Crab Plan Team Report

North Pacific Fishery Management Council
605 W 4th Avenue, Suite 306, Anchorage, AK 99501

The North Pacific Fishery Management Council's Bering Sea/Aleutian Islands (BSAI) Crab Plan Team (CPT) met January 9-11, 2018 at the Hilton Hotel, Anchorage, AK.

Crab Plan Team members present:
Bob Foy, Chair (NOAA Fisheries /AFSC – Kodiak)
Ben Daly, Vice Chair (ADF&G – Kodiak)
Diana Stram (NPFMC)
Bill Bechtol (Univ. of Alaska Fairbanks)
Martin Dorn (NOAA Fisheries /AFSC - Seattle)
Ginny Eckert (Univ. of Alaska Fairbanks/SFOS – Juneau)
Krista Milani (NMFS AKRO - Dutch Harbor)
Katie Palof (ADF&G - Juneau)
Shareef Siddeek (ADF&G – Juneau)
Laura Slater (ADF&G – Kodiak)
William Stockhausen (NOAA Fisheries /AFSC - Seattle)
Jack Turnock (NOAA Fisheries/AFSC – Seattle)
Miranda Westphal (ADF&G – Dutch Harbor)

Crab Plan Team members not present or participated through WebEx for part of the meeting included: Brian Garber-Yonts (NOAA Fisheries – AFSC, Seattle), André 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 (or participated through WebEx) for all or part of the meeting included: Wes Jones, Steve Martell, Arni Thomsen, Justin Leon, John Hilsinger, Jie Zheng, Katie Howard, Jenefer Bell, Tyson Fisk, Scott Goodman, Mark Stichert.

Administration

The attached agenda was agreed upon for the meeting. A teleconference/WEBex line was made available for the meeting and posted to the Council website. All PowerPoint presentations were posted to the agenda. The Team reviewed the assignments and the logistics for finalizing the introductory section and minutes.

The CPT voted on a new Vice Chair as Karla Bush (ADF&G) has changed jobs. Ben Daly (ADF&G) volunteered and the CPT voted unanimously to approve him as the Vice Chair. The CPT thanks Karla for her service with the CPT.

Remaining CPT meetings in 2018: May 7-10, 2018 (TBD, Anchorage); September 10-13, 2018 (AFSC Seattle)

Norton Sound Red King Crab

Toshihide (Hamachan) Hamazaki presented the 2018 Norton Sound red king crab assessment to the CPT. New trend data in the assessment included 2017 ADF&G and NMFS bottom trawl surveys in Norton Sound, and a recalculated fishery CPUE index. The ADF&G and NMFS surveys indicated declines in abundance, while the CPUE index was stable. Other new data included fishery removals and size composition data from various sources.

The ADF&G survey was re-analyzed to standardize the spatial footprint of the survey, to standardize the calculation of area swept, and to exclude re-tows unless the initial tow was unsuccessful. While this work was considered a step forward by the CPT, there are still some issues concerning the ADF&G survey that need to be addressed. In some years not all stations were sampled within the spatial footprint of the survey. In these cases, the catch at unsampled stations was assumed to be zero. The CPT discussed whether it would be possible to improve upon this approach. **The CPT recommends additional consideration of alternative methods to standardize the survey area swept estimates.** One possibility would be to use a stratified estimator and use stratum means for strata with missing stations. Alternatively, model-based approaches, which are gaining both popularity and sophistication, could be considered for generating abundance indices from survey data. The current state-of-the-art model is the VAST model (Vector Autoregressive Spatio-Temporal) developed by James Thorson, but simpler model-based approaches could also be tried, such as delta-GLM models using survey strata as factors.

