Bristol Bay red king crab (BBRKC) proposed models May 2024

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Summary

The model explorations presented here include some of those suggested by CPT and SSC, and updates to GMACS. All GMACS updates were tested to ensure model fit (likelihood values, output, etc.) matched the last accepted base model. These models focus on selectivity - specifically assumptions for selectivity using the BSFRF data as a prior - and time block for molting probability. The models presented here are the beginning of work to explore these topics and the author acknowledges that further exploration is warranted. Model variants were performed using both the accepted 2023 model, 23.0a, and the previously accepted base model, 21.1b. Additionally, models were updated to reflect a correction in the season in which MMB is calculated, which was season 6 but now is season 7. This was a correction that minimally affects the estimated MMB and associated reference points.

The results of these model explorations are presented in this document in section C. Background on the Bristol Bay red king crab modeling approach, modeling framework (GMACS), and history of the stock and fisheries can be found in the last full SAFE published on the NPFMC website and will not be repeated here. (**BBRKC 2023 SAFE**)

B. Responses to SSC and CPT

CPT and SSC Comments on Assessments in General

Response to SSC Comments (June 2023, Oct 2023):

"The SSC recommends that a"fallback" Tier 4 alternative be provided, as recommended by the Simpler Modeling workshop. When doing so the SSC asks the authors to provide plots to compare OFLs with the status quo Tier 3 models for previous years, justification for the time series used for status determination and a recommended ABC buffer."

Response: A Tier 4 fallback based on survey data and the REMA model was provided in Sept. 2023 and will be provided this Sept. The author provide as much additional information as possible along with these model results.

"For the inclusion of trawl survey data, the SSC suggests crab assessment authors and the CPT be more explicit about best practices for which standard years are included for bottom trawl survey data."

Response: This was addressed by the CPT at our Jan 2024 meeting. See meeting minutes for agreed upon "best practices".

"The SSC recommends the crab stocks begin using the established risk table format from groundfish for assessing uncertainty around buffer considerations"

Response: The CPT discussed picking up risk tables for the three main stocks at our Jan 2024 meeting. It was decided that authors would provide draft risk tables for the Sept. 2024 assessments.

"The SSC recommends that uncertainty intervals be included when showing time series of biomass/abundance estimated by models.

Response: These are provided in this document.

Response to SSC Comments (June 2022, Oct 2022):

"The SSC recommends that the RKC authors work together to complete a stock structure template for June 2023."

Response: A structure template for RKC in the Bering Sea was presented at the Sept 2023 CPT meeting (Oct 2023 SSC).

"The SSC suggests that the CPT develop guidelines for when to change model start dates"

Response: This topic was taken up at the Jan 2023 CPT meeting, with some basic guidelines presented in those minutes that included keeping data unless there was a strong reason (environmental, poor data quality, model instability) to exclude the data and data exclusion did not lead to drastic model output changes. Model 22.0, where data starts in 1985 rather than 1975, was presented in May/Sept 2023 but was not adopted. Changes to input data are not considered currently unless the CPT changes their guidance on data inclusion.

Response to SSC Comments (from February 2022):

"The SSC supports the CPT general recommendations that all stock assessments include results from the currently accepted model with new data (base model) so that changes in model performance can be assessed. Values for management-related quantities for all models that may be recommended by the CPT or SSC should also be available."

Response: These recommendations are reflected in the document.

CPT and SSC Comments on BBRKC assessment

Response to SSC Comments specific to this assessment (from October 2023):

Provide basis for the tight prior on M and catchability.

Response: The prior on trawl survey catchability is estimated with a mean of 0.896 and a standard deviation of 0.025 (CV about 0.03) that is based on double-bag experiment results (Weinberg et al. 2004). The prior on M is based on the balance of allowing M to be estimated above the default, historic 0.18 value for males but realizing the limitations of the data to estimate M freely. Future work is planned and will continue to explore the most appropriate estimation of M.

Consider tracking Dungeness crab abundance in the EBS and how this might affect BBRKC dynamics.

Response: Currently there is no abundance estimate of Dungeness crab in the EBS. Conversations have occurred between the author and regional biologist on possible general affects, with the overall consensus that these two species are likely not occupying the same habitat as juveniles/adults. However, the early life spatial occupation for both of these stocks is unknown, so there may be competition for food in these stages. Trends of Dungeness catch over time are being obtained and will be explored in future work.

Explain why equal sample sizes are used for male and female size composition data.

Response: The size composition data for surveys is entered into the model as aggregate data since they are derived from the same survey samples. Therefore the sample size for each is based on the total number of crab measured not those measured by sex.

MCMC output diagnostics, autocorrelation plots and parameter chains

Response: These will be provided in Sept 2024 when a full MCMC is performed on the preferred models.

Possible effect of high 2011 recruitment as scene in survey size composition figures

Response: Size composition plots in Sept 2023 highlighted a potential recruitment event in 2011 for both males and females from the NMFS survey data (Figures 6 and 7 - Sept 2023 SAFE). This peak occurs as size classes that are not included in the assessment model (< 65mm, figures 43 and 44 - Sept 2023 SAFE), therefore this recruitment likely plays little role in the model estimates and resulting retrospective pattern since it is not seen in subsequent years to be included in the model.

Response to CPT Comments (from May 2023 / Sept 2023):

Reconsider which growth parameters are estimated vs. specified. Consider a model run with growth specified outside the model (CPT Sept 2023)

Response: The author is collaborating with biologists on the availability of more recent growth data, and investigating the feasibility of recovering the original raw data used in the historic growth specifications. Work is underway to determine the best path forward for growth parameterizations for this stock.

Survey selectivity / q / catchability. Reconsider the strong prior and shape of the selectivity curve. Consider using the BSFRF data as a prior on selectivity/catchability as was done in the snow crab assessment (CPT and SSC May/June 2023 and Sept/Oct 2023)

Response: Models presented here (24.0 and 24.0b) reflect explorations on using the BSFRF data as a prior on selectivity - similar to snow crab (fall 2023, Figure 2). Further explorations on priors and shape were not explored this round, although the previous assessment author did explore some aspects in models runs between 2020 and 2022.

Revisit blocking on molting probability from tagging data (CPT and SSC May/June 2023)

Response: The blocking of molt probability for males reflects changes in the Bristol Bay ecosystem in the early 80s and has been a historic component of the current model. Models 24.0c and 24.0d reflect removing this blocking to estimate one molting probability for the entire time series.

Response to SSC Comments specific to this assessment (from October 2022):

"The SSC recommends that a high priority be placed on trying to isolate factors that reduce the retrospective bias in mature male biomass."

Response: The author agrees that this should be a high priority, however current explorations have not shed light on these factors yet. This is still a high priority for the author.

"The SSC recommends investigation of the highly biased fits to the BSFRF index and suggests that the current approach of inflating the variance to account for lack of fit is inappropriate when obvious bias is present."

Response: We agree with this recommendation, and are investigating this avenue along with exploring catchability for both surveys. One method to account for this is to use the BSFRF survey to inform a prior on NMFS q and not have it fit directly in the model (Models. 24.0a and 24.0b in this document).

"The accumulation of large males and particularly large females in the plus group indicates length bin groups may need to be re-evaluated."

Response: We acknowledge this observation, recognizing this has only been an issue for about the last 10 years of size compositions since recruitment has been poor. Explorations on extending the size bins is on the list of further work for this model, but was not prioritized on this cycle.

"The SSC noted that the NMFS and the State determined that the survey re-tows would not be conducted in 2022, despite meeting the threshold to do so. The SSC requests an examination from the assessment author of the potential value of these re-tows, and whether re-tows provide a more or less accurate index of abundance."

Response: Model 23.2 was explored in May of 2023 as a bookend for the model output without any retow data. If the CPT and SSC wish to see more variations of this model we can provide them, i.e. removing some years and not all as one possibility. While female re-tow data does not highly affect male model outcomes it does affect fishery closures since the State of Alaska harvest strategy uses a mature female threshold for opening.

Response to SSC Comments specific to this assessment (from June 2022):

The SSC noted that during preliminary model runs in May, a full document need not be produced, but one that focuses a summary of model features and runs would be sufficient.

Response: Starting in May 2023 the proposed model run document reflects these changes, focusing on model runs and explorations. Model structure and historical information is linked to via the NPFMC website in the summary section and not repeated in this document. The author welcomes further suggestions on the "proposed model" run documents since the CPT does not formally have a format for these.

"The SSC recommends exploring how to estimate both catchabilities (NMFS trawl survey and BSFRF survey), but with a linked prior to influence them to scale together (i.e., assume some approximate value of how much higher q is for that survey)."

Response: This is on the authors list of future work to be addressed with explorations of catchability for both surveys, but has not been explored in this document.

Response to CPT Comments (from May 2022):

"The CPT recommended examining how the initial conditions of abundance are treated as a future analysis"

Response: This has not yet been addressed, but is on the list for future work.

Response to SSC Comments specific to this assessment (from October 2021):

"The SSC requests that in addition to temperature effects on the timing of the molt-mate cycle, the authors explore other potential drivers (e.g., prey quality or quantity) that could underlie the incomplete molt-mate cycle observed in 2021. Based on NMFS trawl survey female biomass estimates, the State of Alaska closed the BBRKC fishery. Next year's assessment should estimate the probability that the stock is currently in the overfished condition."

Response: NMFS staff did an evaluation of re-tow survey protocol in Spring 2022; no changes were adopted at that time. Probabilities in the overfished condition for some models were estimated in September 2021, May 2022, and for the base model in September 2022. Model 23.2 was presented in May 2023, as an exploration of the base model (21.1b) without the retow data for females. This model has minimal effects on the federal harvest control rules, but does estimate a lower biomass for females which would directly affect the State harvest strategy.

"The SSC recommends that authors should carefully consider assessment implications of the stock boundaries given the evidence of crabs outside of the managed area. The SSC suggests that the authors should still be able to use data from outside stock boundaries, even if not used in the input survey abundance estimates. For example, the abundance seen outside stock boundaries could be treated as covariate informing catchability within the model. This analysis seems particularly important for females that are increasingly outside of the current stock boundaries and are at low abundance, triggering the State closure. The SSC recommends that the authors formulate separate survey abundance time series inside and outside of the defined area that could prove useful in the assessment model (e.g., informing catchability). If this is not an option in the stock assessment, then it highlights the need for ESRs or ESPs to track movement of these crabs both through survey results and developing indices from local knowledge."

Response: The current version of GMACS seems not to be able to use the Northern RKC survey index to inform BBRKC survey catchability. We tried to add a model to include both BBRKC and Northern RKC data, but the groundfish fisheries bycatch is not currently available in the Northern area. In the last two full SAFEs - September 2022 and 2023 - we plotted more proportional data of the Northern RKC. Overall, the proportions of different size groups of the Northern RKC during a recent dozen years are higher than in the past and do not trend higher except for mature females in 2021. The high survey mature female abundance in the Northern area in 2021 was primarily from three tows and one of them is more than 50% of total mature females. The survey abundance of the Northern RKC will continue to be plotted in the SAFE report in the future. After migration patterns between BBRKC and the Northern RKC are fully understood, we will model them in the stock assessment.

"The SSC supports the BSFRF collaborative work with ADF&G and NMFS to tag BBRKC."

Response: We fully support tagging efforts, especially those to understand seasonal movement and the flow of individuals in or out of the Bristol Bay management area.

"It would be useful to investigate if there is a mechanism for higher natural mortality or fishing mortality for females only during that early time period while following the CPT recommendation of looking at model 21.0 with constant but separate Ms by sex. Since Model 21.0 estimates a very high level of fishing mortality, but does seem to account for the decline in large females, there may be a fishery selectivity issue in that period. If the modelers choose not to continue to use historic data prior to 1985, this suggestion may not be useful."

Response: Figuring out the exact causes of high mortality in the early 1980s is always difficult and we summarize the potential causes in Appendix A of the last full SAFE, section C-vi, "Potential Reasons for High Mortality during the Early 1980s". The directed fishery does not catch many large females and small crab, so it is difficult to remove these crab from the population without a large mortality event. If this period of high natural mortality was a concern, it would be preferred to start the model in 1985, which has two advantages: avoiding the early 1980s period so that a constant M over time can be used, and the same NMFS survey gear throughout the whole model time period.

"The SSC supports continued exploration of the use of VAST estimates for this assessment, particularly if their use will inform mechanisms underlying shifting distributions outside of the current management area."

Response: We also support improvement of VAST estimates and are willing to provide feedback to Jon for further improvement. In general the CPT has not prioritized using VAST output in crab models but we hope to revisit this soon, potentially at the Jan 2025 modeling workshop.

Response to CPT Comments (from September 2021):

"When projecting the stock to determine whether it is approaching an overfished condition, identify the uncertainties included and ignored in the projection. It is particularly important to distinguish those that are captured in the projection (i.e. those associated with the model) and the additional uncertainties that form the basis for the ABC buffer."

Response: Uncertainties are discussed in the projection section included in the final SAFE in Sept. 2023.

"When projecting MMB, label figures with the date to which it is projected (e.g., Feb. 15, 2022), not just the year (which can lead to confusion)."

Response: Working on following this recommendation as we improve plotting standardization from GMACS output.

"Consider a model in which the data starts in 1985 (as suggested by the CIE reviewers)."

Response: Model 22.0 starts in 1985, and was presented in May 2022, May 2023, and Sept 2023. After discussions during the 2023/24 CPT meetings the author is uncertain whether removing the early part of the time series is appropriate. Therefore the model will not be presented again unless specifically requested.

Response to SSC Comments specific to this assessment (from June 2021):

"The SSC supports exploring more modern methods for estimating natural mortality, but notes that this method still relies strongly on the maximum age for BBRKC. The SSC recommends continued research to validate the ages for this stock."

Response: We agree with this suggestion. The maximum age was determined by old tagging data, and due to funding and personnel constraints, age validation for BBRKC is more likely a long-term goal than a short-term project.

"The likelihood profile suggests that the values of M for male and female might be similar and that the current difference may be because of the constraint of base M to a low value. When M is misspecified, it can be the cause of a strong positive retrospective pattern, which BBRKC has. The SSC would have liked to have seen compositional fits and a retrospective analysis for model 19.6 or some model with a higher M value, particularly to see if it fits the plus group better. Despite the increase in F35%, there was not a commensurate increase in OFL. An exploration of the underlying reasons for this outcome is needed."

Response: Based on our past modelling experience, when M values for males and females are estimated separately, estimated M values tended to be always higher for females than for males. The likelihood profile was created through fixing M values for males and estimating M values for females, and when the fixed M values for males were very high, estimated M values for females tended to be similar to M values for males. The increase in F35% but not a commensurate increase in OFL is due to reduction of mature male biomass caused by the high M.

As a reference, we copied the likelihood profile computed in May 2020 below. Model 19.6 uses male base M of 0.257 estimated by Then et al. (2015), and the likelihood profile of base M from 0.1 to 0.4 is as follow:

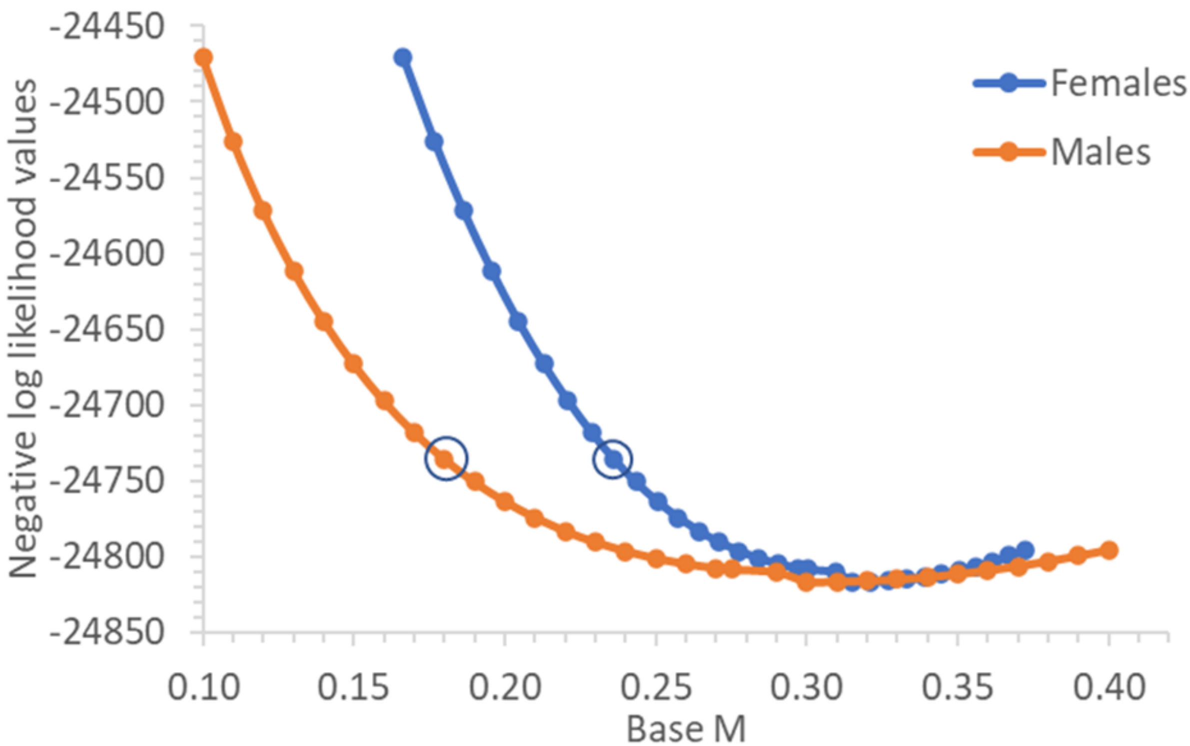

Figure 1: Likelihood profile on M from May 2020 and 2021; 2022 values of M are circled.

It appears that the maximum likelihood value is achieved with a base M of 0.31 for males and 0.321 for females.

In May 2023, models 23.0, 23.0a, 23.0b, and 23.3 all involve variations of higher base M values for males. Higher base M values do not appear to improve the plus group fittings. In Sept 2023, the accepted model was 23.0a which estimates M for males with a tight prior. This was an increase in M (~0.23) from previous fixed values of 0.18 and is thought to be more appropriate for king crab stocks.

"In addition to the CPT recommended models (19.3d, 19.3e, and 19.3g), the SSC recommends a simplified version of model 19.3d that estimates one natural mortality parameter across sex and time, and one shared catchability and selectivity curve for the NMFS trawl survey to help make several selectivity parameters better defined."

Response: We named this as model 21.0 and included it in the September 2021 assessment.

"The SSC requests that the current crab management zones be included in the maps of VAST model-derived spatial distributions of BBRKC."

Response: We will ask Dr. Jon Richar to add the current crab management zones to the VAST spatial plots.

"The SSC also looks forward to the summary report from the March 2021 CIE Review for this stock."

Response: The summary report of the 2021 CIE review is included in Appendix D of the 2022 full SAFE (referenced on the NPFMC website).

Response to CPT Comments (from May 2021):

"The CPT was concerned that the 'information' content of the data with respect to natural mortality could be related to strong assumptions elsewhere in the model, and recommended further exploration of natural mortality after September and suggested attending the June 2021 CAPAM workshop on natural mortality, which may provide some insights into best practices. A large increase in estimated natural mortality would likely increase fishing mortality reference points, with management implications."

Response: Model runs in May 2022/2023 addressed some variations on M. Estimated M values in the length-based crab models tend to have higher values than the other approaches, and confounding among estimated M, survey selectivity/catchability, and recruitment in a length-based model makes it difficult to accurately estimate M in the model. The base model accepted in fall 2023 (model 23.0a) includes an estimated M for males using a tight prior. Further exploration of the appropriateness of this prior are planned.

"The CPT was interested in more exploration of the retrospective patterns, which seem to have increased since the last assessment despite no new data being added. Reported Mohn's rhos were starting to reach concerning magnitudes in the proposed models?"

Response: Higher than expected BSFRF survey biomass during 2007-2008 and 2013-2016 and NMFS survey biomass in 2014 are likely behind some of these retrospective patterns. Also, much lower than expected NMFS survey biomass during 2018-2019 and 2021-2022 results in lower biomass estimates in recent years. The biases for total abundance are much smaller than mature male biomass. As other model explorations are tackled retrospective patterns will be considered.

C. Modeling Approaches and Explorations for spring 2024

Assessment Methodology

This assessment model uses the GMACS modeling framework (since 2019) and is detailed in Appendix A of the last full SAFE report (link in the summary section). An updated version of GMACS (version 2.01.M.10, 2024-02-27) was used. The fall 2023 assessment used version 2.01.M.01, 2023-03-13. Progress of GMACS development has been documented on the GitHub development site (GMACS GitHub).

Model explorations

Models explored in this document:

- **23.0a**: base model (fall 2023), M for males estimated in the model + updated GMACS
- **23.0a (MMB season)**: base model + MMB estimated at the beginning of the last season
- **21.1b**: previous base model, M fixed = 0.18 for males + updated GMACS
- **21.1b (MMB season)**: 21.1b + MMB estimated at the beginning of the last season
- **24.0**: 23.0a (MMB season) + selectivity informed by BSFRF
- **24.0b**: 21.1b (MMB season) + selectivity informed by BSFRF
- **24.0c**: 23.0a (MMB season) + a single molt period for males and females
- **24.0d**: 21.1b (MMB season) + a single molt period for males and females

Reasoning for model explorations

Six model scenarios are presented in this report. The first two models have nearly identical results and were compared to show the effect of estimating MMB at the beginning of the last season of the year (which is season 7 in the model), versus season 6 in previous versions (models 21.1b.p7 and 23.0a.p7). During some GMACS updating it was discovered that, due to the order of events that take place within a season in the model, the MMB for each year should be estimated in the last season - here season 7 instead of season 6. The mature male biomass used for management is estimated on Feb. 15th in each year and this corresponds to the beginning of season 7. Small differences in the reference points are present with this update due to small changes in MMB caused by the fraction of natural mortality being applied during the year for this estimate. The overall model fit is nearly identical, including the MLE and likelihood components (Table 4).

The rest of the model scenarios can be divided into two areas of exploration: 1) exploring a prior on selectivity using the BSFRF data similar to snow crab models in 2023 (models 24.0 and 24.0b); and 2) simplification of molting probabilities to one time period instead of two (models 24.0c and 24.0d). Both lines of model exploration were done using the fall 2023 accepted base model 23.0a, which estimates the base M for males using a log-normal prior with a mean of 0.18 and a CV of 0.04, and the previously accepted base model 21.1b, which has a fixed value of 0.18 for the base M for males. This allows the assumption of two different natural mortality values to play out in all situations. Further work estimating natural mortality with a less informed prior was not performed in these model explorations but is on the list of potential model explorations for the future.

Recent CPT/SSC comments and the simpler modeling workshop report suggested that the author should explore methods to estimate catchability (Q) for the NMFS trawl survey. In the base models, initial trawl survey catchability is estimated to be 0.896 with a standard deviation of 0.025 (CV about 0.03) that is based on double-bag experiment results (Weinberg et al. 2004). The appropriateness of this prior and the relationship between NMFS trawl survey Q and that assumed for the BSFRF survey have been on the list of model suggestions.

Model explorations here use methods similar to those for snow crab in 2023 to explore using the BSFRF data as a prior on selectivity for the NMFS survey. BSFRF surveys were performed in 5 years (2007, 2008, 2013, 2014, 2015, and 2016) and are currently treated as a separate index in the assessment model, with both the index and size composition data being fit with the Q for BSFRF set to 1. Models 24.0 (based on 23.0a) and 24.0b (based on 21.1b) remove the BSFRF data as an index and size composition data set and instead use the information from these data to set a normal prior on selectivity for the NMFS survey. A GAM was fit to inferred selectivity (assuming the catchability of the BSFRF survey was 1) at size by year weighted by the sample size by year (gam(sel~s(size), weights= sample_size)). For these purposes males and females were combined as one sample. The predicted mean and standard error of the resulting GAM was input as a prior on a selectivity parameter for each size class in GMACS (Figure 2). Specifically, the selectivity type was set to 0 (parametric) in the .ctl file and catchability was fixed at 1.

Models 24.0c (based on model 23.0a) and 24.0d (based on model 21.b) are explorations of the suggestion to simplify the molting probability time periods to 1 instead of the 2 periods in the base model. The necessity of the two periods for molting probability is not well documented but it is assumed to be correlated with changes in the environment and the Bristol Bay stock since it coincides with regime shifts and stock crash in the early 80s. The models explored here remove the time periods for molting probability and estimate one curve for the entire model time frame.

Results

a. Sensitivity to GMACS changes

Models 23.0a, 23.0a.p7, 21.1b, and 21.1b.p7 reflect changes to the point at which MMB is calculated during the model year. The likelihoods for these model comparisons are identical (Table 4). However, there are slight differences in calculation of terminal year MMB, $B_{35\%}$, and specifications resulting from changes in the annual timing of MMB estimation (Table 2). The estimated $F_{35\%}$ and F_{ofl} are the same for both models.

b. Effective sample sizes and weighting factors

- CVs are assumed to be 0.03 for retained catch biomass, 0.04 for total male biomass, 0.07 for pot bycatch biomasses, 0.10 for groundfish bycatch biomasses, and 0.23 for recruitment sex ratio. Models also estimate sigmaR for recruitment variation and have a penalty on M variation and many prior-densities.

- Initial trawl survey catchability (Q) is estimated to be 0.896 with a standard deviation of 0.025 (CV about 0.03) based on the double-bag experiment results (Weinberg et al. 2004). These values are used to set a prior for estimating Q in models with both the BSFRF and NMFS data, but not in models 24.0 or 24.0b.

b. Tables of estimates

- Negative log-likelihood values are summarized in Table 4 for all models, while parameter estimates are summarized in Tables 5 – 8 for a few representative models.
- Natural mortality estimates are shown in Table 3.
- Abundance, MMB, and recruitment time series for a few representative models are found in Tables 9 – 12.

c. Evaluation of the fit to the data and model estimates.

- Selectivities by length (Figures 3 and 4)

Model explorations focus on estimated trawl survey selectivity. The use of the BSFRF data as a prior on survey selectivity in models 24.0 and 24.0b resulted in a difference in selectivity, especially for large size bins. However, the overall shape of the selectivity curve for these models is similar to that estimated in the base models. Interestingly, since the selectivity priors are the same the estimated selectivity curve for both M models are similar instead of the divergence you see in the two base models.Survey selectivity affects not only the fitting of the data but also the absolute abundance estimates. These estimated survey selectivities are generally smaller than the capture probabilities in Figure A1 (refer to last full SAFE draft) because survey selectivities include capture probabilities and crab availability. The NMFS survey catchability (Q) is estimated to be 0.896 from the trawl experiment. The reliability of estimated survey selectivities will greatly affect the application of the model to fisheries management since under- or over-estimates of survey selectivities will cause a systematic upward or downward bias of abundance estimates, respectively. Information about crab availability in the survey area at survey times will help estimate the survey selectivities. Higher estimated natural mortalities generally result in lower NMFS survey selectivities.

- Molting probability by length (Figure 5)

Models 24.0c and 24.0d remove the time blocking for male molt probability in an attempt to simplify the modeling process. Overall, differences in model results are minimal. Historically, male molting probabilities have been estimated with two time blocks (1975-1980 and 1981-present) but the estimates are very similar between time blocks. For all models, estimated molting probabilities during 1975-2022 are generally lower than those estimated from the 1954-1961 and 1966-1969 tagging data (Balsiger 1974, Figure 15 in the last full SAFE). Lower molting probabilities mean more oldshell crab, possibly due to changes in molting probabilities over time or shell aging errors. Female molting probability is assumed to be 1 for all time periods.

- NMFS trawl survey biomass and BSFRF surveys (Figures 6 – 11).

Survey biomass of males and female is generally up from the low points of 2018 and 2019. Among the model scenarios, model estimated NMFS survey biomasses are similar, with some changed in scale due to changes in M and Q, which is expected. Models 24.0c and 24.0d have differences in the early part of the time series due to there being only one molt probability function for the entire time series.

The fit to BSFRF survey data are similar among the models, with some variability in scale due to changes in M within the two base models, however these are expected due to the large additional CV placed on these data.

All models fits the catch and bycatch biomasses very well and similarly so they are not presented in this document.

- Recruitment (Figures 12 and 13)

Recruitment time series are plotted for all model scenarios in groups of like models. Recruitment is estimated at the end of year in GMACS. Estimated recruitment time series are generally similar in trends for all models, with those models with higher M values having generally higher recruitment. Model 24.0 - which uses the BSFRF data as a prior for selectivity in NMFS survey - reduces the effect of a larger M value on total recruitment due to a higher estimated selectivity (comparing models m23.0a.p7 and m24).

- Fishing mortality (Figure 16)

The full fishing mortalities for the directed pot fishery at the time of fishing are plotted against mature male biomass on Feb. 15 in the last full SAFE (See BBRKC 2023 SAFE link and Figures 29, 30 and 31). Estimated fishing mortalities in most years before the current harvest strategy was adopted in 1996 were above F35%. Under the current harvest strategy, estimated fishing mortalities were at or above the F35%

limits in 1998-1999, 2005, 2007-2010, and 2014-2019 for models 21.1b, but below the F35% limits in the other post-1995 years.

Estimated fishing mortalities for pot female and groundfish fisheries bycatches are generally small and less than 0.07 (not shown in this document but available in last full SAFE).

- Estimated mature male biomass (Figures 17, 18, and 19)

The base models (labeled .p7) reflect the correct timing for mmb estimation to coincide with the intended Feb 15th timing. Estimated mature male biomass for all models has a similar trend over time, however the scaling of the biomass is highly dependent, as expected, on estimates of natural mortality (M) and Q in the model. Overall, higher estimates of M for males produce larger estimates of mature male biomass for most of the time series. Recent mature male biomass, in the last five years or so, was relatively similar for all models. Figure 17 displays the results of changes in the period or season in which MMB is estimated.

- Size composition fits by length and residual plots (Figures 20 – 28).

All models fit the length composition data similarly and well. Modal progressions are tracked well in the trawl survey data, particularly beginning in mid-1990s. Cohorts first seen in the trawl survey data in 1975, 1986, 1990, 1995, 1999, 2002 and 2005 can be tracked over time. Bycatch size composition data provide little information to track modal progression and are not displayed graphically. Pearson residuals of proportions of survey males and females appear to be random over length and year for all models, however models with higher base M - models based on 23.0a - improve the plus group fittings slightly.

d. Retrospective and historical analyses

Retrospective analysis was not performed on these model explorations. Topics explored in these models were not expected to improved retrospective trends and therefore these were not explored at this time. They will be performed on models for the fall full SAFE. Retrospective runs performed for the 2023 SAFE suggested an improvement with estimation of M for males, as reported in the Mohn's rho values, from a Mohn's *rho* of 0.373 to 0.226. The improved retrospective pattern in MMB was one of the reasons model 23.0a was chosen for specification in fall of 2023.

e. Uncertainty and sensitivity analyses.

- Estimated standard deviations of parameters are summarized in Tables 5 – 8 for a few representative models.
- The last completed SAFE document in 2023 details uncertainty estimates in the current base model parameterization (**BBRKC 2023 SAFE**).

f. Comparison of alternative model scenarios.

In this report (May 2024), six models are presented. For negative likelihood value comparisons (Table 4), the base models - 21.1b (updated season, 21.1b.p7) and 23.0a (updated season, 23.0a.p7) were similar in total likelihood, with those models with one molt time block being very similar also (models 24.0c and 24.0d). The base models were run using the most recent updates to GMACS (version 2.01.M.10), which reflected updates to GMACS output and no structural model changes. The likelihood components of these runs using models 21.1b, 23.0a, 21.1b.p7 and 23.0a.7 were identical out to three digits, however reference point differences, although small, do exist as expected due to the change in timing for MMB estimation. Models 21.1b.p7 and 23.0a.p7 should be considered the most correct reference models, and were used to compare other model explorations.

Two models (24.0 and 24.0b) explore the use of the BSFRF survey data as an informed prior on selectivity for NMFS instead of treating these data as another index/size composition under both base models; 24.0 estimates M with a tight prior comparable to model 23.0a and 24.0b has a fixed M of 0.18 which is comparable to model 21.1b. This approach was similar to that used for snow crab in 2023, and is considered a first approach at this line of exploration. First, the inferred selectivity pattern/model estimated using the BSFRF data is similar to that estimated in the base model (Figure 2). Figure 3 visualizes the estimated relationship using the estimated inferred selectivity from the BSFRF data as a prior, and indicates the potential for a dome-shaped relationship. These models, as current specified, do not improve model fit. However, variants of this approach should be considered for exploration in the future. Further model explorations - such as dome shaped selectivity for the NMFS survey selectivity and the potential for selectivity to be greater than 1 for the NMFS survey - are warranted for exploring selectivity and catchability in this model. Additionally, if the BSFRF data were used as a prior, a more appropriate method to incorporate those data is needed since the method used here ignores correlation among size bins in estimating parameters for selectivity.

Two models (24.0c and 24.0d) explore the removal of a time block for molt probability for males and females. Female molt probability is estimated to be 1 so the time block is does not impact model outcomes for females. These models, run using both base model frameworks, suggest the time blocking for molt probability does not improve model fit and is likely not necessary. Removing this blocking reduces the number of parameters while giving a similar model fit.

Based on the above considerations, we recommend bringing models 23.0a (updated season), 21.1b (updated season), and the corresponding models with one molt period (24.0c and 24.0d) forward for consideration in Sept. The reference model - accepted in fall 2023 - was model 23.0a without the updated season for MMB. However, it was determined that the timing in MMB estimation for this model was incorrect and therefore model 23.0a (with the updated season for MMB, also labeled 23.0a.p7 in figures) should be the accepted reference model moving forward. It was the author's understanding that both the CPT and SSC desired the previous reference model - 21.1b - be maintained for model development and comparison, and it is done so here. In line with parsimony and model simplification, models 24.0c and 24.0d are recommended for consideration in the fall since they simplify the molt probability time periods. Further work is needed on explorations for selectivity and catchability before variants of models 24.0 and 24.0b should be considered for specification setting.

