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
May 4-7 2020
Online 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)
Brian Garber-Yonts (AFSC-Seattle)
Krista Milani (NMFS-AKRO-Dutch Harbor)
André Punt (Univ. of Washington)
Shareef Siddeek (ADF&G-Juneau)
William Stockhausen (AFSC-Seattle)
Cody Szuwalski (AFSC–Seattle)
Miranda Westphal (ADF&G-Dutch Harbor)
Jie Zheng (ADF&G-Juneau)

Others in attendance:
Caitlin Allen Akselrud (AFSC Seattle)
Rachel Alinsunurin (ADF&G Dutch Harbor)
Jen Bell (ADF&G Nome)
Lyle Britt (AFSC Seattle)
Karla Bush (ADF&G Juneau)
Connor Cleary (AFSC Kodiak)
Sara Cleaver (Council staff)
Sam Cunninghsm (Council staff)
Maria Davis (Council staff)
Kenny Down (Council member)
Sherri Dressel (ADF&G Juneau)
Doug Duncan (NMFS Juneau)
Diana Evans (Council staff)
Lou Forristall (UW)
Shannon Gleason (Council staff)
Jamie Goen (ABSC)
Scott Goodman (BSFRF)
Gretar Gudmundsson (F/V Valiant)
Kate Haapala (Council staff)
Toshihide Hamazaki (ADF&G Anchorage)
Madison Heller-Shipley (UW, BSFRF)
Mark Henkel (F/V Erla N)
Kendall Henry (ADF&G Juneau)
Leonard Herzog (F/V Tempo Sea, BSFRF)
John Hilsinger (AKCR)
Jim Ianelli (AFSC)
Tyler Jackson (ADF&G)
Wes Jones (NSEDC)
Frank Kelty (Unalaska)
Scott Kent (NSEDC)
Linda Kozak (FVOA)
Sarah La Belle (Council staff)
Owen Larson (ADF&G Kodiak)
Charlie Lean (Fisherman)
Mike Litzow (AFSC Kodiak)
Craig Lowenberg (ABSC)
Steve MacLean (Council staff)
Sarah Marrinan (Council staff)
Heather McCarty (CBSFA)
Steven Minor (Golden Harvest)
Angela Moran (UW)
Andy Nault (ADF&G Kodiak)
Mateo Paz-Soldan (St Paul)
Edward Poulsen (BSFRF)
Landry Price (YDFDA)
Jonathan Richar (AFSC Kodiak)
Matt Robinson (BBEDC)
Kalei Shotwell (AFSC Juneau)
Chris Siddon (ADF&G Juneau)
Joletta Silva (AFSC Kodiak)
Gary Stauffer (BSFRF)
Mark Stichert (ADF&G Kodiak)
Diana Stram (Council staff)
Anne Vanderhoeven (Arctic Storm)
Ernie Weiss (Aleutians East Borough)
Paul Wilkins (CVRF)
Leah Zacher (AFSC Kodiak

1. Administrative

Public health concerns due to the COVID19 pandemic forced the May 2020 Crab Plan Team (CPT) meeting to be 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, May 4, 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 their guidelines for the meeting including public comment and welcomed Erin Fedewa as a provisional member of the CPT. Erin was expected to be appointed to the CPT at the April Council meeting, but that meeting was cancelled due to COVID19.

2. Summer trawl survey

Lyle Britt (NMFS) reported to the CPT on the status of the 2020 NMFS summer trawl surveys in the Eastern Bering Sea (EBS), Northern Bering Sea (NBS), and Aleutian Islands (AI). All planned 2020 NMFS trawl surveys are still in flux. NMFS survey leads are currently working on developing protocols and coordinating logistics to maintain the health and safety of vessel crews, scientists, and Alaskan communities. All three surveys are currently delayed with the earliest start date being June 20, but will continue to be delayed until COVID-19 safety issues are addressed and protocols can be developed. Any potential surveys would need to occur in the June 20 to mid-September window. It is possible for all surveys to be cancelled if the safety of workers is not manageable or logistics prove insurmountable.

Status of stock and multispecies assessments (SSMA) survey priorities and evaluation of all survey work is still being developed. SSMA has ranked work in support of Bering Sea crab stock as very important.

If NMFS surveys were to occur this summer, there are three likely scenarios. It was noted that all options and ideas are still being discussed in addition to the three scenarios below.

- June 20 survey start: EBS, NBS, and AI surveys could be completed by fall. All surveys would occur as normal, but survey dates shifted 20 days later than the established survey timeline. If this scenario goes forward, data would most likely be available for Bristol Bay red king crab and Tanner crab fisheries on time for setting OFL/ABCs and for TAC setting. Bering Sea snow crab data, and most likely the fishery, would be delayed.
- July 11 survey start: AI survey would be cancelled, EBS survey would proceed as planned, NBS would only be surveyed as time allowed. It is possible that the two vessels slated to survey the AI could be reallocated to the EBS survey. With four vessels and one single survey leg, data would most likely be available for Bristol Bay red king crab and Tanner crab fisheries on time for setting OFL/ABCs and for TAC setting. Bering Sea snow crab data, and most likely the fishery, would be delayed. With two vessels and two survey legs, it may be possible to still survey NBS in addition to EBS. This plan would be contingent on staffing availability since the survey would occur outside of regular survey timing and survey vessels would have to agree to adjusted survey timing and areas.
- August 1 survey start: No AI or NBS surveys would be possible. This scenario would require four vessels to participate and only the EBS would be surveyed. No crab data would be available on time for OFL/ABC or TAC setting. Bering Sea crab fisheries could possibly be delayed.

In a normal year, crab data collected on the survey are transmitted daily to Alaska Fishery Science Center (AFSC) staff, where it is processed and distributed to fishery scientists and managers. This procedure would continue should surveys occur this year and would be most likely ramped up in any of the above scenarios. New vessels participating in the surveys would need to be brought up to speed and requirements for

transmission of data would need to be negotiated. AFSC staff believes it is possible to get data to stock assessment authors in close to real time.

For the June 20 start date, a decision to proceed would need to be made by around May 13. Several weeks are needed to prepare and then ship survey equipment and get staff in place. If more than two boats participate in the ENS and NBS surveys, additional time will be needed to fabricate equipment for those vessels. There are already enough trawl nets to equip four survey vessels.

Depending on which of the above scenarios goes forward, it may be necessary for the CPT to convene an additional meeting in October or November for the Bering Sea snow crab stock assessment. The Alaska Department of Fish and Game currently has the authority to delay the opening date of the crab fisheries.

The CPT verified that stock assessment authors are able to run models without complete survey data. Stock assessment authors would need survey data by August 15 in order to run stock assessment models in time for the October 15 fishery opening. Fishery data for 2019/20 was collected in full and will be available for incorporation into fishery models. Preferred models will be identified by the CPT during this meeting so that the SSC and NPFMC can review the selections during their June meeting. Selecting preferred models early provides direction to stock assessment authors if the assessment schedule is compressed. Only preferred models would need to be run, in addition to last year's base model, if survey data are delayed.

Depending on when or if survey data becomes available, the CPT is recommending stock assessment authors plan for the following scenarios: data are available in September, data are delayed beyond September, and no survey data are available. All stock assessment models for September are typically tuned to a time series of survey data including the current year survey. Should no survey occur, the CPT recommends that stock assessment authors roll over last year's accepted model, incorporating updated fishery data when possible, and projecting OFL/ABCs based on our understanding of stock trends from surveys to 2019.

3. GMACS

Katie Palof (ADF&G) updated the CPT on progress developing GMACS. A dedicated 2-day GMACS workshop (led by André Punt, UW) was part of the January 2020 CPT meeting and focused on general GMACS improvements and implementing GMACS in various assessments. The January 2020 workshop outlined tasks for the May 2020 CPT meeting including: additional selectivity options, jittering, implementing terminal molt, restructuring the likelihood section, adding maturity partitions to the likelihoods, changing how growth is treated, implementing additional recruit sex ratio options, and improving the "gmr" package.

