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

2014 Final Crab SAFE

Compiled by

The Plan Team for the King and Tanner Crab Fisheries
of the Bering Sea and Aleutian Islands

With Contributions by

K. Bush, W. Donaldson, M. Dorn, G. Eckert, H. Fitch, R.J. Foy,
W. Gaeuman , B. Garber-Yonts, J. Gasper, T. Hamazaki, D. Pengilly, A.E. Punt,
L. Rugolo, M.S.M. Siddeek, W. Stockhausen, D. Stram, B. J. Turnock, and J. Zheng

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North Pacific Fishery Management Council
605 W. 4th Avenue, #306
Anchorage, AK 99501

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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 National Marine Fisheries Service (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 Islands and St Matthew Island), 2 golden (or brown) king crab, *Lithodes aequispinus,* stocks (Aleutian Islands and Pribilof Islands), southern Tanner crab *Chionoecetes bairdi* hereafter referred to as Tanner crab, and snow crab *Chionoecetes opilio*. All other crab stocks in the BSAI are exclusively managed by the State of Alaska (SOA).

The Crab Plan Team (CPT) annually assembles the SAFE report with contributions from ADF&G and the 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, and annual catch limit (ACL) requirements in 2011, the CPT reviews three assessments in May to provide recommendations on OFL, acceptable biological catch (ABC) and stock status specifications for review by the NPFMC Science and Statistical Committee (SSC) in June. In September, the CPT reviews the remaining assessments and provides final OFL and ABC recommendations and stock status determinations. Additional information on the OFL and ABC determination process is contained in this report.

The CPT met from September 15-18, 2014 in Seattle, WA to review the final stock assessments as well as additional related issues, in order to provide the recommendations and status determinations contained in this SAFE report. This final 2014 Crab SAFE report contains all recommendations for all 10 stocks including those whose OFL and ABC were determined in June 2014. This SAFE report will be presented to the NPFMC 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: Bob Foy (Chair), Karla Bush (Vice-Chair), Wayne Donaldson, Heather Fitch, Brian Garber-Yonts, Ginny Eckert, Jason Gasper, Doug Pengilly André Punt, Buck Stockhausen, Martin Dorn, Shareef Siddeek, Jack Turnock and Diana Stram.

Stock Status Definitions

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

Acceptable biological catch (ABC) is a level of annual catch of a stock that accounts for the scientific uncertainty in the estimate of OFL and any other specified scientific uncertainty and is set to prevent, with

a greater than 50 percent probability, the OFL from being exceeded. The ABC is set below the OFL.

ABC Control Rule is the specified approach in the five-tier system for setting the maximum permissible ABC for each stock as a function of the scientific uncertainty in the estimate of OFL and any other specified scientific uncertainty.

Annual catch limit (ACL) is the level of annual catch of a stock that serves as the basis for invoking accountability measures. For EBS crab stocks, the ACL will be set at the ABC.

Total allowable catch (TAC) is the annual catch target for the directed fishery for a stock, set to prevent exceeding the ACL for that stock and in accordance with section 8.2.2 of the FMP.

Guideline harvest level (GHL) means the preseason estimated level of allowable fish harvest which will not jeopardize the sustained yield of the fish stocks. A GHL may be expressed as a range of allowable harvests for a species or species group of crab for each registration area, district, subdistrict, or section.

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. For crab stocks, biomass for determining overfished status is estimated on February 15 of the current year and compared to the MSST established by the NPFMC in October of the previous year.

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

Status Determination Criteria

The FMP defines the following status determination criteria and the process by which these are defined following adoption of amendment 24 and 38.

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 criteria and ABC levels are annually formulated. The ACL for each stock equals the ABC for that stock. Each crab

stock is annually assessed to determine its status and whether (1) overfishing is occurring or the rate or level of fishing mortality for the stock is approaching overfishing, (2) the stock is overfished or the stock is approaching an overfished condition, and (3) the catch has exceeded the ACL.

For crab stocks, the OFL equals the maximum sustainable yield (MSY) and is derived through the annual assessment process, under the framework of the tier system. Overfishing is determined by comparing the OFL 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. For the previous crab fishing year, NMFS will also determine whether the ACL was exceeded by comparing the ACL with the catch estimates for that crab fishing year. 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 and ACL will be set for and compared to the retained catch.

The NMFS will determine whether a stock is in an overfished condition 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. 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 NPFMC to immediately end overfishing and rebuild affected stocks.

The Magnuson-Stevens Act requires that FMPs include accountability measures to prevent ACLs from being exceeded and to correct overages of the ACL if they do occur. Accountability measures to prevent TACs and GHLs from being exceeded have been used under this FMP for the management of the BSAI crab fisheries and will continue to be used to prevent ACLs from being exceeded. These include: individual fishing quotas and the measures to ensure that individual fishing quotas are not exceeded, measures to minimize crab bycatch in directed crab fisheries, and monitoring and catch accounting measures. Accountability measures in the harvest specification process include downward adjustments to the ACL and TAC in the fishing year after an ACL has been exceeded.

Annually, the NPFMC, SSC, and CPT will review (1) the stock assessment documents, (2) the OFLs and ABCs, and TACs or GHLs, (3) NMFS's determination of whether overfishing occurred in the previous crab fishing year, (4) NMFS's determination of whether any stocks are overfished and (5) NMFS's determination of whether catch exceeded the ACL in the previous crab fishing year.

Optimum yield is defined in Chapter 4 of the FMP. Information pertaining to economic, social and ecological factors relevant to the determination of optimum yield is provided in several sections of the FMP, including sections 7.2 (Management Objectives), Chapter 11, Appendix D (Biological and Environmental Characteristics of the Resource), and Appendix H (Community Profiles).

For each crab fishery, the optimum yield range is 0 to < OFL catch. For crab stocks, the OFL is the annualized MSY and is derived through the annual assessment process, under the framework of the tier system. Recognizing the relatively volatile reproductive potential of crab stocks, the cooperative management structure of the FMP, and the past practice of restricting or even prohibiting directed harvests of some stocks out of ecological considerations, this optimum yield range is intended to facilitate the achievement of the biological objectives and economic and social objectives of the FMP (see sections 7.2.1 and 7.2.2) under a variety of future biological and ecological conditions. It enables the SOA to determine the appropriate TAC levels below the OFL to prevent overfishing or address other biological

concerns that may affect the reproductive potential of a stock but that are not reflected in the OFL itself. Under FMP section 8.2.2, the SOA establishes TACs at levels that maximize harvests, and associated economic and social benefits, when biological and ecological conditions warrant doing so.

Five-Tier System

The OFL and ABC for each stock are 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 CPT process to the SSC. The SSC recommends tier assignments, stock assessment and model structure, and parameter choices, including whether information is "reliable," for the assessment authors to use for calculating the proposed OFLs and ABCs based on the five-tier system.

For Tiers 1 through 4, once a stock is assigned to a tier, the determination of stock status level is 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" (β).

In stock status level "c," the ratio of current biomass to B_{MSY} (or a proxy for B_{MSY}) is below β. 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 α is set at a default value of 0.1, and β set at a default value of 0.25, with the understanding that the SSC 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, γ, 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 SSC recommends an alternative value based on the best available scientific information.

Second, the assessment author prepares the stock assessment and calculates the proposed OFLs by applying the F_{OFL} and using the most recent abundance estimates. The assessment authors calculate the proposed ABCs by applying the ABC control rule to the proposed OFL.

Stock assessment documents shall:

- use risk-neutral assumptions;
- specify how the probability distribution of the OFL used in the ABC control rule is calculated for each stock; and
- specify the factors influencing scientific uncertainty that are accounted for in calculation of the probability distribution of the OFL.

Second, the CPT annually reviews stock assessment documents, the most recent abundance estimates, the proposed OFLs and ABCs, and complies the SAFE. The CPT then makes recommendations to the SSC on the OFLs, ABCs, and any other issues related to the crab stocks.

Third, the SSC annually reviews the SAFE report, including the stock assessment documents, recommendations from the CPT, and the methods to address scientific uncertainty.

In reviewing the SAFE, the CPT and the SSC shall evaluate and make recommendations, as necessary, on:

- the assumptions made for stock assessment models and estimation of OFLs;
- the specifications of the probability distribution of the OFL;
- the methods to appropriately quantify uncertainty in the ABC control rule; and
- the factors influencing scientific uncertainty that the SOA has accounted for and will account for on an annual basis in TAC setting.

The SSC will then set the final OFLs and ABCs for the upcoming crab fishing year. The SSC may set an ABC lower than the result of the ABC control rule, but it must provide an explanation for setting the ABC less than the maximum ABC.

As an accountability measure, the total catch estimate used in the stock assessment will include any amount of harvest that may have exceeded the ACL in the previous fishing season. For stocks managed under Tiers 1 through 4, this would result in a lower maximum ABC in the subsequent year, all else being equal, because maximum ABC varies directly with biomass. For Tier 5 stocks, the information used to establish the ABC is insufficient to reliably estimate abundance or discern the existence or extent of biological consequences caused by an overage in the preceding year. Consequently, the subsequent year's maximum ABC will not automatically decrease. However, when the ACL for a Tier 5 stock has been exceeded, the SSC may decrease the ABC for the subsequent fishing season as an accountability measure.

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 such as mature male biomass at mating) per recruit equal to X% of the equilibrium level in the absence of any fishing.

The OFL and ABC calculation accounts for all losses to the stock not attributable to natural mortality. The OFL and ACL are total catch limits 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 insufficient to achieve Tier 3. 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 γ.

In Tier 4, a default value of natural mortality rate (M) or an M proxy, and a scalar, γ, 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, γ, is multiplied by M to estimate the F_{OFL} for stocks at status levels **"**a**"** and **"**b,**"** and γ is allowed to be less than or greater than unity. Use of the scalar γ is intended to allow adjustments in the overfishing definitions to account for differences in biomass measures. A default value of γ 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 and ACLs is available for a Tier 4 stock, then the OFL and ACL will be total catch limits comprised of three catch components: (1) non-directed fishery discard losses; (2) directed fishery discard losses; and (3) directed fishery retained catch. If the information necessary to determine total catch OFLs and ACLs is not available for a Tier 4 stock, then the OFL and ACL are 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 and ACL from this approach, therefore, would be the total catch OFL and ACL.

Tier 5

Tier 5 stocks have no reliable estimates of biomass and only historical catch data are available. For Tier 5 stocks, the OFL is set equal to the average catch from 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. The ABC control rule sets the maximum ABC at less than or equal to 90 percent of the OFL and the ACL equals the ABC.

For Tier 5 stocks where only retained catch information is available, the OFL and ACL will be set for the retained catch portion only, with the corresponding limits applying to the retained catch only. For Tier 5 stocks where information on bycatch mortality is available, the OFL and ACL calculations could include discard losses, at which point the OFL and ACL 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 β.

