Crab Plan Team Report

The North Pacific Fishery Management Council's Crab Plan Team (CPT) met September 20-23, 2016 at the Alaska Fisheries Science Center, Seattle, WA

Crab Plan Team members present:

Bob Foy, Chair (NOAA Fisheries /AFSC – Kodiak)
Karla Bush, Vice-Chair (ADF&G – Juneau)
Diana Stram (NPFMC)
Laura Slater (ADF&G – Kodiak)
Miranda Westphal (ADF&G – Dutch Harbor)
Jack Turnock (NOAA Fisheries/AFSC – Seattle)
Shareef Siddeek (ADF&G – Juneau)
Martin Dorn (NOAA Fisheries /AFSC - Seattle)
William Stockhausen (NOAA Fisheries /AFSC - Seattle)
Bill Bechtol (Univ. of Alaska Fairbanks/CFOS)
Brian Garber-Yonts (NOAA Fisheries – AFSC - Seattle)
Ginny Eckert (Univ. of Alaska Fairbanks/CFOS – Juneau)
André Punt (Univ. of Washington)
Gretchen Harrington (NMFS AKRO-Juneau)
Members of the public and State of Alaska (ADF&G), Federal Agency (AFSC, NMFS, NOAA General Counsel), and Council (NPFMC) staff that were present (or participated through WebEx) for all or part of the meeting included: Keeley Kent, Maura Sullivan, Ben Daly, Mark Stichert, Jie Zheng, Hamachan Hamazaki, Cody Szuwalski, D'Arcy Webber, Linda Kozak, Ruth Christiansen, Edward Poulson, John Hilsinger, John Gauvin, Scott Goodman, Madison Shipley, Jim Ianelli, Stephani Zador, Anne Vanderhoeven, Matt Robinson, Susan Robinson, Scott Kent, Simon Kineen, Angel Drobnica, Joshua Songstad, Lance Farr, Brett Reasnor, Farron Wallace, Ray Nomura, Dean Fasnacht, Leonard Hertzog, Gary Stauffer, and Paul Peyton.

Administration

The attached agenda was agreed upon for the meeting. The only changes noted were removing the ecosystem report card which will be taken up at a future meeting. The following link to all documents and powerpoint presentations was available:

http://legistar2.granicus.com/npfmc/meetings/2016/9/947_A_Crab_Plan_Team_16-09-20_Meeting_Agenda.pdf

Membership: The team gratefully acknowledges the many years of service from Mr. Doug Pengilly who recently retired from ADF&G.

Meeting schedule for 2017: January 17-19 (Seattle); May 2-5 (Juneau); September 18-22 (Seattle)

Ecosystem Considerations

Stephanie Zador (NMFS) presented an overview of the Bering Sea ecosystem. This presentation was a reduced version of what she presented to Groundfish Plan Team as it focused on the Bering Sea and parameters relevant to crab, including climate and oceanography and ecosystem surveys.

Climate and Oceanography

Sea surface temperatures showed anomalously warm temperatures in the Bering Sea in summer 2016, typical of a positive phase of the Pacific Decadal Oscillation (PDO). The Aleutian Low was very strong in Winter 2015/16 and was the lowest low recorded since 1949. This low transitioned to a high-pressure system in Summer 2016 that resulted in fewer storms, less mixing and warmer sea surface temperatures. The El Nino Southern Oscillation (ENSO) index and the PDO were not tracking together in 2015-2016 as they have in previous years, and the PDO is at very high levels. The North Pacific Gyre Oscillation (NPGO) has been negative during this time period, which results in reduced flows in Alaska. Seasonal sea surface temperature projections suggest continuation of warm conditions through fall and winter of 2016. Projections suggest neutral ENSO pattern for fall/winter 2016. Eddy kinetic energy in the Aleutians has been low in the past few years, with a small increase in 2016; overall little transport of materials in eddies to the Aleutian Islands region is expected. Eastern Bering Sea (EBS) wind forcing based on the Ocean Surface Current Simulations (OSCURS) model suggests an offshore flow pattern in Spring 2016; a pattern that in the past has been linked to low flatfish recruitment. Sea ice extent in March 2016 was below the median Arctic Sea Ice extent in 2016 and was tied with 2007 as the lowest ice minimum. The summer EBS cold pool did not extend further south than St. Lawrence Island and was absent from most of the Bering Sea. Bottom temperatures in the Bering Sea are similar to those observed in the early 2000s. A Bering Sea Ecosystem Study - Nutrient, Phytoplankton, and Zooplankton (BEST-NPZ) model now projects surface and bottom temperatures and may be able to provide information on bottom temperatures during the time period without surveys. Late summer Bering Arctic Subarctic Integrated Surveys (BASIS) show increased temperatures in the Bering Sea. Preliminary data suggest that a coccolithophore bloom occurred in 2016, which may have negative impacts for visual foragers and zooplankton.

Ecosystem Surveys

Zador presented notable results from biological surveys, many of which are rapid assessments and as such should be considered preliminary. The Northern Bering Sea Survey found large catches of age-0 pollock and juvenile chum salmon in late summer. The 2016 spring egg and larval survey focused on eggs and larvae of groundfish and zooplankton and found that the zooplankton were dominated by small copepods (which are less-energy rich prey) and catches of larval pollock were high. The late summer EBS survey found similar results. Midwater trawls found high catches of age-0 pollock throughout the water column. These survey results suggest low food availability for larval and juvenile pollock. The prediction during periods of warm conditions matches what was observed: abundant pollock larvae and juveniles that will likely have low overwinter success. In summary, water temperatures are anomalously warm, zooplankton biomass is low and composed of lower-lipid taxa, and larval and age-0 pollock and juvenile chum salmon are in high abundance.

Survey Overview

Bob Foy (AFSC) presented results from the 2016 NMFS trawl survey with the current area (current area extent surveyed since 1987) covered by 375 stations spanning 139,949 nm^2. For the 2016 survey, a 20 nm^2 area was added to the east of the ADF&G Pribilof Islands District to define the stock boundary for bycatch and survey. The 2016 survey was conducted from May 31 to July 26 with no resampling of Bristol Bay stations necessary (due to warm water temperatures and resulting advanced progression of red king crab clutches). Only one vessel surveyed Bristol Bay, instead of the usual two, because the second vessel was assigned to a special project. Six special projects were conducted for crabs during the survey: bitter crab sampling; collection of snow crab for evaluation of annual vs. biennial reproductive cycle; collection of red king crab for ocean acidification studies; collection of snow and Tanner crabs for growth studies; specimen collections for female reproductive potential studies on snow, Tanner, and snow-Tanner hybrid crabs; and collections of snow crab for age determination studies. It was noted that pop-up

satellite tagging of female red king crab in Bristol Bay in 2015 was not successful due to tag malfunctions. Pop-up tags are currently deployed on red king crab in Norton Sound and are due to surface within the next month.

Eastern Bering Sea sea surface and bottom temperatures have increased substantially and are at the highest levels seen since the late 1970s. Bottom temperatures greater than 6 °C were recorded from Bristol Bay up to Nunivak Island as well as around St Paul Island. A cold pool, with bottom temperatures ranging from <-1° to 2°C, was recorded around St. Matthew Island but was further north and more limited in spatial extent than previous years. Foy noted these extreme temperatures could potentially affect Bering Sea snow crab and St. Matthew Island blue king crab. Recent years have seen large fluctuations in temperature, from among the coldest observations in the time series in 2012 to among the warmest observations in 2016.

Overall, total biomass of commercially fished mature male crabs was lower in 2016 relative to 2015 and 2014. Biomass and distribution for each of the surveyed Bering Sea crab stocks were presented by sex and maturity. Abundance estimates and spatial distributions by sex and size were discussed for each stock.

Bristol Bay red king crab

Mature male biomass of Bristol Bay red king crab decreased 21% while mature female biomass increased 28% relative to 2015. Abundance of juvenile females increased 47% whereas juvenile males decreased 21%. Stock spatial distribution was similar to 2015 with high concentrations to the north and overall higher size class variation. Foy noted that the survey found more females in shallower water, more males offshore, and juveniles throughout.

Centers of distribution for mature male biomass show a northward progression since 2012, most likely in response to warmer water temperatures. Length frequency graphs for mature males show a large portion of the size class distribution missing for new shell animals which may suggest poor recruitment. Like most years, no recruitment pulse was seen for female crab. Female length frequency graphs are as expected for animals that recently underwent the molting and mating cycle, although there were fewer full clutches observed relative to 2015.

Red king crab were found in the Northern District, south and west of Nunivak Island. It is uncertain whether these crab are part of the Bristol Bay stock. For this small area, overall biomass peaked in 2013-2014, dropped substantially in 2015, and males continued to drop this year; females remained stable compared to last year. Abundances are comparatively small, approximately 3% of the mature Bristol Bay males and 1% of Bristol Bay mature females.

Pribilof Islands red king crab

The 2016 Pribilof Islands red king crab mature male and female biomass estimates decreased dramatically relative to 2015 (by 73% and 51%, respectively); juvenile biomass remained roughly the same. The majority of mature male biomass is located north of St. Paul Island. Mature females were seen offshore east of St. Paul Island with another grouping in the northeastern most corner of the Pribilof Islands area. Male center of distribution is much further north and offshore although sample size was low and uncertainty was high. Male length frequency by shell condition suggests a slight increase in new shell males with few old shell males.

Pribilof Islands blue king crab

Mature male biomass for Pribilof Islands blue king crab decreased (79%), while mature female biomass increased (120%), both showing large differences relative to 2015; juvenile male biomass was about the same. Sample size was exceedingly low with a high degree of uncertainty, particularly for females, which

prefer rocky habitat that is inaccessible to bottom trawls. The stock distribution appears similar to Pribilof Islands red king crab. It is assumed that these crab are predominantly biennial spawners, with females observed in the survey being old shell or very old shell and barren.

St Matthew Island blue king crab

Mature male biomass for blue king crab decreased 40% in the St. Matthew Island section with female and juvenile biomass remaining about the same as in 2015. In 2016, a survey station off the southeast end of the island accounted for the majority of the biomass, unlike previous years when station R-24 was the main driver of the abundance estimate. Females and juveniles, which are not usually seen in the survey, were found further offshore, and males were found throughout the area. Length frequency plots show low legal male abundance with low recruitment which may suggest that this stock has been fished down. Females that were seen in the survey were mainly new shell and barren. However, any potential trend in recent population abundance estimates must be interpreted with caution due to their sensitivity to catch numbers in station R-24.

