

Saint Matthew Island blue king crab stock assessment

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Executive Summary

1. Stock

Blue king crab, *Paralithodes platypus*, Saint Matthew Island (SMBKC), Alaska.

2. Catches

Peak historical harvest was 4,288 t (9.454 million pounds) in 1983/84; note that 1983/84 refers to a fishing year that extends from 1 July 1983 to 30 June 1984. The fishery was closed for 10 years after the stock was declared overfished in 1999. Fishing resumed in 2009/10 with a fishery-reported retained catch of 209 t (0.461 million pounds), less than half the 529 t (1.167 million pound) total allowable catch (TAC). Following three more years of modest harvests supported by a fishery catch per unit effort (CPUE) of around 10 crab per pot lift, the fishery was again closed in 2013/14 due to declining trawl survey estimates of abundance and concerns about the health of the stock. The directed fishery resumed again in 2014/15 with a TAC of 300 t (0.655 million pounds), but the fishery performance was relatively poor with a retained catch of 140 t (0.309 million pounds). The retained catch in 2015/16 was even lower at 48 t (0.105 million pounds) and the fishery has remained closed since 2016/17.

3. Data sources

The data sources used in this assessment are summarized in Figure 1 and include retained catch, discards, and size compositions from the pot fishery, discards from trawl and fixed gear bycatch, size compositions and a biomass index from the National Oceanic and Atmospheric Administration (NOAA) Eastern Bering Sea (EBS) bottom trawl survey, and size compositions and a CPUE-based relative abundance index from the Alaska Department of Fish and Game (ADF&G) St. Matthew Island blue king crab pot survey. Only males with carapace length (CL) ≥ 90 mm are included in the assessment model. Beginning in 2024, the EBS bottom trawl survey ceased sampling the high density “corner” stations that were added to the St. Matthew Island survey area in 1983 and sampled through 2023 (NPFMC 2024). Corner stations were originally added to the survey in order to improve survey data quality for the blue king crab stocks near St. Matthew and the Pribilof Islands, but the declines in these stocks and the low probability that they will rebuild to harvestable levels in the near future motivated examination of the utility of continuing to allocate survey time and funds to sampling these stations (DePhilippo et al. 2023). A previous analysis found that excluding corner stations reduced the scale of, but not the trends in, biomass estimates for the St. Matthew Island blue king crab stock assessment, and that spatiotemporal model-based biomass estimates were more robust to the removal of corner stations than design-based estimates (DePhilippo et al. 2023). We developed a spatiotemporal model-based index that takes into account sampling changes in the EBS trawl survey time series (section

D5, below), and compare results from stock assessment models that use this model-based index with those of models using the design-based index in this document.

4. Stock biomass

Biomass of the SMBKC stock is monitored by the NOAA EBS trawl survey (1978-2026) and the ADF&G SMBKC pot survey (1995-2025). In 2026, estimated biomass of males ≥ 90 mm CL from the NOAA EBS trawl survey was 2915 t (CV = 0.44), up from the 2025 estimated biomass of 1861 t (CV = 0.44), but below the time series mean biomass of 5134 t. The CPUE of males ≥ 90 mm CL from the 2025 ADF&G pot survey was 4.59 (CV = 0.10), up from the 2022 CPUE of 4.09 (CV = 0.14), but below the time series mean CPUE of 6.90. Both EBS trawl survey estimated biomass and ADF&G pot survey estimated CPUE remain low relative to historical estimates (Figure 2). Note that the 2024-2026 NOAA EBS trawl survey biomass estimates are not directly comparable to 1983-2023 biomass estimates because the 2024-2026 surveys did not sample corner stations, and thus some bias in biomass estimates is expected. The spatiotemporal model-based index we developed for the NOAA EBS trawl survey time series accounts for changes in survey sampling over time (see section D5, below, for details). This standardized index estimates 2026 biomass as 3796 t (CV = 0.35), up from the estimated 2025 biomass of 2337 t (CV = 0.34).

5. Recruitment

Recruitment is based on the estimated number of male crab in the 90-104 mm carapace length (CL) size class in each year. The 2026 EBS trawl survey area-swept estimate of 773,187 male SMBKC in this size class is ranked 22 out of the 49 years of the survey, up from 44th in 2025. Mean recruitment over the most recent five years (2022 - 2026) is 50% of the long-term mean. There is some evidence of a pulse of smaller males beginning to grow into the sizes included in the model (Figure 3). In the ADF&G pot survey, the abundance of male crab in the 90-104 mm CL size class in 2025 ranked 9th in the time series (36% of the mean for the 13 available years of pot survey data). The relative frequency of small males not included in the model appeared to be higher in the 2025 than in the 2022 pot survey (Figure 4). Both the design-based and model-based EBS trawl survey size compositions (development of model-based size compositions is detailed in section D6, below) show an increase in the proportion of males in the 90-104 mm CL size class: the proportion of males in size class 1 in 2026 is the highest since 2022 for the design-based size compositions and the highest since 2010 for the model-based size compositions (Figures 5 and 6).

6. Management performance

In this assessment, estimated total male catch is the sum of fishery-reported retained catch, estimated male discard mortality in the directed fishery, and estimated male bycatch mortality in the groundfish fisheries. Because SMBKC is a Tier 4 stock, B_{MSY} is estimated as the mean of mature male biomass (MMB) over a specified time period, here 1978 to the most recent completed crab year. The minimum stock-size threshold (MSST) is calculated as $B_{MSY}/2$. Both of the models to be considered for harvest specifications estimate that MMB was above the MSST in 2025/26 and thus the stock is not in an “overfished” condition (Tables 1 and 2). A directed fishery closure has been in place since the 2016/17 season and estimated total bycatch has remained well below the overfishing level (OFL), hence overfishing has not occurred. The tables below show the status and catch specifications based on the models to be considered for harvest specifications in both 1,000 t and million lb (Tables 1 and 2).

Table 1: Status and catch specifications (1,000 t) for model 26.1b, the base model with updated data, and model 26.2, with a model-based biomass index for the EBS trawl survey. Note that the OFL and ABC for 2024/2025 and 2025/2026 were set in autumn 2024 for this biennially assessed stock. Values for 2024/2025 are estimates or projections based on the 2024 assessment. Values for 2024/2025 and earlier are based on historical estimates and are not updated except for total and retained catch. The MSST for 2024/2025 is left blank because there was no assessment in 2025 and thus MSST was not estimated for that year.

Year	MSST	Biomass (MMB_{mating})	TAC	Retained catch	Total male catch	OFL	ABC	Model
2021/22	1.63	1.18	0.00	0.00	0.0003	0.05	0.04	
2022/23	1.50	1.31	0.00	0.00	0.0021	0.066	0.05	
2023/24	1.48	1.41	0.00	0.00	0.0004	0.066	0.05	
2024/25		1.53	0.00	0.00	0.0007	0.129	0.097	24.1
2025/26	1.44	1.67	0.00	0.00	0.0019	0.129	0.097	26.1b
2025/26	2.25	2.33	0.00	0.00	0.0019	0.129	0.097	26.2
2026/27		1.53				0.151	0.113	26.1b
2026/27		2.12				0.182	0.136	26.2

Table 2: Status and catch specifications (million pounds) for model 26.1b, the base model with updated data, and model 26.2, with a model-based biomass index for the EBS trawl survey. Note that the OFL and ABC for 2024/2025 and 2025/2026 were set in autumn 2024 for this biennially assessed stock. Values for 2024/2025 are estimates or projections based on the 2024 assessment. Values for 2024/2025 and earlier are based on historical estimates and are not updated except for total and retained catch. The MSST for 2024/2025 is left blank because there was no assessment in 2025 and thus MSST was not estimated for that year.

Year	MSST	Biomass (MMB_{mating})	TAC	Retained catch	Total male catch	OFL	ABC	Model
2021/22	3.59	2.59	0.00	0.00	0.002	0.112	0.08	
2022/23	3.32	2.89	0.00	0.00	0.002	0.146	0.11	
2023/24	3.27	3.10	0.00	0.00	0.011	0.146	0.11	
2024/25		3.37	0.00	0.00	0.002	0.285	0.214	24.1
2025/26	3.17	3.68	0.00	0.00	0.004	0.285	0.214	26.1b
2025/26	4.96	5.14	0.00	0.00	0.004	0.285	0.214	26.2
2026/27		3.37				0.333	0.250	26.1b
2026/27		4.66				0.401	0.301	26.2

7. Basis for the OFL

Estimated mature male biomass (MMB) on 15 February is used as the measure of biomass for this Tier 4 stock, with males measuring ≥ 105 mm CL considered mature. The B_{MSY} proxy is obtained by averaging estimated MMB over a specific reference period, and current Crab Plan Team (CPT) guidance recommends using the full assessment time frame (1978 - the most recent completed crab year) as the default reference period.

Table 3: Basis for the OFL (1,000 t) from model 26.1b, the base model with updated data, and model 26.2, with a model-based biomass index for the EBS trawl survey.

Year	Tier	B_{MSY}	Biomass (MMB_{maturing})	B/B_{MSY}	F_{OFL}	γ	Basis for B_{MSY}	Natural mortality	Model
2021/22	4b	3.30	1.18	0.34	0.048	1	1978-2020	0.18	
2022/23	4b	3.26	1.31	0.40	0.061	1	1978-2021	0.18	
2023/24	4b	2.97	1.41	0.47	0.096	1	1978-2022	0.18	
2024/25	4b	2.93	1.53	0.52	0.11	1	1978-2023	0.23	24.1
2025/26	4b	2.90	1.67	0.57	0.12	1	1978-2024	0.23	26.1b
2025/26	4b	4.54	2.33	0.51	0.11	1	1978-2024	0.23	26.2
2026/27	4b	2.88	1.53	0.53	0.11	1	1978-2025	0.23	26.1b
2026/27	4b	4.50	2.12	0.47	0.10	1	1978-2025	0.23	26.2

8. Probability density function (PDF) of the OFL:

The PDFs of the OFL for models 26.1b, 26.2, and 26.2a are shown in Figures 7 - 9.

9. Basis for the ABC recommendation

In 2024, the CPT and SSC supported the author-recommended 25% buffer to set the ABC for the following reasons: 1) the stock was in a fixed rebuilding time frame; 2) there was a significant retrospective pattern on MMB estimates; 3) limited life history information was available for correctly specifying the population processes; and 4) ADF&G pot and NOAA EBS trawl survey data showed contradictory trends. An additional concern for the 2024 assessment was that the NOAA EBS trawl survey corner stations were not surveyed in 2024, potentially adding bias to biomass estimates, although that bias was expected to lead to biomass underestimates rather than overestimates. Two of these concerns have been addressed in the 2026 assessment: the retrospective pattern on MMB estimates is improved and the dropping of corner stations is accounted for by using a spatiotemporal model-based index of abundance for the EBS trawl survey in models 26.2 and 26.2a. The trawl and pot survey time series have shown greater agreement in population trends in recent years (Figure 2), but combining these time series into a single index of abundance remains an important goal for this assessment. The authors recommend retaining the 25% ABC buffer for setting 2027 and 2028 harvest specifications due to the lack of stock-specific life history information to specify key population processes such as natural mortality.

10. Summary of rebuilding analyses

The estimate for MMB was above the minimum stock-size threshold (MSST) in 2025/26 and thus the stock was not in an “overfished” condition. Both models presented for harvest specifications project a decline in MMB in 2026/2027. The base model, 26.1b, projects an estimated B/B_{MSY} greater than 50%, but the alternative model projects that B/B_{MSY} will fall below 50% (Tables 1 - 4). This projected decline may be due to an increased proportion of size class 1 (90-104 mm CL) males, which are not considered mature and thus not included in the MMB estimate. However, this projected decline in MMB is still concerning for a stock under a rebuilding plan and a long-term directed fishery closure.

A. Summary of Major Changes

1. Changes to the management of the fishery

There are no changes to the management of the fishery.

2. Changes to the input data

Data used in this assessment have been updated to include the most recent available fishery data and survey data (Figure 1). Data added to this assessment since the final SAFE in 2024 include biomass and size composition data from the 2025 and 2026 EBS trawl surveys, relative abundance and size composition data from the 2025 ADF&G pot survey, and groundfish trawl and fixed gear fisheries bycatch estimates based on NMFS Alaska Regional Office (AKRO) data for the 2024/2025 and 2025/2026 seasons. The directed fishery has been closed since 2016/17, so no recent fishery data are available. Models 26.2 and 26.2a use a model-based rather than design-based biomass estimate time series for the EBS trawl survey (see section D5, below) and model 26.2a uses model-based rather than design-based estimates for the EBS trawl survey size composition time series (see section D6, below). Although the model-based size composition time series was not developed in time to be used in May 2026 model runs, the authors include a model run using this time series here with the goals of 1) consistency in processing of EBS trawl survey biomass and size composition data, and 2) making as much progress on model development in the current assessment cycle as possible, given that this stock will not be assessed again until 2028.

3. Changes to the assessment methodology

This assessment has used the Generalized size-structured Model for Assessing Crustacean Stocks (GMACS) framework since 2016. The model, which is configured to track three stages of length categories, was first presented in May 2011 by W. Gaeuman, ADF&G, and accepted by the Crab Plan Team (CPT) in May 2012. A difference between the original approach and that used here is that natural and fishing mortalities are continuous within five discrete time blocks within a year, using the appropriate catch equation rather than assuming an applied pulse removal. The time blocks within a year in GMACS are controlled by changing the proportion of natural mortality that is applied to each block. Diagnostic output includes estimates of the “dynamic B_0 ”, which is the ratio of the estimated spawning biomass relative to the spawning biomass that would have occurred had there been no historical fishing mortality. Details of this implementation and other model details are provided in Appendix A.

In this document, we present five models. Two of these models, 26.1 and 26.1a, are presented only for bridging analysis purposes and are not recommended for harvest specifications.

1. Model 26.1, the base model following May/June 2026 CPT and SSC recommendations, uses GMACS version 2.20.34a and includes data updates available in May 2026: 2025 EBS trawl survey biomass and size composition data, 2025 ADF&G pot survey biomass and size composition data, and 2024/2025 groundfish fisheries bycatch data.
2. Model 26.1a is model 26.1 transitioned to GMACS version 2.20.44.
3. Model 26.1b is model 26.1a with updated data: 2026 EBS trawl survey biomass and size composition data and 2025/2026 groundfish fisheries bycatch data.
4. Model 26.2 is model 26.1b with a spatiotemporal model-based index used in place of the design-based EBS trawl survey biomass index.
5. Model 26.2a is model 26.2 with spatiotemporal model-based estimates for the EBS trawl survey size composition data used in place of the design-based size composition estimates.

B. Responses to SSC and CPT comments

Responses to SSC comments on the SMBKC May 2026 proposed models (June 2026)

The SSC concurs with the CPT and authors' recommended models for setting harvest specifications in October. These include models 26.1, the new base model, and 26.2. Model 26.3 was not recommended at this time, and the SSC notes that this model exhibits a degraded retrospective pattern compared to models 26.1 and 26.2, and an anomalous spike in early 1980s estimated recruitment. The SSC agrees that excluding Model 26.3 for final harvest specifications is appropriate but recommends continued exploration of estimating catchability in future models, at the author's discretion.

Models 26.1b (26.1 with updated GMACS version and data) and 26.2 are presented in this document for consideration for harvest specifications. We also present research model 26.2a, which is model 26.2 with model-estimated EBS trawl survey size compositions, with the goal of receiving feedback from the CPT and SSC on this approach before the next assessment cycle for this stock begins in May 2028. The authors plan to continue exploring estimation of catchability in future assessment cycles.

The SSC also recommends more detailed information on the new model-based index be provided in the main assessment document in October, which will inform model selection for final specifications.

We thank the SSC for this recommendation and have moved information about the model-based index from the appendix to the main assessment document to facilitate review of this new methodology (section D5, below). We understand the need to have detailed information about the model-based index in the main assessment document while this new index is being considered for the first time. In future iterations of this assessment, we suggest that this information could be moved back to an appendix, as is done for groundfish stock assessments that use a model-based index such as the 2024 EBS walleye pollock SAFE (Ianelli et al. 2024).

Finally, the SSC supports the research priorities listed by the CPT, including further understanding of molting as a function of size and continued exploration of survey selectivity and catchability. Regarding previous recommendations to integrate the EBS bottom trawl survey and the ADF&G pot survey, the SSC acknowledges the difficulties in aligning an area-swept survey with a discrete pot survey and recommends exploring alternative methodologies, such as developing separate model-based indices for each survey and using ensemble models or model averaging, to continue progress toward creating a comprehensive index of abundance for this stock.

We thank the SSC for these helpful recommendations and plan to explore creating an index of abundance that combines information from the trawl and pot surveys in a future assessment cycle.

Responses to SSC comments on the SMBKC September 2024 SAFE (October 2024)

A significant change occurred in the 2024 NMFS bottom trawl survey, where the "corner stations" around St. Matthew Island were not sampled. These stations, added in 1983, are areas of higher crab density and have played a key role in estimating crab abundances. The decision to not sample these stations was made to prioritize survey modernization fieldwork, and their inclusion in future surveys is uncertain. The assessment showed that removing these stations reduced biomass estimates (19%) but didn't alter size composition significantly. The biomass estimates are now computed based on a single stratum, instead of high and low-density strata with corner stations. This change has introduced a consistent downward bias, possibly due to the exclusion of the corner stations, or a previous upward bias when they were included. This discrepancy deserves further investigation, highlighting the potential benefits of model-based estimates that incorporate historical corner station data to address any biases. For this assessment, using the corner stations prior to 2024 is acceptable, but this issue should be addressed in the next full assessment. This may include developing an integrated pot and trawl index, as suggested in October 2022. The expectation is that the removal of the

corner stations should increase uncertainty but not introduce consistent bias unless they regularly have higher crab density than the parent station to which they are a corner of.

In this document, we present models using a spatiotemporal model-based biomass index that incorporates historical corner station data. Developing an integrated pot and trawl survey index using the spatiotemporal modeling approach applied here presents difficulties because an estimate of area swept would be required for pot survey observations, and it is unclear to the authors how to calculate area swept for crab pots. However, the authors plan to pursue alternative approaches for developing an integrated pot and trawl survey in a future assessment cycle.

The SSC recommends that the producers of the crab trawl survey estimates should explore showing both high and low-density strata estimates without the corner stations, alongside the one-stratum estimate seen in this assessment, to better understand potential biases.

The authors plan to work with the NOAA staff who produce the EBS trawl survey biomass estimates to address this comment in a future assessment cycle.

In Table 8, it was noted that the SDNRs (Standardized Deviance Residuals) and MARs (Mean Absolute Residuals) for the surveys are all listed as zero, which is likely not the case. The SSC recommends the authors re-evaluate these diagnostics if they are included in future assessments.

These diagnostics are not included in this document since they did not seem to be as commonly used for model evaluation as other diagnostics, but SDNRs and MARs are easily accessible in the model output and the authors are happy to include them in future if the SSC finds them helpful.

Responses to CPT comments on the SMBKC May 2026 proposed models (May 2026)

The author recommended models 26.1 and 26.2 be brought forward for setting specifications in September and the CPT concurred with this recommendation.

Models 26.1b (26.1 with updated GMACS version and data) and 26.2 are presented for setting harvest specifications in this document. In addition, the authors present a research model, 26.2a, which includes model-based estimates of EBS trawl survey size compositions, with the goal of receiving feedback from the CPT and SSC on this approach before the next assessment cycle for this stock begins in May 2028.

The author and CPT also discussed estimated trawl survey selectivity values greater than the bounded value of 1 for the middle size class, across all three models. The CPT recommended adding this issue for the January modeling workshop but is likely related to scaling of selectivity over size-classes.

All three models included in this assessment exhibit estimated EBS trawl survey selectivity values slightly greater than 1 for size class 2 (~ 1.1 ; Table 5). In September 2026, CPT members pointed out that the SMBKC assessment model is currently configured to renormalize selectivity such that the largest size class, size class 3, has selectivity equal to 1. A parameter is estimated for each size bin, and the selectivities for size classes 1 and 2 are defined as p_1/p_3 and p_2/p_3 , respectively, where p_i is the selectivity parameter for size class i . This explains why an upper bound of 1 for p_2 does not necessarily lead to selectivity ≤ 1 for size class 2: selectivity for size class 2 is > 1 when $p_2 > p_3$. The authors could explore different trawl survey selectivity configurations in future if the CPT and SSC deem this useful.

The CPT also agreed with the author's proposal to focus on exploration of model-based estimates of survey size-composition data and the development of a single model-based index to incorporate both the trawl and pot surveys as the highest-priority research directions for this assessment.

We present a research model including model-based estimates of survey size-composition data, model 26.2a, in this document, and look forward to CPT's and SSC's feedback. We realize that it is not common practice to present a new model run in the September SAFE document, but thought it was important to include this alternative model for two reasons. First, using both a model-based EBS trawl survey biomass index and model-based EBS trawl survey size composition estimates means that data from the EBS trawl survey

are processed consistently before being used as assessment model inputs. Second, this stock is assessed only every two years, meaning that opportunities to receive feedback on model development are limited. Development of a single model-based index incorporating both the trawl and pot survey data is planned for a future assessment cycle.

A rebuilding update for this stock will be presented in the final SAFE in September. The CPT noted that this stock might be usefully moved to a triennial schedule, with the next assessment due in 2029, in order to scale overall workload to match capacity in the CPT and SSC. The CPT recommended coordinating with the NMFS Regional Office to evaluate the implications of a triennial assessment schedule given current rebuilding updates are required biennially.

A rebuilding update is presented in this document. We recommend maintaining a biennial schedule at least through the 2028 assessment cycle in order to complete the transition to using model-based estimates for the survey and size composition data, and allow for progress on development of a single model-based index incorporating both the trawl and pot survey data.

Responses to CPT comments on the SMBKC September 2024 SAFE (September 2024)

Caitlin noted that work on standardizing the survey index to better account for the elimination of the corner stations from future surveys is underway, using both sdmTMB and VAST methods for comparison. The CPT confirmed that model-based approaches such as VAST would be appropriate for this and suggested that sdmTMB might be considered as an “easier” alternative to VAST.

The authors used sdmTMB to produce the model-based index presented in this document, and found the extensive set of vignettes and other resources available for the sdmTMB package to be very helpful in learning how to use this tool.

It was noted that elimination of the NMFS trawl survey corner station sampling increases the importance of future ADF&G pot surveys. The CPT discussed the selectivity of the pot survey vs. the trawl survey. It was noted that relating the two gears is difficult, but that the pot survey covers the spatial footprint of the population more accurately. Additionally, it is believed that the ADF&G pot surveys better sample SMBKC due to limitations of the NMFS trawl survey gear in some habitats, such as rocky bottom and nearshore areas. The CPT discussed timing of the ADF&G pot surveys relative to the assessment, noting that the ADF&G pot survey did a better job of capturing the recent population decline, and that future ADF&G pots surveys will help to better understand the stock status. While annual pot surveys are ideal, a 3-year cycle is likely effective in capturing broad population trends. The next ADF&G pot survey will tentatively be conducted in August-September 2025.

Data from the 2025 ADF&G pot survey are included in this assessment.

Responses to SSC and CPT comments on SMBKC May 2024 model runs (May/June 2024)

The SSC agreed with the CPT that using the M estimate from Model 24.0a as the fixed value in Model 24.0c was improper. The CPT recommended that the authors construct a new model, 24.1, which builds on 16.1 as its base but uses a fixed value for M from the 2023 BBRKC assessment (i.e., 0.23 yr⁻¹).

In September 2024, we presented model 24.1, with $M = 0.23$. That model was accepted for harvest specifications in December 2024.

The SSC also supports the authors presenting a version of Model 16.1 in October 2024 with the corner stations dropped from all previous years. This research model would provide retrospective insights into the impacts of dropping these stations, as will occur in the 2024 EBS trawl survey, but this research model would not be used for management.

In September 2024, we presented models 16.1a and 24.1a, versions of model 16.1 and 24.1, respectively, with the corner stations dropped from all previous years in the NMFS trawl survey time series. These models both estimated lower mature male biomass than did the models with corner stations included.

The SSC supports the CPT recommendations for future work and offers the following suggestions:

Continue work to create a single index of abundance integrating data from both trawl and pot surveys using spatiotemporal approaches. The SSC suggests the authors explore the use of these methods for each survey separately before initiating work to combine them. An exploratory spatial analysis, including maps depicting the spatial structure of relevant survey observations, should be provided to support the selection of an appropriate geostatistical approach. In addition to standard diagnostic plots (i.e. Q-Q plot, residual histograms, and observed vs. predicted encounter probabilities), the distribution of spatial residuals should accompany model results (e.g., see the December 2020 SSC minutes on the use of the VAST Model for EBS Pollock).

We present models using a spatiotemporal model-based index for the EBS trawl survey time series in this document, with maps of survey observations and diagnostics including spatial residuals.

Explore increasing the number of size bins used in the assessment models.

We plan to present the results of these explorations in a future assessment document.

Examine the likelihood profile on selectivity.

We plan to present a likelihood profile on selectivity in a future assessment document.

Correct the y-axis labels on pot survey CPUE plots.

We made this correction.

C. Introduction

1. Scientific name

The blue king crab is a lithodid crab, *Paralithodes platypus* (Brant 1850).

2. General distribution

Blue king crab are sporadically distributed throughout the North Pacific Ocean from Hokkaido, Japan, to southeastern Alaska (Figure 10). In the eastern Bering Sea, small populations are distributed around St. Matthew Island, the Pribilof Islands, St. Lawrence Island, and Nunivak Island. Isolated populations also exist in some other cold water areas of the Gulf of Alaska (NPFMC 1998). The St. Matthew Island Section for blue king crab is within Area Q (Figure 11), which is the Northern District of the Bering Sea king crab registration area and includes the waters north of Cape Newenham (58°39' N. lat.) and south of Cape Romanzof (61°49' N. lat.).

3. Evidence of stock structure

The Alaska Department of Fish and Game (ADF&G) Gene Conservation Laboratory has detected regional population differences between blue king crab collected from St. Matthew Island and the Pribilof Islands¹. The NMFS tag return data from studies on blue king crab in the Pribilof Islands and St. Matthew Island support the idea that legal-sized males do not migrate between the two areas (Otto and Cummiskey 1990). St. Matthew Island blue king crab tend to be smaller than their Pribilof conspecifics, and the two stocks are managed separately. An analysis of genetic markers from blue king crab populations in Southeast Alaska, the Pribilof Islands, St. Matthew Island, Little Diomedea, Chaunskaya Bay, the western Bering Sea, and two

¹NOAA grant Bering Sea Crab Research II, NA16FN2621, 1997.

locations from Shelikof Gulf in the Sea of Okhotsk found genetic differences among all locations (Stoutamore 2014).

4. Life history

Like the red king crab, *Paralithodes camtschaticus*, the blue king crab is considered a shallow water species by comparison with other lithodids such as golden king crab, *Lithodes aequispinus*, and the scarlet king crab, *Lithodes couesi* (Donaldson and Byersdorfer 2005). Adult male blue king crab are found at an average depth of 70 m (NPFMC 1998). The reproductive cycle appears to be annual for the first two reproductive cycles and biennial thereafter (Jensen and Armstrong 1989), and mature crab seasonally migrate inshore where they molt and mate. Unlike red king crab, juvenile blue king crab do not form pods, but instead rely on cryptic coloration for protection from predators and require suitable habitat such as cobble and shell hash. Somerton and MacIntosh (1983) estimated SMBKC male size at sexual maturity to be 77 mm carapace length (CL). Paul et al. (1991) found that spermatophores were present in the vas deferens of 50% of the St. Matthew Island blue king crab males examined with sizes of 40-49 mm CL and in 100% of the males at least 100 mm CL. Spermatophore diameter also increased with increasing CL with an asymptote at ~100 mm CL. It was noted, however, that although spermatophore presence indicates physiological sexual maturity, it may not be an indicator of functional sexual maturity. For purposes of management of the St. Matthew Island blue king crab fishery, the State of Alaska uses 105 mm CL to define the lower size bound of functionally mature males (Pengilly and Schmidt 1995). Otto and Cummiskey (1990) reported an average growth increment of 14.1 mm CL for adult SMBKC males.

5. Management history

The commercial blue king crab fishery in the Saint Matthew Island Section of the Northern District began in 1977 (Leon et al. 2017). Legal males for the Saint Matthew Island Section blue king crab fishery are defined as males at least 5.5 inches in carapace width, or 120 mm in carapace length if only length measurements are available; mature males are defined as all male blue king crab at least 105 mm in carapace width (5 AAC 34.917). In 1993, the Board of Fisheries (BOF) established pot limits for the fishery of 75 pots for vessels over 125 feet in overall length and 60 pots for vessels equal to or less than 125 feet. In the same year, the BOF changed the fishery opening date from September 1 to September 15. The CDQ program was first implemented in 1998 (Leon et al. 2017). For more details on management history, please see the “History of the target fishery” section, below.

6. ADF&G harvest strategy

The ADF&G harvest strategy relies upon a preseason survey estimate to determine whether the SMBKC fishery may open; this estimate may be derived from the stock assessment model or estimated directly from the annual trawl survey data. The fishery may open only if the preseason survey estimate of mature male SMBKC is at least 50% of the 1978-2012 average survey estimate of mature males. If the fishery is open and the preseason survey estimate of mature males is between 50% and 100% of the 1978-2012 average estimate of mature males, the maximum number of legal males available for harvest is the lesser of 1) 25% of the preseason survey estimate of legal males, and 2) $0.1 * m * \frac{m}{m_{1978-2012}}$, where m = the current year preseason estimate of mature males, and $m_{1978-2012}$ = the 1978-2012 average survey estimate of mature males (5 AAC 34.917).

7. History of the basis and estimates for B_{MSY}

SMBKC is a Tier 4 crab stock, meaning that the information necessary to reliably estimate B_{MSY} is lacking and instead a B_{MSY} proxy is obtained by averaging estimated biomass over a specific reference period

(NPFMC 2024). For SMBKC, the B_{MSY} proxy is calculated as the mean model-estimated mature male biomass (MMB) from 1978 to the most recent completed crab year. The choice of this time period was based on a hypothesized shift in stock productivity due to a climatic regime shift indexed by the Pacific Decadal Oscillation (PDO) in 1976-77.

8. History of the target fishery

The SMBKC fishery developed subsequent to baseline ecological studies associated with oil exploration (Otto 1990). Ten U.S. vessels harvested 545 t (1.202 million pounds) in 1977, and harvests peaked in 1983 when 164 vessels landed 4,288 t (9.454 million pounds) (Fitch et al. 2012; Table 6).

The fishing seasons were generally short, often lasting only a few days. The stock was declared overfished and the fishery was closed in 1999, when the stock biomass estimate was below the minimum stock-size threshold (MSST) of 4,990 t (11.0 million pounds) as defined by the Fishery Management Plan (FMP) for the Bering Sea/Aleutian Islands King and Tanner crabs (“Crab FMP”; NPFMC 1999). Zheng and Kruse (2002) hypothesized a high level of SMBKC natural mortality from 1998 to 1999 as an explanation for the low catch per unit effort (CPUE) in the 1998/99 commercial fishery and the low numbers across all male crab size groups caught in the annual NOAA EBS trawl survey from 1999 to 2005. In November 2000, Amendment 15 to the Crab FMP was approved to implement a rebuilding plan for the SMBKC stock (NPFMC 2000). The rebuilding plan included a State of Alaska regulatory harvest strategy (5 AAC 34.917), area closures, and gear modifications. In addition, commercial crab fisheries near St. Matthew Island were limited to fall and early winter to reduce the potential for bycatch mortality of vulnerable molting and mating crab.

NMFS declared the stock rebuilt on 21 September 2009, and the fishery was reopened after a 10-year closure on 15 October 2009 with a TAC of 529 t (1.167 million pounds), closing again by regulation on 1 February 2010. Seven participating vessels landed a catch of 209 t (0.461 million pounds) with a reported effort of 10,697 pot lifts and an estimated CPUE of 9.9 retained individual crab per pot lift. The fishery remained open in the next three years with modest harvests and similar CPUE, but large declines in the EBS trawl survey estimate of stock abundance raised concerns about the health of the stock. This prompted ADF&G to close the fishery again for the 2013/14 season. The fishery was reopened for the 2014/15 season with a low TAC of 297 t (0.655 million pounds) and in 2015/16 the TAC was further reduced to 186 t (0.411 million pounds) before the fishery was closed for the 2016/17 season. The stock was declared overfished in 2018 (NOAA 2019).

In October 2020, Amendment 50 to the Crab FMP was approved to implement a second rebuilding plan for the SMBKC stock (NOAA 2020). The primary factors limiting stock rebuilding were identified as warm bottom temperatures, low pre-recruit biomass, and northward shifts in predator populations, rather than fishing mortality. The aim of the rebuilding plan was thus to maintain a low rate of fishing mortality while awaiting ecosystem conditions conducive to stock rebuilding. The lack of stock rebuilding in Pribilof Islands blue king crab despite fisheries closures and abundant juvenile habitat has similarly been attributed to limited larval supply and warm bottom temperatures (Weems et al. 2020).

Although historical observer data are limited due to low sampling effort, bycatch of female and sublegal male crab from the directed blue king crab fishery off St. Matthew Island was relatively high historically, with estimated total bycatch in terms of number of crab captured sometimes more than twice as high as the catch of legal crab (Moore et al. 2000; ADF&G Crab Observer Database). Pot-lift sampling by ADF&G crab observers (Gaeuman 2013; ADF&G Crab Observer Database) indicated similar bycatch rates of discarded male crab after the reopening of the fishery (Table 7), with total male discard mortality in the 2012/13 directed fishery estimated at about 12% (88 t or 0.193 million pounds) of the reported retained catch weight, assuming 20% handling mortality.

These data suggest a reduction in the bycatch of females, which may be attributable to the later timing of the contemporary fishery and the more offshore distribution of fishery effort since reopening in 2009/10 (D. Pengilly, ADF&G, pers. comm.). Some bycatch of discarded blue king crab has also been observed historically in the eastern Bering Sea snow crab fishery, but in recent years it has generally been negligible. The St. Matthew Island golden king crab fishery, the third commercial crab fishery to have taken place in

the area, typically occurred in areas with depths exceeding blue king crab distribution. The NMFS observer data suggest that variable, but mostly limited, St. Matthew Island blue king crab bycatch has also occurred in the eastern Bering Sea groundfish fisheries (Table 8).

D. Data

1. Summary of new information

Data used in this assessment were updated to include the most recently available fishery and survey estimates. New data include 2025 and 2026 EBS trawl survey biomass and size composition data as well as 2025 ADF&G pot survey abundance and size composition data. The assessment uses updated 1993-2025 groundfish and fixed gear bycatch estimates based on NMFS Alaska Regional Office data, accessed through the Alaska Fisheries Information Network. The directed fishery has been closed since the 2016/17 season, and therefore no directed fishery catch data are available. The data sets used in the models are summarized in Figure 1.

2. Data which should be presented as time series

The time series data used in this assessment are summarized in Figure 1 and include retained catch, discards, and size compositions from the commercial fishery; bycatch estimates from the trawl and fixed gear groundfish fisheries; biomass estimates and size compositions from the National Oceanic and Atmospheric Administration (NOAA) Eastern Bering Sea (EBS) trawl survey (1978-2026); and abundance estimates and size compositions from the Alaska Department of Fish and Game (ADF&G) pot survey (1995-2025). We used the R (R Core Team 2026) package *crabpack* (Hennessey 2025) to extract the NOAA EBS trawl survey data for 1978-2026. All data included in the assessment model are displayed in Appendix B.

a. Total catch

Annual directed fishery retained catch statistics from fish tickets (1978/79-1998/99, 2009/10-2012/13, and 2014/15-2015/16) are shown in Table 6.

b. Information on bycatch and discards

The NMFS groundfish-observer bycatch biomass estimates (1991/92-2025/26) are shown in Table 8. St. Matthew Island blue king crab groundfish fisheries bycatch data are provided by the NMFS Regional office and have been compiled to coincide with the St. Matthew Island blue king crab management area.

c. Catch-at-length for fisheries, bycatch, and discards

Size frequency information from ADF&G crab-observer pot-lift sampling (1990/91-1998/99, 2009/10-2012/13, and 2014/15-2016/17) is shown in Table 7. Crab observer sampling protocols are detailed in the crab observer training manual (ADF&G 2013).

d. Survey biomass estimates

This assessment includes two survey time series: annual NOAA EBS trawl survey (1978-2026) biomass estimates and ADF&G SMBKC pot survey (every third year during 1995-2013, every year during 2015-2018; every third year during 2022-2025) CPUE estimates. Figure 12 maps the stations from which SMBKC trawl survey and pot survey data were obtained. Further information concerning the NOAA EBS trawl survey as it relates to commercial crab species is available in Daly et al. (2014); see Gish et al. (2012) for a

description of ADF&G SMBKC pot survey methods. It should be noted that the two surveys cover different geographic regions and that each has in some years encountered proportionally large numbers of male blue king crab in areas not covered by the other survey. As discussed above, the 2024-2026 NMFS trawl surveys excluded corner stations. For years in which corner stations were surveyed, the St. Matthew section was separated into two strata (high and low density) and biomass and variance were estimated separately for each stratum (Zacher et al. 2024b). For each stratum, the per-station CPUE was averaged, then expanded over the total area of the stratum to obtain that stratum's biomass estimate. The two biomass estimates were added together to obtain the total estimated St. Matthew section biomass. Due to increased sampling within the high density stratum, the biomass estimate for the high density stratum had reduced variance. For years in which corner stations were not surveyed, the St. Matthew section had one stratum, with biomass estimated by multiplying the mean station-level CPUE of all standard stations in the stratum across the total section area (S. Hennessey, NOAA Fisheries Alaska Fisheries Science Center, pers. comm.).

Following the end of survey sampling at the extra corner stations in 2023, the EBS survey estimated biomass time series no longer consists of directly comparable annual estimates, since fewer survey stations were sampled in 2024-2026 than in the 1983-2023 surveys that included the corner stations. Across the time series, NOAA EBS survey biomass estimates are consistently lower when corner stations are excluded than when they are included; size compositions are similar overall when corner stations are excluded versus included but can show large differences for individual years (Stern and Palof 2024).

A previous analysis found that excluding corner stations reduced the scale of, but not the trends in, biomass estimates for the St. Matthew Island blue king crab stock assessment, and that spatiotemporal model-based biomass estimates were more robust to the removal of corner stations than design-based estimates (DePhilippo et al. 2023). Spatiotemporal models including spatial and spatiotemporal random effects have the potential to mitigate the effects of inconsistent survey sampling by accounting for the spatiotemporal processes that underlie survey observations (Thorson et al. 2021; Yalcin et al. 2023). Simulation work suggests that index standardization using well-specified spatiotemporal models can reduce the impact of changes in survey effort by providing a consistent method of inferring abundance in missing areas (Yalcin et al. 2023). In addition to suffering from bias due to changes in survey sampling, design-based indices of abundance can inflate temporal variability by failing to account for spatial dependence (Shelton et al. 2014; Thorson et al. 2015). Due to the importance of indices of abundance in stock assessment models, this can lead to increased uncertainty in stock assessment model outputs used in fishery management (Cao et al. 2017). By accounting for spatial variation in survey catch, as well as incorporating habitat variables, spatiotemporal model-based index standardization can produce abundance indices with reduced variability compared to design-based indices (Cao et al. 2017, Chen et al. 2024). Important outcomes for stock assessment models can include less extreme retrospective patterns when using model-based rather than design-based indices (Cao et al. 2017, Chen et al. 2024).

Given the changes in survey sampling over time, index standardization is recommended to derive a survey biomass index for inclusion in the SMBKC stock assessment model. The development of a spatiotemporal model-based survey biomass index that accounts for differences in survey station sampling among years is detailed in section D5, below.

e. Survey catch-at-length

Survey size composition data used for the assessment model are shown in Appendix B and include catch-at-length data from the NOAA EBS survey (1978-2026), and the ADF&G SMBKC pot survey (every third year during 1995-2013, every year during 2015-2018; every third year during 2022-2025). In May 2026, the CPT recommended using model-based size composition estimates for the EBS trawl survey data in assessment models that use a model-based EBS trawl survey biomass index, to ensure consistency in the treatment of data from this survey. The development of spatiotemporal model-based size composition estimates for the EBS trawl survey is described in section D6, below.

f. Catch-per-unit-effort time series

This assessment does not include a fishery CPUE time series.

g. Other time series data

No other time series data are included in the model.

3. Data which may be aggregated over time

a. Growth-per-molt; frequency of molting

The growth transition matrix used is based on Otto and Cummiskey (1990), as in previous assessments for this stock; to the authors' knowledge, no more recent information is available. Other relevant data sources, including assumed population and fishery parameters, are presented in Appendix A, which also provides a detailed description of the model configuration used for this assessment.

b. Weight-at-length

Mean somatic mass given length category by year is fixed across years and models and is specified as 0.7 kg for Stage-1, 1.2 kg for Stage-2, and 1.9 kg for Stage-3.

4. Data sources that were available but were excluded from the assessment

To the best of the authors' knowledge, no data sources were available but excluded from the assessment.

5. Spatiotemporal model-based estimation of Eastern Bering Sea trawl survey biomass index

a. Survey data for spatiotemporal analysis

Three different visualizations of the NOAA EBS trawl survey data for 1978-2026 are shown in Figures 13 - 15. Figure 13 illustrates the changes across the time series in both survey station sampling and the set of survey stations at which at least one male blue king crab ≥ 90 mm in carapace length (CL) was recorded. The dropping of the higher-density corner stations in 2024-2026 is visually apparent, as is a possible contraction of the area occupied by blue king crab. Figure 14 shows crab biomass density at each survey station, illustrating patterns such as the large estimated densities of crab caught to the north of St. Matthew Island in some years (e.g., 2010, 2011, 2014, 2015). Figure 15 shows the same information as Figure 14, but with crab biomass density represented using point color rather than point size, making it easier to determine at which survey stations the highest crab biomass densities were recorded.

b. Spatiotemporal models

We fit geostatistical generalized linear mixed effects models (GLMMs) with spatiotemporally correlated random effects to survey data using the R package sdmTMB (Anderson et al. 2022). In this approach, spatial effects are modeled using the stochastic partial differential equation (SPDE) approximation to Gaussian random fields (Lindgren et al. 2011). The rate at which spatial covariance decays with distance is defined by the Matérn covariance function, a derived parameter of which is the spatial (or Matérn) range, the distance at which spatial correlation decays such that two points are effectively independent (Anderson et al. 2022).

This approach allows for index standardization when the set of stations surveyed is not consistent across years: one can generate a spatial grid that covers the area of interest, predict from the model onto that grid, and sum the predicted abundance to obtain an area-weighted index that is independent of sampling locations (Anderson et al. 2022).

Applying the SPDE approach to modeling random fields requires defining a triangulation mesh of the spatial domain (Anderson et al. 2022). We constructed a triangulation mesh for the EBS survey data set using the `sdmTMB` function `make_mesh()`, a wrapper for the triangulation mesh functions in the `finesher` package (Lindgren 2023), and incorporated correlation barriers based on the St. Matthew Island coastline using the `sdmTMBextra` package (Anderson 2025). The resulting mesh is shown in Figure 16. Figure 17 shows the vertices included (black circles) versus excluded (red crosses) from the mesh, demonstrating that the barrier mesh approach effectively excluded vertices on land and outside of the designated spatial polygon from the mesh.

For all models, we estimated spatiotemporal random fields as independent and identically distributed (IID). The spatial random fields are estimated for each time slice, the period of which is specified in the model (e.g., time = year). Estimating spatiotemporal random fields as IID is likely most appropriate for the standardization of survey indices intended to be used in stock assessment models as this approach minimizes the estimation covariance among years, which is usually ignored in stock assessment models (Thorson et al. 2020, Chen et al. 2024). We compared models in which the only fixed effect was year, specified as a factor, with models that also included survey station depth (m) as a covariate, as we hypothesized that variation in the depth of stations surveyed between years including versus excluding corner stations could influence estimated abundance. We compared two approaches for handling the depth covariate: 1) depth centered and scaled by its standard deviation, and 2) a smooth on depth. We ran models with the Tweedie, delta gamma, and delta lognormal distribution families.

c. Model evaluation and diagnostics

After fitting models, we checked model convergence using the `sdmTMB` `sanity()` function. Models were considered converged if they met the following criteria evaluated by the `sanity()` function: the non-linear minimizer suggested successful convergence, the Hessian matrix was positive definite, no extreme or very small eigenvalues were detected, all gradients with respect to fixed effects were < 0.001 , no fixed-effect standard errors were NA, no standard errors looked unreasonably large, no sigma parameters were < 0.01 , no sigma parameters were > 100 , and the range parameter was of a reasonable size. Models that did not converge were excluded from further consideration.

For models that passed all the sanity checks, we calculated residuals using the `DHARMA` package (Hartig 2024) and examined diagnostics included in the package. We plotted the `DHARMA` residuals over space and time to visualize potential patterns of autocorrelation.

We evaluated model predictive skill (the predictive ability of the model for new observations; Anderson *et al.* 2024) using the cross validation function `sdmTMB_cv()`. This function measures model predictive skill by holding out subsets of the data in turn and using each as a test set. These subsets of data are termed “folds”. Following the practices of similar investigations (e.g., Vihtakari *et al.* 2026), we compared models by performing cross validation with 10 randomly arranged folds for each model before extracting the model’s total predicted out-of-sample negative log-likelihood (NLL). The model with the smallest NLL was deemed the best-fitting model. We calculated Root Mean Square Error (RMSE) and Mean Absolute Error (MAE) based on the predictive values; smaller RMSE and MAE values indicate better model fit.

d. Predictions

To generate a prediction grid, we pulled the SMBKC survey strata from the `akgfmmaps` package (AFSC 2026; Figure 18) using the `get_crab_strata()` function, then produced a grid with a resolution of 5 km² that matched the SMBKC survey area (Figure 19). We added depth information to the prediction grid by matching bathymetry data from the NOAA Southern Alaska Coastal Relief Model (<https://www.ngdc.noaa>).

gov/mgg/coastal/s_alaska.html) to the grid coordinates, rounding to the nearest integer UTM to ensure that each pair of grid coordinates received a matching depth. We used the sdmTMB predict() function to generate predicted crab abundance from each model over the prediction grid.

e. Indices of abundance

We used the sdmTMB get_index() function to calculate total biomass estimates and standard errors from each model, then plotted these model-based indices with the design-based index currently used in the stock assessment model for visual comparison.

f. Spatiotemporal model diagnostics

Five models converged and passed sanity checks: the Tweedie distribution family models with year as a fixed effect, year and scaled depth as fixed effects, and year and a smooth on depth as fixed effects; and the delta gamma distribution family models with year as a fixed effect and with year and scaled depth as fixed effects.

Comparing diagnostics using DHARMA residuals among the models showed that the models performed similarly: all five models showed no evidence of significant deviation in the Kolmogorov-Smirnov or outlier tests, but showed evidence of significant deviation in the dispersion test (Figures 20 - 24). The spatial distributions of residuals did not appear to show concerning patterning (Figures 25 - 29).

Cross-validation for the delta gamma distribution family models was unsuccessful, with 5 of the 10 folds for each model failing to produce positive-definite Hessian matrices, so these models were excluded from further consideration. Cross-validation analysis was successful for all of the Tweedie distribution family models. The model with year and depth as fixed effects had the smallest NLL value, indicating that this model had the best out-of-sample predictive skill of the models evaluated; this model also had the smallest RMSE and MAE values (Figure 30). The model with only year as a fixed effect scored next best on all three metrics. Given the CPT's and SSC's previously expressed concerns about including depth as a covariate in the first iteration of these models, we chose to use the model that did not include a depth covariate to generate the biomass estimates for the model-based index in the stock assessment models presented here. We plan further explorations of the costs and benefits of using a depth covariate in the spatiotemporal models in a future assessment cycle.

The Matérn range for the chosen model was 68 km, indicating spatial autocorrelation in crab abundance over a large distance (Table 9). Standard deviations were higher for spatial fields (σ_ω) than for spatiotemporal fields (σ_ϵ), indicating that spatial variability was larger than spatiotemporal variability (Table 9).

g. Spatiotemporal model predicted biomass

The two best models produce similar predictions of the spatial distribution of crab abundance (Figures 31 and 32).

h. Model-based biomass indices compared to the design-based biomass index

Biomass estimates from the design-based index are shown alongside estimates from the selected model, as well as estimates from the Tweedie distribution family model with year and scaled depth as fixed effects for comparison (Figure 33). The same information with only years from 2000 to the present included is shown in Figure 34, providing a finer-scale visualization as early years with large uncertainties for the index are excluded. The spatiotemporal model-based biomass estimates are larger than the design-based biomass estimates in most years in the time series (Table 10). The model-based biomass estimates also show somewhat reduced interannual variability compared to the design-based biomass estimates, a finding consistent with previous work (Cao et al. 2017, Chen et al. 2024). The model with only year as a fixed effect estimates slightly higher scale across the time series than the model with both year and scaled depth as fixed effects.

i. Conclusions

The spatiotemporal model-based biomass index for St. Matthew Island blue king crab accounts for differences in survey stations sampled among years, producing a consistent time series that includes both years in which corner stations were sampled (1983-2023) and years in which corner stations were not sampled (1978-1982; 2024-2026). This model-based biomass index is included in models 26.2 and 26.2a, while model 26.1b includes the design-based biomass index.

6. Spatiotemporal model-based estimation of Eastern Bering Sea trawl survey size compositions

Area-weighted age composition standardization has the potential to produce more accurate proportion-at-age estimates when sampling data are spatially unbalanced, and can lead to better stock assessment model fits (Thorson and Haltuch 2018). The use of spatiotemporal model-standardized survey age composition estimates as data inputs was recommended by the SSC in December 2019 for the Eastern Bering Sea walleye pollock and Bering Sea Pacific cod stock assessment models (Ianelli et al. 2019, Thompson and Thorson 2019, SSC 2019), and in December 2022 for the BSAI yellowfin sole stock assessment model (Spies et al. 2022, SSC 2022), and has been successfully employed in subsequent assessments for these stocks. However, to the best of the authors' knowledge, the use of model-based size composition estimates has not previously been recommended for a BSAI crab stock assessment.

Conducting area-weighted age or size composition standardization formerly required the use of the R packages VAST or tinyVAST but, in April 2026, a method for using sdmTMB to conduct this analysis was described in the vignette "Area-weighted age composition standardization with sdmTMB". Spatiotemporal model-based standardization can thus be applied to both survey biomass and survey age or size composition time series within the sdmTMB framework, allowing for a consistent approach to generating stock assessment input data.

a. Survey data for spatiotemporal analysis

Figure 35 shows biomass per unit area (kg / km^2) for each of the three modeled male size classes from the NOAA EBS trawl survey data for 2021-2026; the whole survey time series (1978-2026) was used in the analysis, but only a subset is displayed here for easier visualization. In 36 of the 48 years of the time series, size class 1 males were recorded at fewer survey stations than were males in size classes 2 and 3.

b. Spatiotemporal analysis

Much of the analysis process for the survey size composition data parallels that for the biomass data described above, but briefly: we followed the methods for area-weighted age composition standardization with sdmTMB described in the package vignette "Area-weighted age composition standardization with sdmTMB", modified to apply to size rather than age classes. We did not have *a priori* hypotheses about the ways in which the magnitude of spatial or spatiotemporal variation might differ among size classes, and thus we specified the spatial fields with shared standard deviations across size classes and the spatiotemporal fields with shared standard deviations across size-year combinations. To match the spatiotemporal model used to estimate the biomass index, described above, we used the Tweedie distribution family and included year-size as the only fixed effect.

The fitted model passed the built-in sanity checks. We calculated DHARMA residuals by simulating new data conditional on the fixed and random effects and using those data as the simulated response in DHARMA::createDHARMA(), as outlined in the tinyVAST package vignette "Comparison with mgcv" and used when producing model-estimated age compositions for Bering Sea groundfish stocks (code available on the Mod Squad model-based indices GitHub repository). Visual inspection of the Q-Q plot suggested good model fit, although the model showed evidence of significant deviation in the Kolmogorov-Smirnov, outlier,

and dispersion tests (Figure 36). The spatial distributions of residuals did not appear to show concerning patterning for any of the size classes (Figures 37 - 39). The Matérn range for the model was 59 km, indicating spatial autocorrelation in crab abundance over a slightly smaller distance for the size class model than for the model used to estimate the biomass index (Table 11). The marginal standard deviation of the spatial field for the size classes was 1.88 and the marginal standard deviation of the spatiotemporal field for the size-year combinations was 1.02 (recall that all sizes share a spatial standard deviation and all size-year combinations share a spatiotemporal standard deviation) (Table 11).

We used the same prediction grid as we used in the model-based biomass index standardization to produce predictions of the spatial distribution of crab abundance by size class. Comparing the spatial predictions among size classes, it appears that, in most years, males in size class 1 show a more restricted spatial distribution than males in size classes 2 and 3 (Figures 40 to 42). We calculated separate biomass indices for each size class using the `sdmTMB::get_index()` function, as above. We then converted these size-specific biomass indices to proportions at size (Figure 6). Figure 5 shows the proportions at size generated using design-based methods for comparison. We calculated effective sample sizes for the size composition as described in Thorson and Haltuch (2018), both for each size class and a median effective sample size across size classes. The resulting model-estimated proportions at size and median effective sample size for each year in the survey time series are shown in Table 12, with the design-based proportions at size and effective sample sizes included for comparison. Compared to the design-based size compositions, the model-based size compositions consistently estimate a smaller proportion of males in the smallest size class (Table 12; Figures 6, 5, and 43). The model-estimated proportions at size and median effective sample sizes were included in model 26.2a, replacing the design-based proportions at size and effective sample sizes.

At the September 2026 CPT meeting, CPT members pointed out that the model-based size compositions should be based on relative abundance, not relative biomass. The authors agree and re-ran the spatiotemporal model using abundance per km^2 as the response variable. Results were broadly similar and are shown in Figures 44, 45, 46, and 47, and Table 13. Due to time constraints, the authors did not re-run model 26.2a using the corrected model-based size compositions, but will use this approach in future.

E. Analytic approach

1. History of modeling approaches for this stock

A four-stage catch-survey-analysis (CSA) assessment model was used before 2011 to estimate abundance and biomass and recommend fishery quotas for the SMBKC stock. The four-stage CSA is similar to a full length-based analysis, the major difference being coarser length groups, which are more suited to a small stock with consistently low survey catches. In this approach, the abundance of male crab with a CL ≥ 90 mm was modeled in terms of four crab stages: stage 1: 90-104 mm CL; stage 2: 105-119 mm CL; stage 3: newshell 120-133 mm CL; and stage 4: oldshell ≥ 120 mm CL and newshell ≥ 134 mm CL. Motivation for these stage definitions came from the fact that, for management of the SMBKC stock, male crab measuring ≥ 105 mm CL are considered mature, whereas 120 mm CL is considered a proxy for the legal size of 5.5 in carapace width, including spines. Additional motivation for these stage definitions came from an estimated average growth increment of about 14 mm per molt for SMBKC (Otto and Cummiskey 1990).