The CPT also discussed how fishery discard is modeled in the assessment. The retention curve was not estimated but derived from the relationship between the legal carapace width and carapace length. Discussions with AFDG field biologists and industry representatives indicated that there were differences between the definition of legal-sized crab and the crab that are preferred by processors. A small-scale observer program has been sampling discarded and retained crab since 2012 (5 years). Therefore, sufficient observer data may be available to estimate a retention curve in the model. This may also allow the ABC and OFL to be expressed in terms of total catch rather than retained catch, as is currently the case. **The CPT recommends an evaluation of whether estimating a retention curve using observer data is feasible for Norton Sound red king crab.** As a first step, further evaluation of the representativeness of the observer data is needed. Simple statistics such as the percent of the catch that is observed, the percent of the catch that comes from boats that carry observers, and the percent of the catch comes from vessels that never carry observers should be calculated. Additional work is also needed to quantitatively compare the spatial distribution of observer sampling and the spatial pattern of the fishery. If the observer sampling is deemed to be sufficiently representative, a model should be developed to estimate a retention curve. This work should be done in conjunction with evaluating fishery selectivity patterns, and simple versus more complex curves should be evaluated, i.e., one-parameter versus two-parameter logistic curves.

The assessment author summarized five model run alternatives, a base model (model 0) identical to last year's assessment model, and several models that changed fisheries selectivity and added in estimation of natural mortality for the largest size classes in various ways (models 3, 4, and 5). A final model, model 6, included the summer pot survey data. The author recommended use of Model 3. The CPT has the following comments on the various models:

- Models 3, 4, and 5 contrasted models that handled estimation of natural mortality for the largest size classes differently. Model 3 estimated one natural mortality for the last two sizes class, while Model 4 estimated separate mortalities for the last two size class. The improvement of fit for model 4 was very slight, so model 3 is preferred on the basis of parsimony.
- Model 5 estimated separate natural mortalities for the last three size bins. In comparison to model 3, there was improvement of 3.8 likelihood units for two additional parameters. The CPT regarded this as a marginal improvement in fit and questioned whether increase in natural

mortality for the 114 mm size bin was plausible. It would be difficult to argue that crab of this size are experiencing senescence. Therefore, the CPT considers model 3 preferable to model 5.

- Model 6 was an exploration of whether addition of the summer pot survey data collected in 2014-2016 contributed to assessment. Since model results were similar when these data were added, and since this survey will not be continued, the CPT sees little benefit to including this short time series in the assessment.
- A final comparison was between model 0, the base model, and model 3, which differed by whether a one-parameter or a two-parameter logistic curve was used for fishery selectivity. While there was an improvement in fit from model 0 to model 3, the improvement in fit was not to the fishery length composition data, as would be expected, but instead to other data sets unrelated to the fishery, such as the tagging data and the survey size composition. In addition, the estimated selectivity pattern was a gradually inclining curve that continued to increase at sizes above the legal limit, a pattern which the CPT found difficult to rationalize. This suggests that the model used the more flexible two-parameter selectivity curve to account for some other unmodeled process, and therefore should not be considered a model improvement.

Based on these considerations, the **CPT recommends that the OFL and ABC be based on model 0, the base model**. A model similar to model 3 may be acceptable in the future if concerns about how fishery discards are modeled are addressed.

Since the base model includes different natural mortalities by size bin, the CPT recommended in January 2017 that the Tier 4 OFL be calculated by $F_{OFL} = M$ for each size bin using the appropriate natural mortality for that size bin. This was regarded as a refinement of the Tier 4 OFL specifications which did not anticipate that size-specific natural mortality would be used. While this approach seemed conceptually straightforward, the OFL was highly sensitive to this change. Comparison of the 2018 OFL using this approach with the previously used approach of using M = 0.18 for all sizes indicated that the OFL increased by 74%. This increase was caused by the use of $F_{OFL} = M = 0.588$ for the largest two size bins, which is a much higher fishing mortality rate than was recommended previously for Norton Sound red king crab. The CPT was reluctant to recommend a change of this magnitude without confirmation from the SSC that this approach is consistent with the philosophy of a Tier 4 approach, especially since the stock assessment and survey data indicate a recent decline in stock abundance. Therefore the **CPT recommendation is to apply the Tier 4 approach that has been used previously, where $F_{OFL} = M = 0.18$ for all legal biomass.** An alternative approach would be to consider elevating Norton Sound red king crab to Tier 3, which would eliminate these difficulties.

The **CPT has the following recommendations for the next assessment**:

- Evaluate methods to improve ADF&G bottom trawl survey biomass estimation, including model-based approaches.
- Quantitatively evaluate the representativeness of observer sampling.
- Estimate a fishery retention curve. Consider alternative (2-parameter and 1-parameter) curves for both retention and selectivity.
- Provide Tier 3 calculations for the Norton Sound red king crab stock and evaluate its suitability for Tier 3 status.

