C1 BSAI Crab

The SSC received a report on the January 2024 Crab Plan Team (CPT) meeting from Sarah Rheinsmith (NPFMC), Katie Palof (ADF&G), and Mike Litzow (NOAA-AFSC). The SSC also received oral public testimony from John Gauvin (Alaska Seafood Cooperative) under the Balance of the CPT Report section of the agenda item.

BSAI Crab SAFE and Harvest Specifications

The SSC reviewed the Norton Sound red king crab (NSRKC) SAFE chapter and information provided by the CPT with respect to the stock status information from 2023/2024 relative to total catch during the 2023/2024 season (Table 1). In addition, Table 2 contains the SSC recommendations for 2024/2025 harvest specifications. The remaining crab SAFEs will be reviewed and harvest specifications set at the June and October SSC meetings. The 2025 NSRKC SAFE review is planned for the SSC in December 2024, if scheduling allows (see Balance of CPT section).

Table 1. Stock status in relation to status determination criteria for 2023/24 as estimated by the most recent assessment. 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_{MSY}proxy[1]	2023/24[2] MMB	2023/24 MMB/ MMB_{MSY}	2023/24 OFL	2023/24 Total Catch	Rebuilding Status
1	EBS snow crab	3			65.77		15.44		
2	BB red king crab	3			14.98		4.42		
3	EBS Tanner crab	3			48.77		36.20		
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[2]	4	1.20	2.02	2.40	1.19	0.31	0.2	
8	AI golden king crab	3			12.07		4.18		
9	Pribilof Islands golden king crab[3]	5					0.114		
10	Western AI red king crab	5					0.056		

[1] As estimated in the 2023 assessment.
[2] For Norton Sound red king crab, MMB on 2/1/2024 is estimated using the current assessment in January 2024. Stock status for NSRKC is determined in February.
[3] PIGKC specifications are set on a calendar year basis.

Table 2. SSC recommendations for NSRKC. Stocks for which specifications are rolled over between assessments (PIRKC, PIBKC, PIGKC and WAIRKC) are also included. Biomass values are in thousand metric tons (kt). Tier designations in this table are based on the projected stock status in 2024/2025. 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).

Ch.	Stock	Tier	F_{OFL}	B_{MSY} or B_{MSY}proxy	B_{MSY} basis years[1]	2024/2025[2] MMB	2023/24 MMB / MMB$_{MSY}$	Natural Mortality (M)	2024/25 OFL	2024/25 ABC	ABC Buffer
1	E. Bering Sea snow crab	3b									
2	Bristol Bay red king crab	3b									
3	E. Bering Sea Tanner crab	3a									
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	4c	0	4.20	1980/81-1984/85; 1990/91-1997/98	0.18	0.04	0.18	0.00116	0.00087	25%
6	St. Matthew blue king crab	4b									
7	Norton Sound red king crab	4a	0.18	2.02	1980-2024	2.5	1.24	0.18	0.33	0.23	30%
8	Aleutian Is. golden king crab[3]	3									
9	Pribilof Is. golden king crab[4]	5	-	-	-	-	-	-	0.114	0.085	25%
10	W. Aleutian Is. red king crab	5	-	-	-	-	-	-	0.056	0.014	75%

[1] For Tiers 3, 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 catch average for OFL is estimated. MMB on 2/1/24 is estimated using the current assessment for Norton Sound red king crab.

[2] MMB is estimated on 2/1/2024 for Norton Sound red king crab and on 2/15/2024 for all other Tier 1-4 stocks, using the current assessments.

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

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

Norton Sound Red King Crab

The SSC thanks the CPT and author for the NSRKC 2024 assessment and for being responsive to the SSC's requests. In particular, the timeline of previous recommendations and their responses provided an opportunity to inform future recommendations or clarify past requests. The SSC appreciated the detailed review of past survey efforts.

