Crab Plan Team Report
The North Pacific Fishery Management Council's Crab Plan Team (CPT) met September 14 – 17, 2015 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)
Doug Pengilly (ADF&G – Kodiak)
Laura Stichert (ADF&G – Kodiak)
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)
Bill Bechtol (Univ. of Alaska – Fairbanks)
Brian Garber-Yonts (NOAA Fisheries – AFSC Seattle)
Ginny Eckert (Univ. of Alaska – Fairbanks)
Andre Punt (Univ of Washington)

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 included: Linda Kozak, Ruth Christiansen, Edward Poulson, Jie Zheng, Mark Stichert, Hamachan Hamazaki, Jenefer Bell, Ben Daly, Caitlin Allen Akselrud, John Gauvin, Wes Jones, Scott Goodman, Chris Siddon, Jim Ianelli, Paul Starr, Stephani Zador, Gary Stauffer.

Survey Overview
Ben Daly (AFSC) presented results from the 2015 NMFS survey, and changes made to the long term survey data set, the latter of which were initially presented by Bob Foy at the May 2015 meeting. The survey area has changed over the time series, with the current area covered since 1987 by ~375 tows/year. The 2015 survey was conducted from June 2 to July 29. Several special projects were conducted for crabs during the survey: bitter crab sampling; collection of snow crab for evaluation of annual vs biennial reproductive cycle, temperature-dependent growth and habitat associations, and age determination samples; specimen collections for female reproductive potential studies on snow and Tanner crabs; continued; and tagging of red king crab females using 'pop-up' tags to locate spawning grounds.

Revisions to the historical annual abundance and biomass estimates in the time series included: using the shape of abdominal flap and presence of eggs to score maturity of female crab rather than size cut off points;; applying updated size-weight regression relationships throughout the time series for males, non-ovigerous females, and ovigerous females based on data obtained from 2006−2010; and standardizing tow density to one tow per station through exclusion of supplemental and "hot spot" tows. Additionally, station Z04 was excluded for crab analyses, thereby reducing the number of standard stations from 376 to 375. A full document summarizing the revisions made to the EBS trawl time series data is anticipated to be available later in fall 2015.

Overall, mature male biomass of crabs was lower in 2015 relative to 2014, and was similar to levels observed in 2013. As in 2014, water temperatures were among the warmest in the survey time series, and the cold pool was further north than usual, extending to between St. Matthew Island and the Pribilof

Islands. Recent years have seen large fluctuations in temperature, from among the coldest observations in the time series in 2012 and 2013 to among the warmest observations in 2014 and 2015.

Abundance estimates and spatial distributions by sex and size were discussed for each stock. Anomalies or notable comments are listed here for each stock. The Pribilof Island red king crab mature male and female biomass estimates increased, though estimates were associated with high variance. Mature male biomass for blue king crab decreased slightly in the St. Matthew Island Section and there was a lack of notable recruitment. As in several prior years for this stock, survey station R-24 drove the abundance estimate, accounting for 68% of mature males captured in 2015.

Abundance estimates for Tanner crab were lower in areas both east and west of 166° W long., though declines were stronger in the east. The distribution of Tanner crab in the east was proximate to the 166° W long. line, and densities deep within Bristol Bay were low. While there were large densities of Tanner crab in the west along the southern extent of the surveyed area, the report noted that few crab are caught beyond the extent of the survey area in deeper waters.

Snow crab male, female, and juvenile biomass decreased in 2015 compared to 2014. 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. Snow crabs were distributed further to the east than in recent years, with large densities of immature crab between the Pribilof Islands and St. Matthew Island and along the edge of the surveyed extent in the northeast. Additional stations in the northern extent have not been surveyed in recent years but are anticipated to be surveyed in 2016. However, it is known that the snow crab population is continuous to the north to St. Lawrence Island and that pulses of small crab (including mature females) periodically enter into the surveyed area. 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 decreased growth and smaller size at maturity with increased latitude.

A decreasing trend in biomass for hair crab has occurred over the last three years, except in the northern area (to the west and southwest of Nunivak Island) where the biomass trend is flat.. Hybrid *Chionoecetes* crab abundance decreased relative to 2014 and constituted 8% and 2% of the legal male snow and mature female snow crab biomass, respectively. Red king crab outside of defined management areas constituted 4% and 1% of the Bristol Bay red king crab male and female biomass, respectively.

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 97% of the snow crab were measured. A timeline of the fishery evaluation and management process for federally managed crab stocks in Alaska in 2015 was provided for context as follows: survey data arrived in Kodiak August 4, final area-swept abundance and biomass estimates were provided to assessment authors and ADF&G on August 14, the draft survey technical memo was available to the public on September 1, CPT meets September 14–17, SSC meets October 6, TAC setting October 6–10, and the fisheries begin October 15.

Ecosystem Considerations

Stephani Zador (AFSC) presented an overview of the 2014 Ecosystem Assessment and an update on ecosystem outlook for 2015. An important component of the presentation was an overview of indices contained in the Ecosystem Considerations Report (http://access.afsc.noaa.gov/reem/ecoweb/Index.php). Some of the environmental indices are the Aleutian low, sea level pressure, jellyfish density and distribution, sea surface temperature, and the cold pool. The comprehensive ecosystem report is given annually to the SSC and Council in December, which is after crab assessments are reviewed by the SSC and adopted during the October Council meeting. Development of an ecosystem chapter for the crab SAFE document was attempted in 2010 and 2011, but was discontinued due to staffing constraints. The

CPT discussed a process for incorporating crab-specific ecosystem information into the ecosystem report and crab stock assessments, and the development of indices that would better reflect crab-specific environmental forcing.

CPT Discussion of Process

The CPT discussed a process that could be used to inform crab assessments, while also not duplicating information in the existing Alaska Ecosystem Report. Being finalized in November and presented to the Council in December (after the September CPT meeting), the Ecosystem Report is out of sync with the crab assessment cycle. **Therefore, the CPT recommends reviewing the finalized Ecosystem Report at its May meeting so the most up-to-date information is available.**

The Ecosystem Considerations report already has a broad ecosystem focus, which logically would include crab stocks, and is evolving into the more comprehensive Integrated Ecosystem Assessment construct that NOAA is promoting. Rather than prepare a separate ecosystem chapter for the crab SAFE document, resources would be better used to provide technical support to augment the existing Ecosystem Considerations report with crab-specific information. However, the Ecosystem Considerations report provides broad scale information, such as climate indices, and does not necessarily provide species-specific information. The groundfish assessments currently incorporate some species-specific ecosystem information into each assessment, though the extent to which this is done varies from among assessments. The AFSC is refining this process by developing species-specific ecosystem report cards. **The CPT recommended using the report card format to provide ecosystem information that is specific to crab stocks in the BSAI and/or to individual crab stocks.**

To further the development of the crab ecosystem report cards, the CPT recommended an ecosystem session during the 2016 January Crab Plan Team meeting held just prior to the crab modeling workshop. Long-term development of ecosystem report cards will require that a group of crab assessment authors and scientists to work collaboratively with ecosystem report authors. The possibility of soliciting funding from FATE or NPRB for workshops and indicator development was also discussed.

Ecosystem Indicators

The general recommendation of the CPT concerning developing ecosystem report cards is to relate ecosystem indices to crab stocks where possible, recognizing this may not always be possible due to the small spatial scale of some stocks. The CPT recommends the following ecosystem information be considered for the report cards:

- **Prioritize the development of species-specific report cards where adequate information is available for a breakout.**
- **Predator types should be consolidated into groups**
- **Information about primary production should be related to crab, including any information that might be useful for informing impacts on crab larvae.**
- **Use OSCARS or other hydrodynamic models to explore the impacts of wind and current forcing on crab larval drift.**
- **Consider work being conducted by AFSC for the EFH review on bottom contact for trawl vessels to improve the estimates of habitat impact for crab stocks.**
- **Investigate the relationship of the cold pool and important prey items for crab**.

