Aleutian Islands Golden King Crab Stock Assessment 2025

Tyler Jackson
Alaska Department of Fish and Game, tyler.jackson@alaska.gov

July 2025

Note: This SAFE document has been revised from the original version released on May 5, 2025. Minor changes were made to figures and text to comply with confidentiality rules for the 2024 fishing year.

Executive Summary

1. **Stock**: Golden king crab, *Lithodes aequispinus*, Aleutian Islands, east of 174° W longitude (EAG) and west of 174° W longitude (WAG).

2. **Catch**: The Aleutian Islands golden king crab (AIGKC) commercial fishery has been prosecuted every year since 1981/82. Retained catch peaked in 1986/87 at 2,686 t (5,922,425 lb) and 3,999 t (8,816,319 lb), respectively, for the EAG and WAG, but the retained catch dropped sharply from 1989/90 to 1990/91. The fishery has been managed separately east (EAG) and west (WAG) of 174° W longitude since 1996/97, and Guideline Harvest Levels (GHLs) of 1,452 t (3,200,000 lb) for the EAG and 1,225 t (2,700,000 lb) for the WAG were introduced into management. The GHL was subsequently reduced to 1,361 t (3,000,000 lb) beginning in 1998/99 for the EAG. The reduced harvest levels remained at 1,361 t (3,000,000 lb) for the EAG and 1,225 t (2,700,000 lb) for the WAG through 2007/08 but were increased to 1,429 t (3,150,000 lb) for the EAG and 1,294 t (2,835,000 lb) for WAG beginning with the 2008/09 fishing season following an Alaska Board of Fisheries (BOF) decision. The management specification changed from GHL to TAC (Total Allowable Catch) with adoption of the Crab Rationalization Program in 2005/06 (NPFMC 2007b). The TACs were increased by another BOF decision to 1,501 t (3,310,000 lb) for EAG and 1,352 t (2,980,000 lb) for WAG beginning with the 2012/13 fishing season. The below par fishery performance in WAG in 2014/15 and 2015/16 lead to reduction in TAC to 1,014 t (2,235,000 lb), which reflected a 25% reduction in the TAC for WAG, while the TAC for EAG was kept at the same level, 1,501 t (3,310,000 lb) for the 2016/17 through 2017/18 fishing seasons. With the improved fishery performance and stock status in 2017/18, the TACs were further increased to 1,134 t (2,500,000 lb) for WAG and 1,749 t (3,856,000 lb) for EAG beginning with the 2018/19 fishing season. With the implementation of a revised state harvest strategy in 2019, the TACs were further increased to 1,302 t (2,870,000 lb) for WAG and 1,955 t (4,310,000 lb) for EAG. In the 2024/25 the TAC was 1,706 t (3,760,000 lb) in the EAG and 508 t (1,120,000 lb) in the WAG. At the time of this report, the EAG fishery was ongoing and the WAG was completed. Projected retained catch was 2.215 t (4,883,000 lb) in total, though due to the number of participants, catch information by subdistrict is confidential.

   Total catch mortality includes retained catch, discard mortality in the directed fishery, and bycatch mortality in groundfish fixed gear and trawl fisheries. Directed fishery discard mortality and groundfish fishery bycatch have remained low and stable in recent history, with the exception of several pulses in groundfish bycatch during 2016 and 2020 in the EAG and 2022 in the WAG. Catch per unit effort (CPUE, i.e., crab per pot lift) of retained legal males was low from the 1980s into the mid-1990s, but increased after 1999/00, particularly with the initiation of the Crab Rationalization Program in 2005/06. Although CPUE for the two areas showed similar trends through 2010/11, CPUE trends have since diverged (increasing for the EAG and decreasing for the WAG).

3. **Stock biomass**: Estimated mature male biomass (MMB) decreased rapidly through 1988 in the EAG and until 1992 in the WAG. MMB remained at low levels for several years before steadily increases starting in 1995 (in both areas) and reaching a peak during the early (EAG) to mid (WAG) 2000s.

Since then, estimated MMB has remained somewhat stationary in the EAG, though undergoing a dip from about 2011 - 2020. MMB in the EAG has slightly decreased since 2022, but remains relatively high for the recent time series. MMB in the WAG has steadily decreased since 2008, with a small increase from 2014 - 2017. The most recent several seasons suggest little change since 2020.

4. **Recruitment**: Estimated recruitment has remained stationary in the EAG and has undergone a slow decreasing trend in the WAG since the 1990s. The largest recruitment pulse occurred during 1989 in the EAG and 1985 in the WAG, and the lowest in 1985 and 2003 in the EAG, and 2021 in the WAG. Both models suggest decreasing recruitment in the EAG, except during the terminal year, though increasing recruitment in the WAG since 2021.

5. **Management performance**: AIGKC has been managed as a Tier 3 stock since 2017. Biological reference points computed for EAG and WAG subdistricts separately are summed for the full stock prior to stock status determination. The stock was above Minimum Stock Size Threshold (MMST; 50% of $B_{35\%}$) in 2024/25, and thus was not overfished, nor has ever been overfished at any point in its history. Completed fishery totals are not anticipated to exceed the OFL of 3.725 kt (8.212 mil lb). Estimated fully selected fishing mortality (F) and MMB relative to fishing mortality and biomass targets suggest fishery management has been conservative in recent history in the EAG, and somewhat aggressive in the WAG. Based on all model scenarios, estimated F exceeded the F_{OFL} control rule in a number of seasons, but most recently 2018/19 - 2023/24.

Status and catch specifications for models EAG and WAG combined. Model 23.1c was used for 2025/26 reference points.

1,000 t

Year	MSST	Biomass (MMB_{mating})	TAC	Retained Catch	Total Catch	OFL	ABC
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	2.612	3.761	2.821
2023/24	5.772	12.716	2.508	2.578	2.765	4.182	3.137
2024/25	5.632	11.087	2.214	2.215	2.341	3.725	2.794
2025/26		10.480				3.166	2.374

Million lb

Year	MSST	Biomass (MMB_{mating})	TAC	Retained Catch	Total Catch	OFL	ABC
2021/22	12.917	27.761	5.930	5.950	6.737	10.620	7.434
2022/23	12.857	29.983	5.051	5.223	5.758	8.292	6.219
2023/24	12.725	28.034	5.530	5.684	6.096	9.220	6.916
2024/25	12.417	24.443	4.881	4.883	5.161	8.212	6.159
2025/26		23.104				6.980	5.234

2022/23 refence points were estimated before the WAG fishery was completed.
2023/24 refence points were estimated before EAG and WAG fisheries were completed.
2025/26 refence points were estimated before the EAG fishery was completed.

6. **Basis for the OFL**:

Basis for the OFL from EAG accepted models.

1000 t

				Stock			Natural
Year	Tier	B_{MSY}	(MMB_{mating})	Status	F_{OFL}	Basis for B_{MSY}	Mortality
2021/22	3a	6.760	8.720	1.29	0.61	1987 - 2017	0.21
2022/23	3a	6.630	7.390	1.12	0.52	1987 - 2017	0.21
2023/24	3a	6.680	7.490	1.12	0.59	1987 - 2017	0.22
2024/25	3a	6.905	7.551	1.09	0.55	1987 - 2020	0.22
2025/26	3a	6.734	6.906	1.03	0.52	1987 - 2021	0.22

Million lb

				Stock		$\bar{R}$	Natural
Year	Tier	B_{MSY}	(MMB_{mating})	Status	F_{OFL}	Basis for B_{MSY}	Mortality
2021/22	3a	14.903	19.224	1.29	0.61	1987 - 2017	0.21
2022/23	3a	14.617	16.292	1.12	0.52	1987 - 2017	0.21
2023/24	3a	14.727	16.513	1.12	0.59	1987 - 2017	0.22
2024/25	3a	15.223	16.647	1.09	0.55	1987 - 2020	0.22
2025/26	3a	14.847	15.224	1.03	0.52	1987 - 2021	0.22

Basis for the OFL from WAG accepted models.

1,000 t

				Stock		$\bar{R}$	Natural
Year	Tier	B_{MSY}	(MMB_{mating})	Status	F_{OFL}	Basis for B_{MSY}	Mortality
2021/22	3a	5.290	6.100	1.15	0.57	1987 - 2017	0.21
2022/23	3b	5.090	4.550	0.89	0.49	1987 - 2017	0.21
2023/24	3b	4.982	4.570	0.92	0.50	1987 - 2017	0.22
2024/25	3b	4.638	3.837	0.83	0.44	1987 - 2020	0.22
2025/26	3b	4.530	3.570	0.79	0.39	1987 - 2021	0.22

Million lb

				Stock		$\bar{R}$	Natural
Year	Tier	B_{MSY}	(MMB_{mating})	Status	F_{OFL}	Basis for B_{MSY}	Mortality
2021/22	3a	11.662	13.448	1.15	0.57	1987 - 2017	0.21
2022/23	3b	11.222	10.031	0.89	0.49	1987 - 2017	0.21
2023/24	3b	10.983	10.075	0.92	0.50	1987 - 2017	0.22
2024/25	3b	10.226	8.460	0.83	0.44	1987 - 2020	0.22
2025/26	3b	9.986	7.870	0.79	0.39	1987 - 2021	0.22

A. Summary of Major Changes

1. Changes in management of the fishery

There are no new changes in management of the fishery.

2. Changes to the input data

a) Updated directed fishery total catch 1990 - 2024 (Appendix A);

b) Updated directed fishery total length composition data 1990 - 2024 (Appendix A);

c) Updated observer CPUE index 2005 - 2024 (Appendix B);

d) Retained catch for the directed fishery during the 2024/25 season;

e) Total catch for the directed fishery during the 2024/25 season;

f) Bycatch in groundfish fisheries during the 2024 crab year;

g) Retained and total length composition data for the directed fishery during the 2024/25 season;

h) Observer size composition data include data from all rectangular shaped pots to better estimate total size composition in the WAG in 1993 (Jackson 2024b).

3. Changes in assessment methodology

a) Update to GMACS version 2.20.21;

b) Average recruitment reference period for calculation of $B_{35\%}$ updated to 1987 - 2021;

c) Two models are compared in this report (See Section E.3.a for details):

- **23.1c**: 2024 base model, with updated time series data, and alternative bias correction on recruitment deviations from 1960 - 1981;
- **25.0b**: Model 23.1c + with non-equilibrium initial conditions, starting in 1981, equal emphasis on all likelihood components ($\lambda = 1$), and bootstrap estimated stage-1 effective sample sizes.

4. Changes in assessment results

Model 23.1c was recommended by the CPT to replace the 2024 acceptable model as the 'base' model since it corrected 1993 size composition data in the WAG and bias correction of recruitment deviations in years preceding data (Jackson 2024b). The alternative model (25.0b) explored non-equilibrium initial conditions, equal likelihood weighting for catch data series, and bootstrap estimated input sample sizes for size composition data. Non-equilibrium initial conditions result in differing numbers at size in both districts during the early time series. Model 25.0b had greater numbers at smaller sizes and fewer numbers at larger sizes in the EAG, whereas the opposite was evident in the WAG. There was little change to fits to any data series, notably, poor fits to post-rationalization observer CPUE data in the EAG remained unresolved.

Bootstrap estimate sample size for size composition data were larger than used for model 23.1c, though Francis re-weighting resulted in lower stage-2 weights for total size composition data compared to model 23.1c in many pre-rationalized years and the greater weights in post-rationalized years. Alternative size composition weighting lead to slightly different recruitment estimates in a number of years, which likely contributed to increased selectivity of the pre-rationalized directed fishery. Model 25.0b resulted in a lower MMB from 1997 onward, following the same trajectory as model 23.1c. Since EAG models appear to be somewhat sensitive to size composition data weighting (here; Jackson 2024b), yet these changes do not improve model performance, the base model is recommended for 2025/26 harvest specifications.

B. Response to Comments

CPT September 2024

Comment: "*CPT requested that a risk table for AIGKC be brought forward in May* "

Response: See Appendix C.

. . . .

SSC June 2024

Comment: "*The SSC requests the rationale for using the terminal year minus four year approach to define the reference period for future assessments*"

Response: See plots below. The CPT recommend using 1987 - 2020 during the May 2024 assessment, and adding a year sequentially after that. The reference time series was chosen because recruitment deviations are estimated with reasonable precision during that time period following the method used for other BSAI crab stocks. There was not rigorous analysis of the optimal reference period.

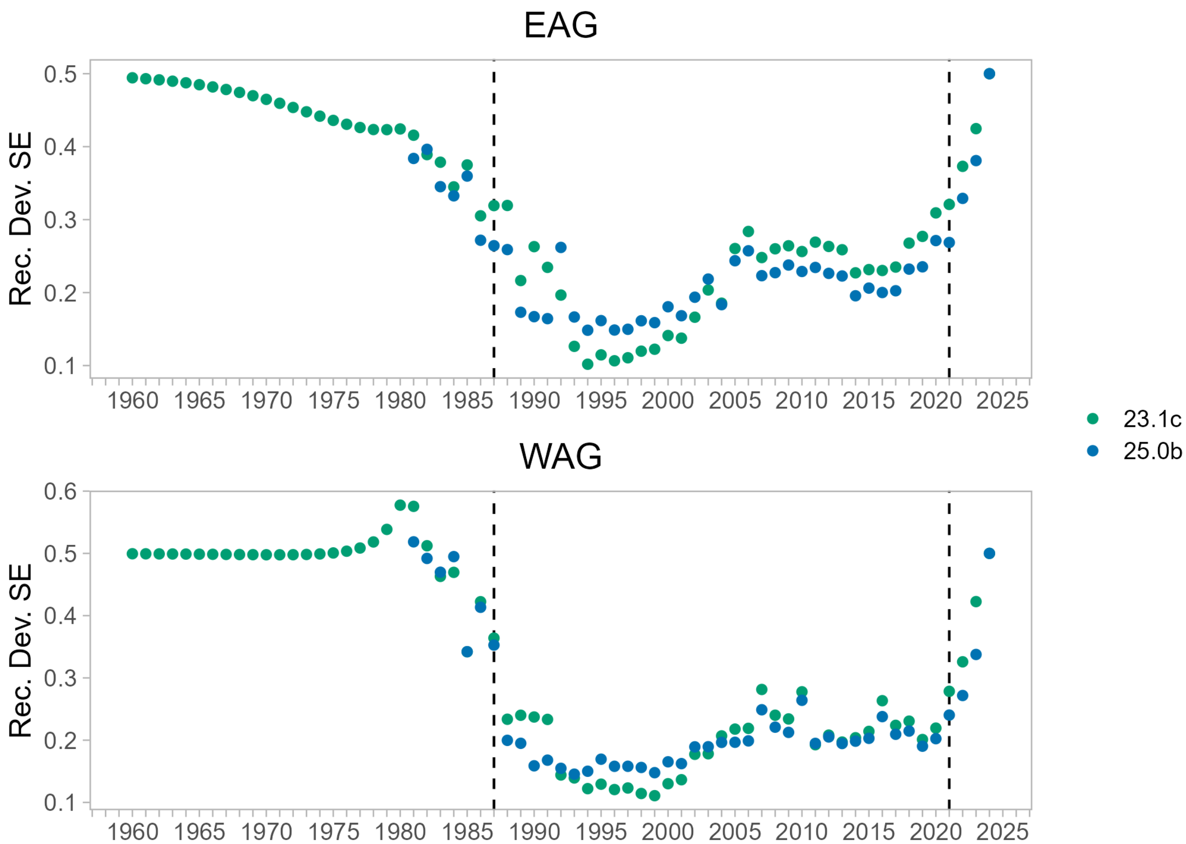

Figure 1: Standard errors of recruitment deviations for models 23.1c and 25.0b. Dotted lines indicate the reference time series for mean recruitment used in reference point calculation, 1987 - 2021.

....

Comment: "*The SSC recommends that the CPT explore whether to conduct this final assessment on the same cycle as other crab assessments in September/October to better align the assessment with the annual cycle of catch mortality.* "

Response: ADF&G and the CPT do not think moving the timing of the final assessment to September would be suitable because the fishery opens in August.

....

Comment: "*The SSC recommends prioritizing further consideration of data weighting, as the Francis re-weighting continues to be an issue in this assessment.*"

Response: This analysis explores data weighting, specifically with respect to size composition data.

....

Comment: “*The SSC places a high priority on incorporating information from the cooperative survey into the assessment and supports the CPT recommendation to incorporate this survey as a separate fleet.*”

Response: See models 25.1 and 25.1b (Jackson 2024b).

. . . .

Comment: “*Further examination of the retrospective pattern in terms of magnitude, direction and cause continues to be important.*”

Response:

retrospective pattern in MMB appears to arise from data conflict that also results in poor fit to post rationalization observer CPUE in the EAG, which has the same retrospective pattern. Data conflict is less apparent in the WAG. Jackson 2024b discusses model misspecfication, but more work is necessary.

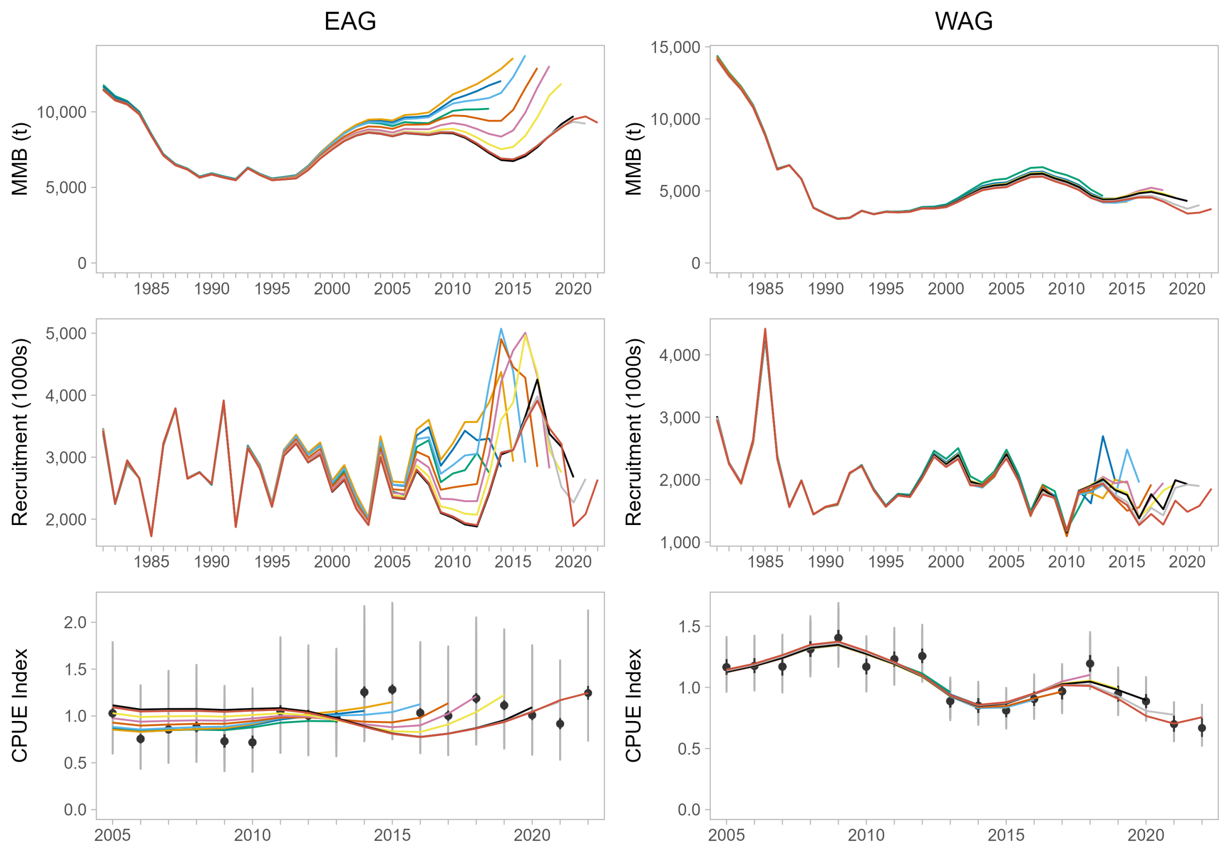

Figure 2: MMB trajectory, recruitment, and fits to observed CPUE index for EAG retrospective peels up to 10 years.

. . . .

Comment: “*The CPT suggested that next year’s model should be 25.0. The SSC reminds the CPT and authors that new model year numbers are only applicable if there is a major structural model change.*”

Response: Noted.

. . . .

Comment: “*The current method of projecting the remaining landings for the current incomplete season seems overly complicated and the SSC recommends a more straightforward method for determining total catch be considered, such as basing it on the average fraction harvested to date.* ”

Response: See Section D.2.f of this document. . . . .

CPT May 2024

Comment: "*Use the standard convention for model numbering, i.e. the models for the May 2025 assessment, will be 25.xx and not 24.xx.*"

Response: This is done.

. . . .

Comment: "*Document why the 1993 bycatch and total catch size-composition data are not included in this and past assessments.*"

Response: Issues with 1993 observer data (not bycatch) have been resolved by model 23.1 (data). There was no observer coverage in the 1993 crab year for EAG directed fishing and for WAG, most pots were previously removed because they were of unknown size. Those pots are now included for size composition data only, which also affects total catch estimation.

. . . .

Comment: "*Explore reasons for the retrospective pattern for the EAG.*"

Response: See above. This work is ongoing.

. . . .

Comment: "*Consider models for the EAG and WAG that allow for the bias-correction in recruitment, especially given there is virtually no information in the data on the sizes of the recruitments before 1985.*"

Response: See model 23.1c.

. . . .

Comment: "*Include the EAG cooperative survey data (index and size-composition) as an additional fleet.*"

Response: See models 25.1 and 25.1b of Jackson (2024b).

. . . .

Comment: "*Fit models that assume that the size-composition data are Dirichlet-multinomial distributed instead of Francis weighting the size-composition data.*"

Response: See models 25.0c and 25.0d of Jackson (2024b).

. . . .

Comment: "*Explore the reasons for the implausible values for groundfish fishing mortality in some years for some of the retrospectives and some of the jitter runs.*"

Response: This was presented at the May 2024 plan team meeting. The model estimated a large recruitment pulse preceding 1996, which appeared to allow for better fit to 1996 observer index data. Because size composition data in the directed fishery and the base natural mortality rate could not support such a recruitment pulse, the model 'killed off' the extra crab in the bycatch fishery which does not have associated composition data and large CV. Running the model with a .pin file that specifies appropriate starting values for F deviations or increasing the penalty on F deviations in that fleet resolves the issue.

. . . .

Comment: "*Consider starting the model in a non-equilibrium state around 1981.*"

Response: Model 25.0 and its derivations addresses this Jackson (2024b), and see model 25.0b in this analysis.

. . . .

Comment: "*Revisit estimation of size-at-maturity given the addition of new data.*"

Response: This will be revisited during September 2025.

. . . .

Comment: "*Continue exploration of CPUE standardization, including investigation of models with block:year interactions and using geostatistical methods.*"

Response: CPUE standardization using a spatiotemporal model was explored here, but will be refined and used in the assessment model during the next cycle.

. . . .

Comment: "*Explore time-varying catchability (e.g. as blocks) rather than the use of additional variance to reconcile the trends in CPUE and those in abundance. Given the known difficulties estimating time-variation in catchability, this could be explored as part of a simulation study – with initial discussions at the January 2025 modeling workshop.*"

Response: This could be further explored, with some guidance on design of a simulation experiment..

. . . .

SSC Feb 2024

Comment: "*The SSC recommends that any new substantial standardization changes should be reviewed during the next cycle, not during specifications in May/June 2024*

Response: The only revisions to CPUE standardization between model explorations and the final assessment addressed poor model diagnostics, though this will be noted for the future.

. . . .

CPT Jan 2024

Comment: "*The CPT recommends that the CPUE standardization be revised for the 2024 assessment by:*

- *exploring the use of a Tweedie instead of the negative binomial distribution;*
- *dropping the data for gear types 4 and 13 which have few observations;*
- *reporting DHARMa residuals and providing influence plots as additional diagnostics; and*
- *exploring the basic data used for the fish ticket CPUE index because the data on which the standardization is based for the current analyses include many zero observations – this may be because the extracted data may include trips for red king crab in the Aleutians. If the residual pattern for the fish ticket analysis (Fig. 44 of Appendix B) is not resolved, results should be presented in May 2024 for model runs that use and ignore the fish ticket CPUE index.*"

Response: All of these recommendations were addressed in CPUE standardization except dropping gear types 4 and 13. This recommendation will be followed up in 2025 model explorations.

. . . .

Comment: "*Include measures of uncertainty (for at least one model configuration) in the plots for the estimates of recruitment and MMB*

Response: This has been addressed.

. . . .

Comment: "*Include a plot of the survey index overlaid on the observer CPUE index (EAG)*

Response: This plot will be included in documents that evaluate models containing survey data.

. . . .

Comment: "*Describe why the MMB for the EAG declines substantially before 1980 while this is not the case for the WAG*

Response: This is explained in section 4.g of Jackson (2024).

. . . .

Comment: "*Start the y-axis for the plots of recruitment and MMB at zero*

Response: This has been addressed.

. . . .

Comment: "*Include the number of parameters in likelihood tables*

Response: This has been addressed.

. . . .

Comment: "*Apply jittering to ensure that the reported parameters correspond to the global minimum of the objective function.*

Response: Jitter analysis was performed for the two author preferred model scenarios.

. . . .

SSC June 2023

Comment: "*The SSC agrees with the CPT recommendation for a 25% buffer for this assessment and supports the resulting ABC. For the future, the SSC specifically requests that jitter and retrospective analyses be conducted for all final models that have the potential to be used for setting harvest specifications*"

Response: Retrospective and jitter analyses were performed here. . . . .

Comment: "*The SSC places a high priority on incorporating information from the cooperative survey into the assessment and supports the CPT recommendation that this be incorporated as a separate fleet.*"

Response: Model 23.2, 25.1, and 25.1b explored the utility of the pot survey as an additional fleet. They are not presented here. . . . .

Comment: "*Further examination of the retrospective pattern in terms of magnitude, direction and cause continues to be important.*"

Response: More work will be done to address the retrospective pattern in the EAG during the next cycle.
. . . .

Comment: "*Revisit the choice to maintain the recruitment years at 1987 – 2017 rather than successively adding recent years to the time series, as is done for other crab stocks.*"

Response: See response to similar comment above. . . . .

Comment: "*The CPT recommended removing the data on the smallest size bin for the total catch prior to 2005/2006. The SSC requests first plotting these data and the model fit and providing further consideration of why these data may or may not be representative of the fishery at that time.*"

Response: For clarification, the CPT recommended to remove data on crab below the smallest size bin (i.e. ≤ 100 mm) that were being included in the 101-105 mm bin. . . . .

Comment: "*The current method of projecting the remaining landings for the current incomplete season seems overly complicated and the SSC recommends that a more straightforward method for determining total catch be considered, such as basing it on the average fraction harvested to date.*"

Response: Total catch was determined using the effort required to achieve the TAC at current CPUE on the date when data were pulled. . . . .

Comment: "*Further analysis and discussion of the retrospective pattern is needed to justify the size of the buffer used.*"

Response: This was noted during the final assessment in May 2024. . . . .

CPT May 2023

Comment: "*Continue work to obtain an index using the cooperative pot survey data for use in the EAG assessment model.*"

Response: Models 23.2, 25.1, and 25.1b explored the utility of the pot survey as an additional fleet, but we not recommended for the 2025 final assessment. . . . .

Comment: "*Identify and eliminate the conflict between the model and the data giving rise to the retrospective patterns for EAG models. Revisit the analysis considering a model with time-varying catchability, but impose a penalty on the devs to allow the index data to inform the model.*"

Response: We will revisit time varying catchability in a future assessment cycle. . . . .

Comment: "*Plot observed vs. predicted values for fitted data to help diagnose misfits.*"

Response: It's unclear what model process this is referring to. When applicable, observations are always plotted with fitted data in this document. . . . .

Comment: "*Add confidence intervals to plots of fits to catch data (i.e., retained catch, total catch) reflecting assumed data uncertainty.*"

Response: All plots of catch and index data now include confidence intervals. . . . .

Comment: "*Perform retrospective analyses for all models that have the potential to serve as the basis for calculating reference points.*"

Response: Retrospective analysis with 10 yr peels have been explored here for all models. . . . .

Comment: "*Calculate reference points using both combined-area and area-specific size-at-maturity values.*"

Response: Combined area models were explored in previous cycles, and area-specific maturity will be re-revaluated in September 2025. . . . .

Comment: "*Re-evaluate the time frame over which to calculate mean recruitment every year by, for example, using a plot of the variance in estimated recruitment deviations.*"

Response: See revised response to SSC comment in June 2024. . . . .

Comment: "*Continue work to obtain an index using the cooperative pot survey data for use in the EAG assessment model.*"

Response: Analysis of the cooperative pot survey is detailed in Appendix C of Jackson 2024b. . . . .

Comment: "*The cooperative survey should be fit as an additional CPUE index, not substituted for existing indices as was done for models 22.1g and 22.1h.*"

Response: That is what has been explored by Jackson 2024b. . . . .

Comment: "*Size-composition data should not include a "minus" group (i.e., crab smaller than the smallest size bin used in the model).*"

Response: This is rectified by model 23.1. ....

Comment: "*The data used to determine the total catch size-compositions in the two areas should be re-examined to determine whether the abundances in the smallest size bin from 1990 to 2004 are correct.*"

Response: Appendix A (Jackson 2024) recomputes size composition time series using data directly pulled from the observer database. Updated time series still appear to contain a disproportionate amount of crab 101-105 mm CL, even without minus-sized crab (model 23.1). This is possibly due to escape mesh not being required until the 1997 season. ....

Comment: "*Explore models that provide better fits to EAG CPUE data.*"

Response: More work in this area is needed during the next cycle. ....

Comment: "*Use GAMs rather than GLMs to standardize the CPUE indices (e.g., use the R package "mgcv").*"

Response: All models derivative of 23.0a take this approach. ....

Comment: "*Show both the original CV's and effective CV's (i.e., incorporating additional variance) when showing fits to the CPUE index time series.*"

Response: This has been done in all plots showing fits to the CPUE index. ....

Comment: "*In the SAFE document*

- *Add a note to explain that retained catch can exceed TAC in some years due to the cost recovery fishery associated with the cooperative survey.*
- *Drop Appendix D.*
- *Remove tier designation from area-specific management Table.*
- *Add explanation for extrapolation of total catch in final year"*

Response: All items have been addressed since the May 2024 SAFE document. ....

C. Introduction

1. Scientific Name

Golden king crab, (*Lithodes aequispinus*), J.E. Benedict, 1895.

