Scientific and Statistical Committee's
Ecosystem-Based Management and Groundfish Subcommittees Report on the Fishery Ecosystem Plan's Ecosystem and Climate Information Initiative

Pacific Fishery Management Council
Online Meeting

September 21, 2023

The Scientific and Statistical Committee's (SSC) Ecosystem-Based Management Subcommittee and Groundfish Subcommittee (hereafter "the subcommittees") met via webinar September 21, 2023, to review the Ecosystem Work Group's (EWG) proposed approach for developing ecosystem risk evaluation tables and pilot risk tables for sablefish and petrale sole, in support of the Fishery Ecosystem Plan's Initiative 4: Ecosystem and Climate Information for Species, Fisheries, and Fishery Management Plan. In addition to reviewing the EWG's work, the subcommittees had a discussion about the potential intersections between risk tables and existing SSC processes to set stock assessment categories and scientific uncertainty buffers. Dr. Kristin Marshall chaired the meeting and subcommittee participants are listed in Appendix A.

A. Ecosystem Workgroup approach to developing risk tables

Mary Hunsicker (Northwest Fisheries Science Center [NWFSC]) presented an overview of the Ecosystem Workgroup approach to developing risk tables to the subcommittees (summarized in [September 2023 Agenda Item F.1.a EWG Report 1](#)). The EWG approach is adapted from Dorn and Zador (2020) and risk tables used by the North Pacific Fishery Management Council (NPFMC). The NPFMC risk table approach is not meant to be a comprehensive risk assessment, but provides a formal process for reducing the acceptable biological catch (ABC) if contextual information warrants it.

The EWG's draft risk evaluation tables consist of three "columns" or categories of information: Environmental/ecosystem considerations, assessment-related considerations, and population dynamics considerations. Each category consists of information not accounted for in the current stock assessment. Considerations for model and population dynamics uncertainty would be developed during the assessment process and compiled by assessment authors. The environmental/ecosystem considerations category would be compiled by a multidisciplinary team. The EWG indicated that these tables would be used to achieve consensus on identifying risks. The subcommittees note that there should be a clear process for cases when no consensus can be reached.

The subcommittees support the proposed risk table approach as a structured way to consider a broad range of uncertainties relevant to PFMC decisions, including climate and ecosystem information. The subcommittees generally agree with the categories and risk levels proposed by the EWG, but recommend that the structure of a risk table be adapted to each intended type of use. The EWG identified at least five uses for the risk tables and the contextual information those tables provide:

- Stock assessment prioritization

- Scientific uncertainty buffer in stock assessment (sigma)
- Management uncertainty / risk tolerance (P*)
- The time-varying penalty on sigma used to account for the age of the assessment
- In-season adjustments

The subcommittees agreed that ecosystem information could inform these proposed uses. The EWG indicated that there was a great deal of interest from Council advisory bodies in using these tables for stock assessment prioritization.

While the NPFMC uses risk tables that are embedded in stock assessment reports, many of which are completed annually, the subcommittees discussed the potential benefits of producing tables in non-assessment years. For example, if risk tables are used in the groundfish stock assessment prioritization process where stock assessments for most species are produced infrequently (or irregularly), they could influence the frequency of stock assessments conducted for some species. Similarly, risk tables used to inform in-season adjustments or the penalty on sigma could be constructed in non-assessment years or for stocks that were not being assessed.

The subcommittees also discussed the need to tailor the risk level characterization depending on the use of the table to ensure risks are categorized appropriately and not considered in multiple ways concurrently. For example, if a risk table was used to influence the time-varying penalty on sigma, a high recruitment event detected for a species with an older assessment may result in a lower risk score because this high recruitment was not incorporated in the most recent assessment. However, the same recruitment event incorporated into a stock assessment model may result in a higher risk score because of the risk of the event not transpiring into a larger spawning biomass. The subcommittees recommend careful consideration of how frequently risk tables are produced and what decision processes they will influence so that they can best inform the management process.