Concerns about the pre-2011 assessment model led to CPT and SSC recommendations that included development of an alternative model with provisional assessment based on survey biomass or some other index of abundance. An alternative 3-stage model was proposed to the CPT in May 2011, but a survey-based approach was requested for the fall 2011 assessment. In May 2012, the CPT approved a slightly revised and better-documented version of the alternative model for assessment. The model developed and used from 2012 to 2015 was a variant of the previous four-stage SMBKC CSA model and similar in complexity to that described by Collie et al. (2005). Like the earlier model, it considered only male crab ≥ 90 mm in CL, but combined stages 3 and 4 of the earlier model, resulting in three stages (male size classes) defined by CL measurements of (1) 90-104 mm, (2) 105-119 mm, and (3) 120 mm+ (i.e., 120 mm and above). This consol-

idation was driven by concern about the accuracy and consistency of shell condition information, which had been used in distinguishing stages 3 and 4 of the earlier model.

In 2016, the accepted SMBKC assessment model made use of the modeling framework GMACS, with a three-stage model structure (Webber et al. 2016). In that assessment, an effort was made to match the 2015 SMBKC stock assessment model while bridging to a new framework that provided greater flexibility and opportunity to evaluate model assumptions more fully. Since 2016, the assessment has continued to use GMACS, transitioning to more recent versions of GMACS as development has progressed.

2. Model description

a. Description of overall modeling approach

The model is a male-only size-structured model based on biomass that combines data from surveys, fishery catches, and discards using a maximum likelihood modeling framework to estimate population dynamics under fisheries. Model details are presented in Appendix A. The model estimates biomass of male crab with $CL \geq 90$ mm in 3 length classes: 90 - 104 mm, 105 - 119 mm, and ≥ 120 mm. Natural mortality is fixed at the value estimated by the most recent accepted Bristol Bay red king crab stock assessment model. Here, $M = 0.23$. The timeline of events in the model is as follows:

- The model begins on 1 July.
- Season 1: instantaneous survey period.
- Season 2: natural mortality occurs.
- Season 3: instantaneous fishing mortality occurs.
- Season 4: natural mortality occurs.
- Season 5: 15 February-30 June. Mature male biomass is calculated on 15 February. Growth and recruitment occur.

b. Reference software used

The Generalized size-structured Model for Assessing Crustacean Stocks (GMACS) version 2.20.44, compiled with AD Model Builder 13.2. GMACS source code and information is available at <https://github.com/GMACS-project>.

c. Description of all likelihood components

Likelihood components are shown in Table 14.

d. Description of how the state of the population at the start of the first year of the assessment period is determined and the size-range that the model covers

The first year of the assessment period was set to 1978, such that the assessment covers the period following a hypothesized shift in stock productivity due to a climatic regime shift indexed by the Pacific Decadal Oscillation (PDO) in 1976-77. The model includes male crab with $CL \geq 90$ mm in 3 length classes: 90-104 mm, 105-119 mm, and ≥ 120 mm.

e. Parameter estimation framework

A maximum likelihood approach was used to estimate parameters. Priors, bounds, and constraints on parameters are detailed in the model control file, shown in Appendix B.

f. Definition of model outputs

Mature male biomass is defined as the biomass of males with $CL \geq 105$ mm. Male recruit biomass is defined as the biomass of males with CL of 90-104 mm.

g. Critical assumptions and consequences of assumption failures

- Male size at maturity is 105 mm CL .
- Mean weight by stage is constant across years.
- Natural mortality is constant across size classes and is equal to the value estimated in the BBRKC stock assessment model ($M = 0.23$).
- A natural mortality event occurred in 1998/1999, the magnitude of which is estimated in the model.
- NOAA EBS trawl survey abundance has the same scale as the population, i.e., catchability (q) is equal to 1.

h. Changes to any of the above since the previous assessment

The critical assumptions listed above have not changed since the previous assessment.

i. Outline of methods used to validate the code to implement the model and whether the code is available

Files needed to implement the model are available on the GMACS GitHub model repository and GMACS source code is available at <https://github.com/GMACS-project>. Results are compared to those of previous assessments. GMACS code is validated by CPT members.

3. Model selection and evaluation

a. Alternative model configurations

In this document, we present five models. Two of these models are presented only for bridging analysis purposes and are not recommended as candidates for harvest specifications because they either use an older version of GMACS (model 26.1) or do not include the most updated data (model 26.1a). Model 26.2a is a research model and is also not recommended as a candidate for harvest specifications. The models presented are as follows:

1. Model 26.1 was recommended as the updated base model by the CPT and SSC in May/June 2026. This model used GMACS version 2.20.34a and contains data updates available in May 2026: 2025 EBS trawl survey biomass and size composition data, 2025 ADF&G pot survey biomass and size composition data, and 2024/2025 groundfish fisheries bycatch data.

2. Model 26.1a is model 26.1 transitioned to a newer version of GMACS, 2.20.44. This model is presented to verify that transitioning to a newer version of GMACS does not substantially alter model results.
3. Model 26.1b, the new base model, is model 26.1a updated with data available in August 2026: 2026 EBS trawl survey biomass and size composition data and 2025/2026 groundfish fisheries bycatch data.
4. Model 26.2 is model 26.1b with a spatiotemporal model-based index used in place of the design-based EBS trawl survey biomass index.
5. Model 26.2a is model 26.2 with spatiotemporal model-estimated size compositions for the EBS trawl survey time series used in place of the design-based size composition estimates.

b. Progression of results

The impacts of moving from GMACS version 2.20.34a to version 2.20.44 can be observed by comparing models 26.1 and 26.1a. The transition between GMACS versions had little to no discernable impact on model fits to data and the overall negative log-likelihood value was unchanged (Table 14). The impacts of adding 2026 NOAA EBS trawl survey data and 2025/2026 groundfish bycatch data can be observed by comparing models 26.1a and 26.1b (Table 14). The fit to the EBS trawl survey biomass index was improved with the addition of new data, while the fit to the ADF&G pot survey abundance index was slightly worse. The fit to the fishery size composition data showed little change. The fit to the EBS trawl survey size composition data improved with the addition of new data, while the fit to the ADF&G pot survey size composition data was slightly worse. The estimated mature male biomass trajectory was similar among the three models in the bridging analysis (Figure 49). Estimated recruitment trajectories were nearly identical among the models in the bridging analysis, with the exception of the terminal year estimates, in which estimated recruitment was higher for models 26.1 and 26.1a than for model 26.1b (Figure 48). Overall, the transition to a newer GMACS version and the addition of 2026 data do not seem to have had unexpected or concerning effects on the base model fits or estimates. Model 26.1b is designated as the new base model. For results from the models to be considered for harvest specifications, as well as the research model, please see below.

c. Model numbering conventions

We have endeavored to follow the conventions for numbering models.

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

The alternative models presented, 26.2 and 26.2a, use spatiotemporal model-based methods for estimating the EBS trawl survey biomass index and size compositions, and may represent a move towards greater realism by accounting for spatiotemporal variation when producing these estimates. The alternative models are not otherwise different in complexity from the base model.

e. Convergence status/criteria

We used the default ADMB convergence criteria.

f. Sample sizes for length composition data

Input sample sizes for length composition data are shown in Appendix B.

g. Credible parameter estimates

All estimated parameters seem to be credible and within bounds.

h. Model selection criteria

A variety of model selection criteria are considered, including likelihood values (when comparable among models), analysis of residuals, and retrospective analysis.

i. Residual analysis

Residuals plots are presented below.

j. Model evaluation

Model evaluation is provided under Results below.

k. Jittering

We performed 100 jitter runs for each model using GMACS, with starting parameter values for the jitter runs randomly selected within a range of 0.3 standard deviations from the existing initial parameter values. Jittering results are discussed in the “Model convergence” section of the Results section and shown in Table 18.

4. Results

Model convergence

We evaluated model convergence by using parameter jittering to find the parameter values that minimized the model objective function, checking that the model Hessian was invertible and that the maximum gradient at the candidate maximum likelihood estimate (MLE) was close to zero. Starting parameter values for the jitter runs were randomly selected within a range of 0.3 standard deviations from the existing initial parameter values. We performed 100 jitter runs for each of models 26.1b, 26.2, and 26.2a.

For each model, the jittering analysis appeared to identify the set of parameters corresponding to the minimum objective function value, with the majority of model runs converging to the same minimum objective function value (Table 18). Similar percentages of model runs converged to the MLE for all models, ranging from 81-90%. Maximum gradients at the MLE were small for all models.

Fits to fishery catch data

Fits to fishery retained catch data were similar among the three models (26.1b, 26.2, and 26.2a), while fits to fishery discarded catch data were worse for the models fitting to the model-based EBS trawl survey index (26.2 and 26.2a) than for the base model (26.1b) (Figure 50 and Table 14). Fits to bycatch in the groundfish trawl and fixed gear fisheries were nearly identical across models 26.1b, 26.2, and 26.2a (Table 14).

Fits to abundance indices

Fit to the EBS trawl survey design-based biomass index was improved by the addition of 2026 survey data, with model 26.1b fitting the index better than models 26.1 and 26.1a (Figure 51, Table 14). Between the models fitting to the model-based index for the EBS trawl survey, the model that also included model-based size composition estimates for the EBS trawl survey (model 26.2a) fit the index better than the model using the design-based size composition estimates for the EBS trawl survey (model 26.2) (Figure 52, Table 14).

Fit to the ADF&G pot survey relative abundance index was worsened by the addition of 2026 survey data, with model 26.1b showing a poorer fit to the index than models 26.1 and 26.1a (Figure 53, Table 14). Both of the models fitting to the model-based index for the EBS trawl survey fit the ADF&G pot survey index worse than model 26.1b; the model with model-based EBS trawl survey size composition estimates (model 26.2a) fit the index more poorly than the model with design-based EBS trawl survey size composition estimates (model 26.2) (Figure 54, Table 14). Model-estimated catchability for the ADF&G pot survey was 0.0037 (SE = 0.0002) for model 26.1b, 0.0025 (SE = 0.0002) for model 26.2, and 0.0022 (SE = 0.0001) for model 26.2a.

Fits to size compositions

Fits to size composition data from the directed fishery catch were similar across the model scenarios, with model 26.2a showing the best fit to this time series (Figures 55 and 56, Table 14). Fit to size composition data from the EBS trawl survey was better for the model using the model-based EBS trawl survey biomass index (26.2) than for the model using the design-based index (26.1b); the model using the model-estimated EBS trawl survey size compositions was fitting to a different data set than the other two models (Figures 57 and 58, Table 14). Fit to size composition data from the ADF&G pot survey was best for model 26.1b and worst for model 26.2a (Figures 59 and 60, Table 14). One-Step-Ahead (OSA) residuals for model fits to size composition time series are shown in Figures 61 - 69.

Estimated population quantities

Recruitment Estimated recruitment trajectories were similar between model 26.1b and the models using a model-based biomass index for the EBS trawl survey, with the main difference being the larger estimated scale of the population in the models using the model-based biomass index (Figure 70, Tables 15 - 17). In all model scenarios, estimated recruitment in 2025 was the highest for several years, although still low compared to estimates earlier in the time series.

Mature male biomass Estimated MMB trajectories differed between the base model (26.1b) and the models using a model-based biomass index for the EBS trawl survey in scale but not in trend: model 26.2, with the EBS trawl survey model-based biomass index, and model 26.2a, with both the EBS trawl survey model-based biomass index and model-estimated size compositions, both estimated higher MMB than the base model throughout most of the time series (Figure 71, Tables 15 - 17). Model 26.2a estimated a slightly higher scale than model 26.2. All three models projected a decrease in MMB for 2026/2027. Estimated population abundances by size class for model 26.1b are displayed in Table 22.

Estimated fishery selectivity

In all model scenarios, selectivity for the directed fishery was estimated for the two smaller size classes and fixed at 1 for the largest size class. The size classes are determined by CL measurements of (1) 90-104 mm, (2) 105-119 mm, and (3) 120+ mm. For size class 1, the base model estimated lower selectivity than did the two models using the model-based EBS survey index, while estimated selectivity for size class 2 was similar across the three models (Figure 72).

Estimated survey selectivity

For both surveys in all model scenarios, survey selectivity was estimated for the two smaller size classes and fixed for the largest size class. For the ADF&G pot survey, estimated selectivity was lower for both size classes 1 and 2 for the base model than for the two models using the model-based EBS survey index (Figure 72). For the EBS trawl survey, estimated selectivity for size class 2 was slightly greater than 1 for all model scenarios (Figure 72, Table 5). This is despite the upper bound of 1 placed on this parameter in the model control file (Appendix B); the CPT plans to address this issue with out-of-bounds estimation in its 2027 January modeling workshop. Estimated selectivity for size class 1 was much lower for the model using model-based size compositions for the EBS trawl survey (26.2a) than for either of the other models, consistent with the smaller estimated proportion of males in size class 1 in the model-based compared to the design-based size compositions (Table 12).

Estimated fishing mortality

Estimated fishing mortalities from the directed pot fishery, bycatch in the groundfish fixed gear fisheries, and bycatch in the groundfish trawl fisheries were similar across model scenarios (Figure 73). The models using a model-based biomass index for the EBS trawl survey estimate lower fishing mortality rates in some years, but these differences are relatively small in the more recent years of the time series.

Estimated natural mortality

For all model scenarios, natural mortality is fixed at 0.23 for all years except 1998/1999, in which an estimated natural mortality pulse occurs (i.e., M_{1998}). This estimated M_{1998} was nearly identical across model scenarios (Figure 74).

Retrospective analyses

In the previous iteration of this assessment, a positive retrospective bias appeared beginning with the 2016 peel (Stern and Palof 2024). The authors noted that the relative stability of MMB estimates for the 2022-2017 peels could be a result of the stability in EBS trawl survey biomass estimates in the years following 2016 relative to the larger fluctuations in biomass estimates over 2013-2016, and/or the greater consistency in trends between the EBS trawl survey biomass index and ADF&G relative abundance index beginning in 2017 (Figure 2).

Similarly, retrospective analyses for all three models found a positive retrospective pattern that was visually apparent for the 2016 and 2015 peels (Figures 75 - 77). The Mohn's ρ estimates for models 26.1b and 26.2 were nearly equal while the estimate for model 26.2a was closer to zero, suggesting reduced model misspecification for model 26.2a compared to the other two models. The Mohn's ρ estimates for all three models were lower than in past iterations of this assessment.

Uncertainty and sensitivity analyses

Uncertainty for parameters and derived quantities was estimated using the covariance matrix obtained by inverting the model Hessian matrix at the MLE. Estimated standard errors of parameters for models 26.1b - 26.2a are summarized in Tables 19 - 21.

Comparison of alternative model scenarios

The authors recommend model 26.2 for harvest specifications. While model 26.2a has both the lowest total negative log-likelihood and the Mohn's ρ estimate closest to zero, suggesting improved fits to input data

and reduced model misspecification compared to models 26.1b and 26.2, model 26.2a is currently a research model, and the approach to producing model-based size composition estimates requires further development before being used in a model for harvest specifications.

By incorporating a spatiotemporal model-based index in place of the design-based EBS trawl survey biomass index, both models 26.2 and 26.2a take into account spatiotemporal processes that underlie survey observations, effectively standardizing a time series in which survey sampling has changed over time. Model 26.2a, by additionally including spatiotemporally standardized EBS trawl survey size composition estimates in place of the design-based size composition estimates, represents a consistent approach to standardizing EBS trawl survey data. The authors request feedback from the CPT and SSC on the spatiotemporal standardization of size composition estimates used in Model 26.2a, with the goal of moving to a model that uses this approach in a future assessment cycle.

Selecting model 26.2 for harvest specifications would address previous concerns about possible bias introduced into the EBS trawl survey time series by the changes in survey station sampling that occurred in 2024-2026. In future, using a model that also includes the model-based size compositions, similar to model 26.2a, would ensure that the two EBS trawl survey time series included in the model (biomass index and size compositions) were standardized using a unified approach. Using a model with both a model-based index and model-based size composition estimates would also accord with precedent, since the SSC accepted stock assessment models using both model-based biomass and size composition estimates when first moving to using model-based survey data estimation for the EBS pollock, EBS Pacific cod, and BSAI yellowfin sole stocks (Ianelli et al. 2019, Thompson and Thorson 2019, SSC 2019, Spies et al. 2022, SSC 2022).

Stock projections

Projections of the stock 5 years into the future based on models 26.1b, 26.2, and 26.2a suggest stock growth when mean recruitment over 1978-2024 is used to project future recruitment and directed fishing pressure is set at $F = 0$, $F = 0.05$, or $F = 0.1$ (Figures 78 - 80). Model 26.1b projected that MMB will exceed B_{MSY} by 2031 for all directed fishing pressure scenarios, while model 26.2 projected MMB exceeding B_{MSY} by 2031 only if $F = 0$, and model 26.2a projected MMB below B_{MSY} in 2031 even if $F = 0$. Recall that, for this Tier 4 stock, B_{MSY} is estimated as the mean MMB from 1978 to the most recent completed crab year.

To capture the possibility that future recruitment may be more accurately predicted by recruitment estimated in more recent years, we also ran projections that used mean recruitment over 2015-2024 to project future recruitment. In that case, with directed fishing pressure again set at $F = 0$, $F = 0.05$, or $F = 0.1$, models 26.1b, 26.2, and 26.2a all projected more limited population growth (Figures 81 - 83). Model 26.1b projected that MMB will remain above the MSST but below B_{MSY} during the next 5 years, while models 26.2 and 26.2a both projected that MMB will remain above the MSST until 2031 only if $F = 0$ (Figures 81 - 83). Given that recruitment estimates have been low compared to the historical time series over the past 10 years (Figures 70), using a more recent recruitment period likely yields more realistic projections of the future stock size trajectory.

F. Calculation of the OFL

The overfishing level (OFL) is the total catch associated with the F_{OFL} fishing mortality. The SMBKC stock is currently managed as Tier 4, and only a Tier 4 analysis is presented here. Thus, given stock estimates or suitable proxy values of B_{MSY} and F_{MSY} , along with two additional parameters α and β , F_{OFL} is determined by the control rule

$$F_{OFL} = \begin{cases} F_{MSY}, & \text{when } B/B_{MSY} > 1 \\ F_{MSY} \frac{(B/B_{MSY} - \alpha)}{(1 - \alpha)}, & \text{when } \beta < B/B_{MSY} \leq 1 \end{cases} \quad (1)$$

$F_{OFL} < F_{MSY}$ with directed fishery $F = 0$ when $B/B_{MSY} \leq \beta$

where B is quantified as mature-male biomass (MMB) at mating with time of mating assigned a nominal date of 15 February. Note that B is a function of the fishing mortality F_{OFL} (therefore numerical approximation of F_{OFL} is required). As implemented for this assessment, all calculations proceed according to the model equations given in Appendix A. F_{OFL} is taken to be full-selection fishing mortality in the directed pot fishery, and groundfish trawl and fixed-gear fishing mortalities are set at their geometric mean values over years for which there are data-based estimates of bycatch mortality biomass.

The currently recommended Tier 4 convention is to use the full assessment period, 1978 to the most recent completed crab year, to define a B_{MSY} proxy in terms of average estimated MMB and to set $\gamma = 1.0$ with assumed stock natural mortality $M = 0.23 \text{ yr}^{-1}$ in setting the F_{MSY} proxy value γM . The parameters α and β are assigned their default values $\alpha = 0.10$ and $\beta = 0.25$. The F_{OFL} , OFL, ABC, and MMB in 2026/27 for all the models are summarized in Table 4. The currently recommended ABC is 75% of the OFL (ABC buffer = 25%).

Table 4: Comparisons of management measures for models 26.1b, 26.2, and 26.2a. Biomass, OFL, and ABC are in tons. Model 26.1b is the new base model, with updated data and a newer GMACS version. Model 26.2 is model 26.1b with a model-based index for the Eastern Bering Sea (EBS) trawl survey biomass time series replacing the design-based index. Model 26.2a is model 26.2 with model-based rather than design-based size compositions for the EBS trawl survey time series.

Model	MMB ₂₀₂₆	B_{MSY}	MMB/B_{MSY}	F_{OFL}	OFL ₂₀₂₆	ABC ₂₀₂₆	MSST	M
26.1b	1528	2876	0.53	0.11	151	113	1438	0.23
26.2	2116	4497	0.47	0.10	182	136	2249	0.23
26.2a	2311	4812	0.48	0.10	202	152	2406	0.23

G. Calculation of the ABC

The ABC is calculated as the OFL multiplied by (1 - the ABC buffer). For this stock, the ABC buffer was 25% in 2020, 2022, and 2024. In 2024, the CPT and SSC supported the author-recommended 25% buffer to set the ABC for the following reasons: 1) the stock was in a fixed rebuilding time frame; 2) there was a significant retrospective pattern on MMB estimates; 3) limited life history information was available for correctly specifying the population processes; and 4) ADF&G pot and NOAA EBS trawl survey data showed contradictory trends. An additional concern for the 2024 assessment was that the NOAA EBS trawl survey corner stations were not surveyed in 2024, potentially adding bias to biomass estimates, although that bias was expected to lead to biomass underestimates rather than overestimates. Two of these concerns have been addressed in the 2026 assessment: the retrospective pattern on MMB estimates is improved for both of the models presented for harvest specifications, and the dropping of corner stations is accounted for by using a spatiotemporal model-based index of abundance for the EBS trawl survey in models 26.2 and 26.2a. The trawl and pot survey time series have shown greater agreement in population trends in recent years (Figure 2), but combining these time series into a single index of abundance remains an important goal for this assessment. The authors recommend retaining the 25% ABC buffer for setting harvest specifications.

H. Rebuilding analysis and update

This stock was declared overfished in fall of 2018, and a rebuilding plan was approved by the NPFMC in June 2020 (NPFMC 2020a). The most updated rebuilding plan can be found on the NPFMC website for the June 2020 meeting (NPFMC 2020b). This assessment was moved to a biennial assessment in early 2021, with full assessments performed in even-numbered years, which falls in line with the two-year rebuilding progress updates required under the rebuilding plan.

In 2024, estimated B/B_{MSY} was greater than 50% in 2024/2025 for the accepted model, the first year since the rebuilding plan was approved that the stock had reached this threshold (Stern and Palof 2024). While both models to be considered for harvest specifications this year estimate that B/B_{MSY} was greater than 50% in 2025/2026, both models also project decreased MMB in 2026/2027 compared to 2025/2026. Model 26.1b projects that B/B_{MSY} will remain above 50% in 2026/2027, but model 26.2 projects that B/B_{MSY} will fall below 50%. For both models, estimated MMB remains well below B_{MSY} . As stated in the Crab FMP, when a rebuilding plan is required, the minimum standard for a rebuilding target is B_{MSY} (NPFMC 2021).

The recovery of this stock is highly dependent upon successful recruitment, which is likely linked to climate variability but not well understood. Recruitment was likely negatively impacted by an ecosystem regime shift in the Bering Sea in 1989, and above-average bottom temperatures in recent years (NPFMC 2020b). Consistently cooler bottom temperatures might be expected to have a positive effect on St Matthew Island blue king crab recruitment, although more research on the factors affecting recruitment is needed. EBS trawl survey estimated biomass of males in the model was low in 2021-2025 before increasing in 2026, and ADF&G pot survey estimated CPUE, while increasing, is still low relative to historical estimates (Figure 2). Model estimates of recruitment suggest the potential for future stock growth, but ecological conditions will likely impact whether this potential is realized (Figure 70).

I. Data gaps and research priorities

The following topics have been identified as areas where more research on SMBKC is needed: 1) growth increments and molting probabilities as a function of size; 2) trawl survey catchability and selectivities; 3) pot survey catchability and selectivities; 4) temporal changes in spatial distributions near the island; and 5) natural mortality.

Important model development priorities for future assessment cycles include 1) developing a single index of abundance that integrates both the EBS trawl survey and ADF&G pot survey time series; 2) explorations of

estimating catchability for the EBS trawl survey biomass index; and 3) determining the causes of estimated EBS trawl survey selectivity for size class 2 exceeding the upper bound placed on this parameter.

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Tables

Table 5: Capture selectivities in the Eastern Bering Sea (EBS) trawl survey for each size class. Model 26.1b is the new base model, with updated data and a newer GMACS version. Model 26.2 is model 26.1b with a model-based index for the EBS trawl survey biomass time series replacing the design-based index. Model 26.2a is model 26.2 with model-based rather than design-based size compositions for the EBS trawl survey time series. Selectivity is fixed for size class 3 and estimated selectivity for size classes 1 and 2 is bounded by (0.001, 1.0) for all three models.

Model	Size 1	Size 2	Size 3
26.1b	0.71	1.10	1
26.2	0.85	1.11	1
26.2a	0.33	1.11	1

Table 6: Fishery characteristics and update. Columns include the 1978/79 to 2015/16 directed St. Matthew Island blue king crab pot fishery. The Guideline Harvest Level (GHL) and Total Allowable Catch (TAC) are in millions of pounds. Harvest includes deadloss. Catch per unit effort (CPUE) in this table is the harvest number / pot lifts. The average weight is the harvest weight / harvest number in pounds. The average carapace length (CL) is the average of retained crab in mm from dockside sampling of delivered crab. Source: Fitch et al 2012; ADF&G Dutch Harbor staff, pers. comm. Note that management (GHL) units are in pounds, for conserving space, conversion to tons is ommitted.

Year	Dates	GHL/TAC	Harvest		Pot lifts	CPUE	Avg wt	Avg CL
			Crab	Pounds				
1978/79	07/15 - 09/03		436,126	1,984,251	43,754	10	4.5	132.2
1979/80	07/15 - 08/24		52,966	210,819	9,877	5	4.0	128.8
1980/81	07/15 - 09/03		CONFIDENTIAL					
1981/82	07/15 - 08/21		1,045,619	4,627,761	58,550	18	4.4	NA
1982/83	08/01 - 08/16		1,935,886	8,844,789	165,618	12	4.6	135.1
1983/84	08/20 - 09/06	8.0	1,931,990	9,454,323	133,944	14	4.9	137.2
1984/85	09/01 - 09/08	2.0-4.0	841,017	3,764,592	73,320	11	4.5	135.5
1985/86	09/01 - 09/06	0.9-1.9	436,021	2,175,087	46,988	9	5.0	139.0
1986/87	09/01 - 09/06	0.2-0.5	219,548	1,003,162	22,073	10	4.6	134.3
1987/88	09/01 - 09/05	0.6-1.3	227,447	1,039,779	28,230	8	4.6	134.1
1988/89	09/01 - 09/05	0.7-1.5	280,401	1,236,462	21,678	13	4.4	133.3
1989/90	09/01 - 09/04	1.7	247,641	1,166,258	30,803	8	4.7	134.6
1990/91	09/01 - 09/07	1.9	391,405	1,725,349	26,264	15	4.4	134.3
1991/92	09/16 - 09/20	3.2	726,519	3,372,066	37,104	20	4.6	134.1
1992/93	09/04 - 09/07	3.1	545,222	2,475,916	56,630	10	4.5	134.1
1993/94	09/15 - 09/21	4.4	630,353	3,003,089	58,647	11	4.8	135.4
1994/95	09/15 - 09/22	3.0	827,015	3,764,262	60,860	14	4.9	133.3
1995/96	09/15 - 09/20	2.4	666,905	3,166,093	48,560	14	4.7	135.0
1996/97	09/15 - 09/23	4.3	660,665	3,078,959	91,085	7	4.7	134.6
1997/98	09/15 - 09/22	5.0	939,822	4,649,660	81,117	12	4.9	139.5
1998/99	09/15 - 09/26	4.0	635,370	2,968,573	91,826	7	4.7	135.8
1999/00 - 2008/09			FISHERY CLOSED					
2009/10	10/15 - 02/01	1.17	103,376	460,859	10,697	10	4.5	134.9
2010/11	10/15 - 02/01	1.60	298,669	1,263,982	29,344	10	4.2	129.3
2011/12	10/15 - 02/01	2.54	437,862	1,881,322	48,554	9	4.3	130.0
2012/13	10/15 - 02/01	1.63	379,386	1,616,054	37,065	10	4.3	129.8
2013/14			FISHERY CLOSED					
2014/15	10/15 - 02/05	0.66	69,109	308,582	10,133	7	4.5	132.3
2015/16	10/19 - 11/28	0.41	24,076	105,010	5,475	4	4.4	132.6
2016/17 - 2025/26			FISHERY CLOSED					

Table 7: Observed proportion of crab by size class during the ADF&G crab observer pot lift sampling. Size classes are (1) 90-104 mm, (2) 105-119 mm, and (3) 120+ mm. Source: ADF&G Crab Observer Database.

Year	Total pot lifts	Pot lifts sampled	Number of crab (90 mm+ CL)	Stage 1	Stage 2	Stage 3
1990/91	26,264	10	150	0.113	0.393	0.493
1991/92	37,104	125	3,393	0.133	0.177	0.690
1992/93	56,630	71	1,606	0.191	0.268	0.542
1993/94	58,647	84	2,241	0.281	0.210	0.510
1994/95	60,860	203	4,735	0.294	0.271	0.434
1995/96	48,560	47	663	0.148	0.212	0.640
1996/97	91,085	96	489	0.160	0.223	0.618
1997/98	81,117	133	3,195	0.182	0.205	0.613
1998/99	91,826	135	1,322	0.193	0.216	0.591
1999/00 - 2008/09			FISHERY CLOSED			
2009/10	10,484	989	19,802	0.141	0.324	0.535
2010/11	29,356	2,419	45,466	0.131	0.315	0.553
2011/12	48,554	3,359	58,666	0.131	0.305	0.564
2012/13	37,065	2,841	57,298	0.141	0.318	0.541
2013/14			FISHERY CLOSED			
2014/15	10,133	895	9,906	0.094	0.228	0.679
2015/16	5,475	419	3,248	0.115	0.252	0.633
2016/17 - 2025/26			FISHERY CLOSED			

Table 8: Groundfish SMBKC male bycatch biomass (t) estimates. Trawl includes pelagic trawl and non-pelagic trawl types. Source: NMFS Alaska Regional Office.

Year	Trawl bycatch	Fixed gear bycatch
1978	0.000	0.000
1979	0.000	0.000
1980	0.000	0.000
1981	0.000	0.000
1982	0.000	0.000
1983	0.000	0.000
1984	0.000	0.000
1985	0.000	0.000
1986	0.000	0.000
1987	0.000	0.000
1988	0.000	0.000
1989	0.000	0.000
1990	0.000	0.000
1991	3.538	0.045
1992	1.996	2.268
1993	1.542	0.500
1994	0.318	0.091
1995	0.635	0.136
1996	0.500	0.045
1997	0.500	0.181
1998	0.500	0.907
1999	0.500	1.361
2000	0.500	0.500
2001	0.500	0.862
2002	0.726	0.408
2003	0.998	1.134
2004	0.091	0.635
2005	0.500	0.590
2006	2.812	1.451
2007	0.045	69.717
2008	0.272	6.622
2009	0.638	7.522
2010	0.360	9.564
2011	0.170	0.796
2012	0.011	0.739
2013	0.163	0.341
2014	0.010	0.490
2015	0.010	0.711
2016	0.229	1.630
2017	0.048	5.935
2018	0.001	1.224
2019	0.030	1.124
2020	0.001	0.671
2021	0.001	0.323
2022	0.001	2.118
2023	0.005	0.415
2024	0.001	0.720
2025	0.001	1.879

Table 9: Spatial parameters for the spatiotemporal model used for biomass index standardization. The model used the Tweedie distribution family and included year as a fixed effect. Terms include the Matérn range (the distance at which spatial correlation decays such that two points are effectively independent), the standard deviation for spatial fields (σ_ω), and the standard deviation for spatiotemporal fields (σ_ϵ).

Distribution	Fixed effects	Term	Estimate	SE
Tweedie	year	range	67.77	7.10
Tweedie	year	phi	29.41	0.97
Tweedie	year	sigma_O	1.87	0.21
Tweedie	year	sigma_E	1.05	0.05
Tweedie	year	tweedie_p	1.18	0.01
Tweedie	year, depth	range	68.16	7.20
Tweedie	year, depth	phi	29.40	0.97
Tweedie	year, depth	sigma_O	1.85	0.21
Tweedie	year, depth	sigma_E	1.05	0.05
Tweedie	year, depth	tweedie_p	1.18	0.01

Table 10: Estimated biomass of St. Matthew Island blue king crab males ≥ 90 mm in carapace length using either design-based (DB) or model-based (MB) methods.

Year	DB biomass	DB CV	MB biomass	MB CV
1978	6,833	0.39	22,279	0.63
1979	7,990	0.46	25,095	0.51
1980	9,987	0.51	17,888	0.41
1981	6,551	0.40	23,266	0.51
1982	16,222	0.34	26,073	0.29
1983	9,634	0.30	27,023	0.52
1984	4,071	0.18	5,966	0.28
1985	3,111	0.21	5,773	0.35
1986	1,417	0.39	2,654	0.49
1987	2,279	0.29	4,252	0.41
1988	3,158	0.25	4,600	0.32
1989	6,339	0.27	7,077	0.22
1990	6,730	0.27	11,391	0.33
1991	6,948	0.25	11,906	0.33
1992	7,093	0.20	8,980	0.24
1993	9,548	0.17	14,411	0.29
1994	6,539	0.18	8,011	0.23
1995	5,704	0.18	7,458	0.26
1996	9,410	0.24	16,863	0.34
1997	10,924	0.34	12,299	0.23
1998	7,977	0.36	9,728	0.29
1999	1,595	0.18	2,339	0.33
2000	2,097	0.31	3,635	0.47
2001	2,831	0.25	3,192	0.26
2002	1,733	0.32	2,586	0.40
2003	1,567	0.34	2,405	0.40
2004	1,524	0.30	2,742	0.43
2005	1,642	0.37	3,697	0.59
2006	3,894	0.33	4,978	0.29
2007	6,471	0.38	6,811	0.25
2008	4,654	0.28	5,829	0.30
2009	6,301	0.26	10,249	0.38
2010	11,131	0.47	11,414	0.25
2011	10,931	0.56	10,272	0.28
2012	6,200	0.34	7,219	0.25
2013	2,288	0.22	3,248	0.33
2014	6,029	0.45	6,346	0.29
2015	5,877	0.77	4,642	0.36
2016	3,529	0.39	4,365	0.32
2017	1,814	0.60	1,546	0.33
2018	1,750	0.28	2,066	0.29
2019	3,207	0.34	3,439	0.26
2021	1,949	0.43	2,492	0.40
2022	2,391	0.50	3,904	0.45
2023	2,141	0.44	2,562	0.35
2024	1,858	0.47	2,692	0.38
2025	1,861	0.44	2,337	0.34
2026	2,915	0.47	3,796	0.34

Table 11: Spatial parameters for the spatiotemporal model used for size composition estimation. The Matérn range term indicates the distance at which spatial correlation decays such that two points are effectively independent. The σ_ζ value of 1.88 is the marginal standard deviation of the spatial field for the size classes (all sizes share a spatial standard deviation). The σ_ζ value of 1.02 is the marginal standard deviation of the spatiotemporal field for the size-year combinations (all size-year combinations share a spatiotemporal standard deviation).

Distribution	Fixed effects	Term	Estimate	SE
Tweedie	year	range	58.55	4.47
Tweedie	year	phi	25.42	0.45
Tweedie	year	sigma_Z size	1.88	0.13
Tweedie	year	sigma_Z size-year	1.02	0.04
Tweedie	year	tweedie_p	1.16	0.01

Table 12: Proportions of male blue king crab in each model size bin estimated using either design-based (DB) or model-based (MB) methods, with the MB method based on biomass per area. Size bin 1 is 90-104 mm, size bin 2 is 105-119 mm, and size bin 3 is 120 mm and larger. n DB = estimated effective sample sizes for the DB size compositions. n MB = estimated median effective sample sizes for the MB size compositions.

year	Size 1 DB	Size 2 DB	Size 3 DB	n DB	Size 1 MB	Size 2 MB	Size 3 MB	n MB
1978	0.387	0.348	0.266	50.0	0.186	0.527	0.287	23.5
1979	0.428	0.319	0.253	50.0	0.187	0.451	0.362	28.0
1980	0.359	0.322	0.319	50.0	0.149	0.407	0.445	30.9
1981	0.122	0.306	0.572	38.5	0.039	0.344	0.617	20.8
1982	0.167	0.244	0.589	50.0	0.063	0.266	0.671	42.1
1983	0.175	0.273	0.552	50.0	0.059	0.247	0.694	24.1
1984	0.182	0.208	0.609	36.2	0.081	0.232	0.687	44.9
1985	0.202	0.201	0.597	26.8	0.101	0.190	0.709	41.4
1986	0.198	0.436	0.365	15.8	0.086	0.500	0.414	18.8
1987	0.194	0.378	0.428	24.5	0.104	0.441	0.455	26.0
1988	0.188	0.374	0.438	28.8	0.086	0.437	0.476	32.6
1989	0.425	0.226	0.350	50.0	0.222	0.308	0.470	66.8
1990	0.238	0.233	0.529	49.8	0.088	0.390	0.522	30.7
1991	0.227	0.330	0.443	50.0	0.123	0.410	0.467	37.2
1992	0.226	0.291	0.483	50.0	0.102	0.351	0.547	51.7
1993	0.230	0.276	0.495	50.0	0.104	0.272	0.624	49.6
1994	0.199	0.293	0.509	50.0	0.119	0.295	0.586	61.0
1995	0.259	0.300	0.440	50.0	0.112	0.375	0.513	44.1
1996	0.200	0.305	0.495	50.0	0.082	0.352	0.566	30.1
1997	0.162	0.310	0.528	50.0	0.086	0.281	0.633	67.8
1998	0.128	0.321	0.551	50.0	0.064	0.341	0.596	38.8
1999	0.222	0.221	0.556	16.8	0.106	0.256	0.638	32.8
2000	0.215	0.218	0.567	17.8	0.083	0.242	0.674	25.0
2001	0.225	0.270	0.505	27.0	0.116	0.337	0.547	39.8
2002	0.113	0.235	0.653	10.2	0.034	0.286	0.680	23.3
2003	0.376	0.234	0.389	26.2	0.205	0.316	0.479	29.9
2004	0.249	0.185	0.566	20.0	0.095	0.253	0.651	24.6
2005	0.282	0.274	0.443	16.5	0.127	0.356	0.517	18.1
2006	0.328	0.229	0.443	39.2	0.182	0.203	0.615	56.8
2007	0.439	0.353	0.208	50.0	0.260	0.424	0.315	62.7
2008	0.375	0.222	0.404	50.0	0.206	0.281	0.513	49.6
2009	0.306	0.420	0.274	50.0	0.137	0.538	0.324	35.4
2010	0.408	0.337	0.255	50.0	0.204	0.409	0.387	63.4
2011	0.218	0.394	0.388	50.0	0.132	0.429	0.438	54.2
2012	0.157	0.439	0.403	50.0	0.084	0.516	0.400	42.4
2013	0.210	0.283	0.507	24.2	0.098	0.358	0.544	29.4
2014	0.174	0.391	0.435	50.0	0.084	0.400	0.515	38.9
2015	0.234	0.299	0.467	40.2	0.119	0.413	0.468	35.2
2016	0.225	0.278	0.496	30.2	0.094	0.294	0.612	39.5
2017	0.085	0.299	0.616	12.0	0.036	0.325	0.639	27.2
2018	0.148	0.222	0.631	26.2	0.063	0.243	0.694	34.2
2019	0.196	0.235	0.569	45.8	0.086	0.255	0.660	47.3
2021	0.332	0.132	0.536	30.8	0.128	0.142	0.730	42.2
2022	0.353	0.212	0.435	46.0	0.162	0.284	0.554	27.2
2023	0.321	0.297	0.381	24.0	0.150	0.384	0.466	32.2
2024	0.204	0.255	0.541	14.5	0.091	0.374	0.535	23.1
2025	0.183	0.295	0.522	28.0	0.100	0.295	0.605	28.3
2026	0.347	0.270	0.383	50.0	0.173	0.394	0.433	34.3

Table 13: Proportions of male blue king crab in each model size bin estimated using either design-based (DB) or model-based (MB) methods, with the MB method based on abundance per area. Size bin 1 is 90-104 mm, size bin 2 is 105-119 mm, and size bin 3 is 120 mm and larger. n DB = estimated effective sample sizes for the DB size compositions. n MB = estimated median effective sample sizes for the MB size compositions.

year	Size 1 DB	Size 2 DB	Size 3 DB	n DB	Size 1 MB	Size 2 MB	Size 3 MB	n MB
1978	0.387	0.348	0.266	50.0	0.279	0.530	0.191	29.2
1979	0.428	0.319	0.253	50.0	0.308	0.442	0.250	45.5
1980	0.359	0.322	0.319	50.0	0.237	0.449	0.314	48.1
1981	0.122	0.306	0.572	38.5	0.085	0.472	0.442	26.5
1982	0.167	0.244	0.589	50.0	0.119	0.330	0.552	55.7
1983	0.175	0.273	0.552	50.0	0.118	0.403	0.479	18.4
1984	0.182	0.208	0.609	36.2	0.150	0.317	0.533	44.2
1985	0.202	0.201	0.597	26.8	0.222	0.275	0.503	46.1
1986	0.198	0.436	0.365	15.8	0.143	0.560	0.297	26.6
1987	0.194	0.378	0.428	24.5	0.180	0.484	0.336	41.0
1988	0.188	0.374	0.438	28.8	0.155	0.488	0.357	59.9
1989	0.425	0.226	0.350	50.0	0.382	0.294	0.325	131.9
1990	0.238	0.233	0.529	49.8	0.151	0.488	0.361	46.4
1991	0.227	0.330	0.443	50.0	0.205	0.458	0.337	64.1
1992	0.226	0.291	0.483	50.0	0.187	0.406	0.407	69.5
1993	0.230	0.276	0.495	50.0	0.186	0.312	0.502	59.5
1994	0.199	0.293	0.509	50.0	0.186	0.346	0.468	87.4
1995	0.259	0.300	0.440	50.0	0.182	0.448	0.371	60.4
1996	0.200	0.305	0.495	50.0	0.142	0.415	0.443	40.2
1997	0.162	0.310	0.528	50.0	0.182	0.328	0.489	108.7
1998	0.128	0.321	0.551	50.0	0.131	0.384	0.484	78.8
1999	0.222	0.221	0.556	16.8	0.203	0.324	0.474	39.7
2000	0.215	0.218	0.567	17.8	0.151	0.331	0.518	29.3
2001	0.225	0.270	0.505	27.0	0.190	0.420	0.390	64.1
2002	0.113	0.235	0.653	10.2	0.072	0.424	0.504	27.2
2003	0.376	0.234	0.389	26.2	0.339	0.347	0.314	45.6
2004	0.249	0.185	0.566	20.0	0.207	0.332	0.461	31.2
2005	0.282	0.274	0.443	16.5	0.236	0.430	0.335	26.6
2006	0.328	0.229	0.443	39.2	0.304	0.251	0.445	63.5
2007	0.439	0.353	0.208	50.0	0.378	0.414	0.208	70.9
2008	0.375	0.222	0.404	50.0	0.326	0.307	0.367	76.7
2009	0.306	0.420	0.274	50.0	0.197	0.587	0.217	52.1
2010	0.408	0.337	0.255	50.0	0.274	0.423	0.304	90.1
2011	0.218	0.394	0.388	50.0	0.201	0.463	0.336	83.2
2012	0.157	0.439	0.403	50.0	0.125	0.575	0.300	58.2
2013	0.210	0.283	0.507	24.2	0.143	0.435	0.422	34.5
2014	0.174	0.391	0.435	50.0	0.147	0.449	0.404	60.6
2015	0.234	0.299	0.467	40.2	0.192	0.460	0.348	56.4
2016	0.225	0.278	0.496	30.2	0.180	0.349	0.471	58.7
2017	0.085	0.299	0.616	12.0	0.068	0.403	0.529	34.3
2018	0.148	0.222	0.631	26.2	0.118	0.319	0.562	48.2
2019	0.196	0.235	0.569	45.8	0.162	0.320	0.518	75.0
2021	0.332	0.132	0.536	30.8	0.240	0.182	0.578	56.1
2022	0.353	0.212	0.435	46.0	0.277	0.339	0.385	41.2
2023	0.321	0.297	0.381	24.0	0.244	0.435	0.321	57.4
2024	0.204	0.255	0.541	14.5	0.174	0.421	0.405	35.5
2025	0.183	0.295	0.522	28.0	0.200	0.329	0.471	41.0
2026	0.347	0.270	0.383	50.0	0.252	0.416	0.332	57.4

Table 14: Comparisons of negative log-likelihood values for the selected model scenarios. Catch fleet values refer to the directed fishery retained catch (1), directed fishery discarded catch (2), groundfish trawl fisheries discarded catch (3), and groundfish fixed gear fisheries discarded catch (4). Index fleet values refer to the NOAA EBS trawl survey (1) and the ADFG pot survey (2). Size composition fleet values refer to the pot fishery (1), NOAA EBS trawl survey (2), and ADFG pot survey (3). Model 26.1b is the new base model, with updated data and a newer GMACS version. Model 26.2 is model 26.1b with a model-based index for the Eastern Bering Sea (EBS) trawl survey biomass time series replacing the design-based index. Model 26.2a is model 26.2 with model-based rather than design-based size compositions for the EBS trawl survey time series.

Component	Model 26.1	Model 26.1a	Model 26.1b	Model 26.2	Model 26.2a
1. Catch: fishery retained	-68.98	-68.98	-68.97	-68.71	-68.69
2. Catch: fishery discarded	4.41	4.41	4.46	7.00	7.68
3. Catch: trawl bycatch	-9.36	-9.36	-9.64	-9.64	-9.64
4. Catch: fixed gear bycatch	-9.35	-9.35	-9.63	-9.63	-9.63
1. Index: EBS trawl survey	0.31	0.31	-0.20	-3.91	-7.39
2. Index: ADFG pot survey	74.93	74.93	75.12	83.53	88.02
1. Size comp: pot fishery	-105.12	-105.12	-105.12	-105.19	-105.80
2. Size comp: EBS trawl survey	-283.43	-283.43	-291.23	-298.27	-306.56
3. Size comp: ADFG pot survey	-109.15	-109.15	-108.55	-108.47	-107.66
rec_pen_1	67.01	67.01	66.69	64.83	64.31
rec_pen_2	0.00	0.00	0.00	0.00	0.00
rec_pen_3	0.00	0.00	0.00	0.00	0.00
tagging_1	0.00	0.00	0.00	0.00	0.00
n_pars	162.00	162.00	165.00	165.00	165.00
total	-425.01	-425.01	-433.35	-434.75	-441.64

Table 15: St. Matthew Island blue king crab estimated mature male biomass (MMB) and standard deviations (SD) in metric tons, as well as estimated recruits and SD in numbers, for model 26.1b.

Year	MMB (t)	MMB SD (t)	Recruits (n)	Recruits SD (n)
1978	4,316	781	4,461,928	798,996
1979	6,016	788	3,747,896	847,695
1980	9,418	874	910,011	594,084
1981	9,782	690	1,516,895	487,012
1982	6,797	545	632,830	321,830
1983	3,923	446	589,826	247,459
1984	2,502	352	975,136	312,515
1985	2,120	345	1,354,142	451,168
1986	2,122	336	1,384,787	440,147
1987	2,556	397	1,292,638	397,672
1988	2,902	460	3,306,769	843,109
1989	3,412	503	1,620,623	578,135
1990	4,666	496	1,915,616	399,815
1991	4,705	461	2,145,303	407,305
1992	4,808	427	2,423,169	431,687
1993	5,076	406	1,417,748	339,385
1994	4,904	356	1,894,068	319,497
1995	4,722	343	1,768,542	351,233
1996	4,506	328	766,901	235,362
1997	3,956	348	640,548	187,564
1998	2,024	204	435,851	172,410
1999	1,730	193	434,867	122,296
2000	1,853	160	409,152	110,698
2001	1,959	149	89,112	59,152
2002	2,029	143	351,299	94,163
2003	1,854	137	248,146	90,114
2004	1,805	134	620,407	175,546
2005	1,736	131	769,068	150,193
2006	1,925	156	470,870	208,253
2007	2,254	175	1,010,607	168,359
2008	2,404	145	703,257	132,661
2009	2,598	146	638,082	124,828
2010	2,221	126	434,151	96,800
2011	1,643	113	215,736	65,342
2012	1,080	110	245,930	55,222
2013	1,220	110	214,063	46,979
2014	1,110	106	176,105	40,262
2015	1,066	102	179,615	43,612
2016	1,094	101	131,508	40,813
2017	1,075	96	166,218	48,198
2018	1,024	89	285,980	85,168
2019	994	87	204,091	108,028
2020	1,058	102	387,960	82,606
2021	1,088	107	460,265	93,142
2022	1,229	117	491,146	154,399
2023	1,440	136	208,072	92,930
2024	1,667	158	308,484	88,449
2025	1,671	156	871,671	249,554

Table 16: St. Matthew Island blue king crab estimated mature male biomass (MMB) and standard deviations (SD) in metric tons, as well as estimated recruits and SD in numbers, for model 26.2.

Year	MMB (t)	MMB SD (t)	Recruits (n)	Recruits SD (n)
1978	7,050	1,158	5,526,419	1,057,392
1979	9,125	1,149	4,238,833	1,036,855
1980	13,323	1,276	1,058,287	684,855
1981	13,601	1,122	1,936,484	609,460
1982	10,296	992	1,057,889	452,950
1983	7,326	922	900,986	380,789
1984	5,455	765	1,406,779	493,950
1985	5,135	754	1,929,445	661,765
1986	4,801	672	1,753,573	592,609
1987	5,275	659	1,507,913	518,268
1988	5,479	630	3,660,284	625,135
1989	5,933	632	1,984,982	494,913
1990	6,933	623	2,290,580	483,627
1991	6,997	633	2,466,159	496,247
1992	7,010	591	2,849,467	528,418
1993	7,294	571	1,778,857	405,989
1994	7,036	515	2,204,530	382,681
1995	6,902	510	2,080,004	430,882
1996	6,589	489	1,119,231	293,394
1997	6,075	516	813,722	236,342
1998	3,513	338	598,296	243,506
1999	2,882	328	601,311	172,989
2000	2,951	273	578,663	151,375
2001	3,016	249	135,405	90,029
2002	3,058	230	502,000	127,569
2003	2,777	213	315,629	116,393
2004	2,682	206	819,415	227,210
2005	2,536	196	956,625	187,309
2006	2,738	213	629,232	203,740
2007	3,100	224	1,193,801	204,071
2008	3,265	207	875,593	165,276
2009	3,469	217	829,815	148,899
2010	3,073	197	598,448	128,197
2011	2,532	189	319,605	93,695
2012	1,974	185	381,436	85,261
2013	2,120	184	337,100	73,495
2014	1,963	173	259,833	60,561
2015	1,869	164	252,515	64,062
2016	1,870	160	184,991	58,496
2017	1,785	149	225,619	67,044
2018	1,660	137	381,499	114,499
2019	1,568	130	337,358	167,224
2020	1,607	145	525,043	114,092
2021	1,654	153	600,445	120,824
2022	1,824	165	671,026	204,246
2023	2,068	186	273,766	119,234
2024	2,350	210	378,804	107,810
2025	2,332	205	1,015,771	282,666

Table 17: St. Matthew Island blue king crab estimated mature male biomass (MMB) and standard deviations (SD) in metric tons, as well as estimated recruits and SD in numbers, for model 26.2a.

Year	MMB (t)	MMB SD (t)	Recruits (n)	Recruits SD (n)
1978	8,386	1,632	4,930,098	1,720,360
1979	11,117	1,581	3,248,300	1,730,909
1980	15,007	1,624	1,331,025	1,042,500
1981	14,209	1,191	1,250,950	782,701
1982	10,710	979	736,942	467,135
1983	7,202	831	638,456	343,428
1984	4,955	673	1,577,366	472,959
1985	4,365	663	1,904,382	626,555
1986	4,208	609	2,185,733	659,409
1987	4,782	624	1,722,040	579,477
1988	5,379	628	4,448,551	782,613
1989	6,101	653	1,807,691	670,602
1990	7,691	718	2,652,906	620,060
1991	7,746	704	2,296,039	579,266
1992	7,878	649	2,810,932	584,835
1993	8,016	622	2,292,368	490,195
1994	7,557	568	2,195,949	463,410
1995	7,670	571	1,943,003	494,042
1996	7,327	546	1,359,694	353,319
1997	6,657	566	969,626	297,136
1998	3,778	356	629,802	257,161
1999	3,055	337	698,605	190,806
2000	3,132	289	696,510	173,535
2001	3,245	267	185,006	124,232
2002	3,355	252	498,541	146,251
2003	3,093	238	349,602	136,211
2004	2,960	228	610,223	207,646
2005	2,790	215	1,225,485	216,507
2006	2,807	219	594,409	191,532
2007	3,287	228	1,255,780	252,042
2008	3,446	228	964,745	199,431
2009	3,663	242	846,779	156,255
2010	3,301	219	662,829	157,075
2011	2,757	214	351,593	115,849
2012	2,212	207	404,460	98,198
2013	2,366	206	401,694	90,376
2014	2,188	192	264,447	70,388
2015	2,101	183	277,325	73,018
2016	2,086	177	220,533	65,982
2017	1,983	164	253,795	78,586
2018	1,853	152	494,200	162,276
2019	1,754	145	193,931	114,721
2020	1,847	165	582,463	122,736
2021	1,780	165	616,491	143,086
2022	1,937	175	818,203	237,081
2023	2,174	196	262,693	130,454
2024	2,545	230	451,008	135,230
2025	2,523	225	1,246,756	514,447

Table 18: Summary of convergence diagnostics from jitter runs. OF = objective function. MLE = maximum likelihood estimate.

Model	No. converged jitter runs	No. runs with min. OF value	Max. gradient at MLE
26.1a	100	89	-0.00000434
26.1b	100	90	0.00000027
26.2	100	81	-0.00000146
26.2a	100	84	0.00000256

Table 19: Summary of St. Matthew Island blue king crab estimated model parameter values and standard errors (SE) for model 26.1b, the new base model, with updated data and newer GMACS version.

