NORTH PACIFIC FISHERY MANAGEMENT COUNCIL
Angel Drobnica, Chair | David Witherell, Executive Director
1007 W. 3rd Avenue, Suite 400, Anchorage, AK 99501
Phone 907-271-2809 | www.npfmc.org

Crab Plan Team

REPORT

May 12-15, 2025, VIRTUAL

Plan Team Members in attendance:

Katie Palof, **Co-Chair** (ADF&G-Juneau)
Mike Litzow, **Co-Chair** (AFSC-Kodiak)
Anita Kroska, **Coordinator** (NPFMC)
André Punt (Univ. of Washington)
Andrew Olson (NMFS-Juneau)
Ben Daly (ADF&G-Kodiak)
Brian Garber-Yonts (AFSC-Portland)
Cody Szuwalski (AFSC–Seattle)
Erin Fedewa (AFSC-Kodiak)
Ethan Nichols (ADF&G- Dutch Harbor)
Ginny Eckert (UAF/CFOS-Juneau)
Tyler Jackson (ADF&G-Kodiak)
William Stockhausen (AFSC-Seattle)
William Bechtol (UAF-Homer)
Vacant, quantitative expert

Council Updates

Anita Kroska and Diana Stram (NPFMC) provided the Crab Plan Team (CPT) with updates from the Council and guidance on responding to Scientific and Statistical Committee (SSC) comments (slides). The CPT was advised to prioritize SSC comments, especially recurring ones, and to clearly document responses. When addressing SSC comments, the Team should explain how the comment was resolved or, if not addressed, why not—along with a proposed plan and, ideally, a timeline for future action. While authors are often hesitant to commit to timelines due to competing priorities, the SSC is requesting more transparency around prioritization decisions. This includes articulating the rationale for recommendations, particularly how addressing a comment may clarify an assessment or improve communication. The CPT agreed that clear and transparent responses to SSC comments are essential.

Guidance was also provided on documentation practices, including the preparation of meeting minutes. It was suggested that for future meetings, minute leads should focus on facilitating discussion, while a second person takes notes. Minutes should concisely summarize discussions, highlight specific requests or recommendations (including rationale and timing), and bold consensus items. Relevant assessments and documents should be linked, or, if not available, presentation materials such as PowerPoints should be referenced. Draft minutes should be uploaded to the shared Google document promptly after meetings.

Concerns were raised about the workload on assessment authors, many of whom are also CPT members. These authors often receive materials for review just a week before meetings while simultaneously preparing presentations, leading to significant strain. To help address this, the CPT is working to recruit additional assessment experts to join the CPT.

Council staff have also developed a draft worksheet to help the SSC evaluate the impacts of potential reduced survey effort survey effort for different stocks. This tool is still in development, but is intended to aid in future prioritization decisions for survey effort. Related discussions included refining the use of risk tables and catch/ABC metrics. The CPT supports including catch/TAC and catch/ABC information in SAFE report summaries, but this should be done in a way that avoids substantially increasing the authors' workload. There is also interest in exploring whether proximity of catches to the outcomes from harvest control rules (HCR) could serve as a prioritization factor, though crab-specific management metrics may differ from those used for groundfish.

Finally, Council updates were provided. Key initiatives include survey modernization, climate resilience planning, and a SSC harvest control rule workshop that is scheduled for June 2025. The Ecosystem Committee will be reconstituted in 2025, with a forthcoming call for nominations, and terms of reference are currently in development. Although the Council continues to regard social and economic information for setting total allowable catch (TAC) as important - particularly for groundfish stocks - the related SSC agenda item has been postponed from the June meeting due to AFSC staffing shortages impacting preparation of the Economic SAFE Reports.

General ESP Updates

Erin Fedewa (AFSC) gave an update on Ecosystem and Socioeconomic Profile (ESP) development and noted that the CPT has given valuable feedback on this topic previously. Erin went on to describe ongoing ESP challenges and noted that decision points in the management process are informed by both qualitative/contextual information and quantitative/predictive information, but ESP indicators are not communicated to align with these intents. She noted that it is unclear which ESP indicators should be considered in qualitative management on-ramps (e.g., risk tables) vs. quantitative on-ramps (e.g., research models). Many ecosystem indicators in crab ESPs have not been quantitatively linked to population processes despite hypothesized mechanistic links. Erin described the ecosystem indicator traffic light approach and noted that it assumes directional relationship and stationarity. She noted that ESPs have no mechanism for down-weighting indicators that do not quantitatively inform population processes and that uninformative indicators in ESPs can lead to information overload for managers. Ecosystem indicators are currently categorized by life history stage rather than weighting by importance to the stock, so it is difficult to discern which indicators are most important.

Erin described a proposed solution for a new ESP ecosystem indicator workflow and communication pathway to develop criteria that categorize ecosystem indicators as “predictive” or “contextual” and improve communication of indicator importance by highlighting indicators that demonstrate robust statistical relationships with stock response variables. Predictive indicator evaluation criteria include a quantitative, demonstrated relationship with population processes (e.g., recruitment and mortality) that would be evaluated via indicator importance scores, out-of-sample predictive skill, etc. Erin noted examples of predictive indicators such as juvenile snow crab temperature occupied and juvenile snow crab energetic condition.

Contextual indicator evaluation criteria are meant to highlight potential red flags related to the exploitable portion of the population (MMB) but are not quantitative drivers of recruitment (e.g., mature male area occupied and center of abundance). Contextual indicators are meant to provide anticipatory information or a direct measure of the status/health of large immature "pre-recruits" to the fishery or effective spawning biomass (e.g., mature female clutch fullness, immature snow crab disease prevalence). The contextual indicators are also meant to inform a management concern or risk table category (e.g., BBRKC Northern District ratio). Erin went on to describe the annual workflow for ESP report cards and proposed a new ESP report card template to improve communication of indicators for various ESP user groups and to clarify the intent and management on-ramps for ecosystem and socioeconomic indicator categories. Other ESP development includes work to automate socioeconomic indicators, an AFSC internal review of crab ESPs, development of ESP Tech Memos, second stage indicator analysis methodology development, and dynamic structural equation modeling exploration.

The CPT mentioned that growth could be included as a predictive indicator because growth is measured; however, the point was made that time variation in the process would be important to consider. The CPT also noted that statistical power is an important consideration when evaluating the role of indicators in decision making. There was some discussion about the timeliness of indicator use, and formal incorporation of indicators in assessments may take longer than desired, thereby limiting their practical utility. It was noted that our perception of relationships can change over time, and that reacting to noise is dangerous from a management standpoint.

There was discussion about the intent of socioeconomic ESP indicators, and it was noted that more guidance is needed from the SSC/Council about 1) how to assess the utility of reporting socioeconomic information and indicators in economic SAFE documents relative to reporting socioeconomic content in ESPs and 2) whether both are needed. Socioeconomic ESP authors are eager to get feedback from the Council about whether existing socioeconomic ESPs are useful for the Council, or whether the annual Economic SAFE and Annual Community Engagement and Participation Overview (ACEPO) documents provide the needed information. One CPT member noted that socioeconomic indicators are difficult to incorporate in TAC decisions because they are looking backwards (it is understood that closed/reduced fisheries have negative economic consequences). Predictive indicators (e.g., projected price per pound) would potentially be more useful for informing TAC. A point was made that some backward-looking indicators (e.g., crew involvement, % income from crab fisheries, active crew members) could be useful for situations where very small TACs vs. closures are being considered.

Contextual indicators are a good place to note novel observations, which could feed into risk tables. A question was asked about how exactly we should use predictive indicators if they are not included in the stock assessment. Formal inclusion of predictive indicators into the stock assessment analysis is the ultimate goal. Species-specific life history (e.g., life span) is important when interpreting biological implications of the various indicators. The CPT discussed how qualitative indices are used in management. The example of TAC decisions for the 2023/24

BBRKC fishery was noted where various ecosystem indicators (e.g., low chlorophyll *a*, low pH, high sockeye salmon abundance, warm temperatures), in addition to population projections under various exploitation rates, prompted a more precautionary exploitation rate than prescribed in regulation. Some CPT members voiced concerns about using qualitative information for decision making, while another member noted that the CPT should be risk neutral, and that ADFG has more flexibility with dealing with risk in the TAC-setting process and balances risk in a different way. A list of predictive/quantitative indicators would likely be incomplete, but may be an honest depiction of what is known about the biology of the stock, and establishing a clear distinction between quantitative vs. qualitative information is important for ABC buffering and risk table considerations. Erin asked if an ESP methods/results document should be prepared for the CPT in September or if it could be published later in a Tech Memo. The CPT would like any new methodology to be included in September when the indicator is presented for review, but established methods could be referenced to other documents. In general, the CPT supported Erin's proposed changes to ESP development, acknowledged that predictive and contextual indicator categorization is a useful advancement in the ESP approach, and recognized that ESPs are used differently among user groups.

Risk table discussion

Erin Fedewa (AFSC) presented updates to the Crab Plan Team (CPT) on the development and use of risk tables for crab stocks in response to a Council request to create a more structured, transparent, and defensible approach to setting acceptable biological catch (ABC) buffers. Draft crab risk tables were introduced in September and October 2024, with the SSC recommending that they mirror the more established Groundfish Plan Team (GPT) model. The groundfish risk tables operate as a living repository, tracking trends and justifications over time, and are used to document reductions from the maximum ABC (maxABC). However, crab stocks do not have a maxABC calculated based on harvest control rules as groundfish does, and ABCs are generally set below the overfishing limit (OFL) using buffers based on expert judgment, without a standardized control rule.

The current groundfish workflow for risk table development includes collaboration between assessment authors and ESR/ESP leads, with ecosystem-level risks summarized and incorporated into final risk table scores. Though risk tables aim to reflect ecosystem and stock-specific concerns, the SSC has advised against adopting prescriptive scoring methods or default baseline buffers, emphasizing the need to maintain flexibility and author-driven discretion. The goal is not to mechanize decisions but rather to document the rationale behind buffer choices.

The crab and groundfish harvest control rule frameworks differ significantly, and therefore risk table usage will differ. Groundfish maxABC calculations are defined in the Tier based harvest control rules within the FMP, and therefore reductions from maxABC using risk tables are infrequent and based on authors' discretion. The CPT uses what amounts to risk tables to justify setting ABCs below OFL, since the maxABC is equal to the OFL for crab. Historically, the CPT "buffers" have been based on combinations of Tier level uncertainty and information that can now be found in the risk table format.

The dual management of crab by the State of Alaska and the federal system is another difference between crab and groundfish that could influence the usefulness of the adoption of the groundfish-based risk tables for crab. In the time that ABCs for crab fisheries have been established at the federal level, they have never been constraining for the state harvest control rules. The average decrease from the OFL to the state harvest for stocks that had an open fishery from 2011-2023 was 61%, which is far beyond any of the buffers considered by the federal system for actively fished stocks, except for snow crab. This suggests extensive preparation of risk tables and deliberation on these buffers will not have meaningful impacts on crab management. If there were changes to the federal and/or state harvest control rules, risk tables and the resulting buffers could play a more important role in management.

