Proposed models for the 2025 Norton Sound red king crab stock assessment

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Executive summary

This proposed models document includes much but not all of the information that will be presented in the full SAFE document this fall, as the new assessment authors work through the process of updating the document.

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

2. **Catches**: The Norton Sound red king crab (NSRKC) stock supports three fisheries: summer and winter directed commercial fisheries and a winter subsistence fishery, all male-only. 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 year. Since 1994, the summer commercial fishery has accounted for 94% of commercially-harvested crab on average. During the 2024 fishery seasons, commercial fishers harvested 4,834 crab (13,675 lb) in winter and 148,111 crab (457,524 lb) in summer. The winter subsistence fishers caught a total of 5,500 male crab (15,565 lb) and 181 female crab, and retained 4,708 (13,324 lb) male and no female crab, with 96% of permits returned. In total, a harvest of 149,921 crab (459,635 lb) was reported during the 2024 season. Discard mortality for the winter and summer commercial fisheries, derived from the previously-used model 21.0, was 14,375 lb. The total fishing mortality was 0.474 million lb (0.215 kt), below the ABC of 0.513 million lb (0.233 kt). Overfishing did not occur during the 2024 season.

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 (2010-2023; next scheduled for 2025), and the ADF&G trawl survey (1996-2024; next scheduled for 2025). In 2024, estimated abundance from the ADF&G trawl survey was 1.41 million crab (CV = 0.28).

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 (24.0b), average recruitment over 1976-2024 was 0.77 million (range 0.16 - 3.38 million).

6. **Management performance**: The tables below show the status and catch specifications based on models 24.0, 24.0b, 24.0b6, and 25.0 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 0.7*OFL, since the ABC buffer for 2025 was set at 30%. The GHL listed is for the summer commercial fishery retained catch. Note that harvest specifications for this stock in 2025 were set in December 2024. The fall 2025 version of this assessment will contain harvest recommendations for 2026.

Table 1: Status and catch specifications (1,000 t) for models 24.0, 24.0b, 24.0b6, and 25.0.

Year	MSST	Biomass (MMB_{mating})	GHL	Retained catch	Total catch	OFL	ABC	Model
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				0.284	0.199	24.0
2025/25	1.06	2.05				0.113	0.079	24.0b
2025/25	0.97	2.10				0.262	0.183	24.0b6
2025/25	1.05	2.24				0.123	0.086	25.0

Table 2: Status and catch specifications (million pounds) for models 24.0, 24.0b, 24.0b6, and 25.0.

Year	MSST	Biomass (MMB_{mating})	GHL	Retained catch	Total catch	OFL	ABC	Model
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				0.628	0.440	24.0
2025/25	2.33	4.52				0.250	0.175	24.0b
2025/25	2.15	4.64				0.577	0.404	24.0b6
2025/25	2.32	4.93				0.271	0.190	25.0

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 (million lb) from models 24.0, 24.0b, 24.0b6, and 25.0.

Year	Tier	B_{MSY}	Biomass (MMB_{mating})	B/B_{MSY}	F_{OFL}	Basis for B_{MSY}	Natural mortality	Model
2021/21	4a	4.53	5.05	1.1	0.18	1980-2021	0.18	
2022/22	4a	4.17	5.33	1.3	0.18	1980-2022	0.18	
2023/23	4a	4.37	5.29	1.2	0.18	1980-2023	0.18	
2024/24	4a	4.45	5.52	1.2	0.18	1980-2024	0.18	
2025/25	4a	4.33	4.72	1.09	0.18	1980-2025	0.18	24.0
2025/25	4a	4.66	4.52	0.97	0.18	1980-2025	0.18	24.0b
2025/25	4a	4.30	4.64	1.08	0.18	1980-2025	0.18	24.0b6
2025/25	4a	4.65	4.93	1.06	0.18	1980-2025	0.18	25.0

Table 4: Basis for the OFL (1000 t) from models 24.0, 24.0b, 24.0b6, and 25.0.

Year	Tier	B_{MSY}	Biomass (MMB_{mating})	B/B_{MSY}	F_{OFL}	Basis for B_{MSY}	Natural mortality	Model
2021/21	4a	2.05	2.29	1.1	0.18	1980-2021	0.18	
2022/22	4a	1.90	2.42	1.3	0.18	1980-2022	0.18	
2023/23	4a	1.98	2.40	1.2	0.18	1980-2023	0.18	
2024/24	4a	2.02	2.50	1.2	0.18	1980-2024	0.18	
2025/25	4a	1.96	2.15	1.09	0.18	1980-2025	0.18	24.0
2025/25	4a	2.11	2.05	0.97	0.18	1980-2025	0.18	24.0b
2025/25	4a	1.95	2.10	1.08	0.18	1980-2025	0.18	24.0b6
2025/25	4a	2.11	2.24	1.06	0.18	1980-2025	0.18	25.0

8. **Probability density function (PDF) of the OFL:** The PDF of the OFL will be presented in the draft SAFE in fall 2025, after a subset of the models presented here have been selected to bring forward for harvest specifications.

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 using a size-independent M, as do other Bering Sea and Aleutian Islands (BSAI) crab stock assessment models; and 5) a retrospective pattern in model-estimated mature male biomass. Depending on the model chosen for harvest specifications for 2026, this set of concerns may change.

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

A. Summary of major changes

Changes to the management of the fishery

There are no changes to the management of the fishery.

Changes to the input data

The only new data included here are the spatiotemporal model-based indices of abundance used in models 24.0b4 and 24.0b5 (Table 11). The development of those indices is detailed in a separate document (Stern 2025). Otherwise, there are no changes to the input data beyond the updates described in the 2024 SAFE document (Hamazaki 2024).

Changes to the assessment methodology

This assessment has used the Generalized size-structured Model for Assessing Crustacean Stocks (GMACS) framework since 2024. The model, which is configured to track eight stages of male length categories, was accepted by the Crab Plan Team (CPT) in November 2024 and is detailed in the 2024 SAFE document (Hamazaki 2024).

In this document, we first present a bridging analysis documenting the transition of the most recently accepted model (Model 24.0; Hamazaki 2024) from GMACS version 2.20.14 to version 2.20.20, including correcting errors in the accepted model input data that were discovered during the transition. We then present proposed models on three topics: 1) shell condition, 2) natural mortality, and 3) spatiotemporal model-based indices of abundance, following suggestions from the North Pacific Fishery Management Council (NPFMC) Scientific and Statistical Committee (SSC) and the Crab Plan Team (CPT). Background on the Norton Sound red king crab stock, fisheries, modeling approach, and modeling framework can be found in the 2024 SAFE document (Hamazaki 2024).

B. Responses to SSC and CPT comments

The status of SSC and CPT recommendations is summarized in Table 10.

SSC comments specific to NSRKC assessment, December 2024

In response to a CPT and SSC request in October, jittering results were presented at the CPT meeting and a table of the results was provided in the assessment. The author indicated that both models performed acceptably. The SSC supports the CPT recommendation related to the presentation of this analysis, and further requests a full suite of diagnostics and sensitivities per best practices for the next cycle for the new GMACS model.

We present jittering results for models 24.0b and 25.0 in plots and a table below. We welcome feedback on the presentation of the jittering analysis. We plan to present jittering results for the models recommended by the CPT and SSC in the final SAFE document for this stock in November. We welcome suggestions for further diagnostics that would be helpful in evaluating model performance.

There were two issues discovered with Model 24.0 that the author and CPT have prioritized for further work during this transition. First, the inclusion of the winter subsistence total catch data were problematic and these data were removed from the GMACS model. Second, the calculation of the OFL in the GMACS framework did not accommodate multiple fisheries operating at different times of the year, so OFL needed *to be calculated outside of the assessment model. The SSC supports the resolution of these issues to finalize this transition.*

At the CPT modeling workshop in January 2025, André Punt modified GMACS to enable calculation of the OFL when multiple fisheries occur at different times of year; we thank Dr. Punt for resolving this issue. Using GMACS version 2.20.20, we are able to correctly calculate the OFL for the Norton Sound red king crab stock. We have not yet resolved the issues with including the winter subsistence total catch data in the model; only winter subsistence retained catch data are included in the models presented here.

In terms of the buffer, the CPT recommended a continuation of the 30% buffer as the move to GMACS didn't directly address all of the persistent issues with this assessment. These include uncertainty in the biological characteristics of the stock; a lack of information on discards which makes it difficult to manage to a total mortality; overestimation of the largest male crab which can only be resolved with the higher M at the larger sizes classes and whether that is appropriate. The SSC noted that the concern over parameters on bounds had been alleviated, but the move to GMACs resulted in a higher retrospective bias than the previous model. For these reasons, the SSC concurs with the use of the 30% buffer for this assessment. The SSC requests the authors focus on addressing these issues, following finalization of the transition to GMACS.

We address some of these issues in this document and plan to address the others in future. Here, we investigate whether excluding shell condition improves estimation of the largest male crab (model 25.0). We also examine the effects on model fits to size compositions of using a size-independent M and of using the M value estimated for the Bristol Bay red king crab stock (Palof 2024) both with shell condition included (models 24.0b1, 24.0b2, 24.0b3) and with shell condition excluded (models 25.0a, 25.0b, 25.0c). We examine and discuss the retrospective patterns for most of the models presented in this document.

We do not address uncertainty in the biological characteristics of the stock and the lack of information on discards. A satellite tagging study planned for summer 2025 aims to provide information about whether large males are moving outside of the study area or suffering mortality events, which could aid in determining whether estimating a higher M for males in the larger size classes is appropriate.

The SSC looks forward to the presentation of the author's work implementing model-based methodologies to develop a combined index for this stock and appreciate the progress made on the SSC's past comments on index standardization.

We present alternative models below that incorporate spatiotemporal model-based indices of abundance. The development of those model-based indices is described in Stern (2025).

The SSC would be interested in seeing a model that uses a prior for a size-independent natural mortality from Bristol Bay red king crab, as a continuation of the model considered for harvest specifications in February 2024.

We present a model in this document that uses a prior for size-independent natural mortality from Bristol Bay red king crab.

The SSC also supports the other recommendations from the CPT, such as including fits to catch data in the assessment, investigating the retrospective pattern and reviewing how shell condition influences size composition fits.

In this document, we present a model (25.0) with shell condition removed from the size compositions, such that males with both shell conditions (newshell and oldshell) are combined, and analyze the effects of shell condition removal on size composition fits. We include plots of model fits to catch data. We present plots showing retrospective patterns for most of the models.

There were multiple readability issues noted in the current document and the SSC requests that this assessment be aligned with current standards outlined in the crab SAFE guidelines.

We hope that this proposed models report is readable. We will endeavor to align the final SAFE document with the crab SAFE guidelines, and ensure that readability issues are addressed.

SSC comments on assessments in general, December 2024

The SSC did not provide comments on BSAI crab stock assessments in general in December 2024.

CPT comments specific to NSRKC assessment, November 2024

The main difference between the bespoke model and 24.0 is that fishing mortality (i.e., catch) is subtracted exactly in the bespoke model, whereas model 24.0 estimates fishing mortality as a rate, F. Hamachan noted that the fits to total catch during the winter subsistence fishery were poor and this dataset was ultimately removed from model 24.0, although it was included in the bespoke model. Catch during the winter subsistence fishery is typically very minor, and fits to retained winter subsistence catch are included in model 24.0. Fits to catch data were not shown, but are requested for future assessments.

We show fits to catch data below. We have not yet determined how best to include total catch from the winter subsistence fishery in the model, but plan to do so in future.

The CPT requested that jitter results be presented as plots during the next cycle, following guidance for all assessments to be discussed at the January modeling workshop.

We present jitter results in both a table and plots below.

Model 24.0 had greater retrospective bias than the bespoke model, but there was not clear evidence as to a potential reason other than differences in model structure. It was noted that this retrospective analysis evaluated the projection year for both the bespoke model and 24.0, which may be more aptly interpreted as a one step ahead residual analysis. All other BSAI crab assessments evaluate retrospective bias without including the projection year.

We present retrospective analyses excluding the projection year below.

CPT comments on assessments in general, November 2024

The CPT did not provide comments on BSAI crab stock assessments in general in November 2024.

SSC comments specific to NSRKC assessment, October 2024

The SSC noted and recommends that the authors consider why the GMACS model estimates higher MMB in the most recent years and results in a higher B_{MSY} and OFL.

Thanks to Dr. Punt, GMACS version 2.20.20 is now able to correctly calculate the OFL for stocks with multiple fisheries that occur at different times of year. We do not revisit the comparison between the first GMACS (model 24.0) and bespoke (model 21.0) versions of the model, as that model comparison was presented and the GMACS model accepted in November-December 2024.

The SSC requests that the author seek and incorporate editorial review prior to posting the draft SAFE document going forward.

This document has received editorial review by two reviewers.

SSC comments on assessments in general, October 2024

The SSC suggests the following guidance for constructing and interpreting jitter analyses.

1) In a good jitter analysis, many models should fail to converge to the maximum likelihood estimates (MLE), which is indicative of exploring a broad region of the parameter space; conversely, if all models return to the MLE, the analysis was not a strong test. All those that do converge have to be at the MLE being used as the *base, as there would never be a better solution than at the MLE. This is a one-sided test that doesn't indicate the model converged, only that a better solution was not found than the one reported.*

2) The results of models that fail to return to the best solution (the MLE) are not useful for statistical inference; restarting those models from the local minima in which they stopped with a perfect solving algorithm would always return to the MLE, and so the results are an artifact of imperfect diagnostic tools.

3) Uncertainty in management quantities (e.g. small changes in the likelihood can correspond to large changes in biomass) is best expressed with likelihood profiles on key model scaling quantities, not unconverged model results.

The SSC would like to see additional residual diagnostics other than raw residuals for length composition data from GMACS models. The SSC encourages crab authors to collaborate with groundfish assessment authors regarding the use of One-Step-Ahead and Pearson residuals.

We present jitter analysis results in this document, and look forward to the SSC's feedback. Many models failed to converge to the MLE, suggesting that a broad region of parameter space was explored. We show plots of One-Step-Ahead residuals for model fits to size composition data for the new base model (24.0b) and for the model with shell condition removed (25.0).

The SSC suggests the CPT live link assessments and other documents in their report to facilitate review.

We have live-linked the assessments to which we refer in this document.

The SSC suggests that, to the extent possible, the implementation of and process used to develop BSAI crab risk tables mirrors that of groundfish to maintain consistency among managed stocks and Council's goals for risk tables as defined in their December 2019 motion (collaboration and communication among stock assessment scientists and those in other disciplines and increasing transparency and consistency in the rationale for reducing the ABC not already addressed in the stock assessment, tier system, and harvest control rules).

The CPT plans to recommend general guidelines for developing risk tables for all crab assessments following the May 2025 CPT meeting. We anticipate presenting a risk table for the NSRKC stock in future versions of the assessment.

CPT comments specific to NSRKC assessment, September 2024

For the final assessment at the upcoming November meeting the CPT requested the following:

Plots separating fits to trawl survey indices

Retrospective and jittering analysis of the GMACS model

We present plots showing fits to each trawl survey index separately. We include retrospective and jittering analyses in this document.

CPT comments on assessments in general, September 2024

At this meeting the CPT reviewed draft risk tables for the three main Bering Sea stocks - snow, Tanner, and BBRKC. During this review several key questions and decision points came up that the CPT felt would be better addressed through a separate agenda item in May 2025. At the May meeting the CPT can work to develop a set of SOPs for crab risk tables.

We look forward to developing a risk table for the NSRKC stock in accordance with the CPT's guidelines.

C. Introduction

1. **Scientific name**:

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

2. **General distribution**:

Red king crab are distributed throughout the North Pacific, from the Gulf of Alaska and northern British Columbia, including populations in Southeast Alaska and around Kodiak Island, to the Bering and Chukchi Seas, the Sea of Okhotsk, the Kuril Islands, and Hokkaido (Stevens & Lovrich 2014). Norton Sound red king crab (NSRKC) is one of the northernmost red king crab populations that supports a commercial fishery (Powell et al. 1983). For management purposes, the NSRKC stock is defined as those red king crab in the Norton Sound Section (Q3) of ADF&G Registration Area Q (Menard et al. 2022). The Norton Sound Section consists of all waters in Registration Area Q north of the latitude of Cape Romanzof (61° 49' N latitude), east of the International Dateline, and south of 66° N latitude (Figure 2; Menard et al. 2022). Data from the NOAA NBS and Eastern Bering Sea trawl surveys indicate that the NSRKC stock may be connected with the Bristol Bay red king crab stock in some years (Figure 3; Markowitz et al. 2023).

3. **Evidence of stock structure**:

Red king crab from Norton Sound and the Chukchi Sea form a distinct genetic subgroup within the Gulf of Alaska-Eastern Bering Sea-Norton Sound/Chukchi Sea genetic grouping, based on analysis of genetic structure using whole genome sequencing (St. John *et al.* 2025). An earlier analysis using SNP loci as well as mitochondrial DNA found that Norton Sound red king crab fell within the Okhotsk Sea/Norton Sound/Aleutian Islands evolutionary lineage and were genetically isolated from southeastern Bering Sea red king crab populations; this study did not include samples from Chukchi Sea red king crab (Grant and Cheng 2012).

4. **Life history**:

Female NSRKC attain 50% sexual maturity at 68 mm carapace length (CL; Powell et al. 1983). Female NSRKC mature at smaller sizes and have higher fecundity than RKC females studied in Kodiak, Adak, Bristol Bay, and the Pribilof Islands (Powell et al. 1983; Otto et al. 1989). Male NSRKC attain 50% maturity at 50-59 mm CL and 95% maturity at 70-79 mm CL (Paul et al. 1991). Examination of grasping pairs found that male crab were nearly always larger than the female crab with which they mated (Powell and Nickerson 1965), suggesting that functional maturity of male crab may occur at a larger size than physiological maturity.

NSRKC molt annually until reaching approximately 110 mm CL, after which they molt biennially (Bell et al. 2016). Molting seems to occur in April-June, although the timing of molting may be more variable for NSRKC than for other RKC stocks in Alaska due to the lack of deep water refugia commonly used by molting crab (Powell et al. 1983). Norton Sound is uniformly shallow, with depth typically 10-35 m (Powell et al. 1983). The growth increment for legal male crab, defined as 103-115 mm CL, was estimated as 11 mm using tagging data (Bell et al. 2016). The growth increment for sublegal male crab, defined as $<$ 103 mm CL, was estimated to be slightly larger at 13 mm (Bell et al. 2016). Mating occurs immediately after female crab have molted, likely in April-June (Powell et al. 1983) or January-June (Otto et al. 1989). Norton Sound red king crab migrate from offshore to nearshore waters in late winter and early spring before moving back to offshore waters in the summer (Bell et al. 2016).

Little information is available to estimate NSRKC natural mortality. Based on tagging information, Powell et al. (1983) estimated a natural mortality rate of at least 0.37. The natural mortality rate currently used, 0.18, was calculated using $M = -ln(p)/t_{max}$, assuming that a proportion (p) equal to 0.01 of crab reach the estimated maximum age (t_{max}) of 25 years old (Hamazaki 2024).

5. **Management history**:

A complete summary of the management history is provided in the ADF&G Annual Management Report for the Norton Sound, Port Clarence, and Arctic/Kotzebue management areas (Menard et al. 2022).

The NSRKC commercial fisheries occur in summer (June – August) and winter (December – May), while the subsistence fishery is open year-round. The majority of NSRKC harvest occurs during the summer commercial fishery; the winter commercial and subsistence fisheries occur through the ice and take a much smaller harvest. In Norton Sound, a legal crab is defined as $\geq$ 4.75 inch carapace width (CW; Menard et al. 2022), which is approximately equivalent to $\geq$ 104 mm CL. In 2005 and 2006, commercial buyers, specifically the Norton Sound Economic Development Corporation (NSEDC), accepted only legal crab of $\geq$ 5 inch CW. This preference became permanent in 2008.

Further detail about the NSRKC fishery management history is provided in Hamazaki (2024).

6. **ADF&G harvest strategy**:

Since 1997, NSRKC has been managed based on a guideline harvest level (GHL). From 1999 to 2011, the GHL for the summer commercial fishery was determined using model estimated biomass: (1) 0% harvest rate of legal crab when estimated legal biomass $<$ 1.5 million lb; (2) $\leq$ 5% of legal male biomass when the estimated legal biomass falls within the range 1.5-2.5 million lb; and (3) $\leq$ 10% of legal male biomass when estimated legal biomass $>$ 2.5 million lb. In 2012, the summer commercial fishery GHL was revised to (1) 0% harvest rate of legal crab when estimated legal biomass $<$ 1.25 million lb; (2) $\leq$ 7% of legal male biomass when the estimated legal biomass falls within the range 1.25-2.0 million lb; (3) $\leq$ 13% of legal male biomass when the estimated legal biomass falls within the range 2.0-3.0 million lb; and (4) $\leq$ 15% of legal male biomass when estimated legal biomass >3.0 million lb. In 2015 the Board of Fisheries passed regulations revising the GHL to include summer and winter commercial fisheries and setting the GHL for the winter commercial fishery at 8% of the total GHL. The Community Development Quota (CDQ) harvest share is 7.5% of the GHL and can be harvested in both summer and winter.

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

NSRKC is a Tier 4 crab stock, meaning that the information necessary to reliably estimate B_{MSY} is lacking and instead a B_{MSY} proxy is obtained by averaging estimated biomass over a specific reference period (NPFMC 2024). For NSRKC, the B_{MSY} proxy is calculated as the mean model-estimated mature male biomass (MMB) from 1980 to the present. The choice of this time period was based on a hypothesized shift in stock productivity due to a climatic regime shift indexed by the Pacific Decadal Oscillation (PDO) in 1976-77.

8. **History of the target fishery**:

The large vessel commercial fishery for NSRKC began in 1977, with legal size set at $\geq$ 5 inch CW. In 1978, legal size was changed to $\geq$ 4.75 inch CW. The fishery was closed in the 1991 season due to staff constraints. The large vessel commercial fishery ended in 1993, when the fishery was restricted to small vessels. Other important changes in regulations in the 1990's include super exclusive designation (1994), implementation of the CDQ allocation (1998), and implementation of the GHL (1999). In the 2000's, changes in the fishery included implementation of the North Pacific License Limitation Program (2000); revision of the summer commercial fishery closure areas intended to protect crab accessed by the inshore subsistence fishery (2002; Figure 4); expansion of the Norton Sound Section (Q3) of Registration Area Q to include the portion of the former St. Lawrence Island Section south of 66° N latitude and west of 168° W longitude (2006); changes in escape ring requirements for pots and the start date of the open access fishery (2008); and the market-preferred size of $\geq$ 5 inch CW becoming the standard commercial retained size. In the 2010's, the BOF adopted a revised GHL for the summer commercial fishery (2012), the winter GHL for commercial fisheries was established and modified winter fishing season dates were implemented (2016), and the NSEDC stopped purchasing crab harvested in the winter commercial fishery. In 2020, the BOF closed the summer commercial fishery east of 167° W longitude. In 2020-2021, the summer commercial fisheries opened but, as the NSEDC was not purchasing crab harvested in these fisheries, commercial harvests were very small. In 2021, the winter fishery open date was changed to February 1.

D. Data

The data sources used in this assessment are described in detail in the 2024 SAFE document (Hamazaki 2024). The only new data included here are the spatiotemporal model-based indices of abundance used in models 24.0b4 and 24.0b5 (Table 11). The development of those indices is detailed in a separate document (Stern 2025). Briefly, the stock assessment model for NSRKC 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 design-based abundance estimate from the ADF&G trawl survey is unexpanded, meaning it is likely an underestimate of stock abundance (Hamazaki 2024). The SSC has expressed concerns about the lack of consistency in the area over which stock abundance is estimated and recommended development of model-based indices of abundance for the Norton Sound red king crab stock to address these concerns.

We used the R package **sdmTMB** (Anderson et al. 2022) to develop a model-based approach for deriving NSRKC trawl survey indices of abundance with the aims of standardizing abundance estimation for each trawl survey index and providing a shared abundance estimation framework among the three existing trawl survey indices. We selected the model with the best predictive skill for each survey index. For the ADF&G trawl survey, this was the delta-gamma model with a depth covariate; for the NOAA NBS trawl surveys, the Tweedie model without a depth covariate; and for the NOAA Norton Sound trawl survey, the delta-lognormal model with a depth covariate (Stern 2025).

To explore the implications of estimating abundance over different spatial scales, we generated prediction grids with the prediction area defined to include either all survey stations sampled in all three surveys (area = 76,487 km^2), or the prediction area defined to include only the survey stations sampled in the ADF&G trawl survey since 2010 (area = 32,413 km^2). Note that the area of the smaller prediction grid is still larger than the area over which the design-based estimates of abundance used in the stock assessment model are currently calculated, as those calculations leave out some southern and closer to shore areas of Norton Sound (Figure d1 in Hamazaki 2024). Comparing the prediction grids to commercial harvest information, which is available at the level of ADF&G statistical area, showed that the full prediction grid encompasses all statistical areas in which Norton Sound red king crab harvest has been recorded since 1985, as well as in more recent years, while the reduced prediction grid does not (Stern 2025). We predicted crab abundance from each model over both the full area prediction grid and the reduced area prediction grid. Model 24.0b4 uses the model-based indices of abundance generated by predicting over the full area and model 24.0b5 uses those generated by predicting over the reduced area. The authors request feedback on which prediction grid should be used as development of model-based indices for this stock continues.

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). The CPT and SSC had previously noted that recommended model explorations should be delayed until after the NSRKC model was transitioned to GMACS, as this transition was the top priority for the model. Now that the model is in GMACS, we can begin to address these deferred recommendations, which are summarized in Table 10.

2. Model description

For a full description of the model and its assumptions, please see Hamazaki (2024).

3. Model selection and evaluation

The model configurations evaluated in this report are the following:

Bridging analysis

Model 24.0: The model recommended by the CPT and SSC for harvest specifications in November 2024 and December 2024, respectively, and presented in the final 2024 SAFE document (Hamazaki 2024). Model 24.0 used GMACS version 2.20.14.

Model 24.0a: Model 24.0 with the following errors corrected in the input data file. First, shell condition was incorrectly specified for the oldshell male size composition data from the ADF&G trawl survey in 2023 and 2024: shell condition was entered as 1 when it should have been 2. Second, effective sample size was incorrectly entered for size composition data for newshell males in the 2018 ADF&G trawl survey: the entered effective sample size was 14.6 but should have been 20. We compared model 24.0a with model 24.0 to show the impacts of correcting these errors.

Model 24.0b: Model 24.0a transitioned to the new version of GMACS, 2.20.20. Andre Punt and Buck Stockhausen made several changes to GMACS between versions 2.20.14 and 2.20.18, including in the methods for calculating the OFL. The change in methods for calculating the OFL allows for correct OFL calculation when a stock is fished by multiple directed fleets, as is the case for NSRKC. We compared model 24.0b with model 24.0a in order to identify the effects of the changes in GMACS on model results. Model 24.0b is considered the base model for further model explorations described below.

Model 24.0b6: Model 24.0b at the second best objective function value found after jittering. Model 24.0b, which is the MLE as evaluated by jittering analysis, includes a large estimated fully selected fishing mortality value for the winter commercial fishery in some years (see below). Results from model 24.0b6, which are more similar to the results of models 24.0 and 24.0a, are presented for comparison. The authors request feedback from the CPT and SSC on whether the MLE model is preferred in this context.

Removing shell condition

Model 25.0: Model 24.0b with only one shell condition for males. Size composition data are combined for all males rather than being split into separate data sets for newshell males and oldshell males.

New base model + natural mortality explorations

Model 24.0b1: Model 24.0b with the natural mortality value for smaller males taken from the most recent BBRKC stock assessment (Palof 2024). As in the base model, natural mortality is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm. However, the fixed value of natural mortality is $M = 0.23$ rather than the base model's $M = 0.18$.

Model 24.0b2: Model 24.0b with size-independent natural mortality fixed at $M = 0.18$.

Model 24.0b3: Model 24.0b with size-independent natural mortality fixed at $M = 0.23$.

Shell condition removed + natural mortality explorations

Model 25.0a: Model 25.0 with the natural mortality value for smaller males taken from the most recent BBRKC stock assessment (Palof 2024). As in model 25.0, natural mortality is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm. However, the fixed value of natural mortality is $M = 0.23$ rather than $M = 0.18$.

Model 25.0b: Model 25.0 with size-independent natural mortality fixed at $M = 0.18$.

Model 25.0c: Model 25.0 with size-independent natural mortality fixed at $M = 0.23$.

Model-based indices of abundance

Model 24.0b4: Model 24.0b with spatiotemporal model-based indices of abundance used in place of the design-based indices of abundance for the NOAA Norton Sound, ADF&G, and NOAA Northern Bering Sea trawl surveys. The prediction grid for the spatiotemporal model predictions encompasses the full spatial extent of survey stations sampled.

Model 24.0b5: Model 24.0b with spatiotemporal model-based indices of abundance used in place of the design-based indices of abundance for the NOAA Norton Sound, ADF&G, and NOAA Northern Bering Sea trawl surveys. The prediction grid for the spatiotemporal model predictions encompasses a reduced spatial area based on the ADF&G trawl survey stations sampled since 2010.

4. Results

Model convergence

We evaluated model convergence by using parameter jittering to find the parameter values that minimized the model objective function, checking that the model Hessian was invertible and that the maximum gradient at the candidate MLE was close to zero. Starting parameter values for the jitter runs were randomly selected within a range of 0.2 standard deviations from the existing initial parameter values. We performed 100 jitter runs for the new base model (24.0b) as well as for the model with shell condition removed (25.0). For model 24.0b, 7 runs converged to the apparent maximum likelihood of 4181, 59 converged to the most frequent maximum likelihood (4183), and 8 failed to finish; the maximum gradient for the model run with maximum likelihood of 4181 was 0.000191 (Figure 5, Table 12). For model 25.0, 3 runs converged to the apparent maximum likelihood of 2507, 48 converged to the most frequent maximum likelihood (2510), and none failed to finish; the maximum gradient for the model run with maximum likelihood of 2507 was 0.000951 (Figure 6, Table 12).

We note that the current accepted model, 24.0, may not be the model with the minimum objective function: the results of jitter runs presented in the 2024 SAFE show that the model most frequently arrived at a maximum likelihood of 4188 but, in 13 of the 100 jitter runs, arrived at a maximum likelihood of 4186 (Table 14 in Hamazaki 2024).

Fits to fishery catch data

Fits to fishery catch data are nearly identical for the bridging analysis models (24.0, 24.0a, 24.0b, 24.0b6; Figure 7 and Table 13). The new base model (24.0b) and the model with shell condition removed (25.0) also show very similar fits to catch data (Figure 8 and Table 14). Changing the size-dependence and/or value of natural mortality does not appear to have a large effect on fits to catch data for either models based on the new base model (24.0b1, 24.0b2, 24.0b3; Figure 9 and Table 15)) or models based on the model without shell condition (25.0a, 25.0b, 25.0c; Figure 10 and Table 16)). Using model-based indices in place of design-based indices of abundance for the three trawl surveys also does not appear to affect fits to catch data compared to the new base model (24.0b4, 24.0b5; Figure 11 and Table 17)). Note that subsistence total catch was not fitted in any of these models (emphasis set to 0). A run of model 24.0b with emphasis for the subsistence total catch data set to 1 confirmed the finding reported in the 2024 SAFE document that including these data leads to differences in model fit and references points: estimated MMB in the terminal year is 34% lower and total negative log likelihood is 2% higher when the subsistence total catch data are included. Approaches to including subsistence total catch data will be explored further in future iterations of this assessment.

Fits to abundance indices

The new base model (24.0b) shows improved fits to all three trawl survey indices, particularly the ADF&G trawl survey index, and poorer fits to two of three fishery CPUE indices, compared to models 24.0, 24.0a, and 24.0b6 (Figures 12 - 17 and Table 13).

The model with shell condition removed (25.0) has fits similar to those of the new base model (24.0b), with slightly worse fits to the three trawl survey indices and slightly better fits to the fishery CPUE indices (Figures 18 - 23 and Table 14).

Using $M = 0.23$ but retaining size-dependent natural mortality leads to very similar abundance index fits for both the model based on model 24.0b (24.0b1) and the model based on model 25.0 (25.0a), but using size-independent M leads to worsened abundance index fits for both the models based on model 24.0b (24.0b2, 24.0b3) and the models based on model 25.0 (25.0c, 25.0d) (Figures 24 - 35 and Tables 15 - 16). Fits for models with size-independent M were better when using $M = 0.23$ than when using $M = 0.18$.

Fits to abundance indices for models using model-based rather than design-based indices (24.0b4, 24.0b5) were worse for all three of the trawl survey indices and one of the pot CPUE index time blocks (Figures 36 - 41 and Table 17).

Fits to fishery size compositions

Model 24.0b, the new base model, had a worse fit to the winter commercial fishery retained catch size composition than models 24.0, 24.0a, and 24.0b6. Fits to the other fishery size compositions were similar across the models in the bridging analysis (Figures 42 - 49 and Table 13).

The model with shell condition removed (25.0) appears to show improved fits to all four fishery size compositions compared to the new base model (24.0b; Figures 50 - 57 and Table 14). Note that removing shell condition reduces the number of dimensions in the model, so likelihood components may not be directly comparable. The size composition data used to fit the models with versus without shell condition are shown in Appendix B.

Using $M = 0.23$ but retaining size-dependent natural mortality did not strongly affect fits to any of the fishery size compositions for either model 24.0b1 or model 25.0a, but using size-independent M worsened fits to the summer commercial retained catch size composition for models 24.0b2, 24.0b3, 25.0b, and 25.0c, while having little effect on fits to the other fishery size compositions (Figures 58 - 65 and Tables 15 - 16).

Fits to fishery size compositions for the models using model-based rather than design-based indices (24.0b4, 24.0b5) were relatively similar (Figures 66 - 69 and Table 17).

Fits to survey size compositions

Among the models in the bridging analysis, model 24.0b showed improved fits to all three trawl survey size compositions compared to models 24.0, 24.0a, and 24.0b6 (Figures 70 - 77 and Table 13).

The model with shell condition removed (25.0) appears to show improvements in fits to all four survey size compositions compared to the new base model (24.0b; Figures 78 - 85 and Table 14). Note that removing shell condition reduces the number of dimensions in the model, so likelihood components may not be directly comparable. The size composition data used to fit the models with versus without shell condition are shown in Appendix B.

Changing the value of M while retaining size-dependence had little effect on fits to survey size compositions for both the models based on the new base model and those based on the model without shell condition (Figures 86 - 93 and Tables 15 - 16). Introducing size-independent M led to worse fits to the ADF&G trawl survey size compositions and better fits to the NOAA NBS trawl survey size compositions for the models based on the new base model (24.0b1, 24.0b2, 24.0b3), but worse fits to all of the survey size compositions for the models based on model 25.0 (25.0a, 25.0b, 25.0c).

Fits to the survey size compositions were slightly worse for all but the NBS trawl survey size compositions for the models using model-based rather than design-based indices (Figures 94 - 97 and Table 17).

One-step-ahead (OSA) residuals for model fits to size composition data for models 24.0b (the new base model) and 25.0 (the new base model with shell condition removed) are shown in Figures 98 - 114.

Estimated population quantities

The new base model estimates a recruitment trajectory notably different from those estimated by model 24.0, 240a, and 24.0b6, with higher estimated recruitments in the years leading up to 2014 (Figure 115). This is consistent with model 24.0b's better fit to the high estimated abundance in the ADF&G trawl survey in 2014 (Figure 12). Estimated recruitment trajectories are relatively similar between the new base model and the model with shell condition removed (Figure 116 and Tables 18 - 19). Models with size-independent natural mortality tend to estimate lower recruitment over the time series than do models with size-dependent natural mortality (Figures 117 - 118). Models using model-based indices consistently estimate higher recruitment than the new base model, consistent with the increased scale of the population estimated by the models using model-based indices (Figure 119). This increased scale is to be expected given that the design-based abundance estimate from the ADF&G trawl survey is unexpanded and likely underestimates stock abundance (Hamazaki 2024).

The new base model estimates a mature male biomass (MMB) trajectory that differs from that of models 24.0, 24.0a, and 24.0b in that the scale of the population is higher in the years leading up to 2014, reflecting the new base model's better fit to the ADF&G trawl survey time series, which documents high estimated abundance in 2014; following 2020, estimated MMB is similar among the three models in the bridging analysis (Figure 120). Removing shell condition does not have a consistent effect on estimated MMB across the time series, but estimated MMB in the two most recent years (2023 and 2024) is higher for the model without shell condition (Figure 121 and Tables 18 - 19). Models with size-independent natural mortality estimate lower MMB across much of the time series than models with size-dependent natural mortality, though estimates are similar in the most recent years (Figure 122 - 123). Models with model-based indices estimate higher MMB over the time series than the new base model, with similar population trends (Figure 124), demonstrating the importance of determining the appropriate area over which to estimate population abundance for this stock.

Estimated fishery selectivity

Model-estimated fishery capture selectivities for the summer commercial fishery, winter commercial fishery, and subsistence fishery are shown in Figures 125 - 129. Model 24.0b estimates notably higher selectivity for all but the largest size classes in the winter commercial fishery compared to the other models in the bridging analysis. Note that selectivity in the subsistence fishery is not estimated but instead is mirrored to the selectivity estimated for the winter commercial fishery.

Estimated survey selectivity

In the base model, survey selectivity is estimated only for the NOAA Norton Sound trawl survey. 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. Selectivity for the winter pot survey is mirrored to selectivity estimated for the winter commercial fishery. Survey selectivity for the NOAA Norton Sound trawl survey is estimated to be equal to 1 for all 8 size bins. In an exploratory model run in which we allowed survey selectivities for all three trawl surveys to be estimated, using the same initial values, bounds, and priors, survey selectivity for all three trawl surveys was estimated to be equal to 1 for all 8 size bins.

Estimated fishing mortality

The models in the bridging analysis (24.0, 24.0a, 24.0b, 24.0b6) estimate similar values for fully-selected fishing mortality in the subsistence and summer commercial fisheries, but model 24.0b estimates much higher F values for the winter commercial fishery over the years 2010 - 2020 (Figure 130). This is likely related to the increased estimated abundance and recruitment that allow model 24.0b to better fit the ADF&G trawl survey data. The new base model (24.0b) and the model with shell condition removed (25.0) estimate relatively similar fishing mortality values over the time series for each fishery (Figure 131). Models with size-independent natural mortality tended to estimate higher F than models with size-dependent natural mortality (Figures 132 - 133). Both of the models using model-based rather than design-based indices of abundance estimate lower fishing mortality values over most of the time series compared to the new base model for the summer commercial and subsistence fisheries, and higher F for the winter commercial fishery (Figure 134).

Retrospective analyses

Retrospective analyses for models were performed by sequentially removing each of the most recent 9 years of data, fitting the model, and recorded 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 model 24.0 reported in the 2024 SAFE was 0.201 (Hamazaki 2024), indicating that MMB estimates generally increased as each year of data was removed.

The retrospective pattern for the new base model (24.0b) is less extreme than the pattern for that model at the second lowest objective function value (24.0b6) (Figures 135 - 136). Retrospective patterns for the new base model (24.0b) and the new base model without shell condition (25.0) are similar, with a higher positive Mohn's ρ value for model 25.0 (Figures 135 - 137).

For both the new base model (24.0b) and the model with shell condition removed (25.0), retaining size-dependent natural mortality while increasing the value of M from 0.18 to 0.23 leads to less extreme retrospective patterns, while moving to size-independent natural mortality leads to more extreme retrospective patterns (Figures 138 - 143).

Both the addition of spatiotemporal model-based indices with abundance predicted over the full surveyed area (model 24.0b4) and the reduced surveyed area (model 24.0b5) lead to higher positive Mohn's ρ values compared to the new base model, although the Mohn's ρ value is lower for model 24.0b5 than for model 24.0b4 (Figures 144 - 145).

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 are summarized in Table 20 for model 24.0b and Table 21 for model 25.0. Estimated standard deviations of mature male biomass and male recruitment for models 24.0b and 25.0 are listed in Tables 18 - 19. Results of Markov chain Monte Carlo (MCMC) runs will be included in the fall 2025 SAFE report.

Comparison of alternative model scenarios

The new base model (24.0b) represents an improvement on the current accepted model (24.0) in that the new base model includes corrected data, runs in a version of GMACS that can correctly calculate the OFL with multiple fisheries in different seasons, and converges to the MLE based on jitter analysis. However, the new base model estimates much higher F values for the winter commercial fishery in approximately 2010 - 2020 than does the model representing the second lowest objective function value, model 24.0b6. Model 24.0b has a weaker positive retrospective pattern than does model 24.0b6. The authors request feedback from the CPT and SSC on whether model 24.0b or model 24.0b6 is preferred.

The model with shell condition removed (25.0) simplifies the base model and eliminates a source of error (classification of shell condition as newshell or oldshell) that is unaccounted for in the base model. Using a prior from Bristol Bay red king crab for natural mortality did not have a large impact on fits to size composition data when size-dependent natural mortality was retained, either for the models based on 24.0b or those based on 25.0, and fits to size composition data generally worsened for models with size-independent natural mortality. However, the models with the least extreme retrospective patterns were 24.0b1, the new base model with size-dependent natural mortality using a prior for M from BBRKC, and 25.0a, the model with shell condition removed, size-dependent natural mortality, and a prior for M from BBRKC. Using model-based rather than design-based indices for the three trawl surveys led to stronger positive retrospective patterns and similar or poorer fits to most data sources in the model.

The authors note that further work is needed on many of the topics explored in the models presented here, and look forward to CPT and SSC comments to guide future investigations. In particular, the authors request feedback on the prediction area to use for model-based indices and approaches to combining the three trawl surveys time series into a single model-based index. Given the current results, the authors recommend considering models 24.0b, 24.0b6, 25.0, 24.0b1, and 25.0a as options for harvest specifications in the fall.

F. Calculation of the OFL

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

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

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

where B is quantified as mature-male biomass (MMB) at mating.

Table 5: Comparisons of management measures for the bridging analysis models 24.0, 24.0a, 24.0b, and 24.0b6. Biomass and OFL are in tons. Note that the OFL and ABC values for models 24.0 and 24.0a are miscalculated because those models use a version of GMACS (2.20.14) that could not accommodate multiple fisheries occuring in different seasons. The accepted OFL and ABC for 2025 were 284 t and 199 t, respectively. GMACS version 2.20.20, used for all other models in this document, calculates the OFL and ABC correctly.

Component	24.0	24.0a	24.0b	24.0b6
MMB_{2025}	2139.00	2105.00	2051.00	2105.00
B_{MSY}	1963.00	1949.00	2115.00	1949.00
MMB/B_{MSY}	1.09	1.08	0.97	1.08
F_{OFL}	0.18	0.18	0.12	0.01
OFL_{2025}	520.00	511.00	114.00	262.00
ABC_{2025}	364.00	358.00	79.00	183.00

Table 6: Comparisons of management measures for the new base model (24.0b) and the model with shell condition removed (25.0). Biomass and OFL are in tons.

Component	24.0b	25.0
MMB_{2025}	2051.00	2238.00
B_{MSY}	2115.00	2108.00
MMB/B_{MSY}	0.97	1.06
F_{OFL}	0.12	0.12
OFL_{2025}	114.00	123.00
ABC_{2025}	79.00	86.00

Table 7: Comparisons of management measures for the new base model (model 24.0b) and three models exploring natural mortality (M). In model 24.0b1, as in model 24.0b, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 24.0b and 0.23 for model 24.0b1. Model 24.0b2 uses a size-independent $M = 0.18$. Model 24.0b3 uses a size-independent $M = 0.23$. Biomass and OFL are in tons.

Component	24.0b	24.0b1	24.0b2	24.0b3
MMB_{2025}	2051.00	1879.00	2291.00	2079.00
B_{MSY}	2115.00	2181.00	1143.00	1293.00
MMB/B_{MSY}	0.97	0.86	2.00	1.61
F_{OFL}	0.12	0.12	0.09	0.11
OFL_{2025}	114.00	133.00	189.00	218.00
ABC_{2025}	79.00	93.00	132.00	152.00

Table 8: Comparisons of management measures for the model with shell condition excluded (model 25.0) and three models exploring natural mortality (M). In model 25.0a, as in model 25.0, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 25.0 and 0.23 for model 25.0a. Model 25.0b uses a size-independent $M = 0.18$. Model 25.0c uses a size-independent $M = 0.23$. Biomass and OFL are in tons.

Component	25.0	25.0a	25.0b	25.0c
MMB_{2025}	2238.00	2083.00	2467.00	5014.00
B_{MSY}	2108.00	2115.00	1336.00	3233.00
MMB/B_{MSY}	1.06	0.98	1.85	1.55
F_{OFL}	0.12	0.14	0.11	0.14
OFL_{2025}	123.00	161.00	167.00	436.00
ABC_{2025}	86.00	113.00	117.00	305.00

Table 9: Comparisons of management measures for the new base model (model 24.0b) and models using spatiotemporal model-based rather than design-based indices of abundance for the three trawl surveys. In model 24.0b4, abundance is estimated over the full area covered by all three surveys while, in model 24.0b5, abundance is estimated over the reduced area covered by the ADF&G trawl survey since 2010. Biomass and OFL are in tons.

Component	24.0b	24.0b4	24.0b5
MMB_{2025}	2051.00	4095.00	2709.00
B_{MSY}	2115.00	3942.00	2803.00
MMB/B_{MSY}	0.97	1.04	0.97
F_{OFL}	0.12	0.15	0.13
OFL_{2025}	114.00	158.00	124.00
ABC_{2025}	79.00	110.00	87.00

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 2023-2024. 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 using a size-independent M, as do other BSAI crab stock assessment models; and 5) a retrospective pattern in model-estimated mature male biomass. Depending on the model chosen for harvest specifications for 2026, this set of concerns may change.

H. Rebuilding analyses

This stock is not currently subject to a rebuilding plan.

I. Data gaps and research priorities

A key research priority is spatiotemporal modeling of size composition data, in order to account for potential spatial variation in size structure. Other priorities include exploring ways to incorporate the winter subsistence total catch data as well as addressing uncertainty in the biological characteristics of the stock and the lack of information on discards. As noted above, a satellite tagging study planned for summer 2025 aims to provide information about whether large males are moving outside of the study area or suffering mortality events. The results of this study could help inform whether estimating a higher M for males in the larger size classes is appropriate.

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K. Literature cited

Anderson SC, Ward EJ, English PA, Barnett LAK (2022) sdmTMB: An R package for fast, flexible, and user-friendly generalized linear mixed effects models with spatial and spatiotemporal random fields. bioRxiv, *2022.03.24.485545*. doi:10.1101/2022.03.24.485545.

Bell J, Leon JM, Hamazaki T, Kent S, Jones WW (2016) Red king crab movement, growth, and size composition within eastern Norton Sound, Alaska, 2012-2014. Alaska Department of Fish and Game, Division of Commercial Fisheries, Fishery Data Series No. 16-37. PDF.

Grant WS, Cheng W (2012) Incorporating deep and shallow components of genetic structure into the management of Alaskan red king crab. Evolutionary Applications 5:820-837. doi:10.1111/j.1752-4571.2012.00260.x.

Hamazaki T (2024) Norton Sound red king crab stock assessment for the fishing year 2025. North Pacific Fishery Management Council, Anchorage, AK. PDF.

Markowitz E, Dawson L, Anderson C, Rohan S, Charriere N, Stevenson D (2023) Northern Bering Sea groundfish and crab trawl survey highlights. National Oceanic and Atmospheric Administration, Community Report. PDF.

Menard J, Leon JM, Bell J, Neff L, Clark K (2022) 2021 annual management report: Norton Sound-Port Clarence area and Arctic-Kotzebue management areas. Alaska Department of Fish and Game, Division of Commercial Fisheries, Fishery Management Report No. 22-27. PDF.

North Pacific Fishery Management Council (2024) Fishery management plan for Bering Sea/Aleutian Islands king and Tanner crabs. North Pacific Fishery Management Council, Anchorage, Alaska. PDF.

Otto RS, MacIntosh RA, Cummiskey PA (1989) Fecundity and other reproductive parameters of female red king crab (*Paralithodes camtschatica*) in Bristol Bay and Norton Sound, Alaska. In: Proceedings of the International Symposium on King and Tanner Crabs, pp. 65-90. Alaska Sea Grant College Program Report No. 90-04. Anchorage, AK. PDF.

Palof K (2024) Bristol Bay red king crab stock assessment 2024. North Pacific Fishery Management Council, Anchorage, AK. PDF.

Paul JM, Paul AJ, Otto RS, Macintosh RA (1991) Spermatophore presence in relation to carapace length for eastern Bering Sea blue king crab (*Paralithodes platypus*, Brandt, 1850) and red king crab (*P. camtschaticus* (Tilesius, 1815)). Journal of Shellfish Research 10:157-163.

Powell GC, Nickerson RB (1965) Reproduction in king crabs, *Paralithodes camtschatica* (Tilesius). Journal of the Fisheries Board of Canada 22:101-111. doi:10.1139/f65-009.

Powell GC, Peterson R, Schwarz L (1983) The red king crab, *Paralithodes camtschatica* (Tilesius), in Norton Sound, Alaska: History of biological research and resource utilization through 1982. Alaska Department of Fish and Game, Division of Commercial Fisheries, Informational Leaflet No. 222. PDF.

St. John CA, Timm LE, Gruenthal KM, Larson WA (2025) Whole genome sequencing reveals substantial genetic structure and evidence of local adaptation in Alaska red king crab. Evolutionary Applications 18:e70049. doi:10.1111/eva.70049.

Stern CA (2025) Spatiotemporal model-based survey indices of abundance for Norton Sound red king crab. North Pacific Fishery Management Council, Anchorage, AK.

Stevens BG, Lovrich GA (2014) King crabs of the world: species and distributions. In: King Crabs of the World, pp. 1-30. CRC Press. doi:10.1201/b16664.

Tables

Table 10: Status of recommendations made by the Scientific and Statistical Committee (SSC) and Crab Plan Team (CPT) for the Norton Sound red king crab assessment model and for Bering Sea/Aleutian Islands crab models in general. Recommendations addressed in the current document are listed first, followed by recommendations that will be addressed in future iterations of the assessment.

Recommendation	Date	Body	Status
Present jittering results as plots	12/2024	CPT and SSC	Addressed here
Full suite of diagnostics and sensitivities	12/2024	SSC	Addressed here
Calculate OFL within GMACS	12/2024	CPT and SSC	Addressed here
Address overestimation of largest male crab	12/2024	CPT and SSC	Addressed here
Evaluate use of size-dependent M	12/2024	CPT and SSC	Addressed here
Evaluate model-based indices of abundance	12/2024	CPT and SSC	Addressed here
Use prior from BBRKC for size-independent M	12/2024	SSC	Addressed here
Include fits to catch data	12/2024	CPT and SSC	Addressed here
Investigate retrospective patterns	12/2024	CPT and SSC	Addressed here
Review shell condition effects on size comp fits	12/2024	CPT and SSC	Addressed here
Align document with crab SAFE guidelines	12/2024	SSC	Addressed here
Additional residual diagnostics for size comp data	10/2024	SSC	Addressed here
Individual plots of fits to survey indices	9/2024	CPT	Addressed here
Include winter subsistence total catch data	12/2024	CPT and SSC	Not yet addressed
Address uncertainty about stock biology	12/2024	CPT and SSC	Not yet addressed
Address lack of discard information	12/2024	CPT and SSC	Not yet addressed

Table 11: Design-based and model-based trawl survey indices of abundance in thousands of crab. The design-based indices were used in all models except for 24.0b4 and 24.0b5, which used the model-based indices generated by predicting over the full surveyed area and the reduced area covered by the ADF&G survey since 2010, respectively. For details on model-based index development for Norton Sound red king crab, see Stern (2025).

Year	Trawl survey	Design est.	Design est. CV	Model est. (full)	Model est. CV (full)	Model est. (red.)	Model est. CV (red.)
1976	NOAA NS	4247.46	0.31	2922.98	0.26	2647.49	0.25
1979	NOAA NS	1417.21	0.20	1032.53	0.27	952.58	0.27
1982	NOAA NS	2791.73	0.29	3007.71	0.24	2661.34	0.22
1985	NOAA NS	2306.32	0.25	3141.68	0.22	2769.39	0.20
1988	NOAA NS	2263.35	0.29	1204.27	0.36	1127.66	0.35
1991	NOAA NS	3132.51	0.43	1749.98	0.35	1558.87	0.33
1996	ADFG	1313.76	0.26	3557.91	0.43	2250.26	0.33
1999	ADFG	2630.53	0.24	8135.80	0.39	4987.49	0.29
2002	ADFG	1769.85	0.42	3591.91	0.40	2305.89	0.29
2006	ADFG	3322.53	0.39	5044.77	0.35	3200.65	0.25
2008	ADFG	2962.10	0.30	6318.34	0.35	3954.94	0.25
2011	ADFG	3209.28	0.29	5252.34	0.38	3438.35	0.28
2014	ADFG	5949.46	0.47	11139.70	0.39	7065.55	0.30
2017	ADFG	1762.07	0.22	3668.55	0.40	2392.98	0.30
2018	ADFG	1109.39	0.25	1814.10	0.46	1264.61	0.36
2019	ADFG	4675.99	0.60	2554.71	0.43	1908.76	0.34
2020	ADFG	1725.99	0.30	2721.33	0.43	1934.91	0.33
2021	ADFG	2430.44	0.61	4110.76	0.46	2796.78	0.36
2023	ADFG	3548.08	0.32	6672.40	0.40	4296.05	0.30
2024	ADFG	1407.40	0.28	6942.14	0.41	4268.44	0.32
2010	NOAA NBS	1980.08	0.44	2654.92	0.33	1921.53	0.32
2017	NOAA NBS	864.50	0.47	2192.78	0.36	1536.50	0.35
2019	NOAA NBS	2071.94	0.35	5864.40	0.26	3873.37	0.26
2021	NOAA NBS	2338.06	0.44	3022.23	0.33	2180.82	0.31
2022	NOAA NBS	2103.02	0.36	6748.61	0.28	3706.68	0.29
2023	NOAA NBS	1686.34	0.39	2737.49	0.33	2022.33	0.32

Table 12: Summary of convergence diagnostics from jitter runs.

Model	Jitter runs	Objective function value	Converged to MLE	Max gradient	MMB (current year)	OFL
24.0b	100	4180.59	7	0.00019051	4521	250
25.0	100	2506.875	3	0.00009505	4934	271

Table 13: Comparisons of negative log-likelihood values for the models in the bridging analysis. Model 24.0 is the model recommended by the CPT and SSC for harvest specifications in December 2024 and presented in the final 2024 SAFE document. Model 24.0a is model 24.0 with errors in the input data corrected. Model 24.0b is model 24.0a transitioned to GMACS version 2.20.20. Model 24.0b6 is model 24.0b with the second lowest objective function value.

Component	24.0	24.0a	24.0b	24.0b6
Winter comm. retained catch	-119.04	-119.04	-119.03	-119.04
Subsistence retained catch	-121.63	-121.63	-121.63	-121.63
Subsistence total catch	0.00	0.00	0.00	0.00
Summer comm. retained catch	-116.44	-116.44	-116.45	-116.44
NMFS trawl survey 1976-1991	-3.32	-3.32	-3.57	-3.32
ADF&G trawl survey	-4.12	-4.03	-7.05	-4.03
NOAA NBS survey	-5.37	-5.41	-5.52	-5.41
Pot survey CPUE 1977-1992	-2.98	-2.98	-2.70	-2.98
Pot survey CPUE 1993-2006	-5.05	-5.06	-4.95	-5.06
Pot survey CPUE 2007-2024	-11.52	-11.34	-13.24	-11.34
Winter com. retained size comp.	50.95	50.97	57.08	50.97
Summer com. retained size comp.	701.54	703.58	703.53	703.58
Summer com. discard size comp.	279.43	279.73	280.04	279.73
Summer com. total size comp	216.39	216.64	216.45	216.64
NMFS trawl survey size comp.	318.49	317.69	316.81	317.69
ADF&G trawl survey size comp.	288.26	282.76	280.61	282.76
NBS trawl survey size comp.	158.01	157.32	155.40	157.32
Winter pot survey size comp.	614.12	613.76	614.68	613.76
Recruitment deviations	51.86	51.15	52.33	51.15
Tagging	1724.64	1724.67	1724.14	1724.67
Growth	1724.64	1724.67	1724.14	1724.67
F penalty	14.21	14.21	14.21	14.21
Prior	95.49	95.49	95.34	95.49
Total	4188.03	4182.61	4180.59	4182.61
Total estimated parameters	226.00	226.00	226.00	226.00

Table 14: Comparisons of negative log-likelihood values for the models analyzing the effects of removing shell condition. Model 24.0b is the new base model, which includes separate size composition data sets by shell condition (newshell or oldshell). Model 25.0 excludes shell condition information, such that males of both shell conditions are combined in each size composition data set.

Component	24.0b	25.0
Winter comm. retained catch	-119.03	-119.04
Subsistence retained catch	-121.63	-121.63
Subsistence total catch	0.00	0.00
Summer comm. retained catch	-116.45	-116.45
NMFS trawl survey 1976-1991	-3.57	-3.42
ADF&G trawl survey	-7.05	-6.49
NOAA NBS survey	-5.52	-5.19
Pot survey CPUE 1977-1992	-2.70	-3.17
Pot survey CPUE 1993-2006	-4.95	-6.78
Pot survey CPUE 2007-2024	-13.24	-14.74
Winter com. retained size comp.	57.08	26.03
Summer com. retained size comp.	703.53	272.04
Summer com. discard size comp.	280.04	108.15
Summer com. total size comp	216.45	79.25
NMFS trawl survey size comp.	316.81	45.20
ADF&G trawl survey size comp.	280.61	115.69
NBS trawl survey size comp.	155.40	49.99
Winter pot survey size comp.	614.68	303.23
Recruitment deviations	52.33	50.46
Tagging	1724.14	1689.11
Growth	1724.14	1689.11
F penalty	14.21	14.21
Prior	95.34	95.46
Total	4180.59	2506.88
Total estimated parameters	226.00	226.00

Table 15: Comparisons of negative log-likelihood values for the new base model (model 24.0b) and three models exploring natural mortality (M). In model 24.0b1, as in model 24.0b, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 24.0b and 0.23 for model 24.0b1. Model 24.0b2 uses a size-independent $M = 0.18$. Model 24.0b3 uses a size-independent $M = 0.23$. Note that models 24.0b and 24.0b1 each have one more parameter than do models 24.0b2 and 24.0b3 because the former include an estimated M value for larger males.

Component	24.0b	24.0b1	24.0b2	24.0b3
Winter comm. retained catch	-119.03	-119.04	-119.03	-119.04
Subsistence retained catch	-121.63	-121.63	-121.63	-121.63
Subsistence total catch	0.00	0.00	0.00	0.00
Summer comm. retained catch	-116.45	-116.45	-116.28	-116.36
NMFS trawl survey 1976-1991	-3.57	-3.60	2.29	-0.11
ADF&G trawl survey	-7.05	-6.70	16.15	5.77
NOAA NBS survey	-5.52	-5.55	-4.83	-5.13
Pot survey CPUE 1977-1992	-2.70	-2.87	-1.58	-2.05
Pot survey CPUE 1993-2006	-4.95	-4.97	-4.31	-4.95
Pot survey CPUE 2007-2024	-13.24	-12.71	-11.45	-12.13
Winter com. retained size comp.	57.08	56.95	58.55	57.91
Summer com. retained size comp.	703.53	702.65	723.11	721.90
Summer com. discard size comp.	280.04	280.60	280.31	280.56
Summer com. total size comp	216.45	216.83	218.69	218.45
NMFS trawl survey size comp.	316.81	316.39	316.50	316.83
ADF&G trawl survey size comp.	280.61	280.25	283.35	283.42
NBS trawl survey size comp.	155.40	155.39	153.83	153.98
Winter pot survey size comp.	614.68	614.13	616.75	615.99
Recruitment deviations	52.33	52.37	53.88	52.43
Tagging	1724.14	1724.96	1739.94	1739.01
Growth	1724.14	1724.96	1739.94	1739.01
F penalty	14.21	14.21	14.21	14.21
Prior	95.34	95.28	93.23	93.23
Total	4180.59	4180.94	4256.43	4237.30
Total estimated parameters	226.00	226.00	225.00	225.00

Table 16: Comparisons of negative log-likelihood values for the model excluding shell condition (model 25.0) and three models exploring natural mortality (M) that also exclude shell condition. In model 25.0a, as in model 25.0a, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 25.0 and 0.23 for model 25.0a. Model 25.0b uses a size-independent $M = 0.18$. Model 25.0c uses a size-independent $M = 0.23$. Note that models 25.0 and 25.0a each have one more parameter than do models 25.0b and 25.0c because the former include an estimated M value for larger males.

Component	25.0	25.0a	25.0b	25.0c
Winter comm. retained catch	-119.04	-119.04	-119.02	-119.03
Subsistence retained catch	-121.63	-121.63	-121.63	-121.63
Subsistence total catch	0.00	0.00	0.00	0.00
Summer comm. retained catch	-116.45	-116.45	-116.36	-116.41
NMFS trawl survey 1976-1991	-3.42	-3.38	0.37	-1.56
ADF&G trawl survey	-6.49	-6.23	4.95	-0.48
NOAA NBS survey	-5.19	-5.29	-4.88	-5.08
Pot survey CPUE 1977-1992	-3.17	-3.38	-2.00	-2.32
Pot survey CPUE 1993-2006	-6.78	-6.85	-6.37	-6.84
Pot survey CPUE 2007-2024	-14.74	-14.49	-13.96	-14.25
Winter com. retained size comp.	26.03	26.02	27.48	26.93
Summer com. retained size comp.	272.04	271.45	287.02	284.27
Summer com. discard size comp.	108.15	108.09	108.98	108.66
Summer com. total size comp	79.25	79.49	81.32	81.07
NMFS trawl survey size comp.	45.20	45.21	46.11	46.28
ADF&G trawl survey size comp.	115.69	114.93	119.82	118.53
NBS trawl survey size comp.	49.99	49.42	50.66	50.01
Winter pot survey size comp.	303.23	303.14	304.89	304.03
Recruitment deviations	50.46	50.38	53.85	51.70
Tagging	1689.11	1688.87	1694.71	1693.45
Growth	1689.11	1688.87	1694.71	1693.45
F penalty	14.21	14.21	14.21	14.21
Prior	95.46	95.32	93.23	93.23
Total	2506.88	2504.97	2558.31	2539.93
Total estimated parameters	226.00	226.00	225.00	225.00

Table 17: Comparisons of negative log-likelihood values for the new base model (model 24.0b) and models using spatiotemporal model-based rather than design-based indices of abundance for the three trawl surveys. In model 24.0b4, abundance is estimated over the full area covered by all three surveys while, in model 24.0b5, abundance is estimated over the reduced area covered by the ADF&G trawl survey since 2010.

Component	24.0b	24.0b4	24.0b5
Winter comm. retained catch	-119.03	-119.03	-119.03
Subsistence retained catch	-121.63	-121.63	-121.63
Subsistence total catch	0.00	0.00	0.00
Summer comm. retained catch	-116.45	-116.45	-116.45
NMFS trawl survey 1976-1991	-3.57	-1.05	-0.49
ADF&G trawl survey	-7.05	-2.91	-3.77
NOAA NBS survey	-5.52	-2.40	-3.55
Pot survey CPUE 1977-1992	-2.70	-1.54	-2.03
Pot survey CPUE 1993-2006	-4.95	-5.66	-5.48
Pot survey CPUE 2007-2024	-13.24	-13.50	-13.52
Winter com. retained size comp.	57.08	57.48	57.10
Summer com. retained size comp.	703.53	704.99	704.40
Summer com. discard size comp.	280.04	280.20	280.04
Summer com. total size comp	216.45	216.15	216.21
NMFS trawl survey size comp.	316.81	318.14	317.86
ADF&G trawl survey size comp.	280.61	282.02	282.36
NBS trawl survey size comp.	155.40	154.73	154.89
Winter pot survey size comp.	614.68	616.34	615.88
Recruitment deviations	52.33	52.56	51.97
Tagging	1724.14	1723.66	1723.83
Growth	1724.14	1723.66	1723.83
F penalty	14.21	14.21	14.21
Prior	95.34	95.93	95.63
Total	4180.59	4196.60	4192.65
Total estimated parameters	226.00	226.00	226.00

Table 18: Estimated mature male biomass (MMB), male recruits, and standard deviations (SD) for model 24.0b, the new base model, for Norton Sound red king crab.

Year	MMB	SD MMB	Male recruits	SD male recruits
1976	15638.60	2575.47	303.18	159.40
1977	17411.28	2223.13	235.48	94.87
1978	16096.30	1893.19	235.05	87.17
1979	11765.42	1457.49	881.81	246.84
1980	6584.13	1059.86	1174.07	284.41
1981	4546.46	806.22	1079.44	255.58
1982	3595.28	775.25	1131.81	302.95
1983	4469.72	865.84	1189.25	292.66
1984	5170.42	977.03	751.21	196.53
1985	5848.27	1086.94	903.36	231.14
1986	6224.42	1152.08	624.71	163.32
1987	6130.01	1140.80	658.16	150.15
1988	6024.29	1089.02	681.61	160.09
1989	5740.39	997.03	470.09	119.46
1990	5408.36	902.84	474.05	111.25
1991	5068.33	808.17	388.00	103.72
1992	4792.26	703.42	284.30	87.59
1993	4363.49	601.94	309.41	86.34
1994	3656.84	507.75	423.37	100.07
1995	2988.61	425.74	605.57	119.59
1996	2530.35	379.93	1158.77	224.97
1997	2506.45	373.67	545.71	144.34
1998	3140.90	424.72	236.29	73.75
1999	4048.54	518.93	475.25	133.35
2000	4296.87	531.30	786.85	168.17
2001	3859.32	499.76	746.14	150.42
2002	3680.83	478.31	458.56	128.66
2003	3843.11	487.17	375.22	112.07
2004	3913.95	488.04	906.85	177.52
2005	3656.52	459.56	1114.75	202.69
2006	3475.89	435.14	1391.84	273.82
2007	3823.61	465.99	1273.61	251.69
2008	4722.84	546.63	845.34	213.77
2009	5407.47	621.25	503.37	133.76
2010	5833.54	665.46	870.29	188.27
2011	5584.38	650.91	1533.37	370.67
2012	5133.99	617.73	3382.89	747.18
2013	4950.59	632.85	1000.43	290.62
2014	5658.28	743.30	465.07	148.40
2015	7105.22	1008.80	312.15	78.87
2016	5487.43	667.69	411.71	69.32
2017	3850.81	419.35	534.37	92.03
2018	2387.79	266.34	2161.55	295.96
2019	1902.56	245.42	1559.50	266.31
2020	2983.16	332.43	776.63	170.32
2021	5385.68	557.40	508.38	125.38
2022	7056.79	712.42	157.50	56.52
2023	6985.25	751.80	211.39	85.18
2024	5969.25	701.20	384.43	270.34

Table 19: Estimated mature male biomass (MMB), male recruits, and standard deviations (SD) for model 25.0, with shell condition excluded, for Norton Sound red king crab.

Year	MMB	SD MMB	Male recruits	SD male recruits
1976	16083.32	3223.13	360.10	205.57
1977	17205.44	2647.22	254.53	112.03
1978	15668.41	2174.37	243.45	98.09
1979	11250.04	1615.70	556.58	221.03
1980	6106.07	1142.89	1289.63	366.27
1981	4024.32	832.98	1087.00	317.76
1982	3033.69	777.86	1016.24	350.20
1983	4114.60	924.84	1058.90	338.72
1984	4913.16	1069.80	791.95	254.40
1985	5541.99	1194.00	834.33	277.53
1986	5864.82	1259.82	584.46	195.99
1987	5786.16	1245.14	608.36	178.31
1988	5653.66	1183.57	636.59	194.51
1989	5351.83	1078.42	439.89	143.79
1990	5012.32	972.38	532.55	155.56
1991	4672.09	870.43	410.20	140.27
1992	4459.19	759.52	422.10	152.86
1993	4157.51	660.55	438.00	142.50
1994	3611.50	569.93	494.63	147.44
1995	3181.64	501.29	669.07	164.90
1996	2924.77	477.16	1203.92	298.07
1997	3024.98	483.06	540.54	184.76
1998	3746.77	544.68	264.57	95.52
1999	4637.44	652.97	438.33	165.48
2000	4759.75	650.03	915.75	238.58
2001	4187.69	600.27	673.32	181.29
2002	3958.68	570.56	439.33	150.80
2003	4134.51	589.89	411.84	145.20
2004	4095.66	581.09	805.20	213.32
2005	3764.70	536.65	1027.05	244.67
2006	3529.94	493.20	1326.29	330.51
2007	3770.05	505.77	1231.11	317.09
2008	4590.48	576.76	1116.43	320.03
2009	5206.39	654.79	528.61	171.28
2010	5732.55	702.21	790.00	218.76
2011	5697.31	710.10	1437.32	443.88
2012	5270.23	674.15	3668.06	1007.26
2013	5002.24	678.51	1080.99	402.67
2014	5834.24	840.32	473.34	196.41
2015	7473.17	1204.19	325.44	107.60
2016	5674.37	778.87	406.20	88.78
2017	3896.08	472.37	517.75	111.44
2018	2335.06	283.03	1786.41	310.98
2019	1814.00	257.06	1706.69	346.56
2020	2796.70	353.59	1086.61	282.99
2021	5083.11	580.68	616.27	188.62
2022	7032.01	755.97	213.74	85.04
2023	7289.33	823.51	258.95	116.35
2024	6390.50	785.66	429.98	305.18

Table 20: Summary of estimated model parameter values and standard errors (SE) for model 24.0b, the new base model, for Norton Sound red king crab.

Count	Parameter	Estimate	SE
1	Log(Rinitial):	9.1477	0.1223
2	Log(Rbar):	6.4425	0.1539
3	Recruitment_ra-males:	72.9601	1.8216
4	Recruitment_rb-males:	0.0708	0.4991
5	Scaled_logN_for_male_mature_mature_newshell_class_2:	-0.1882	0.4056
6	Scaled_logN_for_male_mature_mature_newshell_class_3:	0.6801	0.3731
7	Scaled_logN_for_male_mature_mature_newshell_class_4:	0.9176	0.3582
8	Scaled_logN_for_male_mature_mature_newshell_class_5:	0.8806	0.3369
9	Scaled_logN_for_male_mature_mature_newshell_class_6:	0.3431	0.3642
10	Scaled_logN_for_male_mature_mature_newshell_class_7:	-0.3493	0.4192
11	Scaled_logN_for_male_mature_mature_newshell_class_8:	-0.6734	0.4534
12	Alpha_base_male:	35.4852	1.1410
13	Beta_base_male:	0.2270	0.0116
14	Gscale_base_male:	3.8702	0.1357
15	Molt_probability_mu_base_male_period_1:	124.7282	1.2522
16	Molt_probability_CV_base_male_period_1:	0.1274	0.0062
17	Sel_Winter_Com_male_base_Dec_Logistic_cv:	0.5679	0.0338
18	Sel_Winter_Com_male_base_Dec_Logistic_cv:	4.7934	0.0206
19	Sel_Winter_Com_male_base_Dec_Logistic_extra_par1:	-2.0445	0.1858
20	Sel_Winter_Com_male_base_Dec_Logistic_extra_par2:	-2.7051	0.3269
21	Sel_Winter_Com_male_base_Dec_Logistic_extra_par3:	-0.7853	0.1707
22	Sel_Summer_Com_male_base_Dec_Logistic_mean:	-0.2157	0.1421
23	Sel_NMFS_Trawl_male_base_Dec_Logistic_mean:	-2.0433	0.0287
24	Ret_Winter_Com_male_base_Logistic_mean:	-11.5080	18.1216
25	Ret_Winter_Com_male_Logistic_cv_block_group_2_block_1:	5.1018	0.0530
26	Ret_Subsistence_male_base_class_1:	2.4870	0.1521
27	Ret_Summer_Com_male_base_Logistic_cv:	4.6401	0.0057
28	Ret_Summer_Com_male_Logistic_mean_block_group_1_block_1:	0.8388	0.0964
29	Ret_Summer_Com_male_Logistic_cv_block_group_1_block_1:	4.6681	0.0055
30	Log_vn_aggregated_size_comp1:	0.8727	0.1212
31	Log_fbar_Winter_Com:	-4.6262	0.7211
32	Log_fbar_Subsistence:	-5.7558	2.2391
33	Log_fbar_Summer_Com:	-2.2259	0.7141
172	Rec_dev_est_1976:	-0.7282	0.5300
173	Rec_dev_est_1977:	-0.9809	0.4121

174	Rec_dev_est_1978:	-0.9827	0.3815
175	Rec_dev_est_1979:	0.3395	0.2947
176	Rec_dev_est_1980:	0.6257	0.2590
177	Rec_dev_est_1981:	0.5417	0.2523
178	Rec_dev_est_1982:	0.5891	0.2810
179	Rec_dev_est_1983:	0.6386	0.2601
180	Rec_dev_est_1984:	0.1792	0.2733
181	Rec_dev_est_1985:	0.3636	0.2687
182	Rec_dev_est_1986:	-0.0052	0.2733
183	Rec_dev_est_1987:	0.0469	0.2434
184	Rec_dev_est_1988:	0.0820	0.2520
185	Rec_dev_est_1989:	-0.2896	0.2710
186	Rec_dev_est_1990:	-0.2812	0.2558
187	Rec_dev_est_1991:	-0.4815	0.2886
188	Rec_dev_est_1992:	-0.7925	0.3264
189	Rec_dev_est_1993:	-0.7078	0.2976
190	Rec_dev_est_1994:	-0.3943	0.2593
191	Rec_dev_est_1995:	-0.0363	0.2263
192	Rec_dev_est_1996:	0.6126	0.2229
193	Rec_dev_est_1997:	-0.1404	0.2865
194	Rec_dev_est_1998:	-0.9775	0.3291
195	Rec_dev_est_1999:	-0.2787	0.2987
196	Rec_dev_est_2000:	0.2255	0.2419
197	Rec_dev_est_2001:	0.1724	0.2324
198	Rec_dev_est_2002:	-0.3144	0.3021
199	Rec_dev_est_2003:	-0.5150	0.3184
200	Rec_dev_est_2004:	0.3675	0.2295
201	Rec_dev_est_2005:	0.5739	0.2162
202	Rec_dev_est_2006:	0.7959	0.2261
203	Rec_dev_est_2007:	0.7071	0.2280
204	Rec_dev_est_2008:	0.2972	0.2729
205	Rec_dev_est_2009:	-0.2212	0.2844
206	Rec_dev_est_2010:	0.3263	0.2389
207	Rec_dev_est_2011:	0.8927	0.2543
208	Rec_dev_est_2012:	1.6840	0.2343
209	Rec_dev_est_2013:	0.4657	0.2980
210	Rec_dev_est_2014:	-0.3003	0.3238
211	Rec_dev_est_2015:	-0.6990	0.2673
212	Rec_dev_est_2016:	-0.4222	0.2051

213	Rec_dev_est_2017:	-0.1614	0.2134
214	Rec_dev_est_2018:	1.2361	0.1879
215	Rec_dev_est_2019:	0.9096	0.2142
216	Rec_dev_est_2020:	0.2125	0.2521
217	Rec_dev_est_2021:	-0.2113	0.2753
218	Rec_dev_est_2022:	-1.3831	0.3736
219	Rec_dev_est_2023:	-1.0888	0.4111
220	Rec_dev_est_2024:	-0.4907	0.6961
221	Survey_q_survey_1:	0.7300	0.1348
222	Survey_q_survey_3:	0.6881	0.1255
223	Survey_q_survey_4:	0.0007	0.0001
224	Survey_q_survey_5:	0.0013	0.0002
225	Survey_q_survey_6:	0.0011	0.0001
226	Log_add_cvt_survey_4:	-1.1107	0.1527

Table 21: Summary of estimated model parameter values and standard errors (SE) for model 25.0, with shell condition excluded, for Norton Sound red king crab.

Count	Parameter	Estimate	SE
1	Log(Rinitial):	9.1237	0.1481
2	Log(Rbar):	6.4798	0.1569
3	Recruitment_ra-males:	72.8407	2.4411
4	Recruitment_rb-males:	0.0808	0.6218
5	Scaled_logN_for_male_mature_mature_newshell_class_2:	-0.1627	0.4292
6	Scaled_logN_for_male_mature_mature_newshell_class_3:	0.3933	0.4181
7	Scaled_logN_for_male_mature_mature_newshell_class_4:	0.6372	0.4042
8	Scaled_logN_for_male_mature_mature_newshell_class_5:	0.6537	0.3957
9	Scaled_logN_for_male_mature_mature_newshell_class_6:	0.3392	0.4037
10	Scaled_logN_for_male_mature_mature_newshell_class_7:	-0.2582	0.4416
11	Scaled_logN_for_male_mature_mature_newshell_class_8:	-0.4677	0.4730
12	Alpha_base_male:	40.0743	2.7552
13	Beta_base_male:	0.2864	0.0313
14	Gscale_base_male:	4.8726	0.2700
15	Molt_probability_mu_base_male_period_1:	135.1376	9.4609
16	Molt_probability_CV_base_male_period_1:	0.0716	0.0122
17	Sel_Winter_Com_male_base_Dec_Logistic_cv:	0.5808	0.0468
18	Sel_Winter_Com_male_base_Dec_Logistic_cv:	4.7899	0.0306
19	Sel_Winter_Com_male_base_Dec_Logistic_extra_par1:	-2.0834	0.2722
20	Sel_Winter_Com_male_base_Dec_Logistic_extra_par2:	-2.7080	0.4645
21	Sel_Winter_Com_male_base_Dec_Logistic_extra_par3:	-0.7525	0.2483
22	Sel_Summer_Com_male_base_Dec_Logistic_mean:	-0.1441	0.2097
23	Sel_NMFS_Trawl_male_base_Dec_Logistic_mean:	-2.0620	0.0393
24	Ret_Winter_Com_male_base_Logistic_mean:	-11.5045	31.7822
25	Ret_Winter_Com_male_Logistic_cv_block_group_2_block_1:	5.1256	0.0766
26	Ret_Subsistence_male_base_class_1:	2.5401	0.2190
27	Ret_Summer_Com_male_base_Logistic_cv:	4.6398	0.0078
28	Ret_Summer_Com_male_Logistic_mean_block_group_1_block_1:	0.8314	0.1351
29	Ret_Summer_Com_male_Logistic_cv_block_group_1_block_1:	4.6672	0.0077
30	Log_vn_aggregated_size_comp1:	0.8774	0.1642
31	Log_fbar_Winter_Com:	-4.5733	0.7320
32	Log_fbar_Subsistence:	-5.7319	2.2415
33	Log_fbar_Summer_Com:	-2.2289	0.7152
172	Rec_dev_est_1976:	-0.5935	0.5738
173	Rec_dev_est_1977:	-0.9404	0.4466

174	Rec_dev_est_1978:	-0.9849	0.4105
175	Rec_dev_est_1979:	-0.1580	0.4052
176	Rec_dev_est_1980:	0.6823	0.2983
177	Rec_dev_est_1981:	0.5113	0.3035
178	Rec_dev_est_1982:	0.4440	0.3527
179	Rec_dev_est_1983:	0.4852	0.3283
180	Rec_dev_est_1984:	0.1947	0.3289
181	Rec_dev_est_1985:	0.2468	0.3393
182	Rec_dev_est_1986:	-0.1091	0.3408
183	Rec_dev_est_1987:	-0.0691	0.3017
184	Rec_dev_est_1988:	-0.0237	0.3156
185	Rec_dev_est_1989:	-0.3933	0.3372
186	Rec_dev_est_1990:	-0.2021	0.3084
187	Rec_dev_est_1991:	-0.4632	0.3578
188	Rec_dev_est_1992:	-0.4346	0.3798
189	Rec_dev_est_1993:	-0.3976	0.3426
190	Rec_dev_est_1994:	-0.2760	0.3172
191	Rec_dev_est_1995:	0.0261	0.2725
192	Rec_dev_est_1996:	0.6135	0.2706
193	Rec_dev_est_1997:	-0.1873	0.3576
194	Rec_dev_est_1998:	-0.9017	0.3747
195	Rec_dev_est_1999:	-0.3968	0.3878
196	Rec_dev_est_2000:	0.3399	0.2844
197	Rec_dev_est_2001:	0.0324	0.2924
198	Rec_dev_est_2002:	-0.3946	0.3598
199	Rec_dev_est_2003:	-0.4592	0.3705
200	Rec_dev_est_2004:	0.2113	0.2941
201	Rec_dev_est_2005:	0.4546	0.2692
202	Rec_dev_est_2006:	0.7103	0.2744
203	Rec_dev_est_2007:	0.6358	0.2844
204	Rec_dev_est_2008:	0.5381	0.3039
205	Rec_dev_est_2009:	-0.2096	0.3384
206	Rec_dev_est_2010:	0.1922	0.2937
207	Rec_dev_est_2011:	0.7907	0.3152
208	Rec_dev_est_2012:	1.7276	0.2806
209	Rec_dev_est_2013:	0.5058	0.3732
210	Rec_dev_est_2014:	-0.3200	0.4122
211	Rec_dev_est_2015:	-0.6947	0.3362
212	Rec_dev_est_2016:	-0.4730	0.2465

213	Rec_dev_est_2017:	-0.2303	0.2497
214	Rec_dev_est_2018:	1.0081	0.2177
215	Rec_dev_est_2019:	0.9625	0.2421
216	Rec_dev_est_2020:	0.5110	0.2886
217	Rec_dev_est_2021:	-0.0561	0.3280
218	Rec_dev_est_2022:	-1.1151	0.4092
219	Rec_dev_est_2023:	-0.9232	0.4536
220	Rec_dev_est_2024:	-0.4161	0.7014
221	Survey_q_survey_1:	0.7834	0.1584
222	Survey_q_survey_3:	0.6956	0.1281
223	Survey_q_survey_4:	0.0007	0.0002
224	Survey_q_survey_5:	0.0012	0.0002
225	Survey_q_survey_6:	0.0011	0.0001
226	Log_add_cvt_survey_4:	-1.2375	0.1638

Figures

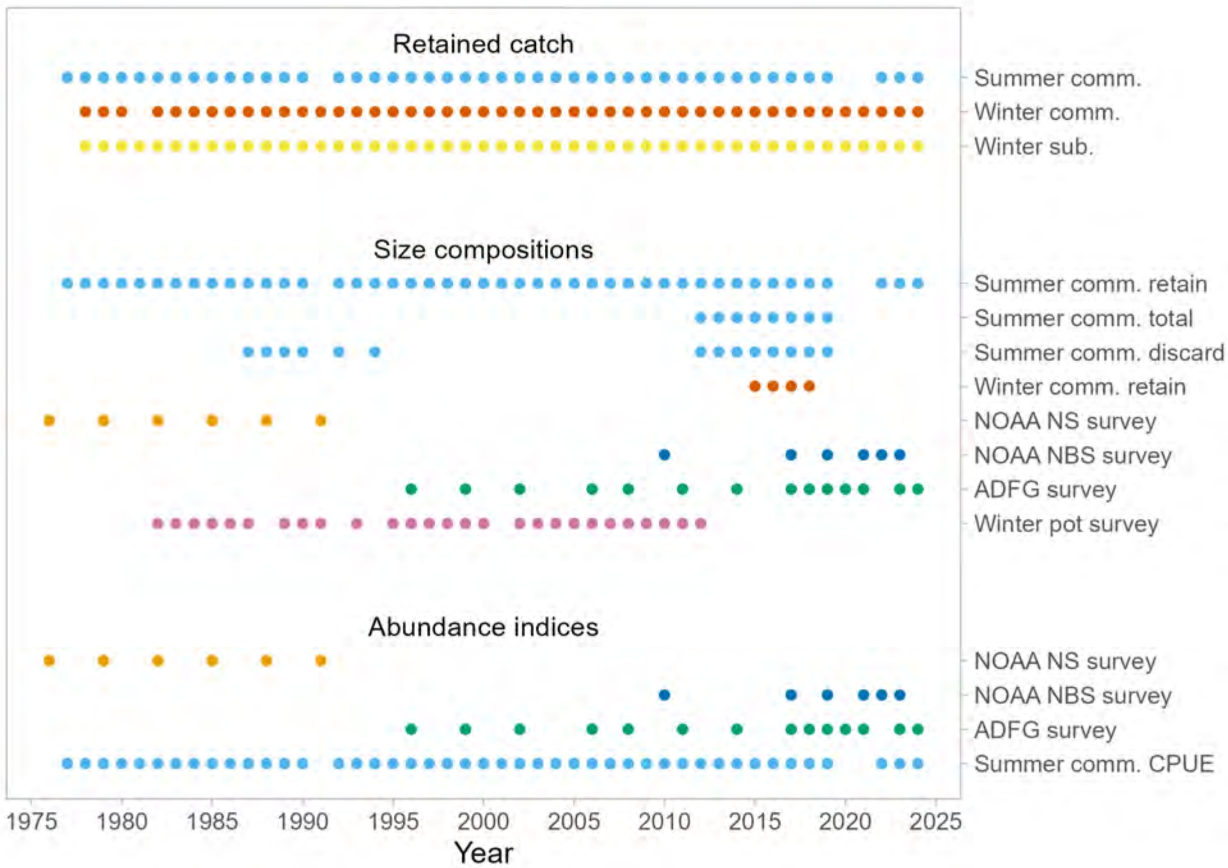


Figure 1: Data sources available for the Norton Sound red king crab stock assessment.