Parameter	Estimate	SE
Log(Rbar):	14.0824	0.1839
Initial_logN_for_sex_male_mature_mature_newshell_class_1:	15.1174	0.1775
Initial_logN_for_sex_male_mature_mature_newshell_class_2:	14.5715	0.2176
Initial_logN_for_sex_male_mature_mature_newshell_class_3:	14.3911	0.2255
M_male_mature_block_group_3_block_1:	0.8425	0.1323
Sel_Pot_Fishery_male_base_class_1:	-1.0971	0.1818
Sel_Pot_Fishery_male_base_class_2:	-0.6752	0.1315
Sel_Pot_Fishery_male_class_1_block_group_2_block_1:	-0.7777	0.1706
Sel_Pot_Fishery_male_class_2_block_group_2_block_1:	-0.0000	0.0000
Sel_NMFS_Trawl_male_base_class_1:	-0.4416	0.0708
Sel_NMFS_Trawl_male_base_class_2:	-0.0105	0.0599
Sel_ADFG_Pot_male_base_class_1:	-1.0015	0.1202
Sel_ADFG_Pot_male_base_class_2:	-0.0884	0.0707
Log_fbar_Pot_Fishery:	-2.1257	0.0545
Log_fbar_Trawl_Bycatch:	-10.3350	0.0703
Log_fbar_Fixed_bycatch:	-8.0910	0.0703
Survey_q_survey_2:	0.0037	0.0002

Table 20: Summary of St. Matthew Island blue king crab estimated model parameter values and standard errors (SE) for model 26.2, which uses a model-based biomass index in place of the design-based EBS trawl survey biomass index.

Parameter	Estimate	SE
Log(Rbar):	14.3626	0.1839
Initial_logN_for_sex_male_mature_mature_newshell_class_1:	15.4105	0.1828
Initial_logN_for_sex_male_mature_mature_newshell_class_2:	15.0092	0.2164
Initial_logN_for_sex_male_mature_mature_newshell_class_3:	14.8159	0.2182
M_male_mature_block_group_3_block_1:	0.7837	0.1235
Sel_Pot_Fishery_male_base_class_1:	-0.8341	0.1762
Sel_Pot_Fishery_male_base_class_2:	-0.3923	0.1304
Sel_Pot_Fishery_male_class_1_block_group_2_block_1:	-0.6063	0.1620
Sel_Pot_Fishery_male_class_2_block_group_2_block_1:	0.0000	0.0000
Sel_NMFS_Trawl_male_base_class_1:	-0.2660	0.0616
Sel_NMFS_Trawl_male_base_class_2:	0.0000	0.0000
Sel_ADFG_Pot_male_base_class_1:	-0.8496	0.1159
Sel_ADFG_Pot_male_base_class_2:	-0.0000	0.0000
Log_fbar_Pot_Fishery:	-2.6406	0.0588
Log_fbar_Trawl_Bycatch:	-10.7094	0.0724
Log_fbar_Fixed_bycatch:	-8.4656	0.0724
Survey_q_survey_2:	0.0025	0.0002

Table 21: Summary of St. Matthew Island blue king crab estimated model parameter values and standard errors (SE) for model 26.2a, which uses both a model-based biomass index and model-based size compositions for the EBS trawl survey time series.

Parameter	Estimate	SE
Log(Rbar):	14.4030	0.1843
Initial_logN_for_sex_male_mature_mature_newshell_class_1:	15.5911	0.2775
Initial_logN_for_sex_male_mature_mature_newshell_class_2:	15.3530	0.2463
Initial_logN_for_sex_male_mature_mature_newshell_class_3:	14.8177	0.2829
M_male_mature_block_group_3_block_1:	0.8391	0.1203
Sel_Pot_Fishery_male_base_class_1:	-0.7502	0.1745
Sel_Pot_Fishery_male_base_class_2:	-0.3484	0.1309
Sel_Pot_Fishery_male_class_1_block_group_2_block_1:	-0.6109	0.1659
Sel_Pot_Fishery_male_class_2_block_group_2_block_1:	0.0000	0.0000
Sel_NMFS_Trawl_male_base_class_1:	-1.2127	0.0866
Sel_NMFS_Trawl_male_base_class_2:	0.0000	0.0000
Sel_ADFG_Pot_male_base_class_1:	-0.8367	0.1234
Sel_ADFG_Pot_male_base_class_2:	-0.0000	0.0000
Log_fbar_Pot_Fishery:	-2.6985	0.0581
Log_fbar_Trawl_Bycatch:	-10.7906	0.0727
Log_fbar_Fixed_bycatch:	-8.5467	0.0728
Survey_q_survey_2:	0.0023	0.0001

Table 22: Population abundances (n) by crab stage in numbers of crab at the time of the survey and mature male biomass (MMB) in tons on 15 February for the base model, model 26.1b.

Year	n_1	n_2	n_3	MMB	CV MMB
1978	3,676,225	2,129,688	1,778,208	4,316	0.181
1979	5,051,160	2,599,515	2,380,922	6,016	0.131
1980	4,571,894	3,541,140	3,551,731	9,418	0.093
1981	1,656,488	3,582,097	4,907,656	9,782	0.070
1982	1,783,185	1,980,744	4,884,748	6,797	0.080
1983	914,338	1,522,579	3,380,307	3,923	0.114
1984	730,684	903,938	1,860,275	2,502	0.141
1985	1,089,682	645,931	1,267,053	2,120	0.163
1986	1,527,037	766,156	1,042,022	2,122	0.158
1987	1,630,224	1,046,815	1,143,101	2,556	0.155
1988	1,554,931	1,189,239	1,358,509	2,902	0.158
1989	3,556,790	1,192,114	1,545,896	3,412	0.147
1990	2,194,771	2,266,939	1,906,574	4,666	0.106
1991	2,268,564	1,863,713	2,453,090	4,705	0.098
1992	2,506,844	1,760,464	2,411,983	4,808	0.089
1993	2,825,396	1,869,243	2,514,041	5,076	0.080
1994	1,870,051	2,066,094	2,596,793	4,904	0.073
1995	2,191,503	1,607,844	2,497,958	4,722	0.073
1996	2,118,934	1,648,382	2,378,816	4,506	0.073
1997	1,105,329	1,620,348	2,299,156	3,956	0.088
1998	814,621	1,057,887	1,886,557	2,024	0.101
1999	505,606	402,164	793,092	1,730	0.112
2000	517,434	399,574	868,624	1,853	0.086
2001	493,668	405,228	928,630	1,959	0.076
2002	169,741	394,148	976,786	2,029	0.071
2003	379,022	215,723	980,274	1,854	0.074
2004	310,035	272,519	916,278	1,805	0.074
2005	671,052	253,246	886,778	1,736	0.076
2006	878,673	442,126	886,823	1,925	0.081
2007	614,276	613,236	995,543	2,254	0.078
2008	1,109,761	518,612	1,127,296	2,404	0.060
2009	884,387	762,038	1,244,112	2,598	0.056
2010	781,121	707,983	1,333,520	2,221	0.057
2011	558,239	620,321	1,180,871	1,643	0.069
2012	302,482	461,942	859,970	1,080	0.102
2013	292,304	279,956	561,391	1,220	0.090
2014	261,810	246,004	606,797	1,110	0.095
2015	218,343	215,025	559,269	1,066	0.096
2016	215,114	184,387	544,406	1,094	0.092
2017	166,627	174,133	540,123	1,075	0.089
2018	193,378	144,502	526,559	1,024	0.087
2019	317,555	149,872	504,587	994	0.088
2020	255,950	218,640	501,456	1,058	0.096
2021	429,766	207,056	526,445	1,088	0.098
2022	530,472	297,328	556,620	1,229	0.095
2023	577,761	379,953	632,726	1,440	0.094
2024	302,456	431,700	737,440	1,667	0.095
2025	357,890	299,260	820,361	1,671	0.093

Figures

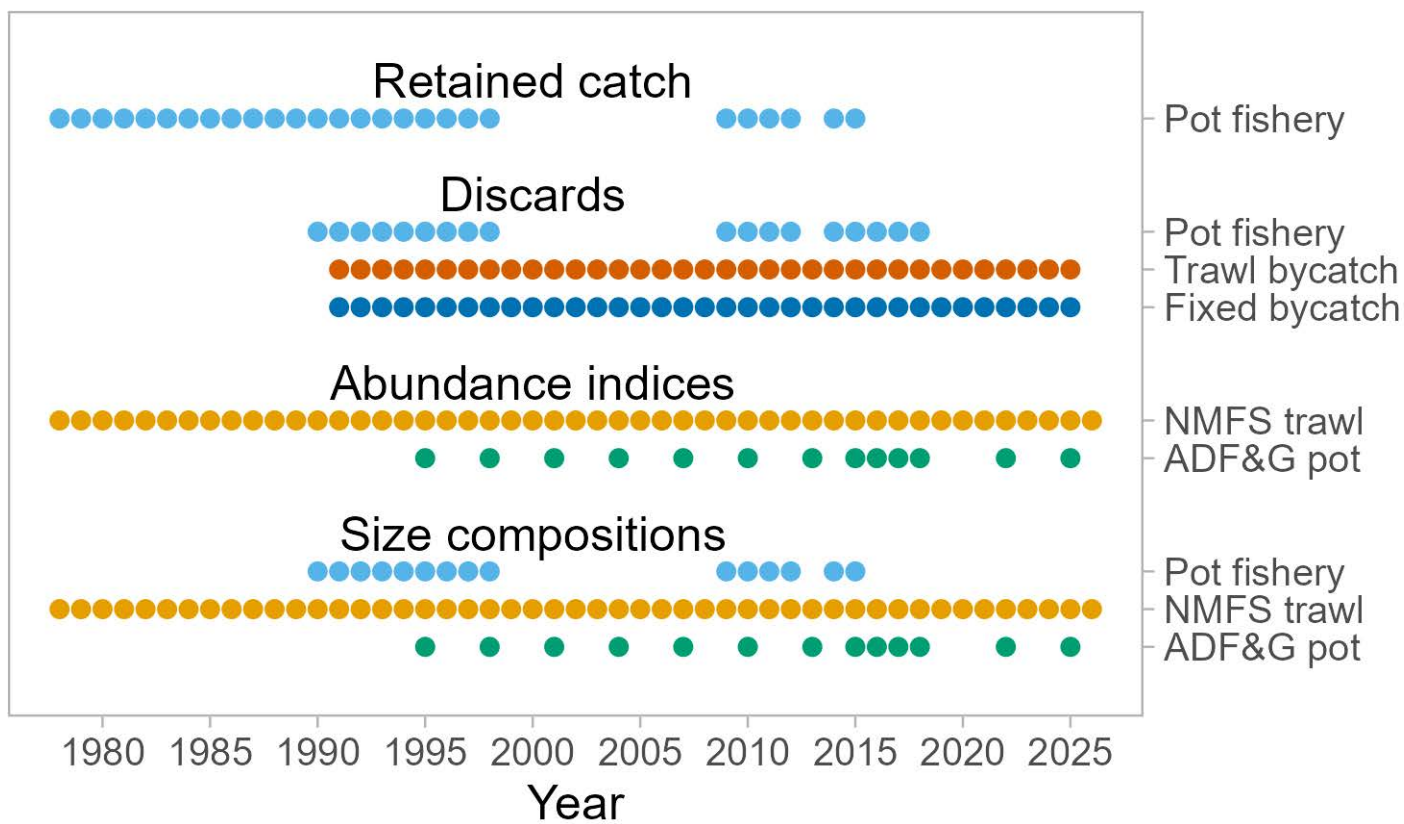


Figure 1: Data extent for the SMBKC assessment.

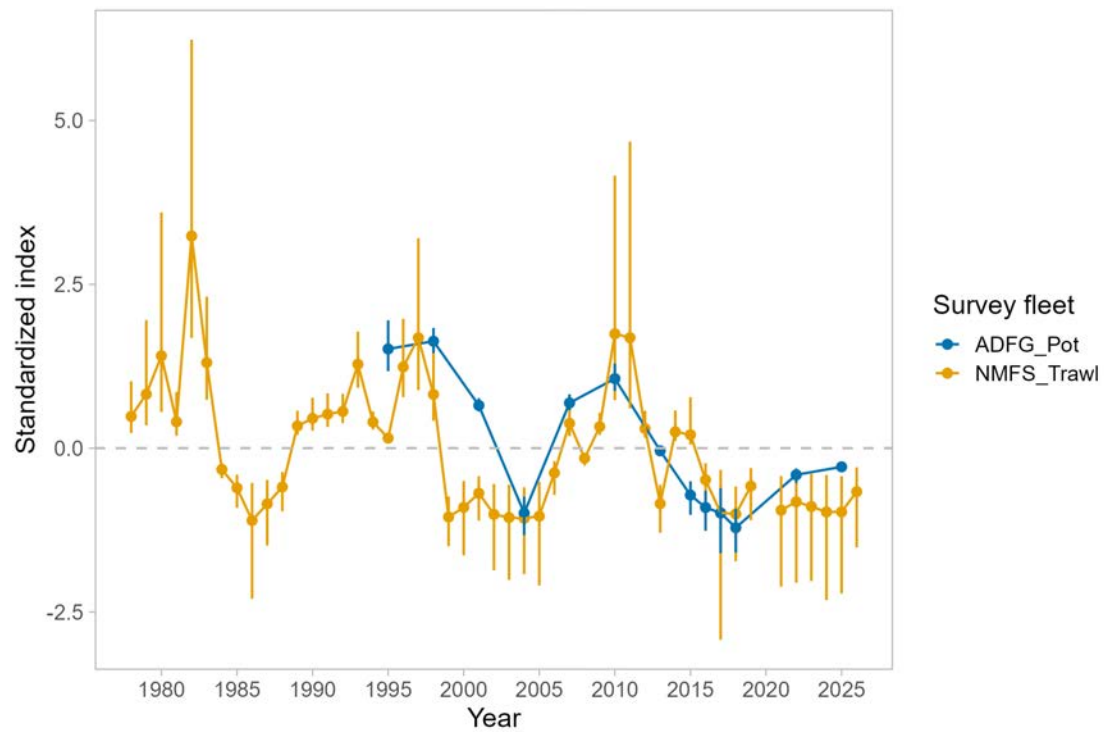


Figure 2: Standardized biomass index from the NMFS trawl survey compared to standardized abundance index from the ADFG pot survey. Indices are z-score standardized to allow for visual comparison. Dashed horizontal line represents the mean.

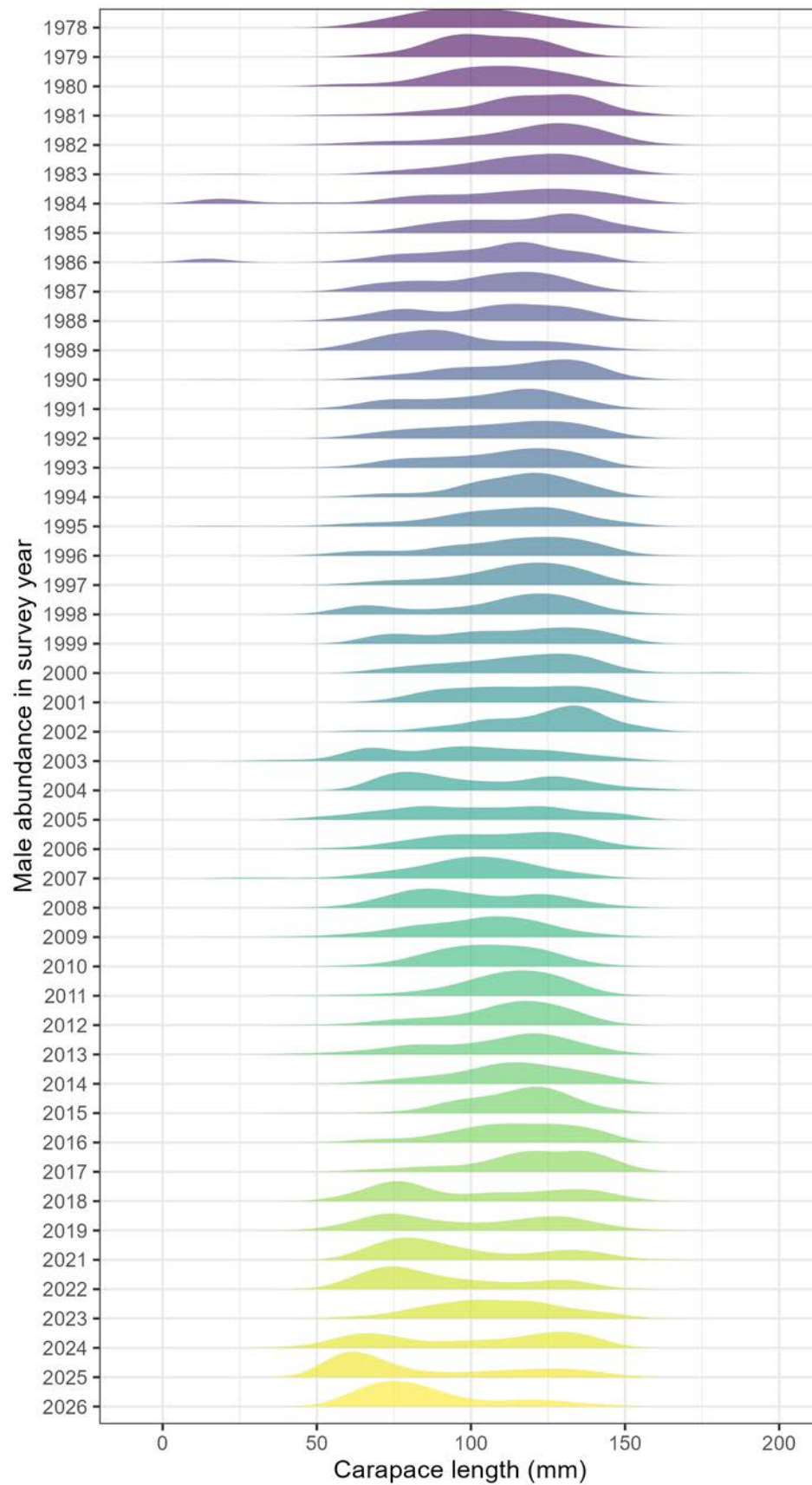


Figure 3: NMFS trawl survey abundances by carapace length for male St. Matthew Island blue king crab from 1978 to 2026.

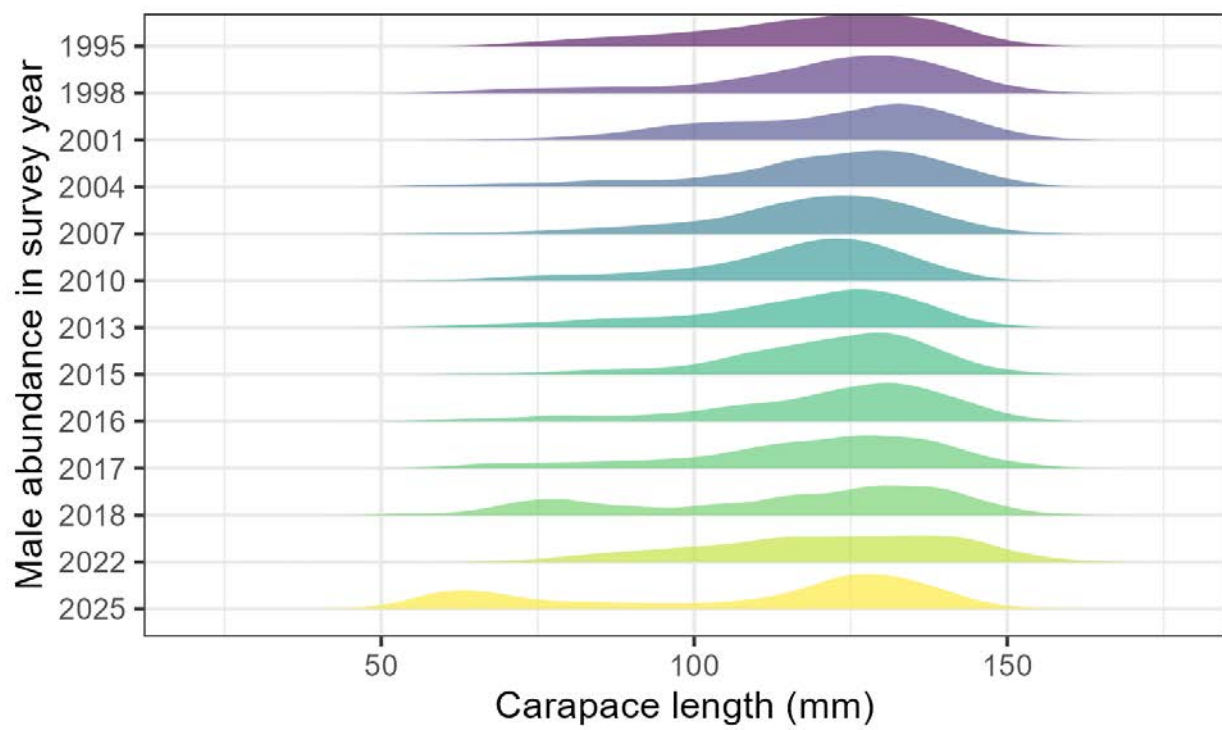


Figure 4: ADFG pot survey abundances by carapace length for male St. Matthew Island blue king crab from 1995 to 2025.

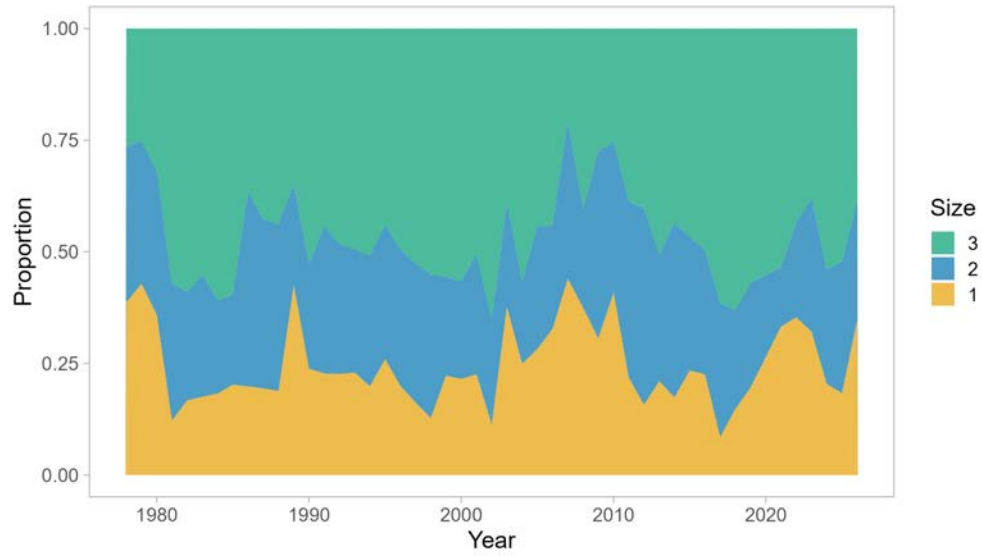


Figure 5: Design-based size class proportion estimates for the EBS trawl survey time series (1978-2026).

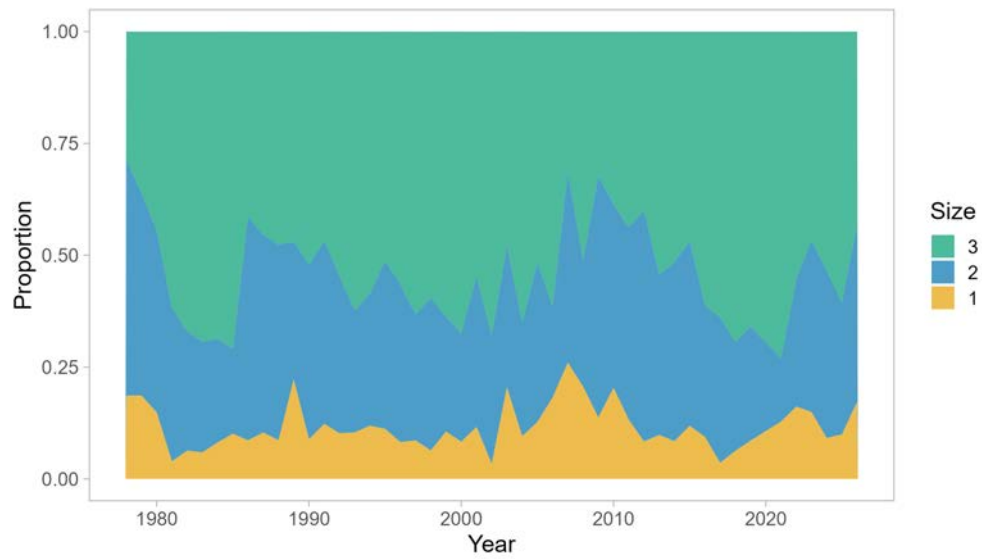


Figure 6: Model-based size class proportion estimates for the EBS trawl survey time series (1978-2026).

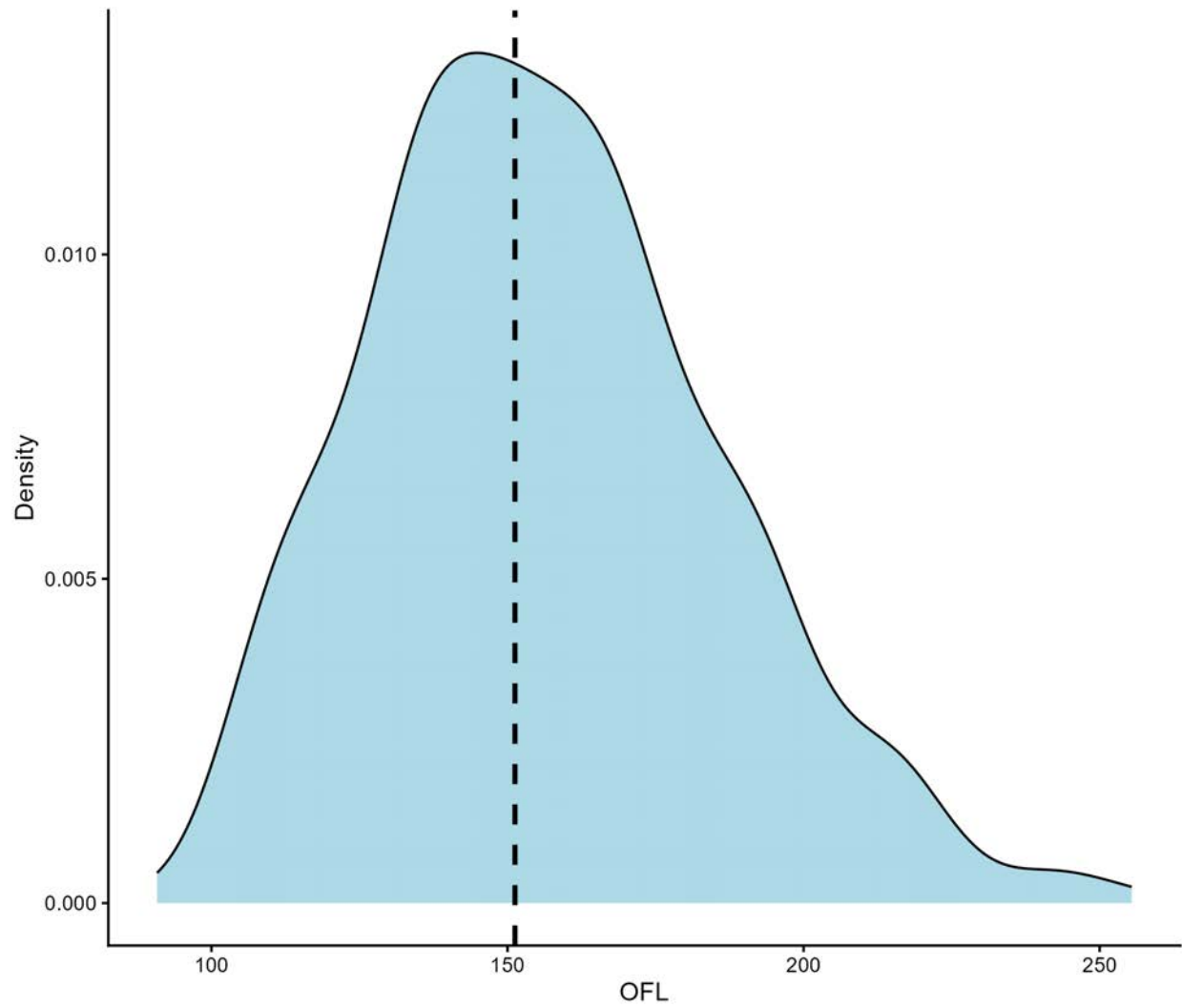


Figure 7: The probability density function of the OFL for model 26.1b, based on 500 Markov chain Monte Carlo (MCMC) draws. The vertical dashed line represents the OFL from the original model run.

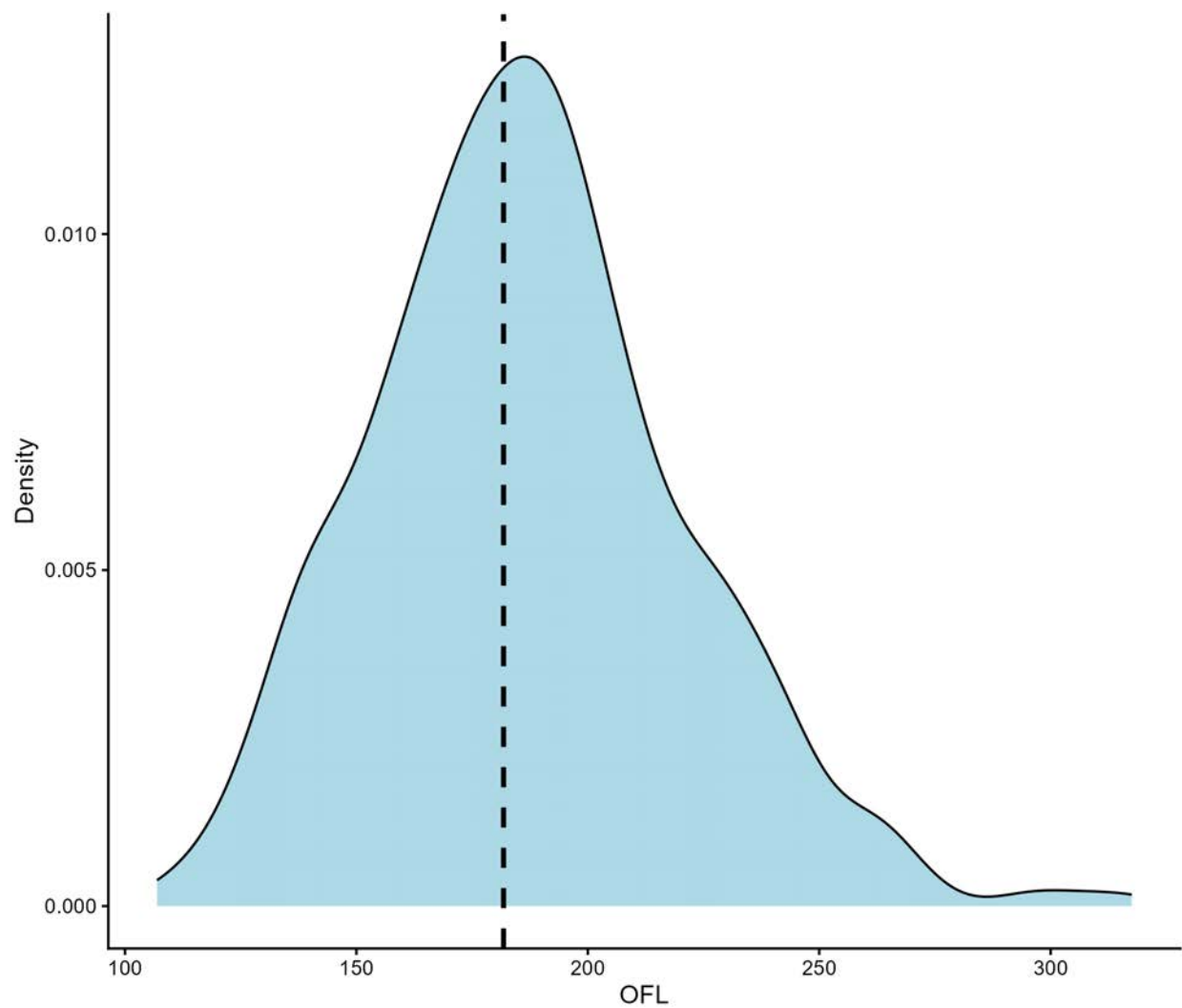


Figure 8: The probability density function of the OFL for model 26.2, based on 500 Markov chain Monte Carlo (MCMC) draws. The vertical dashed line represents the OFL from the original model run.

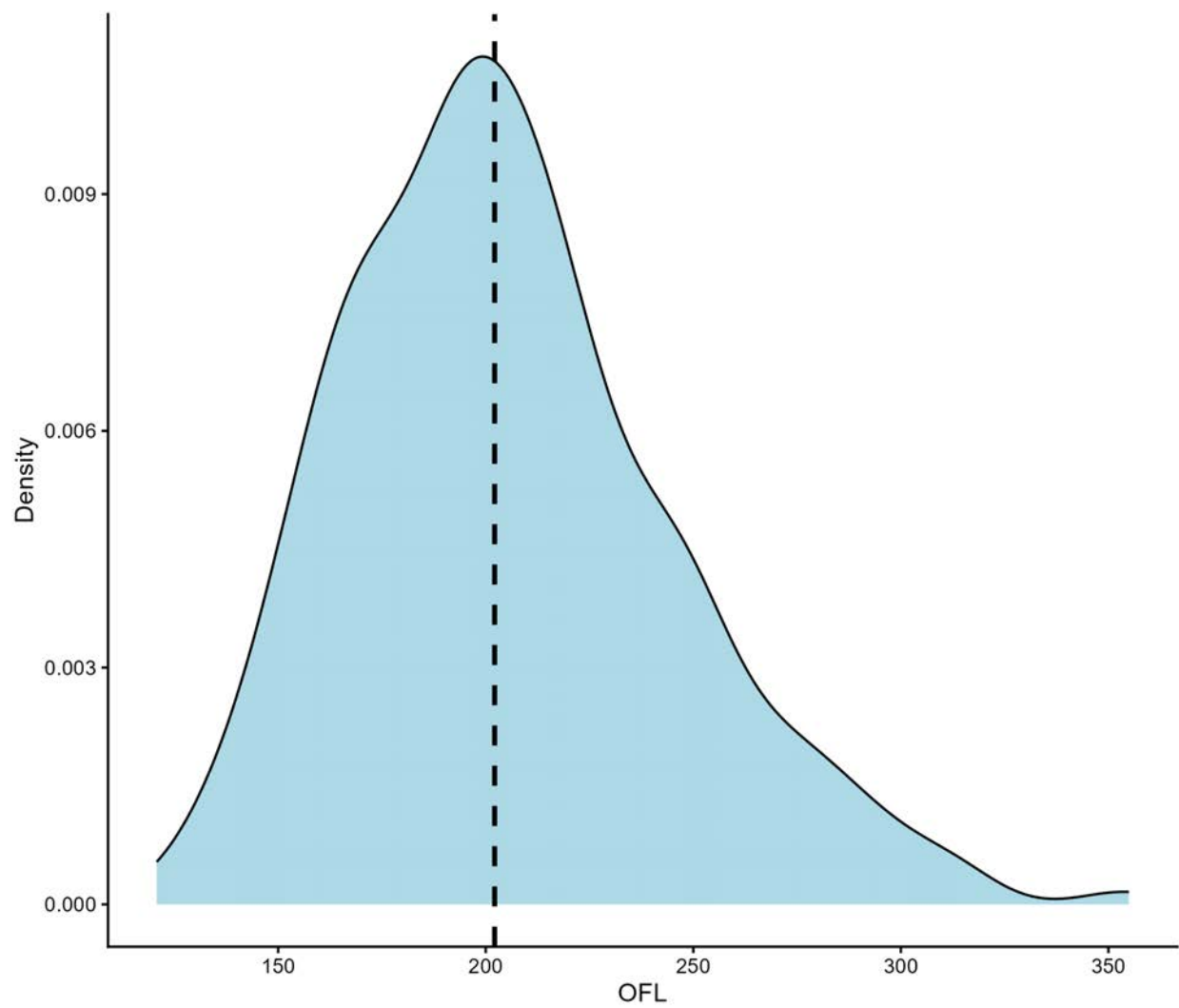


Figure 9: The probability density function of the OFL for model 26.2a, based on 500 Markov chain Monte Carlo (MCMC) draws. The vertical dashed line represents the OFL from the original model run.

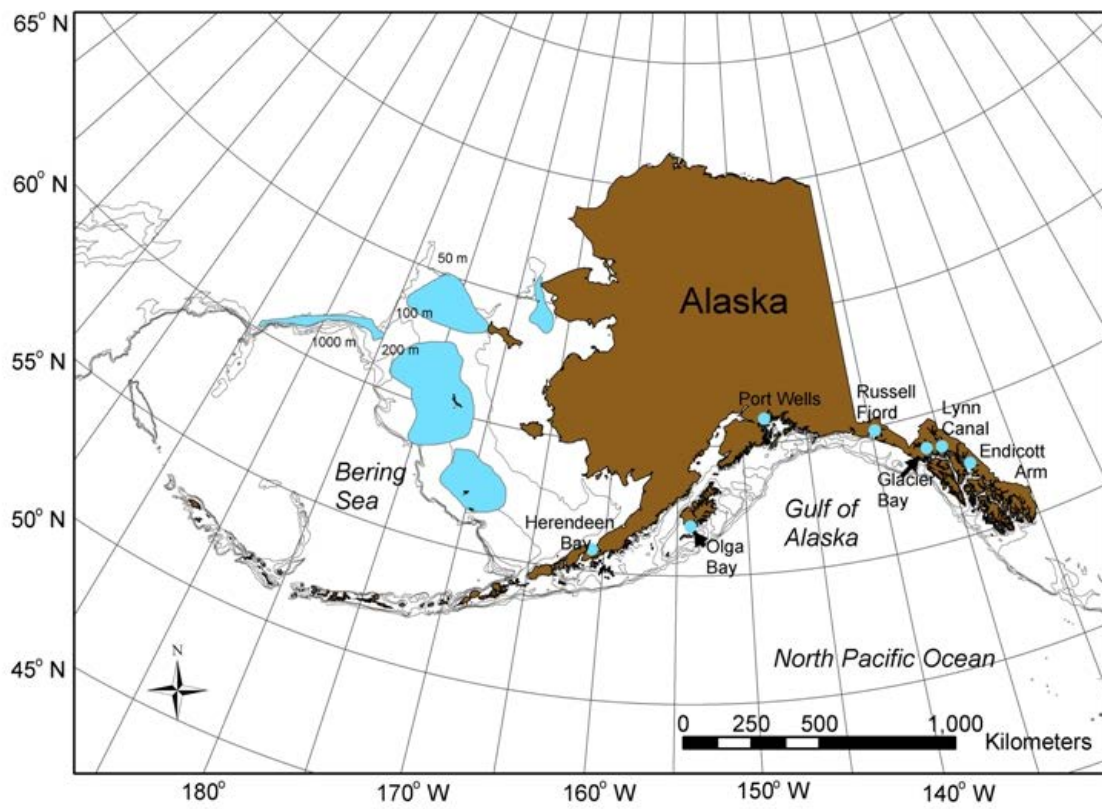


Figure 10: Distribution of blue king crab (*Paralithodes platypus*) in the Gulf of Alaska, Bering Sea, and Aleutian Islands waters (shown in blue).

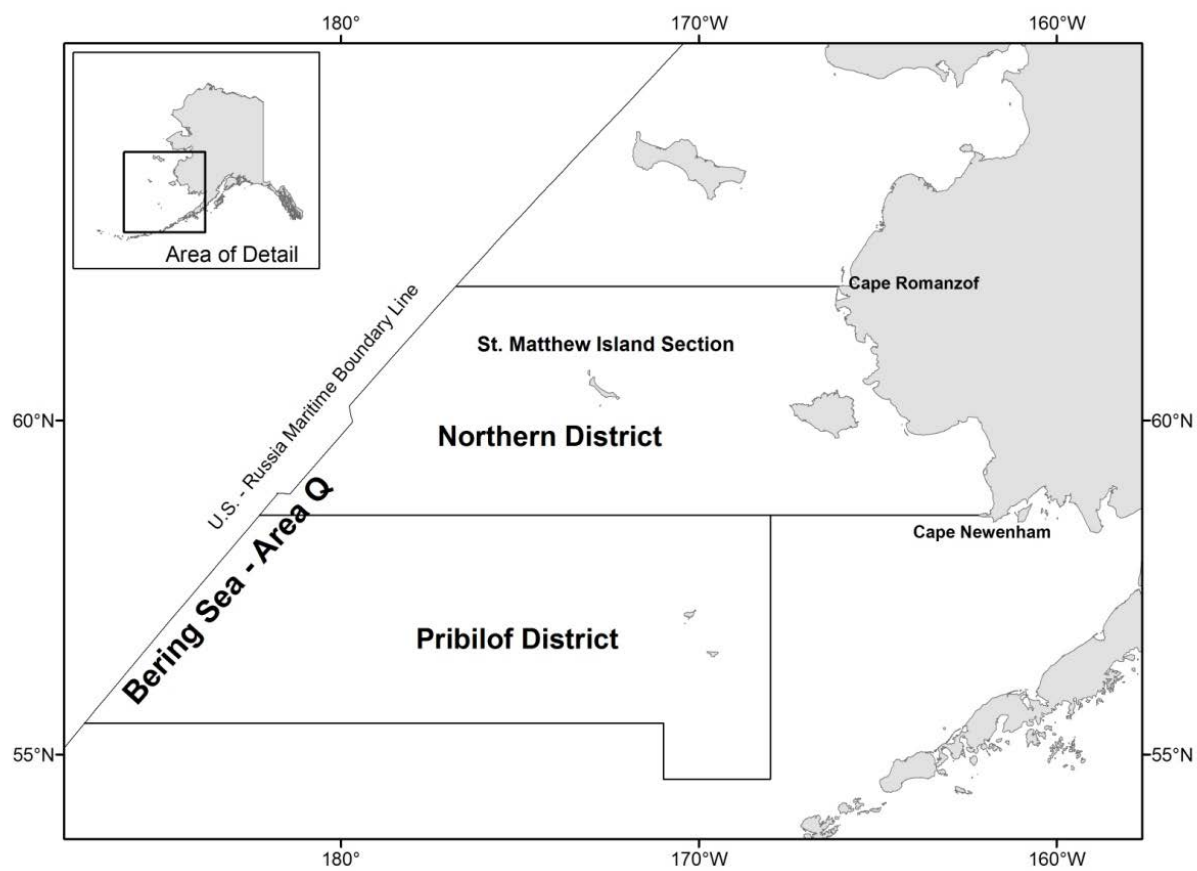


Figure 11: Blue king crab Registration Area Q (Bering Sea)

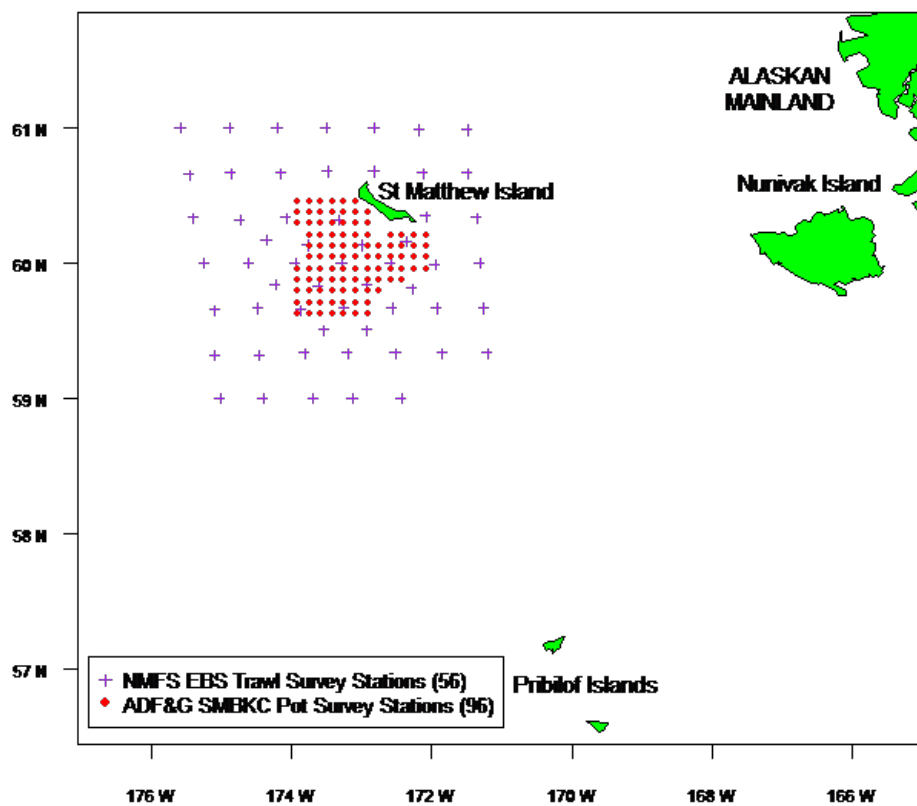


Figure 12: Trawl and pot-survey stations used in the SMBKC stock assessment.

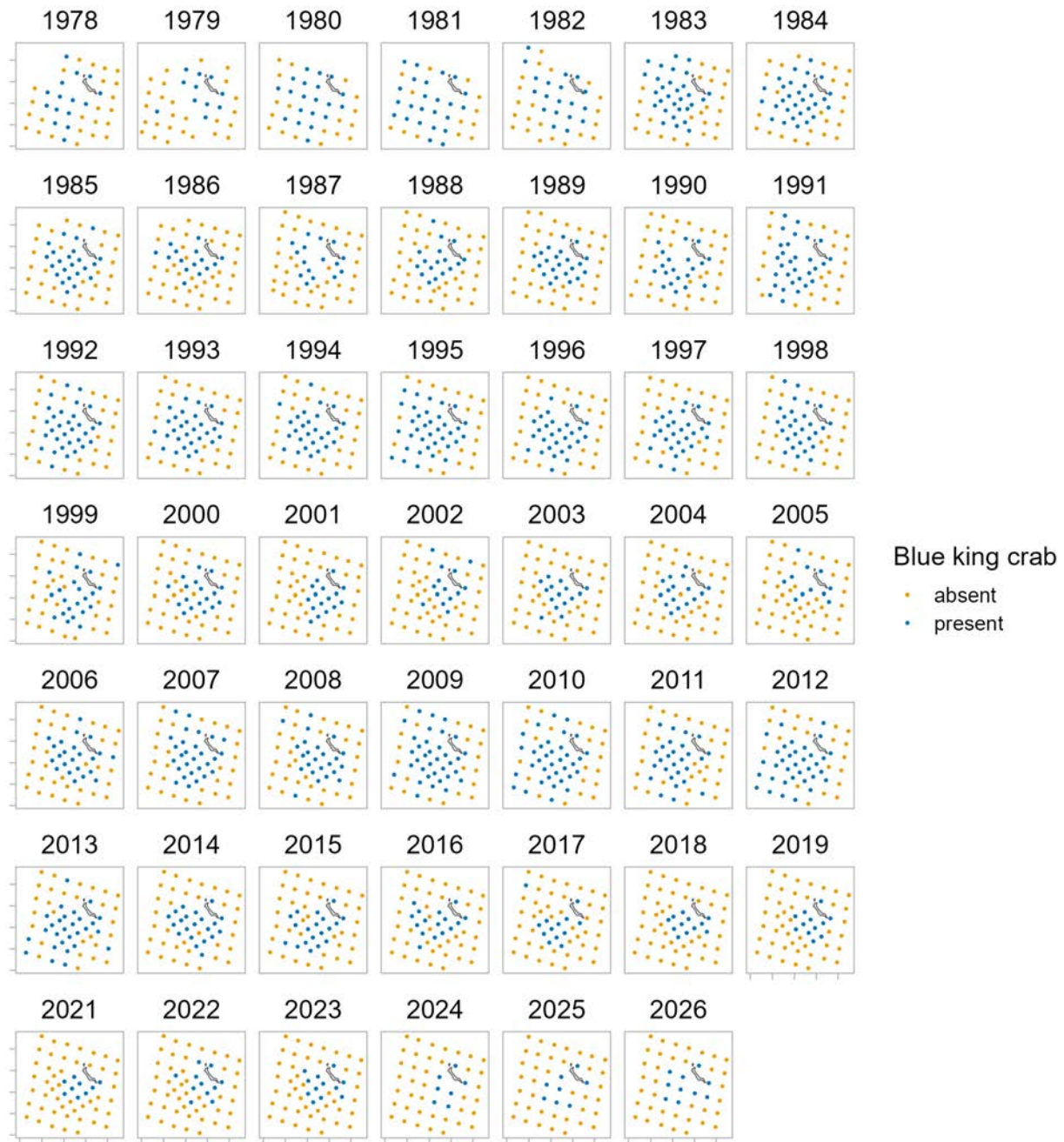


Figure 13: St Matthew Island blue king crab survey stations sampled in each year of the Eastern Bering Sea bottom trawl survey time series. Note that corner stations were not sampled in 2024 and 2025. Stations colored orange recorded no male blue king crab ≥ 90 mm in carapace length, while stations colored blue recorded at least one male blue king crab ≥ 90 mm in carapace length.

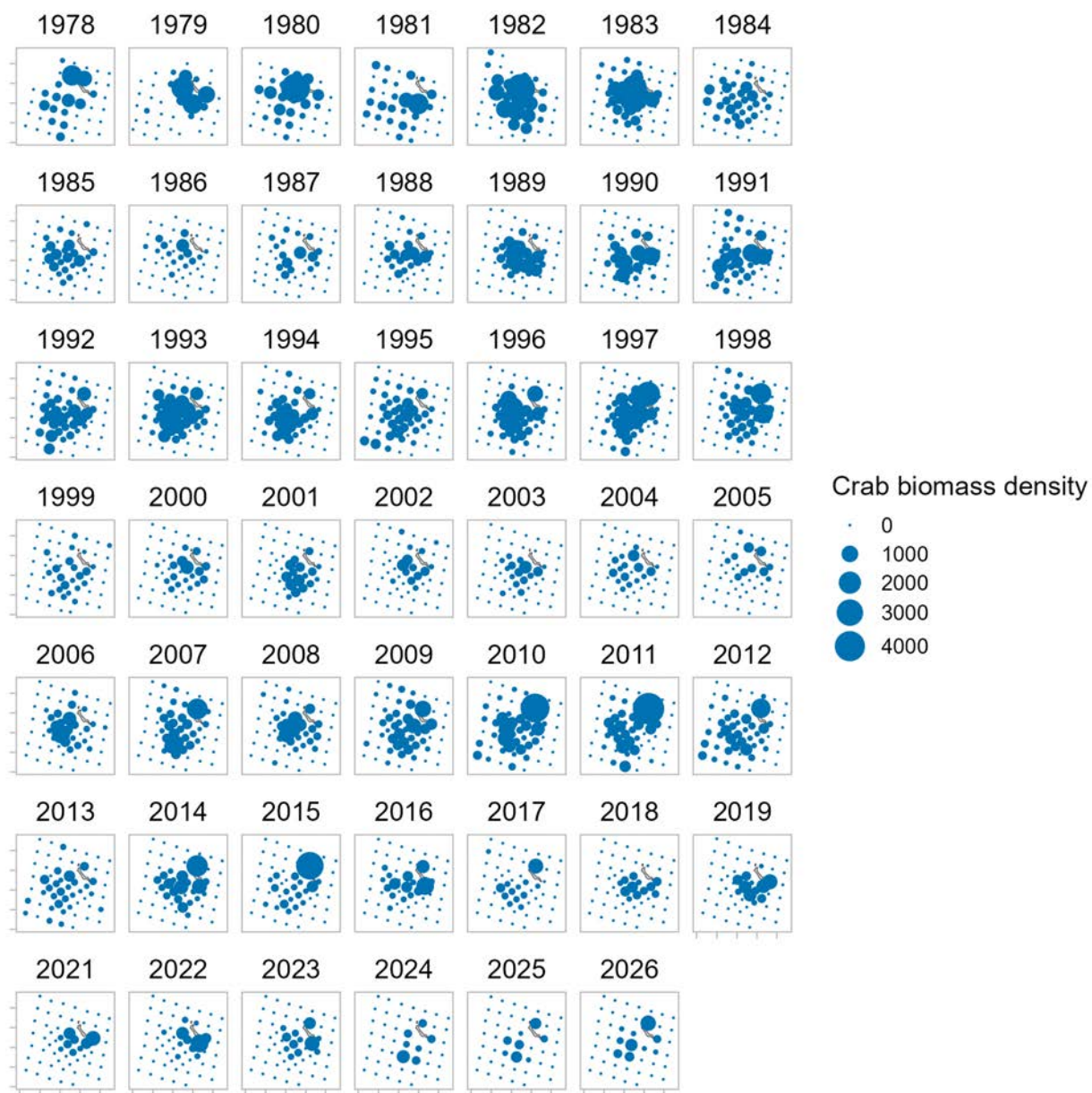


Figure 14: St Matthew Island blue king crab biomass density at survey stations sampled in each year of the Eastern Bering Sea bottom trawl survey time series. Point size is proportional to the biomass density of male blue king crab ≥ 90 mm in carapace length at the station.



Figure 15: St Matthew Island blue king crab biomass density at survey stations sampled in each year of the Eastern Bering Sea bottom trawl survey time series. Point color is proportional to the biomass density of male blue king crab ≥ 90 mm in carapace length at the station.