The subcommittees discussed some important differences between the EWG's approach and the NPFMC's approach, which served as a model. In contrast to the NPFMC risk tables, which only allow for a reduction in ABC, the EWG's proposed approach to risk tables allows for categorization of conditions as "Above or better than normal." While the subcommittees support the idea of a risk level that is better than normal for ecosystem conditions, some concerns were raised about the meaning of a level 1 (better than average) assignment for the population dynamics and assessment-related categories that do not have a clear baseline to compare against.

B. Pilot risk tables for petrale sole and sablefish

Dr. Kiva Oken (NWFSC) presented pilot risk tables for petrale sole and sablefish to demonstrate the potential application of the new risk table methodology to those species (September 2023 Agenda Item F.1.a Supplemental EWG Report 2). The subcommittee discussed the contents of the risk tables, the application of the risk evaluation rubric, and potential recommendations for how this information might inform fisheries management decisions for each species in the 2025-2026 harvest specifications cycle. Both of these species are in the Pacific Coast Groundfish Fishery Management Plan (FMP) and the subcommittee and presenters noted that risk tables for other FMPs (salmon, coastal pelagics) may present distinct challenges.

Petrale sole and sablefish were chosen as pilot species because both have stock assessments or assessment updates being conducted in 2023. Petrale sole is a species with a high quality assessment with minimal conflicts among the assessment components. Sablefish was considered

in part because information in the 2023 Ecosystem Status Report suggested a strong incoming year class. Each risk table included a narrative description of three categories of information: (1) environmental/ecosystem considerations (provided by the EWG), (2) assessment considerations (provided by the stock assessment team [STAT]), and (3) population dynamics consideration (provided by the STAT) and an associated risk evaluation for each category between level 1 (conditions above or better than normal) to level 4 (conditions are of major concern).

For petrale sole, the environmental/ecosystem considerations focused on oceanographic conditions that predicted a very large 2023 recruitment event and were concluded to produce a level 1 recommendation. This environmental information was considered for inclusion in the 2023 assessment, but was not incorporated into the adopted base model. Assessment-related considerations highlighted the quality of the assessment data and lack of data conflicts for this stock leading to a level 1 recommendation. Population dynamics considerations noted the reliance of the stock on infrequent, large recruitment events and recent declines in biomass relative to its target reference point, producing a level 2 recommendation.

For sablefish, the environmental/ecosystem considerations focused on evidence provided by the 2023 Ecosystem Status Report suggesting a very large recent recruitment event and subsequent oceanographic conditions affecting this cohort (level 2 recommendation). Assessment-related considerations highlighted the overall quality of the assessment data but emphasized data conflicts that lead to uncertainty in absolute stock size (level 2 recommendation). The assessment section also emphasized that the sablefish assessment includes an environmental driver of recruitment, which meant that the positive environmental conditions associated with recruitment should not be incorporated in the choice of a risk level for the environmental/ecosystem considerations category to avoid double-counting the expected effect of the environmental driver. Population dynamics considerations included the high variability in recruitment through time, relatively strong information about recent recruitment strength, and stock biomass above its target reference point and increasing (level 1 recommendation). The subcommittees noted that the risk level assigned to a corresponding situation of recently observed high recruitment event in sablefish in Alaska resulted in a higher risk level being assigned in the population dynamics category due to uncertainty in how density dependence could affect the growth and mortality of an anomalously large cohort through time (Dorn and Zador 2020). The SSC noted a similar concern when endorsing the assessment (Agenda Item G.2.a Supplemental SSC Report 1 September 2023).

The subcommittees support the risk tables as presented as a useful starting point and support the level recommendations provided by the EWG and STATs for both tables. The subcommittee next discussed practical considerations for implementing risk tables and connecting the risk tables to management decisions. The subcommittee recommended developing advice for how to determine which attributes were assigned to which category. For example, environmentally driven recruitment was discussed under the ecosystem category for petrale sole but in the assessment category for sablefish because of what factors were considered in the stock assessment. Transboundary considerations were included in the petrale sole risk table but not in the sablefish risk table yet both are transboundary stocks. Improved guidance should help to make risk tables more consistent moving forward. In addition, the subcommittee agreed that having a single reviewer look over all risk tables produced during a cycle would improve consistency.

