Crab Plan Team Report

The North Pacific Fishery Management Council's Crab Plan Team (CPT) met September 15 – 18, 2014 at the Alaska Fisheries Science Center, Seattle, WA.

<u>Crab Plan Team members present:</u>
Bob Foy, Chair (NOAA Fisheries /AFSC – Kodiak)
Karla Bush, Vice-Chair (ADF&G – Juneau)
Diana Stram (NPFMC)
Doug Pengilly (ADF&G – Kodiak)
Wayne Donaldson (ADF&G – Kodiak)
Heather Fitch (ADF&G – Dutch Harbor)
Jack Turnock (NOAA Fisheries/AFSC – Seattle)
Shareef Siddeek (ADF&G – Juneau)
Martin Dorn (NOAA Fisheries /AFSC)
William Stockhausen (NOAA Fisheries /AFSC)
Bill Bechtol (Univ. of Alaska – Fairbanks)
Brian Garber-Yonts (NOAA Fisheries – AFSC Seattle)
Ginny Eckert (Univ. of Alaska – Fairbanks)

CPT members absent: *Josh Greenberg (Univ. of Alaska – Fairbanks), Jason Gasper (NOAA Fisheries – Juneau), and André Punt (Univ. of Washington).*

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 included: Linda Kozak, John Olson, Kristan Blackhart, Ruth Christiansen, Edward Poulson, Jie Zheng, Bill Gaemann, Hamachan Hamazaki, John Gauvin, Athol Whitten, Sarah Marrinan, Wes Jones, Scott Goodman, Chris Siddon, Cody Szuwalski, Jim Ianelli, Paul Starr, Stephani Zador

1. Administration

The team reviewed the attached agenda and discussed the use of the NPFMC granicus system in posting documents and archiving in-meeting presentations. The team noted that the system facilitated document and powerpoint distribution and increased the facility of paperless meetings. The team noted that it intends to discuss the objectives of the model workshop planning after reviewing progress on Gmacs on Thursday. The team reviewed dates for the May 2015 meeting (May 4-7 in Anchorage) and set the dates for the September 2015 meeting (September 14-18 in Seattle). Diana Stram will work with Bob Foy, Karla Bush and Sarah Marrinan (NPFMC staff) to organize the agenda and documents for the May meeting. Sarah Marrinan will represent Council staff for the May 2015 meeting. Discussion of May meeting agenda will occur at the half-day January 15th 2015 CPT webex meeting for NSRKC review. The chair noted that he and Council staff will contact Josh Greenberg about removing him from the CPT due to his scheduling constraints.

2. Survey Overview

Bob Foy (AFSC) summarized results from the 2014 NMFS survey. The 2014 survey was conducted from June 8 to August 2, 2014. Water temperatures were among the warmest in the survey time series and the cold pool was further north than usual, between St. Matthew Island and the Pribilof Islands. All king crab captured in the survey, 94 percent of the Tanner crab east of 166° W long, 86 percent of the Tanner crab west of 166° W long, and 77 percent of the snow crab were measured.

Ten special projects were conducted for crab during the survey. Bitter crab sampling was modified from prior years to develop three index areas instead of sampling throughout the entire survey area in order to reduce sampling effort while retaining the ability to detect changes in prevalence over time. Collection of snow crab gastric mills and eyestalks began this year for a snow crab aging study. Other snow crab studies included: ocean acidification, physiological maturity, annual vs. biennial reproductive cycles, temperature-dependent growth and habitat associations. Reproductive potential studies on Snow and Tanner crab continued. Cod stomachs were collected to study predation on red king crab, and red king crab females were tagged using 'pop-up' tags to assess larval release.

Abundance estimates, spatial distributions by sex and size, and distribution centers were discussed for each stock. Anomalies or notable comments are listed here for each stock. Biomass increases and relatively even distributions occurred for most stocks. No retows occurred in Bristol Bay because red king crab had gone through the molt/mate cycle well before the survey and retows are typically associated with cold years. The Pribilof Island red king crab distribution was shifted south and west of St. Paul Island and further offshore than normal. Mature male biomass increased in the St. Matthew Island Section; however, survey station R-24 drove this increase, accounting for 38% of mature males and with a lack of notable recruitment. Tanner crab abundance estimates increased in the area west of 166° W long. and decreased in the area east of 166° W long. in 2014. Snow crab male abundance increased in 2014, which contrasts to decreases in the past two surveys. While snow crab occurred in more survey stations than in recent years, snow crab appeared more aggregated, with notable aggregations at the edge of the cold pool. Hybrid *Chionoecetes* abundance has increased over the past few years and is not likely attributable to identification differences among survey personnel.

The CPT discussed catchability and its relationship to temperature. This discussion was prompted by two observations: 1) the shift from cool to warm temperatures in the eastern Bering Sea, and 2) the increase in abundance for nearly all crab stocks in the 2014 survey. Hypotheses included that effects of temperature could be related to absolute temperature, timing of temperature changes, and temperature relative to surrounding areas. The CPT recommends that effects of temperature to survey catchability be looked at closely.

Cooperative research the AFSC is currently involved in includes: red king crab selectivity, larval distribution for recruitment work, catchability behavior, Tanner crab growth, tag development, and larval drift.

A timeline of fishery evaluation and management of many crab stocks was provided for context as follows: survey ends August 4, area-swept data distributed August 11, final abundance and biomass to the state August 15, draft survey to public September 3, CPT meeting September 15–18, SSC meeting October 6, TAC setting October 6–10, fishery start October 15.

3. Ecosystem overview

Stephani Zador (NMFS – AFSC) presented an overview of the Ecosystem Considerations report with a focus on the Eastern Bering Sea. The current report has been developed for the groundfish plan teams and is concentrated on ecosystem implications for groundfish stocks. A major component of this report is the time series of environmental indices, such as the Aleutian low, sea level pressure, jellyfish densities and distributions, sea surface temperatures, and the cold pool. Efforts are underway to develop 9-month forecasts of some indices. The comprehensive ecosystem report is given annually to the SSC and Council in December, which is out of sync with the crab assessment cycle. Development of an ecosystem chapter for the crab SAFE document was attempted in 2010 and 2011, but was discontinued due to staffing constraints. Of .interest to the team was an analysis of 2013 data that showed the area disturbed by trawl fishing gear in the EBS (Grieg). The team suggested that future analyses look at the area disturbed in relation to crab stock distribution areas instead of over the entire Bering Sea. The CPT appreciated the informative presentation and considers it worthwhile to continue receiving an ecosystem report at its September meeting in the future. Rather than prepare a separate ecosystem chapter for the crab SAFE document, a more effective use of resources would be to provide technical support to augment the existing Ecosystem Considerations report with more crab-specific indicators. The Ecosystem

Considerations report already has a broad ecosystem focus, which logically would include crab stocks, and is evolving into the more comprehensive Integrated Ecosystem Assessment construct that NOAA is promoting.

4. Assessment reviews

4.1 Eastern Bering Sea snow crab

Responding to CPT requests at its May 2014 meeting, Jack Turnock presented nine model scenarios for the 2014 eastern Bering Sea snow crab assessment. These scenarios included:

1) the 2013 assessment model (Model 0 in the SAFE chapter,), which incorporated a sex-specific, linear growth model
2) Model 1, same as Model 0, but with a sex-specific, two-segment linear model with a fixed intersection (a "hockey stick" model) describing mean growth increment.
3) Model 2a, same as Model 0, but with a sex-specific, two segment linear model with a smooth (differentiable) transition between the segments and using 1 as the weighting factor in the final estimation phase on likelihood penalties related to fishing mortality (i.e., on average F's and F deviations)
4) Model 2b (or the base model), same as Model 2a, but with a factor of 2 weighting the growth data likelihood component
5) Model 2c, same as Model 2b, but with a factor of 3 weighting the growth data likelihood component
6) Model 2d, same as Model 2b, but using 0.5 as the weighting factor on the F penalties
7) Model 2e, same as Model 2b, but using 0.25 as the weighting factor on the F penalties
8) Model 2f, same as Model 2b, but using 0.1 as the weighting factor on the F penalties
9) Model 2g, same as Model 2b, but using 0.001 as the weighting factor on the F penalties

The two-segment linear model with the differentiable ("smooth") transition was suggested as a potential growth model for snow crab at the CIE review of the assessment conducted in January 2014. The two-segment linear model with the fixed intersection (non-differentiable) was requested at the May 2014 CPT meeting as an alternative to be evaluated, even though the author had tried unsuccessfully to use an identical growth model as an alternative in the 2013 assessment. All of the growth models were fit using the Somerton et al. (2013) growth data inside the assessment model.

