North Pacific Fishery Management Council

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SCIENTIFIC AND STATISTICAL COMMITTEE
FINAL REPORT TO THE
NORTH PACIFIC FISHERY MANAGEMENT COUNCIL
February 6th – 8th, 2023

The SSC met from February 6 – 8th, 2023 in Seattle, WA. Members present in Seattle were:

Sherri Dressel, Co-Chair *Alaska Dept. of Fish and Game*	Franz Mueter, Co-Chair *University of Alaska Fairbanks*	Alison Whitman, Vice Chair *Oregon Dept. of Fish and Wildlife*
Chris Anderson *University of Washington*	Amy Bishop *University of Alaska Anchorage*	Curry Cunningham *University of Alaska Fairbanks*
Martin Dorn *University of Washington*	Mike Downs *Wislow Research*	Robert Foy *NOAA Fisheries—AFSC*
Jason Gasper *NOAA Fisheries—AKRO*	Dana Hanselman *NOAA Fisheries—AFSC*	Brad Harris *Alaska Pacific University*
Michael Jepson *Independent Contractor*	Kailin Kroetz *Arizona State University*	Kathryn Meyer *Washington Dept. of Fish and Wildlife*
Andrew Munro *Alaska Dept. of Fish and Game*	Chris Siddon *Alaska Dept. of Fish and Game*	Ian Stewart *Intl. Pacific Halibut Commission*
Patrick Sullivan *Cornell University*	Robert Suryan *NOAA Fisheries—AFSC*	

SSC Election of Officers

The SSC re-elected Sherri Dressel (ADF&G) and Franz Mueter (University of Alaska Fairbanks) to serve as co-chairs for 2023. The SSC also re-elected Alison Whitman (ODFW) to serve as vice chair.

SSC Administrative Discussion

The SSC extends a warm welcome to new members Dr. Michael Jepson (Independent contractor), Dr. Rob Suryan (NOAA-AFSC) and Dr. Martin Dorn (University of Washington). The SSC is grateful for their contributions of time and expertise and the SSC is appreciative to the Council for their appointments.

C2 BSAI Crab

The SSC received a report on the January 2023 Crab Plan Team (CPT) meeting from Sarah Rheinsmith (NPFMC), Katie Palof (ADF&G), and Mike Litzow (NOAA-AFSC). There was no public testimony for BSAI CPT agenda items or the Norton Sound red king crab (NSRKC) assessment.

General BSAI Crab SAFE Comments

The SSC wishes to congratulate Shareef Siddeek (ADF&G) on his upcoming retirement and thank him for his work on advancements to the BSAI Aleutian Islands golden king crab assessment, his work on other crab assessments, and his many years of participation on the Crab Plan Team.

BSAI Crab SAFE and Harvest Specifications

The SSC reviewed the NSRKC SAFE chapter and information provided by the CPT with respect to the stock status information from 2022/2023 relative to total catch during the 2022/2023 season (Table 1). In addition, Table 2 contains the SSC recommendations for 2023/2024 catch specifications. The remaining crab SAFEs will be reviewed, and harvest specifications set, at the June and October SSC meetings.

Table 1. Stock status in relation to status determination criteria for 2022/23. Hatched areas indicate parameters not applicable for that tier. Values are in thousands of metric tons (kt).

Chapter	Stock	Tier	MSST	B_{MSY} or B_{MSY} proxy	2022/23 MMB	2022/23 MMB/ B_{MSY}	2022/23 OFL	2022/23 Total Catch	Rebuilding Status
1	EBS snow crab	3			55.0		10.32		
2	BB red king crab	3			17.0		3.04		
3	EBS Tanner crab	3			47.58		32.81		
4	Pribilof Islands red king crab	4			3.88		0.685		
5	Pribilof Islands blue king crab	4			0.18		0.00116		
6	St. Matthew Island blue king crab	4			1.31		0.07		
7	Norton Sound red king crab [1]	4	0.95	1.90	2.42	1.27	0.30	0.16	
8	AI golden king crab	3			11.94		3.76		
9	Pribilof Islands golden king crab [2]	5					0.093		
10	Western AI red king crab	5					0.056		

[1] For Norton Sound red king crab, all values in the table except 2022/23 total catch were projected using the January 2022 assessment. Stock status for NSRKC is determined in February (2022/23 MMB was projected for 2/1/23 and compared with the projection of B_{MSY} proxy for the 2022/23 year).

[2] PIGKC specifications are set on a calendar year basis.

Table 2. SSC recommendations for EBS crab stocks. Stocks for which specifications are rolled over between assessments (PIRKC and SMBKC) or were set in February (NSRKC) are included. Biomass values are in thousand metric tons (kt). Tier designations in this table are based on the projected stock status in 2023/2024. Stocks for which the SSC recommended different harvest specifications from the CPT are bolded. Harvest specifications for SAFE Chapters 1 – 4 and 6 are set in October and Chapters 5 and 8 – 10 are set in June, in the year according to the assessment frequency cycle (see current SAFE Introduction for assessment cycle). Chapter 7 is set in February.

Ch.	Stock	Tier	F_{OFL}	B_{MSY} or B_{MSY} proxy	B_{MSY} basis years[1]	2023/24[2] MMB	2023/24 MMB/ B_{MSY}	Natural Mortality (M)	2023/24 OFL	2023/24 ABC	ABC Buffer
1	E. Bering Sea snow crab										
2	Bristol Bay red king crab										
3	E. Bering Sea Tanner crab										
4	Pribilof Is. red king crab	4a	0.21	1.71	2000-2021	3.88	2.27	0.21	0.685	0.51	25%
5	Pribilof Is. blue king crab										
6	St. Matthew blue king crab	4b	0.06	3.26	1978-2021	1.31	0.40	0.18	0.07	0.05	25%
7	Norton Sound red king crab	4a	0.18	1.98	1980-2023	2.40	1.21	0.18	**0.31**	**0.22**	30%
8	Aleutian Is. golden king crab										
9	Pribilof Is. golden king crab[3]										
10	W. Aleutian Is. red king crab										

[1] For Tiers 3 and 4, where B_{MSY} proxy is estimable, the years refer to the time period over which the estimate is made. For Tier 5 stocks, it is the years from which the average catch for OFL is estimated.

[2] MMB is estimated on 2/1/2024 for NSRKC and on 2/15/2023 for all other Tier 1-4 stocks, using the current assessments.

[3] PIGKC specifications are set on a calendar year basis

Norton Sound Red King Crab

The SSC thanks the CPT and the author for the final 2023 assessment and being responsive to the SSC's requests. The assessment author presented results from one model (21.0) with updated data for status determination and OFL and ABC calculation. This model assumes a constant natural mortality (M) of 0.18 yr-1 for all length classes except the largest length-class, which had an estimated M of 0.62 yr-1. The SSC appreciates the exploratory models with different retention probabilities and length-specific natural mortality, but notes that they were not being put forward as alternatives for harvest specifications.