The CPT/SSC comments above address many other topics that were not able to be addressed in this round of model improvements but are on the author's list for consideration. Additionally, the author is currently pursuing analyses to assist the Alaska Department of Fish and Game in updating the female threshold used for State management and will update on progress on that front when appropriate in the Council process.

D. Calculation of the OFL and ABC

Tier 3 control rules and methodology behind these calculations are explained in detail in the last full SAFE report published on the NPFMC website (see summary section for link).

Table 1: Changes in management quantities for each scenario explored. Reported quantities are derived from maximum likelihood estimates. MMB, B35, and OFL are reported in 1,000 t. Average recruitment is males and females combined in millions of animals.

Model	Current MMB	B35	MMB/B_{MSY}	F35	F_{OFL}	OFL	avg male rec	maleM
m21.1b	16.48	21.72	0.76	0.30	0.22	3.52	6.98	0.18
m21.1b.p7	15.92	20.97	0.76	0.30	0.22	3.52	6.98	0.18
m23.0a	14.98	19.36	0.77	0.40	0.30	4.42	9.89	0.23
m23.0a.p7	14.32	18.51	0.77	0.40	0.30	4.42	9.89	0.23
m24	13.35	18.76	0.71	0.35	0.24	3.23	7.95	0.21
m24.0b	15.01	20.67	0.73	0.30	0.21	3.14	6.82	0.18
m24.0c	14.31	18.47	0.77	0.40	0.30	4.42	9.85	0.23
m24.0d	15.93	20.95	0.76	0.30	0.22	3.53	6.96	0.18

E. Projections and Future Outlook

Projections into the future will be performed in the Sept. 2024 assessment with the models selected from this document.

The projections are subject to many uncertainties. Constant population parameters estimated in the models used for the projections include M, growth, and fishery selectivities. The uncertainty of abundance and biomass estimates in the terminal year also affects the projections. Uncertainties of the projections caused by these constant parameters and abundance estimates in the terminal year would be reduced by the 20% ABC buffer. However, if an extreme event occurs, like a sharp increase of M during the projection period, the ABC buffer would be inadequate, and the projections might underestimate uncertainties. The largest uncertainty is likely from recruitment used for the projections. Higher or lower assumed recruitment would cause too optimistic or too pessimistic projections. Overall, recruitment and M used for projections are main factors for projection uncertainties.

J. Acknowledgements

Drs. Andre Punt, James Ianelli, and D'Arcy Webber first applied BBRKC data to GMACS for stock assessments and our GMACS model mainly comes from their work. Thanks to Tyler Jackson (ADF&G) for assistance with graphical output for GMACS, survey data summaries, REMA modeling code and review of this document.

K. References

References can be found in the last full SAFE published on the NPFMC website and will not be repeated here. (**BBRKC 2023 SAFE**)

Tables

Catch, sample size, and survey results tables are not repeated here but can be found in the last full completed SAFE (link in summary).

Table 2: Changes in management quantities for each scenario explored. Report quantities are derived from maximum likelihood estimates. Average recruitment is males and females combined in millions of animals.

Model	Current MMB	B35	F35	F_{OFL}	OFL	avg male rec
m21.1b	16.48	21.72	0.30	0.22	3.52	6.98
m21.1b.p7	15.92	20.97	0.30	0.22	3.52	6.98
m24.0b	15.01	20.67	0.30	0.21	3.14	6.82
m24.0d	15.93	20.95	0.30	0.22	3.53	6.96
m23.0a	14.98	19.36	0.40	0.30	4.42	9.89
m23.0a.p7	14.32	18.51	0.40	0.30	4.42	9.89
m24	13.35	18.76	0.35	0.24	3.23	7.95
m24.0c	14.31	18.47	0.40	0.30	4.42	9.85

Table 3: Natural mortality estimates for model scenarios during different year blocks.

Model	Sex	baseM	1980-84
m21.1b	female	0.24	1.17
m21.1b	male	0.18	0.89
m21.1b.p7	female	0.24	1.17
m21.1b.p7	male	0.18	0.89
m23.0a	female	0.27	1.15
m23.0a	male	0.23	0.99
m23.0a.p7	female	0.27	1.15
m23.0a.p7	male	0.23	0.99
m24	female	0.25	1.17
m24	male	0.21	0.96
m24.0b	female	0.23	1.17
m24.0b	male	0.18	0.90
m24.0c	female	0.27	1.16
m24.0c	male	0.23	1.00
m24.0d	female	0.24	1.17
m24.0d	male	0.18	0.89

Table 4: Comparisons of negative log-likelihood values and some parameters for all model scenarios. Reference models are versions with MMB estimated in season 7.

Component	m23.0a(ref)	m24.0	m24.0c	m21.1b(ref)	m24.0b	m24.0d
Pot-ret-catch	-61.84	-63.46	-61.70	-60.77	-62.61	-60.64
Pot-totM-catch	27.75	26.09	27.73	28.49	26.88	28.41
Pot-F-discC	-57.45	-57.45	-57.45	-57.44	-57.44	-57.44
Trawl-discC	-65.14	-65.13	-65.14	-65.13	-65.13	-65.13
Tanner-M-discC	-43.54	-43.54	-43.54	-43.54	-43.54	-43.54
Tanner-F-discC	-43.51	-43.49	-43.51	-43.48	-43.48	-43.48
Fixed-discC	-37.42	-37.42	-37.42	-37.42	-37.42	-37.42
Traw-suv-bio	-38.98	-40.22	-38.62	-37.28	-38.51	-36.85
BSFRF-sur-bio	-4.82		-4.72	-2.94		-2.83
Pot-ret-comp	-3998.15	-3995.34	-3996.07	-3991.77	-3993.03	-3988.77
Pot-totM-comp	-2444.35	-2446.78	-2444.54	-2443.63	-2446.17	-2443.85
Pot-discF-comp	-1494.87	-1493.04	-1494.88	-1493.90	-1492.87	-1493.92
Trawl-disc-comp	-5945.91	-5931.94	-5948.13	-5937.57	-5929.03	-5940.66
Tanner-disc-comp	-1276.68	-1275.78	-1276.73	-1274.30	-1273.78	-1274.35
Fixed-disc-comp	-3483.07	-3488.61	-3483.37	-3486.24	-3490.68	-3486.55
Trawl-sur-comp	-7137.97	-7143.71	-7135.96	-7130.66	-7141.80	-7127.86
BSFRF-sur-comp	-844.78		-844.80	-843.09		-843.15
Recruit-dev	73.83	75.27	73.66	72.95	74.02	72.73
Recruit-ini	0.00	0.00	0.00	0.00	0.00	0.00
Recruit-sex-R	78.50	78.50	78.52	78.49	78.52	78.52
M-deviation	40.42	42.23	40.52	43.92	44.29	44.05
Sex-specific-R	0.01	0.01	0.01	0.00	0.00	0.00
Ini-size-struct	33.58	32.91	33.13	30.82	31.30	30.19
PriorDensity	250.58	187.56	236.56	265.30	198.30	251.06
Tot-likelihood	-26473.80	-25683.34	-26486.44	-26429.18	-25662.17	-26441.47
Tot-parms	379.00	391.00	377.00	378.00	390.00	376.00
MMB35	18509.95	18757.79	18471.37	20973.44	20669.60	20947.76
MMB-terminal	14316.67	13353.26	14310.28	15915.19	15006.84	15930.92
F35	0.40	0.35	0.40	0.30	0.30	0.30
$Fofl$	0.30	0.24	0.30	0.22	0.21	0.22
OFL	4424.14	3226.77	4424.88	3522.29	3144.79	3530.48

Table 5: Summary of estimated model parameter values and standard deviations for model 21.1b.p7 for Bristol Bay red king crab.

Index	Name	Value	StdDev
1	M-female	0.2739	0.0138
2	Log(Rinitial)	19.8194	0.0488
3	Log(Rbar)	16.1721	0.1370
4	Recruitment-rb-males	0.7004	0.1250
5	Recruitment-rb-females	-0.5304	0.2247
6	Scaled-logN-for-male-mature-1-shell-1-class-2	0.9575	0.4194
7	Scaled-logN-for-male-mature-1-shell-1-class-3	0.6521	0.4674
8	Scaled-logN-for-male-mature-1-shell-1-class-4	0.8596	0.3318
9	Scaled-logN-for-male-mature-1-shell-1-class-5	0.7087	0.3044
10	Scaled-logN-for-male-mature-1-shell-1-class-6	0.5452	0.2945
11	Scaled-logN-for-male-mature-1-shell-1-class-7	0.5007	0.2770
12	Scaled-logN-for-male-mature-1-shell-1-class-8	0.3438	0.2773
13	Scaled-logN-for-male-mature-1-shell-1-class-9	0.3784	0.2639
14	Scaled-logN-for-male-mature-1-shell-1-class-10	0.4107	0.2583
15	Scaled-logN-for-male-mature-1-shell-1-class-11	0.1840	0.2812
16	Scaled-logN-for-male-mature-1-shell-1-class-12	0.1620	0.2770
17	Scaled-logN-for-male-mature-1-shell-1-class-13	0.0561	0.2868
18	Scaled-logN-for-male-mature-1-shell-1-class-14	0.1714	0.2625
19	Scaled-logN-for-male-mature-1-shell-1-class-15	-0.0061	0.2036
20	Scaled-logN-for-male-mature-1-shell-1-class-16	-0.2357	0.1957
21	Scaled-logN-for-male-mature-1-shell-1-class-17	-0.3883	0.1978
22	Scaled-logN-for-male-mature-1-shell-1-class-18	-0.7366	0.2114
23	Scaled-logN-for-male-mature-1-shell-1-class-19	-1.1967	0.2326
24	Scaled-logN-for-male-mature-1-shell-1-class-20	-1.2417	0.2349
25	Scaled-logN-for-female-mature-1-shell-1-class-1	1.2834	0.6755
26	Scaled-logN-for-female-mature-1-shell-1-class-2	1.4473	0.4616
27	Scaled-logN-for-female-mature-1-shell-1-class-3	1.3906	0.3675
28	Scaled-logN-for-female-mature-1-shell-1-class-4	1.1656	0.3363
29	Scaled-logN-for-female-mature-1-shell-1-class-5	1.0791	0.2955
30	Scaled-logN-for-female-mature-1-shell-1-class-6	0.5974	0.3188
31	Scaled-logN-for-female-mature-1-shell-1-class-7	0.2118	0.3529
32	Scaled-logN-for-female-mature-1-shell-1-class-8	-0.0262	0.3616
33	Scaled-logN-for-female-mature-1-shell-1-class-9	-0.2151	0.3547
34	Scaled-logN-for-female-mature-1-shell-1-class-10	-0.5471	0.3742
35	Scaled-logN-for-female-mature-1-shell-1-class-11	-0.9334	0.3857
36	Scaled-logN-for-female-mature-1-shell-1-class-12	-1.1914	0.3903
37	Scaled-logN-for-female-mature-1-shell-1-class-13	-1.4218	0.3888
38	Scaled-logN-for-female-mature-1-shell-1-class-14	-1.7911	0.3769
39	Scaled-logN-for-female-mature-1-shell-1-class-15	-1.8971	0.3728
40	Scaled-logN-for-female-mature-1-shell-1-class-16	-1.8388	0.3526
41	Gscale-male-period-1	0.9669	0.1825
42	Gscale-female-period-1	1.4454	0.1214
43	Molt-probability-mu-male-period-1	142.4929	1.7326
44	Molt-probability-CV-male-period-1	0.0579	0.0101
45	Molt-probability-mu-male-period-2	139.9796	0.5900
46	Molt-probability-CV-male-period-2	0.0707	0.0033
47	Sel-Pot-Fishery-male-period-1-par-1	4.7608	0.0082
48	Sel-Pot-Fishery-male-period-1-par-2	2.2714	0.0458
49	Sel-Pot-Fishery-female-period-1-par-1	4.5126	0.0165
50	Sel-Pot-Fishery-female-period-1-par-2	2.0491	0.1084

51	Sel-Trawl-Bycatch-male-period-1-par-1	5.1631	0.0595
52	Sel-Trawl-Bycatch-male-period-1-par-2	2.8582	0.0452
53	Sel-Bairdi-Fishery-Bycatch-male-period-1-par-1	4.7219	0.2188
54	Sel-Bairdi-Fishery-Bycatch-male-period-1-par-2	2.1638	0.3059
55	Sel-Bairdi-Fishery-Bycatch-female-period-1-par-1	4.7463	0.0775
56	Sel-Bairdi-Fishery-Bycatch-female-period-1-par-2	0.9000	0.3035
57	Sel-Fixed-Gear-male-period-1-par-1	4.7870	0.0222
58	Sel-Fixed-Gear-male-period-1-par-2	2.3329	0.0863
59	Sel-NMFS-Trawl-male-period-1-par-1	4.0895	0.1956
60	Sel-NMFS-Trawl-male-period-1-par-2	2.2357	0.4015
61	Sel-NMFS-Trawl-male-period-2-par-1	3.7549	0.6262
62	Sel-NMFS-Trawl-male-period-2-par-2	3.2493	0.4070
63	Sel-BSFRF-male-period-1-par-1	4.4282	0.0288
64	Sel-BSFRF-male-period-1-par-2	2.4212	0.0709
65	Ret-Pot-Fishery-male-period-1-par-1	4.9232	0.0015
66	Ret-Pot-Fishery-male-period-1-par-2	0.6747	0.0533
67	Ret-Pot-Fishery-male-period-2-par-1	4.9321	0.0020
68	Ret-Pot-Fishery-male-period-2-par-2	0.7186	0.0990
69	Log-fbar-Pot-Fishery	-1.6673	0.0424
70	Log-fbar-Trawl-Bycatch	-4.3416	0.0751
71	Log-fbar-Bairdi-Fishery-Bycatch	-5.5892	0.2909
72	Log-fbar-Fixed-Gear	-6.5084	0.0705
73	Log-fdev-Pot-Fishery-year-1975-season-3	0.9136	0.1188
74	Log-fdev-Pot-Fishery-year-1976-season-3	0.8714	0.0906
75	Log-fdev-Pot-Fishery-year-1977-season-3	0.7824	0.0743
76	Log-fdev-Pot-Fishery-year-1978-season-3	0.8759	0.0604
77	Log-fdev-Pot-Fishery-year-1979-season-3	1.0872	0.0541
78	Log-fdev-Pot-Fishery-year-1980-season-3	1.9548	0.0563
79	Log-fdev-Pot-Fishery-year-1981-season-3	2.4908	0.1194
80	Log-fdev-Pot-Fishery-year-1982-season-3	0.9171	0.1770
81	Log-fdev-Pot-Fishery-year-1983-season-3	-8.7942	0.1261
82	Log-fdev-Pot-Fishery-year-1984-season-3	1.2519	0.1125
83	Log-fdev-Pot-Fishery-year-1985-season-3	1.3254	0.0894
84	Log-fdev-Pot-Fishery-year-1986-season-3	1.4907	0.0733
85	Log-fdev-Pot-Fishery-year-1987-season-3	1.0240	0.0643
86	Log-fdev-Pot-Fishery-year-1988-season-3	0.0849	0.0531
87	Log-fdev-Pot-Fishery-year-1989-season-3	0.1991	0.0476
88	Log-fdev-Pot-Fishery-year-1990-season-3	0.8477	0.0389
89	Log-fdev-Pot-Fishery-year-1991-season-3	0.8623	0.0415
90	Log-fdev-Pot-Fishery-year-1992-season-3	0.3484	0.0462
91	Log-fdev-Pot-Fishery-year-1993-season-3	1.0177	0.0508
92	Log-fdev-Pot-Fishery-year-1994-season-3	-4.1351	0.0487
93	Log-fdev-Pot-Fishery-year-1995-season-3	-4.5473	0.0422
94	Log-fdev-Pot-Fishery-year-1996-season-3	-0.0773	0.0408
95	Log-fdev-Pot-Fishery-year-1997-season-3	-0.0286	0.0412
96	Log-fdev-Pot-Fishery-year-1998-season-3	0.8877	0.0437
97	Log-fdev-Pot-Fishery-year-1999-season-3	0.5304	0.0428
98	Log-fdev-Pot-Fishery-year-2000-season-3	-0.0566	0.0412
99	Log-fdev-Pot-Fishery-year-2001-season-3	-0.1361	0.0408
100	Log-fdev-Pot-Fishery-year-2002-season-3	-0.0247	0.0397
101	Log-fdev-Pot-Fishery-year-2003-season-3	0.4387	0.0384
102	Log-fdev-Pot-Fishery-year-2004-season-3	0.3962	0.0385
103	Log-fdev-Pot-Fishery-year-2005-season-3	0.6865	0.0390

104	Log-fdev-Pot-Fishery-year-2006-season-3	0.4391	0.0384
105	Log-fdev-Pot-Fishery-year-2007-season-3	0.8043	0.0383
106	Log-fdev-Pot-Fishery-year-2008-season-3	0.9760	0.0400
107	Log-fdev-Pot-Fishery-year-2009-season-3	0.7919	0.0407
108	Log-fdev-Pot-Fishery-year-2010-season-3	0.6609	0.0400
109	Log-fdev-Pot-Fishery-year-2011-season-3	0.0241	0.0388
110	Log-fdev-Pot-Fishery-year-2012-season-3	-0.0523	0.0378
111	Log-fdev-Pot-Fishery-year-2013-season-3	0.1347	0.0376
112	Log-fdev-Pot-Fishery-year-2014-season-3	0.4639	0.0379
113	Log-fdev-Pot-Fishery-year-2015-season-3	0.5360	0.0400
114	Log-fdev-Pot-Fishery-year-2016-season-3	0.5352	0.0449
115	Log-fdev-Pot-Fishery-year-2017-season-3	0.4455	0.0529
116	Log-fdev-Pot-Fishery-year-2018-season-3	0.2550	0.0620
117	Log-fdev-Pot-Fishery-year-2019-season-3	0.1953	0.0694
118	Log-fdev-Pot-Fishery-year-2020-season-3	-0.2388	0.0721
119	Log-fdev-Pot-Fishery-year-2021-season-3	-4.6866	0.0712
120	Log-fdev-Pot-Fishery-year-2022-season-3	-4.7690	0.0704
121	Log-fdev-Trawl-Bycatch-year-1976-season-5	0.2419	0.1247
122	Log-fdev-Trawl-Bycatch-year-1977-season-5	0.6801	0.1165
123	Log-fdev-Trawl-Bycatch-year-1978-season-5	0.6588	0.1106
124	Log-fdev-Trawl-Bycatch-year-1979-season-5	0.7342	0.1090
125	Log-fdev-Trawl-Bycatch-year-1980-season-5	1.4516	0.1117
126	Log-fdev-Trawl-Bycatch-year-1981-season-5	1.2246	0.1308
127	Log-fdev-Trawl-Bycatch-year-1982-season-5	2.5078	0.1315
128	Log-fdev-Trawl-Bycatch-year-1983-season-5	2.2296	0.1190
129	Log-fdev-Trawl-Bycatch-year-1984-season-5	3.4537	0.1163
130	Log-fdev-Trawl-Bycatch-year-1985-season-5	2.2496	0.1115
131	Log-fdev-Trawl-Bycatch-year-1986-season-5	1.1873	0.1113
132	Log-fdev-Trawl-Bycatch-year-1987-season-5	0.7329	0.1089
133	Log-fdev-Trawl-Bycatch-year-1988-season-5	1.5068	0.1046
134	Log-fdev-Trawl-Bycatch-year-1989-season-5	0.0746	0.1036
135	Log-fdev-Trawl-Bycatch-year-1990-season-5	0.5289	0.1036
136	Log-fdev-Trawl-Bycatch-year-1991-season-5	0.9539	0.1048
137	Log-fdev-Trawl-Bycatch-year-1992-season-5	0.7909	0.1051
138	Log-fdev-Trawl-Bycatch-year-1993-season-5	1.2704	0.1079
139	Log-fdev-Trawl-Bycatch-year-1994-season-5	-0.4997	0.1049
140	Log-fdev-Trawl-Bycatch-year-1995-season-5	-0.7897	0.1034
141	Log-fdev-Trawl-Bycatch-year-1996-season-5	-0.7230	0.1036
142	Log-fdev-Trawl-Bycatch-year-1997-season-5	-1.1886	0.1035
143	Log-fdev-Trawl-Bycatch-year-1998-season-5	0.1119	0.1039
144	Log-fdev-Trawl-Bycatch-year-1999-season-5	-0.1674	0.1037
145	Log-fdev-Trawl-Bycatch-year-2000-season-5	-0.9286	0.1030
146	Log-fdev-Trawl-Bycatch-year-2001-season-5	-0.1601	0.1029
147	Log-fdev-Trawl-Bycatch-year-2002-season-5	-0.4595	0.1026
148	Log-fdev-Trawl-Bycatch-year-2003-season-5	-0.5528	0.1024
149	Log-fdev-Trawl-Bycatch-year-2004-season-5	-0.3201	0.1024
150	Log-fdev-Trawl-Bycatch-year-2005-season-5	-0.5953	0.1023
151	Log-fdev-Trawl-Bycatch-year-2006-season-5	-0.4262	0.1020
152	Log-fdev-Trawl-Bycatch-year-2007-season-5	-0.3489	0.1021
153	Log-fdev-Trawl-Bycatch-year-2008-season-5	-0.3753	0.1023
154	Log-fdev-Trawl-Bycatch-year-2009-season-5	-0.7326	0.1024
155	Log-fdev-Trawl-Bycatch-year-2010-season-5	-0.8816	0.1023
156	Log-fdev-Trawl-Bycatch-year-2011-season-5	-1.3459	0.1020

157	Log-fdev-Trawl-Bycatch-year-2012-season-5	-1.8676	0.1021
158	Log-fdev-Trawl-Bycatch-year-2013-season-5	-1.1533	0.1023
159	Log-fdev-Trawl-Bycatch-year-2014-season-5	-1.7176	0.1025
160	Log-fdev-Trawl-Bycatch-year-2015-season-5	-1.3343	0.1031
161	Log-fdev-Trawl-Bycatch-year-2016-season-5	-0.8092	0.1045
162	Log-fdev-Trawl-Bycatch-year-2017-season-5	-0.3763	0.1065
163	Log-fdev-Trawl-Bycatch-year-2018-season-5	-0.4417	0.1087
164	Log-fdev-Trawl-Bycatch-year-2019-season-5	-0.3477	0.1111
165	Log-fdev-Trawl-Bycatch-year-2020-season-5	-0.3768	0.1129
166	Log-fdev-Trawl-Bycatch-year-2021-season-5	-1.3634	0.1134
167	Log-fdev-Trawl-Bycatch-year-2022-season-5	-2.3064	0.1149
168	Log-fdev-Bairdi-Fishery-Bycatch-year-1975-season-5	-0.1164	0.0682
169	Log-fdev-Bairdi-Fishery-Bycatch-year-1976-season-5	0.6699	0.0682
170	Log-fdev-Bairdi-Fishery-Bycatch-year-1977-season-5	1.2283	0.0682
171	Log-fdev-Bairdi-Fishery-Bycatch-year-1978-season-5	1.0927	0.0682
172	Log-fdev-Bairdi-Fishery-Bycatch-year-1979-season-5	1.3825	0.0682
173	Log-fdev-Bairdi-Fishery-Bycatch-year-1980-season-5	1.4243	0.0682
174	Log-fdev-Bairdi-Fishery-Bycatch-year-1981-season-5	0.9927	0.0682
175	Log-fdev-Bairdi-Fishery-Bycatch-year-1982-season-5	0.4764	0.0682
176	Log-fdev-Bairdi-Fishery-Bycatch-year-1983-season-5	-0.9874	0.0682
177	Log-fdev-Bairdi-Fishery-Bycatch-year-1984-season-5	-0.5787	0.0682
178	Log-fdev-Bairdi-Fishery-Bycatch-year-1987-season-5	-1.0994	0.0682
179	Log-fdev-Bairdi-Fishery-Bycatch-year-1988-season-5	-0.2563	0.0682
180	Log-fdev-Bairdi-Fishery-Bycatch-year-1989-season-5	0.9400	0.0682
181	Log-fdev-Bairdi-Fishery-Bycatch-year-1990-season-5	1.4182	0.0682
182	Log-fdev-Bairdi-Fishery-Bycatch-year-1991-season-5	3.2422	0.0755
183	Log-fdev-Bairdi-Fishery-Bycatch-year-1992-season-5	1.2884	0.0949
184	Log-fdev-Bairdi-Fishery-Bycatch-year-1993-season-5	0.5871	0.1209
185	Log-fdev-Bairdi-Fishery-Bycatch-year-1994-season-5	-0.7543	0.0815
186	Log-fdev-Bairdi-Fishery-Bycatch-year-2006-season-5	-2.1386	0.0735
187	Log-fdev-Bairdi-Fishery-Bycatch-year-2007-season-5	-2.9910	0.0925
188	Log-fdev-Bairdi-Fishery-Bycatch-year-2008-season-5	-2.4123	0.1123
189	Log-fdev-Bairdi-Fishery-Bycatch-year-2009-season-5	-3.4950	0.0757
190	Log-fdev-Bairdi-Fishery-Bycatch-year-2013-season-5	-0.8486	0.0937
191	Log-fdev-Bairdi-Fishery-Bycatch-year-2014-season-5	-0.1237	0.1113
192	Log-fdev-Bairdi-Fishery-Bycatch-year-2015-season-5	1.0591	0.1333
193	Log-fdev-Fixed-Gear-year-1996-season-5	0.5581	0.1030
194	Log-fdev-Fixed-Gear-year-1997-season-5	-0.1048	0.1021
195	Log-fdev-Fixed-Gear-year-1998-season-5	-0.3206	0.1027
196	Log-fdev-Fixed-Gear-year-1999-season-5	0.6006	0.1020
197	Log-fdev-Fixed-Gear-year-2000-season-5	-1.8269	0.1014
198	Log-fdev-Fixed-Gear-year-2001-season-5	0.1279	0.1011
199	Log-fdev-Fixed-Gear-year-2002-season-5	-0.1302	0.1007
200	Log-fdev-Fixed-Gear-year-2003-season-5	-0.9636	0.1006
201	Log-fdev-Fixed-Gear-year-2004-season-5	-0.7899	0.1004
202	Log-fdev-Fixed-Gear-year-2005-season-5	-0.5165	0.1003
203	Log-fdev-Fixed-Gear-year-2006-season-5	-0.5631	0.1000
204	Log-fdev-Fixed-Gear-year-2007-season-5	-0.0163	0.1001
205	Log-fdev-Fixed-Gear-year-2008-season-5	-0.7163	0.1004
206	Log-fdev-Fixed-Gear-year-2009-season-5	-1.7133	0.1001
207	Log-fdev-Fixed-Gear-year-2010-season-5	-2.5481	0.0997
208	Log-fdev-Fixed-Gear-year-2011-season-5	-1.0676	0.0994
209	Log-fdev-Fixed-Gear-year-2012-season-5	-0.5125	0.0993

210	Log-fdev-Fixed-Gear-year-2013-season-5	0.6269	0.0993
211	Log-fdev-Fixed-Gear-year-2014-season-5	1.4777	0.0994
212	Log-fdev-Fixed-Gear-year-2015-season-5	1.1606	0.0997
213	Log-fdev-Fixed-Gear-year-2016-season-5	0.3295	0.1004
214	Log-fdev-Fixed-Gear-year-2017-season-5	1.9314	0.1016
215	Log-fdev-Fixed-Gear-year-2018-season-5	2.1884	0.1027
216	Log-fdev-Fixed-Gear-year-2019-season-5	0.9856	0.1040
217	Log-fdev-Fixed-Gear-year-2020-season-5	0.7804	0.1057
218	Log-fdev-Fixed-Gear-year-2021-season-5	0.7715	0.1070
219	Log-fdev-Fixed-Gear-year-2022-season-5	0.2512	0.1092
220	Log-foff-Pot-Fishery	-2.7448	0.0396
221	Log-foff-Bairdi-Fishery-Bycatch	-0.1036	0.4149
222	Log-fdov-Pot-Fishery-year-1990-season-3	1.9426	0.0836
223	Log-fdov-Pot-Fishery-year-1991-season-3	-0.7302	0.0828
224	Log-fdov-Pot-Fishery-year-1992-season-3	1.9421	0.0841
225	Log-fdov-Pot-Fishery-year-1993-season-3	1.7744	0.0858
226	Log-fdov-Pot-Fishery-year-1994-season-3	-0.4582	0.0846
227	Log-fdov-Pot-Fishery-year-1995-season-3	-0.2257	0.0824
228	Log-fdov-Pot-Fishery-year-1996-season-3	-3.7226	0.0813
229	Log-fdov-Pot-Fishery-year-1997-season-3	-0.3543	0.0820
230	Log-fdov-Pot-Fishery-year-1998-season-3	1.4261	0.0823
231	Log-fdov-Pot-Fishery-year-1999-season-3	-2.8064	0.0815
232	Log-fdov-Pot-Fishery-year-2000-season-3	1.1234	0.0807
233	Log-fdov-Pot-Fishery-year-2001-season-3	0.8492	0.0806
234	Log-fdov-Pot-Fishery-year-2002-season-3	-1.8978	0.0800
235	Log-fdov-Pot-Fishery-year-2003-season-3	1.1895	0.0801
236	Log-fdov-Pot-Fishery-year-2004-season-3	0.3967	0.0802
237	Log-fdov-Pot-Fishery-year-2005-season-3	0.9277	0.0796
238	Log-fdov-Pot-Fishery-year-2006-season-3	-1.2564	0.0791
239	Log-fdov-Pot-Fishery-year-2007-season-3	-0.2176	0.0791
240	Log-fdov-Pot-Fishery-year-2008-season-3	-0.4845	0.0794
241	Log-fdov-Pot-Fishery-year-2009-season-3	-0.7522	0.0796
242	Log-fdov-Pot-Fishery-year-2010-season-3	-0.2721	0.0794
243	Log-fdov-Pot-Fishery-year-2011-season-3	-1.1676	0.0785
244	Log-fdov-Pot-Fishery-year-2012-season-3	-1.8840	0.0781
245	Log-fdov-Pot-Fishery-year-2013-season-3	0.1371	0.0780
246	Log-fdov-Pot-Fishery-year-2014-season-3	-0.2697	0.0781
247	Log-fdov-Pot-Fishery-year-2015-season-3	0.7877	0.0785
248	Log-fdov-Pot-Fishery-year-2016-season-3	0.2371	0.0800
249	Log-fdov-Pot-Fishery-year-2017-season-3	-0.4174	0.0826
250	Log-fdov-Pot-Fishery-year-2018-season-3	0.9058	0.0865
251	Log-fdov-Pot-Fishery-year-2019-season-3	-0.1694	0.0895
252	Log-fdov-Pot-Fishery-year-2020-season-3	-0.6953	0.0901
253	Log-fdov-Pot-Fishery-year-2021-season-3	2.8968	0.0896
254	Log-fdov-Pot-Fishery-year-2022-season-3	1.2413	0.0898
255	Log-fdov-Bairdi-Fishery-Bycatch-year-1975-season-5	-0.0000	0.0962
256	Log-fdov-Bairdi-Fishery-Bycatch-year-1976-season-5	0.0001	0.0962
257	Log-fdov-Bairdi-Fishery-Bycatch-year-1977-season-5	0.0003	0.0963
258	Log-fdov-Bairdi-Fishery-Bycatch-year-1978-season-5	0.0002	0.0963
259	Log-fdov-Bairdi-Fishery-Bycatch-year-1979-season-5	0.0004	0.0963
260	Log-fdov-Bairdi-Fishery-Bycatch-year-1980-season-5	0.0001	0.0963
261	Log-fdov-Bairdi-Fishery-Bycatch-year-1981-season-5	-0.0001	0.0963
262	Log-fdov-Bairdi-Fishery-Bycatch-year-1982-season-5	-0.0002	0.0962

263	Log-fdov-Bairdi-Fishery-Bycatch-year-1983-season-5	-0.0002	0.0962
264	Log-fdov-Bairdi-Fishery-Bycatch-year-1984-season-5	-0.0001	0.0962
265	Log-fdov-Bairdi-Fishery-Bycatch-year-1987-season-5	-0.0001	0.0962
266	Log-fdov-Bairdi-Fishery-Bycatch-year-1988-season-5	0.0001	0.0962
267	Log-fdov-Bairdi-Fishery-Bycatch-year-1989-season-5	0.0004	0.0962
268	Log-fdov-Bairdi-Fishery-Bycatch-year-1990-season-5	0.0008	0.0963
269	Log-fdov-Bairdi-Fishery-Bycatch-year-1991-season-5	1.5517	0.1690
270	Log-fdov-Bairdi-Fishery-Bycatch-year-1992-season-5	1.8070	0.1203
271	Log-fdov-Bairdi-Fishery-Bycatch-year-1993-season-5	0.5731	0.1421
272	Log-fdov-Bairdi-Fishery-Bycatch-year-1994-season-5	-3.4377	0.1082
273	Log-fdov-Bairdi-Fishery-Bycatch-year-2006-season-5	-2.1316	0.1445
274	Log-fdov-Bairdi-Fishery-Bycatch-year-2007-season-5	-0.7745	0.1255
275	Log-fdov-Bairdi-Fishery-Bycatch-year-2008-season-5	0.0419	0.1322
276	Log-fdov-Bairdi-Fishery-Bycatch-year-2009-season-5	0.3868	0.1027
277	Log-fdov-Bairdi-Fishery-Bycatch-year-2013-season-5	0.9394	0.1676
278	Log-fdov-Bairdi-Fishery-Bycatch-year-2014-season-5	0.1583	0.1525
279	Log-fdov-Bairdi-Fishery-Bycatch-year-2015-season-5	0.8840	0.1671
280	Rec-dev-est-1975	1.1089	0.2653
281	Rec-dev-est-1976	0.6603	0.2932
282	Rec-dev-est-1977	1.1136	0.2384
283	Rec-dev-est-1978	1.6938	0.2055
284	Rec-dev-est-1979	1.9597	0.2148
285	Rec-dev-est-1980	1.1627	0.2565
286	Rec-dev-est-1981	2.4345	0.1640
287	Rec-dev-est-1982	1.4802	0.1782
288	Rec-dev-est-1983	1.0973	0.1655
289	Rec-dev-est-1984	-0.7272	0.2478
290	Rec-dev-est-1985	0.3481	0.1616
291	Rec-dev-est-1986	-0.8087	0.2423
292	Rec-dev-est-1987	-1.2347	0.2742
293	Rec-dev-est-1988	-0.9696	0.2210
294	Rec-dev-est-1989	-0.0248	0.1625
295	Rec-dev-est-1990	-0.4839	0.1825
296	Rec-dev-est-1991	-1.9423	0.3554
297	Rec-dev-est-1992	-0.8543	0.1959
298	Rec-dev-est-1993	-1.9743	0.4167
299	Rec-dev-est-1994	1.0212	0.1454
300	Rec-dev-est-1995	-0.8946	0.2571
301	Rec-dev-est-1996	-1.5594	0.3361
302	Rec-dev-est-1997	-0.5418	0.1972
303	Rec-dev-est-1998	0.4557	0.1540
304	Rec-dev-est-1999	-0.5294	0.2223
305	Rec-dev-est-2000	-0.5048	0.2384
306	Rec-dev-est-2001	0.8824	0.1527
307	Rec-dev-est-2002	-0.5931	0.2632
308	Rec-dev-est-2003	-0.6566	0.2613
309	Rec-dev-est-2004	0.6189	0.1550
310	Rec-dev-est-2005	-0.1138	0.1807
311	Rec-dev-est-2006	-0.4985	0.1875
312	Rec-dev-est-2007	-1.0812	0.2349
313	Rec-dev-est-2008	-0.9518	0.2344
314	Rec-dev-est-2009	0.0295	0.1766
315	Rec-dev-est-2010	-0.5126	0.2259