In the assessment, likelihood penalties are placed on the average F for males, on F-deviations for males and females in the directed fishery, and on F-deviations for trawl bycatch. This was motivated by the lack of data on discards prior to 1992 in the directed fishery: the model can generate large discard catches early in the time series while closely fitting the retained catch because there is no discard data to constrain the large F's. However, simulation work by Cody Szuwalski suggested that such penalties might introduce biases into the estimates. Consequently, the CPT had requested the author consider scenarios in which the penalties were reduced or eliminated. Turnock noted that he was unable to get a model with a weight of 0 to converge successfully. Also, the weights in question were only applied in the final model estimation phase; in earlier estimation phases, identical weights (1.0) were applied to the estimated fishing mortality rates in all scenarios.

One effect of the reduced weights on the fishing mortality penalties in the model likelihood was to estimate higher survey q's (catchability), which resulted in lower biomass estimates. Fits to the length compositions also improved, but at the expense of worse fits to survey biomass.

The author selected Model 2b (with a weighting factor of 2 on the growth data) as his preferred model because it used the smooth, 2-segment growth model and it fit the growth data much better than did the similar model with the weighting factor of 1, while the fit was not substantially improved using the model with the weighting factor of 3. Jie Zheng asked whether the smallest crab in the data fit by the models might molt more than once-per-year, which contradicts the model assumption of one annual growth increment (until maturity).

Turnock noted several differences in model results between his preferred model this year and last year's assessment model. Among these was that, while both models estimated a recent peak in recruitment, its timing was shifted from a peak in 2009 for the current model from a peak of 2008 in last year's model. Turnock also noted that this recruitment event was not immediately evident in survey length frequencies (e.g., poor fits in the 2011 and 2012 models), but has appeared in mature and legal-sized male size ranges this year and model fits are better to the 2013 and 2014 size frequencies this year. However, the model continues to under-estimate large females. Marginal fits to the length frequencies (i.e., averaged across all years) are reasonable for both sexes.

The CPT discussed regarding the degree of change (~80 million crab) in the estimate of 2013/14 MMB from last year's assessment. Turnock explained that this was consistent with the model shift in the timing of the recent peak in recruitment from 2008 to 2009 because cohorts from the peak biomass are actually available a year later, shifting biomass and mortality on that biomass accordingly.

Plan Team recommendations

The Plan Team recommended that the author explore the use of different penalty weights by time period to quantities related to fishing mortality. One specific suggestion was to eliminate the weights on average F and to put penalties on F deviations only in the "early" time period when data on discards is unavailable. Other alternatives to eliminate the F penalities should be considered, for example, by incorporating effort data for the "early" time period to stabilize the fishing mortality estimates.

The Team also recommended the author consider whether the smallest crab used to estimate growth increments in the model could be molting more than once per year (contrary to the assumption used to incorporate the size data in the model) and to explore the ramifications of this assumption.

4.2 Eastern Bering Sea Tanner crab

William ("Buck") Stockhausen (NMFS) presented the draft Tanner crab assessment. The fishery was opened for the 2013/2014 season with an aggregate GHL of 3.1 million lbs, apportioned 1.645 million lbs west of 166^0 W and 1.463 million lbs east of 166^0 W. Approximately 80.9% of the GHL was taken in the west and 99.5% in the east. The greatest sources of Tanner crab discards during the 2013/14 year was the snow crab fishery. The 2014 survey showed increases in immature males, mature males, and legal males, and decreases in mature females (maturity based on presence of eggs). The survey size composition shows a recruitment pulse in ~2010 carrying through subsequent years.

The current assessment model structure, based on crab size, sex, shell condition, and maturity, is the same as in the 2013 assessment. The model is a Tier 3 stage-based model involving both male and female crab. The model year runs from July 1 to June 30 with natural mortality estimated for two time periods. In addition to updating directed fishery, bycatch, and survey data for 2013/14, the author made considerable revisions to some of the input data based on revised data provided by ADF&G staff (W. Gaeuman, H.

Fitch, and D. Pengilly) and AKFIN. In particular, the author recalculated effort, sample size, and size compositions for the directed fishery; revised groundfish bycatch compositions back to 2009 per changes in the AKFIN data to use bycatch apportionments by ADF&G statistical reporting areas instead of federal reporting areas; summarized groundfish bycatch data by crab year instead of groundfish fishing year; and corrected an error in size composition data for immature females. Most of these changes had little impact on model results, although substantial changes did occur in some factors, notably in estimated selectivity for the 1996 directed fishery.

The author considered three basic suites of models: (1) Alt0 models, usingused the base model from the previous assessment (including previous data errors) and updated only with new 2013/14 survey and fishery data; (2) Alt 1 models used corrected and recalculated data; and (3) Alt2 and Alt3 modelswere TCSAM-FRev based models incorporating Gmacs fishing mortality components. Each of these model sets incorporated an “a” scenario in which handling mortality in the pot fisheries was set to the default of H=0.50 and a “b” scenario with H=0.321. The value of 0.321 was recommended at the May 2014 CPT meeting based on a presentation by Dan Urban showing results of a short-term handling mortality study using Reflex Action Mortality Predictor (RAMP) scores and endorsed by the SSC at its June 2014 meeting.

All models assume a model year of July 1 to June 30, a trawl survey that occurs July 1, fisheries that occur February 15, and the spawning stock assessed at the time of mating. The author described the various model components, including data periods, but was asked to explain in the future the use of three periods for the groundfish bycatch data.

The Alt0- models were rejected owing to the data being incorrect or unrevised. The Alt2- and Alt3- models failed to converge and, given the limited time available for this assessment, the author opted to defer further work on these alternatives until 2015. Of the remaining two models (Alt1a and Alt1b), Model Alt1b with H=0.321 failed to provide a plausible selectivity curve for male snow crab during the years 1997-2004, possibly related to poor parameterization of male bycatch selectivity in the snow crab fishery during this time period. Therefore, the author initially recommended model Alt1a, the model using H=0.50. The author acknowledged that having H=0.321 may be based on better data and more biologically realistic, but did not have sufficient time to pursue a better model prior to document deadlines. The CPT appreciated the extensive efforts taken by the author to improve the input data. Given the CPT concerns about all models proposed, the CPT asked the author to return later in the meeting with a specific set of model runs to address the parameterization issue for fishery selectivity, , including an option in which selectivity is fixed, and with H alternatives of 0.5, 0.321, and 0.23 (per industry request). The specific problem identified was that the parameter for the inflection age for the ascending portion of the curve was estimated to greater than the parameter for the inflection age for descending portion of the curve. The run requested by the CPT simply parameterized the inflection age for the descending portion as a positive offset from the inflection age for the ascending portion.

The CPT noted concerns about having authors make new model runs during the course of a CPT meeting, potentially introducing errors into the modeling process. However, such requests are an infrequent occurrence, typically focusing on exploring sensitivity of a given model parameter.

The author reran the Alt1 model with a revised model parameterization for the selectivity curve for snow crab bycatch as scenarios Alt4a (H=0.5), Alt4b (H=0.321), and Alt4c (H=0.23). As handling mortality decreased in the new scenarios, estimated model recruitment also decreased (but only ~10% overall) because fewer crab died as a result of being discarded and it took fewer new crab entering the population to support fishery removals and trawl survey estimates. Overall, $F_{35\%}$ showed little change. Of the final four model scenarios compared, Alt4b had the smallest objective function value (better fit) while Alt4c had the largest (worse fit). However, comparing objective function values for Alt4b and Alt1a was questionable because the input data differed (models fits to "observed" discard mortalities are functions of assumed handling mortality rates). AltA1a had better fits, except to retained catch biomass and directed fishery size comps. Most results changed little under the alternatives, except female discard biomass predicted higher discard mortality under H=0.50 during peak historical years. The CPT discussed an expectation of seeing greater differences in total mortality for the directed fishery among different H scenarios; the author will examine this result. None of the models fit the recent years of low bycatch mortality in the snow crab fishery well. Estimates of total mortality rates were virtually the same among models for retained males, total males, and females. Model estimates of Tanner crab fishing mortality in the snow crab fishery showed pronounced differences among models due to differences in assumed handling mortality. In contrast, little difference was found for the lower magnitude bycatch estimates for the Bristol Bay red king crab fishery. The CPT noted that the size composition residuals for retained males and total males in directed fishery indicate some issues, perhaps suggesting that growth estimates should be revisited. Another potential cause may be mis-specification of sample sizes, or a combination of fishing selectivity and handling mortality may be causing mis-fits. The MMB and recruitment appear to be fairly tightly estimated.