AIGKC/WAIRKC Overfishing Status Determination

The 2015/16 stock assessments for AIGKC and WAIRKC were prepared for the May meeting, but the 2014/15 catch data were not available at that time. The CPT received an update on the 2014/15 catch from Doug Pengilly: the two stocks were not overfished in 2014/15. The catch east and west of 174˚ long., as requested in May, are now split for golden king crab (Table 1b in AIGKC). The CPUE values

are quite different west versus east. A comment was made that the fishing gear may be influencing CPUE. Further discussion on this issue is in the AIGKC agenda item.

Norton Sound Red King Crab

Research studies update

Jenefer Bell (ADF&G) presented ongoing research projects on red king crab in Norton Sound. She presented results from the spring tagging project, fall pot survey, and molting hormone concentration study. Objectives were to: 1) identify areas of high abundance of juveniles and breeding females; 2) document female reproductive condition; 3) document growth increments; 4) estimate movement patterns; and 5) estimate discards in the commercial fishery. Results of the 2014 trawl survey in Norton Sound were also discussed. The trawl survey has been conducted from 1976 to 2014, and the winter pot survey from 1983 to 2012. The fishery transitioned from mostly large vessels to smaller vessels after 1995. Observers were placed on commercial vessels for tag recovery and discard estimation.

Tagging was conducted during the winter pot survey, 2008–2012, to identify migrations and habitat areas for juveniles and breeding females, and 25,196 crab >70 mm CL were tagged from 2012 to 2015 during the spring pot survey, with 7% of the tags were recovered in the commercial fishery during 2012 to 2014. The presentation highlighted the following tagging results:

- Data from recovered male crab showed declining male molt increment with larger size; molt increment also appears to depend on shell condition.
- Tagged crab were generally recovered farther offshore and west of the release location, although this may be an artifact of where tagging and fishing efforts occurred.

Fall and spring pot surveys during 2012–2014found differences in size composition that were not necessarily consistent with expected growth and molt timing. Hormone concentrations collected monthly from April to September found high hormone concentrations in sublegal crab in July. However, these results could be biased near-molting crab not entering pots, so there is still uncertainty in molt timing.

Surveys indicated female crab are more abundant along the 10 mile depth contour, although juvenile crab exhibited two areas of high abundance. Female maturity was found to be about 65-70 mm carapace length. Only core and “tier 1” stations were sampled in the 2014 trawl survey, with one tow catching the majority of pre-recruit and legal crab from the entire survey. The retow protocol used historically for high CPUE tows was not applied in the 2014 survey.

Assessment update

Hamachan Hamazaki (ADF&G) presented an update on the Norton Sound red king crab assessment model. The total retained harvest in the winter and summer fishery was 0.52 million lbs, which was below the ABC of 0.58 million lbs.

There were no alternative model requests from the CPT in May 2015 or the SSC in June 2015. Other requests were to provide documentation on the trawl survey, pot survey CPUE standardization, and explanation of figures. The trawl survey report will be published in fall 2015. Documentation was also provided on pot survey CPUE standardization (Appendix A). Explanation of figures comparing input sample size with effective sample size was added and standardization of software for plots was added. New data collected in 2015 on the length-weight relationship was used in the model. The model is fit to abundance not biomass, so the length-weight relationship is only used to estimate MMB. The high abundance of large crab and the higher M currently used in the model was discussed; however, no new recommendations to deal with this were made by the CPT.

The information needed for moving NSRKC from tier 4 to tier 3 was requested by the CPT and SSC. Maturity information for male crab is needed for Norton Sound. The fate of large males needs to be investigated. At present, the assessment applies a large natural mortality value to the largest size bin. The CPT commented that the fate of large males is not really a tier 3 question, although this does need more investigation. The assessment for BBRKC uses size data from mating pairs from waters near Kodiak Island adjusted for lower growth in Bristol Bay to estimate male maturity. The Norton Sound assessment adjusts the maturity from Bristol Bay down to 94 mm CL to reflect slower growth in Norton Sound relative to Bristol Bay. In the model, molting occurs after the summer fishing (July–September), which is consistent with the high hormone concentrations found in juvenile crab in July. The tagging data show a higher molt probability for old shell males vs. new shells, but shell condition is not currently used in the model.

The CPUE standardization was done by Gretchen Bishop (ADF&G) in the Norton Sound assessment in 2013. Two time periods were used: 1976–1992, and 1993–2015. Censored data were used for the final analysis, which only made a difference in the years before 1980. Documentation on the CPUE standardization is in Appendix A. The model does not fit the early data well.

Comparison of observer data with dockside sampling data suggest vessels with observers tend to retain more small legal crab. Therefore, observer obtained discard data may not be representative of the fishery. While the legal size is 4.75 inches CW, processors prefer crab >5 inches CW. Boats with observers tend to keep crab down to 4.75 inches instead of 5 inches (although this comprises <2% of the total catch). It is not clear if this is a difference in catch composition or retention and would not be a problem if the model fit to total observer length composition.

CPT Recommendations

- **Explore iterative data reweighting after guidance from the data weighting workshop.**
- **Maturity data on males is needed before moving NSRKC to tier 3.**

Snow Crab

Jack Turnock presented six model scenarios for the 2015 eastern Bering Sea snow crab assessment. These scenarios included:

- Model 0 – The assessment model forwarded from September 2014, but with the standard deviation parameter of the growth function set to 0.5. Growth is modeled with two linear segments connected at a differentiable ("smooth") transition point.
- Model 1 – Same as Model 0, but (1) changing the survey logistic curves from estimating a size at 95% selected to an offset from the size at 50% selected; and (2) survey q for 1978–1981 and availability for the 2010 industry survey set as probit scales[1].
- Model 2 – Same as Model 1, but with the constant maturation probability removed and an increased weight on smoothing point for the female probability of maturing.
- Model 3 – Same as Model 2, but with the size-at-50% selected for female discard length changed from 4.2 to 4.4 (log scale) and the weight on growth likelihood increased from 2.0 to 3.0.
- Model 4 – Model 3, but with removal of the penalty on directed F mortality for male crab from 1992 to present (was on average F). F penalty for 1978-91 is on F devs only.
- Model 5 – Model 4, but with the penalty on female fishing mortality from 1992-present removed, and using potlift data on males and females during 1992-present as an estimate of pre-1992 fishing mortality for female discards.