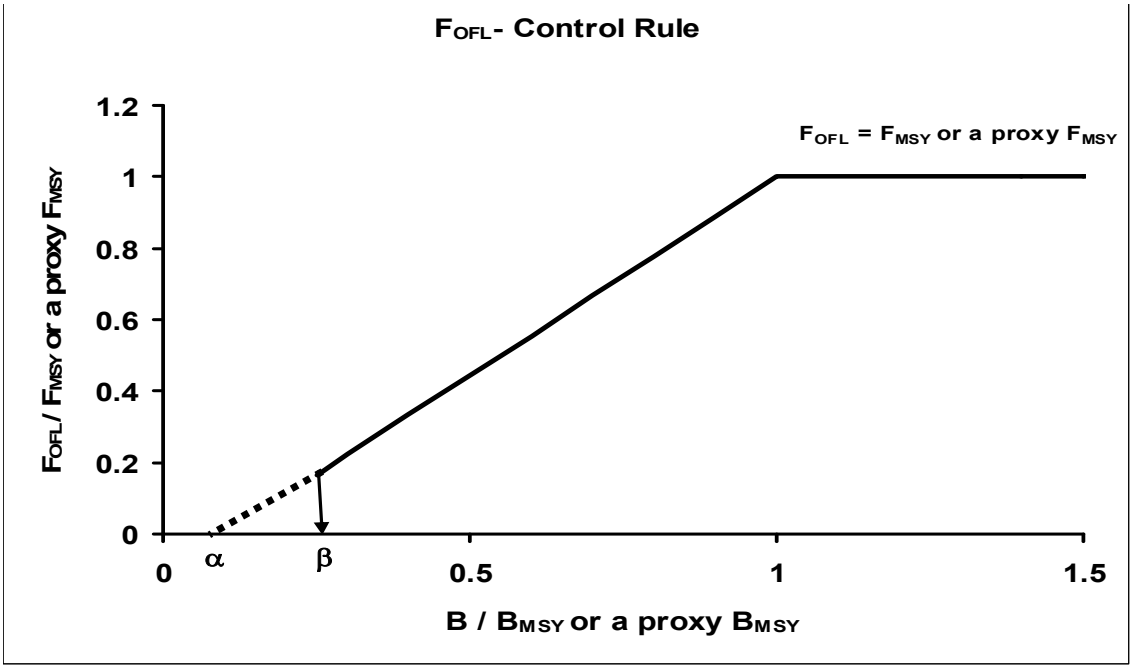

Table 1 Five-Tier System for setting overfishing limits (OFLs) and Acceptable Biological Catches (ABCs) for crab stocks. The tiers are listed in descending order of information availability. Table 2 contains a guide for understanding the five-tier system.

Information available	Tier	Stock status level	F_{OFL}	ABC control rule
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. $\beta < \frac{B}{B_{msy}} \leq 1$	$F_{OFL} = \mu_A \frac{B/B_{msy} - \alpha}{1-\alpha}$	ABC≤(1-b_y) * OFL
		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. $\beta < \frac{B}{B_{msy}} \leq 1$	$F_{OFL} = F_{msy} \frac{B/B_{msy} - \alpha}{1-\alpha}$	ABC≤(1-b_y) * OFL
		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. $\beta < \frac{B}{B_{35\%}*} \leq 1$	$F_{OFL} = F^{*}_{35\%} \frac{\frac{B}{B^{*}_{35\%}} - \alpha}{1-\alpha}$	ABC≤(1-b_y) * OFL
		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. $\beta < \frac{B}{B_{msy^{prox}}} \leq 1$	$F_{OFL} = \gamma M \frac{B/B_{msy^{prox}} - \alpha}{1-\alpha}$	ABC≤(1-b_y) * OFL
		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.	ABC≤0.90 * OFL

*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 an overfished 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
  - β — a parameter with restriction that $0 \leq \beta < 1$.
  - α — 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, β, determines the threshold level of B at or below which directed fishing is prohibited.
- The parameter, α, 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 α result in a smaller value of F_{OFL} when B decreases to $\beta \cdot B_{MSY}$.
  - Larger values of α result in F_{OFL} decreasing at a higher rate with decreasing values of B when $\beta \cdot B_{MSY} < B \leq B_{MSY}$.
- The parameter, b_y, is the value for the annual buffer calculated from a P* of 0.49 and a probability distribution for the OFL that accounts for scientific uncertainty in the estimate of OFL.
- P* is the probability that the estimate of ABC, which is calculated from the estimate of OFL, exceeds the "true" OFL (noted as OFL') (P(ABC>OFL').

Crab Plan Team Recommendations

Table 3 lists the team's recommendations for 2014/2015 on Tier assignments, model parameterizations, time periods for reference biomass estimation or appropriate catch averages, OFLs and ABCs. The team recommends three stocks be placed in Tier 3 (EBS snow crab, Bristol Bay red king crab and EBS Tanner crab), four stocks in Tier 4 (St. Matthew blue king crab, Pribilof Islands blue king crab, Pribilof Islands red king crab, and Norton Sound red king crab) and three stocks in Tier 5 (AI golden king crab, Pribilof Islands golden king crab, and Adak red king crab). Table 4 lists those stocks for which the team recommends an ABC less than the maximum permissible ABC for 2014/15. Stock status in relation to status determination criteria are evaluated in this report (Table 5). Status of stocks in relation to status determination criteria for stocks in Tiers 3 and 4 are shown in Figure 1. EBS Tanner crab is estimated to be above B_{MSY} for 2014/15 while snow crab, Bristol Bay red king crab, Pribilof Islands red king crab and Norton Sound red king crab are all estimated below B_{MSY}. Pribilof Islands blue king crab stock remains overfished and estimated to be well below its MSST.

The CPT has general recommendations for all assessments and specific comments related to individual assessments. All recommendations are for consideration for the 2015 assessments. The general comments are listed below while the comments related to individual assessments are contained within the summary of CPT deliberations and recommendations contained in the stock specific summary section. Additional details regarding recommendations are contained in the Crab Plan Team Report (September 2014 CPT Report).

General recommendations for all assessments

1. The team recommends that all assessment authors document assumptions and simulate data under those assumptions to test the ability of the model to estimate key parameters in an unbiased manner. These simulations would be used to demonstrate precision and bias in estimated model parameters.
2. The CPT recommends that weighting factors be expressed as sigmas or CVs or effective sample sizes. The team requests all authors to follow the Guidelines for SAFE preparation and to follow the Terms of Reference as listed therein as applicable by individual assessment for both content and diagnostics.
3. Authors should focus on displaying information on revised models as compared to last year's model rather than focusing on aspects of the assessment that have not changed from the previous year.
4. The team recommends supporting the recruitment and survey average workgroup recommendations for crab assessments as well as groundfish
5. The current approach for fitting length-composition data accounts for sampling error but ignores the fact that selectivity among size classes is not constant within years; a small change in the selectivity on small animals could lead to a very large change in the catch of such animals (as may have happened for NSRKC). Authors are encouraged to develop approaches for accounting for this source of process error. This issue is generic to assessments of crab and groundfish stocks.
6. Authors are reminded that assessments should include the time series of stock estimates at the time of survey for at least the author's recommended model in that year.

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

- million lb to 1000 t [/2.204624]
- 1000 t to million lb [/0.453592]

Stock Status Summaries

1 Eastern Bering Sea Snow crab

Fishery information relative to OFL setting

Total catch mortality in 2013/14 was 28,200 t (with discard mortality rates applied), while the retained catch in the directed fishery was 24,480 t. This is below the 2013/14 OFL of 78,100 t. Snow crab bycatch occurs in the directed fishery and to a lesser extent in the groundfish trawl fisheries. Estimates of trawl bycatch in recent years are less than 1% of the total snow crab catch. Prior to this year, estimates of stock status were above $B_{35\%}$ in the assessment since 2010/11. This year, MMB for 2014/15 (137,600 t) is 96% of the value for $B_{35\%}$ calculated in this assessment (142,900 t).

Data and assessment methodology

The stock assessment is based on a size- and sex-structured model in which crabs are categorized into immature, mature, new and old shell. The model is fitted to abundance and size frequency data from the NMFS trawl survey, total catch data from the directed fishery, bycatch data from the trawl fishery, and size frequency data for male retained catch in the directed fishery, and male and female bycatch in the directed fishery and trawl fishery. The model is also fitted to biomass estimates and size frequency data from the 20019 and 2010 BSFRF surveys and to growth increment data from Somerton. New data used in the model include biomass and length frequency data from the 2014 NMFS Eastern Bering Sea trawl survey, retained and discard catch and length size frequencies from the 2013/14 directed fishery, and discard catch and length frequency data from the groundfish fisheries.

Three growth models were considered in this assessment. The first growth model considered was the one used in the 2013 assessment, which modeled growth increment as a function of crab size using a single linear segment. A second model was based on a suggestion during the 2014 CIE review of the snow crab assessment that fits two linear segments to growth increment data using a smooth transition between the segments—with the result that the resulting function is differentiable at all points. The final model described growth increments using two linear segments and a fixed transition point; this model is not differentiable at the transition point from one segment to the other.

The assessment author presented nine model scenarios in this assessment. These scenarios included the 2013 assessment model with the old growth model, the two-segment "hockey stick"-type growth model, three models based on the smooth, 2-segment growth model but with different weights (1, 2 and 3) in the likelihood placed on fitting the growth data, and four other models (based on the smooth growth model with growth likelihood weight 2) that also incorporated different weights on likelihood penalties placed on fishing mortality rates in the final model estimation phase. Model estimates of biomass were relatively insensitive to these changes, as were the associated $F_{35\%}$'s and $B_{35\%}$'s (except for the model with the smallest penalty on fishing mortality rates). OFLs for the 2014/15 fishery were somewhat sensitive to individual model scenarios. The author's selected model (Model 2b) incorporated the CIE-suggested 2-segment growth model with the smooth transition with the moderate (2*x*) weighting in the likelihood to fit the growth data as his preferred model, and the CPT concurred with this recommendation. This model was selected because it used the smooth, 2-segment growth model and it fit the growth data much better than the similar model with the 1*x* weighting factor, while the fit was not substantially improved using model with the 3*x* factor on fitting the growth data.

Stock biomass and recruitment trends

Observed survey mature male biomass decreased from 167,400 t in 2011 to 120,800 t in 2012 and to 96,100 t in 2013. It increased to 156,900 t in 2014. Similarly, the observed survey mature female biomass also decreased from 2011 to 2013 (from 280,000 t in 2011, 220,600 t in 2012, and to 195,100 t in 2013) but increased in 2014 to 212,500 t. In contrast to the survey observations available at the time, the 2013 model had estimated that mature male biomass increased between 2012 and 2013, almost returning to the

2011 level. This was partly driven by a peak in 2009 in estimated recruitment that was not evident in the surveys for 2012 and 2013. The 2014 model also estimated a similar peak in recruitment, but delayed by a year (2010 rather than 2009), as well as an increasing trend in biomass (now supported by the survey results). The 2013 model-predicted mature male biomass at the time of the survey for 2013 was 1.5 times higher than the observed value. The 2014 model under-predicts mature male biomass at the time of the survey for 2014. Fits by the 2014 model to the size frequency data from the 2012 and 2013 surveys were poor; fitted size frequencies were lower than observed for females and higher than observed for males. The 2013 survey exhibited similar behavior. Fits to the 2014 data are somewhat improved, as the predicted recruitment event in 2010, apparently influenced a relatively high abundance of small (~50 mm CW) males observed in the 2010 survey propagates into the more fully-selected size classes in the survey.

