in consultation with the GMT, a clear description of the implications of each alternative in terms of the status and trajectory of the biomass under the various states of nature and harvest levels should be provided. Decision tables must include the harvest control rules that produce the catch streams.

Determination of assessment model uncertainty

The STAR panel and STAT in consultation with Council staff should propose an appropriate method for measuring the scientific uncertainty in the stock assessment, known as "sigma". Uncertainty should be based on the OFL uncertainty, to correspond to the newly adopted approach for addressing scientific uncertainty (Wetzel and Hamel 2019; Privitera-Johnson and Punt 2020). Typically, sigma would be based on the larger of the category-specific default value or the asymptotic uncertainty estimate (SD) associated with the estimated OFL distribution. The log-space uncertainty around the OFL value for the first forecast year is calculated as:

$$\sigma_{OFL} = \sqrt{log((SD/OFL)(SD/OFL) + 1)}.$$

Alternatively, sigma could be based on the spread of uncertainty underlying the decision table where $\sigma = (log\left(\frac{Base\ State\ of\ Nature}{Low\ State\ of\ Nature}\right))/1.15$, where 1.15 is the normal quantile corresponding to a 75% two-sided confidence interval. The SSC will determine the appropriate sigma value (e.g., a proxy sigma value for the stock category or a stock-specific sigma) to apply to estimates of acceptable biological catch based on these calculations. As of 2019, sigma values account for the increase in scientific uncertainty with time, incorporating a concomitant increase in the buffer between the overfishing limit and acceptable biological catch with each year since the most recent last full or update assessment, which should be accounted for in producing projections (Wetzel and Hamel 2019; Privitera-Johnson and Punt 2020). If changes to the sigma values are proposed, these should be adopted prior to the April Council meeting in odd years to facilitate their application in stock assessments, to prevent the need for revisions in catch projections due to changes made after completion of the assessments.

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, dissenting STAR panel members may prepare a 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 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;
- Recommended sigma value and the basis for the recommendation;
- 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 STAR panel advisors);
- 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 STAR panel advisors 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 a full assessment or could be an update assessment and explain reasons for its recommendation. Additionally, the STAR panel should recommend the category for the assessment based on the definitions of species categories in Appendix F and associated rules for relating category designations with sigma (the metric for an assessment's scientific uncertainty). The SSC will consider this recommendation when ultimately deciding the appropriate stock category.

The STAR panel report should be made available for review by the STAT within two weeks of the conclusion of the review, with sufficient time that the STAT can comment on issues of fact or differences in interpretation prior to the briefing book deadline. 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.

If a groundfish STAR Panel recommends an assessment undergo further review at a mop-up panel, the STAR report should document the deficiencies that are recommended to be addressed at the mop-up panel. In the event an assessment is rejected by the STAR panel or withdrawn by the STAT and there is no recommendation for a subsequent review at a mop-up STAR panel, the STAR panel report should document the deficiencies in the assessment that will need to be

addressed before the stock is next assessed.

5.3.   STAR Panel Chair Responsibilities

The STAR Panel chair is appointed by the SSC and is responsible to: 1) develop a STAR panel meeting agenda; 2) ensure that STAR panel participants follow the Terms of Reference; 3) guide the STAR panel and the STAT to mutually agreeable solutions; and 4) coordinate and conduct reviews of revised stock assessment documents before they are forwarded to the SSC.

It is the STAR panel chair's responsibility to ensure that STAR panel participants adhere to the TOR and that the meeting is run effectively and efficiently. This avoids discussing topics beyond the scope of the assessment review to focus efforts on the task at hand. Additional resources on running an efficient review can be provided by Council staff upon request. During the 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. Participation in the pre-assessment workshop is expected to provide input on direction of the assessment early in the process and to be aware of all issues raised. The STAR panel chair should prepare a report detailing issues raised at the pre-assessment workshop and ensure that any issues raised at the pre-assessment workshop are adequately addressed. The STAR panel Chair (or an appropriate designee) should document modeling decisions agreed at pre-assessment workshop, including the spatial strata for assessments, via the pre-assessment meeting workshop report, in consultation with the STAT.

It is the obligation of the STAR panel chair, in consultation with other panel members, to prioritize requests to the STAT for additional analyses and to make certain that STAT responses are thorough and clearly presented. It is the responsibility of the STAR panel reviewers (and a designated rapporteur) to capture the explanation and discussion of each request in the 'response' section of the requests, rational, and responses, and the Chair should ensure that sufficient details are captured. 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., as dictated by the schedule below).

Following the STAR panel meeting, the chair will lead the effort to draft the STAR panel report. In addition to the reviewers, the Chair will solicit comments on the draft report from the STAT and the STAR panel advisors. The purpose of this is limited to ensuring that the report is technically accurate and reflects the discussion that occurred at the 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 STAR panel advisors as the report is the panel's report of the meeting. 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 responsible for communicating with the STAT to determine if the revised stock assessment document is complete. In particular, the chair should confirm that the revised stock assessment document includes an accurate description of the final base model that was agreed during the review (rather than the pre-STAR base model). Any post-STAR drafts of the stock assessment must be reviewed and approved 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 on the Council's web site (www.pcouncil.org) must also be approved by the STAR panel chair prior to being accepted by Council staff.

The STAR panel chair is the party responsible for presenting the stock assessment review to the SSC, with any issues raised by the SSC being addressed by the STAT, STAR panel chair, or both, as appropriate. If there are areas of disagreement between the STAR panelists and the STAT then both sides will present to the GFSC, and the conflict resolution mechanisms in the current TOR will be followed.

The STAR panel chair is also expected to attend the SSC subcommittee meeting, SSC meeting, and, if requested, Management Team 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. If a groundfish assessment over which the Chair presided is sent to the mop-up STAR panel, they should attend the meeting to present the findings of the panel that resulted in the need for further review. In addition, the Chair is expected to participate in the stock assessment process review meeting to discuss any issues and provide feedback to improve the process for future assessment cycles.

The STAR panel chair is responsible for ensuring that the following schedule is adhered to (as closely as possible, recognizing that exceptional and personal circumstances do arise):

1. The STAR panel report should be in complete form, except for minor wording edits, etc. within two weeks of the end of the STAR panel, so that the STAT can review and ensure the post-STAR draft assessment document sent to the STAR panel chair adheres to the STAR panel report (or at least explains reasons for any discrepancies in that version of the assessment)

2. Comments on the post-STAR/Pre-SSC draft of the assessment should be returned to the STAT within two weeks after the deadline for that draft.

3. Comments on the post-SSC assessment document draft, if there is one, should be returned to the STAT within two weeks after the deadline for that draft, to ensure the STAT has time to complete any changes prior to the relevant briefing book deadline (or as soon as practicable for assessments sent to the "mop-up" panel for further work and review).

4. When time is limited between the STAR panel and the briefing book (or subcommittee) submission deadline, an accelerated timeline of intermediate deadlines for the STAT and STAR panel/chair should be decided upon when the STAR panel calendar is approved to ensure an appropriately reviewed and revised version of the assessment will be available by the submission deadline.

5.4.   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.

For any assessment reviewed at a STAR panel, 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 (or GFSC), the Council, and GMT and GAP; and
3) a "final version" to be posted on the Council's web site.

For assessment products reviewed only by the GFSC, the STAT is responsible for preparing two versions of the stock assessment document:

1) a "draft" for discussion during a GFSC review; and
2) a "final version" to be posted on the Council's web site.

The draft assessment document for full and update assessments should follow the outline in Appendix B with an optional executive summary (required in the final version) as in the template in Appendix C. Where possible, the executive summary should paraphrase the shared content of the body of the report to minimize redundancy. Draft assessment documents for data-moderate should follow the outline in Appendix E.

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 GMT and GAP representatives two weeks prior to the STAR panel meeting.

If the STAT brings a model to the STAR panel that differs from what was described in the pre-STAR document, the STAT should prepare and distribute a detailed errata sheet and/or list of changes detailing how the pre-STAR draft assessment differs from the version that will be presented at the STAR panel. The STAT should document any major pre-STAR model changes (including a sequential analysis of model changes) and present them at the beginning of the STAR Panel to allow as much time as possible for consideration and review as well as providing an errata sheet.

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. The mop-up panel generally is not able to review more than two full assessments, though this may depend on the particular issues being addressed. Therefore, the review options are limited for assessments for which review, revision and endorsement are not completed within the anticipated schedule.

The STAT is also responsible for providing model files and data (in digital format) to the review meeting. 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 as an electronic index of tables and figures. Inclusion of the electronic index may reduce the need to include some tables and figures historically included in the assessment document unless they are pertinent to considerations explicitly discussed. A list of available tables and figures provided in the electronic index should be included as an appendix in the assessment to make the readers aware of what tables and figures are available and where the electronic index can be found.

