Crab Plan Team Report

The North Pacific Fishery Management Council's Crab Plan Team (CPT) met May 4-7, 2015 at the Hilton in Anchorage, AK.

Crab Plan Team members present:
Bob Foy, Chair (NOAA Fisheries /AFSC – Kodiak)
Karla Bush, Vice-Chair (ADF&G – Juneau)
Sarah Marrinan (NPFMC- Anchorage) - filling in for D. Stram
Doug Pengilly (ADF&G – Kodiak)
Jason Gasper (NOAA Fisheries – Juneau)
Heather Fitch (ADF&G – Dutch Harbor)
Jack Turnock (NOAA Fisheries/AFSC – Seattle)
Shareef Siddeek (ADF&G – Juneau)
Martin Dorn (NOAA Fisheries /AFSC)
William Stockhausen (NOAA Fisheries /AFSC)
André Punt (Univ. of Washington)
Bill Bechtol (Univ. of Alaska – Fairbanks)
Brian Garber-Yonts (NOAA Fisheries – AFSC Seattle)
Ginny Eckert (Univ. of Alaska – Fairbanks)
Laura Stichert (ADF&G – Kodiak)

CPT members absent: *Diana Stram (NPFMC- Anchorage)*

Members of the public and State of Alaska (ADF&G), Federal Agency (AFSC, NMFS), and Council (NPFMC) staff that were present for all or part of the meeting include: *John Hilsinger, Jie Zheng, Toshihide Hamazaki, Clem Tillion, Linda Kozak, Kevin Keith, Wayne Donaldson, Miranda Westphal, Dave Frasier, Darcy Webber, Scott Goodman, Ruth Christianson, Ernie Weiss, Chris Siddon, Jim Armstrong, Steve Martell, and Cody Szuwalski.*

1. Administration

The CPT members and members of the public introduced themselves. The CPT team welcomed new member Laura Stichert from ADF&G in Kodiak. Wayne Donaldson from ADF&G in Kodiak stepped down as a CPT member. Josh Greenberg officially stepped down as a CPT member, and the CPT will consider whether to recruit an additional member.

An updated agenda with modifications for the meeting was made available and is appended to this report. Minute takers were assigned and minutes were encouraged to be submitted as soon as they are available. Documents for the SAFE and minutes were requested to be submitted to by May 13.

Members were encouraged to keep research priorities in mind throughout the stock assessments and the agenda to be discussed during the research priority agenda item on the last day.

2. Final Assessments

A general recommendation to all stock assessment authors from the CPT was to consider stepwise changes to data as individual model runs instead of changing multiple parameters at once so that changes in model performance may be attributed to specific data.

2.1 Pribilof Islands Golden King Crab

2.1.1 Stock Assessment

Doug Pengilly presented the Pribilof Islands golden king crab stock assessment. The Pribilof Islands golden king crab fishery is managed on a calendar-year basis therefore this assessment is for 2016. Retained catch and total catch are often confidential throughout the fishery history due to limited participation. Participation has ranged from one to two vessels since 2009. Because complete data from all crab fisheries in 2014 are not presently available, total catch in 2014 cannot be estimated for comparison with the 2014 OFL and ABC at this time but will be updated for the September CPT. The GHL for the 2015 season has yet to be established. The CPT expressed concerns about not having an estimate of harvest in years when the catch was confidential; while estimates cannot be released, the GHL has not been reached in recent years. **The CPT recommends the author add a notation to tables specifying whether or not the GHL was reached.**

The CPT expressed concerns that bycatch from groundfish fisheries is reported by crab fishery year (July-June) instead of a calendar year. Groundfish bycatch data are made available by crab fishery year because Pribilof Islands golden king crab is the only stock managed on a calendar year. **The CPT recommends NMFS assess if it is feasible to supply groundfish bycatch data for Pribilof Islands golden king crab by calendar year.** The CPT also discussed the potential of changing the management for the Pribilof Islands golden king crab stock to crab fishery year instead of calendar year to align better with the other crab stocks.

A Tier 4 assessment was intended to be presented in September 2014 based on results from the NMFS eastern Bering Sea slope survey. However, that survey did not occur. Therefore, the Pribilof Islands golden king crab stock assessment remains Tier 5. The CPT inquired about the future of the slope survey; NMFS plans to continue the biennial slope survey during even years contingent on funding. **The CPT recommends a preliminary Tier 4 assessment be brought to the September 2015 meeting using available slope survey data and applying a Kalman filter approach (e.g., the program developed by Jim Ianelli for groundfish stock assessments). The CPT recommends that regardless of whether a Tier 4 assessment is adopted or the stock assessment remains Tier 5, the document should include a summary of available slope survey data.** NMFS will provide the author with slope survey CPUE data based on State statistical areas or other stratification instead of the entire slope survey area because the entire survey extends beyond the Pribilof management area.

The CPT concurred with the author recommendation of status quo Tier level, OFL, and ABC. The status quo OFL has been in use since 2012. The ABC applies a 25% buffer to the OFL; use of the 25% buffer has been in place since the 2014 assessment for the 2015 season and was adopted to maintain consistency with other Tier 5 stocks with similar levels of uncertainty.

2.2 Western Aleutian Islands Red King Crab

2.2.1 Stock Assessment

Doug Pengilly provided an overview of the Aleutian Islands red king crab stock assessment. The fishery has been closed since the 2004/05 fishing season. **The CPT concurs with the author's recommended OFL and ABC based on the Tier 5 assessment and a 40% buffer.** The 2015/16 specification is unchanged from the 2014/15 specification. The 2014/15 recommended OFL was 123,867 lb (0.12-million lb; 56 t) and the recommended ABC was 74,000 lb (0.07-million lb; 34 t). A 0.07-million lb (34 t) ABC was recommended for the 2013/14 season by the SSC in June 2012 as a value that would "be

sufficient to allow for bycatch and groundfish prohibited species catch in non-directed fisheries and the proposed test fishery catch" (June 2012 SSC minutes, page 10).

In recent years, industry has expressed interest in conducting a test fishery in the Adak Island area. However, no test fishery has occurred. Industry is working with ADF&G to perform a "reconnaissance survey" for red king crab in the vicinity of Adak during the September 2015 golden king crab fishery. No retention of red king crab is planned, but handling mortality is expected and will be accounted for in the 2016/17 assessment. Members of the CPT recommended that as much biological data (e.g. genetic, size, shell condition) as possible be collected during the "reconnaissance survey" to help assess stock structure.

The CPT discussed whether length and effort information could be recovered to inform an assessment. However, these data are thought to be sparse. **If information could be recovered, the CPT requested the author provide a plot of CPUE through time in the 2016/17 assessment.**

2.2.2 Split Stock Proposal

Doug Pengilly discussed the current management areas for this stock, which is now referred to as the western Aleutian Islands red king crab stock. The Alaska Board of Fisheries in March 2014 established two districts for the management of commercial red king crab fisheries west of 171° W longitude. The Adak District was established from 171° to 179° W longitude, and the Petrel District was established west of 179° W longitude. The fishery west of 179° W longitude is rationalized, while the other is not. The fishery has been closed consistently since 2004/05.

Industry representatives joined Doug in explaining their interest in identifying separate stocks and splitting the annual OFL for these regions. A similar request was proposed to the Council and the CPT in the past. In June 2013, a proposal to remove the Adak District from the FMP failed at the Council. In September 2013, the CPT weighed in on the issue and the minutes from that meeting list some recommendations that should be considered prior to a FMP amendment analysis. The industry members supportive of action asked the CPT what additional information would be needed to inform a future agenda item on this topic for consideration by the Council. Industry members noted that areas east of 179° W are best-suited for a small vessel fishery based on the availability of safe harbors. Industry representatives also suggested that the crabs do not cross deep channels and, thus, these two management areas should be managed separately. The CPT suggested that larvae likely transverse this boundary, so the larger issue is how to define a stock. The CPT discussed that available data about currents in the area are likely insufficient to inform the degree of larval transport in the area. Guidelines regarding stock boundaries are available from the AFSC Stock Structure Working Group.

The CPT looked at Grant and Cheng (2012), which included genetic analyses of samples taken from the Adak and Dutch Harbor areas. The paper concludes that the Adak samples are more similar to Russian stocks and may be genetically distinct from the Dutch Harbor samples which were similar to those from Bristol Bay. No samples were available from other sites in the Aleutians, so whether genetic separation occurs within the western Aleutian Islands red king crab stock is unclear. More genetic samples from the region could help inform this stock structure question.

