North Pacific Fishery Management Council

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SCIENTIFIC AND STATISTICAL COMMITTEE FINAL REPORT TO THE NORTH PACIFIC FISHERY MANAGEMENT COUNCIL June 1st – 4th, 2021

The SSC met remotely from June 1st to 4th, 2021.

Members present were:

Sherri Dressel, Co-Chair *Alaska Dept. of Fish and Game*	Anne Hollowed, Co-Chair *NOAA Fisheries – AFSC*	Alison Whitman, Vice Chair *Oregon Dept. of Fish and Wildlife*
Chris Anderson *University of Washington*	Amy Bishop *University of Alaska Fairbanks*	Curry Cunningham *University of Alaska Fairbanks*
Mike Downs *Wislow Research*	Dana Hanselman *NOAA Fisheries—AFSC*	Brad Harris *Alaska Pacific University*
George Hunt *University of Washington*	Andrew Munro *Alaska Dept. of Fish and Game*	Matt Reimer *University of California, Davis*
Chris Siddon *Alaska Dept. of Fish and Game*	Ian Stewart *Intl. Pacific Halibut Commission*	Patrick Sullivan *Cornell University*

Members absent were:

Milo Adkison *University of Alaska Fairbanks*	Jason Gasper *NOAA Fisheries–Alaska Region*	Tien-Shui Tsou *Washington Dept. of Fish and Wildlife*

SSC Administrative Discussion

Diana Evans (NPFMC) informed the SSC that the Council will be discussing plans for the October 2021 Council meeting at this meeting. While there is a high likelihood that the SSC meeting will be held virtually, the final decision will be made in early August. The Council is working on the assumption that SSC members would either participate all in person or all virtually.

Ms. Evans also informed the SSC that NPFMC Sea Grant fellow Angela Forristall has prepared and published a summary document for IFQ amendments that can be found on the Council website under

Publications/Summary Reports. This publication is a companion volume to the BSAI Groundfish and GOA Groundfish Amendment Summaries published previously.

Finally, Ms. Evans informed the SSC that the NPFMC has postponed the seventh national meeting of the Council Coordination Committee's Scientific Coordination Subcommittee (SCS7) until 2022 so that the meeting can be held in person. After much consideration, it was determined that too many benefits of the meeting would be lost if held virtually. If NPFMC cannot extend allocated funding until next year, the event may need to be scaled back. The NPFMC will be hosting the meeting and the themes will continue to be:

1. How to incorporate ecosystem indicators into the stock assessment process

2. Developing information to support management of interacting species in consideration of EBFM

3. How to access and develop fishing level recommendations for species exhibiting distributional change

B-1 Plan Team Nomination

The SSC reviewed the nomination of Andrew Olson (ADF&G) to the Gulf of Alaska Groundfish Plan Team. The SSC finds Mr. Olson to be well qualified and recommends the Council approve his nomination.

B-5 Alaska Fisheries Science Center Report

Robert Foy (NOAA-AFSC) provided the Alaska Fisheries Science Center (AFSC) report. The SSC thanks Dr. Foy for keeping the SSC up to date on AFSC's efforts to meet the dynamic needs of Alaska resources, ecosystems, and communities. Likewise, the SSC appreciates Dr. Foy's efforts to highlight where input and feedback from the SSC would be useful. No public testimony was provided.

The presentation by Dr. Foy provided an update on 2021 surveys, the AFSC response to recent Executive Orders (EOs) on climate and environmental justice, an overview of AFSC's plans for advancing ecosystem-based fisheries management (EBFM), and how AFSC is planning to address and respond to the new NOAA Climate and Fisheries Initiative.

AFSC 2021 Surveys

Dr. Foy provided an update on survey operations that are planned, underway, and already completed in 2021. Bottom trawl surveys in the Gulf of Alaska (GOA), on the Eastern Bering Sea (EBS) shelf, and in the Northern Bering Sea (NBS) are underway. It was noted that the GOA Bottom Trawl survey is currently and will continue to operate with a two, rather than three, vessel design, resulting in no sampling of depths greater than 700 m. Dr. Foy noted that this is a necessary tradeoff to ensure consistent sampling of the NBS. Dr. Foy also highlighted the range of critical ecosystem, ichthyoplankton, and acoustic surveys that have been completed or are ongoing this year. **The SSC thanks Dr. Foy for this update and continues to highlight the critical nature of surveys in Alaskan waters to index fisheries resources, monitor environmental change, and support process-based research.**

The SSC inquired whether additional surveys in the Arctic are under consideration by AFSC, to which Dr. Foy responded that the AFSC mission includes the Arctic as an important area of research but resources are limited for expanded survey effort beyond the NBS. The SSC notes its previous report on Trawl Survey Options and Priorities (October 2020 SSC Report, Appendix A). **The SSC supports the AFSC Arctic**

research mission, highlighting that Federal waters in the Arctic will remain closed to commercial fishing until such time as sufficient information is available to sustainably prosecute potential fisheries. In the absence of active data collection, it will be difficult to conclude that sufficient information has been collected to effectively manage resources within the Arctic.

AFSC's Response to Recent Executive Orders

The AFSC report described the recent (2021) EO 14008 "*Tackling the Climate Crisis at Home and Abroad*", which directs NOAA to collect input on how to make fisheries and protected resources more resilient to climate change. Dr. Foy highlighted several areas of ongoing effort by the AFSC that address the goals put forth in this EO, and key aspects of each area that may require additional focus. The report described the existing NMFS EBFM Roadmap and emphasized how an expanded focus may be required in analyzing uncertainty and risk related to climate change. Dr. Foy also noted that an expanded focus may be needed to look at resilience and community well-being. He described the Alaska Integrated Ecosystem Assessment (IEA) Program and its focus on expanding understanding of Alaska's marine ecosystems, communities, and resources through participatory science, including co-development of conceptual models of ecosystem dynamics to synthesize knowledge from resource users and aid in scenario planning.

Dr. Foy highlighted AFSC products that directly integrate climate-focused research within the assessment and fisheries management processes, including the Ecosystem Status Reports, Ecosystem and Socioeconomic Profiles and Regional Action Plans. In describing these ongoing efforts, Dr. Foy reiterated the continuing need to adapt management of North Pacific fisheries to climate change and the need for expanded research to facilitate development of climate-informed reference points and climate-informed management strategy evaluations and adaptation pathways. **The SSC supports AFSC research to address questions of how and when to re-evaluate reference points and to inform management in the context of climate-driven ecosystem change, as well as stock productivity and distribution. The SSC further supports research to evaluate optimal methods for addressing increased uncertainty due to climate change within the assessment and management processes.**

The AFSC report further described the Center's approach to addressing recent EOs related to environmental justice in research, including EO 13985 "*Advancing Racial Equity and Support for Underserved Communities Through the Federal Government*", and the recent Presidential Memorandum (2021) and EO 13175 (2000) focused on strengthening consultation and coordination with Tribal governments. Dr. Foy described AFSC's long-standing commitment to co-management through the International Whaling Commission, and expansion of survey and research communication plans to inform coastal and Tribal communities about AFSC activities in their area. **The SSC acknowledges AFSC's longstanding work with fishing communities and related Tribal entities.** Specifically with respect to the AFSC's mission to foster cooperation, collaboration, communication, and co-development of knowledge with Tribal communities, Dr. Foy highlighted that AFSC has recently hired a Tribal Research Coordinator, and that there is a forthcoming white paper on best practices for communication and collaboration with fishing and Tribal communities. The SSC looks forward to this upcoming paper.

The SSC supports AFSC research efforts to assess and quantify the inequality of the effects of environmental change across communities, fishing sectors, and fishery participant groups. Further, the **SSC would like to acknowledge the AFSC's longstanding work with fishing communities and affiliated Tribal entities as well as its proactive approach to developing best practices for incorporating Local Knowledge and Traditional Knowledge in the research process.**

The SSC requests to be kept up-to-date as NOAA promulgates formal guidance to its Science Centers on specific actions or research that must be undertaken to address recent EOs.

C-1 Observer Annual Report

The SSC reviewed the North Pacific Observer Program 2020 Annual Report (Annual Report). Presentations were given by: Kate Happala (NPFMC), Jennifer Ferdinand (NOAA-AFSC; FMA Division Director), Craig Faunce (NOAA-AFSC), and Jaclyn Smith (NOAA-OLE). Public testimony was provided by Linda Behnken (Alaska Longline Fishermen's Association, oral testimony) and Jon Warrenchuk (Oceana, oral and written testimony).

The North Pacific Observer Program 2020 Annual Report documents the performance of fishery-dependent sampling of fisheries off the coast of Alaska during 2020. The 2020 report was abbreviated compared to the usual annual reports at the request of the Council and because of COVID changes during 2020. There was no annual report prepared for 2019, but the SSC did receive an update on observer issues in June 2020.

The SSC finds this report to be a comprehensive summary of the following fishery dependent monitoring activities:

- The annual planning and reporting process
- Summary of 2020 ADP and modifications for COVID-19
- Fees and budget
- Deployment performance review
- Descriptive information
- Compliance and enforcement
- NMFS recommendations

The document describes the rapid adoption of a blended virtual and in-person training protocol that allowed for the training of 404 individual observers. These observers collected data on board 259 fixed-gear and trawl vessels and 11 processing facilities for a total of 40,838 observer days. Overall, for all federal fisheries off Alaska, 4,072 trips (44.8%) and 375 vessels (38.2%) were monitored by either an observer or EM system in 2020. The full coverage fleet reported 97% compliance. **The SSC reiterates its appreciation for the agency's rapid response to COVID-19. Their adaptive approach protected the lives and livelihoods of fishery dependent communities. The SSC thanks all who have worked to adapt the fishery-dependent data collection enterprise to these unprecedented conditions.**

The document summarizes the costs of observer coverage for the partial coverage fleet, the full coverage fleet and electronic monitoring (EM). The average cost of observers on the partial coverage fleet ($1,381 per day) was approximately 33% higher than the EM coverage fleet ($922 per day), but EM coverage was associated with loss of haul-by-haul biological information. The average cost of full coverage was substantially lower than either the partial coverage observers or the EM. In 2020, the median time between receipt and completion of EM video review was 24 days for EM HAL and 60 days for EM POT (Figure 3-2). This was compared to a median of seven days during pre-implementation in 2016 (NMFS 2017, p. 87). **The SSC requests that the Fishery Monitoring Science Committee (FMSC) investigate the factors underlying the higher than expected time between the receipt and completion of EM video review to assess whether the expected cost benefits of EM will be fully realized.**

The report explores the representativeness of the sampling by examining: a) temporal representativeness; b) spatial representativeness; and c) representativeness of trip characteristics. The report showed that there was no overall significant observer effect in 2020. However, the report acknowledges that the days-fished metric was always shorter for monitored trips than for unmonitored trips, with differences ranging from less than 1% in the EM HAL stratum to over 12% in the EM POT stratum (Table 3-6). The analysis also revealed that HAL non-tendered trips were shorter in duration when observed, which was also seen in permutation tests. **The SSC encourages investigation of the possible causes of these apparent observer effects.**

The report notes that several analytical changes were necessary to properly address the changes to the deployment of observers caused by COVID-19. These changes impacted the ability to fully assess the adequacy of the sample size in Period 2. The observer deployment into the HAL and POT strata was nearly zero during the waiver period (Period 2), and substantially below expected rates for much of the third time period (Figure 3-3). The analysis revealed evidence of inadequate spatial sampling for some sectors. For example, the report notes that the presence of NMFS Areas with a greater than 50% chance of containing no monitored trips is most common in the HAL and POT strata (Figure 3-11). **The SSC supports NMFS recommendations for the development of an integrated evaluation of the partial coverage category. The SSC welcomes the opportunity to review and comment on the design of the holistic evaluation and the results of the analysis.**

The report acknowledges that the lack of linkage between the ODDS and eLandings contributes to the differences between programmed selection rates in ODDS and trips that are ultimately observed. **The SSC supports the recommendation by NMFS that all ODDS trips be closed using the existing pull down menu that lists eLandings report numbers associated with the vessel.** This recommendation will strengthen the existing linkage between ODDS and eLandings.

The report provides evidence that the mean weight per fish that is calculated from the observer's sample of the combined discarded and retained fish in the halibut IFQ fishery overestimates the weight of discarded fish and underestimates the weight of retained fish. **The SSC supports NMFS plans to develop an analytic (modeled) method to address this bias by adjusting the percentage of halibut retained to reflect the differences in mean weight for retained (and discarded) halibut. The SSC looks forward to reviewing this approach,** which will be documented in a NOAA Technical Memorandum.

The SSC supports NMFS recommendation for continued collaboration with industry partners on EM development. In particular, the SSC looks forward to reviewing the National Fish and Wildlife Foundation-funded project to explore the performance of portable EM Systems.

The 2020 Observer report quantifies the expansion of EM coverage in the partial coverage fleet. **The SSC repeats its earlier recommendation that the FMSC should work with stock assessment scientists to communicate the potential impacts on key data streams to assessment and management.**

Finally, the SSC appreciated the report on Compliance and Enforcement. The SSC continues to be concerned about maintaining safe and professional working conditions for observers. The SSC appreciates the efforts to improve metrics for tracking compliance issues and commends the fishing and processing companies for their in-season efforts and ongoing collaboration with the Observer Program to address these issues.

C3 Bering Sea/Aleutian Islands Crab

The SSC received a detailed report on the May 2021 Crab Plan Team (CPT) meeting from Jim Armstrong (NPFMC) and the CPT co-chairs, Martin Dorn (NOAA-AFSC) and Katie Palof (ADF&G). The SSC appreciates the CPT's efforts to streamline their presentation to the SSC. Not all CPT agenda items were presented to the SSC, though they are detailed in the CPT report. Items on which the SSC provided comments are below. Table 1 includes the stock status determination criteria, Table 2 includes the June 2021 SSC recommendations, and Table 3 details the maximum permissible ABCs and SSC-recommended ABCs.

Table 1. Stock status in relation to status determination criteria for 2020/21 as estimated in June 2021. Hatched areas indicate parameters not applicable for that tier. Values are in thousands of metric tons (kt).

Chapter	Stock	Tier	MSST[1]	B_{MSY} or $B_{MSYproxy}$	2020/21[2] MMB	2020/21 MMB/ MMB_{MSY}	2020/21 OFL	2020/21 Total Catch	Rebuilding Status
1	EBS snow crab	3							
2	BB red king crab	3							
3	EBS Tanner crab	3							
4	Pribilof Islands red king crab	4							
5	Pribilof Islands blue king crab	4	2.05	4.10	0.18	0.04	0.00116	0[3]	**overfished**
6	St. Matthew Island blue king crab	4							
7	Norton Sound red king crab	4	1.03	2.05	2.27	1.11	0.13	0.09	
8	AI golden king crab	3	6.03	12.05	16.21	1.34	4.80	3.15[3]	
9	Pribilof Islands golden king crab	5							
10	Western AI red king crab	5							

[1] As estimated in the 2021 assessment.
[2] For Norton Sound red king crab, MMB on 2/1/2021 is estimated using the current assessment in January 2021.
[3] Catch and overfishing determination will be finalized in October after fishery is completed.

Table 2. SSC recommendations from the final 2021 SAFE for Pribilof Islands blue king crab and Aleutian Islands golden king crab in June 2021. Stocks for which specifications are rolled over between assessments (Pribilof Islands golden king crab and Western Aleutian Islands red king crab) or were set in February 2021 (Norton Sound red king crab) are also included. Biomass values are in thousand metric tons (kt). Stocks for which the SSC recommended different harvest specifications from the CPT are bolded. Harvest specifications for SAFE Chapters 1 – 4 and 6 are set in October and Chapters 5 and 8 – 10 are set in June, in the year according to the assessment frequency cycle (see current SAFE Introduction for assessment cycle).

SAFE Ch.	Stock	Tier	F_{OFL}	B_{MSY} or $B_{MSYproxy}$	B_{MSY} basis years[1]	2021/22[2] MMB	2021/22 MMB / MMB_{MSY}	γ	Natural Mortality (M)	2021/22 OFL	2021/22 ABC	ABC Buffer
1	E. Bering Sea snow crab	3										
2	Bristol Bay red king crab	3										
3	E. Bering Sea Tanner crab	3										
4	Pribilof Is. red king crab	4										
5	Pribilof Is. blue king crab	4c	0	4.10	1980/81-1984/85 & 1990/91-1997/98 [MMB]	0.18	0.04	1	0.18	0.00116	0.00087	25%
6	St. Matthew blue king crab	4										
7	Norton Sound red king crab	4a	0.18	2.05	1980-2020 [MMB]	2.27	1.11	1	0.18 (0.58 >124 mm)	0.29	**0.17**	**40%**

[1] For Tiers 3 and 4, where B_{MSY} proxy is estimable, the years refer to the time period over which the estimate is made. For Tier 5, it is the years upon which the catch average for OFL is obtained.
[2] MMB is estimated on 2/1/2021 for Norton Sound red king crab and on 2/15/2021 for AIGKC and PIBKC, using the current assessments.

Table 2 (continued). SSC recommendations from the final 2021 SAFE for Pribilof Islands blue king crab and Aleutian Islands golden king crab in June 2021. Stocks for which specifications are rolled over between assessments (Pribilof Islands golden king crab and Western Aleutian Islands red king crab) or were set in February 2021 (Norton Sound red king crab) are also included. Biomass values are in thousand metric tons (kt). Stocks for which the SSC recommended different harvest specifications from the CPT are bolded. Harvest specifications for SAFE Chapters 1 – 4 and 6 are set in October and Chapters 5 and 8 – 10 are set in June, in the year according to the assessment frequency cycle (see current SAFE Introduction for assessment cycle).

SAFE Ch.	Stock	Tier	F_{OFL}	B_{MSY} or $B_{MSYproxy}$	B_{MSY} basis years[1]	2021/22[2] MMB	2021/22 MMB / MMB_{MSY}	γ	Natural Mortality (M)	2021/22 OFL	2021/22 ABC	ABC Buffer
8	Aleutian Is. golden king crab [3]	3a	0.61 (EAG) 0.57 (WAG)	12.05	1987/88-2017/18	14.82	1.23		0.21	4.817	**3.372**	**30%**
9	Pribilof Is. golden king crab	5	-	-	See intro chapter	-	-	-	-	0.093	0.070	25%
10	W. Aleutian Is. red king crab	5	-	-	1995/96-2007/08	-	-	-	-	0.056	0.014	75%

[3] AIGKC OFL and ABC calculated by combining two separate assessment models for the EAG and WAG, as presented in the current assessment

Table 3. Maximum permissible ABCs for 2021/22 and SSC-recommended ABCs for three stocks where the SSC recommendation is below the maximum permissible ABC, as defined by Amendment 38 to the Crab FMP. Stocks for which specifications are rolled over between assessments (Pribilof Islands GKC and Western Aleutian Islands RKC) or were set in February 2021 (Norton Sound red king crab) are included. Values are in thousand metric tons (kt). Harvest specifications for SAFE Chapters 1 – 4 and 6 are set in October, and Chapters 5 and 8 – 10 are set in June, in the year according to the assessment frequency cycle (see current SAFE Introduction for assessment cycle).

SAFE Ch.	Stock	Tier	2021/22 Max. ABC	2021/22 ABC
1	EBS Snow Crab[1]	3		
2	Bristol Bay RKC[2]	3		
3	Tanner Crab[3]	3		
4	Pribilof Islands RKC[1]	4		
5	Pribilof Islands BKC[4]	4	0.00104	0.00087
6	Saint Matthew BKC[2]	4		
7	Norton Sound RKC[2]	4	0.288	0.17
8	Aleutian Islands GKC[2]	3	4.793	3.372
9	Pribilof Islands GKC[4]	5	0.092	0.070
10	Western Aleutian Islands RKC[4]	5	0.056	0.014

Basis for P* calculation of Max ABC,
[1]CV on terminal year biomass
[2]CV on OFL
[3]MCMC
[4]Tier 5 (90% OFL)

General Comments to Crab Assessment Authors

Crab assessments should generally follow the default groundfish practice of projecting the current year's catches if one or more fisheries are incomplete at the time of the assessment.

Aleutian Islands Golden King Crab

The SSC received the CPT report and summary of the AIGKC stock assessment. There was no public testimony.

The SSC thanks the authors for the careful responses to previous CPT and SSC comments as well as the continuing development of the AIGKC assessment. The SSC recognizes the challenges unique to the stock, the biology of AIGKC and the data available.

The AIGKC stock is based on two separate models (the EAG and WAG) that are configured similarly. The results are summed to provide stock-wide management advice. The 2021 assessment provided a series of incremental model changes beginning with 19.1 (last year's base model). Model 21.1a included an extension of the period over which recruitment is included in the mean calculation (1987-2017, from 1987-2012 previously). Also provided were models using time blocks on selectivity (21.1b), a fishery index of abundance based on CPUE standardization using a year:area interaction (21.1c), and a series of alternative approaches to the treatment of male maturity.

The SSC appreciates the discussion of the apparent disappearance of larger crab in recent catches, and the model alternatives allowing for changes in selectivity, but notes that the disappearance of larger crab in recent catches may also indicate changes in the underlying population.

The SSC supports the CPT's recommendation to use model 21.1a for setting the Tier 3a harvest specifications for 2021/22 (Table 2). The stock is not overfished. As final fishery catches were not available in time for the assessment, overfishing for the 2020/2021 season will be evaluated in October. The SSC agrees with the extension of the period of recruitment included in the reference point calculations to 2017 and looks forward to seeing this period sequentially extended in each upcoming stock assessment.

The SSC has applied a 25% buffer, somewhat larger than other similar Tier 3 crab stocks, to the maximum permissible ABC for AIGKC since 2017. This has been based on a series of concerns related to specific aspects of this stock and the data available, including: (1) the use of fishery CPUE rather than fishery-independent surveys used for all other Tier 3 stocks, (2) uncertainties in size of maturity for AIGKC, including the untested regression approach involving chela height against carapace length, (3) uncertainties in natural mortality, (4) limited spatial coverage of the fishery with respect to the total stock distribution, and (5) the small number of vessels upon which CPUE is based. For this year, the CPT recommended continuing to apply a 25% buffer. **The SSC instead recommends an increase to a 30% buffer from the maximum permissible ABC**, based on: 1) the continued positive retrospective pattern in the EAG Model, 2) continued model convergence concerns indicating remaining parameter confounding (specifically, the jitter analysis for the 19.1 WAG model resulted in multiple solutions for MMB and B35% at identical total likelihood values), and 3) the CPUE series that included a year:area interaction indicating a steeper decline in recent years than the series used in model 21.1a (the model accepted for harvest specifications).

The SSC recommends that CPUE standardization use a year:area interaction on principle, as this avoids the strong assumption that trends among sub-areas are equal. However, as noted by the CPT, some additional diagnostics were needed for the current CPUE model with a year:area interaction before basing the model on this result. Noting the highly unbalanced fishery data, the SSC recommended presentation of the trend information by sub-area in the next analysis to better understand why these results showed a steeper decline in recent years than the model that did not include the interaction term. **The SSC looks forward to the potential use of the year:area interaction CPUE index in the next assessment, requests that remaining issues with the analysis be addressed, and suggests that the interaction CPUE index be evaluated carefully in the assessment models for next year.**

The SSC supports the specific CPT recommendations for additional research and development of upcoming assessments:

- The analysis of the maturity data should be repeated using, for example, the methods of Olson et al. (2018) and Somerton and Macintosh (1983). The results of the analyses should be presented to the CPT.

- Consider including the NMFS Aleutian Islands trawl survey as an additional index of abundance. The first step in this process should be to compare the depths at which the survey is conducted to those at which AIGKC are found/fished.

- The CPUE standardization for the post rationalization years:

    - explore why the index for the WAG is lower in the last three years based on area*year interactions;

    - explore why the index for the WAG is more precise in the earlier years based on area*year interactions; and

    - better justify the degrees of freedom for smooths, and plot the smooths.

- The specifications of smooths when analyzing the cooperative survey should be selected using the survey data and not taken from analyses of other indices.

- Model 21.1b was unable to provide a better fit to the length-frequency data for the EAG. The reasons for the change in total length-frequency in recent years need to be understood better before new models are formulated. Edward Poulsen noted that the number of vessels in the EAG was less in recent years than before, and that the higher CPUE areas tend to have higher abundance of smaller animals, which may be part of the reason for the change in the total length-frequency.

- 92% of the WAG TAC was taken at the time of the meeting. Adjusting the catches to reflect the final catch is not likely to impact the TAC set by the State (which is usually well below the ABC). However, future assessments should be based on the best projection of total catch when the season is not complete, similar to standard groundfish methods.

- Progress towards further GMACS implementation for this stock is expected for the next cycle in 2022.

The SSC also offers several additional recommendations:

The author's rationale for continued use of two separate stock assessment models for the EAG and WAG was very helpful, and the SSC recognizes that this approach is reasonable. However, the SSC notes that sharing biological parameters and basic stock dynamics within a single assessment model that has two largely independent areas modelled simultaneously may help address recurrent convergence and estimation challenges. The SSC suggests that such an approach be considered further, as either a replacement for the current approach, or as part of a multi-model evaluation.

The SSC did not find the logistic fit to the maturity predictions based on the chela-height-to-carapace-length relationship to be compelling and supports the CPT's recommendations for additional modelling. However, the SSC also notes that direct observational data on maturity may ultimately be needed to resolve this process and recommends holding studies or other research be considered.

Pribilof Islands Blue King Crab

The SSC received a presentation on the stock assessment for Pribilof Islands blue king crab (PIBKC) and recommendations for harvest specifications. There was no public testimony.

The PIBKC stock is assessed biennially and the last full assessment was in 2019; therefore, a full assessment was conducted in 2021. The assessment methods for 2021 are the same as those used in 2019 (approved in 2015). The directed fishery has been closed since 1999/2000, and the stock was declared overfished in 2002. New data used in the assessment included finalized fishery bycatch data for 2018/19 and 2019/20, catch estimates for 2020/21, and NMFS survey data for 2019. Abundance and biomass estimates for 2020 were not available because the NMFS EBS bottom trawl survey was not conducted in 2020 because of COVID-19 concerns. The 2021 survey has not yet been conducted. A random effects time series model is used in the assessment to fit MMB estimates from the NMFS bottom trawl survey. Status determination is based on the Tier 4 approach while a Tier 5 approach is used for determining an OFL.

