North Pacific Fishery Management Council

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SCIENTIFIC AND STATISTICAL COMMITTEE
FINAL REPORT TO THE
NORTH PACIFIC FISHERY MANAGEMENT COUNCIL
September 28th – October 2nd, 2020

The SSC met from September 28th to October 2nd remotely.

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 *Alaska Sea Life Center*	Curry Cunningham *University of Alaska Fairbanks*
Mike Downs *Wislow Research*	Jason Gasper *NOAA Fisheries–Alaska Region*	Dana Hanselman *NOAA Fisheries—AFSC*
Brad Harris *Alaska Pacific University*	George Hunt *University of Washington*	Gordon Kruse *University of Alaska Fairbanks*
Franz Mueter *University of Alaska Fairbanks*	Andrew Munro *Alaska Dept. of Fish and Game*	Kate Reedy *Idaho State University Pocatello*
Matt Reimer *University of California, Davis*	Ian Stewart *Intl. Pacific Halibut Commission*	Tien-Shui Tsou *Washington Dept. of Fish and Wildlife*

Survey Loss Uncertainty Analysis

The SSC received a presentation from Meaghan Bryan (NOAA-AFSC) on a multi-species analysis of variance and bias in stock assessment results as a function of loss of survey data. This analysis was based on retrospective analyses both including and excluding the terminal year survey observation. There was no public testimony. The document and presentation were very helpful in evaluating the potential consequences of the loss of all trawl survey data in 2020.

The SSC noted that missing biennial surveys (i.e., the Aleutian Islands examples) generally produced a larger effect than missing annual surveys, implying a greater loss of information when biennial surveys are missed, commensurate with the gap between surveys.

The SSC found both the "additional sigma" and change in OFL with and without survey data are relevant to the consideration of buffers between the maximum permissible ABC and the SSC's recommended ABC. Species-specific assessment model responses were clearly evident, indicating that buffers may need to take into consideration the range of potential bias/uncertainty observed for each stock. Snow crab provided a notable example of a large degree of uncertainty due to missing survey data combined with a strong positive bias (in biomass and OFL) in the absence of survey data. The presence of existing large retrospective biases appears to be an important factor. The SSC suggests that these results are not prescriptive, but informative for the consideration of the buffer appropriate for each stock and for assessment considerations in the development of risk tables.

The SSC noted that differences between the retrospectives with and without the survey data indicate conflicts among data sources and/or model structure, or anomalous observations. To better understand why some of these patterns were occurring, in the future it might be helpful for authors to explore whether the trend, the biological information, or both contribute to observed differences.

The SSC recommends thinking beyond the current (2020) situation to develop methods for making stock assessment analyses more robust to possible future survey reductions/loss. These may include:

- Renewed investigation of data conflicts in the assessment models, perhaps addressed through data weighting and/or identification of un-modelled processes, or occasional anomalous data points.
- Model-based survey time series (e.g., vector-autoregressive spatio-temporal (VAST) models) that can accommodate incomplete data, changes in survey design, or alternative survey platforms and still produce indices of abundance with statistical variance estimates. These may be particularly helpful for stocks (e.g., Tier 4 crab and Tier 5 groundfish) where harvest levels are informed directly by trends in survey data rather than solely by the results of the stock assessment.
- Exploration of harvest control rules that are explicitly linked to survey and assessment uncertainty and the lag between surveys and assessments.

C-1/C-2 Ecosystem Status Report Preview

The SSC received a preview of the Ecosystem Status Reports (ESR) on the Gulf of Alaska (GOA) by Bridgett Ferriss (NOAA-AFSC), the Aleutian Islands (AI), by Yvonne Ortiz (NOAA-AFSC), and the eastern Bering Sea (EBS) by Elizabeth Siddon (NOAA-AFSC). There was no public testimony. The SSC greatly appreciates the clear and informative presentations, which were all the more impressive given the restrictions on data gathering and in-person meetings due to the COVID-19 pandemic.

One issue, common to all three areas, was the lack of surveys and a significant loss in related environmental data. This issue was least acute in the GOA, as 2020 was a year in which bottom trawl surveys were not scheduled to occur. The problem was most acute in the AI region, as there has not been a bottom trawl survey in three years. Missing too were the zooplankton surveys in the GOA and the EBS. In some cases, these losses were in part mitigated by data from partner organizations, but in others, there was no way to make up for the missing data.

A second issue common to two of the three areas was the continued presence of elevated SSTs. These concerns were moderate in the SE Bering Sea, especially in autumn 2019 and summer 2020, and most severe in summer 2020 in the GOA, where temperatures periodically exceeded the Hobday heatwave threshold. There were no data on sub-surface temperatures in the AI or the EBS, but ROMS model estimates were presented. In the GOA, sub-surface temperatures were sufficiently elevated to raise concerns about their effects on larval and juvenile fish.

Gulf of Alaska Regional Report

Beach seine data from ADF&G showed moderately elevated numbers of age-0 pollock and high numbers of age-0 Pacific cod. In contrast, commercial catches of chum and sockeye salmon in the GOA were low, and in Southeast Alaska, commercial catches of pink, sockeye, and chum were the lowest since 1976. There is evidence of increasing numbers of juvenile salmon that may result in increasing future catches. For seabirds, there were no major mortality events, and colony attendance and reproductive success was in the normal range.

Aleutian Islands Regional Report

Eddy kinetic energy in the vicinity of Amukta and Samalga passes was again low, as it has been since 2012. The result is a sustained below-average transport of heat, salt, and nutrient fluxes to the Bering Sea, the Bering Slope, and the Aleutian North Slope Currents. The transport of zooplankton from the GOA and North Pacific Ocean to the Bering Sea may also be reduced. A “red flag” was the loss of a life in the community of Unalaska to harmful algal blooms (HABs) after the consumption of blue mussels and snails. There were extreme high levels (140x) of toxicity in Unalaska Bay. There is now an expanded monitoring effort for toxicity, and the golden king crab harvest has been temporarily closed. The SSC discussed the need for systematic outreach to coastal communities for HABs monitoring and information exchange. The

SSC also discussed the potentially negative effects of HABs on commercially harvested fin fish. It was noted that there has been a reduction in the sizes of vessels promulgating the Atka mackerel fishery. This has led to higher quality fish being landed and better prices for the product.

Southeastern Bering Sea Report

There was almost no collection of fishery-independent data on either commercially important fish stocks, or environmental data that might have been used to indicate probable year-class strength, or fish distribution. Remote-sensing data on sea-ice cover was available and, for 2020, it appears that ice cover was about average in aerial extent, though perhaps thinner than usual for an average year, and with an early retreat in mid-March. It is unclear how well this thin ice and early retreat will support the 2020 year-classes of pollock and Pacific cod. Reduced levels of chlorophyll-a concentrations (an estimate of phytoplankton biomass), typical of the last five years, may affect fish recruitment, though the connections are not well established. **The SSC suggested that the authors examine indices of region-wide chlorophyll-a rather than focusing solely on the middle shelf.** The unexplained mortality event (UME) of grey whale die-offs continued in 2020. The SSC raised questions as to whether the beaching of grey whales was confined to the Bering Sea. **There were apparently beachings of these whales quite far south along the west coast of the United States, and the SSC requested that more information on this topic be provided in the December ESR**. If starvation is found to be the most likely cause, it may indicate that the whales have reached or exceeded the carrying capacity of their foraging grounds under current environmental conditions in the northern Bering and Chukchi seas.

Considerable time was devoted to new modeling of ocean acidification and the spatial distribution of aragonite concentrations over the eastern Bering Sea shelf. From 15 July through August 2020, waters over the outer shelf were likely corrosive. **The SSC requested that there be an effort to model aragonite concentrations at those times of year and locations where commercially important species of crabs would be most vulnerable and to compare these estimates to threshold levels for deleterious effects for Bristol Bay Red King crab, northern rock sole and pteropods.**

In addition to the "In Brief" handouts developed by ESR authors for public outreach, the ESR authors have been preparing other public outreach materials. Story Maps were developed for the 2019 ESRs and will be produced for the 2020 ESRs, and educational outreach videos based on the ESRs are planned for 2020 to enable additional public engagement. The SSC was pleased to hear how the outreach efforts are being expanded and looks forward to hearing updates on their progress. **The SSC also recommends that the ESR authors pursue the systematic and consistent incorporation of local knowledge (LK) and traditional knowledge (TK) as relevant to ecosystem status updates and reports.** This would be beneficial in the short-term for the identification of potential ecosystem "red flags" especially in a time when researchers do not have timely access to the typical full suite of survey data and over the long-term as the Council moves toward a greater focus on ecosystem-based management. The SSC recognizes that the systematic, methodologically sound, and culturally appropriate collection of all forms of LK and TK is beyond the purview of ESR authors, but sees the benefits of ESR use of these types of data as one more reason for moving forward in building relationships and exploring partnerships with the fishing industry, coastal communities, and regional entities, including tribal entities, in a coordinated manner with ESP authors, SAFE authors, and the Bering Sea LK/TK/Subsistence Task Force, among others.

The authors questioned the SSC as to whether the SSC would like to continue the practice of having brief ecosystem status updates at the October Council meeting. **The SSC expressed appreciation for these valuable reports and requested that they be continued annually**, even if there is no pending crisis.

C-1 BSAI Crab

The SSC received a detailed report on the September 2020 BSAI Crab Plan Team (CPT) meeting from Martin Dorn (NOAA-AFSC, CPT co-chair) and Katie Palof (ADF&G, CPT co-chair), with a presentation on the EBS snow crab assessment by Cody Szuwalski (NOAA-AFSC). Public testimony under the C-1

agenda item was received from Leonard Herzog (F/V Tempo Sea), Jamie Goen (Alaska Bering Sea Crabbers), Kiril Basargin (K-Bay Fisheries Association), and Scott Goodman (Bering Sea Fisheries Research Foundation). Written testimony was provided by Jamie Goen (Alaska Bering Sea Crabbers), Scott Goodman (Bering Sea Fisheries Research Foundation), and Louis Green, Jr. (Seward Peninsula Subsistence Regional Advisory Council). Testimony is characterized in the sections for the stocks spoken about: EBS snow crab, St. Matthew blue king crab (SMBKC), Tanner crab and Norton Sound red king crab (NSRKC).

The SSC also provided comments on select CPT agenda items.

General SSC Comments to the Crab Plan Team

The SSC thanks the CPT and all the assessment authors for both their presentations and all their work in this challenging year. Although included in the written CPT report, the SSC did not receive presentations on all CPT meeting agenda items. Items not presented orally include the crab prohibited species catch (PSC) analysis (Section 13 in the CPT report), the Pribilof Island blue king crab (PIBKC) North Pacific Research Board (NPRB) project report (Section 11 in the CPT report) and the trawl survey updates (Section 2 in the CPT report). The CPT received a presentation from Lyle Britt (AFSC-RACE) regarding plans for the 2021 bottom trawl surveys and received more detail on AFSC survey plans in the Alaska Fishery Science Center presentation (D-1 AFSC Report). The SSC is encouraged to hear that plans for the standard suite of bottom trawl surveys are progressing for 2021. Finally, the SSC encourages continued research into crab recruitment limitations, as presented to the CPT by Jared Weems (University of Alaska Fairbanks) for PIBKC.

The SSC also notes that a separate preview on the ESR was received by the SSC, and comments are reflected in Section C-1/C-2 of this SSC report. Additionally, the SSC received information from the CPT on fishery performance for each of the four crab stocks for October harvest specifications, the Ecosystem and Socioeconomic Profiles (ESP) for Bristol Bay red king crab (BBRKC) and SMBKC, and the NSRKC modeling options for February 2021. SSC comments related to these agenda items are covered in separate sections for their respective stocks in this SSC Report under C-1.

Survey Loss Uncertainty Analysis for Crab

The SSC appreciates the efforts of the CPT and crab assessment authors to address the difficult question of how, or if, to adjust harvest specifications due to the loss of the 2020 summer surveys. In general, the SSC believes that this process was helpful to provide a more rigorous scientific basis for this decision and additional transparency on evaluating scientific uncertainty in stock assessments. In the future, **the SSC encourages continued exploration of approaches that provide for resiliency in cases of unexpected survey effort reductions** including model-based indices that can account for changes in survey effort and in-depth analyses of potential disruptions to data collection to provide information when they arise. The SSC notes that research to better inform management decisions is generally moving in the right direction in this regard. However, the **SSC continues to reiterate its continued support for large-scale fishery-independent surveys as absolutely necessary for scientifically-based, sustainable fisheries management in the North Pacific, Bering Sea, and Aleutian Islands.**

The four crab stocks reported on here include BBRKC, snow crab, Tanner crab and SMBKC**. The SSC agrees that the stock-specific approach utilized by the CPT was the most appropriate course of action.** The CPT and assessment authors provided results from two separate approaches. First, a comparison of retrospective runs and variance in various management quantities, such as OFL and MMB, was presented both with and without a terminal year of survey data, as in Bryan et al. (C-1/C-2 Survey Loss Uncertainty). Second, an additional sensitivity analysis was conducted where the 2019 accepted model was run with hypothetical low and high 2020 survey biomass proxy values, as suggested by the SSC in the June 2020 report. The 25th and 75th percentiles of the multiplicative residuals were used to represent plausible low and high survey observations for 2020. The SSC appreciated the detailed approach to the development of the low/high survey proxy values, which allows for consistency across stocks. This approach would also work

well for groundfish stocks and would be informative for harvest specifications in December, if available. The SSC suggests that, for authors who investigate individual sensitivities to the survey proxy values, that a standard set of reference points, with their individual sensitivities to the survey proxy values, be presented in a consistent format, perhaps similar to the table presented for BBRKC.

Results from these analyses revealed that the impact of the loss of a single survey to these assessments was relatively minor for most crab stocks. However, some stocks exhibited a high sensitivity to this loss of data, and of the four reviewed by the CPT, EBS snow crab seems to be one of these stocks. Though noting that the survey uncertainty analysis for snow crab was completed with an early version of a GMACS model that was ultimately not accepted for setting harvest specifications, a strong and consistent retrospective pattern may contribute to this sensitivity, and this pattern has been observed in multiple recent snow crab assessments. Another factor may have been the timing of a large, recent recruitment event that required additional survey data to clarify the trajectory of the survey biomass within the snow crab model. As noted below in the SSC comments for ABC buffers (C-1 agenda item), there could be a number of reasons why a stock assessment is sensitive to the loss of survey data, and this sensitivity might change over time, with different models and in different situations regarding the stocks' population dynamics.

During the SSC discussion regarding the Bryan et al. analysis, it was noted that this analysis was continuing to follow the results of the loss of a survey fully through to the economic impacts with a full MSE. The SSC encourages this approach, and further suggests that one of the crab stocks could be a useful case study in this regard. There could also be some options from the WKUSER report that could be brought forward to inform future research into this area. Finally, the SSC noted that, while a generally highly useful exercise, the retrospective analyses presented may not provide a true picture of how uncertainty increases with the loss of a single survey, owing to the difficulty in quantifying changes in the perception of stock status.

BSAI Crab ABC Buffers

Following the discussions for each of the four crab stocks for which harvest specifications were set in this meeting, the SSC reviewed the CPT's and SSC's overall approach to setting ABC buffers for these stocks, particularly in regards to additional buffers related to the loss of the 2020 survey data. These stocks include EBS snow crab, Tanner crab, BBRKC and SMBKC. The SSC notes that the summary table provided in the CPT report (p. 24) that details the CPT ABC buffers and the rationale for these buffers for each of the four stocks was useful.

The rationale for ABC buffers was a primary topic of SSC discussion, and the CPT summary table indicated a wide range of issues in support of their chosen buffers. The SSC agreed with the general species-by-species approach adopted by the CPT. Further, it was noted that there could be multiple reasons that a particular stock may exhibit sensitivity to the loss of survey data. The example of EBS snow crab indicated that a strong retrospective pattern may be a factor that contributes to sensitivity to loss of surveys; however, stock status or trajectory may also contribute, and rationales related to the latter were brought forward in discussions of the buffers for SMBKC and BBRKC. Additionally, environmental conditions were also cited for BBRKC and SMBKC, and as was suggested in the SSC comments pertaining to the SMBKC ESP (see SSC C-1 section on SMBKC), unfavorable environmental conditions need to be more tightly tied to impacted biological processes, such as recruitment or natural mortality, in order to provide a clearer, stock-specific explanation of the rationale.

Given the range in rationale for buffers and the desire of the SSC to be consistent and transparent in the application of ABC buffers for crab stocks in general, **the SSC reiterates its 2015 request for a workshop to clarify the criteria for ABC buffers**. The categorization of uncertainty as done in risk tables for groundfish stocks may provide an appropriate starting point for the CPT in this regard, as noted in the SSC comments for C-1/C-2 Survey Loss Uncertainty, acknowledging the differences between the specifications process for crab and groundfish, and the interaction with the State of Alaska crab management. **The SSC encourages the CPT to discuss options for new approaches to specify and clarify additional sources**

of uncertainty more distinctly. Following this discussion, the SSC chose not to make any changes to the SSC recommended OFL, ABC or buffers as described for the four individual stocks below.

BSAI Crab SAFE and Harvest Specifications

The SSC reviewed the SAFE chapters and information provided by the CPT with respect to the stock status information from 2019/2020 and relative to total catch during the 2019/2020 season (Table 1). In addition, Table 2 contains the SSC recommendations for 2020/2021 catch specifications, with maximum permissible ABCs for 2020/2021 shown in Table 3. **The SSC endorsed all of the OFL and ABC recommendations of the CPT, with the exception of the EBS snow crab OFL and ABC (Table 2).** St. Matthew blue king crab and Pribilof Islands blue king crab are overfished; none of the other crab stocks were overfished or approaching overfished status. None of the crab stocks were subject to overfishing.

Table 1. Stock status in relation to status determination criteria for 2019/20 as estimated in May and September 2020. 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 $B_{MSYproxy}$	2019/20[2] MMB	2019/20 MMB / MMB_{MSY}	2019/20 OFL	2019/20 Total catch	Rebuilding Status
1	EBS snow crab	3	60.26	126.10	167.30	1.33	54.90	20.80	
2	BB red king crab	3	12.72	21.25	15.96	0.75	3.40	2.22	
3	EBS Tanner crab	3	18.31	41.07	39.55	0.96	28.86	0.54	
4	Pribilof Islands red king crab	4	0.87	1.73	5.37	3.10	0.86	0.00384	
5	Pribilof Islands blue king crab	4	2.05	4.11	0.175	0.04	0.00116	0.00042	**overfished**
6	St. Matthew Island blue king crab	4	1.67	3.48	1.08	0.31	0.04	0.001	**overfished**
7	Norton Sound red king crab	4	1.04	2.06	1.41	0.68	0.11	0.04	
8	AI golden king crab	3	5.909	11.76	15.94	1.36	5.25	3.74	
9	Pribilof Islands golden king crab	5					0.09	Conf.	
10	Western AI red king crab	5					0.06	< 0.001	

[1] As estimated in the 2020 assessment. [2] For stocks 1-6 MMB on 2/15/2020 is estimated using the current assessment in October 2020. For Norton Sound red king crab MMB on 2/1/2020 is estimated using the current assessment in January 2020.

Table 2. SSC recommendations for October 2020. Note that recommendations for stocks 7, 8 represent those final values from the SSC in February and June 2020 while 4,5,9,10 represent final values from October 2020. Hatched areas indicate parameters not applicable for that tier. Bold indicates where SSC recommendations differ from Crab Plan Team recommendations. Values are in thousands of metric tons (kt).

