Stock Assessment and Fishery Evaluation Report
for the
**KING AND TANNER CRAB FISHERIES**
of the
Bering Sea and Aleutian Islands Regions

# 2010 Final Crab SAFE

Compiled by

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of the Bering Sea and Aleutian Islands

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**September 2010**

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# Stock Assessment and Fishery Evaluation Report for the King and Tanner Crab Fisheries Fisheries of the Bering Sea and Aleutian Islands Regions

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**2010 Stock Assessment and Fishery Evaluation Report for the King and Tanner Crab Fisheries in the Bering Sea and Aleutian Islands**

# Introduction

The annual stock assessment and fishery evaluation (SAFE) report is a requirement of the North Pacific Fishery Management Council's *Fishery Management Plan for Bering Sea/Aleutian Islands King and Tanner Crabs (FMP)*, and a federal requirement [50 CFR Section 602.12(e)]. The SAFE report summarizes the current biological and economic status of fisheries, total allowable catch (TAC) or Guideline Harvest Level (GHL), and analytical information used for management decisions. Additional information on Bering Sea/Aleutian Islands (BSAI) king and Tanner crab is available on the NMFS web page at http://www.fakr.noaa.gov and the Alaska Department of Fish and Game (ADF&G) Westward Region Shellfish web page at: http://www.cf.adfg.state.ak.us/region4/shellfsh/shelhom4.php.

This FMP applies to 10 crab stocks in the BSAI: 4 red king crab, *Paralithodes camtschaticus*, stocks (Bristol Bay, Pribilof Islands, Norton Sound and Adak), 2 blue king crab, *Paralithodes platypus*, stocks (Pribilof District and St Matthew Island), 2 golden (or brown) king crab, *Lithodes aequispinus*, stocks (Aleutian Island and Pribilof Islands), EBS Tanner crab *Chionoecetes bairdi*, and EBS snow crab *Chionoecetes opilio*. All other BSAI crab stocks are exclusively managed by the State of Alaska.

The Crab Plan Team (CPT) annually assembles the SAFE report with contributions from ADF&G and the National Marine Fisheries Service (NMFS). This SAFE report is presented to the North Pacific Fishery Management Council (NPFMC) and is available to the public on the NPFMC web page at: http://fakr.noaa.gov/npfmc/membership/plan_teams/CRAB_team.htm. Under a process approved in 2008 for revised overfishing level (OFL) determinations, the Crab Plan Team reviews draft assessments in May to provide recommendations in a draft SAFE report for review by the Council's Science and Statistical Committee (SSC) in June. In September, the CPT reviews final assessments and provides final OFL recommendations and stock status determinations. Additional information on the new OFL determination process is contained in this report.

The Crab Plan Team met from September 13-16, 2010 in Seattle, WA to review the final stock assessments as well as Annual Catch Limits analysis and related issues, in order to provide the recommendations and status determinations contained in this SAFE report. This final 2010 Crab SAFE report builds upon review and recommendations from the draft Crab SAFE report reviewed in May 2010. This SAFE report will be presented to the Council in October for their annual review of the status of BSAI Crab stocks. Members of the team who participated in this review include the following: Forrest Bowers (Chair), Ginny Eckert (Vice-Chair), André Punt, Jack Turnock, Shareef Siddeek, Bill Bechtol, Karla Bush, Bob Foy, Brian Garber-Yonts, Gretchen Harrington, Doug Pengilly, Bob Foy, Lou Rugolo, Wayne Donaldson, Josh Greenberg, and Diana Stram.

## Stock Status Definitions

The FMP (incorporating all changes made following adoption of Amendment 24) contains the following stock status definitions:

Maximum sustainable yield (MSY) is the largest long-term average catch or yield that can be taken from a stock or stock complex under prevailing ecological and environmental conditions. MSY is estimated from the best information available.

$F_{MSY}$ control rule means a harvest strategy which, if implemented, would be expected to result in a long-term average catch approximating MSY.

$B_{MSY}$ stock size is the biomass that results from fishing at constant $F_{MSY}$ and is the minimum standard for a rebuilding target when a rebuilding plan is required.

Maximum fishing mortality threshold (MFMT) is defined by the $F_{OFL}$ control rule, and is expressed as the fishing mortality rate.

Minimum stock size threshold (MSST) is one half the $B_{MSY}$ stock size.

Overfished is determined by comparing annual biomass estimates to the established MSST. For stocks where MSST (or proxies) are defined, if the biomass drops below the MSST (or proxy thereof) then the stock is considered to be overfished.

Overfishing is defined as any amount of catch in excess of the overfishing level (OFL). The OFL is calculated by applying the $F_{OFL}$ control rule annually estimated using the tier system in Chapter 6.0 to abundance estimates.

## Status Determination Criteria

The FMP defines the following status determination criteria and the process by which these are defined following adoption of amendment 24.

Status determination criteria for crab stocks are annually calculated using a five-tier system that accommodates varying levels of uncertainty of information. The five-tier system incorporates new scientific information and provides a mechanism to continually improve the status determination criteria as new information becomes available. Under the five-tier system, overfishing and overfished criterion are annually formulated and assessed to determine the status of the crab stocks and whether (1) overfishing is occurring or the rate or level of fishing mortality for a stock or stock complex is approaching overfishing, and (2) a stock or stock complex is overfished or a stock or stock complex is approaching an overfished condition.

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. For the previous crab fishing year, NMFS will determine whether overfishing occurred by comparing the previous year's OFL with the catch from the previous crab fishing year. This catch includes all fishery removals, including retained catch and discard losses, for those stocks where non-target fishery removal data are available. Discard losses are determined by multiplying the appropriate handling mortality rate by observer estimates of bycatch discards. For stocks where only retained catch information is available, the OFL will be set for and compared to the retained catch.

NMFS will determine whether a stock is in an overfished condition by comparing annual biomass estimates to the established MSST, defined as ½ $B_{MSY}$. For stocks where MSST (or proxies) are defined, if the biomass drops below the MSST (or proxy thereof) then the stock is considered to be overfished. MSSTs or proxies are set for stocks in Tiers 1-4. For Tier 5 stocks, it is not possible to set an MSST because there are no reliable estimates of biomass.

If overfishing occurred or the stock is overfished, section 304(e)(3)(A) of the Magnuson-Stevens Act, as amended, requires the Council to immediately end overfishing and rebuild affected stocks.

Annually, the Council, Scientific and Statistical Committee, and Crab Plan Team will review (1) the stock assessment documents, (2) the OFLs and total allowable catches or guideline harvest levels for the upcoming crab fishing year, (3) NMFS's determination of whether overfishing occurred in the previous crab fishing year, and (4) NMFS's determination of whether any stocks are overfished.

Five-Tier System

The OFL for each stock is annually estimated for the upcoming crab fishing year using the five-tier system, detailed in Table 6-1 and 6-2. First, a stock is assigned to one of the five tiers based on the availability of information for that stock and model parameter choices are made. Tier assignments and model parameter choices are recommended through the Crab Plan Team process to the Council's Scientific and Statistical Committee. The Council's Scientific and Statistical Committee will recommend tier assignments, stock assessment and model structure, and parameter choices, including whether information is "reliable," for the assessment authors to use for calculating the OFLs based on the five-tier system.

For Tiers 1 through 4, once a stock is assigned to a tier, the stock status level is determined based on recent survey data and assessment models, as available. The stock status level determines the equation used in calculating the $F_{OFL}$. Three levels of stock status are specified and denoted by "a," "b," and "c" (see Table 6-1). The $F_{MSY}$ control rule reduces the $F_{OFL}$ as biomass declines by stock status level. At stock status level "a," current stock biomass exceeds the $B_{MSY}$. For stocks in status level "b," current biomass is less than $B_{MSY}$ but greater than a level specified as the "critical biomass threshold" ($\beta$).

Lastly, in stock status level "c," current biomass is below $\beta$ * ($B_{MSY}$ or a proxy for $B_{MSY}$). At stock status level "c," directed fishing is prohibited and an $F_{OFL}$ at or below $F_{MSY}$ would be determined for all other sources of fishing mortality in the development of the rebuilding plan. The Council will develop a rebuilding plan once a stock level falls below the MSST.

For Tiers 1 through 3, the coefficient $\alpha$ is set at a default value of 0.1, and $\beta$ set at a default value of 0.25, with the understanding that the Scientific and Statistical Committee may recommend different values for a specific stock or stock complex as merited by the best available scientific information.

In Tier 4, a default value of natural mortality rate (M) or an M proxy, and a scalar, $\gamma$, are used in the calculation of the $F_{OFL}$.

In Tier 5, the OFL is specified in terms of an average catch value over an historical time period, unless the Scientific and Statistical Committee recommends an alternative value based on the best available scientific information.

OFLs will be calculated by applying the $F_{OFL}$ and using the most recent abundance estimates. The Crab Plan Team will review stock assessment documents, the most recent abundance estimates, and the proposed OFLs. The Alaska Fisheries Science Center will set the OFLs consistent with this FMP and forward OFLs for each stock to the State of Alaska prior to its setting the total allowable catch or guideline harvest level for that stock's upcoming crab fishing season.

Tiers 1 through 3

For Tiers 1 through 3, reliable estimates of B, $B_{MSY}$, and $F_{MSY}$, or their respective proxy values, are available. Tiers 1 and 2 are for stocks with a reliable estimate of the spawner/recruit relationship, thereby enabling the estimation of the limit reference points $B_{MSY}$ and $F_{MSY}$.

- Tier 1 is for stocks with assessment models in which the probability density function (pdf) of $F_{MSY}$ is estimated.
- Tier 2 is for stocks with assessment models in which a reliable point estimate, but not the pdf, of $F_{MSY}$ is made.
- Tier 3 is for stocks where reliable estimates of the spawner/recruit relationship are not available, but proxies for $F_{MSY}$ and $B_{MSY}$ can be estimated.

For Tier 3 stocks, maturity and other essential life-history information are available to estimate proxy limit reference points. For Tier 3, a designation of the form "$F_X$" refers to the fishing mortality rate associated with an equilibrium level of fertilized egg production (or its proxy) per recruit equal to X% of the equilibrium level in the absence of any fishing.

The OFL calculation accounts for all losses to the stock not attributable to natural mortality. The OFL is the total catch limit comprised of three catch components: (1) non-directed fishery discard losses; (2) directed fishery discard losses; and (3) directed fishery retained catch. To determine the discard losses, the handling mortality rate is multiplied by bycatch discards in each fishery. Overfishing would occur if, in any year, the sum of all three catch components exceeds the OFL.

Tier 4

Tier 4 is for stocks where essential life-history, recruitment information, and understanding are lacking. Therefore, it is not possible to estimate the spawner-recruit relationship. However, there is sufficient information for simulation modeling that captures the essential population dynamics of the stock as well as the performance of the fisheries. The simulation modeling approach employed in the derivation of the annual OFLs captures the historical performance of the fisheries as seen in observer data from the early 1990s to present and thus borrows information from other stocks as necessary to estimate biological parameters such as $\gamma$.

In Tier 4, a default value of natural mortality rate (M) or an M proxy, and a scalar, $\gamma$, are used in the calculation of the $F_{OFL}$. Explicit to Tier 4 are reliable estimates of current survey biomass and the instantaneous M. The proxy $B_{MSY}$ is the average biomass over a specified time period, with the understanding that the Council's Scientific and Statistical Committee may recommend a different value for a specific stock or stock complex as merited by the best available scientific information. A scalar, $\gamma$, is multiplied by M to estimate the $F_{OFL}$ for stocks at status levels a and b, and $\gamma$ is allowed to be less than or greater than unity. Use of the scalar $\gamma$ is intended to allow adjustments in the overfishing definitions to account for differences in biomass measures. A default value of $\gamma$ is set at 1.0, with the understanding that the Council's Scientific and Statistical Committee may recommend a different value for a specific stock or stock complex as merited by the best available scientific information.

If the information necessary to determine total catch OFLs is not available for a Tier 4 stock, then the OFL is determined for retained catch. In the future, as information improves, data would be available for some stocks to allow the formulation and use of selectivity curves for the discard fisheries (directed and non-directed losses) as well as the directed fishery (retained catch) in the models. The resulting OFL from this approach, therefore, would be the total catch OFL.

Tier 5

Tier 5 stocks have no reliable estimates of biomass or M and only historical data of retained catch is available. For Tier 5 stocks, the historical performance of the fishery is used to set OFLs in terms of retained catch. The OFL represents the average retained catch from a time period determined to be representative of the production potential of the stock. The time period selected for computing the average catch, hence the OFL, would be based on the best scientific information available and provide the appropriate risk aversion for stock conservation and utilization goals. In Tier 5, the OFL is specified in terms of an average catch value over a time period determined to be representative of the production potential of the stock, unless the Scientific and Statistical Committee recommends an alternative value based on the best available scientific information.

For most Tier 5 stocks, only retained catch information is available so the OFL will be estimated for the retained catch portion only, with the corresponding overfishing comparison on the retained catch only. In the future, as information improves, the OFL calculation could include discard losses, at which point the OFL would be applied to the retained catch plus the discard losses from directed and non-directed fisheries.