The projected MMB at mating for 2021/22 (0.18 kt) remains well below the MSST (2.05 kt). The projected MMB at mating for 2021/22 is based on projecting forward since the last survey in 2019, accounting for natural mortality and assumptions regarding discard mortality. The B_{MSY} was estimated at 4.10 kt and was based on MMB at mating from 1980/81-1984/85 and 1990/91-1997/98 as a proxy for B_{MSY}. The current estimate of MMB at 0.18 kt is well below the B_{MSY} proxy, the stock status is at level "c", and there is no directed fishing.

The stock remains overfished with no signs of recovery. Overfishing will be evaluated at the October meeting once all bycatch data have been finalized. The author- and CPT-recommended a Tier 5 OFL of 0.00116 kt based on average fishing mortality during 1999/2000-2005/06, and an ABC of 0.00087 kt based on a 25% buffer to the OFL. These recommendations represent no change from the last specification and **the SSC agreed with the recommended OFL, ABC, and ABC buffer for 2021/22 and 2022/23**.

The SSC supports the CPT recommendation to move the timing of the PIBKC assessment back to September for the CPT. Although this will result in additional workload for the October SSC meeting, that workload has been recently reduced for odd years because the SMBKC assessment has switched from an annual to a biennial cycle in even years. The advantage of this change would be that the most recent survey and bycatch data through the end of June would be available to be included in assessment, so the evaluation of whether overfishing occurred could be made at the same meeting in which the assessment is reviewed and harvest specifications are set.

The SSC appreciates the author's responsiveness to previous recommendations of reducing the file size of the report, integrating the appendices into the main text, and reducing the redundancy of the presentation of figures and tables. The SSC looks forward to the report on the blue king crab stock structure template in the near future.

Snow Crab Proposed Model Runs

The SSC received a presentation describing proposed September assessment model alternatives for EBS snow crab, responses to CPT and SSC comments, and the authors' exploration of alternative methods for addressing the persistent positive retrospective pattern in past assessments. **The SSC commends the authors for their work on options to address retrospective patterns in the snow crab assessment.** In October 2020, the SSC did not support the authors' and CPT's recommended GMACS model for the final assessment due in part to the retrospective pattern, uncertainty in the large 2015 estimated recruitment, high estimated fishing mortality rates, and the large impact on OFL recommendations. In the authors' response to SSC comments, it was clarified that the strong retrospective pattern was present in both the status quo and GMACS model estimates, recent survey size and abundance data through 2018 continue to support the large 2015 recruitment event, and high fishing mortality estimates early in the time series are more pronounced for the status quo model than for the GMACS version. The presentation further highlighted that the higher OFL estimate from the GMACS model, relative to the status quo model, was due in part to the GMACS version following better the trend in high survey abundance indices in 2018/19. When the status quo model was forced to fit these higher survey estimates at the end of the time series, the OFL estimates were more similar to the estimates from the GMACS model. The SSC thanks the authors' for clarification on these points. The SSC also looks forward to the summary report from the March 2021 CIE Review for this stock, which should be available in the coming months.

The snow crab assessment authors describe three potential options for addressing the retrospective patterns observed for this assessment: (1) incorporating additional model structure that provides increased flexibility, (2) performing post-hoc adjustment of management quantities similar to the increased buffer recommended by the SSC in October 2020, or (3) use of a survey-based abundance index for defining the OFL similar to a Tier 4 approach. The authors also followed CPT guidance to explore data weighing as a potential avenue for addressing retrospective bias by exploring the impact of down-weighting size composition data. To explore Option #1, several variants of the status quo model were fit that incorporated sex-specific time-varying survey catchability (Model 20.2q), time-varying natural mortality (20.2m), or estimated both natural mortality and survey catchability as time-varying (20.2qm). Each of these model variants also included the down-weighting of size composition data, and required that growth be estimated external to the assessment model and fixed. Results indicated that reweighting of composition data only reduced the positive retrospective bias by a small amount, while inclusion of time-varying natural mortality and survey catchability resulted in larger reductions in retrospective bias. However, estimation of time-varying processes lead to very different management advice and implausibly high variation in time-varying parameters (i.e., q ranging from 0.1-1 for females under Model 20.2qm). The authors expressed concern over the plausibility of the estimated variation in time-varying processes and resulting model instability, and highlighted that although some of these variants did indeed reduce the retrospective pattern, management recommendations may be misleading if the specified time-varying process is inconsistent with the true underlying dynamics of the stock. The SSC noted that the models that estimated time-varying catchability and time-varying M greatly reduced the retrospective bias and appeared to result in different average values of these parameters. **The SSC recommends that the authors experiment with models that either allow those time-invariant parameters to be free or add more constraints on the time-variance in these models. The SSC would like to see at least one model alternative emerge in September that alleviates the strong retrospective bias.**

As an exploration of Option #3, the authors describe a "Tier 3.5" approach wherein the terminal year biomass and B_{MSY} proxy are determined directly from smoothed mature male biomass estimates from the random effects model, similar to a Tier 4 approach. Conversely, proxies for F_{MSY} and MSY are based on the population dynamics model as is the practice under Tier 3. **The SSC concurs with the CPT that**, while this is a useful thought exercise, **it is not currently recommended for providing management advice**.

With respect to proposed models for review in September 2021, **the SSC concurs with the CPT recommended models**:

- Model 20.1: the status quo model
- Model 20.1g: the GMACS version of the status quo model

- Model 20.2: the status quo model with re-weighted size compositions using an appropriate tuning method

- Model 20.2 with time-varying fishery selectivity

The SSC further recommends that if a variant of the status quo (20.1) model is preferred, it would be ideal to review a parallel version of the GMACS model.

The SSC supports CPT recommendations to:

- Continue development of the GMACS snow crab model

- Revisit data weighting within the status quo model, with a more holistic consideration of all data inputs

- Explore time blocks for fishery selectivity coinciding with the timing of rationalization

The SSC further supports continued exploration of VAST for survey index standardization given the changes in distribution observed for the snow crab stock. Based on historical observations of snow crab north of the EBS survey area, this modelling should include the NBS. The SSC also suggests that authors consider whether estimating a common time-varying process for survey catchability for both sexes and a scaling or offset parameter for the other sex may present an appropriate model of intermediate complexity for consideration, relative to 20.2q and 20.2qm which estimate time-varying catchability separately for each sex. The SSC supports continued research to identify optimal methods for defining the minimum size used to delineate MMB given the sensitivity of estimated OFL to this assumption. Finally, the SSC reiterates its recommendation to consider the basis for estimating sex ratio at recruitment rather than the simpler assumption of a 50/50 ratio, as is common in most assessments.

The SSC appreciates the authors' efforts to develop a Risk Table for the snow crab stock, and looks forward to a draft risk table for the full assessment in the fall.

Tanner Crab Model Runs

The SSC received a presentation describing analyses related to the Tanner crab stock assessment and proposed models for September 2021. A major challenge for this stock assessment has been the eleven selectivity, catchability and growth parameters that were hitting upper or lower bounds during estimation. **The SSC commends the authors for their hard work in attempting to address this issue with over 20 models explored, highlighting the tremendous progress that has been made with this assessment.** A key recommendation to transition from a normal to a lognormal likelihood for fishery catch and bycatch data was followed by the authors, and **the SSC fully supports this change in assumed likelihoods,** given that this agrees with common practice and assumes a more appropriate multiplicative error structure.

The SSC supports the CPT recommended models for September 2021:

- Model 20.07: the base model from September 2020

- Model 21.22: implementing changes to address parameters hitting bounds during estimation and using the Dirichlet-multinomial likelihood for size compositions

- Model 21.22 + pre-specification of growth increments per molt based on external estimates

The SSC supports CPT recommendations for model development including exploration of methods for reducing the complexity of assumed selectivity and model sensitivity to penalties on time-varying parameters, and exploration of the impact in changing the timeframe for the model. The SSC further requests that the September 2021 documentation include plots of standardized residuals for size compositions to ensure residuals are on a reasonable scale following implementation of the Dirichlet-multinomial likelihood. The SSC also cautions that fixing the Dirichlet-multinomial variance parameter at a large value (specifying the nominal sample size) makes sense, but that support for this weighting must be re-checked for every new alternative model considered in future assessments to ensure data weighting remains consistent with model fit. The SSC supports continued exploration of VAST indices within this assessment and research to evaluate optimal methods for addressing changes in index uncertainty in the context of data weighting. Finally, the SSC sees no need for continued exploration of the two area-specific VAST models, and indicated a preference for post-hoc apportionment from a single model covering the entire Tanner crab stock as needed for spatial management measures.

Bristol Bay Red King Crab Proposed Model Runs

The SSC received a report on model alternatives for Bristol Bay red king crab (BBRKC) as part of the CPT report from Martin Dorn (NMFS-AFSC) and Katie Palof (ADF&G). The SSC appreciates the responsiveness of the assessment scientists to previous comments by the CPT and SSC. The authors presented eight models as candidates for consideration for the final SAFE. In addition to base model (19.3) accepted by the CPT and SSC in September 2020, models included updated observer data (19.3c), updated sample sizes for retained and total size composition data (19.3d), and explorations of the priors on survey catchability parameters (19.3e and 19.3f). Model 19.3g built on model 19.3d, but used VAST estimates for NMFS survey trawl biomass and CVs. Model 19.3i estimated additional variance for the VAST estimates and model 19.6 changed the natural mortality from 0.18 to 0.257, based on Then et al. (2015). **The SSC supports exploring more modern methods for estimating natural mortality, but notes that this method still relies strongly on the maximum age for BBRKC. The SSC recommends continued research to validate the ages for this stock.**

Although the authors and CPT did not recommend model 19.6 for the September assessment, the likelihood profiles and more current methods show that there is information in the model about M and suggest M may be higher even than the estimates from Then et al.'s methods. The likelihood profile suggests that the values of M for male and female might be similar and that the current difference may be because of the constraint of base M to a low value. When M is misspecified, it can be the cause of a strong positive retrospective pattern, which BBRKC has. **The SSC would have liked to have seen compositional fits and a retrospective analysis for model 19.6 or some model with a higher M value,** particularly to see if it fits the plus group better. Despite the increase in $F_{35\%}$, there was not a commensurate increase in OFL. An exploration of the underlying reasons for this outcome is needed.

Evidence of different catchabilities and selectivity by sex seem scant despite the Plan Team's recommendation of the inclusion of Model 19.3e. The survey selectivities, natural mortalities and catchabilities when estimated separately by sex all appear very similar. There is a lot of potential confounding between separate recruitment deviations by sex, the sex ratio penalty, separate selectivities, catchabilities and natural mortalities.

In addition to the CPT recommended models (19.3d, 19.3e, and 19.3g), the SSC recommends a simplified version of model 19.3d that estimates one natural mortality parameter across sex and time, and one shared catchability and selectivity curve for the NMFS trawl survey to help make several selectivity parameters better defined. This simpler model may not end up being a viable model for management advice, but it may lead to insights about other aspects of the population and model.

The new VAST model diagnostics seem promising and the SSC supports their inclusion in model 19.3g or other new models. Figure 5 in Appendix E of the spring 2021 draft BBRKC assessment (published on the May CPT e-agenda) that describes the VAST model, illustrates interesting distributional shifts in the population that may bring into question the one-stock hypothesis for BBRKC in the future, as there may be mixture with other RKC stocks. **The SSC requests that the current crab management zones be included in the maps of VAST model-derived spatial distributions of BBRKC.** Additional general comments are included in the section of this SSC report on VAST models for crab stocks. The SSC very much looks forward to seeing the 2021 NMFS trawl survey results. The SSC also looks forward to the summary report from the March 2021 CIE Review for this stock, which should be available in the coming months.

Summer Survey Contingency Planning

The SSC received a briefing on the summer bottom trawl survey planning and the timeline for data availability. The SSC appreciates the CPT's consideration of the assessment cycle, specifically the data dissemination timelines, in their planning process. The presenters reported that full survey coverage of the EBS and NBS are expected for 2021 but noted that one of the two vessels will be delayed six days leading to a slight delay (two days) in data delivery. They also reported that summer bottom water temperature forecasts from the Bering10K ROMS model suggest that re-tows for BBRKC may be necessary, potentially causing some further delay in data availability. The SSC appreciated the work of K. Kearney (CICOES, UW) and K. Aydin (NOAA-AFSC) to provide the temperature forecasts to the CPT and notes that survey delays will likely result in a tight turn around to produce VAST model results. The SSC notes that none of the crab assessment authors are planning on using VAST estimates in their preferred models in September, but that the CPT did recommend bringing forward models with VAST for BBRKC. Further detail is provided in the BBRKC section of this SSC report. In general, the SSC is concerned that there seems to be a mismatch between survey planning and the crab assessment cycle that may impact data availability for assessments going forward. Crab assessment authors have a very short time-window for producing final model runs in the fall and even small delays in survey timing may impact the authors' ability to complete VAST-based assessments. **The SSC acknowledged that continued exploration of options regarding the timing of surveys, VAST estimates, and assessment timing will be needed for there to be time for VAST estimates to be incorporated into crab assessments.**

VAST Model Discussion

The presenters summarized efforts to refine VAST modelling for three crab stocks (BBRKC, Tanner and snow crab), and outlined efforts to address previous SSC recommendations to the CPT. Similar to VAST implementation in groundfish assessments, there are large differences between VAST and design-based survey estimates in some years and for some species. However, model performance diagnostics have improved steadily and are contributing to an improved understanding of the utility of VAST models for crab. **The SSC commends the assessment authors' work to establish a VAST expert review committee to provide technical oversight on the ongoing development and implementation of this tool for crab stock assessments.**

As noted in the Survey Planning section above, **the SSC acknowledged the continued concern of the CPT that the tight turnaround time of crab assessments impacts the availability of VAST estimates**. In general, VAST models showed promise primarily for BBRKC, but also for Tanner, with generally good diagnostics, though there were exceptions to this. **The SSC concurs with the CPT recommendation that VAST estimates be produced for BBRKC in the fall and that authors continue to refine the Tanner and snow crab models. The SSC supports the CPT's advice to these authors to focus on improving model fits and continued visualization of diagnostics for both species, and to incorporate NBS data in the snow crab models.** The SSC discussed the importance of continued comparisons of design-based and VAST-based models and noted the need for transparency regarding the configuration of the VAST model spatial and temporal autocorrelation settings. In addition, the SSC noted that it would be instructive to examine the model performance diagnostics for crab in the context of groundfish assessments for which VAST is already being implemented. Finally, the SSC supported the CPT recommendation that going forward, Tanner crab models be constructed using the full EBS population and then partitioned into eastern and western management areas. Further comments from the SSC regarding the stock-specific applications of VAST are provided in the proposed model runs sections of this report.

BSFRF Survey catchability/selectivity

The Bering Sea Fisheries Research Foundation (BSFRF) conducted side-by-side tows in conjunction with the NMFS EBS bottom trawl survey in 2013-2018. These paired hauls have simultaneous starts, are separated by 0.5 nmi, and use the same tow direction. BSFRF employs a modified Nephrops trawl, which is assumed to capture all crab in its path during standard 5-minute tows. NMFS uses the standard EBS 83-112 bottom trawl gear and standard 30-minute tows. The presenters provided an update on efforts to refine estimates of NMFS survey catchability and gear selectivity, which are currently focused on Tanner crab. Two analytical approaches external to the assessment model are being pursued. One approach considers data for each experiment in aggregate. The other approach takes advantage of the side-by-side nature of the data (haul-level). In general, after accounting for differing areas swept, the catch rates for the BSFRF net are typically higher than the NMFS catch rates, suggesting that the NMFS survey net only captures a fraction of the Tanner crab in the path of the net. Both temperature and sediment data are also incorporated into these comparisons. **The SSC recognizes BSFRF for their continued support of research and Dr. Stockhausen (NOAA-AFSC) for his continued work on this analysis. The SSC concurs with the CPT's assessment that this work is important for refining crab assessments but that it is too soon to conclude whether the aggregated approach or the haul-level approach will be most useful for crab stock assessment and that work should continue to refine both approaches.** The SSC discussed the current assumptions regarding the Nephrops trawl catch performance and notes that the temperature and sediment-based mechanisms thought to impact the NMFS trawl performance may also impact the Nephrops trawl. The SSC recommends prioritizing the 2018 BSFRF data for inclusion in all future updates to these analyses.

Research Priority Update

The SSC received an update on CPT efforts to complete research priorities. The SSC appreciates the planning and forethought that the CPT is putting into their research priority recommendations for the next cycle. The SSC notes that changes to the research prioritization process are being recommended to the Council, which will impact the CPT's work going forward. These are provided under the Research Priorities (Agenda Item D-5) section of this report.

Risk Table Discussion

The SSC received an update on the development of Risk Tables for crab stocks including an overview of the current P* approach for setting the buffer between ABC and OFL. Draft Risk Tables were provided for St. Matthew blue king crab, and snow crab. The CPT listed several questions for SSC consideration. **The SSC appreciated the authors' efforts to bring these draft tables forward and supports bringing forward draft risk tables for BBRKC and snow crab in September.** Questions from the CPT were addressed in the SSC discussion of D-4 and are included in that section of this report. Finally, the SSC supports the CPT recommendation that an ecosystem expert be assigned to help the assessment authors in evaluating the risk table ecosystem category, as has been done for groundfish.

C-4 BSAI Pacific Cod Trawl Catcher Vessel LAPP

The SSC received a presentation from Jon McCracken (NPFMC), Darrell Brannan (Brannan & Associates LLC), Mike Downs (Wislow Research), and Joe Krieger (NOAA-AKRO); Abby Jahn (NOAA-AKRO) was available for questions. Public testimony was received from Trent Hartell (American Seafoods), Mateo

Paz-Soldan (City of Saint Paul), Heather McCarty (CBSFA), Brent Paine (United Catcher Boats), Shannon Carroll (Trident Seafoods), and John Iani (Unisea).

The SSC commends the analysts for a comprehensive description of the potential impacts of a particularly large suite of elements being considered at this stage. The approach of identifying two strawman proposals to demonstrate methodology and to highlight how different elements would operate was effective for informing the selection of Council preferred alternatives. The approaches taken in the SIA and EA are insightful and persuasive.

However, the **SSC finds that the EA/RIR is not sufficient to advance to final action and requests another chance to review the analysis after the Council identifies a preferred alternative or set of alternatives.** This is important because many of the elements, whose effects are currently presented in isolation, have significant interactions with one-another, and with the current structure of the fishery. The proposed policy is distinct from previous LAPPs in that Pacific cod is not the primary target species for a significant portion of the vessels that will likely be eligible for the program; therefore, the effects of the elements will depend on existing arrangements in the primary fisheries. It is likely these effects will be different for AFA vessels with established processor-based cooperatives, and non-AFA vessels who do not have established cooperatives.

The SSC identified the following elements as requiring additional analysis reflecting interactions among elements, and existing institutions in the vessels' primary fisheries. For each of these elements, the analysis should include reflection on experiences in previous LAPP implementations: not just on their outcomes, but also on their enabling conditions and whether they are met in the case of this LAPP, which is centered on a secondary species.

- The analysis relies on select past experience, such as with halibut and IFQ crab, to suggest that there may be consolidation in the Pacific cod fleet. However, consolidation has not happened in all LAPP programs, and it is not clear why it would occur around a species that accounts for less than 10% of catch for most affected vessels (though this heterogeneity needs to be characterized better). The SSC recommends distinguishing consolidation from specialization in Pacific cod and other species. This will importantly affect the element that prohibits the sale of QS separate from the LLP. It will also affect predictions of how seasons and the structure of employment in the fishery will change. If the intent of these measures is to ensure continued participation in the harvest or processing sector, consultation with those communities may provide valuable insights as to the measures' impacts.

- Several of the elements affect the balance of market power between processors and harvesters. These include processor-centered cooperatives, processor-owned quota shares, sideboards, and a regional set-aside. These will work differently depending on how the elements of the Pacific cod LAPP interact with AFA cooperatives for AFA and non-AFA vessels. How competitive is the post-harvest market for Pacific cod now for each group? Why would that change with the LAPP? If the intent of these measures is to compensate processors for stranded capital, some estimate of the value of the stranded capital and the value of the compensation should be provided.

- The mechanisms of Element 14, conversion to pot gear, needs further consideration to assess whether this will be a frequent or infrequent strategy. If this increases the number of pot days, effects on whales (e.g., North Pacific right whale) should be considered.

The complexity of, and uncertainty surrounding, these interactions underscores the need to be able to adapt and refine this program following implementation. **The SSC recommends the Council identify**

measurable objectives for this program for which metrics and a data collection program can be developed to monitor performance against those objectives in compliance with MSA.

The extensive geographic reach and diversity of fleets and communities affected by this measure also raised the question of whether this measure will increase or decrease vulnerability to foreseeable effects of climate change. In particular, the analysis assumes BSAI Pacific cod and pollock stocks will vary as they have in recent history. While effects are probably not idiosyncratic to this action, **the SSC recommends a general consideration of the implications of climate change on the harvesting fleet and engaged communities be included in the cumulative effects section.**

Finally, while the SSC appreciates how comprehensive and thorough the current analysis is, the focus on description of elements led to a document that was long and often difficult to navigate to find particular pieces of information. **The SSC recommends that the document be made more concise and organized in a way that is easier to navigate, without losing the predictive content of the current analysis**.

D-3 Bering Sea Fishery Ecosystem Plan

Climate Change Task Force

The SSC received a presentation from Diana Stram (NPFMC) and Kirstin Holsman (NOAA-AFSC) from the BS FEP Climate Change Task Force (CCTF). No public testimony was provided. Membership of the CCTF now includes Todd Loomis (Ocean Peace, Inc.) as an industry representative. It was noted that the CCTF minutes did not include a summary of an informational update the CCTF received from the Alaska Climate Integrated Modeling (ACLIM) project and an update from the Local Knowledge/Traditional Knowledge/Subsistence (LKTKS) Task Force. With the busy schedule, the CCTF only included materials with actionable components in their minutes.

Considerable effort and progress has been made by the CCTF throughout the past year. In this fourth meeting of the CCTF, the goals were to improve accessibility and understanding of the CCTF on-ramps and interactions with the existing Council processes using plain language and figures, and to identify timelines and deliverables. To the first, **the SSC commends the authors on the strong improvement in graphics, much clearer delineation of various groups and tasks, and plain language incorporated into the overview of the work plan.** The graphics in particular clarify the process by focusing on relationships among products and where they plug into the existing management process (e.g., emphasizing that most information is going through the fall Stock Assessment and Fishery Evaluation (SAFE) report process). The figures also identify three on-ramps for differing forms of climate change information including: tactical near-term advice, strategic near-term advice, and a new on-ramp for long-term strategic advice (e.g., long-term projections of the state of the eastern Bering Sea ecosystem, novel-interactions across sectors, new challenges on the horizon). Projects like ACLIM inform across all on-ramps, but the on-ramp system as a whole was designed to be generic and inclusive to capture a range of information types and sources, including LKTKS among others.

As new products emerge, **the SSC suggests careful consideration of how to continue ensuring they are complementary and not redundant.** Overall these improvements are expected to help the public, industry, and stakeholders in the participation process.

The CCTF had three goals for September: (1) Updating a collation of climate change data sources (Table 1) that is matched to the on-ramps described above. (2) Producing a synthesis of current climate readiness in a Climate Briefing that investigates what aspects of the current management program are adaptive and which will be more ‘climate-ready’ moving into the future. This synthesis will include information from sources like the Science for Nature and People Partnership (SNAPP) program on climate resilient fisheries. (3) Outlining the climate change report for communication. They noted that the communication moving forward will be an iterative process, but the aim is for the Climate Report to be synchronized with the BS FEP report (biennial) and that Briefings (annual) will work with existing processes so stock assessment authors are aware of emergent issues each spring. The CCTF further discussed their plans to enhance coordination and communication with the BS FEP Plan Team, including monthly meetings for co-chairs and twice-yearly joint meetings. **The SSC agrees that this timeline is manageable and appropriate** and looks forward to updates on how this program and tasks will be sustained post 2025.

Bering Sea Fishery Ecosystem Plan Team

The SSC received a presentation from Diana Evans (NPFMC) and Kerim Aydin (NOAA-AFSC) on the Bering Sea Fishery Ecosystem Plan (BS FEP) Team Report from the May 2021 meeting, which covered four major topics: (1) updates from taskforces, (2) outreach and communication, (3) the Bering Sea Ecosystem Health Report (BSEHR), and (4) maintaining the core BS FEP moving forward. Updates from the taskforces are not covered here as the Council and the SSC received briefings from the LKTKS Taskforce in February 2021, and from the CCTF (SSC Report section above) at this meeting. No public testimony was provided.

Outreach and communication: **The SSC commends the BS FEP on their progress with outreach and communication materials,** in particular the excellent use of graphics and images. Prior concerns of overlap and redundancy were addressed through graphics that distinguished differences and the complementary nature of various ecosystem reports (Ecosystem Status Reports, Ecosystem and Socioeconomic Profiles, and the newly developing BSEHR).

Bering Sea Ecosystem Health Report (BSEHR): This document is aimed at providing strategic, not tactical, guidance that is informative within a broader temporal and synthetic framework. **The SSC supports the report as a whole and looks forward to seeing the draft product**; however, as originally suggested at the February Council meeting, **the SSC is still not supportive of the use of the word “health” in the product title.** Health implies a narrow interpretation, and suggests we have to define what is healthy. It also may imply a static state that is desired for the ecosystem when everything is changing, and will continue to change. The SSC provided several suggestions for revision including ‘ecosystem evaluation report’ or “ecosystem dashboard” and recommends that the BS FEP Team continue to evaluate the use of “health” in the product title.