The CPT discussed whether there are other reasons to divide the stock (other than biological). The different catch history could be a reason. Industry is interested in conducting a reconnaissance survey in the Petrel District in 2016. There is industry interest in managing the stock differently in the two districts in case there is a sufficient population to support a fishery in one area but not in the other, so that area could be fished while the other is closed.

CPT provided recommendations for analyses to inform this issue:

1. During the reconnaissance survey, take genetic samples to inform if a genetic difference occurs across Amchitka Pass and measure crabs to identify size distribution.
2. Investigate if Amchitka Pass is truly a stock boundary. Research could address movement of larvae using models and what is known about currents. The oceanographic models may not work well in the Aleutian region because of boundary issues and because of the extent of models that are currently available.
3. Use the template from the AFSC Stock Structure Working Group to evaluate red king crab stock structure and extent of available information.
4. Data are needed on crab abundance throughout the Aleutian Islands. A more standardized pot survey would be needed after the planned reconnaissance survey before a fishery could be prosecuted.
5. A larger analysis could be conducted to identify if there is evidence for stock boundaries in this area. Until more information is available, the CPT cannot provide a recommendation on this issue.

2.3 Aleutian Islands Golden King Crab

2.3.1 Stock Assessment

Doug Pengilly presented the Tier 5 assessment for Aleutian Islands golden king crab. The management area includes waters west of 164° 44' W and is separated into eastern and western areas at 174° W. The fishery data have been updated with the data for 2013/14: retained catch for the directed fishery and bycatch estimates for the directed fishery, non-directed crab fisheries, and groundfish fisheries.

Starting with the 2013/14 season, total harvest includes crab harvested for cost recovery towards a $300,000 allocation to fund the deployment of observers. In 2014, the Alaska legislature increased the allocation for cost recovery from $300,000 to $500,000, with the additional $200,000 dedicated to fund research and surveys for Aleutian Islands red king crab. Golden king crabs harvested for cost recovery are counted towards the ABC and OFL, but are not counted towards the TAC (and are therefore not included in the "Total Catch" column of Council reports).

The CPT concurred with the assessment author recommendation to use the same approach to determine the OFL as has been used since 2012/13. This approach uses retained catch for the 1985/86 – 1995/96 seasons, the average annual ratio of bycatch mortality due to crab fisheries to retained catch in the directed fishery for the 1990/91 – 1995/96 seasons (excluding 1993/94 -1994/95 due to data confidentiality and lack of data), and the average annual estimate of bycatch mortality in the groundfish fisheries for the 1993/94 – 2008/09 seasons.

The CPT concurred with the assessment author's recommendation of a 25% buffer for the ABC, the same as used last year. The CPT maintains that there is uncertainty regarding the appropriate years to compute the Aleutian Islands golden king crab OFL, as it includes years of high catches and declining catch rates.

The assessment author noted that CPUE in the west area has trended down while CPUE in the east area has remained steady. **The CPT recommended the author plot CPUE over time by area rather than by both areas combined so that these trends can be tracked in the Tier 5 assessment.**

2.3.2 AIGKC Cooperative Survey

Chris Siddon gave a presentation on progress to develop a cooperative survey with the fishing industry for AIGKC. Historically, there was dedicated pot survey for AIGKC on a triennial schedule, but the survey extent was too limited to provide an index of abundance at the stock level. The area in the Aleutian Islands that is fished for AIGKC is vast, and surveys costs are high, making a fishery-independent survey of the entire area infeasible. The current approach of using standardized fishery CPUE indices for the assessment has a number of shortcomings, such as concerns about hyper-stability in the index and non-random distribution of fishing effort. However, some of these concerns can be addressed, at least partially, through the CPUE standardization process and how the CPUE indices are modeled in the assessment.

The CPT discussed the importance of understanding how information from a survey might be used for stock assessment. An appropriately designed and implemented pot survey will provide a CPUE index of relative stock abundance. An index of abundance has limited value if only one survey has been completed, and while a trend can be calculated if two or more surveys have been completed, this data source only becomes valuable for stock assessment when 5-10 years of survey data are available. Therefore the pot survey should be considered a long-term project. In addition, under the current tier system, an index of abundance will only be useful for stock status determination if a stock assessment model is adopted for AIGKC. Catchability (Q) must also be considered when setting up the survey for use in the assessment.

The proposed survey methodology is based on directed pot fishing by multiple fishing vessels at the beginning of the fishing season. The initial focus is on developing a survey for the EAG component of the stock. Historical fishery locations in this area were analyzed to identify a region where 90% of the post-rationalization cumulative catch had occurred. A 2 X 2 nmi grid was overlaid on this area, and grid cells were selected where at least one pot was observer-sampled during the post-rationalization period. Several filters were applied, such as excluding: depths greater than 1,000 m; sets with zero catch; or positions recorded on land. The remaining cells constitute the data frame subject to selection for sampling. Various stratification schemes were considered, such as three east to west spatial strata and two strata defined on the basis of historical fishing effort (a high density region with >20 observer-sampled pot lifts and a low density region with <20 observer-sampled pot lifts). **The CPT recommends that both spatial and density strata be used in the survey design.** It was recognized that a procedure would need to be developed to ensure minimum spacing was achieved between sampling locations.

The CPT also discussed issues associated with a vessel-effect during the survey. Initial plans are for all three vessels to participate in the survey in the eastern area in August, 2015. Each boat will use a range of different-sized pots that may be configured differently. As a first step, an inventory of the types of pots used by each vessel should be conducted. Options for addressing this issue include making efforts to standardize the gear, or considering vessel effects explicitly in the survey design. Given the variety of gear used by each vessel and the high amount of pots used in the fishery, it is unlikely gear could be standardized or replaced. Addressing vessel effects might require some level of spatial overlap between the areas sampled by the different boats, though the CPT recognizes that there may be logistical reasons why this would be difficult to achieve, at least within a year. Limiting soak time could prevent gear saturation from being a problem (potentially an issue when different-sized pots are used).

Preliminary fieldwork was conducted during August 2014. Twelve strings of commercial pots were set and retrieved. The focus of the fieldwork was to evaluate whether on-deck sampling could be conducted without adversely affecting fishing operations. Generally, the fieldwork indicated that sampling

procedures were feasible when a subset of the pots in a string were sampled and that those procedures were not unduly disruptive of fishing operations.

The CPT recommends that the expected precision of the survey be evaluated. This could be done by regarding the pot-by-pot observer data as the set of all possible samples from a survey, and sampling with replacement from that data set according to the proposed survey design.

2.3.3 AIGKC Model Update

A size-structured assessment model for AIGKC using a fishery CPUE index of abundance has been under development by ADF&G for several years. Shareef Siddeek presented a revised AIGKC assessment model that addressed recommendations made by the CPT in September 2014.

On the whole, considerable progress has been made in the development of a model for AIGKC. Items of current concern to the CPT included relatively minor tweaks and sensitivity analyses to better understand the behavior of the model. The draft assessment achieved a good fit to the composition data and an adequate fit to the CPUE indices. The assessment model did not show strong retrospective patterns. A likelihood profile indicated that the CPUE index was the most important data source for determining catchability for both eastern and western models and, thus, determined stock component scaling. However stock assessments using an index of abundance often depend on relatively subtle features of the data, and it was unclear what those features were. The standardized abundance indices were relatively flat throughout the entire period. The draft assessment did estimate relatively high fishing mortalities for the period prior to establishing the GHL. However, high fishing mortalities have been estimated for other pot fisheries in Alaska. Whether or not estimated fishing mortalities were unrealistically high is a factor to be considered when evaluating whether or not to accept the model.