The author recommended model Alt1a. However, the CPT felt that model Alt4b resolved some of the issues over model Alt1a and also incorporated what was thought to be a more realistic representation of handling mortality. Model Alt4b was subsequently forwarded by the CPT as the preferred model. Under this model, the stock was not overfished and overfishing did not occur in the past year.

Based on the above discussion, the CPT has the following **recommendations** for the May 2015 assessment:

1. Explain/justify the three periods used for groundfish bycatch.

2. The industry asked about the potential for incorporating additional growth data into future assessment models given that the existing data is based on Tanner crab from the Kodiak area.

3. Examine or clarify why the different H scenarios do not result in greater differences in total mortality for the directed fishery.

4. Examine issues related to misfits of the size composition residuals for retained males and total males in directed fishery. Consider exploring alternative growth components, specification of sample sizes, or a combination of fishing selectivity and handling mortality is causing mis-fits.

5. The CPT suggests the author free up the constraint on catchability priors to see how that affects model results.

4.3 Bristol Bay red king crab
Jie Zheng (ADF&G) presented the stock assessment analyses for the Bristol Bay red king crab (BBRKC) stock in 2014/15.

Jie opened with a summary of the information provided in Appendix C of the 2014 BBRKC stock assessment chapter focusing on, temporal changes, and proposed causes, in spatial distribution of mature female red king crab. This investigation was a response to an SSC June 2014 encouragement that the author further study this topic in the hope of disentangling the causes for the well-documented southwest-to-northeast shift in distribution of mature female red king crab within the Bristol Bay area that occurred during the late 1970s to early 1980s.

Jie summarized the 1975−2013 data on mature female distribution by grouping into eight periods and by plotting annual centroids of distribution for sex-size classes. The distribution centroid of large (>104 mm CL) mature females was south of 56° N in 1975–1976, slightly north of 56° N in 1977, and further north afterward. Southward shifts of mature females occurred during 1988−1991 and 1999−2000, but not as far as the southwest distribution of 1975−1977.

Evidence for fishing as a factor in the distributional shift was evaluated by examining temporal trends in the distribution of commercial fishing concentration and the proportional distribution of specific sex-size classes across three latitudinal zones (<56° N, 56°−57.5° N, and ≥57.5° N) in the trawl survey data. Jie argued that the trends in those data do not support the hypothesis that fishing was an important factor in the distribution shift: centroids of directed fishery catch distribution were in the mid-latitude (56°−57.5° N) in all years; proportions of all size groups (including immature females <90 mm CL that should have low selectivity/catchability by commercial fishing gear) declined south of 56° N during 1977−1983.

Jie also considered the evidence for environmental forcing by examining trends in near bottom temperature recorded during the summer survey and in the winter PDO index. Jie argued that the trends in those data are consistent with the hypothesis that environmental conditions were an important factor: near bottom temperatures and winter PDO index were both low prior to 1977, increased in the late 1970s to early 1980s, and were correlated with the northward shift of large (>104 mm CL) mature females.

When the CPT questioned what impact the groundfish fishery had, Jie noted that the groundfish trawling was not allowed in the primary BBRKC habitat area during the 1970s. When asked about the indirect effects of fishing on recruitment, Jie pointed out that the directed fishery would have affected breeding success in the middle area, but not the southeast area. One team member cautioned that fishing effects should not be ruled out as a possible factor for the distribution shift on the basis of the analysis that Jie presented.

For the current stock assessment, changes to input data from the 2013 assessment were: the trawl survey time series through 2014 per revised NMFS estimates; updated catch and bycatch data through 2013/14; new trawl bycatch length frequency data for 1986−2012 revised groundfish bycatch estimates for 2009/10−2013/14; and re-estimated direct and indirect crab fishery bycatch and effort estimates. Results from three model scenarios were presented:

- 4na – the model scenario that was accepted for the 2013 assessment and was presented as the base model.
- 4nb – similar to 4na except trawl survey selectivity, Q, is estimated within the model (4na assumes Q=0.896, based on the Somerton and Otto under-bag experiment). Model scenario 4nb was presented as the author’s recommendation for the 2014 assessment.
- 4n7 – the same as 4nb except additional M parameters for males and females during 2006−2010 is estimated to allow for higher natural mortality during that period. This model scenario was presented to satisfy a June 2014 request from the SSC.

Before presenting the three models’ results, Jie reviewed the survey data and noted that the 2014 area-swept estimates for biomass and abundance of males and females are outliers from the 2008−2013 trend by being higher than expected given previous years’ estimates and size frequency distributions.

The fits by model scenarios 4na and 4nb to survey to the survey biomass and mature male and female abundance are nearly indistinguishable when plotted, whereas the fits by model scenario 4n7 depart from the 4na and 4nb fits after 2000. Model scenarios 4na and 4nb are below the 2002−2008 observed values and above the 2009−2013 observed values, whereas model scenario 4n7 fits the 2002−2013 values well. Negative log likelihood values were generally consistent, although model scenario 4n7 provided a slightly better fit than scenarios 4na and 4nb, with particular improvements in the survey length composition and pot discard male biomass components. Model scenario 4nb gave slightly better likelihood values than 4na, with improvements in the survey length composition and survey biomass components. The improved fit by model scenario 4n7 over model scenarios 4na and 4nb was achieved through an increase in natural mortality from the assumed M=0.18 to an estimate of 0.27 during the period 2006-2010. The improved fit by model scenario 4nb over 4na was achieved by estimating survey selectivity at Q=0.941, as opposed to the assumed value of Q=0.896 in model scenario 4na. Plots presented by Jie of standardized residuals for annual total survey biomass fit by model scenarios 4na and 4nb were virtually indistinguishable, as were the "bubble plots" of standardized residuals of male and female survey size composition proportions fit by model scenarios 4na and 4nb.

Two kinds of retrospective analyses for model scenario 4nb were presented: a hindcast analysis, in which 4nb was used to fit time series of abundance and mature male biomass data from 1975 through terminal data years of 2008−2014; and a historical analysis in which the fit by 4nb for 1968−2014 is compared with the models that had been used historically used to fit the mature male and legal male abundance data with terminal years 2004−2013. Both retrospective analyses showed fits with increasing trends from 2005 through 2010 when only data through terminal year 2010 are available; fits with terminal years ≥2011 showed flattened trends after 2004. A hindcast analysis of annual total recruitment from 1976 through terminal data years 2008−2014, as estimated by model scenario 4nb, showed little terminal year effect on the major features of estimated recruitment trend. Graphs of total annual recruits as estimated by model scenarios 4na and 4nb were virtually indistinguishable. Average annual recruitment estimates were higher for 1976−1983 than 1984−2014, and lower for 2006−2014 than 1984−2014.

Estimates of historical fishing mortality under model scenarios 4na and 4nb relative to the control rule with $F_{35\%}$ serving as the proxy for F_{MSY} were presented; under both scenarios; fishing mortality was estimated to be in the range of F=0.1−0.4 for most years during 1975/76−2013/14 and fishing mortality in 2013/14 was estimated to be below F_{OFL}.

Jie presented tables of biological reference points and of status and catch specifications for 2014/15 under model scenarios 4na, 4nb, and 4n7, all with 1984−2014 used as the recruitment time period to determine the $B_{35\%}$ proxy for B_{MSY}. Values were more similar under 4na and 4nb. Values estimated under 4n7 differed from 4na and 4nb by having a higher estimate of $B_{35\%}$ and a lower estimate of F_{OFL}, mature male biomass on 15 February 2015, and the OFL.

Jie closed his presentation with graphs of the 2010−2014 area-swept estimates of male and female size frequencies, noting the lack of any signal of a strong cohort entering the stock during 2010−2014, foretelling a declining trend in abundance and an increasing trend in size of the remaining crab for the near-term future. That has been a recurring theme of recent stock assessments and the sharp increase in area-swept abundance estimates of large males and females between the 2013 and 2014 surveys was not consistent with the size frequencies from the 2010−2013 surveys.

