

Crab Plan Team Report

The Crab Plan Team (CPT) met September 13-16, 2010 at the Alaska Fisheries Science Center in Seattle, WA.

Crab Plan Team members present:

<i>Forrest Bowers, Chair</i>	<i>(ADF&G)</i>
<i>Ginny Eckert, Vice-Chair</i>	<i>(Univ. of Alaska – Fairbanks)</i>
<i>Diana Stram</i>	<i>(NPFMC)</i>
<i>Doug Pengilly</i>	<i>(ADF&G – Kodiak)</i>
<i>Gretchen Harrington</i>	<i>(NOAA Fisheries – Juneau)</i>
<i>Wayne Donaldson</i>	<i>(ADF&G – Kodiak)</i>
<i>Jack Turnock</i>	<i>(NOAA Fisheries/AFSC – Seattle)</i>
<i>Shareef Siddeek</i>	<i>(ADF&G – Juneau)</i>
<i>Karla Bush</i>	<i>(ADF&G – Juneau)</i>
<i>Lou Rugolo</i>	<i>(NOAA Fisheries /AFSC – Kodiak)</i>
<i>André Punt</i>	<i>(Univ. of Washington)</i>
<i>Bill Bechtol</i>	<i>(Univ. of Alaska – Fairbanks)</i>
<i>Bob Foy</i>	<i>(NOAA Fisheries /AFSC – Kodiak)</i>
<i>Brian Garber-Yonts</i>	<i>(NOAA Fisheries – AFSC Seattle)</i>
<i>Josh Greenberg</i>	<i>(Univ. of Alaska – Fairbanks)</i>

Members of the public and State of Alaska (ADF&G), Federal Agency (AFSC, NMFS), and Council (NPFMC) staff present for all or part of the meeting included: Mark Casto, Ron Namma, Dennis Thompson, Scott Campbell, Anne Vanderhoeven, Rob Rogers, Jack Tagart, Frank Kelty, Dewey Hostetler, Chris Arnim, Gary Stauffer, Dale Schwarzmiller, Ken Weinberg, Chris Pugmire, Shane Moore, Doug Woodby, K. Magatelle, Gary Painter, Kevin Kaldestad, Jie Zheng, Tom Suryan, Roger Thomas, Bill Gaeuman, Eric Olson, Walt Casto, John Jorgensen, Caliste Sonoptad, Neil Rodriguez, Pat Livingston, Anne Hollowed, Martin Dorn, Jim Ianelli, Russ Nelson, Earl Krygier, Gary Loncon, Dave Witherell, Stefanie Moreland, John Gauvin, Steve Hughes, Lori Swanson, Edward Poulsen, Tom Casey.

The attached agenda was approved for the meeting.

1. Update on Council actions

Diana Stram provided the team an update on Council action on Crab ACLs and crab bycatch from the June 2010 Council meeting. The Council in June identified status quo as their preliminary preferred alternative for Crab ACLs. The Council also initiated an analysis of crab bycatch limits in BSAI groundfish fisheries. Further discussion of the implications of these actions was deferred to the ACL analysis later in the week.

2. 2010 Survey Overviews

NMFS AFSC Survey – Bob Foy (AFSC) summarized preliminary results from 2010 NMFS survey. During June 7 to August 4, the standard survey involved 376 stations during and 23 re-sampled stations. The 2010 survey included data collection for a variety of special projects (e.g., sampling for bitter crab; pathology vouchers; Tanner diets; reproductive potential of snow crab, Tanner crab, and red king crab; and reproductive indices of male snow crab). The 3rd survey leg involved re-sampling of 23 stations due to changes in shell condition/mating status of female red king crab. The cold pool extended deeper into SE Bering Sea, but some northern areas were warmer. Abundance estimates and spatial distributions by sex and size were briefly summarized and compared to those for recent years.

The Northern Bering Sea was surveyed in 2010 with 142 successful tows during July 27-August 8. Bottom temperatures were warmer inside Norton Sound and to the southeast, with colder (negative) values to the west. Species distributions varied with bottom temperature. The CPT discussed how the FMP treats crabs in the northern area, in addition to how observed abundances relate to more southern observations for a given species. For example, high densities of snow crab, virtually all immature, were found in the northern area, but linkages to more southern snow crab are unknown. A spatially differential mortality may be indicated if periodic large recruitments of immature crab occur largely in the northern area without a subsequent observed increase in abundance to the south. Previous studies have also indicated that size at maturity for some species is significantly smaller in the northern area, an issue needing further analysis. The CPT also noted that survey catches of some species were quite high along the northwestern boundaries of the northern area, suggesting that the full spatial distribution of these species is not being captured by the additional survey stations.

AFSC/BSFRF cooperative survey selectivity update – Steve Hughes (BSFRF) reviewed results of previous experiments (1998 under bag study and 2009 side-by-side and comparison experiments) as precursors to the 2010 study. Ken Weinberg (NMFS) described the 2010 selectivity study as focusing on aspects of: (1) adjusted, standardized tow duration (30-minute NMFS tows and 5-minute BSFRF tows); (2) spatial survey coverage (e.g., depth, bottom temperature, and sediment type); and (3) temporal synchronicity of comparative tows, resulting in a “shadow” study with the objective of developing a survey-wide efficiency curve by snow crab size and sex using catch ratio data from the NMFS survey and the BSFRF nephrops trawl, assuming that the latter is 100% efficient for all sizes. A total of 93 tows were conducted over 18 days in the western Bering Sea. The survey design was generally followed well, although coverage of shallow depths was limited. The size distribution of the captured crab was generally similar between the NMFS and BSFRF surveys, although the CPT suggested that a better impression of differences in size-frequency distributions could be obtained by expressing the length-frequency for BSFRF survey as a fraction of that for the NMFS survey. The BSFRF generally had higher densities among stations; although the CPT suggested that the paired comparisons may display better as scatter plot rather than paired bars for individual tows. Analysis is ongoing on another aspect of the study - the use of underwater video to collect data on potential herding related to the slower tow speed of BSFRF net.