Previously, the CPT identified some large estimates of discard in the early 1990s due to the estimated total catch being much higher than landed catch. Total catch is estimated from observer sampling by multiplying the observer-estimated CPUE by total effort. The observer data were checked and found to be correct, but very low observer coverage in those early years results in relatively uncertain total catch estimates. **The CPT recommends that the precision of the total catch estimates be taken into account in model fitting by giving lower weights to the earlier total catch estimates.**

The CPT identified a potential problem with the equation for total fishing mortality for a pulse fishery used in the model (in particular equation 3 in the appendix). **An improved equation has been provided to the author, which should be used in all models going forward. The equation for total fishing mortality in other crab assessment models (e.g., that for BBRKC) should be checked.**

Model 3 used commercial fishery retained CPUE indices as an additional abundance trend. A GLM model was fit to retained CPUE using only year as factor. If this data set is to be used in future models, additional factors should be considered in a stepwise procedure, such as month and vessel. **The CPT does not recommend using this time series in any final model, so this index should be used only for sensitivity runs.**

It was noted that when modeling breaks in catchability and selectivity for the CPUE index, the retention curve was also allowed to change at the same time as selectivity and catchability. In most cases, retention should be considered constant unless there is evidence to the contrary. **The CPT recommends that model alternatives with different catchability/selectivity breaks be carried forward for review in September, but the same retention curve should be used in all years.**

Based on the above discussion, the CPT has the following recommendations for the September 2015 CPT meeting:

- Include results from the CPUE standardization in the assessment document.
- Use the improved total mortality formula for all models.
- Explore methods for standardizing the commercial fishery retained CPUE indices using available information.
- Total catch estimates should be given reduced weights when model fitting when they are based on low observer sample sizes.
- Provide likelihood profiles for catchability while showing the impact of catchability on other variables (e.g. current biomass) on the y-axis. As an exploratory approach, consider "jittering" the starting values to examine the effects on the likelihood profiles.
- If possible construct a profile on current MMB and not catchability. Since MMB is model output and not a parameter, this is usually done by forcing the model to fit a pseudo survey in the final year and varying the survey values.
- Provide a sensitivity analysis to potential changes in catchability and selectivity in the CPUE time series. Results should be compared for the following alternatives: Alternative 1—no changes in selectivity or catchability; Alternative 2 (base)—one break in catchability/selectivity for the post rationalization period; and Alternative 3—two catchability/selectivity breaks, one break in 1999 and another post-rationalization. Provide likelihood profiles as described above for each alternative. In all alternatives keep the retention curve the same for the whole time period.
- Provide additional plots to evaluate the fit to the tagging data:
    - Plot observed tag recaptures vs. predicted tag recapture by year at liberty.
    - Plot the growth increment rather than size at recapture (and by year at liberty)
    - Plot the growth increment but break the lengths-at-release into groups.
- Provide confidence intervals assuming log-normality when plotting biomass trends and fits to CPUE indices (see Burnham et al. 1987:page 212)
- Provide an analysis of sensitivity to the F penalty in model fitting. During estimation phases, relax the F penalty earlier than the final phase. Evaluate the effect of different mean F values in the F penalty term (from low to high).
- The model currently initializes the population size-structure in the first year of the modeled period by estimating the abundance by length category. To evaluate sensitivity to this method, compare this method to an approach that obtains the initial size composition by assuming some average level of recruitment has occurred for a number of years (i.e., the approach used in snow and Tanner crab assessments).

The CPT anticipates that it will be prepared to make a recommendation to the SSC in September 2015 on whether the model should be used for setting the OFL and ABC and the Tier level for AIGKC in May 2016, or alternatively, if the model will not be adopted and development of this model would discontinue.

3. EBS Trawl Survey Time Series

Bob Foy provided an update on revisions to the EBS trawl time series data; a full document is anticipated for the September 2015 CPT meeting. The survey area has changed over the time series with the current area covered since 1987 by ~375 tows. The revision project started in 2008 and has corrected for numerous errors (<1% change); unmeasured crab (<25% change); revised net width tow length based on net mensuration (<10% change); and recalculated length-weight regressions. Efforts included resolving re-tow data, hot spots, and special project tows. The project provided one revision in 2010 and recently completed a follow-up revision, with several new aspects being addressed in this latest revision.

Unmeasured crab (e.g., recorded as "U" due to aspects such as individual crab being crushed) were corrected by extrapolation from adjacent tows. New length-weight regressions were calculated and used for conversion of estimated abundance to biomass.

Several revisions follow recommendations from the January 2014 Modeling Workshop such as selecting one standardized tow per station; and providing crab sizes in 1-mm size bins. Selecting single tows within each station involved using algorithms based on factors such as survey timing, location within a station cell, optimizing spatial coverage, and using tows from leg 1 for male red king crab and from leg 3, when available, for female red king crab. Bob is still exploring tow duration (i.e., avoid 1 hr tows) and use of data from corner stations that are no longer surveyed.

The effects of the trawl time series changes varies by stock and stock component (e.g., sex and maturity); averages across years generally changed <10%, but annual minimum and maximum differences can be quite large. Assessment authors were informed of specific survey estimate changes >10%. Comparisons of survey biomass estimates were shown for BBRKC, PIRKC (new time series has immature males 250% greater in 1980), PIBKC; SMBKC; Tanner crab east; Tanner crab west, and snow crab. The methods of incorporating non-hot spot species caught in hot spot tows were historically inconsistent (e.g., Tanner crab east caught in RKC hot spot tows). **The CPT suggested differences between old and new time series be displayed on a log scale.** There were also some potential inconsistencies between the plotted changes of the old time series vs. the revised series, and a plot of annual percentage changes.

Bob requested that the authors consider a separate run for the September CPT meeting with the new data series. Authors should make one base run with the old time series and 2015 data, plus a base run with the new time series and 2015 data. **One CPT member recommended looking at: (1) how removal of corner stations data affects estimates, especially around Pribilof Islands and Saint Matthew Island because of the perceived importance of these stations to crab biomass estimates; and (2) how to consider 15-min vs. 30-min tows.** Bob noted that when groundfish scientists examine the impact of corner stations on biomass estimates for groundfish stocks a combined discussion will take place.

The format in which assessment authors receive crab survey biomass data by maturity stage was discussed. Most biomass data are currently based on the ADF&G knife-edged (cut line) transition at size for both male and female maturity. However, maturity data are available for females based on clutch presence, and chela height data are also available for some male Chionoecetes crabs, but data are not available for all years and it is not feasible to measure chela heights for all crabs on a survey. The current approach is to provide data to assessment authors in 1-mm bins by sex, shell condition, and maturity status for females. Bob examined the effects of using the cut line approach vs. application of maturity data and found dramatic differences in mature female biomass for some stocks (e.g., 51% average difference for Tanner crab west). However, this change is not significant for most stocks because of how maturity data is currently treated in the assessments. **The CPT agreed the revised database would include crabs by maturity in 1-mm size increments, giving the assessment authors the ability to recalculate for a cut line maturity schedule.** For example, the Tanner crab assessment uses a maturity ogive for males.

Bob discussed alternatives to revise the length-weight regression in the time series: 1-factor regression using a single conversion for the entire time series; or 2-factor regression using one relationship to describe the historical data to 2009, and a second relationship for 2010 to present. Bob noted that a lack of data and small sample sizes, as well as uncertainty in the timing (e.g., season) of historical data collection, complicates replicating some historical regressions. However, there are also some fairly dramatic differences in regression parameters for some stocks, especially for mature females. For instance, survey biomass for mature females of Bristol Bay red king crab increased under a single regression for the data

through 2009; biomass estimates for 2010–present were already calculated using the 1-factor regression. In contrast, Tanner crab mature female biomass decreased under a single regression.

Bob commented that the estimated weight-at-size seemed a little small under the new relationship, but other CPT members thought the new regression results seemed more realistic. **The CPT agreed that the 1-factor regression is the best approach.** The regression parameters will continue to be evaluated annually for differences potentially driven by factors such as warm-cold year changes; Bob noted he annually compares total tow weight to extrapolated basket weight to see if results are consistent. Industry representatives concurred that only a single relationship should be applied across the time series.

4. Model Updates

4.1 St. Matthew Blue King Crab

Jie Zheng presented an update for the St. Matthew blue king crab (SMBKC) assessment. Due to personnel changes, Jie only recently assumed responsibility for this assessment on an interim basis. The presentation addressed CPT and SSC comments from previous meetings and presented eight model scenarios for the CPT to consider in the Fall 2015 assessment. Six of these scenarios were based on the current NMFS trawl survey time series and two were based on the newly-revised time series. Patterns of crab distribution centers and temperature indices from the NMFS survey data were also examined. Doug Pengilly made a presentation to the CPT regarding analyses he has conducted examining crab spatial patterns from NMFS trawl surveys and ADF&G pot surveys and their associations with bottom temperatures.