Bering Sea Tanner crab

Different trends in abundance relative to 2015 were observed for Tanner crab east vs. west of 166° W long. Mature male and female biomasses decreased east of 166° W long. 32% and 69%, respectively, while mature males increased 13% and mature females decreased 7% west of 166° W long. Tanner crab in the east were distributed fairly evenly throughout Bristol Bay. In the west, larger densities of Tanner crab occurred along the shelf edge than have typically been seen, though this pattern was initially observed in 2015. Bob stated that large catches of Tanner crab were not observed in the slope survey that also occurred over the summer. Males, females, and juveniles were distributed as in recent years. Unlike the past couple of years, there was a sharp decrease in the number of juveniles seen east of 166° W long. In the west, the proportion of hard shell male crab in the larger size classes transitioned to predominantly old and very old shell crab. Although the total stock center of distribution for mature male biomass has moved to the west, especially relative to the cold year in 2012, this likely represents different population trajectories between the east and west (which may be related to temperature) rather than large-scale movement patterns by the crab.

Bering Sea snow crab

Snow crab mature male and female biomass decreased substantially in 2016 compared to 2014 and 2015 (by 35% and 60% relative to 2015, respectively); juvenile biomass increased substantially, as in 2014 and 2015. Other than the increase in mature male biomass observed in 2014 (with high variance), the snow crab population has seen an overall decrease during the last several years. The spatial extent of snow crab distribution was typical of recent years, however, density of mature females was concentrated further to the north (north of St. Matthew Island) than in recent years; this observation is not unprecedented but has not been seen since the early 2000s.

It is known that the snow crab population is continuous to the north to St. Lawrence Island and that pulses of crab (including mature females) periodically occur in the surveyed area. Foy noted that there are ten times as many snow crab to the north of the survey area than within the survey area, so we may be seeing a southerly movement rather than a northerly movement. It is unknown how connectivity with the area north of the standard survey area, in terms of larval transport to the north and migration of crabs south into the surveyed area, impacts abundance estimates, especially with recognized processes of ontogenetic migration patterns and decreased growth and smaller size at maturity with increased latitude.

Hybrid snow/Tanner crab

Male hybrid crab biomass west of 166° W long. decreased compared to 2015 while hybrid female biomass remained about the same. With respect to the Bering Sea snow crab and western Tanner crab fisheries, if the surveyed hybrids were considered snow crab (legal size of 78 mm CW), they would account for 8% of the legal male snow crab and 3% of the mature female snow crab. If the observed hybrids were considered Tanner crab (legal size of 110 mm CW), they would account for 10% of the legal male crab and 22% of mature female Tanner crab. The majority of hybrid crab were observed west of 164° W long.

Bering Sea hair crab

An overall decreasing trend in biomass for hair crab has been observed since the peak in 2012, for both males and females in all areas of their distribution. Distribution was more dispersed than in the previous year with groupings of hair crab around the Pribilof Islands and also in the northeast, to the south of both Nunivak and St. Matthew Islands.

Summary

Of the crabs captured during the survey, 100% of king crabs and Tanner crab east of 166° W long., 91% of the Tanner crab west of 166° W long., and 86% of the snow crab were measured. All stocks showed a decrease in mature male biomass, ranging from an 8% drop for overall EBS Tanner (combined east and west) to a 79% drop for Pribilof Islands blue king crab. A timeline of the fishery evaluation and management process for federally managed crab stocks in Alaska in 2016 was provided for context as follows: survey data arrived in Kodiak July 26, final area-swept abundance and biomass estimates were provided to assessment authors and ADF&G on August 15, the draft survey technical memo was available to the public on August 30, CPT meets September 20–23, SSC meets October 3, TAC setting October 3–10, and the fisheries begin October 15.

General recommendations:

The CPT requests that all authors revise their SAFE documents to follow the guides to authors. Specifically, the authors should follow the document outline, include all appropriate diagnostic analyses/figures, and properly update the document with the catch and biomass estimates from the previous year. In addition, it was noted that authors are not using a consistent species specific handling mortality for bycatch in fixed vs trawl gear. The CPT will assess which stocks are using which values for handling mortality and make a recommendation at the January or May CPT meeting to standardize across stock in the 2017 assessment cycle.

Pribilof Islands blue king crab

William Stockhausen (NMFS) presented the Pribilof Islands blue king crab (PIBKC) stock assessment. The assessment uses a random effects model to smooth out the survey biomass time series under Tier 4, but estimates the OFL and ABC under Tier 5. Since the directed fishery is closed, the OFL and ABC apply to PIBKC bycatch in the Bering Sea groundfish and other crab fisheries. The stock remains overfished and shows no signs of rebuilding.

Total PIBKC bycatch in 2015/16 was 1.18 t, which exceeded the OFL of 1.16 t. Bycatch had been well below the OFL in the last couple of years. Most bycatch occurs in the Bering Sea groundfish fisheries. Bycatch of PIBKC increased during the 2015/2016 crab fishing year in the hook-and-line Pacific cod fishery inside the Pribilof Islands Habitat Conservation Zone (PIHCZ) and in the non-pelagic trawl fishery outside the PIHCZ. The CPT discussed the bycatch data and maps of the distribution of bycatch in

Appendix B of the stock assessment. This increase in Pribilof Islands blue king crab bycatch in the Bering Sea groundfish fishery, along with a small amount of bycatch in the Tanner crab fishery, caused overfishing to occur during the 2015/2016 crab fishing year.

The CPT discussed the handling mortality estimates used to calculate bycatch in the pot, hook-and-line, and trawl fisheries. The assessment used the following handling mortality rates: 50% for pot and hook-and-line gear in groundfish fisheries, 80% for trawl gear, and 50% for crab fisheries. For the 2016 assessment, the CPT agreed with the author's use of mortality rates as they are consistent with past assessments. However, other king crab assessments use a handling mortality rate of 20% for bycatch in crab fisheries, indicating there are inconsistencies between crab assessments in the treatment of handling mortality.

For 2016/2017, the CPT recommended

1. The author's recommended OFL based on average bycatch and a 25% buffer between OFL and ABC;

For 2017, the CPT recommended:

2. **An analysis of the PIBKC stock boundaries using recent data to see if it is more appropriate to align stock boundaries with State statistical areas.**

Stock Prioritization

Steve Kasperski (AFSC/ESSR) presented the Stock Assessment Prioritization Plan (SAPP) for the North Pacific Fishery Management Council: Methods and Scenarios discussion paper, and AFSC's contribution to the 2017 Stock Assessment Improvement Plan (SAIP). The paper was authored by Anne Hollowed and a working group of AFSC and OST scientists, with assistance from a large group of expert contributors. The presentation reviewed the background of the SAIP, including the three components of Next Generation Stock Assessment: Innovation; Ecosystem-linked; and Timely, Efficient, and Effective, with Steve noting that the latter is the focus of prioritization protocols that have been, and continue to be developed. Initiation of the project began in 2011, culminating in the release of NOAA Technical Memorandum NMFS-F/SPO-152 in August 2015, edited by Rick Methot. The current phase of development focuses on implementation at the regional level, with the working group having completed the process of collecting data and expert opinion to support ranking each North Pacific FMP stock according to five criteria: fishery importance, stock status, ecosystem importance, assessment information, and stock biology. Prioritization will ultimately address targeting of assessment level (which is generally determined by tier status), but the current focus of regional efforts is determination of target assessment frequency for all FMP stocks. As with groundfish, all FMP crab stocks will continue to be assessed, but the frequency of some assessments may change as a result of this process. The discussion paper provides preliminary assessment frequency scenarios for BSAI/GOA FMP groundfish stocks, illustrating how data is gathered, ranked and applied within the proposed guidelines, and providing a series of alternative scenarios for NPFMC consideration. Steve stressed that, as all BSAI crab are under a federal FMP, they are subject to the SAPP requirements and the CPT must participate, but may choose to recommend a different approach to scoring and weighting than that proposed for groundfish assessments.

Steve then reviewed the national proposal for priority scoring, which includes separate factors for scoring and weighting within each of the five themes/categories, the source of the scoring values (quantitative indices/model calculations, or expert opinion, and the range of possible scores and weights for each factor. Fishery importance factors include recreational value, subsistence value, constituent demand, and non-catch value, (scored by expert opinion from 0-5), commercial value (0-5 score calculated on log scale as function of gross revenue produced by fishery), and rebuilding status (0-1). A single factor for ecosystem importance (species' role in ecosystem) was scored by expert opinion. Assessment factors include: on years assessment is overdue - based on target frequency, and stock recruitment variability

(expert opinion). Expert opinion data were gathered using surveys of stock assessment authors, economists, and fishery managers from AFSC, NPFMC, and AKRO, which asked respondents to provide score values for each stock (surveys included both groundfish and crab stocks), and Steve showed the fishery importance scores for crab stocks, calculated as the weighted average of score values from the survey (weighted by respondents' confidence in their scored value). Total fishery importance ranking indicated that fisheries for Bristol Bay red king crab ranked #1, Norton Sound red king crab ranked #2, and Bering Sea snow crab ranked #11 across of all crab and groundfish stocks. CPT members questioned the outcome of the fishery importance scoring, particularly the #2 rank of NSRKC over all other groundfish and crab stocks, and asked for clarification regarding the scoring criteria and sources of expert opinion.

The discussion paper outlines several alternative scenarios for estimating target assessment frequency based on factor scores and weights. As a default Base Case scenario (as recommended in Methot 2016), target frequency (in years) is derived from estimated mean age of the catch (if available from catch data, or one of several proxy values depending on available data), multiplied by regional scaling factor, and adjusted by recruitment variability, fishery and ecosystem importance (+/- 1 for each factor). Alternative scenarios included the status quo/current assessment frequency, and four others, which identified alternative maximum values for years between assessments and different adjustments to the baseline for importance score.

CPT members inquired about the GPT's process and initial reaction to the proposal. It was noted that the GPT has not yet completed the process of assigning weights to the stocks. Based on the preliminary results shown in the paper, the baseline scenario resulted in target frequency of 10 years for many rockfish species. The GPT did not identify a preferred scenario when they reviewed to discussion paper at the September GPT meeting, but elected to start with Scenario 4, which adjusts the regional scalar value to produce target frequency of 1 year for stocks with the highest commercial value, and modify the scenario based on the results. The GPT will meet in January 2017 to complete the prioritization process, and will report results at the February 2017 Council meeting.