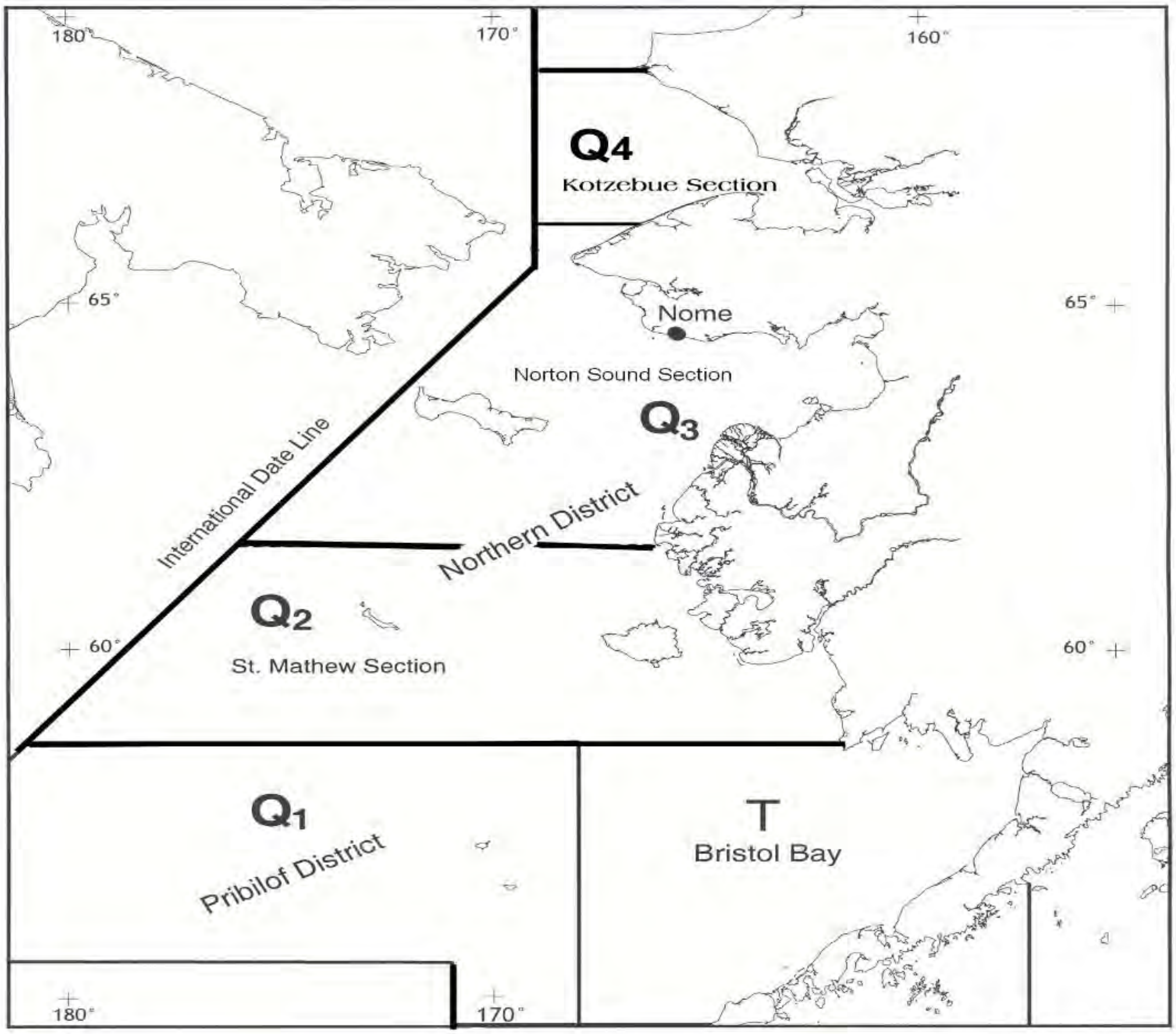


Figure 2: King crab fishing districts and sections of Alaska Department of Fish and Game Registration Area Q. Source: Menard et al. (2022).

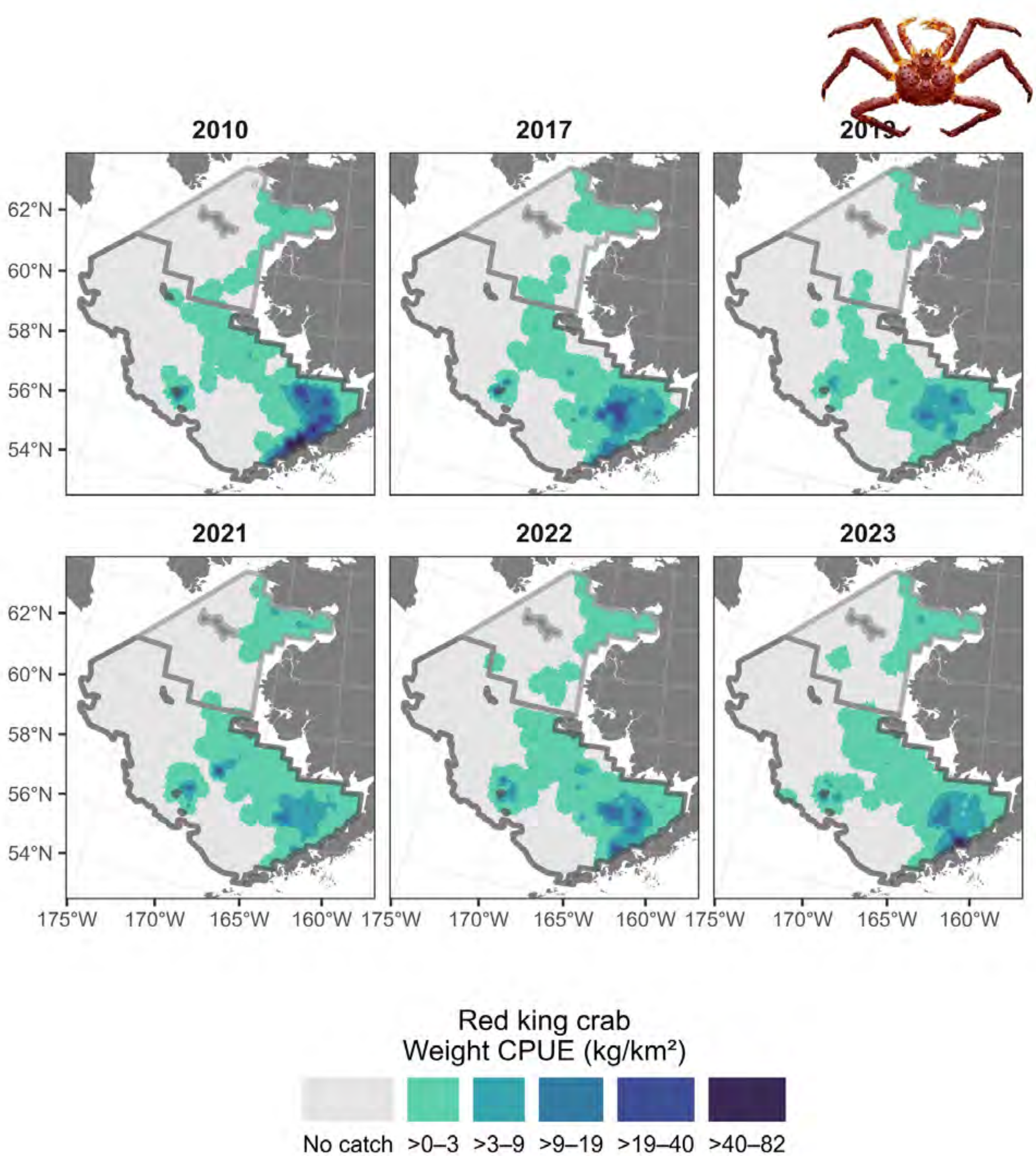


Figure 3: Distribution of red king crab from the 2010, 2017, 2019, and 2021-2023 Eastern and Northern Bering Sea trawl surveys. Source: Markowitz et al. (2023).

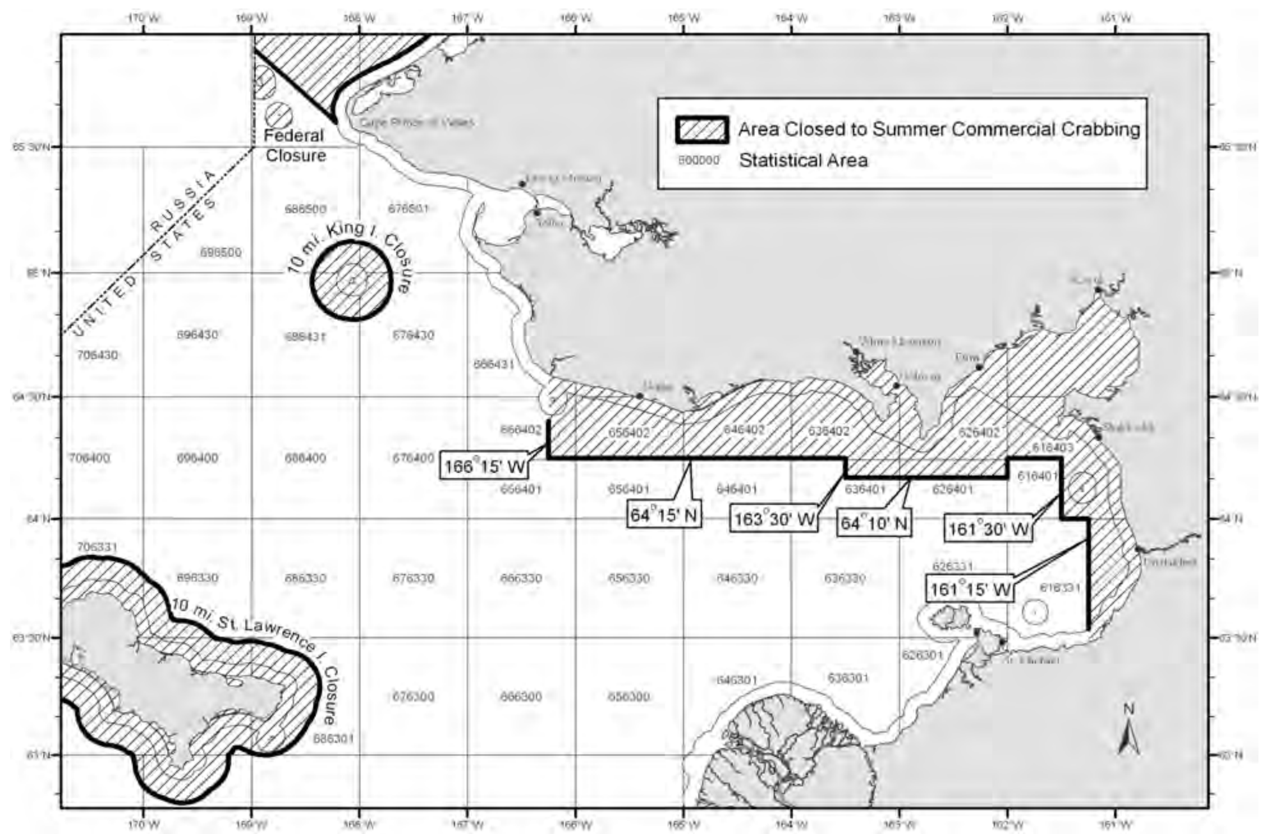


Figure 4: Waters closed to the Norton Sound summer commercial crab fishery. Source: Menard et al. (2022).

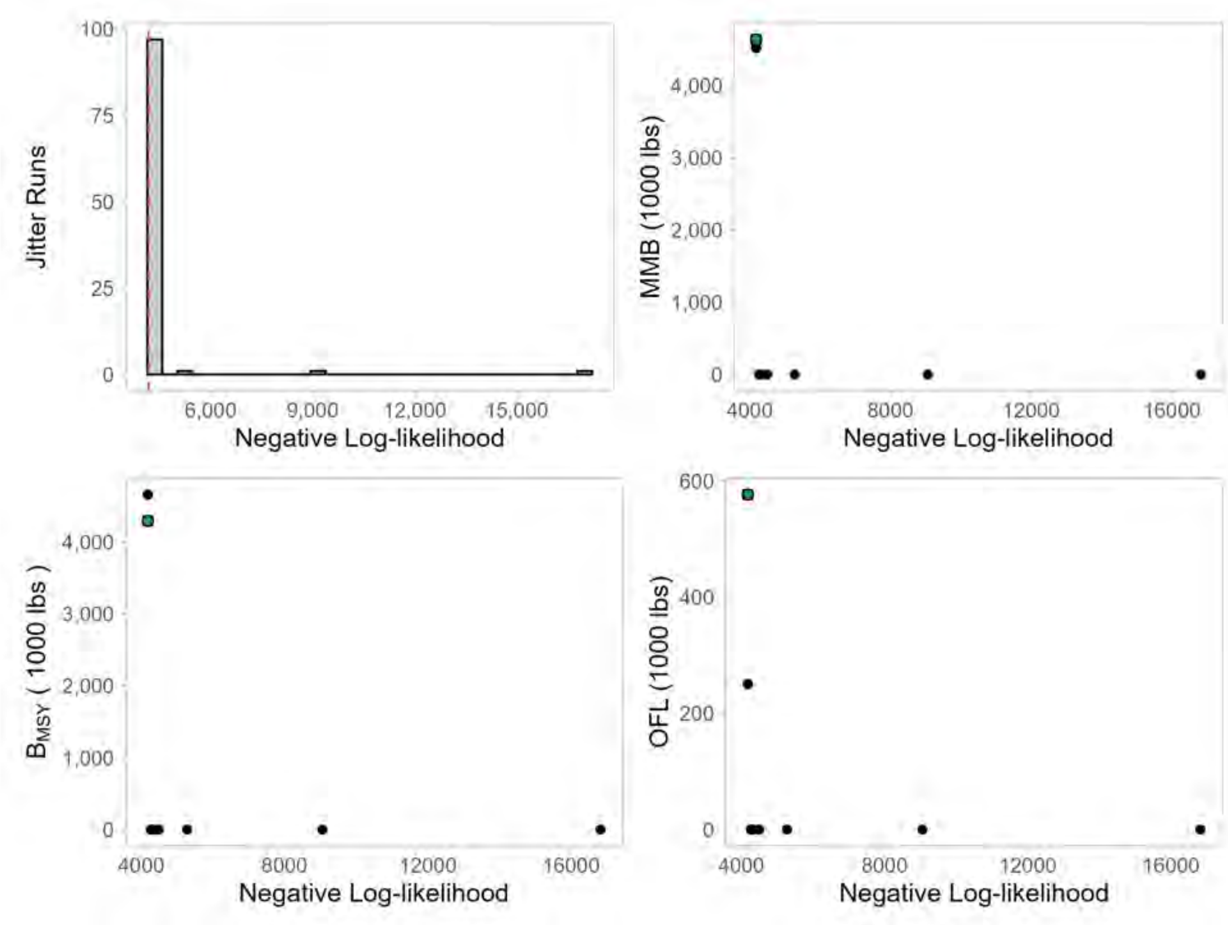


Figure 5: Results from 100 jitter runs for model 24.0b. Of these runs, 7 converged to the apparent maximum likelihood of 4181, 59 converged to the most frequent maximum likelihood (4183), and 8 failed to finish. The maximum gradient for the model run with maximum likelihood of 4181 was 0.000191. Green dots represent values at the MLE. Note that axes with units listed as 1000 lbs in fact have units of 1000's of crab.

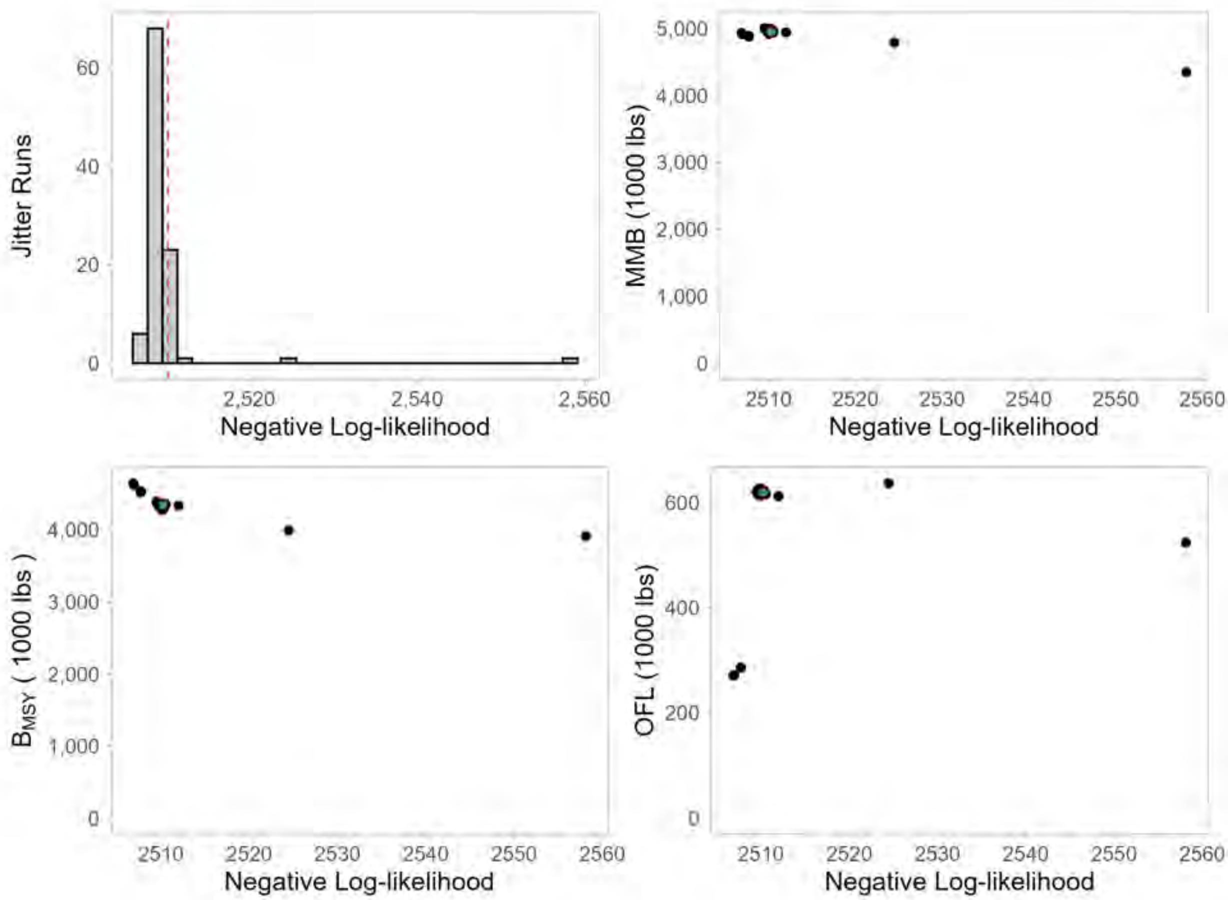


Figure 6: Results from 100 jitter runs for model 25.0. Of these runs, 3 converged to the apparent maximum likelihood of 2507, 66 converged to the most frequent maximum likelihood (2509.5), and none failed to finish. The maximum gradient for the model run with maximum likelihood of 2507 was 0.0000951. Green dots represent values at the MLE. Note that axes with units listed as 1000 lbs in fact have units of 1000's of crab.

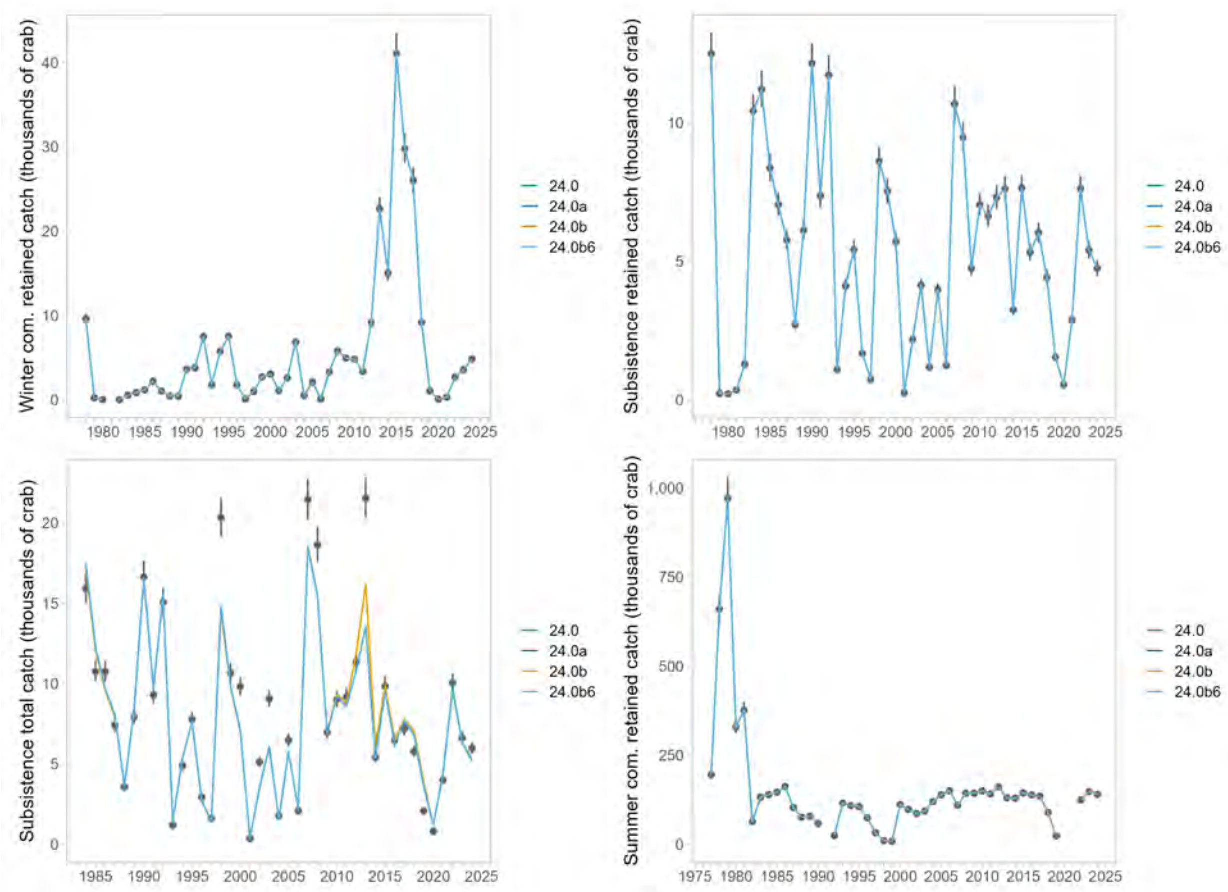


Figure 7: Observed and model-estimated catch of male red king crab caught in the winter commercial, summer commercial, and subsistence fisheries for the models in the bridging analysis: 24.0 (2024 accepted model), 24.0a (24.0 with errors corrected), 24.0b (24.0a transitioned to GMACS 2.20.20), and 24.0b6 (24.0b at the second lowest objective function value). Note that subsistence total catch was not fitted in these models (emphasis set to 0).

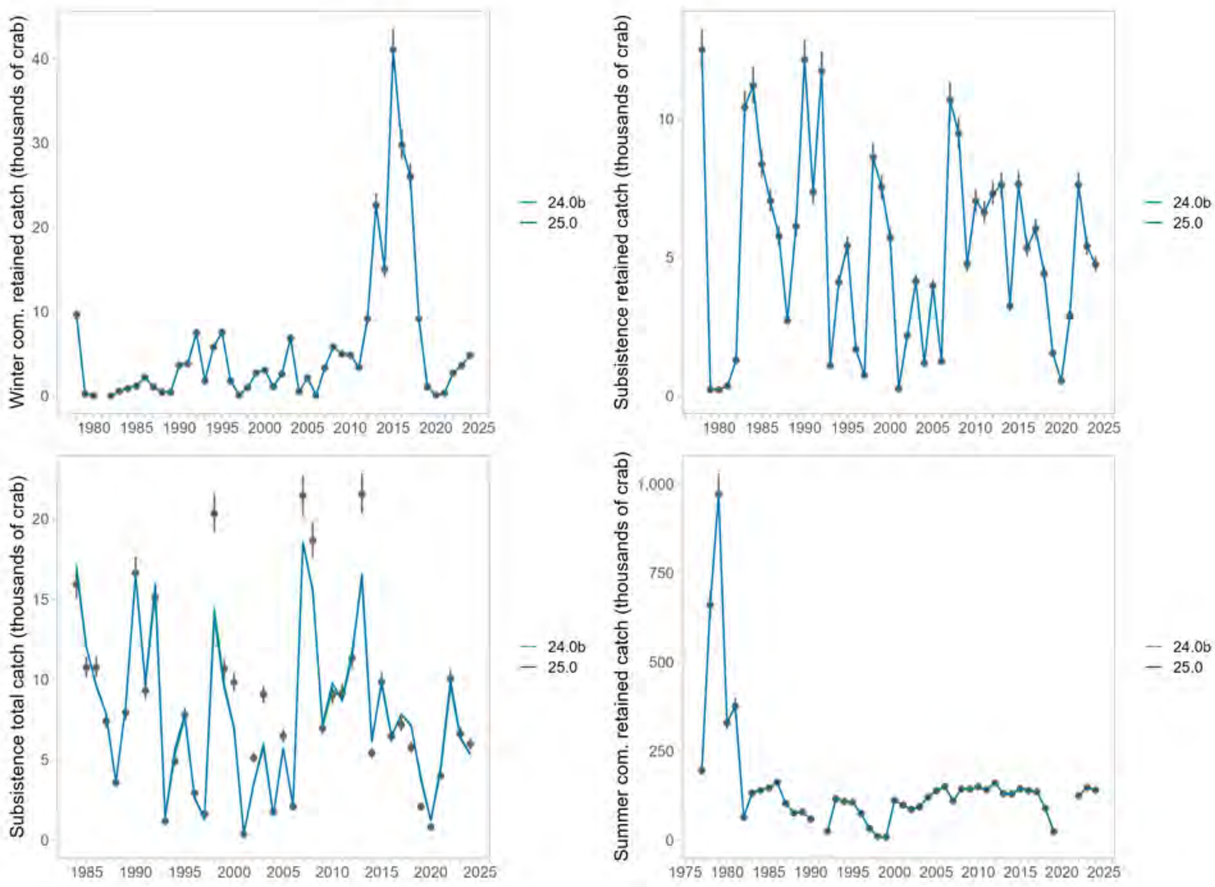


Figure 8: Observed and model-estimated catch of male red king crab caught in the winter commercial, summer commercial, and subsistence fisheries for the new base model (24.0b) and that model with shell condition excluded (25.0). Note that subsistence total catch was not fitted in these models (emphasis set to 0).

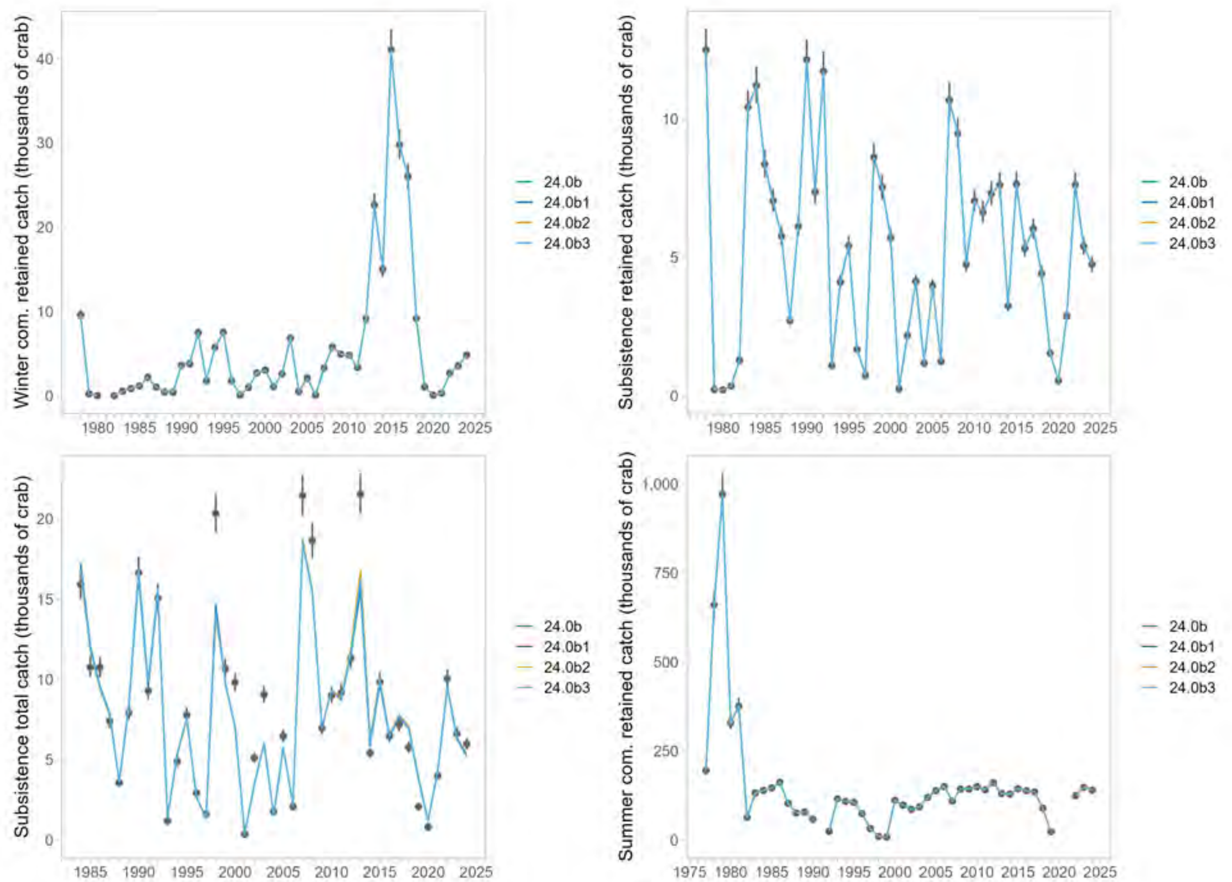


Figure 9: Observed and model-estimated catch of male red king crab caught in the winter commercial, summer commercial, and subsistence fisheries for the new base model (model 24.0b) and three models exploring natural mortality (M). In model 24.0b1, as in model 24.0b, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 24.0b and 0.23 for model 24.0b1. Model 24.0b2 uses a size-independent $M = 0.18$. Model 24.0b3 uses a size-independent $M = 0.23$. Note that subsistence total catch was not fitted in these models (emphasis set to 0).

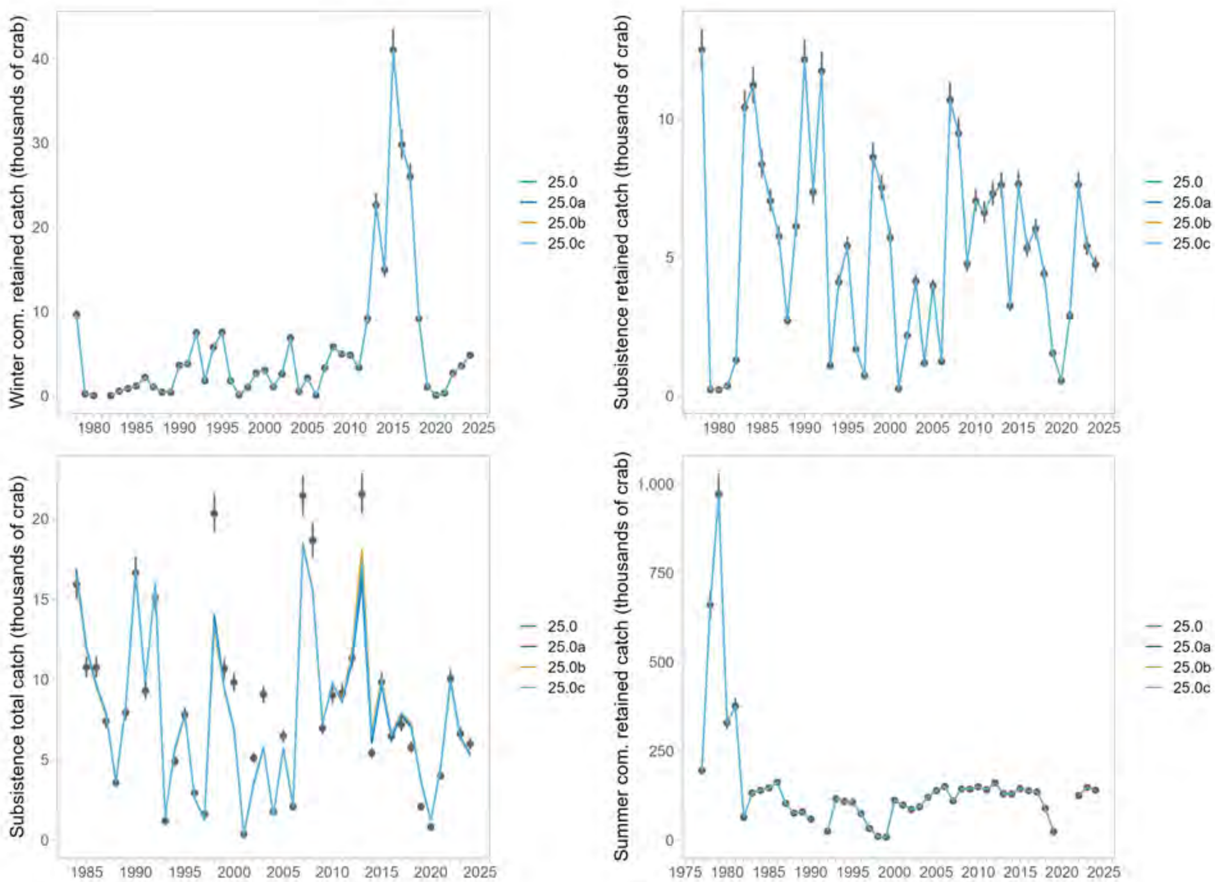


Figure 10: Observed and model-estimated catch of male red king crab caught in the winter commercial, summer commercial, and subsistence fisheries for the model with shell condition excluded (model 25.0) and three models exploring natural mortality (M). In model 25.0a, as in model 25.0, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 25.0 and 0.23 for model 25.0a. Model 25.0b uses a size-independent $M = 0.18$. Model 25.0c uses a size-independent $M = 0.23$. Note that subsistence total catch was not fitted in these models (emphasis set to 0).

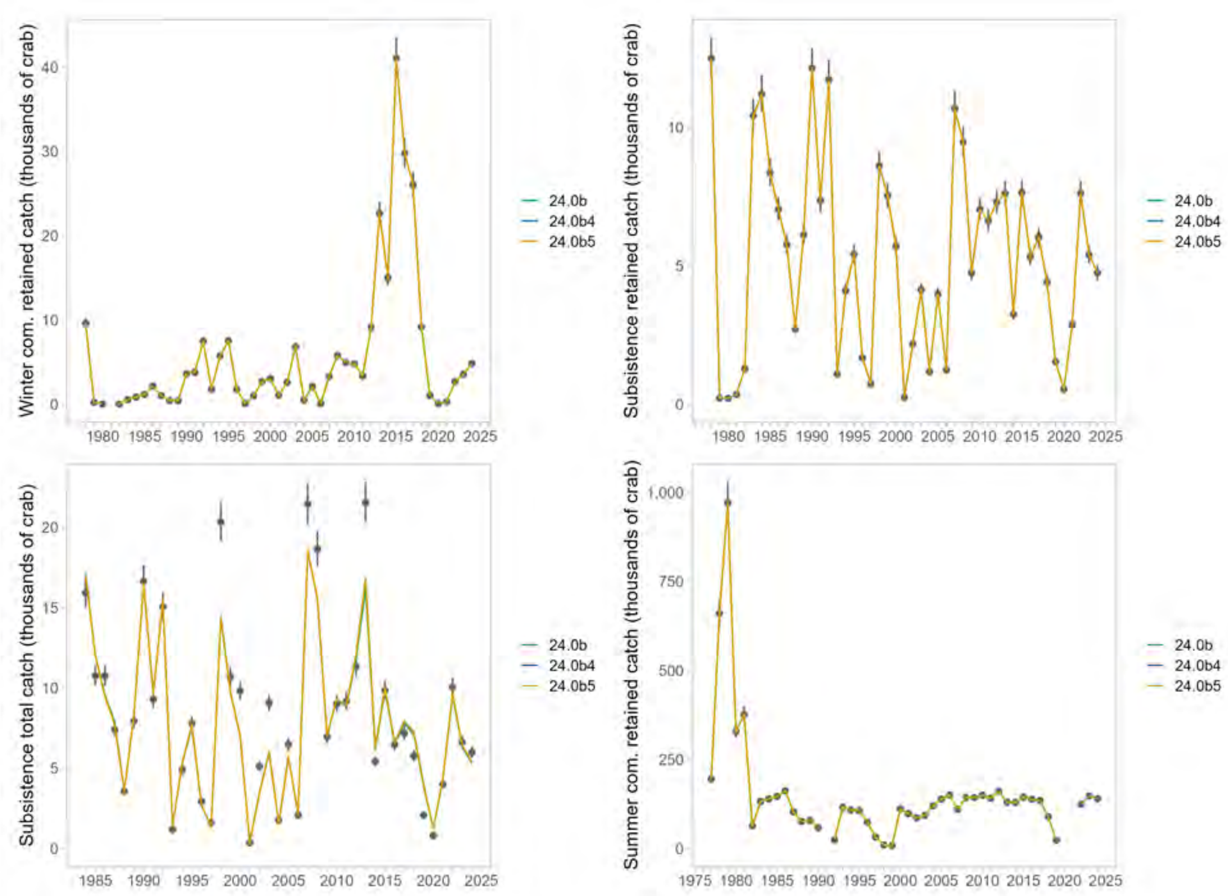


Figure 11: Observed and model-estimated catch of male red king crab caught in the winter commercial, summer commercial, and subsistence fisheries for the new base model (model 24.0b) and models using spatiotemporal model-based rather than design-based indices of abundance for the three trawl surveys. In model 24.0b4, abundance is estimated over the full area covered by all three surveys while, in model 24.0b5, abundance is estimated over the reduced area covered by the ADF&G trawl survey since 2010. Note that subsistence total catch was not fitted in these models (emphasis set to 0).

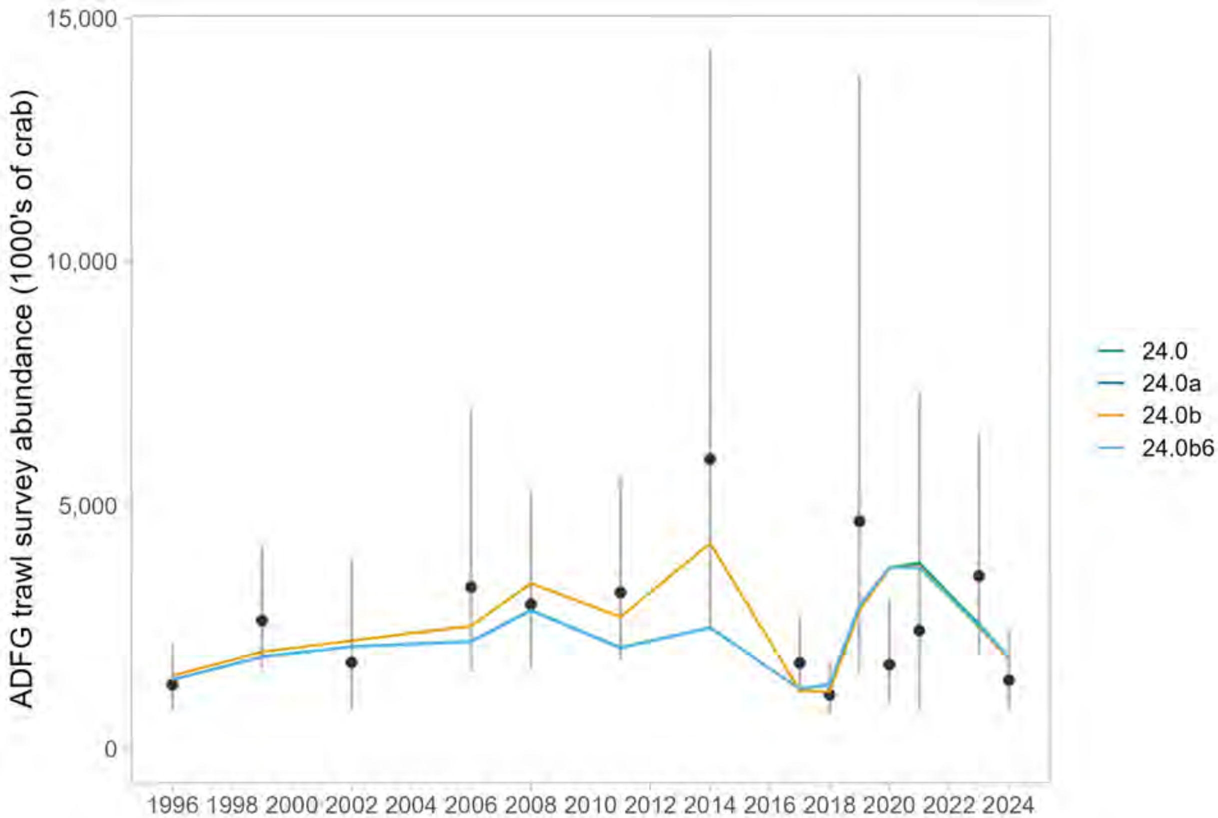


Figure 12: Model fits to the design-based index of abundance from the ADF&G trawl survey for the models in the bridging analysis: 24.0 (2024 accepted model), 24.0a (24.0 with errors corrected), 24.0b (24.0a transitioned to GMACS 2.20.20), and 24.0b6 (24.0b at the second lowest objective function value).

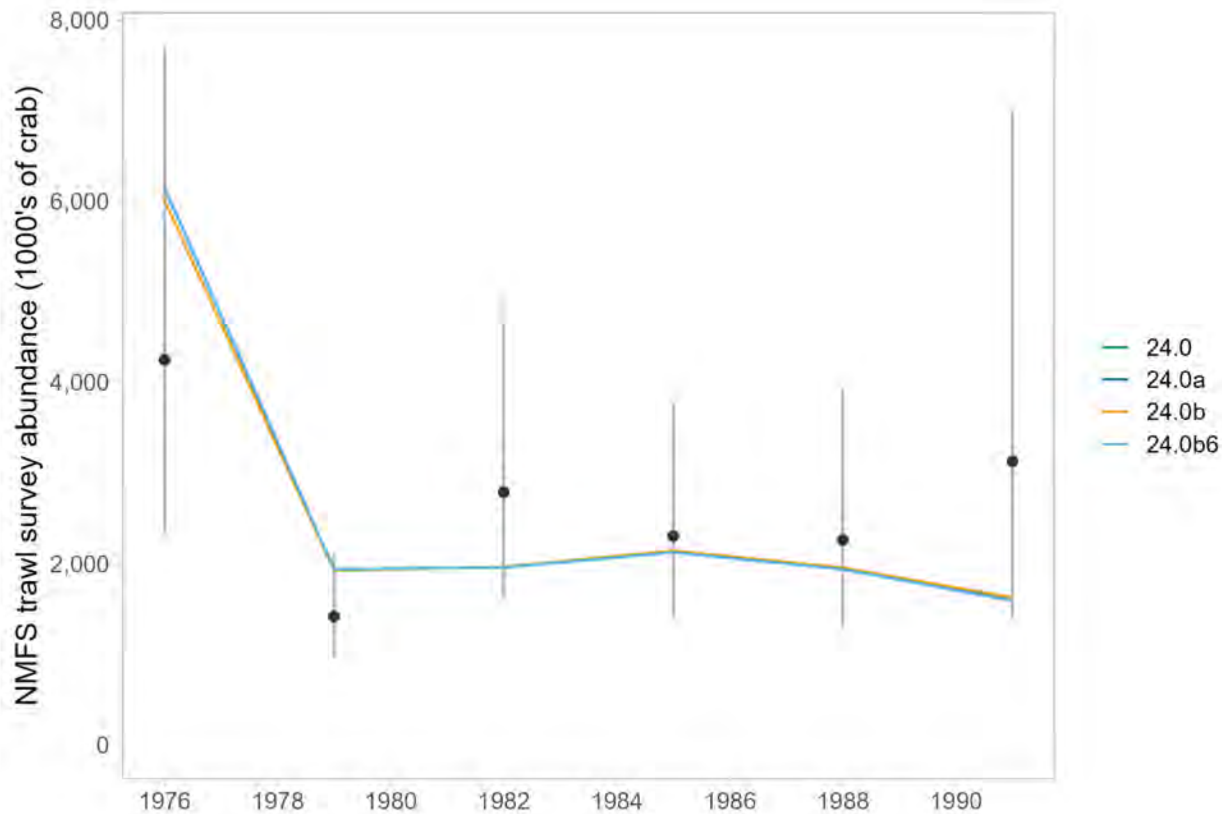


Figure 13: Model fits to the design-based index of abundance from the NOAA Norton Sound trawl survey for the models in the bridging analysis: 24.0 (2024 accepted model), 24.0a (24.0 with errors corrected), 24.0b (24.0a transitioned to GMACS 2.20.20), and 24.0b6 (24.0b at the second lowest objective function value).

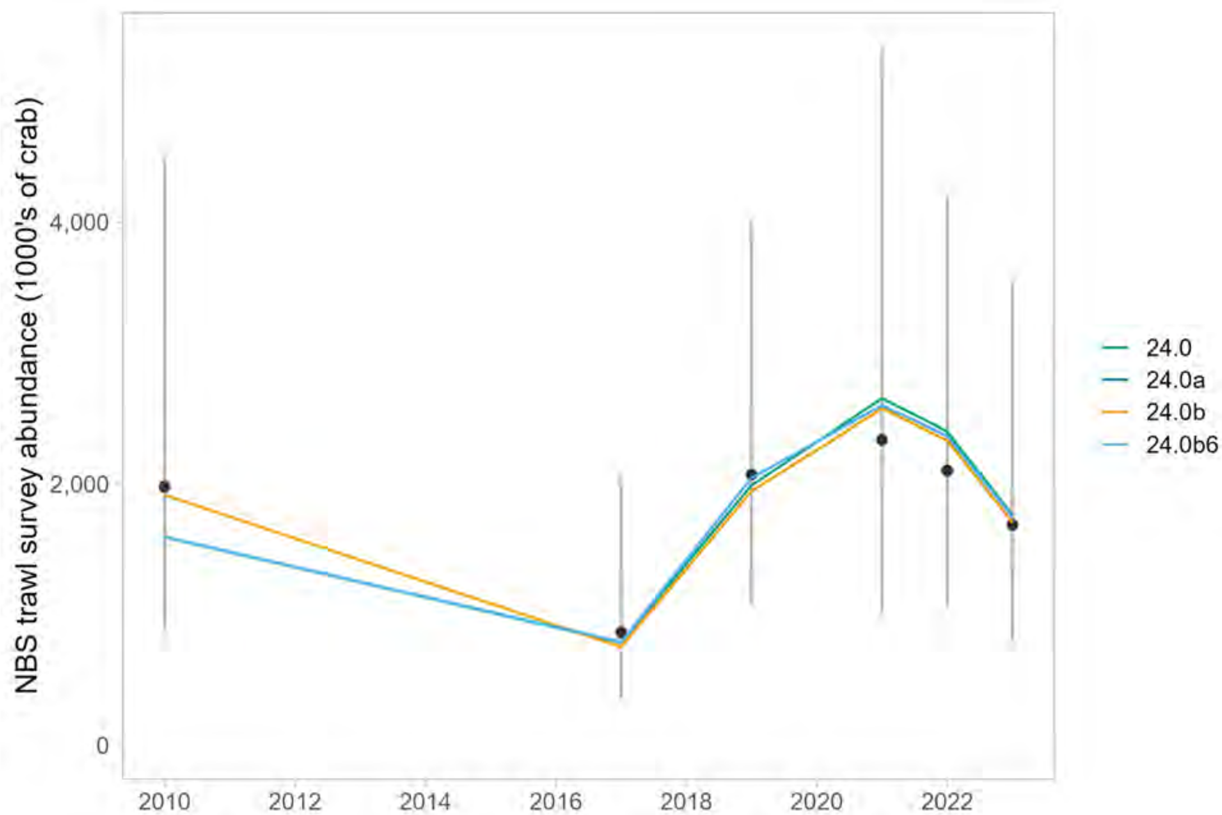


Figure 14: Model fits to the design-based index of abundance from the NOAA Norton Sound trawl survey for the models in the bridging analysis: 24.0 (2024 accepted model), 24.0a (24.0 with errors corrected), 24.0b (24.0a transitioned to GMACS 2.20.20), and 24.0b6 (24.0b at the second lowest objective function value).

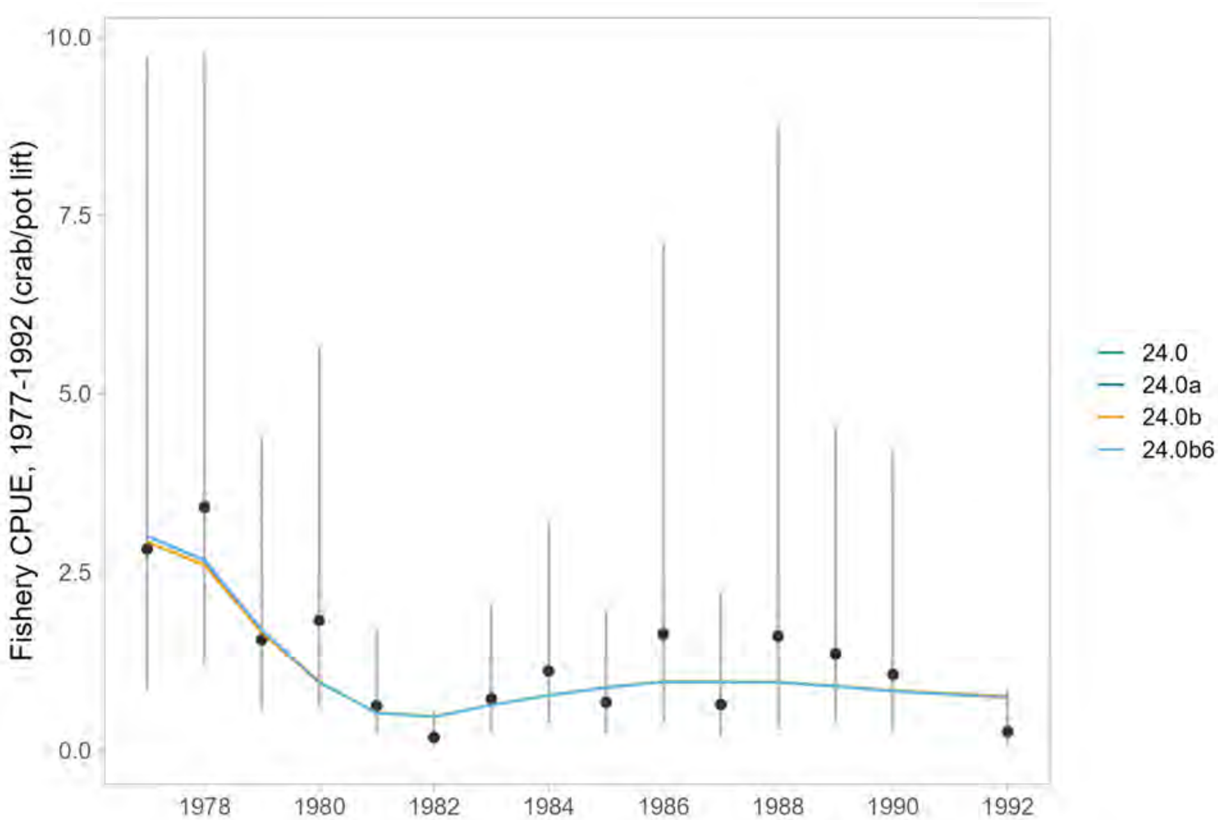


Figure 15: Model fits to the summer commercial fishery standardized CPUE index (1977-1992) for the models in the bridging analysis: 24.0 (2024 accepted model), 24.0a (24.0 with errors corrected), 24.0b (24.0a transitioned to GMACS 2.20.20), and 24.0b6 (24.0b at the second lowest objective function value).

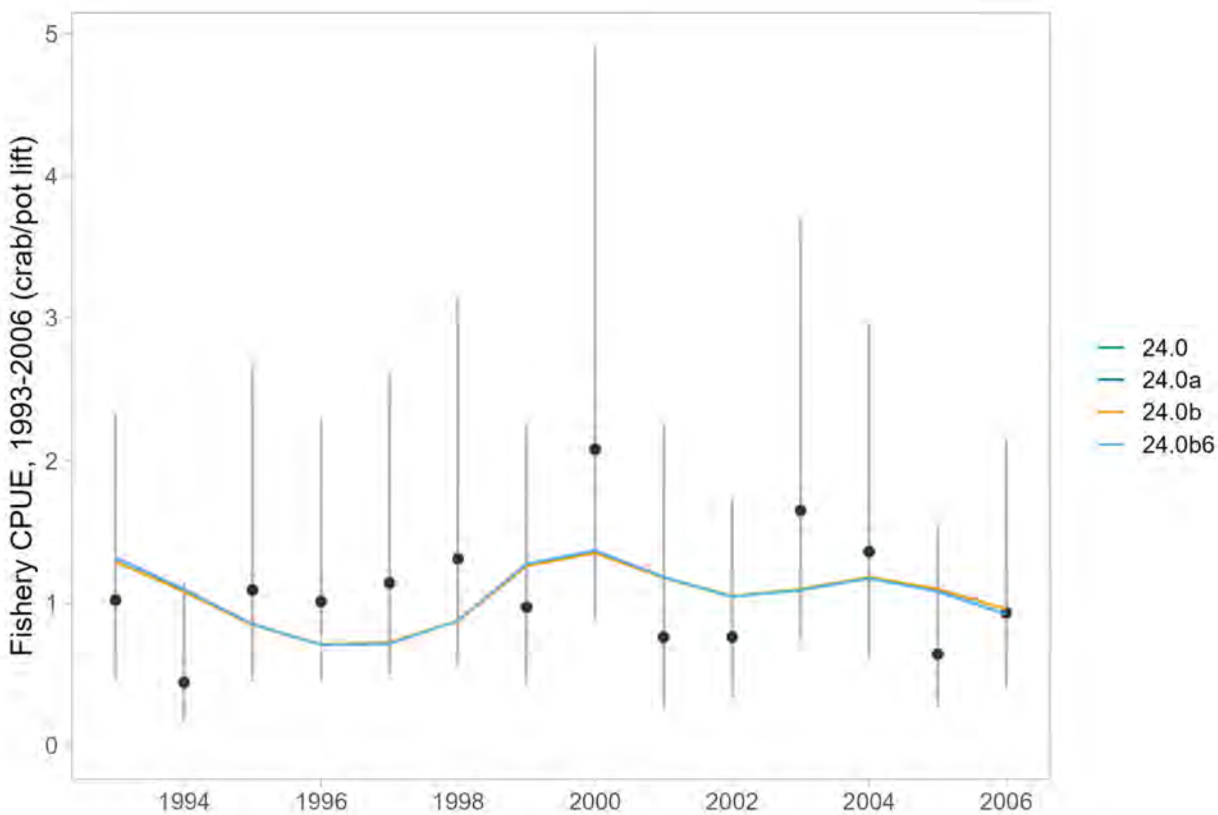


Figure 16: Model fits to the summer commercial fishery standardized CPUE index (1993-2006) for the models in the bridging analysis: 24.0 (2024 accepted model), 24.0a (24.0 with errors corrected), 24.0b (24.0a transitioned to GMACS 2.20.20), and 24.0b6 (24.0b at the second lowest objective function value).

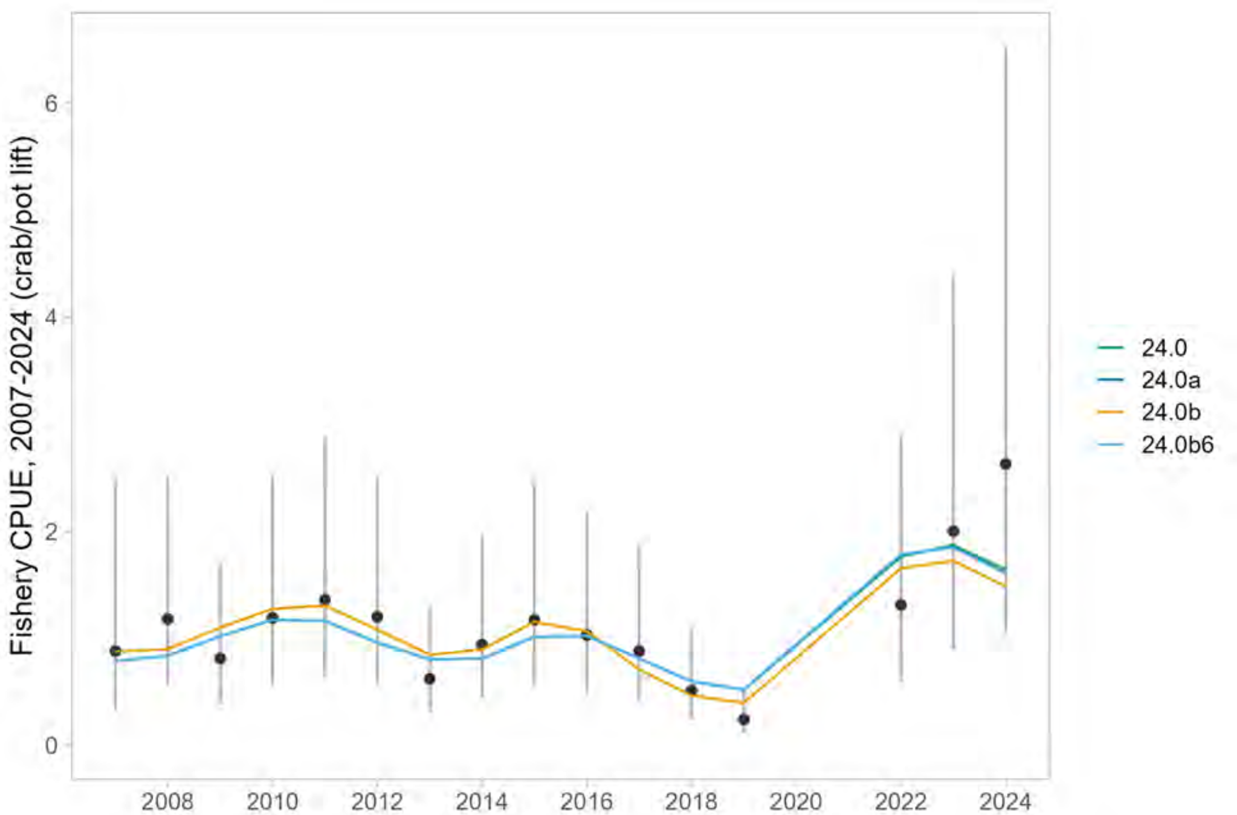


Figure 17: Model fits to the summer commercial fishery standardized CPUE index (2007-2024) for the models in the bridging analysis: 24.0 (2024 accepted model), 24.0a (24.0 with errors corrected), 24.0b (24.0a transitioned to GMACS 2.20.20), and 24.0b6 (24.0b at the second lowest objective function value).

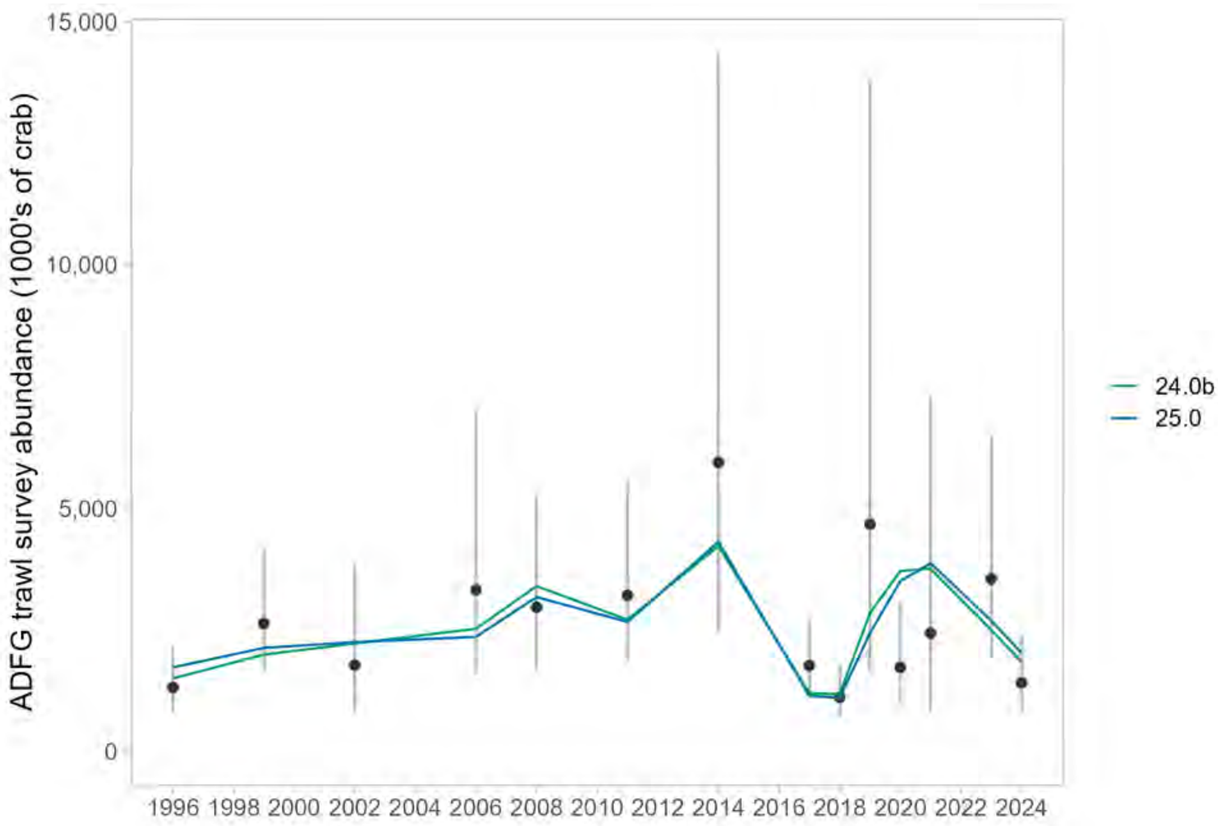


Figure 18: Model fits to the design-based index of abundance from the ADF&G trawl survey for the new base model (24.0b) and that model with shell condition excluded (25.0).

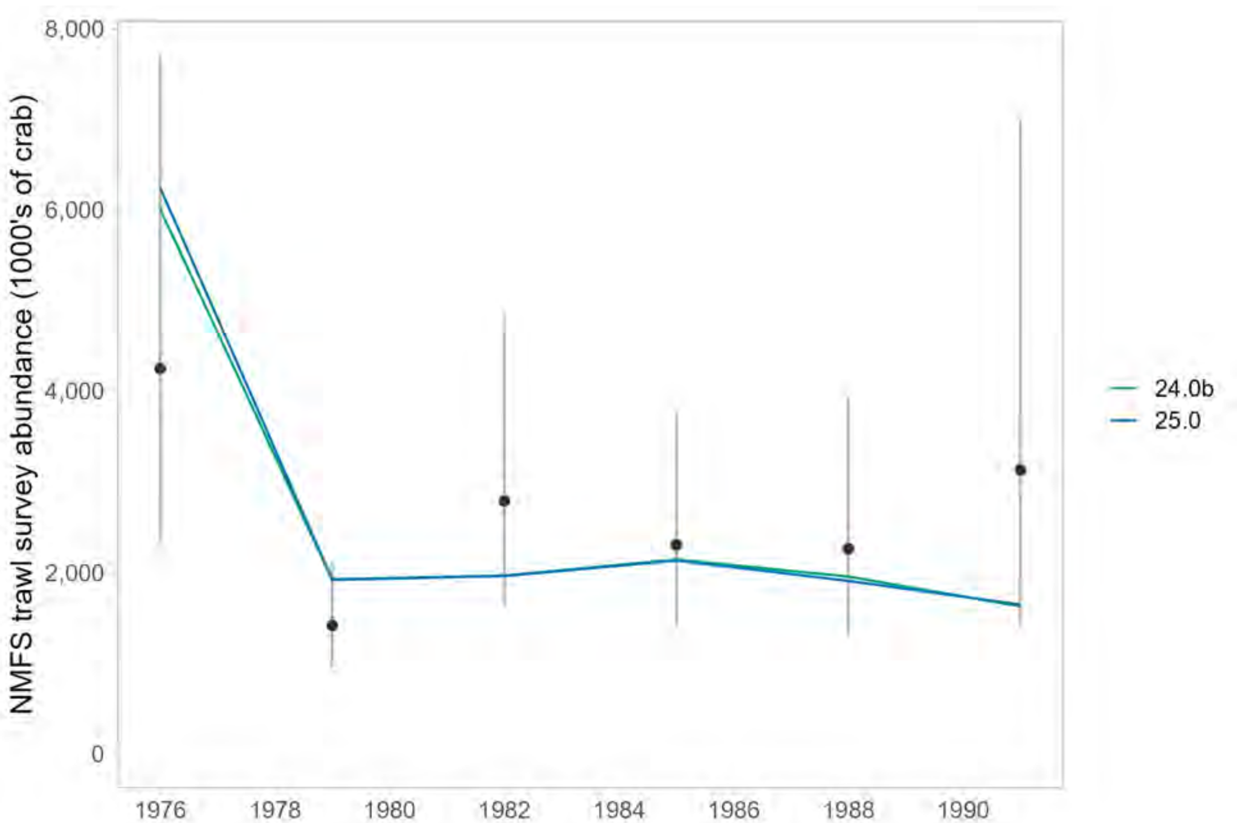


Figure 19: Model fits to the design-based index of abundance from the NOAA Norton Sound trawl survey for the new base model (24.0b) and that model with shell condition excluded (25.0).

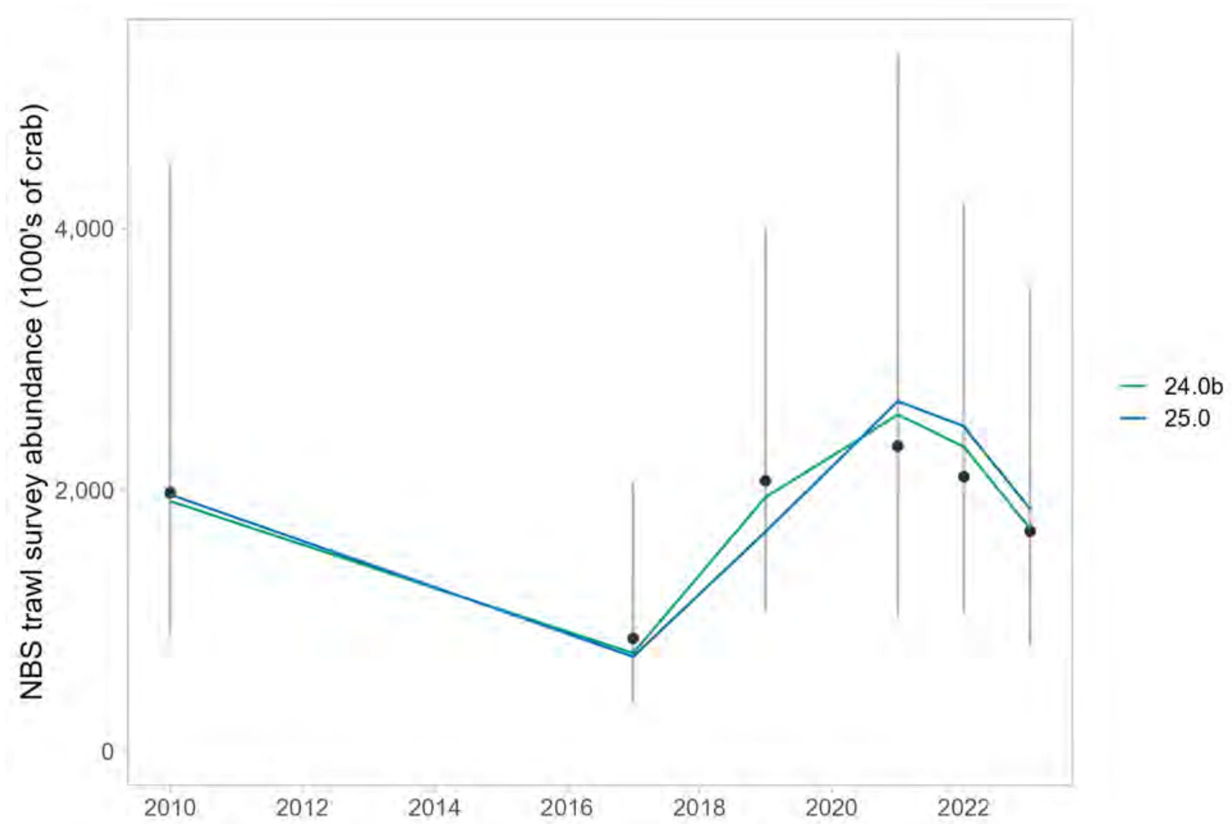


Figure 20: Model fits to the design-based index of abundance from the NOAA Norton Sound trawl survey for the new base model (24.0b) and that model with shell condition excluded (25.0).

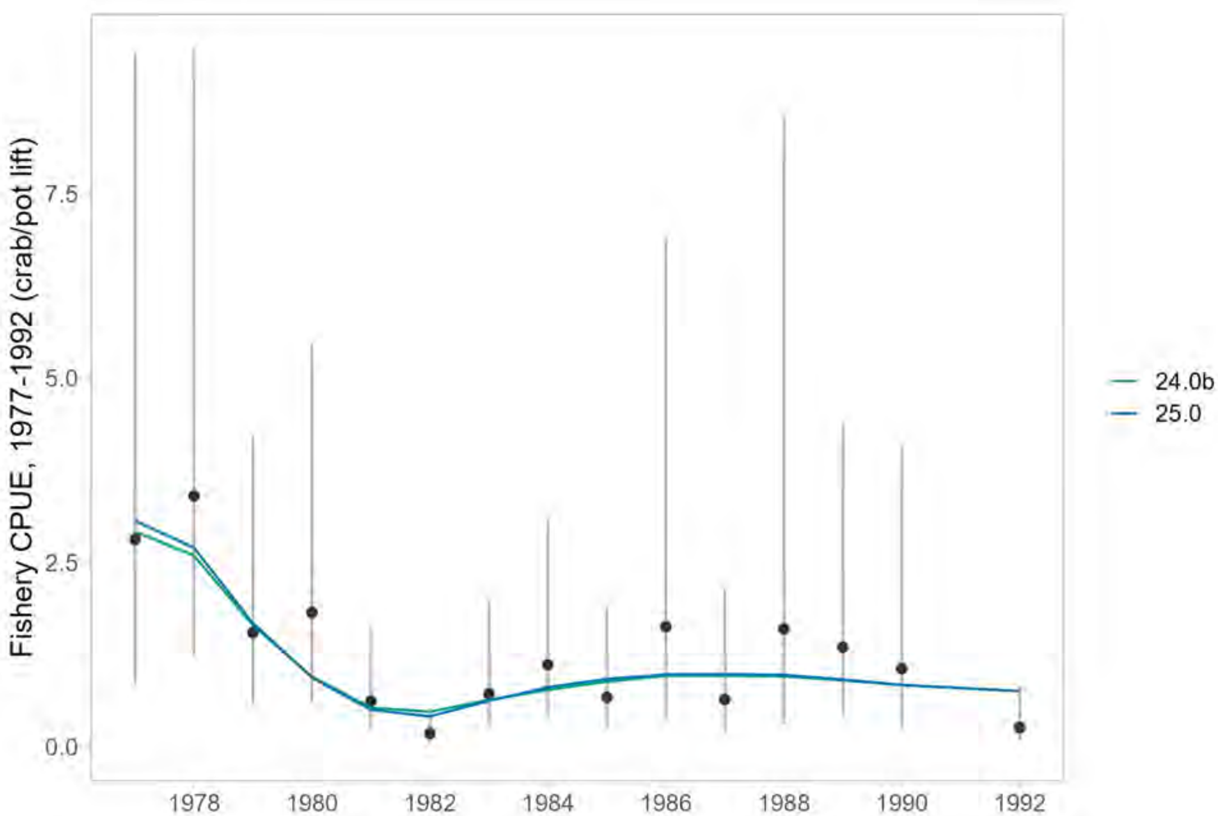


Figure 21: Model fits to the summer commercial fishery standardized CPUE index (1977-1992) for the new base model (24.0b) and that model with shell condition excluded (25.0).

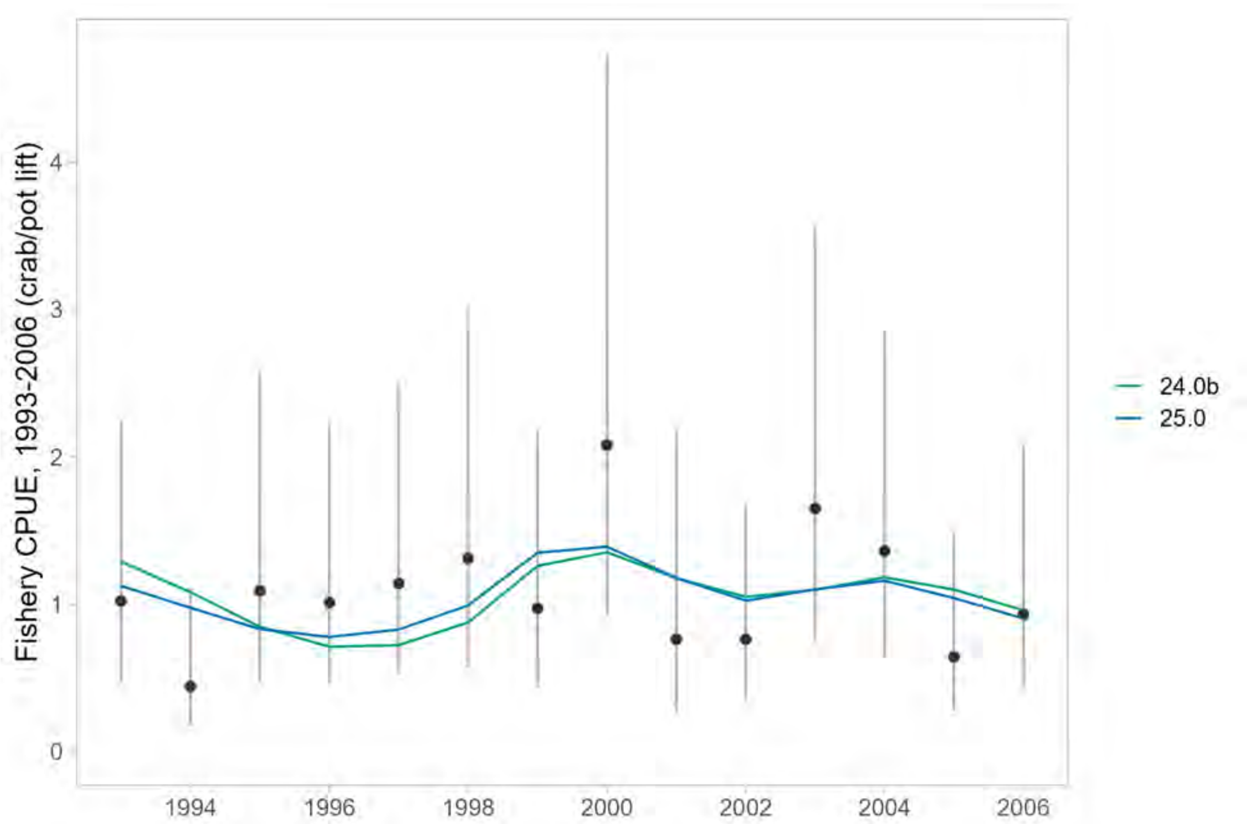


Figure 22: Model fits to the summer commercial fishery standardized CPUE index (1993-2006) for the new base model (24.0b) and that model with shell condition excluded (25.0).

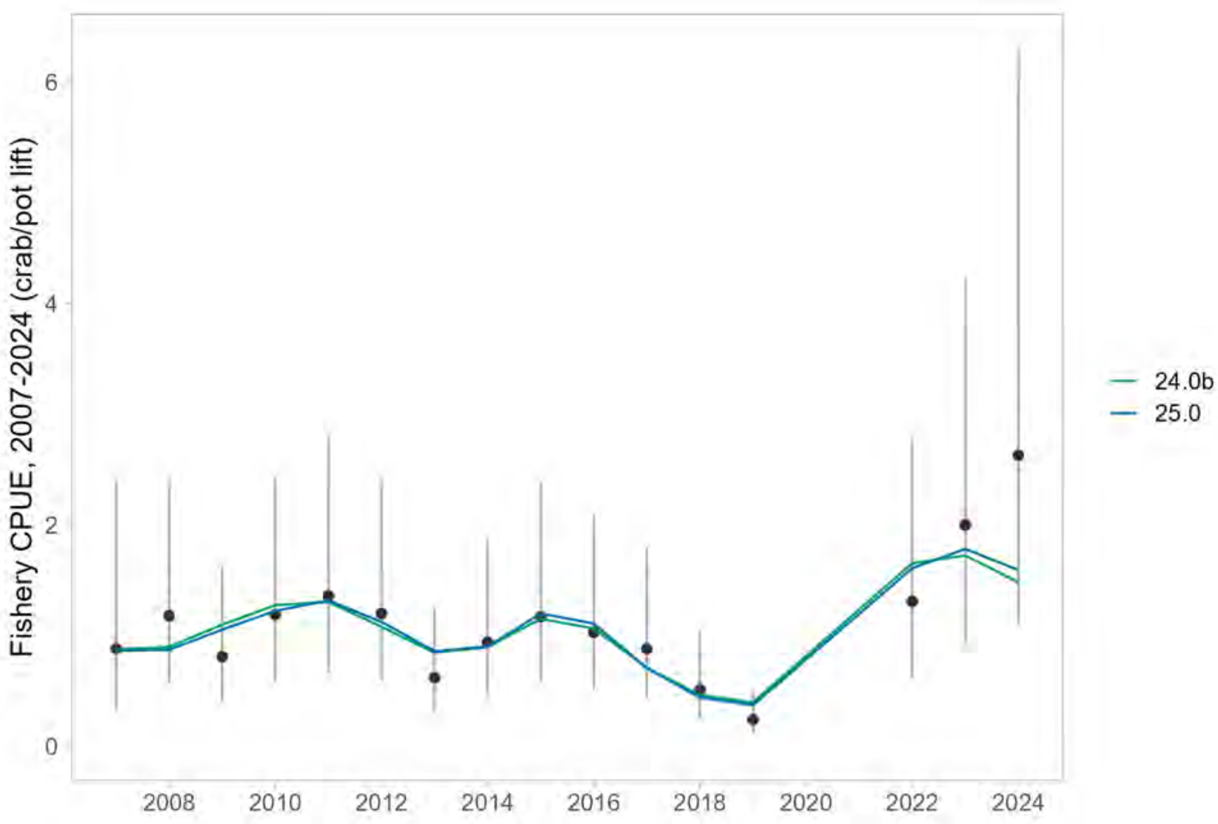


Figure 23: Model fits to the summer commercial fishery standardized CPUE index (2007-2024) for the new base model (24.0b) and that model with shell condition excluded (25.0).

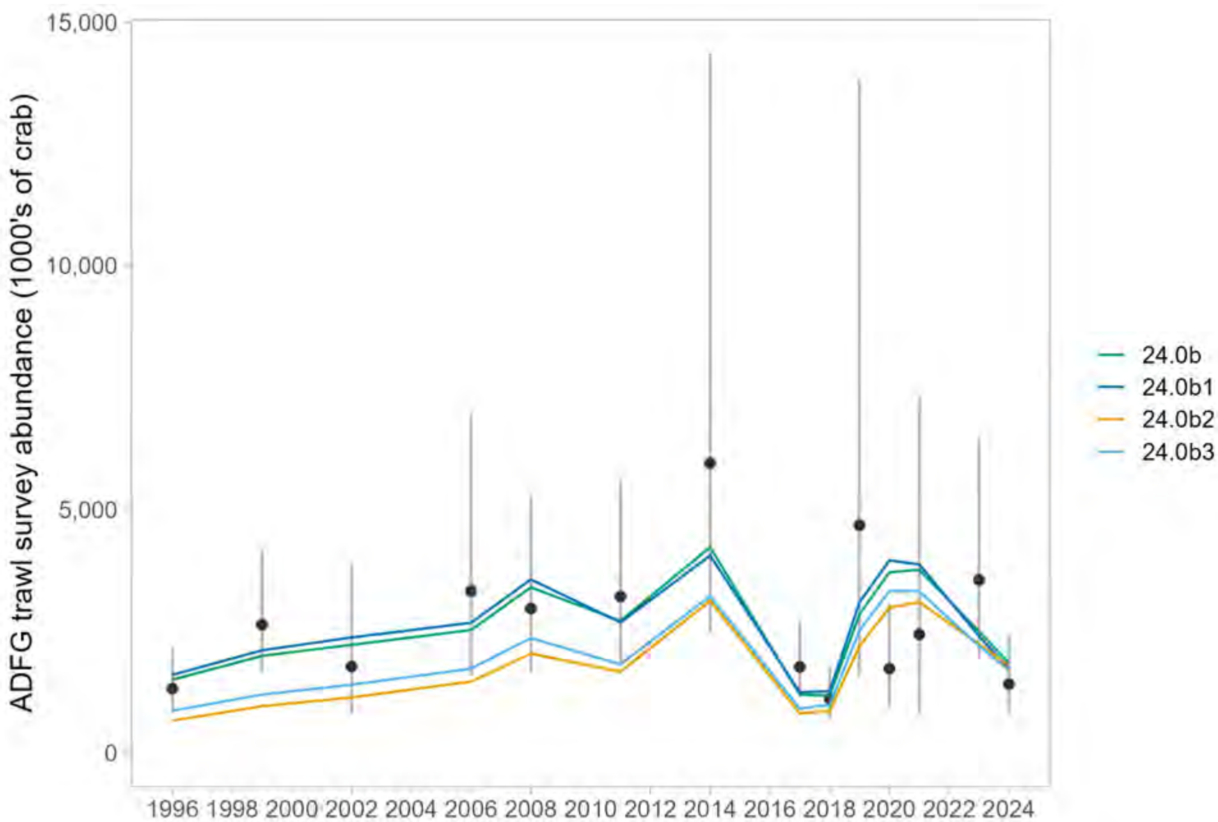


Figure 24: Model fits to the design-based index of abundance from the ADF&G trawl survey for the new base model (model 24.0b) and three models exploring natural mortality (M). In model 24.0b1, as in model 24.0b, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 24.0b and 0.23 for model 24.0b1. Model 24.0b2 uses a size-independent M = 0.18. Model 24.0b3 uses a size-independent M = 0.23.

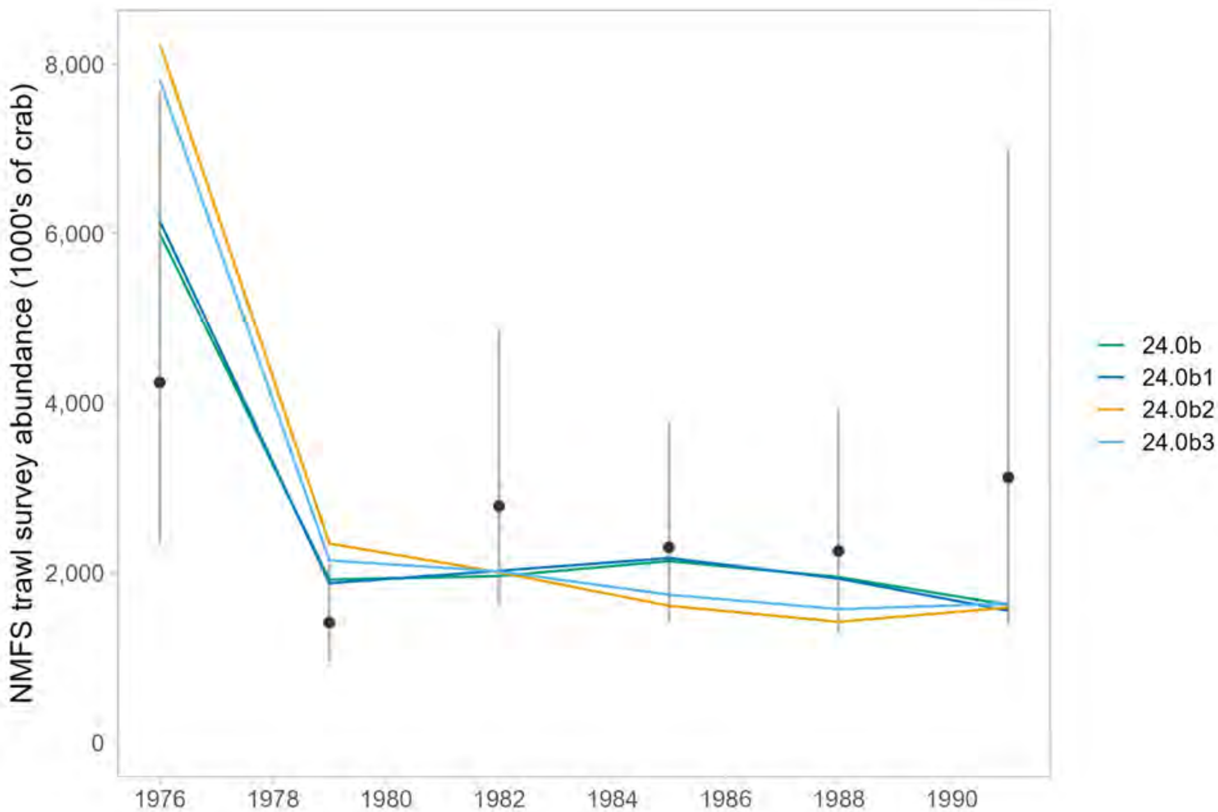


Figure 25: Model fits to the design-based index of abundance from the NOAA Norton Sound trawl survey for the new base model (model 24.0b) and three models exploring natural mortality (M). In model 24.0b1, as in model 24.0b, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 24.0b and 0.23 for model 24.0b1. Model 24.0b2 uses a size-independent $M = 0.18$. Model 24.0b3 uses a size-independent $M = 0.23$.