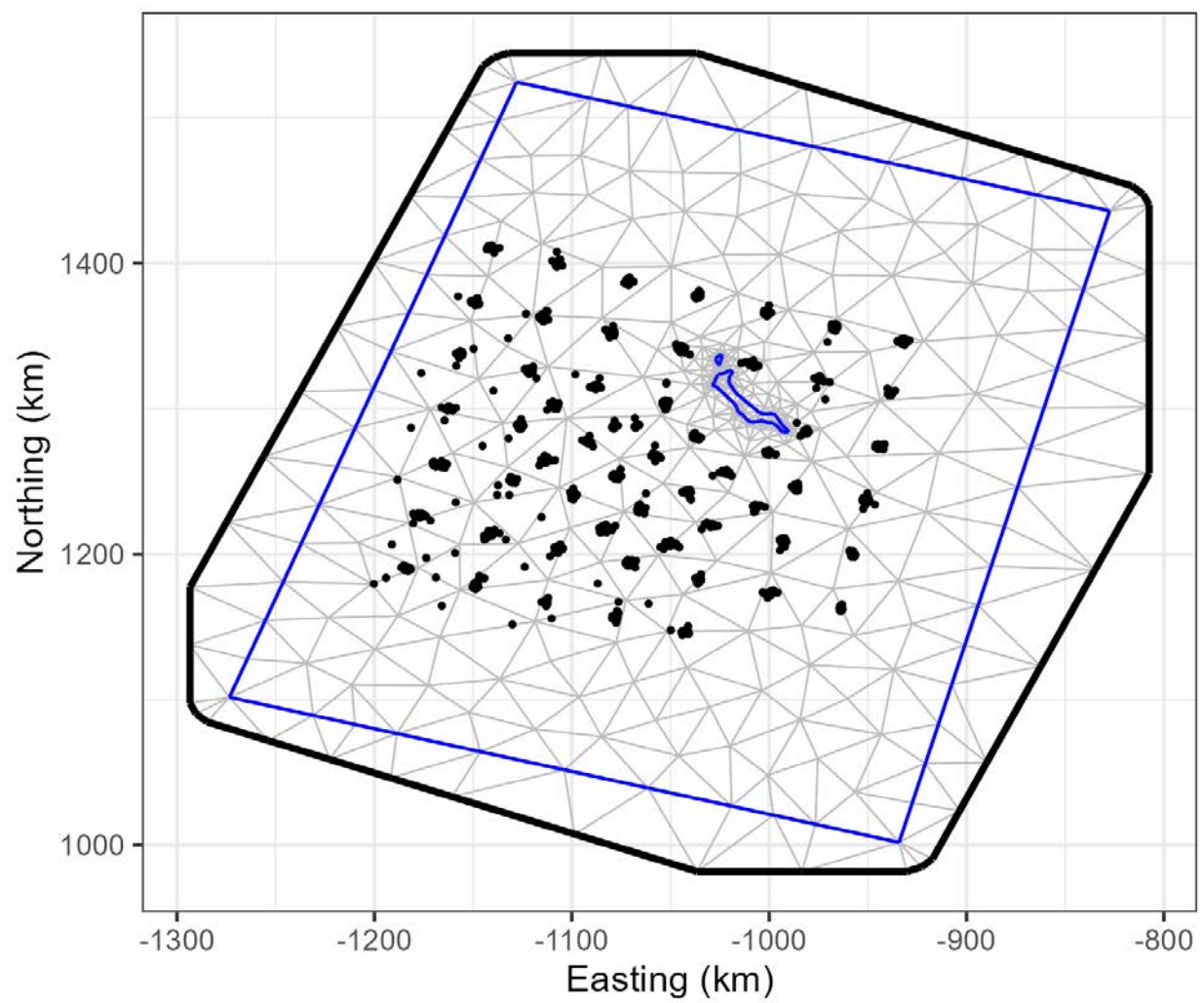


Figure 16: Spatial mesh used in spatiotemporal models, with NOAA EBS survey data observations (black points) overlaid.

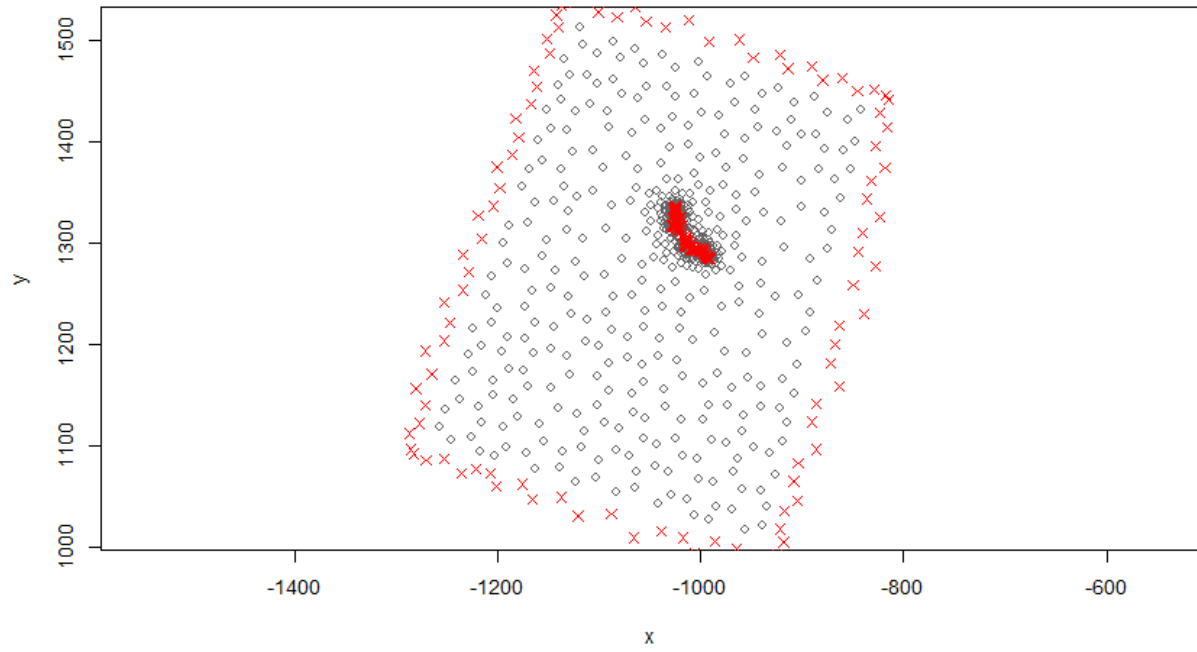


Figure 17: Vertices of the spatial barrier mesh used in spatiotemporal models, demonstrating that land as well as the area outside the designated polygon are excluded from the mesh (red crosses).

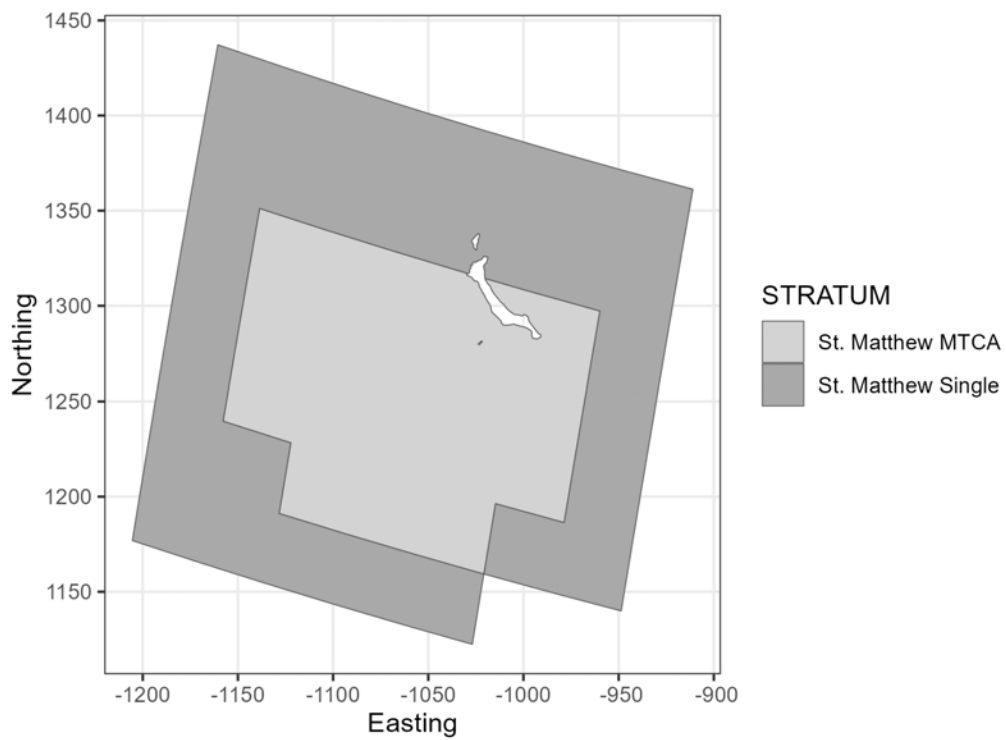


Figure 18: NOAA Eastern Bering Sea summer bottom trawl survey strata for the St. Matthew Island blue king crab stock.

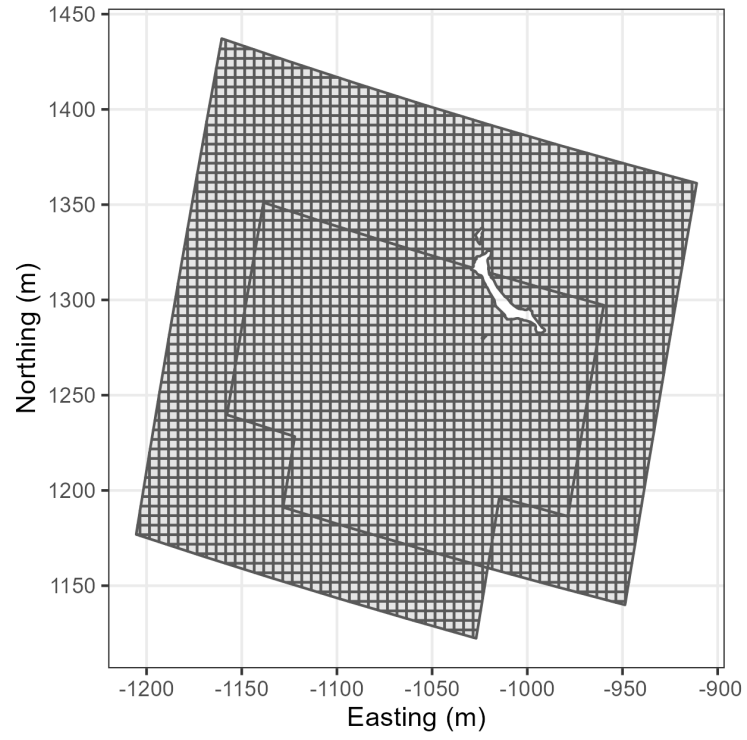


Figure 19: Prediction grid used to generate St. Matthew Island blue king crab biomass estimates.

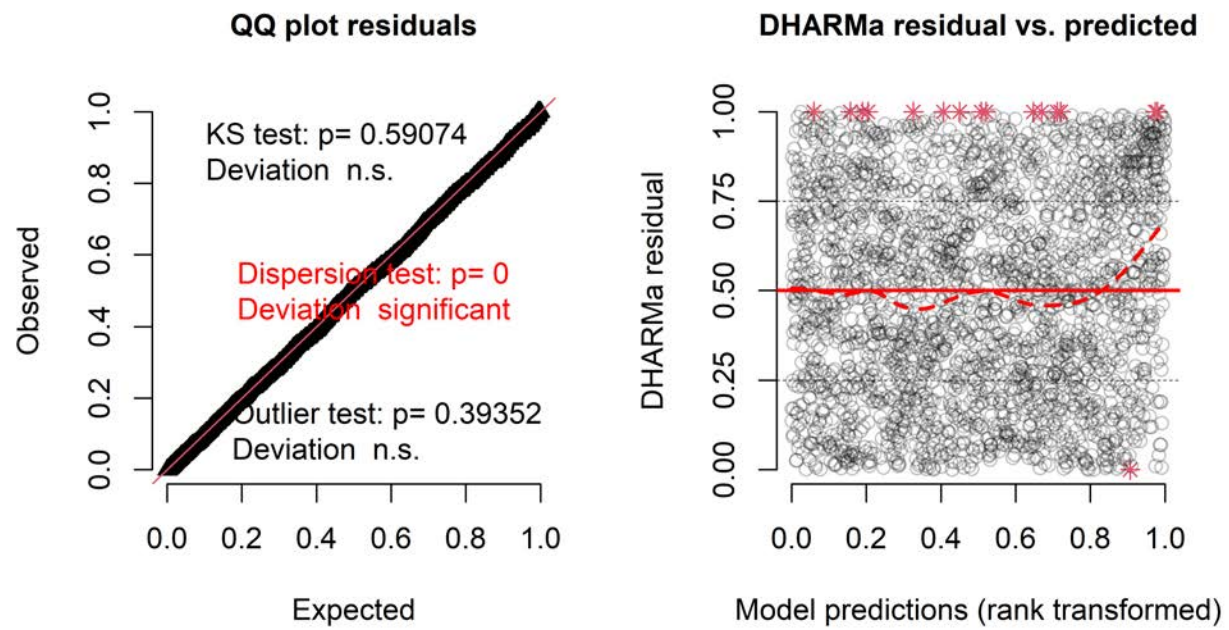


Figure 20: Diagnostics for the delta gamma distribution family model with year as a fixed effect, using DHARMA residuals.

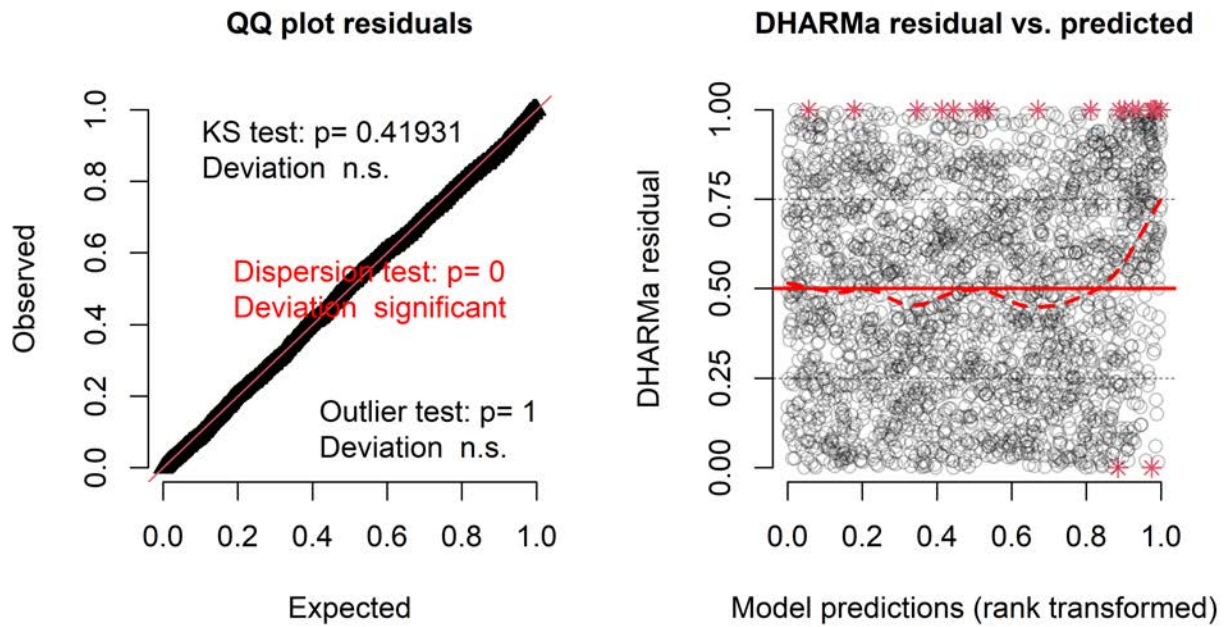


Figure 21: Diagnostics for the delta gamma distribution family model with year and depth as fixed effects, using DHARMA residuals.

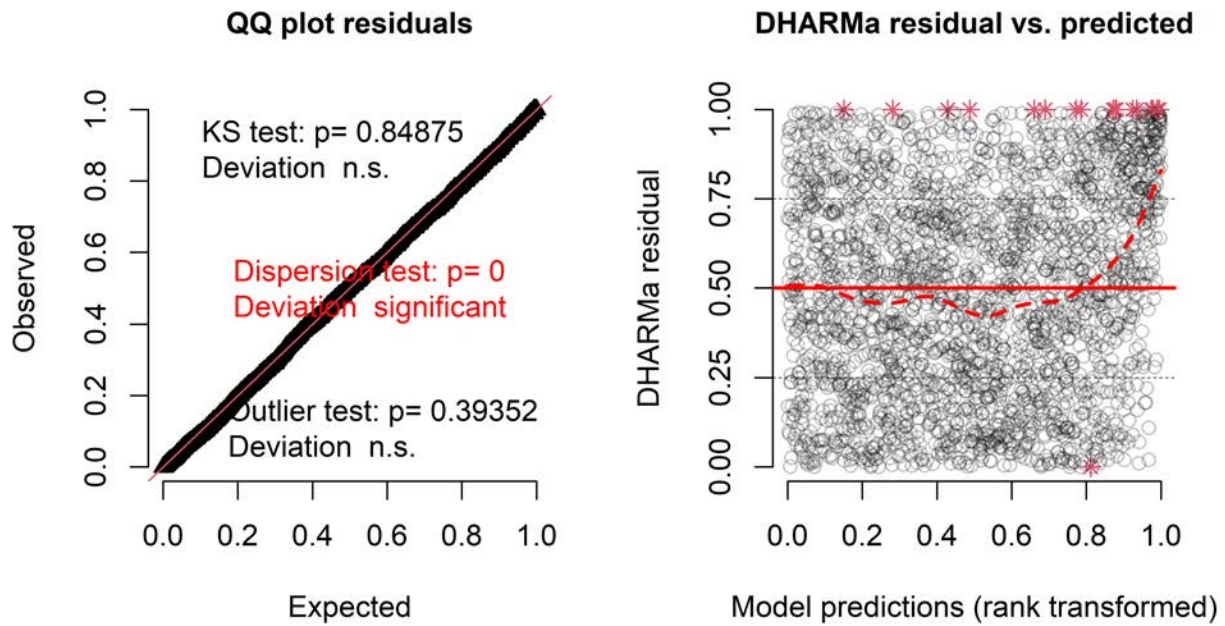


Figure 22: Diagnostics for the Tweedie distribution family model with year as a fixed effect, using DHARMA residuals.

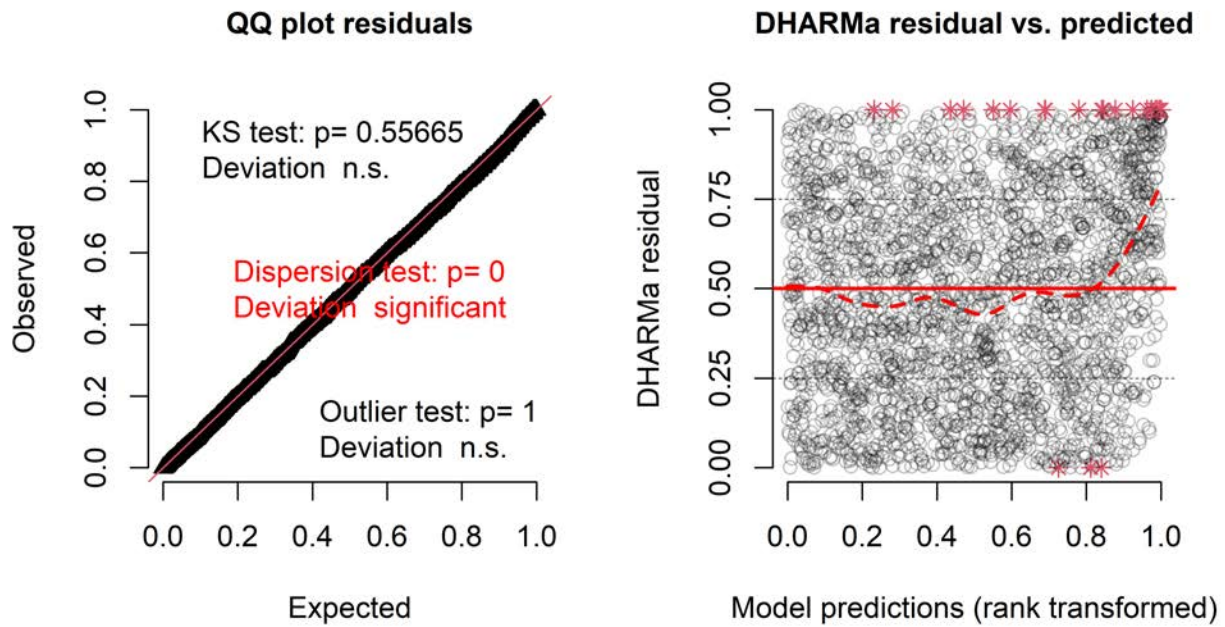


Figure 23: Diagnostics for the Tweedie distribution family model with year and depth as fixed effects, using DHARMA residuals.

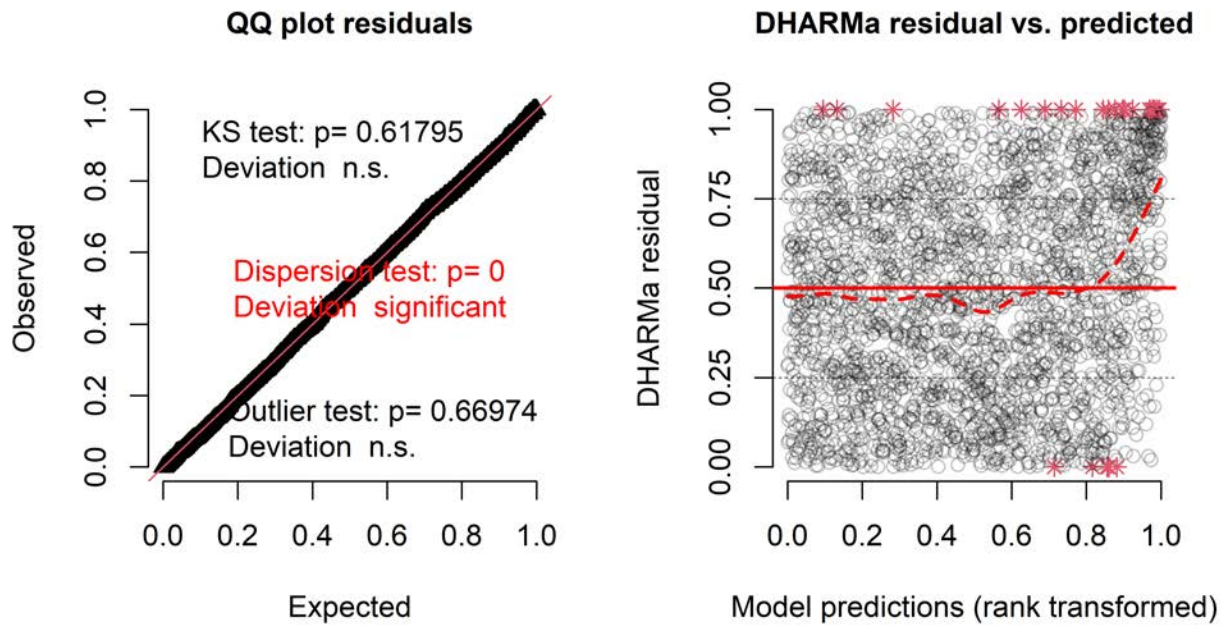


Figure 24: Diagnostics for the Tweedie distribution family model with year and a smooth on depth as fixed effects, using DHARMA residuals.

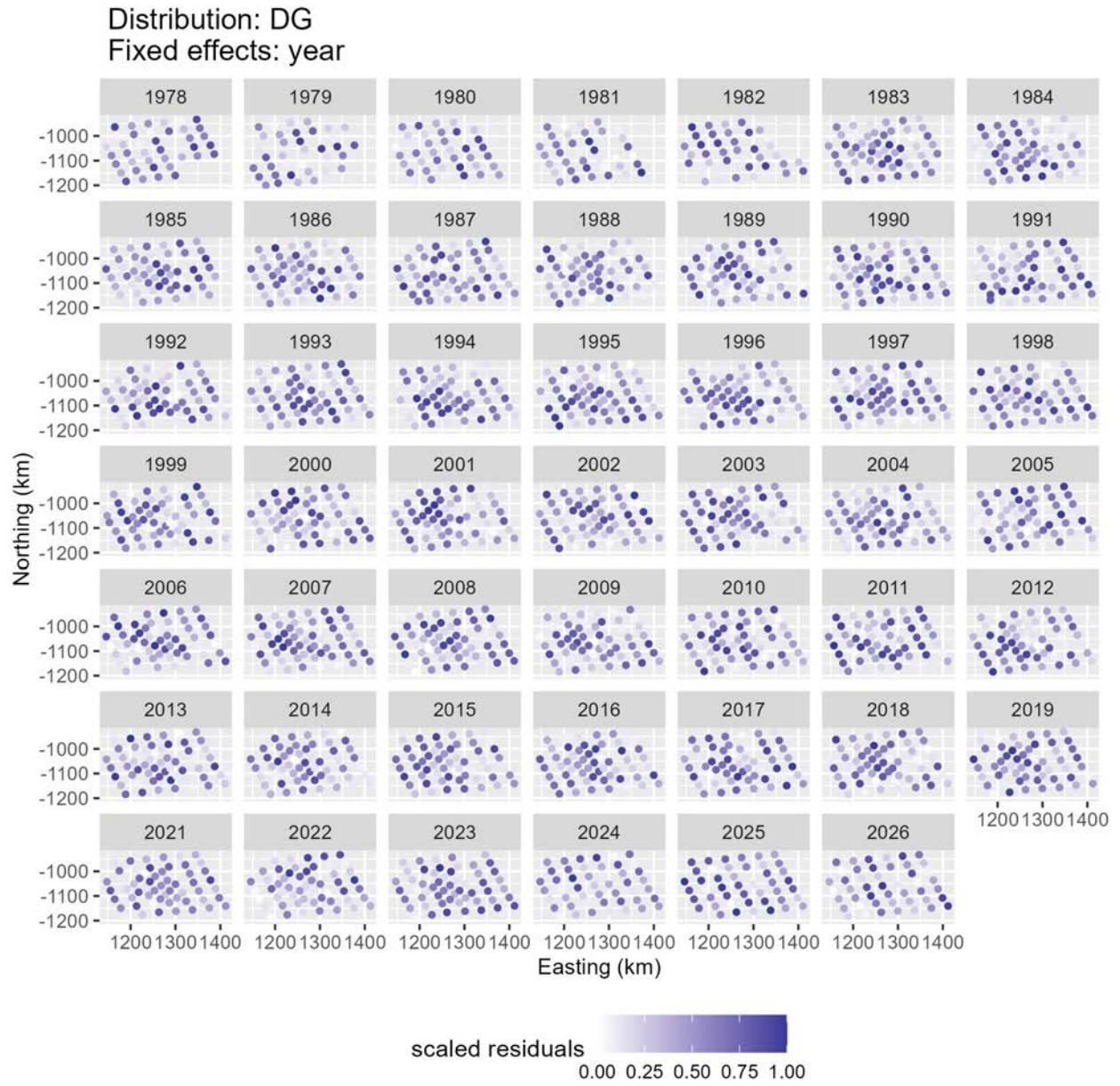


Figure 25: Spatial distribution of DHARMA residuals for the model using the delta gamma distribution with year as a fixed effect.

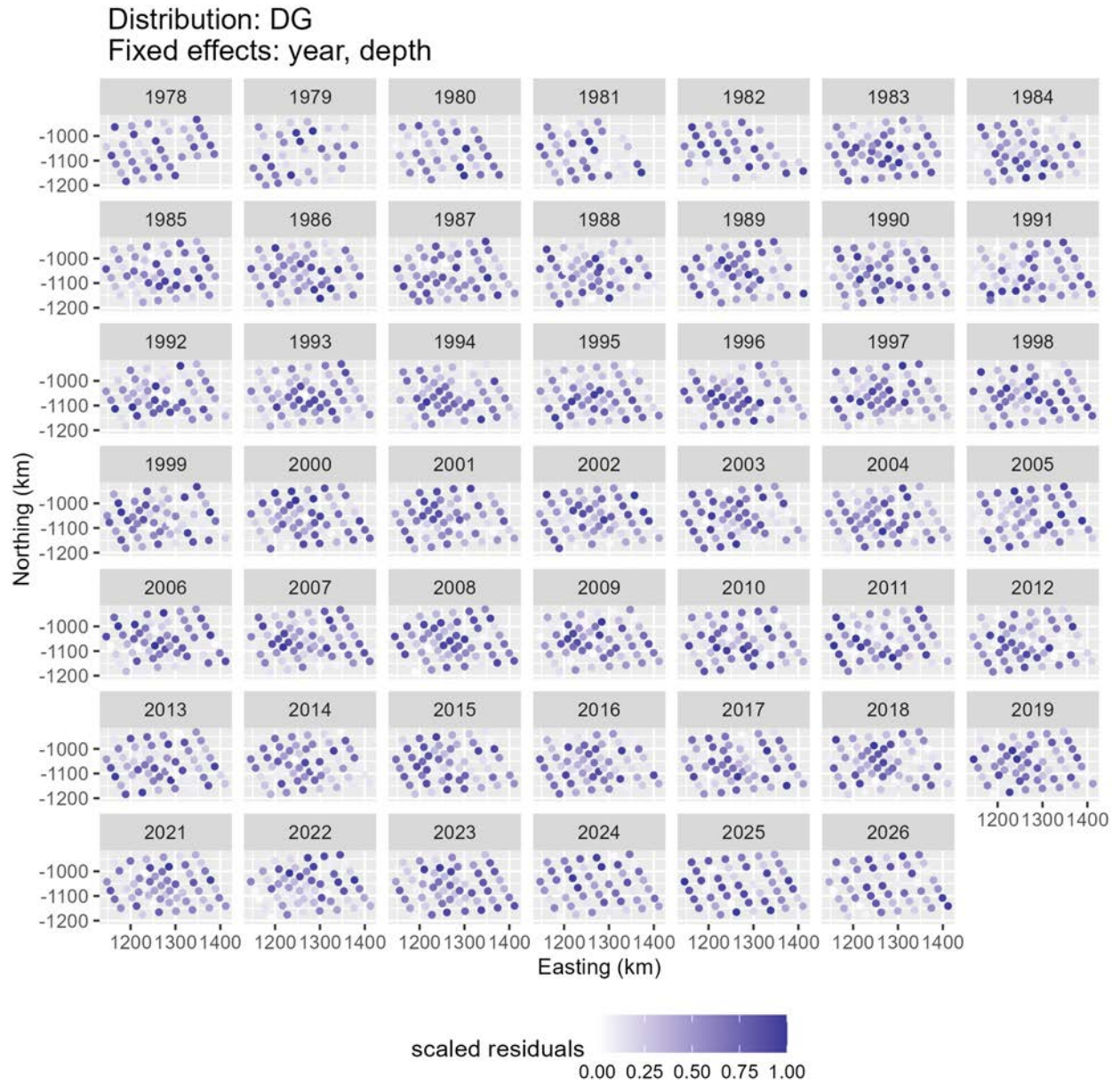


Figure 26: Spatial distribution of DHARMA residuals for the model using the delta gamma distribution with year and depth as fixed effects.

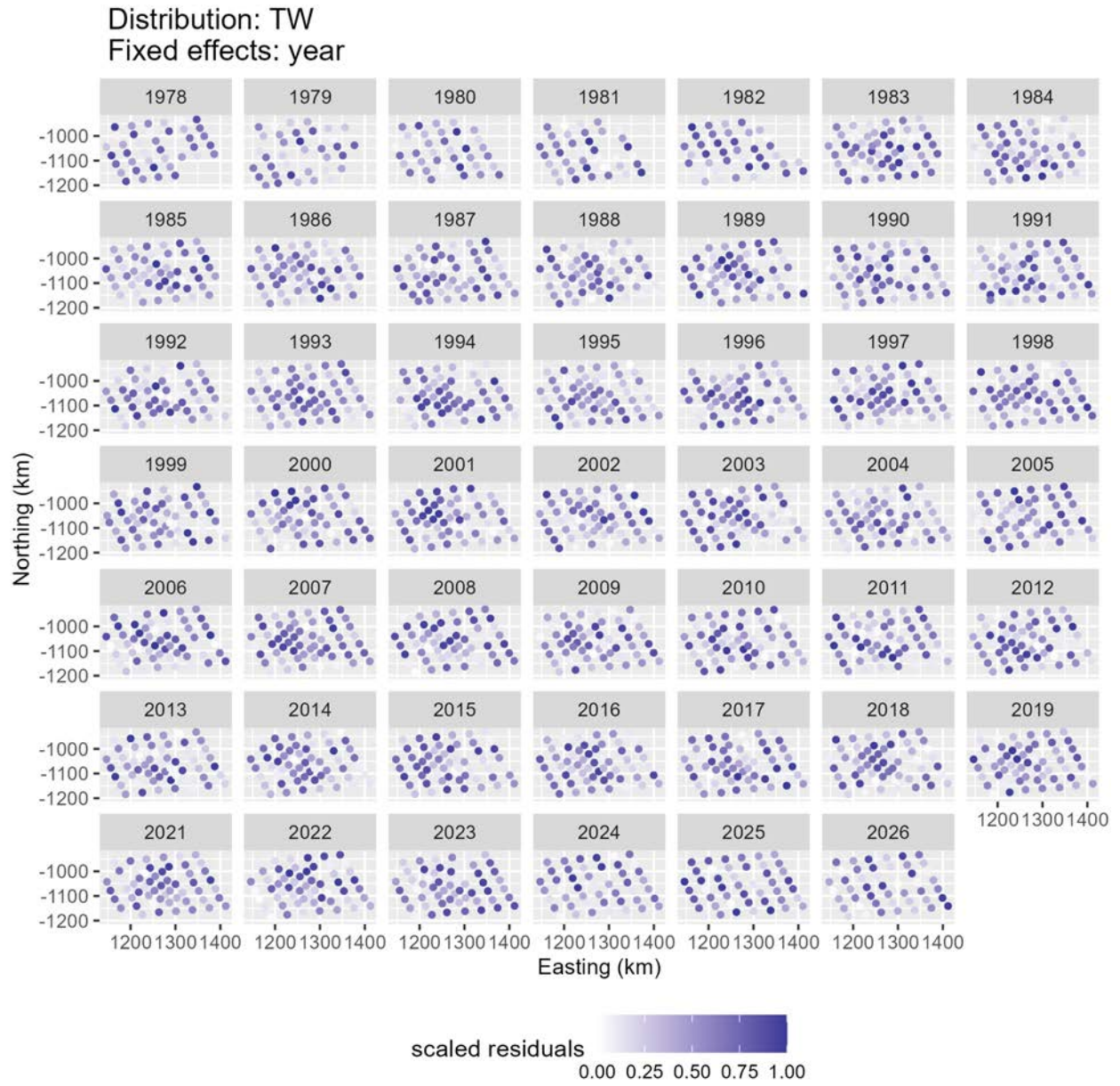


Figure 27: Spatial distribution of DHARMA residuals for the model using the Tweedie distribution with year as a fixed effect.

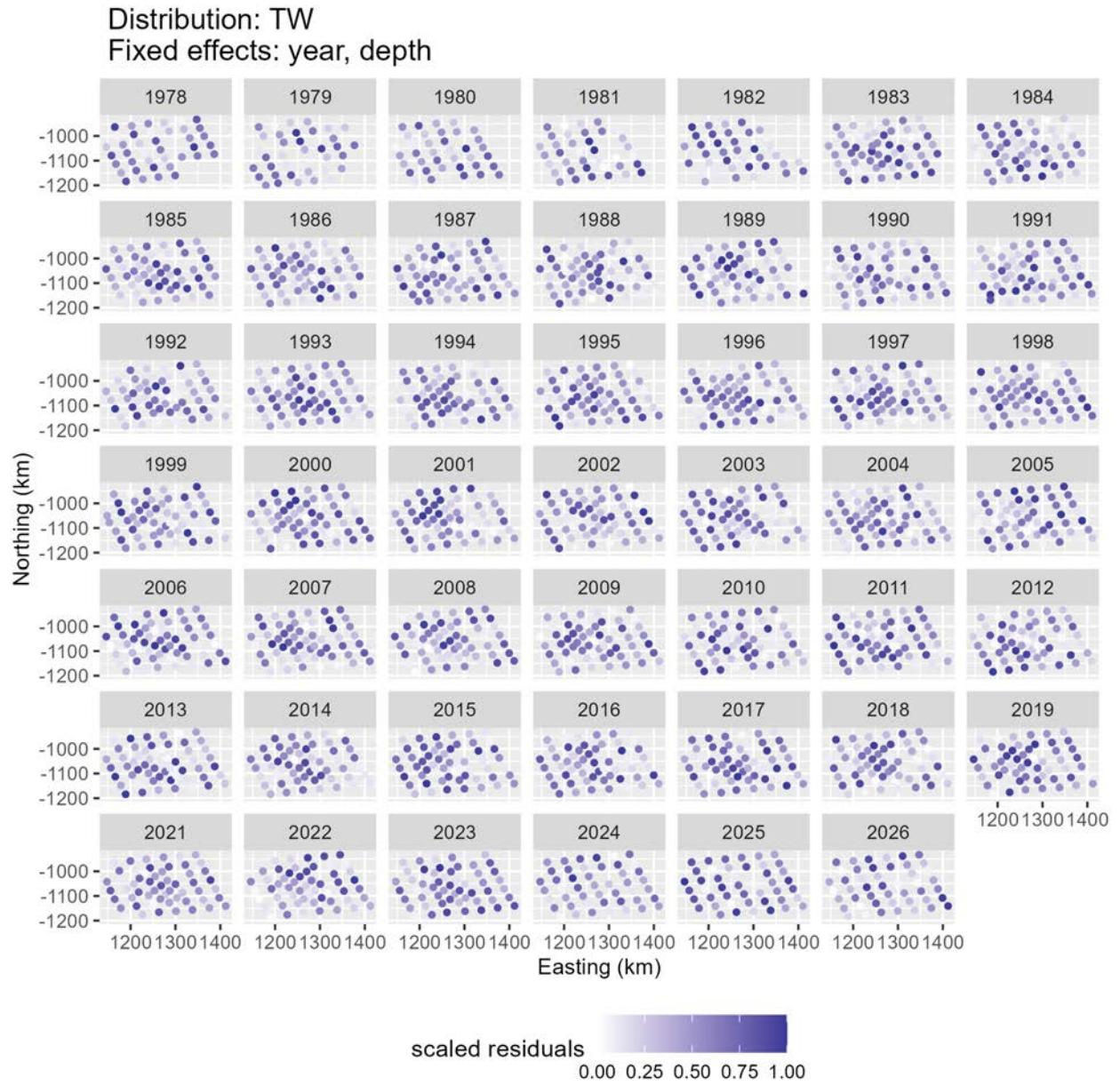


Figure 28: Spatial distribution of DHARMA residuals for the model using the Tweedie distribution with year and scaled depth as fixed effects.

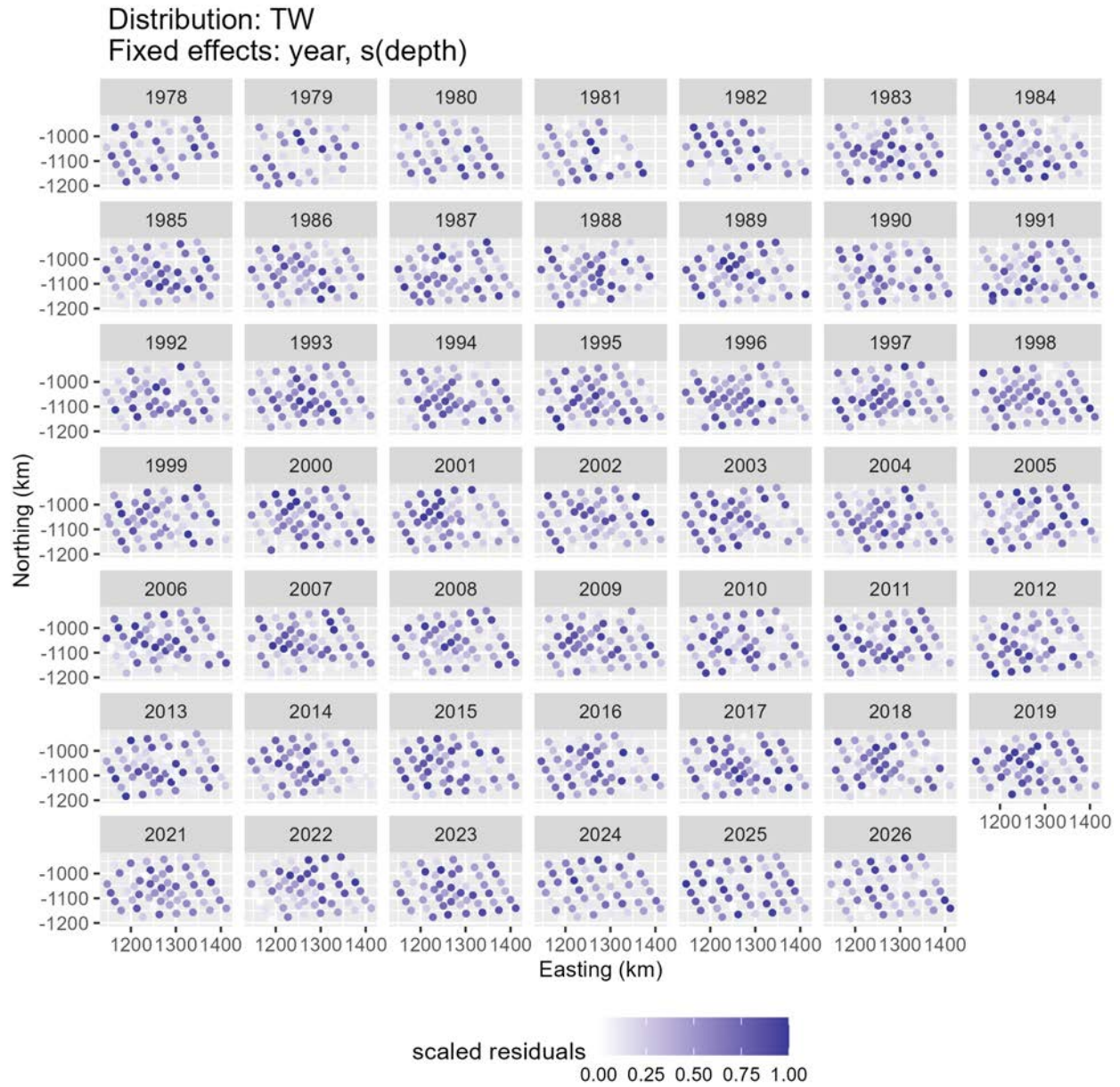


Figure 29: Spatial distribution of DHARMA residuals for the model using the Tweedie distribution with year and a smooth on depth as fixed effects.

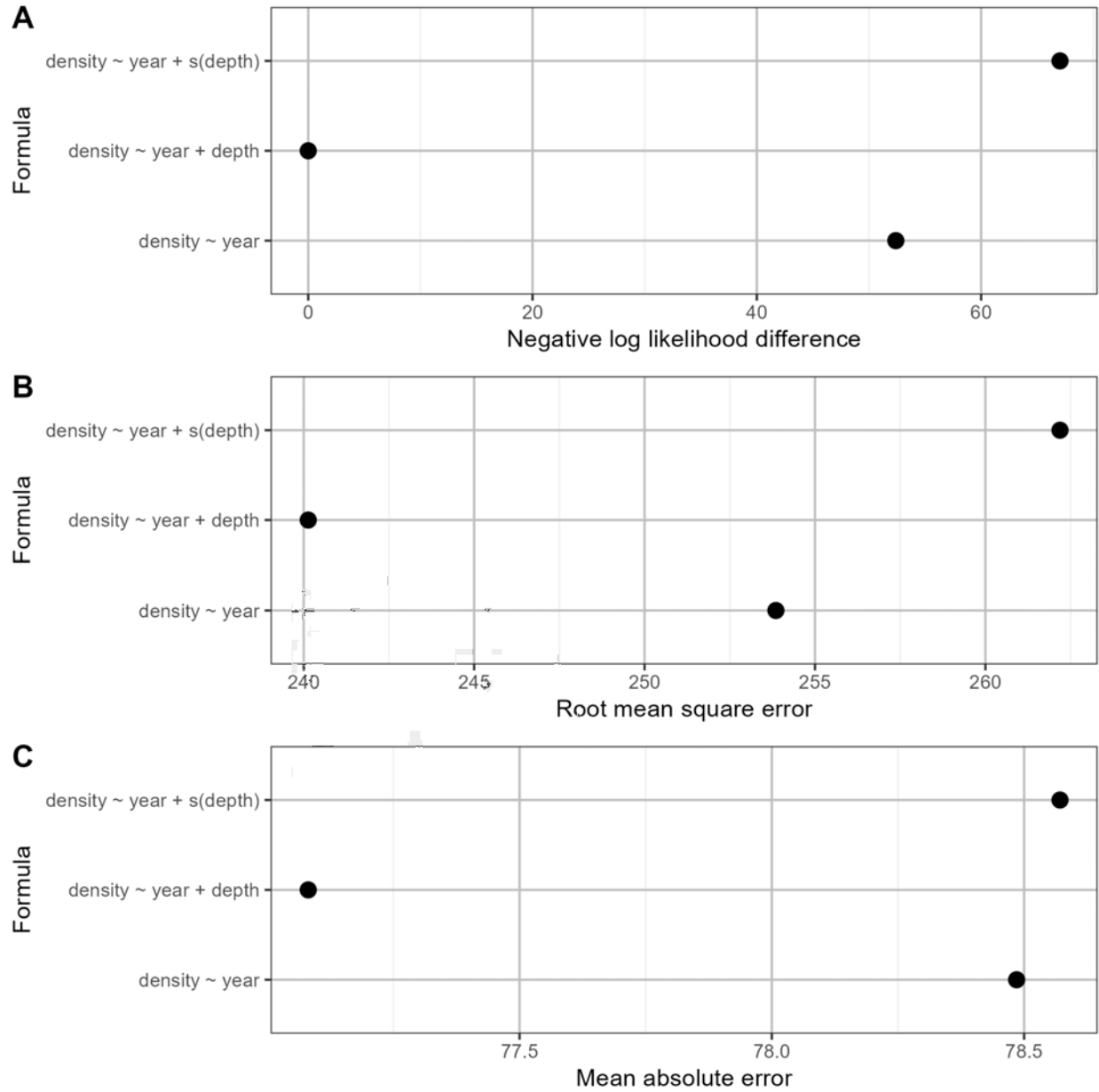


Figure 30: Metrics used in model selection, based on 10-fold cross validation. Note that all three models shown use the Tweedie distribution family, because either the model or the cross-validation for the model failed to converge for the models using the delta-gamma and delta-lognormal distribution families. A) Negative log likelihood difference compared to the best-fitting model, which has NLL difference = 0, where smaller values indicate better model fit. B) Root mean square error, a measure of the average difference between observed and predicted values, where a lower value indicates better model fit. C) Mean absolute error, a measure of the average absolute value of the difference between observed and predicted values, where a lower value indicates better model fit.

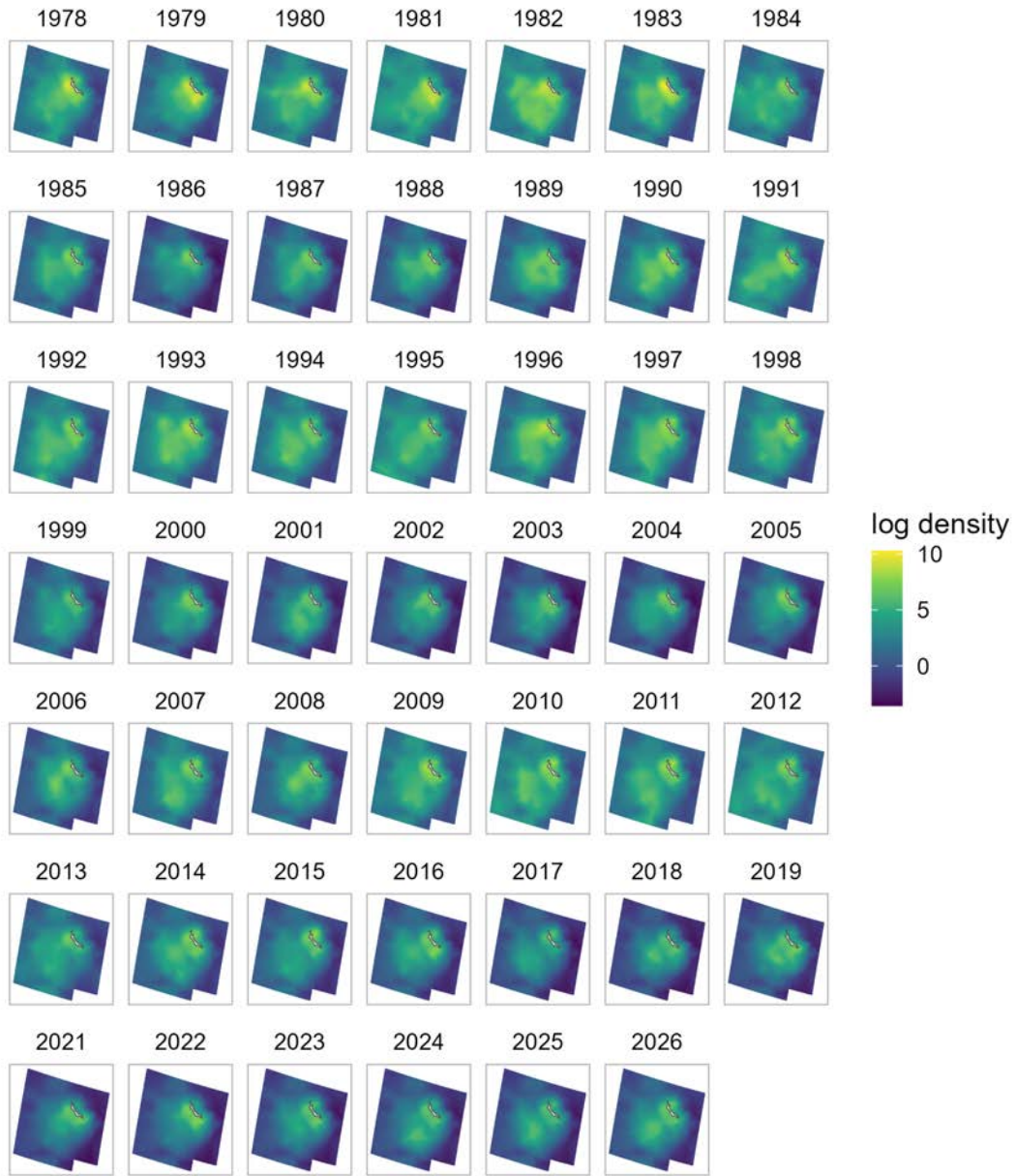


Figure 31: Spatial predictions of St. Matthew Island blue king crab males ≥ 90 mm in carapace length by year from the model using the Tweedie distribution with year as a fixed effect.

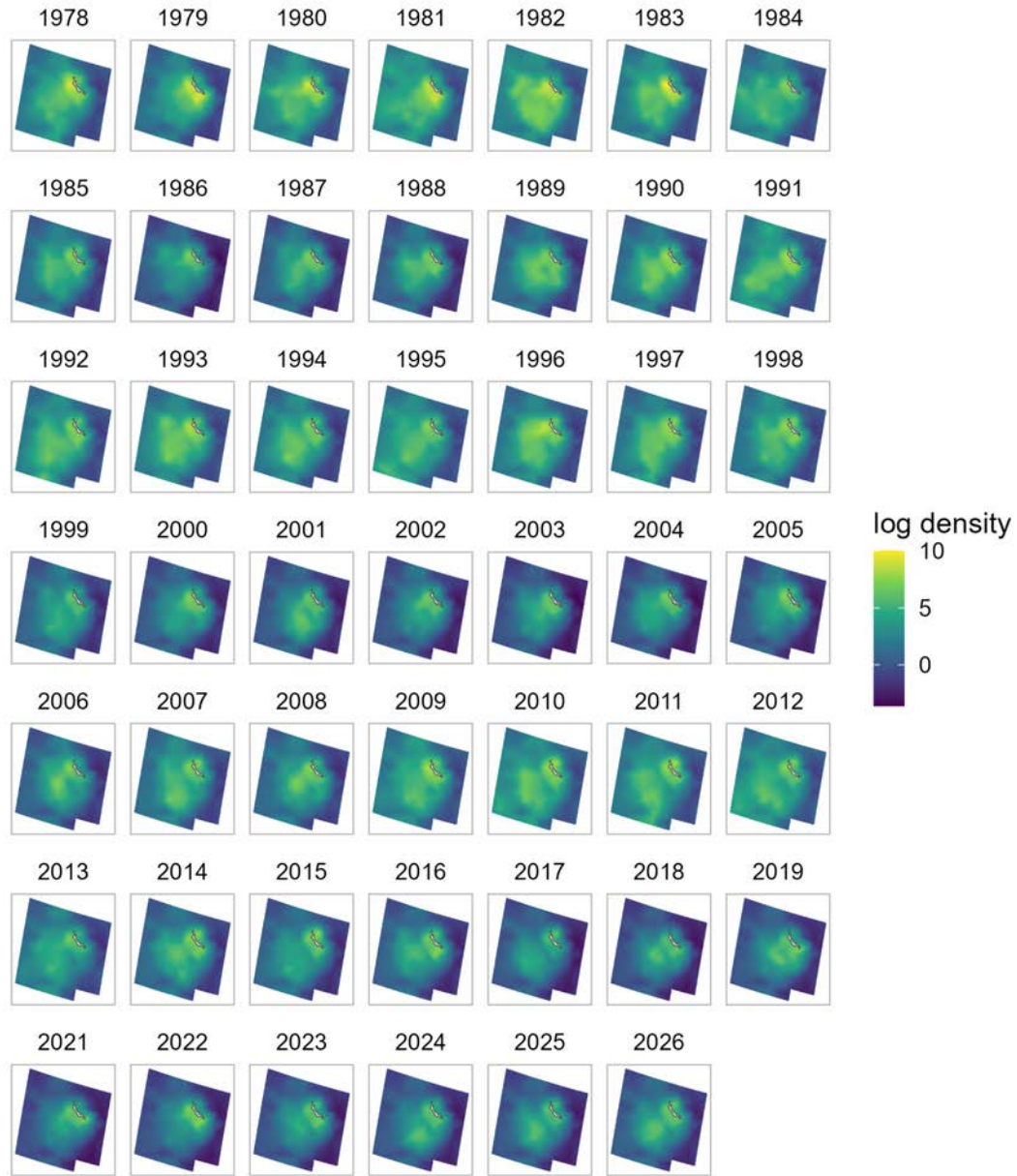


Figure 32: Spatial predictions of St. Matthew Island blue king crab males ≥ 90 mm in carapace length by year from the model using the Tweedie distribution with year and scaled depth as fixed effects.