3. Spatial Model Presentation

James Murphy (UW) presented a Spatial Population model of Bering Sea snow crab that was developed for his Ph.D. dissertation at UW in Seattle. Analysis of the 1982–2006 summer survey data showed that females increased aggregation with age and males increased dispersion with age. Colder temperatures further increased female aggregation. Younger females occurred in shallower water than average depth of survey tows, while older females occurred deeper. Younger females occurred in colder temperatures than the mean of the survey stations, while older females occur in temperatures similar to mean. Spatial autocorrelation analysis showed a temperature (summer survey temperature) relationship for young crab, but a depth relationship for older crab.

A spatial model is important if there are spatial differences in growth and/or maturation. Spatial differences in the fishery catch may result in fewer mature males in the southern region of the snow crab range and possible sperm limitation.

Murphy developed a two-area spatial model with data from 1991 to 2008, the time period when fishery observer data were available. Input survey selectivity, natural mortality, growth, parameters were the same as the 2008 snow crab assessment model estimates. Testing of the model found very similar results for a one area model and the 2008 assessment model.

Movement probabilities for immature and mature males seem well estimated (north to south movement only). Female movement was not well estimated. Females have more of a cross shelf movement rather than north/south movement. The fits to immature and mature male biomass in north and south areas were good.

Exploitation rates on mature males (harvest/mature male biomass) shows higher exploitation rates in the southern area than in the northern area. Movement in the model occurs between the summer survey and the winter fishery. However, fewer mature females are in southern area compared to the north.

The ratio of females to males (>101mm) was high in the southern area. The extent to which females in one area (e.g. south) contribute to future recruitment in another area is unknown. Murphy plans on doing a three area model for future publication.

Andre Punt commented that to show an advantage of fitting a spatial model the same data would need to be used and likelihood values compared. Doug Pengilly asked clarification on the assumptions for estimating movement. James Murphy responded that the model assumes a logistic curve with parameters estimated in model. When asked if the model accounts for different temperatures over time and area, he responded that crab movement seems to occur more along depth gradients than temperature gradients.

4. EBS snow crab

Jack Turnock (AFSC) summarized the 2010 stock assessment for EBS snow crab, along with the results of projections under different levels of future fishing mortality. The model is identical to that selected by the CPT at its May 2010 meeting, and endorsed by the SSC at their June 2010 meeting. New data in the September 2010 assessment includes the 2010 NMFS survey and the 2009/10 catch in the directed fishery and the groundfish fisheries. The EBS snow crab stock is estimated to be 95.8% of the proxy for B_{MSY} in 2009/10, a more optimistic appraisal of stock status than in September 2009. This is owing to an increase to the estimated 2009/10 MMB at mating and to a reduction in the proxy for B_{MSY} . The CPT **recommended** that the progression between the September 2009 and September 2010 be included in the assessment (and similar progressions documented in future assessments). The catch was less than the OFL set in 2009, i.e. no overfishing occurred during 2009/10.

The September 2010 assessments did not make use of the 2010 BSFRF data, which were not available. The CPT **recommended** that the 2010 BSFRF data be reviewed and included in the 2011 assessment. There may be value during the mid-winter CPT meeting in previewing how these data will be included in the next assessment.

The CPT noted that the 2010 assessment indicated that MMB did not drop below MSST anytime after 1980. Whether a rebuilding analysis is still needed given the change in stock status is a policy decision which will be made by NMFS Alaska Region. In relation to the projections, the CPT noted that the approach taken was that on which the ACL analyses were based. The rebuilding analysis was based on defining “rebuilt” as being above the proxy for B_{MSY} (rather than being above this proxy for two years in succession) as recommended by the CPT and SSC and adopted by the Council.

The CPT noted that the rebuilding projections in the ACL EA and the assessment are based on the same definition of “rebuilt” (being above B_{MSY} for one year). However, the projections in the ACL EA are based on the May 2010 assessment while those in the 2010 assessment are based on an assessment which uses the 2010 survey data and the 2009/10 fishery data. The economic analyses in the ACL EA have been updated since the May 2010 assessment.

The CPT noted that the TAC calculated using the ADFG harvest strategy is substantially lower than the OFL. Some reasons for this include a higher estimate of the F_{MSY} proxy, a lower estimate for the B_{MSY}

proxy, and fishing mortality reference points in the ADFG harvest strategy that do not depend on the results of the stock assessment. The CPT **recommended** that future assessments report the details of the application of the ADFG harvest strategy to Total Mature Biomass (TMB) as calculated from the survey as well as the model-estimated TMB, in tabular form.

The assessments includes three measures of survey biomass: (a) the value from the survey itself; (b) the model estimate corresponding to the survey biomass estimate (which includes the impact of survey selectivity and survey catchability); and (c) the model estimate corresponding to the survey biomass estimate (which only takes account of survey selectivity). Future assessments should clearly document which biomass is being reported.

The CPT made the following additional suggestions for changes to the assessment report:

- Correct the column labels in Table 10.
- Check for consistency in the text regarding whether shell condition provides accurate information on age.
- Update the plot of centroids.
- Check for consistency regarding the text related to which parameters are fixed and which are estimated.