Figure 1. Overfishing control rule for Tiers 1 through 4. Directed fishing mortality is 0 below $\beta$.

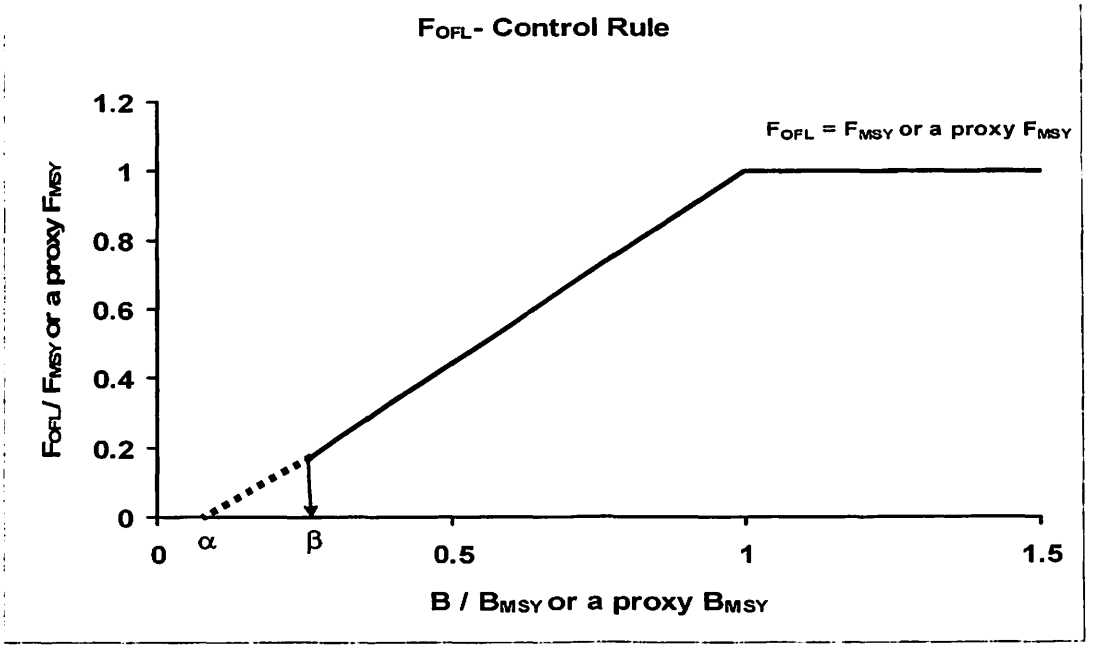

Table 1 Five-Tier System for setting overfishing limits for crab stocks. The tiers are listed in descending order of information availability. Table 2 contains a guide for understanding the five-tier system.

| Information available | Tier | Stock status level | $F_{OFL}$ |
|---|---|---|---|
| $B$, $B_{MSY}$, $F_{MSY}$, and pdf of $F_{MSY}$ | 1 | a. $\frac{B}{B_{msy}} > 1$ | $F_{OFL} = \mu_A$ =arithmetic mean of the pdf |
| | | b. $\beta < \frac{B}{B_{msy}} \leq 1$ | $F_{OFL} = \mu_A \frac{B/B_{msy} - \alpha}{1-\alpha}$ |
| | | c. $\frac{B}{B_{msy}} \leq \beta$ | *Directed fishery F = 0* $F_{OFL} \leq F_{MSY}$† |
| $B$, $B_{MSY}$, $F_{MSY}$ | 2 | a. $\frac{B}{B_{msy}} > 1$ | $F_{OFL} = F_{msy}$ |
| | | b. $\beta < \frac{B}{B_{msy}} \leq 1$ | $F_{OFL} = F_{msy} \frac{B/B_{msy} - \alpha}{1-\alpha}$ |
| | | c. $\frac{B}{B_{msy}} \leq \beta$ | *Directed fishery F = 0* $F_{OFL} \leq F_{MSY}$† |
| $B$, $F_{35\%}$*, $B_{35\%}$* | 3 | a. $\frac{B}{B_{35\%}*} > 1$ | $F_{OFL} = F_{35\%}$* |
| | | b. $\beta < \frac{B}{B_{35\%}*} \leq 1$ | $F_{OFL} = F^*_{35\%} \frac{\frac{B}{B^*_{35\%}} - \alpha}{1-\alpha}$ |
| | | c. $\frac{B}{B_{35\%}*} \leq \beta$ | *Directed fishery F = 0* $F_{OFL} \leq F_{MSY}$† |
| $B$, $M$, $B_{msy^{prox}}$ | 4 | a. $\frac{B}{B_{msy^{prox}}} > 1$ | $F_{OFL} = \gamma M$ |
| | | b. $\beta < \frac{B}{B_{msy^{prox}}} \leq 1$ | $F_{OFL} = \gamma M \frac{B/B_{msy^{prox}} - \alpha}{1-\alpha}$ |
| | | c. $\frac{B}{B_{msy^{prox}}} \leq \beta$ | *Directed fishery F = 0* $F_{OFL} \leq F_{MSY}$† |
| Stocks with no reliable estimates of biomass or M. | 5 | | OFL = average catch from a time period to be determined, unless the SSC recommends an alternative value based on the best available scientific information. |

*35% is the default value unless the SSC recommends a different value based on the best available scientific information.

† An $F_{OFL} \leq F_{MSY}$ will be determined in the development of the rebuilding plan for that stock.

Table 2 A guide for understanding the five-tier system.

- $F_{OFL}$ — the instantaneous fishing mortality (F) from the directed fishery that is used in the calculation of the overfishing limit (OFL). $F_{OFL}$ is determined as a function of:
  - $F_{MSY}$ — the instantaneous F that will produce MSY at the MSY-producing biomass
    - A proxy of $F_{MSY}$ may be used; e.g., $F_{x\%}$, the instantaneous F that results in x% of the equilibrium spawning per recruit relative to the unfished value
  - B — a measure of the productive capacity of the stock, such as spawning biomass or fertilized egg production.
    - A proxy of B may be used; e.g., mature male biomass
  - $B_{MSY}$ — the value of B at the MSY-producing level
    - A proxy of $B_{MSY}$ may be used; e.g., mature male biomass at the MSY-producing level
  - $\beta$ — a parameter with restriction that $0 \leq \beta < 1$.
  - $\alpha$ — a parameter with restriction that $0 \leq \alpha \leq \beta$.
- The maximum value of $F_{OFL}$ is $F_{MSY}$. $F_{OFL} = F_{MSY}$ when $B > B_{MSY}$.
- $F_{OFL}$ decreases linearly from $F_{MSY}$ to $F_{MSY} \cdot (\beta-\alpha)/(1-\alpha)$ as B decreases from $B_{MSY}$ to $\beta \cdot B_{MSY}$
- When $B \leq \beta \cdot B_{MSY}$, $F = 0$ for the directed fishery and $F_{OFL} \leq F_{MSY}$ for the non-directed fisheries, which will be determined in the development of the rebuilding plan.
- The parameter, $\beta$, determines the threshold level of B at or below which directed fishing is prohibited.
- The parameter, $\alpha$, determines the value of $F_{OFL}$ when B decreases to $\beta \cdot B_{MSY}$ and the rate at which $F_{OFL}$ decreases with decreasing values of B when $\beta \cdot B_{MSY} < B \leq B_{MSY}$.
  - Larger values of $\alpha$ result in a smaller value of $F_{OFL}$ when B decreases to $\beta \cdot B_{MSY}$.
  - Larger values of $\alpha$ result in $F_{OFL}$ decreasing at a higher rate with decreasing values of B when $\beta \cdot B_{MSY} < B \leq B_{MSY}$.

# Crab Plan Team Recommendations

Table 3 lists the team's recommendations for 2010/2011 on Tier assignments, model parameterizations, time periods for reference biomass estimation or appropriate catch averages, and OFLs. The team recommends two stocks be placed in Tier 3 (EBS snow crab and Bristol Bay red king crab), five stocks in Tier 4 (EBS Tanner crab, St. Matthew blue king crab, Pribilof Island blue king crab, Pribilof Island red king crab and Norton Sound red king crab) and three stocks in Tier 5 (AI golden king crab, Pribilof Island golden king crab and Adak red king crab).

Stock status in relation to status determination criteria are evaluated in this September report (Table 4). The team has general recommendations for all assessments and specific comments related to individual assessments. All recommendations are for consideration for the 2011 assessment cycle unless indicated otherwise. The general comments are listed below while the comments related to individual assessments are contained within the summary of plan team deliberations and recommendations contained in the stock specific summary section. Additional details regarding recommendations are contained in the Crab Plan Team Report (September 2010 CPT Report).

## General recommendations for all assessments

The CPT would like to request SSC input regarding whether we should reconsider whether females should be included in the 'total' catch OFL. The male component of OFLs is based on the OFL control rule and relate directly to the sustainability of harvest relative to management benchmarks, i.e. $B_{MSY}$. The measure of what produces MSY on a continuing basis is mature male biomass ($B_{MSY}$ defined in terms of MMB). There is an inherent mis-match when considering female catch. When female catch is additive to mature male catch it represents what is expected from current fishing practices rather than a catch that would jeopardize the ability of the stock to achieve MSY on a continuing basis. This can lead to potentially undesirable outcomes. For example if a total catch OFL such as Tanner crab in 2010 is computed as the sum of males and female estimated losses at 2.0 s with the breakout estimated at 1.76 t of males and 0.24 of females, overfishing would not be designated to occur if more than the estimated fraction of males or females were caught such that the sum did not exceed 2.0 t. This could allow for more males being extracted than have been estimated as sustainable based on the assessment without being considered overfishing and does not seem responsive to the intent of the overfishing definition. Given this concern the assessment authors should list the sources and components of the OFL (similar to the ACL EA, e.g. tables 6-2).

The team discussed that each assessment should explain how the groundfish bycatch data is used in the assessment and that all assessment chapters should be consistent in how the groundfish bycatch data is used and which handling mortality rate is applied.

By convention the CPT used the following conversions to include tables in both lbs and t in the status status summary sections:

- lbs to t [/2.204624]
- t to lbs [x 0.453592]

## Ecosystem SAFE overview

The ecosystem chapter is composed of three main sections 1) ecosystem assessment , 2) current status of ecosystem indicators, and 3) ecosystem-based management indicators. The objectives of this chapter are to assess the BSAI ecosystem trends, identify and provide annual updates of ecosystem status indicators and research priorities for BSAI crab stocks, and to update management status indicators.

A summary of the most recent ecosystem trends affecting BSAI crab is summarized below with additional information detailed in the ecosystem consideration indicators chapter.
*Recent trends in the 2010 ecosystem indicators (physical & biological trends)*

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

# Stock Status Summaries

## 1. Eastern Bering Sea Snow Crab

*Fishery information relative to OFL setting.*

The snow crab fishery has been opened, and harvest reported, every year since the 1960s. Prior to 2000, the GHL was 58% of abundance of male crab over 101 mm CW, estimated from the survey. The target harvest rate was reduced to 20% following the declaration of the stock as overfished in 1999, and the GHL/TAC since 2000 has been based on a harvest strategy that aims to allow recovery to the proxy for $B_{MSY}$. The stock remained below the proxy for $B_{MSY}$ ($B_{35\%}$) during the 2008/09 fishing year. Consequently, the current rebuilding plan failed to recover the snow crab stock within the required 10-year time period. A new rebuilding plan for EBS snow crab is currently under development.

*Data and assessment methodology*

The assessment is based on a size-structured population dynamics model in which crabs are categorized into mature, immature, new shell and old shell crabs by sex. The model is fitted to data on historical catches (landed and discard), survey estimates of biomass, and fishery, discard and survey size-composition data. It covers the 1978-2010 seasons and estimates abundance from 25-29mm to 130-135mm using 5mm size bins. The results of the annual NMFS Bering Sea bottom trawl survey are analyzed in three periods: before 1982, 1982-88, and 1989 onwards, with different selectivity and catchability parameters for each period. The model is based on the assumption of a terminal molt at maturity. The 2010 assessment is based on the same model and estimation framework as the 2009 assessment except that natural mortality and growth are estimated within the model, maturity is a smooth function of size, selectivity and catchability are estimated separately for males and females, the over-weighting of the NMFS survey data has been eliminated, and the "new" survey estimates as well as the BSFRF data in "the study area" for animals of 40mm and larger are used when fitting the model.

Compared with the assessment presented to the CPT in May 2010, the final assessment uses catch and fishery length-frequency data for the 2009/10 season as well as survey abundance and length-frequency data for 2010.

*Stock biomass and recruitment trends*

Mature male biomass (at the time of mating) peaked between the late-1980s and mid-1990s, declined to a minimum in 2002 and has increased thereafter. The estimates of female mature biomass are higher than during the 2009 assessment, due primarily to the lower estimate of female survey catchability. Recruitment has varied considerably over the period 1979-2010, with the recruitment (at 25mm) in 1986 the highest on record. The recruitment estimates for 2009 and 2010 are the highest since 1992. However, these estimates remain very imprecise.