Following the Fall 2014 meetings, the CPT and SSC requested further investigation of the use of time-varying selectivity in the assessment, better molting probability information for the two smaller stages (of three) used in the model, and that the author explore the inclusion of potential environmental variables such as nearshore temperature data as an explanation for temporally patterned residuals in the survey composition data. In response to the last request, patterns of crab distribution centers and temperature indices based on the NMFS summer bottom trawl surveys were examined. Jie found a weak association between crab distribution centers and bottom temperature averaged across either 8, 11, or 14 stations, with the centers shifting to the northeast in warmer years and to the southwest in colder years.

Jie addressed issues in the assessment model concerning temporally-patterned size composition residuals, time-varying selectivity and molting probabilities using six model scenarios starting with the 2014 assessment model (formerly Model T) as Model 0. Model 1 was similar to Model 0, but used a different algorithm to set input sample sizes and the robust normal (rather than the multinomial) likelihood for size compositions. Model 2 was similar to Model 0, as well, but used a random-walk model to estimate time-varying molting probabilities. Model 3 was similar to Model 2, but incorporated temperature-dependent survey catchability. Model 4 was similar to Model 2 but fixed molting probabilities during 1978-2000 based on Otto and Cummiskey (1990) and estimated trawl survey selectivities separately in two time blocks. Model 5 was similar to Model 4, except that temperature-dependent catchabilities were estimated.

Model-estimated quantities tended to fall into two groupings: 1) Models 0 and 1, and 2) Models 2-5. Including bottom temperature as a covariate for catchability did not improve model fits (Models 3, and 5). Strong patterns in size composition residuals were evident in Models 0 and 1, but were not present in Models 4 (and 2). Considering model parsimony as well, Jie preferred Model 4 as one to move forward for use in the fall.

The CPT expressed some concern with fixing the probabilities of maturing outside the model in the early time period in Model 4, as well as the magnitude of the changes between the two time periods in Models 4 and 2, even though this appeared to solve the size composition residuals problem. A member of the CPT thought that temporal changes in selectivity were a more plausible explanation for the residual patterns than temporal changes in maturity schedules. During his presentation, Doug noted that station R-24 from the trawl survey contributes to the residuals problem, as well, because abundance at this station is highly variable and has a large effect on the overall survey size compositions and the survey abundance/biomass estimates. Concern was also expressed over the potential for bias arising from the use penalties for fishery F's in the final stage of the model fitting process.

The potential impacts of the newly-revised NMFS trawl survey time series on assessment were explored in two model scenarios, 0n and 4n, which repeated the model configurations used in Models 0 and 4, but ran them with the new time series data. The new time series data had almost no impact on model results. Estimates of total male trawl survey biomasses, pot survey CPUEs, recruitments and mature male biomasses on Feb. 15 were almost identical between scenarios 0 and 0n and between scenarios 4 and 4n.

Doug addressed potential changes in trawl survey catchability due to the availability of stage 2 and 3 males to the trawl survey. He considered bottom temperature as an indicator for potential changes in availability and found that annual MMB (adjusted for harvest) was somewhat related to bottom temperature. Much of the preferred area (as indicated by the pot survey) is not in the trawl area. Warmer years may result in SMBKC spreading out more into trawl area.

During colder years, larger males tend to be closer to the south side of the island. Additionally, the top four trawl survey stations contribute to >50% of the resulting survey abundance. Data from the triennial 1996-2013 pot surveys suggest that mature males (stage 2 and stage 3 together) may not be fully available to the trawl survey, and that availability is not constant across years and may be negatively associated with bottom temperature. The pot survey data also suggest that stage 2 males may have higher availability to the trawl survey than stage 3 males.

Additionally, the strong influence of survey catches at trawl survey station R-24 on the mature male population estimates and size composition estimates during ~1996-1998, 2010-2012, and 2014 were reviewed. Doug felt that R-24 should not be pooled with the remaining stations in the "single-tow" trawl survey stratum. He recommended separating out trawl survey station R-24 data and either: (1) treating it as a separate survey (weighted to the area it represents); or (2) excluding it from the assessment. A member of the CPT speculated on the importance of biennial spawning affecting the availability of crab to the survey. **Following an extended discussion of how to treat R-24, the CPT recommended an analysis for May 2016 with R24 excluded.**

For Fall 2015, the CPT recommended modeling scenarios:

- Drop all current models from further consideration
- Develop new model scenarios incorporating the following elements:
    - data weighting
    - additional variance
    - revised survey time series
    - selectivity (various time-blocks)
    - molting probability (various time-blocks)

The above elements should be added singly to model scenarios building from the base (2014 assessment model) to more easily discern the effects of the individual changes. In addition, the author should try to achieve parsimony in the final models.

4.2 Bristol Bay Red King Crab

Jie Zheng presented four model scenarios for Bristol Bay red king crab.

- Scenarios 1 is the September 2014 model.
- Scenario 1n differs with scenario 1 by using the new time series of NMFS trawl survey area-swept estimates (September 2014 time series).
- Scenario 2 is the same as scenario 1 except:
    1) Growth of immature and mature females is modeled with two discontinuous functions.
    2) Immature female growth data from Kodiak red king crab are used to estimate initial parameter values of the immature female growth function.
    3) Initial parameter values for three growth increments-per-molt functions are estimated using the growth increments per molt data: immature females, mature females, and males.
    4) The initial parameter values for growth increments per molt from data are used as priors.
    5) A random walk approach is used to model the annual changes of sizes at the 50% maturity for females.
    6) A two-parameter logistic function is used to separate the immature and mature female length compositions for the initial year (1975) to reduce the number of parameter estimates.
    7) Extra mortality for females is not estimated during 1976-79 and 1985-1993.

- Scenario 2n is the same as Scenario 2 with the new survey data added.

Scenario 2 fits two separate linear curves for female growth. The immature female growth curve parameters are estimated in the model with priors estimated from Kodiak growth data as there are only five data points on growth of immature females from Bristol Bay. Other growth curve parameters are estimated with priors from Bristol Bay data. The CPT questioned whether Kodiak data were appropriate for Bristol Bay. Scenario 1 uses a continuous curve for female growth with priors estimated from uncertain estimates of growth for immature females from modal analysis of female length frequency Bristol Bay data. Kodiak growth may be different than Bristol Bay growth. Growth of immature female red king crab is needed from Bristol Bay.
The CPT is concerned about estimating growth in the model with so few data points from Bristol Bay.

Two discontinuous curves are used for growth because size at maturity changes in the model over time. The growth curve that is applied to a size bin will change as the size at maturity changes.

Scenario 2 and 2n estimate the size a t 50% maturity as a random walk. However, the model does not fit immature and mature females separately in the model. The random walk in Scenario 2 estimates many more parameters which may result in the model being overparameterized. **The CPT recommended that the author document the model better for scenario 2 if it is presented in future assessments.**

In scenario 1 female maturity in the BBRKC model is defined by a knife edge cutoff at 90 mm. The use of survey data with egg codes to determine maturity may be better than knife edge at 90 mm.

Scenario 1 changes the shift in growth from immature to mature in three time periods from about 85 mm in 1975-82, to 90 mm in 1983-93, to 93mm in 1994 to present.

The CPT recommends a model run that inputs female maturity data based on egg codes from the survey, and then fits immature and mature females in the model.

The new survey time series resulted in higher estimates of biomass for 2003 and 2004 and lower estimates for 1979, other years were very similar. However, the biomass estimates from scenarios 1, 1n, 2, and 2n are very similar. The male length composition residual plots for scenarios 1, 2, 1n, and 2n show similar residual patterns. Female length composition residual patterns are similar with little differences among scenarios 1 and 2, 1n, and 2n.

The 1984 survey length data are very different with high abundance of small crab that the model doesn't fit. The author explained that the 1984 survey had one huge tow of small crab.

The CPT discussed the lack of fit to the recent survey biomass estimates. The model estimates are above total survey biomass in 2010 to 2013, then below in 2014. Total survey biomass increased from 2013 to 2014. Female biomass increased more than male biomass, however, both increased. The model does not fit the increase in biomass from 2013 to 2014 due to the lack of any evidence of recruitment in the survey length frequency data. Female survey length frequency data in 2014 have a mode of smaller mature female crab that don't appear in previous years and the model is not able to fit.