Progress has been made in GMACS, but work is ongoing. Long-term tasks include adding a cubic spline to selectivity (done), including retrospective analyses (some progress, but the code hasn't been tested yet), including a projection module with additional recruitment options (in progress), estimating a stock-recruit relationship internally, the ability to input the mean and standard error for recruitment for projections (mostly complete), including options to fit "observed maturity" ogives (little progress, considered long-term goal), and adding growth data based on pre- and post-molt sizes (with corresponding likelihood component, as in Tanner crab assessment).

The CPT emphasized the importance of retrospective capability and stock-recruit function improvements. While a stock-recruit function exists, there is still a fair amount of work needed: the function is not linked to model estimation, has not been fully tested, and no bias corrections have been built in. However, if the stock-recruit function is not used in potential applications, then improvements may not be a priority. Andre noted that there are several options for including retrospective capabilities, but each needs to be fully explored.

André has done much housekeeping work including revising labels for recruitment distribution parameters, adding column headers and row labels to the diagnostic input CTL file, documenting the headers for the

columns in the likelihood specification, performing error checks on the size transition pointer for growth data, and performing error checks for negative growth increments. The TPL documentation is progressing, and there is funding for a postdoc to continue progress on documentation and further model development. Cody Szuwalski and Katie Palof made progress on developing a generalized GMR package for output that will work for multiple stocks. The GMR package was placed on github as a separate repository and most plots now work, but some still need updating. Functions to get table output organized into standardized SAFE tables still need to be completed. The GMACS has the ability to jitter input parameters and rerun the model, but jittering needs further testing. It was noted that diagnostic files should help in troubleshooting and that the amount of jittering relative to what has been done in the past may affect output.

Toshihide Hamazaki was able to run the NSRKC assessment in GMACS and will compare model runs (GMACS and the current model) at the September 2020 meeting with associated documentation. Shareef Siddeek plans to focus on the application of GMACS for the AIGKC assessment, and will present a brief progress report at the September 2020 meeting. Review of AIGKC GMACS model for potential adoption is tentatively scheduled for the January 2021 CPT meeting.

André asked about the process for further developing GMACS, such as a follow up workshop in January 2021. Merging the terminal molt code for snow crab into the main branch of GMACS by September 2020 was considered unlikely. It was suggested that the main goal for the next workshop could be to focus on troubleshooting the merging of several branches of code (e.g., terminal molt, jittering, retrospective analyses) to get one cohesive set that works for both lithodid and Chionoecetes crab stocks.

4. VAST Model

Jon Richar (NOAA-SAP) presented VAST model results and diagnostics for BBRKC. VAST output and diagnostics for several additional stocks was provided to assessment authors for use in model runs for consideration at this meeting. Jon gave a brief overview of the VAST model, covering specifying equations and parameters for the delta model structure as well as linear predictors for encounter and catch-rates.

Both abundance and biomass models were run for BBRKC with spatial and spatio-temporal components enabled. Jon noted that the epsilon component (i.e., spatio-temporal random effect) was disabled in the abundance model to allow the model to converge, although assessment authors are not fitting to abundance estimates so this may not be a major concern. There was some confusion as to what each model component represents in the VAST parameter settings and André referred the CPT to Table 2 in the Thorson et al. (2019) VAST publication. In future presentations, the CPT requested clearer documentation and labeling of components in model settings and diagnostic tables.

Jon then presented model diagnostics for BBRKC estimates. Design-based and VAST abundance and biomass trends track each other fairly well, with VAST abundance and biomass estimates 3-4% larger on average and VAST confidence intervals notably smaller. Density maps generated by VAST estimates are also fairly consistent with spatial results from survey data. Jon showed encounter rate Pearson residuals, which show evidence of a spatial trend related to the zero/low catch stations. Positive catch rate Q-Q plots and quantile histograms were skewed for both abundance and biomass, potentially indicating that the tails of the distribution are underpopulated. Model parameters were also presented, and the CPT requested presenting parameter diagnostics in a more interpretable format rather than the parameterization used in the R setup files.

The CPT discussed how authors should assess diagnostics to definitively reject VAST model output for operational use. Andre suggested presenting an example model that would define a 50:50 point for rejecting or accepting model fit. The CPT agreed that after standards for accepting a model have been defined, authors should include diagnostics for VAST output as an appendix within each SAFE chapter. Andre also suggested viewing the recent SAFS think tank seminar by Andrea Havron and Cole Monnahan, which was focused on residual diagnostics for validation of VAST models. The discussion also addressed how barriers

such as islands are being treated in modeling spatial correlation in VAST for some stocks. This issue is currently being ignored in VAST, but Jim Thorson and others are working on a solution.

In summary, Jon expressed concern that the VAST diagnostics indicated that modeling issues have not been successfully addressed, and he was not entirely comfortable with using the VAST estimates in stock assessments at this time. Jon envisions the development of VAST estimates for crab as a multi-year process as he continues to refine methods. Overall, the CPT recognized the work that Jon put in implementing the model, providing timely output to authors, and fielding additional data requests for individual stock assessment model runs. The CPT shares Jon's concerns about diagnostics and recommends a delay in the use of VAST model output in crab assessments to allow time to investigate model configuration and improve model diagnostics. The CPT recommends that Jon provide an update on VAST modeling at the January 2021 modeling workshop, and the CPT will re-assess the use of VAST model output then. The CPT would like to see part of the January presentation and discussion include examples of diagnostics from an approved use of VAST in assessment models, likely from groundfish stocks, and examples of diagnostics from a model that would not be accepted.

5. BSFRF survey selectivity

Buck Stockhausen (NOAA-REFM) gave an overview of methods used to incorporate data from BSFRF side-by-side catchability studies into the Tanner crab assessment. BSFRF conducted side-by-side tows in conjunction with the NMFS EBS bottom trawl survey in Bristol Bay in 2013-2016 and further west on the shelf in 2017 and 2018. The earlier studies were focused on Bristol Bay red king crab but included information on Tanner crab while the later studies were focused more directly on Tanner crab. The 2018 data has not yet been released by BSFRF pending completion of quality assurance and data screening. Buck highlighted the differences between BSFRF and NMFS trawl gear and he noted that, after converting numbers of crab to area-swept abundance estimates, BSFRF gear consistently caught more Tanner crab across the study period. Buck reviewed availability and catchability relationships between the NMFS EBS survey, NMFS side-by-side, and BSFRF side-by-side size composition data and illustrated how these relationships could be estimated "empirically" outside the assessment model from ratios of the observed crab numbers-at-size.

Buck noted that interannual differences in empirical availability reflected the different study areas sampled each year in the side-by-side studies. Catchability in the EBS NMFS trawl survey, assumed the same for all years, was estimated empirically by fitting a GAM to the ratio of numbers-at-size from the annual NMFS and BSFRF side-by-side data. The smoothed sex-specific fits indicated selectivity was approximately logistic for both sexes, with maximum catchability for females at approximately 0.38 and males at 0.60. Scott Goodman noted that the addition of 2018 BSFRF side-by-side data might increase the scope of sampling to help clarify interannual variation in catchability and availability estimates from model fits.

Buck also reviewed previous studies conducted by Dave Somerton, Stan Kotwicki and colleagues to estimate net efficiency and selectivity ratios of NMFS gear to BSFRF gear. He noted that the Kotwicki et al. (2017) selectivity ratio decreased slightly for larger snow crab (indicating that the BSFRF gear was not as efficient for large snow crab as the NMFS gear), which may need to be considered for Tanner crab as well. Buck ended by summarizing future model developments to estimate catchability and availability, several of which have been incorporated in 2020 assessment scenarios for Tanner crab. Buck also showed preliminary results from a bootstrapping analysis to define catchability and availability priors.