Steve then outlined several issues and questions for CPT discussion:

- Should crab stocks be included in GF process? (this would require ADF&G assessment authors to complete the scoring surveys).
- Does the CPT agree that assessment frequency should be principal focus for NPFMC prioritization?
- Does the CPT have a preferred scenario from those in the discussion paper, or other suggested alternatives?
- How should criteria for out-of-cycle assessments be established?

CPT members posed numerous questions and identified several potential problems with applying the GPT prioritization approach to crab. Lack of age data for crab, which provides the core basis of the target frequency estimation, poses a critical problem. Key factors for crab assessments, including survey abundance, population volatility, and survey uncertainty, don't appear to be taken into account and may increase risk resulting from less frequent assessments. It was noted that results from the Management Strategy Evaluation (MSE) for snow crab performed a few years ago indicated high sensitivity to dropping years from time series, but a member of the audience from NMFS HQ pointed out that that assessment prioritization doesn't equate to changes in survey frequency, and that surveys would continue to occur on current cycle. A CPT member suggested that there may be a difference between target frequency for assessments that use established models and those that are in the process of model development (e.g. NSR). As a counterpoint to many of these concerns, some CPT members noted that precision of the scoring and target frequency is less important than clarifying a process and the basis for identifying priorities. While there was a concern about the prospect of creating an entirely different process for crab stocks, other comments pointed out that the smaller number of crab stocks, and greater

similarity of the species, may not necessitate a process as complex as that required for groundfish. The adequacy and representativeness of the expert opinion survey data was questioned, and it was pointed out that even if more data was collected, it would only be useful if a similarly quantitative approach to calculating prioritization indices is chosen rather than a more qualitative method.

There was general agreement among the CPT that a more qualitative approach than that proposed by the GPT would be preferred. A working group was formed to develop a draft outline of a prioritization process for crab, to be reviewed at the January 2017 CPT workshop. The draft will focus on target frequency, and should draw from the prioritization factors outlined in the working paper, without the scoring and weighting components. Additional prioritization factors that were discussed, and that should be considered in the outline, included survey uncertainty, stock volatility, model maturity, and implications for out-of-cycle assessments and the role of the ABC constraint in the State of Alaska's TAC setting process should also be addressed.

Working group: Bob Foy, Diana Stram, Martin Dorn, Karla Bush, and Ginny Eckert.

Bristol Bay Red King Crab

Jie Zheng (ADF&G) presented the 2016 stock assessment for Bristol Bay red king crab (BBRKC). The focus of the 2016 assessment was incorporation of recent BSFRF survey data (2013-2016) into the assessment. The assessment also added biomass and length composition data from the 2016 NMFS trawl survey, and updated fishery and bycatch data. In addition, revised estimates of CVs for survey biomass provided by NMFS were used.

Jie presented three models for CPT consideration. Model 1 was the model used in 2015 to determine the OFL and ABC. CPT deliberations focused on the relative merits of model 1n and 2. Model 1n is a straightforward addition of new survey data to the BSFRF survey time series for 2013-2016, which is modeled as an independent time series, as in previous BBRKC assessments. Model 2 adopted the approach used in the snow crab assessment for modeling the BSFRF survey, in which the BSFRF survey provides information on availability of crab in the area covered by both surveys, and the NMFS survey is modeled with a selectivity pattern and a catchability parameter that reflects the proportion of the crab in the surveyed area that are captured by the NMFS trawl. This approach makes more extensive use of the BSFRF survey data, and relies on the assumption that the BSFRF survey captures all of the crab in front of the net.

The CPT decided on model 2 for this year's OFL and ABC recommendations for the following reasons. First, the overall fit to the data (particularly the NMFS survey length composition) was improved with model 2. (Both model 1n and 2 estimated the same number of parameters.) Second, the approach was consistent with how the BSFRF survey data has been used in the snow crab model. Finally, the estimated selectivity/availability curves for the BSFRF survey were considered more plausible.

Jie expressed concern about the potential for herding by the trawl sweeps for the BSFRF net, which would call into question whether catchability (q) should be assumed to be 1.0 for the BSFRF survey. This concern did not seem important enough to the CPT to merit changing model assumptions, but we do recommend that available information on herding by trawl sweeps and how differences in net configurations (doors and sweeps) between the two surveys could potentially lead to differences in herding be reviewed during an upcoming CPT meeting. Additional observational work may be needed if evidence of herding is strong enough to call into question model assumptions regarding catchability.

Since the BSFRF survey data are now fully incorporated into the assessment, the prior on catchability from the 2004 under-bag experiment (Weinberg et al. 2004) may no longer be necessary to stabilize the model. **The CTP requests that model runs be provided to evaluate the impact of including or excluding the prior on catchability based on the under-bag experiment.**

Gmacs update and application to Bristol Bay Red King Crab

D'Arcy Webber (Quantifish, via WebEx) and Jim Ianelli (AFSC) presented their plans for developing a Gmacs-based (Generalized Modeling for Alaskan Crab Stocks) assessment for Bristol Bay red king crab (BBRKC). The main focus of D'Arcy's work up to now has been on developing a St. Matthew Island blue king crab Gmacs-based assessment, but since that effort is nearing completion, his focus will shift to the BBRKC Gmacs model. D'Arcy outlined a series of functionalities that have been added to Gmacs since the May meeting. These include:

- N-year stock projections (one-year projections were used for OFL and ABC estimates in the SMBKC assessment);
- SPR/OFL/ABC calculations, as needed to implement tier 3 and tier 4 harvest control rules;
- Francis method for reweighting composition data;
- Different estimation phases for initial recruitment and recruitment deviation parameters;
- A method for dealing with small bycatch amounts;
- Custom transition matrices (in addition to the molting and growth transition matrices); and
- Time-varying season lengths and time-varying length-weight relationships.

D'Arcy discussed a general approach for modeling selectivity and retention using indexing. The basic idea is to first specify the number of unique selectivity curves and how they are parameterized, then to input a matrix that defines this set for whatever gear/sex/time period is required. Retention curves will be handled in the same way. This approach has a number of benefits. However, a potential shortcoming is that these matrices may get relatively large and unwieldy. Consequently, D'Arcy plans to develop a graphical interface that would assist and simplify the practice of creating control and data files.

D'Arcy presented initial results for a male-only BBRKC Gmacs-based model, which showed reasonable fits to the survey trend. The CPT appreciated the approach used for the SMBKC Gmacs assessment, in which a matching model was developed first and then other models were compared to that matching model. **The CPT recommends that the same approach be used for development of a BBRKC Gmacs-based assessment (while recognizing that the BBRKC model is more complex than the SMBKC model).** The Gmacs team expects to be able provide updates on further development of a BBRKC Gmacs model for review at the January meeting.

BSFRF – research update

Scott Goodman (Bering Sea Fisheries Research Foundation, BSFRF) provided a review and update on BSFRF-NMFS cooperative research studies to provide data for estimating NMFS trawl survey selectivity of Bristol Bay red king crab (BBRKC) and eastern Bering Sea Tanner crab (east of 166° W long.). Goodman has presented much of this material at previous CPT meetings, most recently in May 2016.

Selectivity studies were performed on BBRKC from 2013−2016 concurrent with the NMFS EBS trawl survey. The study area for this duration was defined as the 59 NMFS survey stations in inner Bristol Bay that contained most of the BBRKC caught during the NMFS summer survey (the entire Bristol Bay area comprises 136 NMFS survey stations). Side-by-side tows were performed in each of the 59 stations in each study year, with NMFS chartered survey vessels towing a standard 83-112 trawl net and vessels chartered by BSFRF towing a Nephrops trawl net. The Nephrops net is assumed to catch all crabs in the area it sweeps (q=1.0). The survey in 2013 occurred over a relatively cold bottom-water year and subsequent years (2014−2016) occurred over much warmer bottom water.

Estimates of BBRKC selectivity by the NMFS trawl were presented as the ratio of CPUEs (NMFS:BSFRF) by sex-size class, where CPUE is number of crab per nmi^2 swept for all 59 stations (see summary table below). Results of side-by-side RKC selectivity study in 2015 (warm year) were similar to

2013 (cold year) rather than 2014 (warm year). The 2016 CPUE ratios were intermediate (lower than the 2014 CPUE ratios and higher than the 2013 and 2015 CPUE ratios).

Summary table of CPUE ratios for RKC

Sex & size	2013	2014	2015	2016
males <110 mm CL	0.48	0.74	0.33	0.60
males 110–134 mm CL	0.48	1.01	0.51	0.72
males >134 mm CL	0.66	0.98	0.56	0.83
females <90 mm CL	0.28	0.48	0.35	0.98
females ≥90 mm CL	0.86	1.04	0.77	0.69

Bubble plots of CPUE ratios were presented across the size range for male RKC by year. As discussed at previous meetings, 2014 displays an anomalous pattern. All other years (2013, 2015, and 2016) are relatively consistent, even though this combines both cold (2013) and warm (2015 and 2016) years. This implies that temperature doesn't have a strong effect on selectivity. Other possible explanations for a temperature effect that isn't accounted for in this evaluation may include potential differences in the relative distribution and patchiness of RKC, which may be influenced by more than one year of difference in relative temperatures. Another possibility that should be explored is the effect of bottom type on catchability, particularly whether crab are displaced into areas with different bottom type due to temperature changes, thereby influencing catchability.

Goodman also re-presented data on Tanner crab catches in the 2013–2015 side-by-side and nearshore RKC pre-recruit (index) studies in Bristol Bay, which showed highly variable CPUE ratios (NMFS:BSFRF) for male Tanner crab by size. As discussed in January 2016, areas surveyed during these years did not cover all of the Tanner crab habitat east of 166° W long.; therefore, it was unknown how much of the stock biomass was present inside vs. outside the study areas. The 2016 BSFRF study expanded the area covered by side-by-side tows in 2016 to 140 NMFS stations, extending from inner Bristol Bay to selected stations slightly west of 166° W long. The CPUE ratios for male and female Tanner crab remained variable by size, but were similar to those from a similar BSFRF-NMFS selectivity study on snow crab. Additionally, multiple tows were performed in two focused (index) blocks of NMFS stations, with one of these sites occurring where small size classes of Tanner crab (down to 20 mm CW) were historically caught. Data from these index areas were not available for this meeting. The BSFRF plans to continue selectivity work for Tanner crab in 2017, with further expansion west of 166° W long.