[1] The CPT found that this model also increased weight on the trawl discard data (see text)

The CPT was concerned that Models 0 and 1 in the assessment document differed by an unexpected large amount given that the changes were relatively minor reparameterizations, and not changes to model assumptions. In addition, the likelihood associated with the female growth smoothing parameter changed substantially among Models 1, 2, and 3. The lack of data near the transition point in the growth curve, and the clumped nature of the available data, may limit a clear definition of the transition point. Given the variety of potential causes of these differences (e.g., data not fully updated prior to comparative runs) and, after substantial discussion, the author was asked to confirm the input data and rerun Model 1 prior to the CPT recommending a preferred model during this meeting. The author later confirmed the Model 0 configuration was correct, but the Model 1 configuration incorrectly increased weighting of the trawl discard catch. A reconfigured Model 1 produced results similar to Model 0. Results also suggest the Model 0 converges to a local minimum because the objective function was higher than for the almost-identical Model 1. Reruns of Models 2–5 did not change results, although Model 2 now differs substantially from Models 0 and 1. The CPT is still concerned about the differences between the objective function values for Models 0 and 1, and a slightly worse fit of Model 2 than Model 1. Minor configuration changes from Model 1 to Model 2 led to large differences in results. The shift from Model 0 to Model 1 incorporated three changes to the model; the implications of any single adjustment were not evaluated in the analysis. The CPT again cautioned that any sequential model revisions should incorporate only a single change so the effect of that change may be evaluated without confounding by other changes. **The CPT again requests that any model steps be evaluated in individual model scenarios.**

The CPT noted that the potlift data used in Model 5 were not available in the document, but should be provided. The protocol for using post-1991 discard data to extrapolate for pre-1992 historical female discards also needs to be documented. **The author was asked to provide both the data and the protocol.** The CPT further noted that Models 4 and 5 use an F penalty vector that is not broken out over time; the author should evaluate a vector broken over time; specifically, the F penalty should pertain only to the year being penalized, otherwise the penalty is forcing F for the period the penalty applies to, to pertain to the average F for the other years.

The model uses a total of eight growth parameters by sex, with the standard deviation of the growth function fixed at 0.5 per CPT and SSC recommendations. The transition point for males in Model 5 is ~28 mm (which is smaller than Somerton's estimates), but the female transition is less informative, likely due to lack of data points near the transition point. The point could also represent a tradeoff in fit to some other model component.

The CPT discussed the poor model fit to the data on female mature biomass, but the solution is uncertain. A similar poor fit existed for Tanner crab (e.g., biomass dip in mid 1980s with relatively small CIs). There was also concern about serial bias (sequential 10 years) in the time series, but data are lacking for comparing pre- and post-1982 net catchability. An option of cropping off the early data was discussed, but those data contribute to biological reference points for the stock. The molt-to-maturity function likely affects fitting the growth function since the probability of molting is linked to crab size.

Given the resolution of the issues concerning Model 1, the CPT discussed why Model 2 was so different from the corrected Model 1. The author recognized that trawl discard was not fitted well in Model 2 (predicting 0 catch), so the weighting had been increased to force a better fit. But this may have conflicted with changes in survey biomass and the larger model recruitment observed in 2010. There needs to be an exploration of the potential conflicts of trawl data weighting (Model 2) with other data sources. While the CPT recognized that a choice needed to be made between Model 0 and Model 2, several sequential diagnostic steps are missing between these models, despite previous CPT requests not to combine multiple model changes into single scenario increments. **The CPT requests a scenario in which the only change is that weight on the likelihood for the trawl discard is increased**, although this effect

should be negligible given the relatively small amount of trawl bycatch. In addition to the model uncertainties, it was noted that the 2014/15 fishery CPUE went down in concert with 2015 survey biomass, contrasting to the 2014 assessment when the fishery CPUE had declined but the survey had increased substantially. Future modeling efforts should re-evaluate the influence of recruitment on model results and consider re-weighting survey observations for small crabs.

Given the unresolved concerns with available model runs, the CPT recommends Model 0, which is closest to the 2014 model configuration, as the best model to use for status determination and setting the OFL. Under any of the evaluated model scenarios, the stock is not overfished. In addition, overfishing did not occur in 2014/15. Given the large uncertainty in the choice of the best model scenario, the lack of clarity in what factors are important in determining model results, and concerns regarding model convergence, the CPT further recommends use of a one-time buffer of 25% to set the ABC. These recommendations would result in: $B_{35\%}$ = 157.8, $F_{35\%}$ = 1.42; OFL = 83.1; and ABC with a 25% buffer = 62.3 thousand t.

There was concern expressed by the public to confirm that the 25% buffer would not be intended as a long-term approach for snow crab. The CPT clarified that the buffer was only intended for the 2016 ABC, and will be re-evaluated next year, and would likely be reduced with future data and a better understanding of the model(s).

CPT Recommendations

1. **Model 0 changed dramatically in this iteration – explore the convergence to a global minimum by starting at different parameter values.**
2. **The CPT requests that any steps between Models 0 and 1 be evaluated in individual model scenarios.**
3. **Provide both the potlift data and the protocol used to extrapolate post-1991 discard data to pre-1992 historical female discards.**
4. **Explore potential conflicts of trawl likelihood weighting (Model 2) with other data sources.**
5. **Explore the dramatic differences in sequential survey estimates and why the models do not split the difference between the last two survey years.**
6. **Models 4 and 5 use an F penalty vector that is not broken out over time; evaluate a vector broken over time.**
7. **Explore a scenario in which the weight of the trawl discard likelihood is increased.**

The CPT recommends that these changes to the extent possible be evaluated for the January 2016 CPT meeting in order to resolve outstanding issues prior to model review in May 2016.

Bristol Bay Red King Crab

Jie Zheng (ADF&G) presented the 2015 stock assessment for the Bristol Bay red king crab (BBRKC). The assessment is an update, plus an evaluation of the relationship between bottom temperature and catchability for the NMFS trawl survey.

The update was based on the accepted model for the September 2014 assessment. NMFS trawl survey data were updated with the newly re-estimated time series provided by NMFS in 2015, and catch and bycatch data were updated through the 2014/15 crab fishery year. he assessment author did not bring forward Scenario 2, which had been requested by the CPT in May. This scenario featured two separate linear segments for female growth, but Jie concluded that there was insufficient data to support this scenario. Jie reported he plans to work on Scenario 2 in the future when additional growth data become available.

The analysis of a temperature-catchability relationship is a response to a long-standing request by the SSC, but also reflects heightened interest in the issue because of the substantial increase in the BBRKC survey estimates associated with the change from cold to warm conditions in 2014. Interestingly, 2015 was also warm year in the EBS, but survey estimates in 2015 were more consistent with previous years, rather than 2014, which now appears to be anomalously high.

Two variants of the base model (model scenarios 1a and 1b) explored alternative ways to model the dependence of trawl survey catchability on bottom temperature. The bottom temperature observations used for this analysis were averages from survey stations in Bristol Bay. Scenario 1b is the conventional approach of modeling an environmental covariate in which log catchability is linearly related to temperature. This approach does not allow error to be in the relationship between temperature and catchability. Scenario 1a is the "data method" described in Schirippa et al. (2009)[2], which is intended to address this concern. A penalized vector of annual deviations is used to model the relationship between observed temperature and the linear term related to catchability. The assumed variance term (σ_T) controls the degree to which there is variability in the temperature-catchability relationship. A large value of $\sigma_T$allows the survey biomass estimates to be fit perfectly, while a small σ_T is an assumption that there is no error is the temperature-catchability relationship, and therefore model reverts to scenario 1b. A value of σ_T =0.3 was considered appropriate for this analysis. A sensitivity analysis indicated that results were not sensitive to this assumption.

Both approaches to modeling a temperature-catchability relationship suggested that there was a weak positive relationship between temperature and trawl survey catchability (see for example Figure 27c lower panel of the BBRCK stock assessment). However, based on the small changes in log likelihood between the base model and scenarios 1a and 1b, the temperature-catchability relationship did not significantly improve model fit. For example, the change in log likelihood from scenario 1 to scenario 1b is 0.9, which has an approximate p-value of 0.18 based on a likelihood ratio test. Incorporating the temperature-catchability relationship also had a minor impact on model results.

Because including a temperature-catchability relationship did not improve the model, the assessment author recommended scenario 1 as the base model. The CPT agreed with the assessment author and recommends scenario 1 for status determination and OFL setting.