The SSC believes that its previous recommendation for estimating M across length bins was imprecise and was interpreted by the author as estimating M for each length bin, rather than estimating a single M for all length bins. Assessments for NSRKC over multiple years have indicated that the data suggest a higher M than currently used. The high M at just one length group has questionable biological rationale. It would be more parsimonious to estimate just one M parameter across all lengths of crab for a future model. The base value for M for NSRKC has been estimated using the maximum age of 25 with the 1% method (the rule of thumb that if 1% of the animals live to the maximum age, then M=-log(p)/t_max or for king crab M=-log(0.01)/25=0.184) and fixed in the model. A recent synthesis paper (Maunder et al. 2023) recommends using the Hamel and Cope (2022) maximum age approach ($M = 5.4/t_{max}$) where using age 25 as the maximum age yields M = 0.22. .

Previously, a rationale for maintaining the current value of 0.18 was that a higher M may result in a higher OFL. The SSC does not agree with this rationale and the assessment should explore a higher value for M if that may be the best description of the stock's dynamics. The SSC requests a variant of model 21.0 for next year's assessment with one estimated value of natural mortality for all sizes, perhaps with a prior distribution using the previously mentioned updated methods.

The SSC agrees with the CPT and the author to use Model 21.0 for setting harvest specifications, which places the stock above MSY and in Tier 4a. **The SSC also supports the author- and CPT-proposed 30% buffer, which is a reduction from last year's 40% buffer**. The SSC appreciates the table providing a rationale for the buffer and the comparison to the previous assessment. **The SSC disagrees with the CPT's recommendation to only use retained catch for OFL determinations and recommends total catch OFL again for 2023, as this is best practice for assessing stock status**. **The SSC-recommended total catch OFL and total catch ABC differ from those recommended by the CPT.** The SSC encourages the author to continue to provide total catch OFL in the future. **Results from model 21.0 indicate that the NSRKC stock is not overfished and catch during 2022/2023 did not exceed the OFL so the stock is not subject to overfishing.**

In addition to bringing forward a model with higher natural mortality, the SSC has the following specific recommendations as time allows:

- Prioritize transitioning the model to GMACS.
- Consider an update to the standardized commercial fishery CPUE model, which is developed external to the assessment model.
- Continue to develop VAST or other model-based survey estimates of abundance.
- Consider using NSRKC as a case study for the incorporation of local knowledge, traditional knowledge, and subsistence information for Council decision-informing analyses as previously suggested (see February 2018, 2019, 2020, and 2021 SSC Reports in BSAI Crab, BS FEP Climate Change Task Force, and BS FEP- LKTKS Taskforce sections). It is assumed that this work would be led by AFSC social science personnel (or other similarly qualified researchers) and would

involve inputs from the Local Knowledge, Traditional Knowledge, and Subsistence (LKTKS) Task Force and the Climate Change Task Force (CCTF). The assessment authors could facilitate such an effort because as noted in this year's BSAI Crab SAFE, "the ADF&G NSRKC biologists are members of the Nome community and are acquainted with many local fishermen and staff of community organizations such as [the] Norton Sound Economic Development Corporation and Kawerak, exchanging information and research ideas about crab biology and fisheries", indicating the existence of established personal working relationships considered key for the co-production of knowledge that would make for a useful case study. The SSC would welcome a presentation on recent work done by the AFSC in this area.

- Based on the recent work by Leah Zacher and others, test the sensitivity of the assessment model to a much lower size at maturity.
- A more thorough description on how the tagging data are being fit and the source of the form of the multinomial component of the likelihood in the appendix would be helpful, including some diagnostic plots of the fit to the data.
- In Figure B, the scale of the different color dots should be defined if this figure is to be included in future assessments.
- Define "tau" in the likelihood; presumably it reflects recruitment deviations.
- A small-scale observer program should be considered for the NSRKC fishery. The program should be designed to provide information on the quantity and size-composition of discards that could be used in the assessment to update selectivity and retention curves and allow total catch (retained catch plus discard mortality) to be estimated.

Finally, the SSC shares the general frustration of the author and the CPT that significant headway has not been made on some of the key issues present with this stock and recognizes the review process as currently structured can have some duplication of previous recommendations. However, constructive language in the SAFE document is required to continue to work towards the collective goal of providing as accurate an assessment of the NSRKC stock as possible for use in management.

Pribilof Island Golden King Crab Model Runs

The Pribilof Islands golden king crab stock is currently a Tier 5 stock, with the OFL determined by average catch over a specified time frame. The assessment is conducted every three years and the last assessment was conducted in 2020. Several candidate models were previously requested by the SSC. These fell into 3 broad categories:

1. The previously-accepted Tier 5 model with updated catch estimates;
2. Tier 4 models that use a random effects approach to fit NOAA EBS slope survey data for PIGKC mature male biomass (MMB) and that determine a proxy for B_{MSY} from average model-estimated MMB, estimate a projected MMB, and use M as a proxy for F_{MSY}; and
3. A mixed (groundfish) Tier 4/5 approach that uses the "raw" estimates of survey biomass to determine the current biomass based on a straightforward average of survey MMB.

The SSC commends the authors for their work addressing previous CPT and SSC comments and for bringing forward Tier 5, Tier 4 and mixed Tier 4/5 approaches as requested. Models presented by the author included (1) the previously accepted Tier 5 approach with updated catch estimates, (2) Tier 4 models using the *rema* package (Sullivan et al. 2022) to fit EBS slope survey data and (3) a Tier 4/5 approach similar to

the 2010 GOA spiny dogfish assessment, where the OFL is calculated as product of the assumed natural mortality and average observed MMB from the survey.

The NOAA EBS slope survey provides the only basis for fishery-independent data to assess the PIGKC stock, but the data are limited in temporal extent (2002, 2004, 2008, 2010, 2012, 2016). In addition, size composition data are lacking for the first two survey years and mature male biomass in those years had to be inferred from other surveys. An important limitation is there has been no slope survey in six years, which constrains the ability to evaluate current abundance. The random effects approach gave reasonable results given the uncertainty of the survey estimates, and indicated relatively stable temporal trends.

The SSC notes that to explore a Tier 4 assessment and use the random effects model, it was necessary to compute an estimate and variance for the 2022 and 2024 MMB estimates as there were no length compositions available. The calculation was improved (from that used in the 2020 assessment) by using the approximation of the variance of a ratio. These estimates (in addition to the rest of the time series of the EBS slope survey) were subsequently used in the "*rema*" R package to fit random effects models as part of the Tier 4 approaches evaluated.

