



NORTH PACIFIC FISHERY MANAGEMENT COUNCIL

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BSAI Crab Plan Team REPORT

September 12-14, 2023

Hybrid Meeting: AFSC Seattle, WA

Committee Members in attendance:

Mike Litzow, **Co-Chair** (AFSC-Kodiak)
Katie Palof, **Co-Chair** (ADF&G-Juneau)
Sarah Rheinsmith, **Coordinator** (NPFMC)
William Bechtol (UAF-Homer)*
Ben Daly (ADF&G-Kodiak)
Erin Fedewa (AFSC-Kodiak)
Brian Garber-Yonts (AFSC-Seattle)*

Tyler Jackson (ADF&G-Kodiak)*
Krista Milani (NMFS- Dutch Harbor)
Krista Milani (NMFS- Dutch Harbor)
William Stockhausen (AFSC-Seattle)
Cody Szuwalski (AFSC–Seattle)
Vacant, ADF&G
Vacant, quantitative expert

*indicates members who participated remotely

Members absent:

Ginny Eckert (UAF/CFOS-Juneau)
André Punt (Univ. of Washington)

Summer Trawl Survey Results

Mike Litzow presented 2023 NOAA summer trawl survey results for eastern Bering Sea (EBS) crab stocks including survey effort, bottom temperatures, and abundance estimates and spatial distribution data for the following stocks: red king crab (Bristol Bay, Pribilofs, Northern District), blue king crab (St. Matthew and Pribilofs), Tanner crab, snow crab (Eastern and preliminary Northern Bering results), and *Chionoecetes* hybrids. All 375 stations were sampled in the EBS, but illnesses on board survey vessels limited sampling effort so that 116 stations were sampled out of 144 planned stations in the Northern Bering Sea (NBS). As in 2022, the cold pool was present in the southeast Bering Sea in 2023 and bottom temperature was close to the 1975–2023 time series mean.

Bristol Bay red king crab male abundance was down relative to 2022, but mature female abundance increased by 46% mostly due to a large catch at station E-12 (37% of all mature female BBRKC). A low percentage of mature females had an incomplete molt/mate cycle (6%), therefore no retows were conducted in 2023. Clutch fullness averaged around $\frac{3}{4}$ full.

Pribilof Islands red king crab (PIRKC) mature males decreased by 49%, while mature females increased by 9% in 2023 over 2022. Northern District mature males and females showed a modest decrease in abundance in 2023. No Pribilof Islands mature male blue king crab were captured on the 2023 survey and mature females were observed in very low numbers. There was a question about the utility of future pot surveys around PIBKC as much of the population is

in rocky habitat and outside of the trawl survey area. A point was made that ADF&G has conducted pot surveys in the past, and that those data should show some contraction in spatial distribution as the abundance declined.

Saint Matthew Island mature male blue king crab abundance was similar to 2022, but mature female survey abundance was down by 71% in 2023.

Tanner crab survey abundance in the eastern management area decreased in 2023 but increased in the western management area. There was some discussion about Tanner crab juveniles not propagating to larger size classes. A question was asked about a possible correlation between the decline in snow crab and the large juvenile Tanner crab abundances, and it was noted that that is a research question that warrants further investigation. A question was asked about whether distinct Tanner crab pseudo-cohorts are apparent in the survey data, and it was noted that similar size distributions were seen in snow crab surveyed in 2023. There was a question about ontogenetic Tanner crab movement from west to east with regard to possible differences in size at maturity in the two management areas. It was noted that ADF&G is currently piloting hydroacoustic tags and unmanned gliders to investigate Tanner movement. The survey saw more old shell Tanner crab in the east which means those crab are getting close to aging out of the population. In contrast, in the west, there were more new shell Tanner crab observed. There is some evidence to suggest an overall NW shift of Tanner crab.

Snow crab survey abundance decreased in 2023: all components of the population are at or near timeseries lows. The size composition data indicate that we are seeing what we would expect given last year's survey results (i.e., further declines in large size classes). The NBS survey results do not indicate many large animals or that a large migration would explain the decline of EBS snow crab. New recruitment (30 - 40mm CW juveniles) was observed in the population, which is an encouraging sign for future fisheries. A timeseries of male size-at-50%-maturity was presented. A question was asked about observed carapace width and chela height measurements relative to the size distribution of the population surveyed (i.e. potential bias in the size of males sampled for chela height measurements). It was noted that the chela measurements are distributed fairly uniformly across the entire size distribution to avoid sampling bias. Snow crab female clutch fullness was low in 2022, but a higher proportion of full clutches was observed in 2023. *Chionoecetes* hybrid survey abundance has been low in recent survey years, but the 2023 survey results showed a modest increase relative to 2022.

Fishery summary 2022- directed and bycatch

Ben Daly (ADF&G) and Krista Milani (NOAA) gave an overview of 2022/23 crab catch, incidental catch, and fishery performance for each BSAI commercial crab stock, with Ben covering directed crab fisheries and Krista covering bycatch in groundfish fisheries. Ben started with a review of directed fishery observer coverage rates; all minimum vessel coverage targets were met for the season, and actual coverage in the respective fisheries active during 2022/23 was on par with the status quo over most of the rationalized period, noting that coverage of harvest activity, in terms of potlifts observed, is lower than vessel coverage and averages between 1% and 5% of potlifts. Krista noted that almost all trawl groundfish is currently 100%

observed at minimum (one to two observers onboard at all times), including all at-sea (catcher-processor and mothership) processors, as well as AFA catcher vessels either covered 100% on-board or by electronic monitoring (EM). Selection rates for partial coverage gear types were on par with the previous five years. Pacific cod trawl vessels are the only remaining partial coverage trawl category in the Bering Sea, and Krista noted that many vessels in this fleet already voluntarily carry 100% coverage, and that they will be required to do so beginning in 2024.

Estimated bycatch mortality of WAIRKC in the AIGKC fishery was low in 2022/23, as it was in both fixed and trawl gear groundfish, and incidental catch in trawl fisheries was concentrated in rockfish and Atka mackerel target trawls, 90% of which occurred in April 2023. Due to closures of Bristol Bay red king crab and Bering Sea snow crab during 2022/23, targeted fishing in the Bering Sea was limited to the Tanner crab fisheries and the BBRKC cost recovery fishery. Ben displayed a map of catch distribution in both fisheries, with most Tanner crab catch occurring north of Unimak Island and with no harvest in the Pribilof Islands area.

Ben reviewed ADFG's harvest strategy for the BBRKC fishery, in particular the mature female abundance threshold element, in place since 2009 and the basis for the decision to close the fishery in 2022/23, as well as earlier closures. The female abundance threshold is intended to prevent recruitment overfishing and the risk of depensation effects, with the 8.4 million female threshold intended to approximate the minimum female abundance that allows sufficient recruitment to enable the stock to eventually reach MSY. Ben reviewed results from the cost recovery fishery, noting the purpose of which is to fund the observer program and ADFG's research program at the Kodiak lab. Time series of cost recovery fishery catch, CPUE, size composition and mean carapace length were presented. In response to a question from the public regarding the discrepancy between trends in CPUE in the test fishery and in male abundance estimates from the survey, Ben noted that it has occurred previously, including the spike in CPUE in 2016 coinciding with a decline in survey abundance that year, and cautioned against interpreting CPUE in the small, spatially concentrated test fishery as being strongly associated with overall abundance. Bycatch of BBRKC in the Tanner crab fishery remained low, owing to spatial difference, with harvest activity in the Eastern Tanner fishery occurring further west than the core area of BBRKC concentrations.

Krista reviewed incidental catch statistics for BBRKC in groundfish fisheries by season/year and gear type. In recent years, minimal BBRKC bycatch has been observed in either hook-and-line or pelagic trawl fisheries; most bycatch in the pot fishery occurs in the Pacific cod fishery, concentrated on the north side of Unimak Island and Port Moller, with a higher rate of females caught in recent years in pots than in trawl bycatch due to spatial and timing difference between gears. Total estimated trawl bycatch in 2022/23 was the lowest in the last 10 years. Krista noted the apparently unprecedented zero BBRKC bycatch reported by observers in pot gear from January through June, 2023, which was not readily explained by unusually low or spatially concentrated observer sampling. Although use of crab excluder gear in the pot fishery may be having some effect, observer rates are low in the fishery, and some pot vessels did voluntarily report seeing BBRKC during the January cod fishery; it was also noted that the January pot cod

fishery occurred further east of the BBRKC savings area than usual, which is being avoided as the result of a voluntary informal agreement among the fleet. As usual, BBRKC bycatch in the 2022/23 non-pelagic trawl fisheries occurred primarily in the yellowfin sole and rock sole fisheries, followed by flathead sole and all other groundfish fisheries, with a substantial spike of bycatch in April. Under regulation, the red king crab savings area in Bristol Bay was closed to non pelagic trawl during 2022 and 2023, triggered by closure of the directed fishery by ADFG. Krista displayed maps showing spatial distribution by month of combined catch volume and BBRKC bycatch rates in the trawl fisheries for these three targets during 2021/22 and 2022/23, noting the relative concentration of bycatch occurring in April 2023 in the statistical area just north of the savings area, with a distinctly different spatial and temporal pattern in the bycatch rate in 2021/22.

A member of the public questioned low BBRKC bycatch results shown for pelagic trawl, inquiring what the CPT is doing to improve consideration of the risk of unobserved mortality not accounted for in bycatch estimates. Granting that it is difficult to quantify at this point, he noted that the crab industry is concerned that we don't know what the impact of pelagic trawl bottom contact is on the stock. Mike Litzow responded, citing two research initiatives to address this concern: ongoing cooperative research by NMFS and Alaska Pacific University (APU), applying the APU fishing effects model output to examine the overlap of fishing effects by gear group, including pollock trawl, and BBRKC population distributions. Second, the Unobserved Fishing Effects Working Group requested by the Council will begin work after the October Council meeting, with the goal of producing a report for the Council's February meeting. Mike noted that, as an interagency working group, per the Council's request, meetings will not be public, but that there will be opportunity to submit public comment on the report at the January CPT meeting, and at the February Council meeting, and that subsequently the Council may opt to hold a public workshop as a next step. There was a question from the public about whether discard mortality rates would be considered at the January CPT meeting. Katie responded that the team considered discard mortality rates within the last year, and that its immediate priority is to make progress on addressing unobserved mortality in its process.

