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 5.700 million lb for 2007/08, but was increased to 5.985 million lb for the 2008/09-2011/12 seasons, and to 6.290 million lb starting with the 2012/13 season. The TAC was reduced to 5.545 million lb for the 2016/17 season. This fishery is rationalized under the Crab Rationalization Program.

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 bycatch in the directed fishery. Total annual non-retained catch of golden king crab during crab fisheries decreased relative to the retained catch after the 1990s. Bycatch in the post-rationalized fishery (2005/06-2016/17) has ranged from 2.5 million lb in 2005/06 (46% of the retained catch) to 3.2 million lb for 2013/14 (50% of the retained catch). Estimated total mortality (retained catch plus bycatch in crab and groundfish fisheries) ranged from 5.8 to 9.4 million lb since 1995/96.

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 EAG and WAG owing to different spatial trends in the fishery. Through the 2016/17 fishing year, the assessment was based on a Tier 5 methodology applied to data from ADF&G fish tickets, size-frequencies from samples of landed crabs, at-sea observations from pot lifts sampled during the fishery, and bycatch estimates from the groundfish fisheries. The modeling framework has been under development for several years, with model assumptions and data inputs refined by reviews by the SSC and CPT. The modeling framework was recommended by the CPT in September 2016 and approved by the SSC in October 2016 for use in the 2017/18 specifications cycle.

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 CPUE data, length-frequency data for the directed fishery (landing and total catch), and mark-recapture data. These data are available through the 2015/16 season.

The assessment author examined 11 model scenarios for this assessment. Model 1 assumed that the proportion mature was a logistic function of length, was fitted to observer CPUE data for 1995/96 – 2015/16 and fish ticket data from 1985/86 to 1998/99, and fixed M for both stocks to be $0.224 yr^{-1}$. Models 2 – 11 varied the assumptions of Model 1 by: omitting the fish ticket data (Model 2), including additional observer CPUE data for 1991/92-1994/95 (Model 3), considering three rather than two selectivity patterns (Model 4), assuming higher and lower values for M (Models 5 and 6), assuming knife-edged maturity at 111 mm CL (Model 9), area-specific values for M (Model 10), and area-specific values of M with knife-edged maturity at 111 mm CL (Model 11). Models 7 and 8 are identical to Model 1, except they consider different definitions for the mean recruitment used to define B_{MSY}. The CPT recommended Model 9 which concurs with the author's recommendation, noting that the data on maturity at length were not reliable enough to estimate a logistic function which forms the basis for models other than Model 9 and 11 but could estimate a knife-edged length at maturity. Model 9 was preferred to Model 11 because the evidence for area differences in M is weak.

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. The CPT recommended that the

model be used to provide management reference points based on the Tier 3 control rule in January 2017 and this tier recommendation was endorsed by the SSC in February 2017.

An industry-ADF&G collaborative survey was implemented for this stock in 2015.

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 WAG increased from a low in the 1990s until 2007/08 and then declined again. Recruitment for the EAG is variable with a generally increasing trend while recruitment for WAG is 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 is based on a male-only population dynamics model rather than the Tier 5 methodology. The changes to the assessment from the January 2017 modeling workshop were specification of maturity-at-length and refinement of the proposed models.

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 2017/18. A single OFL and ABC is defined for AIGKC. However, separate models are available by area. The CPT considered two ways for computing an OFL for AIGKC.

- Apply the OFL control rule by area and sum the OFLs by area.
- Determine stock status for the stock 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 CPT recommended the second alternative because it relies on a single stock status determination rather than for area specific status determinations for the EAG and WAG. In contrast, use of the first alternative would lead to the EAG area being in tier 3a and the WAG area being in tier 3b, which would not result in a unique tier level for the stock.

The CPT recommends that the $B_{MSYproxy}$ for the Tier 3 harvest control rule be based on the average recruitment from 1987-2012, years for which recruitment is relatively precisely estimated.

