Crab Plan Team Report

The Crab Plan Team (CPT) met May 9-13, 2011 at the Alaska Fisheries Science Center Ted Stevens Marine Research Institute (9-11 May) and the NOAA Fisheries Alaska Region Office (12-13 May) in Juneau, AK.

Crab Plan Team members present:

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

CPT members absent:
Josh Greenberg (Univ. of Alaska – Fairbanks).

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: Jack Tagart, Frank Kelty, Doug Woodby, Jie Zheng, Bill Gaeuman, Stefanie Moreland, Forrest Bowers, Linda Kozak, Edward Poulson, Lori Swanson, Heather McCarty, Joel Webb, Clayton Jernigan, Maura Sullivan, Glenn Merrill, and Stephanie Madsen.

The attached agenda was approved for the meeting.

1. Administration
Terms of Reference - The Crab Plan Team modified their Terms of Reference; the revised TOR is attached.
Election of Officers – The CPT elected Bob Foy as chair and Ginny Eckert as vice chair. The team gratefully acknowledges the service by former CPT member Forrest Bowers as chair for several years.
Membership – The team welcomes new member Heather Fitch, ADF&G, who replaced Forrest Bowers as the area management biologist in Dutch Harbor. Following recommendation from the Council (and SSC) in April, the team will be soliciting an additional member with quantitative stock assessment experience in the near future. Ideally, this person will be approved by the SSC and Council in time for participation during the September 2011 meeting.
SAFE Report – The team discussed comments in the SSC minutes regarding the inherent confusion in producing two SAFE reports each year and the time consuming nature of producing draft assessments for the summer-surveyed stocks and then updating them again in the Fall. Recognizing that the process itself has changed by virtue of Amendment 38 (ACLs) to allow for a final review and recommendation by the SSC in the fall, the team recommends that full assessments for the May meeting be limited to NSRKC and AIGKC (for which there are summer fisheries), and the Tier 5 stocks for which only average catch is used to set OFL and ABC. The team therefore recommends that the Introductory SAFE sections in May be confined to only those stocks while the full introduction will be produced in conjunction with the final SAFE report in the Fall. The team recommends that, in future, assessment authors produce "white

papers" addressing any model or assessment based issues for discussion at the May meeting. This will avoid confusion with a draft assessment and focus the discussion and review on the specific issue being raised with respect to that stock. Recommendations on these stocks will be in the May CPT minutes henceforth rather than in a draft SAFE introduction. Since draft assessment were already produced for this meeting, the team recommended forwarding those to the SSC as individual assessments this year, but not including them in a draft SAFE report at this time.

Model workshop – The team reviewed recommendations provided to authors from the NPFMC modeling workshop held in February 2011. The team requested that each author address these in their respective presentations (i.e. where addressed or plans to address). Team members and other participants indicated that the workshop was very useful in providing mid-term input to authors, particularly with respect to developing models. Diana Stram informed the team that the Council is able to host another workshop and consideration should be given to both the format as well as candidate stocks. The team decided to return to this following review of all stocks and make decisions then regarding the format, timing and stocks. This discussion and decisions regarding the 2012 workshop are summarized under 'New Business" at the end of this report.

2. B_{MSY} timeframe

The years used to compute $B_{MSY(prox)}$ or mean recruitment corresponding to B_{MSY} can have a critical impact on OFL and hence ABC recommendations. The team developed general criteria for comparing different candidate B_{MSY} time frames based on a draft document provided to the meeting [attached]. The team discussed what constitutes compelling evidence of a change in these characteristics which might provide a basis for defining the needed timeframe. The team discussed that 'regime shift' is different from a 'productivity shift'. The latter is a change in productivity and hence not identical to 'regime shift' which inherently relates to the physics of the system. The team thus uses the term 'change in average productivity' rather than "regime shift effect' in the attachment. The team noted that the power to detect changes in productivity may be low. However, it also emphasized the need for consistency across stocks when selecting the timeframe for defining B_{MSY} if there is an indication of a regime or productivity shift.

The team noted that inferences from data-rich stocks regarding B_{MSY} and changes in productivity could be used when selecting a timeframe for B_{MSY} for data-poor stocks. It also noted that plots of surplus production over time could be examined for where a maximum occurs and that all authors should consider timeframes proposed by stock assessment authors who bring forward a regime shift effect or time frame over which a change is assumed to occur.

Comments from the public included concern that that the selection of a timeframe for B_{MSY} is always going to be largely qualitative and there will not be a defining point explicitly for making this modification. Other considerations should include changes in rates of consumption of crab as well as distributional effects that affect how each stock responds to the same environmental effect.

The team discussed the section of the attached document on exploitation rates, noting that it would be necessary to consider taking a modeled population and modifying parameters to see whether affect perceived is actually due to environment or could be explained by other factors. A second-order effect then after selecting the years for B_{MSY} estimation is how to estimate mature male biomass at the time of mating. This is particularly important for declining stocks (each year the biomass will be less than would be expected if fishing mortality was F_{MSY}); the effect is likely inconsequential for stocks for which the exploitation rate varies about F_{MSY}.

The Team discussed when the new criteria should be used in assessments. The team suggests having each assessment author include an evaluation against the criteria in their September assessment for discussion. It will be possible to change the set of years currently used to define B_{MSY} in September if there is compelling evidence that this is necessary. Otherwise the September discussion will be primarily to

identify common issues among stocks and/or to suggest further evaluation for May 2012. Authors are still requested to include in the assessment in September the years currently used to evaluate B_{MSY} for comparison.

3. ACLs and Uncertainty
The team reviewed the FMP text which has been forwarded to the SOC for approval in the ACL amendments to the FMP (Amendments 38 and 39). The team understands that this text has already been forwarded for approval thus comments on revisions included here are for a subsequent amendment to the FMP (housekeeping or otherwise).

