

## Crab Plan Team Report

The North Pacific Fishery Management Council's Crab Plan Team (CPT) met May 5-8, 2014 at the Federal Building, Juneau, AK.

### Crab Plan Team members present:

<b>Bob Foy, Chair</b>	<b>(NOAA Fisheries /AFSC – Kodiak)</b>
<b>Karla Bush, Vice-Chair</b>	<b>(ADF&amp;G – Juneau)</b>
<b>Diana Stram</b>	<b>(NPFMC)</b>
<b>Doug Pengilly</b>	<b>(ADF&amp;G – Kodiak)</b>
<b>Jason Gasper</b>	<b>(NOAA Fisheries – Juneau)</b>
<b>Heather Fitch</b>	<b>(ADF&amp;G – Dutch Harbor)</b>
<b>Jack Turnock</b>	<b>(NOAA Fisheries/AFSC – Seattle)</b>
<b>Shareef Siddeek</b>	<b>(ADF&amp;G – Juneau)</b>
<b>Martin Dorn</b>	<b>(NOAA Fisheries /AFSC)</b>
<b>William Stockhausen</b>	<b>(NOAA Fisheries /AFSC)</b>
<b>André Punt</b>	<b>(Univ. of Washington)</b>
<b>Bill Bechtol</b>	<b>(Univ. of Alaska – Fairbanks)</b>
<b>Brian Garber-Yonts</b>	<b>(NOAA Fisheries – AFSC Seattle)</b>
<b>Ginny Eckert</b>	<b>(Univ. of Alaska – Fairbanks)</b>

CPT members absent: *Josh Greenberg (Univ. of Alaska – Fairbanks), Wayne Donaldson (ADF&G – Kodiak)*

Members of the public and State of Alaska (ADF&G), Federal Agency (AFSC, NMFS), and Council (NPFMC) staff were present for all or part of the meeting (or WebEx) included: John Hilsinger, Linda Kozak, Matt Eagleton, John Olson, Maura Sullivan, Ruth Christianson, Edward Poulson, Jie Zheng, Bill Gaemann, Hamachan Hamazaki, John Gauvin, Athol Whitten, Sarah Marrinan, Wes Jones, Steve Hughes, Scott Goodman, Chris Siddon, Glenn Merrill, Gretchen Harrington, Cody Szuwalski, Dan Urban, Diana Evans, Heather Brandon.

## 1. Administration

*Agenda:* An updated agenda with modifications for the meeting was made available and is appended to this report.

*WWF request for feedback:* Heather Brandon (WWF) requested assistance assessing the biological implications of illegal fishing for snow and king crab in Russia. It is unknown to what extent females are harvested in the illegal fishery. Management set TAC numbers, catch harvest numbers, and export numbers are available and do not indicate any illegal harvests. However, import numbers in other countries suggest there is additional catch beyond the TAC. WWF is comparing import numbers to catch data to quantify the difference. Species identification in the import data is difficult to determine due to false or “mixed crab” reporting. She will solicit feedback and further information from assessment scientists directly to incorporate into her study.

## 2. Final assessments

### *2.1 Norton Sound red king crab*

#### 2.1.1 Stock assessment

Toshihide Hamazaki provided an overview of the Norton Sound Red King Crab (NSRKC) stock assessment for the fishing year 2014/15. The author focused on recent model data updates and recommendations of the January 2014 modeling workshop, given that this stock has been the subject of modeling workshops in recent years. During the presentation, Wes Jones (NSEDG) summarized a new

program survey with NPRB funding starting this year to tag crabs, with tag recovery anticipated over coming years.

The CPT again discussed the assessment calendar, recognizing that harvesting occurs in both summer and winter, summer fishing can start in May and extend into September, and one of the most informative data sources is a triennial trawl survey that occurs in August. Consequently, it is difficult to obtain the new data in time for the September CPT meeting, and updated OFL/ABC determinations are needed prior to potential May fishery opening. Although catch in the recently completed winter fishery was relatively low, it was pointed out that poor ice conditions for much of the past winter curtailed much of the potential fishing effort. The CPT recommends setting an OFL/ABC from the current analysis for the near term, addressing model structure revisions at the September CPT meeting, and adding a mid-winter meeting starting in 2015 to review the annual stock assessment for NSRKC. Contingent on scheduling, the CPT concluded the mid-winter assessment review could be added to a crab modeling workshop or could be a WebEx meeting.

The author summarized several of the workshop recommendations for alternative model runs. The base model (Model 0) was developed during the January 2014 modeling workshop. Model 1, which assumed identical selectivity curves for the NMFS and ADF&G trawl surveys, produced little change in the likelihood estimates. In contrast, Models 2-4 assumed separate selectivity patterns for the NMFS/ADF&G trawl surveys. Model 3 included the winter survey CPUE data as a means to inform the winter fishery harvest, but this had negligible impact on model results. The CPT noted that the winter fishery is relatively small and would play a lesser role in informing the assessment compared to the data from the summer fishery and the survey. Model 4 excluded all winter survey data and had convergence problems. Model 2o estimated a growth transition matrix outside of the model; Model 2io estimated a growth matrix inside the model but separated newshell and oldshell crab, and Model 2ii estimated the transition matrix inside the model but pooled crab across shell condition. Estimation of a growth transition matrix for Models 2io and 2ii relies on tag data. One suggestion for improving model fit is to explore different weighting schemes for the tag data; this may be important since there are a relatively small number of tags compared to other data. At present the tagging data may be overweighted because no account is taken of the possibility of overdispersion.

Although the author felt that there were little differences in the log-likelihoods among many of the model configurations, the CPT pointed out that the models differed substantially in aspects such as the number of parameters and simply looking at likelihood values was inappropriate. However, it was apparent that many of the model configurations, including Model 2io, were having problems with parameters hitting bounds during model convergence. One suggestion was to relax some of the parameter bounds as model convergence progressed. The CPT also noted that results of some model results were not available in the assessment appendices, making it difficult to evaluate potential problems.

The author discussed the issue of needing to have a high  $M$  for largest size class ( $0.64\text{yr}^{-1}$ ) to keep  $M$  for other classes more reasonable ( $0.18\text{ yr}^{-1}$ ). The CPT requested that the author plot likelihood profiles for a single  $M$  for all size classes and also likelihood profiles when  $M$  differs between the last size-class and the other size-classes.

The Plan Team concurred with the author's recommendation of Model 2io for the current assessment. The author questioned whether 10% buffer on ABC is still appropriate given the decline to Tier 4b. The CPT noted that just a drop tier status does not necessarily mean a change in uncertainty. When reviewing the Status and Catch Specifications, the CPT questioned whether the author's OFL/ABC was based on total catch. The FMP indicates that the OFL/ABC should be based on total catch, not just retained catch, if data are available. However, discard estimates in the NSRKC model are derived from only 2 to 4 observations

from of up to 60 vessels annually, and sampling trips are opportunistic, meaning that the discard data may be very uncertain. The CPT felt there is insufficient data to adequately estimate discards for setting OFL/ABC and recommended **only retained catch be used for OFL/ABC calculations**. It was, however, recommended to pursue research on non-retained catch.

### 2.1.2 Overview of LLP issue for June Council Meeting

Sarah Marrinan (Council staff) provided an overview of a draft discussion paper on the Norton Sound Red King Crab fishery. In October 2013, the Council received public testimony from a NSRKC fisherman asking for action to discourage over-capitalization of this fishery. Specifically, he asked the Council to consider requiring LLP licenses for all vessels, as well as applying a recency requirement for the existing pool of LLP licenses. The paper describes the stock, the fishery, and participation by vessel size and licenses. Sixty-two licenses are available for NSRKC participants; a total of 22 licenses were used on vessels  $\leq 32'$  and seven were used on vessels  $> 32'$  during 2008 – 2012. Federal Regulation exempts vessels smaller than 32' from the LLP requirement. However, all vessels that qualified for an LLP received one, regardless of size. Additionally, vessel loan programs through area CDQ groups provide more money for vessels tied to an LLP than those that are not.

The final discussion paper is expected to have errors in total harvest information corrected in Table 2 and Appendix B (some harvest was double-counted and the final tables will report summer harvest only) and include fishery information through 2013. The CPT asked about local participation, and the analyst said she would look at the addresses listed on the LLP licenses; generally it was thought the fishery is prosecuted by a local fleet due to the superexclusive fishery designation. Some of the vessels likely participate in the local halibut fishery and at least one is known to participate in the Kodiak Pacific cod fishery.