The CPT recommended continuation of the Tier 5 approach given the lack of a recent survey and noted that all three approaches performed similarly. The SSC discussed the CPT recommendation to bring back the Tier 5 approach as the single model for consideration in May, but instead recommends bringing back all three. The SSC is interested to hear CPT recommendations and justifications relative to each in June. Similar to the CPT, the SSC saw advantages to the Tier 5 approach. However, it was noted in SSC discussion that an advantage of the Tier 4 random effects approach is that it can carry uncertainty in the assessment estimates forward into projections, reflecting increased uncertainty when surveys do not occur. In addition, the SSC recommends:

- using M=0.22 yr-1, or another value consistent with the AIGKC assessment, in future Tier 4 models to be considered when more data become available

- exploring a VAST model for biomass estimates

Aleutian Islands Golden King Crab Model Runs

The SSC was presented with a list of the proposed models to be brought forward for the annual assessment of the Aleutian Islands golden king crab stock (AIGKC) at the May 2023 CPT meeting. The models recommended by the CPT were:

- Model 21.1e2: The base model from the May 2022 assessment, except that the pre-specified value of M was changed from 0.21yr-1 to 0.22yr-1 based on a re-analysis of historical tagging data.

- Model 21.1f: As for model 21.1e2, plus observer CPUE data standardized including Year: Block interactions.

- Model 21.1g: As for model 21.1e2, but with the EAG cooperative survey standardized CPUE included.

- A model similar to 21.1g but with 21.1f as the base rather than 21.1e2

The SSC appreciates the work by the assessment author and others to transition this assessment to the GMACS framework as well as the detailed bridging analysis. **The SSC agrees with the CPT that the May 2023 assessment be conducted using GMACS only and that the status quo model not be brought forward for the May assessment. However, the SSC requests that the base GMACS model EAG21.9c**

(modified 21.e2), which closely follows the legacy model, be included to facilitate comparisons with the previous bridging exercises.

The SSC endorses the GMACS assessment model alternatives 21.e2 and 21.1f as recommended by the CPT to be prioritized for consideration and be brought forward in May 2023. In addition, if time permits, a modification of alternative 21.1f to include the cooperative survey might also be considered. However, not all permutations of model alternatives with and without the cooperative survey are needed for consideration.

The SSC recognizes that alternative recruitment scenarios exist, and that results were provided for variants of model 21.1e2 in which the period used to define average recruitment was changed from 1987-2017 to 1987-2019, 1987-2020, and 1987-2021, but it was unclear from the CPT report which time series was used. **The SSC agrees that the 1987-2017 recruitment time period be used for this assessment, but that for future assessments the authors continue to consider other recruitment time periods (including routinely adding a year to the series as is done in other assessments) and provide justification for the final choice.**

Regarding projections, the SSC requests clear documentation of what elements are treated as stochastic (e.g., recruitment, mortality) and which are fixed (e.g., catchability, selectivity) even if they were represented as stochastic in the assessment model. Such choices will influence the uncertainty captured in the projections.

GMACS Modeling Workshop

The SSC received a summary of the modeling workshop held during the January CPT meeting. The SSC appreciates the update, and the continued effort of the workshop leads, CPT, and assessment authors to improve GMACS, such as merging the king crab and snow crab coding branches, the 'gmr' R package, and the introduction to the base level of GitHub interactions. Additional updates that are underway include: simulation code, environmental variable linkages, and improved documentation. The SSC is also encouraged that GMACS will likely be ready for NSRKC and Tanner crab assessments in the near future. **These workshops provide an excellent opportunity to make significant progress in a short time and the SSC supports similar workshops in the future. The SSC further supports continued efforts to ensure GMACS will be appropriately curated and accessible into the future, which should include planning for long-term funding.**

Start Date Workshop

The SSC received an update on the criteria to be used for changing start dates of assessment models. This discussion was based on an October 2022 SSC request to ensure consistent rationale was applied if/when different model start dates were proposed. The CPT recommended and the SSC supports the following criteria or methods when considering a change to an assessment start date:

1) More data are generally better and using all the standardized data available, including reliable catch time series, should be the default for selecting a start date.

2) For the inclusions of trawl survey data, the SSC suggests crab assessment authors and the CPT be more explicit about best practices for which standard years are included for bottom trawl survey data. The SSC suggests that the years recommended by the Groundfish Plan Teams would be a good starting point, which specify using the following bottom trawl survey data years:

- Aleutian Islands: 1991 - present (standard gear)

- Eastern Bering Sea: 1982 - present (standard gear), 1987 - present for species that inhabit the northwest corner of the survey (which was added in 1987).

3) Consider removing early data if:

- Data quality is suspect or deemed inappropriate to use.
- Inconsistencies between current data and historic data exist that lead to convergence issues or divergent trajectories for the stock.
- Ecosystem driver or regime shifts have occurred present difficulties in modeling periods with markedly different population dynamics.

Additionally, any proposed new start date should include diagnostics to show how the removal of earlier data may affect the current reference point calculations or stock status determinations.

The SSC also recommends that stock assessment authors continue to report on the entire time series of available data even if start dates change in order to maintain the historical perspective that may be informative into the future.

Model Complexity Working Group

The SSC received a brief update on the initial discussion to create a working group to address the SSC's October 2022 recommendation regarding simpler models for snow, Tanner, and BBRKC stocks. The SSC recognizes that size-structured models are inherently challenging, and that assessment model complexity can increase over time. The CPT discussed the general goal for the working group was to establish a simpler "base" model for stocks and then add features from there (for each stock), and to bridge the differences between the State and Federal processes. Members of the working group were initially selected during the CPT and included both CPT and SSC members. Additional SSC members were added to the working group during the SSC meeting and the whole group will consist of: Katie Palof, Buck Stockhausen, Cody Szuwalski, Franz Mueter, Ian Stewart, Curry Cunningham, Dana Hanselman, and Sherri Dressel. The SSC discussion supported this working group using the first meeting, slated for March 27-28, 2023, to determine the explicit goals and objectives for the work and focus on exploring simpler models, with the State-federal interaction for crab assessment and management as a secondary objective.

Crab Updates and Crab Conservation Prioritization

The SSC did not review and discuss this topic since the Council motion was directly for the CPT.

Research Updates

The SSC received research updates on a number of new and ongoing crab projects: BBRKC cooperative research, crab tagging, ocean acidification, and on BBRKC bycatch distribution. The SSC was excited for the opportunity to hear about these projects.

The BBRKC cooperative research is a new project not yet underway between BSFRF, ADF&G, and NOAA to provide a better understanding of the winter distribution and movement of BBRKC. This project also seeks to provide information on reducing regulatory discards of crab in the directed fishery and provide some economic relief to crab vessels and their crews due to the recent fishery closures.