1. The paragraph which uses the term annual catch target should be redefined as this wording carries ACL implications regarding ACT where it is not meant to.
2. Reword sentence as follows: **For crab stocks, the overfishing level (OFL) is derived through the annual assessment process, under the framework of the tier system, and aims to achieve maximum sustainable yield (MSY).** Overfishing is determined by comparing ~~the overfishing level (OFL), as calculated in the five-tier system for the crab fishing year,~~ with the catch estimates for that crab fishing year.

Accountability measures:
Some team members expressed concern with the lack of specificity in the language describing accountability measures. It was noted that the language is meant to convey that specific AMs will implemented as needed on a case by case basis.

OY:
The team discussed the current language which defines the OY range. The team notes that it will include an item on future agenda to discuss options for assessing and specifying OY to provide guidance to the Council for specifying OY in a subsequent amendment process.

State accounting for scientific uncertainty:
The team will need to assess how best to document the uncertainty considerations that the State has accounted for in TAC setting. The team discussed options including listing these in the team minutes and/or a separate section of the SAFE report. The State intends to give a presentation to SSC in June on what TAC was by stock and which uncertainties were considered when setting each TAC. The team requests a similar presentation during their annual May meeting.

ABC recommendation:
The team discussed the implications of the maximum permissible ABC (maxABC) established by the Council's control rule. The team noted that authors, the CPT, and the SSC may recommend an ABC less than the maxABC and would provide rationale for this. The team notes that the ABC will not be based on 'additional uncertainty' (i.e. sigma-b) because the Council has already agreed that only within-assessment uncertainty should be accounted for (along a P* of 0.49). However, possible biases not accounted for in the assessment and other considerations may require additional conservatism when setting the ABC. Each assessment author will provide an 'authors ABC' (with appropriate rationale), along with the max ABC, and the team will provides its ABC recommendation (which may differ from the 'authors ABC'. The team recommends that the fall SAFE report includes a table which lists which sources of uncertainty are included in the pdf for the OFL estimate and which are not addressed.

The team noted that authors are working on how to incorporate research catches into stock assessments.

4. Final assessments

Norton Sound red king crab –
Hamachan Hamazaki presented the final Norton Sound red king crab assessment. He noted that tagging studies will be forthcoming next year to provide additional life-history data for estimating parameters.

The team had the following comments:
1. The OFL for Norton Sound red king crab should take account of all three fisheries and their selectivity patterns rather than assuming that the catch is taken entirely from the legal crab biomass.
2. Table 10 should be clarified regarding the definitions of parameters and which are log-transformed and which are not (e.g. SST1 and SST2). These two parameters appear inestimable (very large standard errors); this needs to be addressed further.
3. The author indicated he used the MCMC to estimate the pdf for OFL. The mean of this OFL distribution is higher than the point estimate of the OFL from the assessment. The team expressed concern that the posterior was not smooth, which suggests some MCMC convergence issues. However the team noted this OFL is more conservative as it is based on the retained legal proportion.

ABC deliberations: The retrospective pattern suggests that each time an assessment is conducted the biomass estimates are reduced relatively to the estimates for the prior year. This is an issue that needs to be resolved. The team agreed that the best means to account for the retrospective pattern is to formulate an ABC recommendation that would capture the inherent uncertainty rather than correcting for this in the OFL estimate. The author provided an estimate of the average error over time (~60% each year) as a means to correct for the overestimation of biomass in each year. The team notes that this is only one source of correction in the assessment, solely to address the bias-related issue. There are other sources of uncertainty in addition to this retrospective pattern, for example, catchability and natural mortality are assumed rather than being estimated. The team recommends that the author conduct a sensitivity analysis based on M and growth to see if modifications to these parameters affects the retrospective pattern. This stock appears a candidate for the modeling workshop.

Further comments on model requests and ABC recommendations are contained in the SAFE intro section for this stock.

Aleutian Islands golden king crab –
The CPT recommends that AIGKC be managed as a Tier 5 stock for 2011/12. Doug Pengilly provided an overview of the Tier 5 assessment for AIGKC. Two alternative OFLs were considered by the team, one employing a mechanism which uses the actual bycatch data from a specified time frame, and another which uses bycatch data according to the "SSC formula" from the previous years. The team concurred with the author's recommended approach for setting the OFL based on the actual data (noting these data were not available last year). The author's recommended approach for setting the OFL is based on the use of bycatch data from the directed fishery for years after the 1990/91 season (excluding 1993/94 and 1994/95 seasons) and from groundfish fisheries since the 1993/94 season.

The team note that CPUE has been increasing over recent years. In discussing an ABC recommendation for this stock, the CPT considered how to estimate a sustainable annual catch. The team concurred with the author that the ABC should be set to the maxABC.

Siddeek presented an overview of the Tier 4 AIGKC assessment model. Model estimates of biomass in relation to estimated reference points would indicate that both stocks are currently slightly below (0.47 to 0.49 of) MMB_{ref} and thus would be considered overfished. The team noted that the P* approach put forward in the document that accounts overages was inconsistent with Council action to establish a

control rule based on P*-0.49. However, the team noted that the ABC values for the two regions, which were based on P* =0.49, were also presented at the meeting, but not documented.

André noted that the perceived one-way trip is caused by the model trying to mimic a declining index and stable length-composition data simultaneously. It achieves this by placing a large fraction of the stock in the plus-group (which is not accessible by the fishery). Given the initial conditions, the incoming recruitment is insufficient to account for losses to plus-group animals due to natural mortality. The team noted that the length-composition data for the bycatch prior to 1997 was unrealistic given the 1998+ length data. It recommended going back to bycatch length frequency data historically and in particular prior to 1997. The model fits bycatch data better than retained catch.

The team recommended fixing selectivity to be asymptotic, modifying weights on the likelihoods (run scenarios with modified weighting of data components: e.g., emphasize the fit to the length frequency in retained catch, in pot survey, CPUE, etc) and evaluating a range of model scenarios. Scenarios should start with a simple model and only free up parameters as necessary. The authors should also look at shell ages to see if there is some sort of accumulation effect of old shells.

The CPT would like to see this model again for review in September to continue to move the model forward for May review.