316	Rec-dev-est-2011	-1.0539	0.2306
317	Rec-dev-est-2012	-1.3729	0.2207
318	Rec-dev-est-2013	-1.8383	0.2667
319	Rec-dev-est-2014	-1.3622	0.2298
320	Rec-dev-est-2015	-0.7046	0.1724
321	Rec-dev-est-2016	-1.5169	0.2433
322	Rec-dev-est-2017	-0.8475	0.1907
323	Rec-dev-est-2018	-1.5416	0.2770
324	Rec-dev-est-2019	-1.5340	0.2716
325	Rec-dev-est-2020	-1.6594	0.2882
326	Rec-dev-est-2021	-0.8932	0.2358
327	Rec-dev-est-2022	-1.3340	0.3508
328	Logit-rec-prop-est-1975	-0.0843	0.4263
329	Logit-rec-prop-est-1976	-0.8587	0.5197
330	Logit-rec-prop-est-1977	-0.2347	0.3548
331	Logit-rec-prop-est-1978	-0.4360	0.2667
332	Logit-rec-prop-est-1979	0.0866	0.2536
333	Logit-rec-prop-est-1980	0.2636	0.3346
334	Logit-rec-prop-est-1981	0.3608	0.1399
335	Logit-rec-prop-est-1982	0.4040	0.2303
336	Logit-rec-prop-est-1983	-0.0648	0.1763
337	Logit-rec-prop-est-1984	0.4403	0.4533
338	Logit-rec-prop-est-1985	-0.4756	0.1655
339	Logit-rec-prop-est-1986	0.2249	0.4165
340	Logit-rec-prop-est-1987	-0.1054	0.4544
341	Logit-rec-prop-est-1988	0.4154	0.3821
342	Logit-rec-prop-est-1989	-0.0802	0.1667
343	Logit-rec-prop-est-1990	0.1809	0.2415
344	Logit-rec-prop-est-1991	0.7068	0.7172
345	Logit-rec-prop-est-1992	0.2500	0.2837
346	Logit-rec-prop-est-1993	-0.3047	0.6763
347	Logit-rec-prop-est-1994	-0.2839	0.0864
348	Logit-rec-prop-est-1995	1.3209	0.6445
349	Logit-rec-prop-est-1996	0.4112	0.6328
350	Logit-rec-prop-est-1997	0.5011	0.3215
351	Logit-rec-prop-est-1998	-0.0401	0.1400
352	Logit-rec-prop-est-1999	0.2166	0.3610
353	Logit-rec-prop-est-2000	-0.5522	0.3755
354	Logit-rec-prop-est-2001	-0.4728	0.1239
355	Logit-rec-prop-est-2002	-0.4070	0.4247
356	Logit-rec-prop-est-2003	-0.0094	0.4363
357	Logit-rec-prop-est-2004	-0.3851	0.1379
358	Logit-rec-prop-est-2005	-0.0794	0.2360
359	Logit-rec-prop-est-2006	0.3627	0.2780
360	Logit-rec-prop-est-2007	-0.1878	0.3691
361	Logit-rec-prop-est-2008	-0.4417	0.3583
362	Logit-rec-prop-est-2009	-0.7824	0.1942
363	Logit-rec-prop-est-2010	-0.4576	0.3174
364	Logit-rec-prop-est-2011	-0.5404	0.3449
365	Logit-rec-prop-est-2012	-0.2384	0.3305
366	Logit-rec-prop-est-2013	-0.3179	0.4276
367	Logit-rec-prop-est-2014	-0.3592	0.3366
368	Logit-rec-prop-est-2015	0.2842	0.2152

369	Logit-rec-prop-est-2016	0.5167	0.4432
370	Logit-rec-prop-est-2017	0.6098	0.2835
371	Logit-rec-prop-est-2018	-0.1925	0.4560
372	Logit-rec-prop-est-2019	0.3735	0.4700
373	Logit-rec-prop-est-2020	0.5544	0.5226
374	Logit-rec-prop-est-2021	0.1438	0.3470
375	Logit-rec-prop-est-2022	-0.2362	0.5730
376	M-dev-est-par-1	1.5980	0.0292
377	Survey-q-survey-1	0.9680	0.0251
378	Log-add-cvt-survey-2	-0.7750	0.2728

Table 6: Summary of estimated model parameter values and standard deviations for model 23.0a for Bristol Bay red king crab.

Index	Name	Value	StdDev
1	M-base	0.2318	0.0065
2	M-female	0.1511	0.0185
3	Log(Rinitial)	20.0186	0.0590
4	Log(Rbar)	16.5133	0.1436
5	Recruitment-rb-males	0.7638	0.1264
6	Recruitment-rb-females	-0.5830	0.2145
7	Scaled-logN-for-male-mature-1-shell-1-class-2	1.0828	0.4281
8	Scaled-logN-for-male-mature-1-shell-1-class-3	0.7376	0.4877
9	Scaled-logN-for-male-mature-1-shell-1-class-4	0.9567	0.3339
10	Scaled-logN-for-male-mature-1-shell-1-class-5	0.7947	0.3034
11	Scaled-logN-for-male-mature-1-shell-1-class-6	0.6106	0.2925
12	Scaled-logN-for-male-mature-1-shell-1-class-7	0.5506	0.2736
13	Scaled-logN-for-male-mature-1-shell-1-class-8	0.3721	0.2743
14	Scaled-logN-for-male-mature-1-shell-1-class-9	0.3846	0.2618
15	Scaled-logN-for-male-mature-1-shell-1-class-10	0.3996	0.2555
16	Scaled-logN-for-male-mature-1-shell-1-class-11	0.1577	0.2774
17	Scaled-logN-for-male-mature-1-shell-1-class-12	0.1209	0.2732
18	Scaled-logN-for-male-mature-1-shell-1-class-13	-0.0034	0.2841
19	Scaled-logN-for-male-mature-1-shell-1-class-14	0.0894	0.2641
20	Scaled-logN-for-male-mature-1-shell-1-class-15	-0.0787	0.2038
21	Scaled-logN-for-male-mature-1-shell-1-class-16	-0.3239	0.1966
22	Scaled-logN-for-male-mature-1-shell-1-class-17	-0.4817	0.1988
23	Scaled-logN-for-male-mature-1-shell-1-class-18	-0.8343	0.2124
24	Scaled-logN-for-male-mature-1-shell-1-class-19	-1.2965	0.2331
25	Scaled-logN-for-male-mature-1-shell-1-class-20	-1.3406	0.2354
26	Scaled-logN-for-female-mature-1-shell-1-class-1	1.3360	0.7879
27	Scaled-logN-for-female-mature-1-shell-1-class-2	1.5444	0.4942
28	Scaled-logN-for-female-mature-1-shell-1-class-3	1.4441	0.3822
29	Scaled-logN-for-female-mature-1-shell-1-class-4	1.1954	0.3507
30	Scaled-logN-for-female-mature-1-shell-1-class-5	1.1145	0.3028
31	Scaled-logN-for-female-mature-1-shell-1-class-6	0.6386	0.3227
32	Scaled-logN-for-female-mature-1-shell-1-class-7	0.2334	0.3564
33	Scaled-logN-for-female-mature-1-shell-1-class-8	-0.0048	0.3595
34	Scaled-logN-for-female-mature-1-shell-1-class-9	-0.2030	0.3501
35	Scaled-logN-for-female-mature-1-shell-1-class-10	-0.5457	0.3688
36	Scaled-logN-for-female-mature-1-shell-1-class-11	-0.9406	0.3802
37	Scaled-logN-for-female-mature-1-shell-1-class-12	-1.2002	0.3850
38	Scaled-logN-for-female-mature-1-shell-1-class-13	-1.4328	0.3837
39	Scaled-logN-for-female-mature-1-shell-1-class-14	-1.8195	0.3727
40	Scaled-logN-for-female-mature-1-shell-1-class-15	-1.9277	0.3691
41	Scaled-logN-for-female-mature-1-shell-1-class-16	-1.8706	0.3491
42	Gscale-male-period-1	0.9741	0.1871
43	Gscale-female-period-1	1.3991	0.1226
44	Molt-probability-mu-male-period-1	143.0002	1.7373
45	Molt-probability-CV-male-period-1	0.0558	0.0097
46	Molt-probability-mu-male-period-2	141.1893	0.6119
47	Molt-probability-CV-male-period-2	0.0687	0.0034
48	Sel-Pot-Fishery-male-period-1-par-1	4.7815	0.0083
49	Sel-Pot-Fishery-male-period-1-par-2	2.2786	0.0424
50	Sel-Pot-Fishery-female-period-1-par-1	4.5656	0.0189

51	Sel-Pot-Fishery-female-period-1-par-2	2.2325	0.0907
52	Sel-Trawl-Bycatch-male-period-1-par-1	5.1331	0.0453
53	Sel-Trawl-Bycatch-male-period-1-par-2	2.7830	0.0406
54	Sel-Bairdi-Fishery-Bycatch-male-period-1-par-1	4.7191	0.2337
55	Sel-Bairdi-Fishery-Bycatch-male-period-1-par-2	2.1670	0.3047
56	Sel-Bairdi-Fishery-Bycatch-female-period-1-par-1	4.7363	0.0906
57	Sel-Bairdi-Fishery-Bycatch-female-period-1-par-2	0.9030	0.3027
58	Sel-Fixed-Gear-male-period-1-par-1	4.8083	0.0217
59	Sel-Fixed-Gear-male-period-1-par-2	2.3330	0.0767
60	Sel-NMFS-Trawl-male-period-1-par-1	4.1631	0.1150
61	Sel-NMFS-Trawl-male-period-1-par-2	2.2419	0.3295
62	Sel-NMFS-Trawl-male-period-2-par-1	4.0732	0.2604
63	Sel-NMFS-Trawl-male-period-2-par-2	3.5909	0.4034
64	Sel-BSFRF-male-period-1-par-1	4.4676	0.0273
65	Sel-BSFRF-male-period-1-par-2	2.5605	0.0766
66	Ret-Pot-Fishery-male-period-1-par-1	4.9234	0.0015
67	Ret-Pot-Fishery-male-period-1-par-2	0.6765	0.0525
68	Ret-Pot-Fishery-male-period-2-par-1	4.9323	0.0020
69	Ret-Pot-Fishery-male-period-2-par-2	0.7223	0.0977
70	Log-fbar-Pot-Fishery	-1.7100	0.0439
71	Log-fbar-Trawl-Bycatch	-4.3773	0.0755
72	Log-fbar-Bairdi-Fishery-Bycatch	-5.7052	0.3304
73	Log-fbar-Fixed-Gear	-6.5343	0.0751
74	Log-fdev-Pot-Fishery-year-1975-season-3	0.8957	0.1207
75	Log-fdev-Pot-Fishery-year-1976-season-3	0.8609	0.0912
76	Log-fdev-Pot-Fishery-year-1977-season-3	0.7821	0.0752
77	Log-fdev-Pot-Fishery-year-1978-season-3	0.8751	0.0615
78	Log-fdev-Pot-Fishery-year-1979-season-3	1.0881	0.0557
79	Log-fdev-Pot-Fishery-year-1980-season-3	1.9587	0.0589
80	Log-fdev-Pot-Fishery-year-1981-season-3	2.5121	0.1137
81	Log-fdev-Pot-Fishery-year-1982-season-3	0.9623	0.1538
82	Log-fdev-Pot-Fishery-year-1983-season-3	-8.7023	0.1033
83	Log-fdev-Pot-Fishery-year-1984-season-3	1.4238	0.0999
84	Log-fdev-Pot-Fishery-year-1985-season-3	1.4629	0.0919
85	Log-fdev-Pot-Fishery-year-1986-season-3	1.5506	0.0778
86	Log-fdev-Pot-Fishery-year-1987-season-3	1.0415	0.0671
87	Log-fdev-Pot-Fishery-year-1988-season-3	0.0746	0.0547
88	Log-fdev-Pot-Fishery-year-1989-season-3	0.1836	0.0487
89	Log-fdev-Pot-Fishery-year-1990-season-3	0.8291	0.0399
90	Log-fdev-Pot-Fishery-year-1991-season-3	0.8341	0.0430
91	Log-fdev-Pot-Fishery-year-1992-season-3	0.3180	0.0476
92	Log-fdev-Pot-Fishery-year-1993-season-3	0.9766	0.0519
93	Log-fdev-Pot-Fishery-year-1994-season-3	-4.1904	0.0492
94	Log-fdev-Pot-Fishery-year-1995-season-3	-4.5887	0.0425
95	Log-fdev-Pot-Fishery-year-1996-season-3	-0.1000	0.0409
96	Log-fdev-Pot-Fishery-year-1997-season-3	-0.0337	0.0413
97	Log-fdev-Pot-Fishery-year-1998-season-3	0.8845	0.0440
98	Log-fdev-Pot-Fishery-year-1999-season-3	0.5036	0.0435
99	Log-fdev-Pot-Fishery-year-2000-season-3	-0.0862	0.0418
100	Log-fdev-Pot-Fishery-year-2001-season-3	-0.1511	0.0413
101	Log-fdev-Pot-Fishery-year-2002-season-3	-0.0314	0.0400
102	Log-fdev-Pot-Fishery-year-2003-season-3	0.4279	0.0387
103	Log-fdev-Pot-Fishery-year-2004-season-3	0.3851	0.0388

104	Log-fdev-Pot-Fishery-year-2005-season-3	0.6775	0.0393
105	Log-fdev-Pot-Fishery-year-2006-season-3	0.4216	0.0386
106	Log-fdev-Pot-Fishery-year-2007-season-3	0.7858	0.0387
107	Log-fdev-Pot-Fishery-year-2008-season-3	0.9539	0.0409
108	Log-fdev-Pot-Fishery-year-2009-season-3	0.7547	0.0420
109	Log-fdev-Pot-Fishery-year-2010-season-3	0.6098	0.0415
110	Log-fdev-Pot-Fishery-year-2011-season-3	-0.0285	0.0400
111	Log-fdev-Pot-Fishery-year-2012-season-3	-0.0929	0.0387
112	Log-fdev-Pot-Fishery-year-2013-season-3	0.1068	0.0383
113	Log-fdev-Pot-Fishery-year-2014-season-3	0.4386	0.0385
114	Log-fdev-Pot-Fishery-year-2015-season-3	0.5084	0.0402
115	Log-fdev-Pot-Fishery-year-2016-season-3	0.5119	0.0442
116	Log-fdev-Pot-Fishery-year-2017-season-3	0.4370	0.0509
117	Log-fdev-Pot-Fishery-year-2018-season-3	0.2702	0.0590
118	Log-fdev-Pot-Fishery-year-2019-season-3	0.2312	0.0658
119	Log-fdev-Pot-Fishery-year-2020-season-3	-0.1941	0.0683
120	Log-fdev-Pot-Fishery-year-2021-season-3	-4.6342	0.0676
121	Log-fdev-Pot-Fishery-year-2022-season-3	-4.7048	0.0673
122	Log-fdev-Trawl-Bycatch-year-1976-season-5	0.2348	0.1256
123	Log-fdev-Trawl-Bycatch-year-1977-season-5	0.6808	0.1173
124	Log-fdev-Trawl-Bycatch-year-1978-season-5	0.6643	0.1115
125	Log-fdev-Trawl-Bycatch-year-1979-season-5	0.7431	0.1102
126	Log-fdev-Trawl-Bycatch-year-1980-season-5	1.4692	0.1132
127	Log-fdev-Trawl-Bycatch-year-1981-season-5	1.2510	0.1254
128	Log-fdev-Trawl-Bycatch-year-1982-season-5	2.5449	0.1224
129	Log-fdev-Trawl-Bycatch-year-1983-season-5	2.2925	0.1129
130	Log-fdev-Trawl-Bycatch-year-1984-season-5	3.5424	0.1126
131	Log-fdev-Trawl-Bycatch-year-1985-season-5	2.3227	0.1122
132	Log-fdev-Trawl-Bycatch-year-1986-season-5	1.2198	0.1126
133	Log-fdev-Trawl-Bycatch-year-1987-season-5	0.7320	0.1100
134	Log-fdev-Trawl-Bycatch-year-1988-season-5	1.4900	0.1054
135	Log-fdev-Trawl-Bycatch-year-1989-season-5	0.0502	0.1041
136	Log-fdev-Trawl-Bycatch-year-1990-season-5	0.4934	0.1042
137	Log-fdev-Trawl-Bycatch-year-1991-season-5	0.9075	0.1056
138	Log-fdev-Trawl-Bycatch-year-1992-season-5	0.7468	0.1058
139	Log-fdev-Trawl-Bycatch-year-1993-season-5	1.2109	0.1085
140	Log-fdev-Trawl-Bycatch-year-1994-season-5	-0.5487	0.1052
141	Log-fdev-Trawl-Bycatch-year-1995-season-5	-0.8266	0.1036
142	Log-fdev-Trawl-Bycatch-year-1996-season-5	-0.7493	0.1037
143	Log-fdev-Trawl-Bycatch-year-1997-season-5	-1.1997	0.1036
144	Log-fdev-Trawl-Bycatch-year-1998-season-5	0.0992	0.1041
145	Log-fdev-Trawl-Bycatch-year-1999-season-5	-0.1916	0.1040
146	Log-fdev-Trawl-Bycatch-year-2000-season-5	-0.9561	0.1033
147	Log-fdev-Trawl-Bycatch-year-2001-season-5	-0.1792	0.1031
148	Log-fdev-Trawl-Bycatch-year-2002-season-5	-0.4695	0.1028
149	Log-fdev-Trawl-Bycatch-year-2003-season-5	-0.5651	0.1026
150	Log-fdev-Trawl-Bycatch-year-2004-season-5	-0.3342	0.1025
151	Log-fdev-Trawl-Bycatch-year-2005-season-5	-0.6109	0.1024
152	Log-fdev-Trawl-Bycatch-year-2006-season-5	-0.4440	0.1021
153	Log-fdev-Trawl-Bycatch-year-2007-season-5	-0.3717	0.1023
154	Log-fdev-Trawl-Bycatch-year-2008-season-5	-0.4022	0.1026
155	Log-fdev-Trawl-Bycatch-year-2009-season-5	-0.7660	0.1028
156	Log-fdev-Trawl-Bycatch-year-2010-season-5	-0.9229	0.1028

157	Log-fdev-Trawl-Bycatch-year-2011-season-5	-1.3835	0.1023
158	Log-fdev-Trawl-Bycatch-year-2012-season-5	-1.8944	0.1024
159	Log-fdev-Trawl-Bycatch-year-2013-season-5	-1.1676	0.1025
160	Log-fdev-Trawl-Bycatch-year-2014-season-5	-1.7240	0.1026
161	Log-fdev-Trawl-Bycatch-year-2015-season-5	-1.3363	0.1032
162	Log-fdev-Trawl-Bycatch-year-2016-season-5	-0.8027	0.1045
163	Log-fdev-Trawl-Bycatch-year-2017-season-5	-0.3540	0.1063
164	Log-fdev-Trawl-Bycatch-year-2018-season-5	-0.3985	0.1084
165	Log-fdev-Trawl-Bycatch-year-2019-season-5	-0.2857	0.1107
166	Log-fdev-Trawl-Bycatch-year-2020-season-5	-0.3046	0.1124
167	Log-fdev-Trawl-Bycatch-year-2021-season-5	-1.2860	0.1127
168	Log-fdev-Trawl-Bycatch-year-2022-season-5	-2.2207	0.1141
169	Log-fdev-Bairdi-Fishery-Bycatch-year-1975-season-5	-0.1163	0.0682
170	Log-fdev-Bairdi-Fishery-Bycatch-year-1976-season-5	0.6699	0.0682
171	Log-fdev-Bairdi-Fishery-Bycatch-year-1977-season-5	1.2283	0.0682
172	Log-fdev-Bairdi-Fishery-Bycatch-year-1978-season-5	1.0926	0.0682
173	Log-fdev-Bairdi-Fishery-Bycatch-year-1979-season-5	1.3824	0.0682
174	Log-fdev-Bairdi-Fishery-Bycatch-year-1980-season-5	1.4242	0.0682
175	Log-fdev-Bairdi-Fishery-Bycatch-year-1981-season-5	0.9927	0.0682
176	Log-fdev-Bairdi-Fishery-Bycatch-year-1982-season-5	0.4764	0.0682
177	Log-fdev-Bairdi-Fishery-Bycatch-year-1983-season-5	-0.9874	0.0682
178	Log-fdev-Bairdi-Fishery-Bycatch-year-1984-season-5	-0.5787	0.0682
179	Log-fdev-Bairdi-Fishery-Bycatch-year-1987-season-5	-1.0994	0.0682
180	Log-fdev-Bairdi-Fishery-Bycatch-year-1988-season-5	-0.2563	0.0682
181	Log-fdev-Bairdi-Fishery-Bycatch-year-1989-season-5	0.9401	0.0682
182	Log-fdev-Bairdi-Fishery-Bycatch-year-1990-season-5	1.4182	0.0682
183	Log-fdev-Bairdi-Fishery-Bycatch-year-1991-season-5	3.2430	0.0758
184	Log-fdev-Bairdi-Fishery-Bycatch-year-1992-season-5	1.2810	0.1059
185	Log-fdev-Bairdi-Fishery-Bycatch-year-1993-season-5	0.5511	0.1271
186	Log-fdev-Bairdi-Fishery-Bycatch-year-1994-season-5	-0.7692	0.0854
187	Log-fdev-Bairdi-Fishery-Bycatch-year-2006-season-5	-2.1203	0.0742
188	Log-fdev-Bairdi-Fishery-Bycatch-year-2007-season-5	-2.9806	0.0990
189	Log-fdev-Bairdi-Fishery-Bycatch-year-2008-season-5	-2.4158	0.1186
190	Log-fdev-Bairdi-Fishery-Bycatch-year-2009-season-5	-3.5068	0.0757
191	Log-fdev-Bairdi-Fishery-Bycatch-year-2013-season-5	-0.8373	0.0966
192	Log-fdev-Bairdi-Fishery-Bycatch-year-2014-season-5	-0.1100	0.1203
193	Log-fdev-Bairdi-Fishery-Bycatch-year-2015-season-5	1.0782	0.1481
194	Log-fdev-Fixed-Gear-year-1996-season-5	0.5319	0.1033
195	Log-fdev-Fixed-Gear-year-1997-season-5	-0.1164	0.1024
196	Log-fdev-Fixed-Gear-year-1998-season-5	-0.3359	0.1031
197	Log-fdev-Fixed-Gear-year-1999-season-5	0.5736	0.1023
198	Log-fdev-Fixed-Gear-year-2000-season-5	-1.8535	0.1017
199	Log-fdev-Fixed-Gear-year-2001-season-5	0.1090	0.1013
200	Log-fdev-Fixed-Gear-year-2002-season-5	-0.1457	0.1009
201	Log-fdev-Fixed-Gear-year-2003-season-5	-0.9819	0.1008
202	Log-fdev-Fixed-Gear-year-2004-season-5	-0.8062	0.1006
203	Log-fdev-Fixed-Gear-year-2005-season-5	-0.5347	0.1005
204	Log-fdev-Fixed-Gear-year-2006-season-5	-0.5833	0.1002
205	Log-fdev-Fixed-Gear-year-2007-season-5	-0.0364	0.1002
206	Log-fdev-Fixed-Gear-year-2008-season-5	-0.7387	0.1006
207	Log-fdev-Fixed-Gear-year-2009-season-5	-1.7420	0.1004
208	Log-fdev-Fixed-Gear-year-2010-season-5	-2.5820	0.0999
209	Log-fdev-Fixed-Gear-year-2011-season-5	-1.0972	0.0996

210	Log-fdev-Fixed-Gear-year-2012-season-5	-0.5316	0.0995
211	Log-fdev-Fixed-Gear-year-2013-season-5	0.6176	0.0994
212	Log-fdev-Fixed-Gear-year-2014-season-5	1.4737	0.0995
213	Log-fdev-Fixed-Gear-year-2015-season-5	1.1636	0.0998
214	Log-fdev-Fixed-Gear-year-2016-season-5	0.3441	0.1005
215	Log-fdev-Fixed-Gear-year-2017-season-5	1.9614	0.1017
216	Log-fdev-Fixed-Gear-year-2018-season-5	2.2364	0.1028
217	Log-fdev-Fixed-Gear-year-2019-season-5	1.0474	0.1041
218	Log-fdev-Fixed-Gear-year-2020-season-5	0.8488	0.1057
219	Log-fdev-Fixed-Gear-year-2021-season-5	0.8446	0.1068
220	Log-fdev-Fixed-Gear-year-2022-season-5	0.3335	0.1090
221	Log-foff-Pot-Fishery	-2.7574	0.0445
222	Log-foff-Bairdi-Fishery-Bycatch	-0.1395	0.4885
223	Log-fdov-Pot-Fishery-year-1990-season-3	1.9051	0.0841
224	Log-fdov-Pot-Fishery-year-1991-season-3	-0.7521	0.0833
225	Log-fdov-Pot-Fishery-year-1992-season-3	1.9208	0.0846
226	Log-fdov-Pot-Fishery-year-1993-season-3	1.7587	0.0860
227	Log-fdov-Pot-Fishery-year-1994-season-3	-0.4574	0.0846
228	Log-fdov-Pot-Fishery-year-1995-season-3	-0.2380	0.0823
229	Log-fdov-Pot-Fishery-year-1996-season-3	-3.7300	0.0813
230	Log-fdov-Pot-Fishery-year-1997-season-3	-0.3775	0.0822
231	Log-fdov-Pot-Fishery-year-1998-season-3	1.3843	0.0829
232	Log-fdov-Pot-Fishery-year-1999-season-3	-2.8344	0.0821
233	Log-fdov-Pot-Fishery-year-2000-season-3	1.1036	0.0811
234	Log-fdov-Pot-Fishery-year-2001-season-3	0.8195	0.0810
235	Log-fdov-Pot-Fishery-year-2002-season-3	-1.9359	0.0805
236	Log-fdov-Pot-Fishery-year-2003-season-3	1.1622	0.0803
237	Log-fdov-Pot-Fishery-year-2004-season-3	0.3689	0.0806
238	Log-fdov-Pot-Fishery-year-2005-season-3	0.8870	0.0802
239	Log-fdov-Pot-Fishery-year-2006-season-3	-1.2844	0.0796
240	Log-fdov-Pot-Fishery-year-2007-season-3	-0.2406	0.0796
241	Log-fdov-Pot-Fishery-year-2008-season-3	-0.5040	0.0800
242	Log-fdov-Pot-Fishery-year-2009-season-3	-0.7546	0.0802
243	Log-fdov-Pot-Fishery-year-2010-season-3	-0.2552	0.0799
244	Log-fdov-Pot-Fishery-year-2011-season-3	-1.1339	0.0791
245	Log-fdov-Pot-Fishery-year-2012-season-3	-1.8477	0.0785
246	Log-fdov-Pot-Fishery-year-2013-season-3	0.1682	0.0784
247	Log-fdov-Pot-Fishery-year-2014-season-3	-0.2354	0.0785
248	Log-fdov-Pot-Fishery-year-2015-season-3	0.8310	0.0789
249	Log-fdov-Pot-Fishery-year-2016-season-3	0.2867	0.0802
250	Log-fdov-Pot-Fishery-year-2017-season-3	-0.3677	0.0824
251	Log-fdov-Pot-Fishery-year-2018-season-3	0.9450	0.0854
252	Log-fdov-Pot-Fishery-year-2019-season-3	-0.1385	0.0880
253	Log-fdov-Pot-Fishery-year-2020-season-3	-0.6617	0.0886
254	Log-fdov-Pot-Fishery-year-2021-season-3	2.9322	0.0886
255	Log-fdov-Pot-Fishery-year-2022-season-3	1.2716	0.0893
256	Log-fdov-Bairdi-Fishery-Bycatch-year-1975-season-5	-0.0000	0.0962
257	Log-fdov-Bairdi-Fishery-Bycatch-year-1976-season-5	0.0001	0.0962
258	Log-fdov-Bairdi-Fishery-Bycatch-year-1977-season-5	0.0003	0.0962
259	Log-fdov-Bairdi-Fishery-Bycatch-year-1978-season-5	0.0003	0.0963
260	Log-fdov-Bairdi-Fishery-Bycatch-year-1979-season-5	0.0004	0.0963
261	Log-fdov-Bairdi-Fishery-Bycatch-year-1980-season-5	0.0001	0.0963
262	Log-fdov-Bairdi-Fishery-Bycatch-year-1981-season-5	-0.0001	0.0963

263	Log-fdov-Bairdi-Fishery-Bycatch-year-1982-season-5	-0.0001	0.0962
264	Log-fdov-Bairdi-Fishery-Bycatch-year-1983-season-5	-0.0001	0.0962
265	Log-fdov-Bairdi-Fishery-Bycatch-year-1984-season-5	-0.0001	0.0962
266	Log-fdov-Bairdi-Fishery-Bycatch-year-1987-season-5	-0.0001	0.0962
267	Log-fdov-Bairdi-Fishery-Bycatch-year-1988-season-5	0.0000	0.0962
268	Log-fdov-Bairdi-Fishery-Bycatch-year-1989-season-5	0.0003	0.0962
269	Log-fdov-Bairdi-Fishery-Bycatch-year-1990-season-5	0.0006	0.0963
270	Log-fdov-Bairdi-Fishery-Bycatch-year-1991-season-5	1.4897	0.1588
271	Log-fdov-Bairdi-Fishery-Bycatch-year-1992-season-5	1.7778	0.1278
272	Log-fdov-Bairdi-Fishery-Bycatch-year-1993-season-5	0.5861	0.1485
273	Log-fdov-Bairdi-Fishery-Bycatch-year-1994-season-5	-3.4396	0.1108
274	Log-fdov-Bairdi-Fishery-Bycatch-year-2006-season-5	-2.1782	0.1733
275	Log-fdov-Bairdi-Fishery-Bycatch-year-2007-season-5	-0.8057	0.1313
276	Log-fdov-Bairdi-Fishery-Bycatch-year-2008-season-5	0.0358	0.1377
277	Log-fdov-Bairdi-Fishery-Bycatch-year-2009-season-5	0.3959	0.1029
278	Log-fdov-Bairdi-Fishery-Bycatch-year-2013-season-5	0.9906	0.1745
279	Log-fdov-Bairdi-Fishery-Bycatch-year-2014-season-5	0.2097	0.1576
280	Log-fdov-Bairdi-Fishery-Bycatch-year-2015-season-5	0.9364	0.1833
281	Rec-dev-est-1975	1.1022	0.2632
282	Rec-dev-est-1976	0.5911	0.2966
283	Rec-dev-est-1977	1.0292	0.2415
284	Rec-dev-est-1978	1.6112	0.2076
285	Rec-dev-est-1979	1.9106	0.2149
286	Rec-dev-est-1980	1.1326	0.2575
287	Rec-dev-est-1981	2.4109	0.1630
288	Rec-dev-est-1982	1.4616	0.1772
289	Rec-dev-est-1983	1.0946	0.1641
290	Rec-dev-est-1984	-0.6997	0.2424
291	Rec-dev-est-1985	0.3635	0.1614
292	Rec-dev-est-1986	-0.7477	0.2371
293	Rec-dev-est-1987	-1.1841	0.2717
294	Rec-dev-est-1988	-0.9526	0.2229
295	Rec-dev-est-1989	-0.0131	0.1630
296	Rec-dev-est-1990	-0.4073	0.1802
297	Rec-dev-est-1991	-1.8651	0.3493
298	Rec-dev-est-1992	-0.8225	0.1955
299	Rec-dev-est-1993	-2.0161	0.4386
300	Rec-dev-est-1994	1.0224	0.1455
301	Rec-dev-est-1995	-0.7614	0.2474
302	Rec-dev-est-1996	-1.5274	0.3418
303	Rec-dev-est-1997	-0.5343	0.1991
304	Rec-dev-est-1998	0.4807	0.1539
305	Rec-dev-est-1999	-0.4717	0.2184
306	Rec-dev-est-2000	-0.5440	0.2480
307	Rec-dev-est-2001	0.9146	0.1525
308	Rec-dev-est-2002	-0.5416	0.2585
309	Rec-dev-est-2003	-0.6335	0.2622
310	Rec-dev-est-2004	0.6051	0.1555
311	Rec-dev-est-2005	-0.0439	0.1767
312	Rec-dev-est-2006	-0.4733	0.1854
313	Rec-dev-est-2007	-1.0313	0.2291
314	Rec-dev-est-2008	-0.8961	0.2304
315	Rec-dev-est-2009	0.0044	0.1804

316	Rec-dev-est-2010	-0.4742	0.2207
317	Rec-dev-est-2011	-1.0410	0.2272
318	Rec-dev-est-2012	-1.3850	0.2211
319	Rec-dev-est-2013	-1.8713	0.2653
320	Rec-dev-est-2014	-1.4136	0.2193
321	Rec-dev-est-2015	-0.7704	0.1706
322	Rec-dev-est-2016	-1.5464	0.2395
323	Rec-dev-est-2017	-0.8907	0.1877
324	Rec-dev-est-2018	-1.6169	0.2768
325	Rec-dev-est-2019	-1.5542	0.2642
326	Rec-dev-est-2020	-1.7233	0.2882
327	Rec-dev-est-2021	-0.9453	0.2312
328	Rec-dev-est-2022	-1.3828	0.3457
329	Logit-rec-prop-est-1975	-0.0825	0.4201
330	Logit-rec-prop-est-1976	-0.7944	0.5136
331	Logit-rec-prop-est-1977	-0.2159	0.3595
332	Logit-rec-prop-est-1978	-0.3880	0.2657
333	Logit-rec-prop-est-1979	0.2034	0.2559
334	Logit-rec-prop-est-1980	0.3466	0.3362
335	Logit-rec-prop-est-1981	0.4782	0.1426
336	Logit-rec-prop-est-1982	0.5650	0.2373
337	Logit-rec-prop-est-1983	0.0379	0.1744
338	Logit-rec-prop-est-1984	0.4274	0.4370
339	Logit-rec-prop-est-1985	-0.4809	0.1647
340	Logit-rec-prop-est-1986	0.1744	0.3978
341	Logit-rec-prop-est-1987	-0.1409	0.4463
342	Logit-rec-prop-est-1988	0.3680	0.3809
343	Logit-rec-prop-est-1989	-0.0938	0.1688
344	Logit-rec-prop-est-1990	0.1480	0.2312
345	Logit-rec-prop-est-1991	0.7606	0.7194
346	Logit-rec-prop-est-1992	0.2127	0.2809
347	Logit-rec-prop-est-1993	-0.3721	0.7001
348	Logit-rec-prop-est-1994	-0.3612	0.0888
349	Logit-rec-prop-est-1995	1.2126	0.5986
350	Logit-rec-prop-est-1996	0.3887	0.6422
351	Logit-rec-prop-est-1997	0.4605	0.3233
352	Logit-rec-prop-est-1998	-0.0966	0.1389
353	Logit-rec-prop-est-1999	0.2109	0.3501
354	Logit-rec-prop-est-2000	-0.5932	0.3974
355	Logit-rec-prop-est-2001	-0.5346	0.1235
356	Logit-rec-prop-est-2002	-0.4136	0.4131
357	Logit-rec-prop-est-2003	-0.1001	0.4309
358	Logit-rec-prop-est-2004	-0.4172	0.1415
359	Logit-rec-prop-est-2005	-0.1446	0.2218
360	Logit-rec-prop-est-2006	0.4178	0.2761
361	Logit-rec-prop-est-2007	-0.1220	0.3564
362	Logit-rec-prop-est-2008	-0.4880	0.3493
363	Logit-rec-prop-est-2009	-0.7218	0.2037
364	Logit-rec-prop-est-2010	-0.4455	0.3069
365	Logit-rec-prop-est-2011	-0.5328	0.3376
366	Logit-rec-prop-est-2012	-0.1993	0.3320
367	Logit-rec-prop-est-2013	-0.3440	0.4245
368	Logit-rec-prop-est-2014	-0.3811	0.3182

369	Logit-rec-prop-est-2015	0.2664	0.2081
370	Logit-rec-prop-est-2016	0.5493	0.4405
371	Logit-rec-prop-est-2017	0.6054	0.2787
372	Logit-rec-prop-est-2018	-0.1821	0.4569
373	Logit-rec-prop-est-2019	0.2945	0.4504
374	Logit-rec-prop-est-2020	0.5584	0.5280
375	Logit-rec-prop-est-2021	0.1423	0.3442
376	Logit-rec-prop-est-2022	-0.1831	0.5643
377	M-dev-est-par-1	1.4547	0.0315
378	Survey-q-survey-1	0.9380	0.0258
379	Log-add-cvt-survey-2	-0.9821	0.2863

Table 7: Summary of estimated model parameter values and standard deviations for model 24.0 for Bristol Bay red king crab.

