

## 5 Pribilof Islands blue king crab

The Pribilof Islands blue king crab assessment is biennial with the last assessment conducted in 2019. Information listed below summarizes the 2021 assessment.

### *Fishery information relative to OFL setting.*

The Pribilof Islands blue king crab fishery began in 1973, with peak landings of 4,990 t (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 454 t (1.0 million lb) with low CPUE. The fishery was closed from 1988/89 through 1994/95 fishing seasons. The fishery reopened for the 1995/96 to 1998/99 seasons. Fishery harvests during this period ranged from 589 – 1,134 t (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 to the present.

The stock was declared overfished in 2002 and a rebuilding plan implemented in 2004. The rebuilding plan closed directed fishing for Pribilof blue king crab until the stock is rebuilt. In 2009, NMFS determined the stock would not meet its 10-year rebuilding horizon. Subsequently, Amendment 43 to the King and Tanner Crab FMP and Amendment 103 to the BSAI Groundfish FMP were approved by the Secretary of Commerce in 2014. This action, a revised rebuilding plan, closed the Pribilof Island Habitat Conservation Zone to Pacific cod pot fishing, which accounts for the highest recent rates of bycatch of this stock. This area was already closed to groundfish trawl fishing. To prevent overfishing, ADF&G also implements closure areas for the commercial crab fisheries to reduce the blue king crab bycatch. NMFS has implemented procedures to account for blue king crab bycatch in the groundfish fisheries and to take action to prevent overfishing.

### *Data and assessment methodology*

The calculation of the 2020/21 survey biomass uses the stock area definition established in 2012/13 that includes an additional 20 nm strip east of the Pribilof District. This assessment uses the 2016/17 methodology to project MMB and calculate  $B_{MSY}$ . Prior to 2016/17, MMB was estimated from the NMFS EBS bottom trawl survey using a three-year running average weighted by the inverse of the variance of the area-swept estimate. The current methodology to calculate MMB and  $B_{MSY}$  uses a random effects model to smooth the survey time series.

In 2017, the assessment was moved from September to May, which has required that several data inputs to the model (assessment year MMB at the time of the survey and retained catch and bycatch values from the crab fishery year prior to the assessment year) be estimated in some fashion. The NMFS EBS Shelf Survey is typically conducted on an annual basis in June-August, so biomass estimates from the survey in the year of the assessment are no longer available for the assessment. A value projected by the random effects model used to smooth survey MMB is used as a substitute to calculate MMB-at-mating for the assessment year. The 2020 NMFS EBS Shelf Survey was not conducted due to the COVID-19 global pandemic, so the most recent survey data available is from the 2019 NMFS EBS Shelf Survey. For the 2021 assessment, MMB at the time of survey (July 2021) was estimated from the observed time series using the random effects prediction. The values of year-to-date bycatch in the crab and groundfish fisheries on April 8, 2021 were taken as estimates of the 2020/21 year-end values for rebuilding status determination. These values will be updated in September 2021 to evaluate overfishing status.

### *Stock biomass and recruitment trends*

The 2021/22 MMB at mating is projected to be 180 t, which is approximately 4% of the proxy for  $B_{MSY}$ . The Pribilof Islands blue king crab stock biomass continues to be low with 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 4,098 t for 2021/22.

Because the projected 2021/22 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. For this stock, the  $F_{OFL}$  is based on average groundfish bycatch between 1999/2000 and 2005/06, a time period determined as part of the rebuilding plan. The recommended OFL for 2021/22 is 1.16 t.

The CPT continues to recommend setting the ABC less than the maximum permissible by employing a 25% buffer on the OFL. This recommendation is 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.