The team is not aware of any overcapitalization concerns that affect fishery management; season length has remained consistent at 2+ months with the exception of 2011, which was a one-month season.

## *2.2. Aleutian Islands Golden King Crab*

### 2.2.1 Tier 5 assessment

Doug Pengilly presented the Tier 5 assessment for Aleutian Islands golden king crab. The management area includes waters west of 164° 44' W and is separated into eastern and western areas at 174° W. The fishery data have been updated with the data for 2012/13: retained catch for the directed fishery and bycatch estimates for the directed fishery, non-directed crab fisheries, and groundfish fisheries. In relation to the OFL, the assessment author recommended that the same approach be used to determine the OFL as in 2012 and 2013. This approach uses retained catch for the 1996/97-2008/09 seasons, and the average annual ratio of bycatch mortality due to crab fisheries to retained catch in the directed fishery for the 1985/86-1995/96 seasons

In relation to the ABC, the assessment author noted that the ABC for this stock has been set to the maxABC (a 10% buffer) in the past. The assessment author recommended a 25% buffer be used instead. The time-period used to determine the OFL for tier 5 stocks should be chosen to be representative of the productivity of the stock. There is uncertainty regarding the appropriate years to compute the OFL, and the CPT has suggested various ranges in the past, which suggests that there is uncertainty about the basis for setting the OFL. The assessment author also noted that the ABC for the Tier 5 Western Aleutian Islands (“Adak”) red king crab stock is based on a 40% buffer, and that of the six FMP stocks that are annually surveyed by the NMFS EBS continental shelf bottom trawl survey, the ABCs for three were computed using a buffer  $>10\%$  (EBS Tanner crab with a buffer of 30%, and Pribilof Islands red king crab and St. Matthew blue king crab with buffers of 20% each). The assessment author stated that it is difficult to argue that there is greater uncertainty for those three annually-surveyed stocks than for the unsurveyed

Aleutian Islands golden king crab stock. He recommended a 25% buffer as that is the midpoint between the 20% and 30% buffers applied to those three surveyed stocks.

The CPT agreed that there is more uncertainty in the Aleutian Islands golden king crab assessment than is consistent with a 10% buffer. However, the CPT could not agree on an appropriate approach to determine a buffer for between the OFL and ABC. The CPT agreed that the basis for applying buffers for BSAI crab stocks were not consistent and recommends that a method of determining appropriate buffers for all stocks be developed prior to modifying the buffer for this stock.

The CPT recommended that the minor errors in the document (e.g. 500t instead of 5000t be corrected prior to the document being finalized and sent to the SSC.

### 2.2.2 Survey for Aleutian Islands Golden King Crab

John Hilsinger provided an overview of ongoing research and plans for the Aleutian King Crab Research Foundation (AKCRF), a 501(c)(6) non-profit formed in 2012, which includes all of the vessels that participate in the Aleutian Islands golden king crab fishery. Many of these vessels also hold Aleutian Islands red king crab quota so the foundation is also interested in red king crab. Their current focus is on cooperative research projects such as laboratory studies, pot selectivity and population size distribution, AIGKC model review (Paul Starr contract) and cooperative stock assessment survey efforts which are currently being developed with ADF&G. Currently the fleet is committed to continued meetings and working with ADF&G on survey design.

Chris Siddon (ADF&G) provided an overview of the goals and current design of the cooperative AIGKC survey. Design issues include how to adequately survey a very large area, survey accuracy and precision, and survey cost. Fishing behavior is another issue, since rationalization has resulted in a much smaller area fished. He provided some information on issues with the ‘triennial survey,’ which has not occurred in recent years due to the high cost of surveying in the Aleutian Islands, as well as some initial efforts at a survey sampling design for the cooperative survey. The current triennial survey area is roughly 10% of overall fished area/habitat. One of main goals of survey has been tagging for growth, not necessarily for abundance. He briefed the team on overall issues with respect to observer data, survey design and other design issues.

Intent of cooperative survey is to do better than the current survey by improve spatial extent, reducing potential for hyperstability, improving cost effectiveness. Survey designs will be evaluated in a small area to test the design. Current work includes looking at dividing areas into small sections based on bathymetry and by fishing effort, and evaluating how to use resources most effectively. In addition, one sampler was recently deployed to work out a basic methodology for survey sampling. Preliminary results include using 5 size categories to subsample pots. The sampler found it was possible to sample every 5<sup>th</sup> pot without disrupting regular fishing operations.

A two-stage sampling design is being considered for the survey: pots within strings and strings as sampling unit define by 0.5x6nm band. Observer data, bathymetry, and skipper experience will be used to define possible locations where strings are to be set. Randomly selected strings will be identified for industry to set either during their first fishing trip or with control rules. The initial survey design would include approximately 50 biologist days, 5 subareas, and 90% of catch area.

Current issues to resolve/comments and suggestion by CPT:

- Independence of pots within strings
- Examine influence of subsample on size frequency distributions
- Refine size categories

- Recommendations on selectivities/Q
- Refine string locations and rationale – can improve as survey progresses to find out where best areas to survey are
- Look at variance on select number strings to go back and re-evaluate target number of strings, need to try first based on survey design

### *2.3 Western Aleutian Islands (Adak) red king crab*

Doug Pengilly provided an overview of the Aleutian Islands Red King Crab Tier 5 Assessment. There is no assessment model for this stock and standardized stock surveys have been too limited in geographic and temporal scope to provide a reliable index of abundance for the entire red king crab population in the Aleutian Islands west of 171° W longitude. Doug discussed historical management of the fishery (Table 1 in the SAFE), specifically, how the geographic scope of the fishery has changed, with the 1990/91 crab season representing a shift from the catch being geographically dispersed to primarily occurring on the Petrel Bank. Recent attempts at opening the fishery occurred during 2001/02 when a test fishery was conducted, resulting in opening the directed fishery during 2002/03-2003/04, after which the fishery was closed due to decreasing catch rates and poor representation of pre-recruit crab in the catch. Subsequent pot surveys on Petrel Bank by ADF&G in 2006 and 2009 showed no increase in the legal red king crab abundance and no signs of pre-recruit males. The fishery has remained closed through the 2013/14 season. In recent years there has been industry interest to conduct a test fishery in the Adak Island area, east of 179° W longitude. However, industry chose not to conduct a test fishery in 2012/13 and no such test fishery has been scheduled to date for 2014.

The Team continues to have concerns regarding the depleted status of this stock. Groundfish bycatch in recent years has accounted for the majority of the catch of this stock. The maximum permissible ABC is 0.11 million lb based on the Tier 5 control rule of a 10% buffer on the OFL. Since the 2012/13 crab fishing season, the CPT and SSC recommended an ABC of 0.074-million lb (34 t) to accommodate a potential red king crab survey/test fishery and bycatch in the crab and groundfish fisheries.

The CPT recommended the following 2014/15 specifications: recommended OFL is 123,867 lb (0.12-million lb; 56 t) and recommended ABC is 74,000 lb (0.07-million lb; 34 t). These are status quo values established since the 2012/13 season; the 0.07-million lb (34 t) ABC was recommended for the 2012/13 season by the SSC in June 2012 as a value that would “be sufficient to allow for bycatch and groundfish prohibited species catch in non-directed fisheries and the proposed test fishery catch” (June 2012 SSC minutes, page 10).

A State of Alaska Board of Fisheries meeting in March 2014 divided the area into two management districts: 1) the Petrel District west of 179° W long and 2) the Adak District from 171 to 179° W long. Pot limits were established in the Adak District at 10 pots per vessel in state waters and 15 pots in federal waters. The season opening date was changed for the Adak District from October 15 to August 1 and federal waters of the Adak District would be closed in when the Adak District GHL is less than 250,000 lbs (113 t).

## **3. Modeling scenarios for Fall 2014**

### *3.1 Bristol Bay Red King Crab*

Jie Zheng gave an update on the Bristol Bay red king crab assessment. He first reviewed recent CPT and SSC comments and the responses to those comments. The CPT (Sept. 2013) requested the author consider model scenarios in which he: 1) estimated survey catchability for the NMFS trawl survey while fixing survey catchability to 1 for the BSFRF surveys, and 2) explored the implications of a potential high period of natural mortality in the late 2000s suggested by his Scenario 7 model run in the assessment. In

addition, the CPT requested at the January 2014 Modeling Workshop that all authors run model scenarios incorporating newly revised fishery and trawl survey data. Jie incorporated previously updated trawl survey results into several model scenarios, but this was not the “new” data the CPT was referring to. New trawl survey results based on discussions held at the Modeling Workshop were not available in time for the meeting.