The author presented an extensive retrospective analysis of the BBRKC model, including a true retrospective where data were sequentially removed from the current assessment, and a comparison with previous assessments (historical analysis). Although there was reasonable overall consistency in biomass trends for both types of retrospective analysis, there was a tendency for the model to overestimate stock size during 2007–2010. This was likely caused by an increasing trend in biomass estimates during this period, followed by a shift to lower biomass that is difficult for the model to track.

The CPT recommends that size composition and biomass estimates from the 2013–2015 BSFRF side-by-side surveys be included in the assessment model. Sufficient data from these surveys are now available to help inform catchability of the NMFS trawl survey. The CPT identified several approaches, such as considering these surveys as an extension of the BSFRF surveys in 2007 and 2008, which are already used in the model. The earlier surveys did not use the side-by-side design, so technical aspects considerations of this approach would need to be evaluated. Another approach would be to drop the 2007–2008 surveys and add the 2013–2015 surveys. Since size composition data were collected during 2013–2015 surveys, it should be possible to evaluate survey selectivity, which needed to be assumed for

[2] Schirripa, M.J., C.P. Goodyear, and R.M. Methot. 2009. Testing different methods of incorporating climate data into the assessment of US West Coast sablefish. ICES Journal of Marine Science, 66: 1605–1613

2007–2008 surveys. Due to the amount of analysis required to incorporate a new survey time series into the model, Jie did not think that this would be ready for review at the May 2016 CPT meeting.

EBS Tanner crab
William Stockhausen presented the EBS Tanner crab stock assessment for 2015.

Before presenting an evaluation of the assessment for 2015, survey results for 2015 were reviewed and compared with survey results from 2012 to 2014. There was no evidence of a recruitment pulse in 2015; in particular, the evidence of a possible recruitment pulse for females seen in the 2014 survey was not evident in the 2015 survey. The area around the Pribilof Islands in 2015 showed higher densities of mature-sized and legal males relative to the Bristol Bay area when compared to previous recent surveys. Highest densities of mature females in 2015 occurred about the 166° W long. line and at one station west of 175° W long. near the shelf edge. Results of the 2014/15 fishery season were also briefly reviewed. Retained catch in the 2014/15 season was roughly six times greater than in 2013/14. Essentially all of the TAC for the fishery east of 166° W long. (8.480 million lb) was harvested and 77.5% of the TAC for the fishery west of 166° W long. (6.625 million lb) was harvested. Notable in the 2014/15 season was the high biomass estimate for Tanner crab captured and discarded during the snow crab fishery (during the CPT discussion, it was noted that this may be attributable to the more eastern distribution of effort during the snow crab fishery in 2014/15 relative to previous recent seasons).

Moving to the 2015 assessment, eight model configurations were evaluated:

- Model A – the 2014 assessment model (and the author's preferred model)
- Model B – Model A, but with lognormal error for the fishery catch likelihoods
- Model C – Model A, but with Gmacs model for fishing mortality
- Model D – Model C, but with lognormal error for fishery catch likelihoods
- Model E – Model A, but with fishery selectivity asymptote forced to equal 1
- Model F – Model B, but with fishery selectivity asymptote forced to equal 1
- Model G – Model C, but with fishery selectivity asymptote forced to equal 1
- Model H – Model D, but with fishery selectivity asymptote forced to equal 1.

All models were run using "data set D" (see below). Additionally, Model A was run with six data sets to evaluate effects due to updates and corrections to data:

- The 2014 "base" data set -- the data set used for the 2014 assessment (i.e., a repeat of the 2014 assessment);
- The corrected 2014 "base" data set – the data set used for the 2014 assessment, but with corrections for errors in the 2013/14 retained catch size frequencies that were provided to the author for the 2014 assessment that were discovered after completion of the 2014 assessment;
- Data set A – the corrected 2014 "base" data set, updated with the 2014/15 fishery data and the 2015 trawl survey data;
- Data set B – the current standard NMFS trawl survey data time series through 2015, with corrections for errors in the 2013/14 retained catch size frequencies and updated with the 2014/15 fishery data;
- Data set C – data set B, but with updated 2009/10 to present size composition data for the bycatch in groundfish fisheries; and
- Data set D – data set C with the current NMFS standardized weight-from-width estimator.

The author reviewed the results for Model A using the six different data sets. Model A runs converged with all data sets and the results showed no strong sensitivity to data sets that would raise concerns. The correction to the 2013/14 retained catch size frequencies in the data set used for 2014 had only a very minor effect on overall fit and estimates of MMB and recruitment. Addition of the 2014/15 fishery data and 2015 survey data (data sets A – D) to the Model A analysis reduced estimates of recruitment by

approximately 10% and estimates of 2007/08 – 2013/14 MMB by approximately 10%. Data sets A – D all produced similar estimates of recruitment and similar estimates of 2014/15 MMB. Model A analyses with the data sets that include the current standard NMFS trawl survey time series (data sets B – D) led to estimates of MMB in 2009/10 – 2012/13 that were approximately 10% lower than the analysis using the corrected 2014 "base" data set (data set A).

Models E, F, G, and H, where the fishery selectivity asymptote was forced to equal 1, did not converge, and these models were not considered further. Stockhausen discussed the relative merits of Models A, B, C, and D using Dataset D. Models B and D performed poorly in fitting fishery mortality, particularly for the groundfish fisheries bycatch mortality, whereas Models A and C fit the fishery mortality estimates well. Although Models A and C resulted in very similar fits to the post-1980 period of time series, Model A fit the data overall better than Model C, by approximately 60 likelihood units, due largely to its better fit to the directed fishery catch and retained-catch size composition data. Stockhausen recommended Model A for use in the 2015 assessment.

The CPT agreed with Stockhausen's recommendation to use Model A with data set D for the 2015 stock assessment. After noting that recruitment estimates for recent years are below average, Stockhausen discussed the OFL and status determination from Model A. Recent changes to the state harvest strategy for Bering Sea Tanner crab (the TACs for the 2015/16 Tanner crab season will be set assuming a 5-inch CW size for the preferred-size retained crab both east and west of 166° W long.) and the 2015/16 F_{OFL} for Bering Sea snow crab (the snow crab fishery is a significant source of bycatch mortality to Tanner crab) have effects on OFL determination. Stockhausen considered two new approaches to treating retained-catch selectivity in the directed fishery for 2015/16: 1) the same total catch selectivity curve as estimated for 2014/15, but with the retention selectivity curve being essentially knife edged at 5 inches (a logistic function with steep rise and 50% selectivity at 5 inches CW); and 2) shifting the total selectivity curve slightly to the left (to reflect the possibility of fishing for smaller crab) with the same retention selectivity curve as (1). Neither Stockhausen nor the CPT felt that use of approach (2) was justified. Approach (1) was recommended and resulted in the same OFL as the approach used for predicting retained catch selectivity in the 2014 assessment (but a different estimate of the retained component of the OFL).

After the CPT decided on a recommended F_{OFL} for the Bering Sea snow crab fishery, Stockhausen computed the 2015/16 Bering Sea Tanner crab OFL from Model A. The F_{OFL} estimate is 0.58/yr, and the OFL estimate is 59.94 million lb (27.19 thousand t). The stock is not estimated to have been overfished in 2014/15 (MMB for 2014/15 is estimated at 157.78 million lb, or 2.14 times greater than B_{MSY}) and is projected to be 118.38 million lb (53.70 thousand t), 2.00 times above B_{MSY}, in 2015/16. **The CPT recommended that the 2015/16 ABC be set with a 20% buffer on OFL (i.e., equal to 80% of OFL), with the following rationale: a 20% buffer on OFL was used to set the ABC for 2014/15, the 2015 recommended assessment model is essentially the same as was used in 2014, and the same uncertainties remain in the 2015 assessment.**

During Stockhausen's review of Models A – D, the CPT noted, discussed, or **recommended** the following:

- Issues and concerns remain with the model recommended for the 2015 assessment (Model A):
    - The model fits total catch well, but does a poorer job in fitting retained catch (e.g., the 2014/15 retained catch is underestimated), catch of females, and catch in bycatch fisheries.
    - Fits to survey and retained-catch size compositions by Model A in 2015 remain as poor as in the 2014 assessment. In particular, strong residual patterns exist in fits of male survey and retained-catch size compositions, with overestimation of larger crab and underestimation of smaller crab in recent years.

