North Pacific Fishery Management Council

Simon Kinneen, Chair | David Witherell, Executive Director
1007 W. 3rd Avenue, Suite 400, Anchorage, AK 99501
Phone 907-271-2809 | www.npfmc.org

Crab Plan Team

REPORT

Sept 14-17, 2020
Online Public Meeting

Members in Attendance

Martin Dorn, **Co-Chair** (AFSC-Seattle)
Katie Palof, **Co-Chair** (ADF&G-Juneau)
Jim Armstrong, **Coordinator** (NPFMC)
William Bechtol (UAF-Homer)
Ben Daly (ADF&G-Kodiak)
Ginny Eckert (UAF/CFOS-Juneau)
Erin Fedewa (AFSC - Kodiak)
Brian Garber-Yonts (AFSC-Seattle)
Krista Milani (AKRO-D.Harbor)
André Punt (U.Washington)
Shareef Siddeek (ADFG-Juneau)
William Stockhausen (AFSC-Seattle)
Cody Szuwalski (AFSC–Seattle)
Miranda Westphal (ADFG-D.Harbor)
Jie Zheng (ADF&G-Juneau

Others in Attendance

Rachel Alinsunurin (ADFG, D.Harbor)
Kerim Aydin (AFSC, Seattle)
Julie Ayres (ADFG, D.Harbor)
Jen Bell (ADFG, Nome)
Charles Brazil (ADFG, Anch.)
Lyle Britt (AFSC, Seattle)
Meaghan Bryan (AFSC, Seattle)
David Bryan (AFSC, Seattle)
Ryan Burt (ADFG, Kodiak)
Damien Catala
Kelly Cates
Brett Cheney (Peoples Bank)
Kevin Clark (ADFG, Nome)
Sara Cleaver (NPFMC, Anch.)
Kenny Down (NPFMC)
Sherri Dressel (ADFG, Juneau)
Angel Drobnica (APICDA)
Ashley Dunker
Meaghan Faneuf (ADFG, D.Harbor)
Bridget Ferriss
Robert Foy (AFSC, Juneau)
Shannon Gleason (NPFMC, Anch.)
Jamie Goen (ABSC, Seattle)
Scott Goodman (BSFRF, Seattle)
Gretar Gudmundsson (F/V Valiant)
Hamachan Hamazaki (ADFG, Anch.)
Dana Hanselman (AFSC, Juneau)
Madison Heller-Shipley (UW-BSFRF)
Kendall Henry (ADFG, Juneau)
Leonard Herzog (F/V Tempo Sea)
John Hilsinger (AKCR)
Anne Hollowed (AFSC, Seattle)
Jim Ianelli (AFSC, Seattle)
Tyler Jackson (ADFG, Kodiak)
Wes Jones (NSEDC)
Frank Kelty (City of Unalaska)
Scott Kent (NSEDC)
Linda Kozak (FVOA)
Owen Kvinge (fisherman)
Sarah La Belle (NPFMC, Anch.)
Charlie Lean (NSEDC)
Cory Lescher (ABSC)
Mike Litzow (AFSC, Kodiak)
Chris Lunsford (AFSC, Juneau)
Sarah Marrinan (NPFMC, Anch.)
Angela Moran (NPFMC, Anch.)
Andrew Munro (ADFG, Anch.)
Andy Nault (ADFG, Kodiak)
Nat Nichols (ADFG, Kodiak)
Andrew Olson (ADFG, Douglas)
Ivonne Ortiz
Edward Poulsen (BSFRF)
Landry Price (YDFDA)
Matt Robinson (BBEDC)
Mike Shelford
Rick Shelford
Kalei Shotwell (AFSC, Juneau)
Chris Siddon (ADFG, Juneau)
Elizabeth Siddon (AFSC, Juneau)
Gary Stauffer (BSFRF)
George Steers
Mark Stichert (ADFG, Kodiak)
Diana Stram (NPFMC, Anch.)
Vicki Vanek (ADFG, Kodiak)
Jared Weems (UAF)
Ernie Weiss (AEB)
Bo Whiteside (ADFG, Kodiak)
Paul Wilkins (CVRF)
Katherine Wilson
Noelle Yochum
Leah Zacher (AFSC, Kodiak)
Stephani Zador (AFSC, Seattle)

1. Administrative

Due to the COVID-19 pandemic the September 2020 Crab Plan Team (CPT) meeting was held entirely online. Video conferencing and presentations were provided through the Adobe Connect meeting platform, and connection information was posted to the CPT eAgenda. The meeting began shortly after 8:00 a.m. on Monday, September 14, 2020 with technical set up and overview of the meeting application. The CPT reviewed assignments and timing for meeting deliverables, including finalizing the SAFE Introduction chapter and this CPT Meeting Report. CPT Co-Chairs Martin Dorn and Katie Palof reviewed guidelines for the meeting, including public comments. The CPT reviewed and adopted the recommendations on stock projections from a report by a CPT subgroup that met over the summer. The report is appended to this document for review by the SSC. In adopting the recommendations, the CPT

emphasizes that the number of projection scenarios should be limited to the extent possible to avoid possible confusion.

2. Summer Trawl Survey - Disc. with RACE Div.

Lyle Britt from the AFSC RACE Division presented plans for bottom trawl surveys in 2021, which include the standard suite of surveys for an odd year - annual Eastern Bering Sea (EBS), biennial/annual Northern Bering Sea (NBS), and biennial Gulf of Alaska (GOA) surveys. In order to prepare for these surveys, RACE is working to increase staffing and develop remote training programs for new staff. Over half of the survey team staff will be new and will require extensive training. In addition, new COVID-19 safety and operational procedures are in development, including updating protocols and developing prioritization scenarios for data collection, if needed.

Lyle presented the history of AFSC bottom trawl surveys from 2010-2020 and pointed out that 2020 is not the first time multiple surveys have been cancelled. The Bering Sea slope survey was cancelled in 2014 and 2018 and the use of a third vessel has often been cancelled in the GOA. 2020 was unique, however, as five of six large-scale assessment surveys in federal waters off Alaska were cancelled due to the pandemic.

Lyle also discussed an ICES Workshop on Unavoidable Survey Effort Reduction (WKUSER) that was held in January 2020. This workshop addressed how to gain viable data after sudden inseason changes to surveys, such as from the pandemic or vessel breakdowns. The workshop was not meant to answer survey priority questions such as prioritizing one region over another. The workshop also looked at tools that would optimize the surveys.

The Alaska Fisheries Science Center (AFSC) and a sub-committee of the Science and Statistical Committee (SSC) met on August 28, 2020 to discuss future survey priorities. This discussion was intended to clarify survey priorities regardless of COVID-19. The CPT co-chairs and several other CPT members participated in this meeting. There were five main questions AFSC asked the sub-committee to consider when prioritizing future surveys:

- Should NBS or increased GOA station density and deep station coverage be the priority? The sub-committee recommended the NBS survey over the GOA deep stations.
- Should GOA surveys be annual? The sub-committee concluded that sacrificing another area to achieve annual GOA surveys was undesirable.
- Should the NBS become a standard survey? The sub-committee recommended yes, with combining with the EBS in the near term and assessing the feasibility of a biennial NBS survey in a few years. Norton Sound should be included in these surveys.
- If surveys become severely limited, should full surveys in one core area or partial surveys in multiple core regions take precedent? Although undesirable, the sub-committee proposed a biennial schedule for full surveys in each year instead of conducting partial surveys. The EBS and NBS could take place one year and the GOA and AI on alternate years.
- Should a Chukchi Sea survey take priority over a core survey area? The sub-committee prioritized surveys in areas where fisheries are actively managed instead of expanding to the Chukchi Sea.

The CPT asked what happened to funds from cancelled 2020 surveys. These were redirected to secure contracts for 2021 surveys and to modernize environmental data collection tools, including, for example, purchasing additional CTDs.

The CPT discussed the possibility of crab-specific surveys (pot or trawl) as a contingency plan if there are no 2021 NOAA trawl surveys. At this time, there are no plans to conduct crab-specific surveys, as there is a relatively high expectation that the 2021 surveys will occur as planned, though significant uncertainties remain. There was also some concern on how useful a crab-specific pot survey would be in assessments without a historical time series. Pot survey data would not be immediately useful. Planning for surveys during the COVID-19 pandemic will take considerable effort and it is preferable that resources be used to plan for the traditional trawl surveys, instead of redirecting effort into a contingency plan.

Supplemental surveys beyond the standard NOAA trawl surveys may help to fill in data gaps in the future. For example, if the NOAA trawl surveys in the EBS changed from annual to biennial, a supplemental survey during the off years may help inform stock assessment models. The Bering Sea Fisheries Research Foundation (BSFRF) has conducted trawl surveys in the past to supplement NMFS surveys, and, for specific stocks and in some regions, a BSFRF historical time series exists. However, it is unlikely that an industry survey could cover the full extent of every stock, especially snow crab. Consequently, an industry trawl survey might only be beneficial for some crab stocks. Scott Goodman from BSFRF stated that an industry trawl survey may be possible, but would require considerable planning and advance notice. Hopefully, there will be more information in early 2021 about the progress of the 2021 NOAA surveys. If there is an indication in early 2021 that these surveys will not proceed, contingency plans can be developed.

The CPT recommends further dialogue with BSFRF to discuss the possibility of an industry survey should NOAA surveys be cancelled.

3. CPT approach to evaluating impacts of the cancellation of the 2020 survey

Annual NMFS bottom trawl surveys are critical to the management of crab stocks in the eastern Bering Sea. In the summer of 2020 this survey was cancelled due to safety and logistical issues associated with the COVID-19 pandemic. This represents the first break in a survey time-series that has been conducted annually for over 45 years. Early in the history of Council management of Bering Sea crab stocks, catch limits such as OFL and ABC were derived directly from survey biomass estimates. In the current era, assessment models are fit to survey data as well as fishery data. All crab assessments are able to project a 2020/21 OFL and ABC in the absence of a survey in the final year of the assessment using the information that is available. The critical question that the CPT needed to address at this meeting was whether increased uncertainty associated with the 2020 survey cancellation warranted a change in management recommendations for crab. The SSC is responsible for setting the OFL and the ABC for crab stocks, but the CPT provides preliminary recommendations to the SSC for review and potential modification.