<u>CPT discussion:</u> The CPT found the stock assessment's Table 4 (negative log likelihood components for scenario 4na and differences in negative log-likelihood components among model scenarios) very informative. One public participant (Athol Whitten) noted that the final size bin (>165 mm CL) can account for a significant portion of the retained catch (e.g., ~35% of the 2012/13 retained catch). Model sensitivity to the selection of the size range for the final size bin was questioned, particularly for the retained catch (probably not an issue for the survey and discard size composition data). CPT members suggested that the final size bin might cause the model to miss signals in the size composition or could have an effect on modeling growth. The stock assessment author replied that breaking up the final bin into finer bins causes problems in fitting the model and in producing empty bins in the retained catch size

composition data. A discussion ensued, during which it was noted that approaches to deal with low-probability cells in size composition data are being studied and developed and will be considered at an upcoming workshop. **The CPT recommended that the assessment authors consider the affects of the final size bin used in the retained size composition data on model fitting (including the effects of the assumption of fixed sample size in the final bin) and consider the possibility of subdividing the final size bin into more than one bin.**

Public attendees asked the CPT for clarification on why the 2014 survey showed a large increase in abundance this year, but the 2014 model does not estimate such an increase nor an OFL increase commensurate with the survey data increase. The CPT reviewed the multi-year/multi-data-source nature of the models and the intent of model to provide the best estimates for the current year based on, and consistent, with all available data sources from all available years. CPT members noted that the estimates for 2014 may change, up or down, with accumulation of future years of survey data, incorporation of more data sources, or better estimates of process parameters. A member of the public voiced a concern that the model won't "catch up with reality" in time for the industry to be able to harvest the resource that is available now.

In agreement with the authors' recommendation, **the CPT recommended model scenario 4nb for use in the 2014 stock assessment with 1984−2014 used as the recruitment time period to determine the $B_{35\%}$ proxy.** Model scenario 4nb was recommended over base model scenario (4na) due to a within-model estimation of Q, seen as an improvement over the base model's use of an assumed, fixed value for Q. The CPT choose to not recommend model scenario 4n7; although that model scenario did provide the best fit of the model scenarios examined, the CPT felt reluctant to accept that model without some mechanism that could explain and support the use of Mdifferent than 0.18 during 2006−2010. In addition, the fit to 2014 survey is worse for model scenario 4n7 than the other model scenarios. **The CPT recommended using the status quo 10% buffer on OFL for setting the ABC.**

4.4 Pribilof Island golden king crab

Doug Pengilly presented the Tier 5 assessment for the Pribilof Islands golden king crab. The current fishing season is based on a calendar year. The fishery is not rationalized and there is no state harvest strategy. A guideline harvest level (GHL) was first established for the fishery in 1999 at 0.200-million lb (91 t) and has been managed with a GHL of 0.150-million lb (68 t) since 2000. Because few vessels participated in the fishery in recent years (2010-2013), the catch and fishery performance are confidential. The CPT concurred with the author's recommendation for the 2015 OFL based on the 2014 OFL formula. The author derived the ABC by applying the Tier 5 control rule with a 25% buffer on the OFL.The CPT discussed the merit of using 25% buffer for this stock in particular, and Tier 5 stocks in general. The author's rational for choosing this buffer was that the SSC in their June 2014 meeting recommended a 25% buffer for the Aleutian Islands golden king crab, and the assessment of this stock is at least as uncertain as the Aleutian Islands stock; hence, the 25% buffer. While generally supporting the author's recommendation, the CPT decided to visit this issue again later in the meeting (September 18) to ensure that its recommendations were consistent across all Tiers.

4.5 Pribilof Islands blue king crab

William Stockhausen presented the 2014 Pribilof Islands blue king crab assessment. The directed fishery was closed during 2013/14 and no major management changes occurred.

This assessment, as in 2013, includes waters 20 nm east of the Pribilof District. The Pribilof blue king crab stock is recommended as Tier 4 and utilizes NMFS trawl survey data to estimate abundance. Although recommended as Tier 4, the OFL/ABC is set under Tier 5 criteria ($B < 25\%\ B_{msy}$), as non-directed bycatch mortality of blue king crab may occur in other crab fisheries (none occurred in 2013/14) and in the groundfish fisheries. Along with 2014 trawl survey data, the assessment was updated with groundfish bycatch data. Groundfish bycatch estimates for fixed gear were substantially reduced in this year's assessment using revised methods and new 2013/14 data.. Blue king crab bycatch in groundfish fisheries, while decreasing in recent years, was highest in the Pacific cod hook-and-line fishery in 2013/14.

The 2014 survey caught 10 males and 5 females. Crab distribution was patchy, with no indication of recruitment. The MMB time series was estimated with an average centered on the current year and weighted by the inverse variance. The $MMB_{mating,}$ for 2014/15 was calculated using an average of MMB_{survey} for 2013 and 2014 projected forward to mating using a 3-year average estimate for the ratio of bycatch mortality to $MMB_{mating.}$ The 2014/15 MMB_{mating} is 218,000 t. Biomass is only 5% of $B_{msy,}$ and the stock remains in overfished condition, Tier 4c.

The CPT concurred with the author recommend 2014/15 season OFL, calculated as average bycatch mortality between 1999/2000 through 2005/2006 and is 1.16 t (0.0003 million lbs). The CPT recommends an ABC using a 25% buffer from the OFL or 0.87 t (0.0019 million lbs).

4.6 Pribilof Islands red king crab

Cody Szuwalski presented the 2014/15 stock assessment for Pribilof Islands red king crab (PIRKC). No management changes occurred for this stock in 2013/14. The number of survey stations where PIRKC are captured has increased over time, but the sample size remains low. The assessment incorporated the most recent recommendations made by the CPT and SSC, with the exception of incorporating ADFG pot survey data and retained catch size frequency data. The standard survey time series, standard groundfish discards time series, and the crab fisheries retained and discard catch time series were updated through 2014.

Mature male biomass and derived management quantities were estimated by a 3-year running average method (status quo) and by an integrated length-based assessment method (developed for the May 2014 CPT meeting). Tier 3 and tier 4 harvest control rules were applied to the integrated assessment output and were compared to the OFLs calculated by a Tier 4 harvest control rule applied to the running-average estimates of MMB. Patchy distributions and small sample sizes make fitting the model problematic. Low abundance years with small CVs are likely driving the assessment; high abundance years all have large CVs. The CPT has concerns whether the estimates for low abundance years are actually more precise.

The CPT recommended moving to the integrated assessment because it allows for the incorporation of multiple data sets (including length composition data) into the assessment, seen as an improvement over the running average method. The author recommended, and the CPT agreed, that this stock should remain in Tier 4 for stock status level determination. A Tier 4 approach is more precautionary because it sets a higher MSST and a lower F_{OFL} and ABC for a given MMB. The resulting OFL from the integrated assessment and tier 4 harvest control rule was 320 tons (0.71 million lb) of crab. Maximum ABC for this stock, using a p-star of 0.49, was 311 tons (0.69 million lb). The CPT felt that a larger buffer is warranted given the relatively low level of information for this stock, but notes that moving to an integrated assessment should logically reduce uncertainty even though the stock is considered to remain in Tier 4. Therefore, the CPT recommended a 15% buffer from the OFL (down from 20% with the three-year weighted average calculation) be used to set the ABC at 272 tons (0.60 million lb).

Suggestions from the CPT for next assessment:

- Start fitting the survey data at 1987 (do not include early years when sample size was extremely low)
- Consider alternative weighting schemes

4.7 St. Matthew Island blue king crab

The stock assessment author reviewed input data and formulation of the stock assessment model. The input data include the most recent fishery and survey data, including the 2013 pot survey, and groundfish bycatch estimates. The stock assessment model is a 3-stage length-based model. In this assessment the author explored alternative model formulations in response to CPT and SSC comments regarding retrospective patterns, misspecification of natural mortality and stage transitions. The author presented the profile likelihood for natural mortality, as calculated automatically in ADMB, and noted that it assigns highest likelihood to nonsensical values of the parameter (above 1.0). The CPT suggested that the author calculate the likelihood profile by hand for more meaningful values of the parameter and to develop a plot that shows trends in each likelihood component parameters.

The stock assessment examines four model configurations: 1) the base model used previously; 2) the base model with time-varying trawl-survey selectivity; 3) the base model with an alternative stage-transition matrix; and 4) the base model with both modifications above. These modifications were added to address concerns previously raised by the CPT and SSC. The author recommends use of the base model with both time-varying trawl survey selectivity and the revised stage-transition matrix. Model comparisons suggest that the modified models fit the trawl-survey-index better than the base model and that the author-recommended model fits the trawl survey composition data better than the base-model and two other formulations. The CPT expressed concerns with time varying selectivity as no mechanism was identified to explain this variability and concerns were raised that it was fitting sampling error. Some plan team members regarded the selectivity patterns to be implausible, especially selectivities > 1 for the stage-2 crab. However, others commented that it could be possible given crab movement and the mismatch between survey-station location and crab distribution. The CPT selected the base model with an alternative stage-transition matrix (#3 above) because it fits the data better than the base model and does not have time varying selectivity. However, the CPT noted that this model still has troublesome residuals. The author recommended, and the CPT concurred with a 20% buffer on the OFL for the ABC because of additional uncertainty in the model. This same approach was used last year.