The STAT is responsible for providing responses to any formal STAR panel requests with an explanation of how the new analysis affected model results. Figures should be provided with captions and sufficient written explanation to document the analysis and results. The STAT is encouraged to provide extractable tables and/or figures with their responses to STAR Panel requests to facilitate their use in STAR Panel reports.

In most cases, the STAT should produce a revised draft of the assessment document within three weeks of the end of the review meeting. 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. Changes to drafts of data-moderate and data-limited assessment documents must be reviewed and approved by the chair of the meetings at which the reviews took place. These reviews are limited to editorial issues, verifying that all required elements are included, and confirming that the document reflects the discussion and decisions made during the review meeting.

The final version of the assessment document is produced after the assessment has been reviewed and endorsed 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 and the SAC for inclusion in a stock assessment archive by the November Briefing Book deadline in mid-October of the odd year. 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 conducting an assessment 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 and consulting with other stock assessment and ecosystem assessment scientists. Required pre-assessment workshops will typically be held between January and March of odd years. This time frame provides STATs with sufficient time to conduct preliminary analyses, gather data and begin initial assessment planning. The workshops allow stakeholders to discuss the available data, the potential data gaps, and have the STATs lead discussions regarding the anticipated foundational assumptions/issues and their treatment within the assessment (e.g., modeled spatial stock structure). Sufficient detail and presentation of considerations should be provided to facilitate discussions. The GFSC, associated STAR panel chair, advisors to the STAR panel, Council staff, and relevant data stewards should participate in the workshop to interpret and critically evaluate potential data sources. One goal of the pre-assessment workshop is to provide quality control of the data that will be used in assessments; the STAT should present preliminary data plots and analyses. The concerns raised in the pre-assessment workshop should be submitted

to the STAT in writing by the chair of the review meeting and major concerns and responses should be documented in the draft assessment.

STATs are encouraged to evaluate alternative models and analyses that incorporate ecosystem considerations and cross-FMP interactions that may affect stock dynamics. Early coordination with the Integrated Ecosystem Assessment team to evaluate ecosystem considerations is recommended and, at a minimum, the predators and food habits of the subject species should be included in the ecosystem considerations section of the assessment. 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 typically 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 (Council Operating Procedure 25). 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 and state agency representatives, as well as other data stewards should coordinate early in the process to ensure timely availability of data. This is particularly pertinent to coordination with custodians of ageing structures and parties responsible for processing them including laboratories involved in validation of ageing, which takes substantial time. In addition, the STAT should ensure that all fleets for which catch histories are derived are well defined. The STAT should consult with the GMT member to determine the most suitable projection of mortality to include in the final year of the catch time series as well as in the forward projections in addition to the assumption of full attainment. To facilitate these processes, an ageing prioritization and catch estimation meeting will be convened in July of even numbered years and coordinated by the Groundfish Subcommittee Chair with members of ageing laboratories, NMFS, and the States. The intent of the meeting is to identify all available samples, plan ageing of available structures, update assessment authors on any changes to catch estimation methods, and for the States to bring forward approved historical and recent catches by species. As data are provided and compiled, the STAT will confirm the final catches at the state level with data providers so that state representatives can better review discrepancies, changes, and outliers prior to final approval.

Final data are due to the groundfish STATs at least twelve weeks in advance of the STAR panel meeting, to allow sufficient time for data processing, assessment model development, assessment document preparation, and document review. PFMC staff are responsible for encouraging data delivery by the prescribed deadlines. STATs are not obliged to use data provided after the deadline and delays in provision by responsible parties may affect the availability of information used in the final assessment. If data arrive after the data deadline in spite of the best efforts of the STAT team to request and receive data in a timely fashion, an assessment will not be sent to mop-up solely due to late arriving data. If there are other substantial concerns raised by the STAR panel leading to the recommendation of a mop-up review, the late arriving data could be considered for inclusion in the model at that time. Deadlines for the 2023-2024 stock assessment reviews are provided in Appendix A.

STATs should make themselves available for discussions and meetings with industry and interested parties to discuss data and stock assessment issues as needed. The STAT should initiate contact with the GAP representative early in the assessment process, keep the GAP informed of the data being used and respond to any concerns that are raised. The STAT should also contact the GMT representative and Council staff early in the process for information about changes in fishing regulations and spatial management issues that may influence model structure and the way data are used in the assessment. The latter is particularly important for nearshore groundfish stocks, for which each state has different regulatory histories.

Barring exceptional circumstances, STAT members who are not attending the STAR panel meeting should be available remotely to assist with responses when needed. A member of the STAT is expected to attend the associated Groundfish Subcommittee Meeting that precedes the Council review. The STAT may be requested to attend the SSC and/or Council meeting by the Groundfish Subcommittee, in which case each STAT should appoint a representative to attend the Council meeting where the assessment is scheduled to be reviewed. In any case, a member of the STAT should be available to respond to questions during the review, whether in person or remotely. In addition, the STAT should be prepared to respond to GMT or Council staff requests for model projections to facilitate development of ACL alternatives; these requests will be provided in writing to the STAT.

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 groundfish STATs should follow accepted practices guidelines that will be developed by the SSC and distributed to the STATs and STAR Panels following the November 2022 meeting. An outline of topics that will be covered in the *2022 Accepted Practices Guidelines for Groundfish Stock Assessments* is provided in Appendix G. The STATs may diverge from the guidelines if they provide adequate justification to the STAR panel or GFSC and in the assessment document.

For a groundfish stock identified as needing a rebuilding analysis, a STAT representative is strongly encouraged to attend the GFSC meeting that precedes the September Council meeting. Rebuilding analyses are typically reviewed at the mop-up STAR panel.

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

5.5. National Marine Fisheries Service Responsibilities

NMFS assists in organizing stock assessment reviews. NMFS provides a point of contact (POC) to facilitate and assist in overseeing the STAR process.

NMFS works to develop assessment prioritization guidance and a ranking of stocks for assessment that considers a range of factors for consideration by the Council. NMFS also develops a draft STAR panel schedule for the Council review. The SSC Chair and Council staff identify STAR

panel members based on criteria for reviewer qualifications, and, for groundfish, make 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 for federal or CIE reviewers and the Council for other reviewers not affiliated with a federal agency or the CIE. 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 is encouraged to develop stand-alone documentation of key data sources under its purview that inform assessments (e.g., descriptions of NMFS trawl and hook-and-line surveys) that can be incorporated by reference in stock assessments. Such documentation should include digital maps of the geographical areas covered by surveys. There should also be thorough stand-alone documentation of stock assessment software and associated analytical methods (e.g., the Vector Autoregressive Spatial Temporal (VAST) delta-GLMM model) that have been endorsed by the SSC. Such documentation can be incorporated by reference in stock assessments and will aid reviewers at STAR panels who may be unfamiliar with key data sources or modeling approaches and serves to maintain transparency in the STAR process.

5.6. 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 will also provide STATs with tables of fishery regulatory history and time series of management performance (e.g., ABCs and ACLs) as well as the appropriate database references. This should include the major management measures likely to have impacted selectivity and retention parameters or informed time blocking to address changes in regulations. Documentation of regulatory histories for stock assessments by Council staff is to be developed in consultation with the States.

Council staff coordinate with the STAR panel chair and NMFS 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 coordinate 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 attend and monitor 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 coordinate with the STAR panel chair to develop solutions to correct the inconsistencies. Council staff serves as an advisor to the STAT and STAR panel but does not serve as a member of the STAR panel. Council staff also attends and monitors the SSC review of stock assessments to ensure compliance with the TOR.

For reviews of groundfish assessments (all assessment types) Council staff is responsible for providing the STAT with the information needed to conduct projections, including the default

harvest control rules and the multipliers needed to buffer for scientific uncertainty for the default projections. Council staff will also collaborate with the GMT advisor and the STAT regarding removal assumptions, particularly for the initial two years for which there are approved harvest specifications, which should be made when developing projections. Default assumptions for specifying removals in projections and decision tables (e.g., use ACL or OFL values) are projected attainment for the remainder of the current regulatory specification cycle provided by the GMT advisor and full attainment for the remainder of the projected period. Any deviations from using the default removal assumptions proposed for inclusion in a decision table must be requested and justified in writing prior to the end of the STAR panel meeting for full stock assessments and prior to the SSC review for all other stock assessment types.

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, GMT, GAP, and CIE reviewers, as well as letters from the public and any other relevant documents. These documents are typically posted on the Council's web site.

5.7. Management Team Responsibilities

The GMT is responsible for identifying and evaluating potential management actions based on the best scientific information available. Particularly, the GMT uses stock assessment results and other information to make ACL, HG and ACT recommendations to the Council. The GMT member for a given assessment is responsible for assembling catch streams for projections and passing them to the STATs and fielding questions from the STATs about management. The GMT is also responsible for coordinating with other agencies in validating catch streams using the agreed upon data source to be used for removals (e.g., Groundfish Expanded Mortality Multi-year, GEMM or other sources). This is particularly relevant for historical catches for new assessments. The GMT should work with state data stewards for approved catch histories.