Tier determination/Plan Team discussion and resulting OFL/ABC determination Status and catch specifications

The CPT recommends that the EBS snow crab is a Tier 3 stock so the OFL will be determined by the $F_{35\%}$ control rule. The proxy for B_{MSY} ($B_{35\%}$) is the mature male biomass at mating (142.9 thousand t) based on average recruitment over 1978 to 2014 present (1,351 million crab). Consequently, the minimum stock size threshold (MSST) is 71.5 thousand t. The CPT recommends that the ABC be less than maximum permissible ABC, and concurs with the authors' recommendation to use a default 10% buffer for setting the ABC.

Historical status and catch specifications for snow crab (thousand t).

Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch	OFL	ABC
2010/11	73.7	196.6[A]	24.6	24.7	26.7	44.4	
2011/12	77.3	165.2[A]	40.3	40.5	44.7	73.5	66.2
2012/13	77.1	170.1[A]	30.1	30.1	32.4	67.8	61.0
2013/14	71.5	126.5[A]	24.5	24.5	28.1	78.1	70.3
2014/15		137.6[B]				69.0	62.1

A - Estimated biomass at the time of mating for the year concerned. Note this represents a revised estimate from the projection the previous year.
B - Projected biomass from the current stock assessment. This value will be updated next year.

Historical status and catch specifications for snow crab (millions of lb).

Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch	OFL	ABC
2010/11	162.5	433.4 [A]	54.2	54.5	58.9	97.9	
2011/12	170.4	364.2 [A]	88.8	89.3	98.5	162.0	145.9
2012/13	170.0	375.0 [A]	66.4	66.4	71.4	149.5	134.5
2013/14	157.6	279.0[A]	54.0	54.0	62.0	172.2	155.0
2014/15		303.4[B]				152.1	137.0

A - Estimated biomass at the time of mating for the year concerned. Note this represents a revised estimate from the projection the previous year.
B - Projected biomass from the current stock assessment. This value will be updated next year.

Additional Plan Team recommendations

The Plan Team recommended that the author explore the use of applying different penalty weights by time period to quantities related to fishing mortality. One specific suggestion was to eliminate the weights

on average F and to put penalties on F deviations only in the "early" time period when data on discards is unavailable.

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

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 lb (58.9 thousand t), 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 sex (males only), a minimum size for legal retention (6.5-in carapace width; 135-mm carapace length is used a proxy for 6.5-in carapace width in the assessment), and season (no fishing during mating/molting periods). In addition to the retained catch that occurs during the commercial fishery, which is limited by the TAC, there is also retained catch that occurs in the ADF&G cost-recovery fishery.

The current SOA harvest strategy allows a maximum harvest rate of 15% of mature-sized (≥120 mm CL) males, but also incorporates a maximum harvest rate of 50% of legal males and a threshold of 8.4 million mature-sized (≥90 mm CL) females and 14.5 million lb (6.6 thousand t) of effective spawning biomass (ESB), to prosecute a fishery. Annual non-retained catch of female and sublegal male RKC during the fishery averaged less than 3.9 million lb (8.6 thousand t) since data collection began in 1990. Total catch (retained and bycatch mortality) increased from 16.9 million lb (7.6 thousand t) in 2005/06 to 23.4 million lb (10.6 thousand t) in 2007/08, but has decreased each season since then; retained catch in 2013/14 was 8.80 million lb (3.99 thousand t) and total catch was 10.05 million lb (4.56 thousand t).

Data and assessment methodology

The stock assessment model is based on a sex- and size-structured population dynamics model incorporating data from the NMFS eastern Bering Sea trawl survey, the Bering Sea Fisheries Research Foundation (BSFRF) trawl survey, landings of commercial catch, at-sea observers, and dockside samplers. In the model recommended by the CPT, annual stock abundance was estimated for male and female crabs ≥ 65-mm carapace length from 1975 to the time of the 2014 survey and mature male (males ≥120 mm CL) biomass was projected to 15 February 2015. Catch data (retained catch numbers, retained catch weight, and pot lifts by statistical area and landing date) from the directed fishery, which targets males ≥ 135 mm (6.5 in carapace length), 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. NMFS trawl survey data was updated with the newly re-estimated time series provided by NMFS in 2014, Catch and bycatch data were updated with data from the 2013/14 crab fishery year; data on bycatch during groundfish fisheries during 2009/10−2012/13 were revised with data provided by NMFS in 2014 and data on bycatch during the Tanner crab fishery were revised with data provided by ADF&G in 2014.

Three alternative models were evaluated in the 2014: the accepted model for the 2013 assessment, which served as the base model (model scenario 4na); a variant of the base model that differed from the base model by estimating trawl survey catchability, Q, within the model (model scenario 4nb); and a variant of model scenario 4nb that estimates an additional mortality for males and females during 2006−2010. The author recommended model scenario 4nb for use in the 2014 stock assessment. After discussion, the CPT selected model scenario 4nb as its recommended model to proceed with status determination and OFL setting. Model scenario 4nb provides a slightly better fit than the base model (see Table 4 in the assessment) and reliably estimates survey catchability. Although the addition of an additional mortality parameter for 2006−2010 in model scenario 4n7 provided a better fit than either model scenarios 4na and

4nb, the CPT did not recommend 4n7 because there is presently no biological or environmental mechanism for invoking a higher natural mortality for that period.

Stock biomass and recruitment trends

Model (scenario 4nb) estimates of total survey biomass increased from 262.1 thousand t in 1975 to 310.0 thousand t in 1978, fell to 38.1 thousand t in 1985, generally increased to 94.9 thousand t in 2007, and subsequently declined to 76.3 thousand t in 2014. Estimated recruitment was high during the 1970s and early 1980s and has been generally low since 1985. The near-term outlook for this stock is a continued declining trend. Recruitment has been poor (less than the mean from 1984-2014) since 2006. The 2011 survey produced a high catch of juvenile males and females <65 mm CL in one survey tow but that catch did not track into the 2012−2014 surveys. The survey area-swept estimates for abundance and biomass in 2014 were surprisingly high, given the poor recruitment and the size distributions and area-swept estimates from recent previous surveys.

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

Bristol Bay red king crab is in Tier 3. The proxy of B_{MSY} ($B_{35\%}$) for a Tier 3 stock is based on mature male biomass at mating (MMB) and is computed as the average recruitment over some time period multiplied by the mature male biomass-per-recruit corresponding to $F_{35\%}$ less the mature male catch under an $F_{35\%}$ harvest strategy. Based on the author's discussion regarding an apparent reduction in stock productivity associated with the well-known 1976/77 climate regime shift in the EBS, the CPT continues to recommend computing average recruitment based on model recruitment using the time period 1984 (corresponding to fertilization in 1977) to the last year of the assessment. The estimated $B_{35\%}$ is 25.7 thousand t). MMB projected for 2014/15 is, at 24.7 thousand t, 96% of $B_{35\%}$. Consequently, the Tier 3 status level for the BBRKC stock in 2014/15 is b.

The team recommends that the OFL for 2014/15 be set according to model scenario 4nb, for which the calculated OFL is 6.82 thousand t (15.04 million lb). The team recommends that the ABC for 2014/15 be set below the maximum permissible ABC. The team recommends that a 10% buffer from the OFL be used to set the ABC at 6.14 thousand t (13.53 million lb).

MMB for 2013/14 is estimated to be above MSST (12.85 thousand t) 27.1 thousand t; hence the stock was not overfished in 2013/14. The total catch in 2013/14 (4.56 thousand t) was less than the 2013/14 OFL (7.96 thousand t); hence overfishing did not occur in 2013/14. The stock at 2014/15 time of mating is projected to be above the MSST and 96% of $B_{35\%}$ (see above); hence the stock is not projected to be in overfished condition in 2014/15.

Status and catch specifications (thousand t) for Bristol Bay red king crab

Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch	OFL	ABC
2010/11	13.63	32.64[A]	6.73	6.76	7.71	10.66	
2011/12	13.77	30.88[A]	3.55	3.61	4.09	8.80	7.92
2012/13	13.19	29.05[A]	3.56	3.62	3.90	7.96	7.17
2013/14	12.85	27.12[A]	3.90	3.99	4.56	7.07	6.36
2014/15		24.69[B]				6.82	6.14

A - Estimated biomass at the time of mating for the year concerned. Note this represents a revised estimate from the projection the previous year.
B - Projected biomass from the current stock assessment. This value will be updated next year.

Status and catch specifications (millions of lb) for Bristol Bay red king crab

Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch	OFL	ABC
2010/11	30.0	72.0 [A]	14.84	14.91	17.00	23.52	
2011/12	30.4	68.1 [A]	7.83	7.95	9.01	19.39	17.46
2012/13	29.1	64.0 [A]	7.85	7.98	8.59	17.55	15.80
2013/14	28.3	59.9 [A]	8.60	8.80	10.05	15.58	14.02
2014/15		54.4 [B]				15.04	13.53

A - Estimated biomass at the time of mating for the year concerned. Note this represents a revised estimate from the projection the previous year.
B - Projected biomass from the current stock assessment. This value will be updated next year.

Additional Plan Team comments

The model scenario 4nb that the CPT selected as its preferred model for status determination and OFL setting, was the result of a previous CPT request to the author to evaluate a model that estimates catchability for the NMFS trawl surveys as an alternative model to the 2013 model (i.e., the base model scenario 4na that was reviewed for this assessment).

The CPT noted that, at its May 2014 meeting, it asked that a model allowing for higher natural mortality during 2006−2010 not be brought for consideration as a 2014 stock assessment model. The SSC in June 2014, however, requested that such a model be investigated further for presentation in September 2014, if time permits. The author obliged with a presentation of model scenario 4n7. The CPT noted that model scenario 4n7 appears to result in improved model fits, but feels that this model scenario should not be used for stock assessment until a plausible mechanism for the estimated higher natural mortality during 2006−2010 has been identified.

3 Eastern Bering Sea Tanner crab

Fishery information relative to OFL setting.