2. Distribution

General distribution of golden king crab is summarized by NMFS (2004). Golden king crab, also called brown king crab, occur from the Sea of Japan to the northern Bering Sea (ca. 61° N latitude), around the Aleutian Islands, generally in high-relief habitat such as inter-island passes, on various sea mounts, and as far south as northern British Columbia (Alice Arm) (Jewett et al. 1985). They are typically found on the continental slope at depths of 300 - 1,000 m on extremely rough bottom. They are frequently found on coral bottom.

The Aleutian Islands king crab stock boundary is defined by the boundaries of the Aleutian Islands king crab Registration Area O (Figure 3). In this chapter, "Aleutian Islands Area" means the area described by the current definition of Aleutian Islands king crab Registration Area O. Nichols et al. (2021) define the boundaries of Aleutian Islands king crab Registration Area O:

The Aleutian Islands king crab Registration Area O eastern boundary is the longitude of Scotch Cap Light (164° 44.72'W long); the northern boundary is a line from Cape Sarichef (54° 36'N lat) to 171° W long, north to 55° 30'N lat; and the western boundary the United States–Russia Maritime Boundary Line of 1990.

During 1984/85 - 1995/96, the Aleutian Islands king crab populations had been managed using the Adak and Dutch Harbor Registration Areas, which were divided at 171° W longitude, but from the 1996/97 season to present the fishery has been managed using a division at 174° W longitude (Figure 3). In March 1996, the Alaska Board of Fisheries (BOF) replaced the Adak and Dutch Harbor areas with the newly created Aleutian Islands Registration Area O and directed ADF&G to manage the golden king crab fishery in the areas east and west of 174°W longitude as two distinct stocks. That re-designation of management areas was intended to reflect golden king crab stock distribution, congruent with the longitudinal pattern in fishery production prior to 1996/97. The longitudinal pattern in fishery production relative to 174° W longitude since 1996/97 is like that observed prior to the change in management area definition, although there have been some changes in the longitudinal pattern in fishery production within the areas east and west of 174° W longitude.

Commercial fishing for golden king crab in the Aleutian Islands Area typically occurs at depths of 100 - 275 fathoms (183 - 503 m) (Gaeuman 2014). Pots sampled by at-sea fishery observers during 1990/91 - 2022/23 were fished at an average depth of 181 fathoms (331 m; N = 57,792) in the area east of 174° W longitude and 178 fathoms (326 m; N = 62,062) for the area west of 174° W longitude.

3. Evidence of stock structure

Given the expansiveness of the Aleutian Islands Area and the existence of deep (> 1,000 m) canyons between some islands, at least some weak structuring of the stock within the area would be expected. Data for making inferences on stock structure of golden king crab within the Aleutian Islands are largely limited to the geographic distribution of commercial fishery catch and effort. Catch data by statistical area from fish tickets and catch data by location from pots sampled by observers suggest that habitat for legal-sized males may be continuous throughout the waters adjacent to the islands in the Aleutian chain. However, regions of low fishery catch suggest that availability of suitable habitat, in which golden king crab are present at only low densities, may vary longitudinally. Catch has been low in the fishery in the area between 174° W longitude and 176° W longitude (the Adak Island area) in comparison to adjacent areas, a pattern that is consistent with low CPUE for golden king crab between 174° W longitude and 176° W longitude during the 2002, 2004, 2006, 2010, and 2012 NMFS Aleutian Islands bottom trawl surveys (von Szalay et al. 2011, 2017). In addition to longitudinal variation in density, there is also a gap in fishery catch and effort between the Petrel Bank-Petrel Spur area and the Bowers Bank area; both of those areas, which are separated by Bowers Canyon, have reported effort and catch. Recoveries during commercial fisheries of golden king crab tagged during ADF&G surveys (Blau and Pengilly 1994; Blau et al. 1998; Watson and Gish 2002; Watson 2004, 2007) provided no evidence of substantial movements by crab in the size classes that were tagged (males and females ≥ 90 mm carapace length [CL]). Maximum straight-line distance between release and recovery location of 90 golden king crab released prior to the 1991/92 fishery and recovered through the 1992/93 fishery was 61.2 km (Blau and Pengilly 1994). Of the 4,567 recoveries reported through April 12, 2016, for the male and female golden king crab tagged and released between 170.5° W longitude and 171.5° W longitude during the 1991, 1997, 2000, 2003, and 2006 ADF&G Aleutian Island golden king pot surveys, none of the 3,807 with recovery locations specified by latitude and longitude were recovered west of 173° W longitude and only 15 were recovered west of 172° W longitude (V. Vanek, ADF&G, Kodiak, pers. comm.). Similarly, of 139 recoveries in which only the statistical area of recovery was reported, none were recovered in statistical areas west of 173° W longitude and only one was in a statistical area west of 172° W longitude. Thus, little mixing of Dutch Harbor and Adak areas provide a reason for undertaking a separate stock assessment in each area. A population genetic study of golden king crab throughout Alaska suggested heterogeneity separating Aleutian and southeast Alaska regions, but no substructuring within the Alteutian Islands (Grant and Siddon 2018).

4. Life history characteristics relevant to management

There is a paucity of information on golden king crab life history characteristics due in part to the deep depth distribution (~200 - 1000 m) and the asynchronous nature of life history events (Otto and Cummiskey 1985; Somerton and Otto 1986). The reproductive cycle is thought to last approximately 24 months and at any time of year ovigerous females can be found carrying egg clutches in highly disparate developmental states (Otto and Cummiskey 1985). Females carry large, yolk-rich, eggs, which hatch into lecithotrophic larvae (i.e., the larvae can develop successfully to juvenile crab without eating; Shirley and Zhou 1997) that are negatively phototactic (Adams and Paul 1999). Molting and mating are also asynchronous and protracted (Otto and Cummiskey 1985; Shirley and Zhou 1997) with some indications of seasonality (Hiramoto 1985). Molt increment for large males (adults) in Southeast Alaska is 16.3 mm CL per molt (Koeneman and Buchanan 1985) and was estimated at 14.4 mm CL for legal males in the eastern Aleutian Islands (Watson et al. 2002). Annual molting probability of males decreases with increasing size, which results in a protracted inter-molt period and creates difficulty in determining annual molt probability (Watson et al. 2002). Male size-at-maturity varies among stocks (Webb 2014) and declines with increasing latitude from about 130 mm CL in the Aleutian Islands to 92 mm CL in the Saint Matthew Island section (Somerton and Otto 1986).

5. Summary of management history

A complete summary of the management history through 2015/16 is provided in Leon et al. (2017). The first commercial landing of golden king crab in the Aleutian Islands was in 1975/76 but directed fishing did not occur until 1981/82.

The Aleutian Islands golden king crab fishery was restructured beginning in 1996/97 to replace the Adak and Dutch Harbor areas with the newly created Aleutian Islands Registration Area O and golden king crab in the areas east and west of 174° W longitude were managed separately as two stocks (ADF&G 2002). Hereafter, the east of 174° W longitude stock segment is referred to as EAG and the west of 174° W longitude stock segment is referred to as WAG. Table 1 and 2 provides the historical summary of number of vessels, GHL/TAC, harvest, effort, CPUE, and average weight of crab in the Aleutian Islands golden king crab fishery.

The fisheries in 1996/97 - 1997/98 were managed with GHLs of 1,452 t (3,200,000 lb) in EAG and 1,225 t (2,700,000 lb) in WAG (Table 2). During 1998/99 - 2004/05 the fisheries were managed with GHLs of 1,361 t (3,000,000 lb) for EAG and 1,225 t (2,700,000 lb) for WAG. During 2005/06 - 2007/08 the fisheries were managed with a total allowable catch (TAC) of 1,361 t (3,000,000 lb) for EAG and a TAC of 1,225 t (2,700,000 lb) for WAG. By state regulation (5 AAC 34.612), TAC for the Aleutian Islands golden king crab fishery during 2008/09 - 2011/12 was 1,429 t (3,150,000 lb) for EAG and 1,286 t (2,835,000 lb) for WAG. In March 2012, the BOF changed 5 AAC 34.612 so that the TAC beginning in 2012/13 would be 1,501 t (3,310,000 lb) for EAG and 1,352 t (2,980,000 lb) for WAG. Additionally, the BOF added a provision to 5 AAC 34.612 that allows ADF&G to lower the TAC below the specified level if conservation concerns arise. The TAC for 2016/17 (and 2017/18) was reduced by 25% for WAG to 1,014 t (2,235,000 lb) while keeping the TAC for EAG at the same level as the previous season.

During 1996/97 - 2022/23 the annual retained catch during commercial fishing (including cost-recovery fishing that occurred during 2013/14 - 2022/23) has averaged 2% below the annual GHL/TACs but has ranged from as much as 13% below (1998/99) to 6% above (2000/01) the GHL/TAC.

A summary of other relevant State of Alaska fishery regulations and management actions pertaining to the Aleutian Islands golden king crab fishery is provided below:

Beginning in 2005/06, the Aleutian Islands golden king crab fishery has been prosecuted under the Crab Rationalization Program. Accompanying the adoption of crab rationalization program was implementation of a community development quota (CDQ) fishery for golden king crab in the eastern Aleutians (i.e., EAG) and the Adak Community Allocation (ACA) fishery for golden king crab in the western Aleutians (i.e., WAG; Hartill 2012; Nichols et al. 2021). The CDQ fishery in the eastern Aleutians is allocated 10% of the golden king crab TAC for the area east of 174° W longitude and the ACA fishery in the western Aleutians is allocated 10% of the golden king crab TAC for the area west of 174° W longitude. The CDQ fishery and the ACA fishery are managed by ADF&G and prosecuted concurrently with the individual fishing quota (IFQ) fishery.

Golden king crab may be commercially fished only with king crab pots (defined in state regulation 5 AAC 34.050). Pots used to fish for golden king crab in the Aleutian Islands Area must be longlined and, since 1996, each pot must have at least four escape rings of five and one-half inches minimum inside diameter installed on the vertical plane or at least one-third of one vertical surface of the pot composed of not less than nine-inch stretched mesh webbing to permit escapement of undersized golden king crab [5 AAC 34.625 (b)]. Prior to the regulation requiring an escape mechanism on pots, some participants in the Aleutian Islands golden king crab fishery voluntarily sewed escape rings (typically 139 mm [5.5 inches]) into their gear or, more rarely, included panels with escape mesh (Beers 1992). Regarding the gear used since the establishment of 5 AAC 34.625 (b) in 1996, Linda Kozak, a representative of the industry, reported in a 19 September 2008 email to the Crab Plan Team, *"...the golden king crab fleet has modified their gear to allow for small crab sorting,"* and provided a written statement from Lance Nylander, of Dungeness Gear Works (DGW) in Seattle, who *"believes he makes all the gear for the golden king crab harvesting fleet,"* saying that *"Since 1999, DGW has installed 9[inch] escape web on the door of over 95% of Golden Crab pot orders manufactured."* A study to estimate the contact-selection curve for male golden king crab was conducted aboard one vessel commercial fishing for golden king crab during the 2012/13 season, and found gear and fishing practices used by that vessel were highly effective in reducing bycatch of sublegal-sized males and females (Vanek et al. 2013). In March 2011 (effective for 2011/12), the BOF amended 5 AAC 34.625 (b) to relax the "biotwine" specification for pots used in the Aleutian Islands golden king crab fishery relative to the requirement in 5 AAC 39.145 that *"(1) a sidewall...of all shellfish and bottom fish pots must contain an opening equal to or exceeding 18 inches in length...The opening must be laced, sewn, or secured together by a single length of untreated, 100 percent cotton twine, no larger than 30 thread."* Regulation 5 AAC 34.625 (b)(1) allows the opening described in 5 AAC 39.145 (1) to be *"laced, sewn, or secured together by a single length of untreated, 100 percent cotton twine, no larger than 60 [rather than 30] thread."*

Regulation (5 AAC 34.610 (b)) sets the commercial fishing season for golden king crab in the Aleutian Islands Area as 1 August through 30 April. That regulatory fishing season became effective in 2015/16 (the commercial fishing season was set in regulation as 15 August through 15 May during 2005/06 - 2014/15).

Current regulations (5 AAC 39.645 (d)(4)(A)) stipulate that onboard observers are required on catcher vessels during the time that at least 50% of the retained catch is captured in each of the three trimesters of the 9 month fishing season. Onboard observers are required for 100% of fishing activity on catcher-processor vessels during the crab fishing season.

In addition, the commercial golden king crab fishery in the Aleutian Islands Area may only retain males at least 6.0 inches (152.4 mm) carapace width (CW), including spines [5 AAC 34.620 (b)], which is at least one annual molt increment larger than the 50% maturity length of 120.8 mm CL for males as estimated by Otto and Cummiskey (1985). A carapace length (CL) $\geq$ 136 mm is used to identify legal-size males when CW measurements are not available (Table 3-5 in NPFMC 2007b). Note that the size limit for golden king crab has been 6 inches (152.4 mm) CW for the entire Aleutian Islands Area since the 1985/86 season. Prior to the 1985/86 season, the legal-size limit was 6.5 inches (165.1 mm) CW for at least one of the now-defunct Adak or Dutch Harbor Registration Areas.

The male maturity size using 1991 pot survey measurements of carapace length and chela height in EAG and 1984 NMFS measurements in WAG were re-evaluated (Siddeek et al. 2018). Bootstrap analysis of chela height and carapace length data provided the median 50% male maturity length estimates of 107.02 mm CL in EAG and 107.85 mm CL in WAG. The knife-edge maturity size of 111.0 mm CL, which is the lower limit of the next upper size bin, has been used for mature male biomass (MMB) estimation. Recently collected (2018 to 2020) chela height and carapace length data were analyzed and proposed a higher knife-edge maturity length of 116.0 mm CL for MMB calculation, which was accepted by the CPT/SSC in 2022 (Siddeek et al. 2022).

Daily catch and catch-per-unit effort (CPUE) are determined in-season to monitor fishery performance and progress towards the respective TACs. Increases in CPUE were observed during the late 1990s through the early 2000s, and with the implementation of crab rationalization in 2005. This was likely due to changes in gear configurations in the late 1990s (crab harvesters, personal communication, 1 July 2008), and after rationalization due to increased soak time (Siddeek et al. 2015) and decreased competition. Decreased competition could allow crab vessels to target only the most productive fishing areas. Trends in fishery nominal CPUE within the areas EAG and WAG generally paralleled each other during 1985/86 - 2010/11 but diverged thereafter (EAG CPUE exceeded one and half times of that in WAG). A moderate decreasing trend in CPUE was observed since 2014 in EAG and since 2019 in WAG (Table 1 and 2).

6. Brief description of the annual ADF&G harvest strategy

In March 2019, the BOF adopted a revised harvest strategy (Daly et al. 2019). The annual TAC is set by state regulation, 5 AAC 34.612 (Harvest Levels for Golden King Crab in Registration Area O), per:

a. In that portion of the Registration Area O east of 174° W longitude, the total allowable catch level shall be established as follows:

   (a) if MMA_E is less than 25% of $MMA_{E,1985-2017}$, the fishery will not open;

   (b) if MMA_E is at least 25% but not greater than 100 percent of $MMA_{E,1985-2017}$, the number of legal male golden king crab available for harvest will be computed as (0.15) x ($MMA_E/MMA_{E,1985-2017}$) x (MMA_E) or 25% of LMA_E, whichever is less; and

   (c) if MMA_E is greater than 100 percent of $MMA_{E,1985-2017}$, the number of legal male golden king crab available for harvest will be computed as (0.15) x (MMA_E) or 25% of LMA_E, whichever is less.

b. (b) In that portion of the Registration Area O west of 174° W longitude, the total allowable catch level shall be established as follows:

   (a) if MMA_W is less than 25% of $MMA_{W,1985-2017}$, the fishery will not open;

   (b) if MMA_W is at least 25% but not greater than 100 percent of $MMA_{W,1985-2017}$, the number of legal male golden king crab available for harvest will be computed as (0.20) x ($MMA_W/MMA_{W,1985-2017}$) x (MMA_W) or 25% of LMA_W, whichever is less; and

   (c) if MMA_W is greater than 100 percent of $MMA_{W,1985-2017}$, the number of legal male golden king crab available for harvest will be computed as (0.20) x (MMA_W) or 25% of LMA_W, whichever is less.

c. In implementing this harvest strategy, the department shall consider the reliability of estimates of golden king crab, the manageability of the fishery, and other factors the department determines necessary to be consistent with sustained yield principles and to use the best scientific information available and consider all sources of uncertainty as necessary to avoid overfishing.

d. In this section,

   (a) MMA_E means the abundance of male golden king crab in the portion of the Aleutian Islands Management Area O east of 174° W longitude that are greater than or equal to 116 millimeters in carapace length estimated by the stock assessment model for the time prior to the start of the fishery;

   (b) $MMA_{E,1985-2017}$ means the mean value of the abundance of male golden king crab in the portion of the Aleutian Islands Management Area O east of 174° W longitude that are greater than or equal to 116 millimeters in carapace length estimated by the stock assessment model for the time prior to the start of the fishery for the period 1985 – 2017;

   (c) LMA_E means the abundance of male golden king crab in the portion of the Aleutian Islands Management Area O east of 174° W longitude that are greater than or equal to 136 millimeters in carapace length estimated by the stock assessment model for the time prior to the start of the fishery;

(d) MMA_W means the abundance of male golden king crab in the portion of the Aleutian Islands Management Area O west of 174° W longitude that are greater than or equal to 116 millimeters in carapace length estimated by the stock assessment model for the time prior to the start of the fishery;

(e) $MMA_{W,1985-2017}$ means the mean value of the abundance of male golden king crab in the portion of the Aleutian Islands Management Area O west of 174° W longitude that are greater than or equal to 116 millimeters in carapace length estimated by the stock assessment model for the time prior to the start of the fishery for the period 1985 – 2017;

(f) LMA_W means the abundance of male golden king crab in the portion of the Aleutian Islands Management Area O west of 174° W longitude that are greater than or equal to 136 millimeters in carapace length estimated by the stock assessment model for the time prior to the start of the fishery.

In addition to the retained catch that is limited by the TAC established by ADF&G under 5 AAC 34.612, ADF&G has authority to annually receive receipts up to $500,000 through cost-recovery fishing on Aleutian Islands golden king crab. The retained catch from that cost-recovery fishing is not counted against attainment of the annually established TAC.

7. Summary of the history of the basis and estimates of MMB_{MSY} or proxy MMB_{MSY}

The $MMB^{35\%}$ is estimated as a proxy for MMB_{MSY} using the Tier 3 estimation procedure, which is explained in a subsequent section.

8. Justification for assessing Aleutian Islands golden king crab as two sub stocks

We modeled EAG and WAG stocks separately for several reasons:

1. Fishery catch data (e.g., CPUE magnitude and CPUE temporal trends) suggest that the productivity is different between the two areas;
2. WAG has a wider area of stock distribution compared to limited area distribution in EAG;
3. The fishing areas are spatially separated with an area gap between EAG and WAG. Regions of low fishery catch suggest that availability of suitable habitat may vary longitudinally;
4. Tagging studies have shown little mixing between the two areas (Watson and Gish 2002);
5. Currents are known to be strong around the Aleutian Islands, thus larval mixing between the two regions may occur. Yet needed data to confirm larval drift trajectories or horizontal displacement are lacking. Unlike other king crabs, golden king crab females carry large, yolk-rich, eggs, which hatch into lecithotrophic (non-feeding) larvae that do not require a pelagic distribution for encountering food items. Depth at larval release, the lecithotrophic nature of larvae, and swimming inactivity in lab studies implies benthic distributions, which may limit larval drift between areas if horizontal current velocities are reduced at depth;
6. Integrating contrasting data in one single model may provide parameter estimates in between the two extremes which would not be applicable to either (Richards 1991; Schnute and Hilborn 1993);
7. Area specific assessment is superior to a holistic approach for this stock because of patchy nature of golden king crab distribution;
8. Alaska Board of Fisheries decided to manage the two areas with separate total allowable catches;
9. Genetic analysis shows no significant differentiation between areas within the Aleutian Island population (Grant and Siddon 2018), thus there is no genetic support for subdividing this population; however, the above listed factors support separate stock assessments in the two regions.

D. Data

1. Summary of new information

- Directed fishery retained and total catch, retained and total catch size compositions, and CPUE index from the 2024/25 season.
- Male bycatch from 2024 groundfish fisheries.

2. Time series data

Prior to the crab rationalization, AIGKC regulatory seasons did not conform to the end of the post-rationalization 'crab year' (July - June). Time series data prior to 2005 were date corrected so that data collected after the end of the crab year (i.e., the June following the season opening) were applied to the next crab year. In practice, this affects data collected prior to the 2000/01 season.

a. Directed fishery catch

Retained catch (t) in the directed fishery was summarized from fish ticket data for 1981 - present. Retained catch is only available in units of numbers from 1981 - 1984. Total catch (t) of male crab was estimated from a combination of fish ticket and observer data for 1990 - present (Jackson *in prep*). Handling mortality for directed fishery discards is assumed to be 20%.

Total catch estimates for 1993/94 are not used in EAG models. The 1993/94 season in the EAG (east of 171° W lon) was open from September 1, 1993 to March 1, 1994, and there was no observer coverage in the EAG during that season. Observer data that are assigned to the 1993/94 EAG season were actually from the easternmost portion (174° W lon - 171° W lon) of the WAG fishery in 1992/93, which ran from November 1, 1992 to August 15, 1993 (i.e., July 1 - August 15, 1993 get assigned to the 1993/94 crab year).

b. Bycatch in groundfish fisheries

Bycatch of male GKC in groundfish fisheries was estimated for trawl and fixed gear fisheries from observer data for 1991 - present in the EAG and 1994 - present in the WAG. Analyses assume handling mortality of 80% for trawl fisheries and 50% for fixed gear fisheries.

c. Size composition

Retained and total catch size compositions of males in the directed fishery was estimated from retained catch sampling and on-board observer data. Retained catch size frequencies are available from 1985 - present and observer size frequencies are available from 1990 - present.

Previous assessments removed various uncommon or non-target species gear types by recommendation from the fleet (M. Siddeek, ADF&G personal communication, 2023). Those include: Dungeness crab pots, pyramid pots, conical pots, hair crab pots, snail pots, cods, dome shaped pots, ADF&G research pots with stretch mesh instead of escape rings, and rectangular pots measuring 9'x 9', 8 1/2' x 8 1/2', 9 1/2' x 9 1/2', 8' x 9', 8' x 10', 9' x 10', 7' x 8', or with unknown dimension. In 1993, nearly all WAG observer (162 / 174) pots belonged to one of those categories, mostly unknown sized rectangular pots (160). Including all rectangular pots has little impact on the size composition in other years in either subdistrict, so the total size composition time series was revised to include all rectangular pots (Jackson 2024b).

d. Catch per unit effort (CPUE)

Directed fishery catch per unit effort (CPUE) was estimated as the number of crab per pot lift from 1985 - present. Nominal CPUE data were standardized using generalized additive models in three eras: 1) fish ticket CPUE 1985 - 1998, and 2) observer CPUE from 1995 - 2005 and 3) 2005 - present (Appendix A).

e. Cooperative survey

The AIGKC cooperative pot survey was initiated in 2015 in the EAG and has continued every year since with the exception of 2020. The survey was extended to WAG in 2018. The main purpose of the survey is to generate a cost effective data stream available to the stock assessment that is spatially representative and less susceptible to hyperstability than fishery CPUE. The survey has occurred during the beginning of each season, with participating vessels setting pots strings at pre-determined stations and later picking strings with ADF&G staff on board for collection of biological data. Survey data is available for 2015 - 2022 in the EAG and 2018 and 2019 in the WAG. A summary of analysis of cooperative survey data can be found in Appendix A of Jackson (2024). Models utilizing survey CPUE and size composition data were not recommended by the CPT and SSC for the 2025 final assessment due to unresolved misspecification associated with fishery CPUE index data.

f. Incomplete directed fishery

In the event that the most recent directed fishery is not complete by the time data must be prepared for the final assessment, terminal year data are estimated with the following assumptions:

- Retained catch equals the total allowable catch (TAC);
- Total catch is estimated as usual, though using the observer CPUE ($U_{obs,group}$, crab per pot lift) to-date and total directed effort (N) as

$$N = \frac{\text{TAC}}{wU_{ft}} \tag{1}$$

  where w is the average calculated weight of legal males in the fishery based on observer samples to-date, and U_{ft} is the retained legal male CPUE to date;
- Retained catch size composition is estimated based on dockside samples to-date;
- Total catch size composition is estimated based on observer samples to-date.

Models are re-run with completed data prior to determining the TAC for the upcoming season. At the time of preparing this document, the 2024/25 fishery in the EAG was incomplete.

3. Aggregated data

a. Tagging data

Tag release - recapture - time at liberty records from 1991, 1997, 2000, 2003, and 2006 male tag crab releases were aggregated by year at liberty to determine the molt increment and size transition matrix within GMACS.

b. Weight-at-length

Male length-weight relationship: $W = aL^b$ where $a = 1.445\text{e}\hat{}-4$, $b = 3.28113$.

c. Natural mortality

Siddeek et al. (2022) used a tag recapture model to estimate a fixed natural mortality value of 0.22 yr^{-1}.

4. Available data excluded from the assessment

Data from triennial ADF&G pot surveys for Aleutian Islands golden king crab in a limited area in EAG (between 170° 21' and 171° 33' W longitude) that were performed during 1997 (Blau et al. 1998), 2000 (Watson and Gish 2002), 2003 (Watson 2004), and 2006 (Watson 2007) are available, but were not used as index in this assessment. It may be possible to explore the utility of these data as an index of abundance or informing selectivity in future model explorations. Tag release and recapture data from these surveys were used to estimate the model growth matrix.

E. Analytic Approach

1. History of modeling approaches for this stock

A size structured assessment model (hereafter referred to as the legacy model) based on only fisheries data for the EAG and WAG golden king crab stocks was accepted in 2016, and used to set OFL and ABC for the 2017/18 season (Siddeek et al. 2017). The CPT (January 2017) and SSC (February 2017) recommended using the Tier 3 F_{OFL} control rules to set the OFL and ABC. The legacy model was used from 2016 - 2022, and transitioned to the GMACS modelling framework. The CPT and SSC adopted a GMACS implementation of the assessment in May 2023. Progress of GMACS development has been documented on the GitHub development site (GMACS-project).

2. Model Description

a-f. See GMACS-project GitHub

g. Critical assumptions of the model

1. Directed fishery removals occur as a pulse at the mid-point of the season;
2. Natural mortality, M, was constant at 0.22 yr^{-1} based on analysis of tagging data (Siddeek et al. 2022);
3. Observer and fish ticket CPUE indices were assumed to be linearly related to exploitable abundance. There are three catchability and selectivity time periods (fish ticket data 1985 - 1998, observer data 1995 - 2004 and 2005 - 2023). Selectivity is logistic;
4. Extra variance on GAM standardized CPUE indices was estimated for each catchability period;
5. Male maturity was knife-edged, at 116 mm CL based on previous chela height analysis (Siddeek et al. 2018, 2021, 2022);
6. Discard handling mortality was 0.2 yr^{-1} in the directed fishery;
7. Bycatch mortality in groundfish fisheries was the weighted average of groundfish pot fishery mortality (0.5 yr^{-1}) and groundfish trawl fishery mortality (0.8 yr^{-1}). Groundfish fishery selectivity was set at full selection for all length classes (selectivity = 1.0);
8. Observation errors are log-normal for catch and index data and multinomial for length composition data.

h. Changes to the above since the previous assessment

None.

i. Model code had been checked and validated

GMACS code has been checked at various times by developers and independent reviewers. GMACS code and input files used in this report can be accessed here: ADF&G BSAI Crab Assessments GitHub.

3. Model Selection and Evaluation

a. Alternative model configurations

Two models were evaluated for the EAG and WAG:

- **23.1c**: The base model from the 2024 final assessment (23.1; Jackson 2024) with updated time series data and CPUE indices, and corrected recruitment bias correction from 1960 - 1980 (Jackson 2024b). This model considers:
  - (i) Initial abundance by the equilibrium condition considering the mean number of recruits for 1987–2021: The equilibrium abundance was determined for 1960, projected forward with only M and annual recruits until 1980, then retained catch removed during 1981–1984 and projected to obtain the initial abundance in 1985;
  - (ii) Fish ticket CPUE index for 1985 - 1998, with index specific catchability and logistic selectivity;
  - (iii) Observer CPUE indices for 1995/96 - 2004/05 and 2005/06 - 2024/25, with index specific catchability and logistic selectivity;
  - (iv) Initial (Stage-1) weighting of effective sample sizes: number of vessel-days for retained and total catch size compositions; and (Stage-2) iterative re-weighting of effective sample sizes by the Francis method;
  - (v) Logistic directed fishery retention in a single time block;
  - (vi) Full selectivity (selectivity = 1.0) for groundfish fishery bycatch;
  - (vii) Knife-edge maturity size of 116 mm CL;
  - (viii) Natural mortality, $M = 0.22$ yr^{-1}, directed fishery handling mortality = 0.2 yr^{-1}, and weight groundfish bycatch mortality based on the annual proportion of trawl (0.8 yr^{-1}) and fixed-gear (0.5 yr^{-1}) bycatch;
  - (ix) Size transition matrix using tagging data estimated by the normal probability function with the logistic molt probability sub-model. The tag-recaptures were treated as Bernoulli trials (i.e., Stage-1 weighting);
  - (x) The period, 1987–2021, was used to determine the mean number of recruits for $\text{MMB}_{35\%}$ (a proxy for MMB_{MSY}) estimation under Tier 3.
- **25.0b**: Model 23.1c + with non-equilibrium initial conditions, starting in 1981, equal emphasis on all likelihood components ($\lambda = 1$), and bootstrap estimated stage-1 effective sample sizes.

b. Progression of results

See the new results at the beginning of the report.

c. Evidence of search for balance between realistic and simpler models

Unlike annually surveyed stocks, Aleutian Islands golden king crab stock biomass is difficult to track, and several biological parameters are assumed based on knowledge from red king crab (e.g., handling mortality rate of 0.2 yr^{-1}) due to a lack of species/stock specific information. Several model parameters were fixed after initially running the model with free parameters to reduce the number of parameters to be estimated (e.g., groundfish bycatch selectivity parameters were fixed). In CPUE standardization, instead of using the traditional AIC, the Consistent Akaike Information Criteria (Bozdogan 1987) was used that considers number of parameters and data points used for fitting models when selecting the final model. The assessment models also considered different configuration of parameters to select parsimonious models. The detailed results of all models are provided in tables and figures.

d. Convergence status/criteria

ADMB default convergence criteria. A jittering analysis (descried below) was performed to assess convergence to a global minimum.

e. Sample sizes for length composition data

The initial input sample sizes (i.e., Stage-1) were estimated either as number of vessel-days for retained, or observer-days for total catch size compositions for model 23.1c. Model 25.0b evaluates sample sizes based on variability in the data. Stage-1 effective sample sizes N_{eff} were estimated using a bootstrap approach based on Stewart and Hamel (2014). The resampling design was two-staged, first within the primary sampling unit (delivery or observer pot) and second by individual crab. Resampling was done with replacement to observed sample sizes. Effective sample size for a given year was estimated as

$$N_{eff} = \frac{\sum_l P_l(1-P_l)}{\sum_l (P_l - B_l)^2} \quad (2)$$

where P_l and B_l are the observed and bootstrap proportion of crab measured in length bin, l, respectively. Annual estimates of effective sample size were computed as the mean of 1,000 replicates for each year in both data series. Estimated N_{eff} are in Table 7 and 8. Since estimated N_{eff} was quite large for many years, observed stage-1 sample sizes were reduced to

$$N'_{eff} = \min(2000, N_{eff}) \quad (3)$$

Then effective sample sizes were iteratively re-weighted using the Francis' (2011, 2017) mean length-based method (Table 9).

f. Credible parameter estimates

All estimated parameters seem to be credible and within bounds.

g. Model selection criteria

The likelihood values are used to select among alternatives that could be legitimately compared by that criterion. Total negative log-likelihoods of models 23.1c and 25.0b are not comparable due to differences in data weighting.

h. Residual analysis

Residual plots are illustrated in various figures for CPUE standardization. One step ahead (OSA) residuals were computed for size composition data using the R package *compResidual* (Trijoulet and Nielsen 2022). OSA residuals are preferred for diagnosis of multivariate models because they account for correlation among size bins and conform to a standard normal distribution for correctly specified models (Trijoulet et al. 2023).

i. Model evaluation

Provided under Results, below.

j. Retrospective analysis

Retrospective patterns were evaluated by iteratively re-running a model and 'peeling' (i.e. removing) the terminal year for each iteration. Mohn's ρ (Mohn 1999) was used to compare retrospective patterns in MMB between models:

$$\text{Mohn's } \rho = \frac{1}{n}\sum_{y=1}^{n}\frac{\text{MMB}_y - MMB}{MMB} \tag{4}$$

where MMB_y is the terminal year mature male biomass for each peel, MMB is the mature male biomass for the full model, and n is the number of peels.

k. Historical analysis

Abundance trajectories from previous assessment models were compared to examine the degree of historical bias in derived quantities. Since size at maturity has changed in previous assessments, legal male ($\geq$ 138 mm CL) abundance was plotted here.

k. Jittering

A $Jitter$ factor of 0.3 was multiplied by a random normal deviation $rdev = \mathcal{N}(0, 1)$ to create a transformed parameter value based upon the predefined parameter:

$$temp = 0.5 \cdot rdev \cdot Jitter \cdot \ln(\frac{P_{max} - P_{min} + 0.0000002}{P_{val} - Pmin + 0.0000001} - 1) \tag{5}$$

with the final jittered initial parameter value back transformed as:

$$P_{new} = P_{min} + (\frac{P_{max} - P_{min}}{1 + e^{-2 \cdot temp}}) \tag{6}$$

where P_{max} and P_{min} are upper and lower bounds of parameter search space and P_{val} is the estimated parameter value before the jittering. Each model was re-run in 500 iterations and the distributions of resulting objective functions and reference points were examined.