The subcommittees noted that the ecosystem considerations for both species focused on recruitment which is a time-varying component of most stock assessments, and discussed what might happen if there were ecosystem considerations that were associated with biological components commonly treated as fixed within an assessment (e.g., growth, natural mortality).

Such ecosystem considerations would potentially conflict with the basic structure of a stock assessment and could be difficult to incorporate into management advice. Risk tables offer a way forward. For example, large numbers of Humboldt squid observed in 2006 increased hake mortality and assessment uncertainty but that event was challenging to account for in the hake assessment model. A risk table would have been a way to more formally include the implications of the anomalous event on setting catch levels.

The subcommittees suggested that the risk tables could serve several roles. First, risk tables could provide immediate information not in the current stock assessments for modifying or providing context for upcoming management actions. Second, the risk tables provide a way to identify and record additional factors that could suggest environmental factors that could be considered for incorporation into future stock assessments.

There was considerable discussion around how risk tables could be used to inform management (as discussed in the next section). Once a path for connecting risk tables with management has been identified, the subcommittees suggested that a fruitful path for understanding the potential impact of risk tables on management would be to conduct a retrospective analysis to assess how a risk table would have modified (or not) past management actions.

For the 2025-2026 groundfish harvest specifications cycle, the SSC has already endorsed sigma values for petrale sole and sablefish. The subcommittees discussed how the pilot risk tables could be used by the Council to inform their policy choice of the risk of overfishing (P*) for these two stocks. No alternative to the default P* of 0.45 has been proposed for petrale sole, but there are several alternatives proposed for sablefish. The Groundfish Management Team (GMT) or Council could choose to use risk levels assigned in the table to support recommendations to endorse a particular alternative.

C. **Discussion on potential uses of risk tables and other ecosystem information in the Council process; intersection with SSC-determined category designations, scientific uncertainty buffer, and review process**

The subcommittees discussed four potential pathways for how risk tables could inform the selection of ABCs. The subcommittees also discussed other potential applications of risk tables as well as other ecosystem information and review processes for each potential application. The four pathways identified for informing ABC specification were 1) informing the choice of scientific uncertainty (sigma) when an assessment is adopted, 2) informing the policy choice of risk tolerance (P*) when an assessment is adopted, 3) informing how sigma and/or P* might vary over the course of a projection interval between assessments, and 4) direct specification of the ABC. Because the first three pathways depend heavily on the current P*/sigma framework utilized by the PFMC, the subcommittees spent considerable time discussing the merits and limitations of the framework, as background for comparison of the alternate pathways for risk tables to inform harvest specifications. These discussions are summarized below, then each of the harvest specification pathways are discussed in turn, followed by discussion of other potential applications of risk tables beyond the harvest specification process.

Discussion of the P/sigma framework*

In theory, the P*/sigma approach separates out a policy choice on risk tolerance (P*, the acceptable probability of overfishing) from a scientific quantification of uncertainty (sigma, the log-scale standard deviation of a lognormal distribution describing the ratio between the true but unknown

OFL and the assessed OFL, with the assumption that the median ratio is 1.0 on the arithmetic scale). While sigma is intended to capture assessment uncertainty, there was broad agreement among the subcommittees that the current approach to specifying sigma based on among-assessment comparisons (Ralston et al. 2011, Privitera-Johnson and Punt 2020) does not account for all sources of uncertainty, that not all assessments within a particular category are equally uncertain, and that there could be merits in assigning a wider range of sigma values to assessments within a single category.

In addition, the P*/sigma approach fundamentally assumes that assessments are median unbiased, and different levels of uncertainty are reflected solely through adjustments to the variance (i.e., more uncertain assessments are less precise). However, in some cases risk tables may provide evidence on the likely direction of assessment error and the presence of bias. Given sufficiently strong evidence of bias, the most appropriate response by the SSC may be an adjustment to the OFL (to attempt to remove the bias) rather than adjusting the buffer between the OFL and ABC but the specific approach to implementing this was not discussed and a structured and non-arbitrary process for doing so would be needed.