The BSEHR will monitor indicators across six overarching ecosystem goals, each associated with one or more strategic ecosystem objectives from the FEP. Again, the BS FEP Team was clear that red flags associated with these indicators will be incorporated as management-informing flags, and not action-forcing flags. **The SSC recommends that the BS FEP Team take careful consideration of the indicators that are going to be selected under each goal.** The SSC suggests that the BS FEP Team investigates and considers indicators that are atypical of what is normally measured regarding fish stocks (e.g., wetland inundation, pollution, salmon-river conditions inland) and to consider a suite of broad and local indicators to capture localized impacts that might be important to communities. It was also highlighted that the Bering Sea is not a closed system nor is it static. **The SSC further recommends the BS FEP Team consider not just single metrics, but multidimensional metrics that capture the complexity of the system.**

Maintaining the core BS FEP moving forward: The BS FEP Team presented their suggested path for moving forward over the next year to develop a pilot report of the BSEHR by March 2022. **The SSC is supportive of the proposed iterative path, and of the timeline.** Having reviewed the core BS FEP, the Team is not moving any other modules forward at this time, but did discuss options for expanding this work to the other LMEs or toward developing an AK-wide FEP. The BS FEP Team noted that the end of the GOA-CLIM project may serve to kickstart that process, as it aligns with the end of the taskforces and would ensure less burden on staffing. The SSC continues to support the exploration of pathways moving forward to expand to other LMEs or to a North Pacific-wide program, but did not have specific recommendations at this time. The SSC highlighted that while we talk about the BS Ecosystem, it is not a closed system, and an advantage of having a North Pacific-wide FEP is that the issues are connected at the larger scale. Understanding this connectivity will be important for understanding how the system will respond to climate change, but may omit localized impacts. It was alternatively discussed that a North Pacific-wide program at the administrative level, with LME specific sub-groups, may help in the research prioritization process and may assist the public, industry, and researchers in figuring out points of input for the suggestion of research priorities and what information is needed at different spatial and temporal scales.

D-4 SSC Workshop Report on Risk Table Advice

The SSC reviewed the summary and subsequent subgroup recommendations resulting from a February SSC workshop on risk tables (D4 Draft Report from SSC Risk Table Workshop). The report was compiled by a subgroup of the SSC and had many contributors from the AFSC. The main goal for this agenda item was to provide an opportunity for the full SSC to review, discuss, and revise the draft recommendations developed by the subgroup (see Appendix A for revised report by the full SSC).

Following the presentation by Dr. Anne Hollowed, public testimony by Gerry Merrigan, and a thorough discussion of all the draft recommendations, **the SSC generally agreed with all of the recommendations within the report, provided modifications to two of the recommendations, and provided a few suggestions for Plan Teams and SSC to revisit during their September and October meetings.** Specifically, the SSC recommends one revision (bullet 3) and one deletion (bullet 4) from the draft recommendations (the deletion was due to redundancy, not lack of support from the SSC; see Appendix A for revised report).

Overall, the SSC agrees that the Risk Tables are working well, continue to improve, and are accomplishing the goals set out by the December 2019 Council motion.

The title "Risk Table" continues to cause some concern due to the many ways risk can be defined. While the SSC clarified how risk was being defined (Appendix A, *Preliminary Guidance and SSC recommendations,* bullet 2) and it was determined that this was sufficient to clarify the goal of the Risk Tables, future discussion on a more accurate name was suggested.

The SSC subgroup recommended producing risk tables for all stocks and stock complexes in the fishery (Appendix A, *Preliminary Guidance and SSC recommendations,* bullet 3). **The SSC revised and clarified the recommendation to maintain the status quo and only produce risk tables for full assessments (rather than all assessments, as indicated in the subgroup recommendation).** The main rationale for this was to avoid increasing the workload of stock assessment authors and the time needed to review during Plan Team and SSC meetings. However, the SSC recommendation does not preclude stock assessment authors from producing a risk table in an "off cycle" year if they believe it is warranted. Further discussion of the necessity of producing risk tables for Tier 4–6 groundfish stocks was mixed and the SSC welcomes further guidance from the Plan Teams and authors of those stocks on the trade-offs between the time needed to produce them and their utility. There was some additional discussion on whether to produce risk tables for stocks that have very low catches relative to their ABCs, but the SSC concluded that these stocks still need a risk table because fisheries could rapidly change.

The SSC supports producing risk tables for stock complexes and recommends that they focus on the most abundant species within the complex and other species of particular concern (at the discretion of the stock assessment author). The SSC did not review all the stock complexes in detail and would welcome comments/suggestions from stock assessment authors and the Plan Teams for further refinement.

The SSC commends all the effort and improvements on scoring consistency and rationales across all four categories. As noted in the recommendations, **for cases where a process external to the assessment is relevant to two or more risk categories, the SSC recommends that the narrative reflect the interconnected relationships that exist between rankings among risk categories** (Appendix A, *Preliminary Guidance and SSC recommendations,* bullet 7). Additionally, the **SSC supports the recommendation that the fishery/community performance column should focus only on factors that provide insight as to the condition of the stock and that economic and community impact information be excluded** (Appendix A, *Preliminary Guidance and SSC recommendations,* bullet 6).

The SSC recognizes the current use of LK/TK/S in the population dynamics, ecosystem considerations and fishery/community performance columns, and highlights the desire to encourage usage of this information (Appendix A, *Preliminary Guidance and SSC recommendations,* bullet 6). The SSC also recognized that more direct recommendations of when, where, and how LK/TK/S are used should be discussed in the future. The SSC noted that a point of contact, as there is for ecosystem considerations, would likely be helpful.

The SSC supports the recommendation of reducing the number of category levels from four to three. There was good discussion of the merit of including (or not) an "unknown" score and whether or not removing the "major" concern score was appropriate. Concern that using "unknown" would just provide a "catch-all" score and hearing about the difficulty authors had of deciding between four subjective levels led the SSC to recommend three levels to simplify things. The SSC also discussed the importance of not changing the scoring levels often to ensure the utility of comparisons over time, but believed this change was occurring early enough in the process and was a large enough improvement to justify doing so. The SSC continues to recommend that scores not be directly tied to levels of ABC reduction. While comparison across species or stocks (e.g., within a tier, with similar life histories) is useful for consistency, the SSC does not support requiring a common reduction from the maximum permissible ABC for a given risk score across species because the processes underlying the score may differ among stocks (Appendix A, *Preliminary Guidance and SSC recommendations,* bullet 4).

The SSC continues to support that reductions from the maximum permissible ABC should be infrequent and only for exceptional circumstances (Appendix A, *Preliminary Guidance and SSC recommendations,* bullet 9). The SSC subgroup recommendation (Appendix A, *Preliminary Guidance and SSC recommendations,* bullet 9) also suggested that if reductions become "commonplace" for any assessment, this should warrant further review. While the SSC supports this, there was recognition that future discussions should provide more detail on what "commonplace" actually means and what actions should or could be undertaken.

The SSC also recommends that stock assessment authors and the Plan Teams review all recommendations and provide feedback, especially regarding the inclusion of risk tables being completed for Tiers 4–6 groundfish stocks, which species within stock complexes should be examined, and the reduction from four to three levels within each category.

While the Risk Table Workshop and SSC recommendations centered around groundfish stocks, many would be generally applicable to crab stocks. However, the SSC recognizes the distinct differences between recommending ABCs between crab and groundfish stocks that will warrant some careful consideration in how to best apply risk tables to crab stocks in the future.

D-5 Research Priorities Process

Dana Hanselman (SSC member, NOAA-AFSC) presented a proposal from the SSC subgroup on the NPFMC research priorities review process for 2022 – 2024, as well as suggested revisions from online review by SSC members in preparation for this June 2021 discussion. In addition, Dr. Hanselman presented a few suggested changes to the database of Strategic priorities, because that was the one category of research priorities that had not yet been curated during the SSC 2021 review. He also suggested an additional Critical Ongoing Monitoring (COM) priority and an edit to an existing COM priority that arose in the development of the proposed NPFMC research priorities review process. Matt Baker (North Pacific Research Board, NPRB) presented to the SSC on connections between NPRB and NPFMC research priorities. **The SSC would like to express appreciation for the work done by the Plan Teams, FEP team and NPFMC staff to review the database and to develop their priority lists in the past.** The input provided by the FMP Plan Teams, SSPT, FEP and the public is critical to the research priorities process. Public and written testimony was provided by Lauren Divine (Ecosystem Conservation Office, Aleut Community of St. Paul Island) and Brenden Raymond-Yakoubian (Kawerak, Inc.). The SSC had many questions for the testifiers. Public testimony provided support for the importance of Council research priorities and ensuring that the process is transparent and formalized. While the testifiers recognized that they can always provide input through testimony, they shared that it was not clear how this translated into consideration in the research priority review. There was also concern that testimony from previous years was not retained and tracked. Additionally, there was testimony on the need for documentation of the process with clear on-ramps for stakeholders to submit and/or comment on research priorities, and that having to attend multiple Plan Team, Planning Team, and/or committee meetings was burdensome.

Dr. Baker (NPRB) gave an extremely helpful presentation reviewing the purpose and nature of the NPRB-NPFMC collaboration, identifying opportunities to improve tracking of funded research, an update on the progress in NPRB system developments, and a clarification of NPRB's intention to work with the SSC subgroup in preparation for the 2024 triennial review. The presentation indicated that Council priorities were one of the sources that NPRB uses to populate its science plan as well as its long-term research foci. It was noted that proposals in response to NPRB request for proposals (RFP) frequently reference the Council priorities. Dr. Baker pointed out that NPRB has parallels with the Council with keeping tabs on projects, and employs databases and other software solutions. As a funding agency, they have a requirement to keep close track of their priorities and products. Dr. Baker indicated that NPRB has a strong interest in working with the SSC subgroup on any refinements leading up to the next triennial review. In response to an SSC question, Dr. Baker described that the timeline of NPRB funding may not be realistic to respond to priorities with an Urgent (2-3 year) timeline given that from a priority getting into an NPRB RFP, a proposal reviewed, funded, and completed would probably take three or more years. Dr. Baker indicated that the top 10 list was useful to NPRB, though research identified by other stakeholders in NPRB's RFP development process was also considered. The narratives developed in the proposal by the subcommittee describing categories of COM and Strategic priorities were also helpful, and that it would be useful to see a compiled list of the Top 3-5 priorities from each of the on-ramp groups (Plan Teams, SSPT, BS FEP, and any other onramp groups). Due to the high level of duplication and large number of priorities, it was less clear that the full list of priorities in the database were useful to NPRB.

An extensive discussion occurred during the April 2021 meeting that provided a number of recommendations for the process moving forward and committed the SSC subgroup to further expand on these process recommendations for the June 2021 meeting. The SSC subgroup provided a further refined version of the April draft, which the SSC discussed and revised at this meeting (see *Appendix B: Research Priorities Process* for the SSC subgroup document). The subgroup added a new narrative for Strategic priorities (see Appendix B, sections 2.1–2.4) similar to the narrative provided for Critical Ongoing Monitoring in April (see Appendix B, sections 1.1.1–1.1.4). The SSC subgroup thought a strategic narrative was important for organizations that might propose longer-term funding or plans. The Strategic narrative summarized the 33 strategic priorities by four major categories:

- Climate and ocean change
- Baseline research
- Marine mammals
- Fishery performance, socio-economic analyses, and human dimensions

The SSC approved of the Strategic narrative, but recommended that the "Marine mammals" category be expanded and changed to "Protected species" to ensure the inclusion of seabirds. In addition, the SSC recommended that the COM and Strategic narratives be posted to the Council's Research Priorities section of its website.

Regarding the Research Priorities review process for 2024, the major recommendations from the subgroup were:

- Do not review existing database priorities unless there are additions, deletions, or changes
- Review new or revised database priorities brought forward by FMP Plan Teams or other on-ramp groups
- Update the COM and Strategic narratives if needed
- Put "Born on" date on Top 10 and all database priorities
- FMP Plan Teams should move to a triennial schedule like the SSC, review database priorities and recommend additions, deletions, and edits, and recommend their top 3-5 priorities for consideration in the triennial Top 10 list
- The SSC would appreciate it if the SSPT and BS FEP would forward research priorities on a triennial basis and identify their top 3-5 priorities for consideration in the Top 10 list.
- The SSC should recommend a Top 10 list to the Council, starting from the previous Top 10 list and adding, removing, and revising priorities as needed

During the SSC review of the subgroup's report, an SSC member suggested an alternative process for research priorities (see Appendix B, *SSC Member Suggestion for Alternative Approach to Research Priorities*)

- Discontinue SSC and Plan Team curation of the database
- Focus on knowledge gaps for managing North Pacific federal fisheries
- Proposed topics for "Top 10" should come with a short abstract (150 words)
- If new research priorities do not make it on the "Top 10", they will not continue to be tracked

During the SSC meeting, there was much deliberation on the value and purpose of setting NPFMC research priorities and how this process is similar and different from funding organizations with science panels that also set research priorities. It was noted that the SSC would be better served focusing on specific gaps that could help federal fisheries management. **The SSC supported discontinuing curation of the database by**

the Plan Teams and SSC. However, the SSC agreed that it is important to identify and continue to evaluate a strategic vision of the research needed to support and enhance NPFMC management.

Therefore, with regard to the *Research Priorities Process* document, the SSC agreed to retain the narratives summarizing Critical Ongoing Monitoring and Strategic research. The SSC supported focusing only on a "Top 10", each with a short abstract, as a way to identify and address gaps in knowledge to benefit federal fisheries management. Footnoting the database project numbers that the COM and strategic narratives were derived from was also supported, if that is useful for the Plan Teams and the public.

There was a lengthy discussion about on-ramps for public contributions to research priorities. **On-ramps for the public should be identified ahead of the 2024 Research Priorities review and Research Priorities process should be clearly communicated**, perhaps through a flow-chart graphic. The process needs to be transparent, predictable, efficient, and have trackability of proposed priorities so groups know that their ideas were considered by the SSC. These on-ramps are the mechanism for how the SSC would be able to consider publicly provided ideas that can lead to new multi-dimensional research. There was some concern that a winnowing process might be necessary if a high number of priorities were suggested directly in SSC testimony, yet the SSC recognized the challenge for public testifiers if required to propose their ideas at meetings of multiple groups (e.g., Plan Teams, SSPT, committees). **The SSC determined that there was not sufficient time at this meeting to develop an effective, receptive, and efficient new on-ramp process, but suggested that Council staff work with a small subset of SSC members to develop that process and bring back to the full SSC for comment and public testimony prior to the next triennial review.**

The SSC did not find that the two proposed alternatives in the draft document were incompatible and came up with the following recommendations that were a mixture of the two alternatives and the SSC discussion:

1) **The SSC requests Council staff work to develop on-ramps for receiving stakeholder input on priorities and that the SSC have an opportunity to provide input on on-ramp development.**
2) **The SSC subgroup should develop a rubric of how they will evaluate priorities for inclusion in the Top 10 with a clear goal statement.**
3) **The SSC subgroup should bring proposed methods for items 1-2 back to the full SSC for review and public feedback prior to the 2024 triennial review.**
4) **The SSC subgroup should update the "Research Priorities Process" document with additions from items 1-2 prior to the 2024 triennial review.**
5) **The database of past priorities will remain available, but will not be curated or reviewed by SSC and Plan Teams.**
6) **The SSC subgroup should engage with NPRB while finalizing the process for 2024.**
7) **As part of the triennial review:**
    a) **The SSC will update high-level categorical narratives for Strategic and COM priorities for inclusion on the NPFMC research priorities web page.**
    b) **The Plan Teams and other designated on-ramp entities will produce their top 3 - 5 priorities, each of which should include an ~150 word abstract that describes how the research would address identified data gaps or other recognized Council fisheries management information needs.**

c) **The SSC will review these sets of top 3-5 priorities for inclusion in the Top 10. Priorities not selected for the Top 10 will not continue to be tracked, but will be reconsidered if recommended again in future reviews.**

There were some minor changes to existing research priorities that the SSC subgroup proposed. The subgroup recommended adding a Critical Ongoing Monitoring priority describing fishery monitoring and catch accounting, as the SSC had noted that this was essential in the narrative, but it was not specifically called out in the database. This new priority's (#735) description was:

> "Fishery dependent data collected by observers, electronic monitoring, and the state of Alaska provide information critical for sustainable fisheries management. These data include: a) the amount, distribution, species composition, size, age, maturity and genetics of both the targeted catch and PSC catch (including genetics for chum and Chinook salmon); b) seabird catch; and c) marine mammal encounters and mortalities"

The SSC agreed with this new priority and its addition to the COM narrative, but recommended that this be slightly reworded to (changes in italics):

> "Fishery dependent data collected by observers, electronic monitoring, and the state of Alaska provide information critical for sustainable fisheries management. These data include: a) the amount, distribution, species composition, size, age, maturity and genetics of both the targeted catch and PSC catch *(including genetic and mark or tag data for chum and Chinook salmon)*; b) seabird catch; and c) marine mammal encounters and mortalities."

The SSC recommended that four other suggested changes in the database be adopted:

- Slight change in COM 150 (*Core biological and oceanographic data*): "stomach" to "diet"
- Removal of Strategic 193 (*Species identification*) as it has been marked "Completed"
- Slight change in Strategic 233 (*Product inventories*): "U.S." to "federal"
- Change status of Strategic 533 (*Best practices for age-structure storage*) to "Other" from "Partially underway"

The "Research Priorities and Process" document (Appendix B), drafted by the SSC subgroup and commented on by SSC members prior to this meeting will be refined with the SSC input from this meeting and future work of the subgroup, and will come forward before the 2024 triennial review for public testimony and review by the full SSC.

SSC Member Associations

At the beginning of each meeting, members of the SSC publicly acknowledge any direct associations with SSC agenda items. If an SSC member has a financial conflict of interest (defined in the 2003 Policy of the National Academies and discussed in Section 3) with an SSC agenda item, the member should recuse themselves from participating in SSC discussions on that subject, and such recusal should be documented in the SSC report. In cases where an SSC member is an author or coauthor of a report considered by the SSC, that individual should recuse themselves from discussion about SSC recommendations on this agenda item. However, that SSC member may provide clarifications about the report to the SSC as necessary. If, on the other hand, a report is prepared by individuals under the line of supervision by an SSC member, then that SSC member should recuse themselves from leading the SSC recommendations for that agenda item, though they may otherwise participate fully in the SSC discussion after disclosing their affiliations with the authors. The SSC notes that there are no financial conflicts of interest between any SSC members and items on this meeting's agenda.

At this June 2021 meeting, multiple SSC members declared an association with various agenda items. Anne Hollowed supervises Martin Dorn (CPT co-chair and contributor to the D-4 Risk Table Workshop report), Cody Szuwalski (snow crab author), William Stockhausen (Tanner crab and Pribilof blue king crab author); and James Ianelli, Kalei Shotwell, Paul Spencer, Grant Thompson (contributors to the D-4 Risk Table Workshop report). Brad Harris is the M.S. supervisor of Cody Lescher (contributor to EFP section of the CPT report), and is a contributor to the Fishing Effects model (EFH 5-year review section of the CPT report). Dr. Harris and Ian Stewart are also members of the BS FEP team (agenda item D-3). Dana Hanselman is married to Kalei Shotwell and supervises the supervisors of Dan Goethel and Elizabeth Siddon (contributors to the D-4 Risk Table Workshop report). Mike Downs is a contributing author to the C-4 BSAI Pacific Cod Trawl Vessel LAPP. Finally, Chris Siddon is a co-author of the AIGKC assessment, supervises Katie Palof (CPT co-chair and SMBKC assessment author), Jie Zheng (BBRKC assessment author, AIGKC assessment co-author), Lee Hulbert (AIGKC assessment co-author), and is the second-level supervisor for Shareef Siddeek (AIGKC assessment co-author). He is also married to Elizabeth Siddon (contributor to the D-4 Risk Table Workshop report).

Appendix A: Risk Table Workshop Report

This report summarizes the SSC response to the "Draft Report from the SSC Risk Table Workshop". The report was originally developed by a subcommittee of the SSC. The following SSC members served on the subcommittee: Anne Hollowed, Sherri Dressel, Brad Harris, Ian Stewart, Mike Downs, Curry Cunningham, and Alison Whitman. The report was presented to the full SSC during the June 2021 NPFMC meeting. Suggestions for improvement from the full SSC were incorporated into this report. This updated version of the report reflects the SSC's most current recommendations regarding Risk Tables.

SSC Workshop on Risk Tables for ABC Advice to Council

Compiled by the North Pacific Fishery Management Council's

Scientific and Statistical Committee

June 2021

Contents

Executive Summary and Recommendations

In February 2021, the SSC convened a workshop to evaluate how the risk table process was working*;* address consistency issues with the risk table as identified by the GPTs, authors, and SSC; and to provide guidance for moving forward. The SSC appreciates hearing about the challenges the authors and JGPT have found with the risk table process.

The workshop objectives were to:

1. Assess the progress and value of species-specific risk tables for all stocks
2. Evaluate risk table consistency among species and highlight challenges
3. Define "risk" and "uncertainty"
4. Compare ABC and OFL buffers for scientific uncertainty with ABC reductions due to the risk table
5. Discuss future options

The workshop included two plenary sessions and breakout sessions providing open discussion between stock assessment authors, Plan Teams and SSC members (SSC workshop on Risk Tables Report Appendix 1: *February Workshop Agenda*, session leads in parentheses). Time was set aside for public testimony relevant to the workshop at the end of the workshop. The SSC appreciates the important contributions from the topic session leads and all participants that contributed to the discussions.

In February, the SSC established the following timeline and process for finalizing guidance to stock assessment authors.

Date/Meeting	**Action**	**Who**
June 2021	Assemble full workshop report	SSC/Workshop Session lead
June 2021	Preliminary recommendations	SSC/NPFMC
September 2021	Comment and recommendations	CPT/GPT
October 2021	Finalize 2021 recommendations	SSC/NPFMC

This report provides a short written description of each topic session and a summary of the key findings. Based on this summary, the SSC provides the following preliminary guidance on the development and use of Risk Tables.

Preliminary Guidance and SSC Recommendations

1. The SSC concluded that the risk table framework is working well. The tables have expanded communication among assessment authors and between assessment authors and ecosystem/process researchers. The framework is intended to provide a clear and transparent basis for communicating assessment-related and stock condition concerns that are not directly captured in model-based uncertainty, the tier system, or harvest control rules.
2. The SSC recognizes that within the context of the risk tables, "risk" is the risk of the ABC exceeding the true (but unknown) OFL. The risk tables are intended to inform the process of adjusting the ABC from the maximum permissible when needed. Recommendations of an ABC

reduction from the maximum permissible requires justification. The risk tables provide an avenue for articulating that justification.

3. The SSC recommends that risk tables are produced for all full assessments of groundfish (and perhaps crab) stocks and stock complexes in the fishery. Risk tables can be produced in other years at the discretion of the lead author. The SSC requests that the authors consider if there have been any changes to previous conditions and update the tables accordingly. The SSC recommends that authors of stock complexes consider the most abundant species and any other species of concern within the complex when formulating advice.
4. Risk scores should be specific to a given stock or stock complex. While comparison across species (e.g., within a tier, with similar life histories) or stocks is useful for consistency, the SSC does not support trying to prescribe a common reduction from the maximum permissible ABC for a given risk score across species or stocks because the processes underlying the score may differ among species and stocks. The SSC recommends that considerations of reductions in ABCs below the maximum permissible be made on a case-by-case basis with justification based on risk scoring. The risk table rankings include qualitative information that requires a certain amount of subjective but well-informed interpretation of the available data by the author(s), the Plan Teams and the SSC, and as such, the SSC feels that blanket comparisons across species or stocks for the purpose of explicitly defining reductions in ABC below the maximum permissible are not prudent.
5. The SSC recommends that the fishery/community performance column should focus on information that would inform the biological status of the resource (e.g., an unexplained drop in CPUE that could indicate un-modelled stock decline, or a spatial shift indicating changes in species' range), and not the effects of proposed ABCs on the fishery or communities or bycatch-related considerations. The SSC recognizes that the community impact information is critical for informed decision making for TAC setting and recommends this information be included in other Council documents such as the ACEPO and/or the Economic SAFE.
6. The SSC encourages the inclusion of LK/TK/S as a source of knowledge about the condition of the stock.
7. The SSC appreciates the discussion of avoiding double-counting information, in the assessment/Tier system and risk table, or among columns of the risk table. The SSC agrees that authors should avoid inclusion of stock trends/processes that are incorporated in the assessment or reflected in the Tier when scoring the risk tables. For cases where a process external to the assessment is relevant to two or more risk categories, the SSC recommends that the narrative reflect the interconnected relationships that exist between rankings among risk categories.
8. The SSC suggests a potential revision to the category levels: from the existing four to three categories (normal, increased, extreme).
9. The SSC reiterates that reductions in ABC below the maximum permissible should be applied sparingly and that the tier system should be regarded as the primary basis for establishing the ABC. If they begin to become commonplace, that should warrant further review of the assessment and/or the Tier system.

<u>Acknowledgements</u>

The SSC expresses its sincere appreciation for the contributions of the discussion leads and rapporteurs. The SSC is grateful for the leadership of these individuals in preparing for, and contributing to, discussions during the workshop, and their work to develop summaries contained in this report.

Discussion 1: Introduction to Risk Tables: historical background, conceptual framework, synthesis of applications in 2018-2020.

Martin Dorn, Stephani Zador, Kalei Shotwell
(Discussion Leads & Rapporteurs)

Alaska Fisheries Science Center
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

Historical background and the genesis of risk tables

An explicit part of the NPFMC stock assessment process is an evaluation of whether it is appropriate to reduce the ABC from the ABC resulting from application of the control rules in the Tier system. As described in both the BSAI and GOA groundfish FMPs, groundfish stock assessments should "*determine whether conditions exist that warrant setting ABC at a value lower than the maximum permissible value (such conditions may include—but are not limited to—data uncertainty, recruitment variability, and declining population trend) and, if so:*

a. document those conditions,
b. recommend an ABC lower than the maximum permissible value, and
c. explain why the recommended value is appropriate.

The above steps are undertaken first by the assessment authors in the individual chapters of the SAFE report. The Plan Team then reviews the SAFE report and makes its own recommendation. The SSC then reviews the SAFE report and Plan Team recommendation, and makes its own recommendation to the Council. The Council then reviews the SAFE report, Plan Team recommendation, and SSC recommendation; then makes its own recommendation to the Secretary, with the constraint that the Council's recommended ABC cannot exceed the SSC's recommended ABC."