The CPT requested further investigation of the time-varying selectivity, including further explanation/investigation of plausible explanations. Research needs include better molting probability information for the two smaller stages (of the three used in the model).

5. Modeling scenarios for Winter/Spring 2015

5.1 Norton Sound red king crab

Toshihide Hamazaki provided a progress report on developments to the assessment model subsequent to the May 2014 CPT meeting. As part of a change in the model year, the SSC in June adopted a midyear OFL/ABC with the understanding that a full assessment would be available in the January modeling workshop. The intent of the current presentation is to obtain CPT input on potential model specification, with CPT, and subsequent SSC, evaluation of OFL/ABC.

The 2014 trawl survey occurred during July 18–30 and was hampered by bad weather, resulting in sampling of only 47 stations, the lowest coverage on record. However, the survey resulted in the highest ever area-swept estimate (5.5 million crab), but with 50% of the catch from one station. The 2014 summer commercial fishery occurred from June 25 to August 15, harvesting 129,926 crab with a CPUE (1.23 crab/pot) that was higher than in 2013, but similar to the 2004–2013 average. Data on discards and tag recoveries are not yet analyzed. It was noted that mining is occurring within 10 miles of shore adjacent to city of Nome.

The author provided likelihood profiles of the use of a single M for all size classes across a range of M=0.12 to 0.50. The total likelihood indicated a minimum near M=0.40, although it appeared that the winter pot survey was having an excessive influence on the likelihood. Evaluation of model sensitivity to a single M value suggested larger M values result in an MMB that was greater in the late 1970s and lower in more recent years. The author also explored using a separate M for the largest length class and fixing M at 0.18 for all other size classes. The total likelihood attained a minimum at M=0.2 (similar to M= 0.18 for 2012 SAFE), but the likelihood profile plots were not not converging. In particular, the CPT discussed concerns that the likelihood profile attributed to the winter pot survey was again inconsistent with other parameters profiles; the winter pot survey is the only data set for which a higher M was indicated. The CPT discussed using dome shaped selectivity for the winter pot survey because large crab don't seem to be available to the survey. It was noted that the winter survey occurs at the same time and place as winter subsistence fishery, and the latter may be disproportionately removing the largest crab. For example, the commercial fishery has a 4 ¾" CW size limit, but the subsistence fishery has no size limit. The author clarified that the primary intent of using the winter length composition data is to inform the winter fishery, per previous CPT suggestions to make use of as much of the available data as possible. The winter pot survey was historically used to provide an index of recruitment to inform fishery management decisions. The CPT discussed reducing the weighting of the winter pot survey; it was suggested to review the paper by Francis (2011), which suggests reducing weights on composition data and putting more weights on biomass. As an exploration, the CPT suggested also using a descending logistic selectivity for the winter pot fishery with a separate M for the smallest size class and fully selected for the 2^{nd} size class.

The team discussed aspects of model parsimony; if increasing the number of parameters causes little change in results, then fewer parameters are warranted. But, the author should also explore various alternatives. For example, different weighting of tag recovery data produced little change in estimates of the MMB projection. However, it was clarified that the tag recovery data is only used for the growth matrix.

A major change to the assessment was shifting the model year from starting on July 1 to starting on February 1 in order to better accommodate timing of the major fisheries. The team again discussed the timing of OFL calculations. For this model and stock status, *B* was historically defined at July 1 as being before the fishery, but should be defined as Feb 1; Concerns were expressed that a mid-winter fishery could be split by the MMB timing. The MMB is typically defined as the time of mating (February 15), while the author is currently using February 1 for the MMB. However, the winter fishery is not currently part of the harvest strategy with no GHL set for winter, so the GHL for the summer fishery is actually set in February. It was noted that a proposal before the Alaska Board of Fisheries could change the opening date of the winter fishery, although the actual start of fishing will still depend on ice conditions (there has been little historical harvest in January). The CPT recommends leaving the current model cycle as starting in February and revisiting model year contingent on a Board of Fisheries decision to change the winter season start date. The model will presented to the reviewed during a 1-day review meeting CPT in January 2015.

Bob Foy reported that based on his observations in the 2014 summer trawl survey, biennial spawning may be occurring and should perhaps be considered in future evaluations.

For the Norton Sound Red King Crab Assessment, the CPT requested that the author:

1. Evaluate a reduction in the weighting of the winter pot survey data.

2. Continue to examine models with a single M for all size-classes, and a separate M for the largest size class using likelihood profiles, but evaluate whether use of a descending logistic curve for the winter pot selectivity changes the likelihood profile.

3. Explore a separate estimated selectivity for the smallest size class.

5.2 Aleutian Islands golden king crab

Shareef Siddeek presented an updated model-based assessment for Aleutian Islands golden king crab. Siddeek addressed all concerns and recommendations from the May 2014 CPT meeting in this assessment. The CPT recognizes the model has improved greatly over previous models; however, there are still a few issues to resolve.

Seven scenarios were presented for each area (WAG and EAG):

1) Scenario 1: Normal distribution used in the growth transition method (changed from gamma distribution following CPT recommendations). Tagging data are included in the model to estimate the growth transition matrix.
2) Scenario 2: Same as scenario 1 with the addition of a descending logistic molting probability for male crab.
3) Scenario 3: Same as scenario 1 with the addition of the 1985-1998 standardized CPUE forfishery retained catch (different data than the standardized CPUE for legal crab from observer data 1995-2012).
4) Scenario 4: Same as scenario 2 with the addition of the 1985-1998 standardized CPUE for fishery retained catch.
5) Scenario 5: Same as scenario 2 except the growth transition matrix is estimated outside the model from tagging data with 1 year recaptures only.
6) Scenario 6: Same as scenario 1 with penalties on directed pot fishery mean fishing mortality turned off for all phases. Scenarios 1 – 5 have fishing mortality penalties turned off in the last phase.
7) Scenario 7: Same as scenario 1 with penalties on directed pot fishery mean fishing mortality and deviations turned off for all phases. Scenarios 1 – 5 have fishing mortality penalties turned off in the last phase.

The retained CPUE time series from 1985-1998 is a CPUE index from dockside sampling (added in scenarios 3 and 4). Both CPUE indices included in scenarios 3 and 4 were standardized using the GLM approach as recommended by the CPT.

The predicted sample size is generally greater than the input sample size (effective sample size); this may indicate overfitting to the length frequency data. The CPT discussed the weighting of length frequency data relative abundance index data and the possibility of using the method of Francis (2011). The CPT recommends the Francis method should be investigated in a model workshop context as this would apply to all crab stock assessments, not just Aleutian Golden king crab.

Tier 5 OFL and ABC are currently recommended by the CPT in May for this stock. Goals for the assessment model are to move this stock to Tier 4 or Tier 3.

Tagging data likelihood weight was increased from 0.001 to 0.5 in this assessment. Siddeek used sensitivity analysis to get best fit for the change in weight. Weights on F deviations in the groundfish catch weights were changed to be the same for both areas.

In past assessments a gamma distribution was used with a fixed beta parameter in the growth model. Following CPT recommendations, a normal distribution is used in the growth matrix and sigma (variance parameter) is estimated not fixed.

The better fit to growth data for scenario 5, when the growth matrix is fixed vs estimated in the model, seems to indicate the model is fitting some other data component at the expense of the growth (tagging) data.

A higher weight was put on the total catch likelihood in this assessment to improve the fit of total catch.

There was concern that the fishing mortality values in the early 1990's were too high for the east and west areas. The model estimates a larger decline in the stock in the early period than indicated by the CPUE time series. Also, there are very high estimates of discard in 1994 for the WAG and in 1991 and 1992 for EAG. In the early years observers were only on catcher-processors. In 1995, observer coverage was 100%, until rationalization in 2005. Since 2005 every catcher vessel has an observer with 50% of catch for every 3 months of fishing observed, which results in about 60% of catch observed on average. There is 100% coverage for catcher-processors; however, currently there are no catcher-processors in the fishery.