Eastern Bering Sea (EBS) Tanner crabs are caught in a directed Tanner crab fishery, and as bycatch in the groundfish fisheries, scallop fisheries, the directed Tanner crab fishery (mainly as non-retained females and sublegal males), and other crab fisheries (notably, eastern Bering Sea snow crab and, to a lesser extent, Bristol Bay red king crab). A single OFL is set for Tanner crab in the EBS. Under the Crab Rationalization Program, ADF&G sets separate TACs for directed fisheries east and one west of 166° W longitude. NMFS declared this stock overfished in 1999 and the Council developed a rebuilding plan. Both fisheries were closed from 1997 to 2004 due to low abundance. In 2005/06, abundance increased to a level to support a fishery in the area west of 166° W. longitude. 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 the proxy for B_{MSY} for two consecutive years. The mature male biomass was, however, estimated to be below the Minimum Stock Size Threshold ($0.5B_{MSY}$) in February 2010 (the assumed time of mating) based on trends in mature male biomass from the survey, and NMFS declared the stock overfished in September 2010. The directed fisheries were closed again in 2010/11 and 2011/12 crab fishery years, and remained closed in the 2012/13 crab fishery year. NMFS determined the stock was not overfished in 2012 based on a new assessment model with a revised estimate of B_{MSY}. The fishery was opened for the 2013/14 season with a Guideline Harvest Levels (GHLs) of 1,645,000 lb (746.2 t) for the area west of 166 deg. W and at 1,463,000 lb (663.6 t) for the area east of 166 deg. W.

Data and assessment methodology

A stock assessment model is used for the EBS Tanner crab. The SSC accepted the model for use in harvest specifications in 2012 and classified it as a Tier 3 stock. The current model structure, based on crab size, sex, shell condition, and maturity, is the same as in the 2013 assessment. The model uses available information on the magnitude and size-composition of: landings and discards by the directed fishery; bycatch in the Bristol Bay red king crab, EBS snow crab, and groundfish fisheries; and the NMFS trawl survey. The model includes prior distributions on parameters related to natural mortality and catchability, and penalties on changes in recruitment and in the proportion maturing. New input data were added for the 2014 assessment, and much of the previous data were recalculated and updated. In particular, retained size frequencies in the directed fishery were recalculated for 1990/91–2009/10 and updated for 2013/14. Effort data in the crab fisheries was recalculated for 1990/91–2012/13 to improve apportionment among fisheries and updated for 2013/14. The bycatch time series from crab fisheries' observer data were recalculated for 1992/93–2012/13, as were annual total at-sea size compositions. The time series of Tanner crab bycatch in the groundfish fisheries were recalculated for 2009/10–2012/13, updated to 2013/14, using SOA statistical reporting areas to expand groundfish observer data to unobserved catch. Bycatch size frequencies in the groundfish fisheries were recalculated for 1973/74–2012/13 based on the crab fishing year (July 1–June 30) rather than the groundfish year (Jan. 1–Dec. 1). Abundance, biomass and size frequency estimates from the 2014 NMFS EBS bottom trawl survey were also added to the assessment.

The major change to the assessment methodology this year is consideration of a handling mortality value of 0.321 in the crab fisheries vs. the default value of 0.500.

Stock biomass and recruitment trends

The MMB peaked in the mid-1970s and early 1990s; MMB at the time of mating was highest early in the

modeled period (February 1972; 352.5 thousand t), with secondary peaks in February 1989 (70.6 thousand t) and February 2009 (71.6 thousand t). Estimated MMB subsequently declined. The MMB in February 2015 is estimated to be 63.8 thousand t compared to 53.1 thousand t in February 2014 based on the previous assessment. Recruitment is estimated to have peaked before 1974, the first year for which survey data are included in the assessment. Subsequent peaks in recruitment occurred during 1985 through 1987 and 2009 through 2010. Estimated recruitment fell dramatically in 2011 and 2012, but has increased over the past two years to 187.9 million males in 2014.

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

The team recommends the OFL for this stock be based on the Tier 3 control rule. Application of the Tier 3 control rule requires a set of years for defining R_{MSY}, the mean recruitment corresponding to B_{MSY} under prevailing environmental conditions. The CPT previously recommended that R_{MSY} be set to the mean recruitment from 1990 onwards based on an analysis of the relationship between log(R/MMB) and MMB that identified a change in this relationship in 1985 (1990 year of recruitment to the model). The SSC subsequently recommended that the years from 1982 onwards be used, corresponding to a change in 1977. This recommendation was based on various considerations, including the reliability of the earlier recruitment estimates, and the identification of the late 1970s as a period of rapid ecological change in the EBS.

The model scenario which incorporated the CPT's recommended discard mortality was unable to estimate selectivity during the 1997-2004 time period for male bycatch in the snow crab fishery (Model Alt1b). A new model based on a re-parameterization of selectivity in the snow crab fishery was developed by the author during the CPT meeting (Model Alt4b). This model successfully addressed the problem of estimating selectivity in the snow crab fishery and was the recommended model by the CPT. Results from the model scenario are presented in an appendix to the SAFE chapter.

Based on the estimated biomass at 15 February 2015, the stock is at Tier 3 level a. The F_{MSY} proxy ($F_{35\%}$) is 0.61 yr^{-1}, and the 2014/15 is F_{OFL}=0.61 yr^{-1} under the Tier 3 OFL Control Rule, which results in a total male and female catch of 31.48 thousand t. The team had previously recommended that the ABC be adjusted over three year period due to the major change in stock status, and concern about the stability of assessment model and the uncertainty of the OFL estimate. The NMFS bottom trawl survey showed an increase in male mature biomass and a decrease in female biomass in 2014, but the stock appears to be healthy. Therefore the team considered it appropriate to make the final step incremental to the ABC. However the CPT recommends a 20% buffer to account for model uncertainty and stock productivity uncertainty be applied to the OFL, to give an ABC = 25.18 thousand t.

Status and catch specifications (1000 t) for eastern Bering Sea Tanner crab.

Year	MSST	Biomass (MMB)	TAC (East + West)	Retained Catch	Total Catch Mortality	OFL	ABC
2010/11	41.67	26.73[A]	0	0	0.87	1.45	
2011/12	11.40	58.59[A]	0	0	1.24	2.75	2.48
2012/13	16.77	59.35[A]	0	0	0.71	19.02	8.17
2013/14	16.98	72.70[A]	1.41	1.26	2.78	25.35	17.82
2014/15		63.8[B]				31.48	25.18

A - Estimated biomass at the time of mating for the year concerned. Note this represents a revised estimate from the projection the previous year.
B - Projected biomass from the current stock assessment. This value will be updated next year.

Status and catch specifications (million lb) for eastern Bering Sea Tanner crab.

Year	MSST	Biomass (MMB)	TAC (East + West)	Retained Catch	Total Catch Mortality	OFL	ABC
2010/11	91.87	58.93 [A]	0.00	0.00	1.92	3.20	
2011/12	25.13	129.17 [A]	0.00	0.00	2.73	6.06	5.47
2012/13	36.97	130.84 [A]	0.00	0.00	1.57	41.93	18.01
2013/14	37.43	160.28[A]	3.12	2.78	6.13	55.89	39.29
2014/15		140.66 [B]				69.40	55.51

A - Estimated biomass at the time of mating for the year concerned. Note this represents a revised estimate from the projection the previous year.
B - Projected biomass from the current stock assessment. This value will be updated next year.

4 Pribilof Islands red king crab

Fishery information relative to OFL setting

The Pribilof Islands red king crab fishery began in 1973 as bycatch during the blue king crab fishery. The directed red king crab fishery opened with a specified GHL for the first time in September 1993. Beginning in 1995, combined Pribilof Islands red and blue king crab GHLs were established. Declines in crab abundance of both king crab stocks from 1996 to 1998 resulted in poor fishery performance during those seasons with annual harvest levels below the GHLs. The Pribilof red king crab fishery was closed from 1999 through 2013/14 due to uncertainty in estimated red king crab survey abundance and concerns for incidental catch and mortality of Pribilof blue king crab which was an overfished and severely depressed stock. Prior to the closure, the 1998/99 harvest was 246.9 t (0.544 million lb). The non-retained catches, with application of bycatch mortality rates, from pot and groundfish bycatch estimates of red king crab ranged from 1.2 t (0.003 million lb) to 192.1 t (0.424 million lb) during 1991/92 to 2012/14.

Data and assessment methodology

The 2014 assessment is based on trends in male mature biomass (MMB) at the time of mating inferred from NMFS bottom trawl survey from 1975-2014 and commercial catch and observer data from 1973/74 to 2013/14. The revised time-series of historical NMFS trawl survey abundance estimates were used in this assessment. The 2013/14 non-retained catch from all non-directed pot and groundfish fisheries were included in the SAFE report, incorporating the updated data set for observed groundfish fisheries which aggregates data on crab catch by species to the level of the respective stock area; prior to 2009, bycatch data are aggregated over all crab species by federal reporting area.

Two assessment methods were presented for evaluation: one calculated an annual index of MMB derived as the 3-yr running average centered on the current year MMB and weighted by the inverse variance; and a new integrated length-based assessment model which was reviewed by the CPT and SSC in the spring of 2014. While the 3-yr running average fit the survey data better than the integrated assessment model results, the integrated assessment incorporates additional data including length composition data and was seen as an improvement over the running average. The Crab Plan Team recommended using the biomass estimated derived from the integrated assessment model for setting the 2014/15 harvest specifications. Natural mortality was used as a proxy for F_{MSY} and a proxy for B_{MSY} was calculated by averaging MMB from the 1991/92 through the current season.

Stock biomass and recruitment trends

The stock exhibited widely varying mature male and female abundances during 1975-2014. Using the integrated assessment, the MMB estimated for 2014 was 2,239 t (4.94 million lb). Retained catches have not occurred since the 1998/99 season. Mature stock biomass (both males and females) increased in 2000/01 and has declined slightly in recent years. The estimated recruitment is very poor during recent years (2003 – present) and there does not seem to be a relationship between female mature biomass and recruitment at 4, 5, or 6 year lags, although this stock may not be well sampled by the NMFS survey. Non-directed discard losses in the pot fisheries decreased in recent years, and there are no discard losses in the current year. Bycatch losses resulting from the fixed gear groundfish fleet using the new dataset have ranged from 0.12 t (264 lb) in 2012/13 to 0.45 t (992 lb) in 2010/11, while losses resulting from discards in the groundfish trawl fleet ranged from 12,980 t (28.62 million lb) in 2012/13 to 1.05 t (0.002 million lb) in 2009/10.

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

The author recommended and the CPT agreed that this stock should remain in Tier 4 for stock status level determination. For 2014/15 the $B_{MSY\ proxy}$ = 2,754 t of MMB_{mating} derived as the mean of 1991/92 to 2013/14. Male mature biomass at the time of mating for 2013/14 was estimated at 2.239 t. The $B/\ B_{MSY\ Proxy}$ =0.81 and F_{OFL}=0.18. $B/\ B_{MSY\ Proxy}$ is < 1, therefore the stock status level is *b*. For the 2014/15 fishery, the OFL was estimated at 320 t (0.71 million lb) of crab.