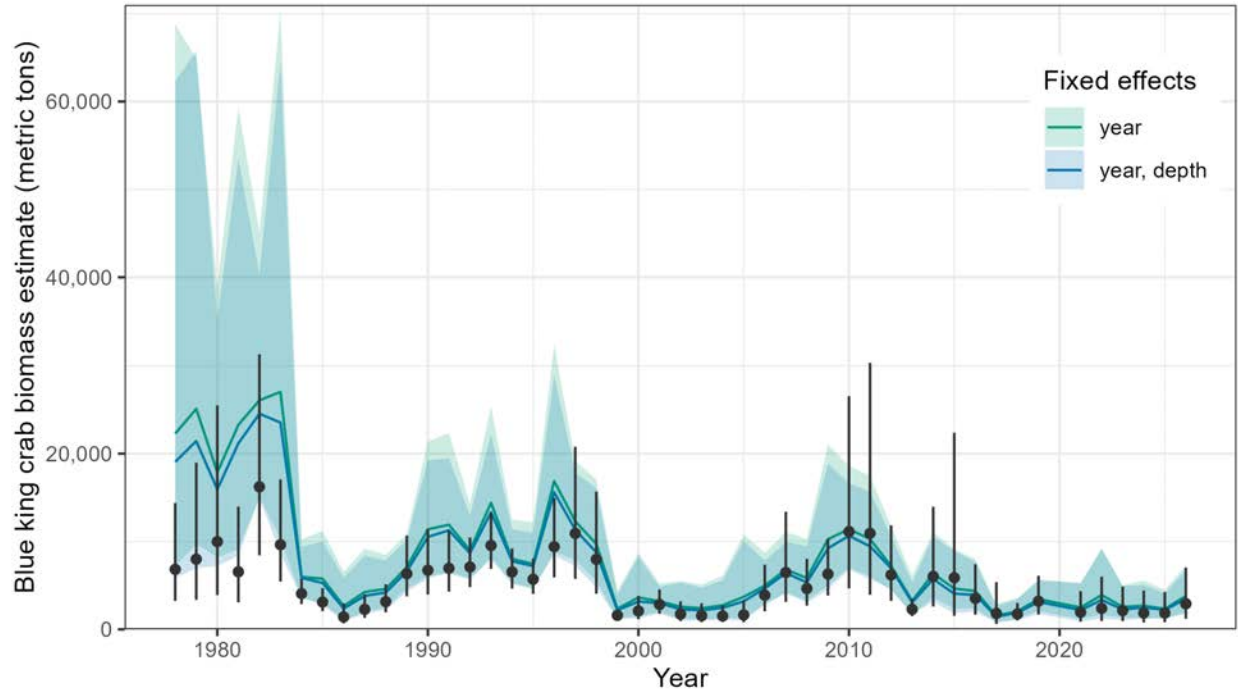


Figure 33: Estimated St. Matthew Island blue king crab biomass for males with carapace length ≥ 90 mm. Colored lines represent abundance ($\pm 95\%$ CI) estimated using spatiotemporal models with the Tweedie distribution family and either a year fixed effect only (green) or year and scaled depth as fixed effects (blue). Black points represent design-based biomass ($\pm 95\%$ CI) estimates currently used in the stock assessment model.

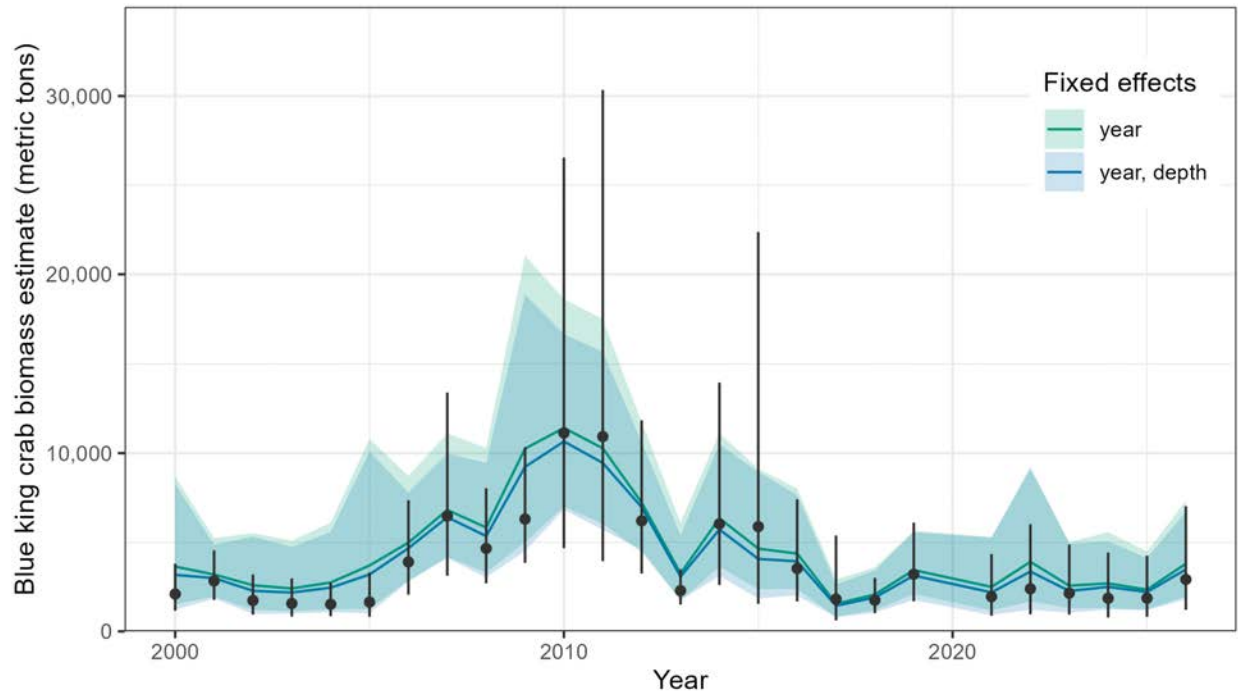


Figure 34: Estimated St. Matthew Island blue king crab biomass for males with carapace length ≥ 90 mm for the years 2000 - 2026 only. Colored lines represent abundance ($\pm 95\%$ CI) estimated using spatiotemporal models with the Tweedie distribution family and either a year fixed effect only (green) or year and scaled depth as fixed effects (blue). Black points represent design-based biomass ($\pm 95\%$ CI) estimates currently used in the stock assessment model.

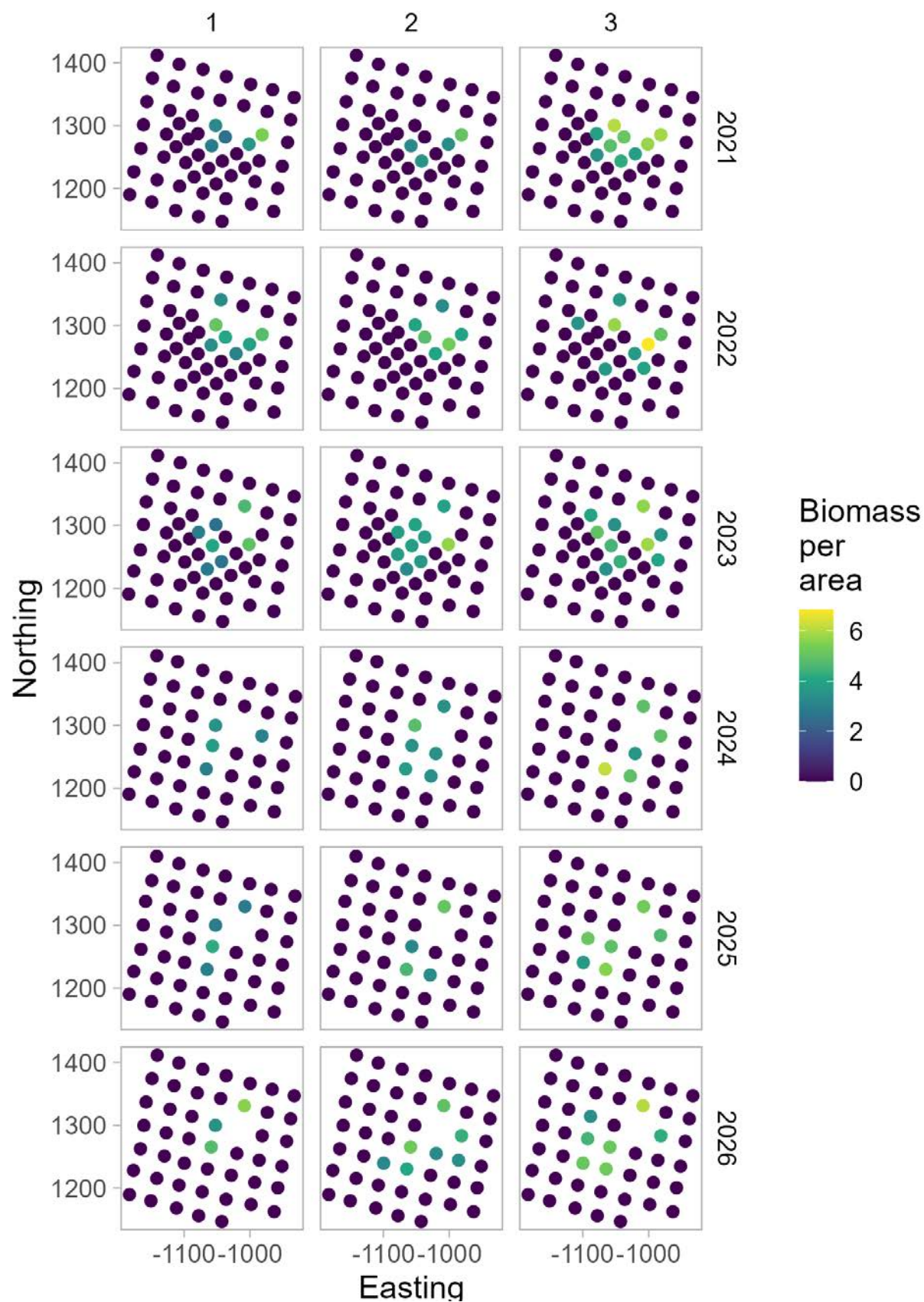


Figure 35: Example of size class survey biomass observations used to generate the model-based size compositions. Only survey observations from the years 2021-2026 are shown here, but the analysis included the full EBS trawl survey time series (1978-2026).

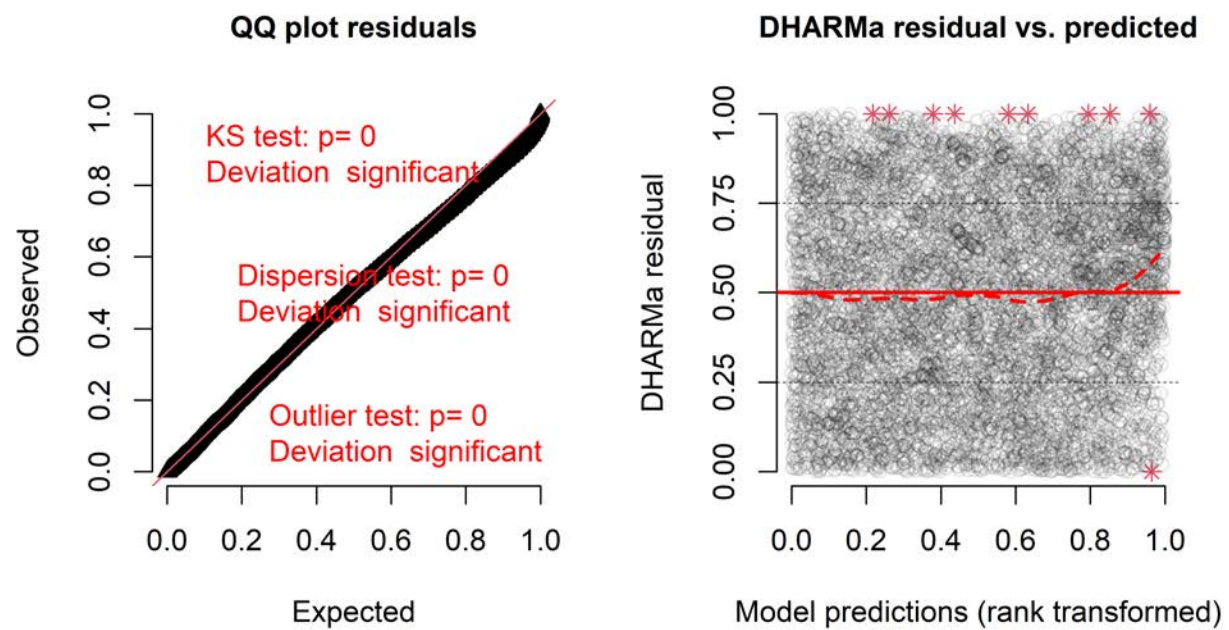


Figure 36: Diagnostics for the spatiotemporal model used to estimate size compositions, using DHARMA residuals.

Size 1

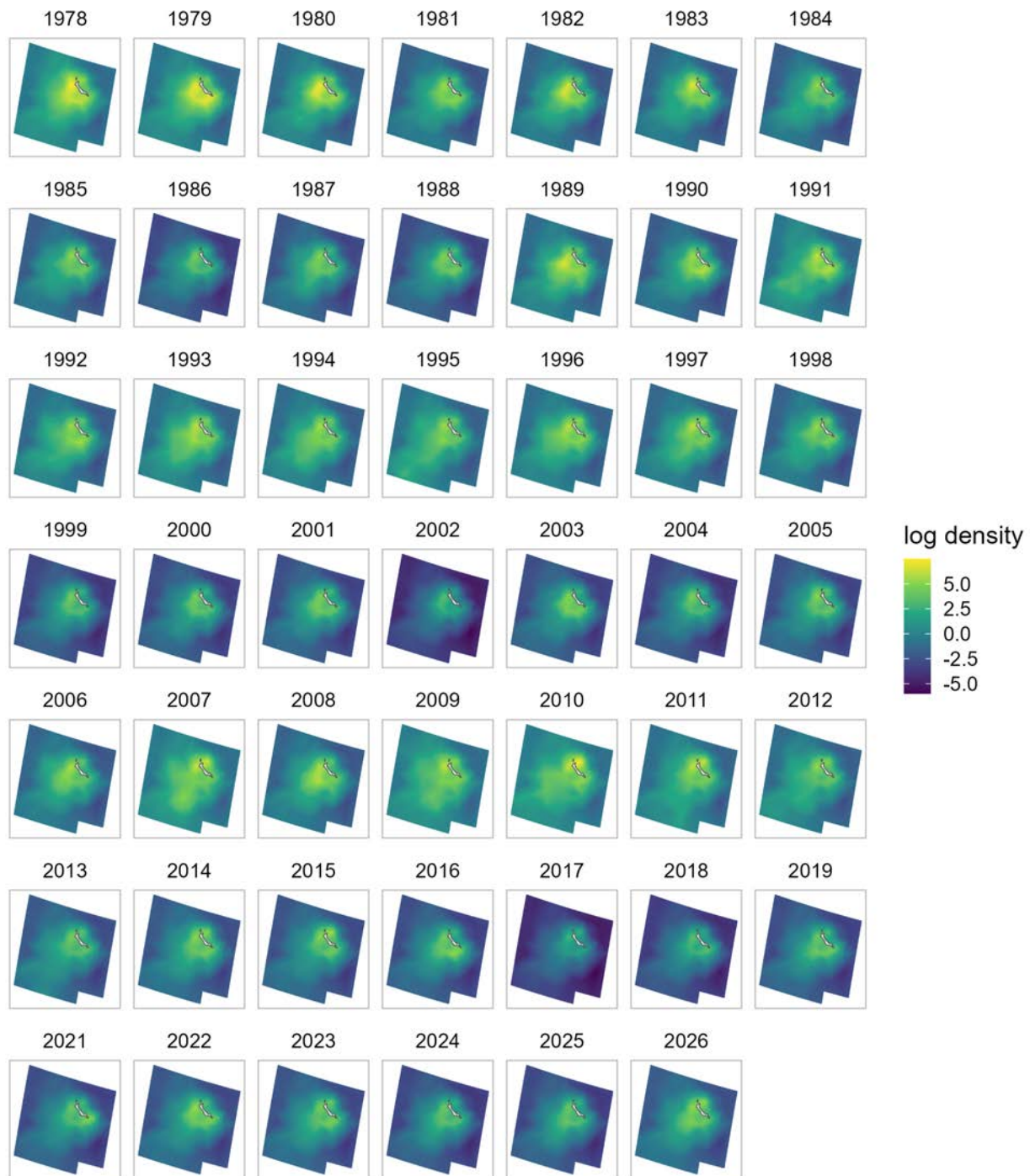


Figure 40: Spatial predictions of St. Matthew Island blue king crab males 90-104 mm in carapace length (size class 1) by year.

Size 2

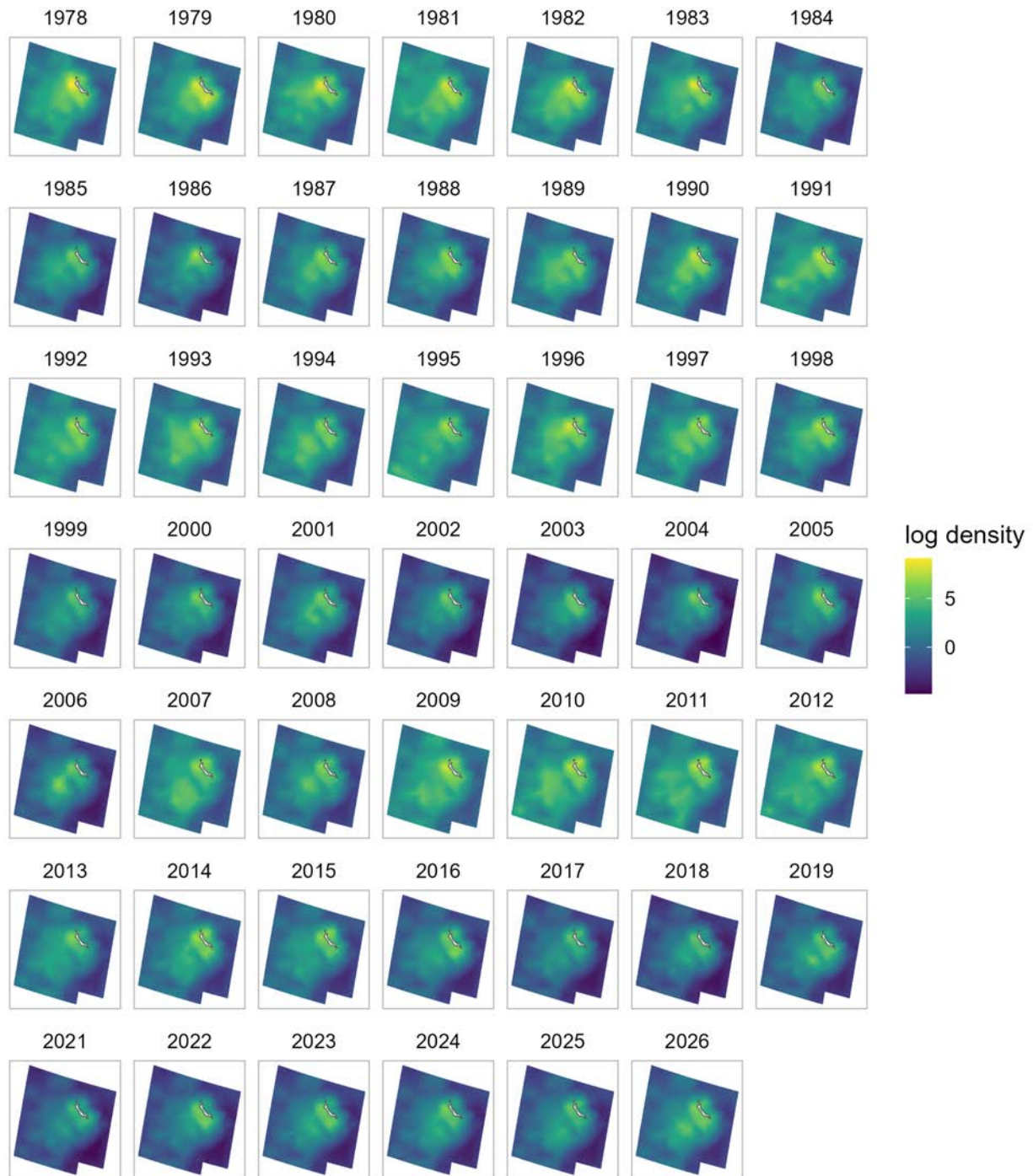


Figure 41: Spatial predictions of St. Matthew Island blue king crab males 105-119 mm in carapace length (size class 2) by year.

Size 3

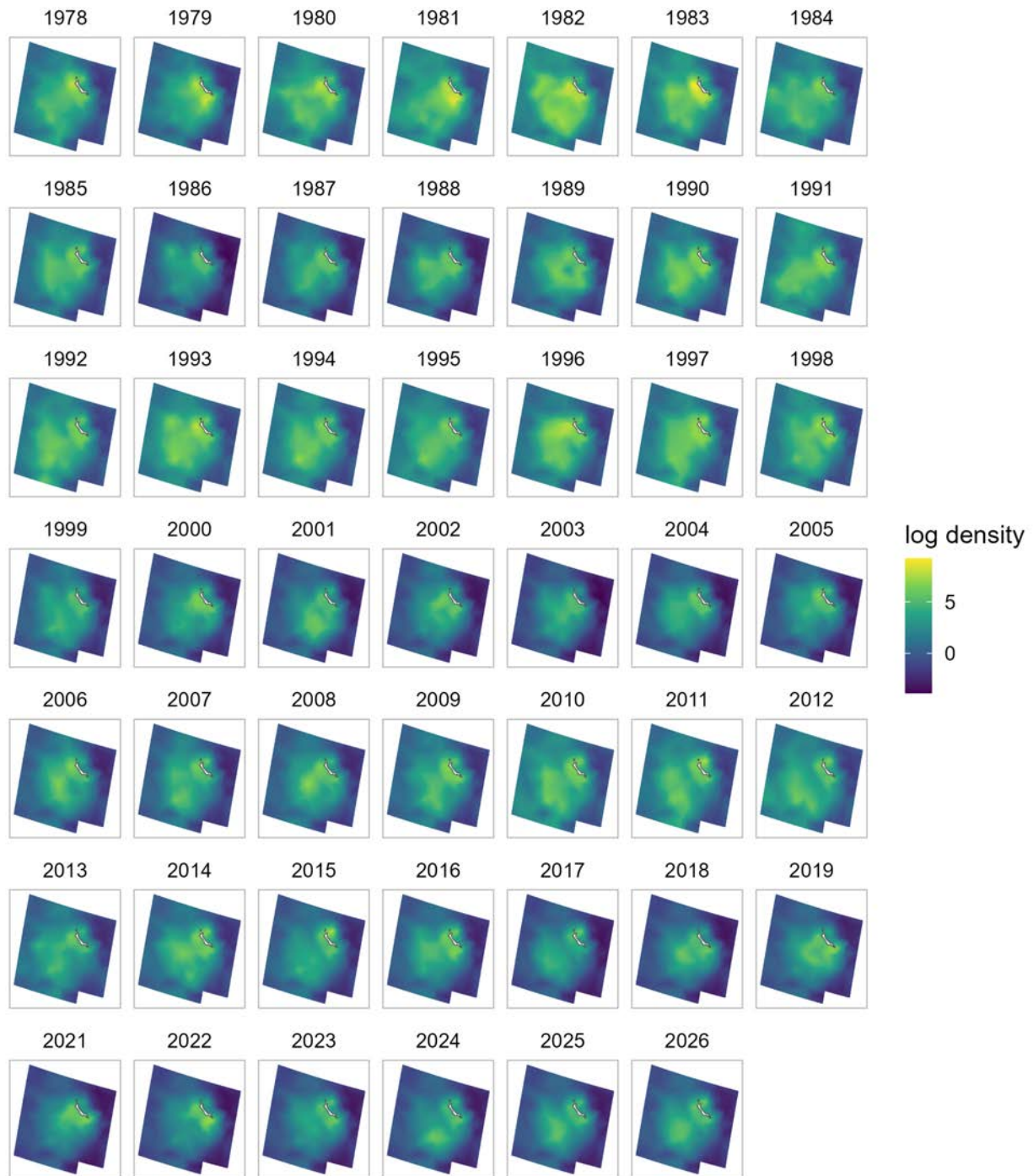


Figure 42: Spatial predictions of St. Matthew Island blue king crab males ≥ 120 mm in carapace length (size class 3) by year.

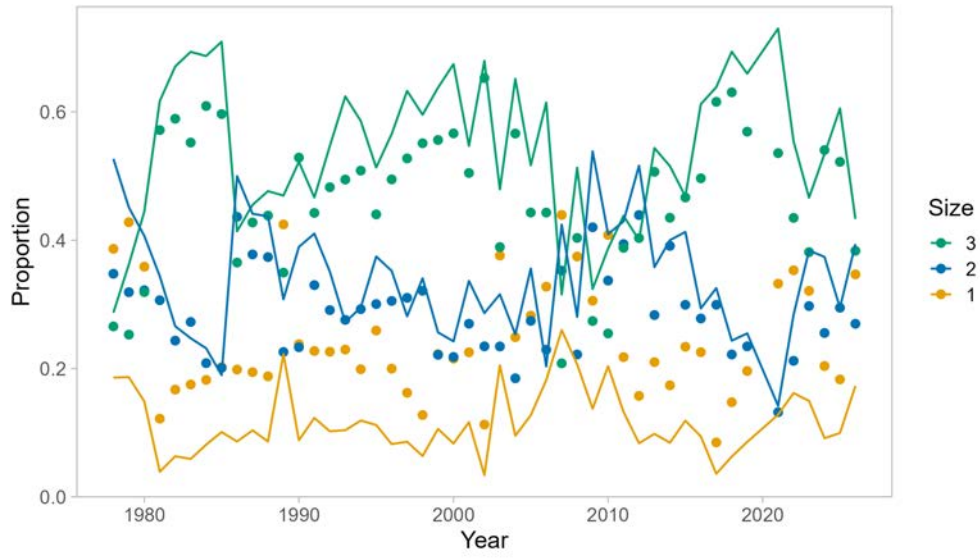


Figure 43: Design-based (points) versus model-based (lines) size class proportion estimates for the EBS trawl survey time series (1978-2026).

Size 1

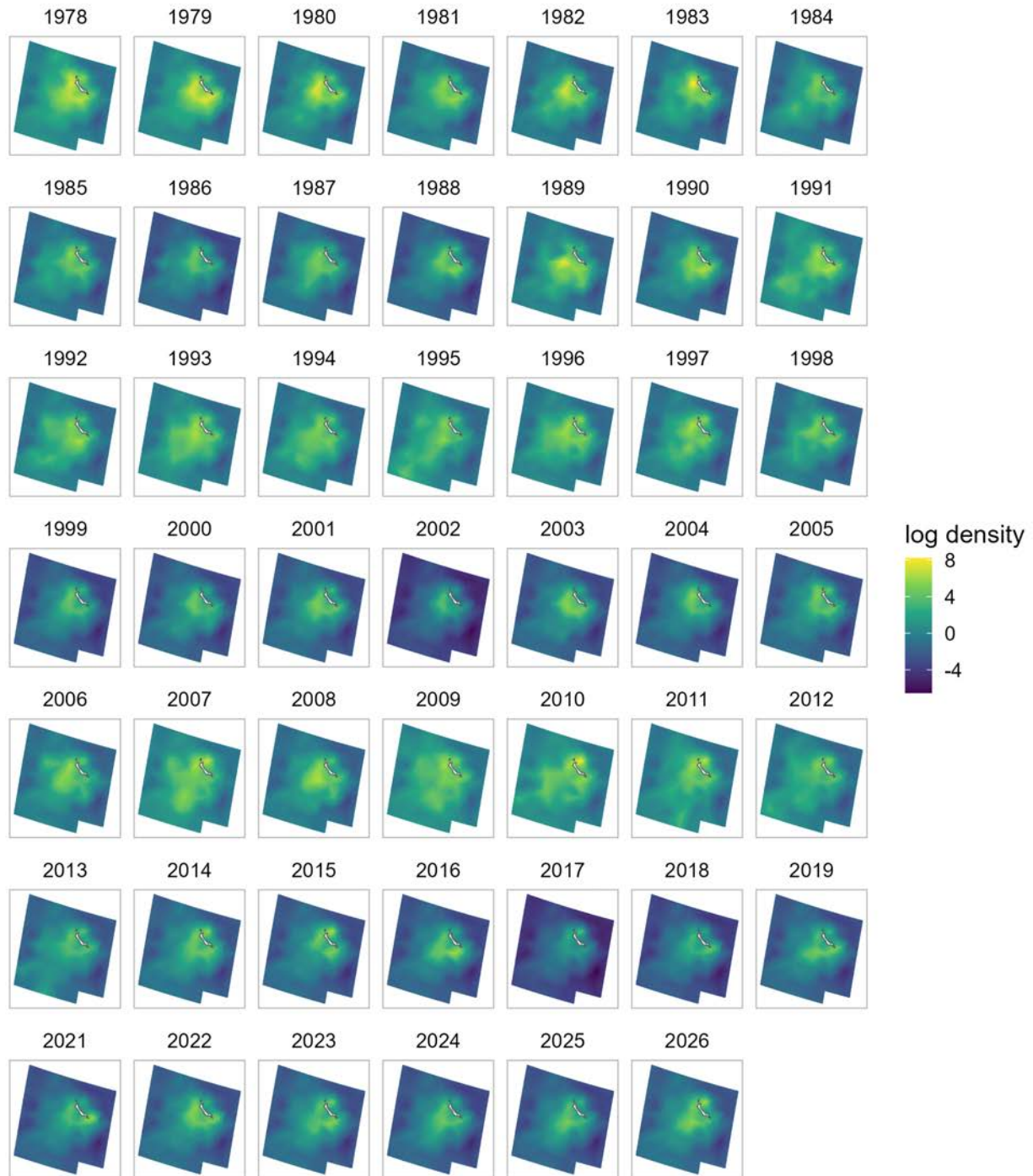


Figure 44: Spatial predictions of St. Matthew Island blue king crab males 90-104 mm in carapace length (size class 1) by year, with density defined as abundance per area rather than biomass per area.

Size 2

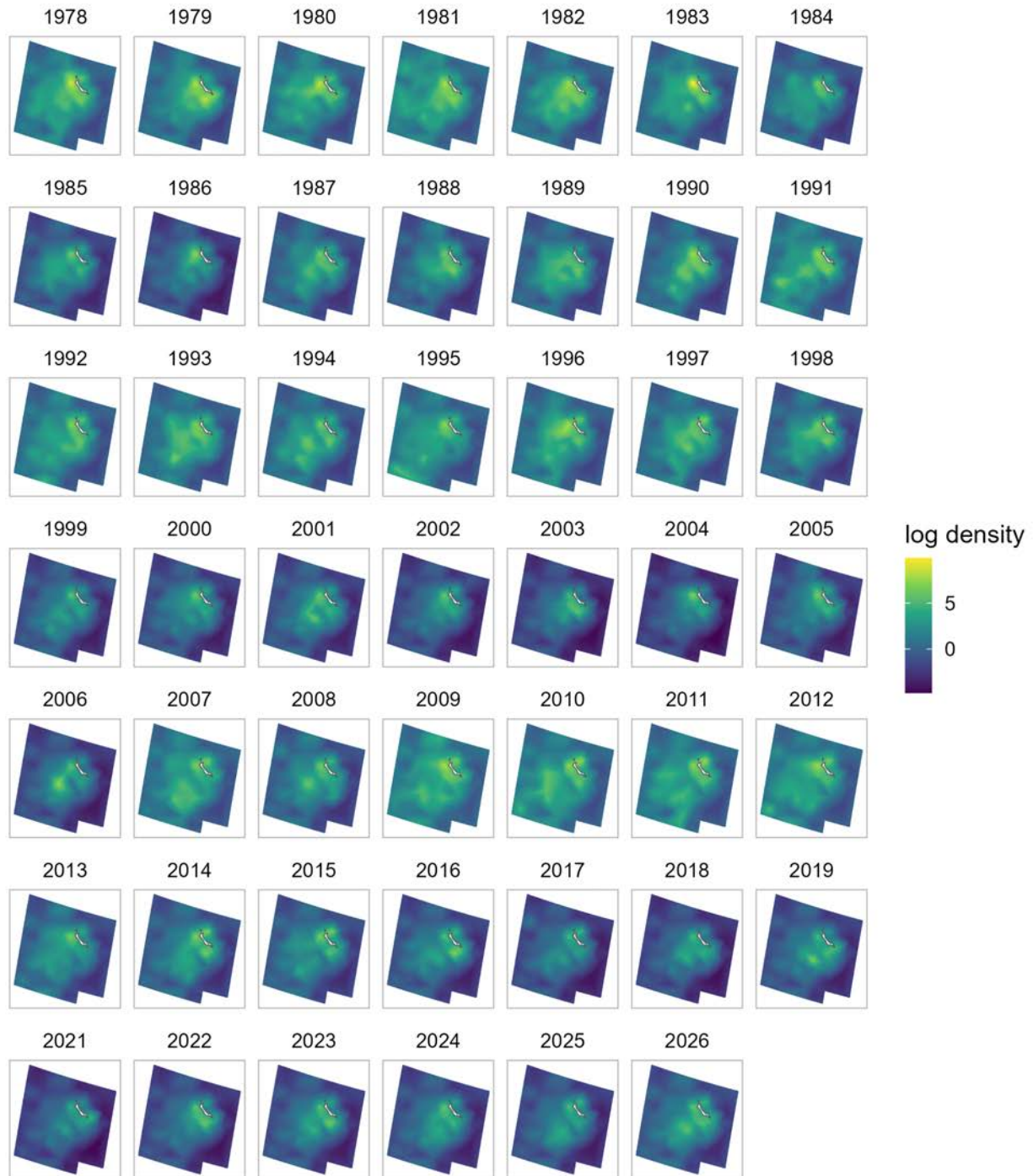


Figure 45: Spatial predictions of St. Matthew Island blue king crab males 105-119 mm in carapace length (size class 2) by year, with density defined as abundance per area rather than biomass per area.

Size 3

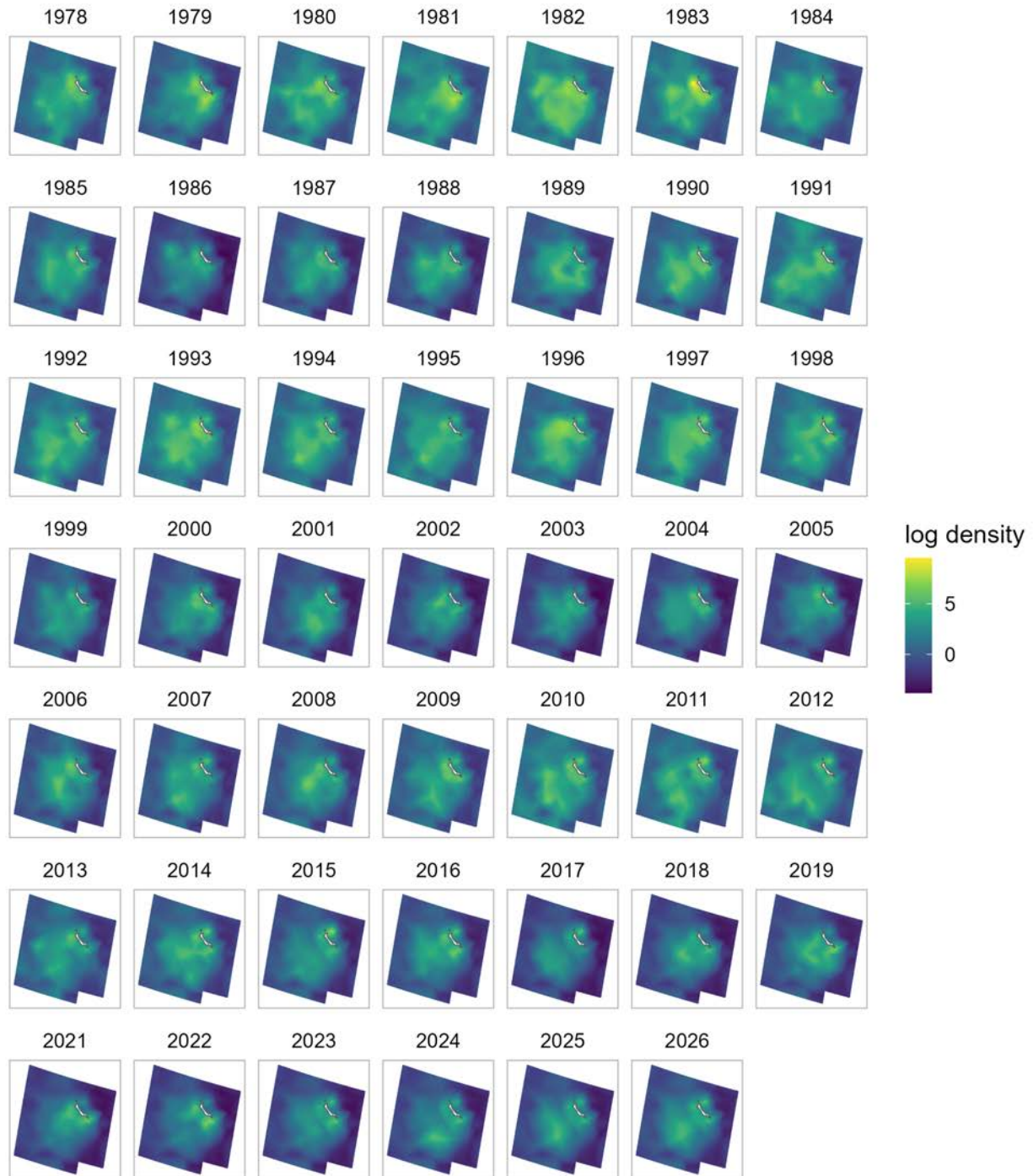


Figure 46: Spatial predictions of St. Matthew Island blue king crab males ≥ 120 mm in carapace length (size class 3) by year, with density defined as abundance per area rather than biomass per area.

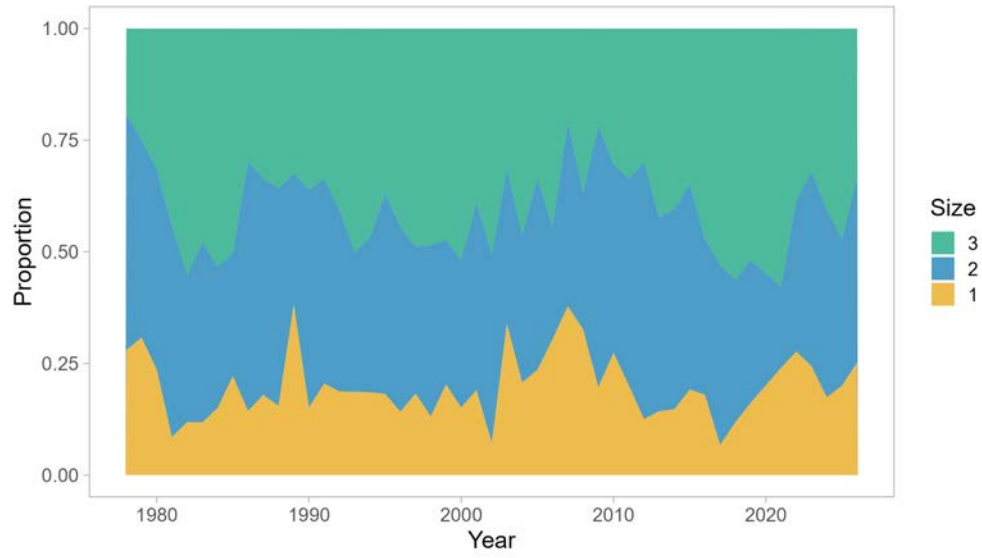


Figure 47: Model-based size class proportion estimates for the EBS trawl survey time series (1978-2026), estimated using abundance per area rather than biomass per area.

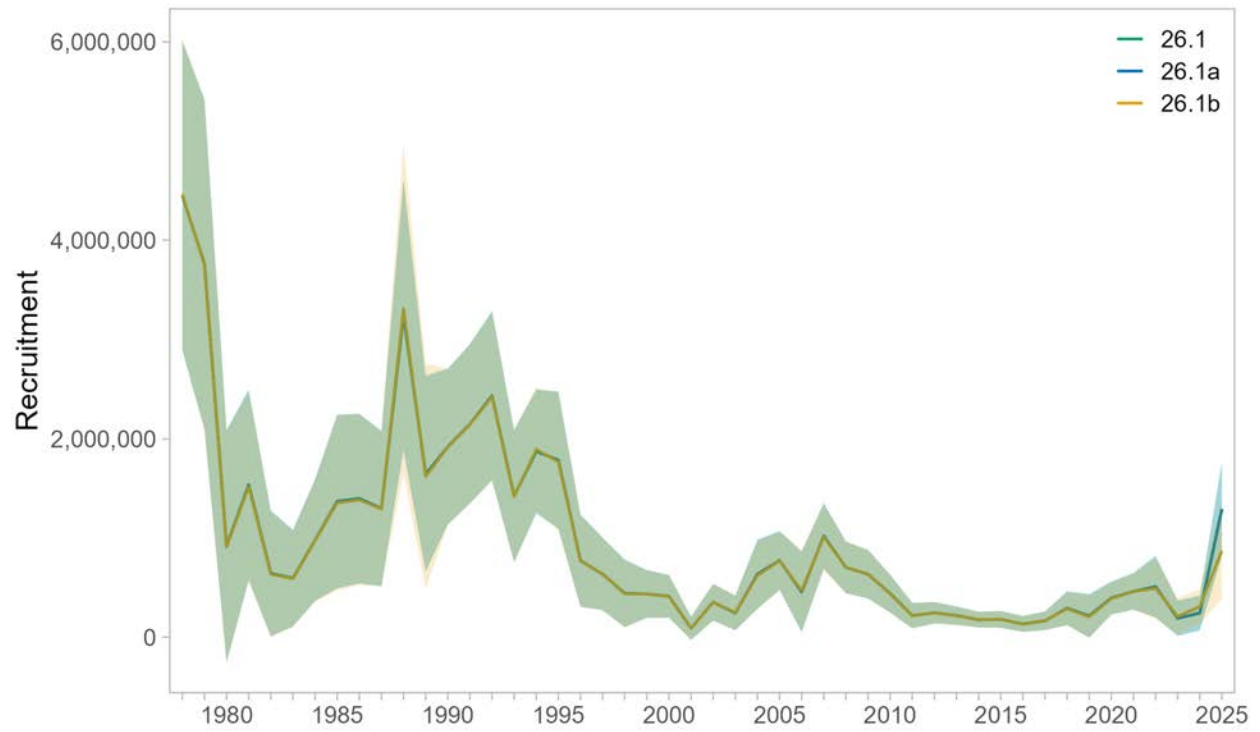


Figure 48: Estimated recruitment (in number of individuals) for the models in the bridging analysis. Model 26.1b is the new base model, with updated data and GMACS version.

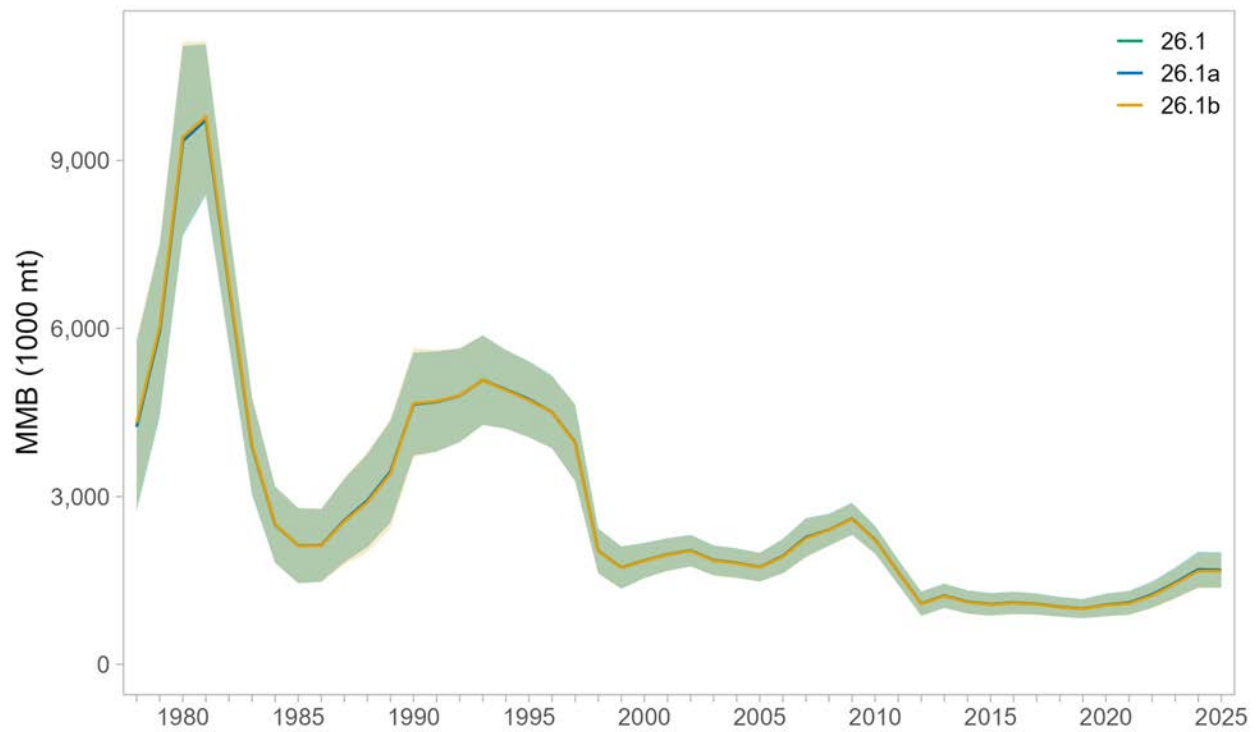


Figure 49: Comparisons of estimated mature male biomass (MMB) time series on 15 February (year + 1) during 1978-2025 for the models in the bridging analysis. Model 26.1b is the new base model, with updated data and GMACS version.

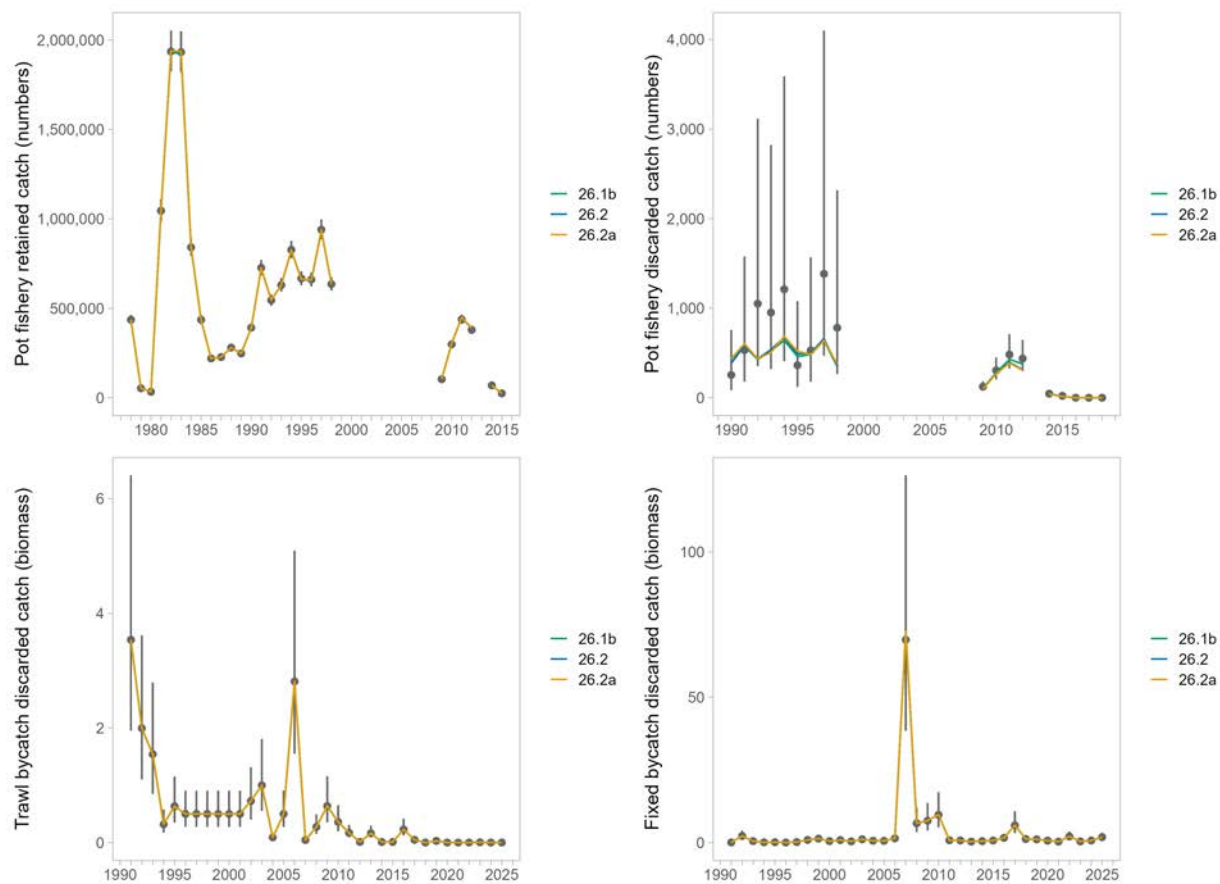


Figure 50: Comparison of observed and model-estimated retained catch and bycatches in each of the model scenarios. Note the difference in units among the panels: some panels are expressed in numbers of crab, some in biomass (tons).

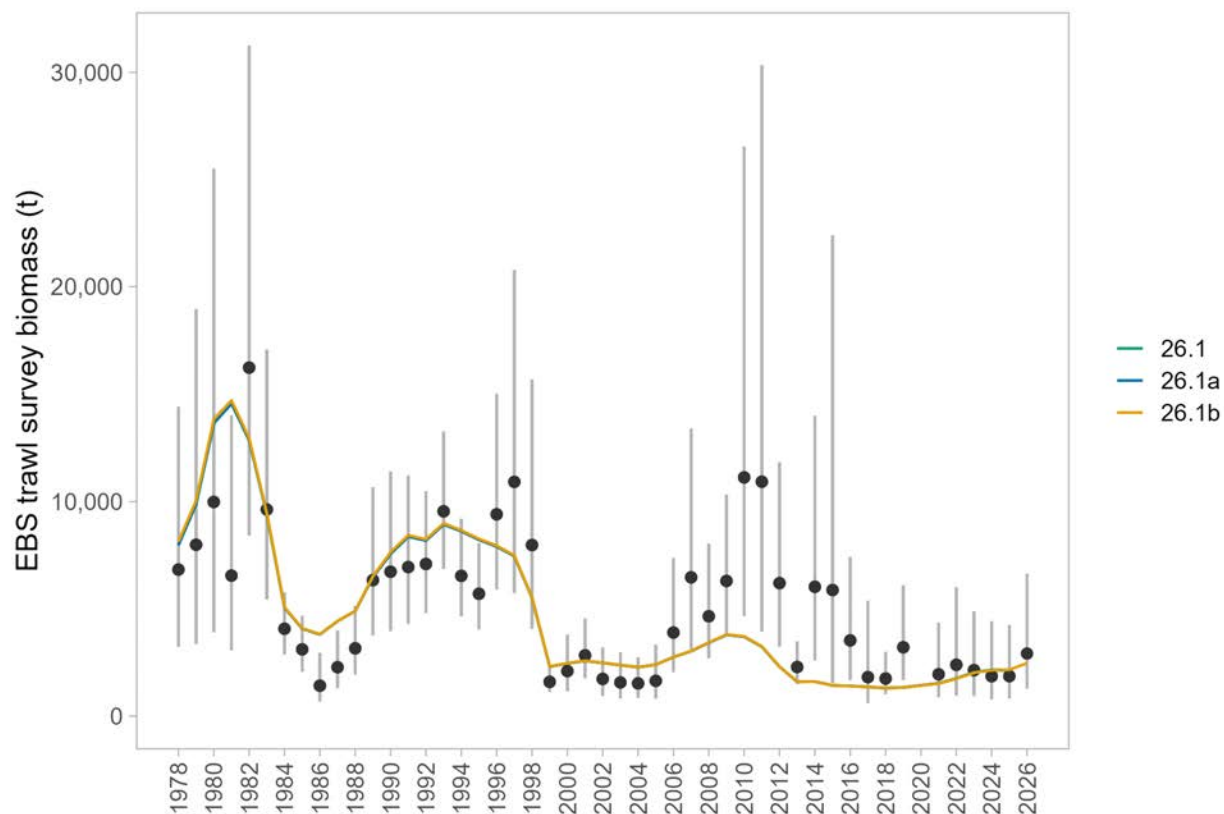


Figure 51: Model fits to the design-based biomass index from the NOAA EBS trawl survey for the reference model (model 26.1), the reference model transitioned to a newer GMACS version (model 26.1a), and the new base model, with a newer GMACS version and updated data (model 26.1b).

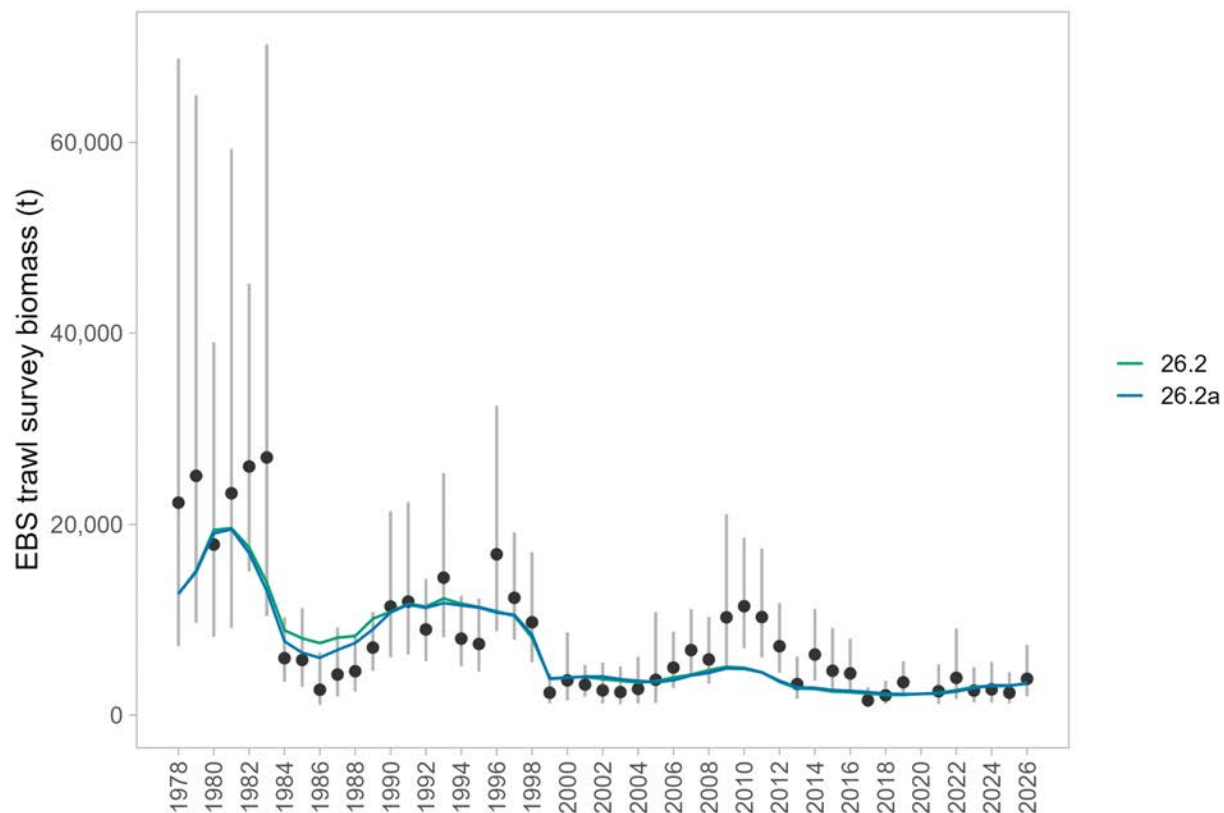


Figure 52: Model fits to the model-based biomass index from the NOAA EBS trawl survey for the models using a spatiotemporal model-based index in place of the EBS trawl survey design-based biomass estimates, with either design-based (model 26.2) or model-based (model 26.2a) size compositions for the EBS trawl survey time series.