The CPT emphasized that continued work for Tanner crab selectivity be carefully planned to ensure it can be properly incorporated into the stock assessment. The CPT supports the continuing efforts of BSFRF in conducting selectivity surveys to inform the Tanner crab and BBRKC assessments. The index site data may particularly help inform Tanner crab recruitment and juvenile growth patterns. The CPT looks forward to reviewing these data at the January 2017 CPT meeting.

Snow crab

Cody Szuwalski (NOAA contractor, PSMFC), the lead author for this assessment, presented an overview of the snow crab assessment, with results from six model scenarios on Sept. 21. On Sept. 22 the author discovered that retained catch numbers for 2016 had been mis-specified in the model input files and he re-ran the analysis. Cody presented results from the corrected analysis on Sept. 23. Results for the model scenarios remained qualitatively similar, and the author's preferred model remained unchanged. However,

OFL changed substantially (from 32,430 t to 23,700 t). The CPT appreciates the author's forthrightness in admitting the mistake and his alacrity in providing a corrected analysis.

New data included in the assessment consisted of growth data (molt increments) for five crab, biomass and size compositions from the 2016 NMFS EBS bottom trawl survey, retained and discard catch and size compositions from the 2015/16 directed fishery, and bycatch and size compositions from the groundfish trawl fisheries. In addition, weight-at-size relationships for males, immature females, and mature males were re-analyzed using previously-collected NMFS EBS trawl survey data and the time series of survey biomass was recalculated.

The new growth data added additional growth information (molt increment) for small females (4 observations) and small males (1 observation) to the previous (rather small) dataset. Sex-specific growth in the model is estimated using separate linear fits for small crab and large crab, with a smooth "join" between the two lines. The new data doubles the observations at small sizes (< 25 mm CW) for both sexes. Unfortunately, the new growth data did not provide information in the 25-40 mm CW size range for females—the critical range in which the (not well-estimated) transition occurs. Growth data on females in this size range is still required. The CPT suggested re-examining data obtained from a lab-holding study by ADF&G (as presented to the CPT in September 2012) for its usefulness in informing the model.

The new weight-at-size relationships were essentially unchanged from the old relationships for males and exhibited fairly small decreases for immature females, but rather substantial decreases in weight-at-size for mature females.

The NMFS EBS survey data exhibited a 35% decrease in mature female biomass and a 21% decrease in mature male biomass from 2015 to 2016. The corresponding size compositions indicate potentially-elevated recruitment, particularly for males, into the smallest size classes in both 2015 and 2016.

The basic model estimation structure did not change from the 2015 assessment, but the status determination and OFL calculations were incorporated directly within the model code. This allowed the authors to employ a Bayesian approach to determining OFL, by using Markov Chain Monte Carlo (MCMC) techniques to develop numerical representations of the posterior distributions of relevant quantities; this approach more fully-incorporated parameter uncertainty than was possible with the previous methods. Cody argued that adopting a Bayesian approach based on MCMC sampling of the posterior distribution obviates the need to employ a number of model runs based on initial parameter jittering to evaluate model convergence because it is not necessary for the model to converge to the maximum likelihood solution (as long as the model Hessian can be still be calculated) before MCMC can be used.

The CPT discussed the advantages and disadvantages of using a Bayesian approach to evaluate model quantities and determine management quantities such as F_{OFL} and OFL by evaluating the associated posterior distributions using MCMC. In previous years, a separate model has been used to project MMB and calculate OFL based on results from the assessment model. For the projection model used in the past, uncertainty in the results for the assessment model was incorporated by randomizing the final numbers-at-size from the assessment model based on the CV associated with terminal year MMB, where the CV was evaluated using the delta method. Using the delta method relies on the assumption that the model has converged to its Maximum Likelihood Estimate (MLE) and that uncertainties associated with model quantities are normally distributed. One major advantage to using the Bayesian approach is that it does not require a model that has initially converged to its MLE (MCMC can be used if the model Hessian can be calculated). Another is that it much better incorporates the full uncertainty associated with the assessment model in derived quantities (such as F_{OFL} and OFL), which are evaluated as posterior distributions given the model and data. One major drawback to using a Bayesian approach is that the posterior distributions of desired quantities must be evaluated using MCMC, which imposes substantial costs in terms of computing power and time to achieve valid approximation to the posterior distribution.

While the costs have been prohibitive in the past, improvements in computing resources have reduced them to the point where the benefits are starting to outweigh the costs for many assessment models.

The six model scenarios evaluated for this assessment were:

- Model 0: was supposed to be equivalent to the 2015 assessment model
    - it actually included down-weighting of size compositions
- Model 1: Model 0 +
    - estimating average F for the groundfish bycatch (it was previously specified)
    - removing penalties on F for 1992-present
    - estimating a separate vector of F-devs for 1978-1990 and 1991-present
    - estimating a constant of proportionality between fishing effort and F for females in the directed fishery
- Model 2: Model 1 +
    - removed priors on the sex/size-specific probabilities of molting-to-maturity
- Model 3: Model 2 +
    - increased the weight on the smoothness penalty for the probabilities of molt-to-maturity
    - estimated the 50%-selected parameter for female discards
- Model 3a: Model 3 +
    - applied the Francis weighting methodology, decreasing effective sample sizes for survey composition data
- Model 3b: Model 3 +
    - increased the weighting in the female growth likelihood component
    - decreased the variance for the prior on natural mortality

Changes in Model 1 from Model 0 were designed primarily to improve estimation of fishing mortalities for the groundfish trawl bycatch fleet and fits to the trawl bycatch. This was not terribly successful because the size compositions were somewhat contradictory. Changes in Models 2 and 3 were directed at removing the assumptions placed on maturity and female discards in the model. While these "worked," the results were fairly sensitive to the weightings used. Model 3a applied a new method (the "Francis" method) for down-weighting size composition data to better fit survey/fishery catch abundance or biomass trends. Iterative Francis weighting was unsuccessful (lack of convergence) and manual down-weighting led to large changes in survey catchability and maturity. Model 3b considered changes in constraints on female growth and natural mortality to improve model fits and move parameter estimates away from bounds.

Only Models 0 and 3b fit both the male and female growth data acceptably. All models except 3a fit the male growth data reasonably well, while only models 0, 3a, and 3b fit the female data adequately well (although not perfectly).

Fits to survey mature male biomass were similar for all the models, although Model 0 was somewhat different from the other models in the 2000s and Model 3a deviated from the others in the early 1990s. These differences improved the fit to the data for both models. Model 0 fit survey female mature biomass somewhat better than the other models, while Models 3, 3a, and 3b fit a bit worse. All models fit the retained catch data very well. The models also fit the discards in the directed fishery adequately. Model 0 fit the trawl bycatch data better than the other models after 2009, but worse during the 2000s.

In general, fits to the size composition data were similar in quality across all models, although Models 0 and 3a were different from the other models in some years.

The CPT was concerned with the magnitude of the change in $F_{35\%}$ from last year's assessment (1.42) to Model 0 (0.95). The author explained that the drop appeared to be due to down-weighting the size compositions (not via the Francis method) in Model 0, resulting in a left-shifted fishery selectivity, a decrease in M, and a left-shifted probability of maturing.

The author selected Model 3b as his preferred model on which to base status OFL and ABC. It fit the growth data reasonably well and did not hit the bound for natural mortality. Model 0 fit the terminal year of survey MMB the worst of all the models and had suspiciously low estimates of trawl selectivity. Models 1, 2, and 3 had poor fits to the female growth data. Model 3a fit the terminal year of survey MMB best, but (among other concerns with the model) fit the survey size compositions poorly in some years, estimated catchability higher in recent NMFS surveys than was implied by the BSFRF surveys, estimated very high F's in the directed fishery in recent years, and did not fit male growth.

The CPT concurred with Cody's preferred model and recommends that Model 3b be adopted for status determination and OFL setting. For Model 3b, $F_{35\%}$ is 1.91 and F_{OFL} is 1.14, OFL is 23,700 t, and maxABC is 23,700 t, the latter based on the p-star approach. Last year, the CPT rejected the author's preferred model because there was insufficient information for the CPT to determine the sources of potentially significant changes between several of the intermediate models leading to the author's preferred model. The CPT recommended using a 25% buffer to set the 2015/16 ABC "due to the model uncertainties and contradictions between model trends and survey and fishery observations." The concerns the CPT had last year have been addressed. **The CPT thus recommends setting ABC this year using the standard 10% buffer for Tier 3 stocks to account for remaining (but reduced) model uncertainties and contradictions between the model and data.** This is the buffer adopted for snow crab used in assessment before last year. A 10% buffer would result in ABC = 21,300 t.

CPT Recommendations for future work

- Review the SAFE guidelines to make sure all required tables and figures (e.g., estimated recruitment, MMB-at-mating, sample sizes, etc.) are included in the SAFE chapter, to the extent possible.
- Plot the relative proportion of new to old shell males to see how important the lack of fit to old shell males really is.
- Extract the bycatch mortality from the Tanner crab directed fisheries that is currently lumped into the groundfish trawl bycatch (in a table in the assessment chapter, not necessarily in the model).
- Examine whether or not the "converged" MLE solution agrees with the MCMC results.
- Currently, it is surprising that M for females is less than for males. Consider estimating M for females.
- Plot Bayesian posterior intervals for growth parameters.
- Document rationale for prior on M for immature crab.
- Try starting the assessment in 1982 to check the behavior of the survey q's when the first survey stanza is excluded.
- Apply priors to the survey q's so they are somewhat constrained.
- Provide more detailed MCMC chain diagnostics.

Economic SAFE

Brian Garber-Yonts (NMFS) presented a summary of three primary economic indicators that describe aggregate changes in gross volume and value of production, labor earnings, and employment in the processing and harvesting sectors, and harvest quota leasing activity in the BSAI crab fisheries. Due to the timing of economic data collection, the final 2016 BSAI Crab Economic Status Report (Economic SAFE) will be presented to the SSC in February 2017. The summary report is included as an appendix to the October 2016 SAFE. Final reports are available online at: http://www.afsc.noaa.gov/REFM/Socioeconomics/SAFE/default.php. In June 2016, the Council completed the 10-year review of the Crab Rationalization (CR) Program. The 10-year review included information on quota share ownership and, as requested by the Council, an analysis of changes in quota ownership over time will be incorporated into the final 2016 Economic SAFE.