CPT recommendations for future work:

- Address the use of sample sizes in the model (i.e. weighting years by number of crab sampled in each size bin).
- Explore the use of GAMM's to treat "year" as a random effect on catchability. This could be used to put a prior on catchability in the assessment model.

- Address the large differences in annual estimates of empirical catchability by incorporating differences in catchability across years.

6. Aleutian Is. golden king crab final 2020 Assessment

Shareef Siddeek (ADF&G) presented the final assessment for Aleutian Islands Golden King Crab, including the responses to past requests from the CPT and the SSC, alternative models, results of model runs and diagnostics, and values for the OFL under the tier 3 control rule.

Alternative models

The assessment authors examined six model scenarios for the EAG and three model scenarios for the WAG. Model 19.1 was the base model last year. Model 20.1b is the same as Model 19.1, except that the standardization of the Fish Ticket CPUE is based on a negative binomial error model. Model 20.1c is the same as Model 20.1b, except that the assessment for the EAG uses the CPUE index from the cooperative survey. Model 20.1d is the same as Model 20.1c, except that the value from the cooperative survey for 2019 is excluded from the assessment. Model 20.2 is the same as Model 20.1b, except that the observer CPUE is based on a standardization model with year*area interactions. Model 20.2b is the same Model 20.2, except that the assessment for the EAG uses the CPUE index from the cooperative survey.

The CPT agreed that basing the standardization of the Fish Ticket CPUE on the negative binomial distribution is an improvement, i.e. in principle Model 20.1b is an improvement on Model 19.1. The CPT noted that while the method used to select the degrees of freedom for the splines was acceptable statistically, there was often a wide range of degrees of freedom with similar AIC values (given the lack of independence among data points) and hence that the lowest value of degrees of freedom at which AIC is approximately constant could have been selected.

The models that used the CPUE index for the cooperative survey in the assessment for the EAG (20.1c, 20.1d, 20.2b) led to a lower final MMB. However, why this should be was unclear because the trend in the cooperative survey index is very similar to that of the commercial CPUE, especially when the 2019 data point is ignored. The reason for the change in results may be due to the relatively poor fit of the model to the CPUE data (the model predicts an increase in biomass perhaps due to an attempt to fit the size-composition data even though the CPUE index for the EAG is flat over recent years), combined with additional data (from the cooperative survey) indicating a lack of an increase in biomass. Thus, further examination of the model results is needed before the data from the cooperative survey can be included in the assessment.

The justification for the blocks used in constructing the CPUE index with area*year interactions is clearer than was the case in 2019. The method used to construct the CPUE indices accounts for years*blocks for which there are no data (and in principle for years*blocks with very few data points) by filling them in using a log-linear model, i.e.:

$$\hat{B}_{i,j} = e^{A_i + C_j}$$

where A_i is the factor estimate for year i, and C_j is the factor estimate for block j, where the A and C parameters are estimated from a log-linear regression of the biomass estimates on year and block (treated as factors). The variance for the final indices (Equation B.16) accounts for the variance of the standardized CPUE values for years*blocks with data, but ignores the biomass estimates based on the above formula. This variance should be based on two contributions: a) from block*years with data, and b) from those based on the above formula for year*blocks with no or few data.

Selecting a basis for calculation $MMB_{35\%}$

Model 19.1 sets the years used to determine the mean recruitment corresponding to MSY (and the mean recruitment in the first year of the model) to those for which the standard error of log-recruitment was less than 70% of Rsigma (the assumed standard error of log-recruitment). The CPT and SSC noted that no rationale was given for the choice of 70%. The results for all models except Model 19.1 calculate $MMB_{35\%}$ based on the recruitments for the years for which the standard error of log-recruitment is in the lowest 90% of the estimates of recruitment. However, this method will also lead to $MMB_{35\%}$ being based on 90% of the estimates of recruitment irrespective of how precise those 90% are.

The CPT agreed that the approach on which Model 19.1 is based is preferable to the 90% method. Siddeek was asked to repeat Model 20.1b but with $MMB_{35\%}$ based on the years 1987-2012—this became the CPT-preferred model. In addition, the CPT requested that the next assessment explore the sensitivity of the results to alternative percentages of Rsigma (e.g. 50%, 60%, 70%, 80%) and describe the trade-offs among alternatives (e.g. inclusion of imprecise estimates; a non-contiguous set of years).

Other recommendations and comments:

- The fits to the observer CPUE series should be shown separately for the index based on area*year interactions and that based on the default approach.
- Time-series of MMB should be shown for all years and for the most recent 15 years—this will help the CPT assess trends.
- The fits to the cooperative survey index should be shown.
- The CPT looks forward to seeing a version of the assessment in GMACS.

Finally, it was noted that the OFL values for 2020/21 in the assessment document are lower than that for 2019/20 even though the MMB values are about the same for these years. This arises because F_{OFL} is re-estimated each year and is lower in the 2020 assessment than in the 2019 assessment. In addition, the OFL is based on selected and retained biomass, which differs from MMB to an extent that depends on the estimated size-structure of the population. The OFL will consequently differ depending on the estimated size-structure of the population.

7. Ecosystem and Socioeconomic Profiles

Erin Fedewa (AFSC) and Brian Garber-Yonts (AFSC) presented a draft Ecosystem and Socioeconomic Profile (ESP) for Bristol Bay Red King Crab (BBRKC) to the CPT. This draft profile was requested at the January 2020 CPT meeting and will be updated and provided to the CPT at the September meeting for inclusion in the BBRKC SAFE chapter as an appendix.

Erin presented the current list of metrics specific to BBRKC. The CPT noted that metrics for BSAI crab stocks should help identify vulnerability or resilience of a stock to ecosystem or socioeconomic pressures and inform fishery management decisions. The CPT recommended that metrics should be measurable and responsive and can be quantitative or qualitative. In the coming months, a dedicated discussion with ESP authors will focus on how to produce and use the metric panel in the context of informing indicators for ESPs. A report card has also been developed for crab stocks and used to assist management in decisions for additional or relaxed caution, and a report card was recently presented at an Alaska Board of Fisheries meeting when revising a harvest strategy.

The candidate ecosystem indicators for the BBRKC ESP were grouped into indicators of climate, life history (larval, juvenile/adult), and spatial distributions. Candidate climate indicators include Bristol Bay cold pool extent, Bristol Bay summer bottom temperature, and PDO index. Candidate larval indicators include EBS wind stress, EBS chlorophyll-a, and EBS juvenile salmon abundance. Candidate juvenile/adult indicators include Bristol Bay Pacific cod biomass, Bristol Bay benthic invertebrate biomass, BBRKC pre-recruit biomass, and BBRKC male length-weight residuals. Candidate spatial indicators include BBRKC

catch area, BBRKC catch distance from shore, BBRKC mature male area occupied, and BBRKC mature female area occupied.

The CPT suggested these indicators be as spatially relevant as possible, e.g., the satellite products of wind stress and chlorophyll-a could be restricted to the Bristol Bay region. Using an online interactive link, the CPT and meeting attendees were polled for ideas of additional indicators using real-time virtual polling. Some specific suggestions of BBRKC indicators to prioritize for development included predator-prey spatial overlap, fishery performance indicators, economic contribution for small ports/communities, and spatial patchiness of the stock.

Preliminary Bayesian analyses were conducted by Curry Cunningham to identify which indicators are associated with mature male biomass and to evaluate uncertainty in the degree of these associations. This analysis requires consistent temporal coverage and could only be conducted with a subset of the indicators, including EBS wind stress, pre-recruit biomass, PDO, Pacific cod biomass, bottom temperature, and benthic invert biomass. Of this subset, RKC pre-recruit biomass and Pacific cod biomass showed the strongest inclusion probability.