Chapter	Stock	Tier	Status (a,b,c)	F_{OFL}	B_{MSY} or $B_{MSYproxy}$	Years[1] (biomass or catch)	2020/21[2] MMB	2019/20 MMB / MMB_{MSY}	γ	Mortality (M)	2020/21[3] OFL	2020/21 ABC	ABC Buffer
1	EBS snow crab	3	a	1.6	120.51	1982-2019 [recruitment]	144.29	1.20		0.40 (females) 0.31 (imm) 0.30 (mat males)	**95.40**	**71.55**	25%
2	BB red king crab	3	b	0.16	25.44	1984-2019 [recruitment]	14.93	0.59		0.18	2.14	1.61	25%
3	EBS Tanner crab	3	b	0.93	36.62	1982-2019 [recruitment]	35.31	0.96		0.32 (mat females) 0.24 (imm) 0.29 (mat males)	21.13	16.90	20%
4	Pribilof Islands red king crab	4	a	0.21	1.73	2001-present [MMB]	5.37	3.10	1	0.21	0.86	0.65	25%
5	Pribilof Islands blue king crab	4	c		4.11	1980/81-1984/85 & 1990/91-1997/98	0.175	0.04	1	0.18	0.00116	0.00087	25%
6	St. Matthew Island blue king crab	4	c	0.05	3.34	1978-2019 [MMB]	1.12	0.34	1	0.18	0.05	0.04	25%

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Chapter	Stock	Tier	Status (a,b,c)	F_{OFL}	B_{MSY} or $B_{MSYproxy}$	Years[1] (biomass or catch)	2020/21[2] MMB	2019/20 MMB / MMB_{MSY}	γ	Mortality (M)	2020/21[3] OFL	2020/21 ABC	ABC Buffer
7	Norton Sound red king crab	4	b	0.14	2.07	1980-2019 [MMB]	1.66	0.80	1	0.18	0.13	0.09	30%
8	AI golden king crab	3	a	EAG (0.61) WAG (0.56)	11.84	1987/88-2012/13	14.77	1.25		0.21	4.798	3.599	25%
9	Pribilof Islands golden king crab	5				See intro chapter					0.09	0.07	25%
10	Western AI red king crab	5				1995/96-2007/08					0.06	0.01	75%

[1] For Tiers 3 and 4 where B_{MSY} or $B_{MSYproxy}$ is estimable, the years refer to the time period over which the estimate is made. For Tier 5 stocks it is the years upon which the catch average for OFL is obtained. [2] MMB as projected for 2/1/2020 for Norton Sound red king crab, 2/15/2021 for all other stocks. [3] AIGKC OFL and ABC calculated by author outside the chapter for using the Approach 2 combination of EAG and WAG and 25% buffer between OFL and ABC.

Table 3. Maximum permissible ABCs for 2020/21 and SSC recommended ABCs for stocks where the SSC recommendation is below the maximum permissible ABC, as defined by Amendment 38 to the Crab FMP. Values are in thousands of metric tons (kt).

Stock	Tier	2020/21 *Max*ABC[2]	2020/21 ABC
EBS Snow Crab	3	94.8	71.55
Bristol Bay RKC	3	2.13	1.61
Tanner Crab	3	20.87	16.90
Pribilof Islands RKC	4	0.857	0.648
Pribilof Islands BKC	4	0.00104	0.00087
Saint Matthew BKC	4	0.05	0.04
Norton Sound RKC[1]	4	0.129	0.10
Aleutian Islands GKC	3	4.773	3.599
Pribilof Islands GKC[1]	5	0.084	0.070
Western Aleutian Islands RKC	5	0.050	0.014

[1] For Norton Sound red king crab and Pribilof Islands golden king crab, this is for the 2020 calendar year instead of the 2020-2021 crab fishing year. [2] For Tier 5 stocks, this is 0.90 of OFL while all other stocks P*.

Bristol Bay Red King Crab

The BBRKC assessment was presented by Katie Palof (ADF&G, CPT co-chair). Written public testimony was provided by Jamie Goen (Alaska Bering Sea Crabbers), who requested that the BBRKC SAFE authors include raw numbers used for PSC limits in a table in the SAFE, as is the current practice for EBS snow crab (see Table 11 in the EBS snow crab SAFE).

The BBRKC assessment includes updated catch and size-composition data for the 2019/20 directed fishery and catch and size-composition data for bycatch in the groundfish fisheries. There were no new survey data owing to the cancelled NMFS bottom trawl survey. Seven model alternatives were analyzed in GMACS for this year's assessment.

All seven models fit the catch and bycatch biomasses well. Of these, two models (19.0a and 19.3) were considered as the main alternatives for this year's specifications. Model 19.0a is the base model from 2019 with the exception that an error was fixed. Model 19.3 was identical to the base model except for the way natural mortality was considered. In model 19.3, a constant M is estimated for males during 1980-1984, M is fixed to 0.18 per year for males during other years, and an estimated constant multiplier is applied to male M to obtain female M (see Fig. 13c in SAFE). Other variants were used to make multi-year projections, characterize uncertainty associated with the lack of a 2020 survey, and to investigate model sensitivity to relaxation of priors on survey catchability (19.3b). Model 19.3b led to an unreasonably high estimate of catchability for the trawl survey. This model was intended for sensitivity analysis only and was not considered to be a viable alternative for this year's assessment. Multi-year projections (19.0b, 19.3a) were developed in response to previous SSC requests by setting the terminal year recruitment equal to the average recruitment for the previous 7 years. The CPT felt that the 7-year averaging period was arbitrary and not sufficiently justified for adoption at this time.

The SSC agrees with the authors and CPT to adopt model 19.3 for this year's assessment. Model 19.3 fit the data better than 19.0a, including a better fit to survey biomass in recent years. Higher biomass estimates associated with model 19.0a were largely due to differences in assumed natural mortality rates. The SSC noted that many different natural mortality structures have been explored for this stock over the decades and the variant embodied in model 19.3 seems to be an improvement based on the slightly better fit to the data.

The assessment shows that this stock has been declining steadily since 2009. In the past 35 years (since 1984), estimated recruitment has been above the historical long-term average in only 6 years, the most recent being 15 years ago (2005). Estimated recruitment has been extremely low for more than a decade and reliable estimates of recruitment do not exist for 2020 due to the lack of a survey. Fishery CPUE has declined steadily since 2014.

The CPT considered the level of uncertainty not addressed by the model that should be considered for setting the buffer between OFL and ABC. First, the CPT considered whether the uncertainty associated with the chosen model differed from the level of uncertainty in the previous year. Second, the CPT considered whether the canceled 2020 survey added sufficient additional uncertainty to warrant enlarging the buffer. Last year, the CPT recommended, and the SSC agreed, to set the ABC using a 20% buffer below the OFL to account for additional uncertainty in the assessment associated with the model's overestimation of the 2018 and 2019 NMFS EBS bottom trawl survey biomass, retrospective patterns, and distribution shifts that may have affected the assessment associated with recent environmental conditions (e.g., elevated bottom temperatures and the lack of a cold pool). **This year, the CPT concluded that the level of uncertainty associated with last year's model was unchanged and thus did not warrant a change in buffer to address these sources of uncertainty. The SSC agrees.**

To determine whether an increase in the buffer may be warranted owing to additional uncertainty associated with the cancelled 2020 NMFS survey, three approaches were undertaken in Appendix D. In the first approach, a pair of retrospective analyses were compared in which, for the first of the pair, data

were removed sequentially one year at a time beginning with the most recent year. In the second of the pair, the same procedure was applied except that survey data in the terminal year were also removed. In the second approach, the 2019 survey was dropped from the 2019 accepted assessment model. In the third approach, a sensitivity analysis was conducted with hypothetical low and high biomass from proxy surveys for 2020. The 25th and 75th percentiles of the multiplicative residuals were used to represent plausible low and high survey observations for 2020. Resultant large changes in management quantities such as OFL and MMB, would be taken to indicate high sensitivity.

Results from these comparisons indicated the likely additional uncertainty introduced by the cancelled 2020 survey is about 5% (the median overestimation was 3.2% and the mean overestimation was 4.7%). **Thus, the CPT recommended adding an additional 5% to the current 20% ABC buffer to account for the additional uncertainty associated with the cancelled 2020 survey for a total 2020 ABC buffer of 25%.** In addition to the analytical basis for this increment described in Appendix D, **the CPT justified this recommendation primarily with additional concerns about whether the declining stock trend continued through 2020 and uncertainty about the stock status relative to the overfished condition**. In this regard, the SSC noted that MMB was estimated to be 14.24 kt compared to the MSST of 12.75 kt in 2019, a difference of just 1.49 kt (3.4 million lbs). During 2016-2019, MMB declined an average of 3.86 kt (8.5 million lbs) per year. If this recent rate of decline continued from 2019 to 2020, then MMB would be less than MSST and the stock would now be overfished. In the absence of new survey data, the model estimates a slight increase in biomass from 2019 to 2020, so it is not currently estimated to be overfished. Given the cancellation of the 2020 EBS trawl survey, the 2021 survey becomes even more important. **For these reasons, the SSC supports the recommendations by the authors and CPT to increase the size of the buffer between OFL and ABC from 20% to 25% owing to the lack of a survey in 2020. Thus, the SSC also supports the OFLs and ABCs recommended by the authors and CPT for 2020.**

Recommendations

The SSC appreciates the improvements in this assessment over the years, including the use of GMACS for this assessment since 2019. The authors have been very responsive to previous CPT and SSC comments.

The CPT provided the following recommendations to the assessment authors:

- Include a table of M values for all scenarios in the document.
- Include a table in the assessment document that provides the differences in likelihood values between the base model and each alternative model scenario considered a candidate for status determination.
- Evaluate different approaches to constraining the terminal year estimate of recruitment for the purpose of developing projections.

The SSC agrees with the CPT recommendations. Additionally, the SSC requests the following:

- Next year's assessment should estimate the probability that the stock is currently in the overfished condition.
- Information should be provided on the prevalence of crab bycatch excluders being used in the pot cod fishery, and whether the excluders influence the length composition of bycatch.
- The SSC also endorses the Alaska Bering Sea Crabber's request to include raw numbers used for PSC limits in a table in the BBRKC SAFE consistent with EBS snow crab (see Table 11 in the EBS snow crab SAFE), if it is practical to do so.
- The SSC looks forward to future analyses of the use of VAST estimates for this stock assessment including diagnostics and better-fitting error distributions.

Ecosystem and Socioeconomic Profile

The SSC commends the inclusion of a new Ecosystem and Socioeconomic Profile (ESP) for BBRKC as Appendix E of the SAFE. This stock was prioritized for an ESP owing to its historical importance, declining abundance and poor recent recruitment. Moreover, this stock depends greatly on habitat and the stock is highly vulnerable to the impacts of future ocean acidification.

This ESP provides an excellent set of mechanisms, metrics and indicators that may control the productivity of the BBRKC stock and fishery. A comprehensive set of data sources and ecosystem information and mechanisms by life history stage were compiled and a preliminary qualitative analysis of indicators was conducted. The metric assessment identifies potential vulnerabilities and bottlenecks by life history stage and provides mechanisms to refine the selection of a suite of indicators that represent the critical processes. Finally, the ESP reports key socioeconomic indicators, including fishery performance, economic, and community indicators, as well as an overview of data gaps and future research priorities. The SSC fully supports the development of the dedicated Annual Community Engagement and Participation Overview (ACEPO) that will accompany groundfish and crab SAFEs, as described in this and the SMBKC ESP, and is encouraged that the ACEPO effort (1) is being coordinated with ESP (and ESR and SAFE) authors and (2) holds the potential for identifying reduced-form indicators of community effects suitable for incorporation in future ESPs. The SSC feels that this ESP provides an excellent first step to considering the multitude of factors that may affect the productivity of this stock. Moreover, it provides a framework upon which we can build a more complete understanding of BBRKC in the ecosystem as progress is made to fill data gaps and address research priorities in the future.

The SSC provides a number of recommendations for future development of this ESP:

1. The ESP authors should examine the proposed indicators for potential strong cross-correlations indicating redundancy. For instance, do indices based on the Arctic Oscillation and wind stress indicate the same process? If so, a reduced set of indicators would consider just one of these.
2. The SSC was somewhat surprised about the use of salmon as an index. Are there stomach studies documenting that RKC larvae are an important component of the diets of out-migrating salmon? Identification of crab larvae to species is important as there are many species of crab larvae in the ocean and hermit crab larvae can be dominant.
3. The SSC also notes that chlorophyll a may be a good indicator of the timing of the spring bloom, but many species of phytoplankton can contribute to this index. Diatoms, particularly of the genus *Thalassiosira* spp., may be important prey for larval RKC nutrition.
4. For predator-prey relationships, the effect of temperature on metabolic rate may be an important consideration for consumption.
5. The SSC is pleased to see community effects and supports their inclusion in the ESP.
6. Consider cross-referencing a similar life stage-based analysis of factors and processes potentially affecting year-class formation that was conducted during a workshop with 14 crab scientists in 1994 and reported by Tyler and Kruse (1995; Report of the modeling workshop on year-class strength formation of red king crab. ADF&G, Comm. Fish. Manag. Devel. Div., Reg. Inform. Rep. 5J95-11) and Tyler and Kruse (1996; Conceptual modeling of brood strength of red king crabs in the Bristol Bay region of the Bering Sea. Pages 511-543 *in* Proceedings of the International Symposium on Biology, Management and Economics of Crabs from High Latitude Habitat. Univ. Alaska Fairbanks, Alaska Sea Grant Prog. Rep. 96-02). By cross-referencing the ESP analysis with these two publications stemming from this workshop, potential additions or modifications to Table 2a of the ESP might be identified. For instance, predators (and prey) suggested during the workshop, but not included in the ESP, include pollock (larvae), *Pycnopodia* sea stars (glaucothoe), flatfish (juveniles) and sculpins (adults). At a minimum, it would be interesting to contrast the views of crab scientists 25 years ago with those of current scientists.

7. The implications of directional changes in physical, biological and socioeconomic indicators on pages 179-181 could be clarified in some cases. Readers should be able to look at this list and understand the implications of increases (or decreases) in each indicator on BBRKC or human well-being (socioeconomic indicators). For instance, it is clear from the description of the index that the corrosivity index represents acidified bottom water conditions in Bristol Bay, which would negatively affect larval condition, juvenile growth and survival, and shell hardness. Admittedly, the range over which increases in this index cause these negative effects could be clarified (i.e., there is some threshold below which increases in the index have no effect). On the other hand, it appears that the response of BBRKC to summer bottom temperatures is a bit ambiguous. Are warmer (less sea ice) or colder temperatures (more sea ice) beneficial to BBRKC? For each index, the description should clearly indicate the effect of increases (or decreases) in the index on BBRKC.
8. Finally, for this first-cut analysis, it makes sense to hypothesize linear responses of some feature of BBRKC to increases (or decreases) in each indicator, leading to the traffic light approach. However, as suggested below, the responses of BBRKC may be nonlinear and may involve multiple mechanisms such that the net response of a directional change in a specific indicator may be dome shaped or uncertain. Future iterations of the ESP for BBRKC might consider these more complex relationships or at least acknowledge them as caveats to the current analysis. For example, below we describe potential additional considerations of the response(s) of BBRKC to temperature.

Temperature is widely held to be a key factor affecting BBRKC, but the implications of an increase in temperature on BBRKC in the ESP were not clear. When summarizing the results of the ESP, the CPT summarized the directional effects of the corrosivity index, chlorophyll a, wind stress and sockeye salmon on BBRKC life history stages, but when summarizing temperature effects, they simply said "Bristol Bay summer seawater bottom temperatures were lower than average."

Moreover, the nature of these temperature effects is likely to be more complex than indicated and deserving of more thorough analysis. For instance, in Table 2b, temperature is identified to affect egg (embryo) survival. However, the temperature effect is not so clear as there may be processes operating at both cold and warm temperatures that may adversely affect embryo survival. For instance, cold temperatures delay incubation thereby prolonging the period of exposure of embryos to disease and egg predators, whereas warm temperatures may promote growth of disease and parasite populations causing higher embryo mortality. Conceivably, both the warmest and coldest temperatures are deleterious and there may be an intermediate range of optimal temperatures for maximum embryo survival. Likewise, the match of larval hatch timing with the spring diatom bloom may not be a simple linear relationship with temperature. Although RKC hatch timing is a function of temperature (degree days) that has been determined in the lab, the spring bloom on the eastern Bering Sea continental shelf depends on water column stratification that is caused by either sea ice extent and melt or by solar heating, depending on the year. Counterintuitively, spring blooms on the shelf occur earlier in cold years than warm years. It has yet to be established whether there is an optimal temperature associated with a match between crab larvae and their diatom prey or if the relationship is more complex. Additionally, primary production results from tidal mixing in Aleutian Island passes, which is then advected into the eastern Bering Sea along the north side of the Alaska Peninsula. The extent to which larval red king crab in nearshore waters depend upon this source of production has not been considered to our knowledge.

As another example, it is postulated in the ESP that the cold pool (a function of temperature) may afford some protection to crabs from predation by cod and some flatfish that tend to avoid temperatures below 1 °C. However, BBRKC also seem to avoid the cold pool (Zacher et al. 2018). In warm years, legal-sized male crab aggregate in the center of Bristol Bay, while in cold years they are closer to the Alaska Peninsula. Likewise, female RKC also appear to avoid waters < 2 °C, perhaps so that they remain in optimal temperatures for embryo development (Zacher et al. 2018). So, the net effect of shifting distributions of both predators (cod and some flatfish) and prey (BBRKC) on predation rates may require more detailed analysis. A key question is, do predators access the relatively warmer nearshore waters of Bristol Bay in

years of an extensive cold pool as crabs do? These examples are for illustration. There are other hypotheses about mechanisms involving temperature and BBRKC life history. The multiplicity of biophysical mechanisms by which temperature can affect BBRKC illustrate the challenge to apply some factors, such as temperature, in a simple traffic light-type analysis. At this stage, it is important that the proposed mechanisms (and directional effects) are clearly stated so that these relationships can be tested and such that future ESPs can consider other mechanisms and non-linear relationships that may be supported by additional research.

Eastern Bering Sea Snow Crab

Cody Szuwalski (NOAA-AFSC) presented the EBS snow crab assessment. Public testimony was received from Leonard Herzog (F/V Tempo Sea), Jamie Goen (Alaska Bering Sea Crabbers), and Scott Goodman (Bering Sea Fisheries Research Foundation). Written testimony was also received from Jamie Goen (Alaska Bering Sea Crabbers), and Scott Goodman (Bering Sea Fisheries Research Foundation). Public testimony was primarily related to the size of the OFL, the size of the ABC buffer, and clarifying earlier SSC comments.

The two primary models under consideration for harvest specifications included Model 20.1, which was the 2019 accepted model with updated data, and a new GMACS model (20.2) that was based on the 2019 accepted model, which was the author's and CPT's preferred model. The SSC appreciates all the effort to make the GMACS transition for snow crab a smooth one. Generally, the SSC accepts a new model when it represents an improvement over the previous model. There are some improvements and advantages with the author-preferred GMACS model relative to the status quo model, but there are also some unresolved problems. Beyond improved fits to the data, one of the most important evaluation criteria is biological plausibility of the results, and a new modeling framework is only as good as the plausibility of the results. The SSC noted that it seems unlikely that the stock is 4x larger than last year's estimate, while lacking new survey data to support that conclusion. Despite this change in scale, there is still a very large positive retrospective pattern which is puzzling because one would expect this positive bias to be reduced if the previous model was overestimating stock size. **The SSC recommends further efforts to reduce the large retrospective pattern in future models, perhaps through time-varying catchability, natural mortality changes, or different selectivity functions.**

The author and CPT had concerns with how recruitment variability is controlled in Model 20.2, which does not appear to have been resolved with the extremely large estimated 2015 year class in the author's preferred model. The GMACS model (20.2) seemed to fit some of the data slightly better, most particularly the MMB survey data in the terminal years, but the SSC considered the recruitment deviation problem too big to ignore. Until a resolution is reached on how to appropriately control recruitment estimates, the author provided a sensitivity to each of the 2018 and 2019 survey data points. This sensitivity revealed that the model responded differently to each survey and showed that under either survey scenario, Model 20.2 was still providing higher estimates of MMB compared to the status quo model (20.1). Another feature of the author-preferred GMACS model is extremely high fully-selected fishing mortality in some years that would imply that 95 - 98% of fully-available large crab would have been harvested, which does not seem logistically possible. In addition, the authors noted that there were no jittering tests done on Model 20.2 and that the alternative GMACS configuration (20.3) had some convergence issues. **The SSC requests the authors provide a biological rationale, if there is one, for differences in the sex ratio of recruitment.**

Owing to these concerns with the scale of the population and the relative biological implausibility of recruitment, the SSC recommends the status quo model (20.1) be used for management advice. The SSC looks forward to seeing a new iteration of the GMACS Model 20.2 next year. The harvest specifications resultant from Model 20.1 represent an increase in the OFL from last year's assessment, but considerably less than the author's preferred model. **The SSC recommends that snow crab continue to be managed as a Tier 3 stock. Results from Model 20.1 indicate that 2020/2021 MMB is greater than B_{MSY} as of February 15, 2021, placing this stock in Tier 3a.**

As Model 20.1 continues to present some concerns, including a strong retrospective pattern, uncertainty in M, and other considerations from the October 2019 SSC report, the SSC continues to recommend a base 20% buffer. The SSC also received information that snow crab was relatively sensitive to the missing terminal year of data, primarily related to its large positive retrospective pattern. However, this analysis of missing survey uncertainty was conducted with an early version of the GMACS model, and the status quo model may respond differently to a missing terminal year survey value. The SSC had considerable discussion about an additional buffer because of the lack of a 2020 survey. As the quantitative examinations of uncertainty due to the loss of the 2020 survey were not applicable to the model selected by the SSC, the SSC based the additional buffer on judgment regarding the potential uncertainty associated with the terminal year recruitment and resultant MMB. **Given the lack of confirmation of the large 2015 year class by a bottom trawl survey, the SSC added an additional 5% buffer for a total ABC buffer of 25% for EBS snow crab.** The SSC notes that in future years, the author and CPT might consider presenting scientific uncertainty in a more categorized way, perhaps as done in the risk tables for groundfish (see "BSAI crab ABC buffers" above).