*Tier determination/Plan Team discussion and resulting OFL determination*

The CPT recommends that snow crab be in Tier 3 (stock status b), so the OFL is based on the $F_{35\%}$ control rule. The team recommends that the proxy for $B_{MSY}$ ($B_{35\%}$) be the mature male biomass at mating, computed as the average recruitment from 1979 to the last year of the assessment multiplied by the mature male biomass-per-recruit corresponding to $F_{35\%}$ less the mature male catch under an $F_{35\%}$ harvest strategy. The estimate of $B_{MSY}$ from the 2010 assessment is 293.7 million lbs (133.2 thousand t). The MSST is defined as half of the proxy for $B_{MSY}$ (146.8 million lbs/ 66.6 thousand t).

*Status and catch specifications (millions lbs.) of snow crab*

| Year | MSST | Biomass (MMB) | TAC | Retained Catch | Total Catch | OFL |
|---|---|---|---|---|---|---|
| 2006/07 | | N/A | 36.2 | 36.4 | 44.9 | |
| 2007/08 | 158.9 | 218 | 63.0 | 63.0 | 77.1 | |
| 2008/09 | 163.4 | 241 | 58.6 | 58.5 | 69.5 | 77.3 |
| 2009/10 | 146.8 | 282 | 48.1 | 48.1 | 52.7 | 73.0 |
| 2010/11 | | 225* | | | | 97.9 |

*Status and catch specifications (kt) of snow crab*

| Year | MSST | Biomass (MMB) | TAC | Retained Catch | Total Catch | OFL |
|---|---|---|---|---|---|---|
| 2006/07 | | | 16.4 | 16.5 | 20.4 | |
| 2007/08 | 72.1 | 98.9 | 28.6 | 28.6 | 35.0 | |
| 2008/09 | 74.1 | 109.3 | 26.6 | 26.5 | 31.5 | 35.1 |
| 2009/10 | 66.6 | 127.7 | 21.8 | 21.8 | 23.9 | 33.1 |
| 2010/11 | | 101.9* | | | | 44.4 |

* Model forecast based on the 2010 assessment under the assumption that the 2010/11 catch equals to the OFL. This value will be updated during the September 2011 assessment when the 2011 survey data and the 2010/11 catch data become available.

The 2009/10 MMB (282 million lbs) exceeds the proxy for MSST (146.8 million lbs) so the stock is not currently overfished. The total catch for 2009/10 (52.7 million lbs) was less than the 2009/10 OFL (73.0 million lbs) so overfishing did not occur during 2009/10. Unlike the 2009 assessment, the 2010 assessment indicates that the MMB did not drop below MSST anytime after 1980.

The CPT notes again that compared to the distribution from surveys, the catch is highly concentrated spatially. This could lead to exploitation rates in the south that exceed the desired rate. In principle, an OFL could be computed for the area in which the fishery operates, for example by applying OFL control rule to the estimated fraction of the population in that area. However, it is not clear how concentrated the stock is at the time of the fishery compared to when the survey takes place.

*Rebuilding analysis*

Under the current rebuilding plan, this stock had to recover to the $B_{MSY}$ proxy in 2008/09 and 2009/10 to be defined as rebuilt. As the 2008/09 mature male biomass was smaller than $B_{MSY}$, the stock failed to recover as planned. The estimate of MMB at mating in 2010 was 95.8% of $B_{MSY}$. The assessment reports the results of projections of MMB relative to the proxy for $B_{MSY}$ for a range of values for the fishing mortality in the directed fishery based on the same methodology that was used in the ACL EA.

*Additional Plan Team recommendations*

The next assessment should: (a) incorporate the 2010 BSFRF survey data, (b) further justify the values chosen for the weighting factors (the lambdas) and explore sensitivity to alternative weights, as outlined in the report of the 13-14 May 2009 stock assessment workshop, (c) include the predictions from the May version of the model in the September assessment to evaluate how well the model forecasts biomass, (d) reduce the number of size classes for females, and (e) fit to the discard length-frequency data for males rather than to the total length-frequency data for males (to avoid fitting to the retained length-frequency data twice), and (e) identify what changes need to be made to the model so that it is able to fit all of the data adequately if survey selectivity is set to the "Somerton selectivity curve".

The CPT continues to support development of a spatially-structured stock assessment model so that the implications of differences in where the catch is taken and where the survey finds snow crab can be evaluated.

# 2 Bristol Bay red king crab

*Fishery information relative to OFL setting.*

The commercial harvest of Bristol Bay red king crab (BBRKC) dates to the 1930s, initially prosecuted mostly by foreign fleets but shifting to a largely domestic fishery in the early 1970s. Retained catch peaked in 1980 at 129.9 million lbs, but harvests dropped sharply in the early 1980s, and population abundance has remained at relatively low levels over the last two decades compared to those seen in the 1970s. The fishery is managed for a total allowable catch (TAC) coupled with restrictions for size (≥ 165.1mm (6.5-in) carapace width), sex (male only), and season (no fishing during mating/molting periods). Prior to 1990, the harvest rate was based on estimated population size and prerecruit and postrecruit abundances, and varied from 20% to 60% of legal males. In 1990, the harvest strategy became 20% of the mature male (≥120-mm CL) abundance, with a maximum of 60% on legal males, and a threshold abundance of 8.4 million mature females. The current stepped harvest strategy allows a maximum harvest rate of 15% of mature males, but also incorporates a maximum harvest rate of 50% of legal males, a threshold of 14.5 million lbs of effective spawning biomass (ESB), and a minimum GHL of 4.0 million lbs to prosecute a fishery. The TAC increased from 15.5 million lbs for the 2006/07 season to 20.4 million lbs for the 2007/08 and 2008/09 seasons, then declined to 16.0 million lbs for 2009/2010. Catch of legal males per pot lift was relatively high in the 1970s, low in the 1980s to mid-1990s. Following implementation of the crab rationalization program in 2005, CPUE increased to 31.0 crab/pot in 2006, but fell to 21.0 crab/pot in 2009. Annual non-retained catch of female and sublegal male RKC during the fishery averaged less than 3.9 million lbs since data collection began in 1990. Estimated fishing mortality ranged from 0.28 to 0.38$yr^{-1}$ following implementation of crab rationalization. Total catch (retained and bycatch mortality) increased from 17.2 million lbs in 2006/07 to 23.2 million lbs in 2007/08 and 23.1 million lbs in 2008/09.

*Data and assessment methodology*

The stock assessment model is based on a length-structured population dynamics model incorporating data from the NMFS eastern Bering Sea trawl survey, commercial catch, and at-sea observer data program. Stock abundance is estimated for male and female crabs ≥ 65-mm carapace length during 1968-2009, an extension from the previous assessment that considered the years 1985-2008. Catch data (retained catch numbers, retained catch weight, and pot lifts by statistical area and landing date from the fishery which targets males ≥ 165.1mm (6.5 in. carapace width) were obtained from ADF&G fish tickets and reports, red king crab and Tanner crab fisheries bycatch data from the ADF&G observer database, and groundfish trawl bycatch data from the NMFS trawl observer database. Catch and bycatch data were updated to September 2010. Several other changes to the assessment included re-analysis of the trawl survey data based on revised estimates of the area-swept from 1975 to 2009, and allowances for changes over time in the size at maturity for females, and mortality. In May 2010, multiple model scenarios were evaluated, including (1) additional mortality for males and females in either 1980-84, 1976-79 and 1985-93, or additional bycatch mortality in 1980-84; (2) inclusion of the Bering Sea Fisheries Research Foundation (BSFRF) survey data for 2007 and 2008; and (3) estimation of male molting probabilities. One of these scenarios was selected as the base model for this SAFE, which included constant natural mortality (0.18), estimation of additional mortality for males during 1980-1984 and for females during 1976-1993, and included the BSFRF survey data from 2007 and 2008. A variant of this base model was evaluated, which included the CV for the BSFRF data.

*Stock biomass and recruitment trends*

Model estimates of total survey biomass increased from 176.4 million lbs in 1968 to 720.6 million lbs in 1978, fell to 69.8 million lbs in 1985, generally increased to 198.0 million lbs in 2008, and declined to 180.2 million lbs in 2010. Mature male biomass at mating increased from 61.6 million lbs in 2004 to 89.0 million lbs in 2009 and was 83.1 million lbs in 2010. Estimated recruitment was high during the 1970s and early 1980s and has been generally low since 1985. During 1985-2009, estimated recruitment was higher than the historical average in 1995, 2002, and 2005. Estimated recruitment was extremely low during the last 3 years.

*Tier determination/Plan Team discussion and resulting OFL determination*

This assessment showed improvement in exploring the use of the data that are available, and model sensitivity to inclusion of various data. In the absence of additional diagnostics, the CPT supports the use of scenario 3a [constant natural mortality ($0.18yr^{-1}$), estimation of additional natural mortality for males during 1980-1984 for females during 1976-1993, BSFRF data].

The Plan Team recommends Bristol Bay red king crab as a Tier 3 stock. The team recommends that the proxy for $B_{MSY}$ ($B_{35\%}$) be the mature male biomass at mating, computed as the average recruitment from 1995 to the last year of the assessment multiplied by the mature male biomass-per-recruit corresponding to $F_{35\%}$ less the mature male catch under an $F_{35\%}$ harvest strategy. Estimated $B_{35\%}$ is 62.7 million lbs. Total catch includes retained male catch and all other bycatch sources.

*Status and catch specifications (million lbs.) of Bristol Bay red king crab*

| Year | MSST | Biomass (MMB) | TAC | Retained Catch | Total Catch | OFL |
|---|---|---|---|---|---|---|
| 2006/07 | | NA | 15.53 | 15.75 | 17.22 | |
| 2007/08 | 44.8 | 85.9 | 20.38 | 20.51 | 23.23 | |
| 2008/09 | 37.6 | 87.8 | 20.37 | 20.32 | 23.10 | 24.20 |
| 2009/10 | 34.3 | 89.0 | 16.0 | 16.0 | 18.31 | 22.56 |
| 2010/11 | | 83.1* | | | | 23.5 |

*Status and catch specifications (kt) of Bristol Bay red king crab*

| Year | MSST | Biomass (MMB) | TAC | Retained Catch | Total Catch | OFL |
|---|---|---|---|---|---|---|
| 2006/07 | | NA | 7.04 | 7.14 | 7.81 | |
| 2007/08 | 20.32 | 38.96 | 9.24 | 9.30 | 10.54 | |
| 2008/09 | 17.06 | 39.83 | 9.24 | 9.22 | 10.48 | 10.98 |
| 2009/10 | 15.56 | 40.37 | 7.26 | 7.26 | 8.31 | 10.23 |
| 2010/11 | | 37.69* | | | | 10.66 |

*Model forecast based on the 2010 assessment under the assumption that the 2010/11 catch equals to the OFL. This value will be updated during the September 2011 assessment when the 2011 survey data and the 2010/11 catch data become available.

The 2009/2010 MMB exceeds the $B_{MSY}$ proxy of $B_{35\%}$ so the stock is not currently overfished. The total catch for 2009/10 (18.31 million lbs) was less than the 2009/10 OFL (22.56 million lbs) so overfishing did not occur during 2009/10.

*Additional Plan Team recommendations*

The assessment author noted that most of the recent CPT and SSC recommendations will be addressed for the May 2011 CPT meeting. A response to the CIE review will be prepared and submitted to the CPT for the May 2011 meeting. In the fishing mortality/MMB figure, the most recent year should be highlighted. The CPT noted that in the model, the retow and standard survey biomass data were averaged for males and only the retow data were used for female biomass in the model. In May 2011, only the standard survey should be used for males and the retow survey data for females to be consistent with the intent of the retow survey.

# 3 Eastern Bering Sea Tanner crab

*Fishery information relative to OFL setting.*

Two fisheries, one east and one west of 166° W. longitude, harvest eastern Bering Sea (EBS) Tanner crab. Under the Crab Rationalization Program, ADF&G sets separate TACs and NMFS issues separate individual fishing quota (IFQ) for these two fisheries. However, one OFL is set for the EBS Tanner crab because there is no evidence that the EBS Tanner crab is not one stock. Both fisheries were closed from 1997 to 2005 due to low abundance. NMFS declared this stock overfished in 1999 and the Council developed a rebuilding plan. In 2005, abundance increased to a level to support a fishery in the area west of $166^0$ W. ADF&G opened both fisheries for the 2006/07 to 2008/09 crab fishing years and to the area east of 166° W. longitude only in 2009/10. In 2007, NMFS determined the stock was rebuilt because spawning biomass was above $B_{MSY}$ for two consecutive years.

Tanner crabs are caught as bycatch in the groundfish fisheries, scallop fisheries, in the directed Tanner crab fishery (principally as non-retained females and sublegal males), and in other crab fisheries (notably, eastern Bering Sea snow crab and to a lesser extent in the Bristol Bay red king crab).