The maxABC, estimated using a p-star of 0.49, was 311 t (0.69 million lb). The author did not provide a recommendation to set the ABC below the maximum permissible. The CPT felt that additional uncertainty was warranted given the comparatively low amount of information available for Pribilof Island red king crab. Moving from a three-year weighted average calculation of MMB to an integrated assessment reduced the amount of uncertainty in this assessment. Therefore, the CPT recommended a 15% buffer (down from 20% the previous year) from the OFL be used to set the ABC at 272 t (0.60 million lb).

Status and catch specifications (t) of Pribilof Islands red king crab

Year	MSST	Biomass (MMB_{mating})	TAC	Retained Catch	Total Catch	OFL	ABC
2010/11	2,255	2,754[A]	0	0	4.2	349	
2011/12	2,571	2,775[A*]	0	0	5.4	393	307
2012/13	2,609	4,025[A**]	0	0	13.1	569	455
2013/14	2,582	4,679[A**]	0	0	2.25	903	718
2014/15	2,754	2,239[B***]				320	272

A - Estimated biomass at the time of mating for the year concerned. Note this represents a revised estimate from the projection the previous year.
B - Projected biomass from the current stock assessment. This value will be updated next year.
*2011/12 estimates based on 3 year running average
**estimates based on weighted 3 year running average using inverse variance
***estimates based on integrated length-based assessment

Status and catch specifications (million lb) of Pribilof Islands red king crab

Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch	OFL	ABC
2010/11	4.97	6.07[A]	0	0	0.009	0.77	
2011/12	5.67	6.12[A*]	0	0	0.011	0.87	0.68
2012/13	5.75	8.87[A**]	0	0	0.029	1.25	1.00
2013/14	5.66	10.32[A**]	0	0	0.005	1.99	1.58
2014/15	6.07	4.94[B***]				0.71	0.60

A - Estimated biomass at the time of mating for the year concerned. Note this represents a revised estimate from the projection the previous year.
B - Projected biomass from the current stock assessment. This value will be updated next year.
*2011/12 estimates based on 3 year running average
**estimates based on weighted 3 year running average using inverse variance
***estimates based on integrated length-based assessment

The stock was above MSST in 2013/14 and is hence not overfished. Overfishing did not occur during the 2013/14 fishing year.

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 lb during the 1980/81 season. A steep decline in landings occurred after the 1980/81 season. Directed fishery harvest from 1984/85 until 1987/88 was annually less than 1.0 million lb with low CPUE. The fishery was closed from 1988/89 through 1994/95 fishing seasons. The fishery reopened from 1995/96 to 1998/99 seasons. Fishery harvests during this period ranged from 1.3 to 2.5 million lb. The fishery closed again for the 1999/00 season due to declining stock abundance and has remained closed through the 2013/14 season. The stock was declared overfished in 2002.

A revised rebuilding plan was submitted for review by the Secretary of Commerce in 2013 as NMFS determined that the stock was not rebuilding in a timely manner and would not meet the rebuilding horizon of 2014; the revised rebuilding plan is still under review. This rebuilding plan closes the Pribilof Island Habitat Conservation Zone to Pacific cod pot fishing, which comprises the highest historical rates of bycatch of this stock. This area is already closed to groundfish trawl fishing.

Data and assessment methodology

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

The calculation of the 2014/15 survey biomass uses the stock area definition established in 2012/13 that includes an additional 20 nm strip east of the Pribilof District. MMB was estimated using a three-year running average centered on the current year weighted by the inverse variance of the area-swept estimate. Groundfish bycatch data for blue king crab from 2009/10 – 2013/14 used SOA statistical areas which provided greater resolution than previous data. The time series of the Pribilof Islands stock area utilizing SOA statistical areas resulted in significantly different estimates of blue king crab bycatch biomass in 2009/2010-2012/2013 than previously reported. In 2013/2014, using the new estimation method, 0.03 t of male and female blue king crab bycatch mortality were attributed to fixed gear (hook-and-line) and none to trawl gear. The targeted species in these fisheries were Pacific cod (99.2%), and yellowfin sole, flathead sole and sablefish each less than 1%.

Stock biomass and recruitment trends

The estimated mature-male biomass decreased to 225 t in 2013/14 from 579 t in 2012/13. The 2014/15 MMB at mating is projected to be 218 t, which is 5% of the proxy for 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 and ABC determination

This stock is recommended for placement into Tier 4. B_{MSY} was estimated using the time periods 1980/81 -1984/85 and 1990/91-1997/98. 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 at 4,022 t (8.82 million pounds).

Because the projected 2014/15 estimate of MMB is less than 25% B_{MSY}, the stock is in stock status c and the directed fishery F is 0. However, an F_{OFL} must be determined for the non-directed catch. Ideally this should be based on the rebuilding strategy. For this stock the F_{OFL} is based on average groundfish bycatch between 1999/00 and 2005/06. The recommended OFL for 2013/14 is 1.16 t (0.003 million lb).
The CPT recommended setting the ABC less than the maximum permissible by employing a 25% buffer

on the OFL. This recommendation was based upon continuing concerns with stock status and consistency with relative buffer levels for other stocks for which the OFL is based upon average catch.

Status and catch specifications (t) of Pribilof Islands blue king crab in recent years.

Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch	OFL	ABC
2010/11	2,105	286[A]	Closed	0	0.18	1.81	
2011/12	2,247	365[A]	Closed	0	0.36	1.16	1.04
2012/13	1,994	579[A]	Closed	0	0.61	1.16	1.04
2013/14	2,001	278 [A]	Closed	0	0.03	1.16	1.04
2014/15		218 [B]				1.16	0.87

A - Estimated biomass at the time of mating for the year concerned. Note this represents a revised estimate from the projection the previous year.
B - Projected biomass from the current stock assessment. This value will be updated next year.

Status and catch specifications (million lb) of Pribilof Islands blue king crab in recent years.

Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch	OFL	ABC
2010/11	4.64	0.63[A]	Closed	0	0.0004	0.004	
2011/12	4.95	0.80[A]	Closed	0	0.0008	0.003	0.002
2012/13	4.39	1.28[A]	Closed	0	0.0013	0.003	0.002
2013/14	4.41	0.61[A]	Closed	0	0.0001	0.003	0.002
2014/15		0.48 [B]				0.003	0.0019

A - Estimated biomass at the time of mating for the year concerned. Note this represents a revised estimate from the projection the previous year.
B - Projected biomass from the current stock assessment. This value will be updated next year.

The total catch for 2013/14 (0.03 t, 0.0001 million lb) was less than the 2013/14 OFL (1.16 t, 0.003 million lb) so overfishing did not occur during 2013/14. The 2014/15 projected MMB estimate of 218 t (0.48 million lb) is below the proxy for MSST (MMB/B_{MSY} = 0.05) so the stock continues to be in an overfished condition and failed to rebuild within the maximum required rebuilding time.

6 St. Matthew blue king crab

Fishery information relative to OFL setting

The fishery was prosecuted as a directed fishery from 1977 to 1998. Harvests peaked in 1983/84 when 9.454 million lb were landed by 164 vessels. Harvest was fairly stable from 1986/87 to 1990/91, averaging 1.252 million lb annually. Harvest increased to a mean catch of 3.297 million lb during the 1991/92 to 1998/99 seasons until the 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, an area closure to control bycatch, and gear modifications. In 2008/09 and 2009/10, the MMB was estimated to be above B_{MSY} for two years and the stock declared rebuilt in 2009.

The fishery re-opened in 2009/10 with a TAC of 1.167 million lb and 0.461 million lb of retained catch were harvested. The 2010/11 TAC was 1.600 million lb and the fishery reported a retained catch of 1.264 million lb. The 2011/12 harvest of 1.881 million lb represented 80% of 2.539 million lb TAC. In 2012/13, by contrast, harvesters landed 99% (1.616 million lb) of a reduced TAC of 1.630 million lb, though fishery efficiency, at about 10 crab per pot, was little changed from what it had been in each of the previous three years. The directed fishery was closed in 2013/14 due to declining trawl survey estimates of abundance and concerns about the health of the stock. Bycatch of non-retained blue king crab has been observed in the St. Matthew blue king crab fishery, the eastern Bering Sea snow crab fishery, and trawl and fixed-gear groundfish fisheries. Based on limited observer data, bycatch of sublegal male and female crabs in 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.

Data and assessment methodology

A three-stage catch-survey analysis (CSA) is used to assess the male crab ≥90 mm CL. The three size categories are: 90–104 mm CL; 105–119 mm CL; and ≥120 mm CL. Males ≥ 105 are used as a proxy to identify mature males, and males ≥ 120 mm CL are used as a proxy to identify legal males. The CSA incorporates the following data: (1) commercial catch data from 1978/79 -1998/99, 2009/10- 2012/13; (2) annual trawl survey data from 1978 to 2014; (3) triennial pot survey data from 1995 to 2013; (4) bycatch data in the groundfish trawl and groundfish fixed-gear fisheries from 1991 to 2014; and (5) ADF&G crab-observer composition data for the years 1990/91–1998/99, 2009/10–2012/13. Trawl survey data are from 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 the three size categories. The pot survey data originate from the ADF&G triennial pot surveys that occurred during July and August in 1995, 1998, 2001, 2004, 2007, 2010 and 2013. The pot survey samples areas of high-relief habitat important to 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 pot survey years. The CPUE (catch per pot lift) indices from those 96 stations for the male categories listed above were used in the assessment.

Groundfish discard information for trawl and fixed gear is estimated from NMFS observer data. 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.

Stock biomass and recruitment trends

The 2014 assessment estimates that the stock is currently below the proxy for $B_{MSY,}$ as it was in the previous year. The MMB has fluctuated substantially over three periods, increasing during 1978 to 1981 of the first period from 7.6 million lb to 17.6 million lb, followed by a steady decrease to 2.9 million lb in

1985. The second period had a steady increase from 1986 to 13.3 million lb in 1997 followed by a rapid decline to 2.8 million lb in 1999. The third period starting in 2000 had a steady increase in all size classes and peaked at 14.77 million lb in 2010/2011 before declining to 6.29 million lb in 2012/2013.

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

The stock assessment examines four model configurations: 1) the base model used previously; 2) the base model with time-varying trawl-survey selectivity (Model S); 3) the base model with alternative stage-transition matrix (Model T); and 4) the base model with both modifications above (Model ST). These modifications were added to address concerns previously raised by the CPT and SSC. The author recommended use of the fourth model. Model comparisons suggest that the modified models fit the trawl-survey-index better than the base model and that the author-recommended model fits the trawl survey composition data better than the base model and two other formulations. The CPT expressed concerns with time varying selectivity, as no mechanism was identified to explain this variability and concerns were raised that it was fitting sampling error. Some plan team members regarded the selectivity patterns to be implausible, especially selectivities > 1 for the stage-2 crab. However, others commented that it could be possible given crab movement and the mismatch between survey-station location and crab distribution. As a result, the CPT selected the base model with an alternative stage-transition matrix (Model T) because the selectivities were reasonable (i.e. < 1 for stage-2 crab) unlike the previous base model. However, the CPT noted that this model still has poor fits to stage composition data and a retrospective pattern.

