Norton Sound red king crab proposed model runs

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Executive summary

1. **Stock**: Red king crab, *Paralithodes camtschaticus*, in Norton Sound, Alaska.

2. **Catches**: The Norton Sound red king crab (NSRKC) stock supports three fisheries: male-only summer and winter directed commercial fisheries and a year-round subsistence fishery. The summer commercial fishery began in 1977 and the highest catches occurred in 1977-1981, peaking in 1979 at 970,962 crab. From 1982 to the present, summer commercial catch has not exceeded 161,113 crab. The Norton Sound red king crab fishery began operating as super-exclusive in 1994, meaning that vessels registered for the fishery cannot participate in any other king crab fishery in the same registration year. From 1994 to 2025, the summer commercial fishery has accounted for an average of 94% of commercially-harvested crab by weight each year.

   In 2025, commercial fishers harvested 2,657 crab (7,360 lb) in winter and 100,758 crab (346,364 lb) in summer. Crab per pot lift (catch per unit effort, CPUE) in the summer commercial fishery was down 57% from 2024, and was 22% below the time series mean.

   Winter 2025 subsistence fishers caught 2,239 male crab and 59 female crab, and retained 1,897 male crab (5,255 lb), with 100% of permits returned. Summer subsistence fishers caught 526 male crab and 29 female crab, and retained 467 (1,605 lb) male crab, with 100% of permits returned. In total, a harvest of 105,779 male crab (360,584 lb) was reported for the commercial and subsistence fisheries in 2025. Discard mortality data are not available because vessels participating in the 2025 NSRKC fisheries did not have observers on board. The discard mortality estimate from model 25.0a2, the author-recommended model, is 8,840 lb. Combining retained and discard mortality, total fishing mortality in 2025 was 369,427 lb (0.168 kt).

   For 2025, the OFL was 0.284 kt (628,000 lb) and the ABC was 0.199 kt (440,000 lb). The GHL was 410,000 lb. Total fishing mortality was below the ABC and overfishing did not occur during 2025. For 2026, the OFL is 0.193 kt (426,000 lb) and the ABC is 0.135 kt (298,000 lb).

3. **Data sources**: The data sources used in this assessment are summarized in Figure 1 and include retained catch, discards, total catch, size compositions, and catch per unit effort (CPUE) from the summer commercial fishery; retained catch, total catch, and size compositions from the winter commercial fishery; retained catch from the winter subsistence fishery; growth information from a tagging study; size compositions from the winter pot survey; and abundance and size compositions from the National Oceanic and Atmospheric Administration (NOAA) Norton Sound (NS) trawl survey (1976-1991), the NOAA Northern Bering Sea (NBS) trawl survey (2010-present), and the Alaska Department of Fish and Game (ADF&G) trawl survey (1996-present).

4. **Stock biomass**: Abundance of the Norton Sound red king crab stock has been monitored by the NOAA NS trawl survey (1976-1991), the NOAA NBS trawl survey (2010-2025), and the ADF&G trawl survey (1996-2024; next scheduled for 2026). In 2025, estimated abundance from the NOAA NBS trawl survey was 1.63 million crab (CV = 0.64).

5. **Recruitment**: Recruitment is based on the estimated number of male crab 64-93 mm in carapace length (CL) in each year. As estimated by the new base model, 26.0, average recruitment over 1976-2024 was 772,504 lb. Data from the NBS trawl survey appear to show a recruitment pulse first apparent in 2019 moving though the population (Figure 2).

6. **Management performance**: The tables below show the status and catch specifications based on the model accepted in 2025 for 2026 harvest specifications (model 25.0a2) in both 1,000 t and million lb (Tables 1 - 2). The minimum stock size threshold (MSST) is calculated as $B_{MSY}/2$. The ABC is calculated as (1 - 0.3) * OFL, using the accepted ABC buffer of 30%. The GHL listed is the total commercial GHL, including summer, winter, and Community Development Quota (CDQ) commercial fisheries. Harvest specifications for this stock in the 2026 fishing season were set in December 2025.

Table 1: Status and catch specifications (1,000 t) for the accepted model, 25.0a2.

Year	MSST	Biomass (MMB_{mating})	GHL	Retained catch	Total catch	OFL	ABC
2021/21	1.02	2.29	0.14	0.003	0.003	0.20	0.16
2022/22	0.95	2.42	0.15	0.15	0.16	0.30	0.18
2023/23	1.20	2.40	0.178	0.192	0.201	0.292	0.204
2024/24	1.00	2.50	0.219	0.209	0.215	0.332	0.233
2025/25	0.98	2.15	0.186	0.164	0.168	0.284	0.199
2026/26	1.00	1.56	0.130			0.193	0.135

Table 2: Status and catch specifications (million lb) for the accepted model, 25.0a2.

Year	MSST	Biomass (MMB_{mating})	GHL	Retained catch	Total catch	OFL	ABC
2021/21	2.25	5.05	0.31	0.007	0.007	0.59	0.35
2022/22	2.08	5.33	0.34	0.34	0.36	0.67	0.40
2023/23	2.65	5.29	0.392	0.425	0.444	0.643	0.450
2024/24	2.2	5.52	0.483	0.460	0.474	0.733	0.513
2025/25	2.16	4.72	0.410	0.361	0.369	0.628	0.440
2026/26	2.21	3.43	0.268			0.426	0.298

7. **Basis for the OFL**: Estimated mature-male biomass (MMB) is used as the measure of biomass for this Tier 4 stock, with males measuring $\geq$ 94 mm CL considered mature. The B_{MSY} proxy is obtained by averaging estimated MMB over a specific reference period, here 1980 to the most recent year.

Table 3: Basis for the OFL (1,000 t) from the accepted model, 25.0a2.

Year	Tier	B_{MSY}	Biomass (MMB_{mating})	B/B_{MSY}	F_{OFL}	Basis for B_{MSY}	Natural mortality
2021/21	4a	2.05	2.29	1.1	0.18	1980-2020	0.18
2022/22	4a	1.90	2.42	1.3	0.18	1980-2021	0.18
2023/23	4a	1.98	2.40	1.2	0.18	1980-2022	0.18
2024/24	4a	2.02	2.50	1.2	0.18	1980-2023	0.18
2025/25	4a	1.96	2.15	1.09	0.18	1980-2024	0.18
2026/26	4b	2.00	1.56	0.78	0.17	1980-2025	0.23

Table 4: Basis for the OFL (million lb) from the accepted model, 25.0a2.

Year	Tier	B_{MSY}	Biomass (MMB_{mating})	B/B_{MSY}	F_{OFL}	Basis for B_{MSY}	Natural mortality
2021/21	4a	4.53	5.05	1.1	0.18	1980-2020	0.18
2022/22	4a	4.17	5.33	1.3	0.18	1980-2021	0.18
2023/23	4a	4.37	5.29	1.2	0.18	1980-2022	0.18
2024/24	4a	4.45	5.52	1.2	0.18	1980-2023	0.18
2025/25	4a	4.33	4.72	1.09	0.18	1980-2024	0.18
2026/26	4b	4.42	3.43	0.78	0.17	1980-2025	0.23

8. **Probability density function (PDF) of the OFL:** The PDFs of the OFL for selected models will be shown in the fall 2026 SAFE report.

9. **Basis for the ABC recommendation:** The CPT and SSC recommended an ABC buffer of 30% for setting harvest specifications for 2025 for the following reasons: 1) uncertainty in the biological characteristics of the stock, 2) difficulty in managing to a total mortality due to lack of information about discards, 3) the model's overestimation of the abundance of the largest male crab, 4) the use of a higher natural mortality value for larger males in order to correct for this overestimation of abundance rather than the size-independent M used by other Bering Sea and Aleutian Islands (BSAI) king crab stock assessment models, and 5) a retrospective pattern in model-estimated mature male biomass (Appendix A). Since these concerns remained largely unchanged, the CPT and SSC again accepted a 30% ABC buffer for setting 2026 harvest specifications.

10. **Summary of rebuilding analyses:** The NSRKC stock is not currently subject to a rebuilding plan.

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

No input data have changed since the 2025 SAFE report (Stern and Palof 2025a), with the exception of the model-based index of abundance that is used in models 26.1 - 26.4 in place of the design-based ADF&G and NOAA NBS trawl survey indices of abundance; the development of the model-based index of abundance is detailed in Appendix D.

3. Changes to the assessment methodology

This assessment has used the Generalized size-structured Model for Assessing Crustacean Stocks (GMACS) framework since 2024. The model used for 2025 harvest specifications was accepted by the Crab Plan Team (CPT) in November 2024 and is detailed in the 2024 SAFE document (Hamazaki 2024). The model used for 2026 harvest specifications was accepted by the Crab Plan Team (CPT) in November 2025 and is detailed in the 2025 SAFE document (Stern and Palof 2025a).

In this document, we first bridge the 2025 accepted model to a newer GMACS version and then explore the incorporation of a model-based index of abundance based on data from the ADF&G and NOAA NBS trawl surveys (Figure 3). Model 25.0a2 was accepted by the CPT and SSC for 2026 harvest specifications in Nov/Dec 2025 and used GMACS version 2.20.20 (Stern and Palof 2025a). The new base model, 26.0, is model 25.0a2 transitioned to GMACS version 2.20.34a. In model 25.0a2, both of the parameters for the recruitment size distribution were estimated in phase 3 of the model; however, in the newer GMACS version, model convergence issues arose that were solved by moving estimation of the alpha parameter of the recruitment size distribution to phase 5. One change not related to the transition was also implemented for model 26.0: the upper bound for the β parameter of growth was reduced from 20 to 1 in order to avoid allowing negative growth at the bound. The estimated value of the β parameter in the base model is 0.29. These minor changes were not expected to influence model results, which are compared in the bridging analysis presented below.

In response to suggestions from the SCC and CPT, we developed (Appendix D) and present models including a model-based index of abundance based on the ADF&G and NOAA NBS trawl survey time series, exploring different catchability and selectivity configurations for the models incorporating the model-based index. In the base model, catchability is fixed at 1 for the ADF&G survey and estimated for the other two surveys, while selectivity is estimated for the historical Norton Sound survey and mirrored to those estimates for the ADF&G and NOAA NBS trawl surveys. The four models that include the model-based index of abundance are configured as follows. Model 26.1 has catchability fixed at 1 for the model-based index and estimated for the historical survey, while the selectivity configuration is as in the base model. Model 26.2 estimates catchability for both the model-based index and the historical survey, while selectivity is again configured as in the base model. Model 26.3 estimates catchability for both the model-based index and the historical survey, and estimates selectivity for all three surveys. Model 26.4 estimates catchability for both the model-based index and the historical survey, and fixes selectivity for all three surveys and all size bins at 1 or close to 1, matching the estimated selectivities. A fifth model, 26.5, is included in order to separate the effects of estimating catchability and selectivity from the effects of adding the model-based index, and is model 26.0 with both catchability and selectivity estimated for all surveys. Since model 26.5 yielded results nearly identical to those of model 26.0, it is not included in most sections of the Results, with the exception of the "Retrospective analyses" section.

B. Responses to SSC and CPT comments

SSC comments on specific to NSRKC assessment, December 2025

The SSC prioritizes further exploration of model-based index of abundance for this stock, given the concern about the apparent lack of overlap between the survey stock distributions. However, the SSC supports further work to update the standardization of the fishery CPUE index planned by the author as a lower priority as well. Authors should prioritize aligning the footprint of the NBS bottom trawl survey abundance index and the length compositions.

The authors present four models exploring the incorporation of a model-based index of abundance in this document, as well as a detailed description of model-based index development (Appendix D). The prediction area for the model-based index is the NBS bottom trawl survey stratum for Norton Sound red king crab and thus the spatial domain of this index aligns with the area over which NBS survey length composition data are collected. The authors do not present an update of the fishery CPUE index standardization in this document, but have begun work on this task and plan to present results in the near future.

The SSC recommends refining projections for this and other Tier 4 stocks so that FMSY reference points more closely align with achieving the resultant BMSY reference point.

Projections presented in the 2026 SAFE report will follow this recommendation. No projections plots appear in this proposed models document.

CPT comments on specific to NSRKC assessment, November 2025

Provide more detail on the CPUE standardization analysis in future assessments and update the full time series with each assessment cycle

The full CPUE time series will be updated for the 2026 SAFE report, and more detail on CPUE standardization will be provided in that document. No input data were updated for this proposed models document, with the exception of the new model-based index of abundance.

Jittering plots should display a larger proportion of the jitter runs, especially if many of the runs converge to likelihood values not near the MLE. Further guidance on this will be discussed at the Jan modeling workshop.

Jittering plots displayed in the 2026 SAFE report will follow this guidance.

Remove the projections plots awaiting guidance to be developed during the January 2026 modeling workshop on the appropriate way to use the GMACS projection module for tier 4 stocks.

No projections plots appear in this document.

SSC comments on assessments in general, October 2025

The SSC recommends continued progress towards making SAFE documents as consistent in structure and content as practicable. The SSC recognizes that assessments vary among stocks, however documents that are as similar as possible will facilitate review and ensure accessibility to a wide audience.

We have attempted to make this document consistent with other BSAI crab SAFE documents.

The SSC notes that crab stock assessment authors currently use the OFL for catch projections. The SSC recommends that the authors and CPT provide a justification if catches are set to the OFL in projections, or use a more realistic estimate of future catches as is done in groundfish assessments.

This item is a topic of CPT discussion, as setting the catch equal to the OFL in projections is currently standard for projections in GMACS.

CPT comments on assessments in general, September 2025

The CPT proposed that using "minimal to moderate concern", "substantial concern", and "extreme concern" to correspond with levels 1, 2, and 3 in the risk table would more effectively describe concern levels and allow them to be tracked year to year.

We have used the CPT's proposed descriptions of the concern levels in the NSRKC risk table presented here (Appendix B).

SSC comments specific to NSRKC assessment, June 2025

One of the more long-standing recommendations echoed by both the SSC and CPT for this stock is the development of model-based indices of abundance. The SSC... concurs with the CPT suggestion that this be explored further in a research model framework. Given that selectivities are assumed to be the same across all three surveys in this assessment, the SSC suggests a single model-based index that includes all three surveys and a broad prediction grid reflecting the distribution of the stock could be a viable option for the future.

We present the development of a model-based index of abundance for NSRKC in Appendix D. The three surveys could not all be included in a single model-based index due to complete lack of temporal overlap between the historical survey and the two ongoing surveys, which led to failures in spatiotemporal model convergence. However, data from the two ongoing surveys were used to produce a single model-based index of abundance. In accordance with the SSC's recommendation, we used a prediction grid that seems to reflect the distribution of the stock: the NOAA NBS trawl survey stratum for NSRKC. We present models incorporating the model-based index in this proposed models document.

SSC comments on assessments in general, June 2025

The SSC notes that a historical retrospective is different from a within model retrospective and requests that crab assessments include a plot comparing the model-estimated time series of mature male biomass from the current assessment with the time series from the ten previous assessments (i.e., historical retrospective).

A historical retrospective plot (using the base model estimates) is included in this assessment (Figure 4).

The SSC recommended that the CPT provide GMACS version updates in each CPT report with information on changes between versions and that authors clearly identify which GMACS versions were used and a brief summary of the effects on the assessment.

The GMACS version used in this assessment is 2.20.34a and a bridging analysis demonstrating the effects on model outputs of the transition from GMACS version 2.20.20 is presented in this document.

The SSC recommends that each crab SAFE chapter include a clear description of the buffers used in harvest specification over the most recent five years, as a basis for comparing the current year's buffer recommendations.

The buffers and buffer justifications used in harvest specifications for NSRKC over the most recent five years are presented in Appendix A.

The SSC recommends that both new and ongoing concerns regarding the stock should be recorded in the risk table, not just new concerns... The CPT intends to include the uncertainty due to the tier level in the risk table, since this uncertainty plays a role in the buffer consideration. The SSC suggests that if the CPT follows this course, that the tier level concern be listed separately in the risk table.

We have followed these recommendations in the risk table for this stock, presented in Appendix B.

CPT comments specific to NSRKC assessment, May 2025

The CPT highlighted the need for continued work on model-based abundance estimates for NSRKC, as survey area consistency has been a reoccurring issue in the assessment... The CPT encouraged the continued development of assessments based on model-based survey indices as a research topic separate from models for management consideration. Specifically, CPT encouraged explorations of the sensitivities of selectivity for joint model-based indices spanning multiple trawl survey time series. In discussion of the appropriate prediction model, the CPT noted that this decision depends on assumptions related to catchability (Q) for different surveys with areas inside and outside of the different prediction areas. The CPT also discussed the possibility of matching the prediction area to the area that matches the fishery, and this comparison might be informed by evaluating the proportion of the fishery that has occurred outside the prediction area. This analysis might be useful for identifying areas that have only rarely been fished that might not be important for prediction area considerations. Further updates on NSRKC model based indices will be reviewed as research models to ensure that inclusion of the model based indices coincides with how they are used in the assessment model.

We present the development of a model-based index of abundance for NSRKC in Appendix D and present models incorporating the model-based index in this proposed models document. We explored different configurations for catchability and selectivity in the models presented here, and hope that these address the CPT's concerns. Following the SSC's recommendation, we used a prediction grid that seems to reflect the distribution of the stock: the NOAA NBS trawl survey stratum for NSRKC.

CPT comments on assessments in general, May 2025

Given that baseline buffers or buffer ranges are not specified by tier level for crab stocks, buffers should consider uncertainty associated with tier level if warranted... The risk table should also be used to evaluate additional uncertainty, on a stock-by-stock basis, that is not already incorporated in the assessment model, tier level, or harvest control rules.

We have followed these guidelines in completing the risk table for NSRKC (Appendix B).

At their discretion, assessment authors should coordinate with ESP authors (and ESR authors when an ESP is not available) to discuss ecosystem considerations prior to completion of a risk table.

An Ecosystem and Socioeconomic Profile (ESP) has not yet been created for NSRKC. We coordinated with Ecosystem Status Report (ESR) author Dr. Ebett Siddon, who provided useful information on ecosystem considerations; this information was used in completion of the risk table.

Risk tables should be conducted for all annual crab stock assessments (Snow crab, Tanner crab, BBRKC, NSRKC, and AIGKC). A full risk table will be contained as an appendix in each individual SAFE chapter with rationale given for risk table scoring.

We provide a full risk table and rationale for scoring in Appendix B.

C. Introduction

For the most recent version of this section, please see the 2025 NSRKC SAFE report (Stern and Palof 2025a).

D. Data

1. Summary of new information

No new data were included in this assessment, with the exception of the model-based index of abundance (see Appendix D) that is included in models 26.1 - 26.4.

2. Data which should be presented as time series

The data sources used in this assessment are summarized in Figure 1 and include retained catch, discards, total catch, size compositions, and CPUE from the summer commercial fishery; retained catch, total catch, and size compositions from the winter commercial fishery; retained catch from the winter subsistence fishery; growth information from a tagging study; size compositions from the winter pot survey; and abundance and size compositions from the National Oceanic and Atmospheric Administration (NOAA) Norton Sound (NS) trawl survey (1976-1991), the NOAA Northern Bering Sea (NBS) trawl survey (2010-present), and the Alaska Department of Fish and Game (ADF&G) trawl survey (1996-present). Data included in the assessment model are displayed in Appendix C.

a. Total catch

Catch data used for the assessment model are shown in Appendix C. These include summer commercial fishery retained catch, winter commercial fishery retained catch, and winter subsistence fishery retained catch. Winter subsistence fishery total catch is included but is not currently fitted by the model; the emphasis is set to 0 for this data set due to large changes in model output observed when emphasis was set to 1. Summer subsistence total and retained catch are not included in the model; the authors plan to explore including these time series in future assessment cycles.

b. Information on bycatch and discards

Bycatch information is not currently included in the model. The only bycatch mortality in the federal groundfish fisheries that the authors were able to find occurred in the fixed gear fisheries and totaled 13 kg in 2018, 24 kg in 2019, and 4 kg in 2020. Bycatch mortality for all other years was zero. Previous investigations showed that this bycatch occurred west of 168° longitude, raising questions about whether the documented bycatch should be included in the model. The NSRKC fisheries are not systematically observed and discard information is available only for the summer commercial fishery and only in a subset of years (1987-1990, 1992, 1994, 2012-2019). Size composition data from the discarded catch are included for that subset of years.

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

Catch-at-length time series used in the assessment model are shown in Appendix C and include catch-at-length data from the summer commercial fishery retained, discarded, and total catch as well as the winter commercial fishery retained catch. Length measurements are not collected for the subsistence harvest.

d. Survey biomass estimates

Survey abundance estimates used for the assessment model are shown in Appendix C and include estimates from the NOAA Norton Sound, ADF&G, and NOAA NBS trawl surveys. The spatial area over which abundance is estimated is inconsistent among the three surveys. The base model currently uses design-based estimates of abundance from the ADF&G survey and NOAA NBS survey that are calculated using a smaller spatial area (maximum 5,641 nm^2 or 19,348 km^2) than are those for the NOAA Norton Sound survey (7,600 nm^2 or 26,067 km^2) (Hamazaki 2024). The abundance estimate from the ADF&G trawl survey is unexpanded, meaning it is likely an underestimate of stock abundance (Hamazaki 2024). To address these concerns, we developed a spatiotemporal model-based index of abundance based on the ADF&G and NOAA NBS survey time series (Appendix D); this index is included in place of the design-based ADF&G and NOAA NBS trawl survey indices in models 26.1 - 26.4.

e. Survey catch-at-length

Survey size composition data used for the assessment model are shown in Appendix C and include catch-at-length data from the NOAA Norton Sound survey, the ADF&G trawl survey, the NOAA NBS trawl survey, and the winter pot survey. When replicating past years' data processing methods for the 2025 assessment, the authors observed that the spatial restrictions applied to the NOAA NBS trawl survey data set when calculating abundance estimates were not applied to the size composition data, meaning that the population of crab from which size composition data are drawn is different from the population of crab used to estimate abundance. The authors intend to explore reconciling the size composition and abundance NOAA NBS survey data sets used in the assessment model for the base model; for the models including the model-based index of abundance, this issue does not apply, because the spatial area used for estimating abundance in the model-based index matches the NOAA NBS trawl survey stratum for NSRKC.

f. Catch-per-unit-effort time series

Standardized summer commercial fishery CPUE is included in the NSRKC assessment model as three separate indices of abundances, reflecting three time periods among which the fishery differed in important aspects: the large scale commercial fishery (1977-1992; industry-preferred male size > 4.75 inches CL); the small vessel commercial fishery with industry-preferred male size > 4.75 inches CL (1993-2007), and the small vessel commercial fishery with industry-preferred male size > 5 inches CL (2008-2025). The methods for CPUE standardization were developed by Bishop and colleagues (2013) and are summarized in Appendix B of Hamazaki (2024). Standardized CPUE is not calculated for 1991, 2020, or 2021; a commercial fishery was closed in 1991 and very few crab were harvested during the 2020 and 2021 commercial fisheries. The authors plan to review and update the CPUE standardization methods in a future assessment cycle.

g. Other time series data

Norton Sound red king crab tagging was initially conducted as a part of mark-recapture abundance survey in 1980-1982 and 1985 (Brannian 1987). From 1986 to 2012, crabs were tagged during the winter pot survey. The winter pot surveys tagged mostly sublegal crab and very few were recovered. Tagging resumed from 2012-2015 for a spring migration movement survey. In all of these studies, most of the tagged crab were recovered by commercial fishermen, although subsistence fishermen also recovered some tags.

3. Data which may be aggregated over time - 4. Data sources that were available but were excluded from the assessment

For the most recent version of this sections, please see the 2025 NSRKC SAFE report (Stern and Palof 2025a).

E. Analytic approach

1. History of modeling approaches for this stock

The GMACS version of the NSRKC stock assessment model, model 24.0, was recommended by the CPT and the SSC in November and December 2024, respectively, for 2025 harvest specifications. The history of model development prior to the transition to GMACS is detailed in Hamazaki (2024).

Following the transition to GMACS, changes made in 2025 included correcting errors in the input data file and transitioning the model to a GMACS version (2.20.20) with the ability to correctly calculate the OFL for stocks with multiple fisheries occurring in different seasons. A bridging analysis documenting the effects of these changes was presented in Stern and Palof (2025b). The model accepted in 2025 for 2026 harvest specifications incorporated additional changes including the removal of shell condition, such that "newshell" and "oldshell" males were aggregated, leading to improved size composition fits; changing the fixed value of M for males $\leq$ 123 mm CL from the value of 0.18 used in the base model to 0.23, the M value estimated in the most recent Bristol Bay red king crab (BBRKC) stock assessment; and shifting the functional form of selectivity for the winter commercial fishery from using the same, dome-shaped functional form used for the winter pot survey, to using the same, asymptotic functional form used for the summer commercial fishery (Stern and Palof 2025a).

2. Model description

a. Description of overall modeling approach

The model is a male-only size-structured model based on abundance that combines data from surveys, fishery catches and discards, and mark-recovery studies using a maximum likelihood modeling framework to estimate population dynamics under fisheries. The model estimates abundances of male crab with CL $\geq$ 64 mm in 10 mm length intervals (8 length classes). Few crab measuring $<$ 64 mm CL were caught during surveys or fisheries. Natural mortality is set to a fixed value of 0.23 for males with CL $\leq$ 123 mm and estimated for males with CL $>$ 123 mm. The timeline of events in the model is as follows:

- Model starts on February 1
- The initial population date is February 1, 1976
- Instantaneous fishing mortality occurs on February 1 for winter fisheries
- Instantaneous fishing mortality occurs on July 1 for summer fisheries
- Instantaneous molting and recruitment occur on July 1

b. Reference software used

The Generalized size-structured Model for Assessing Crustacean Stocks (GMACS) version 2.20.34a, compiled with AD Model Builder 13.2 http://www.admb-project.org/. GMACS source code and information is available at https://github.com/GMACS-project.

c. Description of all likelihood components

Likelihood components are shown in Tables 7 - 8.

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 1976, when the first Norton Sound trawl survey was conducted. The model covers 8 length classes, beginning at CL of 64 mm, with a length class increment of 10 mm.

e. Parameter estimation framework

A maximum likelihood approach was used to estimate parameters. Parameters estimated outside of the model include M for males with CL $\leq$ 123 mm, and the discard mortality rate (set at 0.2). Priors, bounds, and constraints on parameters are detailed in the model control files, shown in Appendix C. Recruitment during the projected year is the average of the past 5 years to reflect the most recent recruitment conditions.

f. Definition of model outputs

Mature male biomass is defined as the biomass of males with CL $\geq$ 94 mm. Male recruit biomass is defined as the biomass of males with CL of 64-93 mm.

g. Critical assumptions and consequences of assumption failures

- Instantaneous annual natural mortality (M) is fixed for males with CL $\leq$ 123 mm and increases for males with CL $>$ 123 mm. M is constant over time. Estimating a higher M for larger males is an approach employed to rectify the model's historical overestimation of large male abundance. Models using size-independent M were presented at the May 2025 CPT meeting but not recommended by the CPT or SSC. The authors plan to continue exploring model runs with size-independent M in future iterations of this assessment.

- Modeled male size at maturity is 94 mm CL. According to a past assessment, this size at maturity was inferred from BBRKC data, incorporating the smaller size of NSRKC (Hamazaki 2024). The authors have not yet located more detailed documentation of the methods used to arrive at this estimate for size at maturity. Studies of NSRKC size at functional maturity in the lab are ongoing, and observations of mating pairs in the wild are needed.

- Molting occurs after the summer fishery. Recruitment occurs at the same time.

- Molting probability is a descending logistic function of crab size.

- Growth increment is a function of length and is constant over time. Molted crab do not shrink.

- ADF&G trawl survey abundance has the same scale as the population, i.e., catchability (q) is equal to 1. Note that different catchability configurations are explored in the alternative models presented in this document.

- Survey selectivity is an asymptotic, one-parameter logistic function equal to 1.0 at the length class 134 mm CL and is the same across years and surveys. Note that different survey selectivity configurations are explored in the alternative models presented in this document.

- Winter pot survey selectivity is a dome-shaped function combining a reverse logistic function starting from length class 84 mm CL and a model estimate for length classes with CL $<$ 84 mm. This assumption is likely based upon the observed percentages of crab by size class that were caught in the winter pot survey (Table 10). The selectivity is constant over time.

- Fisheries occur twice annually, on February 1 and on the midpoint of the summer commercial fishery period, and are instantaneous.

- Selectivity is the same for the summer commercial, winter commercial, and subsistence fisheries and is an asymptotic, one-parameter logistic function of length, with selectivity for length class 134 mm CL set to 1.0. Selectivity is constant over time.

- Retention probability is a logistic function with an asymptote < 1.0; not all legal-sized crab are retained.

- The winter subsistence fishery retains crab > 94 mm CL. By regulation, the subsistence fishery has no size limit for retention. The size of crab caught in the subsistence fishery is not recorded.

- The discard handling mortality rate for all fisheries is 20%, consistent with other BSAI crab stocks.

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

- Catchability. In the base model, catchability is fixed at 1 for the ADF&G survey index and estimated for the NOAA NBS and historical Norton Sound survey indices. After adding the model-based index in place of the ADF&G and NOAA NBS surveys, we retained estimation of catchability for the historical Norton Sound survey index while either fixing catchability for the model-based index at 1 (model 26.1) or allowing the model to estimate catchability for the model-based index (models 26.2 - 26.4). For comparison, we also ran a model without the model-based index but with catchability estimated for all three survey indices (model 26.5).
- Survey selectivity. In the base model, selectivity parameters for the historical Norton Sound survey are estimated while selectivity parameters for the ADF&G and NBS surveys are mirrored to those estimates. After adding the model-based index in place of the ADF&G and NOAA NBS surveys, we either kept the base model selectivity configuration (models 26.1 and 26.2), allowed estimation of selectivity for all three surveys (model 26.3), or fixed selectivity at 1 or very close to 1 for all surveys and size classes (model 26.4). For comparison, we also ran a model without the model-based index but with selectivity estimated for all three surveys (model 26.5).

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

The model configurations evaluated in this report are the following:

Model 25.0a2: The model recommended for harvest specifications by the CPT and SSC in November and December 2025, respectively. This model uses GMACS version 2.20.20 and was presented in the 2025 SAFE report (Stern and Palof 2025a).

Model 26.0: Model 25.0a2 transitioned to a newer GMACS version, 2.20.34a. The estimation phase for the alpha parameter of the recruitment size distribution was changed from phase 3 in model 25.0a2 to phase

5 in model 26.0 to aid in model convergence. Additionally, the upper bound on the β parameter for growth was lowered in order to avoid estimation of negative growth, with the aim of reducing the likelihood of failed model runs. These small changes were not expected to alter model results.

Model 26.1: Model 26.0 with the model-based index of abundance added in place of the design-based indices of abundance from the ADF&G and NOAA NBS trawl surveys. Development of the model-based index of abundance is described in Appendix D. Catchability for the model-based index was fixed at 1 while, as in the base model, catchability for the historical Norton Sound survey index was estimated.

Model 26.2: Model 26.1 with catchability for the model-based index estimated.

Model 26.3: Model 26.2 with selectivities for all three surveys estimated.

Model 26.4: Model 26.2 with selectivities for all three surveys fixed at 1 or very close to 1 for all size classes.

Model 26.5: Model 26.0 with catchabilities and selectivities estimated for all three surveys.

b. Progression of results

The impacts of the transition to GMACS version 2.20.34a can be observed by comparing models 25.0a2 and 26.0. Fits to all catches (winter commercial retained, summer commercial retained, and subsistence retained) were nearly identical (Table 7). Fits to indices of abundance and size compositions were also very similar (Table 7). The estimated recruitment and mature male biomass trajectories for the two models are visually indistinguishable (Figures 8 - 9), as are estimated fishery selectivity, natural mortality, and fishing mortality (Figures 10 - 12). Shifting the estimation phase for the alpha parameter of the recruitment size distribution from phase 3 in model 25.0a2 to phase 5 in model 26.0 did not change the estimated value of this parameter (Tables 11 and 12). Changing the upper bound for the β parameter of growth from 20 to 1 in order to avoid allowing negative growth at the bound did not change the estimated value of this parameter (Tables 11 and 12). Overall, the transition to GMACS version 2.20.34a did not have unexpected or concerning effects on the base model fits or estimates, and model 26.0 is considered the new base model. For results from all the proposed models, 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

Models 26.1 - 26.4 represent simplifications of the base model in that they include a single, model-based index of abundance in place of two design-based indices of abundance. Estimation of catchability for the model-based index of abundance (models 26.2 - 26.4) adds a parameter compared to assuming a catchability of 1 for the model-based index (model 26.1), but leads to improved fits to both the model-based and historical survey design-based indices of abundance, as well as improved retrospective patterns. Estimation of selectivity for all three surveys (model 26.3) adds parameters to the model but does not improve model fit and only marginally improves the retrospective pattern. Fixing selectivity for all three surveys (model 26.4) reduces the number of parameters and leads to an only slightly worse retrospective pattern than observed for model 26.2. The authors thus recommend models 26.2 and 26.4 as those that best balance realism and simplicity.

e. Convergence status/criteria

We used the default ADMB convergence criteria (available at http://www.admb-project.org/).

f. Sample sizes for length composition data

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

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

Residual plots are presented below.

j. Model evaluation

Model evaluation is provided under Results below.

k. Jittering

Jittering analysis will be performed for the models selected to appear in the fall 2026 SAFE report. As in the previous version of this assessment, we will perform 200 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.

4. Results

Model convergence

We evaluated model convergence by checking that the model Hessian was invertible and that the maximum gradient at the candidate MLE was close to zero. Maximum gradients at the MLE were small for all models. Jittering analyses will be presented for all models selected to appear in the 2026 SAFE report.

Fits to fishery catch data

Fits to fishery catch data are nearly identical among the models (Figures 13 - 14 and Tables 7 - 8), demonstrating that adding the model-based index and changing the configuration of catchability and survey selectivity have little effect on fits to catch data. Note that subsistence total catch was not fitted in any of these models (emphasis set to 0), due to the previously-reported finding that including these data leads to differences in model fit and references points. Approaches to including subsistence total catch data will be explored further in future iterations of this assessment.

Fits to abundance indices

Fits to the historical Norton Sound survey index were slightly worse for the models including the model-based index (26.1 - 26.4) than for the base model (26.0), and better for the models that estimated catchability for the model-based index (26.2 - 26.4) than for the one that fixed model-based index catchability at 1 (26.1) (Figures 15 - 16 and Tables 7 - 8). Fits to the fishery CPUE indices were worse for the the models including the model-based index than for the base model, particularly for the CPUE indices from 1993-2006 and 2007-2025 (Figures 17 - 22 and Tables 7 - 8).

Since the models including the model-based index did not include the ADF&G and NBS survey indices, fits to those indices are only shown for the models in the bridging analysis (models 25.0a2 and 26.0; Figures 23 - 24), and were very similar between those models.

Among models including the model-based index, fits to the model-based index were nearly identical for the models that estimated catchability for the model-based index (26.2 - 26.4), and better than the fit for the model that fixed model-based index catchability at 1 (26.1) (Figure 25 and Table 8). Estimated catchability values are shown in Table 9.

Fits to size compositions

Fits to size composition time series were generally similar among the models (Figures 26 - 41 and Tables 7 - 8), as were One-Step-Ahead residuals patterns (Figures 42 - 81). The models including the model-based index had slightly better fits to the winter commercial fishery retained catch and winter pot survey catch size composition data than the base model. The models including the model-based index and estimating catchability for the model-based index had slightly better fits to the summer commercial fishery total catch size compositions than the base model, though the model that included the model-based index without estimating its catchability did not. The models including the model-based index had slightly worse fits to the other size composition data. Overall, differences in fits to size composition data among the models were small.

Estimated population quantities

Recruitment

Recruitment estimates are higher across the time series for the base model (26.0) than for the models including the model-based index of abundance (Figure 82). Among the models including the model-based index, the models that estimate catchability for the model-based index (26.2 - 26.4) estimate higher recruitment than the model that fixes catchability for the model-based index (26.1). Recruitment estimates for each model are displayed in Tables 17 - 21.

Mature male biomass

Mature male biomass (MMB) estimates are higher across the time series for the base model (26.0) than for the models including the model-based index of abundance (Figure 83). Among the models including the model-based index, the models that estimate catchability for the model-based index (26.2 - 26.4) estimate higher (and nearly identical) MMB than the model that fixes catchability for the model-based index (26.1). MMB estimates for each model are displayed in Tables 17 - 21.

Estimated fishery selectivity

Estimated selectivities for the subsistence, summer commercial, and winter commercial fisheries are nearly identical among the models (Figure 84).

Estimated survey selectivity

In the base model, survey selectivity is estimated for the NOAA Norton Sound trawl survey while selectivity for the ADF&G and NOAA NBS trawl surveys is mirrored to that of the NOAA Norton Sound trawl survey, meaning that the estimated values are assigned to the surveys without estimated selectivity. Models 26.1 and 26.2 retain the survey selectivity configuration used in the base model, while model 26.3 estimates selectivity for all three surveys, and model 26.4 fixes selectivity for all three surveys. In all the models in which survey selectivity was estimated, selectivity was estimated to be close to or equal to 1 for all surveys and size bins (Figure 85 and Table 22). Estimated selectivities for the winter pot survey are similar among the models (Figure 84 and Table 22).

Estimated fishing mortality

For all three of the subsistence, winter commercial, and summer commercial fisheries, estimated fishing mortaltiy is lowest across the time series for the base model (26.0), highest for the model that includes the model-based index but does not estimate its catchability (model 26.1), and intermediate for the models that include the model-based index and estimate its catchability (models 26.2 - 26.4) (Figure 86).

Estimated natural mortality

Estimated natural mortality for males with CL $>$ 123 mm is higest for the base model (26.0), lowest for the model that includes the model-based index but does not estimate its catchability (model 26.1), and intermediate for the models that include the model-based index and estimate its catchability (Figure 87).

Retrospective analyses

Retrospective analyses for models were performed by sequentially removing each of the most recent 10 years of data, fitting the model, and recording the estimated MMB. Comparing the estimated MMB time series as each year of data is removed permits identification of retrospective patterns, in which estimates show consistent deviations with each "peel" (removal of a year of data). The Mohn's ρ value for the base model (26.0) was 0.136, indicating that MMB estimates generally increased as each year of data was removed (Figure 88). Adding the model-based index, with catchability for the model-based index fixed at 1 (model 26.1), led to a slightly reduced Mohn's ρ of 0.130 (Figure 89). Estimating catchability for the model-based index (model 26.2) reduced Mohn's ρ substantially to 0.017 (Figure 90). Estimating selectivity for all three surveys while still estimating catchability for the model-based index (model 26.3) reduced the magnitude Mohn's ρ slightly to -0.014 and produced a negative value, indicating that MMB estimates slightly decreased as each year of data was removed (Figure 91). Fixing selectivity for all three surveys while still estimating catchability for the model-based index (model 26.4) led to Mohn's ρ of 0.021, slightly higher than those for models 26.2 and 26.3 (Figure 92). When the base model is configured such that catchability and selectivity are estimated for all surveys (model 26.5), Mohn's ρ decreases slightly to 0.133 (Figure 93). Overall, the models including the model-based index, estimating catchability for the model-based index, and either retaining the base model's survey selectivity configuration (26.2) or estimating selectivity for all three surveys (26.3) had the least extreme retrospective patterns, indicating that these models may have an improved ability to estimate stock biomass in the terminal year. Given that model 26.2 shows a substantially reduced retrospective pattern compared to the base model, but estimates fewer additional parameters than model 26.3, model 26.2 is likely preferable to model 26.3.