*Data and assessment methodology*

This stock is surveyed annually by the NMFS EBS trawl survey. Although a stock assessment model has been developed for the eastern portion of the stock, this model is not employed to assess the stock because it does not cover the entire EBS. Area-swept estimates of biomass from the EBS trawl survey are used to estimate biomass of stock components: mature male biomass (MMB), legal male biomass (LMB), and females. The current assessment used NMFS trawl survey data using measured net width (as opposed to assumed fixed-width as in earlier assessments). Fish ticket data are used for computing retained catch and observer data from the crab, and groundfish fisheries are used to estimate the non-retained catch; assumed handling mortality rates for fishery components are used to estimate the discard mortality.

*Stock biomass and recruitment trends*

MMB and LMB showed peaks in the mid-1970s and early 1990s. MMB at the survey revealed an all-time high of 623.9 million pounds in 1975, and a second peak of 255.7 million pounds in 1991. From late-1990s through 2007, MMB has risen at a moderate rate from a low of 25.1 million pounds in 1997. Post-1997, MMB at the time of survey increased to 185.2 million pounds in 2007, but has subsequently declined. The survey data continue to show a general overall decline in stock abundance. The MMB projected for February 2011 (26.07 thousand t) is 8% less than MMB in February 2010 (28.44 thousand t). Some moderate sign of recruits in the male and female size frequency at about 25-35 mm CW were shown in the 2010 survey data, but a general decline in abundance of males > 70 mm CW in the 2010 survey raises concerns for near-term future reproductive potential of the stock.

*Tier determination/Plan Team discussion and resulting OFL determination*

The team recommends the OFL for this stock be based on the Tier 4 control rule because no stock assessment model has been developed for the entire EBS stock. Based on the estimated biomass, the stock is at stock status level b. The team recommends that $B_{MSY}$ be based on the average MMB for the years 1969-1980, discounted by fishery removals (retained and non-retained mortalities) and natural mortality between the time of survey and the time of mating. This time period is thought to represent the reproductive potential of the stock because it encompasses periods of both high and low stock status equivalently. This equates to a BREF of 83.8 thousand t MMB. The 2009/10 estimate of MMB is 28.44 or 34% of BREF. Hence the stock is estimated to have been in overfished condition. The team recommends that $\gamma$=1.0 and M = 0.23yr$^{-1}$. Under the OFL Control Rule, the 2010/11 FOFL=0.05, equating to a total male and female catch of 1.61 thousand t.

The projected 2010/11 estimate of MMB at the time of mating is 26.07 thousand t, or 31% of BREF.

*Historical status and catch specifications (millions lbs) for eastern Bering Sea Tanner crab*

| Year | MSST | Biomass (MMB) | TAC (east + west) | Retained Catch | Total Catch | OFL |
|---|---|---|---|---|---|---|
| 2006/07 [c] | | 130.47 | 2.98 | 2.12 | 6.94 | |
| 2007/08 [c] | | 151.59 | 5.62 | 2.12 | 8.00 | |
| 2008/09 [c] | 94.89 | 118.23 | 4.30 | 1.94 | 4.96 | 15.52 |
| 2009/10 | 92.37 | 62.70 | 1.34 [a/] | 1.32 | 3.73 | 5.00 |
| 2010/11 | | 57.47 [b/] | | | | 3.55 |

*Historical status and catch specifications (kt) for eastern Bering Sea Tanner crab*

| Year | MSST | Biomass (MMB) | TAC (east + west) | Retained Catch | Total Catch | OFL |
|---|---|---|---|---|---|---|
| 2006/07 [c] | | 59.18 | 1.35 | 0.96 | 3.15 | |
| 2007/08 [c] | | 68.76 | 2.55 | 0.96 | 3.63 | |
| 2008/09 [c] | 43.04 | 53.63 | 1.95 | 0.88 | 2.25 | 7.04 |
| 2009/10 | 41.90 | 28.44 | 0.61 [a/] | 0.60 | 1.69 | 2.27 |
| 2010/11 | | 26.07 [b/] | | | | 1.61 |

a/ Only the area east of 166 deg. W opened in 2009/10; TAC was 1.85 million lbs.
b/ Projected 2009/10 MMB at time of mating after extraction of the estimated total catch OFL.
c/ biomass and threshold values based on fixed net width

In 2009/10, Tanner crab MMB was below the MSST at the time of the 2009 survey, below MSST at the time of the 2009/10 fishery, and below MSST at the time of mating in mid-February 2010. Overfishing did not occur during the 2009/10 fishing year because total catch losses (1.69 thousand t) did not exceed the total catch OFL (2.27 thousand t). The 2009/10 MMB at the time of mating was 38% of BREF. The 2009/10 Tanner crab MMB was estimated to be below MSST. In 2010 at the time of the survey, Tanner crab MMB declined further relative to 2009 and once again was estimated to be below MSST. The stock is projected to remain below MSST in 2011, even if there is zero retained catch in 2010/11

*Additional Plan Team recommendations*

Alternatives for the time period for computing $B_{REF}$ should be discussed with rationale provided for each alternative period in the May 2011 assessment.

# 4 Pribilof Islands red king crab

*Fishery information relative to OFL setting*

ADF&G has not published harvest regulations for the Pribilof Islands red king crab fishery. The fishery began as bycatch in 1973 during the blue king crab fishery. A red king crab fishery opened with a specified GHL for the first time in September 1993. Beginning in 1995, combined red and blue king crab GHLs were established. Declines in red and blue king crab abundance from 1996 through1998 resulted in poor fishery performance during those seasons with annual harvests below the GHL. The Pribilof red king crab fishery was not open from 1999 to 2008/09 uncertainty with estimated red king crab survey abundance, and concerns for incidental catch and mortality of Pribilof blue king crab(an overfished and very depressed stock). Prior to the closure, the 1998/99 harvest was 0.544 million pounds. The non-retained catches (with application of bycatch mortality rates) from pot and groundfish bycatch estimates of red king crab ranged from 0.009 to 0.424 million pounds during 1991/92 – 2009/10.

*Data and assessment methodology*

Although a catch survey analysis has been used for assessing the stock in the past, which incorporated data from the eastern Bering Sea trawl survey, commercial catch, pot survey, and at-sea observer data; this year's assessment is again based on trends in MMB at mating time inferred from NMFS annual trawl survey for 1980-2010 and commercial catch and observer data. The revised time-series of historical NMFS trawl survey abundance estimates were used in this assessment. The 2009/2010 assessments of non-retained catch from all groundfish fisheries were included in this SAFE report. Groundfish catches of crab are reported for all crab combined by federal reporting areas. Catches from observed fisheries were applied to non-observed fisheries to estimate a total catch. An $F_{OFL}$ for 2009/10 was determined using a mean mature male biomass (MMB) at the time of mating (projected to mating time), the default $\gamma$ value of 1, and an $M$ value of $0.18yr^{-1}$. As suggested by CPT and SSC, the stock assessment considered the period 1991/92-2009/10 for estimating mean MMB as a proxy $B_{MSY}$. This $F_{OFL}$ was applied to the projected legal male biomass at the time of the fishery to determine the total (male) catch OFL. Total crab removal (retained, and directed and non-directed bycatch losses) with legal male biomass and MMB were used to estimate the exploitation rates on legal male and mature male biomasses, respectively, at the time of the fishery.

*Stock biomass and recruitment trends*

The stock exhibited widely varying mature male and female abundances during 1980-2010. The estimate of MMB from the 2010 survey was 5.44 million pounds. Recruitment is not well understood for Pribilof red king crab. Pre-recruitment indices have remained relatively consistent in the past 10 years, although pre-recruits may not be well assessed with the survey. The point estimates of stock biomass from the survey in recent years has decreased since the 2007 survey with a substantial decrease in all size classes in 2009, but the stock increased in 2010 relative to 2009. The 2010 size frequency for males shows a decrease in the number of old shell and very old shell legal sized males in comparison to 2008 shell conditions, but an increase when compared to 2009. Red king crabs have been historically harvested with blue king crabs and are currently the dominant of the two species in this area.

*Tier determination/Plan Team discussion and resulting OFL determination*
This stock is in Tier 4 and $\gamma$ be set to 1.0.

*Historical status and catch specifications (million lbs) of Pribilof Islands red king crab*

| Year | MSST | Biomass (MMB) | TAC | Retained Catch | Total Catch | OFL |
|---|---|---|---|---|---|---|
| 2006/07 | | 13.87 | Closed | 0 | 0.024 | |
| 2007/08 | 4.33 | 14.69[A] | Closed | 0 | 0.015 | |
| 2008/09 | 4.39 | 11.06[B] | Closed | 0 | 0.021 | 3.32 |
| 2009/10 | 4.22 | 4.46[C] | Closed | 0 | 0.006 | 0.50 |
| 2010/11 | | 5.44[D] | | | | 0.77 |

*Historical status and catch specifications (kt) of Pribilof Islands red king crab*

| Year | MSST | Biomass (MMB) | TAC | Retained Catch | Total Catch | OFL |
|---|---|---|---|---|---|---|
| 2006/07 | | 6.29 | Closed | 0 | 0.01 | |
| 2007/08 | 1.96 | 6.66[A] | Closed | 0 | 0.007 | |
| 2008/09 | 1.99 | 5.02[B] | Closed | 0 | 0.01 | 1.51 |
| 2009/10 | 1.91 | 2.02[C] | Closed | 0 | 0.003 | 0.23 |
| 2010/11 | | 2.47[D] | | | | 0.35 |

A – Based on survey data available to the Crab Plan Team in September 2007 and updated with 2007/2008 catches
B – Based on survey data available to the Crab Plan Team in September 2008 and updated with 2008/2009 catches
C – Based on survey data available to the Crab Plan Team in September 2009 and updated with 2009/2010 catches
D – Based on survey data available to the Crab Plan Team in September 2010

Overfishing did not occur during 2009/10. The 2010/11 MMB was 5.44, which was above 2009/10 MSST, but below $MMB_{MSY}$. Therefore, the stock was assigned to Tier 4b for OFL calculation.

*Additional plan team recommendations*

1. Because of high variability in abundance, CPT recommended that consideration be given to basing estimates of MMB on moving averages of survey biomass when computing OFLs.
2. The CPT is looking forward to reviewing the new CSA model in 2011 .

# 5 Pribilof Islands blue king crab

*Fishery information relative to OFL setting.*

The Pribilof blue king crab fishery began in 1973, with peak landings of 11.0 million lbs during the 1980/81 season. A steep decline in landings occurred after the 1980/81 season. Directed fishery harvest from 1983 until 1987 was annually less than 1.0 million lbs with low CPUE. The fishery was closed from 1988 until 1995. The fishery reopened from 1995 to 1998. Fishery harvests during this period ranged from 1.3 to 0.5 million lbs. The fishery closed again in 1999 due to declining stock abundance and has remained closed through the 2009/10 season. The stock was declared overfished in 2002.

*Data and assessment methodology*

The NMFS conducts an annual trawl survey that is used to produce area-swept abundance estimates. The CPT discussed the history of the fishery and the rapid decline in landings. It is clear that the stock has collapsed, although the annual area-swept abundance estimates are imprecise.

*Stock biomass and recruitment trends*

Based on 2010 NMFS bottom-trawl survey, the estimated total mature-male biomass decreased to 0.71 million lbs from 1.28 million lbs in 2009. The 2010/11 MMB at mating is projected to be 0.63 million lbs which is about 7% of $B_{MSY}$. The Pribilof blue king crab stock biomass continues to be low. From recent surveys there is no indication of recruitment.

*Tier determination/Plan Team discussion and resulting OFL determination*

This stock is recommended for placement into Tier 4. The time period for $B_{MSY}$ is 1980/81-1984/85 plus 1990/1991-1997/1998, i.e. excluding the period 1985/1986-1989/1990. This range was chosen because it eliminates periods of extremely low abundance that may not be representative of the production potential of the stock. $B_{MSY}$ is estimated as 9.28 million pounds.

The retained catch OFL is 0 because the 2010/11 estimate of MMB is less than 25% $B_{MSY}$. Due to the Tier level and stock status an $F_{OFL}$ must be determined for the non-directed catch. Ideally this should be based on the rebuilding strategy. However the current rebuilding plan needs to be revised due to inadequate progress towards rebuilding.

The OFL for 2010/11 was set at 0.004 million lbs, the average catch between 1999/00 and 2005/06. The CPT recommended $\gamma = 1$, given the absence of information presented to establish an alternate value at this time. Natural mortality was $M=0.18yr^{-1}$.