Ben reviewed the rationale for closure of the 2022/23 snow crab fishery under the State's harvest strategy and control rule, and showed historical results for three sources of estimated total mature biomass (TMB) considered under the control rule: raw survey data and assessment model estimates of the survey and population TMB, showing that all three inputs indicated that TMB for 2022 were below the closure threshold. Ben noted that, unlike the prior years' assessments, the 2022 assessment estimates both indicated that TMB was below the threshold in 2020 and 2021 as well. Snow crab bycatch in the western Tanner crab fishery during 2022 was very low. Krista presented snow crab incidental catch in groundfish fisheries by year and gear group, and by groundfish target for the non-pelagic trawl. Across gear groups, bycatch was relatively low in 2022/23, as usual accruing mainly to non-pelagic trawl followed by pot gear, and within non-pelagic trawl, primarily to yellowfin sole, followed by flathead and rock sole targets, with the highest bycatch volume in 2022/23 occurring in February during the yellowfin sole fishery.

Total combined retained catch in the Eastern and Western Tanner crab fisheries was 2.013 million pounds. In contrast to earlier years, Ben noted that the spatial distribution of catch in the Western fishery showed minimal catch in the Pribilof Islands area, with 2022/23 catch and effort concentrated along the 166° latitude east/west management area boundary, owing to low catch rates near the Pribilofs in recent years, combined with closure of the 2022/23 snow crab fishery. In response to a question regarding the rationale for the current location of the management area boundary, which imposes additional travel costs for the fleet to make separate deliveries, Ben explained that management is based on current understanding of stock substructure based on different size at maturity in the east and west Tanner crab stock components, and noted that whether that has changed in recent years would require research, potentially considering tagging data and recent size at maturity information. Ben reviewed anecdotal observations reported to ADFG's Dutch Harbor office by members of the Tanner crab fleet. In the Eastern fishery, high CPUE Tanner crab fishing found mostly new shell crab along the management area boundary and north of Unimak Island in the southwestern most part of the grounds, with most proactive fishing between 50 and 65 fathoms, and many vessels reported retaining smaller Tanner crab than the traditional industry preferred size of 5 inches. Vessels also reported concern about bottom trawl flatfish fisheries in Bristol Bay impacting Tanner crab numbers and habitat. In the western Tanner fishery, vessels reported low CPUE in northern grounds and east of the Pribilof Islands closure box, with no effort expended west of the Pribilof Islands due to low CPUE in previous seasons and high fuel costs, and similar reports regarding high CPUE and new-shell crab along the management area boundary, retention of smaller Tanner crab, and concerns regarding bottom-trawl flatfish effects on Tanner crab. In response to a question regarding the validity of anecdotal concerns reported regarding flatfish trawl impacts on Tanner crab, Ben clarified that, in collecting observational reports from the fleet and reporting them to the CPT, ADFG does not assess or attest to the accuracy of such information. Ben showed a plot of the proportion of retained catch below the industry preferred size of 5 inches over time, which was consistently below 5% prior to 2019, and spiked to over 30% in 2021 and 15% in 2022, owing to an improved market for smaller Tanner crab in response to the collapse in snow crab landings during the two most recent seasons.

Tanner crab bycatch in non-directed crab fisheries was low in recent years due to the low snow crab TAC in 2021/22 and closures of BBRKC and snow crab in the most recent season. A member of the public suggested reporting bycatch as a proportion of total mature biomass rather than weight, and Ben agreed that, while that metric is more indicative of efficiency of fleet performance rather than the scale of bycatch, both would be useful to include in the presentation. Krista reported on eastern and western Tanner crab bycatch in groundfish fisheries, indicating that eastern Tanner bycatch was relatively low in 2022/23, and again accrued mainly to non-pelagic trawl followed by pot gear, and in the yellowfin and rock sole trawl fisheries, with highest periods in October and March. Krista presented the spatial distribution of non-pelagic trawl bycatch by month for 2021/22 and 2022/23, with different temporal patterns between the two seasons. Bycatch of western Tanner crab was relatively high in 2022/23, compared to previous years, again accruing mainly in the trawl fishery, with relatively little fixed gear fishing west of the 166° boundary, mainly hook-and-line and pot Pacific cod fisheries, and yellowfin sole trawl fishing accounting for most bycatch in the non-pelagic trawl fisheries.

Retained catch in eastern and western Aleutian golden king crab (EAG and WAG) fisheries remained relatively steady up until 2018, when the Council adopted a new assessment model and ADFG adopted a harvest strategy that scaled TACs to population abundance estimates. TAC and retained catch in the WAG fishery during 2022 was the lowest since 1998 owing to low abundance estimates. Legal CPUE in the EAG fishery increased during 2022 to greater than the post-rationalization average, whereas CPUE in the WAG fishery was lowest of the post-rationalization period during the last two seasons. It was noted that a pattern of consistently lower CPUE values for retained catch than for observer data in the EAG over the last several seasons, which was not observed in CPUE values for WAG, and the CPT discussed possible reasons for these results, which is potentially attributable to differences in sorting and sampling by observers at high CPUE levels.

Ecosystem Status Report

Ebett Siddon (NMFS) presented the Ecosystem Status Report (ESR) for the Bering Sea. Crab-relevant information from 2022 was presented alongside 2023 data that were available, along with preliminary forecasts for 2024. The ESR is divided into larval pelagic indicators and benthic adult indicators across 4 categories: environmental processes, prey, competitors, and predators.

Environmental Processes

There are five climate indices that describe the North Pacific, with the North Pacific Index (NPI) and the Arctic Oscillation (AO) best characterizing large-scale climate variability in the Bering Sea (BS). The NPI reflects the Aleutian low pressure system (ALPS) and positive values indicate a weak ALPS and calmer conditions along the BS shelf. The NPI was in a positive phase in 2023, resulting in calmer conditions for the BS. The positive NPI value may be linked to the extended La Niña conditions that have persisted for the last three years. La Niña conditions are transitioning to an El Niño state, which is expected to intensify this upcoming winter. The AO is a measure of the polar vortex and transitioned from a positive to a negative phase in late 2022 due to the warm weather north of Alaska.

The Bering Sea shelf experienced cool to average environmental conditions last fall and winter. Sea surface temperatures were near or below the long-term mean in spring and summer of 2022, whereas winter 2022 exhibited warming in the outer and southern-middle domain of the BS. Marine heatwaves have been infrequent since 2021. The 2023 cold pool extent was average, although slightly larger than 2022 with the tongue more shoreward. January to April bottom water pH has continued to decline in the past five years. While ocean acidification (OA) is not the main driver for the collapse of many BSAI crab stocks, laboratory studies have shown that increased OA has a negative effect on many stocks. Winter months in 2022/23 experienced more southerly winds which brought warmer air across the EBS. Wind and sea ice variability exhibit a correlative relationship whereby, in years where there is little sea ice there are also usually strong winds from the south, as seen in 2018/19 and 2022. Sea ice phenology shifted in 2022/23 and maximum sea ice extent was exhibited one month later than 21/22 (March vs.

February). The delay in sea ice growth can be attributed to the AO in the Chukchi Sea. The 2022 early sea ice extent was the lowest since 2007, and has decreased 55% over the timeseries. Ebett presented a new time series measuring sea ice thickness in 4 areas: the Bering Strait, Norton Sound, St. Lawrence Island/St. Matthew Island, and St. Matthew Island/St. Paul Island. St. Lawrence to St. Matthew regions have seen increases in ice thickness since 2013.

Prey

There are no direct measurements for benthic infaunal prey. Continuous plankton recorders have been collecting data on diatoms, copepod community size, and mesozooplankton biomass for the past five years. In 2022, mean diatom and mesozooplankton biomass declined and the copepod community size decreased, suggesting an overall reduction in food availability for crab. The 2023 spring bloom chlorophyll a biomass trends are among the lowest in all regions in the BS, although the cause of the decline is unclear. The Rapid Zooplankton Assessment (RZA) exhibited low spring abundances with both small and large copepod numbers decreasing, which is a trend similar to other cold years that follow warm periods. The Fall RZA resulted in a moderate abundance of small copepods in the fall with a small uptick from spring, but maintained low abundances of large copepods, particularly in the southern BS. The coccolithophore bloom has been increasing since 2018 in inner and middle domains of the BS. Coccolithophores tend to result in longer trophic chains, are a less desirable food source for predators, and reduce visibility for visual predators.

Competitors

Bottom trawl survey data for 2023 were not available in time for this report. The 2022 data indicate that motile epifauna biomass (sea stars, crab, etc) is above the long-term mean, and peaked in 2017. However, sea stars and brittle stars were above-average and driving the overall biomass rather than crab. Benthic foragers (yellowfin sole, rock sole, etc) are seen as indirect indicators of benthic infauna and remain below the long-term mean.

Predators

Pelagic forager biomass (pollock, herring, etc.) increased from 2021/22, and apex predators (Pacific cod and arrowtooth flounder) also increased from 2021/22. In 2019 there was a distributional shift of groundfish northward, but in 2021 there was a reversal of this trend. Adult Pacific cod body condition in the northern Bering Sea was higher than 2021, but still below average. There was a general increase in Pacific cod body condition in the EBS which may be reflective of cooler thermal conditions resulting in lowered metabolic demand and increased food sources. In 2023, Bristol Bay sockeye salmon run size was smaller than the record-high run size in 2022 (54 mil. Vs 84 mil.), but is still considered an overall high run year for the Bristol Bay stock. Sockeye feed on zooplankton and age-0 pollock in warm years and adults feed on zooplankton and krill. Larval crab is likely included in these zooplankton.

Conclusions and Forecast for 2023/24

Ebett summarized 2023 crab-specific ecosystem indicators by highlighting average environmental conditions, potential red flags for reduced primary productivity and zooplankton biomass, and potential increased top-down pressures for benthic crab stages with increased competitor and predator biomass. Future El Niño conditions could result in near-average conditions for sea ice extent, AO, and other environmental conditions.

Economic status of Fisheries update

Brian Garber-Yonts presented information on the economic SAFE preliminary summary report for 2023. This includes a report card of 15 different indicators and a summary. The full report will have a detailed analysis of economic status and trends and will be presented to the Council in February 2024. The draft should be available for CPT review at the January 2024 meeting. The economic SAFE for crab and associated data is available online, including tables and figures, and can be downloaded for citable statistics.

Brian presented report card metrics for the 15 indicators intended to represent all crab fisheries as a whole. Data in the indicators include the most recent data available, which in some cases was 2022 data, and with the closed fisheries resulting in poor economic conditions.