4. Results

a. Effective sample sizes and weighting factors

Weighting factors were used for catch biomass, recruitment deviation, pot fishery F, and groundfish fishery F. The retained catch biomass weight was set to an arbitrarily large value 500.0 (corresponding to a CV of 0.0316), because retained catch data are more reliable than any other data sets. The total catch biomass weight was scaled in accordance with the observer annual sample sizes (number of non-zero pots) with a maximum of 250.0 (corresponding to variable CV; Table 3). A small groundfish bycatch weight (0.5 corresponding to a CV of 1.3108) was chosen based on the September 2015 CPT suggestion. The CPUE weights were set to 1.0 for all models. A constant (model estimated) variance was included in addition to input CPUE variance for the CPUE fit. Note that the estimated additional variance values were small for both observer and fish ticket CPUE indices for the two subdistricts. Input and re-weighted effective sample sizes for retained and total catch size compositions are in Tables 6 - 9.

b. Parameter estimates and tables

- i Time series of retained and total catch in the directed fishery, bycatch in groundfish fisheries, and total fishing mortality is summarized in Tables 1 - 2;
- ii Negative log-likelihood values and parameter estimates, excluding annual deviations, are summarized in Tables 11 - 12;
- iii Estimated recruitment and MMB time series among models are in Tables 13 - 14.

c. Graphs of estimates

- i Models 23.1c and 25.0b estimated similar selectivity in both subdistricts. Selectivity was considerably greater in the post-rationalized period in comparison to the pre-rationalized period, with selectivity in the EAG being slightly greater than in the WAG (Figure 19). All models assumed full selectivity for groundfish fishery bycatch. Retention probability was similar among models, characterized as a very steep curve, reaching full retention at approximately legal size (138 mm CL).
- ii There was little difference in molt probability among models 23.1c and 25.0b.
- iii Recruitment trends were similar among models. Model 25.0b estimated more variable recruitment during the early 90s in the EAG, whereas model 23.1c produced slightly more variable estimates during that period in the WAG. Time series in both subdistricts appear to be increasing from recent lows (Figure 22).
- iv Trajectories of mature male biomass (MMB) at mating (Feb 15) are shown in Figure 24. Model 23.1c estimated slightly greater MMB since $\tilde{2}000$, reflecting differences in selectivity. This disparity is more apparent in the EAG than in the WAG. Estimated MMB in 2024 (i.e. Feb 15, 2025) for the EAG decreased again from its recent post-rationalization high in 2022 and increased from the 2023 time series low in the WAG (Table 14; Figure 24).
- v Fully selected fishing mortality (F) in the directed fishery and groundfish fisheries are shown in Figure 25. Directed fishing mortality was highest in the early-1990s, then decreased through the early-2000s. Fishing mortality in the EAG fishery steadily increased and peaked in 2019, before sharply decreasing from 2020-2022. WAG F underwent two cyclical peaks in 2012 and 2020. Groundfish fishery F is low throughout the timeseries, but has had the most prominent pulses in 2016 and 2020 in the EAG, and 2022 in the WAG (Figures 25).

  Total F exceeded the F_{OFL} control rule throughout much of the 1990s. Since the 2000s MMB in the EAG has exceeded $\mathrm{B}_{35\%}$ and F has been below $F_{35\%}$ (Figure 26). In the WAG, estimated recent total F exceeded the F_{OFL} control rule, with MMB less than $\mathrm{B}_{35\%}$, though 2024 total F was marginally under the control rule (Figure 26).

d. Evaluation of the fit to the data

i There was very little difference among model fits to catch data (Figures 7 and 8).

ii Fits to index data for models 23.1c and 25.0b differed slightly, but neither fits EAG data particular well (Figure 9). Model 25.0b improved fit to WAG observer CPUE from 1995-2004, and all models fit post-rationalized observer CPUE reasonably well (Figure 10).

iii There was little difference in fits to size composition data (Figures 11 - 12 and 15 - 16). While both models appear to capture total size composition modes reasonably well, residual diagnostics highlighted clear patterns. Middle size bins (i.e., 130 - 150 mm CL) tended to be under predicted across all years, while smaller size bins were over predicted in the latter half of the time series (Figures 13 - 14 and 17 - 18).

e. Retrospective analysis

Retrospective analysis was performed by sequentially removing one year of data for ten model runs. Models 23.1c and 25.0b had considerable, positive retrospective pattern in the EAG with Mohn's ρ of $\rho = 0.372$ and $\rho = 0.5$, respectively (Figure 27). EAG retrospective patterns likely arise from model misspecification that results in poor fit to index data. Retrospective pattern is less of a concern in the WAG, though models 23.1c and 25.0b have a minor positive pattern (Mohn's $\rho = 0.104$ and $\rho = 0.117$, respectively) (Figure 27). The 2014 terminal year peel in WAG 23.1c had a large spike in 1995. This issue has been previously encountered with WAG models and is likely due to that peel converging to a local minimum.

f. Historical analysis

Legal male abundance estimated from previous stock assessments were plotted to assess historical patterns in derived quantities. Legal male trajectories in both areas indicated a downward historical pattern, though the WAG was more severe, particularly in the terminal year (Figure 28). Back calculation of exploitation rates computed from the time series of legal male abundance for model 23.1c would suggest that realized exploitation exceeded the maximum cap imposed by the ADF&G harvest strategy (25%) in many years (Figure 29).

g. Uncertainty and sensitivity analyses

i Estimated standard errors for estimated parameters are in Table 12. Uncertainty in estimated MMB and recruitment is detailed in Table 14.

ii Distribution of the OFL is shown in Figure 34.

iii Distribution of terminal year MMB relative to $B_{35\%}$ estimated from MCMC draws is described in Figure 34.

iv Jitter distributions of negative log-likelihood, and scatter plots of MMB projected to Feb 15, 2025, $B_{35\%}$, and OFL as a function of jitter NLL for all models are in Figures 30 - 33. Jitter analysis results identified several local minima and provided strong evidence for convergence to a global minimum (Tables 16 - 19).

h. Comparison of alternative models

Model 23.1c is regarded as the base model, which is the 2024 accepted model with updated bias correction of recruitment deviations prior to 1981 and corrected observer size composition data (using all rectangular pots). Model 25.0b starts the model in 1981 in a non-equilibrium state, assumes equal likelihood weighting for catch data series, and uses bootstrap estimated input sample sizes for size composition data. Estimated equilibrium numbers at size were greater than at the start of the catch data time series, leading to a decreasing ramp in in recruitment and mature male biomass (Figure 22 and 24). Non-equilibrium starting conditions resulted in lower numbers at larger sizes, but greater recruitment in the EAG, whereas the opposite is evident in the WAG (Figures 20 - 22). Reducing the likelihood emphasis on retained and total catch to $\lambda = 1$ had negligible impact on fits to catch data in either subdistrict (Figure 7 and 8).

Bootstrap estimated N_{eff} for size composition data were highly variable and larger than the observed number of crab measured in many cases. This is possible when bootstrap proportion at size approximates observed size composition with high precision. Annual means of bootstrap N_{eff} were less than observed sample sizes in all years and followed the same trend, though the bootstrap distribution was highly variable (Table 7 and 8). The CPT recommended considering using the harmonic or geometric mean of bootstrap samples opposed to arithmetic mean, though in many cases estimates would have still been large and capped at 2,000. Francis re-weighting considerably reduced input sample sizes in model 25.0b, which resulted in lower weights for total size composition data compared to model 23.1c in many pre-rationalized years and the greater weights in post-rationalized years (Table 9).

Model 25.0b fit the pre-rationalized CPUE index marginally better in both subdistricts, but did not resolve poor fits to observer index data in the EAG (Figure 9 and 10). Differences in fits to size composition data were negligible, except for the first couple years of the retained composition time series due to differences in initial conditions (Figures 11 and 18). Recruitment in models 23.1c and 25.0b underwent different trajectories from ~ 1989 - 1993 in both subdistricts (Figure 22), which analysis of intermediate models attributed to size composition weighting (Jackson 2024b). Greater numbers at size for EAG model 25.0b during this time period and earlier may have contributed to the minor increase in pre-rationalization selectivity over model 23.1c (Figure 19).

EAG models appear to be somewhat sensitive to size composition data weighting (here; Jackson 2024b), yet the alternative weighting scheme explored here did not improve model performance. In fact, model 25.0b increased retrospective bias over the base model. Despite simplified initial conditions and catch data weighting scheme, it would be prudent to remain with the base model during this assessment cycle. Variants of intermediate models (25.0 and 25.0a; Jackson 2024b), which explored initial conditions and catch data weighting, can be revisited in the future.

F. Calculation of the OFL and ABC

1. Aleutian Islands GKC is currently placed in Tier 3a (NPFMC 2007).
2. For Tier 3 stocks, estimated biological reference points include $B_{35\%}$ and $F_{35\%}$. Estimated model parameters are used to conduct mature male biomass-per-recruit analysis.
3. Specification of the overfishing limit (OFL):

The Tier 3 OFL is calculated using the F_{OFL} control rule

$$F_{\text{OFL}} = \begin{cases} 0 & \frac{B_{prj}}{B_{35\%}} \leq \beta \\ F_{35\%}\frac{(\frac{B_{prj}}{B_{35\%}} - aa)}{1-aa} & \beta < \frac{B_{prj}}{B_{35\%}} \leq 1 \\ F_{35\%} & B_{prj} > B_{35\%} \end{cases} \tag{7}$$

where

B_{prj} = the measure of the productive capacity of the stock, in this case mature male biomass (MMB), projected to time of mating (Feb 15);

$F_{35\%}$ = a proxy for F_{MSY} , which is a full selection instantaneous F that will produce MSY at the MSY producing biomass;

$B_{35\%}$ = a proxy for B_{MSY} , which is the value of biomass (MMB) at the MSY producing level;

β = a parameter with restriction that $0 \leq \beta < 1$. A default value of 0.25 is used;

aa = a parameter with restriction that $0 \leq aa \leq \beta$. A default value of 0.1 is used.

Average recruitment during a period of 1987-2021 was used to estimate $B_{35\%}$. The reference period for average recruitment is based on the time period for which uncertainty in estimated recruitment is below a reasonable threshold. In January 2024, the CPT recommended a 'terminal year minus four' approach to setting the upper bound of the reference period. Because B_{prj} depends on the intervening retained and discard catch (i.e., B_{prj} is estimated after the fishery), an iterative procedure was applied with predicted retained and discard catch, whereby the F_{OFL} and OFL were estimated using MCMC in GMACS.

The control rule is used for stock status determination. If total catch exceeds OFL estimated at B (B_{prj}), then "overfishing" occurs. If B equals or declines below 50% B_{MSY} (i.e., MSST), the stock is "overfished." If B/B_{MSY} or B/B_{MSY} proxy equals or declines below β, then the stock productivity is severely depleted, and the directed fishery is closed. Biological reference points for all models evaluated in this assessment are detailed in Table 15.

MCMC runs with 100,000 replicates and 100 draws for model 23.1c were performed to estimate the distribution of $B_{35\%}$ and OFL. Probability distribution of estimated OFL for model 23.1c is shown in Figure 34. The distribution of projected MMB (Feb 15, 2025) to $B_{35\%}$ suggests that probability of the stock being overfished is approximately zero. The CPT and SSC recommended the 2023/24 acceptable biological catch (ABC) be set at ABC = (1 - 0.25) × OFL citing continued concerns about poor fits to index data and retrospective patterns in the EAG model. The current assessment did not resolve those issues, so the author recommendation is to continue with a 25% ABC buffer.

At the time of writing this document, the 2024/25 fishery in the EAG was incomplete. Completed fishery totals are not anticipated to exceed the OFL of 3.725 kt (8.212 mil lb). The OFL and ABC values for 2025/26 in the tables below are values estimated by the author-recommended model (23.1c) for consideration.

Status and catch specifications for models EAG and WAG combined. Model 23.1c was used for 2025/26 reference points.

1,000 t

Year	MSST	Biomass (MMB_{mating})	TAC	Retained Catch	Total Catch	OFL	ABC
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	2.612	3.761	2.821
2023/24	5.772	12.716	2.508	2.578	2.765	4.182	3.137
2024/25	5.632	11.087	2.214	2.215	2.341	3.725	2.794
2025/26		10.480				3.166	2.374

Million lb

Year	MSST	Biomass (MMB_{mating})	TAC	Retained Catch	Total Catch	OFL	ABC
2021/22	12.917	27.761	5.930	5.950	6.737	10.620	7.434
2022/23	12.857	29.983	5.051	5.223	5.758	8.292	6.219
2023/24	12.725	28.034	5.530	5.684	6.096	9.220	6.916
2024/25	12.417	24.443	4.881	4.883	5.161	8.212	6.159
2025/26		23.104				6.980	5.234

2022/23 refence points were estimated before the WAG fishery was completed.
2023/24 refence points were estimated before EAG and WAG fisheries were completed.
2025/26 refence points were estimated before the EAG fishery was completed.

G. Rebuilding Analysis

N/A, not applicable for this stock.

H. Data Gaps and Research Priorities

1. List of variables related to scientific uncertainty

a) Models rely solely on fishery data;

b) Observer and fisheries CPUE indices played a major role in the assessment model;

c) Fixed bycatch mortality rates were used in each fishery (crab fishery and the groundfish fishery) that discarded golden king crab;

d) Discarded catch and bycatch mortality for each fishery in which bycatch occurred during 1981/82 - 1989/90 were not available;

e) Growth (i.e., tagging) data are only based on the EAG.

2. Research priorities

a) Resolve data conflict in EAG models;

b) Continuation of the cooperative pot survey;

c) Male size at maturity;

d) Area specific growth;

e) Connectivity between EAG and WAG.

I. Acknowledgements

We thank ADF&G personnel in Kodiak and Dutch Harbor for preparing/providing various fisheries and biological data for this assessment. Ethan Nichols, Rachel Alinsunurin, Ric Shepard, and Janis Shaisnikoff were helpful in getting needed information for preparing this report. Caitlin Stern and Ben Daly reviewed an earlier draft of this document. We also appreciate technical and editorial input from CPT and SSC members, and industry personnel.

Tables

Table 1: Total allowable catch (TAC; t), number of vessels, retained catch, pot lifts, CPUE (crab per pot), directed fishery total catch (t), bycatch in groundfish fisheries (t), and sum of fishing mortality in all fisheries (t) in the EAG from 1985 - present.

			Retained Catch				Directed	GF	Total
Year	TAC	Vessels	(t)	(N)	Pots	CPUE	Total Catch	Bycatch	Mortality
1985		20	2,955	1,387,430	112,851	12			
1986		31	2,686	1,374,943	156,521	9			
1987		35	2,010	968,614	135,707	7			
1988		38	2,335	1,156,046	157,382	7			
1989		24	2,666	1,423,561	166,384	9			
1990		18	1,688	888,332	101,110	9	3,521		
1991		15	2,035	1,083,243	126,501	9	4,017	0.1	2,432
1992		14	2,112	1,127,291	131,477	9	5,118	0.2	2,713
1993		10	1,439	767,918	95,273	8		5.2	
1994		19	2,044	1,088,614	190,503	6	3,974	1.8	2,432
1995		19	2,259	1,150,168	184,470	6	4,658	1.6	2,740
1996	1,451	14	1,738	854,502	146,630	6	3,208	0.5	2,032
1997	1,451	13	1,588	780,610	106,403	7	2,897	0.2	1,850
1998	1,361	14	1,473	740,011	83,378	9	2,951	1.7	1,770
1999	1,361	15	1,392	709,332	79,129	9	2,541	6.0	1,625
2000	1,361	15	1,422	704,702	71,551	10	2,592	3.3	1,657
2001	1,361	19	1,442	730,030	62,639	12	2,154	0.6	1,584
2002	1,361	19	1,280	643,886	52,042	12	1,871	42.8	1,420
2003	1,361	18	1,350	643,074	58,883	11	1,854	39.9	1,471
2004	1,361	19	1,309	637,536	34,848	18	1,670	1.4	1,382
2005	1,361	7	1,300	623,966	24,569	25	1,620	1.4	1,365
2006	1,361	6	1,357	650,588	26,195	25	1,617	42.2	1,430
2007	1,361	4	1,356	633,253	22,653	28	1,755	132.0	1,502
2008	1,429	3	1,426	666,947	24,466	27	1,796	56.9	1,529
2009	1,429	3	1,429	679,886	26,298	26	1,814	30.7	1,523
2010	1,429	3	1,428	670,981	25,851	26	1,709	92.1	1,534
2011	1,429	3	1,429	668,828	17,915	37	1,805	46.2	1,530
2012	1,501	3	1,504	687,666	20,827	33	1,950	12.4	1,602
2013	1,501	3	1,546	720,220	21,388	34	1,854	6.6	1,613
2014	1,501	3	1,554	719,064	17,002	42	1,948	14.2	1,642
2015	1,501	3	1,590	763,604	19,376	39	2,210	43.4	1,736
2016	1,501	4	1,578	793,983	24,470	32	2,221	189.4	1,802
2017	1,501	4	1,571	802,610	25,516	31	2,350	89.2	1,773
2018	1,751	3	1,830	940,336	25,553	37	2,783	44.8	2,044
2019	1,955	3	2,031	1,057,464	30,998	34	3,044	30.9	2,250
2020	1,656	3	1,733	902,121	30,072	30	2,605	248.3	2,034
2021	1,637	3	1,706	863,269	30,948	28	2,408	32.5	1,863
2022	1,506	3	1,585	811,282	21,600	38	2,091	15.0	1,695
2023	1,687	3	1,758	900,225	23,593	38	2,316	15.4	1,878
2024	1,706	2	Conf.	Conf.	Conf.	Conf.	Conf.	5.4	Conf.

Table 2: Total allowable catch (TAC; t), number of vessels, retained catch, pot lifts, CPUE (crab per pot), directed fishery total catch (t), bycatch in groundfish fisheries (t), and sum of fishing mortality in all fisheries (t) in the WAG from 1985 - present.

Year	TAC	Vessels	Retained Catch (t)	Retained Catch (N)	Pots	CPUE	Directed Total Catch	GF Bycatch	Total Mortality
1985		40	2,821	1,112,529	92,354	12			
1986		48	3,999	2,052,652	252,015	8			
1987		49	2,189	1,248,732	176,295	7			
1988		60	2,485	1,285,914	164,208	8			
1989		58	3,024	1,610,281	202,580	8			
1990		15	1,615	889,017	118,056	8	2,695		
1991		14	1,397	747,852	102,316	7	1,705		
1992		18	1,025	543,541	92,743	6	1,201		
1993		20	686	352,339	76,966	5	1,887	0.5	927
1994		29	1,540	845,058	198,761	4	5,197	0.2	2,271
1995		22	1,203	619,636	142,480	4	3,171	1.0	1,598
1996	1,225	20	1,259	652,801	114,121	6	2,291	5.8	1,470
1997	1,225	10	1,083	558,446	87,445	6	1,856	0.6	1,238
1998	1,225	6	955	505,407	50,885	10	1,590	0.8	1,083
1999	1,225	15	1,222	658,377	104,223	6	2,079	1.0	1,394
2000	1,225	12	1,342	723,794	104,056	7	2,314	0.7	1,537
2001	1,225	9	1,243	686,738	105,512	7	2,176	0.4	1,430
2002	1,225	6	1,198	664,823	78,979	8	1,889	1.4	1,337
2003	1,225	6	1,220	676,633	66,236	10	1,782	4.9	1,335
2004	1,225	6	1,219	685,465	56,846	12	1,839	1.0	1,344
2005	1,225	3	1,204	639,370	30,116	21	1,646	1.5	1,293
2006	1,225	4	1,030	527,737	26,110	20	1,400	1.8	1,105
2007	1,225	3	1,142	600,595	29,950	20	1,593	5.9	1,236
2008	1,286	3	1,150	587,661	26,200	22	1,762	9.5	1,280
2009	1,286	3	1,253	628,332	26,489	24	1,721	6.8	1,351
2010	1,286	3	1,279	626,246	29,944	21	1,618	4.4	1,350
2011	1,286	3	1,276	616,118	26,326	23	1,547	6.1	1,335
2012	1,352	4	1,339	672,916	32,716	21	1,785	8.8	1,435
2013	1,352	3	1,347	686,883	41,835	16	1,913	8.7	1,467
2014	1,352	2	1,217	635,312	41,548	15	1,618	6.8	1,302
2015	1,352	2	1,139	615,355	41,108	15	1,534	3.1	1,221
2016	1,014	3	1,015	543,796	38,118	14	1,506	5.1	1,117
2017	1,014	3	1,014	519,051	30,885	17	1,420	3.0	1,097
2018	1,134	3	1,135	578,221	29,156	20	1,643	4.7	1,240
2019	1,302	3	1,288	649,610	42,924	15	1,618	9.3	1,360
2020	1,343	3	1,267	682,107	46,701	15	1,817	10.8	1,383
2021	1,052	3	993	538,064	46,161	12	1,569	1.7	1,110
2022	785	3	784	427,696	32,786	13	1,130	43.8	876
2023	821	3	820	449,624	34,850	13	1,136	6.1	887
2024	508	2	Conf.	Conf.	Conf.	Conf.	Conf.	1.8	Conf.

Table 3: Number of non-zero observer pots and observed CV for total catch in the directed fishery for the EAG and WAG. The 2024/25 fishery is excluded due to data confidentiality.

	EAG		WAG	
Year	$Pots_{nz}$	CV	$Pots_{nz}$	CV
1990	130	0.28	220	0.22
1991	144	0.27	620	0.13
1992	137	0.28	533	0.14
1993			123	0.30
1994	41	0.53	1,080	0.10
1995	4,184	0.05	3,338	0.06
1996	5,052	0.04	5,297	0.04
1997	3,573	0.05	3,312	0.06
1998	2,976	0.06	1,747	0.08
1999	2,917	0.06	3,906	0.05
2000	4,432	0.05	4,038	0.05
2001	4,018	0.05	3,765	0.05
2002	3,491	0.05	2,181	0.07
2003	3,534	0.05	3,035	0.06
2004	1,961	0.07	2,374	0.07
2005	1,154	0.09	1,243	0.09
2006	1,073	0.10	1,116	0.10
2007	976	0.10	1,040	0.10
2008	606	0.13	950	0.11
2009	402	0.16	863	0.11
2010	425	0.15	816	0.11
2011	358	0.17	794	0.12
2012	437	0.15	1,070	0.10
2013	515	0.14	1,145	0.10
2014	370	0.17	1,030	0.10
2015	509	0.14	1,193	0.09
2016	660	0.12	968	0.10
2017	636	0.13	760	0.12
2018	513	0.14	688	0.12
2019	585	0.13	922	0.11
2020	567	0.13	1,137	0.10
2021	477	0.15	858	0.11
2022	336	0.17	804	0.12
2023	366	0.17	719	0.12

Table 4: Standardized observer CPUE index and associated CV for the pre- and post-rationalized EAG and WAG.

	EAG		WAG	
Year	Index	CV	Index	CV
1995	0.937	0.04	1.158	0.03
1996	0.926	0.02	0.987	0.02
1997	0.910	0.02	1.005	0.02
1998	1.050	0.02	1.120	0.02
1999	0.956	0.02	0.889	0.02
2000	0.843	0.02	0.877	0.02
2001	0.986	0.02	0.759	0.03
2002	1.103	0.02	0.905	0.03
2003	0.915	0.02	1.155	0.02
2004	1.505	0.02	1.257	0.02
2005	1.029	0.03	1.165	0.03
2006	0.755	0.03	1.176	0.03
2007	0.855	0.03	1.170	0.03
2008	0.881	0.03	1.312	0.02
2009	0.731	0.05	1.405	0.02
2010	0.718	0.05	1.169	0.03
2011	1.050	0.03	1.231	0.03
2012	1.003	0.03	1.256	0.02
2013	0.984	0.03	0.888	0.03
2014	1.254	0.02	0.850	0.04
2015	1.281	0.02	0.811	0.04
2016	1.032	0.02	0.905	0.03
2017	1.002	0.03	0.967	0.04
2018	1.188	0.02	1.195	0.03
2019	1.114	0.02	0.947	0.03
2020	1.009	0.03	0.886	0.03
2021	0.916	0.03	0.700	0.05
2022	1.245	0.03	0.668	0.06
2023	1.242	0.03	0.747	0.05

Table 5: Standardized fish ticket CPUE index and associated CV from 1985 - 1998 in the EAG and WAG.

	EAG		WAG	
Year	Index	CV	Index	CV
1985	1.524	0.09	3.248	0.04
1986	0.892	0.18	1.342	0.09
1987	0.827	0.10	1.094	0.07
1988	0.965	0.06	1.317	0.04
1989	1.109	0.04	1.152	0.04
1990	0.936	0.06	0.801	0.06
1991	0.923	0.06	0.755	0.08
1992	0.906	0.07	0.684	0.08
1993	0.929	0.06	0.761	0.08
1994	0.800	0.07	0.769	0.06
1995	0.856	0.07	0.939	0.05
1996	0.964	0.06	0.807	0.05
1997	1.408	0.04	0.726	0.05
1998	1.231	0.05	1.039	0.04

Table 6: Input and re-weighted effective sample size for retained (number of vessel days) and total (number of observer days) catch size composition for model 23.1c. The 2024/25 fishery is excluded due to data confidentiality.

	EAG				WAG			
	Retained Size Comp.		Total Size Comp.		Retained Size Comp.		Total Size Comp.	
Year	N_{obs}	23.1c	N_{obs}	23.1c	N_{obs}	23.1c	N_{obs}	23.1c
1985	366	73			346	33		
1986	221	44			348	33		
1987	276	55			359	34		
1988	498	99			368	35		
1989	606	120			755	73		
1990	213	42	67	36	342	33	239	87
1991	149	29	44	24	166	16	106	38
1992	104	20	44	24	104	10	85	31
1993	369	73			415	40	51	18
1994	777	155	121	66	734	71	237	87
1995	1,046	208	1,013	558	734	71	700	256
1996	615	122	615	338	957	92	957	351
1997	800	159	800	440	968	93	968	355
1998	605	120	605	333	525	50	525	192
1999	624	124	624	343	1,140	110	1,140	418
2000	545	108	545	300	1,099	106	1,099	403
2001	550	109	550	303	923	89	923	338
2002	497	99	497	273	695	67	695	255
2003	457	91	457	251	645	62	645	236
2004	333	66	333	183	453	43	453	166
2005	395	78	210	115	452	43	352	129
2006	297	59	194	106	312	30	250	91
2007	352	70	189	104	367	35	232	85
2008	310	61	148	81	391	37	242	88
2009	257	51	141	77	330	32	225	82
2010	272	54	172	94	305	29	211	77
2011	249	49	157	86	351	34	285	104
2012	277	55	143	78	406	39	322	118
2013	289	57	166	91	471	45	333	122
2014	200	39	108	59	531	51	353	129
2015	204	40	126	69	514	49	323	118
2016	271	54	176	96	459	44	280	102
2017	252	50	164	90	370	35	215	78
2018	255	50	141	77	361	35	237	87
2019	260	51	152	83	462	44	244	89
2020	286	57	158	87	502	48	305	111
2021	281	56	138	76	479	46	247	90
2022	238	47	90	49	341	33	226	82
2023	278	55	139	76	407	39	220	80

Table 7: Time series of number of crab measured (N) in retained catch sampling and bootstrap estimated effective sample size (N_{eff}). Total measured crab includes only those > 100 mm carapace length. Values for 2024 in the EAG were based on an incomplete fishery.