Index	Name	Value	StdDev
1	M-base	0.2070	0.0049
2	M-female	0.1979	0.0173
3	Log(Rinitial)	19.9088	0.0474
4	Log(Rbar)	16.2820	0.1383
5	Recruitment-rb-males	0.7825	0.1768
6	Recruitment-rb-females	-0.7391	0.2381
7	Scaled-logN-for-male-mature-1-shell-1-class-2	1.0489	0.4278
8	Scaled-logN-for-male-mature-1-shell-1-class-3	0.7050	0.4768
9	Scaled-logN-for-male-mature-1-shell-1-class-4	0.9000	0.3393
10	Scaled-logN-for-male-mature-1-shell-1-class-5	0.7977	0.3083
11	Scaled-logN-for-male-mature-1-shell-1-class-6	0.6153	0.2978
12	Scaled-logN-for-male-mature-1-shell-1-class-7	0.5797	0.2756
13	Scaled-logN-for-male-mature-1-shell-1-class-8	0.3645	0.2782
14	Scaled-logN-for-male-mature-1-shell-1-class-9	0.3831	0.2637
15	Scaled-logN-for-male-mature-1-shell-1-class-10	0.3864	0.2575
16	Scaled-logN-for-male-mature-1-shell-1-class-11	0.1631	0.2780
17	Scaled-logN-for-male-mature-1-shell-1-class-12	0.0969	0.2746
18	Scaled-logN-for-male-mature-1-shell-1-class-13	0.0072	0.2814
19	Scaled-logN-for-male-mature-1-shell-1-class-14	0.0545	0.2655
20	Scaled-logN-for-male-mature-1-shell-1-class-15	-0.0645	0.2027
21	Scaled-logN-for-male-mature-1-shell-1-class-16	-0.2771	0.1960
22	Scaled-logN-for-male-mature-1-shell-1-class-17	-0.4311	0.1977
23	Scaled-logN-for-male-mature-1-shell-1-class-18	-0.7843	0.2116
24	Scaled-logN-for-male-mature-1-shell-1-class-19	-1.2420	0.2329
25	Scaled-logN-for-male-mature-1-shell-1-class-20	-1.2930	0.2341
26	Scaled-logN-for-female-mature-1-shell-1-class-1	1.3605	0.5549
27	Scaled-logN-for-female-mature-1-shell-1-class-2	1.5008	0.4433
28	Scaled-logN-for-female-mature-1-shell-1-class-3	1.4183	0.3689
29	Scaled-logN-for-female-mature-1-shell-1-class-4	1.1775	0.3453
30	Scaled-logN-for-female-mature-1-shell-1-class-5	1.1380	0.3074
31	Scaled-logN-for-female-mature-1-shell-1-class-6	0.6259	0.3348
32	Scaled-logN-for-female-mature-1-shell-1-class-7	0.2043	0.3715
33	Scaled-logN-for-female-mature-1-shell-1-class-8	-0.0375	0.3667
34	Scaled-logN-for-female-mature-1-shell-1-class-9	-0.2297	0.3541
35	Scaled-logN-for-female-mature-1-shell-1-class-10	-0.5643	0.3696
36	Scaled-logN-for-female-mature-1-shell-1-class-11	-0.9610	0.3813
37	Scaled-logN-for-female-mature-1-shell-1-class-12	-1.2189	0.3833
38	Scaled-logN-for-female-mature-1-shell-1-class-13	-1.4498	0.3821
39	Scaled-logN-for-female-mature-1-shell-1-class-14	-1.8345	0.3707
40	Scaled-logN-for-female-mature-1-shell-1-class-15	-1.9243	0.3686
41	Scaled-logN-for-female-mature-1-shell-1-class-16	-1.8457	0.3509
42	Gscale-male-period-1	1.0302	0.2144
43	Gscale-female-period-1	1.3817	0.1268
44	Molt-probability-mu-male-period-1	143.1532	1.5414
45	Molt-probability-CV-male-period-1	0.0509	0.0082
46	Molt-probability-mu-male-period-2	141.7649	0.5451
47	Molt-probability-CV-male-period-2	0.0639	0.0030
48	Sel-Pot-Fishery-male-period-1-par-1	4.7733	0.0083
49	Sel-Pot-Fishery-male-period-1-par-2	2.2707	0.0440
50	Sel-Pot-Fishery-female-period-1-par-1	4.5349	0.0179

51	Sel-Pot-Fishery-female-period-1-par-2	2.1257	0.1016
52	Sel-Trawl-Bycatch-male-period-1-par-1	5.1522	0.0544
53	Sel-Trawl-Bycatch-male-period-1-par-2	2.8175	0.0434
54	Sel-Bairdi-Fishery-Bycatch-male-period-1-par-1	4.7385	0.2180
55	Sel-Bairdi-Fishery-Bycatch-male-period-1-par-2	2.1635	0.3060
56	Sel-Bairdi-Fishery-Bycatch-female-period-1-par-1	4.7279	0.0829
57	Sel-Bairdi-Fishery-Bycatch-female-period-1-par-2	0.9005	0.3031
58	Sel-Fixed-Gear-male-period-1-par-1	4.8054	0.0232
59	Sel-Fixed-Gear-male-period-1-par-2	2.3471	0.0816
60	Sel-NMFS-Trawl-male-period-1-par-1	-1.9156	0.0971
61	Sel-NMFS-Trawl-male-period-1-par-2	-1.6589	0.1156
62	Sel-NMFS-Trawl-male-period-1-par-3	-1.2592	0.0888
63	Sel-NMFS-Trawl-male-period-1-par-4	-0.9430	0.0601
64	Sel-NMFS-Trawl-male-period-1-par-5	-0.7669	0.0476
65	Sel-NMFS-Trawl-male-period-1-par-6	-0.5653	0.0403
66	Sel-NMFS-Trawl-male-period-1-par-7	-0.4279	0.0366
67	Sel-NMFS-Trawl-male-period-1-par-8	-0.2715	0.0324
68	Sel-NMFS-Trawl-male-period-1-par-9	-0.1839	0.0296
69	Sel-NMFS-Trawl-male-period-1-par-10	-0.1086	0.0283
70	Sel-NMFS-Trawl-male-period-1-par-11	-0.0841	0.0286
71	Sel-NMFS-Trawl-male-period-1-par-12	-0.0181	0.0278
72	Sel-NMFS-Trawl-male-period-1-par-13	-0.0096	0.0283
73	Sel-NMFS-Trawl-male-period-1-par-14	0.0400	0.0285
74	Sel-NMFS-Trawl-male-period-1-par-15	0.0177	0.0302
75	Sel-NMFS-Trawl-male-period-1-par-16	-0.0435	0.0329
76	Sel-NMFS-Trawl-male-period-1-par-17	-0.0280	0.0374
77	Sel-NMFS-Trawl-male-period-1-par-18	-0.0302	0.0418
78	Sel-NMFS-Trawl-male-period-1-par-19	-0.0734	0.0508
79	Sel-NMFS-Trawl-male-period-1-par-20	0.0284	0.0497
80	Ret-Pot-Fishery-male-period-1-par-1	4.9230	0.0015
81	Ret-Pot-Fishery-male-period-1-par-2	0.6727	0.0535
82	Ret-Pot-Fishery-male-period-2-par-1	4.9322	0.0020
83	Ret-Pot-Fishery-male-period-2-par-2	0.7188	0.0992
84	Log-fbar-Pot-Fishery	-1.6138	0.0378
85	Log-fbar-Trawl-Bycatch	-4.2692	0.0731
86	Log-fbar-Bairdi-Fishery-Bycatch	-5.5354	0.3260
87	Log-fbar-Fixed-Gear	-6.4161	0.0707
88	Log-fdev-Pot-Fishery-year-1975-season-3	0.8529	0.1193
89	Log-fdev-Pot-Fishery-year-1976-season-3	0.8251	0.0898
90	Log-fdev-Pot-Fishery-year-1977-season-3	0.7388	0.0736
91	Log-fdev-Pot-Fishery-year-1978-season-3	0.8155	0.0598
92	Log-fdev-Pot-Fishery-year-1979-season-3	1.0182	0.0529
93	Log-fdev-Pot-Fishery-year-1980-season-3	1.8874	0.0549
94	Log-fdev-Pot-Fishery-year-1981-season-3	2.4651	0.1170
95	Log-fdev-Pot-Fishery-year-1982-season-3	0.9114	0.1646
96	Log-fdev-Pot-Fishery-year-1983-season-3	-8.7939	0.1134
97	Log-fdev-Pot-Fishery-year-1984-season-3	1.3153	0.1058
98	Log-fdev-Pot-Fishery-year-1985-season-3	1.3833	0.0905
99	Log-fdev-Pot-Fishery-year-1986-season-3	1.5070	0.0772
100	Log-fdev-Pot-Fishery-year-1987-season-3	1.0201	0.0669
101	Log-fdev-Pot-Fishery-year-1988-season-3	0.0574	0.0545
102	Log-fdev-Pot-Fishery-year-1989-season-3	0.1657	0.0483
103	Log-fdev-Pot-Fishery-year-1990-season-3	0.8155	0.0391

104	Log-fdev-Pot-Fishery-year-1991-season-3	0.8334	0.0421
105	Log-fdev-Pot-Fishery-year-1992-season-3	0.3304	0.0470
106	Log-fdev-Pot-Fishery-year-1993-season-3	1.0053	0.0519
107	Log-fdev-Pot-Fishery-year-1994-season-3	-4.1618	0.0496
108	Log-fdev-Pot-Fishery-year-1995-season-3	-4.5826	0.0426
109	Log-fdev-Pot-Fishery-year-1996-season-3	-0.1037	0.0409
110	Log-fdev-Pot-Fishery-year-1997-season-3	-0.0403	0.0413
111	Log-fdev-Pot-Fishery-year-1998-season-3	0.8844	0.0443
112	Log-fdev-Pot-Fishery-year-1999-season-3	0.5128	0.0438
113	Log-fdev-Pot-Fishery-year-2000-season-3	-0.0801	0.0420
114	Log-fdev-Pot-Fishery-year-2001-season-3	-0.1511	0.0415
115	Log-fdev-Pot-Fishery-year-2002-season-3	-0.0379	0.0402
116	Log-fdev-Pot-Fishery-year-2003-season-3	0.4167	0.0388
117	Log-fdev-Pot-Fishery-year-2004-season-3	0.3724	0.0389
118	Log-fdev-Pot-Fishery-year-2005-season-3	0.6667	0.0395
119	Log-fdev-Pot-Fishery-year-2006-season-3	0.4096	0.0388
120	Log-fdev-Pot-Fishery-year-2007-season-3	0.7747	0.0388
121	Log-fdev-Pot-Fishery-year-2008-season-3	0.9567	0.0410
122	Log-fdev-Pot-Fishery-year-2009-season-3	0.7778	0.0421
123	Log-fdev-Pot-Fishery-year-2010-season-3	0.6512	0.0416
124	Log-fdev-Pot-Fishery-year-2011-season-3	0.0158	0.0400
125	Log-fdev-Pot-Fishery-year-2012-season-3	-0.0574	0.0387
126	Log-fdev-Pot-Fishery-year-2013-season-3	0.1372	0.0382
127	Log-fdev-Pot-Fishery-year-2014-season-3	0.4726	0.0381
128	Log-fdev-Pot-Fishery-year-2015-season-3	0.5498	0.0392
129	Log-fdev-Pot-Fishery-year-2016-season-3	0.5697	0.0428
130	Log-fdev-Pot-Fishery-year-2017-season-3	0.5184	0.0495
131	Log-fdev-Pot-Fishery-year-2018-season-3	0.3688	0.0583
132	Log-fdev-Pot-Fishery-year-2019-season-3	0.3387	0.0663
133	Log-fdev-Pot-Fishery-year-2020-season-3	-0.0998	0.0703
134	Log-fdev-Pot-Fishery-year-2021-season-3	-4.5667	0.0702
135	Log-fdev-Pot-Fishery-year-2022-season-3	-4.6665	0.0696
136	Log-fdev-Trawl-Bycatch-year-1976-season-5	0.1988	0.1243
137	Log-fdev-Trawl-Bycatch-year-1977-season-5	0.6362	0.1159
138	Log-fdev-Trawl-Bycatch-year-1978-season-5	0.6061	0.1101
139	Log-fdev-Trawl-Bycatch-year-1979-season-5	0.6737	0.1084
140	Log-fdev-Trawl-Bycatch-year-1980-season-5	1.4034	0.1107
141	Log-fdev-Trawl-Bycatch-year-1981-season-5	1.2077	0.1259
142	Log-fdev-Trawl-Bycatch-year-1982-season-5	2.5033	0.1255
143	Log-fdev-Trawl-Bycatch-year-1983-season-5	2.2373	0.1153
144	Log-fdev-Trawl-Bycatch-year-1984-season-5	3.4974	0.1143
145	Log-fdev-Trawl-Bycatch-year-1985-season-5	2.2926	0.1121
146	Log-fdev-Trawl-Bycatch-year-1986-season-5	1.2117	0.1126
147	Log-fdev-Trawl-Bycatch-year-1987-season-5	0.7334	0.1102
148	Log-fdev-Trawl-Bycatch-year-1988-season-5	1.4824	0.1052
149	Log-fdev-Trawl-Bycatch-year-1989-season-5	0.0387	0.1040
150	Log-fdev-Trawl-Bycatch-year-1990-season-5	0.4939	0.1040
151	Log-fdev-Trawl-Bycatch-year-1991-season-5	0.9239	0.1054
152	Log-fdev-Trawl-Bycatch-year-1992-season-5	0.7674	0.1056
153	Log-fdev-Trawl-Bycatch-year-1993-season-5	1.2587	0.1085
154	Log-fdev-Trawl-Bycatch-year-1994-season-5	-0.5238	0.1054
155	Log-fdev-Trawl-Bycatch-year-1995-season-5	-0.8250	0.1037
156	Log-fdev-Trawl-Bycatch-year-1996-season-5	-0.7531	0.1038

157	Log-fdev-Trawl-Bycatch-year-1997-season-5	-1.2059	0.1037
158	Log-fdev-Trawl-Bycatch-year-1998-season-5	0.1106	0.1042
159	Log-fdev-Trawl-Bycatch-year-1999-season-5	-0.1762	0.1041
160	Log-fdev-Trawl-Bycatch-year-2000-season-5	-0.9500	0.1034
161	Log-fdev-Trawl-Bycatch-year-2001-season-5	-0.1811	0.1032
162	Log-fdev-Trawl-Bycatch-year-2002-season-5	-0.4767	0.1028
163	Log-fdev-Trawl-Bycatch-year-2003-season-5	-0.5724	0.1026
164	Log-fdev-Trawl-Bycatch-year-2004-season-5	-0.3439	0.1026
165	Log-fdev-Trawl-Bycatch-year-2005-season-5	-0.6170	0.1025
166	Log-fdev-Trawl-Bycatch-year-2006-season-5	-0.4538	0.1022
167	Log-fdev-Trawl-Bycatch-year-2007-season-5	-0.3773	0.1023
168	Log-fdev-Trawl-Bycatch-year-2008-season-5	-0.3939	0.1027
169	Log-fdev-Trawl-Bycatch-year-2009-season-5	-0.7459	0.1028
170	Log-fdev-Trawl-Bycatch-year-2010-season-5	-0.8928	0.1027
171	Log-fdev-Trawl-Bycatch-year-2011-season-5	-1.3577	0.1023
172	Log-fdev-Trawl-Bycatch-year-2012-season-5	-1.8760	0.1024
173	Log-fdev-Trawl-Bycatch-year-2013-season-5	-1.1529	0.1025
174	Log-fdev-Trawl-Bycatch-year-2014-season-5	-1.7056	0.1025
175	Log-fdev-Trawl-Bycatch-year-2015-season-5	-1.3121	0.1030
176	Log-fdev-Trawl-Bycatch-year-2016-season-5	-0.7700	0.1040
177	Log-fdev-Trawl-Bycatch-year-2017-season-5	-0.3111	0.1057
178	Log-fdev-Trawl-Bycatch-year-2018-season-5	-0.3490	0.1077
179	Log-fdev-Trawl-Bycatch-year-2019-season-5	-0.2320	0.1102
180	Log-fdev-Trawl-Bycatch-year-2020-season-5	-0.2562	0.1124
181	Log-fdev-Trawl-Bycatch-year-2021-season-5	-1.2562	0.1133
182	Log-fdev-Trawl-Bycatch-year-2022-season-5	-2.2097	0.1149
183	Log-fdev-Bairdi-Fishery-Bycatch-year-1975-season-5	-0.1163	0.0682
184	Log-fdev-Bairdi-Fishery-Bycatch-year-1976-season-5	0.6699	0.0682
185	Log-fdev-Bairdi-Fishery-Bycatch-year-1977-season-5	1.2282	0.0682
186	Log-fdev-Bairdi-Fishery-Bycatch-year-1978-season-5	1.0926	0.0682
187	Log-fdev-Bairdi-Fishery-Bycatch-year-1979-season-5	1.3823	0.0682
188	Log-fdev-Bairdi-Fishery-Bycatch-year-1980-season-5	1.4242	0.0682
189	Log-fdev-Bairdi-Fishery-Bycatch-year-1981-season-5	0.9927	0.0682
190	Log-fdev-Bairdi-Fishery-Bycatch-year-1982-season-5	0.4765	0.0682
191	Log-fdev-Bairdi-Fishery-Bycatch-year-1983-season-5	-0.9874	0.0682
192	Log-fdev-Bairdi-Fishery-Bycatch-year-1984-season-5	-0.5787	0.0682
193	Log-fdev-Bairdi-Fishery-Bycatch-year-1987-season-5	-1.0994	0.0682
194	Log-fdev-Bairdi-Fishery-Bycatch-year-1988-season-5	-0.2563	0.0682
195	Log-fdev-Bairdi-Fishery-Bycatch-year-1989-season-5	0.9400	0.0682
196	Log-fdev-Bairdi-Fishery-Bycatch-year-1990-season-5	1.4181	0.0682
197	Log-fdev-Bairdi-Fishery-Bycatch-year-1991-season-5	3.2286	0.0779
198	Log-fdev-Bairdi-Fishery-Bycatch-year-1992-season-5	1.2822	0.0967
199	Log-fdev-Bairdi-Fishery-Bycatch-year-1993-season-5	0.5829	0.1357
200	Log-fdev-Bairdi-Fishery-Bycatch-year-1994-season-5	-0.7750	0.0817
201	Log-fdev-Bairdi-Fishery-Bycatch-year-2006-season-5	-2.1574	0.0751
202	Log-fdev-Bairdi-Fishery-Bycatch-year-2007-season-5	-2.9992	0.0882
203	Log-fdev-Bairdi-Fishery-Bycatch-year-2008-season-5	-2.4075	0.1171
204	Log-fdev-Bairdi-Fishery-Bycatch-year-2009-season-5	-3.4887	0.0802
205	Log-fdev-Bairdi-Fishery-Bycatch-year-2013-season-5	-0.8377	0.0942
206	Log-fdev-Bairdi-Fishery-Bycatch-year-2014-season-5	-0.1064	0.1138
207	Log-fdev-Bairdi-Fishery-Bycatch-year-2015-season-5	1.0915	0.1435
208	Log-fdev-Fixed-Gear-year-1996-season-5	0.5257	0.1033
209	Log-fdev-Fixed-Gear-year-1997-season-5	-0.1244	0.1023

210	Log-fdev-Fixed-Gear-year-1998-season-5	-0.3301	0.1031
211	Log-fdev-Fixed-Gear-year-1999-season-5	0.5807	0.1023
212	Log-fdev-Fixed-Gear-year-2000-season-5	-1.8539	0.1016
213	Log-fdev-Fixed-Gear-year-2001-season-5	0.1022	0.1012
214	Log-fdev-Fixed-Gear-year-2002-season-5	-0.1582	0.1007
215	Log-fdev-Fixed-Gear-year-2003-season-5	-0.9956	0.1007
216	Log-fdev-Fixed-Gear-year-2004-season-5	-0.8222	0.1005
217	Log-fdev-Fixed-Gear-year-2005-season-5	-0.5488	0.1004
218	Log-fdev-Fixed-Gear-year-2006-season-5	-0.6012	0.1001
219	Log-fdev-Fixed-Gear-year-2007-season-5	-0.0502	0.1002
220	Log-fdev-Fixed-Gear-year-2008-season-5	-0.7405	0.1007
221	Log-fdev-Fixed-Gear-year-2009-season-5	-1.7348	0.1005
222	Log-fdev-Fixed-Gear-year-2010-season-5	-2.5701	0.1000
223	Log-fdev-Fixed-Gear-year-2011-season-5	-1.0914	0.0996
224	Log-fdev-Fixed-Gear-year-2012-season-5	-0.5318	0.0996
225	Log-fdev-Fixed-Gear-year-2013-season-5	0.6153	0.0994
226	Log-fdev-Fixed-Gear-year-2014-season-5	1.4736	0.0995
227	Log-fdev-Fixed-Gear-year-2015-season-5	1.1675	0.0998
228	Log-fdev-Fixed-Gear-year-2016-season-5	0.3533	0.1004
229	Log-fdev-Fixed-Gear-year-2017-season-5	1.9749	0.1015
230	Log-fdev-Fixed-Gear-year-2018-season-5	2.2524	0.1025
231	Log-fdev-Fixed-Gear-year-2019-season-5	1.0658	0.1040
232	Log-fdev-Fixed-Gear-year-2020-season-5	0.8651	0.1058
233	Log-fdev-Fixed-Gear-year-2021-season-5	0.8500	0.1072
234	Log-fdev-Fixed-Gear-year-2022-season-5	0.3268	0.1095
235	Log-foff-Pot-Fishery	-2.7811	0.0443
236	Log-foff-Bairdi-Fishery-Bycatch	-0.2159	0.4442
237	Log-fdov-Pot-Fishery-year-1990-season-3	1.9640	0.0842
238	Log-fdov-Pot-Fishery-year-1991-season-3	-0.7059	0.0835
239	Log-fdov-Pot-Fishery-year-1992-season-3	1.9593	0.0850
240	Log-fdov-Pot-Fishery-year-1993-season-3	1.7855	0.0868
241	Log-fdov-Pot-Fishery-year-1994-season-3	-0.4303	0.0854
242	Log-fdov-Pot-Fishery-year-1995-season-3	-0.1885	0.0829
243	Log-fdov-Pot-Fishery-year-1996-season-3	-3.6856	0.0817
244	Log-fdov-Pot-Fishery-year-1997-season-3	-0.3384	0.0826
245	Log-fdov-Pot-Fishery-year-1998-season-3	1.4213	0.0833
246	Log-fdov-Pot-Fishery-year-1999-season-3	-2.8012	0.0824
247	Log-fdov-Pot-Fishery-year-2000-season-3	1.1345	0.0813
248	Log-fdov-Pot-Fishery-year-2001-season-3	0.8500	0.0813
249	Log-fdov-Pot-Fishery-year-2002-season-3	-1.9019	0.0806
250	Log-fdov-Pot-Fishery-year-2003-season-3	1.1931	0.0805
251	Log-fdov-Pot-Fishery-year-2004-season-3	0.3983	0.0808
252	Log-fdov-Pot-Fishery-year-2005-season-3	0.9156	0.0803
253	Log-fdov-Pot-Fishery-year-2006-season-3	-1.2585	0.0797
254	Log-fdov-Pot-Fishery-year-2007-season-3	-0.2151	0.0797
255	Log-fdov-Pot-Fishery-year-2008-season-3	-0.4855	0.0803
256	Log-fdov-Pot-Fishery-year-2009-season-3	-0.7547	0.0806
257	Log-fdov-Pot-Fishery-year-2010-season-3	-0.2724	0.0805
258	Log-fdov-Pot-Fishery-year-2011-season-3	-1.1562	0.0796
259	Log-fdov-Pot-Fishery-year-2012-season-3	-1.8656	0.0790
260	Log-fdov-Pot-Fishery-year-2013-season-3	0.1534	0.0789
261	Log-fdov-Pot-Fishery-year-2014-season-3	-0.2552	0.0789
262	Log-fdov-Pot-Fishery-year-2015-season-3	0.8021	0.0793

263	Log-fdov-Pot-Fishery-year-2016-season-3	0.2384	0.0804
264	Log-fdov-Pot-Fishery-year-2017-season-3	-0.4442	0.0826
265	Log-fdov-Pot-Fishery-year-2018-season-3	0.8485	0.0859
266	Log-fdov-Pot-Fishery-year-2019-season-3	-0.2456	0.0890
267	Log-fdov-Pot-Fishery-year-2020-season-3	-0.7572	0.0902
268	Log-fdov-Pot-Fishery-year-2021-season-3	2.8623	0.0901
269	Log-fdov-Pot-Fishery-year-2022-season-3	1.2310	0.0903
270	Log-fdov-Bairdi-Fishery-Bycatch-year-1975-season-5	-0.0001	0.0962
271	Log-fdov-Bairdi-Fishery-Bycatch-year-1976-season-5	0.0001	0.0962
272	Log-fdov-Bairdi-Fishery-Bycatch-year-1977-season-5	0.0004	0.0962
273	Log-fdov-Bairdi-Fishery-Bycatch-year-1978-season-5	0.0003	0.0963
274	Log-fdov-Bairdi-Fishery-Bycatch-year-1979-season-5	0.0006	0.0963
275	Log-fdov-Bairdi-Fishery-Bycatch-year-1980-season-5	0.0002	0.0963
276	Log-fdov-Bairdi-Fishery-Bycatch-year-1981-season-5	-0.0001	0.0963
277	Log-fdov-Bairdi-Fishery-Bycatch-year-1982-season-5	-0.0002	0.0962
278	Log-fdov-Bairdi-Fishery-Bycatch-year-1983-season-5	-0.0002	0.0962
279	Log-fdov-Bairdi-Fishery-Bycatch-year-1984-season-5	-0.0001	0.0962
280	Log-fdov-Bairdi-Fishery-Bycatch-year-1987-season-5	-0.0001	0.0962
281	Log-fdov-Bairdi-Fishery-Bycatch-year-1988-season-5	0.0001	0.0962
282	Log-fdov-Bairdi-Fishery-Bycatch-year-1989-season-5	0.0004	0.0962
283	Log-fdov-Bairdi-Fishery-Bycatch-year-1990-season-5	0.0008	0.0963
284	Log-fdov-Bairdi-Fishery-Bycatch-year-1991-season-5	1.5272	0.1425
285	Log-fdov-Bairdi-Fishery-Bycatch-year-1992-season-5	1.8097	0.1207
286	Log-fdov-Bairdi-Fishery-Bycatch-year-1993-season-5	0.5886	0.1543
287	Log-fdov-Bairdi-Fishery-Bycatch-year-1994-season-5	-3.4069	0.1085
288	Log-fdov-Bairdi-Fishery-Bycatch-year-2006-season-5	-2.1575	0.1584
289	Log-fdov-Bairdi-Fishery-Bycatch-year-2007-season-5	-0.7996	0.1196
290	Log-fdov-Bairdi-Fishery-Bycatch-year-2008-season-5	0.0111	0.1369
291	Log-fdov-Bairdi-Fishery-Bycatch-year-2009-season-5	0.3578	0.1063
292	Log-fdov-Bairdi-Fishery-Bycatch-year-2013-season-5	0.9749	0.1593
293	Log-fdov-Bairdi-Fishery-Bycatch-year-2014-season-5	0.1869	0.1481
294	Log-fdov-Bairdi-Fishery-Bycatch-year-2015-season-5	0.9057	0.1767
295	Rec-dev-est-1975	1.1858	0.2376
296	Rec-dev-est-1976	0.7182	0.2779
297	Rec-dev-est-1977	1.1448	0.2291
298	Rec-dev-est-1978	1.7155	0.2001
299	Rec-dev-est-1979	1.9628	0.1978
300	Rec-dev-est-1980	1.1423	0.2379
301	Rec-dev-est-1981	2.4411	0.1619
302	Rec-dev-est-1982	1.4952	0.1769
303	Rec-dev-est-1983	1.1160	0.1644
304	Rec-dev-est-1984	-0.6928	0.2379
305	Rec-dev-est-1985	0.3626	0.1599
306	Rec-dev-est-1986	-0.7480	0.2325
307	Rec-dev-est-1987	-1.1960	0.2616
308	Rec-dev-est-1988	-0.9446	0.2199
309	Rec-dev-est-1989	-0.0324	0.1622
310	Rec-dev-est-1990	-0.4505	0.1798
311	Rec-dev-est-1991	-1.8417	0.3333
312	Rec-dev-est-1992	-0.8291	0.1919
313	Rec-dev-est-1993	-1.9686	0.4034
314	Rec-dev-est-1994	1.0077	0.1449
315	Rec-dev-est-1995	-0.7442	0.2510

316	Rec-dev-est-1996	-1.4980	0.3256
317	Rec-dev-est-1997	-0.5127	0.1941
318	Rec-dev-est-1998	0.4758	0.1529
319	Rec-dev-est-1999	-0.4496	0.2138
320	Rec-dev-est-2000	-0.4833	0.2387
321	Rec-dev-est-2001	0.9129	0.1523
322	Rec-dev-est-2002	-0.5494	0.2547
323	Rec-dev-est-2003	-0.5420	0.2455
324	Rec-dev-est-2004	0.6351	0.1564
325	Rec-dev-est-2005	-0.2507	0.2026
326	Rec-dev-est-2006	-0.3919	0.1915
327	Rec-dev-est-2007	-0.9927	0.2397
328	Rec-dev-est-2008	-0.9689	0.2369
329	Rec-dev-est-2009	-0.0256	0.1835
330	Rec-dev-est-2010	-0.4403	0.2048
331	Rec-dev-est-2011	-1.1424	0.2418
332	Rec-dev-est-2012	-1.3366	0.2210
333	Rec-dev-est-2013	-1.8442	0.2725
334	Rec-dev-est-2014	-1.5043	0.2409
335	Rec-dev-est-2015	-0.7712	0.1722
336	Rec-dev-est-2016	-1.6255	0.2424
337	Rec-dev-est-2017	-0.9071	0.1862
338	Rec-dev-est-2018	-1.6488	0.2714
339	Rec-dev-est-2019	-1.6094	0.2618
340	Rec-dev-est-2020	-1.7638	0.2814
341	Rec-dev-est-2021	-1.0454	0.2324
342	Rec-dev-est-2022	-1.5020	0.3410
343	Logit-rec-prop-est-1975	-0.0459	0.3766
344	Logit-rec-prop-est-1976	-0.8836	0.5192
345	Logit-rec-prop-est-1977	-0.2687	0.3448
346	Logit-rec-prop-est-1978	-0.4320	0.2654
347	Logit-rec-prop-est-1979	0.1848	0.2511
348	Logit-rec-prop-est-1980	0.2561	0.3314
349	Logit-rec-prop-est-1981	0.4640	0.1371
350	Logit-rec-prop-est-1982	0.4951	0.2290
351	Logit-rec-prop-est-1983	0.0655	0.1729
352	Logit-rec-prop-est-1984	0.3817	0.4128
353	Logit-rec-prop-est-1985	-0.3948	0.1600
354	Logit-rec-prop-est-1986	0.2814	0.3872
355	Logit-rec-prop-est-1987	-0.0644	0.4305
356	Logit-rec-prop-est-1988	0.3568	0.3571
357	Logit-rec-prop-est-1989	-0.0462	0.1666
358	Logit-rec-prop-est-1990	0.2287	0.2326
359	Logit-rec-prop-est-1991	0.5912	0.6289
360	Logit-rec-prop-est-1992	0.3026	0.2755
361	Logit-rec-prop-est-1993	-0.5947	0.6354
362	Logit-rec-prop-est-1994	-0.3087	0.0895
363	Logit-rec-prop-est-1995	1.2797	0.5525
364	Logit-rec-prop-est-1996	0.3272	0.5797
365	Logit-rec-prop-est-1997	0.4406	0.3022
366	Logit-rec-prop-est-1998	-0.0393	0.1373
367	Logit-rec-prop-est-1999	0.2715	0.3335
368	Logit-rec-prop-est-2000	-0.6806	0.3843

369	Logit-rec-prop-est-2001	-0.4552	0.1216
370	Logit-rec-prop-est-2002	-0.3763	0.4149
371	Logit-rec-prop-est-2003	-0.1292	0.3955
372	Logit-rec-prop-est-2004	-0.4696	0.1463
373	Logit-rec-prop-est-2005	0.1761	0.3077
374	Logit-rec-prop-est-2006	0.3269	0.2893
375	Logit-rec-prop-est-2007	-0.1131	0.3798
376	Logit-rec-prop-est-2008	-0.3802	0.3658
377	Logit-rec-prop-est-2009	-0.7023	0.2112
378	Logit-rec-prop-est-2010	-0.4366	0.2817
379	Logit-rec-prop-est-2011	-0.4409	0.3703
380	Logit-rec-prop-est-2012	-0.4314	0.3313
381	Logit-rec-prop-est-2013	-0.1748	0.4477
382	Logit-rec-prop-est-2014	-0.4769	0.3688
383	Logit-rec-prop-est-2015	0.2961	0.2167
384	Logit-rec-prop-est-2016	0.5049	0.4350
385	Logit-rec-prop-est-2017	0.6692	0.2705
386	Logit-rec-prop-est-2018	-0.2056	0.4489
387	Logit-rec-prop-est-2019	0.3472	0.4424
388	Logit-rec-prop-est-2020	0.4573	0.4892
389	Logit-rec-prop-est-2021	0.1010	0.3467
390	Logit-rec-prop-est-2022	-0.2547	0.5608
391	M-dev-est-par-1	1.5302	0.0280

Table 8: Summary of estimated model parameter values and standard deviations for model 24.0c for Bristol Bay red king crab.