Adak red king crab –
The CPT recommends that WAIGKC be managed as a Tier 5 stock for 2011/12. Doug Pengilly provided an overview of the WAIRKC assessment. Total catch estimates include female bycatch (from the groundfish fishery). The team discussed whether the time frame used to compute the OFL is meaningful as an estimate of the productivity potential of the stock. The author recommended ABC is the maximum permissible based upon the application of the ABC control rule. (i.e., 90% of the OFL).

Conservation concerns remain regarding this stock. The team remains concerned that the stock would be assessed to be in an overfished state had biomass information been sufficient to estimate reference values. Wayne noted that a cost-recovery fishery-survey could be precluded by a severely restrictive ABC. The department has continued to close the fishery since 2004 due to survey information indicating low abundance. There have been limited signs of sub-legals in the survey catches.

Linda Kozak commented that the distribution of the fishery is beyond Petrel Bank. Thus it is important that if a survey is conducted it would need to be industry-funded and under the ABC for retention of crab for cost-recovery. Anecdotal evidence indicates more movement in these crab than in RKC in Bristol Bay. It would be important to survey further west as evidence of Adak RKC in that region ~200 miles from Petrel Bank.

The team has a long discussion regarding potential options for setting an ABC below the maximum permissible. The recommended ABC should be an estimate of an acceptable long-term catch. The team did not feel that the max permissible ABC adequately accounted for the uncertainty for this stock. Lou Rugolo questioned whether added precaution should be based on indications of bias (only) or should there be additional considerations for uncertainty. It was noted that the OFL could be considered biased high because of years of high exploitation. Discussion further noted to what extent removing 110,000 lbs in perpetuity is reasonable rate of sustainable catch for this stock given its current size.

The team discussed many proposed ABC levels below the maximum permissible, including establishing ABC = 50% of OFL, and other percentage-based reductions from OFL such as 75% based on groundfish Tier 6 as well as ABC = 0 due to conservation concerns and information indicating a potential stock collapse. The team struggled to establish an adequate means to recommend an ABC to appropriately

reflect the uncertainty surrounding and conservation concerns regarding this stock. The time frame for establishing the OFL leads to a biased estimate of catch and using the maximum permissible ABC control rule would not be appropriate reflection of the bias imparted by the average catch calculation. To account for this bias a lower percentage of OFL is recommended. The intent is reflect the attention to conservation concerns associated with this stock.

Another issue with this stock is the geographic area over which this ABC is considered and the potential for localized depletion. The team discussed accountability measures that would/should be triggered if an ACL was exceeded and the potential for an ACL to be exceeded by a survey. The team notes that an ACL which is exceeded by a survey would clearly not pose an accountability issue as the survey is not anticipated to occur on an annual basis.

After considerable discussion regarding likely stock status and catch trends, the team recommended an ABC based upon the maximum incidental catch (pot and groundfish fishery) over the time frame used to calculate the OFL. The team noted that the ABC could be modified next year if a survey is proposed. André noted that the ABC the CPT is trying to estimate is a sustainable annual average catch and that catches in excess of the ABC due to a survey would not be harmful to the stock if balanced by lower catches later.

Further recommendations for the next assessment include evaluation of the bycatch for each of stat regions 541-543, as well as in total historically and to compile historical fishery information pre-1980.

Pribilof Islands golden king crab -
Doug Pengilly provided an overview of the PIGKC assessment. He provided 3 alternative approaches to estimating an average catch for the OFL based upon use of data now available that includes estimates of catch in the historical time frame that were not available in last year's assessment.

OFL recommendation: The team discussed the differences in data employed in the three approaches and the implications of using all the data as opposed to a subset of these data. The team concurred with the author's recommendation for the OFL based on Alternative 1. This freezes the time frame to that used previously and provides the retained catch data now available corresponding roughly with that time frame and total fishery mortality estimates over that time frame.

ABC discussion: The team discussed the variability among years in total mortality and that the catch is more consistent compared with previous discussion of Adak RKC. The team concurred with the author's recommendation for an ABC = maximum permissible ABC.

5. Ecosystem Considerations chapter
Liz Chilton provided an overview of the ecosystem considerations chapter. This chapter will be annually reviewed by the team at the May CPT meeting with the Ecosystem considerations chapter included (but not further modified) in the final SAFE in the fall. A summary of the ecosystem considerations chapter will be included as a section of the introduction.

Comments for the author included the following:
- Look at the NWS buoy information
- Discuss Pcod predation on Tanner and snow crab. Pacific cod are age 3 + biomass, trend lagged 3 years to show impact on crab population. Ginny Eckert noted that several graduate students are working on this type of predation issue as well as environmental factors impacting crab biomass and recommends coordinating efforts with them. Recommendation to have additional authors provide contributions to this document on an annual basis.
- Discuss benthic productivity and evaluate invertebrates caught on the EBS survey. Include the

top three invertebrates by weight across shelf and average CPUE across all stations by year. Suggest defining instead in terms of ranking of states of abundances, and that should likely be considering smaller size classes of crab rather than MMB. Look at residuals or conduct a co-variate analysis rather than looking at inter-annual trend overall.
- Include additional information on ocean acidification and potential impacts to crab stocks.

A future plan for the chapter is to propose ecosystem indicators for crab stocks. The team discussed how ecosystem indicators would be used in stock assessments and that it would be useful to compile information on how (if any) these indicators relate to crab stocks. The team recommends the author compile proposed ecosystem indicators and conduct a literature search on reference information to evaluate these in relation to crab stocks for September to facilitate team discussion of appropriate indicators.

6. Bristol Bay red king crab EFH
Bob Foy provided an overview of the BBRKC EFH paper that was provided to the Council for review at the April meeting. The CPT has not previously reviewed this paper but has held discussions in relation to EFH which highlighted this issue for Council action.

Edward Poulson commented on the potential for migration, noting that a forthcoming interview process with skippers during a workshop with Armstrong, Lobo and Ernst will provide additional anecdotal information on crab movements. The CPT would be interested in a presentation on the results and implications from this workshop.