Incorporation of biologically meaningful lag times in the analysis is in development, as are additional ecosystem indicators. ROMS model output from hindcasts include carbonate chemistry, fall/spring temperature, circulation patterns, and water column stratification and should be available in the coming months for the development of an ocean acidification indicator. Other potential indicators include summer sea surface temperature, zooplankton abundance, and output from other models, including SDM and IBMs. CPT was asked to rank this suite of indicators for inclusion in future ESPs and an indicator for predator-prey spatial overlap was ranked the highest by polling participants.

Brian provided an overview of candidate BBRKC socioeconomic indicators including factors about the fishing fleet (number of vessels, economic return, port of landing), about the directed pot fishery (fishery closures, bycatch mortality, price, effort), and groundfish fisheries (bycatch, gear conflict). The plan for the September CPT meeting is to present (similar to the SMBKC ESP) five socioeconomic indicators related to commercial value and constituent demand (TAC utilization, local quotient of BBRKC landed in Dutch Harbor, number of active processors, BBRKC ex-vessel revenue share, BBRKC ex-vessel price per pound) and four related to fishing effort (total potlifts, CPUE, number active vessels, BBRKC male bycatch in trawl fisheries). The CPT commented that it would be useful to see real-time price data as most information on price is two years old.

How these socioeconomic indicators are included in the ESP process needs further refinement and could include “upstream” social and economic drivers, which might be explored using bioeconomic models and “downstream” social and economic effects of the fishery on stakeholders and communities. Brian presented a series of slides from a presentation given by Ben Fissel at the 2020 ESP Workshop, depicting a stylized model of decision points and information flow related to the ESPs, differentiating between the two key management analyses and decisions that the ESPs are intended to inform: the stock assessment model and ABC recommendations, and TAC setting. For groundfish, contextual ecosystem information is in a risk table in the stock assessment that feeds information to complement the stock assessment model in groundfish plan team review and ABC recommendations. Social and economic information could, in principle, provide some contextual information for assessment authors and plan teams, but has been excluded by the Council from being considered in ABC determinations. Social and economic information is more generally used to inform decisions regarding TACs, so in theory, it comes in much later in the management process. It was noted that the State, not NPFMC, sets TACs for BSAI crab stocks (in contrast to groundfish), so selection of socioeconomic indicators for inclusion in crab ESPs would ideally include input from ADF&G regarding indicators that the State considers relevant for TAC-setting.

The CPT strongly supports the ESP efforts underway and looks forward to seeing an ESP for BBRKC in the fall. Erin and Brian are interested in including additional expertise from the CPT and beyond to contribute to future ESP efforts.

8. Crab PSC

Sarah Marrinan and Sara Cleaver (Council staff) presented information on a proposed Council action to change crab PSC (Prohibited Species Catch) limits to the lowest possible level when the directed crab fishery is closed. There are currently area PSC limits in place for Bristol Bay red king crab, Tanner crab, and snow crab for groundfish vessels using trawl gear. The current limits are rarely exceeded, and even if they were set at the lowest level would rarely be constraining. This proposed Council action is scheduled to be presented at the October 2020 Council meeting.

BBRKC and snow crab have fixed PSC limits at the lowest level whereas Tanner crab uses a percentage of animals in the PSC calculation. However, Sarah pointed out that the Council will likely have to choose a fixed number for Tanner crab as well. If a fixed number is not used, it would be possible for Tanner crab abundance to be high while the directed fishery is closed, thus resulting in a higher PSC limit instead of the lowest limit.

There were questions as to how the PSC limits were originally set. Snow crab limits were likely created through industry negotiations whereas Tanner crab and BBRKC limits may have taken into account the harvest strategies and rebuilding plans. Council staff plans to investigate this in more detail to determine the source of the stair-step limits.

There was a question about whether limits are based on model estimates or survey estimates. Sara was hoping to get more information from the CPT and Alaska Region as to where these numbers come from. For snow crab, the numbers are coming from expected survey abundance estimates from the model (accounting for survey catchability). These estimates are given annually to the Council and used in the harvest specification process for groundfish.

Council staff asked about the importance of bycatch in crab population dynamics. Currently there is very little crab bycatch in groundfish fisheries compared to the directed fisheries. However, it was noted that there is very little information on the unobserved mortality of crab species. Unobserved mortality is crab mortality that occurs when crab interact with fishing gear but are not brought to the surface to be accounted for by an observer. Unobserved mortality is not being estimated or included in the stock assessments. One suggestion was to use trawl survey catchability to estimate crab not captured in the groundfish bottom trawl fisheries. However, there is uncertainty about mortality rates of crab interacting with the gear. It was noted that Rose (2013) evaluated unobserved mortality and should be consulted. Mortality rates might change depending on time of year due to molting and locations of fishing. Unobserved mortality might also change depending on net configuration. Council staff asked if assessment authors could examine the effects of increased bycatch on model results. Assessment authors said this was possible and could be done relatively quickly.

Council staff asked if there is a relationship between crab abundance and bycatch levels. For example, if a crab stock is rebuilding, would an increase in stock size be associated with increased bycatch mortality? Area closures may be needed to ensure bycatch does not increase when population abundance increases. For crab, in the pre-rationalized years, there was a relationship between abundance and bycatch, but this may be related to fishing behavior rather than crab abundance. In more recent years, bycatch has decreased while population abundance has increased, suggesting there is no relationship. However, there are many elements that can affect the amount of bycatch that make it difficult to determine a correlation between crab population abundance and bycatch levels. These may include gear modification, fishing behavior, observer distribution, and/or spatial mismatch between fishing effort and population distribution.

Council staff asked about non-trawl gear bycatch, which does not accrue towards the PSC limits. In snow crab, pot gear bycatch is very small compared to trawl gear. Tanner crab has not had much pot gear bycatch in Zone 2, but has seen higher levels of pot bycatch in Zone 1. Historically non-trawl bycatch has not been a concern in the Tanner crab assessment because the amounts are small. However, these should be further evaluated in the future. BBRKC has also seen some years with high bycatch levels from pot gear, which

should be further explored. Sarah noted that when the PSC limits were established, pot bycatch was small and not considered a concern.

There was also some discussion regarding the changes in size composition of bycatch over time. It is unclear whether changes in size composition are due to the population size or fishing practices. Size composition may also be important to consider when understanding conservation concerns because the PSC limits are based on numbers of crab regardless of size. As a result, the directed fishery may be closed, but abundance of juvenile and female crab may be high, resulting in high bycatch amounts of smaller crab, which are then unable to recruit into the directed fishery. This information has been requested in the past several times and might be good to further investigate even if it does not fit into this specific Council action.

It was noted that looking at the spatial footprint of gear could be important. There has been some work regarding the spatial footprint of trawl effort and crab abundance, which did show some correlation for snow crab.

CPT recommendations:

- The size composition and spatial pattern of bycatch should be evaluated, including looking at non-trawl bycatch changes over time and discussing if PSC limits should apply.
- The rationale behind the stair-step approach used to set PSC limits, and how limits were originally determined should be documented.
- Assessment authors should 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. These should be provided to Council staff within the next two months for inclusion in the October Council document.

9. Bristol Bay red king crab model runs for Sept 2020

Jie Zheng (ADF&G) presented eight scenarios for the Bristol Bay red king crab assessment to be considered for the September CPT meeting. These scenarios explored the way in which natural mortality was treated in the assessment, how survey selectivity was defined, and the utility of adopting the VAST indices of abundance. Jie began his exploration of natural mortality modeling by specifying a single natural mortality over time for males and estimating female natural mortality as an offset (Model 19.1)—a simplification of the status quo model. Model complexity was then increased by introducing time blocks during which offsets for M were estimated (Model 19.2) and then allowing for male-female offset (Model 19.3). Ultimately, the CPT agreed that more flexibility in natural mortality was needed than a single natural mortality throughout the fishery history, but that the flexibility in the status quo assumptions (different time blocks for males and females) was not warranted.