- With regard to the total directed fishery selectivity curve for males:
    - Attention was drawn to the curve estimated for 1996 by Model A (Figure 46 of assessment): it is an extreme outlier. Although that estimate may not have a large effect on assessment results overall (sample sizes and directed fishery catch in 1996 were low), it was not clear why the model estimates full selection in 1996 at roughly 100 mm CW, whereas estimated selectivity at 100 mm CW is close to 0 for all other years.
    - It was suggested that the author consider using the selectivity curve for 1991/92 or the curves for the early post-1990/91 fisheries for the pre-1991/92 selectivity curve; directed fishery observer data from pre-1991/92 is not available for estimating selectivity.
    - With regard to fitting fishery catch, the poor fit of the models with lognormal fishery catch likelihoods (Models B and D) compared to the models with normal fishery catch likelihoods (Models A and C) was surprising to some CPT members. The CPT recommends the author evaluate the effect on model fit of using different assumed CVs when using lognormal catch likelihoods.
    - Another approach that the author should consider is fitting the retained catch exactly to the reported value rather than treating it as a catch component that must be estimated with error by the model; the retained catch is the only data put into the model that is measured and not estimated.

- Although Model A (which uses the status quo approach for modeling fishery mortality) was judged to provide a better overall fit than Model C (which uses the Gmacs approach for modeling fishery mortality), **the CPT recommended that the author continue to move forward with Model C (the Gmacs approach) and revisit application of that approach at the May 2016 meeting.**
- The presentation chart (slide #29) showing periods of data availability by data source was very useful and informative; it would be useful for all assessment authors to summarize input data this way.

St. Matthew blue king crab

Jie Zheng presented the stock assessment of St. Mathew blue king crab for OFL and ABC setting. The model is a single sex, male-only, three-stage CSA model. The assessment considered data up to the 2014/15 fishery and the 2015 survey, using the updated trawl-survey time series. The SSC did not make any specific recommendations for this stock in its June 2015 meeting. However, the CPT in its May 2015 meeting recommended developing a new model structure considering (1) data weighting, (2) additional survey variances, (3) revised trawl survey time series, and (4) selectivity and molting probability grouped into various time blocks. The authors addressed those recommendations by formulating 20 scenarios, building them by changing one element at a time from the base model, which was Model T used in the 2014 assessment. In several scenarios, they considered the time blocks before and after 2000 for two separate selectivity and molt probability estimations.

The station "R24" frequently generated high survey CPUEs and formed the major component of total abundance. They proposed a reduction factor of 0.3751 for R24 abundance based on pot survey high catch rate stations in the neighborhood and discounting the land area from the survey cell. The CPT did not agree with the reduction factor formulation, noting that time blocks for survey selectivity and molting probability need further justification. Scenario 1 follows the Bristol Bay red king crab effective sample size estimation formula, uses robust normal likelihood, adopts different mean weight based on trawl survey and retained catch information for stage 3 crab, reduces the penalty weight for groundfish bycatch fishery F, changes the effective sample size for pot fishery observer length composition, and uses pot fishery discard biomass. Scenarios 2-7 and9 estimated an additional CV for the pot survey but not for NMFS trawl survey, which had the effect of down weighting the pot survey time series. Given the uncertainty in the NMFS trawl survey, particularly the 2015 survey results, the CPT did not agree with

this approach. **The CPT recommends Scenario 1 because it includes various improvements to the model listed above, but does not include special treatment of station R24, does not include time blocks in survey selectivity and molting probability, and does not estimate an additional CV for the pot survey.** The CPT concluded that all of these features need further evaluation and refinement before they can be included in the model.

CPT Recommendations

1. **The proposed reduction factor for R24 needs further development, considering spatial variation in abundance.**
2. **Additional variances should be added to all data points of both pot and trawl surveys.**

Pribilof Islands red king crab

Jack Turnock presented the Pribilof Islands red king crab stock assessment completed by Cody Szuwalski. Previous CPT and SSC comments and author responses were presented. The assessment included both the status quo 3-year running average with inverse variance method and an integrated length-based assessment model first presented in 2014. The integrated assessment model scenarios presented were: fitting male and female abundance and computing OFLs using the Tier 3 and 4 control rules; and fitting males only and computing OLFs using the Tier 3 and 4 control rules. Exploratory model scenarios included a scenario with variable survey catchability for the males only, and a scenario with reduced survey abundance CVs in the 1990s to force the model to fit the higher abundances.

The integrated assessment also included fishery selectivity curves for retained and discarded catch from the Bristol Bay red king crab fishery. The author had conducted simulations and determined that 5-mm length bins were appropriate in the integrated assessment. Growth was estimated using length frequency data outside the model. Female growth appeared very similar to the Bristol Bay red king crab stock, while males were somewhat different than in Bristol Bay.

The integrated assessment model using male and female data appears to fit the length frequency data, in particular tracking the consistent modes representing large recruitment events passing through the population. However, the fit to survey abundance continues to be poor because the survey data is not particularly informative. The male-only model fits the length frequency data better and fits to survey abundance data are better but still poor. Both the male-only model and two-sex model resulted in an abundance trend that was contrary to survey data. There is insufficient recruitment near the end of the time series to explain trends in the integrated assessment model. Length frequency data shows apparent recruitments in 1988, 1999, and 2004.

A scenario of the integrated assessment model was presented that decreased the CVs during the 1990s, when the survey catches were high. Fits to survey abundance improved during the 1990s, but remained poor in subsequent years, because the low natural mortality of 0.18 should allow high abundances if the 1990s to continue into the 2000s. The author also investigated a model allowing variable Q, which produced good fits to the survey data, as expected. The author found little to no relationship between Q and bottom temperatures or sea surface temperatures. The CPT discussed further investigation of factors influencing Q, specifically applying separate Qs for two time periods, with a split at 2000. Splitting Q at 2000 would effectively allow Q to vary with population density, as the population was high before 2000 and low after 2000.

The CPT hypothesized that highly varying 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 noted that the stock assessment model results are shown in terms of abundance and requested that the model output be presented in terms of biomass to provide a comparison to model output using abundance. The CPT also noted that the survey data do not seem to play much of a role in the integrated assessment model. The CPT recommends a scenario down-weighting the length frequency data to see if fits to survey estimates improve. The CPT also recommends a scenario that applies uniform weighting across all survey years (i.e., either a constant CV or a constant standard error). While the CPT recommends further evaluation of the integrated length-based assessment for PIRKC, the CPT also discussed that a random effects model may be useful for this stock if it is to remain at a tier 4 level.

The CPT recommends for 2015 using the status-quo 3-year running average weighted by the inverse of the variance of the area-swept estimate. The 3-year weighted average assessment uses the inverse of the variance, but it may be more appropriate to use the arithmetic mean to avoid skewing the estimates towards years when survey catches are low. **The CPT recommends a 3-year average weighted by standard errors and a random effects model be presented in May 2016.**

Aleutian Islands Golden King Crab

Model development update

The focus for CPT discussion was whether the model developed for Aleutian Islands golden king crab (AIGKC) could be adopted, and if so which scenarios should be presented at the next CPT meeting.