*Historical status and catch specifications (million lbs.) of Pribilof blue king crab in recent years.*

| Year | MSST | Biomass (MMB) | TAC | Retained Catch | Total Catch | OFL |
|---|---|---|---|---|---|---|
| 2006/07 | | 0.33 | closed | 0 | 0.0004 | |
| 2007/08 | | 0.66 | closed | 0 | 0.005 | |
| 2008/09 | 4.64 | 0.25 | closed | 0 | 0.001 | 0.004 |
| 2009/10 | 4.64 | 1.13 | closed | 0 | 0.001 | 0.004 |
| 2010/11 | | 0.63* | | | | 0.004 |

*Historical status and catch specifications (kt) of Pribilof blue king crab in recent years.*

| Year | MSST | Biomass (MMB) | TAC | Retained Catch | Total Catch | OFL |
|---|---|---|---|---|---|---|
| 2006/07 | | 0.15 | closed | 0 | 0.0002 | |
| 2007/08 | | 0.30 | closed | 0 | 0.0023 | |
| 2008/09 | 2.10 | 0.11 | closed | 0 | 0.0005 | 0.0018 |
| 2009/10 | 2.10 | 0.51 | closed | 0 | 0.0005 | 0.0018 |
| 2010/11 | | 0.29* | | | | 0.0018 |

* Forecast based on survey data available in the 2010 assessment under the assumption that the 2010/11 catch is equal to the OFL. This value will be updated during the September 2011 assessment when the 2011 survey data and the 2010/11 catch data become available.

The total catch for 2009/10 (0.0013 million lbs) was less than the 2009/10 OFL (0.004 million lbs) so overfishing did not occur during 2009/10. The 2010/11 projected MMB estimate of 0.63 million lbs is below the proxy for MSST so the stock continues to be in an overfished condition.

*Additional Plan Team recommendations*

A revised rebuilding plan is under development. Initial review of this analysis will occur at the October 2010 Council meeting. .

1. Because of high variability in abundance, CPT recommended that consideration be given to basing estimates of MMB on moving averages of survey biomass when computing OFLs.
2. The CPT is looking forward to reviewing the new CSA model in 2011.

# 6 St. Matthew blue king crab

*Fishery information relative to OFL setting*

The fishery was prosecuted as a directed fishery from 1977 to 1998. The fishery developed when 10 U.S. vessels harvested 1.202 million pounds during 1977/78. Harvests peaked in 1983/84 when 9.454-million pounds were landed. The fishery was fairly stable from 1986/87 to 1990/91, with a mean annual harvest of 1.252-million pounds. The mean catch increased to 3.297-million pounds during the period from 1991 to 1998.

This fishery was declared overfished and closed in 1999 when the stock size estimate was below the MSST. In November of 2000, Amendment 15 to the FMP was approved to implement a rebuilding plan for the St. Matthew Island blue king crab stock. The rebuilding plan included a harvest strategy established in regulation by the Alaska Board of Fisheries and an area closure to control bycatch as well as gear modifications. In 2008 and 2009, the MMB was above $B_{MSY}$ for two years and was declared rebuilt in 2009.

The fishery re-opened in 2009/10 with a TAC of 1.167-million pounds and 0.461-million pounds of retained catch were harvested. Commercial crab fisheries near St. Matthew Island were scheduled in the fall and early winter to reduce the potential for bycatch from handling mortalities due to molting and mating crabs. Some bycatch has been observed of non-retained St. Matthew blue king crab in the St. Matthew blue king crab fishery, the eastern Bering Sea snow crab fishery, and groundfish fisheries. Based on limited observer data, bycatch of sublegal male and female crabs from the directed blue king crab fishery off St. Matthew Island was relatively high when the fishery was prosecuted in the 1990s, and total bycatch (in terms of number of crabs captured) was often twice as high or higher than total catch of legal crabs. The recent 2009/10 fishery had lower observed bycatch in the directed fishery than historical estimates.

*Data and assessment methodology*

A four-stage catch-survey analysis (CSA) is used to assess the male component of the stock. The CSA incorporates the following data: (1) commercial catch data from 1978 to 2009/2010; (2) annual trawl survey data from 1978 to 2010; (3) triennial pot survey data from 1995 to 2007; and (4) bycatch data in the groundfish trawl fishery from 1989 to 2006 and in the groundfish fixed-gear fishery from 1996 to 2008. Fishery effort and catch data are the vessel numbers, potlifts, catch number and weight, and CPUE for the directed pot fishery; total annual retained catches (including deadloss) were used in the catch-survey analysis. Trawl survey data are from the 1978–2010 NMFS annual summer trawl survey for stations within the St. Matthew Section. Trawl survey data provided estimates of density (number/nm$^2$) at each station for males in four size and shell-condition categories that were used in the assessment: 105–119 mm carapace length (CL); 90–104 mm CL; new-shell 120–133 mm CL; and old-shell ≥120 mm CL and new-shell ≥134 mm CL) males.

Pot survey data are from the July–August 1995, 1998, 2001, 2004 and 2007 ADF&G triennial pot surveys

for Saint Matthew Island blue king crab. The pot survey samples areas of important habitat for blue king crab, particularly females, that the NMFS trawl survey cannot sample. Data used are from only the 96 stations fished in common during each of the five surveys. The CPUE (catch per pot lift) indices from those 96 stations for the male sex and shell-condition categories listed above were used in the assessment. ADF&G conducted a pot survey in 2010. However, data from that survey were not available for use when fitting the model.

NMFS observer data was used to estimate groundfish trawl and fixed-gear bycatch. Bycatch composition data were not available so total biomass caught as bycatch was estimated by summing blue king crab biomass from federal reporting areas 524 and 521 according to gear type.

The CSA uses a maximum likelihood approach to estimate male crab biomass and abundance. The model links crab abundance in four crab stages based on a growth matrix, estimated mortalities, and molting probabilities. The four stages are prerecruit-2s (90-104 mm CL), prerecruit-1s (105-119 mm CL), recruits (newshell 120-133 mm CL), and postrecruits (oldshell ≥ 120 mm CL and newshell ≥ 134 mm CL).

*Stock biomass and recruitment trends*

MMB has fluctuated substantially over three periods. MMB increased during the first period (1978 to 1981) from 7.6 to over 17.6 million lbs, followed by a steady decrease to 2.9 million lbs. in 1985. The second period had a steady increase from the low in 1985 to 13.3 million lbs. in 1997 followed by a rapid decrease to 2.8 million lbs. in 1999. The third period had a steady increase in all size classes from the low in 1999 to the present high of over 12.76 million lbs. in 2009/2010. For 2010/11, the biomass has increased dramatically.

Based on data through 2009/10 and modeled according to the "Scenario 1" assessment model, the stock is estimated to have been above $B_{MSY}$ during 2008/09 and 2009/10 and is projected to be above $B_{MSY}$ in 2010/11. Numbers of legal males, post-recruit-sized legal males, and mature male biomass and abundance (numbers of crabs) are estimated to have increased since 1999/00 and, especially, since 2005/06 through 2009/10. Numbers of recruit-sized legal males and pre-recruit-1-sized sublegal males are estimated to have increased during 2005/06–2009/10. Numbers of pre-recruit-2-sized sublegal males and recruits to the modeled male size class are estimated to have increased during 2004/05–2008/09, but their numbers, especially those of the recruits to the modeled male size class, are estimated to have decreased in slightly 2009/10 and increased dramatically in 2011/2012.

Like stock biomass, estimated recruitment is generally strong in recent years, with estimated 2010 recruitment to the model markedly higher than that for any other year.

*Tier determination/Plan Team discussion and resulting OFL determination*

The CPT and SSC recommends that the stock be in Tier 4, with gamma ($\gamma$)=1 used for calculating $F_{OFL}$, and stock status level a. The CPT and SSC concur with the author recommended Scenario 1 model (i.e., same as used for 2009/10, with M fixed at $0.18yr^{-1}$ for 1978–1998, 2000–2009 and estimated for 1999 and Q fixed at 1.0). The $B_{MSYproxy}$ varies as a function of years used to calculate average MMB. The time period for estimating $B_{MSYproxy}$ is 1989/90 to 2009/10 because the stock was harvested at extremely high rates before 1986 and this time period incorporates stock abundance during rebuilding. The $B_{MSYproxy}$ during this time period is 6.861 million lbs.

*Historical status and catch specifications (millions lbs.) of St. Matthew blue king crab*

| Year | MSST | Biomass (MMB) | TAC | Retained Catch | Total Catch | OFL |
|---|---|---|---|---|---|---|
| 2006/07 | | 7.1 | closed | closed | 0.67 | |
| 2007/08 | | 9.7 | closed | closed | 0.35 | |
| 2008/09 | 4.0 | 10.74 | closed | closed | 0.20 | 1.63 [retained] |
| 2009/10 | 3.4 | 12.76 | 1.17 | 0.46 | 0.53 | 1.72 [total male catch] |
| 2010/2011 | | 15.29* | | | | 2.29 [total male catch] |

*Historical status and catch specifications (kt) of St. Matthew blue king crab*

| Year | MSST | Biomass (MMB) | TAC | Retained Catch | Total Catch | OFL |
|---|---|---|---|---|---|---|
| 2006/07 | | 3.22 | closed | closed | 0.3 | |
| 2007/08 | | 4.39 | closed | closed | 0.16 | |
| 2008/09 | 1.81 | 4.87 | closed | 0.09 | 0.09 | 0.74 [retained] |
| 2009/10 | 1.52 | 5.79 | 0.53 | 0.20 | 0.25 | 0.78 [total male catch] |
| 2010/2011 | | 6.94 | | | | 1.04 [total male catch] |

* Forecast based on survey data available in the 2010 assessment under the assumption that the 2010/11 catch is equal to the OFL. This value will be updated during the September 2011 assessment when the 2011 survey data and the 2010/11 catch data become available.

The total catch for 2009/10 (0.55 million lbs) was less than the 2009/10 OFL (1.72 million lbs) so overfishing did not occur during 2009/10. Likewise, the 2009/2010 MMB (12.76 million pounds) is above the MSST (3.4 million lbs.) so the stock is not overfished.

*Additional Plan Team recommendations*

For the May 2011 assessment the Team recommends that the authors:

- Analyze why some parameters in Table 11 appear not to change from initial values. This is necessary because there is considerable unexpected variation in the time-trajectories of MMB as the end-point of the assessment is changed (see figure 12).
- Calculate $F_{35\%}$ and B35% as proxies for FMSY and BMSY perhaps using the methodology employed in the ACL EA for the May model.
- Add a more detailed description of model changes as an appendix to the May 2011 model.
- Incorporate the 2010 ADF&G pot survey data.

# 7 Norton Sound Red King Crab

*Fishery information relative to OFL setting*

This stock supports three main fisheries: summer commercial, winter commercial, and winter subsistence fisheries. The summer commercial fishery, which accounts for the majority of the catch, reached a peak in the late 1970s at a little over 2.9 million pounds retained catch. Retained catches since 1982 have been below 0.5 million pounds, averaging 275,000 pounds, including several low years in the 1990s. Retained catches in the past two years have been about 400,000 pounds.

*Data and assessment methodology*

Four types of surveys have been conducted periodically during the last three decades: summer trawl, summer pot, winter pot, and preseason summer pot, but none of these surveys were conducted every year. To improve abundance estimates, Zheng et al. (1998) developed a length-based stock synthesis model of male crab abundance that combines multiple sources of survey, catch, and mark-recovery data from 1976 to 1996. A maximum likelihood approach was used to estimate abundance, recruitment, and catchabilities of the commercial pot gear. We updated the model with data from 1976 to 2010 and estimated population

abundance in 2010. Estimated abundance and biomass in 2010 are dependent on the choice of natural mortality (*M*).

*Stock biomass and recruitment trends*

Mature male biomass is estimated to be on an upward trend following a recent low in 1997 and an historic low in 1982 following a crash from the peak in 1977. Estimated recruitment was weak during the late 1970s and high during the early 1980s with a slight downward trend from 1983 to 1993. Estimated recruitment has been highly variable but on an increasing trend in recent years. Uncertainty in biomass is driven in part by infrequent trawl surveys (every 3 to 5 years).

*Tier determination/Plan Team discussion and resulting OFL determination*

The team recommended Tier 4 stock status for Norton Sound red king crab. The team reviewed 7 different models. The Team recommended model 6 for OFL determination in 2010. This model included an estimation of bycatch mortality in the directed fishery, changed the weight on the fishing effort data, increased M to 0.288 for the largest length bin, and assumed flat selectivity for the summer fishery. The estimated abundance and biomass in 2010 are:
Legal males: 1.6940 million crabs with a standard deviation of 0.1892 million crabs.
Mature male biomass: 5.4410 million lbs with a standard deviation of 0.6284 million lbs.
Average of mature male biomasses during 1983-2010 was used as the $B_{MSY}$ proxy and the CPT chose gamma =1.0 to derive the $F_{MSY}$ proxy.
Estimated $B_{MSY}$ proxy, $F_{MSY}$ proxy and retained catch limit in 2010 are:
$B_{MSY}$ proxy = 3.1173 million lbs,
$F_{MSY}$ proxy = 0.18,
Retained catch limit: 0.2791 million crabs or 0.7335 million lbs.