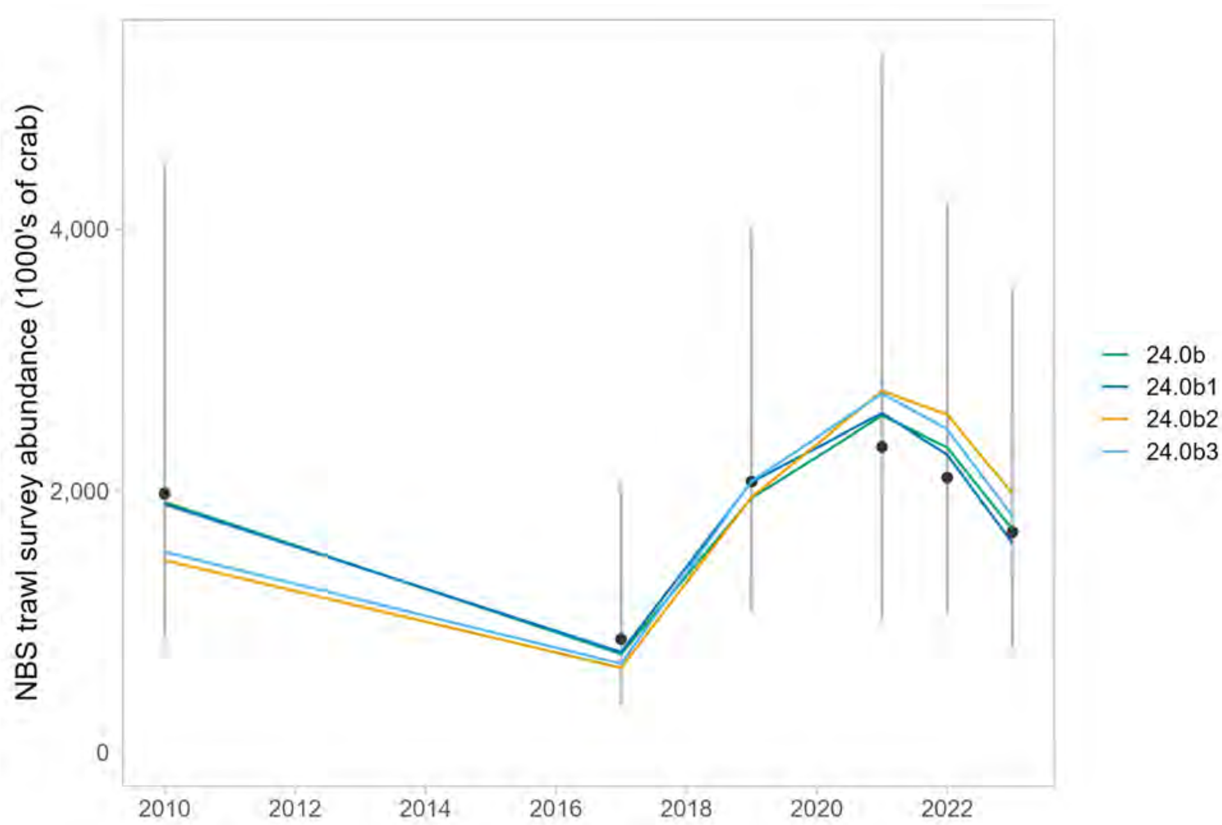


Figure 26: Model fits to the design-based index of abundance from the NOAA Norton Sound trawl survey for the new base model (model 24.0b) and three models exploring natural mortality (M). In model 24.0b1, as in model 24.0b, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 24.0b and 0.23 for model 24.0b1. Model 24.0b2 uses a size-independent $M = 0.18$. Model 24.0b3 uses a size-independent $M = 0.23$.

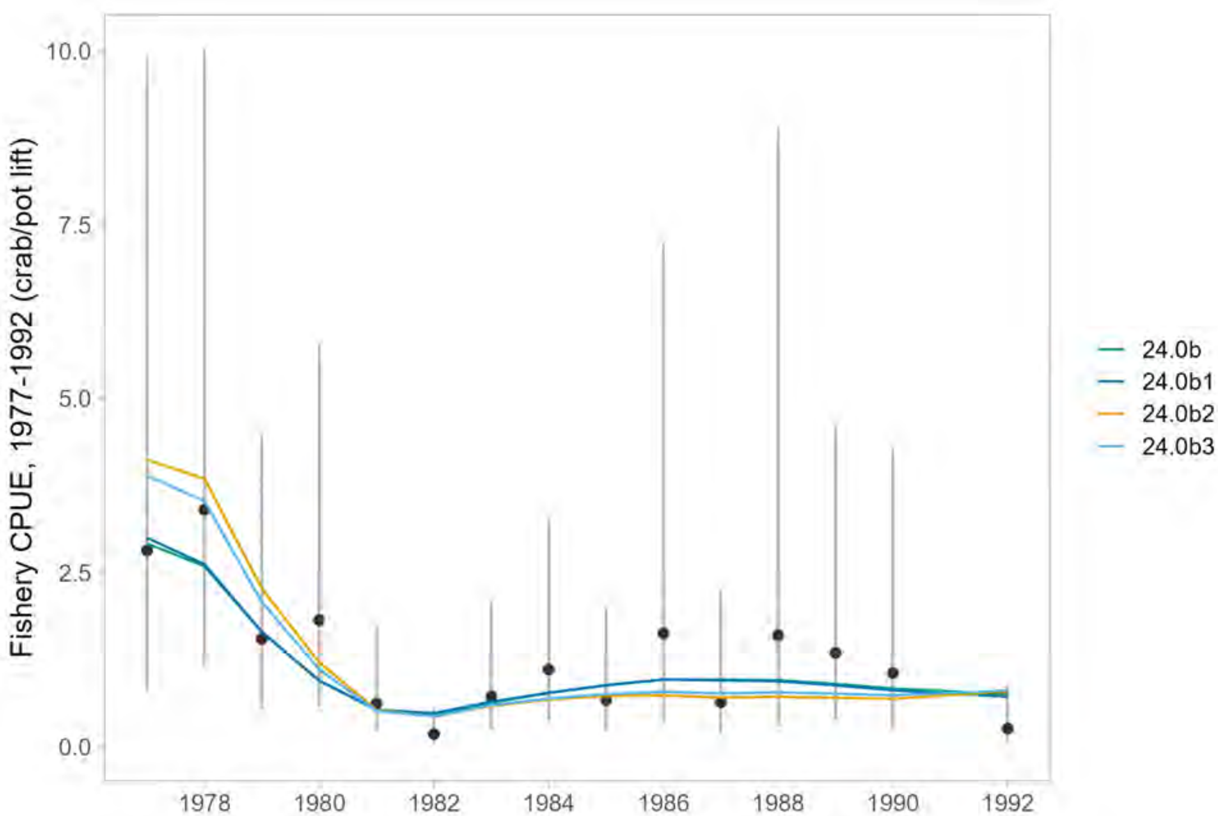


Figure 27: Model fits to the summer commercial fishery standardized CPUE index (1977-1992) for the new base model (model 24.0b) and three models exploring natural mortality (M). In model 24.0b1, as in model 24.0b, M is fixed for males with carapace length (CL) ≤ 123 mm and estimated for males with CL > 123 mm; the fixed M value is 0.18 for model 24.0b and 0.23 for model 24.0b1. Model 24.0b2 uses a size-independent $M = 0.18$. Model 24.0b3 uses a size-independent $M = 0.23$.

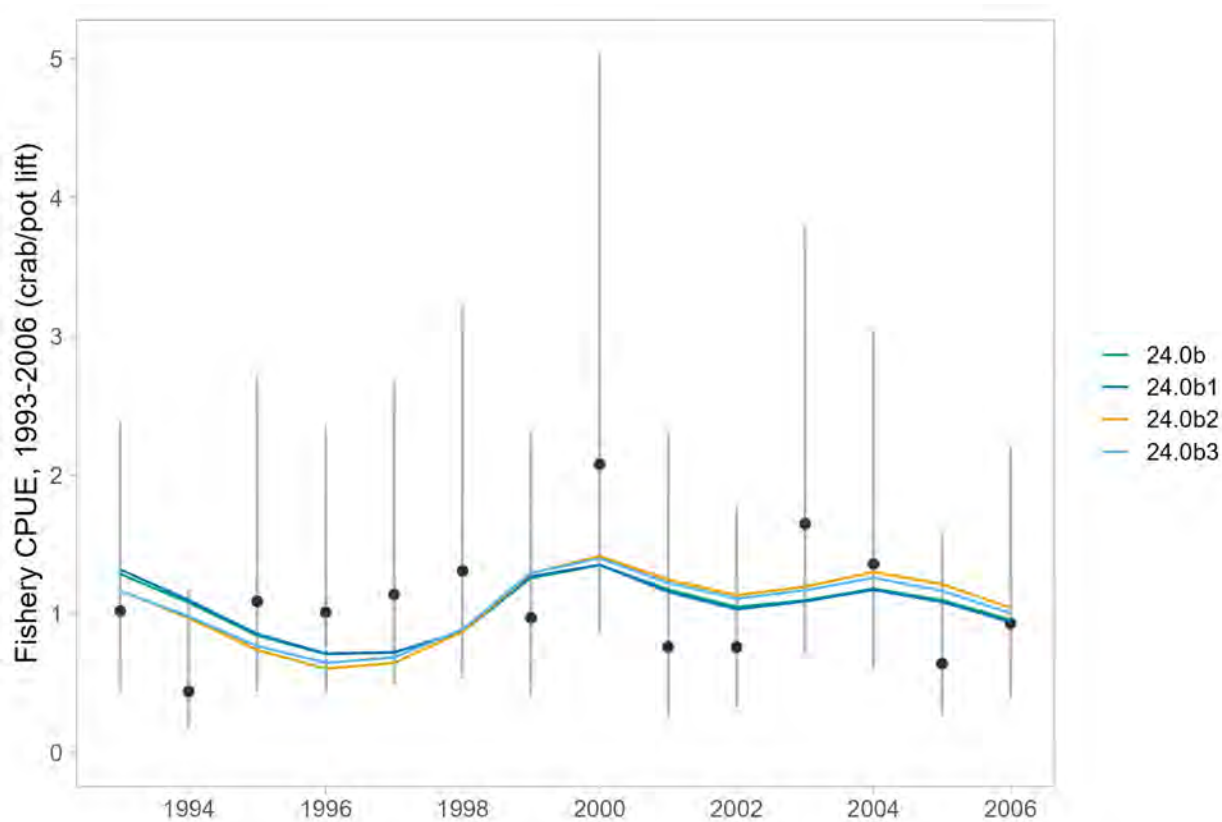


Figure 28: Model fits to the summer commercial fishery standardized CPUE index (1993-2006) for the new base model (model 24.0b) and three models exploring natural mortality (M). In model 24.0b1, as in model 24.0b, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 24.0b and 0.23 for model 24.0b1. Model 24.0b2 uses a size-independent $M = 0.18$. Model 24.0b3 uses a size-independent $M = 0.23$.

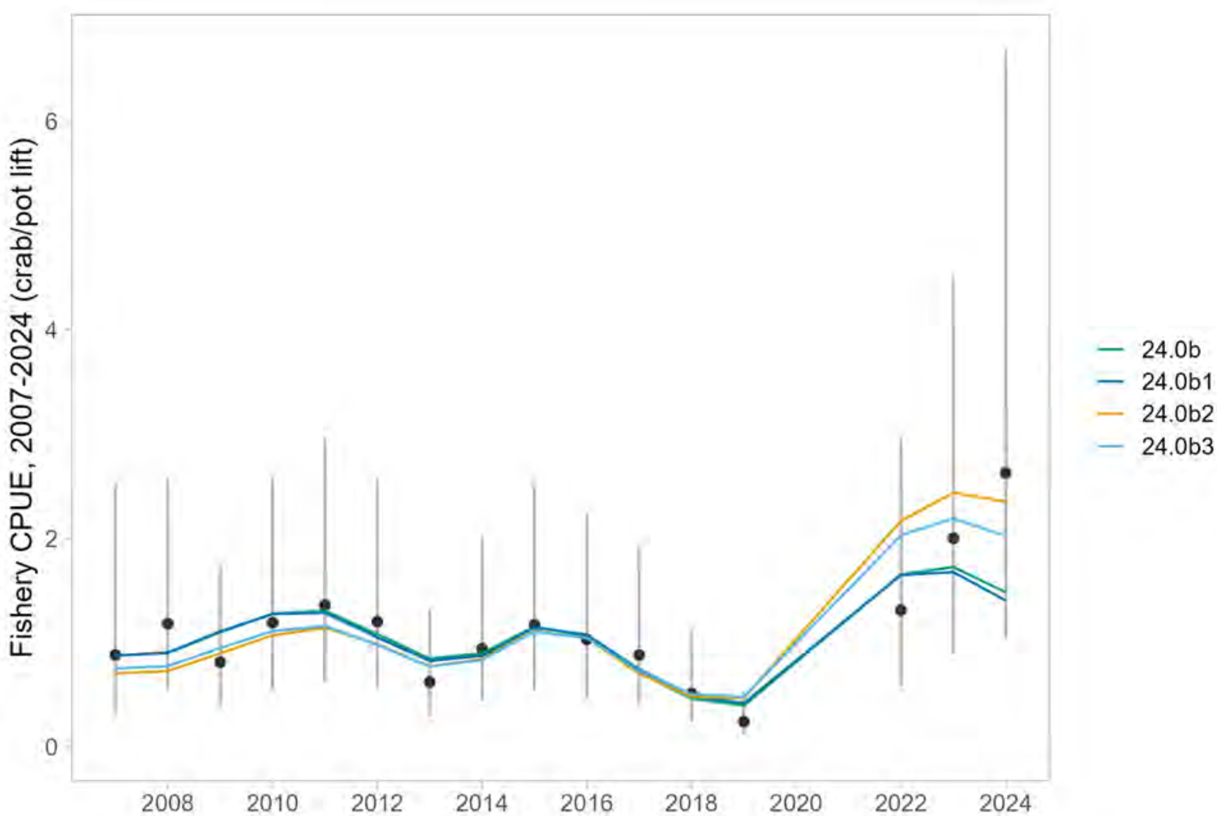


Figure 29: Model fits to the summer commercial fishery standardized CPUE index (2007-2024) for the new base model (model 24.0b) and three models exploring natural mortality (M). In model 24.0b1, as in model 24.0b, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 24.0b and 0.23 for model 24.0b1. Model 24.0b2 uses a size-independent $M = 0.18$. Model 24.0b3 uses a size-independent $M = 0.23$.

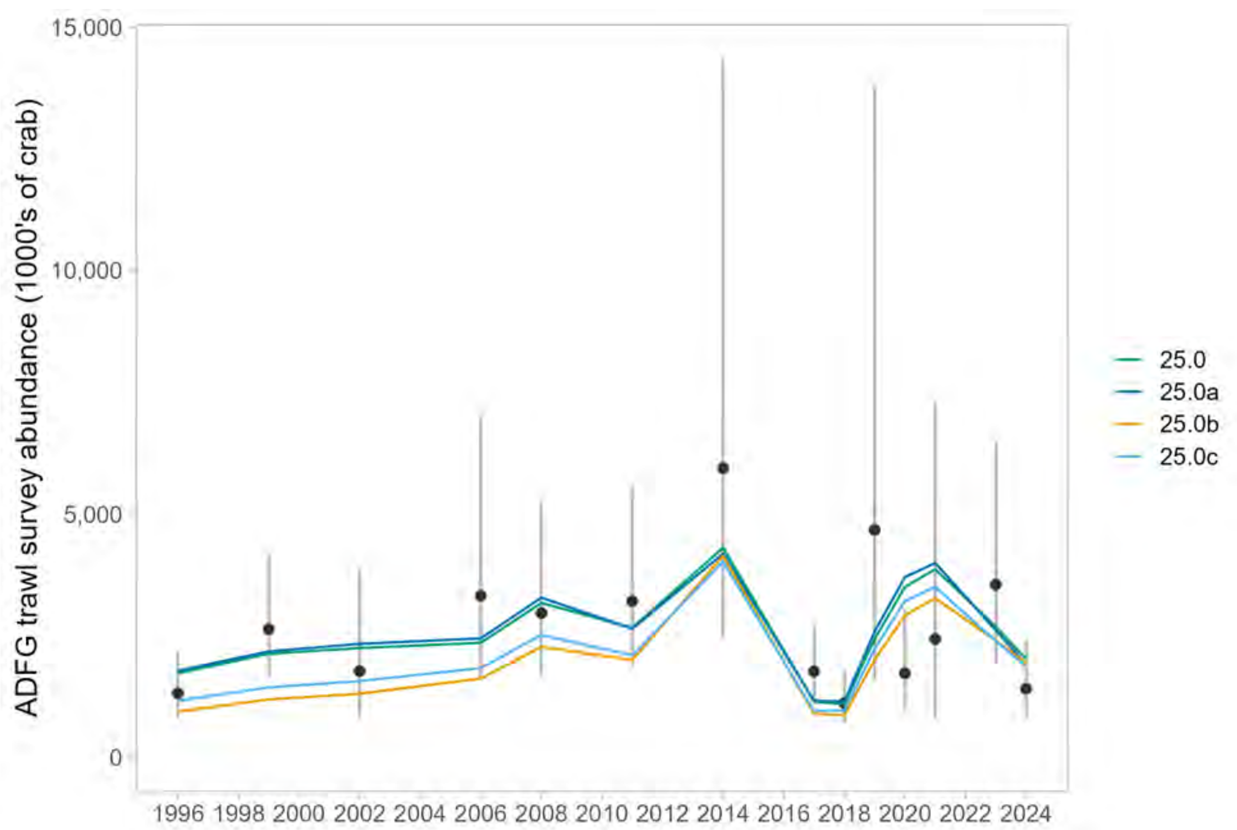


Figure 30: Model fits to the design-based index of abundance from the ADF&G trawl survey for the model with shell condition excluded (model 25.0) and three models exploring natural mortality (M). In model 25.0a, as in model 25.0, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 25.0 and 0.23 for model 25.0a. Model 25.0b uses a size-independent $M = 0.18$. Model 25.0c uses a size-independent $M = 0.23$.

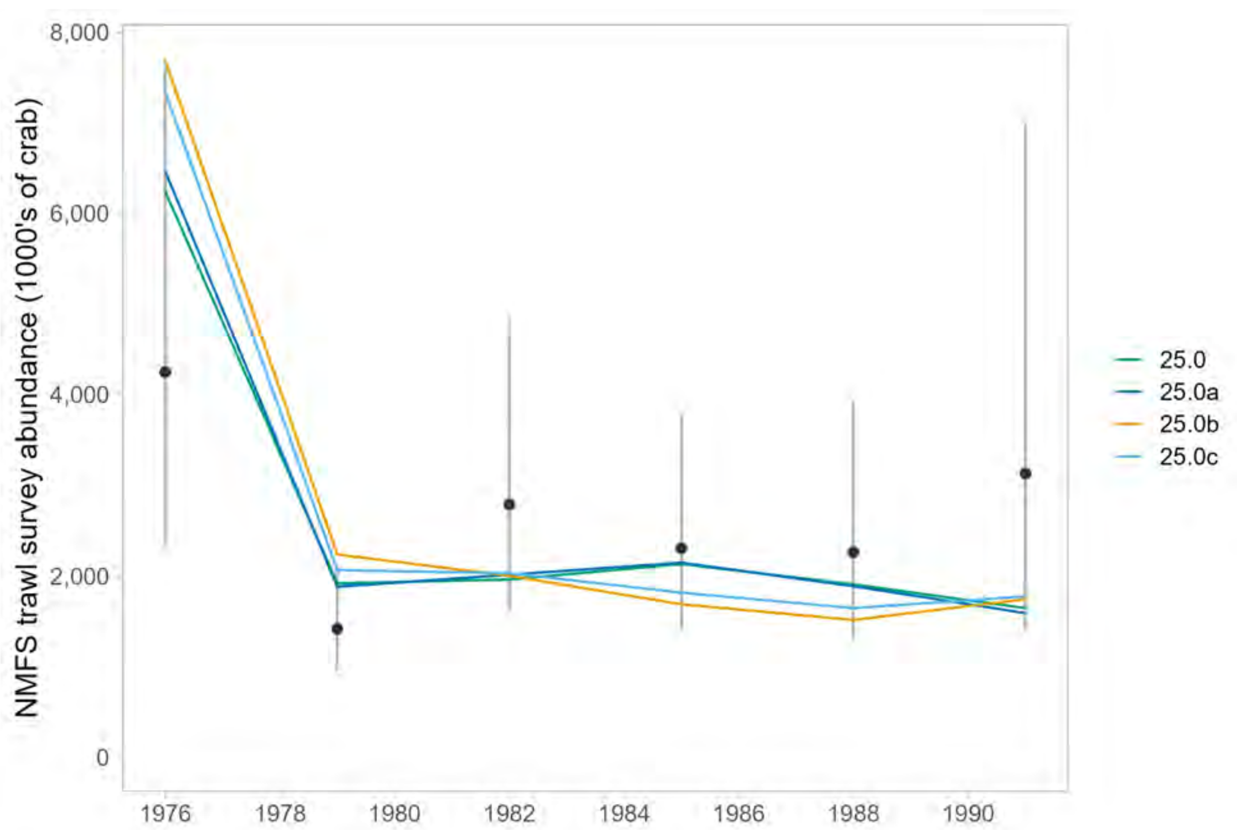


Figure 31: Model fits to the design-based index of abundance from the NOAA Norton Sound trawl survey for the model with shell condition excluded (model 25.0) and three models exploring natural mortality (M). In model 25.0a, as in model 25.0, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 25.0 and 0.23 for model 25.0a. Model 25.0b uses a size-independent $M = 0.18$. Model 25.0c uses a size-independent $M = 0.23$.

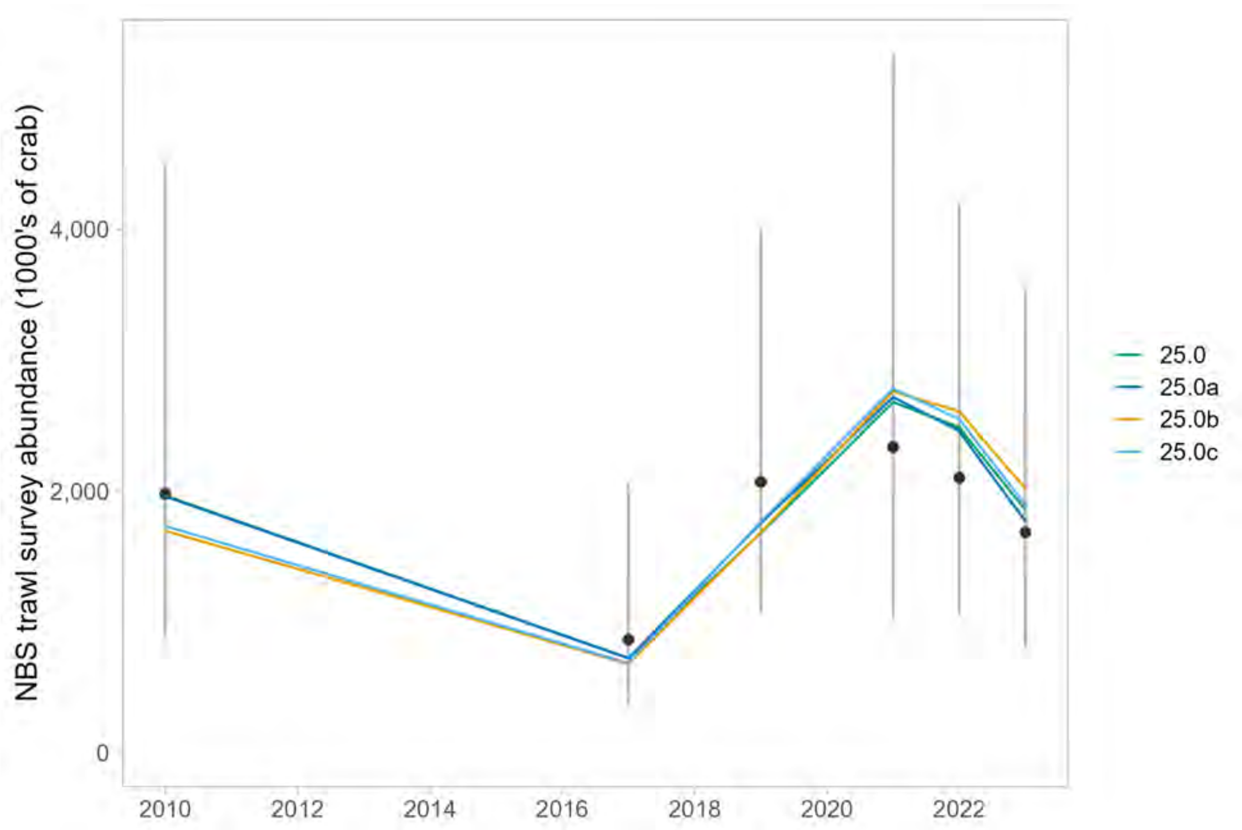


Figure 32: Model fits to the design-based index of abundance from the NOAA Norton Sound trawl survey for the model with shell condition excluded (model 25.0) and three models exploring natural mortality (M). In model 25.0a, as in model 25.0, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 25.0 and 0.23 for model 25.0a. Model 25.0b uses a size-independent $M = 0.18$. Model 25.0c uses a size-independent $M = 0.23$.

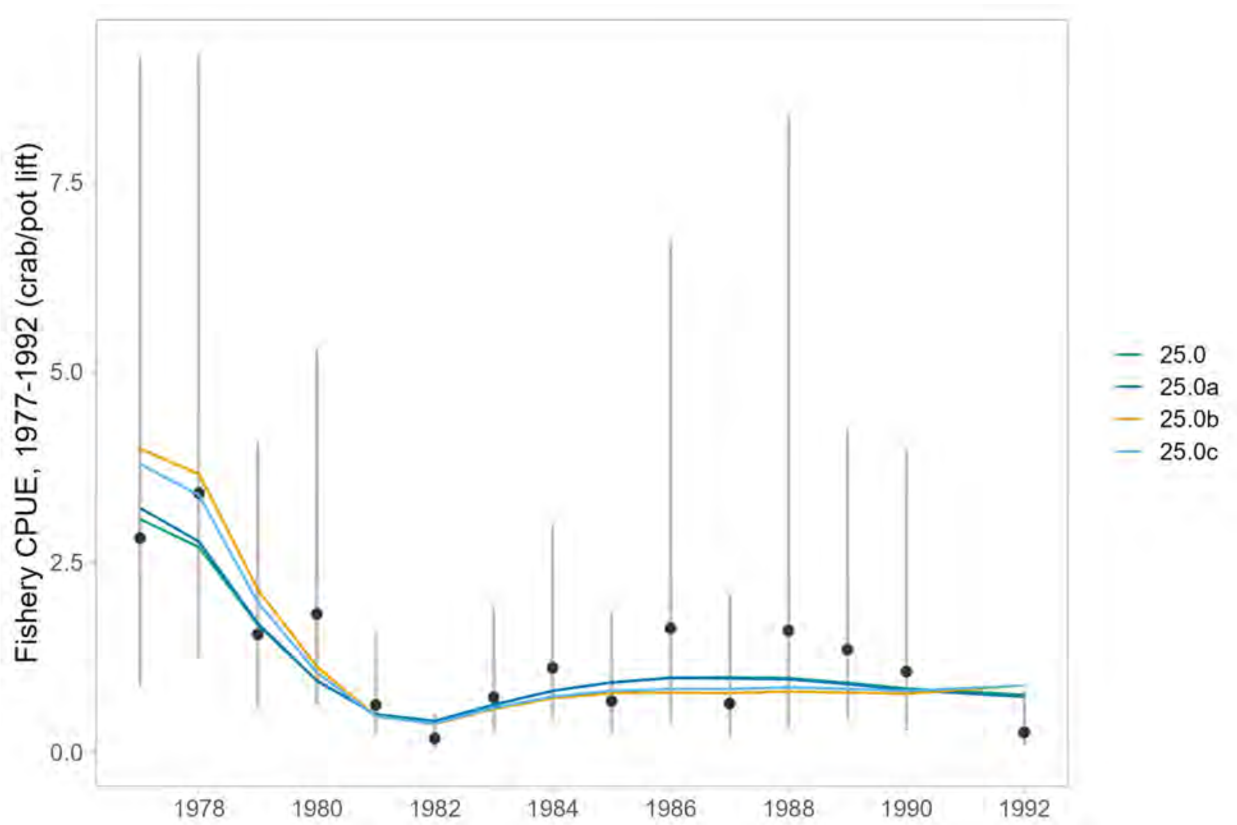


Figure 33: Model fits to the summer commercial fishery standardized CPUE index (1977-1992) for the model with shell condition excluded (model 25.0) and three models exploring natural mortality (M). In model 25.0a, as in model 25.0, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 25.0 and 0.23 for model 25.0a. Model 25.0b uses a size-independent $M = 0.18$. Model 25.0c uses a size-independent $M = 0.23$.

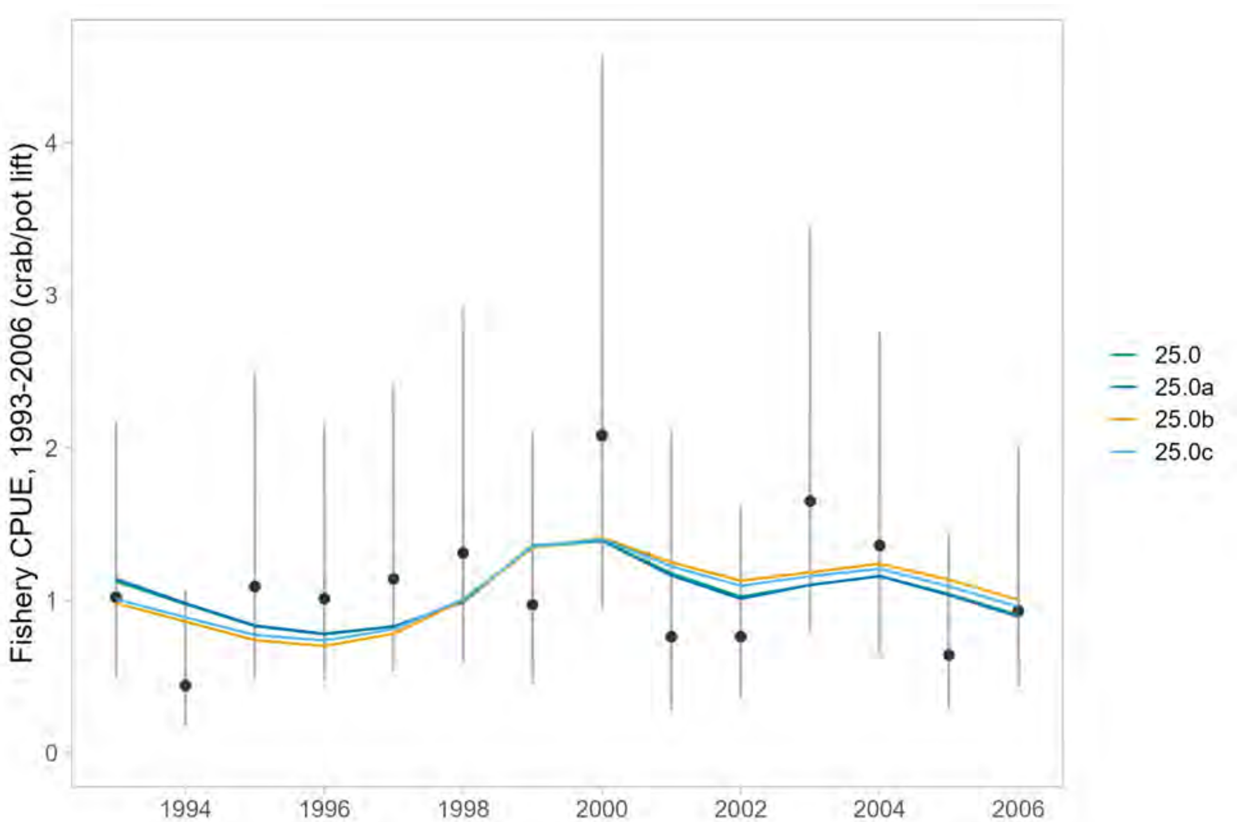


Figure 34: Model fits to the summer commercial fishery standardized CPUE index (1993-2006) for the model with shell condition excluded (model 25.0) and three models exploring natural mortality (M). In model 25.0a, as in model 25.0, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 25.0 and 0.23 for model 25.0a. Model 25.0b uses a size-independent $M = 0.18$. Model 25.0c uses a size-independent $M = 0.23$.

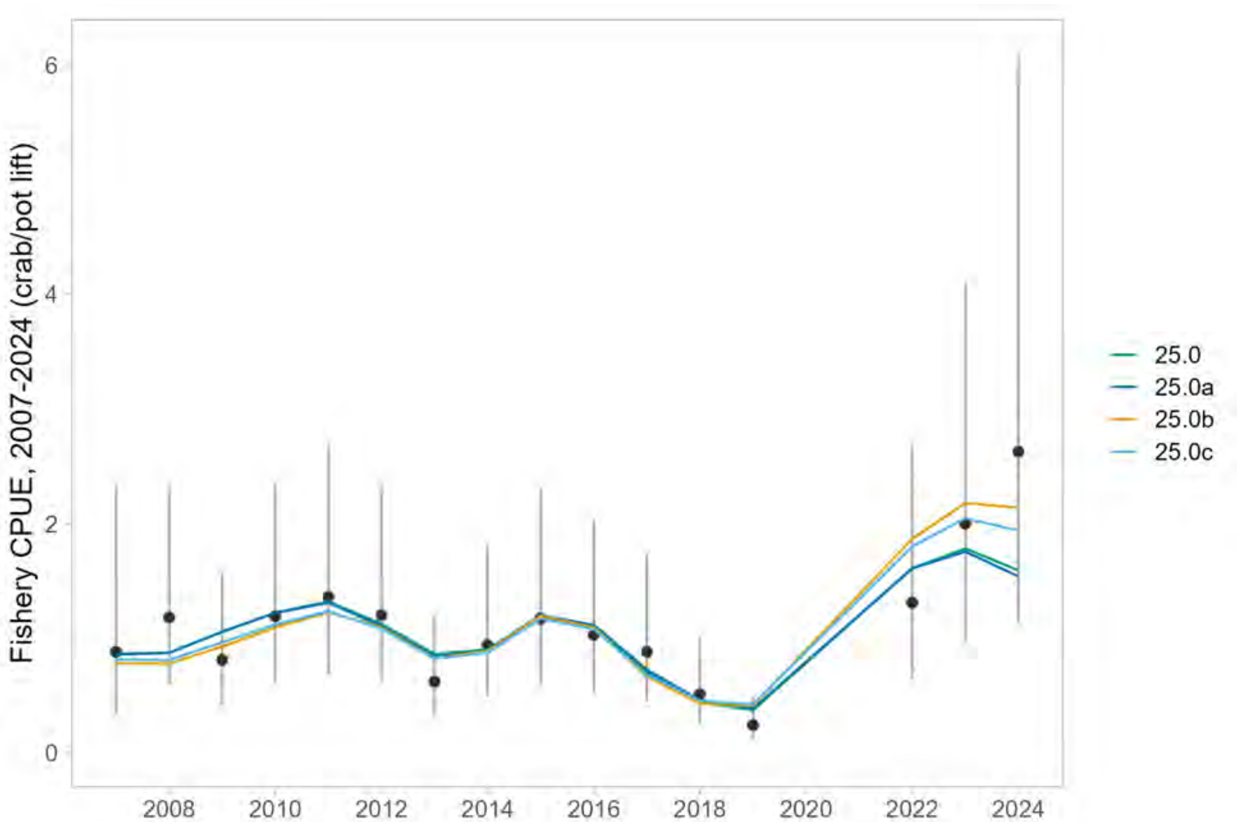


Figure 35: Model fits to the summer commercial fishery standardized CPUE index (2007-2024) for the model with shell condition excluded (model 25.0) and three models exploring natural mortality (M). In model 25.0a, as in model 25.0, M is fixed for males with carapace length (CL) ≤ 123 mm and estimated for males with CL > 123 mm; the fixed M value is 0.18 for model 25.0 and 0.23 for model 25.0a. Model 25.0b uses a size-independent $M = 0.18$. Model 25.0c uses a size-independent $M = 0.23$.

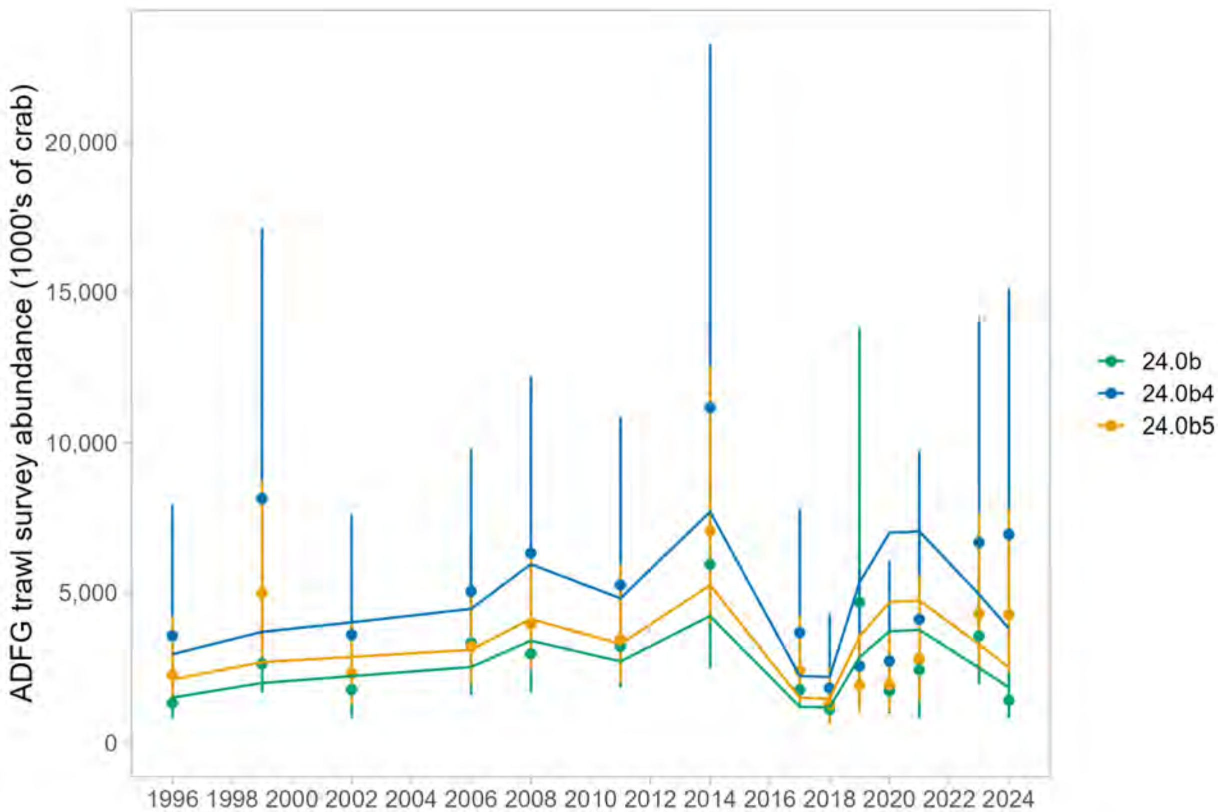


Figure 36: Model fits to the design-based index of abundance from the ADF&G trawl survey for the new base model (model 24.0b) and models using spatiotemporal model-based rather than design-based indices of abundance for the three trawl surveys. In model 24.0b4, abundance is estimated over the full area covered by all three surveys while, in model 24.0b5, abundance is estimated over the reduced area covered by the ADF&G trawl survey since 2010.

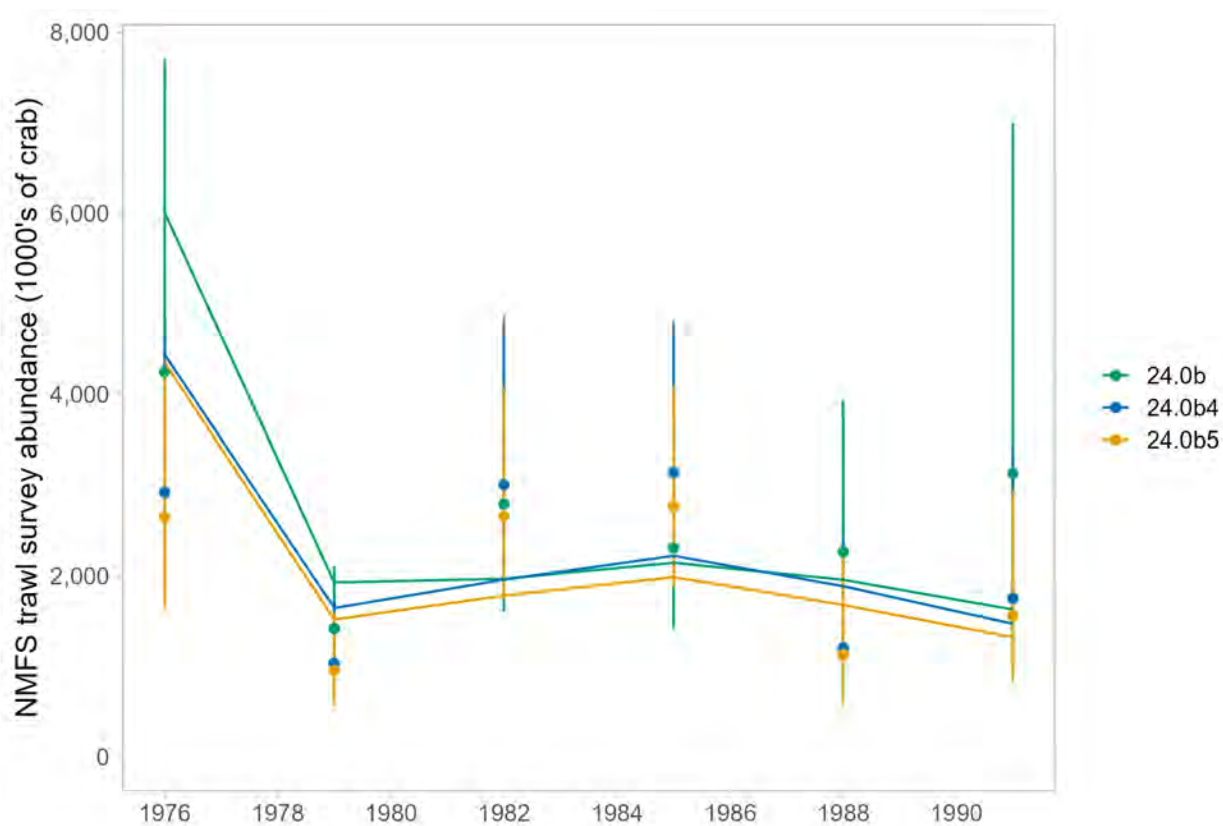


Figure 37: Model fits to the design-based index of abundance from the NOAA Norton Sound trawl survey for the new base model (model 24.0b) and models using spatiotemporal model-based rather than design-based indices of abundance for the three trawl surveys. In model 24.0b4, abundance is estimated over the full area covered by all three surveys while, in model 24.0b5, abundance is estimated over the reduced area covered by the ADF&G trawl survey since 2010.

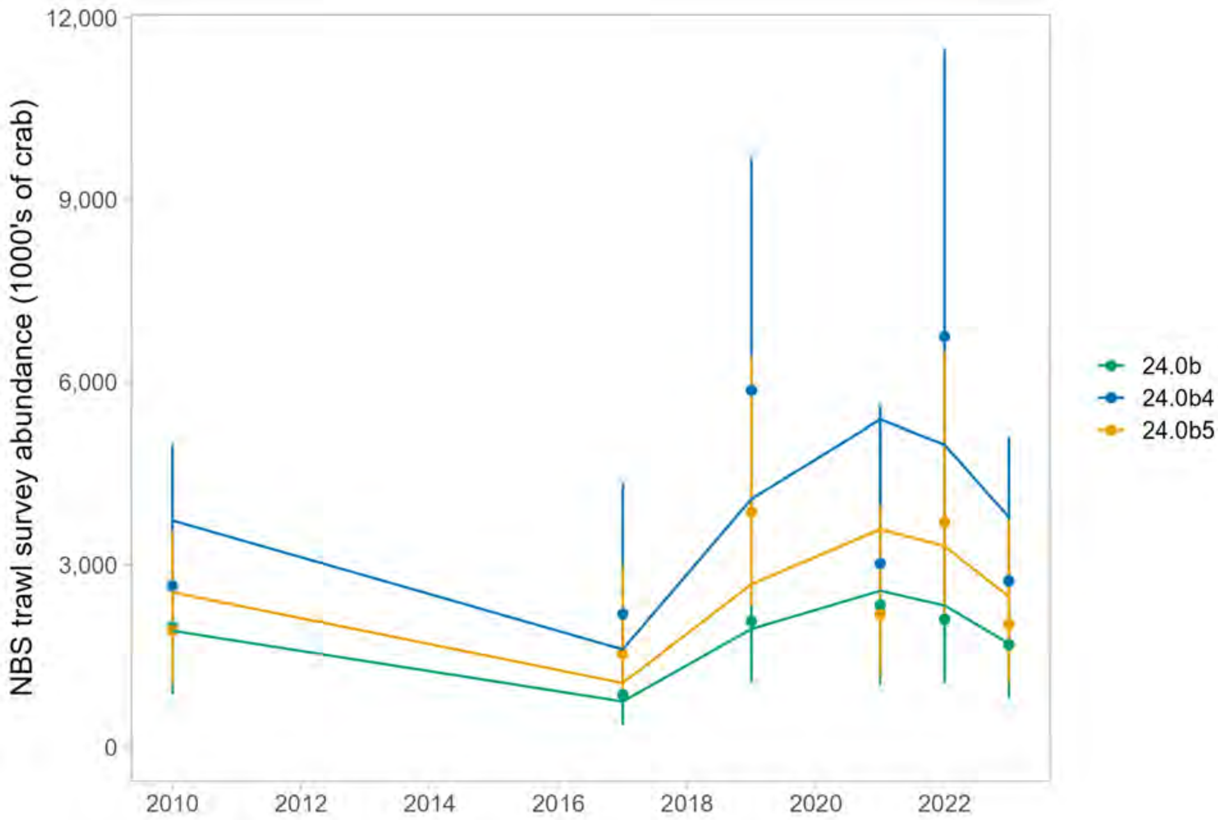


Figure 38: Model fits to the design-based index of abundance from the NOAA Norton Sound trawl survey for the new base model (model 24.0b) and models using spatiotemporal model-based rather than design-based indices of abundance for the three trawl surveys. In model 24.0b4, abundance is estimated over the full area covered by all three surveys while, in model 24.0b5, abundance is estimated over the reduced area covered by the ADF&G trawl survey since 2010.

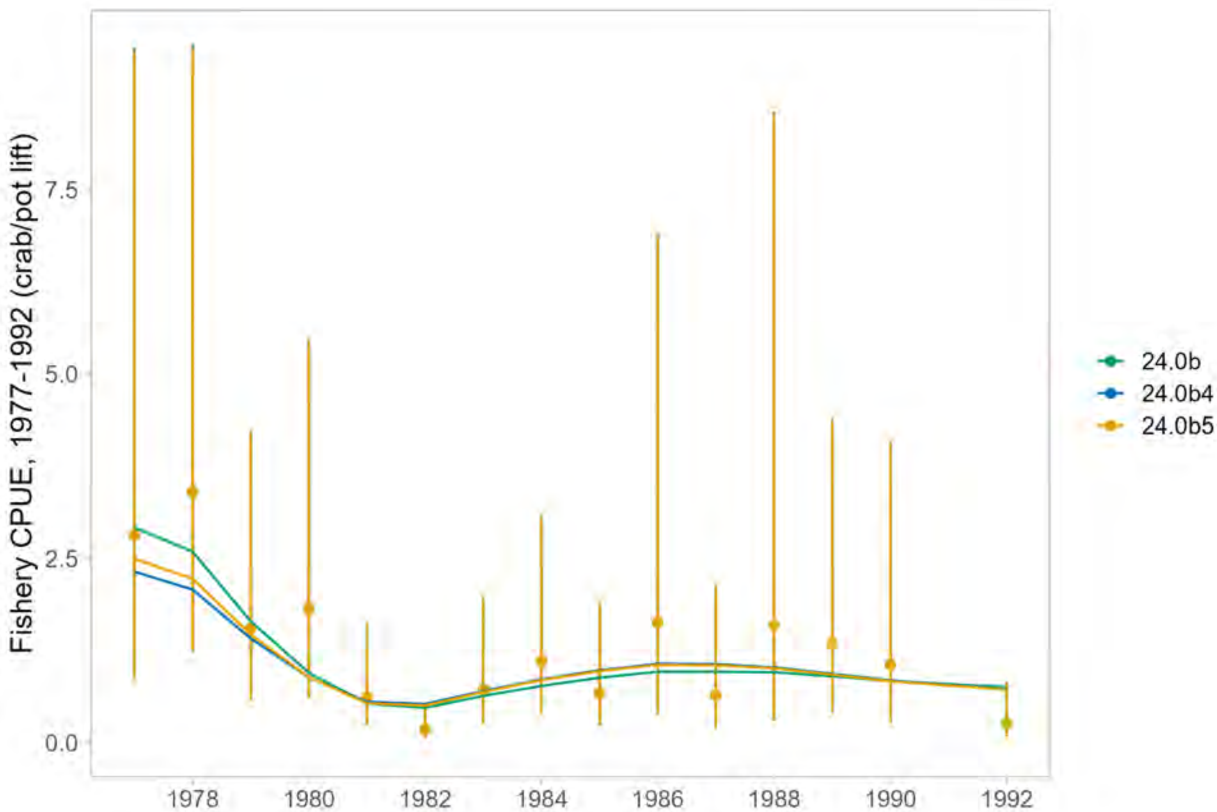


Figure 39: Model fits to the summer commercial fishery standardized CPUE index (1977-1992) for the new base model (model 24.0b) and models using spatiotemporal model-based rather than design-based indices of abundance for the three trawl surveys. In model 24.0b4, abundance is estimated over the full area covered by all three surveys while, in model 24.0b5, abundance is estimated over the reduced area covered by the ADF&G trawl survey since 2010.

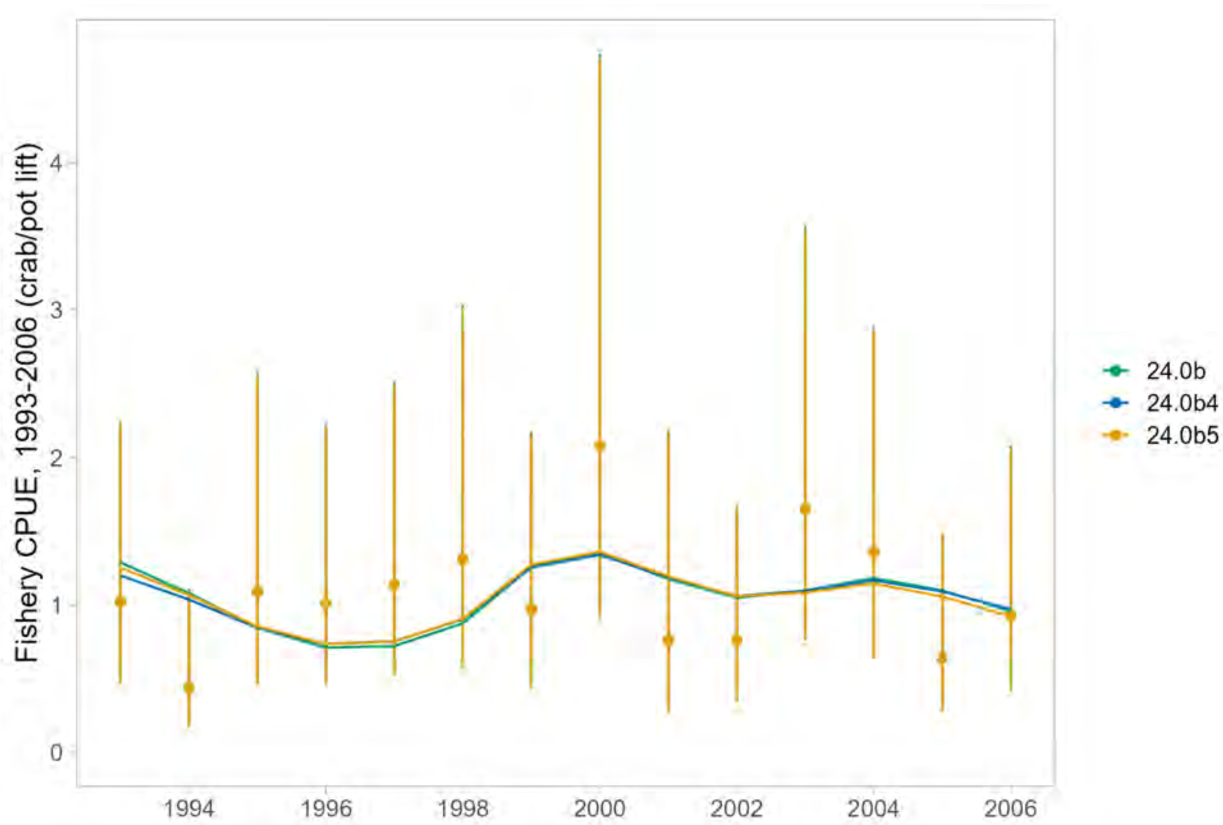


Figure 40: Model fits to the summer commercial fishery standardized CPUE index (1993-2006) for the new base model (model 24.0b) and models using spatiotemporal model-based rather than design-based indices of abundance for the three trawl surveys. In model 24.0b4, abundance is estimated over the full area covered by all three surveys while, in model 24.0b5, abundance is estimated over the reduced area covered by the ADF&G trawl survey since 2010.

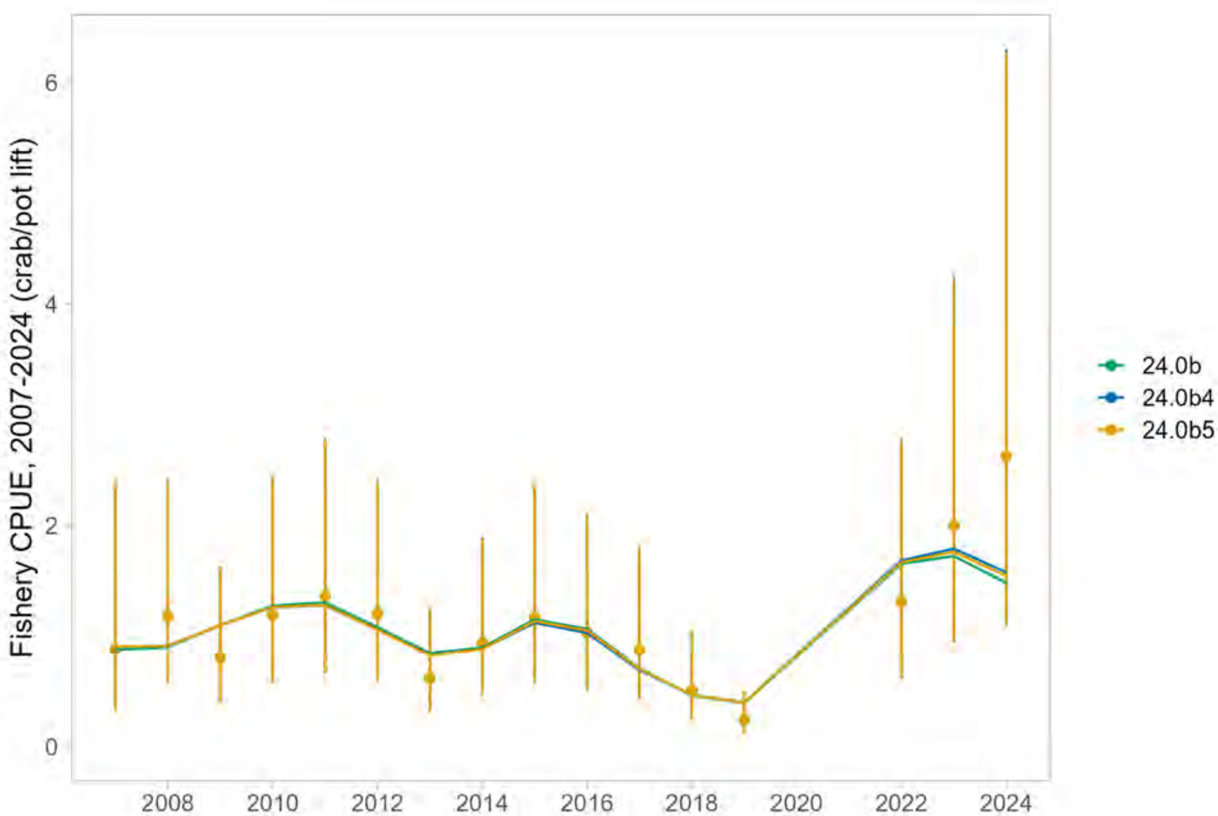


Figure 41: Model fits to the summer commercial fishery standardized CPUE index (2007-2024) for the new base model (model 24.0b) and models using spatiotemporal model-based rather than design-based indices of abundance for the three trawl surveys. In model 24.0b4, abundance is estimated over the full area covered by all three surveys while, in model 24.0b5, abundance is estimated over the reduced area covered by the ADF&G trawl survey since 2010.

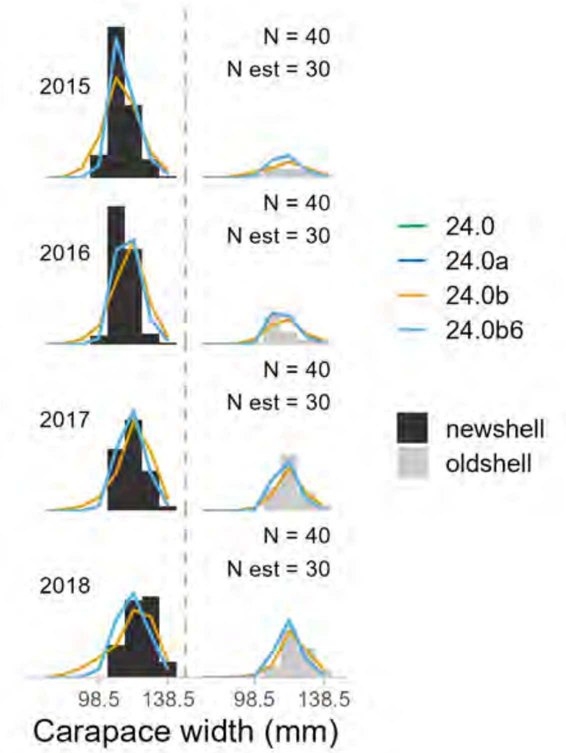


Figure 42: Observed and model-estimated size frequencies of male red king crab retained in the directed winter commercial fishery by year for the models in the bridging analysis: 24.0 (2024 accepted model), 24.0a (24.0 with errors corrected), 24.0b (24.0a transitioned to GMACS 2.20.20), and 24.0b6 (24.0b at the second lowest objective function value). Black bars represent crab classified as newshell and grey bars represent crab classified as oldshell.

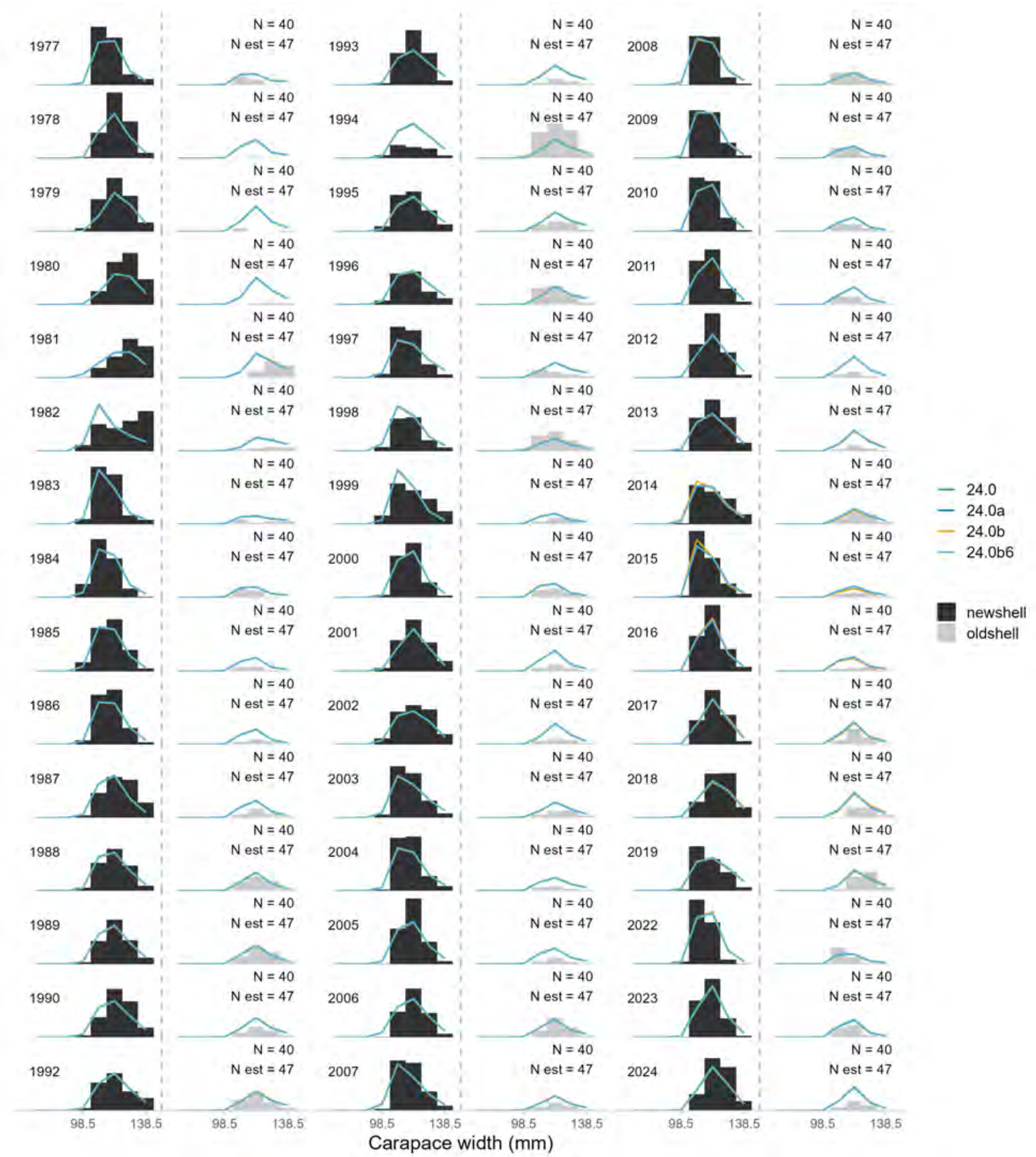


Figure 43: Observed and model-estimated size frequencies of male red king crab retained in the directed summer commercial fishery by year for the models in the bridging analysis: 24.0 (2024 accepted model), 24.0a (24.0 with errors corrected), 24.0b (24.0a transitioned to GMACS 2.20.20), and 24.0b6 (24.0b at the second lowest objective function value). Black bars represent crab classified as newshell and grey bars represent crab classified as oldshell.

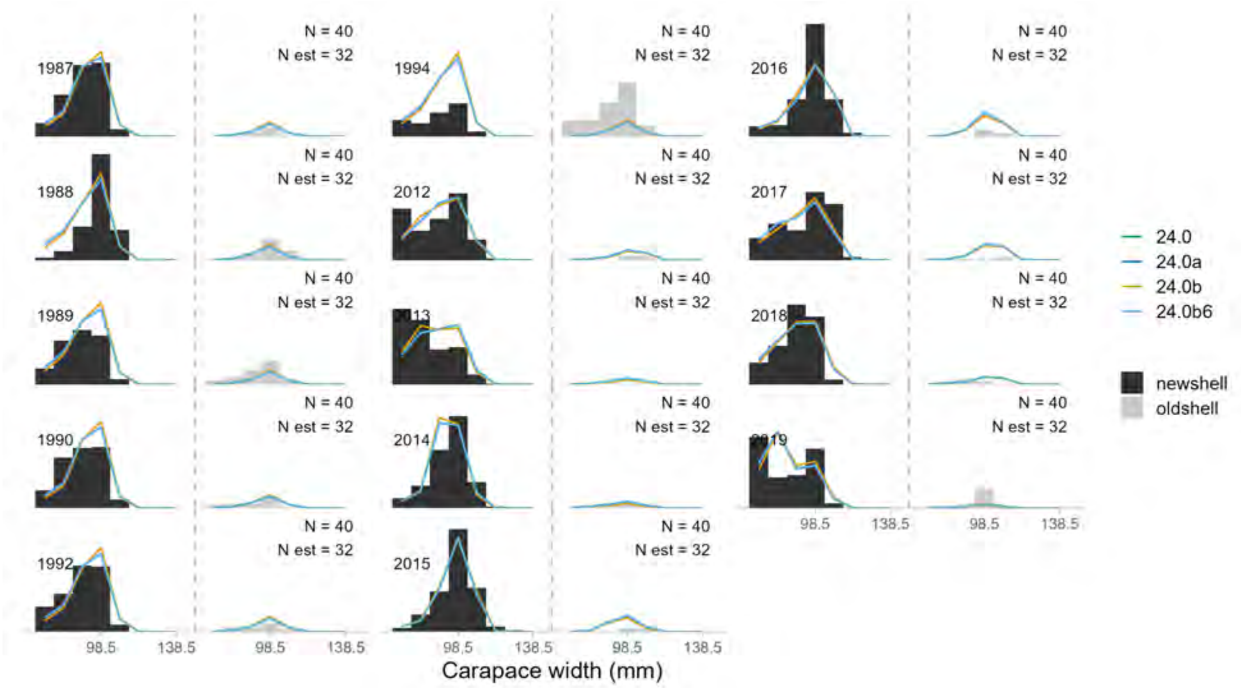


Figure 44: Observed and model-estimated size frequencies of male red king crab discarded in the directed summer commercial fishery by year for the models in the bridging analysis: 24.0 (2024 accepted model), 24.0a (24.0 with errors corrected), 24.0b (24.0a transitioned to GMACS 2.20.20), and 24.0b6 (24.0b at the second lowest objective function value). Black bars represent crab classified as newshell and grey bars represent crab classified as oldshell.

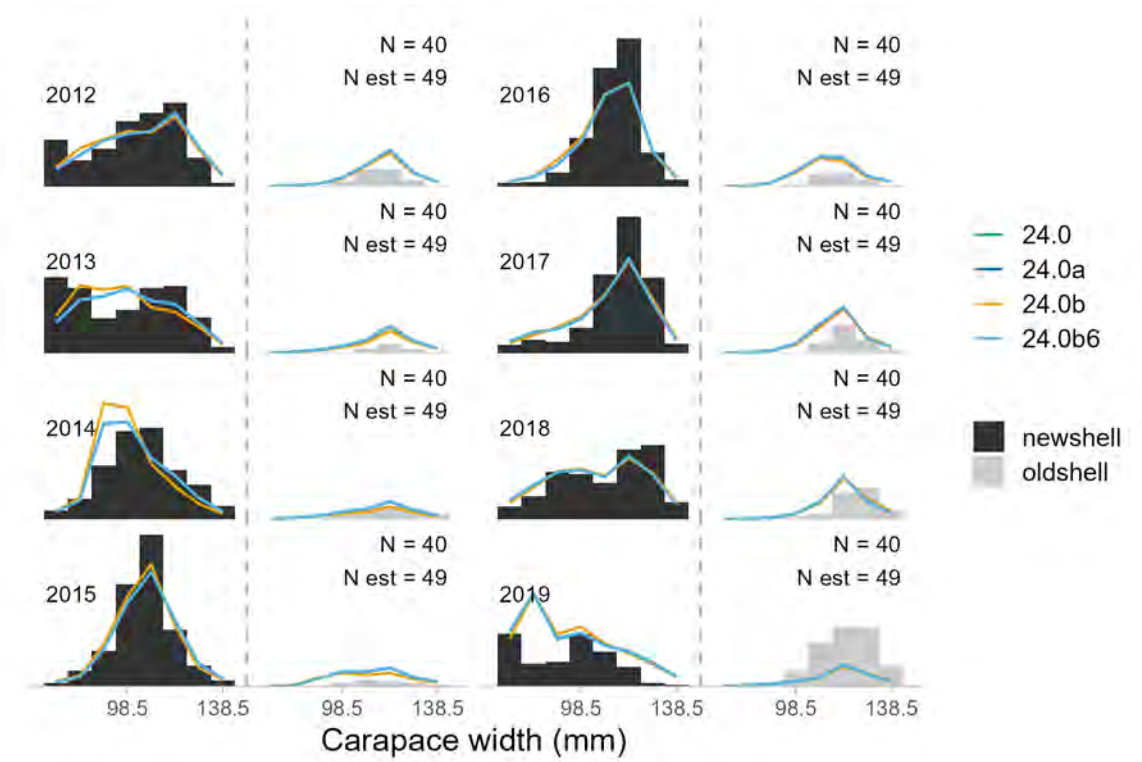


Figure 45: Observed and model-estimated size frequencies of all male red king crab caught in the directed summer commercial fishery by year for the models in the bridging analysis: 24.0 (2024 accepted model), 24.0a (24.0 with errors corrected), 24.0b (24.0a transitioned to GMACS 2.20.20), and 24.0b6 (24.0b at the second lowest objective function value). Black bars represent crab classified as newshell and grey bars represent crab classified as oldshell.

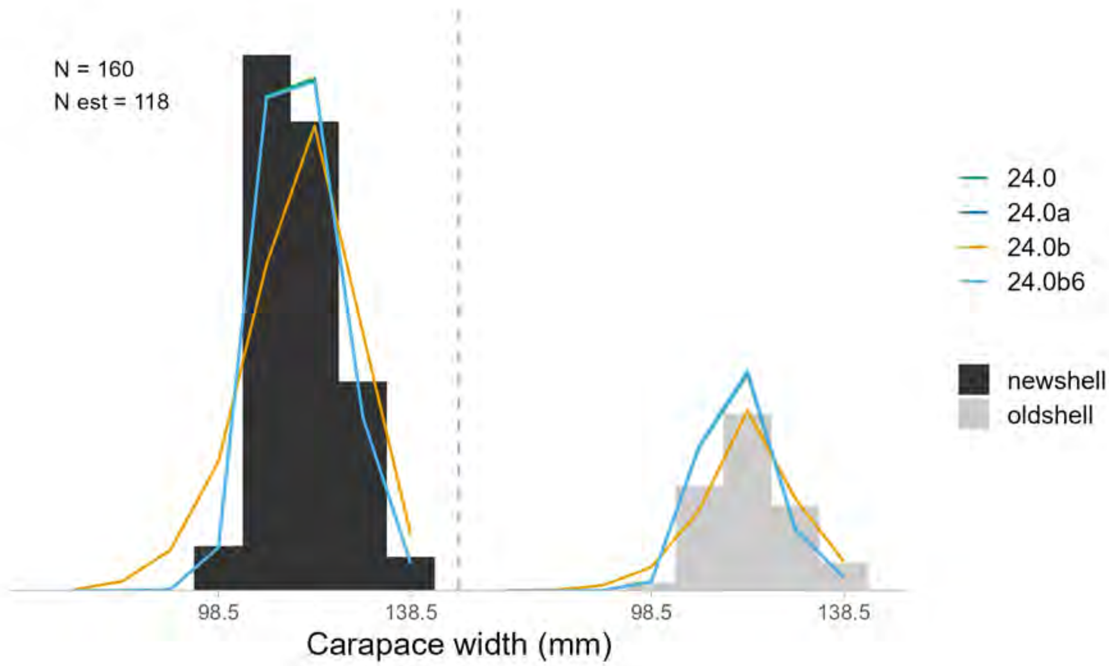


Figure 46: Aggregated observed and model-estimated size frequencies of male red king crab retained in the directed winter commercial fishery for the models in the bridging analysis: 24.0 (2024 accepted model), 24.0a (24.0 with errors corrected), 24.0b (24.0a transitioned to GMACS 2.20.20), and 24.0b6 (24.0b at the second lowest objective function value). Black bars represent crab classified as newshell and grey bars represent crab classified as oldshell.

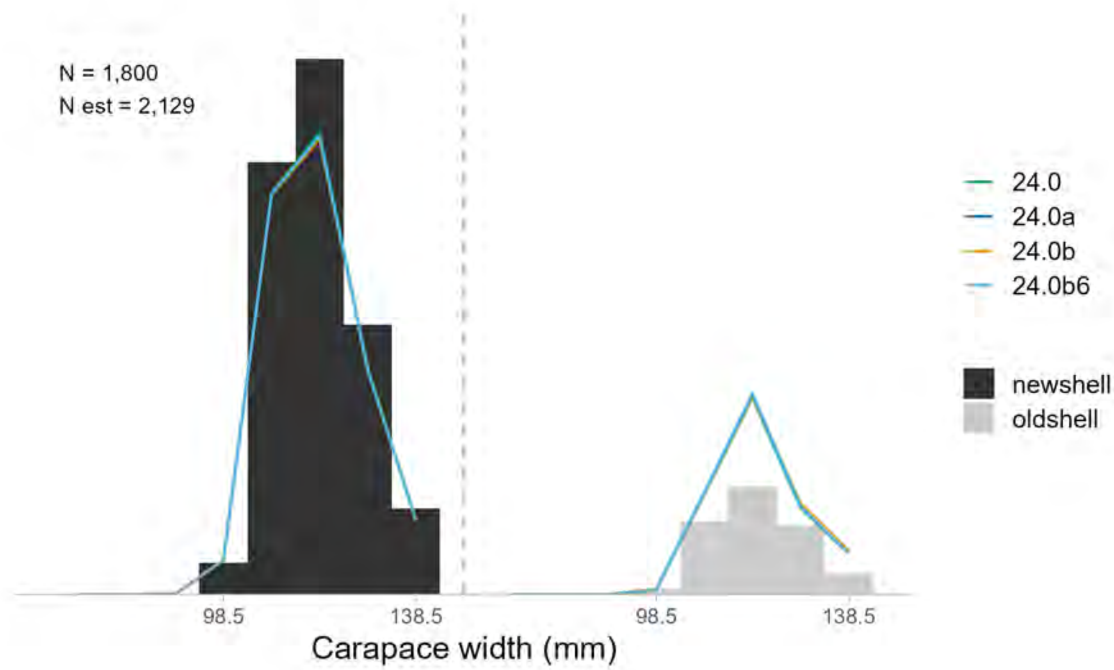


Figure 47: Aggregated observed and model-estimated size frequencies of male red king crab retained in the directed summer commercial fishery for the models in the bridging analysis: 24.0 (2024 accepted model), 24.0a (24.0 with errors corrected), 24.0b (24.0a transitioned to GMACS 2.20.20), and 24.0b6 (24.0b at the second lowest objective function value). Black bars represent crab classified as newshell and grey bars represent crab classified as oldshell.

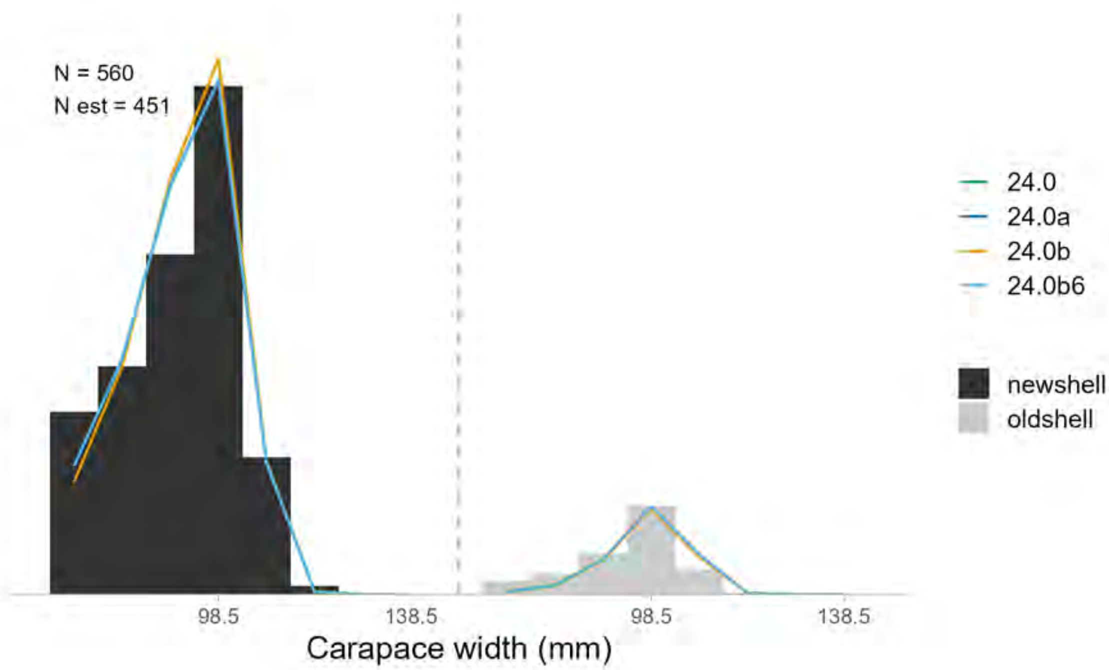


Figure 48: Aggregated observed and model-estimated size frequencies of male red king crab discarded in the directed summer commercial fishery for the models in the bridging analysis: 24.0 (2024 accepted model), 24.0a (24.0 with errors corrected), 24.0b (24.0a transitioned to GMACS 2.20.20), and 24.0b6 (24.0b at the second lowest objective function value). Black bars represent crab classified as newshell and grey bars represent crab classified as oldshell.

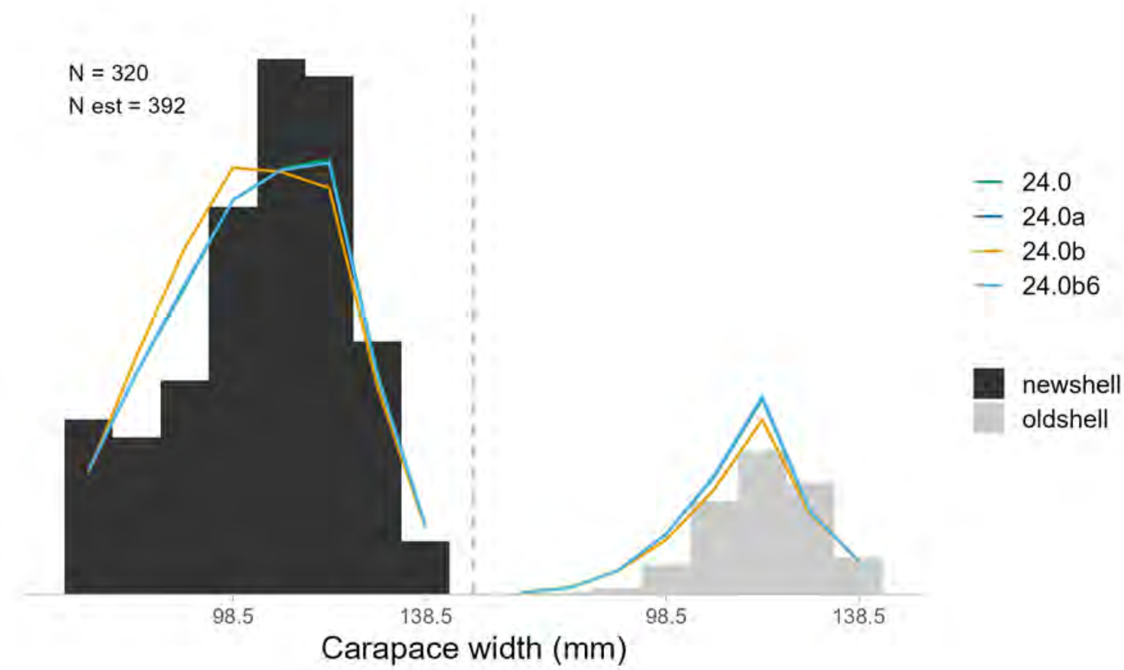


Figure 49: Aggregated observed and model-estimated size frequencies of all male red king crab caught in the directed summer commercial fishery for the models in the bridging analysis: 24.0 (2024 accepted model), 24.0a (24.0 with errors corrected), 24.0b (24.0a transitioned to GMACS 2.20.20), and 24.0b6 (24.0b at the second lowest objective function value). Black bars represent crab classified as newshell and grey bars represent crab classified as oldshell.

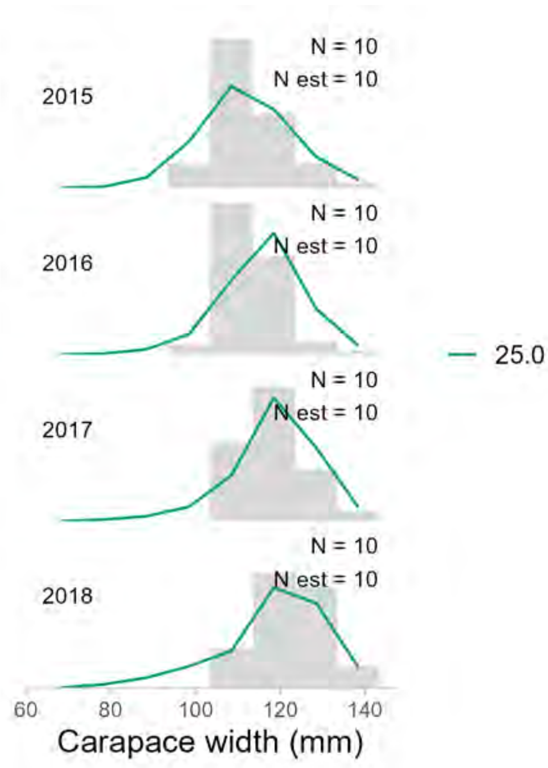


Figure 50: Observed and model-estimated size frequencies of male red king crab retained in the directed winter commercial fishery by year for model 25.0, which is model 24.0b with shell condition excluded.