Fits to the length frequency data in the years where total catch was very high shows a large lack of fit. This could be due to the model trying to fit the large total catches or in the initialization of model.

Tagging data in the model include crab at liberty from 1 to 6 years. Doug Pengilly commented that the growth increments are fairly distinct in the tagging data and that the determination of whether crab molted was reliable. The author did not include crab where the difference between sizes was less than -5 mm carapace length. Including a separate molting probability (scenario 2) improved the fit of the model compared to scenario 1. This results in a higher fraction of crab in the diagonal of the growth matrix than can be estimated by a normal distribution.

Scenario 4 estimated lower q for CPUE index and higher biomass than other scenarios. It was not clear why this occurs. The CPT recommends the author do a manual likelihood profile on q to investigate the differences in q estimates.

Scenarios 6 and 7 (no fishing mortality penalties in any phase) gave same results as scenarios with fishing mortality penalties removed in the last phase. The author doesn't need to include these scenarios in the future.

Figure 57 retrospective plot appears to be incorrect.

The CPT recommendations:

1) Total catch in the early 1990's for both east and west areas have very large discard estimated relative to other years. Need to check these values to see if they are correct and whether they are reliable estimates.
2) If total catch in early1990's is correct, however unreliable, then run a scenario of the model with total catch time series starting from 1995 to present only.
3) Explore sensitivity of initialization of the stock and the fits to the 1990's length frequency data and CPUE data.
4) Model run estimating the growth matrix in the model with 1 year tag return data only (instead of scenario 5 which had growth matrix fixed, but had a much better fit to growth data than scenario 2).
5) There is uncertainty in the scale of biomass (q for the CPUE index). Run the model with fixed values of q and plot all likelihood components vs q.
6) Lower weights on likelihoods for length composition data as a sensitivity on the fit to the CPUE data.

Literature cited

Francis, R.I.C. Chris. 2011. Data weighting in statistical fisheries stock assessment models. Can. J. Fish. Aquat. Sci. 68: 1124–1138 (2011).

6. Norton Sound dredging survey

The CPT received a presentation from Chris Hoffman (US Army Corps of Engineers Alaska District, Anchorage Civil Works Program) on the Corps' preliminary studies for development of deep draft port facilities to support expected Arctic shipping traffic and resource development requirements. Dredging during the course of construction at either the Nome or Port Clarence sites has the potential to generate up to 2 million cubic yards of material, which would necessitate siting and development of an ocean disposal site. The need for the project is based on increasing foreign and domestic commercial vessel traffic through the Bering Strait (forecasted to reach 1400 large commercial vessels per year by 2020) and needs associated with industrial resource development. Chris emphasized that the project is in still in the feasibility study phase and is 2–3 years from advancing. Expectations are that the project would be of moderate to large size, but determinations to proceed with the project or where and what form the project would take depend on results of economic feasibility and efficiency analysis.

A previous site identification study assessed a range of locations extending from Kaktovic to Bethel that are suitable for deep water development, based on existing facilities and proximity to deep water shipping lanes and expected mining, oil, and gas development sites. Two sites have been selected for further consideration at Nome and Port Clarence. The presentation focused on results of preliminary biological fieldwork at the Nome site. Dredging at the site would be required to extend the existing causeway and remove a breakwater, and material generated could range from a negligible quantity up to 2 million cubic yards, depending on the depth of removal required.

Disposal within three nautical miles (nmi) of shore would be prohibited due to existing mining claims. Fieldwork has focused on potential sites 3-6.5 nmi offshore in 50-75 ft of water, but sites up to 15 nmi offshore and at greater depths would be feasible, but at significantly higher cost. CPT members inquired about the potential size of a disposal site area, and Chris indicated that the actual size of the area would depend on the volume of material and depth of the layer of material deposited. The working assumption for the biological assessment is that the area would be 2 km by 2 km, with material deposited in a layer of approximately of 1.5 feet, but actual project could be as large as 3 km by 3 km and/or with a layer substantially deeper than 1.5 ft.

Fieldwork has been initiated at three locations selected according to their distance from shore. The initial biological assessment used 6 pots soaked for 48 hours to sample for presence of fish and crabs. Sampling at the three sites produced from 2 red king crab per pot (at Area A, closest to shore) to 21 RKC per pot (Area C, furthest from shore), as well as some halibut and other crab species. The assessment also employed two bottom trawls conducted in each area (10 minute tows at 3 knots), but the success of trawl sampling was limited by the capability of the tow vessel used.

Chris solicited feedback on issues associated with sampling and site depth and distance from shore, and timing related to crab life history. Bob Foy inquired about what biological criteria are being used to assess disposal site suitability related to presence of organisms, and noted the importance of other factors to assess including potential effects of turbidity downstream of the disposal area, effects on biogenic habitats, and need for sampling for smaller organisms that those collected with pots and trawl sampling. As Chris described, the three sites assessed so far vary in distance offshore. The CPT members noted that other factors that could vary in their biological effects, such as size of area and depth of layer deposited, should be included in the assessment.

The CPT inquired whether other locations east or west of the port site have been considered. Apart from restrictions on disposal in certain areas (e.g. within 3 nmi or offshore of Sledge Is.), distance and direction of alternative areas had not been considered specifically. The CPT noted that there are some trawl survey data available for areas off of both Nome and Port Clarence which indicate greater concentrations of juveniles at different areas east and west of the proposed development sites. CPT member Bill Bechtol also inquired asked about the potential long term need for maintenance dredging, and Chris responded that, generally, maintenance disposal is a small fraction of that required in initial construction, but that disposal site area selection would be take into consideration the size of the site needed to accommodate maintenance dredging over time.

7. Essential Fish Habitat

John Olson (NMFS Habitat Conservation Division) presented an overview of preparations for the 2015 EFH review. The roadmap from the 2010 EFH review will be used again in the 2015 review.

Information by species will be available for review by stock assessment authors in January/February 2015. Stock assessment authors will be asked to review the EFH text descriptions, habitat assessment tables, species profiles, and EFH map descriptions. Fishing effects will be evaluated through the Long-term Environmental Index (LEI) model which combines information on fishing effort, habitat features, and the susceptibility and recovery of those features to and from fishing gear impacts to evaluate and describe the effects of fishing on habitat features. Currently, the model is being updated to incorporate information about the effects of non-fishing activities on EFH. A white paper on the LEI model will be available soon. The CPT plans to review the updated EFH sections during the May 2015 meeting.

Kristan Blackhart (NMFS Office of Science and Technology) presented an overview of the Prioritizing Habitat Assessment Improvement Plan. Habitat assessment prioritization (HAP) is a process, implemented at the regional level, to prioritize habitat science needs. The basic unit for prioritization is stocks managed under Federal FMPs. Stocks represent the fundamental management level under the Magnuson-Stevens Act and are commonly used units for strategic planning throughout NMFS. Stocks not actively managed under Federal FMPs (including state managed species, certain forage species, protected resources, and stocks managed as “Ecosystem Considerations” or “Data Management”) are beyond the scope of this prioritization.

Two types of criteria are used in the process to help determine priorities for habitat science: filter criteria and scorable criteria. The filters are aligned sequentially and stocks must meet the criteria of each in order to continue on in the prioritization process. Stocks not meeting the filter criteria are to be removed from further consideration for habitat assessment prioritization. Next, stocks are considered against a group of scorable criteria. Each stock is assigned a score for each scorable criterion according to a defined scoring rubric. The scores from each criterion are then scored across individual stocks, and final stock scores are ranked and divided into priority bins (high/medium/low).

Stock authors will be asked to review Alaska-specific guidance and score stocks using online prioritization template (same timeline as EFH).

8. Economic SAFE

Brian Garber-Yonts provided a summary of key economic indicators for exvessel and wholesale sectors of BSAI crab fisheries, and an overview of the status of information to be included in the 2014 BSAI Crab Economic Status Report (Economic SAFE). The summary report will be included as an appendix to the SAFE document for October and the full report will be finalized and presented to the SSC in February. Due to the timing of economic data collection, data representing the 2013 calendar year is the most current available for most economic indicators in the 2014 update of the report.. Key economic indicators were discussed and preliminary data on 2013 ex-vessel and wholesale production and value, crew employment and earnings as well as IFQ lease activity for the Bristol Bay red king crab and Bering sea snow crab fisheries. The team did not provide any explicit advice for the authors but did recommend that a more detailed description be included in the SAFE regarding how lease activity is used as an indication of the economic status of the fisheries. The final SAFE will be made available to the team in February and could be discussed in more detail at the May CPT meeting on an annual basis.