Pathway 1: Specifying sigma when assessments are adopted

Some elements contained in risk tables might bear directly on risk tolerance (e.g., mentions of depletion levels near overfished thresholds might warrant extra precaution to avoid triggering a rebuilding plan), but most elements reflect scientific uncertainty in the size and/or population trajectory of the stock of interest. The subcommittees noted that there was minimal overlap in the elements spelled out for inclusion in the risk tables versus the elements of the guidance on category designation in the Groundfish Assessment Terms of Reference (TOR) (PFMC 2022), but that some of the items in the "assessment considerations" column of the risk tables (e.g., retrospective patterns or tension between age and length data) tend to be discussed extensively during stock assessment review (STAR) Panel and SSC deliberations. Still, the risk tables address multiple aspects of uncertainty that are not reflected in the default category choices or the TOR guidance. The subcommittees agreed that there could be merit in using the information in risk tables to assign more finely resolved values of sigma. Potentially, an updated rubric could be developed to describe how elements in a risk table could translate into quantitative adjustments away from the default sigma value. The proposed basis for any deviation from default sigmas could be reviewed along with the accompanying assessment during initial STAR Panel review and final review by the SSC before adoption.

Limitations to this approach include the limited scope for different values of sigma to affect the realized buffer when P* is near 0.5, the dependence of the effect of a change in sigma upon the value of P*, and the inability of sigma to capture all aspects of assessment uncertainty, such as a lack of symmetry in the direction of likely errors. In addition, sigma values for sablefish and petrale sole have already been established for this harvest specifications cycle (2025-2026).

Pathway 2: Specifying P when assessments are adopted*

Some elements of risk tables or other ecosystem considerations might bear directly on risk tolerance, for example a more precautionary approach may be warranted for a depleted stock at risk of triggering a rebuilding plan or for an ecologically important prey species. For other aspects of risk tables that are more reflective of assessment uncertainty than risk tolerance per se, the subcommittees did not reach a clear conclusion on whether such considerations should only inform choice of sigma, or could inform a policy choice of P* as well. Group discussions revealed a lack

of clarity on the factors that currently drive the choice of P*, and concerns that some factors may get considered in specifying both P* and sigma (risking double-counting) while other factors may be ignored entirely. The subcommittees recommend the Council or its management teams develop a descriptive document of the factors that should go into the choice of P* and guidelines on their numeric effects. A retrospective analysis of when the PFMC has chosen P* values less than 0.45 (as well as cases where lower values were adopted as alternatives for consideration but not ultimately implemented) could also be informative. This could guide the development of more specific guidance on how risk tables could inform the selection of P* values. In addition, FMP-specific advisory bodies could consider the information contained in risk tables when making their recommendations to the PFMC on adoption of assessments and harvest specification agenda items.

The SSC could review a document describing the elements informing choices of P*, and given sufficient lead time could review risk tables before they were distributed to other advisory bodies and the Council to inform those groups' recommendations and decision on P*. Traditionally, the PFMC's SSC has not weighed in on policy-based P* values, but could review the technical aspects of arguments made for different levels of P*, if provided with sufficient lead time. It was noted that the SSC does have authority and responsibility to recommend the ABC, which is currently derived as a function of the OFL, sigma, and P* for groundfish and CPS. The SSC has an alternative approach for salmon, recommending the ABCs directly. The subcommittees also discussed whether SSCs could therefore have authority to recommend an upper bound on P*.

Limitations to this approach include a lack of clarity on which aspects of uncertainty, if any, should influence the choice of P*. In addition, the default P* value of 0.45 leaves little room to reduce buffers in the face of positive information about ecosystem conditions, since the default category 1 buffer is only 6%. The subcommittees noted that the range of buffers used for groundfish in the NPFMC (Dorn and Zador 2020) left more room for adjusting the level of precaution in either direction.