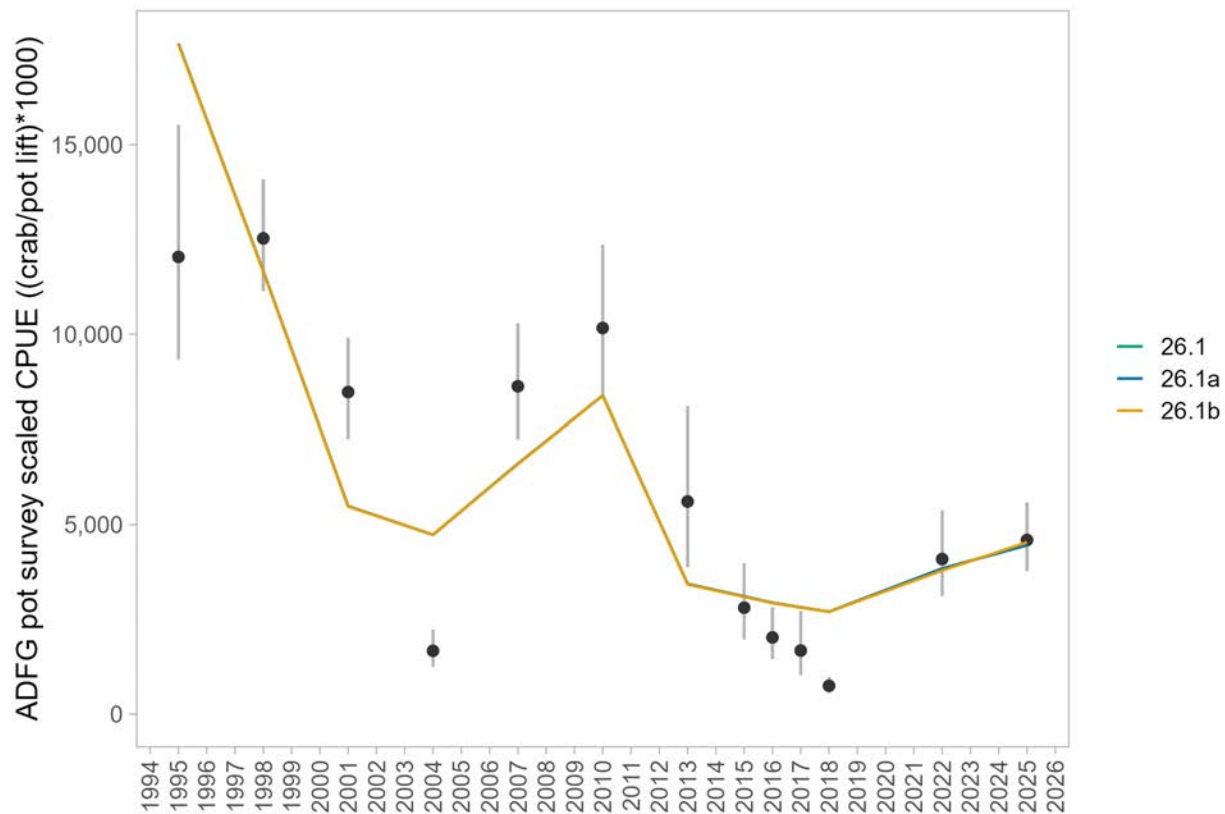


Figure 53: Model fits to the index of abundance from the Alaska Department of Fish and Game (ADFG) pot survey for the reference model (model 26.1), the reference model transitioned to a newer GMACS version (model 26.1a), and the new base model, with a newer GMACS version and updated data (model 26.1b).

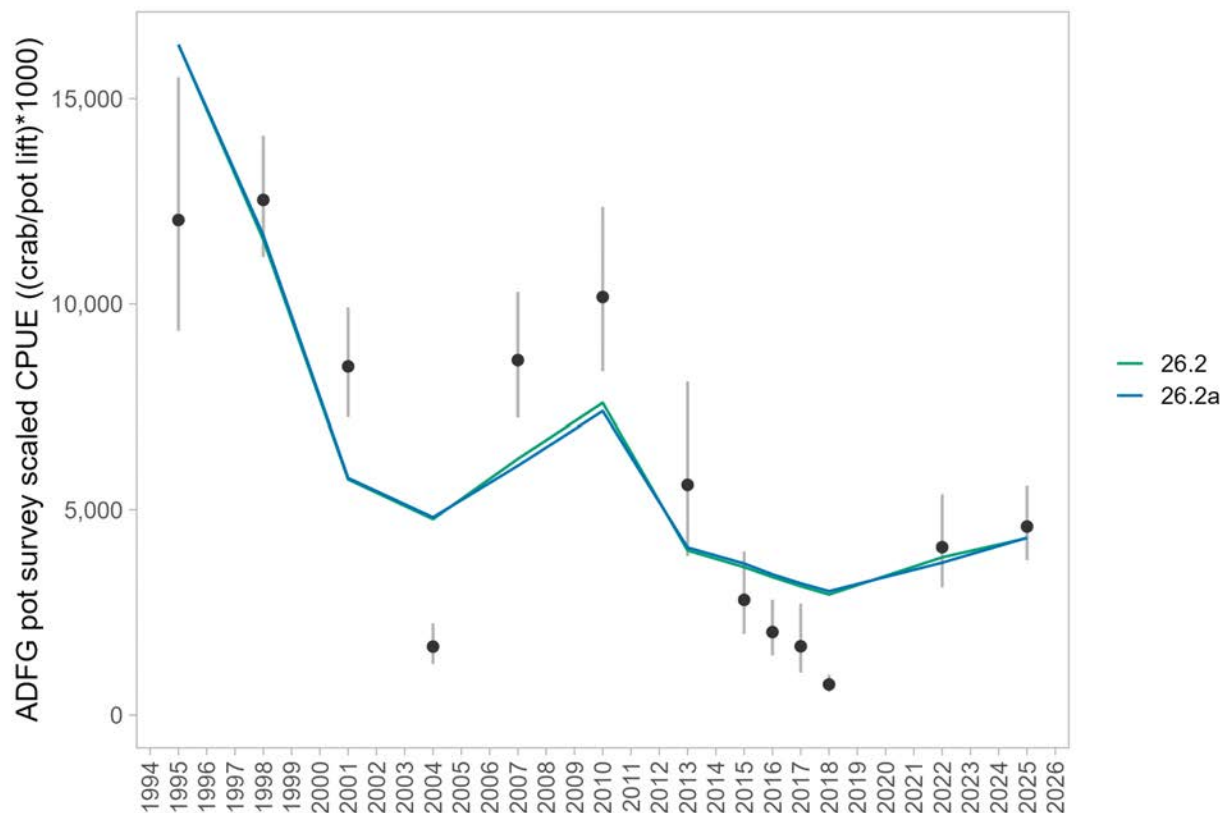


Figure 54: Model fits to the index of abundance from the Alaska Department of Fish and Game (ADFG) pot survey for the models using a spatiotemporal model-based index in place of the EBS trawl survey design-based biomass estimates, with either design-based (model 26.2) or model-based (model 26.2a) size compositions for the EBS trawl survey time series.

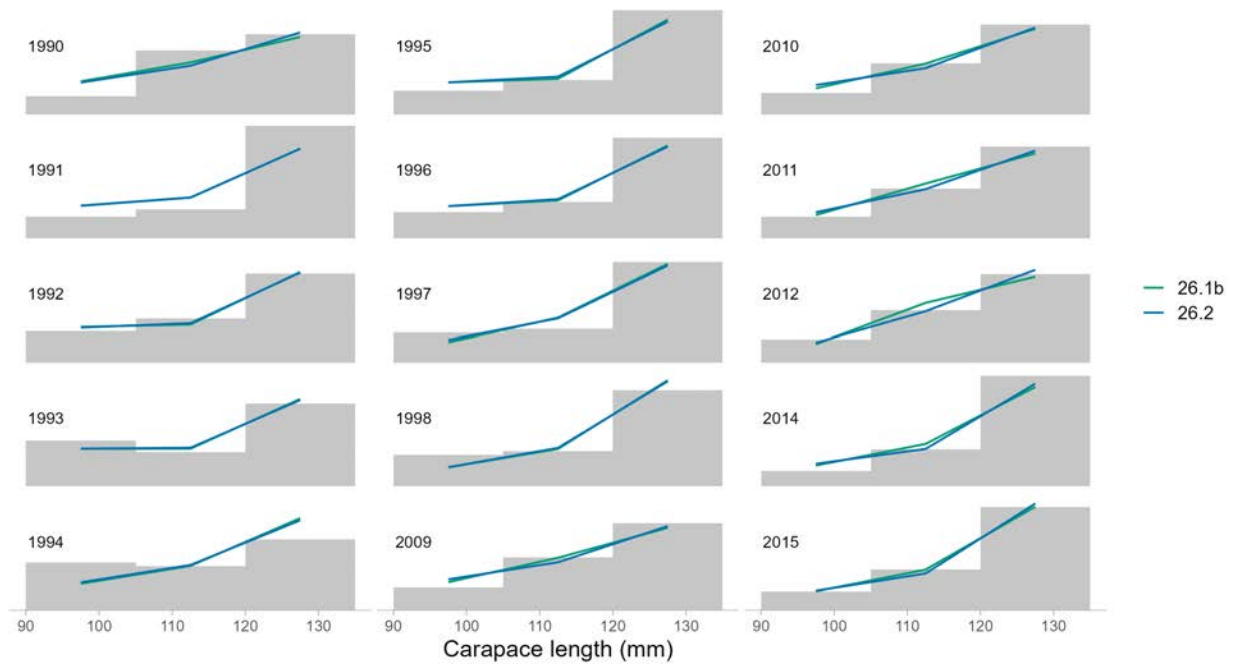


Figure 55: Observed (grey bars) and model estimated (lines) size frequencies of St. Matthew Island blue king crab retained in the directed pot fishery by year for the new base model, with a newer GMACS version and updated data (model 26.1b), and the model using a spatiotemporal model-based index in place of the EBS trawl survey design-based biomass estimates (26.2).

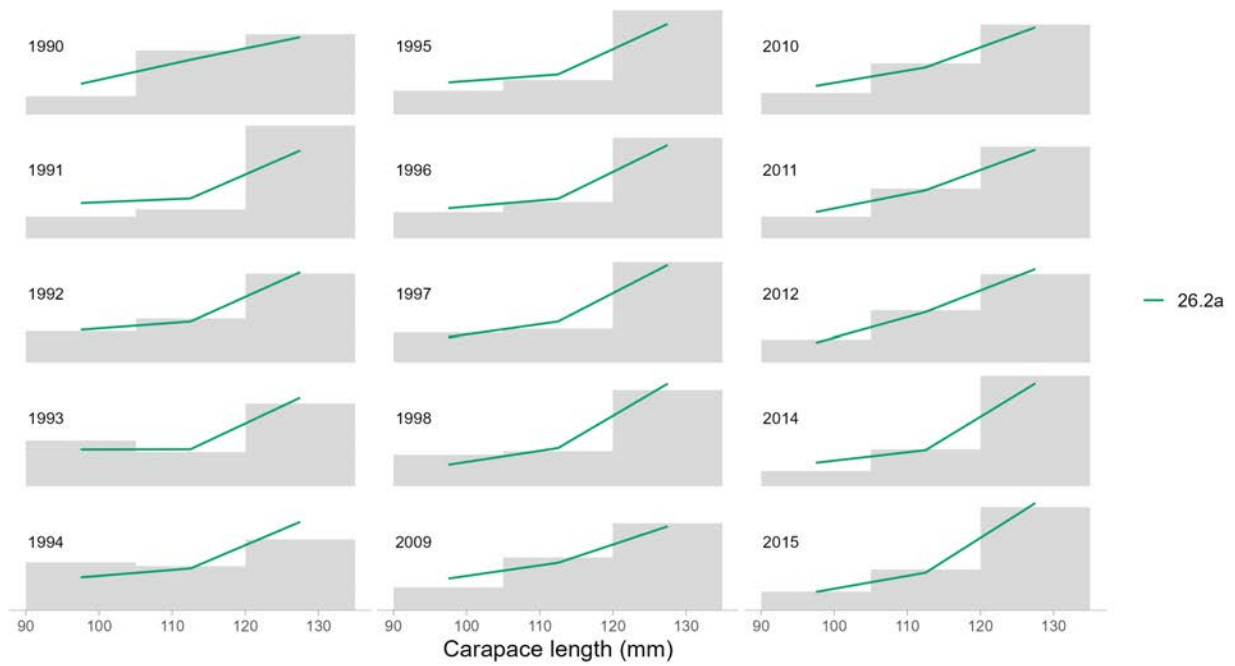


Figure 56: Observed (grey bars) and model estimated (lines) size frequencies of St. Matthew Island blue king crab retained in the directed pot fishery by year for model 26.2a, which uses both a spatiotemporal model-based index in place of the EBS trawl survey design-based biomass estimates and model-based size compositions for the EBS trawl survey time series.

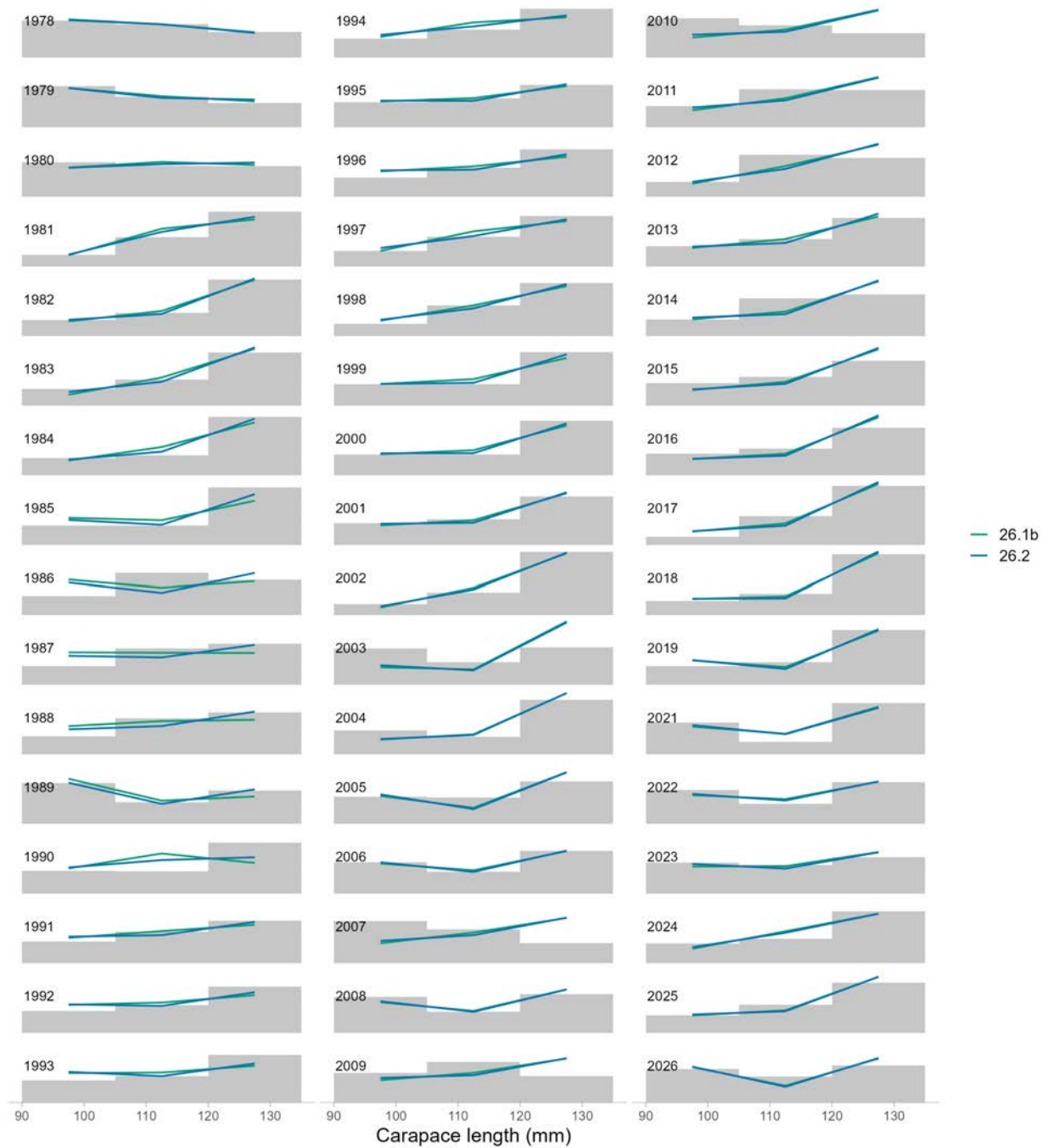


Figure 57: Observed (grey bars) and model estimated (lines) size frequencies of St. Matthew Island blue king crab in the NOAA EBS trawl survey by year for the new base model, with a newer GMACS version and updated data (model 26.1b), and the model using a spatiotemporal model-based index in place of the EBS trawl survey design-based biomass estimates (26.2).

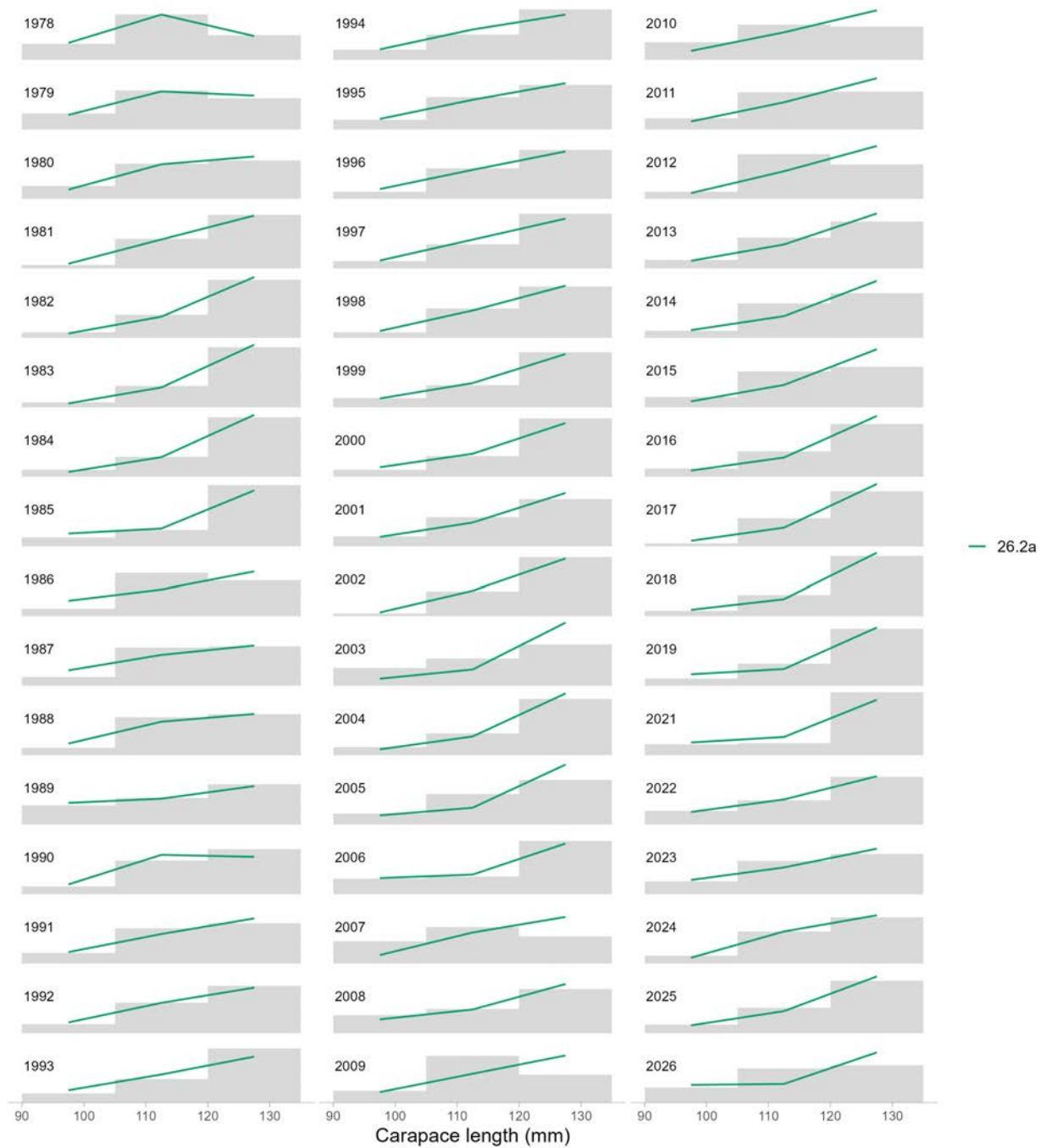


Figure 58: Observed (grey bars) and model estimated (lines) size frequencies of St. Matthew Island blue king crab in the NOAA EBS trawl survey by year for model 26.2a, which uses both a spatiotemporal model-based index in place of the EBS trawl survey design-based biomass estimates and model-based size compositions for the EBS trawl survey time series.

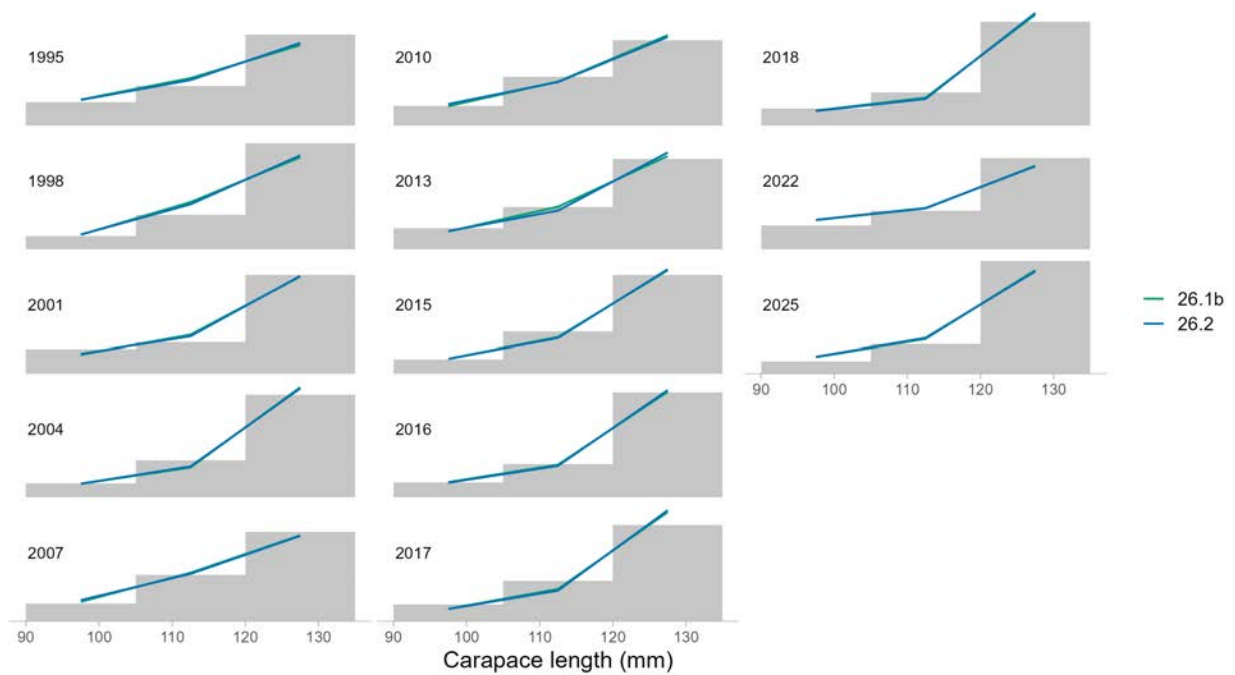


Figure 59: Observed (grey bars) and model estimated (lines) size frequencies of St. Matthew Island blue king crab in the ADFG pot survey by year for the new base model, with a newer GMACS version and updated data (model 26.1b), and the model using a spatiotemporal model-based index in place of the EBS trawl survey design-based biomass estimates (26.2).

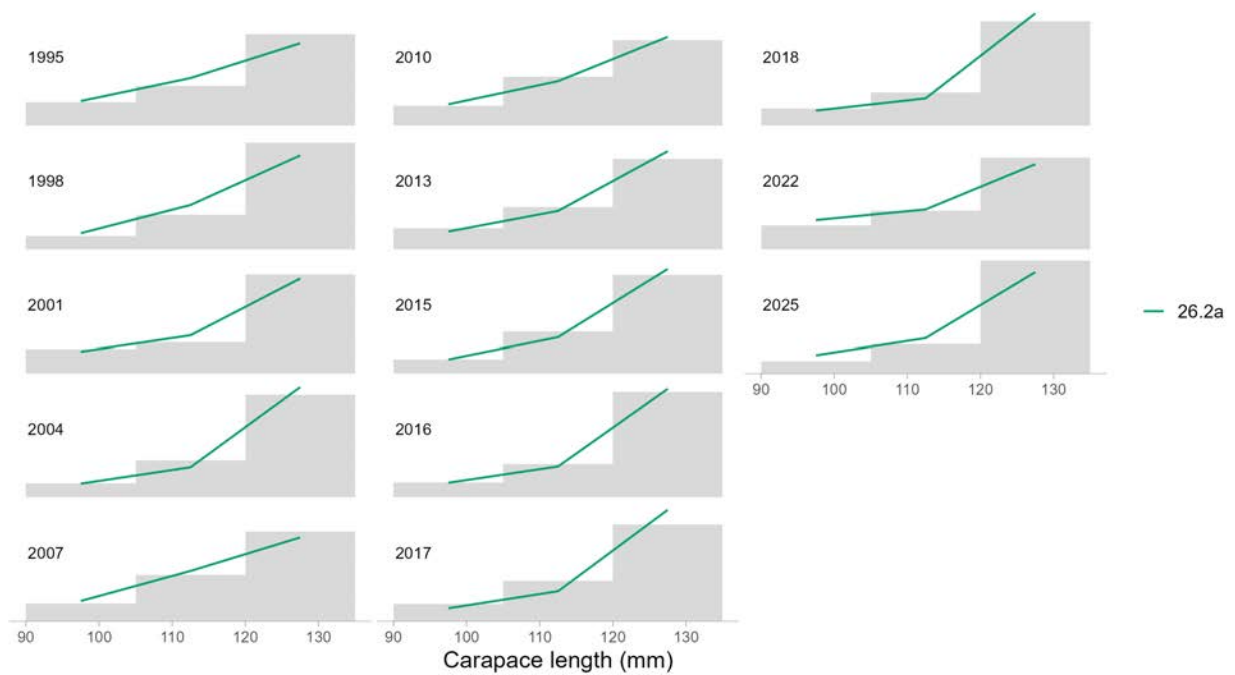


Figure 60: Observed (grey bars) and model estimated (lines) size frequencies of St. Matthew Island blue king crab in the ADFG pot survey by year for model 26.2a, which uses both a spatiotemporal model-based index in place of the EBS trawl survey design-based biomass estimates and model-based size compositions for the EBS trawl survey time series.

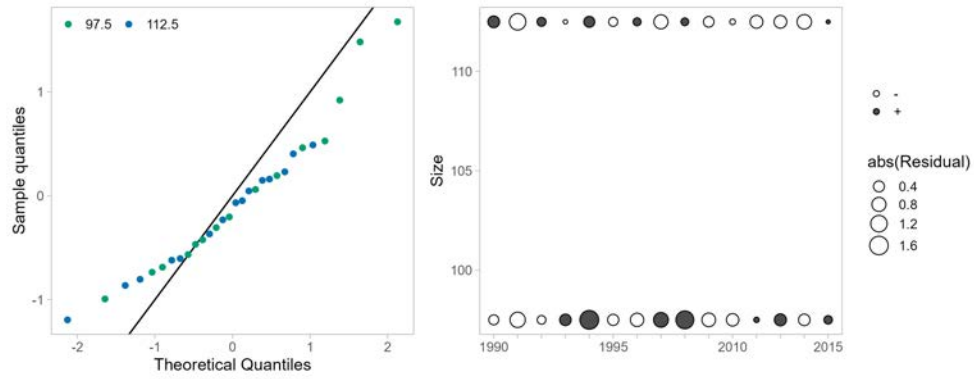


Figure 61: One-Step-Ahead residuals for model 26.1b fits to male size composition data from the directed fishery.

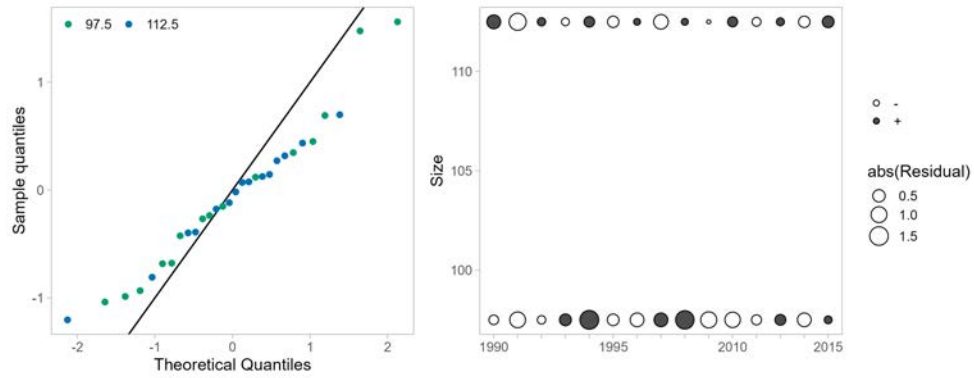


Figure 62: One-Step-Ahead residuals for model 26.2 fits to male size composition data from the directed fishery.

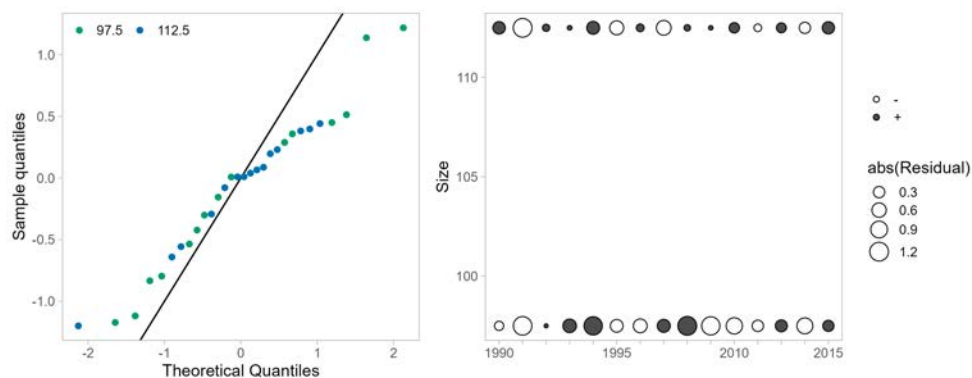


Figure 63: One-Step-Ahead residuals for model 26.2a fits to male size composition data from the directed fishery.

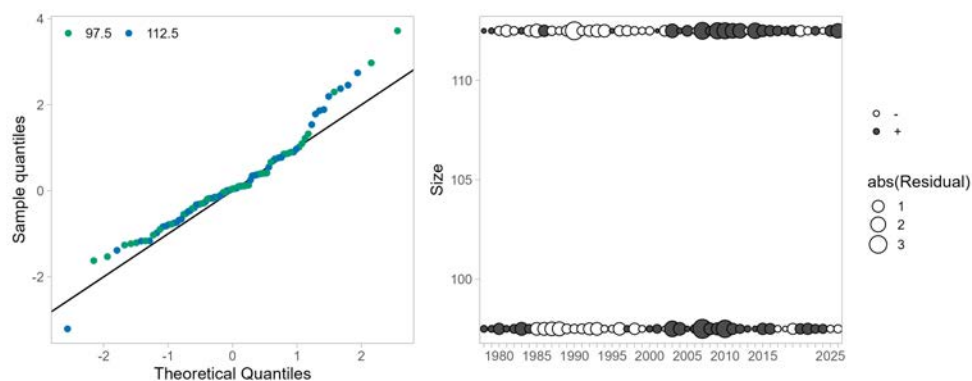


Figure 64: One-Step-Ahead residuals for model 26.1b fits to male size composition data from the NOAA EBS trawl survey.

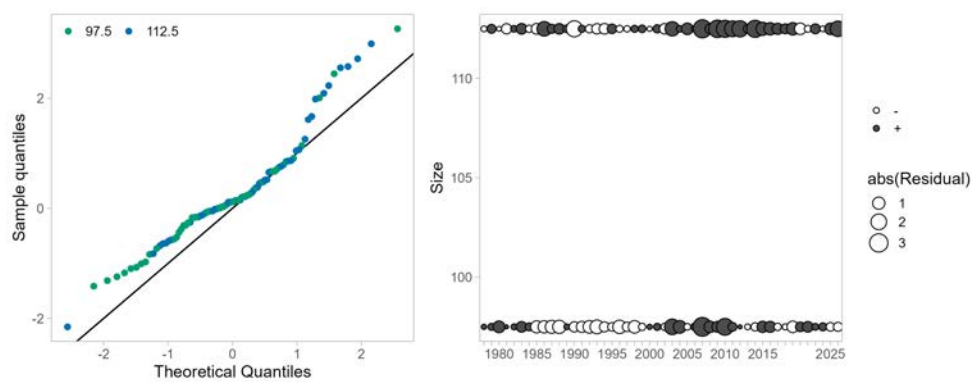


Figure 65: One-Step-Ahead residuals for model 26.2 fits to male size composition data from the NOAA EBS trawl survey.

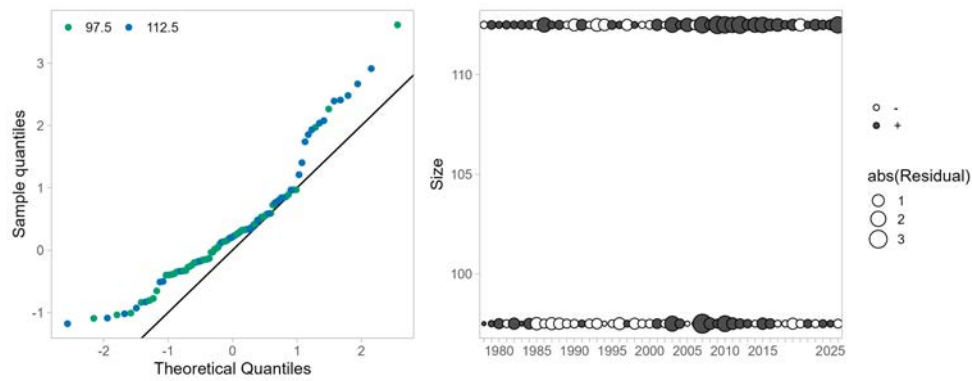


Figure 66: One-Step-Ahead residuals for model 26.2a fits to male size composition data from the NOAA EBS trawl survey. Note that, for this model only, EBS trawl survey size compositions are model-based rather than design-based.

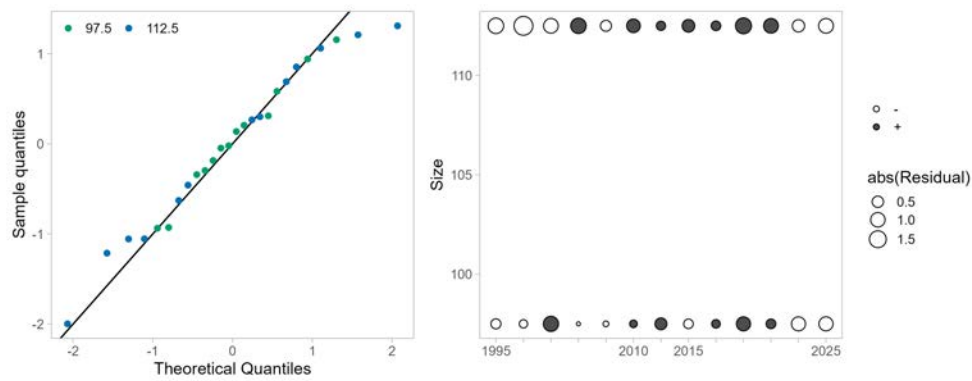


Figure 67: One-Step-Ahead residuals for model 26.1b fits to male size composition data from the ADFG pot survey.

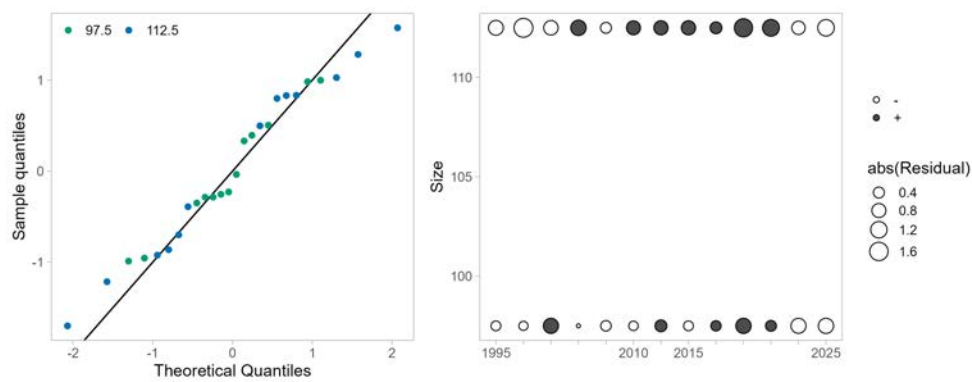


Figure 68: One-Step-Ahead residuals for model 26.2 fits to male size composition data from the ADFG pot survey.

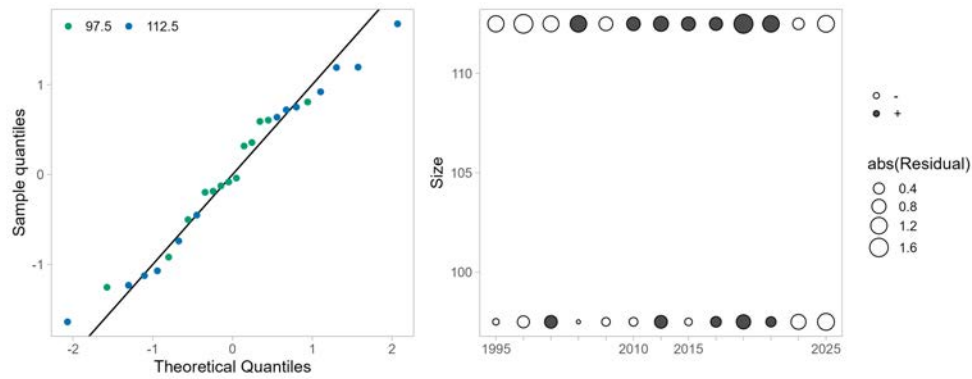


Figure 69: One-Step-Ahead residuals for model 26.2a fits to male size composition data from the ADFG pot survey.

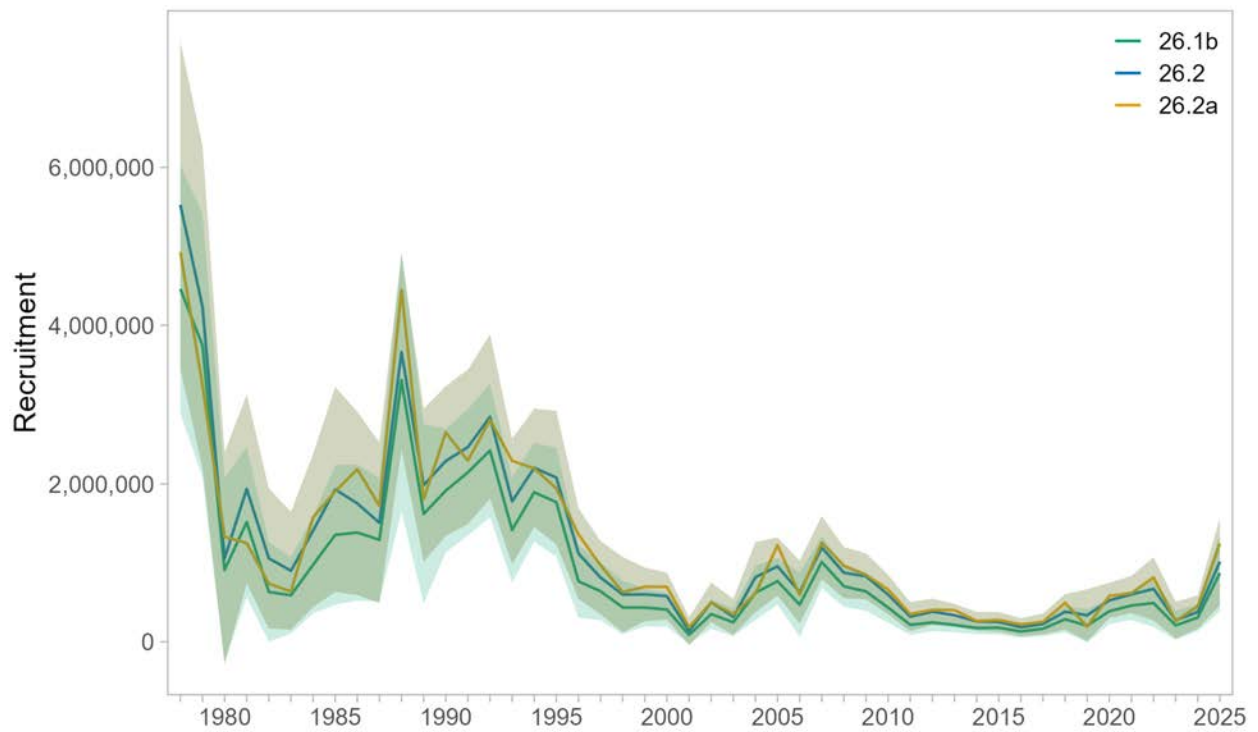


Figure 70: Estimated recruitment (in number of individuals) for 1979 - 2025 comparing the new base model (26.1b) with models incorporating a model-based index for the EBS trawl survey biomass time series (26.2, 26.2a). Model 26.2a also includes model-based size compositions for the EBS trawl survey time series.

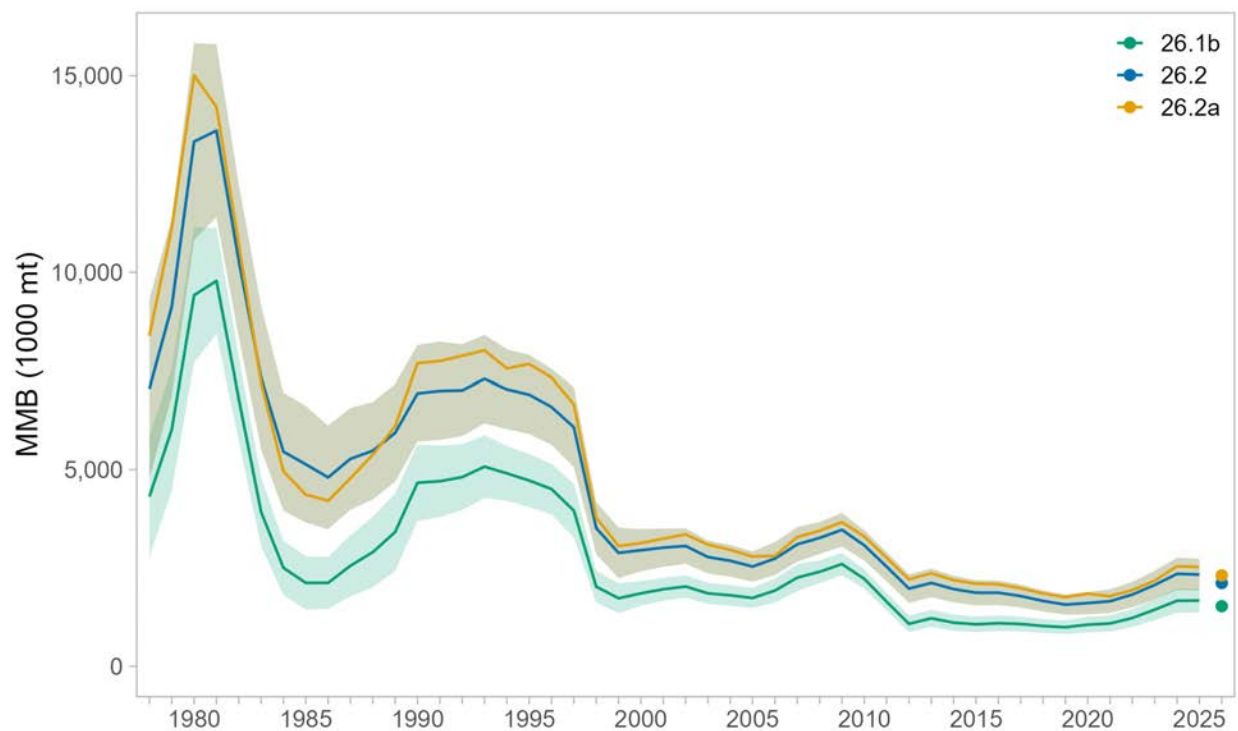


Figure 71: Comparisons of estimated mature male biomass (MMB) time series on 15 February (year + 1) during 1978-2025 for the new base model (26.1b), the new base model using a model-based index for the EBS trawl survey (26.2), and the model that also includes model-based size compositions for the EBS trawl survey time series (26.2a). Points represent projected values for 2026/2027.

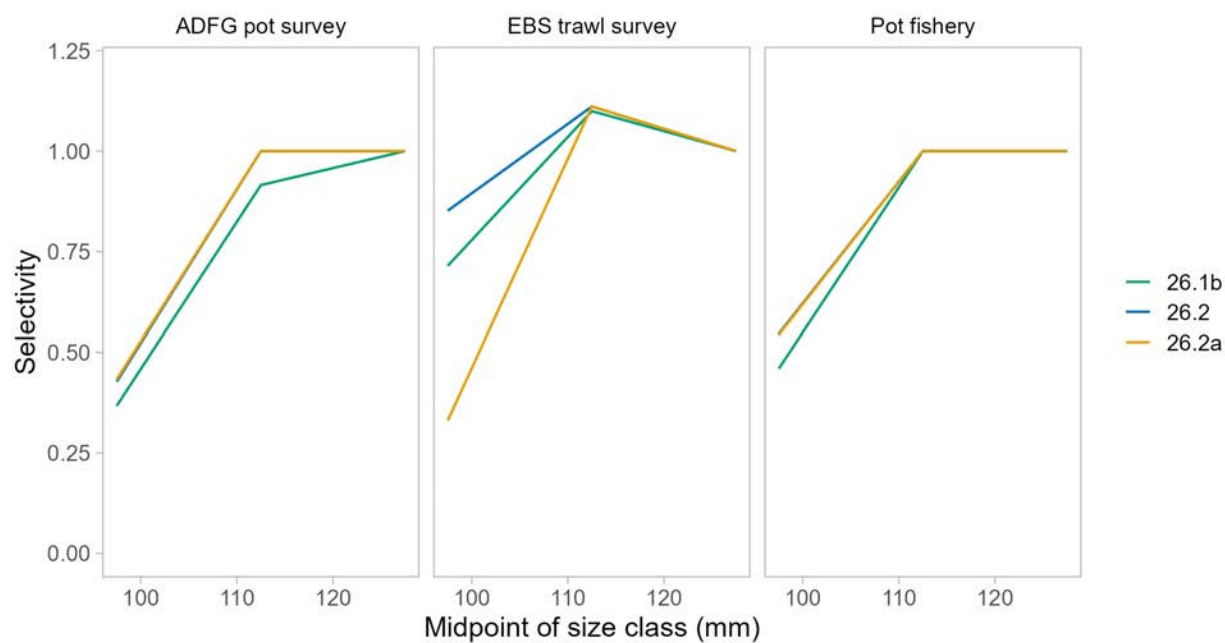


Figure 72: Comparisons of the estimated capture selectivities for the NOAA EBS trawl survey and the ADFG pot survey for the different model scenarios. Note that capture selectivity is estimated for size classes 1 and 2 and fixed at 1 for size class 3 for both fleets in all model scenarios.

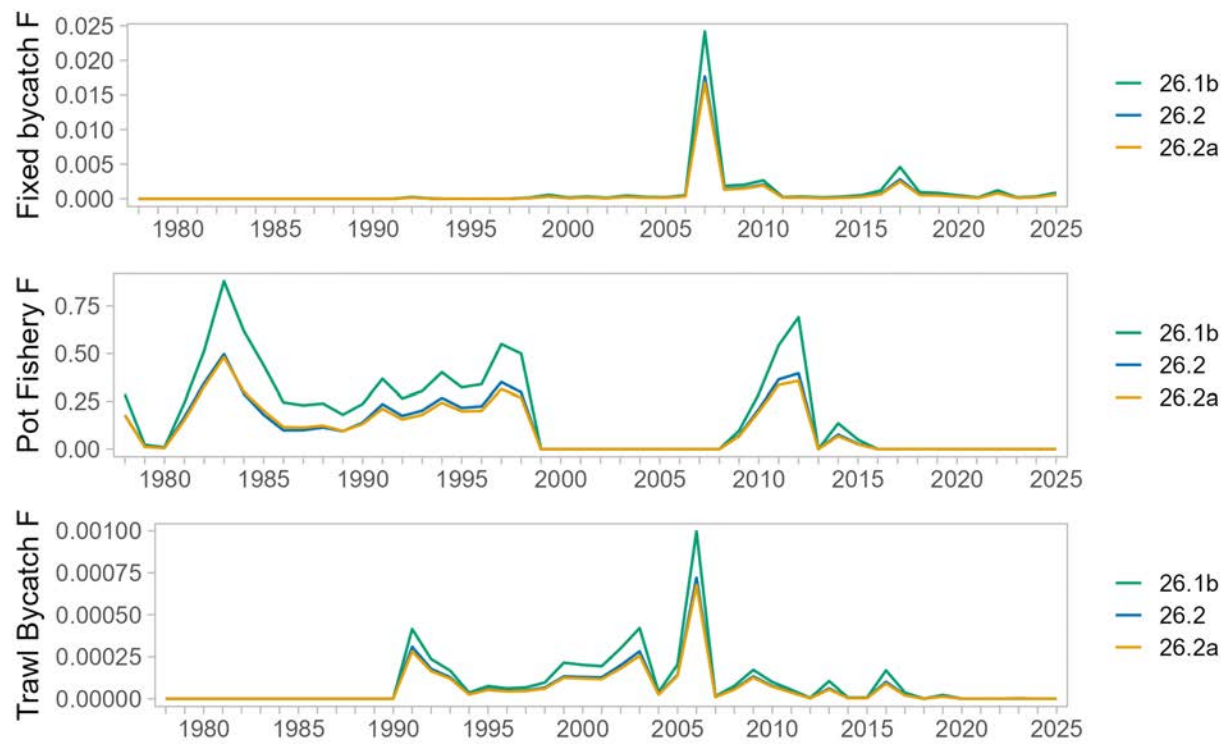


Figure 73: Fishing mortality estimates for directed and bycatch fleets for all model scenarios.

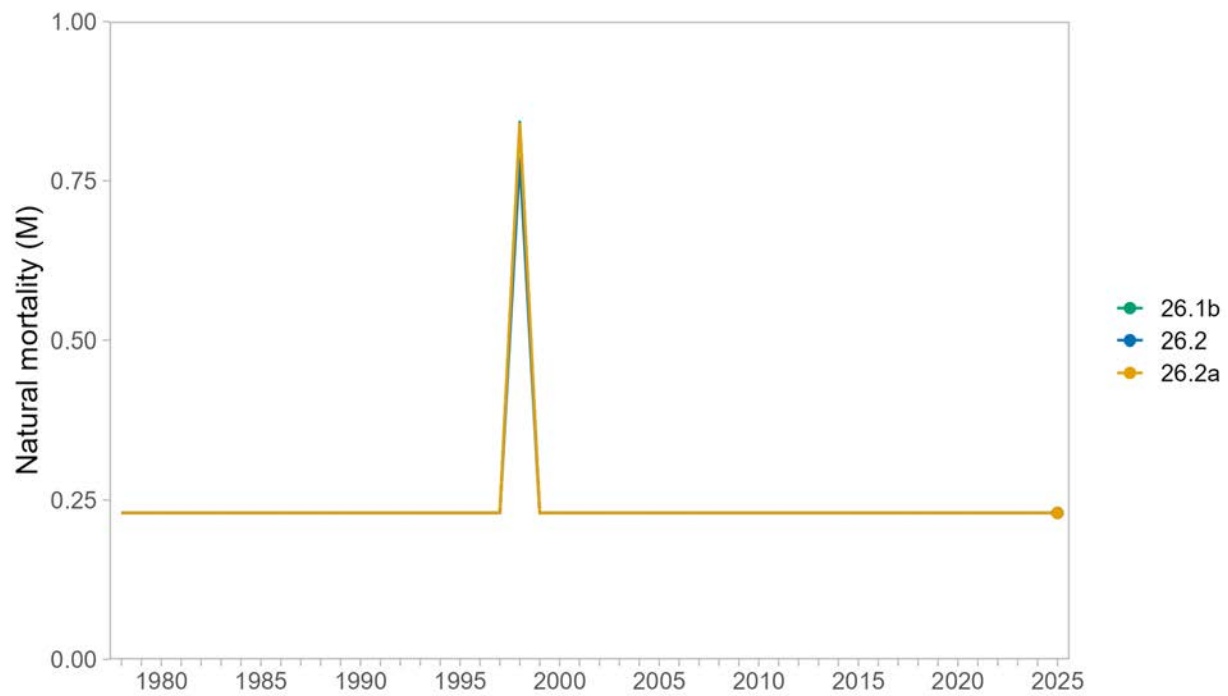


Figure 74: Time-varying natural mortality (M_t) estimates for all model scenarios. Note that, for all model scenarios, natural mortality is fixed at 0.23 for all years except 1998/1999, in which an estimated natural mortality pulse occurs (i.e., M_{1998}).

