

BSAI Crab SAFE

**2011 Stock Assessment and Fishery Evaluation Report
for the King and Tanner Crab Fisheries in the Bering Sea
and Aleutian Islands**

Note that under the new process for setting OFLs and ABCs this May SAFE report introduction contains only summary information and recommendations for chapters 7-10 (stocks with summer fisheries and the Tier 5 stocks).

Recommendations for the remaining 6 stocks (Chapters 1-6) and the full introduction will be prepared for the Final Crab SAFE report in September 2011. Additional recommendations for those stocks based upon the May 2011 Crab Plan Team assessment review are contained in the Crab Plan Team report (prepared for the June 2011 Council meeting briefing materials).

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 275,000 pounds, including several low years in the 1990s. Retained catches in the past three years have been about 400,000 pounds.

Data and assessment methodology

Four types of surveys have been conducted periodically during the last three decades: summer trawl, summer pot, winter pot, and preseason summer pot, but none of these surveys were conducted every year. To improve abundance estimates, a length-based stock synthesis model of male crab abundance was previously developed that combines multiple sources of survey, catch, and mark-recovery data from 1976 to 1996. A maximum likelihood approach was used to estimate abundance, recruitment, and catchabilities of the commercial pot gear. The model has been updated with data from 2010/11 and estimated population abundance in 2011. The current model assumes $M=0.18\text{yr}^{-1}$ for all length classes, except $M=0.288\text{yr}^{-1}$ for the largest ($> 123\text{ mm CL}$) length group.

Stock biomass and recruitment trends

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

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

The team recommended Tier 4 stock status for Norton Sound red king crab. The model was the same as that recommended by the Team for the 2010 assessment. This model estimates bycatch mortality in the directed fishery, assumes M to 0.288yr^{-1} for the largest length bin and 0.18yr^{-1} for other length bins, and assumes flat selectivity for the summer fishery. The estimated abundance and biomass in 2011 are:

Legal males: 1.471 million crabs with a standard deviation of 0.199 million crabs.

Mature male biomass: 4.699 million lb with a standard deviation of 0.644 million lb.

Average of mature male biomasses during 1983-2011 was used as the B_{MSY} proxy and the CPT chose $\gamma=1.0$ to derive the F_{MSY} proxy.

Estimated B_{MSY} proxy, F_{MSY} proxy and retained catch limit in 2010 are:

- B_{MSY} proxy = 2.490 million lb,
- F_{MSY} proxy = 0.18

The maximum permissible ABC would be 0.65 million lbs. A retrospective analysis in the assessment showed that each time new data are added, estimates of historic abundance become lower, i.e. the assessment tends to over-estimate abundance, particularly in the most recent year. Regressing the predicting legal abundance one year beyond the end of the assessment against the corresponding estimates from 2011 indicates that hindcast legal abundance is 59.2% of the estimate. Applying a 59.2% adjustment as a bias correction to the OFL results in a recommended ABC of 0.388 million lb.

Status and catch specifications (millions lb.)

Year	MSST	Biomass (MMB)	GHL	Retained Catch	Total Catch	OFL	ABC
2007/08		4.40	0.32	0.31	0.36		
2008/09	1.78 ^A	5.24 ^A	0.41	0.39	0.43	0.68 ^A	
2009/10	1.54 ^B	5.83 ^B	0.38	0.40	0.43	0.71 ^B	
2010/11	1.56 ^C	5.44 ^C	0.40	0.42	0.46	0.73 ^C	
2011/12	1.25 ^D	4.70 ^D				0.66 ^D	0.39 ^D

A – Calculated from the assessment reviewed by the Crab Plan Team in May 2008

B – Calculated from the assessment reviewed by the Crab Plan Team in May 2009

C – Calculated from the assessment reviewed by the Crab Plan Team in May 2010

D – Calculated from the assessment reviewed by the Crab Plan Team in May 2011

Status and catch specifications (1000t)