	EAG				WAG			
		Bootstrap N_{eff}				Bootstrap N_{eff}		
Year	N	Min	Mean	Max	N	Min	Mean	Max
1985	2,156	353	1,619	13,707	366	52	288	1,831
1986	1,571	268	1,254	6,875	574	68	457	2,037
1987	913	147	712	3,408	176	17	137	1,661
1988	8,532	840	5,335	39,003	17,596	1,354	9,987	59,028
1989	21,700	1,796	12,929	97,108	33,318	4,957	23,869	125,599
1990	8,890	1,210	7,748	62,753	17,873	1,112	9,632	57,899
1991	9,860	1,572	7,539	63,027	14,879	2,434	11,218	54,528
1992	10,286	1,086	7,771	90,286	11,657	1,865	9,260	76,085
1993	3,601	464	2,834	16,873	3,120	437	2,799	22,919
1994	5,345	702	4,776	39,401	6,212	886	5,249	39,575
1995	8,955	1,604	6,842	38,738	1,240	218	1,052	9,959
1996	2,947	507	2,398	16,782	7,524	1,418	6,697	42,045
1997	4,800	879	4,339	31,620	10,640	1,454	8,202	37,220
1998	2,848	560	2,602	15,584	8,326	1,315	6,905	36,524
1999	2,410	273	1,902	10,015	7,698	1,142	6,745	47,098
2000	3,826	645	3,108	23,923	6,849	1,002	5,597	53,210
2001	1,814	363	1,658	14,708	6,675	1,168	5,449	34,086
2002	1,997	358	1,782	18,341	5,091	1,024	4,941	33,983
2003	1,775	291	1,483	8,380	3,984	572	3,581	52,630
2004	1,277	238	1,180	10,519	3,787	604	3,398	21,700
2005	1,113	216	1,061	10,000	3,985	632	3,319	30,128
2006	800	164	734	6,947	4,505	933	4,012	34,551
2007	1,304	269	1,108	6,375	3,770	874	3,353	14,301
2008	831	181	772	5,984	3,831	652	3,401	22,999
2009	878	190	816	5,978	3,799	837	3,471	23,992
2010	889	174	802	11,157	3,824	887	3,424	17,001
2011	815	111	757	5,042	4,230	706	3,425	26,951
2012	958	195	960	6,069	2,402	483	2,080	10,824
2013	943	219	905	6,537	843	185	765	4,611
2014	942	201	861	6,778	1,130	153	989	5,730
2015	940	206	835	4,046	984	259	957	6,015
2016	1,016	205	985	5,140	794	157	786	5,815
2017	928	215	898	5,651	829	160	708	9,132
2018	1,127	191	990	6,965	811	162	695	4,557
2019	983	246	993	5,351	1,015	214	917	4,247
2020	1,200	208	1,099	8,962	1,109	159	924	4,854
2021	1,043	184	941	14,399	942	180	912	6,315
2022	806	173	726	3,932	663	126	673	6,071
2023	1,051	233	1,015	7,329	675	146	687	3,348
2024	839	138	796	4,468	314	77	341	2,694

Table 8: Time series of number of crab measured (N) in observer size composition sampling and bootstrap estimated effective sample size (N_{eff}).Total measured crab includes only those > 100 mm carapace length. Values for 2024 in the EAG were based on an incomplete fishery.

	EAG				WAG			
		Bootstrap N_{eff}				Bootstrap N_{eff}		
Year	N	Min	Mean	Max	N	Min	Mean	Max
1990	5,496	51	758	6,075	6,925	224	1,770	9,467
1991	9,890	317	2,355	13,047	18,512	568	4,141	32,099
1992	10,559	310	1,962	9,755	17,242	551	3,990	18,912
1993	865	66	374	2,170	3,626	141	943	4,702
1994	2,345	103	610	2,852	34,327	1,353	7,945	64,271
1995	148,905	6,244	35,745	186,955	124,804	4,397	25,254	118,741
1996	174,701	7,581	43,247	217,932	162,900	6,435	34,715	188,478
1997	122,632	6,448	32,489	154,951	94,407	2,863	17,250	90,440
1998	118,764	4,051	30,226	255,579	64,869	2,124	14,267	98,227
1999	104,473	4,342	26,948	183,331	102,844	3,337	23,591	133,332
2000	39,176	2,299	11,504	64,619	122,600	2,381	23,043	164,293
2001	43,726	2,987	14,596	101,078	101,483	2,365	21,917	148,961
2002	32,457	2,061	11,145	50,866	63,045	2,395	13,925	79,117
2003	29,826	2,030	10,044	40,225	53,457	2,678	14,957	114,886
2004	24,203	1,391	7,417	31,690	47,091	1,992	12,052	70,304
2005	13,723	1,022	5,315	33,492	29,802	1,130	8,801	54,941
2006	11,606	1,124	4,266	24,591	34,048	1,596	10,987	86,655
2007	13,814	1,178	5,787	33,150	35,821	1,366	9,241	60,621
2008	17,910	1,328	7,115	43,015	33,049	1,271	8,974	46,068
2009	16,433	1,059	5,369	32,781	37,262	1,841	10,036	55,696
2010	18,830	1,041	5,855	28,840	31,970	1,297	9,240	58,500
2011	22,032	1,377	7,458	58,882	33,396	1,565	9,678	53,090
2012	25,026	1,470	8,932	45,928	42,204	1,711	11,976	82,376
2013	29,005	1,310	10,048	70,652	37,817	1,564	10,763	49,163
2014	27,142	1,688	8,104	44,954	34,927	877	7,478	51,720
2015	36,630	1,916	11,382	69,125	37,589	1,653	11,149	93,215
2016	42,865	1,756	12,958	112,057	30,937	946	7,967	64,197
2017	39,916	1,877	13,110	63,729	26,105	1,143	7,207	40,327
2018	37,617	1,396	12,283	75,029	26,787	837	7,628	40,330
2019	39,487	2,142	13,395	74,146	26,377	1,035	7,302	44,721
2020	34,636	1,974	11,799	49,058	32,273	1,530	10,193	82,895
2021	22,822	879	8,231	37,594	23,861	1,232	7,799	37,348
2022	19,908	1,396	7,954	43,369	22,153	805	6,130	42,366
2023	23,032	832	8,118	62,484	18,009	890	5,727	44,697
2024	27,176	1,091	9,377	53,125	9,252	438	2,798	23,427

Table 9: Input and re-weighted effective sample size for retained and total catch size composition for model 25.0b.

	EAG				WAG			
	Retained Size Comp.		Total Size Comp.		Retained Size Comp.		Total Size Comp.	
Year	N_{obs}	25.0b	N_{obs}	25.0b	N_{obs}	25.0b	N_{obs}	25.0b
1985	1,619	111			288	9		
1986	1,254	86			457	15		
1987	712	49			137	4		
1988	2,000	138			2,000	67		
1989	2,000	138			2,000	67		
1990	2,000	138	758	49	2,000	67	1,770	138
1991	2,000	138	2,000	131	2,000	67	2,000	156
1992	2,000	138	1,962	129	2,000	67	2,000	156
1993	2,000	138			2,000	67	943	73
1994	2,000	138	610	40	2,000	67	2,000	156
1995	2,000	138	2,000	131	1,052	35	2,000	156
1996	2,000	138	2,000	131	2,000	67	2,000	156
1997	2,000	138	2,000	131	2,000	67	2,000	156
1998	2,000	138	2,000	131	2,000	67	2,000	156
1999	1,902	131	2,000	131	2,000	67	2,000	156
2000	2,000	138	2,000	131	2,000	67	2,000	156
2001	1,658	114	2,000	131	2,000	67	2,000	156
2002	1,782	123	2,000	131	2,000	67	2,000	156
2003	1,483	102	2,000	131	2,000	67	2,000	156
2004	1,180	81	2,000	131	2,000	67	2,000	156
2005	1,061	73	2,000	131	2,000	67	2,000	156
2006	734	50	2,000	131	2,000	67	2,000	156
2007	1,108	76	2,000	131	2,000	67	2,000	156
2008	772	53	2,000	131	2,000	67	2,000	156
2009	816	56	2,000	131	2,000	67	2,000	156
2010	802	55	2,000	131	2,000	67	2,000	156
2011	757	52	2,000	131	2,000	67	2,000	156
2012	960	66	2,000	131	2,000	67	2,000	156
2013	905	62	2,000	131	765	25	2,000	156
2014	861	59	2,000	131	989	33	2,000	156
2015	835	57	2,000	131	957	32	2,000	156
2016	985	68	2,000	131	786	26	2,000	156
2017	898	62	2,000	131	708	23	2,000	156
2018	990	68	2,000	131	695	23	2,000	156
2019	993	68	2,000	131	917	30	2,000	156
2020	1,099	75	2,000	131	924	31	2,000	156
2021	941	65	2,000	131	912	30	2,000	156
2022	726	50	2,000	131	673	22	2,000	156
2023	1,015	70	2,000	131	687	23	2,000	156
2024	796	55	2,000	131	341	11	2,000	156

Table 10: Comparison of likelihood components for GMACS version 2.20.16 and 2.20.21 based on model 23.1c.

	EAG		WAG	
Component	v2.20.16	v2.20.21	v2.20.16	v2.20.21
catch	-479.341	-479.341	-456.995	-456.703
index	-44.886	-44.886	-69.586	-69.515
n_pars	164.000	164.000	162.000	162.000
rec_pen	19.206	19.206	24.310	24.486
size_comp	827.085	827.085	1,022.729	1,016.130
tagging	2,697.515	2,697.515	2,696.867	2,697.060
total	3,046.523	3,046.523	3,244.180	3,238.325

Table 11: Likelihood components and number of parameters for EAG and WAG models.

	EAG		WAG	
Component	23.1c	23.1b	23.1c	23.1b
Retained Catch	-444.086	-109.051	-442.161	-105.887
Total Catch	-66.519	-32.635	-43.957	-12.476
Groundfish Bycatch	31.264	31.266	29.415	29.416
Obs CPUE 1995 - 2004	-9.756	-11.559	-10.251	-12.341
Obs CPUE 2005 - 2024	-20.625	-19.877	-42.250	-40.226
FT CPUE 1985 - 1998	-14.506	-13.921	-17.014	-19.399
Retained Size Composition	486.653	412.871	612.911	607.889
Total Size Composition	340.432	298.552	403.219	310.803
Recruitment	19.206	12.898	19.206	12.898
Tagging	2,697.515	2,698.616	2,697.515	2,698.616
Penalties	0.151	0.152	0.151	0.152
Priors	26.793	73.387	26.793	73.387
Initial Conditions	0.000	0.948	0.000	0.948
N Parameters	164.000	160.000	162.000	158.000
Total NLL	3,046.523	3,341.648	3,238.325	3,548.931

Table 12: Parameter estimates (standard error) among models, except annual deviations and initial numbers at size.

	EAG		WAG	
Parameter	23.1c	25.0b	23.1c	25.0b
ln R_0	7.78 (0.073)		7.53 (0.073)	
ln R_{ini}		9.07 (0.118)		9.41 (0.117)
ln $\bar{R}$		7.97 (0.082)		7.61 (0.081)
Rec Dist Scale	0.53 (0.075)	0.5 (0.084)	0.48 (0.07)	0.47 (0.072)
Growth α	23.41 (1.475)	23.07 (1.494)	22.54 (1.492)	22.15 (1.495)
Growth β	0.08 (0.011)	0.07 (0.011)	0.07 (0.011)	0.07 (0.011)
Growth σ	3.65 (0.096)	3.65 (0.097)	3.67 (0.098)	3.67 (0.098)
Molt probability μ	141.47 (0.613)	141.99 (0.64)	141.3 (0.689)	141.84 (0.745)
Molt probability cv	0.08 (0.004)	0.08 (0.004)	0.09 (0.005)	0.1 (0.006)
Sel ln S_{50} Pre-Rat	4.73 (0.03)	4.72 (0.029)	4.83 (0.022)	4.83 (0.022)
Sel ln S_{Δ} Pre-Rat	2.84 (0.139)	2.75 (0.159)	2.65 (0.083)	2.63 (0.087)
Sel ln S_{50} Post-Rat	4.9 (0.011)	4.9 (0.009)	4.89 (0.009)	4.9 (0.008)
Sel ln S_{Δ} Post-Rat	2.09 (0.061)	2.07 (0.048)	2.03 (0.054)	2.03 (0.042)
Ret ln R_{50}	4.91 (0.002)	4.92 (0.002)	4.91 (0.002)	4.92 (0.002)
Ret ln R_{Δ}	0.66 (0.059)	0.71 (0.053)	0.63 (0.068)	0.7 (0.068)
ln $\bar{F}$ Directed Fishery	-1.02e+00 (3.372)	-9.62e-01 (3.372)	-7.11e-01 (3.372)	-6.84e-01 (3.371)
ln $\bar{F}$ Groundfish Fisheries	-6.98e+00 (3.839)	-6.94e+00 (3.839)	-7.63e+00 (3.957)	-7.61e+00 (3.957)
Obs CPUE q 1995-2004	4.64e-04 (5.26e-05)	4.83e-04 (5.08e-05)	9.80e-04 (1.02e-04)	1.02e-03 (9.66e-05)
Obs CPUE q 2005-2024	4.60e-04 (5.41e-05)	5.03e-04 (5.46e-05)	9.14e-04 (7.60e-05)	9.81e-04 (7.47e-05)
FT CPUE q 1985-1998	5.69e-04 (5.30e-05)	5.71e-04 (5.30e-05)	9.21e-04 (8.10e-05)	9.41e-04 (7.70e-05)
ln extra cv Obs CPUE 1995-2004	-1.47e+00 (0.248)	-1.65e+00 (0.254)	-1.52e+00 (0.247)	-1.74e+00 (0.265)
ln extra cv Obs CPUE 2005-2024	-1.53e+00 (0.213)	-1.49e+00 (0.203)	-2.82e+00 (0.295)	-2.69e+00 (0.285)
ln extra cv FT CPUE 1985-1998	-1.62e+00 (0.261)	-1.57e+00 (0.25)	-1.78e+00 (0.276)	-1.99e+00 (0.303)

Table 13: Recruitment estimates and associated standard errors (in parentheses) for models 23.1c and 25.0b.

	EAG		WAG	
Year	23.1c	25.0b	23.1c	25.0b
1960	2,350 (1,173)		1,859 (938)	
1961	2,338 (1,164)		1,859 (937)	
1962	2,324 (1,153)		1,858 (936)	
1963	2,307 (1,139)		1,857 (935)	
1964	2,286 (1,124)		1,856 (935)	
1965	2,262 (1,105)		1,855 (933)	
1966	2,234 (1,084)		1,855 (933)	
1967	2,201 (1,060)		1,854 (932)	
1968	2,165 (1,032)		1,854 (931)	
1969	2,124 (1,002)		1,855 (930)	
1970	2,079 (970)		1,858 (930)	
1971	2,032 (935)		1,862 (932)	
1972	1,983 (899)		1,870 (935)	
1973	1,933 (864)		1,882 (941)	
1974	1,887 (830)		1,903 (951)	

1975	1,846 (800)		1,934 (968)	
1976	1,817 (775)		1,984 (996)	
1977	1,805 (760)		2,064 (1,044)	
1978	1,823 (760)		2,193 (1,127)	
1979	1,898 (788)		2,418 (1,287)	
1980	2,050 (852)		2,827 (1,611)	
1981	2,235 (910)	3,408 (1,291)	3,322 (1,882)	2,530 (1,321)
1982	2,308 (883)	2,222 (868)	2,834 (1,438)	2,075 (1,021)
1983	2,624 (972)	2,833 (948)	2,116 (973)	1,896 (888)
1984	2,730 (915)	2,760 (887)	2,426 (1,134)	2,751 (1,355)
1985	1,961 (727)	1,825 (646)	4,757 (1,562)	4,838 (1,577)
1986	3,157 (937)	3,197 (829)	2,670 (1,119)	2,544 (1,040)
1987	3,418 (1,059)	3,458 (868)	2,181 (781)	1,798 (622)
1988	2,744 (858)	2,756 (682)	2,383 (525)	2,363 (427)
1989	3,551 (721)	3,291 (503)	1,250 (288)	1,444 (260)
1990	2,499 (635)	2,882 (425)	1,100 (250)	1,649 (227)
1991	2,755 (615)	3,493 (495)	1,432 (319)	1,720 (256)
1992	2,803 (517)	2,251 (567)	2,978 (373)	2,470 (328)
1993	2,999 (321)	3,037 (444)	2,386 (289)	2,432 (299)
1994	2,978 (228)	2,804 (355)	1,992 (199)	1,970 (252)
1995	2,326 (222)	2,230 (319)	1,547 (169)	1,564 (235)
1996	2,954 (253)	2,801 (360)	1,910 (188)	1,815 (250)
1997	3,267 (301)	3,047 (397)	1,960 (201)	1,853 (256)
1998	2,984 (307)	2,761 (397)	2,123 (195)	1,996 (271)
1999	2,984 (318)	2,815 (396)	2,413 (212)	2,322 (292)
2000	2,260 (290)	2,218 (368)	2,064 (230)	2,072 (304)
2001	2,555 (317)	2,554 (385)	2,115 (251)	2,170 (311)
2002	1,896 (295)	1,954 (350)	1,570 (258)	1,761 (305)
2003	1,668 (325)	1,716 (355)	1,849 (305)	1,789 (310)
2004	3,172 (546)	3,078 (509)	2,032 (399)	2,036 (369)
2005	2,177 (551)	2,148 (500)	2,225 (460)	2,216 (401)
2006	2,087 (578)	2,051 (506)	2,150 (446)	2,071 (377)
2007	2,758 (658)	2,644 (553)	1,417 (390)	1,398 (333)
2008	2,490 (626)	2,495 (534)	1,873 (427)	1,754 (361)
2009	2,164 (555)	2,084 (470)	1,648 (367)	1,708 (335)
2010	2,173 (538)	2,078 (449)	1,127 (306)	1,157 (295)
2011	1,989 (520)	1,955 (435)	1,784 (319)	1,761 (313)
2012	2,064 (529)	2,020 (433)	1,665 (328)	1,702 (325)
2013	2,316 (583)	2,212 (467)	1,805 (334)	1,812 (324)
2014	2,925 (639)	2,926 (530)	1,852 (356)	1,778 (325)
2015	2,977 (667)	2,879 (558)	1,802 (361)	1,701 (316)
2016	3,285 (732)	3,196 (600)	1,190 (304)	1,214 (274)
2017	3,418 (781)	3,321 (636)	1,329 (281)	1,341 (259)
2018	2,919 (769)	2,834 (638)	1,165 (258)	1,187 (239)
2019	2,860 (782)	2,835 (650)	1,378 (261)	1,354 (237)
2020	2,620 (807)	2,338 (629)	1,232 (258)	1,246 (236)
2021	2,736 (877)	2,800 (750)	916 (251)	1,038 (242)
2022	2,180 (819)	2,171 (722)	1,174 (381)	1,113 (297)
2023	2,131 (914)	2,081 (804)	1,557 (663)	1,245 (421)
2024	2,403 (1,215)	2,562 (1,298)	1,863 (941)	1,789 (906)

Table 14: MMB estimates and associated standard errors (in parentheses) for models 23.1c and 25.0b.

	EAG		WAG	
Year	23.1c	25.0b	23.1c	25.0bb
1960	17,184 (1,235)		13,271 (948)	
1961	17,174 (1,253)		13,270 (963)	
1962	17,133 (1,503)		13,267 (1,165)	
1963	17,078 (1,765)		13,263 (1,381)	
1964	17,011 (1,974)		13,259 (1,559)	
1965	16,935 (2,124)		13,254 (1,692)	
1966	16,846 (2,222)		13,249 (1,788)	
1967	16,745 (2,278)		13,244 (1,854)	
1968	16,629 (2,301)		13,238 (1,898)	
1969	16,495 (2,297)		13,234 (1,926)	
1970	16,342 (2,273)		13,230 (1,941)	
1971	16,168 (2,230)		13,227 (1,946)	
1972	15,972 (2,171)		13,227 (1,944)	
1973	15,755 (2,099)		13,232 (1,935)	
1974	15,516 (2,013)		13,243 (1,920)	
1975	15,259 (1,915)		13,266 (1,898)	
1976	14,989 (1,805)		13,307 (1,869)	
1977	14,715 (1,684)		13,373 (1,830)	
1978	14,447 (1,551)		13,482 (1,778)	
1979	14,204 (1,404)		13,657 (1,703)	
1980	14,016 (1,241)		13,943 (1,595)	
1981	13,445 (1,063)	11,395 (1,155)	14,330 (1,431)	17,837 (2,194)
1982	12,306 (880)	10,683 (932)	12,436 (1,218)	14,813 (1,707)
1983	11,174 (732)	10,391 (677)	10,684 (943)	11,823 (1,146)
1984	10,124 (623)	9,700 (574)	11,535 (698)	11,831 (788)
1985	8,408 (528)	8,229 (483)	9,452 (628)	9,410 (612)
1986	7,045 (439)	6,941 (380)	6,740 (553)	6,729 (523)
1987	6,464 (395)	6,335 (326)	6,961 (401)	6,953 (371)
1988	6,061 (405)	5,955 (312)	6,062 (278)	5,945 (238)
1989	5,318 (368)	5,221 (291)	4,224 (215)	3,938 (174)
1990	5,637 (330)	5,486 (276)	3,846 (174)	3,541 (155)
1991	5,745 (300)	5,537 (284)	3,224 (159)	3,110 (151)
1992	5,381 (268)	5,438 (293)	2,925 (144)	3,145 (157)
1993	5,750 (240)	6,072 (287)	3,411 (135)	3,725 (160)
1994	5,604 (236)	5,736 (271)	3,473 (145)	3,561 (163)
1995	5,310 (255)	5,382 (282)	3,725 (146)	3,754 (165)
1996	5,449 (283)	5,423 (303)	3,705 (153)	3,721 (171)
1997	5,585 (318)	5,463 (330)	3,704 (155)	3,702 (172)
1998	6,135 (369)	5,867 (374)	3,980 (161)	3,906 (178)
1999	6,923 (433)	6,491 (427)	4,024 (173)	3,863 (185)
2000	7,569 (492)	6,981 (473)	4,107 (188)	3,862 (198)
2001	8,033 (548)	7,380 (512)	4,414 (209)	4,122 (214)
2002	8,266 (589)	7,630 (534)	4,655 (228)	4,384 (225)
2003	8,328 (628)	7,774 (553)	4,782 (248)	4,605 (237)
2004	8,042 (646)	7,605 (557)	4,680 (260)	4,615 (243)
2005	7,789 (641)	7,421 (549)	4,688 (274)	4,631 (253)
2006	8,064 (645)	7,715 (555)	5,046 (294)	5,001 (270)
2007	7,934 (629)	7,608 (540)	5,381 (306)	5,326 (277)
2008	7,786 (608)	7,462 (521)	5,536 (308)	5,445 (276)

2009	7,931 (589)	7,592 (502)	5,278 (295)	5,161 (263)
2010	7,926 (558)	7,614 (474)	5,108 (264)	4,953 (241)
2011	7,753 (533)	7,428 (447)	4,768 (235)	4,659 (220)
2012	7,451 (514)	7,107 (426)	4,213 (221)	4,133 (205)
2013	7,041 (504)	6,707 (415)	3,931 (216)	3,853 (201)
2014	6,717 (509)	6,376 (416)	3,849 (219)	3,803 (204)
2015	6,644 (529)	6,274 (430)	3,961 (224)	3,922 (207)
2016	6,901 (555)	6,529 (450)	4,232 (226)	4,145 (205)
2017	7,366 (590)	6,951 (480)	4,363 (216)	4,233 (198)
2018	7,787 (648)	7,326 (530)	4,057 (194)	3,939 (180)
2019	8,017 (728)	7,512 (605)	3,575 (177)	3,475 (163)
2020	8,194 (806)	7,667 (687)	3,075 (171)	2,982 (155)
2021	8,339 (914)	7,784 (808)	2,955 (182)	2,850 (166)
2022	8,479 (1,060)	7,840 (963)	2,955 (204)	2,884 (194)
2023	8,323 (1,256)	7,748 (1,193)	2,809 (257)	2,793 (252)
2024	7,928 (1,435)	7,408 (1,402)	3,168 (390)	3,082 (350)

Table 15: Comparison of biological reference points for models 23.1c and 25.0b.

Subdistrict	Model	MMB (t)	$B_{35\%}$ (t)	$\frac{MMB}{B_{35\%}}$	$\bar{R}_{1987-2021}$	$F_{35\%}$	F_{OFL}	OFL (t)
EAG	23.1c	6,906	6,734	1.03	2,691	0.52	0.52	2,401
	25.0b	6,633	6,641	1.00	2,639	0.52	0.52	2,223
WAG	23.1c	3,570	4,530	0.79	1,817	0.51	0.39	765
	25.0b	3,366	4,525	0.74	1,805	0.53	0.38	702

Subdistrict	Model	MMB (mil lb)	$B_{35\%}$ (mil lb)	$\frac{MMB}{B_{35\%}}$	$\bar{R}_{1987-2017}$	$F_{35\%}$	F_{OFL}	OFL (mil lb)
EAG	23.1c	15.22	14.85	1.03	2,691	0.52	0.52	5.29
	25.0b	14.62	14.64	1.00	2,639	0.52	0.52	4.90
WAG	23.1c	7.87	9.99	0.79	1,817	0.51	0.39	1.69
	25.0b	7.42	9.98	0.74	1,805	0.53	0.38	1.55

Table 16: Objective function, catch, index, and size likelihood components, key management quantities, and frequency of each outcome for 500 jitter runs with jitter factor 0.3 for EAG model 23.1c.

Objective Function	Catch	Index	Size	MMB_{proj}	$B_{35\%}$	OFL	N	Percent
3,046.523	-479.341	-44.886	827.085	6,906	6,734	2,401	405	0.81
3,058.144	-480.377	-50.515	843.375	7,372	7,026	2,632	1	0.00
3,067.825	-480.221	-40.582	843.003	7,351	7,023	2,621	1	0.00
3,073.623	-462.559	-73.327	857.306	7,141	7,385	2,009	1	0.00
3,073.626	-462.557	-73.335	857.311	7,141	7,385	2,009	2	0.00
3,073.628	-462.559	-73.335	857.315	7,141	7,385	2,008	2	0.00
3,073.629	-462.561	-73.335	857.315	7,141	7,386	2,008	4	0.01
3,073.630	-462.555	-73.335	857.315	7,141	7,385	2,008	1	0.00
3,073.632	-462.556	-73.340	857.321	7,141	7,385	2,009	1	0.00
3,073.636	-462.561	-73.341	857.326	7,139	7,384	2,008	1	0.00
3,073.642	-462.554	-73.345	857.329	7,141	7,385	2,009	1	0.00
3,073.678	-462.634	-73.276	857.472	7,123	7,367	2,008	1	0.00
3,073.943	-462.763	-73.261	857.666	7,137	7,386	2,008	1	0.00
3,073.950	-462.799	-73.181	857.643	7,140	7,378	2,012	1	0.00
3,074.070	-462.717	-73.253	857.755	7,145	7,388	2,011	1	0.00
3,074.162	-462.346	-73.302	857.313	7,103	7,375	1,991	1	0.00
3,074.641	-462.538	-73.223	857.664	7,118	7,376	1,992	1	0.00
3,076.113	-460.538	-73.136	857.186	7,199	7,431	2,032	1	0.00
3,079.299	-462.558	-67.668	857.318	7,141	7,385	2,008	69	0.14
3,080.847	-453.272	-49.525	837.462	7,108	7,151	2,464	1	0.00
3,085.465	-440.778	-54.398	834.252	7,150	7,229	2,464	1	0.00
3,096.851	-462.092	-68.720	874.077	7,655	7,739	2,233	1	0.00
3,194.469	-463.023	-68.556	974.930	7,074	7,288	2,004	1	0.00

Table 17: Objective function, catch, index, and size likelihood components, key management quantities, and frequency of each outcome for 500 jitter runs with jitter factor 0.3 for EAG model 25.0b.

Objective Function	Catch	Index	Size	MMB_{proj}	$B_{35\%}$	OFL	N	Percent
3,341.648	-110.420	-45.357	711.423	6,633	6,641	2,223	420	0.84
3,365.445	-109.897	-41.284	730.518	6,937	6,831	2,379	3	0.01
3,371.551	-93.343	-72.512	742.975	7,478	7,538	2,047	2	0.00
3,371.558	-93.347	-72.504	742.976	7,479	7,539	2,047	1	0.00
3,371.561	-93.347	-72.517	742.993	7,475	7,536	2,046	1	0.00
3,371.563	-93.347	-72.514	742.997	7,477	7,537	2,046	1	0.00
3,371.565	-93.342	-72.520	742.987	7,475	7,536	2,046	2	0.00
3,371.568	-93.342	-72.519	742.993	7,475	7,536	2,046	2	0.00
3,371.570	-93.342	-72.520	743.001	7,474	7,535	2,045	1	0.00
3,371.571	-93.342	-72.522	742.997	7,474	7,536	2,045	5	0.01
3,371.572	-93.345	-72.522	743.011	7,475	7,536	2,046	1	0.00
3,371.576	-93.339	-72.528	743.004	7,475	7,536	2,045	1	0.00
3,371.577	-93.342	-72.527	743.006	7,475	7,536	2,045	1	0.00
3,371.580	-93.479	-72.404	743.034	7,465	7,520	2,048	1	0.00
3,371.604	-93.348	-72.556	742.977	7,469	7,531	2,042	1	0.00
3,371.908	-93.537	-72.103	743.355	7,530	7,550	2,081	1	0.00
3,372.264	-93.288	-72.552	743.114	7,444	7,519	2,034	1	0.00
3,372.467	-92.734	-72.478	743.176	7,491	7,545	2,057	1	0.00
3,372.941	-93.343	-71.150	742.998	7,475	7,536	2,045	1	0.00
3,380.918	-93.343	-63.174	742.999	7,475	7,536	2,045	52	0.10
3,889.763	129.144	-46.492	1,016.720	6,567	6,710	2,098	1	0.00

Table 18: Objective function, catch, index, and size likelihood components, key management quantities, and frequency of each outcome for 500 jitter runs with jitter factor 0.3 for WAG model 23.1c.