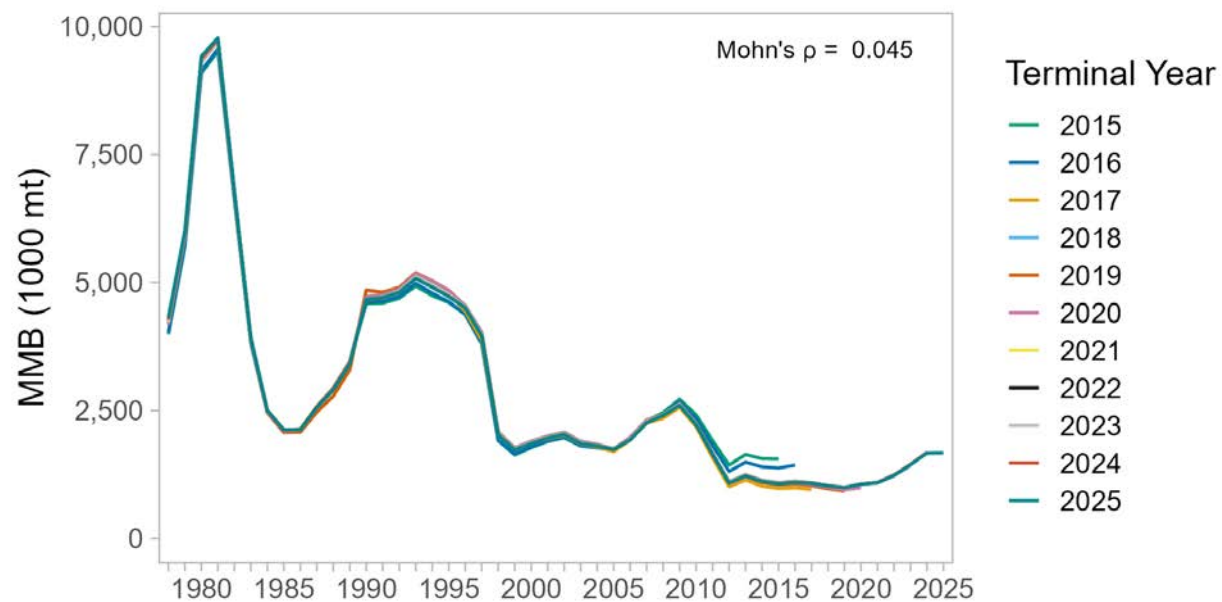


Figure 75: Retrospective pattern in mature male biomass (MMB) for model 26.1b using 10 peels.

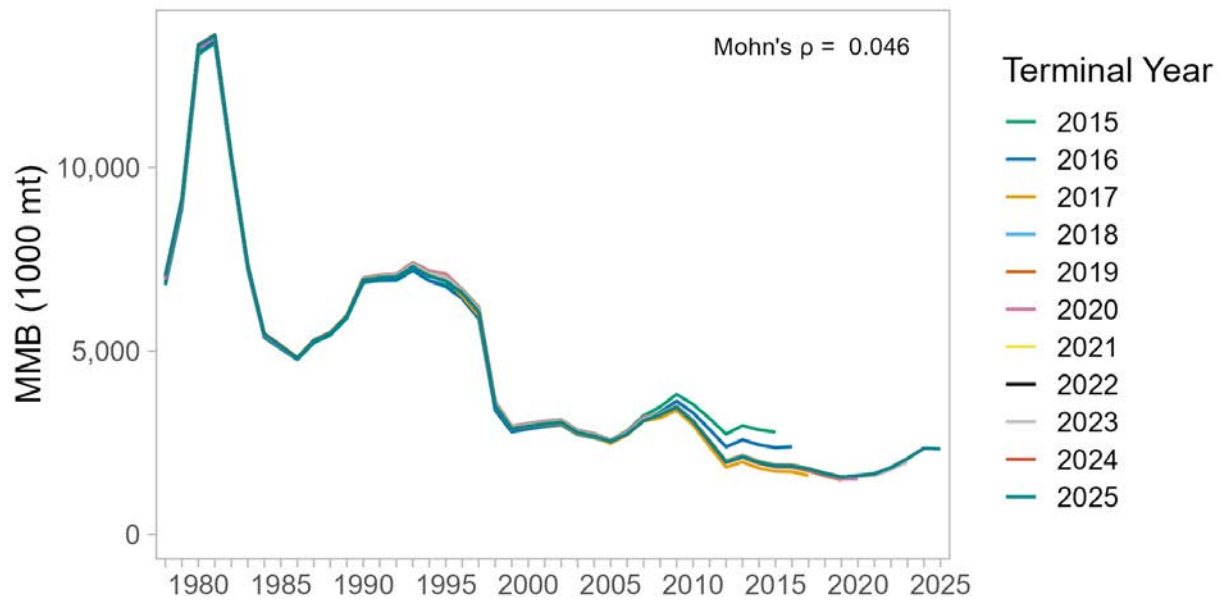


Figure 76: Retrospective pattern in mature male biomass (MMB) for model 26.2 using 10 peels.

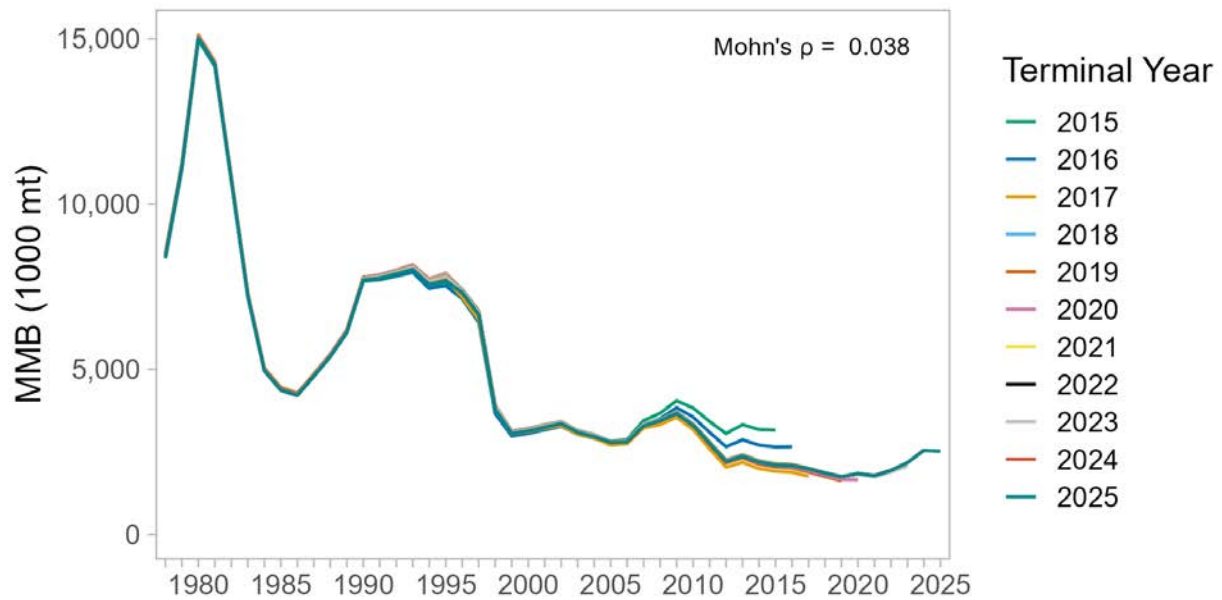


Figure 77: Retrospective pattern in mature male biomass (MMB) for model 26.2a using 10 peels.

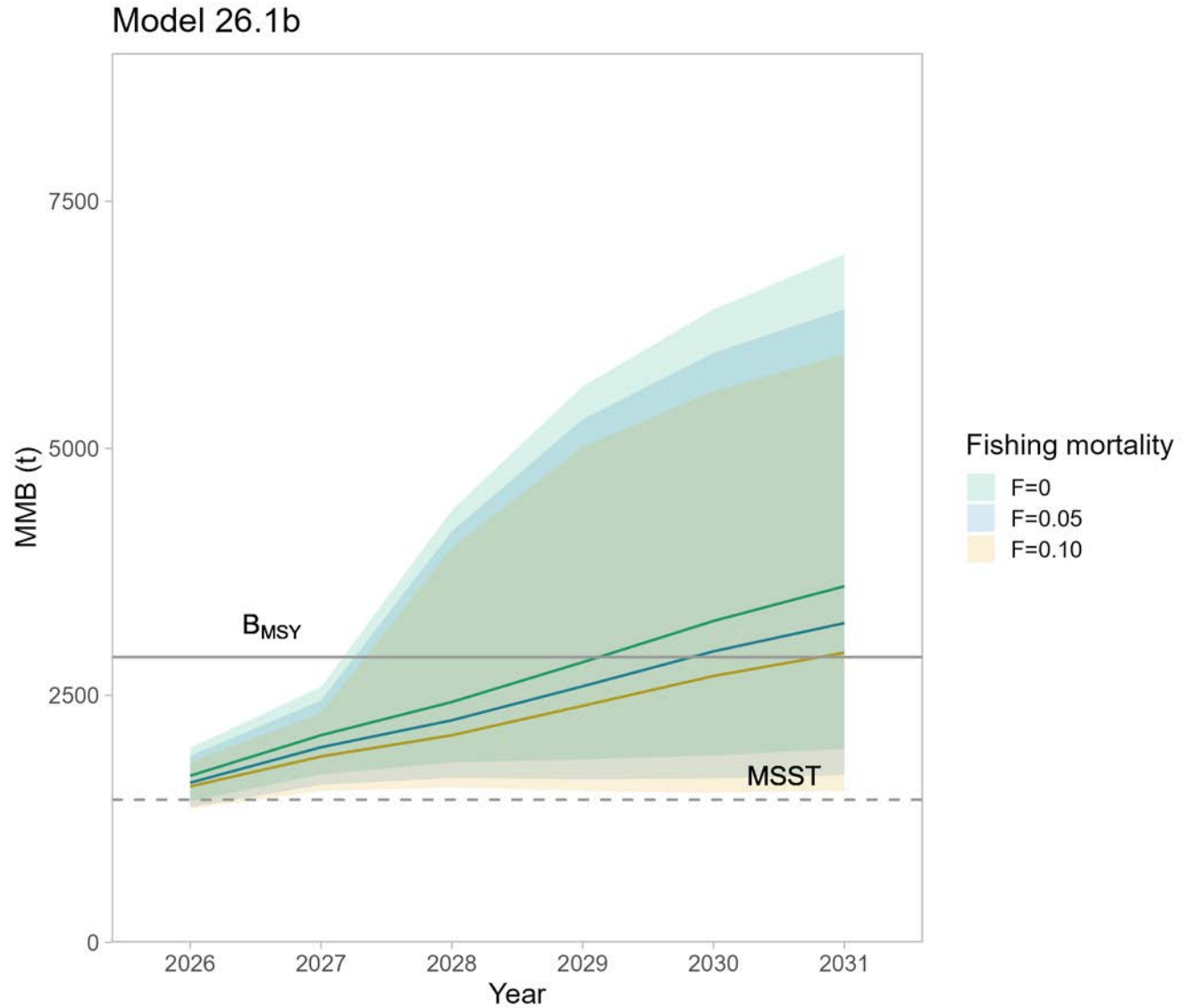


Figure 78: Mature male biomass (MMB) projections from model 26.1b for the next five years using mean recruitment (1978-2024) and average bycatch levels from the last 5 years. Crab year “2025” represents Feb. 15, 2026. Solid colored lines represent mean projected MMB for each fishing mortality rate while shaded regions represent 0.05 to 0.95 quantiles. The solid horizontal line shows B_{MSY} , which is equal to time series mean MMB for this Tier 4 stock, while the dashed horizontal line shows MSST (the minimum stock size threshold, $0.5 * B_{MSY}$).

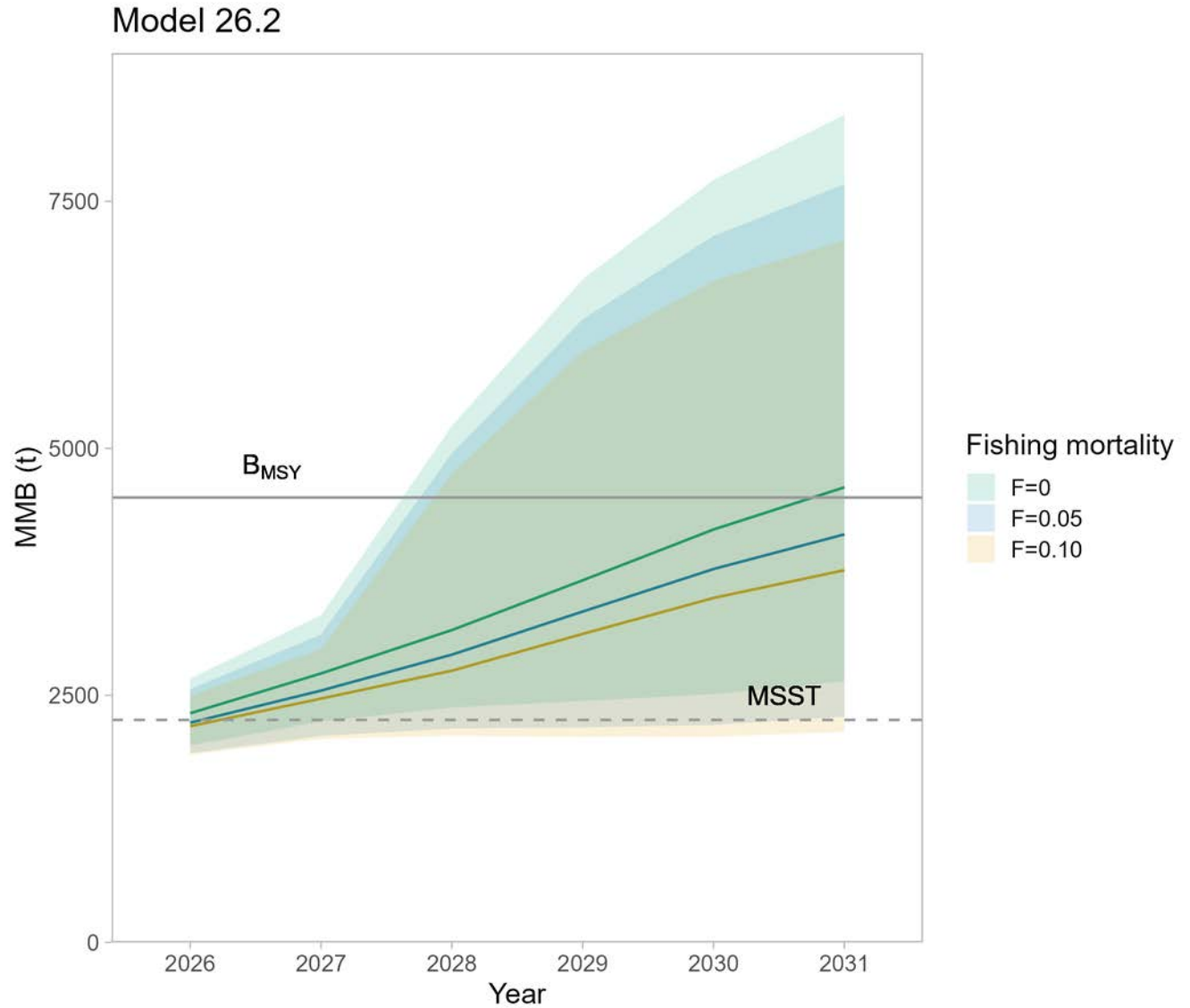


Figure 79: Mature male biomass (MMB) projections from model 26.2 for the next five years using mean recruitment (1978-2024) and average bycatch levels from the last 5 years. Crab year “2025” represents Feb. 15, 2026. Solid colored lines represent mean projected MMB for each fishing mortality rate while shaded regions represent 0.05 to 0.95 quantiles. The solid horizontal line shows B_{MSY} , which is equal to time series mean MMB for this Tier 4 stock, while the dashed horizontal line shows MSST (the minimum stock size threshold, $0.5 * B_{MSY}$).

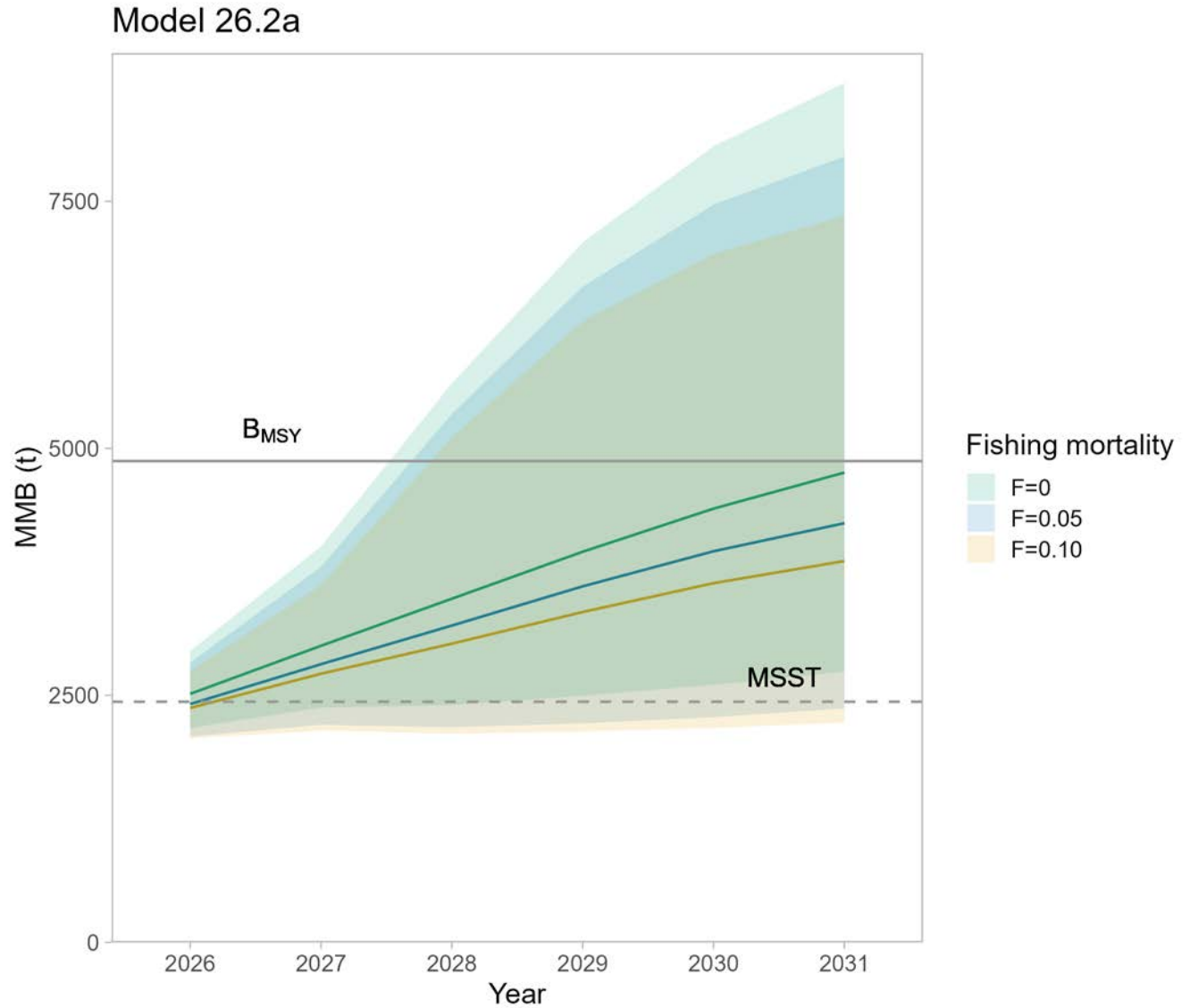


Figure 80: Mature male biomass (MMB) projections from model 26.2a for the next five years using mean recruitment (1978-2024) and average bycatch levels from the last 5 years. Crab year “2025” represents Feb. 15, 2026. Solid colored lines represent mean projected MMB for each fishing mortality rate while shaded regions represent 0.05 to 0.95 quantiles. The solid horizontal line shows B_{MSY} , which is equal to time series mean MMB for this Tier 4 stock, while the dashed horizontal line shows MSST (the minimum stock size threshold, $0.5 * B_{MSY}$).

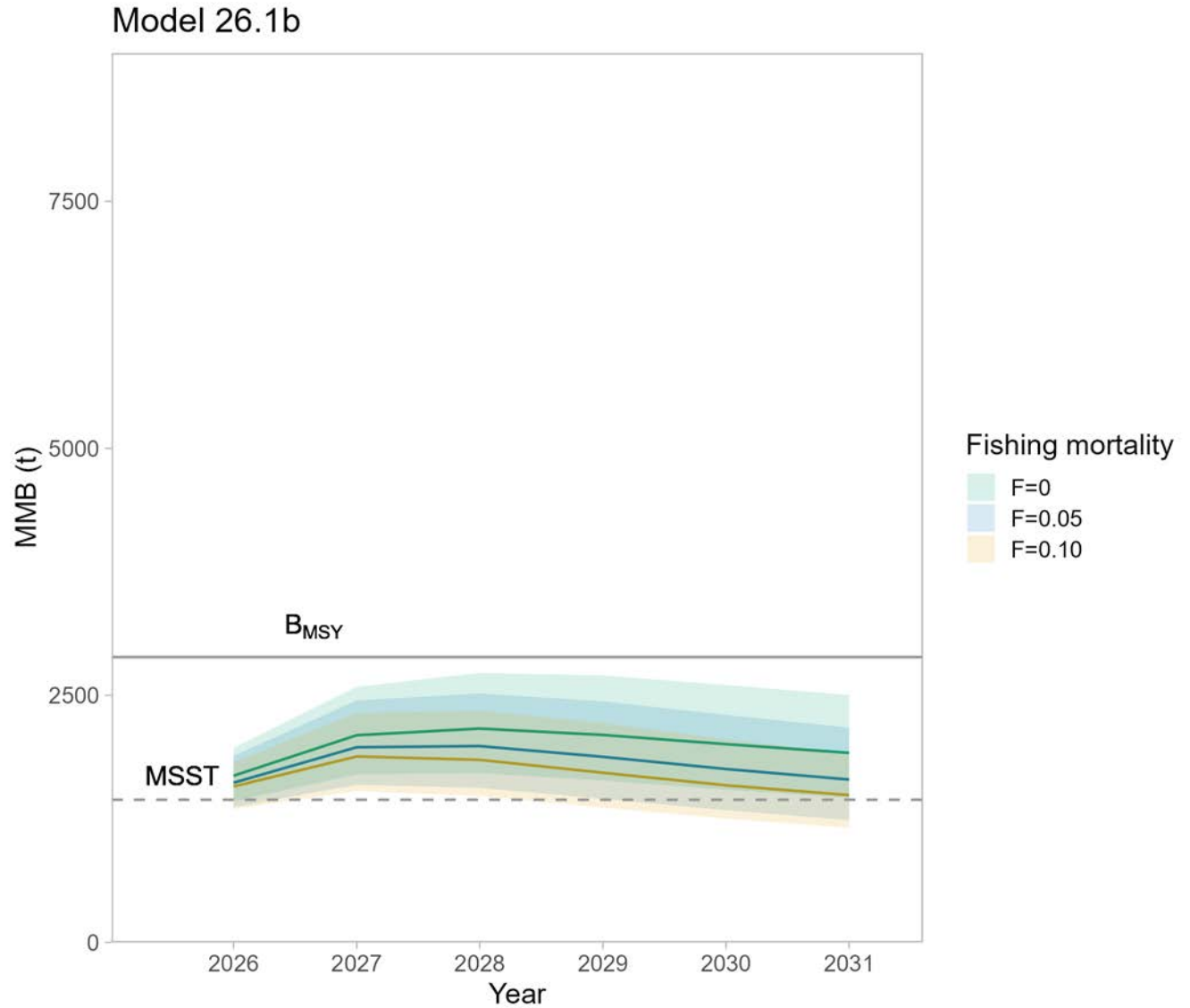


Figure 81: Mature male biomass (MMB) projections from model 26.1b for the next five years using recent mean recruitment (2015-2024) and average bycatch levels from the last 5 years. Crab year “2025” represents Feb. 15, 2026. Solid colored lines represent mean projected MMB for each fishing mortality rate while shaded regions represent 0.05 to 0.95 quantiles. The solid horizontal line shows B_{MSY} , which is equal to time series mean MMB for this Tier 4 stock, while the dashed horizontal line shows MSST (the minimum stock size threshold, $0.5 * B_{MSY}$).

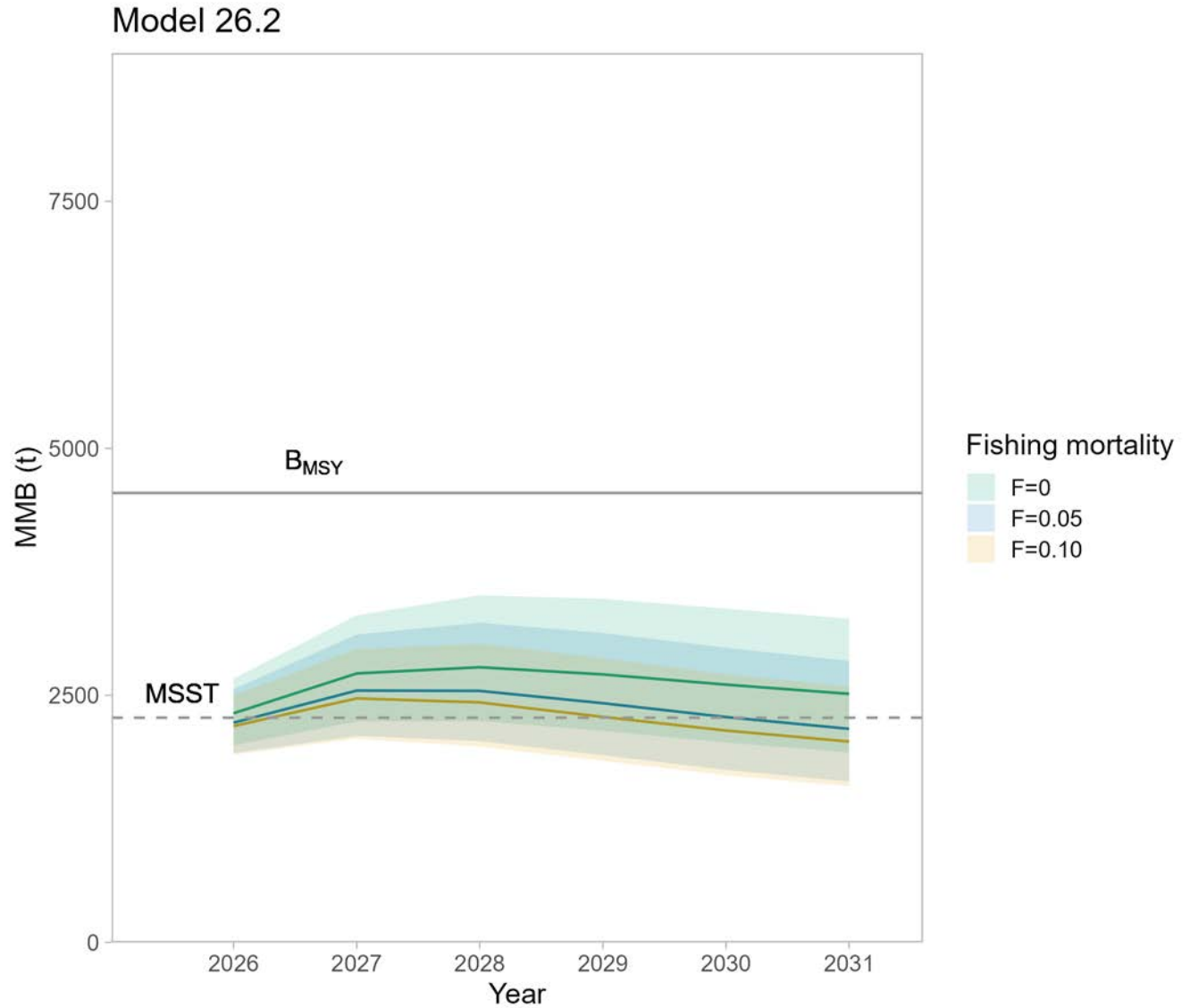


Figure 82: Mature male biomass (MMB) projections from model 26.2 for the next five years using recent mean recruitment (2015-2024) and average bycatch levels from the last 5 years. Crab year “2025” represents Feb. 15, 2026. Solid colored lines represent mean projected MMB for each fishing mortality rate while shaded regions represent 0.05 to 0.95 quantiles. The solid horizontal line shows B_{MSY} , which is equal to time series mean MMB for this Tier 4 stock, while the dashed horizontal line shows MSST (the minimum stock size threshold, $0.5 * B_{MSY}$).

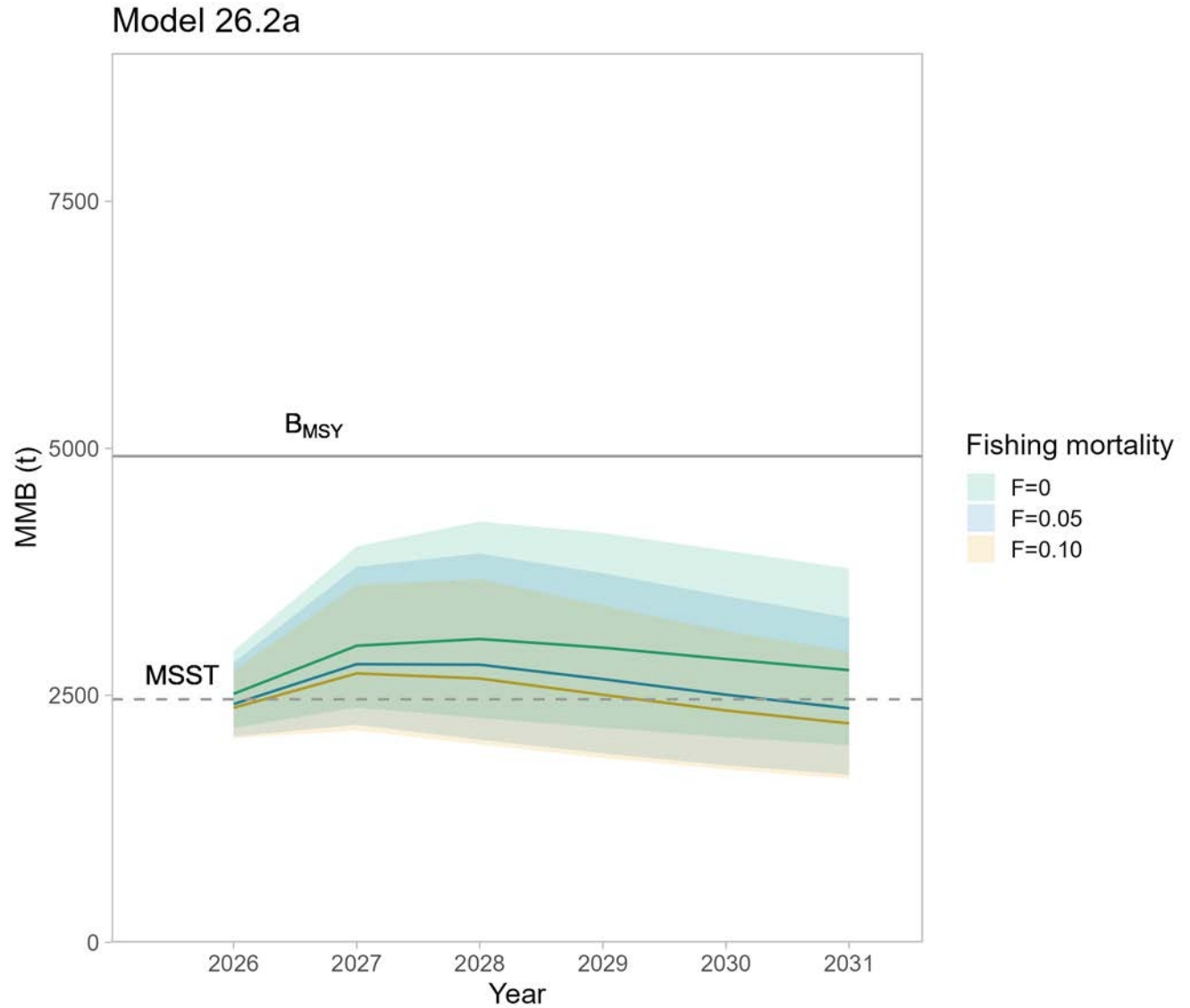


Figure 83: Mature male biomass (MMB) projections from model 26.2a for the next five years using recent mean recruitment (2015-2024) and average bycatch levels from the last 5 years. Crab year “2025” represents Feb. 15, 2026. Solid colored lines represent mean projected MMB for each fishing mortality rate while shaded regions represent 0.05 to 0.95 quantiles. The solid horizontal line shows B_{MSY} , which is equal to time series mean MMB for this Tier 4 stock, while the dashed horizontal line shows MSST (the minimum stock size threshold, $0.5 * B_{MSY}$).

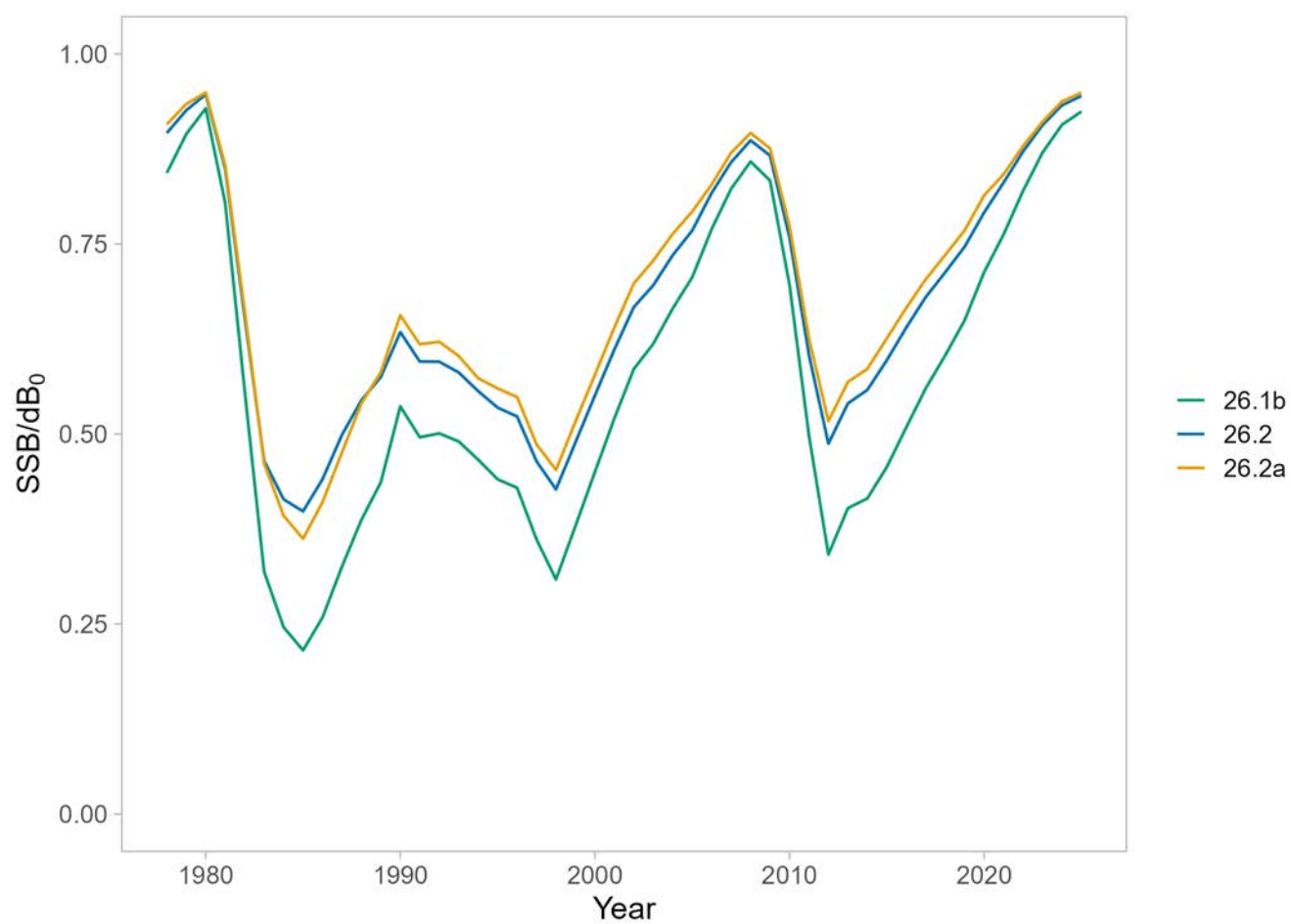


Figure 84: Comparison of spawning stock biomass (SSB) to the dynamic B_0 value (15 February, 1978-2025) for model 26.1b, 26.2, and 26.2a.

Appendix A: SMBKC Model Description

1. Introduction

The GMACS model has been specified to account only for male crab ≥ 90 mm in carapace length (CL). These are partitioned into three stages (size-classes) determined by CL measurements of (1) 90-104 mm, (2) 105-119 mm, and (3) 120+ mm. For management of the St. Matthew Island blue king crab (SMBKC) fishery, 120 mm CL is used as the proxy value for the legal measurement of 5.5 inch carapace width (CW), whereas 105 mm CL is the management proxy for mature-male size (state regulation *5 AAC 34.917 (d)*). Accordingly, within the model only stage-3 crab are retained in the directed fishery, and stage-2 and stage-3 crab together comprise the collection of mature males. Some justification for the 105 mm value is presented in Pengilly and Schmidt (1995), who used it in developing the current regulatory SMBKC harvest strategy. The term “recruit” here designates recruits to the model, i.e., annual new stage-1 crab, rather than recruits to the fishery. The following description of model structure reflects the GMACS base model configuration.

2. Model Population Dynamics

Within the model, the beginning of the crab year is assumed contemporaneous with the EBS trawl survey, nominally assigned a date of 1 July. Although the timing of the fishery is different each year, MMB is estimated at 15 February, which is the reference date for calculation of federal management biomass quantities. To accommodate this, each model year is split into five seasons (t) and a proportion of the natural mortality (τ_t), scaled relative to the portions of the year, is applied in each of these seasons where $\sum_{t=1}^{t=5} \tau_t = 1$. Each model year consists of the following processes with time-breaks denoted here by “Seasons.” However, it is important to note that actual seasons are survey-to-fishery, fishery-to Feb 15, and Feb 15 to July 1. The following breakdown accounts for events and fishing mortality treatments:

1. Season 1 (survey period)
 - Beginning of the SMBKC fishing year (1 July)
 - $\tau_1 = 0$
 - Surveys
2. Season 2 (natural mortality until pulse fishery)
 - τ_2 ranges from 0.05 to 0.44 depending on the time of year the fishery begins each year (i.e., a higher value indicates the fishery begins later in the year).
3. Season 3 (pulse fishery)
 - $\tau_3 = 0$
 - fishing mortality applied
4. Season 4 (natural mortality until spawning)
 - $\tau_4 = 0.63 - \sum_{i=1}^{i=4} \tau_i$
5. Season 5 (natural mortality and somatic growth through to June 30th)
 - $\tau_5 = 0.37$
 - Calculate MMB (15 February)
 - Growth and molting
 - Recruitment (all to stage-1)

The proportion of natural mortality (τ_t) applied during each season in the model is provided in Table 23; see Table 6 for season 2 interaction with directed fishery timing. The beginning of the year (1 July) to the date that MMB is measured (15 February) is 63% of the year. Therefore 63% of the natural mortality must be applied before the MMB is calculated. Because the timing of the fishery is different each year, τ_2 varies and thus τ_4 varies also.

With boldface lowercase letters indicating vector quantities we designate the vector of stage abundances during season t and year y as

$$\mathbf{n}_{t,y} = n_{l,t,y} = [n_{1,t,y}, n_{2,t,y}, n_{3,t,y}]^\top. \quad (2)$$

The number of new crab, or recruits, of each stage entering the model each season t and year y is represented as the vector $\mathbf{r}_{t,y}$. The SMBKC formulation of GMACS specifies recruitment to stage-1 only during season $t = 5$, thus the recruitment size distribution is

$$\phi_l = [1, 0, 0]^\top, \quad (3)$$

and the recruitment is

$$\mathbf{r}_{t,y} = \begin{cases} 0 & \text{for } t < 5 \\ \bar{R}\phi_l\delta_y^R & \text{for } t = 5. \end{cases} \quad (4)$$

where $\bar{R}$ is the average annual recruitment and δ_y^R are the recruitment deviations each year y

$$\delta_y^R \sim \mathcal{N}(0, \sigma_R^2). \quad (5)$$

Using boldface upper-case letters to indicate a matrix, we describe the size transition matrix $\mathbf{G}$ as

$$\mathbf{G} = \begin{bmatrix} 1 - \pi_{12} - \pi_{13} & \pi_{12} & \pi_{13} \\ 0 & 1 - \pi_{23} & \pi_{23} \\ 0 & 0 & 1 \end{bmatrix}, \quad (6)$$

with π_{jk} equal to the proportion of stage- j crab that molt and grow into stage- k within a season or year.

The natural mortality each season t and year y is

$$M_{t,y} = \bar{M}\tau_t + \delta_y^M \text{ where } \delta_y^M \sim \mathcal{N}(0, \sigma_M^2) \quad (7)$$

Fishing mortality by year y and season t is denoted $F_{t,y}$ and calculated as

$$F_{t,y} = F_{t,y}^{\text{df}} + F_{t,y}^{\text{tb}} + F_{t,y}^{\text{fb}} \quad (8)$$

where $F_{t,y}^{\text{df}}$ is the fishing mortality associated with the directed fishery, $F_{t,y}^{\text{tb}}$ is the fishing mortality associated with the trawl bycatch fishery, $F_{t,y}^{\text{fb}}$ is the fishing mortality associated with the fixed bycatch fishery. Each of these are derived as

$$\begin{aligned} F_{t,y}^{\text{df}} &= \bar{F}^{\text{df}} + \delta_{t,y}^{\text{df}} & \text{where } \delta_{t,y}^{\text{df}} &\sim \mathcal{N}(0, \sigma_{\text{df}}^2), \\ F_{t,y}^{\text{tb}} &= \bar{F}^{\text{tb}} + \delta_{t,y}^{\text{tb}} & \text{where } \delta_{t,y}^{\text{tb}} &\sim \mathcal{N}(0, \sigma_{\text{tb}}^2), \\ F_{t,y}^{\text{fb}} &= \bar{F}^{\text{fb}} + \delta_{t,y}^{\text{fb}} & \text{where } \delta_{t,y}^{\text{fb}} &\sim \mathcal{N}(0, \sigma_{\text{fb}}^2), \end{aligned} \quad (9)$$

where $\delta_{t,y}^{\text{df}}$, $\delta_{t,y}^{\text{tb}}$, and $\delta_{t,y}^{\text{fb}}$ are the fishing mortality deviations for each of the fisheries, each season t during each year y , $\bar{F}^{\text{df}}$, $\bar{F}^{\text{tb}}$, and $\bar{F}^{\text{fb}}$ are the average fishing mortalities for each fishery. The total mortality $Z_{l,t,y}$ represents the combination of natural mortality $M_{t,y}$ and fishing mortality $F_{t,y}$ during season t and year y

$$\mathbf{Z}_{t,y} = Z_{l,t,y} = M_{t,y} + F_{t,y}. \quad (10)$$

The survival matrix $\mathbf{S}_{t,y}$ during season t and year y is

$$\mathbf{S}_{t,y} = \begin{bmatrix} 1 - e^{-Z_{1,t,y}} & 0 & 0 \\ 0 & 1 - e^{-Z_{2,t,y}} & 0 \\ 0 & 0 & 1 - e^{-Z_{3,t,y}} \end{bmatrix}. \quad (11)$$

The basic population dynamics underlying GMACS can thus be described as

$$\begin{aligned} \mathbf{n}_{t+1,y} &= \mathbf{S}_{t,y}\mathbf{n}_{t,y}, & \text{if } t < 5 \\ \mathbf{n}_{t,y+1} &= \mathbf{G}\mathbf{S}_{t,y}\mathbf{n}_{t,y} + \mathbf{r}_{t,y} & \text{if } t = 5. \end{aligned} \quad (12)$$

3. Model Data

Data inputs used in model estimation are listed in Table 24. The mean weight (kg) by stage, provided as a vector of weights at length each year to GMACS, is the same for all years and all models: 0.7 kg for Stage-1, 1.2 kg for Stage-2, and 1.9 kg for Stage-3.

4. Model Parameters

Table 25 lists fixed (externally determined) parameters used in model computations. In all scenarios, the stage-transition matrix is

$$\mathbf{G} = \begin{bmatrix} 0.2 & 0.7 & 0.1 \\ 0 & 0.2 & 0.8 \\ 0 & 0 & 1 \end{bmatrix} \quad (13)$$

which is the combination of the growth matrix and molting probabilities.

Estimated parameters are listed in Table 26 and include an estimated natural mortality deviation parameter in 1998/99 (δ_{1998}^M) assuming an anomalous mortality event in that year, as hypothesized by Zheng and Kruse (2002), with natural mortality otherwise fixed at 0.23 yr^{-1} .

5. Model Objective Function and Weighting Scheme

The objective function consists of the sum of several negative log-likelihood terms characterizing the hypothesized error structure of the principal data inputs (Table 14). A log-normal distribution is assumed to characterize the catch data and is modeled as

$$\sigma_{t,y}^{\text{catch}} = \sqrt{\log \left(1 + \left(CV_{t,y}^{\text{catch}} \right)^2 \right)} \quad (14)$$

$$\delta_{t,y}^{\text{catch}} = \mathcal{N} \left(0, \left(\sigma_{t,y}^{\text{catch}} \right)^2 \right) \quad (15)$$

where $\delta_{t,y}^{\text{catch}}$ is the residual catch. The relative abundance data is also assumed to be log-normally distributed

$$\sigma_{t,y}^{\text{I}} = \frac{1}{\lambda} \sqrt{\log \left(1 + \left(CV_{t,y}^{\text{I}} \right)^2 \right)} \quad (16)$$

$$\delta_{t,y}^{\text{I}} = \log \left(I^{\text{obs}} / I^{\text{pred}} \right) / \sigma_{t,y}^{\text{I}} + 0.5 \sigma_{t,y}^{\text{I}} \quad (17)$$

and the likelihood is

$$\sum \log \left(\delta_{t,y}^{\text{I}} \right) + \sum 0.5 \left(\sigma_{t,y}^{\text{I}} \right)^2 \quad (18)$$

GMACS calculates standard deviation of the normalised residual (SDNR) values and median of the absolute residual (MAR) values for all abundance indices and size compositions to help the user come up with reasonable likelihood weights. For an abundance data set to be well fitted, the SDNR should not be much greater than 1 (a value much less than 1, which means that the data set is fitted better than was expected, is not a cause for concern). What is meant by “much greater than 1” depends on m (the number of years in the data set). Francis (2011) suggests upper limits of 1.54, 1.37, and 1.26 for $m = 5, 10$, and 20 , respectively. Although an SDNR not much greater than 1 is a necessary condition for a good fit, it is not sufficient. It is important to plot the observed and expected abundances to ensure that the fit is good.

GMACS also calculates Francis weights for each of the size composition data sets supplied (Francis 2011). If the user wishes to use the Francis iterative re-weighting method, first the weights applied to the abundance indices should be adjusted by trial and error until the SDNR (and/or MAR) are adequate. Then the Francis weights supplied by GMACS should be used as the new likelihood weights for each of the size composition data sets the next time the model is run. The user can then iteratively adjust the abundance index and size composition weights until adequate SDNR (and/or MAR) values are achieved, given the Francis weights.

6. Estimation

The model was implemented using the software AD Model Builder (Fournier et al. 2012), with parameter estimation by minimization of the model objective function using automatic differentiation. Parameter estimates and standard deviations provided in this document are AD Model Builder reported values assuming maximum likelihood theory asymptotics.

Table 23: Proportion of the natural mortality (τ_t) that is applied during each season (t) in the model.

Year	Season 1	Season 2	Season 3	Season 4	Season 5
1978	0	0.07	0	0.56	0.37
1979	0	0.06	0	0.57	0.37
1980	0	0.07	0	0.56	0.37
1981	0	0.05	0	0.58	0.37
1982	0	0.07	0	0.56	0.37
1983	0	0.12	0	0.51	0.37
1984	0	0.10	0	0.53	0.37
1985	0	0.14	0	0.49	0.37
1986	0	0.14	0	0.49	0.37
1987	0	0.14	0	0.49	0.37
1988	0	0.14	0	0.49	0.37
1989	0	0.14	0	0.49	0.37
1990	0	0.14	0	0.49	0.37
1991	0	0.18	0	0.45	0.37
1992	0	0.14	0	0.49	0.37
1993	0	0.18	0	0.45	0.37
1994	0	0.18	0	0.45	0.37
1995	0	0.18	0	0.45	0.37
1996	0	0.18	0	0.45	0.37
1997	0	0.18	0	0.45	0.37
1998	0	0.18	0	0.45	0.37
1999	0	0.18	0	0.45	0.37
2000	0	0.18	0	0.45	0.37
2001	0	0.18	0	0.45	0.37
2002	0	0.18	0	0.45	0.37
2003	0	0.18	0	0.45	0.37
2004	0	0.18	0	0.45	0.37
2005	0	0.18	0	0.45	0.37
2006	0	0.18	0	0.45	0.37
2007	0	0.18	0	0.45	0.37
2008	0	0.18	0	0.45	0.37
2009	0	0.44	0	0.19	0.37
2010	0	0.44	0	0.19	0.37
2011	0	0.44	0	0.19	0.37
2012	0	0.44	0	0.19	0.37
2013	0	0.44	0	0.19	0.37
2014	0	0.44	0	0.19	0.37
2015	0	0.44	0	0.19	0.37
2016	0	0.44	0	0.19	0.37
2017	0	0.44	0	0.19	0.37
2018	0	0.44	0	0.19	0.37
2019	0	0.44	0	0.19	0.37
2020	0	0.44	0	0.19	0.37
2021	0	0.44	0	0.19	0.37
2022	0	0.44	0	0.19	0.37
2023	0	0.44	0	0.19	0.37
2024	0	0.44	0	0.19	0.37
2025	0	0.44	0	0.19	0.37

Table 24: Data inputs used in model estimation.

Data	Years	Source
Directed pot fishery retained catch number (not biomass)	1978/79 - 1998/99 2009/10 - 2015/16	Fish tickets (fishery closed 1999/00 - 2008/09 and 2016/17 - present)
Groundfish trawl bycatch biomass	1992/93 - 2024/25	NMFS groundfish observer program
Groundfish fixed-gear bycatch biomass	1992/93 - 2024/25	NMFS groundfish observer program
NMFS trawl-survey biomass index (area-swept estimate) and CV	1978-2025	NMFS EBS trawl survey
ADF&G pot-survey abundance index (CPUE) and CV	1995-2025	ADF&G SMBKC pot survey
NMFS trawl-survey stage proportions and total number of measured crab	1978-2025	NMFS EBS trawl survey
ADF&G pot-survey stage proportions and total number of measured crab	1995-2025	ADF&G SMBKC pot survey
Directed pot-fishery stage proportions and total number of measured crab	1990/91 - 1998/99 2009/10 - 2015/16	ADF&G crab observer program (fishery closed 1999/00 - 2008/09 and 2016/17 - present)

Table 25: Fixed model parameters for all models.

Parameter	Symbol	Value	Source/rationale
Trawl survey catchability	q	1.0	Default
Natural mortality	M	0.23 yr^{-1}	Borrowed from BBRKC SAFE
Size transition matrix	$\mathbf{G}$	Equation 13	Otto and Cummiskey (1990)
Stage-1 and stage-2 mean weights	w_1, w_2	0.7, 1.2 kg	Length-weight equation (B. Foy, NMFS) applied to stage midpoints
Stage-3 mean weight	$w_{3,y}$	Depends on year	Fishery reported average retained weight from fish tickets, or its average, and mean weights of legal males
Recruitment SD	σ_R	1.2	High value
Natural mortality SD	σ_M	10.0	High value (basically free parameter)
Directed fishery handling mortality		0.2	2010 Crab SAFE
Groundfish trawl handling mortality		0.8	2010 Crab SAFE
Groundfish fixed-gear handling mortality		0.5	2010 Crab SAFE

Table 26: The lower bound (LB), upper bound (UB), initial value, prior, and estimation phase for each estimated model parameter.