Research on crab tagging done by Leah Zacher (NOAA-AFSC) and Jared Weems (ADF&G) is intended to better understand crab movement. Early results from Zacher's work showed evidence that male RKC moved into the Red King Crab Savings Area in the fall, westward in the winter and then back eastward. Female crab in the spring showed some evidence of movement into eastern Bristol Bay, potentially for molting/mating. Weem's project focused on using AUVs to track Tanner crab movement around Kodiak island. This early study provides some proof of concept to track crab and to collect oceanographic data.

Emily Ryznar (NOAA-AFSC) presented recent work on BBRKC distribution models to better understand the spatial distribution of legal-sized crab in non-summer months within the yellowfin sole and northern rock sole fisheries. Model results generally fit well to observed centers of distributions except during years of low bycatch. A number of suggestions were made during the CPT to improve this work into the future, and the SSC additionally encourages the author to work with groundfish trawl and pot gear participants as appropriate.

A brief update of Darren Pilcher's (NOAA-PMEL) and Chris Long's (NOAA-AFSC) work on ocean acidification was presented. The SSC was very supportive of all the work on ocean acidification and would like to see a more detailed presentation including how this research will inform the Council process as time allows in the SSC schedule.

C4 Essential Fish Habitat Report – Arctic

The SSC received a presentation by Dr. Jodi Pirtle (NOAA-AKRO) on updates to proposed Essential Fish Habitat (EFH) definitions for Arctic cod, saffron cod, and snow crab in the Arctic. The SSC thanks the authors for their extensive efforts to advance EFH for these Arctic species during the current 5-year EFH review cycle, both in terms of methodology and the diversity of species and life history stages analyzed. There was no public testimony.

New methods for defining EFH in the Arctic (the U.S. waters of the Chukchi and Beaufort seas), including the use of species distribution models (SDMs) to map suitable habitat under a Level 1 EFH description of distribution for 13 species and life stage combinations, and description of Level 3 EFH (habitat related vital rates) for age-0 and juvenile Arctic cod and juvenile saffron cod. To define species distributions Maximum Entropy (MaxEnt) models were fit to presence-only data from the Beaufort and Chukchi seas, compiled from a range of surveys, employing a variety of sampling designs and gears, in both nearshore and offshore habitats. Spatial predictions for species' presence were informed by a wide range of static and dynamic habitat covariates, ranging from depth and sediment type to summer water temperatures. Habitat-linked growth potential for EFH Level 3 definitions was quantified by identifying regions favorable to growth based on results from laboratory studies on temperature-dependent growth. The EFH report also describes potential shifts in distribution in response to marine temperature patterns, by highlighting differences in predicted distribution among warm and cold years throughout the 2000-2018 timeseries.

The current Arctic EFH assessment represents a clear and substantive improvement over the 2017 Arctic EFH review, which did not utilize an SDM approach and only presented presence-absence data as qualitative maps of distribution for several combined life stages. The set of habitat predictor variables, or habitat covariates, and the treatment thereof, appears appropriate for this purpose. As do the methods for searching across levels of regularization (i.e., model complexity) and feature classes, and selection of predictor variables, based on AICc and AUC performance criteria. The SSC further highlights the value of experimentally-derived snow crab vital rate information for informing Level 3 EFH for this species in the Arctic.

Considering these substantive improvements to EFH analysis methodology, and the species and life stages considered, **the SSC supports updates to EFH Level 1 and 3 text descriptions, and associated maps, based on these research findings**.

For the next 5-year review cycle, the SSC recommends several important considerations and opportunities for refining the Arctic EFH methodology:

The document highlights the decision to utilize a presence-only approach and the MaxEnt SDM framework was based on the realities of the limited sampling within the region and the diversity of gears employed. However, the SDM literature highlights that modeling presence-absence data is preferable when possible, especially under non-random sample designs. Given the absence of temporally consistent and spatially balanced survey sampling in the Alaskan Arctic, the available data are far from a truly random sample, and therefore the **SSC recommends that to the extent practicable future application of SDMs for defining Arctic EFH should attempt to model encounter and non-encounter (presence-absence) data.** In explicitly modeling encounter probability in an SDM context, the SSC notes that in addition to MaxEnt models specifying the complementary log-log link, several other estimation methods are applicable and capable of estimating spatial variation as well as non-linear relationships with habitat covariates, including: generalized additive (mixed) models, vector autoregressive spatiotemporal models, the sdmTMB package that fits spatial predictive-process generalized linear mixed models, and rINLA. However, the SSC notes that decisions regarding expansion of model complexity should always be critically evaluated with respect to whether they provide improvements in sample predictive performance, such as model fit, difference maps, and area occupied.

The SSC offers the following additional suggestions for the next 5-year EFH cycle:

- Continued exploration of the feasibility of statistically intercalibrating observations across gear types by estimating gear-specific catchability coefficients, to the extent practicable given spatial overlap in surveys and associated gear types.
- Plotting the distribution of survey data by warm and cold regimes and years, to better assess potential complications related to spatial imbalance in sampling.
- Given the changes in temperature within this region across the 2000-2018 timeframe of data in forming the SDMs, in addition to 5-fold cross-validation the SSC encourages evaluating predictive performance across temperature regimes (e.g., fitting to data from only cold regimes or only warm regimes, and predicting occurrence in the alternative regime).
- Consideration of spatial-block cross-validation approaches, potentially fitting to data from the Chukchi Sea and predicting into the Beaufort Sea, to evaluate the robustness of model predictions to hydrographic variability among regions.
- The SSC supports the planned and ongoing efforts to incorporate local knowledge, traditional knowledge, and subsistence information into future EFH reviews and analyses, including the human dimensions of vulnerability assessments.
- Consideration of predator-prey relationships and the potential to utilize the abundance of other species as predictors of EFH.
- Laboratory studies of temperature-dependent growth are needed for snow crab to produce maps of growth potential for EFH Level 3 definitions. The potential for improved conditions for snow crab growth in a warming Arctic is likely to be an important management consideration in the future.

- Consideration of how experimentally derived thermal tolerances are interpreted, as species can persist at higher temperatures in ad libitum laboratory conditions than in the environment.
- While the SSC understands that EFH definitions are only required for species described within the Arctic FMP, it encourages consideration of SDM efforts for other species within the Arctic region or potential new entrants to this ecosystem under a warming climate.

Finally, with respect to EFH definitions in the Arctic and advancing our understanding of the abundance and distribution of these ecologically important, and one day potentially commercially important, species in the Arctic, the SSC highlights that predictions from models are only as informative as the data on which they are based. **In order to understand this rapidly changing ecosystem, investment in standardized surveys and ongoing monitoring will be necessary.**

D3 Groundfish Stock Prioritization

The SSC received a report from Chris Lunsford (NOAA-AFSC) and Melissa Haltuch (NOAA-AFSC) on stock prioritization, following the initial consideration of this topic in 2017 and an update to the SSC in October 2022. Diana Stram (NPFMC) and Sara Cleaver (NPFMC) provided a summary of the Joint Groundfish Plan Team's consideration of this topic on 2 February. The SSC thanks the authors and GPTs for their work and for the detailed follow-up to previous discussions and recommendations by the SSC. Public testimony was provided by John Gauvin (Alaska Seafood Cooperative).