Crab assessment authors met with the CPT and SSC co-chairs over the summer and agreed to produce two analyses described below for each assessment affected by the 2020 survey cancellation to help inform the CPT and SSC in developing OFL and ABC recommendations. An additional approach (Approach 2) was determined to be a subset of approach 1 and was not reported. The impacted crab assessments reviewed at this meeting were BBRKC, snow crab, Tanner crab, and SMBKC.

Approach 1: Retrospective analysis with two sets of runs.
This approach entails conducting two sets of retrospective runs. The first set consists of the standard retrospective analysis in which data are removed from the assessment sequentially one year at a time starting with the most recent year. The second set of retrospective runs is like the first except that the survey data in the final year are also removed. One set of comparisons would look at the CVs of estimated management quantities such as OFL and MMB based on the usual Hessian approximations provided by

ADMB. We would anticipate that the average CV for the runs omitting the last year of survey data would be higher than the average CV when these data are available. A second kind of analysis would be to consider the most recent assessment as the "truth," and look at the mean squared error (MSE) between management quantities estimated in the retrospective runs and the most recent assessment. Again the expectation would be that MSE would be larger for runs without a terminal year survey.

Approach 3: Sensitivity analysis with high and low proxy surveys

This method evaluates the impact of different hypothetical 2020 survey outcomes, and is based on a recommendation from the June SSC minutes. For the survey time series fit in the preferred model for this year, calculate the multiplicative residuals, $\hat{y}_i/y_i$, where y_i is observed survey observation, and $\hat{y}_i$is the predicated survey observation after fitting the model. Obtain the 25th and the 75th percentiles of the multiplicative residuals (in R: quantile(mresids,prob=c(0.25,0.75)). The rationale for the 25th and 75th percentiles is that they are typical high and low values for the survey. Obtain the predicted survey value for the 2020 survey by putting in a trial survey value for 2020 with a very high CV, say 100, so that the model does not attempt to fit that observation. Multiply the predicted survey value by the 25th and 75th percentile of the multiplicative residual for a high and a low survey observation for 2020. Assume a CV equal to the median CV and fit these values in two model runs to evaluate sensitivity to variation in the ending year survey. Large changes in management quantities such as OFL and MMB indicate high sensitivity. This sensitivity analysis evaluates the behavior of the assessment model in the current year, while the first analysis evaluates the historical performance of the assessment.

The CPT received a presentation from Meaghan Bryan (AFSC Seattle) on a retrospective analysis using the first approach described above. The purpose of her investigation was to get a better understanding of the uncertainty associated with the loss of the most recent survey data for a number of groundfish and crab species, and to identify those stocks that would be more sensitive to the loss of data. Meaghan described several statistics that she used to characterize retrospective patterns, including model-estimated CVs, Mohn's rho, a sigma statistic used by Ralston et al. (2011) to characterize assessment uncertainty, and an additional variance statistic that quantified the increased variance when the terminal survey is dropped. The results indicated that estimated CVs for ending biomass were consistently higher in runs without a terminal year survey, but in most cases the increase in uncertainty was minor to moderate. Stronger contrast was found in retrospective statistics, with some stocks showing little difference in retrospective statistics while other stocks showing much larger differences. Assessments with a consistent retrospective bias exhibited greatest uncertainty and the largest impact due to a missing terminal year survey.

At the start of this meeting before reviewing any stock assessment, the CPT discussed three possible approaches for dealing with the cancellation of the 2020 survey:

- No additional ABC buffers for any stock assessment to account for the cancellation of the 2020 survey.
- Add the same additional ABC buffer for all assessments affected by the cancellation of the survey (for example a 10% additional buffer).
- Take a species-by-species approach to decide on a buffer. An additional buffer should be considered only for stocks where assessment uncertainty increases appreciably.

Based on Meaghan's analysis showing strongly differing impacts by stock, the CPT concluded that the third option was the best course of action. The CPT also agreed to revisit all of the buffer recommendations at the conclusion of the meeting to ensure that recommendations were consistent, and to address any new issues that might have arisen.

Below, we show two plots that were found by the CPT to be highly informative about the implications of the cancelled 2020 survey. Additional analyses are included in the SAFE chapters and discussed in the

CPT minutes for each stock. Figure 1 shows the proportional increase in the OFL when the terminal year survey is removed in the retrospective analysis. By far the largest increase is for snow crab, followed by a more moderate increase for BBRKC. Proportional increases for SMBKC and Tanner crab are minor. Figure 2 summarizes the percentage change in OFL between high and low proxy 2020 surveys for the third approach. The snow crab assessment shows the largest sensitivity to survey biomass variation, followed by SMBKC and BBRKC with moderate sensitivity, and Tanner crab with low sensitivity.

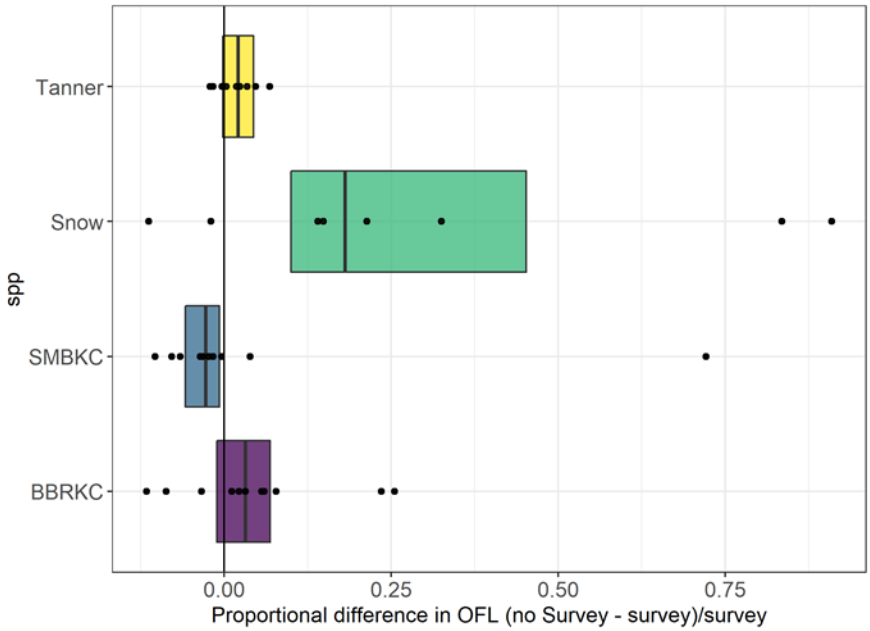

Figure 1. Proportional difference in OFL between retrospective runs without a terminal year survey and with a terminal year survey.

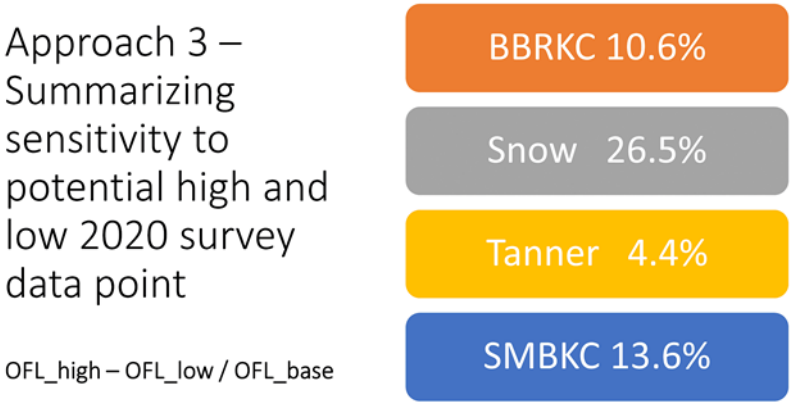

Figure 2. Summary of results from sensitivity analysis with high and low 2020 survey estimates.

4. Fishery summary 2019

Ben Daly and Krista Milani presented summaries of the 2019/20 fishery season and crab bycatch in the groundfish and flatfish fisheries. Funding for the crab fishery catcher-vessel on-board observer program is provided through cost-recovery fishing and three federal grants. Catcher-vessel observer coverage ranges from 20 to 50% depending on the fishery with selected vessels required to carry an observer for all fishing activities during the season. On-board observers are required for all fishing activities on catcher-processors with funding by the vessel. Observer coverage levels are determined by the proportion of landings observed and has met or exceeded coverage levels in the recent time series. For fished pots, 1-5% of all pots fished are observed and these data serve as the basis for all fishery expansions. Observer coverage in the directed fisheries for the upcoming season will be generally status quo and adaptations have been made according to current COVID-19 mandates.

Observer coverage in the groundfish fisheries varies by vessel type and gear type. Full coverage is required for catcher-processors, motherships, and shore-side pollock catcher-vessels; partial coverage is required for catcher-vessels targeting groundfish, halibut, and sablefish; and no observer coverage is required for vessels less than 40 ft length, catcher-vessels using jig gear, vessels without a federal fishing permit, and vessels participating in a state-waters directed fishery. Vessels with electronic monitoring (EM) equipment are not required to carry an observer and instead are required to have their EM turn on and recording for selected trips. Vessels without observer coverage still have bycatch rates applied to their fishing activities, which can skew actual bycatch amounts. Observer coverage rates for 2019 were 24% for trawler catcher-vessels, 18% for hook-and-line vessels, 27% for trawl tenders, 15% for pot vessels, and 16% for pot tenders. For the 2020 season, observer coverage rates are 20% for trawler catcher-vessels, 15% for hook-and-line vessels, 15% for pot vessels, regardless if they deliver to a tender or not. In both 2019 and 2020 the target rate to have the EM recording was 30%. Due to COVID-19, vessels in the partial observer coverage category had observer requirements waived from March 26 through June 28. The EM vessels were not included in the waiver and all BSAI A season Pacific cod fisheries were concluded prior to March 26.

An historical crab table documenting the BSAI crab fisheries dating back to 1960 was constructed by Krista Milani and has been updated to include directed catch. The table is published on the NMFS website and the excel file is available upon request.

Ben provided a perspective on the factors that are considered in the State's TAC setting process used to establish a catch limit less than the ABC. There are annual challenges with TAC setting due to model uncertainty. There is some level of uncertainty with all stock assessment models which is addressed with a buffer between the OFL and ABC; however, other model outputs used as inputs in the state harvest strategies for setting the annual TAC (MFB, MMB, legal male abundance, female abundance, etc.) do not reflect model uncertainty buffers. Ben provided examples of sources of uncertainty for AIGKC, Tanner, and snow crab.