*Status and catch specifications (millions lbs.)*

| Year | MSST | Biomass (MMB) | GHL | Retained Catch | Total Catch | OFL |
|---|---|---|---|---|---|---|
| 2006 | | 3.62 | 0.45 | 0.45 | 0.48 | |
| 2007 | | 4.40 | 0.32 | 0.31 | | |
| 2008 | 1.78 | 5.24[A] | 0.41 | 0.39 | | 0.68[A] |
| 2009 | 1.54 | 5.83[B] | 0.37 | 0.40 | 0.43 | 0.71[B] |
| 2010 | 1.56 | 5.44[C] | 0.40 | 0.42 | | 0.73[C] |

*Status and catch specifications (kt)*

| Year | MSST | Biomass (MMB) | GHL | Retained Catch | Total Catch | OFL |
|---|---|---|---|---|---|---|
| 2006 | | 1.64 | 0.20 | 0.20 | 0.22 | |
| 2007 | | 2.00 | 0.15 | 0.14 | | |
| 2008 | 0.81 | 2.38[A] | 0.19 | 0.18 | | 0.31[A] |
| 2009 | 0.70 | 2.64[B] | 0.17 | 0.18 | | 0.32[B] |
| 2010 | 0.71 | 2.47[C] | | | | 0.33[C] |

A – Calculated from the assessment reviewed by the Crab Plan Team in May 2008
B – Calculated from the assessment reviewed by the Crab Plan Team in May 2009
C – Calculated from the assessment reviewed by the Crab Plan Team in May 2010

Total catch in 2009 was less than the OFL thus overfishing did not occur. Stock biomass is above MSST thus the stock is not overfished.

*Additional Plan Team recommendations*

While the CPT recommended Model 6 (given that no operational differences between Model 2/Model 6),

in future iterations, the team recommends improved rationale for model specifications. Other requested changes and modification for the next assessment include:
Figure 3: include CVs for final version, and noted that apparent CV is .16, which is better than for other stocks;
Figure 7: (Applies to all chapters) Use different symbols for last two years to make visible;
Figure 11: Recommend showing CPUE trend and add XY plot of observed and predicted CPUE.
Figure 5, (residuals of length compositions in the winter pot survey and summer fishery): authors should consider time-varying selectivity and investigate reasons for break points in time series.
The authors should also provide a clearer explanation for OFL result and apportionment of OFL between directed catch, bycatch, and discard, noting that although observer data in directed fishery not available, fixed gear bycatch data is available. It would be useful to plot time series trajectories from each model. Authors should explore higher weight on fit to fishery effort and perform and present sensitivity analysis of alternative weighting of survey sources

# 8 Aleutian Islands golden king crab

*Fishery information relative to OFL setting*

The directed fishery has been prosecuted annually since the 1981/82 season. Retained catch peaked during the 1985/86–1989/90 seasons (average catch of 11.9 million lbs), but average harvests dropped sharply from the 1989/90 to 1990/91 season to an average harvest of 6.9 million lbs. for the period 1990/91–1995/96. Management based on a formally established GHL began with the 1996/97 season. The 5.9 million lb GHL, based on the previous five-year average catch, was subsequently reduced to 5.7-million lbs beginning with the 1998/99 season. The GHL (or TAC, since the 2005/06 season) remained at 5.7 million lbs through the 2007/08 season. In March 2008 the Alaska Board of Fisheries set the TAC for this stock in regulation at 5.985 million pounds. Average retained catch for the period 1996/97–2008/09 was 5.6 million lbs, including 5.68 million lbs in the 2008/09 season. This fishery is rationalized under the Crab Rationalization Program.

*Data and assessment methodology*

An assessment model is currently being developed for this stock. Available data are from ADF&G fish tickets (retained catch numbers, retained catch weight, and pot lifts by ADF&G statistical area and landing date), size-frequency data from samples of landed crabs, at-sea observer data from pot lifts sampled during the fishery (date, location, soak time, catch composition, size, sex, and reproductive condition of crabs, etc), data from a triennial pot survey in the Yunaska-Amukta Island area of the Aleutian Islands (approximately 171° W longitude), recovery data from tagged crabs released during the triennial pot surveys and bycatch data from the groundfish fisheries. These data are available through the 2008/09 season and the 2006 triennial pot survey. Most of the available data were obtained from the fishery which targets legal-size (≥6-inch CW) males and trends in the data can be affected by changes in both fishery practices and the stock. The triennial survey is too limited in geographic scope and too infrequent to provide a reliable index of abundance for the Aleutian Islands area. A triennial survey was scheduled for 2009, but was cancelled.

*Stock biomass and recruitment trends*

Estimates of stock biomass are not available for this stock. Estimates of recruitment trends and current levels relative to virgin or historic levels are not available. However, there is good evidence that the sharp increase in CPUE of retained legal males during recent fishery seasons was not due to a sharp increase in recruitment of legal-size males, but rather to changes in fishing practices (i.e. longer soak times).

*Tier determination/Plan Team discussion and resulting OFL determination*

AIGKC is recommended for Tier 5 stock in 2010/11. $B_{MSY}$ and MSST are not estimated for this stock. Observer data on bycatch from the directed fishery and groundfish fisheries can provide estimates of total bycatch mortality for years after the 1996/97 season. For other time periods under consideration there are no directed fishery observer data prior to the 1988/89 season and observer data are lacking or confidential for four seasons in at least one management area in the Aleutian Islands during 1988/89–1994/95.

Thus, the SSC recommends the following method to calculate a total catch OFL for AIGKC:

$$OFL_{TOT(4)} = (1+RATE_{96/97\text{-}08/09}) \cdot OFL_{RET(85/86\text{-}95/96)} + MGF_{96/97\text{-}08/09} = 11.0 \text{ million lbs}$$

where:
$RATE_{96/97\text{-}08/09}$ = mean annual rate = (bycatch mortality in crab fisheries)/(retained catch) over the period 1996/97-2008/09.
$OFL_{RET(85/86\text{-}95/96}$ = mean annual retained catch over the period 1985/86-1995/96, and
$MGF_{96/97\text{-}08/09}$ = mean of annual bycatch mortality in groundfish fisheries over the period 1996/97-2008/09.

The SSC recommended that this time period be frozen to stabilize the control rule.

*Historical status and catch specifications (millions lbs.) of Aleutian Islands golden king crab*

| Year | MSST | Biomass (MMB) | TAC | Retained Catch | Total Catch | OFL (retained) |
|---|---|---|---|---|---|---|
| 2006/07 | NA | NA | 5.70 | 5.22 | 5.8 | |
| 2007/08 | NA | NA | 5.70 | 5.51 | 6.2 | |
| 2008/09 | NA | NA | 5.99 | 5.68 | 6.3 | 9.18 [retained] |
| 2009/10 | NA | NA | 5.99 | 5.91 | | 9.18 [retained] |
| 2010/11 | NA | NA | | | | 11.0 [total catch] |

*Historical status and catch specifications (kt) of Aleutian Islands golden king crab*

| Year | MSST | Biomass (MMB) | TAC | Retained Catch | Total Catch | OFL (retained) |
|---|---|---|---|---|---|---|
| 2006/07 | NA | NA | 2.59 | 2.37 | 2.63 | |
| 2007/08 | NA | NA | 2.59 | 2.50 | 2.81 | |
| 2008/09 | NA | NA | 2.72 | 2.58 | 2.86 | 4.16 [retained] |
| 2009/10 | NA | NA | 2.72 | | | 4.16 [retained] |
| 2010/11 | NA | NA | | | | 11.0 [total catch] |

No overfished determination is possible for this stock given the lack of biomass information. Retained catch in 2009/10 was below the retained catch OFL thus overfishing did not occur.

*Additional Plan Team recommendations*

In May 2010, the plan team reviewed a new stock assessment model for Aleutian Islands golden king crab (Chapter 8b, Draft May Crab SAFE report). Use of an assessment model could allow for this stock to be moved to Tier 4 and would provide focus for establishing research and data collection priorities. The team believes that the model has been improved greatly from the 2009 iteration. The team recommends incorporation of plan team comments into the model for the September 2010 plan team meeting but did not recommend adopting the model for OFL determination in this year. Specific comments on model suggestions are contained in the May Crab Plan Team report.

# 9 Pribilof Islands golden king crab

*Fishery information relative to OFL setting*

The Pribilof District fishery for male golden king crab ≥ 5.5 in carapace width (≥ 124 mm carapace length) developed in the 1981/82 season. The directed fishery mainly occurs in Pribilof Canyon of the continental slope. Peak directed harvest is 856-thousand pounds during the 1983/84 season. Historical fishery participation has been sporadic and retained catches variable. The current fishing season is a calendar year. Since 2000, the fishery was managed for a guideline harvest level (GHL) of 0.15 million pounds. Non-retained bycatch occurs in the directed fishery as well as Bering Sea snow crab, Bering Sea grooved Tanner crab, and Bering Sea groundfish fisheries. Estimated total fishing mortality in crab fisheries averages 68-thousand pounds (2002-2009). Crab mortality in groundfish fisheries (July 1–June 30, 1991/92–2008/09) averages 3-thousand pounds. There has been no participation in the directed fishery from 2006 through 2009. Pribilof District golden king crab was not included in the Crab Rationalization Program.

*Data and assessment methodology*

Total golden king crab biomass has been estimated during NMFS upper-continental-slope trawl surveys in 2002, 2004, and 2008. There is no assessment model for this stock. Fish ticket and observer data are available (including retained catch numbers, retained catch weight, and pot lifts by statistical area and landing date), size-frequency data from samples of landed crabs, and at-sea observer data from pot lifts sampled during the fishery (including date, location, soak time, catch composition, size, sex, and reproductive condition of crabs, etc), and from the groundfish fisheries. Much of the directed fishery data is confidential due to low number of participants.

*Stock biomass and recruitment trends*

Estimates of stock biomass (all sizes, both sexes) were provided for Pribilof Canyon. The 2008 Pribilof Canyon area-swept estimate of golden king crab biomass is 919 mt, an increase from 692 mt in 2002. There is no recent directed fishery participation (2006-2009).

*Tier determination/Plan Team discussion and resulting OFL determination*

The Team recommends this stock be assigned to Tier 5. Biomass information was provided for Pribilof Canyon, but not specific to mature males.

The assessment author presented a retained-catch OFL based on data from 1993-98, and two alternative retained-catch OFLs based on 1993-1999 and 1993-2002 time periods. The assessment author also presented a total-catch OFL.

The Team recommends a total-catch OFL. The total-catch OFL is derived based on the following relationship to the retained-catch OFL (1993-98 seasons) adopted for 2010 fishing season:

$OFL_{tot} = 1.05 * OFL_{ret} + 0.006$ million

This relationship accounts for groundfish and non-directed crab bycatch mortality at a background level that is independent of the Pribilof District golden king crab stock size and directed catch, however, the bycatch mortality in the directed fishery is assumed to be proportional to retained catch. Bycatch data from crab fisheries was often confidential and only available from 2001 – 2009. The groundfish bycatch data was available from 1991/92 – 2008/09 in federal reporting areas 513, 517 & 521. The 1.05 multiplier accounts for crab bycatch mortality in the directed crab fishery and 6-thousand pounds is the average "background level" groundfish and non-directed crab bycatch mortality. The SSC recommended a total catch OFL of 0.18 million pounds for the 2011 Pribilof District golden king crab fishing year.

*Historical status and catch specifications (millions lbs.) of Pribilof Islands golden king crab*

| Year | MSST | Biomass (MMB) | GHL | Retained Catch | Total Catch | OFL |
|---|---|---|---|---|---|---|
| 2007 | NA | NA | 0.15 | 0 | | |
| 2008 | NA | NA | 0.15 | 0 | 0.00 | |
| 2009 | NA | NA | 0.15 | 0 | 0.001 | 0.17 (retained) |
| 2010 | NA | NA | 0.15 | | | 0.17 (retained) |
| 2011 | NA | NA | | | | 0.18 |

*Historical status and catch specifications (kt) of Pribilof Islands golden king crab*

| Year | MSST | Biomass (MMB) | GHL | Retained Catch | Total Catch | OFL |
|---|---|---|---|---|---|---|
| 2007 | NA | NA | 0.07 | 0 | | |
| 2008 | NA | NA | 0.07 | 0 | 0 | |
| 2009 | NA | NA | 0.07 | 0 | 0.0005 | 0.08 [retained] |
| 2010 | NA | NA | 0.07 | 0 | | 0.08 [retained] |
| 2011 | NA | NA | | | | 0.08 |

No overfished determination is possible for this stock given the lack of biomass information. Overfishing did not occur in 2009.