A recurring concern is the disconnect between the scientific use of risk tables and their interpretation by stakeholders, especially in light of perceived inconsistencies and potential for "buffer fatigue." Some stakeholders view the risk tables as a way to formalize already existing practices for deriving buffers, while others are unclear on whether these tables should actively influence catch advice or simply document considerations. The CPT discussed the need to clarify the purpose of risk tables—whether they are used to adjust buffers or serve as a communication tool—especially since reductions in ABC have not necessarily translated into better management outcomes for crab stocks, many of which remain in poor condition despite conservative management.

There is also an ongoing debate about how to treat information sources such as ESPs and ESRs. While these documents provide valuable context, caution was advised against "double-dipping," or counting the same source of uncertainty in multiple elements of the buffer-setting process. The CPT noted that ESPs and ESRs may not directly inform ABC buffers, but are helpful for explaining stock declines and are incorporated into the TAC-setting conversation conducted by ADF&G. Risk table development is also seen as an opportunity to enhance stakeholder communication by showing the evidence used in decision-making, even when uncertainty remains high.

The CPT acknowledged the difficulty of establishing standardized baseline buffers across crab stocks, particularly given differences in tier levels, stock conditions, and data availability. A proposed table of historical buffers by tier was presented, but no consensus was reached on adopting it. Instead, the CPT recognized the need for consistency within stocks over time rather than across all stocks. Members agreed that any movement toward formalizing ABC buffer processes must be coupled with transparent documentation and a clear understanding of the policy-science boundary, particularly when subjective risk tolerance influences decision-making.

Discussions touched on whether all stocks need risk tables—especially those that are closed or under rebuilding plans—and emphasized that any standard operating procedures (SOPs) should avoid redundancies and clearly distinguish between risk assessment and buffer application. As crab stock management evolves, the CPT agreed on the importance of using risk tables as a tool to explain decisions, not necessarily to change them, and emphasized continued discussion, especially in the context of upcoming harvest control rule workshops.

The role of 'risk' and the purview of the CPT was discussed at length. Because of the difference in how buffers are applied between crab and groundfish (the default is 'no change' for groundfish, yet we have buffers for all crab stocks), the use of risk tables to justify crab buffers begins to push the CPT out of a 'risk neutral' role that we are meant to occupy. No solutions were offered, but a reconsideration of harvest control rules (e.g., reevaluation p* = 0.49 or considering a B35%/B40% system similar to groundfish) could be one way forward.

Ultimately, the following preliminary SOP was proposed for crab risk tables:

1. Given that baseline buffers or buffer ranges are not specified by tier level for crab stocks, buffers should consider uncertainty associated with tier level if warranted.
2. The risk table should also be used to evaluate additional uncertainty, on a stock-by-stock basis, that is not already incorporated in the assessment model, tier level, or harvest control rules.
3. No prescriptive formula will be used to adjust risk table scores or buffers across stocks. This is because identified concerns may not warrant an increase in risk table scores, and an increase in risk table scores does not necessarily require an increase in the ABC buffer. Responsibility for making these decisions will be shared by the assessment author, CPT, and SSC.
4. At their discretion, assessment authors should coordinate with ESP authors (and ESR authors when an ESP is not available) to discuss ecosystem considerations prior to completion of a risk table. The timing of this discussion will also be at the discretion of the author.
5. Risk tables should be conducted for all annual crab stock assessments (Snow crab, Tanner crab, BBRKC, NSRKC, and AIGKC). A full risk table will be contained as an appendix in each individual SAFE chapter with rationale given for risk table scoring. Brief risk table summaries will be included in the SAFE introduction (i.e., general description and risk table template, CPT-recommended risk table scores, and buffer for each stock).
6. The CPT will develop a summary table to track buffers, risk table scores/concerns, and justification for buffers. This table will also be used to ensure that risk table scoring and buffer considerations are consistent within a stock across years.

Draft Tanner crab ESP

Shannon Hennessey and Brian Garber-Yonts provided an overview and preliminary results on the Ecosystem & Socioeconomic Profile (ESP) for Eastern Bering Sea (EBS) Tanner crab, with a plan to bring the final Tanner crab ESP to the September CPT meeting (slides, document).

Shannon reviewed potential ecosystem processes that may influence Tanner crab and are hence hypothesized to affect population dynamics. These processes were organized by life stages. Processes that may influence pelagic larval stages include synchrony with the spring bloom and offshore advection; while bottom temperature and benthic production may influence benthic juveniles and adults, and predation may influence benthic juveniles.

Shannon next presented annual time series for a suite of potential ecological indicators, organized again by life stage, and discussed connections to the hypothesized ecosystem processes that might influence Tanner crab population dynamics. Larval indicators include the winter Aleutian low index and summer sea surface temperature. A weak Aleutian low and higher sea surface temperatures are hypothesized to lead to favorable larval conditions. Juvenile indicators include chlorophyll *a* concentration (data source: satellite derived, direction of hypothesized effect: +), median summer temperature where juveniles are found (EBS survey, +), summer benthic invertebrate density (EBS survey, +), summer benthic predator density (EBS survey, -), Tanner crab consumption by Pacific cod (modelled, -), and prevalence of bitter crab in juveniles (visual data from EBS survey, -). Adult male indicators include the male size at terminal molt (modelled, +), the area occupied by males in the summer (EBS survey, +), and the male center of distribution in terms of longitude (EBS survey, n/a). Adult female indicators include size at terminal molt (EBS survey, +) and female reproductive potential (proportion of females with ¾ to full clutches from EBS survey, +). Plots of the indicator time series used the standard ESP format showing the time series, the mean and +/- 1 standard deviation intervals indicated, and values outside the +/- 1 sd range color-coded to highlight large deviations from the mean. A traffic light table provides the status of the indicators over the last five years. A time series plot of scores from the indicators provides a view across years for the ecosystem indicators, combined by life stage and in total.

Preliminary results of a Bayesian Adaptive Sampling (BAS) analysis of the importance of this suite of ecosystem indicators on observed abundance of male pre-recruits (70-85 mm CW) suggest five indicators have an inclusion probability > 0.5, including the winter Aleutian low index, Pacific cod consumption, juvenile temperature occupied, disease prevalence, and chlorophyll *a* concentration. The results of the importance analysis may be used to determine which indicators are “predictive” as opposed to “contextual”.

Results presented to the CPT were preliminary and will be updated for the final ESP, although survey responsibilities will leave little time for further development of the ESP prior to the September CPT meeting. Next steps include refining the ecosystem indicators and the importance analysis.

Brian discussed potential socioeconomic indicators, which are similar to those included in ESPs for other stocks and fall into in three categories: fishery performance (number of active vessels, fishery CPUE, fishery total potlifts, centroid of fishery, annual incidental catch, TAC utilization), economic (ex-vessel value, ex-vessel price, ex-vessel revenue share, leasing), and community (number of active processors, processing labor hours, local quotient landed). Brian noted that an economic indicator related to leasing would be added, which might be either the proportion of ex-vessel value paid as lease royalties or the proportion of the catch landed on leased quota, and requested that this be highlighted for the SSC to identify what would be most useful. Brian also wanted to draw the SSC’s attention to the “local proportion” community indicator, which captures the percentage of Tanner crab catch volume or value at a port where Tanner crab are

landed relative to the total volume or value of catch processed at that port. In the past, this was reported for crab only for the most dependent port (for Tanner crab, this was St. Paul), but Brian proposed expanded metrics (e.g., top three ports) and requested SSC feedback.

The CPT asked for information that was used in the initial identification of indicators, including providing relationships of the ecosystem indicators with crab response variables.The inclusion of response variable(s) in the time series plots for comparison would also be useful.

The CPT discussed whether to use survey data or model estimates for recruitment as a response variable in indicator selection and in the Bayesian Adaptive Sampling (BAS) analysis, especially given the eventual aim to include the indicators in assessments. It could be helpful to review data inputs to other ESPs to consider the appropriate information source for response variables.

The CPT noted that crab distribution may be influenced by where the fleet is fishing and is not simply a reflection of population movement. The distribution could also be a product of larval release location. Therefore, the indicator based on the centroid of adult male distribution is not a simple indicator of population status.

The CPT discussed that alternative female reproductive potential metrics might be considered and that it would be helpful to determine what question is being answered in the metric chosen. The current metric of the proportion of females that have a full clutch (measured on the survey as ¾ to full) reflects high reproductive potential. The CPT suggested that a metric that reflects low reproductive potential may be more informative of poor environmental conditions and useful when there is future population concern.

The CPT asked for more information on the lags used for each metric in the BAS analysis, as they were not available in the presentation. The author indicated that larval indicators were lagged 4 years, juveniles 2 years, and some others 1 year. The CPT discussed that these lags need additional consideration (e.g., the lag for the larval indicators was considered to be too short) and requested an explanation in the final ESP.

The CPT asked that the results of the BAS analysis include the posterior probability distributions of the model predictions for inclusion on the model fit plot as well as an interpretation of the results in terms of the percent influence each indicator has (e.g., what does a 0.4 for chlorophyll *a* concentration mean in terms of changes in recruitment?). Both types of information should be readily available from the BAS analysis. The model fit plot would be enhanced by adding the sampling-based confidence intervals to the data.

The CPT commented that the time series of indicators used in the BAS analysis are short and that the analysis could be better informed by a longer time series. As the start of the time series is limited by availability of data, the CPT suggested that data for some indicators go back further in time and might be included in an analysis with fewer indicators. The CPT also suggested

there might be ocean model output that could be used to extend, in particular, the chlorophyll *a* time series further back in time.

For Tanner crab economic indicators, the CPT suggested it may be interesting to look at the fishery centroid in relation to the survey centroid.

One challenge to consider in this context is that socio-economic indicators are based on past data, and it would be useful to have a discussion at the CPT, SSC, and Council levels on the best information that we have the capacity to provide that is likely to be the most useful to stakeholders.

CPT Requests/Suggestions:

- provide more information on how indicators were initially identified;
- as practicable, include the response variable(s) in the indicator time series plots for comparison;
- results of the BAS importance analysis should include the posterior probability predictive distributions for the model predictions for inclusion on the model fit plot, as well as an interpretation of the results in terms of the percent influence each indicator has;
- add the sampling-based confidence intervals to the data fit in the importance analysis;
- provide more information on the rationale for the lags used for each metric in the importance analysis;
- develop a metric that reflects the degree of clutch emptiness, because low reproductive potential may be more informative of poor environmental conditions and a useful metric when there is future population concern;
- consider an importance analysis based on fewer indicator time series that extend further back in time;
- consider incorporating information from ROMS or MOM6 output to extend indicator time series for the importance analysis (e.g., model-predicted chlorophyll *a* concentration);
- consider how results from the BAS analysis would be incorporated into the stock assessment model;
- for the economic indicators, consider looking at the centroid of the fishery in relation to the centroid of the stock from the survey; and
- a discussion at the CPT, SSC, and Council levels would be useful on the best information that we have the capacity to provide that is likely to be the most useful to stakeholders.

