

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 6.685 kt (14.8 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 3.110 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; individual GHLS are applied to areas east and west of 174°W longitude (referred to here as the EAG and WAG, respectively). The 2.677 kt (5.9 million lb) combined GHL established for the 1996/97 season, which was based on the previous five-year average catch, was subsequently reduced to 2.586 kt (5.7 million lb) beginning in 1998/99. The GHL remained at 2.586 kt (5.7 million lb) until 2005/06 when the fishery was rationalized, at which time the TAC was set to the same value. The TAC remained at 2.586 kt (5.7 million lb) until 2008/09, at which point it was increased to 2.715 kt (5.99 million lb) and remained so until the 2011/12 season. Between 2012/13 and 2021/22, the TAC fluctuated between 2.515 kt (5.6 million lb; 2016/17 season) and 3.257 kt (7.18 million lb; 2019/20 season). Since 2019/20, the TACs have been based on the harvest strategy adopted by the Alaska Board of Fisheries in March 2019.

Total mortality of Aleutian Islands (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. Prior to 2022/23, retained catch in the post-rationalized fishery ranged from 2.379 kt (5.3 million lb) in 2006/07 to 3.319 kt (7.32 million lb) in 2019/20. Total catch mortality ranged from 2.506 to 3.729 kt (5.5 to 8.2 million lb) for the same period. At the time of the 2023/24 assessment, the fisheries had not been completed, so retained catch and total catch mortality are estimates. The estimated retained catch in 2022/23 was 2.369 t (5.2 million lb), the lowest in the post-rationalized period, while the estimated total catch mortality was 2.612 kt (5.8 million lb), the third lowest in this time period.

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 Tier 3 modeling framework for AI golden king crab based on fisheries-only data was developed over several years starting in 2011 with model assumptions and data inputs refined by reviews by the SSC and CPT. This modeling framework was recommended for the assessment by the CPT in September 2016 and approved by the SSC in October 2016. More recently, transition from this bespoke model to the GMACS modeling framework has been underway for several years. The CPT endorsed, and the SSC subsequently approved, the GMACS model for this stock in January 2023. This assessment includes the bespoke model accepted for the 2022 assessment modified for comparison with GMACS and updated with 2022/23 data, and an equivalent GMACS model.

The model-based stock assessment involves fitting a male-only population dynamics model to data on catches and discards in the directed fishery, discards in the groundfish fishery, standardized indices of abundance based on observer and fish ticket data, length-frequency data for the directed fishery (landings and total catch), and mark-recapture data. The fisheries in both areas were still operating when the assessment was conducted (March 17, 2023), so the assessment was based on the CPT/SSC-recommended assumption that the 2022/23 TACs for the EAG and WAG would be taken before the fishery seasons closed. Year-end total catches in both areas were then projected using the predicted final effort in each area to scale the nominal final-year total catch CPUE, where the predicted final effort was estimated as the ratio of TAC to the final-year retained catch CPUE. Additionally, a cooperative survey was conducted by the Aleutian

King Crab Research Foundation (an industry group) and ADF&G during the 2022/23 fishing year. This survey has been conducted annually (except 2020) in the EAG since 2016, and once in the WAG in 2018.

The assessment authors examined three model scenarios applied in common to both the EAG and WAG this assessment cycle. Model 22.9c was the 2022 assessment model, modified for comparison with the equivalent GMACS model and updated with 2022/23 data. Model 22.1e2 was the equivalent GMACS version. The two versions produced almost identical results. This model configuration included three catchability periods, knife-edge male maturity size at 116 mm CL, M set to 0.22 yr^{-1} , a fixed period (1987–2017) for reference points calculation, and the addition of new data for 2022/23. Model 22.1f was identical to 22.1e2 but was fit to CPUE data that included a Year x Block effect in the CPUE standardization procedures.

Two additional models for the EAG, Models 22.1g and 22.1h, were also examined: these were based on Models 22.1e and 22.1f, respectively, but with the 2015–2022 cooperative survey data substituted for the total catch CPUE. The CPT noted that the cooperative survey data should have been added to these models as an additional fleet, not simply replacing the existing total catch CPUE indices, because the latter approach assumes the same selectivity and catchability apply in the fishery and survey.

For the EAG, the three “common” models provided very similar results. All three fit the retained catch, total catch, and groundfish bycatch data well, except that Model 22.9c did not fit the retained catch data at the start of the time series. Otherwise, the three models fit the catch data almost identically. All three models also fit the standardized CPUE indices similarly, but the overall fits were poor. The fits to the retained catch and total catch size compositions were good, except in the smallest size bin for total catch prior to 2005/06, where the models substantially underestimated the relative abundance. This, however, was likely due to this bin acting as an accumulator for all crab smaller than the model size range, although the reasons why so many small crab were caught during this time period remained unknown. The CPT noted that, in any case, a standard procedure would be to exclude crab smaller than the modeled size range from the size composition data but also cautioned that it might be necessary to drop the early data as suspect. It also noted that fitting these data may in part explain the large change in fishery selectivity between the pre-and post-rationalization periods.