*Historical status and catch specifications for Pribilof Islands blue king crab (t). Shaded values are new estimates or projections based on the current assessment. Other table entries are based on historical assessments and are not updated except for total and retained catch.*

Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch	OFL	ABC
2017/18	2,053	230	Closed	0	0.33	1.16	0.87
2018/19	2,053	230	Closed	0	0.41	1.16	0.87
2019/20	2,049	180	Closed	0	0.42	1.16	0.87
2020/21	2,049	181	Closed	0	0.00	1.16	0.87
2021/22		180				1.16	0.87
2022/23		180				1.16	0.87

*Historical status and catch specifications for Pribilof Islands blue king crab (million lb). Shaded values are new estimates or projections based on the current assessment. Other table entries are based on historical assessments and are not updated except for total and retained catch.*

Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch	OFL	ABC
2017/18	4.526	0.507	Closed	0	0.0007	0.0026	0.0019
2018/19	4.526	0.507	Closed	0	0.0009	0.0026	0.0019
2019/20	4.518	0.398	Closed	0	0.0009	0.0026	0.0019
2020/21	4.518	0.398	Closed	0	0.0000	0.0026	0.0019
2021/22		0.398				0.0026	0.0019
2022/23		0.398				0.0026	0.0019

The most recent full assessment was conducted in May 2021 and the stock was below MSST in 2020/21 and continues to be overfished. The overfishing determination for PIBKC during 2020/21 will be provided in September 2021.

## 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 6.668 kt (14.7 million lb) and averaged 5.398 kt (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 3.130 kt (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 2.676 kt (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 2.585 kt (5.7 million lb) beginning in 1998/99. The GHL (or TAC, since 2005/06) remained at 2.585 kt (5.7 million lb) for 2007/08, but was increased to 2.715 kt (5.985 million lb) for the 2008/09-2011/12 seasons, and to 2.853 kt (6.290 million lb) starting with the 2012/13 season. The TAC was reduced to 2.515 kt (5.545 million lb) for the 2016/17 season and increased to 2.883 kt (6.356 million lb) for the 2018/19 season, to 3.257 kt (7.180 million lb) for the 2019/20 season, and reduced to 2.998 kt (6.610 million lb) for the 2020/21 season. The 2019/20 and 2020/21 TACs were based on the harvest strategy adopted by the Alaska Board of Fisheries in March 2019. This fishery is rationalized under the Crab Rationalization Program.

Total mortality of AI golden king crab includes retained catch in the directed fishery, mortality of discarded catch, and bycatch in fixed-gear and trawl groundfish fisheries, though bycatch in other fisheries is low compared to mortality in the directed fishery. Retained catch in the post-rationalized fishery (2005/06-2020/21) has ranged from 2.387 kt (5.262 million lb) in 2006/07 to 3.319 kt (7.317 million lb) in 2019/20. Total mortality ranged from 2.506 – 3.733 kt (5.525 to 8.230 million lb) for the same period. The retained catch during the 2020/21 fishery was 2.770 kt (6.107 million lbs) split between EAG: 1.733 kt (3.821 million lbs) and WAG: 1.037 kt (2.286 million lbs), but the WAG fishery was still active when the assessment was conducted.

### *Data and assessment methodology*

The assessment for AI golden king crab establishes a single OFL and ABC for the whole stock. However, separate models are evaluated for the EAG and the WAG owing to, *inter alia*, different abundance trends in each area. A modeling framework based on only fisheries data for AI golden king crab was under development for several years with model assumptions and data inputs refined by reviews by the SSC and CPT. The CIE also reviewed the model and stock assessment in June 2018. The current modeling framework was recommended by the CPT in September 2016 and approved by the SSC in October 2016.

The model-based stock assessment involves fitting male-only population dynamics models to data on catches and discards in the directed fishery, discards in the groundfish fishery, standardized indices of abundance based on observer data, fish ticket data, length-frequency data for the directed fishery (landings and total catch), and mark-recapture data. The data for the EAG are complete through the 2020/21 season. The fishery in the WAG was still operating when the assessment was conducted, with 77% of the WAG TAC taken (92% when the assessment was reviewed by the CPT). No cooperative survey was conducted during the 2020/21 fishing year.