Bristol Bay red king crab

The total catch for the 2019/20 season was 3.914 million pounds, the lowest catch in recent history. Legal male CPUE has declined over the past 5 seasons. Harvest this past season was more westerly in Bristol Bay than any other past fishery going back to 1985. Most of the harvest occurred within the first two weeks of the fishery in four statistical areas. Fishermen noted that there seemed to be only one small aggregation of crab that was quickly fished out. Low CPUEs were seen for most vessels throughout the duration of the fishery with vessels moving gear often and letting pots soak for less time in an effort to locate crab. Discard mortality rates within the directed fishery have been high the past two seasons, around 0.2 pounds of bycatch mortality per pound retained crab. This is likely due to an increase in sublegal and old shell legal males being captured in pots. Additionally, average weight of retained catch has been increasing over the past five seasons and was greater than 7 pounds for the last two seasons.

Bycatch of red king crab in the groundfish fisheries comes primarily from the under 60-foot Pacific cod pot fisheries and the yellowfin sole trawl fisheries.

Bering Sea Tanner crab

Uncertainty in the Tanner crab model occurs with the model estimating the population across the eastern Bering Sea, but the stock is also being managed with two distinct fisheries (eastern and western Bering Sea Tanner fisheries). Additionally, the model consistently overestimates the industry-preferred 5-inch male population. Possible treatments of the model outputs are to apportion model estimates east and west based on raw survey proportions, to include buffers to the 5-inch male estimates, or to use raw survey area-swept estimates as inputs to the harvest strategy.

Fishing in the western Bering Sea area mainly occurs near the western and southeast boundary of the Pribilof Islands closure area. In the 2018/19 fishery fishermen reported spotty fishing with CPUE ranging widely. Both eastern and western Tanner crab fisheries were closed for the 2019/20 season, but the 2017-2019 surveys showed strong juvenile cohorts, which could lead to increased catches in the future.

Based on the NMFS bottom trawl survey, approximately 50% of the 5-inch legal male population is located within the Pribilof Islands closure area.

In 2019, ADF&G deployed satellite tags in an effort to better understand immigration and emigration of Tanner crab in the Pribilof Islands closure area between the time of the summer survey and when the fishery occurs. Tagged crab released in the middle of the closure area did not leave the closure area by January, whereas crab located around the boundaries moved into and out of the closure area at approximately the same rate. It was suggested that because of this, the summer survey spatial distribution is a reasonable representation of the population at the time of the survey; however, it was noted that the tagging results presented were for a single year and do not reflect any interannual variation in movement.

In the western area, bycatch in the groundfish fisheries occurs mainly in the yellowfin and flathead sole trawl fisheries. In the eastern area, bycatch is attributed mainly to the fixed gear (pot fishing in A season in January through March and B season in September) Pacific cod fishery and the yellowfin sole trawl fishery.

Bering Sea snow crab

Estimates of MMB are sensitive to how maturity is defined and there is a strong retrospective pattern in the assessment which increases uncertainty in the true population size. ADF&G currently uses a qualitative risk assessment report card to inform any further reductions from the TAC based on the harvest strategy, and has used both survey area-swept and model-based estimates in the harvest strategy. The 2019/20 harvest was 34.025 million pounds and legal male (≥3.1 inches) CPUE was high in observer sample pots, but retained catch CPUE of industry-preferred size males (≥4 inches) in the retained catch was low for the rationalized time series, likely due to a high proportion of legal males below the industry-preferred size in the population. Harvest occurred mostly north and west of the Pribilof Islands with sea ice limiting fishing on the northern grounds for two months (February and March) of the fishery. Harvest accrued steadily over the 4½ month fishery. Fishermen reported heavy sorting throughout the season due to large numbers of crab smaller than industry-preferred size on the fishing grounds. Higher CPUEs occurred farther north but were lower than in the 2018/19 season. Fishermen reported sorting through what appeared to be the same crab over and over to get males of the industry-preferred size. Average weights have decreased over the four seasons. Discard mortality rates of legal males have increased since 2010 and reached a high for the time-series in 2019/20, with a rate of 1.652 legal crabs discarded for every legal crab retained. The proportion of legal males smaller than the industry peferred size has increased over the past ten seasons and is currently close to 90% of the population, although selectivity of sub-industry-preferred legal males has remained steady at 5%, suggesting the higher discard rate in 2019/20 was likely due to the population size composition, not changes in fishing behavior.

Snow crab bycatch in the groundfish fishery mainly occurs in the yellowfin and flathead sole trawl fisheries. It was also noted that current bycatch levels are relatively low in comparison to historical levels.

During CPT discussion, it was noted that the current snow crab stock assessment model assumes discarded crab may only be caught and released once. This contradicts industry reports that harvesters have the impression that they are repeatedly capturing the same crab with compounded mortality. This could be an assessment issue and was flagged for discussion at the January meeting.

Aleutian Islands golden king crab

The stock assessment model for golden king crab is fairly new and it was noted that the EAG portion of the stock has a fairly strong retrospective bias. To deal with this in the TAC setting process, the State has considered buffering the computed TAC based on average terminal year overestimation as depicted in the retrospective analysis.

Total harvests in the Aleutian Islands golden king crab fisheries have increased over the past few years with adoption of a new harvest strategy. CPUE has remained relatively high and steady over the past eight seasons. Harvest accrues steadily over the course of each season and is distributed along most of the Aleutian chain. Severe weather disrupted fishing throughout the 2019/20 season. Total bycatch mortality in the directed fishery in the west has decreased over the most recent seven seasons while bycatch mortality in the east has increased over the past 13 seasons. The bycatch mortality rate in the 2019/20 fishery was ~0.14 pounds of discard mortality per pound of retained catch in the east and ~0.9 pounds of discard mortality per pound of retained catch in the west.

Bycatch in the groundfish fisheries results primarily from fixed gear Pacific cod fisheries in the eastern area and mainly from fixed gear Pacific cod fisheries and rockfish and Atka mackerel trawl fisheries in the west. Fixed gear bycatch in the west correlates with whether or not there is an operating processing plant in the Aleutian Islands.

Pribilof Islands golden king crab

The Pribilof Islands golden king crab fishery occurs within a calendar year with much of the data for this fishery confidential due to limited participation. The GHL was not achieved in 2018 but was achieved in 2019. Most of the harvest in this fishery occurs in the Pribilof Canyon. Bycatch in the groundfish fisheries is mainly attributed to Greenland turbot and rockfish trawl fisheries.

Pribilof Islands red and blue king crab

Directed fisheries for red and blue king crabs in the Pribilof Islands are closed and will remain closed for the foreseeable future. Bycatch of red and blue king crabs in the groundfish fisheries mainly occurs in yellowfin and rock sole trawl fisheries.

Aleutian Islands red king crab

The directed fishery for red king crab in the Aleutian Islands is closed. For the past five seasons, the majority of red king crab bycatch in the groundfish fisheries comes from trawl fisheries and was 742 kg, mostly from the rockfish and Atka mackerel fisheries for the 2019/20 season.

Saint Matthew blue king crab

The directed fishery for blue king crab in Saint Matthews is closed. The majority of bycatch in this area is from fixed gear Pacific cod fisheries. Most of this area is closed to trawl fishing.

Norton Sound red king crab

From 2009 to 2017, there was no reported bycatch of Norton Sound red king crab in the groundfish fisheries. Over the past two seasons, hook-and-line Pacific cod fishing has increased with a small amount of bycatch mortality (8 kg in 2018 and 13 kg in 2019). While pot cod fishing also occurred in this area in 2020, most vessels are too small to require observer coverage so observer data are not available.

The presentation concluded with a brief discussion of groundfish bycatch estimation, and the change in method of obtaining observer data that went into effect during 2017. Data for 2009 to 2016 calendar years are sourced from AKFIN and data from the 2017 calendar year onward are sourced from NMFS Alaska Regional Office. The change in the 2017 calendar year to current was notable because it began including all groundfish rather than just retained groundfish. This change impacts the 2016/17 crab year because of the overlapping time period.

5. Ecosystem Status Report

Ebett Siddon, lead for the EBS Ecosystem Status Report, reviewed 2019 crab-relevant ecosystem indicators, 2020 EBS climate and oceanographic conditions, and 2021 forecasts for sea surface temperatures. 2019 pelagic larval and benthic adult crab indicators were categorized as 1) environmental processes, 2) prey, 3) competitors, and 4) predators. While these categories are not necessarily mutually exclusive, they represent potentially important drivers of crab recruitment and survival.

2019 OSCURS model runs indicated consistent westerly winds and westward drift of surface waters, which may carry crab larvae away from good habitat. However, westerly winds are also unfavorable for flatfish predators. Surface temperatures in 2019 were the second highest in the EBS bottom trawl time series and bottom temperatures reached a record high in 2019, resulting in a small cold pool over the northern EBS shelf. The spring bloom in 2019 was earlier than the long-term average and the magnitude of the bloom was above average, suggesting good feeding conditions for pelagic larval stages of crab. Furthermore, zooplankton communities dominated primarily by small copepod in 2019 may have decreased competition for phytoplankton prey. Motile epifauna competitor biomass in the EBS was above the long-term mean but brittle stars, urchins, sand dollars and sea cucumbers decreased by 10% from 2018 to 2019. Benthic forager biomass remained low in 2019 with continued declines in northern rock sole, suggesting that competition with benthic adult crab may be low.

Predators of larval and adult crab stages were divided into pelagic foragers and apex predators. It was noted that gray whales may be a potential predator of larval crab in warm years, although an unusual whale mortality event in 2019 may reflect poor larval feeding conditions in the Bering Sea. Pelagic forager biomass in 2019 was characterized by large increases in pollock (+74%) and jellyfish (+164%). Apex predators are at the long term mean with declines in Pacific cod offset by increases in Arrowtooth flounder. Bristol Bay sockeye salmon, a potential major predator on crab larvae, have experienced record-high runs coincident with declines in Bristol Bay red king crab. Overall, larval crab indicator scores suggest negative implications for environmental conditions and predation pressure, and positive implications for prey resources and competition. Benthic adult indicator scores suggest negative implications for predation pressure and a combination of negative and positive implications for environmental conditions and competition.

2020 climate and oceanographic conditions were described with sea level pressure and temperature anomalies, large scale climate indices, sea ice extent, as well as bottom temperatures, cold pool extent and ocean acidification indices from Bering 10K ROMS model output. In fall/winter 2019, the development of a large, positive high pressure system in the Gulf of Alaska brought warm winds from the south over the EBS shelf in spring 2020, contributing to the retreat of sea ice and increased sea surface temperatures. The North Pacific Index and Arctic Oscillation best reflect EBS conditions and both indices saw large increases in winter 2020 (though have since returned to neutral), leading to the coldest land temperatures since 1988-1989.