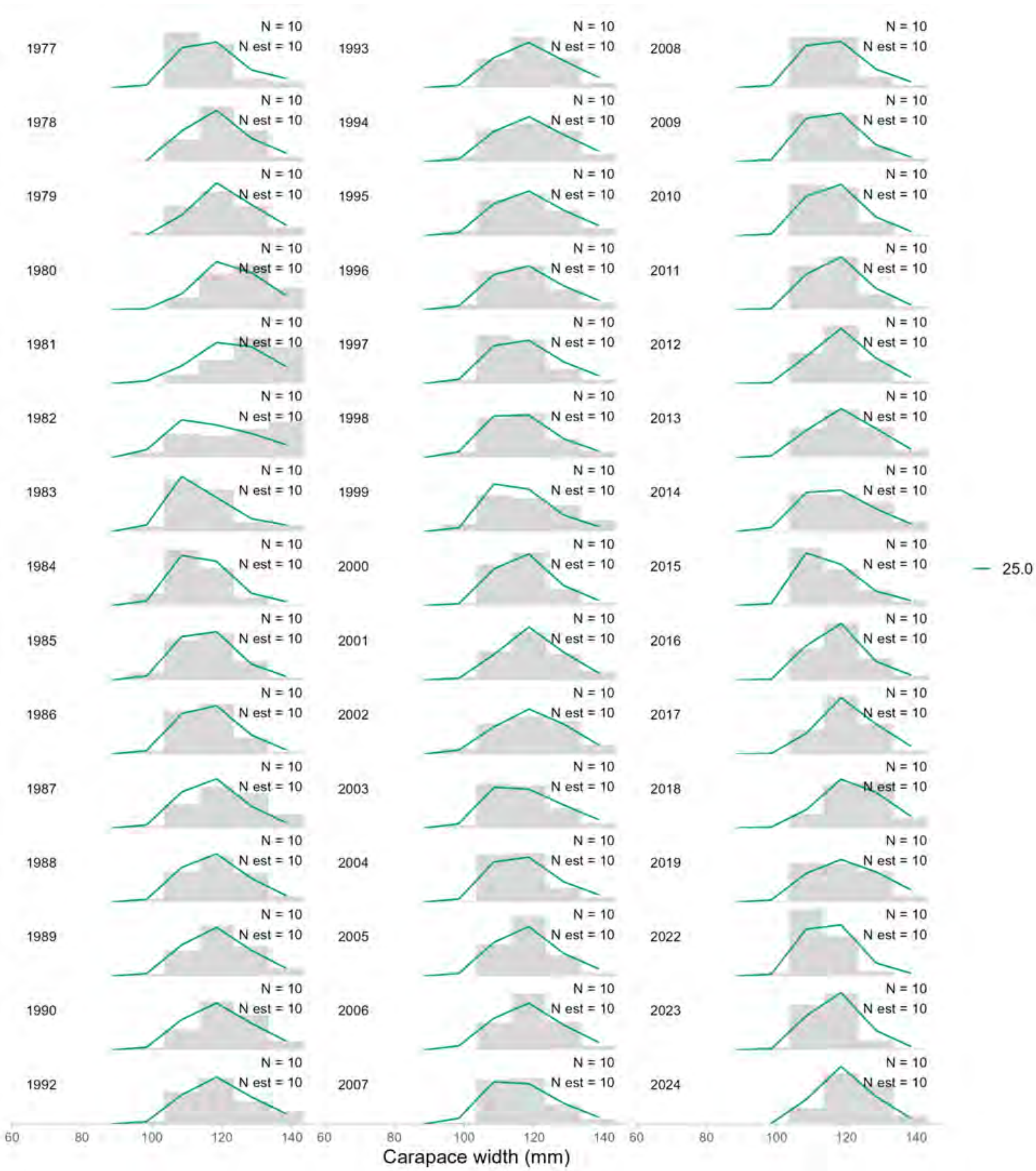


Figure 51: Observed and model-estimated size frequencies of male red king crab retained in the directed summer commercial fishery by year for model 25.0, which is model 24.0b with shell condition excluded.

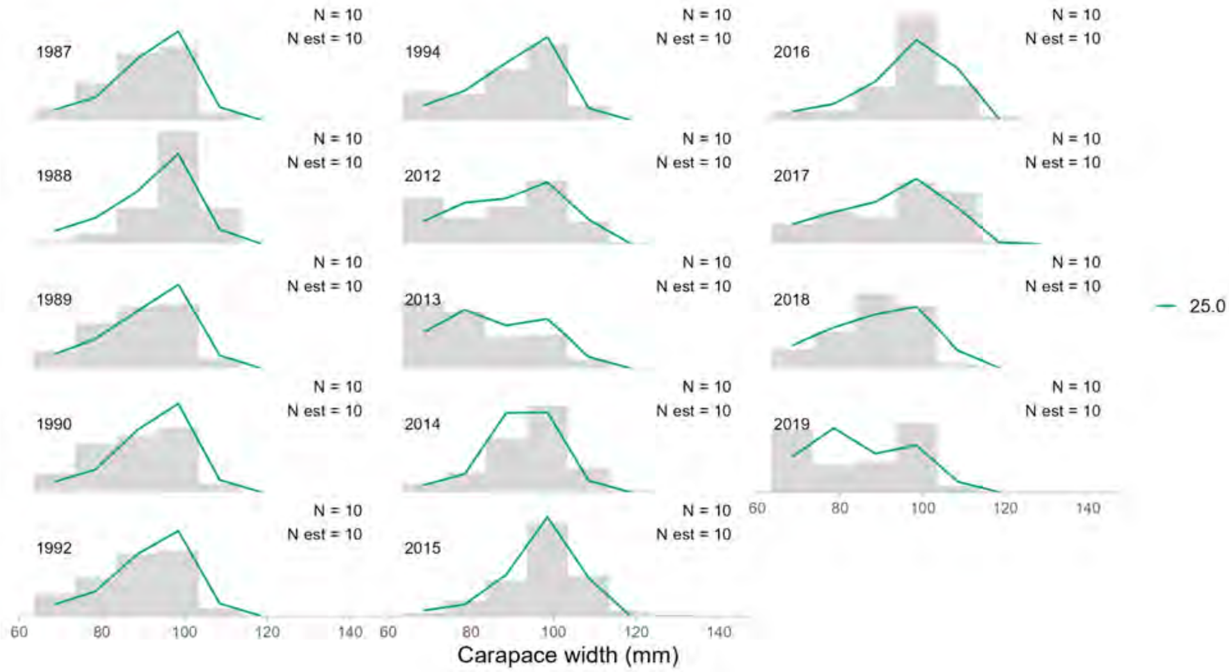


Figure 52: Observed and model-estimated size frequencies of male red king crab discarded in the directed summer commercial fishery by year for model 25.0, which is model 24.0b with shell condition excluded.

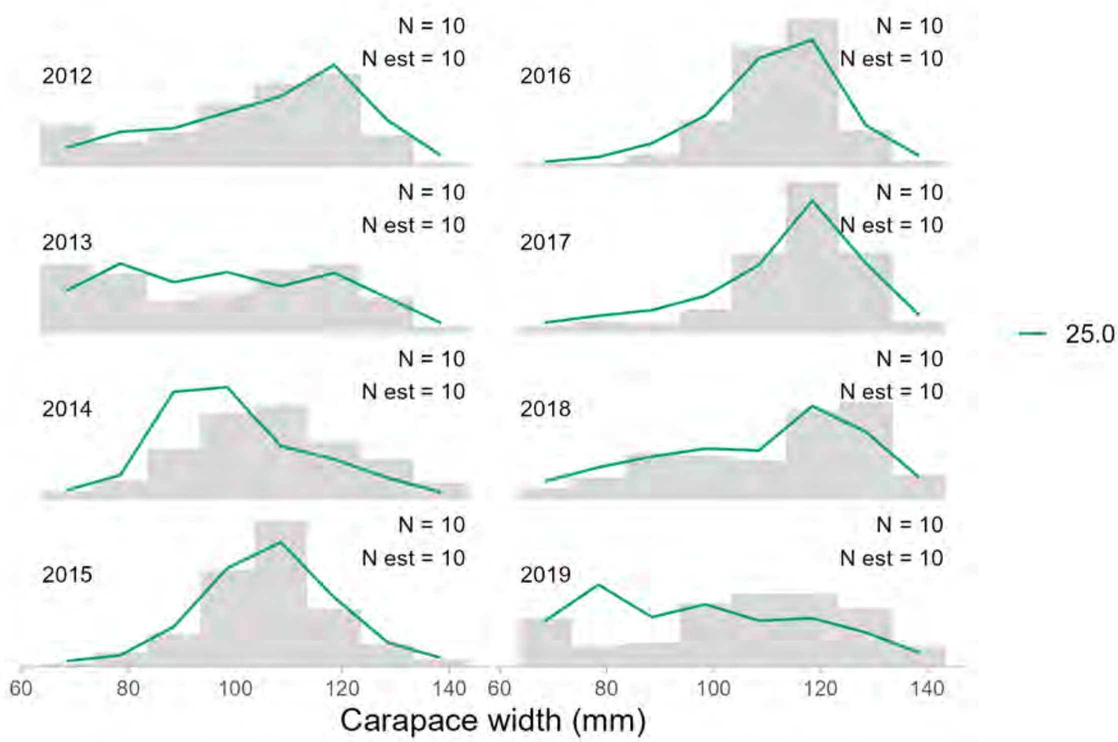


Figure 53: Observed and model-estimated size frequencies of all male red king crab caught in the directed summer commercial fishery by year for model 25.0, which is model 24.0b with shell condition excluded.

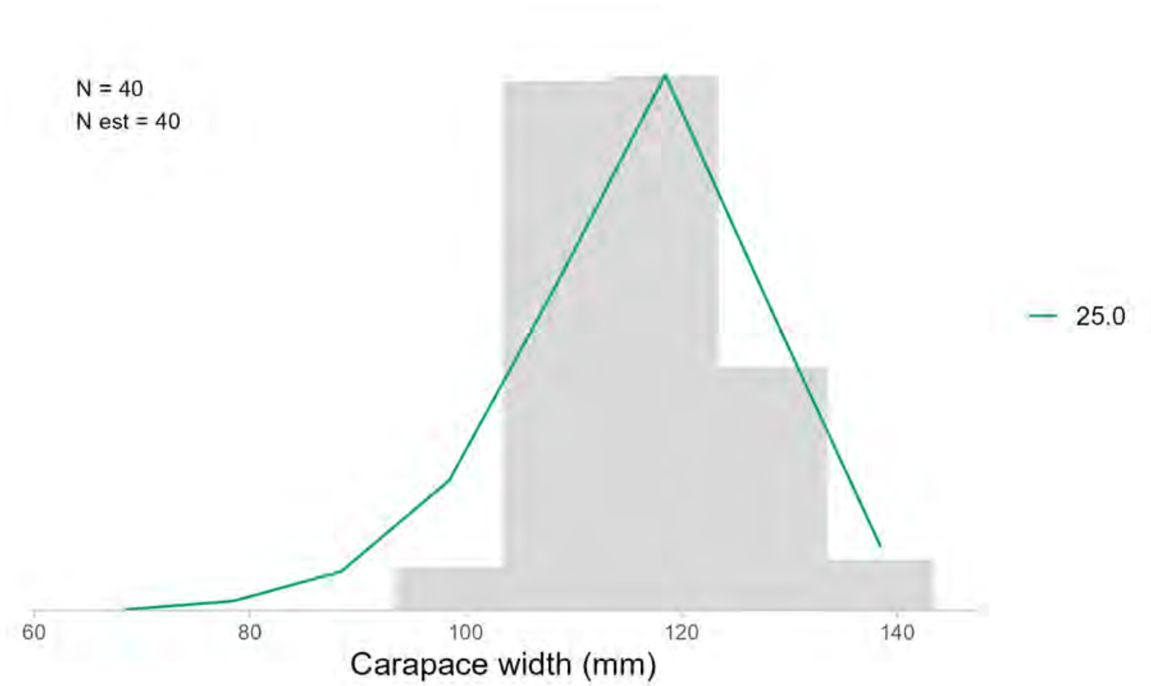


Figure 54: Aggregated observed and model-estimated size frequencies of male red king crab retained in the directed winter commercial fishery for model 25.0, which is model 24.0b with shell condition excluded.

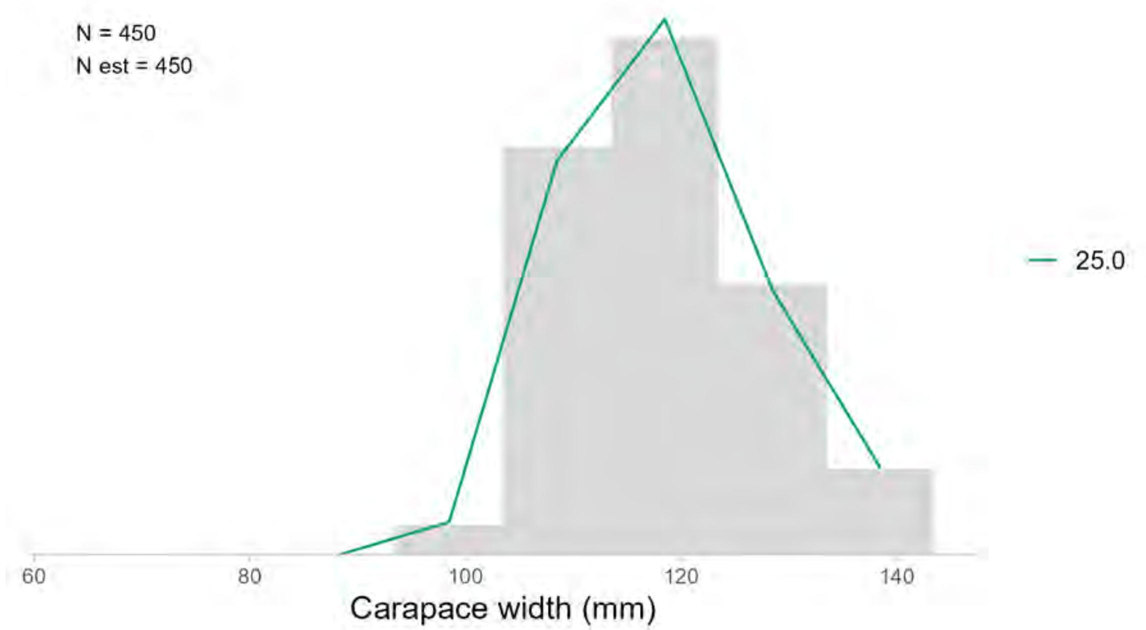


Figure 55: Aggregated observed and model-estimated size frequencies of male red king crab retained in the directed summer commercial fishery for model 25.0, which is model 24.0b with shell condition excluded.

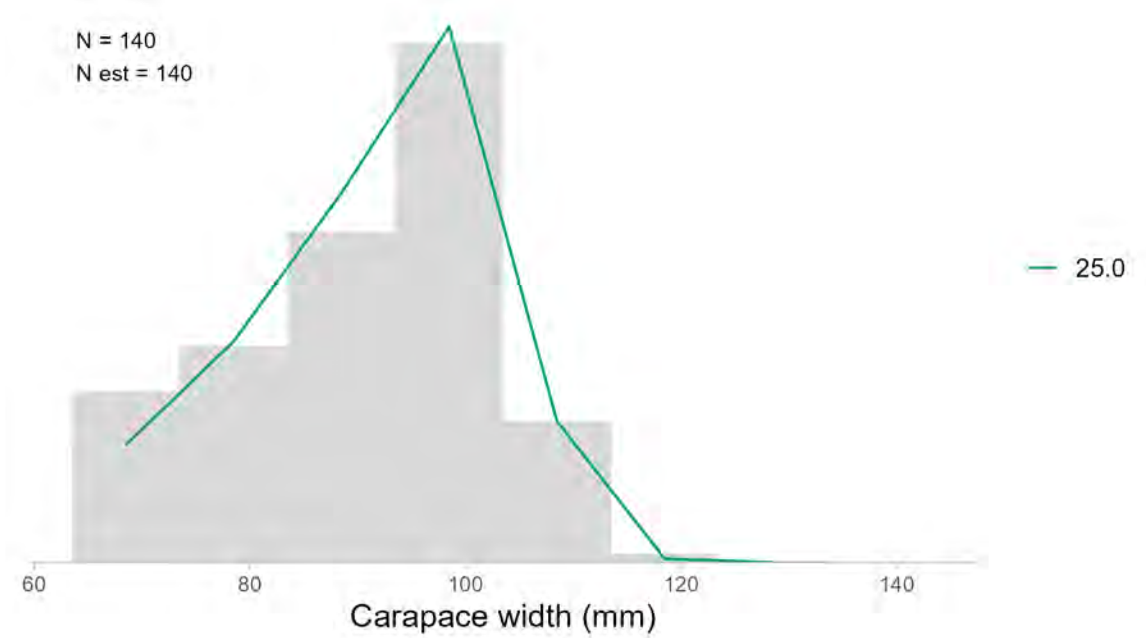


Figure 56: Aggregated observed and model-estimated size frequencies of male red king crab discarded in the directed summer commercial fishery for model 25.0, which is model 24.0b with shell condition excluded.

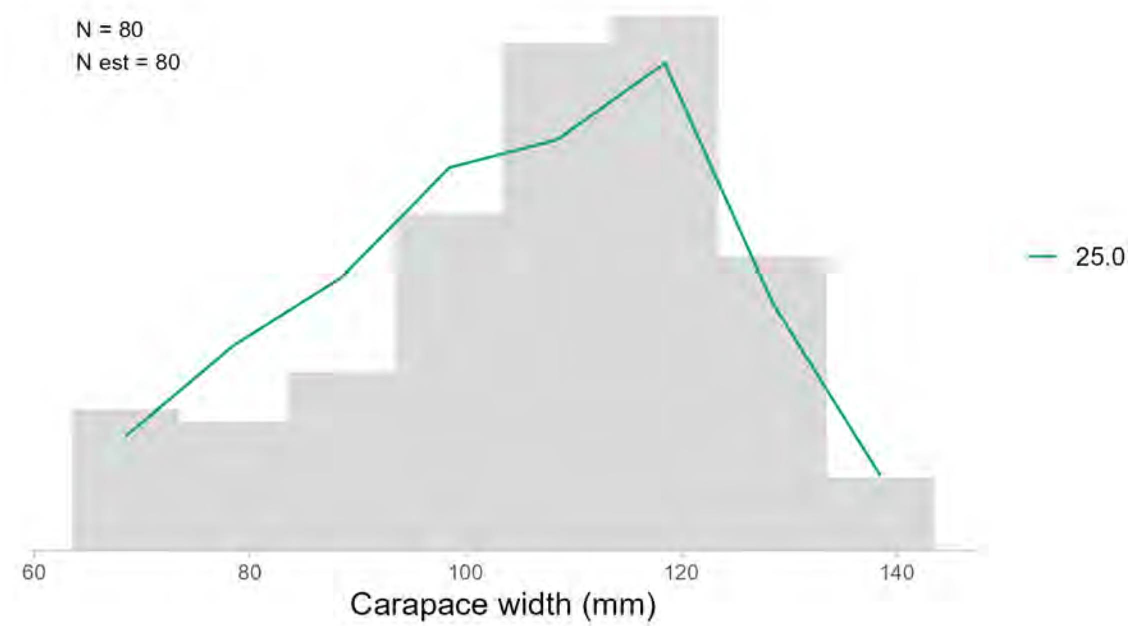


Figure 57: Aggregated observed and model-estimated size frequencies of all male red king crab caught in the directed summer commercial fishery for model 25.0, which is model 24.0b with shell condition excluded.

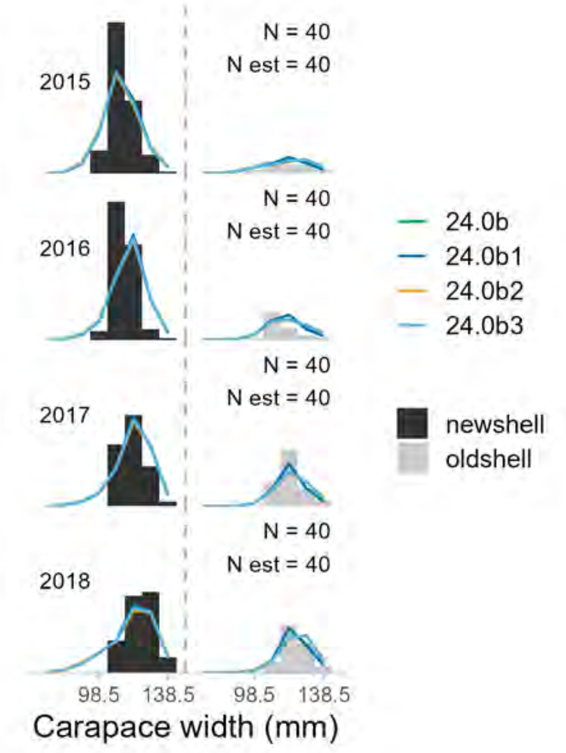


Figure 58: Observed and model-estimated size frequencies of male red king crab retained in the directed winter commercial fishery by year for the new base model (model 24.0b) and three models exploring natural mortality (M). In model 24.0b1, as in model 24.0b, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 24.0b and 0.23 for model 24.0b1. Model 24.0b2 uses a size-independent $M = 0.18$. Model 24.0b3 uses a size-independent $M =$ 0.23. Black bars represent crab classified as newshell and grey bars represent crab classified as oldshell.

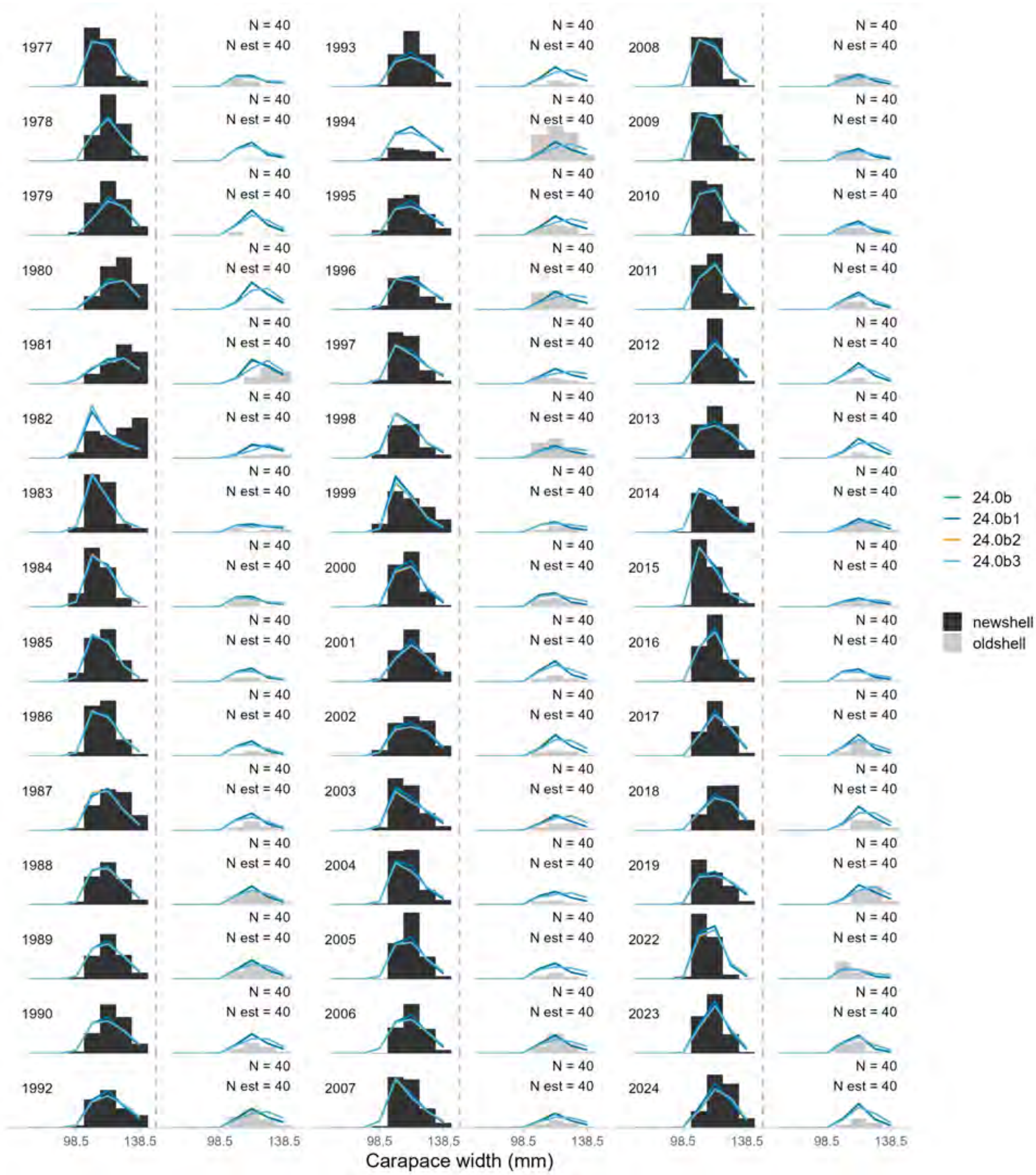


Figure 59: Observed and model-estimated size frequencies of male red king crab retained in the directed summer commercial fishery by year for the new base model (model 24.0b) and three models exploring natural mortality (M). In model 24.0b1, as in model 24.0b, M is fixed for males with carapace length (CL) ≤ 123 mm and estimated for males with CL > 123 mm; the fixed M value is 0.18 for model 24.0b and 0.23 for model 24.0b1. Model 24.0b2 uses a size-independent $M = 0.18$. Model 24.0b3 uses a size-independent $M = 0.23$. Black bars represent crab classified as newshell and grey bars represent crab classified as oldshell.

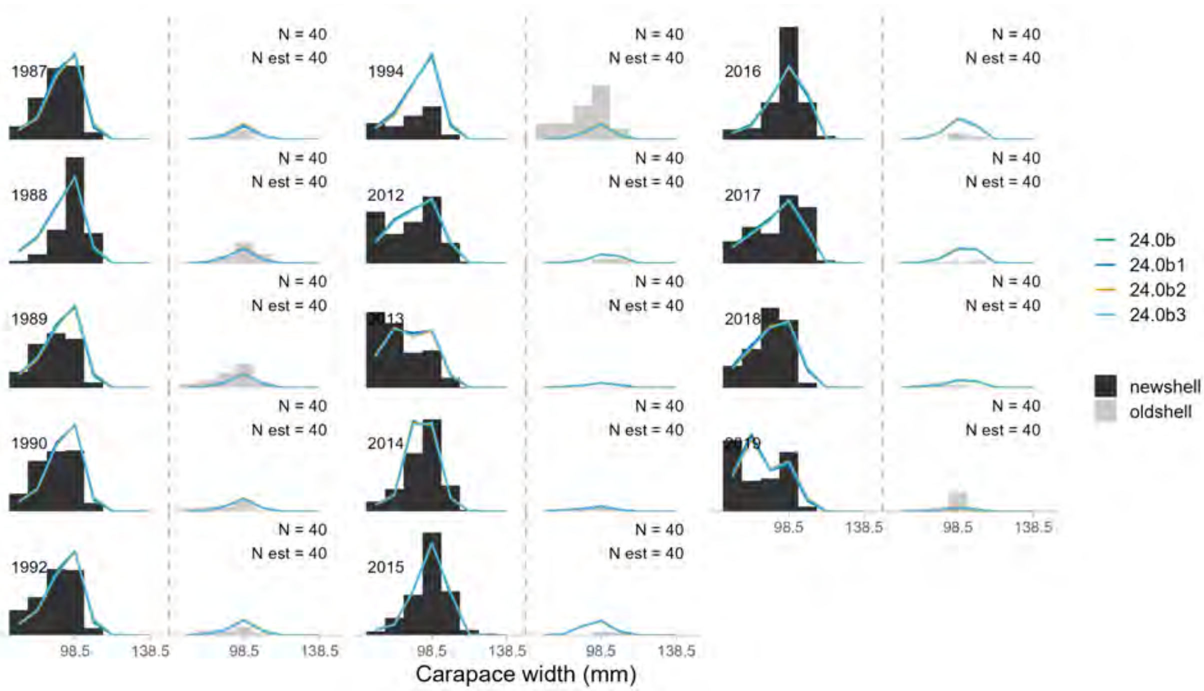


Figure 60: Observed and model-estimated size frequencies of male red king crab discarded in the directed summer commercial fishery by year for the new base model (model 24.0b) and three models exploring natural mortality (M). In model 24.0b1, as in model 24.0b, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 24.0b and 0.23 for model 24.0b1. Model 24.0b2 uses a size-independent $M = 0.18$. Model 24.0b3 uses a size-independent $M = 0.23$. Black bars represent crab classified as newshell and grey bars represent crab classified as oldshell.

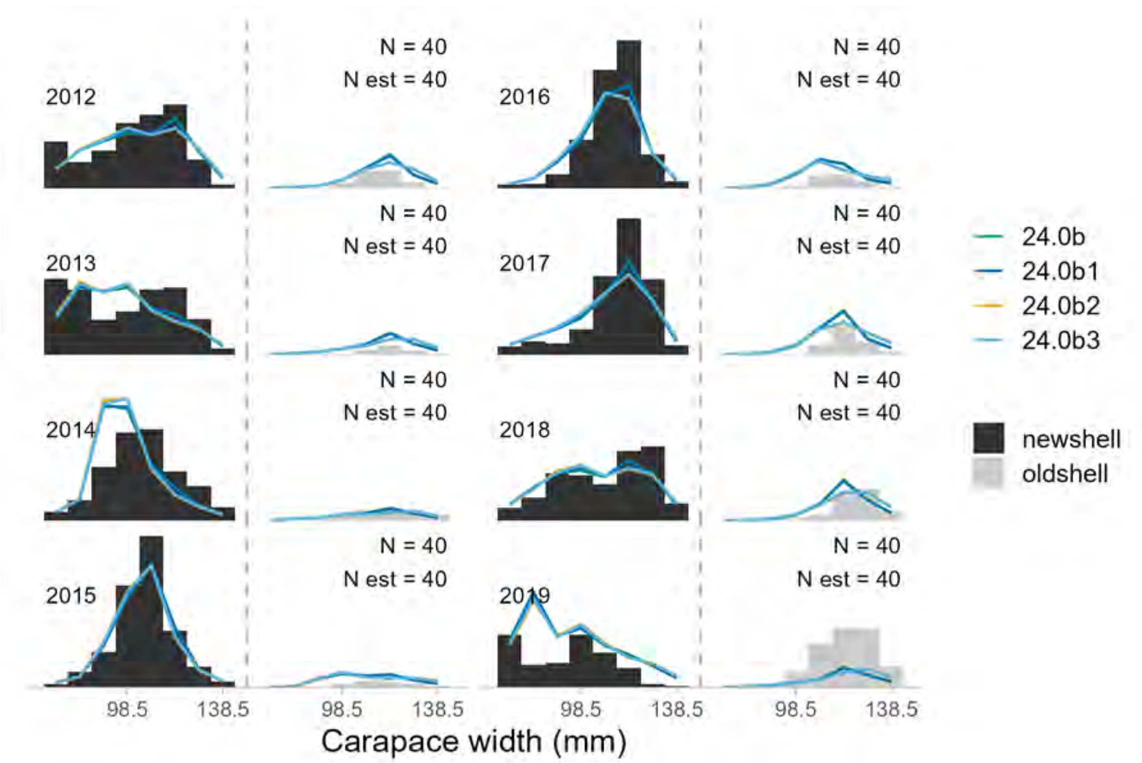


Figure 61: Observed and model-estimated size frequencies of all male red king crab caught in the directed summer commercial fishery by year for the new base model (model 24.0b) and three models exploring natural mortality (M). In model 24.0b1, as in model 24.0b, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 24.0b and 0.23 for model 24.0b1. Model 24.0b2 uses a size-independent $M = 0.18$. Model 24.0b3 uses a size-independent $M = 0.23$. Black bars represent crab classified as newshell and grey bars represent crab classified as oldshell.

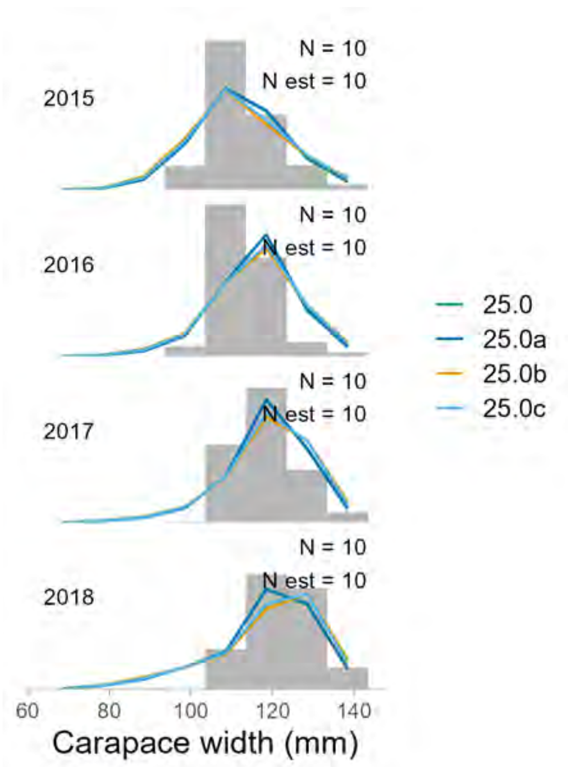


Figure 62: Observed and model-estimated size frequencies of male red king crab retained in the directed winter commercial fishery by year for the model with shell condition excluded (model 25.0) and three models exploring natural mortality (M). In model 25.0a, as in model 25.0, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 25.0 and 0.23 for model 25.0a. Model 25.0b uses a size-independent $M = 0.18$. Model 25.0c uses a size-independent $M = 0.23$.

Figure 63: Observed and model-estimated size frequencies of male red king crab retained in the directed summer commercial fishery by year for the model with shell condition excluded (model 25.0) and three models exploring natural mortality (M). In model 25.0a, as in model 25.0, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 25.0 and 0.23 for model 25.0a. Model 25.0b uses a size-independent $M = 0.18$. Model 25.0c uses a size-independent $M = 0.23$.

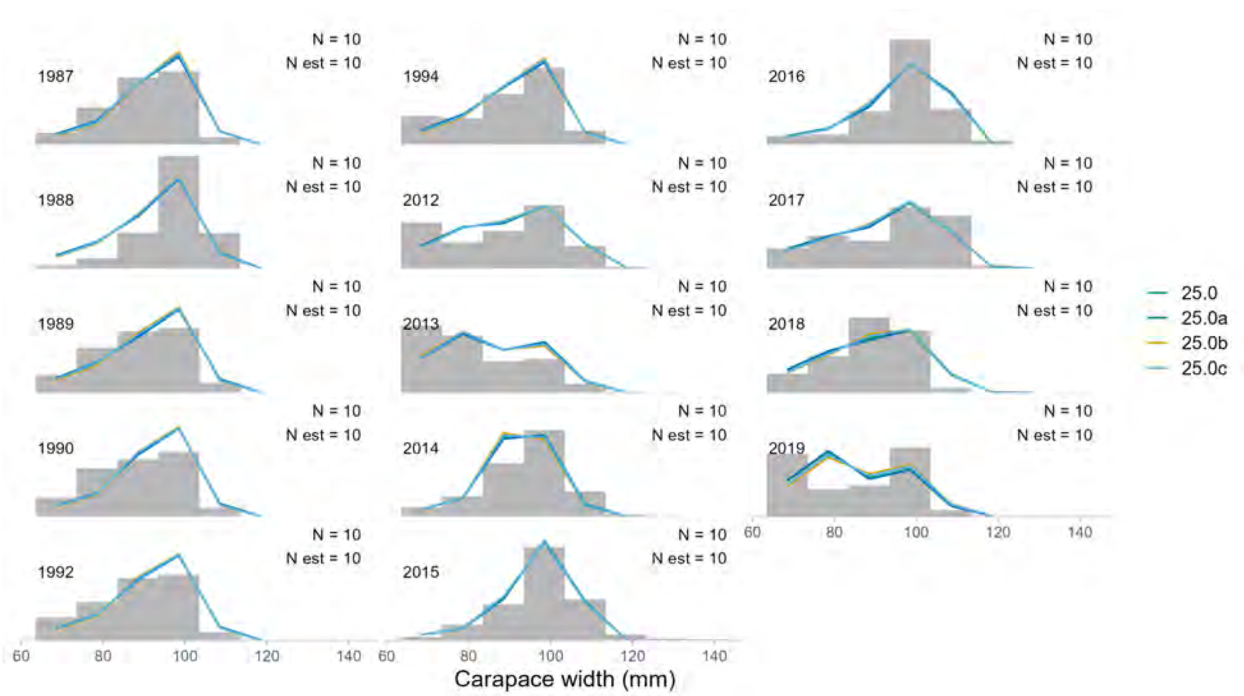


Figure 64: Observed and model-estimated size frequencies of male red king crab discarded in the directed summer commercial fishery by year for the model with shell condition excluded (model 25.0) and three models exploring natural mortality (M). In model 25.0a, as in model 25.0, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 25.0 and 0.23 for model 25.0a. Model 25.0b uses a size-independent $M = 0.18$. Model 25.0c uses a size-independent $M = 0.23$.

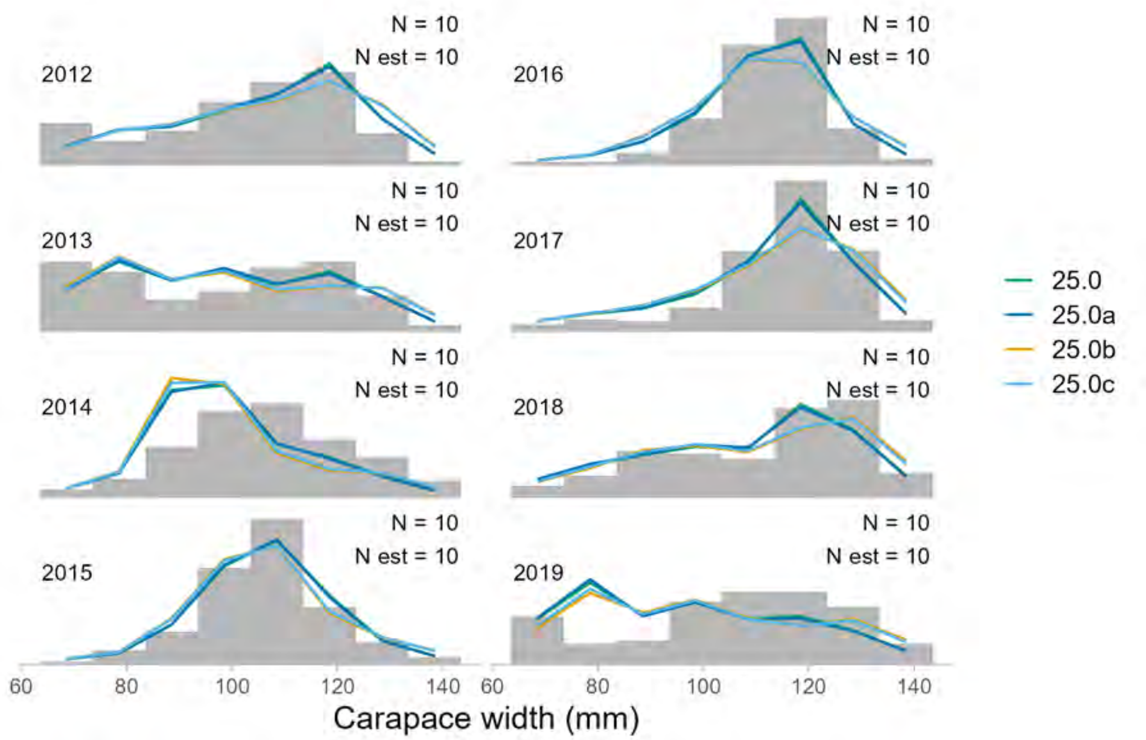


Figure 65: Observed and model-estimated size frequencies of all male red king crab caught in the directed summer commercial fishery by year for the model with shell condition excluded (model 25.0) and three models exploring natural mortality (M). In model 25.0a, as in model 25.0, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 25.0 and 0.23 for model 25.0a. Model 25.0b uses a size-independent $M = 0.18$. Model 25.0c uses a size-independent $M = 0.23$.

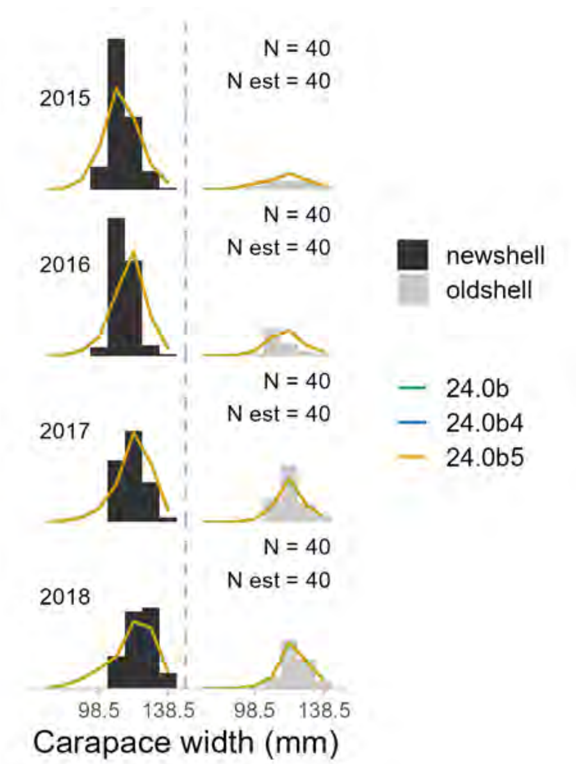


Figure 66: Observed and model-estimated size frequencies of male red king crab retained in the directed winter commercial fishery by year for the new base model (model 24.0b) and models using spatiotemporal model-based rather than design-based indices of abundance for the three trawl surveys. In model 24.0b4, abundance is estimated over the full area covered by all three surveys while, in model 24.0b5, abundance is estimated over the reduced area covered by the ADF&G trawl survey since 2010. Black bars represent crab classified as newshell and grey bars represent crab classified as oldshell.

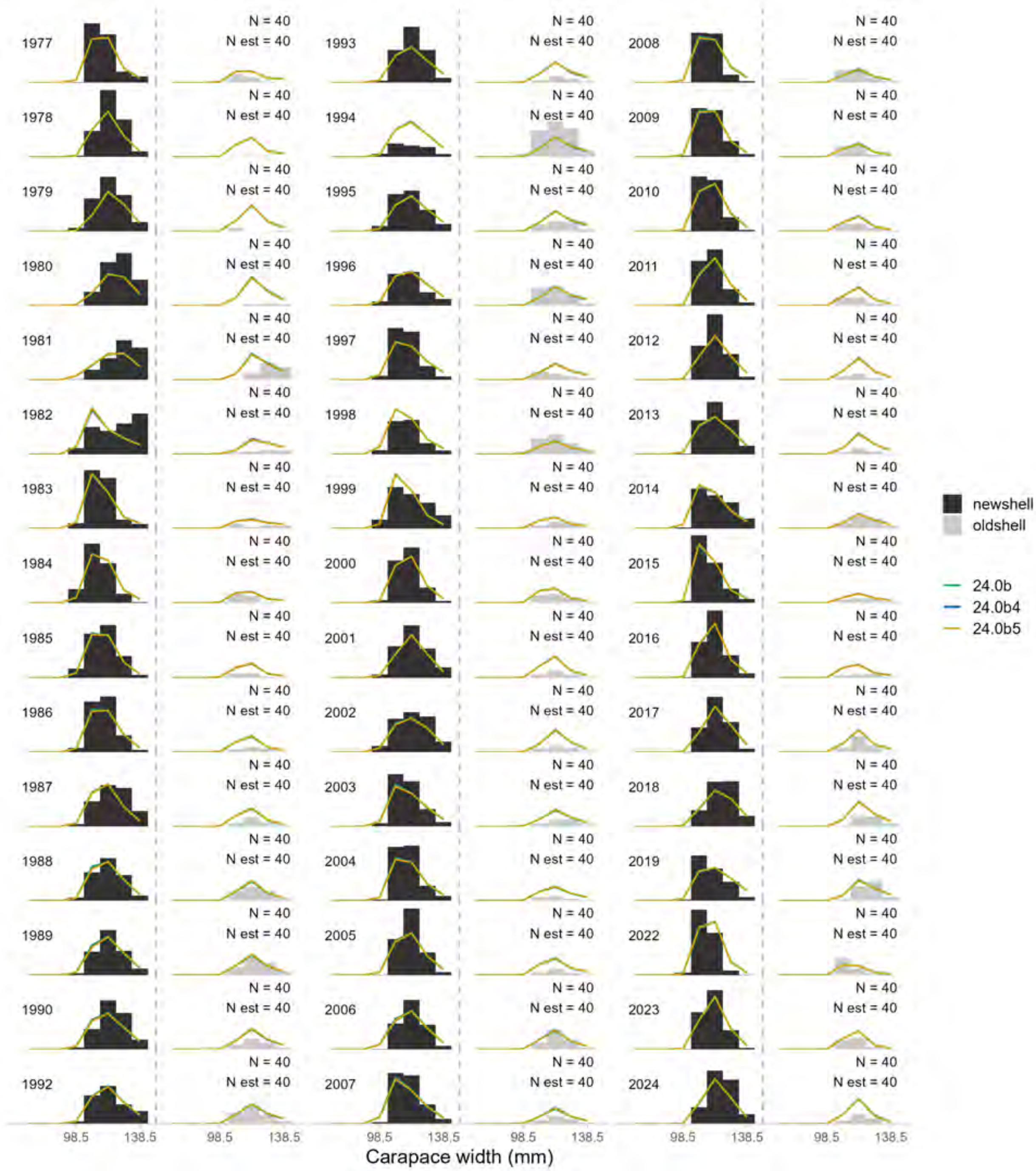


Figure 67: Observed and model-estimated size frequencies of male red king crab retained in the directed summer commercial fishery by year for the new base model (model 24.0b) and models using spatiotemporal model-based rather than design-based indices of abundance for the three trawl surveys. In model 24.0b4, abundance is estimated over the full area covered by all three surveys while, in model 24.0b5, abundance is estimated over the reduced area covered by the ADF&G trawl survey since 2010. Black bars represent crab classified as newshell and grey bars represent crab classified as oldshell.

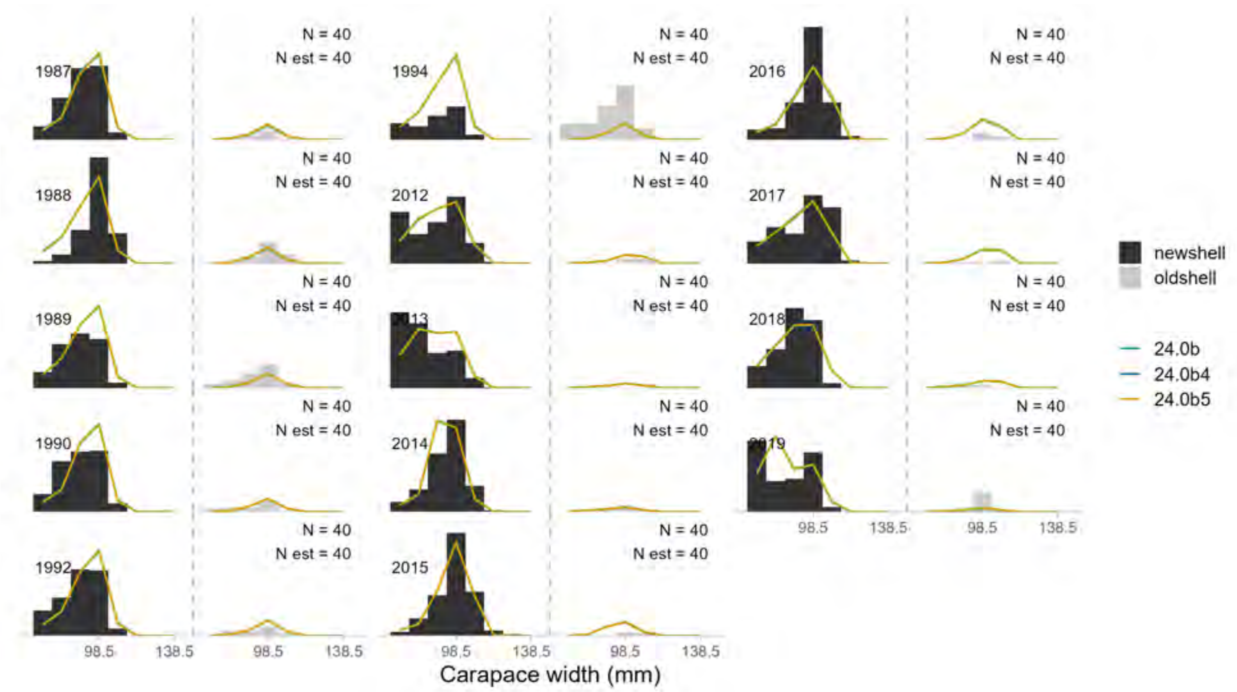


Figure 68: Observed and model-estimated size frequencies of male red king crab discarded in the directed summer commercial fishery by year for the new base model (model 24.0b) and models using spatiotemporal model-based rather than design-based indices of abundance for the three trawl surveys. In model 24.0b4, abundance is estimated over the full area covered by all three surveys while, in model 24.0b5, abundance is estimated over the reduced area covered by the ADF&G trawl survey since 2010. Black bars represent crab classified as newshell and grey bars represent crab classified as oldshell.

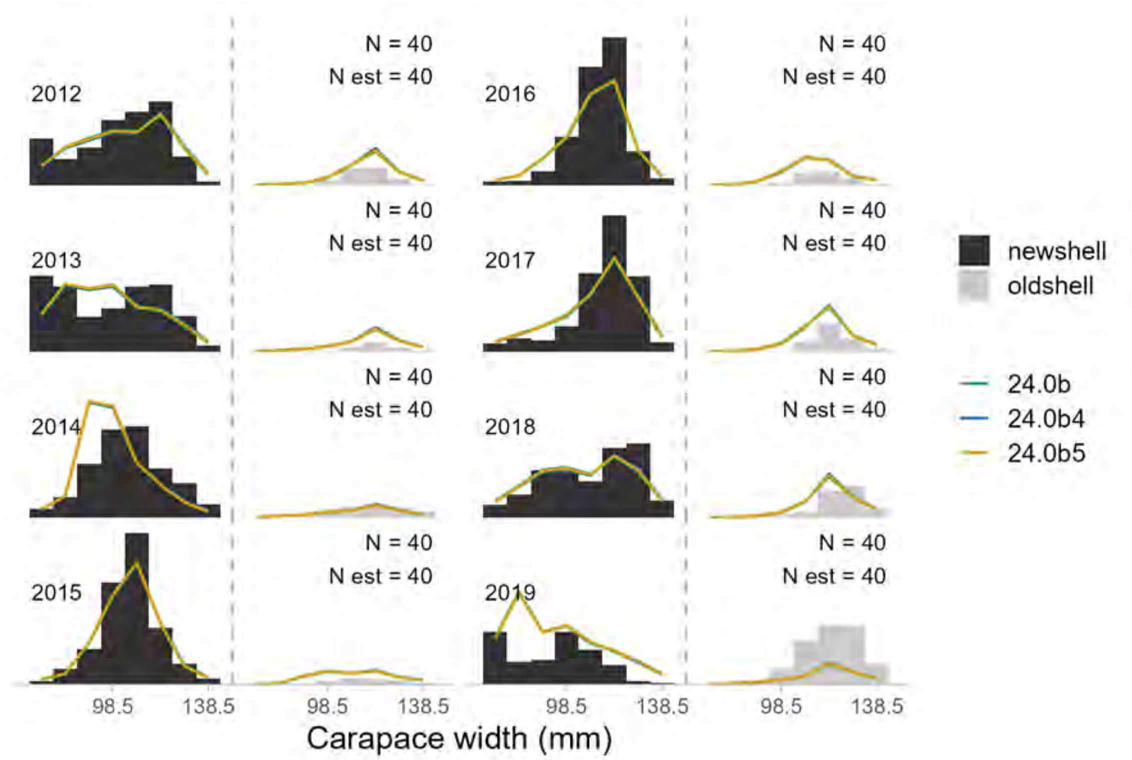


Figure 69: Observed and model-estimated size frequencies of all male red king crab caught in the directed summer commercial fishery by year for the new base model (model 24.0b) and models using spatiotemporal model-based rather than design-based indices of abundance for the three trawl surveys. In model 24.0b4, abundance is estimated over the full area covered by all three surveys while, in model 24.0b5, abundance is estimated over the reduced area covered by the ADF&G trawl survey since 2010. Black bars represent crab classified as newshell and grey bars represent crab classified as oldshell.

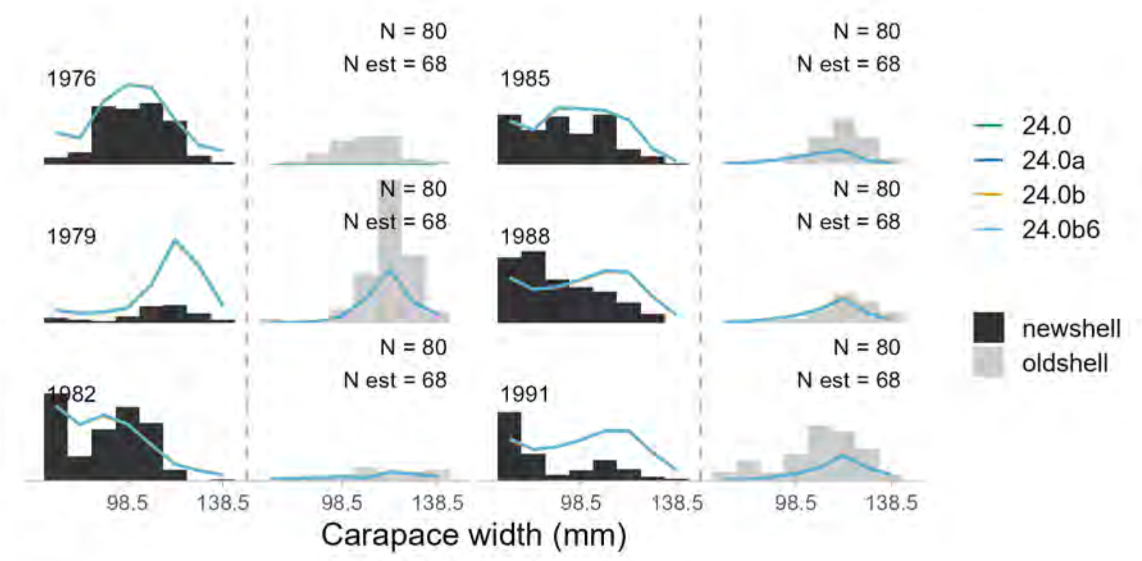


Figure 70: Observed and model-estimated size frequencies of all male red king crab caught in the NMFS trawl survey by year for the models in the bridging analysis: 24.0 (2024 accepted model), 24.0a (24.0 with errors corrected), 24.0b (24.0a transitioned to GMACS 2.20.20), and 24.0b6 (24.0b at the second lowest objective function value). Black bars represent crab classified as newshell and grey bars represent crab classified as oldshell.

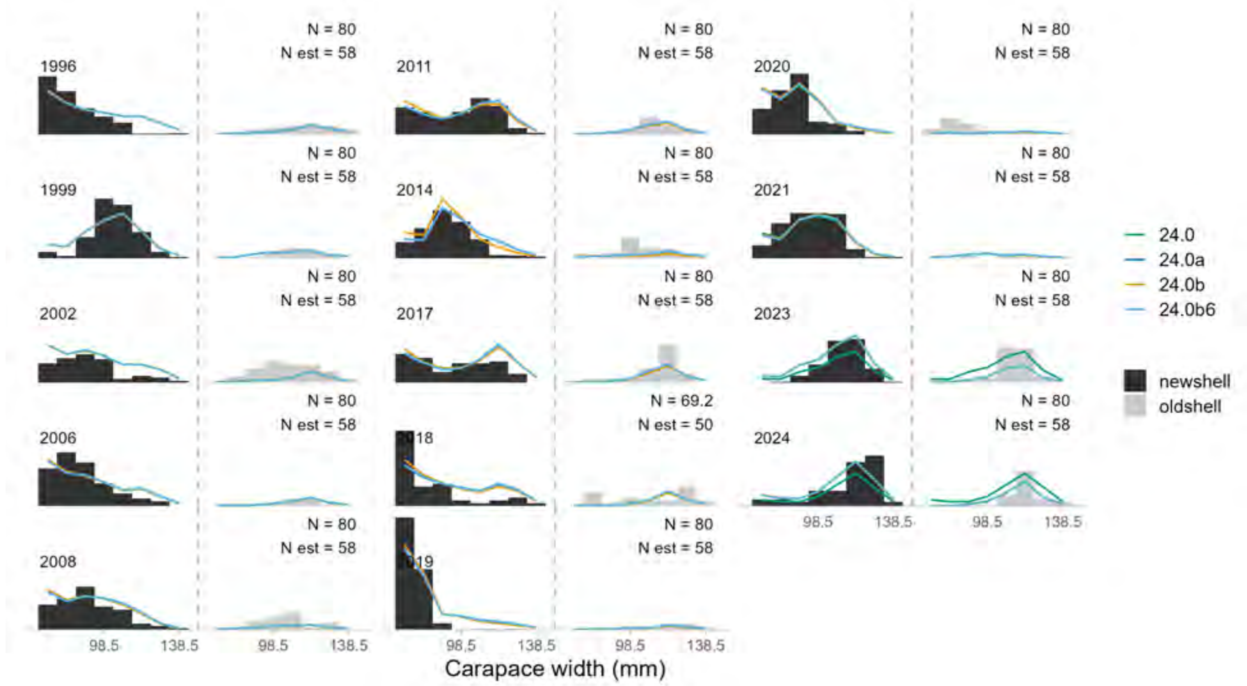


Figure 71: Observed and model-estimated size frequencies of all male red king crab caught in the ADFG trawl survey by year for the models in the bridging analysis: 24.0 (2024 accepted model), 24.0a (24.0 with errors corrected), 24.0b (24.0a transitioned to GMACS 2.20.20), and 24.0b6 (24.0b at the second lowest objective function value). Black bars represent crab classified as newshell and grey bars represent crab classified as oldshell.

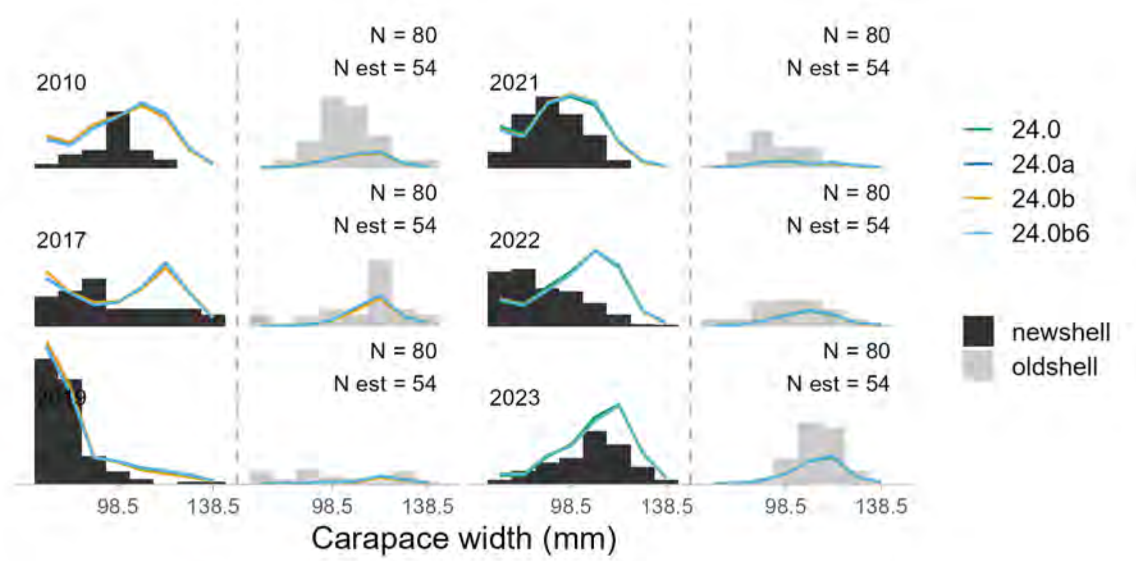


Figure 72: Observed and model-estimated size frequencies of all male red king crab caught in the NBS trawl survey by year for the models in the bridging analysis: 24.0 (2024 accepted model), 24.0a (24.0 with errors corrected), 24.0b (24.0a transitioned to GMACS 2.20.20), and 24.0b6 (24.0b at the second lowest objective function value). Black bars represent crab classified as newshell and grey bars represent crab classified as oldshell.

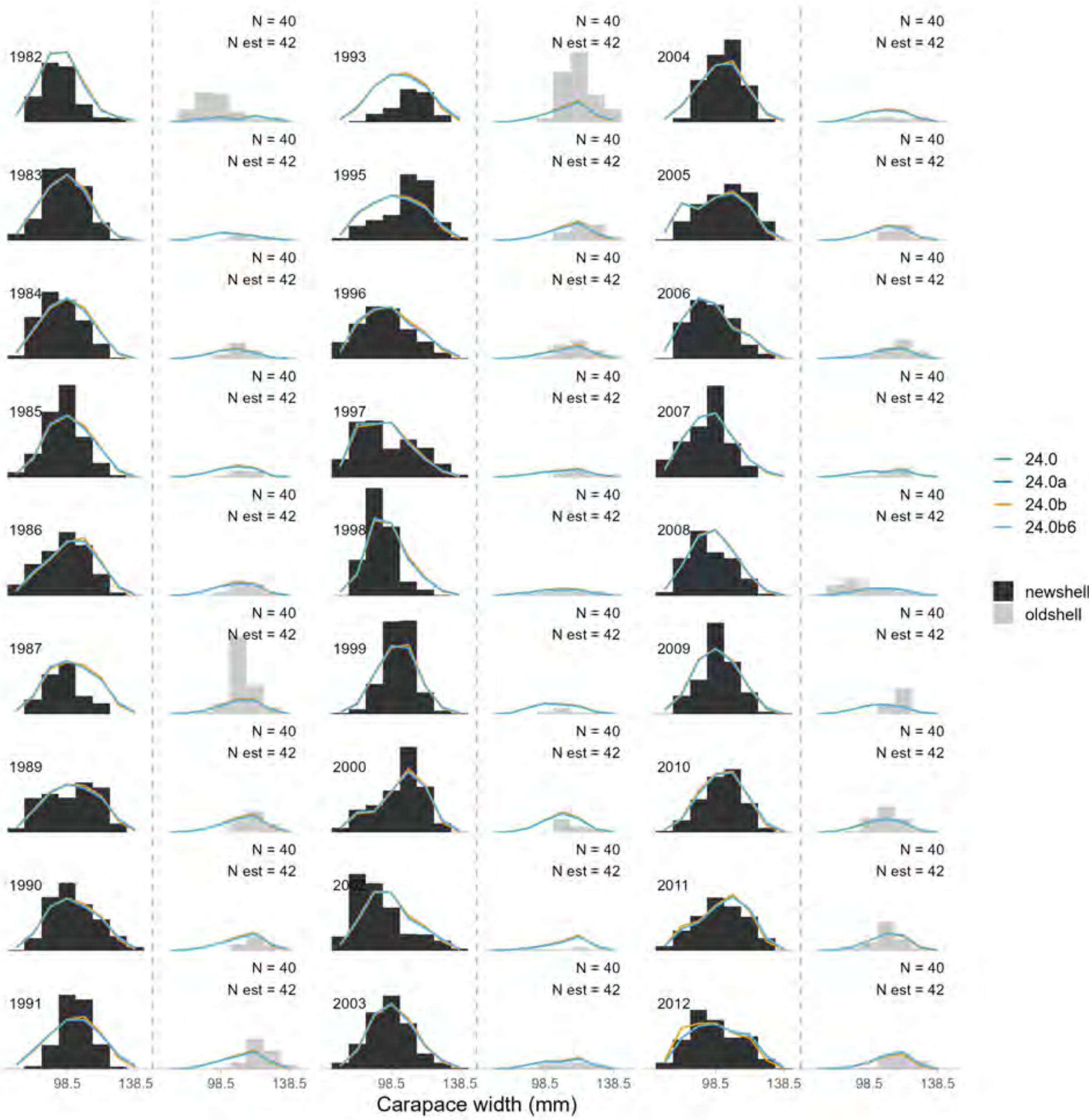


Figure 73: Observed and model-estimated size frequencies of all male red king crab caught in the winter pot survey by year for the models in the bridging analysis: 24.0 (2024 accepted model), 24.0a (24.0 with errors corrected), 24.0b (24.0a transitioned to GMACS 2.20.20), and 24.0b6 (24.0b at the second lowest objective function value). Black bars represent crab classified as newshell and grey bars represent crab classified as oldshell.

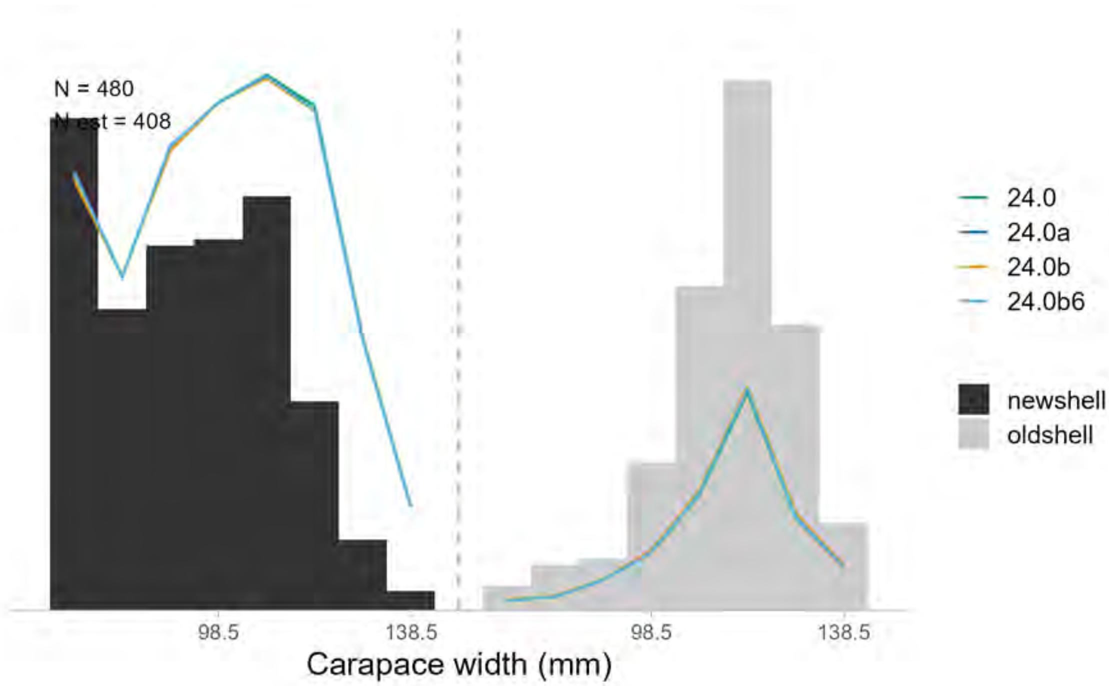


Figure 74: Aggregated observed and model-estimated size frequencies of all male red king crab caught in the NMFS trawl survey for the models in the bridging analysis: 24.0 (2024 accepted model), 24.0a (24.0 with errors corrected), 24.0b (24.0a transitioned to GMACS 2.20.20), and 24.0b6 (24.0b at the second lowest objective function value). Black bars represent crab classified as newshell and grey bars represent crab classified as oldshell.

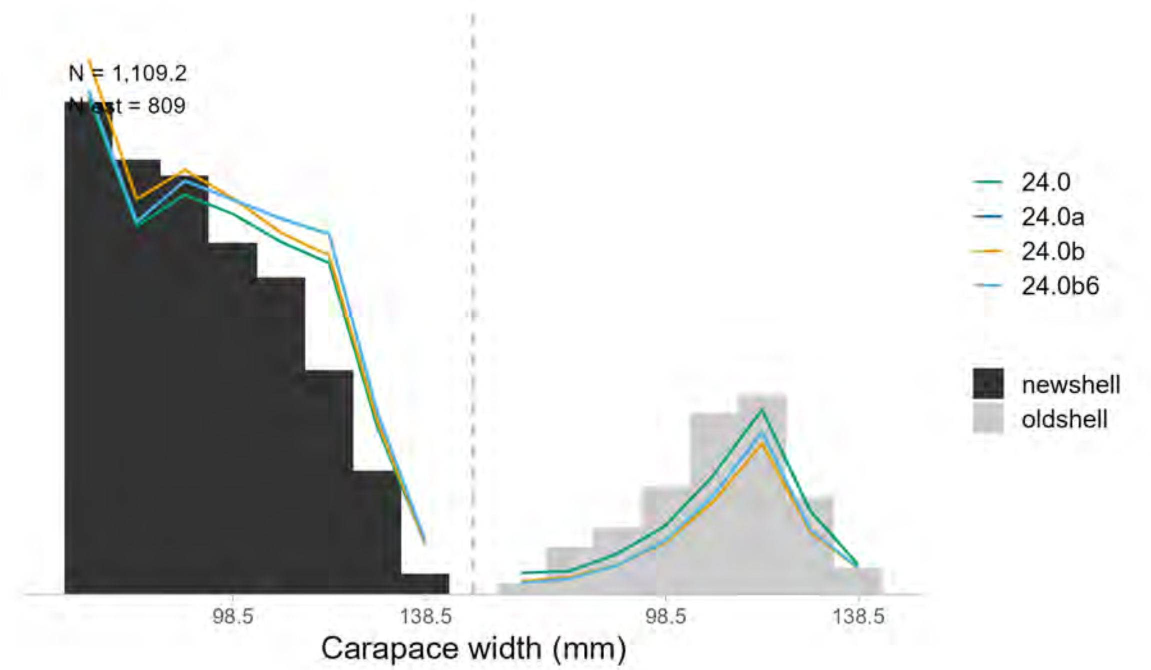


Figure 75: Aggregated observed and model-estimated size frequencies of all male red king crab caught in the ADFG trawl survey for the models in the bridging analysis: 24.0 (2024 accepted model), 24.0a (24.0 with errors corrected), 24.0b (24.0a transitioned to GMACS 2.20.20), and 24.0b6 (24.0b at the second lowest objective function value). Black bars represent crab classified as newshell and grey bars represent crab classified as oldshell.

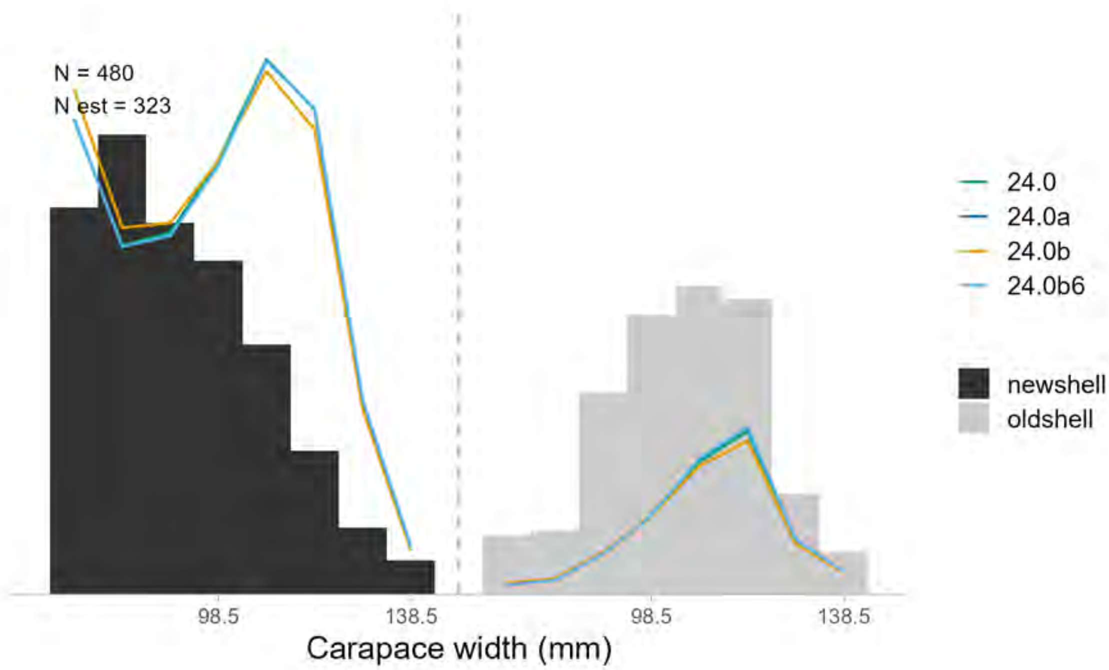


Figure 76: Aggregated observed and model-estimated size frequencies of all male red king crab caught in the NBS trawl survey for the models in the bridging analysis: 24.0 (2024 accepted model), 24.0a (24.0 with errors corrected), 24.0b (24.0a transitioned to GMACS 2.20.20), and 24.0b6 (24.0b at the second lowest objective function value). Black bars represent crab classified as newshell and grey bars represent crab classified as oldshell.

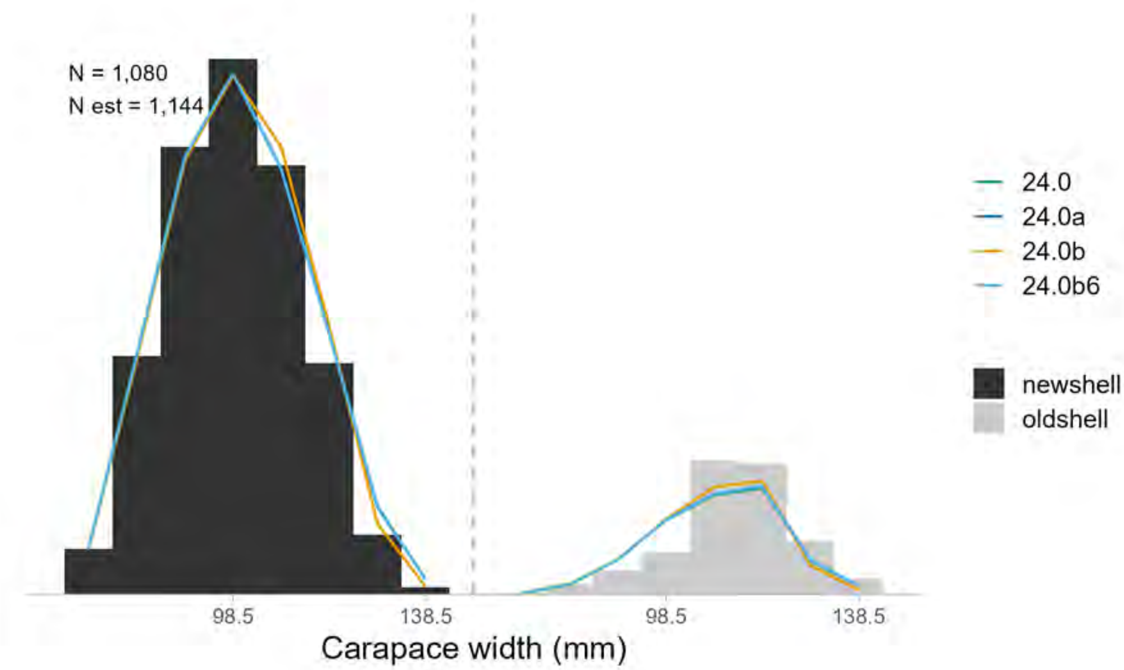


Figure 77: Aggregated observed and model-estimated size frequencies of all male red king crab caught in the winter pot survey for the models in the bridging analysis: 24.0 (2024 accepted model), 24.0a (24.0 with errors corrected), 24.0b (24.0a transitioned to GMACS 2.20.20), and 24.0b6 (24.0b at the second lowest objective function value). Black bars represent crab classified as newshell and grey bars represent crab classified as oldshell.

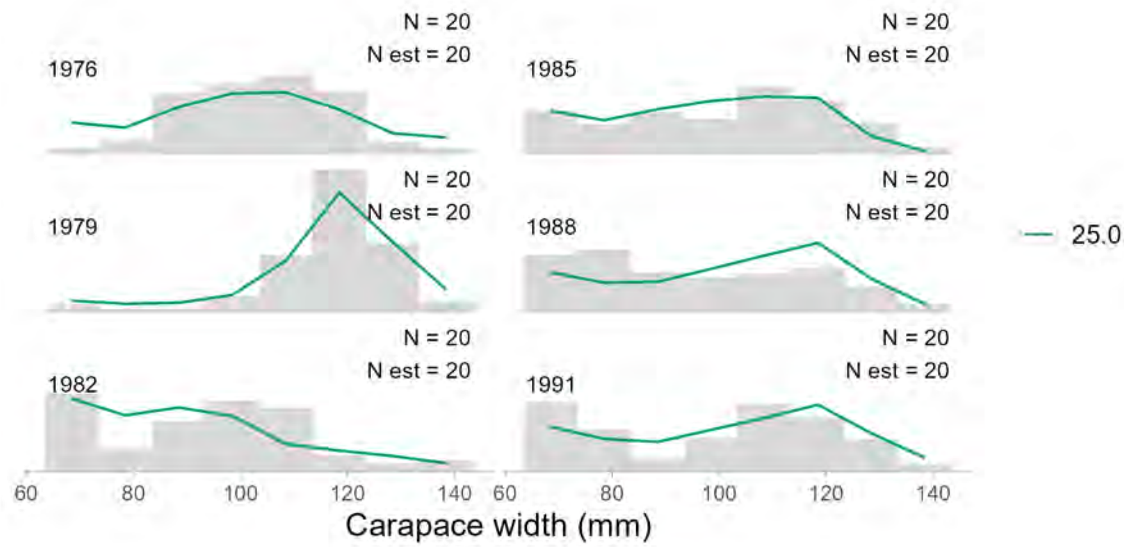


Figure 78: Observed and model-estimated size frequencies of all male red king crab caught in the NMFS trawl survey by year for model 25.0, which is model 24.0b with shell condition excluded.

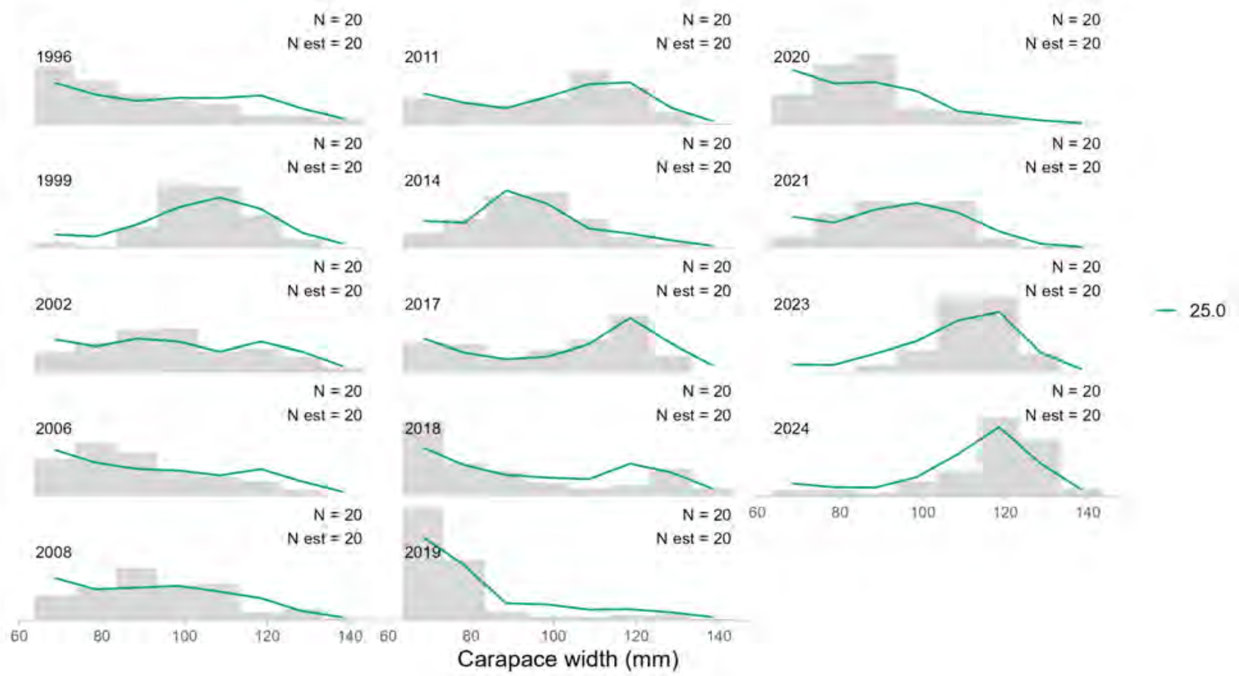


Figure 79: Observed and model-estimated size frequencies of all male red king crab caught in the ADFG trawl survey by year for model 25.0, which is model 24.0b with shell condition excluded.

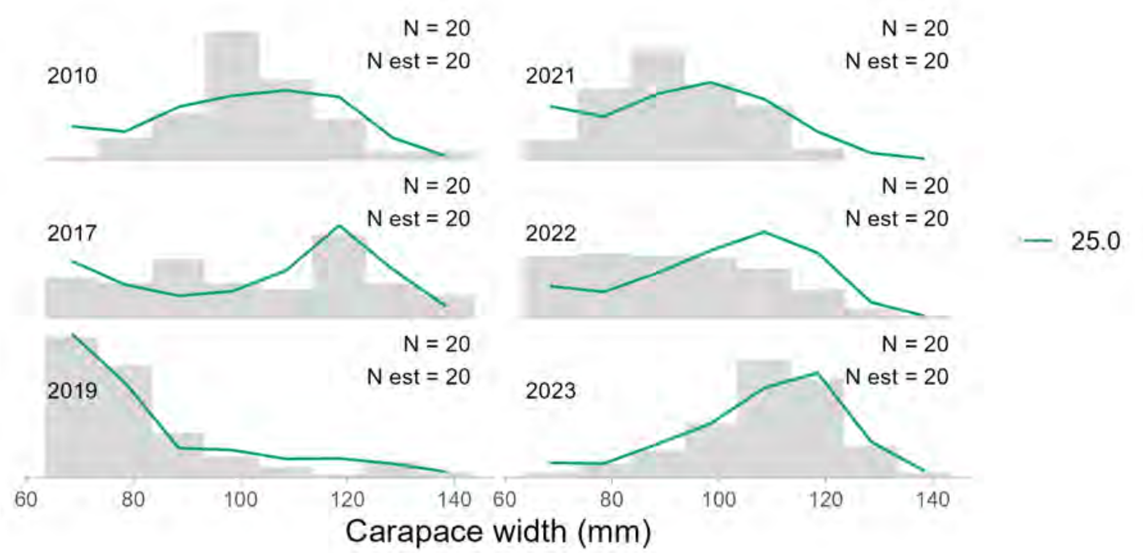


Figure 80: Observed and model-estimated size frequencies of all male red king crab caught in the NBS trawl survey by year for model 25.0, which is model 24.0b with shell condition excluded.

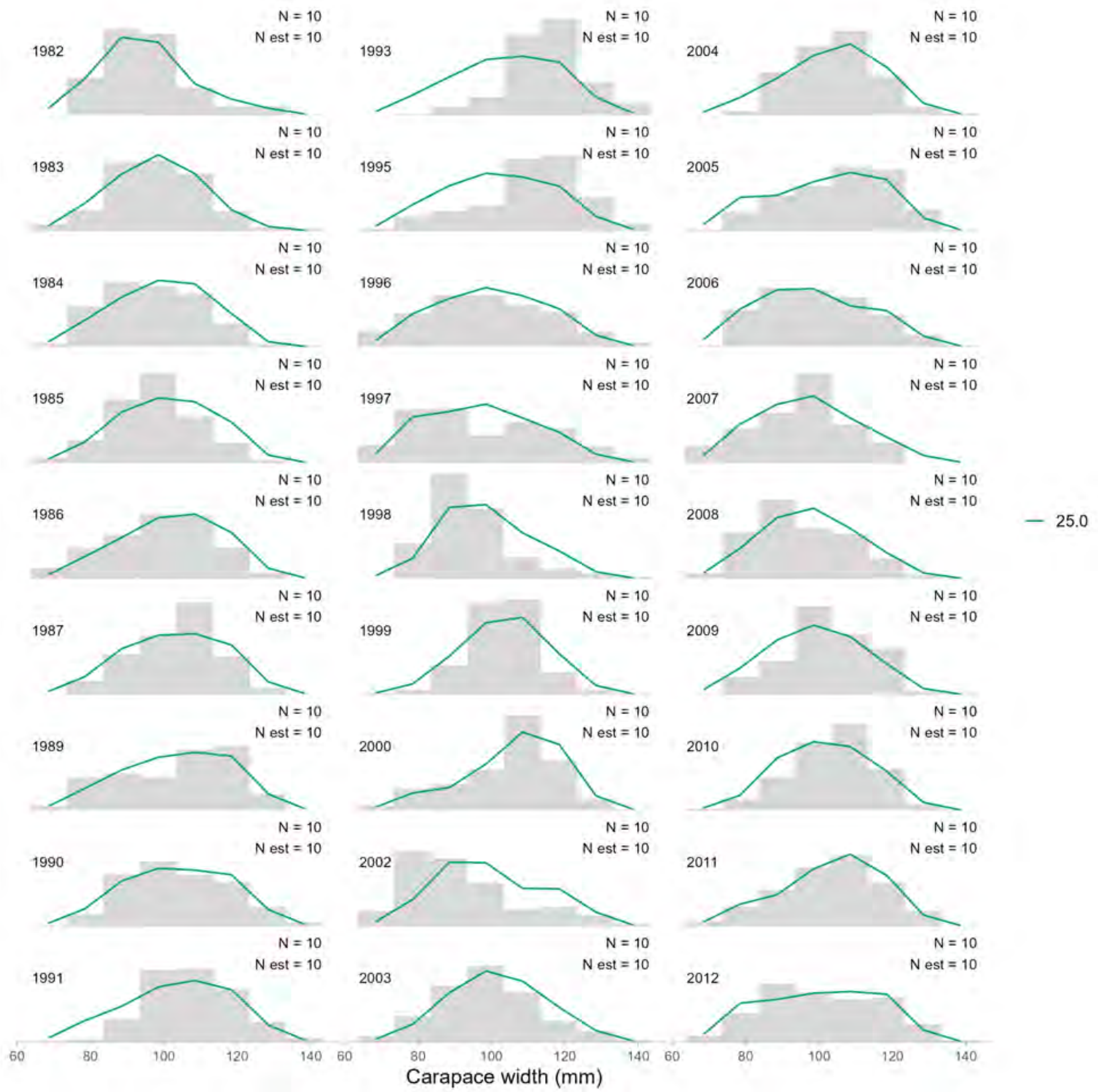


Figure 81: Observed and model-estimated size frequencies of all male red king crab caught in the winter pot survey by year for model 25.0, which is model 24.0b with shell condition excluded.