Other models focused on survey selectivity and catchability. Survey selectivity ogives are currently estimated separately by sex and share a common survey catchability. Jie presented a model with a single selectivity curve for both sexes (Model 19.4a), and one in which survey catchability was estimated by sex (Model 19.5). The rationale for a single selectivity curve was parsimony. However, the survey composition data were better fit when selectivity was assumed to be a function of sex. The model with a sex-independent survey selectivity actually had a better total fit, but this appears to be a result of changes in the *PriorDensity* likelihood component.

The CPT generally favored estimating sex-specific survey selectivity given potential behavioral differences, slight sexual dimorphisms, consistency with other assessments, better fits to survey composition data, and the relatively small number of parameters required. For similar reasons, the CPT preferred sex-specific survey catchability. The CPT also suggested that now that the BSFRF data are incorporated into the model, the priors on survey catchability should be reconsidered. The priors are

currently very informative and do not reflect the catchabilities implied by the BSFRF data (which appear to differ by sex).

Models in which VAST indices of abundance were fit to (Models 19.4a and 19.4b) were not considered for September because documentation of diagnostics and model assumptions were not provided in the review documents. Diagnostics that were presented during the meeting were concerning, particularly the qq-plots. The CPT suggested generally that examples of acceptable and unacceptable diagnostics would be useful in the review process for determining whether or not to adopt VAST indices of abundance.

Given the above discussion, the CPT selected model 19.3 as the priority model (in addition to the status quo model, 19.0a) for presentation in September, understanding that time schedules for producing data used in the assessment may be compressed as a result of the global pandemic. Model 19.3 estimated male natural mortality in an early block (1980-1984) and then specified M as 0.18 thereafter. Female natural mortality was estimated as an offset from males in both periods. Survey selectivity was estimated separately for sexes, but a single catchability was estimated (still with a strong prior). If time allows, a model building from 19.3 in which the prior on catchability is relaxed and estimated separately by sex (and revisited in light of the catchability implied by the BSFRF data) would be useful for comparison.

CPT recommendations:

- Produce the empirical survey selectivity diagnostics that were produced for Tanner crab at this meeting, but for BBRKC. Specifically, display the ratio of NMFS to BSFRF (rather than NMFS/(NMFS+BSFRF)) numbers at size to provide a direct comparison to estimated survey selectivity.
- Describe how the sex ratios for OFL calculations were averaged. It is the same as the recruitments, but was difficult to confirm in the document.
- Check the calculation of total male directed fishery catch as inputted to GMACS to ensure accounting for discard mortality is appropriate. Check the tables for correct numbers and that they match the .DAT files provided. Consider splitting the tables needed by the State of Alaska from those presenting the data used in the assessment. CPT suggests that the methodology for how total catches are calculated should be added to the terms of reference for all assessments.
- Highlight the 'PriorDensity' row in the table listing the contribution of likelihoods to the objective function value. Make sure that it is clear that differences in likelihood comparability are well represented in the tables. It appears that modifications will need to be made to the way that GMACS includes or does not include prior densities so that the objective function values from models with different numbers of parameters (but fitting to identical data) are comparable.
- Include diagnostics for VAST indices of abundance and provide rationale for accepting or rejecting the index in future iterations (but not for September 2020).
- Provide justification for the assumed natural mortality for males of 0.18 yr^{-1}. How does the 1% rule assumed in the assessment compare to empirical studies on natural mortality and longevity (e.g. Then et al. 2016)?

10. W. Aleutian Is. red king crab final 2020 Assessment

Ben Daly (ADF&G) summarized the 2020 assessment for Western Aleutian Islands red king crab. This is a Tier 5 stock assessed on a triennial cycle, most recently in May 2017. Overfishing did not occur during the 2017/18, 2018/19, and 2019/20 seasons. The area west of 179ºW longitude (Pribilof District) is managed under the Crab Rationalization Program and the area east of 179ºW longitude (Adak District) is not rationalized. However, the fishery has remained closed following the 2003/04 season.

New data on AIGKC bycatch and groundfish bycatch for 2017/18–2019/20 were provided but not included into the calculation of the OFL, which has been unchanged since 2010. A relatively high bycatch (1.2 t) of

WAIRKC in the 2015/16 groundfish fishery compared to the previous three low-bycatch seasons represented only ~2% of the OFL and was not deemed a conservation concern; ~95% of the 2015/16 groundfish fishery bycatch occurred in the Atka mackerel fishery. The CPT was curious about the relative increase in the proportion of WAIRKC bycatch attributed to the rockfish fishery during 2017/18–2019/20, an aspect believed related to the Pacific ocean perch trawl fishery.

A change to the OFL calculation is not anticipated unless bycatch information from 1995/96-2007/08 is revised, so the author recommends a status quo OFL of 56 t with a 75% buffer for a status quo ABC of 14 t (30,967 lb), which could allow for a small exploratory fishery. The CPT noted that this approach seems reasonable given the depressed stock status, the lack of new information, and the absence of interest in a directed fishery.

11. Pribilof Is. golden king crab final 2020 Assessment

Ben Daly (ADF&G) presented the Pribilof Islands golden king crab (PIGKC) stock assessment. The PIGKC fishery is currently managed by calendar year. At present, PIGKC is a Tier 5 stock, with the last assessment in May 2017. The OFL computation based on average catch follows the methodology established by the CPT in May 2012 and the SSC in June 2012.

Ben presented results from the 2002–2016 EBS upper continental slope surveys and improvements to the application of a random effects model to estimate MMB, and potentially move this stock to Tier 4. Authors applied the random effects (RE) model to six variants of the EBS slope survey MMB time series, which varied by: the number of years of data, the spatial area extent, and level of stratification. Size composition data are only available for the 2008, 2010, 2012, and 2016 surveys, thus MMB area-swept estimates are only available for those years. However, authors calculated the ratio of MMB to total biomass for the 2008, 2010, 2012, 2016 surveys and applied the average ratio to the 2002 and 2004 survey total biomass to approximate MMB for the 2002 and 2004 surveys.

The Pribilof District Management Area (PDMA) boundaries do not align with those of the EBS slope survey subareas. All of survey subareas 2 and 3, nearly all of subarea 4, and portions of subareas 1 and 5 are encompassed by the PDMA. While most of the survey biomass occurs in subareas 2–4, some GKC occur in subareas 1 and 5. For some model variants, authors included portions of these subareas when calculating MMB estimates. Authors also included MMB time series calculated using average densities within strata within subareas, and strata within the survey area (i.e., similar depth strata were combined among subareas, and subareas were neglected). The RE model appeared to converge for all MMB input scenarios (maximum gradient component < 0.0001) and fitted MMB and parameter estimation was primarily sensitive only to differing numbers of surveys. Lack of an obvious trend and large CVs (> 20%) in model variants that used only data from 2008–2016 resulted in an estimated process error variance that was very small ($\sigma_\lambda \sim 0.001$), resulting in a 'flat' trend in fitted MMB. When including the 2002 and 2004 MMB approximations, the model responded by capturing the relatively low survey biomass estimates in those years following a slight increasing trend.