Index	Name	Value	StdDev
1	M-base	0.2319	0.0065
2	M-female	0.1499	0.0184
3	Log(Rinitial)	20.0449	0.0564
4	Log(Rbar)	16.5088	0.1436
5	Recruitment-rb-males	0.7694	0.1272
6	Recruitment-rb-females	-0.5868	0.2142
7	Scaled-logN-for-male-mature-1-shell-1-class-2	1.0593	0.4355
8	Scaled-logN-for-male-mature-1-shell-1-class-3	0.7217	0.4872
9	Scaled-logN-for-male-mature-1-shell-1-class-4	0.9359	0.3379
10	Scaled-logN-for-male-mature-1-shell-1-class-5	0.7618	0.3100
11	Scaled-logN-for-male-mature-1-shell-1-class-6	0.5702	0.2995
12	Scaled-logN-for-male-mature-1-shell-1-class-7	0.5207	0.2787
13	Scaled-logN-for-male-mature-1-shell-1-class-8	0.3578	0.2778
14	Scaled-logN-for-male-mature-1-shell-1-class-9	0.3862	0.2641
15	Scaled-logN-for-male-mature-1-shell-1-class-10	0.4099	0.2563
16	Scaled-logN-for-male-mature-1-shell-1-class-11	0.1875	0.2743
17	Scaled-logN-for-male-mature-1-shell-1-class-12	0.1685	0.2681
18	Scaled-logN-for-male-mature-1-shell-1-class-13	0.0547	0.2766
19	Scaled-logN-for-male-mature-1-shell-1-class-14	0.1590	0.2518
20	Scaled-logN-for-male-mature-1-shell-1-class-15	-0.0245	0.1982
21	Scaled-logN-for-male-mature-1-shell-1-class-16	-0.2835	0.1912
22	Scaled-logN-for-male-mature-1-shell-1-class-17	-0.4480	0.1937
23	Scaled-logN-for-male-mature-1-shell-1-class-18	-0.7971	0.2076
24	Scaled-logN-for-male-mature-1-shell-1-class-19	-1.2596	0.2289
25	Scaled-logN-for-male-mature-1-shell-1-class-20	-1.3201	0.2290
26	Scaled-logN-for-female-mature-1-shell-1-class-1	1.3592	0.7333
27	Scaled-logN-for-female-mature-1-shell-1-class-2	1.5169	0.4879
28	Scaled-logN-for-female-mature-1-shell-1-class-3	1.4134	0.3811
29	Scaled-logN-for-female-mature-1-shell-1-class-4	1.1670	0.3510
30	Scaled-logN-for-female-mature-1-shell-1-class-5	1.0919	0.3033
31	Scaled-logN-for-female-mature-1-shell-1-class-6	0.6263	0.3245
32	Scaled-logN-for-female-mature-1-shell-1-class-7	0.2154	0.3602
33	Scaled-logN-for-female-mature-1-shell-1-class-8	-0.0252	0.3631
34	Scaled-logN-for-female-mature-1-shell-1-class-9	-0.2213	0.3534
35	Scaled-logN-for-female-mature-1-shell-1-class-10	-0.5672	0.3718
36	Scaled-logN-for-female-mature-1-shell-1-class-11	-0.9599	0.3822
37	Scaled-logN-for-female-mature-1-shell-1-class-12	-1.2195	0.3864
38	Scaled-logN-for-female-mature-1-shell-1-class-13	-1.4507	0.3848
39	Scaled-logN-for-female-mature-1-shell-1-class-14	-1.8284	0.3734
40	Scaled-logN-for-female-mature-1-shell-1-class-15	-1.9355	0.3695
41	Scaled-logN-for-female-mature-1-shell-1-class-16	-1.8820	0.3496
42	Gscale-male-period-1	0.9872	0.1875
43	Gscale-female-period-1	1.3988	0.1226
44	Molt-probability-mu-male-period-1	141.4071	0.5857
45	Molt-probability-CV-male-period-1	0.0673	0.0032
46	Sel-Pot-Fishery-male-period-1-par-1	4.7805	0.0082
47	Sel-Pot-Fishery-male-period-1-par-2	2.2733	0.0422
48	Sel-Pot-Fishery-female-period-1-par-1	4.5656	0.0189
49	Sel-Pot-Fishery-female-period-1-par-2	2.2330	0.0907
50	Sel-Trawl-Bycatch-male-period-1-par-1	5.1342	0.0453

51	Sel-Trawl-Bycatch-male-period-1-par-2	2.7854	0.0402
52	Sel-Bairdi-Fishery-Bycatch-male-period-1-par-1	4.7163	0.2354
53	Sel-Bairdi-Fishery-Bycatch-male-period-1-par-2	2.1674	0.3046
54	Sel-Bairdi-Fishery-Bycatch-female-period-1-par-1	4.7357	0.0905
55	Sel-Bairdi-Fishery-Bycatch-female-period-1-par-2	0.9030	0.3027
56	Sel-Fixed-Gear-male-period-1-par-1	4.8079	0.0215
57	Sel-Fixed-Gear-male-period-1-par-2	2.3302	0.0765
58	Sel-NMFS-Trawl-male-period-1-par-1	4.1526	0.1200
59	Sel-NMFS-Trawl-male-period-1-par-2	2.2173	0.3441
60	Sel-NMFS-Trawl-male-period-2-par-1	4.0776	0.2482
61	Sel-NMFS-Trawl-male-period-2-par-2	3.5278	0.3688
62	Sel-BSFRF-male-period-1-par-1	4.4673	0.0273
63	Sel-BSFRF-male-period-1-par-2	2.5638	0.0773
64	Ret-Pot-Fishery-male-period-1-par-1	4.9237	0.0015
65	Ret-Pot-Fishery-male-period-1-par-2	0.6805	0.0523
66	Ret-Pot-Fishery-male-period-2-par-1	4.9322	0.0020
67	Ret-Pot-Fishery-male-period-2-par-2	0.7209	0.0982
68	Log-fbar-Pot-Fishery	-1.7108	0.0440
69	Log-fbar-Trawl-Bycatch	-4.3759	0.0752
70	Log-fbar-Bairdi-Fishery-Bycatch	-5.7008	0.3287
71	Log-fbar-Fixed-Gear	-6.5286	0.0747
72	Log-fdev-Pot-Fishery-year-1975-season-3	0.8091	0.0904
73	Log-fdev-Pot-Fishery-year-1976-season-3	0.7903	0.0719
74	Log-fdev-Pot-Fishery-year-1977-season-3	0.7310	0.0632
75	Log-fdev-Pot-Fishery-year-1978-season-3	0.8484	0.0560
76	Log-fdev-Pot-Fishery-year-1979-season-3	1.0826	0.0546
77	Log-fdev-Pot-Fishery-year-1980-season-3	1.9751	0.0585
78	Log-fdev-Pot-Fishery-year-1981-season-3	2.5056	0.1147
79	Log-fdev-Pot-Fishery-year-1982-season-3	0.9456	0.1546
80	Log-fdev-Pot-Fishery-year-1983-season-3	-8.7103	0.1043
81	Log-fdev-Pot-Fishery-year-1984-season-3	1.4312	0.1009
82	Log-fdev-Pot-Fishery-year-1985-season-3	1.4795	0.0916
83	Log-fdev-Pot-Fishery-year-1986-season-3	1.5645	0.0775
84	Log-fdev-Pot-Fishery-year-1987-season-3	1.0533	0.0668
85	Log-fdev-Pot-Fishery-year-1988-season-3	0.0836	0.0545
86	Log-fdev-Pot-Fishery-year-1989-season-3	0.1911	0.0485
87	Log-fdev-Pot-Fishery-year-1990-season-3	0.8358	0.0396
88	Log-fdev-Pot-Fishery-year-1991-season-3	0.8414	0.0426
89	Log-fdev-Pot-Fishery-year-1992-season-3	0.3262	0.0472
90	Log-fdev-Pot-Fishery-year-1993-season-3	0.9856	0.0514
91	Log-fdev-Pot-Fishery-year-1994-season-3	-4.1825	0.0489
92	Log-fdev-Pot-Fishery-year-1995-season-3	-4.5824	0.0422
93	Log-fdev-Pot-Fishery-year-1996-season-3	-0.0936	0.0406
94	Log-fdev-Pot-Fishery-year-1997-season-3	-0.0266	0.0409
95	Log-fdev-Pot-Fishery-year-1998-season-3	0.8924	0.0436
96	Log-fdev-Pot-Fishery-year-1999-season-3	0.5114	0.0431
97	Log-fdev-Pot-Fishery-year-2000-season-3	-0.0790	0.0415
98	Log-fdev-Pot-Fishery-year-2001-season-3	-0.1437	0.0409
99	Log-fdev-Pot-Fishery-year-2002-season-3	-0.0242	0.0397
100	Log-fdev-Pot-Fishery-year-2003-season-3	0.4343	0.0385
101	Log-fdev-Pot-Fishery-year-2004-season-3	0.3912	0.0385
102	Log-fdev-Pot-Fishery-year-2005-season-3	0.6831	0.0391
103	Log-fdev-Pot-Fishery-year-2006-season-3	0.4266	0.0385

104	Log-fdev-Pot-Fishery-year-2007-season-3	0.7910	0.0385
105	Log-fdev-Pot-Fishery-year-2008-season-3	0.9603	0.0406
106	Log-fdev-Pot-Fishery-year-2009-season-3	0.7610	0.0418
107	Log-fdev-Pot-Fishery-year-2010-season-3	0.6157	0.0414
108	Log-fdev-Pot-Fishery-year-2011-season-3	-0.0230	0.0398
109	Log-fdev-Pot-Fishery-year-2012-season-3	-0.0876	0.0384
110	Log-fdev-Pot-Fishery-year-2013-season-3	0.1122	0.0381
111	Log-fdev-Pot-Fishery-year-2014-season-3	0.4436	0.0383
112	Log-fdev-Pot-Fishery-year-2015-season-3	0.5126	0.0400
113	Log-fdev-Pot-Fishery-year-2016-season-3	0.5159	0.0441
114	Log-fdev-Pot-Fishery-year-2017-season-3	0.4413	0.0508
115	Log-fdev-Pot-Fishery-year-2018-season-3	0.2750	0.0589
116	Log-fdev-Pot-Fishery-year-2019-season-3	0.2357	0.0657
117	Log-fdev-Pot-Fishery-year-2020-season-3	-0.1913	0.0682
118	Log-fdev-Pot-Fishery-year-2021-season-3	-4.6333	0.0676
119	Log-fdev-Pot-Fishery-year-2022-season-3	-4.7056	0.0674
120	Log-fdev-Trawl-Bycatch-year-1976-season-5	0.1595	0.1129
121	Log-fdev-Trawl-Bycatch-year-1977-season-5	0.6240	0.1100
122	Log-fdev-Trawl-Bycatch-year-1978-season-5	0.6285	0.1084
123	Log-fdev-Trawl-Bycatch-year-1979-season-5	0.7280	0.1096
124	Log-fdev-Trawl-Bycatch-year-1980-season-5	1.4746	0.1131
125	Log-fdev-Trawl-Bycatch-year-1981-season-5	1.2408	0.1256
126	Log-fdev-Trawl-Bycatch-year-1982-season-5	2.5377	0.1227
127	Log-fdev-Trawl-Bycatch-year-1983-season-5	2.2908	0.1131
128	Log-fdev-Trawl-Bycatch-year-1984-season-5	3.5494	0.1125
129	Log-fdev-Trawl-Bycatch-year-1985-season-5	2.3335	0.1119
130	Log-fdev-Trawl-Bycatch-year-1986-season-5	1.2308	0.1123
131	Log-fdev-Trawl-Bycatch-year-1987-season-5	0.7415	0.1099
132	Log-fdev-Trawl-Bycatch-year-1988-season-5	1.4969	0.1053
133	Log-fdev-Trawl-Bycatch-year-1989-season-5	0.0555	0.1041
134	Log-fdev-Trawl-Bycatch-year-1990-season-5	0.4989	0.1042
135	Log-fdev-Trawl-Bycatch-year-1991-season-5	0.9136	0.1056
136	Log-fdev-Trawl-Bycatch-year-1992-season-5	0.7533	0.1057
137	Log-fdev-Trawl-Bycatch-year-1993-season-5	1.2191	0.1084
138	Log-fdev-Trawl-Bycatch-year-1994-season-5	-0.5426	0.1052
139	Log-fdev-Trawl-Bycatch-year-1995-season-5	-0.8224	0.1036
140	Log-fdev-Trawl-Bycatch-year-1996-season-5	-0.7450	0.1037
141	Log-fdev-Trawl-Bycatch-year-1997-season-5	-1.1947	0.1035
142	Log-fdev-Trawl-Bycatch-year-1998-season-5	0.1059	0.1041
143	Log-fdev-Trawl-Bycatch-year-1999-season-5	-0.1852	0.1039
144	Log-fdev-Trawl-Bycatch-year-2000-season-5	-0.9510	0.1033
145	Log-fdev-Trawl-Bycatch-year-2001-season-5	-0.1741	0.1031
146	Log-fdev-Trawl-Bycatch-year-2002-season-5	-0.4643	0.1028
147	Log-fdev-Trawl-Bycatch-year-2003-season-5	-0.5603	0.1025
148	Log-fdev-Trawl-Bycatch-year-2004-season-5	-0.3298	0.1025
149	Log-fdev-Trawl-Bycatch-year-2005-season-5	-0.6061	0.1024
150	Log-fdev-Trawl-Bycatch-year-2006-season-5	-0.4397	0.1021
151	Log-fdev-Trawl-Bycatch-year-2007-season-5	-0.3673	0.1023
152	Log-fdev-Trawl-Bycatch-year-2008-season-5	-0.3968	0.1026
153	Log-fdev-Trawl-Bycatch-year-2009-season-5	-0.7606	0.1028
154	Log-fdev-Trawl-Bycatch-year-2010-season-5	-0.9180	0.1027
155	Log-fdev-Trawl-Bycatch-year-2011-season-5	-1.3793	0.1023
156	Log-fdev-Trawl-Bycatch-year-2012-season-5	-1.8906	0.1024

157	Log-fdev-Trawl-Bycatch-year-2013-season-5	-1.1637	0.1024
158	Log-fdev-Trawl-Bycatch-year-2014-season-5	-1.7202	0.1026
159	Log-fdev-Trawl-Bycatch-year-2015-season-5	-1.3329	0.1032
160	Log-fdev-Trawl-Bycatch-year-2016-season-5	-0.7996	0.1045
161	Log-fdev-Trawl-Bycatch-year-2017-season-5	-0.3509	0.1063
162	Log-fdev-Trawl-Bycatch-year-2018-season-5	-0.3952	0.1084
163	Log-fdev-Trawl-Bycatch-year-2019-season-5	-0.2824	0.1107
164	Log-fdev-Trawl-Bycatch-year-2020-season-5	-0.3023	0.1124
165	Log-fdev-Trawl-Bycatch-year-2021-season-5	-1.2854	0.1127
166	Log-fdev-Trawl-Bycatch-year-2022-season-5	-2.2218	0.1141
167	Log-fdev-Bairdi-Fishery-Bycatch-year-1975-season-5	-0.1164	0.0682
168	Log-fdev-Bairdi-Fishery-Bycatch-year-1976-season-5	0.6698	0.0682
169	Log-fdev-Bairdi-Fishery-Bycatch-year-1977-season-5	1.2282	0.0682
170	Log-fdev-Bairdi-Fishery-Bycatch-year-1978-season-5	1.0926	0.0682
171	Log-fdev-Bairdi-Fishery-Bycatch-year-1979-season-5	1.3823	0.0682
172	Log-fdev-Bairdi-Fishery-Bycatch-year-1980-season-5	1.4242	0.0682
173	Log-fdev-Bairdi-Fishery-Bycatch-year-1981-season-5	0.9927	0.0682
174	Log-fdev-Bairdi-Fishery-Bycatch-year-1982-season-5	0.4764	0.0682
175	Log-fdev-Bairdi-Fishery-Bycatch-year-1983-season-5	-0.9874	0.0682
176	Log-fdev-Bairdi-Fishery-Bycatch-year-1984-season-5	-0.5787	0.0682
177	Log-fdev-Bairdi-Fishery-Bycatch-year-1987-season-5	-1.0994	0.0682
178	Log-fdev-Bairdi-Fishery-Bycatch-year-1988-season-5	-0.2563	0.0682
179	Log-fdev-Bairdi-Fishery-Bycatch-year-1989-season-5	0.9401	0.0682
180	Log-fdev-Bairdi-Fishery-Bycatch-year-1990-season-5	1.4182	0.0682
181	Log-fdev-Bairdi-Fishery-Bycatch-year-1991-season-5	3.2441	0.0755
182	Log-fdev-Bairdi-Fishery-Bycatch-year-1992-season-5	1.2814	0.1067
183	Log-fdev-Bairdi-Fishery-Bycatch-year-1993-season-5	0.5526	0.1262
184	Log-fdev-Bairdi-Fishery-Bycatch-year-1994-season-5	-0.7679	0.0861
185	Log-fdev-Bairdi-Fishery-Bycatch-year-2006-season-5	-2.1208	0.0741
186	Log-fdev-Bairdi-Fishery-Bycatch-year-2007-season-5	-2.9815	0.0995
187	Log-fdev-Bairdi-Fishery-Bycatch-year-2008-season-5	-2.4160	0.1181
188	Log-fdev-Bairdi-Fishery-Bycatch-year-2009-season-5	-3.5064	0.0754
189	Log-fdev-Bairdi-Fishery-Bycatch-year-2013-season-5	-0.8382	0.0963
190	Log-fdev-Bairdi-Fishery-Bycatch-year-2014-season-5	-0.1109	0.1203
191	Log-fdev-Bairdi-Fishery-Bycatch-year-2015-season-5	1.0772	0.1481
192	Log-fdev-Fixed-Gear-year-1996-season-5	0.5331	0.1033
193	Log-fdev-Fixed-Gear-year-1997-season-5	-0.1148	0.1024
194	Log-fdev-Fixed-Gear-year-1998-season-5	-0.3334	0.1031
195	Log-fdev-Fixed-Gear-year-1999-season-5	0.5758	0.1023
196	Log-fdev-Fixed-Gear-year-2000-season-5	-1.8519	0.1017
197	Log-fdev-Fixed-Gear-year-2001-season-5	0.1105	0.1013
198	Log-fdev-Fixed-Gear-year-2002-season-5	-0.1447	0.1009
199	Log-fdev-Fixed-Gear-year-2003-season-5	-0.9811	0.1008
200	Log-fdev-Fixed-Gear-year-2004-season-5	-0.8055	0.1006
201	Log-fdev-Fixed-Gear-year-2005-season-5	-0.5339	0.1005
202	Log-fdev-Fixed-Gear-year-2006-season-5	-0.5829	0.1002
203	Log-fdev-Fixed-Gear-year-2007-season-5	-0.0357	0.1002
204	Log-fdev-Fixed-Gear-year-2008-season-5	-0.7376	0.1006
205	Log-fdev-Fixed-Gear-year-2009-season-5	-1.7411	0.1004
206	Log-fdev-Fixed-Gear-year-2010-season-5	-2.5815	0.1000
207	Log-fdev-Fixed-Gear-year-2011-season-5	-1.0972	0.0996
208	Log-fdev-Fixed-Gear-year-2012-season-5	-0.5319	0.0995
209	Log-fdev-Fixed-Gear-year-2013-season-5	0.6172	0.0994

210	Log-fdev-Fixed-Gear-year-2014-season-5	1.4729	0.0995
211	Log-fdev-Fixed-Gear-year-2015-season-5	1.1625	0.0998
212	Log-fdev-Fixed-Gear-year-2016-season-5	0.3428	0.1005
213	Log-fdev-Fixed-Gear-year-2017-season-5	1.9603	0.1017
214	Log-fdev-Fixed-Gear-year-2018-season-5	2.2354	0.1028
215	Log-fdev-Fixed-Gear-year-2019-season-5	1.0462	0.1041
216	Log-fdev-Fixed-Gear-year-2020-season-5	0.8467	0.1057
217	Log-fdev-Fixed-Gear-year-2021-season-5	0.8411	0.1068
218	Log-fdev-Fixed-Gear-year-2022-season-5	0.3288	0.1090
219	Log-foff-Pot-Fishery	-2.7555	0.0443
220	Log-foff-Bairdi-Fishery-Bycatch	-0.1394	0.4864
221	Log-fdov-Pot-Fishery-year-1990-season-3	1.9054	0.0841
222	Log-fdov-Pot-Fishery-year-1991-season-3	-0.7525	0.0833
223	Log-fdov-Pot-Fishery-year-1992-season-3	1.9198	0.0846
224	Log-fdov-Pot-Fishery-year-1993-season-3	1.7571	0.0860
225	Log-fdov-Pot-Fishery-year-1994-season-3	-0.4579	0.0846
226	Log-fdov-Pot-Fishery-year-1995-season-3	-0.2372	0.0824
227	Log-fdov-Pot-Fishery-year-1996-season-3	-3.7295	0.0813
228	Log-fdov-Pot-Fishery-year-1997-season-3	-0.3777	0.0822
229	Log-fdov-Pot-Fishery-year-1998-season-3	1.3832	0.0830
230	Log-fdov-Pot-Fishery-year-1999-season-3	-2.8355	0.0821
231	Log-fdov-Pot-Fishery-year-2000-season-3	1.1030	0.0811
232	Log-fdov-Pot-Fishery-year-2001-season-3	0.8186	0.0810
233	Log-fdov-Pot-Fishery-year-2002-season-3	-1.9368	0.0805
234	Log-fdov-Pot-Fishery-year-2003-season-3	1.1620	0.0804
235	Log-fdov-Pot-Fishery-year-2004-season-3	0.3690	0.0807
236	Log-fdov-Pot-Fishery-year-2005-season-3	0.8873	0.0803
237	Log-fdov-Pot-Fishery-year-2006-season-3	-1.2835	0.0796
238	Log-fdov-Pot-Fishery-year-2007-season-3	-0.2401	0.0796
239	Log-fdov-Pot-Fishery-year-2008-season-3	-0.5047	0.0800
240	Log-fdov-Pot-Fishery-year-2009-season-3	-0.7554	0.0802
241	Log-fdov-Pot-Fishery-year-2010-season-3	-0.2557	0.0800
242	Log-fdov-Pot-Fishery-year-2011-season-3	-1.1342	0.0791
243	Log-fdov-Pot-Fishery-year-2012-season-3	-1.8480	0.0786
244	Log-fdov-Pot-Fishery-year-2013-season-3	0.1676	0.0784
245	Log-fdov-Pot-Fishery-year-2014-season-3	-0.2356	0.0785
246	Log-fdov-Pot-Fishery-year-2015-season-3	0.8314	0.0789
247	Log-fdov-Pot-Fishery-year-2016-season-3	0.2872	0.0802
248	Log-fdov-Pot-Fishery-year-2017-season-3	-0.3676	0.0824
249	Log-fdov-Pot-Fishery-year-2018-season-3	0.9445	0.0855
250	Log-fdov-Pot-Fishery-year-2019-season-3	-0.1389	0.0880
251	Log-fdov-Pot-Fishery-year-2020-season-3	-0.6605	0.0886
252	Log-fdov-Pot-Fishery-year-2021-season-3	2.9350	0.0886
253	Log-fdov-Pot-Fishery-year-2022-season-3	1.2758	0.0893
254	Log-fdov-Bairdi-Fishery-Bycatch-year-1975-season-5	-0.0000	0.0962
255	Log-fdov-Bairdi-Fishery-Bycatch-year-1976-season-5	0.0001	0.0962
256	Log-fdov-Bairdi-Fishery-Bycatch-year-1977-season-5	0.0004	0.0962
257	Log-fdov-Bairdi-Fishery-Bycatch-year-1978-season-5	0.0003	0.0963
258	Log-fdov-Bairdi-Fishery-Bycatch-year-1979-season-5	0.0005	0.0963
259	Log-fdov-Bairdi-Fishery-Bycatch-year-1980-season-5	0.0001	0.0963
260	Log-fdov-Bairdi-Fishery-Bycatch-year-1981-season-5	-0.0001	0.0963
261	Log-fdov-Bairdi-Fishery-Bycatch-year-1982-season-5	-0.0002	0.0962
262	Log-fdov-Bairdi-Fishery-Bycatch-year-1983-season-5	-0.0002	0.0962

263	Log-fdov-Bairdi-Fishery-Bycatch-year-1984-season-5	-0.0001	0.0962
264	Log-fdov-Bairdi-Fishery-Bycatch-year-1987-season-5	-0.0001	0.0962
265	Log-fdov-Bairdi-Fishery-Bycatch-year-1988-season-5	0.0000	0.0962
266	Log-fdov-Bairdi-Fishery-Bycatch-year-1989-season-5	0.0002	0.0962
267	Log-fdov-Bairdi-Fishery-Bycatch-year-1990-season-5	0.0006	0.0963
268	Log-fdov-Bairdi-Fishery-Bycatch-year-1991-season-5	1.4888	0.1574
269	Log-fdov-Bairdi-Fishery-Bycatch-year-1992-season-5	1.7789	0.1284
270	Log-fdov-Bairdi-Fishery-Bycatch-year-1993-season-5	0.5864	0.1476
271	Log-fdov-Bairdi-Fishery-Bycatch-year-1994-season-5	-3.4397	0.1113
272	Log-fdov-Bairdi-Fishery-Bycatch-year-2006-season-5	-2.1788	0.1729
273	Log-fdov-Bairdi-Fishery-Bycatch-year-2007-season-5	-0.8054	0.1313
274	Log-fdov-Bairdi-Fishery-Bycatch-year-2008-season-5	0.0356	0.1372
275	Log-fdov-Bairdi-Fishery-Bycatch-year-2009-season-5	0.3949	0.1026
276	Log-fdov-Bairdi-Fishery-Bycatch-year-2013-season-5	0.9912	0.1735
277	Log-fdov-Bairdi-Fishery-Bycatch-year-2014-season-5	0.2099	0.1572
278	Log-fdov-Bairdi-Fishery-Bycatch-year-2015-season-5	0.9366	0.1832
279	Rec-dev-est-1975	1.0654	0.2719
280	Rec-dev-est-1976	0.5761	0.3021
281	Rec-dev-est-1977	1.0385	0.2409
282	Rec-dev-est-1978	1.6181	0.2072
283	Rec-dev-est-1979	1.9094	0.2151
284	Rec-dev-est-1980	1.1151	0.2591
285	Rec-dev-est-1981	2.4188	0.1629
286	Rec-dev-est-1982	1.4673	0.1771
287	Rec-dev-est-1983	1.0970	0.1640
288	Rec-dev-est-1984	-0.7002	0.2420
289	Rec-dev-est-1985	0.3619	0.1614
290	Rec-dev-est-1986	-0.7462	0.2364
291	Rec-dev-est-1987	-1.1849	0.2714
292	Rec-dev-est-1988	-0.9547	0.2228
293	Rec-dev-est-1989	-0.0177	0.1629
294	Rec-dev-est-1990	-0.4107	0.1801
295	Rec-dev-est-1991	-1.8625	0.3479
296	Rec-dev-est-1992	-0.8247	0.1953
297	Rec-dev-est-1993	-2.0244	0.4396
298	Rec-dev-est-1994	1.0168	0.1455
299	Rec-dev-est-1995	-0.7559	0.2463
300	Rec-dev-est-1996	-1.5257	0.3410
301	Rec-dev-est-1997	-0.5389	0.1993
302	Rec-dev-est-1998	0.4776	0.1539
303	Rec-dev-est-1999	-0.4692	0.2179
304	Rec-dev-est-2000	-0.5496	0.2486
305	Rec-dev-est-2001	0.9119	0.1525
306	Rec-dev-est-2002	-0.5391	0.2577
307	Rec-dev-est-2003	-0.6361	0.2623
308	Rec-dev-est-2004	0.6019	0.1556
309	Rec-dev-est-2005	-0.0446	0.1767
310	Rec-dev-est-2006	-0.4723	0.1851
311	Rec-dev-est-2007	-1.0287	0.2285
312	Rec-dev-est-2008	-0.8970	0.2303
313	Rec-dev-est-2009	0.0019	0.1805
314	Rec-dev-est-2010	-0.4718	0.2206
315	Rec-dev-est-2011	-1.0404	0.2271

316	Rec-dev-est-2012	-1.3828	0.2206
317	Rec-dev-est-2013	-1.8718	0.2652
318	Rec-dev-est-2014	-1.4172	0.2196
319	Rec-dev-est-2015	-0.7717	0.1705
320	Rec-dev-est-2016	-1.5459	0.2395
321	Rec-dev-est-2017	-0.8862	0.1875
322	Rec-dev-est-2018	-1.6134	0.2764
323	Rec-dev-est-2019	-1.5518	0.2639
324	Rec-dev-est-2020	-1.7245	0.2887
325	Rec-dev-est-2021	-0.9439	0.2312
326	Rec-dev-est-2022	-1.3780	0.3455
327	Logit-rec-prop-est-1975	-0.1608	0.4299
328	Logit-rec-prop-est-1976	-0.8768	0.5400
329	Logit-rec-prop-est-1977	-0.2120	0.3590
330	Logit-rec-prop-est-1978	-0.3724	0.2657
331	Logit-rec-prop-est-1979	0.2061	0.2559
332	Logit-rec-prop-est-1980	0.3460	0.3378
333	Logit-rec-prop-est-1981	0.4754	0.1419
334	Logit-rec-prop-est-1982	0.5642	0.2366
335	Logit-rec-prop-est-1983	0.0431	0.1742
336	Logit-rec-prop-est-1984	0.4319	0.4365
337	Logit-rec-prop-est-1985	-0.4741	0.1642
338	Logit-rec-prop-est-1986	0.1820	0.3971
339	Logit-rec-prop-est-1987	-0.1323	0.4462
340	Logit-rec-prop-est-1988	0.3681	0.3805
341	Logit-rec-prop-est-1989	-0.0940	0.1687
342	Logit-rec-prop-est-1990	0.1509	0.2312
343	Logit-rec-prop-est-1991	0.7678	0.7176
344	Logit-rec-prop-est-1992	0.2174	0.2805
345	Logit-rec-prop-est-1993	-0.3822	0.7006
346	Logit-rec-prop-est-1994	-0.3644	0.0889
347	Logit-rec-prop-est-1995	1.2224	0.5970
348	Logit-rec-prop-est-1996	0.3947	0.6409
349	Logit-rec-prop-est-1997	0.4628	0.3239
350	Logit-rec-prop-est-1998	-0.0964	0.1388
351	Logit-rec-prop-est-1999	0.2192	0.3493
352	Logit-rec-prop-est-2000	-0.5954	0.3990
353	Logit-rec-prop-est-2001	-0.5322	0.1235
354	Logit-rec-prop-est-2002	-0.4052	0.4114
355	Logit-rec-prop-est-2003	-0.0954	0.4314
356	Logit-rec-prop-est-2004	-0.4183	0.1416
357	Logit-rec-prop-est-2005	-0.1416	0.2216
358	Logit-rec-prop-est-2006	0.4253	0.2757
359	Logit-rec-prop-est-2007	-0.1106	0.3550
360	Logit-rec-prop-est-2008	-0.4886	0.3493
361	Logit-rec-prop-est-2009	-0.7190	0.2040
362	Logit-rec-prop-est-2010	-0.4388	0.3068
363	Logit-rec-prop-est-2011	-0.5231	0.3371
364	Logit-rec-prop-est-2012	-0.1903	0.3312
365	Logit-rec-prop-est-2013	-0.3415	0.4245
366	Logit-rec-prop-est-2014	-0.3827	0.3189
367	Logit-rec-prop-est-2015	0.2664	0.2078
368	Logit-rec-prop-est-2016	0.5503	0.4402

369	Logit-rec-prop-est-2017	0.6139	0.2785
370	Logit-rec-prop-est-2018	-0.1752	0.4562
371	Logit-rec-prop-est-2019	0.2987	0.4500
372	Logit-rec-prop-est-2020	0.5576	0.5287
373	Logit-rec-prop-est-2021	0.1445	0.3443
374	Logit-rec-prop-est-2022	-0.1851	0.5640
375	M-dev-est-par-1	1.4588	0.0312
376	Survey-q-survey-1	0.9364	0.0259
377	Log-add-cvt-survey-2	-0.9702	0.2854

Table 9: Annual abundance estimates (mature males, legal males, and mature females in million crab), mature male biomass (MMB, 1000 t), and total survey biomass (1000 t) both estimated by the model and area swept calculated for red king crab in Bristol Bay estimated by length-based model 21.1b during 1975-2022. MMB for year t is on Feb. 15, year t+1.