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 26.0

- 26.4 are summarized in Tables 12 - 16. Estimated standard deviations of mature male biomass and male recruitment for models 26.0 - 26.4 are listed in Tables 17 - 21. The probability density function of the OFL for the selected models will be shown in the fall 2026 SAFE report.

Comparison of alternative model scenarios

Variation among the design-based indices of abundance in the spatial domain and in the temporal and spatial distributions of survey sampling have been long-standing concerns for this stock (Hamazaki 2024). Historical approaches to NSRKC abundance estimation have focused on calculating abundance over the area targeted for commercial harvest, but survey observations indicate that the stock range is likely larger and may be more accurately captured by the NOAA NBS survey stratum (Hamazaki 2024; Appendix D). Survey sampling has not been evenly distributed across the potential stock range or across time, meaning that taking into account both spatial and temporal variation is likely important to derive consistent estimates of stock abundance (Appendix D).

Here, we employed a spatiotemporal modeling approach to develop a single index of abundance based on the ADF&G and NOAA NBS trawl survey time series. While the lack of overlap in time means that the historical Norton Sound trawl survey could not be combined with the other two surveys in a single model, the ongoing ADF&G and NOAA NBS trawl surveys have both spatial and temporal overlap. Spatiotemporal models account for the spatiotemporal processes that underlie survey observations by including both spatial and spatiotemporal random effects (Thorson et al. 2021; Yalcin et al. 2023), and using these methods to produce annual estimates of abundance provides the opportunity to improve the consistency of the abundance time series. Another expected benefit of using a spatiotemporal model-based index of abundance is reduced interannual variability in abundance estimates. Design-based indices of abundance can inflate temporal variability by failing to account for spatial dependence (Shelton et al. 2014; Thorson et al. 2015), potentially leading to increased uncertainty in stock assessment model outputs (Cao et al. 2017). In other stocks, substitution of model-based for design-based indices has led to improved retrospective patterns, reflecting the importance of accounting for spatial variation in survey catch (Cao et al. 2017, Chen et al. 2024).

We found that using a spatiotemporal model-based index of abundance in place of two design-based indices of abundances led to less extreme retrospective patterns for the NSRKC stock assessment model, particularly when catchability for the model-based index was estimated in the model. A notable difference between the new base model and the models using the model-based index of abundance was the poorer fits to the commercial fishery CPUE indices of abundance in models 26.1 - 26.4. These poorer fits to fishery CPUE data are not surprising because the design-based indices of abundance were calculated over a spatial domain that more closely matches that of the commercial fishery harvest than the spatial domain used to estimate the model-based index.

The authors recommend bringing forward both model 26.2, which includes and estimates catchability for the model-based index; model 26.4, which is model 26.2 with selectivity fixed for all three trawl surveys; and model 26.0, the new base model, for 2026 harvest specifications. Models 26.2 and 26.4 both show substantially improved retrospective patterns compared to the base model, with model 26.2 having a slightly less extreme pattern than model 26.4. Both models 26.2 and 26.4 have fewer parameters than model 26.3, which estimates selectivity for all three surveys but shows only a small improvement in the retrospective pattern. Model 26.4, in which selectivity for all three trawl surveys is fixed, has fewer parameters but a slightly worse retrospective pattern than observed for model 26.2. The authors thus recommend models 26.2 and 26.4 as those that best balance realism, simplicity, and the ability to estimate stock biomass in the terminal year.

Stock projections

Projections for this stock will be shown in the fall 2026 SAFE report.

F. Calculation of the OFL

For the most recent version of this section's text, please see the 2025 NSRKC SAFE report (Stern and Palof 2025a). The tables below are updated for this proposed models document.

Table 5: Comparisons of management measures for models 25.0a2 and 26.0. Biomass and OFL are in 1,000 tons. Model 25.0a2 is the 2025 accepted model. Model 26.0 is the new base model.

Model	MMB_{2026}	B_{MSY}	MMB/B_{MSY}	F_{OFL}	OFL_{2026}	ABC_{2026}	MSST	M
25.0a2	1.56	2.00	0.78	0.173	0.193	0.135	1.00	0.23
26.0	1.56	2.00	0.78	0.173	0.193	0.135	1.00	0.23

Table 6: Comparisons of management measures for model 26.0, 26.1, 26.2, 26.3, and 26.4. Biomass and OFL are in 1,000 tons. Model 26.0 is model 25.0a2 transitioned to GMACS version 2.20.34a and is the new base model. Note that, in the base model, catchability (q) for the ADFG trawl survey is fixed at 1 while q for the historical survey and the NBS trawl survey are estimated; selectivity for the ADFG and NBS trawl surveys is mirrored to the selectivity estimated for the historical survey. Model 26.1 is 26.0 with a model-based index (MBI) included in place of the ADFG and NBS trawl survey indices of abundance; q for the historical survey is estimated while q for the MBI is fixed at 1; selectivity is treated as in the base model. Model 26.2 is 26.1 with catchability (q) for the MBI estimated. Model 26.3 is 26.2 with selectivity estimated for all surveys. Model 26.4 is 26.1 with q for the MBI estimated and selectivity fixed at 1 for all surveys and size classes.

Model	MMB_{2026}	B_{MSY}	MMB/B_{MSY}	F_{OFL}	OFL_{2026}	ABC_{2026}	MSST	M
26.0	1.56	2.00	0.78	0.173	0.193	0.135	1.00	0.23
26.1	1.04	1.47	0.71	0.155	0.117	0.082	0.74	0.23
26.2	1.16	1.60	0.73	0.160	0.135	0.094	0.80	0.23
26.3	1.16	1.60	0.73	0.160	0.135	0.094	0.80	0.23
26.4	1.16	1.60	0.73	0.160	0.135	0.094	0.80	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 10% in 2011-2014, 20% in 2015-2019, 30% in 2020, 40% in 2021-2022, and 30% in 2023-2025 (Appendix A). The CPT and SSC recommended an ABC buffer of 30% for setting harvest specifications for 2026 for the following reasons: 1) natural mortality and size-at-maturity are borrowed from other stocks; 2) the impact of seasonal movement on survey estimates is unknown; 3) there is uncertainty in the stock vs. survey areas; 4) the shortage of discard data on which to base estimates of total catch mortality; 5) estimates of total catch mortality rely on ad hoc methods to estimate discards; 6) the proportion of large crab is overestimated; and 7) whether the high estimate for M in the largest size class is reasonable remains unresolved.

H. Rebuilding analyses

This stock is not currently subject to a rebuilding plan.

I. Data gaps and research priorities

A key research priority for some time has been incorporating a spatiotemporal model-based index of abundance into the stock assessment model in order to ensure that abundance information from the trawl surveys is combined in a spatially consistent framework; we address that priority in this document. Other priorities include updating the CPUE standardization methods and documentation, exploring model-based estimation of size compositions, and investigating ways to incorporate the winter subsistence total catch data and the summer subsistence catch data into the model. Addressing uncertainty in the biological characteristics of the stock and acquiring information on discards continue to be priorities for this assessment.

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Tables

Table 7: Comparisons of negative log-likelihood values for models 25.0a2, the 2025 accepted model, and 26.0, the same model transitioned to a newer GMACS version (2.20.34a). Note that subsistence total catch data are not fitted in these models.

Component	25.0a2	26.0
Winter comm. retained catch	-121.63	-121.63
Subsistence retained catch	-124.22	-124.22
Subsistence total catch	0.00	0.00
Summer comm. retained catch	-119.03	-119.03
NMFS trawl survey 1976-1991	-3.18	-3.18
ADF&G trawl survey	-4.56	-4.56
NOAA NBS survey	-5.63	-5.63
Fishery CPUE 1977-1992	-3.63	-3.63
Fishery CPUE 1993-2006	-6.89	-6.89
Fishery CPUE 2007-2025	-13.63	-13.63
Winter com. retained size comp.	22.69	22.69
Summer com. retained size comp.	279.51	279.51
Summer com. discard size comp.	107.72	107.72
Summer com. total size comp	78.92	78.92
NMFS trawl survey size comp.	45.17	45.17
ADF&G trawl survey size comp.	115.96	115.96
NBS trawl survey size comp.	57.48	57.48
Winter pot survey size comp.	302.63	302.63
Recruitment deviations	51.16	51.16
Tagging	1689.52	1689.52
F penalty	14.21	14.21
Prior	95.46	91.25
Total	2513.88	2509.67
Total estimated parameters	230.00	230.00

Table 8: Comparisons of negative log-likelihood values for models 26.1, 26.2, 26.3, and 26.4, all of which include a model-based index of abundance (MBI) in place of the design-based indices of abundance for the ADFG and NOAA NBS trawl surveys. Model 26.1 has catchability for the MBI fixed at 1 and selectivity for the ADFG and NBS surveys mirrored to the historical NOAA/ADFG survey selectivity. Model 26.2 has catchability for the MBI estimated and selectivity for the ADFG and NBS surveys mirrored to the historical NOAA/ADFG survey selectivity. Model 26.3 has catchability for the MBI estimated and selectivity for the ADFG and NBS surveys estimated. Model 26.4 has catchability for the MBI estimated and selectivity for all surveys fixed at 1 for all size classes. Note that subsistence total catch data are not fitted in these models.

Component	26.1	26.2	26.3	26.4
Winter comm. retained catch	-121.63	-121.63	-121.63	-121.63
Subsistence retained catch	-124.22	-124.22	-124.22	-124.22
Subsistence total catch	0.00	0.00	0.00	0.00
Summer comm. retained catch	-119.03	-119.03	-119.03	-119.03
NMFS trawl survey 1976-1991	-2.75	-3.05	-3.05	-3.05
Model-based index	-4.66	-4.86	-4.86	-4.86
Fishery CPUE 1977-1992	-3.62	-3.57	-3.57	-3.57
Fishery CPUE 1993-2006	-0.77	-0.81	-0.81	-0.81
Fishery CPUE 2007-2025	-1.98	-1.95	-1.95	-1.95
Winter com. retained size comp.	22.11	22.18	22.18	22.18
Summer com. retained size comp.	280.05	280.06	280.06	280.06
Summer com. discard size comp.	107.76	107.73	107.73	107.73
Summer com. total size comp	79.04	78.88	78.88	78.88
NMFS trawl survey size comp.	45.30	45.22	45.22	45.22
ADF&G trawl survey size comp.	116.25	116.46	116.46	116.46
NBS trawl survey size comp.	57.69	57.79	57.79	57.79
Winter pot survey size comp.	301.19	301.28	301.28	301.28
Recruitment deviations	50.82	50.75	50.75	50.75
Tagging	1689.31	1689.37	1689.37	1689.37
F penalty	14.21	14.21	14.21	14.21
Prior	89.96	90.76	96.75	87.76
Total	2530.65	2531.17	2537.16	2528.17
Total estimated parameters	229.00	230.00	232.00	229.00

Table 9: Comparisons of catchability values among the new base model (26.0), the new base model with both catchability and selectivity estimated for all surveys (26.5), and models including a model-based index of abundance (MBI) in place of the design-based indices of abundance for the ADFG and NOAA NBS trawl surveys (26.1 - 26.4). Model 26.0 has catchability for the ADFG survey fixed at 1 and selectivity for the ADFG and NBS surveys mirrored to the historical NOAA/ADFG survey selectivity. Model 26.1 has catchability for the MBI fixed at 1 and selectivity for the ADFG and NBS surveys mirrored to the historical NOAA/ADFG survey selectivity. Model 26.2 has catchability for the MBI estimated and selectivity for the ADFG and NBS surveys mirrored to the historical NOAA/ADFG survey selectivity. Model 26.3 has catchability for the MBI estimated and selectivity for the ADFG and NBS surveys estimated. Model 26.4 has catchability for the MBI estimated and selectivity for all surveys fixed at 1 for all size classes.

Index	26.0	26.5	26.1	26.2	26.3	26.4
Historical survey	0.7356	0.7356	0.9056	0.8488	0.8488	0.8488
ADFG survey	1.0000	1.0000				
NBS survey	0.7160	0.7160				
Model-based			1.0000	0.8950	0.8950	0.8950
CPUE series 1	0.0007	0.0007	0.0009	0.0008	0.0008	0.0008
CPUE series 2	0.0013	0.0013	0.0018	0.0017	0.0017	0.0017
CPUE series 3	0.0011	0.0011	0.0017	0.0015	0.0015	0.0015

Table 10: Percentage of crab in each size bin by fleet. Totals may not sum to 100 due to rounding. SC = summer commercial fishery; WC = winter commercial fishery.

Size class midpoint	ADFG survey	NBS survey	NS survey	SC retain	SC discard	SC total	WC	Winter pot survey
68	16	12	14	0	12	6	0	2
78	15	14	9	0	16	6	0	10
88	16	15	11	0	24	8	0	20
98	15	17	14	2	37	15	3	24
108	16	16	20	31	10	23	38	23
118	14	15	20	39	1	24	38	15
128	7	9	10	21	0	13	17	5
138	2	2	3	7	0	3	4	1

Table 11: Summary of Norton Sound red king crab estimated model parameter values and standard errors (SE) for model 25.0a2, the 2025 accepted model.

Parameter	Estimate	SE
Log(Rinitial)	9.26855355	0.14646166
Log(Rbar)	6.47949623	0.15141417
Recruitment_ra-males	72.81244403	2.64007784
Recruitment_rb-males	0.08474249	0.67693258
Scaled_logN_for_male_mature_mature_newshell_class_2	-0.13367453	0.43163908
Scaled_logN_for_male_mature_mature_newshell_class_3	0.41308289	0.41935334
Scaled_logN_for_male_mature_mature_newshell_class_4	0.62699798	0.40543155
Scaled_logN_for_male_mature_mature_newshell_class_5	0.61665755	0.39647028
Scaled_logN_for_male_mature_mature_newshell_class_6	0.29139716	0.40339424
Scaled_logN_for_male_mature_mature_newshell_class_7	-0.30786747	0.43893583
Scaled_logN_for_male_mature_mature_newshell_class_8	-0.51803188	0.46904828
Alpha_base_male	40.15527629	2.76866769
Beta_base_male	0.28674765	0.03145532
Gscale_base_male	4.84831758	0.27218774
Molt_probability_mu_base_male_period_1	134.69750039	9.19431503
Molt_probability_CV_base_male_period_1	0.07127594	0.01169278
Sel_Winter_Com_male_base_Dec_Logistic_mean	0.5804309	0.04533401
Sel_NMFS_Trawl_male_base_Dec_Logistic_mean	-2.10109194	0.03911556
Sel_Winter_Pot_male_base_Dec_Logistic_cv	-11.50488274	31.03737757
Sel_Winter_Pot_male_base_Dec_Logistic_cv	4.79212472	0.05249868
Sel_Winter_Pot_male_base_Dec_Logistic_extra_par1	-2.31942827	0.42725611
Sel_Winter_Pot_male_base_Dec_Logistic_extra_par2	-2.78960211	0.49811005
Sel_Winter_Pot_male_base_Dec_Logistic_extra_par3	-0.81984939	0.3049427
Ret_Winter_Com_male_base_Logistic_mean	-0.18652904	0.27696385
Ret_Winter_Com_male_Logistic_cv_block_group_2_block_1	4.6070091	0.01093615
Ret_Subsistence_male_base_class_1	4.991e-05	0.08636912
Ret_Summer_Com_male_base_Logistic_cv	4.64442976	0.00801102
Ret_Summer_Com_male_Logistic_mean_block_group_1_block_1	0.85115724	0.13519405
Ret_Summer_Com_male_Logistic_cv_block_group_1_block_1	4.66583368	0.00762597
Log_vn_aggregated_size_comp1	0.86319257	0.16821102
Log_fbar_Winter_Com	-6.54017669	0.7134328
Log_fbar_Subsistence	-6.12570014	2.23794433
Log_fbar_Summer_Com	-2.19497055	0.71482039
Survey_q_survey_1	0.73563921	0.14521501
Survey_q_survey_3	0.71601598	0.12888248
Survey_q_survey_4	0.00072926	0.00015998
Survey_q_survey_5	0.00131295	0.00020779
Survey_q_survey_6	0.00109595	0.00014414
Log_add_cvt_survey_4	-1.18415268	0.15617109

Table 12: Summary of Norton Sound red king crab estimated model parameter values and standard errors (SE) for model 26.0, the new base model.

Parameter	Estimate	SE
Log(Rinitial)	9.26855354	0.14646166
Log(Rbar)	6.47949623	0.15141417
Recruitment_ra-males	72.8124445	2.64008713
Recruitment_rb-males	0.08474236	0.67693423
Scaled_logN_for_male_mature_mature_newshell_class_2	-0.13367453	0.43163909
Scaled_logN_for_male_mature_mature_newshell_class_3	0.41308289	0.41935335
Scaled_logN_for_male_mature_mature_newshell_class_4	0.62699798	0.40543155
Scaled_logN_for_male_mature_mature_newshell_class_5	0.61665756	0.39647028
Scaled_logN_for_male_mature_mature_newshell_class_6	0.29139717	0.40339424
Scaled_logN_for_male_mature_mature_newshell_class_7	-0.30786748	0.43893582
Scaled_logN_for_male_mature_mature_newshell_class_8	-0.51803189	0.46904828
Alpha_male	40.15527651	2.76866868
Beta_male	0.28674765	0.03145534
Gscale_male	4.84831759	0.2721878
Molt_probability_mu_base_male_period_1	134.69750153	9.1943199
Molt_probability_CV_base_male_period_1	0.07127594	0.01169278
Sel_Winter_Com_male_base_Dec_Logistic_mean	0.5804309	0.04533401
Sel_NMFS_Trawl_male_base_Dec_Logistic_mean	-2.10109195	0.03911556
Sel_Winter_Pot_male_base_Dec_Logistic_cv	-11.5047193	31.5089496
Sel_Winter_Pot_male_base_Dec_Logistic_cv	4.79212472	0.05249868
Sel_Winter_Pot_male_base_Dec_Logistic_extra_par1	-2.31942829	0.42725612
Sel_Winter_Pot_male_base_Dec_Logistic_extra_par2	-2.78960211	0.49811005
Sel_Winter_Pot_male_base_Dec_Logistic_extra_par3	-0.81984942	0.30494271
Ret_Winter_Com_male_base_Logistic_mean	-0.18652906	0.27696386
Ret_Winter_Com_male_Logistic_cv_block_group_2_block_1	4.6070091	0.01093616
Ret_Subsistence_male_base_class_1	4.992e-05	0.08637443
Ret_Summer_Com_male_base_Logistic_cv	4.64442976	0.00801102
Ret_Summer_Com_male_Logistic_mean_block_group_1_block_1	0.85115725	0.13519405
Ret_Summer_Com_male_Logistic_cv_block_group_1_block_1	4.66583368	0.00762597
Log_vn_aggregated_size_comp1	0.86319257	0.16821102
Log_fbar_Winter_Com	-6.54017675	0.71343281
Log_fbar_Subsistence	-6.12570029	2.2379443
Log_fbar_Summer_Com	-2.19497054	0.71482036
Survey_q_survey_1	0.73563921	0.14521501
Survey_q_survey_3	0.71601598	0.12888248
Survey_q_survey_4	0.00072926	0.00015998
Survey_q_survey_5	0.00131295	0.00020779
Survey_q_survey_6	0.00109595	0.00014414
Log_add_cvt_survey_4	-1.18415268	0.15617109

Table 13: Summary of Norton Sound red king crab estimated model parameter values and standard errors (SE) for model 26.1, the base model with a model-based index of abundance included in place of the ADFG and NOAA NBS trawl survey indices.

Parameter	Estimate	SE
Log(Rinitial)	9.10054151	0.12976987
Log(Rbar)	6.20636166	0.14798101
Recruitment_ra-males	72.82821638	2.57410688
Recruitment_rb-males	0.08581194	0.68497255
Scaled_logN_for_male_mature_mature_newshell_class_2	-0.10725903	0.433943
Scaled_logN_for_male_mature_mature_newshell_class_3	0.43295582	0.42061797
Scaled_logN_for_male_mature_mature_newshell_class_4	0.6247596	0.40687033
Scaled_logN_for_male_mature_mature_newshell_class_5	0.5940967	0.39763448
Scaled_logN_for_male_mature_mature_newshell_class_6	0.25398846	0.40343952
Scaled_logN_for_male_mature_mature_newshell_class_7	-0.35878328	0.43618571
Scaled_logN_for_male_mature_mature_newshell_class_8	-0.57351545	0.46458989
Alpha_male	40.47932062	2.81524928
Beta_male	0.29008799	0.03196887
Gscale_male	4.85226409	0.27203526
Molt_probability_mu_base_male_period_1	134.64337394	9.40570964
Molt_probability_CV_base_male_period_1	0.07089244	0.01157678
Sel_Winter_Com_male_base_Dec_Logistic_mean	0.50593254	0.0465269
Sel_NMFS_Trawl_male_base_Dec_Logistic_mean	-2.09633299	0.03878111
Sel_Winter_Pot_male_base_Dec_Logistic_cv	-11.47856146	113.14139436
Sel_Winter_Pot_male_base_Dec_Logistic_cv	4.80524915	0.04342173
Sel_Winter_Pot_male_base_Dec_Logistic_extra_par1	-2.23730742	0.41290299
Sel_Winter_Pot_male_base_Dec_Logistic_extra_par2	-2.76873597	0.48246524
Sel_Winter_Pot_male_base_Dec_Logistic_extra_par3	-0.80449505	0.27982062
Ret_Winter_Com_male_base_Logistic_mean	-0.15149416	0.24864091
Ret_Winter_Com_male_Logistic_cv_block_group_2_block_1	4.60801263	0.01089242
Ret_Subsistence_male_base_class_1	6.986e-05	0.1208525
Ret_Summer_Com_male_base_Logistic_cv	4.64481552	0.00806625
Ret_Summer_Com_male_Logistic_mean_block_group_1_block_1	0.84550689	0.13460403
Ret_Summer_Com_male_Logistic_cv_block_group_1_block_1	4.66881242	0.00774858
Log_vn_aggregated_size_comp1	0.8665663	0.1688394
Log_fbar_Winter_Com	-6.22192048	0.71304283
Log_fbar_Subsistence	-5.81863743	2.23778643
Log_fbar_Summer_Com	-1.85715184	0.71469977
Survey_q_survey_1	0.90559979	0.17224483
Survey_q_survey_3	0.00090004	0.00019722
Survey_q_survey_4	0.00182858	0.00048873
Survey_q_survey_5	0.00171943	0.00039089
Log_add_cvt_survey_3	-1.00473863	0.34976272

Table 14: Summary of Norton Sound red king crab estimated model parameter values and standard errors (SE) for model 26.2, with a model-based index of abundance included in place of the ADFG and NOAA NBS trawl survey indices and catchability estimated for the model-based index.

Parameter	Estimate	SE
Log(Rinitial)	9.14597534	0.16631734
Log(Rbar)	6.28071571	0.21788019
Recruitment_ra-males	72.82621094	2.56531076
Recruitment_rb-males	0.08446832	0.66939871
Scaled_logN_for_male_mature_mature_newshell_class_2	-0.11575464	0.43358855
Scaled_logN_for_male_mature_mature_newshell_class_3	0.42664251	0.42043363
Scaled_logN_for_male_mature_mature_newshell_class_4	0.62587633	0.40646159
Scaled_logN_for_male_mature_mature_newshell_class_5	0.60160318	0.39767634
Scaled_logN_for_male_mature_mature_newshell_class_6	0.26581356	0.40423644
Scaled_logN_for_male_mature_mature_newshell_class_7	-0.34354826	0.43810392
Scaled_logN_for_male_mature_mature_newshell_class_8	-0.55722378	0.46701823
Alpha_male	40.34758062	2.81579693
Beta_male	0.28872726	0.03196212
Gscale_male	4.84839531	0.27290647
Molt_probability_mu_base_male_period_1	134.52728783	9.26611815
Molt_probability_CV_base_male_period_1	0.07106537	0.01150785
Sel_Winter_Com_male_base_Dec_Logistic_mean	0.52520941	0.06062422
Sel_NMFS_Trawl_male_base_Dec_Logistic_mean	-2.09725435	0.03894773
Sel_Winter_Pot_male_base_Dec_Logistic_cv	-11.49364872	67.957237
Sel_Winter_Pot_male_base_Dec_Logistic_cv	4.80143214	0.04580026
Sel_Winter_Pot_male_base_Dec_Logistic_extra_par1	-2.25405246	0.41379574
Sel_Winter_Pot_male_base_Dec_Logistic_extra_par2	-2.77674465	0.4858152
Sel_Winter_Pot_male_base_Dec_Logistic_extra_par3	-0.8101789	0.28503971
Ret_Winter_Com_male_base_Logistic_mean	-0.16189045	0.2551229
Ret_Winter_Com_male_Logistic_cv_block_group_2_block_1	4.60786045	0.01088896
Ret_Subsistence_male_base_class_1	6.472e-05	0.11196873
Ret_Summer_Com_male_base_Logistic_cv	4.64459419	0.00806612
Ret_Summer_Com_male_Logistic_mean_block_group_1_block_1	0.84624701	0.13478664
Ret_Summer_Com_male_Logistic_cv_block_group_1_block_1	4.66818084	0.00785845
Log_vn_aggregated_size_comp1	0.86651894	0.16884227
Log_fbar_Winter_Com	-6.30987002	0.73725302
Log_fbar_Subsistence	-5.90326593	2.24507458
Log_fbar_Summer_Com	-1.95052437	0.74166036
Survey_q_survey_1	0.84877406	0.20220995
Survey_q_survey_2	0.89495192	0.20712569
Survey_q_survey_3	0.00084207	0.00022285
Survey_q_survey_4	0.00165991	0.00055849
Survey_q_survey_5	0.00153361	0.00050917
Log_add_cvt_survey_3	-0.99681522	0.34859679

Table 15: Summary of Norton Sound red king crab estimated model parameter values and standard errors (SE) for model 26.3, with a model-based index of abundance included in place of the ADFG and NOAA NBS trawl survey indices, catchability estimated for the model-based index, and selectivity estimated for the Norton Sound, ADFG, and NBS surveys.

Parameter	Estimate	SE
Log(Rinitial)	9.14597533	0.16631732
Log(Rbar)	6.2807157	0.21788016
Recruitment_ra-males	72.8262112	2.56531525
Recruitment_rb-males	0.08446825	0.66939984
Scaled_logN_for_male_mature_mature_newshell_class_2	-0.11575463	0.43358855
Scaled_logN_for_male_mature_mature_newshell_class_3	0.42664252	0.42043363
Scaled_logN_for_male_mature_mature_newshell_class_4	0.62587634	0.40646159
Scaled_logN_for_male_mature_mature_newshell_class_5	0.60160318	0.39767634
Scaled_logN_for_male_mature_mature_newshell_class_6	0.26581355	0.40423644
Scaled_logN_for_male_mature_mature_newshell_class_7	-0.34354827	0.43810392
Scaled_logN_for_male_mature_mature_newshell_class_8	-0.55722379	0.46701823
Alpha_male	40.3475803	2.81579748
Beta_male	0.28872726	0.03196213
Gscale_male	4.8483953	0.27290651
Molt_probability_mu_base_male_period_1	134.52728714	9.2661199
Molt_probability_CV_base_male_period_1	0.07106537	0.01150785
Sel_Winter_Com_male_base_Dec_Logistic_mean	0.52520941	0.06062422
Sel_NMFS_Trawl_male_base_Dec_Logistic_mean	-2.09725434	0.03894773
Sel_ADFG_Trawl_male_base_Dec_Logistic_mean	-11.45045528	233.212596
Sel_NBS_Trawl_male_base_Dec_Logistic_mean	-11.46694123	171.00979766
Sel_Winter_Pot_male_base_Dec_Logistic_cv	-11.48312626	114.01393295
Sel_Winter_Pot_male_base_Dec_Logistic_cv	4.80143214	0.04580026
Sel_Winter_Pot_male_base_Dec_Logistic_extra_par1	-2.25405247	0.41379573
Sel_Winter_Pot_male_base_Dec_Logistic_extra_par2	-2.77674465	0.48581519
Sel_Winter_Pot_male_base_Dec_Logistic_extra_par3	-0.8101789	0.28503971
Ret_Winter_Com_male_base_Logistic_mean	-0.16189048	0.25512289
Ret_Winter_Com_male_Logistic_cv_block_group_2_block_1	4.60786045	0.01088911
Ret_Subsistence_male_base_class_1	6.474e-05	0.11201208
Ret_Summer_Com_male_base_Logistic_cv	4.64459419	0.00806612
Ret_Summer_Com_male_Logistic_mean_block_group_1_block_1	0.846247	0.13478664
Ret_Summer_Com_male_Logistic_cv_block_group_1_block_1	4.66818084	0.00785845
Log_vn_aggregated_size_comp1	0.86651895	0.16884226
Log_fbar_Winter_Com	-6.30987003	0.73725305
Log_fbar_Subsistence	-5.90326578	2.2450744
Log_fbar_Summer_Com	-1.95052436	0.74166045
Survey_q_survey_1	0.84877407	0.20220995
Survey_q_survey_2	0.89495194	0.20712566
Survey_q_survey_3	0.00084207	0.00022285
Survey_q_survey_4	0.00165991	0.00055849
Survey_q_survey_5	0.00153361	0.00050917
Log_add_cvt_survey_3	-0.99681521	0.34859679

Table 16: Summary of Norton Sound red king crab estimated model parameter values and standard errors (SE) for model 26.4, with a model-based index of abundance included in place of the ADFG and NOAA NBS trawl survey indices, catchability estimated for the model-based index, and selectivity fixed for the Norton Sound, ADFG, and NBS surveys.

Parameter	Estimate	SE
Log(Rinitial)	9.14597417	0.16631695
Log(Rbar)	6.28071431	0.21787976
Recruitment_ra-males	72.82621065	2.56531316
Recruitment_rb-males	0.08446795	0.66939597
Scaled_logN_for_male_mature_mature_newshell_class_2	-0.11575382	0.43358862
Scaled_logN_for_male_mature_mature_newshell_class_3	0.42664302	0.42043367
Scaled_logN_for_male_mature_mature_newshell_class_4	0.62587605	0.40646161
Scaled_logN_for_male_mature_mature_newshell_class_5	0.60160218	0.39767634
Scaled_logN_for_male_mature_mature_newshell_class_6	0.26581218	0.40423642
Scaled_logN_for_male_mature_mature_newshell_class_7	-0.34354967	0.43810387
Scaled_logN_for_male_mature_mature_newshell_class_8	-0.55722529	0.46701814
Alpha_male	40.34756141	2.81579666
Beta_male	0.28872705	0.03196212
Gscale_male	4.84839425	0.2729067
Molt_probability_mu_base_male_period_1	134.52723845	9.26607931
Molt_probability_CV_base_male_period_1	0.07106539	0.01150781
Sel_Winter_Com_male_base_Dec_Logistic_mean	0.52520934	0.06062422
Sel_NMFS_Trawl_male_base_Dec_Logistic_mean	-2.09725424	0.03894773
Sel_Winter_Pot_male_base_Dec_Logistic_cv	4.80143224	0.04580026
Sel_Winter_Pot_male_base_Dec_Logistic_extra_par1	-2.2540526	0.41379605
Sel_Winter_Pot_male_base_Dec_Logistic_extra_par2	-2.77674522	0.48581518
Sel_Winter_Pot_male_base_Dec_Logistic_extra_par3	-0.81017869	0.2850397
Ret_Winter_Com_male_base_Logistic_mean	-0.16189115	0.25512287
Ret_Winter_Com_male_Logistic_cv_block_group_2_block_1	4.60786046	0.01088918
Ret_Subsistence_male_base_class_1	6.476e-05	0.11203656
Ret_Summer_Com_male_base_Logistic_cv	4.6445942	0.00806612
Ret_Summer_Com_male_Logistic_mean_block_group_1_block_1	0.84624709	0.13478665
Ret_Summer_Com_male_Logistic_cv_block_group_1_block_1	4.66818087	0.00785845
Log_vn_aggregated_size_comp1	0.86651901	0.16884226
Log_fbar_Winter_Com	-6.30986776	0.73725292
Log_fbar_Subsistence	-5.90326359	2.24507471
Log_fbar_Summer_Com	-1.95052188	0.74166029
Survey_q_survey_1	0.8487781	0.20221058
Survey_q_survey_2	0.89495711	0.20712641
Survey_q_survey_3	0.00084207	0.00022285
Survey_q_survey_4	0.00165992	0.00055849
Survey_q_survey_5	0.00153361	0.00050917
Log_add_cvt_survey_3	-0.99681538	0.34859683

Table 17: Norton Sound red king crab estimated mature male biomass (MMB), male recruit biomass, and standard deviations (SD) for model 26.0, in million lb.

Year	MMB	SD MMB	Male recruits	SD male recruits
1976	18.19	3.59	0.43	0.25
1977	19.01	2.89	0.30	0.13
1978	16.81	2.31	0.28	0.11
1979	11.79	1.66	0.66	0.26
1980	6.29	1.15	1.56	0.44
1981	4.09	0.82	1.27	0.37
1982	3.14	0.78	1.24	0.42
1983	4.30	0.95	1.27	0.40
1984	5.11	1.09	0.93	0.30
1985	5.74	1.21	1.04	0.34
1986	6.02	1.27	0.70	0.23
1987	5.90	1.24	0.71	0.21
1988	5.75	1.18	0.74	0.23
1989	5.41	1.07	0.50	0.16
1990	5.02	0.96	0.61	0.18
1991	4.63	0.85	0.46	0.16
1992	4.37	0.74	0.50	0.18
1993	4.03	0.64	0.48	0.16
1994	3.47	0.54	0.55	0.16
1995	3.04	0.48	0.72	0.18
1996	2.77	0.46	1.39	0.34
1997	2.86	0.46	0.62	0.21
1998	3.60	0.53	0.29	0.11
1999	4.50	0.64	0.50	0.19
2000	4.56	0.63	1.05	0.27
2001	3.94	0.57	0.76	0.20
2002	3.74	0.54	0.52	0.18
2003	3.96	0.57	0.47	0.17
2004	3.92	0.56	0.89	0.24
2005	3.58	0.51	1.06	0.25
2006	3.35	0.47	1.30	0.32
2007	3.55	0.48	1.18	0.30
2008	4.21	0.53	1.00	0.28
2009	4.86	0.61	0.46	0.14
2010	5.29	0.64	0.60	0.15
2011	5.12	0.62	0.83	0.21
2012	4.51	0.55	1.75	0.28
2013	4.01	0.50	0.54	0.15
2014	4.34	0.51	0.24	0.08
2015	4.88	0.53	0.21	0.06
2016	4.31	0.47	0.37	0.08
2017	3.38	0.39	0.54	0.12
2018	2.51	0.32	1.97	0.35
2019	2.19	0.28	1.90	0.38
2020	3.14	0.38	1.11	0.28
2021	5.31	0.60	0.59	0.17
2022	7.01	0.75	0.21	0.08
2023	7.03	0.77	0.25	0.10
2024	5.99	0.70	0.31	0.14
2025	4.55	0.59	0.47	0.33

Table 18: Norton Sound red king crab estimated mature male biomass (MMB), male recruits, and standard deviations (SD) for model 26.1, in million lb.

Year	MMB	SD MMB	Male recruits	SD male recruits
1976	15.07	2.75	0.38	0.23
1977	16.26	2.19	0.26	0.12
1978	14.60	1.74	0.24	0.10
1979	10.24	1.24	0.57	0.23
1980	5.29	0.85	1.27	0.36
1981	3.41	0.61	1.05	0.30
1982	2.49	0.60	1.02	0.34
1983	3.46	0.74	1.03	0.32
1984	4.10	0.85	0.76	0.24
1985	4.60	0.95	0.83	0.27
1986	4.81	1.00	0.57	0.19
1987	4.70	0.99	0.58	0.17
1988	4.60	0.95	0.62	0.19
1989	4.36	0.88	0.42	0.14
1990	4.10	0.80	0.50	0.15
1991	3.83	0.74	0.34	0.12
1992	3.69	0.66	0.31	0.12
1993	3.41	0.58	0.31	0.11
1994	2.82	0.50	0.39	0.12
1995	2.31	0.43	0.55	0.14
1996	1.96	0.39	1.04	0.27
1997	1.97	0.39	0.47	0.16
1998	2.56	0.43	0.22	0.08
1999	3.28	0.51	0.35	0.13
2000	3.38	0.50	0.69	0.18
2001	2.88	0.45	0.55	0.14
2002	2.66	0.41	0.41	0.14
2003	2.73	0.41	0.33	0.12
2004	2.68	0.39	0.59	0.16
2005	2.43	0.36	0.73	0.17
2006	2.19	0.33	0.98	0.23
2007	2.23	0.34	0.84	0.21
2008	2.69	0.35	0.74	0.20
2009	3.13	0.40	0.33	0.10
2010	3.43	0.41	0.46	0.12
2011	3.32	0.40	0.66	0.17
2012	2.94	0.36	1.46	0.23
2013	2.64	0.34	0.46	0.13
2014	3.02	0.35	0.20	0.07
2015	3.58	0.38	0.17	0.05
2016	3.19	0.35	0.28	0.06
2017	2.49	0.30	0.39	0.09
2018	1.81	0.25	1.31	0.21
2019	1.56	0.23	1.29	0.26
2020	2.22	0.27	0.73	0.18
2021	3.70	0.38	0.44	0.13
2022	4.85	0.46	0.16	0.06
2023	4.75	0.47	0.20	0.08
2024	4.00	0.44	0.21	0.09
2025	3.03	0.38	0.34	0.24

Table 19: Norton Sound red king crab estimated mature male biomass (MMB), male recruits, and standard deviations (SD) for model 26.2, in million lb.

Year	MMB	SD MMB	Male recruits	SD male recruits
1976	15.87	3.44	0.39	0.24
1977	16.97	2.84	0.27	0.12
1978	15.17	2.28	0.25	0.11
1979	10.65	1.62	0.60	0.25
1980	5.55	1.11	1.35	0.41
1981	3.60	0.80	1.11	0.35
1982	2.68	0.78	1.09	0.40
1983	3.70	0.96	1.10	0.38
1984	4.39	1.13	0.81	0.28
1985	4.93	1.27	0.89	0.33
1986	5.17	1.34	0.61	0.23
1987	5.06	1.34	0.62	0.21
1988	4.95	1.30	0.67	0.24
1989	4.70	1.20	0.45	0.17
1990	4.41	1.12	0.54	0.19
1991	4.13	1.03	0.37	0.15
1992	3.96	0.93	0.33	0.14
1993	3.66	0.83	0.34	0.13
1994	3.04	0.73	0.43	0.16
1995	2.51	0.65	0.60	0.20
1996	2.15	0.61	1.14	0.37
1997	2.18	0.63	0.51	0.19
1998	2.83	0.75	0.24	0.10
1999	3.60	0.91	0.38	0.16
2000	3.69	0.90	0.74	0.23
2001	3.16	0.80	0.59	0.18
2002	2.92	0.73	0.43	0.16
2003	2.99	0.73	0.35	0.13
2004	2.93	0.70	0.64	0.20
2005	2.65	0.64	0.78	0.22
2006	2.40	0.60	1.04	0.29
2007	2.45	0.62	0.90	0.26
2008	2.94	0.70	0.78	0.23
2009	3.43	0.81	0.36	0.12
2010	3.75	0.86	0.50	0.15
2011	3.64	0.84	0.70	0.20
2012	3.22	0.75	1.56	0.34
2013	2.90	0.70	0.50	0.16
2014	3.31	0.75	0.21	0.08
2015	3.91	0.86	0.19	0.06
2016	3.51	0.82	0.31	0.09
2017	2.76	0.70	0.43	0.13
2018	2.04	0.59	1.46	0.40
2019	1.77	0.53	1.42	0.40
2020	2.49	0.66	0.79	0.25
2021	4.10	0.98	0.48	0.17
2022	5.34	1.21	0.18	0.07
2023	5.25	1.22	0.22	0.10
2024	4.44	1.09	0.23	0.11
2025	3.38	0.88	0.37	0.27

Table 20: Norton Sound red king crab estimated mature male biomass (MMB), male recruits, and standard deviations (SD) for model 26.3, in million lb.