Eleven of the 15 total indicators came out more than one standard deviation below the long-term mean. Nine of those are two or more standard deviations below the reference point mean. The number of crab vessels, ex-vessel pounds landed, total pot lifts, CPUE, ex-vessel value, crew labor payment, crab ex-vessel revenue shares, active processing plants, first-wholesale revenue, processing labor hours, and crab first wholesale revenue shares were all down. The price index was up, likely due to high market demand in 2022, which resulted in higher prices. However, prices started to decline at the end of 2022 and continued to decline into 2023. Deck crew pay per day was high in 2021 and above the mean in 2022, likely due to the higher price index. Crew labor payment tends to be a fairly stable metric. Quota lease rates went down. However, this is not a reflection of the actual lease rates, but rather a reflection of which fisheries were opened or closed. Tanner and golden king crab, which were open, tend to have lower lease rates whereas red king crab and snow crab, which were closed, tend to have higher lease rates.

Production and value in golden king crab declined in 2022 to an all-time low. There was a modest increase in the Tanner crab fisheries. Red king crab and snow crab were closed. In 2022 snow crab prices were high, whereas golden king crab and Tanner crab prices were low, likely due to the high price at the beginning of 2022 which declined later in the year when Tanner and golden king crab were landed.

The number of plants processing golden king crab went down and plants processing Tanner crab went up. The number of participating vessels in each fishery was stable. Vessel crew pay went down in both fisheries. However, processing employment has been going up due to general wage and minimum wage increases.

Processing labor by states has been stable since 2018 with no significant shift from one state to another. However, there has been a shift within Alaska communities with “other Alaska” processing a higher percentage than they have historically. Other communities such as Anchorage and Kodiak have decreased significantly in recent years. Vessel crew employment has not changed much across states and Alaska communities. The CPT members thought it might be helpful to show this information with percentages.

Lease rates have been very stable across fisheries, although Tanner crab and golden king crab have historically had lower lease rates than red king crab and snow crab.

Ongoing work includes price forecasting, finding more salient indicators to characterize the current state of stakeholders, and looking at regional economic impacts due to fishery closures. In addition, the SSC recommended that an index be developed that includes references to all the documents that contain metrics on various indicators which can then be communicated to the Council, SSC, and other stakeholders. This effort has been delayed due to staffing issues but remains a priority.

The CPT asked if there are plans to develop new indicators such as a diversity index. Brian stated that there have been some concerns over how many indicators should be included in the report card. While a diversity index might be good for long-term fisheries monitoring, more discussions need to occur with industry to determine how or if other information should be incorporated.

Brian was asked if there are other regions with fishery collapses that could be used to help understand how stakeholders have responded to those collapses. Although these data likely exist, it would take time to research, and this has not been done yet. However, it might be helpful in understanding current conditions in Alaska crab stocks.

The CPT looks forward to reviewing the draft at the January 2024 meeting.

PIBKC final SAFE

William Stockhausen presented the final assessment for Pribilof Island Blue King crab (PIBKC). PIBKC has been overfished since 2002, and is assessed on a biennial cycle. The directed fishery has been closed since 1999, and the Pribilof Islands Habitat Conservation Zone closure area (i.e., the “home plate”) excludes both groundfish pot and trawl fishing in the core range of the stock. Bycatch of PIBKC occasionally occurs in the Tanner crab fishery, although there has not been any Tanner fishery bycatch since the 2018/19 season, or in 11 of the preceding 18 seasons. Discard mortality for crab pot gear is assumed to be 20%. The maximum bycatch during that period occurred in the 2015/16 season, in which 0.33 t of discard mortality was estimated. Groundfish fisheries are the main source of fishing mortality, wherein the yellowfin sole trawl fishery is the largest contributor of PIBKC bycatch. Bycatch mortality rates for groundfish fisheries used in this assessment are 20% for fixed gear fisheries and 80% for trawl fisheries. It was noted that the fixed gear mortality rate is inconsistent with other crab stocks (which use 50%), but Dr. Stockhausen explained that the rate used for PIBKC was changed in

2017 in response to a previous Plan Team request. Total fishery removals for the 2022/23 season was 0.25 t, so overfishing did not occur.

The primary abundance index for this stock is the NMFS EBS bottom trawl survey. Both male and female biomass continued a declining trend, with no mature males caught in the 2023 survey. The 2023 survey also caught only 7 females and 2 immature males. The author mentioned that given the lack of trawl survey catches, it may be appropriate to consider different survey methods for the stock (e.g., pot survey, ROV). It was noted that ADF&G previously conducted pot surveys in the Pribilofs and these data could be compared with NMFS trawl survey data from similar years to gauge the utility of a pot survey, although the number of pot surveys is small.

The assessment for this stock uses the R package *rema* to implement a survey averaging random effects model to smooth trawl survey estimates in mature male biomass (MMB). Estimated survey MMB is then projected to time of mating (February 15) and averaged from 1980/81-1984/85 and 1990/91-1997/98 to obtain B_{MSY} . The 2023 survey MMB observation of zero presents a difficulty for *rema* because the standard option for the random effects model assumes a lognormal error distribution. The author explored three scenarios to address this issue following similar circumstances encountered by the Groundfish Plan Team: 1) setting the zero to 'NA' (i.e., effectively removing the observation), 2) setting the zero to a small non-zero constant, and 3) using a Tweedie distribution, which is defined at $MMB = 0$. All three *rema* models successfully converged, although terminal year estimates were sensitive to the small constant value when taking that approach. Treating the 2023 MMB as NA and the Tweedie distribution scenario resulted in similar terminal year estimates, although MCMC analysis for the Tweedie model could not be completed (MCMC had not yet reached convergence after ~ 24 hr and was terminated). Following the approach adopted by the Groundfish Plan Teams, Buck suggested that treating the 2023 MMB as NA was the most suitable scenario for now, although the Tweedie distribution approach will likely be preferred in the future as *rema* development continues. For the suggested approach, MMB at mating was estimated to be 181 t and B_{MSY} was estimated to be 4,196 t, which results in $B / B_{MSY} = 0.043$; thus the stock remains overfished.

The OFL for the stock is computed via a Tier 5 approach with a reference period from 1999/00 - 2005/06 as prescribed by the rebuilding plan. This reference period results in an OFL of 1.16 t, which is thought to provide necessary conservation measures while allowing bycatch fisheries to operate. Given continuing concerns for the stock with regards to lack of recruitment, the Plan Team recommended continuing with the 25% ABC buffer used in previous years. The 25% buffer acknowledges the low status of the stock, the accommodations made in the rebuilding plan to set the OFL, and the current status of low bycatch in non-directed fisheries.

BBRKC report card

Erin Fedewa presented the most recent ecosystem and socioeconomic profile (ESP) for Bristol Bay red king crab. The ESP full report was done in 2020 and since that time, abbreviated report cards have been completed every year with updates. The ESPs are a standardized format that develop ecosystem and socioeconomic indicators and provide context on the health of a stock,

which may be used as context when setting buffers and TACs, or may eventually be included as covariates directly in the stock assessment model.

Ecosystem indicators are summarized across physical, lower trophic, and upper trophic categories. Erin noted that the MODIS satellites previously used to measure spring chlorophyll a biomass are being retired so data has been replaced with GlobColour satellites. There was also a correction to the ROMS model for pH spatial averaging so this year's data are not directly comparable to previous years. In addition, the catch distance from shore indicator has been calculated with fishery data in previous years, but because the fishery has been closed, fall pop-up locations of acoustically tagged male RKC have been used as a bridging dataset in 2021 and 2022.

Indicators are collected from various data sources, including the NMFS trawl survey, satellites, oceanographic models, and fishery-dependent data. The directional relationships between ecosystem indicators and red king crab stock productivity were generated from an extensive review of scientific literature during the development of the full ESP in 2020. It was noted that the indicators are likely interrelated and changing one "negative" indicator will not likely improve the stock. It may be possible to weight each indicator as having high or low confidence in the strength of a correlation with the health of the stock, and some ongoing work may help inform this in the future.

In 2023 environmental variables were near-average relative to the long-term time series mean. In the past two years the ROMS model hindcast for pH has shown that Bristol Bay is reaching a critical threshold for pH levels in which red king crab can survive. Laboratory studies have seen negative effects on growth and shell hardening in young red king crab when pH reaches 7.8. The spring chlorophyll bloom was less pronounced this year. This bloom is considered an important food source for larval crab, particularly during the first 60 days, and low concentrations may mean less food availability. The BASIS survey is not annual so there were no new juvenile sockeye salmon abundance estimates to report this year, although this dataset will be replaced with a Bristol Bay inshore run size time series that is more consistent and timely. 2022 was a record high for sockeye salmon and 2023 is also projected to be high. Sockeye salmon abundance has been closely correlated with warmer water temperatures and sockeye are thought to prey on larval crab. Data for Pacific cod and benthic invertebrate density were not available at the time of this report. There is evidence that red king crab are using central Bristol Bay more than they have historically, whereas in cold years they tend to aggregate in shallower habitats along the Alaska Peninsula. Spatial extent of RKC appears to be related more to temperature than to crab abundance, and it is difficult to determine if spatial distribution patterns have a negative or positive effect on the stock. As such, distributional indicators were removed from intermediate-stage indicator analyses.

Jamie Goen (Alaska Bering Sea Crabbers; ABSC) asked whether a stock enhancement project to raise crab past the critical larval stage before release might be affected by pH and low spring blooms. Erin stated that it might be beneficial to release benthic stages once they are larger in order to increase survival probability, however, it is costly and difficult to raise them to that size.

It is also uncertain if smaller crab can move out of highly acidic waters, which is important to consider in stock enhancement projects.

The simplistic approach of an ecosystem traffic light table is useful for qualitative context, however, there was discussion about how to interpret current-year indicator trends if linkages between a given indicator and stock productivity are not demonstrated in intermediate and advanced stage indicator analyses within the ESP framework. In the ESP, each of the indicators are being treated individually but are often correlated or inter-related. It is also difficult to know which indicators are most important. The CPT noted that some indicators might be important but we may not be able to model them or don't currently see a significant relationship with BBRKC recruitment. However, that doesn't mean the indicator isn't important; just that it is not well understood. There was some concern over including indicators that have been shown to have a strong correlation to the biology of the stock alongside indicators with weaker or no apparent correlation. It might be beneficial to include rationale as to why it is thought an indicator might have a biological impact, especially when there is not a known statistical relationship. Erin clarified that these hypotheses are included in the full ESP for each stock. It was also acknowledged that statistical relationships can change over time. This information needs refining which hopefully further research will help inform, but for now the traffic light approach is a good way to track trends.