In response to an SSC comment (Oct. 2013), “shifts in the center of distribution of BBRKC can be a function of depletion of the stock, the crab closure area, shifts in larval drift, habitat selection, or fishing. The interpretation of which of these potential causes contributes to selection of a time period should be investigated”, Jie stated that the availability of adequate data to disentangle these causes was unlikely. There have been many studies on this issue, and on the sharp decline of abundance in the early 1980s, during the last 30 years. However, the issue remains unresolved. Jie will attempt a more in-depth analysis of this issue and present the results in the September SAFE report.

Jie also addressed an SSC suggestion (Oct. 2013) that “the authors work with flatfish authors to come up with a consistent approach to treatment of biomass outside of the survey area”. Flatfish authors use a linear regression to “fill in” survey data from strata that were not surveyed. Jie felt this was inappropriate for BBRKC and that the model’s selectivity function reflected availability as well as capture probability reasonably well.

In response to another SSC comment (Oct. 2013) that further study on maturity was necessary, Jie responded that he currently uses a step curve to model changes in female size-at-maturity over time, but that it would be better to fit the data with a continuous curve over time. The reason for modeling the change is to improve estimation of growth increment per molt and the limited availability of growth increment data in the EBS is the main reason for using a simple step curve. In the future, Jie may examine the growth increment data from Kodiak female red king crab to see whether these can be used to construct growth functions for female Bristol Bay red king crab. Once better growth functions are available, Jie will be able to improve methods of estimating variation in female size-at-maturity over time. He noted that female biomass is not used for overfishing determination. He also noted that, although size at sexual maturity for Bristol Bay red king crab males has been estimated (Paul et al. 1991), there are no data for estimating the size of functional maturity using data collected in the natural environment. Functional maturity sizes were estimated for Bristol Bay red king crab males based on the data of size of Kodiak red king crab males in mating pairs and the larger size-at-maturity of Kodiak red king crab females than of Bristol Bay red king crab females (Pengilly et al. 2002). The sizes of males that can successfully mate with females in the laboratory are much smaller than estimated 120+ mm functional maturity sizes.

The SSC (Oct. 2013) also suggested a re-evaluation of predation pressure on Bristol Bay red king crab. Jie requested more detailed guidance from the SSC on how to investigate this issue. His main problem is that the diet data currently collected by NMFS do not reflect the predation of Bristol Bay red king crab by groundfish due to the timing (primarily summer) and spatial distribution of data collection. There is also a lack of information on groundfish abundance in the shallow, nearshore waters where small juvenile red king crab likely occur. At the CIE meeting in 2010 on Bristol Bay red king crab, a model was presented by a NMFS scientist to estimate how many juvenile king crab were consumed by groundfish. However, the juvenile king crab discussed were mainly St. Matthew blue king crab as very few small Bristol Bay juvenile red king crab were present in the diet data.

Jie presented seven model scenarios for evaluation by the CPT. The first (Scenario 4) was the model used for the 2013 assessment. Scenario 4b was the same as Scenario 4, except that catchability for the NMFS trawl survey was also estimated. Two scenarios (4n, 4nb) were the same as Scenarios 4 and 4b except that these included revised time-series of trawl survey biomass, length/sex compositions and biomass CV.

Scenarios 4nb0.5 and 4nb2 were the same as Scenario 4nb, except that the CV of trawl survey catchability was half (0.5) and twice (2) the estimated value. Finally, Scenario 4nb7 was the same as Scenario 4nb, except that one additional natural mortality parameter was estimated for both males and females during 2006-2010. Model-estimated relative survey biomasses were very similar among the scenarios, with the exception of 4nb7 (the additional mortality period scenario). Increasing natural mortality from 0.18 to 0.28yr<sup>-1</sup> during 2006-2010 under Scenario 4nb7 led to a better fit to the trawl survey data during recent years, resulting in a much lower OFL. The estimated CV for trawl survey catchability (Q) was about 0.03, and increasing the CV resulted in higher estimated Q values. Jie recommended using Scenario 4nb for OFL, ABC setting in Sept. 2014.

Jie noted that the re-estimated time series of area-swept abundance estimates was almost the same as the time series used in 2013, with the exception of 2008 (the “new” estimate was 9% lower than the one used in the assessment). Bob Foy stated that the time series Jie used was not the revised trawl survey time series the CPT had requested at the 2014 Modeling Workshop. Bob Foy stated that NMFS would no longer (and hadn't for several years) be conducting “hotspot” tows and that he was working to remove such previously-conducted tows from trawl survey results provided to assessment authors because they can lead to biased estimates of abundance. Revised trawl survey results, incorporating this decision as well as a number of others, will be provided to all assessment authors in time for incorporation into the September 2014 assessments.

### 3.1.1 CPT Recommendations

1. Drop Scenarios 4 and 4b because these use the old data.
2. Move forward with Scenarios 4na, 4nb for September 2014.
3. Although it appears to result in improved model fits, drop Scenario 4nb7 from consideration until a mechanism for the estimated higher  $M$  can be established; this scenario can be presented for re-consideration once a plausible mechanism has been identified.
4. Add the number of estimated parameters to tables that compare values for likelihood components from different Scenarios so that the degree of improved fit can be more easily evaluated. Also, express the values of log-likelihood components between the base and alternative models as differences (e.g., base less alternative), rather than reporting the actual values because it is the differences in log-likelihood values that are informative.

### *3.2 Model-based assessment for Aleutian Islands Golden King Crab*

Siddeek presented an updated model-based assessment for Aleutian Islands golden king crab. The focus of CPT activity in relation to this assessment in the past has been on how to develop standardized indices of relative abundance. The CPT has now adopted an agreed approach for CPUE standardization and is conducting a review of the proposed assessment model. It was not possible to conduct a full review of the draft assessment at the present meeting because the assessment report was only provided to the CPT a few days before the meeting (see General Issues). Siddeek first summarized the changes to the assessment and data since the September 2013 CPT meeting, and then provided an overview of the methods and results. The CPT noted that the model incorporated several of its earlier comments but that some key issues remain to be addressed

1. The weighting factors should be specified as CVs and not as lambda values to assist with interpretation of how much weight is assigned to each likelihood component.
2. The weight (lambda) downweights the tagging data substantially. The CPT requests that the basis for any weight be provided.
3. The fishery “devs” for the groundfish fishery are weighted differently between the assessments for the WAG and EAG. The rationale for this is unclear.
4. The “beta” parameter of the growth model is set to 0.74. However, the basis for this selection is unclear. If this parameter cannot be estimated within the assessment, it should be set to the

- estimate obtained by fitting the growth model to tagging data based on an analysis conducted independently of fitting the assessment model.
5. The growth model, which does not include a molting function, should be based on normal rather than gamma errors so that it is possible that there is an appreciable probability of an animal staying in its current size-class.
  6. The variance of the residuals of the fit to the total catch in numbers data changes over time. Consideration should be given to weighting these data by the number of pots or the proportion of the catch measured each year.
  7. It is unclear why the model based on Scenario 2 fits the data for the WAG worse than model based on Scenario 1 given the former model has more parameters.
  8. Show the predicted catches for all years and not just the years with data.
  9. Ensure that the document is clear between ‘input effective sample sizes’ and ‘estimated effective sample sizes’.
  10. The fit to the CPUE data appears overdispersed. However, this plot does not show the impact of the estimated extent of overdispersion but needs to.
  11. Equation 14 should be corrected to account for the fact that some animals were recaptured more than one year after they were released.
  12. The residual patterns for the fits to the total catch length-frequencies are very similar for the EAG and WAG. This is unexpected if these are independent populations, and efforts should be made to understand why this occurs.
  13. The fishing mortality rates are relatively high ( $\sim 0.4\text{yr}^{-1}$ ) and remarkably similar between the WAG and EAG. The analysts should explore (e.g. using a likelihood profile on the mean fishing mortality in the directed fishery) what in the data suggests this and moreover how the model is able to estimate absolute biomass given what amount to relatively flat CPUE indices (using perhaps a likelihood profile on current abundance).

The CPT strongly recommends that the assessment author provide a draft of the updated assessment to the CPT well before (ideally 2-3 weeks) the September 2014 meeting to allow adequate time to review what amounts a very complicated assessment.

### *3.3 St. Matthew Blue King Crab*

William Gaeuman discussed his response to recent comments and recommendations made by the CPT and SSC regarding the assessment of St. Matthew blue king crab, as well as regarding data he supplies to other assessment authors from the crab observer program.