The CPT was encouraged by Ben's progress, but has concerns about how the RE model was applied. Since the problems seem straightforward to resolve, the CPT would like to see a revised Tier 4 assessment brought forward in May 2021, subject to SSC approval of this timeline. Although a three year assessment cycle has been established for PIGKC, the terms of reference for crab assessments allow for changes if new assessment models or data become available. The CVs for 2002 and 2004 did not account for uncertainty in ratio used to infer MMB. Because the 2002 data point had a relatively small variance, the CPT was concerned that this data point may be highly influential on the trend estimation and hence the ability to infer process error. An approach for determining the variance for 2002 and 2004 MMB estimates using a standard formula for the variance of two independent random variables was recommended. The CPT identified model variants with very small estimated process error as degenerate solutions, and recommends including a prior on the process error to deal with this situation. Finally, although the RE approach is commonly

applied to data-poor groundfish stocks and has been used for the PIBKC assessment, the CPT would like to see basic documentation on the approach included in the assessment.

The CPT also discussed the future of the NMFS slope survey. While NMFS still considers continental slope survey an important element in its resource assessment portfolio for the EBS, future surveys will depend on the availability of sufficient funding, which was lacking in 2018 and 2020. Ben mentioned that ADF&G is developing an industry-cooperative pot survey, but the survey would yield CPUE data (as opposed to area-swept via bottom trawl survey), and the development of a time series for use in a model-based assessment is likely more than five years away.

The CPT accepts the authors' recommended Tier 5 OFL (93t) and ABC (70t). The CPT requests assessment authors bring the Tier 4 modeling work to the January 2021 modeling workshop for review, followed by a presentation at the May 2021 CPT meeting for possible adoption.

CPT recommendations:

- Continue to explore the existence of 2004 survey size composition data.
- Improve CV calculations for 2002 and 2004 MMB estimates.
- Explore a simplified GMACS model.

12. Board of Fisheries Update

Ben Daly provided an overview of the March 2020 presentation to the State of Alaska Board of Fisheries (BOF) concerning ADF&G's Proposal 261, recommending a revised harvest strategy for Bering Sea Tanner crab. The goals of the proposal are to simplify the harvest strategy, reconsider the application of a female-based control rule, and to improve the economic outlook of the fishery. Ben emphasized the extensive collaboration and multi-year effort involved in the harvest strategy revision process, and particularly credited Maddy Heller-Shipley and Buck Stockhausen for their work on the MSE analyses of 15 alternative harvest strategies, Andre Punt for guidance, and Scott Goodman of BSFRF for facilitating industry engagement throughout.

Fifteen harvest strategies were examined and each was projected 100 years into the future. A series of metrics were grouped into broad categories: conservation, catch, and catch stability; and were used to eliminate harvest strategies that did not effectively balance conservation and economic tradeoffs. Using this method, the 15 harvest strategies were narrowed down to two concepts; a male only control rule and a female "dimmer" control rule. The female "dimmer" control rule is the male only sloping control rule where the maximum height of the slope would be adjusted according to the relative female abundance. This female "dimmer" control rule concept was selected as the best option, and four variants were considered including differences in the upper and lower bounds. The final harvest strategy adopted by the BOF included a female dimmer with a 5% floor and 20% ceiling exploitation rate on mature male biomass. The final harvest strategy recommendation took into account multiple sources of uncertainty including limitations of the MSE in fully capturing the reproductive potential of the population (i.e., how recruitment was generated) and the dramatically changing environmental conditions in the Bering Sea. The NOAA Tanner crab report card was presented to the BOF to demonstrate environmental uncertainty and was regarded as a useful tool. The harvest strategy applies to the entire stock and will be used to set the TACs separately east and west of 166 W long based on relative MMB levels in each area. CPT members asked about future State harvest strategy revisions. Ben mentioned that the snow crab harvest strategy is likely the next to be updated, and he hopes to include an MSE in this process. The CPT endorses this process and encourages further efforts to update harvest strategies for additional stocks.

Scott Goodman and Jamie Goen (Alaska Bering Sea Crabbers) both commended the analytical team for a highly successful collaboration.

13. Tanner crab model runs for Sept 2020

William Stockhausen (Buck; NMFS) summarized new features of the Tanner crab assessment model and presented a set of model scenarios for consideration for the September CPT meeting. New features included options for specifying availability and selectivity curves as cubic splines, options for including priors on selectivity and availability, and an option for estimating extra variance when fitting biomass indices (useful for models that include indices produced by VAST). Buck also presented a preliminary analysis that indicated a persistent residual pattern in the length-weight relationship used in the assessment for male Tanner crab. Old shell crab tended to weigh more at length than is indicated by the regression. The RACE shellfish assessment program will look into the original analysis and dataset used to estimate length-weight relationships and provide guidance.

Buck noted that one issue he did not address was a SSC request that a standard approach be developed for projecting the upcoming year's biomass that does not include removing the entire OFL for stocks where recent mortality has been substantially below the OFL. This is an issue for all crab assessments. CPT members expressed reservations about how dependable such projections would be, and mentioned a recent example for snow crab in which such projections would have been wildly overoptimistic. There were concerns that such projections would harm the credibility of the assessment. Projecting stock dynamics using the state's harvest control rule is not presently possible in Gmacs, and would be difficult to implement because state harvest strategies differ among stocks, as well as due to the complexity of the control rules, which include cutoffs, multiple stairsteps, and calculations using female abundance. One option would be to project stock dynamics when the catch is set to some fraction of OFL based on recent history. The CPT agreed to form an ad hoc working group to include assessment authors and CPT co-chairs to consider options, and make recommendations for evaluation at the January modeling workshop.

Buck examined nine model scenarios for consideration at the September CPT meeting. Model 19.03 is the base model from last year. Model 20.01 is the same as Model 19.03, except that the parameters for the gamma distribution that assigns recruits to size bins are estimated rather than being fixed. Model 20.02 drops the pre-1982 survey biomass and size composition from the model. The survey prior to 1982 used a different trawl gear and had varying spatial coverage, and is modeled with its own catchability and selectivity curves. Model 20.02 is thus a simpler model that excludes potentially conflicting data. Model 20.03 evaluates the use of cubic splines to model survey selectivity. Models 20.04 and 20.05 evaluate the use of VAST indices in the assessment. Model 20.04 uses the standard errors estimated by VAST, which are usually much lower than those for area-swept estimates, while Model 20.05 estimates additional variances, as is often done when using VAST estimates in stock assessments.

Models 20.06, 20.07 and 20.08 all explore different ways to incorporate the side-by-side data collected by the BSFRF in the assessment. Model 20.06 uses the same approach as has been used in the snow crab assessment by incorporating both the BSFRF data and NMFS data to estimate non-parametric availability curves and inform NMFS survey selectivity. Model 20.07 includes empirical availability curves estimated outside the model, while model 20.08 used catchability curves estimated outside the model (see details above in the BSFRF selectivity section).

The CPT discussion and evaluation of models was aimed at selecting a single preferred model in addition to last year's base model to reduce workload in a potentially delayed and compressed fall assessment cycle. Model 20.01 gave very similar results to model 19.03, and was considered a clear improvement since the gamma distribution parameters were estimated rather than assumed. All the other models under consideration also included this feature. Model 20.02, which dropped the earlier survey data, also did not show large differences from model 19.03, but it was noted that model 20.02 still estimated an independent recruitment vector for the early years. The CPT regarded this model as promising, but in need of further development, and in general the CPT recommends that efforts to remove unnecessary complexity from the model should continue.

The CPT also regarded the models using the VAST estimates as promising, but needing further development. One concern was that no diagnostics were provided to evaluate whether the VAST estimates were acceptable to use in the assessment. Model 20.04, in which the standard errors estimated by VAST were input directly in the assessment, gave similar results to the base model 19.03, but better tracked the peaks and valleys in Tanner crab abundance, as would be expected given the lower standard errors. Model 20.05, in which additional variance was estimated, was not successful since the additional variance parameter went to its upper bound. This suggests that there is conflict between different data sets in the assessment, most likely between the composition data and biomass indices. It is important to investigate this further. A likelihood table showing fits to the different data sets should be provided (this was left out of the current draft). Generating a likelihood profile across a suitable parameter could also be useful in evaluating data conflicts.