Bimodality in 2017 snow crab reference point estimates

Cody Szuwalski presented on bimodality in the 2017 snow crab assessment. Bayesian methods were used due to bimodal issues in management quantities, which popped up when jittering was done. Depending on where the model was started, the answer was different at the end. The problem was traced back to the gap in the growth data and the change point in the model. Although the model could find a solution, there

were other values for the growth parameters that provided similar fits. Likelihood estimates of management quantities showed two modes for management quantities and couldn't choose between based on the likelihood.

Cody noted that an added perk of using Bayesian methods was that a distribution of the OFL that accounts for scientific uncertainty was also created in the process. Traditional methods estimate parameters via maximum likelihood, input parameters into the projection script, input numbers at length for the final year in the projection script with error, and then calculate a distribution of the OFL based on the error added to the numbers at length. This can be problematic because parameter values are not perfectly known but are assumed to be so. Further, adding error to numbers at length is arbitrary, and jittering is required to ensure MLEs are found.

When Cody added the new growth data provided from a cooperative AFSC-BSFRF research project at the Kodiak Lab, the kink in the female growth curve was removed, but it was not clear if the added data was adequate for reconciling the change point for males. The addition of the growth data caused the bimodality to be removed (as seen through jittering). The Bayesian method was able to account for scientific uncertainty, but this can also be achieved via maximum likelihood frameworks (but assumes normality). Cody showed that MMB estimates were similar whether using Bayesian or maximum likelihood methods.

Cody's take-home message was that (1) problems that initiated the use Bayesian methods are no longer present in the last chosen snow crab model due to new growth data, and (2) the CPT should attempt to represent scientific uncertainty based on the data rather than buffers. In addition to supporting Cody's recommendations, **the CPT recommended that standard jittering methods be identified to detect similar bimodality in other assessments.**

MCMC posterior draws

Buck Stockhausen discussed several MCMC (Markov Chain Monte Carlo) posterior probability methods. The "posterior probability distribution" (PPD) is often used because it better characterizes parameter uncertainty and captures uncertainty for any model output, not just parameters and sd_report variables. Buck noted that MCMC integrates over the model's PPD to get the marginal posterior distribution for any desired quantity. Generally, there are too many parameters to do this using standard integration techniques. MCMC randomly samples desired quantities using the model's PPD to determine relative sampling rates.

The Metropolis-Hastings Random Walk Method (MHRWM) is a standard method in ADMB and runs a single chain from maximum likelihood estimate solution with multiple runs for multiple chains. This method can require substantial time for complex models, have long "burn in", have substantial thinning of samples for independence, and can get trapped near local maxima for long times. Buck showed several examples of MCMC results from the 2017 Tanner crab OFL calculation including correlations in parameter estimates and diagnostics for MCMC quantities. Buck stated that MCMC analysis will be used in future runs of the Tanner crab model to characterize the OFL distribution and noted that the CPT may want to consider reporting practices for SAFE chapters (i.e., what statistics, diagnostics, are appropriate to show?).
Buck also noted that the No U-Turn Sampler (NUTS), which is new in ADMB 12 (released December 2017), has been reported to have better sampling/coverage properties than MHRWM (shorter "burn in" period, uncorrelated sampling) and is faster. The associated R package "adnuts" allows a user to generate multiple chains for an ADMB model.

Steve Martell noted that the Gmacs framework requires MCMC methods to characterize the OFL distribution and related status determination quantities. The GMACS code is not designed to produce status determination quantities that can be converted to sd_report variables.