The CPT requested the author “continue to develop a biologically plausible transition matrix” for use in the SMBKC assessment model at its September 2013 meeting. The author has acquired growth data from crab tagged during the 1995 ADF&G pot survey and recaptured during subsequent commercial seasons. He plans to use these data, along with earlier results from Otto and Cummiskey (1990), to develop a more “biologically plausible” stage-transition matrix/population dynamics model for use in September 2014 model configurations. Plots of individual growth increment vs. size-at-release were presented for recaptures from four fishing seasons. CPT members expressed concern over data quality and potential measurement errors. The author noted that the growth increment appeared constant ( $\sim 15$  mm CL, consistent with Otto and Cummiskey) for crab in the 110-160 mm CL release size range, and CPT members raised the possibility that this was due to quantization (e.g., to 1 cm) in the measurements. In addition, the author noted that, these data would not be terribly informative to the model transition matrix in any case because almost all tagged crab fall into the largest size class in the mode.

The SSC requested that the author address the “retrospective bias” in the current assessment at its October 2013 meeting. In an effort to obtain clarification on this issue, the author presented a ten-year

retrospective plot of model-predicted 90+ mm CL male survey biomass. The CPT regarded the plot as indicating a substantial retrospective problem. Potential sources suggested for the bias included time-varying selectivity or growth. It was recommended that the author examine whether there are retrospective patterns in other model output (e.g., recruitment, fishing mortality), as well as residuals for evidence of time-varying growth or selectivity.

### *3.3. EBS snow crab*

#### 3.3.1 CIE review

Jack Turnock provided an overview of the CIE review of the Eastern Bering Sea snow crab model. Noel Cadigan, Norm Hall, and Billy Ernst provided reviews, and Martin Dorn chaired the review meeting, which occurred in January 2014. The CPT discussed the key recommendations for future model development from the review reports, which included the following:

- 1) improve documentation of the assessment, including the model, data sources and data processing;
- 2) analyze the contribution of snow crab outside the currently surveyed area to the population;
- 3) consider survey catchability and selectivity in the BSFRF and NMFS trawls;
- 4) use shell condition information to estimate  $M$ ;
- 5) conduct comprehensive sensitivity analyses;
- 6) update growth information with newly published information; and
- 7) incorporate immature male and female biomass into the assessment likelihood components and assess the effect with respect to the base model.

Research on the stock is needed to improve the assessment including:

- 1) improve life history information including growth, aging, molt probabilities, natural mortality – including spatial differences in these parameters;
- 2) assess the reproductive contribution of different sized males and of females, including those outside the survey area;
- 3) explore a spatially-explicit model;
- 4) conduct additional management strategy evaluations;
- 5) evaluate connectivity among different regions; and
- 6) further development of Gmacs.

Jack Turnock plans to provide a response to the CIE reviews for the September CPT meeting.

#### 3.3.2 Assessment model

Jack Turnock provided an update on the snow crab stock assessment model. Four model scenarios were presented. Model 0 is the September 2013 model upon which the other scenarios are based, Model 1 fits mean growth increment as two linear segments by sex as recommended by CPT in September 2013 (except that both the x and the y coordinates of the join-point were specified, rather than just the y coordinate), Model 2 has fishing penalties removed, and Model 3 is Model 1 with fishing mortality penalties only for the 1978/79 to 1992/93 directed fishery. Based on the likelihood values, Model 1 does not fit the data as well as Model 0. The CPT noted that this result was unexpected because the two linear segment growth model fits the growth increment data better and concluded that this result may be due to the growth increment at the join-point being pre-specified instead of being estimated. The CPT recommended trying Cadigan's (CIE) suggestion on how to parameterize growth in which there is a smooth transition between two linear components. Models 2 and 3 are not directly comparable because they have different growth curves and F penalties. The removal of F penalties in Model 2 results in very high estimates of fishing mortality for 1981 and 1982, and very high estimated male discards. The CPT questioned the high fishing mortality values observed in all model scenarios in the early time series. The CPT was concerned that the model had not converged, despite that ADMB having indicated convergence, because the negative log-likelihoods for Models 2 and 3 are higher than those for Models 0 and 1 after account is taken of the lack of F penalties, which cannot be correct.

For the September 2014 stock assessment, the CPT would like to see Model 0, Model 1 and Model 0 with Cadigan-recommended growth parameterization. If the model converges, then they would also like to see the model with fishing penalties removed.

Jack Turnock presented chela height data availability from 1989 to 2007, 2009 and 2011. The CPT had suggested using these data to evaluate crab maturity. Bob Foy indicated that the sampling protocol would not result in a representative sample overall as crab are measured in certain size bins to meet minimum sample sizes by length bin for each leg of the survey (length-stratified). There are insufficient resources to determine the proportion mature at each station, so the proportion mature can only be estimated at a larger spatial scale. The CPT recommended re-consideration of this protocol and discussed other possibilities including randomly sampling five crabs (or some number that could be reliably measured consistently) from each station. This suggestion provides for samples from each station, which the current protocol does not. If less than five crab (or whatever number chosen) are caught, then all crab should be measured.

The model uses empirically-derived proportion mature data from the chela height measurements from 1989-2007 (new shell males only). For females, the actual proportion mature is used. The CPT would like to see further analyses of the existing data and evaluate how these data are used in the model. This topic could be considered at a future model/data workshop.

The CPT appreciated the succinct presentation of model scenarios but found it difficult to compare the graphics for each model scenario. Incorrect labeling added to the confusion. Ideally, the various models could be plotted all on one graph for each type of graph produced.

The CPT requested that the data used in the models for the September 2014 assessment be updated with the data set provided by Bob Foy (catch, bycatch, and survey data) to ensure use of the most up-to-date data.

### *3.4 Pribilof Islands red king crab*

Cody Szuwalski outlined a new model for Pribilof Islands red king crab that he developed for a Tier 3 assessment, and compared the approach and results with the *status quo* survey-based Tier 4 assessment for this stock. The CPT considered the feasibility of moving the stock to Tier 3. At the outset of the presentation it was noted that the CPT need not limit consideration to choosing between moving the stock to Tier 3 or staying with the current survey-based Tier 4 assessment; i.e., there is a middle ground to consider, such as using the model Szuwalski developed in a Tier 4 assessment, similar to how management advice is developed for St. Matthew Island blue king crab and Norton Sound red king crab assessment.

The model for Pribilof Islands red king crab has 18 fixed parameters (for growth, natural mortality, proportion recruiting, molting probability, fishery selectivity, weight at size, and survey catchability) and 142 estimated parameters. After review of the Tier 3 assessment presented by Szuwalski, the CPT recommended that the stock not be moved to Tier 3 until data for estimating, and reducing the current high uncertainty on, the maturity curve for males, growth per molt, and survey and fishery selectivity are available. This stock is data-poor relative to the Tier 3 Bristol Bay red king crab stock and numerous assumptions on key Tier 3 parameters must be made. For example, due to lack of data, knifed-edged selectivity at legal size was assumed and survey Q was fixed at 1; growth data from Kodiak red king crab were used to estimate growth for the model, although there was some discussion as to whether growth data for Bristol Bay red king crab would be more appropriate. However, the CPT sees the new model as an improvement over the 3-year running average approach currently used in the Tier 4 assessment as a method for smoothing the erratic survey time series. The CPT judged that the model is better at smoothing through the “spike events” that occur in the time series of survey catch although there is the

cost of additional assumptions. The CPT recommended that the model be presented to the September 2014 CPT meeting for use in the Tier 4 specifications for 2014/15 (with attention given to the recommendations listed below) and that the current survey-based 3-year running average Tier 4 approach also be brought to the September 2014 as a “back-up” for the 2014/15 Tier 4 specifications.

Recommendations for the September 2014 review of the model for use in the 2014/15 Tier 4 specifications:

- Add a likelihood profile for survey Q
- Initialize the model a few years before the first year of with data and estimate the sizes of the cohorts which would have been in the population at the start of the first year of the model (i.e., not the initial size structure). This reduces the number of estimable parameters substantially.
- Consider using a more generalized growth model to represent the relationship between growth increment and pre-molt size; (e.g. the Schnute [1981] approach).
- Approaches for addressing sparse size frequency data and sensitivity to size bin widths:
  - do not calculate likelihood contributions when the observed length-frequency for a size-bin is zero;
  - consider the use of broader size bins; e.g., 10 mm instead of 5 mm; and
  - consider incorporating “plus-and-minus bins” where the length-frequency data are pooled at a low and high size (e.g. so that the proportion of the total length composition in the first and last bins is at least 1%).
- The CPT supported the use of the 35 stations with history of survey catch as the stock boundary for applying the model.
- The author should work with Bob Foy to derive CVs for the survey estimates.
- In time series plots of model estimates:
  - include the 3-year averages used in survey-based Tier 4 assessment; and
  - the error bars about the observed values should be based on the assumption that the survey estimates are log-normally distributed.
- Additional data to consider incorporating in the model:
  - ADF&G pot survey data; and
  - retained-catch (“dockside sampling”) size frequency data as available
- A general request that more details on the model be provided for review.