The assessment was updated to include the following new data from 2023: retained catch for the winter and summer commercial fisheries, carapace length compositions for the summer commercial fishery, total and retained catch for the winter subsistence fishery, standardized CPUE time series, and survey abundance and shell condition/size composition data from the 2023 NOAA Northern Bering Sea (NBS) and ADF&G summer trawl surveys.

The assessment provided results from three models (21.0, 23.0, and 23.1). Model 21.0 was the previously accepted base model with new 2023 data and assumed a constant M of 0.18 yr^{-1} for all length classes except the largest (>123mm CL), for which M was estimated at 0.61 yr^{-1}. Model 23.0 was identical in structure to 21.0 except that a single M was estimated and applied to all length classes.

Model 23.1, requested by the SSC, was identical to model 23.0, except that a prior on natural mortality (M) from the Bristol Bay red king crab (BBRKC) assessment was used. The results of this model were not brought forward for review by the CPT or SSC, as the author considered the results to be similar to the other models. The SSC considered this model as a potentially viable model for setting harvest specifications at this meeting, but the lack of detailed information on model fits, parameter estimates, and model output precluded its adoption by the SSC. Given that other red king crab stocks are data-poor, the SSC recommends using the prior distribution for M established for BBRKC in these assessments, including the NSRKC assessment, unless information is available for the particular stock that suggests use of a different prior. The SSC notes that empirical studies to inform the prior on M would be very useful. However, in the absence of empirical estimates, the prior developed for BBRKC is recommended.

The SSC agrees with the CPT and the author to use Model 21.0 for setting harvest specifications, which places the stock in Tier 4a. **The SSC also supports the CPT-proposed total catch OFL and a 30% buffer for the ABC, which is consistent with last year's buffer**. The SSC appreciates the CPT table providing a rationale for the buffer and the comparison to the previous assessments. **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.**

The SSC supports the CPT recommendation that the effort to complete the transition to GMACS be the top priority for this assessment. In doing so, the SSC emphasizes the need to provide bridging models between the current model and the GMACS version and looks forward to reviewing those. The SSC requests that the CPT and the assessment authors coordinate to ensure that the bridging models are available for review at the September/October 2024 CPT and SSC meetings.

The SSC also supports completion and consideration of laboratory maturity studies to further inform size at maturity for potential use in future assessments. This information would provide the basis to move NSRKC to Tier 3 in the future.

The SSC notes that empirical studies to inform the prior on M would be very useful but recognizes that such studies are logistically challenging.

In addition, the SSC has the following specific recommendations for the stock assessment author:

- Provide details on net mensuration data available for the ADF&G trawl net being used on different vessels with potentially different selectivity.

- Consider developing an index of abundance based on the multiple survey data efforts by further identifying the core stations among the surveys within broader grid cells instead of only those that overlap directly.

- Given the reliance of this assessment on the fishery-independent survey observations within Norton Sound, and the potential for differences in survey gear between NMFS and ADF&G operations, the SSC encourages the authors to explore whether differences in gears used during the NMFS triennial surveys (1976-1991), the ADF&G triennial surveys (1996-2014), and ADF&G annual surveys (2017-present) warrant consideration of time blocks for survey selectivity to account for these changes.

- The SSC highlights that spatiotemporal models can help to address spatial imbalance in sampling among years, not only for the development of abundance indices, but also for first-stage expansion of size composition data (see Thorson and Haltuch 2019[1]). The SSC encourages the exploration of VAST, sdmTMB or an alternative platform for addressing the interaction between variation over time in the areas sampled by Norton Sound surveys and the potential for spatial variation in RKC size structure.

Finally, the SSC notes the CPT-proposed change in the timing of the review of this assessment. SSC comments related to the timing of the crab assessment cycle are provided in the Balance of the CPT SSC report section.

Aleutian Islands Golden King Crab Model Runs

The SSC was presented with proposed models to be brought forward for the annual assessment of Aleutian Islands golden king crab (AIGKC).