The SSC noted the relatively strong correlations for snow crab and BBRKC with the Arctic Oscillation, and suggests this could be further explored to determine the mechanism. The SSC requests that the CPT or the crab assessment authors examine recruitment estimates across crab stocks to see if they share a common underlying pattern. **The SSC recommends that an Ecosystem and Socioeconomic Profile (ESP) be developed for EBS snow crab as time allows that carefully considers what indicators directly affect this stock.** In public testimony, it was postulated that crabbers are catching the same crabs multiple times and re-sorting them. **The SSC recommends short-term tagging projects be considered to understand the extent of this phenomenon and to help further understand discard mortality.**

As with all assessments, the estimation of natural mortality is a challenge for snow crab. **The SSC recommends that the authors consider examining the web-based Barefoot Ecologist tool to develop a natural mortality prior distribution for snow crab.** VAST modeling for the bottom trawl survey was postponed this year and the SSC would like to see it move forward as model-based indices may help add robustness to future missing survey data or a potential change in spatial distribution into the northern Bering Sea. The SSC noted a number of minor formatting and editorial issues in the assessment such as missing axes and labels that will hopefully be corrected next year.

St. Matthew Blue King Crab

Martin Dorn (NOAA-AFSC, CPT co-chair) presented the SMBKC assessment, and the ESP to the SSC. In public testimony, Kiril Basargin (K-Bay Fisheries Association) noted that surveys reveal declining abundance for several crab stocks. He suggested that flatfish fisheries are disrupting feeding habitat for crab in the Unimak area.

In 2020, the SMBKC assessment was conducted in the GMACS framework. The authors brought forward three models. The first was an update of Model 16.0, which is the model configuration that has been accepted in recent years. The authors included a second model run with the terminal year of recruitment set at the mean of the last 7 years (Model 16a) because the estimated recruitment for the terminal year (2020) in Model 16.0 was unrealistically high. Finally, in response to SSC comments, the authors included a model run (Model 20.1) that excluded the ADF&G pot survey data. This sensitivity run was requested due to the contradictory time trends in the NMFS trawl survey and the ADF&G pot survey data. The only new data incorporated into these models were updated 2010-2019 groundfish trawl and fixed gear bycatch estimates. No recent directed fishery data were available because the fishery has been closed since 2016/2017.

In response to SSC and CPT requests, retrospective analyses were included in this year's assessment and iterative re-weighting options for the size composition data were explored. Exploration of initial model time blocks for Q were done in May 2020 and the analyst will present additional analyses during the January

2021 crab modeling workshop. Progress on exploration of potential explanations for the discrepancy in the pot and trawl survey time trends using spatial models was postponed until 2021.

The SSC appreciates the authors' exploration of Model 20.1, which excluded the ADF&G pot survey abundance and length composition data. The results of this model improved the overall fit to the NMFS trawl survey data, however, it failed to fit the declining trend observed in recent years. The SSC agrees with the CPT and the authors that this exploratory model provides useful information but should not be used for estimation of the ABC and OFL for 2020/2021.

Results from Models 16.0 and 16.0a were nearly identical. The CPT suggests that the selection of seven years for the estimation of mean recruitment for use in setting the terminal year recruitment in Model 16.0a was somewhat arbitrary. **The SSC supports the CPT recommendation that the basis for terminal year recruitment estimates should be discussed during the upcoming crab modeling workshop.** Given that the results of Model 16.0 and 16.0a were nearly identical and do not appreciably change quantities used for management, the SSC agrees with the authors and the CPT that Model 16.0 should be used as the base model for the 2020 stock assessment.

The SSC recommends that this stock be managed as a Tier 4 stock. The SSC accepts the author and the CPT recommended OFL for 2020/2021 using Model 16.0. The estimate of MMB on 15 February 2021 relative to the B_{MSY} proxy is 0.34 placing this stock in an overfished condition.

The SSC appreciates the addition of retrospective analyses that were conducted for this stock. These analyses revealed a strong residual pattern (Mohn's Rho 0.346). However, this stock had low sensitivity to the lack of the terminal year survey data. **Based on this finding, the SSC agrees with the CPT that a 25% buffer is appropriate for this stock and accepts the resulting ABC for 2020/2021.** This buffer corrects the buffer specified last year and is consistent with the SSC's concerns of data limitation, and inconsistencies between pot and trawl survey trends for this stock.

The SSC appreciates the continuing evolution of the SMBKC ESP and its inclusion again in this year's assessment. As was discussed for BBRKC, there should be some effort to link the corrosivity index to actual thresholds for expected shell damage (noting that this may require laboratory research) as well as linking physical indices with processes influencing the assessment (e.g., catchability, growth increments, reproductive potential, molting probabilities, etc.). In addition, predation indices based on Pacific cod biomass should be based on spatial overlap with the stock and expected region-specific consumption. The SSC appreciates the thoughtful integration of key socioeconomic indicators in the SMBKC ESP. As noted in last year's SSC report, given the SMBKC fishery's alternating periods of relative abundance and closures, this ESP provides a rare and valuable opportunity to better understand the spatial, temporal, and intensity dimensions of the human component of the fishery within the context of fishery instability and broader changes in the Bering Sea ecosystem. This opportunity for understanding will come if, and as, indicators pick up shifts in patterns of community engagement, harvester annual rounds, and harvesting and processing diversity before and after closures, as fishing portfolios, fleet sizes, CPUE rates, and utilization rates change and communities adapt, or not, to those changes.

Tanner Crab

The Tanner crab stock assessment was presented by Martin Dorn (NOAA-AFSC, CPT co-chair). Oral public testimony was provided by Scott Goodman (Bering Sea Fisheries Research Foundation) who commented on the State's new harvest control rule, which was the result of a collaborative effort, the ABC buffer for Tanner crab, which was set many years ago, and the need for more specific considerations of scientific uncertainty. Written public testimony was provided by Jamie Goen (Alaska Bering Sea Crabbers) who requested the Tanner crab SAFE author include raw numbers used for PSC limits in a table in the SAFE as is current practice for eastern Bering Sea (EBS) snow crab (see Table 11 in the EBS snow crab SAFE).

As the fishery has been closed and the NMFS bottom trawl survey was cancelled, no new survey or target

fishery data are available from 2020 for this assessment. New data were confined to finalized catch data for 2018/19 and new bycatch data for 2019/20. Estimated bycatch abundance and biomass in the groundfish fisheries for 2016/17-2018/19 were revised as AKFIN updated the algorithms so that estimates match those that NMFS uses to calculate PSC estimates.

This year's assessment includes five model scenarios:

1. Model scenario 19.03 (2019) is last year's model (formerly named model 19F03).
2. Model 19.03 (2020) is this year's base model; it is last year's model updated with bycatch fishery data for 2019/20 (from the snow crab, BBRKC, and groundfish fisheries).
3. Model scenario 19.03R is intended to check the revised bycatch estimates of Tanner crab in the groundfish fisheries from 2016/17 to 2018/19. It does not include 2019/20 data and simply accounts for this single incremental change. It is not intended as a viable alternative model for adoption.
4. Model 20.07 fits biomass and size composition estimates from the 2013-2017 BSFRF side-by-side (SBS) catch ratio comparison studies along with the standard NMFS bottom trawl survey data to try to better estimate NMFS survey catchability. Specifically, year-specific availability curves for the BSFRF data were determined outside the model using the ratio of expanded (area-swept) estimates of abundance by 5 mm CW size classes derived from NMFS survey data at stations where SBS tows were conducted to those derived from NMFS survey data for the entire survey grid. Estimating the availability curves outside the model was reasonably straightforward and vastly reduced the number of model parameters that would otherwise be necessary.
5. Model 20.10 represents an alternative approach to incorporate the BSFRF data. In this case, size-specific catch ratio analysis was performed outside the model using the BSFRF and NMFS data from side-by-side tows to directly estimate the size-specific selectivity of the NMFS survey. The estimated curve(s) were then used directly in the assessment, rather than having to estimate survey selectivity (and fully-selected catchability) inside the model. However, this analysis is incomplete (environmental factors such as depth and sediment type need to be incorporated into the analysis) and the selectivity curves used for this scenario are provisional. As such, this model is not considered as a viable alternative for adoption.

In general, the two viable models, 19.03 (2020) and 20.07, both fit the NMFS survey biomass time series data equally well. Model 20.07 is considered an improvement as it includes the BSFRF survey data, which it also fits well. Also, both models tend to fit the other data equally well: molt increment, maturity ogives, total catch size compositions from the directed fishery, and bycatch size compositions for females in the directed fishery. Several undesirable features of this assessment remain. For instance, both models tend to underestimate periods of high observed survey biomass and overestimate periods of low survey biomass, which has been a long-standing issue for this assessment. Also, both models overpredict growth of male crab and overpredict growth for females at small and large sizes, while underpredicting growth of females at intermediate sizes. Finally, in this year's assessment, the terminal year recruitment estimate is highly uncertain for both models because there are no survey size composition data from 2020 to inform the estimate. A retrospective analysis confirmed that the lack of a terminal year survey results in highly variable and highly uncertain estimates of terminal year recruitment.

An important difference between models concerns estimates of mature biomass. The variations in mature biomass over time are similar but the scales are different. The estimated current MMB is about 15% smaller in Model 20.07 than in 19.03 (2020).

The author and CPT prefer Model 20.07 because it fits all of the datasets reasonably well and includes the BSFRF data, which help to scale the NMFS EBS shelf bottom trawl survey data. The SSC agrees with the choice of Model 20.07 for these same reasons.

In previous assessments, average recruitment was calculated including the estimate for the terminal year.

However, lacking a reliable estimate of terminal year recruitment, this assessment uses the period 1982-2019 to compute the long-term average.

Assessment results changed little from last year owing to the paucity of new data. Estimated MMB at the time of mating is strongly pulsed with highest estimates in the early 1970s and smaller peaks in 1991, 2008, and 2014. **MMB is projected to decline from 39.55 kt in 2019/20 to 35.31 kt in 2020/21.** B_{MSY} is estimated to be smaller this year (36.62 kt) than last year (41.07 kt) and current biomass is estimated at 96% of B_{MSY}, **placing the stock in Tier 3b**. Estimates of average recruitment and F_{MSY} are smaller this year. Recruitment has been generally low for the past two decades. Improved recruitment was estimated for 2016, 2017, and 2018, but these estimates remain uncertain and await future trawl surveys.

A Markov Chain Monte Carlo (MCMC) simulation approach was used to characterize model uncertainty including an evaluation of the probability density function (pdf) of OFL. However, the MCMC performed poorly this year. **Thus, the CPT recommended using maximum likelihood estimation (MLE) estimates rather than the MCMC for harvest specifications; the SSC agrees.** Impacts of the two alternative approaches on calculated reference points are presented on p. 43 of the Tanner crab SAFE.

The CPT considered the buffer to address model uncertainty as well as the need for an additional buffer associated with the cancellation of the NMFS bottom trawl survey in 2020. **Last year the SSC determined that the 20% buffer between OFL and ABC accounts for uncertainty associated with concerns about model misspecification, model convergence, parameters hitting bounds, and ongoing retrospective patterns. The CPT determined that these concerns remain with this year's assessment and recommended retaining the 20% buffer for this year's catch specifications; the SSC agrees.**

The CPT also considered the additional uncertainty introduced into the assessment due to the lack of a 2020 bottom trawl survey based on (1) retrospective analyses in which the terminal year was sequentially dropped from the dataset, re-run, and compared with results from the same model run without NMFS survey data in the terminal year, and (2) model runs with simulated 2020 survey biomass data that bracketed the range (25^{th} and 75^{th} percentiles) of the value expected if the survey had been conducted. It was noted that retrospective patterns for Tanner crab were small and did not increase substantially when the terminal year survey was removed. One exception were the estimates of terminal year recruitment, which fluctuated widely when not informed by survey data. However, this uncertainty does not have management implications because recruiting crabs are not mature nor legal-sized. Additionally, the analysis with low and high hypothetical 2020 survey results did not reveal much sensitivity in the OFL and MMB estimates. **Thus, the CPT does not recommend adding any additional buffer for Tanner crab owing to the loss of the 2020 survey and the SSC agrees. Thus, the SSC agrees with the author's and CPT's recommendation to use the 20% buffer previously adopted for this stock to calculate ABC this year.**

Thus, the SSC agrees with the CPT's recommended OFL and ABC based on MLE estimates for 2021 as reported on p. 20 of the Crab SAFE Introduction.

Recommendations

The SSC appreciates the assessment author's efforts to address CPT and SSC comments. Some of these responses remain works in progress, and the SSC looks forward to future additional progress (refer to the SSC's October 2019 report). **Additional recommendations of the SSC are**:

1. **Serious concerns remain about model convergence**. A small percentage of models converge and it is not clear if the model is converging on a global minimum. This should remain a top priority for future work. Efforts should strive to reduce the number of parameters and minimize the number of parameters hitting bounds. Posterior correlations should be thoroughly examined to look for potential sources of the convergence issues.
2. The assessment should include retrospective analyses of each viable candidate model.
3. The SSC agreed with the CPT not to use the MCMC runs, and asks that next year's assessment

include a rationale if MCMC is used to recommend management advice.

4. The SSC also endorses Alaska Bering Sea Crabbers' (ABSC) request to include raw numbers used for PSC limits in a table in the EBS Tanner crab SAFE consistent with EBS snow crab (see Table 11 in the EBS snow crab SAFE), if it is practical to do so.
5. The State of Alaska's harvest control rule was recently changed and involves females. This leads to a disconnect between the federal catch specification process represented by this assessment and state fishery management. Thus, regarding future research, the SSC recommends exploring a stock-recruit relationship incorporating females, including an examination of different hypotheses about the roles of females in stock dynamics. Also, as noted in the assessment, the State manages this fishery as two separate areas but this assessment considers a single EBS-wide stock. In summary, **modifications to the assessment should be considered to the extent practicable that bridge these state-federal disconnects and facilitate application of the stock assessment to the State's harvest strategy for fishery management**.
6. In response to SSC comments, the authors suggested that the current model cannot do likelihood profiles because of lack of functionality of ADMB. The SSC suggests that ADMB has the functionality to do likelihood profiles through the software, and looks forward to reporting of these results in next year's SAFE. It may be helpful to help diagnose convergence issues if the sensitivity to each data source is explored.
7. In Table 35 on p. 94, the heading refers to old model numbering, but the column headings utilize new model naming conventions. Please revise the header to utilize the new model naming conventions. The same applies to Table 36 on p. 95. Please check for other instances.

Overfishing Status Updates

The SSC received an update on the status of the off-cycle stocks and those with incomplete fishery data in June of 2020. Overfishing did not occur in the AIGKC fishery, with an estimated total mortality of 3.74 kt of a 3.94 kt ABC in 2019/2020. Total catch was confidential in the PIGKC fishery, but the stock is not overfished and overfishing did not occur in 2019/2020. The directed fisheries for WAIRKC and for PIRKC were closed in 2019/2020 and overfishing did not occur for either stock, as bycatch mortality was below their respective ABCs and OFLs. Finally, the PIBKC remains in an overfished condition and the 2019/2020 directed fishery was closed. Overfishing did not occur, with the total bycatch mortality below the ABCs and OFLs.

Crab Stock Projections

A subgroup of the CPT met in August to address an October 2019 SSC request to develop projections beyond the upcoming year under realistic exploitation scenarios. This request is as follows:

> "*The SSC requests that the CPT consider developing a standard approach for projecting the upcoming year's biomass that does not include removing the entire OFL for stocks where recent mortality has been substantially below the OFL. This may appreciably change the projected biomass levels for stocks such as Tanner crab, where actual catch mortality has been less than 10% of the OFL." - October 2019 SSC Report*

The SSC would like to thank the CPT and, most particularly, those members of the subgroup for their work and recommendations. Their primary recommendations include:

- Projections should be no longer than five years.
- Projections should be based on an average fishing mortality from the last five years, with the exception of a linear extrapolation of fishing mortality for stocks with a declining trend.

- Recruitment should be bootstrapped from historical recruitments from the period used for status determination of that stock, or for stocks with years of recent low recruitment, a shorter time period reflecting that lower recruitment level.
- Either the maximum likelihood estimates (MLEs) from the assessment or from MCMC draws, as would accommodate both GMACS and ADMB assessment platforms, can be used.
- Beyond this standard approach, the subgroup wanted to allow for some flexibility in the approach for assessment authors to react to specific situations, such as periods of low recruitment or specific management situations.

In general, the SSC agrees with the subgroup's recommendations, with the caveat that if assessment authors want to deviate from this standard approach, for whatever reason, then both the standard projections and their additional explorations should be presented. Furthermore, the SSC notes that it may be difficult to track the scenarios for stocks with declining biomass, as the state harvest control rules would become applicable at a certain point, but that the use of a linearly-extrapolated fishing mortality would be preferable in this situation. At least for the major crab stocks, the SSC requests some consideration of including the applicable harvest control rules for more accurate stock projections.

Norton Sound Red King Crab proposed models

The SSC received a brief summary on the preliminary NSRKC assessment from Katie Palof (ADF&G, CPT co-chair). The SSC appreciates the responsiveness of the assessment authors to numerous CPT and SSC recommendations regarding this stock. Written testimony was received from Louis Green, Jr. (Seward Peninsula Subsistence Regional Advisory Council).

For the upcoming assessment, the authors propose to update the previously accepted base model (19.0) with new data for 2020, including 2020 ADF&G trawl survey abundances and length compositions and a very small amount of subsistence catch and (confidential) winter commercial catch. In addition, the authors plan to continue work on the GMACS model and input data issues.

The 2020 survey estimate of abundance was much lower than the 2019 estimate, but was higher than 2018. The most recent surveys suggest that a large cohort of juvenile crab that was first observed in 2018 and 2019 will likely lead to increases in mature abundance in the near future. However, the SSC notes that the numbers of crab caught in the survey are quite low with many zero catches, resulting in wide survey confidence intervals.

The SSC has a number of recommendations for the upcoming assessment cycle. The first four recommendations are listed in order of priority.

First, the CPT and SSC in February recommended that the assessment authors place a high priority on incorporating discards into the estimate of total mortality for next year's assessment in an effort to move towards a total catch OFL that includes discards, consistent with other crab stocks and with the MSA. Estimates of discards based on several different approaches were produced (Appendix C of SAFE) and the SSC requests that, if possible, the upcoming assessment bring forward OFL and ABC recommendations based on total catch rather than retained catch only.

Second, the authors have developed a GMACS version of the base model, but the CPT noted that a lot of issues remain to be worked out. The CPT recommended, and the SSC concurs, that the authors work with other experts to bring forward a GMACS model (20.0) in the upcoming assessment, including a detailed comparison with the base model (19.0).

Third, in response to previous requests, the authors explored the VAST modeling approach, combining early NOAA surveys (1977-1991), ADF&G surveys and recent NOAA NBS surveys to produce a consistent survey time series for the Q3 management area east of 164 °W. The VAST approach has the potential to address several of our previous concerns such as the large number of zero stations, crab

extending beyond the standard survey area and a consistent area over which to estimate abundances. The VAST estimates tracked survey abundances well but are generally somewhat larger than the standard survey estimates due to the larger area included in the VAST model. As expected, the confidence intervals for the VAST estimates are generally smaller than those for the standard estimates. The model was not fully vetted and the authors indicated that fitting the model was "difficult." The SSC requests that the authors further develop the VAST modeling approach and that they bring forward more complete diagnostics, including spatial residuals. The SSC also strongly encourages the authors to bring forward a model run in the upcoming assessment that uses the VAST estimates rather than standard survey estimates.