Year	MMB	SD MMB	Male recruits	SD male recruits
1976	15.87	3.44	0.39	0.24
1977	16.97	2.84	0.27	0.12
1978	15.17	2.28	0.25	0.11
1979	10.65	1.62	0.60	0.25
1980	5.55	1.11	1.35	0.41
1981	3.60	0.80	1.11	0.35
1982	2.68	0.78	1.09	0.40
1983	3.70	0.96	1.10	0.38
1984	4.39	1.13	0.81	0.28
1985	4.93	1.27	0.89	0.33
1986	5.17	1.34	0.61	0.23
1987	5.06	1.34	0.62	0.21
1988	4.95	1.30	0.67	0.24
1989	4.70	1.20	0.45	0.17
1990	4.41	1.12	0.54	0.19
1991	4.13	1.03	0.37	0.15
1992	3.96	0.93	0.33	0.14
1993	3.66	0.83	0.34	0.13
1994	3.04	0.73	0.43	0.16
1995	2.51	0.65	0.60	0.20
1996	2.15	0.61	1.14	0.37
1997	2.18	0.63	0.51	0.19
1998	2.83	0.75	0.24	0.10
1999	3.60	0.91	0.38	0.16
2000	3.69	0.90	0.74	0.23
2001	3.16	0.80	0.59	0.18
2002	2.92	0.73	0.43	0.16
2003	2.99	0.73	0.35	0.13
2004	2.93	0.70	0.64	0.20
2005	2.65	0.64	0.78	0.22
2006	2.40	0.60	1.04	0.29
2007	2.45	0.62	0.90	0.26
2008	2.94	0.70	0.78	0.23
2009	3.43	0.81	0.36	0.12
2010	3.75	0.86	0.50	0.15
2011	3.64	0.84	0.70	0.20
2012	3.22	0.75	1.56	0.34
2013	2.90	0.70	0.50	0.16
2014	3.31	0.75	0.21	0.08
2015	3.91	0.86	0.19	0.06
2016	3.51	0.82	0.31	0.09
2017	2.76	0.70	0.43	0.13
2018	2.04	0.59	1.46	0.40
2019	1.77	0.53	1.42	0.40
2020	2.49	0.66	0.79	0.25
2021	4.10	0.98	0.48	0.17
2022	5.34	1.21	0.18	0.07
2023	5.25	1.22	0.22	0.10
2024	4.44	1.09	0.23	0.11
2025	3.38	0.88	0.37	0.27

Table 21: Norton Sound red king crab estimated mature male biomass (MMB), male recruits, and standard deviations (SD) for model 26.4, in million lb.

Year	MMB	SD MMB	Male recruits	SD male recruits
1976	15.87	3.44	0.39	0.24
1977	16.97	2.84	0.27	0.12
1978	15.17	2.28	0.25	0.11
1979	10.65	1.62	0.60	0.25
1980	5.55	1.11	1.35	0.41
1981	3.60	0.80	1.11	0.35
1982	2.68	0.78	1.09	0.40
1983	3.70	0.96	1.10	0.38
1984	4.39	1.13	0.81	0.28
1985	4.93	1.27	0.89	0.33
1986	5.17	1.34	0.61	0.23
1987	5.06	1.34	0.62	0.21
1988	4.95	1.30	0.67	0.24
1989	4.70	1.20	0.45	0.17
1990	4.41	1.12	0.54	0.19
1991	4.13	1.03	0.37	0.15
1992	3.96	0.93	0.33	0.14
1993	3.66	0.83	0.34	0.13
1994	3.04	0.73	0.43	0.16
1995	2.51	0.65	0.60	0.20
1996	2.15	0.61	1.14	0.37
1997	2.18	0.63	0.51	0.19
1998	2.83	0.75	0.24	0.10
1999	3.60	0.91	0.38	0.16
2000	3.69	0.90	0.74	0.23
2001	3.16	0.80	0.59	0.18
2002	2.92	0.73	0.43	0.16
2003	2.99	0.73	0.35	0.13
2004	2.93	0.70	0.64	0.20
2005	2.65	0.64	0.78	0.22
2006	2.40	0.60	1.04	0.29
2007	2.45	0.62	0.90	0.26
2008	2.94	0.70	0.78	0.23
2009	3.43	0.81	0.36	0.12
2010	3.75	0.86	0.50	0.15
2011	3.64	0.84	0.70	0.20
2012	3.22	0.75	1.56	0.34
2013	2.90	0.70	0.50	0.16
2014	3.31	0.75	0.21	0.08
2015	3.91	0.86	0.19	0.06
2016	3.51	0.82	0.31	0.09
2017	2.76	0.70	0.43	0.13
2018	2.04	0.59	1.46	0.40
2019	1.77	0.53	1.42	0.40
2020	2.49	0.66	0.79	0.25
2021	4.10	0.98	0.48	0.17
2022	5.34	1.21	0.18	0.07
2023	5.25	1.22	0.22	0.10
2024	4.44	1.09	0.23	0.11
2025	3.38	0.88	0.37	0.27

Table 22: Comparisons of survey selectivity by size bin among the base model (26.0) and models 26.1 - 26.4, which include a model-based index of abundance (MBI) in place of the design-based indices of abundance for the ADFG and NOAA NBS trawl surveys. Model 26.1 has catchability for the MBI fixed at 1 and selectivity for the ADFG and NBS surveys mirrored to the historical NOAA/ADFG survey selectivity. Model 26.2 has catchability for the MBI estimated and selectivity for the ADFG and NBS surveys mirrored to the historical NOAA/ADFG survey selectivity. Model 26.3 has catchability for the MBI estimated and selectivity for the ADFG and NBS surveys estimated. Model 26.4 has catchability for the MBI estimated and selectivity for all surveys fixed for all size classes.

Survey	Size class midpoint	26.0	26.1	26.2	26.3	26.4
historical	68.5	0.9999993	0.9999993	0.9999993	0.9999993	0.9999930
historical	78.5	0.9999994	0.9999994	0.9999994	0.9999994	0.9999940
historical	88.5	0.9999995	0.9999995	0.9999995	0.9999995	0.9999950
historical	98.5	0.9999996	0.9999996	0.9999996	0.9999996	0.9999960
historical	108.5	0.9999997	0.9999997	0.9999997	0.9999997	0.9999970
historical	118.5	0.9999998	0.9999998	0.9999998	0.9999998	0.9999980
historical	128.5	0.9999999	0.9999999	0.9999999	0.9999999	0.9999990
historical	138.5	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
ADFG trawl	68.5	0.9999993	0.9999993	0.9999993	0.9999993	0.9999930
ADFG trawl	78.5	0.9999994	0.9999994	0.9999994	0.9999994	0.9999940
ADFG trawl	88.5	0.9999995	0.9999995	0.9999995	0.9999995	0.9999950
ADFG trawl	98.5	0.9999996	0.9999996	0.9999996	0.9999996	0.9999960
ADFG trawl	108.5	0.9999997	0.9999997	0.9999997	0.9999997	0.9999970
ADFG trawl	118.5	0.9999998	0.9999998	0.9999998	0.9999998	0.9999980
ADFG trawl	128.5	0.9999999	0.9999999	0.9999999	0.9999999	0.9999990
ADFG trawl	138.5	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
NBS trawl	68.5	0.9999993	0.9999993	0.9999993	0.9999993	0.9999930
NBS trawl	78.5	0.9999994	0.9999994	0.9999994	0.9999994	0.9999940
NBS trawl	88.5	0.9999995	0.9999995	0.9999995	0.9999995	0.9999950
NBS trawl	98.5	0.9999996	0.9999996	0.9999996	0.9999996	0.9999960
NBS trawl	108.5	0.9999997	0.9999997	0.9999997	0.9999997	0.9999970
NBS trawl	118.5	0.9999998	0.9999998	0.9999998	0.9999998	0.9999980
NBS trawl	128.5	0.9999999	0.9999999	0.9999999	0.9999999	0.9999990
NBS trawl	138.5	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
Winter pot	68.5	0.0684692	0.0677666	0.0676998	0.0676998	0.0676997
Winter pot	78.5	0.4908491	0.4831420	0.4837887	0.4837887	0.4837888
Winter pot	88.5	0.9246887	0.9282596	0.9251323	0.9251323	0.9251316
Winter pot	98.5	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
Winter pot	108.5	0.8535028	0.8760488	0.8697701	0.8697701	0.8697702
Winter pot	118.5	0.6133140	0.6439421	0.6339196	0.6339196	0.6339198
Winter pot	128.5	0.3500059	0.3637149	0.3572015	0.3572015	0.3572018
Winter pot	138.5	0.1629691	0.1605469	0.1589624	0.1589624	0.1589626

Figures

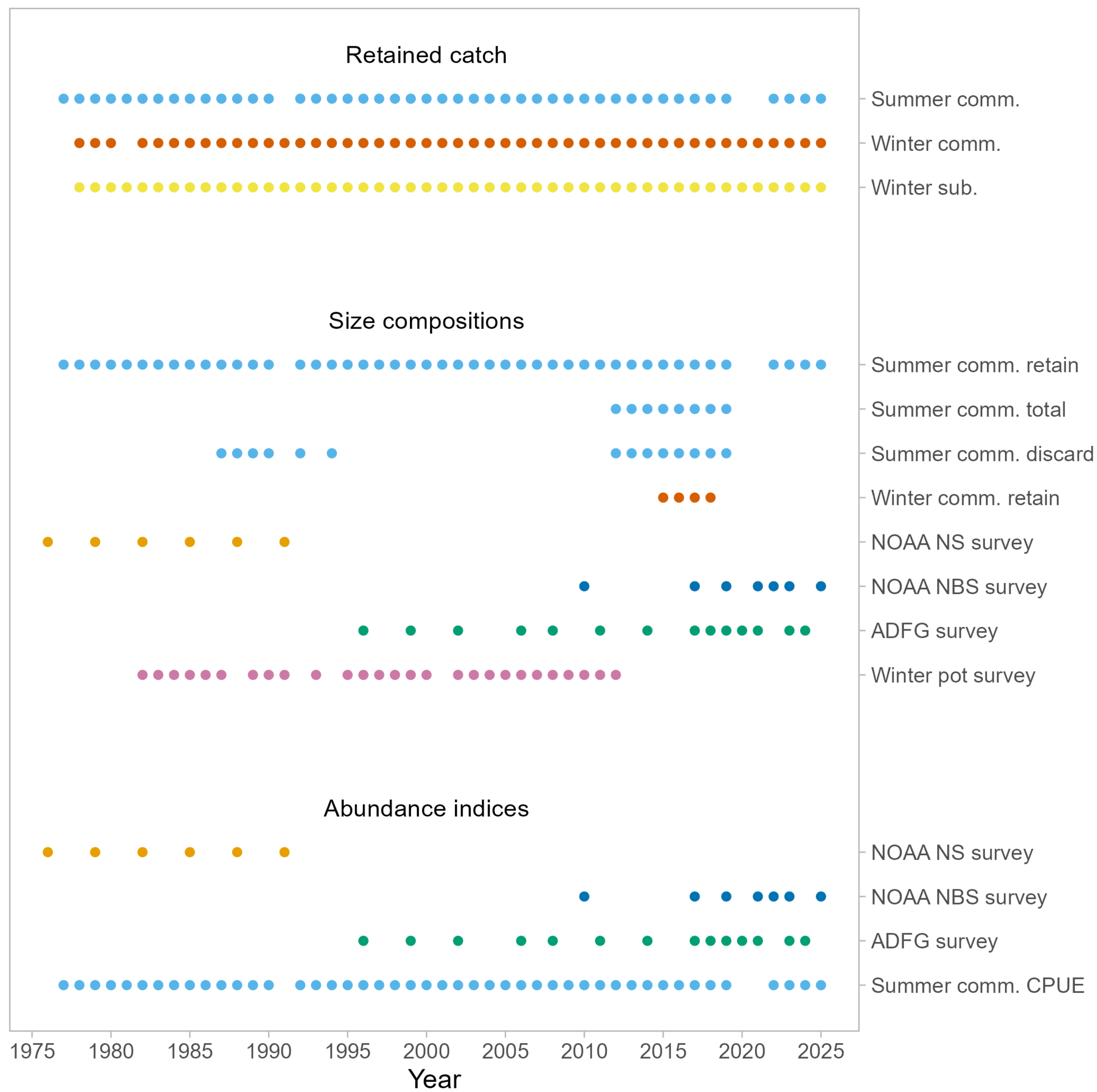

Figure 1: Data sources available for the Norton Sound red king crab stock assessment. Acronyms and abbreviations: National Oceanic and Atmospheric Administration, NOAA; Norton Sound, NS; Northern Bering Sea, NBS; Alaska Department of Fish and Game, ADFG; catch per unit effort, CPUE; comm., commercial; sub., subsistence.

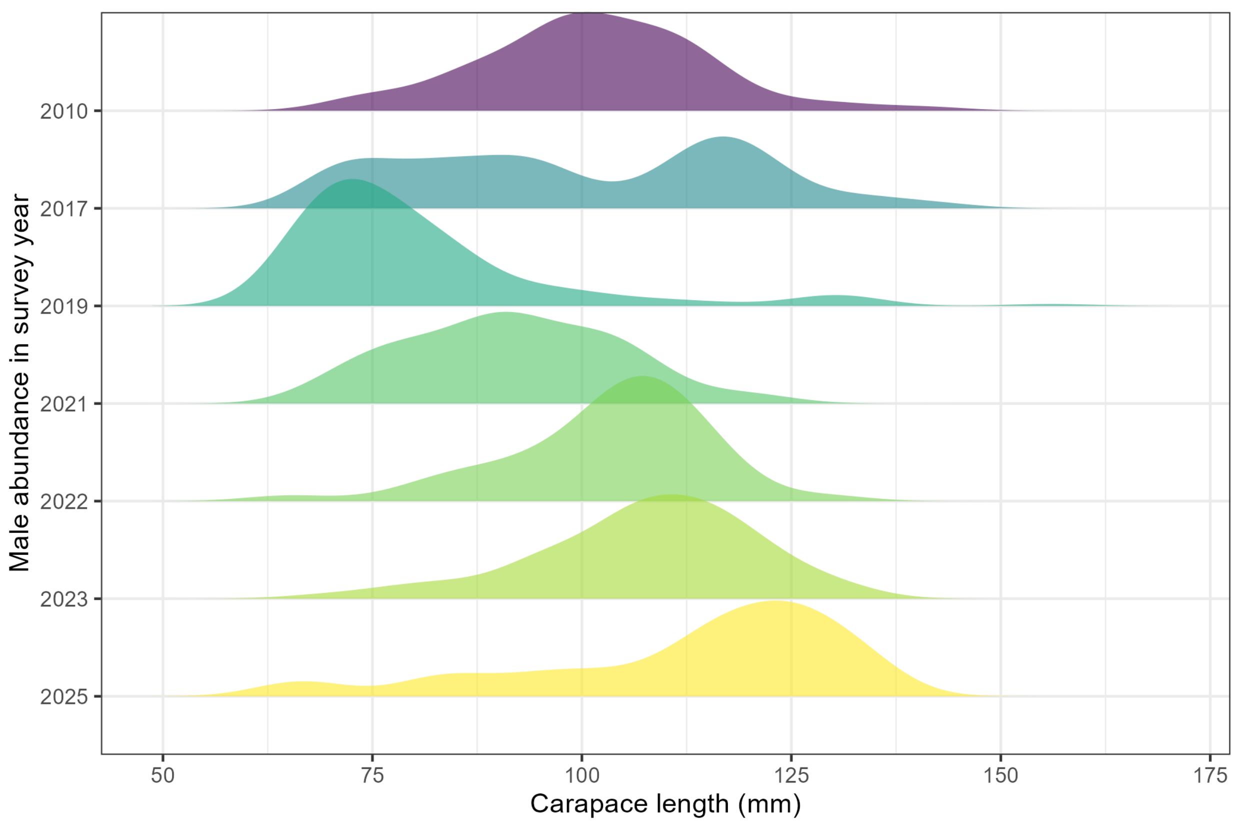

Figure 2: National Oceanic and Atmospheric Administration Northern Bering Sea trawl survey abundances by carapace length for male Norton Sound red king crab from 2010 to 2025.

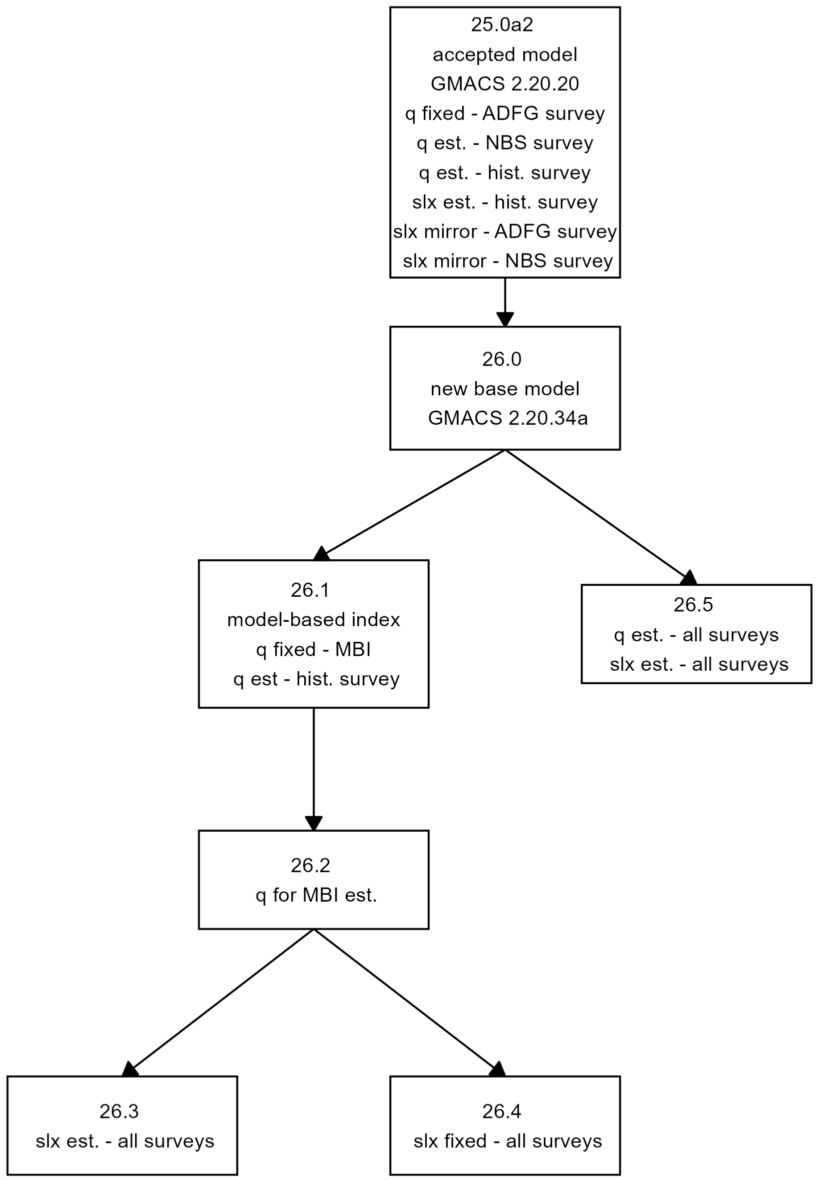

Figure 3: Flow chart of models presented in this document. Model 25.0a2 is the 2025 accepted model. Model 26.0 is model 25.0a2 transitioned to GMACS version 2.20.34a and is the new base model. Note that, in the base model, catchability (q) for the ADFG trawl survey is fixed at 1 while q for the historical survey and the NBS trawl survey are estimated; selectivity for the ADFG and NBS trawl surveys is mirrored to the selectivity estimated for the historical survey. Model 26.1 is 26.0 with a model-based index (MBI) included in place of the ADFG and NBS trawl survey indices of abundance; q for the historical survey is estimated while q for the MBI is fixed at 1; selectivity is treated as in the base model. Model 26.2 is 26.1 with catchability (q) for the MBI estimated. Model 26.3 is 26.2 with selectivity estimated for all surveys. Model 26.4 is 26.2 with selectivity fixed at 1 for all surveys and size classes. Model 26.5 is 26.0 with catchability and selectivity estimated for all surveys.

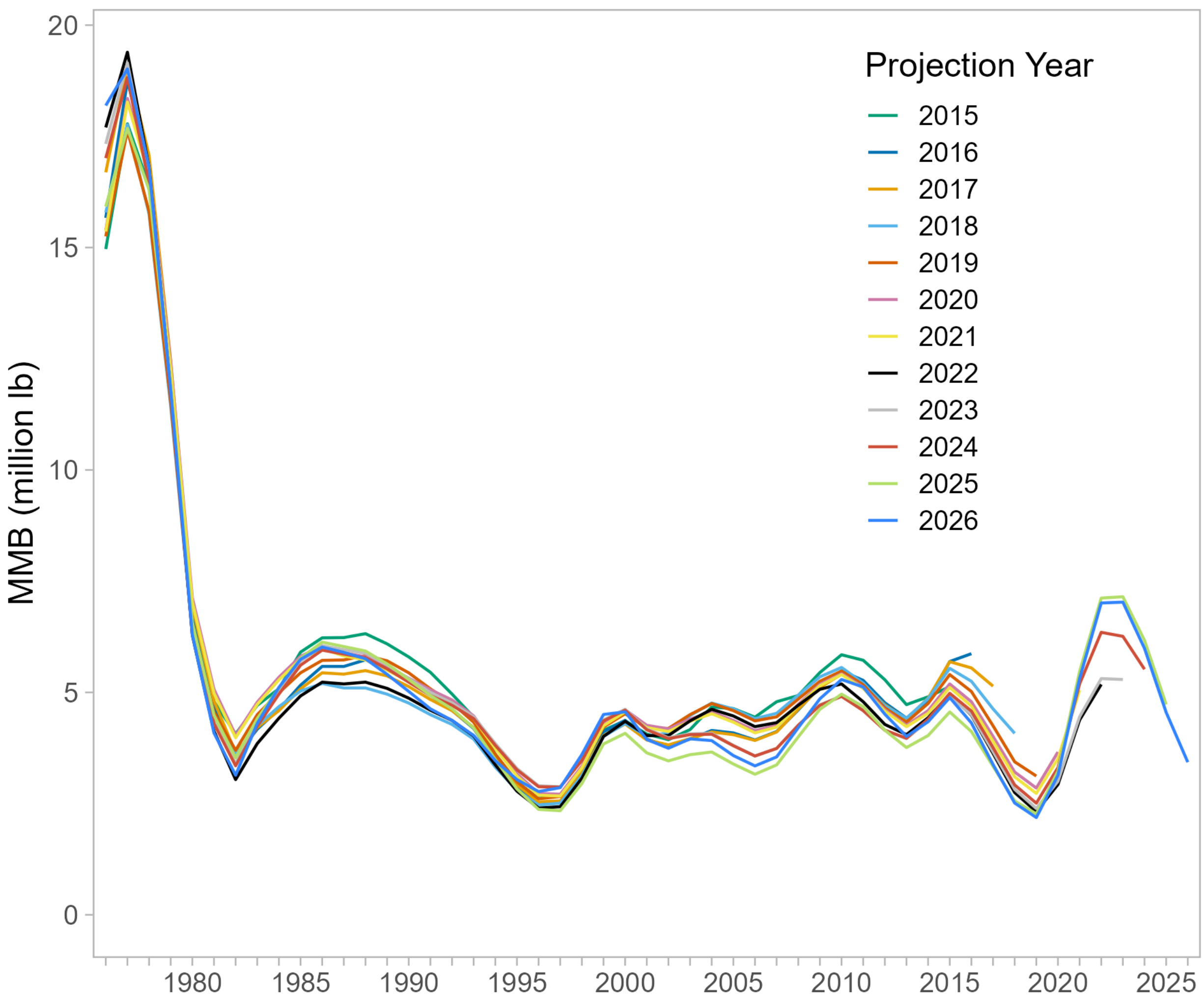

Figure 4: Comparison of historical estimates of mature male biomass of Norton Sound red king crab using the model selected in each year. Data were compiled from reported MMB values for the chosen model in the published SAFE document from the assessment year. The legend shows the year for which model projections were made.

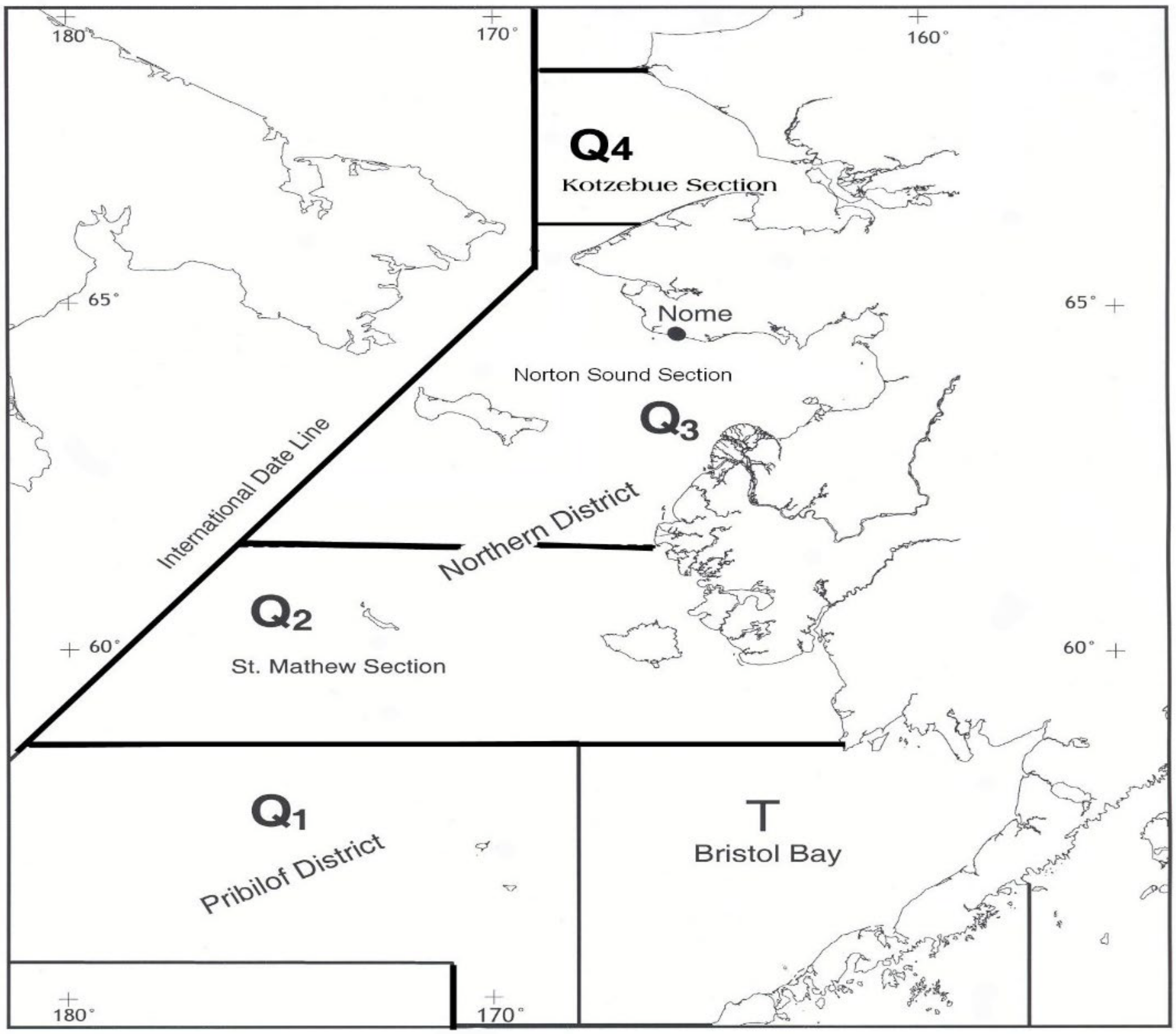

Figure 5: King crab fishing districts and sections of Alaska Department of Fish and Game Registration Area Q. Source: Menard et al. (2022).

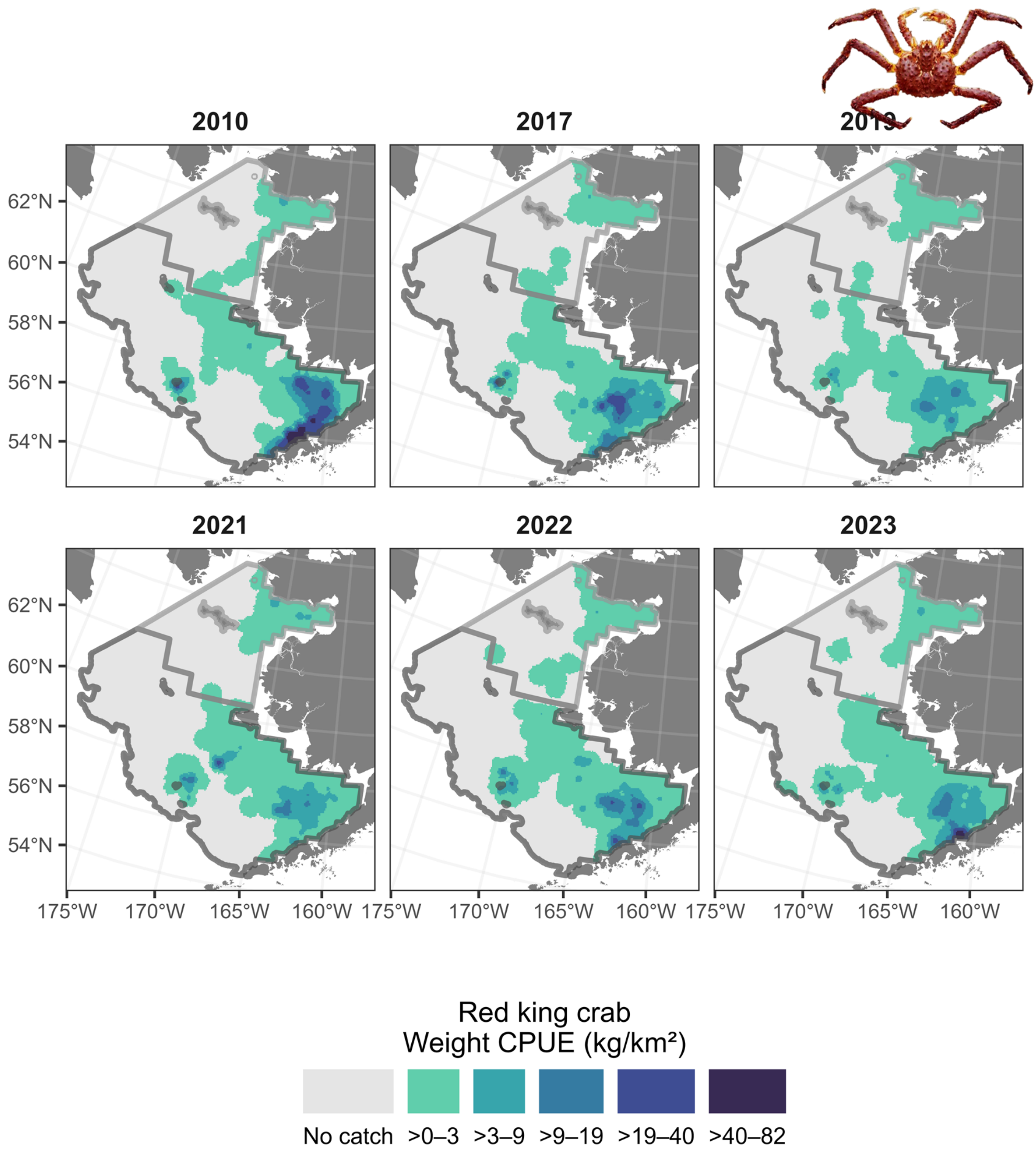

Figure 6: Distribution of red king crab from the 2010, 2017, 2019, and 2021-2023 Eastern and Northern Bering Sea trawl surveys. Source: Markowitz et al. (2023).

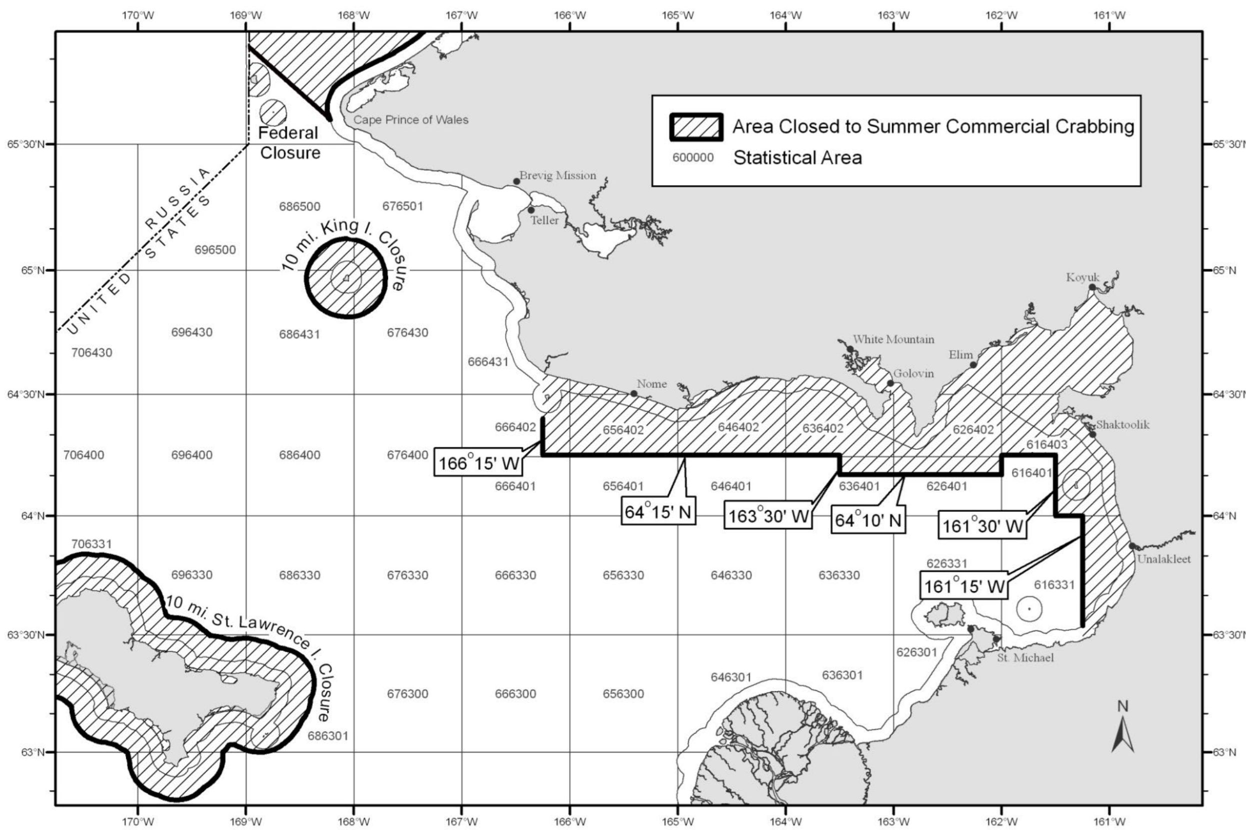

Figure 7: Waters closed to the Norton Sound summer commercial crab fishery. Source: Menard et al. (2022).

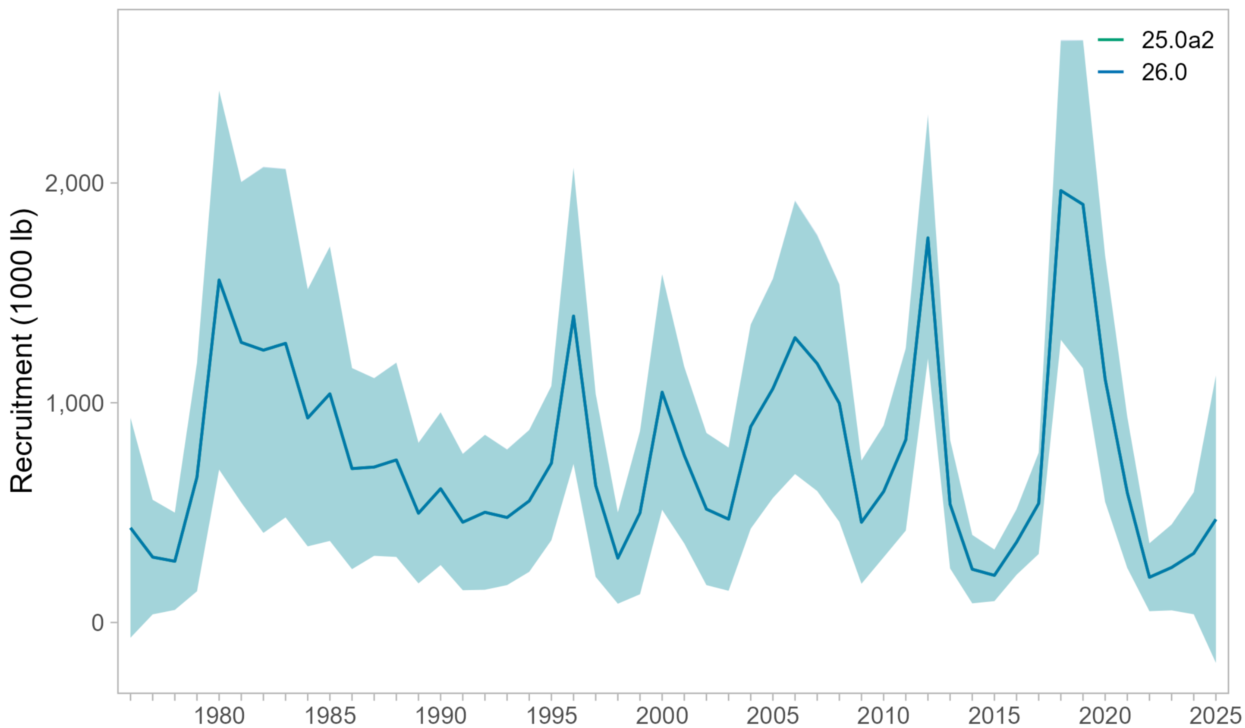

Figure 8: Estimated recruitment (1000 lb) over 1976-2025 for models 25.0a2 and 26.0.