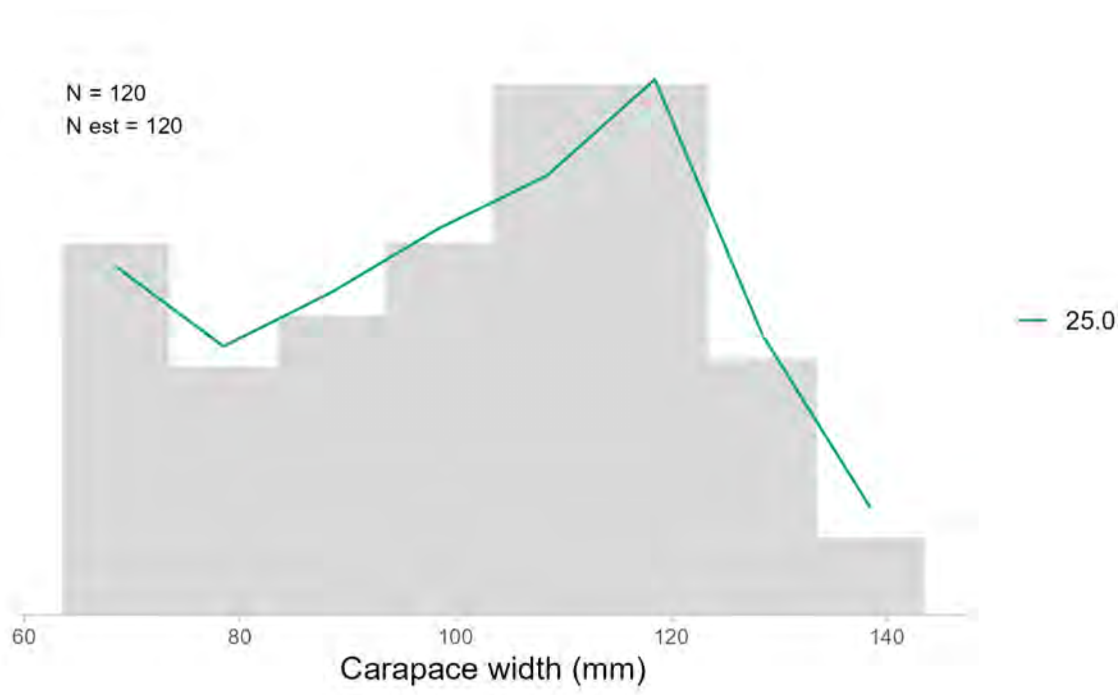


Figure 82: Aggregated observed and model-estimated size frequencies of all male red king crab caught in the NMFS trawl survey by year for model 25.0, which is model 24.0b with shell condition excluded.

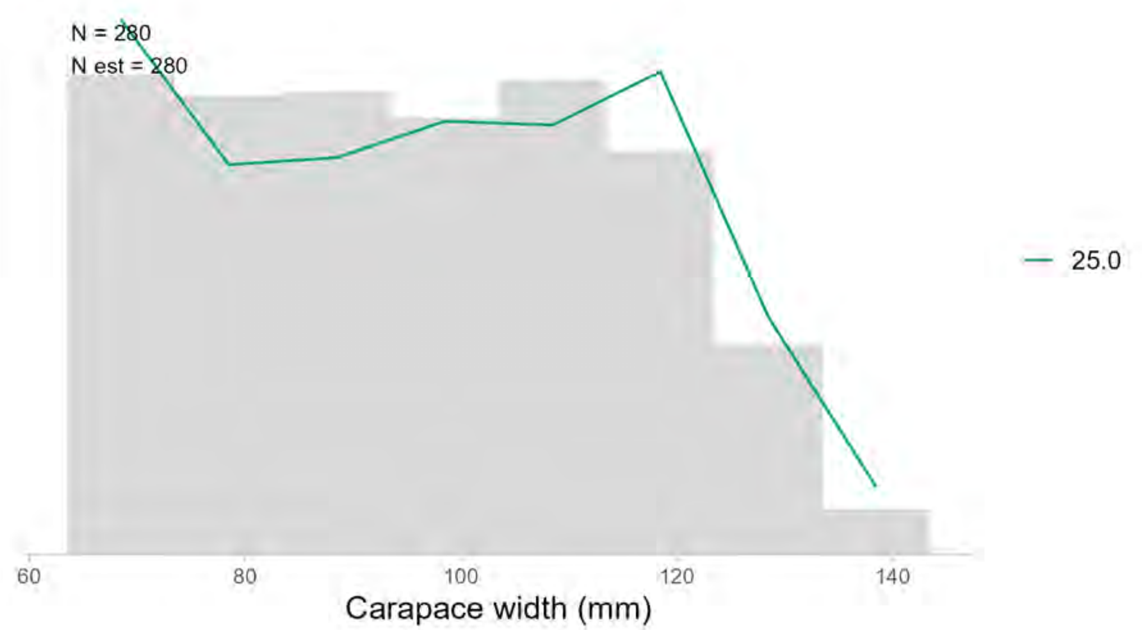


Figure 83: Aggregated observed and model-estimated size frequencies of all male red king crab caught in the ADFG trawl survey by year for model 25.0, which is model 24.0b with shell condition excluded.

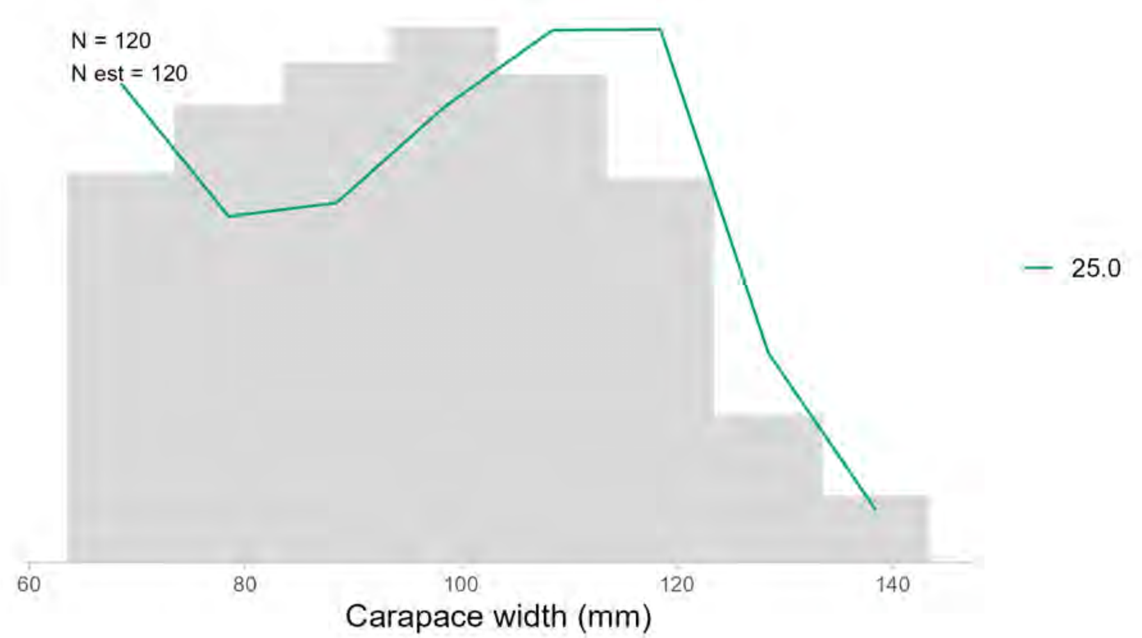


Figure 84: Aggregated observed and model-estimated size frequencies of all male red king crab caught in the NBS trawl survey by year for model 25.0, which is model 24.0b with shell condition excluded.

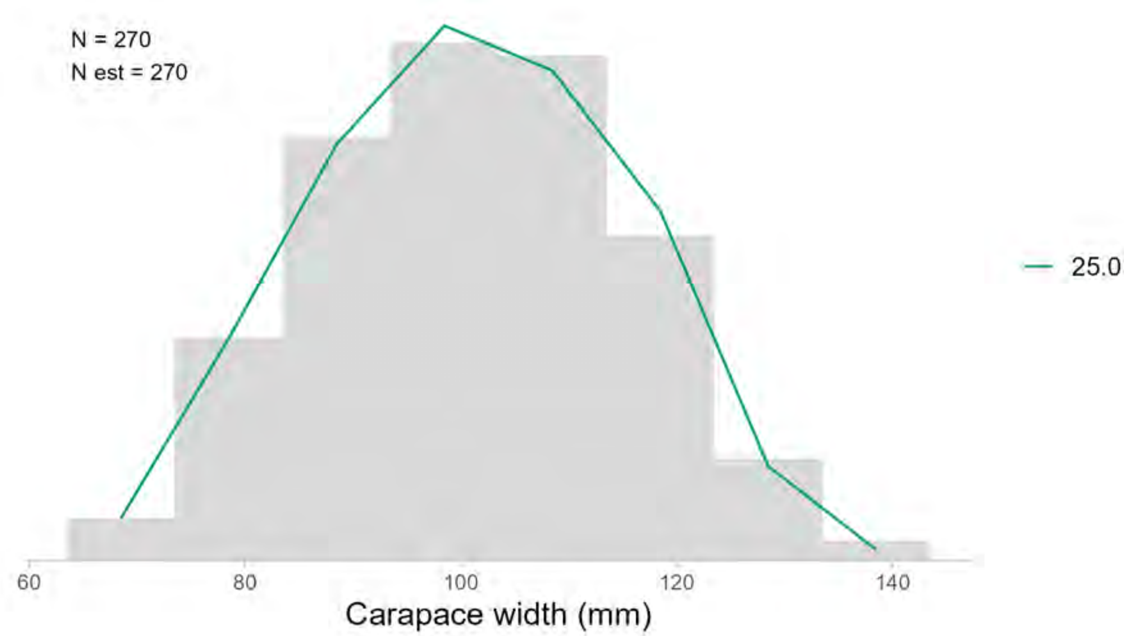


Figure 85: Aggregated observed and model-estimated size frequencies of all male red king crab caught in the winter pot survey by year for model 25.0, which is model 24.0b with shell condition excluded.

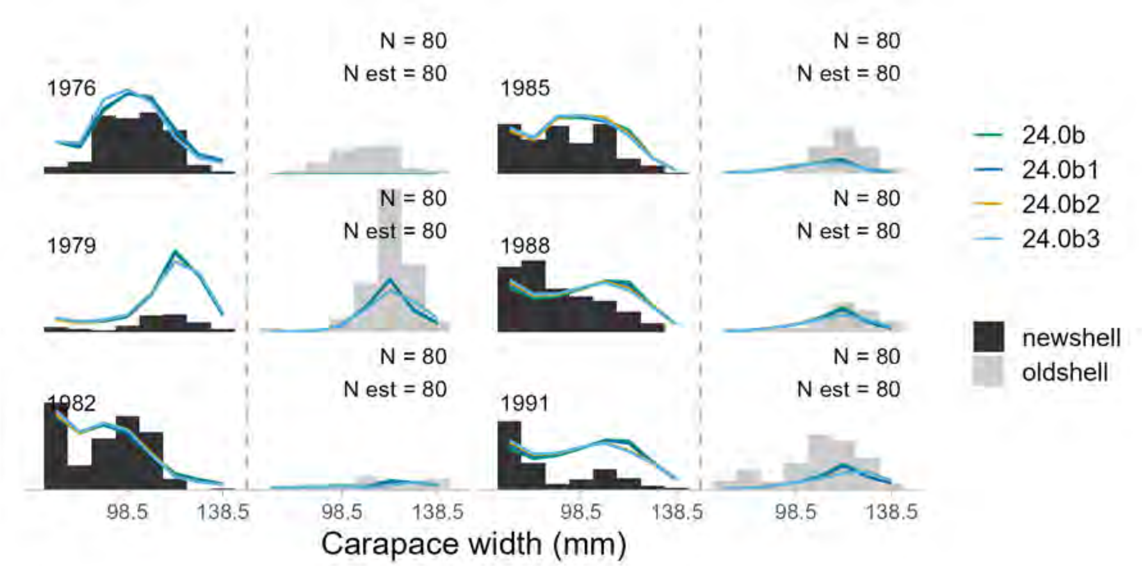


Figure 86: Observed and model-estimated size frequencies of all male red king crab caught in the NMFS trawl survey by year for the new base model (model 24.0b) and three models exploring natural mortality (M). In model 24.0b1, as in model 24.0b, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 24.0b and 0.23 for model 24.0b1. Model 24.0b2 uses a size-independent $M = 0.18$. Model 24.0b3 uses a size-independent $M = 0.23$. Black bars represent crab classified as newshell and grey bars represent crab classified as oldshell.

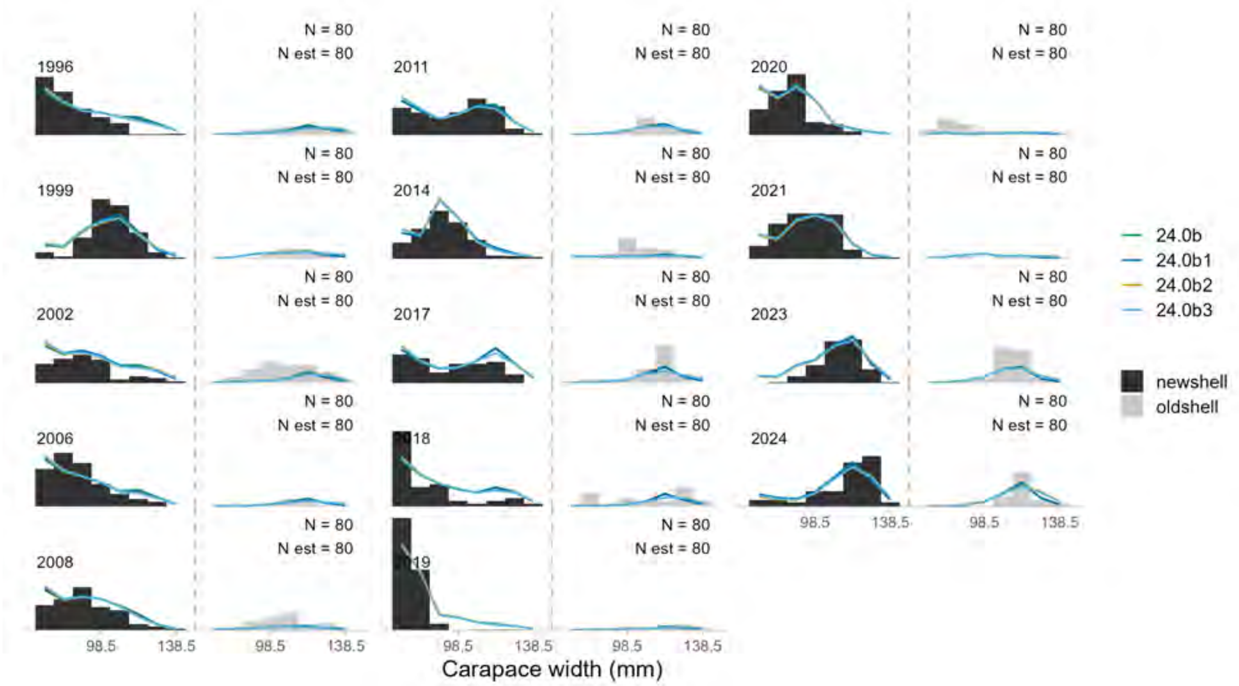


Figure 87: Observed and model-estimated size frequencies of all male red king crab caught in the ADFG trawl survey by year for the new base model (model 24.0b) and three models exploring natural mortality (M). In model 24.0b1, as in model 24.0b, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 24.0b and 0.23 for model 24.0b1. Model 24.0b2 uses a size-independent $M = 0.18$. Model 24.0b3 uses a size-independent $M = 0.23$. Black bars represent crab classified as newshell and grey bars represent crab classified as oldshell.

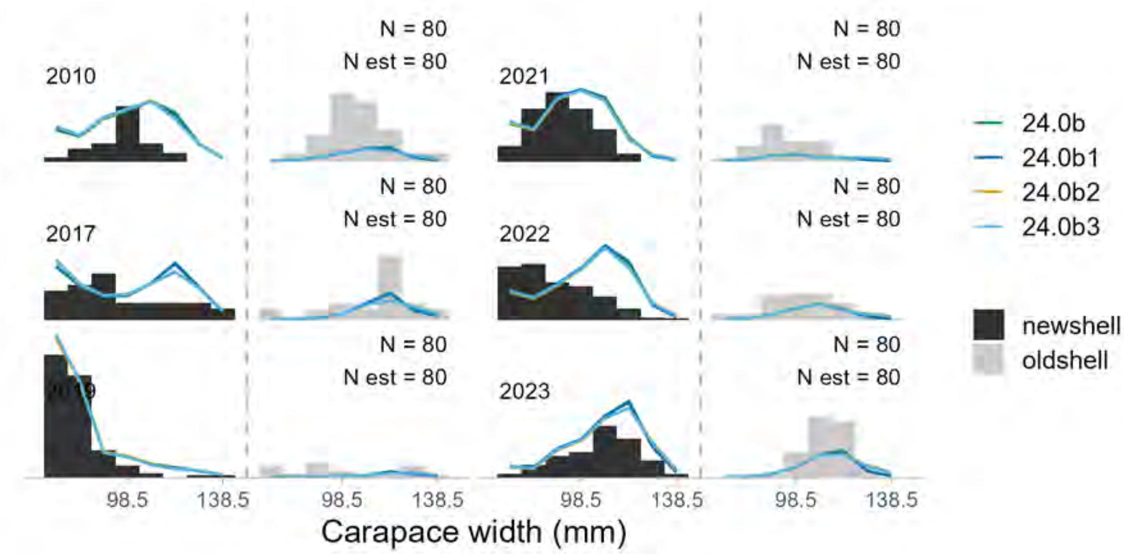


Figure 88: Observed and model-estimated size frequencies of all male red king crab caught in the NBS trawl survey by year for the new base model (model 24.0b) and three models exploring natural mortality (M). In model 24.0b1, as in model 24.0b, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 24.0b and 0.23 for model 24.0b1. Model 24.0b2 uses a size-independent $M = 0.18$. Model 24.0b3 uses a size-independent $M = 0.23$. Black bars represent crab classified as newshell and grey bars represent crab classified as oldshell.

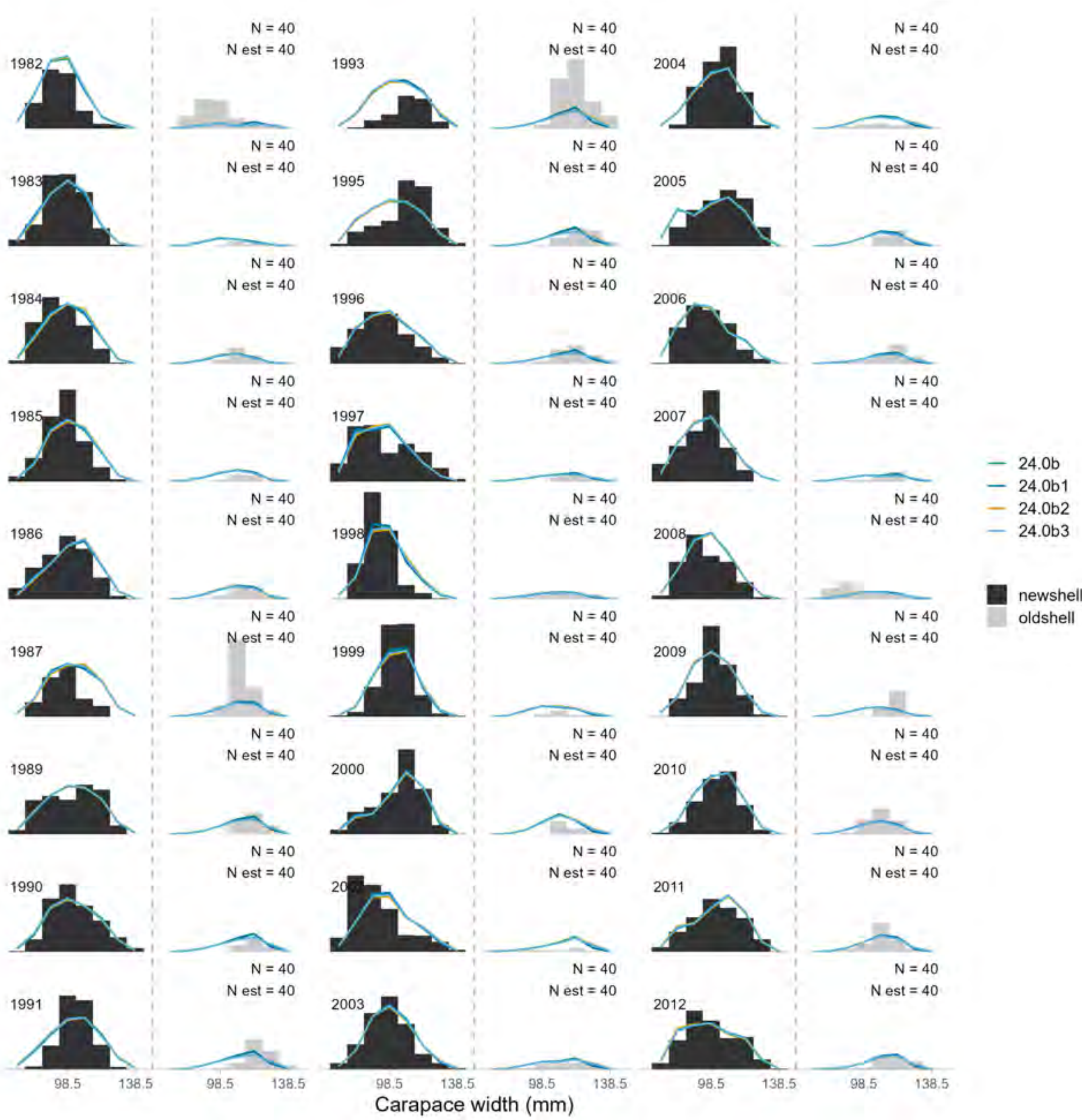


Figure 89: Observed and model-estimated size frequencies of all male red king crab caught in the winter pot survey by year for the new base model (model 24.0b) and three models exploring natural mortality (M). In model 24.0b1, as in model 24.0b, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 24.0b and 0.23 for model 24.0b1. Model 24.0b2 uses a size-independent M = 0.18. Model 24.0b3 uses a size-independent M = 0.23. Black bars represent crab classified as newshell and grey bars represent crab classified as oldshell.

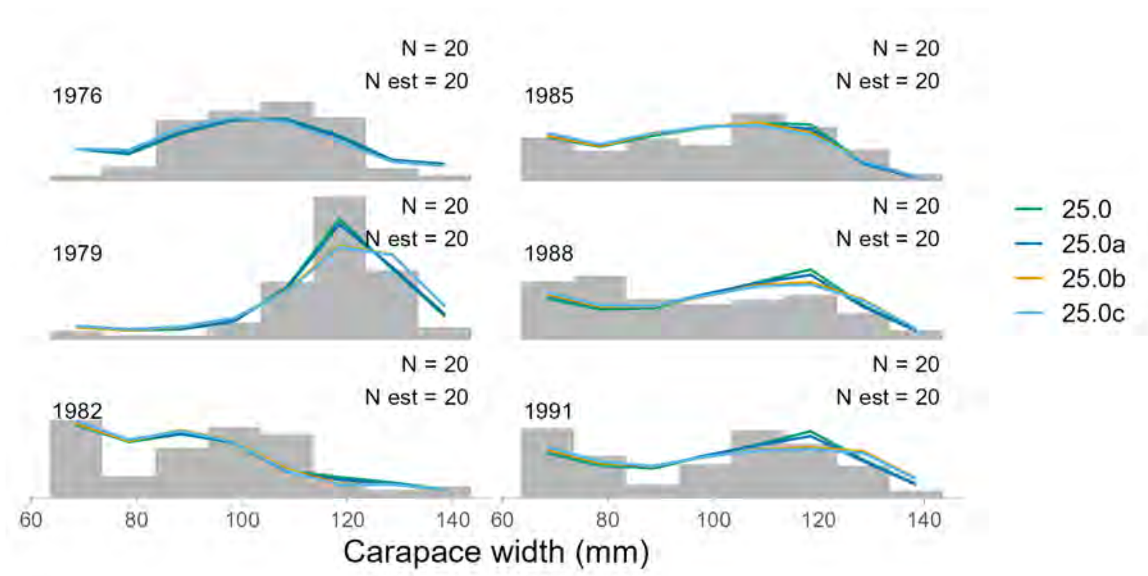


Figure 90: Observed and model-estimated size frequencies of all male red king crab caught in the NMFS trawl survey by year for the model with shell condition excluded (model 25.0) and three models exploring natural mortality (M). In model 25.0a, as in model 25.0, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 25.0 and 0.23 for model 25.0a. Model 25.0b uses a size-independent $M = 0.18$. Model 25.0c uses a size-independent $M = 0.23$.

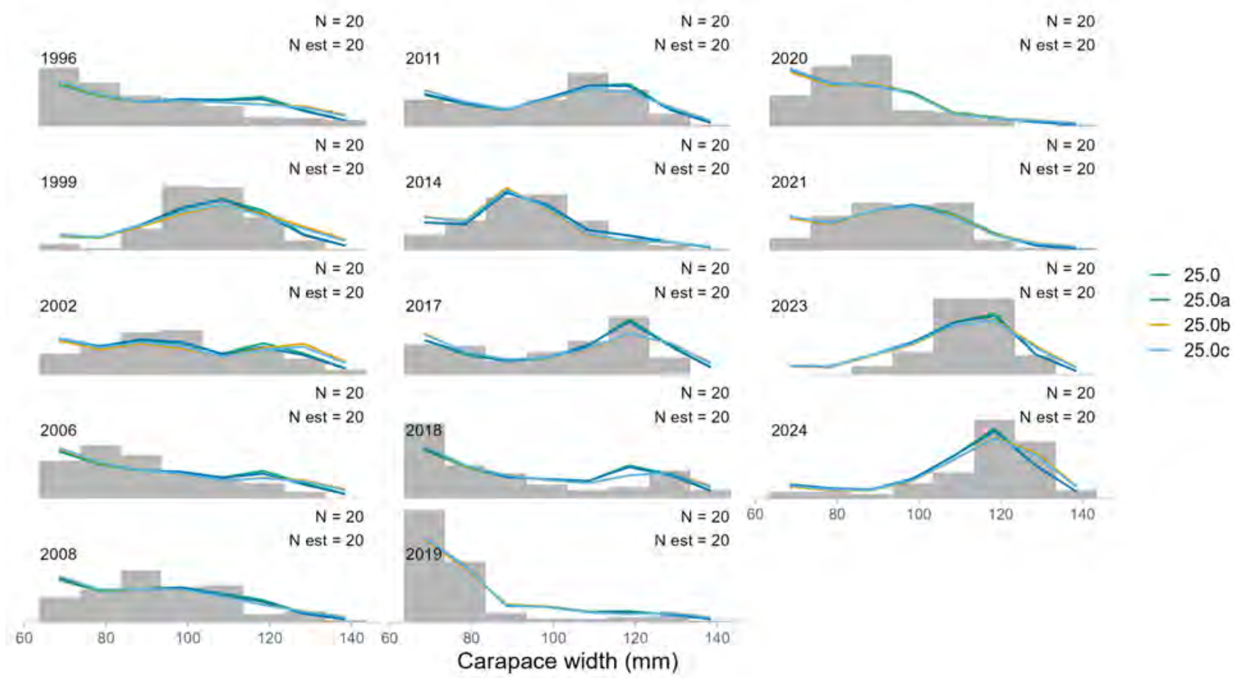


Figure 91: Observed and model-estimated size frequencies of all male red king crab caught in the ADFG trawl survey by year for the model with shell condition excluded (model 25.0) and three models exploring natural mortality (M). In model 25.0a, as in model 25.0, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 25.0 and 0.23 for model 25.0a. Model 25.0b uses a size-independent $M = 0.18$. Model 25.0c uses a size-independent $M =$ 0.23.

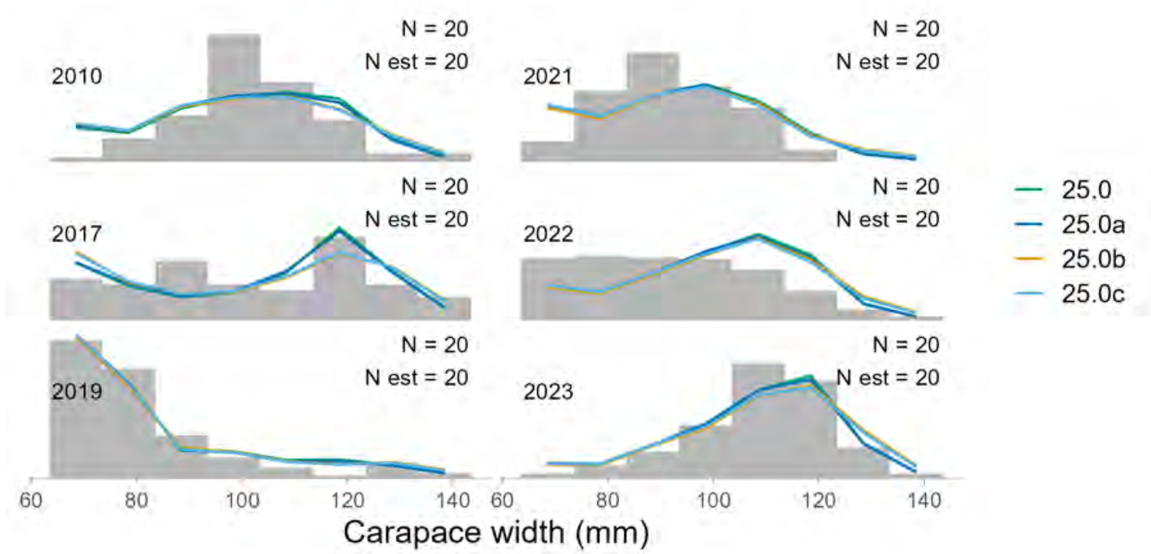


Figure 92: Observed and model-estimated size frequencies of all male red king crab caught in the NBS trawl survey by year for the model with shell condition excluded (model 25.0) and three models exploring natural mortality (M). In model 25.0a, as in model 25.0, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 25.0 and 0.23 for model 25.0a. Model 25.0b uses a size-independent $M = 0.18$. Model 25.0c uses a size-independent $M = 0.23$.

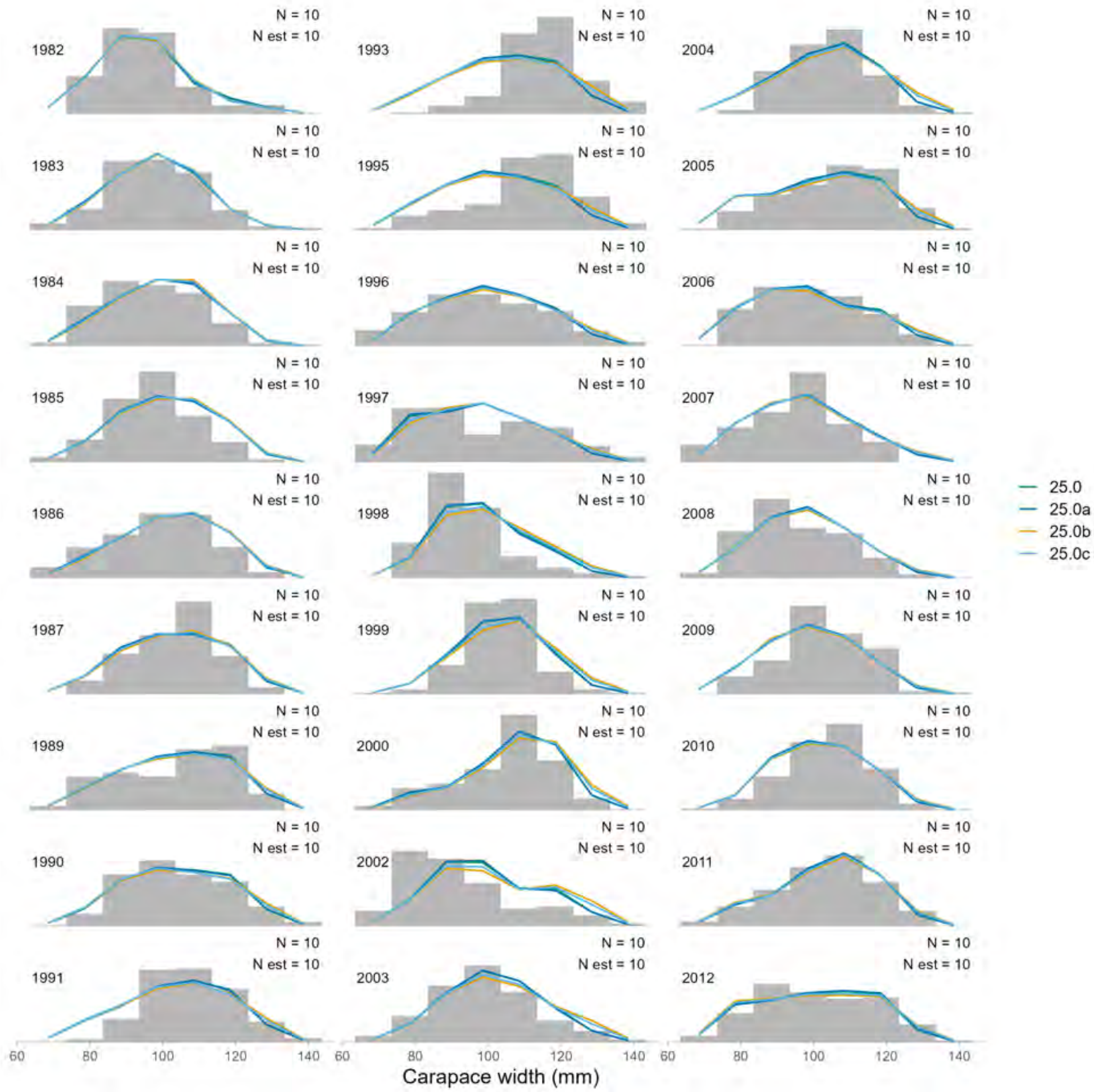


Figure 93: Observed and model-estimated size frequencies of all male red king crab caught in the winter pot survey by year for the model with shell condition excluded (model 25.0) and three models exploring natural mortality (M). In model 25.0a, as in model 25.0, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 25.0 and 0.23 for model 25.0a. Model 25.0b uses a size-independent $M = 0.18$. Model 25.0c uses a size-independent $M = 0.23$. Black bars represent crab classified as newshell and grey bars represent crab classified as oldshell.

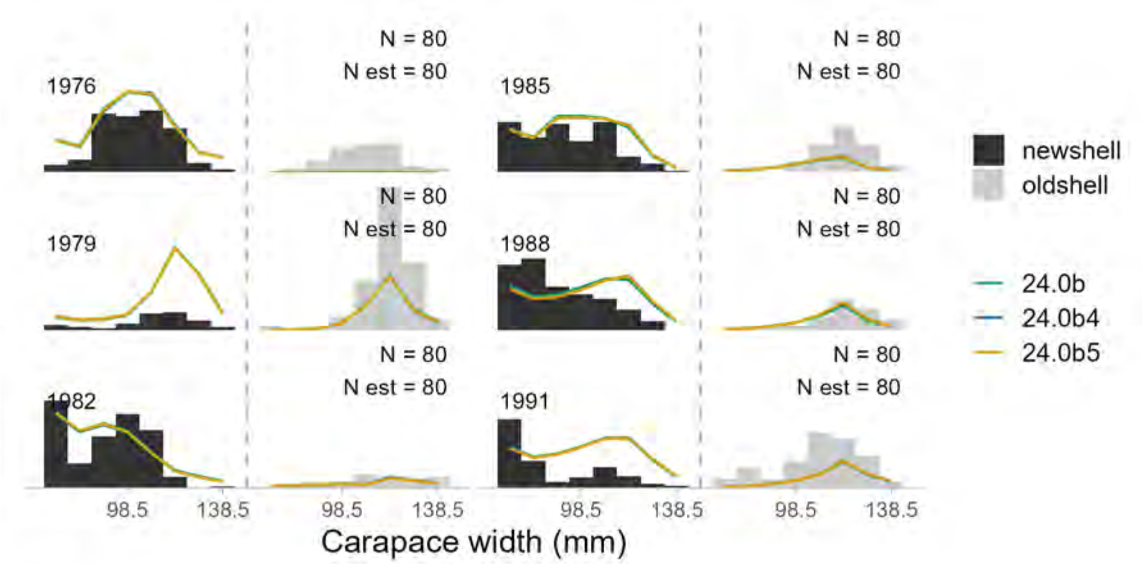


Figure 94: Observed and model-estimated size frequencies of all male red king crab caught in the NMFS trawl survey by year for the new base model (model 24.0b) and models using spatiotemporal model-based rather than design-based indices of abundance for the three trawl surveys. In model 24.0b4, abundance is estimated over the full area covered by all three surveys while, in model 24.0b5, abundance is estimated over the reduced area covered by the ADF&G trawl survey since 2010. Black bars represent crab classified as newshell and grey bars represent crab classified as oldshell.

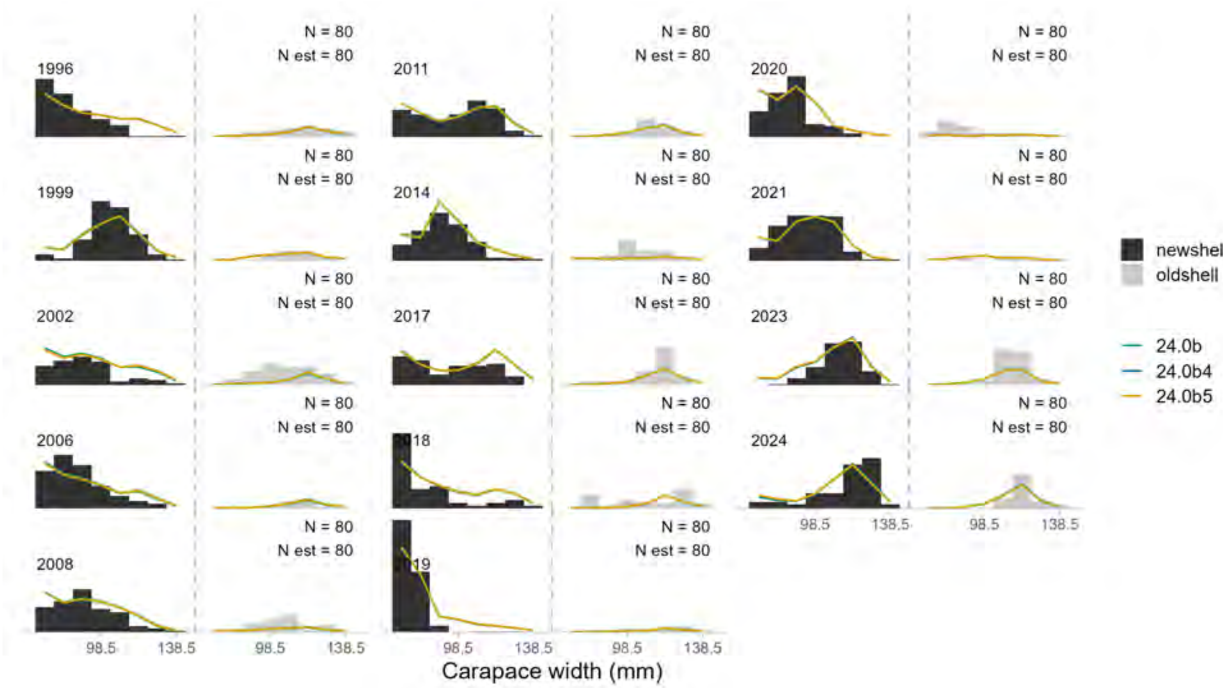


Figure 95: Observed and model-estimated size frequencies of all male red king crab caught in the ADFG trawl survey by year for the new base model (model 24.0b) and models using spatiotemporal model-based rather than design-based indices of abundance for the three trawl surveys. In model 24.0b4, abundance is estimated over the full area covered by all three surveys while, in model 24.0b5, abundance is estimated over the reduced area covered by the ADF&G trawl survey since 2010. Black bars represent crab classified as newshell and grey bars represent crab classified as oldshell.

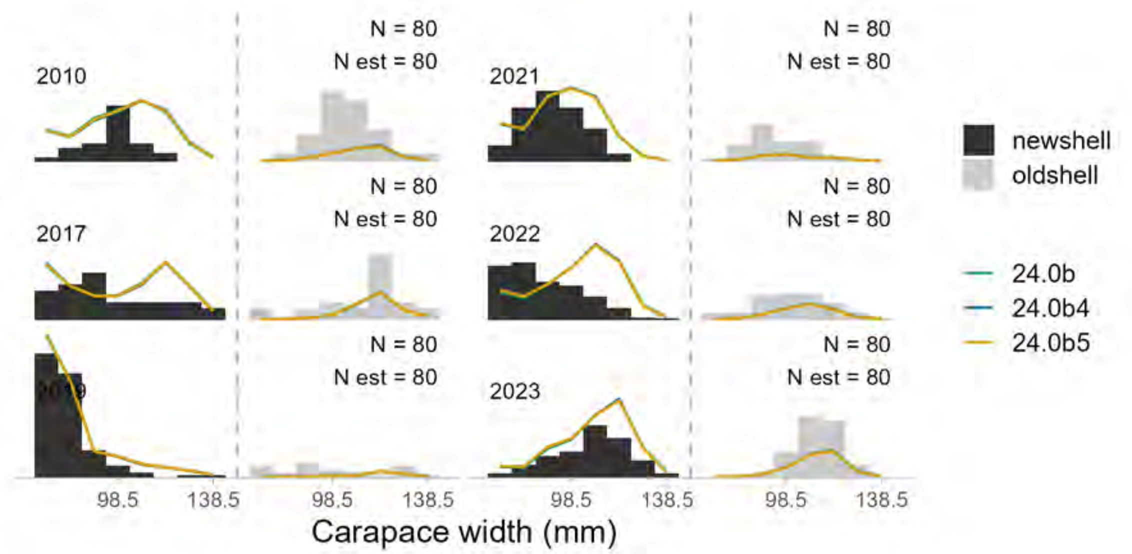


Figure 96: Observed and model-estimated size frequencies of all male red king crab caught in the NBS trawl survey by year for the new base model (model 24.0b) and models using spatiotemporal model-based rather than design-based indices of abundance for the three trawl surveys. In model 24.0b4, abundance is estimated over the full area covered by all three surveys while, in model 24.0b5, abundance is estimated over the reduced area covered by the ADF&G trawl survey since 2010. Black bars represent crab classified as newshell and grey bars represent crab classified as oldshell.

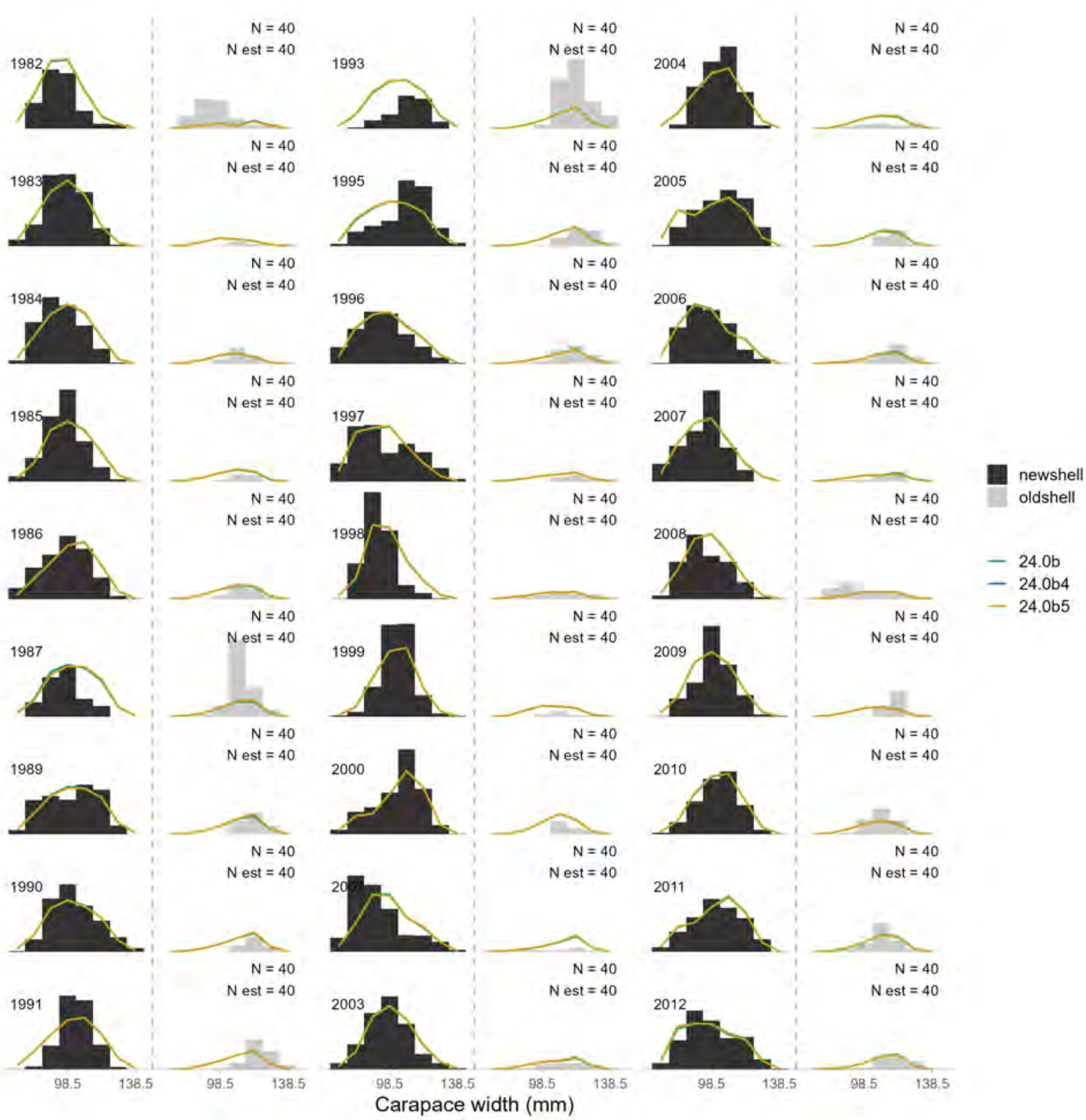


Figure 97: Observed and model-estimated size frequencies of all male red king crab caught in the winter pot survey by year for the new base model (model 24.0b) and models using spatiotemporal model-based rather than design-based indices of abundance for the three trawl surveys. In model 24.0b4, abundance is estimated over the full area covered by all three surveys while, in model 24.0b5, abundance is estimated over the reduced area covered by the ADF&G trawl survey since 2010. Black bars represent crab classified as newshell and grey bars represent crab classified as oldshell.

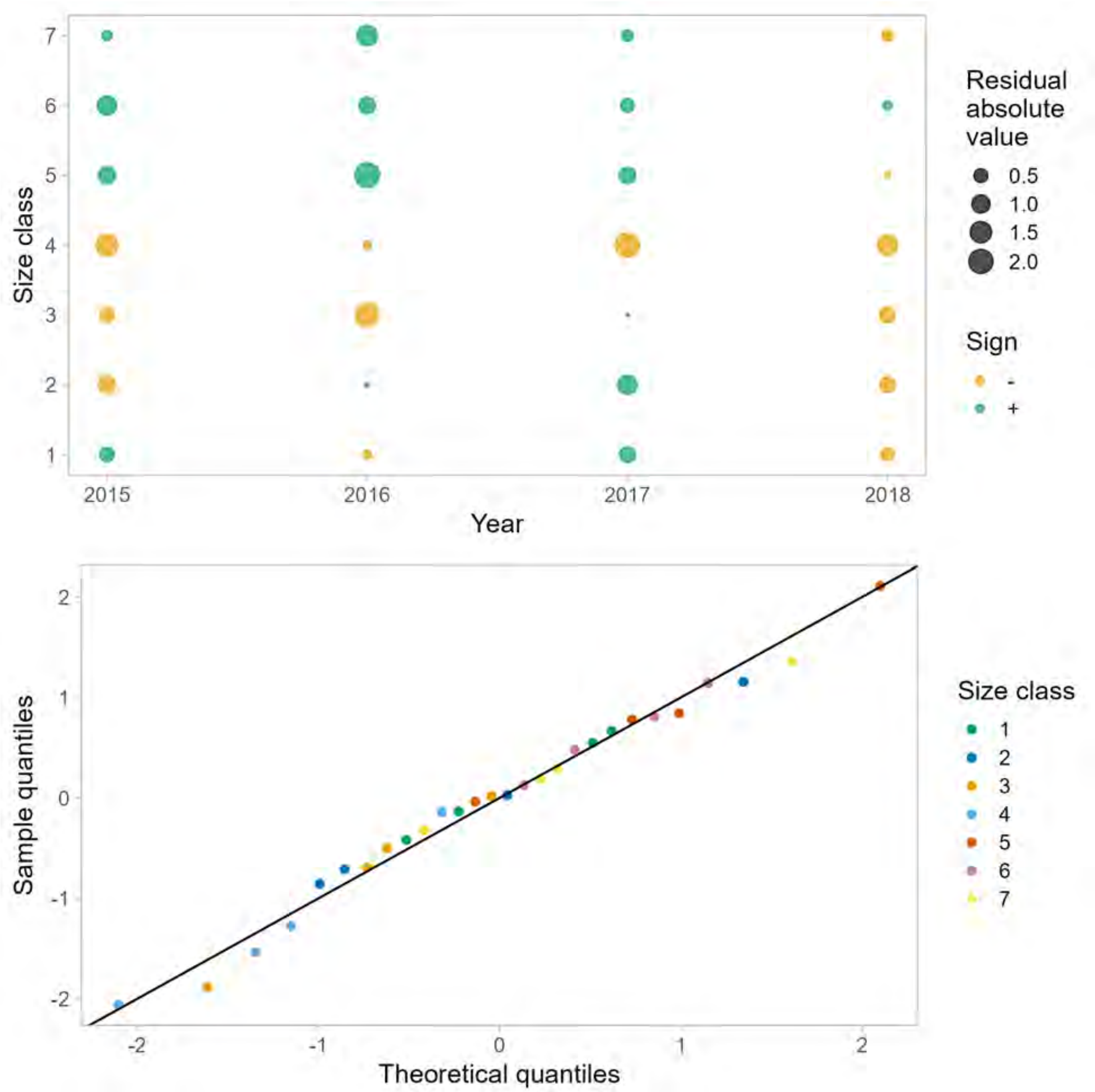


Figure 98: One-Step-Ahead residuals for model 24.0b fits to newshell male size composition data from the winter commercial fishery retained catch.

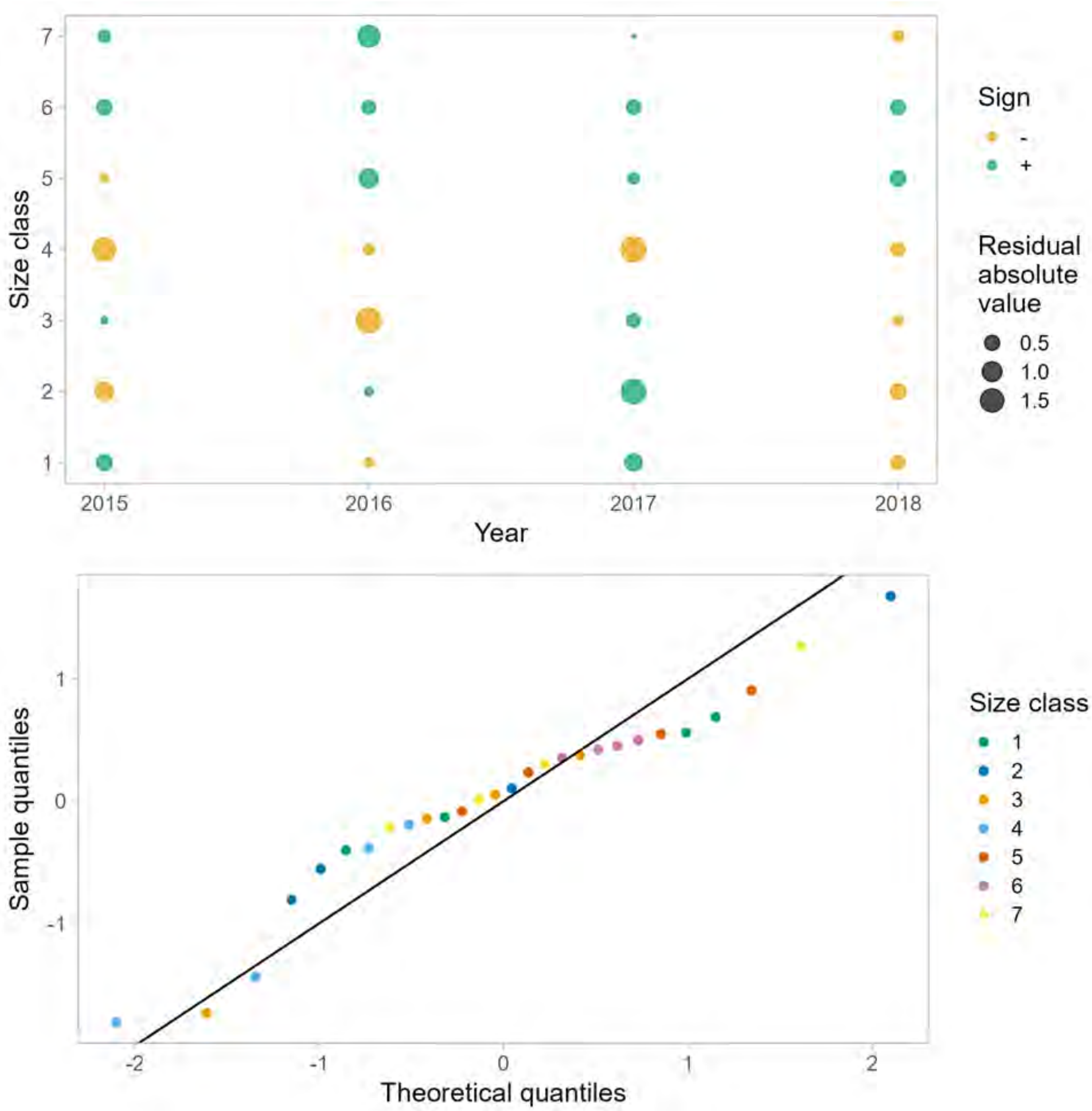


Figure 99: One-Step-Ahead residuals for model 24.0b fits to oldshell male size composition data from the winter commercial fishery retained catch.

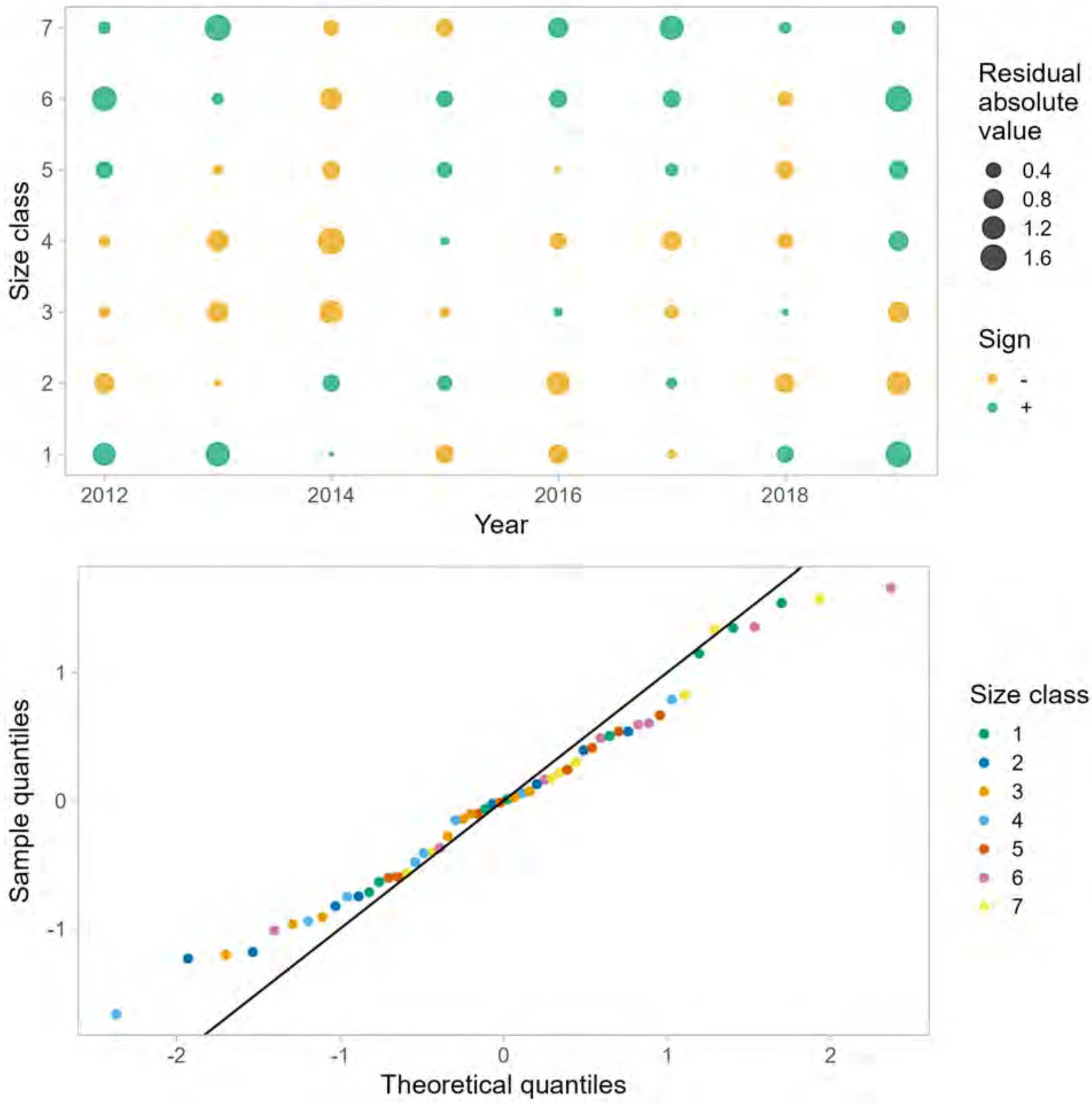


Figure 100: One-Step-Ahead residuals for model 24.0b fits to newshell male size composition data from the summer commercial fishery total catch.

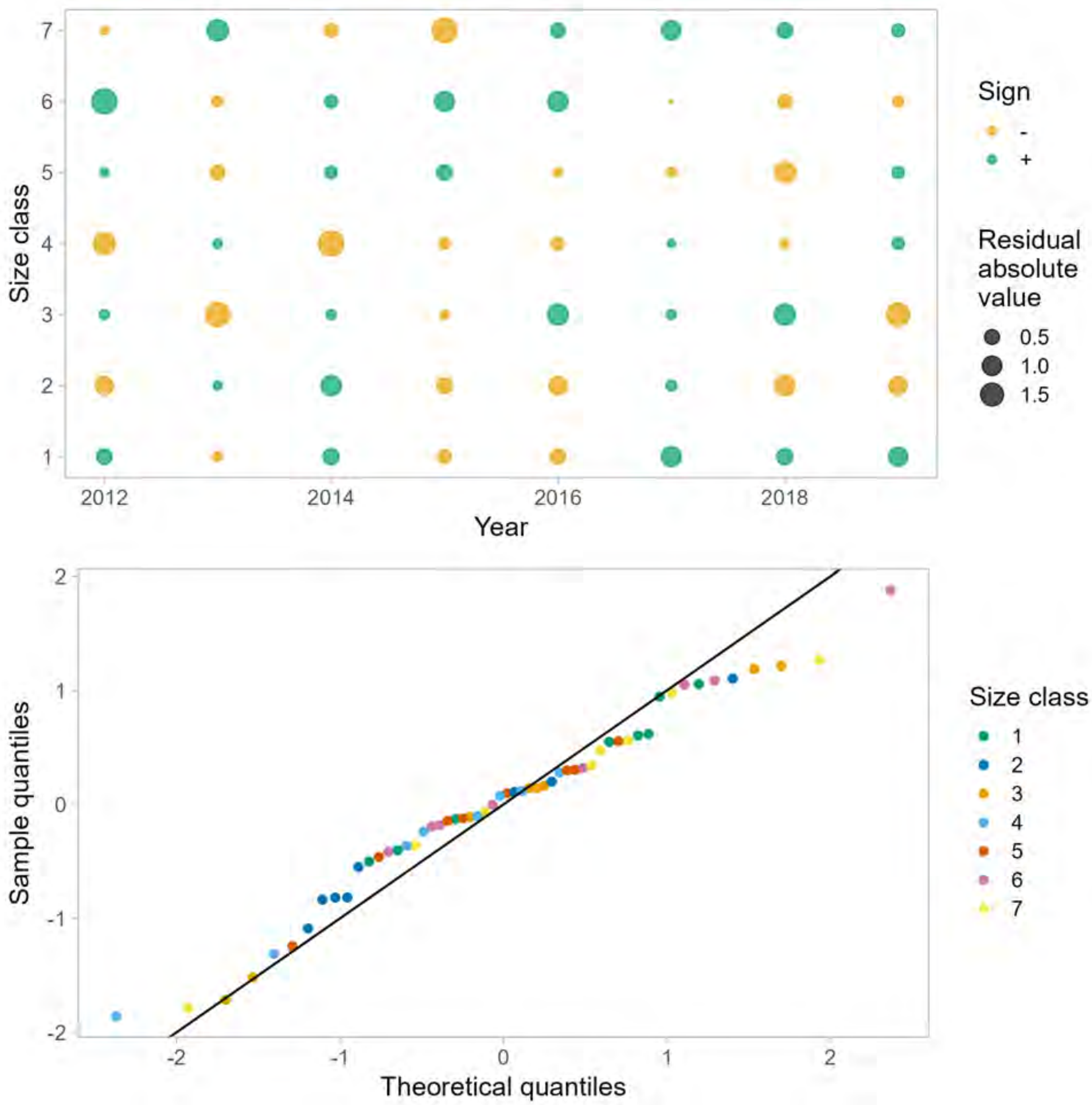


Figure 101: One-Step-Ahead residuals for model 24.0b fits to oldshell male size composition data from the summer commercial fishery total catch.

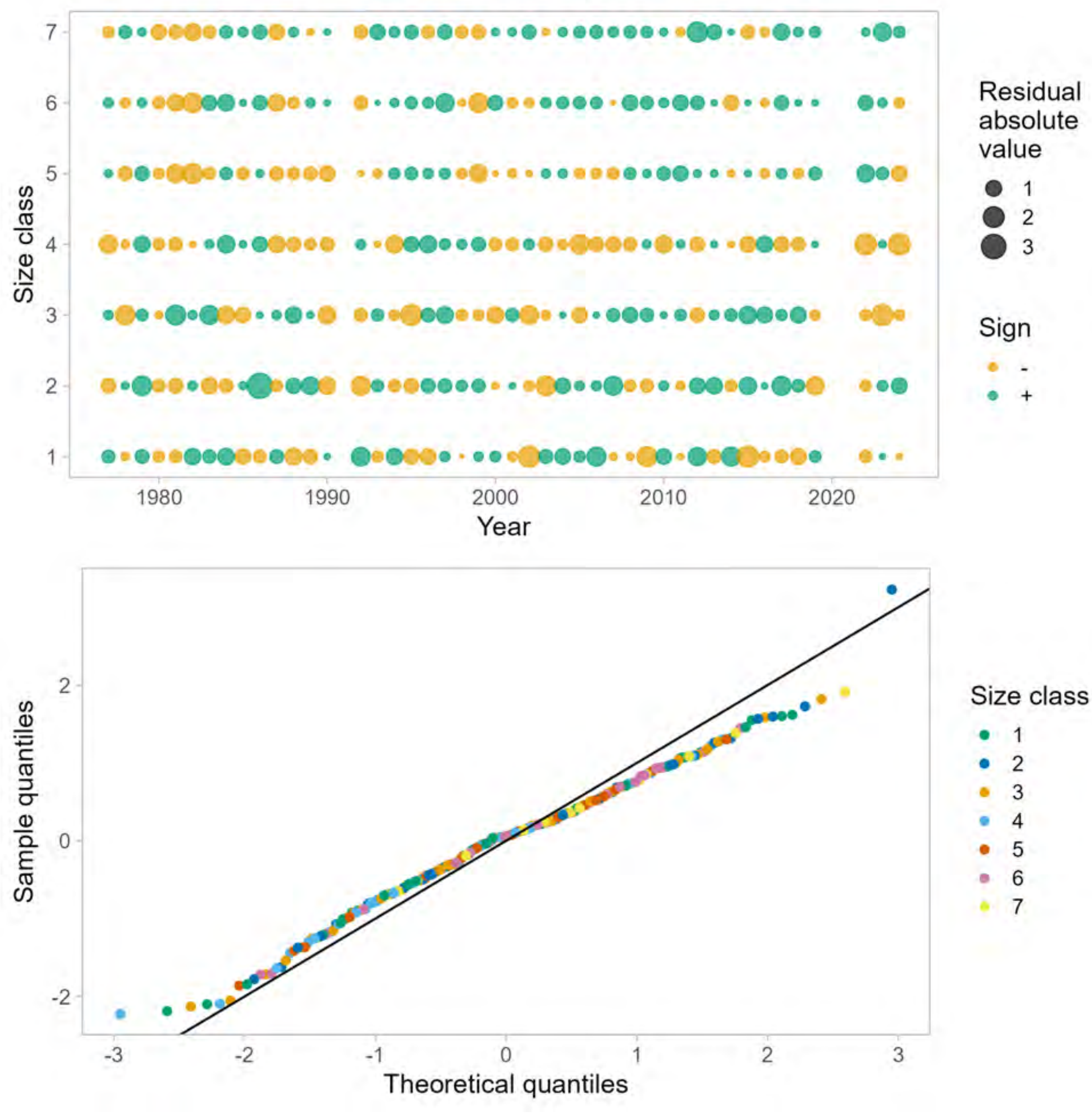


Figure 102: One-Step-Ahead residuals for model 24.0b fits to newshell male size composition data from the summer commercial fishery retained catch.

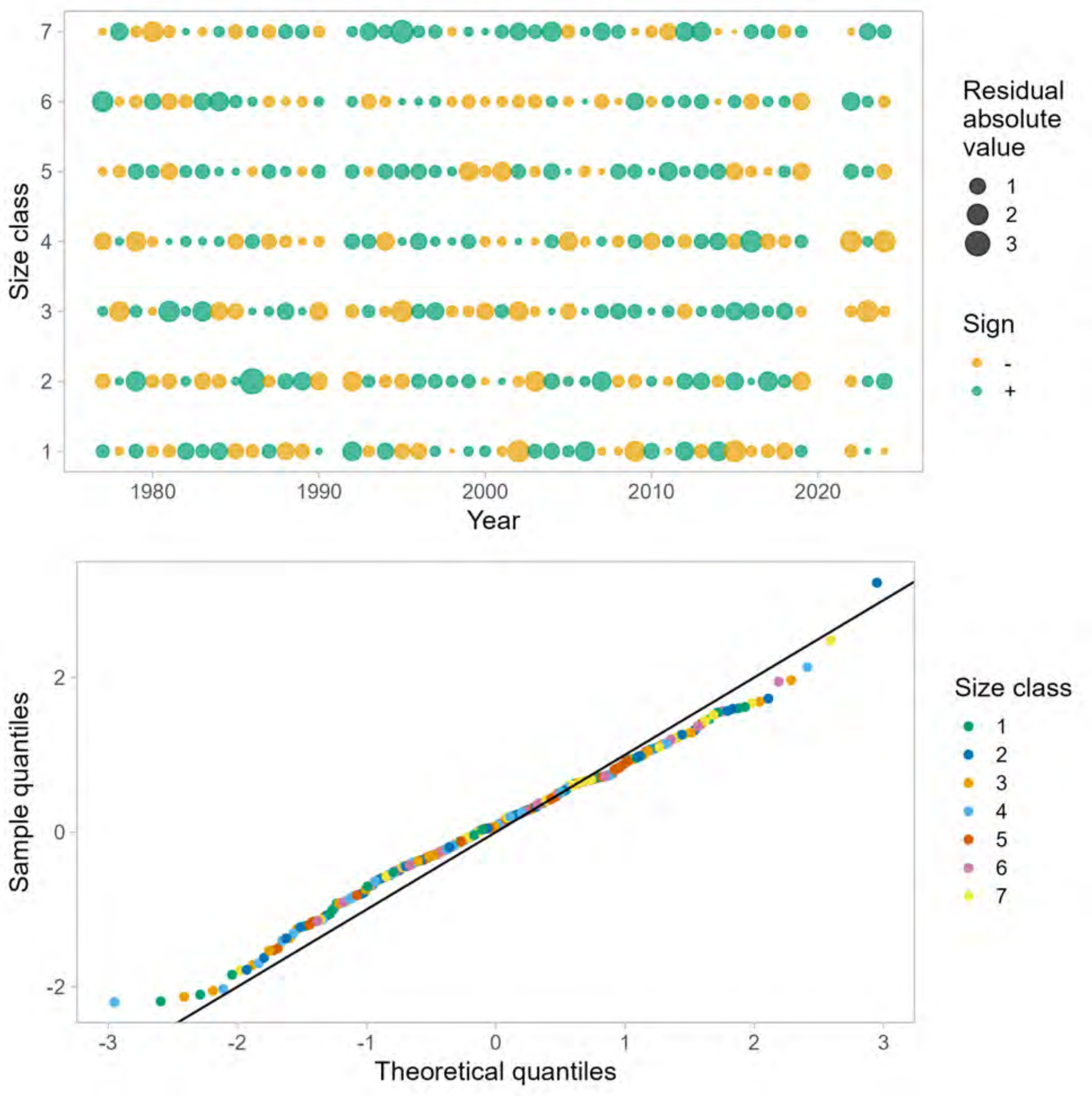


Figure 103: One-Step-Ahead residuals for model 24.0b fits to oldshell male size composition data from the summer commercial fishery retained catch.

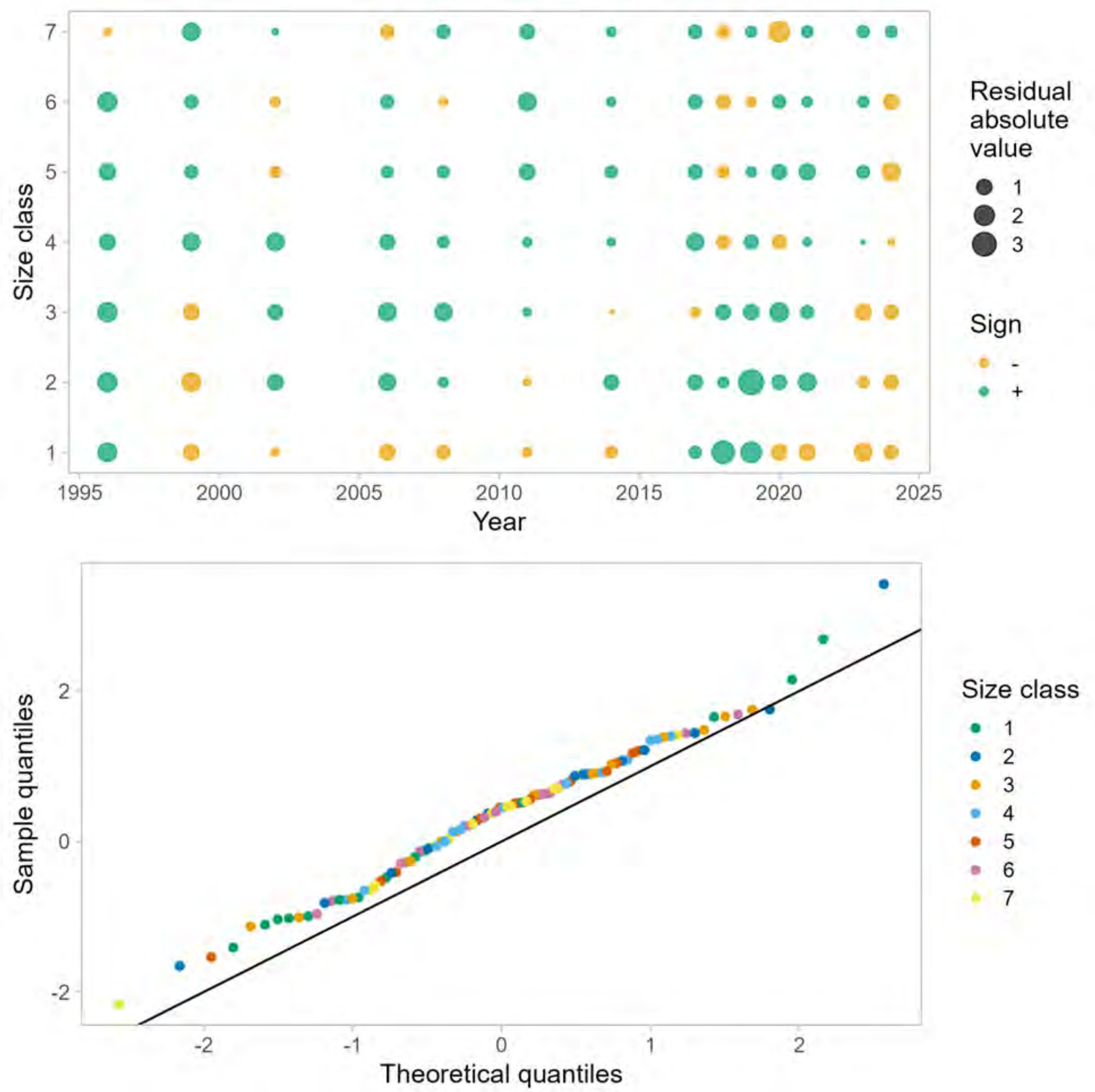


Figure 104: One-Step-Ahead residuals for model 24.0b fits to newshell male size composition data from the ADFG trawl survey.

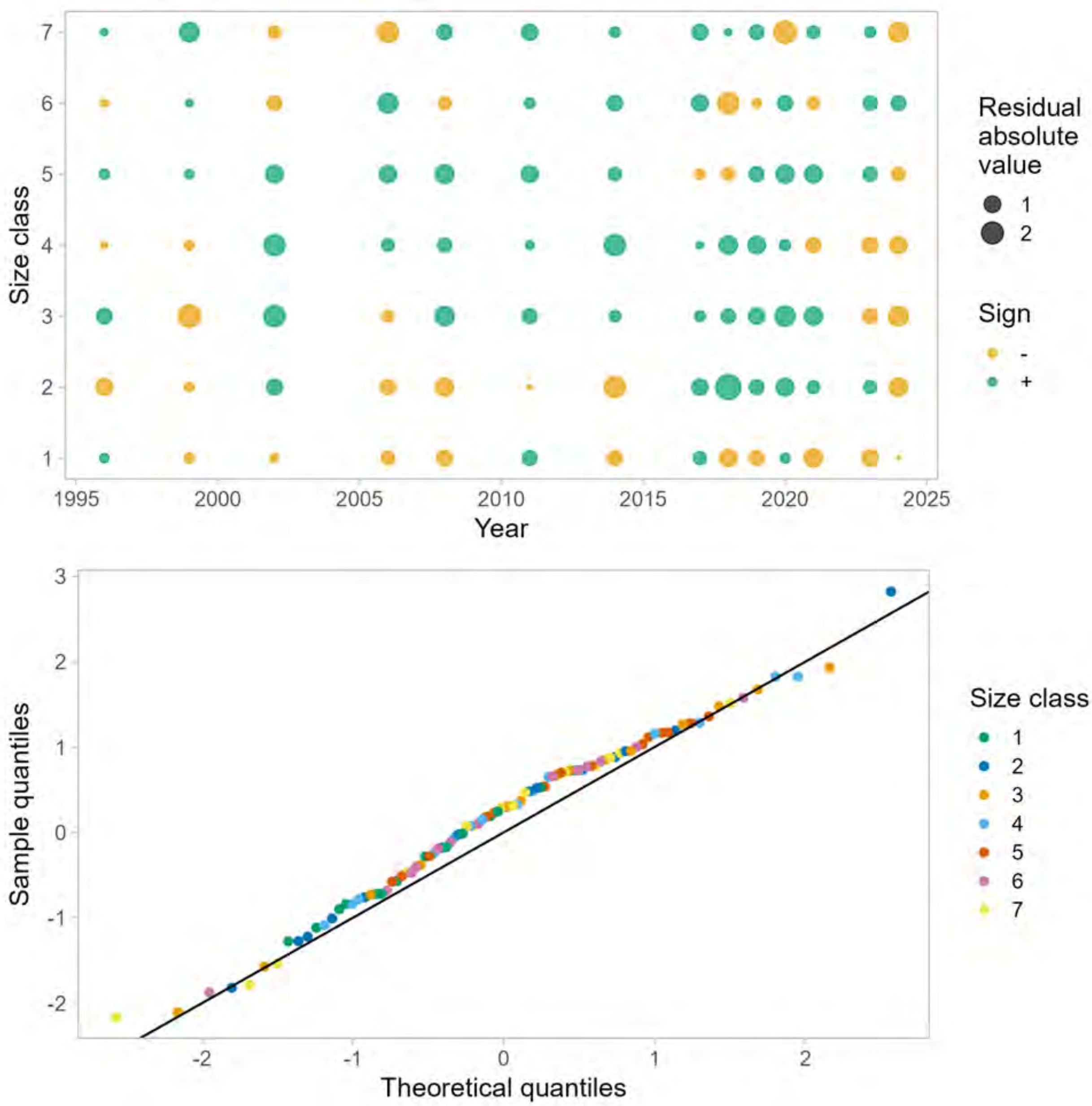


Figure 105: One-Step-Ahead residuals for model 24.0b fits to oldshell male size composition data from the ADFG trawl survey.

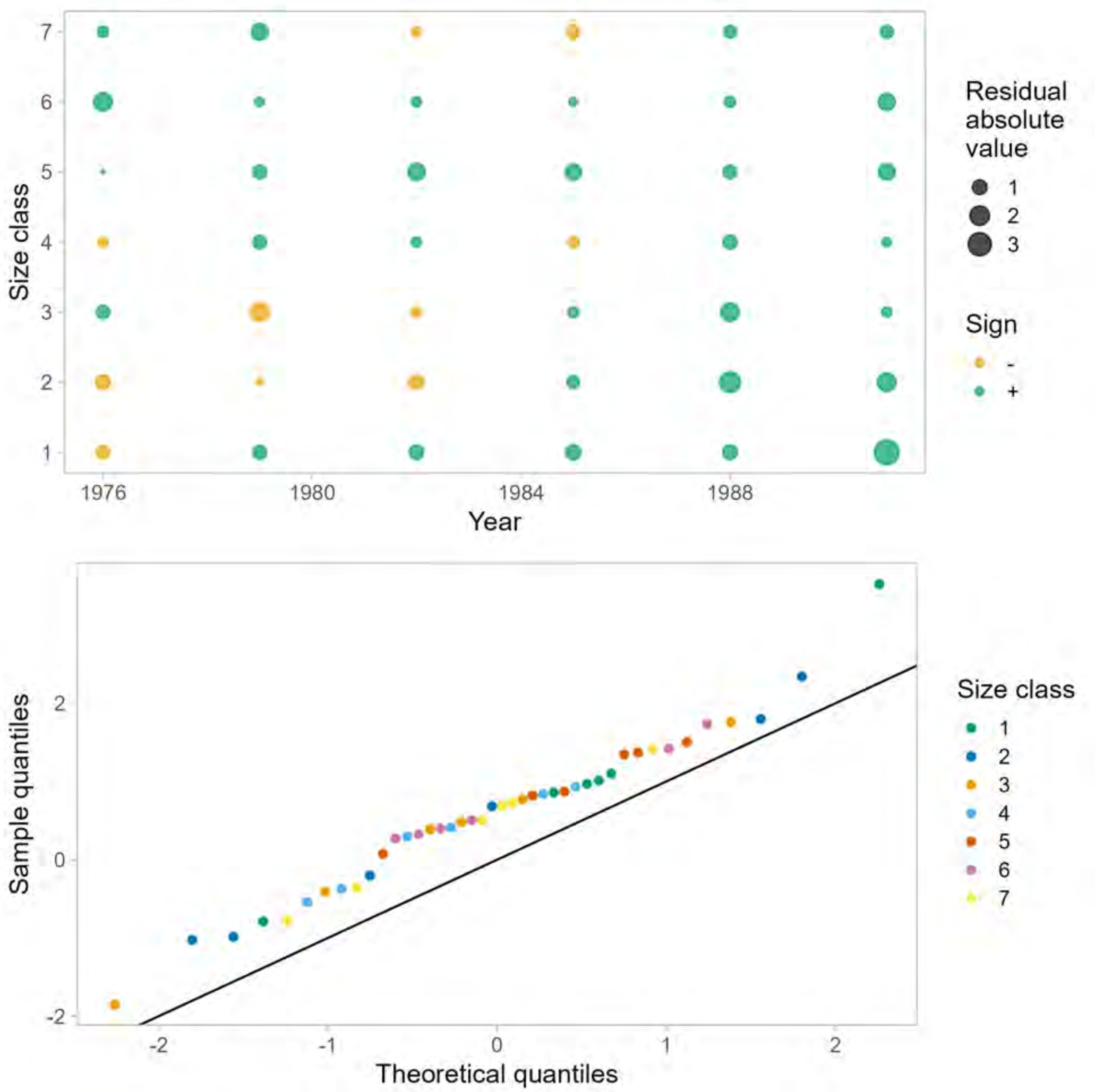


Figure 106: One-Step-Ahead residuals for model 24.0b fits to newshell male size composition data from the NOAA Norton Sound trawl survey.

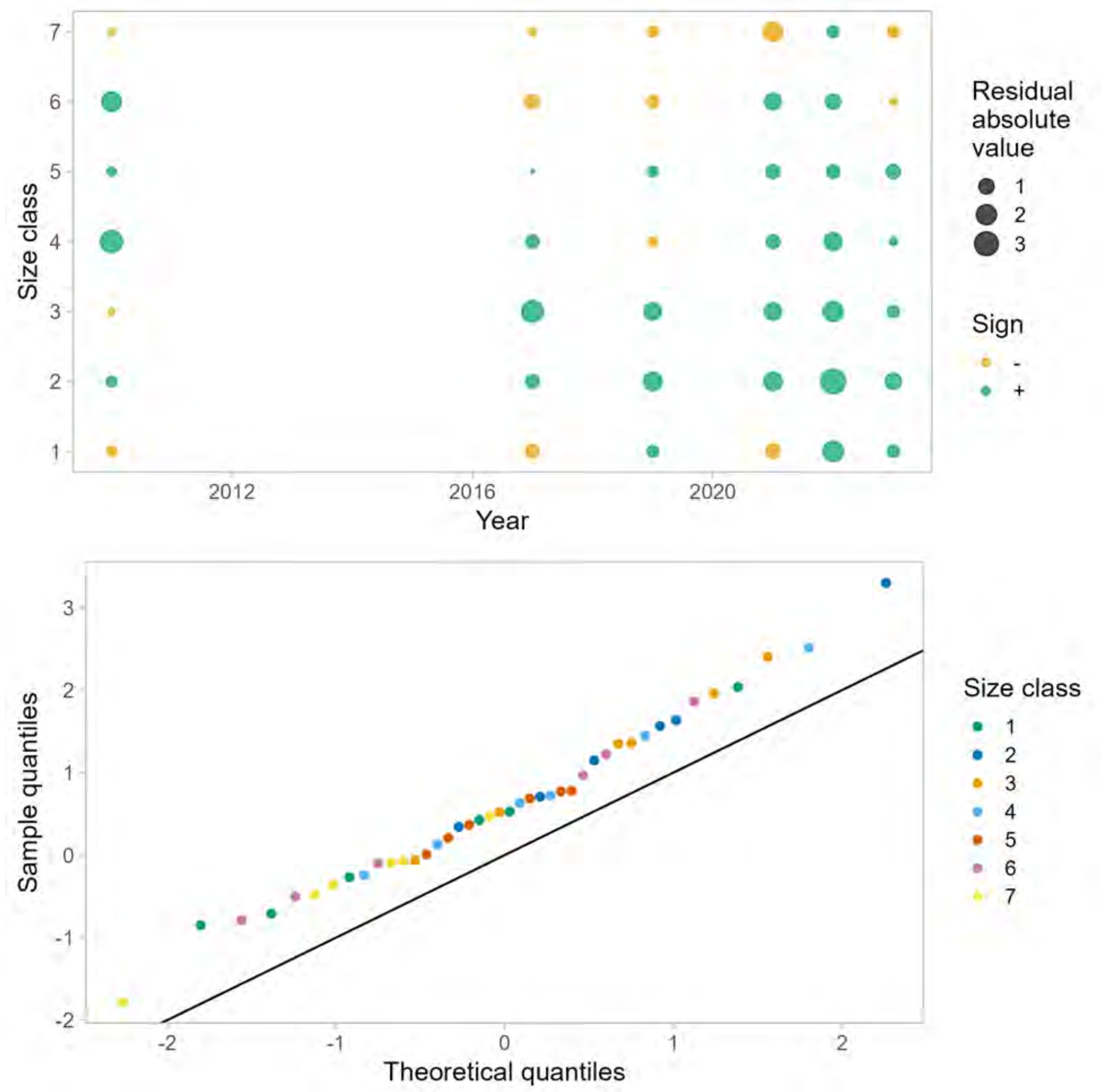


Figure 107: One-Step-Ahead residuals for model 24.0b fits to newshell male size composition data from the NOAA Northern Bering Sea trawl survey.