The authors and SSC recognized the challenge in separating the consideration of stock assessment timing, the category of assessment to be conducted, and the minimum requirements for reporting of each category of assessment. The presentation and subsequent discussion was divided into two parts: 1) specific recommendations for changes in the frequency of stock assessment for 13 groundfish stocks (crab assessments were not included in this analysis), and 2) a discussion of the process for prioritizing and conducting assessments and preliminary definitions of each type.

The authors provided background on the national stock assessment prioritization process and the 'Next-Generation Stock Assessment to Management' framework, noting that the general outline did not correspond exactly to the specific considerations and organization of tools in use in the NPFMC process.

Ten groundfish stocks were proposed by NOAA AFSC for reduced assessment frequency moving from every 2 years to every 4 years. Three additional stocks were proposed for reduced frequency from annual to every 2 years. The JGPT supported the proposed changes for all stocks except BSAI northern rock sole (proposing maintaining the current every two year cycle rather than every four years) and AI Pacific cod (proposing maintaining the current annual cycle rather than moving to every two years).

The SSC generally recognizes that stock assessment prioritization makes sense when resources are limited. The SSC supports freeing up resources and making the analysis and review processes as efficient as possible. The expectation is that reducing annual workload should increase development of assessment-supporting research as well as resources available to rapidly respond to unexpected events.

The SSC supports all JGPT recommendations for frequency except for BSAI yellowfin sole. Specifically, the SSC recommends maintaining BSAI yellowfin sole, BSAI northern rock sole and AI Pacific cod on the current schedule (annual, two year, and annual, respectively), and accepting the proposed reduced frequency of all other stocks recommended by AFSC. The SSC recognized that model development is ongoing for BSAI northern rock sole and there are concerns from the most recent assessment about potentially revised stock size estimates. For AI Pacific cod, the SSC recognizes ongoing efforts to move this stock to a Tier 3 assessment and suggests that this warrants maintaining increased analysis frequency. Both of these stocks may be suitable for reduced frequency when/if these current issues

have been resolved. Further, the SSC recognized the critical importance of the BSAI yellowfin sole fishery as the largest flatfish fishery in the world, and corresponding to a high value compared to other species. The SSC noted that alternatives such as update assessments may provide a compromise between reduced frequency and the full workload of producing the complete yellowfin sole stock assessment analysis each year. The SSC discussed whether the GOA shark complex assessment might also benefit from a more frequent schedule than proposed given the highly variable contribution from spiny dogfish. The SSC concluded that combining the report with BSAI sharks remained a priority, that running the random effects model for spiny dogfish in year three (see recommendation for Tier 5 stocks on a 4-year frequency below) when survey information is available would continue to provide updates to the ABC, OFL, and apportionments, and that if additional changes were made to the shark analysis, these could be brought forward at any time by the author.

After considerable discussion, **the SSC recommended that future stock assessment prioritization need not occur only on a five-year schedule (as was recommended in 2017), but that a complete schedule for all stocks should be compiled and made available to the Council process.** This may help to identify bottlenecks in the process and/or opportunities for additional work. **Subsequent changes to this schedule may then be considered on a case-by-case basis as the need arises and in tandem with planning for the specific type of stock assessment to be conducted.**

The SSC considered what general criteria were relevant when deciding to reduce stock assessment frequency in the future. **The SSC recommends that assessment frequency not be reduced (or perhaps be increased) for groundfish assessments where there were critical model and/or Tier concerns that need to be addressed, when there is potential for limiting interactions between species/fisheries (i.e., 'choke species'), and when upcoming non-assessment analyses require current stock assessment results. Assessments should also be prioritized when the SSC has determined that a reduction from the maximum permissible ABC should be applied.** The SSC notes that authors always have the option to bring forward an assessment out of schedule or elevate the category of an assessment if the need arises.

The SSC identified that transparency in the decision to elevate the frequency of an assessment or elevate the category of an assessment (e.g., moving from operational update to operational full) is very important to the process. **The SSC therefore recommends that, to the degree possible, clear criteria be developed for defining what would trigger an operational full assessment when an operational update was scheduled or an assessment to be conducted in a scheduled 'off' year.** These triggers could include mortality approaching the ABC or other data or model output thresholds. **The SSC also requested clarification on when during the year these triggers would be activated and whether there would be resources made available to, for example, conduct a full assessment for November based on that year's survey data.**

The SSC strongly supports efforts to categorize and clearly define specific types of stock assessments, noting that this will help with planning and transparency of the process.

The authors outlined four categories of analysis:

1) Operational full assessments
2) Operational update assessments
3) Partial catch projections (the SSC suggested an alternative name might be 'harvest projections')
4) Catch monitoring updates (the SSC suggested an alternative name might be 'catch report')

The SSC recognizes that operational full assessments have been the standard product that undergoes GPT and SSC review on an annual or biennial basis and allows for whatever degree of change to data and models is needed. These products receive rigorous review at all stages. Operational update assessments represent an analysis with only updated data and minor changes to the model or software and are anticipated to require only light review. The SSC recognized the challenge in determining exactly what constitutes 'too much' change for an update, but encourages author discretion and does not wish to limit critical analyses due to overly prescriptive guidelines. Partial catch projections (or harvest projections) include rerunning only the projection model with updated catches and in most cases will require little review. Catch monitoring updates (or catch reports) include a comparison of recent and current catch with the ABC and are intended to be produced as a summary table for all stocks on an annual basis. **The SSC supports these categories and looks forward to clear definitions for each Tier level in upcoming documentation of guidelines for stock assessment authors. The SSC requests that the guidelines include specific criteria for authors on the level of documentation for operational updates and partial catch projections. The SSC noted that for catch monitoring updates (or catch reports) consideration of subarea ABCs may enhance the utility of the report.**

The SSC recommends that the planned development of guidelines for stock assessment authors be considered in the context of a larger review of consistency with National Standard 2 guidelines for the inclusion of pertinent economic, social, community, and ecological information across the range of Council decision-informing SAFE documents.

The authors identified differences between national next generation stock assessment categories and the specific categories of models and reviews used by the NPFMC. In particular, **the SSC recommended adding a 5th analysis category 'Research assessments' which would include analyses/methods undergoing external peer review (e.g., CIE) but not immediately feeding into management actions (e.g., assessments in between scheduled analyses and analysis products such as GMACS).** The SSC discussed that it might be worthwhile to compare the NPFMC categories with other regions in case there are common approaches that may be adapted for greater consistency.