The CPT-recommended model uses the full assessment period (1978/79-2013/14) to define the proxy for B_{MSY} in terms of average estimated MMB_{mating} with gamma (γ)=1 and an instantaneous natural mortality 0.18^{-1} year. The MMB estimated for 2013/14 under the recommended model is 6.71 million lb (3,040 t) and the F_{MSY} proxy is taken equal to the assumed instantaneous natural mortality rate (0.18^{-1} year), resulting in a mature male biomass OFL of 0.940 million lb (426 t). The author recommended and the CPT concurred with a 20% buffer on the OFL for the ABC because of additional uncertainty in the model. This same approach was used last year. The ABC based on 20% buffer is 0.752 million lb (341 t).

Status and catch specifications (1000 t) of St. Matthew blue king crab

Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch	OFL*	ABC
2010/11	1.5	6.70[A]	0.73	0.57	0.64	1.04	
2011/12	1.5	5.03[A]	1.15	0.85	0.95	1.70	1.50
2012/13	1.8	2.85[A]	0.74	0.73	0.82	1.02	0.92
2013/14	1.5	3.04[A]	0	0	0.00027	0.56	0.45
2014/15	1.8	3.04[B]				0.43	0.34

A - Estimated biomass at the time of mating for the year concerned. Note this represents a revised estimate from the projection the previous year.
B - Projected biomass from the current stock assessment. This value will be updated next year.*Total male catch only

Status and catch specifications (millions lb) of St. Matthew blue king crab

Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch	OFL*	ABC
2010/11	3.4	14.77[A]	1.60	1.26	1.41	2.29	
2011/12	3.4	11.09[A]	2.54	1.88	2.10	3.31	3.40
2012/13	4.0	6.29[A]	1.63	1.62	1.81	2.24	2.02
2013/14	3.4	6.71[A]	0	0	0.0006	1.24	0.99
2014/15	3.9	6.71[B]				0.94	0.75

The total male catch for 2013/14 (0.00 million lb) was less than the 2013/14 OFL (1.24 million lb) so overfishing did not occur during 2013/14. Likewise, the 2013/14 MMB (6.71 million lb) is above the MSST (3.9 million lb) so the stock is not in an overfished condition.

Additional Plan Team recommendations

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

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. 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 0.3 million pounds, including several low years in the 1990s. As the crab population rebounded, retained catches have increased somewhat to around 0.4 million pounds in recent years

Data and assessment methodology

Four types of surveys have occurred periodically during the last three decades: summer trawl, summer pot, winter pot, and preseason summer pot, but none of these surveys have been conducted every year. To improve abundance estimates, a male-only length-based model of male crab abundance was previously developed that combines multiple sources of data. A maximum likelihood approach was used to estimate abundance, recruitment, and selectivity and catchability of the commercial pot gear. The model has been updated with the following data: 1980–2012 winter pot survey, and 2013/2014 winter commercial and subsistence catches. In addition, the 1976–2011 trawl survey data were revised, but with no new years of data available (the next survey is scheduled for 2014). The current model assumes a constant $M=0.18yr^{-1}$, except for a fixed value of $0.648yr^{-1}$ for the largest length class. Logistic functions are used to describe fishery and survey selectivities, except for a dome-shaped function examined for the winter pot fishery.

The author summarized six model run alternatives, with the base model (Model 0) and alternatives originating from the 2014 modeling workshop. The CPT selected Model 2io as the recommended configuration based on: separate selectivities for NMFS and ADF&G trawl surveys; inclusion of winter survey data as a means of informing the winter fishery harvest,(although this had negligible impact on model results); and estimation of a growth matrix inside the model (separated for newshell and oldshell crab).

Stock biomass and recruitment trends

Mature male biomass was estimated to be at an historic low in 1982 following a crash from the peak biomass in 1977. The MMB then exhibited an upward trend from a recent low in 1997 to a peak in 2010, before declining in recent years. 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 variable but with a slight increase in recent years.

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

The team recommended Tier 4, stock status b, for Norton Sound red king crab. For the recommended Model 2io, the author presented stock status information for retained catch. Model-based total catch estimates were provided, however, these estimates were model-generated from limited observer data and the team did not recommend their use in generating a total catch OFL. Thus the OFL and ABC are based on retained catch (only).

The estimated abundance and biomass in 2014 using model 2io are:
Mature male biomass: 3.71 million lb with a standard deviation of 0.64 million lb.

The $B_{MSY\ \text{proxy}}$, calculated as the average of mature male biomass during 1980-2014, was $B_{MSY\ \text{proxy}} = 4.19$

million lb. The $F_{MSY\ proxy}$ is M =0.18 yr^{-1} and the F_{OFL}=0.157yr^{-1}, because the 2014 mature male biomass is less than $B_{MSY\ proxy}$ with the CPT choosing the default of gamma =1.0, is.

The maximum permissible ABC would be 0.463 million lb, based on retained catch. The CPT recommended an ABC less than the maximum permissible due to concerns with model specification, lack of bycatch data as well as issues noted with the M employed for the largest length group. The CPT recommended an ABC = 90% of the OFL (10% buffer) of 0.417 million pounds.

Status and catch specifications (1000 t) of Norton Sound red king crab

Year	MSST	Biomass (MMB)	GHL	Retained Catch	Total Catch	OFL	ABC
2010/11	0.71	2.47	0.18	0.19	0.22	0.33	
2011/12	0.71	2.13	0.16	0.18	0.20	0.30	0.27
2012/13	0.81	2.08	0.21	0.21	0.21	0.24	0.22
2013/14	0.93	2.16	0.23	0.16	0.16	0.26	0.24
2014/15	0.96	1.68	TBD	TBD	TBD	0.21	0.19

Status and catch specifications (million lb) of Norton Sound red king crab

Year	MSST	Biomass (MMB)	GHL	Retained Catch	Total Catch	OFL	ABC
2010/11	1.56	5.44	0.40	0.42	0.46	0.73	
2011/12	1.56	4.70	0.36	0.40	0.43	0.66	0.59
2012/13	1.76	4.59	0.47	0.47	0.47	0.53	0.48
2013/14	2.06	5.00	0.50	0.35	0.35	0.58	0.52
2014/15	2.11	3.71	TBD	TBD	TBD	0.46	0.42

Total catch in 2013/14 did not exceed the OFL for this stock thus overfishing is not occurring. The stock biomass is above MSST; thus, the stock is not overfished.

Additional Plan Team recommendations

The CPT has the following recommends for the next assessment:

- construct a likelihood profile for M for all size classes vs. a single M for the largest size class and a separate M for the remaining classes;
- explore different weighting schemes for the tag data.

Due to the availability of survey and catch data, the assessment cannot be finalized for the September CPT cycle as planned. Thus the CPT recommends finalizing the assessment at a mid-year meeting (see CPT report for more details).

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 in 1986/87 at 14.7 million lb and averaged 11.9 million lb over the 1985/86-1989/90 seasons. Average harvests dropped sharply from 1989/90 to 1990/91 to a level of 6.9 million lb 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 established for the 1996/97 season, which was based on the previous five-year average catch, was subsequently reduced to 5.7 million lb beginning in 1998/99. The GHL (or TAC, since 2005/06) remained at 5.7 million lb for 2007/08, but was increased to 6.0 million lb for the 2008/09-2011/12 seasons, and to 6.3 million lb for the 2012/13 and 2013/2014 seasons. Average annual retained catch for the period 1996/97–2007/08 was 5.6 million lb, and 6.0 million lb for the period 2008/09-2012/13. The retained catch for 2012/13 was 6.3 million lb. This fishery is rationalized under the Crab Rationalization Program. The 2013/14 season ends by regulation on 15 May 2013.

Non-retained bycatch occurs mainly in the directed fishery, and to a minor extent in other crab fisheries. Bycatch also occurs in fixed-gear and trawl groundfish fisheries although that bycatch is low relative to the weight of bycatch in the directed fishery. Total annual non-retained catch of golden king crab during crab fisheries has decreased relative to the retained catch since the 1990s. It decreased from 13.8 million lb in 1990/91 (199% of the retained catch) to 9.1 million lb in 1996/97 (156% of the retained catch), and to 4.3 million lb in the 2004/05 season (78% of the retained catch). Bycatch in the post-rationalized fishery (2005/06-2012/13) has ranged from 2.5 million lb in 2005/06 (46% of the retained catch) to just over 3.0 million lb for 2007/08 (55% of the retained catch). Bycatch mortality has correspondingly decreased since 1996/97 both in absolute weight and relative to the retained catch weight. Estimated total mortality (retained catch plus bycatch in crab and groundfish fisheries) ranged from 5.8-9.4 million lb over 1995/96–2012/13. Estimated total mortality in 2012/13 was 6.9 million lb.

Data and assessment methodology

Available data used in the Tier 5 assessment are from ADF&G fish tickets (retained catch numbers, retained catch weight, and pot lifts by ADF&G statistical area and landing date), size-frequencies from samples of landed crabs, at-sea observations from pot lifts sampled during the fishery (date, location, soak time, catch composition, size, sex, and reproductive condition of crabs, etc.), and bycatch estimates from the groundfish fisheries. These data are available through the 2012/13 season; complete data from the 2013/14 fishery season, which ends on 15 May 2014, are not currently available. 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. Data from triennial pot surveys (last performed in 2006) in the Yunaska-Amukta Island area of the Aleutian Islands, approximately 171° W longitude, and tag recoveries from crabs released during the triennial pot surveys are also available, but are not included in the Tier 5 assessment. 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 new survey as well as an assessment model are currently being developed for this stock.

Stock biomass and recruitment trends

Although a stock assessment is in development, it has not yet been accepted for use in management. There are consequently no estimates of stock biomass. Estimates of recruitment trends and current levels relative to virgin or historic levels are also not available.

Summary of major changes

Fishery data have been updated with the results for 2012/13: retained catch for the directed fishery and bycatch estimates for the directed fishery, non-directed crab fisheries, and groundfish fisheries.

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

The CPT recommends that this stock be managed as a Tier 5 stock in 2014/15. B_{MSY} and MSST are not estimated for this stock. Observer data on bycatch from the directed fishery and groundfish fisheries provides the estimate of total bycatch mortality. Bycatch data from the directed fishery for years after the 1990/91 season (excluding 1993/94 and 1994/95 seasons due to insufficient data) and from the groundfish fisheries since the 1993/94 season were used. 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.