The assessment authors examined ten model scenarios for each area in this assessment cycle. Model 19.1 was last year's base model. Model 21.1a was the same as Model 19.1 except that mean recruitment was defined in terms of the 1987-2017 average rather than the 1987-2012 average. Model 21.1b was the same as Model 21.1a except there were three total selectivity periods while Model 21.1c extended Model 21.1a by basing the observer CPUE index on a standardization that included year\*area interactions. Models 21.1a1 and 21.1a2 extended Model 21.1a by allowing maturity to occur at 116mm CL and to be a logistic function of size with a size-at-50%-maturity of 117 mm CL. Models 21.1b1 and 21.1b2 extended Model 21.1b in the same way that Models 21.1a1 and 21.1a2 extended Model 21.1a. Similarly Models 21.1c1 and 21.1c2 extended Model 21.1c. Appendix C of the assessment report showed the impact of including the

data from the cooperative survey in Model 21.1a, and Appendix F of the assessment report showed further preliminary applications of GMACS to AI golden king crab.

The CPT did not consider the analyses of the chela height data sufficiently progressed to warrant adoption of any of Models 21.1a1, 21.1a2, 21.1b1, 21.1b2, 21.1c1, and 21.1c2 this year. Model 21.1b did not converge to global minimum of the objective function for the EAG, and the CPT was not convinced that the fits to the recent length-frequency data were improved by allowing for three selectivity periods. Accounting for year\*area interactions when standardizing the post-rationalization CPUE data is likely preferable to ignoring such interactions, but the CPT identified several technical concerns with the current analyses that precluded adopting Model 21.1c this year. The CPT therefore endorsed Model 21.1a as the basis for status determination and the OFL.

#### *Stock biomass and recruitment trends*

Estimated mature male biomass (MMB) for the EAG decreased from high levels until the 1990s after which the trend has been increasing. In contrast, the MMB for the WAG increased from a low in the 1990s until 2007/08 and then declined again, and has since recovered to the MMB levels of the mid-2000s. Recruitment for the EAG was variable and high during 2014-2109 while recruitment for the WAG was lower in recent years than during the 1980s. Stock trends reflected the fishery standardized CPUE trends in both areas.

#### *Summary of major changes*

The assessment model recommended by the CPT is similar to the model used in the previous assessment. There were minor changes to the historical length-frequency data, as well as updated CPUE index data and new fishery data for the 2020/21 fishing season.

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

The CPT recommends that this stock be managed as a Tier 3 stock in 2021/22. A single OFL and ABC is defined for AIGKC. However, separate models are available by area. The CPT recommends that stock status be determined by adding the estimates of current MMB and  $B_{MSY}$  by area. This stock status is then used to determine the ratio of  $F_{OFL}$  to  $F_{35\%}$  by area, which is then used to calculate the OFLs by area, which are then added together to calculate an OFL for the entire stock. The SSC has concurred with this approach. The stock is currently estimated to be above  $B_{MSY}$  in both areas therefore no adjustment is needed to the  $F_{OFL}$  to determine the combined OFL for both areas. The CPT recommends that the  $B_{MSY}$  proxy for the Tier 3 harvest control rule be based on the average recruitment from 1987-2017, years for which recruitment estimates are relatively precise.

This is the only crab assessment that relies solely on fishery CPUE as an index of abundance, with the CPUE index standardization process subject to past CPT and SSC review and this is a key reason for the 25% buffer between the OFL and the ABC in past years. Additional exploration of the model for CPUE standardization is warranted. New uncertainties identified this year are: (a) there have been fewer large animals in the total catch length-frequency for EAG between 2016 and 2020, (b) there were catches from the WAG that were not included in the assessment, (c) the CPUE index for the WAG declined more when account was taken of year\*area interactions (but that index was not included in the assessment), and (d) the size at maturation may be larger than currently assumed. These new sources of uncertainty may be addressed through additional research.