Participation in the pre-assessment workshop is expected to provide input on direction of the assessment early in the process.

A GMT representative, usually appointed by the GMT chair, attends the STAR panel meeting and serves as an 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. Documentation of regulatory histories for stock assessments by Council staff are to be developed in consultation with the States and the GMT.

The GMT representative does not serve as a member of the STAR panel. The GMT should be involved early in the stock assessment process to provide guidance on fishing regulations to ensure the STAT accommodates regulatory changes as best as possible in the modeling framework. In particular, for groundfish assessments, the GMT should provide: 1) catch levels to be used in the assessments for the first two years of the projections for which OFLs and ACLs have already been approved by the PFMC (prior to the assessment in question being used in management, here: 2023 and 2024), 2) as appropriate, catch levels for the last year of the model (the year previous to the year in which the assessment is conducted, here: 2022), and 3) projected catch levels for the PFMC's 12 year projections (in this assessment cycle 2025 forward). Any recommended

deviations from default removal assumptions should be accompanied by written justification. This limits discrepancies between the STAT and GMT that could arise in the STAR panel.

Successful separation of science (e.g., STAT and STAR panels) from management depends on assessment reviews being completed by the time the GMT meets to discuss preliminary ACL, HG and ACT recommendations. The GMT should not seek revision or additional review of the stock assessments after they have been endorsed by the STAR panel. The GMT chair should communicate any unresolved issues to the SSC for consideration. The GMT can request additional model projections from the STAT, to fully evaluate potential management actions. Any additional requests from the remainder of the GMT, GAP, or other outside sources should be conveyed through the GMT representative to avoid communication issues, and formally requested in writing to the STAT through Council staff. Any proposed changes should be discussed informally between the GMT and the STAT before being made officially to avoid functional duplication of alternatives that are redundant or that are similarly bracketed by prior requests. The GMT should review the "revised draft" assessment to verify that the removal assumptions they requested were used in the assessment and projections provided in the assessment document. Where possible, the GMT should provide potential catch streams to the STAT for evaluation at or before the STAR panel.

5.8. Advisory Subpanel Responsibilities

A GAP representative, usually appointed by the GAP chair, attends the STAR panel meeting and serves as an advisor to the STAT and STAR panel. Participation in the pre-assessment workshop (if held) is expected to provide input on direction of the assessment early in the process. The GAP 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 GAP 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 GAP representative (along with STAT and STAR panel chair, if requested) is expected to attend the GMT meeting at which preliminary ACL and ACT/HG recommendations are developed. The GAP representative is also expected to attend subsequent GMT and Council meetings where the relevant harvest recommendations are discussed.

5.9. State / Tribal Data Stewards and State / Tribal Agency Responsibilities

Most stock assessments rely on data collected by state and tribal agency staff as part of their routine fishery monitoring and sampling activities. Although these data are generally housed and available from the PacFIN and RecFIN data repositories, some data from special collections may only be available directly from the state or tribal agencies or may require special consideration (e.g., because of unusual sampling protocols). State and tribal data stewards or other knowledgeable representatives from the state and tribal agencies should be tasked with working with the STATs to provide relevant stock assessment data. These individuals should (a) provide the STATs with information on available data that might be relevant to upcoming assessments, (b) provide data requested by the STATs in a timely manner, (c) provide guidance on any special attributes of the

data that may need consideration for their correct analysis and interpretation, and (d) attend any pre-assessment workshops organized for the assessments. Data stewards should provide STATs with final data at least twelve weeks prior to the start of the STAR. Specific deadlines for data are specified in Appendix A. States should designate data stewards to approve catch histories. The STAT will provide the finalized catches so that state representatives can approve.

5.10. 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, in coordination with NMFS and Council advisory bodies, is responsible for developing the Terms of Reference, and the SSC provides guidelines with accepted practices for data and modeling approaches for developing stock assessments. Participation of members of the relevant SSC Subcommittee in the pre-assessment workshop is recommended to provide input on direction of the assessment early in the process.

The SSC is responsible for overseeing the stock assessment review process. To that end, at regular intervals the SSC should review progress towards the achievement of important milestones such as the assignment of analysts to STATs, provision of data to the STATs, planning and implementation of pre-assessment workshops, and planning and implementation of STAR panels.

The SSC assigns an SSC member to act as the STAR panel chair. The STAR panel chair attends the pre-assessment workshop and the assigned STAR panel meeting and fulfills responsibilities described in the section "STAR Panel Chair Responsibilities".

The SSC conducts a final review of all the types of stock assessment. Reviews of full stock assessments (either by the relevant Subcommittee or the full SSC) should not repeat the detailed technical review conducted by the STAR panel. The SSC reviews the stock assessment document, the STAR panel report, and the relevant Subcommittee report (when applicable) to ensure the assessment and review followed the *Terms of Reference* and *Accepted Practices Guidelines*. The SSC should generally note any concerns for the next assessment and propose changes to an assessment only under exceptional circumstances, such as finding an error or a gross violation of the *Terms of Reference* or *Accepted Practices Guidelines*. Although the SSC has the discretion to look into concerns it deems critical to evaluate, even if this requires requests for additional model runs, the SSC should strive to limit its attention to issues that were not covered in the *Terms of Reference* and/or *Accepted Practices Guideline* or, in some cases, decisions concerning the base model configuration that may not have considered and evaluated all factors and diagnostics associated with the configuration.

The SSC also reviews the STAR panel recommendations and serves as an 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 GMT or Council staff after the stock assessment has been reviewed by the STAR panel. To ensure 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 may request post-STAR analyses and model changes to arrive at an assessment that is acceptable to the SSC, but the requests should be limited and focused.

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 assessment categories in Appendix F, as well as determining the scientific uncertainty in estimating the OFL (i.e., the value for sigma). 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}.

The SSC (for assessments reviewed by the SSC in June) or SSC Groundfish Subcommittee (for other assessments) reviews the STAR panel report and stock assessment document 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 during a meeting that occurs after all of the STAR panels, primarily to review rebuilding analyses for overfished/rebuilding stocks. Soon after completion of all STAR panels, the SSC Groundfish Subcommittee will meet by teleconference, webinar, or, if needed, in person to recommend which assessments, if any, will be sent to the mop-up panel and to prioritize further analyses. At this late-summer meeting the SSC Groundfish Subcommittee will also review all assessments endorsed by STAR panels, consider their own endorsement of these assessments in advance of the SSC's review in September, and recommend which STATs should attend the full SSC review in September. The STATs are required to participate in the late-summer Groundfish Subcommittee meeting. This meeting 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 and which stock assessments are approved for final consideration by the SSC and the Council at their September meeting. 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 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.

6. FULL ASSESSMENTS

Full stock assessments apply statistical models that are age- or size-structured to "data-rich" stocks, meaning the available data are adequate to produce estimates of year-class strength and there is information from surveys or fisheries to resolve trends in biomass and estimate stock status. Each full assessment model has underlying equations to mimic the dynamic processes of fish growth, maturation, reproduction, and mortality (due both to natural causes and related to fishing). The models produce annual estimates of age-specific abundance, biomass, and catch that are compared to the available observational data to find sets of parameters that best-fit the available data. A full assessment in its simplest form might be used with a stock having sexes with identical size-at-age, a single fishery (with an associated series of annual catches, age-specific fishery selection coefficients, weights-at-age, and age-compositional data), and a single survey (with an associated series of annual biomass index values, age-specific survey selection coefficients, and age-compositional data). Most of the Council's full stock assessments have been conducted using

the Stock Synthesis software and most have received a category 1 designation (Appendix F).

7. UPDATE ASSESSMENTS

An update assessment reruns an approved assessment model with the data series extended to include new data. The initial recommendation whether the next assessment should be full or update is made by the STAR panel during the STAR panel meeting. The SSC makes the final recommendation.

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 the 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 common 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 used 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. If more substantial changes to the model are contemplated by the STAT, the SSC Groundfish Subcommittee may recommend that the update be subject to further review at the mop-up STAR panel meeting to evaluate the proposed method more thoroughly.

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.

It is acceptable for the STAT to change the major axis of uncertainty when conducting an update assessment if the STAT provides adequate rationale for making that change and the SSC endorses the change. In such an instance, the STAT should submit two versions of the decision table to the SSC for their review, one assuming the axis of uncertainty in the original full assessment and one with the new proposed axis of uncertainty. The SSC will ultimately decide which axis of uncertainty best characterizes the uncertainty in the update assessment.

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 to the selectivity blocks to extend time periods for the end years of the model; 3) correcting data entry errors; 4) bug fixes in software programming; and 5) improved estimates of parameters such as steepness or the natural mortality rate due to new research or updated meta-analyses. 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.