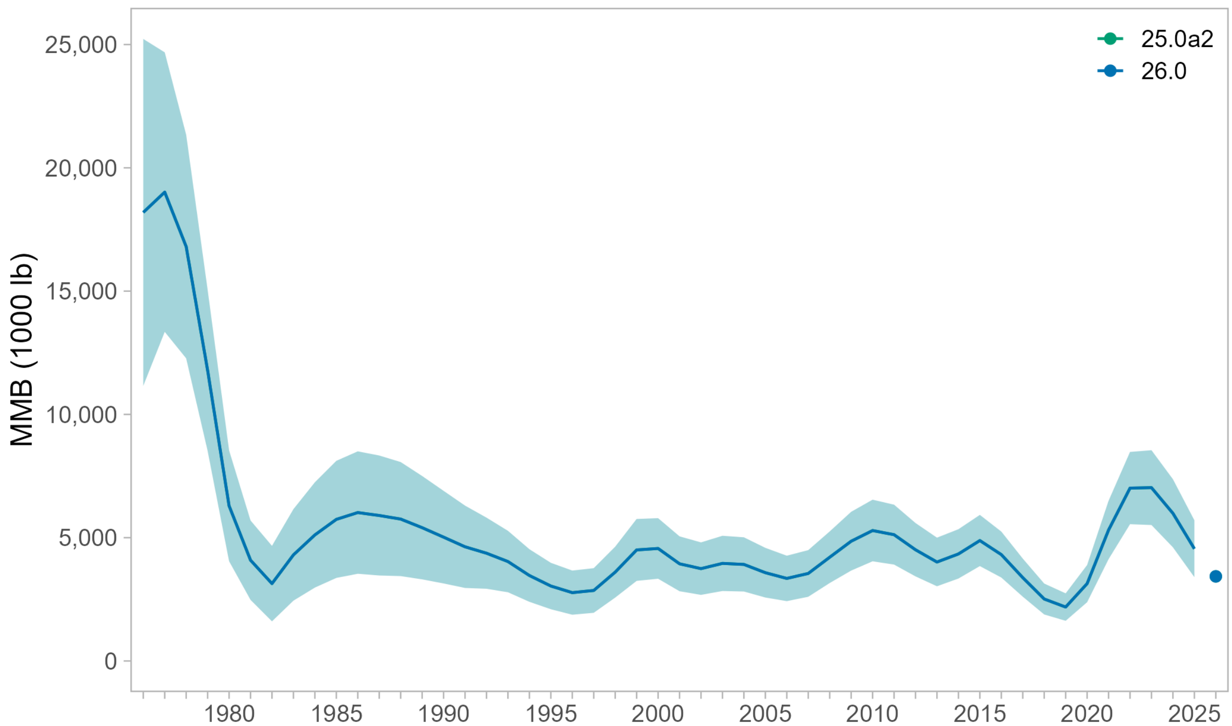

Figure 9: Comparisons of estimated mature male biomass (MMB) time series over 1976-2025 for models 25.0a2 (the 2025 accepted model, in GMACS version 2.20.20) and model 26.0 (model 25.0a2 transitioned to GMACS version 2.20.34a; the new base model). Points represent projected values for 2026.

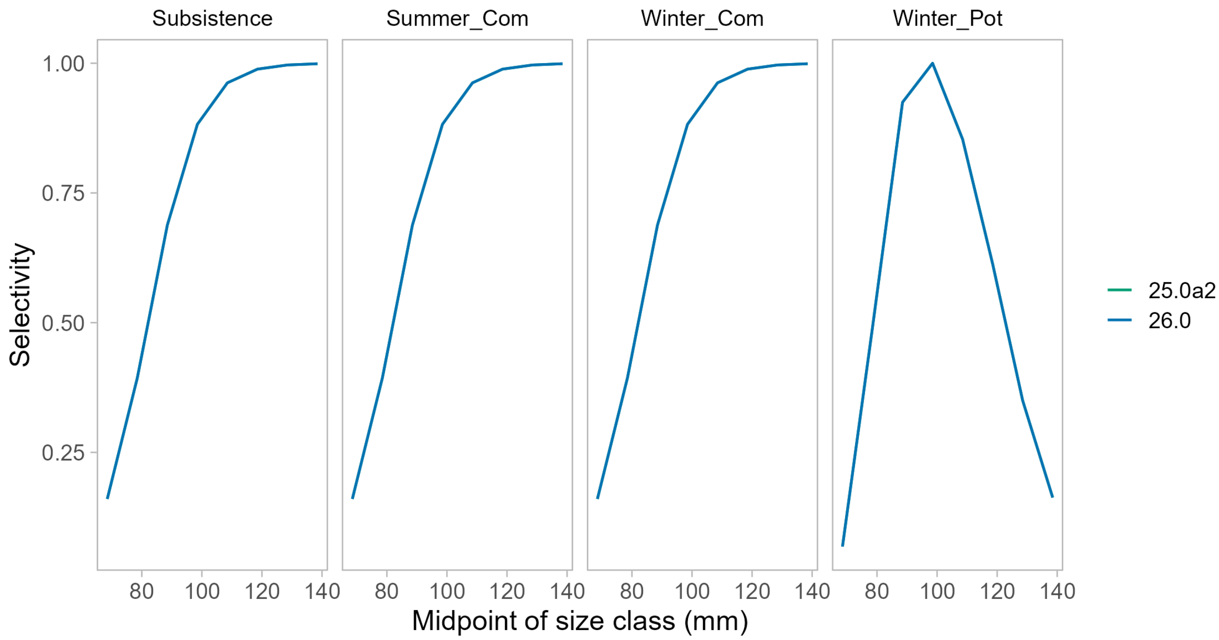

Figure 10: Comparisons of estimated fishery capture selectivities in the summer commercial, winter commercial, and winter subsistence fisheries for the 2025 accepted model (25.0a2, using GMACS version 2.20.20) and the new base model (26.0, using GMACS version 2.20.34a).

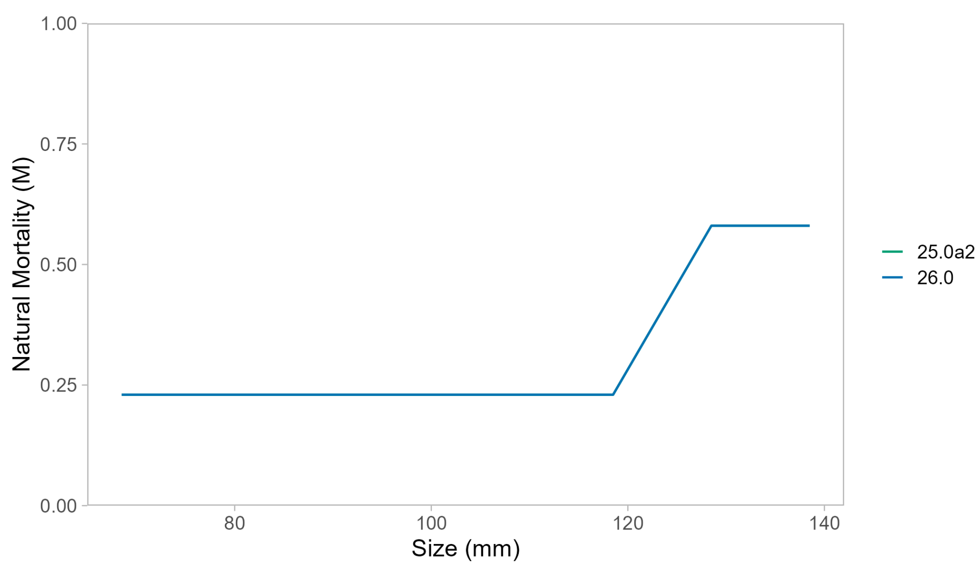

Figure 11: Natural mortality estimates for the 2025 accepted model (25.0a2, using GMACS version 2.20.20) and the new base model (26.0, using GMACS version 2.20.34a).

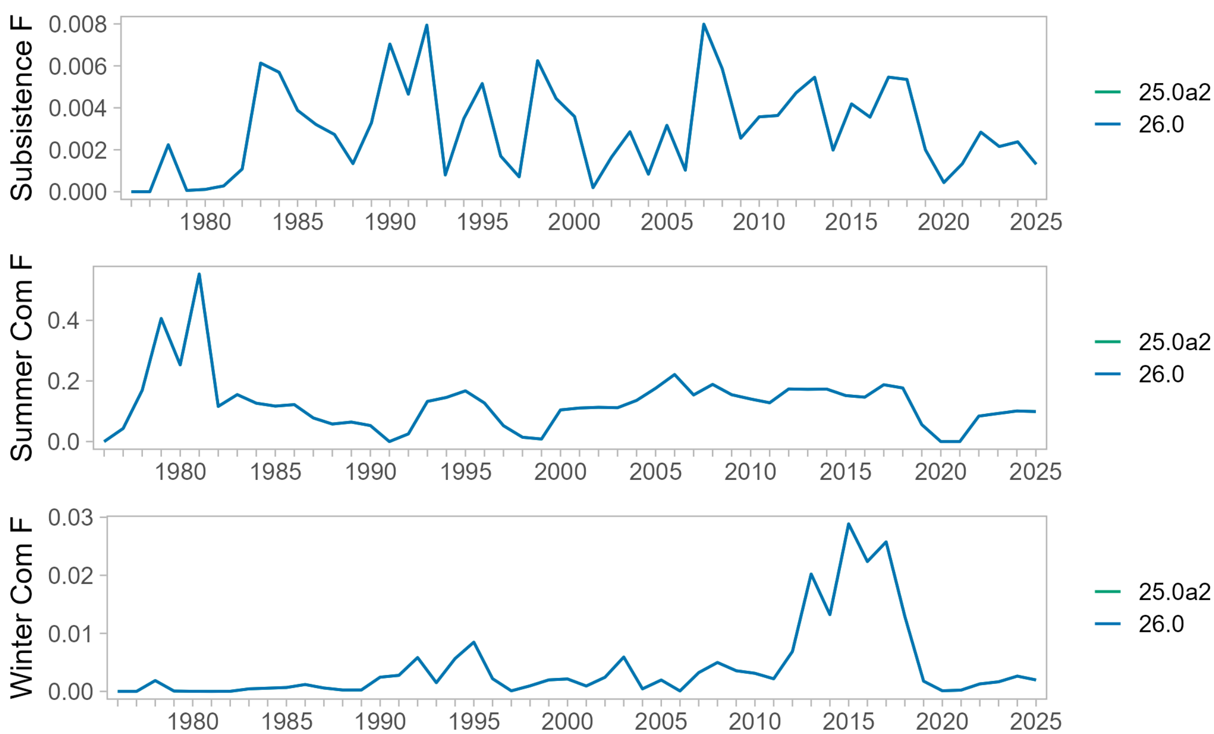

Figure 12: Comparison of estimated fishing mortality (F) for the subsistence, summer commercial, and winter commercial fisheries for the models in the bridging analysis. Note that the scale for F differs among the panels.

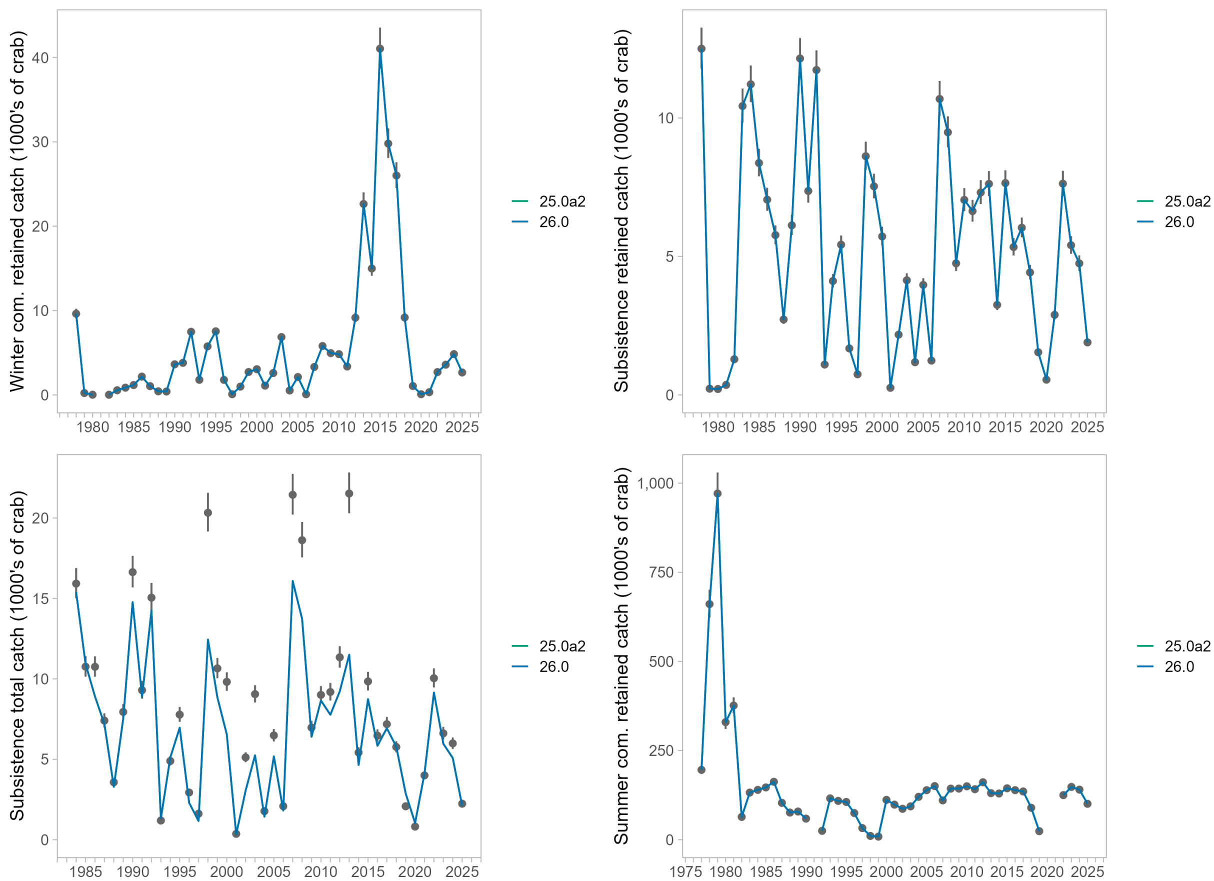

Figure 13: Observed and model-estimated catch of male red king crab caught in the winter commercial, summer commercial, and subsistence fisheries for models in the bridging analysis. Note that subsistence total catch was not fitted in these models (emphasis set to 0).

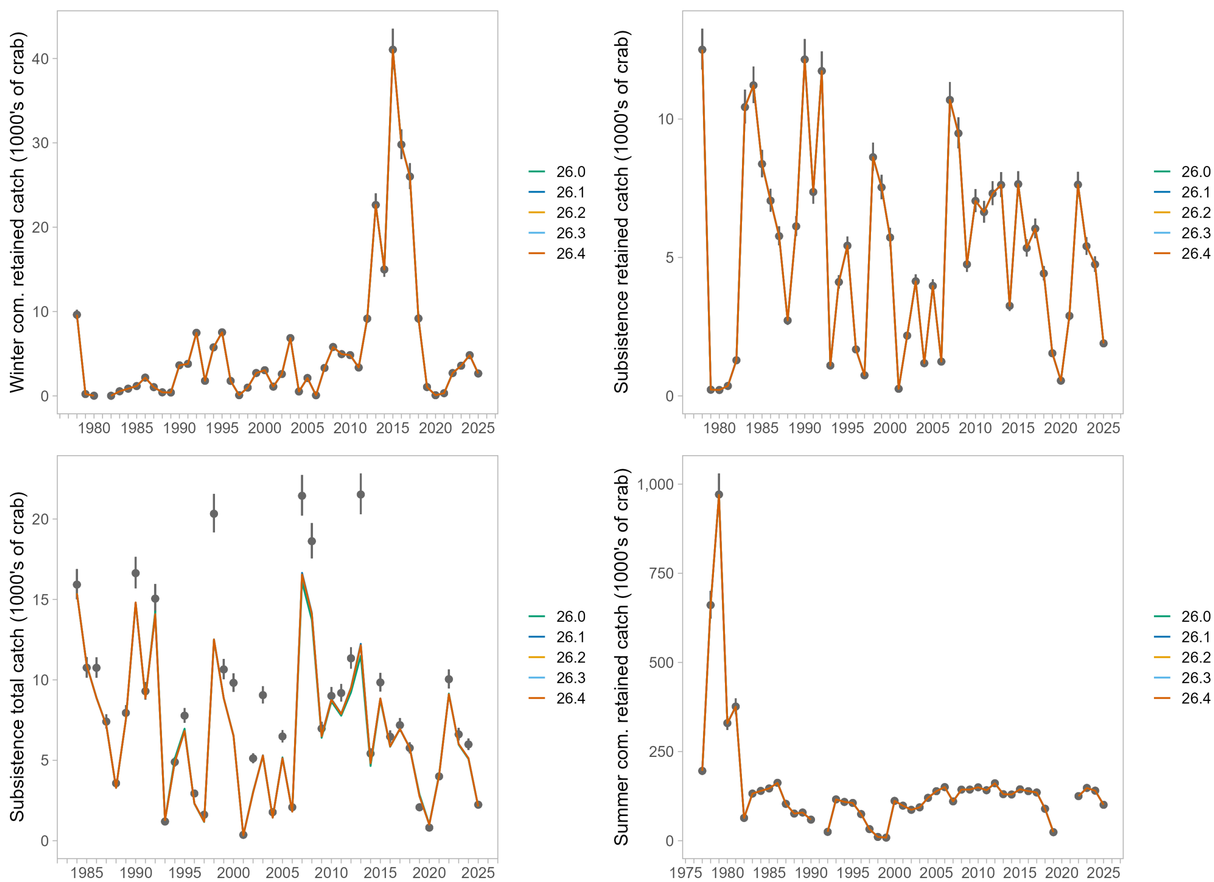

Figure 14: Observed and model-estimated catch of male red king crab caught in the winter commercial, summer commercial, and subsistence fisheries for the new base model (26.0) and the models including the model-based index of abundance (26.1 - 26.4). Note that subsistence total catch was not fitted in these models (emphasis set to 0).

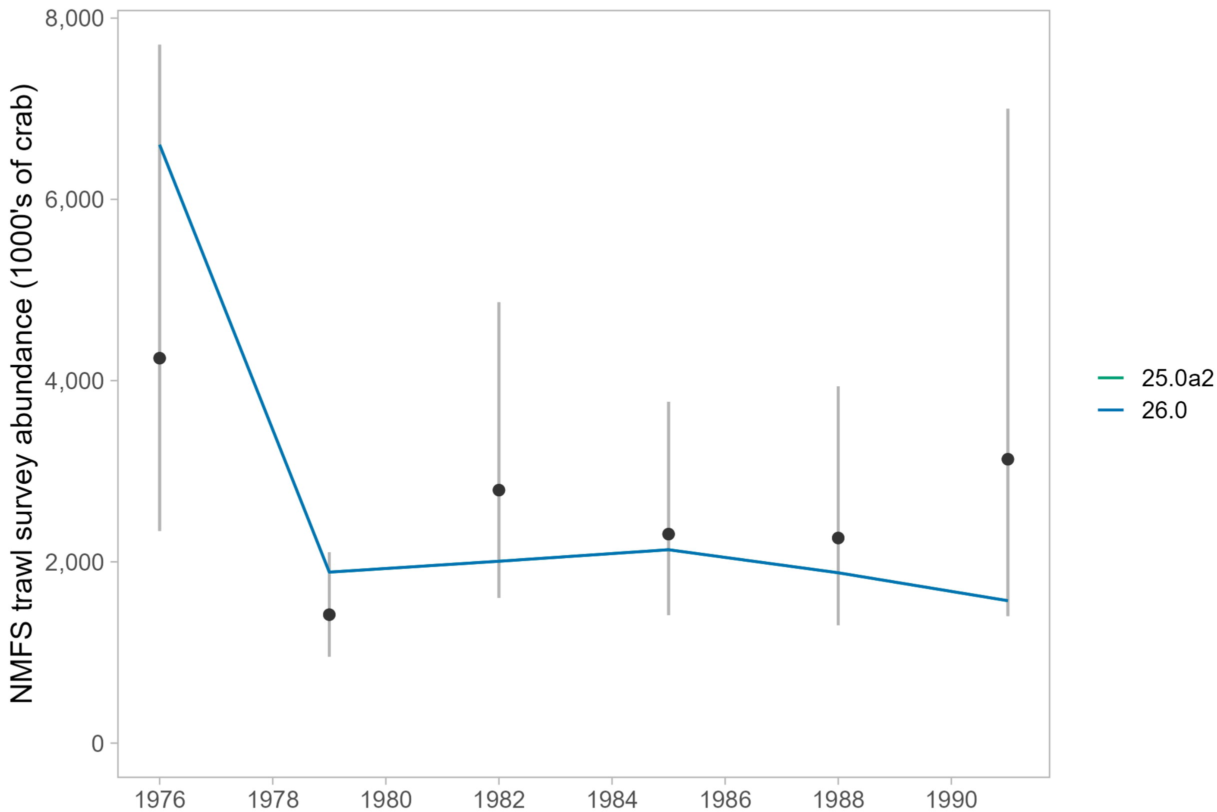

Figure 15: Model fits to the design-based index of abundance from the historical National Oceanic and Atmospheric Administration (NOAA) Norton Sound trawl survey for the accepted (25.0a2) and new base (26.0) models. Note that this design-based index of abundance for the historical survey was used in all models in this document, while the design-based indices of abundance for the ADFG and NBS trawl surveys were only included in models 25.0a2, 26.0, and 26.5.

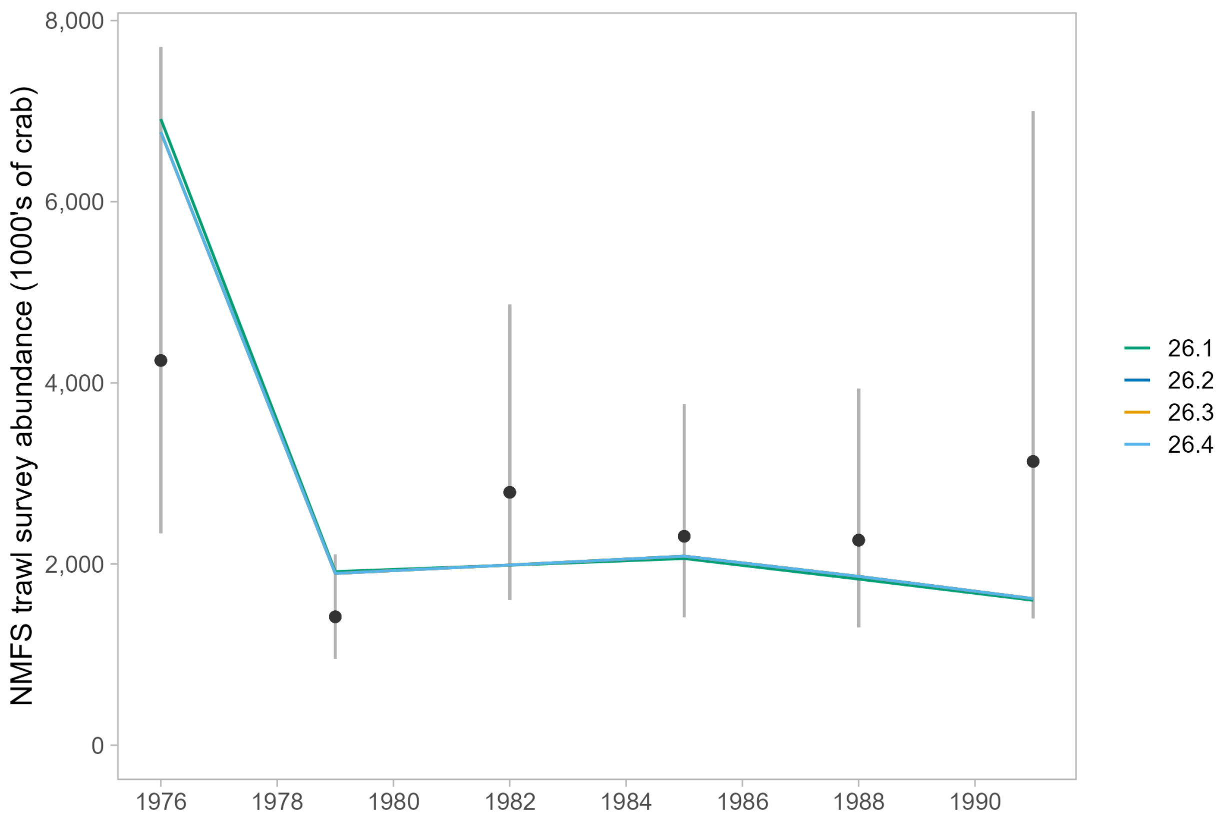

Figure 16: Model fits to the design-based index of abundance from the historical National Oceanic and Atmospheric Administration (NOAA) Norton Sound trawl survey for the models 26.1 - 26.4. Models 26.1 - 26.4 all included the model-based index of abundance in place of the design-based indices for the ADFG and NBS trawl surveys. However, these models still included the design-based index of abundance from the historical survey shown here, as the data from the historical survey was not included in the model-based index.

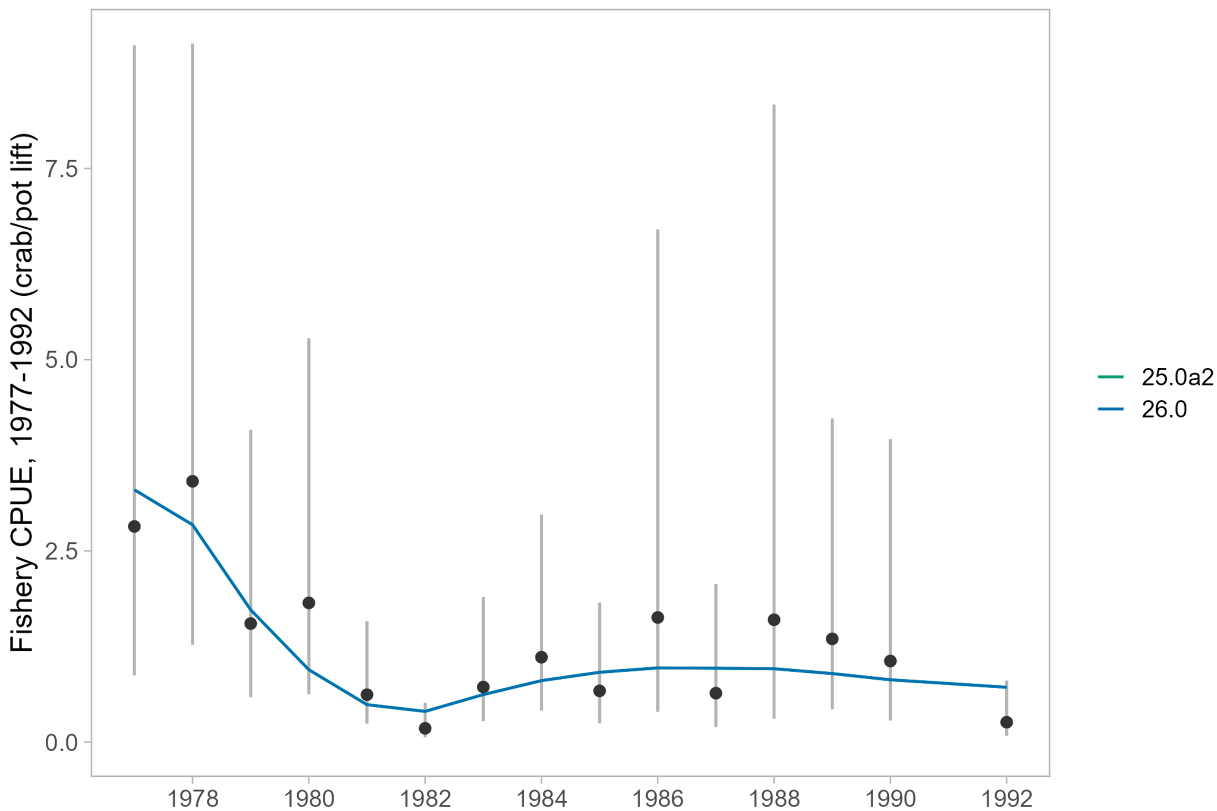

Figure 17: Model fits to the summer commercial fishery standardized catch per unit effort (CPUE) index (1977-1992) for the accepted (25.0a2) and new base (26.0) models.

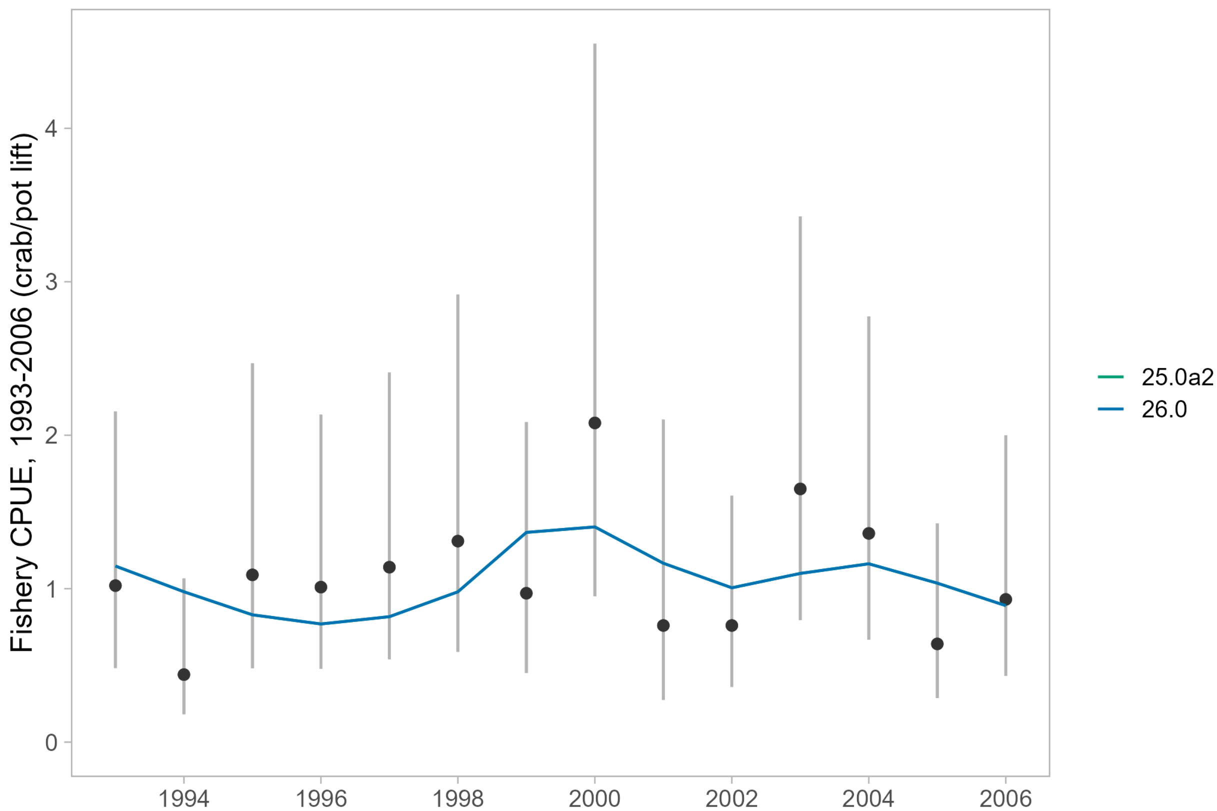

Figure 18: Model fits to the summer commercial fishery standardized catch per unit effort (CPUE) index (1993-2006) for the accepted (25.0a2) and new base (26.0) models.

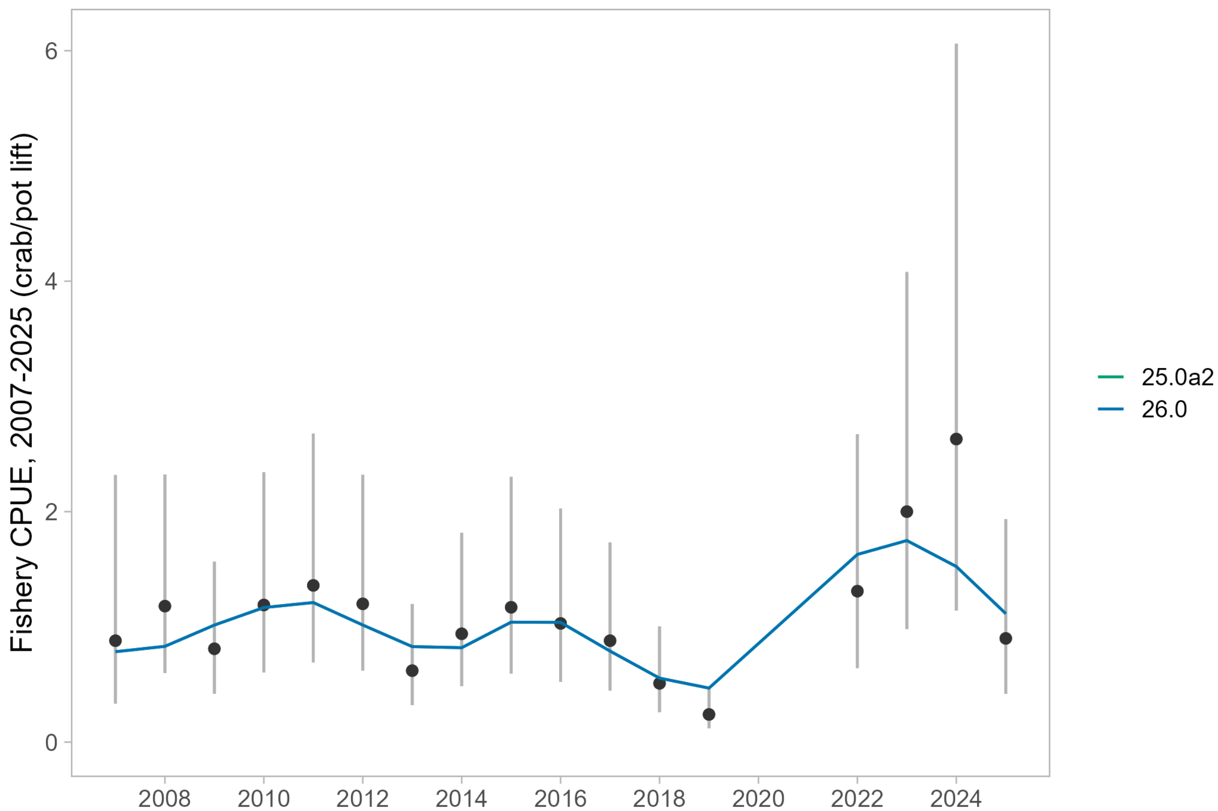

Figure 19: Model fits to the summer commercial fishery standardized catch per unit effort (CPUE) index (2007-2025) for the accepted (25.0a2) and new base (26.0) models.

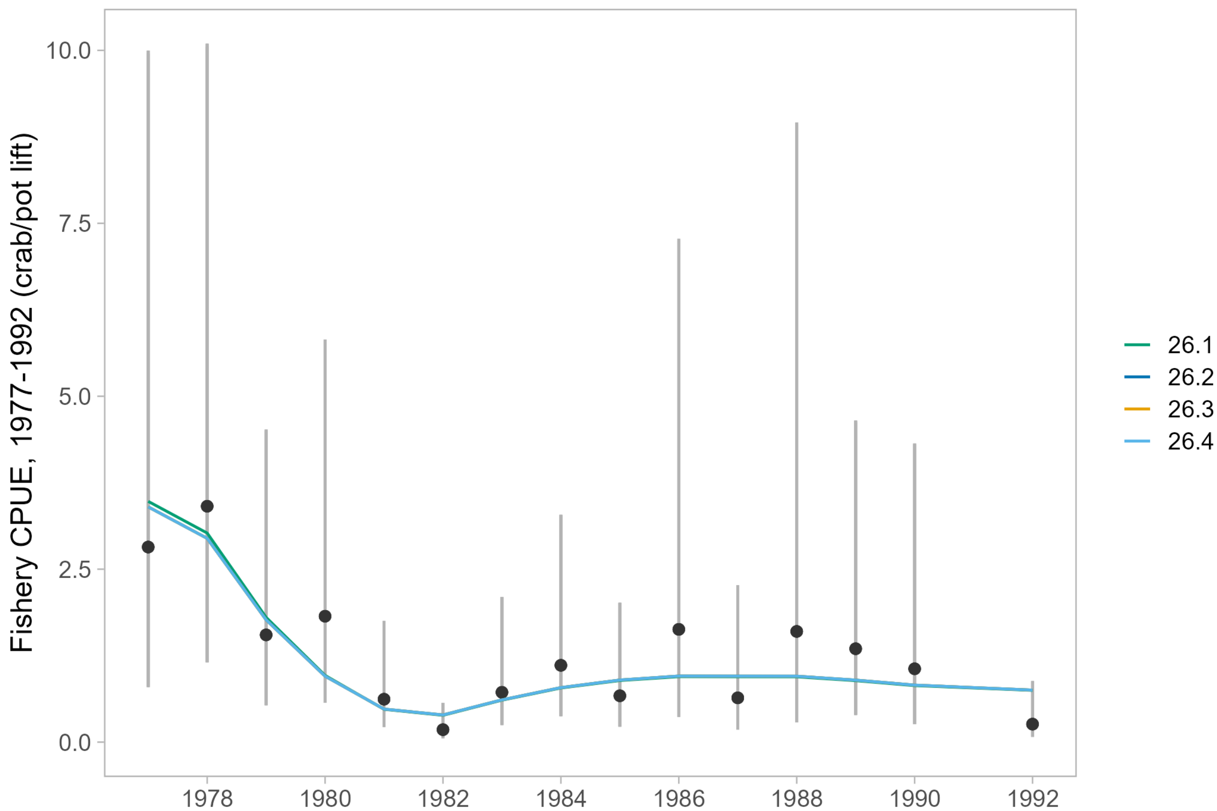

Figure 20: Model fits to the summer commercial fishery standardized catch per unit effort (CPUE) index (1977-1992) for the models including the model-based index of abundance.

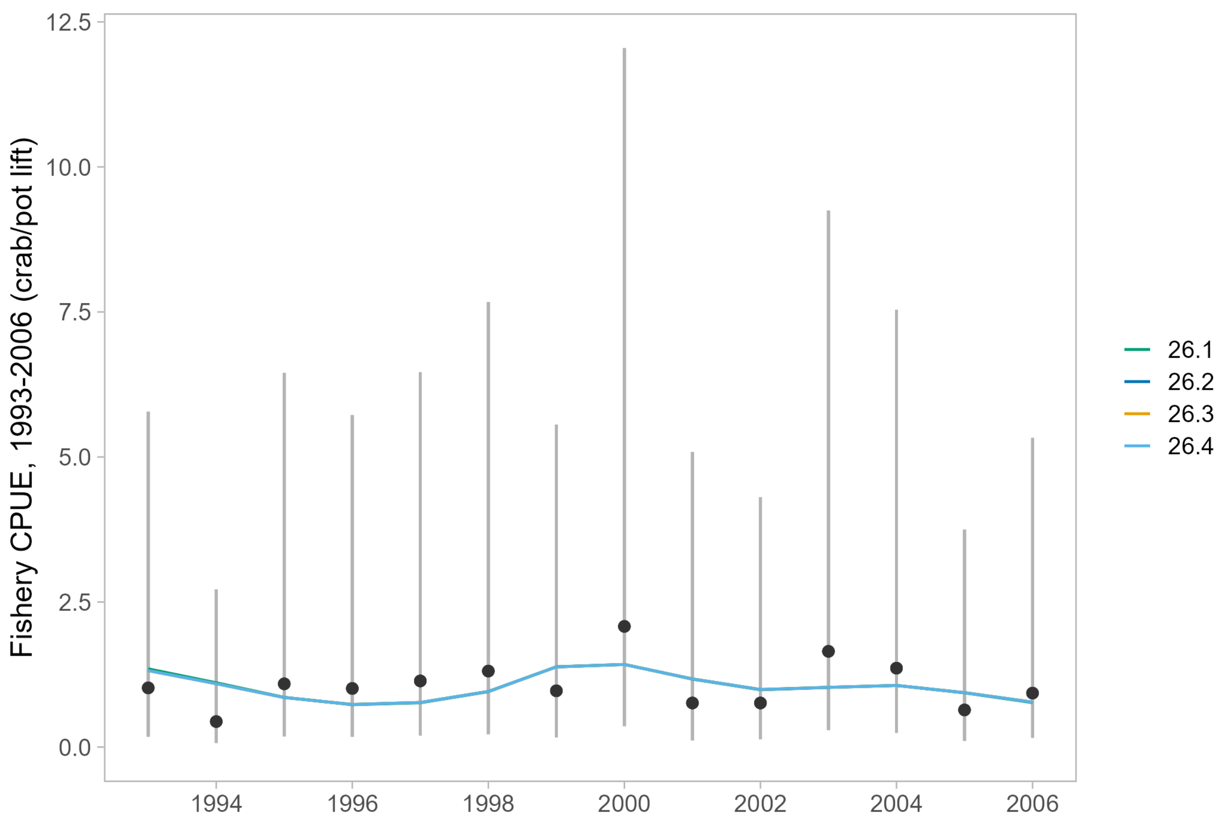

Figure 21: Model fits to the summer commercial fishery standardized catch per unit effort (CPUE) index (1993-2006) for the models including the model-based index of abundance.