9. Bering Sea Research Foundation (BSFRF) research update

Scott Goodman presented the research goals of the Bering Sea Fisheries Research Foundation (BSFRF), completed research, and an overview of the 2013-2014 cooperative trawl surveys for Bristol Bay red king crab (BBRKC) and Tanner crab.

The 2011/12 inshore BBRKC surveys addressed the apparent abundances of red king crab (RKC) that were outside the standard NMFS survey area in the ribbon of marginally trawlable water along the Alaska Peninsula, including an important known high abundance area of RKC females in the middle of this area near the Black Hills. The 2011–12 experiments were conducted over two June seasons where bottom water temperatures appeared to be linked to CPUE of crab captured from both survey gears (NMFS and BSFRF, Northeastern 83-112 and Nephrops trawls). The comparative results from the CPUE ratios (83-112:BSFRF) for 2011 (the warmer year) showed a bigger difference between CPUEs and a poorer efficiency overall for the NMFS trawl. In 2012, the temperatures in the inshore area were much colder and the CPUE ratios narrowed (more efficient NMFS trawl). The two-year comparison suggested that along with high and low densities observed in the standard/non-standard inshore survey area, migration, temperature changes, and other factors across the area may affect the NMFS trawl efficiency.

The BBRKC selectivity work in 2013-14 used methods developed for snow crab in 2009-2010 using side-by-side, paired tows (one Nephrops trawl to one 83-112 trawl) conducted across almost all stations that contain RKC during the summer survey. The sample design covered 60 of the total Bristol Bay district stations (136) and accounts for ≥95% of stations where RKC are observed during the NMFS surveys (since the 83-112's use). The pre-recruit survey design attempted to cover all stations in Bristol Bay district that showed positive samples of pre-recruit RKC. The pre-recruit sampling covers approximately the same set of stations of the side-by-side survey, except that the pre-recruit sampling is completed at a higher density by subdividing each NMFS survey block and towing once in each subdivision.

The survey in 2013 was completed in June during the same period that NMFS completed their Bristol Bay trawl survey (leg 1 NMFS survey) over a relatively cold bottom-water year. For the 2014, the same general schedule was followed but the Bering Sea cold pool had receded by the time of the survey. Therefore, towing was completed over a much warmer-water survey area. Results for side-by-side RKC net selectivity for year-1 (2013, cold year) were, as expected, with the NMFS trawl catching about 50% of the small male RKC, increasing to about 65% of the legal size male RKC. For female RKC, the results showed that the NMFS trawl captured about 28% of immature female and increased to about 85% of mature females. The preliminary results of 2014 differ by showing much more parity for similar size/sex CPUE ratio comparisons for the two gears (83-112:Nephrops trawls). The CPUE ratios were much higher than in 2013; 0.73 for small males and 0.95 for legal males. For females in 2014, the immature CPUE ratio was 0.48 and the mature female ratio was 1.04. Preliminary figures were presented that showed the comparison of Nephrops and 83-112 length frequency distributions by sex and a CPUE ratio plot by size class.

The CPT questioned the differences between the years related to the strong temperature increase in 2014 and any apparent vessel-effect that may be influencing the change in CPUE ratios. The summaries and figures in the presentation were providing only preliminary results with no further analysis to weight the comparative ratios by CPUE or to investigate temperature or vessel effects. Goodman indicated that the collaborative analysis is underway and that those variable and other factors will be reviewed. Further progress on the summary of side-by-side RKC trawl selectivity results will be provided as an update to the CPT in May 2015.

The 2014 pre-recruit RKC summaries were presented and compared length-frequency distributions for both sexes, comparing modes of crab seen in the surveys during the two years covered so far. The CPT asked about the scope of this research (potentially to continue through 2017) with some discussion of how it will be used in RKC assessment model.

Goodman also presented a preliminary summary of Tanner crab selectivity study– that plotted both the length frequencies and the CPUE ratios of the two gears on the same (dual Y-axes) charts. This data was collected during the side-by-side RKC work over the 60 Bristol Bay stations covered – which represents a large portion of the eastern district distribution of the Tanner crab survey stations. For both sexes in both years, the plots of these summarized data showed a relative CPUE index comparison that was very similar to what BSFRF snow crab research on trawl selectivity of the 83-112 reflected – which was a selectivity logistic rising toward 1.0 for larger size crab, but reaching a general asymptote near 0.7-0.8 for the largest size Tanner crab.

10. Gmacs

Athol Whitten and Jim Ianelli presented a progress report on the Gmacs modeling framework, and initial results for a Bristol Bay red king crab application. Gmacs is a size-structured stock assessment modeling framework designed to fit models for North Pacific crab stocks. Since the May CPT meeting, Steve Martell temporarily joined the development team, bringing additional programming expertise. Athol Whitten is leaving for a new job in Australia, but expects to be able to continue participating in the project on a part-time basis, subject to additional funding. A new post-doc will be starting on the project in February.

Substantial progress has been made since the May CPT meeting. The source code underwent a complete rewrite, which improved functionality and interpretability. An R package for displaying results was developed. A working assessment model for Bristol Bay red king crab was demonstrated during the meeting. However, the detailed side-by-side comparison between Gmacs and the current BBRKC model requested by the CPT has not been completed.

The current version of Gmacs resides on a github web page, https://seacode.github.io, which is a dynamic repository with links to source code, documentation, the Bristol Bay red king crab application, and the R package for displaying results (gmr). The team is also working on developing tools to facilitate report generation, with imported tables and figures and that this will follow the current SAFE report guidelines. The CPT suggested that it might be premature to devote time to automated report generation given the current status of the project.

The CPT would like to make Gmacs a focus of the January 2015 modeling workshop. First, the CPT requests a document demonstrating similarities and differences between the current BBRKC assessment model and a Gmacs implementation. This comparison should be sufficiently comprehensive to be the basis for a recommendation on whether Gmacs should be used for assessing BBRKC in 2015. The CPT recommends that two additional Gmacs applications be brought forward for the modeling workshop: a model for Norton Sound red king crab, and model for Pribilof Islands red king crab. The Pribilof Islands RKC assessment was considered a good candidate for a simple demonstration example of Gmacs, which would be thoroughly documented on the project website for new users to learn how to use the software. To begin transferring capacity to crab assessment scientists, the CPT recommends that Norton Sound and Pribilof Islands red king crab Gmacs applications be led by the assessment author with guidance and technical support from the Gmacs development team.

The CPT discussed potential options that could be added to Gmacs. Gmacs currently initializes the numbers at length based on equilibrium assumptions. It will also be important to include the option of estimating the initial length composition as free parameters, since this is how most crab models are initialized at present. There should be an option for a step change in natural mortality, as is used in the Tanner crab and the BBRKC assessments (however, re-arranging the knots on the current spline configuration for natural mortality was shown to closely approximate the step-change approach). There was discussion and debate about including different features in Gmacs. Based on advice from the CPT, and to the extent possible, the developers will include features present in existing crab models and agreed that testing them via simulations (currently existing in the Gmacs framework) would be appropriate. A good example would be to simulation test whether a step increase in natural mortality can be reliably estimated with the data sets available for BBRKC assessment.

To assess whether other options need to be added to the existing Gmacs code, the CPT requests that the author of each crab assessment with an assessment model (snow crab, Tanner crab, BBRKC, NSRKC, SMBKC, PIRKC) provide a list of the key features of the model. Although an AIGKC assessment model has not yet been accepted, the CPT recommends doing the same for the current version of the AIGKC model. Implementing a snow crab or Tanner crab model is a necessary and important step for the Gmacs project. Given the different biology of *Chionoecetes* and the different data sets available for assessment, additional options will need to be added to Gmacs, such as a terminal molt. Buck Stockhausen, lead assessment author for the Tanner crab assessment, proposed bringing forward a Gmacs application for review at May 2015 CPT meeting. The developers presented a work plan leading up to the January workshop and also noted that an outcome from that workshop should include specific terms of reference for the contractor that is due to start sometime in February.

11. Other business

11.1 Model workshop planning

The 2015 model workshop will be held January 12-14 at AFSC Seattle. The agenda will include Gmacs application to BBRKC, PIRKC and NSRKC. The Gmacs discussion will also involve planning to apply Gmacs for the Tanner crab assessment model and establishing a work plan to accomplish this task with the post doc who will be taking over the Gmacs application come March as well as to discuss the upcoming Gmacs CIE review in March. Additional details are contained in the discussion of Gmacs. The model workshop will also include agenda items on the time series survey discussion as well as further review of the AIGKC model. The team will also have a short, half-day CPT meeting on the 15th of January (available by web broadcast for CPT members not intending to participate in the model workshop). The purpose of the CPT meeting is to review the NSRKC assessment and recommend OFL and ABC for that stock.