Of the three alternatives for including the side-by-side data in the assessment, the CPT regarded the approach of Model 20.07, in which empirically derived availabilities were input into the model, as the most robust and technically superior of the approaches. Model 20.06, in which arbitrary smooth curves were estimated by the model, seems not to make best use of the available information. It was also difficult to understand and justify the shapes of estimated availability curves. Model 20.08, in which an empirical catchability is input, is the most straightforward approach, and is likely to become the preferred approach moving forward (possibly as a prior on an estimated curve). However, the CPT thought that additional model development was needed before it could be adopted.

Therefore, the CPT recommends that model 20.07 be identified as a preliminary base model for September. The CPT discussed a refinement to model 20.07 (here denoted model 20.07b), in which the empirical availability curves are input as data vectors with specified uncertainty, rather than assumed known. If Model 20.07b turns out to be straightforward to implement, as we expect, then Model 20.07b could be regarded as the preliminary base model rather than Model 20.07.

Additional CPT recommendations:

- Consider ways to remove any additional complexity in the Tanner crab assessment that does not add to our understanding of stock dynamics.
- Evaluate potential conflicts between data sets in the assessment using likelihood profiles and other approaches.
- Further work is needed to incorporate empirical estimates of catchability in the assessment. Quantifying uncertainty in catchability is critical. Uncertainty estimates should consider year-to-year variation catchability either as a random effect or as a level of a hierarchical model.

14. Snow crab model runs for Sept 2020

Cody Szuwalski (AFSC) summarized his recent work to transition the snow crab assessment from the status quo code to GMACS, discussed incorporating VAST model-based estimates for NMFS survey biomass in the assessment, and suggested three alternative models for consideration during the September CPT Meeting. The discussion regarding the use of VAST model-based estimates in the assessment was new to the presentation and had not been included in the report provided to the CPT.

As part of his effort to transition the snow crab assessment to GMACS, Cody added the option to implement terminal molt to describe the population dynamics for a crab stock. This was done in the GMACS code by: 1) redefining indices representing new shell/old shell characteristics to instead represent immature/mature (pre/post terminal molt) characteristics (future work may allow both sets of characteristics to be simultaneously represented), and 2) setting the annual molting probability to 1 for immature crab (all immature crab molt) and to 0 for mature crab (no mature crab molt).

The terminal molt code was tested by comparing values for numbers-at-length between the status quo and GMACS models using conditions (i.e., parameter values, selectivity curves, etc.) as equivalent as possible between the two models. Cody showed that the numbers-at-length for males were practically identical between the two models, but estimates for females showed less agreement due to inherent differences in the way fishing mortality for females is represented in the two models. Cody felt, while it would be possible to modify the code in one of the two models to achieve agreement similar to that for males, it would involve a substantial amount of effort that would only be useful to demonstrate the two model agree. Thus, Cody concluded, and the CPT concurred, that terminal molt dynamics for *Chionoecetes* stocks were successfully implemented in GMACS.

Results from fitting two GMACS models to the same data as that used in the 2019 assessment were also presented. Both GMACS models were implemented similarly, except that one ("free q") did not impose a prior on survey catchability while the other ("prior q") imposed a diffuse prior on survey catchability. Cody noted that both GMACS models were able to produce "reasonable" fits to the data, and both fitted several (but not all) datasets better than the status quo model. Unlike the status quo model, the GMACS models were able to produce converged fits to the growth data using a linear model between pre- and post-molt sizes, something that had not been achieved with the status quo model which involved a kinked growth curve. The GMACS models also fit NMFS survey biomass and BSFRF data better than the status quo.

GMACS models over-predicted the relative abundance of large crab in the size composition data (particularly retained catch) in the beginning of the modeled time period. This latter effect was referred to as a "pigtail", and the CPT discussed potential causes for these pigtails, as well as the potential use of different likelihood functions for size composition data, without arriving at any substantive conclusions. However, differences in estimates of growth, catchability, natural mortality, and the probability of maturing existed among the models, suggesting that these issues should be considered and may resolve the issue.

The status quo model produced the smallest estimates of MMB, while the prior q model produced the highest. This was mainly attributed to differences in estimated survey catchability among the various models resulting in differences in predicted population abundances, although differences in other parameter estimates also contributed. The impact of these differences on status determination and OFL calculations could not be determined because the necessary code to project the stock and calculate reference points has not yet been implemented in GMACS, although the plan is to do so by September. Cody noted that one downside to the GMACS models was, pending code optimization, the models now take ~2 hours to run to convergence whereas the status quo model converged in about 12 minutes.

An alternative to the standard design-based estimates for NMFS survey biomass, VAST model-based estimates for snow crab (provided by Jon Richar, NMFS) were also discussed. Cody found that the VAST estimates were different from the design-based estimates, particularly for females. On the whole, VAST estimates for male survey biomass were lower than those from the design-based estimator, while those for females were greater. Cody also provided diagnostics on the estimated probability of occurrence, which indicated a tendency for VAST to "fill in" biomass at stations which were sampled but found no snow crab. Although the two GMACS models previously described were fit to the VAST estimates and obtained apparently reasonable fits to the data, both Cody and the CPT recommended postponing the use of VAST estimates for assessment until diagnostics could be more fully analyzed.

Thus, Cody recommended that the status quo, "free q" GMACS, and "prior q" GMACS models be brought forward as alternative scenarios with 2019/20 data for consideration at the September CPT meeting. The CPT agreed with this recommendation, but also discussed possible fallback positions in the event that data from this summer's NMFS EBS bottom trawl survey are delayed as a consequence of the COVID-19 situation. The CPT recognized the need to be flexible in response to changes (i.e., delays, cancellation) in the survey this year, with one option being to delay the snow crab assessment and review it during a special 1-day meeting in November so that it could be reviewed by the SSC at the December Council Meeting. Discussion with ADF&G members of the CPT indicated that the State had the flexibility to delay setting

TAC for this stock until December without substantially impacting the fishery because little fishing for snow crab generally occurs before January.

CPT recommendations thus include the following:

- Identify the cause of the "pigtails", particularly in the retained catch size compositions.
- Pending further diagnostic analysis and CPT consensus on the use of VAST for crab stocks, do not bring forward models that fit the VAST estimates of survey biomass.
- Implement reference point calculations in GMACS for status determination and OFL calculation.
- Bring forward the following alternative model scenarios for the September CPT Meeting:
    - Status quo model with updated data.
    - "Free q" GMACS model with updated data.
    - "Prior q" GMACS model with updated data.

15. St Matthew Is. blue king crab model runs for Sept 2020

Katie Palof (ADF&G) presented the model scenarios and results of the St. Matthew blue king crab (SMBKC) assessment to the CPT. The SMBKC stock is currently overfished with final NPFMC action on a rebuilding plan scheduled for June 2020. The rebuilding plan includes no changes to fishing/bycatch regulations and a focus on recruitment projects, and includes more pessimistic scenarios in which environmental conditions prevent stock rebuilding independent of fishery/bycatch impacts.

A three-stage, length-based, male-only model has been used to assess SMBKC since 2012, with modeling in GMACS since 2016. The model estimates population abundance and biomass for 1978 to 2019 by fitting data on commercial catch, groundfish trawl and fixed-gear bycatch, observer composition, trawl surveys, and pot surveys. Pot survey data were recently updated. Major modeling issues include: trend discrepancies between pot and trawl surveys, spatial hot spots in surveys (e.g., station R24), and poor model fits to surveys after 2009. The CPT concurred with the author that a retrospective analysis would be good for all models.