The team recommended including additional information on bycatch in groundfish fisheries and size and sex of bycatch of RKC in these regions. Bob noted that that this information is being included for the updated discussion paper. The paper will examine the efficacy of existing closure areas for red king crab, noting that the implications could be for possible modification of these areas to better protect crab habitat. The revised discussion paper is most likely to be available late fall/winter and scheduled for CPT review at a subsequent meeting.

6. Draft Assessments
Bristol Bay red king crab-
Jie Zheng provided an overview of the changes to the BBRKC assessment and modeling modifications primarily in response to CIE reviews in 2009.

Team recommendations include the following:
- More information should be provided why it is reasonable that assuming the bycatch rate in the 1980s equaled the two highest bycatch rates can address the question of whether high bycatch mortality in the 1980s caused the drop in abundance.
- Page 175 – the text relative to the assumption being conservative should not be included in text; rather it should be made clear that this is the best estimate.
- Additional justification for differential mortality rates for males and females should be provided because, at present, the model fits the data, but the mechanisms for, for example, sex-specific natural mortality over different periods is unclear.
- The fraction of the female stock outside survey area in each year needs to be linked to something. It is possible that the differences in abundance between legs 3 and 1 relate to the proportion outside of the survey area. There are survey data indicating that the proportion of animals outside of survey area in a cold year. These data could be used as an index. The hot spot issue should be identified as research priority along with the need for tagging data.
- How the BSFRF data are incorporated in the assessment should be re-evaluated in conjunction

with scientists from BSFRF; specifically, the assessment currently ignores the length data from the BSIERP surveys as well as the female data. This could be a topic for a modeling workshop.

- The estimates of time-trajectories of mature biomass are computed from the output of the model because "maturity" is not explicitly represented in the model. The equation for the population dynamics should be modified to indicate that growth (for females) changes over time.
- Indicate the MLE on the graph for OFL

The team recommends additional runs for the September assessment which combine model configurations 7 and 1a (the 'recommended' model). Model configurations 7 a,c should also be included in the September assessment.

Team discussion of Baseline years for computing B_{MSY}:
The team discussed four time frames for computing the mean recruitment used to estimate B_{MSY}: 1969-1984, 1969-2010, 1985-2010 and 1995-2010, noting that the issue is to determine whether there are specific productivity periods. The team recommends including a plot of recruit per spawner (Yaxis) and MMB (yAxis) vs year(Xaxis) in the assessment along with plots of female size maturity vs recruitment, and recruits-per-spawner vs appropriately lagged MMB.

Jie noted that changes over time have occurred in size of maturity for female BBRKC. Doug noted that interpretation of changes over time in size-at-50% maturity involves assumptions about recruitment, F (dependent on recruitment trends) so this is not in itself an independent variable. The team recommends looking separately at the historical pattern of recruitment to see if there is a reflection. Jie uses this as the basis for three stanzas for female size-at-maturity, but this should be conditional probability of maturing (as with snow crab assessment). Recommend looking at survey data and split females into mature and immature.

The team recommended that the author statistically determine if there is change in mean recruitment and mean recruits-per-spawner, indicate what might be expected if there was a regime shift, and compare results to those for groundfish stocks such as Pacific cod. The team discussed the assumption that a change in productivity occurred in 1995 for BBRKC, noting that no other stock assessment assumes such a change. The team recommends the assessment author consider the draft list of criteria to estimate B_{REF} and address each to the extent possible, bringing forward B_{MSY} estimates and biological reference points based upon the four timeframes (for the selected model scenarios).

EBS snow crab-
Jack Turnock presented the snow crab assessment. He highlighted the range of model scenarios, and outlined the major changes to the assessment since September 2010. Specifically, the assessment presented to the team included the data from the 2010 BSFRF-NMFS side-by-side survey, a revised model for the catch by the NMFS survey vessel in the BSFRF survey area, and model scenarios in which natural mortality for immature crab was estimated rather than being assumed to be equal to that for mature males. The revised model for the catch by the NMFS survey vessel in the BSFRF survey area was proposed during the February modeling workshop. The team noted that the changes to the September 2010 assessment led to large changes to the estimates for male Q (0.75 in September 2010 to 0.606 in one of the scenarios presented to the CPT), to values for Q which are much more similar between males and females, as well as to fairly large changes to key model outputs (e.g. MMB, OFL).

Team discussion and public comment focused on (a) the plots of the proportion caught by length in the BSFRF-NMFS side-by-side survey and whether and how points should be weighted in these plots, (b) the treatment of the BSFRF-NMFS data in the assessment, (c) scenarios and modifications to the assessment for September 2011, and (d) the diagnostics and plots which should be used to specify the average recruitment used when calculating $B_{35\%}$.

The team recommends that September 2011 assessment be based on the following six scenarios:
1. Assume logistic availability, estimate immature M, fixed mature M to 0.23yr^{-1}.
2. Assume logistic availability, fix immature M to 0.23 yr^{-1}, estimate mature M with a prior centered at 0.23yr^{-1}.
3. Assume logistic availability, estimate immature M, estimate mature M with a prior centered at 0.23yr^{-1}.
4. Estimate availability using length-specific parameters subject to a smoothing penalty, estimate immature M, fixed mature M to 0.23yr^{-1}.
5. Estimate availability using length-specific parameters subject to a smoothing penalty, fix immature M to 0.23 yr^{-1}, estimate mature M with a prior centered at 0.23yr^{-1}.
6. Estimate availability using length-specific parameters subject to a smoothing penalty, estimate immature M, fixed mature M to 0.23yr^{-1}.

The team agreed that the selectivity pattern for the NMFS survey obtained when separate selectivity parameters were estimated for each length-class was unexpected (dome-shaped), and, while some possible reasons for this were identified (e.g. larger crab burrowing in the substrate, larger crab out of the survey area), the team did not wish to see this option pursued for the September 2011 assessment.