2020 had a near-normal spatial extent of sea ice, although the ice was thin and warm winds in the spring promoted rapid ice retreat. Late winter sea surface temperatures were near the long-term mean in 2020 but above-average temperatures returned in spring to summer months and current temperatures remain above average. The cold pool extent in 2020 was average and most similar to cold pool conditions in 1997. It was also noted that a large coccolithophore bloom occurred in 1997 and recent observations have

indicated that a similar bloom started in mid-August of 2020. ROMS model hindcasts were used to develop an ocean acidification index, defined as the spatial extent of bottom waters with an average July-September aragonite saturation state <1. Bottom water corrosivity in the EBS has remained fairly steady, with ~50-60% of the EBS shelf represented by corrosive waters. To conclude, Ebett reviewed projections for 2021 sea surface temperatures, which suggest continued warmth in the Bering Sea with the potential for delayed sea ice that will be dependent on the pervasiveness of southerly, warm winds.

The CPT acknowledged the efforts of all contributors to the EBS Ecosystem Status Report and thanked Ebett for her focus on indicators specific to crab life history stages. The CPT recommends continued coordination between the EBS Ecosystem Status Report and BSAI Crab Ecosystem and Socioeconomic Profiles, and continues to look forward to the high-level ecosystem overview that the Ecosystem Status Report provides prior to SAFE reviews each September.

6. Ecosystem, Socioeconomic Profiles

Erin Fedewa and Brian Garber-Yonts provided an overview of the 2020 Bristol Bay Red King Crab (BBRKC) Ecosystem and Socioeconomic Profile (ESP) as well as a 2020 Executive Summary for Saint Matthew Blue King Crab (SMBKC) ESP; both will be included as appendices to their respective SAFE chapters. These stocks were previously identified as high priority for ESP development because of continuing declines in abundance, poor recruitment, recent ecosystem changes, and moderate to high national initiative scores. The goal of an ESP is to identify vulnerability or resilience of a stock to ecosystem or socioeconomic pressures.

The BBRKC ecosystem indicators include physical and biological indicators that were presented for discussion during the May 2020 CPT meeting, with a few minor changes. The indicators are specific for the BBRKC management area. Indicators of particular note include the following. 1) The corrosivity index (calculated for the season when BBRKC larvae are in the water) shows a recent increase, which may be detrimental to larvae. 2) Bristol Bay summer seawater bottom temperatures were lower than average. 3) Chlorophyll-a was below average and wind stress was above average, both of which may be less than ideal for crab larvae. 4) Juvenile sockeye salmon abundance was well above average, which may result in increased larval predation. The CPT commented that the indicator time-series are hard to interpret on their own because both increasing or decreasing trends can indicate improving conditions for BBRKC depending on the indicator. The CPT recommends the authors consider ways to improve the interpretability of the indicator plots. A traffic light graphic provides information on whether indicators are positive, negative, or neutral. In summary, physical indicators for 2020 suggest a return to near-average conditions in Bristol Bay. A relatively high positive Arctic Oscillation index in winter 2020 may be favorable for BBRKC. Corrosive bottom waters are a concern. The CPT commented that some of these conditions may result in changes to BBRKC after lags, potentially up to 7 years for parameters that affect larvae. Future ESPs will incorporate lags in indicators.

Future ecosystem indicator analyses will include evaluation of the importance of environmental indicators to BBRKC. A preliminary Bayesian importance analysis (run by Curry Cunningham) indicated that the highest ranked predictor variable was BBRKC recruit biomass, with Pacific cod biomass and the Arctic Oscillation having a weaker effect. When the analysis is run with a shorter time series, some of these relationships change. The CPT asked whether any of these indicators are model output from stock assessment models, given that the model is also fitted to mature male biomass from the assessment. In addition, MMB, being a model output, is not independent among years which renders regression analysis dubious. The CPT discussed that mature male biomass may not be the best response variable for this type of analysis since environmental forcing is indirect and lagged. These analyses are a work in progress and will be updated.

Socioeconomic indicators for BBRKC were presented to CPT at the May 2020 meeting and the traffic light approach was used to show if these indicators are positive, negative or neutral for BBRKC. Several

new indicators include ex-vessel value of landings and processing employment. Time series of several socioeconomic indicators reflect decreasing productivity of this fishery that is fully exploited. The number of vessels fishing shows a steady decline. Ex-vessel value of landings are well below average and at their lowest value. Ex-vessel price per pound has been relatively high over the last several years. To some extent, the high price mitigates the drop in catch because of low TACs. The processing sector shows a decline in the number of processors and a decline in number of hours of processing employment. The share of catch landed in Dutch Harbor as a function of the total annual processing revenue is well below average and very low. Other indicators that could be extracted from the EDR data include crew income and other factors. These indicators would only be available for the time period post-rationalization. The SSC recommended more detailed community-level indicators, but the ESP template is not well suited to this. A community-level SAFE is in development, which may be able to address this SSC concern.

Ecosystem indicators for the SMBKC ESP Executive Summary are similar to those presented for the full 2019 SMBKC ESP, with additions of a corrosivity index, spring bottom temperature, wind stress and chlorophyll-a biomass. All of the ecosystem indicators are calculated for the SMBKC management area. Updates to the full suite of indicators for 2020 suggest near average conditions for environmental parameters in 2020. Persistent corrosive bottom waters surrounding St. Matthew Island are of concern and could negatively impact shell formation, growth and survival. The corrosivity metric currently calculates the percent of bottom area with an aragonite saturation state <1 from February to April (from ROMS model output). The CPT discussed that corrosivity in terms of pH would be helpful in the future for comparison with laboratory studies that report response to waters of different pH.

Socioeconomic indicators for the SMBKC ESP were presented to the CPT at the May 2020 meeting and the traffic light approach was used to show if these indicators are positive, negative or neutral for BBRKC. Most of the socioeconomic indicators are fishery-derived, so there is no change from those reported in May 2020 because the fishery has been closed. One additional indicator on bycatch is provided and updated. Because of a small number of processors, socioeconomic information can be confidential.

Several new ESP developments were discussed. In an attempt to provide an overall score of conditions that impact the stock, indicators will be condensed into categories and scored as +1, -1 and 0. These are then averaged to generate an overall score. A third stage analysis is in development to take the indicator suite and then use it in the assessment. This is meant for stocks where there is an ecosystem model linked with the stock assessment. These are starting to be developed for groundfish. An ESP data dashboard is in development and provides data for indicators currently used in ESPs. The CPT commented that they like the idea of the data all being in one place and being accessible.

The CPT discussed the schedule for future ESP development. BBRKC was developed this year; CPT noted that snow crab is a priority for next year. During development of these full ESPs, other stocks are updated in an executive summary fashion as was done this year for SMBKC. The CPT also notes that without the bottom trawl survey, we lose data points for environmental indicators as well as for stocks. Finally, Kalei Shotwell (AFSC Juneau) announced that there is an upcoming ESP workshop on September 25 to which all are welcome. Erin Fedewa will send the information to CPT members.

7. Bristol Bay Red King Crab Final 2020 Assessment

Jie Zheng (ADF&G) presented the 2020 Bristol Bay red king crab assessment to the CPT. The 2020 assessment included updated data for catch biomass and size-compositions (retained and total) for the 2019/20 directed fishery from ADF&G, and catch biomass and size compositions for bycatch in the groundfish fisheries from AKFIN. There were no new NMFS EBS bottom trawl survey data.

Seven model scenarios were discussed in the assessment report:

- 19.0a: identical to the 2019 assessment model (19.0), except that an error specifying the reference period for the mean sex ratio required to calculate B35% was corrected.
- 19.0b: identical to 19.0a except that the recruitment estimate for the terminal year was set to the average of estimates from the previous seven years
- 19.3: identical to 19.0a, except for the way natural mortality (M) was treated: a constant M estimated for males during 1980-1984, M was fixed to 0.18yr-1 for males during other years, and an estimated constant multiplier was applied to male M to obtain female M.
- 19.3a: identical to 19.3, except that the recruitment estimate for the terminal year was set to the average of estimates from the previous seven years (similar to 19.0b)
- 19.3b: identical to 19.3, except that the CV for the prior on trawl survey catchability was doubled to assess its effect on the estimate
- 19.3l: identical to 19.3, except that simulated values for the 2020 NMFS survey, based on the 25th quantile of relative survey biomass prediction errors, were included in the model fit
- 19.3h: identical to 19.3, except that simulated values for the 2020 NMFS survey, based on the 75th quantile of relative survey biomass prediction errors, were included in the model fit

Model scenarios 19.0a and 19.3 were regarded by the author and the CPT as the principal alternatives for setting OFL. Scenarios 19.0b and 19.3a were developed to allow reasonable multi-year projections to be conducted (because 2020 survey data were unavailable, the standard estimates for recruitment in the terminal year were highly uncertain and needed to have some constraint imposed to allow multi-year projections to be made). Scenario 19.3b provided a test of the model's sensitivity to the prior used for survey catchability. Scenarios 19.3l and 19.3h were developed to help characterize additional uncertainty in the assessment due to the lack of a 2020 NMFS trawl survey.

With a looser prior on survey catchability, scenario 19.3b led to an unreasonably high estimate of catchability for the trawl survey (>1.0), resulting in overall lower biomass estimates relative to scenarios 19.0a and 19.3. Thus, the stronger prior used in scenarios 19.0a and 19.3 was necessary to constrain the estimate of survey catchability. Biomass estimates from scenario 19.0a were higher than those from 19.3 for recent years, which was largely due to the differences between the two scenarios in estimated natural mortality rates. Scenario 19.3 fit survey biomass better than 19.0a in the last few years, particularly for females, but both scenarios over-predicted the data. Overall, model scenario 19.3 fit the data better than 19.0a (~47 likelihood units) with one fewer parameter and was the CPT's preliminary choice for the recommended model scenario during its May 2020 meeting.

Scenario 19.3b was primarily a sensitivity run, and thus not under consideration for status determination and OFL setting. The CPT appreciated the author's efforts to provide multi-year projections (19.0b, 19.3a) in response to previous SSC requests. However, the CPT found the 7-year averaging period for the estimate of terminal recruitment used in the scenarios rather arbitrary and not justified well enough to be adopted yet. Consequently, the CPT selected the author's preferred model scenario, 19.3, as the recommended model for status determination and OFL setting.