Objective Function	Catch	Index	Size	MMB_{proj}	$B_{35\%}$	OFL	N	Percent
3,238.325	-456.703	-69.515	1,016.130	3,570	4,530	765	328	0.66
3,242.041	-439.426	-76.868	1,007.139	3,682	4,932	734	61	0.12
3,242.863	-455.263	-77.249	1,023.011	3,416	4,491	688	1	0.00
3,242.864	-455.235	-77.262	1,022.991	3,415	4,490	688	1	0.00
3,242.865	-455.270	-77.253	1,023.024	3,416	4,491	688	4	0.01
3,242.866	-455.269	-77.254	1,023.018	3,416	4,491	688	4	0.01
3,242.867	-455.274	-77.254	1,023.025	3,416	4,491	688	6	0.01
3,242.868	-455.277	-77.256	1,023.027	3,416	4,491	688	6	0.01
3,242.869	-455.272	-77.254	1,023.023	3,416	4,491	688	8	0.02
3,242.870	-455.275	-77.252	1,023.022	3,416	4,491	688	1	0.00
3,242.871	-455.276	-77.256	1,023.029	3,416	4,491	688	2	0.00
3,242.872	-455.292	-77.250	1,023.039	3,417	4,490	689	1	0.00
3,242.876	-455.290	-77.282	1,023.086	3,414	4,491	687	1	0.00
3,243.056	-455.283	-77.060	1,023.027	3,416	4,491	688	1	0.00
3,246.386	-455.272	-73.735	1,023.023	3,416	4,491	688	47	0.09
3,246.727	-438.035	-84.686	1,014.161	3,513	4,876	658	1	0.00
3,246.729	-438.044	-84.696	1,014.180	3,513	4,876	658	1	0.00
3,246.730	-438.061	-84.697	1,014.197	3,512	4,876	658	1	0.00
3,246.732	-438.051	-84.698	1,014.186	3,512	4,876	658	1	0.00
3,246.733	-438.046	-84.701	1,014.191	3,513	4,876	658	1	0.00
3,246.734	-438.048	-84.700	1,014.189	3,513	4,876	658	5	0.01
3,246.736	-438.050	-84.700	1,014.189	3,513	4,876	658	1	0.00
3,250.433	-438.049	-80.997	1,014.188	3,513	4,876	658	10	0.02
3,285.866	-448.149	-67.771	1,053.620	3,495	4,473	735	1	0.00
3,313.468	-456.977	-68.763	1,090.973	3,484	4,472	731	3	0.01
3,319.824	-455.877	-74.649	1,098.092	3,339	4,437	661	1	0.00
3,453.494	-391.799	-64.110	1,161.370	3,319	4,320	685	1	0.00
3,558.202	-376.757	-65.489	1,252.794	3,286	4,317	661	1	0.00

Table 19: Objective function, catch, index, and size likelihood components, key management quantities, and frequency of each outcome for 500 jitter runs with jitter factor 0.3 for WAG model 25.0b.

Objective Function	Catch	Index	Size	MMB_{proj}	$B_{35\%}$	OFL	N	Percent
3,548.931	-88.948	-71.966	918.692	3,366	4,525	702	473	0.95
3,554.239	-85.217	-77.615	924.147	3,330	4,537	684	1	0.00
3,554.244	-85.212	-77.614	924.151	3,330	4,537	684	1	0.00
3,554.673	-87.478	-80.421	928.107	3,252	4,496	646	1	0.00
3,554.674	-87.485	-80.427	928.116	3,252	4,496	646	1	0.00
3,559.339	-87.480	-75.762	928.112	3,252	4,496	646	5	0.01
3,560.898	-85.209	-70.961	924.147	3,330	4,537	684	1	0.00
3,564.578	-83.760	-81.586	933.593	3,222	4,514	631	1	0.00
3,571.001	-83.759	-75.159	933.591	3,222	4,514	631	2	0.00
3,592.916	-85.924	-70.040	958.468	3,279	4,466	665	1	0.00
3,637.201	-89.414	-70.578	1,006.796	3,286	4,466	674	4	0.01
3,814.914	-44.702	-65.887	1,136.388	3,181	4,335	643	5	0.01
3,826.571	-44.095	-71.548	1,149.684	3,056	4,304	586	1	0.00
4,163.556	45.823	-61.931	1,389.176	3,300	4,293	705	1	0.00
4,168.480	45.656	-61.912	1,394.235	3,300	4,293	706	1	0.00
4,494.190	198.918	-60.224	1,566.184	3,436	4,286	783	1	0.00

Figures

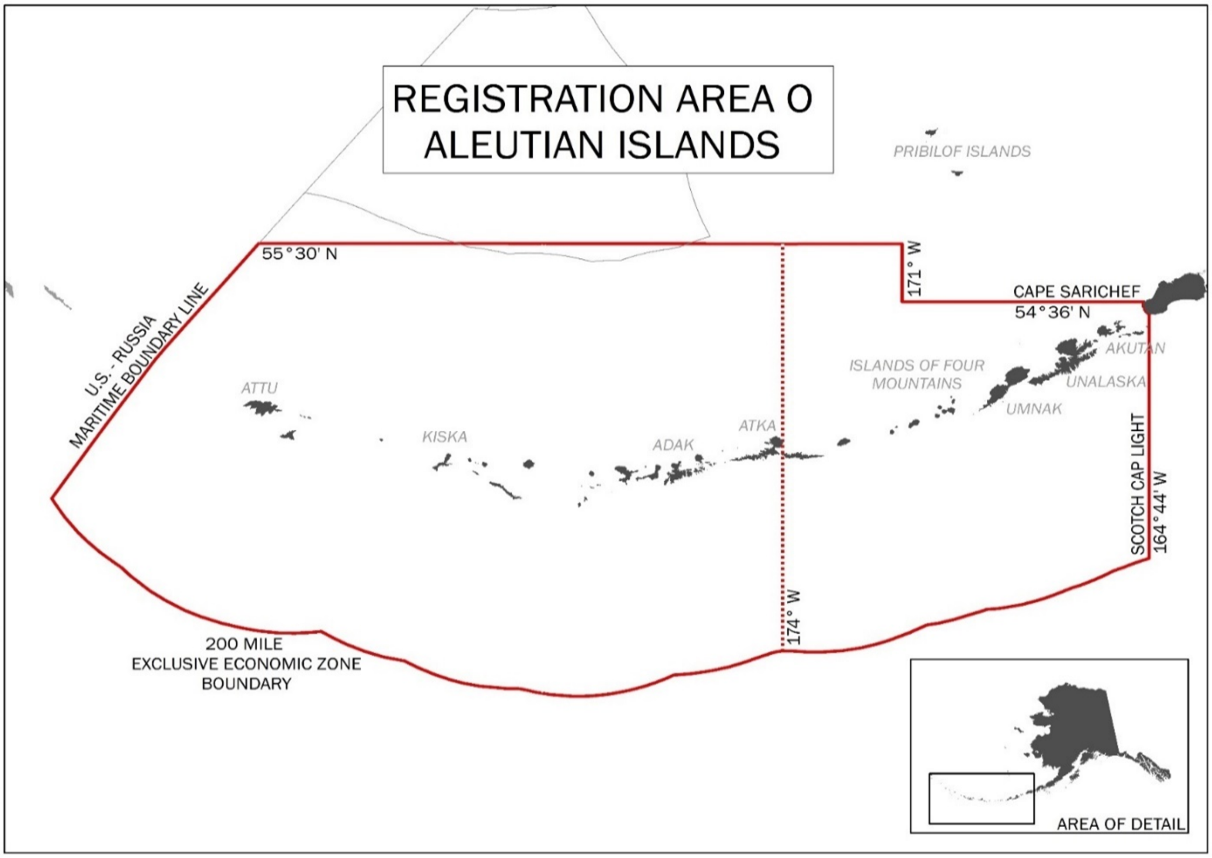

Figure 3: Map of the Aleutian Islands Registration Area (O), divided in to WAG and EAG subdistricts at 174° west longitude.

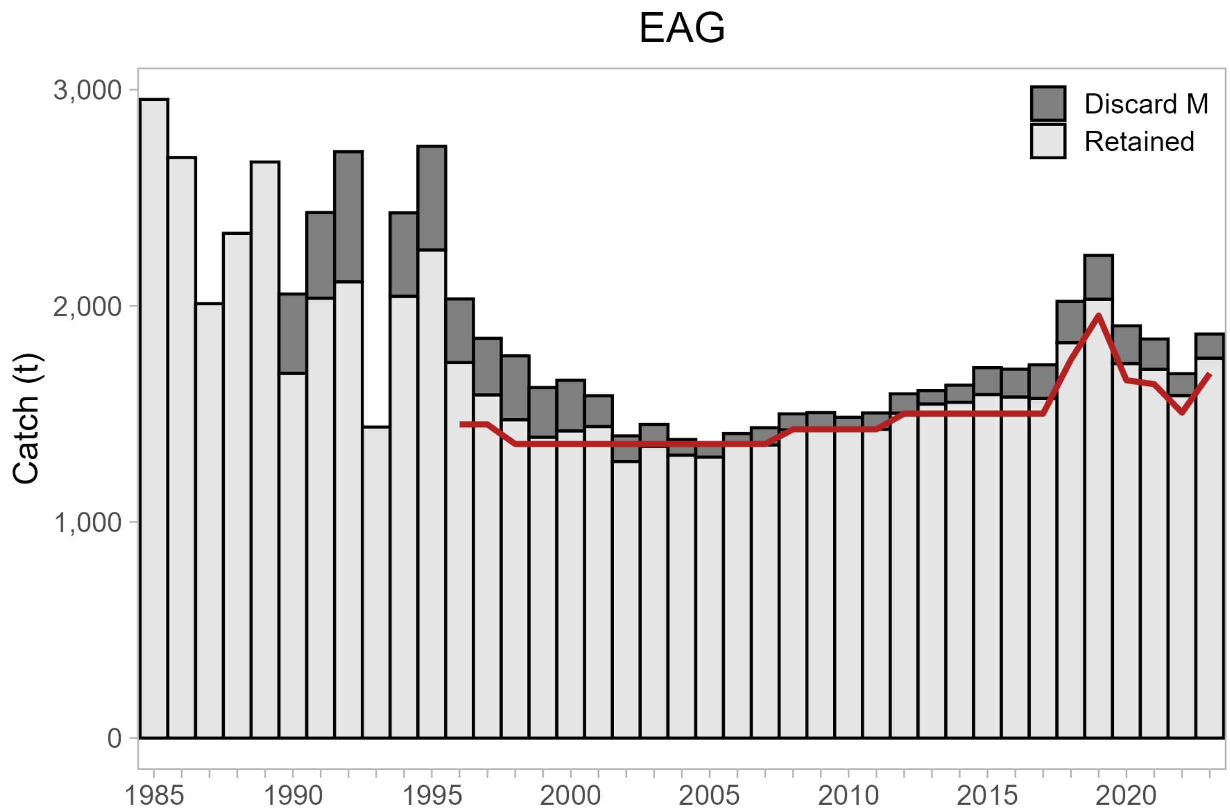

Figure 4: Time series of retained catch (t), directed fishery discard mortality (t), and the total allowable catch (t; red line) in the EAG. Catch in 2024/25 was not included due to data confidentiality.

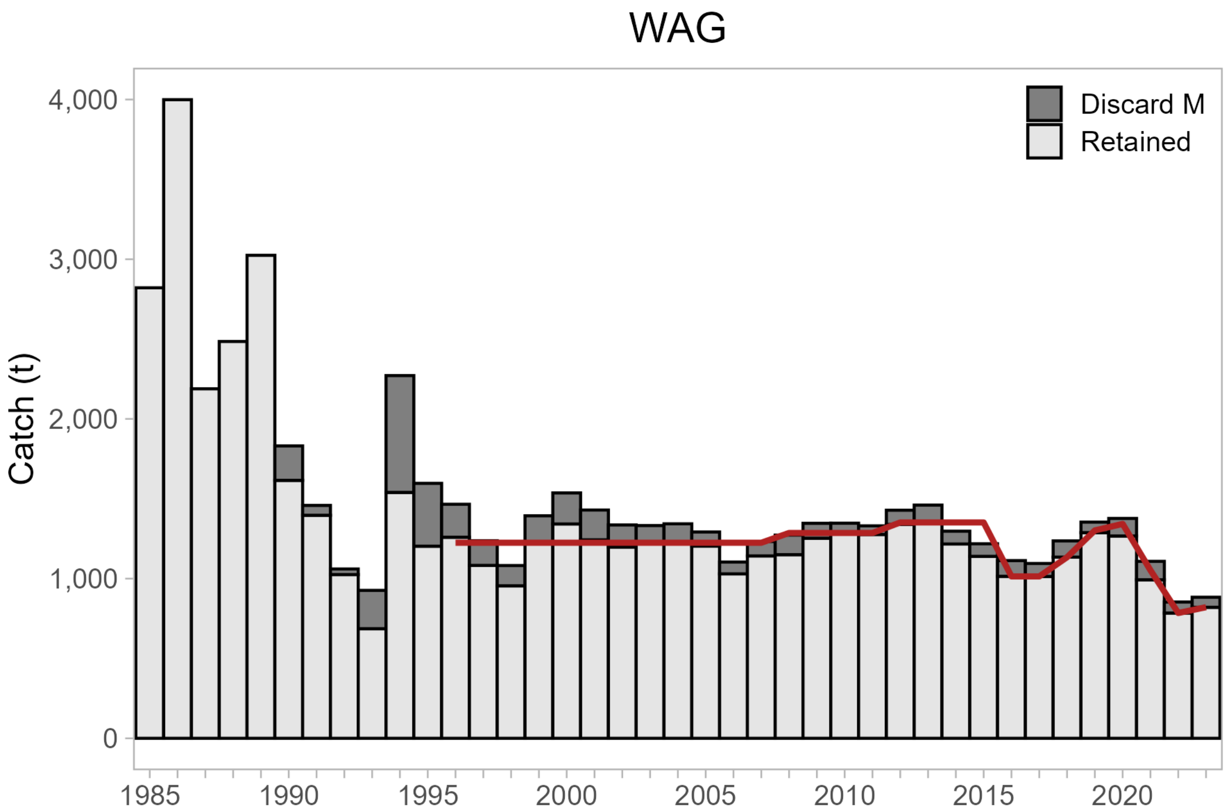

Figure 5: Time series of retained catch (t), directed fishery discard mortality (t), and the total allowable catch (t; red line) in the WAG. Catch in 2024/25 was not included due to data confidentiality.

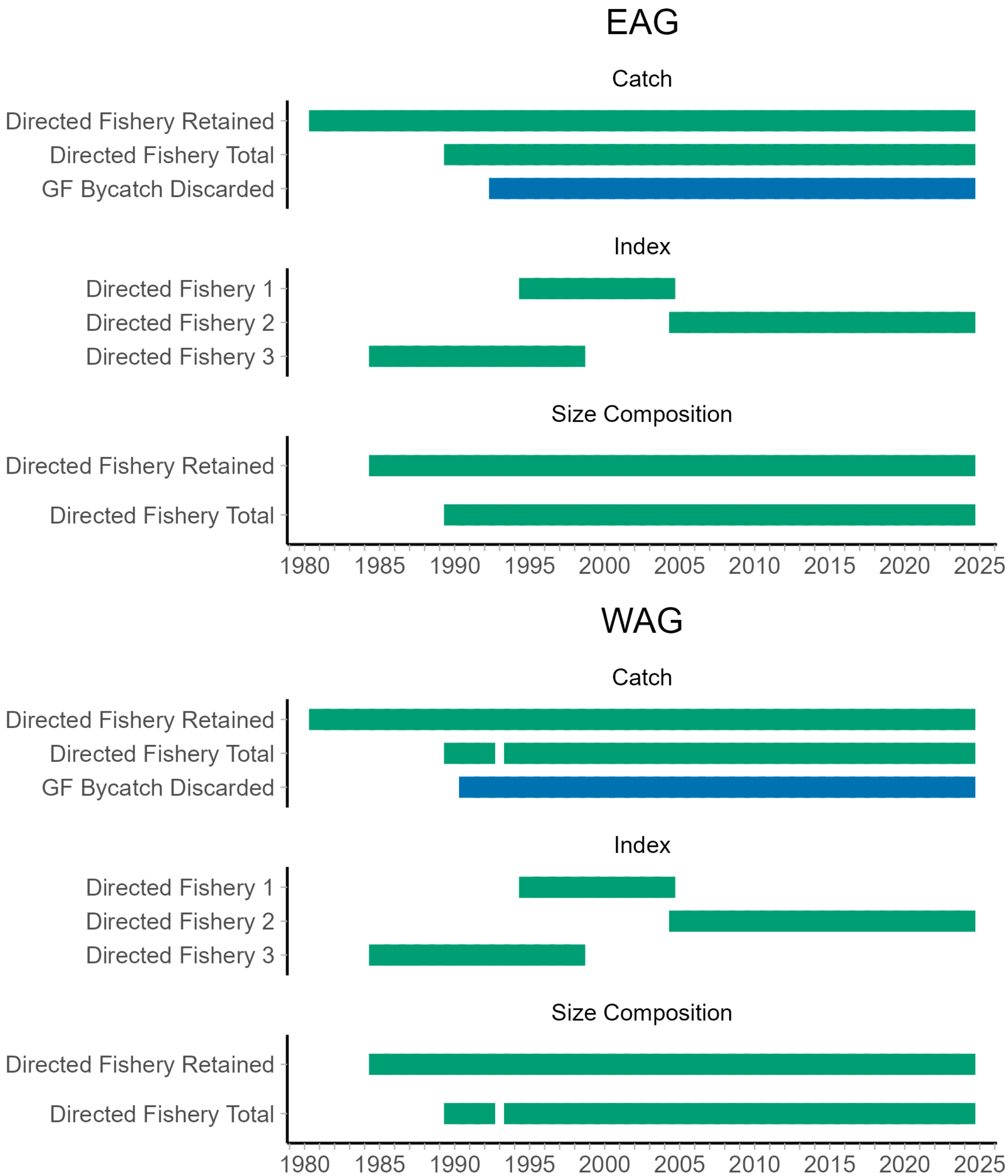

Figure 6: Data range by fleet for EAG and WAG models.

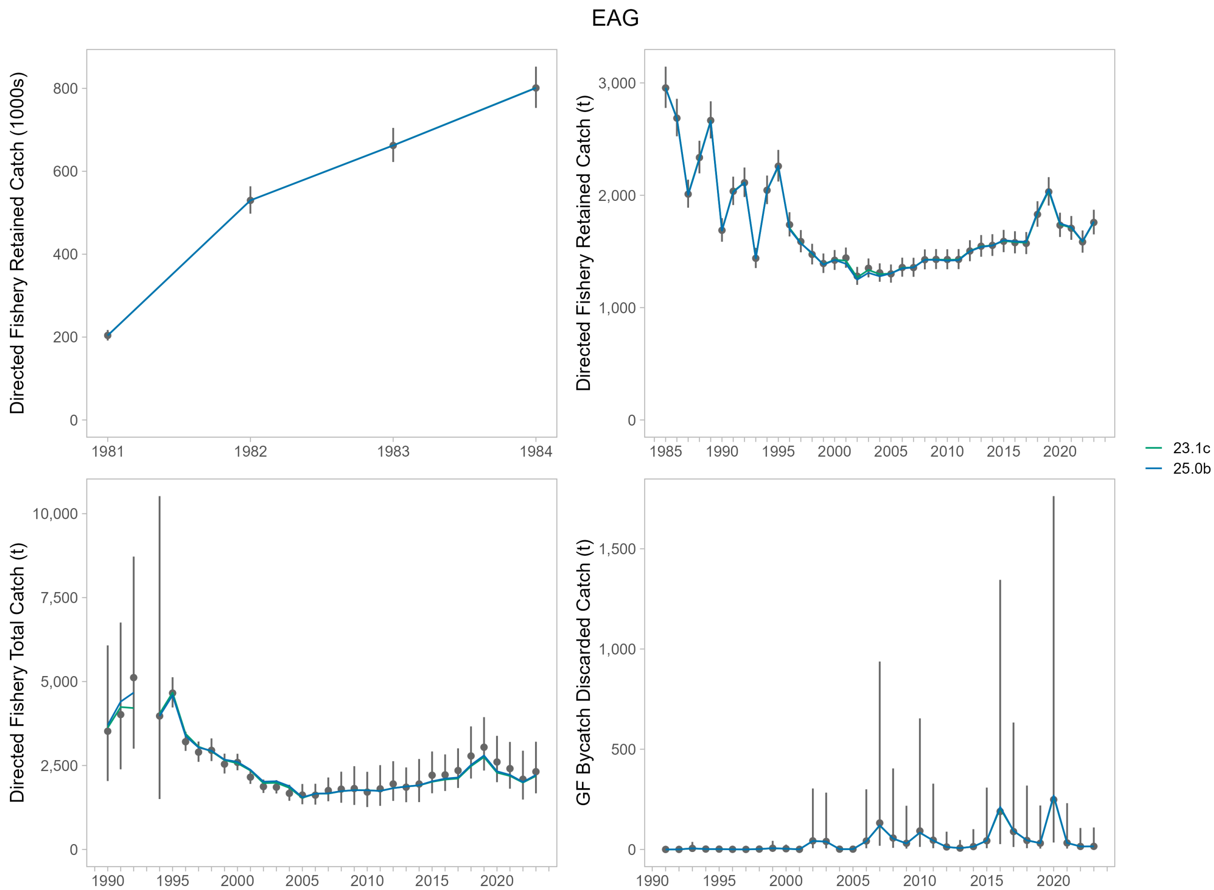

Figure 7: Comparison of model fit to retained catch, total catch, and groundfish bycatch for the EAG. Error bars on observed values represent 95% confidence intervals. Catch in 2024/25 was not included due to data confidentiality.

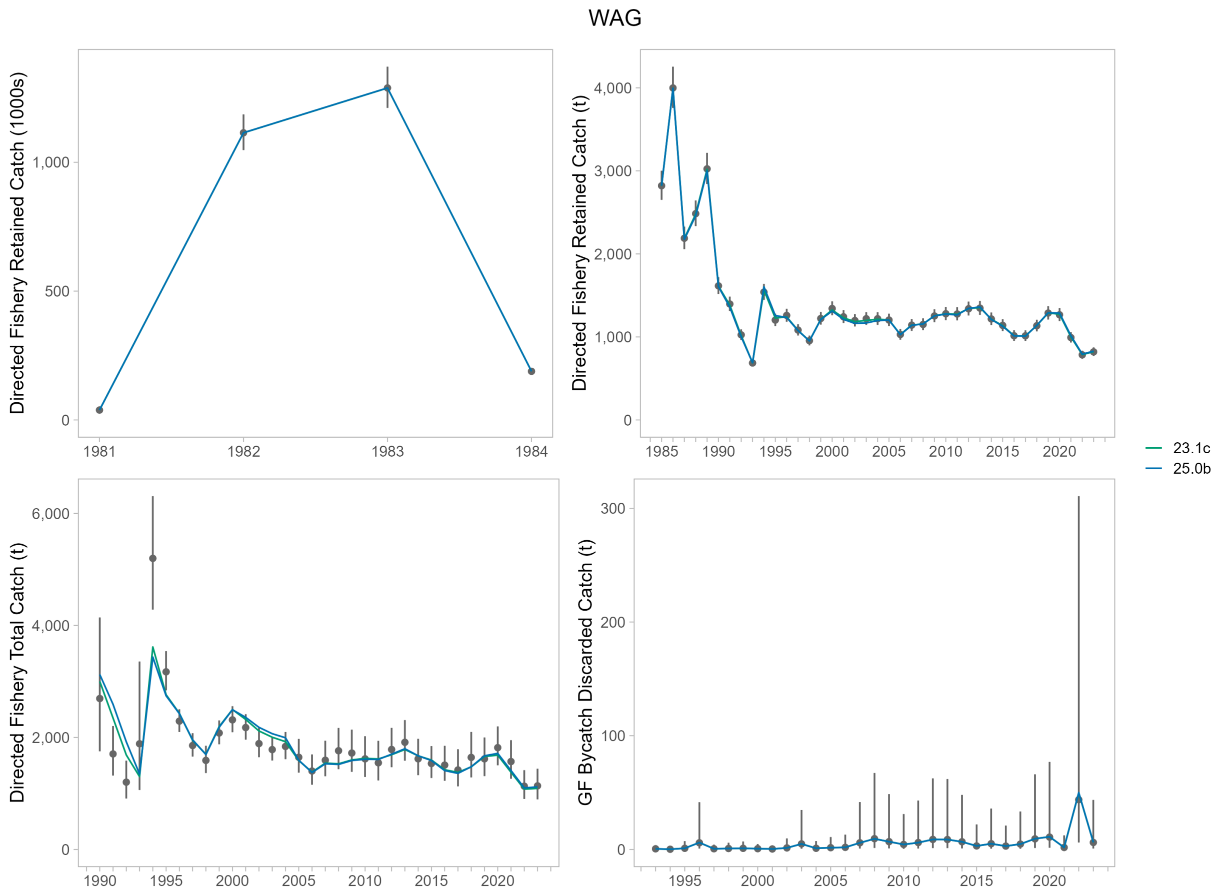

Figure 8: Comparison of model fit to retained catch, total catch, and groundfish bycatch for the WAG. Error bars on observed values represent 95% confidence intervals. Catch in 2024/25 was not included due to data confidentiality.

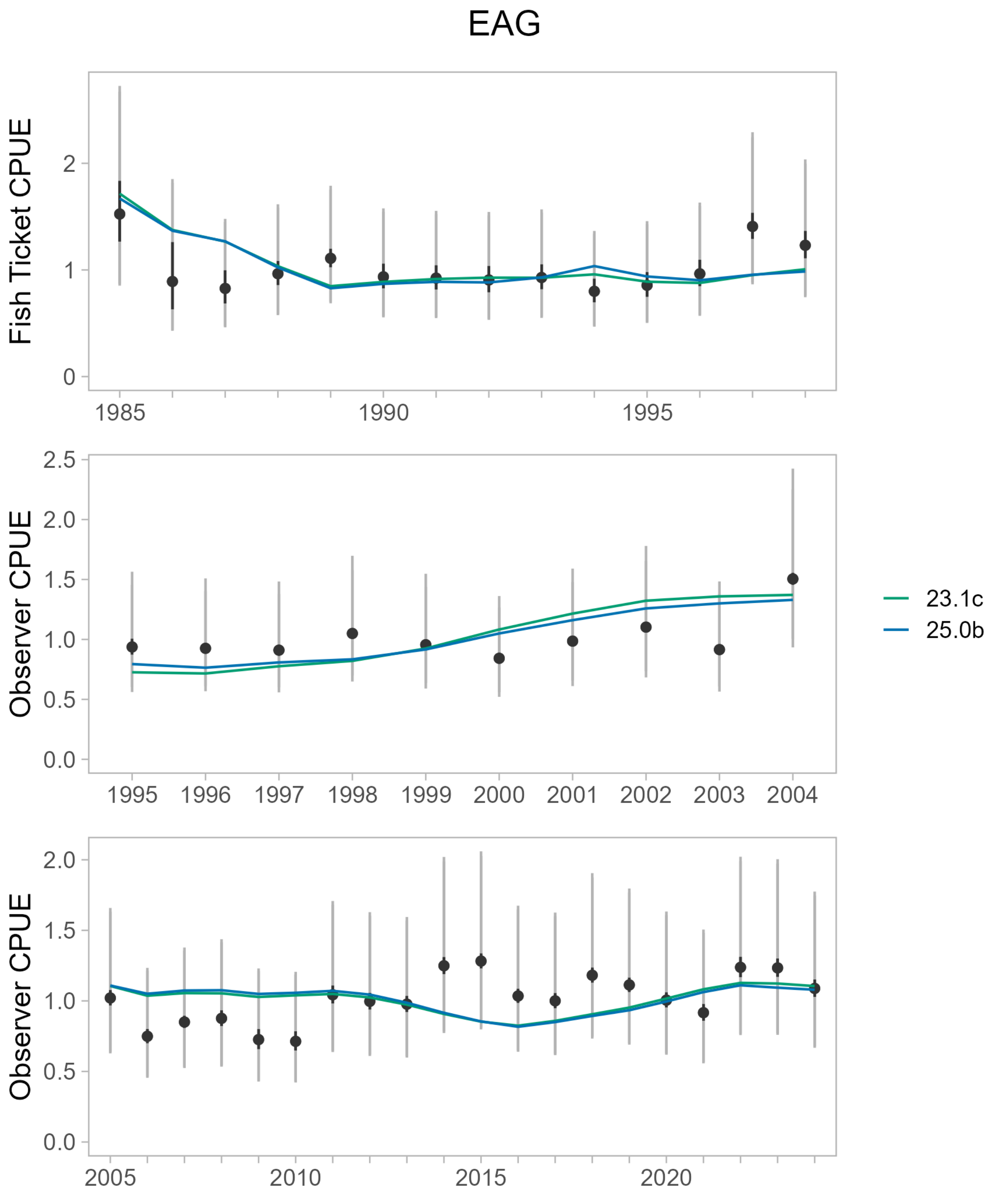

Figure 9: Comparison of model fit to CPUE indices for the EAG. Error bars on observed values represent 95% confidence intervals (black) and estimated additional error (grey).

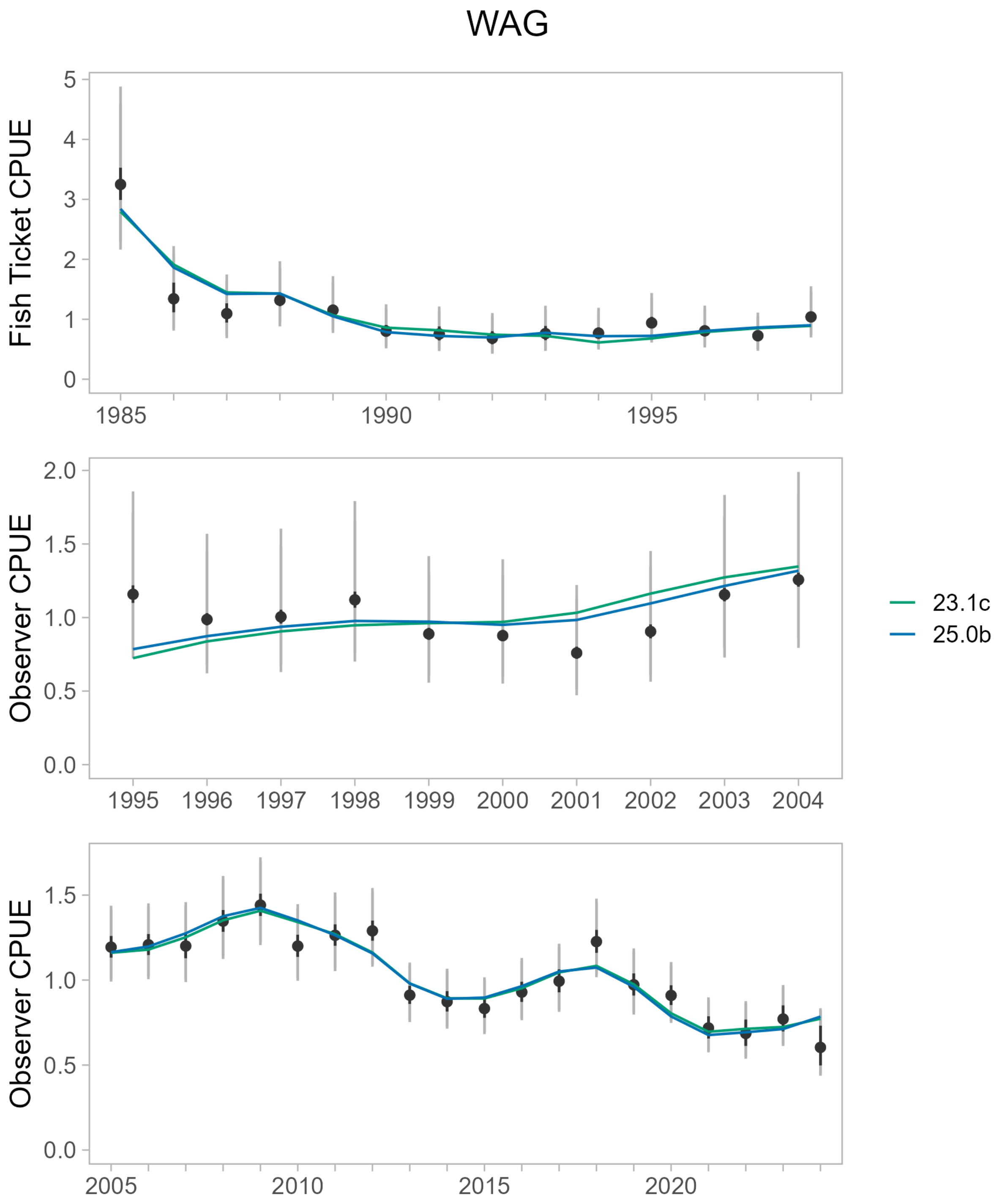

Figure 10: Comparison of model fit to CPUE indices for the WAG. Error bars on observed values represent 95% confidence intervals (black) and estimated additional error (grey).