Review of Update Assessments

Update assessments are reviewed by members of the GFSC during a single meeting. Reviews typically require 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 and include an Executive Summary based on the template in Appendix C. The STAT, however, can reference the last full assessment (or other relevant documentation) for a description of methods, data sources, stock structure, etc., given that they have not been changed. Any new information in 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 follow the same structure as in the last full assessment. In particular, it should highlight differences among alternative models defined using the same axes of uncertainty as those in the last full assessment

or provide good justification for changing the axes of uncertainty.

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. GMT and GAP representatives, as well as Council staff, 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, 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 AND CATCH AND CLIMATE-ONLY PROJECTIONS

In some circumstances, a STAT may be asked to produce an update assessment using only recent fisheries catch or catch and climate information to generate stock projections. Assessments of this type do not include the most recent survey abundance index estimates. Projections with only catches revised will have no new data to inform the stock-recruitment relationship in the model. Projections with catches and climate may have new data to inform the deviations around the stock-recruitment relationship in the model. All projections become more uncertain with increasing the projection period. Full ACL or harvest guideline attainment should be assumed for the catch projections in the absence of a strong rationale from the GMT that an alternative assumption is appropriate. Recent average catch distribution among fleets should be used for projections unless the GMT requests an alternative distribution. 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 and catch and climate-only projections are initially reviewed by the relevant SSC subcommittee, with public notice, then subsequently reviewed by the full SSC.

Technical guidance on conducting catch-only projections for groundfish species will be given in the *Accepted Practices Guidelines* (outline in Appendix G).

The GMT will provide the catches for groundfish catch-only projections using the same stratification as the original assessment. Results of these projections including the OFL, ABC, ACL, spawning biomass, and depletion projections must be provided in a table such as Table 1. The catch data used in the catch-only projection should be compared to the previous assessment or update and differences from catch estimates in years prior to the end of that previous assessment should be explained. If differences result in substantial changes in model outputs or estimates, a benchmark or update assessment may be preferable.

Projections that use climate time series must provide plots or tables of the time series used in the projections.

Table 1. **Example of the table to be included in catch-only projections.**

Year	OFL projections from Last Assessment/ Projection	Updated OFL Projection	Assumed Catch in Last Assessment/ Projection	Actualized Catch and Projection Based on the Default Harvest Control Rule	Summary Biomass	Spawning Output/ Biomass	Depletion (%)	Depletion (%) from Last Assessment/ Projection
2013			189	150				47.3%
2014			189	85				48.2%
2015	206		188	122				49.2%
2016	210		192	139				50.2%
2017	215		197	130				51.1%
2018	219		201	229				51.8%
2019	222		204	*142*	8,451	2,938	54.5%	52.4%
2020	224		206	*142*	8,451	2,983	55.3%	52.9%
2021	226	241	208	199	8,482	3,018	56.0%	53.1%
2022	227	242	209	198	8,455	3,025	56.1%	53.2%
2023	226	242	209	196	8,426	3,024	56.1%	53.1%
2024	226	242	208	195	8,397	3,019	56.0%	53.0%
2025	-	242	-	192	8,369	3,010	55.8%	-
2026	-	241	-	190	8,342	2,999	55.6%	-
2027	-	240	-	187	8,318	2,987	55.4%	-
2028	-	239	-	184	8,297	2,975	55.1%	-

9. DATA-MODERATE ASSESSMENTS FOR GROUNDFISH SPECIES

Data-moderate assessments are a refinement over data-limited methods that result in category 3 assessments (described below) in that a data-moderate assessment includes length and/or abundance trend information in addition to the data informing a data-limited form of the assessment (catch series plus information on life history and status). Data-moderate assessments can result in category 2 (catch and length or catch and index) or category 1 designations (possible when catches, lengths, and index data are incorporated). One defining distinction between category 2 and category 3 assessments is that the length and/or abundance trend information is incorporated in a category 2 assessment enabling an estimate of stock status (Appendix F). While the SS-CL+Index assessments have the potential to be category 1 assessments, simulation analyses indicate that if there are fewer than ten years of length data for a stock in question, there is substantial uncertainty in the results, potentially leading to designation as a category 3 assessment.

Two index-based data-moderate assessment methods have been endorsed since the 2013-14 assessment cycle, XDB-SRA and XSSS. In both cases, abundance trend information (e.g., survey or fishery CPUE indices) is included in the assessment. The length-based data-moderate assessment method using only catches and lengths is SS-CL, while SS-CL+Index uses catches, lengths, and indices of abundance from fishery-independent surveys for which index derivation is well established. A flowchart describing the specific steps to take in conducting these assessments is provided in Appendix J. These specific applications provide assessments that are understood well enough to require only review by the GFSC. More complex data-moderate assessments within the Stock Synthesis framework incorporating fishery-dependent indices of abundance or use of age data are also possible and require review by a STAR panel review to address the added complexities of model fitting and index development.

The continuum of models should be accommodated to allow combinations of catch, lengths, ages and, indices to be applied to both new assessments and length-based extensions of existing benchmark assessments, though review processes may differ. A categorization of each assessment method is provided in Table 2, which defines the scope of each method in terms of data source and assessment type. The flow chart in Appendix J includes how to prepare catch estimates, length data, parameter estimation, model weighting, model convergence, and characterize uncertainty. The SS-CL+Index assessment method includes fishery-independent indices of abundance for which index development methods are well established. Implementation of assessments within the provided specifications allows for standardization and more streamlined review by the GFSC in May or June of odd years along with update assessments. The depth of potential reviews should increase with the estimation of more parameters. Review of one or more length-based models that use an approved standard methodology can be reviewed within a STAR Panel setting, though GFSC review may be sufficient, depending on the particular assessment. Intermediate methods using fishery-dependent indices or age data are subject to review at a STAR panel to allow further evaluation of model fitting and tensions between data sources (see Table 2 for categorization of assessment types). Assessments conducted with data-moderate methods may be category 2 or category 1 depending on whether only catch and length or catch and index data were used resulting in a category 2 assessment or if catch, length, and index data were used, which can result in a category 1 assessment.

Addition of new age data to either type of length-based Stock Synthesis assessment is discouraged to avoid confounding the nature of the assessment, reducing model tension arising from potential conflicts in age and length data, and increasing clarity in the related review process. Due to the complexities and potential data conflicts that can occur from fitting to age data in combination with indices and lengths, assessments that include current age data should be considered full benchmark assessments and reviewed in STAR panels.

Table 2. Model types, their data types and assessment type. All assume a known catch history.

Model	Lengths	Ages	Index	Assessment Type
DB-SRA/SSS	Ignore	Ignore	Ignore	Data-limited
XDB-SRA/XSS	Ignore	Ignore	Use	Data-moderate
SS-CL[1]	Use	Ignore	Ignore	Data-moderate
SS-CL+Index	Use	Ignore	Fishery-independent indices only (e.g., WCGBTS, H&L)	Data-moderate
SS (new config[2])-lite	Use	Ignore	Use	Likely Benchmark
SS (old config[3])	Use / update?	Use new / Ignore unread	Use / update?	Update
SS (new config[2])-heavy	Perhaps new data sources	Perhaps new data sources / Ignore unread	Perhaps new data sources	Benchmark

1: Flow chart for specifications related to fleets, life history parameters, selectivity etc.
2: New specifications for how the assessment is configured.
3: Model specifications are the same as the last assessment.

Index-based Methods
The index-based method 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. The XDB-SRA method 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 SSC Groundfish Subcommittee 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. If more than one model is presented, the SSC Groundfish Subcommittee should recommend adoption of a preferred model, if one can be identified, for use in management.

Length-based Methods
Applying SS-CL and SS-CL-Index is very similar to conducting a standard Stock Synthesis (SS)

assessment since SS-CL is conducted in Stock Synthesis, and all equations for the model can be found in the Stock Synthesis documentation (Appendix A of Methot and Wetzel (2013). Like SS, the data for these methods can include many fleets, sexes, etc. as desired, catches are a full time series and assumed known and length compositions are assumed to be representative, with effective sample size treated in standard ways. Life history values (i.e., steepness, growth parameters (k, $L\infty$, t_0), natural mortality, fecundity, maturity) are initially pre-specified (some degree of this does happen in many standard Stock Synthesis models), but estimation of some values may be possible. Recruitment can be estimated, and standard bias correction procedures are applied. Selectivity is also typically estimated but can be fixed. If multiple fleets have length composition data, data weighting approaches would follow standard procedures as outlined in Appendix B Section H. The starter and forecast files are specified as in traditional Stock Synthesis assessments. The performance and stability of SS-CL was better with smaller model dimensions (e.g., fewer fleets) and is sensitive to errors in the fixed values for $L\infty$ and the coefficient of variation (CV) of length-at-age, which, if fixed, should be explored in sensitivity analyses.