Socioeconomic information is divided into three areas; fishery performance, economics, and community impacts. Currently there are no proposed community indicators, although a Skipper Survey in collaboration with ABSC is planned for the next directed fishery opening. Given recent fishery closures and lack of socioeconomic data available, the socioeconomic traffic light table does not reflect the economic hardship the fishing community is currently experiencing due to closures. The only socioeconomic data available when a fishery is closed is incidental catch. It was noted that it might be useful to add color to show a distinction between data that do not exist due to a fishery closure versus data that just have not been analyzed yet. It is also difficult to determine the directional impact of socioeconomic data because it is hard to correlate a direct impact on the overall health of the stock. However, indicators may have an impact on the stock, as different economic drivers may change the fleet's fishing behavior, which may result in an effect on the overall health of the stock. In addition, some indicators may be positive for one category and negative for another. For example, price increases are positive for fishing vessels but negative for consumers. An industry member also stated that there are socioeconomic effects on other fleets besides the crab fleet. For example, lower PSC limits have impacted the way some flatfish fisheries have been prosecuted in recent years.

The SSC and Council have asked that socioeconomic and community considerations be taken into account throughout the harvest specification process (i.e., OFL/ABC/TAC) and other management decisions. Although the primary goal of ESPs is to communicate to fishery managers the health of the stock, it may be possible to find ways to include socioeconomic and community indicators into the assessment process. It was noted that the TAC is set by the State, which does take socioeconomic information provided in the ESP into account. There may be a need to structure the socioeconomic and community information differently in the ESP to

effectively communicate information for management decisions. Skipper surveys could be a valuable platform for developing community indicators, and Erin suggested that the September 15th Industry Symposium might be a good opportunity to ask industry for indicators that convey community impacts during crab fishery closures. It was also noted that there is a lack of staff resources to fully flush out socioeconomic and community indicators.

When grouping indicators for 2023, the physical and lower trophic indicators scored below average. The physical indicator group score was below average due to the negative score associated with low pH. The lower trophic indicator group score was below average due to the negative score associated with a less pronounced spring bloom. The upper trophic indicator group score was average. Socioeconomic data were not available due to the fishery closure. There was some concern that the figures displaying socioeconomic data are misleading because they do not show a negative effect even though the fishery closure has been an extreme hardship for industry. The ESP team is working on ways to communicate this effectively. It was asked if it was possible to add variances to the indicators.

Bayesian adaptive sampling analysis has been used to quantify the association between ecosystem indicators and BBRKC recruitment. Each indicator is evaluated independently and highly correlated indicators are dropped from the analysis. Immature male red king crab (95-120mm CL) abundance has been used to represent one cohort and was used as the response variable in Bayesian analyses. The CPT noted that it might also be good to look at females as a response variable in models, as well as smaller immature males to reduce uncertainties associated with long lags for larval crab indicators. Lags are difficult to deal with in the ESP given that crab cohorts cannot be reliably aged, and as such, lags outlined in the full document are based on best available science.

Two time series were used in Bayesian adaptive sampling model runs; 2005-2022 and 1988-2022. The shorter time series allows the model to take into account indicators that have a shorter time frame. The shorter time series seems to fit BBRKC recruitment better, whereas the longer time series demonstrates poor fits to observed recruitment. In the longer time series model run, the only indicator that has a high inclusion probability is pH, whereas Pacific cod density, cold pool extent, and benthic invertebrate density had the highest inclusion probabilities in the shorter time series model run. It was noted that these disparate results may be explained by non-stationarity in driver-response relationships. There are plans to explore additional indicator importance tests that are more robust to non-stationarity in the future.

In February 2024, a Request for Indicators will be issued seeking new indicators and data sets that can be explored to highlight data gaps. The ESP team is asking for feedback from people that might have additional data that is not currently reflected in the ESP in order to further develop and incorporate a suite of data sets that are meaningful for this stock. The CPT agreed with the suggestion to move clutch fullness and the ratio of Northern District to Bristol Bay RKC time series from the BBRKC SAFE document to the ESP next year. It was also suggested to re-visit GOA RKC clutch fullness data for additional context relative to failed clutch dynamics. In addition, an ongoing effort to utilize the fishing effects model output will quantify spatial overlap

with the stock and fishing gear, which can then be used in the ESP. Erin also stated that if the CPT was interested, there are long-term projections of pH, which can be shared and incorporated in future ESP presentations.

BBRKC final SAFE

Katie Palof (ADF&G-Juneau) presented the draft 2023 stock assessment for Bristol Bay red king crab (BBRKC) to the CPT. The 2022/23 OFL was 3,040 t while the ABC was 2,430 t. ADF&G closed the fishery in 2022/23 due to low female abundance in accordance with the State's harvest strategy--the TAC was 0 t. A cost-recovery fishery (not included in the TAC) was conducted; retained catch was 0.02 t (which was included in the assessment). Total catch mortality was 70 t, which was less than the OFL, so overfishing did not occur. Based on the CPT's recommended model (Model 23.0a), MMB on Feb. 15, 2023 (18,340 t) was above MSST (9,680 t), so the stock was not overfished in 2022/23.

Mature male (>119 mm CL) area-swept abundance in the 2023 NMFS EBS trawl survey for BBRKC was estimated at 6.2 million crab, a 22% decrease from the 2022 survey. Immature male abundance was 5.8 million, up 35% from 2022 (4.3 million), while immature female abundance decreased 16% from 2.5 million in 2022 to 2.1 million in 2023. The estimated mature female (> 89 mm CL) abundance was 11.0 million crab, an increase of 72% over the recent low of 6.4 million crab in 2021. However, this was primarily the result of a large catch at a single station. The mature female abundance is above the threshold (8.4 million mature females) in the State's harvest strategy for opening the BBRKC fishery. If ADF&G opens the fishery for 2023/24, which will be announced after the October NPFMC Council meeting, it will follow two years of closures. Females were sampled in June; per standardized survey protocols based on the fraction of mature females in June without newly-extruded egg clutches, "re-tows" in August were not conducted because only 6% of mature females sampled in June had not completed the molt-mate cycle (the threshold for re-tows is 10%). Recruitment remains low; substantial recruitment to the stock has not been seen since 2011.

In 2021, immature male and mature female red king crab were found by the survey in the Northern District (north of Bristol Bay and south of Nunivak Island) in high relative abundance compared with previous years, but these crab were outside the BBRKC stock boundary and were not included in the assessment. Several members of the public expressed concern that these crab should be included in the assessment and the CPT noted the potential need to expand the stock boundaries in the future to accommodate northward expansion of the stock under warming environmental conditions. However, the absolute scale of red king crab biomass in the Northern District is small relative to that in Bristol Bay. In 2022, the biomass of mature females in the Northern District declined 24% from that in 2021, such that the fraction of mature females in the Northern District was ~10% of all mature females. Although the biomass of mature males in the Northern District in 2022 almost doubled (+96%) relative to 2021, this represented less than 10% of all mature males. In 2023, survey biomass in the Northern District across all stock categories declined, while the proportion in the Northern District also declined or remained the same as in 2022.

Katie summarized responses to previous SSC and CPT comments, noting that issues with document formatting had been addressed, a stock structure template for Bering Sea RKC had been developed, and that many previous comments had been addressed for the May/June 2023 meetings.

Katie presented results from three models requested by the CPT and SSC in the spring: 21.1b, 22.0, and 23.0a. The base model, 21.1b, was the assessment model used for the last two assessments, but using an updated version of GMACS (2.01.M.01). Model 22.0 represented a simpler version of 21.1b that started in 1985 rather than in 1975; otherwise, it was identical to 21.1b. Model 23.0a was similar to 21.1b except that it estimated a value of M for males (rather than using a fixed value) with a fairly strict prior. Starting the model in 1985 (22.0) removes the need for the model to deal with the gear change between 1981 and 1982 in the NMFS survey by estimating potential differences in survey catchability and selectivity between the two time periods. It also eliminates the need to estimate a separate value for M during the 1980-1984 natural mortality “event.” This model was evaluated last year, but was rejected in favor of 21.1b partly because the CPT had not developed criteria for changing the model start date and because the base model appears to adequately accommodate the gear change and enhanced mortality period. Estimating male M (23.0a) has been shown in previous models to reduce retrospective bias. New data fit in the models included 2023 NMFS EBS trawl survey biomass and size composition estimates, retained catch from the cost-recovery fishery, and bycatch biomass and size compositions from the Tanner crab and groundfish fisheries.

Results for 21.1b and 22.0 were similar overall; notable differences were smaller estimated NMFS survey catchability (0.94 vs 0.97), smaller $B_{35\%}$ (19,967 t vs 21,719 t), and higher OFL (3,917 t vs 3,522 t) for model 22.0. These differences were attributed to the BSFRF data having more influence on Model 22.0 results due to its shorter time frame as well as the influence of the large mortality event (1980-1984) included in the 21.1b time frame. Model 23.0a estimated a base M for males (0.23 yr^{-1}) higher than the fixed value (0.18 yr^{-1}) used in the other two models. The estimated offset for female M was also higher for 23.0a than 21.1b or 22.0, as expected since they are estimated as an offset from male M . The elevated natural mortality rates in 23.0a were accompanied by slight rightward shifts in the estimated NMFS and BSFRF survey selectivity patterns toward larger sizes, resulting in slightly lower survey catchability at any size in 23.0a compared with 21.1b and 22.0. Model 23.0a fit the data slightly better than Model 21.1b and estimated slightly increased annual mature male biomass (with the exception of the last four years) and a slightly lower $B_{35\%}$ than Model 21.1b. The higher estimate for male M in Model 23.0a also resulted in higher values for $F_{35\%}$ and OFL compared with 21.1b.

All three models fit the fishery catch and bycatch biomass, NMFS survey biomass, and BSFRF survey biomass time series data similarly well. Katie noted, however, that the BSFRF biomass data were fit in all the models by also estimating a large additional variance. She questioned whether this was the best use of this data and indicated that she wanted to explore its use to develop a prior for NMFS survey catchability as suggested by the simpler modeling workshop group.

The models also fit the associated size composition data well. Katie pointed out that the models tended to overpredict the proportions in the plus groups after 2014, although the trend in plus group size made sense in light of the lack of recent recruitment to the stock. Model 23.0a, as with models in previous assessments that estimated higher M for males, exhibited slightly better fits to the plus group in size compositions relative to the other models.

All three models exhibited fairly substantial retrospective patterns in MMB, with estimates of year-specific MMB increasing (displaying positive bias) as peels were removed. Mohn's rho for these patterns was smallest for Model 23.0a (0.24) and largest for 22.0 (0.42), with that for 21.1b closer to 23.0a (0.38).