The results presented to the team differ substantially from those of the 2010 assessment. The team therefore recommended that the assessment author provide a sequence of scenarios which start from the model on which the September 2010 was based (model '0') and show the consequences of each change to the model in terms of time-trajectories of MMB and other key model outputs. This will allow the team the ability to evaluate the major reasons for the changes to the assessment outcomes.

The team identified that the following changes need to be made to the assessment report:
- Update the document so that it includes all of the material in the powerpoint presentation (before the June SSC review of the report); the document presented to the CPT did not include some key material included in the powerpoint presentation.
- Add the fit of the model with separate selectivity parameters for each length-class for the NMFS survey in the Bering Sea to Figures 98 and 99.
- Add measures of uncertainty to the circles in Figures 92 and 93.
- Fully specify the model (add the equations used to calculate the length-composition of the catches by the BSFRF survey; add the equations which specify the smoothness penalty; specify how the length-frequencies for the NMFS and BSFRF surveys in the BSFRF survey area were computed; clarify that availability and Q_{BSFRF} are year-specific; specify how the 'offsets' are calculated).
- Include the CVs for the survey estimates in the table of observed biomass.
- Include likelihood profiles over Q and M for immature crab.
- Include a list of sources of uncertainty not considered in the within-assessment uncertainty estimated.
- Include a retrospective analysis (and comment on the causes for any major changes to the assessment outcomes; e.g. due to exclusion of the 2010 BSFRF-NMFS side-by-side data).
- Add a table comparing the likelihood values and discuss it in the text

The team noted that the results of the likelihood profile for Q as well as models based on alternative assumptions could be used as the basis for ABC recommendations. Only models which are 'plausible' (i.e. at least the fit the data) should be considered when developing ABC recommendations below the maximum ABC.

Tanner crab-
Lou Rugolo provided an overview of progress on developing a model for Tanner crab and a draft Tier 4 assessment for this stock. The team had no recommendations on the proposed approach for estimating E & W GHLs, noting that these estimates are for information only and that the proposed approach seems reasonable. This is useful information in the assessment but State may divide catch components using different information and in a different manner. The team also noted that retained catch components are for information only.

ABC discussion: The team recommends the assessment author remove terminology related to sigma-b and make only an author's recommended ABC. If this ABC is below the max ABC the assessment document needs to include a rationale for the author's recommended ABC for the September assessment.

A number of issues were discussed regarding the calculation of OFL and ABC for Tier 3 and 4 stocks (these should be discussed by the workgroup established on how to compute the pdf for the OFL):
1) Should *M* be assumed to be uncertain? If so, how should extent to uncertainty be specified?
2) Should the mean or median of the distribution for the OFL be used when making recommendations?
3) When should the OFL not be set to the 'best estimate' from the assessment (when the median/mean of the distribution for the OFL is not equal to the 'best estimate')
4) How should the uncertainty regarding the B_{MSY} proxy be accounted for (e.g. selecting from the sampling distributions for the biomass estimates in the time-period / sampling with replacement from the set of biomass on which of the B_{MSY} proxy is based).
5) Should the biomasses used to compute the B_{MSY} proxy be the survey estimate discounted (to the time at mating) by the actual catch or by the F_{MSY} proxy? Discussion amongst the team highlighted the fact that the latter correct is correct 'in principle' but that making this correction may change which years are used to determine the B_{MSY} proxy and that the entire process of defining a B_{MSY} proxy is currently very qualitative.
6) The documentation each assessment needs to provide so that what uncertainties are quantified is clear.

The team discussed that how the OFL is calculated should not change given the above issues. Rather, these issues should be reflected in the rationale for a lower ABC which accounts for a source of uncertainty not reflected in the standard calculation process.

Comments from the public related to: (a) whether the survey biomass should be discounted by the F_{MSY} proxy the issues, (b) the dropping of data to end up with a very short time frame over which B_{MSY} proxy is calculated, (c) issues of survey selectivity, and (d) the choice of years when setting the B_{MSY} proxy, and (e) the potential impact of selectivity on the discount factor.

Status of Tanner model: The team was briefed on the development of the Tanner crab model. This model was reviewed during the modeling workshop and subsequently during the SSC meeting in March. It was intended that this model be presented for possible approval in this specifications process, but the model is not sufficiently developed for review at present.

Some suggestions based on the presentation are as follows:
- freeing up Q might help address the residual pattern.
- include the underbag data for review in fall (request Dave Somerton to discuss) as it pertains to this assessment.
- free up as many parameters (growth, M) as possible during this early stage (perhaps with priors as is the case for snow crab – this is particular relevant because the growth data are not from the Bering Sea).

- look at length compositions (and other data sources) to evaluate why the model cannot fit the survey data, particularly in the early years.
- consider a large number of selectivity time-blocks to see what the data want, then explore whether there are reasons (e.g. related to ice cover and/or other spatial issues) which could be used to justify specific choices related to selectivity time-blocks. Doug noted that Bristol Bay was closed during the mid-1990s for RKC so no bycatch would have occurred in BBRKC fishery and thus entire catch in west during the years.
- look at a dynamic B_0, i.e. what would have happened has the fishery never occurred?

Lou reviewed the workshop recommendations for the Tanner model and how they are being addressed and when.
- Catch data: checking into it. Earlier catch data possible amalgamation of combined data. Authors to check into source of early 74-75 catch data in GF fisheries (outlier).
- Prospective analysis: once model running will evaluate this.[longer term]
- Realistically to move model forwarded need more of a STAR panel review process.

The team encourages model development and an update on the revised model in September focusing on improved diagnostics and model fits for moving this model forward as quickly as possible.

Base Years for the B_{MSY} proxy: The team had an extensive discussion of the base years for estimating the B*MSY* proxy for this stock. The team noted that it is now a very limited number of years, and questioned why this stock has such a different year-set than all others. There should be some common productivity periods for all stocks. There are more historical data for this stock than for the others; the stock with the most similar catch history is BBRKC. The assessment document needs to justify the assumed change in production change. In particular, there needs to be more information on recruitment and trends in recruitment over time.