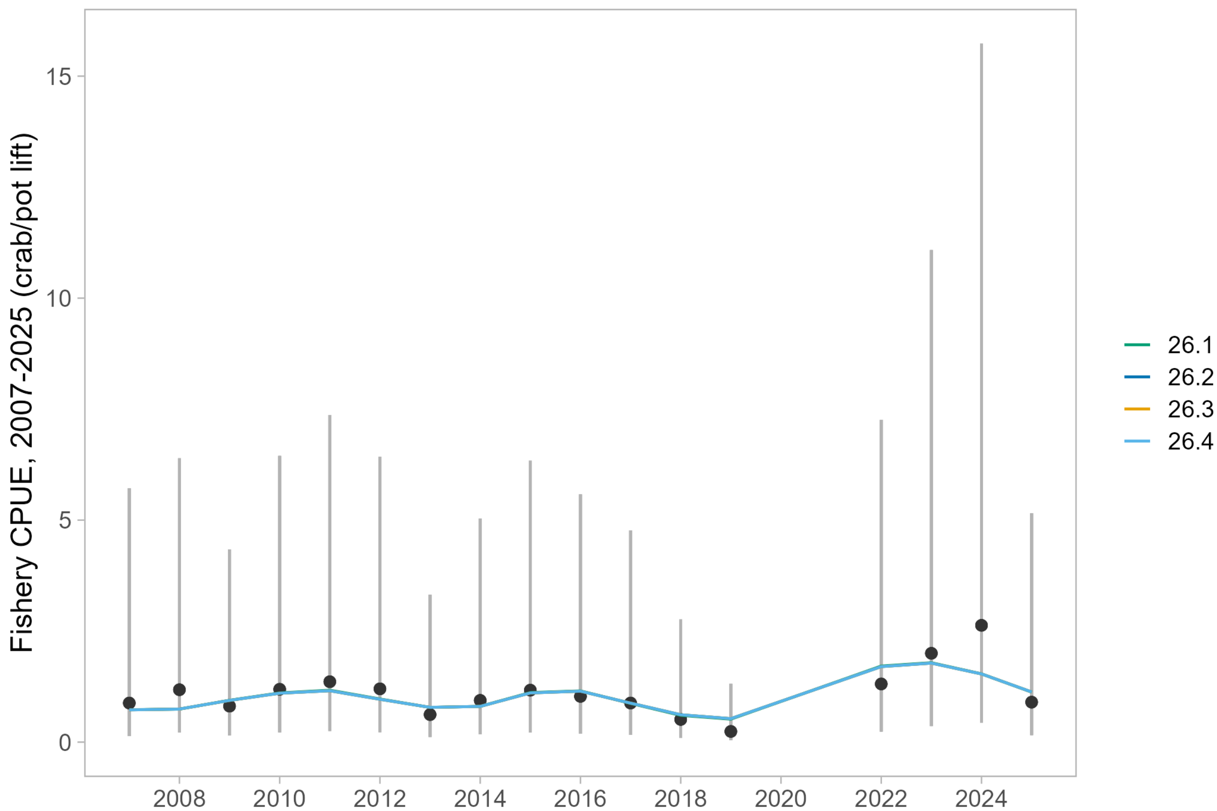

Figure 22: Model fits to the summer commercial fishery standardized catch per unit effort (CPUE) index (2007-2025) for the models including the model-based index of abundance.

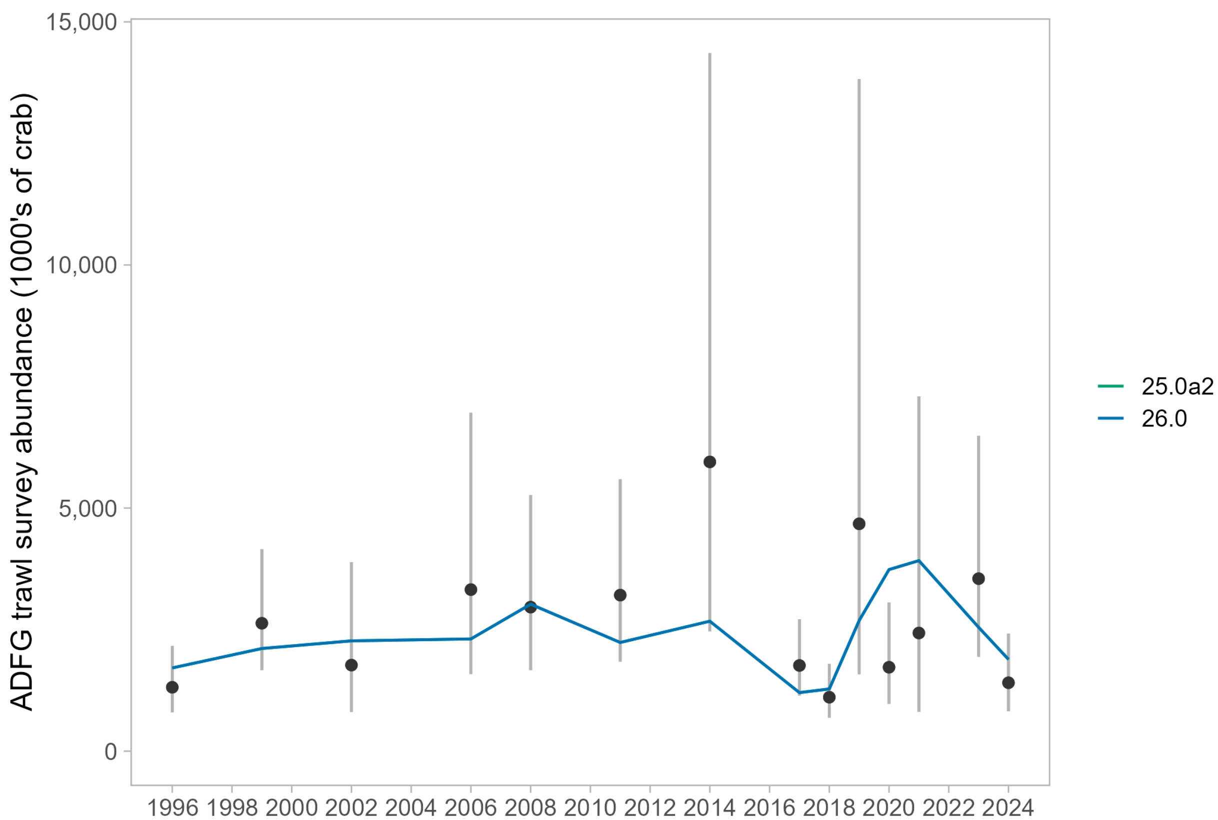

Figure 23: Model fits to the design-based index of abundance from the Alaska Department of Fish and Game (ADFG) trawl survey for the accepted (25.0a2) and new base (26.0) models.

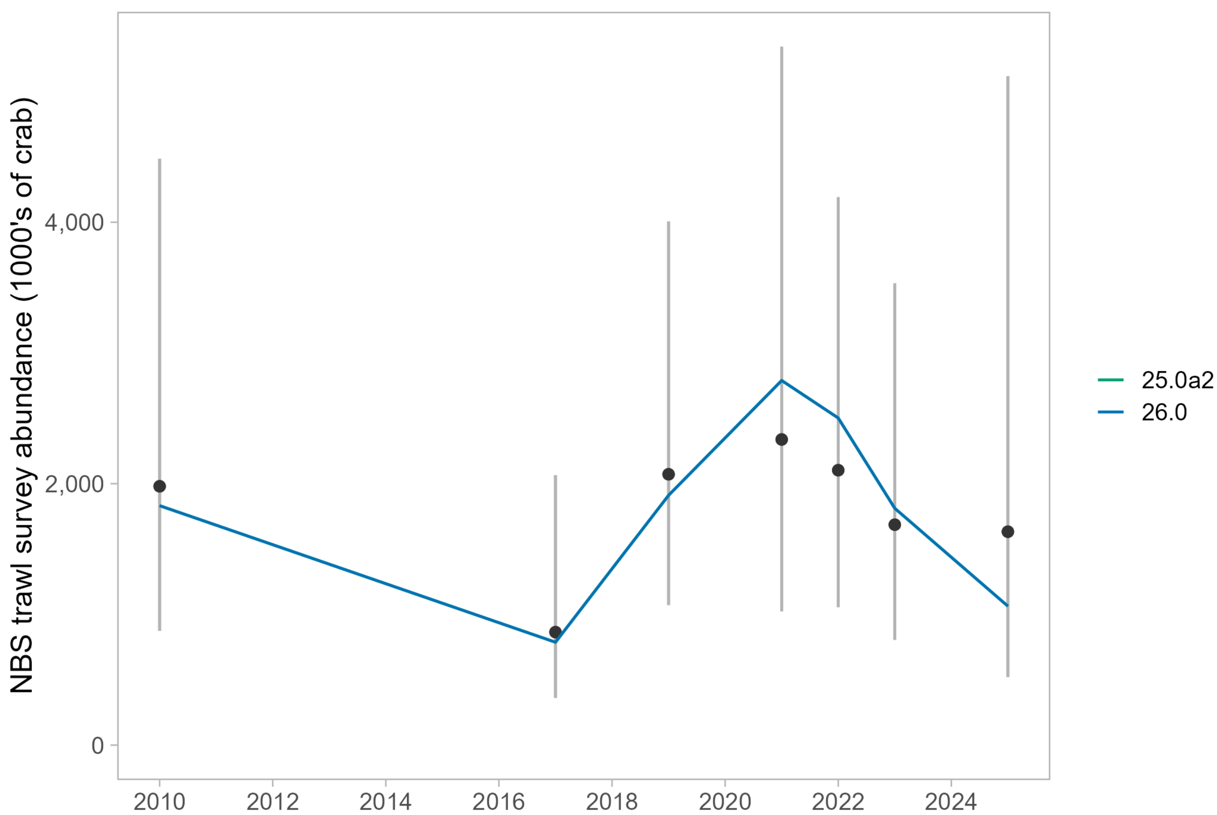

Figure 24: Model fits to the design-based index of abundance from the National Oceanic and Atmospheric Administration (NOAA) Northern Bering Sea (NBS) trawl survey for the accepted (25.0a2) and new base (26.0) models.

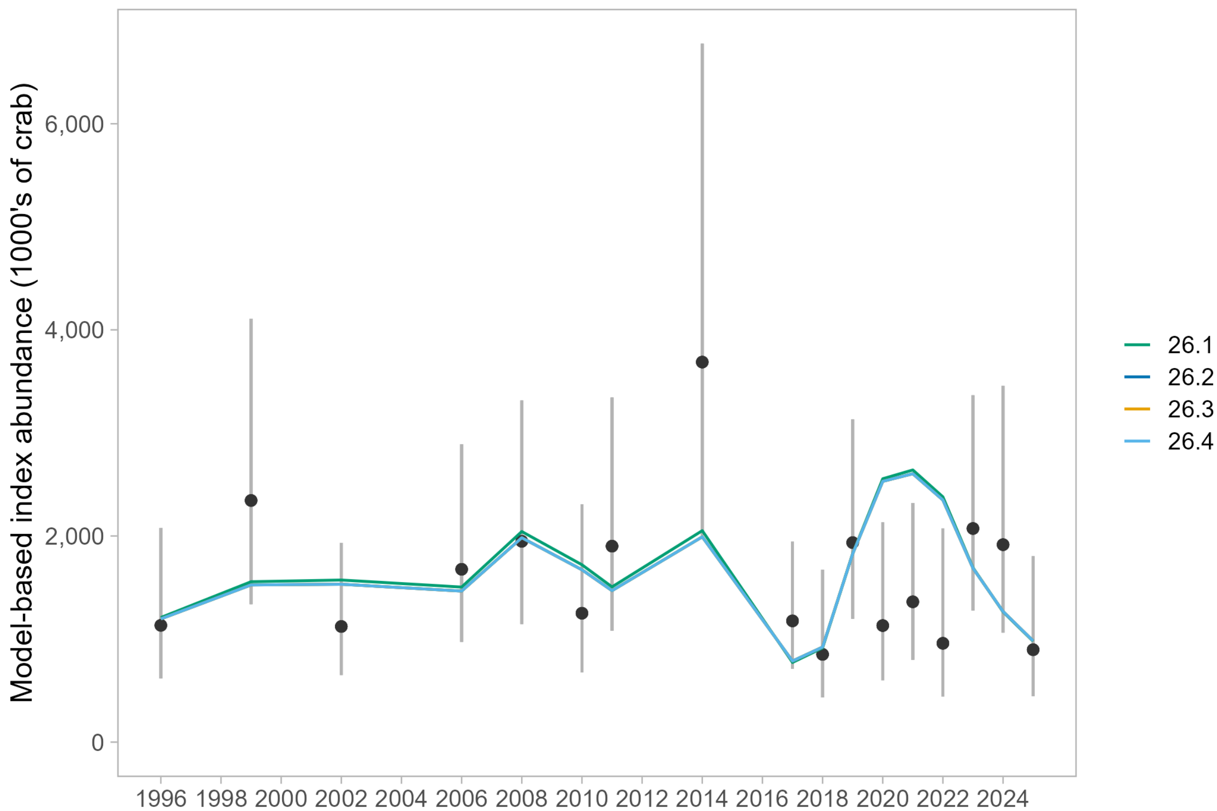

Figure 25: Model fits to the model-based index of abundance for the models including the model-based index of abundance.

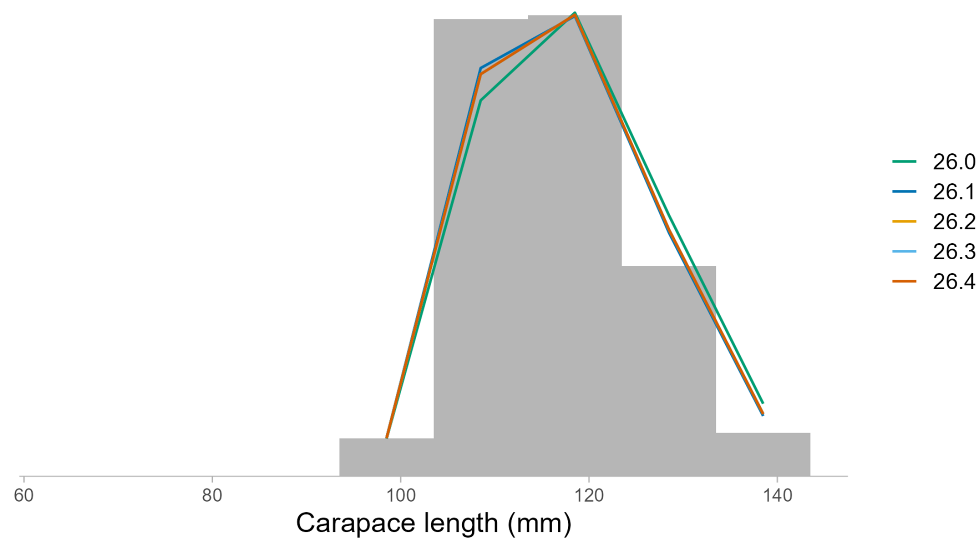

Figure 26: Aggregated observed and model-estimated size frequencies of male red king crab retained in the directed winter commercial fishery for the new base model (26.0) and the models including the model-based index of abundance (26.1 - 26.4).

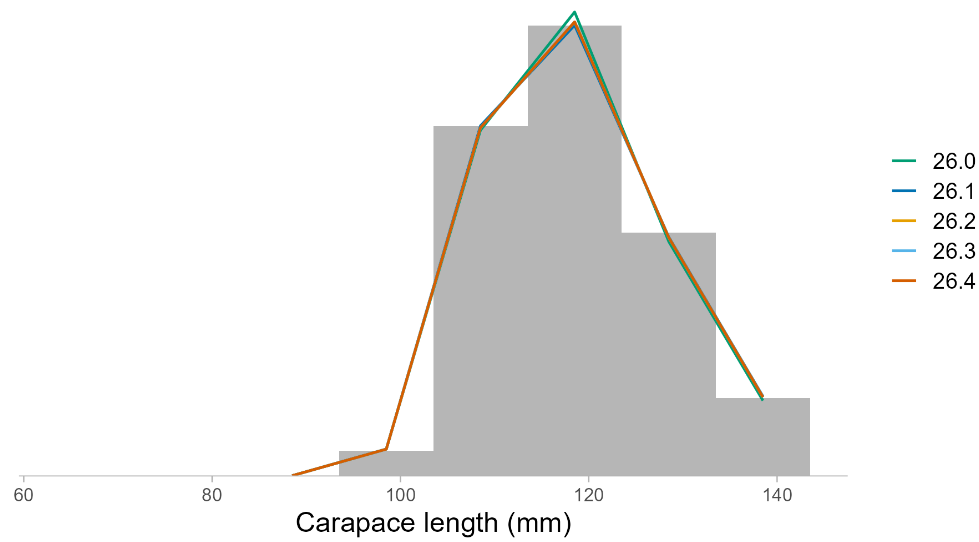

Figure 27: Aggregated observed and model-estimated size frequencies of male red king crab retained in the directed summer commercial fishery for the new base model (26.0) and the models including the model-based index of abundance (26.1 - 26.4).

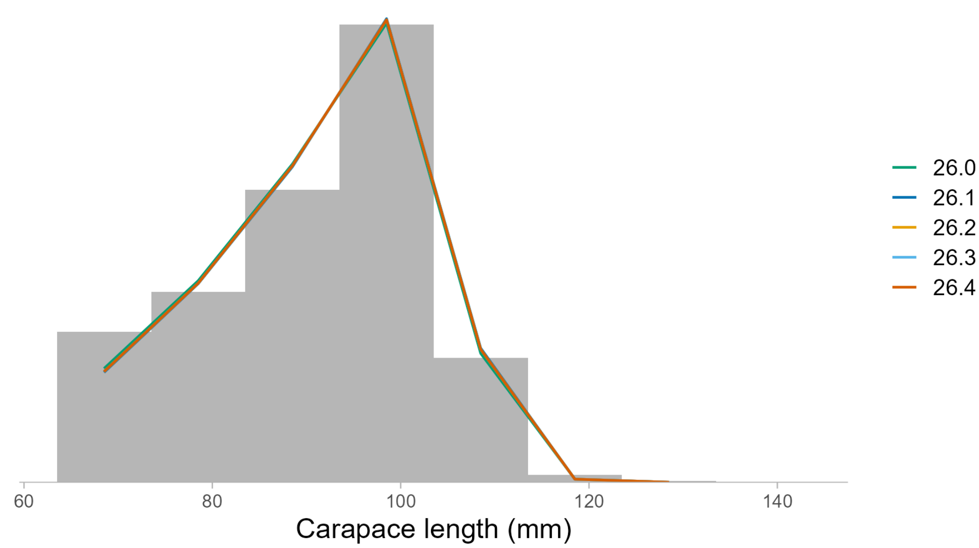

Figure 28: Aggregated observed and model-estimated size frequencies of male red king crab discarded in the directed summer commercial fishery for the new base model (26.0) and the models including the model-based index of abundance (26.1 - 26.4).

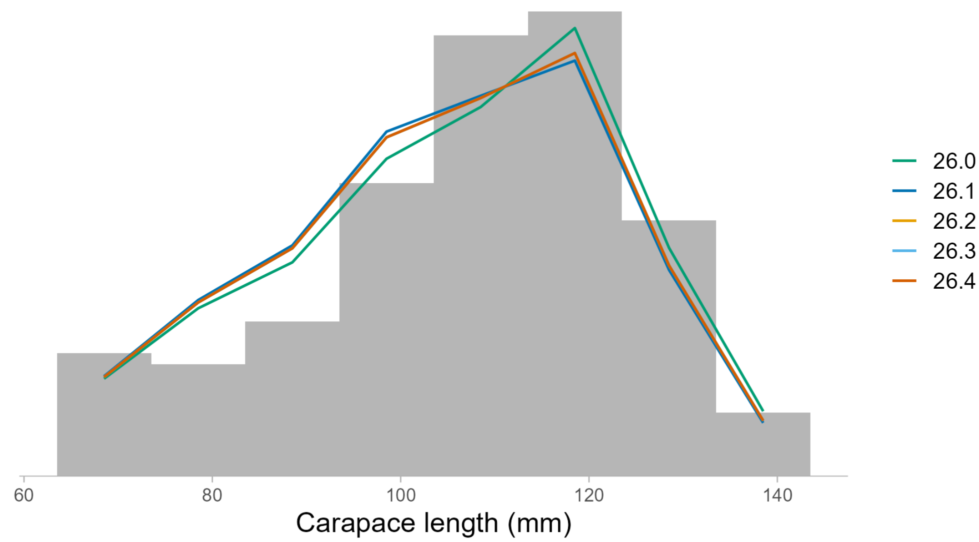

Figure 29: Aggregated observed and model-estimated size frequencies of all male red king crab caught in the directed summer commercial fishery for the new base model (26.0) and the models including the model-based index of abundance (26.1 - 26.4).

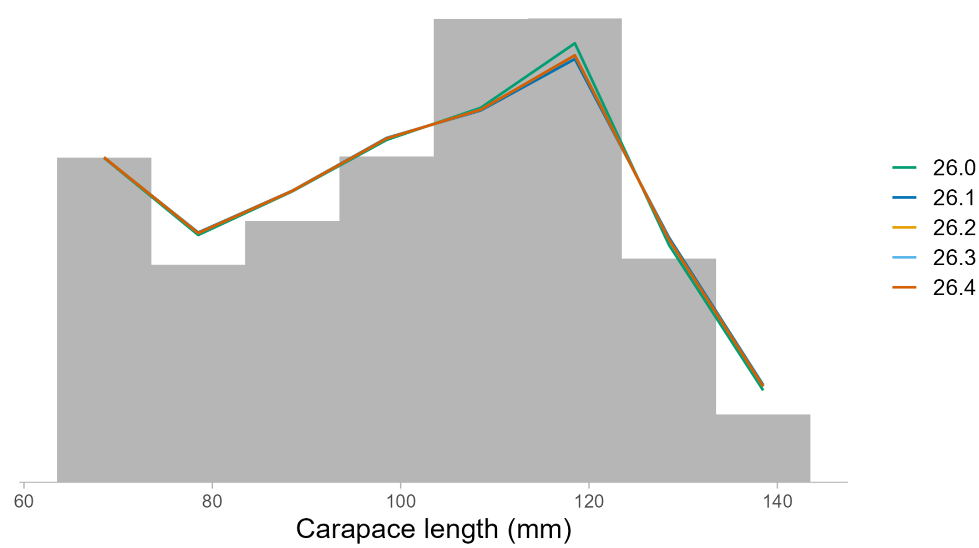

Figure 30: Aggregated observed and model-estimated size frequencies of all male red king crab caught in the National Oceanic and Atmospheric Administration (NOAA) Norton Sound trawl survey for the new base model (26.0) and the models including the model-based index of abundance (26.1 - 26.4).

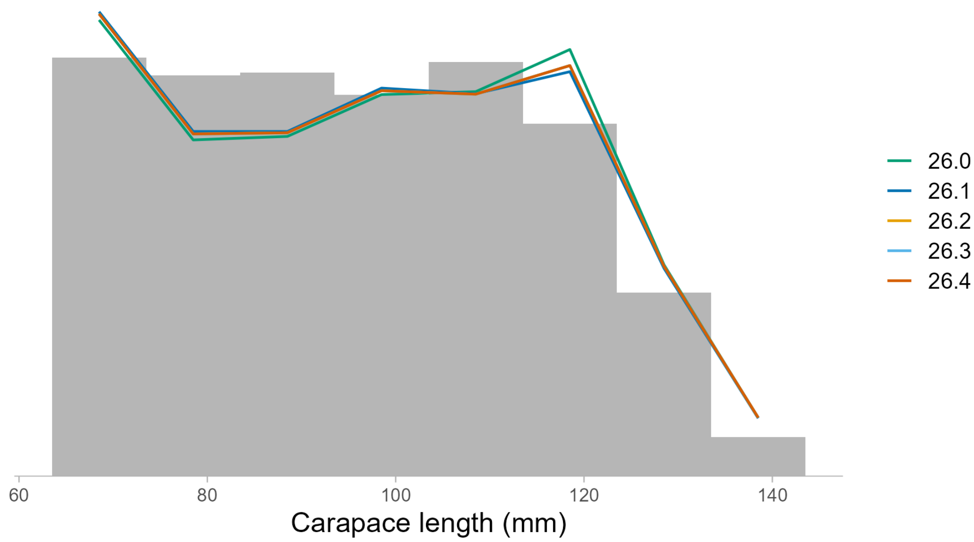

Figure 31: Aggregated observed and model-estimated size frequencies of all male red king crab caught in the Alaska Department of Fish and Game (ADFG) trawl survey for the new base model (26.0) and the models including the model-based index of abundance (26.1 - 26.4).

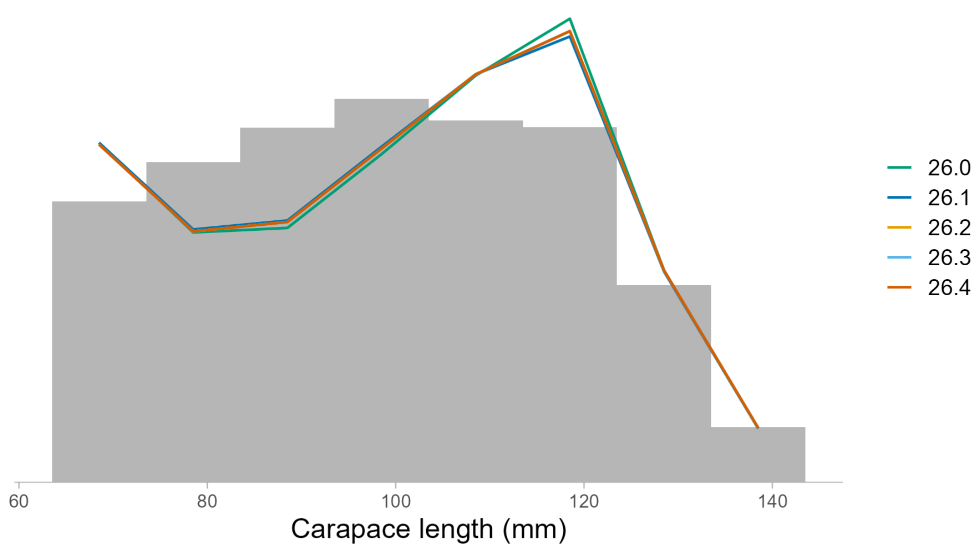

Figure 32: Aggregated observed and model-estimated size frequencies of all male red king crab caught in the National Oceanic and Atmospheric Administration (NOAA) Northern Bering Sea (NBS) trawl survey for the new base model (26.0) and the models including the model-based index of abundance (26.1 - 26.4).

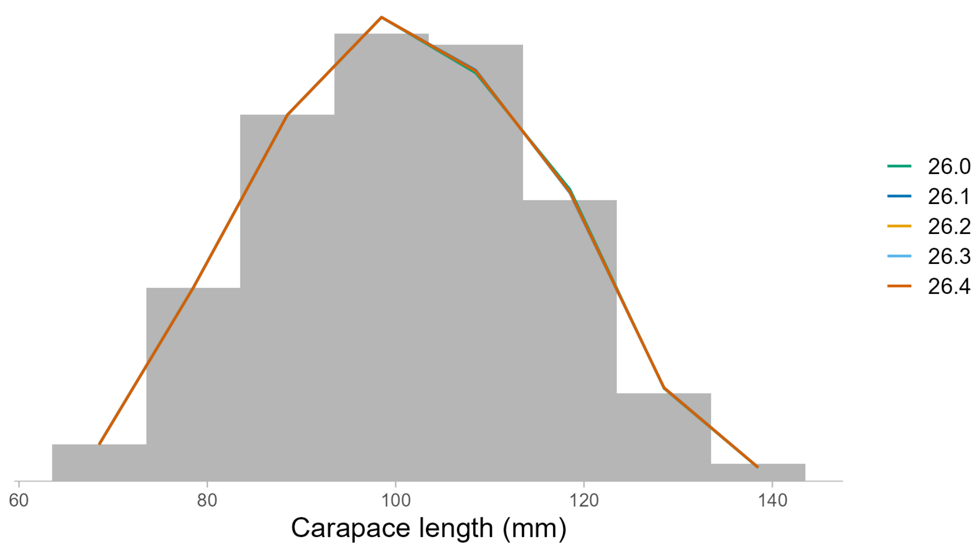

Figure 33: Aggregated observed and model-estimated size frequencies of all male red king crab caught in the Alaska Department of Fish and Game (ADFG) winter pot survey for the new base model (26.0) and the models including the model-based index of abundance (26.1 - 26.4).

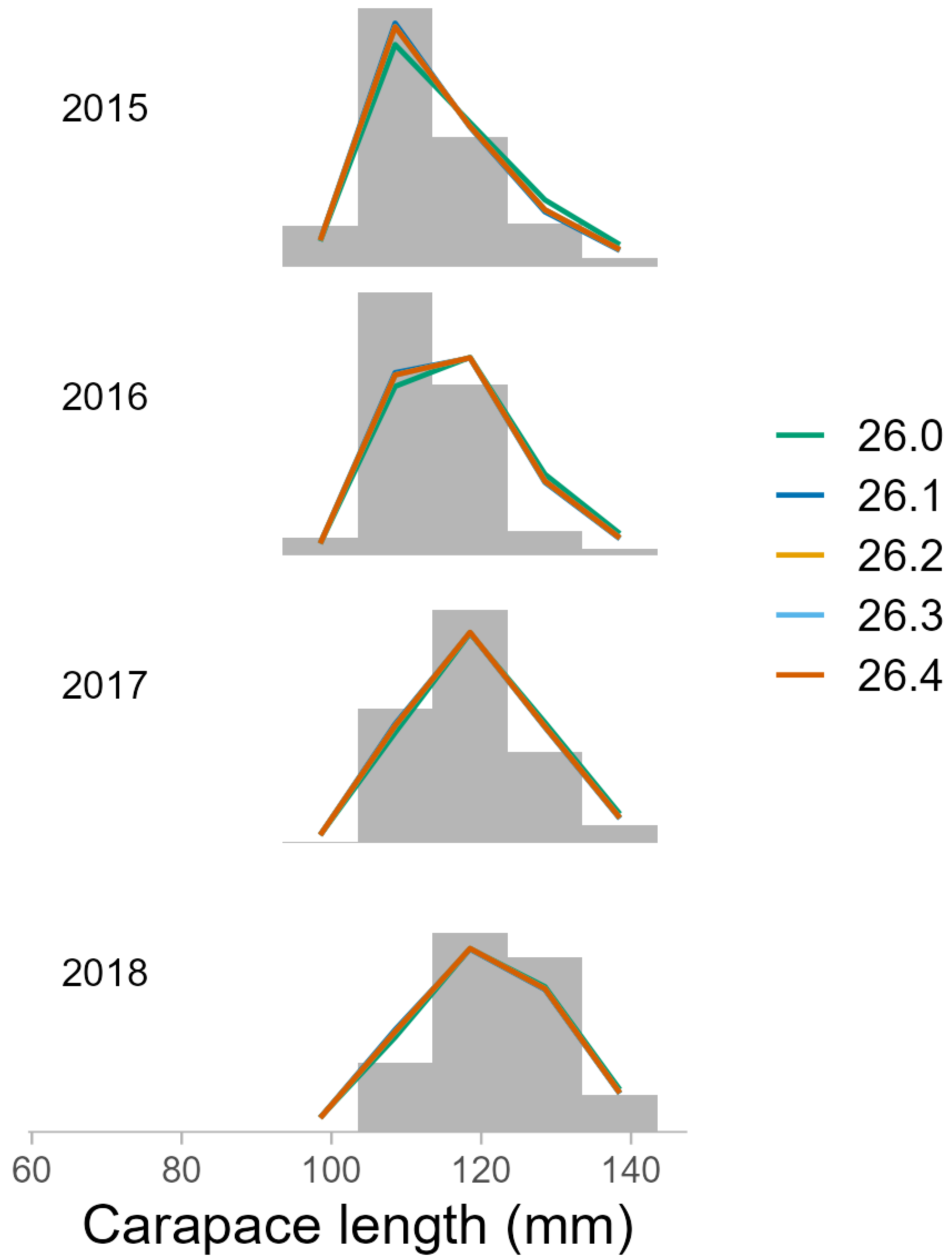

Figure 34: Annual observed and model-estimated size frequencies of male red king crab retained in the directed winter commercial fishery for the new base model (26.0) and the models including the model-based index of abundance (26.1 - 26.4).

Figure 35: Annual observed and model-estimated size frequencies of male red king crab retained in the directed summer commercial fishery for the new base model (26.0) and the models including the model-based index of abundance (26.1 - 26.4).

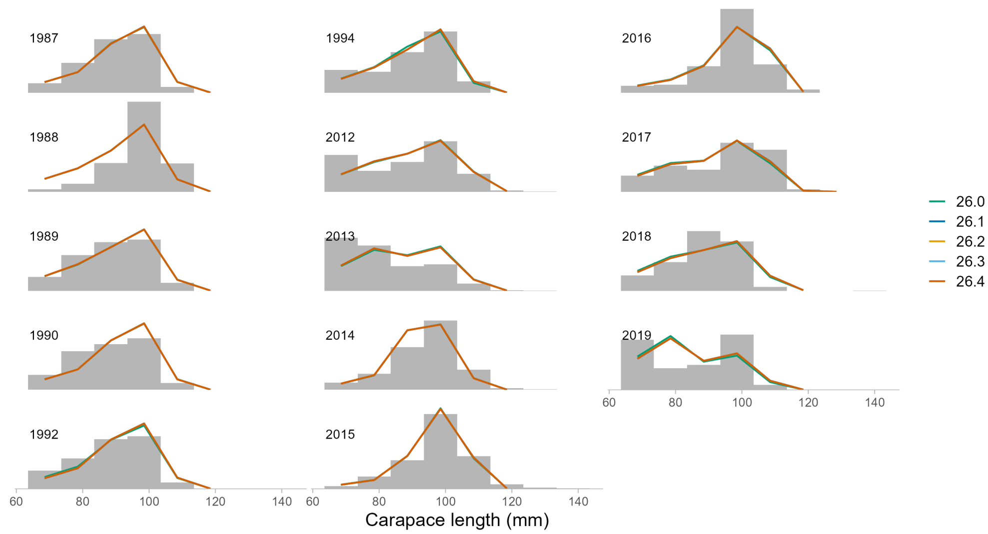

Figure 36: Annual observed and model-estimated size frequencies of male red king crab discarded in the directed summer commercial fishery for the new base model (26.0) and the models including the model-based index of abundance (26.1 - 26.4).

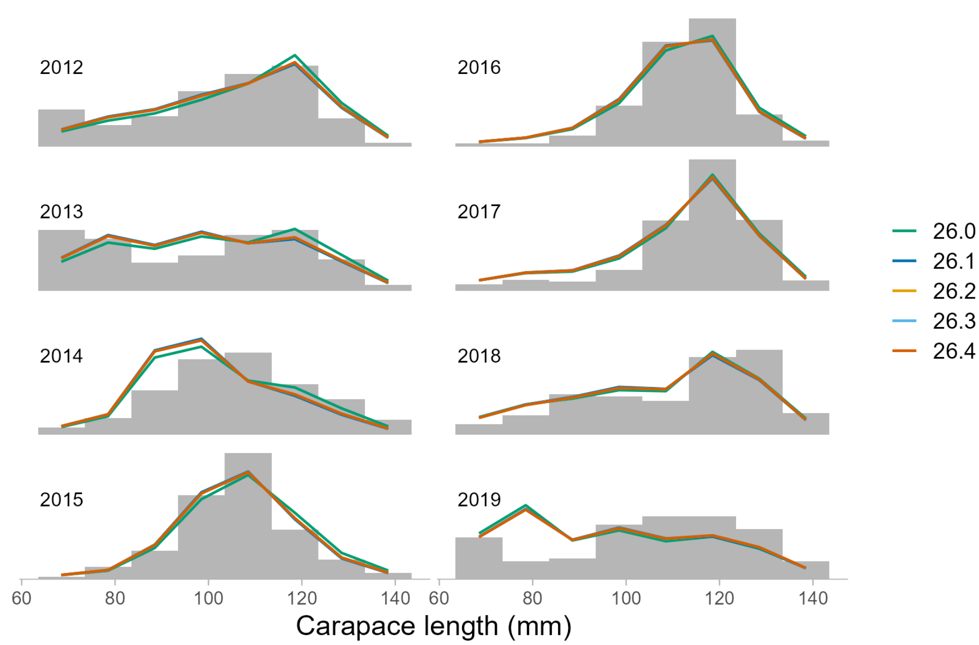

Figure 37: Annual observed and model-estimated size frequencies of all male red king crab caught in the directed summer commercial fishery for the new base model (26.0) and the models including the model-based index of abundance (26.1 - 26.4).

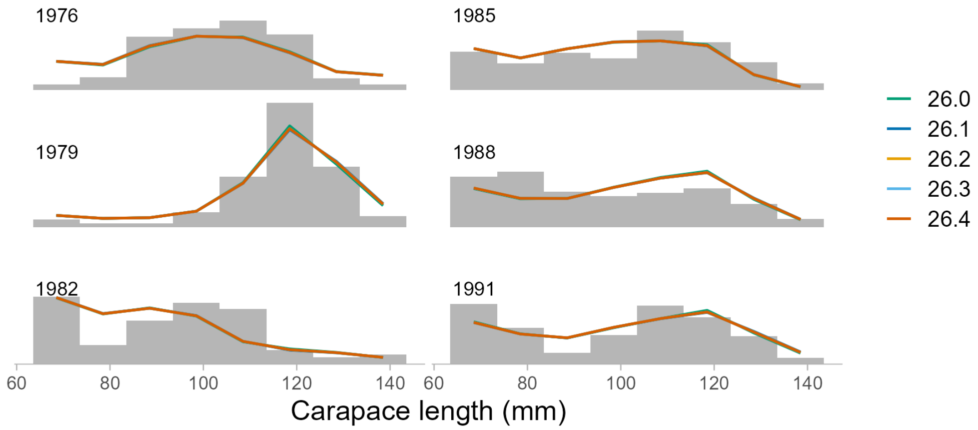

Figure 38: Annual observed and model-estimated size frequencies of all male red king crab caught in the National Oceanic and Atmospheric Administration (NOAA) Norton Sound trawl survey for the new base model (26.0) and the models including the model-based index of abundance (26.1 - 26.4).