All survey biomass estimates for crab were higher in 2014 and most of the groundfish biomass estimates were higher as well. This may indicate a temperature relationship with survey q**. The CPT recommends that the effect of temperature on catchability be investigated for BBRKC.** The 2014 industry survey for BBRKC estimated higher survey q for the NMFS survey than in 2013. In cold years crab may not be as active and may have lower catchability than in warm years.

Model recommendations for September:

1) Use new survey data for all runs.
2) Do runs with stepwise changes from scenario 1 to 2, with one change for each scenario.
3) Run a scenario with a temperature relationship to survey q. Use a method that allows variability in the index such as the "data method" described in Schirippa et al (2009).
4) Use egg code data in the survey to separate immature and mature females and input as data to the model as an alternative for tracking changes in maturity over time. Fit immature and mature females separately in the model.
5) Label x axis on length composition plots with actual length in millimeters.

4.3 Snow Crab

Jack Turnock presented three scenarios on the snow crab stock assessment model and compared results to the 2014 assessment. The three scenarios address (a) variation in linear growth increment model fitting, (b) effect of the removal of the directed fishery F penalty, and (c) measures to overcome the problem of the 2014 assessment model not fitting the terminal year high survey biomass. Model 1 removed a constraint on the probability of maturing likelihood (affects growth estimation), increased the weight on the growth (two linear segments by sex with a smooth transition between the two lines) likelihood, and removed the F penalties. Model 2 modifies Model 1 with a separate fishery selectivity estimated for 2013/14 to address the differences in ending biomasses in 2013 and 2014 assessments. Model 3 modified Model 2 with the standard deviation of growth function fixed at 0.01. Survey catchability during 1978-1982 and the 2010 industry survey hit the upper bound of 1.0 in the 2014 assessment. Therefore, the author transformed the survey catchability to a probit scale in all analyses. He used the effort data with the mean catchability estimate for 1992/93-2013/14 to constrain F during initial years, 1978/79 to 1991/92, to avoid getting very high F values because of the removal of F penalty. In addition, the Francis effective sample size was calculated and a model run with increased weight of likelihood on last four trawl fishery catches due to some years catches estimated at 0.

The overlap between the lower and upper growth segments was dependent on the standard deviation of the cumulative normal distribution in the growth function. The growth curves for Models 1 and 2 coincided for both sexes. With a very small standard deviation, the growth function was essentially a hockey stick type curve. A large standard deviation tended to lead to one smooth curve. However, it did not fit the data as well as a small standard deviation and was not monotonic.

Jack concluded that the difference in ending biomass between the 2013 and 2014 assessments was due to the increase in discards of males in the 2013/14 fishery relative to past years. Observed discards during the last few years has systematically increased and the fit to discard catches was good. The increase in discards in 2014 changed recruitment estimates that resulted in the improved fit to ending biomass values. The addition of a separate fishery selectivity for the 2013/14 fishery removed this influence and resulted in fits to ending biomass (with model 2) similar to the 2013 assessment.

The CPT was concerned about the way effort data were used to determine the fishing mortality rates for the earlier years and also the use of a separate selectivity curve for 2013/14 to fix the problem of under fitting of final year survey biomass. **For the September 2015 stock assessment, the CPT had the following recommendations:**

- Run the 2014 assessment model (Model 0) fixing the standard deviation of the cumulative normal distribution of the growth function to a small value for both male and female growth functions.
- Keep the F penalties for pre 1992/93 as in Model 0 and remove them for post 1991/92. Do separate scenarios changing the F penalties for males and then adding the change in F penalties for female discards. (The CPT was concerned about the way pre 1992/93 effort data and post 1992/93 catchability estimate were used to regularize pre 1992/93 F to overcome the effect of F penalty removal.).
- Do not consider a separate selectivity curve for 2013/14 to correct under fitting of the final year (2014) survey biomass.
- Run model scenarios from Model 0 (2014 assessment) to Model 1 with one change per scenario so that the effect of each change can be evaluated.
- It is not necessary to run a model with the Francis method of effective sample size calculation. It can wait till the data weighting workshop findings are available.

The discussion regarding the generalized increase in survey biomass estimates for crab and groundfish in 2014 recurred in relation to this stock.

4.4 Tanner Crab

William (Buck) Stockhausen outlined the proposed modifications to the data inputs for the assessment of eastern Bering Sea Tanner crab. Updating the 2013/14 retained size-frequencies had little impact on the results from the assessment, including, somewhat surprisingly, the selectivity pattern for the 2013/14 fishery. The new trawl survey series does not include data for 1974. However, dropping the trawl survey data for 1974 only had a minor impact on model outputs. **The CPT agrees that the September 2015 assessment should use the updated retained size-frequencies and be based on an assessment that ignores the survey data from 1974.** No results were available based on the new trawl survey data. The assessment author should report results in September 2015 using the new and original trawl survey data to allow the impact of updating these data to be quantified.

Buck explored the sensitivity of key model outputs to the assumed value for handling mortality in the pot fishery. Increasing handling mortality led to higher recruitment and lower survey Q, particularly for the most recent years. Future exploration of this issue should consider the impact of handling mortality on the

estimate of natural mortality and how the model behaves if Q for the most recent years is assumed known rather than being estimated.

Buck introduced a new implementation of the assessment for Eastern Bering Sea Tanner crab (TCSAM2015). This new implementation differs from the existing model by using the GMACS catch equation and because it is more general; for example the number of fisheries is not hard-wired into the code and is possible to allow almost all parameters to change over time, as a function of sex, etc. The CPT would like to see the results of analyses based on this model at its September 2015 meeting. However, this model will not form the basis for management advice until it has been approved by the CPT and SSC.

The CPT noted the importance of coordinating this work with the developers of GMACS given these assessment methods are similar in many ways. The CPT notes that a spatially-structured model would be ideal for eastern Bering Sea Tanner crab but that the available data may be insufficient to support such a model.

Buck has evaluated TCSAM2015 using data simulated from an alternative version of the model coded in R. This evaluation highlighted some errors in earlier versions of the ADMB code, providing increased confidence that the model is correctly coded. The CPT agreed that simulations such as those conducted for TCSAM2015 are the ideal way to understand the behaviour of assessment methods and looks forward to the results of additional simulation analyses, in particular simulations that explore the implications of noisy data and model mis-specification. The CPT regards the ability to simulation test assessment methods as an important step forward for crab assessments in the North Pacific.

The CPT reiterates its suggestions from the September 2014 meeting, in particular that the sensitivity of the results to the prior on Q should be explored. It was noted that data available from BSFRF surveys may inform estimation of Q using the approach developed for the snow crab assessment. This approach should be evaluated for Tanner crab.

The CPT recommends that model results for the following four model configurations be provided to the September 2015 meeting:

- The 2014 model with 2015 data added (to understand the consequences of adding additional data) (Model 1).
- Model 1, with the revised trawl survey time series.
- Model 2, with survey selectivity constrained to equal 1 for at least one size-class.
- Model 3, with a lognormal likelihood for the fishery catch data (to ensure that the model adequately fits the low catches in several years).

The CPT noted that the Alaska Board of Fisheries has adjusted the State harvest strategy to reflect a reduction in the preferred retention size in the fishery east of 166^0 W from 5.5” to 5.0”. That has implications for how the OFL is calculated for eastern Bering Sea Tanner crab. **The CPT recommends that the change be addressed for OFL calculation by setting the retention curves for areas east and west of 166^0 W with the approach currently used to compute selectivity for the area west of 166^0 W.**

4.5 Pribilof Islands red king crab

Cody Szuwalski presented updated work on an integrated assessment model for Pribilof Islands red king crab. Although the CPT recommended use of the integrated assessment model over the *status quo* 3-year running average approach for setting the 2014/15 specifications in September 2014, the SSC recommended the 3-year running average approach and Tier 4 management for 2014/15. The SSC was

concerned that the integrated model produced a poor fit of mature male abundances to survey data from 1990 onward and produced trends of mature male abundances that contradicted the 3-year running average in recent years. Cody investigated the factors influencing the poor fit of the integrated model to the survey data. Because the September 2014 assessment using 5- and 10-mm carapace length (CL) bins produced notably different estimates of mature male biomass, the CPT had also requested an evaluation of how different bin widths affected assessment model results.