For the WAG, all three models fit the respective catch data and standardized CPUE indices equally well and produced similar estimates for the recruitment and MMB time series. The models followed the trends in standardized CPUE much better than the EAG models. However, the issue with the high relative abundances of small crab in the total catch size compositions was also evident in the data for the WAG.

The authors’ preferred models were 22.1f for the WAG and 22.1e2 for the EAG, noting that a case could be made for including the Year x Block interaction term in the CPUE standardization for the WAG but not the EAG. The CPT noted several potential issues with the Year x Block standardization for the WAG, including a large spike in CPUE in 2009 in block 5 and apparent quantization in the associated partial residual plots for several other blocks. The consensus recommendation by the CPT was to use 22.1e2 for the two areas.

Stock biomass and recruitment trends

Estimated mature male biomass (MMB) for the EAG decreased from the 1980s to the 1990s, then increased during the 2000s, decreased marginally during the early 2010s, and has systematically increased since 2014. Estimated MMB for the WAG decreased substantially during the late 1980s and 1990s, increased somewhat during the 2000s, decreased for several years after 2008 and has since

fluctuated about a relatively low value. Stock trends have generally reflected the fishery standardized CPUE trends in both regions.

Summary of major changes

The assessment model recommended by the CPT, Model 22.1e2, is identical to the model used in the previous assessment, except that it is implemented using GMACS. New data for the assessment included fishery data for the 2022/23 fishing season; in addition, the standardized CPUE indices were updated.

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 2023/24. A single OFL and ABC is defined for AIGKC. However, separate models are available by area. During its May 2017 meeting, the CPT recommended that stock status be determined by adding the area-specific estimates of current MMB and B_{MSY} to ensure that there would only be one stock status for the AIGKC stock. However, area-specific stock status is 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 summed to calculate an OFL for the entire stock. The SSC has concurred with this approach. 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. The CPUE index standardization process, subject to past CPT and SSC review, is a key reason for the 25% buffer between the OFL and the ABC used in past years. Concerns raised in recent assessments are summarized in the following table:

Concern	year expressed	CPT 2023 concern?	Reason
Only crab assessment that relies entirely on fishery CPUE as an index of abundance	2020	Yes	No change.
Uncertainty in natural mortality	2020	Less	A revised estimate for natural mortality based on a peer-reviewed study (Siddeek et al., 2022) was used.
The limited spatial coverage of the fishery with respect to the total stock distribution	2020	Yes	No change.
The small number of vessels on which CPUE is based	2020	Yes	No change.
Retrospective pattern for the EAG	2020	Yes	No change. Retrospective patterns were not presented, but assumed to be similar to those seen last year.
CPUE standardization is still subject to some methodological concerns	2020	Less	No change. Principal methodological concerns have been met, but some issues remain.

Catches from the WAG that were not included in the assessment	2021	Less	Method to extrapolate retained and total catches to year end has been documented; CPT accepted the method used.
Model convergence concerns reflecting potential parameter confounding (jitter analysis resulted in multiple solutions for MMB and $B_{35\%}$ at same likelihood values)	2021	Unknown	Jitter analysis was not conducted for the CPT-recommended models.

The SSC adopted a 30% buffer for the ABC in 2021/22 based primarily on concerns raised by a jitter analysis that suggested the model may be converging to local minima, exhibiting multiple values for reference points associated with a single value for the likelihood. In 2022/23, the CPT recommended, and the SSC concurred with, reducing the buffer for the ABC back to 25%, its value before 2021/22, principally because no problems of this sort occurred for the 2022 recommended models and the CPT found reasons to reduce or eliminate several other concerns. For 2023/24, the CPT found that several previously expressed concerns continued to exist, the principal one being the retrospective patterns for the recommended EAG model. Thus, the CPT recommends continuing to use a 25% buffer, its value last year, on the OFL for the ABC.

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
2019/20	5.909	16.323	3.257	3.319	3.735	5.249	3.937
2020/21	6.026	16.207	2.999	3.000	3.444	4.798	3.599
2021/22	5.859	12.592	2.690	2.699	3.056	4.817	3.372
2022/23	5.832	13.600	2.291	2.369 ^a	2.612 ^a	3.761	2.821
2023/24		12.069				4.182	3.137

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
2019/20	13.027	35.985	7.180	7.317	8.234	11.572	8.679
2020/21	13.284	35.730	6.610	6.614	7.593	10.579	7.934
2021/22	12.917	27.760	5.930	5.951	6.737	10.620	7.434
2022/23	12.857	29.984	5.050	5.223 ^a	5.758 ^a	8.291	6.219
2023/24		26.607				9.220	6.916

^a The fisheries were still being prosecuted when the 2023 assessment was conducted.

Total fishery mortality in 2022/23 will be updated in September 2023.