Possibilities for the years used to define the B_{MSY} proxy and when making catch specifications for the September assessment include: (a) 1974-1980; (b) early 1990's when stock higher (than now); (c) Years in which F was at a reasonable level; and (d) the entire time-period. The team recommended that the author consider all four options and that the assessment document argue why each option is and is not appropriate. The authors should also consider the status of the fishery historically. Siddeek noted a need to evaluate biomass and recruitment over the same period.

Rebuilding Plan: Diana provided an overview of Council action and timing. The team discussed how to develop and analyze alternatives in absence of a projection model. Without a stock assessment model, it is not possible to estimate the required pieces of a rebuilding plan: the minimum time to rebuild, the target time to rebuild, and the harvest rate that would achieve rebuilding in the target time period. This information is also used to evaluate different rebuilding options. The team plans to develop rebuilding plan alternatives in September because the structure of the alternatives will be driven by whether the assessment model can be used. André noted that the model could be used for initial projection of the time frame to rebuild and as the model improves this time frame could be updated.

CPT recommends going forward with projection model focusing on recruitment for September. It should be possible to use the model to develop a rebuilding plan if the model is sufficiently close to acceptance in September. The authors should communicate with Council staff regarding progress towards the model development prior to the September meeting.

St Matthew blue king crab-
Bill Gaeuman provided an overview of the St Matthew assessment model and draft assessment. He acknowledged the assistance of Jim Ianelli. Based on results of the NPFMC modeling workshop the author was requested to revise the stock assessment model, improve and or replace the model and prepare a survey-based assessment as a fallback.

The team recommends that the assessment author reformulate equations for survey-based assessment to be consistent with other Tier 4 assessments. The variance for the OFL is proposed to be based on the delta-method. If the author continue to use this approach, account will need to be taken of the variance of M (and hence the proxy for F_{MSY}). The OFL was computed in the assessment document as exploitation rate multiplied by legal biomass at the time the fishery with bycatch and discarded then added. This is incorrect and the retained catch OFL should be the total OFL less bycatch and discard mortality. The team recommends formulating a more generic model so that additional scenarios can be explored. The team recommends reviewing the model description and additional output from model in September to provide opportunity for additional feedback on model development.

Pribilof red and blue king crab-
Bob Foy presented an overview of the assessment updates for Pribilof Islands red and blue king crab. While a draft model for both stocks was reviewed at the modeling workshop, the development of these models is currently on hold pending development of the St Matthew blue king crab model.

The team recommended that the survey and MMB data (Figure 5) be plotted separately to better highlight differences in trends (if any). It also discussed the procedure for averaging survey biomass estimates, in particular the range of 2-7 years for averaging MMB, noting that the longer time frames for averaging were too long and average over too high (or low) of historical periods to truly reflect recent stock status. The CPT recommends a three-year moving average to estimate MMB in current year. Need to include CVs on graphs of MMB.

Edward Poulson suggested requesting industry evaluate gear modifications for catching red crab and not blue crab.

The team was updated briefly on the revised rebuilding plan analysis for PIBKC. The team recommends that the analysis be revised to extremely caveat the uncertainties in the utility of the projection model in the analysis. The analysis should also highlight issue of weight and PSC bycatch in groundfish fishery management.

7. Groundfish Catch Accounting issues
Jennifer Mondragon briefed the team on some catch accounting issues and answered questions regarding the future plans for more spatially-explicit catch estimates in the groundfish fishery.

Bycatch estimated in numbers and assessment needs in weight: Crab bycatch in the groundfish fisheries are managed in numbers so the current method for estimating crab bycatch only provides an estimate of the number of crabs caught. The crab stock assessment authors, however, need estimates of crab catch in total weight. Data are collected by observers and recorded as the number of crab and weight of all crab caught in that sample plus a sub-set of length. Thus, to obtain an estimate for the stock assessment authors, the Alaska Region converts total PSC estimates of number of crabs to weight of crab using a global average weight per crab by gear (fixed or trawl), species, and crab year. This process results in multiple conversions, from weight to number and then back to weight, that rely on averages that do not necessarily correspond with the sampling frame. A possible solution would be to use the sampled weights collected by observers to calculate bycatch in weight from very beginning for purposes of stock assessment (i.e. never switch over to numbers at any point). This could be possibly done for this year.

However if this method was developed, the groundfish PSC caps would still be managed as numbers, not weight. The mis-match of weight and number may be problematic if caps are set as a proportion of the TAC in weight which then have to be converted to numbers of crab.

Another issue that was raised was that some stock assessment models require a number and then use a LW regression to get weight (per Jie's method). She noted that the observer program data can provide LF and sex ratio.

The team recommended 1) that the CAS provide authors both total numbers and total weight and; 2) that the observer sampled data be used to estimate weight instead of a conversion to weight being applied after to numbers.

It was also recommended that Diana approach the Council for a decision on establishing caps in numbers when conversion from weight will occur. This issue should be highlighted to the SSC for their comments as well. Weight-based caps in the groundfish fishery would eliminate the need for this double-extrapolation.

Bycatch estimates by stock boundary: Currently estimates are provided by NMFS reporting areas. In the past, the team discussed development of PSC estimates at the resolution of state statistical area, since statistical areas are now collected on both groundfish landing reports and groundfish production reports. However, this would require development of a new PSC estimation method. Alternatively, NMFS has already developed the Catch-In-Area (CIA) database which could be used to provide spatially explicit bycatch estimates. The CIA database uses VMS and lat/long information from observer data to apportion catch to a 20x20 km grid (i.e. much smaller than State stat areas). This database provides better spatial resolution than Federal reporting areas and state stat areas.

One issue is that this does not solve the extrapolation issue (as with PIBKC extrapolated bycatch estimated from St Matthew). The analysts for the Pribilof analysis are requested to come up with extrapolation method within the Pribilof Islands area only, but this may end up extrapolating to older data within Pribilof Islands rather than data outside the area.

The team recommends the use of the CIA database for estimating the spatially-explicit bycatch by stock along stock boundaries. Bob should send Jennifer list of spatial demarcations to use. If individual authors need spatial information about the observed catch they can still go to observer data for location information. The team also requested that Steve Lewis provide an overview of the database.