Cody presented model results from three data sources: 1975−2014 trawl surveys; 1993−2013 retained catch; and 1991−2013 trawl bycatch. The model uses 5-mm bins CL with midpoints at 37.5−207.5 mm CL. The model year starts at the survey time, is subject to M (assumed = $0.18yr^{-1}$) until pulse fisheries occur, is then subject to M until molting and mating on February 15, and then subject to M until the next survey. Directed fishery selectivity follows a logistic function, although the parameter results make selectivity essentially knife-edged at the legal size of 138 mm. Total selectivity for the directed fishery is not estimated because observer data are sparse. Non-pelagic trawl selectivity is modeled as logistic, with parameters adopted from the Bristol Bay red king crab model. Growth increments and molting probability at size parameters (fit as a reverse logistic) are based on studies of Kodiak red king crab. Cody noted that survey biomass estimates generally tracked well between the new and old survey data, although specific years showed some differences, particularly with increased female estimates in some years. A Tier 3 harvest control rule using estimates of MMB from the integrated assessment greatly increased estimated OFL relative to a Tier 4 assessment. Discussion noted that the high F_{MSY} ($0.51yr^{-1}$) for the Tier 3 assessment may be due to a lack of directed fishery bycatch mortality in the model.

The influence of bin width for CL data was explored by simulating a population with size frequencies grouped into 2.5-mm bin widths and then analyzing the model results after binning data into 2.5-mm, 5.0-mm, and 10.0-mm bins. The 2.5-mm and 5.0-mm binned data returned unbiased estimates of the simulated population, whereas the 10-mm binned data produced estimates biased high. Results suggested that growth (and to some extent fishing mortality) was poorly estimated and negatively biased with 10-mm groupings, which had been part of the September 2014 assessment. The conclusion was that the bias was associated with growth estimation and that 5-mm bins are more appropriate.

Much of the presentation focused on the integrated model's poor fit to the survey data for the two periods identified by the SSC. Cody found that a model with only males since 1990 increased the MMB estimates compared to a both-sex model. In particular, the males-only model allowed for increasing MMB in recent years (perhaps by decoupling the opposing trends for males and females in recent survey data). Nonetheless, MMB estimates from the males-only model remained below the survey estimates since 1990. Difficulty in fitting survey data may result from trying to fit three recruitment pulses, of which the two largest and earlier pulses disappeared from subsequent surveys in the absence of fishing mortality and at a rate inconsistent with the assumed M = 0.18. However, poor fishery performance, indicated by catch and CPUE data, suggests high survey estimates in the 1990s may have been overly optimistic; i.e., lower estimates produced by the model may be more appropriate for those years. **The CPT suggested looking at time blocking of M, perhaps through temperature regimes. The CPT further suggested the author explore an increased fit to higher survey abundance years rather than a tighter fit to the more recent, low abundance years; this might be accomplished by reducing the survey CVs on the early portion of the time series, or simply reducing survey CVs throughout the time series. Finally, the CPT suggested investigating whether time-varying selectivity might resolve some issues.**

The CPT recommended that the *status quo* 3-year running average Tier 4 assessment and the integrated model Tier 4 assessment be provided for review at the September 2015 CPT meeting. For the integrated model, the CPT suggests the author explore use of total fishery selectivity parameters from Bristol Bay red king crab. The CPT also recommended exploring mean unbiased log-normal likelihoods for survey biomass. Additionally, the CPT requested that the following

analyses be presented for September 2015: (1) results for a model forced to fit the high survey estimates of the 1990s (e.g., perhaps by reducing survey CVs); (2) similar results for males-only data; and (3) results for a model in which survey *q* for males is fixed at *q*=1.0 and *q* for females is estimated annually. The CPT also requested that the author explore the utility of historical pot survey data in the integrated model.

Cody concluded his presentation with his work on applying GMACS to the assessment data. He noted that the catch fits from GMACS seem reasonable, but the length composition fits are not so good. He is still working on the model documentation and exploring sensitivities for molting probability, catchability, and natural mortality.

5. GMACS

5.1 Model Development Update

Steve Martell provided an update on GMACS, a generalized size-structured assessment model for Alaska crab stocks. The assessment model is written in C++, uses ADMB libraries, and involves: inputs (data files of catch, CPUE, composition, etc.); a control file that provides model specification; and outputs that summarize parameter estimates and uncertainties. The main routines focus on steps of: initial setup, fishing dynamics, population dynamics, prediction observations, and objective functions.

Steve described the structure currently used for input data file specification, including dimensions, start and end years, time steps, distinct data groups, sexes, shell conditions, maturity types, and size classes. Being a work in progress, input options are still limited in some cases. For example, size classes must be binned outside of GMACS and code has yet to be written for the CPT request of an option to input data in 1-mm increments with bin compilation within the model structure. Input structure was described for: length schedules (weight-at-length by sex with proportion mature biomass); catch (retained, discarded, or total by fleet, sex, with a CV, multiplier, effort, and discard mortality); relative abundance by abundance or biomass; size composition by sex, type (retained, discarded, or total), maturity (mature, immature, or all), shell condition (new, old, or all); and molt increment (growth) specified as the increment and CV by sex for each size bin midpoint. Discard mortality may be year-specific (e.g., for temperature effects). In response to CPT questions, Steve noted that a molt probability function and tag data components had not been coded yet.

Steve then described the Control File which specifies leading parameters, for example recruitment, with initial values, bounds, phases, prior means and standard deviations. There is also an option for selectivity controls for each gear, including setting selectivity for specific blocks of years and whether the selectivity applies to retained or discarded crab. A model controls section allows the user to define the application of aspects such as leading parameters; growth, selectivity, catchability, *F*, and time varying *M* (blocks, random walk, splines, etc.), all with varying extents of controlling initial values, bounds, priors, and penalized likelihoods. Finally, there is a developing section of "other controls" that allows identification of aspects such as: verbose flags (for debugging); model initialization for unfished recruits; first and last years to define average recruitment; the target *SPR* to be used for $B_{MSY\ proxy}$; the gear index to be used to define *SPR*; the proportion of *MMB* to be used for *SPR* reference points; and the *SR* relationship (currently none or Beverton-Holt with Ricker yet to be coded). Regarding some of these options, it was suggested to include the option to provide output at a Function Call to aid debugging; and to use indicators such as -1, instead of years for identifying years for determining recruitment. Some of the command line options included the use of simulated data for self-testing of routines and the ability to request a retrospective analysis for a specified number of terminal years.

Steve then briefly discussed the github website and gmr, an R package to display GMACS outputs such as plots of MMB, size comps, etc. In response to a CPT query on the steps needed to move forward, he noted GMACS is getting closer but isn't ready for stock assessments. In particular, extensive simulation testing is needed, and more options need to added to give GMACS greater applicability. There will ultimately need to be a strong maintenance effort. The CPT felt this is a research priority. Stevel, Darcy Webber, and Jim Ianelli will likely use Bristol Bay red king crab as example GMACS application for the CIE review. One major problem is the N-matrix; a change to the number of arrays creates problems when scaling from existing matrices. **The CPT would like to have a progress report on the GMACS project in September to help guide the modeling workshop.** Scott Goodman affirmed continued support by the BSFRF for this ongoing effort.

~~5.2 Application to BBRKC~~

5.3 CIE Review Update

The Center for Independent Experts (CIE) review on GMACs is scheduled for June. Significant concern was expressed by the CPT that GMACs may not have had appropriate time and resources to be developed enough for such a review. A BSFRF representative concurred that while they are supportive of efforts made, they would not be supportive of a review process if it is conducted prematurely. However, it is uncertain whether it is too late to withdraw from the review process at this time. The CPT anticipates receiving a report on CIE review at the September CPT meeting.

6. AIGKC Aleutian King Crab Research Foundation Research Update

John Hilsinger presented a research update for the Aleutian King Crab Research Foundation. This Foundation was formed in 2012 as a 501(c)(6) nonprofit and is supported by IFQ shareholders of the AIGKC fishery and the Adak Community Development Corporation (ACDC). The Foundation promotes cooperative research among the industry, ADF&G, and NOAA to improve stock assessment of Aleutian Islands golden and red king crabs and provide other stock-specific life history information.