Year	MSST	Biomass (MMB)	GHL	Retained Catch	Total Catch	OFL	ABC
2007/08		2.00	0.15	0.14	0.18		
2008/09	0.81 ^A	2.38 ^A	0.19	0.18	0.21	0.31 ^A	
2009/10	0.70 ^B	2.64 ^B	0.17	0.18	0.22	0.32 ^B	
2010/11	0.71 ^C	2.47 ^C	0.18	0.19	0.22	0.33 ^C	
2011/12	0.56 ^D	2.13 ^D				0.30 ^D	0.18 ^D

A-Calculated from the assessment reviewed by the Crab Plan Team in May 2008

B-Calculated from the assessment reviewed by the Crab Plan Team in May 2009

C-Calculated from the assessment reviewed by the Crab Plan Team in May 2010

D- Calculated from the assessment reviewed by the Crab Plan Team in May 2011

Stock status determination relative to overfishing in 2010 will be made in September with total catches tabulated for the 2010/11 season. Stock biomass is above MSST; thus, the stock is not overfished.

Additional Plan Team recommendations

The CPT agrees with the authors that systematic declines in the retrospective estimates of abundance points to a model mis-specification that needs to be resolved.

The retrospective analysis shows a strong influence of the periodic trawl survey data. The CPT recommends conducting a retrospective analysis in which profiles are provided for other parameters. The 2011 assessment included only a likelihood profile for M based on the full time series.

Other requested changes and modification for the next assessment include:

- Provide greater consideration of selectivity as applied to the fisheries and surveys.
- Model notations used for equations need to be clarified.

This stock would be a good candidate for the subject of a modeling workshop.

8 Aleutian Islands golden king crab

Fishery information relative to OFL setting

The directed fishery has been prosecuted annually since the 1981/82 season. Retained catch peaked during the 1986/87 season at 14.7 million lb, but average harvests dropped sharply from the 1989/90 to 1990/91 season to an average harvest of 6.9 million lbs. for the period 1990/91–1995/96. Management based on a formally established GHL began with the 1996/97 season. The 5.9 million lb GHL, based on the previous five-year average catch, was subsequently reduced to 5.7 million lb beginning with the 1998/99 season. The GHL (or TAC, since the 2005/06 season) remained at 5.7 million lb through the 2007/08 season. Average retained catch for the period 1996/97–2007/08 was 5.6 million lb. In March 2008, the Alaska Board of Fisheries increased the TAC for this stock in regulation, to 5.985 million lb. Average retained catch for the period 2008/09–2009/10 was 5.8 million lb. This fishery is rationalized under the Crab Rationalization Program.

Data and assessment methodology

An assessment model is currently being developed for this stock. Available data are from ADF&G fish tickets (retained catch numbers, retained catch weight, and pot lifts by ADF&G statistical area and landing date), size-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), triennial pot surveys in the Yunaska-Amukta Island area of the Aleutian Islands (approximately 171° W longitude), tag recoveries from crabs released during the triennial pot surveys, and bycatch from the groundfish fisheries. These data are available through the 2009/10 season and the 2006 triennial pot survey. Most of the available data were obtained from the fishery which targets legal-size (≥ 6 -inch CW) males and trends in the data can be affected by changes in both fishery practices and the stock. The triennial survey is too limited in geographic scope and too infrequent to provide a reliable index of abundance for the Aleutian Islands area. A triennial survey was scheduled for 2009, but was cancelled.

Stock biomass and recruitment trends

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.

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 2011/12. 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. For other time periods under consideration there are no directed fishery observer data prior to the 1988/89 season and observer data are lacking or confidential for four seasons in at least one management area in the Aleutian Islands during 1988/89–1994/95.

Thus, the CPT concurred with the author's recommended approach for establishing the OFL. This method is as follows:

$$OFLTOT = (1 + RATE_{90/91-08/09}) \cdot OFLRET(85/86-95/96) + BM_{GF} 93/94-08/09 = 11.40 \text{ million lb}$$

where:

$RATE_{90/91-08/09}$ = mean annual rate = (bycatch mortality in crab fisheries)/(retained catch) over the period 1990/91–2008/09.