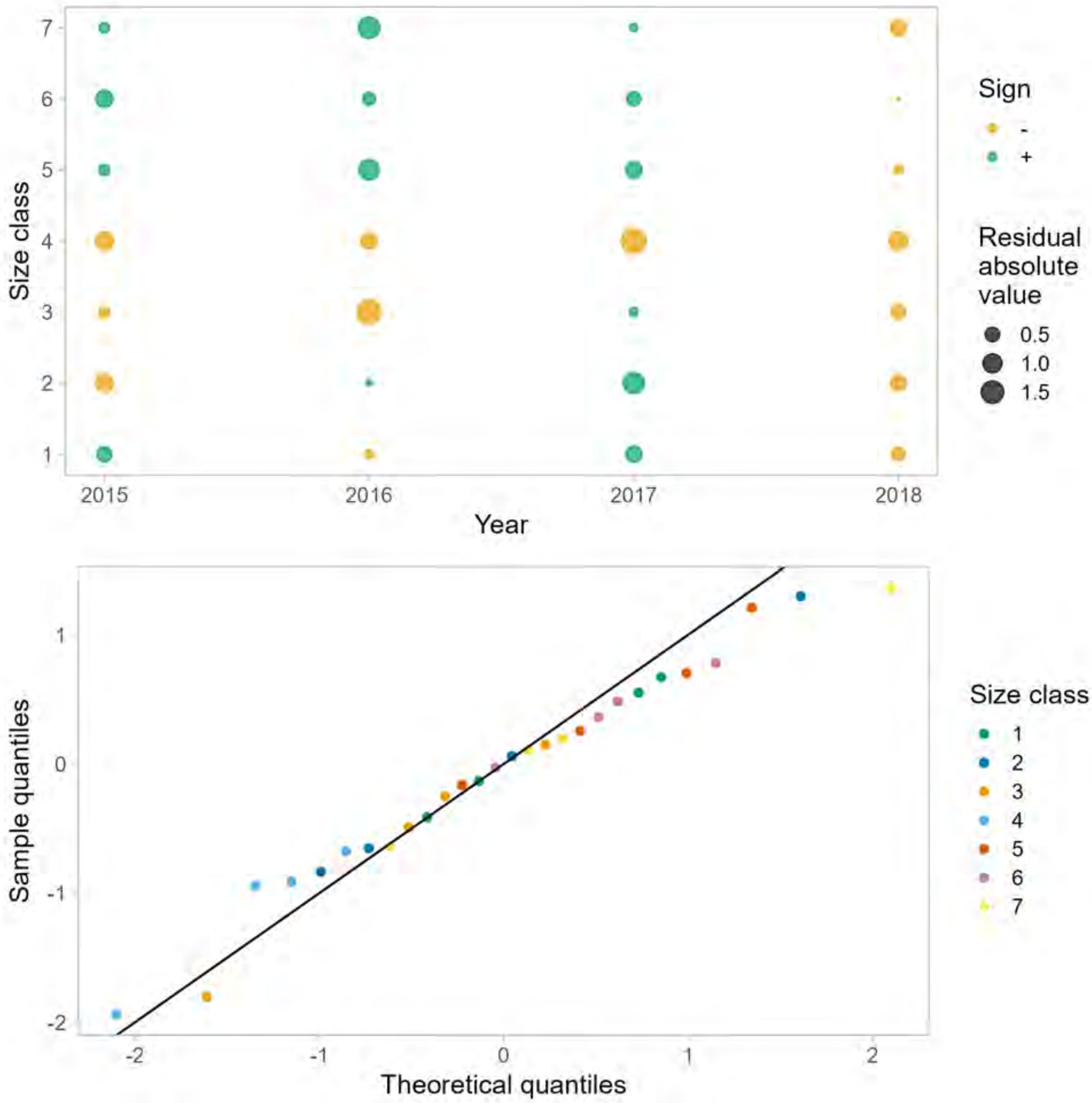


Figure 108: One-Step-Ahead residuals for model 25.0 fits to size composition data from the winter commercial fishery retained catch.

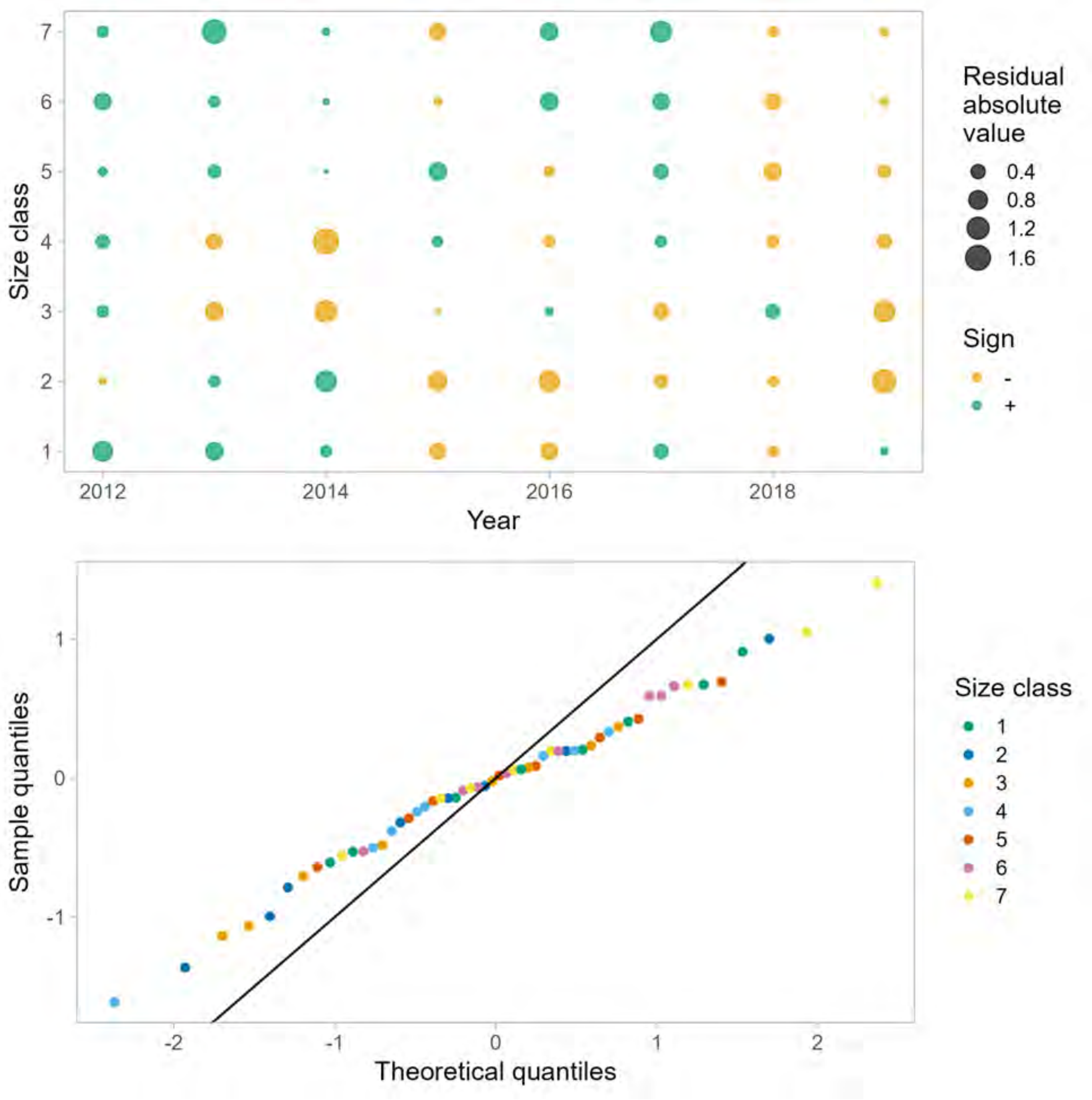
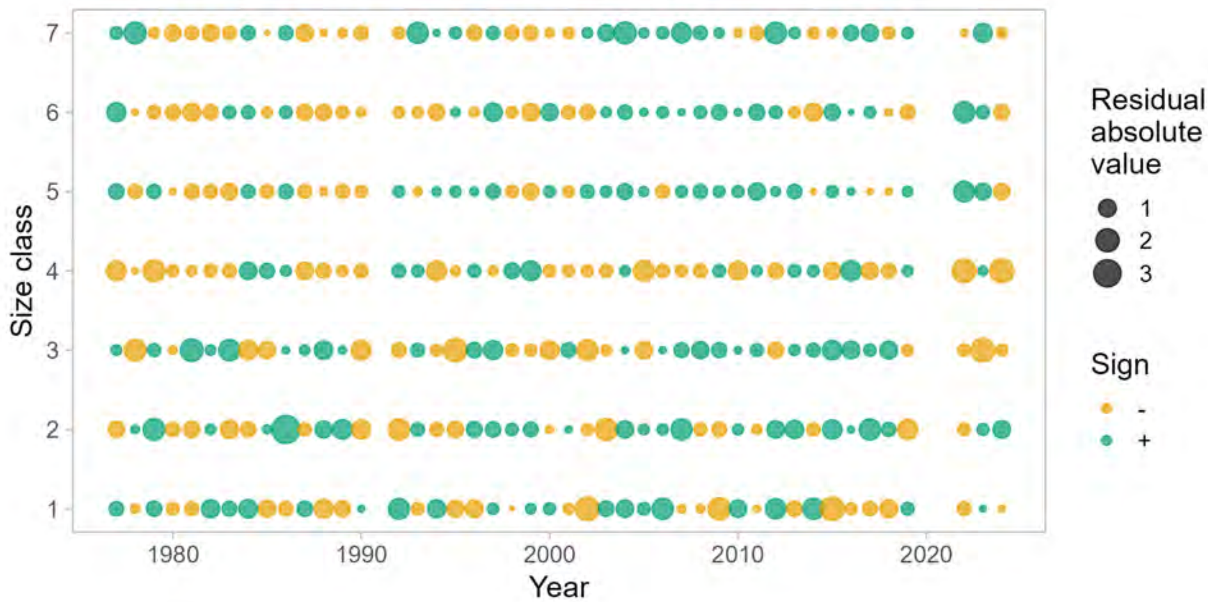


Figure 109: One-Step-Ahead residuals for model 25.0 fits to size composition data from the summer commercial fishery total catch.



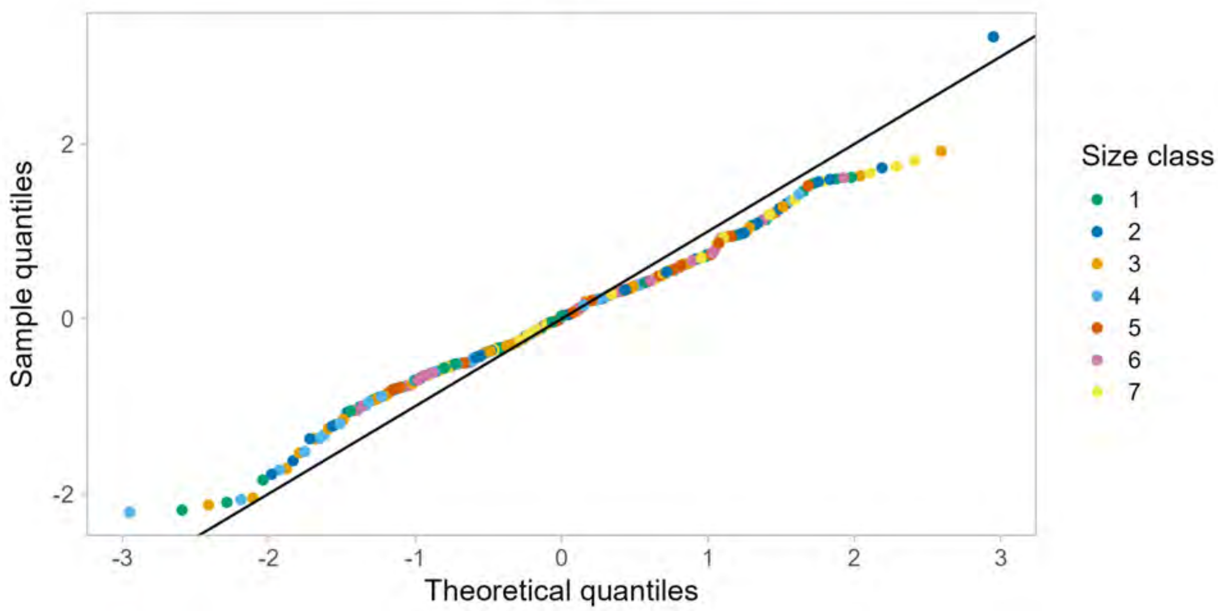


Figure 110: One-Step-Ahead residuals for model 25.0 fits to size composition data from the summer commercial fishery retained catch.

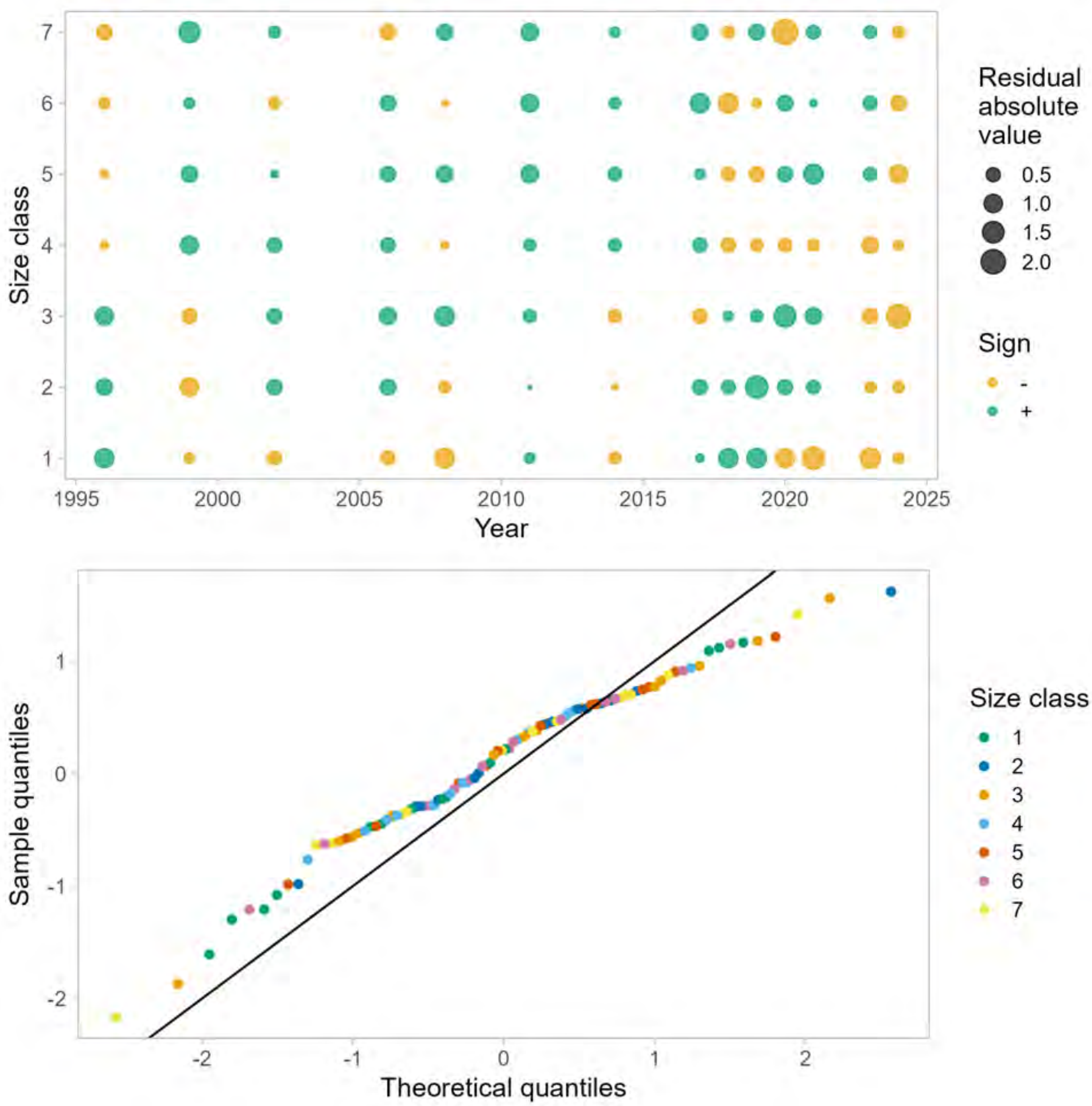


Figure 111: One-Step-Ahead residuals for model 25.0 fits to size composition data from the ADFG trawl survey.

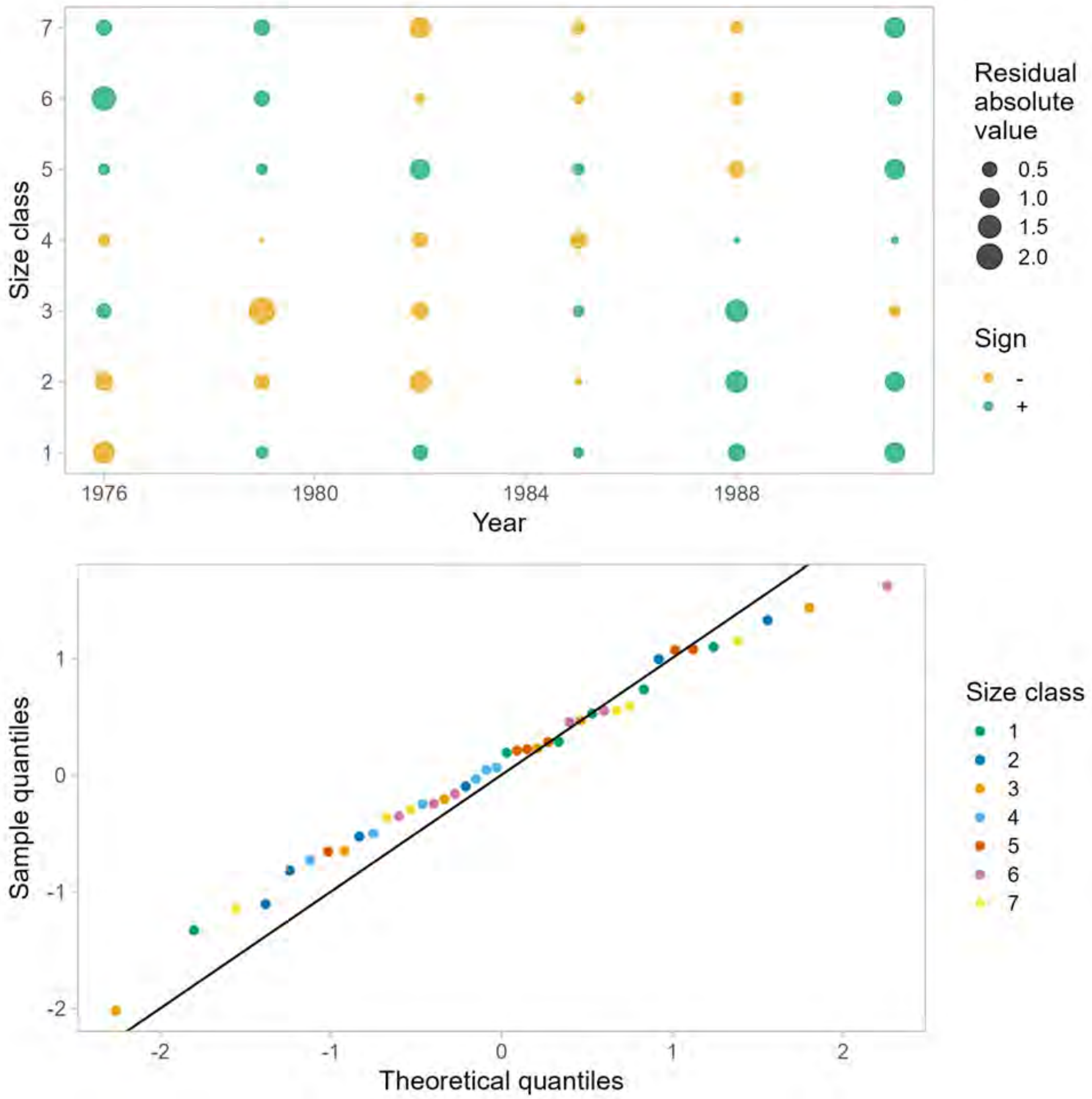


Figure 112: One-Step-Ahead residuals for model 25.0 fits to size composition data from the NOAA Norton Sound trawl survey.

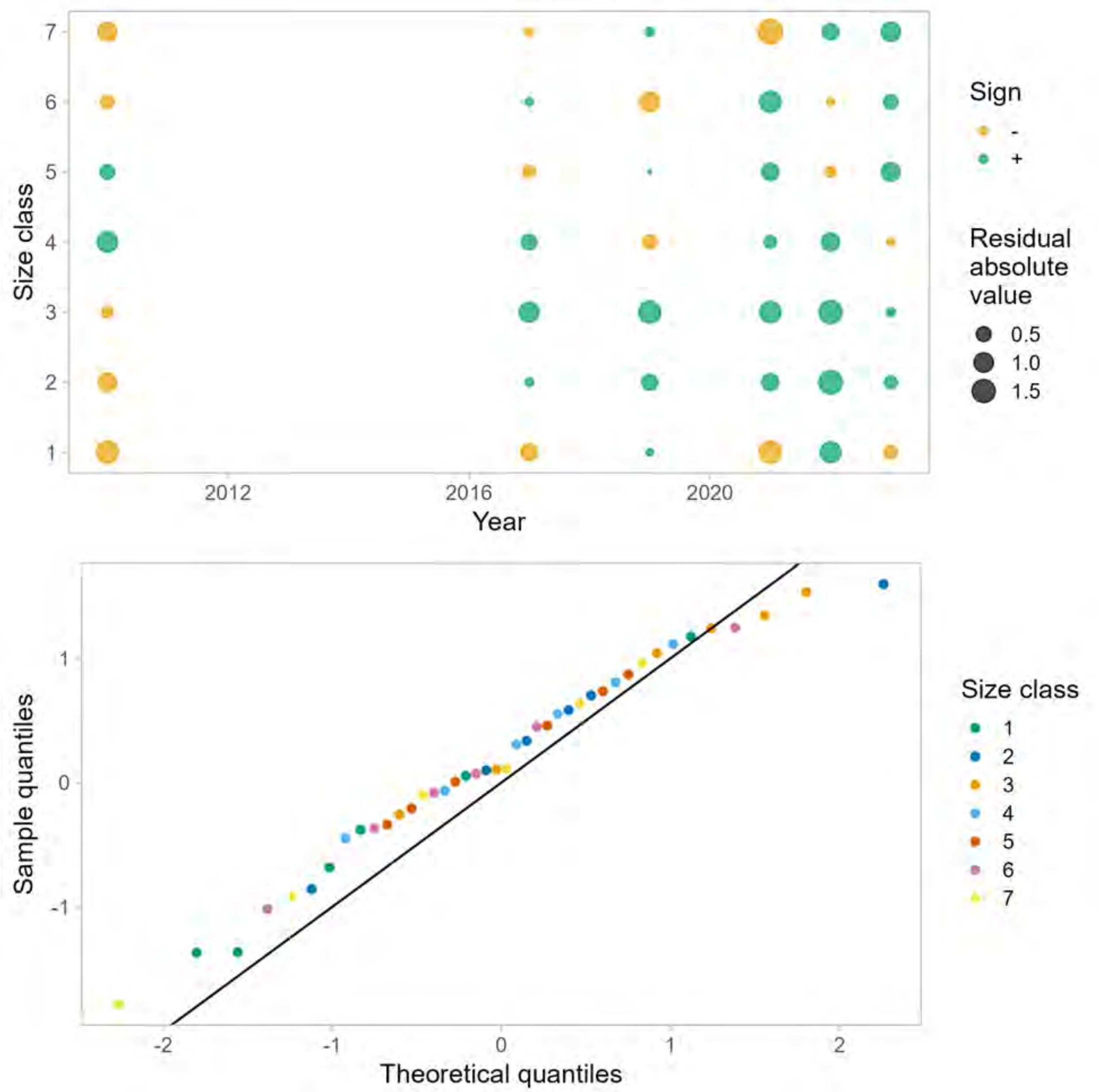


Figure 113: One-Step-Ahead residuals for model 25.0 fits to size composition data from the NOAA Northern Bering Sea trawl survey.

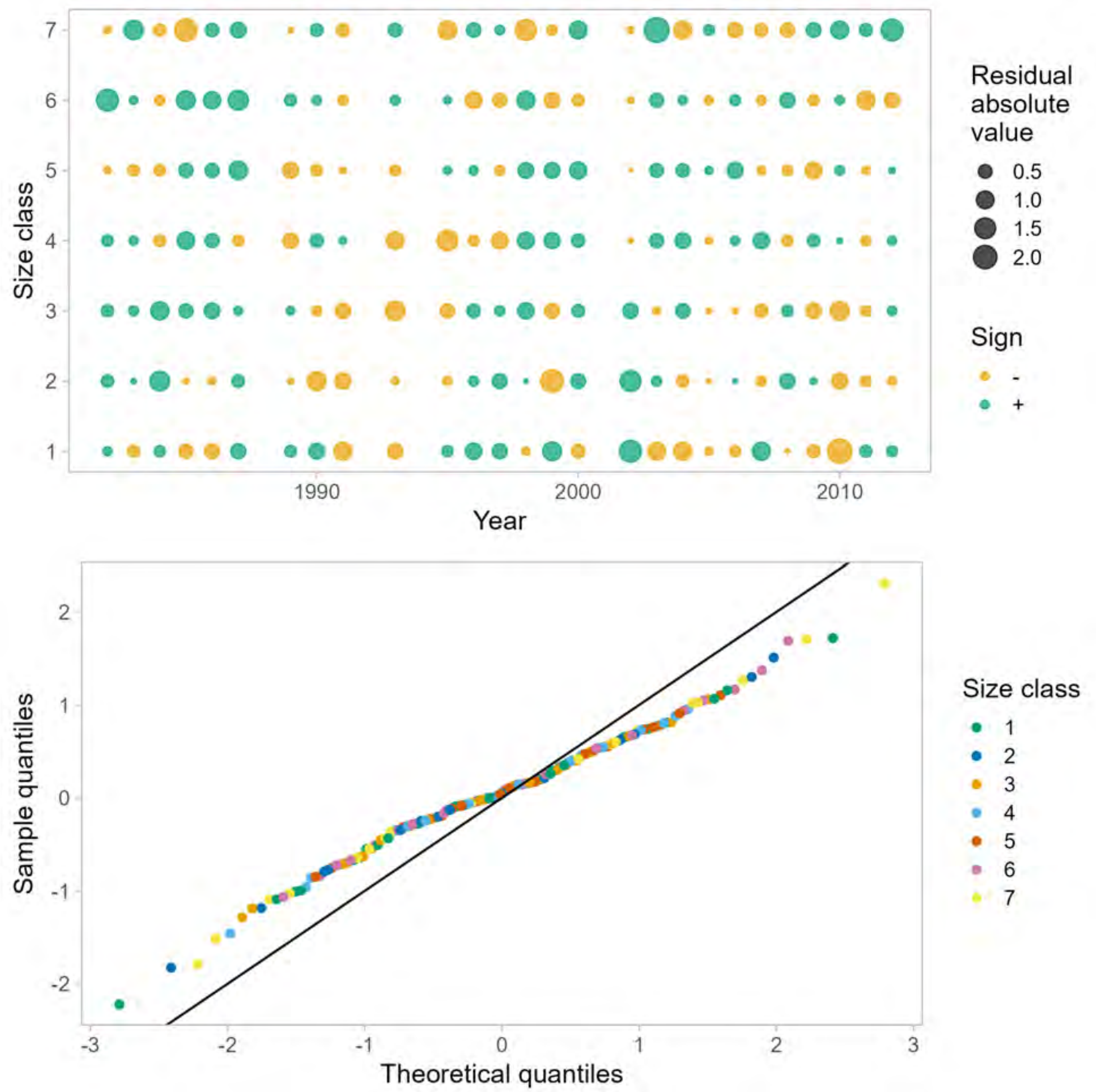


Figure 114: One-Step-Ahead residuals for model 25.0 fits to size composition data from the winter pot survey.

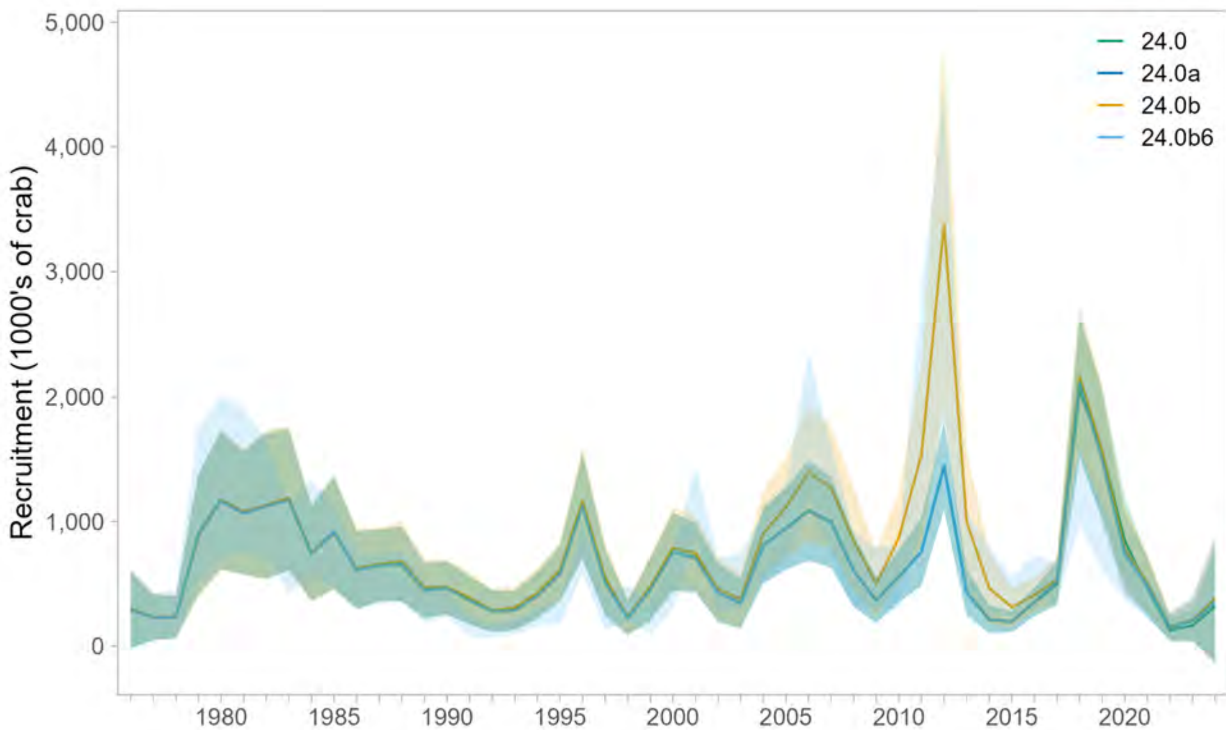


Figure 115: Estimated recruitment (in thousands of individuals) over 1976-2024 for the most recent accepted model (24.0; uses GMACS version 2.20.14), the accepted model with data input errors corrected (24.0a; uses GMACS version 2.20.14), the corrected model transitioned to GMACS version 2.20.20 (24.0b; the new base model), and the new base model at the second lowest objective function value (24.0b6).

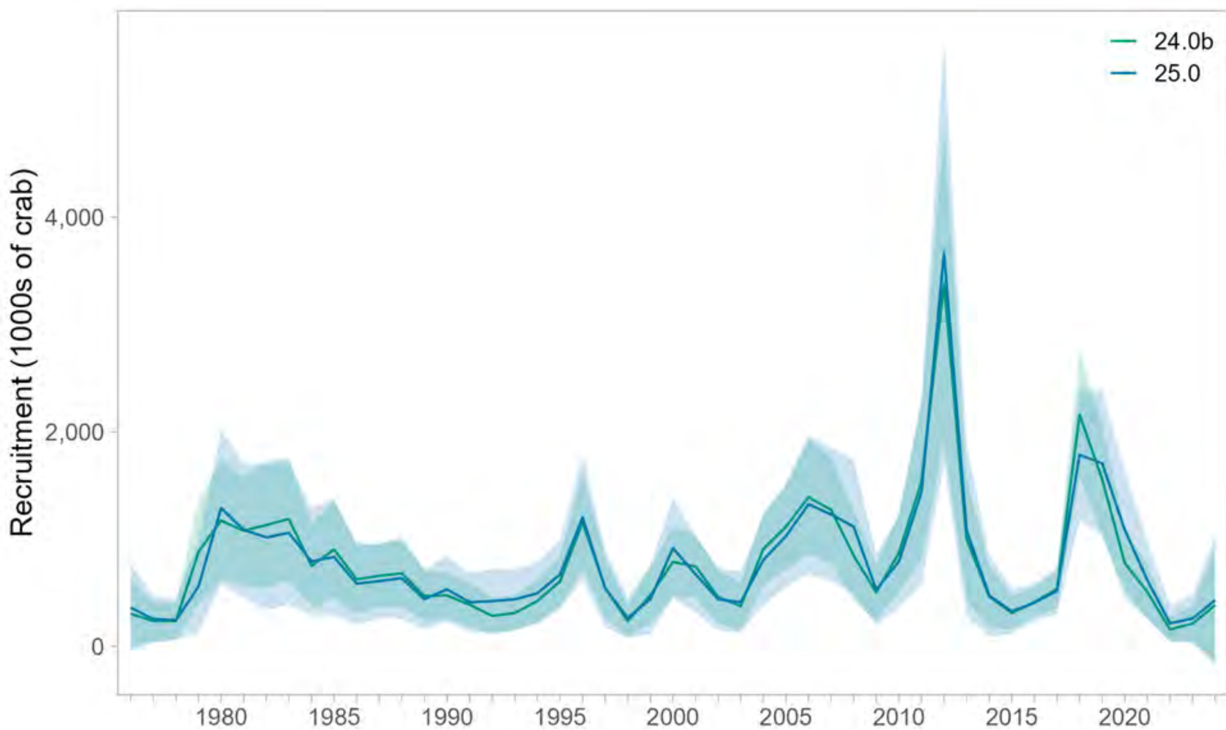


Figure 116: Estimated recruitment (in thousands of individuals) over 1976-2024 for the new base model (24.0b) and that model with shell condition excluded (25.0).

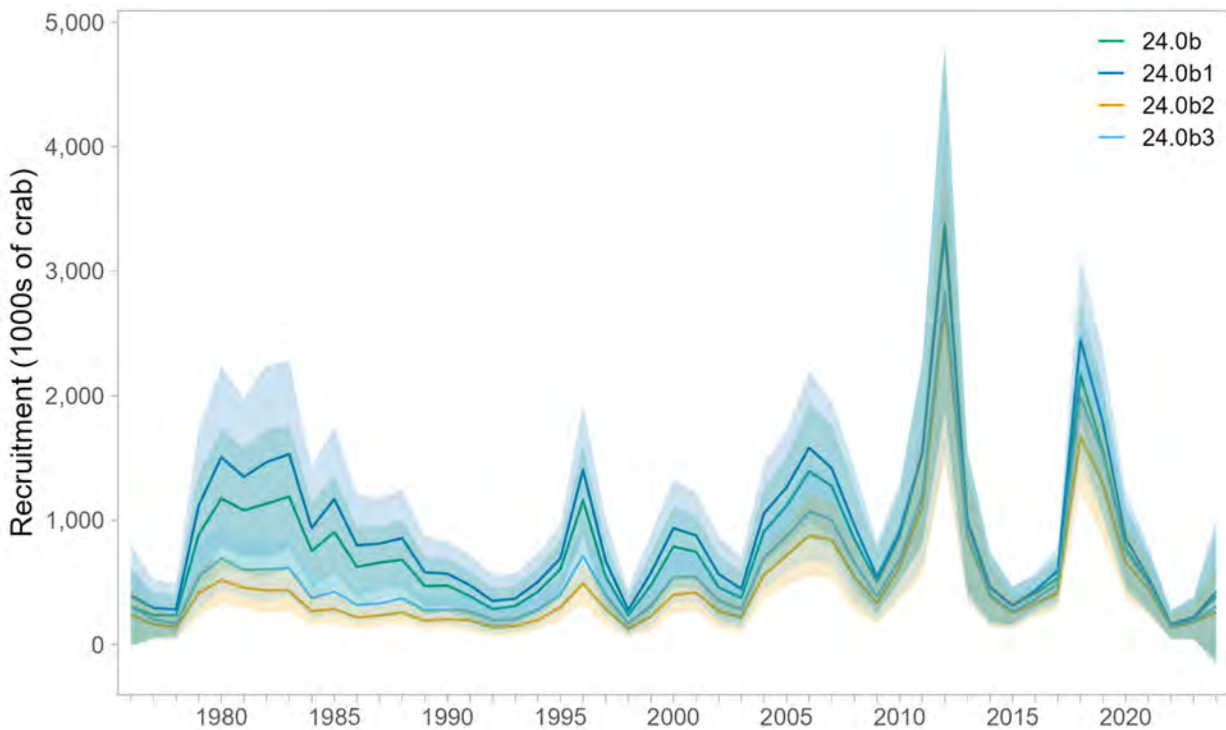


Figure 117: Estimated recruitment (in thousands of individuals) over 1976-2024 for the new base model (model 24.0b) and three models exploring natural mortality (M). In model 24.0b1, as in model 24.0b, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 24.0b and 0.23 for model 24.0b1. Model 24.0b2 uses a size-independent M = 0.18. Model 24.0b3 uses a size-independent M = 0.23.

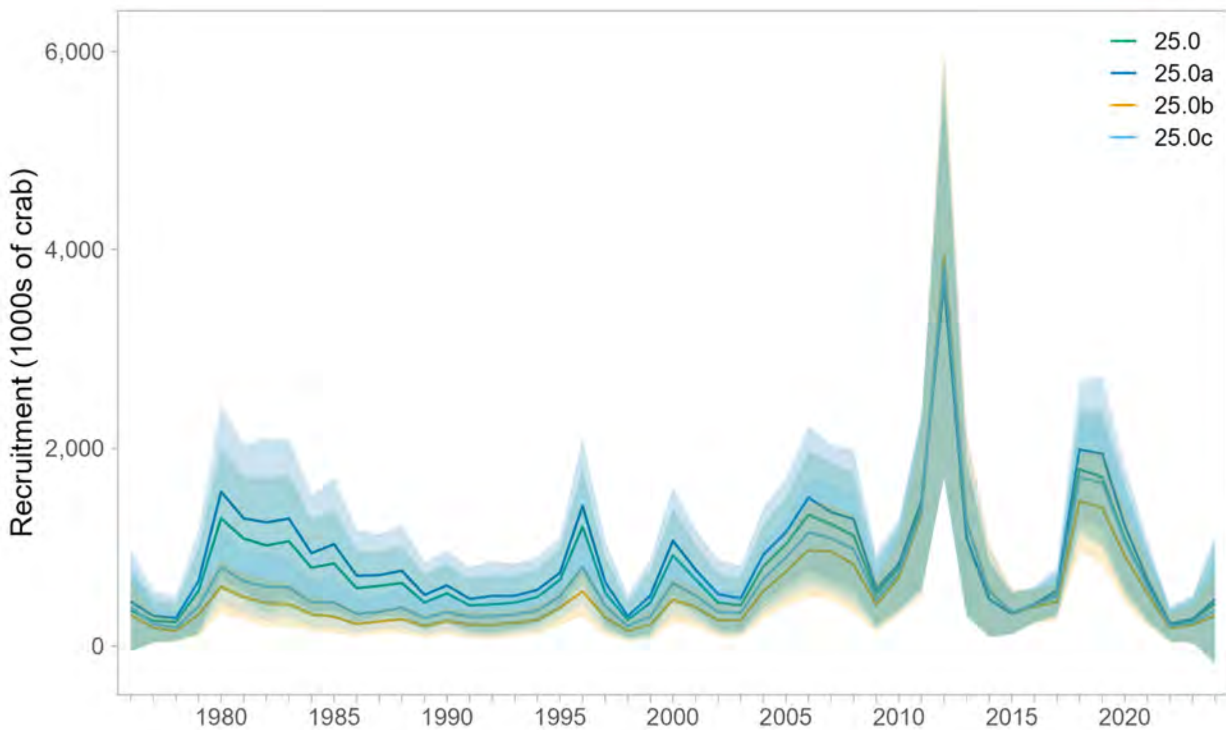


Figure 118: Estimated recruitment (in thousands of individuals) over 1976-2024 for the model with shell condition excluded (model 25.0) and three models exploring natural mortality (M). In model 25.0a, as in model 25.0, M is fixed for males with carapace length (CL) ≤ 123 mm and estimated for males with CL > 123 mm; the fixed M value is 0.18 for model 25.0 and 0.23 for model 25.0a. Model 25.0b uses a size-independent $M = 0.18$. Model 25.0c uses a size-independent $M = 0.23$.

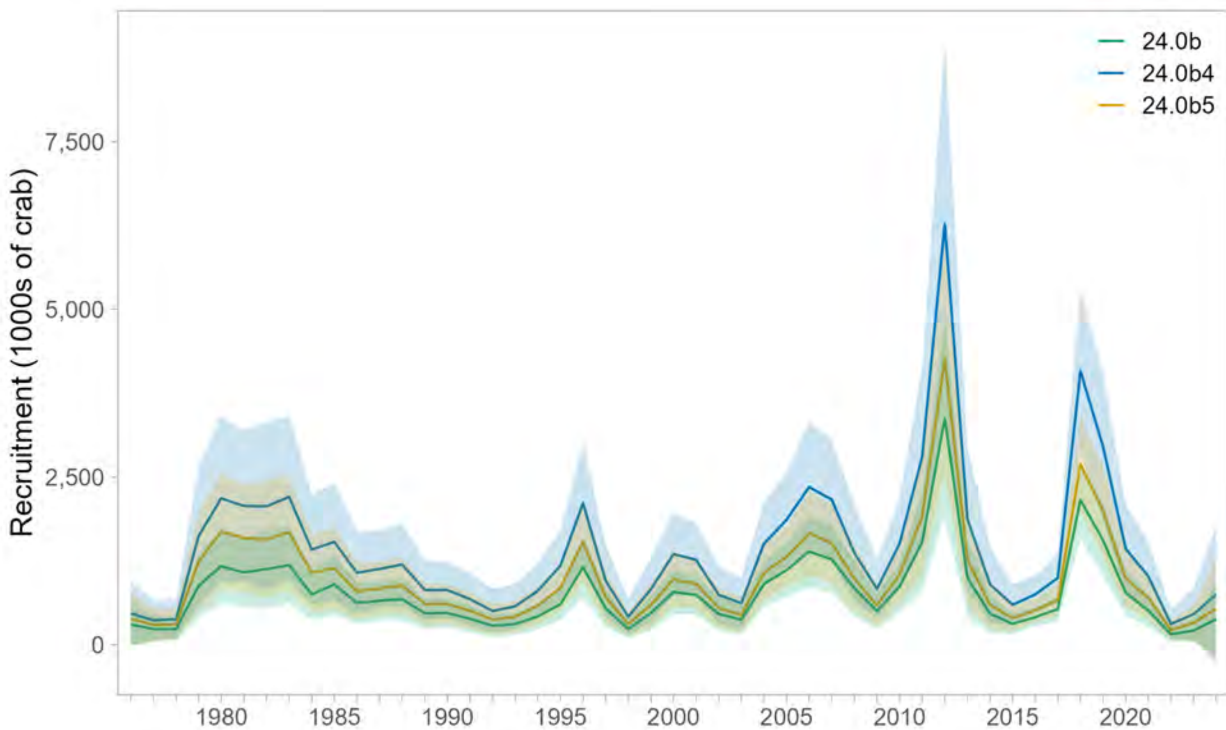


Figure 119: Estimated recruitment (in thousands of individuals) over 1976-2024 for the new base model (model 24.0b) and models using spatiotemporal model-based rather than design-based indices of abundance for the three trawl surveys. In model 24.0b4, abundance is estimated over the full area covered by all three surveys while, in model 24.0b5, abundance is estimated over the reduced area covered by the ADF&G trawl survey since 2010.

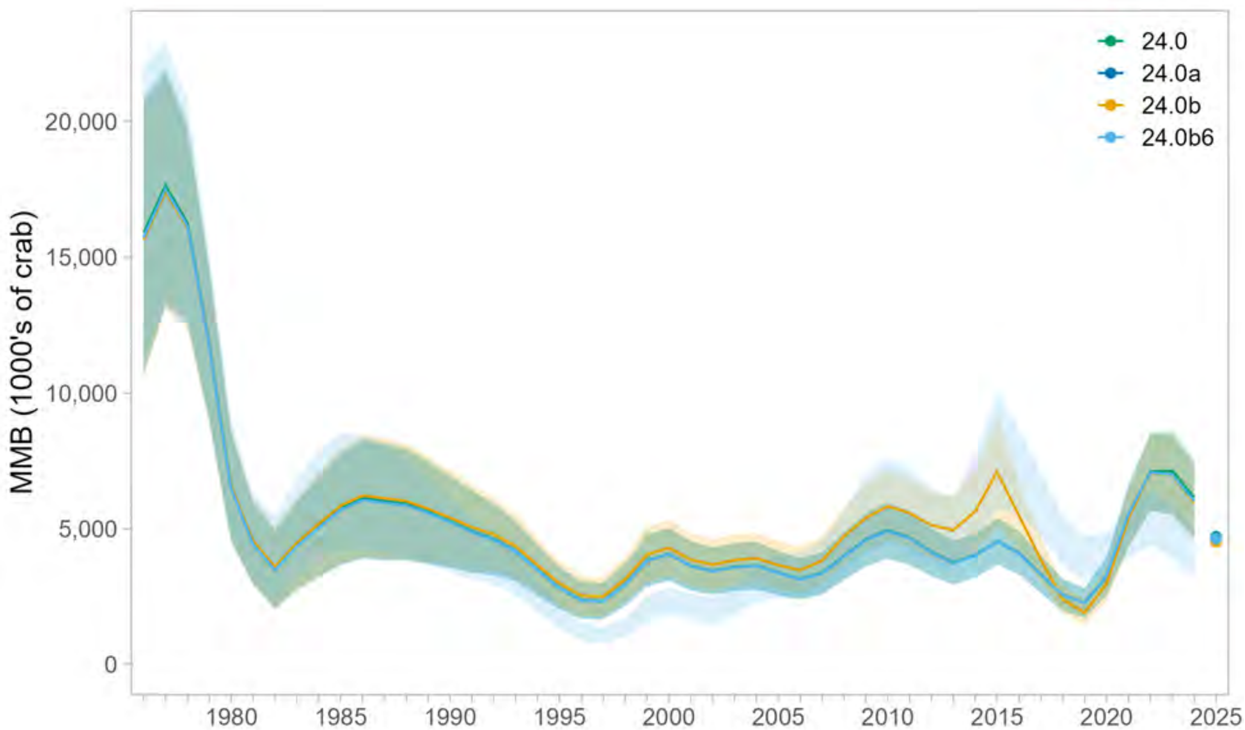


Figure 120: Comparisons of estimated mature male biomass (MMB) time series over 1976-2024 for the most recent accepted model (24.0; uses GMACS version 2.20.14), the accepted model with data input errors corrected (24.0a; uses GMACS version 2.20.14), the corrected model transitioned to GMACS version 2.20.20 (24.0b; the new base model), and the new base model at the second lowest objective function value (24.0b6). Points represent projected values for 2025.

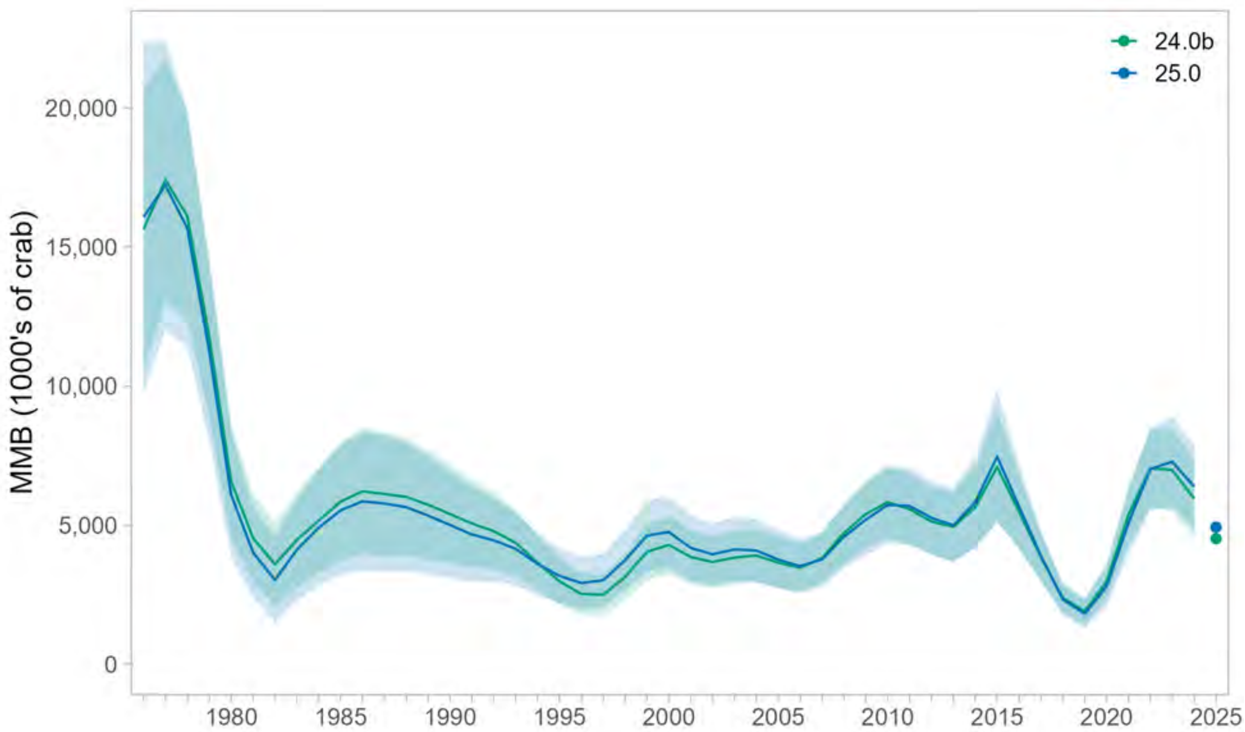


Figure 121: Comparisons of estimated mature male biomass (MMB) time series over 1976-2024 for the new base model (24.0b) and that model with shell condition excluded (model 25.0). Points represent projected values for 2025.

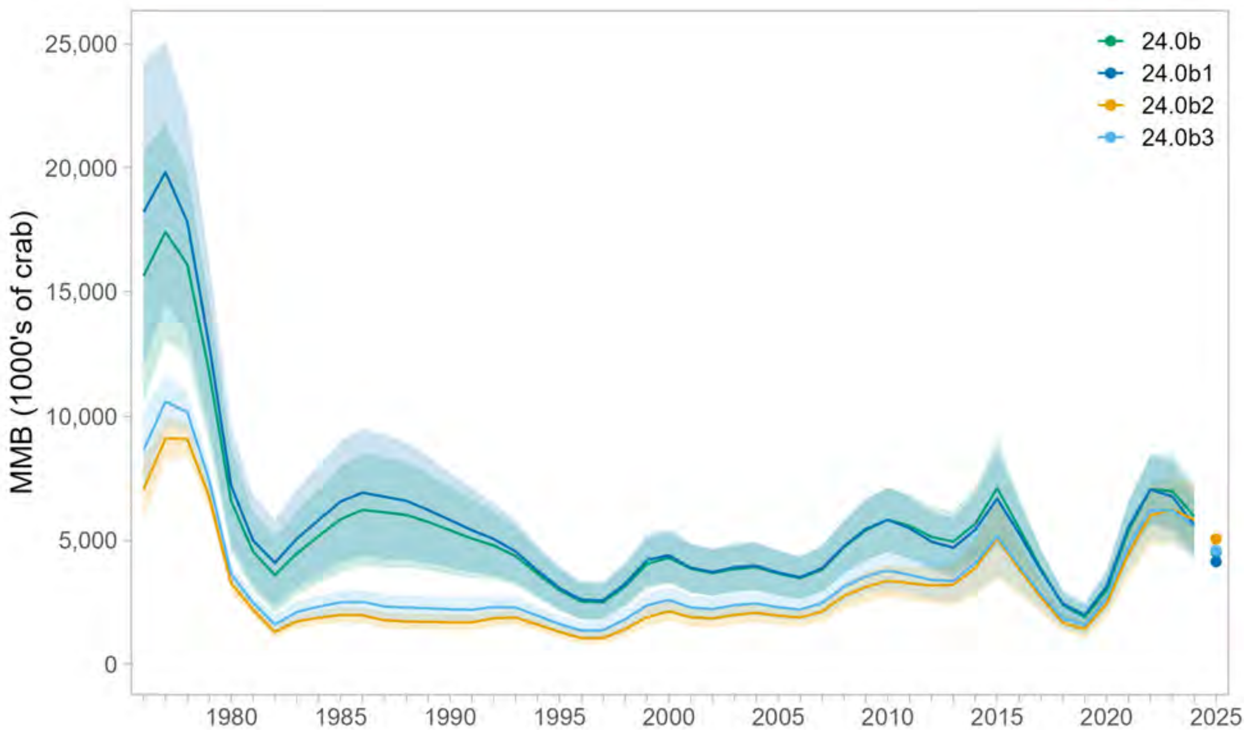


Figure 122: Comparisons of estimated mature male biomass (MMB) time series over 1976-2024 for the new base model (model 24.0b) and three models exploring natural mortality (M). In model 24.0b1, as in model 24.0b, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 24.0b and 0.23 for model 24.0b1. Model 24.0b2 uses a size-independent $M = 0.18$. Model 24.0b3 uses a size-independent $M = 0.23$. Points represent projected values for 2025.

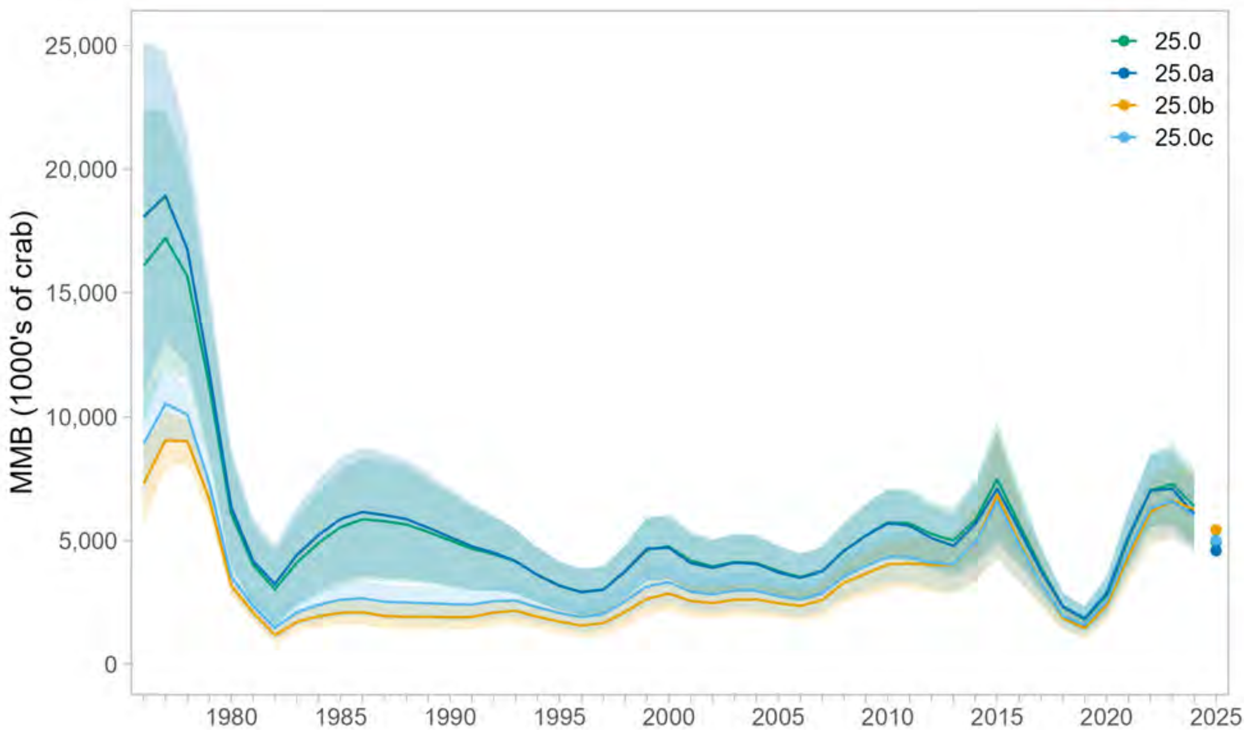


Figure 123: Comparisons of estimated mature male biomass (MMB) time series over 1976-2024 for the model with shell condition excluded (model 25.0) and three models exploring natural mortality (M). In model 25.0a, as in model 25.0, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 25.0 and 0.23 for model 25.0a. Model 25.0b uses a size-independent $M = 0.18$. Model 25.0c uses a size-independent $M = 0.23$. Points represent projected values for 2025.

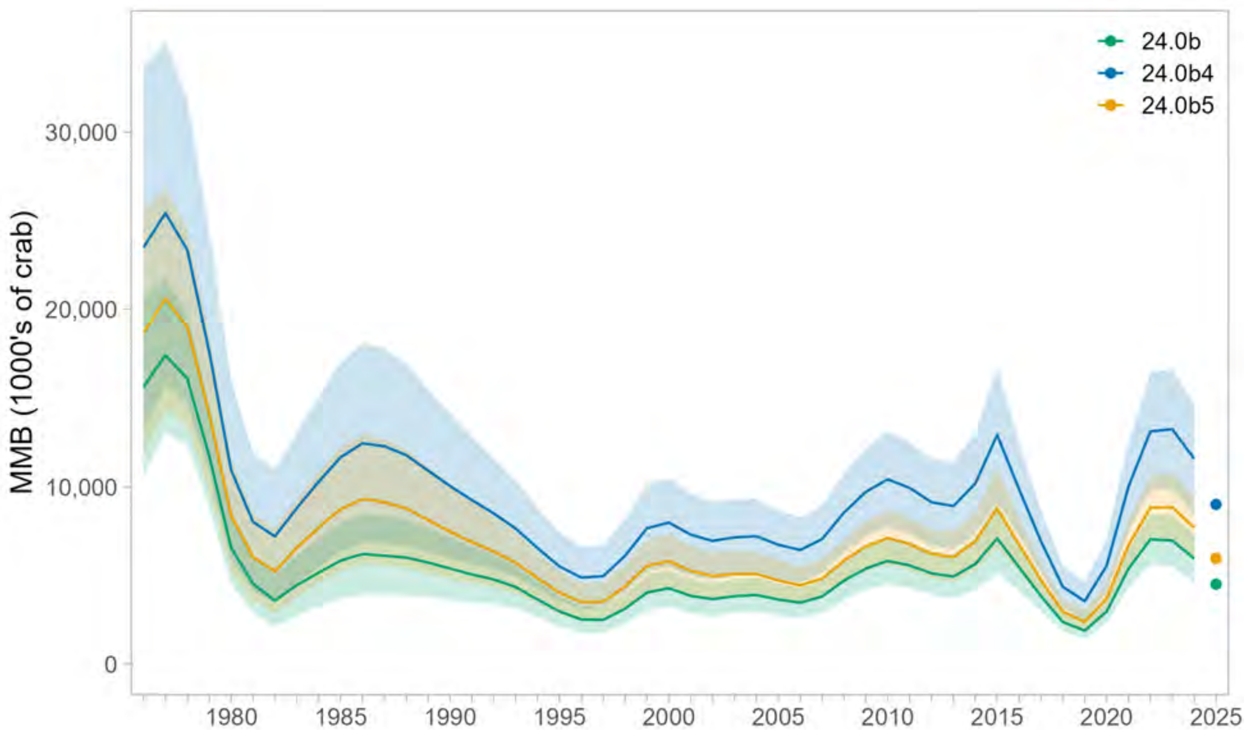


Figure 124: Comparisons of estimated mature male biomass (MMB) time series over 1976-2024 for the new base model (model 24.0b) and models using spatiotemporal model-based rather than design-based indices of abundance for the three trawl surveys. In model 24.0b4, abundance is estimated over the full area covered by all three surveys while, in model 24.0b5, abundance is estimated over the reduced area covered by the ADF&G trawl survey since 2010. Points represent projected values for 2025.

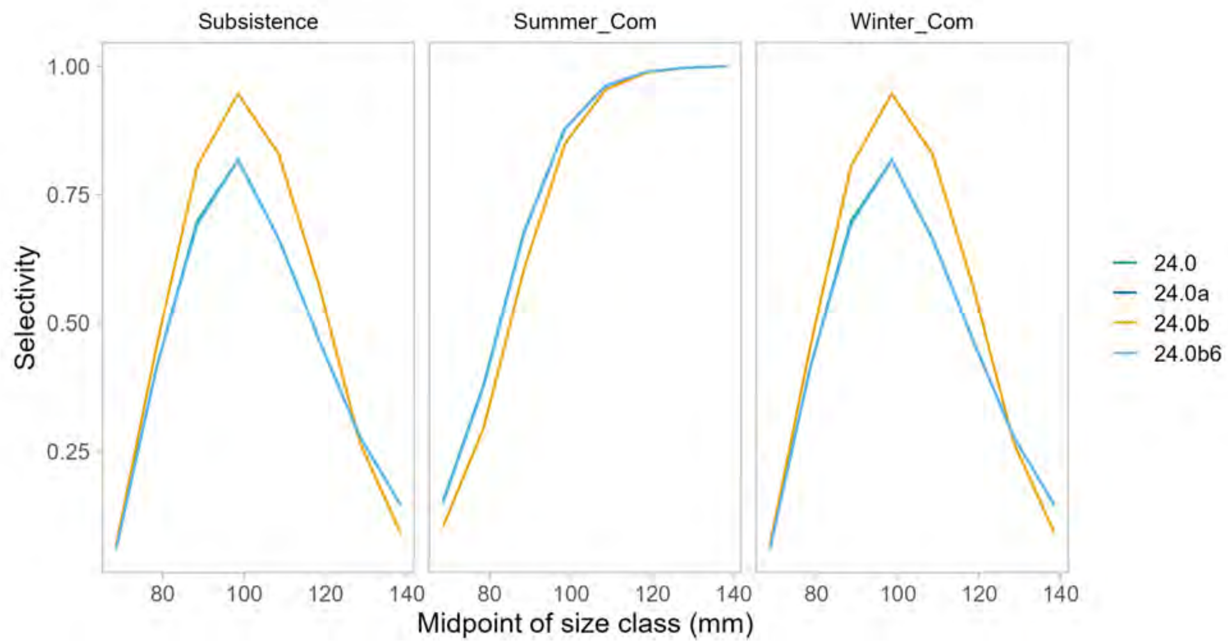


Figure 125: Comparisons of estimated fishery capture selectivities in the summer commercial, winter commercial, and subsistence fisheries for the most recent accepted model (24.0; uses GMACS version 2.20.14), the accepted model with data input errors corrected (24.0a; uses GMACS version 2.20.14), the corrected model transitioned to GMACS version 2.20.20 (24.0b; the new base model), and the new base model at its second-lowest objective function value (24.0b6). Estimates for all models other than 24.0b are nearly identical and not visually distinguishable.

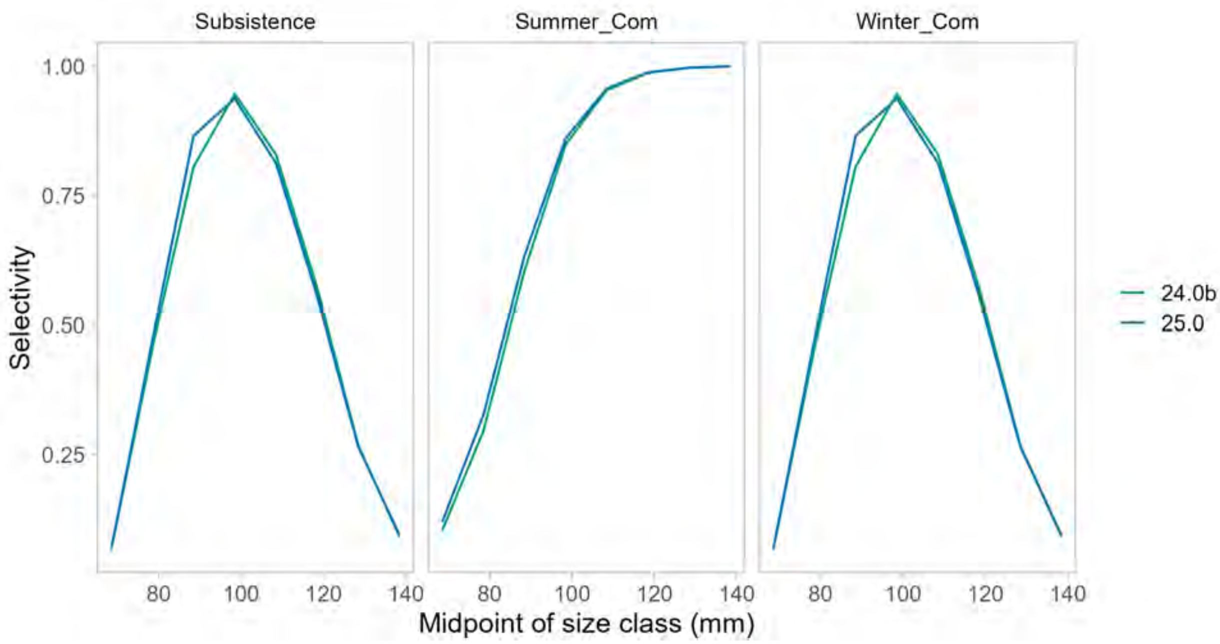


Figure 126: Comparisons of estimated fishery capture selectivities in the summer commercial, winter commercial, and subsistence fisheries for the new base model (24.0b) and that model with shell condition excluded (model 25.0).

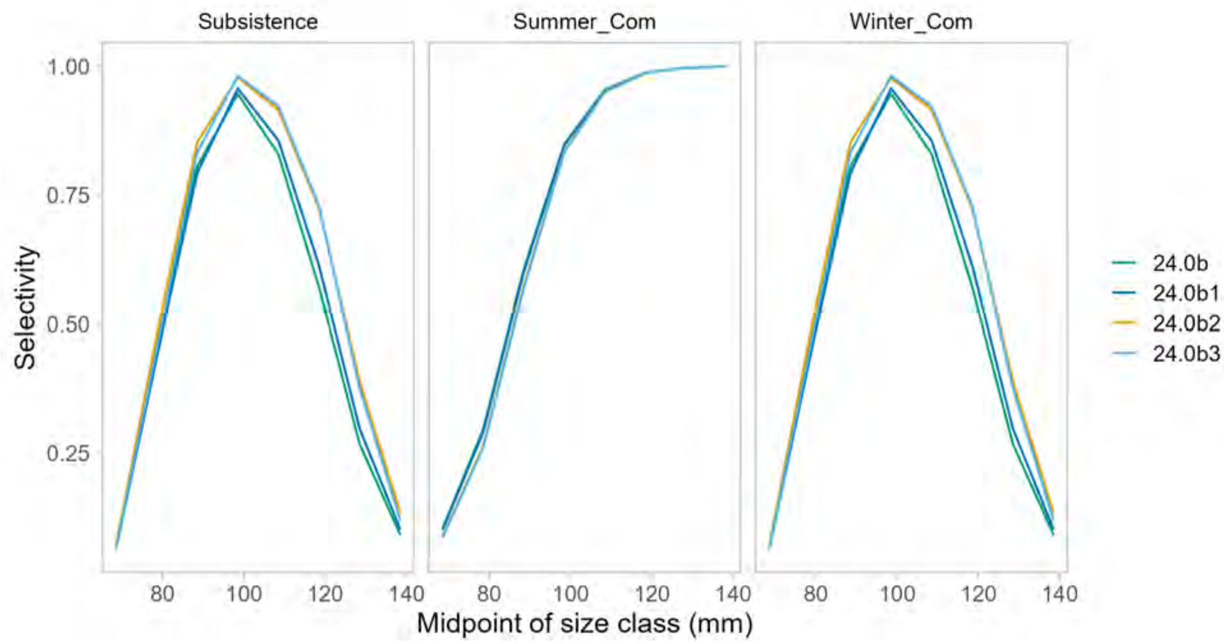


Figure 127: Comparisons of estimated fishery capture selectivities in the summer commercial, winter commercial, and subsistence fisheries for the new base model (model 24.0b) and three models exploring natural mortality (M). In model 24.0b1, as in model 24.0b, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 24.0b and 0.23 for model 24.0b1. Model 24.0b2 uses a size-independent $M = 0.18$. Model 24.0b3 uses a size-independent $M = 0.23$.

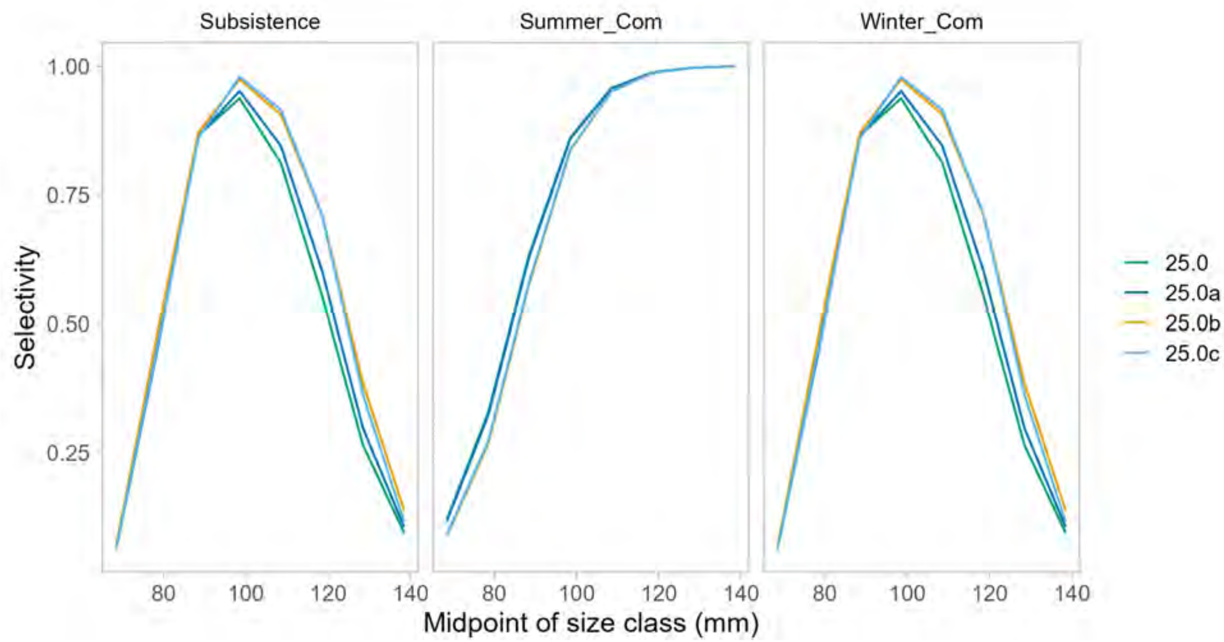


Figure 128: Comparisons of estimated fishery capture selectivities in the summer commercial, winter commercial, and subsistence fisheries for the model with shell condition excluded (model 25.0) and three models exploring natural mortality (M). In model 25.0a, as in model 25.0, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 25.0 and 0.23 for model 25.0a. Model 25.0b uses a size-independent $M = 0.18$. Model 25.0c uses a size-independent $M = 0.23$.

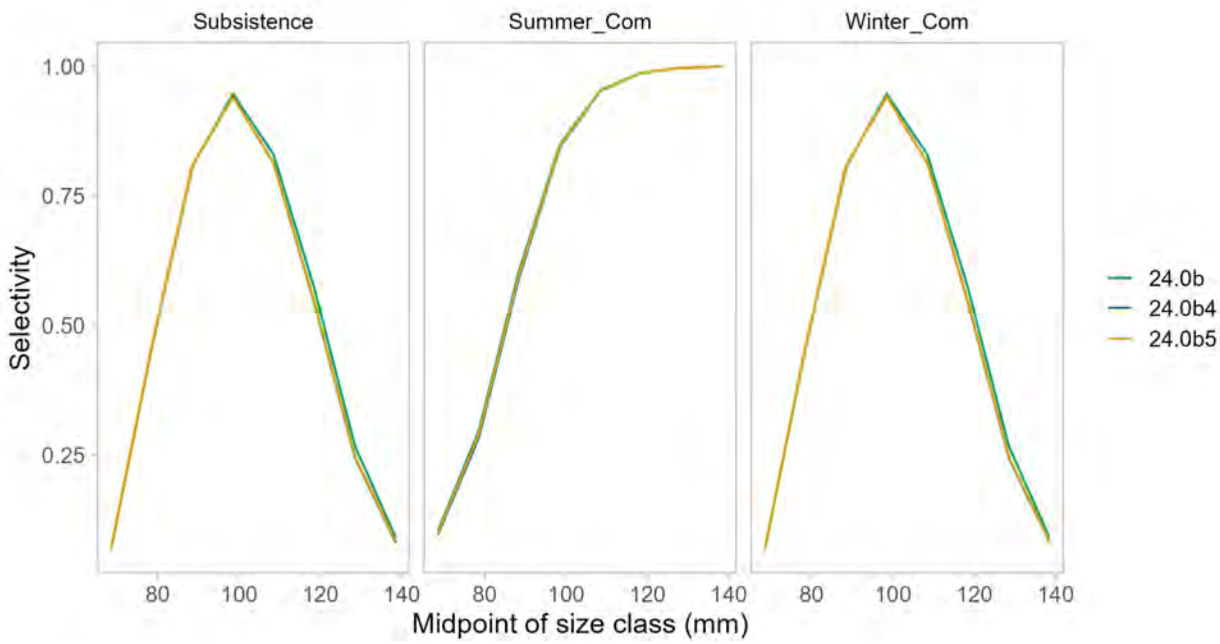


Figure 129: Comparisons of estimated fishery capture selectivities in the summer commercial, winter commercial, and subsistence fisheries for the new base model (model 24.0b) and models using spatiotemporal model-based rather than design-based indices of abundance. In model 24.0b4, abundance is estimated over the full area covered by all three surveys while, in model 24.0b5, abundance is estimated over the reduced area covered by the ADF&G trawl survey since 2010.

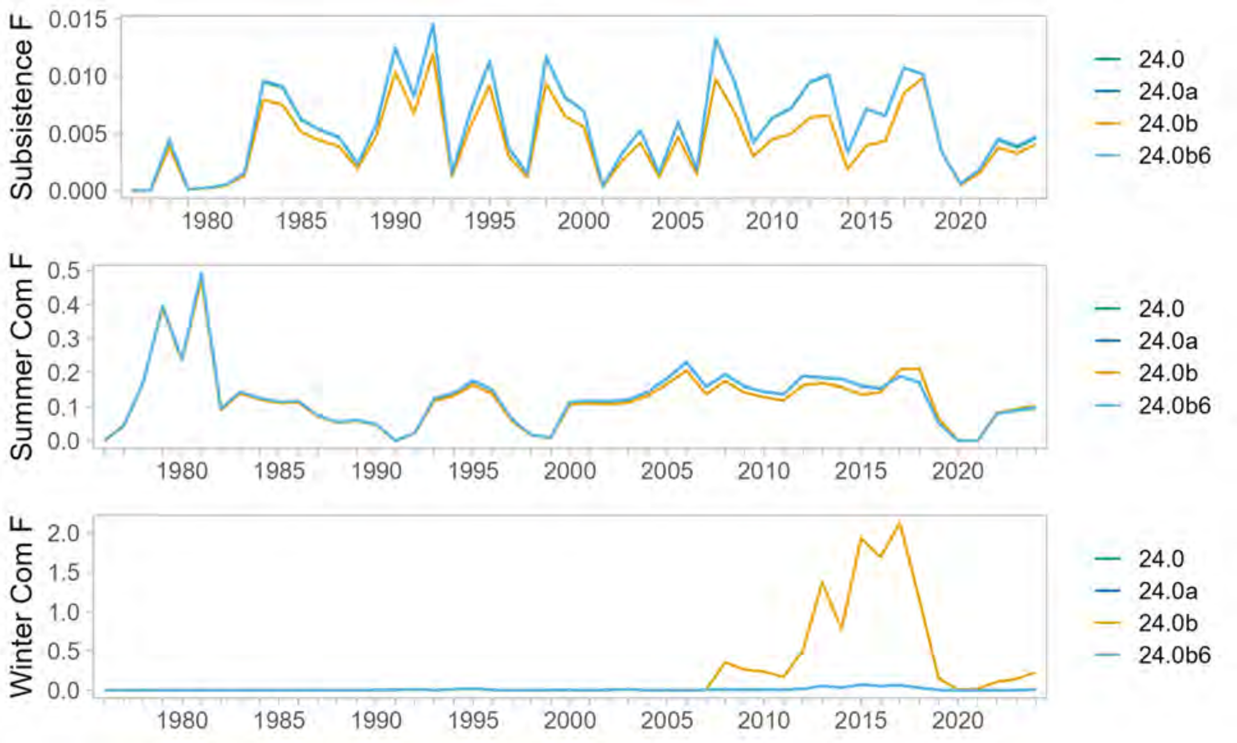


Figure 130: Comparison of estimated fishing mortality (F) for the subsistence, summer commercial, and winter commercial fisheries for the most recent accepted model (24.0; uses GMACS version 2.20.14), the accepted model with data input errors corrected (24.0a; uses GMACS version 2.20.14), the corrected model transitioned to GMACS version 2.20.20 (24.0b; the new base model), and the new base model at the second lowest objective function value (24.0b6). Note that the scale for F differs among the panels.

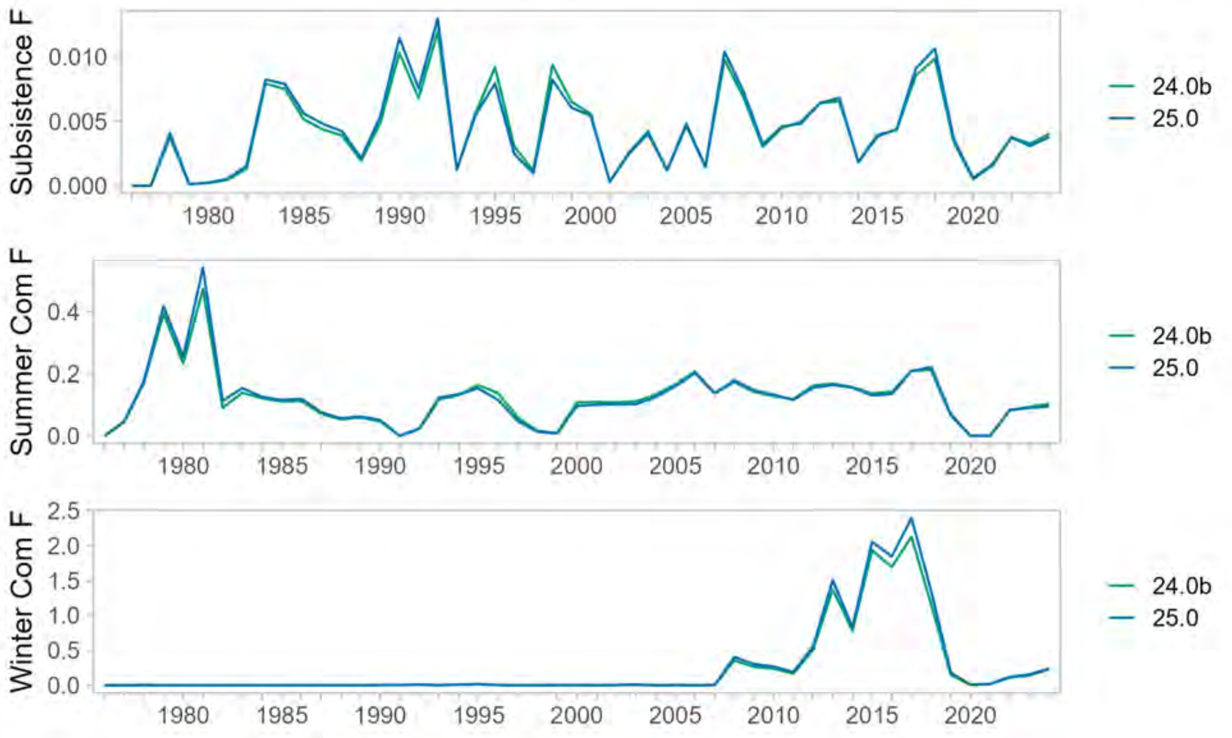


Figure 131: Comparison of estimated fishing mortality (F) for the subsistence, summer commercial, and winter commercial fisheries for the new base model (24.0b) and that model with shell condition excluded (model 25.0). Note that the scale for F differs among the panels.

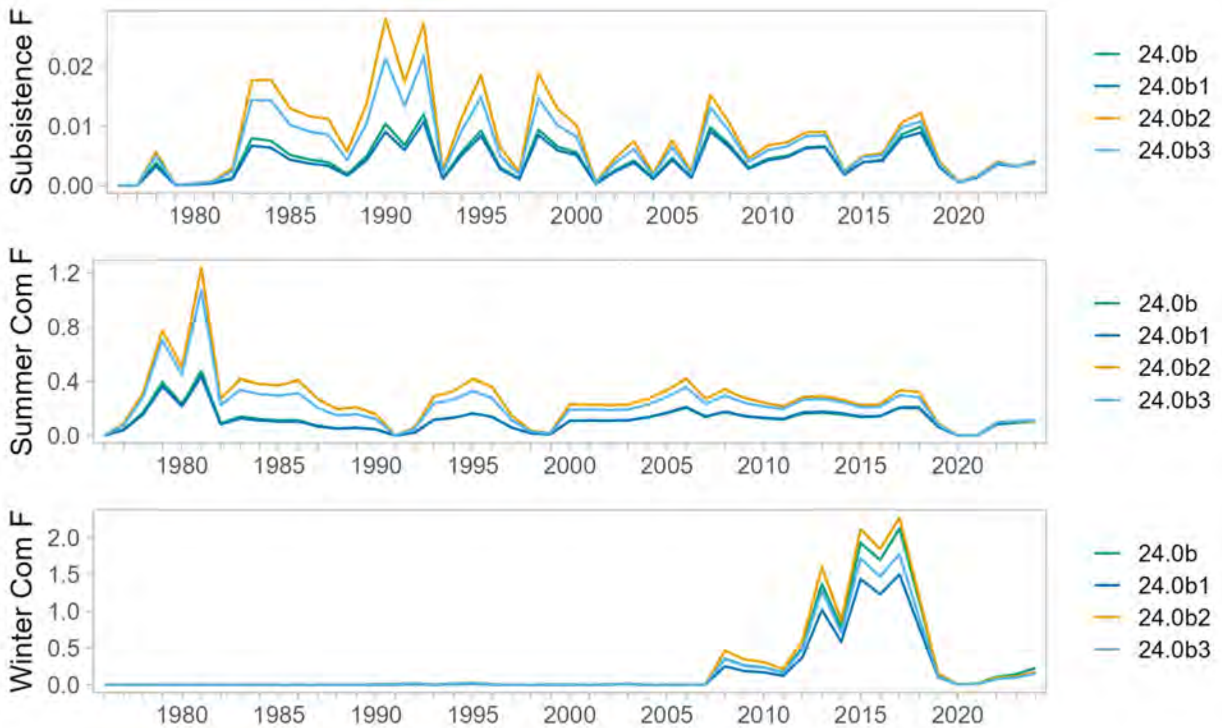


Figure 132: Comparison of estimated fishing mortality (F) for the subsistence, summer commercial, and winter commercial fisheries for the new base model (model 24.0b) and three models exploring natural mortality (M). In model 24.0b1, as in model 24.0b, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 24.0b and 0.23 for model 24.0b1. Model 24.0b2 uses a size-independent $M = 0.18$. Model 24.0b3 uses a size-independent $M = 0.23$. Note that the scale for F differs among the panels.