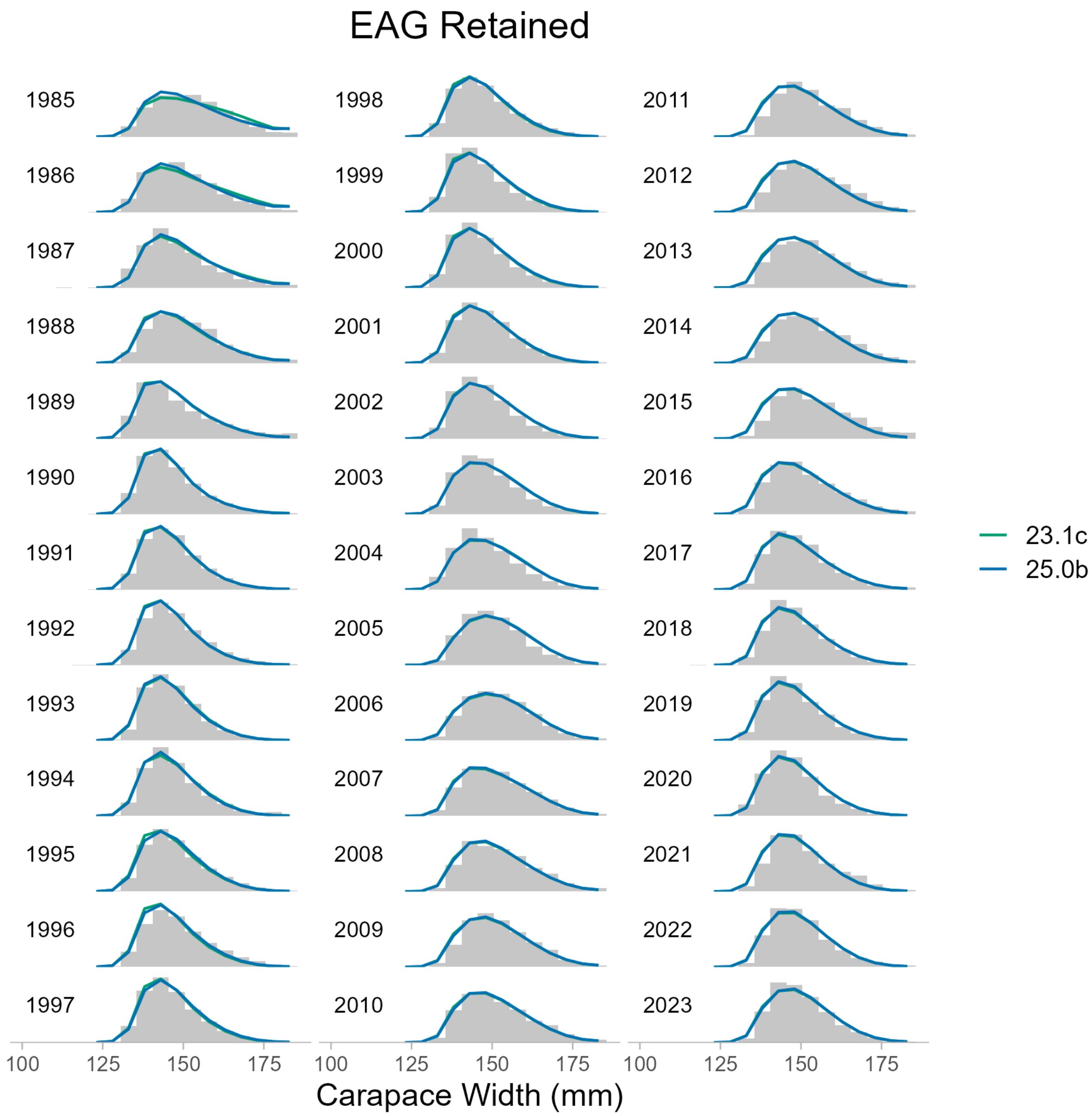

Figure 11: Comparison of model fit to retained catch size composition in the EAG. Composition data in 2024/25 is not included due to data confidentiality.

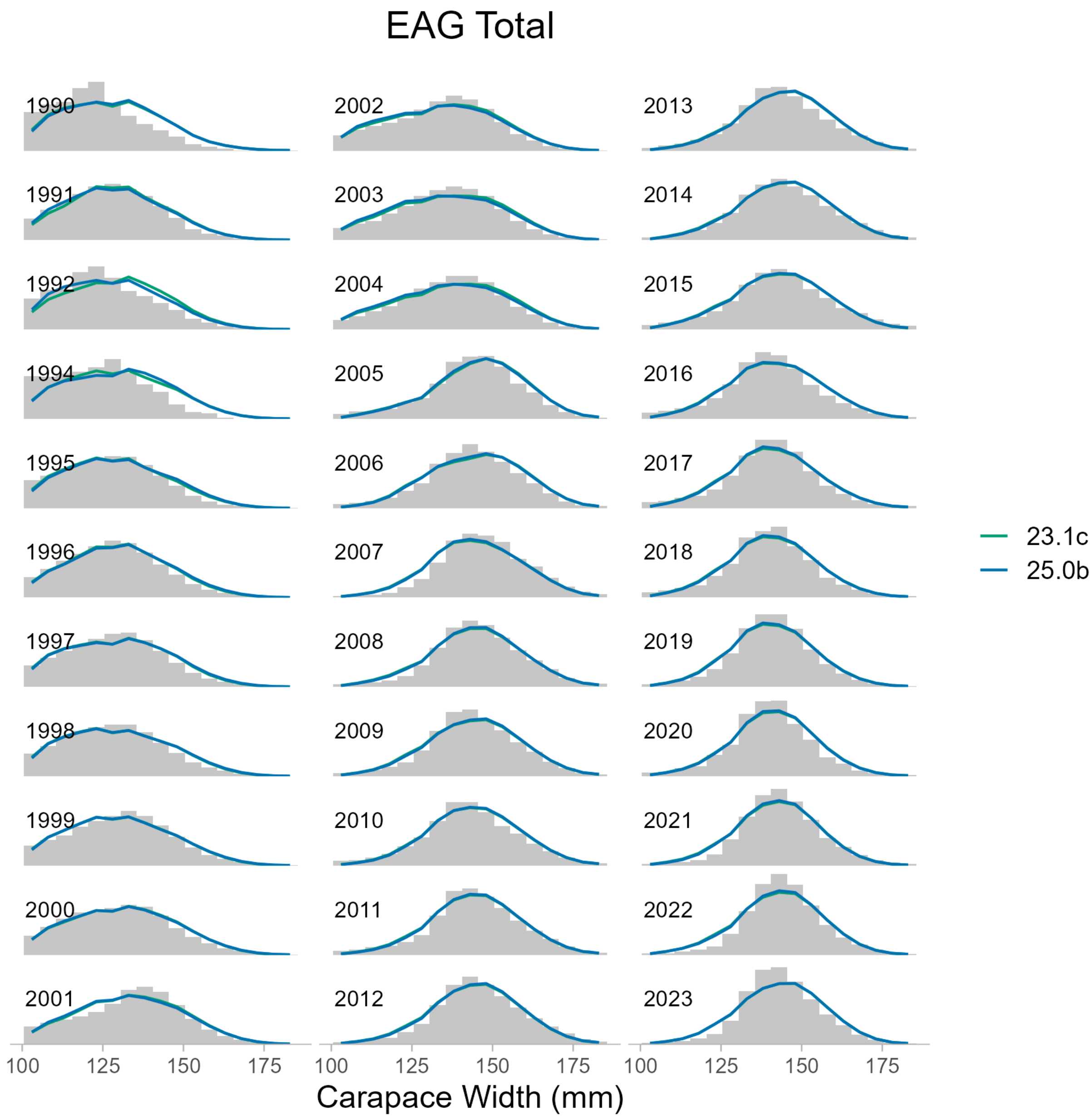

Figure 12: Comparison of model fit to total catch size composition in the EAG. Composition data in 2024/25 is not included due to data confidentiality.

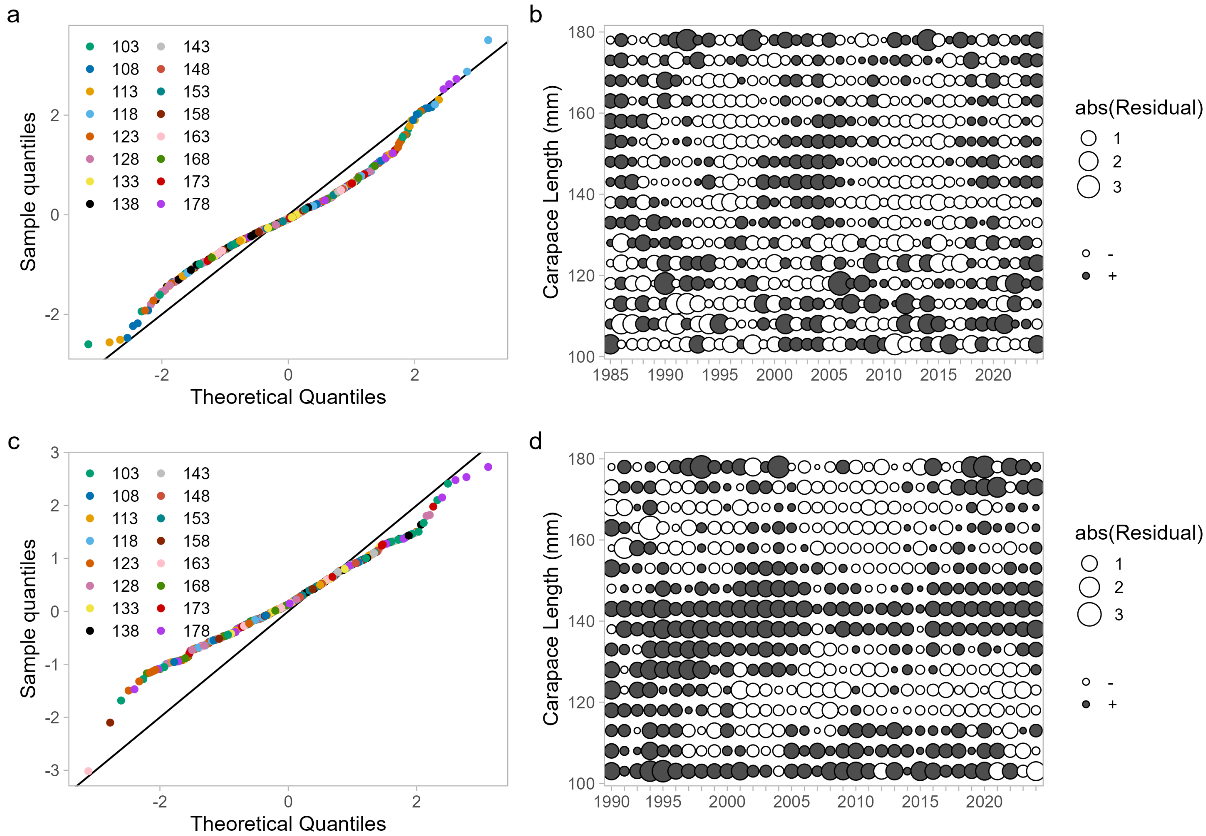

Figure 13: QQ plots and bubble plots for one step ahead residuals for fits to retained (a, b) and total (c, d) size composition data in model EAG 23.1c.

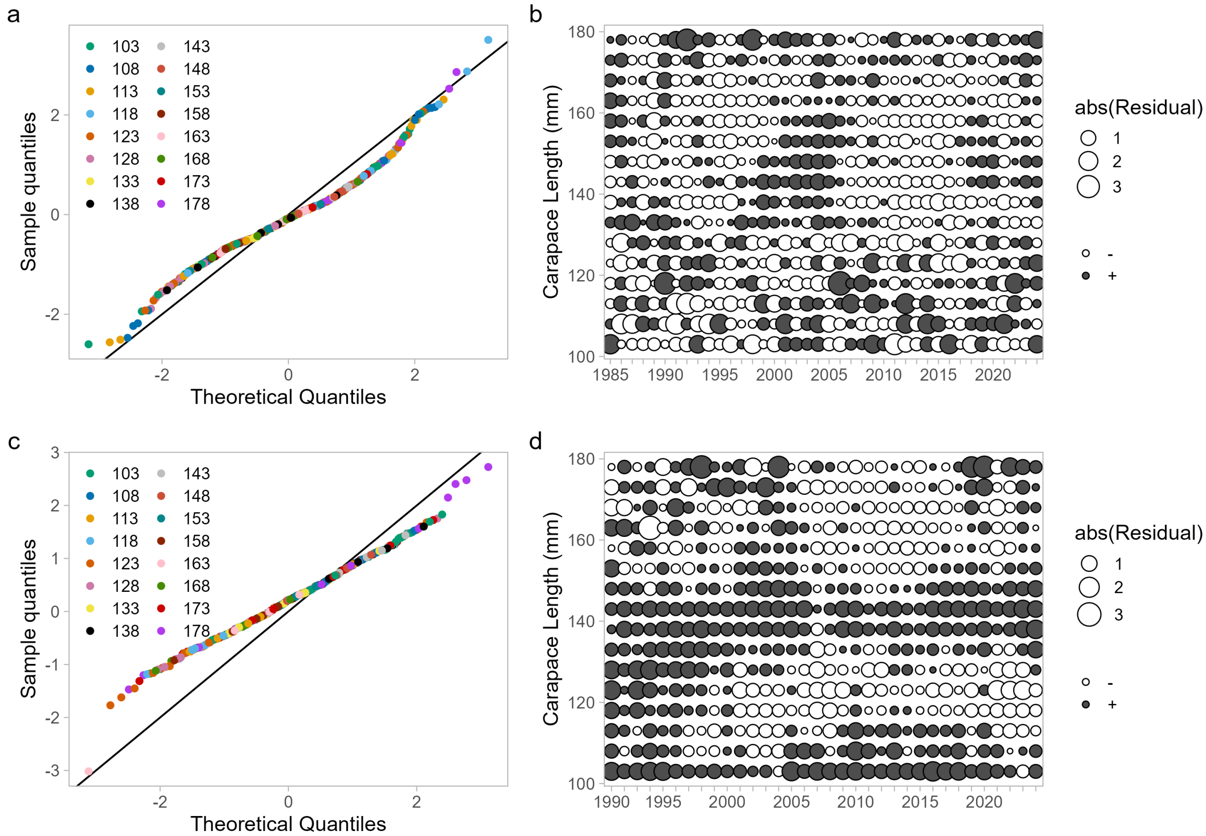

Figure 14: QQ plots and bubble plots for one step ahead residuals for fits to retained (a, b) and total (c, d) size composition data in model EAG 25.0b.

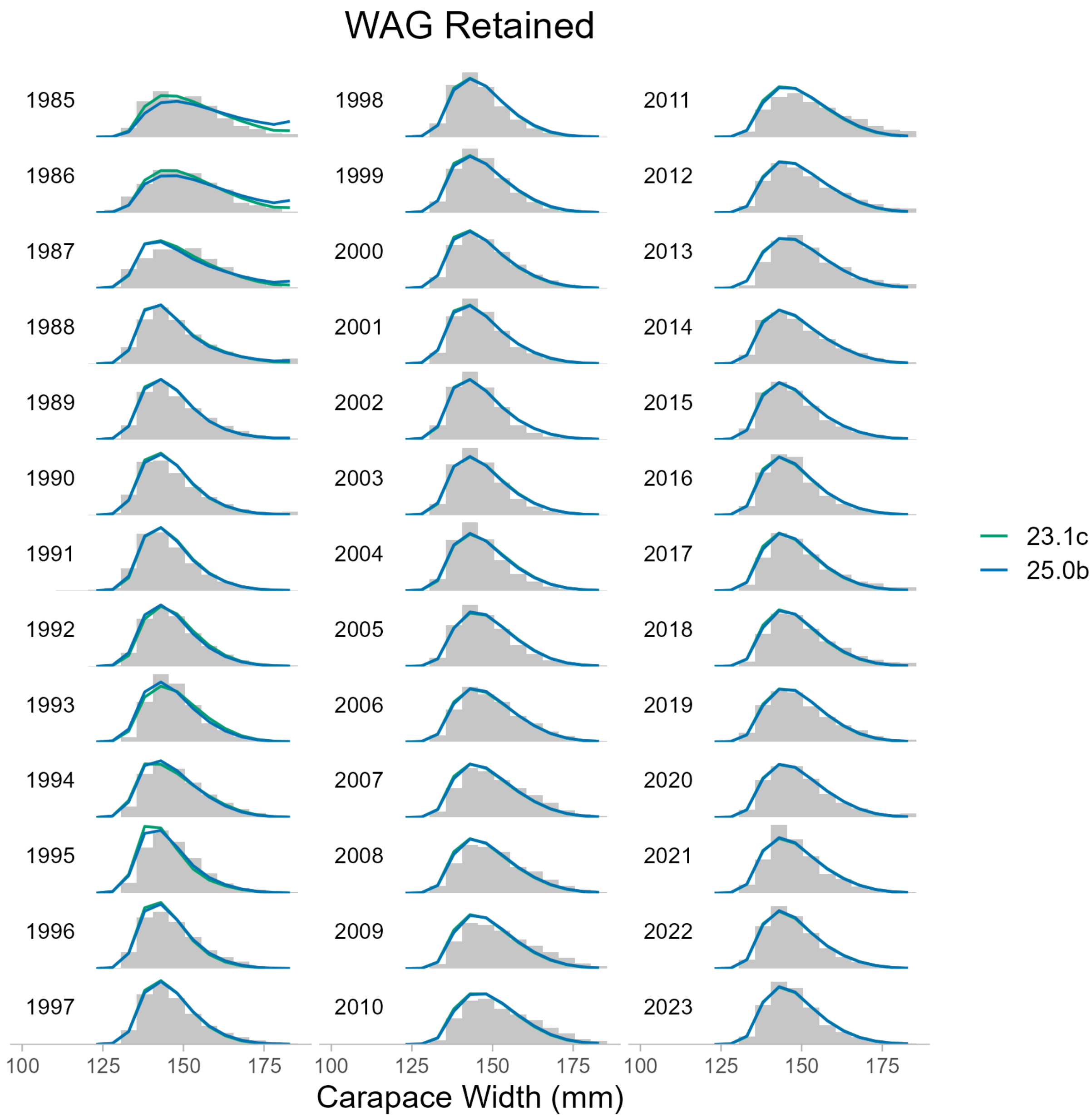

Figure 15: Comparison of model fit to retained catch size composition in the WAG. Composition data in 2024/25 is not included due to data confidentiality.

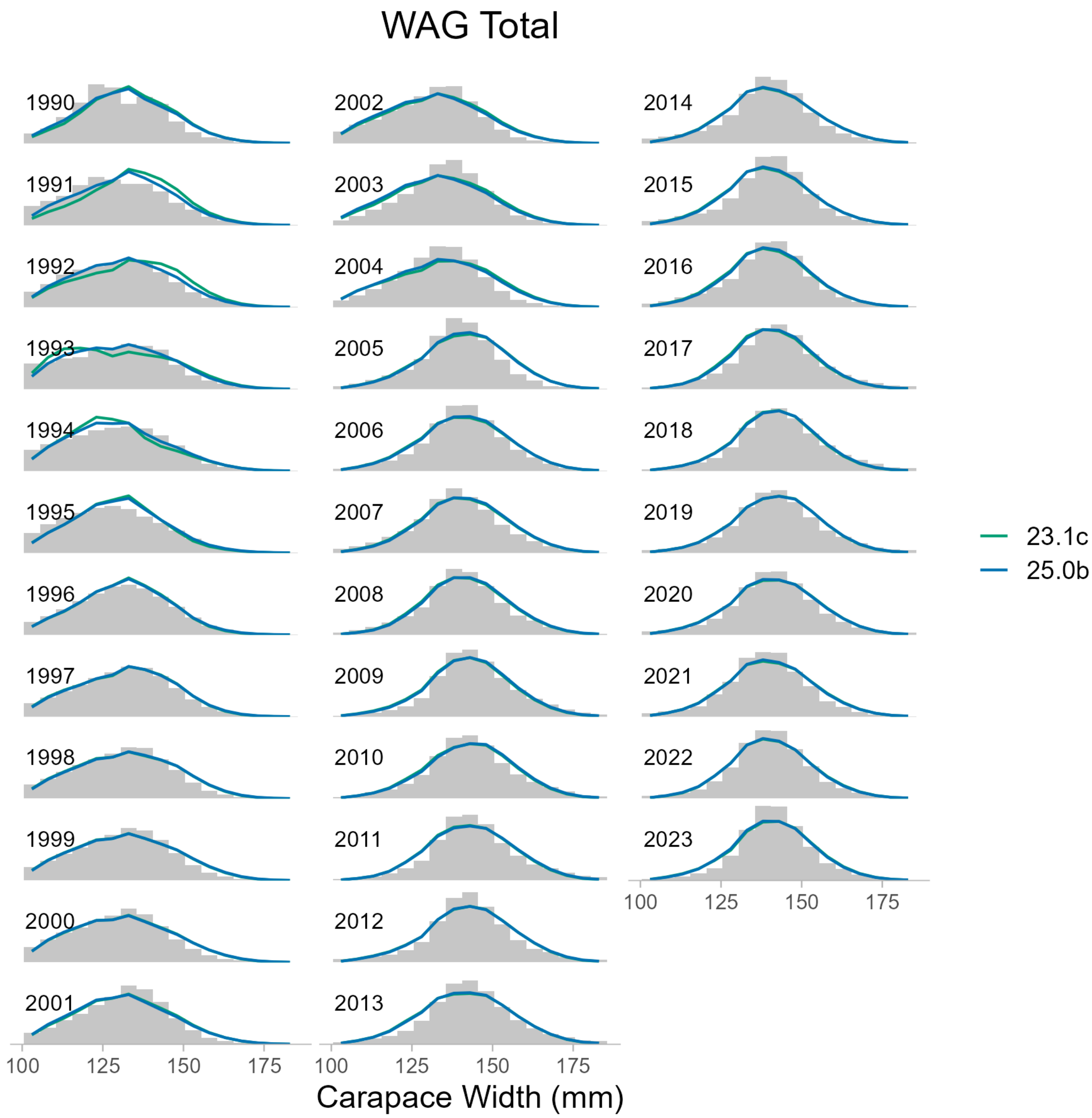

Figure 16: Comparison of model fit to total catch size composition in the WAG. Composition data in 2024/25 is not included due to data confidentiality.

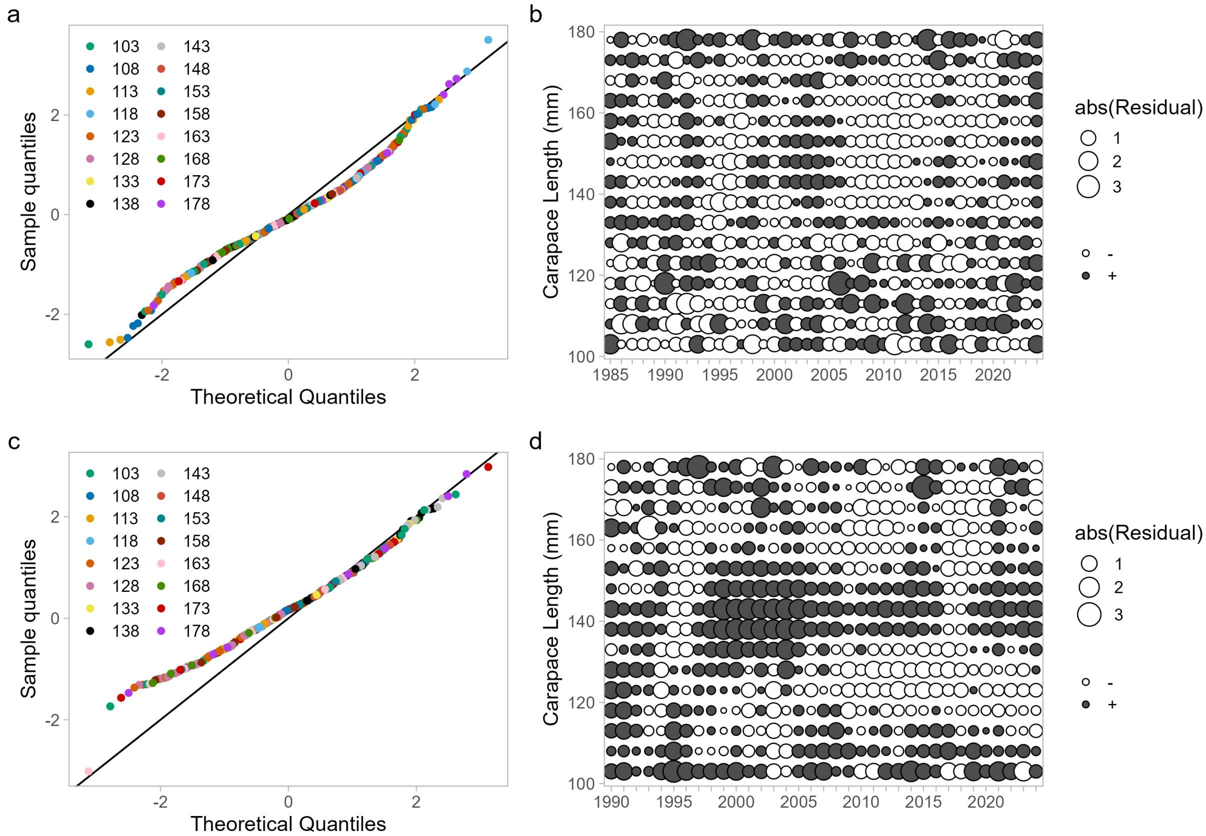

Figure 17: QQ plots and bubble plots for one step ahead residuals for fits to retained (a, b) and total (c, d) size composition data in model WAG 23.1c.

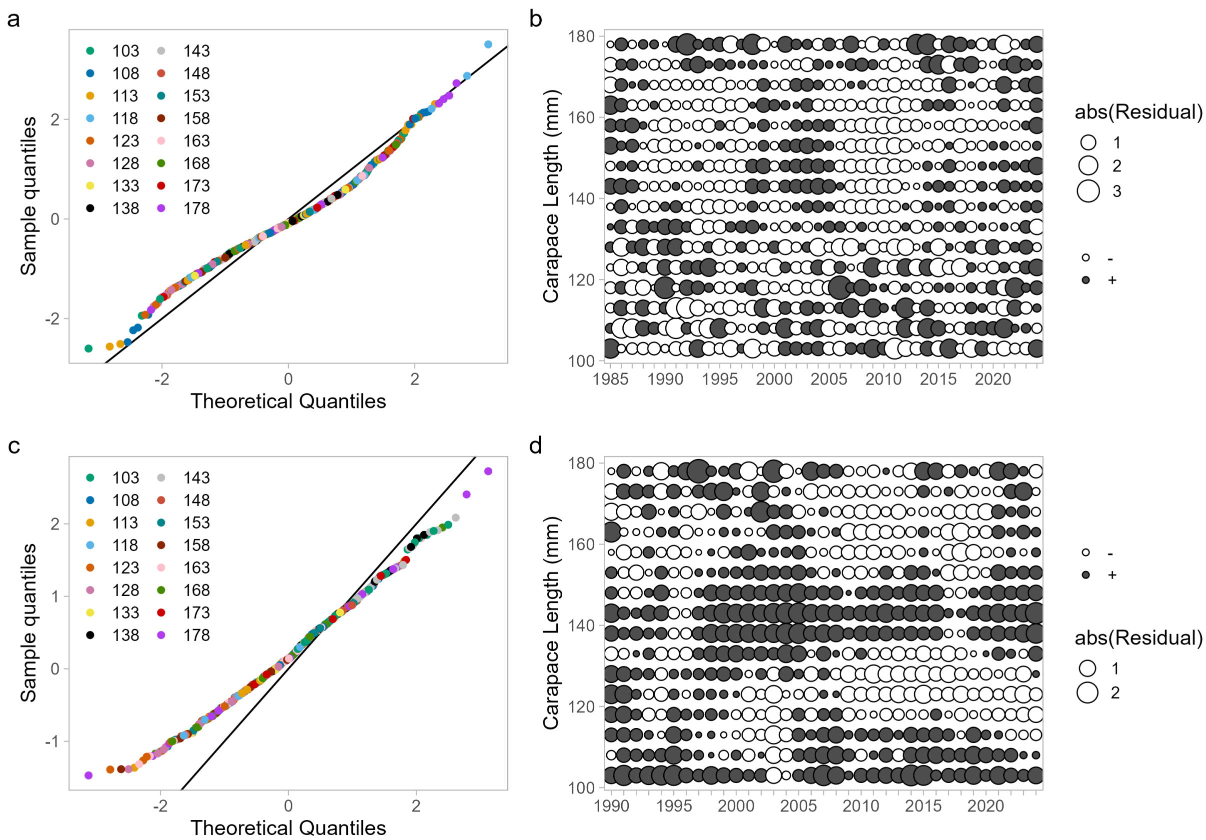

Figure 18: QQ plots and bubble plots for one step ahead residuals for fits to retained (a, b) and total (c, d) size composition data in model WAG 25.0b.