Shareef Siddeek provided an overview of the updated version of the model-based stock assessment of AIGKC. The model is a single-sex size-structured integrated model that divides the population into new and old shell crab. The model is applied separately to data for the regions east of 174◦ W (EAG) and west of 174◦ W (WAG). The analysts considered 12 scenarios for the EAG and 11 scenarios for the WAG. Major changes from model configurations presented at the May 2015 CPT meeting were related to: (a) changes to the population dynamics model so that it is based on the GMACS fishing mortality equation; (b) changes to the weights assigned to the total (landed and discarded) catch biomass; and (c) reduction to the weight assigned to the fishing mortality penalty. Scenario 8 for the EAG assumed that the population was in equilibrium in 1981, whereas all of the scenarios for the WAG made this assumption. The CPT supports all of the changes to the model structure and weighting approach.

Most scenarios were based on a single standardized CPUE series (based on observer data for 1995/96 to 2014/15). Scenario 3 for each region considered a second standardized CPUE series based on fish ticket data. The CPT noted that the model fits the data (CPUE index, size-composition and tagging data) well, with the exception of the size-composition data for the total catches in the EAG for 1990-94. The CPT appreciated the thorough set of diagnostics provided for the CPUE standardizations, in particular the availability of "influence plots" that helped the CPT understand the influence of each covariate on standardized CPUE. The CPT agreed that there was limited scope to improve the model, and most of its suggestions relate to obtaining a better understanding of what is determining the 'scale' of the biomass.

The equilibrium unfished size-structure is defined by the assumed value for natural mortality (M) of $0.18yr^{-1}$ and the estimate of the size-transition matrix. This size-structure includes substantially more large animals than predicted by the assessment for 1985, i.e., WAG and EAG stocks are assumed to be reduced substantially below their unfished 1985 levels. The status of the population relative to unfished biomass will change if M is altered from its current value.

The CPT discussed whether there is sufficient information to 'scale' the biomass estimate, i.e., distinguish between biomass trajectories with different average biomasses. Unlike other crab stocks which have surveys, the assessments for AIGKC rely on CPUE indices to determine trends. The issues raised in discussion included:

- the assumed value for natural mortality likely has a large impact on estimates of absolute biomass (none of the scenarios considered explored sensitivity to *M*).
- whether the CPUE index is tracking abundance given (a) there are currently only two vessels fishing in WAG, (b) the impact of the TAC constraining the fishery, (c) changes in pot construction, (d) the possibility of hyperstability in the relationship between CPUE and abundance, and (e) the area fished has changed over time.

In relation to CPUE, it was noted that for the WAG the recent trend in CPUE is consistent across vessels and captains. Moreover, trends in CPUE will continue to be monitored for TAC setting. None of the standardization diagnostics indicated major problems with the way the standardization procedure has been applied.

The fundamental concern with adopting the assessment model is whether the fishery CPUE trends are able to track stock abundance. Although fishery CPUE indices are widely used in assessment models in other parts of the world, a poll of CPT members found widespread skepticism about reliability of fishery CPUE indices and their utility for stock assessment. After much discussion, the CPT agreed to defer the decision about accepting the model until some additional model explorations have been undertaken. The results of these explorations could be reviewed at the proposed modelling workshop (see agenda under New Business).

The CPT requested analysts to examine:

- the impact of the way the initial conditions are specified:
    - estimated as log-deviations about an initial abundance (as in Scenario 1 for the EAG)
    - based on projecting the model from unfished equilibrium at some earlier time (e.g., 1960), with recruitments estimated for each year after that time and catches from 1981
- the impact of the choice of the value for natural mortality.

The scenarios can be based on factors included in current Scenario 1 (two total selectivity curves, two catchabilities, and one retention curve). Each of the following scenarios should be conducted for all options to specify the initial conditions and for natural mortality.

- Drop the groundfish bycatch size-composition data, pre-specify selectivity for the groundfish fishery (e.g., uniform across sizes), and assign a low weight to the groundfish bycatch mass data.
- Estimate a new selectivity pattern in 1994/95 rather than 1998/99 as in Scenario 2 because the total catch size-composition data for the EAG for the years before 1995 were only collected from Catcher Processor (CP) vessels and appear to contain far more small crab than for the years after 1995.
- Consider dome-shaped rather than asymptotic selectivity.

Survey briefing

Chris Siddon (ADF&G) gave an update on development of a cooperative survey with the fishing industry for AIGKC. Historically, there was a triennial pot survey for AIGKC, but the survey extent was limited and it would not be cost-effective to conduct a pot fishery over the entire stock area.

The sampling design for the 2015 pilot survey was conducted in the EAG, and involved dividing the area to survey (depths < 1000 m) into three strata and then for each stratum selecting 25 2x2 NM blocks at

random from those that have observer data. The design was modified to exclude high trawl areas to reduce potential gear interactions.

Results from the 2015 pilot survey were encouraging, with 57 strings deployed and crab caught in 321 pots measured. Further analysis is needed, in particular, to quantify costs and the variance of the survey index. The latter information could be used to determine how much sampling may be needed to detect trends (i.e., the statistical power) and perhaps adjust the stratification scheme. Whether the success of the EAG survey will apply in the WAG still needs to be examined.

Overall, the results of the work to date are encouraging, particularly given the difficulties the CPT had evaluating the utility of CPUE index for AIGKC. The CPT is looking forward to seeing additional results and a refined sampling strategy, if the analysis of the 2015 data suggests that the precision of the index could be improved if the sampling scheme is refined.

Pribilof Islands Blue King Crab

William Stockhausen presented the 2014 Pribilof Islands blue king crab assessment. The directed fishery was closed during 2014/15, and no major management changes occurred. The Pribilof blue king crab stock is recommended as Tier 4 and utilizes NMFS EBS trawl survey data to estimate abundance. Although recommended as Tier 4, the OFL/ABC is set under Tier 5 criteria ($B < 25\% B_{msy}$), because bycatch mortality of blue king crab may occur in other crab fisheries (none occurred in 2014/15) and in the groundfish fisheries. Along with the 2015 trawl survey data, the assessment was updated with groundfish bycatch data. Consistent with 2014, the 2015 EBS trawl survey caught few crabs (28 blue king crab in 86 tows), indicating abundance is still very low. Groundfish bycatch was also low (0.07 t) with nearly all catch occurring in the hook-and-line Pacific cod fishery.

The 2014 assessment estimated MMB from the NMFS trawl survey with an average centered on the current year and weighted by the inverse of its variance (IV method). An alternative approach using random effects was investigated in the 2015 assessment (random effects method). The random effects method is a statistical approach that models annual log-scale changes in survey MMB as a random walk process. The random effects method resulted in a 25% higher B_{msy} compared to the IV method, but the MMB and OFL were similar because the two methods yielded almost identical results in recent survey years. The difference in B_{msy} is attributed to how the methods respond to the high variability of the MMB survey estimates from the 1980s. The random effects method has higher estimates of MMB during this period because the smoothed time series incorporates process error, rather than being as strongly influenced by low estimates with smaller variances as in the IV method. **The CPT recommends using the random effects method to smooth the MMB time series because it is more robust to inter-annual variation than the IV method.**

The projected 2015/16 MMB_{mating} is 344 t, resulting in a biomass that is only 8% of Bmsy. The stock remains in overfished condition, Tier 4c. **The CPT concurred with the author recommend 2015/16 OFL of 1.16 t (0.0003 million lbs). The CPT recommends an ABC using a 25% buffer from the OFL or 0.87 t (0.0019 million lbs).** Both the OFL and ABC remain unchanged from last year's assessment.