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

Year	MSST	Biomass (MMB)	TAC	Retained Catch[a]	Total Catch[a]	OFL	ABC
2013/14	N/A	N/A	2.853	2.894	3.192	5.69	5.12
2014/15	N/A	N/A	2.853	2.771	3.079	5.69	4.26
2015/16	N/A	N/A	2.853	2,729	3,073	5.69	4.26
2016/17	N/A	N/A	2.515			5.69	4.26
2017/18[b]	6.044	14.205				6.048	4.838

a. Total retained catch plus estimated bycatch mortality of discarded bycatch during crab fisheries and groundfish fisheries.
b. Approach 2 above

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

Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch[a]	OFL	ABC
2013/14	N/A	N/A	6.290	6.38	7.04	12.54	11.28
2014/15	N/A	N/A	6.290	6.11	6.79	12.53	9.40
2015/16	N/A	N/A	6.290	6.016	6.775	12.53	9.40
2016/17	N/A	N/A	5.545			12.53	9.40
2017/18[b]	13.325	31.315				13.33	10.67

a. Total retained catch plus estimated bycatch mortality of discarded bycatch during crab fisheries and groundfish fisheries.
b. Approach 2 above

Overfishing did not occur during 2015/16 because the estimated total catch did not exceed the Tier 5 overfishing limit (OFL) of 12.53-million lb (5.69 kt).

Additional Plan Team recommendations

The CPT recommended that for the next assessment, the assessment author pre-specify the maturity ogive rather than estimating it along with other model parameters, and consider estimating rather the pre-specifying the 1960 recruitment, which would then be used to calculate B_{MSY}. The CPT was informed about analyses to explore the impact of changes to the area fished. Further work was encouraged on this topic, which will help the CPT understand the extent of uncertainty associated with the assessment.

While the CPT recommended the use of the second alternative OFL calculation as listed above, the calculations for the OFL and ABC based upon the first alternative are shown below.

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

Year	MSST	Biomass (MMB)	TAC	Retained Catch[a]	Total Catch[a]	OFL	ABC
2017/18	**6.044**	**14.233**				**6.018**	**4.815**

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

Year	MSST	Biomass (MMB)	TAC	Retained Catch[a]	Total Catch[a]	OFL	ABC
2017/18c	**13.325**	**31.378**				**13.27**	**10.61**

9 Pribilof District Golden King Crab

Fishery information relative to OFL setting

The Pribilof District golden king crab fishery began in the 1981/82 season. The directed fishery mainly occurs in Pribilof Canyon of the continental slope. Peak directed harvest was 0.856-million lb (388 t) by 50 vessels during the 1983/84 season; fishery participation has since been sporadic and retained catches vary from 0 to 0.342-million lb (155 t). The fishing season is based on a calendar year. A guideline harvest level (GHL) was first established in 1999 at 0.200-million lb (91 t) and the fishery has been managed with a GHL of 0.150-million lb (68 t) since 2000; a GHL for 2015 has not yet been set. No directed fishery occurred during 2006–2009. One vessel landed catch in 2010, two vessels landed catch in 2011, and one vessel landed catch each year from 2012 to 2014. The 2015 season is ongoing and no vessels have participated so far. Data from the directed fishery since 2003 cannot be reported under state confidentiality regulations; however, the GHL has not been reached. Non-retained bycatch occurs in the directed fishery and can occur in the eastern Bering Sea snow crab fishery, Bering Sea grooved Tanner crab fishery, and Bering Sea groundfish fisheries. Estimated fishing mortality from 2001 to 2014 due to directed and non-directed crab fisheries ranged from 0 to 0.160 million lb (73 t). Bycatch mortality in the groundfish fisheries ranged from <0.001 million lb (< 1 t) to 0.019 million lb (12 t) from 1991/92 to 2015/16.

Data and assessment methodology

There is no assessment model for this stock. Fish ticket and observer data are available, size-frequency data from samples of landed crabs, and pot lifts sampled during the fishery, and from the groundfish fisheries. Much of the directed fishery data are confidential due to low participation levels. The initial development of a random effects model using slope survey data was presented. The model included the 2016 slope survey data; however, the model fit was poor for mature and legal size male, likely due to small number of data points and the high variance. The CPT sees merit in further developing this model and incorporating more detailed slope survey data.

Stock biomass and recruitment trends

There is no stock biomass data used in this Tier 5 assessment.

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

The CPT recommends this stock be managed under Tier 5 in 2018. The CPT concurs with the author's recommended status quo OFL of 0.20 million lb and an ABC of 0.15 million lb. The ABC was derived by applying a 25% buffer of the OFL, ABC = 0.75 * OFL, the same buffer used for other Tier 5 stocks with similar levels of concern. The 2018 OFL calculation is the same as recommended by the SSC for 2012−2017:

$$OFL_{2016} = (1+R_{2001–2010})*RET_{1993\text{-}1998} + BM_{NC,1994\text{-}1998} + BM_{GF,1992/93–1998/99}$$

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.
- $RET_{1993\text{-}1998}$ is the average annual retained catch in the directed crab fishery during 1993–1998.
- $BM_{NC,1994\text{-}1998}$ 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