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 and responses to the May 2023 CPT and June 2023 SSC comments. The SSC also appreciates the efforts toward reproducibility and better documentation of historical data.

The models proposed by the author and recommended by the CPT were:

- Model 23.0a, to be used as the base model and updated from Model 21.1e2 (the base model from the June 2023 assessment), updated with data from more recent years, a new bycatch expansion adjustment, and a new CPUE standardization method using a GAM;

- Model 23.1: Model 23.0a, but utilizing a truncated size composition (i.e., first bin: 101 - 105 mm);

- Model 23.1b: Model 23.1, but utilizing two selectivity periods in the pre-rationalized directed fishery;

- Model 23.2 (EAG): Model 23.1b, but including the cooperative survey as an additional fleet (i.e., CPUE + size composition).

The SSC agrees with the recommendation by the CPT that models 23.0a, 23.1 and 23.1b move forward for consideration in setting the OFL/ABC in June 2024. The SSC believes that while Model 23.2 should be considered in future iterations of the assessment, it should not be reviewed in June 2024 to

---

[1] Thorson, J. T., and M. A. Haltuch. 2019. Spatiotemporal analysis of compositional data: increased precision and improved workflow using model-based inputs to stock assessment. Canadian Journal of Fisheries and Aquatic Sciences 76:401-414.

allow greater focus on setting harvest specifications. The SSC agrees that the time series for average recruitment should include all years except the last four.

The SSC continues to endorse the use of the GMACS assessment model. In the context of future development of the assessment, the SSC recognizes and appreciates the responses by the author to previous CPT and SSC comments. To facilitate tracking ongoing issues, the SSC requests the author and the CPT identify what research topics from that list might continue to be brought forward, and in what timeframe, in the context of the new assessment model.

A number of model development issues were brought up at the CPT meeting, and the SSC agrees that exploration of possible solutions to these issues be explored in the future. New input sample sizes were introduced in this cycle. When changing these, other data sources are inherently weighted differently. For future assessments, the authors could investigate the weight given to the tagging and size composition data, as these sources may be preventing an adequate fit to the indices, particularly because of the use of the extra variance for these indices. The authors could evaluate if the size-transition matrix could be estimated outside of the model with the tagging data to avoid having it compete with other data sources in the model.

The SSC notes that selectivities in the combined area model were very similar to the single area models, yet the $F_{35\%}$ was very different. Although not a priority for 2024, the authors should continue to explore how to appropriately project $F_{35\%}$ in a multi-area/fleet combined model in GMACS.

The authors discussed moving towards zero-inflated or hurdle models for CPUE standardization, some of which could be accomplished using the same R package (*mgcv*, zIP). **The SSC recommends that any new substantial standardization changes should be reviewed during the next cycle, not during specifications in May/June 2024.**

In addition to the model recommendations above, the SSC recommends that the authors consider how model elements interact and what they contribute individually and together in characterizing, or not, trends in the data. Simpler constructs of the GMACS model that were considered in the Simpler Modeling Workshop (March 2023) might be a useful starting point. Examples of data considerations include exploring why zeros unexpectedly occur in the data, and temporal or spatial variability in timing, selectivity, or other assumptions of the datasets informing the model.

Regarding projections, the SSC requests clear documentation of which 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.

Balance of CPT Report

The SSC received a presentation on a number of additional items from the CPT report. The SSC also received public testimony from John Gauvin (Alaska Seafood Cooperative) The SSC thanks the CPT for their presentation and the information brought forward in their report.

The CPT presentation to the SSC included AIGKC model runs (see previous section in SSC report), CPT responses to SSC general comments, and an update on Council meeting timing and stock prioritization. Additional items were discussed in the CPT report but were not presented to the SSC.