Tanner Crab proposed model runs

William “Buck” Stockhausen (AFSC) presented several analyses related to Tanner crab data preparation and SSC requests, updates on GMACS model development, and recommended preliminary models for consideration for the September 2025 assessment of Tanner crab (slides, document). Buck verified the use of ‘crabpack’ as a source for data pulls for his

assessment, rather than AKFIN as historically done. He suggested using standard stations for the 1979 data and using high-precision carapace width data (rather than rounded data) to convert to weight starting in 2016. **The CPT agreed with using the high-precision carapace width data but recommended using the full set of 1979 stations provided in crabpack.** Buck also looked for differences among 'successful' and 'unsuccessful' cohorts in Tanner crab as requested by the SSC. This analysis suggested that cohorts that successfully survived and grew to harvestable size tended to experience colder bottom temperatures relative to cohorts that showed lower survival and failed to recruit to the fishery in appreciable numbers. The CPT found this analysis helpful but noted that the small sample size precluded a conclusive conclusion about temperature effects.

Much progress was made on replicating the Tanner crab assessment in GMACS, but several issues still need to be addressed before a full bridging analysis can be performed. Fits to the NMFS survey biomass were substantially different between GMACS and the status quo model. **The CPT suggested starting from inputting parameters via a .PIN file in the bridging analyses and then work towards estimating parameter values.** This could be particularly useful for the issues with differing estimates of natural mortality between the models. Given the large estimated fishing mortalities for the BBRKC fisheries, **it might also be useful to consider how selectivity is being estimated**. **A closer look at how priors were placed on the NMFS survey selectivity seems warranted given large differences between estimates from each model.** Differences in the data in the OSA residual plots were initially concerning and led the CPT to ask if the data changed. The author confirmed that the data did not, but the tail compression was occurring over a larger range of size bins than expected.

The author presented four models based on the status quo model that differed in whether or not tail compression was applied, how the survey observations were fit (log space vs. normal space) and how the catchability curves for the BSFRF data were incorporated. Convergence diagnostics were all acceptable, and fits were similar, save for the model in which survey observations were fit in normal space. Tail compression did not appreciably alter the results, consequently, the author recommended bringing forward the base model (22.03d5), the model with NMFS survey capture probabilities determined by the BSFRF side-by-side experiments (25.02), and a GMACS model (G25.05) in September. **The CPT recommended bringing forward only the base model (22.03d5) and the GMACS model (G25.05) so that more effort can be placed on bridging to GMACS**. The CPT appreciated the likelihood profiles and noted that, if time allows, **likelihood profiles over the OFL would be an interesting addition to the currently presented analyses**.

AIGKC final 2025 SAFE

Tyler Jackson (ADFG) presented the May 2025 assessment of Aleutian Islands golden king crab (AIGKC) to the CPT. The assessment was again based on GMACS. This assessment is finalized in May each year because the fishery for AIGKC opens in August.

The 2025 assessment responded to past SSC and CPT comments by providing a risk table (Appendix C of the assessment report), by providing an alternative approach to data weighting (model 25.0b), by documenting how incomplete fisheries are handled (Section D.2.f of the assessment report) and by clarifying that the bycatch and total catch data for 1993/94 were not included in the last assessment for the EAG owing to issues with the 1993 observer data. The problem with the 1993 fishery composition data is now resolved and the models considered for the assessment of the WAG now include data for rectangular pots (including those of unknown size) for 1993 size composition and total CPUE. Tyler noted that the last year used to estimate mean recruitment for the calculation of the B_{MSY} proxy is the last year of the assessment less four years, which matches the years for which recruitment deviations are estimated with reasonable precision. The current assessment does not include models with co-operative survey data (these were explored during September 2024), nor does it explore time-varying selectivity, with work to revise size-at-maturity deferred to September 2025. The CPUE index is based on the approach provided to the SSC in September 2024, and the methodology will be refined further for the next assessment.

Tyler presented two model configurations to the CPT based on the CPT and SSC recommendations from September 2024: (a) an update to the 2024 "base" model (23.1c), which corrected the 1993 size-composition data for the WAG and includes bias-correction for the recruitment deviations for the years preceding monitoring data (years 1960-1981), and (b) an alternative model that started the assessment in 1981 in a non-equilibrium state (25.0b). This approach was recommended by the CPT during May 2024. Both models included updated retained and total length-composition data (Appendix A of the assessment report) as well as catch data for the 2024/25 season. At the time of the analysis, the fishery in the EAG was not yet completed. The retained and total catch size-composition data for the 2024/25 season are based on dockside/observer samples-to-date. No change in CPUE standardization methodology has occurred since 2024, so only the post-rationalized index was updated (Appendix B of the assessment report).

Model 25.0b also placed equal weight on all catch data components and set the stage-1 effective sample sizes for the size-composition data using a bootstrap procedure based on Stewart and Hamel (2014). This continues work to evaluate alternative data weighting schemes as recommended by the CPT in May 2024. An aim of model 25.0b was to reduce the magnitude of the retrospective pattern for the EAG, but the retrospective pattern evident in previous years remained in model 25.0b. The fits of both models were similar, with the fits to the catch data very good while those to CPUE data, particularly the EAG, poorer. The fits to the retained catch size-composition data were better than those to the total catch size-composition data. A jitter analysis supported that the global minimum of the objective function (i.e., the "MLE") was found for all models. Both models indicate relative stability for the EAG but declining MMB and recruitment for the WAG. There is some evidence for improved recruitment in recent years, but the strengths of these cohorts are likely still quite uncertain given these cohorts are poorly selected.

Tyler recommended the "base" model (23.1c) as the basis for management advice for the next fishing year because the derived quantities for model 25.0b were somewhat

sensitive to data weighting, without improved model performance (aka fits to CPUE data, reduced evidence for a retrospective pattern). The CPT concurred with this view.

Tyler explored the question of whether CPUE might not be reflecting trends in abundance and noted that until 2020 the area fished in the WAG had been increasing while the area fished is relatively stable for the EAG. He interpreted this as suggesting that CPUE may be an adequate index of abundance for the WAG but that there was a possibility of hyperstability for the EAG.

Fishers noted that interactions with other operators could be impacting CPUE as an index of abundance.Fishers also remain concerned about unobserved mortality (only observed mortality is reflected in the assessment). The CPT highlighted the value of skipper surveys to inform the interpretation of CPUE, and looks forward to the development of a skipper survey for AIGKC if possible.

The CPT discussed the proposed risk table in Appendix C of the assessment report, and noted there was no discussion of possible gear interactions or benthic habitat impacts on the WAG and EAG, and that the risk tables do not seem to have an obvious way to include this information. Most of the issues identified in the risk table matched considerations discussed before by the CPT when selecting buffers. However, it was noted that the standardized CPUE for the WAG for 2024/25 is the lowest since rationalization. The retrospective patterns for the EAG and the trends in the historical estimates of Legal Male Abundance for both areas (particularly the WAG) were also a concern. The historical analysis detected a pattern for the WAG when the retrospective analysis did not, indicating that this is a useful assessment diagnostic. Tyler noted that realized exploitation rates on legal males exceeded that under the state harvest strategy, particularly for the WAG.

Recommendations for the next assessment:

- Examine time-varying selectivity as a possible solution to the retrospective pattern for the EAG.
- Routinely report “historical analyses” in assessment reports.
- Explore refinement of the estimates of size-at-maturity (separately for the WAG and EAG and for both areas combined).
- Average stage-1 sample sizes using the harmonic mean and not the arithmetic mean when calculating inputs for the stock assessment.
- When reporting jitter analyses, restrict the x-axis range so that it is possible to detect non-convergences to objective function values close to the putative MLE.
- Investigate the possible use of the cooperative Aleutian Islands survey in the EAG for inclusion in future assessments.
- Tyler should meet with the ESR group to identify potential indicators that could be applicable to AI golden king crab.

Model-based indices update

Emily Ryznar (ADF&G Kodiak), Caitlin Stern (ADF&G Juneau), and Jon Richar (NOAA Kodiak) presented an update on model-based survey indices development. Emily began by presenting progress toward a model-based survey index for snow and Tanner crabs (slides, document). Previous efforts to generate model-based indices used the R package VAST, while the current effort uses sdmTMB for its user-friendly interface and improved computational efficiency. Several models were explored that varied the number of knots used to construct the spatial mesh, correlation structure of spatiotemporal random fields (IID, AR1, random walk), and error distribution (Tweedie, delta-gamma, delta-lognormal). Prospective models were diagnosed using sdmTMB's sanity() function, which performs tests of various convergence criteria, and DHARMa residuals were plotted to evaluate model specification. Lastly, Emily used cross validation to estimate log-likelihood values to evaluate predictive skill across models.

For Tanner crab, Emily constructed a triangular mesh using 50, 90, and 120 knots, ignoring the Pribilof and St. Matthew Islands. The prediction grid encompassed the entire EBS at a resolution of 5 km^2. The IID delta-gamma model that used the 50 knots mesh was chosen as the best performing, most parsimonious model. Delta-lognormal models were deemed misspecified by diagnostic tests, and AR1 and random walk models did not converge. QQ-plots and spatial representation of DHARMa residuals were adequate. Indices for male and female (mature and immature) indices tracked design-based estimates regardless of mesh density, though in several instances the 50 knot mesh produced larger values, indicating that the number of mesh knots influences index scale to some degree. The indices produced from sdmTMB were slightly greater in some years than those produced previously using VAST, which may be due to bias correction. Confidence intervals were similar for the male and immature female indices, although the sdmTMB index had much greater uncertainty than the VAST model in many years of the mature female index. **The CPT recommended conducting a spatial comparison of models by mesh size to better understand differences in abundance estimates.** Spatial abundance predictions tend to be smoother than the observed patchiness of the design-based estimates. The CPT noted that by design, spatiotemporal models interpolate over the inherent variability in catch observations, resulting in lower CVs. **The CPT recommended using the same modelling framework for each sex-maturity category.**

Snow crab models were fit to only large male (> 95 mm CW) and mature females, and only included Delta-gamma and Tweedie error distributions. In addition, models either included only the EBS, or the EBS and NBS, although predictions were only made for a 41 km^2 grid in the EBS. EBS models were IID, and EBS/NBS models were estimated with an AR1 process, which was thought to be useful for bridging years without NBS data. Delta-gamma models were considered best performing, though using a 90 knot mesh for males and a 50 knot mesh for mature females. Residual diagnostics suggested spatiotemporal autocorrelation among DHARMa residuals, which improved for models with high resolution (i.e., greater knot) mesh. As with Tanner crab, models predictions approximated design-based estimates, although models that included EBS and NBS data showed greater deviations depending on sex-maturity category. Given that NBS data are not available for all years, and the potential of crab migration

between the EBS and NBS is likely, the CPT acknowledged concern with using NBS data and cautioned against using the AR1 correlation structure, but was not able to make a recommendation on its use. **Further exploration may be to evaluate an IID model that uses NBS data and more closely examine predictions near the boundary.**

Jon Richar presented an ongoing effort to develop model-based size composition indices for Tanner crab using VAST. Due to computational needs, Jon estimated each time series using separate models in 5 mm CW increments, such that size bins are independent. The CPT noted that accounting for correlation among size bins would be one of the benefits of estimating model-based size compositions. Generally, model diagnostics were good, although there were varying degrees of misalignment with design-based estimates by group, bin, and year. Jon noted that model-based abundances were generally lower than design-based estimates, although the CPT suggested that proportions by size would be a better basis of comparison since that is what is used by the assessment**. The CPT suggested limiting size bins to those used by the assessment and examining tinyVAST models used for estimating groundfish age compositions. The CPT appreciated the time and effort Jon has put into this work, but recommended that continuing should not be considered a high priority at this time.**

Caitlin Stern presented model-based indices for the ADF&G Norton Sound Trawl Survey, NMFS Norton Sound Trawl Survey, and NMFS NBS Trawl Survey for Norton Sound red king crab (slides, document). Model structure, error distributions and mesh construction were the same as evaluated for EBS Tanner crab, but with depth evaluated as a covariate. Several models did not converge for the ADF&G and NOAA NBS survey models, while all NMFS Norton Sound survey models converged. The models with the most predictive skill were the delta-gamma model with depth for the ADF&G survey, the delta-lognormal model with depth for the NMFS Norton Sound survey, and the Tweedie model without depth for the NMFS NBS survey. Caitlin used Moran's I to evaluate residual spatial autocorrelation and identified significant results in one year for the ADF&G survey, two years for the NMFS Norton Sound survey, and no years for NMFS NBS survey.