8. Research Priorities
The team compiled the following research priorities (in order of prioritization):
1. Compare productivity shifts across crab stocks to provide a defensible basis for specifying B_{ref} used in the stock assessments.
   a. Can info. from one stock be applied to another, as in Punt et al. (2011)?
   b. Environmental linkages to productivity - Identify time periods that are representative of the productivity of each stock
2. Life history characteristics (natural mortality, size at maturity, fecundity, molting probability, growth) for all species, including variation within and among stocks:
   a. Norton Sound RKC – natural mortality and growth
   b. AIGKC – molting probability, growth, natural mortality
   c. BBRKC - natural mortality, abiotic and biotic factors affecting survival from larva to fishery recruitment
   d. BKC – spatial variation in size at maturity

  e. Pribilof Islands – interactions between RKC, BKC and predators in limiting recovery of BKC.

  f. Tanner & snow crab – growth, size at maturity – variation within stock

  g. Terminal molting species (Tanner, snow crab) – longevity after terminal molt & by sex

  h. Role of predation in recruitment of crab stocks – process level studies focusing on specific regions

3. Crab movement/migrations

  a. AIGKC - depth distribution and size composition

  b. BBRKC – movement during/before hatching – spatial distribution of males vs. females – whether northern animals participate in BB stock

  c. BBRKC – larval drift model

  d. Fishermen knowledge – collect information on historical distributions of adults & juveniles

  e. Movements of snow crab and Tanner crab in relation to timing of mating & relationship to ice cover/cold pool

  f. Effectiveness of closure areas for protecting/recovering stocks

  g. Tag technology development – remote detection methodology, sample through ice

4. Handling mortality

  a. AIGKC

  b. Tanner crab

  c. Crab mortality in groundfish trawl fisheries

5. Stock surveys

  a. Conduct geostatistical analysis using a likelihood based approach (Roa and Niklitschek 2007) instead of an area-swept method.

  b. Pre-recruit survey – AIGKC (in collaboration with industry)

  c. Spatial distribution of Adak RKC

  d. Crab availability to the survey – BBRKC

  e. Juvenile & larval survey – BBRKC

6. Fishery selectivity

  a. AIGKC

  b. Tanner crab

Punt, A.E., Smith, D.C. and A.D.M. Smith. 2011. Among-stock comparisons for improving stock assessments of data-poor stocks – the "Robin Hood" approach. ICES J. Mar. Sci. 68: 972-981.

9. New Business

ACL discussion (summarized in the beginning of this report).

Crab study: André provided an overview of his NPRB-funded study using simple formulations for crab models and the implications for B_{MSY} proxies. He will provide another progress report on this at the September meeting with the project scheduled for completion by the May CPT meeting.

Economic SAFE summary: Brian Garber-Yonts provided an overview of summary information on the upcoming Economic SAFE report. His summary document would be intended to be included in the Crab SAFE introduction in the Fall. Brian will distribute the draft summary document for comments by CPT members over the summer and revise it for presentation in September.

The team discussed some of the information presented and questioned why more recent price information is not included? Brian noted the 2010 price information is not updated with post-season adjustments and is thus not accurate. Team members suggested also looking into including retail pricing. Brian also noted

that some additional information could be included in the fall such as data from fish tickets on CFEC price and revenue data.

Model workshop: The team recommends holding another NPFMC model workshop outside the normal CPT meeting cycle. This time the recommendation is for a 5-day workshop focusing on two stocks simultaneously. This would require substantial work from stock assessment authors before and during the meeting. The authors would need to be prepared to provide real-time work products during the meeting. The team prioritized AIGKC and Tanner crab for this workshop. If the Tanner model is near acceptable in September the next highest priority would be NSRKC. This meeting is scheduled for January 9-13. Diana will work on organizing the meeting and seeking someone (ideally Steve Martell again) to chair the meeting.

Workgroup meeting on OFL pdf: A workgroup is recommended to meet and establish standard approach by Tier for estimating the pdf of the OFL. Some participants suggested include André, Siddeek, Jim Ianelli, Jack Turnock, Martin Dorn and Grant Thompson. The group would be internally chaired and meet, ideally over one day, to come up with a means of producing a report that recommends the method to estimate the pdf of the OFL by tier considering such issues as mean versus median, information availability, and other issues related to estimating this for crab (and groundfish) stocks. Diana and Bob would also participate if possible. The resulting report would then be provided to the stock assessment authors, the CPT and SSC for use in the upcoming assessment cycle (and for additional comments/suggestions as needed).

Topics included for the September CPT meeting (September 19-23) include:
- Final assessments for remaining 6 stocks
- B_{MSY} proxy criteria and time frame discussion
- Tanner model update
- AIGKC model update
- Ecosystem indicators and literature search regarding application to crab stocks
- Update on André's project
- Economic SAFE intro finalization
- Ecosystem introduction finalization
- Model description review for St Matthew BKC

The meeting adjourned on Friday May 13th at 2:30pm.

North Pacific Fishery Management Council Crab Plan Team Meeting
May 9-13, 2011
TSMARI/Lena Point NOAA Lab, Juneau, AK

DRAFT AGENDA 5/6/2011 vers

Monday, May 9 — Room (TBD)

Time	Topic	
10:30	**Administration**	• Introductions, Revise Terms of Reference, election of officers, agenda, minutes (SSC and CPT), timing mts (9/2011, 2012), research priorities (overview of plan to revise by Thursday), SAFE assignments
11:00	**B_{MSY} time frame**	• Discussion of general criteria for establishing B_{MSY} time frames for all stocks
Noon		Lunch-(on own)
1:30	**ACLs and uncertainty**	• Review ACL rule, Addressing uncertainty in ACL rules; plans for September
	Break 3:00 – 3:15	
3:15	**NPFMC Modeling workshop report**	• Summarize main findings (report distributed in advance); Council action
3:45	**Final assessments**	• Review timing for finalizing assessments, tables, SAFE and assignments
		• Norton Sound red king crab Assessment: OFL and ABC recommendations
		•