### 3.5 Eastern Bering Sea Tanner crab

William (Buck) Stockhausen presented EBS Tanner crab data and assessment scenarios for the September 2014 assessment cycle. A directed fishery for Tanner crab occurred for first time in many years in 2013 with a TAC of 1,410 t and a total catch of 1,265 t. Buck summarized key changes the data sets used in the assessment based on an examination of the data used for assessment purposes. Buck received revised at-sea observer sample data and the dockside size composition data in the crab fisheries (1990-2012) from Bill Gaeuman, as well as the groundfish fisheries (1972-2012) from Bob Foy after the January 2014 crab modeling workshop. The 1995 retained catch sample was not included in the revised data due to low sample sizes, although it was used in the 2013 assessment. Buck compared the revised data with the data used in the 2013 assessment:

1. The numbers of crabs from dockside and at-sea observer sampling were substantially different in some years in the revised data set. The sources of these discrepancies were not fully understood, but ultimately had little impact on model results.
2. Numbers sampled in the groundfish fishery were also substantially different in some years between the assessment and the revised data set; differences were due to additional datasets (joint venture fisheries) being included and a shift from calendar year to FMP crab year (July 1-June 30).

Buck compared the time series of MMB, recruitment, and fishing mortality estimates from the model using the revised and the 2013 assessment data. There were only slight changes in the mean recruitment and the final MMB estimates between the two data sets.

Buck proposed the following alternative model scenarios:

1. Base model: 2013 assessment model.
2. Base model with discard mortality formulation similar to that used in the Gmacs model.
3. Base model with Bristol Bay red king crab bycatch,  $F_y$ , estimated.
4. Base model with the changes included in models 2 and 3.

The MMB in models 2 and 4 leveled off during the last few years compared to the base model. The CPT was puzzled by this result because the alternative formulation of discard mortality should not have produced a substantial change in assessment results. There was a slight change in recruitment trends between the base and the other models; the patterns were similar but the variability was slightly larger for models 2 and 4. Trends in fully-selected fishing mortality in the directed fishery were quite similar among the models. The estimate of the 50%-selection parameter for the directed fishery for 1996 hit its lower bound in all model scenarios except the base model using the original assessment dataset. Although the Hessian matrix was invertible for all models (a necessary but not sufficient condition for convergence), the author speculated that this parameter hitting its lower bound might be indicative of model convergence problems. He plans to resolve this issue prior to the September 2014 CPT meeting.

The CPT noted that expansion of observer bycatch sampling to entire fisheries (e.g., Tanner bycatch in the snow crab and BBRKC fisheries) will be affected by the apportionment of effort into the directed or bycatch fisheries. For Tanner crab in particular, this can be a difficult exercise because legal-sized males can be retained in the snow crab and BBRKC fisheries (up to 5% of landed catch currently, but limits have not been consistent throughout the prosecution of these fisheries).

The CPT had the following recommendations and observations:

1. The revised data sets should be used in future assessments.
2. Run the model using: (a) the old data set; (b) the revised data set and the composite fleet fishing mortality formula as used in the Gmacs; and (c) the revised data set and bycatch fishing mortality formula as used in the Gmacs.
3. Compare actual discarded catch with model-estimated discarded catch (separately for directed fishery bycatch, snow crab bycatch, red king crab bycatch, and groundfish bycatch).
4. Present the output in terms of fishing mortality rather than catch.
5. If there was a change in handling mortality on Tanner crab, use the new value in a scenario with the revised data.
6. The error in length composition for groundfish would have more impact on the assessment results than the groundfish bycatch biomass. Therefore, it is more important to get the Tanner crab bycatch size frequencies in the groundfish fisheries adjusted to the crab model year (which the author has done) than it is to get the total bycatch biomass perfect. The latter is possible using AKFIN back to 1990, but it may not be possible to extend this adjustment further into the past.
7. Edit the slides for clarity.

### 3.6 *Tanner crab size restriction proposal*

Ruth Christianson with Alaska Bering Sea Crabbers provided an overview of an agenda change request to the Alaska Board of Fisheries to modify the size of retention used in the state harvest strategy. Ruth's intention on presenting this to the CPT was to receive feedback on potential implications of such a change.

The current Bering Sea Tanner crab harvest strategy provides for a TAC calculation based on a retained carapace width of 5.0 inches in the fishery west of 166° W long and 5.5 inches for the fishery east of 166°

W long. The agenda change request would use a retention size of 5.0 inches in both areas. The team discussed the implications on the assessment, and discussed that such action could change fishery selectivity in the model and thus have biological implications on the OFL; however, a member of the CPT clarified that the 2013/14 fishery retained crab at the proposed harvest strategy size-at-retention and therefore selectivity would not differ from that of the current fishing year. If the Board of Fisheries takes on this proposal, it would be addressed next March, thus there are no implications for the assessment in this cycle. The assessment should estimate the most recent year's selectivity since the fishery is already selectively retaining this size class. Buck noted that the retained selectivity estimated in the model is based on the state harvest strategy, which is what occurred in the fishery west of 166° W long during the 2013/14 fishery but uses a larger size than was actually selected in the fishery east of 166° W long. Bill noted potential issues with estimating a lower terminal molt. The CPT did not note any conservation issues at present, but discussion focused on how this would be addressed within the assessment itself. For the CPT, it is more a matter of addressing the issue in fishery selectivity within the model, the related impact on Fofl, and evaluating within the projections based on impacts on catch. Since the fishery has now been opened with a smaller size at retention than was historically allowed, Buck now has the 2013/14 observer data available to estimate a new fishery selectivity, instead of assuming selectivity based on the state harvest strategy.

The CPT wondered if any price differentials would occur with a Tanner crab size-at-retention closer to snow crab, however industry estimated that the slight increase in price was mitigated by lower CPUE at larger size, and that Tanner crab are typically marketed as snow crab anyway.

### 3.7 *General comments for all assessments*

Some general comments for all assessments (both with respect to model scenario reviews in the spring and final assessments in the fall) are contained below.

- For all model reviews in the spring authors should only be producing white papers, not a document in the form of a stock assessment. An outline will be provided to authors in September for the required sections for these white papers and a consistent outline for content and review.
- For all likelihood results presented, add a row to tables showing differences in likelihoods comparing to the base models.
- When comparing likelihoods and model output do not show models that cannot be compared next to each other. Make it clear which models are comparable and consider using a graphical method.
- Regarding the process for CIE review of assessments: The CPT was informed of AFSC's new plan to notify the public via FR and have a portion of CIE reviews be open to the public. The CPT should weigh in on prioritization for next 5 year plan for assessment CIE reviews. This information may be beneficial to the SSC and eventually the AFSC in determining the schedule for appropriate review of these assessments. The CPT noted that the additional review of stock assessments at the NPFMC sponsored model workshops in recent years was useful and often preferred to CIE reviews for revising crab stock assessment models.
- Provide CVs based on data input into models, not CVs derived from the models.

## 4. **Generic crab model overview**

Dr. Athol Whitten presented an overview of the progress being made on the generic assessment model for Alaska crab stocks (Gmacs). Gmacs is an open source project and makes use of Cstar functions, which are a library of ADMB compatible functions for use in stock assessment modeling. The primary

collaborators in the project with Dr. Whitten are Jim Ianelli and André Punt. A pilot version of the model was presented at the modeling workshop in January 2014. Substantial progress has been made since January 2014 towards developing a full-featured stock assessment modeling package. However, a functioning model was not available for this meeting.

In Gmacs, the modeled population is structured according to size, sex, maturity, and shell condition. Growth is modeled with either a parameter-per-size class formulation, or with a linear growth increment and a gamma distribution for growth variation. Recruitment is modeled using a log mean with an annual deviation, but other stock recruit relationships will eventually be added. The model is set up to provide R-friendly output files, and Dr. Whitten is working on an R package to easily display model output.