	Males				Females	Total	Total Survey Biomass	
Year	Mature >119mm	Legal >134mm	MMB >119mm	sd MMB	Mature >89mm	Recruits	Model Est >64mm	Area-Swept >64mm
1975	55.562	28.226	83.241	8.278	54.555		236.240	199.640
1976	65.255	35.524	99.120	7.985	82.782	63.982	276.140	327.610
1977	72.454	41.313	113.059	6.920	109.948	40.854	297.510	371.220
1978	77.747	46.492	119.857	5.506	114.165	64.281	300.720	343.190
1979	68.365	47.442	100.081	3.875	109.369	114.835	289.340	165.450
1980	50.152	37.802	30.344	1.602	111.384	149.819	274.100	247.230
1981	14.450	8.024	6.525	1.049	48.904	67.521	109.420	131.140
1982	6.754	2.156	6.518	0.920	21.448	240.843	65.620	141.900
1983	6.126	2.156	7.336	0.667	14.125	92.745	58.090	48.480
1984	6.119	2.269	5.174	0.428	13.911	63.245	50.880	152.610
1985	7.516	1.868	9.597	0.643	9.624	10.201	34.910	34.140
1986	12.100	4.620	14.936	0.974	13.466	29.897	45.550	47.430
1987	14.263	6.644	20.227	1.174	16.795	9.403	51.270	69.240
1988	14.347	8.399	24.912	1.230	21.160	6.141	54.610	54.600
1989	15.441	9.681	27.758	1.177	19.980	8.005	57.240	55.140
1990	14.918	10.367	23.921	1.105	17.880	20.592	57.290	59.450
1991	11.459	8.585	18.239	1.043	17.276	13.011	52.200	83.890
1992	9.195	6.398	17.034	1.017	18.409	3.026	47.540	37.330
1993	10.407	6.096	15.635	1.090	17.138	8.983	47.080	52.910
1994	10.253	5.950	21.468	1.199	14.586	2.931	42.500	32.100
1995	10.767	7.824	24.613	1.200	13.514	58.611	48.550	38.070
1996	11.056	8.480	23.106	1.147	19.473	8.629	57.970	43.960
1997	10.515	7.721	21.871	1.126	28.434	4.438	64.140	84.030
1998	15.807	7.695	24.723	1.335	25.007	12.279	68.010	84.100
1999	16.848	9.668	28.419	1.478	21.160	33.294	66.560	64.750
2000	14.539	10.570	28.635	1.469	22.551	12.432	68.210	67.380
2001	14.363	10.134	29.029	1.432	25.582	12.741	71.860	52.460
2002	17.206	10.330	33.083	1.447	24.855	51.013	76.920	69.090
2003	18.043	11.974	32.654	1.411	30.410	11.665	83.120	115.760
2004	16.260	11.560	30.176	1.334	37.544	10.947	84.660	130.560
2005	18.143	10.777	30.730	1.300	34.825	39.195	85.630	105.730
2006	17.263	11.367	31.119	1.262	35.139	18.839	85.520	94.480
2007	15.562	11.121	26.125	1.185	39.030	12.822	87.140	103.330
2008	15.942	9.455	24.803	1.210	36.637	7.160	83.560	113.080
2009	15.795	9.411	25.676	1.254	32.149	8.149	77.560	90.550
2010	14.687	9.644	24.987	1.213	28.194	21.740	72.500	80.500
2011	12.433	9.111	24.717	1.136	27.772	12.643	68.080	66.410
2012	11.082	8.571	23.158	1.050	29.574	7.358	66.520	60.700
2013	11.003	7.831	22.113	0.982	28.019	5.348	63.850	62.220
2014	10.731	7.543	20.130	0.927	24.834	3.358	59.120	113.140
2015	9.213	6.873	17.157	0.885	21.303	5.406	52.330	64.170
2016	7.459	5.780	14.127	0.861	18.208	10.434	45.670	60.960
2017	5.912	4.682	11.538	0.842	16.633	4.631	40.780	52.930
2018	5.153	3.780	10.291	0.844	15.281	9.045	37.780	28.800
2019	5.894	3.504	11.182	0.951	13.527	4.518	36.330	28.540
2020	6.468	4.018	12.805	1.091	12.492	4.553		

2021	7.386	4.623	16.198	1.265	11.346	4.016	35.170	28.480
2022	7.968	5.744	18.523	1.403	10.100	8.641	35.990	36.200
2023	8.052	6.270	15.915	1.041	9.560	5.561	36.820	37.970

Table 10: Annual abundance estimates (mature males, legal males, and mature females in million crab), mature male biomass (MMB, 1000 t), and total survey biomass (1000 t) both estimated by the model and area swept calculated for red king crab in Bristol Bay estimated by length-based model 23.0a during 1975-2022. MMB for year t is on Feb. 15, year t+1.

	Males				Females	Total	Total Survey Biomass	
Year	Mature >119mm	Legal >134mm	MMB >119mm	sd MMB	Mature >89mm	Recruits	Model Est >64mm	Area-Swept >64mm
1975	60.771	30.462	86.323	8.655	65.346		247.750	199.640
1976	71.028	38.070	102.157	8.289	97.117	89.398	288.150	327.610
1977	78.840	44.008	115.986	7.194	127.857	53.625	309.170	371.220
1978	84.071	49.366	122.423	5.785	131.396	83.102	310.310	343.190
1979	73.242	50.080	101.812	4.085	124.065	148.719	296.140	165.450
1980	53.545	39.708	26.709	1.379	125.299	200.649	279.860	247.230
1981	15.287	8.308	5.710	0.811	57.732	92.158	113.500	131.140
1982	7.179	2.241	5.454	0.630	26.494	330.901	64.250	141.900
1983	6.274	2.143	5.854	0.460	18.184	128.055	56.500	48.480
1984	6.389	2.155	4.131	0.344	18.225	88.720	49.350	152.610
1985	7.890	1.828	9.281	0.659	12.824	14.749	33.730	34.140
1986	12.895	4.733	14.913	1.039	17.593	42.710	45.100	47.430
1987	15.640	7.007	20.867	1.310	21.905	14.058	51.850	69.240
1988	15.898	9.078	25.827	1.394	27.518	9.086	56.080	54.600
1989	17.181	10.459	28.912	1.358	25.607	11.453	59.110	55.140
1990	16.472	11.223	25.097	1.283	22.557	29.306	59.120	59.450
1991	12.635	9.332	19.260	1.190	21.842	19.758	54.060	83.890
1992	10.315	6.986	17.998	1.147	23.544	4.599	49.670	37.330
1993	11.877	6.698	17.085	1.249	21.861	13.045	49.490	52.910
1994	11.966	6.791	23.139	1.379	18.422	3.954	45.250	32.100
1995	12.244	8.769	25.903	1.348	16.839	82.539	50.990	38.070
1996	12.240	9.229	23.944	1.254	25.238	13.868	59.600	43.960
1997	11.585	8.259	22.406	1.208	37.251	6.446	65.720	84.030
1998	17.670	8.230	25.963	1.506	32.055	17.403	69.950	84.100
1999	18.892	10.647	29.988	1.683	26.673	48.019	69.040	64.750
2000	16.136	11.618	29.811	1.637	28.676	18.526	70.680	67.380
2001	15.907	10.910	29.971	1.579	32.843	17.235	74.220	52.460
2002	19.218	11.091	34.290	1.627	31.470	74.107	79.320	69.090
2003	19.979	12.961	33.852	1.590	39.146	17.276	85.320	115.760
2004	17.876	12.468	31.098	1.485	48.938	15.759	87.110	130.560
2005	20.195	11.566	32.093	1.487	44.651	54.383	88.230	105.730
2006	19.119	12.390	32.360	1.445	44.764	28.419	88.040	94.480
2007	17.084	12.005	27.174	1.342	49.565	18.497	89.520	103.330
2008	17.732	10.210	26.202	1.402	46.081	10.587	86.170	113.080
2009	17.790	10.357	27.437	1.483	39.576	12.120	80.470	90.550
2010	16.661	10.726	26.943	1.447	34.174	29.824	75.360	80.500
2011	14.094	10.182	26.380	1.334	33.557	18.481	70.480	66.410
2012	12.425	9.439	24.378	1.201	35.601	10.485	68.260	60.700
2013	12.324	8.513	23.169	1.111	33.480	7.433	65.030	62.220
2014	11.994	8.206	21.128	1.034	29.208	4.570	59.820	113.140
2015	10.214	7.498	17.942	0.954	24.539	7.223	52.540	64.170
2016	8.176	6.260	14.623	0.887	20.616	13.742	45.340	60.960
2017	6.371	5.002	11.711	0.831	18.661	6.325	39.860	52.930
2018	5.497	3.953	10.237	0.809	16.978	12.186	36.450	28.800
2019	6.279	3.617	11.023	0.900	14.878	5.895	34.740	28.540
2020	6.855	4.137	12.508	1.022	13.670	6.276		

2021	7.794	4.725	15.691	1.171	12.338	5.299	33.260	28.480
2022	8.181	5.801	17.537	1.268	10.930	11.538	33.740	36.200
2023	8.055	6.155	14.317	0.882	10.377	7.449	34.100	37.970

Table 11: Annual abundance estimates (mature males, legal males, and mature females in million crab), mature male biomass (MMB, 1000 t), and total survey biomass (1000 t) both estimated by the model and area swept calculated for red king crab in Bristol Bay estimated by length-based model 24.0 during 1975-2022. MMB for year t is on Feb. 15, year t+1.

	Males				Females	Total	Total Survey Biomass	
Year	Mature >119mm	Legal >134mm	MMB >119mm	sd MMB	Mature >89mm	Recruits	Model Est >64mm	Area-Swept >64mm
1975	55.656	28.680	79.362	7.625	57.955		244.020	199.640
1976	65.679	35.626	94.513	7.338	88.377	77.130	285.230	327.610
1977	74.132	41.518	109.234	6.482	117.391	48.323	308.810	371.220
1978	79.587	47.354	116.450	5.240	121.908	74.030	313.710	343.190
1979	69.968	48.420	97.687	3.703	116.733	130.998	301.560	165.450
1980	51.308	38.589	25.357	1.228	118.798	167.758	284.720	247.230
1981	14.524	8.045	5.219	0.771	53.054	73.845	112.770	131.140
1982	6.705	2.126	5.157	0.648	23.410	270.647	71.710	141.900
1983	5.868	2.085	5.645	0.460	15.040	105.093	62.400	48.480
1984	5.944	2.116	3.902	0.317	14.895	71.930	54.010	152.610
1985	7.216	1.759	8.542	0.568	10.290	11.785	36.580	34.140
1986	11.702	4.455	13.435	0.858	14.355	33.860	48.100	47.430
1987	14.024	6.457	18.644	1.048	17.782	11.152	54.320	69.240
1988	14.168	8.274	23.241	1.100	22.418	7.126	57.890	54.600
1989	15.416	9.550	26.180	1.047	20.999	9.162	60.710	55.140
1990	14.920	10.302	22.559	0.983	18.683	22.813	60.590	59.450
1991	11.364	8.504	17.021	0.919	17.988	15.016	54.990	83.890
1992	9.097	6.254	15.837	0.890	19.163	3.736	50.100	37.330
1993	10.386	5.973	14.581	0.956	17.819	10.284	49.810	52.910
1994	10.266	5.915	20.267	1.057	15.094	3.291	44.940	32.100
1995	10.695	7.794	23.189	1.050	13.976	64.543	51.040	38.070
1996	10.894	8.337	21.545	0.993	20.319	11.195	60.440	43.960
1997	10.363	7.489	20.255	0.978	30.257	5.268	67.090	84.030
1998	15.655	7.504	22.886	1.164	26.423	14.112	71.840	84.100
1999	16.679	9.558	26.434	1.291	22.281	37.920	70.380	64.750
2000	14.251	10.417	26.542	1.281	23.838	15.031	71.710	67.380
2001	14.115	9.824	26.872	1.246	27.292	14.533	75.720	52.460
2002	17.121	10.055	30.887	1.265	26.512	58.708	81.700	69.090
2003	17.971	11.835	30.545	1.240	32.641	13.603	88.200	115.760
2004	16.113	11.401	28.125	1.167	40.657	13.704	90.010	130.560
2005	18.198	10.592	28.909	1.139	37.581	44.470	91.690	105.730
2006	17.257	11.346	29.309	1.109	38.183	18.337	91.330	94.480
2007	15.483	11.034	24.472	1.031	41.994	15.924	92.420	103.330
2008	15.735	9.314	23.007	1.040	38.246	8.732	88.520	113.080
2009	15.408	9.221	23.551	1.067	33.478	8.942	81.990	90.550
2010	14.355	9.350	22.909	1.013	29.141	22.967	76.100	80.500
2011	12.166	8.814	22.726	0.934	28.226	15.171	70.800	66.410
2012	10.791	8.261	21.181	0.847	29.940	7.518	68.630	60.700
2013	10.698	7.494	20.111	0.771	28.357	6.191	65.570	62.220
2014	10.459	7.223	18.244	0.703	24.883	3.726	60.290	113.140
2015	8.845	6.578	15.306	0.647	21.287	5.235	52.720	64.170
2016	6.947	5.413	12.192	0.611	17.953	10.897	45.300	60.960
2017	5.361	4.223	9.593	0.588	16.203	4.637	39.740	52.930
2018	4.536	3.289	8.257	0.582	14.762	9.512	36.340	28.800
2019	5.188	2.977	8.920	0.667	12.899	4.531	34.600	28.540
2020	5.668	3.440	10.274	0.787	11.810	4.713		

2021	6.517	3.974	13.332	0.938	10.652	4.038	32.870	28.480
2022	6.995	5.020	15.306	1.054	9.449	8.284	33.340	36.200
2023	6.983	5.435	13.353	0.812	8.898	5.247	33.690	37.970

Table 12: Annual abundance estimates (mature males, legal males, and mature females in million crab), mature male biomass (MMB, 1000 t), and total survey biomass (1000 t) both estimated by the model and area swept calculated for red king crab in Bristol Bay estimated by length-based model 24.0c during 1975-2022. MMB for year t is on Feb. 15, year t+1.

	Males				Females	Total	Total Survey Biomass	
Year	Mature >119mm	Legal >134mm	MMB >119mm	sd MMB	Mature >89mm	Recruits	Model Est >64mm	Area-Swept >64mm
1975	66.099	32.842	95.639	6.640	66.522		261.080	199.640
1976	75.920	40.489	111.028	6.228	98.503	85.785	300.070	327.610
1977	82.618	45.981	123.054	5.445	129.748	52.592	318.530	371.220
1978	86.981	50.509	127.490	4.664	133.310	83.514	316.610	343.190
1979	74.892	50.504	104.265	3.802	125.671	149.090	299.850	165.450
1980	54.192	39.646	26.775	1.396	126.580	199.514	282.080	247.230
1981	15.426	8.396	5.769	0.828	57.820	90.162	113.930	131.140
1982	7.216	2.274	5.483	0.641	26.306	332.040	64.320	141.900
1983	6.229	2.159	5.810	0.459	18.037	128.228	56.440	48.480
1984	6.318	2.141	4.059	0.335	18.117	88.540	49.200	152.610
1985	7.797	1.809	9.134	0.640	12.716	14.677	33.520	34.140
1986	12.756	4.695	14.686	1.013	17.445	42.453	44.840	47.430
1987	15.476	6.949	20.591	1.282	21.728	14.017	51.560	69.240
1988	15.741	9.008	25.554	1.367	27.296	9.039	55.780	54.600
1989	17.042	10.389	28.661	1.334	25.405	11.379	58.820	55.140
1990	16.353	11.162	24.880	1.261	22.383	29.043	58.840	59.450
1991	12.534	9.277	19.072	1.170	21.673	19.605	53.780	83.890
1992	10.225	6.933	17.823	1.129	23.352	4.591	49.380	37.330
1993	11.773	6.652	16.893	1.229	21.679	12.959	49.200	52.910
1994	11.847	6.743	22.926	1.358	18.268	3.904	44.960	32.100
1995	12.133	8.714	25.701	1.329	16.700	81.717	50.680	38.070
1996	12.138	9.171	23.753	1.236	25.040	13.882	59.260	43.960
1997	11.495	8.202	22.228	1.192	36.949	6.429	65.350	84.030
1998	17.510	8.182	25.693	1.481	31.804	17.245	69.570	84.100
1999	18.716	10.582	29.684	1.655	26.463	47.657	68.640	64.750
2000	15.981	11.540	29.531	1.612	28.456	18.490	70.280	67.380
2001	15.766	10.827	29.706	1.555	32.598	17.062	73.820	52.460
2002	19.063	11.018	34.005	1.603	31.240	73.578	78.910	69.090
2003	19.831	12.894	33.581	1.567	38.860	17.242	84.920	115.760
2004	17.741	12.401	30.850	1.464	48.579	15.648	86.720	130.560
2005	20.046	11.502	31.829	1.465	44.334	53.969	87.850	105.730
2006	18.980	12.330	32.111	1.424	44.453	28.271	87.670	94.480
2007	16.960	11.944	26.948	1.323	49.228	18.433	89.150	103.330
2008	17.591	10.150	25.953	1.381	45.774	10.567	85.800	113.080
2009	17.644	10.295	27.179	1.462	39.316	12.054	80.130	90.550
2010	16.528	10.663	26.704	1.428	33.957	29.619	75.040	80.500
2011	13.984	10.121	26.176	1.318	33.349	18.443	70.180	66.410
2012	12.333	9.383	24.200	1.187	35.381	10.444	67.990	60.700
2013	12.240	8.463	23.004	1.098	33.282	7.416	64.790	62.220
2014	11.925	8.166	20.991	1.024	29.037	4.548	59.610	113.140
2015	10.159	7.468	17.834	0.945	24.398	7.166	52.370	64.170
2016	8.132	6.236	14.538	0.881	20.499	13.664	45.190	60.960
2017	6.334	4.981	11.638	0.826	18.557	6.300	39.720	52.930
2018	5.462	3.933	10.169	0.803	16.886	12.186	36.330	28.800
2019	6.240	3.601	10.952	0.895	14.800	5.889	34.630	28.540
2020	6.819	4.123	12.444	1.017	13.602	6.263		

2021	7.770	4.717	15.651	1.168	12.280	5.269	33.220	28.480
2022	8.165	5.802	17.520	1.267	10.881	11.503	33.710	36.200
2023	8.042	6.159	14.310	0.882	10.334	7.452	34.080	37.970

Figures

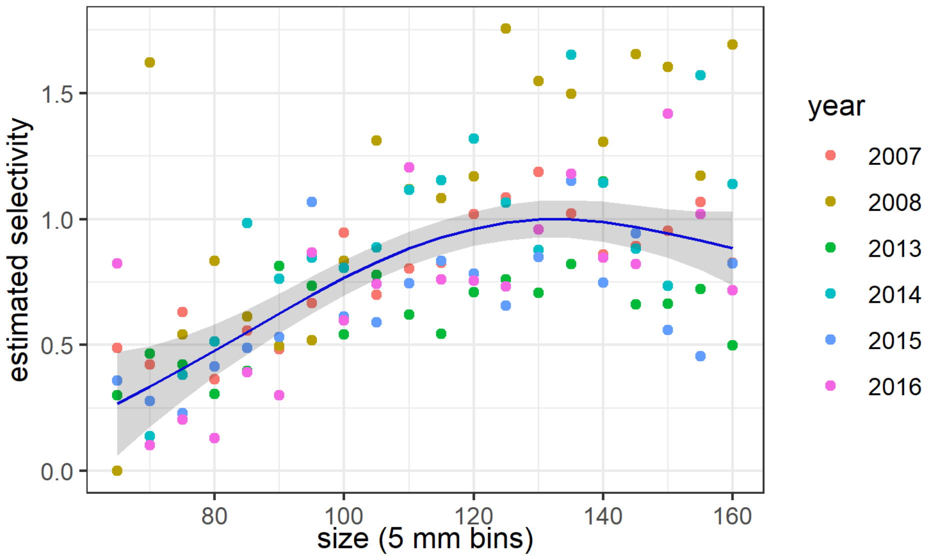

Figure 2: Inferred selectvity estimated from the BSFRF data by year, with resulting GAM model fit.

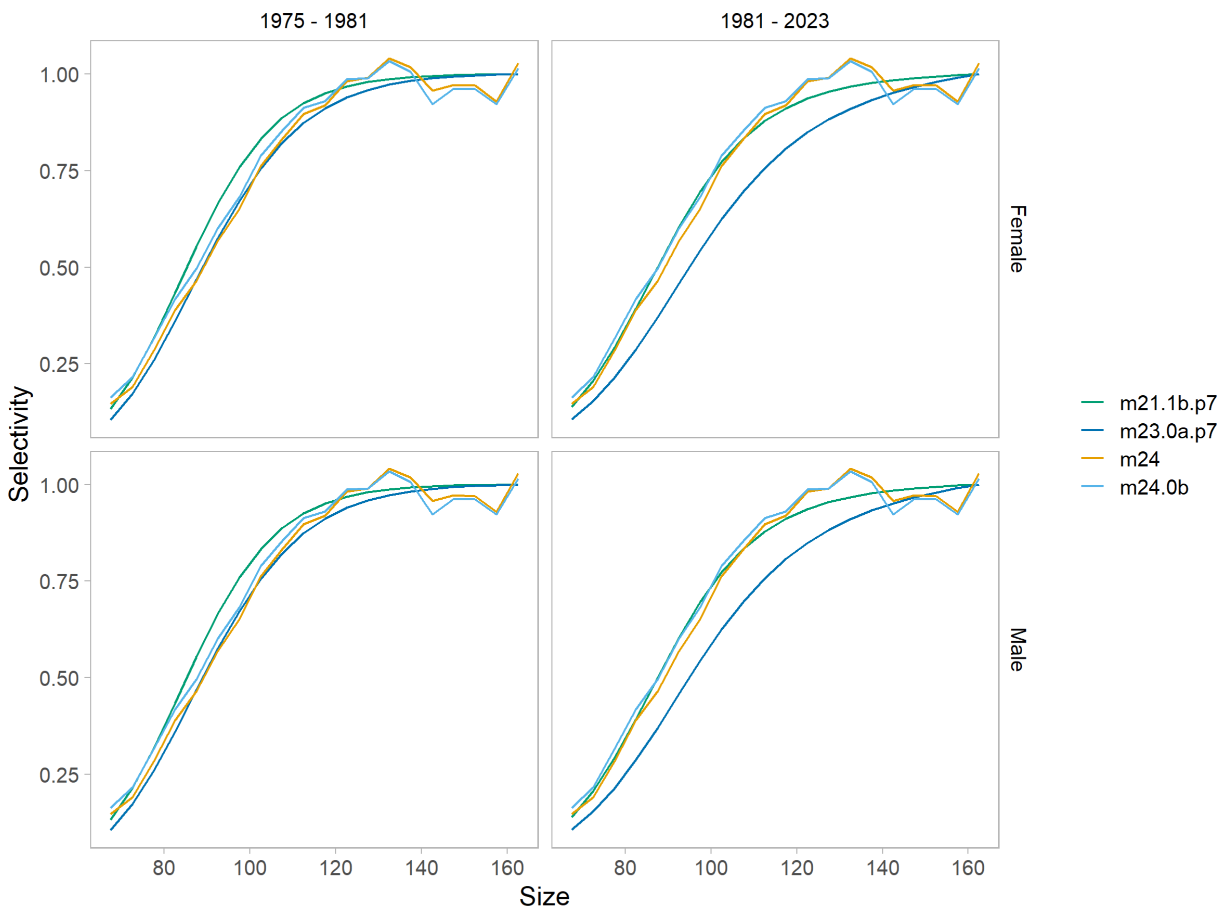

Figure 3: Estimated NMFS trawl survey selectivities under models 21.1b.p7, 23.0a.p7, 24.0, and 24.0b. Models 24.0 and 24.0b have one selectivity period (1975 - 2023) that is plotted on both figures for comparison.

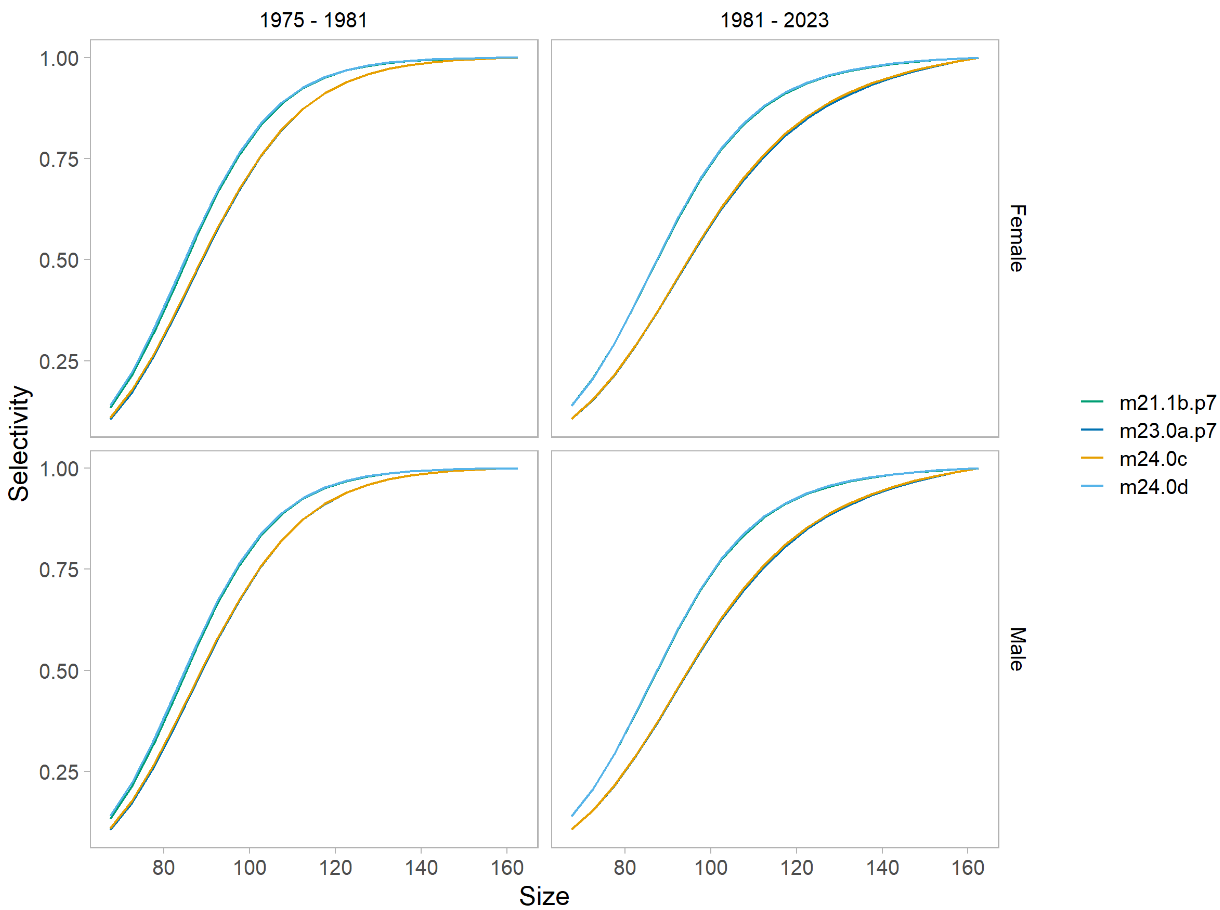

Figure 4: Estimated NMFS trawl survey selectivities under models 21.1b.p7, 23.0a.p7, 24.0c, and 24.0d

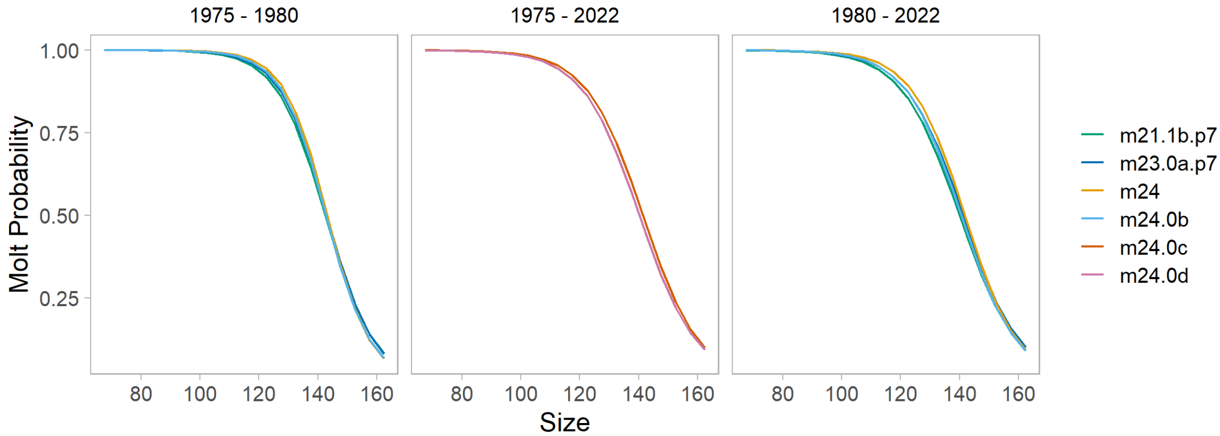

Figure 5: Comparison of estimated probabilities of molting for male red king crab in Bristol Bay for two periods - 1975-1979 and 1980-2022 - for models 21.1b.p7, 23.0a.p7, 24.0, and 24.0b, and one period for models 24.0c and 24.0d.