Pathway 3: Changing values of sigma and/or P during projection intervals between assessments*

The subcommittees noted that much of the information in risk tables pertained to recruitment, potentially both recent recruitment and recruitment in the near future. Recruitment is increasingly relevant for determining exploitable biomass for projections into future years following the adoption of the assessment. The current approach to multi-year harvest specifications has sigma values growing through time at a rate derived from typical rates of divergence between projections from different states of nature (Wetzel and Hamel 2023). If risk tables provide strong information on expected recent or future recruitment, this could warrant adjustments to how rapidly sigma increases over the projection period, or justify the choice of different P* for different years of the projection period. Risk tables also offer a potential venue for considering new information relevant to stock size without a new assessment. However, a framework for making these changes would need to be developed.

Proposals for time-dependent changes to sigma and/or P* might be made at the time assessments were adopted, in which case the SSC could review the technical aspects of the justifications during the assessment review process. This would necessitate a means of keeping track of these recommendations so that they were considered during subsequent harvest specification processes. Alternately, during the assessment prioritization process, stocks could be identified which are not planned for assessment, but for which ecosystem considerations might provide information suitable for updating the buffers used in later years of projections. Efforts to identify such stocks might be led by the GMT (or other FMP-specific Management Teams if the approach spreads

beyond groundfish). The resultant risk tables could be reviewed by the SSC and potentially incorporated into changes in projection parameters during the subsequent harvest specifications agenda item.

Limitations to this approach include all the limitations for sigma and P* specifications described above, as well as the need to develop a process for making year-dependent adjustments to these quantities.

Pathway 4: Direct specification of ABCs

The subcommittees recognized that depending on the choice of P*, changes in sigma may have very minor or fairly substantial effects on the resulting buffer. Thus, translating the insights provided by a risk table into management advice could require joint consideration of P* and sigma together, or a different approach wherein ABCs were specified directly. The subcommittees noted that in many regions, the SSC specifies the ABC directly, and the ABC is the SSC's purview under the Magnuson-Stevens Fishery Conservation and Management Act (MSA). Review would be inherent in the SSC's specification of the ABC via the existing review process that leads to the SSC's specification of OFLs and sigmas under the status quo approach.

Limitations to this approach would include the need to develop guidelines for translating qualitative risk table information into quantitative buffers and a new process for ABC specifications.

Other applications of risk tables

The subcommittees highlighted the value of risk tables in identifying important factors that were not included in the most recent assessment of a stock, but merit close consideration for inclusion in the next assessment. In addition to potentially leading to improved assessments, identifying important components missing from an assessment might lead to assigning higher priority to that stock during the stock assessment prioritization process, so that those components could be included in the next assessment.

The example risk tables reviewed by the subcommittees covered one species each. The subcommittees identified considerable promise, but also challenges, in developing risk tables for "guilds" of similar species that could be expected to respond to ecosystem conditions similarly, for example, a set of ecologically similar species with similar geographic ranges and similar prey bases. The subcommittees are open to reviewing risk tables developed for guilds or other suites of species. The review would include both the evidence to justify grouping species together as well as the evidence in support of the expected ecosystem effects described in the risk tables.

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Appendix A. SSC Subcommittee Members in Attendance

Dr. John Budrick (SSC Groundfish Subcommittee Chair), California Department of Fish and Wildlife, San Carlos, CA

Dr. John Field, National Marine Fisheries Service Southwest Fisheries Science Center, Santa Cruz, CA

Dr. Chris Free, University of California Santa Barbara, Santa Barbara, CA

Dr. Dan Holland, National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA

Dr. Kristin Marshall (SSC Ecosystem-Based Management Subcommittee Chair), National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA

Dr. Matthew Reimer, University of California Davis, Davis, CA

Dr. William Satterthwaite, National Marine Fisheries Service Southwest Fisheries Science Center, Santa Cruz, CA

Dr. Jason Schaffler, Muckleshoot Indian Tribe, Auburn, WA

Dr. Ole Shelton, National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA

Dr. Cameron Speir, National Marine Fisheries Service Southwest Fisheries Science Center, Santa Cruz, CA

Dr. Tien-Shui Tsou, Washington Department of Fish and Wildlife, Olympia, WA