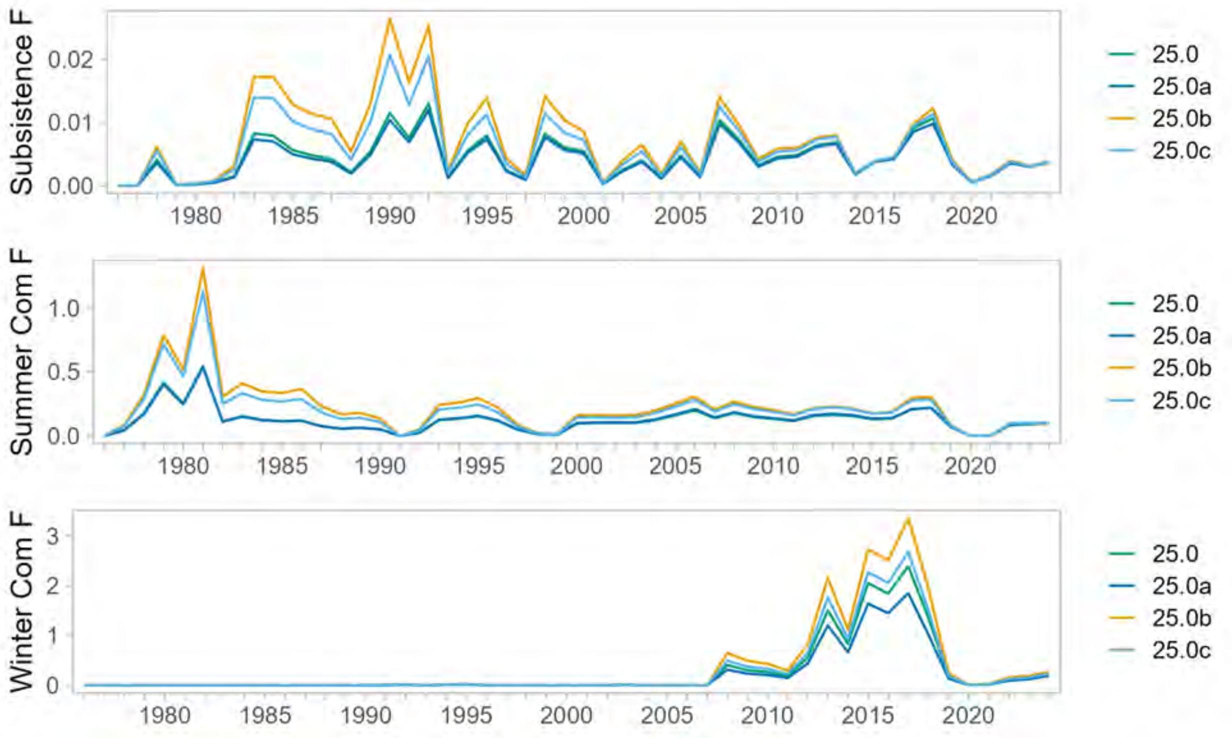


Figure 133: Comparison of estimated fishing mortality (F) for the subsistence, summer commercial, and winter commercial fisheries for the model with shell condition excluded (model 25.0) and three models exploring natural mortality (M). In model 25.0a, as in model 25.0, M is fixed for males with carapace length (CL) $\leq$ 123 mm and estimated for males with CL $>$ 123 mm; the fixed M value is 0.18 for model 25.0 and 0.23 for model 25.0a. Model 25.0b uses a size-independent $M = 0.18$. Model 25.0c uses a size-independent $M = 0.23$. Note that the scale for F differs among the panels.

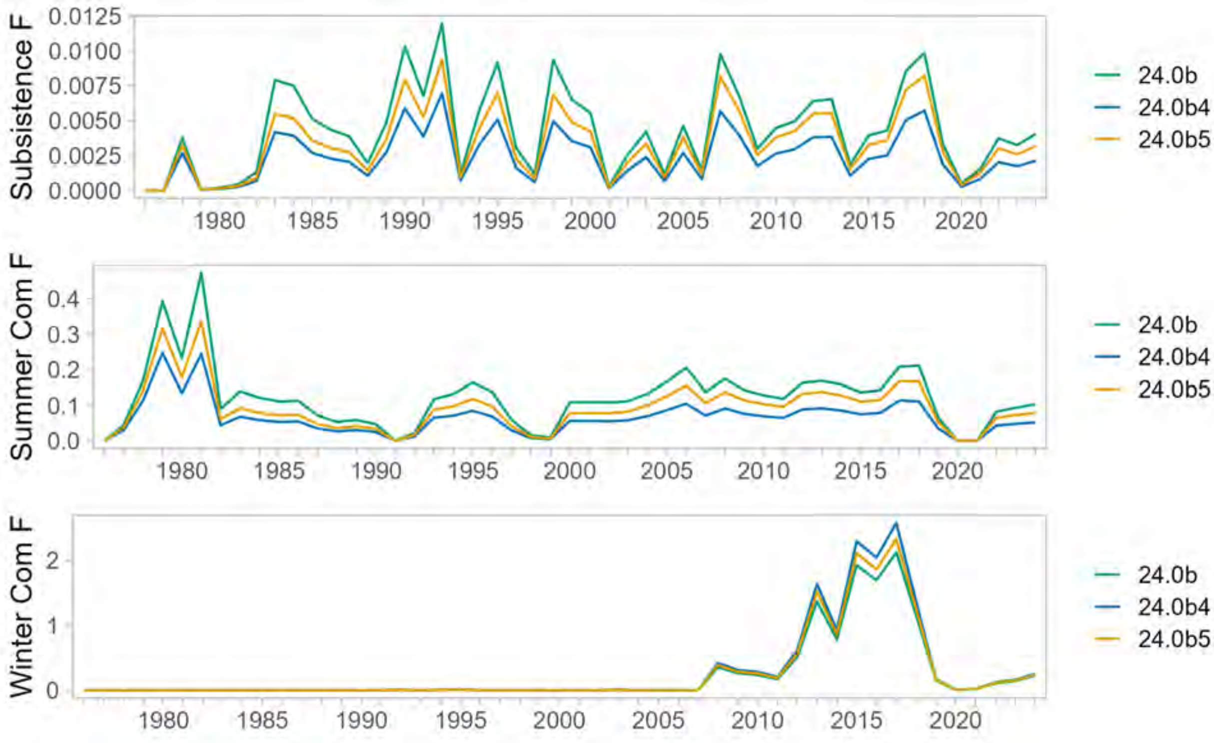


Figure 134: Comparison of estimated fishing mortality (F) for the subsistence, summer commercial, and winter commercial fisheries for the new base model (model 24.0b) and models using spatiotemporal model-based rather than design-based indices of abundance for the three trawl surveys. In model 24.0b4, abundance is estimated over the full area covered by all three surveys while, in model 24.0b5, abundance is estimated over the reduced area covered by the ADF&G trawl survey since 2010. Note that the scale for F differs among the panels.

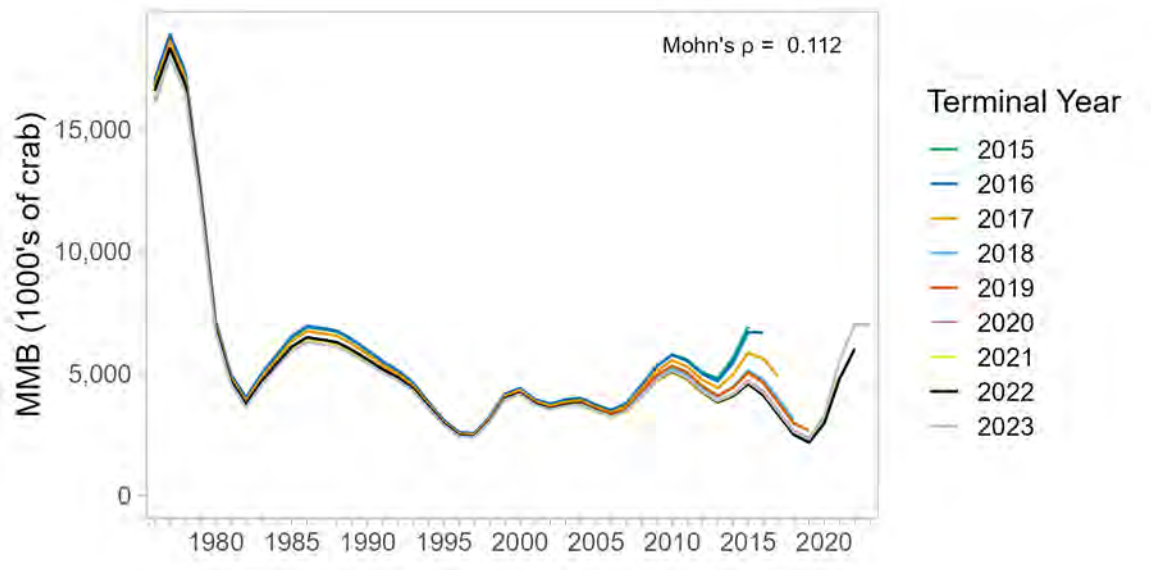


Figure 135: Retrospective patterns in estimated mature male biomass (MMB) for the new base model, 24.0b.

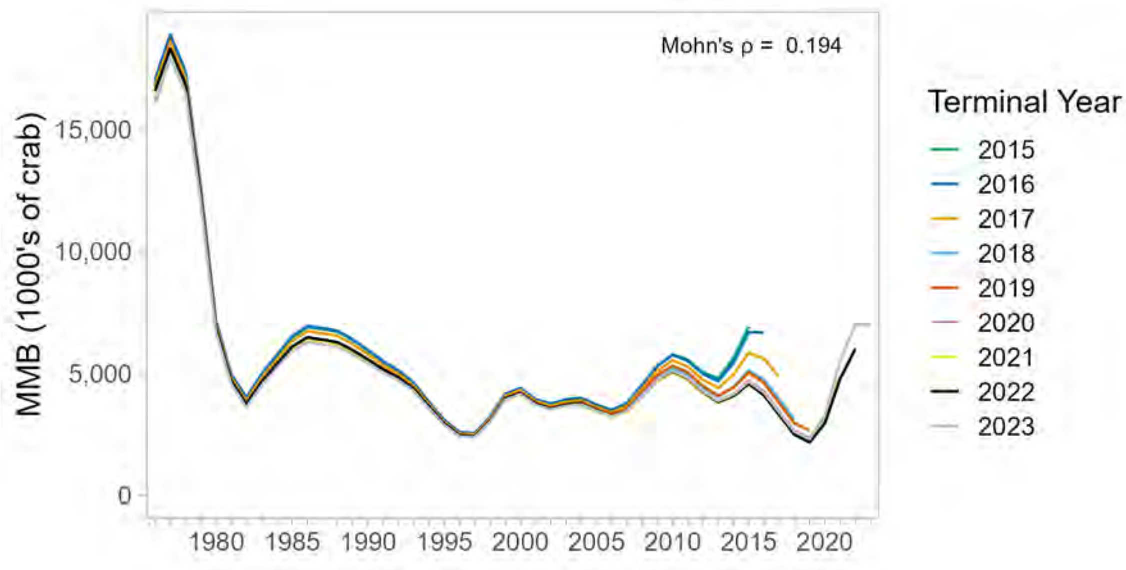


Figure 136: Retrospective patterns in estimated mature male biomass (MMB) for the new base model at the second lowest objective function value, 24.0b6.

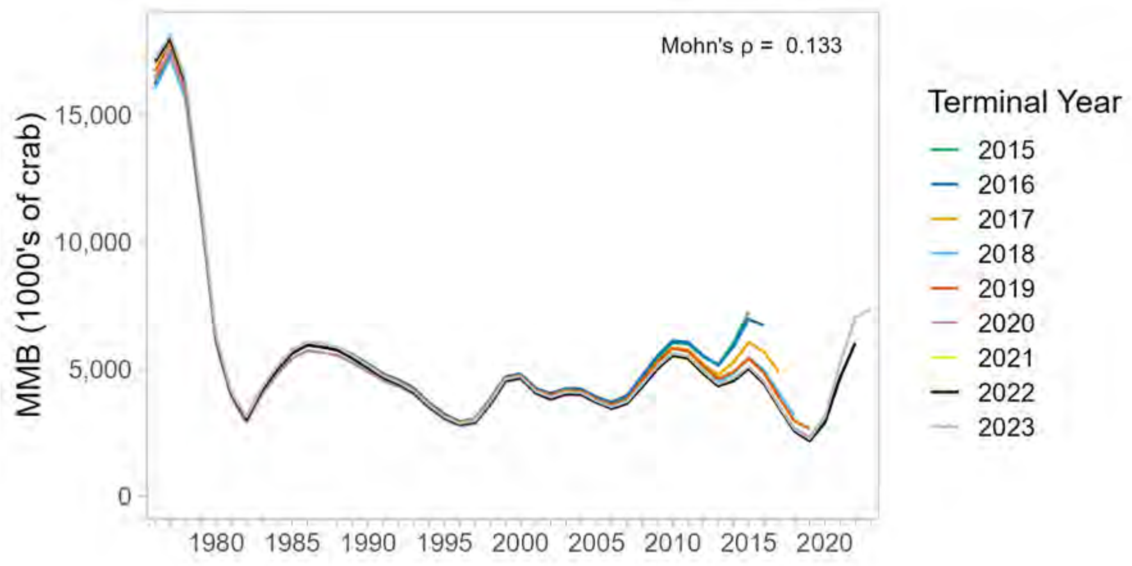


Figure 137: Retrospective patterns in estimated mature male biomass (MMB) for the new base model with shell condition removed, 25.0.

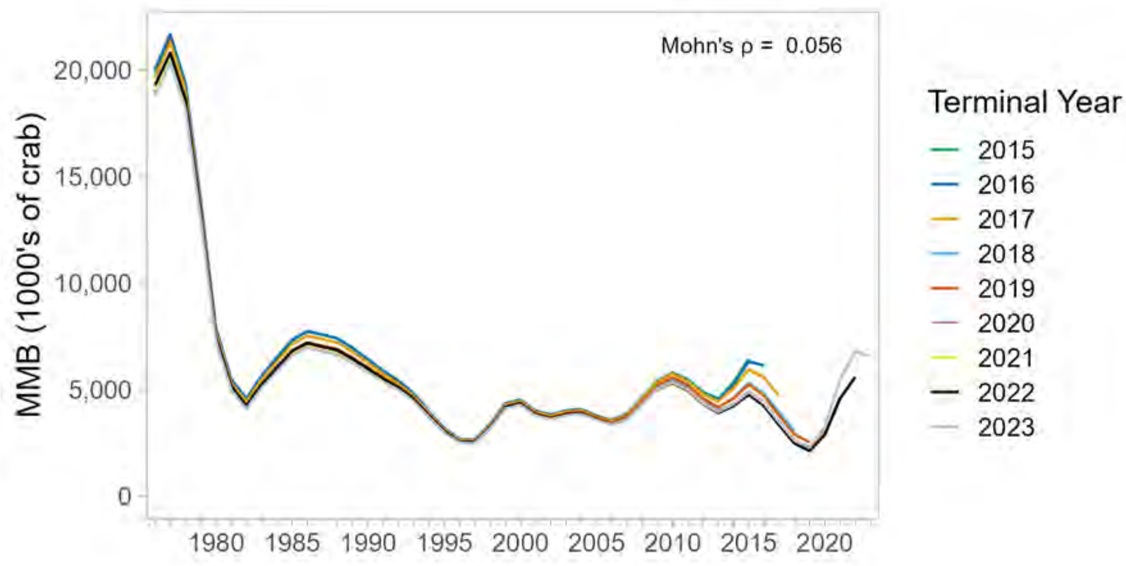


Figure 138: Retrospective patterns in estimated mature male biomass (MMB) for the new base model with natural mortality fixed at M = 0.23 for males less than or equal to 123 mm and M estimated for males > 123 mm in carapace length, 24.0b1.

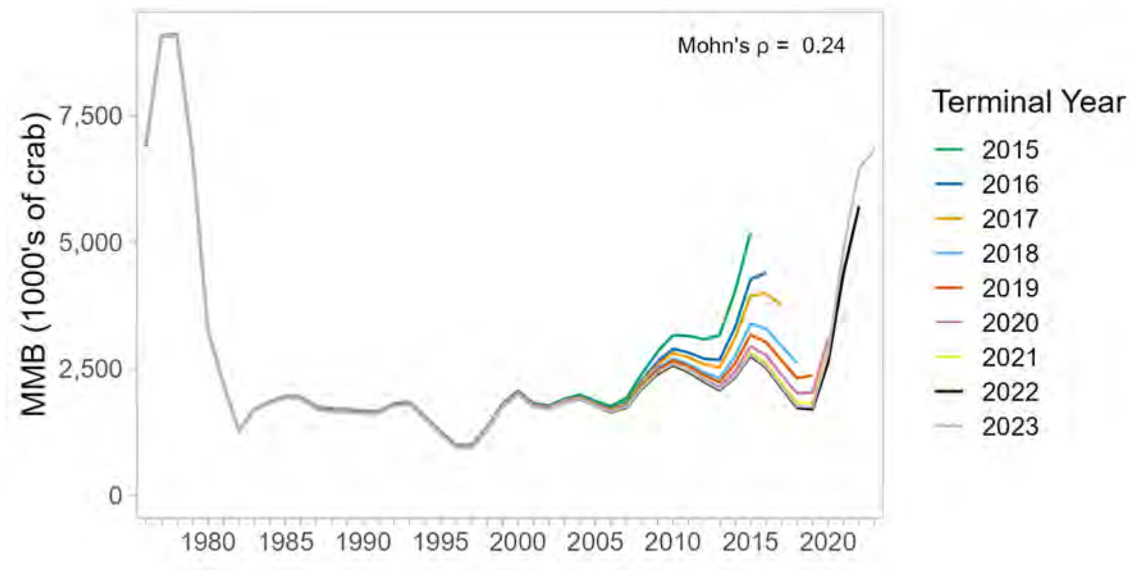


Figure 139: Retrospective patterns in estimated mature male biomass (MMB) for the new base model with natural mortality fixed at M = 0.18 for all size classes, 24.0b2.

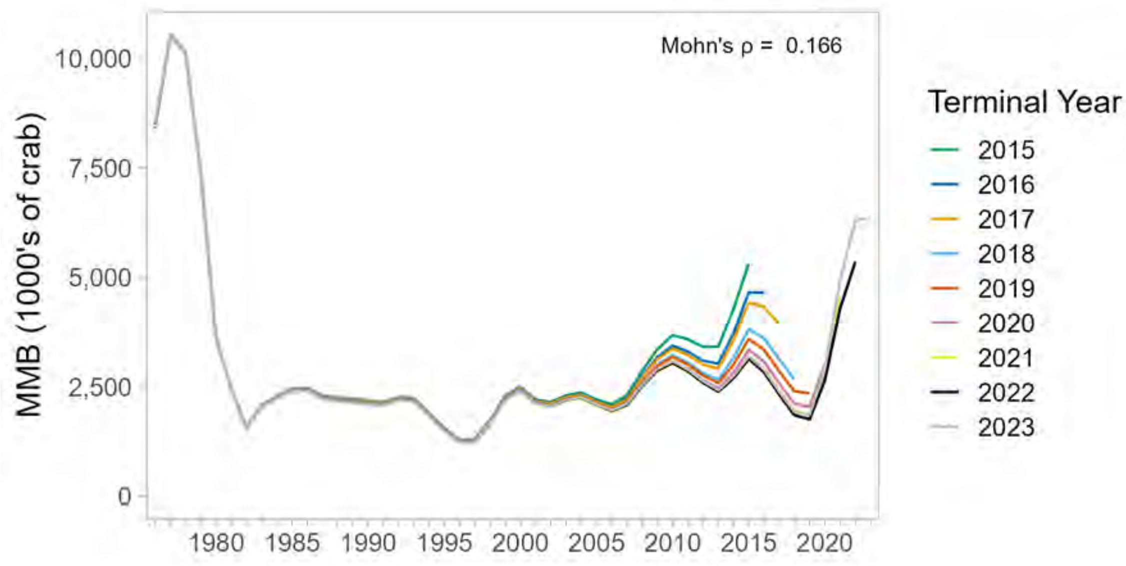


Figure 140: Retrospective patterns in estimated mature male biomass (MMB) for the new base model with natural mortality fixed at M = 0.23 for all size classes, 24.0b3.

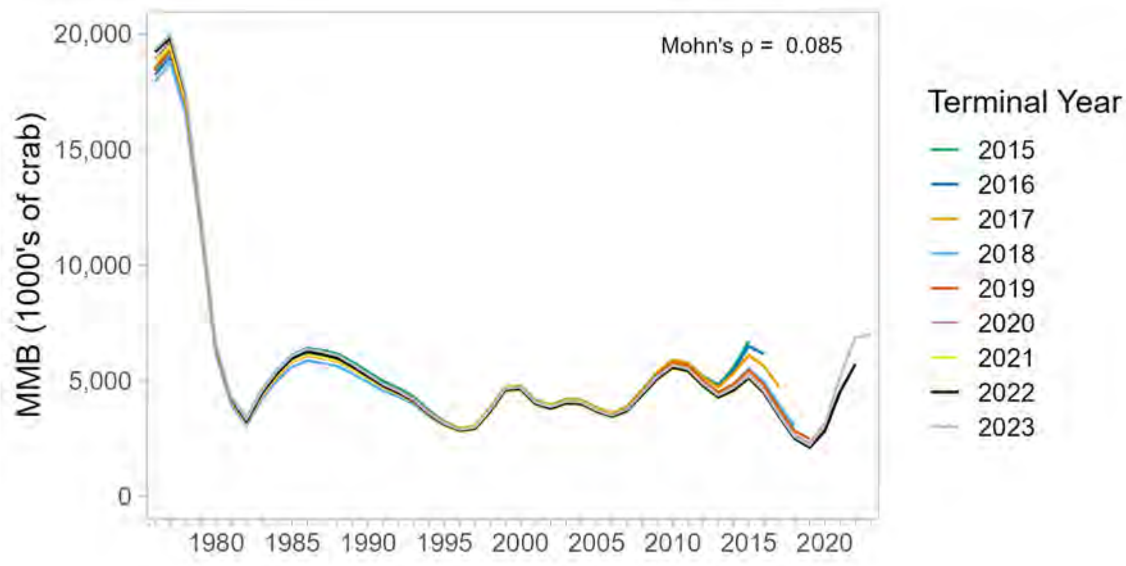


Figure 141: Retrospective patterns in estimated mature male biomass (MMB) for the model without shell condition with natural mortality fixed at M = 0.23 for males less than or equal to 123 mm and M estimated for males > 123 mm in carapace length, 25.0a.

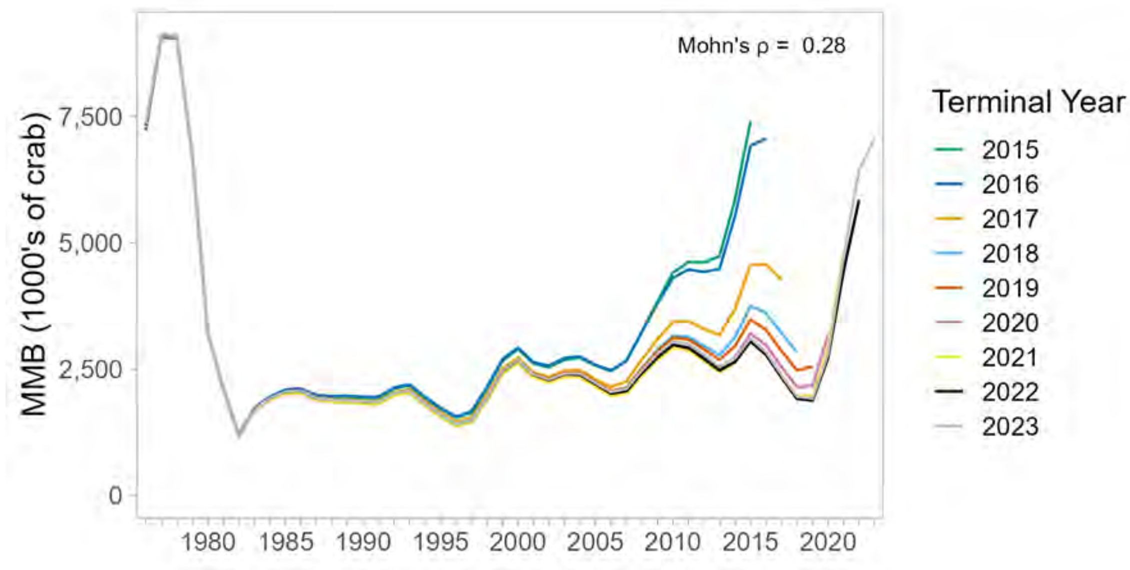


Figure 142: Retrospective patterns in estimated mature male biomass (MMB) for the model without shell condition with natural mortality fixed at M = 0.18 for all size classes, 25.0b.

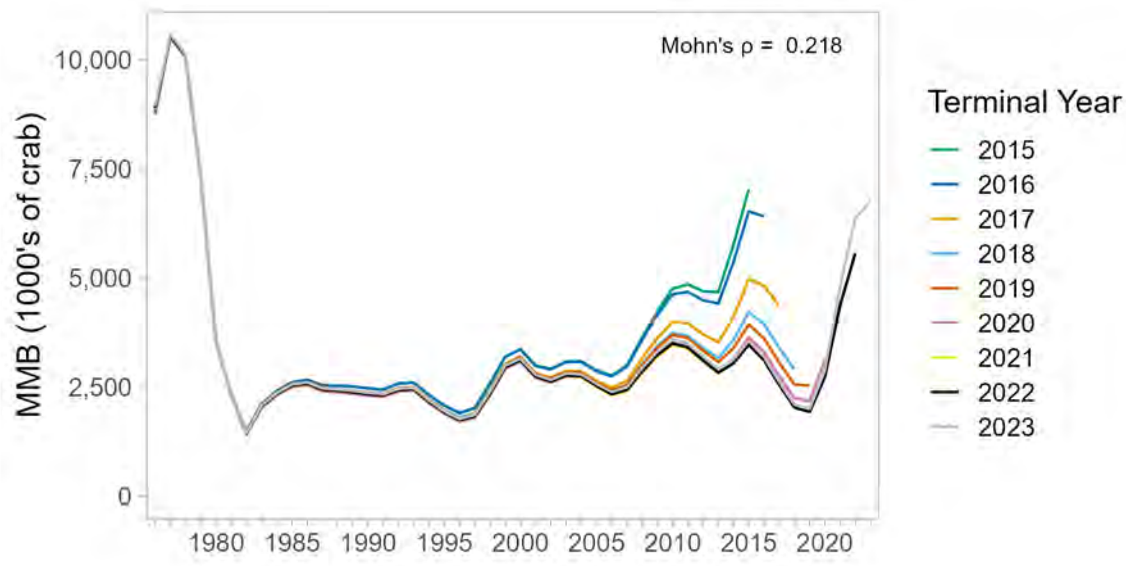


Figure 143: Retrospective patterns in estimated mature male biomass (MMB) for the model without shell condition with natural mortality fixed at M = 0.23 for all size classes, 25.0c.

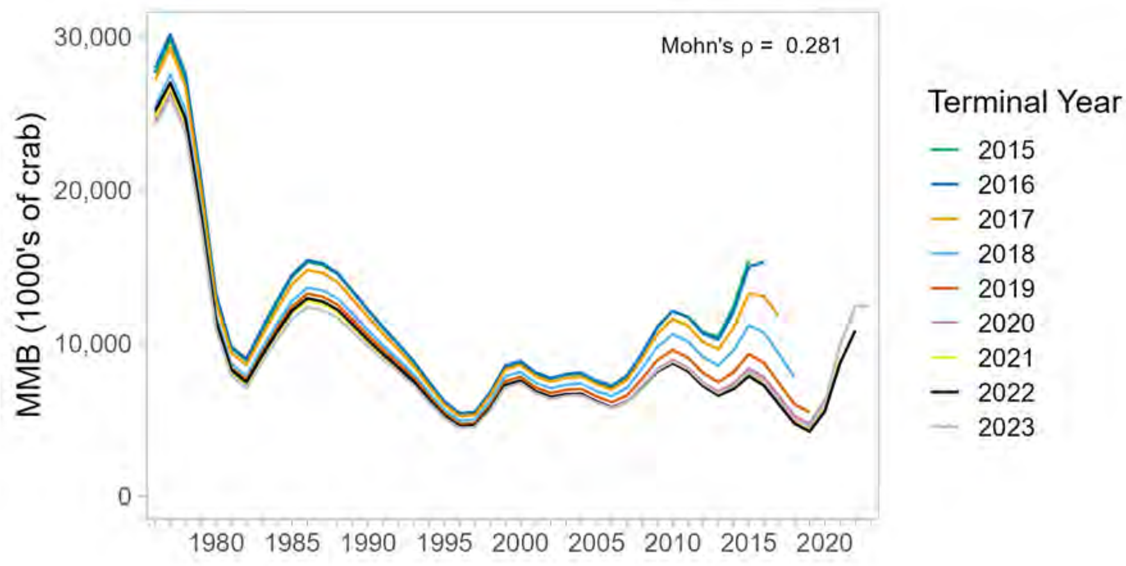


Figure 144: Retrospective patterns in estimated mature male biomass (MMB) for the new base model with spatiotemporal model-based rather than design-based indices of abundance for the three trawl surveys. In this model, 24.0b4, abundance is estimated over the full area covered by all three surveys.

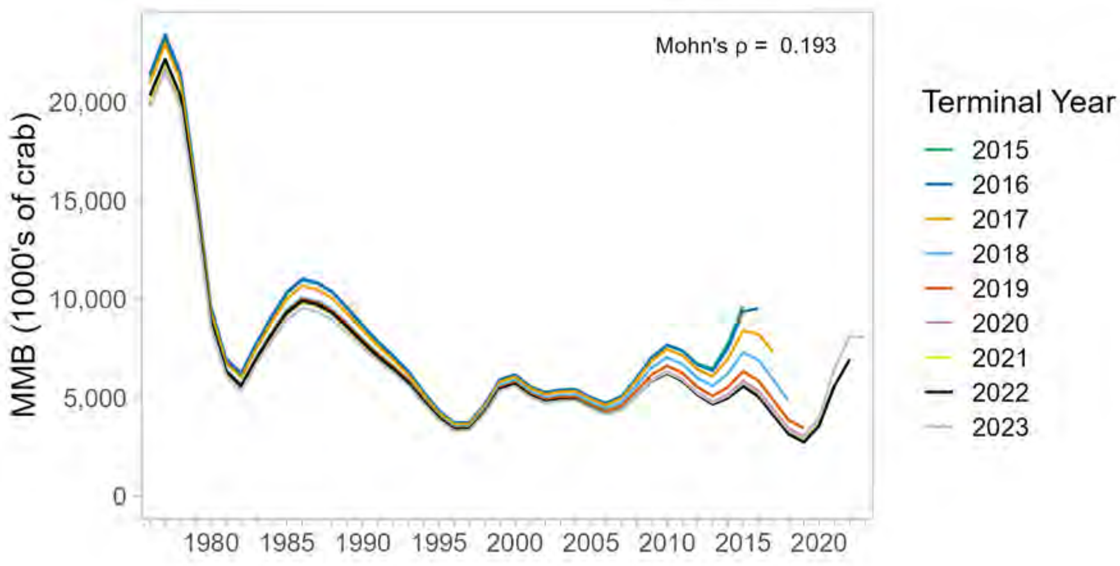


Figure 145: Retrospective patterns in estimated mature male biomass (MMB) for the new base model with spatiotemporal model-based rather than design-based indices of abundance for the three trawl surveys. In this model, 24.0b5, abundance is estimated over the reduced area covered by the ADF&G trawl survey since 2010.

Appendix A: GMACS data and control files

The new base model (24.0b) data file

```
#=========================================================================================================
# Gmacs Main  Data  File  NSRKC 2024 - January 2025 - used with GMACS version 2.20.20
# GEAR_INDEX   DESCRIPTION
#    1       : Winter Commercial Fishery Retained catch
#    2       : Winter Subsistence Fishery Retained catch
#    3       : Winter Subsistence Fishery Total catch
#    4       : Summer Commercial Fishery Retained catch
#    5       : Summer Commercial Fishery Total catch
#    6       : ADF&G Survey
#    7       : NMFS Survey
#    8       : Pot CPUE

# Fisheries:  1 Winter Pot Fishery, 2 Winter Subsistace, 3 Summer Pot Fishery
# Surveys:    4 NMFS Trawl Survey, 5 ADFG Trawl Survey, 6 NBS Trawl Survey, 7 Winter Pot survey
#=========================================================================================================

1976  # Start year
2024  # End year
#2025  # Projection year
7     # Number of seasons
7     # Number of distinct data groups (fleet, among fishing fleets and surveys)
1     # Number of sexes
2     # Number of shell condition types
1     # Number of maturity types
8     # Number of size-classes in the model
#6     # Season recruitment occurs
7     # Season recruitment occurs
#3     # Season molting and growth occurs
4     # Season molting and growth occurs
1     # Season to calculate SSB
1     # Season for N output
# maximum size-class (males then females)
8
# size_breaks (a vector giving the break points between size intervals with dimension nclass+1)
63.5    73.5    83.5    93.5    103.5   113.5   123.5   133.5   143.5
# Natural mortality per season input type (1 = vector by season, 2 = matrix by season/year)
2
# Proportion of the total natural mortality to be applied each season (each row must add to 1)
# 1. Winter Fishery (Feb01)
# 2. Mortality between winter and summer fishery
# 3. Summer fishery
# 4. Time between summer fishery and Nov 1 (Molt and recruit)
# 5. Time to Feb 01
# 6. Feb 01 recruit

0   0   0.3452055   0.1863014   0.1351932   0.3333  0 # 1976
```

```
0   0   0.3452055   0.1863014   0.1351932   0.3333  0 # 1977
0   0   0.3452055   0.1863014   0.1351932   0.3333  0 # 1978
0   0   0.4493151   0.04109589  0.176289    0.3333  0 # 1979
0   0   0.4493151   0.04109589  0.176289    0.3333  0 # 1980
0   0   0.4493151   0.1013699   0.1160151   0.3333  0 # 1981
0   0   0.5150685   0.06027397  0.09135753  0.3333  0 # 1982
0   0   0.4931507   0.0109589   0.1625904   0.3333  0 # 1983
0   0   0.4931507   0.03835616  0.1351932   0.3333  0 # 1984
0   0   0.4931507   0.06027397  0.1132753   0.3333  0 # 1985
0   0   0.4931507   0.06575342  0.1077959   0.3333  0 # 1986
0   0   0.4931507   0.03013699  0.1434123   0.3333  0 # 1987
0   0   0.4931507   0.02739726  0.1461521   0.3333  0 # 1988
0   0   0.4931507   0.008219178 0.1653301   0.3333  0 # 1989
0   0   0.4931507   0.0109589   0.1625904   0.3333  0 # 1990
0   0   0.4931507   0.0109589   0.1625904   0.3333  0 # 1991
0   0   0.4931507   0.005479452 0.1680699   0.3333  0 # 1992
0   0   0.4109589   0.1561644   0.09957671  0.3333  0 # 1993
0   0   0.4109589   0.07945205  0.176289    0.3333  0 # 1994
0   0   0.4109589   0.1643836   0.09135753  0.3333  0 # 1995
0   0   0.4109589   0.169863    0.08587808  0.3333  0 # 1996
0   0   0.4109589   0.1150685   0.1406726   0.3333  0 # 1997
0   0   0.4109589   0.169863    0.08587808  0.3333  0 # 1998
0   0   0.4109589   0.1726027   0.08313836  0.3333  0 # 1999
0   0   0.4109589   0.2410959   0.01464521  0.3333  0 # 2000
0   0   0.4109589   0.1863014   0.06943973  0.3333  0 # 2001
0   0   0.3671233   0.2136986   0.08587808  0.3333  0 # 2002
0   0   0.3671233   0.1890411   0.1105356   0.3333  0 # 2003
0   0   0.3671233   0.1452055   0.1543712   0.3333  0 # 2004
0   0   0.3671233   0.1972603   0.1023164   0.3333  0 # 2005
0   0   0.3671233   0.1835616   0.1160151   0.3333  0 # 2006
0   0   0.3671233   0.169863    0.1297137   0.3333  0 # 2007
0   0   0.3890411   0.1917808   0.08587808  0.3333  0 # 2008
0   0   0.3671233   0.260274    0.03930274  0.3333  0 # 2009
0   0   0.4027397   0.1534247   0.1105356   0.3333  0 # 2010
0   0   0.4027397   0.08767123  0.176289    0.3333  0 # 2011
0   0   0.4054795   0.1890411   0.07217945  0.3333  0 # 2012
0   0   0.4164384   0.1945205   0.0557411   0.3333  0 # 2013
0   0   0.3945205   0.1369863   0.1351932   0.3333  0 # 2014
0   0   0.4054795   0.06849315  0.1927274   0.3333  0 # 2015
0   0   0.4000000   0.06575342  0.2009466   0.3333  0 # 2016
0   0   0.3972603   0.07945205  0.1899877   0.3333  0 # 2017
0   0   0.3917808   0.09589041  0.1790288   0.3333  0 # 2018
0   0   0.3945205   0.1643836   0.1077959   0.3333  0 # 2019
0   0   0.3945205   0.1643836   0.1077959   0.3333  0 # 2020
0   0   0.3945205   0.1643836   0.1077959   0.3333  0 # 2021
0   0   0.3671233   0.109589    0.189987    0.3333  0 # 2022
0   0   0.3835616   0.07671233  0.206426    0.3333  0 # 2023
0   0   0.3643836   0.07945205  0.2228644   0.3333  0 # 2024

# Fishing fleet names (delimited with : no spaces in names)
Winter_Com Subsistence Summer_Com
# Survey names (delimited with : no spaces in names)
```

```
NMFS_Trawl ADFG_Trawl NBS_Trawl Winter_Pot
# Are the seasons instantaneous (0) or continuous (1)
1 1 1 1 1 1 1
# Use Old format (0)
0
# Number  of  catch data  frames
 4
# Number  of  rows  in  each  data  frame
 46  47  41 45
##  CATCH DATA
##  Type of catch: 1 = retained, 2 = discard
##  Units of catch: 1 = biomass, 2 = numbers

##      Winter commercial
# year  seas    fleet   sex     obs     cv      type    units   mult    effort  discard_mortality
1978    2   1   1   9.625   0.03    1   2   1   0   0.2
1979    2   1   1   0.221   0.03    1   2   1   0   0.2
1980    2   1   1   0.022   0.03    1   2   1   0   0.2
#1981   2   1   1   0   0.03    1   2   1   0   0.2
1982    2   1   1   0.017   0.03    1   2   1   0   0.2
1983    2   1   1   0.549   0.03    1   2   1   0   0.2
1984    2   1   1   0.856   0.03    1   2   1   0   0.2
1985    2   1   1   1.168   0.03    1   2   1   0   0.2
1986    2   1   1   2.168   0.03    1   2   1   0   0.2
1987    2   1   1   1.04    0.03    1   2   1   0   0.2
1988    2   1   1   0.425   0.03    1   2   1   0   0.2
1989    2   1   1   0.403   0.03    1   2   1   0   0.2
1990    2   1   1   3.626   0.03    1   2   1   0   0.2
1991    2   1   1   3.8 0.03    1   2   1   0   0.2
1992    2   1   1   7.478   0.03    1   2   1   0   0.2
1993    2   1   1   1.788   0.03    1   2   1   0   0.2
1994    2   1   1   5.753   0.03    1   2   1   0   0.2
1995    2   1   1   7.538   0.03    1   2   1   0   0.2
1996    2   1   1   1.778   0.03    1   2   1   0   0.2
1997    2   1   1   0.083   0.03    1   2   1   0   0.2
1998    2   1   1   0.984   0.03    1   2   1   0   0.2
1999    2   1   1   2.714   0.03    1   2   1   0   0.2
2000    2   1   1   3.045   0.03    1   2   1   0   0.2
2001    2   1   1   1.098   0.03    1   2   1   0   0.2
2002    2   1   1   2.591   0.03    1   2   1   0   0.2
2003    2   1   1   6.853   0.03    1   2   1   0   0.2
2004    2   1   1   0.522   0.03    1   2   1   0   0.2
2005    2   1   1   2.121   0.03    1   2   1   0   0.2
2006    2   1   1   0.075   0.03    1   2   1   0   0.2
2007    2   1   1   3.313   0.03    1   2   1   0   0.2
2008    2   1   1   5.796   0.03    1   2   1   0   0.2
2009    2   1   1   4.951   0.03    1   2   1   0   0.2
2010    2   1   1   4.834   0.03    1   2   1   0   0.2
2011    2   1   1   3.365   0.03    1   2   1   0   0.2
2012    2   1   1   9.157   0.03    1   2   1   0   0.2
2013    2   1   1   22.639  0.03    1   2   1   0   0.2
2014    2   1   1   14.986  0.03    1   2   1   0   0.2
```

```
2015    2   1   1   41.046  0.03    1   2   1   0   0.2
2016    2   1   1   29.792  0.03    1   2   1   0   0.2
2017    2   1   1   26.008  0.03    1   2   1   0   0.2
2018    2   1   1   9.18    0.03    1   2   1   0   0.2
2019    2   1   1   1.05    0.03    1   2   1   0   0.2
2020    2   1   1   0.08    0.03    1   2   1   0   0.2
2021    2   1   1   0.32    0.03    1   2   1   0   0.2
2022    2   1   1   2.708   0.03    1   2   1   0   0.2
2023    2   1   1   3.580   0.03    1   2   1   0   0.2
2024    2   1   1   4.830   0.03    1   2   1   0   0.2


#       Subsistence retained
1978    2   2   1   12.506  0.03    1   2   1   0   0.2
1979    2   2   1   0.224   0.03    1   2   1   0   0.2
1980    2   2   1   0.213   0.03    1   2   1   0   0.2
1981    2   2   1   0.36    0.03    1   2   1   0   0.2
1982    2   2   1   1.288   0.03    1   2   1   0   0.2
1983    2   2   1   10.432  0.03    1   2   1   0   0.2
1984    2   2   1   11.22   0.03    1   2   1   0   0.2
1985    2   2   1   8.377   0.03    1   2   1   0   0.2
1986    2   2   1   7.052   0.03    1   2   1   0   0.2
1987    2   2   1   5.772   0.03    1   2   1   0   0.2
1988    2   2   1   2.724   0.03    1   2   1   0   0.2
1989    2   2   1   6.126   0.03    1   2   1   0   0.2
1990    2   2   1   12.152  0.03    1   2   1   0   0.2
1991    2   2   1   7.366   0.03    1   2   1   0   0.2
1992    2   2   1   11.736  0.03    1   2   1   0   0.2
1993    2   2   1   1.097   0.03    1   2   1   0   0.2
1994    2   2   1   4.113   0.03    1   2   1   0   0.2
1995    2   2   1   5.426   0.03    1   2   1   0   0.2
1996    2   2   1   1.679   0.03    1   2   1   0   0.2
1997    2   2   1   0.745   0.03    1   2   1   0   0.2
1998    2   2   1   8.622   0.03    1   2   1   0   0.2
1999    2   2   1   7.533   0.03    1   2   1   0   0.2
2000    2   2   1   5.723   0.03    1   2   1   0   0.2
2001    2   2   1   0.256   0.03    1   2   1   0   0.2
2002    2   2   1   2.177   0.03    1   2   1   0   0.2
2003    2   2   1   4.14    0.03    1   2   1   0   0.2
2004    2   2   1   1.181   0.03    1   2   1   0   0.2
2005    2   2   1   3.973   0.03    1   2   1   0   0.2
2006    2   2   1   1.239   0.03    1   2   1   0   0.2
2007    2   2   1   10.69   0.03    1   2   1   0   0.2
2008    2   2   1   9.485   0.03    1   2   1   0   0.2
2009    2   2   1   4.752   0.03    1   2   1   0   0.2
2010    2   2   1   7.044   0.03    1   2   1   0   0.2
2011    2   2   1   6.64    0.03    1   2   1   0   0.2
2012    2   2   1   7.311   0.03    1   2   1   0   0.2
2013    2   2   1   7.622   0.03    1   2   1   0   0.2
2014    2   2   1   3.252   0.03    1   2   1   0   0.2
2015    2   2   1   7.651   0.03    1   2   1   0   0.2
2016    2   2   1   5.34    0.03    1   2   1   0   0.2
```

```
2017    2   2   1   6.039   0.03    1   2   1   0   0.2
2018    2   2   1   4.424   0.03    1   2   1   0   0.2
2019    2   2   1   1.54    0.03    1   2   1   0   0.2
2020    2   2   1   0.55    0.03    1   2   1   0   0.2
2021    2   2   1   2.892   0.03    1   2   1   0   0.2
2022    2   2   1   7.630   0.03    1   2   1   0   0.2
2023    2   2   1   5.407   0.03    1   2   1   0   0.2
2024    2   2   1   4.751   0.03    1   2   1   0   0.2

# Subsistence total
#1978   2   2   1   0       0.03    0   2   1   0   0.2
#1979   2   2   1   0       0.03    0   2   1   0   0.2
#1980   2   2   1   0       0.03    0   2   1   0   0.2
#1981   2   2   1   0       0.03    0   2   1   0   0.2
#1982   2   2   1   0       0.03    0   2   1   0   0.2
#1983   2   2   1   0       0.03    0   2   1   0   0.2
1984    2   2   1   15.923  0.03    0   2   1   0   0.2
1985    2   2   1   10.757  0.03    0   2   1   0   0.2
1986    2   2   1   10.751  0.03    0   2   1   0   0.2
1987    2   2   1   7.406   0.03    0   2   1   0   0.2
1988    2   2   1   3.573   0.03    0   2   1   0   0.2
1989    2   2   1   7.945   0.03    0   2   1   0   0.2
1990    2   2   1   16.635  0.03    0   2   1   0   0.2
1991    2   2   1   9.295   0.03    0   2   1   0   0.2
1992    2   2   1   15.051  0.03    0   2   1   0   0.2
1993    2   2   1   1.193   0.03    0   2   1   0   0.2
1994    2   2   1   4.894   0.03    0   2   1   0   0.2
1995    2   2   1   7.777   0.03    0   2   1   0   0.2
1996    2   2   1   2.936   0.03    0   2   1   0   0.2
1997    2   2   1   1.617   0.03    0   2   1   0   0.2
1998    2   2   1   20.327  0.03    0   2   1   0   0.2
1999    2   2   1   10.651  0.03    0   2   1   0   0.2
2000    2   2   1   9.816   0.03    0   2   1   0   0.2
2001    2   2   1   0.366   0.03    0   2   1   0   0.2
2002    2   2   1   5.119   0.03    0   2   1   0   0.2
2003    2   2   1   9.052   0.03    0   2   1   0   0.2
2004    2   2   1   1.775   0.03    0   2   1   0   0.2
2005    2   2   1   6.484   0.03    0   2   1   0   0.2
2006    2   2   1   2.083   0.03    0   2   1   0   0.2
2007    2   2   1   21.444  0.03    0   2   1   0   0.2
2008    2   2   1   18.621  0.03    0   2   1   0   0.2
2009    2   2   1   6.971   0.03    0   2   1   0   0.2
2010    2   2   1   9.004   0.03    0   2   1   0   0.2
2011    2   2   1   9.183   0.03    0   2   1   0   0.2
2012    2   2   1   11.341  0.03    0   2   1   0   0.2
2013    2   2   1   21.524  0.03    0   2   1   0   0.2
2014    2   2   1   5.421   0.03    0   2   1   0   0.2
2015    2   2   1   9.84    0.03    0   2   1   0   0.2
2016    2   2   1   6.468   0.03    0   2   1   0   0.2
2017    2   2   1   7.185   0.03    0   2   1   0   0.2
2018    2   2   1   5.767   0.03    0   2   1   0   0.2
2019    2   2   1   2.079   0.03    0   2   1   0   0.2
```

```
2020    2   2   1   0.815   0.03    0   2   1   0   0.2
2021    2   2   1   3.999   0.03    0   2   1   0   0.2
2022    2   2   1   10.041  0.03    0   2   1   0   0.2
2023    2   2   1   6.613   0.03    0   2   1   0   0.2
2024    2   2   1   5.9879  0.03    0   2   1   0   0.2

# Summer Commercial Retain
1977    4   3   1   195.877 0.03    1   2   1   0   0.2
1978    4   3   1   660.829 0.03    1   2   1   0   0.2
1979    4   3   1   970.962 0.03    1   2   1   0   0.2
1980    4   3   1   329.778 0.03    1   2   1   0   0.2
1981    4   3   1   376.313 0.03    1   2   1   0   0.2
1982    4   3   1   63.949  0.03    1   2   1   0   0.2
1983    4   3   1   132.205 0.03    1   2   1   0   0.2
1984    4   3   1   139.759 0.03    1   2   1   0   0.2
1985    4   3   1   146.669 0.03    1   2   1   0   0.2
1986    4   3   1   162.438 0.03    1   2   1   0   0.2
1987    4   3   1   103.338 0.03    1   2   1   0   0.2
1988    4   3   1   76.148  0.03    1   2   1   0   0.2
1989    4   3   1   79.116  0.03    1   2   1   0   0.2
1990    4   3   1   59.132  0.03    1   2   1   0   0.2
#1991   4   3   1   0   0.03    1   2   1   0   0.2
1992    4   3   1   24.902  0.03    1   2   1   0   0.2
1993    4   3   1   115.913 0.03    1   2   1   0   0.2
1994    4   3   1   108.824 0.03    1   2   1   0   0.2
1995    4   3   1   105.967 0.03    1   2   1   0   0.2
1996    4   3   1   74.752  0.03    1   2   1   0   0.2
1997    4   3   1   32.606  0.03    1   2   1   0   0.2
1998    4   3   1   10.661  0.03    1   2   1   0   0.2
1999    4   3   1   8.734   0.03    1   2   1   0   0.2
2000    4   3   1   111.728 0.03    1   2   1   0   0.2
2001    4   3   1   98.321  0.03    1   2   1   0   0.2
2002    4   3   1   86.666  0.03    1   2   1   0   0.2
2003    4   3   1   93.638  0.03    1   2   1   0   0.2
2004    4   3   1   120.289 0.03    1   2   1   0   0.2
2005    4   3   1   138.926 0.03    1   2   1   0   0.2
2006    4   3   1   150.358 0.03    1   2   1   0   0.2
2007    4   3   1   110.344 0.03    1   2   1   0   0.2
2008    4   3   1   143.337 0.03    1   2   1   0   0.2
2009    4   3   1   143.485 0.03    1   2   1   0   0.2
2010    4   3   1   149.822 0.03    1   2   1   0   0.2
2011    4   3   1   141.626 0.03    1   2   1   0   0.2
2012    4   3   1   161.113 0.03    1   2   1   0   0.2
2013    4   3   1   130.603 0.03    1   2   1   0   0.2
2014    4   3   1   129.656 0.03    1   2   1   0   0.2
2015    4   3   1   144.225 0.03    1   2   1   0   0.2
2016    4   3   1   138.997 0.03    1   2   1   0   0.2
2017    4   3   1   135.322 0.03    1   2   1   0   0.2
2018    4   3   1   89.613  0.03    1   2   1   0   0.2
2019    4   3   1   23.964  0.03    1   2   1   0   0.2
#2020   4   3   1   0   0.03    1   2   1   0   0.2
#2021   4   3   1   0   0.03    1   2   1   0   0.2
```

```
2022    4   3   1   125.042 0.03    1   2   1   0   0.2
2023    4   3   1   148.062 0.03    1   2   1   0   0.2
2024    4   3   1   140.379 0.03    1   2   1   0   0.2

##  RELATIVE  ABUNDANCE DATA
##  Units of abundance: 1 = biomass, 2 = numbers
## Use old format (0)
0
##  Number  of  relative  abundance indicies
6
# Type of 'survey' catchability (1=Selectivity; 2=Selectivity+Retention), by data frame
1 1 1 2 2 2
##  Number  of  rows  in    index
71
# ADFG/NOAA Trawl survey
#Index  Year    Season  Fleet   Sex Maturity    Value   CV  Type    Time
1   1976    4   4   1   0   4247.462    0.311   2   1.411765
1   1979    4   4   1   0   1417.215    0.204   2   1
1   1982    4   4   1   0   2791.733    0.289   2   1.318182
1   1985    4   4   1   0   2306.321    0.254   2   2.363636
1   1988    4   4   1   0   2263.353    0.288   2   2.2
1   1991    4   4   1   0   3132.508    0.428   2   6.25

#   ADFG    Trawl survey
2   1996    4   5   1   0   1313.757    0.259   2   0.6612903
2   1999    4   5   1   0   2630.53     0.236   2   0.4920635
2   2002    4   5   1   0   1769.85     0.418   2   0.5897436
2   2006    4   5   1   0   3322.53     0.391   2   0.6865672
2   2008    4   5   1   0   2962.1      0.30    2   0.5571429
2   2011    4   5   1   0   3209.285    0.289   2   1.03125
2   2014    4   5   1   0   5949.46     0.473   2   0.58
2   2017    4   5   1   0   1762.072    0.223   2   1.241379
2   2018    4   5   1   0   1109.39     0.249   2   0.8857143
2   2019    4   5   1   0   4675.99     0.598   2   0.4666667
2   2020    4   5   1   0   1725.99     0.298   2   0.7
2   2021    4   5   1   0   2430.44     0.608   2   0.5166667
2   2023    4   5   1   0   3548.08     0.315   2   1.214286
2   2024    4   5   1   0   1407.401    0.281   2   1.413793


#   NOAA    NBS survey
3   2010    4   6   1   0   1980.079    0.436   2   0.6071429
3   2017    4   6   1   0   864.497     0.467   2   1.965517
3   2019    4   6   1   0   2071.94     0.346   2   0.5882353
3   2021    4   6   1   0   2338.06     0.441   2   0.6666667
3   2022    4   6   1   0   2103.02     0.363   2   0.6166667
3   2023    4   6   1   0   1686.34 0.391   2   1.3


#   ST  CPUE
4   1977    4   3   1   0   2.82    0.35    2   0.5
4   1978    4   3   1   0   3.41    0.23    2   0.5
```

```
4   1979   4   3   1   0   1.55   0.22   2   0.5
4   1980   4   3   1   0   1.82   0.28   2   0.5
4   1981   4   3   1   0   0.62   0.20   2   0.5
4   1982   4   3   1   0   0.18   0.27   2   0.5
4   1983   4   3   1   0   0.72   0.22   2   0.5
4   1984   4   3   1   0   1.11   0.23   2   0.5
4   1985   4   3   1   0   0.67   0.24   2   0.5
4   1986   4   3   1   0   1.63   0.52   2   0.5
4   1987   4   3   1   0   0.64   0.35   2   0.5
4   1988   4   3   1   0   1.60   0.71   2   0.5
4   1989   4   3   1   0   1.35   0.33   2   0.5
4   1990   4   3   1   0   1.06   0.45   2   0.5
4   1992   4   3   1   0   0.26   0.32   2   0.5
5   1993   4   3   1   0   1.02   0.09   2   0.5
5   1994   4   3   1   0   0.44   0.17   2   0.5
5   1995   4   3   1   0   1.09   0.13   2   0.5
5   1996   4   3   1   0   1.01   0.09   2   0.5
5   1997   4   3   1   0   1.14   0.09   2   0.5
5   1998   4   3   1   0   1.31   0.12   2   0.5
5   1999   4   3   1   0   0.97   0.10   2   0.5
5   2000   4   3   1   0   2.08   0.11   2   0.5
5   2001   4   3   1   0   0.76   0.25   2   0.5
5   2002   4   3   1   0   0.76   0.09   2   0.5
5   2003   4   3   1   0   1.65   0.08   2   0.5
5   2004   4   3   1   0   1.36   0.07   2   0.5
5   2005   4   3   1   0   0.64   0.12   2   0.5
5   2006   4   3   1   0   0.93   0.10   2   0.5
6   2007   4   3   1   0   0.88   0.22   2   0.5
6   2008   4   3   1   0   1.18   0.05   2   0.5
6   2009   4   3   1   0   0.81   0.04   2   0.5
6   2010   4   3   1   0   1.19   0.05   2   0.5
6   2011   4   3   1   0   1.36   0.05   2   0.5
6   2012   4   3   1   0   1.20   0.04   2   0.5
6   2013   4   3   1   0   0.62   0.04   2   0.5
6   2014   4   3   1   0   0.94   0.04   2   0.5
6   2015   4   3   1   0   1.17   0.05   2   0.5
6   2016   4   3   1   0   1.03   0.05   2   0.5
6   2017   4   3   1   0   0.88   0.05   2   0.5
6   2018   4   3   1   0   0.51   0.05   2   0.5
6   2019   4   3   1   0   0.24   0.06   2   0.5
6   2022   4   3   1   0   1.31   0.07   2   0.5
6   2023   4   3   1   0   2.00   0.07   2   0.5
6   2024   4   3   1   0   2.63   0.14   2   0.5

## Use old format (0)
0
##  Number  of  length  frequency matrices
16
##  Number  of  rows  in  each  matrix
4 4 45 45 14 14 8 8 6 6 14 14 6 6 27 27
##  Number  of  bins  in  each  matrix  (columns  of  size  data)
8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
```

```
##  SIZE  COMPOSITION DATA  FOR ALL FLEETS
##  SIZE  COMP  LEGEND
##  Sex:  1 = male, 2 = female, 0 = both  sexes combined
##  Type  of  composition:  1 = retained, 2 = discard,  0 = total composition
##  Maturity  state:  1 = immature, 2 = mature, 0 = both  states  combined
##  Shell condition:  1 = new shell,  2 = old shell,  0 = both  shell types combined

##Winter        Com     Retain  newshell
##Year, Seas,   Fleet,  Sex,    Type,   Shell,  Maturity,       Nsamp,  DataVec
2015    2   1   1   1   1   0   10  0   0   0   43  287 138 35  3
2016    2   1   1   1   1   0   10  0   0   0   29  462 318 35  5
2017    2   1   1   1   1   0   10  0   0   0   1   110 162 71  9
2018    2   1   1   1   1   0   10  0   0   0   0   43  102 107 21

##Winter        Com     Retain  oldshell
##Year, Seas,   Fleet,  Sex,    Type,   Shell,  Maturity,       Nsamp,  DataVec
2015    2   1   1   1   2   0   10  0   0   0   6   23  17  17  7
2016    2   1   1   1   2   0   10  0   0   0   8   93  42  16  8
2017    2   1   1   1   2   0   10  0   0   0   1   42  101 32  11
2018    2   1   1   1   2   0   10  0   0   0   0   15  64  39  10

##Summer    Com Retain  newshell
##Year, Seas,   Fleet,  Sex,    Type,   Shell,  Maturity,   Nsamp,  DataVec
1977    4   3   1   1   1   0   10  0   0   0   5   650 530 119 70
1978    4   3   1   1   1   0   10  0   0   0   4   72  184 103 16
1979    4   3   1   1   1   0   10  0   0   0   42  386 636 425 109
1980    4   3   1   1   1   0   10  0   0   0   4   105 327 396 196
1981    4   3   1   1   1   0   10  0   0   0   7   131 275 502 406
1982    4   3   1   1   1   0   10  0   0   0   46  210 180 239 313
1983    4   3   1   1   1   0   10  0   0   0   31  331 287 51  27
1984    4   3   1   1   1   0   10  0   0   0   93  404 270 62  7
1985    4   3   1   1   1   0   10  0   0   1   173 840 1000    417 53
1986    4   3   1   1   1   0   10  0   0   0   33  405 448 134 20
1987    4   3   1   1   1   0   10  0   0   0   33  355 578 539 215
1988    4   3   1   1   1   0   10  0   1   0   36  305 457 274 58
1989    4   3   1   1   1   0   10  0   0   0   33  426 826 442 117
1990    4   3   1   1   1   0   10  0   0   0   19  185 447 331 88
#1991   4   3   1   1   1   0   10  0   0   0   0   0   0   0   0
1992    4   3   1   1   1   0   10  0   0   0   44  515 682 350 229
1993    4   3   1   1   1   0   10  0   0   0   253 4116    7013    4095    589
1994    4   3   1   1   1   0   10  0   0   0   10  38  33  28  8
1995    4   3   1   1   1   0   10  0   0   0   46  307 335 176 60
1996    4   3   1   1   1   0   10  0   0   0   25  176 188 74  37
1997    4   3   1   1   1   0   10  0   0   0   35  438 409 119 30
1998    4   3   1   1   1   0   10  0   0   0   30  246 256 85  28
1999    4   3   1   1   1   0   10  0   0   0   36  165 137 103 53
2000    4   3   1   1   1   0   10  0   0   0   334 5149    6743    1884    266
2001    4   3   1   1   1   0   10  0   0   0   487 4472    7394    4116    1455
2002    4   3   1   1   1   0   10  0   0   0   231 1222    1469    1316    382
2003    4   3   1   1   1   0   10  0   0   0   121 1923    1671    634 162
2004    4   3   1   1   1   0   10  0   0   0   84  3660    3727    1016    324
2005    4   3   1   1   1   0   10  0   0   0   12  1361    2524    860 117
```

```
2006    4   3   1   1   1   0   10  0   0   0   14  1222    2337    1168    167
2007    4   3   1   1   1   0   10  0   0   0   68  2189    2087    842 208
2008    4   3   1   1   1   0   10  0   0   0   27  2025    2004    322 63
2009    4   3   1   1   1   0   10  0   0   0   63  2076    1985    675 132
2010    4   3   1   1   1   0   10  0   0   0   31  2275    2135    586 60
2011    4   3   1   1   1   0   10  0   0   0   11  809 1013    294 60
2012    4   3   1   1   1   0   10  0   0   0   13  1224    2336    932 113
2013    4   3   1   1   1   0   10  0   0   0   27  1450    2253    1465    369
2014    4   3   1   1   1   0   10  0   0   0   40  1324    1105    866 335
2015    4   3   1   1   1   0   10  0   0   0   58  1987    1177    418 122
2016    4   3   1   1   1   0   10  0   0   0   5   392 731 247 48
2017    4   3   1   1   1   0   10  0   0   0   4   602 1341    728 86
2018    4   3   1   1   1   0   10  0   0   0   9   300 842 845 197
2019    4   3   1   1   1   0   10  0   0   0   10  364 260 151 29
#2020   4   3   1   1   1   0   10  0   0   0   0   0   0   0   0
#2021   4   3   1   1   1   0   10  0   0   0   0   0   0   0   0
2022    4   3   1   1   1   0   10  0   0   0   56  1375    892 96  5
2023    4   3   1   1   1   0   10  0   0   0   10  645 1027 331 25
2024    4   3   1   1   1   0   10  0   0   0   4   312 1008    833 184

##Summer    Com Retain  oldshell
##Year, Seas,   Fleet,  Sex,    Type,   Shell,  Maturity,   Nsamp,  DataVec
1977    4   3   1   1   2   0   10  0   0   0   0   97  62  10  6
1978    4   3   1   1   2   0   10  0   0   0   0   2   4   3   1
1979    4   3   1   1   2   0   10  0   0   0   0   42  1   5   14
1980    4   3   1   1   2   0   10  0   0   0   0   3   12  17  8
1981    4   3   1   1   2   0   10  0   0   0   0   8   90  207 158
1982    4   3   1   1   2   0   10  0   0   0   4   14  24  33  30
1983    4   3   1   1   2   0   10  0   0   0   3   29  8   17  18
1984    4   3   1   1   2   0   10  0   0   0   10  63  47  6   1
1985    4   3   1   1   2   0   10  0   0   0   7   90  84  23  3
1986    4   3   1   1   2   0   10  0   0   0   2   23  43  27  3
1987    4   3   1   1   2   0   10  0   0   0   5   53  129 60  18
1988    4   3   1   1   2   0   10  0   0   0   9   98  148 107 29
1989    4   3   1   1   2   0   10  0   0   0   11  144 315 221 60
1990    4   3   1   1   2   0   10  0   0   0   1   48  95  61  14
#1991   4   3   1   1   2   0   10  0   0   0   0   0   0   0   0
1992    4   3   1   1   2   0   10  0   0   0   7   203 331 153 52
1993    4   3   1   1   2   0   10  0   0   0   7   308 778 512 133
1994    4   3   1   1   2   0   10  0   0   0   10  76  101 81  19
1995    4   3   1   1   2   0   10  0   0   0   9   57  87  75  15
1996    4   3   1   1   2   0   10  0   0   0   11  94  107 62  13
1997    4   3   1   1   2   0   10  0   0   0   4   67  50  32  14
1998    4   3   1   1   2   0   10  0   0   0   23  118 151 86  32
1999    4   3   1   1   2   0   10  0   0   0   1   13  27  25  2
2000    4   3   1   1   2   0   10  0   0   0   48  914 1125    609 141
2001    4   3   1   1   2   0   10  0   0   0   17  483 996 476 134
2002    4   3   1   1   2   0   10  0   0   0   24  147 219 165 44
2003    4   3   1   1   2   0   10  0   0   0   6   114 243 276 76
2004    4   3   1   1   2   0   10  0   0   0   4   245 333 143 70
2005    4   3   1   1   2   0   10  0   0   0   0   110 242 102 32
2006    4   3   1   1   2   0   10  0   0   0   2   334 922 464 77
```

```
2007    4   3   1   1   2   0   10  0   0   0   5   151 351 186 38
2008    4   3   1   1   2   0   10  0   0   0   8   516 535 204 62
2009    4   3   1   1   2   0   10  0   0   0   7   463 479 114 32
2010    4   3   1   1   2   0   10  0   0   0   11  322 322 136 24
2011    4   3   1   1   2   0   10  0   0   0   5   156 150 42  12
2012    4   3   1   1   2   0   10  0   0   0   1   131 214 79  13
2013    4   3   1   1   2   0   10  0   0   0   2   85  256 137 28
2014    4   3   1   1   2   0   10  0   0   0   1   193 405 336 77
2015    4   3   1   1   2   0   10  0   0   0   3   99  137 137 35
2016    4   3   1   1   2   0   10  0   0   0   2   27  36  45  10
2017    4   3   1   1   2   0   10  0   0   0   3   100 384 164 22
2018    4   3   1   1   2   0   10  0   0   0   0   23  197 196 50
2019    4   3   1   1   2   0   10  0   0   0   0   18  119 154 31
#2020   4   3   1   1   2   0   10  0   0   0   0   0   0   0   0
#2021   4   3   1   1   2   0   10  0   0   0   0   0   0   0   0
2022    4   3   1   1   2   0   10  0   0   0   20  359 149 24  5
2023    4   3   1   1   2   0   10  0   0   0   1   169 209 36  5
2024    4   3   1   1   2   0   10  0   0   0   0   59  178 96  12

##Summer    Com Discards    newshell
##Year, Seas,   Fleet,  Sex,    Type,   Shell,  Maturity,   Nsamp,  DataVec
1987    4   3   1   2   1   0   10  69  216 367 379 37  0   0   0
1988    4   3   1   2   1   0   10  9   29  108 344 99  0   0   0
1989    4   3   1   2   1   0   10  71  193 242 216 25  0   0   0
1990    4   3   1   2   1   0   10  40  115 137 139 19  0   0   0
1992    4   3   1   2   1   0   10  65  99  173 171 19  0   0   0
1994    4   3   1   2   1   0   10  63  50  92  126 19  0   0   0
2012    4   3   1   2   1   0   10  242 137 195 313 97  9   0   0
2013    4   3   1   2   1   0   10  845 722 390 416 113 6   2   0
2014    4   3   1   2   1   0   10  79  175 460 724 207 14  4   0
2015    4   3   1   2   1   0   10  26  120 278 709 303 37  11  1
2016    4   3   1   2   1   0   10  19  22  71  215 71  7   0   0
2017    4   3   1   2   1   0   10  53  88  73  166 137 8   0   0
2018    4   3   1   2   1   0   10  52  91  189 160 12  0   0   0
2019    4   3   1   2   1   0   10  30  13  14  25  2   0   0   0

##Summer    Com Discards    oldshell
##Year, Seas,   Fleet,  Sex,    Type,   Shell,  Maturity,   Nsamp,  DataVec
1987    4   3   1   2   2   0   10  0   2   23  47  5   0   0   0
1988    4   3   1   2   2   0   10  2   8   23  69  31  0   0   0
1989    4   3   1   2   2   0   10  18  34  67  109 25  0   0   0
1990    4   3   1   2   2   0   10  8   9   10  27  3   0   0   0
1992    4   3   1   2   2   0   10  3   13  11  23  5   0   0   0
1994    4   3   1   2   2   0   10  61  63  128 205 43  0   0   0
2012    4   3   1   2   2   0   10  2   2   2   22  22  0   1   0
2013    4   3   1   2   2   0   10  2   1   1   7   2   2   0   0
2014    4   3   1   2   2   0   10  0   4   15  50  19  3   1   0
2015    4   3   1   2   2   0   10  0   0   2   24  17  6   1   4
2016    4   3   1   2   2   0   10  0   0   1   12  6   2   0   0
2017    4   3   1   2   2   0   10  2   2   3   2   7   0   0   0
2018    4   3   1   2   2   0   10  0   6   12  7   1   0   0   1
2019    4   3   1   2   2   0   10  0   0   1   8   1   0   0   0
```

```
##Summer    Com total   newshell
##Year, Seas,   Fleet,  Sex,    Type,   Shell,  Maturity,   Nsamp,  DataVec
2012    4   3   1   0   1   0   10  242 137 195 339 385 437 150 19
2013    4   3   1   0   1   0   10  845 722 390 481 722 747 397 68
2014    4   3   1   0   1   0   10  79  175 460 754 782 419 296 115
2015    4   3   1   0   1   0   10  26  120 278 794 1177    440 162 48
2016    4   3   1   0   1   0   10  19  22  71  247 607 755 173 35
2017    4   3   1   0   1   0   10  53  88  73  168 514 894 496 63
2018    4   3   1   0   1   0   10  52  91  189 181 144 277 294 69
2019    4   3   1   0   1   0   10  30  13  14  30  20  11  2   1

##Summer    Com total   oldshell
##Year, Seas,   Fleet,  Sex,    Type,   Shell,  Maturity,   Nsamp,  DataVec
2012    4   3   1   0   2   0   10  2   2   2   25  91  92  34  4
2013    4   3   1   0   2   0   10  2   1   1   8   55  103 43  12
2014    4   3   1   0   2   0   10  0   4   15  54  97  119 87  50
2015    4   3   1   0   2   0   10  0   0   2   27  54  42  32  13
2016    4   3   1   0   2   0   10  0   0   1   14  64  67  34  5
2017    4   3   1   0   2   0   10  2   2   3   3   64  186 86  20
2018    4   3   1   0   2   0   10  0   6   12  10  25  109 127 40
2019    4   3   1   0   2   0   10  0   0   1   9   25  34  34  12

##NMFS      Trawl   newshell
##Year, Seas,   Fleet,  Sex,    Type,   Shell,  Maturity,   Nsamp,  DataVec
1976    4   4   1   0   1   0   20  10  17  81  77  85  60  13  4
1979    4   4   1   0   1   0   20  3   2   1   4   10  11  6   2
1982    4   4   1   0   1   0   20  71  20  42  60  47  9   0   1
1985    4   4   1   0   1   0   20  29  20  28  18  29  9   5   1
1988    4   4   1   0   1   0   20  60  66  40  33  29  19  8   0
1991    4   4   1   0   1   0   20  66  26  6   10  20  11  4   2

##NMFS      Trawl   oldshell
##Year, Seas,   Fleet,  Sex,    Type,   Shell,  Maturity,       DataVec
1976    4   4   1   0   2   0   20  0   6   15  33  39  40  8   6
1979    4   4   1   0   2   0   20  3   1   2   8   30  88  42  7
1982    4   4   1   0   2   0   20  0   0   4   5   11  6   7   9
1985    4   4   1   0   2   0   20  0   0   0   6   16  27  16  4
1988    4   4   1   0   2   0   20  0   0   2   4   12  27  20  10
1991    4   4   1   0   2   0   20  9   19  8   26  53  47  31  6

#   ADFG    Trawl   Newshell
1996    4   5   1   0   1   0   20  78  58  35  24  16  1   1   2
1999    4   5   1   0   1   0   20  9   3   29  82  74  36  9   2
2002    4   5   1   0   1   0   20  23  29  33  28  4   8   6   2
2006    4   5   1   0   1   0   20  69  98  80  42  23  14  9   0
2008    4   5   1   0   1   0   20  34  42  58  31  27  8   5   2
2011    4   5   1   0   1   0   20  42  35  27  35  56  44  10  3
2014    4   5   1   0   1   0   20  30  57  91  69  36  6   5   3
2017    4   5   1   0   1   0   20  16  14  6   11  11  12  5   0
2018    4   5   1   0   1   0   20  27  7   8   2   1   2   3   1  # Was ‘14.6
2019    4   5   1   0   1   0   20  169 91  10  0   1   1   1   0
```

```
2020    4   5   1   0   1   0   20  14  24  33  7   6   2   0   0
2021    4   5   1   0   1   0   20  10  27  35  35  34  7   1   1
2023    4   5   1   0   1   0   20  0   1   8   21  48  50      16   1
2024    4   5   1   0   1   0   20  3   3   2   7   7   20      23   2

##  ADFG    Trawl   Oldshell
##Year, Seas,   Fleet,  Sex,    Type,   Shell,  Maturity,   Nsamp,  DataVec
1996    4   5   1   0   2   0   20  1   1   7   9   12  12  11  7
1999    4   5   1   0   2   0   20  0   0   1   8   14  11  5   0
2002    4   5   1   0   2   0   20  2   7   17  25  22  21  13  4
2006    4   5   1   0   2   0   20  0   0   0   6   14  14  3   1
2008    4   5   1   0   2   0   20  0   2   12  17  23  3   10  1
2011    4   5   1   0   2   0   20  0   1   4   7   27  14  10  0
2014    4   5   1   0   2   0   20  0   0   10  38  20  17  5   0
2017    4   5   1   0   2   0   20  1   2   2   2   8   21  5   0
2018    4   5   1   0   2   0   20  0   5   1   3   2   2   7   2
2019    4   5   1   0   2   0   20  1   1   4   6   4   7   9   2
2020    4   5   1   0   2   0   20  3   9   6   2   2   2   0   1
2021    4   5   1   0   2   0   20  0   0   2   0   3   1   1   1
2023    4   5   1   0   2   0   20  0   0   2   6   41  39  7   0
2024    4   5   1   0   2   0   20  0   0   0   0   5   16  3   2

##NOAA  NBS Trawl   newshell
##Year, Seas,   Fleet,  Sex,    Type,   Shell,  Maturity,   Nsamp,  DataVec
2010    4   6   1   0   1   0   20  1   3   4   12  4   2   0   0
2017    4   6   1   0   1   0   20  5   6   8   3   3   3   3   2
2019    4   6   1   0   1   0   20  49  41  11  5   2   0   1   1
2021    4   6   1   0   1   0   20  4   13  17  13  8   2   0   0
2022    4   6   1   0   1   0   20  60  63  42  38  26  13  3   2
2023    4   6   1   0   1   0   20  1   3   5   6   12  9   4   1

##NOAA  NBS Trawl   oldshell
##Year, Seas,   Fleet,  Sex,    Type,   Shell,  Maturity,   Nsamp,  DataVec
2010    4   6   1   0   2   0   20  0   2   6   15  13  7   2   2
2017    4   6   1   0   2   0   20  2   0   2   3   2   11  3   2
2019    4   6   1   0   2   0   20  5   2   6   3   2   1   5   1
2021    4   6   1   0   2   0   20  1   4   9   5   5   1   0   0
2022    4   6   1   0   2   0   20  8   8   27  29  29  19  9   2
2023    4   6   1   0   2   0   20  0   0   1   6   14  13  3   0

##Winter        Pot     Survey  newshell
##Year, Seas,   Fleet,  Sex,    Type,   Shell,  Maturity,       Nsamp,  DataVec
1982    2   7   1   0   1   0   10  0   72  164 154 50  14  12  0
1983    2   7   1   0   1   0   10  68  215.5   711.5   719 543 178 18  3.5
1984    2   7   1   0   1   0   10  23  271 433.5   379 248.5   99.5    9   0.5
1985    2   7   1   0   1   0   10  16  72  199 279.5   122.5   44  7   0.5
1986    2   7   1   0   1   0   10  25.5    72.5    102 145 115 49  7   0.5
1987    2   7   1   0   1   0   10  0   8   22  28  10  6   0   0
1989    2   7   1   0   1   0   10  8   66  74.5    66.5    95.5    86.5    17  0
1990    2   7   1   0   1   0   10  7   102.5   430 542 372 253 118 29.5
1991    2   7   1   0   1   0   10  2   16  118 366 343 123 13  1
1993    2   7   1   0   1   0   10  0   1   6   10  23  21  5   0
```

```
1995    2   7   1   0   1   0   10  8   49  68  84  219 199 61  11
1996    2   7   1   0   1   0   10  102 215 320 307 181 106 40  7
1997    2   7   1   0   1   0   10  28  85  87  44  58  45  21  4
1998    2   7   1   0   1   0   10  1   122 364 234 48  21  3   0
1999    2   7   1   0   1   0   10  6   25  152 464 469 109 17  3
2000    2   7   1   0   1   0   10  10  50  60  93  189 101 20  1
2002    2   7   1   0   1   0   10  45  244 215 137 53  52  32  7
2003    2   7   1   0   1   0   10  20  80  180 233 145 49  20  4
2004    2   7   1   0   1   0   10  0   5   48  77  94  42  4   0
2005    2   7   1   0   1   0   10  2   30  57  72  88  75  30  1
2006    2   7   1   0   1   0   10  2   72  116 107 80  28  10  1
2007    2   7   1   0   1   0   10  11  22  31  56  21  7   0   0
2008    2   7   1   0   1   0   10  50  514 884 596 513 234 24  4
2009    2   7   1   0   1   0   10  1   37  69  184 106 44  5   2
2010    2   7   1   0   1   0   10  4   27  74  124 141 65  10  1
2011    2   7   1   0   1   0   10  11  46  80  122 102 78  29  1
2012    2   7   1   0   1   0   10  17  76  154 128 82  85  27  3

##Winter        Pot     Survey  oldshell
##Year, Seas,   Fleet,  Sex,    Type,   Shell,  Maturity,       Nsamp,  DataVec
1982    2   7   1   0   2   0   10  0   36  82  79  29  11  14  2
1983    2   7   1   0   2   0   10  0   0   0   10  49  24.5    21.5    21
1984    2   7   1   0   2   0   10  0   0   1   29.5    107.5   54.5    11  9.5
1985    2   7   1   0   2   0   10  0   0   1   5   22.5    18.5    1   0
1986    2   7   1   0   2   0   10  0   0   2   8.5 34.5    25  7   0
1987    2   7   1   0   2   0   10  0   0   1   6   43  16  4   0
1989    2   7   1   0   2   0   10  0   0   0   1   26  42  16  1
1990    2   7   1   0   2   0   10  0   0   0   2   54.5    116 44  5.5
1991    2   7   1   0   2   0   10  0   0   0   5   34  149 92  21
1993    2   7   1   0   2   0   10  0   0   0   3   35  49  19  9
1995    2   7   1   0   2   0   10  0   1   0   3   28  61  53  13
1996    2   7   1   0   2   0   10  0   0   5   20  87  114 55  21
1997    2   7   1   0   2   0   10  0   0   0   0   7   10  5   4
1998    2   7   1   0   2   0   10  0   1   6   14  28  15  16  8
1999    2   7   1   0   2   0   10  0   0   0   13  29  9   8   3
2000    2   7   1   0   2   0   10  0   0   0   1   29  13  7   1
2002    2   7   1   0   2   0   10  5   4   7   6   4   12  4   1
2003    2   7   1   0   2   0   10  1   5   5   18  20  22  17  5
2004    2   7   1   0   2   0   10  0   0   3   5   6   4   6   2
2005    2   7   1   0   2   0   10  0   1   1   1   16  24  5   2
2006    2   7   1   0   2   0   10  0   4   5   9   22  38  15  3
2007    2   7   1   0   2   0   10  0   0   1   1   3   6   0   0
2008    2   7   1   0   2   0   10  22  148 239 120 118 53  28  5
2009    2   7   1   0   2   0   10  0   0   1   1   20  52  2   1
2010    2   7   1   0   2   0   10  0   0   4   33  58  31  5   1
2011    2   7   1   0   2   0   10  1   0   7   19  66  27  7   0
2012    2   7   1   0   2   0   10  0   2   2   6   35  35  21  2

##  Growth data (increment)
# Type of growth increment (0=no growth data;1=size-at-release; 2= size-class-at-release)
3
# nobs_growth
```

```
66
# Class-at-release; Sex; Class-at-recapture;  Years-at-liberty;  number transition matrix; sample size
1 1 2 1 1 3 1993 1
1 1 3 1 1 3 1993 4
1 1 3 2 1 3 1993 1
1 1 4 2 1 3 1993 6
1 1 5 2 1 3 1993 4
1 1 5 3 1 3 1993 11
1 1 6 3 1 3 1993 11
2 1 3 1 1 3 1993 21
2 1 4 1 1 3 1993 22
2 1 4 2 1 3 1993 12
2 1 5 1 1 3 1993 4
2 1 5 2 1 3 1993 96
2 1 5 3 1 3 1993 19
2 1 6 2 1 3 1993 5
2 1 6 3 1 3 1993 48
2 1 7 3 1 3 1993 6
3 1 4 1 1 3 1993 47
3 1 4 2 1 3 1993 5
3 1 4 3 1 3 1993 2
3 1 5 1 1 3 1993 91
3 1 5 2 1 3 1993 36
3 1 5 3 1 3 1993 14
3 1 6 1 1 3 1993 7
3 1 6 2 1 3 1993 70
3 1 6 3 1 3 1993 28
3 1 7 1 1 3 1993 1
3 1 7 2 1 3 1993 3
3 1 7 3 1 3 1993 9
4 1 4 1 1 3 1993 10
4 1 4 2 1 3 1993 2
4 1 5 1 1 3 1993 196
4 1 5 2 1 3 1993 34
4 1 5 3 1 3 1993 3
4 1 6 1 1 3 1993 108
4 1 6 2 1 3 1993 39
4 1 6 3 1 3 1993 35
4 1 7 1 1 3 1993 2
4 1 7 2 1 3 1993 19
4 1 7 3 1 3 1993 14
4 1 8 1 1 3 1993 1
5 1 5 1 1 3 1993 75
5 1 5 2 1 3 1993 7
5 1 6 1 1 3 1993 143
5 1 6 2 1 3 1993 77
5 1 6 3 1 3 1993 9
5 1 7 1 1 3 1993 22
5 1 7 2 1 3 1993 24
5 1 7 3 1 3 1993 21
5 1 8 3 1 3 1993 4
6 1 6 1 1 3 1993 88
```

```
6 1 6 2 1 3 1993 11
6 1 7 1 1 3 1993 98
6 1 7 2 1 3 1993 47
6 1 7 3 1 3 1993 11
6 1 8 1 1 3 1993 24
6 1 8 2 1 3 1993 7
6 1 8 3 1 3 1993 3
7 1 7 1 1 3 1993 56
7 1 7 2 1 3 1993 9
7 1 7 3 1 3 1993 1
7 1 8 1 1 3 1993 25
7 1 8 2 1 3 1993 16
7 1 8 3 1 3 1993 9
8 1 8 1 1 3 1993 26
8 1 8 2 1 3 1993 8
8 1 8 3 1 3 1993 1

# Environmental data
## Use old format (0)
0
# Number of series
0
# Year ranges

# Indices
# Index Year Value

##  eof

## eof
9999
```