Two options were presented for a prediction grid, one that was larger which encompassed all survey stations, but extended into areas not fished by the commercial fishery, and one that was smaller than the full footprint of the ADF&G and NMFS surveys. Resulting abundances were greater for the larger prediction grid than for the smaller prediction grid, as expected. Generally, model-based abundance indices were greater than design-based estimates for ADF&G and NMFS NBS surveys, but lower for the NMFS Norton Sound survey. The CVs were comparable between model-based and design-based estimators in most situations, although model-based CVs were greater for the ADF&G survey when predicting over the larger grid. **The CPT noted that the larger prediction grid covers a broader portion of the stock, but cautioned against estimating abundance in areas that are poorly sampled. The CPT highlighted the need for continued work on model-based abundance estimates for NSRKC, as survey area consistency has been a reoccurring issue in the assessment.**

Snow Crab proposed models

In introducing the assessment, Cody Szuwalski (NMFS, AFSC) highlighted that OFLs and ABCs for all major crab stocks have never constrained removals and many stocks are still at historical lows in spite of conservative management (slides, document). He noted that the biomass of commercial-sized snow crab males is at a historical low, and that the current OFL harvest control rule (HCR) for snow crab, using morphometrically-mature male biomass as the currency of management, would result in an OFL that would allow removal of the entire biomass of commercial-sized males. He highlighted his perspective that persistent declines in the abundance of commercial-sized males (>101 mm CW) was the primary challenge facing management of this stock. Cody stated further that the current basis for setting management reference points leads to OFLs that are not constraining for fishery removals, and that the state TAC is the actual constraint on removals, with management that is effectively much more conservative than the limits set by the federal process. On the other hand, moving to the biomass of "large males" (e.g., ≥ 95mm CW) as the currency of management could lead to snow crab being a "choke species" at the federal and state level, and HCRs based on such reference points might lead to outcomes that are perhaps in conflict with the outcomes of state HCRs, which are based on the biomass of morphometrically mature males and females.

Cody then outlined the analyses conducted in response to CPT and SSC comments and presented the proposed model runs for the September 2025 assessment. In response to past SSC comments:

- *Maximin analysis*: As requested by the SSC, Cody included steepness values of 0.50, 0.67, and 0.80 in the maximin analysis for reference points. The SSC had also recommended using the Ricker stock-recruitment relationship, but Cody did not bring that analysis forward. The B_{MSY} proxy using the Beverton-Holt model based on the values for steepness listed above was $B_{36\%}$ when used with a currency of > 95mm male biomass. Cody noted that values of $B_{36\%}$ used with either morphometrically mature males or males > 95mm as the currency would result in federal closures to the fishery, as would a value of $B_{45\%}$ for > 95 mm biomass (from the analysis conducted in 2024).
- *Tier 4 fallback model*: No results for a standardized Tier 4 "fallback" model were provided at this meeting, but Cody plans to present such results for September 2024. This Tier 4 model will follow SSC guidelines in terms of being consistent with the approach used for Tanner crab and BBRKC.
- *Probability of maturing / terminal molt*: Two model configurations (25.4 and 25.4a) were developed to explore the impacts of a time-varying probability of terminal molt and reflect the consequences of new information on the probability of maturing / terminal molt. Specifically, model 25.4 fit a single specified molting probability (not time-dependent) and 25.4a used annually-resolved molting probabilities informed by a different data processing routine by the survey group (weighting chela measurements by CPUE rather than sampling factor). The results of these model runs were, however, not qualitatively different from those of the updated base model. In addition, Cody noted that survey data processing that provides the annual maturity ogives was reviewed at this meeting under a separate agenda item. The CPT did not agree on a recommended replacement for the

legacy survey data workflow (see “Survey data updates”), and this item is planned for review by the CPT at the November meeting. No work on a hierarchical analysis that treats year as a random effect was presented. Cody proposed that more work on treatment of maturity in the model should wait until the survey data processing change is finalized, and the CPT agreed.

- *Skewed sex ratios in estimated recruitment*: Cody responded to the SSC request for relevant data from outside the model by noting that he was unaware of any such data at the larval or juvenile settlement life stages that would be helpful. No new analyses were presented to address the skewed sex ratios at recruitment and the mismatch between recent large recruitments for males and females occurring in different years. The CPT discussed the idea of moving to a male-only model to concentrate on the issues surrounding currency of management and the decline in abundance of large males, but it was noted that the state requires estimates of mature male and female biomass for TAC setting. There was some discussion that the reason for the sex-specific differences in recruitment may be due to the different survey selectivity curves for males and females.
- *Model-based survey indices of survey biomass*: Cody noted that model-based indices of abundance based on the NMFS trawl survey had been computed and were presented during the “Model based indices update” agenda item.

Cody provided results for eight model configurations:

- Model 24.1: the accepted model from September 2024;
- Model 25.1: model 24.1 but with the assessment conducted using the latest version of GMACS;
- Model 25.2: model 25.1 with updated catch from 1990 to the present – the adjustments to the catch data (retained catch and discards) made by ADF&G were: (a) date corrections in the pre-rationalized fisheries to the regulatory crab year (July – June); (b) exclusion of pots that had compromised biotwine (i.e. rot cotton); (c) consistent handling of missing data fields such as legal status / maturity; and (d) total catch / bycatch in a fishery extrapolated using directed effort as opposed to total fishery effort.
- Model 25.3: model 25.2 with updated growth data from the Kodiak laboratory and BSFRF;
- Model 25.3a: as for model 25.3, except that management reference points are based on commercial biomass and not morphometrically mature male biomass;
- Model 25.4: model 25.3 but with a single (pre-specified) molting probability instead of a time-varying specification;
- Model 25.4a: model 25.3 but with a single (pre-specified) terminal molting probability based on a proposed correction to survey data processing (CPUE weighting); and
- Model 25.5: model 25.4 but with a stacked logistic curve for survey selectivity.

Cody noted that many changes and updates had occurred to GMACS since the last assessment and this led to changes to the model outputs. Given the large number of changes, it has proven impossible to fully identify the causes for the changes in results such as the change in the year during which the recent peak in MMB is estimated to have occurred.

The CPT discussed models for the September assessment. Model 25.3a was the author's preferred model because it focuses management on large males, and Cody proposed that models 25.3 and 25.3a be brought forward as the basis for management advice in September 2025. The patterns of fishing mortality for the directed fishery differed considerably among models, which may partly be explained by the incorporation of new growth data. However, other quantities such as trends in recruitment were similar among models. The CPT agreed with the author's recommendation, noting that models 25.4 and 25.5 were primarily conducted to understand the sensitivity of the model results to changing assumptions related to maturation and survey selectivity and should not be brought forward for September. Cody noted that there may be value in conducting a male-only assessment, although the snow crab assessment is already essentially two assessments (for males and females) conducted in parallel (although there are some shared likelihood components such as groundfish bycatch), and some female information from the assessment may be informative for (state) TAC setting.

The CPT had an extensive discussion of the "management currency" for computing reference points, noting that there is no evidence for a stock-recruitment relationship for snow crab based on the stock assessment outputs. Models 25.3 and 25.3a differ only in whether stock status is defined in terms of mature male biomass (i.e., morphometric maturity) or the biomass of males > 101 mm CW. In recommending that the September 2025 meeting be provided with results for the management currency of mature males > 101 mm, the CPT noted that:

- while 101 mm is essentially a "cut-off" width, most crab assessments define maturity this way, and the CPT discussed the expectation that many male crab in stocks assessed with this cutoff approach are mature below the cutoff;
- the level of fishing intensity on large (commercially-preferred) males implied by a management currency of MMB and the current OFL control rule is unrealistically high given the large difference between maturity and the industry-preferred size, such that the OFL could be essentially the entire industry-preferred biomass;
- there is currently no definitive information of what sizes correspond to "functional maturity" and this is likely to continue to be the case; although some research is ongoing, this size is likely to differ spatially and over time; and
- there is evidence from Canadian research that density is important for determining size-at-maturity such that higher densities of large males tend to produce more large males with higher reproductive value, while lower densities of large males tend to result in crab making the terminal molt to maturity at smaller sizes (Mullowney and Baker 2021, cited in the September 2024 CPT report).

The CPT agreed that it would allocate time during its September meeting to further summarize the evidence to support either retaining the current management currency or changing to be based on larger males and hence ensure that management advice continues to be based on best available science, even when this science is, and will remain, uncertain. This documentation would also include a summary of the potential qualitative consequences of basing management on the "wrong" management currency.

The CPT noted the potential for conflict between the current state harvest strategy and the method for setting OFL and ABC were the management currency to be based on males > 101 mm, but recognized that a change in management currency would reflect an updated understanding of the drivers of reproductive success. Changing to a set size reflects that the size at "functional maturity" is currently unknown (and will likely remain so), but that it is larger than morphometric maturity. Changing the management currency may require a management strategy evaluation, ideally considering a collaboration of both federal and state harvest control rules.

The CPT noted that model 25.3 does not converge. If this continues to be the case, the assessment author should either (a) move back to model 25.2 which did converge, (b) consider estimating growth outside of the model, or (c) fit the retained catch and total catch rather than retained catch and discards (as is the case for other crab stock assessments). The CPT identified options (b) and (c) as issues that require additional work irrespective of whether they are implemented for the September 2025 assessment. The CPT recommended presenting a model configuration based on (c) at the September meeting even if model 25.3 converges.

Recommendations for future assessment work:

- Consider estimating growth both outside and inside the model and perhaps weight the growth data for females to avoid placing undue emphasis on fitting the data for small animals (as would be the case if the data were weighted by sample size).
- Review the growth data and ensure that the data included in the assessment exclude animals that were molting to maturity if there appears to be a difference in molt increment among the two groups.
- Fit to retained catch and total catch rather than retained catch and discards for males for consistency with other crab assessments (e.g., Tanner crab and AIGKC). This is also more consistent with how the data on removals are collected and avoids problems caused by the use of the "subtraction method" to calculate discards (which can lead to zero or negative discard values in some years).
- Fit to the data for immature females, mature females, and total males (rather than immature females, mature females, immature males, and mature males) as the data collected do not actually distinguish between immature and mature males. This is also how the assessment for Tanner crab is formulated.

Finally, Cody has conducted additional research on the broader population dynamics of snow crab (Sections D and E of the assessment report) and found that mortality events played an important or dominant role in driving population trends for BSAI crab stocks, and that there appears to be spatial depletion of commercial-sized snow crab by the directed fishery.