OFLRET85/86-95/96 = mean annual retained catch over the period 1985/86-1995/96, and

BM_{GF}93/94-08/09 = mean of annual bycatch mortality in groundfish fisheries over the period 1993/94-2008/09.

The recommended OFL is set following the June 2010 recommendation of the SSC, but uses additional historical data on bycatch that was not available for review in 2010.

The team concurred with the author's recommendation to set the ABC based on the maximum permissible from the ABC control rule which specifies an ABC based on a 10% buffer on the OFL. The recommended ABC is 10.26 million lb.

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

Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch	OFL	ABC
2007/08	NA	NA	5.70	5.51	6.25	NA	NA
2008/09	NA	NA	5.99	5.68	6.31	9.18 ^A	NA
2009/10	NA	NA	5.99	5.91	6.51	9.18 ^A	NA
2010/11	NA	NA	5.99	5.97		11.06	NA
2011/12	NA	NA				11.40	10.26

A – retained catch

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

Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch	OFL	ABC
2007/08	NA	NA	2.59	2.50	2.83	NA	NA
2008/09	NA	NA	2.72	2.58	2.86	4.16 ^A	NA
2009/10	NA	NA	2.72	2.68	2.95	4.16 ^A	NA
2010/11	NA	NA	2.72	2.71		5.02	NA
2011/12	NA	NA				5.17	4.66

A – retained catch

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

Additional Plan Team recommendations

In May 2011, the plan team reviewed a developing stock assessment model for Aleutian Islands golden king crab. Use of an assessment model could allow for this stock to be moved out of Tier 5 and would provide focus for establishing research and data collection priorities. The team recommends incorporation of plan team comments into the model for the September 2011 plan team meeting but did not recommend adopting the model for OFL determination in this year. Specific comments on model suggestions are contained in the May 2011 Crab Plan Team report.

9 Pribilof District Golden King Crab

Fishery information relative to OFL setting

The Pribilof District fishery for male golden king crab ≥ 5.5 in carapace width (≥ 124 mm carapace length) developed in the 1981/82 season. The directed fishery mainly occurs in Pribilof Canyon of the continental slope. Peak directed harvest is 856-thousand lb during the 1983/84 season. Historical fishery participation has been sporadic and retained catches variable. The current fishing season is based on a calendar year. Since 2000, the fishery was managed for a guideline harvest level (GHL) of 150-thousand lb. Non-retained bycatch occurs in the directed fishery as well as Bering Sea snow crab, Bering Sea grooved Tanner crab, and Bering Sea groundfish fisheries. Estimated total fishing mortality in crab fisheries averages 78-thousand lb (2001-2010). Crab mortality in groundfish fisheries (July 1–June 30, 1991/92–2009/10) averages 6-thousand lb. There was no participation in the directed fishery from 2006-2009; one vessel participated in 2010. Pribilof District golden king crab is not included in the Crab Rationalization Program.

Data and assessment methodology

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

Stock biomass and recruitment trends

Estimates of stock biomass (all sizes, both sexes) were provided for Pribilof Canyon. The 2008 Pribilof Canyon area-swept estimate of golden king crab biomass from the triennial slope survey was 2.026 million lb (CV=38%). This estimate is not being used for estimating stock biomass because it does not represent the whole distribution of the stock.

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

The Team recommends this stock be managed under Tier 5 in 2012.

The assessment author presented three alternatives for establishing the OFL. The Team concurs with the author's recommendation for an OFL based on Alternative 1 for 2012 of 0.2 million lb and the maximum permissible ABC of 0.18 million lb. The ABC was derived by applying the Tier 5 control rule a 10% buffer of the OFL, $ABC = 0.9 * OFL$. The OFL was derived based on the following data:

$$OFL_{TOT,2012} = (1+R_{2001-2010}) * RET_{1993-1998} + BM_{NC,1994-1998} + BM_{GF,92/93-98/99}$$

- $R_{2001-2010}$ is the average of the estimated average annual ratio of pounds of bycatch mortality to pounds 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 (period of unconstrained catch).
- $BM_{NC,1994-1998}$ 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.