Collaborative research efforts conducted and planned include:

- Laboratory studies on golden king crab in Kodiak in cooperation with NOAA have provided data on response to ocean acidification, survival after injury, growth, and retention of tags through molting.
- Bottom temperature data have been collected using data loggers in commercial pots during the AIGKC fishery. Plans involve NOAA analyzing this data to evaluate its usefulness for continued efforts.
- A study was performed in cooperation with ADF&G to estimate commercial fishing gear selectivity by collecting data from paired pots (pots with small mesh and no escape mechanisms paired with adjacent commercially fished pots) deployed during the EAIGKC fishery. The gear selectivity estimated by this study was very similar to the fishery selectivity estimated in the AIGKC model and results showed that gear was highly successful in allowing the escape of females and sublegal males (Vanek et al., 2013, ADF&G report). "Reconnaissance" surveys are planned for WAIRKC in cooperation with ADF&G and ACDC, with the first survey planned in September 2015. The last survey in this area was conducted in 2002 at Adak, Atka, and Amlia Islands with 1000 pots deployed and a total RKC catch of 3 legal male and 1 sublegal male, all near Adak (specifically in the Yoke Bay area). There is intent to expand this study to Petrel Bank in 2016, an area which has not been surveyed since 2009. The purpose of these "reconnaissance" surveys is to evaluate whether crab abundance is sufficient to design a stock assessment survey.

The foundation will obtain the vessel, skipper, and gear, plan the survey, and oversee the budget (obtained through cost recovery on AIGKC). ADF&G will lead data collection and analysis. The survey in September 2015 is planned with 1 vessel for 13 days to set 1000 pots and collect data including the number of RKC caught by sex and size group (legal, pre-recruit size class, etc). Spatial coverage and the presence or absence of RKC was prioritized above gathering detailed biological data. The surveyed area will extend from the shoreline to the 125 fathoms depth contour (so both state and federal waters will be covered). The foundation will be able to provide an update on the Adak area "reconnaissance" survey at the September 2015 CPT meeting, and results will be available by the May 2016 CPT meeting.

- ADF&G historically surveyed AIGKC on a triennial basis. However, since 2006, efforts to contract a vessel to perform this survey have not succeeded. The Foundation began discussions with ADF&G in 2013 for an alternative to fishery-independent triennial survey. A sampler was deployed on a vessel to collect biological data during the WAIGKC fishery in spring 2014 and another sampler was deployed on a vessel during the EAIGKC fishery in fall 2014. The Foundation is continuing to work in cooperation with ADF&G to meet data needs for this now unsurveyed stock and has secured commitments from the fleet to participate, carry a data sampler, and cover GKC habitat beyond normal fishing grounds. There are plans for three vessels to participate in a pilot survey using this alternative survey strategy for EAIGKC in fall 2015 and for one vessel to participate in a pilot survey for WAIGKC in fall/winter 2015.

The Foundation welcomed input from the CPT regarding data collection during the "reconnaissance" surveys for red king crab and sought guidance on whether the study to estimate commercial fishing gear selectivity for EAGKC should be performed for WAGKC.

The CPT recommended collecting as much biological data as possible on red king crab captured during the "reconnaissance" surveys, including genetic sampling using non-lethal methods such as blood draws. The CPT did not see high a priority to incorporating the fishing gear selectivity estimates obtained for EAIGKC into the stock assessment model, particularly because fishery selectivity as estimated in the model was so similar to the fishing gear selectivity estimated from the study. Other factors (unrelated to gear) could potentially affect the fishery selectivity estimated by the model. The discussion on whether to conduct a fishing gear selectivity experiment for WAIGKC was generally supported, with alternatives ranging from a study of similar scale as performed on EAIGKC to adding some mix of small mesh pots into the pilot survey for WAIGKC. Future exploration of how to incorporate fishing gear selectivity experiments into the EAIGKC assessment model may provide better input on this topic. **It was recommended that incorporating some small mesh gear in the pilot surveys for AIGKC would be valuable to provide data on smaller crab and potentially track recruitment for both the EAIGKC and WAIGKC stocks.**

7. BBRKC Selectivity Bering Sea Research Foundation Research Update

Scott Goodman presented an update on ongoing cooperative research projects for the Bering Sea Fisheries Research Foundation (BSFRF), focusing on recent developments in the Bristol Bay red king crab selectivity survey and pre-recruit results (3rd year results), Tanner crab selectivity study, and Tanner crab growth study.

Tanner Crab Growth Research
The collaborative (BSFRF, NOAA, and ADF&G) Tanner crab growth study collected data on 30 crabs in 2012. To collect additional data for this species, BSFRF chartered the F/V Sunset Bay for a 10 day charter, April 9-15, 2015, conducting collection of live Tanner crab males and females with a Nephrops trawl net. From 34 tows, 584 crabs were retained for transport to Dutch Harbor for holding during

molting. The sample was divided into two groups: one group was placed in onshore tanks at Westward Seafoods in Unalaska, and one group was placed in lantern nets suspended from the dock in Carl Moses Harbor. Survival to date is about 350 crab, with approx. 200 expected to molt, and 150-180 others in stand-by condition; sample is approx. 50/50 female to male. About 25 growth measurements have been taken to date, using 20 mm length bins spanning 20-140 mm (approx. size at last terminal molt); of the 30 crabs that have molted to date, most are in the 80 mm bin, and none in the largest (120-140 mm) bin.

Bristol Bay Red King Crab Trawl Net Selectivity Survey
The study began in 2013, initially expected to be 2-year study, but continuing into a 3rd year for 2015. The objective of the study is to compare CPUE results for BBRKC for Nephrops and NMFS 83-112 trawl nets towed side-by-side. The field area is comprised of the 60 easternmost of 136 stations of the NMFS trawl survey area and is conducted with two vessels for each net type, each surveying 30 stations. Results for 2013 indicated a CPUE ratio (83-112/Nephrops) averaged over 60 stations ranging from 0.28 to 0.86 across size and sex classes; 2014 results were closer, ranging from 0.48 to 1.04, mainly resulting from increased efficiency of the NMFS trawl in 2014. The average selectivity ratio for large males in 2013 was 0.66 and 0.86 in 2014, and 0.95 and 1.04 for mature females, respectively. The temperature difference between 2013 to 2014 was marked, with temperatures much lower generally in 2013, and the cold pool extending into Bristol Bay. The mean temperatures (C) across the 60 stations were 2.84 and 4.92, in 2013 and 2014, respectively. Regression results indicated a weak positive effect of higher temperature on the relative selectivity of the NMFS trawl, but the data were highly variable (e.g., R^2=0.0723 and 0.1385 shown for alternate model specifications). Contrary to expectations, several data points were above 1.0, indicating higher efficiency of the NMFS trawl in those instances. Scott described a working hypothesis for the mechanism of temperature effect on selectivity as the relative increase in activity of crab with higher temperature causing them to be elevated higher off the seabed where they are more likely to be caught in the NMFS net, which doesn't tend the bottom as the Nephrops.

A figure was presented displaying the spatial variation of temperature by station for 2013 and 2014, overlaid with circle plots comparing standardized CPUE for the two surveys. The figure indicated greater spatial distribution of crab with the colder conditions of 2013, but greater concentration and abundance of catch in the core area of the BBRKC range in 2014. This suggests an additional potential hypothesis of spatial effects in addition to temperature for the causal mechanism producing the net selectivity results.

One of the two chartered vessels for each survey changed between 2013 and 2014, and in the two years of data, there is some indication of a vessel effect in the comparative CPUE results. To isolate this effect, and to address other issues in the two years of data, BSFRF is undertaking an additional survey for 2015, with the NMFS survey being conducted by the same vessels as chartered for 2014, and the BSFRF survey using the two vessels chartered in 2013. Video monitoring of nets will be deployed on 30 pairs of tows for 2015, featuring improved camera housing after equipment failure in 2014. The CPT asked several questions about potential explanations for the vessel effect, and Scott described additional planned analyses and modifications to the survey for 2015 intended to improve controls, including increased use of bottom sensors on footropes and better regulation and monitoring of tow speed on the Nephrops survey. One aspect of the 2015 study will include speed profiling to look at the effect of different tow speeds on catch.