In selecting a model on which to base management decisions, the CPT noted its previous recommendation to authors that in most cases more data is better and that the default approach should be to use all the available data. Katie agreed that the rationale for ignoring data before the 1985 start time in model 22.0 was not strong enough, when coupled with its poor retrospective patterns, to justify using it for management decisions. She did not have strong reasons for selecting between model 21.1b or 23.0a, but suggested that the estimated value for male M from 23.0a (0.23 yr^{-1}) was more biologically realistic, based on current life history-based estimators for M , than the fixed value used in 21.1b (0.18 yr^{-1}). Although the estimate from 23.03a is constrained by a tight prior, it is more in line with estimates for Pribilof Islands RKC (0.21 yr^{-1}) and southeast Alaska RKC (0.30 yr^{-1} , with the caveat that this probably includes subsistence/recreational fishing mortality) than the fixed value from the FMP, which is 0.18 yr^{-1} . Several members of the CPT and other experts in attendance supported this contention. The value from the FMP corresponds to a maximum age greater than 30 years, which seemed out of line with current thinking on maximum ages for RKC. The CPT discussed the efficacy of estimating M and noted that recent work on length-based assessments (Cronin-Fine and Punt 2022) found that it was better to estimate than to pre-specify M , since pre-specifying M to the wrong value could lead to inaccurate and imprecise estimates for growth parameters and spawning stock biomass. The CPT also agreed with Katie's observation that there was nothing to prevent fixing M in the future if such a model were found to be an improvement. As a result, the CPT recommends that Model 23.0a be adopted for status determination and OFL setting.

The Bristol Bay red king crab stock is in Tier 3, which requires that a time period for calculating average recruitment be chosen. Using results from the retrospective analysis, Katie presented means and standard deviations of the ratio of terminal year recruitment to the corresponding estimate from the current model by number of years in the model. A substantial drop in both quantities from 1- to 2-year inclusion in the model was evident, leading Katie to recommend dropping the terminal year from the recruitment-averaging time period (as with recent assessments). The CPT agreed with her rationale and thus recommends computing average recruitment as has been done in recent assessments—i.e., based on model recruitment using the time period from 1984 (corresponding to fertilization in 1977) to the penultimate year of the assessment. Based on Model 23.0a, the estimated $B_{35\%}$ is 19.36 kt. Projected MMB for 2023/24 is 14.98 kt, 77% of $B_{35\%}$. Consequently, the BBRKC stock is in Tier 3b for 2023/24. The corresponding OFL is 4.42 kt.

Katie also presented MCMC results for model projections of the stock into the future to evaluate the probability of approaching an overfished status. Annual recruitment for the projections was drawn from the recent period (2013-2022) of low recruitment to better reflect recent environmental conditions. If the probability that the stock would fall below MSST when fished at F_{OFL} in the next two years was greater than 50%, the stock is considered to be not approaching an overfished status. For each MCMC realization, the ratios of MMB projected to 2023/24 to B_{MSY} were evaluated and the proportion of realizations in which the ratio was less than 0.5 was determined. The SAFE chapter and presentation include figures for model 21.1b; MCMC runs were done for all three models and results were very similar so only 21.1b results were included. Based on this approach, the probability of approaching an overfished status was 0 for all models. Katie also provided 10-year projections for a range of fully-selected F values in the directed fishery (from 0 to $1.5 \times F_{OFL}$). Results showed that if the stock were not fished at a directed fishing mortality of more than 0.167 yr^{-1} , the stock would not be approaching an overfished condition within the next four years.

Katie recommended continuing to use a 20% buffer for ABC for this stock because she felt that the level of additional uncertainty in the assessment matched the levels previously expressed in 2021 and 2022, although the basis for those concerns had changed somewhat. These included:

- Continued lack of recent recruitment, coupled with near historically-low abundance
- Poor and variable environmental conditions (e.g., cold pool distributional shifts)
- The lack of fit to 2018-2023 NMFS female survey biomass
- The retrospective patterns exhibited by the recommended model, even though this was improved over last year's assessment model (21.1b)

The CPT noted that the buffer consideration should focus on uncertainty not captured in the model but generally agreed with Katie's rationale. The CPT thus recommended that a 20% buffer on OFL be used to compute the ABC.

Katie presented a Tier 4 fallback model for BBRKC that adopted the same time period for calculating B_{MSY} as that used in the Tier 3 model for calculating average recruitment, as well as an ABC buffer that matched the Tier 3 recommendation. Although the SSC had requested that several options for time periods and a rationale for choosing an ABC buffer be developed, the CPT decided to curtail extended discussion on issues pertaining to the Tier 4 fallback model at this meeting given the likelihood that the Tier 3 model would be adopted for the assessment. It was suggested that the Modeling Workshop or other meeting might provide a more convenient forum for a more detailed discussion.

Finally, Katie noted that proposed model work for 2023/24 would focus on re-examining the available tagging data to determine the source of differences in molting probabilities determined from the 1950s and other tagging data, better estimating growth and survey catchability (Q), as well as using the BSFRF data to develop a prior on Q . The CPT supported Katie's suggestions for future work.

RKC stock structure template

Katie Palof (ADF&G) presented a finalized red king crab (RKC) stock structure document that included more succinct directions and conclusions following the May 2023 draft. Given that BSAI crab stock management boundaries were originally based on historic fishing grounds, the stock structure document provides guidance for splitting and lumping RKC stocks using available scientific information. Katie presented Bering Sea RKC distribution plots, highlighting the overlap in spatial distributions of Northern District, Pribilof Islands and Bristol Bay stocks. Genetic studies indicate that the Western Aleutian and Norton Sound RKC populations are isolated populations, while gene flow between BBRKC, PIRKC and GOA RKC suggests that these stocks are not demographically independent populations. Understanding gene flow between Northern District RKC and other Bering Sea stocks has been limited due to a lack of genetic studies.

Non-genetic information such as size compositions and patterns in growth do not demonstrate any meaningful trends across time. However, small sample sizes in the Northern District prevent more formal cross-stock statistical analyses. Katie acknowledged that oceanographic barriers exist between the Aleutian Islands and Norton Sound stocks, while southeastern Bering Sea stocks do not exhibit physical barriers to population structure. Notably, the proportion of RKC in the Northern District relative to Bristol Bay has increased in recent years, suggesting potential connectivity between the two management areas. Additional tagging and genetics studies are needed to better understand this potential connectivity.

Overall, further research should include 1) contemporary seascape genetic studies to better understand larval flow and connectivity between southeastern Bering Sea stocks, 2) additional information on southeastern Bering Sea RKC stocks, 3) tagging studies to assess movement between the Northern District and Bristol Bay, and 4) analysis of oceanographic information within and across management areas. The CPT expressed interest in hearing a presentation from a PhD candidate currently conducting genomic sequencing on RKC from samples throughout the Bering Sea, specifically related to PIRKC and BBRKC. Discussion after the presentation noted that while Northern District RKC have been tagged in ongoing studies, sample sizes are small and there may be added utility in assessing archived tag data, or using genetic tools. Industry representatives noted that despite overlapping spatial distributions between Bristol Bay, PIRKC and Northern District RKC, the existing rigid management boundaries make it difficult to fish small populations of crab stocks that are likely moving between boundaries. Future work should provide biological and/or environmental considerations for these management boundaries rather than existing latitudinal boundaries that do not account for connectivity between stocks.

NSRKC proposed model runs

Hamachan Hamazaki (ADF&G) presented two models for consideration for use in January 2024 for Norton Sound red king crab. The status quo model (21.0) has a length dependent natural mortality (M) set to 0.18 for crab less than 124 mm carapace length and estimates an M for larger crab. The second model (23.0) estimated a single natural mortality that did not vary by

carapace length. The CPT recommended bringing both models forward in January for consideration and are looking forward to seeing an implementation of GMACS in the near future for NSRKC.

The CPT discussed the survey data used in the model and expressed some concern for the way in which some of the stations for the most recent year were selected for sampling. It was mentioned that the station that returned the most females in the surveyed area for 2023 was chosen because it had been a big producer of females in the past and time was limited. Non-random sampling like this can bias survey indices and this produced some concerns from CPT members. A few suggestions arose from these concerns:

- Include maps of all of the survey years in all future assessments so changes in spatial coverage of the surveys are clear over time
- Include a figure that shows how many stations were used for each year to develop the index of abundance. Include the total number of crab observed by year.
- Compare the index of abundance currently used (that presumably uses all of the stations sampled in a given year) to an index of abundance that uses only stations that were consistently sampled over the length of the time series
- Compare the current index of abundance to one developed using VAST

The CPT questioned the use of 0.18 as a fixed natural mortality for NSRKC and suggested that the tagging data could be useful for understanding what maximum age could be for NSRKC. Given an estimated maximum age, the Barefoot Ecologist's natural mortality calculator can provide a prior with which to estimate natural mortality within the assessment. In addition, given potential issues accurately identifying new and old shell animals, the CPT suggested that eliminating shell condition might be a useful simplification to model population dynamics for this stock.

Hamachan also presented responses to a number of CPT and SSC comments, including an SSC suggestion that a small-scale observer program be implemented. Discussion focused on issues with a previous observer program for NRKC. The data were considered to be substantially biased for estimating discard mortality because only larger vessels could take on an observer, while large boats and small boats typically fished in different areas with different catch compositions. Wes Jones (NSEDG) noted that the available (limited) funding from NSEDG was used to help conduct the ADF&G trawl survey in Norton Sound, which was regarded as the most important source of information for the assessment.

Snow crab report card

Erin Fedewa (NMFS) presented the Ecosystem and Socioeconomic Profile (ESP) report card for Bering Sea snow crab; the initial full ESP was completed in 2022. The report card includes 12 ecosystem indicators, 10 socioeconomic indicators, analyses and considerations for these indicators, and plans for updates in 2024.

For the category of ecosystem physical indicators, the winter-spring Arctic Oscillation, summer bottom temperatures, and the extent of the cold pool were all near average in 2023. For lower trophic ecosystem indicators, chlorophyll-a concentration was noticeably low, perhaps indicating poor feeding conditions for pelagic larvae, while lower trophic level (prey availability) data for benthic invertebrates are not yet available. Upper trophic level ecosystem indices were neutral (i.e., within 2 standard deviations of the time series mean) for juvenile bottom temperature, visual observations of bitter crab disease in immature crab, mean size at 50% probability of males maturing, the area representing 95% of the mature male crab spatial distribution, and juvenile crab body condition. The distributional center of mature male crab was shifted northward, which is seen as a positive indicator for the stock. A model that considers Pacific cod consumption of crab was modified to include unidentified *Chionoecetes* in this year's update, although 2023 data are not yet available.