The NPFMC tier system is designed to be a precautionary system in which buffers are already in place to achieve a preferred degree of conservatism. Therefore the rationale for a reduction from the maximum permissible ABC should be that there is either additional uncertainty in the assessment and/or additional risks (probability of something bad happening) to the stock that are not adequately taken into account by the default precautionary settings. The risks generally relate to a loss of fishery sustainability and an inability of the stock to perform its role in a functioning ecosystem, such as might occur due to severe decline in stock abundance. This understanding of risk is consistent with how risk is understood in the context of ecological systems (e.g. see Holsman et al. 2017), and the concept is broader than just the uncertainty associated with the assessment, though of course assessment uncertainty is an important element of it.

For example, in 2006 a reduced ABC for EBS walleye pollock was justified in part due to an increase in biomass of juvenile pollock predators and an apparent lack of pollock prey (Zador et al., 2017). The SSC's intent is that setting the ABC below the maximum permissible should be applied sparingly and that the tier system should be regarded as the primary basis for establishing the ABC. It is also important to note that the sloping harvest control rule for the ABC will substantially reduce the target fishing mortality rate when the stock is at a low abundance. This reduction in the fishing mortality rate is intended to address the concerns related to low stock abundance.

In 2018, the NPFMC SSC recognized that the process of considering whether to reduce the ABC below the maximum permissible was a long-standing aspect of scientific advice that is provided to the NPFMC. However, the magnitude of the reduction and the criteria used to justify the reduction had not been standardized across groundfish species. The NPFMC SSC therefore encouraged the development of a more objective and rigorous process for considering ABC reductions that included a review of both stock assessment and ecosystem factors. In February 2018, the NPFMC SSC requested that a workshop be held to address the topic of adjustments made from the maximum permissible ABC, and asked for the identification of clear and transparent rules for defining the specific criteria to be used when adjusting the ABC.

To provide an overview of historical practice of recommending ABCs less than the maximum permissible, Thompson (2018) provided the workshop with a review of the annual stock assessments from 2003 to 2017 and identified all instances when the Plan Teams recommended setting the ABC below the maximum permissible (also see Discussion 3 this report). During the 15 years, the Plan Teams recommended setting ABC below the maximum permissible in a total of 76 instances (roughly five per year). Reasons varied but generally grouped around concerns regarding the stock assessment (e.g., uncertain survey estimates or parameter estimates), population dynamics (e.g., poor recruitment or declining biomass), or ecosystem considerations (e.g., predation pressure or bird die-offs, though reductions due to ecosystem considerations were relatively uncommon). In some cases, economic factors were cited, such as variability in yield or the amount of effort required to catch the ABC. The buffers ranged from less than 10% to greater than 90%, but were most often between 10% and 30%, with a mode at a buffer of 15%.

One shortcoming of the historical analysis is that documentation existed only when there was a recommended reduction. In some cases, an evaluation identified various concerns, but a reduction was not recommended because the conditions were regarded as not sufficiently extreme to warrant a reduction. In other cases, no evaluation was made. It was noted that one advantage to applying a framework consistently for all stocks was that it would establish a stock-specific record of concerns and issues with the assessment, population dynamics, and the ecosystem. There would be supporting documentation in situations where the maximum permissible ABC was considered scientifically appropriate. There are many stocks in the North Pacific with reliable stock assessments, are at healthy levels of abundance, and have no severe environmental/ecosystem concerns, and documentation of these cases is important for a balanced perspective.

In response to the 2018 workshop, an Ad Hoc working group was assigned to develop the risk table framework. At that time, the Ad Hoc working group recommended a framework that distinguishes between three types of considerations (assessment, population dynamics, and environmental/ecosystem). Within each type of consideration, there is a range of concern from level 1 (no concern) to 4 (the highest level of concern) (Table 1). As a standard part of the annual stock assessment process, assessment authors and ecosystem scientists assign risk levels by qualitatively evaluating each of the three types of considerations using available information that is not modeled analytically in the stock assessment model, but which might inform a decision on the ABC in the current year. This distinction is important to avoid double counting. Information in the risk table comes either from the assessment itself, in the case of assessment uncertainty and population dynamics or, in the case of environmental/ecosystem information, from two main sources: the ecosystem status report, and the species-specific ecosystem and socioeconomic profiles (ESP, Shotwell 2018, 2020) that are available for some North Pacific stocks. The ecosystem status reports contain a broad range of ecosystem indicators that reflect ecosystem-level processes. The ESPs contain ecosystem indicators that are linked to the stock through known mechanistic relationships. This information was combined to inform risk tables as part of the harvest specification process, with the caveat that indicators in the ecosystem status reports have to be interpreted with respect to the particular stock. In December 2018, SSC recommended adding a fishery performance column.

The initial risk levels are assigned by the assessment authors and included in the draft stock assessments. They are then reviewed and adjusted through the same annual review process as the stock assessment. The amount of any recommended reduction needs to be clearly stated along with the risk table, with an explanation of how this value was selected.

A timeline on the introduction and use of risk tables in the NPFMC harvest specification process is as follows:

- In October 2017, following the near collapse of GOA cod stock, SSC specified the need for a formal way to evaluate ecosystem conditions within the stock assessment. "*The SSC also recommends explicit consideration and documentation of ecosystem and stock assessment status for each stock … to aid in identifying stocks of concern.*"
- In summer of 2018 an Ad Hoc working group formed in response to an SSC request to develop a consistent approach to recommending ABC reductions
- Fall 2018: ABC adjustment workshop recommendations presented to Plan Team/SSC, draft risk tables developed for 5 stocks with assessment, population dynamics, and ecosystem columns.
- December 2018: SSC/AP/Council recommended that risk tables be done for all assessments in 2019: *"Additional environmental, ecosystem or other species specific biological concerns that the Plan Team identifies that are not addressed in the stock assessment model should be clearly documented and provided to the SSC for consideration...The Council supports the SSCs recommendation of adding a fishery performance column."* - Council motion Dec 2018.
- June 2019: SSC recommended that *"The combined efforts of developing ESPs for key species, the planned fall and spring meetings of the Ecosystem Status Report team to assess ecosystem change, and the development of risk tables should provide the information needed to inform the NPFMC of relevant ecosystem change...In addition, risk tables only need to be produced for groundfish assessments that are in a "full" year in the cycle."*
- Fall 2019: risk tables are completed for all full assessments, SSC recommends dropping the overall risk score and provides direct responses to ten requests raised by Plan Teams.
- December 2019: Council reiterated the dual purpose of the risk table *"...1) to facilitate further collaboration and communication among stock assessment scientists and those in other disciplines (for example, ecosystem and climate scientists) and 2) to increase transparency and consistency in the rationale for reducing from maximum permissible ABC based on exceptional risks/circumstances that are not already addressed in the stock assessment, tier system, and harvest control rules."*
- Fall 2020: risk tables completed for all full assessments, dedicated risk table workshop slated for the February 2021 SSC meeting and September 2021 Joint Plan Team meeting.

Synthesis of Stock Responses

In preparation for the workshop on risk tables, we collated the minutes from previous Plan Team, SSC, AP, and Council meetings regarding risk tables and their development from 2017 to 2020. These minutes were provided to the SSC prior to the start of the workshop (Shotwell, 2021). Additionally, each SAFE report that completed a risk table contains between two to twelve pages on risk table evaluation (not including the risk categories definition table). We generated a summary table of the risk table scores for the stocks that have completed risk tables from 2018 through 2020 (Table 2). To date, there have been fifty-three total risk tables completed, five in 2018, nineteen in 2019, and twenty-nine in 2020, indicating that the number of risk tables completed each year has increased since the introduction of the risk tables in 2018. Over that time, only six stocks have used the risk tables to reduce from maximum ABC, four in 2018, four in 2019 and three in 2020. Only two stocks (Alaska sablefish and EBS pollock) have proposed a reduction in all three years. There have also only been three stocks with levels greater than 2 (Alaska sablefish, GOA Pacific cod, and BSAI blackspotted and rougheye rockfish), and one (GOA Pacific cod) was downgraded by the SSC from a level 4 to a level 2. In contrast, there have been twenty-two stocks with all categories at level 1 and fourteen stocks with no reduction that had at least one level greater than a level 1. This summary demonstrates the rarity of reductions from maximum ABC using this tool.

Lessons Learned

After three years of implementing risk tables with stock assessments, there are some general lessons we have learned. First, using the standard risk table format whether or not a reduction was ultimately recommended has provided a level of transparency that did not exist with the previous ad-hoc method, where there was no way to compare one instance where a reduction was applied to another because rationales were specific to a stock. The succinct synopsis of concerns for multiple categories provided in risk tables has allowed stakeholders to easily compare concerns across stock assessments. Previously, such comparisons were more difficult as it required in-depth understanding of multiple stock assessments as both the types of concerns and levels of explanation provided varied among assessments. Anecdotally, this transparency has created some uncomfortable moments where stakeholders asked questions about apparent differences in responses to similar concerns across assessments that authors could not easily answer. We believe that the risk tables will facilitate research on these types of questions that may allow us to move towards standardizing maxABC reductions across assessments.

Second, risk tables have established a record of concerns that were considered in developing scientific recommendations, whether or not a reduction was recommended. Previously, concerns were not recorded if no reduction was recommended. Analysis of historical reductions as related to concerns could only be informed by data conditioned on there being a reduction, excluding the same concerns that existed for an assessment model but did not justify a reduction (“zeros”). Over time, these records will allow analysis of historical decision-making that can inform future decision-making.

A third benefit of developing risk tables is that the process of building the tables has fostered collaboration among assessment authors and ecosystem scientists. A process has developed that assigns at least one Ecosystem Point of Contact (POC) to each stock assessment. After meetings to exchange information gaps and needs, the Ecosystem POC compiles relevant information and text for the author to use as needed to complete their risk tables. Grouping meetings among stock assessments authors of stocks with similar life histories and using standardized categories of predators, prey, competitors, and environmental processes for ecosystem information supports further collaboration and knowledge-sharing. The previous ecosystem text within stock assessments varied among assessments in both breath and how often they were updated to address current state of knowledge. As ESPs are produced, they will replace the old ecosystem text. But risk tables will always be a record of the current state of knowledge, including information from ESPs and ESRs, to inform the current ABC.

A fourth benefit to the risk tables is that they can document unusual or unexpected observations that are not addressed in the stock assessment model. Recent phenomena such as marine heatwaves and changes in fish distribution have led to observations/data that assessment models cannot fit well. In these cases, having a standard place to record these observations—essentially caveats to the estimated maxABC—serves as a record of the best available science at the time of the assessment, which fisheries management relies upon. There is a lag inherent in the scientific process; observations/data need to be analyzed before relationships can be quantified and incorporated into stock assessment models. Usually, mechanistic relationships between environmental variables and biological responses are considered stationary. Thus, ignoring current observations that seem to indicate that underlying biophysical mechanistic relationships have changed (i.e., evidence of non-stationarity) could lead to inaccurate predictions. The documentation of unusual/unexpected observations in risk tables included in the stock assessments provide scientific context for future development of stock assessment models. This could be especially important in years when an assessment model is not fully updated. A risk table in a year without a full update could document concerns that did not exist when the stock assessment model was last fully updated. This would serve to be a transparent record of best available science, that over time could help to prioritize research, explain past decision-making, and other efforts to build trust in the robustness of our fisheries management process.

Challenges of producing risk tables have also come to light during the three years of their implementation. As mentioned above, the increased transparency and ease of comparing across assessments has highlighted some past inconsistencies across assessments in the level of response (i.e., amount of reduction from maxABC) to the level of concerns. There has been interest in having a standard reduction level in response to concerns. Risk tables provide the baseline data to inform research on the feasibility of developing standardized responses. It is also possible that the increased transparency of responses to concerns as summarized in risk tables may encourage communication among stock assessment authors and review bodies that would result in a shift over time to more consistent levels of response.

An additional set of challenges that have come to light are how to produce risk tables for bycatch/non-target stocks, stock complexes and Tier 5 and 6 stocks. The question arose as to whether it is appropriate to provide justification for or against reduction against maxABC (i.e., complete a risk table) when the stock is not targeted or caught only as bycatch. In this case, concerns would be relative to the overall impact of the maxABC on the stock, even if it is known that the catch will not approach the final ABC. Producing risk tables for stock complexes was challenging due to a number of factors related to the differences in the amount of scientific knowledge for individual species within the complex. One strategy included focusing on a single species in the risk table to represent the complex, such as Dover sole in the GOA deepwater flatfish stock assessment. Similarly, producing risk tables for Tier 5 and Tier 6 stocks were challenged by both the limited amount of scientific knowledge of the stock and the discontinuity between the ABC and the catch.

Discussions have also taken place about how to know which information goes into which column of the risk tables. For example, heatwave-level temperatures could lead to below average survival of larval/age-0 fish, which is a population dynamics concern. However, heatwave-level temperatures could also have a negative impact on prey availability for all age-classes in that same stock. This would be an environmental/ecosystem concern. Is having the same temperature time series noted in two risk table columns double-counting? The concern about double-counting is based upon an assumption that having variables listed multiple times would artificially elevate the importance of that variable. However, an alternate explanation is that if that variable has impacts in more than one distinct aspect of a fish stock's structure and dynamics as intended to be modelled well in the stock assessment model, then the variable can be listed in multiple columns. This type of double-counting is distinct from the double-counting that is explicitly not allowed for something that is already addressed in the stock assessment model. For example, in the pilot year for risk tables, the GOA Pacific cod risk table included the heatwave as part of an overall level 4 ecosystem concern on the stock size. However, as the precipitous decline in stock size was already captured by the stock assessment model, the level of concern was downgraded to a 2.

Discussion and Questions to Consider

The SSC has provided guidance on the use of risk tables several times during the last several years (see collated minutes). In some cases, this guidance has altered the responsibilities of assessment authors and Plan Teams, and it is important to consider the implications of these changes. The first issue is whether assessment authors and Plan Teams should feel bound to provide a recommendation on an ABC reduction when the risk table indicates an increased concern. The SSC minutes of December 2018 advised that the author and Plan Team do not have to recommend a specific ABC reduction, but should provide a complete evaluation to allow the SSC to come up with a recommendation. Although the FMPs for groundfish do give assessment authors and the Plan Team a role in making ABC recommendations, authors may prefer to avoid making non-model based recommendations and defer this role to the SSC. *Does the SSC have the desire and capacity to take on this larger role? Does the SSC depend on authors and Plan Teams to generate options for consideration, even if the SSC chooses a different course?*

A second related issue is whether an increased risk requires a reduction in ABC. The SSC minutes of December 2019 advised that adjustment from maxABC in response to levels of concern should be left to the discretion of the author, the Plan Team, and/or the SSC, but should not be mandated by the inclusion of a >1 level in any particular category. The stated purpose of the risk table to support a decision whether or not a reduction in the maximum permissible is needed. *What is the intended message if the table is filled out appropriately, and an increased risk is identified, but no reductions are recommended? That increased risk does not matter?* In several cases, authors decided not to recommend an adjustment in the ABC when recent catches were far below the ABC, since there was nothing that would be accomplished by a reduction in the ABC. Some guidance on this situation may be helpful since finding a defensible basis for an ABC reduction can be difficult and time consuming.

The section leads provided a series of question prompts at the end of the presentation for discussion in the breakout groups. Many of these questions are related to issues described above. Responses to these prompts are embedded in the reports from the break out groups.

- *How to distinguish double-counting robustly?*
- *How to weigh multiple time series indicators?*
- *How to choose the level value? Current descriptions are not clear enough. How to balance prescriptive rules with new information?*
- *Can the same data be interpreted two ways or is this double counting?*
- *Is there value to adding an "unknown" level?*
- *Should we keep risk tables for tier 1-3 stocks only? Non-targets?*
- *Should there be an overall score? If so, how to weigh across categories?*
- *Should PT/SSC provide explicit risk scores and justifications? When?*

Discussion 2: Frameworks for Addressing Uncertainty and Risk

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Genesis of the Tier System

The groundfish tier system is used by the NPFMC to specify the OFL and ABC for stocks and stock complexes in the groundfish fisheries management plans for the Bering Sea and Aleutian Islands and the Gulf of Alaska. The groundfish tiers range from one to six and are structured according to the availability of information about the stock, and the ability to reliably estimate management quantities such as maximum sustainable yield (MSY) and stock-recruit relationships (Table 1). Most stocks with age-structured assessments are in tier 3, where the OFL and ABC are calculated using proxies for the MSY fishing mortality rate based on spawning biomass per recruit.

The tier system was developed during the period 1992-1996 when there were many iterations of early versions of the system. There was robust discussion between the plan teams and the SSC about harvest strategies, and controversies over appropriate limit and target fishing mortality reference points, and over appropriate proxies for FMSY and BMSY. Papers by Clark (1991, 1993) were extremely influential in shaping the tier system. The current groundfish tier system in its present form dates from 1999. A structured approach for providing management advice that deals with availability of information and assessments of different types was, at the time, a novel approach, and one that served as a template for national guidance in the development of harvest strategies. In addition, application of the tier system by the NPFMC over the past twenty years has proven successful in maintaining productive fisheries in the North Pacific that are widely recognized both nationally and internationally as examples of sustainably managed fisheries.

The reauthorization of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) in 2006 changed the requirements for how management actions are developed for U.S. fisheries. Councils were required to set annual catch limits (ACLs) for all managed stocks that are "in the fishery." National Standard Guidelines developed to assist in the implementation of the reauthorized act (Federal Register, 2009) defines two sources of uncertainty that must be considered when establishing ACLs: 1) scientific uncertainty, including error pertaining to both the data and to parameter estimation; and 2) management uncertainty, which represents uncertainty in the efficacy of management practices that are designed to ensure that harvest limits are not exceeded (Figure 1).

As stated in the National Standard 1 guidelines, *"The Acceptable biological catch (ABC) is defined as the level of a stock or stock complex's annual catch that accounts for the scientific uncertainty in the estimate of OFL and any other scientific uncertainty, and should be specified based on the ABC control rule.…NMFS believes that determining the level of scientific uncertainty is not a matter of policy and is a technical matter best determined by stock assessment scientists as reviewed by peer review processes and SSCs. Determining the acceptable level of risk of overfishing that results from scientific uncertainty is the policy issue. The SSC must recommend an ABC to the Council after the Council advises the SSC what* *would be the acceptable probability that a catch equal to the ABC would result in overfishing."* (Federal Register, 2009).

Although the National Standard 1 Guidelines adopted the terminology used in the tier system, the ABC and the OFL were given new definitions with a broader understanding of scientific uncertainty than was originally envisioned in the tier system. The new definitions are most consistent in tier 1, where the buffer between OFL and the ABC control rules varies directly with the amount of scientific uncertainty. However, in general the primary type of uncertainty addressed in the tier system is the uncertainty in the stock production curve (i.e., the shape of the stock recruit relationship). This is true for tier 1, tier 3, and tier 5, all of which have an OFL/ABC calculation based on FMSY or proxies thereof. Currently, ABCs are calculated using the point estimate of stock size (usually the MLE). For tiers (1-5), if a reliable pdf of B is available, the preferred point estimate is the geometric mean of its pdf, but this use of this provision is currently limited to tier 1 stocks. Thus, for most stocks, the estimate of the buffer between ABC and OFL for a given tier does not vary in response to changes in the uncertainty in stock size and/or status. At the time, there was recognition that this was a potential shortcoming, but it was considered preferable to grandfather in the tier system under the new MSA requirements, with the understanding that any potential issues could be addressed at some later time.

What additional role do risk tables accomplish?

The NPFMC tier system uses the buffer between the OFL and ABC to implement precautionary management. As the SSC has repeatedly emphasized, the SSC's intent is that the tier system should be regarded as the primary basis for establishing the ABC. The sloping harvest control rule for the ABC will substantially reduce the harvest rate when the stock is at a low abundance, and provide a built-in response to concerns related to low stock abundance. The risk table evaluates whether there is either additional uncertainty in the assessment and/or additional risks (probability of something bad happening) to the stock that are not adequately taken into account by the default precautionary settings. The risks generally relate to a loss of fishery sustainability and an inability of the stock to perform its role in a functioning ecosystem, such as might occur due to severe decline in stock abundance. One challenge to application of the risk table is that the tier system focuses primarily on uncertainty in the productive capacity of the stock, as discussed above. Consequently, there is no clear guidance on how other kinds of scientific uncertainty should be taken into account, or how concerns related to the ecosystem and environment are intended to be dealt with in the management system.

Development and application of the P-star approach to account for scientific uncertainty in setting the ABC (Shertzer et al. 2008)

A P-star (P*) approach has been adopted by other Councils, including the Pacific Fishery Management Council (Ralston et al. 2010) and Mid-Atlantic Fishery Management Council to deal with Magnuson-Stevens Fishery Conservation and Management Act (MSA) requirements to account for scientific uncertainty. A P-star approach has also been used by the NPFMC for crab harvest specification, though SSC routinely reduces the ABC from the values obtained by the P-star approach.

Briefly, the implementation of the P-star approach requires input from both the SSC and Council. SSC adopts or specifies some level of uncertainty (sigma) (usually uncertainty in the OFL, but uncertainty of ending biomass is also used). The Council specifies its P-star value, which is the acceptable probability of exceeding the OFL, which needs to be less than 0.5 to be in compliance with National Standard Guidelines. These two assumptions, along with an assumption about the form of a probability density function, usually lognormal, produces a unique result for the buffer between OFL and ABC (Figure 2).

The approach taken by the SSC of the Pacific Fishery Management Council was to quantify scientific uncertainty by using variation between repeated assessment or between assessment variation (Figure 3). Ralston et al. (2009) estimated the coefficient of variation (CV) of the among-assessment variation in estimates of historical biomass, based on 81 assessments of 15 groundfish and 2 coastal pelagic stocks. Since there seemed to be similar levels of variability for the different stocks, an overall sigma of 0.36 was applied (with the proviso that if estimated uncertainty in ending year was larger than a CV of 0.36 the actual value would be used)

In an approach similar to the NPFMC tier system, PFMC stocks are grouped according to three stock categories:

Category 1: Data rich, Age/size structured assessment with year-class estimation.

Category 2: Data moderate, Aggregate production model, M*survey biomass, year classes not resolved, or highly uncertain category 1 assessment.

Category 3: Data poor. Average catch assessment.

Since the derivation of sigma used only category 1 stocks, the default sigma was used only for those stocks. For category 2 stock a sigma of 0.72 (i.e., twice the sigma for category 1 stock) was used, while for category 3 stocks, a sigma of 1.44 (i.e., four times the sigma for category 1 stocks) was used. While the approach for category 2 and category 3 stocks is somewhat arbitrary, assessments for those stocks clearly have greater uncertainty than category 1 stocks, so this approach is logically consistent and has the outcome of more precautionary management for stocks whose assessments are regarded as being more uncertain. SSC also informed the Council that any P-star greater than 0.45 as would not be considered a meaningful response to MSA mandate to account for scientific uncertainty in setting the ABC. The Council adopted a P* = 0.45 for all category 1 assessments, and P* = 0.40 for category 2 and 3 assessments.

There have been several recent refinements to the P-star approach used by PFMC. The first refinement was to base sigma on uncertainty in the projected OFL instead of ending year biomass (Privitera-Johnson and Punt 2020). This resulted in a new sigma of 0.50. The second refinement was to account for the number of years since the assessment (Wetzel and Hamel 2019). Assessments for many West Coast stocks are done infrequently, so therefore it was considered important to account for the increased uncertainty as assessments become progressively less indicative of current status. While both of these refinements are clear technical improvements in the treatment of uncertainty, the consequence is the buffer between the OFL and the ABC has become progressively larger given the same Council decision on P-star (Figure 4). As might be expected, this ratcheting effect was not welcomed by the fishery managers on the Council. Furthermore, there are still sources of uncertainty that are not adequately addressed by current stock assessment approaches, so additional increases in the buffer could occur as the scientific community develops techniques for a more comprehensive evaluation of uncertainty.

The SSC of the Mid-Atlantic Council has also used a P-star approach to account for scientific uncertainty and make ABC recommendations. The SSC developed a framework table similar to the risk table in which assessments are evaluated according to nine criteria and are assigned to one of three categories on a spectrum of good to poor assessment performance for each of the nine criteria (Table 2). Each of the three categories has a default CV (or sigma) value associated with it, ranging from 0.6 for the “good” assessments to 1.5 for the “poor” assessments. These CV values were loosely based on simulation results, MSE evaluations, and expert judgement. One notable feature of the framework is that no overall scoring is done. The SSC reaches a consensus on the overall classification of the stock into one of the three categories, which is then used by the Council’s P-star strategy to provide the buffer between the OFL and the ABC.

There are several distinguishing features of these applications of the P-star approach in the Council process. First is that applying the approach requires strong engagement of both the SSC and Council, where SSC provides an approach to characterize assessment uncertainty, and the Council decides on a risk policy by choosing a P-star. This type of decision is foreign to the usual gamut of Council actions, and typically some education and guidance is needed to get the Council up to speed on risk and uncertainty. Another feature is that the approach to characterizing uncertainty tends to be a mix of technical analysis and expert judgement, reflecting both the complexity of the problem, and the incompleteness of current scientific approaches. A final observation is that the SSCs for PMFC and MAFMC (like the NPFMC SSC) are review bodies whose principal role is to review analyses used to support fisheries management decision-making by the Council. However, in both examples presented here, the SSCs took the lead in developing their approach to consider scientific uncertainty in setting the ABC, which is defined as a critical role of the SSC in reauthorized MSA.

Discussion 3: Quantifying the importance of assessment risk

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The SSC Workshop on Risk Tables included separate presentations for each column of the risk table, with a particular focus on *quantifying* the importance of the risks associated with that column. This section of the report summarizes the presentation for the "assessment" column of the risk table.

Enumerating the risk factors

To begin the process of understanding how risks associated with the assessment column are currently quantified, the most recent versions of the risk tables for BSAI groundfish assessments were examined in detail. A total of 23 BSAI groundfish assessments have presented a risk table at least once. Of those, the most recent version for 21 assessments appears in the 2020 SAFE Report, while the most recent version for the other two (Alaska plaice and northern rockfish) appears in the 2019 SAFE report.