Fourth, this stock remains of concern due to recent declines in mature male biomass, declines in fishery CPUE and possible consequences for the reproductive capacity of the stock. In response to these concerns, the authors constructed a time series of the proportion of barren females. Consistent with public testimony, the observed proportion of barren females in the 2019 survey was the highest in the time series and was higher than has been observed anywhere in Alaska since the decline of red king crab stocks in the Gulf of Alaska 50 years ago. At that time, ADF&G trawl samples in Kaguyak Bay, Kodiak Island, found that 76% of mature females were barren when female:male sex ratios were highly skewed (72:1) in 1968. The authors noted some problems with the time series, including differences in how mature and immature females are classified in the NOAA and ADF&G surveys. The SSC concurs with the CPT recommendation to include this information in the upcoming assessment and, if possible, include additional measures of reproductive success such as a time series of average clutch fullness. The SSC notes that some training will be required to distinguish viable embryos from unfertilized (dead) eggs in the female's clutch that have not yet sloughed off. The authors should also evaluate the reliability and consistency of these estimates over time, particularly for recent years. The status of reproductive measures will be helpful in evaluating potential risks to the stock to inform the size of any buffer.

In addition, the SSC highlights some recommendations from our previous meeting reports (plus one new one) and from the current CPT minutes that have not yet been addressed:

- The retrospective analysis should peel off more than 4 years to evaluate performance over a longer time period (~10 years) to better assess the magnitude and possible causes of the apparent positive bias in biomass estimates.
- In the February 2020 SAFE, the author requested help with earlier SSC recommendations to incorporate LK/TK in the management process. In response, the SSC suggested that this could be a test case for efforts by the LKTKS Taskforce. In June the SSC acknowledged the challenges to this effort posed by the COVID pandemic and encouraged relationship building in an effort to work towards a more comprehensive, coordinated LK/TK and climate change-oriented outreach and community engagement effort beginning in 2021.
- The CPT, SSC and public comments have pointed out the lack of maturity data as well as potential trends in size at maturity. Specifically, the SSC suggested a meta-analysis across red king crab stocks that occur at different temperatures. For a more detailed discussion, we refer the authors to our February 2020 minutes.
- The SSC agrees with additional recommendations in the CPT minutes, including a review of the growth matrix to determine if growth is overestimated in the model, which may explain some of the observed discrepancies between estimates of MMB and mature males caught in the survey.
- The SSC adds one new recommendation with the goal of eventually including females in the assessment model, which is currently a male-only model. Specifically, we would like to see an inventory of available data on females, including a list of any surveys and studies that have sampled females, the type of data collected, sample sizes, the length of available time series, etc.

C-2 BSAI/GOA Groundfish

The SSC received a series of presentations from Grant Thompson (NOAA-AFSC, BSAI-GPT co-chair) and Jim Ianelli (NOAA-AFSC, GOA-GPT co-chair) that included items from the September 2020 Joint Groundfish Plan Team (JPT), BSAI Groundfish Plan Team (BSAI-GPT), and GOA Groundfish Plan Team (GOA-GPT) meetings.

Joint Plan Team Report

The SSC received a presentation from Grant Thompson (NOAA-AFSC, BSAI-GPT co-chair) on the September 2020 JPT meeting.

Observer Program Update
The JPT commended the observer program for their responsiveness to the unprecedented circumstances this year resulting from the global pandemic. **The SSC also thanks the FMA Division for their responsiveness and efforts to adapt the 2020 deployment plan on short notice, and efforts underway to develop the 2021 ADP.**

Longline Survey
The JPT thanked the longline survey team for completing the 2020 longline survey in the Aleutian Islands and GOA shelf/slope break, which provided preliminary relative population numbers (RPNs) for a number of species during the pandemic. **The SSC echoes this commendation**.

Ecosystem and Socioeconomic Profiles
The JPT received a presentation on the ESP process and updates. Four ESPs are currently available, three of which are characterized as partial ESPs (Sablefish, GOA pollock, and SMBKC) and one that is characterized as a full ESP (BBRKC). Two new full ESPs, EBS Pacific cod and GOA Pacific cod, are scheduled to become available in November 2020. The JPT discussed questions with respect to the (1) current formats of templates, (2) 3-stage indicator analysis and scoring methods, and (3) development of an ESP dashboard on AKFIN. The JPT were in support of the current templates and the current 3-stage indicator analysis, but noted concerns of over-emphasizing weighting in the first stage and recommended that indicators should be appropriately caveated to not over-generalize indicators across species. The JPT also fully supported the development of the ESP dashboard on AFKIN that includes metadata for each data source, but suggested a staged approach to the integration of data that have not been thoroughly vetted and published.

The SSC endorses the recommendations, comments, and suggestions from the JPT, all of which are consistent with previous SSC recommendations and guidance. In particular, the SSC considers the efforts to build an integrated ESP dashboard hosted on AKFIN to be a positive development that will increase availability of data and associated metadata to analysts, and looks forward to these results when available. We are glad to see that the teams preparing ESPs, ESRs and SAFEs are closely coordinating efforts with each other as well as with staff developing the new annual community engagement and participation overview, which promises to be a useful analytic product in its own right. The SSC continues to encourage efforts directed toward connecting communities to this process, as it continues to evolve.

Ecosystem Surveys
The JPT received updates on the Recruitment Process Alliance (RPA) surveys. This survey year, 2020, most NOAA surveys scheduled for the Bering Sea were cancelled due to COVID-19, but the Distributed Biological Observatory (DBO) survey was conducted with some data collected from moorings. The only GOA ecosystem survey conducted this year was the beach seine survey in the western GOA (Kodiak and the Aleutian Chain). Partner organizations conducted some surveys (e.g., Gulf Watch Alaska and northern GOA Long Term Ecological Research) to cover oceanographic sampling, plankton recording, and seabird/mammal observations in the central GOA, with focus on Prince William Sound and Kachemak Bay. The data presented from these surveys aligned with information included in the ESR preview, with particular note of potential recruitment carry over effects from the 2019 heatwave. The JPT also received updates on several research projects that involve working towards integrating indicators into assessments,

including: artificial intelligence machine learning analyses, estimation of phytoplankton from satellite data, and pop-up floats and Pacific cod spawning habitat.

The JPT valued these updates, and recommended that next year these presentations focus on highlighting projects and information that are important to management. The JPT further recommended that the ESR and ESP committees provide a prioritized list of ecosystem information to be reported to the JPT for the September meeting. **The SSC also supports the JPT recommendations, including the JPT recommendation for an RPA update next year.** It was further suggested that this could be a good opportunity to identify whether the discussed research projects address Council research priorities.

Halibut DMRs

The SSC supports the JPT's recommendation to approve the Halibut DMR Working Group recommendation for proposed halibut DMRs for 2021-2022. No changes in methodology were discussed.

VAST Applications in Survey Group

The SSC commends the efforts by the survey team to develop and provide VAST results for authors to consider for use in their stock assessments and recognizes that this is a substantial amount of additional work. The SSC notes the growing list of papers supporting the use of spatio-temporal models (and VAST specifically), recognizing that the use of the method is becoming generally more common in fisheries and ecology.

The SSC recommends that standardized documentation (both format and content) will be very helpful to the authors, Plan Teams and SSC for review and diagnosis of VAST model results for each species. However, the SSC cautions against standardized model fitting (e.g., a single error distribution, set of covariates), other than as a starting point. The species-specific biological distribution, and interaction of this distribution with covariates, may require differing error distributions to fit the data adequately. It is more important for each species to have a statistically rigorous model selection process resulting in good model fit and diagnostics than the simplicity of fitting the same approach to all species: unlike design based estimators, the SSC suggests that one size does not fit all for VAST models.

The SSC provides a number of additional recommendations for further analyses.

The SSC supports further investigation of the use of covariates such as the extent of the cold pool in the Bering Sea, depth, and perhaps a coastline covariate in the GOA to ameliorate the assumption of anisotropy in this heterogeneous region. Covariates may be especially important for extrapolating predictions into unsampled areas, but care should be taken to explore the implications of predicting biomass when sampling did not occur. Specifically, critical evaluation of biomass predicted to be in the northern Bering Sea in years without sampling may need to be evaluated against fishery and other data for plausibility. Using depth as a covariate may require a spline, GAM, or other flexible relationship to approximate complex biological distribution patterns. Exploring models on species that do not have appreciable abundance in unsampled areas (e.g., deep water) may help to better understand whether edge effects are important and being dealt with appropriately (e.g., northern rockfish example). Specifically, a species whose distribution tapers to very low levels over sampled depths should not have an appreciably different index if deep strata are projected and a depth covariate is included.

The SSC notes that when VAST models are used to predict biomass in unsampled areas, biological sampling will not be available. This situation may suggest the need to apply either time-varying selectivity to account for the missing samples if there is significant demographic differences across the area, or a VAST model standardization by age or size (e.g., Thorson and Haltuch 2019).

The SSC recommends consideration of including the NBS in the modelled area even for species that have low density there now, but could increase under shifting environmental conditions. This would avoid another change in the survey analysis paradigm required to extend the modelled area, as has been the case with recent extensions to include the NBS for pollock, Pacific cod and yellowfin sole.

The SSC recommends further consideration of the optimal number of knots on which to build VAST models for the GOA and Bering Sea, as the current choice of number of knots appears arbitrary. Ideally, the number of knots should represent a compromise between technical feasibility and the coarseness of the approximation for the density surface (see Thorson 2019): more is often better, but not if the model cannot be run.

Finally, the SSC notes the discussion regarding inclusion of untrawlable habitat in VAST models for the GOA (and potentially the Aleutian Islands). The design-based approach includes untrawlable areas in the area-swept expansion and the SSC suggests that a VAST estimator that assumes no biomass in untrawlable areas could be of reduced value to stock assessment authors requiring an index of total biomass/abundance unless the biology of the species suggests that this is the case.

Survey Loss Uncertainty

The SSC received a summary of the work done by Meaghan Bryan (NOAA-AFSC) and Grant Thompson (NOAA-AFSC) to inform the JPT regarding the effects of missing survey data on groundfish stock assessments. The SSC notes that missing data are expected due to the biennial nature of the GOA and AI surveys, and that the planned or unplanned nature of missing data does not inherently imply bias in the stock assessment. The **SSC supports the JPT's recommendation for authors to explicitly consider the survey loss analyses (or analyses like them) in developing their risk tables for this year**, but does not suggest a standardized buffer for all species, noting important differences in the sensitivity to missing survey data varies across individual assessments. The SSC appreciates the additional analysis of Tier 5 stocks and notes the increased variance observed when the terminal year was absent for these analyses since these stocks use only survey biomass to update harvest recommendations.

The SSC cautions that, although the loss of the 2020 survey does not appear to warrant a comprehensive increase in the ABC buffer across all species, additional lost surveys may have an increasingly important effect on uncertainty and warrant a different approach to buffers should the 2021 survey be cancelled.

BSAI Plan Team Report

The SSC received a presentation from Grant Thompson (NOAA-AFSC, BSAI-GPT co-chair) on the September 2020 BSAI-GPT meeting. Items where the SSC had comments or recommendations in addition to, or different from the BSAI-GPT are listed below.

BSAI Preliminary Groundfish Harvest Specifications

The SSC recommends approval of the preliminary 2021/2022 BSAI groundfish specifications as provided by the BSAI GPT, noting the revision to the 2021 and 2022 OFL and ABC for northern rock sole due to a model correction.

The SSC received public testimony on sablefish ABCs and apportionment from Brent Paine (United Catcher Boats), Linda Behnken (Alaska Longline Fishermen's Association) and Tory Curran (F/V Cherokee), and written comments from Brent Paine.

Bogoslof & EBS Pollock

The SSC received presentations on the AI and Bogoslof Pollock Survey and a saildrone acoustic survey that was deployed as a contingency response to the cancellation of the 2020 EBS summer acoustic trawl survey because of the COVID-19 pandemic. The SSC applauds the research team for their successful efforts to organize and mobilize the unmanned surface vehicles (manufactured by Saildrone) to collect data that can be used to estimate a 2020 biomass index for inclusion in the pollock assessment. **The SSC agrees with the BSAI-GPT's recommendation to evaluate model results that include acoustic data collected by unmanned surface vehicles in the 2020 pollock assessment.** The SSC encourages the assessment authors and BSAI-GPT to thoroughly discuss assumptions, caveats, issues, and concerns with using the 2020 saildrone data in place of ship-based acoustic-trawl survey results and looks forward to receiving the

report and assessment in December.

BSAI Octopus

The SSC received a presentation on the stock structure template report for the BSAI octopus complex. The BSAI octopus complex is a Tier 6 stock comprised of multiple species that are not targeted by a directed fishery and for which little information exists. The SSC recognizes the challenges in applying the components of the stock structure template to a data-poor stock like octopus and agrees with the BSAI-GPT that this exercise nevertheless provides valuable insights. The SSC discussed the difference between the "little or no concern" category and a possible "unknown" category for data limited stocks/stock complexes such as BSAI octopus. **The SSC requests that the BSAI-GPT review the stock structure template's "scale of concern" categorization and consider whether stocks with insufficient information to determine a level of concern should be clearly characterized as "unknown" to distinguish them from stocks with an affirmative determination of "little or no concern" and to motivate additional research on their stock structure.** The SSC emphasized that characterizing a stock as "unknown," consistent with the Council's Stock Structure and Spatial Management Policy, would not imply a need for action or an imminent need for research. If the BSAI-GPT determines that an "unknown" designation would be useful moving forward, another issue to consider would be possible inconsistencies between past and future evaluations of potential stock structure for stocks with "little or no concern."

It was clarified during questioning that the reported octopus catch includes the total retained bycatch and 100% of the discard. The SSC recommends the authors explore a "worst case" scenario where exploitation rate is calculated for the predominant species (e.g. *Enteroctopus dofleini*) using the species-specific biomass estimate from the surveys and assuming that all of the reported harvest is from that species.

The SSC recommends that the authors explore the potential use of Local Knowledge and/or Traditional Knowledge that might provide additional information that would indicate whether or not there should be concerns for this stock complex, especially in the absence of other types of data.

The SSC agrees with the BSAI-GPT's and author's conclusion that, with respect to stock structure issues, the BSAI octopus complex be given a rating of "little or no concern."

BSAI Blackspotted/Rougheye

The BSAI blackspotted/rougheye rockfish stock is assessed with an age-structured model for the AI portion of the stock, and a non-age-structured model for the EBS portion of the stock. The SSC reviewed an investigation of recruitment for the AI portion of the stock that focused on the fully-integrated base model (18.1) presented in the 2018 stock assessment employing McAllister-Ianelli weighting for compositional samples, and a new model (18.2) with Frances weighting. The last full assessment compared the McAllister-Ianelli approach to data weighting with the Francis weighting method, and these two data weighting schemes were also considered in this assessment. In addition, the authors provided a bridge analysis by evaluating an update to the ageing error matrix, using dome-shaped selectivity for the survey composition, and a new prior distribution for natural mortality as suggested by the BSAI-GPT. The SSC appreciates the authors' investigations towards improving this assessment.

An important trend in this assessment is that survey and fishery data show a notable decline in older and larger fish and an increase in younger and smaller fish, resulting in conflict between biomass estimates and composition data. The base model is unable to capture these dynamics and consistently overestimates older age classes, with large downward revisions in cohort size between assessments (e.g., the 1998 year class assessed in 2014 versus 2018 dropped from 23.1 million to 7.8 million fish) and a strong positive pattern in retrospective bias for estimates of recruitment and spawning stock biomass. In addition, the fit and residual pattern to the AI survey estimate is poor, with the large biomass estimates from 2000, 2002, and 2012 not well fit by the base model.

The analysis showed the updated prior on M increased recruitment for all age classes, and the updated aging

error matrix resulted in changes to several year classes. The updated M prior increased total biomass for the entire time series, relative to model 18.1, and the M estimate of 0.092 was unrealistically high compared to literature values. Similarly, using a mean 14-year recruitment period resulted in M values higher than Then et al. (2015). An update to the aging error methodology increased flexibility to estimate large recruitment events and resulted in small changes to the annual biomass estimates. **The PT recommended the updated model use the Then et al. (2015) literature value of M=0.045 as either a mean on the prior distribution for M or as a fixed M. The SSC concurs with the PT recommendation for the December assessment.** Given the high values of M in the model fit, the authors will likely need to investigate different prior distributions than currently evaluated should a prior be used in the next assessment. The SSC also notes that the double-normal dome shaped selectivity should not be brought forward in the next assessment because it had little impact on model fit and the near-knife edge selectivity pattern for the plus size class is implausible. However, alternative forms of approximating dome-shaped selectivity but with less flexibility than the double-normal, such as the gamma distribution, may be worthy of further exploration.

The updated aging error method and parameterization of M did not resolve the retrospective issues in the model, nor did these changes provide insight into the reasons for the apparent conflict between the compositional and survey indices. Model outputs are particularly sensitive to the data weighting procedures, which suggest conflicting signals between the survey trends in biomass and the composition data. Comparison of the data weighting procedures showed the Francis weighting to have improved retrospective patterns, small improvements to the fit to the biomass index data, and degraded fits to the compositional data, particularly for the plus age group. This result is consistent with the 2018 assessment and is expected because the Francis method down-weighted the length and age data relative to the survey biomass trends. However, the SSC notes that simply changing the weighting procedure does not necessarily provide information about the underlying assumptions associated with inclusion of both the length and age data in the model specification. To investigate this issue, the SSC recommended in its December 2018 minutes that the authors remove length data from the model, which may improve the fit to the age data that otherwise would not occur by only adjusting data weighting.

For the December assessment, **the SSC reiterates its December 2018 recommendation that the authors bring forward a model without the length data. The SSC also reiterates its recommendation to include updated maturity information as available.** The new model without length composition would include the updated aging error matrix, updated estimate of natural mortality, and new maturity information.

Northern Rock Sole

The SSC appreciates the updated Executive Summary table for this assessment. The corrected values for projected total biomass and female spawning biomass were approximately 10% greater than documented in last year's assessment. **The SSC concurs with the PT recommendation to use the corrected ABC and OFL values for BSAI northern rock sole in the 2021-2022 harvest specifications.**

The SSC notes this assessment has persistent challenges in estimating year class strength because younger ages (1-6) are not particularly well indexed by the bottom trawl survey. The SSC encourages continued research, building on preliminary results presented in 2019, to explore informing recruitment based on environmental conditions.

Yellowfin Sole

The SSC reviewed an analysis that brought forward a new model for consideration in the 2020 BSAI yellowfin sole stock assessment. The currently accepted model from the 2018 assessment (18.1a) uses a combined male and female natural mortality. The proposed model, 18.2, uses a fixed value for female natural mortality (M=0.12) and allows male natural mortality to be freely estimated. During its 2018 review of the model, the SSC requested the authors clarify why natural mortality was estimated just for males, and whether it should be estimated differently for the sexes. The SSC notes that model 18.2 is responsive to this request and appreciates the authors work on this issue.

The proposed model 18.2 showed improved overall fit (as noted by likelihood values), with substantial improvements in fits to survey and fishery age composition data, and a slightly worse fit to the survey biomass. Improvement in the retrospective pattern for female spawning biomass was also observed as noted by graphical illustration and Mohn's rho. The authors note that a higher natural mortality value for males is an appropriate biological trait for flatfish and is consistent with the skewed sex ratio observed for this species (more females in the population). **The SSC agrees that sex-linked mortality is biologically plausible and concurs with the BSAI-GPT's and authors' recommendation to bring forward 18.2 (in addition to the 18.1 base model) for consideration in the next assessment.**

The SSC notes a couple of long-term development issues with this assessment. A question remains about the timing of the trawl survey relative to the availability of male and female fish, and whether the sex-ratio observed at the time of the survey is influenced by the timing of annual spawning migrations to adjacent inshore areas. Thus, it is questionable that a freely estimated male M is really reflecting the population sex ratio better. For future assessments, **the SSC requests the authors consider developing a prior on male M** using the literature values and/or fixing the male M based on the literature value. Additionally, the **SSC requests the authors investigate whether recent work by Somerton et al. (2017) on wave height, as it relates to gear efficiency, is informative to the parameterization of catchability.**

Eastern Bering Sea Pacific Cod

Grant Thompson (NOAA-AFSC, BSAI-GPT co-chair) presented the EBS Pacific cod assessment as part of the BSAI-GPT report. The SSC thanks the authors for the considerable work done throughout the year. Public testimony was given by Chad See (Freezer Longline Coalition), Gerry Merrigan (Freezer Longline Coalition), Kenny Down (self), and Kiril Basargin (K-Bay Fisheries Association). Written testimony was provided by Dave Little (Freezer Longline Coalition), Chad See (Freezer Longline Coalition), Scott Hansen (Beauty Bay), Gerry Merrigan (Industry Workgroup on stock assessment), and Alistair Dunn (Ocean Environmental). Much of the testimony spoke to the complexity of exploring ensemble models and whether this represents a prudent change in a year with a missed survey. Additional testimony related to the probable further reduction in ABC expected in 2021 relative to the alternative industry requested model with fixed catchability. They also attested to high longline fishery CPUE, which Dr. Thompson also confirms in the draft assessment, and whether this might provide valuable information in the absence of a survey. There was a substantial number of age-1 cod in the 2019 survey age compositions indicating a potential for a large 2018 year class and further indications of this in the fishery data. Without a 2020 trawl survey, this will be difficult to confirm until 2021. There was also discussion of the extremely low sea ice extent in 2018. Foraging conditions in 2018 seemed to be good for pollock because euphausiids were available, as determined from stomach contents of age-0 pollock.