Erin noted the following additional changes to ecosystem indicators in 2023: (1) chlorophyll a concentrations are now derived from GlobColour, rather than MODIS satellites; (2) winter sea ice extent is now derived from the NOAA National Snow and Ice Data Center; and (3) a new indicator, juvenile snow crab condition, was added to monitor interannual variation in physiological condition of snow crab during the summer BT survey. Stage one indicator monitoring analysis, which involves weighting of positive and negative indicators that are outside one standard deviation of the long-term mean and pooling the results within ecosystem indicator category, resulted in average scores for physical indicators, below average for lower trophic level indicators, and slightly above average for upper trophic level indicators. Bayesian adaptive sampling was used to quantify associations between hypothesized ecosystem predictors (with appropriate lags) and snow crab recruitment (survey abundance of immature male snow crab, 50–65 mm CW), and to assess the strength of support for each indicator. The highest ranked predictors were : (1) temperature of juvenile crab occupancy; and (2) Pacific cod consumption, although the associated effect sizes could not be distinguished from 0 and the probability of inclusion in a predictor model was small (<0.5) for all indicators as predictors of recruitment.

Socioeconomic indicators were largely unavailable for the past year due to the directed fishery closure. The sole exception was incidental catch of snow crab in eastern Bering Sea groundfish fisheries, which has remained near average for the past five years. Given the lack of socioeconomic data, an indicator monitoring analysis was not conducted. Erin noted that the absence of socioeconomic data was itself an indication of the severe socioeconomic stress currently being experienced by snow crab stakeholders.

Several aspects of ESP development are planned for the near future, recognizing that ESP indicators should help characterize snow crab physiological and biological responses to changing ecosystem conditions in the Bering Sea. Additionally, socioeconomic indicators should provide information on the economic stress that crab stock declines and fishery closures have on the harvesting and processing sectors of Bering Sea crab fisheries. In terms of future developments, a Request for Indicators will be issued in February 2024. Some proposed revisions to existing indicators, or development of new indicators, include: (1) using size at maturity data to re-define immature/mature cutlines; (2) development of a mature female clutch

fullness indicator; (3) standardization of Pacific cod consumption rates relative to snow crab abundances; (4) examination of disease prevalence in the Northern Bering Sea; (5) development of an indicator of bloom timing and type; (6) development of an overlap metric between snow crab and fishing gear; and (7) development of a localized habitat disturbance metric. It was suggested that female size at maturity and the snow crab male/female sex ratio might also be meaningful indicators to develop and may serve as proxies for reproductive success, fecundity, or sperm limitation due to reduced abundances of large males in the population.

Snow crab final SAFE

Cody Szuwalski presented the final 2023 stock assessment for EBS snow crab. The stock is assessed on an annual basis and was declared overfished in 2021. The 2022/23 fishery was closed. The NMFS EBS bottom trawl survey estimated abundances of legal and commercially-preferred (> 101 mm CW) males are at another historical low this year (2021 was the previous time series low). There was a small increase in estimated total male abundance, though the majority of that increase is from small crab that are several years from being available to the fishery. To emphasize this point, Cody noted that the most recent year with a similar numbers-at-size observation was 2003, and it took about 3-4 years before an appreciable number of those crab reached the size targeted by the fishery. Several figures showed that the distribution centers for medium sized males (45 – 85 mm CW) and large males (> 101 mm CW) caught during the NMFS survey were further north in 2023 and recent years than on average.

Cody also presented some preliminary analysis of the directed fishing effect on localized portions of the stock with a heat map of the total number of pots fished in each ADF&G statistical area aggregated across fishing seasons since 1990. Further, he plotted the trend in CPUE by week of the fishery in each year for these statistical areas. The overall trend suggested that the more retained catch that came from an area, the more CPUE declined in that area throughout the season.

Models presented to the CPT incorporated changes in the treatment of size-dependent probability of molting to maturity, and changes in the approach for using BSFRF survey data to inform estimates of NMFS survey selectivity. Cody noted that the terminal molt to maturity is a critical biological process to capture in the model, as it determines when growth stops and thereby has direct implications for estimates of spawning biomass and reference point calculation. In the models presented to CPT, annual values for size-dependent probability of undergoing the molt to maturity for hardshell new males were estimated outside the model, using NMFS survey data. In years where morphometric maturity data were not available from the survey (1982-1988, 2008, 2012, 2016, 2020), the long-term average size-dependent probability was used. Estimating terminal molt probability outside the model is a departure from the approach used in last year's accepted model, which used a single maturity ogive representing all years that was estimated inside the model. Cody presented a plot showing that this single ogive from last year's model greatly overestimated the size at which most males mature, and therefore misrepresents the biology of the stock.. BSFRF survey data were

previously used in the assessment as an additional fleet, in which selectivity for the NMFS survey was linked to selectivity from the BSFRF survey. This method assumed selectivity to be logistic, which allowed the model to overestimate exploitable biomass (i.e., estimate smaller selectivity than realized). The approach taken in 2023 was to estimate inferred selectivity of the BSFRF survey by comparing catches at size between surveys from comparison hauls, and using those data as priors on NMFS survey selectivity. In addition, selectivity was defined as a non-parametric (rather than logistic) function, which is supported by the inferred selectivity of BSFRF data as well as double bag experiments by Somerton and Otto (1999).

The CPT reviewed five model scenarios:

- 22.1: 2022 accepted model;
- 23.1: 22.1 with most recent survey and catch data;
- 23.2: 23.1 + specifying the probability of having undergone terminal molt based on NMFS survey data (i.e., an intermediate option between 23.1 and 23.3);
- 23.3: 23.2 + specifying NMFS survey selectivity based on BSFRF data, and removing BSFRF data as a survey fleet;
- 23.3a: 23.3 + estimating NMFS survey selectivity using BSFRF inferred selectivity estimates as priors;
- 23.3b: 23.3a + loosening the prior on natural mortality (M).

All models converged, producing invertible Hessian matrices and small gradients. Retrospective patterns were acceptable to good among all models, with some having both positive and negative residuals in peels. Bimodality of the OFL remained an issue in model 23.1, but the issue was largely resolved in the 23.3 series of models. Cody noted that there were issues with convergence related to jittering analyses, which may have something to do with not having 2022 retained catch data for the model; this remains a work in progress.

All models showed relatively similar ability to fit NMFS survey biomass estimates, although the 23.3 model series did estimate an uptick in survey mature male biomass in the terminal year. The cause of this uptick is unknown and will be the subject of future model exploration. Growth data were also fit similarly by the candidate models, though there were minor differences in fits to female growth data. The different models showed nearly identical, close fits to catch data. There was very little difference among retained and total catch size composition fits, other than that in some years the 23.3 series estimates a larger number of males in the largest size bins, compared to the other models which track the observed data more closely. Female discard size composition fits were adequate and similar among models. Fits to non-directed fisheries size comps are poor in several years, but that is unsurprising given that the data consist of multiple fisheries. All models estimate survey selectivity for two eras in the data (1982-1988 and 1989-2023) to account for differences in the spatial extent of the survey over time. Fits to immature males in the NMFS survey data for the first era varied among models, though Cody noted that typically not a lot of emphasis has been placed on those years since they only constitute a short period of the full time series, and do not have a large impact on the dynamics in the current era. There does remain, to a lesser extent, some variability in fits to these data in the current era. Models that specified the probability of terminal molt (23.2 – 23.3b) fail to

capture bimodality in the observed survey size distribution of mature males in some years, but unlike the models that estimate the maturity ogive, they did not estimate a bimodal fit to unimodal observed data. Survey size distributions of mature females were well fit among all models.

Estimates of MMB at the time of survey from models that specified the probability of terminal molt differed from base models by a sharp increase in MMB in 2019, followed by a steep decline. Among models with updated terminal molt probabilities, model 23.2 estimated larger MMB, owing to the assumption of logistic NMFS survey selectivity. Cody shared a plot of the time series of observed estimates of commercial-sized male biomass overlaid with the model estimated biomass extracted from model N matrices. He noted that these data are not fit in the model, but perhaps should be in the future given their importance to management. The 23.3 series of models (i.e., those including specified probability of terminal molt and non-parametric survey selectivity) estimated a trend in MMB that was clearly better aligned with observed data. Cody explained that differences in estimated stock size were likely related to survey selectivity among models. He also noted a large hump in female survey selectivity in models 23.3a and 23.3b during the current era that he could not presently explain. It was mentioned that there was a similar observation during Somerton and Otto's (1999) double bag experiment.

Fishery selectivity remained logistic in all models. Non-directed fishery selectivities shifted right (i.e., to larger sizes) for 23.3 series models. Estimated fishing mortalities were high in 2020 for most models and high in the early 1990s for the 23.3 series models. Calculated exploitation rates, estimated by dividing the retained catch by the exploitable biomass (males > 101 mm CW), suggest an exploitation rate that seems more reasonable. Recruitment patterns were similar across models, though models differed on the timing and scale of the most recent large recruitment pulse. Estimated mortality events were similar among models, except for the 2019 mortality event for mature males being estimated in 2018 for models 23.2 – 23.3b.

Cody recommended that model 23.3a be used because it incorporates the best available science on the biology of the stock and it propagates uncertainty in survey selectivity. Model 23.3b was not preferred because loosening the prior on M resulted in a high estimated value of M that is inconsistent with our current understanding of snow crab longevity. The CPT agreed with the author's recommendation that model 23.3a best represented the stock dynamics.

While model 23.3a and other models that specify the probability of terminal molt from annual data represent an improvement in modeling the biology of the stock, these models introduce a difficulty when applying the Tier 3 proxy for F_{MSY} ($F_{35\%}$) to the currency of management (MMB). Because a large fraction of males mature at a smaller size than targeted by the fishery (>101 mm CW), and because these crab will not grow after the terminal molt, a considerable fraction of MMB is protected from interaction of the fishery. Achieving $F_{35\%}$ in this situation would require near 100% exploitation of industry-preferred males (> 101 mm CW). This problem has long been recognized as an outcome of improved treatment of terminal molt biology in the assessment, and possible approaches for dealing with the problem were discussed by the Simpler Modeling working group. The author has expressed a desire to examine the currency of management for future assessments, potentially changing to an estimate of functional maturity

to better account for the variability in reproductive potential with size, however the CPT has not come to consensus on this approach yet. Three options for tier status and reference point calculation using model 23.3a were presented to the CPT for addressing the problem of very high F values for industry-preferred males, in addition to a fallback Tier 4 option using survey data. These approaches varied in their use of biomass currency, biomass target, and fishing mortality target:

Strategy	F_{MSY} proxy	B_{MSY} proxy	Biomass currency
Tier 3	$F_{35\%}$	$B_{35\%}$	MMB (model)
Tier 4_ssc	M	$B_{35\%}$	MMB (model)
Tier 4_specs	M	B_{avg} (1982-2022)	MMB (model)
Tier 4_survey	M	B_{avg} (1982-2022)	MMB (survey, > 101 mm CW)

The Tier 4_ssc option was not described in the draft SAFE document, but was presented to the CPT. The stock was managed using Tier 3 calculations in previous assessments, with the OFL determined by the F_{OFL} control rule using $F_{35\%}$ as the proxy for F_{MSY} . The Tier 3 proxy for B_{MSY} ($B_{35\%}$) is the MMB at mating based on average recruitment from 1982 to present. The Tier 4_ssc still targets $B_{35\%}$, preserving the use of SPR methods, but would use M as a fishing mortality target to reduce fishing pressure on the largest mature males (i.e., fishing mortality at M will not achieve $B_{35\%}$). Tier 4_specs follows Tier 4 specifications as described in the FMP. Tier 4_survey is the same as Tier 4_specs, but tracks MMB of only large males (> 101 mm) estimated by the NMFS survey as the currency of management.