The limited scope of SS-CL and SS-CL+Index allow for more limited documentation requirements, described in Appendix E. For more complex intermediate models beyond the scope of these focused methods, reporting requirements should be developed in an assessment-specific TOR developed by the Chair of the STAR panel to provide flexibility to cover the range of possible applications, while still providing appropriate specificity and thorough evaluation. The reviews are expected to take between a half day and two days depending on the number, type, and novelty of the assessments. It may be beneficial to hold a half day preliminary review during a virtual meeting prior to the Groundfish Subcommittee at which the review will be conducted. The number of SS-CL or SS-CL+Index assessments that can be conducted at a given STAR panel or the Groundfish Subcommittee of the SSC in combination with update assessments, depends on the complexity of the models, spatial areas, and novelty of the methods. Between two and four assessments in a review may be reasonable, and flexibility should be provided to the SSC in determining how many assessments should be reviewed and the process for each review.

The critical modeling steps for SS-CL and SS-CL+Index are included in the methodology step flow chart in Appendix J in addition to the following guidance. Jittering and alternative phasing should be used given the difficulties encountered by the analysts during this review finding the global minimum of the objective function. If there is dimorphic growth, then sex-specific information should be included, given increased uncertainty in simulation results with increasing variance in length at age, which is greater when sex data associated with lengths are not available or included in assessment of sexually dimorphic species. This may be less of a concern if only males or females are predominantly sampled by the survey or caught in the fishery but can be confounding if more equal sex ratios are observed in the catch or survey and sex data is unavailable for measured fish. Fleet consolidation is recommended if selectivity is similar among sectors or surveys to reduce model conflict and confounding effects. If a survey is included in an SS-CL+Index assessment, the length-composition from that survey should also be included, as well as length-composition from other fishery-independent or fishery-dependent data sources. Application of dome-shaped selectivity should be investigated when plausible, in addition to asymptotic selectivity. It is recommended that the model be run with asymptotic selectivity for at least one fleet if natural mortality is being estimated. Simplifying model structure and spatial areas will reduce complexity in the assessments and workload in both the analysis and review.

10. DATA-LIMITED ASSESSMENTS FOR GROUNDFISH SPECIES

Data-limited assessment methods to assess groundfish species were adopted by the Council in 2011 to inform harvest specifications for category 3 stocks (Appendix F). 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).

Data-limited stock assessment reports should follow the template in Appendix E.

11. CATCH REPORTS

In certain cases (e.g., cowcod in 2017) 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 SSC during a single meeting (typically June of odd years for groundfish when 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 and 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 subsequently reviewed by the full SSC. The GMT and GAP representatives, as well as Council staff, also participate in the review.

12. LITERATURE CITED

Cope, J. M. 2013. Implementing a statistical catch-at-age model (Stock Synthesis) as a tool for deriving overfishing limits in data-limited situations. Fish. Res. 142:3-14.

Dick, E. J. and A. D. MacCall. 2011. Depletion-based stock reduction analysis: a catch-based method for determining sustainable yields for data-poor fish stocks. Fisheries Research 110:331-341.

Hilborn, R. and C. J. Walters. 1992. Quantitative Fisheries Stock Assessment: Choice, Dynamics and Uncertainty. Chapman and Hall, New York.

MacCall, A. D. 2009. Depletion-corrected average catch: a simple formula for estimating sustainable yields in data-poor situations. ICES J.of Mar.Sci. 66:2267-2271.

Methot, R. D. and C. R. Wetzel. 2013. Stock Synthesis: A biological and statistical framework for fish stock assessment and fishery management. Fisheries Research 142:86-99.

Methot, R. D. E. 2015. Prioritizing fish stock assessments. U.S. Department of Commerce.

Privitera-Johnson, K. M. and A. E. Punt. 2020. Leveraging scientific uncertainty in fisheries management for estimating among-assessment variation in overfishing limits. ICES J. of Mar.Sci. 77:515-526.

APPENDIX A: 2023 GROUNDFISH STOCK ASSESSMENT REVIEW CALENDAR

<mark>TBD after the June 2022 meeting.</mark>

Review Meeting	Data Distribution Deadline and State Contacts	Initial Review Deadline	Document Distribution Dates	STAR Panel Dates	Post-STAR and Briefing Book Deadlines	Location	Species	Lead Stock Assessor

APPENDIX B: OUTLINE FOR FULL AND UPDATE STOCK ASSESSMENT DOCUMENTS

This is a general outline of elements that should be included in full and update stock assessment documents for groundfish 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 guideline on how to organize and communicate stock assessment results. Some items are identified as being optional for draft assessment documents prepared for STAR panel meetings but should be included in the final document. Also, some items are identified as being not applicable for a final assessment document associated with an assessment rejected by the STAR panel or withdrawn by the STAT. A check-list of elements to be included in full or update stock assessment documents is included in Appendix D and a list of tables and figures to include in groundfish assessment documents or associated electronic indices are described in Appendix I.

Tables placed in assessment documents should not use a font-size smaller than 10 point and preferably should be in editable form (i.e., tables that can be copied or converted from the document, not images). For assessments undergoing review, all tables should be available upon request in editable, electronic files in text or spreadsheet format.

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., Wetzel, 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. Executive Summary (should follow the template in Appendix C). Where possible the executive summary should paraphrase the shared content of the body of the report to minimize redundancy. **The executive summary is not required (though is useful) in a draft assessment undergoing review and not submitted to a Council Briefing Book.**

A. Introduction ***An update assessment may include abbreviated information from each of the following items, citing the previous full assessment for additional information, if there has not been new or changed understanding of the following attributes.**

   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. ***Not required for an update assessment.**
   3. Important features of life history that affect management (e.g., migration, sexual dimorphism, bathymetric demography).
   4. Ecosystem considerations that include relevant information on how environmental drivers,

prey, competition, predation, and/or (habitat requirements/preferences may affect stock's status, vital rates (growth, survival, productivity, recruitment), or range and distribution. Ecosystem considerations may also include how these factors, cross-FMP interactions with other fisheries and human social dynamics that may affect the stock (e.g., reliance and dependence by fishing communities, non-target species constraining harvest rates). The length and depth of this section will depend on availability of information from published studies and Integrated Ecosystem Assessment reports, expertise of the STAT, and whether ecosystem factors contribute quantitative information to the assessment. ***Not required for an update assessment if a citation to the previous assessment is provided.**

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), landings, and catch (i.e., landings plus discard) for each area and year. Groundfish assessments that estimate dead discarded catch must include a disclaimer noting that total mortality estimates from the WCGOP and from the stock assessment may differ due to the use of different methods. Investigation into how these methods differ is beyond the scope of a benchmark assessment. The rationale for modeling discard mortality can also be provided. This should be included in all update assessments.
8. Description of fisheries for this species off Canada, Alaska and/or Mexico, including references to any recent assessments of those stocks extending beyond the Council's jurisdiction. STATs are strongly encouraged to include a summary of catches and estimates of stock size and stock status for the most recent ten years if such information can be assembled without excessive difficulty. ***Not required for an update assessment.**

D. Data

Description of all data and sources, used in the assessment; if not all data sources are used, provide the rationale for excluding particular data sources; report on consulting with GAP and GMT 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. Description of methods to estimate abundance indices, sample size information by survey and year. 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 (or drops or sites for hook and line data) 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 or model products used in the stock assessment model and/or in the preparation of data or estimation of biological parameters. If environmental

or ecosystem data are incorporated in the stock assessment model, provide a report of consultations with technical teams that evaluate ecosystem data or methodologies used in the assessment.

E. Model

1. History of modeling approaches used for this stock. ***Not required for an update assessment.**
2. Response to the most recent previous STAR panel and SSC recommendations for remedying deficiencies in the most recent previous full assessment. ***Not required for an update assessment.**
3. For groundfish update assessments, point by point response to the current Groundfish Subcommittee recommendations. ***Not required in draft update assessment undergoing review.**
4. Description of new modeling approaches and changes made from the last assessment, with rationale. ***Not required for an update assessment.**
5. 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.).
6. 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. Figures showing data and model changes that produce the greatest change in spawning biomass trend and stock status in the new base model compared to the previous stock assessment model accepted for management decision making.
2. 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. ***Not required for an update assessment.**
3. Evaluation of model parameters. Likelihood profile for the base model over key parameters (e.g., natural morality, 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?
4. Residual analysis for the base-run configuration, e.g., residual plots, time series plots of observed and predicted values, etc.
5. Convergence status and convergence criteria for the base-run model (or proposed base-run). Randomization of starting parameter value run (e.g., jitter) results or other evidence of search for global best estimates.