Trawl sampling efficiency

Buck Stockhausen (AFSC) provided a presentation on using survey data from two vessels fishing side-by-side trawl to estimate station level catchability. In 2010, side-by-side data were collected from 92 stations during the snow crab survey with the BSFRF and NOAA vessels. The snow crab stock assessment incorporates the data as an independent time series (i.e. the individual station data resolution is not used) with the assumption that the BSFRF sampling efficiency is 1. The goal of the analysis is to estimate station level trawl efficiency similar to Somerton (2013) who used GAM models that incorporate environmental data such as crab size, depth, and grain size to assess efficiency over a region. These data were updated in Somerton (2017) to include acoustically-determined sediment characteristics instead of the kriged interpolated grain size data used in 2013. The results of the GAM analyses are trawl efficiency relationships with carapace width that are not logistic. The proposed analysis would incorporate the ratio of the swept areas and sampling fractions in the two gear types at each station to account for localized environmental effects and estimate a population abundance. Further analysis needs to be done to consider where the BSFRF data would still be incorporated into the assessment model as an independent survey source. The CPT discussed how stations where no side-by-side data are available would be considered. There was some concern that any interannual variability that exists would need to be considered and, along those lines, temperature could be incorporated into the analysis. **The CPT recommended that the author further develop the analysis to address the concerns and to identify research or data needs that would be informative.** Further is was recommended that the Tanner crab selectivity data collected by BSFRF during the AFSC EBS trawl survey be used a as test dataset.

Dynamic B0

Jim Ianelli (via WEBex) described computation of "dynamic B0", presented examples of its use, and demonstrated a simple spreadsheet application for exploring its behavior. Subsequent CPT discussion focused on clarification and possible utility of the method for BSAI crab stock assessments. A notable advantage of the method, which consists in hindcasting the fitted model with all fishing mortality removed, would seem to be that it obviates the need to select a reference period for defining a $B_{MSY\ proxy}$, which choice can seem somewhat arbitrary. On the other hand, the method could be considered less transparent and could potentially lead to a fishing-down effect. Given general interest in the method, **the CPT recommends as a next step that assessment authors do the dynamic B0 calculation and come forward in May with results for comparison.** It was observed that, if nothing else, this effort could prove valuable as a diagnostic tool.

Chela data and Tanner crab male maturity

Bob Foy presented on the results of the 2017 study of Tanner crab maturity using measurements of chela height / carapace width. He covered the data available, the survey methods used, methods to use these data to determine maturity, and how this maturity compares to the current cutline used. Buck Stockhausen then provided a potential avenue for how this information could be incorporated into the current assessment model and what changes in the model that would involve.

While chela heights have been collected historically on the NMFS survey the methodologies have changed over the years. From 1990 to 2006, measurements were only taken to a 1 mm resolution, but starting in 2007 this was transitioned to a 0.1 mm resolution. However, in 2007 the sample size also decreased, and chela height measurements annually alternated between snow and Tanner crab. The current sampling methods are to measure chela heights on 40 crab per size bin in the length range where the transition from immature to mature occurs and distributed across the stock range. The study in 2017

set out to measure chela heights on every new shell Tanner crab to improve the methodology and influence sample size requirements. The relative spatial distribution of the 2017 data was compared to previous years and it appears that the sample of 40 crab per size bin was adequately covering the population spatially.

Multiple methods were used with the 2017 data to establish a relationship between chela height and carapace width to determine the probability of a new shelf crab being mature at a particular length bin. Three methods were reviewed: the discriminant analysis (using prior information of maturity), a mixed regression approach, and a single histogram approach of the CH:CW ratio. None of these methods adequately separated out the crab in the "transition" zone where mature and immature crab overlap considerably.

A final method, that adapted the single histogram approach, examined multiple histograms throughout the overlap (transition) region. In this range of widths, the carapace width data were binned and a breakpoint (low point) in the histogram was identified. A line was then fit to those breakpoints for just the overlap area. This line appeared to separate out immature and mature crab well. The line resulting from this method was applied to older data, 2006 to 2017, and was shown to fit the data well over time. When comparing these results to the current cutline value used, the current cutline underestimates maturity at smaller size classes in the eastern Tanner crab management region and over all size classes in the western region. The new results suggest that in some years we are underestimating the number of mature crab present in the Tanner crab population.

Overall, the goal of this analysis was to receive feedback on current sampling methods, specifically sample sizes and to provide information to inform the model. Concern was expressed from the audience on measurement error on the surveys, if old shell crabs should be included in the analysis, and if there is inter-annual variability in these data. Research questions brought by a CPT member: we still need to confirm maturity using an alternative method, such as hormones and we need to address how this relationship changes over time/space with alternative environmental regimes. There was also concern from State of Alaska managers as to how this change in maturity would affect the harvest control rule since it currently uses the cutline value. The hope is that the new maturity line could be used to also inform the State instead of the cut line.