The stock status using Tier 3 calculations for model 23.3a would be 63% of B_{MSY} in 2022 (i.e., not overfished). As previously described, Tier 4_ssc calculations result in the same $B_{35\%}$, but reduce the F_{MSY} proxy and F_{OFL} based on the model estimate of M . This results in a lower OFL, but maintains that the stock status is above MSST. Tier 4_specs calculations result in a much higher proxy for B_{MSY} (~ double $B_{35\%}$), but stock status (34% B_{MSY}) is more similar to what has been computed by previous assessments, and OFL is about half of what was derived from Tier 4_ssc calculations. Tier 4_survey would close the fishery by the F_{OFL} control rule.

The CPT discussed the pros and cons of these options. Tier 3 calculations are a well established and studied technique, but do not appear to provide appropriate management advice for the stock in its current state (i.e., $B_{35\%}$ can only be reached by removing all the large males). The CPT emphasized that this would be a poor management decision since the best available science on the reproduction of snow crab suggests that small and large mature males are not functionally equivalent in their reproductive contribution. In addition, research on snow crab in eastern Canada suggests that the probability of terminally molting may be affected by the density of large crab (i.e., very low density of large males leads to an increased probability

of terminal molt at a smaller size; Mullaney et al. 2021). Cody noted that EBS snow crab have undergone a period of very low density of large males in the past and preliminary modeling explorations of EBS maturity-at-size data support the findings of Mullaney et al. (2021). A smaller size at terminal molt would likely reduce the reproductive capacity of the stock and decrease the number of crab reaching commercial size. Further, there is added complexity in that there is time-varying probability of terminal molt (i.e., maturity) at size. For this assessment, reference point calculations used the average maturity-at-size across years for which data were available, but those probabilities may not be representative of the population structure in future terminal years given current low densities. Lastly, the stock status confirmed that using $B_{35\%}$ places the stock above MSST, which does not seem appropriate given that the exploitable portion of the stock is estimated to be at an all-time low. The Tier 4_ssc approach would ease fishing mortality on the most reproductively important males, but maintains all the negative issues associated with using $B_{35\%}$ and creates a logical disconnect in that the F_{MSY} proxy, M , cannot reach the biomass target. Tier 4_specs reduces maximum fishing mortality similar to Tier 4_ssc, but B_{avg} (1982-2022) is larger than previously used biomass reference points. Tier 4_survey was dismissed because the CPT felt that model 23.3a better described the dynamics of the population and there was no reason to not use model estimated MMB for reference point calculation.

The CPT ultimately recommended using Tier 4_spec calculations, which result in a stock status that is 34% of B_{MSY} and an OFL of 0.31 kt. This decision was arrived at on the basis that $B_{35\%}$ does not appear to be a conservative biomass target under current conditions, and the stock status better aligns with what the CPT considers the state of the stock to be. The CPT also highlighted that Tier 4_spec calculations are based on moving the snow crab stock into Tier 4 for proxies of both F_{OFL} and B_{MSY} , and is therefore not a departure from methods outlined in the FMP. The CPT emphasized that the move to Tier 4 is only intended to be a temporary measure for 2023, and that the management approach should return to SPR-based methods once more appropriate reference point calculations are available. Solving the root of this problem would require reassessing the currency of management for this stock. The CPT recommended that the ABC buffer be decreased to 20% citing reduced concern over model convergence and bimodality, and use of Tier 4 harvest control rules (i.e., more conservative reference points).

Tanner crab final SAFE

Buck Stockhausen provided a presentation on the Tanner crab final SAFE for 2023/24. The 2022/23 season was the first time since 2015/16 that the State of Alaska set a TAC for both the east (528 t TAC) and west (386 t TAC) Tanner crab management areas. The retained catch was approximately the TAC in both areas, but combined harvest was much less than the OFL (32,810 t). Total catch mortality for this stock was much less than the OFL, therefore overfishing is not occurring. The MMB in 2022/23 was greater than B_{MSY} , placing this stock into Tier 3a.

The NMFS EBS trawl survey results for Tanner crab generally were down in the east and up in the west for male biomass, while female biomass increased in both areas. There is evidence from the size compositions for a large recruitment event in the west, although this should be

interpreted cautiously because recent recruitment events have not materialized into larger size classes.

Buck addressed a number of CPT and SSC comments. He pointed out that the 2022 assessment model's retrospective pattern for MMB was small, although the pattern for recruitment was higher (an SSC request was to explain the large retrospective bias in MMB). He also highlighted recent model development and explorations because the CPT and SSC only recommended one model, essentially the 2022 accepted model (22.03b), be brought forward for specifications at this meeting.

The author provided a thorough review of the recent fishery season data. Overall, larger crab are caught in the east, which is consistent with previous years when that area was open to harvest. The author also provided spatial maps to visually examine spatial survey patterns for multiple life stages. The CPT appreciated the background material on both the fishery and survey data.

The assessment model is based on a Tier 3 size-structured modeling framework that is fit to survey and fishery data, including both removals and size composition data. The model presented here, 22.03b, is last year's accepted model with an adjustment to fix one parameter that was hitting a bound (the parameter controlling the slope of the curve describing retention in the directed fishery during 2006/07 to 2009/10). Overall concerns for this stock and model are similar to previous years. Recent recruit classes observed in the survey size compositions are not moving through the population as expected and, therefore, the model is overly optimistic about the current status of this stock.

Buck reviewed model fit compared to last year and overall. Model fit is very similar to past years, but with no parameters estimated at a bound. Additionally, the majority of jitter runs reached the MLE with a low maximum gradient, so there are no concerns about convergence. The CPT discussion focused on model fit to male maturity data and how it compared to the changes we've seen in size at maturity for snow crab. The same data on annual size at maturity are not available for Tanner crab, so the probability of undergoing terminal molt is estimated in the model for Tanner crab, whereas it is an annual input in the snow crab assessment. The data for Tanner crab does not exhibit the large variability in size at maturity that is seen in snow crab, but some interannual variability does exist.

The CPT agreed that model 22.03b represents the dynamics of the stock as well as possible, and is a slight improvement over prior years. This model is based on the previous assessment model, has good convergence, has no parameters at bounds, and the results are similar to the previous assessment. The model results in an OFL of 36,200 t for 2023/24.

Buck recommended a buffer of 25%, which he also recommended last year (the ABC would be 27,1500 t). Buffer considerations from the past include, but are not limited to: overestimating large crab, uncertainty in population trajectory, and lack of recent recruit classes moving through the population. In addition to the concerns from 2022, there is increased concern for

Chionoecetes stocks that the current harvest control rules do not adequately reflect the reproductive potential of different-sized males. Like snow crab, research suggests that large mature male Tanner crab are much more effective than small mature crab at mating and consequently MMB may not reflect the true contribution of different-sized males to the reproductive potential of the stock. While this issue has been recognized previously by the CPT, the recent concern regarding snow crab has increased our caution regarding the assumptions behind using $B_{35\%}$ and $F_{35\%}$ for these stocks. The CPT found these reasons compelling enough to adopt the recommendation for this year.

As requested from the CPT/SSC and the simpler modeling workshop, Buck provided survey-based Tier 4 “fallback” options based on several time periods for estimating the B_{MSY} proxy required for this approach. The CPT found the rationales behind the candidate time periods unconvincing and, ultimately, recommended using the entire time series since 1982 if this method was adopted for specification setting. This recommended time frame falls in line with what has been used for other Tier 4 stocks and reduces the complexity of choosing another time period without clear criteria. Buck suggested a buffer for this fallback method that would be approximately equivalent to the CV on model-estimated terminal biomass (~8.9%). The CPT approved the use of the CV to set the buffer, but recommended a 10% buffer in order to remain consistent with the current practice of setting buffers in 5% increments.

Overfishing status updates: WAIRKC, PIGKC, PIRKC, AIGKC, SMBKC

The Plan Team determined status updates for WAIRKC, PIRKC, AIGKC, SMBKC, and PIGKC based on total catch in the 2022/23 fishery. Estimated total fishing mortality for WAIRKC fishing in 2022/23 was 0.0012 kt and resulted from bycatch in the AIGKC fishery (0.0002 kt) and bycatch in the groundfish fisheries (0.0010 kt). PIRKC estimated fishing mortality was 0.004 kt. Estimated fishing mortality for AIGKC was 2.567 kt. Estimated total fishing mortality for SMBKC was 0.002 kt. PIGKC estimated total catch mortality is confidential. For all the above stocks, total catch mortality was less than the OFL; therefore overfishing did not occur.

For PIRKC and AIGKC MMB was above MSST, therefore these stocks were not overfished. Estimated MMB for SMBKC was below MSST, thus this stock remains in overfished status. WAIRKC and PIGKC are in Tier 5, therefore, an overfished status determination cannot be made due to lack of biomass data on the stock.

Bering Sea Fisheries Research Foundation update

Scott Goodman and Tim Lohrer provided an update on Bering Fisheries Research Foundation (BSFRF) research activities, funding opportunities, and future planning. Tim recently joined BSFRF as a scientific advisor. Scott began the presentation by potential future funding sources and priorities for future research, including movement, surveys, habitat, recruitment limitation, bycatch, and predation. Current research effort is focused on winter surveys of BBRKC. The first year of the Cooperative Pot sampling project (CPS1) was conducted in March/April 2023 for BBRKC. Planning is in progress for a similar BBRKC pot survey in 2024 and a smaller pilot-scale survey effort for snow crab. Scott noted that current and planned research activities

address several of the top 10 research priorities established by the North Pacific Fisheries Management Council (NPFMC) for 2022-2024. Improved maturity estimation was highlighted as an urgent need given issues with the currency of management in the snow and Tanner crab assessments. Madison Heller-Shiple's PhD work is aimed at addressing management options for *Chionoecetes* crab related to retention size and size-at-maturity.