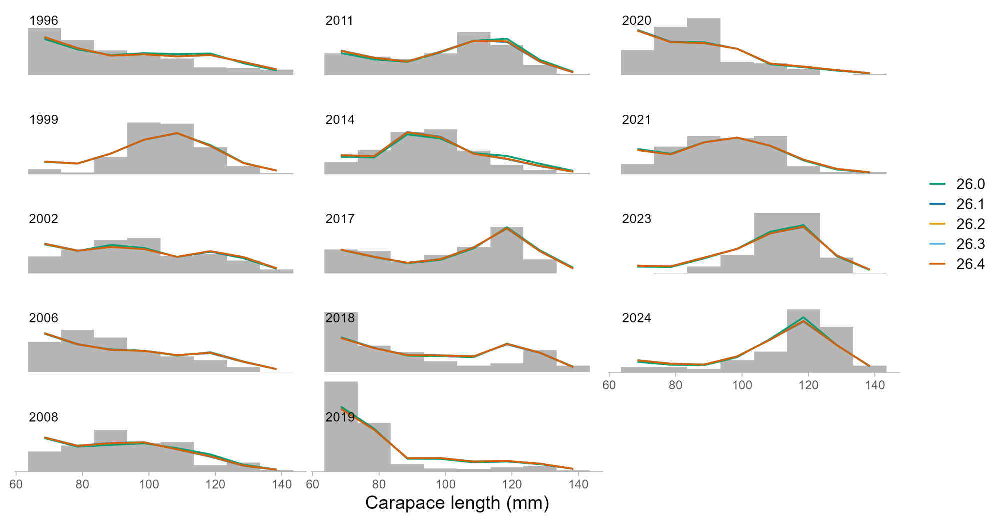

Figure 39: Annual observed and model-estimated size frequencies of all male red king crab caught in the Alaska Department of Fish and Game (ADFG) trawl survey for the new base model (26.0) and the models including the model-based index of abundance (26.1 - 26.4).

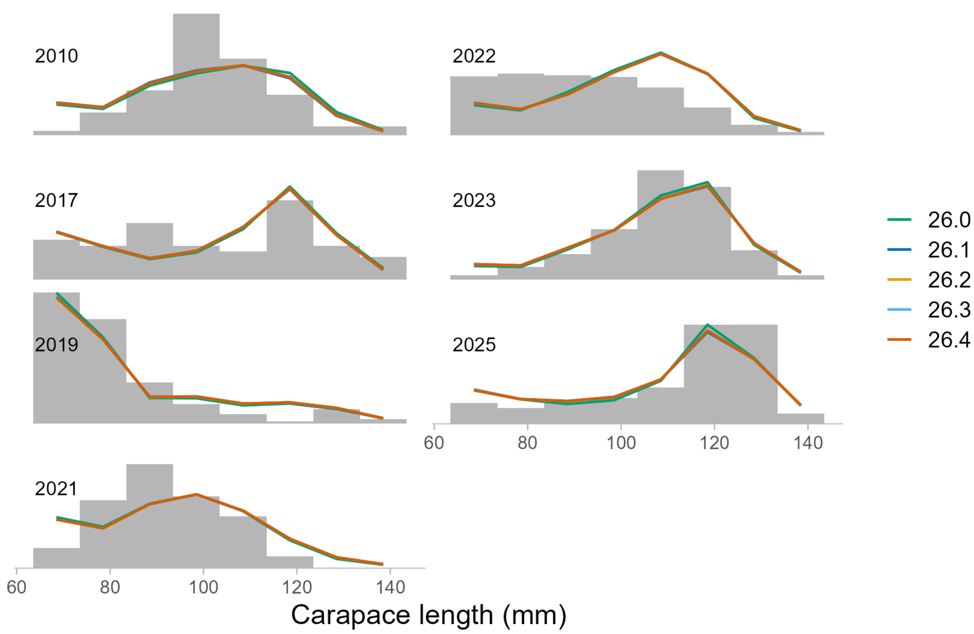

Figure 40: Annual observed and model-estimated size frequencies of all male red king crab caught in the National Oceanic and Atmospheric Administration (NOAA) Northern Bering Sea (NBS) trawl survey for the new base model (26.0) and the models including the model-based index of abundance (26.1 - 26.4).

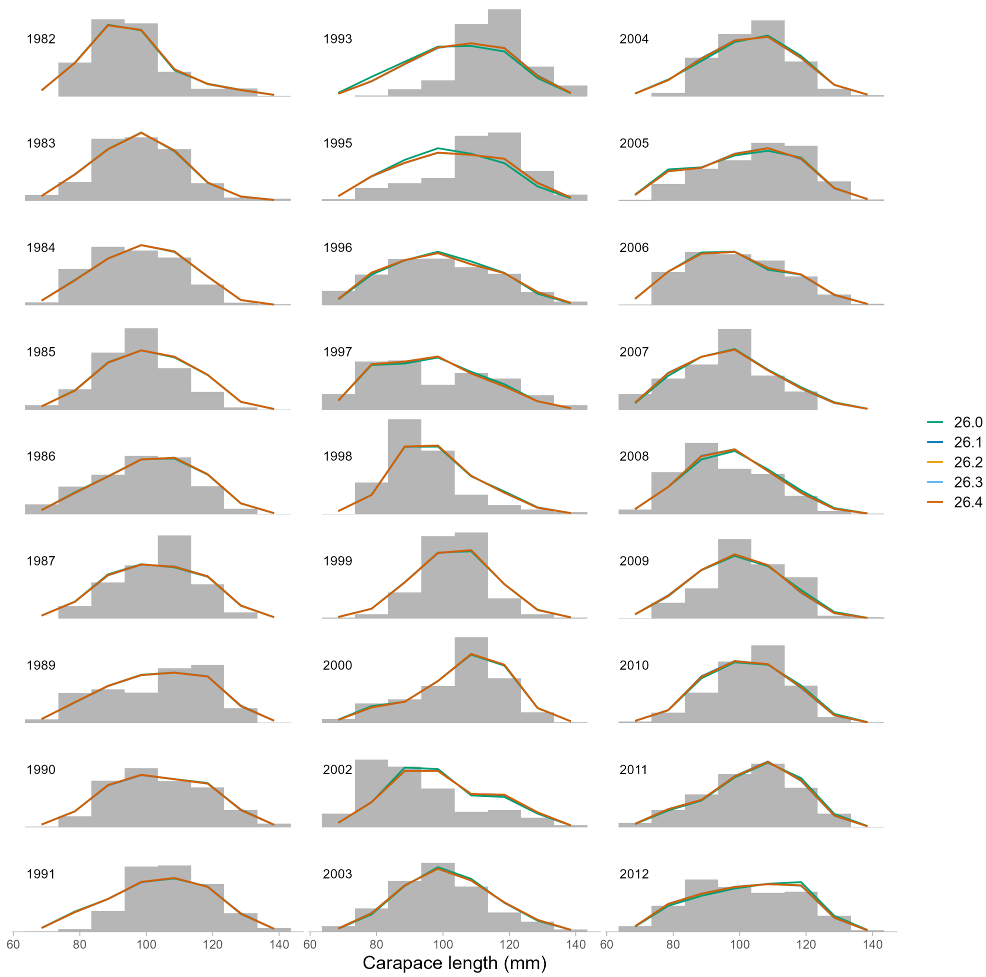

Figure 41: Annual observed and model-estimated size frequencies of all male red king crab caught in the Alaska Department of Fish and Game (ADFG) winter pot survey for the new base model (26.0) and the models including the model-based index of abundance (26.1 - 26.4).

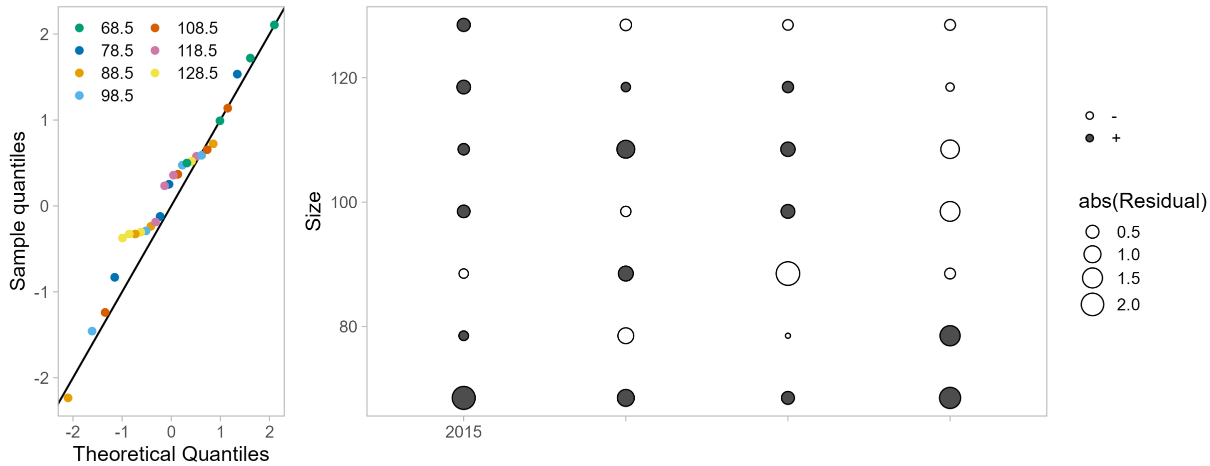

Figure 42: One-Step-Ahead residuals for model 26.0 fits to size composition data from the winter commercial fishery retained catch.

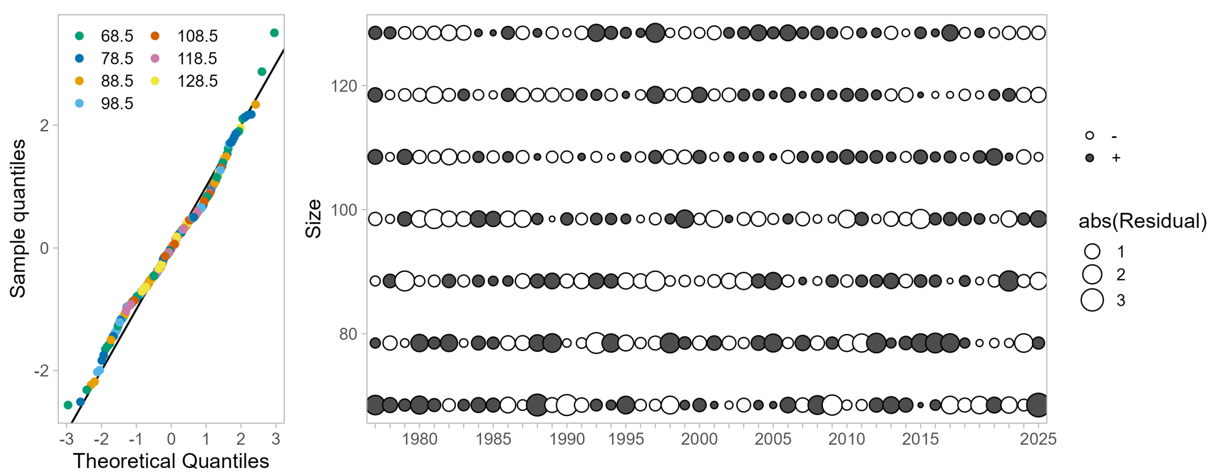

Figure 43: One-Step-Ahead residuals for model 26.0 fits to size composition data from the summer commercial fishery retained catch.

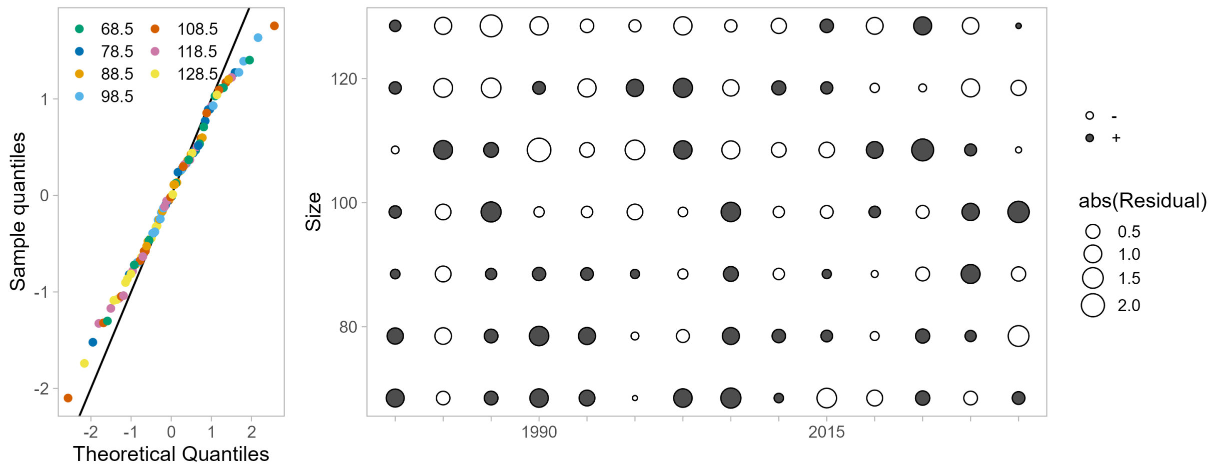

Figure 44: One-Step-Ahead residuals for model 26.0 fits to size composition data from the summer commercial fishery discarded catch.

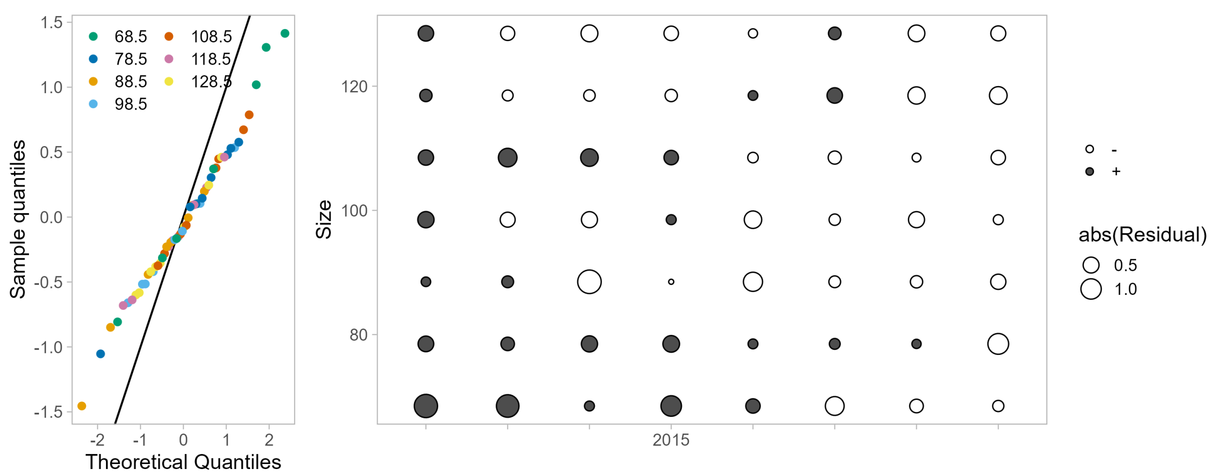

Figure 45: One-Step-Ahead residuals for model 26.0 fits to size composition data from the summer commercial fishery total catch.

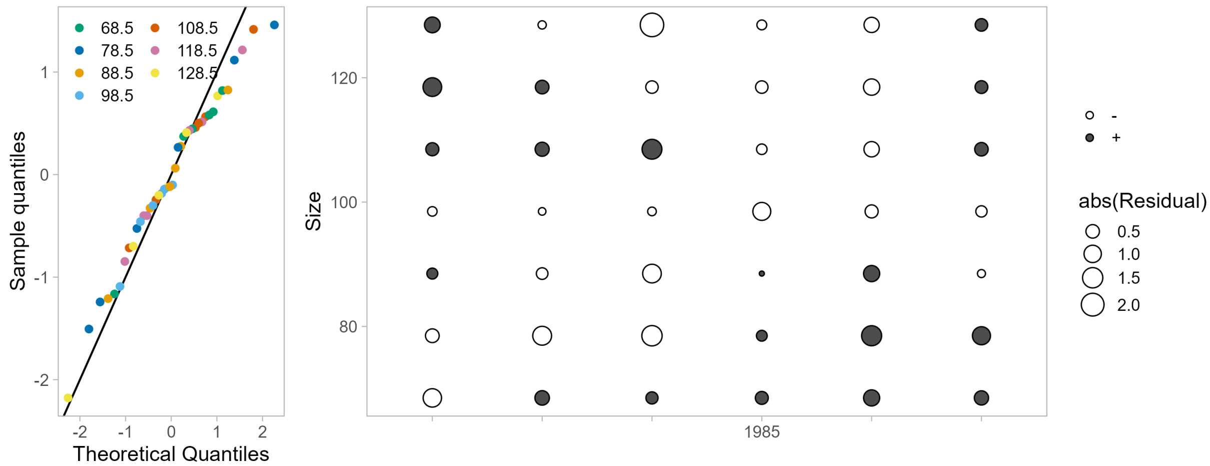

Figure 46: One-Step-Ahead residuals for model 26.0 fits to size composition data from the National Oceanic and Atmospheric Administration (NOAA) Norton Sound trawl survey.

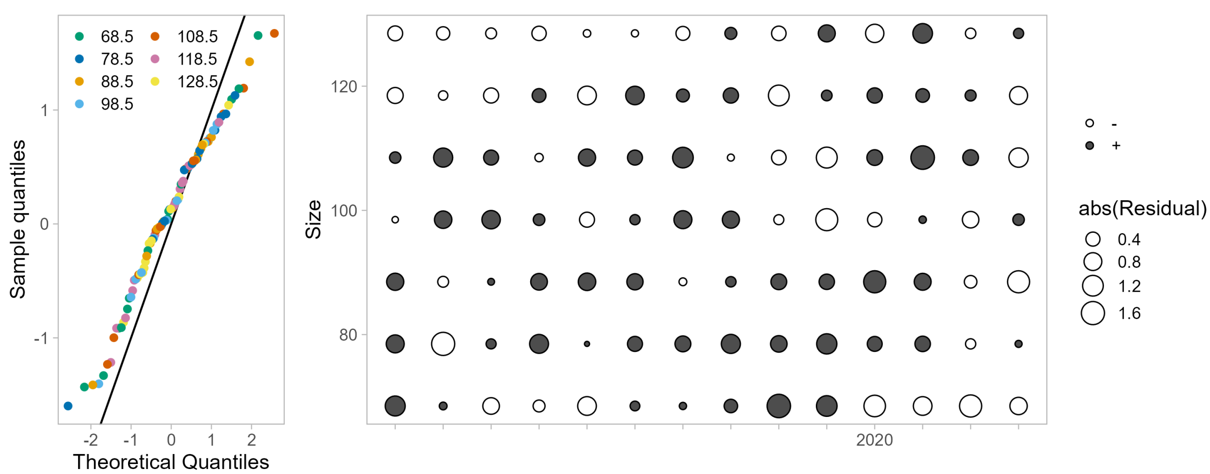

Figure 47: One-Step-Ahead residuals for model 26.0 fits to size composition data from the Alaska Department of Fish and Game (ADFG) trawl survey.

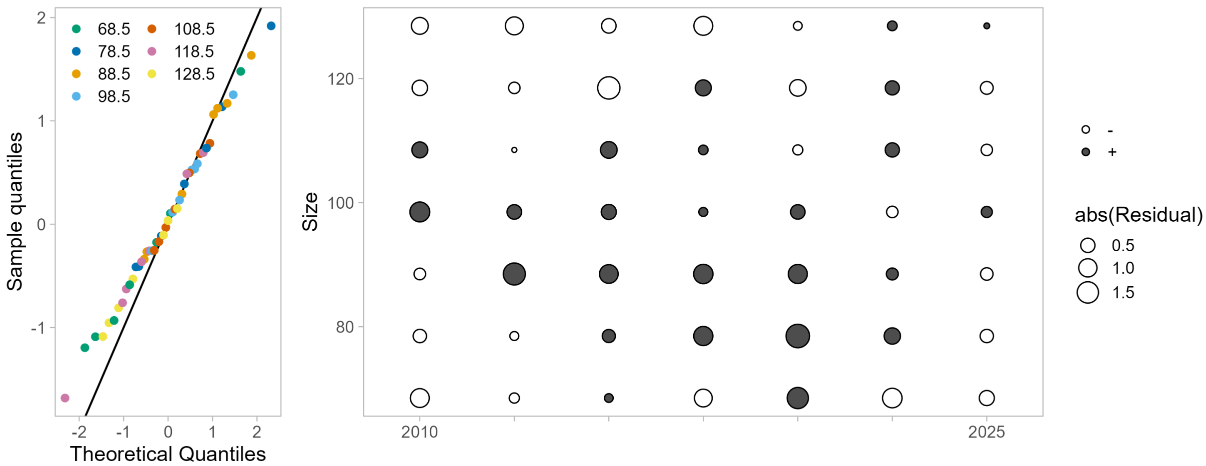

Figure 48: One-Step-Ahead residuals for model 26.0 fits to size composition data from the National Oceanic and Atmospheric Administration (NOAA) Northern Bering Sea (NBS) trawl survey.

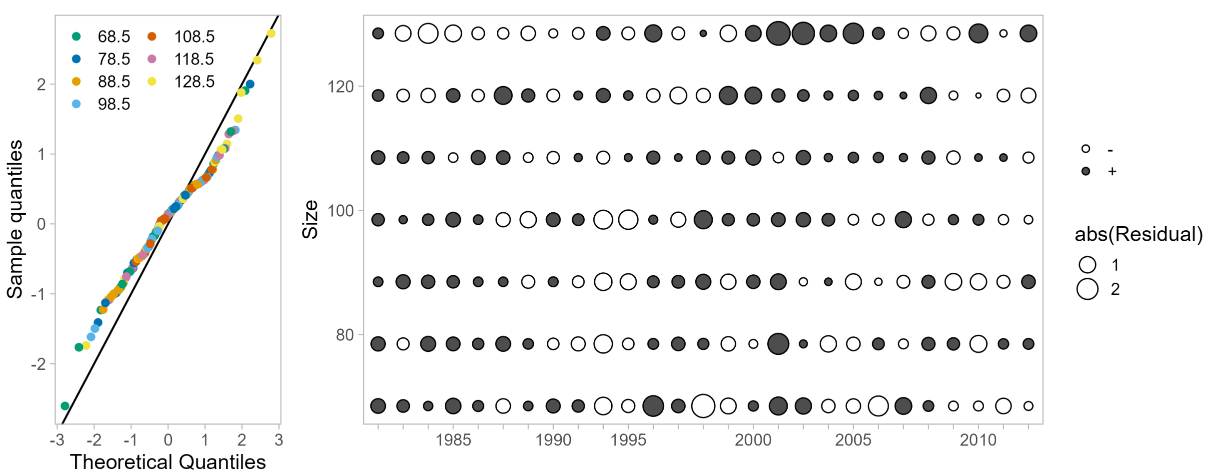

Figure 49: One-Step-Ahead residuals for model 26.0 fits to size composition data from the Alaska Department of Fish and Game (ADFG) winter pot survey.

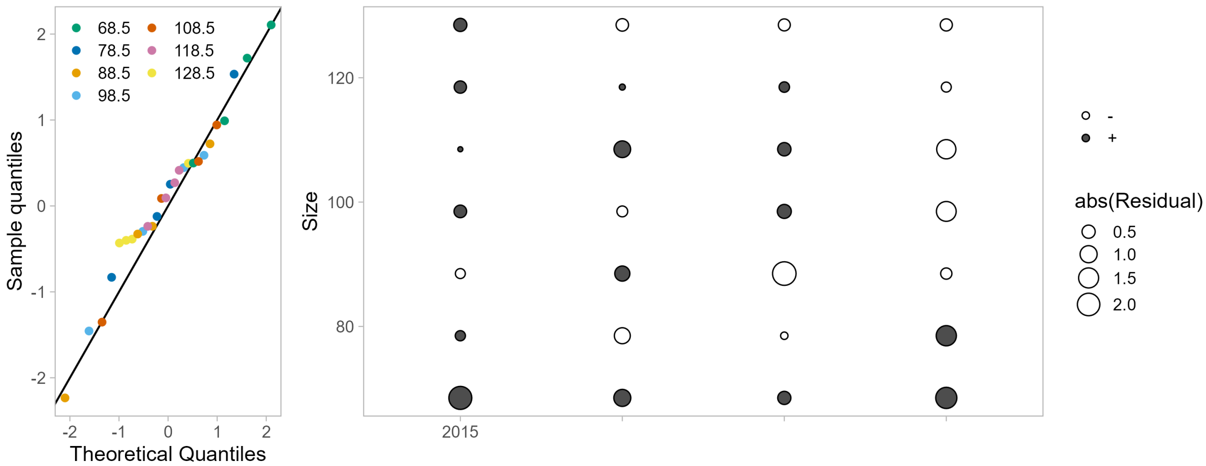

Figure 50: One-Step-Ahead residuals for model 26.1 fits to size composition data from the winter commercial fishery retained catch.

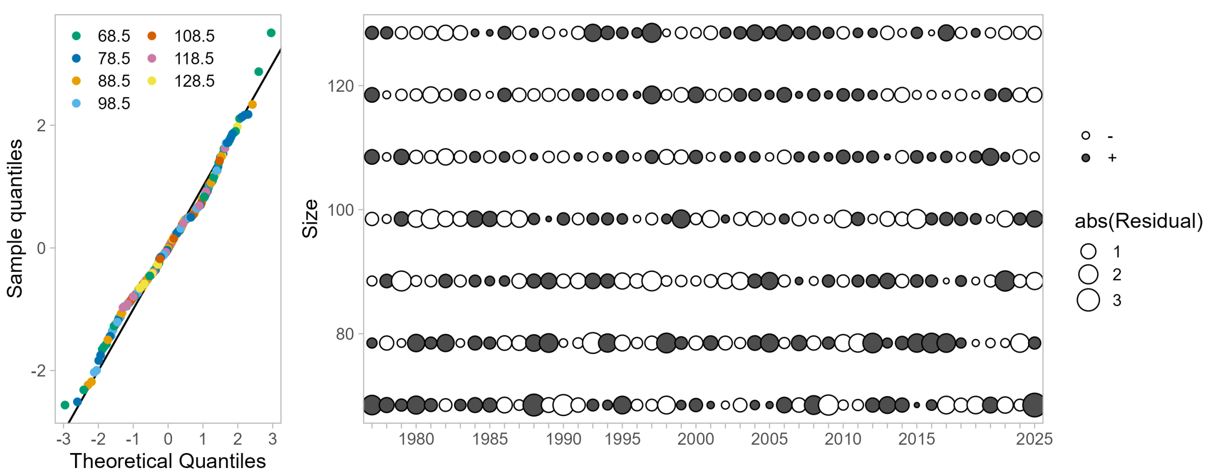

Figure 51: One-Step-Ahead residuals for model 26.1 fits to size composition data from the summer commercial fishery retained catch.

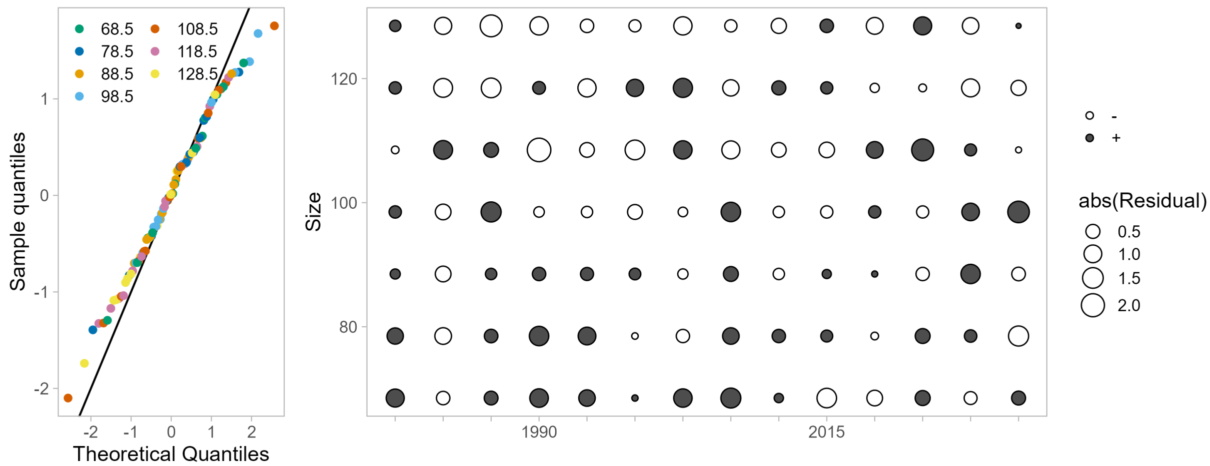

Figure 52: One-Step-Ahead residuals for model 26.1 fits to size composition data from the summer commercial fishery discarded catch.

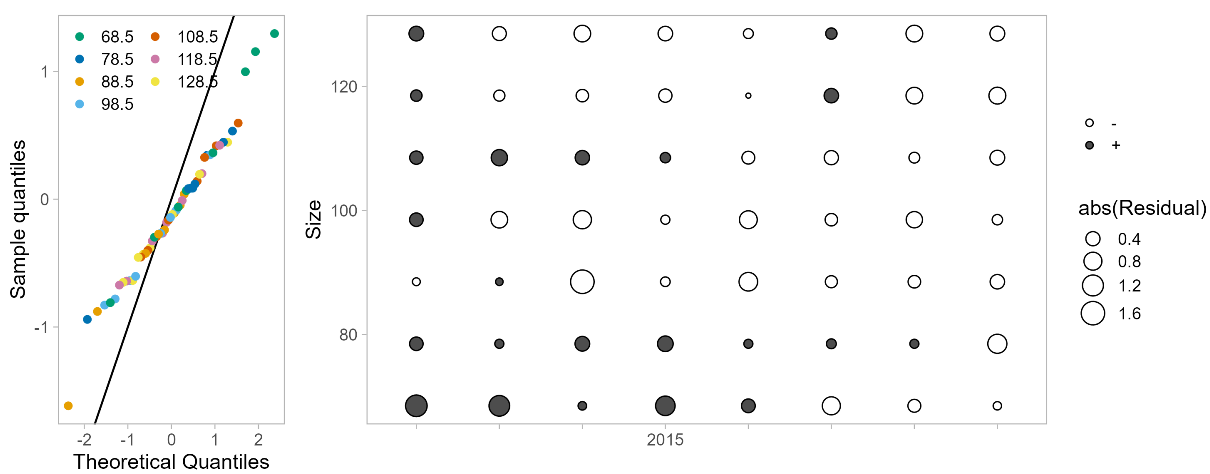

Figure 53: One-Step-Ahead residuals for model 26.1 fits to size composition data from the summer commercial fishery total catch.

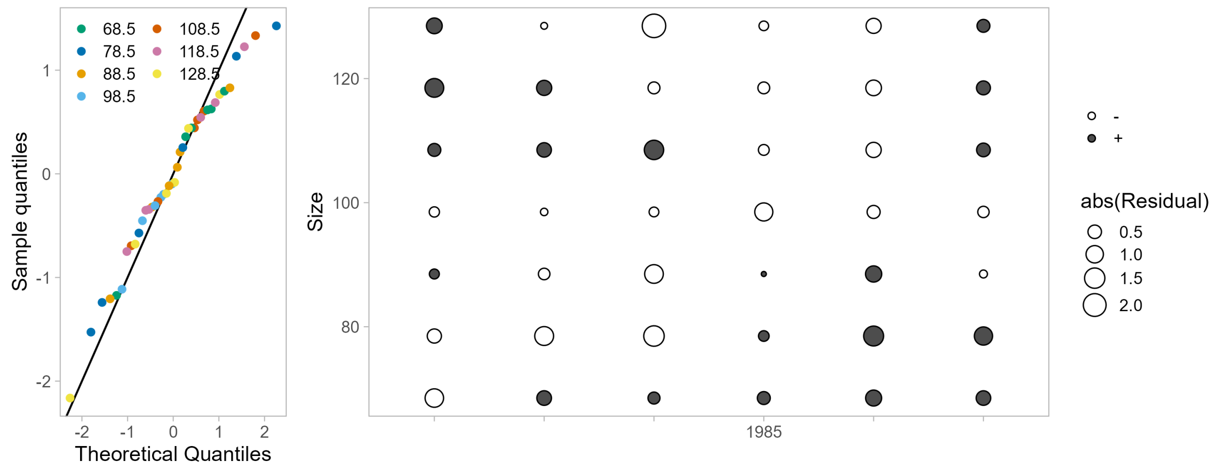

Figure 54: One-Step-Ahead residuals for model 26.1 fits to size composition data from the National Oceanic and Atmospheric Administration (NOAA) Norton Sound trawl survey.

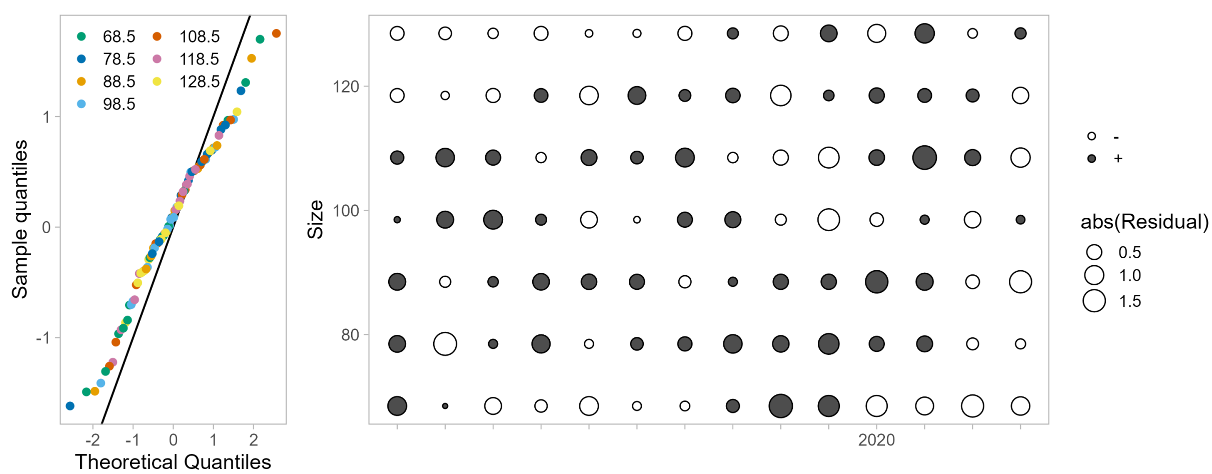

Figure 55: One-Step-Ahead residuals for model 26.1 fits to size composition data from the Alaska Department of Fish and Game (ADFG) trawl survey.

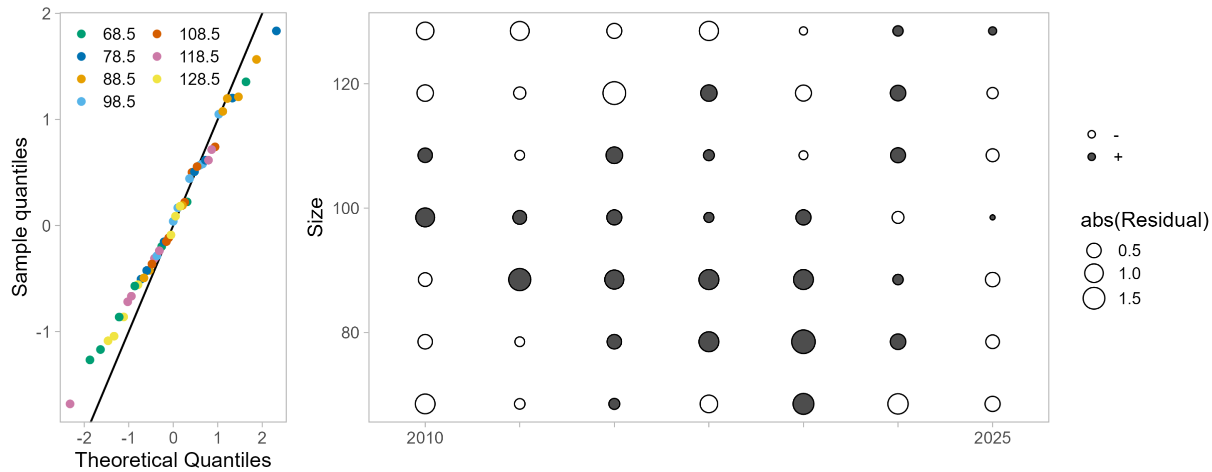

Figure 56: One-Step-Ahead residuals for model 26.1 fits to size composition data from the National Oceanic and Atmospheric Administration (NOAA) Northern Bering Sea (NBS) trawl survey.

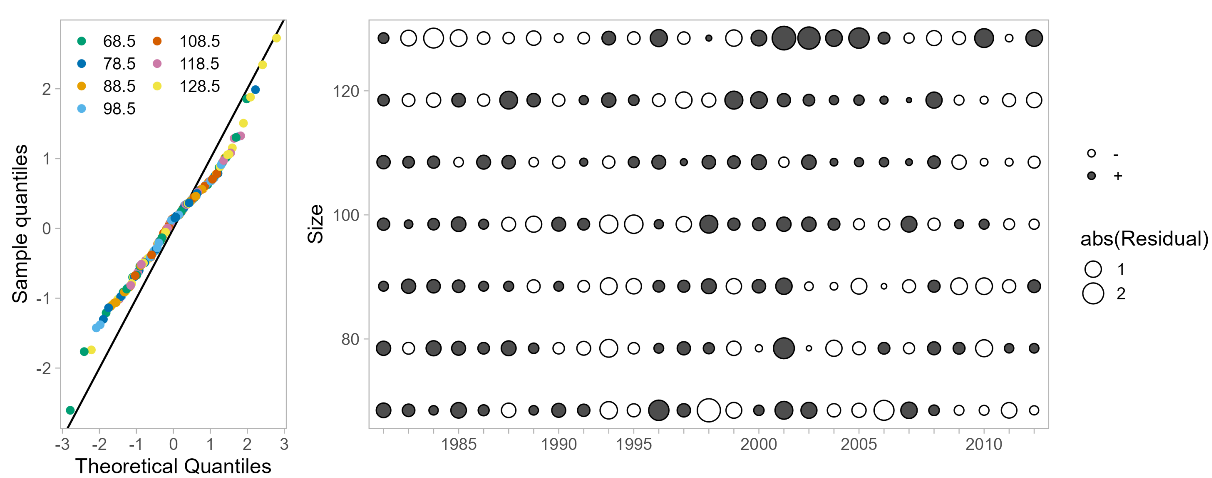

Figure 57: One-Step-Ahead residuals for model 26.1 fits to size composition data from the Alaska Department of Fish and Game (ADFG) winter pot survey.