The SSC recommended that **for Tier 5 stocks on a four year frequency, the random effects model should be rerun and the OFL/ABC/apportionment calculations should be updated in year 3 if new survey biomass estimates are available.**

The SSC notes that the current review, after five years of initial stock prioritization, did not include information about how the released capacity has specifically been used to improve existing assessments, the methods supporting them, or climate readiness. The SSC suggests that this type of information will be important in the long term to determine whether the prioritization process has been successful in achieving its goals.

The SSC notes that the critical information from regular surveys has to be maintained regardless of assessment frequency; survey observations benefit a broad suite of species, which may be on differing assessment schedules and will likely provide the first indicators of change that can trigger assessment analyses and management response.

The SSC highlights that uncertainty will inevitably go up with decreased assessment frequency and decreased assessment detail, however, the SSC emphasizes that this may be offset by freeing up time and resources to address unexpected events. The SSC recognizes that this process is intended to avoid surprises and avoid having to increase buffers (the reduction of ABC from maxABC based on the risk table) as the time since the most recent assessment increases, while also trying to free up time and resources.

D6 Climate Change Readiness Report

The SSC received an informational presentation from Diana Stram (NPFMC) and Kirstin Holsman (NOAA-AFSC). No public testimony was provided. The SSC appreciates and commends the enormous amount of work that went into preparing the draft Climate Readiness Synthesis. The SSC acknowledges and appreciates the efforts of the Climate Change Taskforce (CCTF) and authors in addressing a complicated and difficult issue, and the exceptional job of unpacking literature and linkages between communities, fisheries, ecology, and a changing climate.

The report focused on providing a snapshot of the baseline readiness of North Pacific marine fisheries management, in terms of Council processes and management systems, and does so by quantifying how management tools, processes, or information include features that explicitly consider climate change. It was noted that an important distinction at this stage is that this document is not recommending how to increase adaptive capacity, nor is it identifying specific objectives for improving climate readiness. The goal of understanding the status quo was agreed to be a valuable first step in addressing the question of whether our current toolbox includes policies that can account for the added uncertainty due to climate change. However, it was less clear whether it is possible to have an accurate assessment of climate "readiness" without discussing whether the system currently can or cannot adjust at a rate reflective of the anticipated rapid and large-scale changes; that is, whether effective tools are available and the necessary data are acquired or available. Assessing if our processes and tools are effective was not the goal of this report, but it is a critical next step towards the Council's ultimate goals of assessing whether our current management system has the capacity to respond quickly and nimbly to future climate perturbations and directional change.

Another key aspect of this report was the thoughtful consideration given to defining key terminology. The SSC appreciated how the authors emphasized the socio-environmental linkages and highlighted the importance of considering fishing communities throughout the document, but **the SSC highlights a lack of exploration of the resilience of fishing communities in the report**. This is particularly important as the SSC notes the past difficulties in developing community resilience measures. While community vulnerability indicators have been developed and are now commonly used in other areas, community resilience is difficult to define. The SSC discussed how when the Community Social Vulnerability Indicators (CSVIs) that NOAA fisheries currently includes in its webtool were initially developed, there was an intention to also develop a resilience index, but the team was never able to develop a valid quantitative measure. Some of the struggle to define resilience stems from the concept of community. We tend to focus on the fishing communities in isolation, but in practice the fishing community resides within a larger geographic, cultural or economic community, so what is good for an individual fishing community may not always be advantageous for the larger community. An example is a transition from commercial to recreational fishing. This then becomes a community specific sense of resilience, which may differ substantially from that of a smaller, more isolated rural fishing community. The SSC highlights that policy is an intermediary between the physical changes and community outcomes, so when thinking about community resilience it is important to emphasize that it is dependent on policy.

The SSC suggests the treatment of community resilience within the document could be enhanced by clarifying the scope and goals of the current document and next steps. This could include comparing and contrasting the goal of community resilience (as generally defined in terms of community sustainability) and mandated policy goals like the sustained participation of fishing communities (as defined as being those communities that are substantially engaged in or dependent on fisheries with a federal management nexus). The SSC also discussed that it could be helpful to explore the different scales at which community resilience may be described and suggested that it is important to elevate the potential importance of thinking across fisheries. Additionally, the goals of climate readiness are related to achieving the national standards, but the SSC noted it is important to clarify what this implies at the level of species and communities.

The report includes three distinct sections related to assessing climate readiness.

Section 1: Management Overview

This section provided an overview of management measures and an evaluation of the potential strengths and weaknesses of a subset of current management approaches in relation to climate adaptive strategies. The report ranks the management section as '..."*On the way to climate ready (2)" because, while some management tools may be effective, many measures presently used were not developed to respond explicitly to climate change*.'

The SSC supports this effort as an opportunity and a means to reassess management readiness over time and suggests the "Opportunities for Improvement" row in Table 1-2 is a good starting point for identifying potential actions that can be formalized into specific recommendations (both near-term and long-term).

The SSC notes that in this section there were several nuances that could be clarified in terms of assessing management tools and processes. Quota programs are described without consideration for the suite of regulations (new and ongoing) that result in loss of efficiency and reduced flexibility under a changing climate. Some examples include regulatory discarding, PSC avoidance, and static closures. Likewise, gear modifications considered (e.g., excluders) can change gear selectivity for PSC or non-target species but these are maladapted to climate change if they reduce CPUE. The gear modification section should consider the potential to increase CPUE, which can result in direct climate benefits including reductions in fishing time, carbon emissions, and seabed disturbance.

The SSC suggests a useful outcome would be for CCTF to make recommendations on how the various items ranked in the management overview section and SAFE review could be altered to improve climate readiness. A clear set of recommendations on improving readiness will help to establish benchmarks and evaluate progress in climate readiness in the future. For example, the team may choose to identify common themes amongst the case studies that lead to adaptability or are maladaptive. One specific example is whether the challenges associated with the Herring Savings Area are due to outdated baselines, seasonal biases, or the solution being a fixed measure. Similarly, it could identify features of specific tools that are promising and climate ready.

Section 2: The SAFE report review

This section was ranked highest in terms of readiness based on an assessment of how climate change information was accounted for in stock assessments. **The SSC discussed that while this section sought to quantify the presence of climate information and where it is placed, the approach taken of scanning SAFE documents for keywords may overestimate readiness.** The presence of key climate-related words in the various documents, does not provide evidence of whether climate change information is actually being used (e.g., to provide management advice), and under the current methodology, a positive detection could range from the word temperature in the introduction to actual inclusion of temperature covariates in stock assessment models. This distinction is critical as noted in section 3 of the report. Climate resilience from the fishing industry's perspective is measured by how quickly climate effects can be detected in the stock assessment, and how robust the harvest control rule (e.g., a fixed harvest rate) is to model misspecification and uncertainty about climate effects.