This preliminary assessment represents interesting progress on different avenues in Pacific cod research and analysis. The authors presented eight models for the ensemble following a factorial design of different hypotheses and resulting model structures, and an alternative set that did not include a prior on catchability. The SSC appreciates the clear description and tables highlighting differences between models explored under the factorial design, which helped make complex model comparisons more tractable. An additional model was presented at the request of industry that fixed the trawl survey catchability at the former Nichol et al. (2007) derived value of 0.465 for fish between 60 - 80 cm, which is significantly below the value estimated by the base model. Both the BSAI-GPT and the SSC have recommended against using the Nichol estimate due to new research indicating catchability is more likely closer to 1, and recommendations from a 2016 CIE review suggesting it is preferable to estimate catchability directly when possible within the assessment model. However, the SSC does think there is value in looking back at previously accepted models to consider what advice they would provide under current conditions.

There was some discussion about aspects of the different models. The use of the Dirichlet-multinomial distribution was discussed because the sample size parameter was quite large, potentially creating a flat

likelihood surface as the modelled sample size approaches the input sample size. The author did not think this was causing any convergence issues, but the SSC recommends that the authors explore this.

The SSC was very interested to see the exploration of spatial models with movement. New tagging analyses and the analysis of western Bering Sea data show there is likely considerable movement between sub-areas which would support the development of a single-stock spatial model with movement. However, the **SSC notes that this is a fairly large modeling innovation that needs further review before it is used for management as either a single model or as part of an ensemble**. Although Stock Synthesis is under frequent and ongoing development, it may not have the flexibility to model movement in this context without additional tagging data to inform movement rates among areas**.** The structure of the underlying linear model for age-dependent movement across a certain subset of ages needs further justification; a simplifying assumption would be to estimate a common movement probability across all ages and perhaps constrain movement rates to only vary among years for which strong evidence of ontogenetic movement is available. In some years, like 2018, the interpretation of model results is that there is almost a complete exchange between EBS and NBS and in other years almost zero exchange. These movement parameters are necessarily confounded with the recruitment allocation to each area as well as catchability when it is allowed to vary over time or when estimated separately for the EBS and NBS surveys. The SSC would like to have clear evidence of spawning occurring in the NBS that would result in large amounts of age-0 Pacific cod being apportioned there as some models suggest. Fully vetting all of the models for these ensembles may be better suited for the upcoming CIE review in 2021, but the SSC supports continued progress in this assessment cycle. **The SSC supports the BSAI-GPT recommendation of using the set of models that do not have a catchability prior.** It was thought early on that constraining priors on catchability were needed, but later it was discovered that catchability could be estimated without a prior. The SSC notes that the BSAI-GPT and SSC in recent history have preferred not to specify a prior on catchability.

The SSC supports the models that the BSAI-GPT selected for inclusion in the ensemble, but not 19.12e because the SSC would like to see additional exploration of hypotheses about movement and spatial dynamics and how these are handled by the model. This reduces the model ensemble to four models. These models are 19.12a, 19.12, 20.4, and 19.15. Model 19.12a is the base model, 19.12, without time varying catchability. Model 20.4 considers the NBS and EBS survey separately with time-invariant catchability. Model 19.15 has time-varying catchability and separate surveys. This selection of models eliminates all four of the two-area models. **If it were desired to have a fifth model in the ensemble or for consideration on its own, a simpler model that was previously used for management (e.g., 16.6i) might be a useful addition. The SSC expects to consider these models for use in an ensemble or for use as a single assessment model for management advice.**

The SSC suggests that spatial models that apportion movement and recruitment to sub-areas be considered research models and be brought along in parallel as time allows, including explorations of the relationships of the environmental covariates used, and other hypotheses about movement such as natal homing. The SSC suggests that if environmental covariates are to be used in the future, they should be sufficiently constrained by informative priors penalizing estimates toward no effect, such that only when there is strong evidence of their relationship will movement be substantially altered. The SSC notes that the use of time-varying catchability in the NBS may be diluting the information content from that small set of surveys. It may be possible to include movement in a simple way by mirroring the NBS with the EBS catchability inversely (e.g., NBS catchability = 1 - EBS catchability).

The BSAI-GPT recommended examining survey catches at the northern stations in the EBS survey over time as a potential index of movement. In addition to the BSAI-GPT request, there are some outputs of VAST that might be useful, including the index of area occupied and the center of gravity estimates. **The SSC recommends trying to obtain some fishery size and age composition samples in the NBS to verify that selectivities for both areas are similar.**

Finally, the cross-conditional decision analysis (CCDA) is interesting and the SSC really appreciates the work done to identify viable alternative methods for weighting ensemble models, and the comparison to machine learning. This is a novel effort to address model weighting which is one of the most controversial aspects of ensemble modeling. However, it was noted that CCDA is a new, computationally-intensive method that might be too difficult for use due to time limitations before the November Plan Team meeting in the current assessment cycle. The SSC recommends that this methodology be reviewed at the upcoming CIE review. **The SSC affirms that the authors should use last year's ensemble averaging methodology (without the exponential weighting as per the SSC recommendations from 2019).**

GOA Plan Team Report

The SSC received a presentation from Jim Ianelli (NOAA-AFSC, GOA-GPT co-chair) on the September 2020 GOA-GPT meeting. Items where the SSC had comments or recommendations in addition to, or different from, the GOA-GPT are listed below.

GOA Preliminary Groundfish Harvest Specifications

The SSC recommends approval of the preliminary 2021/2022 GOA groundfish specifications as provided by the GOA-GPT, acknowledging a correction following the GOA-GPT meeting to change the 2021/2022 specification for the sculpin complex to "n/a". The sculpin complex has been moved to an ecosystem component species beginning in 2021, and therefore, an OFL and ABC are no longer necessary. The GOA groundfish specifications provided to the Council for the October 2020 meeting reflect this correction.

Survey Optimization

The SSC received a presentation on efforts to develop a multispecies survey design optimization simulation analysis of the GOA bottom trawl survey. The SSC appreciates the efforts of the research team in developing a tool that promises to increase the flexibility and efficiency of the stratified random survey design, which is timely given constraining budgets and COVID-related constraints.

The SSC supports the comments from the GOA-GPT and encourages the research team to have conversations with the survey planning team to discuss items brought up by the SSC and Plan Team in addition to suggestions they may have. The **SSC suggests examining the potential for extending the tool to optimizing composition data as well as examining tradeoffs between species when allocating stations**, especially with respect to deepwater stations. The SSC also wondered if the optimized survey design scheme would be sensitive enough to be able to capture distributional changes in species (e.g., eastern GOA where current optimization results in low station density) and suggests building checks in gateway areas or areas with habitat concerns.

The SSC notes that this optimization tool replaces the Neyman allocation in the optimization, which has the potential to result in low-value species having relatively more influence than they would with Neyman allocation at the expense of optimizing survey design for more valuable species. T**he SSC suggests that consideration be made as to which species to include and potential weighting of the species** to minimize unintended influence. Also, the operating model that has been developed relies on model-based abundance estimators that have different needs than designed-based estimators. T**he SSC recommends that in the future a comparison between results from designed-based and model-based estimators be included in the evaluation of the optimization scheme**.

What has been demonstrated so far has the advantage of being fast and tactical, which was a need identified in the WKUSER workshop. The SSC is supportive of continued work in this area as the development of this tool moves forward.

Pacific Ocean Perch

The SSC received an update on the progress being made by an internal review team ahead of a scheduled CIE review for GOA Pacific ocean perch (POP) as well as the status of the stock assessment for 2020.

Public testimony was provided by Jon Warrenchuk (Oceana). Progress has been made in two areas, although it was reported that more work still needs to be done before the CIE review that was rescheduled for 2021 because of COVID. The SSC is encouraged by the progress so far and in addressing recommendations from December 2019, despite the unfortunate delay of the CIE review. The authors recommend bringing forward a model that incorporates the improvements to date for the full assessment in 2020. The improvements include updates to priors for catchability and natural mortality, estimates of fishery age composition through an age-length key, and an updated ageing error matrix. **The SSC agrees with the authors and GOA-GPT to bring forward a model with the proposed updates along with updated data and looks forward to the CIE review.**

Dover Sole

The SSC reviewed materials describing a suite of research stock assessment models for GOA Dover sole and an exploratory application of VAST models for generating biomass indices from bottom trawl survey data. The SSC would like to thank the NOAA-AFSC and University of Washington researchers for their continued efforts and thorough documentation of these exploratory analyses.

The GOA Dover sole stock is currently assessed with an age- and sex-structured model. Exploration of alternative statistical catch-at-age model structures for GOA Dover sole was motivated by known ontogenetic movement into deeper waters as fish age, observed differences in size-at-age of older cohorts in deeper waters, and inconsistent coverage of deep strata by the bottom trawl survey. Analysts describe a comparison of three alternative two-area assessment models implemented in Stock Synthesis (SS3.3), with different treatment of growth, recruitment and movement between shallow (0-500 m) and deep (501-1000 m) areas. All three model structures assume sexual dimorphism in growth, fix movement rates between areas for ages 0-3 at zero while allowing age-specific movement rates to increase to a plateau at age 10 after which movement rates are constant, and all recruitment occurring to the shallow area. The movement rate from deep to shallow areas is fixed at zero in all cases. Model 0 assumed that, while growth differs between sexes, it is the same for each sex in the shallow and deep areas. Model 1 assumes two subpopulations occur in the GOA, each with sex-specific growth parameters estimated within the model, of which one subpopulation remains in the shallow area and the other moves to the deep area with the movement rate for fish age 10+ directly estimated. Recruitment in Model 1 also occurs in the shallow area and is evenly apportioned between the two subpopulations. Model 2 differs from Model 1 by estimating the proportion of recruitment to the two subpopulations, and fixing the movement rate for age 10+ fish at 1 for the subpopulation exhibiting the ontogenetic shift in distribution. This model represents the hypothesis that all fish exhibiting lower maximum size eventually move from shallow to deep areas by age 10.

Comparison of model fits to bottom trawl survey biomass indices indicates that Models 1 and 2 better capture the trend in survey catches in shallow areas. However, the SSC notes that none of the three model structures explored was able to successfully explain the lower-than-expected bottom trawl survey indices from shallow waters in 2015, 2017, and 2019, and encourages consideration of whether time-varying or temperature-linked movement or catchability may be appropriate, given the concordance between this period of poor fit and the onset of the GOA marine heatwave. The SSC suggests that comparison of model residuals for biomass indices and compositions with appropriate metrics for bottom temperature may provide insight as to whether other environmental processes may be helpful in explaining differences between observations and model predictions. Model fits to fishery and survey length composition data were improved for deep areas when separate shallow and deep growth relationships for each sex were included, with Model 2 showing the best fit to these data.

Differences in the magnitude of estimated recruitment were observed between Model 0 and models incorporating area-specific growth trajectories, but were similar between Models 1 and 2. The scale and trend in estimated spawning biomass also differed among models. Compared with Models 0 and 1, the spawning biomass estimated by Model 2 was substantially lower throughout the time series. While the estimated trend in spawning biomass was fairly consistent between Models 1 and 2, estimated trends

differed from Model 0 with lower relative biomass at the beginning of the time series (prior to 1990) and no increase in biomass after 2005.

The SSC appreciates the analysts' efforts and encourages continued exploration of alternative model structures that may better approximate the growth and population dynamics of this stock. The SSC concurs with the analysts that further exploration of the sensitivity of model results and model fit to the assumed age at which maximum movement occurs is warranted, and that fixing growth, selectivity, or movement parameters and exploring the sensitivity of other parameters may help to address model issues; and that exploration of models with additional spatial structure beyond shallow and deep may be useful to the extent possible given available data. The SSC further suggests that, given the poor fits to conditional age-at-length data, perhaps the authors should explore estimating movement within the model but fitting age-length relationships outside the model and specifying these as inputs. Generally speaking, Dover sole may not have sufficient data-richness to justify the number of parameters in these models. Estimating some of the parameters externally might make it easier to test hypotheses about ontogenetic movement, etc., inside the model.

The SSC reviewed the application of VAST models to bottom trawl survey data for GOA Dover sole and a comparison of design-based indices and smoothed estimates from a random effects (RE) model. The application of a spatio-temporal model in this context is motivated by the known distribution of the species into deeper waters that are inconsistently indexed by the GOA bottom trawl survey. This analysis explored the sensitivity of VAST indices to the spatial complexity specified in the model (i.e. number of knots), the assumed distribution for catches, and a user-defined mesh structure for the Gaussian Markov Random Fields approximating spatial random effects. Analysts further describe a process for VAST model validation wherein new data are simulated from the fitted VAST model either conditional or not conditional on spatial and spatio-temporal random effects, and compared to design-based estimators.

VAST models that assume a lognormal distribution for positive catch rates estimated biomass indices higher than design-based and RE-based estimates throughout the time series, with the difference between indices appearing uncorrelated with the extent to which surveys extended into deeper waters (> 500 m) among years. Lognormal models also exhibited sensitivity in the scale, but not the trend, of the resulting model-based indices to the assumed spatial complexity with the specification of more knots resulting in VAST indices more consistent in scale to the design-based or RE-based indices, as has been observed for other species in the GOA. Biomass estimates from VAST models with a gamma observation model were closer in scale to design- and RE-based indices. The SSC notes that this finding is also consistent with similar VAST model comparisons for other species in the GOA.

Analysts presented an additional VAST model validation exercise in which new data were simulated from a fitted model, both conditional and not conditional on spatial random effects, and compared with trawl survey observations. Kolmogorov-Smirnov (KS) tests were then performed on scaled quantile residuals to test the null hypothesis that observed and simulated data were derived from the same distribution. This null hypothesis was rejected for all VAST models when results from unconditional simulations were compared, and for all VAST models under conditional simulations except a model specifying 250 knots and assuming a gamma distribution for the observation model. **The SSC appreciates the analysts' efforts to explore this approach to VAST model validation and encourages the use of similar validation exercises in the future.**

The SSC concurs with analysts that VAST models show potential to improve annual biomass estimates from GOA bottom trawl survey data for this species, given their ability to account for unobserved depth strata and areas. T**he SSC further supports research to explore ways to approximate 2nd order anisotropy within VAST models** to account for the spatial orientation of the GOA shelf, or other ways to confront this challenge including fitting separate VAST models to different regions of the GOA. Finally, the **SSC suggests that analysts consider alternative VAST models for GOA Dover sole that include depth and possibly bottom temperature as covariates**.

GOA Pacific Cod

The SSC commends the analysts on their efforts to publish the unfolding story of GOA Pacific cod in the peer-reviewed literature. It is helpful to formalize the analyses supporting the stock assessment and to provide the background for future discussions.

GOA Pollock

The SSC received a presentation on topics related to the GOA pollock stock, which is assessed with an age-structured model under Tier 3. Results from the Shelikof acoustic-trawl survey indicated lower than expected abundance of the 2018 year class, which appeared strong in the prior year's survey. The SSC was concerned that perhaps the Shelikof survey may have missed the fish altogether because other year classes also appeared to be absent. Public testimony suggested that temperatures may affect the timing of when pollock enter and exit the Shelikof area. The SSC looks forward to results from the 2020 ADF&G survey in area 620, which may provide additional insight as to the strength of this incoming year class. It was noted that research to compare the new "LFS" sampling net with the standard "AWT" sampling net for this survey is ongoing, and the SSC looks forward to reviewing results of this calibration study when complete.

The SSC also reviewed a brief discussion paper exploring application of VAST models to Eastern GOA (EGOA) bottom trawl survey data for potential use in the EGOA pollock assessment. VAST model-based indices were compared with estimates from the current random effects (RE) model. Results indicated that estimation of temporal autocorrelation coefficients was problematic, whether specified as a random walk or an AR-1 process, suggesting the data do not support specifying temporal autocorrelation in the spatio-temporal process for encounter probability. With respect to model diagnostics, the SSC notes that the model appeared to underestimate encounter probability in high occupancy regions, and overestimate encounter probability in low occupancy regions. The VAST model incorporating temporal autocorrelation appears to provide an intermediate level of interannual stability between design-based and RE model estimates. **The SSC supports the GOA-PT recommendation that additional comparison of spatio-temporal and current methods for projecting biomass estimates forward under Tier 5 are needed** to identify a preferred approach. The **SSC supports further consideration of VAST as an alternative to the RE model for management purposes**. The SSC notes that it is worth considering whether the purpose of using the VAST estimator or the RE for the EGOA is smoothing out uncertain survey estimates or following real biological changes in abundance. Given that management boundaries are often arbitrary in a biological context, it may be useful to run a VAST model across the entire GOA and extract the EGOA biomass post-hoc, to inform management recommendations.

C-4 Cook Inlet Salmon FMP Amendment

The SSC received reports from Doug Duncan (NOAA-AKRO), Gretchen Harrington (NOAA-AKRO) and Marcus Hartley (Northern Economics) on the Initial Review draft of the Environmental Assessment/Regulatory Impact Review (EA/RIR) for a proposed amendment to the Fishery Management Plan (FMP) for salmon fisheries in the Exclusive Economic Zone (EEZ) off Alaska. Additional clarifications and description of community impacts were provided by Mike Downs (Wislow Research Associates, LLC). These revisions are needed to comply with the Ninth Circuit Court's ruling that the Cook Inlet portion of the salmon fishery within the EEZ must be included in the federal FMP. The SSC reviewed a preliminary draft EA/RIR in June 2020 to help the Council meet the court-ordered December 31, 2020, deadline for this action and provided substantial comments at that time. Public testimony was provided by Kiril Basargin (K-Bay Fisheries Association).

To bring the salmon FMP in compliance with the MSA, consistent with the court ruling, the Council adopted three alternatives for analysis, including Alternative 1: No Action, Alternative 2: Federal management with specific management measures delegated to the State, and Alternative 3: Federal management of those portions of the fishery that occur in the EEZ, which would result in separate State and Federal commercial salmon fisheries for Upper Cook Inlet salmon stocks. Alternative 3 under the section

on 'Status Determination Criteria and Annual Catch Limits' (2.5.3) includes two options to (1) "Specify salmon status determination criteria and a harvest limit in Federal waters of Cook Inlet" and (2) "Prohibit Salmon Harvest in Federal waters of Cook Inlet".

The SSC commends all authors who contributed to this EA/RIR draft for the comprehensive documentation of the current status of affected Cook Inlet marine resources and the Upper Cook Inlet (UCI) driftnet salmon fishery. The authors substantially reorganized and expanded sections of the document in response to SSC comments in June 2020. **The SSC finds that the EA/RIR clearly describes the alternatives and options under consideration and that the wealth of information contained in the document sufficiently summarizes the marine environment, the UCI salmon fishery, other affected fisheries, and the communities that could be impacted by the FMP amendment under consideration.**

The SSC recommends that the draft is sufficient to be advanced to final action but that the following clarifications and additions, to the extent possible, be incorporated into the draft prior to release:

Alternatives and Options

In the description of the alternatives, the SSC requests clarification of Option 2 under the section on 'Status Determination Criteria and Annual Catch Limits' (section 2.5.3) of Alternative 3. This option would "Prohibit Salmon Harvest in Federal waters of Cook Inlet" as an alternative to specifying status determination criteria (SDC) and would be "responsive to one or more […] conditions". **The SSC requests clarification as to which of the listed conditions must be met to avoid closure of the EEZ to salmon harvests and if this would be an annual determination or a permanent prohibition on salmon harvests in these federal waters.** For purposes of the impact analysis, this option was interpreted as a potential measure to halt directed fishing in the EEZ in a given year by setting the Total Allowable Catch (TAC) to zero. Therefore, this option was not considered separately and was instead analyzed in the context of setting a conservative TAC, which appears inconsistent with the description of the option as an alternative to specifying SDC and ACL.