BBRKC proposed models

Katie Palof (ADF&G) presented results from seven potential models implemented in GMACS for Bristol Bay red king crab (BBRKC) and addressed several CPT and SSC comments (slides, document). She first reminded the CPT that GMACS modeling framework has been used since

2018 and that the fishery has been open the past two years following two years when it was closed by the State harvest strategy due to low mature female abundance. Additionally, recruitment has been low for ~15 years and the population, barring an unforeseen large recruitment event, is projected to continue to decline. However, CPUE in the 2024/25 directed fishery was higher than the average over the last ten years (~30 crab per pot).

Regarding recent recruitment trends, Katie expressed her concern that this was not being captured appropriately enough in the stock assessment's risk table, even though the trend is captured by the assessment model, because management quantities for the stock are based on long term average recruitment and do not reflect more recent trends. The CPT commented that, while using the long term average to determine BMSY and stock status might be appropriate, it might be better to use recent recruitment to inform projections. Katie responded that she does provide projections under several recruitment "regimes", including the recent time period, but responded that she remained dissatisfied with whether or not this information was included in the risk table. Discussion then focused on the time frame for calculating long term average recruitment: The CPT suggested that adding recent years to the time frame would not be appropriate in the context of a declining trend, but the time frame used in most annual assessments is generally updated by one year each assessment cycle. A public comment by someone fishing the stock since 1998 suggested that the current stock was as "healthy as [he] had ever seen it" and that the high CPUEs were spread across Bristol Bay, so they were not due to the fleet fishing on a spatially-aggregated stock. The CPT noted it might be helpful to have indicators for the degree of spatial aggregation of the stock and fishery (Tyler Jackson (ADF&G) indicated that his "fishery extent index" might be useful in this context).

Katie presented a comparison between red king crab biomass in the "Northern Unstratified Area" adjacent to, but north of, Bristol Bay with that in Bristol Bay management area. The fraction in the Northern Area is very small for both males and females, but has exhibited increasing variability in recent years. Data from the Northern Area are not included in the assessment model because it is collected outside the stock area defined for BBRKC, but the trends are tracked in the assessment document. As an avenue for future research, Katie is considering how the data from the Northern Area might be used with a model-based approach to index generation. Kendall Henry (ADFG) pointed out that the Bristol Bay and Northern Areas are defined in regulation in the Crab Rationalization Plan and the IFQ for BBRKC is specific to the stock within the defined boundary. Katie suggested the crab in the Northern Area could be included in fitting a spatiotemporal model for a model-based index, but that estimates of biomass or other quantities for Bristol Bay would exclude model predictions outside the management area. Ben Daly (ADF&G) noted that the issue in recent years with red king crab near the boundary between Bristol Bay and the Northern Area has been that estimates for mature female biomass in Bristol Bay have been very close to the cutoff used to close the fishery in the State harvest strategy and that, depending on exactly which data were used to calculate mature female biomass, could determine whether the fishery was opened or closed by regulation.

Addressing another SSC request, Katie also discussed some recent work looking at whether the range of sizes in the assessment model should be expanded. Katie examined size compositions for both sexes. For males, she found that, while there may have been an increase in large males in recent years, the model size range was appropriate. For females, though, she found that recent increases in large females may warrant expanding the size range used in the model for females. This would, however, require changing the growth matrix. Extended size compositions for all data sets and a reexamination of the historic growth data are both high priorities for model explorations in the next cycle.

Katie described how she used BSFRF data to develop the priors for NMFS survey selectivity she used in several of the models she presented. Size-specific GAMs (sexes were combined) were fit to survey-aggregated ratios of size-specific abundance estimates from the NMFS survey to the BSFRF survey for studies in 2007, 2008, and 2013-16 (the “side-by-side” studies). The “side-by-side” studies in 2013-2016 consisted of a series of experiments in which BSFRF vessels “shadowed” NMFS survey vessels to conduct hauls paired with synchronous NMFS hauls, where the BSFRF gear was assumed to catch all crab within its area swept and could be used to inform NMFS gear selectivity at the haul level. The sampling in 2007 and 2008 was not conducted in this closely-coordinated fashion. For both sexes, estimated mean selectivity rose from a small value (< 0.3) at small sizes to 1 at a sex-specific intermediate size, then declined slightly at the largest sizes. William “Buck” Stockhausen (AFSC) noted that this slightly domed-shape pattern was seen when similar data was analyzed for other crab stocks and may simply be an artifact of the few samples occurring at large sizes for any species.

Three of the models (m24.0c.1, m24.0c.1a, m24.0c.2) Katie presented results for were characterized as “housekeeping” updates and illustrated the progression of changes in results from the 2024 assessment model (m24.0c, using updated GMACS code) due to updated catch data from ADFG (model m24.0c.1), a potential change in fixed gear handling mortality (model m24.0c.1a: model m24.0c.1 + 20% handling mortality rate for discards in the groundfish fisheries), and updated input files (model m24.0c.2: model m24.0c.1 + shell condition, unused in the model, removed as a population category to be tracked). The model (m24.0c.1a) with the 20% fixed gear handling mortality addressed an SSC request, based on previous public comment, to consider a lower fixed gear handling mortality rate. The fixed gear handling mortality rate used in the other models was 50%, the standard value since 2008. None of these models exhibited any substantial differences from the others.

Model m24.0c.2 was then used as the base model for further model explorations that explored the impacts of different approaches to using the BSFRF survey data to inform NMFS survey selectivity in the model. Model m25.1a updated model m24.0c.2 to include a prior on NMFS survey selectivity based on using the BSFRF survey data from all years in which it was collected for BBRKC (2007-08, 2013-16). For model m25.1b, only the BSFRF data from the “side-by-side” studies (2013-16) were included in developing the prior on NMFS survey selectivity. Model m25.1b2 was similar to model m25.1b but doubled the range of the prior on NMFS selectivity. These models evinced very few differences in fits to survey and fishery time series data and overall fits were good. Estimated selectivity curves among the m25 model variants exhibited

differences between the models and with the base model. Model m25.1a exhibited a dome shape for selectivity in the 1975-81 time period but not in the more recent time period, while the selectivity curves in both time periods in the other models exhibited asymptotic shapes. Andre expressed surprise that model m25.1b2, because its selectivity prior was less constraining, did not result in a better overall fit to the data than the other models. Changes in survey selectivity resulted in small changes in natural mortality (*M*), with the base model having a slightly larger estimate of M than the other models, as well as changes in MMB related to scale (but not trend). The changes in M influenced changes in F_{MSY} among the models; CPT members were initially concerned about the differences in F_{MSY} until it was realized that M was being estimated in these models.

Katie presented plots of mean predicted and observed proportions for the NMFS survey data, as well as OSA residuals, as diagnostics for fitting the size compositions. Because these compositions were fit as aggregated (i.e., extended) size compositions, Tyler raised the question of whether it was appropriate to calculate the OSAs on the extended comps or the sex-specific portions of the comps. After some discussion, the CPT decided to refer the matter to Cole Monnahan (AFSC), the assessment author responsible for introducing OSAs to the Groundfish Plan Teams.

Katie proposed that model m24.0c.2 be brought forward for the September 2025 assessment and noted that a Tier 4 model, as per standard procedure now, would also be brought forward as a "fallback" model. She also noted that future development would include finishing the BSFRF selectivity analysis and determining the extent to which model size bins should be increased.

The CPT returned to the issue of the value for the fixed gear handling mortality. It noted that there was little information available to inform this value and that it made little difference to the model results. To standardize across stocks would involve a more detailed consideration of the timing of the individual fisheries, because handling mortalities with other gear types has been shown to depend on on-deck temperatures. It was also noted that "fixed gear" in the assessment model is really a combination of groundfish pot and longline gear, and both would have different handling mortality rates. Andre suggested, if one really wanted to do it, the simplest way to include differential handling mortalities would be to create fleets with different handling mortalities but that otherwise shared selectivity characteristics. The CPT concluded that, while there may be value in using a standardized value across stocks, it was not regarded as a high priority for future effort given the limited resources available.

CPT recommended that Katie:

- bring model 24.0c.2 forward in the fall for the 2025 assessment
- consider increasing the upper limit on size bins for females in the model
- determine how the growth matrices were created and extend them to the new size limits
- use a spline function to represent NMFS survey selectivity when using the BSFRF data as a prior, rather than estimating a parameter for each size bin

- in the future, identify the source(s) of the difference in F_{MSY} between m24.0c.2 and the m25.1a models (which does not appear to relate to survey selectivity, but may relate to fishery selectivity and likely is related to M estimates)

Survey modernization update

Lewis Barnett and Sean Rohan presented ongoing work toward NMFS EBS survey modernization. The broader survey modernization project involves several working groups researching 1) sampling design, 2) reductions in tow duration, 3) extending coverage to the EBS slope, 4) trawl gear redesign, 5) gear calibration, and 6) survey design transition. The optimistic timeline for survey modernization implements redesign efforts after 2030, though Sean noted that given funding uncertainties, that timeline may be unrealistic. The remainder of the talk focused on two specific aspects of survey modernization: sampling design and tow duration.

The primary goal of the survey redesign is to unify Bering Sea Surveys (EBS, EBS Slope, NBS) under a flexible and efficient design, which performs optimally for a wide range of FMP species. Sampling designs evaluated included random sampling, stratified random sampling, and spatially balanced stratified random sampling. Optimization used a multivariate approach to design strata and sample allocation based on simulations of species distribution models for key FMP species. 'Optimal' designs were either stratified or spatially balanced stratified. Generally, abundance trends indicated continuity in the historical time series, but differing survey designs presented trade-offs in precision and accuracy by species. CVs were similar to the historic surveys and differed little among designs for snow and Tanner crab, but were variable among prospective designs for king crab stocks. Multispecies optimum designs were more aligned with the single species optimum designs for species with broader distributions, like snow crab. Lewis discussed the inclusion of the upper EBS slope down to 600 m depth and the different gear used by the current shelf and slope surveys. **The CPT emphasized the need for a gear with good retention of crab.** Lewis briefly highlighted ongoing work to explore dynamic allocation based on changing environmental conditions. SDMs detected poleward distribution shifts for several species, including snow crab, but did not detect changes in depth distribution with warming conditions. Ben Daly suggested fishery observer data may be informative to changes in depth distribution for crab socks. **Overall, the CPT recommended exploring optimization over specific size/sex groups, highlighting crab ontogenetic migration and patchiness observed in crab.**

Survey tow duration will be reduced to 15 min to reduce subsampling errors, enable auxiliary data collection, and reduce ergonomic injuries of survey staff (i.e., lighter lifting/sorting/measuring). Currently, the total catch is subsampled in about 70% of 30 min tows, though several species including crab are always whole-hauled. To date, 161 side-by-side tows have been completed between 1995 and 2024. Previous comparisons by Somerton et al. (2002) suggested that CPUE is markedly higher in 15 min tows for snow and Tanner crab. Preliminary results for the going effort corroborate that CPUE is higher in 15 min tows than 30 min tows. Sean discussed several implementation options being considered and centered on two approaches: 1) a phased approach in which 30 min tows are replaced over time, progressively increasing the proportion of 15 min tows, and 2) a 'rip the band-aid off' (i.e., knife

edge) approach where the switch to 15 min tows happens at all stations in a single year. The CPT acknowledged that the knife-edge approach would be cleanest from an assessment standpoint once the new time series has developed, but it would create a lot of uncertainty in survey results in the initial few years. Likewise, the CPT noted that the phased approach will also present other difficulties for interpreting survey results in the interim, as will other planned survey changes including those to sampling design and gear. **The CPT highlighted the need to develop a plan for dealing with survey transition in the affected assessments, potentially using the results of the calibration analyses, before implementing either transition approach.**

NSRKC proposed models

Caitlin Stern (ADF&G Juneau) presented proposed model runs for the Norton Sound red king crab (NSRKC) stock (slides). Final specifications for this stock will be presented for review at the November CPT meeting. This timing is driven by availability of data from the NMFS Northern Bering Sea survey. Caitlin noted the change of authorship for this assessment, as she and co-author Katie Palof (ADF&G Juneau) have taken over for longstanding author Hamachan Hamazaki.