Key economic indicators were summarized over the past five years (2011–2015). Exvessel and first wholesale revenue aggregated over all BSAI crab fisheries increased from 2014 to 2015 despite lower production volume in the Bristol Bay red king and Aleutian Island golden king crab fisheries. Average exvessel price for most fisheries generally declined through 2014 from peak levels in 2011, but reversed trend and increased in 2015; snow crab price showed the opposite trend, with increasing average exvessel price through 2014, but declining slightly in 2015. Overall production for 2015 was up 13 percent in both the harvest and processing sectors and gross revenue increased in both sectors (7.2% and 13.7%, respectively).

Eighty-two vessels were active across all CR Program fisheries in 2015, up from 74 vessels in 2014. This increase was primarily due to more vessels targeting Tanner crab in response to the higher 2015 TAC. Aggregate crew and captain share earnings over all CR fisheries increased 18 percent from 2014, to $54.5 million, and crab processing labor earnings increased 39 percent to $12.7 million, largely due to increases in the minimum wage. Previous declines in processing labor earnings were likely influenced by fewer overtime hours in the post-CR Program period.

Tanner crab IFQ leasing activity and total lease payments increased in 2015; the median lease payment was 28 percent of ex-vessel price ($0.73 per pound). Bristol Bay red king crab IFQ lease activity decreased (9%); total lease payments increased (9%) as did the median lease payment of $5.24 per pound (64% of ex-vessel price). Total lease payments for snow crab decreased (12%) and the median lease payment was 47 percent of ex-vessel price ($0.98 per pound).

Norton Sound Red King Crab

Toshihide (Hamachan) Hamazaki (ADF&G) discussed the assessment methodology for the Norton Sound red king crab stock. This was only an update of model methodology and not the formal assessment which will be presented to the CPT in January 2017. The current assessment model is male-only and size structured, combining multiple sources of survey, catch, and mark-recovery data using a maximum likelihood. This has been a Tier 4 assessment stock. The model year starts February 1 with the stock subject to a winter fishery; the fishery actually runs from December to May, but effort can be highly variable so the assessment treats the winter fishery as occurring February 1. The model then applies M for the period February 1 to July 1, at which time the summer fishery is assumed to occur. The true fishery is open from June until the guideline harvest level is achieved, or to September, whichever occurs first. The estimated population is then subjected to molting, growth, and recruitment, then natural mortality until the start of the next assessment model year on February 1.

The base model under a size-invariant M overestimated abundances of crab larger than 123 mm CL. The concern was that large crab move out of the area. However, surveys in and near the core survey area did not find large crab moving outward and so did not support this concept. In addition, a dome-shaped selectivity and growth curve didn't improve the model fit. This issue was previously resolved by applying a higher M for larger-sized crab, which provided a better fit but was deemed biologically implausible.

The model scenarios brought forward include:

- Model 0 – Default base model
- Model 1 – Non-linear growth, to address aspect of crab not recruiting to larger length classes but apply equal M for all lengths
- Model 2 – Random walk on molt probability, to examine whether molt probability is not time invariant
- Model 3 – High M for largest (134+ mm CL) group (kill 'em off approach)
- Model 4 – Estimate separate summer commercial fishery selectivities for 1976-2004 and 2008-2015 to see if selectivity has changed based on factors such as market preferences.

For the above, M = 0.18 for Models 0 and 1, but there are some higher values applied for one or more length classes in Models 2–4.

The author noted that the aspect of two, temporally separated commercial fisheries may complicate OFL determination. The winter fishery has typically harvested an average of ~8% of the GHL, with ~92% taken in the summer fishery. However, comments from the author and the public suggested the winter harvest proportion may have increased to as much as 16% in recent years. The CPT noted that an OFL is not typically apportioned across fishery sectors or time periods (although this could potentially be applied to east and west components of EBS Tanner, as an example). Such an application to Norton Sound could also limit management flexibility (e.g., when the winter fishery is delayed or limited due to sea ice conditions). Apportioning of the OFL would need to start with the February 1 OFL, and then apportion the OFL to anticipated fishing in the winter and summer seasons, incorporating additional M for the summer season OFL. The CPT suggested that the OFL could be split for winter and summer fisheries using the following:

The OFL is comprised of catch in the winter and summer fisheries such that

OFL = catch in winter fishery + catch in summer fishery.

Given the anticipated winter catch proportion, *P*, (e.g., 0.08), and setting $F_{OFL}=M$ per the 2016 SAFE assessment, the OFL may be estimated through solving Equations 1 and 2 in which B_w is the winter biomass and *x* is a value for apportioning the F_{OFL} (=M):

$$OFL = B_w\left(1 - e^{(-xM)}\right) + \boldsymbol{B}_w\, e^{(-xM-0.42M)}\left(1 - e^{-M(1-x)}\right) \quad (1)$$

$$P = \frac{B_w\left(1-e^{(-xM)}\right)}{OFL} \quad (2)$$

Solving the above two equations, the OFL formula is

$$OFL = B_w\left(1-e^{-1.42M} - (1-e^{-0.42M})e^{\ln\left(\frac{1-p(1-e^{-1.42M})}{1-p(1-e^{-0.42M})}\right)}\right) \quad (3)$$

The lack of older crab in the assessment also remains a concern. Satellite tags applied last summer should pop up next week to indicate the current location of tagged crabs, potentially providing additional information on crab movement. It was also noted that historical data showing larger crab in commercial samples, and where those crab were caught, may be archived with Kodiak ADF&G.

Results of the preliminary model runs showed limited improvement over the base model. For Model 1 there was little evidence of growth increments that varied from a linear increase with carapace length. Model fit declined when applying a higher M to the largest size class for Model 3. Parameter estimates for Model 4 were largely similar to the base model with the exception of different likelihoods for the tagging data, which might be attributable to confounding of time-at-large with changes in the size selectivity of the summer fishery over time; the tags are recaptured in the summer fishery.

Several suggestions emerged regarding Model 2:

1. The current approach uses a descending logistic for molt probability. Instead, consider calculating molt probabilities for each size class, or within lumped size categories such as small, medium, and large crab.

2. Estimate molt probabilities with the time series broken into two periods.

3. Apply a smoothing penalty on the molt probabilities of individual size classes.

4. Explore for correlation between Model 2 random walk and temperature. While there is not likely a long time series of ocean temperature in Norton Sound, air temperature for Nome might serve as a proxy.

5. Don't set the molt probability for the smallest size class at 1.0.

In summary, the CPT recommends bringing forward Model 0 (base model), but also Model 2 with some of the variations suggested above.

EFH review/update

Steve MacLean (Council, via WebEx), Pete Hulson (NMFS, via WebEx), and Matt Eagleton (NMFS, via WebEx) presented new methods to assess the effects of fishing of essential fish habitat (EFH) using a fishing effects model as well as an example application of the model to GOA POP and pollock with indications of correlation analysis should the results of the fishing effects model indicate that further steps were warranted. Steve provided 3 overarching questions for the CPT to consider while reviewing the model presentation.

EFH descriptions

Steve provided an overview of the history of EFH species descriptions in fishery management plans. Now, analysts are using models to define EFH for some species using many different types of data and many different variables.

Fishing effects models

New models are under development to understand the effects of fishing on EFH. These models are based on considerable previous work on quantifying fishing effects and habitat reduction from fishing. Stock indices that are now included are: time trends in growth/maturity, spawning success (recruitment), breeding success (spawning distributions), and feeding success (feeding distributions). An example application of the model for GOA POP and pollock was provided. While no correlation was indicated, the correlation analysis was run regardless in order to inform the process should application of the model to any stock indicate a need for further analysis. If correlations had been indicated and there seems to be a plausible connection to habitat there could be a population level effect associated with habitat reduction and the next steps would be to raise these to the plan teams (SSC and Council) to evaluate needs for mitigation.

Steve described the hierarchical impact assessment should correlations indicate that there are reasons for examining mitigation. Development of the first model focused on pollock and Pacific ocean perch in the Gulf of Alaska. Model results show less than a 5% habitat reduction for pollock and Pacific ocean perch. However, the maps show some intense effects in some areas (slide 9 of ppt). The CPT questioned whether the model could provide a more fine scale spatial analysis to look at impacts in these areas. While a finer spatial scale would be interesting, there are data limitations and more data is available at a larger scale. Stocks are distributed over a large area. Future work could be done to look at high impact areas.

The CPT discussed the questions outlined in the presentation.

Should assessments be based on regional boundaries for the stock or species?

The CPT evaluates multiple stocks within a region, so fishing impacts should perhaps be evaluated at the stock level as identified by the individual assessment authors.

Is the 50% threshold the right one?

This threshold balances making sure enough areas are covered without covering areas of marginal importance. The CPT considered whether analysis should look at a 25% threshold, or others, to see differences. One possible method is to weigh the habitat disturbance proportional to abundance. Problems

with weighting according to abundance in an area are: (1) animals may move to avoid areas of high impact, (2) we don't know how the models react to changes in distribution or detect movement, and (3) we don't know what impacts movement has on population level effects. A time series of maps could illustrate movement over time. Also, we could look at abundance in closed areas compared to open areas. The CPT discussed whether it would be possible to detect impacts given we only have population level data and we don't have the information necessary to make correlations. One suggestion was to overlay habitat maps over time with population distributions to indicate if there appears to be some inherent response mechanism. The CPT expressed concern that finding will likely always be of no impact as a result of weak factors to correlate due to paucity of information for crab. A suggestion was made to look at the change in disturbance and then go back and evaluate how recruitment changes (or other variable) have changed since that time to see if there is correlation. The effects will be most likely subtle and chronic.

Continue the 10% habitat reduction threshold?

The CPT concurred that it is not possible to answer this question because the model has not yet been applied to crab stocks.

What seasons should be used for the analysis?

Seasonal variability is important. If only one map is selected, the CPT concurs with the recommendation of the groundfish plan team for creating one map that reflects seasonal distributions. It was pointed out that while the Council had requested a single map to identify critical habitat for a species, additional maps identifying seasonal distributions should also be considered as seasonal differences are particularly important for crab stocks.