5. Bristol Bay red king crab

Jie Zheng (ADF&G) presented the Bristol Bay red king crab stock assessment. New information in the assessment included data on the 2009/10 catch and bycatch, and the 2010 survey. The selected model also included a sensitivity test which estimated CVs for the 2007-08 BSFRF survey. The 2010 MMB was lower than in previous years. Although the SSC requested an exploration of a model with common time periods for survey q and survey selectivity, the author fixed q at 0.896 (from Weinberg et al. 2004), and estimated q during 1970-72 when potential gear problems may have existed. Jie averaged the standard and retow abundance data for males but used only the retow data for females because the retows during survey leg 3 missed many of larger males compared to leg 1 tows. The CPT requested that the May 2011 assessment be based on only the standard tows for males and the retows for females. Decline in survey abundance estimate in 2010 were one of the important reasons for the reduced model estimates of MMB in recent years.

The CPT discussed the projected stock biomass declines until 2014 with subsequent increases as recruits enter the model. However, the uncertainty in model projections was noted. The author attributed differences in retained catch between Table 8 and page 20 to mean vs. median values. The CPT also discussed the differences between area-swept and model estimates of MMB in recent years and its declining trend, and noted that molting probabilities are likely affected by errors in shell condition. Also, the movement of larger crabs and the effects on weighting in the SOA harvest strategy were discussed.

The CPT **recommended** the following changes to the document: fixing the MSST and MMB values in the summary table; highlighting the most recent year in the plot of F against MMB; and ensuring that the tables and figures in the CIE review transfer correctly to this SAFE chapter.

Jie Zheng summarized the recommendations from the Bristol Bay CIE review of June 2009. In response to CIE recommendations, Jie will make model and scenario changes prior to a mid-winter CPT meeting. The CPT was also noted that the assessment author addressed the recommendations, but not necessarily including all the weaknesses, identified by the CIE review. The CPT **requested** that a report with comprehensive responses to the CIE recommendations be developed for the mid winter CPT meeting and added to the May 2011 assessment. In discussing the CIE review with the assessment author, the CPT **emphasized** a variety of CIE recommendations: (a) consider the use of implicit sample sizes for size/sex composition data because observed sample sizes are often much smaller than the estimated effective

sample sizes; (b) explore geostatistical models (other than kriging, which was tried previously) to examine spatial variability in survey catches; (c) estimate the initial size-structure (subject to a smoothing penalty similar to the snow crab model) instead of fixing the initial size-structure at the start year survey abundance size composition; and (d) use observed proportions instead of predicted values to calculate the variance term of the likelihood function (unless the data contain lots of zeroes). The CPT also **recommended** that the assessment author look at Maunder's (manuscript under review) study on how composition data can be included in stock assessments, with special focus on the selection of weights. Lastly, comparison of models, including the base model, should be provided in the May 2011 assessment report.

6. EBS Tanner crab

Lou Rugolo (AFSC) presented the 2010 EBS Tanner crab assessment. This stock is recommended to be placed in Tier 4. The 2010 assessment is based on estimating MMB at time of mating (15 February, nominally 8 months after the "time of survey") by projecting the survey MMB forward and removing (retained and non-retained) catch from the directed fishery, bycatch in non-directed crab and groundfish fisheries (i.e., handling/bycatch mortalities of 50% for pot fishery discards and 80% for groundfish fishery discards), and natural mortality; an assessment model that incorporates historic survey and fishery data is in development (see below). The 2010 assessment assumes fishery removals occur instantaneously before the time of mating. Natural mortality is assumed to be 0.23yr^{-1} .

Rugolo noted that the 2009 estimate of MMB at time of the survey (summer 2009) was below MSST, but that the determination that the stock is overfished is based on the estimate of MMB at 15 Feb 2010 – hence, the CPT had to wait for the data on 2009/10 losses to the stock before determining the status of the stock relative to MSST.

There were no changes in assessment methodology for the 2010 assessment, except for use of the revised survey data that are based on measured net width rather than an assumed fixed net width and 2009/10 fishery retained and all bycatch and discard losses. Use of the variable net width results in slightly lower area-swept estimates. Legal males were distributed patchily over the area surveyed by the NMFS EBS trawl survey during the 2010 survey, with highest densities near Pribilof Islands and southwest Bristol Bay and low densities elsewhere. Other size-sex classes showed similar areas of concentration, but the distributions for these classes were generally not as aggregated. Rugolo reported that the estimate of the MMB at the 15 February 2010 time of mating was 28.44 thousand tons (t), 34% of estimated B_{REF} (83.80 thousand t). Thus, this stock is estimated to be below MSST.

The 2010 NMFS EBS trawl survey revealed an overall decline in stock abundance. Projected MMB for 15 February 2011 (assuming fishery removals at F_{OFL} and $M=0.23\text{yr}^{-1}$) is 26.07 thousand t, an 8% from 15 February 2010. There are some moderate signs of recruitment in the male and female survey size frequencies (25-35 mm CW), but declines in the abundance of males larger than 70 mm CW raise concerns for reproductive potential in the near-term. The assessment authors noted that the shell condition recorded for large males (a high frequency of old and very-old shell males) adds to those concerns.

The analysts' estimate of the OFL for 2010/11 is a total male catch of 1.45 thousand t (3.19 million lbs). An additional loss of 0.17 thousand t (0.37 million lbs) of females is projected under assumptions for female bycatch and discards, for a total catch OFL of 1.61 thousand t (3.55 million lbs). The retained catch to avoid overfishing is 0.09 thousand t (0.20 million lbs) given assumptions on bycatch and mortality in the directed fishery, in other crab fisheries (largely the snow crab fishery), and in the groundfish fisheries.