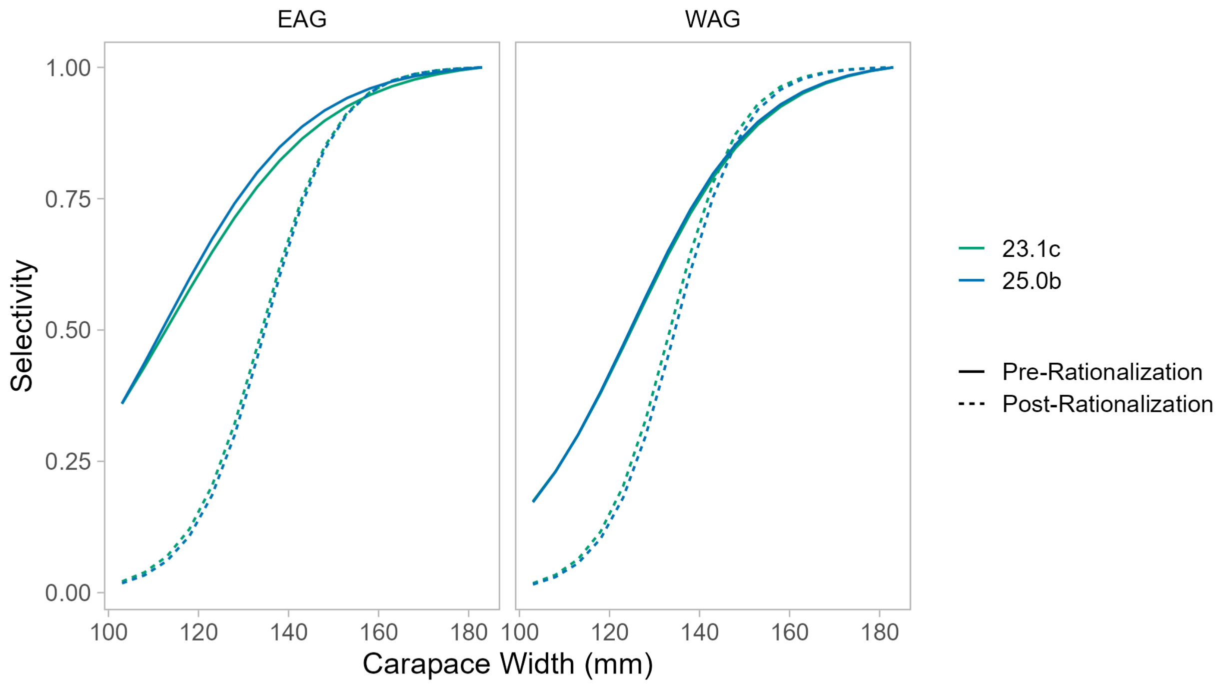

Figure 19: Comparison of estimated selectivity for the directed fishery during pre- and post-rationalized eras for models 23.1c and 25.0b.

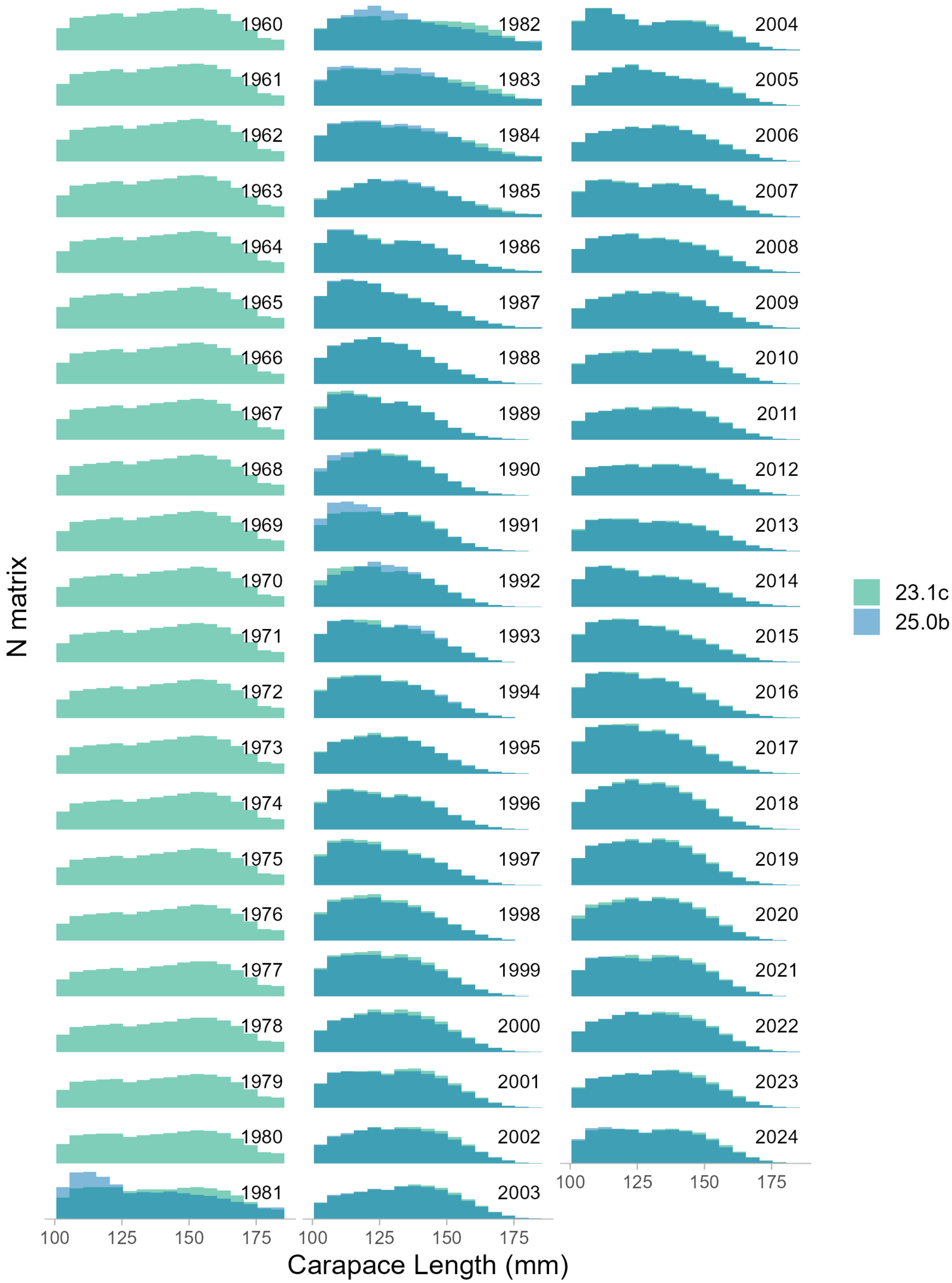

Figure 20: End of year numbers at size for EAG models 23.1c and 25.0b.

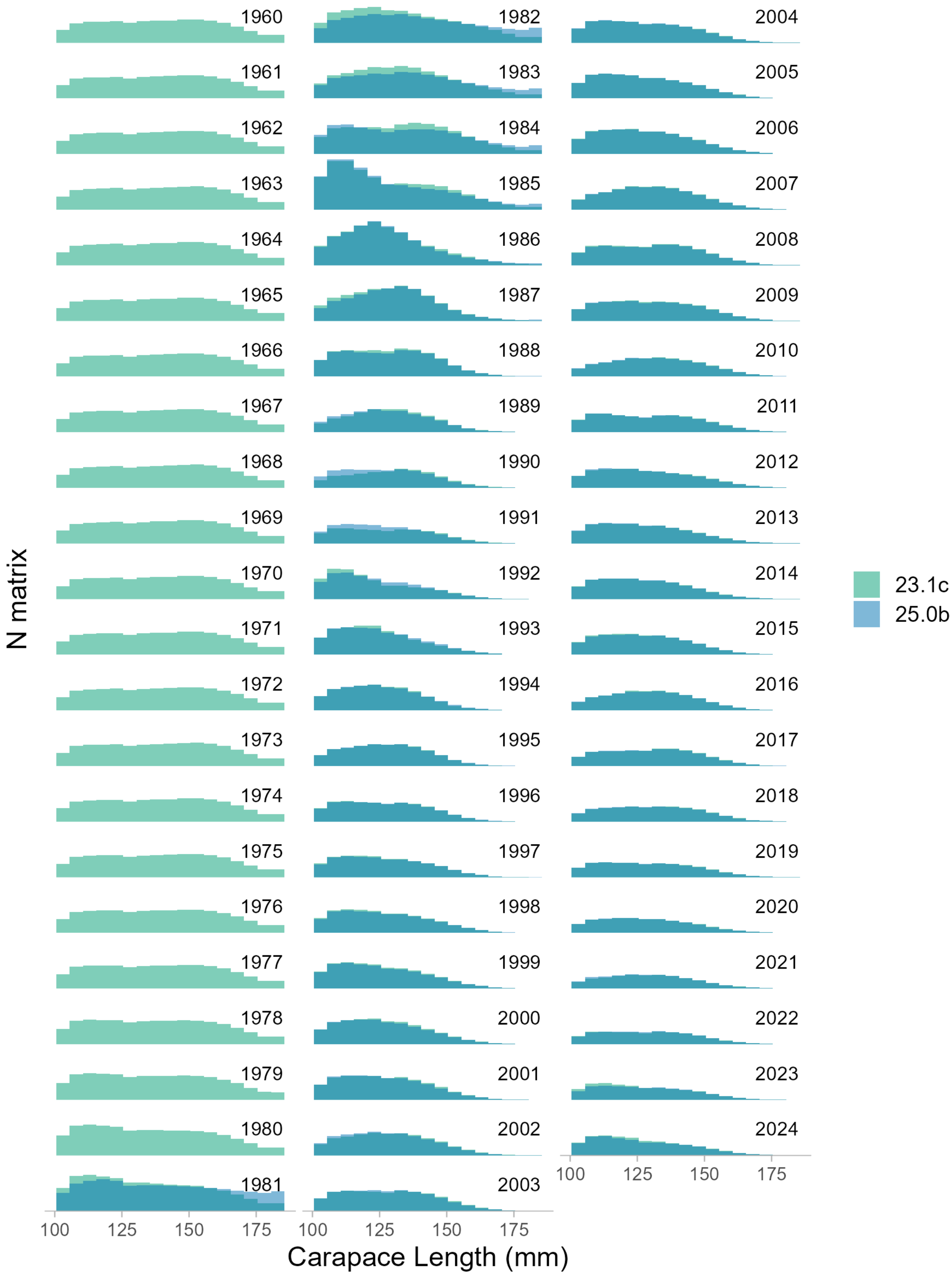

Figure 21: End of year numbers at size for WAG models 23.1c and 25.0b.

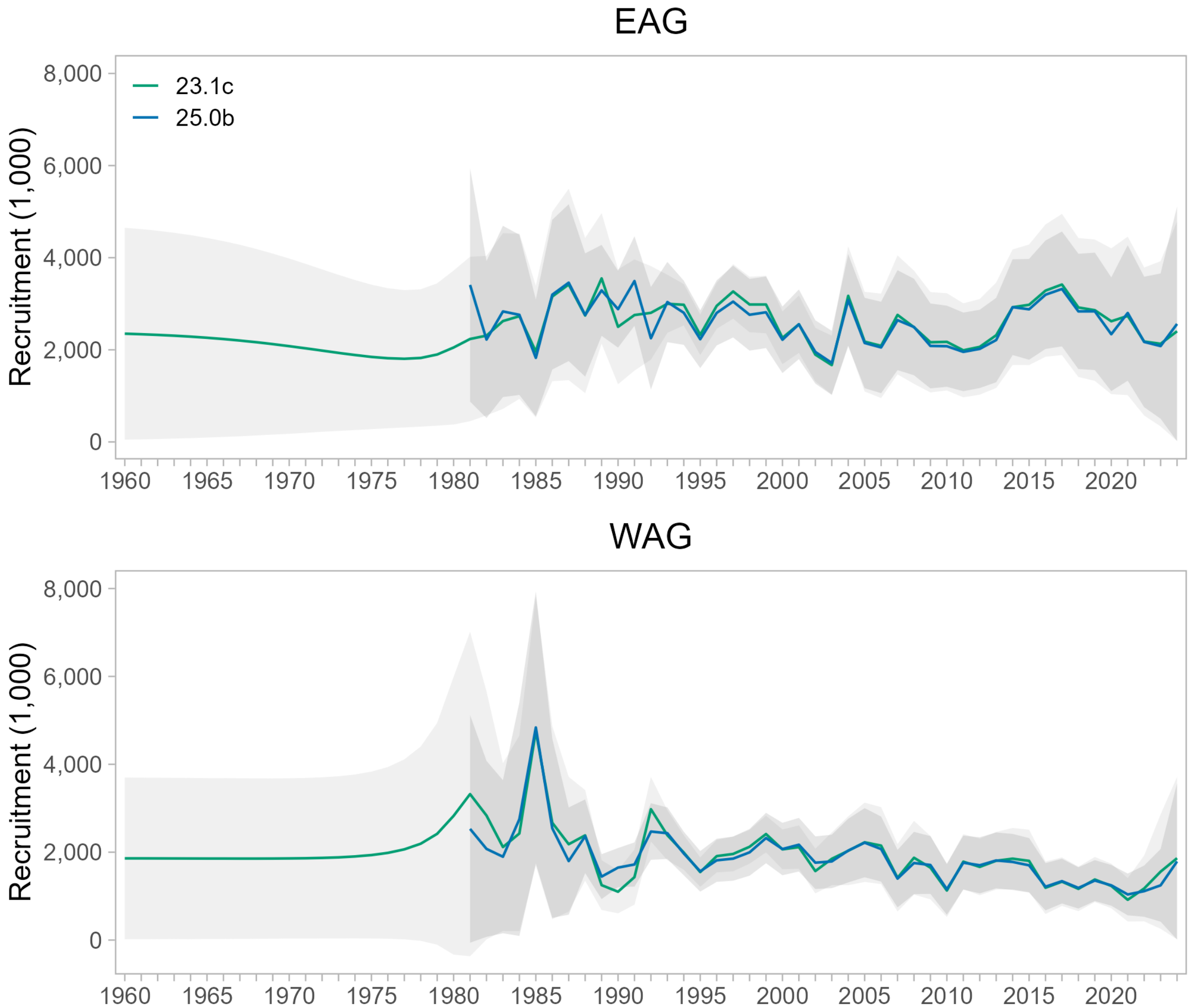

Figure 22: Comparison of model estimated recruitment and associated 95% CI for models 23.1c (green / light grey) and 25.0b (blue / dark grey).

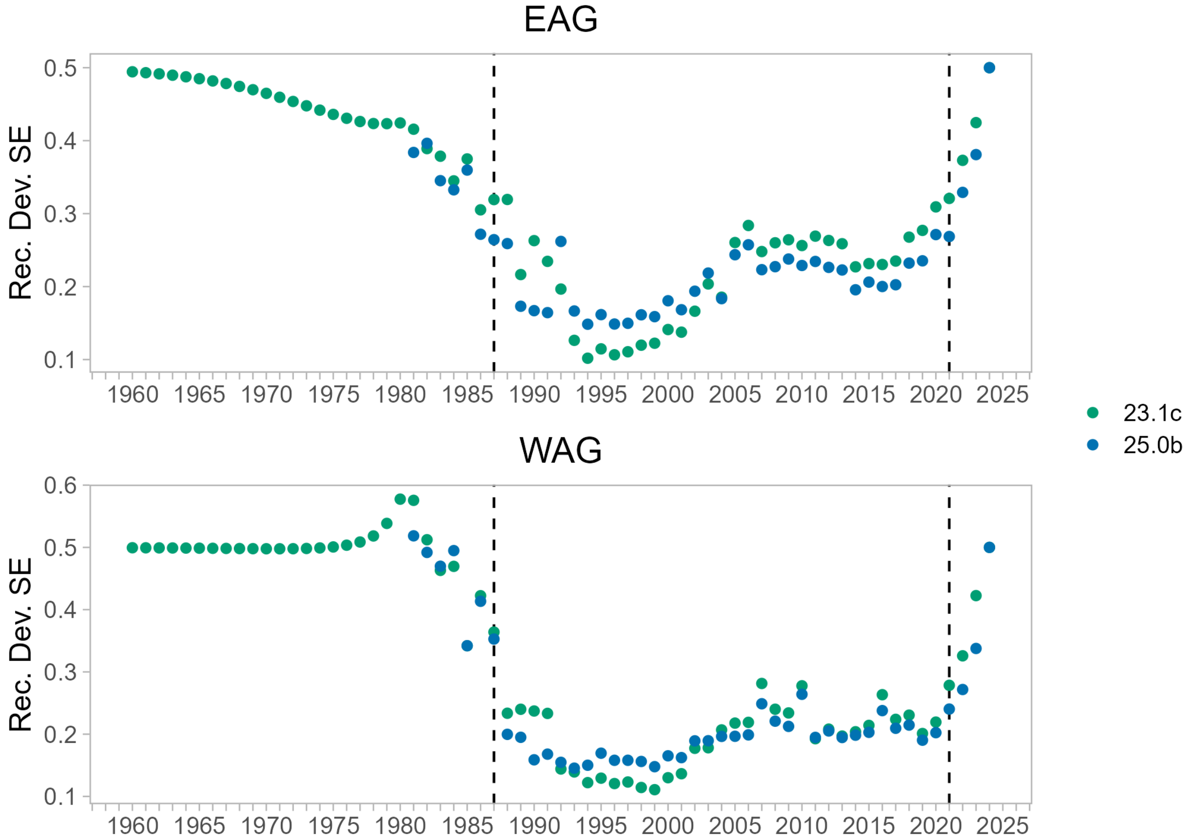

Figure 23: Standard errors of recruitment deviations for models 23.1c and 25.0b. Dotted lines indicate the reference time series for mean recruitment used in reference point calculation, 1987 - 2021.

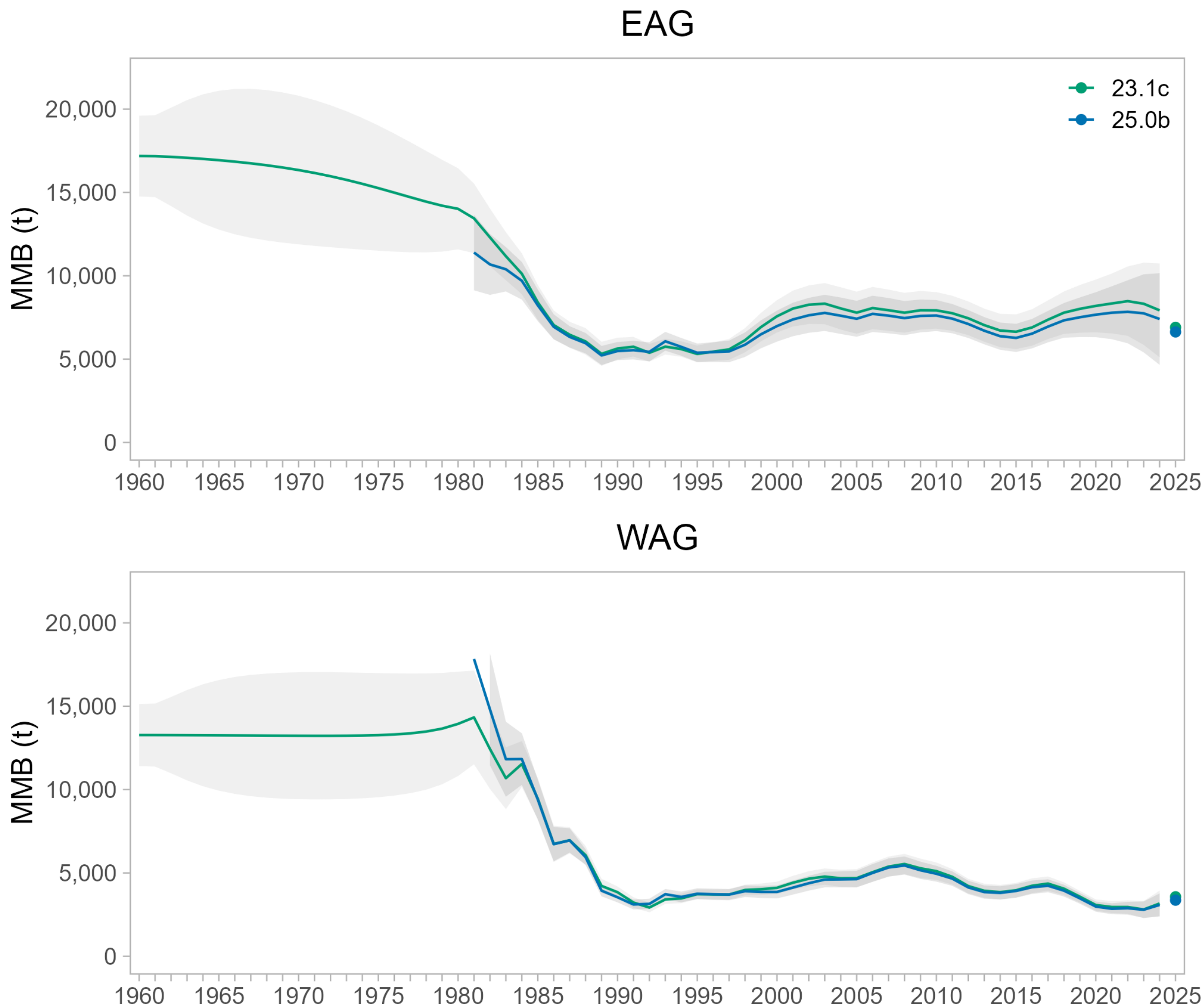

Figure 24: Comparison of model estimated MMB and associated 95% CI for models 23.1c (green / light grey) and 25.0b (blue / dark grey). Points indicate projected MMB for Feb 15, 2026.

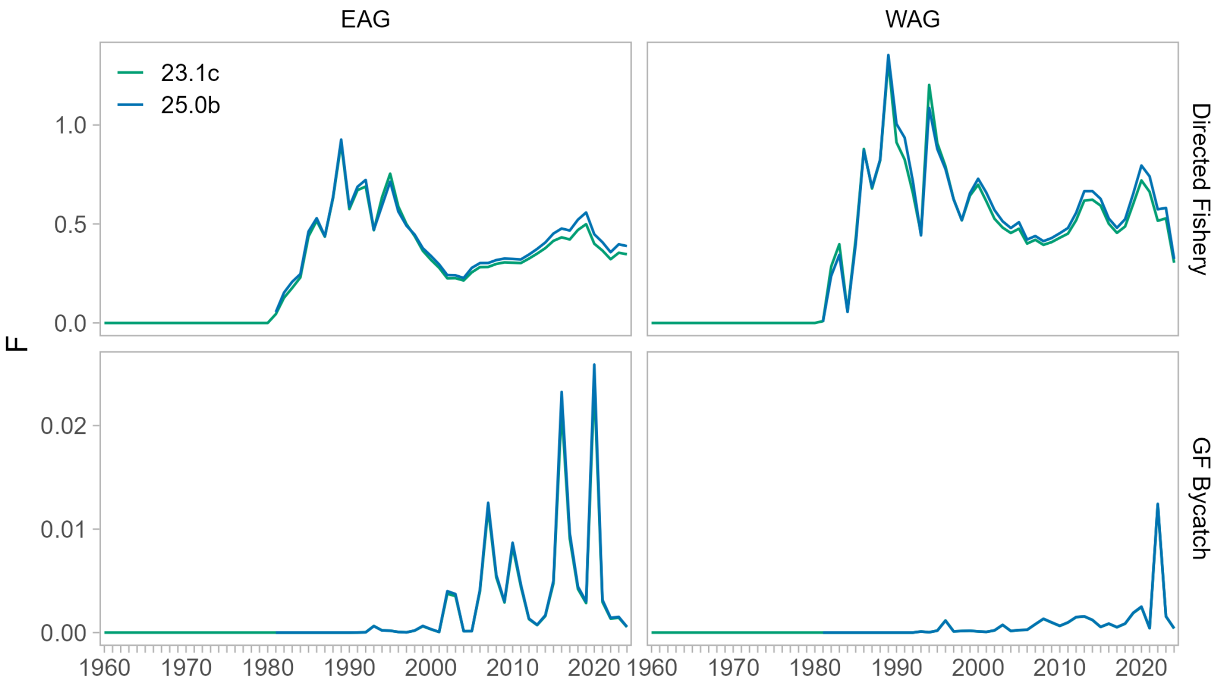

Figure 25: Comparison of model estimated fully selected fishing mortality for models 23.1c and 25.0b by fleet.

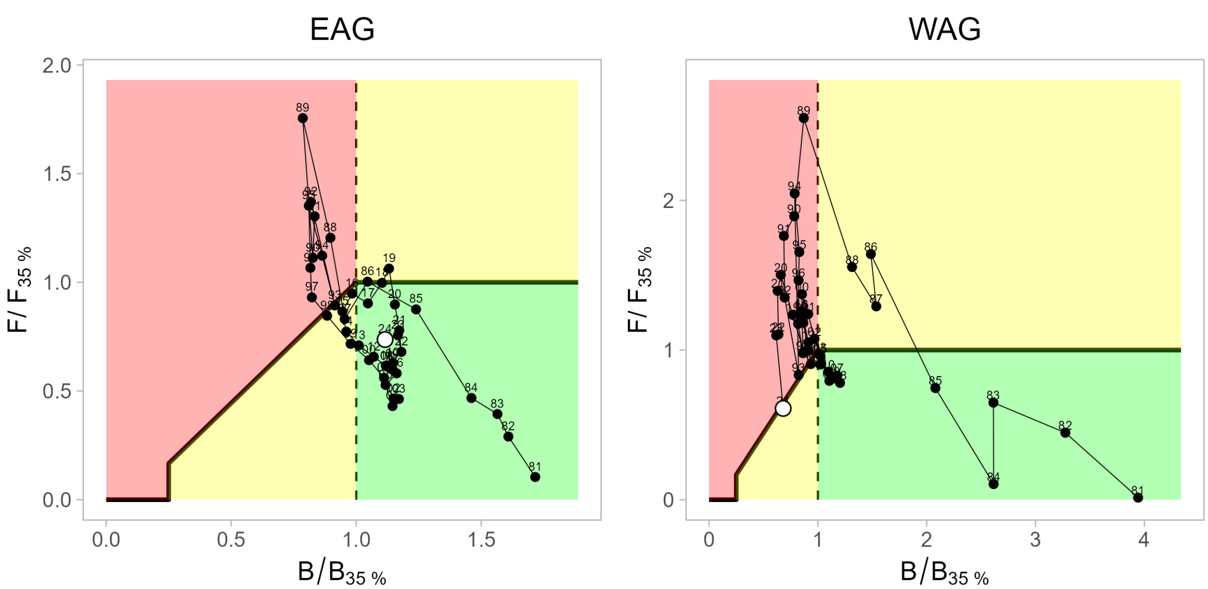

Figure 26: Kobe plots for models 25.0b. Bolded line indicates the tier 3 F_{OFL} control rule.

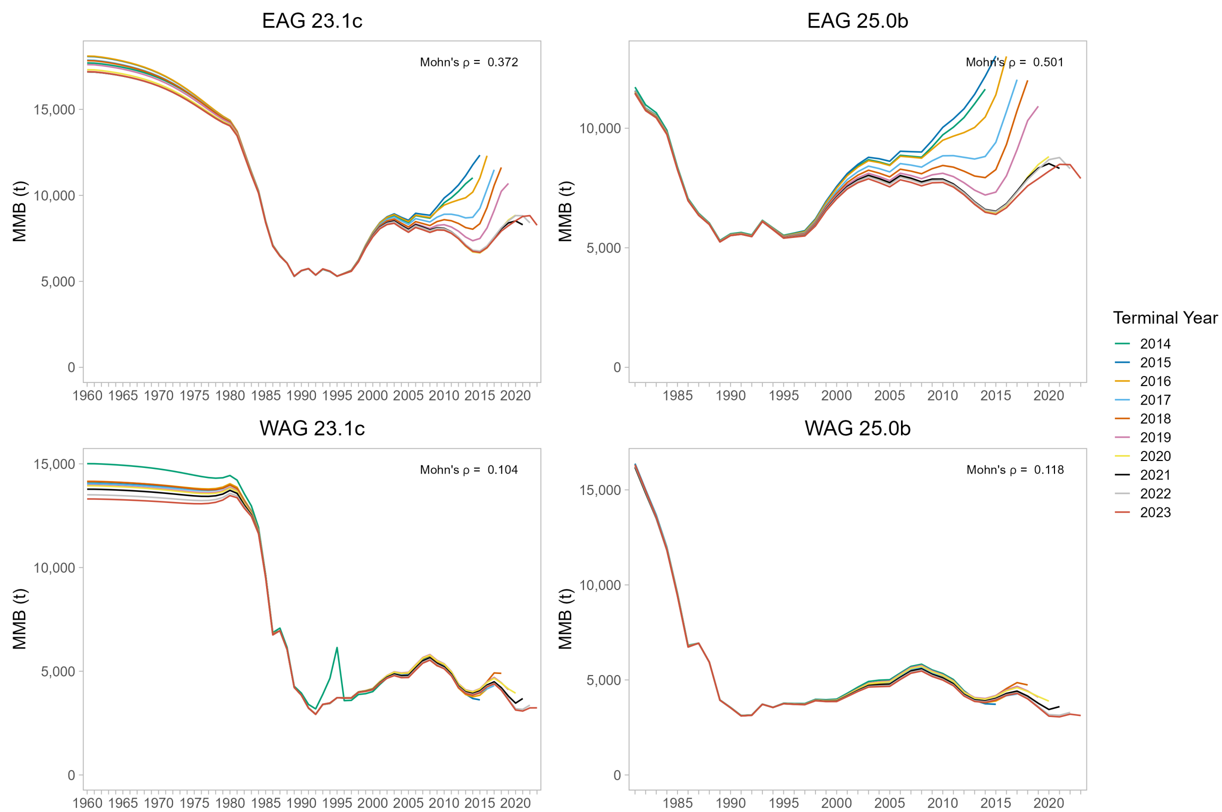

Figure 27: Estimated MMB and associtated Mohn's ρ from retrospective analyses of models 23.1c and 25.0b.