BBRKC pre-recruit survey
The pre-recruit survey follows on the net selectivity project, and is also in its third year for 2015. The research is intended to collect BBRKC pre-recruit information with improved accuracy and precision to detect size-sex modes with higher sampling density and more efficient gear across areas of expected pre-recruit BBRKC. Scott presented time series plots of the length frequencies of male and female RKC from the NMFS survey, noting a spike in 2011 results centered on 45 mm, and showing the expected modes that would be observed in subsequent years of the NMFS and BSFRF surveys as the cohort ages; 2013

and 2014 results from both surveys were shown, with 2013 not showing the expected signal from the 2011 spike, but 2014 showing a possible but weak signal. Scott noted that more detailed spatial modeling results will be undertaken, and should provide more accurate results. The CPT discussed how the recruitment results could be incorporated into the BBRKC assessment, but did not draw any conclusions, and discussed the potential issues with unobserved vessel effect in survey design that may confound survey results. Scott noted that the intent in undertaking a third year of BBRKC surveys is to better control for sources of variability in prior year results, and he hopes to work with the CPT to resolve how the results should be incorporated into the assessment in the future.

2013/14 Tanner selectivity survey
Scott presented comparative CPUE results by length class for male and female Tanner crab, based on data collected during the side-by-side BBRKC surveys. Results for males and females in 2013 show a general positive effect of relative selectivity of the NMFS net with increasing length, but relatively high variability over length class; all 2013 CPUE ratio values were < 1.0. The 2014 results show a weaker association, with lower CPUE values for the Nephrops trawl compared to 2013, and much lower abundances for females; ratio values from 2014 were generally higher, with several data points > 1.0. The CPT discussed the potential for using the selectivity results in the Tanner assessment, similar to the application in the snow crab assessment. Scott indicated that the principal limitation is the spatial extent of the data, which only covers the eastern 40% of the stock distribution. Noting the limited basis for the prior on catchability currently specified in the Tanner model, the CPT debated the merit of incorporating the BSFRF results to date into the assessment, despite questions about the representativeness of the data, which are collected outside of the core area for the Tanner stock. The snow crab assessment author noted that the Somerton analysis of the side-by-side snow crab survey found that depth and substrate were covariates with the relative efficiency of the NMFS trawl, which may provide some basis for assessing the utility of the Tanner survey results for the assessment, but the CPT did not draw any strong conclusion on recommendations for the assessment.

8. Research Priorities

Jim Armstrong, NPFMC staff, updated the CPT on the changes that have been made to the way that the Council and its advisory bodies consider and set research priorities. The Council has developed a database that is accessible online (https://research.psmfc.org/), which includes research priorities, detailed information on what is needed, the status of the research, and prioritization by the SSC/Council and plan teams. The priority terminology was updated and now includes Critical Ongoing Monitoring, Urgent, Important (Near Term), and Strategic (Future Needs).

Jim described that the plan teams will make recommendations to the priorities and these will go to the SSC and also be carried over to the Council. He suggested that the CPT could designate a Research Priorities representative to log in to the database each meeting in which Research Priorities are addressed by the CPT. This person will make the changes in the database and they will be accepted and incorporated by the data manager.

The CPT discussed the new categories and at first struggled with how to apply them to the list of topics. It was noted that the new terminology does not transfer one-to-one from the previous ranking of Critical, High, Medium, Low and the new terms have more of a temporal meaning than previous terms. The CPT determined that “Critical Ongoing Monitoring” is for information that is needed on a regular basis (e.g., regular ongoing surveys). “Urgent” is for dire needs. Most research projects fall under the remaining two categories: “Important” if they are going to inform stock assessments in the next five years or “Strategic” if they will be used to inform management in greater than five years. The CPT based their decisions

between “Important” and “Strategic” on the determination of whether a priority is expected to significantly and realistically aid stock assessments within the next five years.

The CPT reviewed and edited the list of research priorities (see attached file with track changes). Topics mentioned during the meeting were addressed in this process. Additional details should be available in the minutes for each stock.

The CPT hopes that the Council process for research priorities will stabilize and there will be no need for additional categorization, as it takes a considerable amount of time to review the entire list each year. In the future, the CPT would like to list (e.g., in a separate column) specific stocks, that represent a near-term focus within a research priority.

9. Crab 10-yr Review

Sarah Marrinan and Karla Bush reported to the CPT on the 10-year review of the crab rationalization program. Sarah explained that the Council and the AP reviewed a work-plan in February 2015 and commented on the scope of the review, while the SSC reviewed a revised work-plan at a subsequent meeting and commented on methodology within that scope. She noted that the review is scheduled to be released in February of 2016.

Karla provided an update of what was planned for the biological management section of the review. This would include issues such as deadloss in the crab program fisheries, bycatch and discard issues such as high-grading, rail dumping, handling mortality, soak times, catch per unit effort, lost pots and ghost fishing. In addition it would address changes in season length and temporal and spatial distribution. The review will also address pot gear selectivity due to pot modifications, and potential impacts that this may have on the stock.

These areas have previously been addressed for pre- and post-rationalization (in the 5 year review); this would add five more years of information. Sarah noted that that SSC did not voice concerns or specific recommendations on the section on biological management. It was clarified that procedurally, any CPT recommendations for this section could be detailed in the CPT minutes, which would be available to inform the Council process in June 2015.

The CPT members had a number of questions and comments that could be leading in development of this section of the review. It was noted that it would be good to talk about the extent to which there has been changes in data quality; the CPT noted that better effort data is available since program inception. There was some discussion on the topics listed that may not continue to be a large concern in the crab fisheries, for example ghost fishing (all pots are required to have biodegradable escape mechanisms and lost pots have not increased) and onboard observer coverage (which has not had significant changes in the past five years).

The CPT also noted that one benefit of rationalization is the formation of industry-funded crab research foundations. Members were unsure of whether the biological management section would be the appropriate section to discuss this result. Collaborative efforts in research lead to better fishery information, better stock assessments, and ultimately improve management of the resource.

10. Finalize SAFE Intros

The CPT walked through and edited introductions for PIGKC, WAIRKC, and AIGKC.

11. New Business

The Board of Fish passed two proposals for the NSRKC fishery in March 2015: 1) to change the season dates of the winter fishery; 2) they set a GHL for the winter fishery of 8% due to increased effort for the winter fishery; previously the winter fishery was unconstrained and there was some risk of exceeding the ABC. Therefore the summer fishery will be set at 92% of the GHL. The GHL is set such that the ABC is not exceeded.

BSAI king and Tanner crab proposals are not in-cycle during the 2015/16 Board of Fisheries cycle; however, agenda change requests may be submitted before the deadline in August 2015.

The next CPT meeting is tentatively scheduled for September 14-17, 2015 and will be held in Seattle, WA at the NOAA Alaska Fisheries Science Center. It will be a very full agenda; thus the CPT should prepare for a potential fifth day, September 18, as well.

The Alaska Bering Sea Crabbers are planning a symposium in September and are considering several topics that may be of interest to the CPT. One potential topic would focus on biological impacts from the crab rationalization program. A second potential topic would be a discussion of the fundamentals of crab stock assessment and how this relates to what participants may see on the fishing grounds and the catch limits they may be subject to. For example, this discussion could cover how variables in the stock assessments are related and what industry/ the public can expect or not expect when there are changes in specific attributes. They would schedule this symposium either before or after the September CPT meeting.

A tentative schedule for the September CPT meeting includes:

- Final Assessments for:
    - EBS Snow Crab
    - BBRKC
    - EBS Tanner Crab
    - PIRKC
    - PIBKC
    - SMBKC
- NSRKC: Model update
- AIGKC: Discussion on model
- PIGKC: – Tier 4 approach review
- EFH: Final recommendations
- GMACs: Update on CIE review
- Economic SAFE: Update
- Ecosystem considerations
- EBS trawl survey results

It was noted that the CPT should consider scheduling an update on Ecosystem Considerations. The CPT would need to contact Stephani Zador to check on her availability and interest.

There was some discussion on location and timing for the next May meeting of 2016. Tentatively, the group decided the week of May 9 – 13 would be appropriate for 2016. Juneau or Anchorage were suggested for meeting locations.

CPT members were encouraged to consider topics for modeling workshops in the near future. Suggested topics include the CIE review and a Tanner crab comparison in GMACS.

12. References

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