G. 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. Include the associated asymptotic standard error estimates.
2. Population numbers and biomass at age × year × sex (if sex-specific M, growth, or selectivity) (may be provided as a text or spreadsheet file). ***Not required in draft assessment undergoing review.** Can be included in electronic appendices (SS report files), should be provided as supplementary material for assessments developed with alternative assessment platforms.
3. Time-series of total biomass, 1+ (if age 1s are in the model), summary biomass, and spawning biomass (and/or spawning output), depletion relative to B_0, recruitment and fishing mortality (1-SPR) (or exploitation rate estimates if fishing mortality not available) (table and figures).
4. Selectivity estimates (if not included elsewhere).
5. Stock-recruitment relationship.
6. Clear description of units for all outputs.
7. Description of how discard is included in yield estimates.

H. Evaluation of uncertainty in model results.

1. Sensitivity to assumptions about model structure, i.e., model specification uncertainty.
2. Sensitivity to data set choice (e.g., using emphasis factors to selectively remove data sources) and weighting schemes (e.g., MacAllister & Ianelli weighting versus Francis weighting vs. Dirichlet weighting for compositional data), 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, steepness, and R_0). This element for evaluating uncertainty 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 uncertainty around the OFL (sigma) 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.

I.   Reference points.

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 round fish 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.

J.   Unresolved problems and major uncertainties. ***Not required in draft assessment undergoing review**.

Describe any special issues (e.g., unbalanced or questionable data, missing survey data) that complicate scientific assessment, questions about the best model scenario.

K.   Harvest projections and decision tables (groundfish only). ***Not required in draft assessment undergoing review**. **** Not applicable to assessments rejected by a STAR Panel or withdrawn by the STAT.**

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) 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, the GMT may recommend other alternatives 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 the two years of the current biennial harvest specifications cycle plus ten years into the future. An example template for a table of harvest projections is provided below.
3. Include both years of the current biennium in projections / decision tables, so there is no gap shown in the tables between the current biennium and projection years. Do not report model-estimated OFLs and ABCs (and ACLs) for years in the current biennium that have management specifications in place. Instead used the OFLs and ABCs (and ACLs) specified in regulation. For stocks with estimated 2018 *Depletion* greater than 40% the ABCs are equal to the ACLs.

Table 3. Hypothetical projections of potential OFL, ACL, estimated summary biomass (age-1 and older), spawning output, and depletion based on target SPR of 50% for the OFL and under the ACL = ABC (P*= 0.45) harvest control rule. Projections use assumed total removals of 707 and 744 mt (the Council's adopted ACLs) for 2019 and 2020 respectively. Because this hypothetical table is for a stock that is not in the precautionary zone it does not require a separate column for the ABC values.

Year	OFL (mt)	ACL (mt) = ABC	Summary biomass (mt)	Spawning output (million eggs)	Depletion (%)
2019	739	707*	20,265	1,424	44%
2020	778	744*	20,503	1,468	46%
2021	778	744	20,606	1,512	47%
2022	759	726	20,624	1,548	48%
2023	738	706	20,597	1,574	49%
2024	721	690	20,544	1,592	50%
2025	708	678	20,478	1,604	50%
2026	699	669	20,403	1,611	50%
2027	693	662	20,334	1,615	50%
2028	688	657	20,264	1,617	50%
2029	684	653	20,193	1,617	50%
2030	681	649	20,123	1,617	50%

* Assumed removals consistent with 2019 / 2020 harvest specifications.

L. Evaluation of scientific uncertainty.

- Fully document the calculation of the base model's sigma associated with the current year's OFL value.

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 standard data product (e.g., the proportion of the survey biomass in each management area) can be provided as the basis for GMT discussions regarding harvest allocation. The GMT advisor and Council staff should be consulted on the appropriate management areas for each stock.

N. Research and data needs.

1. Describe progress on Research and Data Needs items identified in the most recent previous stock assessment document and associated STAR Panel report.
2. Describe new research and data needs and specify their priority (high, medium, low).

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. <u>Literature cited</u>.

Q. <u>Auxiliary files</u>.

A list naming the required text files (complete parameter and data files in the native code of the stock assessment program) and any other supplementary electronic files that will accompany the assessment document when archived with the PFMC.

For assessments conducted using Stock Synthesis, the following files should be included and archived with the stock assessment document: starter.ss, forecast.ss, Fishstock.ctl, Fishtock.dat, Report.sso and the Stock Synthesis model executable.

Items marked with an asterisk (*) are optional for draft assessment documents prepared for STAR panel meetings but should be included in the final document. Items with double asterisks (**) are not applicable for a final assessment document associated with an assessment rejected by its STAR panel or withdrawn by its STAT.

Stock	Species/area, including an evaluation of any potential biological basis for regional management.
Catches	Trends and current levels - include table for last ten years and graph with long term data.
Data and assessment	Date of last assessment, type of assessment model, data available, new information, and information lacking.
Stock biomass and dynamics	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.
Recruitment	Trends and current levels relative to virgin or historic levels- include table for last 10 years and graph with long term estimates
Exploitation status	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).
Ecosystem considerations	A summary of reviewed environmental and ecosystem factors that appear to be correlated with stock dynamics These may include variability in the physical environment, habitat, competitors, prey, or predators that directly or indirectly affects the stock's status, vital rates (growth, survival, productivity/recruitment) or range and distribution. Note which, if any, ecosystem factors are used in the assessment and how (e.g., as background information, in data preparations, as data inputs, in decisions about model structure).
Reference points	Groundfish: 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.

Management performance	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.
Unresolved problems and major uncertainties	Any special issues that complicate scientific assessment, questions about the best model scenario, etc.
Decision table and projections (groundfish only) * *	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.
Scientific Uncertainty	State the sigma value and the basis for its calculation.
Research and data needs	Identify information gaps that seriously impede the stock assessment.
Rebuilding Projections *	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: CHECK LIST OF ELEMENTS TO BE INCLUDED IN FULL AND UPDATE ASSESSMENT DOCUMENTS

Section	Element description
A	STAT names and affiliations
A	Citation instructions, on the back of the title page.
B	Executive Summary *** Not required in draft assessment undergoing review.**
B	Exec. Summ., Stock description: Species and area; basis for regional management.
B	Exec. Summ., Catches: Table with last 10 years; graph with long term information.
B	Exec. Summ., Data & assessment: Date and type of last assessment, model type, …
B	Exec. Summ., Stock biomass and dynamics: Trends and current levels relative to unfished; . . . table with last 10 years; graph with long term information.
B	Exec. Summ., Recruitment: Trends and current levels relative to unfished; . . . table with last 10 years; graph with long term information.
B	Exec. Summ., Exploitation status: Exploitation rates . . . ; table with last 10 years; Kobe (phase) plot with long term information.
B	Exec. Summ., Ecosystem considerations: Summary of relevant environmental and ecosystem factors . . .
B	Exec. Summ., Reference points:
B	Exec. Summ., Management performance: Catches compared to OFLs, ABCs, . . . table with values for last 10 years. (To be provided by Council staff).
B	Exec. Summ., Unresolved problems and major uncertainties: Special issues that complicate the assessment . . .
B	Exec. Summ., Decision table and projections (groundfish only): Projected yields, spawning biomass, and depletion levels . . .
B	Exec. Summ., Scientific uncertainty: Sigma and how calculated.
B	Exec. Summ., Research and data needs: Identify information gaps . . .
B	Exec. Summ., Rebuilding projections: Reference to principal results from the rebuilding analysis (if applicable) . . .
C	Introduction: 1. Scientific name, distribution, choice of stock structure, . . .
C	Introduction: 2. A map showing the scope of the assessment . . . ***Not required for update assessments. May refer to the most recent full assessment for additional information.**
C	Introduction: 3. Important features of life history . . . ***Not required for update assessments. May refer to the most recent full assessment for additional information.**
C	introduction: 4. Ecosystem considerations . . . ***Not required for update assessments. May refer to the most recent full assessment for additional information.**