Status Determination Criteria and Annual Catch Limits

With regards to the description of the proposed escapement-based status determination criteria (SDC) and options for determining Annual Catch Limits (ACL), the SSC finds that the corresponding sections have been greatly improved since the June 2020 draft and suggests a few additional clarifications.

1. Regarding the use of the lower bound of the escapement goal range to define maximum yield, the SSC suggests that the description of the MSY Control Rule (p 70/71) add some clarifying language, for example by inserting the following statement at the end of the section following "…if deemed appropriate": "*Use of the lower bound of the escapement goal is consistent with Alaska regulatory policy as the point below which a concern occurs (similar to exceeding the OFL). It recognizes the fact that constant escapement cannot be achieved due to implementation errors associated with lags between commercial fishing and the arrival of fish in the river for assessing escapement. Realized escapements are therefore distributed within the escapement goal range and are considered by policy to be the best expression of the number of spawners that produce MSY over the long term.*"
2. The retrospective estimates of SDC and ACL for selected stocks in section 3 (Tables 3-5 through 3-12) are very useful to illustrate how SDCs would have performed in the past for these stocks and possibly led to different management outcomes. The examples illustrate that the criteria trigger concerns (e.g. overfished status or ACL exceeded) in some years and for some stocks that experience periods of several years of low escapements, without being overly sensitive to natural fluctuations in catches and escapements. The SSC suggests, to the extent possible, to describe the relationship between when the proposed SDCs indicated a concern (overfished, overfishing or post-season ACL exceeded) in the past, relative to if or when the State actually identified a concern for these stocks.

3. In Sections 2.4.6 (p. 76, Alt 2) and 2.5.5 (p. 91, Alt 3), which define Optimum Yield (OY) and Maximum Sustainable Yield (MSY), the SSC suggests that the authors consider specifying OY as a range (similar to groundfish FMPs), such that "The OY range for the commercial salmon fishery in the Cook Inlet EEZ is that fishery's annual catch which, when combined with the catch from all other salmon fisheries within Cook Inlet, results in a post-harvest abundance within the escapement goal range for each indicator stock."
4. The SSC requests clarification on whether the sum of the ACLs across stocks for a given species in the EEZ accounts for all catches of this species in the EEZ or if some non-indicator stocks are not accounted for in the SDC and ACL calculations and would therefore not be monitored. While it was noted that the indicator stocks account for the vast majority or possibly all of the catches (through the use of 'other' groups), this should be clarified in the document. This is particularly important under Alternative 3, as the ACL needs to account for all catches in order to set a species-specific TAC below the corresponding ACL.

With regard to revisions to the Environmental Assessment (Chapter 3), the SSC finds that concerns from the June 2020 meeting report have been addressed and that the section is well written and largely complete. However, the SSC suggests that the document include a brief description of the methods used for catch apportioning and stock identifications in the catches as they relate to the example specification tables (i.e., Tables 3.5-3.12). These methods could be described in an appendix and referenced in the analysis text as appropriate.

Analysis of Impacts

While impacts of the alternatives are not fully quantified due to data limitations, the SSC finds that they do allow the Council and the public to understand at least the relative impacts of Alternatives 2 and 3 on affected groups. The direction of impacts and the potential or likely costs of some key impacts on affected groups are adequately characterized and we look forward to a concise summary of the overall net benefits once the Council selects its Preliminary Preferred Alternative. To the extent possible, the SSC requests that the following modifications be considered in a revised draft:

- As was noted in the presentation, one of the main uncertainties in analyzing impacts is uncertainty as to how state management might respond to federal measures taken under either alternative. In this context, it would be useful to understand and describe how the State has responded to low escapements in the past and how the timing of 'stock of concern' designations by the State relates to when federal accountability measures for Tier 1 and Tier 2 stocks were triggered in the retrospective analyses (UCI coho salmon in 2013, other sockeye salmon in 2008). Moreover, to better evaluate the impacts of the Alternatives vis-a-vis uncertain interactions between state and federal measures, the SSC suggests that the Council identify possible scenarios of how state management would respond to federal determinations of overfishing, overfished, or ACL exceedance, that could be used by the analysts for evaluating impacts. For example, would the State take measures to attempt to provide additional opportunities for the drift gillnet fleet or would potential benefits or costs accrue to other groups?
- With regard to setting conservative TACs under Alternative 3, including potential prohibitions on salmon harvests in the EEZ under Option 2, the SSC requests that the analysis be augmented to consider additional conservation issues and to expand the analysis of distributional impacts. The impact analysis should characterize the type of conservation issues (negative or positive) that may be anticipated due to closure of the EEZ, particularly in regard to the stocks of concern. The analysis should also describe whether there are benefits to gillnet groups outside the UCI region, specifically groups utilizing Mat-Su stocks which likely use the EEZ as a migration corridor. The distributional impacts of a potential closure of federal waters should be further analyzed to better characterize the likelihood that participants in the federal waters gillnet fishery could realize similar benefits, relative to status quo, should federal waters be closed. While the analysts note the large

uncertainties, perhaps gross comparisons of catch rates between state and federal waters could be made (e.g., either using fish ticket information or apportionment estimates) and analyzed in the context of the types of measures the State could take to mitigate federal closures. In addition, the analysis could be improved by clearly describing the benefits being realized by vessels fishing in federal waters under status quo. Specifically, the impact analysis mentions congestion issues and rip tide zones in the EEZ as favored fishing areas, but it is unclear whether these or other factors are the primary reasons for vessels to fish in federal waters.

- The discussion of impacts under both alternatives has a notable emphasis on costs and revenue at risk, suggesting that the actions have few, if any, benefits. The SSC suggests that the analysts consider other potential conservation benefits in addition to those noted above, specifically improved accounting for bycatch of other species, as well as an additional layer of review to identify potential concerns.

Minor Corrections and Recommendations

- P. 71: In the definition of the MSY control rule, Y_t should be changed to $Y_{EEZ,\,t}$ for consistency with its use in the definition of the Annual Catch Limit on the same page.
- P. 71: In the definition of $MSST_i$ under (4), S should have subscript 'i' to read: "…where S_i is spawning escapement in year *i*"
- P. 91: Section 2.5.4. In the second sentence in the first paragraph following the bulleted list, ACL should be replaced with escapement goal: "A harvest limit would be specified at a level that is expected to produce spawning abundance sufficiently above the escapement goal to address ..."
- In the draft FMP language, sections 2.4.6 and 2.5.5 (Optimum Yield and Maximum Sustainable Yield), we suggest a minor wording change to replace "post-season run size" with "post-season abundance" because "run-size" as used by ADF&G and others generally refers to total run-size.

C-6 BSAI Halibut Abundance Based Management Draft Environmental Impact Statement

The SSC received a presentation of the Draft Environmental Impact Statement (DEIS) for abundance-based management (ABM) of BSAI halibut PSC limits from Diana Stram (NPFMC), Carey McGilliard (NOAA-AFSC), Jim Ianelli (NOAA-AFSC), Sam Cunningham (NPFMC) and Anna Henry (NPFMC). Mike Downs (Wislow Research Associates, LLC) presented the Draft Social Impact Assessment (DSIA).

Public testimony was provided by six individuals or groups:

1. Jeff Kauffman, Heather McCarty, and Ray Melovidov (Central Bering Sea Fishermen's Association - CBSFA) provided oral and written testimony and noted that they were summarizing written comments submitted in a letter to the Council. They highlighted their involvement in directed halibut and groundfish fisheries, and expressed concern that none of the alternatives in the DEIS appeared to show much impact on the directed fishery and that the modelled directed fishery yield was not responsive to PSC usage. They noted the 1.2 lb yield gain to the directed fishery per a 1 lb reduction to PSC. They pointed out that the model ignores the U26 component and expressed doubt that the outputs were accurate. Finally, they indicated that the Council would benefit from some advice from the SSC on the directed fishery modeling decisions made by the working group.
2. Linda Behnken (Alaska Longline Fishermen's Association - ALFA) stated that the analysis does a good job of explaining why the ABM was needed and pointed out that the directed fishery maintains the full burden of conserving the halibut stock. She spoke in support of using the IPHC setline survey to index halibut abundance and noted that she did not support using the trawl survey index because of the U26 component caught in that index. She indicated that the model outcomes seem inconsistent with realized directed fishery fleet experiences and asked where the fish are going if

not going into the SSB or into the directed fishery. She highlighted that the yield-to-gain ratio referenced in the CBFSA testimony is from current fishing activities, but this is not reflected in the model. Finally, she requested further scrutiny of the yield-to-gain ratio and a harder look at the B30 rule.

3. Kiril Z Basargin (K-Bay Fisheries Association - KFA) stated that he supported the comments made by CBSFA and ALFA and requested that the SSC look more into the bycatch in the BSAI because he felt that the numbers were not correct. He stated that the trawl fleet was catching a lot of small fish that were discarded and strongly encouraged the SSC to look more closely at this. He noted that halibut biomass was getting lower in every area in Alaska and that Area 4 has lost 80% of its IFQ. Finally, he stated that the SSC needs to consider both economic benefit and sustainability of the halibut stock.
4. John Gauvin (Alaska Seafood Cooperative - ASC) provided a summary of the comments he submitted in written testimony to the SSC. He stated that the model did a good job of looking at the average impacts to the Amendment 80 (A80) sector and that grouping years into low and high halibut PSC was useful. He noted that in recent years (2016 – 2019) A80 deck-sorting was in full use and that this is not clear in the DEIS. He pointed out that none of the abundance indices align with groundfish fleet realized halibut encounter rates and that, without a good index that ties the A80 encounter rate to the biomass, there was no good way to evaluate the impacts of PSC alternatives. He referenced the ABM discussion paper being considered by the Council and noted analyses there and in the DEIS that show poor and variable correlations between the available abundance indices and A80 fleet halibut encounter rates. He indicated that this is a risky action and could have extreme impacts. Finally, he noted that future red king crab PSC restrictions and reductions in Pacific cod caps would strongly impact the fleet's ability to avoid halibut.
5. Mateo Paz-Soldan (City of Saint Paul Island, Alaska) said he supported comments made earlier by CBSFA. He said that the SIA did a good job of describing the dependency of the City of St. Paul on halibut. He indicated that the regulatory section was missing important legal context, specifically related to National Standard 4 and the NMFS guidelines regarding the rights of federally recognized tribes. He noted that the SIA highlighted 17 communities dependent on the halibut directed fishery that are dominated by Aleut people and stated that many of these communities have already been dramatically negatively impacted. He pointed to the trust doctrine intended to ensure the survival and the welfare of Indian peoples that is legally enforceable and had been violated in his view. Finally, he stated that halibut must be managed to a level sufficient to sustain the local economy and subsistence use of the St. Paul tribes.
6. Lauren Divine (Aleut Community of St. Paul Island) stated that she appreciated that the halibut ABM analysis was a Herculean effort and supported the comments made by CBSFA, ALFA and the City of St. Paul. She pointed out that improvements could be made to reach a more equitable management system for the directed fisheries on St. Paul and that fisheries are a cornerstone of the culture of St. Paul. She noted that she had provided written comments to the AP and the Council. She said she supported the previous comments about the National Standard 4 and highlighted the need for equitable access of fisheries for communities. She stated that reductions in bycatch should flow one-to-one to the directed fishery and that refinements to the analyses were needed to ensure equitable outcomes.

The DEIS analyzes proposed management measures to index Pacific halibut PSC limits in the BSAI groundfish fisheries to halibut abundance for the A80 sector. The objective of modifying PSC limits, as stated in the Council's purpose and need statement, is to index PSC limits to halibut abundance in order to provide flexibility to the groundfish fisheries in times of high halibut abundance, protect spawning biomass of halibut especially at low levels, provide for directed fishing operations in the Bering Sea, and stabilize inter-annual variability in PSC limits.

The DSIA evaluates community and regional participation patterns in the BSAI A80 groundfish fishery and the BSAI/Area 4 halibut commercial fishery as well as potential community level impacts from the no-action and action alternatives. Potential impacts to regional subsistence and sport halibut fisheries are also evaluated.

The SSC reviewed the DEIS and the DSIA in October 2019 and provided the authors with a number of recommendations to improve the analyses and increase the clarity of the documents. Subsequently, the Council refocused the alternatives, narrowing the scope from all sectors with halibut PSC to the A80 sector only. The SSC notes that the Council will also review a separate discussion paper under this agenda item at this October 2020 meeting that examines several action alternatives not presented in the DEIS. The SSC did not review this discussion paper.

Scope of Review

In reviewing the ABM DEIS, the SSC identified several inconsistencies in the analyses and asked for clarification from authors in preparation for the SSC meeting. On further investigation, errors were found in the estimation of 2019 and 2020 directed halibut fishery catch in the operating model, which affects all outputs from the simulation model. Authors worked diligently to correct these and updated versions of the documents and associated errata were posted before and during the SSC meeting, the most recent and significant of which was made available the afternoon of Wednesday, September 30.

The SSC recognizes previous support for moving amendment packages to final action with recommendations for minor modifications before release. However, in this case, **the nature of the changes impact the baseline from which the alternatives and performance metrics relative to Council objectives are assessed. The SSC was not afforded sufficient time to review the revised model results and their impacts on all aspects of the DEIS, and as such, was not able to comment on the analyses nor determine if the DEIS is acceptable to move forward for final action at this time.** In addition, the SSC notes that the public comment period closed before these issues were identified and revised documents were posted. As such, the **SSC agreed to focus its discussion on the simulation modeling recommendations provided to the ABM workgroup in October 2019 and the revenue impacts assessment and the DSIA, with the other aspects of the presentation taken as information only**. As a result, the SSC did not discuss public comments associated with model outputs, alternatives, or performance metrics.

Simulation Model

A simulation framework was employed to compare the Pacific halibut stock trends and PSC limits across the set of alternatives. The simulation consists of a two-area, age- and sex-structured model of Pacific halibut population dynamics with the BSAI modeled as one area and the remaining components of the range of the halibut stock comprising the aggregate "other" area. Recruitment is assumed to occur at the coastwide level and the proportion of new recruits that settle in the BSAI is time-varying and temporally autocorrelated. The model allows for adult movement between the two areas, includes five fishing fleets, and generates SSB, PSC limits, PSC usage, directed halibut fishery catches, and survey indices outputs to support the assessment of the alternatives. The model was first run for 26 historical years to verify that population dynamics, survey indices, distribution of survey biomass by area, and catches by fleet were able to mimic historical data and assessment-based perceptions of stock dynamics. For each management alternative, the model dynamics were simulated over 100 future years, and replicated across 500 simulations, each with a unique set of random deviations for yearly recruitment, recruitment allocations, survey observation errors, and assessment estimation error.

In our October 2019 Report the SSC recommended:

1. Implementation of a simple version of the "30:20 control rule" to further reduce TCEY at very low levels of stock abundance as it better approximates the current IPHC management approach,
2. Incorporating interseason variability in halibut encounters and corresponding PSC usage rates, along with a performance metric related to foregone groundfish catch,
3. Consider a wider range of recruitment variability, specifically a low recruitment scenario to evaluate the performance of the rules at low abundances, and
4. Consider some model runs over a longer time frame to examine if the relative rankings among alternatives are sensitive to adopting a longer simulation period.

The analysts addressed all four of these recommendations by:

- Adding a 30:20 harvest control rule for TCEY determination to the model.
- Shifting the definition and calculation of unfished spawning biomass to a dynamic calculation of B_0 to reflect the IPHC's process.
- Incorporating variability in PSC usage into the base case model.
- Updating the relationship between historical spawning biomass and total mortality used to estimate the harvest control rule for TCEY determination.
- Adding a future Pacific Decadal Oscillation (PDO) scenario to examine the population effects of periodic changes in the PDO.
- Adding sensitivity analyses to examine the impacts of 1) different levels of recruitment scenarios, 2) incorporating temporal autocorrelation in assessment results, 3) modeling PSC usage as a function of PSC limits, and 4) exploring alternative trawl PSC selectivity curves.

The SSC commends the ABM working group for its substantial efforts to improve the analysis and, in particular, for its responsiveness to the concerns and recommendations the SSC provided in its October 2019 Report. The summary of model changes in Section 6.1 and notations in the figure and table captions indicating where SSC-based revisions were made throughout the document were very helpful. **The SSC looks forward to reviewing the full document and analyses at a future meeting** and offers the following comments and recommendations.

- Owing to the Council's decision to narrow the scope of this action concerning halibut PSC to the A80 sector only, the impact of U26 mortality on annual TCEY calculations may be of much greater importance than in previous iterations (the document states that the majority of the [modelled] PSC use is U26 fish). Public testimony on the way U26 fish are handled in the model was provided by CBSFA and ALFA.
- The simulation framework could consider including the calculation of SPR to more accurately represent the IPHC's process and also to eliminate the need to use the approximation of TCEY to spawning biomass as a proxy calculation; this would also explicitly include the effects of U26 mortality on the annual TCEY. Public testimony on the way U26 fish are handled in the model was provided by CBSFA and ALFA.
- There is currently no discussion of the effects of shifting PSC use among IPHC Regulatory Areas within the BSAI – this is where some of the year-to-year effects on the 4CDE directed fishery have come from and may be an important contributor to the variability in annual directed fishery catch limits. Public testimony on the allocation of PSC savings to the 4CDE directed fishery were provided by KFA and the Aleut Community of St. Paul Island.

- The simulation may be overestimating the proportion of the coastwide TCEY in BSAI, because it appears to be using the stock distribution and not correcting for the 0.75 relative harvest rate applied by the IPHC.
- This policy action relies on the premise that A80 PSC is lower when halibut abundance is lower so a greater share of lower TCEYs can be allocated to the highly-dependent directed fleet. The approach of drawing from historical observations of percentage PSC utilization (Figure 5-2) assumes this key premise to be true. This assumption is reasonable only if the fleet has high levels of control over how much of the PSC they catch at all levels of abundance, but there was considerable discussion at the October 2019 SSC meeting that PSC catch is independent of abundance (see the October 2019 SSC Report). This was reiterated in public testimony provided by the ASC at this meeting. The SSC recommends that the simulation model draw from the abundance-conditional distribution of PSC catches. The analysis should include graphs of halibut catch as a function of halibut abundance, as represented by either index, that can be used to validate that simulated PSC catches mirror observed catches.
- Although there was insufficient time to fully consider how broadly the model revisions that were posted during the SSC meeting affected all aspects of the DEIS, one example of the potential importance of these changes is reflected in the dramatically different scale of the directed fishery over the entire simulation space. Specifically, in the original analysis the median directed fishery catch traversed a range from approximately 50% to 110% of the 2019 level. It appears that in the newest revision of the analysis the median directed fishery catch ranges from approximately 110% to 200%, which exceeds the 2019 level for the entire duration of the simulation and for all alternatives. **The SSC is concerned that this revised projection may not provide for the ability to evaluate differences among the performance of alternatives at relevant fishery levels - those levels over which the alternatives are most likely to differ importantly.**
- More generally, while the ABM analyses focus on relative impacts across alternatives, the context within which these relative impacts take place matters a great deal. By using the correct directed halibut fishery catch levels in the model, the alternatives are now evaluated within a context of increasing directed halibut fishery catch, not declining. **This raises the question of whether the comparison of the alternatives within this context is even relevant. The SSC believes that careful consideration of the relative impacts within this new context is important, and thus, a thorough review of the revised DEIS is warranted.**
    - For example, one of the performance metrics for "*maintaining directed halibut fishery in the BSAI*" is the probability that the directed halibut catch limit in the BSAI is less than 75% of the 2019 limit over 20 years. In the revised Table 6-6, these probabilities go down significantly, but do not change substantially across alternatives. The SSC notes that this is because these probabilities essentially go to zero due to the model-predicted increase in directed halibut catch across all alternatives, including the status quo. **Further review is needed to determine whether such a potential setting is realistic, and whether comparison of alternatives within such a setting is relevant.** Public testimony regarding the modeling of the direct fishery catches was provided by CBSFA and ALFA.