*Status and catch specifications (1000 t) for Aleutian Islands golden king crab. Shaded values are new estimates or projections based on the current assessment. Other table entries are based on historical assessments and are not updated except for total and retained catch.*

Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch	OFL	ABC
2016/17	N/A	N/A	2.515	2.593	2.947	5.69	4.26
2017/18	6.044	14.205	2.515	2.585	2.942	6.048	4.536
2018/19	5.880	17.848	2.883	2.965	3.355	5.514	4.136
2019/20	5.909	16.323	3.257	3.319	3.735	5.249	3.937
2020/21	6.026	16.207		2.770 <sup>a</sup>	3.148 <sup>a</sup>	4.798	3.599
2021/22		14.816				4.817	3.613

*Status and catch specifications (million lb) for Aleutian Islands golden king crab. Shaded values are new estimates or projections based on the current assessment. Other table entries are based on historical assessments and are not updated except for total and retained catch.*

Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch	OFL	ABC
2016/17	N/A	N/A	5.545	5.716	6.497	12.53	9.40
2017/18	13.325	31.315	5.545	5.699	6.487	13.333	10.000
2018/19	12.964	39.348	6.356	6.536	7.396	12.157	9.118
2019/20	13.027	35.985	7.180	7.317	8.234	11.572	8.679
2020/21	13.284	35.730		6.107 <sup>a</sup>	6.940 <sup>a</sup>	10.579	7.934
2021/22		32.662				10.620	7.965

<sup>a</sup> WAG fishery was still being prosecuted when the assessment was conducted.

Total fishery mortality in 2020/21 (to date) was 3.148 kt (6.940 million lb), less than the OFL of 4.798 kt (10.579 million lb). The CPT will revisit total mortality in September 2021 when final catch statistics are available to determine overfishing status .

#### *Additional Plan Team recommendations*

The CPT recommended additional assessment work in several areas. Additional development of CPUE standardization is needed for the post-rationalization period, including the choice of smoothers applied. In addition, there is a need to analyze chela height data to refine the assumptions regarding the size at maturity. Reasons for the reduction in large animals in the total catch length-frequencies in recent years in EAG should be explored. Future assessments should be based on the best estimates of total catches rather than basing assessments on catches at the time of the assessment. Use of GMACS for the AIGKC assessment should continue to be explored. Finally, work should continue to obtain an index using the cooperative pot survey data for use in the EAG assessment model.

Table 1. Summary recommendations for each BSAI crab stock from the most recent SAFE chapter. Dashes (-) indicate parameters not applicable for that tier. Biomass values are in thousand metric tons (kt). Grayed out text is taken from the 2020 SAFE and is for stocks that have not been updated yet in 2021. All stock values will be updated in Sept 2021.

SAFE Chapt.	Stock	Tier	F <sub>OFL</sub>	B <sub>MSY</sub> OR B <sub>MSYproxy</sub>	B <sub>MSY</sub> basis years <sup>1</sup>	2021/22 <sup>2</sup> MMB	2021/22 MMB / MMB <sub>MSY</sub>	γ	Natural Mortality (M)	2021/22 OFL	2021/22 ABC	ABC Buffer	Add'l 2021 Buffer <sup>3</sup>
1	E. Bering Sea snow crab	3a	1.65	113.7	1982-2019 [recruitment]	276.7	2.43		0.34 (mat.fem) 0.36 (imm.) 0.36 (mat.male)	184.90	92.5	25%	25%
2	Bristol Bay red king crab	3b	0.16	25.4	1984-2019 [recruitment]	14.93	0.59		0.18	2.14	1.61	20%	5%
3	E. Bering Sea Tanner crab	3b	0.93	36.62	1982-2018 [recruitment]	35.31	0.96		0.32 (mat.fem) 0.24 (imm.) 0.29 (mat.male)	21.13	16.90	20%	50%
4	Pribilof Is. red king crab	4a	0.21	1.73	2001-2018 [MMB]	6.43	3.72	1	0.18	0.86	0.65	25%	
5	Pribilof Is. blue king crab	4c	0.00	4.10	1980/81-1984/85 & 1990/91-1997/98 [MMB]	0.180	0.04	1	0.18	0.00116	0.00087	25%	
6	St. Matthew blue king crab	4c	0.047	3.34	1978-2019 [MMB]	1.12	0.34	1	0.18	0.05	0.04	25%	0%
7	Norton Sound red king crab	4a	0.18	2.05	1980-2020 [MMB]	2.27	1.11	1	0.18 (0.58 >124 mm)	0.29	0.20	30%	
8	Aleutian Is. golden king crab	3a	EAG (0.61) WAG (0.57)	12.05	1987/88-2017/18	14.82	1.23		0.21	4.817	3.613	25%	
9	Pribilof Is. golden king crab	5	-	-	See intro chapter	-	-	-	-	0.093	0.070	25%	
10	W. Aleutian Is. red king crab	5	-	-	1995/96-2007/08	-	-	-	-	0.056	0.014	75%	

<sup>1</sup> For Tiers 3, 4 where B<sub>MSY</sub> proxy 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.