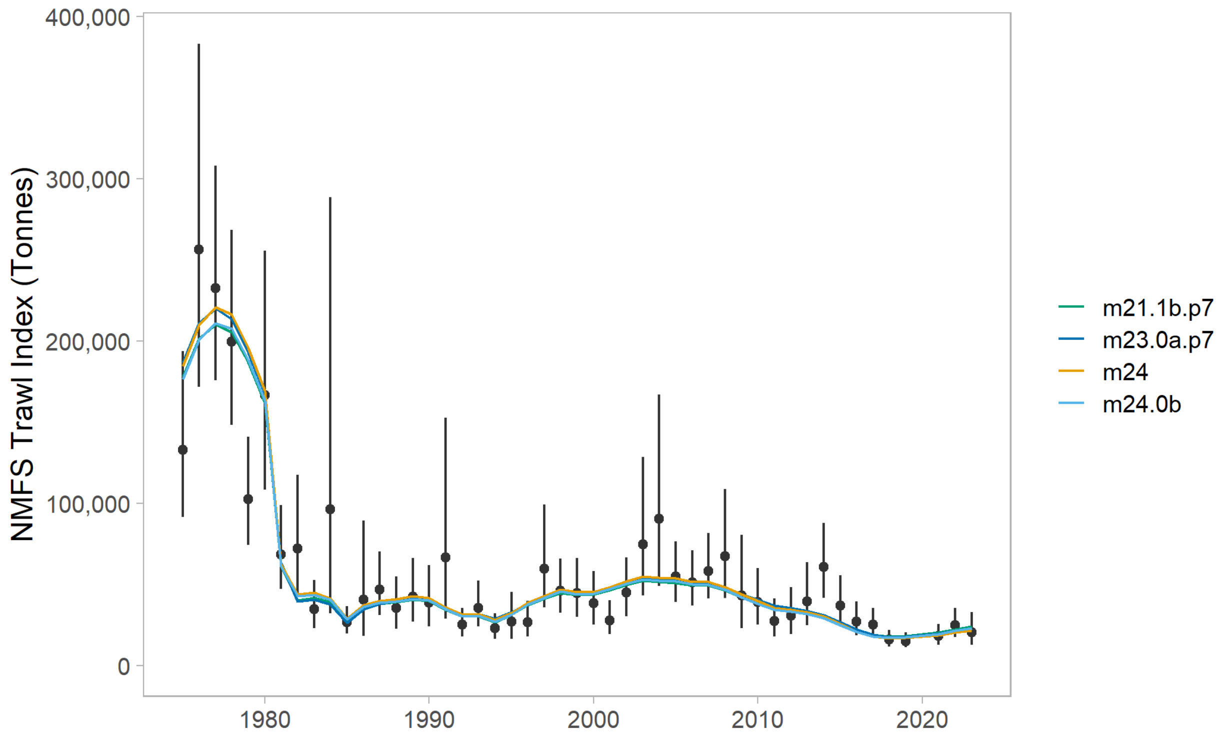

Figure 6: Comparisons of area-swept estimates of total male NMFS survey biomass and model predictions for model estimates in 2023 under models 21.1b.p7, 23.0a.p7, 24.0, 24.0b. The error bars are plus and minus 2 standard deviations of the area swept estimates.

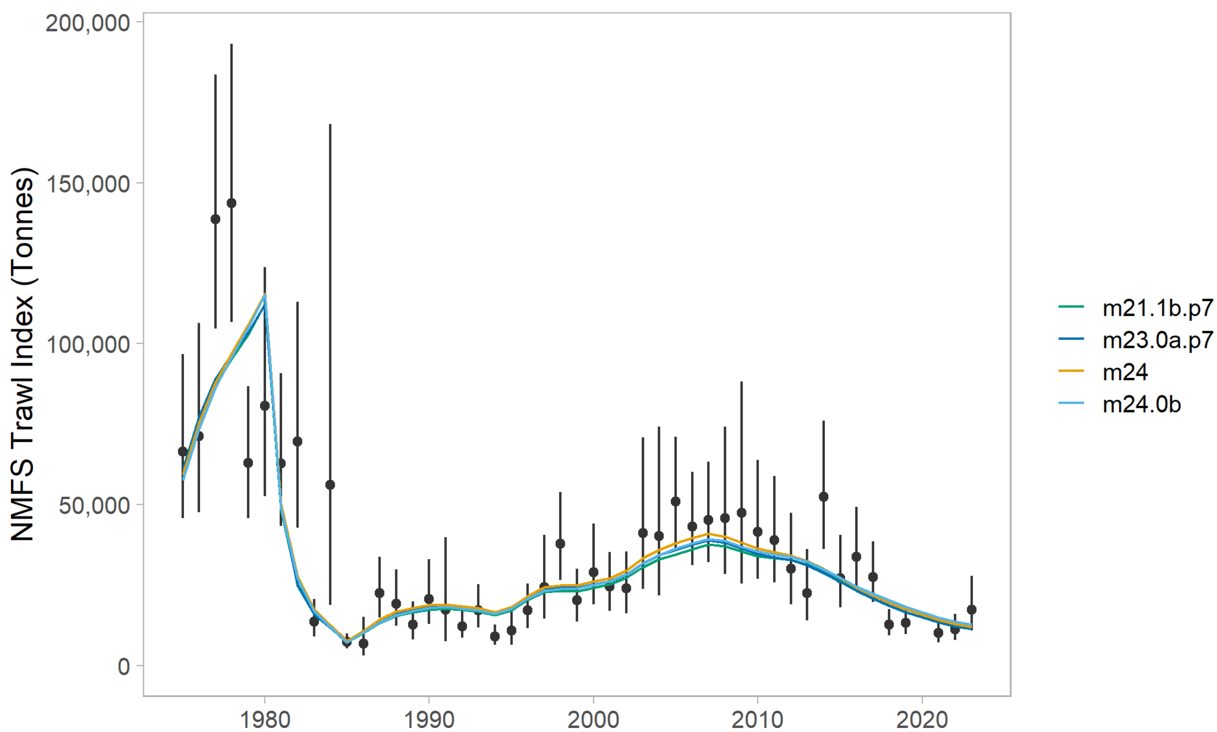

Figure 7: Comparisons of area-swept estimates of total female NMFS survey biomass and model predictions for model estimates in 2023 under models 21.1b.p7, 23.0a.p7, 24.0, 24.0b. The error bars are plus and minus 2 standard deviations of the area swept estimates.

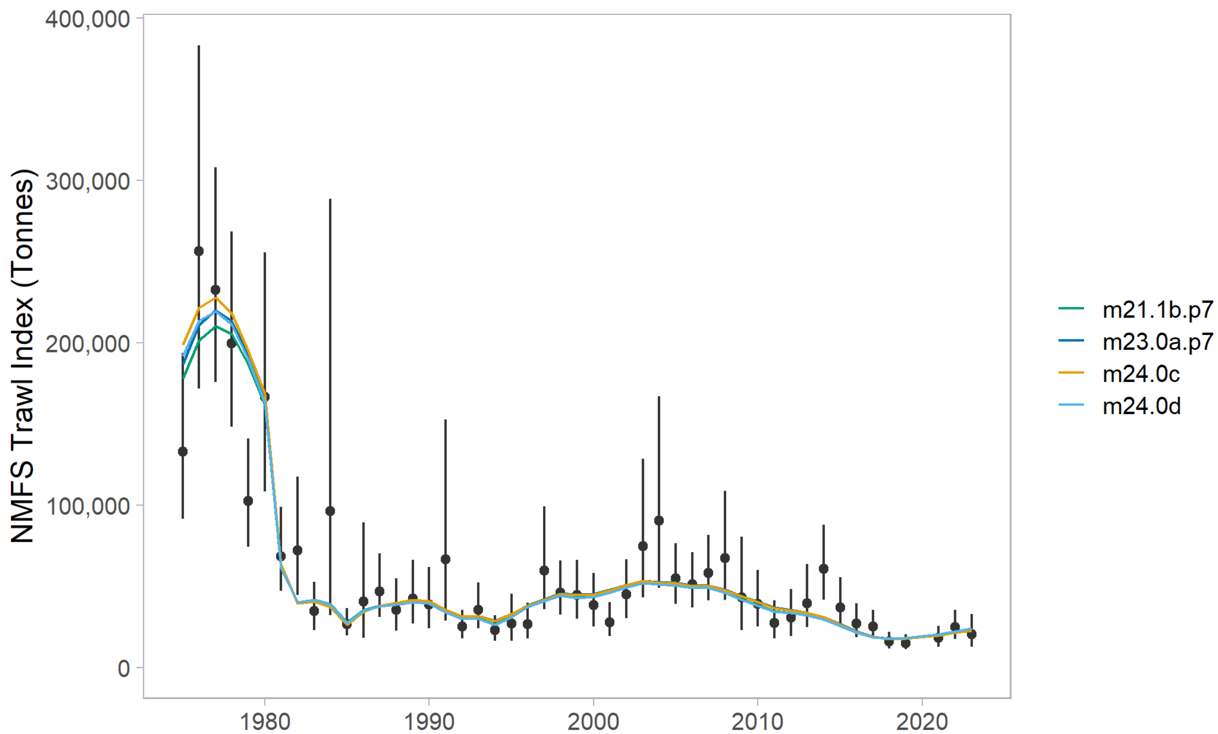

Figure 8: Comparisons of area-swept estimates of total male NMFS survey biomass and model predictions for model estimates in 2023 under models 21.1b.p7, 23.0a.p7, 24.0c, 24.0d. The error bars are plus and minus 2 standard deviations of the area swept estimates.

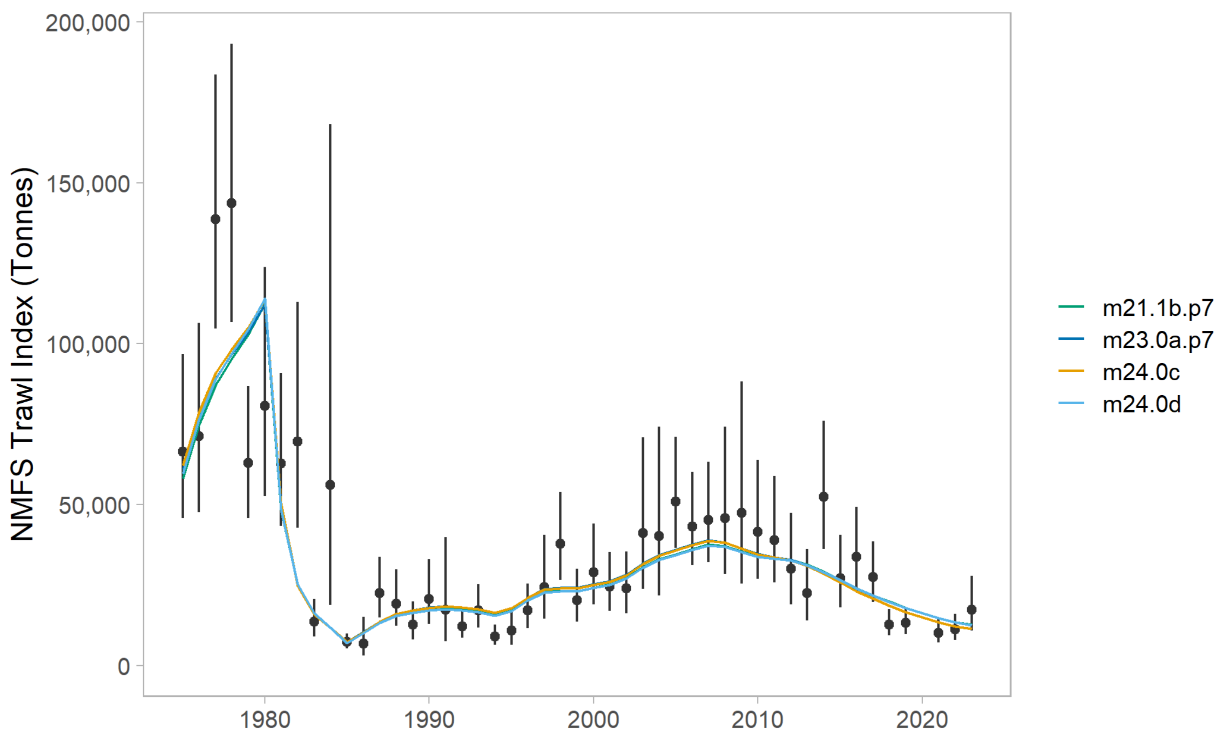

Figure 9: Comparisons of area-swept estimates of total female NMFS survey biomass and model predictions for model estimates in 2023 under models 21.1b.p7, 23.0a.p7, 24.0c, 24.0d. The error bars are plus and minus 2 standard deviations of the area swept estimates.

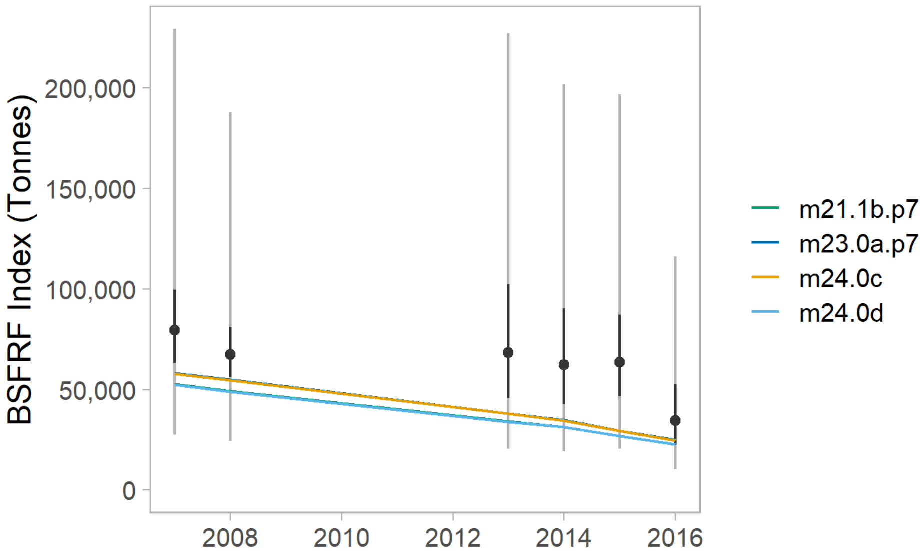

Figure 10: Comparisons of survey biomass estimates for males from the BSFRF survey and model predictions for model estimates in 2023 (models 21.1b.p7, 23.0a.p7, 24.0c, 24.0d). The error bars are plus and minus 2 standard deviations of the survey esimates. The BSFRF survey catchability is assumed to be 1.0 for all models.

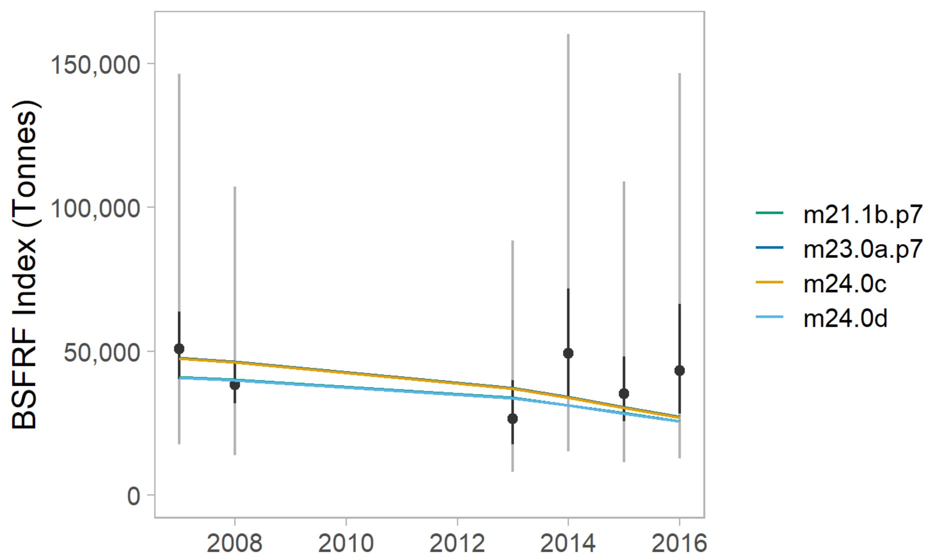

Figure 11: Comparisons of survey biomass estimates for females from the BSFRF survey and model predictions for model estimates in 2023 (models 21.1b.p7, 23.0a.p7, 24.0c, 24.0d). The error bars are plus and minus 2 standard deviations of the survey esimates. The BSFRF survey catchability is assumed to be 1.0 for all models.

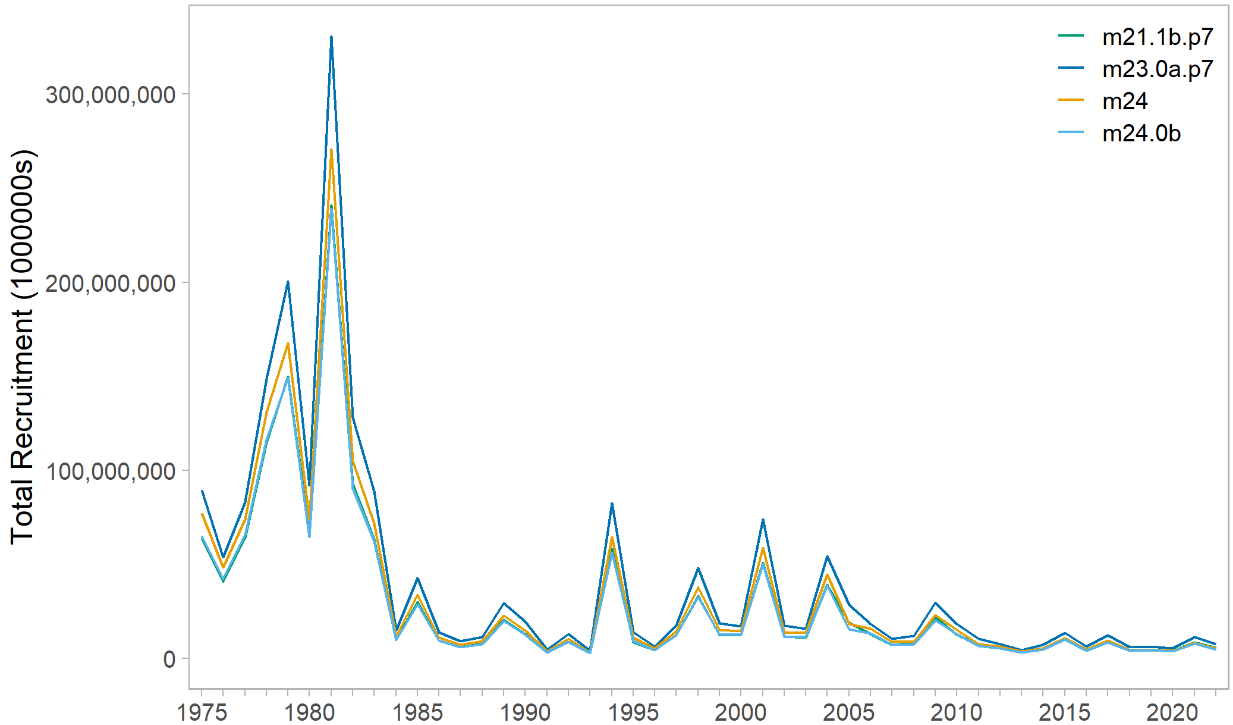

Figure 12: Estimated recruitment (million of individuals) time series during 1976-2022 with models 21.1b.p7, 23.0a.p7, 24.0, 24.0b (those models that remove BSFRF data and use it as a prior for NMFS q). Mean male recruits during 1984-2021 was used to estimate B35. Recruitment estimates in the terminal year (2022) are unreliable.

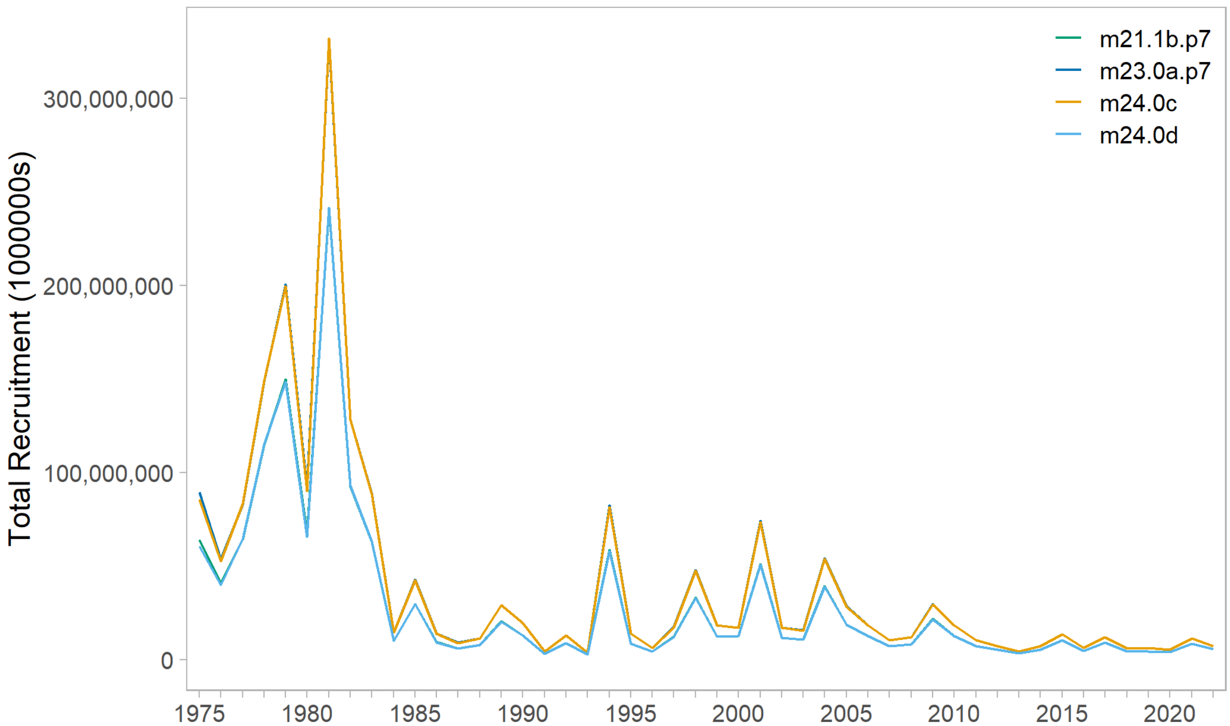

Figure 13: Estimated recruitment (million of individuals) time series during 1976-2022 with models 21.1b.p7, 23.0a.p7, 24.0c, 24.0d (base models compared with models with 1 molt probability period). Mean male recruits during 1984-2021 was used to estimate B35. Recruitment estimates in the terminal year (2022) are unreliable.

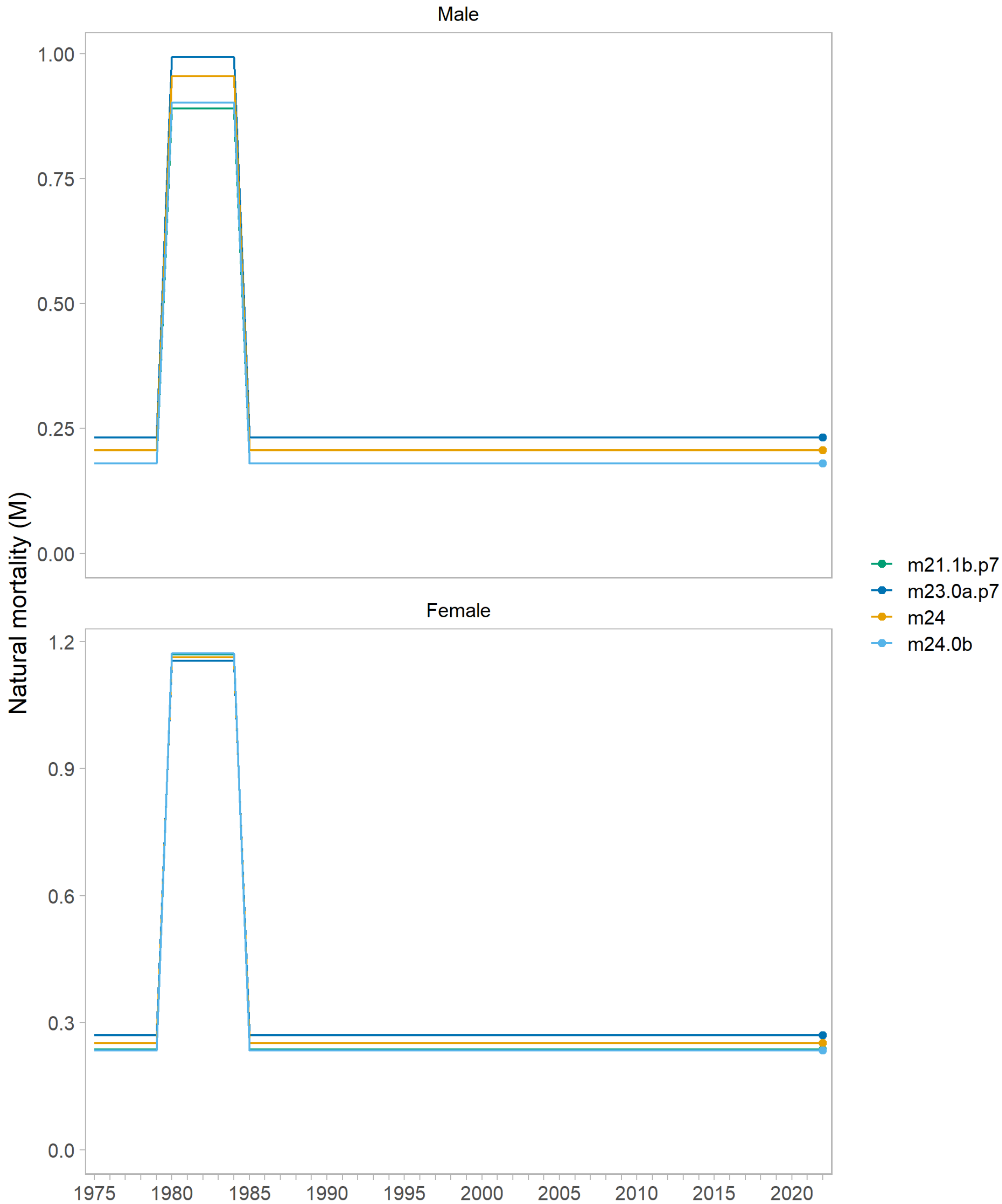

Figure 14: Comparison of natural mortality - either estimated or fixed depending on the model - for models 21.1b.p7, 23.0a.p7, 24.0, and 24.0b. Estimates for models 21.1b and 23.0a were identical to those labeled .p7 here.

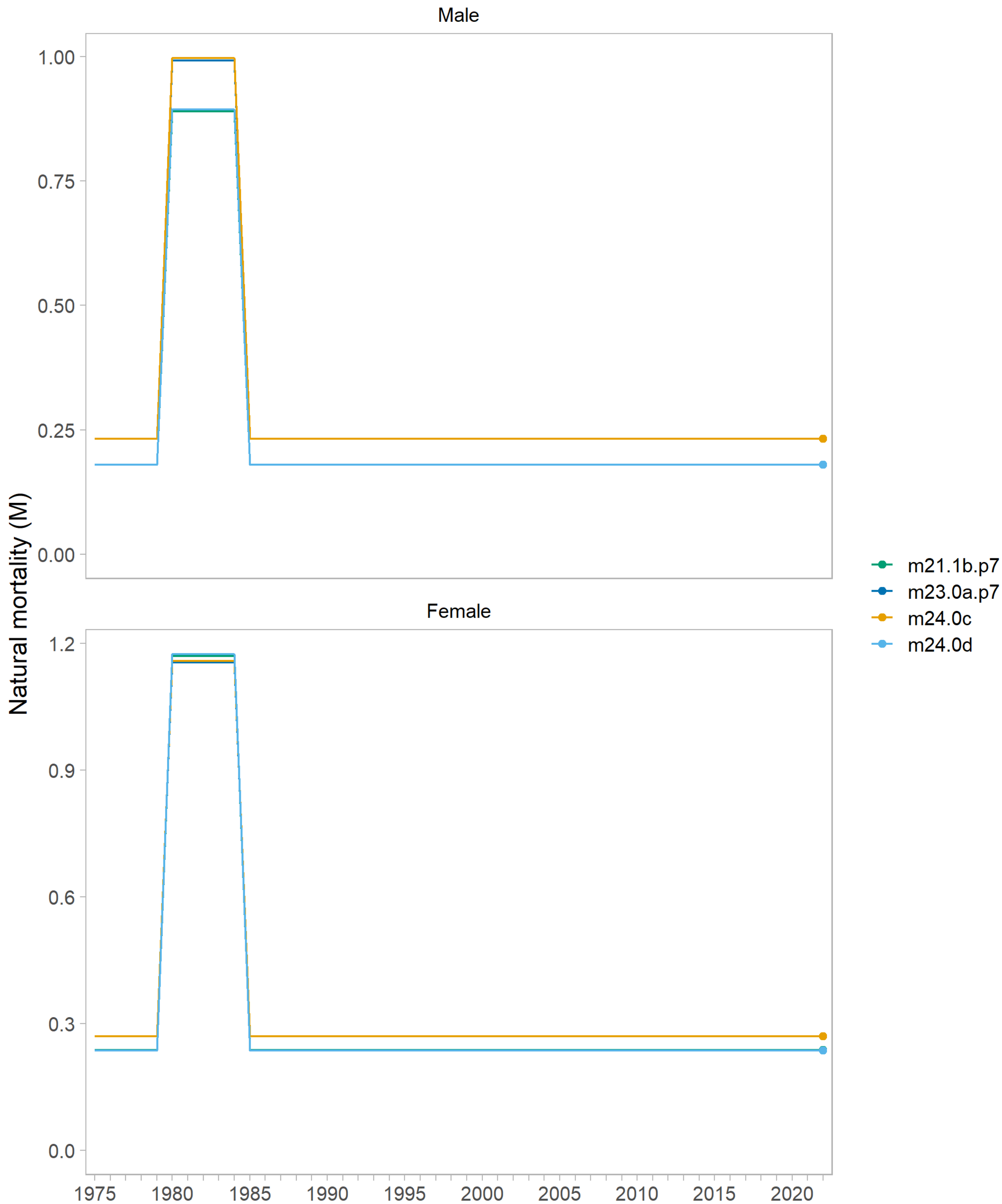

Figure 15: Comparison of natural mortality - either estimated or fixed depending on the model - for models 21.1b.p7, 23.0a.p7, 24.0c, and 24.0d.

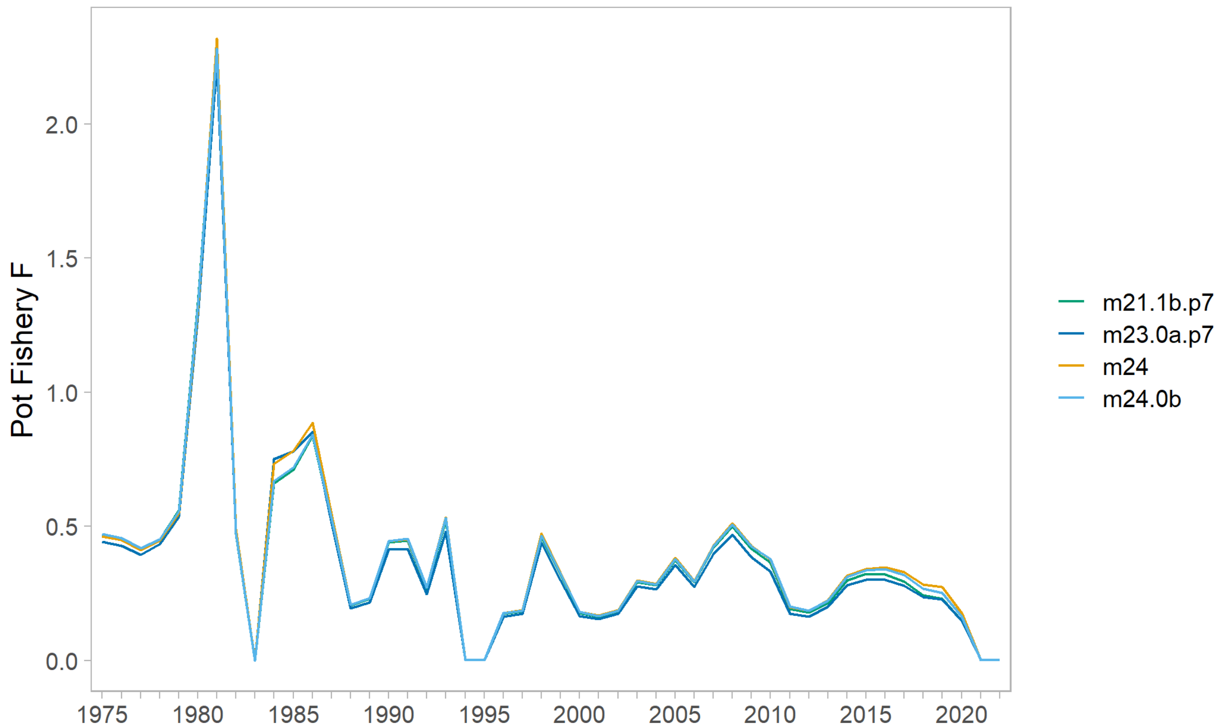

Figure 16: Comparison of estimated fishing mortality for models 21.1b.p7, 23.0a.p7, 24.0, and 24.0b. All other models are similar to base models shown here.

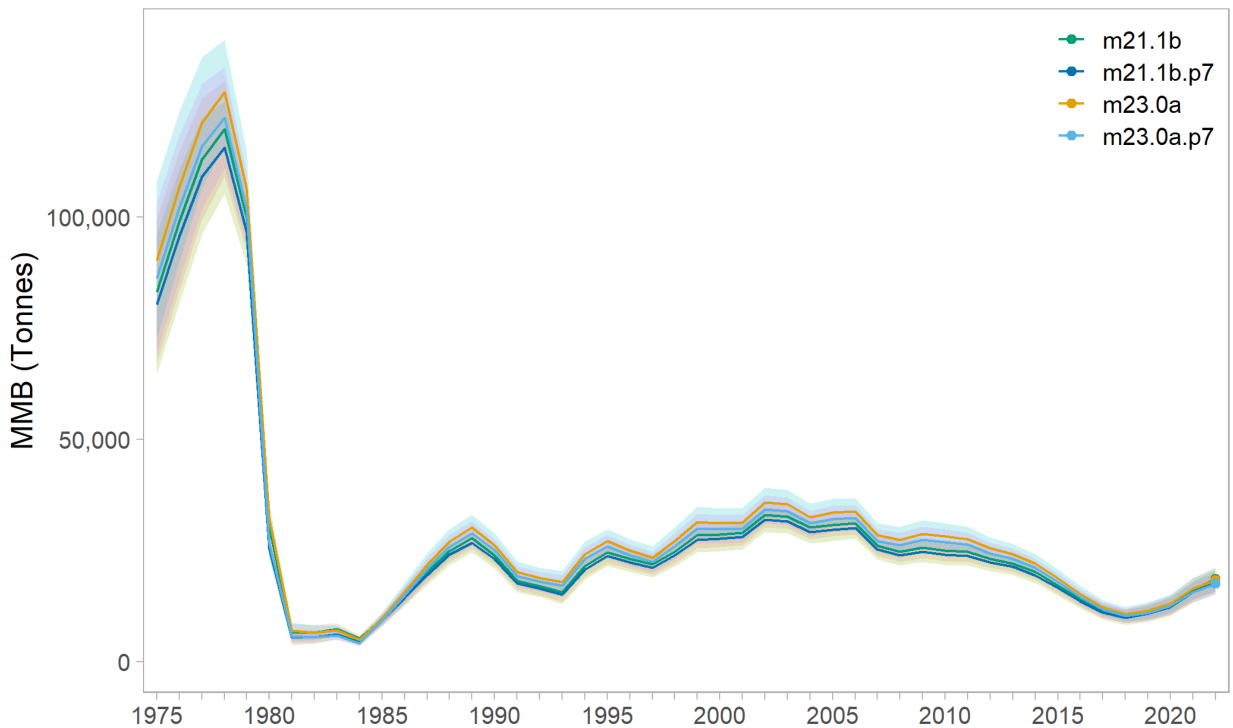

Figure 17: Estimated absolute mature male biomasses during 1975-2022 for models 21.1b, 23.0a, 21.1b.p7, and 23.0a.p7. Mature male biomass is estimated on Feb. 15, year+1 (i.e. 2022 value is Feb. 15 2023).