The base model for this assessment is model 24.0, which is in GMACS and was accepted for setting specifications for the 2025 calendar year fishery. This is a male-only model for animals ≥ 64 mm carapace length (CL) in eight size bins. The model is informed by three trawl survey time series and standardized CPUE for the summer commercial fishery. Natural mortality (*M*) is fixed at 0.18 for animals ≤ 123 mm CL and estimated for animals > 123 mm CL. The OFL is partitioned among the three fisheries that exploit the stock: summer commercial (by far the largest fishery), winter commercial, and winter subsistence.

Caitlin began the presentation by responding to SSC comments from the last cycle. The OFL had previously been partitioned among the three fisheries outside the model, and in response to SSC feedback functionality has been added to GMACS that now allows the OFL to be calculated for each fishery within the model. The SSC also previously asked for issues including winter subsistence fishery total catch to be addressed. This issue was investigated during model explorations but was not resolved; changes to model fit and reference points were still observed when total catch for this fishery was included. Models presented to the CPT at this meeting only included the retained winter subsistence catch, and work on addressing this issue will continue in future assessments. Several other more minor SSC comments were addressed in the proposed model runs document, and the CPT did not note any SSC or CPT comments from previous cycles that were not addressed.

In addition to these responses to the SSC, Caitlin also presented work on a number of long-standing issues with this assessment, including:

- Fitting to separate size comps for old-shell and new-shell crab given the potential for shell class observation error;
- Over-estimation of abundance for larger males;

- Use of size-dependent natural mortality (*M*) values;
- Using the estimate of *M* from the Bristol Bay red king crab assessment for the base male *M*;
- Inconsistencies in the area used to calculate abundance among the different trawl surveys.

These explorations were conducted through comparison of a number of model formulations falling into broad categories of enquiry:

- Bridging analysis
    - Model 24.0: The model recommended by the CPT and SSC for harvest specifications in November 2024, run in GMACS 2.20.14.
    - Model 24.0a: Model 24.0 with errors for shell condition and effective sample sizes corrected in the input data file.
    - Model 24.0b: Model 24.0a transitioned to the new version of GMACS, 2.20.20, which allows OFL to be calculated for each fishery within the model. **Model 24.0b is considered the base model for further model explorations described below.**
    - Model 24.0b6: Model 24.0b at the second best objective function value found after jittering.
- Shell condition
    - Model 25.0: Model 24.0b with only one shell condition for males.
- Natural mortality
    - Model 24.0b1: Model 24.0b with the natural mortality value for males ≤ 123 mm CL fixed at the value from the most recent BBRKC stock assessment (*M* = 0.23), estimated for males with CL > 123 mm.
    - Model 24.0b2: Model 24.0b with size-independent natural mortality fixed at *M* = 0.18.
    - Model 24.0b3: Model 24.0b with size-independent natural mortality fixed at *M* = 0.23.
- Shell condition + natural mortality
    - Model 25.0a: Model 25.0 with the size-dependent natural mortality, and the value for smaller males taken from the most recent BBRKC stock assessment (*M* = 0.23).
    - Model 25.0b: Model 25.0 with size-independent natural mortality fixed at *M* = 0.18.
    - Model 25.0c: Model 25.0 with size-independent natural mortality fixed at *M* = 0.23.
- Model-based indices of abundance
    - Model 24.0b4: Model 24.0b with spatiotemporal model-based indices of abundance used in place of the design-based indices of abundance for the NOAA Norton Sound, ADF&G, and NOAA Northern Bering Sea trawl surveys, and a prediction grid that encompasses the full spatial extent of survey stations sampled.

- Model 24.0b5: As model 24.0b4, but with a reduced prediction grid encompassing the ADF&G trawl survey stations sampled since 2010.

In discussion of the bridging analysis, the CPT focused on the question of what might justify selection of the 2nd-lowest MLE (model 24.0b6) instead of the base model (24.0b). The critical difference between these two outcomes is a very high estimated fishing mortality (*F*) in the winter commercial fishery during roughly 2009 - 2019, when *F* reached values of 1-2 for the base model (24.0b), which is much higher than the rest of the estimated time series; model 24.0b6 showed only slight increases in *F* for the winter commercial fishery that were in line with the rest of the time series. The CPT discussed this difference in *F* as possibly arising either from differences in selectivity or fits to the winter commercial size composition data. **The CPT recommended that the author investigate how realistic the parameters space explored in the MLE solution (24.0b) is, suggesting that a better approach would be to place a prior on *F* that would penalize high *F* values.**

In discussion of the shell condition explorations, the CPT noted that shell condition was included in the GMACS version of this assessment only out of the desire to replicate the legacy modeling approach to support a bridging analysis for the transition to GMACS; there is no need to continue modeling old- and new-shell size composition separately if this approach does not continue to serve the needs of the assessment. Caitlin highlighted the leading drawback of including shell condition as producing worse size composition fits than the model that ignores shell condition (model 25.0). When compared with the base model, model 25.0 showed no meaningful differences in recruitment (*R*) or mature male biomass (MMB), a slightly worse retrospective pattern (Mohn's ρ = 0.112 for model 24.0b; 0.133 for model 25.0), and slightly higher estimates of terminal year stock status (MMB / B_{MSY} = 0.97 for model 24.0b; 1.06 for model 25.0).

The discussion of different approaches for handling *M* in the model explorations occurred in the context of overestimation of abundance for larger size bins in the model, which has been a long-standing problem for this assessment. The different approaches for handling *M* showed similar fits to catch time series. But fits to survey indices and summer commercial fishery retained size composition were better with size-dependent than size-independent *M*. For models invoking size-independent *M*, fits to survey indices and fishery CPUE time series were better at *M* = 0.23 than at *M* = 0.18, and retrospective patterns were less extreme for models invoking size-dependent mortality. **Based on these considerations, the CPT recommended bringing forward models 24.0b (base) and 25.0a (no shell condition, *M* fixed at 0.23 for males ≤ 123 mm CL and estimated for males > 123 mm CL) for setting specifications in November. When bringing forward model 24.0b, the author should ensure the solution is at the actual MLE, and confirm that this MLE includes realistic explorations of the parameter space. This may include a prior on *F* to penalize solutions based on unrealistically high values for the winter commercial fishery.**

In presenting assessment models using model-based survey indices, Caitlin noted that these models produced worse fits to survey time series than did assessment models that were

informed by design-based survey indices. Model-based indices also produced time series of *R* and MMB that showed similar patterns to those based on design-based indices, though the model-based time series were scaled higher. Retrospective patterns were worse for the model-based indices, which is consistent with the worse fits to survey time series.

The CPT encouraged the continued development of assessments based on model-based survey indices as a research topic separate from models for management consideration. Specifically, CPT encouraged explorations of the sensitivities of selectivity for joint model-based indices spanning multiple trawl survey time series. In discussion of the appropriate prediction model, the CPT noted that this decision depends on assumptions related to catchability (*Q*) for different surveys with areas inside and outside of the different prediction areas. The CPT also discussed the possibility of matching the prediction area to the area that matches the fishery, and this comparison might be informed by evaluating the proportion of the fishery that has occurred outside the prediction area. This analysis might be useful for identifying areas that have only rarely been fished that might not be important for prediction area considerations. Further updates on NSRKC model based indices will be reviewed as research models to ensure that inclusion of the model based indices coincides with how they are used in the assessment model.

Bering Sea Fisheries Research Foundation update

Scott Goodman provided an update on Bering Sea Fisheries Research Foundation (BSFRF) projects/progress and disaster relief research planning. Winter/Spring BSFRF crab surveys were completed in 2023 (CPS1) and 2024 (CPS2). CPS3 was scheduled for 2025 and postponed to 2026 based on funding uncertainty. BSFRF co-convened an Opilio workshop in Spring 2024, and the workshop summary is in press with a manuscript based on the workshop results near completion. BSFRF Opilio pot sampling (OPS1) planning is underway; there are plans to charter two crab vessels and one trawl vessel. They are refining the scope, scale, and specifics of the sampling and are coordinating with the survey modernization effort. The BSFRF CAMSLED2 project is underway on F/V *Early Dawn* with Drs. Weems & Loher on board. The CAMSLED project is continuing efforts that started in 2024 and will continue later this year with another charter. BSFRF has plans to support an opilio MSE with funding from collaborators and leadership from a steering committee that includes BSFRF, ADFG, NOAA, and others. They will seek input from the industry though an Industry ad-hoc Committee. They plan to follow the strategy used to develop the bairdi MSE in 2020.

Disaster relief funds are anticipated to become available in the near future. BSFRF has funding pending for a handful of research projects that include CPS in 2026, 2027 and 2028; OPS each year 2025-2028; Camsled in alternate years, 2025 and 2027. The disaster relief funds are focused on bairdi, opilio, and BBRKC. A separate pot of disaster relief funds was competed for through an open request for proposals, with administration of the proposal review process by NPRB. An independent board from a diversity of organizations made final decisions on which projects were selected for funding. Six proposals were funded out of 11, with total funding of

approximately $6M. Disaster relief funds will be administered through PSMFC. Chris Siddon (ADFG) is interested to receive feedback on the disaster relief proposal review process.

BSFRF will present a research update to the Council in June. The summary will be high level and focused on new information. BSFRF and Alaska Bering Sea Crabbers are planning to host a Fall 2025 crab symposium. CPT suggested that the symposium is a great opportunity for industry and agency/scientist exchange.

PIBKC proposed models

William “Buck” Stockhausen (NOAA-AFSC) presented draft assessment models for the Pribilof Islands blue king crab (PIBKC) stock following the last full assessment in September 2023 (slides). New analyses included a comparison of abundance and biomass estimates derived from *crabpack*, a new R package to access crab survey data from NOAA’s Shellfish Assessment Program. Similar to the Tanner crab assessment comparisons, small differences were noted in 1979 (abundance and biomass) due to discrepancies in which hauls were included in the calculations, and post-2015 (biomass only) due to differences in the carapace width measurement resolution used to calculate crab weights. Buck also presented survey time series comparisons with and without corner stations, noting that estimates of PIBKC mature male biomass (MMB) were generally higher with the inclusion of corner stations.