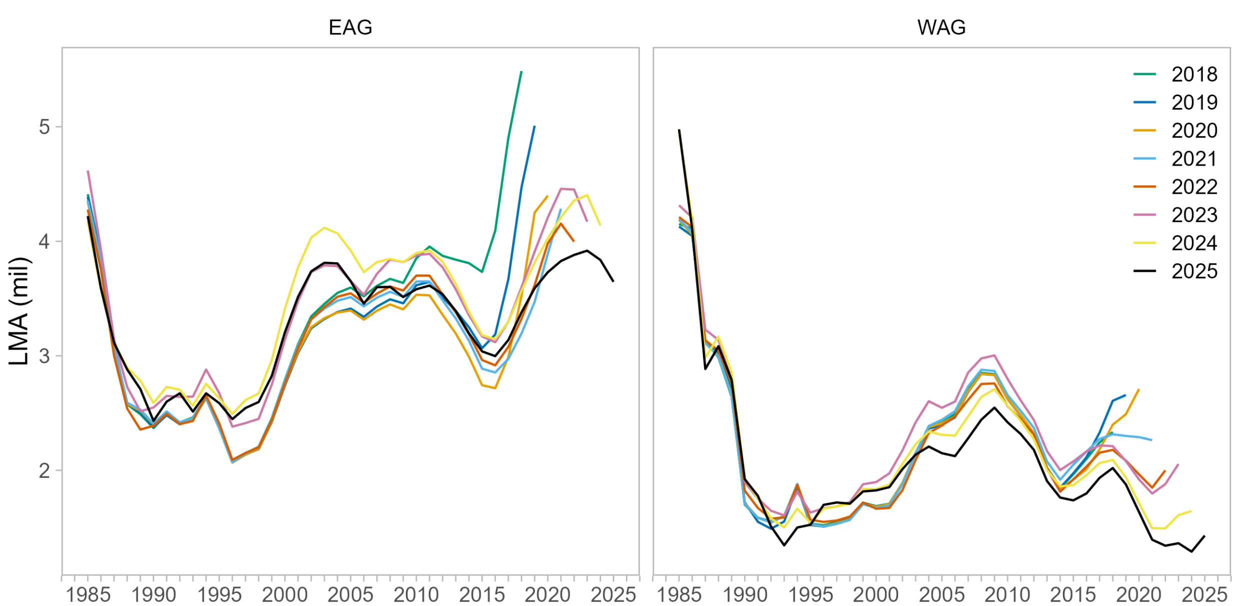

Figure 28: Estimated legal male abundance from 1985 - present by assessment year going back to 2018/19.

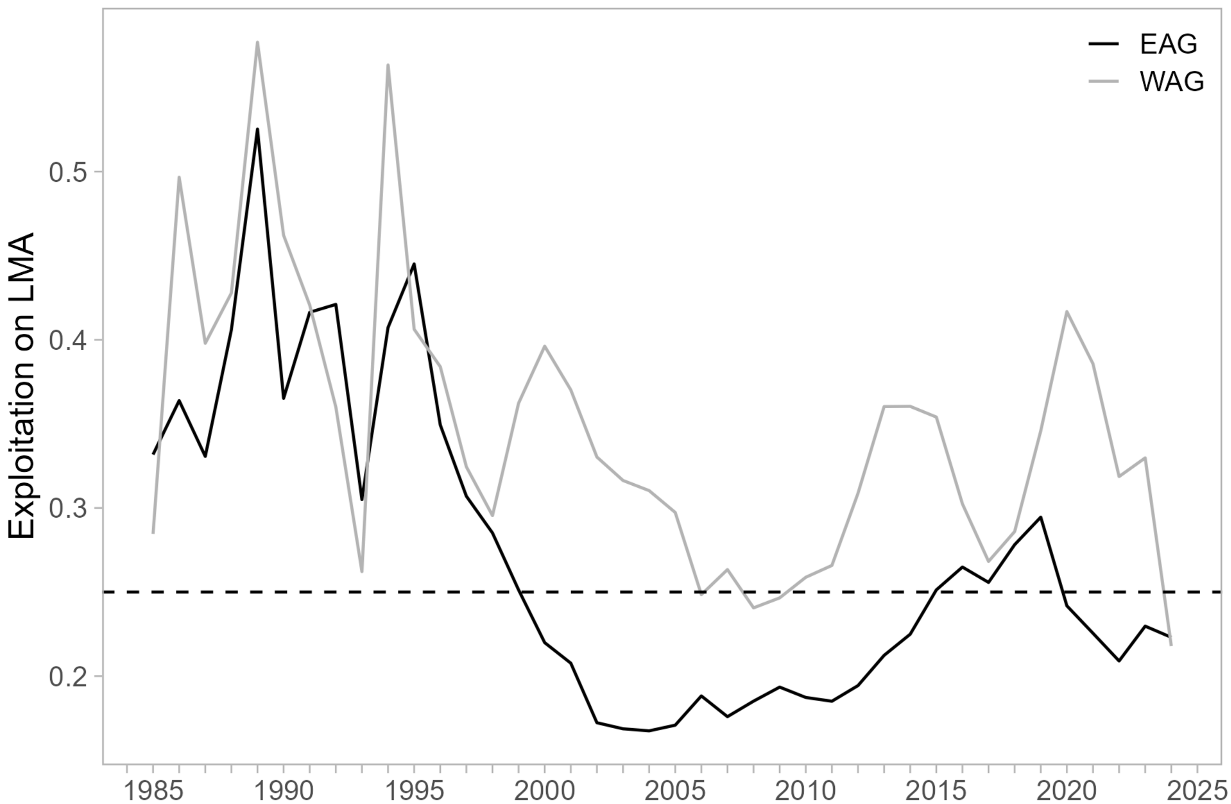

Figure 29: Realized exploitation rates based on legal male abundance from model 23.1c and retained catch in the EAG and WAG. The dotted line represents the 25% maximum cap on legal male abundance in the ADF&G harvest strategy.

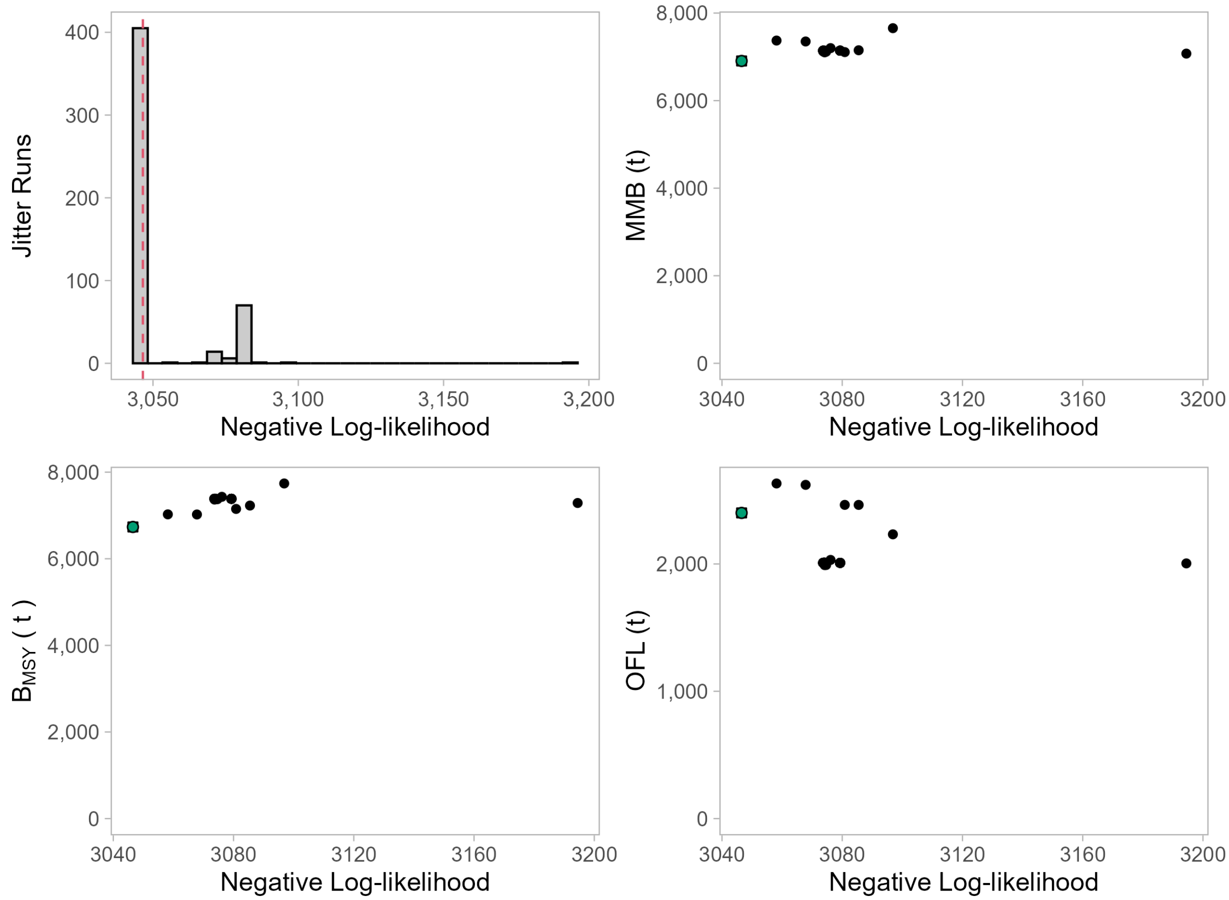

Figure 30: Distrubition of NLL, mature male biomass, and $B_{35\%}$ for 500 jitter runs of model EAG 23.1c.

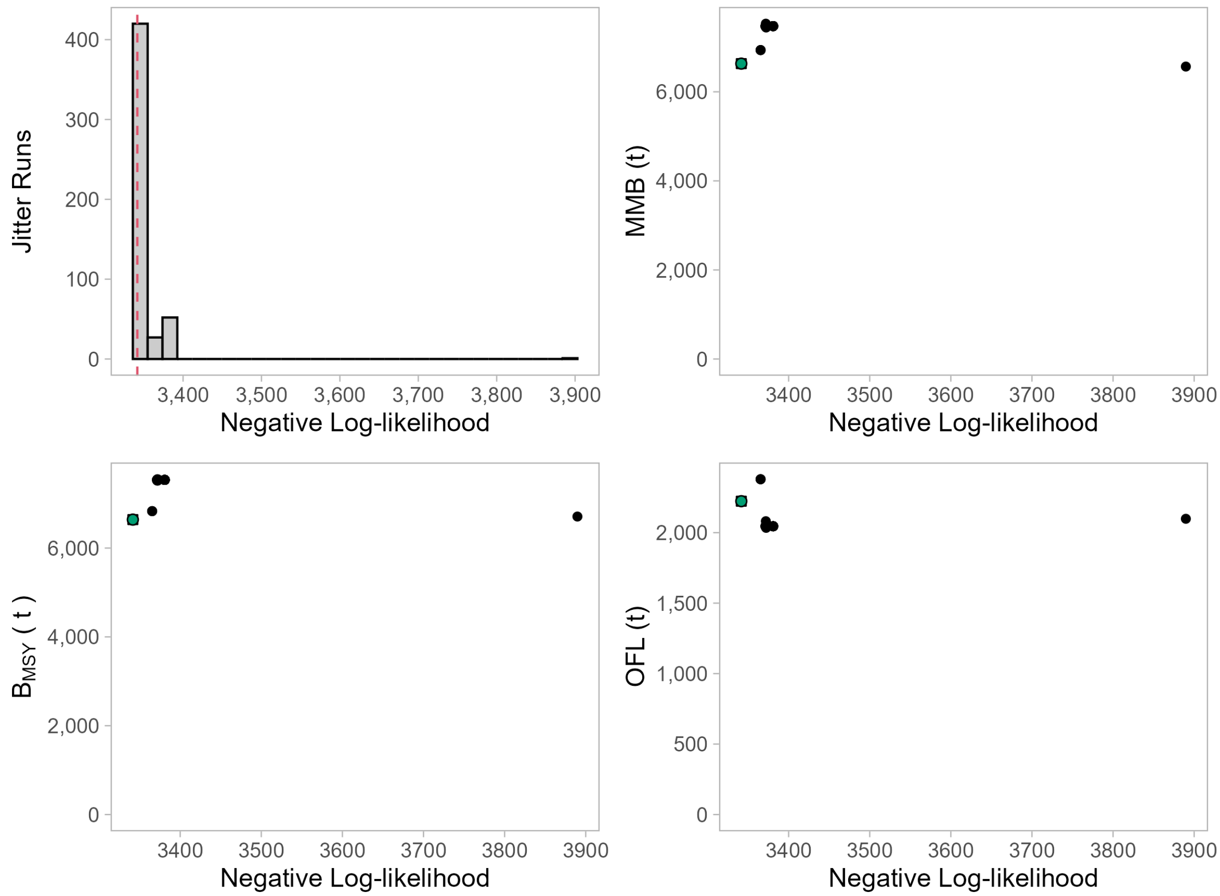

Figure 31: Distrubition of NLL, mature male biomass, and $B_{35\%}$ for 500 jitter runs of model EAG 25.0b.

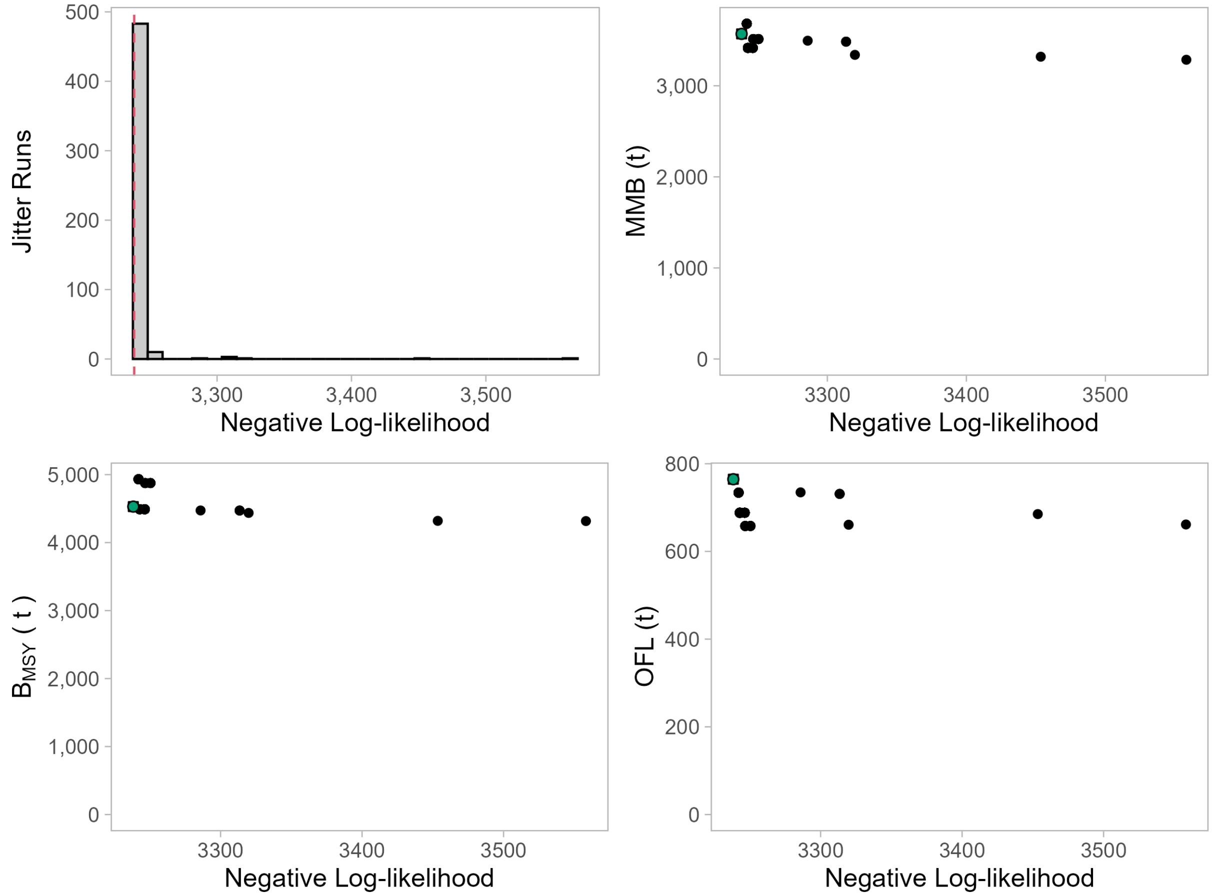

Figure 32: Distrubition of NLL, mature male biomass, and $B_{35\%}$ for 500 jitter runs of model WAG 23.1c.

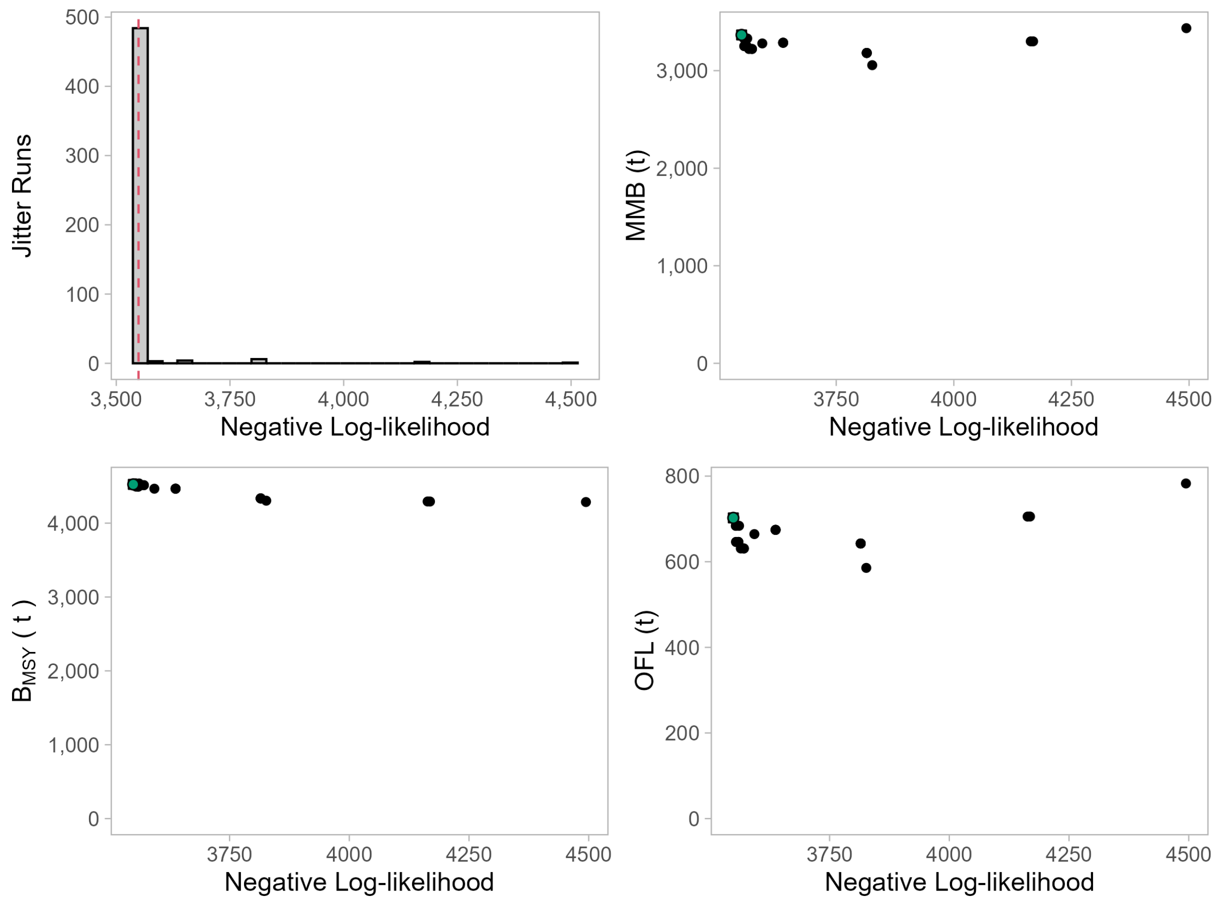

Figure 33: Distrubition of NLL, mature male biomass, and $B_{35\%}$ for 500 jitter runs of model WAG 25.0b.

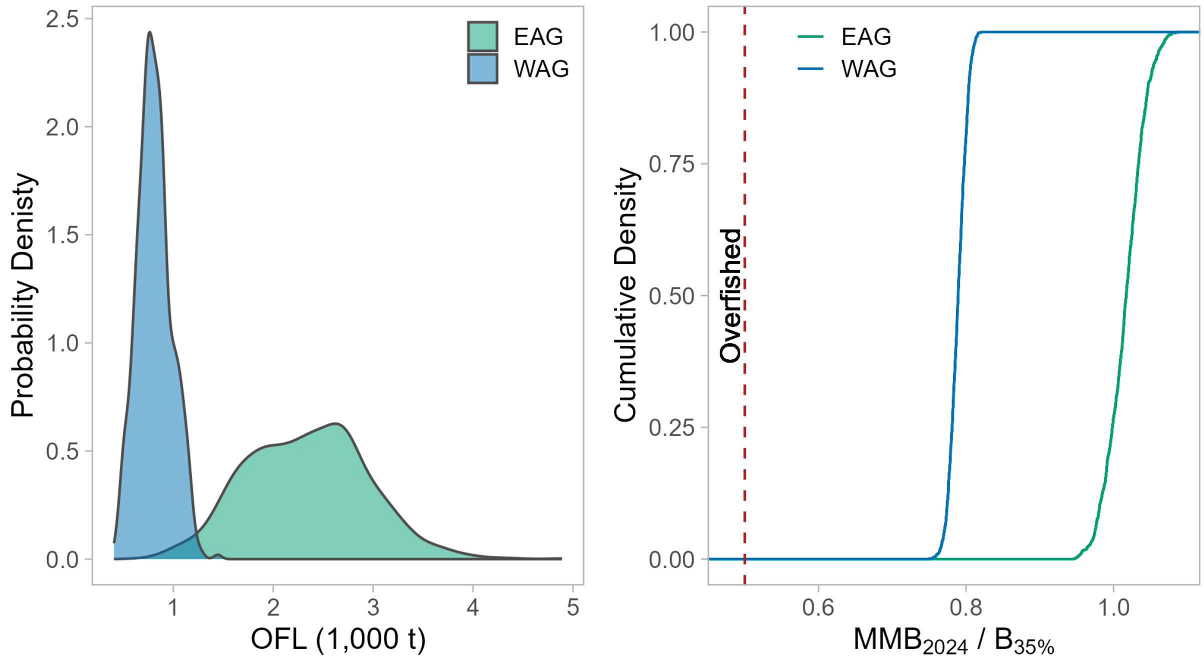

Figure 34: Distrubition of OFL (1,000 t) and cumulative density function of MMB projected to Feb 15, 2025 relative to B[35%] from MCMC draws on model 23.1c.

Literature Cited

Beers, DE 1992. Annual biological summary of the Westward Region shellfish observer database, 1991. Alaska Department of Fish and game, Division of Commercial Fisheries, Regional Information Report 4K92-33, Kodiak, AK.

Blau, SF, and D Pengilly. 1994. Findings from the 1991 Aleutian Islands golden king crab survey in the Dutch Harbor and Adak management areas including analysis of recovered tagged crab. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Regional Information Report 4K94-35, Kodiak, AK.

Blau, SF, LJ Watson, and I Vining. 1998. The 1997 Aleutian Islands golden king crab survey. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Regional Information Report 4K98-30, Kodiak, AK.

Daly, B, MSM Siddeek, M Stichert, S Martell, and J Zheng. 2019. Recommended harvest strategy for Aleutian Islands golden king crab. Alaska Department of Fish and Game, Fishery Manuscript Series No. 19-03, Anchorage, AK.

Francis, RICC. 2011. Data weighting in statistical fisheries stock assessment models. Canadian Journal of Fisheries and Aquatic Sciences 68: 1124-1138.

Francis, RICC. 2017. Revisiting data weighting in fisheries stock assessment models. Fisheries Research 192: 5-15.

Gaeuman, WB 2014. Summary of the 2013/2014 mandatory crab observer program database for the Bering Sea/Aleutian Islands commercial crab fisheries. Alaska Department of Fish and Game, Fishery Data Series No. 14-49, Anchorage, AK.

Grant W and C Siddon. 2018. Phylogeography and management of golden king crab populations in Alaska. NPRB Project 1526 Final Report. 42 pp.

Hartill, T. 2012. Annual management report for the community development quota and Adak Community Allocation crab fisheries in the Bering Sea and Aleutian Islands, 2010/11. Pages 177–194 in Fitch, H, M Schwenzfeier, B Baechler, T Hartill, M Salmon, M Deiman, E Evans, E Henry, L Wald, J Shaishnikoff, and K Herring. Annual management report for the commercial and subsistence shellfish fisheries of the Aleutian Islands, Bering Sea, and the Westward Region's Shellfish Observer Program, 2010/11. Alaska Department of Fish and Game, Fishery Management Report No. 12-22, Anchorage.

Hiramoto, K. 1985. Overview of the golden king crab, *Lithodes aequispina*, fishery and its fishery biology in the Pacific waters of Central Japan. Pages 297–315, in Proceedings of the International King Crab Symposium. Alaska Sea Grant College Program, AK-SG-85-12, Fairbanks, AK.

Jackson, TM. 2024a. Aleutian Islands golden king crab stock assessment 2024. North Pacific Fishery Management Council, Anchorage, Alaska.

Jackson, TM. 2024b. Aleutian Islands golden king crab draft models. North Pacific Fishery Management Council, Anchorage, Alaska. eAgenda Link.

Jewett, SC, NA Sloan, and DA Somerton. 1985. Size at sexual maturity and fecundity of the fjord-dwelling golden king crab *Lithodes aequispina* Benedict from northern British Columbia. Journal of Crustacean Biology 5: 377–385.

Koeneman, TM, and DV Buchanan. 1985. Growth of the golden king crab, *Lithodes aequispina*, in Southeast Alaskan waters. Pages 281–297, in Proceedings of the International King Crab Symposium. Alaska Sea Grant College Program, AK-SG-85-12, Fairbanks, AK.

Leon, JM, J Shaishnikoff, E Nichols, and M Westphal. 2017. Annual management report for shellfish fisheries of the Bering Sea–Aleutian Islands management area, 2015/16. Alaska Department of Fish and Game, Fishery Management Report No. 17-10, Anchorage, AK.

Mohn, R. 1999. The retrospective problem in sequential population analysis: An investigation using cod fishery and simulated data. ICES Journal of Marine Science 56: 473-488.

Nichols, E, J Shaishnikoff, and M Westphal. 2021. Annual management report for shellfish fisheries of the Bering Sea/Aleutian Islands Management Area, 2019/20. Alaska Department of Fish and Game, Fishery Management Report No. 21-06, Anchorage, AK.

North Pacific Fishery Management Council (NPFMC). 2007b. Public Review Draft: Environmental Assessment for proposed Amendment 24 to the Fishery Management Plan for Bering Sea and Aleutian Islands King and Tanner Crabs to Revise Overfishing Definitions. 14 November 2007. North Pacific Fishery Management Council, Anchorage.

Otto, RS, and PA Cummiskey. 1985. Observations on the reproductive biology of golden king crab (*Lithodes aequispina*) in the Bering Sea and Aleutian Islands. Pages 123–136 in Proceedings of the International King Crab Symposium. Alaska Sea Grant College Program, AK-SG-85-12, Fairbanks, AK.

Richards, LJ 1991. Use of contradictory data sources in stock assessments. Fisheries Research 11(3-4): 25–238.

Schnute, JT and R Hilborn. 1993. Analysis of contradictory data sources in fish stock assessment. Canadian Journal of Fisheries and Aquatic Sciences 50(9): 1916–1923.

Shirley, TC, and S Zhou. 1997. Lecithotrophic development of the golden king crab *Lithodes aequispinus* (Anomura: Lithodidae). Journal of Crustacean Biology 17(2): 207–216.

Siddeek, MSM, J Zheng, and D Pengilly. 2015. Aleutian Islands Golden King Crab (Lithodes aequispinus) Model-Based Stock Assessment in Fall 2015. Draft report submitted for the September 2015 Crab Plan Team Meeting. North Pacific Fishery Management Council, Anchorage, AK.

Siddeek, MSM, J Zheng, C Siddon, B Daly, J Runnebaum, and MJ Westphal. 2018. Aleutian Islands golden king crab model-based stock assessment. North Pacific Fishery Management Council, Anchorage, Alaska.

Siddeek, MSM, J Zheng, C Siddon, B Daly, MJ Westphal, L Hulbert, and T Jackson. 2022. Aleutian Islands golden king crab stock assessment. North Pacific Fishery Management Council, Anchorage, Alaska.

Siddeek, MSM, T Jackson, B Daly, C Siddon, MJ Westphal, and L Hulbert. 2023. Aleutian Islands golden king crab model scenarios for May 2023 assessment. North Pacific Fishery Management Council, Anchorage, Alaska.

Somerton, DA, and RS Otto. 1986. Distribution and reproductive biology of the golden king crab, *Lithodes aequispina*, in the Eastern Bering Sea. Fishery Bulletin, 81(3): 571–584.

Stewart, IJ and OS Hamel. 2014. Bootstrapping of sample sizes for length- or age-composition data used in stock assessments. Canadian Journal of Fisheries and Aquatic Sciences 71: 581-588.

Trijoulet V, A Nielsen. 2022. compResidual: Residual calculation for compositional observations. R package version 0.0.1, commit d4c74845089074d8016454f235044c5d13ded3a5, https://github.com/fishfollower/compResidual.

Trijoulet V, C Moesgaard Albertsen, K Kristensen, CM Legault, TJ Miller, A Nielsen. 2023. Model validation for compositional data in stock assessment models: Calculating residuals with correct properties. Fisheries Research 257: 106487.

Vanek, V, D Pengilly, and MSM Siddeek. 2013. A study of commercial fishing gear selectivity during the 2012/13 Aleutian Islands golden king crab fishery east of 174W longitude. Alaska Department of Fish and Game, Division of Sport Fish and Commercial Fisheries, Fishery Data Series No. 13-41.

Von Szalay, PG, CN Roper, NW Raring, and MH Martin. 2011. Data report: 2010 Aleutian Islands bottom trawl survey. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-AFSC-215.

Von Szalay, PG, NW Raring, CN Roper, and EA Laman. 2017. Data report: 2016 Aleutian Islands bottom trawl survey. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-AFSC-349.

Watson, LJ. 2004. The 2003 triennial Aleutian Islands golden king crab survey and comparisons to the 1997 and 2000 surveys (revised October 17, 2005). Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 4K04-42, Kodiak, AK. [Revised 10/17/2005].

Watson, LJ. 2007. The 2006 triennial Aleutian Islands golden king crab survey. Alaska Department of Fish and Game, Fishery Management Report No. 07-07, Anchorage, AK.

Watson, LJ, and RK Gish. 2002. The 2000 Aleutian Islands golden king crab survey and recoveries of tagged crab in the 1997–1999 and 2000–2002 fishing seasons. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 4K02-6, Kodiak, AK.

Watson, LJ, D Pengilly, and SF Blau. 2002. Growth and molting of golden king crab (*Lithodes aequispinus*) in the eastern Aleutian Islands, Alaska. Pages 169–187 in Crabs in cold water regions: biology, management, and economics, Alaska Sea Grant College Program, AK-SG-02-01, Fairbanks, AK.

Webb, J. 2014. Reproductive ecology of commercially important Lithodid crabs. Pages 285–314 in B.G. Stevens (ed.). King Crabs of the World: Biology and Fisheries Management. CRC Press, Taylor & Francis Group, New York.