The **CPT has the following recommendations**:

- Look at measurement error, maybe a side by side comparison of two measurements on a subset of crab
- Assess whether proportion mature is adequately sampled spatially and statistically using 40 crab per size bin? Look at a sensitivity analysis using subsets of the 2017 data where 100% of crabs were sampled.
- Assess temporal sampling error.
- Perform a sensitivity analysis on these results to determine the variability about this line/relationship (this would feed into its use in the assessment model)

Buck Stockhausen presented an option to incorporate these data and analysis into the current Tanner crab assessment model. This would involve using male chela heights from the NMFS survey to determine immature/mature status for measured new shell male crab, and the addition of a likelihood component to fit the observed ratios of mature new shell males to total new shell males by size bin and year.

Currently, the maturity status is estimated outside the model and the number of mature and immature crab is input into the model. Both mature male biomass and the male size compositions by immature/ mature categories are summed over all shell conditions.

Changes to the current model would include fitting to total male biomass by shell condition, rather than mature male biomass, and fitting the observed ratios of mature new shell crab to total male new shell crab, as determined using NMFS survey chela height data, as a new component in the model's likelihood. The data are informing the probability, by size bin, that an immature crab will undergo terminal molt to a mature, new shell crab. Currently, these size-dependent probabilities apply to the entire model time period, but it will be possible to explore temporal variability in these probabilities using a multiple time-block approach.

There was concern from the CPT that classification error (e.g., mature crab incorrectly classified as immature) for the maturity relationship established from the 2017 data was unknown and could not be incorporated into the model. A sensitivity analysis (see suggestions above) would need to be performed on the 2017 data analysis to determine the possible extent of classification error.

The **CPT recommends** that these changes be applied into a model run for consideration by the CPT at the May 2018 meeting.

Terminal year of recruitment

Buck Stockhausen presented a discussion on estimate the terminal year of recruitment in calculating average recruitment for B35% determination with tier 3 stocks. The time period of recruitments to use for B35% varies by assessment but is generally after 1977 (after the 1977 regime shift) and may include the terminal year. Currently, the Tanner crab and BBRKC models include the terminal year in the average recruitment while the snow crab model does not. The Aleutian Islands golden king crab model uses 2012 as the last year of average recruitment. The Norton Sound red king crab model averages the last three values to estimate the final year of recruitment in the model.

The CPT discussed the larger uncertainty that exists in the most recent year of data. The last (most recent) year of recruitment has only one year of data to inform the estimate and, therefore, the model estimated CV may be underestimated. The addition of data in future years can change the recruitment estimate over time and the average recruitment. The effect that the last year of recruitment has on the average will depend on how close it is to the average of previous recruitments. Some assessment models on other species or in other regions fix the last few years recruitments at the average of the previous three years.

The CPT discussed use of a retrospective analysis to determine how many years of data are necessary to stabilize recruitment estimates. **The CPT recommends that assessment authors conduct a retrospective analysis for the May 2018 CPT meeting**. The authors should examine the recruitment estimates, the variance of recruitments, and the estimation of the average recruitment and its variance with respect to the number of years of data that influence a particular year's recruitment.

ADF&G harvest strategies

Ben Daly provided an overview of how uncertainty is considered in the ADF&G TAC setting process to provide transparency and improve how the state & federal processes work together. The CPT discussed that the goal of this agenda item is to consider (1) where the hand-off occurs between the federal stock assessment process and the state TAC setting process, (2) if there could be double-buffering in the federal and state processes, and (3) if stock dynamics are considered similarly between the federal and state processes.

The state sets the TAC for each stock so that the sum of all fishing mortality and the State's assessment of additional uncertainty do not exceed the annual catch level (ACL). Ben reviewed three example areas of uncertainty that the state considered in past TAC setting.