After review of the June 2010 SSC comments on years selected for computing B_{REF} relative to presumptive effects of “regime change,” the Crab Plan Team **requested that** alternative periods of years to estimate B_{REF} be evaluated (particularly those corresponding with the “regime shift” periods cited by the SSC) with pros and cons listed for each.

Rugolo also briefed the CPT on the TCSAM (“Tanner crab stock assessment model”) that is being developed with Turnock. The CPT considers a TCSAM model to be essential for development of a rebuilding plan for EBS Tanner crab. Rugolo and Turnock’s goal is to have a draft of the TCSAM ready for review by the CPT no later than March 2011. The CPT stressed that it is essential that a draft of the TCSAM be available for review by the CPT by that time as it said by the SSC in April 2011, with a revised TCSAM for use in rebuilding plan development presented to the CPT in May 2011 and the SSC in June 2011. Use of the model for the 2011/12 stock assessment and hence, stock status determination, may be considered by the CPT in May 2011 and by the SSC in June 2011, but of greatest importance is that the model be ready and sufficient for analysis and development of a rebuilding plan. Discussion followed on need for and timing of a modeling workshop when a draft of the TCSAM is ready for review. Dates during late February through March were considered. The discussion on timing noted the following constraints: 1) the rebuilding plan must be implemented for 2012/13 fishery, assuming that NOAA Fisheries declares the stock to be in an overfished condition this year; 2) given the pace of the federal process for final Secretarial approval of an FMP amendment (estimated to require at least 6 months), the Council must be able to recommend final action on a rebuilding plan no earlier than December 2011 so that a rebuilding plan may be implemented; and 3) hence the CPT needs to be able to recommend a model for the rebuilding plan analysis to the SSC at their September 2011 meeting (if not earlier).

The CPT has the following **recommendations** related to the Tanner crab rebuilding plan (in addition to the completion of an acceptable “TCSAM”):

- The rebuilding plan will need to consider and address possible effects of groundfish fisheries and may need to recommend controls on the mortality to EBS Tanner crab due to bycatch in the groundfish fisheries.
- The time period for computing B_{REF} should be reviewed and evaluated in the rebuilding plan; options for that time period should be considered and evaluated for review by the SSC. In this regard, the CPT received public testimony recommending a reconsideration of the validity of the period used to compute B_{REF} in the September 2010 assessment (i.e., 1969-1980).

7. Pribilof Islands red king crab stock

Bob Foy (AFSC) presented the assessment of Pribilof Islands RKC. The October 2009 SSC comments were not addressed in this report. However, text on stock structure was added based on SSC comments from June 2010, while all units were converted to lbs and confidence intervals added to the MMB estimated following CPT comments in May 2010.

There were no major changes to the estimates, except for the addition of the 2009/10 total removal and 2010 survey data. The B_{REF} was calculated using 1991/92-2009/10 estimates of MMB at the mating time, 15 February. The MMB at mating declined towards MSST last year, but MMB on 15 February was greater in 2010 than in 2009. As the 2009/10 MMB was larger than the MSST and there was no fishery in 2009/10, it can be concluded that the stock is not currently overfished and overfishing did not occur during 2009/10. The 2010/11 OFL (male only) for Pribilof red king crab was 0.77 million lbs. It was noted that the fishery interaction between red and blue king crab will be addressed in the blue king crab rebuilding plan, and that during 2009/10 the Pacific cod target fishery accounted for most groundfish

discards (30%) and that bottom trawl was the main type of gear, contributing 82% of discards. A CSA model is being developed for Pribilof Island red king crab, and will be presented at the winter 2011 modeling workshop.

The CPT **recommended** that the author base MMB estimates on moving averages when computing OFLs owing the high uncertainty associated with the survey estimates.

8. Pribilof Islands blue king crab

Bob Foy (AFSC) presented the assessment of Pribilof Islands BKC. Stock separation (compared to Saint Matthew blue king crab) information and information about the spatial distribution of groundfish bycatch will be added to the rebuilding plan analysis in response to recommendations from the June 2010 SSC comments and the May 2010 CPT comments. Bycatch in groundfish fisheries mainly occurs in the yellowfin sole and Pacific cod bottom trawl fisheries.

No changes were made to the assessment methodology or the data, except for the addition of 2009/10 total removal and 2010 survey data. Estimated B_{REF} was 9.28 million lbs (the same as for the 2009 assessment). Mature male biomass decreased from 1.28 million lbs in 2009 to 0.71 million lbs in 2010. Legal male biomass increased by 19% and mature females biomass decreased 41%. The MMB at mating was projected to be 0.63 million lbs in 2010/11, about 7% of B_{REF} . Total catch in 2009/10 was 0.0013 million lbs, below the OFL of 0.004 million lbs, i.e. overfishing did not occur during 2009/10.

A CSA model for Pribilof Islands blue king crab is in development and is planned for review at the winter 2011 CPT meeting.

9. St Matthew Blue king crab

Bill Gaeuman (ADF&G) summarized the 2009/10 fishery, the first since 1999. The 2009/10 fishery was prosecuted later in the year, occurred further south, and had less female bycatch than the historic fishery. However, fishery CPUE of 10 crabs per pot was in the range of the historic average.

The CPT discussed model changes from the 2009 assessment, such as a correction for misclassification of shell age and the change to the likelihood component for the size-composition data. The CPT also discussed how the groundfish bycatch data were incorporated in the model.

The CPT **recommended** that MSST should be recalculated using the B_{MSY} estimate from the current assessment and the assessment document updated.

For the May 2011 assessment, the CPT **recommends** that the authors:

- Analyze why some parameters in Table 11 appear not to change from initial values. This is necessary because there is considerable unexpected variation in different end-points between assessments (see Figure 12).
- Calculate $F_{35\%}$ per the ACL analysis for the May model.
- Add a more detailed description of model changes as an appendix to the May model.
- Incorporate the 2010 ADF&G pot survey data.