The lack of a 2020 NMFS EBS bottom trawl survey is a unique event in the history of the assessment. The CPT considers the absence of the 2020 survey from the data used to fit all assessment models this year to be a potentially substantial source of additional uncertainty to be considered when determining the ABC. The CPT adopted a two-stage approach to characterizing additional uncertainty in the context of determining the ABC. The first stage was to discuss whether or not, ignoring the issue of the cancelled 2020 survey, the level of uncertainty associated with the selected model scenario differed substantially (either better or worse) from last year's model and thus warranted changing the buffer applied last year. The second stage was to consider whether the canceled survey introduced enough additional uncertainty to warrant expanding the buffer.

Last year, the CPT recommended setting the ABC below the maximum permissible for BBRKC, using a 20% buffer on the OFL to account for additional uncertainty in the assessment associated with the model's lack of fit to the 2018 and 2019 NMFS EBS bottom trawl survey data, retrospective patterns, and recent environmental conditions (e.g., elevated bottom temperatures and the lack of a cold pool). After substantial discussion, the CPT concluded that the level of uncertainty associated with this year's assessment, ignoring the issue of the cancelled 2020 NMFS survey, had not changed substantially from last year. Although scenario 19.3 fit female survey biomass for 2018 and 2019 much better than 19.0a, 19.3 still overpredicted survey biomass in these years. In addition, the CPT expressed continued concern over poor environmental conditions (as reflected in the BBRKC ESP) and the lack of recent recruitment. However, members agreed that the uncertainty associated with these issues was already included in the 20% buffer previously adopted and did not warrant further increase.

The additional uncertainty associated with the cancelled 2020 NMFS survey was addressed by the assessment author using: 1) results from a pair of retrospective analyses in which the terminal year survey data were either included or excluded from the model fits; 2) comparison of CV's for management-related quantities from the 2019 assessment run with and without the 2019 NMFS survey included in the model fit; and 3) comparison of management-related quantities from scenarios (19.3l and 19.3h) using simulated 2020 survey biomass data based on the predicted 2020 survey biomass from scenario 19.3 and the 25^{th} and 75^{th} quantiles for relative errors in the fits to the survey biomass time series. Results from these comparisons indicated the likely additional uncertainty introduced by the cancelled survey is ~5%. The CPT also noted additional concerns: 1) the cancelled survey would have provided critical information on whether the declining trend in survey biomass continued from 2019 to 2020; 2) the stock may be approaching an overfished condition (MMB/B_{MSY} was 59%) and up-to-date survey information on stock level is critical to an accurate determination of status; and 3) red king crab stocks in Alaska do not seem to rebuild easily, so avoiding being overfished is an important objective for the future of the stock and fishery. Consequently, the CPT recommends adding an additional 5% to the 20% ABC buffer to account for the additional uncertainty associated with the cancelled 2020 survey, for a total ABC buffer of 25%.

The CPT has the following recommendations:

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

8. WAIRKC, AIGKC, PIRKC, PIBKC Overfishing Updates

The CPT reviewed updates on overfishing status for BSAI crab stocks with final assessments in May, and for those that are on either bi- or triennial cycles and need to be evaluated for overfishing determinations for the past season (2019/20). Ben Daly (ADF&G) presented total catch data for the AIGKC, PIGKC, and WAIRKC fisheries. Buck Stockhausen (NMFS/AFSC) presented total catch data for the PIBKC fishery, and Cody Szuwalski (NMFS/AFSC) presented total catch data for the PIRKC fishery.

Overfishing did not occur in the AIGKC fishery in 2019/20. Estimated total fishery mortality was 3,735 t, which resulted from 3,319 t retained catch in the directed fishery, 388 t bycatch mortality in the directed fishery, and 29 t bycatch mortality in the groundfish fisheries. The ABC and OFL for the 2019/20 fishery were 3,937 t and 5,249 t respectively.

The total catch for the PIGKC fishery was confidential but overfishing did not occur in 2019/20 and the stock is not overfished. The WAIRKC directed fishery was closed in 2019/20 and the estimated fishery

mortality was 0.75 t due to bycatch in the AIGKC (0.01 t) and groundfish (0.74 t) fisheries. Overfishing did not occur for this stock. Both of these stocks are on a triennial cycle and will be assessed next in May 2023.

The PIBKC stock remains overfished but overfishing did not occur during the 2019/20 season. The total fishery mortality for this stock was 0.42 t due to bycatch in the groundfish fisheries, mostly from trawl gear in the yellowfin sole and rock sole fisheries. PIBKC will be up for assessment next in May 2021.

The PIRKC fishery remains closed to directed fishing, but bycatch did occur in the groundfish fisheries resulting in a total catch of 3.84 t. Overfishing did not occur during the 2019/20 season because the total catch mortality did not exceed the ABC of 648 t. PIRKC will be up for a full assessment next September 2021.

9. Snow Crab Final 2020 SAFE

Cody Szuwalski (AFSC Seattle) presented the 2020 assessment of Eastern Bering Sea (EBS) snow crab to the CPT. The 2019 assessment was based on a bespoke model written in AD Model Builder while the author-preferred model for 2020 was based in GMACS. Cody presented the GMACS version of the assessment to the May 2020 meeting of the CPT and updated the model code after May 2020 to enable reference points (including overfishing levels) to be computed.

Ideally, there should be a direct comparison between the 2019 and GMACS models for EBS snow crab, but this is not feasible because of structural differences (e.g., GMACS allows for estimation of sex-specific differences in natural mortality for immature crab and parameterizes recruitment differently than the 2019 model) and because the likelihood function in the 2019 and GMACS models differ. However, Cody used plots of model fits and summary statistics based on residuals to show that GMACS generally provides a better fit to the available data. It was noted that GMACS only places a weak penalty on the recruitment deviations, which means that GMACS has additional flexibility in terms of using recruitment to fit the available data.

The 2020 assessment included (a) updated AKFIN bycatch data, (b) catch biomass and size-composition data (retained and total) for 2019/20 directed fishery, and (c) catch biomass and size-composition data for the trawl fishery. There were no new NMFS trawl survey data.

The four model configurations in the assessment report were:

- 19.1: the final model from 2019 with updated bycatch data;
- 20.1: as for 19.1, except that the 2019/20 directed fishery and groundfish data are included;
- 20.2: as for 20.1 but implemented in GMACS; and
- 20.3: as for 20.2 but with extra weight placed on the BSFRF data to force the estimated catchability coefficient to equal the catchability implied by the BSFSF data.

Model 20.2 was the author's preferred model. This is because, qualitatively, model 20.2 fits the data better than model 20.1 in terms of survey biomass, catch, BSFRF size-composition, and survey size-composition for immature females, while model 20.1 fits the retained fishery size-composition data better than model 20.2. Model 20.2 leads to more realistic time-trajectories of fishing mortality during the late-1980s early 1990s than model 20.1 and also to estimates of *M* for immature animals that are higher than those for mature animals (unlike model 20.1). Model 20.2 implies a linear relationship between post- and pre-molt size for both sexes unlike model 20.1. Model 20.3 was not considered plausible given the very high estimates of biomass compared to the alternative models. The CPT concurred with the author's preferred model.

Model 20.2 leads to a much higher OFL than model 20.1 due to a higher estimate of 2021/21 MMB (207.2 kt for model 20.2 compared to 144.29 kt for model 20.1), which was related directly to model 20.2

estimating a much larger recruitment for 2015. A key focus for CPT discussion was consequently why the estimate of recruitment for 2015 in model 20.2 was larger than in model 20.1 and what determines this recruitment. Unfortunately, the CPT was unable to resolve the reason(s) for the difference in results. It was noted that the estimate of 2015 recruitment increased with the addition of the data on the total catch and its size-composition as well as the data on discarded females, and particularly the data on trawl bycatch and its size-composition. The latter is surprising because the fits to trawl size-composition data are quite poor for some years (e.g., 2016 and 2017).

There is a weak penalty on the recruitment deviations in the assessment. Without this penalty the final recruitment estimate is implausibly high. Cody examined the sensitivity of the results to the weight placed on a penalty related to the amount by which deviations in recruitment change among years. As expected, increasing the weight reduces the size of the 2015 recruitment, but at the cost of a poorer fit to the data, particularly for females. Surprisingly, increasing the weight on the recruitment penalty increases the magnitude of the last (2019) recruitment and hence leads to poorer fits to the 2019 length-frequency data. Increasing the weight from 1 (default) to 100 leads to a reduction in OFL from 184.9 kt to 107.3 kt. However, further investigation of the effects of the penalty are needed because the change in estimates of recruitments are counter-intuitive.

Preliminary projections indicate abundance after 2021 may decline owing to the post-2015 recruitments being both uncertain and apparently much lower than the 2015 recruitment. The confidence intervals for this projection are very large.

The CPT discussed the choice of the buffer between the OFL and the ABC. It was noted that the unexpected post-molt to pre-molt relationship that was characteristic of the 2019 assessment was no longer a concern. However, the earlier concerns regarding the ability to estimate *M* (and its impact on biomass estimates) remain, as do the strong retrospective patterns, and the apparent discrepancy between the 2018 and 2019 survey estimates of mature male biomass. The unexpectedly high estimate of 2015 recruitment (and the inability to determine what in the data leads to the estimate to become greater with the addition of composition data for the total catch in the directed fishery, the trawl fishery bycatch, and the size-composition of total catch in the directed fishery and the trawl fishery) is a new concern which has a major impact on the biomass estimates (and hence the OFL). The CPT agreed that the model structure uncertainties would, on their own, lead to an increase in the buffer from 20 and 25%. The CPT anticipates that additional work, for example, related to including recruitment penalties in GMACS, could resolve some of these uncertainties.