The plan for model development is to make relatively quick progress over the next few months, potentially by adding an additional person with programming expertise to the project. The goal is to have an operational initial version (1.0) of the model for review at the September CPT meeting. Dr. Whitten will begin a permanent position with South Australian Research and Development Institute (SARDI) starting in November, but indicated that he plans to continue to be involved in the project in the future.

The highest priority for the CPT for September 2014 is a detailed side-by-side comparison of a Gmacs model with the Bristol Bay red king crab assessment. A second goal, with lower priority, is a side-by-side comparison with the Norton Sound red king crab assessment. The CPT also requests that a projection module for setting OFLs and ABCs be developed for review at the September meeting.

The CPT recommends that the model development team work more closely with the crab assessment authors, especially over the next few months. This two-way communication will be important to ensure the model is useful to address the modeling issues in the crab assessments, and will allow the assessment authors to become more familiar with the modeling approaches being developed.

## **5. Crab bycatch**

Diana Stram gave a presentation on the current effort by the Council to revise bycatch limits in groundfish fisheries. The Council is interested in evaluating new methods to assess and potentially change the existing closures and bycatch limits, evaluate new ones for additional stocks and to discuss the effectiveness of the current closure areas. Diana provided an overview of the current bycatch limits in the North Pacific which are based on some estimate of population abundance or tiered to stock status indications. Currently, herring, snow crab, Bristol Bay red king crab, and southern Tanner crab all have prohibited species caps which trigger area closures when reached. For herring there are 3 different closure areas with 1% of the total biomass triggering a closure. For snow crab the cap is set at 0.1133% of the modelled estimate of total survey biomass. There is a minimum and maximum PSC cap level that was negotiated by a Council committee. For Bristol Bay red king crab the cap criteria matches the harvest strategy and for southern Tanner crab, the survey or modeled estimate of the survey abundance are used to determine which stair-step of the cap level to set. Diana will be providing a discussion paper for Council consideration in October which focusses on snow crab and the COBLZ area definition in order to provide a template of appropriate information upon which to extend to other stocks for future consideration. Previously the Council had identified the following stocks for further consideration: Bristol Bay red king crab, snow crab, Tanner crab, and St. Matthew blue king crab. Once the template is developed the Council may iteratively consider measures for each of the BSAI stocks.

The Team discussed new methods to set biomass-based limits. One issue is that the impact of PSC on crab stocks is dependent on the size and sex of the crab caught in the groundfish fishery. There was concern about the amount of size and sex information available from observer information to assess bycatch composition. The Team discussed the interaction of bycatch issues with habitat protection concerns. While they are different topics, the importance and effect of crab bycatch is spatially and temporally specific and should be considered in the analysis. Current PSC limits could also be evaluated to determine whether any conservation benefits are derived from changing status quo and the potential interaction between PSC limits and stock status determination. One way to compare bycatch limit methods brought forward was to use the assessment model to consider portioning the OFL to determine how the groundfish bycatch portion of the OFL compares to the PSC limit. How much yield lost to bycatch could be estimated in units of “adult equivalents” to account for size. The MMST from model output could be used as an upper level threshold. A constant F could be evaluated as an alternative to the current stair step approach now that models can be used to effectively smooth out survey variability. Some thought that this was really more of an economic (allocative) issue as there is no control on where the crab mortality is counted. It was noted that the bycatch for Amendment 80 vessels are allocated to a single vessel through the cooperative structure so small changes in the total amount of bycatch allowed could dramatically affect a single vessel. Lastly, it was noted that the TAC setting process also takes into account bycatch by qualitatively assessing bycatch trends in recent years (5-10 y) absent more data being available.

## **6. Data-poor workshop**

Diana Stram updated the CPT on plans to hold a data-poor workshop for scallops, and discussed the utility of including data-poor crab stocks in the workshop. Crab stocks may also benefit from better methods to estimate OFLs and to characterize uncertainty for setting ABCs. In general, the CPT has struggled with how best to estimate uncertainty for all Tier levels in a consistent manner.

The CPT discussed reviewing the 2010 analysis for Amendment 38 (ACLs) which used  $\sigma_b$  to account for uncertainty in addition to that captured in the stock assessment, to determine if our ability to quantify uncertainty has improved. It was suggested that changes could be made to the current Tier system to better estimate or provide a buffer between OFL and ABC to avoid annually fluctuating buffers that are based on limited information. The CPT agreed that there needs to be consistency in how uncertainty is applied within and between stocks and between Tiers. The CPT will first review (in September) how uncertainty has been incorporated into the ABC for all crab stocks since Amendment 38 was implemented and compare that to what was considered in the Amendment 38 analysis. This evaluation will serve as a basis for developing criteria that can be used in a consistent manner to incorporate uncertainty when determining ABCs.

The CPT agreed that since the focus of the data-poor workshop is on scallops, including Tier 5 crab stocks could easily overwhelm any discussion on scallops, so the CPT did not support inclusion of crab stocks in the proposed workshop. CPT members with data-limited stock experience are encouraged to attend and the workshop should be scheduled in conjunction with the crab modeling workshop to facilitate participation.

Several suggestions were made on methods used in other regions for data poor stocks, such as depletion-based methods used in west-coast groundfish fisheries.

## **7. BBRKC closure**

John Gauvin, the Science Projects Director for the Alaska Seafood Cooperative (ASC), presented a proposal to the CPT to collect information on groundfish bycatch of red king crab in the Red King Crab Zone 1 (RKC), including the Red King Crab Savings Sub-Area (RKSSA). The Prohibited Species Catch (PSC) limit for red king crab in Zone 1 is established in federal regulation and is specific to vessels fishing trawl gear. The RKSSA is a sub-area within Zone 1 (often referred to as the 10' strip) that is closed when a catch limit is reached. In addition, Federal reporting area 516 is closed to bottom trawling March 15-June 1. The proposed study would require an Exempted Fishing Permit (EFP) to collect biological information and to document bycatch.

ASC indicated the closure of Federal reporting area 516 and the RKSSA has constrained their ability to manage king crab bycatch and halibut. The cooperative structure within ASC allows them to share catch information and move from areas of high bycatch. The existing area closures were put into place prior to Amendment 80 and may actually limit the fleets' ability to move from areas with high bycatch (for both crab and halibut). Mr. Gauvin indicated this project could spread effort out across Zone 1 rather than having fishing effort focused in fewer areas due to area closures.

Currently the only fishery-dependent red king crab data available from the Amendment 80 vessels are collected by at-sea observers. These data include sex, length, numbers, and weight of king crab. The ASC proposal would place at-sea samplers on member vessels to census king crab and collect biological information. This would likely require ASC-sponsored at-sea samplers to sample king crab before the observers (AFSC Observer Program) are able to sample and would require an exemption from regulations prohibiting the presorting of catch prior to sampling by an observer. Mr. Gauvin indicated the census information collected by at-sea samplers would provide exact fishery-dependent information on crab catch inside versus outside the closed areas and during a time period when the flatfish fishery is occurring. The AFSC observer program currently takes a sample of crab caught in each haul.

The CPT commented that it would be very difficult to estimate changes in catch rates unless a controlled study design was used. This type of design would require vessels to remain both in and out of a closure area during the same time period and to be fishing in "standardized" fashion to allow a statistical comparison. Mr. Gauvin indicated the intent was not to conduct a survey, but the study may provide previously unavailable biological information on crab caught in both closed and open areas. The CPT indicated if the project moves forward, then the study design for the EFP should follow the same biological sampling protocol used for the BSAI trawl surveys. However, the CPT had concerns about the study's ability to determine true differences between closed and open areas because of the fleet dynamics such as vessels moving due to crab or halibut bycatch rates and movement to optimize target species catch. These fleet dynamics could make statistical comparisons of catch composition and catch rates between open and closed areas impossible.

The CPT also questioned how the potential EFP would interact with the other Amendment 80 cooperative and the BSAI limited access trawl sector since the RKSSA is managed under a single cap. The proposal indicated the RKCSSA area allocation could be applied to the overall Zone 1 cap; however, an EFP would only apply to vessels under the authority of the EFP and thus non-EFP participants could still fish in the closed area.

The CPT expressed concern that the area closure may be in place to protect sensitive life stages, such as if the area were a breeding area. It is unknown any sensitive life stages occur in this area, and possibly the EFP could help provide that information. Public comment from Ruth Christiansen (Alaska Bering Sea

Crabbers) indicated that the EFP would need to be designed to insure that the study could collect reliable and useful information to evaluate the closure areas.