Section	Element description
C	<u>Introduction</u>: 5. Important features of current fishery . . . ***Not required for update assessments. May refer to the most recent full assessment for additional information.**
C	<u>Introduction</u>: 6. Summary of management history. ***Not required for update assessments. May refer to the most recent full assessment for additional information.**
C	<u>Introduction</u>: 7. Management performance, including a table with OFLs ACLs, HGs, landings, and catch . . .
C	<u>Introduction</u>: 8. Description of fisheries for this species off Canada, Alaska and/or Mexico . . . ***Not required for update assessments. May refer to the most recent full assessment for additional information.**
D	<u>Data</u>: 1. Fishery-dependent data: Commercial fisheries landings by state, year and gear . . .
D	<u>Data</u>: 2. Fishery-independent data: Description of surveys used . . . Table with sample size information for length- and age-composition data . . . , including both the number of tows and fish sampled.
D	<u>Data</u>: 3. Sources used to estimate biological parameters (e.g., natural mortality, . . .
D	<u>Data</u>: 4. Environmental or ecosystem data used.
E	<u>Model</u>: 1. History of modeling approaches used for this stock. ***Not required for update assessments. May refer to the most recent full assessment for additional information.**
E	<u>Model</u>: 2. Response to most recent past STAR panel recommendations . . . ***Not required for update assessments. May refer to the most recent full assessment for additional information.**
E	<u>Model</u>: 3. (Groundfish updates only) Response to Groundfish Subcommittee recommendations from the previous assessment accepted for management. ***Not required for update assessments. May refer to the most recent full assessment for additional information. *Not required in a draft assessment undergoing review.**
E	<u>Model</u>: 4. Description of new modeling approaches and changes from the last assessment. ***Not required for update assessments. May refer to the most recent full assessment for additional information.**
E	<u>Model</u>: 5. General model specifications: Assessment program, model structure, area and fleet definitions, initial conditions.
E	<u>Model</u>: 6. Model parameters: estimated and fixed parameters, parameter constraints, priors, selectivity assumptions, …
F	<u>Base model selection</u>: 1. Figure with changes when bridging from the previous to the new base model.
F	<u>Base model selection</u>: 2. Evidence of search for balance between model realism and parsimony . . . ***Not required for update assessments. May refer to the most recent full assessment for additional information.**

Section	Element description
F	Base model evaluation: 3. Evaluation of model parameters. Likelihood profile for natural mortality; Likelihood profile for steepness; Likelihood profile for R_0.
F	Base model evaluation: 4. Residual analysis, residual plots, time-series of observed and predicted values.
F	Base model evaluation: 5. Convergence status and convergence criteria, randomization runs.
G	Base-model results: 1. Table with all explicit parameters in the base model and associated SDs.
G	Base-model results: 2. Table with population numbers at age × year × sex, which may be included as a text or spreadsheet file. ***Not required in a draft assessment undergoing review.**
G	Base-model results: 3. Table with time-series of total biomass, summary biomass, spawning biomass, depletion, recruitment, . . .
G	Base-model results: 4. Selectivity estimates (if not included elsewhere).
G	Base-model results: 5. Stock-recruitment relationship.
G	Base-model results: 6. OFL, ABC, and ACL . . . for recent years.
G	Base-model results: 7. Clear description of units for all outputs.
G	Base-model results: 8. Description of how discard is included in yield estimates.
G	Base-model results: 9. Description of environmental or ecosystem data.
H	Evaluation of uncertainty: 1. Sensitivity runs to evaluate assumptions about model structure.
H	Evaluation of uncertainty: 2. Sensitivity to data set choice and weighting schemes: removal of data sources; alternative weighting methods for compositional data.
H	Evaluation of uncertainty: 3. Parameter uncertainty . . . Uncertainty estimates for parameters and derived quantities; Likelihood profiles (tabular format) for M, *h*, and R_0 . . .
H	Evaluation of uncertainty: 4. Retrospective analysis, . . .
H	Evaluation of uncertainty: 5. Historical analysis . . .
H	Evaluation of uncertainty: 6. If a range of models runs for characterizing uncertainty . . . information on their relative probability.
H	Evaluation of uncertainty: 7. Ranges depicting uncertainty should include at least three runs . . . for use in the decision table.
H	The following model runs in the table below are required.

Parameter(s) / Issue	Base Model Run	Sensitivity Model Run	Notes
Natural mortality (M) Prior	Use natural mortality prior (Hamel, 2015; Then et al. 2015). This prior is defined as a lognormal distribution with median value (corresponding to the mean in log-space) =	None Required, though exploration of the Lorenzen M for age-varying M is recommended where appropriate.	The maximum age values on which *M* priors are based should be from fish caught within the area of the assessment, not from Alaska, for example.

Section	Element description			
		5.40/maximum age and log-scale sigma. Both parameters should include three significant digits.		If the prior for M is used to provide a fixed value for M, the fixed value should be set equal to the median value of the prior (5.40 / maximum age).
	Age or sex specific M	If: Sex specific M	Then: Single M	
	Weighting of compositional data	Francis (2011)	McAllister and Ianelli (1997) harmonic mean	STATs may also explore the Thorson et al. (2016) Dirichlet multinomial likelihood.
	Selectivity	If: All dome shaped	Then: One fleet asymptotic	
	Rockfish fecundity	Use fecundity relationships from the meta-analysis in Dick et al. (2017), at the appropriate taxonomic scale, if better species-specific relationships are not available.	None required.	
	Rockfish steepness	Use SSC-approved steepness prior for rockfish species in 2019 has a mean value of 0.72 and standard deviation of 0.16. If the assessment model does not estimate steepness, the STAT should fix the steepness value at 0.72.	None required.	
	Confirm convergence	50-100 jitter model runs with a strong preference for 100 jitter runs when feasible.	NA	

Section	Element description

I   <u>Reference points</u>: 1. Unfished spawning stock biomass, summary age biomass, . . .

I   <u>Reference points</u>: 2. Reference points based on $B_{40\%}$ for rockfish and roundfish and on $B_{25\%}$ for flatfish . . .

I   <u>Reference points</u>: 3. Reference points based on SPR proxy . . .

I   <u>Reference points</u>: 4. Reference points based on MSY . . .

I   <u>Reference points</u>: 5. Equilibrium yield curve showing various B_{MSY} proxies.

J   <u>Unresolved problems and major uncertainties</u>: Describe any special issues . . .

K   <u>Harvest projections and decision tables</u> :
* Not required in a draft assessment undergoing review.
** Not applicable to assessments rejected by a STAR Panel or withdrawn by the STAT.

K   <u>Harvest projections and decision tables</u>: 1. Harvest projections and decision tables should . . .

K   <u>Harvest projections and decision tables</u>: 2. Information presented should include biomass, stock depletion, . . .

K   <u>Harvest projections and decision tables</u>: 3. Fully document the calculation of the base model's sigma.

L   <u>Evaluation of scientific uncertainty</u>. Sigma and how it was calculated.

M   <u>Regional management considerations</u>.
Discuss biological evidence for a regional management approach and provide the estimates of survey biomass in each management region using the standard survey index standardization software used in the assessment.

N   <u>Research and data needs</u>: 1. Describe progress on research and data needs identified in the most recent previous assessment . . .

N   <u>Research and data needs</u>: 2. Describe new research & data needs and priority . . .

O   <u>Acknowledgments</u>: Include STAR Panel members and affiliations . . .
* Not required in a draft assessment undergoing review.

P   <u>Literature cited</u>:

Q   <u>Auxiliary files</u>: A list naming the required text files (. . .) and any other supplementary electronic files . . .

APPENDIX E: TEMPLATE FOR A DATA-MODERATE ASSESSMENT DOCUMENT

1. Title page and list of preparers – the names and affiliations of the stock assessment team (STAT).
2. Executive Summary (Required after, and appreciated for, the STAR Panel Review)
3. Introduction: Scientific name, distribution, basic biology (growth, longevity, ecology), the basis for the choice of stock unit(s) (no more than 1-2 paragraphs).
4. Development of indices (used and rejected). Novel approaches should be fully documented.
5. Treatment of length composition data (weighting, addressing discards, etc.).
6. Survey of other data available for assessment: data available to inform indices of abundance, 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.
7. Selection of method: length-based (SS-CL), index-based (XSSS or XDB-SRA; authors are "encouraged" to do both) or hybrid method (SS-CL+Index).
8. Assessment model
    a. Specification of priors / production function (defaults are acceptable)
    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. Acceptable parameter estimates
        v. Time-trajectories of biomass, depletion, etc.
        vi. 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 where applicable.

Category 3: **Data-Limited**. OFL is derived from historical catch.	a	No reliable catch history. No basis for establishing OFL.
	b	Reliable catches estimates only for recent years. OFL is the average catch during a period when stock is considered to be stable and close to BMSY equilibrium on the basis of expert judgment.
	c	Reliable aggregate catches during the period of fishery development and approximate values for natural mortality. Default analytical approach DCAC.
	d	Reliable annual historical catches and approximate values for natural mortality and age at 50% maturity. Default analytical approach DB-SRA or SSS.
Category 2: **Data-Moderate**. OFL is derived from model output (or natural mortality).	a	M*survey biomass assessment (as in Rogers 1996).
	b	Historical catches, fishery-dependent trend information only. An aggregate population model is fit to the available information.
	c	Historical catches, survey trend information, or at least one absolute abundance estimate, and/or length composition information. An aggregate population model is fit to the available information.
	d	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 reasonable model and data assumptions, or that the assessment has not been updated for many years.
	e	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, or the species that are different are a very minor component of the complex, or a large majority of those stocks are outside the geographical area of the complex.
Category 1: **Data-Rich**. OFL is based on F_{MSY} or F_{MSY} proxy from model output. ABC based on P* buffer.	a	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	As in 1a, but trend information is also available from surveys. Age/size structured assessment model.
	c	Age/size structured assessment model with reliable estimation of the stock-recruit relationship.