This assessment author recommended using the same approach for determining the 2014/15 total catch OFL as was used to determine the 2013/14 total catch OFL. This approach uses data for 1985/86–1995/96 to estimate the mean retained catch in the crab fisheries, and bycatch data for 1990/91-95/96 to estimate the mean bycatch rate (0.363):

$$OFL_{2013/14} = (1+R_{90/91\text{-}95/96})\bullet RET_{85/86\text{-}95/96} + BM_{GF,93/94\text{-}08/09} = 12{,}537{,}757 \text{ lb}$$

where,

- $R_{90/91\text{-}95/96}$ is the average of the annual ratios of bycatch mortality due to crab fisheries to retained catch in pounds over the period of the subscripted years, excluding 1993/94–1994/95 due to data confidentiality and lack of data,
- $RET_{85/86\text{-}95/96}$ is the average annual retained catch in the directed crab fishery over the period 1985/86-1995/96), and
- $BM_{GF,93/94\text{-}08/09}$ is the average of the annual estimates of bycatch mortality due to groundfish fisheries over the period 1993/94-2008/09.

The assessment author recommended a 25% buffer between the OFL and ABC, which is an increase over the 10% buffer used in recent years. The author noted that the time-period used to determine the OFL for Tier 5 stocks should be representative of a stock's productivity. In the past, the CPT has suggested various time ranges to compute the OFL, which suggests uncertainty regarding the time-period to represent productivity and the basis for setting the OFL. The assessment author noted that the ABC for the Tier 5 Adak red king crab stock is based on a 40% buffer, and three of the six FMP stocks that are surveyed by the EBS bottom trawl survey have buffers >10%. The CPT agreed that there is more uncertainty than is accommodated by a 10% buffer; however, the CPT agreed that uncertainty estimation issues should be more comprehensively addressed in the September CPT meeting and thus recommended the status quo 10% buffer for 2014/15 for this stock. The CPT recommended ABC is 11,283,981 lb.

Status and catch specifications (1000 t) of Aleutian Islands golden king crab

Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch[a]	OFL	ABC
2010/11	N/A	N/A	2.72	2.71	2.98	5.02	N/A
2011/12	N/A	N/A	2.72	2.71	2.95	5.17	4.66
2012/13	N/A	N/A	2.85	2.84	3.12	5.69	5.12
2013/14	N/A	N/A	2.85	2.89	3.19	5.69	5.12
2014/15	N/A	N/A	2.85			5.69	4.26

a. Total retained catch plus estimated bycatch mortality of discarded bycatch during crab fisheries and groundfish fisheries.

Status and catch specifications (million lb) of Aleutian Islands golden king crab

Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch[a]	OFL	ABC
2010/11	N/A	N/A	5.99	5.97	6.56	11.06	N/A
2011/12	N/A	N/A	5.99	5.96	6.51	11.40	10.26
2012/13	N/A	N/A	6.29	6.27	6.87	12.54	11.28
2013/14	N/A	N/A	6.29	6.38	7.04	12.54	11.28
2014/15	N/A	N/A	6.29			12.53	9.40

a. Total retained catch plus estimated bycatch mortality of discarded bycatch during crab fisheries and groundfish fisheries.

Overfishing did not occur during 2013/14 because the estimated total catch did not exceed the Tier 5 overfishing limit (OFL) of 12.54-million lb (5.69 thousand t). The total catch did not exceed the ABC established for 2013/14 (11.28-million lb, or 5.12 thousand t). The OFL and ABC values for 2014/15 in the table below are the values recommended by the SSC in June 2014. The 2014/15 TAC was established by ADF&G on 15 July 2014. The TACs for 2013/14 and 2014/15 in the table below do not include landings towards a cost-recovery fishing goal of $300,000 to cover costs of observer deployments in the fishery; the catch totals for 2013/14 do include the catch towards the 2013/14 cost-recovery fishery.

Additional Plan Team recommendations

The CPT reviewed progress on the assessment model for Aleutian Islands golden king crab. Detailed comments and recommendations for the model are contained in the CPT report. The team intends to further review this model at the January 2015 modeling workshop.

9 Pribilof District Golden King Crab

Fishery information relative to OFL setting

The Pribilof District fishery for male golden king crab developed in the 1982/83 season. The directed fishery mainly occurs in Pribilof Canyon of the continental slope. Peak directed harvest is 0.856-million lb (388 t) during the 1983/84 season by 50 vessels. Following the close of the 1983/84 season, since then, fishery participation has been sporadic and retained catches vary from 0 to 0.342-million lb (155 t). The current fishing season is based on a calendar year and the 2014 season is ongoing. The fishery is not rationalized and there is no SOA harvest strategy. A guideline harvest level (GHL) was first established for the fishery in 1999 at 0.200-million lb (91 t) and has been managed with a GHL of 0.150-million lb (68 t) since 2000. No directed fishery occurred during 2006–2009. One vessel landed catch in 2010, two vessels landed catch in 2011, and one vessel landed catch in each of 2012 and 2013. Catch and other fishery data from the directed fishery for those four years cannot be reported under the confidentiality requirements of the SOA. Non-retained bycatch occurs in the directed golden king crab fishery and can occur in the eastern Bering Sea snow crab fishery, Bering Sea grooved Tanner crab fishery, and Bering Sea groundfish fishery. Estimated total fishing mortality during 2001-2013 due to directed and non directed crab fisheries range from 0 to 0.160- million lb (73 t). Crab mortality in groundfish fisheries range from < 0.001 - million lb (< 1t) to 0.027-million lb (12 t) during 1991/92-2012/13.

Data and assessment methodology

Total golden king crab biomass has been estimated during the NMFS upper-continental-slope trawl surveys in 2002, 2004, 2008, 2010 and 2012. The survey scheduled for 2014 was cancelled, precluding a survey-based approach for establishing an OFL for 2015. The estimated total stock biomass for the entire slope survey area and the Pribilof Canyon have been estimated independently by the NMFS and ADFG. The estimates from the 2012 survey range 4.244 – 4.475 million lb (1925-2030 t) for the whole upper continental slope and 1.567 – 1.716 million lb (711 -778 t) for the Pribilof Canyon area.

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 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 are confidential due to low number of participants.

Stock biomass and recruitment trends

Using the size-sex composition data from the slope surveys, the estimated mature male biomass in the entire survey area have increased slightly from 1.692 million lb (767 t) in 2010 to 1790 million lb (812 t) in 2012. However, estimated mature male biomass in the Pribilof canyon area has decreased markedly from 0.970 million lb (440 t) in 2010 to 0.565 million lb (256 t) in 2012.

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

The Team recommends this stock be managed under Tier 5 in 2015.

The assessment author presented only one alternative for establishing the OFL. The Team concurs with the author's recommendation for the 2015 OFL based on the same analysis as the 2014 OFL of 0.2 million lb and the maximum permissible ABC of 0.15 million lb. The ABC was derived by applying the Tier 5 control rule a 25% buffer of the OFL, ABC = 0.75 * OFL. The 2015 OFL calculation formula is the same as recommended by the SSC for 2012−2014:

$OFL_{2015} = (1+R_{2001–2010})*RET_{1993-1998} + BM_{NC,1994-1998} + BM_{GF,1992/93–1998/99}$

where,

- $R_{2001–2010}$ is the average of the estimated annual ratio of lb of bycatch mortality to lb of retained in the directed fishery during 2001–2010
- $RET_{1993-1998}$ is the average annual retained catch in the directed crab fishery during 1993–1998
- $BM_{NC,1994-1998}$ is the estimated average annual bycatch mortality in non-directed crab fisheries during 1994–1998
- $BM_{GF,1992/93–1998/99}$ is the estimated average annual bycatch mortality in groundfish fisheries during 1992/93–1998/99.

Status and catch specifications (t) of Pribilof District golden king crab

Year	MSST	Biomass (MMB)	GHL	Retained Catch	Total Catch	OFL	ABC
2011	N/A	N/A	68	Conf.	Conf.	82	N/A
2012	N/A	N/A	68	Conf.	Conf.	91	82
2013	N/A	N/A	68	Conf.	Conf.	91	82
2014	N/A	N/A	68			91	82
2015	N/A	N/A				91	68

N/A = not available

Conf. = confidential

Status and catch specifications (millions lb) of Pribilof District golden king crab

Year	MSST	Biomass (MMB)	GHL	Retained Catch	Total Catch	OFL	ABC
2011	N/A	N/A	0.15	Conf.	Conf.	0.18	N/A
2012	N/A	N/A	0.15	Conf.	Conf.	0.20	0.18
2013	N/A	N/A	0.15	Conf.	Conf.	0.20	0.18
2014	N/A	N/A	0.15			0.20	0.18
2015	N/A	N/A	0.15			0.20	0.15

N/A = not available

Conf. = confidential

10 Adak red king crab, Aleutian Islands

Fishery information relative to OFL and ABC 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 in 1998/99, and from 2000/01-2003/04. Peak harvest occurred during the 1964/65 season with a retained catch of 21.19 million lb. 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, a large portion of the retained catch came from the area west of 179° 15' W longitude.

Retained catch during the 10-year period, 1985/86 through 1994/95, averaged 0.94 million lb, but the retained catch during the 1995/96 season was low, only 0.04 million lb. 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 0.50 million lb 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 0.51 million lb (2002/03) and 0.48 million lb (2003/04). The fishery has been closed 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 1995/96-2012/13 seasons averaged 0.002 million lb in crab fisheries and 0.019 million lb in groundfish fisheries. Estimated annual total fishing mortality (in terms of total crab removal) during 1995/96-2012/13 averaged 0.091 million lb. The average retained catch during that period was 0.070 million lb. This fishery is rationalized under the Crab Rationalization Program only for the area west of 179° W longitude. Bycatch in 2012/13 was 196 lb in crab fisheries and 428 lb in groundfish fisheries (total catch 624 lb).

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 1995/96-2012/13 and from groundfish fisheries during 1993/94-2012/13 are available. There is no assessment model 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. An ADF&G-Industry survey was conducted as a commissioner's permit fishery in the Adak-Atka-Amlia Islands area in November 2002 and provided no evidence of recruitment sufficient to support a commercial fishery. A pot survey conducted by ADF&G in the Petrel Bank area in 2006 provided no evidence of strong recruitment. A 2009 survey conducted by ADF&G in the Petrel Bank area encountered a smaller, ageing population with the catch of legal male

crab occurring 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 and ABC determination

The CPT recommends that this stock be managed under Tier 5 for the 2014/15 season. The CPT concurs with the assessment author's recommendation of an OFL based on the 1995/96–2007/08 average total catch following the recommendation of the SSC in June 2010 to freeze the time period for computing the OFL at 1995/96–2007/08. The CPT recommends an OFL for 2014/15 of 0.12 million lb.

The Team continues to have concerns regarding the depleted status of this stock. Groundfish bycatch in recent years has accounted for the majority of the catch of this stock. The maximum permissible ABC is 0.11 million lb based on the Tier 5 control rule of a 10% buffer on the OFL.

The CPT recommends an ABC of 0.074 million lb for 2014/15, which is below the maximum permissible ABC (maxABC = 0.11 million lb). Industry has expressed interest in past years in an exploratory fishery around the Adak area based on anecdotal information that there may be legal crab available in this stock. Industry chose not to conduct a test fishery in 2012/13 and no such test fishery has been scheduled to date for 2014.