1) BBRKC – Ben acknowledged that there has been a disconnect between fishery performance and population abundance estimates from the survey and stock assessment model in recent years, where CPUE has been increasing while population estimates have been decreasing. Multiple possible hypotheses for this disconnect include spatial aggregation, movement of the stock between the survey and the fishery, and potential greater efficiency of the fleet. One audience member commented that the CPUE is different before/after rationalization. **The CPT suggested the BBRKC author consider adding CPUE indices to the stock assessment.**
2) Tanner crab – The state does not use the model survey or model population estimates in TAC setting due to the lack of model fit (particularly in overestimation of 5-inch males) and instead uses area swept estimates of abundance and other model outputs (F_{MSY}, M, fishery selectivity curve). Additional stock-structure uncertainty exists because of conflicting biological evidence of east-west stock sub-structure. Further, Ben noted uncertainty associated with closure areas, which affect the functional exploitation rate in areas outside of the closed areas.
3) Snow crab – ADF&G considers model performance annually and developed a report card on model uncertainty to help guide how to use model output in TAC setting. The CPT discussed that this evaluation of uncertainty could be useful in setting the buffer between the OFL and ACL and in evaluating the performance of the stock assessment model.

Daly noted that because of the condensed timeline of the BSAI crab assessment process (survey, CPT assessment model recommendations, SSC approval) the TAC setting timeline allows for a brief (often ~ 2-week) window for TAC setting. The CPT and industry representatives commented that they appreciated the presentation and dialogue. **The CPT recommended that ADF&G could provide a report on TAC setting for the January CPT meeting each year.**

Aleutian Island golden king crab genetic results

Chris Siddon (ADF&G) provided some preliminary results from the genetic studies of the Aleutian golden king crab (AIGKC). This study involved AIGKC industry vessel support and North Pacific Research Board funding. A total of 917 AIGKC were sampled, including ~115 crab from each of 8 subareas. The survey design sampled a maximum of 1 crab/pot and up to 5 crab/string, but did not selectively sample across size or sex. Sample collection is essentially completed, although sample analyses are still underway, particularly samples collected from the far west Aleutians. Analyses have involved mitochondrial DNA and microsatellites. Preliminary results show no isolation by distance (i.e., samples from farther away do not appear less closely related). Although no genetic differences were large, there appeared to be more variation within areas than between areas, suggesting little evidence of local structure across the Aleutian Islands. The intent is to complete the project over the next 6 months. While analyses are ongoing, for now there does not appear to be a management need to delineate AIGKC into separate stocks based on genetics.

Aleutian Island golden king crab proposed harvest strategy

Ben Daly (ADF&G) presented the current status of revisions to the Aleutian Islands golden king crab harvest strategy under development. The revisions will be presented for consideration the Alaska Board of Fisheries in March 2018. Current state regulations include fixed TACs of 3.31 million pounds for waters east of 174° W. long. (EAG) and 2.98 million pounds for waters west of 174° W. long. (WAG), with a provision to reduce the TAC(s) based on stock conditions. The AIGKC assessment was previously listed as a Tier 5 stock but shifted to Tier 3 in the most recent assessment. One aspect of the proposed revisions is to allow the TAC to either increase or decrease beyond the existing TAC in response to stock status. The timing mismatch between the assessment and TAC setting under the current annual cycle was also discussed. The assessment is reviewed by the CPT in May to provide ABC/OFL recommendation, the SSC/NPFMC approves the ABC/OFL in June, and ADF&G announces the TAC in July. The fishery

opens in August and ends in May, but not with sufficient time to allow the fishery data to be included in the next assessment. As a result, the assessment lacks the most current harvest data by about a year.

The core elements of the draft strategy include (1) a threshold for allowing a fishery, (2) an exploitation rate based on mature male abundance, and (3) a maximum exploitation rate for legal males. For opening a fishery, it is proposed that the current mature male abundance (MMA) be at least 25% of the long-term average MMA, and that separate thresholds be established for the EAG and the WAG. The period 1987–2012 is proposed for the long-term average MMA, similar to the use of this period for determining average mature male biomass for the Tier 3 assessment. A range of potential slopes for the exploitation rate of MMA may be considered. Historical exploitation rates, calculated as the guideline harvest level relative to MMB, ranged from a maximum of around 30% to around half those rates in more recent years, although historical harvests have been somewhat restricted by the maximum TAC listed in state regulation. For the proposed strategy, the exploitation rate would be multiplied by mature male abundance and converted to biomass by multiplying by legal male crab weight. However, the TAC would not exceed a maximum exploitation rate for legal male abundance. The CPT expressed concerns about the using average legal male weight to convert mature male abundance to legal male harvest biomass. It was also noted that the timing mismatch between assessment, fishery, and mating/molting for GKC differs from the timing for some other king crab species.