<sup>2</sup> MMB as projected in Feb of this year for NSRKC, and June of this year for PIBKC and AIGKC.

<sup>3</sup> Additional ABC buffer added for some stock to address added uncertainty in OFL due to absence of 2020 trawl survey data

Table 2. Maximum permissible ABCs for 2021/22 and SSC-recommended ABCs for stocks where the SSC recommendation is below the maximum permissible ABC, as defined by Amendment 38 to the Crab FMP. Values are in thousand metric tons (kt). Grayed out text is taken from the 2020 SAFE and is for stocks that have not been updated yet in 2021. All stock values will be updated in Sept 2021.

Stock	Tier	2021/22 Max ABC	2021/22 ABC
EBS Snow Crab <sup>1</sup>	3	184.2	92.5
Bristol Bay RKC <sup>2</sup>	3	2.13	1.61
Tanner Crab <sup>3</sup>	3	20.87	16.90
Pribilof Islands RKC <sup>1</sup>	4	0.857	0.648
Pribilof Islands BKC <sup>4</sup>	4	0.00104	0.00087
Saint Matthew BKC <sup>2</sup>	4	0.05	0.04
Norton Sound RKC <sup>2</sup>	4	0.288	0.20
Aleutian Islands GKC <sup>2</sup>	3	4.793	3.613
Pribilof Islands GKC <sup>4</sup>	5	0.092	0.070
Western Aleutian Islands RKC <sup>4</sup>	5	0.056	0.014

Basis for P\* calculation of Max ABC:

<sup>1</sup>CV on terminal year biomass

<sup>2</sup>CV on OFL

<sup>3</sup>MCMC

<sup>4</sup>Tier 5 (90%OFL)

## BSAI Crab SAFE, June 2021

## Introduction

**SSC Table 1.** Stock status in relation to status determination criteria for 2020/21 as estimated in May 2021. Hatched areas indicate parameters not applicable for that tier. Values are in thousands of metric tons (kt). Grayed out text is taken from the 2020 SAFE and is for stocks that have not been updated yet in 2021. All stock values will be updated in Sept 2021.

Chapt.	Stock	Tier	MSST	BMSY or BMSYproxy	2020/21 MMB	2020/21 MMB / MMBMSY	2020/21 OFL	2020/21 Total catch	Rebuilding Status
1	Eastern Bering Sea snow crab	3	60.26	126.10	167.30	1.33	54.90	20.80	
2	Bristol Bay red king crab	3	12.72	21.25	15.96	0.75	3.40	2.22	
3	Eastern Bering Sea Tanner crab	3	18.31	41.07	39.55	0.96	28.86	0.54	
4	Pribilof Islands red king crab	4	0.87	1.73	5.37	3.10	0.86	0.00384	
5	Pribilof Islands blue king crab	4	2.05	4.10	0.18	0.04	0.00116	0.00000	<b>overfished</b>
6	St. Matthew Island blue king crab	4	1.67	3.48	1.08	0.31	0.04	0.001	<b>overfished</b>
7	Norton Sound red king crab	4	1.03	2.05	2.27	1.11	0.13	0.09	
8	Aleutian Islands golden king crab	3	6.03	12.05	16.21	1.34	4.798	3.148 <sup>a</sup>	
9	Pribilof Islands golden king crab	5					0.09	Conf.	
10	W. Aleutian Islands red king crab	5					0.06	< 0.001	

Values from 2021 draft SAFE Chapter updates for PIBKC (5/21), NSRKC (1/21), and AIGKC (5/21).

<sup>a</sup>WAG fishery for AIGKC still active when the assessment was conducted