Of these 23 tables, the risk "levels" for the assessment column were distributed as follows: two tables assigned a level of 3 (sablefish and blackspotted/rougheye rockfish), five tables assigned a level of 2 (northern rock sole, Pacific ocean perch, northern rockfish, other rockfish, and sharks), and the remaining 16 tables assigned a level of 1. There was almost no correlation between risk level and harvest control rule tier ($\rho = -0.044$), suggesting, perhaps, that authors were basing their assignments of risk level primarily on either: 1) previous versions of the same assessment, or 2) assessments of other stocks or stock complexes within the same tier.

Each determination of risk level is accompanied by a rationale supplied by the assessment author, and each rationale lists one or more risk factors that contributed to the author's determination. For this exercise, an overall list of risk factors was compiled from the 23 most recent risk tables. Risk factors that appeared to be essentially similar were grouped together. (It should be noted that this involved a degree of subjectivity as to what constituted "essentially similar," meaning that different analysts could easily have arrived at a somewhat different final list of risk factors.) Given that level 1 is defined in the risk table template as being the "normal" level of risk, the risk factors listed by the authors were divided into those that tended to favor a "normal" level of risk (i.e., level = 1), and those that tended to favor a higher level of risk. For ease of reference, the former were termed "positive" risk factors (lower risk) and the latter were termed "negative" risk factors (higher risk).

Twenty-five positive risk factors were identified, while 23 negative risk factors were identified. Table 5 shows the 10 positive risk factors that were listed more than once, and Table 6 shows the 10 negative risk factors that were listed more than once.

Tangible steps toward quantifying risk

The SSC offered the following guidance for the 2018 Groundfish Plan Team workshop that ultimately led to the development of the risk table:

- "The SSC recommends identification of clear and transparent rules for defining the specific criteria to be used when adjusting the recommended ABC." (SSC minutes, February 2018)

In an attempt to satisfy the above recommendation, Thompson (2018) suggested that a multivariate logistic equation could be used to determine an appropriate proportional reduction in ABC:

$$reduction = 2\left(1+\exp\left(-\sum_{var=1}^{nvar} x_{var}\beta_{var}\right)\right)^{-1} - 1\,,$$

where **x** is a vector, each element of which is either 0 or 1, indicating whether the risk factor corresponding to that element applies in a particular assessment; and **β** is a vector of non-negative coefficients.

Thompson (2018) tabulated the set of *nfac* (=32) risk factors that had been identified by the respective Groundfish Plan Team for the *nobs* (=76) cases where an ABC reduction was recommended during the period 2003-2017 (a period that predates use of the risk table). For each of the *nobs* observed reductions, he then created a vector **x** by tallying whether each of the *nfac* risk factors was mentioned in the context of that observed reduction, and then combined those into an *nfac* × *nobs* matrix **X**. Finally, he fit **β** to the *nobs* proportional reductions by a constrained least squares approach (i.e., constrained to prevent any element of **β** from becoming negative). The resulting fit gave an R^2 of 0.824, just slightly lower than the value obtained by an unconstrained least squares fit (0.826).

However, further development of this approach was suspended upon recommendation of the SSC:

- "Although it provided a valuable historical perspective, **the SSC recommends not pursuing this analysis further.**" (SSC minutes, October 2018 (emphasis original))
- "Although helpful in developing this process so far, further summary of historical ABC reductions is likely not the best avenue for development of ranges of ABC reduction appropriate for each of the three concern levels." (SSC minutes, December 2018)

Nevertheless, in view of the possibility that the SSC might be open to reconsidering the above recommendations, some initial steps toward updating Thompson's (2018) analysis were undertaken for the purpose of the present exercise. Cursory examination of the risk factors and their relationships to risk levels specified on the basis of the 23 current BSAI groundfish risk tables suggested that the difference between the numbers of positive and negative risk factors might have a substantial amount of explanatory power. The average number of positive risk factors listed in the 23 tables was 2.783, with a range of 0 – 7, while the average number of negative risk factors listed in the 23 tables was 2.261, also with a range of 0 – 7. Of the individual risk factors, the presence of a large retrospective bias appeared to be highly correlated with risk level. A simple linear regression of risk level against the negative-minus-positive difference (x_1) and the presence of a large retrospective bias (x_2) yielded the following model:

$$level = 1.328 + 0.090x_1 + 1.267x_2$$

This model gave an R^2 of 0.721, which might be considered promising for a very simple initial attempt, suggesting that further modeling efforts could be worthwhile.

<u>*Internalizing structural uncertainty in the assessment*</u>

The SSC has previously noted that there are at least two ways to address structural uncertainty in the assessment, one of which is to use the risk table (referred to as "this tool" in the following excerpt), and another of which is to use ensemble modeling:

- "Reductions from the maximum ABC are made in response to factors not included in the Tier system. Therefore, the most preferable solution to avoid invoking this tool is to find quantitative ways to include these uncertainties in the assessment analyses.... Ensemble modelling may also provide a tool for this task." (SSC minutes, December 2018)

Use of the risk table to account for structural uncertainty in the assessment might proceed according to the following algorithm:

1. Run *n* models.
2. Choose a preferred model.
3. Note that, because the *n* models imply *n* different ABCs, the preferred model does not account for structural uncertainty.
4. Raise the risk score for the assessment category accordingly.
5. After considering all four risk categories, (perhaps) recommend an *ad hoc* reduction from the maxABC implied by the preferred model.

Use of ensemble modeling to internalize structural uncertainty in the assessment might proceed according to the following algorithm:

1. Run *n* models.
2. Choose a set of model weights.
3. Create an ensemble model as the weighted average of the *n* models.
4. Recommend no reduction from the maxABC implied by the ensemble.

Note that both approaches involve subjective elements: specification of risk level in the former, and specification of model weights in the latter. However, once those have been specified, the ensemble approach is completely objective and transparent, but the risk table approach (at least as typically implemented) is neither.

Both approaches also require selection of a set of models to run. However, this selection is more critical in the ensemble approach than in the risk table approach, because only the "best" model has a direct impact on ABC in the risk table approach, but *all* models have a direct impact on ABC in the ensemble approach. Because of this, when using an ensemble approach, special care should be taken to avoid "stacking the deck." Stacking the deck occurs when the ensemble includes multiple models that might be expected to result in ABC values that satisfy some (presumably subconscious) bias on the part of the assessment scientist or other participant(s) in the assessment process. Using a factorial design to create an ensemble can help to avoid stacking the deck. Some possible factors in such a design include the following:

- Data selection, for example:
    - Choice of data sets
    - Choice of data weighting
- Parameterization, for example:
    - Choice of functional forms
    - Choice of fixed parameter values

- Model complexity, for example:
  - Number of free parameters
  - Number of constrained time-varying parameters

Double counting in the assessment category

The SSC has been clear that factors used to determine risk levels should not include those already incorporated into either the assessment model or the harvest control rules:

- "Reductions from the maximum ABC are an infrequent action prompted by extraordinary circumstances, or considerable uncertainty, in an attempt to respond to substantial unquantified risk. Importantly, adjustments from the maximum ABC are based on uncertainty and risk that is not already accounted for in the tier-system approach to reducing the maximum ABC relative to the OFL; these should not overlap." (SSC minutes, October 2018)
- "Recalling the October 2018 report on this topic, the SSC reiterated that reductions from the maximum ABC are intended to be an infrequent action to respond to substantial unquantified risk. Adjustments from the maximum ABC are used to address uncertainty and risk that is not already accounted for via the Tier system and associated harvest control rules." (SSC minutes, December 2018)

Nevertheless, a review of the current risk tables and the associated Groundfish Plan Team discussions suggests that, in practice, some ambiguities remain when it comes to the potential for "double counting" in the assessment column of the risk table. Broadly speaking, two categories of risk factors that continue to be listed in the assessment column of the risk table are:

1. Signals in the data that are being fitted by the model.
   - Example (paraphrased): "The survey biomass data show a downward trend, so the assessment risk level should go up."
2. Uncertainties in the data that are incorporated in the fitting process.
   - Example (paraphrased): "The variances associated with the survey biomass data are large, so the assessment risk level should go up."

With respect to the potential for double counting, the Groundfish Plan Teams often address risk factors such as those listed above by considering whether the information *is already used by the assessment model or harvest control rule when estimating maxABC*. By this criterion, inclusion of either of the above in determining the risk level for the assessment column would appear to constitute double counting.

However, perhaps a more relevant criterion is whether the information *suggests that the ABC should be less than the estimate of maxABC obtained by the model and harvest control rule*. By this criterion, item #1 above would still constitute double counting, but item #2 might not.

Discussion 4: Population Dynamics Risk

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The population category of the risk table considers whether there is additional risk to the stock based on population dynamics considerations, which are not typically included in stock assessments or the NPFMC harvest control rule. Dorn and Zador (2020) identified some of these considerations, including decreasing biomass trends, poor recent recruitments, inability of the stock to rebuild, abrupt increase or decrease in stock abundance, and other unusual changes in stock age structure or recruitment patterns. Although these guidelines represent an adequate starting point, several issues merit further consideration to improve risk table development: 1) incorporating and extending the population dynamics category to include additional factors (e.g., spatial considerations); 2) addressing risk for data-limited and non-target species; 3) evaluating "double-counting" of risk across risk table categories; and 4) development of quantitative methods to translate risk scores into ABC reductions. Here, we review the cases (i.e., species and circumstances) for which elevated population dynamics risk scores were identified, discuss alternate population dynamics factors that warrant consideration in future risk table development, and highlight broader cross-category risk table issues that require more explicit guidance.

Overall, a total of eight NPFMC managed fish species or species groups were identified as having been assigned elevated population dynamics risk table scores. The factors resulting in heightened risk scores varied widely, but were generally based on the main factors highlighted in Dorn and Zador (2020). For instance, variable and uncertain recruitment, potential changes in growth or condition due to density-dependent effects, reductions or uncertainty in biomass, erosion of age diversity, and low productivity were commonly identified as reasons for heightened scores. Of these eight species, the stock assessment author suggested reductions from the maximum permissible ABC allowed under the NPFMC harvest control rule for only two species, Alaska-wide sablefish and Eastern Bering Sea pollock. Reasons for not suggesting reductions in ABC varied, often depending on the data availability, productivity of the species, and fishery type. For instance, for many data-poor species (e.g., BSAI and GOA sharks, GOA Atka mackerel) authors suggested that ABC reductions were not likely warranted until improved data could be collected or associated stock assessment methods could be improved. In these cases, the uncertainty in the underlying data was sufficiently large to preclude any recommendation for departing from the ABC specified by the harvest control rule. The 2019 Atka Mackerel assessment characterized the population risk as "unknown", and this would be a useful designation for similar situations in the future. GOA Pacific Ocean Perch met some of the considerations specified by Dorn and Zador (i.e., "abrupt increase or decrease in stock abundance"); however, a reduction in ABC was not recommended because survey biomass estimates were at time series highs and the assessment was thought to underestimate biomass. For other species where harvest is taken as bycatch, lowering the ABC was viewed as having little impact on catch levels. In the NPFMC system, once the ABC is attained, directed fishing is typically prevented and incidental catch is discarded. Although population risks are recognized in recent BSAI blackspotted and rougheye rockfish and GOA Pacific cod assessments, both of these species were bycatch species (for Pacific cod the abundance was reduced such that no directed fishing was allowed for some recent years), and lowering the ABC would not affect the level of incidental catch. When ABC reductions were suggested, they tended to be dramatic (e.g., 43% for EBS pollock and 57% for sablefish). In both cases, high recruitment variability and 'peculiarities' (e.g., gaps or unevenness) in the age structure were cited as reasons to warrant more precautionary management approaches; both factors, but particularly spasmodic recruitment, have been demonstrated to cause issues with traditional harvest control rules leading to overly optimistic ABCs and subsequent population declines (Licandeo et al., 2020).

However, the relatively limited number of species with elevated population dynamics risk scores may be attributed to the moderately limited scope of the factors initially identified for consideration under the population dynamics category. Although downward or atypical trends and uncertainty in biomass, abundance, or recruitment are important indicators of population health that merit careful monitoring, a wide variety of alternate factors should also be considered. For instance, expansion of the population risk category to include spatial considerations is warranted. For example, the stock may expand or contract their range or change their level of spatial aggregation, which could affect their exposure to fishery effort and/or environmental conditions. For many stocks, changes in spatial distributions should be evaluated by age due to ontogenetic patterns in habitat use. Indicators of stock status are based on spatially-aggregated indices, and may mask disproportionate patterns in sub-area exploitation rates and localized depletion. These types of spatial changes in fishery targeting and availability, or stock distribution, could potentially occur abruptly, leading to interannual changes in risk evaluation. Finally, stock boundaries that are inconsistent with the spatial stock structure could increase the risk of local depletion or overfishing, and would not be indicated by the current risk table. Similarly, the risk category should also be expanded to include some useful metrics of population health based on age truncation. For example, diversity of age structure is an important indicator of population health, which can be severely altered by fishing pressure (Barnett et al., 2017), as it is undesirable for relatively long-lived stocks to have the bulk of their population concentrated into a small number of age classes (Spencer et al., 2014). Simple metrics such as the Shannon-Weiner (Shannon, 1948) index can be easily calculated and can be compared over time. Interpretation of such metrics would be enhanced by a fuller understanding of the importance to age-structure diversity for particular stocks or life-history patterns, including information on reproductive biology, recruitment, and portfolio effects.

Additionally, data limited and/or non-target species present a conundrum for the general use of the risk table approach, which is especially apparent within the population dynamics category. As noted, many stock assessment authors have suggested that reductions in ABCs are not necessarily warranted based on increased population dynamics risk scores, because the ABC reduction would either not effectively limit the fishery (i.e., for bycatch or incidental catch species) or not enough information was available to make a well-informed decision regarding population dynamics (e.g., biomass trends for data limited species). For extremely data-limited species (e.g., NPFMC tier 6 species), the risk table approach may not be warranted or informative, because there simply is not enough information to score the various risk categories. However, for data limited species for which basic population trend (e.g., survey abundance) information is available, then a basic risk table can likely be useful, but scoring may need to be refined based on more coarse knowledge (e.g., basing population dynamics scores on biomass trends and general understanding of productivity levels rather than stock assessment based estimates of recruitment). For non-target species, novel application of risk table scores may be warranted outside of the traditional adjustment to the ABC. In addition to the potential ineffectiveness of an ABC reduction for limiting incidental bycatch, for some stocks the realized catches are substantially lower than the ABC, which would also limit the utility of lowering the ABC. There is no clear consensus on how risk table scores might improve management of bycatch and/or data-poor stocks, but potential options could include increasing implementation of spatiotemporal area or fishery closures to reduce bycatch. However, it may still be useful to suggest lower ABCs in the case of bycatch or incidentally caught species with elevated population dynamics risk scores, because it may increase awareness regarding the potential negative impacts of comparatively higher ABCs on these species even though reduced ABCs may not have any tangible impact on the realized catch.

The risk table approach was implemented by the NPFMC to identify factors that may increase the risk of overfishing, which are not directly accounted for in the stock assessment or harvest control rule. As a relatively new approach to aid management decision making, there remain a number of issues that have yet to be fully resolved. Although not necessarily unique to the population dynamics category, the lack of a quantitative framework to translate risk table scores into ABC reductions and the potential impact of double counting across risk table categories represent important factors that often influence stock assessment authors' scoring of the population dynamics category. By necessity, risk table scoring is currently subjective and varies across assessment authors as well as across review and management bodies (e.g., the Plan Teams, SSC, and Council). As a qualitative tool to identify areas of increased concern for a species, risk tables are extremely valuable. However, without a general framework to translate risk table scores into quantified ABC reductions and/or a methodology to objectively rank category scores across species, it becomes increasingly hard for authors to justify a given set of risk table scores in relation to a suggested ABC reduction. The issue of ‘double counting’ factors of concern (i.e., accounting for a single issue under separate risk table categories) can also be viewed as both a positive and negative of the risk table approach. Much of the information on population-level attributes is obtained from assessment models, which have some degree of estimation error and model misspecification; thus, it can be difficult to tease apart population risk from assessment risk. Addressing the same issue under multiple categories can lead to inflated scores across categories and might lead to a larger ABC reduction than may be necessary. Conversely, from a qualitative perspective, emphasizing important issues across categories can help highlight the most important factors that may be detrimental to the population. Although a completely prescriptive approach to risk table scoring is not necessary or warranted, more complete guidance (i.e., on how to deal with cross-category factors and how to determine ABC reductions based on risk table scores) could help improve consistency across species, as well as within assessments, as inevitable stock assessment author turnover occurs.

Identifying factors that may increase the risk of overfishing is necessarily an iterative process, which is refined as new data is collected and knowledge synthesized. Necessarily, the risk table process must also be iterative and continually refined. In the case of the population dynamics category, we suggest that stock assessment authors should expand the factors considered to include spatiotemporal dynamics including expansion, contraction, and/or localized depletion, while also better emphasizing the importance of age diversity for healthy populations. More generally, expanding the risk table approach to include alternate management responses, aside from ABC reductions, when elevated scores are given is also warranted in the case of non-target species for which ABCs rarely limit harvest. Similarly, methods are needed to aid in objectively assigning ABC reductions when heightened risk table scores exist. For instance, a more formal approach to implementing alternate projections to account for demographic or recruitment uncertainty could guide bounds on ABC reductions (e.g., in the case of highly variable recruitment, an average recruitment projection could provide guidance on upper or lower bounds on ABC). As the risk table approach matures in the coming years, continued guidance to ensure consistency and objectivity within and across categories, species, authors, and management bodies will be helpful.

Discussion 5: tangible steps towards quantifying risk of external changes in ecosystem conditions

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Introduction

The ecosystem conditions category of the risk table considers whether there is additional risk to the stock based on environmental or ecosystem conditions that are not included in the main stock assessment. These conditions may include adverse trends in predators, prey, competitors, and environmental processes as reflected in environmental/ecosystem indicators, ecosystem model results, and empirical observations (e.g., survey or satellite data). Dorn and Zador (2020) state that the environmental/ecosystem considerations will usually be based on indicators that track environmental or ecosystem properties that are regarded as important to the stock because of a plausible ecological connection. They also suggest that the indicators could be species-specific or ecosystem-wide, could include direct forcing variables that have been linked to the population dynamics of the stock, or indirect indicators that inform a population process.

The ESR and the ESP reports are the two main sources of information to fill out the ecosystem category of the risk tables. The Alaska groundfish stock assessment authors first started completing the risk tables in 2018 and at that time, only five stocks conducted the risk tables. At that point, only the sablefish assessment had a completed ESP to reference. The other stock assessment authors consulted with the ESR editors regarding ecosystem conditions to fill out the risk tables. In 2019, the GOA pollock ESP was added and at least one of the ESR editors was assigned as a Point of Contact for each full stock assessment that was slated to complete a risk table. Finally, in 2020, the GOA and EBS Pacific cod ESPs were completed and the ESR editors created a standardized template to help with completing the risk tables. This template consisted of four main categories (predators, prey, competitors, and environmental processes) to help organize the ecosystem-level data from the ESR and describe adverse trends in the four categories (Figure 5). Additionally, ESP teams now include at least one ESR representative. This helps to avoid redundancy in the contributions of the ESRs and ESPs to the risk tables for each stock.

Review of Current Risk Table Ecosystem Levels

Over the three years of conducting risk tables at the NPFMC, sixteen risk tables from nine stocks were assigned an elevated ecosystem risk table score. The elevated score was to level 2 in all cases and did not always result in a reduction. The stocks with elevated ecosystem levels and an associated reduction were usually data-rich stocks with several species-specific indicators developed for reference. Generally, there was also another category elevated (typically the population dynamics category) for stocks where an ABC reduction was recommended. This occurred in nine risk tables from four stocks (Alaska sablefish, EBS pollock, GOA pollock, and GOA Pacific cod). The exception to this was EBS Pacific cod in 2019 where only the ecosystem category was elevated, and the SSC adopted the ensemble model as a means to reduce from max ABC. Three stocks had elevated ecosystem levels that did not result in an ABC reduction (BSAI Greenland turbot, BSAI northern rockfish, and GOA arrowtooth flounder). The elevated level was related to uncertain recruitment, shifts in the cold pool extent, poor condition of the fish, and lack of forage due to heatwave conditions. Two stocks (GOA pollock and GOA dusky rockfish) had recommended ABC reductions but did not have elevated ecosystem scores, citing that the indicators were mixed but conditions were better than the previous year or that there was limited survey information (e.g., due to COVID-19). The majority of risk tables (37 of 53 or 70%) did not have elevated ecosystem levels and provided descriptions of the four categories in the template with a mix of signals.

Suggestions on New Approaches for the Ecosystem Category

The risk tables have evolved since their inception at the NPFMC in 2017; information that is now included in the ecosystem category has benefitted from two major elements, consistency and coordination. The four category template was instrumental in ensuring that the main pressures on a stock were all considered and thus enabled consistency among stocks in their ecosystem sections. The coordination among the stock assessment authors, the ESR editors, and the ESP teams has allowed for a more refined stock-specific selection of indicators for evaluation in the risk table and increased collaboration between scientists of different disciplines. In addition to the ESRs and ESPs, there are perhaps several other sources of information that could inform the ecosystem category. For instance, output from more complex multi-species or ecosystem models (e.g., closed life cycle Individual Based Models, CEATTLE, ecopath with ecosim, Atlantis, FEAST) may be helpful for identifying relevant predator/prey relationships and point to additional indicators to monitor for a given stock. Ocean modeling is now becoming more operational (e.g., ROMS, NPZ) and when combined with observations from ecosystem process studies, could increase in skill level to allow for indicator development at multiple temporal and spatial scales. This could allow further exploration of indicator importance methods and ecosystem research models that may inform the risk tables on a more quantitative level. These models could provide estimates of the direction and magnitude of the effect on the stock as well as an estimate of the unaccounted for uncertainty in the main stock assessment model. The ESP process is also evolving concurrently with the risk tables. The guideline criteria for indicator selection for an ESP and subsequent potential use within the research ecosystem model could very well be used to weight indicators for use in the risk table. This would assist in stabilizing the subjectiveness of author scoring and potentially the level of reduction if warranted.

Issues to Address in Future Risk Tables

As with the other risk table categories, there remain several unresolved issues on how to create and score the ecosystem category in the risk table for a given stock. Double counting remains an issue. As mentioned previously, multiple risk table categories may reference a single indicator (e.g., the marine heatwave) and this may cause concern that the multiple instances may artificially elevate the importance of the indicator. However, the standardized ESR framework (predator/prey/competitor/environment) should help to distinguish the different pressures of an indicator on the stock (e.g., heatwave decreases availability of prey X and increases predator Y). Consistent and disciplined use of this framework will be essential to avoiding the pitfall of double counting if we move from a qualitative to a more quantitative risk table in the future. To that end, it is subjective and difficult to determine relative importance qualitatively when there are multiple indicators within the ecosystem category. An option may be to include subject matter experts to assist with interpreting the influence of different ecosystem indicators and providing mechanistic linkages to the stock of interest. When an ESP is developed for a given stock, this would be within the scope of the associated ESP team. However, it is unclear how to accomplish this for stocks without an ESP (of which there may be many). One possible solution may be to create ESP guild teams (e.g., flatfish, rockfish) to assist with risk tables of stocks with similar life histories and ecological niches and begin development of ESPs for priority stocks. A related issue to double counting is the instance when the same mix of indicators is used to describe both level 1 and level 2 ecosystem concerns. The ESP guild approach may also help to identify stock-specific life history vulnerabilities that would cause a set of indicators to influence one stock more than another within a guild. Finally, there seems to be general agreement that the Plan Teams and SSC should review the risk scores and justifications; however, it is unclear how to record the rationale when the Plan Teams and SSC disagree with an author recommended risk table score or ABC reduction. These issues are all somewhat developed in each of the risk table categories and further guidance from the Plan Teams and SSC would be very helpful.

Discussion 6: tangible steps towards quantifying the importance of external changes in fishery performance in stock assessments

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Our main goals in this session were to 1) discuss fishery performance measures, 2) describe situations where they may provide valuable out-of-model insights into stock health, 3) identify research needed to better identify the relationship between performance metrics and stock health, and 4) note cases where fishery performance metrics may be relevant for the bycatch stocks rather than the target fishery stock. To this end, we constructed a pre-workshop survey on these topics. This summary reports the results from this survey and the discussion held during the workshop.

Are there mechanistic linkages to stock health that are revealed by fishery performance data?

For example, are there fishery performance indicators that differ substantially from trends or conditions indicated by the assessment? One case of note was for GOA Pacific cod where fishing performance (specifically catch rates and fishery participation) dramatically declined prior to when the impacts of the marine heatwave were identified in the survey and assessment. Fish condition (skinniness given length within the fishery) was also suggested as a metric to consider. Consistency between the stock characteristics (age structure, etc.) as estimated within the assessment could be revealed by changes in product mix. For example, more large fish in the catch could reflect population structure or increased price premium for larger fish and fleet targeting in response to that price premium. The group cautioned over simple interpretations of CPUE and general effort measures.

In most fisheries, environmental conditions and management measures significantly affect fishery timing and other behaviors and may not reflect changes in the health of the stock. It is essential that stock assessment scientists consider non-stock factors that may impact fishery-dependent metrics such as CPUE, selectivity, etc., even if only presented qualitatively. Additionally, we noted that fishery data may reflect species distribution which in turn could affect how survey data should be interpreted.

Recognizing that there are data lags between the provision of management advice and the availability of fishery data, what are best practices for integrating fishery indicators with advice derived from assessment model results?

As an example, the group discussed how it appeared that the 2020 EBS pollock fishery likely caught/selected younger fish than expected based on previous years. This affected the choice of what age-specific selectivity was used for advice for the 2021 fishery. Other cases discussed were the impacts of having intermittent surveys (e.g., GOA Pacific cod when conditions were changing quickly and the management reaction could potentially have reacted sooner).

How do we define "fishery" performance risk for bycatch stocks, and how would it be affected by changes in bycatch and incidental catch?

Examples discussed included sablefish bycatch in the Bering Sea pollock fishery evaluated in the sablefish assessment. Target fishery impacts on other stocks are accounted for based on observer data collections and in-season management measures. However, should changes become apparent, impacts on specific stocks (e.g., based on Chinook salmon stock identification work) relaying such information to fishers could minimize the impact on more compromised stocks. A general discussion point was that the presence of another species bycatch may be a consideration to reduce TAC of the target species (as opposed to reducing the ABC of the target species).