Scott displayed location data from archival pop-up satellite tags deployed on CPS1 and on the 2023 NMFS summer Bering Sea bottom trawl survey. Tim provided an overview of CPS1 pot survey study design, methods, and preliminary results (water temperature, crab distribution, crab biological attributes, and movement data from satellite tags). As expected, bottom water was colder in March/April than on the summer trawl survey, with the cold pool reaching the northwest corner of the Bristol Bay management area. Crab spatial distribution in CPS1 was: 1) generally similar to that of the subsequent summer trawl survey in June; 2) generally absent in the southwest area below the red king crab savings area; and 3) generally "smoother" than the NMFS trawl survey owing to the larger sample size of the pot survey compared to the trawl stations. Spatial statistics are needed and in the queue for further analysis. It was pointed out that Emily Ryznar's modeling work shows that the NMFS trawl survey has good predictive skill for bottom trawl bycatch of BBRKC in the fall/winter/spring following the summer survey. In response to a question about habitat assessment in areas where crab are absent, it was noted that a project is in the works but funding has not been finalized (Weems et al., NPRB proposal is under review). The CPS1 study also found the majority (>60%) of the captured crab were in areas closed to bottom trawling.

Tim Loher reviewed the biological attributes of female spawning dynamics including the abundance of primiparous and multiparous mature females and egg condition. There were relatively few females captured compared to males, which may imply pot-shyness associated with molting activities. Further, there was a broader range of sizes over which the proportion of mature females occurred than what has been observed in summer trawl survey data, which could be due to a low sample size or timing. Tim summarized the plan for CPS2 which will include an additional pot survey and parallel Nephrops trawl work to better understand the biased sex ratio and the potential for pot shyness. Scott reiterated that planning for the next cooperative pot survey slated for 2024 (CPS2) is underway. The timing will match that of CPS1, but will not include satellite tagging. The spatial footprint will largely be consistent with CPS1, but some changes are under consideration including additional sampling in areas open to bottom trawling. Drafts of CPS1 results are forthcoming: a short report with methods and distribution data is coming imminently, and a second more in-depth report with statistical analyses, tagging analyses, and a fuller discussion will be available ahead of the January CPT meeting. Scott briefly noted what is on the horizon for research planning (pot sampling, camera work, trawl sampling, tagging charters, gear work, etc.) and that coordination with State of Alaska and NOAA partners is underway.

Research Priorities/ CPT Vacancies

Sarah Rheinsmith (NPFMC) presented the MSA-required process for identifying science-based research priorities, which are identified by NPFMC as 5-year priorities, but renewed on a triennial basis with the previous review in 2021. Current priority categories by rank include: (1) critical ongoing monitoring, (2) urgent, (3) important (near term), and (4) strategic for future needs. The different Plan Teams will serve as initial filters to consolidate the priorities with the SSC reducing the list in February 2024 to 8–12 priorities subject to public input and reduced to 10 priorities for presentation to the Council in April 2024. An online link for public input into existing or new priorities is open through October 31, 2023.

The CPT will prioritize the top 3–5 priorities for crab in January 2024, but general consensus was for the CPT to review and narrow priorities to a top 10 prior to January. A tentative ½ day virtual meeting will be held sometime in late November or early December to start the prioritization process, and identify a mechanism for prioritization. The CPT expressed confusion over the current research prioritization categories, and noted that better explanation of categories such as “critical, ongoing monitoring” would be helpful in determining the top 3-5 priorities. Additionally, pre-filtering out research priorities that belong to a broader category of priorities would be helpful. The list of potential priorities currently listed in the database remain as candidates. Brian Garber-Yonts offered to serve as a liaison to the Social Science Planning Team which is meeting on November 3, 2023 to discuss research priorities. In response to CPT uncertainty over the results of identifying research priorities, Sarah noted that priorities are distributed to funding entities (e.g., NPRB) for funding considerations. Industry representatives noted that these priorities guide a lot of which research to pursue next, and some items are figured out and some are not in terms of logistics and working with agencies, etc., to identify issues and possible funding. Nicole Watson (NPFMC) is also working on a process to track priority submissions, and will also review new potential priorities (submissions up to October 31) to see which already exist in the research priority database. Research priorities identified in 2021 largely remain true, although a new priority could emerge.

The CPT discussed the two current vacancies on the team: one position intended to focus on a management perspective (tentatively from ADF&G) and one position (previously from ADF&G) with biometric expertise. The ADF&G management position has worked out well being based out of Dutch Harbor because of the link to the fishing industry. For the biometric position, it would be useful to have someone with stock assessment expertise that could help with assessments, but that individual doesn't necessarily need to come from the crab realm. It was noted that all crab stocks have an assessment author on the CPT except for Norton Sound RKC. Although not in the current list of member positions, the CPT also lacks an individual with social science skills beyond Brian's role as an economist. Brian noted that most agencies have limited socioeconomic positions, so finding a position might involve recruiting from academia. Nominees for these positions could presumably be presented for consideration at the December Council meeting. People should contact Sarah with names of individuals that might be interested in being on the CPT.

Survey Modernization

Mike Litzow (NMFS-Kodiak) presented an update on the process for survey modernization. The NMFS survey team is proposing updates to the Bering Sea summer bottom trawl survey that include updated survey techniques, modernized equipment, and efforts to improve sampling methodology to provide a holistic view of the Bering Sea to include surveys in the Northern Bering Sea (NBS), Eastern Bering Sea (EBS), and Bering sea slope. Additionally, the survey modernization would aim to reduce total tow time to aid with catch volume, number of tows performed, and split catch. The six proposed components of the survey modernization effort are:

1. Sampling design – area, frequency, sampling density (work started in 2023; Lewis Barnett)
2. Determining 15 versus 30 minute catchability/selectivity correction factors (work started, more data collections needed; no lead)
3. Combining slope/shelf data and determine calibration factors between current slope and shelf gears (work started in 2023; no lead)
4. Survey bottom trawl gear and fishing methods redesign (workshop with stakeholders planned for October 2023; Shawn Russel, Nicole Charriere)
5. New survey gear calibration (no start date yet, no lead)
6. Survey time series calibration, transition design, and transition implementation (no start date yet, no lead)

Projects 1-4 can be done in parallel, projects 5-6 can be completed only after 1-4 are done.

Given the number of changes proposed, Mike indicated that the NBS survey is going to be moved to a biennial cycle, on odd years. The process for modernizing the survey is still in the early stages, and the need for stakeholder engagement at this point was highlighted. Establishment of public facing workshops to gain feedback on the modernization process is underway. The October 2023 workshop will specifically focus on component number 4, and additional industry insight is requested. If interested please email: Nancy Roberson nancy.roberson@noaa.gov, workshop coordinator. It was also suggested that ADF&G be included in northern Bering Sea survey effort reduction conversations, as the ADF&G NSRKC trawl survey could offset the biennial NMFS NBS survey, and side-by-side gear comparisons between the two surveys could be warranted to permit the inclusion of both data sources in the NSRKC assessment model.

New business

Request for Reporting on Industry voluntary crab avoidance measures at the December 2023 Council meeting. Sarah Rheinsmith communicated the Council request for industry members to provide on voluntary crab avoidance measures at the December 2023 meeting, during B reports.

Upcoming meetings:

Jan 8th - 12th, Anchorage, AK

May 13th - 17th, Location TBD

September 9th - 13th, Seattle, WA

January modeling workshop topics:

- Review the SAFE intro “recommendations for all assessments”
- GMACS development - NSRKC, Tanner
 - Potential for GMACS user group pre-meeting to work on a consensus version of GMACS file annotation
- Simpler modeling workshop suggestions / outcomes
 - Q: options for using BSFRF data
 - Reductions in bycatch fleets in the models
- BSFRF selectivity studies used for BBRKC and Tanner crab (Buck)
- Currency of management discussion (modeling workshop and CPT discussion)
- B35% / F35% discussions on appropriateness for terminally molting crab
- Review projections for crab stocks, including the settings for these projections and how they should be reported (future CPT meeting - Jan or May).

January CPT agenda topics:

- NSRKC final SAFE
- AIGKC proposed models
- Economic SAFE
- Research priorities
- Currency of management discussion
- Tier 4 reference period criteria
- UFMWG (unobserved fishing mortality working group) update
- Handling mortality rates - consistency among stocks and next steps
- ESP development and prioritization (30 mins discussion and planning for May)
- Stock prioritization
- Research updates:
 - Genetics of RKC (Carl St. John)
 - Stock enhancement review of research (Ben Daly)
 - LTK for NSRKC (Sara Wise)
 - Temperature effects on survival, intermolt duration, molt increment, and growth rates of early benthic snow cra band tanner crab (Louise Copeman, AFSC-Newport)
 - Bitter crab disease spatiotemporal dynamics (Laurie Balstad)

Others in attendance: *(alpha order)*

Ali Whitman	Heather McCarty	Nicole Watson
Allie Conrad	Henry Tashijan	Nikolai Silverstol
Andrew Olson	Intrafish media	Noelle Yochum
Andy Nault	Jamie Goen	Paul Wilkins
Anne Vanderhoeven	Jared Weems	Rachel Sapin
Austin Estabrooks	John Gauvin	Ralin Sunurin
Bo Whiteside	John Hilsinger	Russel Dame
Brian Ritchie	Jonathan Richar	Ruth Christiansen
Bridgette Ferris	Joshua Songstad	Sam Cunningham
Caitlin Stern	Julien Lartigue	Scott Callahan
Cassie Whiteside	Kalei Shotwell	Scott Goodman *
Charlie Hansel	Katie Sweeney	Sean Dwyer
Chris Siddon	Kristen Dobroth	Sean Rohan
Connie Melovidov	Kyle Trader	Shannon Hennessey
Cory Lescher	Lance Farr	Sherri Dressel
Craig Lowenberg	Landry Price	Steve Ricci
Dana Hanselman	Leah Zacher	Susie Zagorski
Dana Rudy	Samuel Comeau	Tim Loher *
David Bryan	Leah Zacher	Tom Gemmell
Diana Evans	Linda Kozak	Vicki Vanek
Doug Wells	Lorena Rosenberger	Wes Jones
Edward Paulsen	Lucas Henkel	Zach Liller
Elizabeth Siddon *	Madison Heller-Shiple	
Emily Ryznar	Maggie Mooney-Seus	
Ernie Weiss	Marc Solano	
Frank Kelty	Mark Stickert	
George Steers	Martin Dorn	
Gordon Kruse	Michael Martin	
Gretar Gudmunson	Nat Nichols	
Hamachan Hamazaki*	Nick Sagalkin	
Heather Mann	Nicole Kimball	

* denotes a presenter at CPT