Is p-value of 0.1 reasonable?

Probably, but it would be good to see the results for crab; if a lot of crab stocks fall on $p<0.05$, we may want to reconsider.

The CPT discussed they found it useful to have separate maps by life stage, showing juvenile and adult details separately. The CPT also discussed ways to annotate the maps to show where data is not available to inform whether fishing impacts were occurring in delineated EFH areas (as it was questioned whether fishing effort data was available from State water fisheries occurring within 3 miles of the coastline). Conversely, it would be valuable to annotate maps to show limits of where survey data was available to inform which areas were considered to delineate EFH for stocks (again limiting inferences in nearshore waters).

The CPT will need to meet, probably via WebEx, sometime after January and before the April NPFMC meeting to discuss the updated EFH model results applied to crab.

Pribilof Islands red king crab

Jack Turnock (NMFS) presented the Pribilof Islands red king crab stock assessment. Previous CPT and SSC comments and author responses were presented. The authors didn't explore the universal weighting recommendation, but other recommendations were pursued and found to be not particularly useful. The assessment included the status quo 3-year running average with inverse variance method, a random effects model with different process variances, and an integrated length-based assessment model first presented in 2014. The integrated assessment model scenarios presented were: fitting males only and computing OFLs using the Tier 3 and 4 control rules.

The male-only integrated assessment model fit to survey abundance continues to be poor because the survey data is not particularly informative. The assessment model fits abundance data well from 1975 to 1987, underestimates abundance in the period 1988 to 2004, and then improves fit to abundance from 2006 to

2016. Since there is no directed fishery operating on this stock, eliminating early abundance data (pre-1988) from the model resulted in model estimates that overestimated abundance for the more recent period. Francis effective sample size was explored and a multiplier was estimated at 0.05 for the assessment model. However, when sample sizes were reduced using the Francis multiplier (0.05) and for a multiplier of 0.1, the model failed to converge. Model scenarios were run with larger multipliers (0.2, 0.4, and 0.6). Limitations on available data may constrain further exploration of this method.

The CPT hypothesized that highly variable survey estimates could be caused from a low density population combined with aggregation behavior of red king crab. An alternative hypothesis is that a variable portion of the stock is unavailable to the survey. The 3-year survey average approach attempts to address the issue of catching high numbers of crab in some years and missing crab aggregations in other years. The CPT expressed concern that, while in all years the CVs are high, years with low survey catches tend to have lower estimated CVs than high years. In reality, survey catches are probably equally uncertain every year. The CPT continues to recommend a scenario that applies uniform weighting across all survey years (i.e., a process error, a constant CV, or a constant standard error). The CPT reduced priority on further evaluation of the integrated length-based assessment for PIRKC, as the random effects model may prove more useful if this stock is to remain at a Tier 4 level.

The CPT recommends for 2016 using the status-quo 3-year running average weighted by the inverse of the variance of the area-swept estimate. The CPT recommends further development of the random effects model using universal weighting to be presented in May 2017.

Tanner crab

Buck Stockhausen presented the stock assessment and fishery evaluation for eastern Bering Sea Tanner crab for 2016. Changes to the previous 2015 model included:

- Recruitment estimate started in 1975 instead of 1974
- Groundfish size comps normalized on original sample sizes
- Separate female fishing mortality multipliers from males (log-scale)
- Fs estimated for BBRKC fishery instead of default rates
- Probability of molting to maturity using logit- instead of log-scale parameterization
- Selectivity = 1 in largest size bin
- Fishing mortality estimated similar to that in the GMACS model
- Use of jittering to evaluate convergence

In addition, new trawl survey biomass and size composition data in addition to 2015/16 pot and groundfish fishery data was updated. Minor changes were also made that affected the starting model results relative to the 2015 model: recruitment was in millions instead of thousands of crab and a new version of ADMB was used. The CPT discussed that with jittering in a size structured model the final parameter values may vary likely due to the relative flatness of the objective function in the vicinity of the maximum likelihood estimate and the inherent imprecision in numerical solutions to minimization problems. Finally, it was noted that the CVs for mature survey biomass were relatively larger in the 2016 assessment than the 2015 assessment due to a change in calculation. In 2015 CVs were based on a summation of variances from 1mm bin estimates. The new calculation is consistent with the method prior to 2015.

Author responses to CPT and SSC comments from previous meetings were discussed. The author addressed most of the requests in this assessment. Future iterations will include the use of the Francis weighting method for composition data that were recommended by the CPT and SSC. Also, new data on Tanner crab growth will be incorporated into future assessments, although it was noted that there was little difference to the Gulf of Alaska (GOA) data currently informing the model. The CPT recommended

that in future model iterations, the author incorporate the available growth data in stages: 1) new EBS data only, 2) old GOA data only, and 3) both data sets to assure that there are no difference in the data. The CPT also recommended that the author require all the size composition data to fit better (less constrained by weighting) now that there is empirical growth data available.

The fishery data are not separated into east and west in the model as they are for the TACs. Retained catch has increased substantially each year since the fishery reopened in 2013, and size composition have shifted slightly smaller. Bycatch in crab and groundfish fisheries was also higher in 2014 and 2015 relative to the previous 6 years. The snow crab fishery does not catch many large male Tanner crab, hence the use of a dome-shaped selectivity function in the model. In the discussion it was noted that all groundfish fisheries are aggregated in the model and a handling mortality of 80% is applied. **The CPT requested that in the future the groundfish fisheries be separated by trawl and pot and appropriate handling mortality rates be applied consistent with other EBS crab stocks.**

Survey results showed a decline in overall biomass between 10 and 25% in each broad size and sex category from 2015 to 2016. The author noted, however, that the mature males in the west had an opposite trend (increasing in the past few years) and discussed the correlation of temperature on the Tanner crab distribution.

The author presented 11 new model scenarios for consideration. The first 5 models (2015AMO through Model A) stepped through multiple changes from the 2015 model to the model selected by the CPT at the May 2016 meeting as a "base" model. Those changes included parameter jittering, new survey CVs, and addition of new 2016 data. The new base model had no convergence issues with the jittering method. The new survey CV estimates (generally a bit larger than last year) lead to slightly down-weighting the survey biomass time series in the model likelihood relative to the size comps, so they may appear not fit as well.

The remaining models considered a new fishing mortality calculation, decreased F weighting in the BBRKC fishery, effort parameters estimated, penalties on the F-deviations, and lognormal likelihood estimated for fishery catch data. The use of the new fishing mortality calculation based on capture probability led to no changes in F in males. Model C with no minimum fishing mortality constraints in the Bristol Bay red king crab fishery had minimal effects on the model results. Model D, however, estimated bycatch fishing mortality rates in the snow crab and BBRKC fisheries that were far too small (essentially 0) before 1992 due to a missing likelihood component for estimating the associated effort extrapolation parameters (fishery q's). **The CPT recommended including the extra component associated with estimating the effort extrapolation parameters in the likelihood function.** All remaining models depend on Model D so were not considered further. Therefore**, the CPT agreed with the author recommended Model C for use for the 2016/17 assessment.** In Model C**,** female fishery fits were better. There were still some residual patterns in size compositions similar to all model scenarios. Retrospectives showed that the model slightly overestimated the current year and 2005 (observed in previous models also).

The CPT discussed the large increase in the F_{OFL} in 2016/17 relative to previous years. The new method for estimating mortality in the directed fishery estimates the mortality based on the probability of capture which accounts for smaller discards at increasing F as opposed to the old method of estimating selectivity in the fishery. The average Fs in other bycatch fisheries do not change because there is no retention the rates are fixed when calculating F_{OFL} (the bycatch fishing mortality of Tanner crab in the in snow crab fishery is based on the snow crab F_{OFL} scaled to bycatch in recent years). The CPT also noted that the reason that the OFL went down relatively more than the biomass from 2015/16 to 2016/17 is that it is assumed that the whole OFL will be taken the fishery in the subsequent year but the TAC has been set much lower than OFL in recent years. **The CPT recommended that this stock remain in Tier 3, that the OFL be 25.61 thousand t, and the ABC be 20.49 thousand t based on a 20% buffer consistent with previous years.**

Specific items across Tanner crab model scenarios that the CPT discussed or questioned:

- The fishing mortality for males is unreasonably high in the early period and appears to be driven by fitting retained catch. **The CPT requested that the author look into the M estimates during that period to try to find the specific reason the Fs are so high.** Specifically, how do changes in M affect mean recruitment relative to the current model with high fishing mortality? Also since the survey q is hitting the bottom bound for 19785-1981, the CPT recommends freeing up q to see if there is a change in F.
- The Bering Sea Research Foundation has collected data in the eastern portion of the Tanner crab distribution. Because those data do not cover the entire stock, the author suggested and the CPT agreed to wait until additional data is available to incorporate into the model.
- The total selectivity curves in 1996 continue to shift to the right and left with minor input changes to the model likely due to the few data points informing that year. Because that year is included in an average used to estimate selectivity in the pre-1991 period it may be affecting model results. **The CPT requests that the author run a scenario with the 1996 data removed from the data used to estimate the pre-1991 selectivity data.**
- There are still large penalties being used in the model that need to be explained. **The CPT requests that methods used in Model E to reduce penalties on the F-devs be brought forward in future scenarios.** Other penalties need to be explained:
    - What is the basis for the female survey q penalty?
    - Are there extra weights set up to help with model convergence that have not been revisited?
    - Are the penalties on F-devs responsible for the total catch mortality in the groundfish fishery not fitting?
- Why are the retained catch estimate not fitting smaller size classes? **The CPT recommends considering if there was different retention function in those years.**
- Why does Model C underestimate small crab and overestimate large crab in the directed fishery size composition relative to the 2015 model?
- The assessment model has consistently overestimated large male crab in the size compositions, which has large implications for estimation of mature male biomass and resulting OFL setting. It was suggested that the greater male growth rate estimated in the model relative to available empirical data may be contributing to this offset.
- Why does the model predict more, larger crab in the past 10 years in the model?