Based on CPT and SSC review comments and suggestions, the authors proposed and investigated five model scenarios:

- Model 16.0 (2019 reference model): updated with Jan 2020 revisions to GMACS.
- Model 19.1 (VAST NMFS trawl data): model 16.0 with VAST data output for the NMFS trawl survey time series.
- Model 19.2 (add CV pot): Model 16.0 + an estimated additional CV on the ADF&G pot survey.
- Model 19.3 (add CV both): Model 16.0 + an estimated additional CV on the ADF&G pot survey and the NOAA trawl survey.
- Model 19.4 (time block pot): catchability for ADF&G pot survey estimated in two time blocks: 1995–2013 and 2015–2018.

Models 16.0 and 19.2 were presented in September 2019 and run with the updated version of GMACS. Model 16.0 is essentially Model 19.0 in the 2019 SAFE report, with a name change to reflect that the model was first accepted in 2016. The model updated to the most recent version of GMACS revealed no differences. Models 19.3 and 19.4 are used to address CPT and SSC review comments and Model 19.1 is used to evaluate VAST-estimated NMFS trawl survey biomass and CV. Time blocks for Model 19.4 were based on pot survey index residuals.

As expected, additional CV models (Models 19.2 and 19.3) fit NMFS trawl survey biomass better and ADF&G pot survey index worse than the reference model (Model 16.0) due to increased pot survey index CVs. Estimates of mature male biomass differ greatly in recent years due to the model more closely fitting

the trajectory of the trawl survey and downweighting the declines in the pot survey with Models 19.2 and 19.3. The VAST scenario generally estimates higher mature male biomass since the early 1990s, which would be expected since the trawl survey biomass estimates from VAST are larger in the 1990s and 2000s. The VAST model biomass also fits the 1990s trawl survey data more closely than the reference model. Although stock estimates generally increased, the stock still remains overfished under the VAST model. The *q* block pot fit the mature male biomass very similarly to the reference model, which is expected since they both fit the survey data similarly. The addition of a time block for recent years of the pot survey did not appear to improve model fit to this survey or change overall fit. The CPT suggested that a random walk in *q* may be better than time blocks for pot survey *q*. Because a random walk option in GMACS has only been coded for *M*, the authors will work with others to code this option for *q*. The CPT also noted that the 2004 pot survey data point seems unrealistic given the remainder of the pot survey time series.

The CPT discussed the model results and the model scenarios for September 2020. In September 2019, the CPT considered that model 19.2, which estimates a parameter for additional CV for the pot survey, seemed a potentially viable base model. However, due to concern about the unbalanced treatment of the two surveys, the CPT asked for a model scenario to estimate extra CVs for both surveys, which is model 19.3. Both models 19.2 and 19.3 have similar fit to NMFS trawl and ADF&G pot survey biomass indices during the last 20 years and do not solve the data fitting problems. While Model 19.1 (VAST) is an option for consideration, the CPT remains concerned about island barrier issues of VAST and much higher survey biomass estimates from VAST during the first five years. One option may be to "split" the habitat based on a line through the island with VAST estimates on each side of the island; the author will make a heuristic model run. After eliminating these models, the CPT agrees with the authors' recommendation that Model 16.0, the 2019 reference model, remains a viable base model option for September 2020 in the absence of new data.

CPT Recommendations:

- Conduct the following four models for September 2020:
    - Model 16.0.
    - Model 19.1 (VAST).
    - A model with a random walk in pot survey catchability.
    - Model 16.0 without ADF&G pot survey data.

  The last three models are explorative, with the model with a random walk in pot survey catchability depending on modifications of GMACS.
- Conduct a retrospective analysis for the base model.
- Initiate a spatial analysis of NMFS trawl and ADF&G pot survey data to investigate changes in spatial distributions over time and how these changes affect both trawl and pot survey catchabilities.

16. Climate Change and LT/TK for NSRKC

The co-chairs of the Local Knowledge, Traditional Knowledge, and Subsistence Taskforce (LK/TK TF) gave a short presentation on their goals and tasking, with specific attention to the Norton Sound red king crab (NSRKC) fishery. At the February council meeting the SSC suggested that the Climate Change Taskforce (CCTF) and the LKTK TF use this fishery as a case study since it "combines the need for long-term, strategic recommendations on how to adapt to climate change with a need to involve a variety of local stakeholders (SSC minutes, Feb 2020)". The LK/TK TF agreed that this would be a good case study and addressed some initial ideas and questions when they met in January 2020. However, the LK/TK task force would like to put on hold any further consideration of case studies until at least 2021 due to COVID-19

travel restrictions and the need to develop a community-driven plan. The next LK/TK TF meeting is scheduled for Fall 2020.

The CPT used this presentation as a jumping off point to have a discussion on how local and traditional knowledge could inform management of the NSRKC. Most participation in this fishery, both commercial and subsistence, is community-based in the Norton Sound region and involves a small number of individual harvesters. Specifically, the CPT entertained the idea of recommending an informal request for information from regional stakeholders, with the goal of having information to feed into the assessment process in the near future. CPT members and members of the public—which included some industry and community representatives from Norton Sound—thought it would be helpful to request anecdotal information from the participants in this fishery. This could be accomplished by ADF&G or NSEDC reaching out to permit holders to survey their current fishing experiences and observations and to report this information to CPT.

During this discussion, the NSRKC assessment author and others inquired as to how this information could be used in the assessment process. The CPT responded that we are early in the process to identify how LK/TK could be used in a stock assessment model, but LK/TK could be used to inform uncertainty in setting buffers on the ABC, to develop model parameterizations, or by the state in TAC setting. There was also some discussion about potential effects of ghost fishing from lost pots on this stock, and the initial information that is being done to determine the magnitude of lost pots present in the Sound.

The CPT stressed the value and immediacy of the need for current local knowledge in the NSRKC fishery management process, since changing climate is rapidly evolving in this region in an unprecedented manner. Local observations on climate and stock changes are needed in order to be proactive in fisheries management. This was a very productive discussion, from which the CPT made recommendations for the immediate future.

The CPT recommends:

- Formation of a local (Norton Sound) committee
    - Composed of local stakeholders, community members, and ADF&G representatives.
    - Would report back to the CPT.
    - Would informally request information to start the conversation and build relationships
- Request knowledge and data from local stakeholders, specifically NSCDC, to be presented at the September CPT to help inform the stock assessment modeling framework and again at the January meeting when OFL and ABC recommendations are developed.

Diana Stram (NPFMC) noted that a work plan for the Climate Change task force was still being developed and the potential application to NSRKC is still being discussed.

17. New business

The September 2020 CPT meeting will be held in Seattle from September 14-18. Proposed agenda items include:

- Final 2020 SAFE chapters for BBRKC, SMBKC, Tanner and snow crab
    - Tanner and snow crab assessments may be late due to a delay in the summer trawl survey. In this event, a one day online CPT meeting is proposed for early November followed by SSC review in December 2020. An exact date for the one day meeting has not yet been established.

- Update bycatch estimates for WAIRKC and PIGKC to determine final overfishing status
- Proposed model runs for January CPT meeting for NSRKC including GMACS
- LK/TK draft input for NSRKC
- Research reports on snow crab:
    - Spatial model
    - Individual-based model with incorporation of ROMS inputs
- Tanner crab MSE
- Final report for NPRB project on Pribilof Island blue king crab

The January 2021 CPT meeting will be held in Anchorage during the week of January 11-15. At that meeting, the CPT will review the final 2021 NSRKC assessment, which will include consideration of LK/TK input. Proposed model runs for AIGKC will be reviewed, including a GMACS application. Terms of reference for the CPT will also be reviewed during that meeting. Additionally, based on the success of the January 2020 GMACS modeling workshop, the CPT is planning to hold another modeling workshop in January 2021. Likely topics include GMACS and VAST diagnostics, but others may be added.