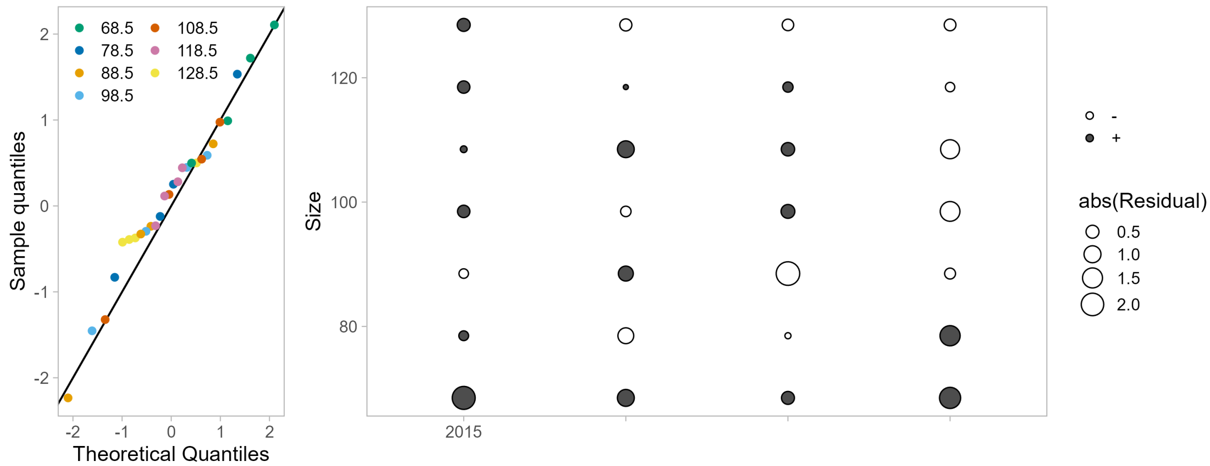

Figure 58: One-Step-Ahead residuals for model 26.2 fits to size composition data from the winter commercial fishery retained catch.

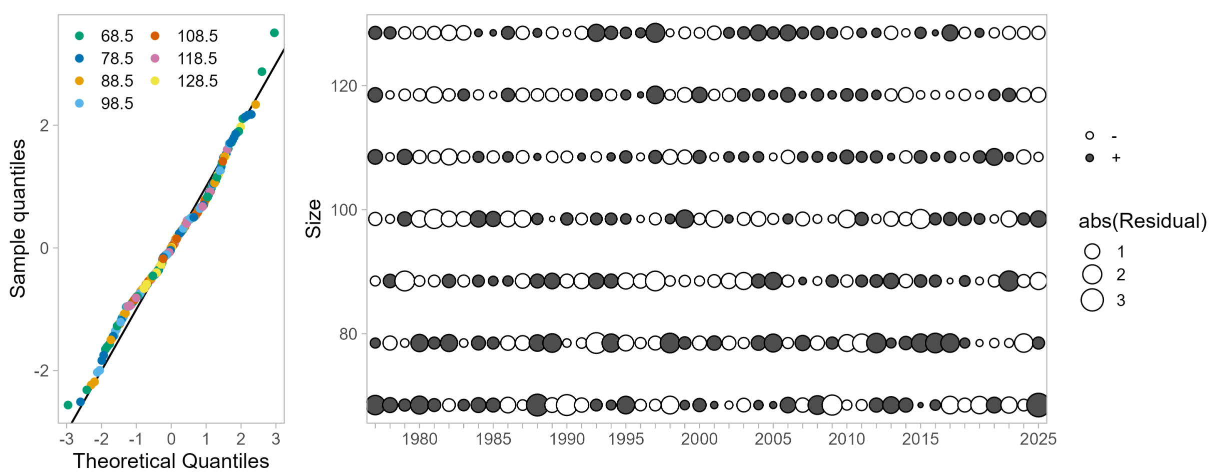

Figure 59: One-Step-Ahead residuals for model 26.2 fits to size composition data from the summer commercial fishery retained catch.

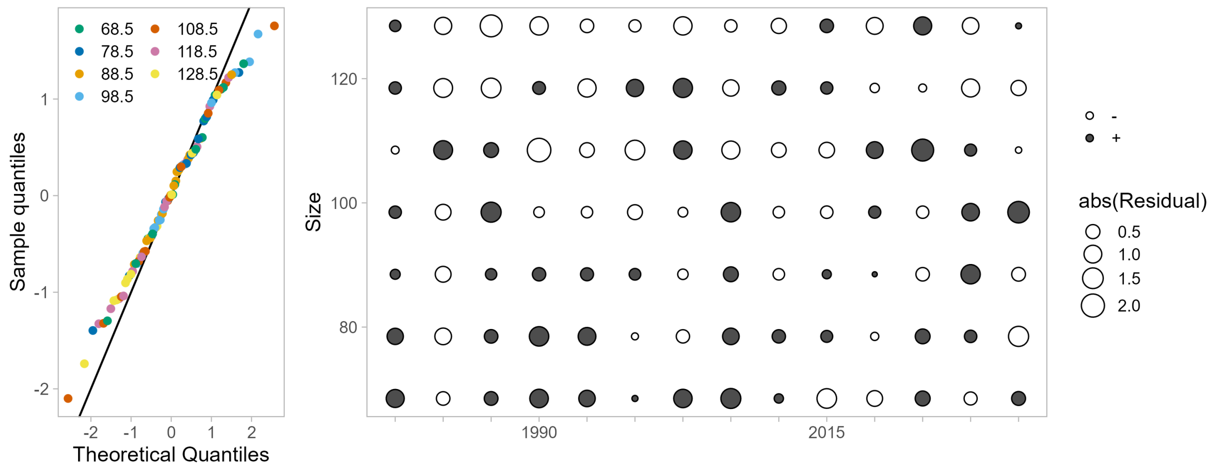

Figure 60: One-Step-Ahead residuals for model 26.2 fits to size composition data from the summer commercial fishery discarded catch.

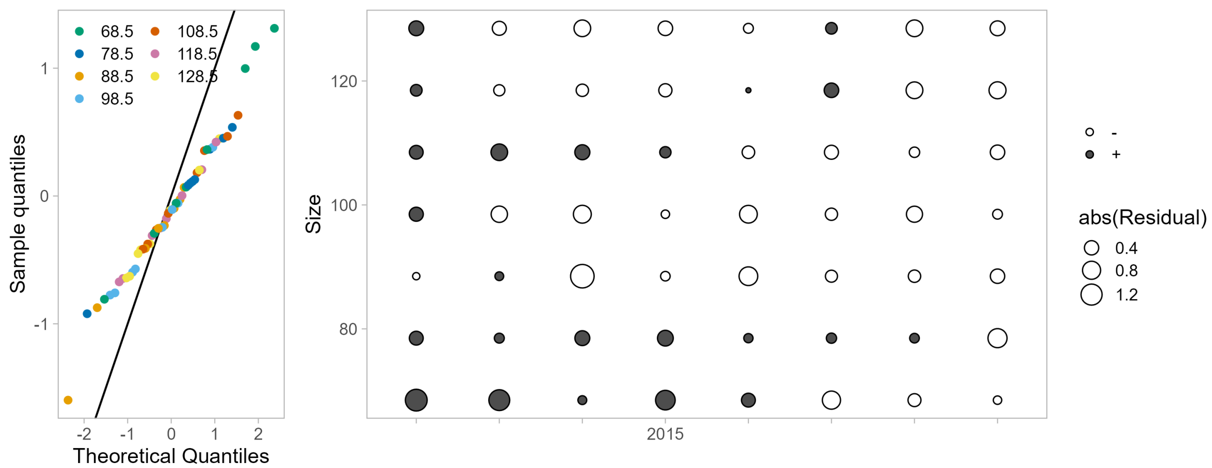

Figure 61: One-Step-Ahead residuals for model 26.2 fits to size composition data from the summer commercial fishery total catch.

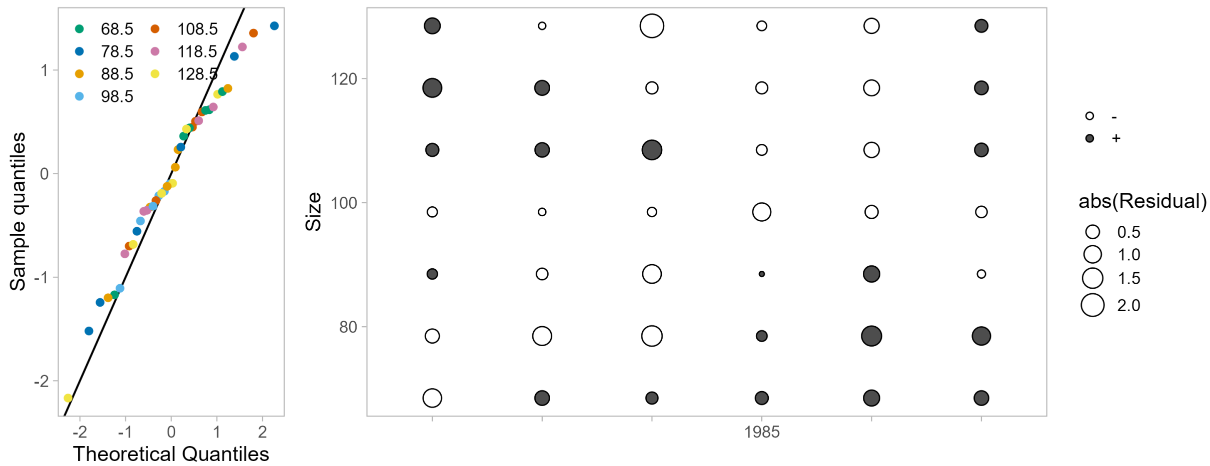

Figure 62: One-Step-Ahead residuals for model 26.2 fits to size composition data from the National Oceanic and Atmospheric Administration (NOAA) Norton Sound trawl survey.

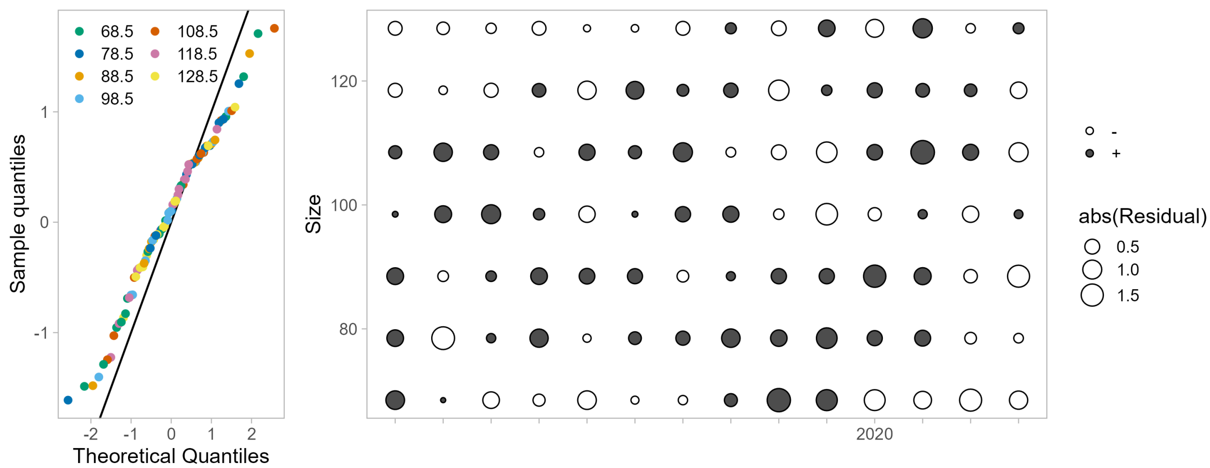

Figure 63: One-Step-Ahead residuals for model 26.2 fits to size composition data from the Alaska Department of Fish and Game (ADFG) trawl survey.

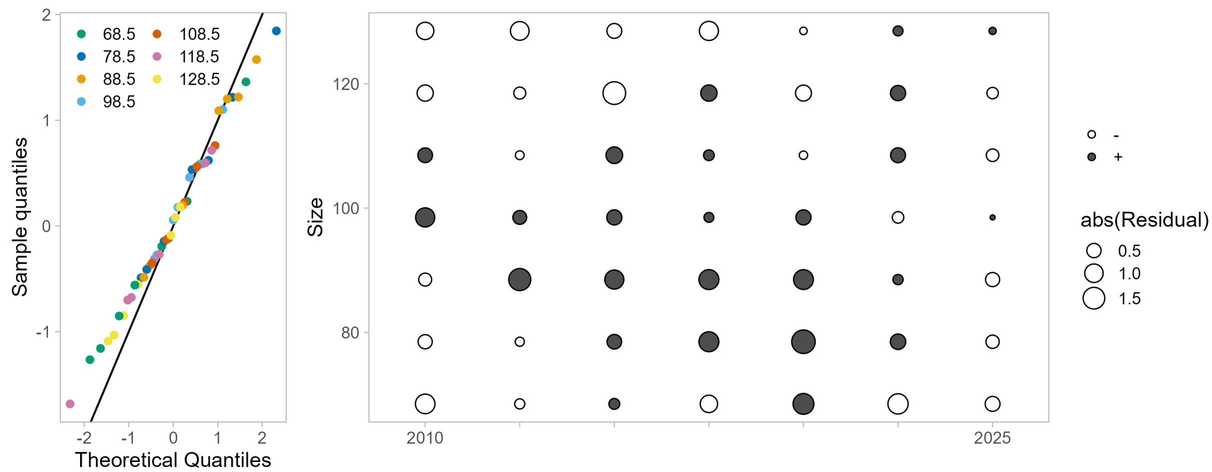

Figure 64: One-Step-Ahead residuals for model 26.2 fits to size composition data from the National Oceanic and Atmospheric Administration (NOAA) Northern Bering Sea (NBS) trawl survey.

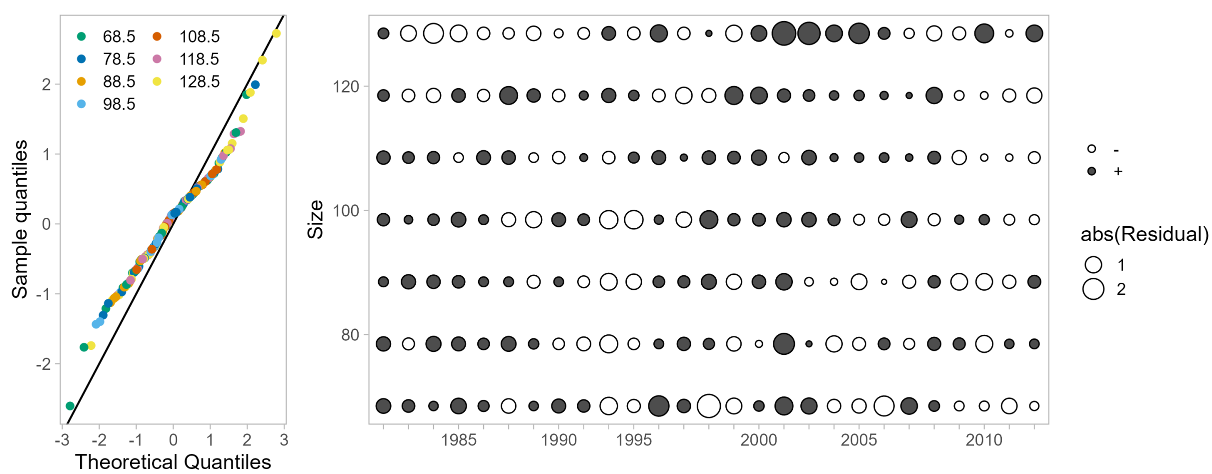

Figure 65: One-Step-Ahead residuals for model 26.2 fits to size composition data from the Alaska Department of Fish and Game (ADFG) winter pot survey.

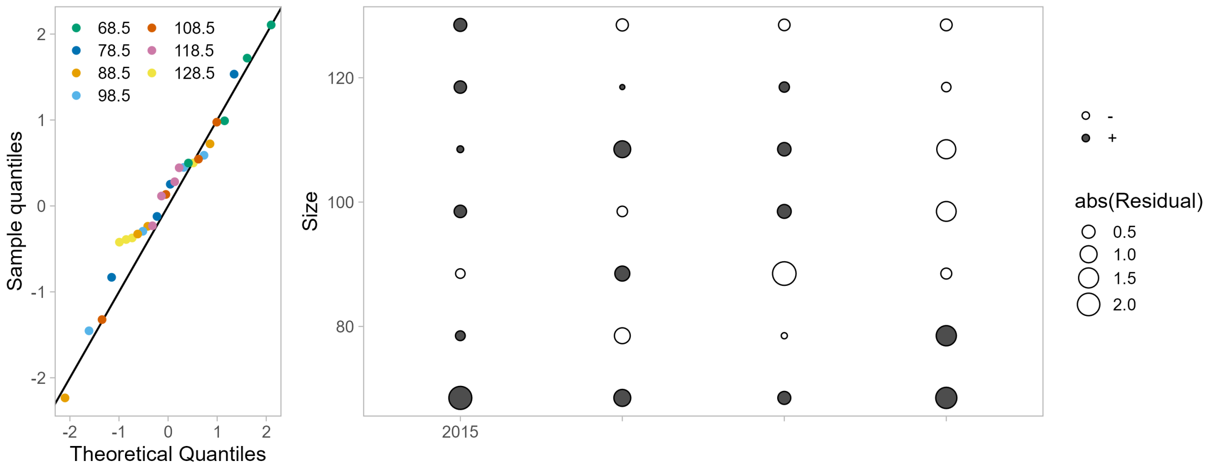

Figure 66: One-Step-Ahead residuals for model 26.3 fits to size composition data from the winter commercial fishery retained catch.

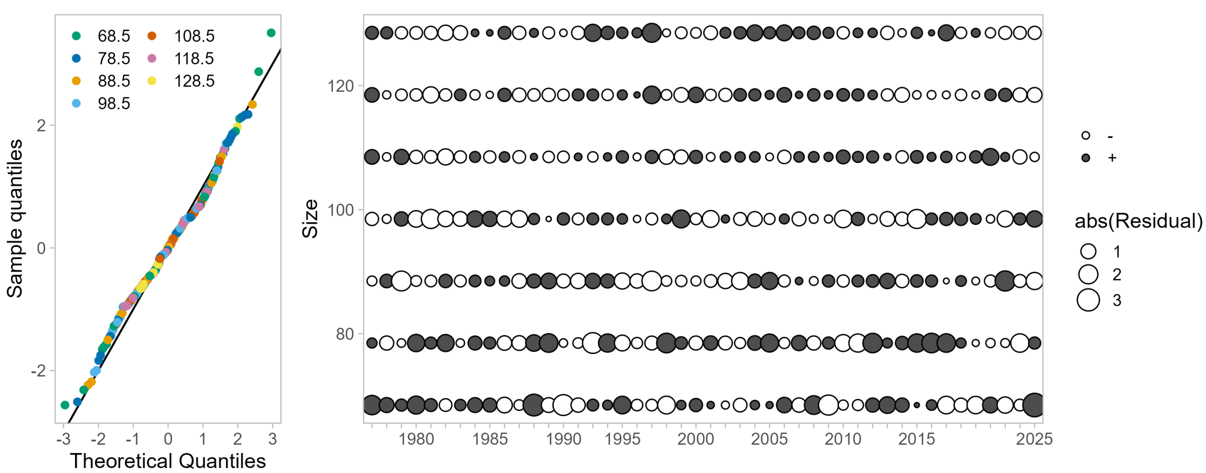

Figure 67: One-Step-Ahead residuals for model 26.3 fits to size composition data from the summer commercial fishery retained catch.

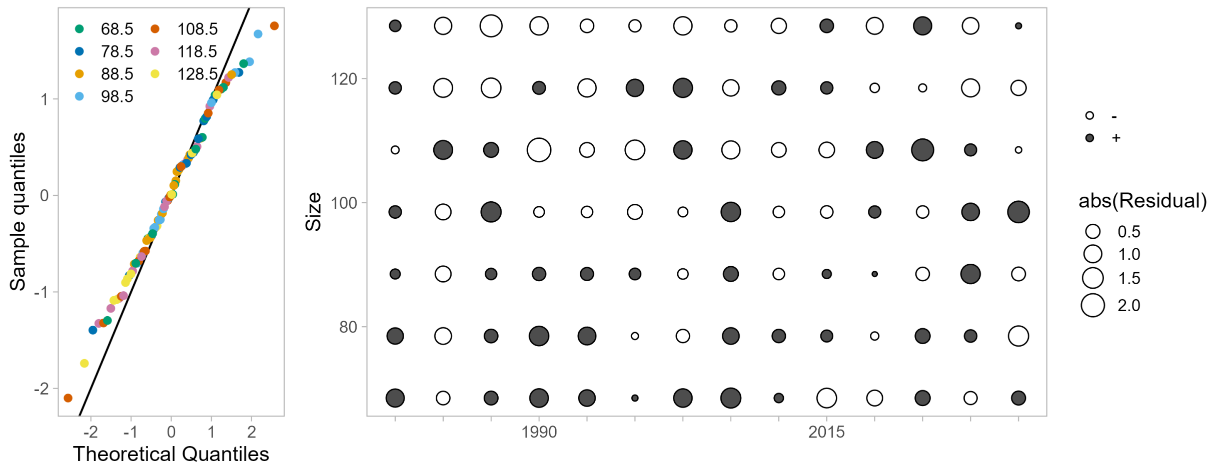

Figure 68: One-Step-Ahead residuals for model 26.3 fits to size composition data from the summer commercial fishery discarded catch.

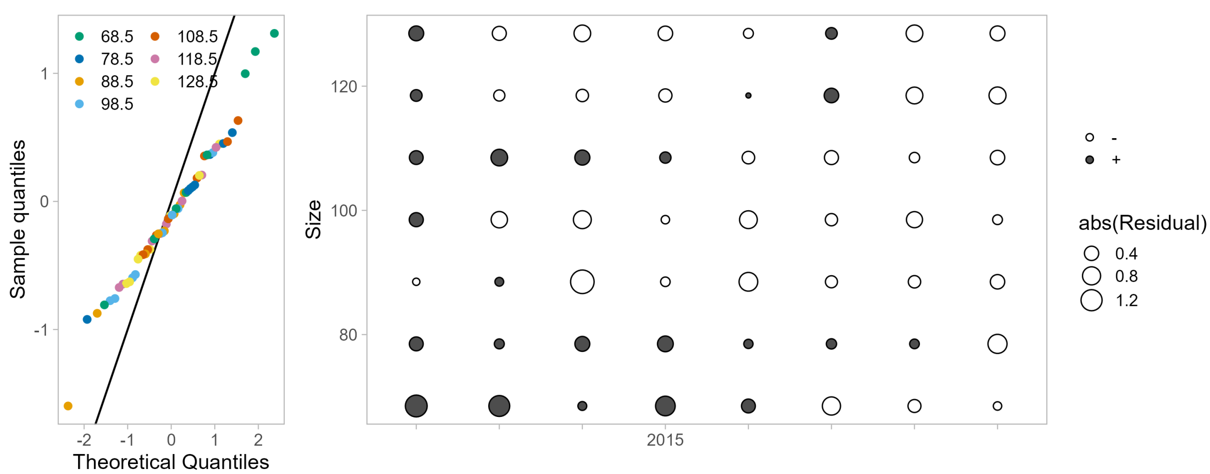

Figure 69: One-Step-Ahead residuals for model 26.3 fits to size composition data from the summer commercial fishery total catch.

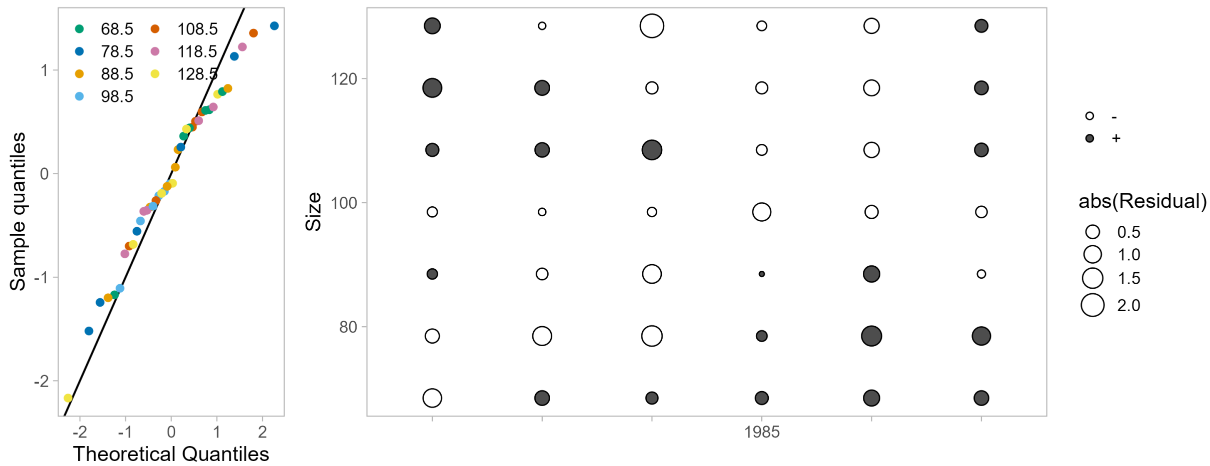

Figure 70: One-Step-Ahead residuals for model 26.3 fits to size composition data from the National Oceanic and Atmospheric Administration (NOAA) Norton Sound trawl survey.

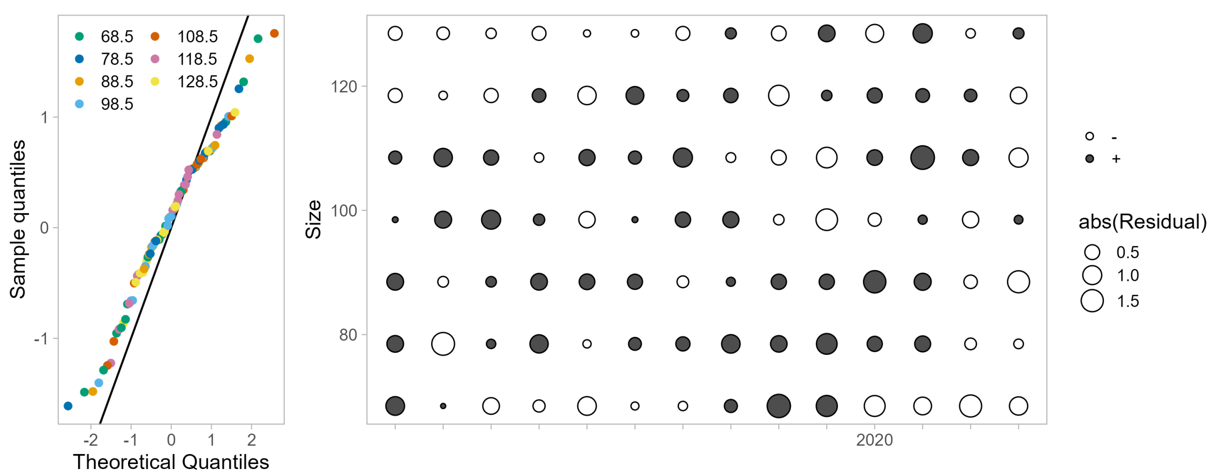

Figure 71: One-Step-Ahead residuals for model 26.3 fits to size composition data from the Alaska Department of Fish and Game (ADFG) trawl survey.

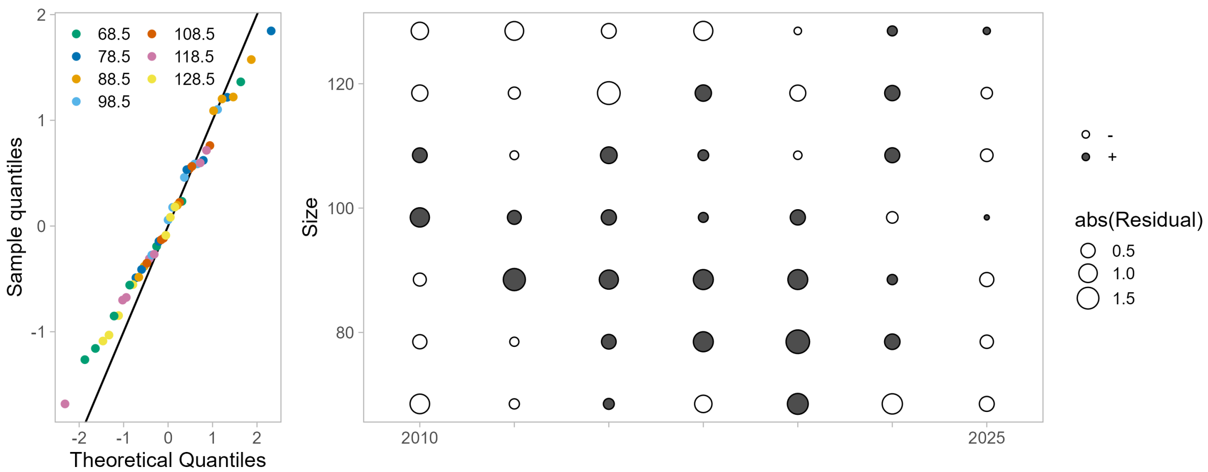

Figure 72: One-Step-Ahead residuals for model 26.3 fits to size composition data from the National Oceanic and Atmospheric Administration (NOAA) Northern Bering Sea (NBS) trawl survey.

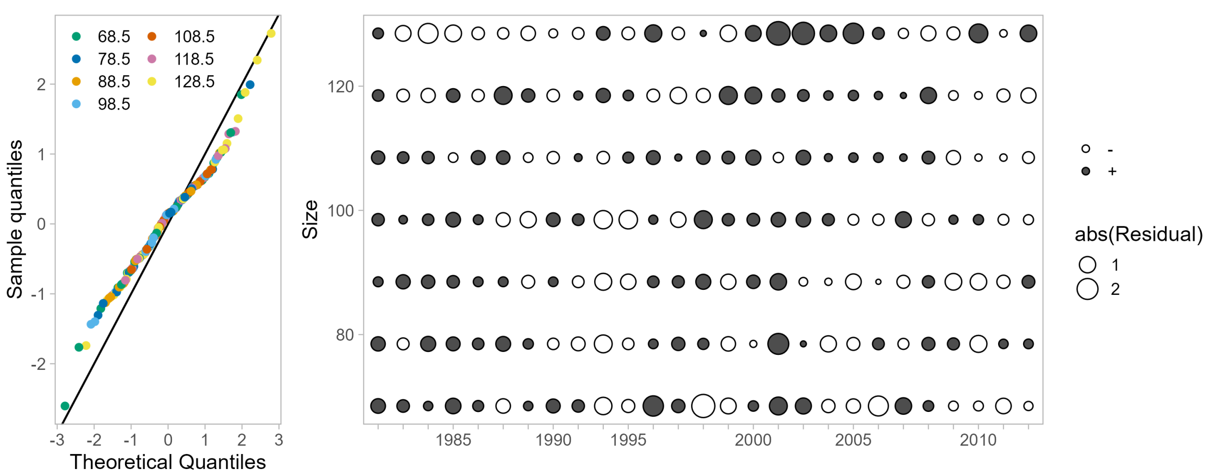

Figure 73: One-Step-Ahead residuals for model 26.3 fits to size composition data from the Alaska Department of Fish and Game (ADFG) winter pot survey.

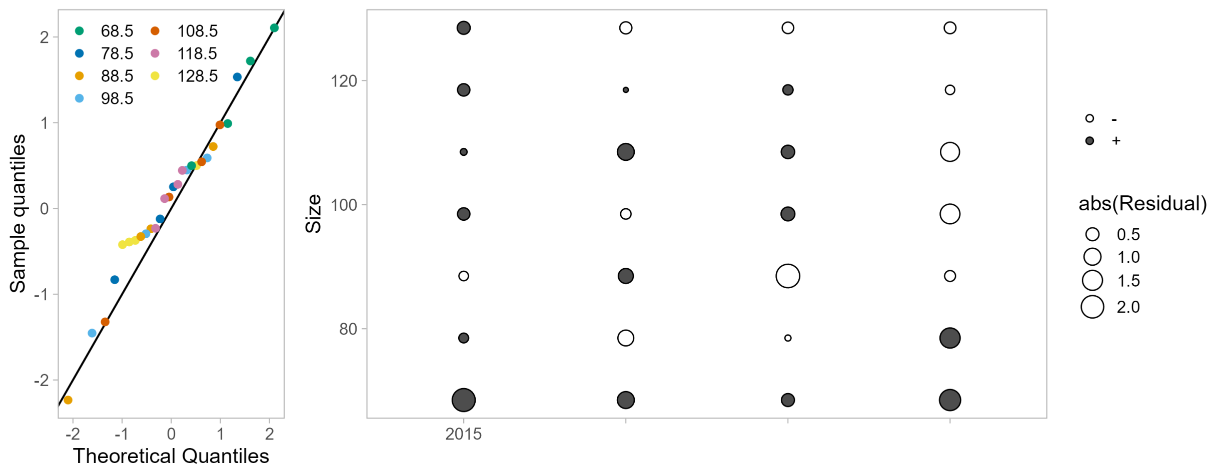

Figure 74: One-Step-Ahead residuals for model 26.4 fits to size composition data from the winter commercial fishery retained catch.

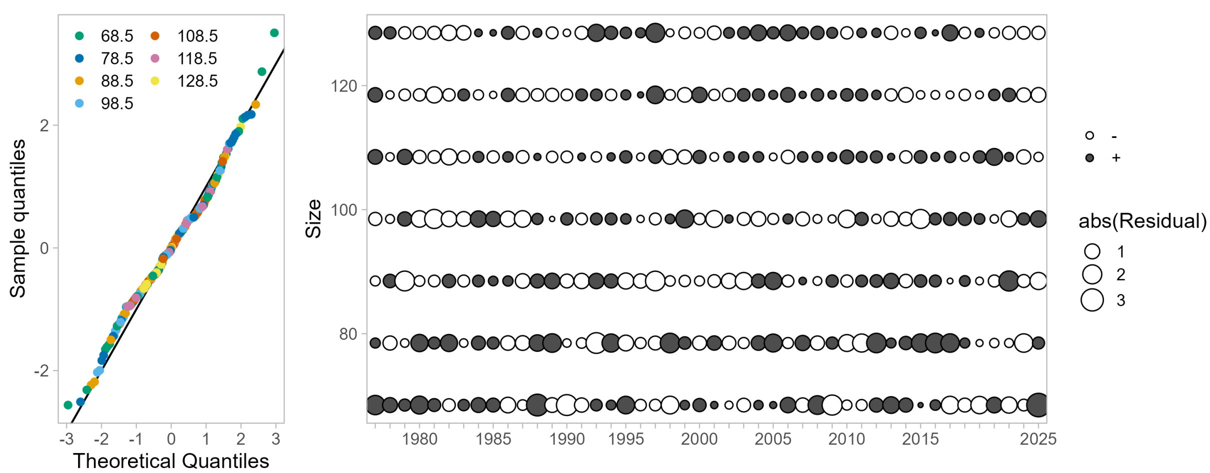

Figure 75: One-Step-Ahead residuals for model 26.4 fits to size composition data from the summer commercial fishery retained catch.

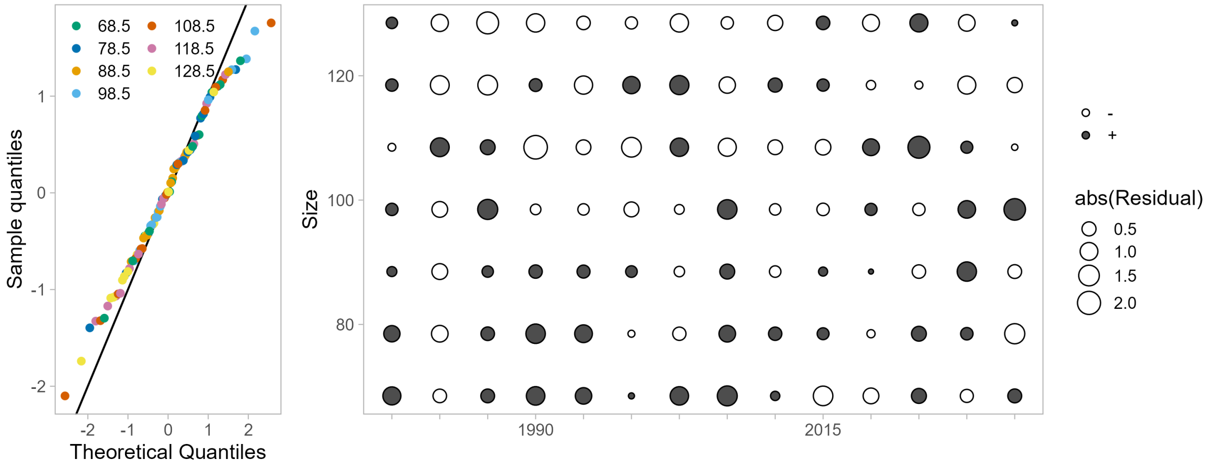

Figure 76: One-Step-Ahead residuals for model 26.4 fits to size composition data from the summer commercial fishery discarded catch.

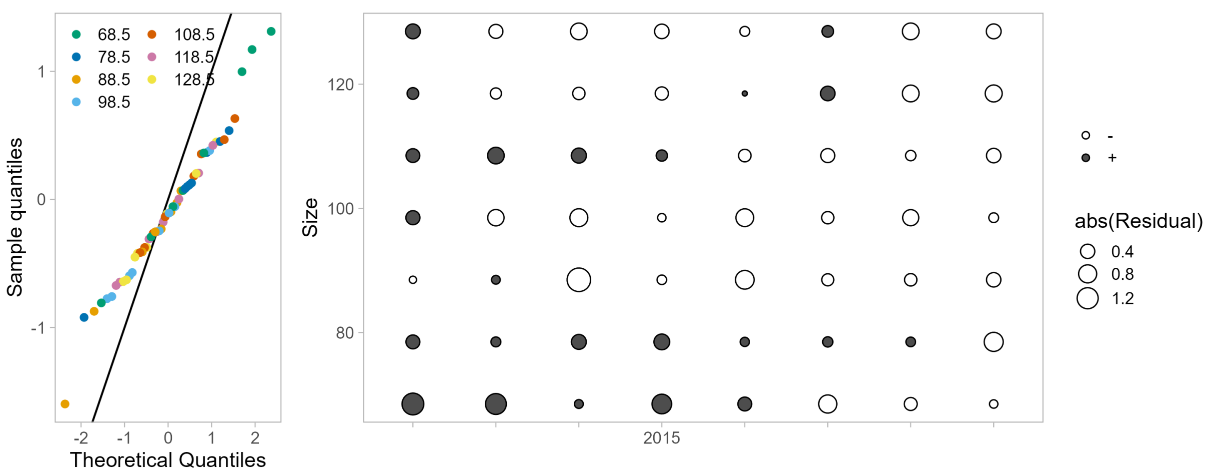

Figure 77: One-Step-Ahead residuals for model 26.4 fits to size composition data from the summer commercial fishery total catch.