Parameter	LB	Initial value	UB	Prior	Phase
Average recruitment $\log(\bar{R})$	-7	10.0	20	Uniform(-7,20)	1
Stage-1 initial numbers $\log(n_1^0)$	5	14.5	20	Uniform(5,20)	1
Stage-2 initial numbers $\log(n_2^0)$	5	14.0	20	Uniform(5,20)	1
Stage-3 initial numbers $\log(n_3^0)$	5	13.5	20	Uniform(5,20)	1
ADF&G pot survey catchability q	0	3.0	5	Uniform(0,5)	1
Stage-1 directed fishery selectivity 1978-2008	0	0.4	1	Uniform(0,1)	3
Stage-2 directed fishery selectivity 1978-2008	0	0.7	1	Uniform(0,1)	3
Stage-1 directed fishery selectivity 2009-2017	0	0.4	1	Uniform(0,1)	3
Stage-2 directed fishery selectivity 2009-2017	0	0.7	1	Uniform(0,1)	3
Stage-1 NMFS trawl survey selectivity	0	0.4	1	Uniform(0,1)	4
Stage-2 NMFS trawl survey selectivity	0	0.7	1	Uniform(0,1)	4
Stage-1 ADF&G pot survey selectivity	0	0.4	1	Uniform(0,1)	4
Stage-2 ADF&G pot survey selectivity	0	0.7	1	Uniform(0,1)	4
Natural mortality deviation during 1998 δ_{1998}^M	-3	0.0	3	Normal(0, σ_M^2)	4
Recruitment deviations δ_y^R	-7	0.0	7	Normal(0, σ_R^2)	3
Average directed fishery fishing mortality $\bar{F}^{\text{df}}$	-	0.2	-	-	1
Average trawl bycatch fishing mortality $\bar{F}^{\text{tb}}$	-	0.001	-	-	1
Average fixed gear bycatch fishing mortality $\bar{F}^{\text{fb}}$	-	0.001	-	-	1

Appendix B. Data and control files for model 26.1b

The base model (26.1b) data file

```
#####
# Gmacs Main Data File Version 2.20.44: August 2026 version (model 26.1b)
# GEAR_INDEX DESCRIPTION
# 1 : Pot fishery retained catch.
# 1 : Pot fishery with discarded catch/ total catch
# 2 : Trawl bycatch GF
# 3 : Fixed bycatch GF
# 4 : NMFS Trawl survey
# 5 : ADF&G Pot survey
#####
# Fisheries: 1 Pot Fishery, 1 Pot Discard, 2 Trawl by-catch, 3 Fixed by-catch !fix why two fleet 3?
# Surveys: 4 NMFS Trawl Survey, 5 Pot Survey
#####
1978 # Start year
2025 # End year (updated) last year of fishery does NOT include current survey year
5 # Number of seasons
5 # Number of fleets (fisheries and surveys)
1 # Number of sexes
1 # Number of shell condition types
1 # Number of maturity types
3 # Number of size-classes in the model
5 # Season recruitment occurs
5 # Season molting and growth occurs
5 # Season to calculate SSB
1 # Season for N output
# maximum size-class (males then females)
3
# size_breaks (a vector giving the break points between size intervals with dimension nclass+1)
90 105 120 135
# Natural mortality per season input type (1 = vector by season, 2 = matrix by season/year)
2
# Proportion of the total natural mortality to be applied each season (each row must add to 1)
0.000 0.070 0.000 0.560 0.370 #1978
0.000 0.060 0.000 0.570 0.370 #1979
0.000 0.070 0.000 0.560 0.370 #1980
0.000 0.050 0.000 0.580 0.370 #1981
0.000 0.070 0.000 0.560 0.370 #1982
0.000 0.120 0.000 0.510 0.370 #1983
0.000 0.100 0.000 0.530 0.370 #1984
0.000 0.140 0.000 0.490 0.370 #1985
0.000 0.140 0.000 0.490 0.370 #1986
0.000 0.140 0.000 0.490 0.370 #1987
0.000 0.140 0.000 0.490 0.370 #1988
0.000 0.140 0.000 0.490 0.370 #1989
0.000 0.140 0.000 0.490 0.370 #1990
0.000 0.180 0.000 0.450 0.370 #1991
```

```

0.000 0.140 0.000 0.490 0.370 #1992
0.000 0.180 0.000 0.450 0.370 #1993
0.000 0.180 0.000 0.450 0.370 #1994
0.000 0.180 0.000 0.450 0.370 #1995
0.000 0.180 0.000 0.450 0.370 #1996
0.000 0.180 0.000 0.450 0.370 #1997
0.000 0.180 0.000 0.450 0.370 #1998
0.000 0.180 0.000 0.450 0.370 #1999
0.000 0.180 0.000 0.450 0.370 #2000
0.000 0.180 0.000 0.450 0.370 #2001
0.000 0.180 0.000 0.450 0.370 #2002
0.000 0.180 0.000 0.450 0.370 #2003
0.000 0.180 0.000 0.450 0.370 #2004
0.000 0.180 0.000 0.450 0.370 #2005
0.000 0.180 0.000 0.450 0.370 #2006
0.000 0.180 0.000 0.450 0.370 #2007
0.000 0.180 0.000 0.450 0.370 #2008
0.000 0.440 0.000 0.190 0.370 #2009
0.000 0.440 0.000 0.190 0.370 #2010
0.000 0.440 0.000 0.190 0.370 #2011
0.000 0.440 0.000 0.190 0.370 #2012
0.000 0.440 0.000 0.190 0.370 #2013
0.000 0.440 0.000 0.190 0.370 #2014
0.000 0.440 0.000 0.190 0.370 #2015
0.000 0.440 0.000 0.190 0.370 #2016
0.000 0.440 0.000 0.190 0.370 #2017
0.000 0.440 0.000 0.190 0.370 #2018
0.000 0.440 0.000 0.190 0.370 #2019 (updated)
0.000 0.440 0.000 0.190 0.370 #2020 (updated 4-14-22)
0.000 0.440 0.000 0.190 0.370 #2021 (updated 8-25-22)
0.000 0.440 0.000 0.190 0.370 #2022 (updated 2-14-24)
0.000 0.440 0.000 0.190 0.370 #2023 (updated 8-14-24)
0.000 0.440 0.000 0.190 0.370 #2024 (updated 2-03-26)
0.000 0.440 0.000 0.190 0.370 #2025 (updated 2-03-26)
#0 0.0025 0 0.6245 0.373
# Season 1: survey period. 1 July. Length 0.
# Season 2: natural mortality until pulse fishery. Length ranges from 0.05 to 0.44.
# Season 3: pulse fishery. Length 0.
# Season 4: natural mortality until spawning. Equal to 0.63 - length of season 2.
# Season 5: growth, recruitment, calculate MMB on 15 Feb. 15 Feb - 30 June. Length = 0.37.
# Fishing fleet names (delimited with spaces no spaces in names)
Pot_Fishery Trawl_Bycatch Fixed_bycatch
# Survey names (delimited with spaces no spaces in names)
NMFS_Trawl ADFG_Pot
# Are the fleets instantaneous (0) or continuous (1)
1 1 1 1 1
## ----- ##
## CATCH DATA
## Type of catch: 1 = retained, 2 = discard
## Units of catch: 1 = biomass, 2 = numbers
## for SMBKC Units are in number of crab for landed & 1000 kg for discards.
## Male Retained

```

```

## ----- ##
0 #--input catch data format (0: old format, 1: new format)
#--option for effort extrapolation (0: standard gmacs approach; 1: TCSAM02 approach)
0
# Number of catch data frames
4
# Number of rows in each data frame
27 18 35 35 # (updated - all should increase 1 if value for current year NO placeholder for direct fishery if closed)
# year seas fleet sex obs cv type units mult effort discard_mortality
1978 3 1 1 436126 0.03 1 2 1 0 0.2
1979 3 1 1 52966 0.03 1 2 1 0 0.2
1980 3 1 1 33162 0.03 1 2 1 0 0.2
1981 3 1 1 1045619 0.03 1 2 1 0 0.2
1982 3 1 1 1935886 0.03 1 2 1 0 0.2
1983 3 1 1 1931990 0.03 1 2 1 0 0.2
1984 3 1 1 841017 0.03 1 2 1 0 0.2
1985 3 1 1 436021 0.03 1 2 1 0 0.2
1986 3 1 1 219548 0.03 1 2 1 0 0.2
1987 3 1 1 227447 0.03 1 2 1 0 0.2
1988 3 1 1 280401 0.03 1 2 1 0 0.2
1989 3 1 1 247641 0.03 1 2 1 0 0.2
1990 3 1 1 391405 0.03 1 2 1 0 0.2
1991 3 1 1 726519 0.03 1 2 1 0 0.2
1992 3 1 1 545222 0.03 1 2 1 0 0.2
1993 3 1 1 630353 0.03 1 2 1 0 0.2
1994 3 1 1 827015 0.03 1 2 1 0 0.2
1995 3 1 1 666905 0.03 1 2 1 0 0.2
1996 3 1 1 660665 0.03 1 2 1 0 0.2
1997 3 1 1 939822 0.03 1 2 1 0 0.2
1998 3 1 1 635370 0.03 1 2 1 0 0.2
2009 3 1 1 103376 0.03 1 2 1 0 0.2
2010 3 1 1 298669 0.03 1 2 1 0 0.2
2011 3 1 1 437862 0.03 1 2 1 0 0.2
2012 3 1 1 379386 0.03 1 2 1 0 0.2
2014 3 1 1 69109 0.03 1 2 1 0 0.2
2015 3 1 1 24407 0.03 1 2 1 0 0.2
#2016 3 1 1 10.000 0.03 1 2 1 0 0.2
#2017 3 1 1 10.000 0.03 1 2 1 0 0.2
#2018 3 1 1 10.000 0.03 1 2 1 0 0.2 # placeholder no fishery
# Male discards Pot fishery
1990 3 1 1 254.9787861 0.6 2 1 1 0 0.2
1991 3 1 1 531.4483252 0.6 2 1 1 0 0.2
1992 3 1 1 1050.387026 0.6 2 1 1 0 0.2
1993 3 1 1 951.4626128 0.6 2 1 1 0 0.2
1994 3 1 1 1210.764588 0.6 2 1 1 0 0.2
1995 3 1 1 363.112032 0.6 2 1 1 0 0.2
1996 3 1 1 528.5244687 0.6 2 1 1 0 0.2
1997 3 1 1 1382.825328 0.6 2 1 1 0 0.2
1998 3 1 1 781.1032977 0.6 2 1 1 0 0.2
2009 3 1 1 123.3712279 0.2 2 1 1 0 0.2
2010 3 1 1 304.6562225 0.2 2 1 1 0 0.2
2011 3 1 1 481.3572126 0.2 2 1 1 0 0.2

```

2012	3	1	1	437.3360731	0.2	2	1	1	0	0.2
2014	3	1	1	45.4839749	0.2	2	1	1	0	0.2
2015	3	1	1	21.19378597	0.2	2	1	1	0	0.2
2016	3	1	1	0.021193786	0.2	2	1	1	0	0.2
2017	3	1	1	0.021193786	0.2	2	1	1	0	0.2
2018	3	1	1	0.214868020	0.2	2	1	1	0	0.2 # (updated)
#2019	3	1	1	0.0	0.2	2	1	1	0	0.2
#2020	3	1	1	0.0	0.2	2	1	1	0	0.2
#2021	3	1	1	0.0	0.2	2	1	1	0	0.2
#2022	3	1	1	0.0	0.2	2	1	1	0	0.2
#2023	3	1	1	0.0	0.2	2	1	1	0	0.2
# Trawl fishery discards										
1991	2	2	1	3.538	0.31	2	1	1	0	0.8
1992	2	2	1	1.996	0.31	2	1	1	0	0.8
1993	2	2	1	1.542	0.31	2	1	1	0	0.8
1994	2	2	1	0.318	0.31	2	1	1	0	0.8
1995	2	2	1	0.635	0.31	2	1	1	0	0.8
1996	2	2	1	0.500	0.31	2	1	1	0	0.8
1997	2	2	1	0.500	0.31	2	1	1	0	0.8
1998	2	2	1	0.500	0.31	2	1	1	0	0.8
1999	2	2	1	0.500	0.31	2	1	1	0	0.8
2000	2	2	1	0.500	0.31	2	1	1	0	0.8
2001	2	2	1	0.500	0.31	2	1	1	0	0.8
2002	2	2	1	0.726	0.31	2	1	1	0	0.8
2003	2	2	1	0.998	0.31	2	1	1	0	0.8
2004	2	2	1	0.091	0.31	2	1	1	0	0.8
2005	2	2	1	0.500	0.31	2	1	1	0	0.8
2006	2	2	1	2.812	0.31	2	1	1	0	0.8
2007	2	2	1	0.045	0.31	2	1	1	0	0.8
2008	2	2	1	0.272	0.31	2	1	1	0	0.8
2009	2	2	1	0.638	0.31	2	1	1	0	0.8
2010	2	2	1	0.360	0.31	2	1	1	0	0.8
2011	2	2	1	0.170	0.31	2	1	1	0	0.8
2012	2	2	1	0.011	0.31	2	1	1	0	0.8
2013	2	2	1	0.163	0.31	2	1	1	0	0.8
2014	2	2	1	0.010	0.31	2	1	1	0	0.8
2015	2	2	1	0.010	0.31	2	1	1	0	0.8
2016	2	2	1	0.229	0.31	2	1	1	0	0.8
2017	2	2	1	0.048	0.31	2	1	1	0	0.8 # updated in 2020 was 0.052, now 0.48?
2018	2	2	1	0.001	0.31	2	1	1	0	0.8 # (data is 0 but small value for placeholder)
2019	2	2	1	0.030	0.31	2	1	1	0	0.8 # (updated)
2020	2	2	1	0.001	0.31	2	1	1	0	0.8 # (4-14-22)
2021	2	2	1	0.001	0.31	2	1	1	0	0.8 # (8-25-22) (data is 0 but small value for placeholder)
2022	2	2	1	0.001	0.31	2	1	1	0	0.8 # (updated 2-14-24) (data is 0 but small value for placeholder)
2023	2	2	1	0.005	0.31	2	1	1	0	0.8 # (updated 8-14-24 - bycatch_groundfish.R)
2024	2	2	1	0.001	0.31	2	1	1	0	0.8 # (updated 2-03-26 - bycatch_groundfish.R) (real value is 0.0005)
2025	2	2	1	0.001	0.31	2	1	1	0	0.8 # (updated 8-12-26 - bycatch_groundfish.R) (real value is 0.0005)
# Fixed fishery discards										
1991	2	3	1	0.045	0.31	2	1	1	0	0.5
1992	2	3	1	2.268	0.31	2	1	1	0	0.5
1993	2	3	1	0.500	0.31	2	1	1	0	0.5
1994	2	3	1	0.091	0.31	2	1	1	0	0.5

```

1995  2  3  1  0.136  0.31  2  1  1  0  0.5
1996  2  3  1  0.045  0.31  2  1  1  0  0.5
1997  2  3  1  0.181  0.31  2  1  1  0  0.5
1998  2  3  1  0.907  0.31  2  1  1  0  0.5
1999  2  3  1  1.361  0.31  2  1  1  0  0.5
2000  2  3  1  0.500  0.31  2  1  1  0  0.5
2001  2  3  1  0.862  0.31  2  1  1  0  0.5
2002  2  3  1  0.408  0.31  2  1  1  0  0.5
2003  2  3  1  1.134  0.31  2  1  1  0  0.5
2004  2  3  1  0.635  0.31  2  1  1  0  0.5
2005  2  3  1  0.590  0.31  2  1  1  0  0.5
2006  2  3  1  1.451  0.31  2  1  1  0  0.5
2007  2  3  1  69.717  0.31  2  1  1  0  0.5
2008  2  3  1  6.622  0.31  2  1  1  0  0.5
2009  2  3  1  7.522  0.31  2  1  1  0  0.5
2010  2  3  1  9.564  0.31  2  1  1  0  0.5
2011  2  3  1  0.796  0.31  2  1  1  0  0.5
2012  2  3  1  0.739  0.31  2  1  1  0  0.5
2013  2  3  1  0.341  0.31  2  1  1  0  0.5
2014  2  3  1  0.490  0.31  2  1  1  0  0.5
2015  2  3  1  0.711  0.31  2  1  1  0  0.5
2016  2  3  1  1.630  0.31  2  1  1  0  0.5 # updated from 1.632
2017  2  3  1  5.935  0.31  2  1  1  0  0.5 # updates was 6.032
2018  2  3  1  1.224  0.31  2  1  1  0  0.5 # updated was 1.281
2019  2  3  1  1.124  0.31  2  1  1  0  0.5 # (updated - bycatch_groundfish.R)
2020  2  3  1  0.671  0.31  2  1  1  0  0.5 # (4-14-22 - bycatch_groundfish.R)
2021  2  3  1  0.323  0.31  2  1  1  0  0.5 # (8-25-22 - bycatch_groundfish.R)
2022  2  3  1  2.118  0.31  2  1  1  0  0.5 # (updated 2-14-24 - bycatch_groundfish.R)
2023  2  3  1  0.415  0.31  2  1  1  0  0.5 # (updated 8-14-24 - bycatch_groundfish.R)
2024  2  3  1  0.720  0.31  2  1  1  0  0.5 # (updated 2-03-26 - bycatch_groundfish.R)
2025  2  3  1  1.879  0.31  2  1  1  0  0.5 # (updated 8-12-26 - bycatch_groundfish.R)
## ----- ##
## RELATIVE ABUNDANCE DATA
## Units of abundance: 1 = biomass, 2 = numbers
## for SMBKC pot survey Units are in crabs for Abundance.
## ----- ##
# 0- old format; 1 - new format
0
## Number of relative abundance indices
2
# Index Type (1=Selectivity; 2=retention)
# AEPAEP
1 1
## Number of rows in both indices, need to update when survey data is added
61 # updated 8-12-26
# Survey data (abundance indices, units are mt for trawl survey and crab/potlift for pot survey)
# q_index, Year, Seas, Fleet, Sex, Maturity, Abundance, CV abundance units timing RAI_id #<-RAI_id column is NEW as of version 2.20.29
# EBS bottom trawl survey
1 1978 1 4 1 0 6832.824 0.394 1 0 1 # whole time series updated 2-04-2026, incorporating changes esp. from 2016 forward in biomass calculation (see crabpack results)
1 1979 1 4 1 0 7989.887 0.463 1 0 1
1 1980 1 4 1 0 9986.838 0.507 1 0 1
1 1981 1 4 1 0 6551.137 0.402 1 0 1

```

1	1982	1	4	1	0	16221.950	0.344	1	0	1
1	1983	1	4	1	0	9634.257	0.298	1	0	1
1	1984	1	4	1	0	4071.222	0.179	1	0	1
1	1985	1	4	1	0	3110.544	0.210	1	0	1
1	1986	1	4	1	0	1416.850	0.388	1	0	1
1	1987	1	4	1	0	2278.919	0.291	1	0	1
1	1988	1	4	1	0	3158.172	0.252	1	0	1
1	1989	1	4	1	0	6338.627	0.271	1	0	1
1	1990	1	4	1	0	6730.136	0.274	1	0	1
1	1991	1	4	1	0	6948.190	0.248	1	0	1
1	1992	1	4	1	0	7093.277	0.201	1	0	1
1	1993	1	4	1	0	9548.466	0.169	1	0	1
1	1994	1	4	1	0	6539.139	0.176	1	0	1
1	1995	1	4	1	0	5703.595	0.178	1	0	1
1	1996	1	4	1	0	9410.410	0.241	1	0	1
1	1997	1	4	1	0	10924.120	0.337	1	0	1
1	1998	1	4	1	0	7976.846	0.355	1	0	1
1	1999	1	4	1	0	1594.548	0.182	1	0	1
1	2000	1	4	1	0	2096.796	0.310	1	0	1
1	2001	1	4	1	0	2831.442	0.245	1	0	1
1	2002	1	4	1	0	1732.601	0.320	1	0	1
1	2003	1	4	1	0	1566.677	0.336	1	0	1
1	2004	1	4	1	0	1523.870	0.305	1	0	1
1	2005	1	4	1	0	1642.018	0.371	1	0	1
1	2006	1	4	1	0	3893.879	0.334	1	0	1
1	2007	1	4	1	0	6470.779	0.385	1	0	1
1	2008	1	4	1	0	4654.477	0.284	1	0	1
1	2009	1	4	1	0	6301.475	0.256	1	0	1
1	2010	1	4	1	0	11130.910	0.466	1	0	1
1	2011	1	4	1	0	10931.240	0.558	1	0	1
1	2012	1	4	1	0	6200.224	0.339	1	0	1
1	2013	1	4	1	0	2287.559	0.217	1	0	1
1	2014	1	4	1	0	6029.225	0.449	1	0	1
1	2015	1	4	1	0	5877.438	0.770	1	0	1
1	2016	1	4	1	0	3528.701	0.393	1	0	1
1	2017	1	4	1	0	1814.159	0.600	1	0	1
1	2018	1	4	1	0	1750.262	0.281	1	0	1
1	2019	1	4	1	0	3206.744	0.337	1	0	1
1	2021	1	4	1	0	1948.794	0.427	1	0	1
1	2022	1	4	1	0	2390.681	0.497	1	0	1
1	2023	1	4	1	0	2141.211	0.439	1	0	1
1	2024	1	4	1	0	1857.825	0.465	1	0	1
1	2025	1	4	1	0	1861.496	0.440	1	0	1
1	2026	1	4	1	0	2915.236	0.440	1	0	1
# ADF&G pot survey										
2	1995	1	5	1	0	12042	0.13	2	0	2
2	1998	1	5	1	0	12531	0.06	2	0	2
2	2001	1	5	1	0	8477	0.08	2	0	2
2	2004	1	5	1	0	1667	0.15	2	0	2
2	2007	1	5	1	0	8630	0.09	2	0	2
2	2010	1	5	1	0	10167	0.10	2	0	2
2	2013	1	5	1	0	5606	0.19	2	0	2

(updated - EBSsurvey_analysis.R)

updated 4-14-22

updated 8-25-22

updated 2-14-24

updated 8-14-24

updated 2-04-26

updated 8-12-26

```

2 2015 1 5 1 0 2805 0.18 2 0 2
2 2016 1 5 1 0 2021 0.17 2 0 2
2 2017 1 5 1 0 1674 0.25 2 0 2
2 2018 1 5 1 0 745 0.14 2 0 2 # no smbkc pot survey in 2019, 2020, 2021
2 2022 1 5 1 0 4089 0.14 2 0 2 # updated 2-14-24. No SMBKC pot survey in 2023, 2024
2 2025 1 5 1 0 4591 0.10 2 0 2 # updated 3-10-26
999 #chk <-NEW as of version 2.20.29

```

```

## ----- ##
## SIZE COMPOSITION DATA FOR ALL FLEETS
## ----- ##
# 0- old format; 1 - new format
0
## Number of length frequency matrices
3
## Number of rows in each matrix
15 48 13 # (updated 8-12-26)
## Number of bins in each matrix (columns of size data)
3 3 3
## SIZE COMP LEGEND
## Sex: 1 = male, 2 = female, 0 = both sexes combined
## Type of composition: 1 = retained, 2 = discard, 0 = total composition
## Maturity state: 1 = immature, 2 = mature, 0 = both states combined
## Shell condition: 1 = new shell, 2 = old shell, 0 = both shell types combined
##length proportions of pot discarded males
##Year, Seas, Fleet, Sex, Type, Shell, Maturity, Nsamp, DataVec
1990 3 1 1 0 0 0 15 0.1133 0.3933 0.4933
1991 3 1 1 0 0 0 25 0.1329 0.1768 0.6902
1992 3 1 1 0 0 0 25 0.1905 0.2677 0.5417
1993 3 1 1 0 0 0 25 0.2807 0.2097 0.5096
1994 3 1 1 0 0 0 25 0.2942 0.2714 0.4344
1995 3 1 1 0 0 0 25 0.1478 0.2127 0.6395
1996 3 1 1 0 0 0 25 0.1595 0.2229 0.6176
1997 3 1 1 0 0 0 25 0.1818 0.2053 0.6128
1998 3 1 1 0 0 0 25 0.1927 0.2162 0.5911
2009 3 1 1 0 0 0 50 0.1413 0.3235 0.5352
2010 3 1 1 0 0 0 50 0.1314 0.3152 0.5534
2011 3 1 1 0 0 0 50 0.1314 0.3051 0.5636
2012 3 1 1 0 0 0 50 0.1417 0.3178 0.5406
2014 3 1 1 0 0 0 50 0.0939 0.2275 0.6786
2015 3 1 1 0 0 0 50 0.1148 0.2518 0.6333 #no fishery so not updated
##length proportions of trawl survey males
##Year, Seas, Fleet, Sex, Type, Shell, Maturity, Nsamp, DataVec
1978 1 4 1 0 0 0 50 0.3865 0.3478 0.2657
1979 1 4 1 0 0 0 50 0.4281 0.3190 0.2529
1980 1 4 1 0 0 0 50 0.3588 0.3220 0.3192
1981 1 4 1 0 0 0 39 0.1219 0.3065 0.5716
1982 1 4 1 0 0 0 50 0.1671 0.2435 0.5893
1983 1 4 1 0 0 0 50 0.1752 0.2726 0.5522
1984 1 4 1 0 0 0 36.5 0.1823 0.2085 0.6092
1985 1 4 1 0 0 0 26.75 0.2023 0.2010 0.5967
1986 1 4 1 0 0 0 16.25 0.1984 0.4364 0.3652

```

```

1987 1 4 1 0 0 0 24.5 0.1944 0.3779 0.4277
1988 1 4 1 0 0 0 29.75 0.1879 0.3737 0.4384
1989 1 4 1 0 0 0 50 0.4246 0.2259 0.3496
1990 1 4 1 0 0 0 50 0.2380 0.2332 0.5288
1991 1 4 1 0 0 0 50 0.2274 0.3300 0.4426
1992 1 4 1 0 0 0 50 0.2263 0.2911 0.4826
1993 1 4 1 0 0 0 50 0.2296 0.2759 0.4945
1994 1 4 1 0 0 0 50 0.1989 0.2926 0.5085
1995 1 4 1 0 0 0 50 0.2593 0.3005 0.4403
1996 1 4 1 0 0 0 50 0.1998 0.3054 0.4948
1997 1 4 1 0 0 0 50 0.1622 0.3102 0.5275
1998 1 4 1 0 0 0 50 0.1276 0.3212 0.5511
1999 1 4 1 0 0 0 17.25 0.2224 0.2214 0.5562
2000 1 4 1 0 0 0 18 0.2154 0.2180 0.5665
2001 1 4 1 0 0 0 27.75 0.2253 0.2699 0.5048
2002 1 4 1 0 0 0 10.75 0.1127 0.2346 0.6527
2003 1 4 1 0 0 0 26.5 0.3762 0.2345 0.3893
2004 1 4 1 0 0 0 20.75 0.2488 0.1848 0.5663
2005 1 4 1 0 0 0 16.75 0.2825 0.2744 0.4431
2006 1 4 1 0 0 0 39.5 0.3276 0.2293 0.4431
2007 1 4 1 0 0 0 50 0.4394 0.3525 0.2081
2008 1 4 1 0 0 0 50 0.3745 0.2219 0.4036
2009 1 4 1 0 0 0 50 0.3057 0.4202 0.2741
2010 1 4 1 0 0 0 50 0.4081 0.3371 0.2548
2011 1 4 1 0 0 0 50 0.2179 0.3940 0.3881
2012 1 4 1 0 0 0 50 0.1573 0.4393 0.4034
2013 1 4 1 0 0 0 26 0.2100 0.2834 0.5065
2014 1 4 1 0 0 0 50 0.1738 0.3912 0.4350
2015 1 4 1 0 0 0 40.5 0.2340 0.2994 0.4666
2016 1 4 1 0 0 0 30.75 0.2255 0.2780 0.4965
2017 1 4 1 0 0 0 12 0.0849 0.2994 0.6157
2018 1 4 1 0 0 0 26.25 0.1475 0.2219 0.6306 #55
2019 1 4 1 0 0 0 45.75 0.1961 0.2346 0.5692 #105 no survey so not updated
2021 1 4 1 0 0 0 30.75 0.3323 0.1320 0.5357 #59 updated 4-14-22
2022 1 4 1 0 0 0 46 0.3531 0.2121 0.4348 #75 updated 8-25-22
2023 1 4 1 0 0 0 24 0.3211 0.2974 0.3815 # updated 2-14-24
2024 1 4 1 0 0 0 14.5 0.2040 0.2555 0.5405 # updated 8-14-24
2025 1 4 1 0 0 0 28.0 0.1831 0.2948 0.5221 # updated 2-04-26
2026 1 4 1 0 0 0 50.0 0.3467 0.2698 0.3835 # updated 2-04-26
##length proportions of pot survey
##Year, Seas, Fleet, Sex, Type, Shell, Maturity, Nsamp, DataVec
1995 1 5 1 0 0 0 100 0.151581 0.257254 0.591165
1998 1 5 1 0 0 0 100 0.086263 0.223461 0.690276
2001 1 5 1 0 0 0 100 0.158784 0.202492 0.638725
2004 1 5 1 0 0 0 100 0.092476 0.240596 0.666928
2007 1 5 1 0 0 0 100 0.116245 0.301801 0.581954
2010 1 5 1 0 0 0 100 0.12951 0.316528 0.553962
2013 1 5 1 0 0 0 100 0.137872 0.275316 0.586812
2015 1 5 1 0 0 0 100 0.090959 0.271233 0.637808
2016 1 5 1 0 0 0 100 0.097938 0.217784 0.684278
2017 1 5 1 0 0 0 100 0.110656 0.262295 0.627049
2018 1 5 1 0 0 0 100 0.109272 0.215232 0.675497 # no survey so not updated

```

```

2022 1 5 1 0 0 0 100 0.15414 0.250955 0.594904 # updated 2-14-2024
2025 1 5 1 0 0 0 100 0.080264 0.190764 0.728972 # updated 3-10-2026

## ----- ##
## Growth data (increment)
### ----- ##
0 #-- Type of growth increment (0=ignore;1=growth increment with a CV;2=size-at-release; size-at)

0 #-- nobobs_growth

# MidPoint Sex Increment CV

# MidPoint Sex MidPoint Time-at-liberty Size-trans matrix Number of points
# Release Recapture

#-----#
#-----MALE MATURITY OGIVE DATA-----#
#-----#
0 #--has mature male ogive data? (0: no, 1: yes)

## ----- ##
# Environmental data
## ----- ##
0 #--format flag (0 = old format; 1 = new format)
0 #--Number of series
# Year ranges

# Indices
# Index Year Value

## eof
9999

```

The base model (26.1b) control file

```

## SMBKC model 26.1b, August 2026
## GMACS v2.20.44, updated with 2026 EBS survey data
#
## ===== ##
# Time Block_Groups to be used in the model (Block_Group 0 is the year range)
## ===== ##
# Block_Groups to be used in the model (Block_Group 0 is the model year range)
4
# Number of blocks per group (after the first block, i.e. 1 means two blocks)
1 1 1 1
# Block_Group definitions (first block always start with syr; year 0 is last year)
# Block 1: styr endyr #--applies to almost everything (and always defined)
1978 0 # Block Group 1: M and NMFS survey
# Block Group 2: directed fishery

```

```

2009 0 # Block Group 3: directed fishery
# Block Group 3: natural mortality event
1998 1998
# Block Group 4: directed fishery
1978 0 # Block Group 4

## =====##
# Treatment of environmental variable use
# Number of environmental treatments
0
# Number of links for each treatment
#1
#2
# Treatment #1
# Var power Zscore
#1 1 1990 2020
# Treatment #2
# Var power Zscore
#1 2 2000 2020
#2 1 2010 2020

## ===== ##
## GENERAL CONTROLS
## ===== ##
1978 # First rec_dev
2025 # last rec_dev (updated annually, should be last completed crab year?)
0 # Terminal molting (0 = off, 1 = on). If on, the calc_stock_recruitment_relationship() isn't called in the procedure
3 # Estimated rec_dev phase
-3 # Estimated sex_ratio
0.5 # initial sex-ratio
2 # Initial conditions (0 = Unfished, 1 = Steady-state fished, 2 = Free parameters)
1 # Reference size-class for initial conditons = 3 only
1 # Lambda (proportion of mature male biomass for SPR reference points)
0 # Stock-Recruit-Relationship (0 = None, 1 = Beverton-Holt)
1 # Use years specified to computed average sex ratio in the calculation of average recruitment for reference points (0 = off -i.e. Rec based on End year, 1 = on)
200 # Years to compute equilibria
5 # Phase for deviation parameters
1978 # First year of bias-correction - what is this? Buck had it as 1910.
1978 # First full bias-correction - what is this? Buck had it as 1920.
2050 # Last full bias-correction
2050 # Last year of bias-correction
0 # recruitment size distribution option (0: standard way; 1: Tanner crab approach) <-NEW as of version 2.20.29
0 # mirror growth between sexes (0: standard way; 1: AIGKC way) <- also new

## ----- ##
## RECRUITMENT ##
#Initial Lower_bound Upper_bound Prior_type Prior_1 Prior_2 Phase Block Blk_fn Env_L Env_vr RW RW_Blkw RW_Sigma
14.3 -7 30 0 -7 30 -2 0 0 0 0 0 0 300 # log(R0)
10 -7 20 1 -10 20 -1 0 0 0 0 0 0 300 # log(Rini)
13.39 -7 20 0 -7 20 1 0 0 0 0 0 0 300 # log(Rbar)

#13.39 -7 20 0 -7 20 1 0 0 0 0 0 11 5 300 # log(Rbar)

```

```

#13.39 -7 20 0 -7 20 1 2 1 0 0 0 0 300 # log(Rbar)
#13.39 -7 20 0 -7 20 1 0 0 1 1 0 4 300 # log(Rbar)

80 30 310 1 72.5 7.25 -2 0 0 0 0 0 0 300 # Recruitment
0.25 0.1 7 0 0.1 9 -4 0 0 0 0 0 0 300 # Recruitment
0.2 0.01 0.75 0 -10 0.75 -4 0 0 0 0 0 0 300 # log(sigma_R)
0.75 0.2 1 3 3 2 -2 0 0 0 0 0 0 300 # steepness
0.01 0 1 3 1.01 1.01 -3 0 0 0 0 0 0 300 # recruitment
## ----- ##
## Initial abundance ##
# Initial Lower_bound Upper_bound Prior_type Prior_1 Prior_2 Phase Block Blk_fn Env_L Env_vr RW RW_Blkw RW_Sigma
14.5 5 20 0 5 20 1 0 0 0 0 0 0 300 # logN0 vector of initial numbers at length
14 5 20 0 5 20 1 0 0 0 0 0 0 300 # logN0 vector of initial numbers at length
13.5 5 20 0 5 20 1 0 0 0 0 0 0 300 # logN0 vector of initial numbers at length

# Initial Lower_bound Upper_bound Prior_type Prior_1 Prior_2 Phase Relative
# 0.2 0.01 1 0 0.23 0.02 4 0 # Dev par=2; linear

## ----- ##
# weight-at-length input method (1 = allometry i.e. w_l = a*l^b, 2 = vector by sex, 3 = matrix by sex)
## ----- ##
3
# Male weight-at-length
0.000748427 0.001165731 0.001930510 # 1978
0.000748427 0.001165731 0.001688886 # 1979
0.000748427 0.001165731 0.001922246 # 1980
0.000748427 0.001165731 0.001877957 # 1981
0.000748427 0.001165731 0.001938634 # 1982
0.000748427 0.001165731 0.002076413 # 1983
0.000748427 0.001165731 0.001899330 # 1984
0.000748427 0.001165731 0.002116687 # 1985
0.000748427 0.001165731 0.001938784 # 1986
0.000748427 0.001165731 0.001939764 # 1987
0.000748427 0.001165731 0.001871067 # 1988
0.000748427 0.001165731 0.001998295 # 1989
0.000748427 0.001165731 0.001870418 # 1990
0.000748427 0.001165731 0.001969415 # 1991
0.000748427 0.001165731 0.001926859 # 1992
0.000748427 0.001165731 0.002021492 # 1993
0.000748427 0.001165731 0.001931318 # 1994
0.000748427 0.001165731 0.002014407 # 1995
0.000748427 0.001165731 0.001977471 # 1996
0.000748427 0.001165731 0.002099246 # 1997
0.000748427 0.001165731 0.001982478 # 1998
0.000748427 0.001165731 0.001930932 # 1999
0.000748427 0.001165731 0.001930932 # 2000
0.000748427 0.001165731 0.001930932 # 2001
0.000748427 0.001165731 0.001930932 # 2002
0.000748427 0.001165731 0.001930932 # 2003
0.000748427 0.001165731 0.001930932 # 2004
0.000748427 0.001165731 0.001930932 # 2005

```

```

0.000748427 0.001165731 0.001930932 # 2006
0.000748427 0.001165731 0.001930932 # 2007
0.000748427 0.001165731 0.001930932 # 2008
0.000748427 0.001165731 0.001891628 # 2009
0.000748427 0.001165731 0.001795721 # 2010
0.000748427 0.001165731 0.001823113 # 2011
0.000748427 0.001165731 0.001807433 # 2012
0.000748427 0.001165731 0.001930932 # 2013
0.000748427 0.001165731 0.001894627 # 2014
0.000748427 0.001165731 0.001850611 # 2015
0.000748427 0.001165731 0.001930932 # 2016
0.000748427 0.001165731 0.001930932 # 2017
0.000748427 0.001165731 0.001930932 # 2018
0.000748427 0.001165731 0.001930932 # 2019
0.000748427 0.001165731 0.001930932 # 2020
0.000748427 0.001165731 0.001930932 # 2021
0.000748427 0.001165731 0.001930932 # 2022
0.000748427 0.001165731 0.001930932 # 2023
0.000748427 0.001165731 0.001930932 # 2024
0.000748427 0.001165731 0.001930932 # 2025
0.000748427 0.001165731 0.001930932 # 2026
0.000748427 0.001165731 0.001930932 # 2027 # this should be one year greater than the projection year in the prj
# Proportion mature by sex
0 1 1
# Proportion legal by sex
0 0 1
## ===== ##
## GROWTH PARAMETER CONTROLS ##
## ===== ##
1 # Maximum size-class for recruitment(males then females)
0 # use functional maturity for terminally molting animals?
## ----- ##
#--General inputs
# ----- ##
# Block: Block number for time-varying growth
# Block_fn: 0:absolute values; 1:exponential
# Env_L: Environmental link - options are 1:additive; 2:multiplicative; 3:exponential
# EnvL_var: Environmental variable
# RW: 0 for not random walk changes; 1 otherwise
# RW_blk: Block number for random walks
# Sigma_RW: Sigma for the random walk parameters
## ----- ##
#--Growth transition
# ----- ##
## Type_1: Options for the growth matrix
# 1: Pre-specified growth transition matrix (requires molt probability)
# 2: Pre-specified size transition matrix (molt probability is ignored)
# 3: Growth increment is gamma distributed (requires molt probability)
# 4: Post-molt size is gamma distributed (requires molt probability)
# 5: Von Bert.: kappa varies among individuals (requires molt probability)
# 6: Von Bert.: Linf varies among individuals (requires molt probability)
# 7: Von Bert.: kappa and Linf varies among individuals (requires molt probability)

```

```

# 8: Growth increment is normally distributed          (requires molt probability)
## Type_2: Options for the growth increment model matrix (if Type_1 in 3-8)
# 1: Linear
# 2: Individual
# 3: Individual (Same as 2)
# 4: Power law for mean post-molt size
# Block: Block number for time-varying growth
## Type_1 Type_2 Block
# 1 -1 0 # Growth-transition Males
# ----- ##
##--Molt probability
# ----- ##
## Options for the molt probability function
# 0: Pre-specified
# 1: Constant at 1
# 2: Logistic
# 3: Individual
## Type Block
# 2 0 # Molt probability Males
# ----- ##
## General parameter specifications
# ----- ##
## Initial: Initial value for the parameter (must lie between lower and upper)
## Lower & Upper: Range for the parameter
## Prior type:
## 0: Uniform - parameters are the range of the uniform prior
## 1: Normal - parameters are the mean and sd
## 2: Lognormal - parameters are the mean and sd of the log
## 3: Beta - parameters are the two beta parameters [see dbeta]
## 4: Gamma - parameters are the two gamma parameters [see dgamma]
## Phase: Set equal to a negative number not to estimate
## Relative: 0: absolute; 1 relative
## Block: Block number for time-varying selectivity
## Block_fn: 0: absolute values; 1: exponential
## Env_L: Environmental link - options are 0: none; 1: additive; 2: multiplicative; 3: exponential
## EnvL_var: Environmental variable
## RW: 0 for no random walk changes; 1 otherwise
## RW_blk: Block number for random walks
## Sigma_RW: Sigma used for the random walk
# Inputs for sex * type 2
## MAIN PARS:
# Initial Lower_bound Upper_bound Prior_type Prior_1 Prior_2 Phase Block Blk_fn Env_L Env_vr RW RW_Blkw RW_Sigma
# 121.5 65.0 145.0 0 0.0 999.0 -4 0 0 0 0 0 0 0 300 # molt_mu males or combined
# 0.060 0.0 1.0 0 0.0 999.0 -3 0 0 0 0 0 0 0 300 # molt_cv males or combined
# Initial Lower_bound Upper_bound Prior_type Prior_1 Prior_2 Phase Relative
# 121.5 65.0 145.0 0 0.0 999.0 -4 0 0 3 2 0 4 300 # molt_mu males or combined
# 0.060 0.0 1.0 0 0.0 999.0 -3 0 0 3 2 0 4 300 # molt_cv males or combined
# Initial Lower_bound Upper_bound Prior_type Prior_1 Prior_2 Phase Relative
# 0.2 -1 1 0 0.23 0.02 -4 0 # Dev par=2; linear
# 0.3 -1 1 0 0.23 0.02 -4 0 # Dev par=2; linear

```

```

#   0.4      -1      1      0      0.23      0.02      -4      0      # Dev par=2; linear
#   0.5      -1      1      0      0.23      0.02      -4      0      # Dev par=2; linear
#   0.6      -1      1      0      0.23      0.02      -4      0      # Dev par=2; linear
#   0.7      -1      1      0      0.23      0.02      -4      0      # Dev par=2; linear

# EXTRA PARS: Initial Lower_bound Upper_bound Prior_type Prior_1 Prior_2 Phase Reltve
#----no extra pars

# ----- ##
# The custom growth matrix (if not using just fill with zeros)
# ----- ##
# Alternative TM (loosely) based on Otto and Cummiskey (1990)
# Size1...Size2...Size3
#   0.1761  0.0000  0.0000
#   0.7052  0.2206  0.0000
#   0.1187  0.7794  1.0000

# ----- ##
# custom molt probability matrix
# ----- ##

## ===== ##
## NATURAL MORTALITY PARAMETER CONTROLS ##
## ===== ##
## baseline M: immature crab; mature M's: sex-specific ln-scale offsets
# Relative: 0 - absolute values; 1+ - based on another M-at-size vector (indexed by ig)
# Type: 0 for standard; 1: Spline
# For spline: set extra to the number of knots, the parameters are the knots (phase -1) and the log-differences from base M
# Extra: control the number of knots for splines
# Brkpts: number of changes in M by size
# Mirror: Mirror M-at-size over to that for another partition (indexed by ig)
# Block: Block number for time-varying M-at-size
# Block_fn: 0: absolute values; 1: exponential
# Env_L: Environmental link - options are 0: none; 1: additive; 2: multiplicative; 3: exponential
# EnvL_var: Environmental variable
# RW: 0 for no random walk changes; 1 otherwise
# RW_blk: Block number for random walks
# Sigma_RW: Sigma for the random walk parameters
# Mirror_RW: Should time-varying aspects be mirrored (Indexed by ig)
#--control info by group (ig)
#----group 1: males
## Relative? Type Extra Brkpts Mirror Block Blk_fn Env_L EnvL_Vr RW RW_blk Sigma_RW Mirr_RW
#   0      0      0      0      0      3      0      0      0      0      0      0      0.3000      0
## Relative? Type Extra Brkpts Mirror Block Blk_fn Env_L EnvL_Vr RW RW_blk Sigma_RW Mirr_RW
#   0      0      0      0      0      3      0      3      2      0      4      0.3000      0

#----parameter values
# Initial Lower_bound Upper_bound Prior_type Prior_1 Prior_2 Phase
#   0.23      0.01      1      2      0.23      0.02      -4 # M for males

```

```

    1.6      0.0      2      0      0      0      3 # M for males
# Initial Lower_bound Upper_bound Prior_type Prior_1 Prior_2 Phase
# 0.23     0.01      1      2      0.23     0.02    -4 # M for males
# 1.6      0.0      2      0      0      0      3 # M for males
# 0.1      -1      1      0      0.23     0.02    -4 # Dev par=1
# 0.2      -1      1      0      0.23     0.02    -4 # Dev par=2; linear
# 0.3      -1      1      0      0.23     0.02    -4 # Dev oar=3; power

## ===== ##
## SELECTIVITY PARAMETERS CONTROLS ##
## ===== ##
##
## ## Selectivity parameter controls
## ## Selectivity (and retention) types
## ## <0: Mirror selectivity
## ## 0: Nonparametric selectivity (one parameter per class)
## ## 1: Nonparametric selectivity (one parameter per class, constant from last specified class)
## ## 2: Logistic selectivity (inflection point and width (i.e. 1/slope))
## ## 3: Logistic selectivity (50% and 95% selection)
## ## 4: Double normal selectivity (3 parameters)
## ## 5: Flat equal to zero (1 parameter; phase must be negative) UPDATE 2.20.31: description now correct
## ## 6: Flat equal to one (1 parameter; phase must be negative) UPDATE 2.20.31: description now correct
## ## 7: Flat-topped double normal selectivity (4 parameters)
## ## 8: Declining logistic selectivity with initial values (50% and 95% selection plus extra)
## ## 9: Cubic-spline (specified with knots and values at knots)
## ## Inputs: knots (in length units); values at knots (0-1) - at least one should have phase -1
## ## 10: One parameter logistic selectivity (inflection point and slope)
## ## 11: Pre-specified selectivity (matrix by year and class)

## Selectivity specifications --
## ## Extra (type 1): number of selectivity parameters to estimated
## # Pot_Fishery Trawl_Bycatch Fixed_bycatch NMFS_Trawl ADFG_Pot
##      0      0      0      0      0 # is selectivity sex=specific? (1=Yes; 0=No)
##      0      3      3      0      0 # male selectivity type
##      0      0      0      0      0 # selectivity within another gear
##      0      0      0      0      0 # male extra parameters for each pattern
##      1      1      1      1      1 # male: is maximum selectivity at size forced to equal 1 (1) or not (0)
##      3      3      3      3      3 # size-class at which selectivity is forced to equal 1 (ignored if the previous input is 1)

## Retention specifications --
## # Pot_Fishery Trawl_Bycatch Fixed_bycatch NMFS_Trawl ADFG_Pot
##      0      0      0      0      0 # is retention sex=specific? (1=Yes; 0=No)
##      3      5      5      5      5 # male retention type
##      1      0      0      0      0 # male retention flag (0 = no, 1 = yes)
##      0      0      0      0      0 # male extra parameters for each pattern
##      0      0      0      0      0 # male - should maximum retention be estimated for males (1=Yes; 0=No)

## ===== ##
## SELECTIVITY/RETENTION PARAMETER VALUES ##
## ===== ##
# Inputs for type*sex*fleet:
# Selectivity male Pot_Fishery block 2

```

```

#Initial Lower_bound Upper_bound Prior_type Prior_1 Prior_2 Phase Block Block_fn Env_L EnvL_var RW RW_Block Sigma
0.4 0.001 1.0 0 0 1 3 2 0 0 0 0 0 0 1 #--directed fishery, block 2 (1978-2008)
0.7 0.001 1.0 0 0 1 3 2 0 0 0 0 0 0 1 #--directed fishery, block 2 (1978-2008)
1.0 0.001 2.0 0 0 1 -2 2 0 0 0 0 0 0 1 #--directed fishery, block 2 (1978-2008)

# EXTRA PARS: Initial Lower_bound Upper_bound Prior_type Prior_1 Prior_2 Phase Reltve
0.4 0.001 1.0 0 0 1 3 0 #--directed fishery, (2009-2024)
1.0 0.001 1.0 0 0 1 3 0 #--directed fishery, (2009-2024)
1.0 0.001 2.0 0 0 1 -2 0 #--directed fishery, (2009-2024). Upper bound must = 2.0

# Selectivity male trawl bycatch groundfish
20 10.0 200 0 10 200 -3 0 0 0 0 0 0 0 1 #--block 1 (1978-2024)
60 10.0 200 0 10 200 -3 0 0 0 0 0 0 0 1 #--block 1 (1978-2024)

# Selectivity male trawl fixed gear groundfish
40 0.0 200 0 10 200 -3 0 0 0 0 0 0 0 1 #--block 1 (1978-2024)
60 10.0 200 0 10 200 -3 0 0 0 0 0 0 0 1 #--block 1 (1978-2024)

# Selectivity NMFS trawl survey
0.7 0.001 1.0 0 0 1 4 0 0 0 0 0 0 0 1 #--block 1 (1978-2024)
1.0 0.001 1.0 0 0 1 4 0 0 0 0 0 0 0 1 #--block 1 (1978-2024)
0.9 0.001 1.0 0 0 1 -5 0 0 0 0 0 0 0 1 #--block 1 (1978-2024)

# EXTRA PARS: Initial Lower_bound Upper_bound Prior_type Prior_1 Prior_2 Phase Reltve
# 0.1 0.001 1.0 0 0 1 -3 0 #--directed fishery, (2009-2024)
# 0.2 0.001 1.0 0 0 1 -3 0 #--directed fishery, (2009-2024)
# 0.3 0.001 2.0 0 0 1 -2 0 #--directed fishery, (2009-2024). Upper bound must = 2.0

# Selectivity ADFG pot survey
0.4 0.001 1.0 0 0 1 4 0 0 0 0 0 0 0 1 #--block 1 (1978-2024)
1.0 0.001 1.0 0 0 1 4 0 0 0 0 0 0 0 1 #--block 1 (1978-2024)
1.0 0.001 2.0 0 0 1 -2 0 0 0 0 0 0 0 1 #--block 1 (1978-2024)

# Inputs for type*sex*fleet:
# Retention male Pot_Fishery
#Initial Lower_bound Upper_bound Prior_type Prior_1 Prior_2 Phase Block Block_fn Env_L EnvL_var RW RW_Block Sigma
120 50 200 0 1 900 -7 0 0 0 0 0 0 0 1 #--directed fishery, block 2 (1978-2008)
123 110 200 0 1 900 -7 0 0 0 0 0 0 0 1 #--directed fishery, block 2 (1978-2008)

# EXTRA PARS: Initial Lower_bound Upper_bound Prior_type Prior_1 Prior_2 Phase Reltve
# 120 50 200 0 1 900 -7 0 #--directed fishery (2009 - 2024)
# 123 110 200 0 1 900 -7 0 #--directed fishery (2009 - 2024)

## ===== ##
## PRIORS FOR CATCHABILITY
## If a uniform prior is selected for a parameter then the lb and ub are used (p1 ##
## and p2 are ignored). ival must be > 0 ##
## only allowed to use uniform or lognormal prior ##
## if analytic q estimation step is chosen, turn off estimating q by changing the estimation phase to be -ve ##
## LEGEND ##
## prior: 0 = uniform, 1 = normal, 2 = lognormal, 3 = beta, 4 = gamma ##

```

```

## ===== ##
## LAMBDA: Arbitrary relative weights for each series, 0 = do not fit.
## SURVEYS/INDICES ONLY
## Analytic (0 = not analytically solved q, use uniform or lognormal prior; 1 = analytic) ##
## Lambda = multiplier for input CV, Emphasis = multiplier for likelihood ##

## Analytic? LAMBDA Emphasis Mirror block Env_L EnvL_Var RW RW_blk Sigma_RW
      0      1      1      0      0      0      0      0      0      0.3      # NMFS trawl
      0      1      1      0      0      0      0      0      0      0.3      # ADF&G pot

## ival      lb      ub      prior      p1      p2      phz
      1.0      0.5      1.2      0      0.0      9.0      -4      # NMFS trawl
      0.003      0      5      0      0.0      9.0      3      # ADF&G pot

### ===== ##
## ADDITIONAL CV FOR SURVEYS/INDICES ##
## If a uniform prior is selected for a parameter then the lb and ub are used (p1 ##
## and p2 are ignored). ival must be > 0 ##
## LEGEND ##
## prior: 0 = uniform, 1 = normal, 2 = lognormal, 3 = beta, 4 = gamma ##
## ===== ##

## Mirror Block Env_L EnvL_Var RW RW_blk Sigma_RW
      0      0      0      0      0      0      0.3 # NMFS
      0      0      0      0      0      0      0.3 # ADF&G

## ival      lb      ub      prior      p1      p2      phz
      0.0000001      0.000000001      10.0      4      1.0      100      -4 # NMFS (PHASE -4)
      0.0000001      0.000000001      10.0      4      1.0      100      -4 # ADF&G

## ===== ##

## ===== ##
## PENALTIES FOR AVERAGE FISHING MORTALITY RATE FOR EACH GEAR ##
## ===== ##
## Mean_F Female Offset STD_PHZ1 STD_PHZ2 PHZ_M PHZ_F Fbar_l Fbar_h Fdev_L Fdev_h Foff_l Foff_h
      0.2      0.0      3.0      50.0      1      -1      -12      4      -10      10      -10      10 # Pot
      0.0001      0.0      4.0      50.0      1      -1      -12      4      -10      10      -10      10 # Trawl
      0.0001      0.0      4.0      50.0      1      -1      -12      4      -10      10      -10      10 # Fixed
      0.00      0.0      2.00      20.00      -1      -1      -12      4      -10      10      -10      10 # NMFS
      0.00      0.0      2.00      20.00      -1      -1      -12      4      -10      10      -10      10 # ADF&G
## ===== ##

## ===== ##
## OPTIONS FOR SIZE COMPOSITION DATA (COLUMN FOR EACH MATRIX) ##
## ===== ##
## LIKELIHOOD OPTIONS
## -1) Multinomial with estimated/fixed sample size
## -2) Robust approximation to multinomial
## -3) logistic normal (NIY)

```

```

## -4) multivariate-t (NIY)
## -5) Dirichlet
## -6) Dirichlet-Alt (Thorson et al 2016 rec'd)
## AUTOTAIL COMPRESSION
## pmin is the cumulative proportion used in tail compression.
## ===== ##
# Pot_Fishery NMFS_Trawl ADFG_Pot
# M M M
# tot tot tot
# N+S N+S N+S
# I+M I+M I+M
# 2 2 2 # Type of likelihood
# 0 0 0 # Auto tail compression
# 0 0 0 # Auto tail compression (pmin)
# 1 2 3 # Composition splicer
# 1 2 2 # Set to 1 for catch-based predictions; 2 for survey or total catch predictions
# 1 1 1 # LAMBDA
# 1 1 1 # Emphasis
# 0 1 2 # Survey to set Q for this comp
## ----- ##
##--the number of parameters listed here must match the MAXIMUM composition splicer index
# Initial Lower_bound Upper_bound Prior_type Prior_1 Prior_2 Phase
# 1.00000000 0.10000000 5.00000000 0 0.00000000 999.00000000 -4
# 1.00000000 0.10000000 5.00000000 0 0.00000000 999.00000000 -4
# 1.00000000 0.10000000 5.00000000 0 0.00000000 999.00000000 -4
## ===== ##
## EMPHASIS FACTORS ##
## ===== ##

0 # Emphasis on tagging data

#Ret_POT Disc_POT Disc_trawl Disc_fixed
# 1 1 1 1

## EMPHASIS FACTORS (Priors) by fleet: Fdev_total, Fdov_total, Fdev_year, Fdov_year
1 0 0.000 0 # Pot fishery
1 0 0.000 0 # Trawl bycatch
1 0 0.000 0 # fixed gear bycatch
1 0 0.000 0 # NMFS survey
1 0 0.000 0 # ADF&G survey

## ===== ##
## EMPHASIS FACTORS (Priors) ##
## ===== ##

## Emphasis Factors (Priors/Penalties: 13 values) ##
10000.0000 #--Penalty on log_fdev (male+combined; female) to ensure they sum to zero
0.0000 #--Penalty on mean F by fleet to regularize the solution
0.0000 #--Not used
0.0000 #--Not used

```

```
0.0000 #--Not used
0.0000 #--Smoothness penalty on the recruitment devs
1.0000 #--Penalty on the difference of the mean_sex_ratio from 0.5
0.0000 #--Smoothness penalty on molting probability
0.0000 #--Smoothness penalty on selectivity patterns with class-specific coefficients
0.0000 #--Smoothness penalty on initial numbers at length
0.0000 #--Penalty on annual F-devs for males by fleet
0.0000 #--Penalty on annual F-devs for females by fleet
0.0000 #--Penalty on deviation parameters
```

```
## EOF
```

```
9999
```