11.2 Uncertainty

As requested by the CPT in May, the team had a discussion to review the treatment of uncertainty and consistency in recommendations of establishing ABC buffers. This review and consideration has been a long-standing request of the Council since the ABC control rule was implemented and reiterated by the SSC in their June 2014 minutes. Diana Stram provided a table (included below) of the relative groupings in assessment uncertainty employed in the 2010 ACL analysis, together with a review of tier levels and buffer levels recommended historically by the SSC (and CPT) since the ABC control rule was first included to set ABCs for crab stocks in 2011 The team reviewed relative buffer levels and tier levels for all stocks, noting that previous buffer amounts in hindsight were not always consistent with an objective of assigning a larger buffer to assessments with greater uncertainty. The team developed a more consistent and overarching approach in buffer values for 2014/15, which more consistently addresses the relative uncertainty in the OFL estimates for all stocks. The buffers recommended for 2014/15 range from 10% to 40%, and buffers increase (on average) from Tier 3 to Tier 5. Within a Tier, larger buffers are recommended for assessments that are considered relatively less certain. Finally, buffers for different tiers do not strongly overlap (though the Team considered some overlap justifiable depending on the circumstances). The team would like to solicit feedback from the SSC on including further discussion of relative buffer values and a table similar to that presented at the Plan Team meeting as a section of the SAFE report introduction beginning in 2015. The team also notes that the 2015 data poor workshop will also address different approaches to estimating uncertainty and may provide suggested approaches to improving the maxABC control rule for crab stocks as the control rule has been only rarely used to set ABCs for any stock since it was implemented.

Stock	Tier	Recommended ABC buffer (%) in 2014/15	ABC buffer (%) in 2013/14	Uncertainty ABC buffer (%) in 2011/12	SSC Rationale 2011
EBS snow crab	**3**	10%	10%	10%	considerable uncertainty about natural mortality, growth, and the appropriate structure of the model
BB red king crab	**3**	10%	10%	10%	provide a modest buffer between OFL and ABC and for consistency with other stocks
EBS Tanner crab	**3**	20%	30%	10%	Consistency with other stocks (and not making higher buffer than lower tier stocks)
Pribilof Islands red king crab	**4**	15%	20%	σ_b = 0.4, leads to 22%	brief history of exploitation of this stock makes it difficult to identify an appropriate period of time suitable for establishing B_{MSY}, such that the true distribution of the OFL is poorly known.
Pribilof Islands blue king crab	**4**	25%	10%	10%	Tier 5 buffer on ave byc but noted uncertainty in biomass estimates, B_{MSY}
St. Matthew Island blue king crab	**4**	**20%**	20%	10%	Uncertainty in mis-match between survey station distribution and distribution of crab stock
Norton Sound red king crab	**4**	10%	10%	10%	Need better reflection of scientific uncertainty in assessment
AI golden king crab	**5**	25%	25%	10%	Tier 5 calculation
Pribilof Island golden king crab	**5**	25%	10%	10%	Tier 5 calculation
Adak red king crab	**5**	40%	40%	75%	Average bycatch needs in groundfish fisheries leads to buffer

Stock	Tier	Factors considered in estimating uncertainty					
		Model CV estimate on MMB	Key population dynamics parameters pre-specified	Survey Q fixed	Basis for F_{MSY}	Uncertainty in B_{MSY} estimation	Additional considerations
Bristol Bay red king crab	3	0.05	Yes	Yes	Yes	Yes	
EBS snow crab	3	0.086	Some	No	Yes	Yes	
Tanner crab	4	0.01 (estimated unreliable-not used) 0.140 (survey)	Yes	Yes	Yes	Considerable	Model under development
St. Matthew blue king crab	4	0.160	Yes	Yes	Yes	Considerable	Uncertainty in trawl survey distribution
Aleutian Island golden king crab	5	0.021 (Dutch) 0.027 (Adak)	Yes	Yes	Yes	Yes	Model under development, no trawl survey data
Pribilof Island blue king crab	4	0.713 (survey data) 0.271 (model)	Yes (M)	Yes	Yes	Considerable	Model under development
Norton Sound red king crab	4	0.110	Yes	Yes	Yes	Considerable	No bycatch estimates, periodic surveys only
Pribilof Island golden king crab	5	N/A – Tier 5	N/A – Tier 5	N/A – Tier 5	N/A – Tier 5	N/A – Tier 5	Tier 5 fishery with no effort on 150,000-lb GHL during 2006–2009
Adak (AI) red king crab	5	N/A – Tier 5	N/A – Tier 5	N/A – Tier 5	N/A – Tier 5	N/A – Tier 5	Fishery closed due to stock concerns

11.3 BOF proposals

Statewide king and Tanner crab proposals were considered during the 2013/14 Alaska Board of Fisheries (Board) meeting cycle and will again be in cycle during 2016/17. Proposals may be considered out-of-cycle through an Agenda Change Request (ACR) and state regulations (5 AAC 39.999) define the guidelines by which an ACR may be accepted. The Board considers ACRs at its first meeting in the fall (October 15–16, 2014); if an ACR is accepted it is scheduled during one of the regularly scheduled meetings that cycle.

The Board received five ACRs this year for Bering Sea crab fisheries; three for EBS Tanner crab and two for Norton Sound red king crab.

ACR 1 – Reduce the size of exploitable legal male Tanner crab, from 5.5 inches to 5 inches carapace width, for purposes of calculating total allowable catch in waters east of 166° W longitude in the Bering Sea District (5 AAC 35.508 (g)(5)).

ACR 2 – Change the *C. bairdi* Tanner crab regulatory fishing season closure date from March 31 to May 15 in waters west of 166° W longitude of the Bering Sea District (5 AAC 35.510 (f)(1)).

ACR 3 – Increase the allowable level of incidental harvest of *C. bairdi* Tanner crab allowed while directed fishing for Bristol Bay red king crab east of 166° W longitude from the current level of 5%, up to the amount of *C. bairdi* individual fishing quota held by the vessel operator (5 AAC 35.506 (i)(2)).

ACR 4 – Develop a guideline harvest level for the Norton Sound red king crab winter commercial fishery (5 AAC 34.915. (a)(1)).

ACR 5 – Change the duration of the Norton Sound winter through-the-ice commercial king crab fishing season to be open by emergency order on or after January 15 and close April 30, unless extended by emergency order (5 AAC 34.910(d)(2)).

The CPT did not comment on these ACRs at this time because it is unknown whether or not they will be accepted by the Board and scheduled for this cycle. The CPT will likely have an opportunity to provide comment in January (during the teleconference for the Norton Sound stock assessment), should any of these ACRs be accepted.

NPFMC Crab Plan Team

Traynor room, AFSC Seattle

September 15-18, 2014

Sept. 15 Mon		**Draft agenda 8/21/2014**
9:00am	administration	Welcome, administrative issues, approve agenda, assign minutes
9:30am	Survey overview	
10:30am	Ecosystem overview (T)	
11:30am	Gmacs overview	Intro for thursday session
12:00-1:00pm lunch		
1:00	Snow crab	OFL/ABC
3:00	Tanner crab	OFL/ABC
Sept 16 Tues		
9:00am	Tanner cont if needed	
10:00am	BBRKC	OFL/ABC
11:30am	BSFRF selectivity study	
12:00-1:00pm lunch		
1:00	PIGKC	OFL/ABC
1:15pm	PIBKC	OFL/ABC
1:30pm	PIRKC	Review new assessment; OFL/ABC
3:15pm	SMBKC	OFL/ABC
Sept 17 Wed		
9:00am	NSRKC	summer survey and commercial catch, plan for January assessment
10:00am	AIGKC assessment	OFL/ABC
10:30am	AIGKC model	

12:00-1:00 lunch		
1:00	AIGKC model (cont if needed)	
2:00	Norton Sound dredging survey feedback	
3:00pm	EFH	
4:00pm	Econ SAFE	
4:30	Report review time	
Sept 18th Thursday		
9:00am	Gmacs	Results of BBRKC side-by-side
11:00am	Survey time series	Overview of changes and plan for modeling workshop discussion
12:00-1pm lunch		
1:00 pm	Other business:	
	Model workshop planning, BOF proposals, other admin	
1:30pm	Report review time	
5:00pm	adjourn	