The next steps for ADF&G will be to use model population projections (based on the 2017 assessment model) to simulate management strategies. Recruitment will be derived from either (1) a random draw of recruitment from the 1987–2012 time period, or (2) a Ricker S-R model. Each simulation scenario will be projected 30 years, and 1,000 iterations run. Although the management area split historically differed from the 174° W. long. delineation currently used, the analysts have apportioned historical harvest data according to the current EAG/WAG delineation.

The analysts are seeking input on the proposed management revision with the perspective of also hoping to continue the cooperative AIGKC survey. The CPT suggested that the fishery closure threshold be coordinated with the NPFMC control rule so that state is not fishing at a level below the NPFMC threshold; it is anticipated that having the OFL set to 0 would be considered in the TAC setting process, even though the ABC/OFL as currently established are based on data over a year old. It may also be informative to run the simulations for more than 30 years in order to get more separation from the initial conditions. The public noted that the main factor being varied in the current simulation is recruitment, but the simulation should also consider other aspects that may vary. In addition, it would be useful to list the management objectives to be optimized by the management strategies, such as harvest, lack of fishery closures, etc.

Crab bycatch (legal vs non-legal retained)

William Gaeuman (ADF&G) presented details and issues with legal/legal not retained designations made by ADF&G observers sampling on-board crab vessels in the Bering Sea Aleutian Islands crab fisheries. Fishermen discard legal crab in the fishery for a number of reasons: industry preferred size which is larger than the legal size; injured, diseased, or unmarketable crab; conservative sorting ‘by eye’ on deck by fishing crew; and/or observer impact. Designations of legal not retained are made by observers based on what the captain or crew has communicated to the observer prior to going on deck rather than on actual observation of discarded crab, making this information suspect as real "data", potentially subject to misinterpretation and is ultimately indefensible. To address this problem, the SSC previously suggested having crew presort the catch for the observer to sample in order to more accurately report on legal discards. It was argued, however, that this alternative would in fact do little to solve the problem and would come at the cost of disrupting normal fishing operations, as well as potentially resulting in an increase in discard mortality due to observer impact. It was proposed instead that observers stop

collecting information on legal retention status, and two simple examples were given to show that estimates of discard mortality could be obtained without such information.

The **CPT requested for the May 2018 meeting that assessment authors evaluate the impacts associated with discontinuing the collecting of information on legal retention status by crab observers**. In addition, authors were encouraged to evaluate alternative discard calculations and/or suggest alternative methods for the determination of legal male retention status. **The CPT also recommended that stock assessment authors outline for the CPT how legal not retained information is used or addressed in stock assessments.**

Weighting and lambdas in Tier 3 and other assessments

Shareef Siddeek provided a presentation on data weighting tools to facilitate a discussion with the CPT on guidance for best practices to authors. The CPT generally discussed the difference between stage 1 (e.g., base unit for size composition data) and stage 2 (effective sample size of likelihood components) weighting. For stage one weighting it was generally agreed that actual sample size for variables such as length are not appropriate, but number of tows, pots sampled, or trips would be more appropriate. However, it was apparent that this is being implemented differently by different stock assessment authors, so the CPT recommended that a table be developed for the May 2018 CPT to compare methods being used in each model. Future discussions also need to consider the necessity of re-weighting after data is jittered when analyzing model convergence.

The discussion on stage two weighting started with the differences among the McAllister and Ianelli (1997), Francis (2011), and Thorson et al. (2017) methods. The McAllister and Ianelli method assumes simple random sampling and multiplies sample size by the overall mean weight. The Thorson et al.'s method uses Dirichlet –multinomial distribution method to estimate effective sample size using priors (instead of proportions). This is an automated version of the McAllister and Ianelli method that could be easily coded into stock assessment using ADMB. The Francis method is an iterative process that matches variability in the observed vs predicted mean length thus addressing correlation in the data not addressed by the other two methods. However, the Francis method weights across all years and thus does not address autocorrelation among years (unlike the McAllister and Ianelli method).

The CPT discussed the importance of initial weighting and effects on convergence to local minima. The **CPT recommended a further discussion on data weighting once the current methods used by the different authors are clear.** In general, the **CPT recommended that authors use the Francis method first and then consider other approaches as necessary.**