Gmacs

The General Model for Alaskan Crab Stocks, Gmacs, is a generalized size-structured stock assessment modeling framework under development for application to Alaskan crab stocks, as well as other crustacean species. The initial application of Gmacs to Alaskan crab stocks is to the BBRKC stock, and

effort has gone into replicating the most important features of the BBRKC assessment within the Gmacs framework.

Martin Dorn, who chaired the CIE review, presented a summary of a review of Gmacs held in June 2015 at the AFSC conducted by Michael Bell (Heriot-Watt University, Orkney Islands), Nick Caputi (Western Australian Fisheries and Marine Research Laboratories) and Malcolm Haddon (CSIRO Hobart) for the Center for Independent Experts (CIE). The review was performed at the request of the AFSC. Martin pointed out that because Gmacs is still a work in progress, it was thus difficult for the reviewers to give a definitive review. However, the reviewers were very complimentary regarding the approach and direction Gmacs was taking and that it was a worthwhile endeavor. Specific recommendations Martin highlighted included: 1) convert the continuous-F equations now used in Gmacs to a step-wise seasonal interpretation of events (as in the BBRKC assessment); 2) include a stock-recruitment relationship with suitable lag; 3) add an option for environmental forcing; 4) add features to accommodate snow crab biology; and 5) conduct an audit of key characteristics of Alaskan crab fisheries and crab biology. In addition, the reviewers noted that it was probably not necessary to incorporate all features of existing assessments into Gmacs, but it was certainly necessary to include enough to make valid side-by-side comparisons with current models. Further recommendations included creating a core development team (CDT) and an advisory committee to discuss features to be added to Gmacs and to outline future efforts by the CDT.

The CPT discussion focused on recommendations of the CIE reviewers, all of which the CPT endorsed. Most of the discussion related to the use of continuous-F vs. pulse fishery dynamics—Gmacs is currently configured for the former while most assessments use the latter. Andre Punt suggested that using the continuous-F approach over sub-annual (e.g., monthly) time steps might have its own advantages in terms of incorporating multiple, temporally-overlapping or extended fisheries.

Jim Ianelli (AFSC) then presented an update to the CPT on the current status of Gmacs development. Jim thanked Martin for chairing the CIE review and Jie Zheng, Bob Foy, Jack Turnock, and William Stockhausen for participating. Jim demonstrated a number of features on GitHub (https://github.com/seacode/gmacs), the source code repository where the Gmacs code is hosted, including "cloning" the current code (as well as the document for the meeting).

Jim also presented a comparison between Gmacs and Jie Zheng's current assessment model for BBRKC. Time series and size compositions estimated by both models were overlaid on individual plots, simplifying comparison of results between the two models. Gmacs estimated higher recruitment and MMB, compared with Jie's model. Andre suggested comparing survey Q's and selectivity functions, but it was noted that the graphs showing the comparisons plotted catchability-at-size from Jie's model, but selectivity for Gmacs, which confounded the comparisons.

Overall, the CPT was encouraged by the progress made in the past year and focused its recommendations on keeping development of Gmacs moving forward, noting that it plans to hold a modeling workshop in January and to fully evaluate the Gmacs BBRKC model against Jie's model at the May 2016 CPT meeting. As part of this effort, Jie will develop a SMBKC Gmacs model for the January workshop. Bob Foy, Martin, Jie, William, Jack, Hamachan, and Siddeek, volunteered to conduct monthly phone meetings with Jim to check on development progress. One suggestion for making progress is "hard-wiring" the idiosyncratic features of Jie's BBRKC model into Gmacs as a means to facilitate direct comparisons between the two models. **The CPT also requested a brief overview of the Gmacs development "history" be given at the Jan. 2016 Modeling Workshop, covering progress made from the Jan. 2015 workshop to the Jan. 2016 workshop, as well as what remained to be developed before the May 2016 "head-to-head" comparison between Gmacs and Jie's BBRKC model.**

BSFRF selectivity and recruitment study
Scott Goodman (BSFRF) presented an overview of the 2013–2015 cooperative trawl surveys for Bristol Bay red king crab (BBRKC). The BBRKC selectivity work utilizes methods developed for snow crab in 2009–2010 using side-by-side, paired tows (Nephrops trawl compared to 83-112 trawl) conducted across almost all stations that contain RKC during the summer survey. The sample design covered 60 of the total Bristol Bay district stations (136) and accounts for ≥95% of stations where RKC are observed during the NMFS surveys (since the 83-112 trawl's use). The pre-recruit survey design attempted to cover all stations in the Bristol Bay district that showed positive samples of pre-recruit RKC. The pre-recruit sampling covers approximately the same set of stations as the side-by-side survey, except that the pre-recruit sampling is completed at a higher density by subdividing each NMFS survey block and towing once in each subdivision.

The survey in 2013 was completed in June during the same period that NMFS completed their Bristol Bay trawl survey (leg 1 NMFS survey) over a relatively cold bottom-water year. For 2014 and 2015, the same general schedule was followed but the Bering Sea cold pool had receded by the time of the survey. Therefore, towing was completed over much warmer water in 2014 and 2015. Results for side-by-side RKC net selectivity in year-3 (warm year) were more similar to year-1 (cold year) than year-2.

PIGKC – Data input update
Doug Pengilly provided the results of applying the program developed for groundfish stock assessments (a random effects approach) to the available slope survey area-swept biomass estimates of golden king crab in the Pribilof Islands area. Doug also discussed the stock delineation chosen for the preliminary assessment and prepared a Stock Structure Template for Pribilof Islands golden king crab. No OFLs or ABCs were computed in these results. Slope survey data from 2002, 2004, 2008, 2010 and 2012 were considered for use in the assessment; detailed information on carapace length, sex, and shell condition were collected during the last three surveys. The next survey is expected to occur in 2016.

Stock boundaries were based on the state's Pribilof district which encompasses subareas 2, 3, and 4 of the slope survey. A majority (83%) of the historic catch occurs in the Pribilof canyon (survey subarea 2); 68% of the historic total catch is reported from one statistical area. The team reviewed plots of estimated and projected total biomass, mature male biomass, and legal male biomass for the entire district and for only for the Pribilof canyon (Figures 13 and 14) and noted that more survey data is required. Information on mature and legal biomass from the surveys (size/sex measurements) is only available for the last 3 surveys. Random effect model runs did not appear to be able to estimate a process error term when only 3 years of data were used. **The CPT recommends the random effects model be re-evaluated after results from the 2016 slope survey are available.**

Bristol Bay Closure Area EFP request
John Gauvin provided an overview of the application to NOAA to allow for exploratory flatfish fishing in the Red King Crab (RKC) Savings Area from February 1-June 15, 2016 and January 20-June 15, 2017. The presentation was an update to a CPT presentation in May 2014. The Alaska Seafood Cooperative (AKSC) at-sea sampler will collect data on crab bycatch, if permitted, to trawl in the RKC Savings Area. Onboard samplers would be trained as fishery observers and the question was raised whether there was a need for additional training. The CPT suggested that information on crab shell condition, length, clutch fullness, and embryo clutches from females would be useful. The state has a December training program for crab observers that the at-sea samplers could perhaps attend. Water temperature data will be collected. Bob Foy suggested the CPT support the proposal. The crab industry supported the idea of collecting the data and questioned if the end timing could be shifted earlier.