St. Matthew blue king crab (SMBKC)

D'Arcy Webber (Quantifish, via WebEx) presented the stock assessment of St. Matthew blue king crab (SMBKC) for developing OFL and ABC recommendations. The assessment uses the Gmacs model which the CPT and SSC approved for use at the May and June 2016 meetings respectively. CPT recommendations from May 2016 addressed in this assessment are: 1) addition of a 1-year projection for calculating Tier 3 or 4 OFLs; 2) options to specify catchability as a fixed or estimated parameter or use the analytic calculation for the MLE; and 3) allowing for different phases for "rec_ini", "rec_dev" estimation.

The September 2015 model (not Gmacs) was corrected for an error discovered during the May 2016 CPT meeting. The stock assessment examines six model configurations: 1) the corrected September 2015 model; 2) a Match model which is the Gmacs model with selectivity parameters fixed to match the September 2015 model; 3) Gmacs base model with selectivity parameters estimated; 4) M scenario is the Gmacs base model removing the large natural mortality spike estimated in 1998 (i.e., constant M in all years); 5) Francis scenario is the Gmacs M model using the Francis method to estimate effective sample sizes with the multinomial likelihood; and 6) Force model is the Francis scenario with increased weight on the likelihood for the pot survey (2.0) and trawl survey biomass (1.5). Scenarios 1, 2, 3, and 4 use the robust normal likelihood for length data.

In the 2015 model and the Gmacs match, selectivities for stage 2 were estimated above 1. For the other model scenarios, the survey selectivities were bound at 1.0, the stage 3 selectivity was fixed at 1.0, and the stage 1 and 2 selectivities were estimated in the model. The Gmacs models estimated biomass lower than the 2015 model in recent years, primarily due to incorporation of the 2016 NMFS trawl survey and the ADF&G pot survey biomass estimates, both of which decreased. The Gmacs M and Gmacs Force models estimated biomass lower than other model scenarios. The Francis weights were estimated to be higher than 1.0 for the pot fishery and pot survey length frequency data, and lower than 1.0 for the trawl survey length frequencies data for scenarios Francis and Force. One potential reason the Francis weights did not go to low values, as has been seen in other assessment models, is that the SMBKC model has only 3 length bins. The CPT found it difficult to justify giving higher weighting to length frequency data. The Gmacs Force model, which arbitrarily increased the weighting on the survey data, was considered by the CPT as an exploratory model but not suitable for use in estimating OFL and ABC.

The CPT requested a scenario with the Gmacs Base model plus constant M over time (the Gmacs M model) without using the Francis weights (which were used in initial model runs) due to concerns about up-weighting some length frequency datasets. The authors completed the model and presented it during the meeting. The model still showed much lower ending biomass than the Gmacs Base model even though the only change from the Gmacs Base was removing the high M estimate in 1998. This sensitivity of current status was regarded as an undesirable feature of the Gmacs M model even though the assumption of constant M was considered by the CPT as a more parsimonious and potentially more defensible approach. The CPT recommends further exploration of constant M models for SMBKC.

The CPT recommends that the Gmacs Base model be used for OFL and ABC estimation. The Gmacs Base model makes the transition from the old SMBKC model to a Gmacs model. The model improves the treatment of selectivity by constraining selectivity to be less than 1.0 for stages 1 and 2. The Gmacs Base model fits the data better than the Gmacs M model, and it does not use the Francis weights to up-weight length frequency data.

CPT Recommendations

The CPT requests that the equations for the likelihoods, as well as the formula for the Francis weighting, be included in the document. **For the May 2017 meeting, the CPT recommends continued exploration of data weighting (Francis and other approaches) and evaluation of models with and without the 1998 natural mortality spike.** The authors are encouraged to bring other models forward for CPT and SSC consideration.

Aleutian Islands golden king crab (AIGKC)

AIGKC Model: Siddeek Shareef briefed the CPT on the model-based stock assessment for Aleutian Islands golden king crab. The assessment divides the Aleutian Islands at 174° W into eastern and western components (EAG and WAG). The model is based on a single-sex length-structured population dynamics model. Unlike most model-based assessments of North Pacific crab stocks, the primary data source on trends in abundance included in assessment of AIGKC is fishery-dependent standardized catch-rate (CPUE) data. The model runs provided to the CPT examined sensitivity to how natural mortality (M) is specified, whether fishery selectivity is dome-shaped or asymptotic, the basis for the stage-1 effective sample sizes for the length-frequency data, whether the observer fish ticket CPUE series is included in the assessment, and the basis for variable selection when standardizing fishery CPUE. Eight of the models were the focus for graphical and tabular summaries.

The CPT reviewed progress in relation to the recommendations by the CPT and SSC from May 2016.

- The analysts provided an estimate of total mortality based on tagging data. However, given uncertainties related to, for example, the tag loss rate and estimation of fishing mortality, there is little power to discriminate among alternative values for M (CPT comment 3).
- The likelihood profile for M did not include results for the EAG and WAG combined. Siddeek provided the plot to the CPT, which indicated that the data are informative for M when all data are considered (CPT comment 4). The plot of the total likelihood (EAG and WAG combined) should be included in future assessment reports.
- When applying Francis weighting, there is no need to impose an upper bound on the effective sample sizes, except that the effective sample sizes should not exceed the actual number of sampled animals (CPT comment 5).
- The CPT was satisfied with the analyses undertaken to examine the behaviour of the CPUE standardization (SSC comment 4).
- The groundfish data are very noisy and the fits to these data are poor. However, the results presented to the CPT for scenarios 4a, 4c, 14a and 14c ignored the groundfish catches as well as the associated length-frequency data. However, it was not the intent (of the CPT) to ignore the catches. Future analyses should include the groundfish catches, but not the length-frequencies (SSC comment 7). Siddeek provided example results when only the groundfish length-frequency data are excluded, but these results are not included in the document.

In general, the CPT found the analyses conducted to help understand the "scaling" of the biomass (e.g. the likelihood profiles, starting the model in 1960) helped it evaluate the model. The CPT agreed that the model fits to the data are adequate (and often better than those to models that are already accepted for use in management) and most of the results are not unexpected given the available data. **The CPT therefore recommends that the model be accepted for use in management, including computation of OFLs and ABCs in May 2017.** The CPT recognizes that the reliance on standardized CPUE adds an extra amount of uncertainty, but it has evaluated the method of standardization extensively and is confident that there is little additional benefit to further evaluation. It is never possible to confirm that CPUE is proportional to abundance, but where assessments for North Pacific crabs have plotted (unstandardized) CPUE against biomass, the relationship is broadly linear.

There are several steps that need to be completed before the model can be used to set OFLs and ABCs, and the CPT developed a workplan so that it would be able to use the model to calculate OFLs and ABCs in May 2017.

Recommendations (for January 2017)

The tasks that the CPT need to conduct during the January 2017 CPT meeting are:

- Review the model runs developed to better understand the behavior of the model (in particular why there is a declining trend in MMB for the EAG before the first catches in 1981). This is likely due to the high proportion of large animals in the early years of observer data,
- Select model configurations for presentation to the CPT in May 2017.
- Evaluate whether OFLs should be based on the Tier 3 or Tier 4 control rules, and compare alternative choices for the years for defining the BMSY proxy for the Tier 4 control rule and alternative choices for the years for computing mean recruitment to compute B35% for the Tier 3 control rule.
- Evaluate alternative buffers between the OFL and the ABC.
- The analysts should conduct the following analyses for presentation to the CPT in January.
- The catches in tables 1 and 15 do not match those in Figs 21 and 37. These figures should not include zero catches when these are actually "missing" catches.
- Consider analyses to more fully understand the behavior of the model. In particular, (a) analyses should be undertaken where the early length-frequency data are omitted from the assessment one

year at a time, (b) the author should assess which data are causing the 6c and 7c to estimate high recruitment in the early 1980s, and (c) the predicted catches and fishing mortality time-series should be extended back to 1981.

- The "base model" should:
  - ignore the groundfish length-frequency data (but retain the catches);
  - base the annual stage-1 sample sizes on the number of days on which sampling took place (rather than the number of length measurements) - the stage-1 sample sizes should be based on the number of trips if it is not possible to compute the annual number of days on which sampling occurred;
  - set M to the estimate based on fitting to all of the data combined; and
  - fit to the early observer CPUE data
- The additional model runs should involve changing one aspect of the specifications of the base model in turn to allow the impact of changes to be examined.
- Additional sensitivity tests should be conducted in which catch rate is assumed to proportional to the square root and the square of exploitable biomass to evaluate sensitivity to non-linear relationships between catch rate and abundance.

Recommendations (for May 2017)

The report to be presented to the CPT in May 2017 should include all elements that should be included in an assessment report. In particular:

- The report should include likelihood profiles (for M, mean biomass and depletion) as well as retrospective analyses.
- Tables 1 (EAG) and 15 (WAG) should be modified to provide the retained catch, pot bycatch breakdown by males and females (make clear if mortality applied) and trawl bycatch followed by total catch. As an example, it could be organized as in the BBRKC assessment - Table 1a in the 2016 BBRKC SAFE. That will help resolve the confusion in how total catch was calculated.
- The plots showing estimated selectivity curves should include both the estimates for pre- and post-rationalization periods.
- Recommendations (longer-term)
- Continue the development of a spatial model that could be used to explore the implications of changed in fishing locations

AIGKC Survey:

John Hilsinger (Aleutian King Crab Research Foundation) briefed the CPT on concerns regarding the impacts of trawling on AIGKC. He noted that trawlers have moved back in to golden crab fishing grounds and there have been reports of reduced catch rates in the WAG. The causes of reduced catch-rates might be due to mortality or movement from the trawled areas. In principle, reduced catch-rates due to movement could negatively impact the ability to assess the stock through stock assessment, catch-rate indices, or surveys.

The CPT notes that a full analysis that accounts for the depth distribution and location of non-pelagic trawls is required to better understand whether changes in catch-rates are occurring and whether any such changes are related to trawling. This analysis would also need to account for habitat and present estimated of bycatch (of males, females, and juveniles) both recently and historically when trawlers had access to the areas currently fished for golden king crab.

The analyses need be conducted by analysts who have access to detailed effort and observer data for the trawl fishery. It was noted that this could be a component of or extension to the EFH analysis.