## **8. EFH**

### *8.1 EFH 5- year review*

John Olson, Matt Eagleton, and Diana Evans from the AKRO habitat group and NPFMC staff gave an update of the work plan for the 2015 EFH 5-Year Review (Item D-2 on the April 2014 Council meeting) to provide stock assessment authors and other CPT members expected to participate in the review with an outline of the timing and tasks required.

Of the 10 required EFH components in the Council's FMPs produced in the 2010 EFH review, three stand out as needing further development: 1) EFH descriptions, 2) the fishing effects model, and 3) the non-fishing effects model. The EFH descriptions currently use the same GIS methodology employed in the EFH plan finalized in 2005. Noting the four levels used to classify habitat information in the EFH rule, Matt pointed out that EFH information for crab stocks is classified at level 1 at best. An EFH review workgroup has been identified and an official memo assigning members is forthcoming (Bob Foy to be included). The EFH technical working group (including Bob Foy and Chris Long from the AFSC Kodiak Lab) will begin working on updating the EFH description methodology in May, to be completed and presented for the plan teams in September and to the SSC in October 2014. Bob inquired whether the CPT will be asked to provide technical feedback/comments on the description methodology in September, or will the document/presentation provided at that time only be informational. Diana responded that stock assessment authors will be asked during January-February 2015 to provide a comprehensive review of EFH status for their species/stock similar to that which they provided for the 2010 EFH review, and the working group will then incorporate results from stock assessment authors into the summary report to be presented to the Council in April 2015. The proposed description methodology will be available by August, and the CPT chair can then decide whether a formal review of the methodology by the CPT is warranted as part of the September 2014 CPT agenda. Bob inquired if it will be possible to involve members of the CPT other than stock assessment authors, given that they provided much of the substantive feedback to the 2010 report. Diana responded that the intention is to provide a better methodological framework through the technical working group to solicit more specific feedback from assessment authors. However, it was recommended that a working group within the Plan Teams provide the review of proposed methodology in August rather than only the stock assessment authors.

John discussed the fishing effects model, which is the second major EFH component to be revised. In the 2010 report, the focus was on whether there were additional data related to the parameters of the effects model. For 2015, working w/ APU (incl. Craig Rose adjunct faculty) to extend the model, translate it from MATLAB to R, and incorporate additional data on catch, VMS, substrate, and bathymetry. Per SSC direction, the updated/recoded effects model is currently being tested to ensure replication of results from the previous model. Siddeek asked whether the effects model is global or species-specific; Martin responded that the model is spatially-specific, and estimates the effect of gear types on habitat of a given species in particular areas. John added that ongoing work is focused on updating the model to reflect changes in trawl practices and gear (e.g. sweeps, new footropes), and a small working group will be established to review the model to ensure that gear effects are accurately represented. Matt noted that the gear descriptions were most recently updated in the 2005 EIS.

Matt discussed the ongoing effort to develop the spatial methods, including data and models for assessing non-fishing effects (e.g. near-shore mining, pilings and infrastructure in urban areas, off-shore drilling, major road development, and landings strips in inter-tidal areas) on EFH. Ideally, the model/tool will be written in R to provide a common framework with the fishing effects model, and AKRO has recently been successful in obtaining funding to hire a contractor/post-doc to take the lead on developing the data

and model code. Matt mentioned a pending study that John and Bob will start working on in fall 2014 to assess effects of near-shore gold mining on king crab habitat in Norton Sound. Bob inquired whether the EFH leads have interacted with Bureau of Ocean Energy Management (BOEM) regarding the effects of current oil drilling plans and potential effects on EFH. Matt indicated that they have interacted with BOEM, primarily through BOEM's annual studies RFP, noting that increased funding has been allocated through BOEM's Environmental Studies in Anchorage program to extend research beyond earlier focus on marine mammal habitat effects into mining effects on broader habitat effects. Bob noted that the FMP includes minimal material regarding the effects of non-fishing activities, but that it is likely to be more important in the Arctic FMP. Matt responded that EFH leads have been involved to a limited extent, but that the EFH component of the Arctic FMP is acknowledged as being inadequate, with need for greater focus on cumulative effects, including climate change. Libby Loggerwell at AFSC has been contacted and is expected to provide input on the EFH summary report for the Arctic FMP.

Matt outlined plans for reviewing and updating the habitat assessment improvement plan (HAIP), noting that Doug Demaster has directed him and Mike Sigler to develop a method/rubric for assessing the existing HAIP to score the plan for each FMP stock and rank the stocks according to info available. Results will then be used to prioritize areas where improved assessment is more important. Bob inquired whether the rubric will be applied across FMP's, or by FMP. Matt responded that the rubric will be applied to individual FMPs, but that it will address all stocks within a FMP, and not be limited to FSSI stocks.

Diana reviewed the EFH timeline regarding what will be asked for from Plan Teams over the next year. There will be an opportunity for feedback regarding the description methodology this August/September, depending on Plan Team chair direction. In January, stock assessment authors will receive a packet for their stock containing current habitat information listed in the FMP and the current EFH description. The authors to review, identify the need for updated description and assessment of fishing and non-fishing effects, and identify research needs. Stock assessment author reviews are needed by end of February 2015. Pending decisions by the Council, it is expected that the EFH assessments will be available to the CPT by next May if not sooner. Diana also noted the connection between the EFH review and the projects focused on the effectiveness of closure areas discussed earlier in the CPTs agenda (e.g. spawning areas, gear modification, and effort limitation).

## **9. Handling mortality**

Dan Urban (AFSC – Kodiak) provided a presentation on the application of the “reflex action mortality predictor” (RAMP) method to estimate handling mortality rate of discarded Tanner crab in the commercial BSAI crab fisheries. Estimates of bycatch biomass during the fishery are multiplied by the handling mortality rate and that product is added to the retained catch biomass to estimate total fishery mortality. Hence, assumptions about handling mortality will affect the time series of estimates of total fishery mortality used in stock assessments, the determination of annual OFLs, and annual total-catch accounting. The RAMP method was estimated to be 80% accurate in predicting mortality in Tanner crab and has already been used to estimate handling mortality for EBS snow crab. As a result snow crab handling mortality rate in directed fisheries were lowered from 0.50 to 0.30 last year.

In the EBS Tanner crab fishery, the discarded catch of Tanner crab is roughly equivalent to the catch of retained crab. The legal size for Tanner crab is 4.8 inches carapace width east of 166° W. longitude and 4.4 inches carapace width west of 166° W. Approximately 80% of all discarded catch is composed on sublegal males. The EBS Tanner crab assessment model has been using 0.5 as the handling mortality rate for Tanner crab discarded during the directed fishery.

RAMP scores were recorded for over 10,000 Tanner crabs from six vessels during the 2013/14 Tanner crab fishery in the Bering Sea. Discard mortality rates for Tanner crab are higher than those for snow crab at most fishery temperatures. Predicted short-term mortality for Tanner crab averaged 11.4% over temperatures from 2° C to -14° C with no observed increase in reflex impairment at the coldest temperatures as was observed for snow crab. Directly obtaining back-deck temperatures on all vessels throughout the season is not feasible so temperatures recorded at the St. Paul airport were used as a proxy and extended to all vessels in the fishery. Injuries were assessed during the study and were observed in 4.1% of the crab; with the most common injury being damaged legs.

Urban concluded his presentation with a summary of the attempts to develop a RAMP-based method to estimate handling mortality for red and golden king crab. Those attempts were not successful and suggested that the RAMP approach may have no useful application to king crab. Urban noted that one observation from this study was that golden king crab appear to be more hardy than red king crab.

The CPT discussed how to apply the findings presented for use in the Tanner crab stock assessment. The CPT was reminded that estimates used in the stock assessment should be unbiased and that conservation concerns related to uncertainty should enter in the consideration of the ABC.

Discussion identified three options to consider for a total handling mortality rate for Tanner crab:

1. 0.321, derived by summing the average estimate based on back deck RAMP scores taken across a range on temperature (0.114) with the highest estimate of injury rates (0.10) to capture the short-term mortality and multiplying that sum by 1.5 to provide an estimate that includes long-term mortality. Since there is no information on long-term mortality, the CPT agreed that the best first-order estimate of long-term mortality is 50% of the short-term mortality.
2. 0.233, derived by summing the average estimate based on back deck RAMP scores taken across a range of temperatures (0.114) with the average estimate of injury rates (0.041) to capture the short-term mortality and multiplying that sum by 1.5 to provide an estimate that includes long-term mortality.
3. A third approach to estimating a handling mortality rate considered the difference between the snow crab and Tanner crab mortality rate curves relative to temperature. This method would increase the Tanner crab rate above the 0.30 rate chosen for snow crab in 2013. The Team did not pursue this approach.