10. Crab ACLs and AMs

Diana Stram presented the public review draft ACL EA and the substantive changes in the document from the initial review draft. Diana explained that the EA contains a more detailed description of the MSA and NS1 guidelines driving the development of the alternatives and analysis. The primary issue in choosing a buffer or P^* is that there is at least a 50% probability that overfishing would not occur. Diana explained

the alternatives and how the Council could create a new blended alternative from the alternatives in the analysis. The team discussed the accountability measures requirement and how, while the FMP does not explicitly specify AMs, existing management measures would be used as AMs for the directed crab fisheries. The two areas where new AMs may necessary are mechanisms for the SSC to adjust the ABC control rule and AMs that apply to crab bycatch in the groundfish fisheries. The team discussed that the Council has initiated an analysis to evaluate AMs for the crab bycatch groundfish fisheries.

ABC control rules that increase the buffer for lower tiers assume that the OFL for all 5 tiers are set without considering the uncertainty intrinsic in placing the stock in the lower tiers. In practice, OFLs may have been set to buffer for the uncertainty by setting a more conservative OFL. In this case, there may not be the need to have larger buffers for lower tiers. The CPT should review the assessments to make sure they are unbiased or “risk-neutral” before applying buffers for uncertainty.

The team discussed how crab assessments use the most recent data and an annual assessment to set the OFL for that year’s fishery and that there is a relationship between size of the appropriate buffer and the time between the assessment and the OFL. The longer from the assessment, the less likely the OFL is accurate and therefore the need for a larger buffer.

Diana presented how uncertainty is dealt with in the analysis and the relevant NS1 guidelines and SSC minutes that discuss how to address uncertainty.

If the Council selects a P* approach, the team has the following recommendations and concerns with estimating scientific uncertainty. The values in the analysis for sigma-b (σ_b) are default values and the CPT expects to reassess them in the first year of implementation. The team noted that analysis does not include a method for estimating σ_b specific for crab. The team expressed concern that, in the absent of a method for defining σ_b , it could be very difficult to move away from the default values in future assessment cycles. OFL setting can’t include all of the known information on a stock, however, the key question is whether this type of uncertainty can be accommodated by a σ_b number. The team expressed concern over potential for a layering buffer effect.

The team discussed that there is uncertainty in the OFL estimate that is outside of the model. The team discussed how assigning σ_b values can be very subjective and that current σ_b values for Tier 4 stocks, for example, may actually reflect uncertainty in survey data, and that is really a within model uncertainty. Models make simplifying assumptions and potentially include biases that results in more conservative OFLs (e.g., assumption that survey trawl selectivity is 1). The team raised questions of how would σ_b be evaluated and set annually and whether criteria would be needed to set the σ_b values. The team discussed that these criteria could be determined in advance of actually using the approach during an assessment cycle. Additionally, the team discussed that we’ve gone through a similar process in establishing B_{REF} and that that was a long and complex process.

MSA requires that scientific uncertainty be included when calculating ABCs from OFLs, but does not specify how to do so. Professional judgment will be needed to estimate out of model uncertainty. However, to date, the CPT has not developed criteria and processes for doing this. The Team discussed the values specified in the analysis and that creating criteria to determine accurate numbers is a hard process. The CPT will require considerable time if it is to be able to develop these prior to application of any P* based ABC control rule. Moreover, experience with the application of OFL control rules suggests that this process will be iterative.

The Team discussed other ways to address out of the model uncertainty that meets the specific circumstances of crab management and recognizing that each region is developing ACLs that address scientific uncertainty in a practical way for specific fisheries. The team recognizes that there are existing ways address uncertainty.

The NS1 guidelines are not well suited to the unique State-Federal management regime specified in the BSAI crab FMP; i.e., those regulations do not acknowledge that uncertainty can and has been accommodated after the federal status determination process by the state's TAC-setting process. For crab, the FMP established a process for ADF&G to set TACs and by doing so recognizes that existing approach includes important stock conservation tools. In that process, the State considers a variety of information and uncertainty. This process allows the State to respond quickly to changes in stock status information and take into account all sources of relevant information. σ_b can't accommodate all of the factors the State takes into account in TAC setting based on all of the information available at the time of decision-making. σ_b does quantify some uncertainty in factors effecting overfishing, but it does not estimate that value. The State's system accounts for out of the model uncertainty to prevent overfishing using information that the proposed maximum ABC control rule employing σ_b is not able to accommodate (e.g., closure of the Adak red king crab fishery due to concerns for stock status). However, the SSC may consider other factors in setting the ABC on an annual basis.

The Team discussed the choice between P* and/or buffers by tier or by stock but did not discuss how the stocks should be assigned to either method. The team discussed how a fixed buffer would be a simpler than P* and incorporates all uncertainty without specifying values for specific types of uncertainty that can change over time. A P* approach is more consistent with risk management theory because the size of the buffer changes with uncertainty. The EA analysis assumes that the OFL estimates are unbiased, however, the CPT recognizes that some potential for bias may exist and the team will focus on ensuring that each assessment is as unbiased as is technically possible.

Brian presented the economic analysis that shows the probability of being overfished for each buffer size and the cost of that buffer over 5 years and 30 years. The results show that the % change in total present value increases as the buffer increases and the more risk adverse the buffer, the higher the incremental cost.