The SSC had a number of general comments to crab assessment authors in the October 2023 SSC Report. These included requests for more information on the standard years of bottom trawl survey data in crab assessments, tracking SSC requests to assessment authors from previous years, developing risk tables for crab stocks, exploring the use of VAST across multiple crab stocks and having authors available for questions during the SSC review. The SSC thanks the CPT for their discussions and responsiveness to these requests. Further SSC recommendations follow.

The SSC supports revisiting the topic of VAST or other spatiotemporal model-based methods for the 2025 CPT modeling workshop, as this topic is relevant to several stocks and there have been some updates that might improve applicability to crab assessments. Further, the SSC requests that consideration be given to fishery-dependent VAST applications for CPUE standardization, in addition to fishery-independent datasets. Likewise, the SSC highlights the applicability of spatiotemporal models for first stage expansion of size composition data to address concerns about the impact of spatial imbalance in sampling if spatial variation in size distribution exists.

The SSC looks forward to seeing draft risk tables for the crab stocks being reviewed in October. The SSC reiterates that the risk table framework is intended to provide a clear and transparent basis for communicating assessment-related and stock condition concerns that are not directly captured in model-based uncertainty, the tier system, or harvest control rules (see *Preliminary Guidance and SSC recommendations* on risk tables in June 2021 SSC Report p.33). Also, the SSC recommends that crab assessment authors follow the same organization scheme as the groundfish assessment authors, where the full risk table is contained in each individual chapter and brief summaries are included in the SAFE introduction.

In response to the Council's change to the meeting schedule for 2025 (no in-person meeting in February), the CPT recommended changes to the annual review timing of the NSRKC stock assessment and the AIGKC model runs, and the SSC appreciates the CPT's flexibility on these issues. **The CPT proposes reviewing the NSRKC assessment at a virtual meeting in November, so that the SSC can review harvest specifications at their December meeting.** While expressing some reservations related to the chronically compressed timeline for the use of NBS survey data in crab assessments, **the SSC supports this change as proposed by the CPT.** The SSC notes that accommodation may need to be made with respect to other agenda items to include SSC review of NSRKC in December and that this schedule could be re-evaluated at a later date.

With regard to shifting PIBKC to a quadrennial (4-year) cycle, the SSC supports the shift in assessment timing. As this stock is overfished and under a rebuilding plan, the SSC proposes that this change begin after the October 2025 assessment. The timing of future assessments for this stock may need to be flexible as monitoring and the rebuilding plan continue.

The SSC supports the work completed at the modeling workshop and notes the significant progress that is being made. Further discussion of the application of GMACS to the NSRKC stock is provided in the NSRKC stock assessment section of this SSC report.

The SSC is encouraged by the CPT discussion on the currency of management and the exploration of alternative functional maturity definitions. The SSC agrees that the 95 mm carapace width threshold for functional maturity based on Canadian research is a viable option for further exploration in EBS snow crab model runs in May. The SSC reiterates its October 2023 request that a full yield analysis for snow crab be done to provide a basis for any changes in management procedures, including the relationship between fishing mortality and catch, MMB, and various definitions of functional maturity. The SSC highlights the fundamental importance of this issue for *Chionoecetes* crab stocks and looks forward to reviewing future proposed changes in methodology and analyses in support of those proposed changes.

Finally, there were multiple research updates provided in the CPT report, including RKC genetics, the potential for crab stock enhancement and related considerations, recent laboratory and field studies on crab, and development of snow crab and BBRKC species distribution models (SDMs). With respect to public testimony regarding the BBRKC SDM, the SSC encourages testifiers to continue to communicate with researchers using fishery-dependent data to ensure the data are being interpreted appropriately and to fully

understand the context of those data. With respect to laboratory and field projects exploring thermal tolerances and temperature-driven variation in growth, the SSC highlights the value of having comparative laboratory studies and observational studies in understanding the key processes driving population and growth dynamics. The SSC thanks the researchers and the CPT for providing these updates. The SSC finds these updates helpful and requests they continue to be elevated to the SSC through the CPT report in the future.