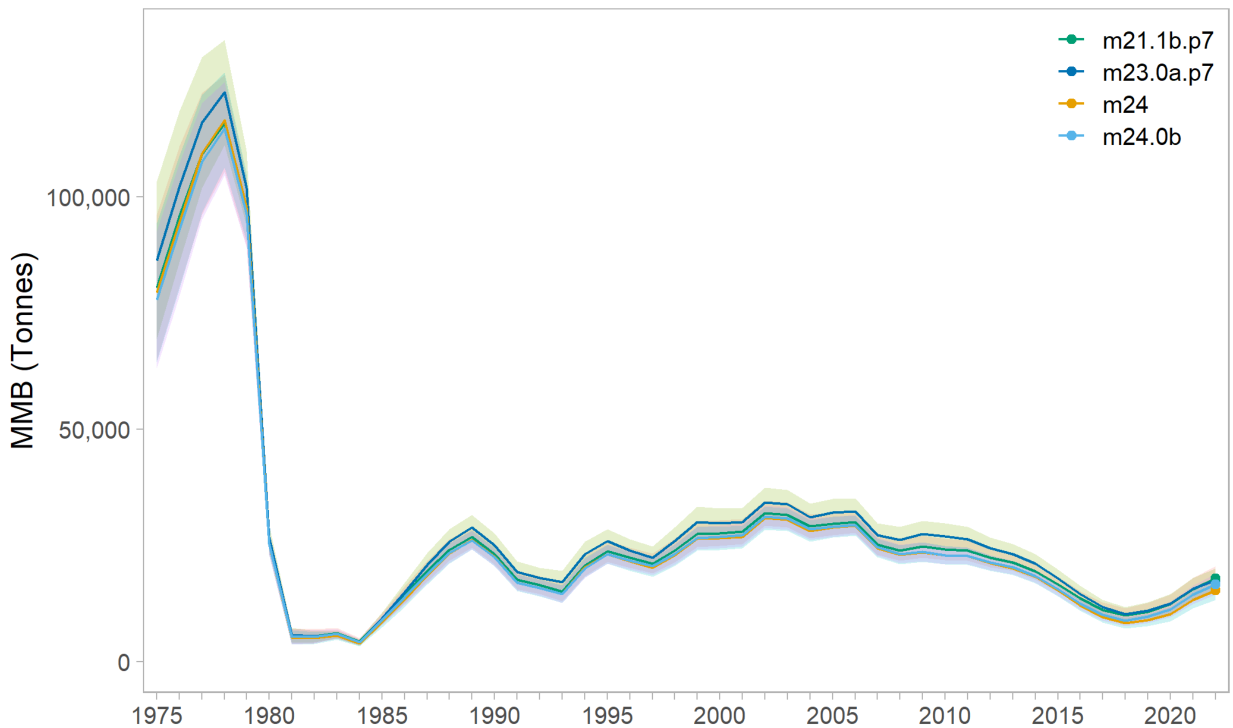

Figure 18: Estimated absolute mature male biomasses during 1975-2022 for models 21.1b.p7, 23.0a.p7, 24.0, and 24.0b. Mature male biomass is estimated on Feb. 15, year+1 (i.e. 2022 value is Feb. 15 2023).

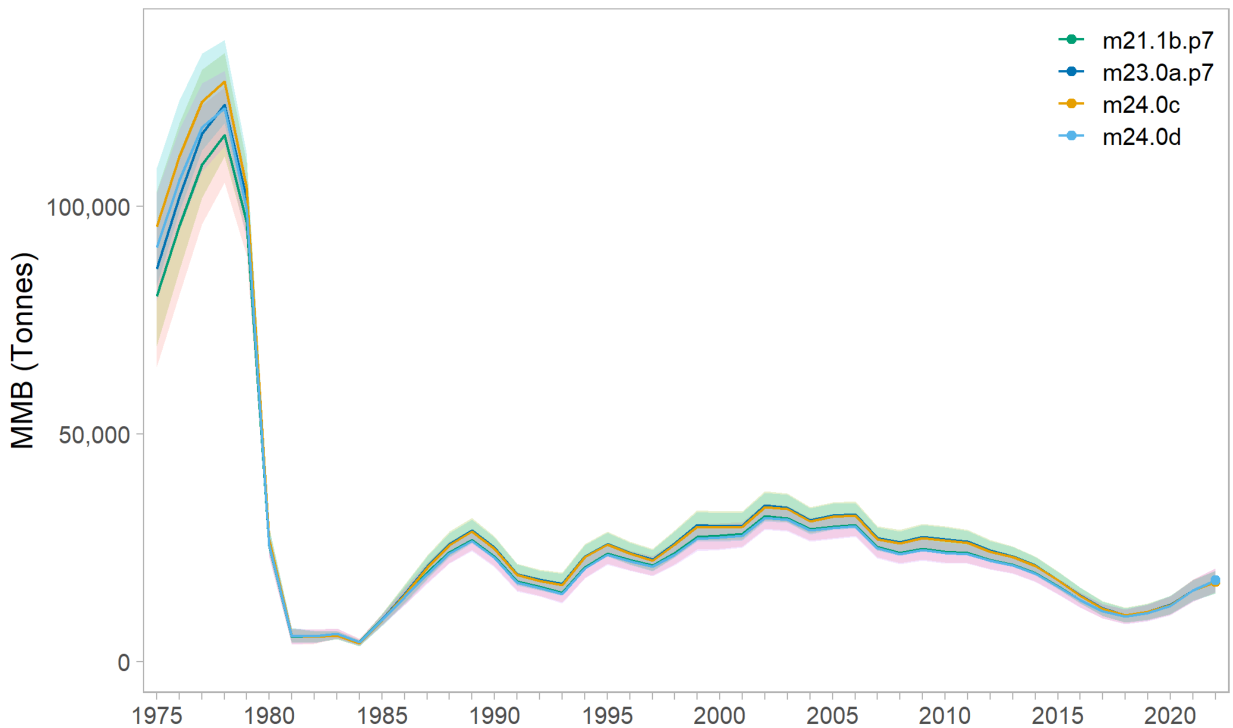

Figure 19: Estimated absolute mature male biomasses during 1985-2022 for models 21.1b.p7, 23.0a.p7, 24.0c, and 24.0d. Mature male biomass is estimated on Feb. 15, year+1 (i.e. 2022 value is Feb. 15 2023).

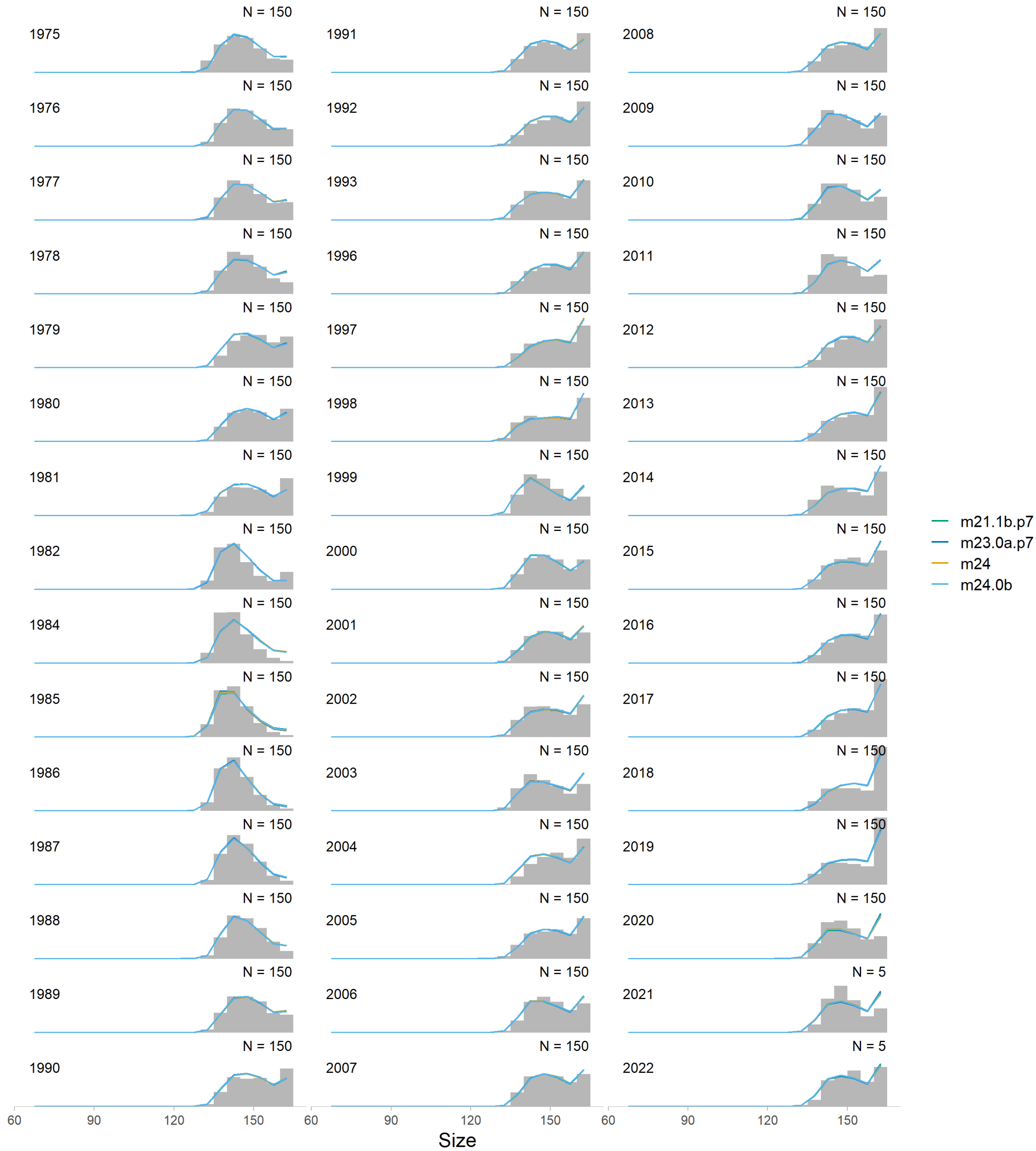

Figure 20: Observed and model estimated length-frequencies of male BBRKC by year retained in the directed pot fishery for the base model and model scenarios 24.0 and 24.0b.

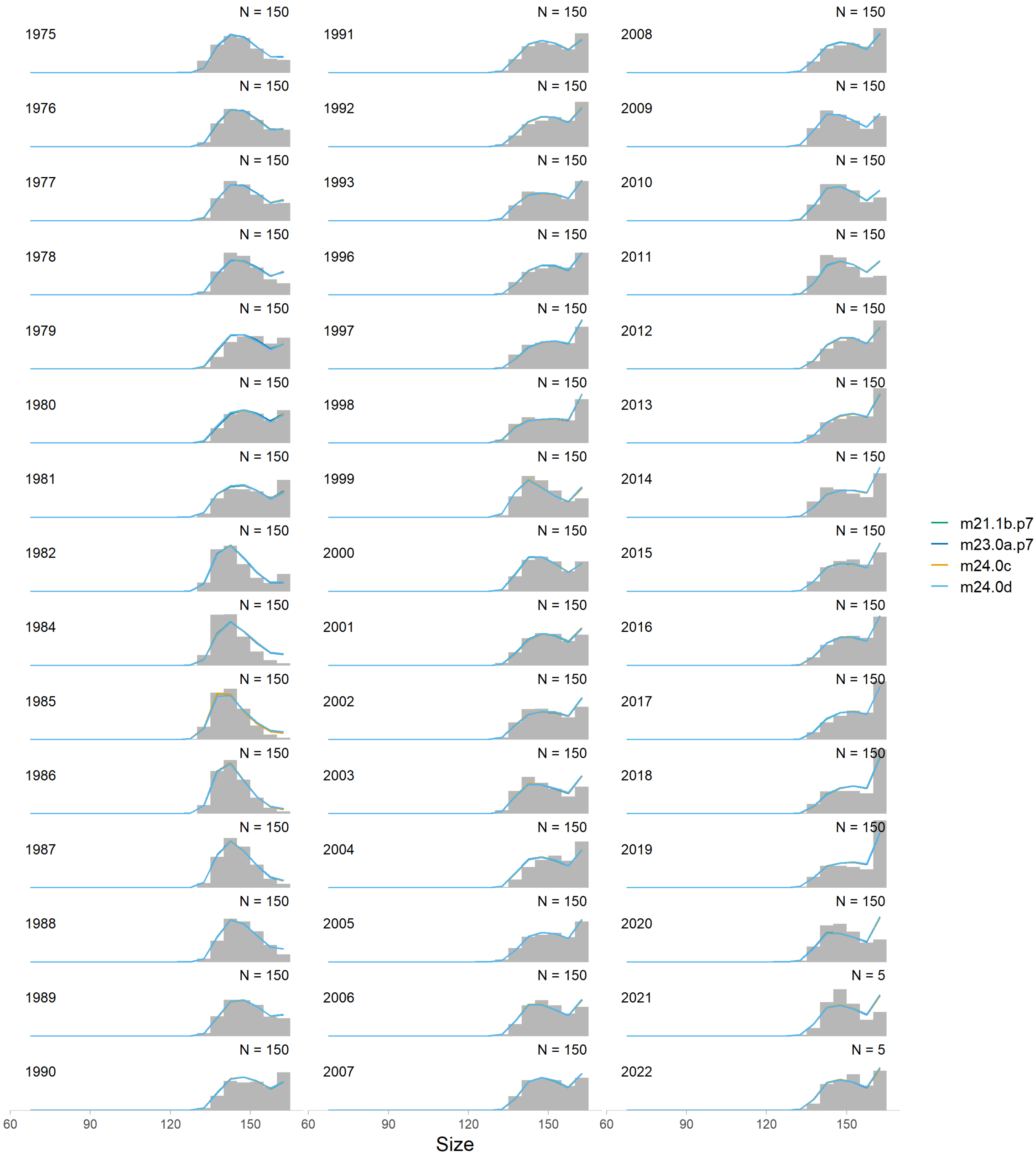

Figure 21: Observed and model estimated length-frequencies of male BBRKC by year retained in the directed pot fishery for the base models and model scenarios 24.0c and 24.0d.

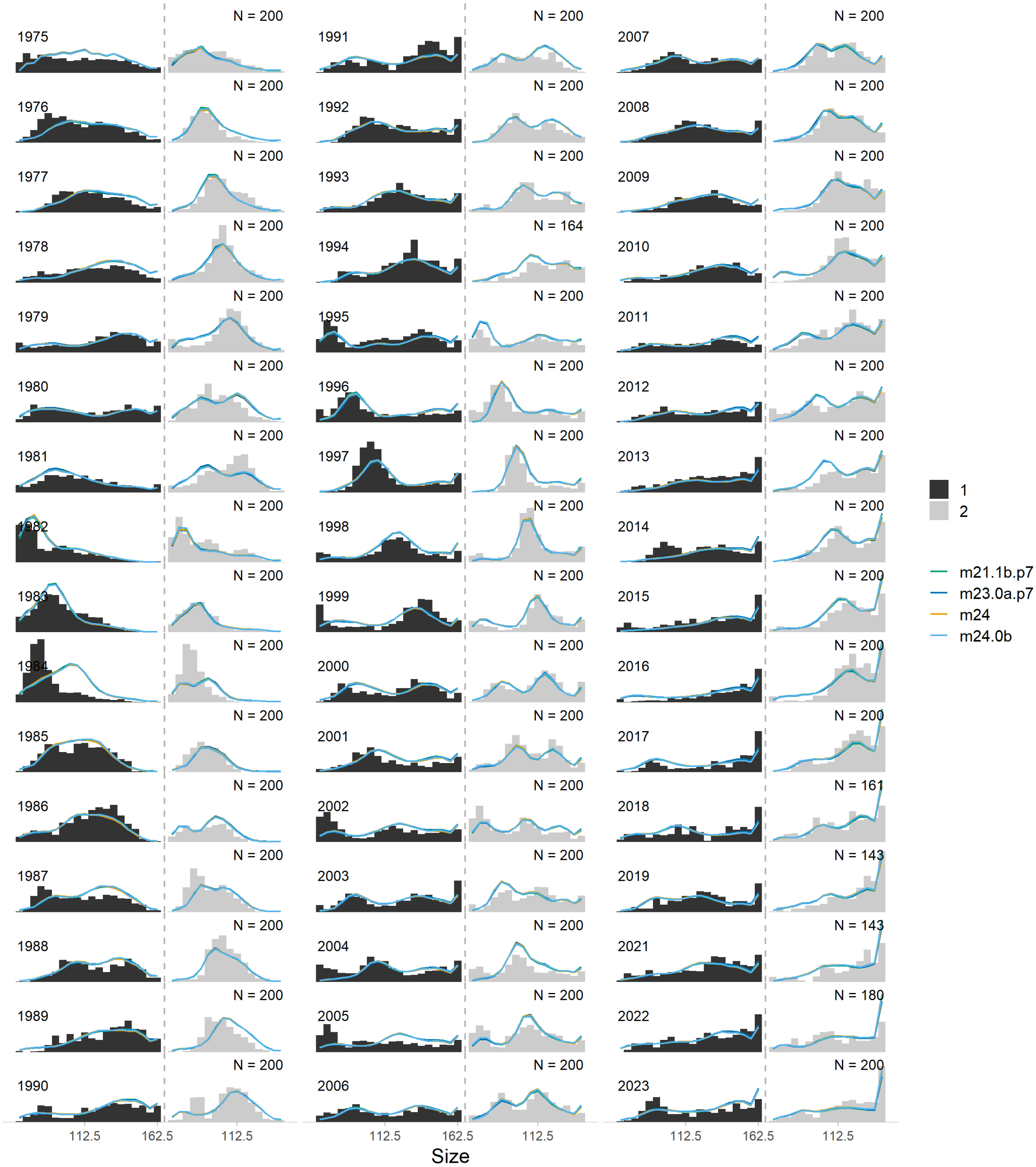

Figure 22: Comparison of area-swept and model estimated NMFS survey length frequencies of Bristol Bay male (black) and female (gray) red king crab by year for the base models and model scenarios 24.0 and 24.0b, which have changes in selectivity estimation.

Figure 23: Comparison of area-swept and model estimated NMFS survey length frequencies of Bristol Bay male (black) and female (gray) red king crab by year for the base models and model scenarios 24.0c and 24.0d, changes in molt periods.

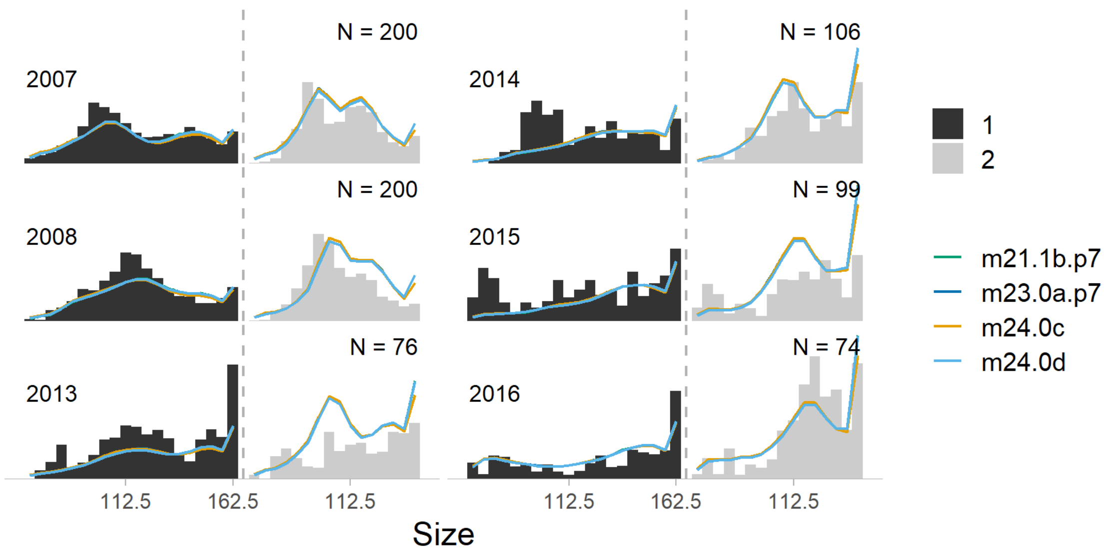

Figure 24: Comparisons of length compositions by the BSFRF survey and the model estimates during 2007-2008 and 2013-2016 for most model scenarios (male (black) and female (gray) red king crab).

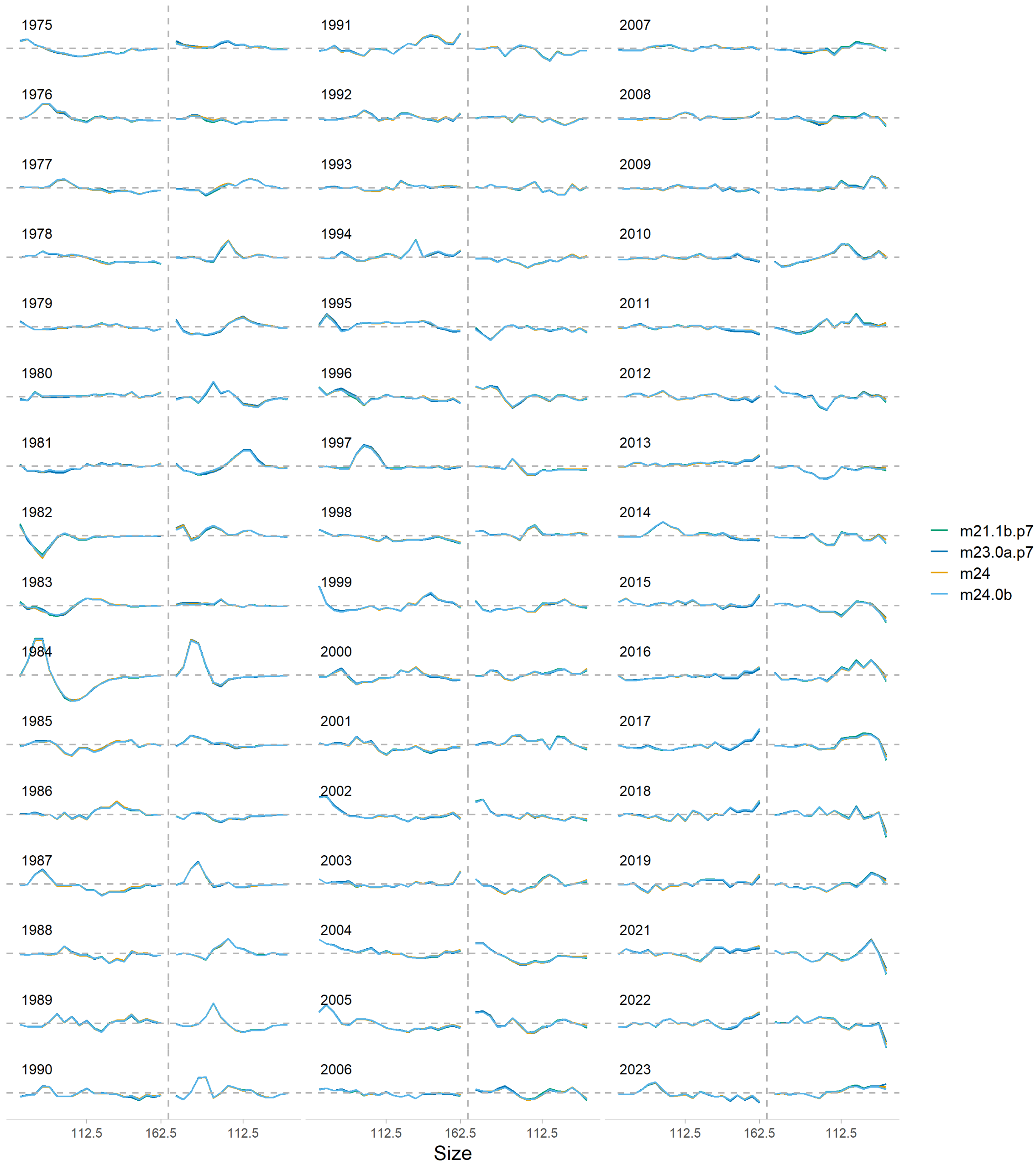

Figure 25: Residual line plot for male (left panel each year) and female (right panel each) size and year for the NMFS trawl survey size composition data sets for models 21.1b and 23.0a, along with 24.0 and 24.0b (models with selectivity priors based on BSFRF).

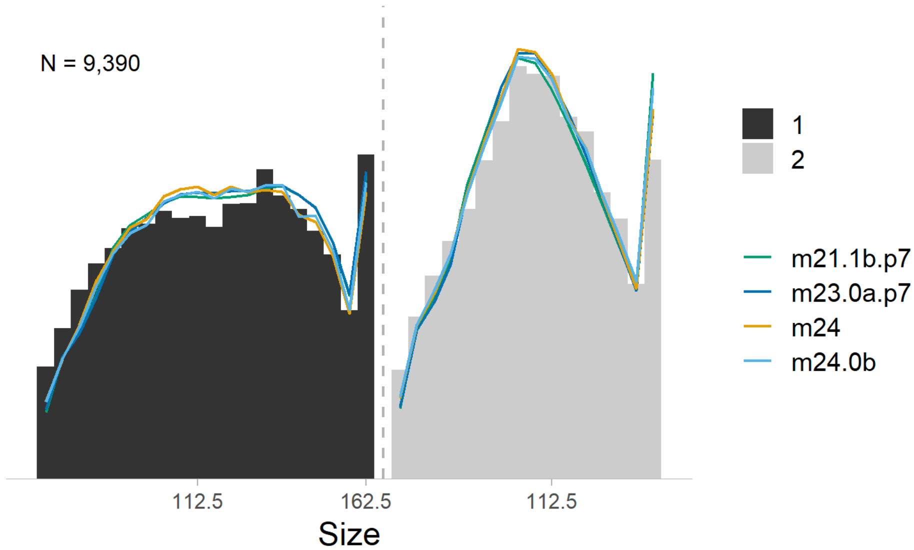

Figure 26: Aggregated size comps over all years for the NMFS survey for males (black) and females (grey) for base models and selectivity models.

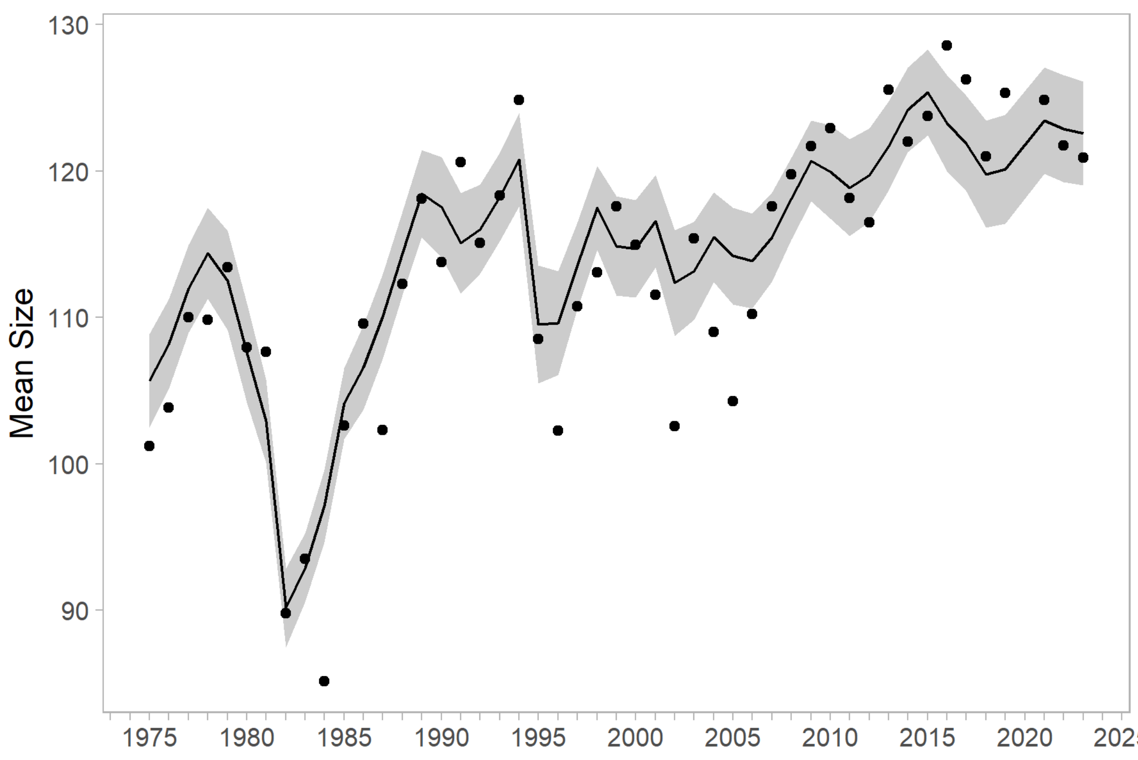

Figure 27: Mean size over all years for the NMFS survey for males under model 23.0a.p7 (2023 accepted model).

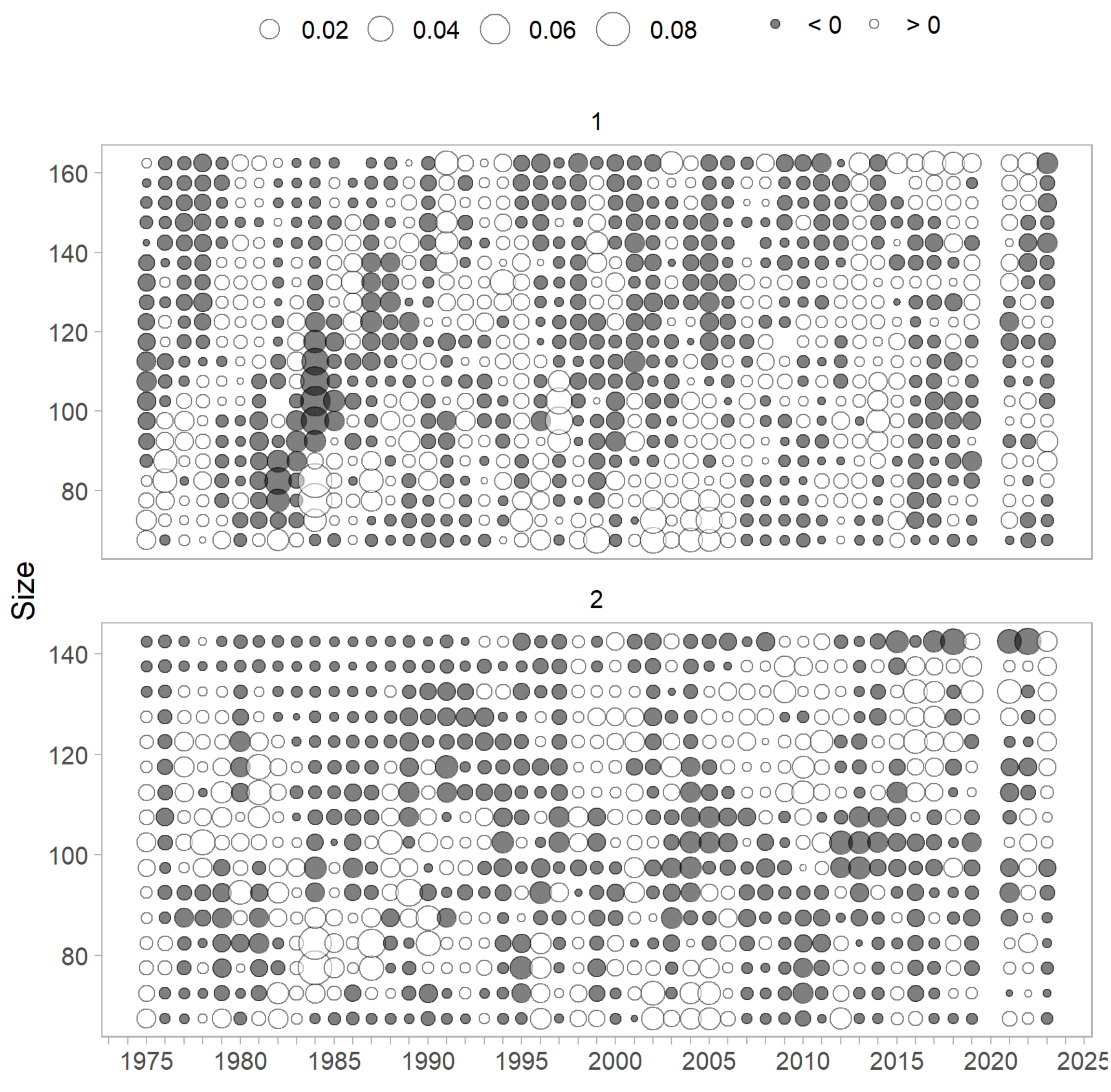

Figure 28: Bubble plot for residuals of size comps for males (1) and females (2) for the NMFS survey for males under model 23.0a.p7 (2023 accepted model).