The average of the estimated annual ratio of pounds of bycatch mortality to pounds of retained in the directed fishery during 2001–2010 is used to estimate bycatch mortality in the directed fishery during 1993–1998 because, whereas there are no data on bycatch for the directed fishery during 1993–1998, there are such data from the directed fishery during 2001–2010 (excluding 2006–2009, when there was no fishery effort).

The estimated average annual bycatch mortality in non-directed fisheries during 1994–1998 is used to estimate the average annual bycatch mortality in non-directed fisheries during 1993–1998 because there is no bycatch data available for the non-directed fisheries during 1993.

The estimated average annual bycatch mortality in groundfish fisheries during 1992/93–1998/99 is used to estimate the average annual bycatch mortality in groundfish fisheries during 1993–1998 because 1992/93–1998/99 is the shortest time period of crab fishery years that encompasses calendar years 1993–1998.

Status and catch specifications (millions lb)

Year	MSST	Biomass (MMB)	GHL	Retained Catch	Total Catch	OFL	ABC
2008	N/A	N/A	0.15	0	0.000	N/A	N/A
2009	N/A	N/A	0.15	0	0.001	0.17 ^A	N/A
2010	N/A	N/A	0.15	Conf.	Conf.	0.17 ^A	N/A
2011	N/A	N/A	0.15			0.18	N/A
2012	N/A	N/A				0.20	0.18

A= Retained-catch OFL

Conf. = confidential

Status and catch specifications (t)

Year	MSST	Biomass (MMB)	GHL	Retained Catch	Total Catch	OFL	ABC
2008	N/A	N/A	68	0	0.0	N/A	N/A
2009	N/A	N/A	68	0	0.5	77.1 ^A	N/A
2010	N/A	N/A	68	Conf.	Conf.	77.1 ^A	N/A
2011	N/A	N/A	68			81.6	N/A
2012	N/A	N/A				90.7	81.6

A= Retained-catch OFL

Conf. = confidential

No overfished determination is possible for this stock given the lack of mature biomass information. Although catch information is confidential under Alaska statute (AS 16.05.815) the assessment author indicated that the retained catch did not exceed the retained catch OFL of 0.17 million lb therefore overfishing did not occur. The 2011 fishery is ongoing until the GHL is achieved or until December 31.

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 21.193 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 0.943 million lb, but the retained catch during the 1995/96 season was low, only 0.039 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 0.5 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 0.506 million lb (2002/03) and 0.479 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 1995/96-2009/10 seasons averaged 0.003 million lb in crab fisheries and 0.022 million lb in groundfish fisheries. Estimated annual total fishing mortality (in terms of total crab removal) during 1995/96-2009/10 averaged 0.109 million lb. The average retained catch during that period was 0.084 million lb. This fishery is rationalized under the Crab Rationalization Program only for the area west of 179° W longitude.

Data and assessment methodology

The 1960/61-2007/08 time series of retained catch (number and pounds of crabs), effort (vessels, landings and pot lifts), average weight and average carapace length of landed crabs, and catch-per-unit effort (number of crabs per pot lift) are available. Bycatch from crab fisheries during 1995/96-2009/10 and from groundfish fisheries during 1993/94-2009/10 are available. There is no assessment model in use for this stock. The standardized surveys of the Petrel Bank area conducted by ADF&G in 2006 and 2009 and the ADF&G-Industry Petrel Bank surveys conducted in 2001 have been too limited in geographic scope and too infrequent for reliable estimation of abundance for the entire western Aleutian Islands area.