The CPT discussed if the results would affect the survey, which occurs in June, and concluded that this would be very unlikely. The CPT suggested however that ending earlier would reduce the risk of

collecting reproductive or molting females, particularly in a warm year; May 15 would be preferable to June 15. The groundfish fleet plans to stay within the current bycatch caps and they propose that this plan would allow for lower bycatch of king crab. The application fits within Council priorities to re-examine the effectiveness of closure areas. When the CPT discussed whether information on habitat-forming structural invertebrates could be collected, Gauvin indicated that the trawl is designed to avoid these benthic invertebrates. Groundfish observers will be on board and can collect data on bycatch of non-crab invertebrates. The BSFRF research surveys may have video information that could address differences in benthic invertebrates inside and outside the RKC Savings Area.

Stock assessment prioritization

Rick Methot, NMFS Senior Scientist for stock assessment, provided an overview of the new national policy for prioritizing stock assessments. A NOAA tech memo was released in August 2014 and is available online. Prioritization involves a multiple-component weighted-factor decision analysis. This prioritization will be implemented for Pacific coast groundfish for next June. The MSEs are intended to be used for each FMP to better inform target assessment level and frequency.

Team members had a variety of questions on the intent and implications of the process:

- Why would annual assessments for crab in the North Pacific be done less frequently? Prioritization may look at variability in ABCs from one year to the next. The intent is not to reallocate effort between regions but rather, within regions, for staffing and necessity of annual assessments.
- What about importance of the survey when it's a multi-stock crab/groundfish survey? What collection of assessments may be produced simultaneously? Recruitment variability should also be factored into this. Suggestions include calculating the mean age of catch as a measure of inertia in the ACL. Target frequency should be weighted according to fishery importance. There could be a rationale for less frequency of assessments if there is an established protocol for decreasing the ABC in every year away from the assessment update. Team members noted that the assessment process in the North Pacific is more focused on refinements than on 'benchmarks' and is dissimilar to other regions.
- Team members questioned the necessity of national prioritization. It was explained that the return on this nationally is in national budget allocation. In order to better allocate resources and increase existing budgets for assessments by region we need to have a nationally consistent prioritization.
- How do survey-based assessments factor into prioritizations? Rick indicated that there could be an opportunity to look at signal-to-noise ratio in inter-annual fluctuations, i.e., smooth out measurement error but continue annual surveys. Year-to-year changes in quota may not accurately reflect changes in biomass.
- How are results weighted against each other nationally? Rick noted that they are not trying to develop a national list, but to prioritize by region. Regional processes can be compared nationally for identifying gaps on a national level. While investments in capacity by region are unlikely to erode, maintaining the program at its current level remains a priority.
- How does the push to Ecosystem Based Fishery Management and multi-species integrated stock assessment fit in? It would be identified as a gap and the priority would then be to move to a higher level. Gap analysis through SAIP may help to prioritize research plan but the goal is not to use this process for directly prioritizing either surveys or research gaps.

Economic Assessment

Brian Garber-Yonts presented a summary of key economic indicators for ex-vessel and wholesale sectors of BSAI crab fisheries and an overview of the status of information to be included in the 2015 BSAI Crab Economic Status Report (Economic SAFE). The summary report will be included as an appendix to the

SAFE document for October and the Economic SAFE will be finalized and presented to the SSC in February. Reports are available online at http://www.afsc.noaa.gov/REFM/Socioeconomics/SAFE/default.php. Due to the timing of economic data collection, data representing the 2014 calendar year is the most current available for most economic indicators in the 2015 report update. Key economic indicators, including trends in 2014 ex-vessel and wholesale production and value, crew employment and earnings, and IFQ lease activity for the Bristol Bay red king crab and Bering Sea snow crab fisheries, were discussed. Most economic indicators of production and sales, and employment and wages, declined from 2013 to 2014. Average prices declined for the third year from peak levels in 2011. Brian noted that price declines were being driven by the economic downturn and, more importantly, by competition from increased Russian crab exports. There was a slight decrease in number of active vessels across all Crab Rationalization program fisheries, but total crew positions increased due to the opening of the Bering Sea Tanner crab fishery for the 2013/14 season. Aggregate crew and captain share earnings went down, as did the crab processing labor hours and earnings, with average hourly wage rates declining 16%. Bristol Bay red king crab IFQ lease activity increased while the leased amounts declined for snow crab, and median lease rate, calculated as percent of ex-vessel price, remained stable at 63-65% in Bristol Bay red king crab and 46-48% in snow crab. The CPT did not provide any explicit advice for the authors. The final SAFE will be made available to the team in February.

Essential Fish Habitat 5-Year Review

The CPT briefly discussed the progress of the EFH 5-Year Review. Bob Foy indicated that the current workplan no longer includes an opportunity for the CPT to provide input on the review. The CPT was in agreement that the EFH review should be reviewed by crab assessment authors and the CPT as a whole, with the opportunity to provide input.

Other/New business
Meetings: January CPT meeting January 11-13, 2016 Anchorage

Agenda items for CPT: NSRKC assessment (OFL and ABC); Data weighting discussion; TOR/assessment and presentation guidelines; Ecosystem report card development; snow crab assessment model; EFH; Selectivity discussion; AIGKC (pending resolution of continued effort and resources available toward AIGKC model)

Crab Modeling workshop: January 14-15, 2016 Anchorage

Agenda items for modeling workshop: Gmacs application to BBRKC, SMBKC; BSFRF data presentationCPT meeting: September 19-23, 2016 AFSC Seattle

North Pacific Fishery Management Council Crab Plan Team Meeting

September 14-17, 2015

AFSC Traynor room, Seattle, WA

FINAL AGENDA [revisions from previous in RED] 09/03/2015 version

Monday, September 14		
09:00	**Administration**	Introductions, agenda, meeting minutes, documents/timing for October Council
09:15	**EBS Trawl Survey**	2015 survey update
10:30	**EBS Ecosystem report**	2015 update
11:00	**AIGKC/WAIRKC**	Overfishing status determination
Noon	LUNCH	
1:00	**Snow Crab**	Final Assessment: OFL and ABC
3:00	**BBRKC**	i. Final Assessment: OFL and ABC ii. BSFRF selectivity and recruitment study
Tuesday, September 15		
09:00	**EBS Tanner Crab**	Final Assessment: OFL and ABC
Noon	LUNCH	
1:00	**SMBKC**	Final Assessment: OFL and ABC
3:00	**PIRKC**	Final Assessment: OFL and ABC
4:30	**PIBKC**	Final Assessment: OFL and ABC
Wednesday, September 16		
09:00	**AIGKC**	i. Survey briefing ii. Model development update iii. Discussion on model approval
Noon	LUNCH	
1:00	**NSRKC**	i. Norton Sound survey & research update ii. Model discussions and scenarios for January assessment
3:30	**GMACS**	i. CIE review update ii. Model development update iii. Application to BBRKC
Thursday, September 17		
09:00	**Assessment Prioritization**	Update on National Assessment Prioritization Policy (Rick Methot)
10:00	**BBRKC**	Bristol Bay Closure Area EFP request
10:30	**PIGKC**	Data input update
11:00	**Economics Assessment**	Data update
11:30	**EFH Review**	5 year EFH and Effects of Fishing Review
Noon	LUNCH	
1:00	**CPT TOR review**	Update/edit the TOR
2:00	**WAIRKC FMP update**	Council discussion paper planning

2:30	**Finalize SAFE introduction**	Finalize 6 Intro summaries; summarize minutes as necessary
4:30	**New business**	Meeting planning 2015/16 (model workshop, January/May/Sept 2016 CPT)
5:00	**Adjourn**	

Note: There will be webex available for this meeting Monday through Thursday 9am-5pm. Information below for participants:
https://akfsc.webex.com/akfsc/j.php?MTID=mfdb662ad3df12e63d7835e3983143ed1

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