Andre explained the concept of skewness, why the distributions for the OFL for some of the species are skewed and hence that setting the ABC equal to the OFL for these species does not correspond to a probability of overfishing of 0.5. The effect of skewness is greatest for the Tier 4 stocks for which the OFL is based on survey estimates rather than model results (tanner crab and Pribilof red king crab) because the OFL is primarily a function of the most recent survey estimate, the sampling distribution for which can be highly skewed owing to high survey variance. The CPT agreed that there are a number of ways to compute the ABC given P*, σ_w and σ_b and that the ACL EA includes different methods for different stocks and hence shows the possible impact of the choice of method on the ABC. The CPT will select a method for computing a distribution for the OFL for each stock. It was noted that defining that setting the ABC to OFL leads to a 0.5 probability of overfishing and assuming that the distribution of the OFL is log-normal for Tiers 3 and 4 and t for Tier 5 (e.g. Table x-x) would provide a fairly straightforward approach to applying the ABC control rule (i.e. computing the buffer given σ_w , σ_b and P*).

11. Pribilof blue king crab rebuilding plan

Bob Foy (AFSC) presented the Pribilof Islands BKC rebuilding plan. New alternative 6 contains trigger closures with cap levels established for PIBKC in all groundfish fisheries. New options would set the cap

at either the OFL or ABC. The analyst is obtaining estimates of Pribilof blue king crab bycatch in the commercial halibut fishery, but issues still exist with confidentiality. For now, the analysis includes information on effort in the commercial halibut fishery through log data and fish ticket data, and information on crab catch during the IPHC survey. Similar information should be included for the Pacific cod longline fleet in this area.

The CPT **requested** that the analyst remove St. Matthew Island blue king crab bycatch from the maps as those data may be misleading and distracting. The analyst should examine whether Pribilof Islands and St. Matthew blue king crab are the same stock. In principle, genetic methods can inform this examination, but the genetic information may have insufficient statistical power to be of use.

Recruitment processes and habitat needs (and availability) for Pribilof blue king crabs are poorly understood. Based on snow crab larval distribution models, it is understood that eddies periodically form north of the Pribilof Islands and may entrap and redistribute larvae. This may also be true for blue king crab and may be affect larval settlement on optimal habitat.

12. Economic SAFE

Brian Garber-Yonts (AFSC) presented an overview of the Draft Economic SAFE report. The document has progressed to the point of application on an annual basis for economic and regulatory analysis, and will be posted online soon. Jean Lee (Jean.Lee@noaa.gov) can be contacted for a copy of the draft. abstracts of ongoing economic research on crab fisheries. The CPT discussed incorporating economic sections to species chapters in SAFE. Brian confirmed that the CPT will have opportunity to see these draft economic sections in May 2001. This past summer, an audit of the EDR database code was performed. Most of code has been corrected, absent a few minor bugs, and the database is clean and ready to use.

13. Ecosystem Considerations

Liz Chilton (AFSC) reviewed the ecosystem chapter that will be included as an Appendix to the SAFE report. The objectives of this chapter are to assess the BSAI ecosystem trends, identify and provide annual updates of ecosystem status indicators and research priorities for the 10 BSAI crab stocks, and to update management status indicators. The ecosystem chapter is composed of three main sections 1) ecosystem assessment, 2) current status of ecosystem indicators, and 3) ecosystem-based management indicators.

A summary of the most recent ecosystem trends affecting BSAI crab is summarized below with additional information detailed in the ecosystem consideration indicators chapter.

- 2010 was a cold year in the Bering Sea, with extensive winter ice cover, and was one of the largest summer cold pools measured since 1999.
- Analysis of ice extent suggests that the northern Bering Sea will remain cold for the foreseeable future. This has important implication for the ecosystem and the northward spread of species.
- A new analysis shows a shift of groundfish survey biomass to the northwest over the last several years. This shift to the northwest has persisted even through recent colder years.
- Very few indicator trends are available for the Aleutian Islands.

Suggestions were made from the CPT as to how to focus the chapter for future versions. One major recommendation was to streamline by removing crab stock assessment information and to focus on ecosystem issues. With regards to research priorities, which were taken from last year's Crab Plan Team minutes, the suggestion was to focus research priorities within this document on ecosystem issues. The CPT acknowledged the hard work by Liz and her colleagues in putting together this document.

14. Review of Alaska Board of Fisheries proposals for 2010/2011 cycle

Wayne Donaldson (ADF&G) presented the FMP crab stocks regulatory proposals to be presented at the next Alaska Board of Fisheries (BOF) meeting. The BOF will meet in March 2011 to consider proposals related to statewide king and Tanner crab regulations. Donaldson provided the CPT with an overview of the eight proposals in this cycle that are related to FMP crab stocks and their FMP management measure category. The CPT discussed the process by which their comments on the proposals could be conveyed to the BOF; it was noted that these proposals will be reviewed at the October meeting of the BOF-NPFMC Joint Protocol Committee.

- With regard to proposal 301 to move the eastern boundary of the Bering Sea Tanner crab district east to 159 W longitude the CPT expressed concern that this action could increase bycatch mortality of Bristol Bay red king crab, a stock that is decreasing in abundance with little potential for recruitment in the near-term. The CPT noted that they have previously expressed concern for bycatch mortality of this stock in southwestern Bristol Bay.
- Proposal 305 would allow the Saint Matthew Island blue king crab fishery to open on September 15. The CPT expressed concern for how this proposed earlier season opening date would interact with the existing process of recommending OFLs and that it would not be possible, under the current process, to recommend an OFL for this stock in time for a September 15 season opening. The CPT expressed concern over options that would specify an OFL earlier in the assessment cycle would introduce uncertainty by not utilizing the latest survey and fishery data.
- Proposal 307 seeks reduce the minimum size limit for Tanner crabs in the Bering Sea District. The proposal does not mention a specific size limit that it is attempting to achieve, but it was discussed that an analysis has been undertaken to examine legal size limits between the existing 5.5" carapace width limit down to 5.0" carapace width. It was noted that comments to the BOF on this proposal would be well informed if the range of potential new legal size limits could be analyzed in the developing Tanner crab assessment model and if that output could be available by mid-November.