## 10 Adak red king crab, Aleutian Islands

*Fishery information relative to OFL setting*

The domestic fishery has been prosecuted since 1960/61 and was opened every season through the 1995/96 season. Since 1995/96, the fishery was opened only occasionally, 1998/99, 2000/01-2003/04. Peak harvest occurred during the 1964/65 season with a retained catch of 21 million pounds. During the early years of the fishery through the late 1970s, most or all of the retained catch was harvested in the area between 172° W longitude and 179° 15' W longitude .As the annual retained catch decreased into the mid-1970s and the early-1980s, the area west of 179° 15' W longitude began to account for a larger portion of the retained catch

Retained catch during the 10-year period, 1985/86 through 1994/95, averaged 0.943 million pounds, but the retained catch during the 1995/96 season was low, only 0.039 million pounds. There was an exploratory fishery with a low guideline harvest level (GHL) in 1998/99; three Commissioner's permit fisheries in limited areas during 2000/01 and 2002/03 to allow for ADF&G-Industry surveys, and two commercial fisheries with a GHL of 0.5 million pounds during the 2002/03 and 2003/04 seasons. Most of the catch since the 1990/91 season was harvested in the Petrel Bank area (between 179° W longitude and 179° E longitude) and the last two commercial fishery seasons (2002/03 and 2003/04) were opened only in the Petrel Bank area. Retained catches in those two seasons were 0.506 million pounds (2002/03) and 0.479 million pounds (2003/04). The fishery has been closed through the 2009/10 season since the end of the 2003/04 season.

Non-retained catch of red king crabs occurs in both the directed red king crab fishery (when prosecuted), in the Aleutian Islands golden king crab fishery, and in groundfish fisheries. Estimated bycatch mortality during the 1995/96-2008/09 seasons averaged 0.003 million pound in crab fisheries and 0.023 million pounds in groundfish fisheries. Estimated annual total fishing mortality (in terms of total crab removal) during 1995/96-2008/09 averaged 0.116 million pounds. The average retained catch during that period was 0.09 thousand pounds. This fishery is rationalized under the Crab Rationalization Program only for

the area west of 179° W longitude.

*Data and assessment methodology*

The 1960/61-2007/08 time series of retained catch (number and pounds of crabs), effort (vessels, landings and pot lifts), average weight and average carapace length of landed crabs, and catch-per-unit effort (number of crabs per pot lift) are available. Bycatch from crab fisheries during 1995/96-2008/09 and from groundfish fisheries during 1992/93-2008/09 are available. There is no assessment model in use for this stock. The standardized surveys of the Petrel Bank area conducted by ADF&G in 2006 and 2009 and the ADF&G-Industry Petrel Bank surveys conducted in 2001 have been too limited in geographic scope and too infrequent for reliable estimation of abundance for the entire western Aleutian Islands area.

*Stock biomass and recruitment trends*

Estimates of stock biomass are not available for this stock. Estimates of recruitment trends and current levels relative to virgin or historic levels are not available. The fishery has been closed since the end of 2003/04 season due to apparent poor recruitment. A pot survey conducted by ADF&G in the Petrol Bank area in 2006 provided no evidence of strong recruitment. The 2009 survey encountered smaller ageing population with the catch of legal male crabs occurred in a more limited area and at lower densities than were found in the 2006 survey and provided no expectations for recruitment. A test fishery conducted by a commercial vessel during October-December 2009 in the area west of Petrel Bank yielded only one legal male red king crab.

*Tier determination/Plan Team discussion and resulting OFL determination*

The CPT recommends this as a Tier 5 stock for the 2009/10 season. Author provided three model alternatives (Alt.) with different time periods (Base: 1984/85-2007/08; Alt.1: 1977/78-2007/08; Alt.2: 1960/61-2007/08) to compute the average retained catch as OFL. The team recommended a total catch OFL for the 2010/11 season because complete information on total catch is available for the period 1995/96-2007/08. The total catch OFL for this period is 0.12-million pounds. The CPT also recommends freezing the final fishing season at 2007/08.

*Status and catch specifications (millions of lbs) of Adak RKC.*

| Year | MSST | Biomass (MMB) | TAC | Retained Catch | Total Catch | OFL |
|---|---|---|---|---|---|---|
| 2006/07 | NA | NA | Closed | 0 | 0.004 | NA |
| 2007/08 | NA | NA | Closed | 0 | 0.011 | NA |
| 2008/09 | NA | NA | Closed | 0 | 0.014 | 0.46[A] (retained) |
| 2009/10 | NA | NA | Closed | 0 | TBD | 0.50[A] (retained) |
| 2010/11 | NA | NA | Closed | | | 0.12 |

A-based on 1984/85-07/08 mean retained catch

*Status and catch specifications (kt) of Adak RKC.*

| Year | MSST | Biomass (MMB) | TAC | Retained Catch | Total Catch | OFL |
|---|---|---|---|---|---|---|
| 2006/07 | NA | NA | Closed | 0 | 0.002 | NA |
| 2007/08 | NA | NA | Closed | 0 | 0.005 | NA |
| 2008/09 | NA | NA | Closed | 0 | 0.01 | 0.21[A] [retained] |
| 2009/10 | NA | NA | Closed | 0 | | 0.23[A] [retained] |
| 2010/11 | NA | NA | Closed | | | 0.05[B] |

A-based on 1984/85-07/08 mean retained catch

No overfished determination is possible for this stock given the lack of biomass information. Retained catch did not exceed the retained catch OFL for this stock thus overfishing did not occur.

Table 3 Crab Plan Team recommendations September 2010 millions lbs.
(Note diagonal fill indicated parameters not applicable for that tier level)

| Chapter | Stock | Tier | Status (a,b,c) | $F_{OFL}$ | $B_{MSY}$ or $B_{MSYproxy}$ | Years[1] (biomass or catch) | 2011[2] MMB | 2011 MMB / $MMB_{MSY}$ | $\gamma$ | Mortality $(M)yr^{-1}$ | 2010/11 OFL mill lbs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | EBS snow crab | 3 | b | 0.91 | 293.7 | 1979-current [recruitment] | 225 | 0.76 | | Male-estimated(0.29) Female – 0.23 | 97.9 |
| 2 | BB red king crab | 3 | a | 0.32 | 62.7 | 1995-current [recruitment] | 83.1 | 1.33 | | 0.18 default , estimated otherwise[3] | 23.5 |
| 3 | EBS Tanner crab | 4 | b | 0.05 | 183.6 | 1969-1980 [survey] | 57.48 | 0.31 | 1.0 | 0.23 | 3.55 |
| 4 | Pribilof Islands red king crab | 4 | b | 0.11 | 8.44 | 1991-current [survey] | 5.44 | 0.64 | 1.0 | 0.18 | 0.77 |
| 5 | Pribilof Islands blue king crab | 4 | c | 0.0[4] | 9.28 | 1980-1984; 1990-1997 [survey] | 0.63 | 0.07 | 1.0 | 0.18 | 0.004 |
| 6 | St. Matthew Island blue king crab | 4 | a | 0.18 | 6.80 | 1989-current [model estimate] | 15.29 | 2.23 | 1.0 | 0.18 (1978-98, 2000-08); 1.8 (1999) | 2.29 [total male catch] |
| 7 | Norton Sound red king crab | 4 | a | 0.18 | 3.12 | 1983-current [model estimate] | 5.44 | 1.7 | 1.0 | 0.18 | 0.73 |
| 8 | AI golden king crab | 5 | | | | SSC Formula[5] [total catch] | | | | | 11.0 |
| 9 | Pribilof Island golden king crab | 5 | | | | | | | | | 0.18 |
| 10 | Adak red king crab | 5 | | | | | | | | | 0.12 |

1 For Tiers 3 and 4 where $B_{MSY}$ or $B_{MSYproxy}$ is estimable, the years refer to the time period over which the estimate is made. For Tier 5 stocks it is the years upon which the catch average for OFL is obtained.
2 MMB as projected for 2/15/2011 at time of mating.
3 Additional mortality males: two periods-1980-1985; 1968-1979 and 1986-2008. Females three periods: 1980-1984; 1976-1979; 1985 to 1993 and 1968-1975; 1994-2008. See assessment for mortality rates associated with these time periods.

Table 4. Stock status in relation to status determination criteria 2009/10
(Note diagonal fill indicates parameters not applicable for that tier level)

| Chapter | Stock | Tier | MSST | $B_{MSY}$ or $B_{MSYproxy}$ | 2010[1] MMB | 2010 MMB / $MMB_{MSY}$ | 2009/10 OFL mill lbs [retained] | 2009/10 Total catch |
|---|---|---|---|---|---|---|---|---|
| 1 | EBS snow crab | 3 | 146.8 | 293.6 | 281.5 | 0.96 | 73.0 | 52.7 |
| 2 | BB red king crab | 3 | 34.3 | 68.5 | 89.0 | 1.39 | 22.6 | 18.3 |
| 3 | EBS Tanner crab | 4 | 92.37 | 189.76 | 62.7 | 0.33 | 5.0 | 3.73 |
| 4 | Pribilof Islands red king crab | 4 | 4.39 | 8.44 | 4.46 | 0.53 | 0.50 | 0.006 |
| 5 | Pribilof Islands blue king crab | 4 | 4.64 | 9.01 | 1.13 | 0.24 | 0.004 | 0.001 |
| 6 | St. Matthew Island blue king crab | 4 | 3.48 | 6.95 | 12.76 | 1.83 | 1.72 [total male catch] | 0.53 |
| 7 | Norton Sound red king crab | 4 | 1.54 | 3.12 | 5.83 | 1.9 | 0.73 [retained] | 0.43 |
| 8 | AI golden king crab | 5 | | | | | 9.18 [retained] | 5.9 [retained] |
| 9 | Pribilof Island golden king crab | 5 | | | | | 0.17 [retained] | 0 [retained] |
| 10 | Adak red king crab | 5 | | | | | 0.12 [retained] | 0 [retained] |

1 MMB as estimated during this assessment for 2009/10 as of 2/15/2010.

# Crab Plan Team Report

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

Crab Plan Team members present:

| | |
|---|---|
| ***Forrest Bowers, Chair*** | ***(ADF&G)*** |
| ***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)*** |
| ***Bob Foy*** | ***(NOAA Fisheries /AFSC – Kodiak)*** |
| ***Brian Garber-Yonts*** | ***(NOAA Fisheries – AFSC Seattle)*** |
| ***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: Mark Casto, Ron Namma, Dennis Thompson, Scott Campbell, Anne Vanderhoeven, Rob Rogers, Jack Tagart, Frank Kelty, Dewey Hostetler, Chris Arnim, Gary Stauffer, Dale Schwarzmiller, Ken Weinberg, Chris Pugmire, Shane Moore, Doug Woodby, K. Magatelle, Gary Painter, Kevin Kaldestad, Jie Zheng, Tom Suryan, Roger Thomas, Bill Gaeuman, Eric Olson, Walt Casto, John Jorgensen, Caliste Sonoptad, Neil Rodriguez, Pat Livingston, Anne Hollowed, Martin Dorn, Jim Ianelli, Russ Nelson, Earl Krygier, Gary Loncon, Dave Witherell, Stefanie Moreland, John Gauvin, Steve Hughes, Lori Swanson, Edward Poulsen, Tom Casey.

The attached agenda was approved for the meeting.

**1. Update on Council actions**

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

**2. 2010 Survey Overviews**

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

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

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

**3. Spatial Model Presentation**

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

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

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

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

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

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

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

**4. EBS snow crab**

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

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

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

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

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

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

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

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

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

**5. Bristol Bay red king crab**

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

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

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

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

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

**6. EBS Tanner crab**

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

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

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

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

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

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

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

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

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

**7. Pribilof Islands red king crab stock**

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

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

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

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

**8. Pribilof Islands blue king crab**

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

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

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

**9. St Matthew Blue king crab**

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

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

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

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

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

**10. Crab ACLs and AMs**

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

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

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

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

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

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

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

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

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

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

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

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

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

**11. Pribilof blue king crab rebuilding plan**

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

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

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

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

**12. Economic SAFE**

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

**13. Ecosystem Considerations**

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

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

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

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

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

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

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

**15. Crab EFH definitions and discussion paper planning**

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

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

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

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

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

DISCUSSION OF EFFECTS OF FISHING ON CRAB IN PARTICULAR AREAS
-What is the important spawning area for red king crab identified by the CPT?
-Changing distribution of red king crab throughout their range.
-Changing distribution of other crab species?
-Research questions

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

**16. Handling mortality presentations**

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

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

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

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

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

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

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

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

**17. Research Priorities:**

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

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

**18. New Business:**

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

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

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

The meeting adjourned at 5pm on September 16th.