Stock biomass and recruitment trends

Estimates of stock biomass are not available for this stock. Estimates of recruitment trends and current levels relative to virgin or historic levels are not available. The fishery has been closed since the end of 2003/04 season due to apparent poor recruitment. 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 2011/12 season. The CPT concurs with the assessment author's recommendation of an OFL based on the 1995/96–2007/08 average total catch. The CPT recommends a total catch OFL for 2010/11 of 0.12 million lb, following the recommendation of the SSC in June 2010 to freeze the time period for computing the total-catch OFL at 1995/96–2007/08.

The team recommends that the directed fishery remain closed given concerns of stock status. The team struggled to establish an ABC which would account solely for bycatch in other fisheries. Groundfish bycatch in recent years has accounted for the majority of the catch of this stock. The maximum permissible ABC is 0.111 million lb based on the Tier 5 control rule of a 10% buffer on the OFL. However, the CPT recommends an ABC of 0.074 million lb based on the maximum annual groundfish and crab fishery bycatch during the period 1995/96–2009/10.. Based on the limited information available on this stock, the team struggled to adequately quantify the uncertainty in order to develop an ABC below the maximum permissible. the team recognizes that the stock is distributed over a wide area, making an appropriate recommendation for an ABC difficult..

Status and catch specifications (millions of lb) of Adak RKC.

Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch	OFL	ABC
2007/08	NA	NA	Closed	0	0.011	NA	NA
2008/09	NA	NA	Closed	0	0.014	0.46 ^A	NA
2009/10	NA	NA	Closed	0	0.012	0.50 ^A	NA
2010/11	NA	NA	Closed	0		0.12 ^B	NA
2011/12	NA	NA				0.12 ^B	0.07

A-Retained catch OFL based on 1984/85-2007/08 mean retained catch

B-Total catch OFL of 0.12 million lb based on the average for 1995/96-2007/08.

Status and catch specifications (t) of Adak RKC.

Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch	OFL	ABC
2007/08	NA	NA	Closed	0	4.99	NA	NA
2008/09	NA	NA	Closed	0	6.35	208.7 ^A	NA
2009/10	NA	NA	Closed	0	5.44	226.8 ^A	NA
2010/11	NA	NA	Closed	0		54.43 ^B	NA
2011/12	NA	NA				54.43 ^B	33.57

A-Retained catch OFL based on 1984/85-2007/08 mean retained catch

B-Total catch OFL of 54.43 t based on the average for 1995/96-2007/08.

No overfished determination is possible for this stock given the lack of biomass information. Overfishing will be assessed in September for the 2010/2011 fishery.

Table 3 Crab Plan Team recommendations May 2011

(Note diagonal fill indicated parameters not applicable for that tier level while shaded sections are to be filled out for the final SAFE in September 2011)

Chapter	Stock	Tier	Status (a,b,c)	F _{OFL}	B _{MSY} or B _{MSYproxy}	Years ¹ (biomass or catch)	2011 ² ₃ MMB	2011 MMB / MMB _{MSY}	γ	Mortality (M)	2011/12 OFL mill lb	2011/12 ABC mill lb
1	EBS snow crab	3										
2	BB red king crab	3										
3	EBS Tanner crab	4										
4	Pribilof Islands red king crab	4										
5	Pribilof Islands blue king crab	4										
6	St. Matthew Island blue king crab	4										
7	Norton Sound red king crab	4	a	0.18	2.49	1983-current [model estimate]	4.70	1.9	1.0	0.18	0.66	0.39
8	AI golden king crab	5				See intro chapter					11.40	10.26
9	Pribilof Island golden king crab	5				See intro chapter					0.20	0.18
10	Adak red king crab	5				1995/96– 2007/08					0.12	0.07

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 2/15/2012 at time of mating.

³ Model mature biomass on 7/1/2011

Table 4 Maximum permissible ABCs for 2011/12 and 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. Values are in millions lb.

Stock	Tier	2011/12 <i>MaxABC</i>	2011/12 ABC
Norton Sound red king crab	4a	0.65	0.39
Adak red king crab	5	0.11	0.07