The CPT requested that the next Tanner crab assessment use 0.321 as handling mortality for all pot fisheries (crab and fish) in the base run and 0.5 as an alternative scenario. The 0.5 run should be included so that the effects on OFL, stock status, etc., can be evaluated.

The CPT emphasizes that developing a method to adequately estimate handling mortality remains a priority research objective for king crab species.

## **10. EBS survey time series**

Bob Foy presented a revised EBS survey time series based on recommendations from the January 2014 crab modeling workshop. The new time series considered spatial coverage differences over time, estimating measurements to unmeasured crab, avoiding biases associated with multiple tows per station, tow duration, and increasing coverage where possible using available data from similar survey time. Scenarios included: 1) the current data set, 2) using only one tow per station, 3) excluding/including corner stations, and 4) survey leg 1 versus leg 3 male red king crab retow data. Results for various scenarios were provided for mature male biomass for each stock.

Time series differences for Bristol Bay red king crab varied in a few years in which a large number of additional projects were conducted and when hotspot protocols were applied. Notably, confidence

intervals were higher when data from hotspot tows were removed. Snow crab was minimally affected in the scenarios presented. Tanner crab was affected by the removal of hotspot tows and corner stations. Removing corner stations increased variance for St. Matthew blue king crab substantially. Pribilof red king crab biomass was drastically affected by removing corner stations, but Pribilof blue king crab showed almost no differences among scenarios.

While many data points were removed in the new time series, the overall affect was minimal. The CPT agreed that the rationale behind the new time series was an improvement over the current time series, as long as standard Pribilof and St. Matthew corner stations are included. The CPT recommends that assessment authors should investigate the effects of the new time series on size frequencies.

The CPT discussed the use of hotspot tows in the time series and concluded that the variance associated with a high density tow which would invoke a post-hoc sampling method should be addressed within stock assessments, rather than adding tows to the survey. The CPT also discussed retows for Bristol Bay red king crab. Bob Foy clarified that the protocol for choosing retow stations was based on female red king crab, not males. Specifically, retow stations are chosen based on where 90% of the female red king crab are caught during leg 1. Using leg 1 versus leg 3 data for male red king crab would not make much difference for red king crab because the abundance of male red king crab was only different in 1 of 12 years when retows were conducted. The CPT agreed that only abundance estimates for female red king crab should be based on leg 3 retows, and the leg 1 data should be used for male red king crab abundance estimates. The CPT concluded that the corner stations are useful because they increase the area surveyed, provide lower confidence intervals for most stocks, and are a long-term consistent protocol.

The CPT recommends that the new time series use standard corner stations, no hotspots or other extra tows, increased coverage following standard protocol where possible, and include an estimate for unmeasured crab. The CPT would like a presentation of the new time series in September 2014, including additional documentation (tow-by-tow metadata including number of data points used and available) that is being developed by Bob Foy and his staff this summer. For May 2015, the CPT recommends that stock assessments include comparisons of the old and new time series.

## **11. Research Priorities**

The CPT reviewed the list of research priorities from the NPFMC database. CPT priority classes were added or updated. After discussion, the group decided to define priority classes as follows:

- **High priority:** topics that agencies should be working on now and are immediately needed to improve stock assessments.
- **Medium priority:** topics that are important and informative.
- **Low priority:** topics that would be nice to know or continue to monitor.

Each research priority was discussed and updated where needed. Where CPT knew about ongoing research efforts, they were noted. The discussion included a few new research gaps to be addressed. Revised priorities are attached in strike-out and additions.

## **12. Directed crab fishery catch estimation issues**

At the January 2014 Crab Modeling workshop, the CPT requested that Bill Gaeuman provide assessment authors with updated crab fishery bycatch data using the “simple averaging” method to expand crab observer data to the entire fisheries, so that authors can run model scenarios mimicking the 2013 assessments using the updated data. Bill noted that he has provided some updated size frequency data from the crab observer program to authors and discussed problems associated with determining fishery

effort needed to expand observer bycatch data counts to the fishery level. Legal-sized Bairdi crab, for example, can be retained in the snow crab and BBRKC fisheries (up to 5% of catch, but this has changed historically), as well as in the directed Tanner crab fishery. Andre Punt opined that double-counting effort was worse than mis-allocating it. Concern was expressed that there could be interactions with observer data in terms of the mean weights used to convert from numbers to weights. Bill expressed his preference that assessment authors be responsible for this conversion and for clearly documenting how it is done.

The CPT directed assessment authors to compare new and old bycatch totals once fishery effort is reevaluated by ADFG and updated observer data become fully available. Anticipating a resolution to this problem, Bill presented preliminary data file formats and requested feedback from assessment authors regarding their suitability.

As requested during the 2014 Crab Modeling workshop, Bill also compared the “simple averaging” method for expanding crab observer data to the entire fishery with a more sophisticated hierarchical ratio estimator. The latter cannot consistently be applied to historical datasets, or even uniformly to all current crab fisheries, so it was encouraging to the CPT that differences between the two methods were relatively small.

### **13 New Business**

*Modeling workshop:* The team discussed the intent to host another Crab Modeling workshop in January, 2015. The team notes the utility in recent years of these workshops and that they have greatly benefited the evolution and peer-review of current crab stock assessment models. A major focus of the 2015 workshop would be continued development of Gmacs application.

Another recommendation for consideration at modeling workshop was to evaluate the available chela height data for snow crab. Objectives would be to compare historical and more recent sampling methods, sample sizes, sample stratification, and identify the availability of mature and immature crab data assess changes in sampling proportions.

*NSRKC Plan Team meeting:* In conjunction with timing of the modeling workshop and data-poor workshop, the team intends to hold an abbreviated plan team meeting to set specifications for NSRKC.

**North Pacific Fishery Management Council Crab Plan Team Meeting  
 May 5-8, 2014**

Federal Building, Juneau AK

**DRAFT AGENDA**

04/9/2014 version

**Monday, May 5**

- 8:30 **Administration** Introductions, agenda, meeting minutes, documents/timing for June Council
- Model discussions:** Feasibility analysis of moving to Tier 3 for PIRKC
- 8:45 **PIRKC**
- 10:00 **Model discussion:** Scenarios for consideration in Fall 2014 assessment
- BBRKC**
- Noon LUNCH
- 1:00 **AIGKC**
  - i. Final assessment: OFL and ABC
  - ii. Model update/recommendations
  - iii. survey

**Tuesday, May 6**

- 8:30 **Final assessments:**
  - i. Final assessment: OFL and ABC
  - ii. Pot survey proposal
- Adak RKC**
- 9:30 **Final assessments:**
  - i. Final assessment: OFL and ABC
  - ii. Model recommendations for Fall assessment (switch timing of assessment)
  - iii. Overview of LLP issue for June Council meeting
- NSRKC**
- 11:30 **Model discussions:** CIE review update/recommendations
- snow crab**
- Noon LUNCH
- Model discussions;** Model scenarios for September
- 1:00 **snow crab (cont)**
- 2:00 **Model discussions:**
  - i. Model scenarios
  - ii. Review/comment proposed size restrictions
- Tanner crab**

**Wednesday, May 7**

- 8:30 **Model discussions:** Model scenarios for fall assessment
- SMBKC**
- 9:30 **Crab bycatch (part 1)** Data needs for estimating biomass-based limits:
  - i. Data available for crab and examples from other biomass-based bycatch limits in other fisheries
- 11:30 **Data-poor workshop** Plans and ideas for data-poor workshop (scallop) and application to crab stocks (control rules) and characterizing uncertainty
- Noon LUNCH
- 1:00 **Gmacs: BBRKC** application to BBRKC

**Thursday, May 8**

- 8:30 **Crab bycatch (part 2)** Discussion of data availability and analyses needed for evaluation of efficacy of existing closures and impact of bycatch on population
- 10:00 **BBRKC closure** Efficacy discussion/industry plans
- 10:30 **EFH** Plan for 5 year review
- 11:00 **Handling mortality** Update on research results
- 11:30 **Update on PIBKC research** Overview of on-going research
- Noon LUNCH
- 1:00 **EBS time series** Review progress on analyses

2:00	<b>Research Priorities</b>	Review and revise; new database
3:45	<b>Finalize SAFE introduction</b>	Finalize 4 intro summaries; summarize minutes as needed
5:15	<b>New business</b>	BOF proposals; meeting planning 2014/15
5:30	<b>Adjourn</b>	

---