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

DRAFT AGENDA August 31 vers

| | | |
|---|---|---|
| **Monday, September 13** | | **Room (Traynor Room, all week)** |
| 9:00 | **Administration** | • Introductions, agenda, minutes, and 2011 timing |
| 9:15 | **Council action update** | • Overview of crab Council action from June 2010 meeting |
| 9:30 | **Survey** | • Overview of 2010 survey and results : NMFS AFSC survey; AFSC/BSFRF cooperative survey selectivity update |
| | **Break 10:30-10:45am** | |
| 10:45 | **Paper Presentation** | • Snow crab spatial population model – *Murphy* |
| 11:15 | **Snow crab MSE** | • Snow crab management strategy evaluation project |
| 11:30 | **Stock Assessment Review / OFL** | • Snow crab: final assessment results and rebuilding analysis |
| Noon | | Lunch |
| 1:00 | **Stock Assessment Review / OFL** | • Snow crab: continue as necessary |
| 2:20 | | • BBRKC assessment, CIE review and plans |
| | Break 3:00 – 3:15 | |
| 3:15 | | • BBRKC-continue as necessary<br>• St. Matthew blue king crab |
| **Tuesday, September 14** | | |
| 9:00 | **Stock Asses. / OFL cont.-Model Review day** | • Tanner crab-assessment overview and model review |
| | Break 10:30 – 10:45 | |
| Noon | | Lunch |
| 1:00 | | ~~• AIGKC model review~~ |
| | Break 3:00 – 3:15 | • Pribilof red and blue king crab model review (T) |
| **Wednesday, September 15** | | |
| 9:00 | **Stock Asses. / OFL cont** | • Finalize SAFE report introduction |
| | **Break 10:30-10:45** | |
| 10:45am | **ACLs/AMs** | • Review of final ACL analysis; update on Council action in June and revisions to initial review draft over summer ; CPT recommendations as necessary ~~on preferred alternative~~ |
| Noon | | Lunch |
| 1:00 | **ACLs/AMs cont.** | • Continue as necessary |
| | Break 3:00 – 3:15 | |
| **Thursday, September 16** | | |
| 9:00 | **PIBKC rebuilding** | • Pribilof blue king crab rebuilding plan: review initial review draft |
| | Break 10:15-10:30 | |
| Noon | | Lunch |
| 1:00 | **Handling Mortality** | • Update on handling mortality estimates in different fisheries |
| 1:30 | **Ecosystem** | • overview |

| | | |
|---|---|---|
| | **considerations chapter** | |
| 2:30 | **Economics** | • ~~5 year economic review of CRP~~ |
| | Break 3:00 – 3:15 | • Overview of final Economic SAFE |
| | | • ~~Presentation on crab crew remuneration~~ |
| 3:15 | Economics | • Continue as necessary |
| 4:00 | **New business** | • Crab EFH definitions and discussion paper planning |
| | | • Additional meeting scheduling in 2010/2011 as needed (per model review discussion) |
| 5:00 | | Adjourn |

**UNITED STATES DEPARTMENT OF COMMERCE**
**National Oceanic and Atmospheric Administration**
*National Marine Fisheries Service*
*P.O. Box 21668*
*Juneau, Alaska 99802-1668*

AGENDA C-2
Supplemental
OCTOBER 2010

October 1, 2010

Mr. Eric Olson, Chair
North Pacific Fishery Management Council
605 West 4th Avenue, Suite 306
Anchorage, Alaska 99601

Dear Chairman Olson:

This letter serves as the North Pacific Fishery Management Council's (Council's) notification under section 304(e) of the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) that Bering Sea Tanner crab (*Chionoecetes bairdi*) is overfished, according to the criteria in the Fishery Management Plan for Bering Sea/Aleutian Islands King and Tanner Crabs (FMP).

The Alaska Fisheries Science Center (AFSC) has determined that the Tanner stock has declined below its minimum stock size threshold (MSST) based on the final 2010 stock assessment. The 2010 estimate of mature male biomass (MMB) at the time of mating is 62.70 million pounds, which is below the MSST of 92.37 million pounds. A copy of the memorandum from the AFSC on the 2010 status of the stocks, rebuilding progress, and overfishing levels for Bering Sea and Aleutian Islands crab stocks is enclosed. The status for the other stocks did not change.

To comply with section 304(e)(3) of the Magnuson-Stevens Act, the Council and NMFS have two years from this notification to develop and implement a plan to rebuild the overfished Tanner crab stock. Under section 304(e)(4) of the Magnuson-Stevens Act, the rebuilding plan for Tanner crab must specify a time period for rebuilding the fishery that is as short as possible, taking into account the status and biology of the stock, the needs of fishing communities, and the interactions of the stock within the marine ecosystem. The rebuilding period shall not exceed 10 years, except if the biology of the stock or other environmental conditions dictate otherwise. We look forward to working with the Council and the Alaska Department of Fish and Game to develop, analyze, and implement a rebuilding plan for the Tanner crab stock.

Sincerely,

James W. Balsiger, Ph.D.
Administrator, Alaska Region

Enclosure: Memorandum from Douglas P. DeMaster, Science and Research Director, Alaska Region, regarding the 2010 status of the stocks, rebuilding progress, and overfishing levels for Bering Sea and Aleutian Islands crab stocks

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Alaska Fisheries Science Center
7600 Sand Point Way N.E.
Bldg. 4, F/AKC
Seattle, Washington 98115-0070

September 27, 2010

MEMORANDUM FOR: James W. Balsiger
Regional Administrator, Alaska Region

FROM: Douglas P. DeMaster
Science and Research Director, Alaska Region

SUBJECT: 2010 status of stocks, rebuilding progress, and overfishing levels for Bering Sea and Aleutian Island Crab Stocks

This memorandum provides the current status of stocks, progress towards rebuilding, and the Alaska Fisheries Science Center's recommendations for the 2010/2011 overfishing levels for ten eastern Bering Sea crab stocks.

**2010 Status of Stocks Determinations**

At the May and September 2010 meetings of the North Pacific Fishery Management Council's Bering Sea/Aleutian Islands Crab Plan Team, the status of the ten Fishery Management Plan (FMP) crab stocks were reviewed and their status relative to overfished and overfishing determined (Table 1). A stock is determined to be overfished if the 2009/2010 estimate of mature male biomass on February 15, 2010 ($MMB_{mating}$) was below the minimum stock size threshold (MSST) or 0.5 $B_{MSY}$. In September 2010, stock projections of MMB at mating on February 15, 2011 are used to determine if a stock is approaching an overfished condition. ***Note that Tanner crab stock is now in an overfished condition. The Pribilof Islands blue king crab stock remains overfished. No crab stocks are approaching an overfished condition.***

The Tanner crab stock was determined to be overfished in 2009/10. The eastern Bering Sea Tanner crab stock biomass declined in 2009/10 below the minimum stock size threshold (MSST). In September 2009, the Tanner crab stock was determined to be approaching an overfished condition based on projections of MMB at mating (February 15, 2010). During the September 2010 Crab Plan Team meeting, 2009/2010 total catches were assessed and the MMB at the time of mating (62.70 million lbs.) was found to be below MSST (92.37 million lbs.). The projected 2010/2011 MMB at mating (57.48 million lbs.) is estimated to be lower than the 2009/10 MMB at mating estimate.

Overfishing is occurring if the total catch in 2009/2010 exceeds the 2009/2010 overfishing level (OFL) for the stock. The 2009/2010 overfishing determinations for the ten FMP crab stocks were reviewed by the Crab Plan Team in May and September 2010. The OFL is based on total catches including retained and discard mortalities except where noted. ***As shown in Table 1, there were no stocks where overfishing occurred in 2009/2010.***

Table 1. 2010 Status of stocks relative to the 2009/2010 overfishing determination and the current overfished status for ten Being Sea/Aleutian Islands crab stocks. Additional information on status and catch specifications can be found in the 2009 and 2010 Stock Assessment and Fishery Evaluation Reports for the King and Tanner Crab Fisheries in the Bering Sea and Aleutian Islands.

| Stock | Tier | MSST ($10^6$ lbs) | 2009/2010* $MMB_{mating}$ ($10^6$ lbs) | Overfished status | 2009/2010 OFL ($10^6$ lbs) | 2009/2010 Total catch ($10^6$ lbs) | 2009/2010 Overfishing status |
|---|---|---|---|---|---|---|---|
| Bristol Bay red king crab | 3 | 34.3 | 89.0 | No | 22.6 | 18.3 | No |
| Eastern Bering Sea snow crab | 3 | 146.83 | 281.55 | No | 72.97 | 52.69 | No |
| Eastern Bering Sea Tanner crab | 4 | 92.37 | 62.70 | **Yes** | 5.00 | 3.72 | No |
| Pribilof Islands red king crab | 4 | 4.22 | 4.46 | No | 0.50 | 0.006 | No |
| Pribilof Islands blue king crab | 4 | 4.64 | 1.13 | **Yes** | 0.004 | 0.001 | No |
| St Matthew Island blue king crab | 4 | 3.48 | 12.76 | No | 1.72 [retained] | 0.53 | No |
| Pribilof Island golden king crab | 5 | NA | NA | NA** | 0.17 [retained] | 0 [retained] | No |
| Adak red king crab | 5 | NA | NA | NA** | 0.50 [retained] | 0 [retained] | No |
| Norton Sound red king crab | 4 | 1.54 | 5.83 | No | 0.71 [retained] | 0.43 | No |
| Aleutian Island golden king crab | 5 | NA | NA | NA** | 9.18 [retained] | 5.91 [retained] | No |

*MMB as estimated during the 2010 assessment.

**For Tier 5 stocks, it is not possible to set an MSST to determine overfished status because there are no reliable estimates of biomass.

**2010 Progress Towards Stock Rebuilding**

In 2009/2010 there were two Bering Sea/Aleutian Islands King and Tanner crab stocks still under rebuilding plans: Eastern Bering Sea snow crab and Pribilof Islands blue king crab. A review of the status of these stocks relative to rebuilding found that:

1. The eastern Bering Sea snow crab stock did not make adequate progress towards the 2009/2010 target rebuilding period. In order to be considered rebuilt by the established 10 year time period, $MMB_{mating}$ would have needed to be greater than $B_{MSY}$ in 2008/2009 and again in 2009/2010 in order to meet the two year standard above $B_{MSY}$ required for rebuilding. The $MMB_{mating}$ in 2008/2009 (241.1 million lbs) and in 2009/2010 (281.55 million lbs) were determined to be below $B35\%_{2008/2009}$ (326.7 million lbs) and $B35\%_{2009/2010}$ (293.7 million lbs). A revised rebuilding plan was called for by the North Pacific Fisheries Management Council (NPFMC) in collaboration with the National Marine Fisheries Service Alaska Region and the Alaska Department of Fish and Game (ADF&G) in 2009/2010. The initial review of the rebuilding plan occurred in June 2010 and final Council review is expected in October 2010.

   In the interim, an OFL based on the F35% control rule was recommended by the Crab Plan Team in September 2010. The AFSC recommends that F be below the maximum permissible (75% F35%) under National Standard Guidelines of the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) to best meet the MSFCMA (Section 304(e)(4)) requirements for rebuilding time periods that are as short as possible, taking into account the needs of fishing communities. In addition, a reduced F during the interim period provides additional protection to Tanner crab, which is caught in the directed snow crab fishery and which is now in an overfished condition.

2. The Pribilof Islands blue king crab stock is not making adequate progress towards the 2012/2013 target rebuilding date. As a result, a revised rebuilding plan was initiated in 2009/2010 with preliminary review in April 2010. The initial Council review of the rebuilding plan is expected to occur in October 2010. In the interim, a low total catch OFL was recommended by the Crab Plan Team in September 2010 to account for low bycatch levels expected to occur in 2010/2011.

**Recommended 2010/2011 Overfishing Level Definitions**

Overfishing level (OFL) definitions for the ten Bering Sea and Aleutian Island crab stocks were discussed and reviewed at the May and September Crab Plan Team meetings and recommendations were made for OFLs (Table 2). Total allowable catch and guideline harvest levels are set by the ADF&G consistent with the FMP for the Bering Sea/Aleutian Islands King and Tanner crab and the State/Federal Action Plan for Management of Commercial King and Tanner Crab Fisheries of the Bering Sea and Aleutian Islands. For all ten stocks, SAFE reports which present the stock data, model estimates, and biological reference points have been prepared for review by the SSC and NPFMC in October.

Table 2. 2010/2011 Overfishing Levels for ten Being Sea/Aleutian Islands crab stocks. Additional information on status and catch specifications can be found in the 2010 Stock Assessment and Fishery Evaluation Report for the King and Tanner Crab Fisheries in the Bering Sea and Aleutian Islands.

| Stock | Tier | 2010/2011 $MMB_{mating}$ ($10^6$ lbs) | $F_{OFL}$ | 2010/2011 OFL ($10^6$ lbs) |
|---|---|---|---|---|
| Bristol Bay red king crab | 3a | 83.1 | 0.32 | 23.5 |
| Eastern Bering Sea snow crab | 3b | 224.6 | 0.91 | 97.9 |
| Eastern Bering Sea Tanner crab | 4b | 57.48 | 0.05 | 3.55 |
| Pribilof Islands red king crab | 4b | 5.44 | 0.11 | 0.77 |
| Pribilof Islands blue king crab | 4c | 0.63 | 0 | 0.004 |
| St Matthew Island blue king crab | 4a | 15.29 | 0.18 | 2.29* |
| Pribilof Island golden king crab | 5 | NA | NA | 0.18 |
| Adak red king crab | 5 | NA | NA | 0.12 |
| Norton Sound red king crab | 4a | 5.44 | 0.18 | 0.73 |
| Aleutian Island golden king crab | 5 | NA | NA | 11.0 |

NA = not applicable

*total male catch