Discussion 7: Frameworks for addressing scientific uncertainty: Comparing and contrasting the P* and decision-theoretic approaches

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Overview of the approaches

In the context of managing the BSAI and GOA groundfish fisheries, two frameworks for addressing scientific uncertainty have been discussed for a number of years: the $P*$ approach and the decision-theoretic (DT) approach.

The approach (e.g., Prager et al. 2003) consists of the following steps:

- Set a value of $P*$ between 0 and 0.5.
- Compute the cumulative distribution function of the true-but-unknown value of the overfishing level, $CDF(truOFL)$.
- Set $ABC = CDF^{-1}(P*)$.

The DT approach (e.g., Thompson 1992, 1996, and 1999; also section 3.1 of Restrepo et al. 1998) can be viewed as either a maximization problem or a minimization problem. When viewed as a maximization problem, the approach consists of the following steps (the equivalent minimization problem corresponds to the terms shown in parentheses):

- Define a utility (loss) function specifying the desirability (undesirability) of each possible outcome; for example, long-term yields.
- Weight the utility (loss) of each relevant outcome by the probability or probability density of that outcome, then sum or integrate to get the expected utility (loss).
- Fish at the rate that maximizes (minimizes) expected utility (loss).

Advantages and disadvantages of the approaches

Advantages of the $P*$ approach include the following:

- Sounds like hypothesis testing, so is a natural choice for advocates of hypothesis testing.
- Much more widely known than the DT approach.
    - In fact, until the most recent revision of the NS1 guidelines, it was the only approach officially allowed.
- Computationally simpler than the DT approach (integrating a function versus maximizing the integral of a product).

- Resulting ABC is always less than OFL.

Advantages of the DT approach include the following:

- Rooted in Bayesian theory, so this is a natural choice for advocates of Bayesian methods.
- Considers all relevant outcomes.
- Provides an estimate of the optimal catch.

Disadvantages of the $P*$ approach include the following:

- Considers only one possible outcome ($ABC > truOFL$), regardless of the amount of overestimating or underestimating.
- Does not provide an estimate of the optimal catch.
- As with a value in hypothesis testing, difficult to justify $P*$ value.
- Choice of model/data can have major impacts on the form of the CDF.

Disadvantages of the DT approach include the following:

- Computationally more complicated than $P*$ approach.
- Requires specifying a utility (loss) function.
  - However, unlike the value of $P*$, the utility (loss) function can be estimated from experimental data.
- In some (perhaps rare?) situations, can result in ABC > OFL.
- Choice of model/data can have major impacts on the form of the PDF.

Possible hybrid approaches

The problem of choosing an approach does not have to be an either/or situation, as some hybrid options are also possible:

- Choose the DT approach unless the resulting ABC exceeds the OFL, in which case default to the $P*$ approach.
- Choose the minimum of the ABCs resulting from the two approaches.
- Use $P*$ approach for ABC, DT for a TAC option (if less than ABC).

Current state of the discussion

During development of Amendments 96/87 (implemented November 2010), it became apparent that some issues related to the treatment of ACLs in the National Standard Guidelines were too complicated to address fully. Trailing amendments were anticipated for some issues, such as the buffer between ABC and OFL. A discussion paper was therefore developed in the spring of 2011. This was reviewed by the SSC in June 2011 and by the Joint Groundfish Plan Teams in September 2013, with follow-up comments provided by the SSC in October 2013. The recommendations from the Teams and SSC were as follow:

- SSC recommendations (June 2011)
  - "The SSC recommends a deliberative approach to improving the treatment of uncertainty in the groundfish FMPs and encourages the author and/or other analysts to further develop the document to:

        - “explore the advantages and disadvantages of the DT and *P** approaches using more realistic scenarios, and
        - “determine how the approaches would be applied across different tiers....”

    - “This will require continued research on developing appropriate models for understanding the interactions between fisheries in response to changes in harvest policy.”

- Joint Team recommendations (September 2013)
    - “The Teams did not recommend a preferred alternative for this issue, but did recommend that any future analysis of the DT approach [should] consider a variety of utility functions.
    - “It was noted that AFSC economist Chang Sueng has done some work in this regard.
    - “Furthermore, the Teams recommended that analysis of all options should evaluate risk for a range of years and species.”
- SSC recommendations (October 2013)
    - “In their September 2013 meeting, the Joint Plan Teams provided new advice..., which the SSC supports.”
    - “The SSC encourages further development of these analyses over a reasonable time frame.”

Discussion 8: Frameworks for addressing scientific uncertainty: A joint probability approach for linking the risk table to ABC reductions

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Overview

An approach for implementing the risk table, termed the "joint probability" approach, is described here. The joint probability approach augments the current approach in a way that ties the risk table directly to:

- The need for a reduction from *maxABC*.
- The appropriate amount of reduction (if any).

The joint probability approach is completely consistent with the current features of the risk table. Although the number of columns, or risk "categories" (*ncat*), and the number of rows, or risk "levels" (*nlev*), is entirely flexible, for the example considered here *ncat* and *nlev* will both be set equal to 4, corresponding to the structure of the current risk table:

- *ncat*=4 categories (assessment, population dynamics, environmental/ecosystem, fishery performance).
- *nlev*=4 levels (1, 2, 3, 4), with definitions as currently given in the risk table template.

From a broad, overview perspective, the steps involved in the current and joint probability approaches to implementing the risk table can be summarized as described below.

For the current approach:

1. The assessment author uses a set of subjective methods to arrive at levels for the categories in the risk table.
2. The assessment author uses a *second* set of subjective methods to determine whether an ABC reduction is necessary.
3. If step 2 results in an affirmative determination, the assessment author uses a *third* set of subjective methods to determine the size of the reduction.

For the joint probability approach:

1. The assessment author uses a set of subjective methods to arrive at "scores" for the categories in the risk table (similar or identical to the current approach; see below).
2. The need for an ABC reduction is determined statistically.
3. If step 2 results in an affirmative determination, the size of the reduction is determined statistically.

A quantifiable interpretation of "concern," with an example

The language used in the risk table template suggests that the currency of the risk table is "concern," but this term is left undefined. In the joint probability approach, "concern" is interpreted in terms of the probability that *maxABC* exceeds the true-but-unknown overfishing level (*truOFL*, as distinguished from the overfishing level specified on the basis of the assessment model point estimate, *OFL*). In the joint probability approach, an ABC reduction is necessary if the probability of *maxABC* being greater than *truOFL* exceeds 50%.

Two types of probability need to be considered:

- Probabilities of overfishing that are internal to the model.
  - These are routinely quantified.
- Probabilities of overfishing that are external to the model.
  - These are associated with the factors identified under the categories in the risk table, and are *not* routinely quantified.

Figure 6 provides an example of the cumulative probability of exceeding *truOFL*. The cumulative probability (i.e., the cumulative distribution function of *truOFL*, *CDF*(*truOFL*)) that is internal to the model is shown by the blue curve (this example is based on a lognormal distribution with μ = ln(100,000) and σ = 0.2). The point estimate of *OFL* obtained from the assessment model is 100,000 t (solid red line), corresponding to a cumulative probability of 50% (dashed red line). The point estimate of *maxABC* obtained from the assessment model is about 90,000 (solid green line), corresponding to a cumulative probability of about 30%. Thus, if ABC were set equal to *maxABC*, the "internal" probability of overfishing would be about 30%. The question addressed by the joint probability approach is whether consideration of the external factors would be expected to bridge the gap between the 30% probability associated with *maxABC* and the 50% probability threshold.

Viewing the problem in terms of joint probabilities

The joint probability of overfishing, $Pjnt$, can be viewed in terms of the internal probability of overfishing, $Pint$, and the external probability of overfishing, $Pext$, as follows:

$$Pjnt = 1 - (1 - Pint)(1 - Pext)\,.$$

Because there are $ncat$ categories in the risk table, $Pext$ itself is also a joint probability, and depends on the probabilities associated with the $ncat$ individual categories, $Pext.ind_j$, as follows:

$$Pext = 1 - \prod_{j=1}^{ncat}\left(1 - Pext.ind_j\right)\,.$$

From this perspective, the past practice of ignoring all categories other than the one with the highest level is incorrect, as it implicitly re-sets each of the other $Pext.ind_j$ to a value of 0.

What is needed is a way to move from the information already contained in the risk table categories to a set of probabilities. Both the current and joint probability approaches begin by requiring authors to specify a value of $level$ for each category. The joint probability approach expands on this by allowing authors to specify an (optional) *intralevel* value for each category, with a range of 0 to 1.

A continuous $score$ is then defined for each category j as:

$$score_j = \frac{(level_j - 1 + intralevel_j)}{nlev},$$

with a range of 0 to 1.

If an author prefers not to specify an *intralevel* value for each category, a default value (e.g., 0 or 0.5) could be assumed instead.

The next step is to convert each $score$ into an individual external probability as

$$Pext.ind_j = Pmax \cdot score_j{}^{\alpha},$$

where $Pmax = 1 - 2^{-\frac{1}{ncat}}$ and α is a parameter (choosing a value for α is addressed below).

The coefficient $Pmax$ is needed in order to:

- Keep the external probability of overfishing from expanding in the event that more categories are added in the future.
- Keep the ABC associated with $Pjnt = 0.5$ positive.

Given the above, only two more steps are necessary. The first is to solve for $Pabc$, which is the value of $Pint$ that sets $Pjnt = 0.5$, viz.:

$$Pabc = \frac{(1 - 2Pext)}{\big(2(1 - Pext)\big)}.$$

Finally, ABC is set as follows:

- If $Pabc \geq Pint$, then set $ABC = maxABC$.
- If $Pabc < Pint$, then set $ABC = CDF^{-1}(Pabc)$.

Finishing the example

For the example illustrated in Figure 6, recall that the internal probability of exceeding the true-but-unknown OFL was given by the model at a value of about 30% (more precisely, 29.9%). Suppose that $level_j$ and $intralevel_j$ were set by the assessment author at values of 2 and 0.5, respectively, for all j; and that the value of α was set by the SSC or Council at a value of 0.2. Given these quantities, the determination of whether an ABC reduction is appropriate, and the size of the reduction in the event of an affirmative determination, proceeds formulaically as follows:

- $score_j = \frac{(2+0.5-1)}{nlev} = 0.375$ for all j
- $Pext.ind_j = \left(1 - 2^{-\frac{1}{ncat}}\right) 0.375^{0.2} = 0.131$ for all j
- $Pext = 1 - \prod_{j=1}^{ncat}(1 - 0.131) = 0.429$
- $Pjnt = 1 - (1 - 0.299)(1 - 0.429) = 0.600 > 0.5$
- $Pabc = \frac{(1-2\cdot 0.429)}{(2(1-0.429))} = 0.124 < Pint$
- $ABC = CDF^{-1}(0.124) = 79{,}400$ (a 12% reduction from *maxABC*)

The entire set of computations can be done in an Excel spreadsheet of only 10 kb in size.

Figure 7 adds the above results to Figure 6. The blue curve and the red and green lines are the same as those shown in Figure 6. The dashed magenta line corresponds to *Pjnt* (=0.600). Although not listed in the above set of calculations, the dashed magenta line crosses the internal cumulative distribution function at a value that might be termed the "effective" *maxABC* (approximately 105,000), indicated by the solid magenta line. The dashed purple line corresponds to *Pabc* (=0.124), which crosses the internal cumulative distribution function at the final ABC value of about 79,400 (solid purple line).

Choosing a value of α

As noted above, the joint probability approach requires a method for converting the value of each $score_j$ into a probability. Although many other methods can be imagined, the method for doing so suggested here involves raising each $score_j$ to a power α. Presumably, the value of α would be set by the SSC or Council. Setting the value of α should involve an understanding of how it relates to quantities such as *Pabc* and the reduction (if any) from *maxABC*, which will also require information about the range of *Pint* values suggested by the assessment models. One way to simplify the task is to assume that the value of $score_j$ is constant across j (although information about the range of *Pint* values suggested by the assessment models will still ultimately be necessary).

Figure 8 shows *Pabc* as a function of $score_j$ for various values of α in the special case where $score_j$ is the same for all categories. The dashed black lines demarcate the four values of *level* in the risk table. Recalling that an ABC reduction is necessary only if $Pint > Pabc$, Figure 8 can be used to gain some understanding of the likely frequency of ABC reductions under different values of α. For example, suppose that an assessment author were to set $level_j$=1 and $intralevel_j$=0.5 for all j, thus giving $score_j$=0.125 for all j. Then, if the Council or SSC were to set α at a value of 0.2, an ABC reduction would be required whenever *Pint* exceeded a value of about 0.221. At the other extreme, if the Council or SSC were to set α at a value of 1.0, an ABC reduction would not be required unless *Pint* exceeded a value of about 0.458.

Figure 9 shows the reduction from *maxABC* as a function of $score_j$ for various combinations of *Pint* and lognormal σ in the special case where α=0.2 (as in Figure 7) and where $score_j$ is the same for all categories. If the range of σ values shown here (0.3 to 0.6) is sufficiently broad, then, if $score_j$=0.125 (the midpoint of level 1), reductions will fall within a range of about 0.143−0.266 if *Pint*=0.4, and within a range of about 0.071−0.136 if *Pint*=0.3; but no reductions will be necessary if *Pint*=0.2 or *Pint*=0.1. If $score_j$=0.875 (the midpoint of level 4), reductions will fall within a range of about 0.208−0.662 for all parameter combinations shown.

The α value of 0.2 used to develop Figure 6 was estimated by the method of least squares, using as data the levels specified in all risk tables completed to date and the associated reductions (including reductions of zero), setting $intralevel_j$=0 for all j in all assessments, and calculating the lognormal σ for each *truOFL* distribution by assuming that the *OFL* and *maxABC* values from each of these assessments corresponded to the geometric and harmonic means of the distribution, respectively.

Concluding thoughts: potential non-independence of events

Note that the equations for computing joint probability listed above assume that the events are independent. This may not be entirely accurate, but it should at least be a reasonable starting point. Based on the most recent risk tables for assessments of BSAI groundfish, the specified risk levels for the various categories tend to be positively correlated in practice (whether they should be positively correlated *in principle* may be another matter). If the risk levels are positively correlated, then the value of $Pext$ obtained by assuming that the $Pext.ind_j$ are independent will be biased upward, meaning that the value of $Pjnt$ will likewise be biased upward. Given the inherent subjectivity of the *level* determinations that are necessary in both the current and joint probability approaches, such bias could reasonably be assumed to be of little concern, comparatively speaking. If, however, such bias is nevertheless deemed a serious concern, the approach could be modified by treating the specified reduction (if any) as an *upper bound* on the appropriate reduction rather than the final value. Although this would result in a situation somewhat similar to the status quo, in which the assessment author (or Groundfish Plan Team or SSC) would be left with the problem of how to set the appropriate reduction within the resulting range, at least the range would be bounded far more reasonably than at present, in which the admissible range is essentially 0% to 100%.

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Tables

Table 1. Risk classification table for assessment, population dynamics, and environmental/ecosystem considerations.

	Assessment-related considerations	Population dynamics considerations	Environmental/ecosystem considerations	Fishery Performance
Level 1: Normal	Typical to moderately increased uncertainty/minor unresolved issues in assessment.	Stock trends are typical for the stock; recent recruitment is within normal range.	No apparent environmental/ecosystem concerns	No apparent fishery/resource-use performance and/or behavior concerns
Level 2: Substantially increased concerns	Substantially increased assessment uncertainty/ unresolved issues.	Stock trends are unusual; abundance increasing or decreasing faster than has been seen recently, or recruitment pattern is atypical.	Some indicators showing an adverse signals relevant to the stock but the pattern is not consistent across all indicators.	Some indicators showing adverse signals but the pattern is not consistent across all indicators
Level 3: Major Concern	Major problems with the stock assessment; very poor fits to data; high level of uncertainty; strong retrospective bias.	Stock trends are highly unusual; very rapid changes in stock abundance, or highly atypical recruitment patterns.	Multiple indicators showing consistent adverse signals a) across the same trophic level as the stock, and/or b) up or down trophic levels (i.e., predators and prey of the stock)	Multiple indicators showing consistent adverse signals a) across different sectors, and/or b) different gear types
Level 4: Extreme concern	Severe problems with the stock assessment; severe retrospective bias. Assessment considered unreliable.	Stock trends are unprecedented. More rapid changes in stock abundance than have ever been seen previously, or a very long stretch of poor recruitment compared to previous patterns.	Extreme anomalies in multiple ecosystem indicators that are highly likely to impact the stock. Potential for cascading effects on other ecosystem components	Extreme anomalies in multiple performance indicators that are highly likely to impact the stock

Table 2: Summary table of risk table scores for Alaska groundfish from 2018 to 2020. Note that the fishery performance category was added in 2019.

Stock	Assessment related			Population Dynamics			Environment / Ecosystem			Fishery Performance		Proposed Reduction		
	2018	2019	2020	2018	2019	2020	2018	2019	2020	2019	2020	2018	2019	2020
Sablefish	2	2	3	4	3	3	2	2	2	3	3	45%	57%	57%
EBS pollock	1	1	1	2	2	1	2	2	2	2	2	30%	43%	30%
Bogoslof pollock			1			1			1		1			0%
AI pollock			1			1			1		1			0%
EBS Pacific Cod		1	1		1	1		2	2	1	1		*	0%
AI Pacific cod		1	1		1	1		2	2	1	1		**	0%
BSAI Yellowfin sole		1	1		1	1		1	1	1	1		0%	0%
Alaska Plaice		1			1			1		1			0%	
BSAI Greenland turbot			1			1			2		1			0%
BSAI Arrowtooth			1			1			1		1			0%
BSAI Kamchatka			1			1			1		1			0%
BSAI Northern rock sole			2			1			1		1			0%
BSAI Flathead			1			1			1		1			0%
BSAI Other Flatfish			1			1			1		1			0%
BSAI POP			2			1			1		1			0%
BSAI Blackspotted/ RE			3			2			1		2			0%
BSAI Northern Rockfish		2			1			2		1			0%	
BSAI Shortraker			1			1			1		1			0%
BSAI Other Rockfish			2			1			1		1			0%
BSAI Atka Mackerel	1	1	1	1	1	1	1	1	1	1	1	0%	0%	0%
BSAI Skates			1			1			1		1			0%
BSAI Sharks			2			2			1		1			0%

BSAI Octopus			1			1			1		1			0%
GOA pollock	2	2	1	2	1	1	2	1	1	1	1	15%	10%	0%
GOA Pacific cod	2	2	2	***	2	2	2	2	1	1	1	13.6%	****	0%
GOA Northern Rockfish			1			1			1		1			0%
GOA Arrowtooth		1			1			2		1			0%	
GOA Deepwater Flatfish		2			1			1		1			0%	
GOA POP		2	2		2	2		1	1	1	1		0%	0%
GOA Northern Rockfish			1			1			1		1			0%
GOA Dusky Rockfish			2			1			1		1			24%
GOA Rougheye/BS		1			1			1		1			0%	
GOA Thornyheads			1			1			1		1			0%
GOA Other Rockfish		1			1			1		1			0%	
GOA Shortraker		1			1			1		1			0%	
GOA Atka Mackerel		1			*****			1		1			0%	
GOA Skate		1			1			1		1			0%	
GOA Sharks			2			2			1		1			0%
GOA Octopus		1			1			1		1			0%	

*Authors did not provide a recommendation and deferred to the SSC. The SSC adopted the ensemble to lower the ABC.
**Authors did not provide a recommendation and deferred to the SSC. The SSC did not recommend a reduction since the stock was at Tier 5.
***Author recommended a level 4 for population dynamics in 2018 and the SSC downgraded that to a level 2.
****Authors did not provide a recommendation and deferred to the SSC. The SSC set the 2021 ABC the same as the 2020 ABC.
*****Author stated "Unknown" for this category

Table 3. Description of the groundfish tier system used by NPFMC since 1999 for defining fishing-mortality rate related to the overfishing level (FOFL) and the acceptable biological catch (FABC) based on the type of information available (From DiCosimo et al. 1991).

Tier 1	Info: reliable point estimates of B and B_{MSY} and reliable pdf of F_{MSY}	
	(1a)	Stock status: $B/B_{MSY} > 1$
		$F_{OFL} - m_A$; $F_{ABC} \times m_H$
	(1b)	Stock status: $a < B/B_{MSY} \leq 1$
		$F_{OFL} = m_A \times (B/B_{MSY} - a)/(1 - a)$; $F_{ABC} \leq m_H \leq (B/B_{MSY} - a)/(1 - a)$
	(1c)	Stock status: $B/B_{MSY} \times a$
		$F_{OFL} = F_{ABC} = 0$
Tier 2	Info: reliable point estimates of B, B_{MSY}, F_{MSY}, $F_{35\%}$, and $F_{40\%}$	
	(2a)	Stock status: $B/B_{MSY} > 1$
		$F_{OFL} = F_{MSY}$; $F_{ABC} \leq F_{MSY} \times (F_{40\%}/F_{35\%})$
	(2b)	Stock status: $a < B/B_{MSY} \times 1$
		$F_{OFL} = F_{MSY} \times (B/B_{MSY} - a)/(1 - a)$; $F_{ABC} \leq F_{MSY} \times (F_{40\%}/F_{35\%}) \times (B/B_{MSY} - a)/(1 - a)$
	(2c)	Stock status: $B/B_{MSY} \leq a$
		$F_{OFL} = F_{ABC} = 0$
Tier 3	Info: reliable point estimates of B, $B_{40\%}$, $F_{35\%}$, and $F_{40\%}$	
	(3a)	Stock status: $B/B_{40\%} > 1$
		$F_{OFL} = F_{35\%}$; $F_{ABC} \leq F_{40\%}$
	(3b)	Stock status: $a < B/B_{40\%} \leq 1$
		$F_{OFL} = F_{35\%} \times (B/B_{40\%} - a)/(1 - a)$; $F_{ABC} \leq F_{40\%} \times (B/B_{40\%} - a)/(1 - a)$
	(3c)	Stock status: $B/B_{40\%} \leq a$
		$F_{OFL} = F_{ABC} = 0$
Tier 4	Info: reliable point estimates of B, $F_{35\%}$, and $F_{40\%}$	
		$F_{OFL} = F_{35\%}$; $F_{ABC} \leq F_{40\%}$
Tier 5	Info: reliable point estimates of B and natural mortality rate M	
		$F_{OFL} = M$; $F_{ABC} \leq 0.75 \times M$
Tier 6	Info: reliable catch history from 1978 to 1995	
		OFL = average catch (1978–1995), unless otherwise established by SSC; ABC $\leq 0.75 \times$ OFL

Table 4. Mid-Atlantic Fishery Management Council framework table for assessment evaluation metrics associated with the nine decision criteria for each OFL CV bin.

Decision Criteria	Default OFL CV=60%	Default OFL CV=100%	Default OFL CV=150%
Data quality	One or more synoptic surveys over stock area for multiple years. High quality monitoring of landings size and age composition. Long term, precise monitoring of discards. Landings estimates highly accurate.	Low precision synoptic surveys or one or more regional surveys which lack coherency in trend. Age and/or length data available with uncertain quality. Lacking or imprecise discard estimates. Moderate accuracy of landings estimates.	No reliable abundance indices. Catch estimates are unreliable. No age and/or length data available or highly uncertain. Natural mortality rates are unknown or suspected to be highly variable. Incomplete or highly uncertain landings estimates.
Model appropriateness and identification process	Multiple differently structured models agree on outputs; many sensitivities explored. Model appropriately captures/considers species life history and spatial/stock structure.	Single model structure with many parameter sensitivities explored. Moderate agreement among different model runs indicating low sensitivities of model results to specific parameterization.	Highly divergent outputs from multiple models or no exploration of alternative model structures or sensitivities.
Retrospective analysis	Minor retrospective patterns.	Moderate retrospective patterns.	No retrospective analysis or severe retrospective patterns.
Comparison with empirical measures or simpler analyses	Assessment biomass and/or fishing mortality estimates compare favorably with empirical estimates.	Moderate agreement between assessment estimates and empirical estimates or simpler analyses.	Estimates of scale are difficult to reconcile and/or no empirical estimates.
Ecosystem factors accounted	Assessment considered habitat and ecosystem effects on stock productivity, distribution, mortality and quantitatively included appropriate factors reducing uncertainty in short term predictions. Evidence outside the assessment suggests that ecosystem productivity and habitat quality are stable. Comparable species in the region have synchronous production characteristics and stable short-term predictions. Climate vulnerability analysis suggests low risk of change in	Assessment considered habitat/ecosystem factors but did not demonstrate either reduced or inflated short-term prediction uncertainty based on these factors. Evidence outside the assessment suggests that ecosystem productivity and habitat quality are variable, with mixed productivity and uncertainty signals among comparable species in the region. Climate vulnerability analysis suggests moderate	Assessment either demonstrated that including appropriate ecosystem/habitat factors increases short-term prediction uncertainty, or did not consider habitat and ecosystem factors. Evidence outside the assessment suggests that ecosystem productivity and habitat quality are variable and degrading. Comparable species in the region have high uncertainty in short term predictions. Climate vulnerability analysis suggests

Table 4. Continued. Mid-Atlantic Fishery Management Council framework table for assessment evaluation metrics associated with the nine decision criteria for each OFL CV bin.

Decision Criteria	Default OFL CV=60%	Default OFL CV=100%	Default OFL CV=150%
	productivity due to changing climate.	risk of change in productivity from changing climate.	high risk of changing productivity from changing climate.
Trend in recruitment	Consistent recruitment pattern with no trend.	Moderate levels of recruitment variability or modest consistency in pattern or trends. OFL estimates adjusted for recent trends in recruitment. OFL estimate appropriately accounted for recent trends in recruitment.	Recruitment pattern highly inconsistent and variable. Recruitment trend not considered or no recruitment estimate.
Prediction error	Low estimate of recent prediction error.	Moderate estimate of recent prediction error.	High or no estimate of recent prediction error.
Assessment accuracy under different fishing pressures	High degree of contrast in landings and surveys with apparent response in indices to changes in removals. Fishing mortality at levels expected to influence population dynamics in recent years.	Moderate agreement in the surveys to changes in catches. Observed moderate fishing mortality in fishery (i.e., lack of high fishing mortality in recent years).	Relatively little change in surveys or catches over time. Low precision of estimates. Low fishing mortality in recent years. "One-way" trips for production models.
Simulation analysis/MSE	Can be used to evaluate different combinations of uncertainties and indicate the most appropriate OFL CV for a particular stock assessment.		