It was also noted that the search terms for the document analysis chosen were very environment-specific, and other terms that we would associate with human-system resilience were not searched (although some are used and discussed in the document). **The SSC recommends the team consider including other terms (adapt, adaptation, portfolio, diversify, diversification, alternatives, dependency, cumulative impacts, projections) and that a broader review of documents could enhance the report (e.g., ACEPO).**

The Taskforce identified several potential on-ramps for more explicit climate information to enter the SAFE process. Progress has already been made on incorporating more climate data in the ESR, however the SSC suggests the Taskforce consider the potential for overloading this document and losing focus on its utility in tactical, annual decision making. At the same time, the SSC was concerned about expanding individual stock assessments with new sections (on-ramps 2-4), and discussed whether the currently accepted frameworks like ESR and particularly ESPs can be used or adapted to achieve the climate-ready goals. To align these two suggestions, **the SSC recommends the team consider focusing climate change modifications in ESRs and ESPs on short-term responses to climate change effects for tactical management, while considering inclusion of a risk, vulnerability (and adaptation potential) table in the SAFE introductions for each FMP area (on-ramp 4.c)** as a way to condense and integrate the data we have, or data gaps that lead to vulnerability, in a stock-specific format that could drive decisions on the frequency, data, and impacts on communities. However, relevant climate drivers likely vary by species or stock, therefore some additional climate-specific information may be relevant within individual SAFE chapters, perhaps presented in a standardized format.

The SSC appreciates and supports the continued exploration and goals of longer-term implementation (such as EBFM harvest targets based on long-term projections) as these have the potential to inform development of climate proactive solutions rather than being reactive.

Across both sections 1 and 2, the SSC noted the draft synthesis provides some suggestions of easy to implement changes to increase readiness and suggests a useful outcome would be for CCTF to make recommendations on how the various items ranked in the management overview section and the SAFE review section could be altered to improve climate readiness. A clear set of recommendations to the Council on improving readiness will help to evaluate progress in the future.

Section 3: Knowledge base

An overarching theme of the knowledge base section is the critical importance of survey sampling. The SSC notes that incorporating climate data and information is critical, but will not overcome the lack of fundamental research establishing the mechanistic links between environmental variables and our commercially exploited fish and shellfish species. This gap is substantial and filling it should be the highest priority. **Frequent, consistent, and comprehensive sampling is the most important tool in our climate-readiness toolbox**. Fundamental sampling theory tells us that we should be increasing our sampling efforts, especially in areas of increasing variability or uncertainty, rather than reducing effort.

The SSC commends the team on the excellent section detailing LK/TK/subsistence information and strategies and for casting a very broad net regarding the scope of information. While some of this information may be duplicative of the LK/TK/S Taskforce efforts, the SSC continuous to encourage collaborations and synergy and notes the next steps will certainly benefit from promoting and facilitating networking, expansion and syncing of these programs to streamline LK/TK/S data and make it readily available to these efforts.

The section describing the NMFS and specifically AFSC knowledge bases (p. 43-44) seemed like it was intended to be eventually expanded but was not. The SSC recommends this section is completed if this draft is revised.

The SSC supports the future efforts identified by the team in this section, in particular

- Finalizing and implementing the LK/TK/S Taskforce protocol regarding incorporation of LK, TK, and subsistence information into the Council process
- Scope development of Fishery Ecosystem Plans in other regions to address connectivity issues (e.g., Gulf of Alaska, Arctic), as discussed at the March 2022 meeting of the Ecosystem Committee

Next Steps:

The knowledge gaps, potential future directions, and future work included in this report was noted as a good start for broader discussions and specific next steps to improve climate readiness and management effectiveness. This addresses the ultimate goal of identifying whether management measures are robust, and management processes nimble and adaptive enough to respond to changes in the short-term, long-term and in response to 'shocks.' The plans and goals of the taskforce are an important outcome of this report and the **SSC is strongly supportive of the next steps laid out that include specific and targeted evaluation of effectiveness through workshops and scenario testing.** The SSC highlights the importance of transitioning the suggestions in this document into clear recommendations, and suggests that the readiness report would benefit from formalizing this process.

There were several specific recommendations from the SSC related to the proposed workshop(s):

- As we think about applying integrated models like ACLIM to understand medium and long term future states, it is important to reflect on how those models represent the types of shocks we are likely to see. Models necessarily average and smooth over longer periods, because they are relying on past data. However, experience with Pacific cod and crab show that the biggest challenges to resilience are not well described by draws from smooth distributions; they are severe infrequent events, tipping points and shocks. **The SSC recommends focusing on how to *anticipate* or *respond* to infrequent shocks or tipping points.** The SSC suggested it may be useful to systematically develop a catalog of types of shocks and how they may manifest for specific stocks.

- For scenario testing, the SSC notes that for many shocks we may not have hindcast examples of what may come in the future. To address this, it may be beneficial to simulate potential abrupt changes and model them with the tools we have on hand in order to evaluate the efficacy of a potentially climate-ready tool to meet goals (National Standards). This would clarify readiness by assessing if measures specifically aimed to be robust to long-term climate change absorb climate shocks, and facilitate equitable and timely responses to novel conditions and challenges that are unprecedented or outside of historical ranges.

- On a similar topic, it was noted that the report doesn't address process lessons learned, and how this relates to our policy process time and efforts. **The SSC suggests it may be helpful to conduct a quantitative assessment of council bodies' efforts and actions in the years preceding the GOA Pacific cod or EBS snow crab stock collapses to identify what we could have done (or not done) to increase our awareness of climate impacts taking place.** This evaluation would be useful in designing scenarios for consideration in scenario planning exercises, as well as providing more realistic expectations about what is achievable by a "climate-ready" management system.

- **The SSC recommends working towards more actionable outcomes that include focusing on building the capacity to adapt and respond to climate change and less on the idea of flexibility.** It is important to be proactive and create actionable outcomes for management, communities and science to consider. **Assembling a collection of case studies might help to identify what actions have or have not worked elsewhere when considering actions for**

our region. Specific examples that were suggested included examining the decline in crab or Pacific cod stocks to better understand what management, policy, and data mechanisms are needed to be adaptable to similar shocks in the future and determine if we are ready for the next perturbation. A case study on Norton Sound Red King Crab (already recommended under agenda item C2) was suggested as potentially useful in this context. A resource that might prove helpful is The Climate-Resilient Fisheries Planning Tool (ClimateResilientFisheries.net) developed by the SNAPP Climate Resilience Fisheries working group.