Calendar Year	MSST	Biomass (MMB)	GHL[a]	Retained Catch	Total Catch[b]	OFL	ABC
2013	N/A	N/A	68	Conf. [c]	Conf. [c]	91	82
2014	N/A	N/A	68	Conf. [c]	Conf. [c]	91	82
2015	N/A	N/A	59	0	1.92	91	68
2016	N/A	N/A	59	0	0.24	91	68
2017	N/A	N/A	59			93	70
2018	N/A	N/A				93	70

N/A = not available

Conf. = confidential

TBA = to be announced

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

Calendar Year	MSST	Biomass (MMB)	GHL[a]	Retained Catch	Total Catch[b]	OFL	ABC
2013	N/A	N/A	150,000	Conf.[c]	Conf.[c]	0.20	0.18
2014	N/A	N/A	150,000	Conf.[c]	Conf.[c]	0.20	0.18
2015	N/A	N/A	130,000	0	0.004	0.20	0.15
2016	N/A	N/A	130,000	0	<0.001	0.20	0.15
2017	N/A	N/A	130,000			0.20	0.15
2018	N/A	N/A				0.20	0.15

N/A = not available

Conf. = confidential

TBA = to be announced

10 Western Aleutian Islands Red King Crab

Fishery information relative to OFL and ABC setting

The domestic fishery has been prosecuted every season from 1960/61 to 1995/96. 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. Peak harvest occurred during the 1964/65 season with a retained catch of 21.19 million lb. As the annual retained catch decreased into the mid-1970s and the early-1980s, the area west of 179°15' W longitude began to account for a larger portion of the retained catch. After 1995/96, the fishery was opened only occasionally. There was an exploratory fishery in 1998/99, three commissioner's permit fisheries in limited areas during 2000/01–2002/03 to allow for ADF&G-Industry surveys, and two commercial fisheries with a GHL of 0.5 million lb in 2002/03 and 2003/04 in the Petrel Bank area. The fishery has been closed since 2003/04.

Retained catch from 1985/86 to 1994/95 averaged 0.94 million lb, but the retained catch during the 1995/96 season dropped to 0.04 million lb. 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 were opened only in the Petrel Bank area with 0.51 million lb in 2002/03 and 0.48 million lb in 2003/04. Non-retained catch of red king crabs occurs in both the directed red king crab fishery, the Aleutian Islands golden king crab fishery, and in groundfish fisheries. Estimated bycatch mortality in the crab fisheries during the 1995/96 to 2015/16 seasons averaged 0.002 million lb in crab fisheries and 0.020 million lb in groundfish fisheries. Estimated annual total fishing mortality from 1995/96 to 2015/16 averaged 0.079 million lb. The average retained catch during that period was 0.060 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 to 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 from 1995/96 to 2015/16 and from groundfish fisheries from 1993/94 to 2015/16 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 were 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, recruitment trends, and current levels relative to virgin or historic levels are not available for this stock. The fishery has been closed since 2003/04 due to apparent poor recruitment. A 2009 survey conducted by ADF&G in the Petrel Bank area encountered an ageing population of legal male crab occurring in a more limited area and at lower densities than were found in a 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. A cooperative red king crab survey was performed by the Aleutian Islands King Crab Foundation and ADF&G in the Petrel Bank area in November 2016 averaged less than one crab per pot lift suggesting that the stock is in poor condition.

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

The CPT recommends that this stock be managed under Tier 5 for the 2017/18 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 set the time period for computing the OFL at 1995/96–2007/08. The CPT recommends an OFL for 2017/18 of 0.123867 million lb.

The CPT continues to have concerns regarding the depleted condition of this stock. Groundfish bycatch in recent years has accounted for the majority of the total catch. The CPT recommends an ABC of 0.030967 million lb for 2017/18, which is equivalent to a 75% buffer on OFL.

Status and catch specifications t of Western Aleutian Islands red king crab

Fishing Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch	OFL	ABC
2013/14	N/A	N/A	Closed	0	<1	56	34
2014/15	N/A	N/A	Closed	0	<1	56	34
2015/16	N/A	N/A	Closed	0	1.3	56	34
2016/17	N/A	N/A	Closed	0		56	34
2017/18	N/A	N/A				56	14

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

Fishing Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch	OFL	ABC
2013/14	N/A	N/A	Closed	0	0.00073	0.12387	0.07432
2014/15	N/A	N/A	Closed	0	0.00047	0.12387	0.07432
2015/16	N/A	N/A	Closed	0	0.00296	0.12387	0.07432
2016/17	N/A	N/A	Closed	0		0.12387	0.07432
2017/18	N/A	N/A				0.12387	0.03097