Table 5. Counts of "positive" risk factors that were listed more than once in current BSAI risk tables.

Rationale	Count
Small retrospective bias	10
Good fits to data overall	9
Results from analysis of missing a survey indicate no major problems	8
Annual surveys through 2019	4
No convergence issues	3
Good availability of age data	2
Mis-ageing is not a concern	2
New data had little impact	2
Recruitment estimates are consistent with the data	2
Retrospective bias is improved relative to previous assessments	2

Table 6. Counts of "negative" risk factors that were listed more than once in current BSAI risk tables.

Rationale	Count
Lack of 2020 summer trawl surveys	10
Large retrospective bias	6
Data conflicts exist	4
Lack of EBS slope surveys since 2016	4
Tight prior distributions cause uncertainty to be underestimated	3
Alternative models show disparate results	2
Shortcomings in harvest control rule	2
Shortcomings in structure of Tier 5 RE model	2
Strong residual patterns	2
Survey biomass estimates are relatively imprecise	2

Figures

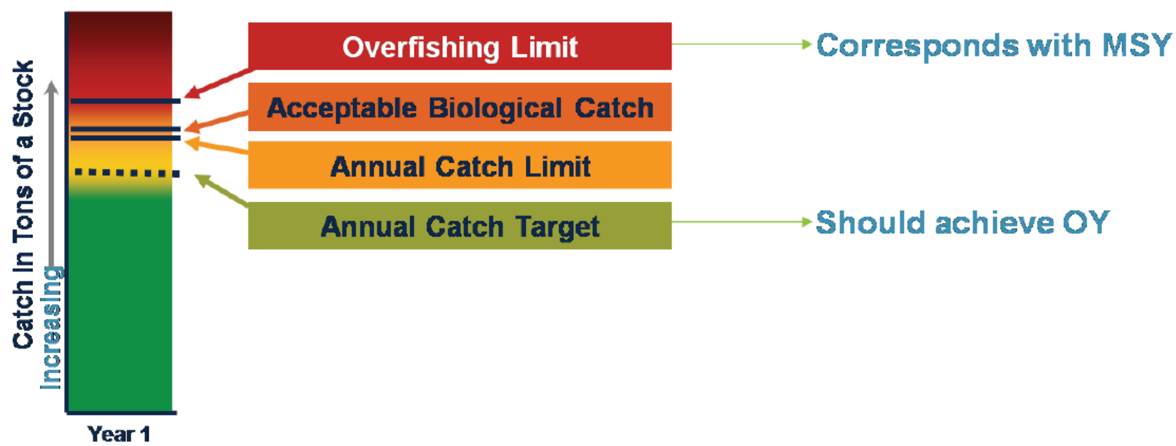

Figure 1. Fishing limits and targets defined by the National Standard 1 Guidelines (2009).

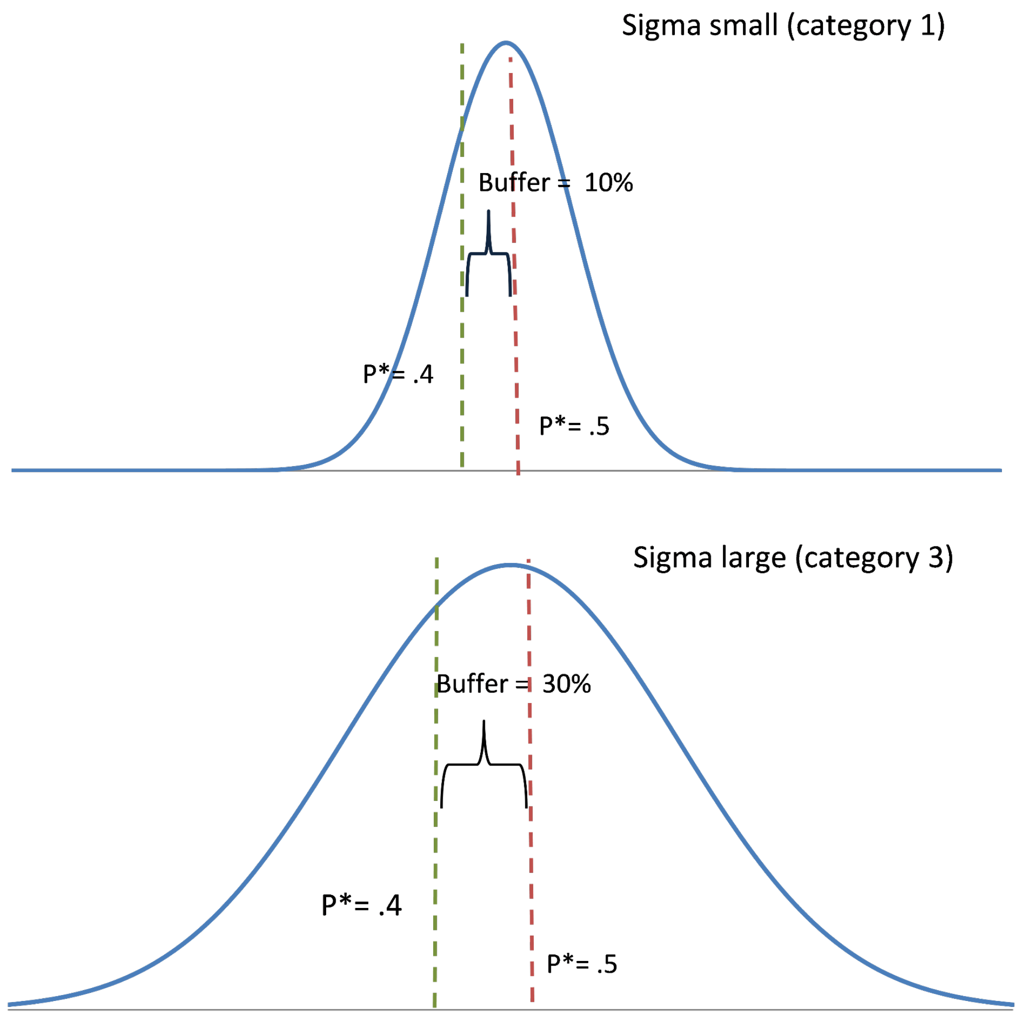

Figure 2. Illustration of the P-star approach.

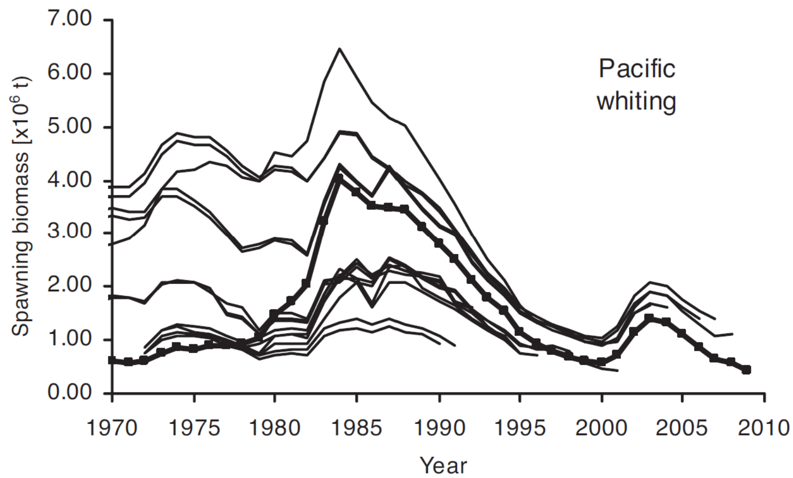

Figure 3. Example of between assessment variation in estimated spawning biomass (from Ralston et al. 2011).

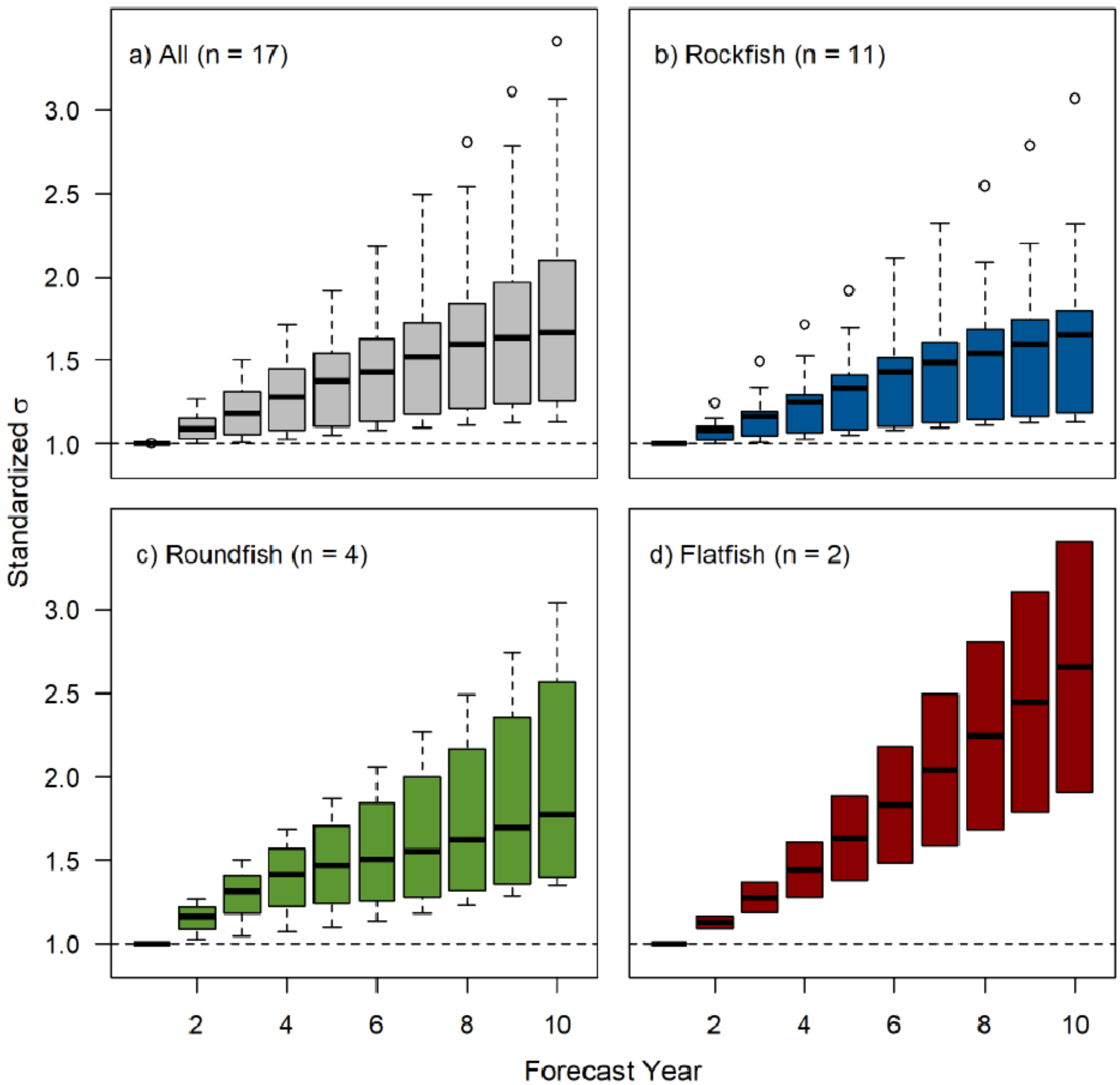

Figure 4. Change in sigma reflecting increased uncertainty during the projection period grouped by life history for assessed West Coast stocks. The number of species in each life history grouping is shown in each figure. (From Wetzel and Hamel 2019).

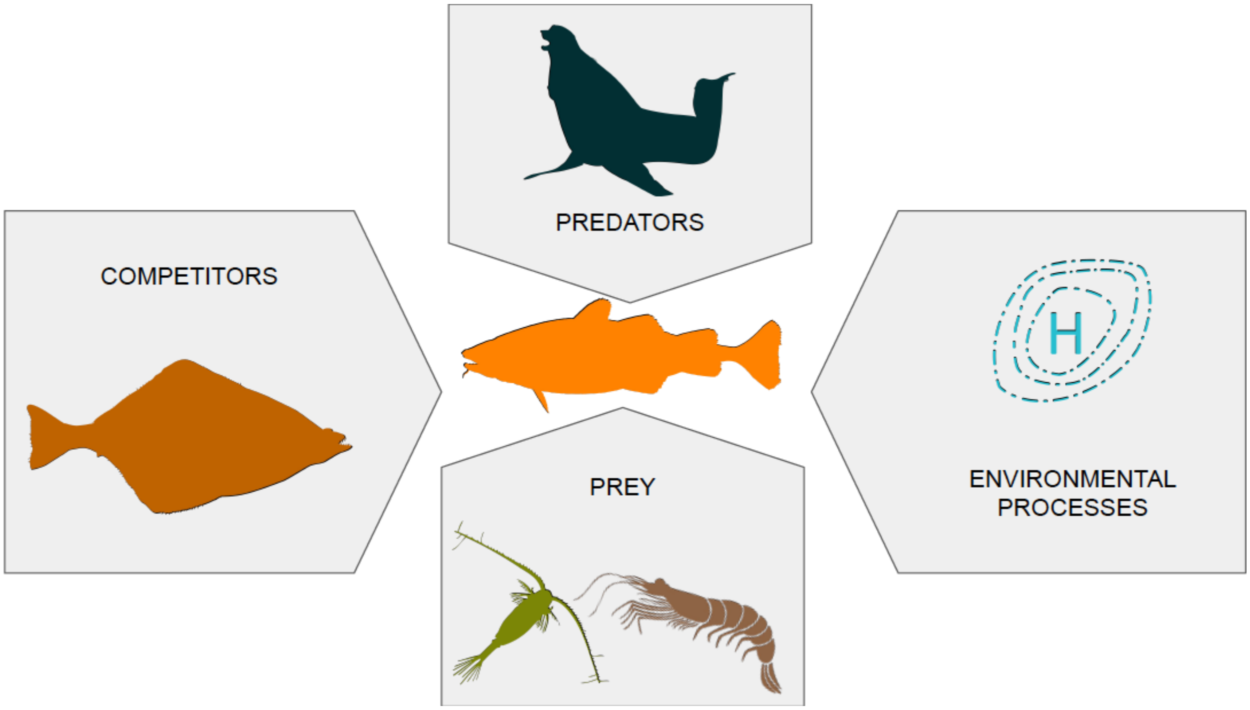

Figure 5. Framework for information for Ecosystem Status Reports

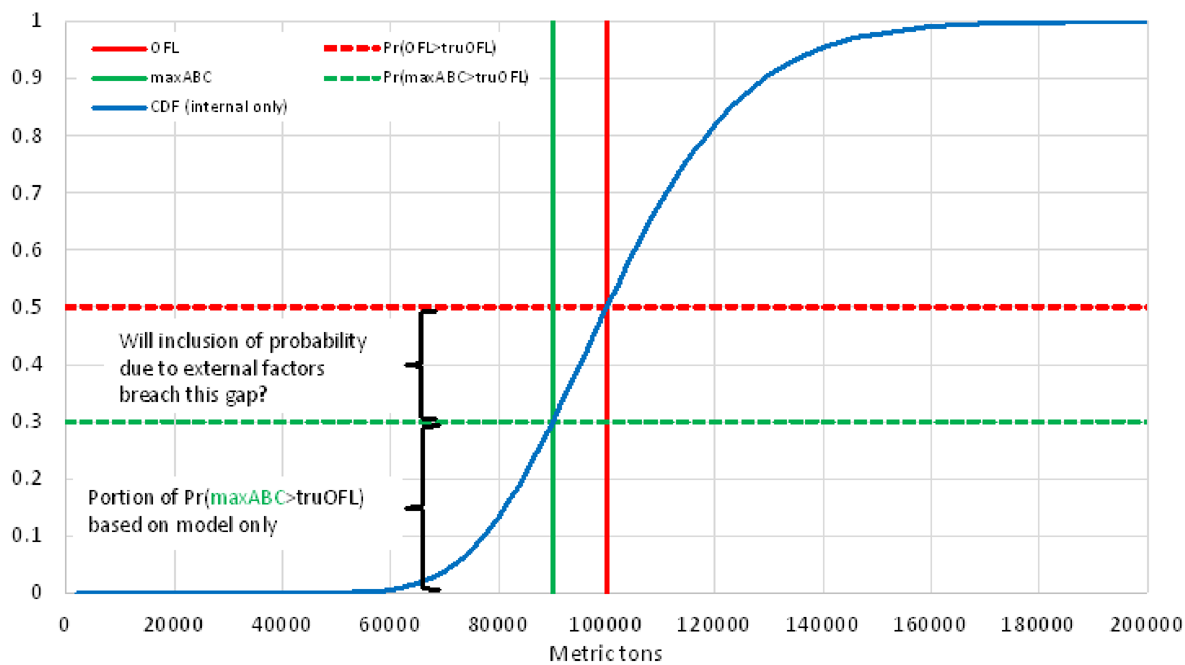

Figure 6. Example cumulative distribution function of *truOFL* (lognormal with μ=100,000 and σ=0.2).

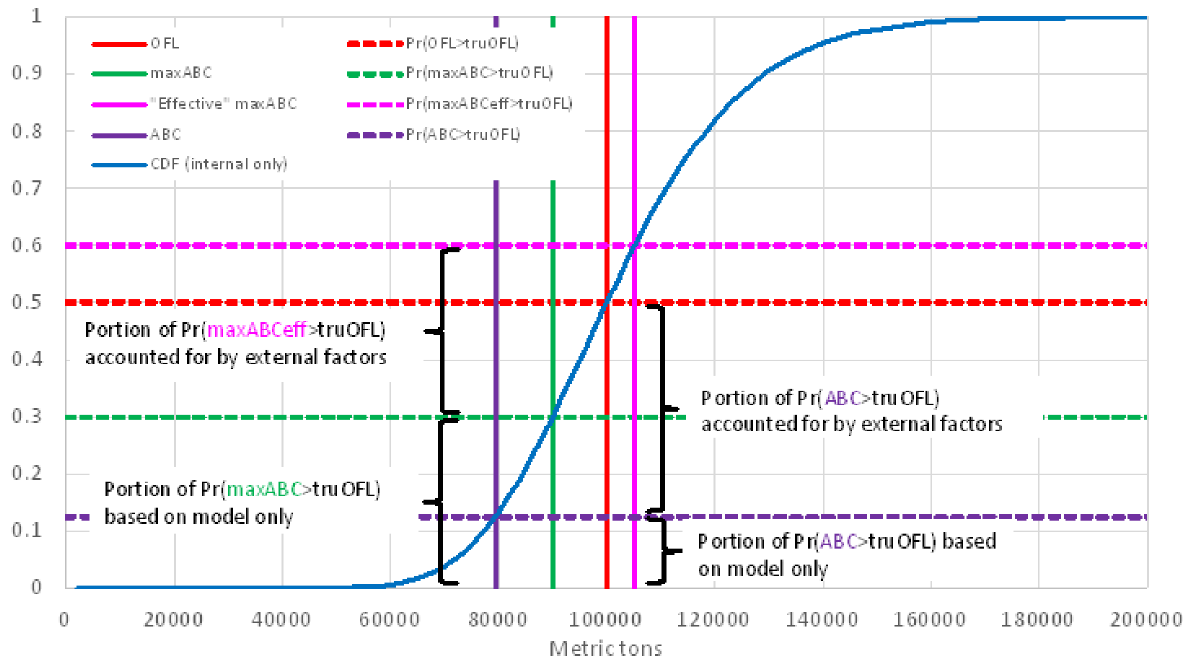

Figure 7. Application of the joint probability approach to the example shown in Figure 1, with α=0.2 and *score*=0.375 for all categories.

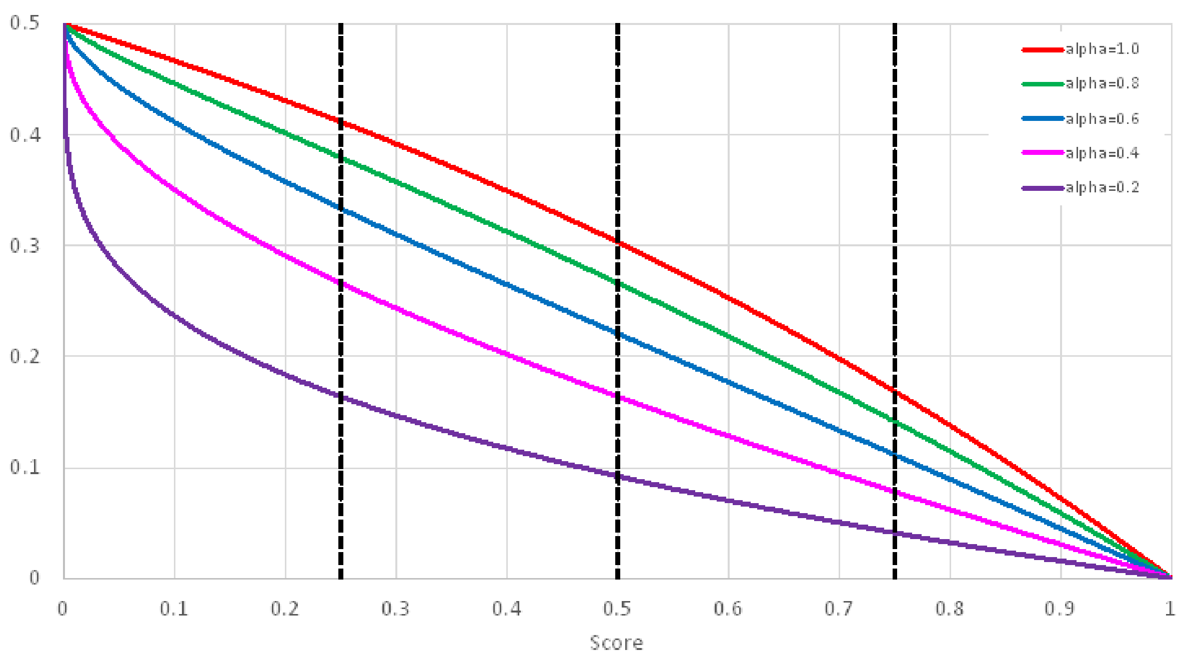

Figure 8. P_{ABC} as a function of *score* for various values of α for the special case where *score* is the same for all categories.

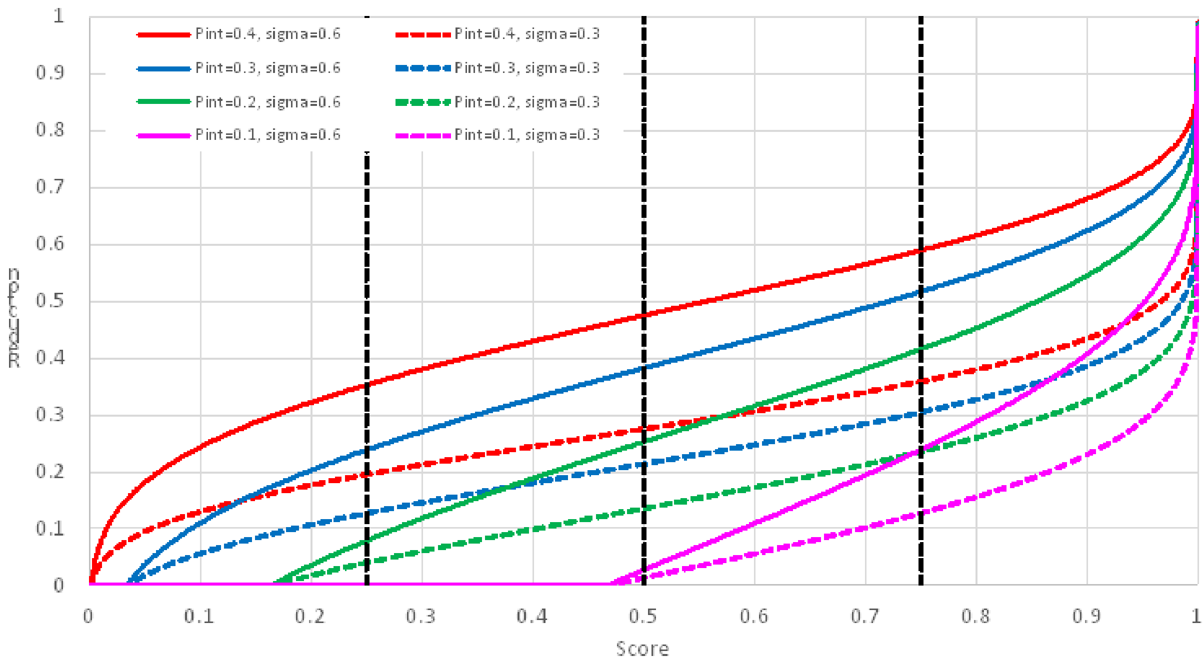

Figure 9. Reduction from *maxABC* as a function of *score* for various combinations of *Pint* and lognormal σ for the special case where α=0.2 (as in Figure 2) and *score* is the same for all categories.

Appendix 1.

Agenda

Feb 5, 8am - 12:00pm AST

8:00 - 8:10 AM AKT Introduction and workshop goals

8:10 - 8:30 (20 min) Summary of case studies for risk table adjustments

(Shotwell, Zador and Dorn)

- Brief historical overview of risk tables (timeline and purpose) (Table 1)
- Synthesis of stock responses 2018-2020 (Tables 2 and 3)
- Lessons learned (e.g., transparency, evaluation of consistency, documentation of when there is no concern, acknowledgement of novel observations)

8:30 - 8:50 (20 min) Issues, challenges and concerns

Group Discussion (Anne Hollowed facilitator)

- Challenges for species complexes
- Challenges for data limited stocks
- Interpreting response for non-target stocks
- Should we continue to produce risk tables for all (or any) full assessments
- Challenges with time constraints - Should Plan Teams and SSC review all of them, or only when a reduction is recommended?