- **The SSC encourages the authors to think about taking advantage of data, processes, tools, and policy evaluations that relate to socioeconomics and are already available, but may not have been explicitly developed for climate change resilience.** For example, there is a legacy of work on community well-being and sustained community participation, including work by the AFSC and work nationally on fishing community vulnerability that could be a useful indicator in this context or modified to suit the goals of assessing resilience and climate readiness.

- New data or new analysis of existing data could also support a deeper understanding of community resilience. The SSC supports showing how communities may or may not be changing and that is where both some quantitative measures and qualitative measures of resilience can be developed to be able to show how those changes are occurring. This could be important to think more in terms of tipping points and identifying where a community is steering toward a significant change.

- The SSC recommends when developing the workshops to limit the exploration of knowledge bases to types of knowledge with a clear nexus with federal fisheries. This will also help focus the workshop on sources of knowledge, information and data that can support identifying sources of strategies for resilience of stocks and communities.

- **Finally, in the upcoming workshops, the SSC suggests identifying process guidance for the Council on how to accomplish complementary and simultaneous policy actions, or omnibus actions, as part of our climate ready toolbox.**

SSC Workshop

The SSC held a workshop on "*Rapid change in the northern Bering and southern Chukchi seas – Identifying ecosystem responses and effects on the management of Federal fisheries*". The workshop was motivated by recent rapid changes in the Pacific Arctic and, in particular, in the northern Bering Sea (NBS) and Bering Strait region. A number of Bering Sea commercial fish stocks extend into and possibly beyond the northern Bering Sea and their abundances in these areas increased dramatically during the recent marine heatwave. These changes have resulted in increased uncertainty about the status of Bering Sea stocks, as exemplified by the sudden and unexpected decline of snow crab following an unprecedented warm period. There is a need to better understand the role of the NBS and southern Chukchi Sea ecosystems in supporting Bering Sea commercial fish and shellfish stocks, and – in turn – to understand the impacts of a northward expansion of Bering Sea fish stocks on the NBS ecosystem.

The goals of the workshop were to assess our current understanding of the major changes occurring in the northern Bering and southern Chukchi seas that affect all components of the ecosystem (Session 1), identify some of the critical gaps in understanding, as well as research and monitoring needs to address these gaps and to adequately assess ecosystem status and trends (Session 2), and assess whether the tools and approaches that are currently used to manage Bering Sea fish and crab stocks, including assessment models, the tier system and current harvest control rules, are adequate to deal with the management challenges that

arise under increased uncertainty, or whether we need to consider novel approaches to deal with a rapidly changing, and increasingly non-stationary environment (Session 3).

To address the first two goals, the SSC received overview presentations on changes in the physical environment (Seth Danielson, UAF), phyto- and zooplankton (Dave Kimmel and Lisa Eisner, NOAA-AFSC), epibenthic invertebrate communities (Lauren Sutton, Kachemak Bay National Estuarine Research Reserve (NERR)), and Libby Logerwell, NOAA-AFSC), seabirds (Adrian Gall, ABR Inc., and Robb Kaler, USFWS), marine mammals (Michael Cameron, NOAA-AFSC) and groundfish (Franz Mueter, UAF, SSC member, Kerim Aydin, NOAA-AFSC, and Lauren Rogers, NOAA-AFSC). The presentations highlighted recent observations that illustrate changes in all ecosystem components that were unprecedented in the historical record. The SSC received a presentation on the potential for improving the predictive capacity of climate informed ecosystem functioning to support commercial fish species (Kirstin Holsman, NOAA-AFSC). The presentation highlighted ongoing efforts to model the effects of downscaled climate predictions and food web dynamics and provided initial applications that predict short term trends in key Bering Sea stocks. To address the third goal, Curry Cunningham (UAF, SSC member) and Ian Stewart (IPHC, SSC member) provided food for thought on the challenges associated with non-stationary processes and dynamic reference points, highlighting the potential benefits, risks, and necessary considerations for managing fisheries in a changing ecosystem.

The workshop included opportunities for open discussions among SSC members and among the SSC and subject matter experts. Opportunities were also provided for the public and a wide variety of stakeholders to comment on the challenges the Council faces and to participate in these discussions, as well as for Council members to contribute ideas or ask questions. The SSC workshop was part of an emerging dialogue among the SSC, scientists working in the NBS and southern Chukchi sea, other knowledge holders from the NBS and southern Chukchi sea and other interested stakeholders. Many issues were raised during the workshop to inform and support the work that is needed to develop the scientific basis for managing eastern Bering Sea fish stocks in a time of unprecedented changes and given the expanding footprint of eastern Bering Sea fish populations into habitats that previously were dominated by an Arctic fish assemblage and that provide the food and livelihoods for people in the region.

The SSC thanks all presenters for their insightful and thought-provoking contributions and thanks Council member Bill Tweit for providing the introduction to the workshop. The SSC was very pleased with the number of participants. The SSC particularly appreciates the thoughtful comments that were provided by a variety of stakeholders throughout the workshop. The SSC will synthesize the main outcomes of the workshop and provide recommendations on next steps to the Council at the April 2023 meeting.

SSC Member Associations

At the beginning of each meeting, members of the SSC publicly acknowledge any direct associations with SSC agenda items. If an SSC member has a financial conflict of interest (defined in the 2003 Policy of the National Academies and discussed in Section 3) with an SSC agenda item, the member should recuse themselves from participating in SSC discussions on that subject, and such recusal should be documented in the SSC report. In cases where an SSC member is an author or coauthor of a report considered by the SSC, that individual should recuse themselves from discussion about SSC recommendations on that 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 immediate line of supervision by an SSC member, then that 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 associations 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 February 2023 meeting, a number of SSC members acknowledged associations with specific agenda items under SSC review. Dana Hanselman is a contributor to agenda item D3 Groundfish Stock Prioritization and supervises Chris Lunsford (D3 Groundfish Stock Prioritization). Robert Foy is the second level supervisor for Dana Hanselman (D3 Groundfish Stock Prioritization) and third or greater level supervisor for contributors to the following agenda items: NOAA-AFSC members of the CPT; Mike Litzow (C2 BSAI Crab - CPT co-chair), Chris Lunsford (D3 Groundfish Stock Prioritization), Kirstin Holsman (D6 Climate Readiness report), Stan Kotwicki (D7 GOA trawl survey changes), Jim Thorson (C4 EFH report). Jason Gasper is a co-author on the D6 Climate Readiness Synthesis report and is married to Cindy Tribuzio, who contributed to D3 Groundfish Stock Prioritization. Franz Mueter is a contributor to the C4 EFH Arctic. Andrew Munro supervises Toshihide Hamazaki (C2 Crab SAFE - NSRKC stock assessment author). Finally, Chris Siddon supervises Katie Palof (C2 Crab - CPT co-chair) and is a second-level supervisor for Tyler Jackson and Shareef Siddeek (C2 Crab - AIGKC assessment authors).