15. Crab EFH definitions and discussion paper planning

Bob Foy summarized recent Council action on crab EFH. In April 2010, the Council initiated a discussion paper to reevaluate fishing effects on crab EFH and to assess the importance of protecting southwest Bristol Bay habitat for spawning red king crab (perhaps as a HAPC). The discussion paper is tentatively scheduled for review during the December 2010 Council meeting.

Foy stated that the discussion paper was initiated because methodology for evaluating adverse effects of fishing on crab EFH may not capture all the appropriate habitat parameters that are important for crab (e.g., oceanic parameters, pelagic habitat) and that there may not be enough information about crab habitat needs to draw any conclusion about the effects of fishing other than 'unknown' in some cases. In addition, the CPT identified an area in southwestern Bristol Bay where there has recently been an increase in the red king crab population, and where there has also been an increase in trawling activity over the last 5 years. The CPT had previously identified a need to evaluate the potential for adverse interactions of trawling on crab habitat in this area. The team had also noted that crab distributions may have shifted in recent years such that areas like southwestern Bristol Bay area are now more important and existing closure areas (e.g., the red king crab savings area) may not fully enclose all important habitat and the full stock distribution. The existing closure areas should be examined to determine whether they are still achieving their purpose of protecting the crab stocks and potential new closure areas should be evaluated.

Foy reviewed an outline of the discussion paper and identified key questions the paper should address. The paper will be structured with two components as follows:

GENERAL DISCUSSION OF EFFECTS OF FISHING METHODOLOGY AND CONCLUSIONS FOR CRAB STOCKS

- Methodology used for evaluating adverse effects of fishing in the 2005 EFH EIS
- What are the conclusions about fishing impacts on crab EFH that are drawn in the 2005 EFH EIS?
- Habitat needs for crab stocks
- How might improved methodology for evaluating adverse impacts of fishing on crab EFH be devised?
- Are the 2005 EIS' conclusions about the effects of fishing on crab EFH likely to be valid, or should they be reconsidered?

DISCUSSION OF EFFECTS OF FISHING ON CRAB IN PARTICULAR AREAS

- What is the important spawning area for red king crab identified by the CPT?
- Changing distribution of red king crab throughout their range.
- Changing distribution of other crab species?
- Research questions

The CPT discussed that this issue remains a high priority for both the team and the Council, but because of the range of questions to be addressed in the discussion paper it may be challenging to have a fully developed paper available for review at the December 2010 Council meeting. It was noted that this action is not explicitly tied to the EFH amendment action and that the quality of the discussion paper could be improved by delaying presentation until the January 2011 Council meeting. If a delay until January 2011 is required the CPT noted that this would not be reflective of a reprioritization of this issue, but rather an attempt to provide a more fully developed document for Council review.

16. Handling mortality presentations

Craig Rose (AFSC) presented information on mortality rates for crab taken as bycatch in bottom trawls. Rose reviewed the previously developed RAMP method for assessing health of crabs encountered by trawls and described research to apply RAMP to Tanner and snow crabs taken as bycatch in Gulf of Alaska and Bering Sea bottom trawl fisheries. The presentation included a review of past research on this topic performed in the Russian Joint Venture fishery (Stevens 1990).

Rose noted that his work on GOA trawl vessels showed lower on-vessel holding and processing times compared to Stevens (1990), as well as a lower mortality rate – 46% for GOA Tanner crab compared to 78% in the Russian Joint Venture fishery. In the Bering Sea fishery, holding and processing times and mortality estimates differed between study legs but were greater than in the GOA and were slightly higher for Tanner crab than snow crab (64% for Tanner crab, 60% for snow crab).

Rose discussed the issues with applying RAMP methods developed for unobserved mortality to bycatch crabs; additional issues aerial exposure (wind-chill, drying, freezing), cod-end effects (turbidity, physical effects), onboard handling, and the holding bin/tank environment. Rose presented work to address the effect of aerial exposure and found modest increases in mortality due to aerial exposure, however some individuals with poor RAMP scores after extended aerial exposure did recover.

Rose summarized that mortality rates estimated by this study were somewhat lower than Stevens, and confirmed the effect of captivity time on mortality rate. More work is needed on application RAMP characteristics for bycatch mortalities. Ongoing research includes efforts to characterize pelagic gear unobserved mortality rate, proportion of crabs captured (bycatch vs. unobserved), and footrope modifications to reduce mortality.

The CPT expressed appreciation for the work presented and noted that in directed crab fisheries, exposure to very cold conditions is common and should be considered in future studies. The CPT also **requested** that future figures depicting RAMP mortality estimates include confidence intervals.

Liz Chilton (AFSC) presented research applying RAMP methods onboard vessels in the directed snow crab fishery. Chilton reviewed current estimates of bycatch volume in the directed fishery, made comparisons to crab bycatch in the groundfish fisheries, and discussed handling mortality rates applied to the directed fishery. Chilton noted that bycatch mortality in the directed crab fisheries occurs as a function of thermal stress (evaporation and radiation) and physical stress (carapace breaks, frozen tissue, anoxia). The goal of the study was to examine how on-deck handling techniques effect crab bycatch mortality, examine whether current assumptions about handling mortality are valid, and to document on-deck weather conditions to assist with future research planning.