8:50 - 9:40 (50 min) Breakout Session 1

Discussion of tangible steps towards quantifying the importance of external changes in fishery performance in stock assessments

(Haynie, Ianelli, and Kasperski)

- Are there mechanistic linkages to stock health that are revealed by fishery performance data?
- Recognizing Data lags and interpreting trends (e.g., fishery selectivity changes in most recent years, predictions in future years).
- How do we define “fishery” performance risk for bycatch stocks, and how would it be affected by changes in bycatch and incidental catch?

Discussion of tangible steps toward quantifying the importance of assessment risk (Thompson)

- Data selection
- Parameterization
- Trade-offs in model complexity
- Ensembles

8:50 - 9:40 (50 min) Breakout Session 2

Discussion of tangible steps towards quantifying the risk of external changes in population conditions

(Spencer and Goethel)

- Importance of age diversity?

- Importance of recruitment uncertainty?
- Importance of growth uncertainty?
- Importance of maturation uncertainty?
- Interaction between perceived stock status and population risk category.

Discussion of tangible steps towards quantifying risk of external changes in ecosystem conditions

(Shotwell, Ferriss, Siddon, Zador)

- Mechanistic linkages quantifying risk of ecosystem process (the four factors).
- Pathway for moving from recognition of ecosystem anomalies to qualitative projection of risk of overfishing.

9:40 - 9:55 Break

9:55 - 10:25 30 min Plenary discussion of key findings from breakout groups

The following session will include ~ 30 min of introduction to the topic followed by a ~15 min open discussion between stock assessment authors, PTs and SSC

10:25 - 11:10 (45 min) Frameworks for addressing scientific uncertainty

(Dorn and Thompson)

- What sources of scientific uncertainty are already incorporated in the existing buffer between ABC and OFL? Do these differ from the Risk Table?
- P* approaches for crab and PFMC Decision theoretic approaches
- A probabilistic approach for linking the risk table to ABC reductions
- Full feedback MSE
- Scoring - pros and cons of overall scores?
- Should "increased" concern be evaluated relative to: (1) previous assessments of the same stock/complex or (2) typical assessments with the same tier or (3) typical assessments across all tiers, conditions under which elevated risk levels should result in reduction from maxABC.

11:10 - 11:40 (30 min) Public Testimony relevant to workshop topics

11:40 - 12:00 (20 min) SSC discussion

Appendix B: Research Priorities Process

The SSC reviewed NPFMC Research Priorities in April 2021. Resulting from SSC recommendations at that meeting, a subgroup was formed to recommend revisions to the Research Priorities process, SSC members were asked to comment on the subgroup report online prior to the meeting, and the following report (with comments) was presented to the full SSC during the June 2021 NPFMC meeting. This report has not yet been updated to reflect SSC recommendations from this meeting, as detailed in the D-5 Research Priorities agenda item above.

NPFMC Research Priorities Process[1]

In 2011, the SSC and North Pacific Fishery Management Council (Council) established procedures for conducting "multi-year research priorities for fisheries, fisheries interactions, habitats, and other areas of research that are necessary for management purposes" in accordance with the Magnuson-Stevens Act (MSA). At that time, the Council established that research priorities were to be annually reviewed at the Council's June meeting. Prior to Council review, the Council's Plan Teams (GOA and BSAI Groundfish, Crab, and Scallop) would review existing research priorities and make recommendations for modifications or additions to the list, as needed. From 2011 to 2018, the Council updated research priorities annually following the June meeting. In 2018, a new process for review of the research priorities was executed. This change stems from a proposal from a working group of SSC and Council members that was reviewed by the SSC in April 2018. In this proposal, the annual curation of the database would be conducted as normal, with consideration given to the Plan Team's suggested changes. In addition, the subgroup requested that the SSC develop a Top 10 list of research priorities for 2018 from the priorities identified as Urgent or Important. This top priority list would be developed from a combination of sources. First, the Plan Teams would identify three to five top priorities relevant to their particular team that would be candidates for the top priority list. Second, the SSC would additionally consider any priorities not reviewed by any Plan Team, including those relevant to halibut, marine mammals, seabirds, and social science topics. The intent of this top priority list was to both reduce the review burden on the Council and to improve communication of these highly relevant priorities to external funding sources and the general public. In February 2019, the Council moved review of research priorities from an annual to triennial schedule. This change recognizes that the MSA does not require annual review and reflects the Council's desire to streamline the overall review process.

The Council's research priorities consist of a wide range of science-based needs and interests that support or improve the Council's ability to provide stewardship over marine resources offshore Alaska and provide for the sustained participation of communities substantially engaged in or dependent on federally managed fisheries. A primary purpose of the NPFMC research priorities is identifying to agencies and funding partners which projects are considered to be most needed to inform the NPFMC management process. Specific research topics are organized online through a publicly accessible database that can be queried for changes in research status. It can also be downloaded completely for detailed information about all of the Council's research needs.

Research topics are ranked through four priority categories: *Critical ongoing monitoring, Urgent, Important (near term), and Strategic (future needs)*. These priority categories have specific definitions that emphasize correspondence of research to the Council's time horizon of management concerns. Under the revised triennial schedule, the SSC and Council continue to develop and review a "Top 10" list of research priorities to highlight the most pressing research needed to inform the NPFMC management process. In February 2020, the SSC held a workshop to discuss research priorities. This workshop specifically focused on *Critical Ongoing Monitoring* and *Strategic* research. After this review, it became clear that the existing collection of research topics contained in the database ranged widely in the level of detail and specificity and a subgroup was formed to address potential streamlining of the process. While the SSC completed the review of *Critical Ongoing Monitoring* priorities, a review of *Strategic* research priorities was not

[1] This draft document was developed by the SSC's Research Priorities Subgroup (Dana Hanselman [lead], Anne Hollowed, Sherri Dressel, Mike Downs, George Hunt) for SSC review at the June 2021 SSC meeting. An SSC member's suggestion for an "Alternative Approach" is provided following the Subgroup draft.
All subsequent footnotes are highlighted and comprise comments that SSC members provided in their review of this draft in preparation for the SSC discussion at the June meeting.

completed at that time and will be addressed at the June 2021 meeting through the narrative summary in this report (see *Strategic Research*) and curation of *Strategic* priorities during the June 2021 meeting.

The SSC subgroup comprised to lead the Research Priorities discussion for the April 2021 SSC meeting provided a number of recommendations that were reviewed, addressed and applied for the triennial review that occurred at the April 2021 Council meeting. The following summarizes the SSC's recommendations on the review process for the next triennial review in 2024.

1. Procedure for review of each research category

1.1. Critical, ongoing monitoring research

Research priorities designated as *Critical Ongoing Monitoring* are the highest priority level for the North Pacific Fishery Management Council. These priorities create and maintain indispensable data that substantially contribute to our understanding and management of fish populations, fisheries, and the communities engaged in or dependent upon those fisheries. Discontinuation or diminishment of the research that provides these datasets would leave a significant gap in the science needed to support sustainable and successful fisheries management in the North Pacific. The North Pacific Fishery Management Council and its Scientific and Statistical Committee continue to provide the utmost support for these priorities. The SSC recommends retaining this description of *Critical Ongoing Monitoring* research on their website.

Going forward, the SSC recommends not highlighting and reviewing *Critical Ongoing Monitoring* research unless the SSC receives a proposal to move a research priority into this category or to remove research from this category. The SSC views these categories as the most important science products produced by the various agencies and partners for scientific management of fisheries. The SSC expects these research needs to persist indefinitely. The SSC would like an opportunity to comment if any of these activities were to be considered for discontinuation. While there are currently 17 individual priorities that the SSC categorizes under this heading, they fit broadly in four categories. The SSC recommends adding a *Critical Ongoing Monitoring* priority in the database describing Fishery monitoring and catch accounting, as the SSC considers this to be a fifth *Critical Ongoing Monitoring* category. The five category descriptions follow.

1.1.1 Fishery Monitoring and Catch Accounting

In-season catch monitoring is a vital element of the NPFMC sustainable and equitable management portfolio. Critical data collections include: a) the amount, distribution, species composition, size, age, maturity and genetics of both the targeted catch and PSC catch (including genetics for chum and Chinook salmon); b) seabird catch; and c) marine mammal encounters and mortalities. The SSC proposes to add this as a *Critical Ongoing Monitoring* priority as fishery-dependent monitoring is an ongoing need and is considered among the highest priority research activities, contributing to assessment of commercial groundfish, crab, and scallop fisheries of Alaska. These activities ensure the NPFMC has the basis for completing stock assessments in compliance with NS-1, NS-2, NS-3 and NS-9.

1.1.1 Groundfish, crab and scallop surveys

Regularly conducted surveys by federal and state agencies provide baseline distribution, abundance, stock structure and life history data that form the foundation for stock assessments and the development of ecosystem approaches to management. The scope of these surveys are broad including the GOA, AI, NBS and EBS. Critical elements of this theme include estimates of abundance, age, length, genetics and maturity data. Although an ongoing need, these surveys are among the highest priority research activities, contributing to assessment of commercial groundfish, crab, and scallop fisheries of Alaska. These surveys ensure the NPFMC has the basis for completing stock assessments in compliance with NS-1, NS-2, NS-3 and NS-9.

1.1.2 Ecosystem, oceanographic and protected resource time series

Federal, tribal and state agencies maintain time series of surveys and moorings that collect core biological and oceanographic data. Collections under this theme include but are not limited to biophysical data from moorings, diet data, zooplankton, beach seine surveys and age-0 fish surveys. These are a necessary part of the survey portfolio to support integrated ecosystem assessment under rapidly changing environmental conditions. Marine mammal and seabird surveys need to be routinely conducted to assess spatial changes, vital rates, and interactions with fisheries. These surveys provide the basis for the NPFMCs responsibilities regarding the Marine Mammal Protection Act and the Endangered Species Act as well as adherence to existing recovery plans. Recognizing the potential scope of this category, the SSC recognizes that prioritization within this category is needed to elevate the importance of ecosystem surveys that have the greatest potential to influence management decisions.

1.1.3 Ecosystem Indicators

Maintenance of ecosystem and environmental indicators derived from data collected on surveys, moorings and satellites and from modeled sources (e.g., high resolution ocean models) in the North Pacific provide context for interpretation of changes in the distribution, production, and trends of managed species as well the basis for interpreting and forecasting encounter rates with prohibited species and other incidental species. Indicators such as temperature, currents, predator/prey dynamics, and pH will be needed both to advise current tactical science decisions and conduct long term strategic planning. Continued monitoring of these indicators through the Ecosystem Status Reports and Ecosystem and Socioeconomic Profiles and research toward incorporating these data into assessments is highly encouraged. As noted above, the SSC recognizes that prioritization within this category is needed to elevate the importance of ecosystem indicators that have the greatest potential to influence management decisions.

1.1.4 Fishery performance, socio-economic analyses, and human dimensions

The SSC needs research on data collected from the fisheries, the communities they affect, and how to incorporate local knowledge (LK), traditional knowledge (TK), and subsistence information into the management process. This is needed to better assess impacts of management decisions on stakeholders. The SSC particularly is interested in monitoring time series data on the community engagement in and dependence on federally managed commercial fisheries, linkages between commercial and subsistence fisheries, policy effects on communities, and understanding fishery performance as it relates to population dynamics.

2. Strategic research[2]

The North Pacific Fisheries Management Council has a long history of advancing proactive planning to prepare for analytical advancements in sampling and modeling as well as aligning the Council's goals and objectives with national and global policy changes. The following narrative identifies a suite of key *Strategic* research activities that are consistent with the evolving landscape of fisheries management in the Gulf of Alaska, Bering Sea Aleutian Islands, and the high Arctic. During each triennial review, the subgroup recommends that the SSC review additions, deletions, and changes to *Strategic* priorities as recommended by the Plan Teams and edit these changes as necessary. The SSC should then revise the following narrative, if necessary, based on the changes made. The database in 2021 has 33 priorities listed as *Strategic.* These 33 priorities, while diverse, can be grouped into four broad categories.

[2] **SSC member comment:** This is a placeholder comment so I don't forget, but it may be addressed further on in document: If we (SSC) are truly committed to Strategic (ie longer-time scale vision), then we should be promoting some things in this category into the "top ten" (or similar) on a regular basis; if we aren't doing it, who will?

2.1 Climate and ocean change

The rapidly changing climate and environmental conditions in the North Pacific demand the development[3] of tools and strategies to prepare and respond to both expected and unexpected environmental change. Priorities in this category are almost all *underway* or *partially underway.* Development of data streams and models that can inform or predict changes in the abundance and distribution of managed stocks are of utmost importance. Additionally, ensuring that our harvest control rules and regulations can be climate adaptive is critical.

This research category supports the work to identify and map climate and environment change drivers and their likely response within fishery management, and specifically work on management options that provide a management response. Research and planning efforts currently underway include: the Climate Change Taskforce; NMFS Climate Science Strategy Regional Action Plans for the EBS and GOA; NOAA's Climate Program Office Modeling, Analysis, Predictions and Projections (MAPP) and Coastal and Ocean Climate Applications (COCA) research projects in the GOA and EBS; and the North Pacific Research Board Arctic IERP. Collectively these research teams are expected to develop climate-informed decision support tools that will support groundfish and crab specifications through contributions to risk tables, and predictive tools to evaluate the potential risks and tradeoffs of different management responses related to potential scenarios.

Ocean acidification, similar to climate change, will require strategic research on what stocks will be the most affected, and developing tools to test and respond to those effects. Research is underway to answer some of these questions for specific species, but the more complicated research goal is to understand how those effects ripple out through the ecosystem. Similarly, the effects of anthropogenic pollutants (e.g., microplastics) on the ecosystem is a project listed but has yet to be started.

2.2 Baseline research

Priorities in this category are longer term priorities to help inform fundamental stock assessment processes. Several priorities propose using genetics to better define stock structure for groundfish and crabs. Collection of additional maturity data for managed species will greatly improve the estimates of stock status of some stocks that have few or no maturity estimates and potentially advance stocks up the tier system. Development of new stock assessment models for some stocks (e.g., scallops) is another project that will take long-term investment. Continued development of advanced and more effective stock assessment methods (e.g., NOAA's nascent Fisheries Integrated Modeling System) will be important for implementation of climate-linked management.

2.3 Marine mammals

The priorities related to marine mammals include long-term goals like developing stock assessment models, and management strategy evaluations for Steller sea lions are mostly listed as *No action* and are viewed as important research for long term planning.

2.4 Fishery performance, socio-economic analyses, and human dimensions

Priorities in this category for the most part have not been started and the prioritization of these projects will be informed by the relatively new Social Science Planning Team (SSPT) processes. In the economics realm, these include databases of product inventories and non-market valuation of ecosystem services.[4] In the multidisciplinary social sciences realm, in the near future it is anticipated that these will include LK/TK/subsistence information access, development, and application efforts and case studies of fishery and community participation sustainability issues.

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[3] **SSC member comment:** Another "random" thought/question (not tied to this section: While we are only reviewing research priorities every three years, do we (or should we if we don't) have an annual update on who is doing what research for the urgent or top ten list? Seems like we would like to know that progress is being made or not.

[4] **SSC member comment:** If these have been lingering for a decade are they really a priority? Not that they shouldn't be; how do we promote action on these and a timeline to getting them jumpstarted?

3. Urgent research

Urgent research is essential for compliance with federal requirements, including National Standards, or that has been identified by management as necessary to aid decision-making. It is expected that a short-term project (2-3 year time frame) would meet the information need and that postponement would have a significant impact on management. During each triennial review, the subgroup recommends that the SSC review additions, deletions, and changes to *Urgent* priorities as recommended by the Plan Teams and edit these changes as necessary. *Urgent* priorities represent the primary category the SSC would focus on for potential[5] inclusion in the Top 10 list. Because the Plan Teams and SSC have already reviewed all of the priorities in the database, the subgroup recommended that the SSC should focus on new *Urgent* priorities and priorities that have been previously identified as *Urgent* but have not been started as additional candidates for the Top 10 list.

4. Important research

During each triennial review, the subgroup recommends that the SSC review additions, deletions, and changes to *Important* priorities as recommended by the Plan Teams and edit these changes as necessary. While research priorities that the SSC has previously reviewed and classified as *Important* are unlikely to be included in a Top 10 list[6], new priorities emerging from the Plan Teams might be considered for the Top 10 list.

5. Roles of Plan Teams, Social Science Planning Team, and FEP

5.1 Groundfish, Crab, and Scallop Plan Teams

During each triennial review, members of the Plan Teams should review *Critical Ongoing Monitoring*, *Strategic*, *Urgent*, and *Important* database priorities and recommend additions, deletions, and edits as appropriate. In addition, each should recommend their top 3-5 priorities for consideration in the triennial Top 10 list.

5.2 Social Science Planning Team

A substantial proportion of the Top 10 list in both 2018 and 2021 were related to human dimensions, economics and socio-economics. The SSPT thus far has not been separately recommending new research priorities so these priorities have emerged primarily from SSC members. However, as the SSPT matures and data gaps are identified, the SSC would appreciate if the SSPT would review and forward research priorities related to socioeconomic and human dimensions research for the next triennial review, as well as identify their top 3-5 priorities for consideration in the Top 10 list.

5.2 Bering Sea Fishery Ecosystem Plan

The Bering Sea Fishery Ecosystem Plan (FEP) has its own list of research priorities and the SSC requests that the FEP forward research priorities on a triennial basis and identify 3-5 priorities for consideration in the Top 10 list. FEP priorities by the nature of the Plan tend to be long-term, *Strategic* priorities. Unless *Urgent* priorities are identified, FEP priorities will be added to the database as *Strategic*.

5.3 On-ramps

There are multiple on-ramps for the public to submit research priorities for consideration to the database and to the Top 10 list. The SSC will review new research priorities forwarded by the Groundfish, Crab, Scallop Plan Teams, and Social Science Planning Team. In addition, the SSC would welcome Council staff

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[5] **SSC member comment:** Seems like if they are determined to be "urgent" and the timeline is 2-3 years, then we should delete "potential" and just automatically put them on the top ten list.

[6] **SSC member comment:** Why? or Why not? We need to discuss what should be included in the top 10. Should all levels be able to be part of the top ten?

to provide on-ramps for other groups to forward their priorities such as the Alaska Scientific Review Group for marine mammals, as well as a framework for stakeholders to propose research priorities that do not fit under the Plan or Planning Teams. For instance, the FEP task forces may be possible on-ramp. The SSC benefits greatly from the knowledge, discernment, and prioritization of priorities that occurs during the Plan Teams, SSPT, and potential other groups, so asks that on-ramps to these groups be the primary source of new research priority and "Top 10" recommendations.

6. Research Top 10

The SSC believes that an effective way to highlight the most pressing research needs is to produce a "Top 10" list. At each triennial review, the starting point of the Top 10 should be the previous Top 10 list and the SSC will evaluate whether they should remain on the Top 10 or be replaced by new priorities proposed by the Plan Teams and other bodies, or whether existing research priorities should be elevated to the "Top 10" list. For existing priorities, the subgroup recommended that the SSC should focus primarily on research identified by the Plan Teams and SSC as *Urgent* (2-3 year time frame), but is either *no action* or *partially underway*. Partially underway priorities may represent priorities that have started (e.g., a pilot project) but are in need of further funding to fully achieve. The SSC also will include a "year-added" field on the Top 10 list so that it is known how long a priority has remained on the list if there is rollover from previous reviews.

7. Process

The move to triennial review has reduced the total workload involved in updating Council research priorities, but further efficiency can be achieved by having the SSC focus on changes to research priorities that are developed and recommended by an SSC subgroup well in advance of the SSC review meeting. The SSC chairs will, therefore, appoint a subgroup of SSC members representing a wide range of expertise to prepare for the triennial review. The following processes and deliverables are suggested to prepare for triennial review cycles.

In advance of the Council meeting at which research priorities will be approved:

1. In the year before the triennial review:
    - Council staff coordinate review of research priorities by FMP Plan Teams, BSFEP Team, SSPT.[7] This includes updating the following information:
        i. research status,
        ii. priority ranking,
        iii. changes to titles and descriptions,
        iv. new priorities,
        v. completed priorities and report availability,
        vi. consolidations,
        vii. deletions,
        viii. recommendations for Top 10,
        ix. any other project-specific comments, as possible.
    - Council staff review non-Plan Team on-ramps[8] where research ideas for topics not generally subject to Plan Team review are identified (e.g., marine mammals, seabirds,

[7] **SSC member comment:** Earlier there is mention of other potential (e.g., Industry groups) but they are not listed here. I would suggest that the SSC and the Council have a time before the actual meeting to be able to review/submit their own priorities, just as PTs do. Then the SSC has all the priorities and doesn't get caught up with creating new ones "on the fly" when we should just be picking the top ten. If these non PT groups are wanted to be able to provide input there needs to be a mention of it now. Or we just focus on PTs being able to review/submit priorities and these other entities must work through the PTs (SSC and council included)..

[8] **SSC member reply:** This is getting "messy" I might suggest we keep this "simple". The onramps will be all plan teams, the AP, the SSC, and the Council. And as it says in the note below any/all public generated topics can come through any of these. Then we just make sure if folks

salmon). Presentations to the SSC and Council occur several times a year within these subject areas. The presenters and other contributors can be contacted for suggestions on research priorities, and often include suggestions for research as a part of their presentations. Committee meetings can also be a source of research priority suggestions.
- Recommendations on research provided by members of the public to Council advisory groups (Plan Teams, Committees, etc.[9]) should be considered and responded to at the meeting within the group's operating protocols. If the advisory group agrees with a research recommendation from the public, it should be communicated as one of that group's recommendations to the SSC. If the group does not adopt the recommendation, the member of the public should be advised of the opportunity to make their recommendation during public testimony to the SSC or Council.
- Council will review and approve a 3-year outlook of emerging management issues to be used in characterizing the relevance of research topics to Council needs

2. At least 2 meetings before, select SSC members for the research priorities subgroup based on area of expertise
   - Divide/distribute among SSC subgroup members
     i. the previous "top-ten" research priority list,
     ii. recommended additions, deletions, and changes from Plan Teams and others
     iii. Council-approved 3-year outlook of emerging management issues
   - Discuss tasking among subgroup members
   - Establish deliverables for subsequent subgroup meetings
3. At least 1 meeting before, convene subgroup to review
   - Subgroup member recommendations for responding to the changes suggested by the Plan Teams and others
   - Draft Top 10 list **including rationale** for review/approval at meeting
   - Relevance of recommendations to the Council's 3-year outlook of emerging management issues
   - Draft summary statements, statistics for overall list
   - Any other draft recommendations

At the meeting

1. Review staff report:
   a. Present Council research priorities from the last triennial review, with an overview of any changes the Council made from the SSC recommendation, and why
   b. Brief overview of the additions, deletions, and changes recommended by Plan Teams and other bodies[10]
2. Review subgroup report, and revise/approve as appropriate:
   a. Top 10 list, include a rationale for why those are Top 10
   b. Subgroup's recommended revisions to the *Critical Ongoing Monitoring* summary based on any priority additions or deletions, as needed
   c. Subgroup's recommended revisions to the *Strategic* summary narrative based on any priority additions or deletions, as needed
   d. Subgroup's recommended changes to the database as necessary

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want to provide input they show up to any of these.
Staff reply: I see your point. This is responsive to a recommendation from the April SSC report (3rd bullet under "additional recommendations" in D7). The SSC has been solely responsible for reviewing /tracking projects focused on protected resources and wanted additional input. No plan teams review that type of research and the subgroup wanted a review step for it prior to SSC review.

[9] **SSC member comment:** FMP Plan Teams, BSFEP Team, SSPT, and Ecosystem Committee

[10] **SSC member comment:** I think it would be much more efficient to have each Chair get 5 minutes to present their "case" of why their priorities should be on the top ten list. Then we get them all together and it would be much easier for us to then prioritize.

e. Consider revisions or improvements to the SSC research priority review process [11](at a later meeting)

[11] **SSC member comment:** It is difficult to set research priorities and evaluate the process at the same time. Would reviewing how things went and suggesting revisions to this process better be done at the following SSC meeting?

SSC Member Suggestion for Alternative Approach to Research Priorities

This alternative approach to research priorities is designed to focus our evaluation of research activities on those that will have the largest impact to the Council's mission of managing federal fisheries consistent with the MSA, and where our emphasis on them will have the greatest impact in terms of attracting or guiding prioritization or directing funding by NOAA, Sea Grant, NPRB and other stakeholders. This is where the Council's distinctive voice and perspective can have the most impact (without being a funder), with a level of effort from the Council and SSC that is commensurate with that impact

Suggested Elements of the Process

- Maintain only a Top 10 (or so) list
  - This will focus us on the priorities that are of greatest significance, and give more weight and urgency to our voice
  - We will need to develop standards of scope so we don't end up with "All surveys" and "Economic data collection"

- Focus on knowledge gaps that would produce significant changes in the metrics we use to monitor FMP or national standard performance (including those facilitated by reducing uncertainty or buffers)

- Develop a clear statement for attaining prioritization that reflects the distinctive needs and influence of the Council and its mandate to manage federal fisheries consistent with the national standards.
  - This rubric will make clear how closing the knowledge gap will improve
  - This will allow non-experts in the priority's knowledge area to understand its impact, and compare it to impacts of other priorities, which is not now really possible.

- Populating the initial Top 10
  - Develop 150 word abstracts for the current "Top 10" (perhaps request from the nominating plan teams)
    - This provides description, justification, and associated benefit to the Council's mission for these priorities

- Triennial review
  - Plan teams can update abstracts, including arguments for expected changes in performance metrics, for existing Top 10
  - SSC will evaluate existing priorities for progress or shifting importance in the context of other work.
    - Abstracts of current priorities and proposed replacement priorities will be provided to the entire SSC prior to the review meeting
    - With sufficient information about the benefits of all top priority projects, the SSC can have a discussion of the credibility and importance of the suite of benefits claimed, and make tradeoffs when all members can participate from an informed position.

- Plan teams may propose replacement priorities by developing a 150 word abstracts including expected benefits that may be compared with those of the existing priorities.

- The SSC will give deference to Plan Teams suggesting replacement priorities from the same Plan Team
- Meeting minutes will clarify why the Top 10 were selected, and others were not, but not attempt to carry forward unselected priorities.