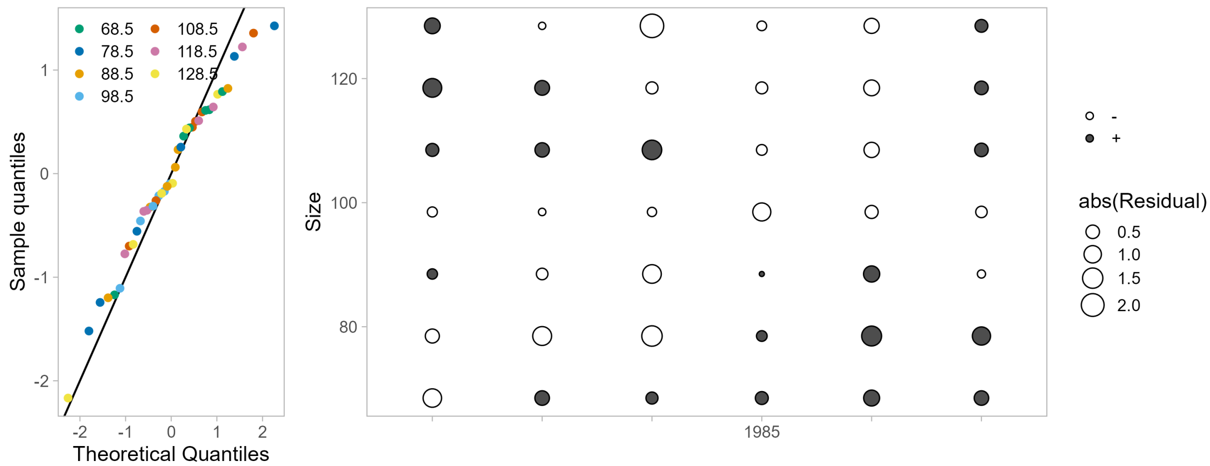

Figure 78: One-Step-Ahead residuals for model 26.4 fits to size composition data from the National Oceanic and Atmospheric Administration (NOAA) Norton Sound trawl survey.

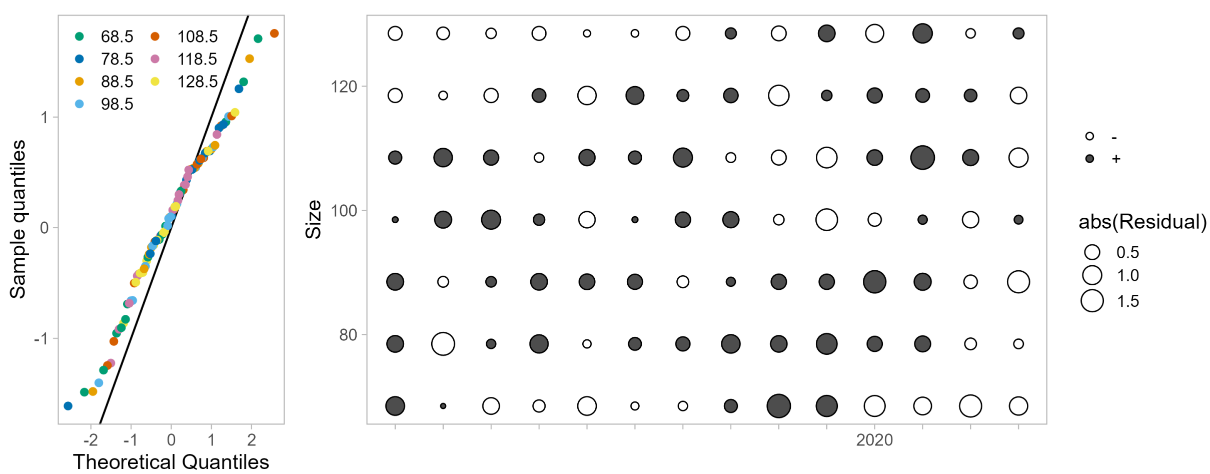

Figure 79: One-Step-Ahead residuals for model 26.4 fits to size composition data from the Alaska Department of Fish and Game (ADFG) trawl survey.

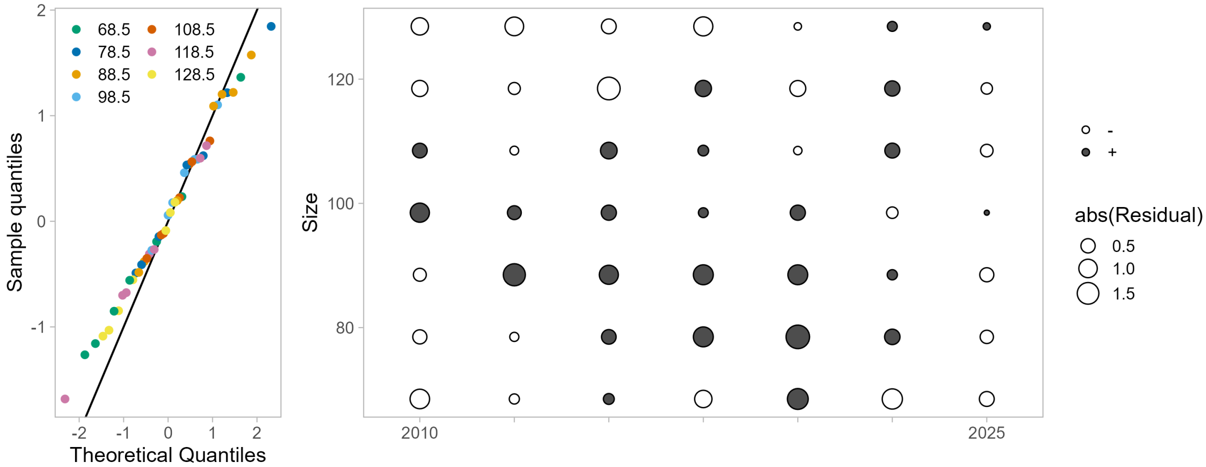

Figure 80: One-Step-Ahead residuals for model 26.4 fits to size composition data from the National Oceanic and Atmospheric Administration (NOAA) Northern Bering Sea (NBS) trawl survey.

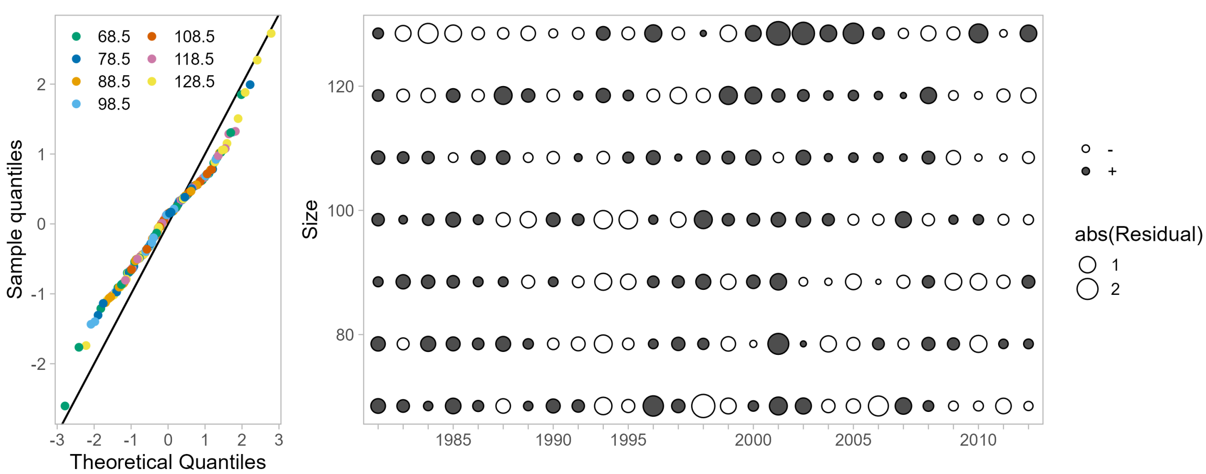

Figure 81: One-Step-Ahead residuals for model 26.4 fits to size composition data from the Alaska Department of Fish and Game (ADFG) winter pot survey.

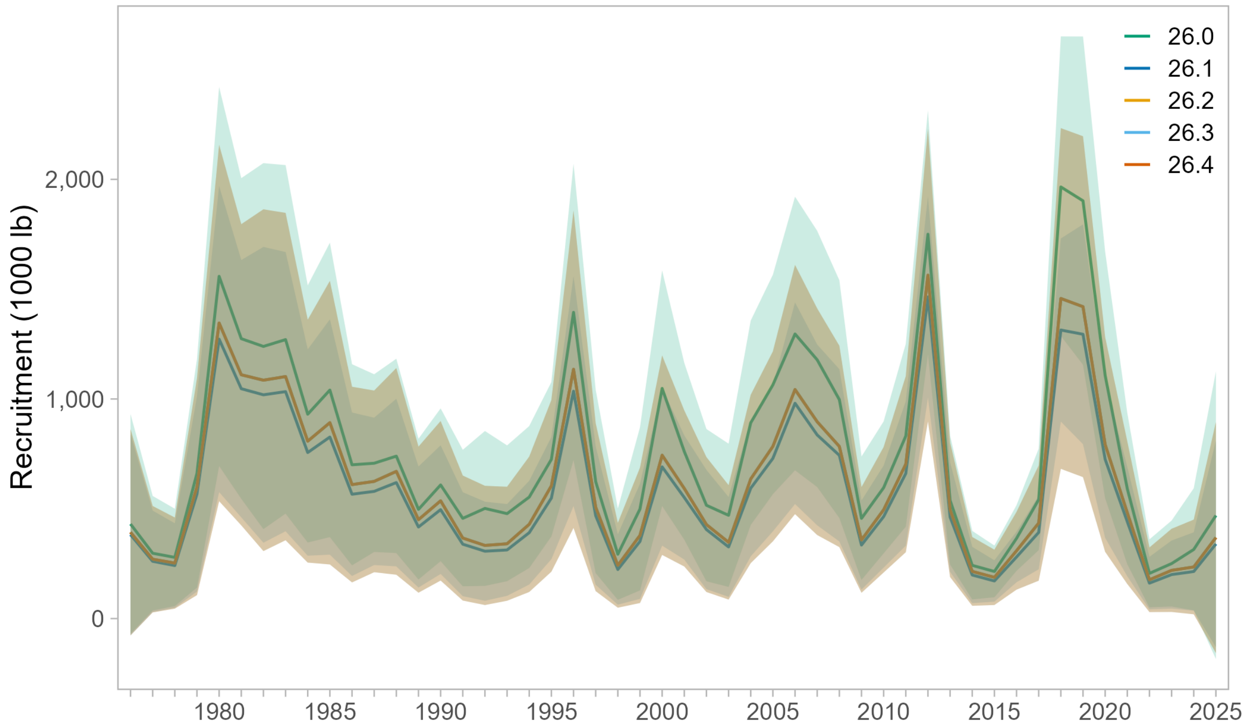

Figure 82: Estimated recruitment (1000 lb) over 1976-2025 for the new base model (26.0) and the models including a model-based index of abundance (26.1 - 26.4).

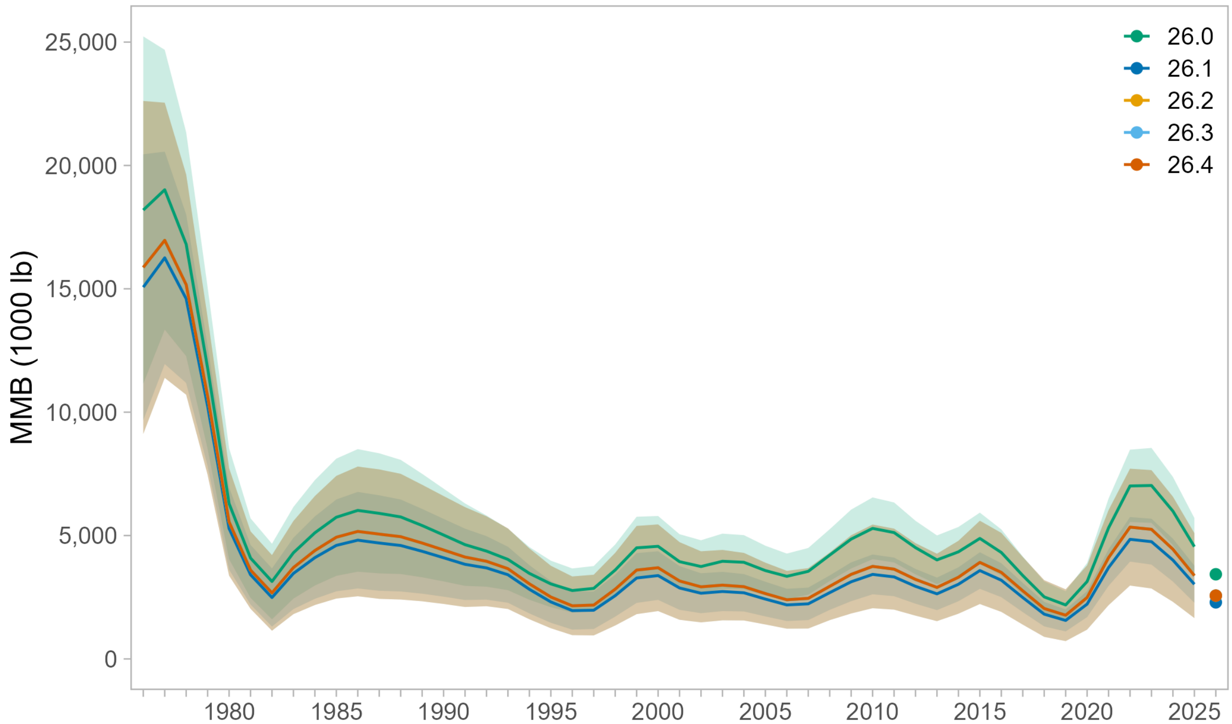

Figure 83: Comparisons of estimated mature male biomass (MMB) time series over 1976-2025 for the new base model (26.0) and the models including a model-based index of abundance (26.1 - 26.4). Points represent projected values for 2026. The estimated time series for models 26.2 - 26.4 are visually indistinguishable.

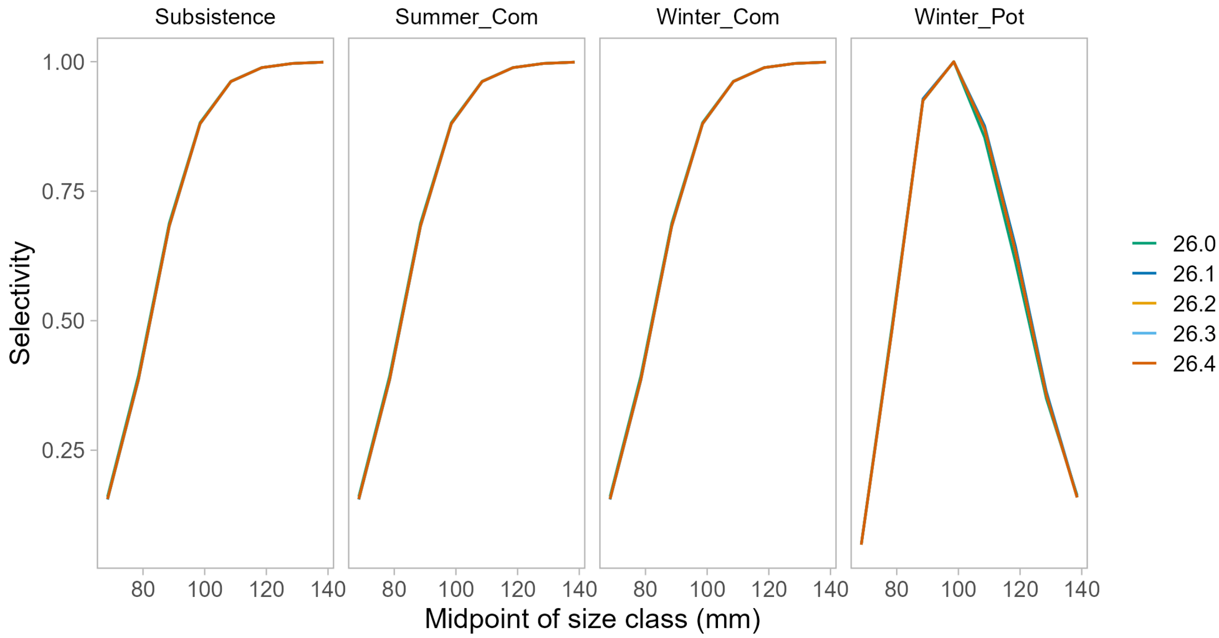

Figure 84: Comparisons of estimated capture selectivities in the summer commercial, winter commercial, and winter subsistence fisheries, as well as the winter pot survey, for the new base model (26.0) and the models including a model-based index of abundance (26.1 - 26.4).

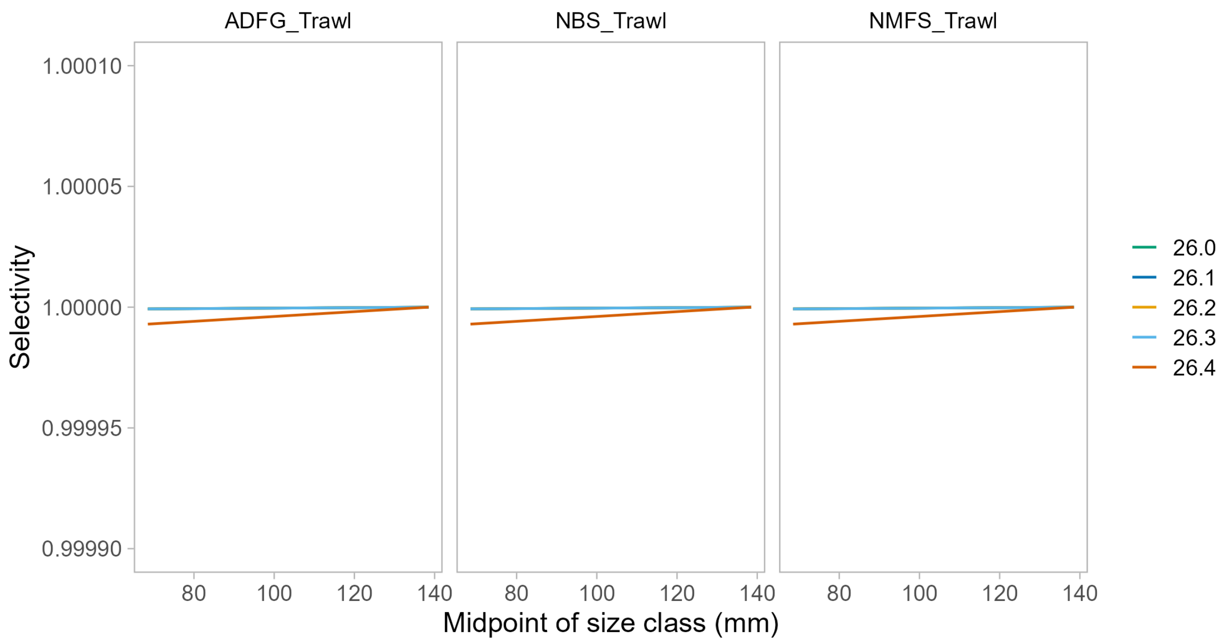

Figure 85: Comparisons of estimated survey capture selectivities in ADFG trawl, NOAA NBS trawl, and historical Norton Sound surveys for the new base model (26.0) and the models including a model-based index of abundance (26.1 - 26.4). Note the small range of the y-axis.

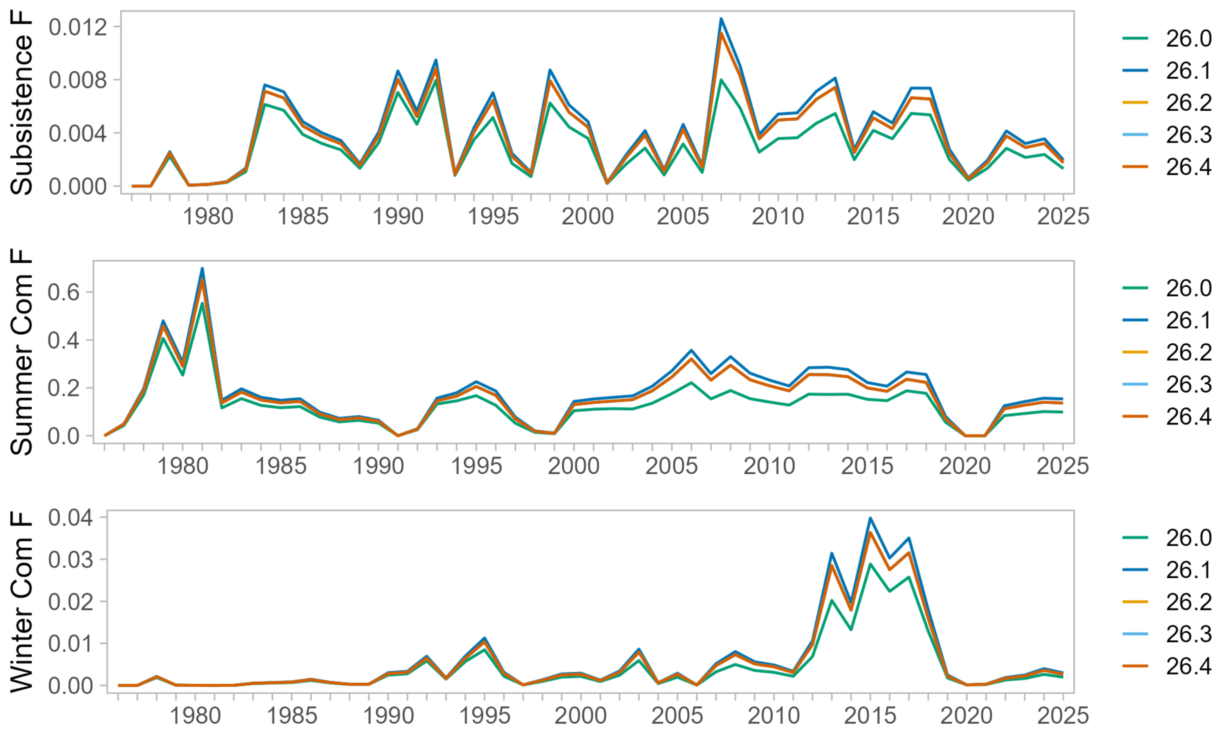

Figure 86: Comparison of estimated fishing mortality (F) for the subsistence, summer commercial, and winter commercial fisheries for the new base model (26.0) and the models including the model-based index of abundance (26.1 - 26.4).

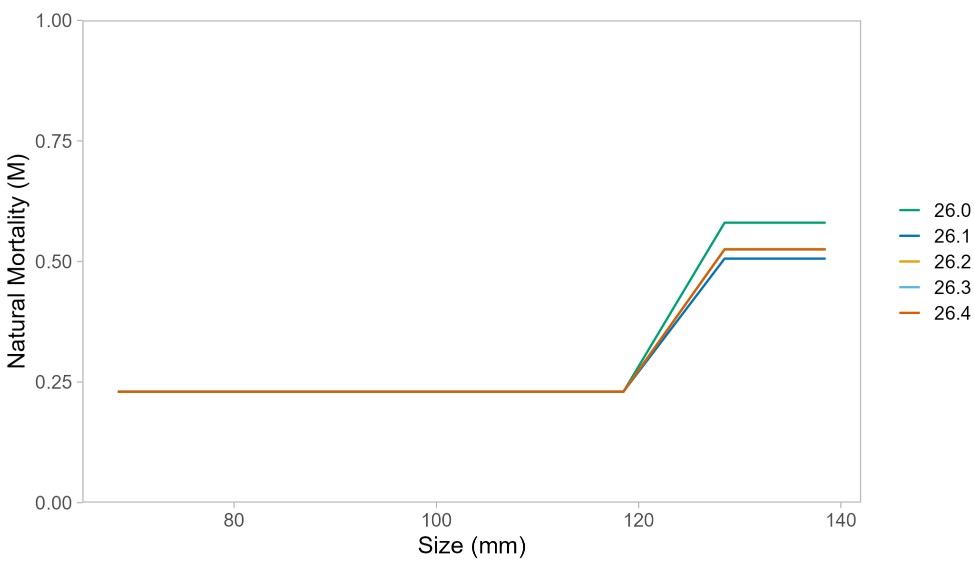

Figure 87: Natural mortality estimates for the new base model (26.0) and the models including a model-based index of abundance (26.1 - 26.4).

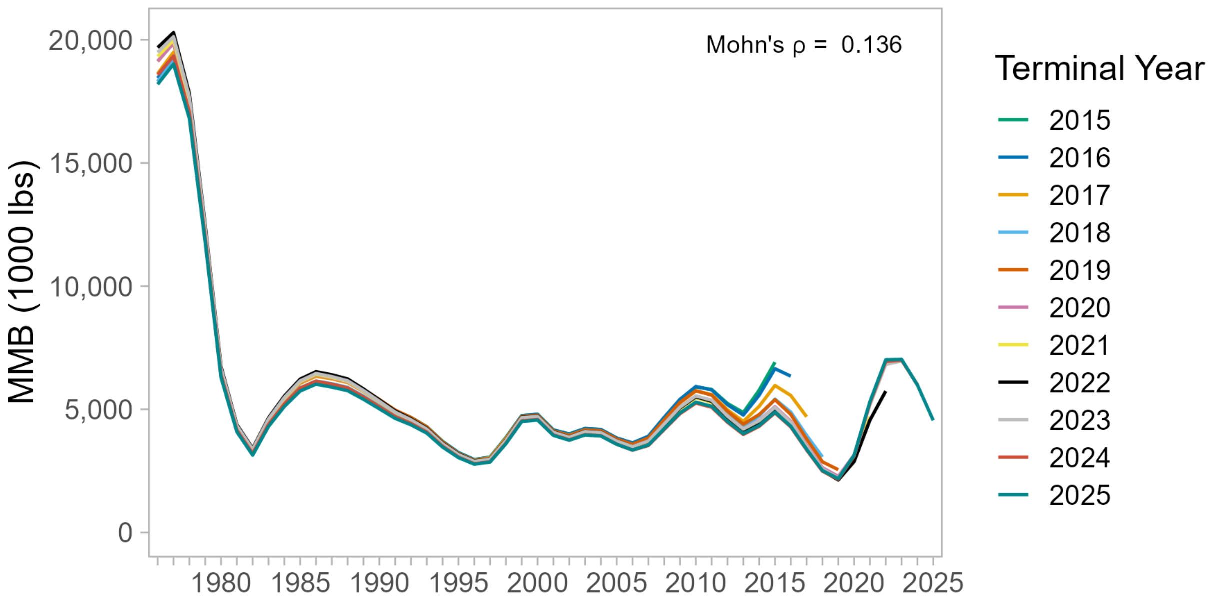

Figure 88: Retrospective patterns in estimated mature male biomass (MMB) for the new base model, 26.0. This model has catchability fixed at 1 for the ADFG survey and estimated for the NBS and historical NOAA/ADFG surveys, while selectivity for the ADFG and NBS surveys is mirrored to that of the historical NOAA/ADFG survey.

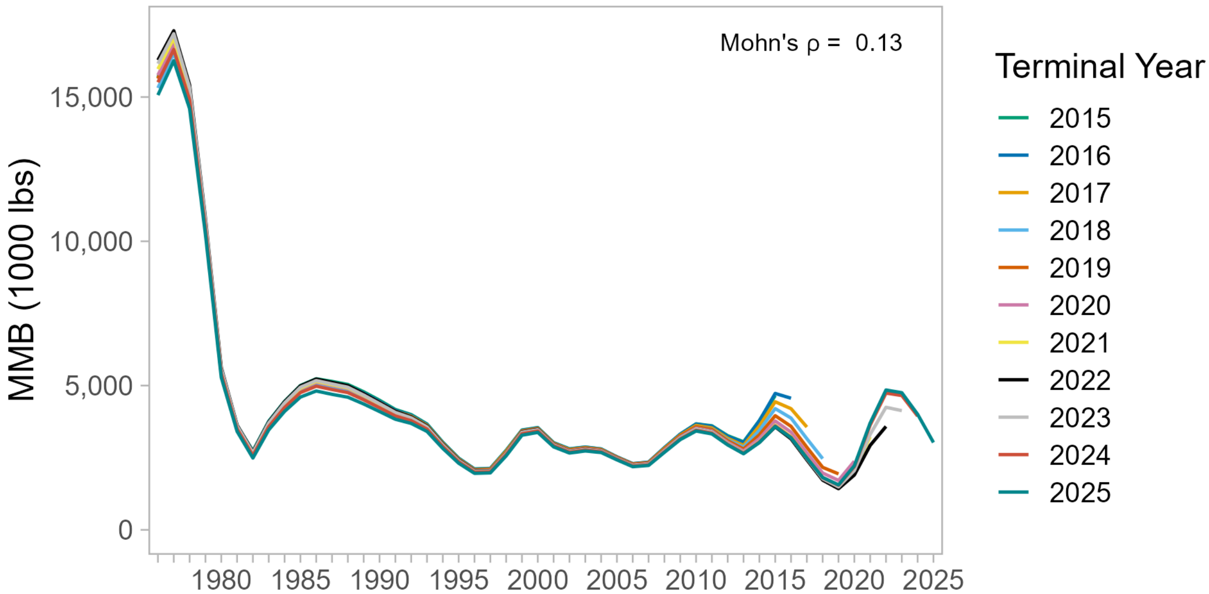

Figure 89: Retrospective patterns in estimated mature male biomass (MMB) for model 26.1, with the model-based index of abundance (MBI), catchability fixed at 1 for the MBI and estimated for the historical NOAA/ADFG survey, and selectivity for the ADFG and NBS surveys mirrored to the historical NOAA/ADFG survey selectivity.

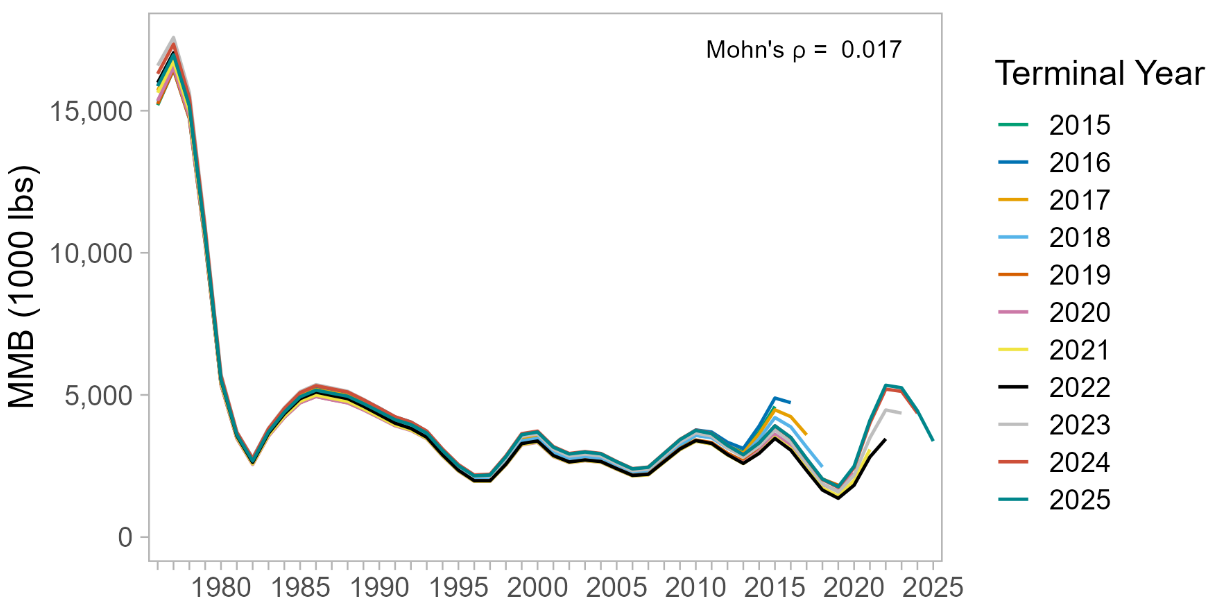

Figure 90: Retrospective patterns in estimated mature male biomass (MMB) for model 26.2, with the model-based index of abundance (MBI), catchability estimated for both the MBI and the historical NOAA/ADFG survey, and selectivity for the ADFG and NBS surveys mirrored to the historical NOAA/ADFG survey selectivity.

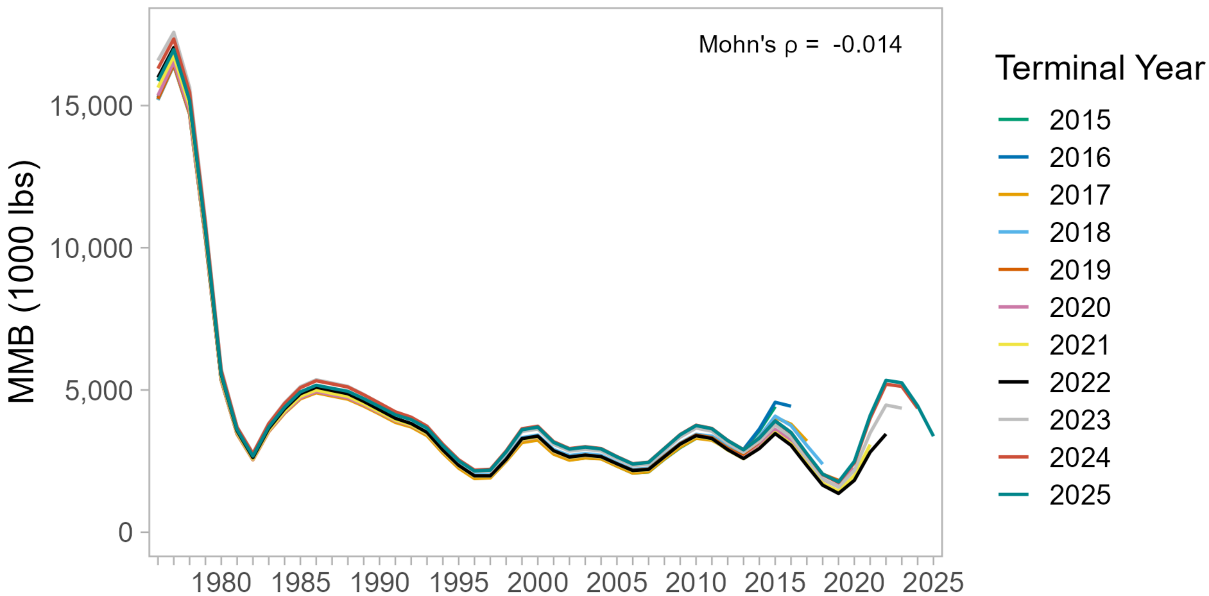

Figure 91: Retrospective patterns in estimated mature male biomass (MMB) for model 26.3, with the model-based index of abundance (MBI), catchability estimated for both the MBI and the historical NOAA/ADFG survey, and selectivity estimated for all three surveys.

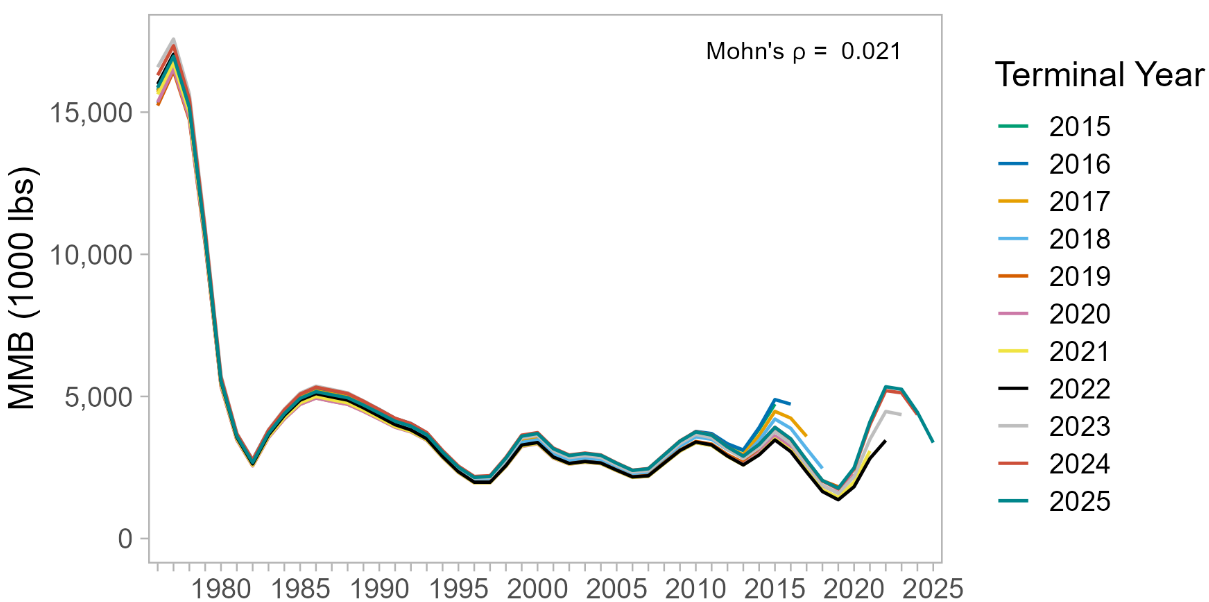

Figure 92: Retrospective patterns in estimated mature male biomass (MMB) for model 26.4, with the model-based index of abundance (MBI), catchability estimated for both the MBI and the historical NOAA/ADFG survey, and selectivity for all three surveys fixed at 1 for all size classes.

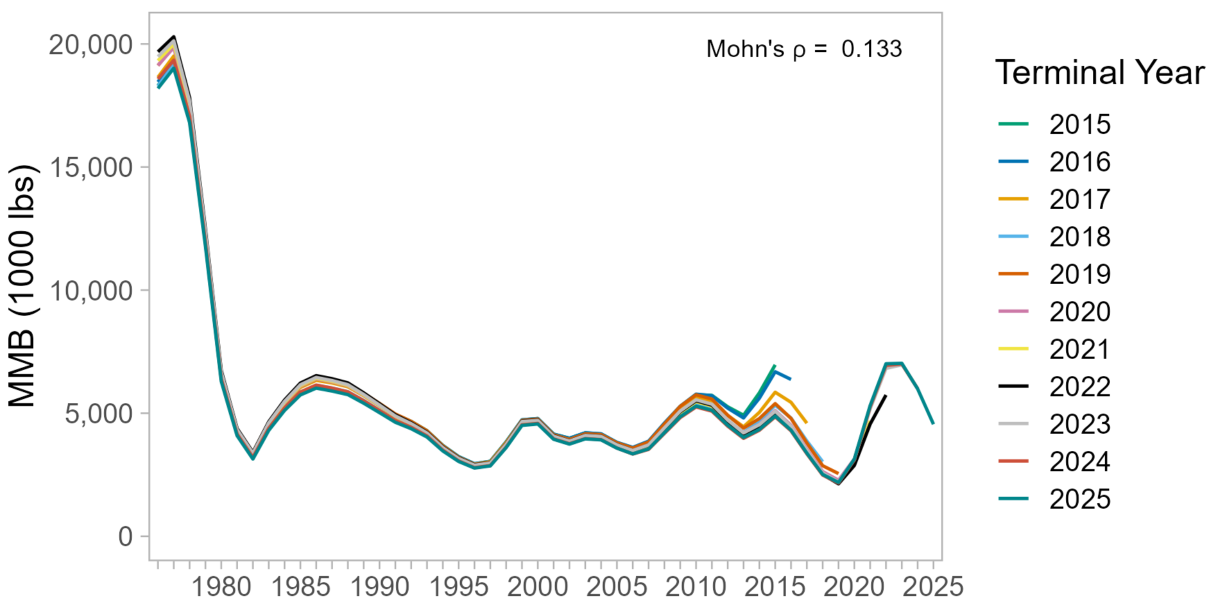

Figure 93: Retrospective patterns in estimated mature male biomass (MMB) for model 26.5, with both catchability and selectivity estimated for all three surveys.