The lack of survey data for 2020 is unique. For the four model-based assessments reviewed at this meeting, the snow crab assessment by far is the most sensitive to leaving out the most recent survey data. Both the respective analysis and the sensitivity analysis with high and low proxy 2020 surveys support this conclusion. The population structure of snow crab in 2020 makes the cancellation of the 2020 survey a particular challenge to providing management advice. There is good evidence of strong recruitment to the stock, but, due inconsistent survey observations, there is substantial uncertainty regarding its magnitude. This recruit pulse is entering into the fishable component of the stock in 2020/21, resulting in a large increase in the OFL and ABC. Had the survey occurred in 2020, the assessment would have been in a much stronger position to establish the magnitude of the recruitment event, and support the increase in OFL and ABC. To account for this uncertainty, the CPT recommends that the buffer be increased by an additional 25%. This value is close to the median over time of the "(no survey – survey)/survey" statistic (see above), and is intended to make the probability of exceeding the OFL commensurate with the probability in years with a terminal year survey. The CPT notes that although the existing buffer for snow crab was established in part because of the retrospective bias in the assessment, it did not take into account the additional retrospective bias due to a cancelled survey in the terminal year.

The CPT has the following recommended changes for the assessment document:

- Include a table that lists all of the differences between GMACS and the model on which the 2019 assessment is based.
- Include the estimates of recruitment and M in Table 8
- Add additional discussion and information about the penalties imposed on recruitment in GMACS.

The CPT and the author identified the additional following work (for the January 2021 workshop or the May 2021 CPT meeting):

- Review the data sources on which the assessment is based and perhaps modify the basic inputs.
- Investigate the implications of placing penalties on the recruitment deviations and the sex-ratios of the annual recruitments.
- Explore within-year observer data to determine support for the hypothesis of multiple recaptures of discarded crab (due to extended season timing and high discard rates in recent years) and, if necessary, modify the model to reflect multiple discards.
- Modify the model to include the data on male maturity rather than splitting the male data into immature and mature animals prior to running the model.
- Consider time-variation in the probability of retention in the directed fishery.
- Explore how the various data sources (in particular the bycatch size-composition data) are weighted.
- Continue to explore model diagnostics such as jittering.

10. Saint Matthew Blue King Crab Final 2020 SAFE

Katie Palof (ADF&G) presented the 2020 assessment of the fishery for Saint Matthew's blue king crab (SMBKC) to the CPT. SMBKC is currently overfished and under a rebuilding plan. Overfishing did not occur in the crab year 2019/2020. All models presented were implemented in GMACS and the base model (16.0) was initially accepted in 2016. Two variants of 16.0 were presented: 16.0a in which the terminal year of recruitment was fixed, and 20.1, in which the ADF&G pot survey was excluded.

Model 16.0a was introduced because the terminal year of estimated recruitment (2020) was unrealistically high as a result of missing survey data. The high estimates of terminal year recruitment did not appreciably impact the quantities used in management for the terminal year, but forward projections would be impacted. Model 20.1 was introduced as a sensitivity run because the ADF&G pot survey and the NMFS trawl survey appear to be in conflict.

Fits of model 20.1 to the NMFS data improved in some years with the exclusion of the ADF&G data (e.g., 2009-2016), but the model was unable to track the decline in the stock evident from the last three years of survey data. Fits of model 16.0a to the data were essentially identical to those of model 16.0. All models had undesirably long runs of positive or negative residuals in fits to the indices of abundance.

Based on the fits of the models and estimated population processes, the author suggested model 16.0 is the only model under consideration. Model 20.1 should be considered exploratory and model 16.0a did not appreciably change management advice. The CPT agreed with this evaluation and further agreed with the author's goals for future work, including:

- Examine the potential for time-varying catchability/availability of the ADF&G pot survey. The footprint of the ADF&G survey does not capture the entire distribution of the stock, and the proportion of the stock within the ADF&G footprint appears to vary over time. Plotting the proportion of the calculated NMFS abundance that is found within the footprint of the ADF&G pot survey would be a good first step in understanding how catchability/availability of the

ADF&G pot survey might vary over time. A second step would be to allow survey catchability to follow a random walk and to compare the estimates of catchability from that random walk to the 'empirical' availability calculated above.

- Compare model runs using indices of abundance calculated using VAST to the current design-based estimates.
- Consider increasing the number of size bins so that cohorts might be more easily tracked and growth better estimated.
- Explore the assumed and estimated life history parameters (e.g., natural mortality, growth, and maturity) to ensure the best available science is being used to assess this stock. Implement methods for more appropriately weighting the data sources in the model.

Several of these points were already on the authors' list to do, but much of their time this assessment season was consumed by attempting to understand the impact of the lack of a trawl survey in 2020 on the assessment. Retrospective analyses were completed for the first time this year, with and without the terminal year of survey data. Large retrospective patterns were revealed for the stock, related to the large increase in the stock during the late 2000s. The authors suggested these retrospective patterns may have resulted in the large estimate of directed fishing mortalities in the early 2010s. Retrospective analyses in which the terminal year of survey data was excluded did not produce retrospective patterns larger than when the terminal year of survey was included, so the authors did not feel that an additional ABC buffer was warranted based on the missing 2020 survey.

The CPT agreed with the author that no additional buffer should be applied to the ABC and noted that the buffer had mistakenly been set at 20% last year. This year it should be correctly set at 25% based on consistency with other similar stocks (e.g., PIBKC and PIRKC), the mismatch in spatial footprint of the NMFS and ADF&G survey data in the assessment, and concerns about data weighting.

11. Pribilof Island Blue King Crab North Pacific Research Board Research Project Review

Jared Weems, UAF graduate student, gave a presentation on his PhD research focused on evaluating recruitment limitation as a possible bottleneck for rebuilding Pribilof Island blue king crab from its overfished status. The objectives of the project were to 1) quantify supply and abundance of early juvenile stages of blue king crab and red king crab, 2) assess habitat availability in nearshore St. Paul Island areas relative to historical survey sites, and 3) identify juvenile king crab predators and predation potential.

To assess abundance, Jared compared historical (a 1980s habitat study) bottom trawl and rock dredge young-of-the-year (YOY) crab abundance data to current abundance levels via collector settlement bags (sausage-shaped artificial collector; SAC) and scuba diver visual surveys. Historical results showed YOY BKC occurred at relatively high abundance levels in St Paul Island nearshore areas (N=514 YOY), whereas current abundance levels were low (N=8 YOY). Conversely, historical RKC abundance levels were low (N=14 YOY), but current abundance levels are high (N=145 YOY) and with broad spatial distribution. This result confirms that BKC abundance is limiting and RKC has expanded in abundance and spatial distribution since the 1980s.

Jared compared historical bottom trawl and rock dredge benthic habitat data to current habitat assessed via scuba diver and drop camera surveys (qualitative evaluation of substrate complexity). Benthic habitat complexity matched in 87% of the locations that were sampled in both time periods (1980s and this study). Jared showed habitat maps he created with scuba dive and camera surveys: shellhash, an important habitat type for BKC, occurred in relatively high density on the east and southern sides of St. Paul Island, but no BKC were encountered in the SACs deployed in those areas. It was noted that optimal settlement habitat includes areas of shell hash consisting of both broken and whole bivalve shells. Pelagic

sampling was conducted to gather temperature, salinity, and zooplankton data. Jared noted that 2018 was a very stormy year with substantial loss of sampling gear, which led to additional sampling in 2019.

Predation on small YOY RKC was assessed via diver/camera surveys, in situ tethering experiments, and fish stomach analysis (commercially caught halibut and hook-and-line caught small fish). The tethering experiments, conducted with YOY and age 1+ RKC due to the very low catch of BKC in the SACs, showed high predation was correlated with high fish densities. Predation events occurred at the "dock site" which also had higher fish densities, whereas zero predation events occurred at the "natural" site. RKC hiding behavior increased with high fish densities. Kelp greenling was the most abundant predator, and confirmed predation events by kelp greenling, wolf eel, and pygmy rock crab occurred. Twenty-one percent of halibut stomachs included crab (no king crab, some lithodid and decorator), but no crab were found in small fish stomachs.

Overall, with respect to king crab recruitment limitation in the Pribilof Islands, this study suggests that 1) BKC abundance is limiting but RKC may not be limiting, 2) benthic habitat is non-limiting and relatively unchanged over time, 3) pelagic habitat is warming with delayed stratification, and 4) predation is likely non-limiting, is density dependent, and behavioral responses are evident in at risk juvenile RKC.

There was a question about whether his study can state that predation is non-limiting. Based on metrics for predation including low predation on tethered crab in a natural site, crab cryptic behavior, and stomach analysis (no king crab) support that predation may not be a driving factor for low abundance around the Pribilof Islands. There were questions about the appropriateness of the location of the Pribilof Island closure area and the possibility of a directed RKC fishery. Jared mentioned that he feels that the current closure area is appropriate, given locations of juveniles and adults depicted in the summer bottom trawl survey, and wouldn't recommend a directed RKC fishery at this time. There was a question about continued monitoring. Jared would like to continue monitoring in the Pribilof Islands, but there are no firm plans to do so. There was a question about tethering RKC and whether the results would apply to BKC given the more pronounced spines of RKC compared to BKC. Jared mentioned that RKC in St Paul were more cryptic at the dock site (higher predators) and that supination between RKC and BKC is similar at the settling size. There is some thought that BKC are more cryptic at the earlier stages than RKC, and as such, may be less vulnerable to predation than RKC.

12. Tanner Crab Final 2020 Assessment

William (Buck) Stockhausen (AFSC Seattle) presented the Tanner crab stock assessment and recommendations for the 2020/2021 fishery. This year's assessment used the bespoke modeling framework TCSAM02, which was endorsed by the SSC in June 2017. The base model from last year differed from earlier versions of TCSAM02 by adding a likelihood component to fit annual male maturity ogives determined from chela height-to-carapace width ratios in the NMFS survey, and fitting to time series of undifferentiated male survey biomass, abundance, and size compositions rather than survey biomass and size composition data for male crab already classified as mature/immature.

The model is structured by crab size, sex, shell condition, and maturity. The model uses available data on biomass and size-composition from, the NMFS trawl survey, landings and discards by the directed fishery, bycatch in the Bristol Bay red king crab, EBS snow crab, and groundfish fisheries. The model includes prior distributions on parameters related to natural mortality and catchability, and penalties on changes in recruitment and in the proportion maturing. There was limited new information for Tanner crab this year due to a closed 2019/2020 directed fishery and a cancelation of 2020 NMFS EBS trawl survey. Input data sets were updated with the most recent information on bycatch and size composition data from other crab fisheries, and data on Tanner crab bycatch in the groundfish fisheries.

In March 2020, the harvest control rule for Tanner crab was changed based on results from an extensive management strategy evaluation (MSE) conducted with input from industry stakeholders, NMFS and

academic scientists, and ADF&G managers. The current HCR defines the period for calculating average mature biomass as 1982-2018, and implements a ramped exploitation rate on mature males that slides up and down depending on the ratio of mature female biomass to its long-term average. The new harvest control is likely to reduce the number of years that the fishery is closed.