The SSC also has the following minor editorial comments.

- In the figures, the directed fishery catch is incorrectly labelled as (t).
- Page 201 "…simulated starting with the IPHC assessment estimates…" The IPHC estimates are based on multiple models, these represent just one of the four.
- The description of dynamic SB0 is incorrect (p. 23 & 187): low recruitment does not feed into the dynamic calculation until years later when those fish mature.

- Table 1-3 was correct when the ABM analysis started, but the NMFS AKRO now pro-rates the halibut mortality to IPHC areas from NMFS statistical areas and it is no longer correct to map statistical areas directly.

Revenue impact estimation

Analysts use a resampling approach to estimate the revenue impacts on the A80 sector, whereby observed hauls from previous years (2010-2019, minus 2015) are sampled from the empirical distribution (without replacement), and the cumulative sum of groundfish catch and halibut mortality are compared against groundfish catch and halibut PSC limits, respectively. Once either of these two limits is reached, sampling stops and revenues from groundfish catch are calculated. This resampling procedure is conducted for different groundfish and halibut limit scenarios, as well as across different "high" and "low" halibut PSC years. For each scenario, 500 sampling draws were conducted to produce distributions of revenues.

The SSC finds that this is a straightforward way to assess revenue impacts, with a few limitations, which are outlined below. The basic underlying assumption is that the factors that determined A80 revenue as a function of PSC mortality in the past will be the same in the future. This includes environmental conditions and avoidance incentives, among many other things. To investigate how the impacts of PSC limits vary across different environmental conditions, the analysts divided the sample into "high-PSC" years (2010-2014) and "low-PSC" years (2016-2019). One nice feature of this approach is that it provides a sense of how impacts are sensitive to the underlying conditions to which PSC limits are applied.

Ultimately, however, the revenue impacts are difficult to assess across alternatives because, despite reporting that the focus should be on relative impacts, the results are reported in "levels," instead of values relative to the status quo. Moreover, the impacts are calculated for seven different PSC levels (each level associated with some element—e.g., starting point, floor, ceiling—of the four alternatives), but not for the four different alternatives themselves. This requires a lot of comparisons across tables and/or across columns and rows within a table to come up with an estimate of an alternative's groundfish revenue impact.

While the SSC believes the presentation of results in regard to the impacts of alternatives could be greatly improved, the SSC finds the analysis adequate for the DEIS, with the following recommendations below.

- The analysts claim to not be imposing any behavioral structure on the A80 fleet in their approach; however, their sampling procedure implicitly assumes a behavioral change on behalf of the A80 fleet—namely, that the fleet will scale their within-season fishing effort up or down such that the proportion of hauls over the course of the year stays the same. For example, if the PSC limit is lower, A80 is assumed to scale down effort in each month such that the proportion of annual fishing effort remains the same in each month. One difficulty with this "proportional-effort-reduction" assumption is that it is not clear where this assumption lies within the range of all possible assumptions—i.e., is it a conservative or radical estimate of revenue impacts? The SSC notes that it is not possible to know how the A80 sector will respond to changes in the PSC limit, and the analysts should not be expected to come up with such a prediction. But one useful approach when accurate predictions are not possible is to calculate the impacts for informative benchmarks, such as upper or lower bounds. A useful benchmark in this case would be the "business-as-usual" assumption, which would assume that A80 effort levels (not proportions) remain the same as in previous years, but harvesting would stop once the groundfish catch or halibut PSC limit is reached. An attractive feature of the "business-as-usual" assumption is that it arguably provides an upper bound on revenue impacts—if fishing behavior does change in response to lower PSC limits, it should not change for the worse.
    - The SSC recommends that the "business-as-usual" impacts be calculated for the sake of having a meaningful reference point. The analysts should emphasize that "business-as-usual" is not expected behavior under PSC limit changes; instead, they should

highlight its use as providing an "upper bound" for impacts, and its usefulness for providing a reference point for "proportional-effort-reduction" impacts.

- The "business-as-usual" assumption could be implemented through a stratified random sampling approach, whereby hauls are sampled in month 1 (or week, day, etc., with replacement) using the observed frequency for that month, then month 2, etc., until the cumulative groundfish catch or PSC mortality are equal to their limits. Note that this differs from the analysis in the DEIS because the effort in the later part of the year is only sampled if the groundfish or PSC limits haven't become binding yet.

- While calculating the revenue impacts for different PSC limits is a first step, it would have been informative to see the next step, where these estimates are explicitly mapped onto the alternatives themselves using the predictions from the simulation model. Instead, if readers want to know the impact of a particular alternative, they have to combine revenue impacts for different PSC levels in one table with PSC level predictions in another table. This sets this analysis apart from the other analyses in the document, which report results relative to a status-quo baseline and for each alternative under consideration.
- Public comment also pointed out the importance of the variance in the potential impacts, not just the average, particularly given the poor correlation between A80 halibut encounter rates and the abundance indices. Under certain conditions, it is possible that the impacts of a PSC limit are large enough that it would preclude a company from operating in future years. While it is impossible to predict under which conditions this would occur, the analysts should consider this possibility in future versions when the revenue impacts are mapped onto the alternatives more explicitly.
- Lastly, the SIA was an impressive document when the SSC saw it in October 2019, and it's even more impressive today with all the data updates and the new findings. The SSC recommends that future versions of the document explore some of the concerns raised in public testimony regarding National Standard 4 and the disproportional impact to tribes, given the number of Alaska Native communities in the analysis.

D-1 Survey Planning

Alaska Fishery Science Center Report

Robert Foy (NOAA-AFSC) gave an update on planning for surveys in 2021. Public testimony was provided by Stephanie Madsen (At-sea Processor's Association), Chris Barrows (Pacific Seafood Processors Association), Raychelle Daniel (The Pew Charitable Trusts), and Rebecca Skinner (self). Public testimony cited the outstanding success by the fishing industry to conduct fishing operations under COVID-19. Public testimony explained that outbreaks were rare and contained without spreading to coastal communities. A lot of money was spent by the fishing industry to conduct their business safely. It was suggested that the industry's track record demonstrates the ability to safely conduct assessment surveys during a pandemic. Other public testimony stressed the importance of involving coastal communities and tribal organizations in the planning stage for future surveys in the northern Bering Sea (NBS). Moreover, it was stressed that inclusion of local knowledge (LK) and traditional knowledge (TK) is especially important in data-limited areas, like the NBS. Finally, it was pointed out that skippers, many of whom have fished for decades and possess a deep understanding of Alaskan waters and resources, are particularly important sources of LK and should be included in TK and LK discussions.

In July, the Council requested Dr. Foy to provide an update on survey planning for 2021 at its October and December Council meetings. At this meeting, Dr. Foy presented an update on scenario planning for surveys. At the December 2020 meeting, he plans to present a further update representing a semi-final plan for 2021 surveys. Then, in February or April 2021, Dr. Foy plans to present his usual AFSC State of the Center report that will represent a clearer understanding of the FY21 budget and how it will impact the 2021 and

2022 surveys. For 2021 and beyond, AFSC survey priorities have been informed by the SSC and its subgroups in 2018 and 2020, an ICES workshop on unavoidable reductions in survey effort, and analyses of bias and uncertainty by Bryan et al. (C-1/C-2 Survey Loss Uncertainty) that was presented at this meeting.

Despite the cancellation of most AFSC surveys in 2020, Dr. Foy pointed out that a couple of surveys were conducted as planned (e.g., longline survey, nearshore research). Also, a number of mitigation efforts were undertaken to partially address the loss of some other surveys, most notably the conduct of an EBS acoustic pollock survey by saildrone.

Reflective of the range of uncertainty in AFSC funding, Dr. Foy outlined three broad planning scenarios for 2021 surveys: (1) full complement of surveys possible with current staffing capacity, (2) partial survey coverage, and (3) enhanced use of advanced technology and analytical tools, as well as more cooperative research with the fishing industry. Funding to conduct surveys depends, in part, on carry-over funds from FY20, the size of the approved base budget, and congressionally approved survey funds. Budget challenges include rising charter vessel costs and declining days-at-sea available to the AFSC for the *R/V Oscar Dyson*.

At this point, current plans are to resume the normal schedule of surveys for the Gulf of Alaska (GOA) and eastern Bering Sea (EBS) including a two-vessel GOA trawl survey, GOA acoustic-trawl surveys, EBS trawl survey, and a northern Bering Sea trawl survey. No surveys are planned for the Aleutian Islands, as 2021 is a scheduled off year.

In response to SSC questions, Dr. Foy indicated that AFSC would be better positioned to conduct surveys under an ongoing pandemic in the future owing to new standard operating procedures (SOPs) specifying protocols for quarantine, testing, etc. Also, Dr. Foy indicated that much was learned from the fishing industry about how to successfully execute at-sea operations under a pandemic. **The SSC expresses its gratitude to the fishing industry for their successful efforts that can help inform best practices for conducting surveys during a pandemic**.

The SSC greatly appreciates Dr. Foy's survey update and is very pleased to see the planned resumption of the broad suite of surveys in 2021, subject to current vagaries of funding availability. The SSC also appreciates that Dr. Foy intends additional updates in December 2020 and February or April 2021, when budget uncertainties should be resolved. This is a very important issue, as the loss of many AFSC surveys has increased the uncertainty in many crab and groundfish stock assessments and resulted in reduced ABCs for some stocks.

As it appears likely that the pandemic will continue through 2021, the **SSC stresses the importance for advanced planning for the implementation of new SOPs and strongly supports efforts to develop and foster cooperative research with the fishing industry** to address ongoing concerns about survey budgets and the health and safety of all involved. **The SSC also recognizes the added importance of LK and TK in data-limited areas, such as the NBS, and strongly recommends that the development of protocols and guidelines for gathering LK and TK, as planned under the Bering Sea FEP LK/TK/Subsistence action module, move forward to the extent feasible, given the challenges posed by the ongoing pandemic,** which include the present inability to conduct key face-to-face meetings. The SSC recognizes that these challenges, in turn, may mean that the development of pandemic era-specific protocols will be necessary and that more progress can be made on accessing and utilizing some types of LK and/or TK than others under these conditions. LK/TK efforts should involve all those with knowledge of fishery resources, including coastal communities, tribal organizations, and fishing vessel skippers.

SSC Survey Prioritization Sub-Committee Report

The SSC reviewed recommendations from an August 2020 SSC sub-committee meeting on trawl survey options and priorities. Public testimony was provided by Julie Bonney (Alaska Groundfish Data Bank) and Chad See (Freezer Longline Coalition). Chad See (Freezer Longline Coalition) also provided written testimony. The August 2020 meeting included members of the SSC, NPFMC and AFSC staff and heard

public testimony. The sub-committee reviewed outcomes and recommendations from the January 2020 ICES Workshop on Unavoidable Survey Effort Reduction (WKUSER) and addressed an AFSC request to consider five key questions related to survey prioritization. **The SSC notes that consideration of survey alternatives was in the context of long-term prioritization and planning, rather than specifically in the context of tactical 2021 survey planning in response to COVID-19.**

The SSC supports recommendations from the sub-committee and highlights the emergent theme across specific questions that continued monitoring of core areas should be prioritized, and that any reduction in survey effort is an undesirable outcome. With respect to the first question of whether an NBS survey or sampling of GOA deep stations (> 700m) should be prioritized, the **SSC agrees with the sub-committee recommendation that a paired NBS-EBS survey should be prioritized over sampling of non-core (> 700m) GOA survey stations, but that continued sampling of the NBS region would not be supported at the expense of core (< 700 m) GOA survey station sampling.**

With respect to the second question of how an annual GOA survey should be prioritized among other survey efforts, **the SSC agrees with the sub-committee that it would not support prioritization of an even-year GOA survey at the expense of other core areas.** However, the SSC agrees that an annual survey in the GOA might have assisted in early detection of demographic impacts from the marine heatwave, and encourages other GOA assessment authors to explore the feasibility of including relevant information from alternative annual surveys that index this region (e.g., NMFS longline survey, IPHC fishery-independent setline survey) if practicable.

With respect to the third question of whether the NBS should become a standard survey**, the SSC supports the subcommittee recommendation that the NBS should be combined with the EBS shelf survey and that Norton Sound should be included as part of this survey. The SSC likewise agrees that the priority should be for an annual survey in the NBS region** until such time that sufficient data are available to quantitatively evaluate the potential impacts of changing to a biennial survey frequency in the NBS. The sub-committee also considered the potential to change from a systematic to a randomized survey design in the NBS, given the short time series of surveys. The SSC concurs that, despite potential benefits of a randomized design in the NBS with respect to index uncertainty and bias under possible reductions to sampling density, the potential for edge effects and the need for continuity with the EBS design is most important and a systematic design should be continued at present. However, the SSC supports future analyses to quantify tradeoffs between systematic and randomized survey designs in the NBS, especially if available survey effort for the NBS region becomes limited in the future or will vary across years.

With respect to the fourth question of whether available effort should focus on a full survey in one core area, or partial surveys in multiple core areas, if survey effort becomes extremely limited, the **SSC supports the sub-committee recommendation that, under this undesirable scenario, full surveys should be maintained in all core areas at a reduced frequency.** Alternatives would perhaps include a biennial schedule with combined NBS and EBS surveys alternating with GOA and AI surveys.

Finally, with respect to the fifth question addressing whether a survey in the Chukchi Sea should be considered, the **SSC supports the sub-committee conclusion that, although surveys of this region are of interest and a necessary precursor to development of fisheries in this region, the highest priority is placed on continuation of surveys necessary for the sustainable management of existing fisheries.** The SSC also agrees with the sub-committee advice that development and expansion of collaborations with academic partners, governmental and non-governmental agencies and organizations, and regional communities, as well as cooperative research should be pursued as a means to facilitate expanded research in this region. The SSC specifically recommends outreach to Chukchi Sea coastal communities and regional institutions to solicit input on preferences and priorities for research, and to gauge interest in and opportunities for potential research partnerships with local and regional entities to enhance understanding of the region's ecosystems and fish resources that are undergoing dynamic climate-related change. This outreach could also provide a beneficial two-way communication opportunity that may result in the input

of local knowledge and traditional knowledge that would further inform the research prioritization and survey planning process.

As noted in 2018, the SSC continues to support thorough evaluation of the impacts resulting from changes in survey design, effort, and frequency, on the quality of resulting data and stock assessment results. The SSC concurs with the sub-committee recommendation that analyses of survey design and effort allocation should, to the extent practicable, propagate effects through the stock assessment process to quantify impacts of survey changes on management recommendations, reference points (OFL and ABC) and harvest allocation. The SSC concurs with the sub-committee that these "end-to-end" analyses are necessary to identify how survey alternatives might impact the attainment of optimum yield (NS 1) or sustained participation in harvesting or processing (NS 8), and that critical knowledge gaps remain regarding how changes to surveys may impact the economic and societal benefits provided by fisheries. The SSC further recommends that analysis of changes to survey effort and design should not only consider impacts to the bias and precision of resulting biomass indices, but other survey data products including age and length compositions. The SSC looks forward to reviewing outcomes from the ongoing management strategy evaluation effort (PIs Bryan, Barnett and Kasperski, NOAA-AFSC) focused on assessing the influence of changes in survey frequency and station density on key stock assessment outputs including biological reference points. **The SSC supports recommendations by the sub-committee that survey prioritization analyses and decisions should also include the full suite of surveys conducted by the AFSC, including trade-offs between research surveys and standard stock assessment surveys, and efforts to explore opportunities to collect relevant ecosystem information during stock assessment surveys.** The SSC further supports efforts to explore the potential for research partnerships with the fishing industry and for the incorporation of local knowledge held by fishery participants to help inform the survey prioritization process.

SSC Member Agenda 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 meeting, multiple SSC members acknowledged associations with specific agenda items under SSC review. Anne Hollowed is the supervisor of Steve Barbeaux, Martin Dorn, Jim Ianelli, Paul Spencer, William Stockhausen, Cody Szuwalski, and Grant Thompson, who are all members of the CPT, BSAI-GPT or GOA-GPT. Anne Hollowed is the second-level supervisor of Meaghan Bryan (lead author of C-1/C-2 Survey Loss Uncertainty), and Ingrid Spies (the assessment author of BSAI yellowfin sole), Kalei Shotwell (groundfish ESP coordinator), Olav Ormseth (lead author of the octopus stock structure analysis) and Carey McGilliard (lead author for BSAI northern rock sole and GOA Dover sole assessments and an author of C-6 Halibut ABM). Andrew Munro supervises Hamachan Hamazaki, the lead author of the NSRKC assessment. Mike Downs and Andrew Munro both contributed to C-4 Cook Inlet Salmon FMP, and Curry Cunningham consulted on this. Similarly, Jason Gasper was consulted on an early draft of C-4 Cook Inlet Salmon FMP but did not contribute to any analysis or writing. Mike Downs and Dana Hanselman contributed to C-6 Halibut ABM. Dana Hanselman also supervises Elizabeth Siddon, an editor of the ESR, is a third-level supervisor for Pete Hulson, the author of the GOA POP assessment, and is a third-level

supervisor of Jordan Watson, a contributor to C-4 Cook Inlet Salmon FMP. Finally, Jason Gasper and Ian Stewart are both part of the Halibut DMR working group.

Appendix A: Report of NPFMC SSC Sub-Committee Meeting with AFSC on Trawl Survey Options and Priorities – August 28, 2020

Overview:

This report summarizes the Scientific and Statistical Committee (SSC) response to a request from the Alaska Fisheries Science Center (AFSC) for input on a series of questions regarding trawl survey options and priorities. The report was originally developed by a sub-committee of the SSC. The following SSC members served on the sub-group: Anne Hollowed (chair), Sherri Dressel, Chris Anderson, Dana Hanselman, George Hunt, Dayv Lowry, Franz Mueter, Andrew Munro, and Alison Whitman. The report was presented to the full SSC during the October 2020 NPFMC meeting. Suggestions for improvement from the full SSC were incorporated into this report. This updated version of the report reflects the SSC's response to AFSC's request for clarification of survey priorities.

The sub-committee meeting was attended by many members of the public. Dr. Ian Stewart attended as a participant. Diana Evans (NPFMC Deputy Director) provided logistical assistance. Drs. Stan Kotwicki (NOAA-AFSC) and Robert Foy (NOAA-AFSC) gave oral presentations. The following Plan Team co-chairs also attended: Steve Barbeaux, Martin Dorn, James Ianelli, Chris Lunsford, Katie Palof, and Grant Thompson.

The sub-group received public testimony from Gerry Merrigan (NPFMC), John Gauvin (Alaska Seafood Cooperative), Stephanie Madsen (At-sea Processors Association) and Julie Bonney (Alaska Groundfish Databank). Gerry Merrigan provided written testimony.

Background:

During the June 2020 virtual Council meeting, Robert Foy, Science and Research Director for the AFSC, provided the AFSC report. For the past several years, the SSC has expressed concerns about funding needed to maintain stock assessment surveys in the Alaska Region given budget cuts, loss of one-time funding sources, and the need for new routine assessments in the northern Bering Sea (NBS) and Arctic. The COVID-19 created a worst-case scenario for 2020, as five of six large-scale assessment surveys in federal waters off Alaska were cancelled owing to uncertainties surrounding the pandemic, lack of vessel availability, logistical constraints, and a need to minimize health risks to staff, crew, and communities. Cancelled surveys included trawl surveys in the eastern Bering Sea (EBS), the NBS, and the Aleutian Islands (AI), as well as the Bering Sea pollock acoustic survey, and the fall ecosystem survey. The annual Alaska longline survey in the Gulf of Alaska (GOA) and AI (primarily targeting sablefish), and the Southeast Alaska Coastal Monitoring survey (primarily targeting salmon and providing valuable environmental data), proceeded as planned. During his comments in June, Dr. Foy raised questions that needed to be answered to develop future survey plans and priorities.

Dr. Foy sought SSC advice once again on survey prioritization. The SSC welcomed this opportunity. Following the protocol used in 2018, the SSC formed a 2020 survey prioritization sub-committee with the following members: Chris Anderson, Sherri Dressel, Dana Hanselman, Anne Hollowed, George Hunt, Dayv Lowry, Franz Mueter, Andrew Munro, and Alison Whitman. This meeting was coordinated with the NPFMC and was open to the public.