Rules for Making Category Assignments for Full or Update Stock Assessments

If the measured value of sigma from the assessment (derived either from the estimated relative uncertainty in ending biomass or from the relative difference in ending biomass between the base model and the low state of nature) is greater than the default proxy sigma value specified by the SSC, then use the sigma from the assessment. Otherwise use the default proxy sigma value.

APPENDIX G: PROPOSED OUTLINE FOR 2023 ACCEPTED PRACTICES GUIDELINES FOR GROUNDFISH STOCK ASSESSMENTS

Presented below is a general outline of new topics to be included in the set of *Accepted Practices Guidelines* that the SSC will finalize by the end of 2022 for use with 2023 groundfish stock assessments. The guidelines provide STATs with default approaches they should use for dealing with certain stock assessment data and modeling issues. The STATs may diverge from the guidelines if they provide adequate justification for doing so. The guidelines, which are not comprehensive, focus on certain issues the SSC has so far considered. The purpose of having guidelines is to lessen the time that might otherwise be spent during stock assessment reviews in discussions about how particular steps in the assessment process should have been conducted.

Modeling:

●   Guidance on when to turn on/off recruitment deviations or perform sensitivities.

●   If possible, add SPAY plots to R4SS to allow for comparing the consistency of recruitment across data sources (if logistically feasible in the R4SS platform).

●   Guidance on sex-specific selectivity.

●   Guidance on application of the Lorenzen M to account for length/age specific M.

●   Guidance on time varying selectivity and time blocking.

●   Guidance on interpretation, causes and addressing uncertainty from retrospective patterns.

APPENDIX H: TIMELINE TABLE FOR GROUNDFISH STOCK ASSESSMENT AND REVIEW DEADLINES

Event	Timing	STAT	STAR	Panel Chair	Council Staff	SSC GFSC	NMFS POC	GMT Rep.	GAP Rep.
Assessment prioritization finalized	Jun. of even years								
STAR Panel schedule drafted	After June Council meeting in even years						X		
Ageing/Data Coordination Meeting	Jul/Aug,	X		X	X	X		X	X
Accepted Practices Updated	Aug.				X	X			
Pre-assessment workshop	Dec. to Mar.	X		X	X	X		X	X
Final data cutoff	12 weeks before STAR panel	X			X				
Pre-STAR draft stock assessment document submitted	3 weeks before STAR panel	X							
Pre-review for completion and compliance with TOR	3 weeks before STAR panel			X	X		X		
Pre-STAR draft assessment distributed to STAR Panel	2 weeks before STAR panel			X	X				
STAR Panel	Various	X	X	X	X			X	X
STAR Panel complete report due	2 weeks after end of STAR panel		X	X	X			X	X
Comments on draft assessment report due	2 weeks after end of STAR panel		X	X					

Event	Timing	STAT	STAR	Panel Chair	Council Staff	SSC GFSC	NMFS POC	GMT Rep.	GAP Rep.
Revised draft assessment	3 weeks after STAR panel	X							
Post-STAR review for compliance with TOR	2 weeks after revised draft assessment submission			X	X		X		
Review to verify removal assumptions are as requested	2 weeks after Revised draft assessment submission							X	X
SSC GFSC review	Aug./Sep.	X		X	X	X			
Comments on revised draft assessment	2 weeks after SSC GFSC review					X			
Pre-SSC draft assessment	Briefing Book deadline Sep. meeting	X							
SSC Review	Sep. Council meeting			X	X	X			
Mop-up panel, if needed	Last week of Sep. of odd years								
Final version of assessment report	Briefing book deadline Nov. meeting	X							
All files submitted to assessment archive	Dec. of odd years	X							
Post-assessment process review meeting	Dec. of odd years			X	X	X		X	X

APPENDIX I: TABLES AND FIGURES TO BE INCLUDED IN GROUNDFISH STOCK ASSESSMENT REPORTS OR IN ASSOCIATED ELECTRONIC INDICES

Section	Figure (f) / Table (t)	Keep	Eliminate	Electronic Index
Executive Summary	t:10 yr. catches	x		
	f:all yrs. catches	x		
	t:10 yr. SB and depletion	x		
	f:all yrs. SB	x		
	f:all yrs. depletion	x		
	t: 10 year recruits, recruitment deviations	x		
	f: all yrs. recruitments	x		
	f: all yrs. recruitment deviations		x	
	t: 10 year exploit, SPR	x		
	f: all yrs. 1-SPR	x		
	f: phase plot (1-SPR)		x	
	t: reference point table	x		
	t: management performance	x		
	t: projections	x		
	t: decision table	x		
	t: 10 yr. base model summary		x	
	f: equilibrium yield curve		x	
Introduction and Data	f: assessment area map		x	
	t: all year landings	x		
	t: management performance (OFL, ACL, Landings, WCGOP estimates)	x	x	
	t: historical management actions		x	
	t: number of tows, samples, and N			x
	t: strata for designed-based indices			x
	t: vast specifications		x	
	t: survey estimates		x	
	t: design-based indices		x	
	f: data used in the model for each fleet and across years	x		
	f: catch figures	x		
	f: all indices used in the model	x	?	
	f: VAST QQ plots	x		
	f: VAST Residuals plots			x
	f: general data figures (compositions)	x	?	
	f: parameter prior distributions	x		
	f: assorted biology plots	x		
Model	t: model set-up description	x		
	t: parameters in the model		x	
	t: parameter estimates/fixed and distributions	x		
	t: time-series table	x		
	t: jitter results		x	
	t: data weights by data type	x		

Section	Figure (f) / Table (t)	Keep	Eliminate	Electronic Index
	t: likelihood and parameters from base and sensitivities	x		
	t: profile likelihoods		x	x
	t: numbers-at-age			x
	f: estimated biology	x		
	f: stock synthesis version comparison and simple bridging	x		
	f: all fits to data	x		
	f: selectivity estimates	x		
	f: population time series (SSB, recruits, depletion)	x		
	f: sensitivity results	x		
	f: profiles (Piner plots preferred)	x		
	f: population trajectories by profile parameter values	x		
	f: retrospective results	x		
	f: comparison with previous assessments	x		
	f: equilibrium yield curve	x		
Projection and Decision Table	t: projections	x	x	
	t: decision table	x	x	
	t: reference points	x	x	

APPENDIX J: FLOW CHART FOR SS-CL

Take the following steps in completing an SS-CL assessment:

1. Prepare catch data
   •   Catch treated as known. Use total mortality (landings + dead discards).

2. Prepare length composition
   •   Determine length bins and frequency within bins across years. More than 10 years of data (with reasonable sample sizes) is recommended. Otherwise, it is a category 3 assessment.
   •   This can be done for as many fleets as needed, but use the parsimony principle to define fleets, as model convergence may be more difficult with more fleets.
   •   Female, male and unknown data can be used.
   •   Determine effective sample sizes following standard protocol.
   •   Combine length data from landings and discards (or reasonable assumptions for the latter if no data) appropriately.

3.   Define life history parameters
   •   Natural Mortality: define using estimators (e.g., Hamel method (must include as a sensitivity at least, if an estimate of longevity/maximum age is available), Natural Mortality Tool (which includes the Hamel method)). Fix to central tendency (median value) and retain uncertainty for sensitivity analyses.
   •   Growth parameters. Externally fit the von Bertalanffy growth function and use point estimates to fix in model. Choose a fixed value for CV at length. Retain uncertainty for sensitivity analyses.
   •   Steepness defined either through meta-analysis or expert opinion. Retain uncertainty for sensitivity analyses.
   •   Recruitment variability is also defined through meta-analysis or expert opinion. Retain uncertainty for sensitivity analyses.
   •   Life history parameters will generally be pre-specified but consideration could be given to estimating these parameters (see Section 1.5.3).

4.   Parameter estimation
   •   Estimate R0, recruitment deviations and selectivity parameters.
   •   Life history parameters if likelihood profiles show information.
   •   Selectivity can be logistic, dome-shaped, or whatever form is chosen in Stock Synthesis.
   •   Bias correction to recruitment deviations can subsequently be applied.

5. Model weighting
   •   Consider weighting the length compositions if there are multiple fleets.

6. Model convergence
   •   Length-only models may take additional jittering to find convergence and avoid local likelihood minima.

- Check model fits to length compositions.
- Determine whether selectivity shapes and subsequent estimates make sense.
- Review other parameters estimates for bounds and poor estimation (and whether they are reasonable).

7. Characterize uncertainty
   - Likelihood profile over, at minimum, M, L2 (preferably parameterized as L∞, though can also make the transformation for reporting) and k (retain correlation structure if possible), CV at length, and h.
   - Sensitivity analysis should be conducted, either based on likelihood profile information or identified model specification.
   - Ensemble modeling to quantify model specification error would be useful. This would need further discussion on how best to approach it.