The major effort in this assessment cycle for Tanner crab was to explore ways to incorporate the BSFRF side-by-side survey data into the assessment. In addition, there was an effort to understand the assessment impacts of cancellation of the 2020 NMFS EBS bottom trawl survey. There was ongoing work to analyze the BSFRF side-by-side data to estimate catchability outside the assessment, though both the assessment author and the CPT regarded this work as not having advanced sufficiently far enough to be used as a preferred model. The SSC had recommended a hierarchical approach for analyzing catchability that included multiple species, but the stock assessment author proposed and the CPT agreed that the first priority was to focus on modeling the hierarchical structure for a single species, and then add multiple species as appropriate when the single-species modeling issues have been resolved.

There was some progress on improving model parameterization, but there are still problems with parameters hitting bounds. It was suggested that using a half-normal curve rather than a logistic curve to model selectivity might help, and the CPT also discussed the possibility of adding a bounding function to the likelihood to prevent parameters from approaching bounds. Further work is also needed to bring data weighting up to current best practice. More rigorous approaches to obtaining input sample sizes are available, and the CPT suggested looking at the methods used for the Pacific halibut assessment as an example. Residual plots indicated that the survey biomass estimates are assumed to be more precise that is warranted by the fit to the data. There are well established methods for model tuning or estimation of additional variance terms that could be considered. In addition, the CPT is still looking forward to an evaluation of potential conflicts between data sets in the assessment using likelihood profiles and other approaches.

The CPT discussed whether it would be useful (and possible) to model the terminal molt (specifically for the males) with a different transition matrix than the non-terminal molt. This may help with the model's tendency to overestimate the abundance of large crab. It is questionable whether enough data is available to support estimation of another growth transition matrix, but an effort should be made to see what maturity stage information is available for the molt increment data. It may be necessary to use Kodiak area data to obtain an adequate sample size. An intermediate approach of sharing some growth parameters between transition matrices but estimating others could also be tried.

There were three models presented in the assessment:

- Model 19.03: Last year’s model updated with new data. This was considered the base model.
- Model 20.07: Availability to the BSFRF side-by-side was modeled outside the model using a generalized additive model with a cubic spline.
- Model 20.10: Catchability was estimated outside the assessment model using the BSFRF side-by-side survey data and incorporated into the assessment as a selectivity/catchability curve.

Model 20.10 was regarded as an exploratory model, but could become the preferred model once the complexities of estimating catchability have been addressed. The model recommended by the assessment author is a revised model (Model 20.07) that incorporates the BSFRF trawl survey data from its cooperative side-by-side catch comparison studies with the NMFS EBS shelf bottom trawl survey in order to better fix the scale of the NMFS survey data. Empirical availability curves for the BSFRF study area were estimated outside the assessment model using a generalized additive model with cubic splines. These were used in the model to relate the BSFRF estimates of absolute abundance (at spatial scales smaller than the stock distribution) and the stock abundance estimated by the assessment model. The CPT regarded this model as an improvement over last year’s model (Model 19.03) because it made robust use

of data from BSFRF catch comparison studies, which had not been used previously for Tanner crab, and thus recommends Model 20.07 for setting the OFL and the ABC.

CPT discussed the buffer used to set the ABC below the OFL. Last year, the SSC identified poor model performance, such as parameters being hitting bounds and poor convergence properties, as the rationale for recommending that a 20% buffer continue to be used for Tanner crab. Although there have been some improvements to the model to address these issues, they are still present in current assessment. Therefore the CPT does not recommend changing the buffer. The CPT also considered whether the cancellation of the 2020 EBS NMFS survey warranted any adjustment to the buffer. The CPT noted that retrospective patterns for Tanner crab were minimal and did not increase substantially when the terminal year survey was removed. An exception was the estimates of recruitment in the terminal year, which could fluctuate wildly when survey data were not available. This variation did not have management implications since recruiting crab are neither mature nor legal sized. The sensitivity analysis with a high and a low hypothetical 2020 survey did not indicate high sensitivity in estimates of the OFL and mature male biomass. Therefore the CPT does not recommend any additional buffer be used for Tanner crab.

CPT recommendations:

- Evaluate the use of half-normal curves for selectivity rather than logistic functions.
- To improve model performance, evaluate the use of a bounding function to the likelihood to keep parameters from approaching bounds.
- It is somewhat disconcerting how many model parameters are devoted to modeling bycatch, which is not important in the stock dynamics (see report section on PSC limits). Consider ways to model bycatch fisheries more parsimoniously. It was noted that using a low accumulator size might help to address these issues.
- Survey catchability in the early period is still hitting the parameter bound. Evaluate using a prior for survey catchability in the early period that is the same as the prior for catchability used for the main part of the survey time series.
- Evaluate potential conflicts between data sets in the assessment using likelihood profiles and other approaches.
- Evaluate methods for model tuning or estimation of additional variance terms to address issues with model giving too much weight to fitting survey biomass estimates.

13. Crab Prohibited Species Catch

Sarah Marrinan introduced the agenda item, referring to the presentation given by her and Sara Cleaver (both Council staff) at the May 2020 CPT meeting on a proposed Council action to change crab Prohibited Species Catch limits to the lowest possible level when the directed crab fishery is closed. The proposed action is scheduled to be presented at the February 2021 Council meeting. During the discussion at the May meeting, the CPT recommended that assessment authors rerun the assessments for BBRKC, Tanner crab, and snow crab with higher assumed levels of bycatch abundance (increases of 50% and 100%) as a sensitivity analysis, and provide reports of results to Council staff for use in the analysis for Council action.

Jie Zheng presented the report on his analysis for BBRKC, in which he estimated the effects of assumed increases in the levels of groundfish fishery bycatch on estimated mature male biomass for BBRKC using two approaches, both of which used the CPT's preferred model for 2020 (19.3). In the first approach, the model was run with the observed bycatch biomass and three hypothetical levels of increase (1.5x, 2x, and 5x the observed level), with all model parameters estimated. In the second approach, the same scenarios were run with only fishing mortality parameters being estimated and all other parameters fixed at levels estimated in the base model. Results from both approaches indicated small effects of the 1.5x and 2x scenarios on terminal MMB (from -0.5% to -2.8% below baseline), and only the 5x scenario producing

substantially lower estimates of terminal MMB (-9% and -11% for the 1st and 2nd approach, respectively), with $F_{35\%}$ and F_{OFL} increasing slightly with bycatch level under both approaches, and OFL increasing for the 1st approach and decreasing for the 2nd approach.

Jie was asked if the analysis should have assessed the effect of increased bycatch on the stock population, including females, which he indicated would have required a more thorough study, and may not be feasible. The CPT discussed how to interpret the alternative approaches, noting that neither reflect realistic simulations of counterfactual historical bycatch levels. Rather, the first approach represents the effects of hypothetical biases in bycatch estimates on biomass trends estimated by the assessment, while the second approach attempts to quantify impacts of actual changes in bycatch on population biomass trends, without altering other biological processes such as recruitment.

Buck Stockhausen and Cody Szuwalski presented the results of their analyses for Tanner and snow crab, respectively, both using approaches similar to the second approach used for BBRKC, with all biological parameters fixed at the baseline levels for the preferred 2019/20 assessment models, and only fishery-related parameters estimated using the baseline model for alternative scenarios, varying only groundfish bycatch biomass. In the Tanner crab analysis, hypothetical bycatch levels of 0.5x, 2x, and 8x the groundfish bycatch time-series were tested, with results indicating that only the 8x scenario produced significantly lower estimates of current and projected MMB. Time series plots of estimated Tanner biomass of female/male mature/immature population components indicated that effects of increased bycatch estimates declined over time and were virtually identical over the 2004-2021 time period for all but mature males under the 8x scenario. Cody's analysis for snow crab specified bycatch scenarios of 0.5x, 2x, and 10x the groundfish bycatch time-series, and fixed all parameters in the base model other than fishing mortality parameters in the directed fishery (retained and discard) and bycatch. Results indicated that only the 10x scenario led to a significant decrease from the baseline estimate of MMB, and time-series plots of estimated mature biomass were indistinguishable for smaller bycatch increases.

The CPT and Council staff discussed whether the analyses performed provided adequate results to inform analysis for Council action, and whether more standardized bycatch level scenarios would be more appropriate. Sarah Cleaver indicated that the results, with varying upper bounds of bycatch scenarios tested across fisheries, were appropriate to report to the Council for initial review of the action, and any further analytical support needed from the CPT could be identified at that point.

Jami Goen (ABSC) gave a brief presentation summarizing a Bering Sea Crab Bycatch Data and Mapping Review report (prepared by ABSC intern Lou Forristall) submitted by ABSC as public comment to this CPT agenda item. Jamie presented results from analysis of PSC and stock abundance, which found no correlation for BBRKC, but significant correlations for snow and Tanner crab. Mapping of bycatch levels by gear for the respective stocks indicated that overall bycatch for all stocks was highest for non-pelagic trawl and pot gears across all areas, was highest for BBRKC around the edges of the Red King Crab Savings Area (RKCSA); highest for Tanner crab west of the RKCSA at the border of zones 1 and 2, west of the Pribilof Islands closed area, and north of Unimak Island; and highest for snow crab to the east of the Pribilof Islands closed area and the SE corner of the C. opilio Bycatch Limitation Zone (COBLZ). An analysis to identify areas where crab bycatch was higher than expected relative to NMFS trawl survey results indicated that potential areas of concern for localized depletion of BBRKC were south of the RKCSA and the SE border of the Pribilof Islands closed area, north of Unimak Island for Tanner crab, and east of the Pribilof Island closed area for snow crab. The CPT noted that the correlation of snow crab and Tanner crab stock abundance with bycatch is likely higher for mature males than for the stock as a whole, and that localized depletion is likely more associated with fixed gear bycatch than trawl.

14. Norton Sound Red King Crab - Proposed Model Runs for Jan 2021

Hamachan Hamazaki (ADF&G) presented the model scenarios and preliminary results of the Norton Sound red king crab (NSRKC) assessment to the CPT. The model is a male-only, size structured model

that combines multiple sources of survey, catch, and mark-recovery data using a maximum likelihood approach to estimate abundance, recruitment, catchability of the commercial pot gear, and parameters for selectivity and molting probabilities from 1978 to 2020. A few years ago, the NSRKC crab year was changed to start from February 1 to January 31 of the following year to better match the summer and winter fisheries. The model was expanded from six to eight length groups in 2016. Hamachan did not propose new model scenarios for January 2021. Instead, he updated the base model (19.0) with new data for 2020 (model 20.0) and presented preliminary results of application of GMACS to this stock.