Models presented to the CPT included time series modeling (*rema* R package) and spatiotemporal modeling (*sdmTMB* R package) approaches for dealing with zeros in the survey time series given that no mature males were caught during the 2023 and 2024 NMFS bottom trawl surveys. Five models were run using *rema* and utilized three options for dealing with zeros: 1) treat as missing data, 2) substitute a small value, or 3) assume a Tweedie error distribution. The default option with *rema* is 2), to substitute a small value of 0.0001. Buck presented a method to calculate a value for CPUE consistent with an assumed probability of non-detection and the number of hauls sampled. Of the five *rema* models brought forward, the lognormal error model that used the total biomass corresponding to PIBKC densities with a non-detection probability of 0.5 exhibited the most satisfactory results. In addition, four *sdmTMB* models were evaluated to estimate a MMB time series for PIBKC using a combination of delta-gamma or Tweedie distributions, and first-order autoregressive or random walk spatiotemporal random field estimation. While the trends in MMB estimated using the four *sdmTMB* models were similar, the Tweedie + AR1 model had the smallest AIC and REML, and was therefore the author recommended model and preferable approach for dealing with zero data.

The CPT agreed with the author on both model choice (model “tw-ar”) and methodology (*sdmTMB*) for the final assessment in September, noting that the use of a spatiotemporal model to estimate MMB across space and time is preferable to more arbitrary *rema* approaches for dealing with zero data, and result in more defensible estimates of MMB in 2023 and 2024 given continued declines in PIBKC population estimates.

CPT recommendations for September include:

- The corner stations should remain in the pre-2024 survey time series for PIBKC
- The use of *crabpack* biomass estimates for 1979. While *crabpack* estimates include non-standard corner stations in 1979, this decision was vetted by the CPT and SSC (2014 and 2015 "Survey data" CPT agenda items), and spatiotemporal modeling approaches are suitable for dealing with changes in spatial sampling design.
- Consider coloring points on DHARMa residual QQ plots by size-class/ year (see AIGKC residual plots as an example)
- Refer to "Model-based indices" (2025 May CPT agenda item) documents for NSRKC, Tanner crab and snow crab *sdmTMB* models for suitable diagnostics to report for PIBKC models for September. In addition, with respect to the *sdmTMB* analyses, the CPT requests:
    - Accounting for land when creating a spatial grid and mesh;
    - exploring different mesh size;
    - including predictive skill scores; and
    - explorating MCMC residuals in addition to DHARMa residuals

Climate readiness/climate planning update

Diana Stram (Council staff) provided an overview of NPFMC climate-related activities, the Bering Sea Fisheries Ecosystem Plan Climate Change Task Force (BSFEP CCTF), and climate-informed harvest control rule (HCR) activities. The CCTF conducted a climate scenario workshop in October 2024, finalized a report in 2024 (item D1b on the December 2024 Council agenda), and is in the process of developing a climate resilience work plan. The CCTF final report describes the conceptual process of the incorporation of climate information into fisheries management via various "on ramps". The CCTF final report focused on three key elements: 1) expanding existing and new processes, collaborations, and partnerships for including multiple knowledge systems into climate planning and response, 2) considering management tools and options focused on inclusion of existing and emergent climate information, and 3) establishing a review group for packaging information entering the Council process. Diana reviewed key element 2, which includes forecast-linked management advice, ecosystem indicators/models, development of dynamic management tools, and climate-informed biomass targets/limits and HCRs. The Council adopted a climate change work plan in December 2024 focusing on key elements 1 and 2 to develop climate-robust/forecast-informed HCRs and biomass targets; the Council opted to address key element 3 through the Council's Ecosystem Committee (currently in the process of being reconstituted).

Diana reviewed Council engagement in national-level climate-related activity, and updated the CPT on proceedings and outcomes of the national SSC SCS8 meeting in August 2024, which had the goal of providing actionable guidance on how to best support Councils in the management of fisheries, specifically the application of ABC control rules, in a changing environment. Diana described plans stemming from SCS8, including an SSC HCR workshop in June 2025 and a desire for the SSC to address socio-economic considerations in TAC-setting. A CPT member highlighted the need to better define what socio-economic information is needed

for crab management. Diana reviewed considerations on revising harvest control rules to be more climate resilient and noted that the Council would need to weigh in on policy objectives (including risk tolerance) in modification of HCRs or reference levels. Diana reviewed risk policy in ABC setting and noted that the p* approach has not been used for crab, but rather annually varying buffers. Diana highlighted that the CPT should discuss whether the risk policy should be reconsidered in light of CPT discussion of buffers and annually varying ABCs. Diana showed some information from AFSC's recent Preview of Ecosystem and Economic Conditions (PEEC) meeting and described the format for the upcoming SSC HCR workshop in June 2025.

At the SSC HCR workshop, recommendations on a work plan and terms of reference will be used to develop a discussion paper for review by the CPT and GPT this fall. The CPT chair encouraged CPT members to track the HCR workshop. A CPT member noted the recent emphasis on HCRs and asked about next steps beyond refinement of HCRs. Diana noted that short and long-term tools are being considered and noted the expansion of in-season tools and management are short-term next-steps, whereas HCR changes are part of a longer-term discussion. Another question was asked about diversification of the fleet, but the Council has not picked up that concept at this time.

Jitter and MCMC guidelines for Sept. assessments

Katie Palof (ADF&G) started a broader discussion by the CPT on guidelines for how model convergence should be evaluated using "jittering" in September (and future) assessments by reminding the CPT of previous comments by the SSC on these topics (slides). "Jittering" describes the process of making multiple runs with the same model, but initializing the model at randomly selected locations in the model parameter space in order to evaluate the convergence of the model to the set of estimated parameters that yield the maximum of the objective function (referred to as the maximum likelihood estimate, or MLE). For models with a globally quadratic negative log-likelihood surface (e.g., a linear model), the trajectory through the parameter space taken by a typical optimization routine based on finding the MLE will arrive at the MLE from any starting location because the negative likelihood surface has a single, global minimum and is smooth (and thus jittering is really unnecessary for these models). However, the negative log-likelihood surface for complex nonlinear models (e.g., assessment models) is "bumpy", not smooth, and may contain local minima as well the global minimum. If the parameter trajectory passes near a local minimum, it is possible that the optimization algorithm could get "sucked in" to the local minimum and incorrectly identify the associated parameter values as the MLE. To mitigate the possibility of identifying the parameter set yielding a local minimum as the MLE, multiple model runs starting at different locations in the parameter space can be conducted--the ending parameter set that yields the lowest negative log-likelihood (i.e., highest likelihood) should be taken as the putative MLE. This parameter set is not *guaranteed to be* the MLE, but any of the other parameter sets found are *guaranteed not to be* the MLE.

The SSC comments on jittering suggested that "many" model runs should fail to converge to the MLE in a "good" jitter analysis because this provided evidence that the parameter space had been adequately explored. The CPT noted that there were multiple reasons for potential

"failure", including start locations with incompatible parameter values (e.g., implying negative growth) as well as convergence to local minima. Ideally, jittering would only involve starting from a set of compatible parameter values, but this was not possible from a practical standpoint. The CPT noted that plots of jitter results should allow objective function values near the (putative) MLE to be viewed. In addition, if a "better" MLE is found through a jitter analysis, this may be indicative of a complex likelihood surface necessitating a more extensive jitter analysis.

Katie noted that the CPT members who attended the January 2025 Modeling Workshop had begun a discussion on potential jittering guidelines but had postponed making any decisions until the entire CPT could weigh in. The default level for jittering in GMACS is 0.1. Andre Punt (UW) noted that initial values for an estimated parameter that has been selected to undergo jittering are drawn from a uniform distribution centered on its default value (set in the "ctl" file) after transformation to the logit scale based on its minimum and maximum allowed values (i.e., the parameter's bounds). The CPT suggested that authors consider setting a larger level for jittering to explore more of the parameter space, but was not prescriptive in what an appropriate level would be.

The CPT also discussed the SSC comment that it was inappropriate to show management quantities for model runs that did not converge to the MLE and that likelihood profiles were the appropriate means to show the sensitivity of these quantities to the model's solution. The CPT agreed that plotting management quantities derived from model runs converging to local minima was likely to lead to confusion. It also discussed the use of likelihood profiles on key parameters (*M*, initial log R) to illustrate the sensitivity of these management parameters. Andre noted that it was possible to run a likelihood profile on a derived quantity such as terminal MMB or OFL to identify the main drivers in determining its value at the MLE. He suggested that this could be a topic for the next Modeling Workshop because this capability has not yet been coded into GMACS.

Time constraints did not allow the CPT to pursue the topic of MCMC guidelines, but it was suggested that run times in the context of the limited time available for SAFE preparation would be prohibitive for any but the simplest GMACS model (e.g., St. Matthew Island blue king crab). Another topic to be revisited in the future was distinguishing an assessment as a "full" or "update", similar to groundfish assessments. The CPT noted that the application of these terms to crab assessments was unclear but that the distinction could be useful in terms of prioritizing future effort.

CPT recommendations for September include:

- Report the jittering level, the parameters included in jittering, and the number of model runs made;
- report the number of runs that successfully converged to the putative MLE (e.g., runs with objective function values within 0.01 of the lowest value) and the inclusion criteria used;
- plot the distribution of final objective function values, but only include runs within a small interval above the lowest value, the putative MLE (e.g., one or two likelihood units), as a

bar chart or as a point plot with the max gradient or an informative quantity (e.g., estimated mean recruitment) as the y-axis;
- use likelihood profiles over +/- one or two likelihood units from the MLE for key parameters (e.g., log initial R, M) to illustrate how the contribution of different data sources to the likelihood, key scaling parameter values, and key management quantities change with the profiled parameter.

PIRKC proposed models

Pribilof Islands red king crab (PIRKC) is assessed as a Tier 4 stock on a triennial basis; the last assessment was conducted during 2022. Cody Szuwalski (AFSC) presented results from five alternative GMACS models for PIRKC that were built using the previous assessment model as a base model; he also addressed previous CPT/SSC comments related to existing red king crab growth and tagging data (document).

Cody used tagging data provided by the NMFS Kodiak lab to develop priors for growth parameters estimated in GMACS models. He suggested that the variability in growth increment was similar to that in the tagging data (addressing a CPT request to examine this question). He also noted that most of the data were from Bristol Bay and requested the CPT's advice on how useful these data might be to describe growth for red king crab in the Pribilof Islands and, if informative, whether they should be fit in the assessment model rather than used as a prior.

Cody evaluated the five GMACS models for Pribilof Islands red king crab (PIRKC) derived from the 2022 assessment model (22.1) as potential candidates for the 2025 PIRKC assessment. Model 25.1 updated model 22.1 due to changes to the GMACS codebase. Cody noted that many changes and updates had occurred to GMACS since the last assessment and these led to changes to the results for model 25.1 relative to the previous assessment model. Given the large number of changes to the code, it has proven impossible to fully identify the causes for the changes in results and subsequent management advice.

In model 25.2, Cody evaluated the inclusion of data from an ADFG pot survey conducted near the Pribilof Islands during 2003, 2005, 2008, and 2011. He hypothesized that including this survey data might provide more clarity on population trends during the 2000's given its finer spatial sampling density relative to the NMFS EBS survey. After incorporating the standardized survey CPUE into the model, Cody found it resulted in unreasonable changes to estimated growth and NMFS survey selectivity. To create a model that included the pot survey data but produced more reasonable results, Cody downweighted the fits to the size-composition data and used the tagging data to create priors on estimated growth parameters, resulting in model 25.3 which substantially addressed the concerns raised by the results of model 25.2. The remaining two models (25.3a, 25.3b) were experiments to examine the sensitivity of model outcomes to the allowed variability in growth (addressing an SSC request).