The new base model (24.0b) control file

```
## GMACS Version 2.20.20 - January 2025

# Block structure
# Number of blocks
2
# Block structure
1 1
# The blocks
2008 2025
2008 2025

##  ------------------------------------------------------------------------------------ ##
##  GENERAL  CONTROLS
##  ------------------------------------------------------------------------------------ ##
#
```

```
1976      # First year of recruitment estimation,rec_dev.
2024      # last year of recruitment estimation, rec_dev
   0      # Terminal molting (0 = off, 1 = on). If on, the calc_stock_recruitment_relationship() isn't called in the procedure
   2      # phase for recruitment estimation,earlier -1. rec_dev estimation phase, BBRKC uses 2
  -2      # phase for recruitment sex-ratio estimation
  0.5     # Initial value for Expected sex-ratio
   3      # Initial conditions (0 = Unfished, 1 = Steady-state fished, 2 = Free parameters, 3 = Free parameters (revised))
   1      # Reference size-class for initial conditons = 3
   1      # Lambda (proportion of mature male biomass for SPR reference points).
   0      # Stock-Recruit-Relationship (0 = none, 1 = Beverton-Holt)
   1      # Use years specified to computed average sex ratio in the calculation of average recruitment for reference points (0 = off -i.e. Rec based on End year, 1 = on)
  200     ### Year to compute equilibria
   5      # Devpar phase (!!)
   0      # First year of bias-correction
   0      # First full bias-correction
   0      # Last full bias-correction
   0      # Last year of bias-correction

# Expecting 23 theta parameters
# Core parameters
## Initial: Initial value for the parameter (must lie between lower and upper)
## Lower & Upper: Range for the parameter
## Phase: Set equal to a negative number not to estimate
## Prior type:
## 0: Uniform   - parameters are the range of the uniform prior
## 1: Normal    - parameters are the mean and sd
## 2: Lognormal - parameters are the mean and sd of the log
## 3: Beta      - parameters are the two beta parameters [see dbeta]
## 4: Gamma     - parameters are the two gamma parameters [see dgamma]
# Initial_value    Lower_bound    Upper_bound Phase Prior_type        Prior_1        Prior_2
     7.00000000   -15.00000000    20.00000000    -1          0   -10.00000000    20.00000000 # Log(R0)
     10.11100000   -15.00000000    20.00000000     1          0   -10.00000000    20.00000000 # Log(Rinitial)
     8.00000000   -15.00000000    20.00000000     1          0   -10.00000000    20.00000000 # Log(Rbar)
    72.50000000    65.00000000   130.00000000     3          1    72.50000000     7.25000000 # Recruitment_ra-males
     0.75000000     0.00000001     1.60000000     3          0     0.10000000     5.00000000 # Recruitment_rb-males
    -0.10000000   -15.00000000     0.75000000    -2          0   -10.00000000     0.75000000 # log(SigmaR)
     0.75000000     0.20000000     1.00000000    -4          3     3.00000000     2.00000000 # Steepness
     0.00100000     0.00000000     1.00000000    -3          3     1.01000000     1.01000000 # Rho
     0.64670000   -15.00000000     5.00000000     2          0    10.00000000    20.00000000 # Scaled_logN_for_male_mature_mature_newshell_class_2
     1.00340000   -15.00000000     5.00000000     2          0    10.00000000    20.00000000 # Scaled_logN_for_male_mature_mature_newshell_class_3
     1.36040000   -15.00000000     5.00000000     2          0    10.00000000    20.00000000 # Scaled_logN_for_male_mature_mature_newshell_class_4
     1.40420000   -15.00000000     5.00000000     2          0    10.00000000    20.00000000 # Scaled_logN_for_male_mature_mature_newshell_class_5
     1.45990000   -15.00000000     5.00000000     2          0    10.00000000    20.00000000 # Scaled_logN_for_male_mature_mature_newshell_class_6
     1.26570000   -15.00000000     5.00000000     2          0    10.00000000    20.00000000 # Scaled_logN_for_male_mature_mature_newshell_class_7
     0.72280000   -15.00000000     5.00000000     2          0    10.00000000    20.00000000 # Scaled_logN_for_male_mature_mature_newshell_class_8
  -100.00000000  -101.00000000     5.00000000    -2          0    10.00000000    20.00000000 # Scaled_logN_for_male_mature_mature_oldshell_class_1
  -100.00000000  -101.00000000     5.00000000    -2          0    10.00000000    20.00000000 # Scaled_logN_for_male_mature_mature_oldshell_class_2
  -100.00000000  -101.00000000     5.00000000    -2          0    10.00000000    20.00000000 # Scaled_logN_for_male_mature_mature_oldshell_class_3
  -100.00000000  -101.00000000     5.00000000    -2          0    10.00000000    20.00000000 # Scaled_logN_for_male_mature_mature_oldshell_class_4
  -100.00000000  -101.00000000     5.00000000    -2          0    10.00000000    20.00000000 # Scaled_logN_for_male_mature_mature_oldshell_class_5
  -100.00000000  -101.00000000     5.00000000    -2          0    10.00000000    20.00000000 # Scaled_logN_for_male_mature_mature_oldshell_class_6
  -100.00000000  -101.00000000     5.00000000    -2          0    10.00000000    20.00000000 # Scaled_logN_for_male_mature_mature_oldshell_class_7
```

```
  -100.00000000  -101.00000000     5.00000000    -2          0    10.00000000    20.00000000 # Scaled_logN_for_male_mature_mature_oldshell_class_8
##Allometry
# weight-at-length input  method  (1 = allometry  [w_l = a*l^b],  2 = vector by sex; 3= matrix by sex)
2
 0.5239661 0.8202686 1.197317 1.700319 2.317965 2.988772 3.68294 4.367152 # this is from the version 2.20.14 ctl file
# 0.52420370 0.82067430 1.19824500 1.70175900 2.32125400 2.99365100 3.68849500 4.37139500
# Proportion mature by sex and size
 0.00000000 0.00000000 0.00000000 1.00000000 1.00000000 1.00000000 1.00000000 1.00000000
# Proportion legal by sex and size
 0.00000000 0.00000000 0.00000000 0.00000000 1.00000000 1.00000000 1.00000000 1.00000000

## ==================================================================================== ##
## GROWTH PARAMETER CONTROLS                                                            ##
## ==================================================================================== ##
##
# Maximum number of size-classes to which recruitment must occur
 3
# Use functional maturity for terminally molting animals (0=no; 1=Yes)?
0
# Growth transition
##Type_1: Options for the growth matrix
#  1: Pre-specified growth transition matrix (requires molt probability)
#  2: Pre-specified size transition matrix (molt probability is ignored)
#  3: Growth increment is gamma distributed (requires molt probability)
#  4: Post-molt size is gamma distributed (requires molt probability)
#  5: Von Bert.: kappa varies among individuals (requires molt probability)
#  6: Von Bert.: Linf varies among individuals (requires molt probability)
#  7: Von Bert.: kappa and Linf varies among individuals (requires molt probability)
#  8: Growth increment is normally distributed (requires molt probability)
## Type_2: Options for the growth increment model matrix
#  1: Linear
#  2: Individual
#  3: Individual (Same as 2)
#  Block: Block number for time-varying growth
## Type_1 Type_2  Block
        8      1      0
# Molt probability
# Type: Options for the molt probability function
#  0: Pre-specified
#  1: Constant at 1
#  2: Logistic
#  3: Individual
#  Block: Block number for time-varying growth
## Type Block
      2     0

## General parameter specificiations
##  Initial: Initial value for the parameter (must lie between lower and upper)
##  Lower & Upper: Range for the parameter
##  Prior type:
##   0: Uniform   - parameters are the range of the uniform prior
##   1: Normal    - parameters are the mean and sd
```

```
##   2: Lognormal - parameters are the mean and sd of the log
##   3: Beta      - parameters are the two beta parameters [see dbeta]
##   4: Gamma     - parameters are the two gamma parameters [see dgamma]
##  Phase: Set equal to a negative number not to estimate
##  Relative: 0: absolute; 1 relative
##  Block: Block number for time-varying selectivity
##  Block_fn: 0:absolute values; 1:exponential
##  Env_L: Environmental link - options are 0:none; 1:additive; 2:multiplicative; 3:exponential
##  EnvL_var: Environmental variable
##  RW: 0 for no random walk changes; 1 otherwise
##  RW_blk: Block number for random walks
##  Sigma_RW: Sigma used for the random walk

# Inputs for sex * type 1
# MAIN PARS: Initial  Lower_bound  Upper_bound Prior_type       Prior_1      Prior_2  Phase  Block Blk_fn  Env_L Env_vr     RW RW_Blk RW_Sigma
            36.998620     0.000000   200.000000          0     0.000000    20.000000      2      0      0      0      0      0      0   0.3000 # Alpha_male_period_1
             0.243015    -0.200000    20.000000          0     0.000000    10.000000      2      0      0      0      0      0      0   0.3000 # Beta_male_period_1
             3.773156     2.000000    10.000000          0     0.000000     3.000000      5      0      0      0      0      0      0   0.3000 # Gscale_male_period_1
# EXTRA PARS: Initial  Lower_bound  Upper_bound Prior_type      Prior_1      Prior_2  Phase Reltve
# Inputs for sex * type 2
# MAIN PARS: Initial  Lower_bound  Upper_bound Prior_type       Prior_1      Prior_2  Phase  Block Blk_fn  Env_L Env_vr     RW RW_Blk RW_Sigma
          122.965900    50.000000   200.000000          0     0.000000   170.000000      2      0      0      0      0      0      0   0.3000 # Molt_probability_mu_male_period_1
             0.127616     0.000000     1.000000          0     0.000000     3.000000      2      0      0      0      0      0      0   0.3000 # Molt_probability_CV_male_period_1
# EXTRA PARS: Initial  Lower_bound  Upper_bound Prior_type      Prior_1      Prior_2  Phase Reltve


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

#      Initial    Lower_bound    Upper_bound  Prior_type        Prior_1        Prior_2  Phase
    0.18000000     0.00000000     0.20000000           0     0.00000000     0.20000000     -1 # M_base_male_mature
    0.50000000     0.05000000     1.00000000           1     0.00000000     0.25000000      3 # M estimated for males > 123 mm carapace length
```

```
## ==================================================================================== ##
## SELECTIVITY PARAMETERS CONTROLS                                                       ##
## ==================================================================================== ##
##
# ## Selectivity parameter controls
# ## Selectivity (and retention) types
# ##  <0: Mirror selectivity
# ##   0: Nonparametric selectivity (one parameter per class)
# ##   1: Nonparametric selectivity (one parameter per class, constant from last specified class)
# ##   2: Logistic selectivity (inflection point and slope)
# ##   3: Logistic selectivity (50% and 95% selection)
# ##   4: Double normal selectivity (3 parameters)
# ##   5: Flat equal to zero (1 parameter; phase must be negative)
# ##   6: Flat equal to one (1 parameter; phase must be negative)
# ##   7: Flat-topped double normal selectivity (4 parameters)
# ##   8: Declining logistic selectivity with initial values (50% and 95% selection plus extra)
# ##   9: Cubic-spline (specified with knots and values at knots)
# ##      Inputs: knots (in length units); values at knots (0-1) - at least one should have phase -1
# ##  10: One parameter logistic selectivity (inflection point and slope)
## Selectivity specifications --
# ## Extra (type 1): number of selectivity parameters to estimated
# #  Winter_Com Subsistence Summer_Com NMFS_Trawl ADFG_Trawl NBS_Trawl Winter_Pot
 0 0 0 0 0 0 0 # is selectivity sex=specific? (1=Yes; 0=No)
 8 -1 10 10 -4 -4 -1 # male selectivity type. Only NMFS_Trawl survey selectivity is being estimated. All other trawl survey selectivities are mirroring NMFS_Trawl. Winter_Pot survey selectivity
 0 0 0 0 0 0 0 # selectivity within another gear
 3 0 0 0 0 0 0 # male extra parameters for each pattern
 0 0 1 1 1 1 1 # male: is maximum selectivity at size forced to equal 1 (1) or not (0)
 0 0 0 0 0 0 0 # size-class at which selectivity is forced to equal 1 (ignored if the previous input is 1)
## Retention specifications --
 0 0 0 0 0 0 0 # is retention sex=specific? (1=Yes; 0=No)
 2 0 2 6 6 6 6 # male retention type
 1 1 1 0 0 0 0 # male retention flag (0 = no, 1 = yes)
 0 0 0 0 0 0 0 # male extra parameters for each pattern
 0 0 0 0 0 0 0 # male - should maximum retention be estimated for males (1=Yes; 0=No)

## General parameter specificiations
##  Initial: Initial value for the parameter (must lie between lower and upper)
##  Lower & Upper: Range for the parameter
##  Prior type:
##   0: Uniform   - parameters are the range of the uniform prior
##   1: Normal    - parameters are the mean and sd
##   2: Lognormal - parameters are the mean and sd of the log
##   3: Beta      - parameters are the two beta parameters [see dbeta]
##   4: Gamma     - parameters are the two gamma parameters [see dgamma]
##  Phase: Set equal to a negative number not to estimate
##  Relative: 0: absolute; 1 relative
##  Block: Block number for time-varying selectivity
##  Block_fn: 0:absolute values; 1:exponential
##  Env_L: Environmental link - options are 0:none; 1:additive; 2:multiplicative; 3:exponential
##  EnvL_var: Environmental variable
##  RW: 0 for no random walk changes; 1 otherwise
```

```
##  RW_blk: Block number for random walks
##  Sigma_RW: Sigma used for the random walk

# Inputs for type*sex*fleet: selectivity male Winter_Com
# MAIN PARS:  Initial  Lower_bound  Upper_bound Prior_type     Prior_1      Prior_2  Phase  Block Blk_fn  Env_L Env_vr     RW RW_Blk RW_Sigma
           128.894800    40.000000   200.000000          0    10.000000   200.000000      2      0      0      0      0      0      0   0.3000 # Sel_Winter_Com_male_period_1_par_1
             0.154697     0.010000    20.000000          0     0.100000   100.000000      2      0      0      0      0      0      0   0.3000 # Sel_Winter_Com_male_period_1_par_2
             0.045586     0.000010     0.999990          0     0.100000   100.000000      2      0      0      0      0      0      0   0.3000 # Sel_Winter_Com_male_period_1_par_3
             0.375288     0.000010     0.999990          0     0.100000   100.000000      2      0      0      0      0      0      0   0.3000 # Sel_Winter_Com_male_period_1_par_4
             0.733787     0.000010     0.999990          0     0.100000   100.000000      2      0      0      0      0      0      0   0.3000 # Sel_Winter_Com_male_period_1_par_5

# Inputs for type*sex*fleet: selectivity male Summer_Com
# MAIN PARS:  Initial  Lower_bound  Upper_bound Prior_type     Prior_1      Prior_2  Phase  Block Blk_fn  Env_L Env_vr     RW RW_Blk RW_Sigma
             0.143640     0.000010    20.000000          0     0.100000   100.000000      2      0      0      0      0      0      0   0.3000 # Sel_Summer_Com_male_period_1_par_1

# Inputs for type*sex*fleet: selectivity male NMFS_Trawl
# MAIN PARS:  Initial  Lower_bound  Upper_bound Prior_type     Prior_1      Prior_2  Phase  Block Blk_fn  Env_L Env_vr     RW RW_Blk RW_Sigma
             0.092094     0.000010    20.000000          0     0.100000   100.000000      2      0      0      0      0      0      0   0.3000 # Sel_NMFS_Trawl_male_period_1_par_1

# Inputs for type*sex*fleet: selectivity male ADFG_Trawl
# MAIN PARS:  Initial  Lower_bound  Upper_bound Prior_type     Prior_1      Prior_2  Phase  Block Blk_fn  Env_L Env_vr     RW RW_Blk RW_Sigma
#             0.092094     0.000010    20.000000          0     0.100000   100.000000      2      0      0      0      0      0      0   0.3000 # Sel_NMFS_Trawl_male_period_1_par_1

# Inputs for type*sex*fleet: selectivity male NBS_Trawl
# MAIN PARS:  Initial  Lower_bound  Upper_bound Prior_type     Prior_1      Prior_2  Phase  Block Blk_fn  Env_L Env_vr     RW RW_Blk RW_Sigma
#             0.092094     0.000010    20.000000          0     0.100000   100.000000      2      0      0      0      0      0      0   0.3000 # Sel_NMFS_Trawl_male_period_1_par_1

# Inputs for type*sex*fleet: retention male Winter_Com
# MAIN PARS:  Initial  Lower_bound  Upper_bound Prior_type     Prior_1      Prior_2  Phase  Block Blk_fn  Env_L Env_vr     RW RW_Blk RW_Sigma
           100.49375    50.000000   200.000000          0     1.000000   900.000000     -2      2      0      0      0      0      0   0.3000 # Ret_Winter_Com_male_period_1_par_1
             2.48336     0.001000    20.000000          0     1.000000   900.000000     -2      2      0      0      0      0      0   0.3000 # Ret_Winter_Com_male_period_1_par_2
# EXTRA PARS: Initial  Lower_bound  Upper_bound Prior_type      Prior_1      Prior_2  Phase Reltve
           100.49375    50.000000   700.000000          0     0.100000   100.000000      2      0 # Ret_Summer_Com_male_period_2_par_1
              2.4833     1.000000    20.000000          0     0.100000   100.000000      2      0 # Ret_Summer_Com_male_period_2_par_2

# Inputs for type*sex*fleet: retention male Subsistence
# MAIN PARS:  Initial  Lower_bound  Upper_bound Prior_type     Prior_1      Prior_2  Phase  Block Blk_fn  Env_L Env_vr     RW RW_Blk RW_Sigma
             0.000001     0.000000     0.000002          0     1.000000   900.000000     -2      0      0      0      0      0      0   0.3000 # Ret_Subsistence_male_period_1_par_1
             0.000001     0.000000     0.000002          0     1.000000   900.000000     -2      0      0      0      0      0      0   0.3000 # Ret_Subsistence_male_period_1_par_2
             0.000001     0.000000     0.000002          0     1.000000   900.000000     -2      0      0      0      0      0      0   0.3000 # Ret_Subsistence_male_period_1_par_3
             0.999999     0.000000     1.000000          0     1.000000   900.000000     -2      0      0      0      0      0      0   0.3000 # Ret_Subsistence_male_period_1_par_4
             0.999999     0.000000     1.000000          0     1.000000   900.000000     -2      0      0      0      0      0      0   0.3000 # Ret_Subsistence_male_period_1_par_5
             0.999999     0.000000     1.000000          0     1.000000   900.000000     -2      0      0      0      0      0      0   0.3000 # Ret_Subsistence_male_period_1_par_6
             0.999999     0.000000     1.000000          0     1.000000   900.000000     -2      0      0      0      0      0      0   0.3000 # Ret_Subsistence_male_period_1_par_7
             0.999999     0.000000     1.000000          0     1.000000   900.000000     -2      0      0      0      0      0      0   0.3000 # Ret_Subsistence_male_period_1_par_8

# Inputs for type*sex*fleet: retention male Summer_Com
# MAIN PARS:  Initial  Lower_bound  Upper_bound Prior_type     Prior_1      Prior_2  Phase  Block Blk_fn  Env_L Env_vr     RW RW_Blk RW_Sigma
           104.310600    50.000000   700.000000          0     1.000000   900.000000      2      1      0      0      0      0      0   0.3000 # Ret_Summer_Com_male_period_1_par_1
             2.421736     1.000000    20.000000          0     1.000000   900.000000      2      1      0      0      0      0      0   0.3000 # Ret_Summer_Com_male_period_1_par_2
# EXTRA PARS: Initial  Lower_bound  Upper_bound Prior_type      Prior_1      Prior_2  Phase Reltve
           105.150900    50.000000   700.000000          0     0.100000   100.000000      2      0 # Ret_Summer_Com_male_period_2_par_1
```

```
            1.648215     1.000000    20.000000          0     0.100000   100.000000      2      0 # Ret_Summer_Com_male_period_2_par_2

## ==================================================================================== ##
## CATCHABILITY PARAMETER CONTROLS                                                      ##
## ==================================================================================== ##
##
# Catchability (specifications)
# Analytic: should q be estimated analytically (1) or not (0)
# Lambda: the weight lambda
# Emphasis: the weighting emphasis
# Block: Block number for time-varying M-at-size
# Block_fn: 0:absolute values; 1:exponential
# Env_L: Environmental link - options are 0: none; 1:additive; 2:multiplicative; 3:exponential
# EnvL_var: Environmental variable
# RW: 0 for no random walk changes; 1 otherwise
# RW_blk: Block number for random walks
# Sigma_RW: Sigma for the random walk parameters
## Analytic  Lambda Emphass  Mirror   Block   Env_L EnvL_Vr      RW  RW_blk Sigma_RW
         0       1       1       0       0       0       0       0       0   0.3000
         0       1       1       0       0       0       0       0       0   0.3000
         0       1       1       0       0       0       0       0       0   0.3000
         0       1       1       0       0       0       0       0       0   0.3000
         0       1       1       0       0       0       0       0       0   0.3000
         0       1       1       0       0       0       0       0       0   0.3000
# Catchability (parameters)
#      Initial    Lower_bound    Upper_bound  Prior_type        Prior_1        Prior_2  Phase
    0.77700000     0.10000000     2.00000000           0     0.10000000     1.00000000      2 # NMFS trawl survey
    1.00000000     0.10000000     2.00000000           0     0.10000000     1.00000000     -2 # ADF&G trawl survey
    0.77700000     0.10000000     2.00000000           0     0.10000000     1.00000000      2 # NBS trawl survey
    0.00150000     0.00000000     2.00000000           0     0.00000000     1.00000000      1 # block 1 - std CPUE
    0.00150000     0.00000000     2.00000000           0     0.00000000     1.00000000      1 # block 2 - std CPUE
    0.00150000     0.00000000     2.00000000           0     0.00000000     1.00000000      1 # block 3 - std CPUE

## ==================================================================================== ##
## ADDITIONAL CV PARAMETER CONTROLS                                                     ##
## ==================================================================================== ##
##
# Catchability (specifications)
# Mirror: should additional variance be mirrored (value > 1) or not (0)?
# Block: Block number for time-varying M-at-size
# Block_fn: 0:absolute values; 1:exponential
# Env_L: Environmental link - options are 0: none; 1:additive; 2:multiplicative; 3:exponential
# EnvL_var: Environmental variable
# RW: 0 for no random walk changes; 1 otherwise
# RW_blk: Block number for random walks
# Sigma_RW: Sigma for the random walk parameters
##   Mirror   Block   Env_L EnvL_Vr     RW   RW_blk Sigma_RW
         0       0       0       0       0       0   0.3000
         0       0       0       0       0       0   0.3000
         0       0       0       0       0       0   0.3000
         0       0       0       0       0       0   0.3000
         4       0       0       0       0       0   0.3000
```

```
         4       0       0       0       0       0   0.3000
## Mirror Block Env_L EnvL_Var  RW RW_blk Sigma_RW
# Additional variance (parameters)
#      Initial    Lower_bound    Upper_bound  Prior_type        Prior_1        Prior_2  Phase
    0.00010000     0.00000001     2.00000000           0     1.00000000   100.00000000     -4
    0.00010000     0.00000001     2.00000000           0     1.00000000   100.00000000     -4
    0.00010000     0.00000001     2.00000000           0     1.00000000   100.00000000     -4
    0.10000000     0.00000001     2.00000000           0     1.00000000   100.00000000      4
#    0.00010000     0.00000001     2.00000000           0     1.00000000   100.00000000     -4
#    0.00010000     0.00000001     2.00000000           0     1.00000000   100.00000000     -4

## ================================================================================= ##
## CONTROLS ON F                                                                     ##
## ================================================================================= ##
##
# Controls on F
#   Initial_male_F Initial_fema_F Pen_SD (early) Pen_SD (later) Phz_mean_F_mal Phz_mean_F_fem   Lower_mean_F   Upper_mean_F Low_ann_male_F  Up_ann_male_F    Low_ann_f_F     Up_ann_f_F
          0.020000       0.000000       0.500000      45.500000       1.000000      -1.000000     -15.000000       4.000000     -10.000000      10.000000     -10.000000      10.000000  # Winter_C
          0.020000       0.000000       0.500000      45.500000       1.000000      -1.000000     -15.000000       4.000000     -10.000000      10.000000     -10.000000      10.000000  # Subsiste
          0.120000       0.000000       0.500000      45.500000       1.000000      -1.000000     -15.000000       4.000000     -10.000000      10.000000     -10.000000      10.000000  # Summer_C
          0.000000       0.000000       2.000000      20.000000      -1.000000      -1.000000     -15.000000       4.000000     -10.000000      10.000000     -10.000000      10.000000  # NMFS_Tra
          0.000000       0.000000       2.000000      20.000000      -1.000000      -1.000000     -15.000000       4.000000     -10.000000      10.000000     -10.000000      10.000000  # ADFG_Tra
          0.000000       0.000000       2.000000      20.000000      -1.000000      -1.000000     -15.000000       4.000000     -10.000000      10.000000     -10.000000      10.000000  # NBS_Traw
          0.000000       0.000000       2.000000      20.000000      -1.000000      -1.000000     -15.000000       4.000000     -10.000000      10.000000     -10.000000      10.000000  # Winter_P

## ================================================================================= ##
## SIZE COMPOSITIONS OPTIONS                                                         ##
## ================================================================================= ##
##
# Options when fitting size-composition data
## Likelihood types:
##  1:Multinomial with estimated/fixed sample size
##  2:Robust approximation to multinomial
##  3:logistic normal
##  4:multivariate-t
##  5:Dirichlet

#  Winter_Com Winter_Com Summer_Com Summer_Com Summer_Com Summer_Com Summer_Com Summer_Com NMFS_Trawl NMFS_Trawl ADFG_Trawl ADFG_Trawl NBS_Trawl NBS_Trawl Winter_Pot Winter_Pot
#  male male male male male male male male male male male male male male male male
#  retained retained retained retained discard discard total total total total total total total total total total
#  newshell oldshell newshell oldshell newshell oldshell newshell oldshell newshell oldshell newshell oldshell newshell oldshell newshell oldshell
#  immature+mature immature+mature immature+mature immature+mature immature+mature immature+mature immature+mature immature+mature immature+mature immature+mature immature+mature immature+mature
  1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1 # Type of likelihood
  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0 # Auto tail compression
  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0 # Auto tail compression (pmin)
  1   1   2   2   3   3   4   4   5   5   6   6   7   7   8   8 # Composition aggregator codes
  1   1   1   1   1   1   1   1   2   2   2   2   2   2   2   2 # Set to 1 for catch-based predictions; 2 for survey or total catch predictions
# -4   -4   -4   -4   -4   -4   -4   -4   -4   -4   -4   -4   -4   -4   -4   -4 # Phz for estimating effective sample size (if appl.)
  1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1 # Lambda for effective sample size
  1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1 # Lambda for overall likelihood. Or emphasis?
  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0 # Survey to set Q for this comp. Does 0 keep this as is? Ask Buck. Added in version 2.20.16. Use 0 for non-survey fleets.
#  0   0   0   0   0   0   0   0   3   4   1   2   5   6   5   6 # Survey to set Q for this comp. Does 0 keep this as is? Ask Buck. Added in version 2.20.16. Use 0 for non-survey fleets.
```

```
#  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0 # Survey to set Q for this comp. Does 0 keep this as is? Ask Buck. Added in version 2.20.16
#  1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1 # Initial value for effective sample size multiplier

# Effective sample size parameters (number matches max(Composition Aggregator code))
#      Initial    Lower_bound    Upper_bound  Prior_type       Prior_1       Prior_2  Phase
    1.00000000     0.10000000     10.00000000          0       0               999      -1 # Overdispersion_parameter_for_size_comp_1(possibly extended)
    1.00000000     0.10000000     10.00000000          0       0               999      -1 # Overdispersion_parameter_for_size_comp_2(possibly extended)
    1.00000000     0.10000000     10.00000000          0       0               999      -1 # Overdispersion_parameter_for_size_comp_3(possibly extended)
    1.00000000     0.10000000     10.00000000          0       0               999      -1 # Overdispersion_parameter_for_size_comp_4(possibly extended)
    1.00000000     0.10000000     10.00000000          0       0               999      -1 # Overdispersion_parameter_for_size_comp_5(possibly extended)
    1.00000000     0.10000000     10.00000000          0       0               999      -1 # Overdispersion_parameter_for_size_comp_6(possibly extended)
    1.00000000     0.10000000     10.00000000          0       0               999      -1 # Overdispersion_parameter_for_size_comp_7(possibly extended)
    1.00000000     0.10000000     10.00000000          0       0               999      -1 # Overdispersion_parameter_for_size_comp_8(possibly extended)

## ================================================================================= ##
## EMPHASIS FACTORS                                                                  ##
## ================================================================================= ##

1.0000 # Emphasis on tagging data

 1.0000 1.0000 0.0000 1.0000 # Emphasis on Catch: (by catch dataframes)

#AEP AEP AEP AEP
   1.0000   0.0000   0.0000   0.0000 # Winter_Com
   0.1000   0.0000   0.0000   0.0000 # Subsistence
   1.0000   0.0000   0.0000   0.0000 # Summer_Com
   0.0000   0.0000   0.0000   0.0000 # NMFS_Trawl
   0.0000   0.0000   0.0000   0.0000 # ADFG_Trawl
   0.0000   0.0000   0.0000   0.0000 # NBS_Trawl
   0.0000   0.0000   0.0000   0.0000 # Winter_Pot
#
## Emphasis Factors (Priors/Penalties: 13 values) ##
     1.0000 #--Log_fdevs
     0.0000 #--MeanF
     0.0000 #--Mdevs
     1.0000 #--Rec_devs
    15.0000 #--Initial_devs
     1.0000 #--Fst_dif_dev
     3.0000 #--Mean_sex_ratio
    60.0000 #--Molt_prob
     0.1000 #--free selectivity
     1.0000 #--Init_n_at_len
     0.0000 #--Fvecs
     0.0000 #--Fdovss
     1.0000 #--Random walk in selectivity

# eof_ctl
9999
```

Appendix B: Size composition data used to fit models with versus without shell condition included

Table 22: Length composition information by male carapace length size class (in mm) from the winter commercial fishery for retained catch. Sample sizes used when fitting the population model (Input) as well as observed sample sizes (Total) are displayed. This data set was used for fitting models that included shell condition information.

Year	Fleet	Type	Shell	Input	64-73	74-83	84-93	94-103	104-113	114-123	124-133	134+	Total
2015	Winter comm.	retain	new	10	0.00	0.00	0.00	43.00	287.00	138.00	35.00	3.00	506.00
2016	Winter comm.	retain	new	10	0.00	0.00	0.00	29.00	462.00	318.00	35.00	5.00	849.00
2017	Winter comm.	retain	new	10	0.00	0.00	0.00	1.00	110.00	162.00	71.00	9.00	353.00
2018	Winter comm.	retain	new	10	0.00	0.00	0.00	0.00	43.00	102.00	107.00	21.00	273.00
2015	Winter comm.	retain	old	10	0.00	0.00	0.00	6.00	23.00	17.00	17.00	7.00	70.00
2016	Winter comm.	retain	old	10	0.00	0.00	0.00	8.00	93.00	42.00	16.00	8.00	167.00
2017	Winter comm.	retain	old	10	0.00	0.00	0.00	1.00	42.00	101.00	32.00	11.00	187.00
2018	Winter comm.	retain	old	10	0.00	0.00	0.00	0.00	15.00	64.00	39.00	10.00	128.00

Table 23: Length composition information by male carapace length size class (in mm) from the winter commercial fishery for retained catch. Sample sizes used when fitting the population model (Input) as well as observed sample sizes (Total) are displayed. This data set was used for fitting models that excluded shell condition information.

Year	Fleet	Type	Shell	Input	64-73	74-83	84-93	94-103	104-113	114-123	124-133	134+	Total
2015	Winter comm.	retain	-	10	0.00	0.00	0.00	49.00	310.00	155.00	52.00	10.00	576.00
2016	Winter comm.	retain	-	10	0.00	0.00	0.00	37.00	555.00	360.00	51.00	13.00	1016.00
2017	Winter comm.	retain	-	10	0.00	0.00	0.00	2.00	152.00	263.00	103.00	20.00	540.00
2018	Winter comm.	retain	-	10	0.00	0.00	0.00	0.00	58.00	166.00	146.00	31.00	401.00

Table 24: Length composition information by male carapace length size class (in mm) from the summer commercial fishery for retained catch. Sample sizes used when fitting the population model (Input) as well as observed sample sizes (Total) are displayed. This data set was used for fitting models that included shell condition information.

Year	Fleet	Type	Shell	Input	64-73	74-83	84-93	94-103	104-113	114-123	124-133	134+	Total
1977	Summer comm.	retain	new	10	0.00	0.00	0.00	5.00	650.00	530.00	119.00	70.00	1374.00
1978	Summer comm.	retain	new	10	0.00	0.00	0.00	4.00	72.00	184.00	103.00	16.00	379.00
1979	Summer comm.	retain	new	10	0.00	0.00	0.00	42.00	386.00	636.00	425.00	109.00	1598.00
1980	Summer comm.	retain	new	10	0.00	0.00	0.00	4.00	105.00	327.00	396.00	196.00	1028.00
1981	Summer comm.	retain	new	10	0.00	0.00	0.00	7.00	131.00	275.00	502.00	406.00	1321.00
1982	Summer comm.	retain	new	10	0.00	0.00	0.00	46.00	210.00	180.00	239.00	313.00	988.00
1983	Summer comm.	retain	new	10	0.00	0.00	0.00	31.00	331.00	287.00	51.00	27.00	727.00
1984	Summer comm.	retain	new	10	0.00	0.00	0.00	93.00	404.00	270.00	62.00	7.00	836.00
1985	Summer comm.	retain	new	10	0.00	0.00	1.00	173.00	840.00	1000.00	417.00	53.00	2484.00
1986	Summer comm.	retain	new	10	0.00	0.00	0.00	33.00	405.00	448.00	134.00	20.00	1040.00
1987	Summer comm.	retain	new	10	0.00	0.00	0.00	33.00	355.00	578.00	539.00	215.00	1720.00
1988	Summer comm.	retain	new	10	0.00	1.00	0.00	36.00	305.00	457.00	274.00	58.00	1131.00
1989	Summer comm.	retain	new	10	0.00	0.00	0.00	33.00	426.00	826.00	442.00	117.00	1844.00
1990	Summer comm.	retain	new	10	0.00	0.00	0.00	19.00	185.00	447.00	331.00	88.00	1070.00
1992	Summer comm.	retain	new	10	0.00	0.00	0.00	44.00	515.00	682.00	350.00	229.00	1820.00
1993	Summer comm.	retain	new	10	0.00	0.00	0.00	253.00	4116.00	7013.00	4095.00	589.00	16066.00
1994	Summer comm.	retain	new	10	0.00	0.00	0.00	10.00	38.00	33.00	28.00	8.00	117.00
1995	Summer comm.	retain	new	10	0.00	0.00	0.00	46.00	307.00	335.00	176.00	60.00	924.00
1996	Summer comm.	retain	new	10	0.00	0.00	0.00	25.00	176.00	188.00	74.00	37.00	500.00
1997	Summer comm.	retain	new	10	0.00	0.00	0.00	35.00	438.00	409.00	119.00	30.00	1031.00
1998	Summer comm.	retain	new	10	0.00	0.00	0.00	30.00	246.00	256.00	85.00	28.00	645.00
1999	Summer comm.	retain	new	10	0.00	0.00	0.00	36.00	165.00	137.00	103.00	53.00	494.00
2000	Summer comm.	retain	new	10	0.00	0.00	0.00	334.00	5149.00	6743.00	1884.00	266.00	14376.00
2001	Summer comm.	retain	new	10	0.00	0.00	0.00	487.00	4472.00	7394.00	4116.00	1455.00	17924.00
2002	Summer comm.	retain	new	10	0.00	0.00	0.00	231.00	1222.00	1469.00	1316.00	382.00	4620.00
2003	Summer comm.	retain	new	10	0.00	0.00	0.00	121.00	1923.00	1671.00	634.00	162.00	4511.00
2004	Summer comm.	retain	new	10	0.00	0.00	0.00	84.00	3660.00	3727.00	1016.00	324.00	8811.00
2005	Summer comm.	retain	new	10	0.00	0.00	0.00	12.00	1361.00	2524.00	860.00	117.00	4874.00
2006	Summer comm.	retain	new	10	0.00	0.00	0.00	14.00	1222.00	2337.00	1168.00	167.00	4908.00
2007	Summer comm.	retain	new	10	0.00	0.00	0.00	68.00	2189.00	2087.00	842.00	208.00	5394.00
2008	Summer comm.	retain	new	10	0.00	0.00	0.00	27.00	2025.00	2004.00	322.00	63.00	4441.00
2009	Summer comm.	retain	new	10	0.00	0.00	0.00	63.00	2076.00	1985.00	675.00	132.00	4931.00
2010	Summer comm.	retain	new	10	0.00	0.00	0.00	31.00	2275.00	2135.00	586.00	60.00	5087.00
2011	Summer comm.	retain	new	10	0.00	0.00	0.00	11.00	809.00	1013.00	294.00	60.00	2187.00

Table 24: Length composition information by male carapace length size class (in mm) from the summer commercial fishery for retained catch. Sample sizes used when fitting the population model (Input) as well as observed sample sizes (Total) are displayed. This data set was used for fitting models that included shell condition information.

Year	Fleet	Type	Shell	Input	64-73	74-83	84-93	94-103	104-113	114-123	124-133	134+	Total
2012	Summer comm.	retain	new	10	0.00	0.00	0.00	13.00	1224.00	2336.00	932.00	113.00	4618.00
2013	Summer comm.	retain	new	10	0.00	0.00	0.00	27.00	1450.00	2253.00	1465.00	369.00	5564.00
2014	Summer comm.	retain	new	10	0.00	0.00	0.00	40.00	1324.00	1105.00	866.00	335.00	3670.00
2015	Summer comm.	retain	new	10	0.00	0.00	0.00	58.00	1987.00	1177.00	418.00	122.00	3762.00
2016	Summer comm.	retain	new	10	0.00	0.00	0.00	5.00	392.00	731.00	247.00	48.00	1423.00
2017	Summer comm.	retain	new	10	0.00	0.00	0.00	4.00	602.00	1341.00	728.00	86.00	2761.00
2018	Summer comm.	retain	new	10	0.00	0.00	0.00	9.00	300.00	842.00	845.00	197.00	2193.00
2019	Summer comm.	retain	new	10	0.00	0.00	0.00	10.00	364.00	260.00	151.00	29.00	814.00
2022	Summer comm.	retain	new	10	0.00	0.00	0.00	56.00	1375.00	892.00	96.00	5.00	2424.00
2023	Summer comm.	retain	new	10	0.00	0.00	0.00	10.00	645.00	1027.00	331.00	25.00	2038.00
2024	Summer comm.	retain	new	10	0.00	0.00	0.00	4.00	312.00	1008.00	833.00	184.00	2341.00
1977	Summer comm.	retain	old	10	0.00	0.00	0.00	0.00	97.00	62.00	10.00	6.00	175.00
1978	Summer comm.	retain	old	10	0.00	0.00	0.00	0.00	2.00	4.00	3.00	1.00	10.00
1979	Summer comm.	retain	old	10	0.00	0.00	0.00	0.00	42.00	1.00	5.00	14.00	62.00
1980	Summer comm.	retain	old	10	0.00	0.00	0.00	0.00	3.00	12.00	17.00	8.00	40.00
1981	Summer comm.	retain	old	10	0.00	0.00	0.00	0.00	8.00	90.00	207.00	158.00	463.00
1982	Summer comm.	retain	old	10	0.00	0.00	0.00	4.00	14.00	24.00	33.00	30.00	105.00
1983	Summer comm.	retain	old	10	0.00	0.00	0.00	3.00	29.00	8.00	17.00	18.00	75.00
1984	Summer comm.	retain	old	10	0.00	0.00	0.00	10.00	63.00	47.00	6.00	1.00	127.00
1985	Summer comm.	retain	old	10	0.00	0.00	0.00	7.00	90.00	84.00	23.00	3.00	207.00
1986	Summer comm.	retain	old	10	0.00	0.00	0.00	2.00	23.00	43.00	27.00	3.00	98.00
1987	Summer comm.	retain	old	10	0.00	0.00	0.00	5.00	53.00	129.00	60.00	18.00	265.00
1988	Summer comm.	retain	old	10	0.00	0.00	0.00	9.00	98.00	148.00	107.00	29.00	391.00
1989	Summer comm.	retain	old	10	0.00	0.00	0.00	11.00	144.00	315.00	221.00	60.00	751.00
1990	Summer comm.	retain	old	10	0.00	0.00	0.00	1.00	48.00	95.00	61.00	14.00	219.00
1992	Summer comm.	retain	old	10	0.00	0.00	0.00	7.00	203.00	331.00	153.00	52.00	746.00
1993	Summer comm.	retain	old	10	0.00	0.00	0.00	7.00	308.00	778.00	512.00	133.00	1738.00
1994	Summer comm.	retain	old	10	0.00	0.00	0.00	10.00	76.00	101.00	81.00	19.00	287.00
1995	Summer comm.	retain	old	10	0.00	0.00	0.00	9.00	57.00	87.00	75.00	15.00	243.00
1996	Summer comm.	retain	old	10	0.00	0.00	0.00	11.00	94.00	107.00	62.00	13.00	287.00
1997	Summer comm.	retain	old	10	0.00	0.00	0.00	4.00	67.00	50.00	32.00	14.00	167.00
1998	Summer comm.	retain	old	10	0.00	0.00	0.00	23.00	118.00	151.00	86.00	32.00	410.00
1999	Summer comm.	retain	old	10	0.00	0.00	0.00	1.00	13.00	27.00	25.00	2.00	68.00
2000	Summer comm.	retain	old	10	0.00	0.00	0.00	48.00	914.00	1125.00	609.00	141.00	2837.00

Table 24: Length composition information by male carapace length size class (in mm) from the summer commercial fishery for retained catch. Sample sizes used when fitting the population model (Input) as well as observed sample sizes (Total) are displayed. This data set was used for fitting models that included shell condition information.

Year	Fleet	Type	Shell	Input	64-73	74-83	84-93	94-103	104-113	114-123	124-133	134+	Total
2001	Summer comm.	retain	old	10	0.00	0.00	0.00	17.00	483.00	996.00	476.00	134.00	2106.00
2002	Summer comm.	retain	old	10	0.00	0.00	0.00	24.00	147.00	219.00	165.00	44.00	599.00
2003	Summer comm.	retain	old	10	0.00	0.00	0.00	6.00	114.00	243.00	276.00	76.00	715.00
2004	Summer comm.	retain	old	10	0.00	0.00	0.00	4.00	245.00	333.00	143.00	70.00	795.00
2005	Summer comm.	retain	old	10	0.00	0.00	0.00	0.00	110.00	242.00	102.00	32.00	486.00
2006	Summer comm.	retain	old	10	0.00	0.00	0.00	2.00	334.00	922.00	464.00	77.00	1799.00
2007	Summer comm.	retain	old	10	0.00	0.00	0.00	5.00	151.00	351.00	186.00	38.00	731.00
2008	Summer comm.	retain	old	10	0.00	0.00	0.00	8.00	516.00	535.00	204.00	62.00	1325.00
2009	Summer comm.	retain	old	10	0.00	0.00	0.00	7.00	463.00	479.00	114.00	32.00	1095.00
2010	Summer comm.	retain	old	10	0.00	0.00	0.00	11.00	322.00	322.00	136.00	24.00	815.00
2011	Summer comm.	retain	old	10	0.00	0.00	0.00	5.00	156.00	150.00	42.00	12.00	365.00
2012	Summer comm.	retain	old	10	0.00	0.00	0.00	1.00	131.00	214.00	79.00	13.00	438.00
2013	Summer comm.	retain	old	10	0.00	0.00	0.00	2.00	85.00	256.00	137.00	28.00	508.00
2014	Summer comm.	retain	old	10	0.00	0.00	0.00	1.00	193.00	405.00	336.00	77.00	1012.00
2015	Summer comm.	retain	old	10	0.00	0.00	0.00	3.00	99.00	137.00	137.00	35.00	411.00
2016	Summer comm.	retain	old	10	0.00	0.00	0.00	2.00	27.00	36.00	45.00	10.00	120.00
2017	Summer comm.	retain	old	10	0.00	0.00	0.00	3.00	100.00	384.00	164.00	22.00	673.00
2018	Summer comm.	retain	old	10	0.00	0.00	0.00	0.00	23.00	197.00	196.00	50.00	466.00
2019	Summer comm.	retain	old	10	0.00	0.00	0.00	0.00	18.00	119.00	154.00	31.00	322.00
2022	Summer comm.	retain	old	10	0.00	0.00	0.00	20.00	359.00	149.00	24.00	5.00	557.00
2023	Summer comm.	retain	old	10	0.00	0.00	0.00	1.00	169.00	209.00	36.00	5.00	420.00
2024	Summer comm.	retain	old	10	0.00	0.00	0.00	0.00	59.00	178.00	96.00	12.00	345.00

Table 25: Length composition information by male carapace length size class (in mm) from the summer commercial fishery for retained catch. Sample sizes used when fitting the population model (Input) as well as observed sample sizes (Total) are displayed. This data set was used for fitting models that excluded shell condition information.

Year	Fleet	Type	Shell	Input	64-73	74-83	84-93	94-103	104-113	114-123	124-133	134+	Total
1977	Summer comm.	retain	-	10	0.00	0.00	0.00	5.00	747.00	592.00	129.00	76.00	1549.00
1978	Summer comm.	retain	-	10	0.00	0.00	0.00	4.00	74.00	188.00	106.00	17.00	389.00
1979	Summer comm.	retain	-	10	0.00	0.00	0.00	42.00	428.00	637.00	430.00	123.00	1660.00
1980	Summer comm.	retain	-	10	0.00	0.00	0.00	4.00	108.00	339.00	413.00	204.00	1068.00
1981	Summer comm.	retain	-	10	0.00	0.00	0.00	7.00	139.00	365.00	709.00	564.00	1784.00
1982	Summer comm.	retain	-	10	0.00	0.00	0.00	50.00	224.00	204.00	272.00	343.00	1093.00
1983	Summer comm.	retain	-	10	0.00	0.00	0.00	34.00	360.00	295.00	68.00	45.00	802.00
1984	Summer comm.	retain	-	10	0.00	0.00	0.00	103.00	467.00	317.00	68.00	8.00	963.00
1985	Summer comm.	retain	-	10	0.00	0.00	1.00	180.00	930.00	1084.00	440.00	56.00	2691.00
1986	Summer comm.	retain	-	10	0.00	0.00	0.00	35.00	428.00	491.00	161.00	23.00	1138.00
1987	Summer comm.	retain	-	10	0.00	0.00	0.00	38.00	408.00	707.00	599.00	233.00	1985.00
1988	Summer comm.	retain	-	10	0.00	1.00	0.00	45.00	403.00	605.00	381.00	87.00	1522.00
1989	Summer comm.	retain	-	10	0.00	0.00	0.00	44.00	570.00	1141.00	663.00	177.00	2595.00
1990	Summer comm.	retain	-	10	0.00	0.00	0.00	20.00	233.00	542.00	392.00	102.00	1289.00
1992	Summer comm.	retain	-	10	0.00	0.00	0.00	51.00	718.00	1013.00	503.00	281.00	2566.00
1993	Summer comm.	retain	-	10	0.00	0.00	0.00	260.00	4424.00	7791.00	4607.00	722.00	17804.00
1994	Summer comm.	retain	-	10	0.00	0.00	0.00	20.00	114.00	134.00	109.00	27.00	404.00
1995	Summer comm.	retain	-	10	0.00	0.00	0.00	55.00	364.00	422.00	251.00	75.00	1167.00
1996	Summer comm.	retain	-	10	0.00	0.00	0.00	36.00	270.00	295.00	136.00	50.00	787.00
1997	Summer comm.	retain	-	10	0.00	0.00	0.00	39.00	505.00	459.00	151.00	44.00	1198.00
1998	Summer comm.	retain	-	10	0.00	0.00	0.00	53.00	364.00	407.00	171.00	60.00	1055.00
1999	Summer comm.	retain	-	10	0.00	0.00	0.00	37.00	178.00	164.00	128.00	55.00	562.00
2000	Summer comm.	retain	-	10	0.00	0.00	0.00	382.00	6063.00	7868.00	2493.00	407.00	17213.00
2001	Summer comm.	retain	-	10	0.00	0.00	0.00	504.00	4955.00	8390.00	4592.00	1589.00	20030.00
2002	Summer comm.	retain	-	10	0.00	0.00	0.00	255.00	1369.00	1688.00	1481.00	426.00	5219.00
2003	Summer comm.	retain	-	10	0.00	0.00	0.00	127.00	2037.00	1914.00	910.00	238.00	5226.00
2004	Summer comm.	retain	-	10	0.00	0.00	0.00	88.00	3905.00	4060.00	1159.00	394.00	9606.00
2005	Summer comm.	retain	-	10	0.00	0.00	0.00	12.00	1471.00	2766.00	962.00	149.00	5360.00
2006	Summer comm.	retain	-	10	0.00	0.00	0.00	16.00	1556.00	3259.00	1632.00	244.00	6707.00
2007	Summer comm.	retain	-	10	0.00	0.00	0.00	73.00	2340.00	2438.00	1028.00	246.00	6125.00
2008	Summer comm.	retain	-	10	0.00	0.00	0.00	35.00	2541.00	2539.00	526.00	125.00	5766.00
2009	Summer comm.	retain	-	10	0.00	0.00	0.00	70.00	2539.00	2464.00	789.00	164.00	6026.00
2010	Summer comm.	retain	-	10	0.00	0.00	0.00	42.00	2597.00	2457.00	722.00	84.00	5902.00
2011	Summer comm.	retain	-	10	0.00	0.00	0.00	16.00	965.00	1163.00	336.00	72.00	2552.00

Table 25: Length composition information by male carapace length size class (in mm) from the summer commercial fishery for retained catch. Sample sizes used when fitting the population model (Input) as well as observed sample sizes (Total) are displayed. This data set was used for fitting models that excluded shell condition information.

Year	Fleet	Type	Shell	Input	64-73	74-83	84-93	94-103	104-113	114-123	124-133	134+	Total
2012	Summer comm.	retain	-	10	0.00	0.00	0.00	14.00	1355.00	2550.00	1011.00	126.00	5056.00
2013	Summer comm.	retain	-	10	0.00	0.00	0.00	29.00	1535.00	2509.00	1602.00	397.00	6072.00
2014	Summer comm.	retain	-	10	0.00	0.00	0.00	41.00	1517.00	1510.00	1202.00	412.00	4682.00
2015	Summer comm.	retain	-	10	0.00	0.00	0.00	61.00	2086.00	1314.00	555.00	157.00	4173.00
2016	Summer comm.	retain	-	10	0.00	0.00	0.00	7.00	419.00	767.00	292.00	58.00	1543.00
2017	Summer comm.	retain	-	10	0.00	0.00	0.00	7.00	702.00	1725.00	892.00	108.00	3434.00
2018	Summer comm.	retain	-	10	0.00	0.00	0.00	9.00	323.00	1039.00	1041.00	247.00	2659.00
2019	Summer comm.	retain	-	10	0.00	0.00	0.00	10.00	382.00	379.00	305.00	60.00	1136.00
2022	Summer comm.	retain	-	10	0.00	0.00	0.00	76.00	1734.00	1041.00	120.00	10.00	2981.00
2023	Summer comm.	retain	-	10	0.00	0.00	0.00	11.00	169.00	209.00	36.00	5.00	430.00
2024	Summer comm.	retain	-	10	0.00	0.00	0.00	4.00	371.00	1186.00	929.00	196.00	2686.00

Table 26: Length composition information by male carapace length size class (in mm) from the summer commercial fishery for discarded catch. Sample sizes used when fitting the population model (Input) as well as observed sample sizes (Total) are displayed. This data set was used for fitting models that included shell condition information.

Year	Fleet	Type	Shell	Input	64-73	74-83	84-93	94-103	104-113	114-123	124-133	134+	Total
1987	Summer comm.	discard	new	10	69.00	216.00	367.00	379.00	37.00	0.00	0.00	0.00	1068.00
1988	Summer comm.	discard	new	10	9.00	29.00	108.00	344.00	99.00	0.00	0.00	0.00	589.00
1989	Summer comm.	discard	new	10	71.00	193.00	242.00	216.00	25.00	0.00	0.00	0.00	747.00
1990	Summer comm.	discard	new	10	40.00	115.00	137.00	139.00	19.00	0.00	0.00	0.00	450.00
1992	Summer comm.	discard	new	10	65.00	99.00	173.00	171.00	19.00	0.00	0.00	0.00	527.00
1994	Summer comm.	discard	new	10	63.00	50.00	92.00	126.00	19.00	0.00	0.00	0.00	350.00
2012	Summer comm.	discard	new	10	242.00	137.00	195.00	313.00	97.00	9.00	0.00	0.00	993.00
2013	Summer comm.	discard	new	10	845.00	722.00	390.00	416.00	113.00	6.00	2.00	0.00	2494.00
2014	Summer comm.	discard	new	10	79.00	175.00	460.00	724.00	207.00	14.00	4.00	0.00	1663.00
2015	Summer comm.	discard	new	10	26.00	120.00	278.00	709.00	303.00	37.00	11.00	1.00	1485.00
2016	Summer comm.	discard	new	10	19.00	22.00	71.00	215.00	71.00	7.00	0.00	0.00	405.00
2017	Summer comm.	discard	new	10	53.00	88.00	73.00	166.00	137.00	8.00	0.00	0.00	525.00
2018	Summer comm.	discard	new	10	52.00	91.00	189.00	160.00	12.00	0.00	0.00	0.00	504.00
2019	Summer comm.	discard	new	10	30.00	13.00	14.00	25.00	2.00	0.00	0.00	0.00	84.00
1987	Summer comm.	discard	old	10	0.00	2.00	23.00	47.00	5.00	0.00	0.00	0.00	77.00
1988	Summer comm.	discard	old	10	2.00	8.00	23.00	69.00	31.00	0.00	0.00	0.00	133.00
1989	Summer comm.	discard	old	10	18.00	34.00	67.00	109.00	25.00	0.00	0.00	0.00	253.00
1990	Summer comm.	discard	old	10	8.00	9.00	10.00	27.00	3.00	0.00	0.00	0.00	57.00
1992	Summer comm.	discard	old	10	3.00	13.00	11.00	23.00	5.00	0.00	0.00	0.00	55.00
1994	Summer comm.	discard	old	10	61.00	63.00	128.00	205.00	43.00	0.00	0.00	0.00	500.00
2012	Summer comm.	discard	old	10	2.00	2.00	2.00	22.00	22.00	0.00	1.00	0.00	51.00
2013	Summer comm.	discard	old	10	2.00	1.00	1.00	7.00	2.00	2.00	0.00	0.00	15.00
2014	Summer comm.	discard	old	10	0.00	4.00	15.00	50.00	19.00	3.00	1.00	0.00	92.00
2015	Summer comm.	discard	old	10	0.00	0.00	2.00	24.00	17.00	6.00	1.00	4.00	54.00
2016	Summer comm.	discard	old	10	0.00	0.00	1.00	12.00	6.00	2.00	0.00	0.00	21.00
2017	Summer comm.	discard	old	10	2.00	2.00	3.00	2.00	7.00	0.00	0.00	0.00	16.00
2018	Summer comm.	discard	old	10	0.00	6.00	12.00	7.00	1.00	0.00	0.00	1.00	27.00
2019	Summer comm.	discard	old	10	0.00	0.00	1.00	8.00	1.00	0.00	0.00	0.00	10.00

Table 27: Length composition information by male carapace length size class (in mm) from the summer commercial fishery for discarded catch. Sample sizes used when fitting the population model (Input) as well as observed sample sizes (Total) are displayed. This data set was used for fitting models that excluded shell condition information.

Year	Fleet	Type	Shell	Input	64-73	74-83	84-93	94-103	104-113	114-123	124-133	134+	Total
1987	Summer comm.	discard	-	10	69.00	218.00	390.00	426.00	42.00	0.00	0.00	0.00	1145.00
1988	Summer comm.	discard	-	10	11.00	37.00	131.00	413.00	130.00	0.00	0.00	0.00	722.00
1989	Summer comm.	discard	-	10	89.00	227.00	309.00	325.00	50.00	0.00	0.00	0.00	1000.00
1990	Summer comm.	discard	-	10	48.00	124.00	147.00	166.00	22.00	0.00	0.00	0.00	507.00
1992	Summer comm.	discard	-	10	68.00	112.00	184.00	194.00	24.00	0.00	0.00	0.00	582.00
1994	Summer comm.	discard	-	10	124.00	113.00	220.00	331.00	62.00	0.00	0.00	0.00	850.00
2012	Summer comm.	discard	-	10	244.00	139.00	197.00	335.00	119.00	9.00	1.00	0.00	1044.00
2013	Summer comm.	discard	-	10	847.00	723.00	391.00	423.00	115.00	8.00	2.00	0.00	2509.00
2014	Summer comm.	discard	-	10	79.00	179.00	475.00	774.00	226.00	17.00	5.00	0.00	1755.00
2015	Summer comm.	discard	-	10	26.00	120.00	280.00	733.00	320.00	43.00	12.00	5.00	1539.00
2016	Summer comm.	discard	-	10	19.00	22.00	72.00	227.00	77.00	9.00	0.00	0.00	426.00
2017	Summer comm.	discard	-	10	55.00	90.00	76.00	168.00	144.00	8.00	0.00	0.00	541.00
2018	Summer comm.	discard	-	10	52.00	97.00	201.00	167.00	13.00	0.00	0.00	1.00	531.00
2019	Summer comm.	discard	-	10	30.00	13.00	15.00	33.00	3.00	0.00	0.00	0.00	94.00

Table 28: Length composition information by male carapace length size class (in mm) from the summer commercial fishery for total catch. Sample sizes used when fitting the population model (Input) as well as observed sample sizes (Total) are displayed. This data set was used for fitting models that included shell condition information.

Year	Fleet	Type	Shell	Input	64-73	74-83	84-93	94-103	104-113	114-123	124-133	134+	Total
1987	Summer comm.	discard	new	10	69.00	216.00	367.00	379.00	37.00	0.00	0.00	0.00	1068.00
1988	Summer comm.	discard	new	10	9.00	29.00	108.00	344.00	99.00	0.00	0.00	0.00	589.00
1989	Summer comm.	discard	new	10	71.00	193.00	242.00	216.00	25.00	0.00	0.00	0.00	747.00
1990	Summer comm.	discard	new	10	40.00	115.00	137.00	139.00	19.00	0.00	0.00	0.00	450.00
1992	Summer comm.	discard	new	10	65.00	99.00	173.00	171.00	19.00	0.00	0.00	0.00	527.00
1994	Summer comm.	discard	new	10	63.00	50.00	92.00	126.00	19.00	0.00	0.00	0.00	350.00
2012	Summer comm.	discard	new	10	242.00	137.00	195.00	313.00	97.00	9.00	0.00	0.00	993.00
2013	Summer comm.	discard	new	10	845.00	722.00	390.00	416.00	113.00	6.00	2.00	0.00	2494.00
2014	Summer comm.	discard	new	10	79.00	175.00	460.00	724.00	207.00	14.00	4.00	0.00	1663.00
2015	Summer comm.	discard	new	10	26.00	120.00	278.00	709.00	303.00	37.00	11.00	1.00	1485.00
2016	Summer comm.	discard	new	10	19.00	22.00	71.00	215.00	71.00	7.00	0.00	0.00	405.00
2017	Summer comm.	discard	new	10	53.00	88.00	73.00	166.00	137.00	8.00	0.00	0.00	525.00
2018	Summer comm.	discard	new	10	52.00	91.00	189.00	160.00	12.00	0.00	0.00	0.00	504.00
2019	Summer comm.	discard	new	10	30.00	13.00	14.00	25.00	2.00	0.00	0.00	0.00	84.00
1987	Summer comm.	discard	old	10	0.00	2.00	23.00	47.00	5.00	0.00	0.00	0.00	77.00
1988	Summer comm.	discard	old	10	2.00	8.00	23.00	69.00	31.00	0.00	0.00	0.00	133.00
1989	Summer comm.	discard	old	10	18.00	34.00	67.00	109.00	25.00	0.00	0.00	0.00	253.00
1990	Summer comm.	discard	old	10	8.00	9.00	10.00	27.00	3.00	0.00	0.00	0.00	57.00
1992	Summer comm.	discard	old	10	3.00	13.00	11.00	23.00	5.00	0.00	0.00	0.00	55.00
1994	Summer comm.	discard	old	10	61.00	63.00	128.00	205.00	43.00	0.00	0.00	0.00	500.00
2012	Summer comm.	discard	old	10	2.00	2.00	2.00	22.00	22.00	0.00	1.00	0.00	51.00
2013	Summer comm.	discard	old	10	2.00	1.00	1.00	7.00	2.00	2.00	0.00	0.00	15.00
2014	Summer comm.	discard	old	10	0.00	4.00	15.00	50.00	19.00	3.00	1.00	0.00	92.00
2015	Summer comm.	discard	old	10	0.00	0.00	2.00	24.00	17.00	6.00	1.00	4.00	54.00
2016	Summer comm.	discard	old	10	0.00	0.00	1.00	12.00	6.00	2.00	0.00	0.00	21.00
2017	Summer comm.	discard	old	10	2.00	2.00	3.00	2.00	7.00	0.00	0.00	0.00	16.00
2018	Summer comm.	discard	old	10	0.00	6.00	12.00	7.00	1.00	0.00	0.00	1.00	27.00
2019	Summer comm.	discard	old	10	0.00	0.00	1.00	8.00	1.00	0.00	0.00	0.00	10.00

Table 29: Length composition information by male carapace length size class (in mm) from the summer commercial fishery for total catch. Sample sizes used when fitting the population model (Input) as well as observed sample sizes (Total) are displayed. This data set was used for fitting models that excluded shell condition information.

Year	Fleet	Type	Shell	Input	64-73	74-83	84-93	94-103	104-113	114-123	124-133	134+	Total
1987	Summer comm.	discard	-	10	69.00	218.00	390.00	426.00	42.00	0.00	0.00	0.00	1145.00
1988	Summer comm.	discard	-	10	11.00	37.00	131.00	413.00	130.00	0.00	0.00	0.00	722.00
1989	Summer comm.	discard	-	10	89.00	227.00	309.00	325.00	50.00	0.00	0.00	0.00	1000.00
1990	Summer comm.	discard	-	10	48.00	124.00	147.00	166.00	22.00	0.00	0.00	0.00	507.00
1992	Summer comm.	discard	-	10	68.00	112.00	184.00	194.00	24.00	0.00	0.00	0.00	582.00
1994	Summer comm.	discard	-	10	124.00	113.00	220.00	331.00	62.00	0.00	0.00	0.00	850.00
2012	Summer comm.	discard	-	10	244.00	139.00	197.00	335.00	119.00	9.00	1.00	0.00	1044.00
2013	Summer comm.	discard	-	10	847.00	723.00	391.00	423.00	115.00	8.00	2.00	0.00	2509.00
2014	Summer comm.	discard	-	10	79.00	179.00	475.00	774.00	226.00	17.00	5.00	0.00	1755.00
2015	Summer comm.	discard	-	10	26.00	120.00	280.00	733.00	320.00	43.00	12.00	5.00	1539.00
2016	Summer comm.	discard	-	10	19.00	22.00	72.00	227.00	77.00	9.00	0.00	0.00	426.00
2017	Summer comm.	discard	-	10	55.00	90.00	76.00	168.00	144.00	8.00	0.00	0.00	541.00
2018	Summer comm.	discard	-	10	52.00	97.00	201.00	167.00	13.00	0.00	0.00	1.00	531.00
2019	Summer comm.	discard	-	10	30.00	13.00	15.00	33.00	3.00	0.00	0.00	0.00	94.00

Table 30: Length composition information by male carapace length size class (in mm) from the NMFS trawl survey for total catch. Sample sizes used when fitting the population model (Input) as well as observed sample sizes (Total) are displayed. This data set was used for fitting models that included shell condition information.

Year	Fleet	Type	Shell	Input	64-73	74-83	84-93	94-103	104-113	114-123	124-133	134+	Total
1976	NMFS trawl survey	total	new	20	10.00	17.00	81.00	77.00	85.00	60.00	13.00	4.00	347.00
1979	NMFS trawl survey	total	new	20	3.00	2.00	1.00	4.00	10.00	11.00	6.00	2.00	39.00
1982	NMFS trawl survey	total	new	20	71.00	20.00	42.00	60.00	47.00	9.00	0.00	1.00	250.00
1985	NMFS trawl survey	total	new	20	29.00	20.00	28.00	18.00	29.00	9.00	5.00	1.00	139.00
1988	NMFS trawl survey	total	new	20	60.00	66.00	40.00	33.00	29.00	19.00	8.00	0.00	255.00
1991	NMFS trawl survey	total	new	20	66.00	26.00	6.00	10.00	20.00	11.00	4.00	2.00	145.00
1976	NMFS trawl survey	total	old	20	0.00	6.00	15.00	33.00	39.00	40.00	8.00	6.00	147.00
1979	NMFS trawl survey	total	old	20	3.00	1.00	2.00	8.00	30.00	88.00	42.00	7.00	181.00
1982	NMFS trawl survey	total	old	20	0.00	0.00	4.00	5.00	11.00	6.00	7.00	9.00	42.00
1985	NMFS trawl survey	total	old	20	0.00	0.00	0.00	6.00	16.00	27.00	16.00	4.00	69.00
1988	NMFS trawl survey	total	old	20	0.00	0.00	2.00	4.00	12.00	27.00	20.00	10.00	75.00
1991	NMFS trawl survey	total	old	20	9.00	19.00	8.00	26.00	53.00	47.00	31.00	6.00	199.00

Table 31: Length composition information by male carapace length size class (in mm) from the NMFS trawl survey for total catch. Sample sizes used when fitting the population model (Input) as well as observed sample sizes (Total) are displayed. This data set was used for fitting models that excluded shell condition information.

Year	Fleet	Type	Shell	Input	64-73	74-83	84-93	94-103	104-113	114-123	124-133	134+	Total
1976	NMFS trawl survey	total	-	20	10.00	23.00	96.00	110.00	124.00	100.00	21.00	10.00	494.00
1979	NMFS trawl survey	total	-	20	6.00	3.00	3.00	12.00	40.00	99.00	48.00	9.00	220.00
1982	NMFS trawl survey	total	-	20	71.00	20.00	46.00	65.00	58.00	15.00	7.00	10.00	292.00
1985	NMFS trawl survey	total	-	20	29.00	20.00	28.00	24.00	45.00	36.00	21.00	5.00	208.00
1988	NMFS trawl survey	total	-	20	60.00	66.00	42.00	37.00	41.00	46.00	28.00	10.00	330.00
1991	NMFS trawl survey	total	-	20	75.00	45.00	14.00	36.00	73.00	58.00	35.00	8.00	344.00

Table 32: Length composition information by male carapace length size class (in mm) from the ADFG trawl survey for total catch. Sample sizes used when fitting the population model (Input) as well as observed sample sizes (Total) are displayed. This data set was used for fitting models that included shell condition information.

Year	Fleet	Type	Shell	Input	64-73	74-83	84-93	94-103	104-113	114-123	124-133	134+	Total
1996	ADFG trawl survey	total	new	20	78.00	58.00	35.00	24.00	16.00	1.00	1.00	2.00	215.00
1999	ADFG trawl survey	total	new	20	9.00	3.00	29.00	82.00	74.00	36.00	9.00	2.00	244.00
2002	ADFG trawl survey	total	new	20	23.00	29.00	33.00	28.00	4.00	8.00	6.00	2.00	133.00
2006	ADFG trawl survey	total	new	20	69.00	98.00	80.00	42.00	23.00	14.00	9.00	0.00	335.00
2008	ADFG trawl survey	total	new	20	34.00	42.00	58.00	31.00	27.00	8.00	5.00	2.00	207.00
2011	ADFG trawl survey	total	new	20	42.00	35.00	27.00	35.00	56.00	44.00	10.00	3.00	252.00
2014	ADFG trawl survey	total	new	20	30.00	57.00	91.00	69.00	36.00	6.00	5.00	3.00	297.00
2017	ADFG trawl survey	total	new	20	16.00	14.00	6.00	11.00	11.00	12.00	5.00	0.00	75.00
2018	ADFG trawl survey	total	new	20	27.00	7.00	8.00	2.00	1.00	2.00	3.00	1.00	51.00
2019	ADFG trawl survey	total	new	20	169.00	91.00	10.00	0.00	1.00	1.00	1.00	0.00	273.00
2020	ADFG trawl survey	total	new	20	14.00	24.00	33.00	7.00	6.00	2.00	0.00	0.00	86.00
2021	ADFG trawl survey	total	new	20	10.00	27.00	35.00	35.00	34.00	7.00	1.00	1.00	150.00
2023	ADFG trawl survey	total	new	20	0.00	1.00	8.00	21.00	48.00	50.00	16.00	1.00	145.00
2024	ADFG trawl survey	total	new	20	3.00	3.00	2.00	7.00	7.00	20.00	23.00	2.00	67.00
1996	ADFG trawl survey	total	old	20	1.00	1.00	7.00	9.00	12.00	12.00	11.00	7.00	60.00
1999	ADFG trawl survey	total	old	20	0.00	0.00	1.00	8.00	14.00	11.00	5.00	0.00	39.00
2002	ADFG trawl survey	total	old	20	2.00	7.00	17.00	25.00	22.00	21.00	13.00	4.00	111.00
2006	ADFG trawl survey	total	old	20	0.00	0.00	0.00	6.00	14.00	14.00	3.00	1.00	38.00
2008	ADFG trawl survey	total	old	20	0.00	2.00	12.00	17.00	23.00	3.00	10.00	1.00	68.00
2011	ADFG trawl survey	total	old	20	0.00	1.00	4.00	7.00	27.00	14.00	10.00	0.00	63.00
2014	ADFG trawl survey	total	old	20	0.00	0.00	10.00	38.00	20.00	17.00	5.00	0.00	90.00
2017	ADFG trawl survey	total	old	20	1.00	2.00	2.00	2.00	8.00	21.00	5.00	0.00	41.00
2018	ADFG trawl survey	total	old	20	0.00	5.00	1.00	3.00	2.00	2.00	7.00	2.00	22.00
2019	ADFG trawl survey	total	old	20	1.00	1.00	4.00	6.00	4.00	7.00	9.00	2.00	34.00
2020	ADFG trawl survey	total	old	20	3.00	9.00	6.00	2.00	2.00	2.00	0.00	1.00	25.00
2021	ADFG trawl survey	total	old	20	0.00	0.00	2.00	0.00	3.00	1.00	1.00	1.00	8.00
2023	ADFG trawl survey	total	old	20	0.00	0.00	2.00	6.00	41.00	39.00	7.00	0.00	95.00
2024	ADFG trawl survey	total	old	20	0.00	0.00	0.00	0.00	5.00	16.00	3.00	2.00	26.00

Table 33: Length composition information by male carapace length size class (in mm) from the ADFG trawl survey for total catch. Sample sizes used when fitting the population model (Input) as well as observed sample sizes (Total) are displayed. This data set was used for fitting models that excluded shell condition information.

Year	Fleet	Type	Shell	Input	64-73	74-83	84-93	94-103	104-113	114-123	124-133	134+	Total
1996	ADFG trawl survey	total	-	20	79.00	59.00	42.00	33.00	28.00	13.00	12.00	9.00	275.00
1999	ADFG trawl survey	total	-	20	9.00	3.00	30.00	90.00	88.00	47.00	14.00	2.00	283.00
2002	ADFG trawl survey	total	-	20	25.00	36.00	50.00	53.00	26.00	29.00	19.00	6.00	244.00
2006	ADFG trawl survey	total	-	20	69.00	98.00	80.00	48.00	37.00	28.00	12.00	1.00	373.00
2008	ADFG trawl survey	total	-	20	34.00	44.00	70.00	48.00	50.00	11.00	15.00	3.00	275.00
2011	ADFG trawl survey	total	-	20	42.00	36.00	31.00	42.00	83.00	58.00	20.00	3.00	315.00
2014	ADFG trawl survey	total	-	20	30.00	57.00	101.00	107.00	56.00	23.00	10.00	3.00	387.00
2017	ADFG trawl survey	total	-	20	17.00	16.00	8.00	13.00	19.00	33.00	10.00	0.00	116.00
2018	ADFG trawl survey	total	-	20	27.00	12.00	9.00	5.00	3.00	4.00	10.00	3.00	73.00
2019	ADFG trawl survey	total	-	20	170.00	92.00	14.00	6.00	5.00	8.00	10.00	2.00	307.00
2020	ADFG trawl survey	total	-	20	17.00	33.00	39.00	9.00	8.00	4.00	0.00	1.00	111.00
2021	ADFG trawl survey	total	-	20	10.00	27.00	37.00	35.00	37.00	8.00	2.00	2.00	158.00
2023	ADFG trawl survey	total	-	20	0.00	1.00	10.00	27.00	89.00	89.00	23.00	1.00	240.00
2024	ADFG trawl survey	total	-	20	3.00	3.00	2.00	7.00	12.00	36.00	26.00	4.00	93.00

Table 34: Length composition information by male carapace length size class (in mm) from the NBS trawl survey for total catch. Sample sizes used when fitting the population model (Input) as well as observed sample sizes (Total) are displayed. This data set was used for fitting models that included shell condition information.

Year	Fleet	Type	Shell	Input	64-73	74-83	84-93	94-103	104-113	114-123	124-133	134+	Total
2010	NBS trawl survey	total	new	20	1.00	3.00	4.00	12.00	4.00	2.00	0.00	0.00	26.00
2017	NBS trawl survey	total	new	20	5.00	6.00	8.00	3.00	3.00	3.00	3.00	2.00	33.00
2019	NBS trawl survey	total	new	20	49.00	41.00	11.00	5.00	2.00	0.00	1.00	1.00	110.00
2021	NBS trawl survey	total	new	20	4.00	13.00	17.00	13.00	8.00	2.00	0.00	0.00	57.00
2022	NBS trawl survey	total	new	20	60.00	63.00	42.00	38.00	26.00	13.00	3.00	2.00	247.00
2023	NBS trawl survey	total	new	20	1.00	3.00	5.00	6.00	12.00	9.00	4.00	1.00	41.00
2010	NBS trawl survey	total	old	20	0.00	2.00	6.00	15.00	13.00	7.00	2.00	2.00	47.00
2017	NBS trawl survey	total	old	20	2.00	0.00	2.00	3.00	2.00	11.00	3.00	2.00	25.00
2019	NBS trawl survey	total	old	20	5.00	2.00	6.00	3.00	2.00	1.00	5.00	1.00	25.00
2021	NBS trawl survey	total	old	20	1.00	4.00	9.00	5.00	5.00	1.00	0.00	0.00	25.00
2022	NBS trawl survey	total	old	20	8.00	8.00	27.00	29.00	29.00	19.00	9.00	2.00	131.00
2023	NBS trawl survey	total	old	20	0.00	0.00	1.00	6.00	14.00	13.00	3.00	0.00	37.00

Table 35: Length composition information by male carapace length size class (in mm) from the NBS trawl survey for total catch. Sample sizes used when fitting the population model (Input) as well as observed sample sizes (Total) are displayed. This data set was used for fitting models that excluded shell condition information.

Year	Fleet	Type	Shell	Input	64-73	74-83	84-93	94-103	104-113	114-123	124-133	134+	Total
2010	NBS trawl survey	total	-	20	1.00	5.00	10.00	27.00	17.00	9.00	2.00	2.00	73.00
2017	NBS trawl survey	total	-	20	7.00	6.00	10.00	6.00	5.00	14.00	6.00	4.00	58.00
2019	NBS trawl survey	total	-	20	54.00	43.00	17.00	8.00	4.00	1.00	6.00	2.00	135.00
2021	NBS trawl survey	total	-	20	5.00	17.00	26.00	18.00	13.00	3.00	0.00	0.00	82.00
2022	NBS trawl survey	total	-	20	68.00	71.00	69.00	67.00	55.00	32.00	12.00	4.00	378.00
2023	NBS trawl survey	total	-	20	1.00	3.00	6.00	12.00	26.00	22.00	7.00	1.00	78.00

Table 36: Length composition information by male carapace length size class (in mm) from the winter pot survey for total catch. Sample sizes used when fitting the population model (Input) as well as observed sample sizes (Total) are displayed. This data set was used for fitting models that included shell condition information.

Year	Fleet	Type	Shell	Input	64-73	74-83	84-93	94-103	104-113	114-123	124-133	134+	Total
1982	Winter pot survey	total	new	10	0.00	72.00	164.00	154.00	50.00	14.00	12.00	0.00	466.00
1983	Winter pot survey	total	new	10	68.00	215.50	711.50	719.00	543.00	178.00	18.00	3.50	2456.50
1984	Winter pot survey	total	new	10	23.00	271.00	433.50	379.00	248.50	99.50	9.00	0.50	1464.00
1985	Winter pot survey	total	new	10	16.00	72.00	199.00	279.50	122.50	44.00	7.00	0.50	740.50
1986	Winter pot survey	total	new	10	25.50	72.50	102.00	145.00	115.00	49.00	7.00	0.50	516.50
1987	Winter pot survey	total	new	10	0.00	8.00	22.00	28.00	10.00	6.00	0.00	0.00	74.00
1989	Winter pot survey	total	new	10	8.00	66.00	74.50	66.50	95.50	86.50	17.00	0.00	414.00
1990	Winter pot survey	total	new	10	7.00	102.50	430.00	542.00	372.00	253.00	118.00	29.50	1854.00
1991	Winter pot survey	total	new	10	2.00	16.00	118.00	366.00	343.00	123.00	13.00	1.00	982.00
1993	Winter pot survey	total	new	10	0.00	1.00	6.00	10.00	23.00	21.00	5.00	0.00	66.00
1995	Winter pot survey	total	new	10	8.00	49.00	68.00	84.00	219.00	199.00	61.00	11.00	699.00
1996	Winter pot survey	total	new	10	102.00	215.00	320.00	307.00	181.00	106.00	40.00	7.00	1278.00
1997	Winter pot survey	total	new	10	28.00	85.00	87.00	44.00	58.00	45.00	21.00	4.00	372.00
1998	Winter pot survey	total	new	10	1.00	122.00	364.00	234.00	48.00	21.00	3.00	0.00	793.00
1999	Winter pot survey	total	new	10	6.00	25.00	152.00	464.00	469.00	109.00	17.00	3.00	1245.00
2000	Winter pot survey	total	new	10	10.00	50.00	60.00	93.00	189.00	101.00	20.00	1.00	524.00
2002	Winter pot survey	total	new	10	45.00	244.00	215.00	137.00	53.00	52.00	32.00	7.00	785.00
2003	Winter pot survey	total	new	10	20.00	80.00	180.00	233.00	145.00	49.00	20.00	4.00	731.00
2004	Winter pot survey	total	new	10	0.00	5.00	48.00	77.00	94.00	42.00	4.00	0.00	270.00
2005	Winter pot survey	total	new	10	2.00	30.00	57.00	72.00	88.00	75.00	30.00	1.00	355.00
2006	Winter pot survey	total	new	10	2.00	72.00	116.00	107.00	80.00	28.00	10.00	1.00	416.00
2007	Winter pot survey	total	new	10	11.00	22.00	31.00	56.00	21.00	7.00	0.00	0.00	148.00
2008	Winter pot survey	total	new	10	50.00	514.00	884.00	596.00	513.00	234.00	24.00	4.00	2819.00
2009	Winter pot survey	total	new	10	1.00	37.00	69.00	184.00	106.00	44.00	5.00	2.00	448.00
2010	Winter pot survey	total	new	10	4.00	27.00	74.00	124.00	141.00	65.00	10.00	1.00	446.00
2011	Winter pot survey	total	new	10	11.00	46.00	80.00	122.00	102.00	78.00	29.00	1.00	469.00
2012	Winter pot survey	total	new	10	17.00	76.00	154.00	128.00	82.00	85.00	27.00	3.00	572.00
1982	Winter pot survey	total	old	10	0.00	36.00	82.00	79.00	29.00	11.00	14.00	2.00	253.00
1983	Winter pot survey	total	old	10	0.00	0.00	0.00	10.00	49.00	24.50	21.50	21.00	126.00
1984	Winter pot survey	total	old	10	0.00	0.00	1.00	29.50	107.50	54.50	11.00	9.50	213.00
1985	Winter pot survey	total	old	10	0.00	0.00	1.00	5.00	22.50	18.50	1.00	0.00	48.00
1986	Winter pot survey	total	old	10	0.00	0.00	2.00	8.50	34.50	25.00	7.00	0.00	77.00
1987	Winter pot survey	total	old	10	0.00	0.00	1.00	6.00	43.00	16.00	4.00	0.00	70.00
1989	Winter pot survey	total	old	10	0.00	0.00	0.00	1.00	26.00	42.00	16.00	1.00	86.00

Table 36: Length composition information by male carapace length size class (in mm) from the winter pot survey for total catch. Sample sizes used when fitting the population model (Input) as well as observed sample sizes (Total) are displayed. This data set was used for fitting models that included shell condition information.

Year	Fleet	Type	Shell	Input	64-73	74-83	84-93	94-103	104-113	114-123	124-133	134+	Total
1990	Winter pot survey	total	old	10	0.00	0.00	0.00	2.00	54.50	116.00	44.00	5.50	222.00
1991	Winter pot survey	total	old	10	0.00	0.00	0.00	5.00	34.00	149.00	92.00	21.00	301.00
1993	Winter pot survey	total	old	10	0.00	0.00	0.00	3.00	35.00	49.00	19.00	9.00	115.00
1995	Winter pot survey	total	old	10	0.00	1.00	0.00	3.00	28.00	61.00	53.00	13.00	159.00
1996	Winter pot survey	total	old	10	0.00	0.00	5.00	20.00	87.00	114.00	55.00	21.00	302.00
1997	Winter pot survey	total	old	10	0.00	0.00	0.00	0.00	7.00	10.00	5.00	4.00	26.00
1998	Winter pot survey	total	old	10	0.00	1.00	6.00	14.00	28.00	15.00	16.00	8.00	88.00
1999	Winter pot survey	total	old	10	0.00	0.00	0.00	13.00	29.00	9.00	8.00	3.00	62.00
2000	Winter pot survey	total	old	10	0.00	0.00	0.00	1.00	29.00	13.00	7.00	1.00	51.00
2002	Winter pot survey	total	old	10	5.00	4.00	7.00	6.00	4.00	12.00	4.00	1.00	43.00
2003	Winter pot survey	total	old	10	1.00	5.00	5.00	18.00	20.00	22.00	17.00	5.00	93.00
2004	Winter pot survey	total	old	10	0.00	0.00	3.00	5.00	6.00	4.00	6.00	2.00	26.00
2005	Winter pot survey	total	old	10	0.00	1.00	1.00	1.00	16.00	24.00	5.00	2.00	50.00
2006	Winter pot survey	total	old	10	0.00	4.00	5.00	9.00	22.00	38.00	15.00	3.00	96.00
2007	Winter pot survey	total	old	10	0.00	0.00	1.00	1.00	3.00	6.00	0.00	0.00	11.00
2008	Winter pot survey	total	old	10	22.00	148.00	239.00	120.00	118.00	53.00	28.00	5.00	733.00
2009	Winter pot survey	total	old	10	0.00	0.00	1.00	1.00	20.00	52.00	2.00	1.00	77.00
2010	Winter pot survey	total	old	10	0.00	0.00	4.00	33.00	58.00	31.00	5.00	1.00	132.00
2011	Winter pot survey	total	old	10	1.00	0.00	7.00	19.00	66.00	27.00	7.00	0.00	127.00
2012	Winter pot survey	total	old	10	0.00	2.00	2.00	6.00	35.00	35.00	21.00	2.00	103.00

Table 37: Length composition information by male carapace length size class (in mm) from the winter pot survey for total catch. Sample sizes used when fitting the population model (Input) as well as observed sample sizes (Total) are displayed. This data set was used for fitting models that excluded shell condition information.

Year	Fleet	Type	Shell	Input	64-73	74-83	84-93	94-103	104-113	114-123	124-133	134+	Total
1982	Winter pot survey	total	-	10	0.00	108.00	246.00	233.00	79.00	25.00	26.00	2.00	719.00
1983	Winter pot survey	total	-	10	68.00	215.50	711.50	729.00	592.00	202.50	39.50	24.50	2582.50
1984	Winter pot survey	total	-	10	23.00	271.00	434.50	408.50	356.00	154.00	20.00	10.00	1677.00
1985	Winter pot survey	total	-	10	16.00	72.00	200.00	284.50	145.00	62.50	8.00	0.50	788.50
1986	Winter pot survey	total	-	10	25.50	72.50	104.00	153.50	149.50	74.00	14.00	0.50	593.50
1987	Winter pot survey	total	-	10	0.00	8.00	23.00	34.00	53.00	22.00	4.00	0.00	144.00
1989	Winter pot survey	total	-	10	8.00	66.00	74.50	67.50	121.50	128.50	33.00	1.00	500.00
1990	Winter pot survey	total	-	10	7.00	102.50	430.00	544.00	426.50	369.00	162.00	35.00	2076.00
1991	Winter pot survey	total	-	10	2.00	16.00	118.00	371.00	377.00	272.00	105.00	22.00	1283.00
1993	Winter pot survey	total	-	10	0.00	1.00	6.00	13.00	58.00	70.00	24.00	9.00	181.00
1995	Winter pot survey	total	-	10	8.00	50.00	68.00	87.00	247.00	260.00	114.00	24.00	858.00
1996	Winter pot survey	total	-	10	102.00	215.00	325.00	327.00	268.00	220.00	95.00	28.00	1580.00
1997	Winter pot survey	total	-	10	28.00	85.00	87.00	44.00	65.00	55.00	26.00	8.00	398.00
1998	Winter pot survey	total	-	10	1.00	123.00	370.00	248.00	76.00	36.00	19.00	8.00	881.00
1999	Winter pot survey	total	-	10	6.00	25.00	152.00	477.00	498.00	118.00	25.00	6.00	1307.00
2000	Winter pot survey	total	-	10	10.00	50.00	60.00	94.00	218.00	114.00	27.00	2.00	575.00
2002	Winter pot survey	total	-	10	50.00	248.00	222.00	143.00	57.00	64.00	36.00	8.00	828.00
2003	Winter pot survey	total	-	10	21.00	85.00	185.00	251.00	165.00	71.00	37.00	9.00	824.00
2004	Winter pot survey	total	-	10	0.00	5.00	51.00	82.00	100.00	46.00	10.00	2.00	296.00
2005	Winter pot survey	total	-	10	2.00	31.00	58.00	73.00	104.00	99.00	35.00	3.00	405.00
2006	Winter pot survey	total	-	10	2.00	76.00	121.00	116.00	102.00	66.00	25.00	4.00	512.00
2007	Winter pot survey	total	-	10	11.00	22.00	32.00	57.00	24.00	13.00	0.00	0.00	159.00
2008	Winter pot survey	total	-	10	72.00	662.00	1123.00	716.00	631.00	287.00	52.00	9.00	3552.00
2009	Winter pot survey	total	-	10	1.00	37.00	70.00	185.00	126.00	96.00	7.00	3.00	525.00
2010	Winter pot survey	total	-	10	4.00	27.00	78.00	157.00	199.00	96.00	15.00	2.00	578.00
2011	Winter pot survey	total	-	10	12.00	46.00	87.00	141.00	168.00	105.00	36.00	1.00	596.00
2012	Winter pot survey	total	-	10	17.00	78.00	156.00	134.00	117.00	120.00	48.00	5.00	675.00