On August 28, 2020, the SSC sub-committee met virtually with NMFS staff. As was the case in 2018, Dr. Foy provided some key motivating questions (and scenarios) about survey prioritization. Dr. Stan Kotwicki (NOAA-AFSC), summarized the key findings of the ICES Workshop on Unavoidable Survey Effort Reduction (WKUSER) report.

Dr. Foy provided a useful figure depicting bottom trawl survey cancellations in the North Pacific for the period 2010-present (Figure 1).

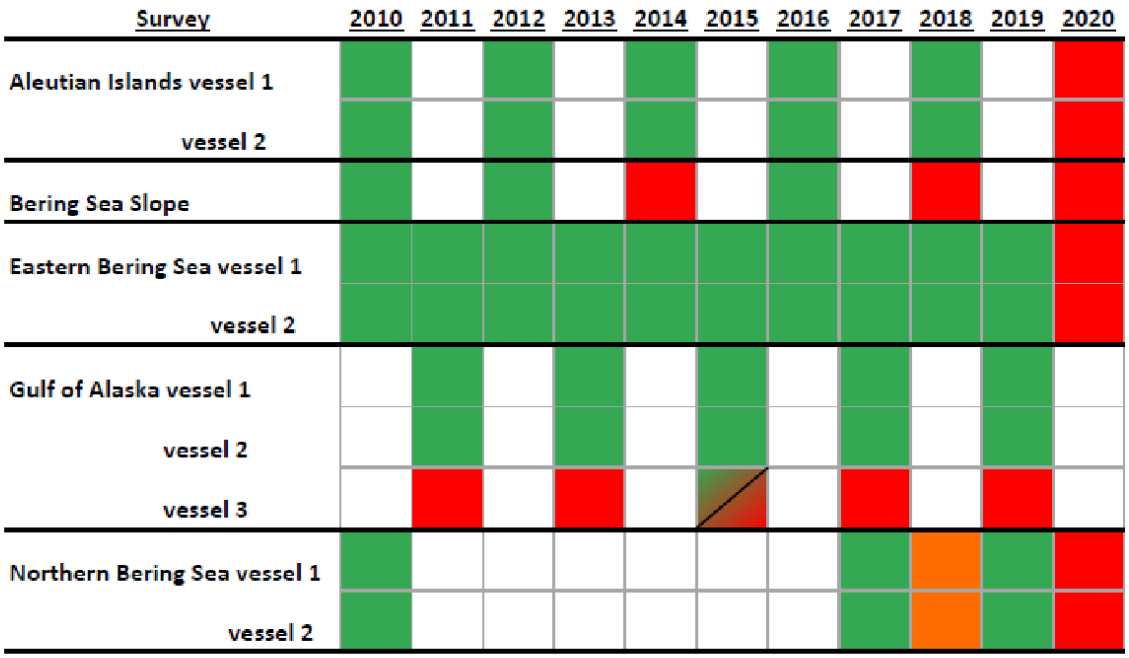

Figure 1. Summary of completed, partial and cancelled Alaska Fishery Science Center bottom trawl surveys 2010-2020.

AFSC Request:

The AFSC request outlined the following key assumptions for fish and crab biomass index monitoring surveys.

- The full complement of survey locations (**core** areas within Alaska's 5 Large Marine Ecosystems) for fishery independent stock assessment surveys includes the Gulf of Alaska, Aleutian Islands, eastern Bering Sea shelf, Bering Sea slope, and the northern Bering Sea. This represents an extension in effort to cover the northern Bering Sea.
- Secondary priorities will include point estimate and process studies in the Chukchi Sea and Beaufort Sea.

Given these key assumptions, the AFSC requested SSC input regarding the following scenarios regarding bottom trawl survey prioritization.

1. In odd years, if staffing or funding limit a full complement of core bottom trawl surveys, would the priority be to conduct the northern Bering Sea or increase GOA station density and deep station coverage?
2. How would an annual GOA survey rank among other core bottom trawl surveys if staffing/funding limit a full complement? That is, in an even year would adding a GOA survey to our research portfolio be prioritized over another core area?
3. If the northern Bering Sea becomes a standard survey:

a. Would biennial surveys be adequate?

b. Should the Norton Sound region be included?

c. Should station spacing be consistent with the eastern Bering Sea?

4. If surveys become severely limited would it be better to focus on a full survey in one core area or partial surveys in multiple core regions?

5. What is the value in considering any surveys in the Chukchi Sea to assess the northern edge of gadid distributions? Should such a survey come at the expense of a core survey area (e.g. EBS slope)?

Note, consideration of survey alternatives was in the context of long-term prioritization and planning, rather than specifically in the context of tactical 2021 survey planning in response to COVID-19.

WKUSER workshop:

In January 2020, AFSC hosted an international workshop sponsored by the International Council for Exploration of the Sea (ICES) focused on Unavoidable Survey Effort Reduction (WKUSER). Dr. Kotwicki provided an overview of the key outcomes of this workshop. The workshop addressed several of the issues regarding reductions in sample size, dropping depth strata, and modifications to survey frequency. While this document provides a useful starting point for discussions of survey modifications, additional studies will be needed including comparisons of status-quo and alternative scenarios. These scenarios should assess the costs and benefits of alternative survey designs. A paper by Spencer et al. included in the WKUSER report demonstrated a relationship between survey variability (CV) and biological reference points used for management. This study suggested that a target range for survey biomass CV for key species should be at or below 0.2-0.3, and it is species dependent. The WKUSER report notes that the survey CVs for most, but not all, GOA groundfish fall within this desirable range. The SSC welcomes continued work on these relationships.

2018 SSC conclusions:

In 2018, the SSC concluded that:

> "*NPFMC enjoys an excellent track record with regard to stock assessment throughput and sustainable management of the valuable fisheries off the coast of Alaska. A high priority should be placed on maintaining current funding to ensure continuation of surveys to continue this high level of performance. A thorough evaluation should also be performed to determine the impacts of reducing sample size during surveys, including dropping depth strata (as has been frequently done in the Gulf of Alaska), before modifications to the standing survey schedule are implemented.*"

The SSC sub-committee continues to place a high priority on maintaining funding to ensure continuation of all surveys. Comments from the CPT noted that we are living in a historic time as the impacts of climate change emerge in our high latitude system. The CPT emphasized the importance of continued data collections during this period of change to fully understand, and appropriately respond to, non-stationary production of living marine resources in the Alaska region. In 2018, the SSC sub-committee provided the following survey priority: 1) eastern Bering Sea shelf; 2) Gulf of Alaska; 3) Aleutian Islands; 4) northern Bering Sea; and 5) Bering Sea slope. **The 2020 SSC sub-committee modified its 2018 prioritization by recommending that the northern Bering Sea survey be combined with the eastern Bering Sea Shelf survey for the near future until sufficient measurements are available to assess whether a switch to biennial NBS surveys is recommended. The 2020 SSC survey sub-committee continues to prioritize these 5 surveys over expansion into the Chukchi Sea.**

Sub-committee responses to AFSC scenarios and questions:

1. "In odd years, if staffing or funding limit a full complement of core bottom trawl surveys, would the priority be to conduct the northern Bering Sea or increase GOA station density and deep station coverage?"

As noted above, the SSC places a high priority on both the GOA surveys and the inclusion of the NBS survey as part of the EBS annual survey (at least for the near future). If the undesirable outcome of a reduction in the number of vessels available occurs, the SSC provides the following guidance with respect to question 1.

a. When referring to 'deep station coverage' in the Gulf of Alaska, the SSC sub-committee clarified that this refers to a scenario based on a two boat versus three boat survey in the GOA, where a two boat survey would not sample the deeper stations (>700m). This scenario was used because sampling deep stations in the GOA requires a separate contract for a vessel with enough trawling cable to sample deep stations (720m). This type of contract is more difficult to secure. In addition, it takes a lot longer to sample deep stations than shallow stations. In this scenario, the two-boat survey would cover stations less than or equal to 700m representing 550 stations. The three boat survey would allow the full survey of 820 stations including stations from 700 to 1000m.

b. The SSC sub-committee reviewed the figure depicting the relationship between one boat, two boat and three boat surveys under current and optimized survey designs in the GOA (See Burnett et al. in WKUSER report).

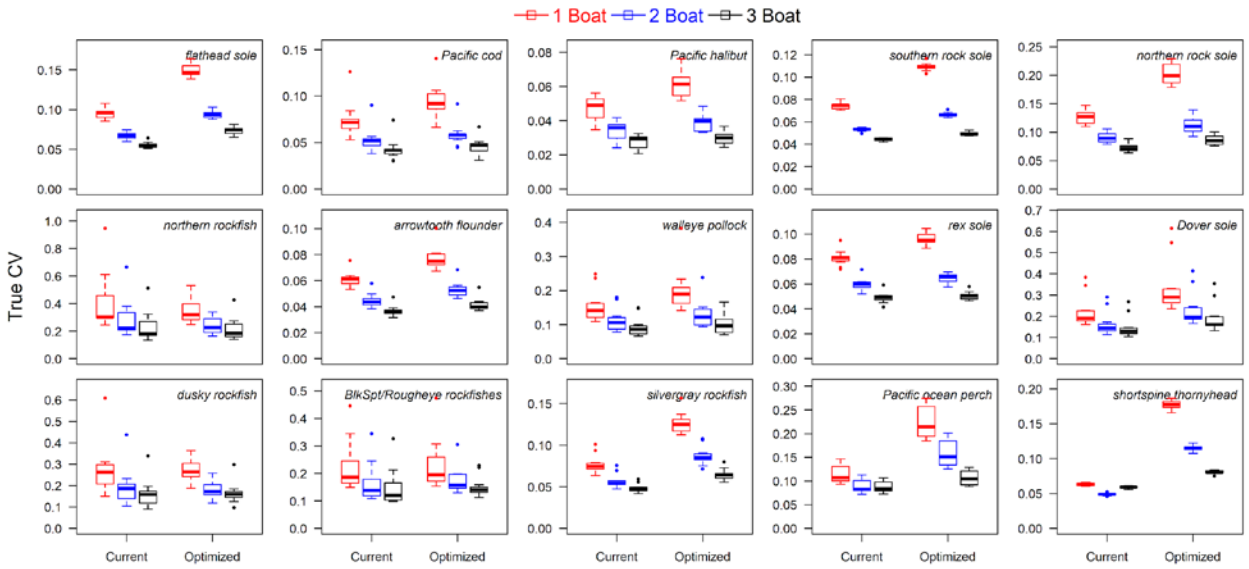

Figure 2. Comparison of the true coefficient of variation (CV) of design-based biomass estimates from simulated surveys between the current and optimized Gulf of Alaska bottom trawl survey design for each of 15 species modeled. The True CV is defined here as the standard deviation of simulated mean density estimates divided by the true mean density computed from a multivariate spatiotemporal operating model fitted to the Gulf of Alaska bottom trawl survey historical data from 1996 to 2019. Color indicates the sampling effort in terms of number of samples or hauls expected given three sampling effort scenarios related to the number of vessels operating simultaneously during a survey: 1 boat (n=280), 2 boat (n=550), 3 boat (n=820).

The sub-committee noted that there are clear advantages to a two boat design over a one boat design. This analysis also revealed that for the majority of species, the two or three boat design resulted in CVs well below 0.2 and the differences between the two and three boat designs were not large. As noted above, this was because the three boat design focused on deep water stations. However, the two versus three boat design made a difference for some valuable rockfish and flatfish stocks. It was noted that only a few commercially important species are found in waters deeper than 700m (e.g., Dover sole and thornyhead) and these species are not heavily exploited. It was also noted that the sablefish longline survey samples deeper stations allowing monitoring of potential shifts to deeper waters by Pacific cod and sablefish under a changing climate. **Therefore, if it becomes necessary (an undesirable outcome), the SSC sub-committee recommends that the GOA deep stations should be dropped from the bottom trawl survey to allow a survey in the NBS.**

c. The SSC sub-committee noted that if reductions beyond dropping the deep stations in the GOA were required, the SSC sub-group did not support surveying the NBS at the expense of the GOA core survey (stations <700m).

d. **The SSC sub-committee recognized that dropping the EBS slope survey and dropping deep stations in the GOA is not a desirable scenario.** If it became clear that these two deepwater surveys would not occur, then alternative ways of monitoring the deep stations would be required.

2. How would an annual GOA survey rank among other core bottom trawl surveys if staffing/funding limit a full complement? That is, in an even year would adding a GOA survey to our research portfolio be prioritized over another core area?

The SSC sub-committee noted that the 2014-2016 marine heatwave in the GOA impacted Pacific cod and detection of these impacts were delayed and limited by the biennial survey schedule in the region. Gadid stocks in the GOA represent valuable resources and, therefore, the SSC sub-committee understands why this question was posed to the group. The sub-committee noted that there are several surveys that occur in the GOA that contribute to our understanding of stock status of gadids. These include: the spring acoustic surveys for spawning walleye pollock, the biennial summer acoustic surveys for walleye pollock, the summer ADF&G bottom trawl surveys, the AFSC longline surveys and the IPHC longline surveys. Assessment authors already utilize information from several of these surveys in their assessments or are exploring ways to incorporate this information into their assessments.

The SSC sub-committee noted that the GOA bottom trawl surveys also provide valuable information on the status and trends for several rockfish species. Rockfish populations are long-lived and therefore abrupt swings in abundance are less likely. Biennial survey time steps for these species has proven to be adequate for many years.

Given the considerations above, the SSC sub-committee did not recommend prioritizing the GOA survey in even years over another core area to achieve annual GOA surveys. It was noted that some consideration might be given to the possibility of sampling stations in the western GOA as part of the Aleutian Islands bottom trawl survey if this could provide useful information on the westernmost portion of the GOA gadid stocks.

3. If the northern Bering Sea becomes a standard survey:

a. Would biennial surveys of the NBS be adequate?

As noted in the response to question 1 above, the sub-committee recommends that the northern Bering Sea survey is combined with the eastern Bering Sea Shelf survey for the near future until sufficient measurements are available to assess whether a switch to biennial NBS surveys is feasible. This region is experiencing considerable change that is influential for several valuable commercial species including: snow crab, Pacific cod, walleye pollock, yellowfin sole, and Alaska plaice.

b. **Should the Norton Sound region be included?** The SSC sub-committee agreed that the Norton Sound region should be included in the NBS survey and that the survey extent should be consistent from year to year, to the extent practicable. It was noted that funding for the ADF&G survey for Norton Sound Red King Crab is uncertain and the bottom trawl survey results are used in the NSRKC assessment. In addition, given the warm water observed in the inner domain of the NBS in 2019, there is continued interest in monitoring this region.

c. Should station spacing be consistent with the eastern Bering Sea? The SSC-subgroup recognized that research on sampling intensity and survey design is continuing at the AFSC. In particular, we note that the papers by Bryan and Hulson and Conner et al. in the WKUSER report are directly relevant to this question. Conner et al. concluded that the bias in systematic sampling is species specific and random sampling is desirable. Systematic sampling, on the other hand, can be more precise than random sampling in a relatively homogenous habitat like the eastern Bering Sea shelf and has distinct logistical advantages. The SSC sub-committee supports continuation of research on sampling intensity and survey design as it may inform future improvements to trawl surveys. The SSC sub-committee noted that, given that the NBS survey is relatively new, a shift to a random or random stratified sampling design could occur now. However, the SSC sub-committee recognized that changing the sampling design of the systematic eastern Bering Sea trawl survey should be done cautiously and only after a well-designed alternative has been brought forward. Furthermore, studies to provide a statistical bridge between the EBS alternative and the EBS systematic survey would be needed.

In light of these issues, the sub-committee considered two scenarios: 1) NBS random or random stratified and EBS systematic or 2) NBS and EBS remain systematic until an alternative design for the EBS is brought forward. In support of scenario 1, it was recognized that VAST models would accommodate different survey designs in the two regions, but the model could behave differently in each area because the resolution will be different and annually changing under a stratified random design. The EBS Pacific cod assessment model currently uses VAST model estimates. It was also noted that if the NBS annual survey used a random design that it might be easier to reduce the number of stations under conditions of unavoidable survey effort reductions without losing the overall information gained by the survey. VAST model estimates can mitigate some issues with missing data. In support of scenario 2, it was recognized that maintaining consistency in the survey design was desirable as it would not create an edge effect between the two surveys. Given that the southern boundary of the NBS coincides with the spatial shifts in some species such as snow crab, avoiding an edge effect was important (see Fedewa et al. In Press, https://doi.org/10.1016/j.dsr2.2020.104878). In addition, a consistent survey design offered some logistical benefits for survey planning. **The SSC sub-committee concluded that scenario 2 was recommended as long as survey effort could remain consistent.**

4. If surveys become severely limited would it be better to focus on a full survey in one core area or partial surveys in multiple core regions?

The sub-committee discussed this undesirable scenario and concluded that if this situation occurred, that adoption of a biennial schedule where the EBS and NBS were surveyed in one year and the GOA and AI were surveyed in another should be considered. It was noted that the limits of reducing station density to accommodate a GOA and AI survey should be carefully examined to ensure that the surveys continue to provide the reliable biological information necessary for estimating population trends of managed species.

5. What is the value in considering any surveys in the Chukchi Sea to assess the northern edge of gadid distributions? Should such a survey come at the expense of a core survey area (e.g. EBS slope)?

The SSC sub-committee recognizes that the Chukchi Sea is a transition zone and that considerable changes are already occurring in the region under changing climate conditions. Monitoring these changes is important to the NPFMC, as they will inform future decisions regarding if, when, and how commercial fisheries could occur in the region. It was noted that the Chukchi Sea region is currently closed to commercial fishing and will remain closed until sufficient information is available to sustainably manage fisheries in the region. Therefore, failing to collect information in the region will delay the future fishing opportunities in the region.

When weighing the issues noted above, the SSC sub-committee concluded that the highest priority currently is to collect relevant information needed to sustainably manage existing fisheries. Thus, the sub-committee agreed that the Chukchi Sea region is of secondary importance to the core surveys discussed above. In light of this conclusion, and in recognition of the importance of monitoring living marine resource responses to changes in ocean conditions, the SSC sub-committee provided the following advice: a) explore options for research partnerships with outside entities, including both local and regional entities and cooperative research with industry, or AFSC ecosystem surveys to sample groundfish in the Chukchi Sea; b) attempt to align these surveys temporally with existing trawl surveys and, to the extent possible, use similar gear and survey sampling protocols. Partnerships might include not only US researchers, but also those from other countries, notably Japan, Korea and Russia.

It was noted that if this type of research partnership was achieved, that outreach to coastal communities would be needed to solicit input on preferences and priorities for research, and to gauge interest in and opportunities for potential research partnerships with local and regional entities to enhance understanding of the region's ecosystems and fish resources.

Additional General Comments

The SSC sub-committee noted that efforts to assess the implications of alternative survey frequencies or survey designs should be carried through to include the implications for catches. What actually gives value to the information gathered through each survey is how it impacts management and resource allocation, because that is what will lead to changes in attainment of optimum yield (NS 1) or sustained participation in harvesting or processing (NS 8). There is a need to continue ongoing analyses, including local analysis of these fisheries and international coordination. However, there is still a critical knowledge gap in how changes in the survey lead to changes in economic or societal benefits. It was noted that some papers have already been published demonstrating the value of this type of analysis (e.g., Hutniczak et al. (2019) https://www.nrcresearchpress.com/doi/abs/10.1139/cjfas-2018-0130). The sub-committee was informed that a first step, incorporating changes in survey frequency and station density into stock assessments within a management strategy evaluation framework to assess the implications of alternative survey operations on biological reference points (ABC and OFL), has been funded (leads Meaghan Bryan, Lewis Barnett and Stephen Kasperski, NOAA-AFSC). The sub-committee looks forward to reviewing the results of this study. The sub-committee recommends that this work be extended to connect survey CV to changes in TACs (considering that many species have headroom to expand buffers without changing TACs) and changes to fleet allocations, given what each fleet is able to harvest (considering limitations on TAC utilization or TAC

flexibility). This information will be critical to making long term plans, and will also help build a case for maintaining and possibly scaling the resources available for these surveys.

The SSC sub-committee also noted that decisions relative to survey prioritization should include the full suite of surveys conducted by the AFSC. Consideration of the trade-offs between research surveys and standard stock assessment surveys should be clearly articulated. In addition, efforts to explore opportunities to collect relevant ecosystem information during stock assessment surveys is recommended.

The SSC appreciated the opportunity to provide input on priorities for strategic survey planning and looks forward to continued opportunities as new information is obtained, new environmental conditions occur, or advice on a different combination of surveys and research is desired.