Cody recommended bringing models 25.1 (the previous assessment model updated to the current version of GMACS) and 25.3 forward as alternative models for the 2025 assessment. He

noted that incorporating the ADFG data changed the model output substantially even when adjusting the weighting schemes and prior specifications, but suggested that including as many data sources as possible seemed prudent when working with a small population with sparse data. He also suggested that discussion regarding the need for a model-based assessment for PIRKC may be warranted, given current resources and the lack of a directed fishery.

The CPT discussed the need for a model-based assessment such as Cody presented, with the alternative being an assessment more similar to that of the "fallback" Tier 4 approaches included in the Tier 3 assessments. The latter are based on using the *rema* R package to fit a simple state-space random walk model to survey MMB to "smooth" observation errors and estimate terminal biomass and a B_{MSY} proxy. Andre suggested that swings in the MMB time series for PIRKC were not biologically feasible but that *rema* could erroneously soak up much of the variability as process error rather than observation error. Cody noted that he devotes a substantial amount of time to producing the GMACS-based assessment and suggested that the time the CPT spends reviewing the assessment might be put to better use given that the fishery has been, and is, closed. The CPT also noted that the fishery is closed to avoid bycatch of PIBKC. It also discussed whether bycatch of this stock would pose an issue with the OFL, but the fishing mortality rates estimated for the stock suggested this was not a concern..

The CPT:

- Concurred with Cody's recommendation to bring forward models 25.1 and 25.3 for the 2025 assessment in the fall
- Recommended the tagging data for growth be fit outside the GMACS model; the amount of tagging data may "swamp" other sources of information if fit inside GMACS
- Supports moving to a simpler assessment (e.g., based on *rema*) for this and other stocks that are not active management issues to better utilize authors' limited resources
- Suggests that the CPT consider the time interval (currently triennial) for this stock and how it fits into stock prioritization and best use of analyst resources.

Survey data processing update

Mike Litzow (NOAA Kodiak) provided an update on NOAA trawl survey data processing. Topics covered were the new survey data platform (R package *crabpack*), a SSC-requested review of survey footprint and gear history, a SSC-requested evaluation of post-corner station calculations, changes to carapace measurement precision, weight-length data, and *Chionoecetes* maturity data processing.

Crabpack is the new platform for trawl survey data dissemination and replaces the previous platform, AKFIN Answers. This R package generates the standard design-based indices of CPUE, abundance, and biomass for the NOAA EBS and NBS surveys with the goal of generating a data product that is standardized, transparent, reproducible, version-controlled, and that reduces effort for the survey group and data users while increasing data availability. Mike noted that while technical issues with the new platform have largely been resolved, it's recommended that any data users experiencing issues should reach out to Shannon

Hennessey with the NOAA survey data group. Katie Palof (ADF&G) flagged for the CPT that ADF&G crabpack data users specifically are still working through State firewall issues in accessing data, but work is ongoing to resolve the issue. Given the staff workload once the upcoming summer surveys are underway, it's recommended that crabpack data users experiencing issues reach out sooner rather than later for assistance.

Mike provided an overview of trawl survey history and a response to an SSC query from October 2024 requesting that survey authors provide a clear overview of the survey's historical standardization and a summary of the EBS shelf survey time series used by each stock assessment. The general approach of the NOAA survey group is to provide survey data from 1975-present to assessment authors and other users via crabpack, while the annual tech memo describing survey results only provides data time series with reasonably comparable survey footprints. The following data time series are published in the tech memo by stock: BBRKC: 1979-present, PIBKC/PIRKC: 1981-present, SMBKC: 1983-present, snow/Tanner: 1988-present, and all stocks combined: 1988-present. The EBS shelf survey began in 1975 and slowly expanded with different stocks getting different amounts of survey coverage early in the survey time series. A brief history of the trawl survey gear was provided with emphasis that the 83-112 trawl net has been consistently used since 1982.

In response to an SSC request that SMBKC trawl survey area swept estimates be compared using both the high and low-density strata without the corner stations alongside the one-stratum estimate used in the assessment, it was shown that estimates using 1 stratum vs 2 stratum are nearly identical. The proportion of SMBKC survey abundance by sex/size class that is inside the corner stations was plotted over the survey time series; the strongest trend was seen in immature males.

Mike presented crab carapace measurement precision relative to biomass estimates. Beginning in 2016, crab carapace measurements moved from 1mm precision to 0.1mm precision. Individual carapace length/width and individual weight data are used in a regression sense to move the survey abundance estimates to biomass estimates. However, an issue was discovered in the legacy workflow when moving this code into R – since 2016, all the precise carapace measurements were being rounded down to the nearest lowest whole millimeter measurement and then used to estimate weight. An analysis comparing the biomass estimates derived from 1mm vs 0.1mm carapace measurements was completed and showed that there was almost no difference in biomass estimates. Moving forward, carapace measurements at 0.1mm precision will be used which will result in a very slight upward adjustment in biomass estimates.

Mike provided the CPT with an update on survey length-weight data. The current workflow uses length-weight data fixed from 2000-2009 to translate abundance and size into biomass estimates for all the stocks. Individual weight data is collected every year for RKC and in alternate years for *Chionoecetes*. Per CPT recommendation from January 2024, the survey program is exploring moving towards collecting *Chionoecetes* weights every year to allow for annual length-weight regressions to estimate biomass. To assess the impact of transitioning to annual regressions, three things were needed: 1) evaluate annual variation in parameter

estimates, 2) evaluate the effects of decreasing sampling effort (not feasible to sample both species annually at current effort levels), and 3) compare changes in estimated biomass with yearly length-weight regressions vs. legacy parameters. Shannon Hennesy investigated each of these three topics with Mike providing a summary of the results for red king, snow, and Tanner crab.

In evaluating annual variation in parameter estimates, the parent data for the current parameter estimates from the 2000-2009 window are not available, so previous estimates cannot be looked at for these parameters. Also, when looking at annual parameter values for each species, the current parameter estimates generally fall on the edge of more recent parameter estimates from 2015-2024, suggesting that there are some meaningful differences. For some of the stock components – male snow crab in particular – there is evidence of what might be meaningful change in parameter estimates among years.

To investigate whether the sampling effort for *Chionoecetes* can be reduced to collect both species in every survey year, the same model-fitting protocol was used with annual estimates but with a bootstrapped regression with 1000 iterations using 40, 50, 60, 80, and 100% of the annual sample size. The resulting average parameter estimates and average uncertainty around that estimate at the lower levels of sampling effort was then evaluated. Bootstrapping results showed that decreasing sampling effort to even 50% of the current sample size has low impact on point estimates, leading to confidence that enough data can be collected with precise estimates for both *Chionoecetes* species each year. CPT members provided feedback on the bootstrapping methodology used and discussed alternate approaches for future analysis.

Biomass estimates were compared using the current 2000-2009 fixed window vs annually resolved data for red king, snow, and Tanner crab mature males and females. Using annual length-weight regression results in minor changes in estimated biomass (maximum ~10%). CPT discussed taking a closer look at evaluating covariates and possibly moving to a spatio-temporal model as a way of incorporating environmental drivers, what range of years is appropriate to include in a window of years, and the potential for creating volatility in biomass estimates if using annual level data. CPT members cautioned that weight is tricky with crustaceans and should not be overinterpreted because of the influence of molt timing, and shared concern about overfitting by using annual length-weight relationships. CPT recommended analysis to compare the historic fixed window with a moving ten year window to avoid overfitting annual variation in the length-weight relationship but still incorporating more recent trends. Work on this topic will be continued as time allows and the historic window (2000-2009) will be used for the current year's estimates.

Finally, Mike provided the CPT with an in-depth review of the current *Chionoecetes* maturity data processing. The process was summarized in the following six steps: 1) bin carapace widths in log space and identify the break between two modes of chela heights, 2) fit linear model to the resulting set of points for chela height breakpoint vs carapace width for all bins, 3) use the line to divide all measured crab into mature/immature categories, 4) weight each observation by its corresponding sampling factor, 5) for each 10mm bin of carapace width, calculate proportion mature, 6) hand these data to assessment authors, who interpolate to 5mm

bins. Mike proposed a new step #5 – instead of binning and calculating the proportion mature, fit binomial GAMs to the data. Mike proposed moving to binomial fits which avoids possible artifacts with binning and allows for error estimation. Mike requested specific input from CPT on weighting using CPUE, noting that this is in line with SSC comments and better than sampling factor. CPT members discussed the merits of CPUE weighting and while some members agreed that CPUE weighting is correct in this case, members also flagged concern that weighting with CPUE consistently pulls the maturity curve downward because you are more likely to catch small, immature crab in the survey. Given a lack of clear consensus, the CPT recommended continuing to use the legacy product for Fall 2025 and plans to invite selected colleagues to form an informal working group on this issue that will report back to CPT at a future meeting before making a definitive change to the processing of maturity data.

New Business

Meeting schedule:

- September 8th - 12th, 2025, Seattle, WA (AFSC?)
- Nov 5th, virtual meeting to approve NSRKC final specs and review *Chionoecetes* maturity estimation from the survey data
- Jan 13th to 15th (T), Jan modeling workshop, Anchorage, AK (T)
- May 11th - 15th, 2026, Location TBD

September agenda topics:

- Final SAFE - snow, BBRKC, Tanner, PIRKC, PIBKC
- Proposed model runs - AIGKC, PIGKC
- Overfishing updates - AIGKC, SMBKC, PIGKC, WAIRKC
- Risk tables - buffers
- ESPs - full Tanner ESP, report card for BBRKC and snow
- ESR updates (T)
- Catch update presentation (ADF&G and NMFS)
- Update vs full assessments
- Currency of management - snow crab, summary of qualitative consequences, getting past binary decision
- Model based indices (T)
- Research updates (T)

November agenda topics:

- NSRKC final specs
- Maturity data flow

Others in attendance (* indicates presenter):

Andrew Nault
Asia Beder
Beth Concepcion
Bridget Ferriss
Caitlin Stern*
Chris Lunsford
Chris Siddon
Chris Woodley
Cory Cole
Cory Lescher
Danielle Merculief
Danielle Lampe
David Capri
Diana Stram*
Duane Stevenson
Elizabeth Siddon
Emily Ryznar*
Ernie Weiss

Frank Kelty
Gordon Kruse
Grant Adams
Harrison Moore
Heather Mann
Ivonne Ortiz
Jamie Goen
Jason Gasper
Jim Ianelli
John Hilsinger
Jonathan Richar*
Joshua Songstad
Kalei Shotwell
Kendall Henry
Krista Milani
Lewis Barnett*
Linda Kozak
Madi Heller-Shipley
Mark Stichert
Martin Dorn
Mateo Paz-Soldan
Melissa Haltuch
Molly Zaleski
Nikolai Sivertstol
Paul Wilkins
Rachel Alinsunurin
Ruth Christiansen
Ryan Lardner
Sarah Webster
Scott Goodman*
Sean Hardison
Sean Rohan*
Shannon Hennessey*
Sherri Dressel
Stephani Zador
Steve Whitney