Catch Update

Overfishing status was determined for the three Tier 5 stocks that were assessed in May 2016. These updates are finalized in the 2016 SAFE report. Overfishing did not occur during the 2015/16 Aleutian Islands golden king crab fishery because the 2015/16 estimated total catch (confidential) did not exceed the Tier 5 OFL established for 2015/16 (5.69-thousand t; 12.54-million lb). The 2015/16 estimated total catch did not exceed the ABC established for 2015/16 (4.26-thousand t; 9.40-million lb). Overfishing did not occur during the 2015/16 Western Aleutian Islands red king crab fishery because the 2015/16 estimated total catch (1.2 t; 2,648 lb) did not exceed the Tier 5 OFL established for 2015/16 (56 t; 0.12-million lb). The 2015/16 estimated total catch did not exceed the ABC established for 2015/16 (34 t; 0.07-million lb). No vessels participated in the 2015 directed Pribilof Islands golden king crab fishery (i.e., retained catch= 0 t; 0 lb), and no bycatch was observed in crab fisheries in 2015. Total catch in 2015 was 1.15 t of fishery mortality that occurred during groundfish fisheries in 2015/16 (note available data for groundfish fisheries are summarized by "crab fishery year" rather than calendar year). Overfishing did not occur in 2015.

BBRKC EFP

John Gauvin of Alaska Seafood Cooperative (AKSC) presented a revised application for an exempted fishing permit (EFP) to allow up to ten (five per year) AKSC vessels to access the red king crab (RKC) savings area and area 516 closures to evaluate potential for reducing RKC bycatch in the winter/spring flatfish fishery in 2017 and 2018. The EFP will be reviewed by the SSC/AP/Council in December 2016. The application includes results of an analysis addressing concerns raised at the SSC about the application submitted previously. Gauvin indicated that they have not yet started talking to the crab fleet and were approaching the CPT first due to timing of our meeting. Gauvin showed an animation of locations of boats fishing flatfish in the vicinity of the RKC savings area in both 2013 and 2015. The fleet follows the flatfish schools and is limited to stay outside the RKC savings area. The locations of the schools varied in these two years. In 2013 (a cold year) the fleet started further south than in 2015 (a warm year). The animation demonstrates that the fleet is grouped together and moving along a trajectory that stops at the boundaries of the RKC savings area. The fleet feels as if their catch is currently being limited by the RKC savings area, and by allowing the fleet to go in there, they could fish shorter trawls and therefore have less bycatch.

The exempted fishing permit is needed for 5 vessels to enter the RKC savings area from January 20 to April 30 in each of the two years (10 vessels total) and to be exempted from catch handling regulations for prohibited crab species, including RKC, *C. bairdi*, and *C. opilio*. The permit application is different from the last time the application was submitted because they are not attempting to change the regulations for the RKC savings area with this application and they changed the timing of the EFP to end earlier to avoid RKC molting (change from June to April). They are requesting this application because they would like to see if they could catch more fish with lower crab bycatch rates when allowed inside the RKC savings area. They believe that if allowed to follow high density fish schools they will be able to reduce total crab bycatch in a the season. They will still be under the status quo PSC limits for crab.

The application includes information on RKC bycatch from observers in the 10 minute strip adjacent to the RKC savings area (p. 8 of the document). One of the goals of the EFP is to collect information on RKC abundance inside the RKC savings area. They are adding a third observer to process the crabs in the whole haul, which will supplement the standard observer basket sampling. This additional sampling will provide information on crab abundance and shell condition for crabs caught as bycatch in the RKC savings area at the time of the fishery. In-season management will be used to communicate results from the whole haul sampling with other observer data. Skippers will try to avoid areas with molting crab, but there is no specific protocol identified. If they get into an area and they catch a lot of crab, then they will

leave the area. It was noted that and supported by new data in the EFP that currently when any crab are caught the vessel moves to a new location.

The application asks for 2 years of exemption although the CPT noted that more years may be necessary to fully identify a trend. AKSC will provide a report to the Council after each fishing year based on their results. Following the 2-year period, they would work with the crab industry to conduct a crab survey in that area before preparing any future applications. The CPT asked if two years are enough data to detect a difference in bycatch rates inside and outside the RKC savings area. Gauvin responded that the EFP can only be requested for 2 years.

AKSC is key to the success of the proposal, as the cooperative started in 2008. Crab bycatch caps are allocated internally by AKSC as individual limits per vessel under the total PSC limit. Since the start of this cooperative, they have reduced their bycatch of both halibut and crab.

The CPT asked about changes that may have occurred in the benthic communities in the RKC savings area as it has been closed to nonpelagic trawl since 1995. The group discussed that the area may have a different composition of benthic fauna, such as sea whips, and may be more pristine given that the habitat has not had nonpelagic trawling for several decades. Gauvin responded that it is not the objective of the EFP to do a habitat study. The BSFRF conducted a survey there with cameras in 2007 and 2008, but they did not evaluate habitat although the video suggests that the habitat is quite similar inside and outside the RKC savings area. Pelagic pollock trawling occurs extensively in the area, thus there may be bottom impact due to trawling inside the RKC savings area regardless.

The CPT asked about the gear configuration used on flatfish trawls. Gauvin responded that flatfish in the Bering Sea are fished with trawls with 12-14 inch disks and have modified sweeps (95%) that are elevated to reduce bycatch. The net comprises 10% of the trawled area, and it is the footrope of the net has the disks. These nets were designed to minimize impacts on crab.

A power analysis is presented in the Appendix to address the question of whether statistically one could figure out if RKC bycatch rates are different inside and outside. The power analysis used, as a proxy, bycatch rates from different areas but there are no data available from inside. The power analysis suggests that several hundred tows are needed to detect a difference. The power is for all king crab and is not broken down by sex or size. An analysis based on size and/or sex would have lower power and thus require more replication.

The CPT commented that the State currently closes the area east of 163° W long. to Tanner crab fishing to protect RKC. This line currently bisects the RKC savings area. Gauvin responded that the desired outcome is to lower the RKC bycatch by the flatfish fleet. Before they would propose to change the area, they would do a crab survey in conjunction with the crab industry.

Gauvin added that the fleet would collect bottom temperature information from the trawl nets and then examine the relationship between bottom temperature and RKC bycatch. AKSC will make the sex, size and shell condition data available to NMFS. Brad Harris will likely assist with data analyses that will be presented to the SSC and Council.

The CPT noted that the whole haul data will be useful to understand the distribution and composition of crab (sex, molting status) and that we don’t know if this area currently protects crab, so this study will provide information that will be useful to evaluate the RKC savings area effectiveness.

There was some support from the CPT for this EFP but no strong recommendations were provided.

Other Business

BOF proposals

The CPT reviewed 17 Alaska Board of Fisheries proposals related to king and Tanner crabs; these proposals all fall under either category 2 or category 3 from the FMP and every three years on the BOF cycle the CPT is requested to review proposals for consistency with designated categories.

Three proposals are in category 3 other--

- Proposal 254, Amend the description of hybrid Tanner crab so that hybrid designation is dependent upon the vessel's target Tanner crab fishery.
- Proposal 260, Adopt ADF&G reference guide for *Chionoecetes bairdi* and *C. opilio* to identify hybrid Tanner crab.
- Proposal 264, Repeal provisions allowing concurrent harvest of red and golden king crab in the Aleutian Islands.

From the FMP: ***Category 3 Other*** - State government is not limited to only the management measures described in the FMP. Implementation of other management measures not described in the FMP must be consistent with the FMP, the Magnuson-Stevens Act, and other applicable federal laws, and may occur only after consultation with the NPFMC. Other management measures the state may implement are subject to the review and appeals procedures described in the FMP. The team concurred with the categorization of all proposals.

Hybrid snow and Tanner crab

In conjunction with some of the BOF proposals noted above, the team held extensive discussion of the issue of hybrid Tanner and snow crab and their respective designation. The characteristics defining a hybrid and the implications it has on Tanner and snow crab stocks were discussed. Buck indicated that the retention of hybrid opilio (snow) in the Tanner crab fishery could be problematic. Hybrids are not included in any stock assessment currently yet may represent a significant proponent of the overall population of snow and Tanner crabs. One proposal under consideration by the BOF would allow hybrid retention against the quota for whichever species is being targeted. This could have potential biomass and specifications implications. Currently hybrids are retained in both snow and Tanner crab fisheries. For purposes of stock assessment there should be some indication in the catch of what catch proportion are hybrids and with this possibly subtracted from the total taken so that we avoid overestimating the productivity of the true stock. Hybrids are not included in survey biomass estimates for either snow crab or Tanner crab. For the Tanner fisheries, retained hybrids are often smaller so the retention curve in the assessment will shift to smaller crab which will have implications for reference point estimation.

Emergency petition for Tanner crab

The CPT was informed of the submission to the BOF for an emergency petition from Bering Sea Crabbers for Tanner crab. The department and BOF have 30 days to respond. The petition is to change the harvest strategy for Tanner crab to modify the female only threshold to match years proposed for recruitment by SSC, and to create two separate harvest strategies for eastern and western portions of the stock. This would need to occur prior to TAC-setting by the state for implementation in the 2016/17 fishing year.

Upcoming meeting agenda items:

For planning purposes, the CPT notes the following draft meeting agenda items and meeting organization. The CPT notes that the January meeting will be a regular CPT meeting for the foreseeable future in order to forward CPT recommendations to the SSC on items discussed and reviewed.

January CPT meeting: January 17-19:

- NSRKC final assessment OFL/ABC
- Stock prioritization
- AIGKC: B_{MSY} (based on draft document on recruitment), Tier 3 runs, Tier 4 results, gamma selection and model scenarios for final assessment
- Tanner crab (list as noted in minutes)
- BBRKC- GMACs model for review including incorporation of BSFRF data similar to snow crab application
- BSFRF survey and herding issue; index sites for Tanner
- Dynamic B0 application and discussion

Feb/March CPT meeting as needed (webex ideally):

- EFH review

May CPT meeting: May 2-5, 2017 Juneau

- Handling Mortality: discuss assumptions and consistency across stocks (and across assessments) for assumed HM for fixed and trawl gears; standardize week-ending date for bycatch reporting in assessments
- PIBKC: additional information to suggest implications of moving stock boundaries to match State Stat areas
- Model scenario recommendations:
  - BBRKC
  - Snow crab
  - Tanner crab
  - SMBKC
  - PIRKC
- AIGKC final assessment OFL/ABC
- PIGKC final assessment OFL/ABC including Tier 4 model update using recent slope survey data.
- WAIRKC final assessment OFL/ABC
- Research Priorities

The meeting adjourned at 5:30pm Friday September 23rd.