Results did not show a positive relationship between time on-deck and bycatch mortality. Under the conditions of this study it appears that on-deck weather conditions likely have a strong influence on handling mortality and may mask the effect of time on-deck. This conclusion is supported by weather data collected on-deck and from local weather data sources, but relatively few samples are available for the lowest temperatures.

The CPT discussed that some handling mortality may occur beyond the time period covered by the RAMP estimates (delayed mortality). This could occur if important biological functions are impeded by injuries resulting from handling (i.e. crab is unable to molt). It was noted that many bycatch crabs are morphometrically mature and would not molt again. The CPT suggested laboratory work where crabs would be held for longer periods to assess delayed mortality and asked for clarification of how time on-deck was quantified (from the time crabs were emptied out of pots). The CPT also discussed how to apply RAMP-derived handling mortality rates to historical bycatch data using variable weather data across and within fishing seasons.

17. Research Priorities:

The CPT discussed research needs and identified the following items (in order of priority) in conjunction with this annual review:

1. Refine estimates of survey catchability coefficients
2. Improve estimated handling mortality rates for discarded crab caught in the targeted and non-targeted fisheries including groundfish trawl and fixed gear fisheries
3. Develop quantitative female reproductive indices to incorporate into stock assessment process particularly with respect to EBS snow and Tanner crab and Bristol Bay RKC
4. Identify and assess production periods that may represent recruitment shifts across BSAI crab stocks
5. Improve estimates of growth, particularly for opilio, with the intent to evaluate spatial and inter-annual variability
6. Investigate current natural mortality estimators and develop longevity-based estimators based on maximum age or using tag-recapture methods
7. Explore the basis for setting the γ parameter particularly with respect to calculating FOFL for Tier 4 crab stocks
8. Identify life history bottlenecks with respect to depleted stocks and lack of recovery despite rebuilding plans
9. Improve in-season catch accounting for crab in non-directed fisheries to incorporate crab bycatch into the assessment models
10. Identify as well as assess productivity trends which may impact crab stock recruitment

18. New Business:

The CPT discussed timing for an interim meeting to review models for Tanner crab, PIBKC, PIRKC and CIE simulations for BBRKC. The team proposes to have a modeling workshop February 15-18 (likely 3

days of those 4) in Seattle. The team will try to encourage the participation of additional modelers from AFSC for this meeting.

Timing of 2011 meetings: February 15-18, 2011 (Seattle); May 9-13 (Juneau); September 12-16 (Seattle).

The meeting adjourned at 5pm on September 16th.

**North Pacific Fishery Management Council Crab Plan Team Meeting
September 13-16, 2010
AFSC, Seattle, WA**

DRAFT AGENDA August 31 vers

Monday, September 13		Room (Traynor Room, all week)
9:00	Administration	<ul style="list-style-type: none"> • Introductions, agenda, minutes, and 2011 timing
9:15	Council action update	<ul style="list-style-type: none"> • Overview of crab Council action from June 2010 meeting
9:30	Survey	<ul style="list-style-type: none"> • Overview of 2010 survey and results : NMFS AFSC survey; AFSC/BSFRF cooperative survey selectivity update
	Break 10:30-10:45am	
10:45	Paper Presentation	<ul style="list-style-type: none"> • Snow crab spatial population model – <i>Murphy</i>
11:15	Snow crab MSE	<ul style="list-style-type: none"> • Snow crab management strategy evaluation project
11:30	Stock Assessment Review / OFL	<ul style="list-style-type: none"> • Snow crab: final assessment results and rebuilding analysis
Noon		Lunch
1:00	Stock Assessment Review / OFL	<ul style="list-style-type: none"> • Snow crab: continue as necessary
2:20		<ul style="list-style-type: none"> • BBRKC assessment, CIE review and plans
	Break 3:00 – 3:15	
3:15		<ul style="list-style-type: none"> • BBRKC-continue as necessary • St. Matthew blue king crab
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Tuesday, September 14		
9:00	Stock Asses. / OFL cont.-Model Review day	<ul style="list-style-type: none"> • Tanner crab-assessment overview and model review
	Break 10:30 – 10:45	
Noon		Lunch
1:00		<ul style="list-style-type: none"> • AIGKC model review
	Break 3:00 – 3:15	<ul style="list-style-type: none"> • Pribilof red and blue king crab model review (T)
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Wednesday, September 15		
9:00	Stock Asses. / OFL cont	<ul style="list-style-type: none"> • Finalize SAFE report introduction
	Break 10:30-10:45	
10:45am	ACLs/AMs	<ul style="list-style-type: none"> • Review of final ACL analysis; update on Council action in June and revisions to initial review draft over summer ; CPT recommendations as necessary on preferred alternative
Noon		Lunch
1:00	ACLs/AMs cont.	<ul style="list-style-type: none"> • Continue as necessary
	Break 3:00 – 3:15	
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Thursday, September 16		
9:00	PIBKC rebuilding	<ul style="list-style-type: none"> • Pribilof blue king crab rebuilding plan: review initial review draft
	Break 10:15-10:30	
Noon		Lunch
1:00	Handling Mortality	<ul style="list-style-type: none"> • Update on handling mortality estimates in different fisheries
1:30	Ecosystem	<ul style="list-style-type: none"> • overview

	considerations	
	chapter	
2:30	Economics	<ul style="list-style-type: none"> ● 5 year economic review of CRP
	Break 3:00 – 3:15	<ul style="list-style-type: none"> ● Overview of final Economic SAFE
3:15	Economics	<ul style="list-style-type: none"> ● Presentation on crab crew remuneration
4:00	New business	<ul style="list-style-type: none"> ● Continue as necessary ● Crab EFH definitions and discussion paper planning ● Additional meeting scheduling in 2010/2011 as needed (per model review discussion)
5:00		Adjourn