The winter fishery involves pots fished through the ice. The authors discussed the issue of lost pots, basically moved by shifting sea ice, and the unknown effect on additional unquantified crab mortality. While the area that shifting ice relocates pots to is important, the CPT suggested starting by documenting the quantity of pots lost per year, particularly compared to the total number of pots fished; up to 15 years of lost pot data may be available based on harvester interviews.

The new data for 2020 include the ADF&G trawl survey abundance and length compositions and a very small amount of subsistence catch and confidential winter commercial catch. The survey abundance was estimated to be 1.72 million crab for male crab >63 mm carapace length, much lower than the estimates for 2019, but higher than the survey abundance in 2018 (1.11 million crab). Male crab caught during the 2020 survey were mainly juveniles. The survey in 2020 tracked the growth progressions of juvenile crab from the 2019 survey, indicating the possibility of future increase of mature abundance. In 2020, NSEDC halted purchasing crab in the winter and summer commercial fisheries, and the Board of Fisheries also closed the summer commercial fishery in Norton Sound east of 164° W. long. There were no participants in the summer commercial fishery in the remainder of Norton Sound during 2020, and participation in the winter commercial fishery was also limited.

Mature male biomass and legal male abundance in 2021 are estimated by model 20.0 to be much larger than the 2019 values. However, there are some concerns regarding this increase. First, the model estimated survey abundance in 2020 is much higher than the observed survey abundance. Second, for male crab, four trawl surveys during 2018-2020 mainly caught juvenile crab, thus very low estimated survey mature male abundance. The CPT encouraged the authors to check the growth matrix to see whether growth was overestimated by the model. The retrospective results indicate that crab abundance was overestimated over time.

The results from the application of GMACS are very preliminary, and further work is needed before GMACS can be adopted as the preferred model for this stock. A CPT subgroup and Hamachan plan to meet in a month to check progress and provide feedback and suggestions on the GMACS modelling. Follow-up meetings of the subgroup may occur if needed before the January CPT meeting.

The CPT made the following recommendations:

- For January 2021, the priority is to run the following models:
    - Model 19.0. Based on the model naming convention, this model should remain as 19.0 and include new data for 2020. For this base model, the estimated growth from the model should be compared to the estimated growth from tagging data outside of the model.
    - Model 20.0. The GMACS model. Detailed comparisons between this GMACS model and model 19.0 are needed. For example, GMACS could be run by taking the parameter estimates from model 19.0 as known inputs to evaluate differences due to model structure. Following this, some of the GMACS parameters could be estimated.
- Improve data weighting, especially effective sample sizes for length composition data.
- Update VAST estimates.
- Report detailed data on female egg conditions and clutch fullness data. The percentages of barren mature females in Table 3 are helpful, but it is difficult to separate immature and mature females

for some years, and the percentages may not be reliable. A table could be constructed that summarizes clutch fullness and percentages of barren mature females by year and length group. If information is not available to separate immature and mature females for a given year, footnotes of the table should show this lack of information.

- Report the annual lost pot data, such as total number of lost pots each year and the proportion of pots lost in each fishery each year.

15. Crab Stock Boundaries Discussion

Krista Milani introduced a discussion of Norton Sound red king crab (NSRKC) in relation to stock boundaries. The current assessment of NSRKC only considers crab caught in an area east of 168° W. long. However, changing fisheries patterns, mainly targeting Pacific cod, led to small amounts (~10 crab) of incidentally caught RKC in 2018 and 2019 from six statistical reporting areas in waters west of 168° W. (no bycatch in 2009–2017). The discussion focused on the stock delineation of NSRKC, how this recent bycatch is accounted, and whether additional measures are needed to address this bycatch. Guidelines under FMP Category 2 (frameworked in the FMP) authorize the State to adjust district, subdistrict, and section boundaries based on a variety of criteria. Therefore, under the FMP, Norton Sound Section Q3 has previously been defined as waters east of 168° W., but now reflects current State regulatory language that extends the western border of Section Q3 to the International Dateline, a change mirrored in the NSRKC SAFE. There is no information, such as genetics, that would suggest RKC east and west of 168° W. are distinct stocks. Treating these crab as a single unit complies with National Standard 3 of the Magnuson-Stevens Fishery Conservation and Management Act to manage an individual stock, to the extent practicable, as a single unit throughout its range.

The CPT concluded that RKC caught in Section Q3 west of 168° W. should be attributed as catch/bycatch from the NSRKC stock and ABC. Given changing environmental conditions, continued RKC bycatch is anticipated west of 168° W. where fisheries occur for groundfish, and also for blue king crab and Hanasaki crab. It was noted that only NSRKC east of 168° W. are included in the current assessment. The magnitude of RKC bycatch has been low to date and does not represent a management or biological concern at this time. However, the CPT recommends monitoring future trends in RKC bycatch for additional consideration. A greater concern is the lack of information on RKC bycatch from the Pacific cod fishery within Norton Sound. The CPT requested that the future SAFE include a table to allow monitoring of changes in RKC bycatch both east and west of 168° W.

16. Summary of CPT recommendations on the 2020 survey cancellation

Stock	2020 proposed ABC buffer	Rationale	Trajectory	Uncertainty analysis results	Proposed additional 2020 buffer
BBRKC	20%	- Overpredicting recent survey (18,19) - Cold pool distribution shifts - Align with other stocks - Long-term declining trend	Down	Minimal	5%
Snow	25%	- Model structure uncertainties (high predicted recruitment in 2015) - Retrospective patterns - Uncertainty around M - Discrepancy between 2018 and 2019 survey data - Specification of recruitment penalty	Up	Strong positive retrospective bias, without survey overestimating OFL	25%
SMBKC	25%	- Overfished - Poor model fit to survey data - Data poor stock - Unfavorable environment	Flat	Minimal - Recent years underestimate OFL without survey	none
Tanner	20%	- Parameters hitting bounds - Poor convergence	Flat/Down	Minimal	none

17. Other discussion

Only catches that were incomplete when an assessment was accepted by the CPT, SSC, and the Council should be updated in the summary tables provided in the SAFE Intro section. In contrast, the record of specified management reference points are not updated in those tables since they were the basis for SSC and Council decision-making.

18. New business

Proposed 2021 meeting dates:
January 11-15, 2021 Anchorage Council offices
May 17-21, 2021 Juneau
Tentative September 13 - 17, 2021

January CPT meeting draft agenda:
NSRKC final SAFE, review of new GMACs model
AIGKC proposed model runs including a GMACS model
Survey planning updates
Data streamlining
Review terms of reference for crab assessments
Introduction to the risk table and how it could be used for crab assessments
Crab survey maturity updates and length-weight regressions
Crab economic SAFE
Research updates
- IBM snow crab model updates

- Snow crab spatial model
- Tagging work (BBRKC updates, ADF&G tagging)
- BSFRF update, field season plans

January 2021 Modeling workshop potential topics:

GMACS

- Options to add to GMACS
    - Random walk for catchability
    - Half-normal selectivity function
- Estimation of recruitment in the terminal year
    - How is this current coded/estimated?
    - Do we need to add "options" for this? (i.e. median or mean of some time frame instead of estimating freely, weighting, etc.)
- Code "keeping"
    - Branching and keeping track of additions on GitHub
    - How to incorporate non-Git users changes/edits
    - Are we using personal.tpl? If not would this help?
- Gmr R package
    - Current status/updates?
    - Plan for future work and documentation
- Documentation progress?

Recruitment modeling

- Preferred approach to modeling recruitment and sex ratios
- If there is no preferred approach, include option to switch between approaches (i.e. BBRKC approach of one recruitment and estimated sex ratio vs. estimating seperate male and female recruitments)
- Recruitment penalty options (random walk, etc)
- Estimating recruitment in terminal year and whether to use in reference point calculations

VAST

- Detailed review of methods and diagnostics
- Presentation on most updated results for stocks of interest

Modeling crab fishery duration, pulse vs seasonal, implications for bycatch (re snow crab in 2019/20)

Modeling survey availability and catchability using BSFRF side-by-side data

Mohn's rho

- Review of how we are all calculating/defining this

Subgroup Report: Stock Projections for Crab Assessments

A subgroup of the CPT consisting of Martin Dorn, Katie Palof, Siddeek, William Stockhausen, Cody Szuwalski, and Jie Zheng met remotely on Aug 12, 2020 to discuss methods of stock projection for crab assessments. Typically crab assessments project only management quantities for the upcoming year, such as the OFL and mature male biomass, but the SSC has previously expressed interest in seeing longer-term stock projections under realistic exploitation scenarios. The subgroup discussed various options, and recommends that the following approach be used:

- The projections should extend for five crab fishing years. Longer term projections depend more on uncertain future recruitment, and are not as reliable.
- Projections should be based on the average fishing mortality over the past five years. An exception to this approach should be used in situations where there is a downward trend in fishing mortality due to declining stock size (such as when the stock is below its BMSY level). In these cases stock projections should be based on a linear extrapolation of fishing mortalities over the past five years.
- Recruitment for the projection should be bootstrapped from historical recruitments during the period used for status determination. An exception to this approach should be used when recent recruitment has been consistently lower than average. In these cases stock projections should be based on bootstrapping recent recruitment.
- Stock projections can be done starting with either the maximum likelihood estimates (MLE) from the stock assessment or from MCMC draws. GMACS implements projections that initialize with MCMC draws, and this is considered a better approach that incorporates assessment uncertainty. However the subgroup did not want to exclude projections using the MLE estimates, since this approach is commonly used, provides relevant information, and may be more straightforward to apply in ADMB assessments.
- While the approach outlined above should be appropriate for most crab assessments, the subgroup recognized that each crab assessment is unique, and other approaches may be needed. Multiple projections may be needed to adequately characterize major assessment uncertainties, such as, for example, doing projections using both the full set of recruitment estimates and recruitment estimates from a more recent time period. The subgroup also thought that it may be appropriate in some cases to provide a series of projections at various percentiles of recent average fishing mortality (e.g. 0%, 25%, 50%, 75%, 100%, 125%), for example when the State is considering a range of options in implementing the TAC.