Tuesday, May 10

Time	Topic	
9:00	**Final assessments**	• NSRKC continue as necessary
		• Adak RKC: OFL and ABC recommendations
	Break 10:30 – 10:45	• PIGKC: OFL and ABC recommendations
10:45		• AIGKC: review model and Tier 5 assessment, Tier recommendation, OFL and ABC recommendations
Noon		Lunch (ordering in sandwiches)
1:00	**Final assessments**	• Ecosystem Considerations chapter
2:00	**BBRKC EFH**	• Discussion paper, overview of Council action
	Break 3:00-3:15	
3:15	**Draft assessments: model and parameter review and recommendations**	• Bristol Bay red king crab; review draft assessment and responses to CIE review

Wednesday, May 11

Time	Topic	
9am	**Draft assessments: model and parameter review and**	• Pribilof red and blue king crab assessments; update on PIBKC rebuilding plan
		• Saint Matthew blue king crab: review model, Tier recommendation

recommendations

Noon		Lunch (ordering in sandwiches)
1:00	**Draft assessments: cont.** Break 3:00 – 3:15	• Snow crab (including survey selectivity treatment)
		• Snow crab (continue)

Thursday, May 12

9:00	**Draft assessments: cont.** Break 10:15-10:30	• Tanner crab: review model, Tier recommendation Draft rebuilding plan alternative management measures
Noon		Lunch (ordering in sandwiches)
1:00	**Catch Accounting issues** Break 3:00 – 3:15	• Groundfish bycatch estimation by stock: Issues of:average weight calculation vs L/W regression, bycatch estimation by stock boundaries vs NMFS reporting areas, issues with extrapolation within species but across stocks\
3:15	**Research Priorities**	• Finalize research priorities

Friday, May 13

9:00 am	**SAFE report** Break 10:00-10:15	• Review and finalize SAFE introduction and all recommendations
Noon		Lunch (order in)
1:00	**SAFE report** Break 3:00 – 3:15	• Continue
3:15	**New Business**	• As needed **NPRB project, FMP amendment txt**
5:00pm	*ADJOURN*	

Straw Proposal for Establishing Criteria in Estimating B_{REF}

Louis J. Rugolo and Benjamin J. Turnock
Alaska Fisheries Science Center
05 May 2011

This is a straw proposal to establish a set of criteria for determining the time period used in estimating B_{REF} for stocks under Tier-3 and Tier-4 designations. We recommend that the CPT first establish the set of objective criteria for this purpose, then require that each assessment author provide results of the analysis in SAFE.

The proposed criteria in selecting the time period to represent B_{REF} are:

Definition: The time period should be representative of the stock fluctuating around B_{MSY}. Time period should be representative of the stock being fished at an average rate near F_{MSY}. For Tier 3 we are looking for an average recruitment and not an average biomass (BREF formally only applies to Tier 4).

1.   The analyst should provide an estimate of the production potential of the stock over the full time period of the assessment.

   a.   Is the stock below a threshold for responding to increase production.

   b.   For modeled stocks, the time series of ln(R/S). For crab stocks, S is mature male biomass at the time of mating, and R is model estimate of recruitment. Also show time series of recruitment.

   c.   For non-modeled Tier-4 stocks, a surplus production analysis using biomass and catch conducted to evaluate the production potential over time [give the formula for surplus production (this is something Andre will be working on) which should be in units of MMB]. Also, evaluate the time series of survey recruiting size class as a recruitment index. If it looks consistent look at time series of survey R/S.

   d.   Potential mechanisms that should be considered to support production changes based on a. b. above. Evidence of a change in magnitude and direction of life-history characteristics that support a proposed change in production should be considered. Candidate life-history characteristics (empirical data) include [need to elaborate]:

      i.   Natural Mortality (M)

      ii.   Growth

      iii.   Maturity (maturity schedule)

      iv.   Fecundity

      v.   Recruitment & recruits/spawner

      Candidate ecosystem characteristics (empirical data) include [need to elaborate]:

      vi.   Overland method of Regime Shift detection

      vii.   Change in production of benthic spp in EBS.

      viii.   Consumption (ecosystem model output).

2. The analyst should provide a plot of the history of the exploitation rate on MMB at the time of the fishery relative to F_{MSY} (Tier-3) or relative to the $F_{MSY}=M$ proxy (Tier-4).

3. The analyst should provide a plot of the history of the exploitation rate on MMB at the time of the fishery relative to $\ln(R/S)$ (Tier-3) or relative to $\ln(R_{OBS}/MMB_{OBS})$ (Tier-4) where R_{OBS} is observed survey recruitment and MMB_{OBS} is observed survey MMB at the time of mating if data allow.

4. The analyst should examine the stock-recruitment relationship (SRR) for evidence of:
   a. Depensation in the SRR.
   b. Multiple SRRs consistent with a proposed regime shift paradigm.

5. For many crab stocks, historical rates of exploitation exceeded current estimates of maximum rates fishing at F_{MSY}. The resultant B_{REF} would be a biased low measure of reproductive potential in such instances, since MMB at mating is tabulated after the extraction of the catch. If recruitment was maintained despite excessive removals, the extent of this bias is proportional to the magnitude of the catch in excess of fishing at F_{MSY}.

For Tier-4 stocks, an alternative B_{REF} can be estimated that adjusts for stock losses in excess of F_{MSY}. The analyst should estimate B_{REF} based on the following approach:
   a. Using observed survey mature male biomass, estimate mature male biomass at the time of the fishery.
   b. Using the F_{MSY} proxy, estimate the catch using the biomass from (a).
   c. In years where exploitation rates exceeded those at F_{MSY}, replace the observed catch with that from (b) and recalculate MMB at mating.
   d. Produce a new time series of MMB at mating replacing those years where MMB was recalculated in (c).
   e. Recalculate B_{REF} over the reference time period with the new time series of MMB at mating derived in (d).