Status and catch specifications (1000 t) of Adak (WAI) red king crab

Year	MSST	Biomass (MMB)	TAC	Retained Catch[a]	Total Catch[a]	OFL	ABC
2010/11	N/A	N/A	Closed	0	2	54	N/A
2011/12	N/A	N/A	Closed	0	1	54	12
2012/13	N/A	N/A	Closed	0	<1	54	32
2013/14	N/A	N/A	Closed	0	<1	54	32
2014/15	N/A	N/A	Closed			54	32

Status and catch specifications (millions lb) of Adak (WAI) red king crab

Year	MSST	Biomass (MMB)	TAC	Retained Catch[a]	Total Catch[a]	OFL	ABC
2010/11	N/A	N/A	Closed	0	0.004	0.12	N/A
2011/12	N/A	N/A	Closed	0	0.002	0.12	0.03
2012/13	N/A	N/A	Closed	0	<0.001	0.12	0.07
2013/14	N/A	N/A	Closed	0	<0.001	0.12	0.07
2014/15	N/A	N/A	Closed			0.12	0.07

a Includes bycatch mortality of discarded bycatch.

Overfishing did not occur during 2013/14; the estimated total catch did not exceed the Tier 5 OFL of 0.12-million lb (56 t). The total catch did not exceed the ABC established for 2013/14 (0.7-million lb, or 34 t). The OFL and ABC values for 2014/15 in the tables below are the values recommended by the SSC in June 2014.

Additional Plan Team discussion

The plan team discussed the history of catch of the stock in continuing to recommend the status quo ABC. A State of Alaska Board of Fisheries meeting in March 2014 divided the area into two management

districts: 1) west of 179 degrees W longitude and 2) 171 to 179 degrees W longitude. Pot limits were established at 10 pots per vessel in SOA waters and 15 pots in federal waters. The season open date was changed from October 15 to August 1 and federal waters would be closed when the GHL is less than 250,000 lb (113 t).

Figures and Tables

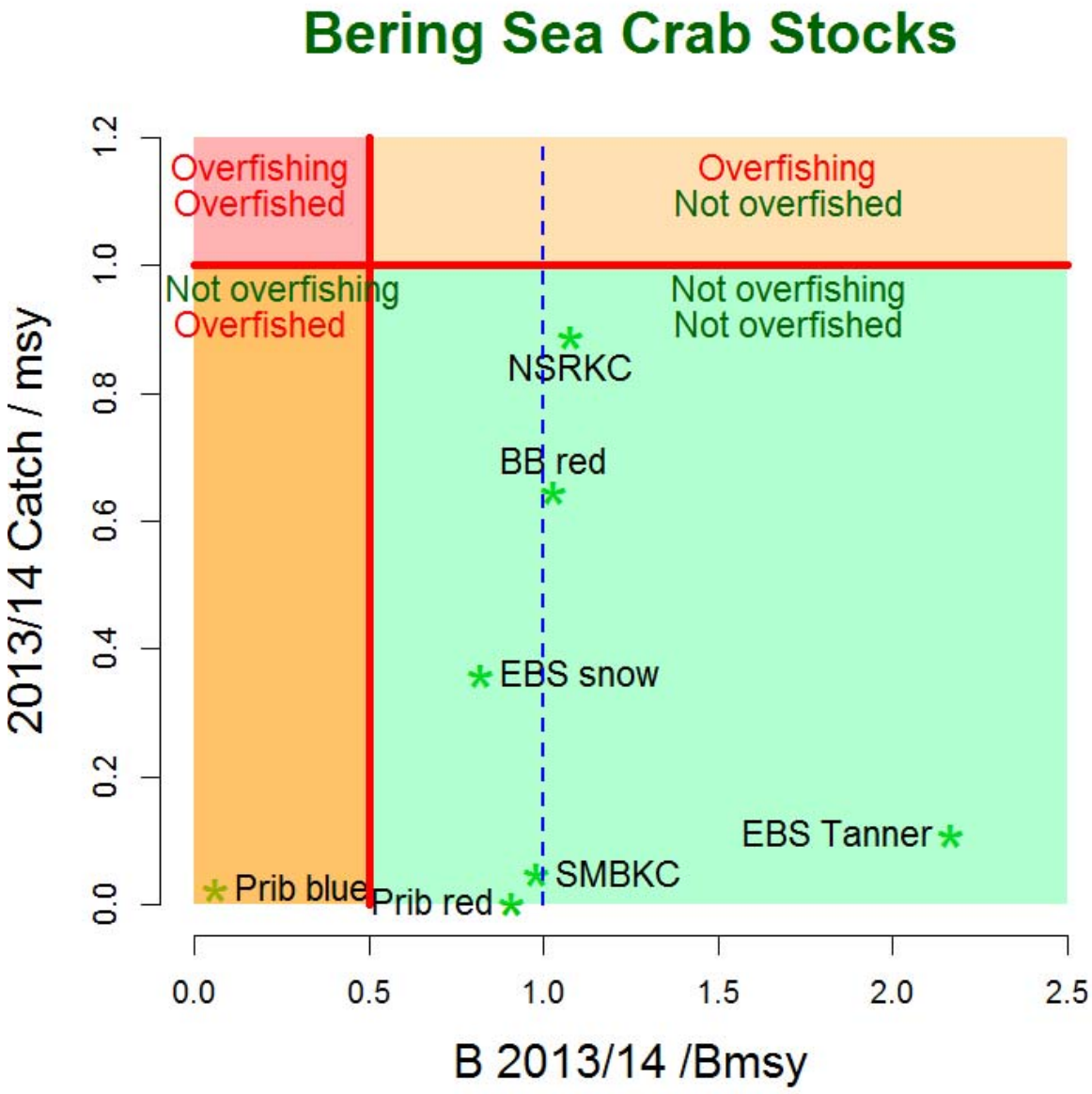

Figure 1. Status of 7 Bering Sea crab stocks in relation to status determination criteria (B_{MSY}, MSST, overfishing). Note that information is insufficient to assess Tier 5 stocks according to these criteria (WAIRKC, AIGKC, PIGKC).

Table 3 Crab Plan Team recommendations for September 2014 (stocks 1-7). Note that recommendations for stocks 7,9, 10 represent those final values recommended by the SSC in June 2014. Note diagonal fill indicates parameters are not applicable for that tier

Chapter	Stock	Tier	Status (a,b,c)	F_{OFL}	B_{MSY} or $B_{MSYproxy}$	Years[1] (biomass or catch)	2014/15[2 3] MMB	2014 MMB / MMB_{MSY}	γ	Mortality (M)	2014/15 OFL	2014/15 ABC	ABC buffer (%)
1	EBS snow crab	3	b	1.34	142.9	1979-current [recruitment]	137.6	0.96		0.23(females) 0.386 (imm) 0.2613 (mat males)	69.0	62.1	10%
2	BB red king crab	3	b	0.28	25.7	1984-current [recruitment]	24.69	0.96		0.18 default Estimated[4]	6.82	6.14	10%
3	EBS Tanner crab	3	a	0.61	29.82	1982-current [recruitment]	63.8	2.14		0.34 (females), 0.25 (mat male), 0.247 (imm males and females)	31.48	25.18	20%
4	Pribilof Islands red king crab	4	b	0.18	2.75	1991-current	2.24	0.81	1.0	0.18	0.32	0.27	15%
5	Pribilof Islands blue king crab	4	c	0	4.00	1980-1984 1990-1997	0.22	0.05	1.0	0.18	0.00116	0.00087	25%
6	St. Matthew Island blue king crab	4	b	0.18	7.78	1978-current	3.04	0.86	1.0	0.18	0.43 [total male catch]	0.34 [total male catch]	20%
7	Norton Sound red king crab	4	b	0.157	1.9	1980-current [model estimate]	1.68	0.88	1.0	0.18 0.68 (>123 mm)	0.21	0.19	10%
8	Aleutian Islands golden king crab	5				See intro chapter					5.69	4.26	25%
9	Pribilof Islands golden king crab	5				See intro chapter					0.09	0.07	25%
10	Adak red king crab	5				1995/96–2007/08					0.05	0.03	40%

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 2/15/2015 at time of mating.
3 Model mature biomass on 7/1/2013.
4 Additional mortality males: two periods-1980-1985; 1968-1979 and 1986-2013. Females three periods: 1980-1984; 1976-1979; 1985 to 1993 and 1968-1975; 1994-2013. See assessment for mortality rates associated with these time periods.

Table 4 Maximum permissible ABCs for 2014/15 and Crab Plan Team recommended ABCs for those stocks where the Plan Team recommendation is below the maximum permissible ABC as defined by Amendment 38 to the Crab FMP. Note that the rationale is provided in the individual introduction chapters for recommending an ABC less than the maximum permissible for these stocks. Recommendations for Adak red king crab represent the final values recommended by the SSC in June 2014.

Stock	Tier	2014/15 *Max*ABC (1000 t)	2014/15 ABC (1000 t)
EBS Snow Crab	3a	68.8	62.1
Bristol Bay red king crab	3b	6.82	6.14
Tanner Crab	3a	31.43	25.18
Pribilof Islands red king crab	4b	0.311	0.027
Pribilof Islands blue king crab	4c	0.00116	0.00087
Saint Matthew blue king crab	4b	0.94	0.75
Aleutian Islands golden king crab	5	5.12	4.26
Pribilof Islands golden king crab [1]	5	0.08	0.07
Norton Sound red king crab	4b	0.21	0.19
Adak red king crab	5	0.05	0.03

1 for Pribilof Islands golden king crab this is for the 2015 calendar year instead of the 2014-2015 crab fishing year.

Table 5. Stock status in relation to status determination criteria 2013/14. (Note diagonal fill indicates parameters not applicable for this tier level).

Chapter	Stock	Tier	MSST	B_{MSY} or $B_{MSYproxy}$	2013/14[1] MMB	2013/14 MMB / MMB_{MSY}	2013/14 OFL 1000 t	2013/14 Total catch	Rebuilding Status
1	EBS snow crab	3	71.50	143.00	126.50	0.88	78.1	28.1	
2	BB red king crab	3	12.85	25.70	27.12	1.06	7.07	4.56	
3	EBS Tanner crab	3	16.98	33.96	72.70	2.14	25.35	2.78	
4	Pribilof Islands red king crab	4	2.58	5.16	4.68	0.91	0.90	0.0023	
5	Pribilof Islands blue king crab	4	2.00	4.00	0.28	0.07	0.00116	0.00003	overfished
6	St. Matthew Island blue king crab	4	1.55	3.1	3.04	0.98	0.56 [total male catch]	0.027 [total male catch]	
7	Norton Sound red king crab	4	1.0	2.0	2.16	1.08	0.18 [total male]	0.16	
8	Aleutian Islands golden king crab	5					5.69	3.19	
9	Pribilof Islands golden king crab	5					0.09	Conf.	
10	Adak red king crab	5					0.054	0.001	

1 MMB as estimated during this assessment for 2013/14 as of 2/15/2014.