



# Bristol Bay red king crab

Final SAFE

September 2026

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ADF&G

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# Summary

- Mature male biomass increased from 2025 with increased variability, still low compared to long term average
- Directed fishery was open in 2025/26, with similar CPUE (crab/pot) to the 2024/25 season
- Female molt/mate cycle delayed, no resampling
- Estimated mature female biomass is higher than recent years but still lower than it's been since the mid-90s
- 2026 area-swept and State of Alaska LBA model estimates of female abundance are above the State Harvest strategy thresholds (8.4 million) this year.
- Low recruitment in recent years (last 10-15 years), projected decline in biomass with higher exploitation rates without a large recruitment event
  - Potential recruitment appearing in survey data but consist of only a few tows

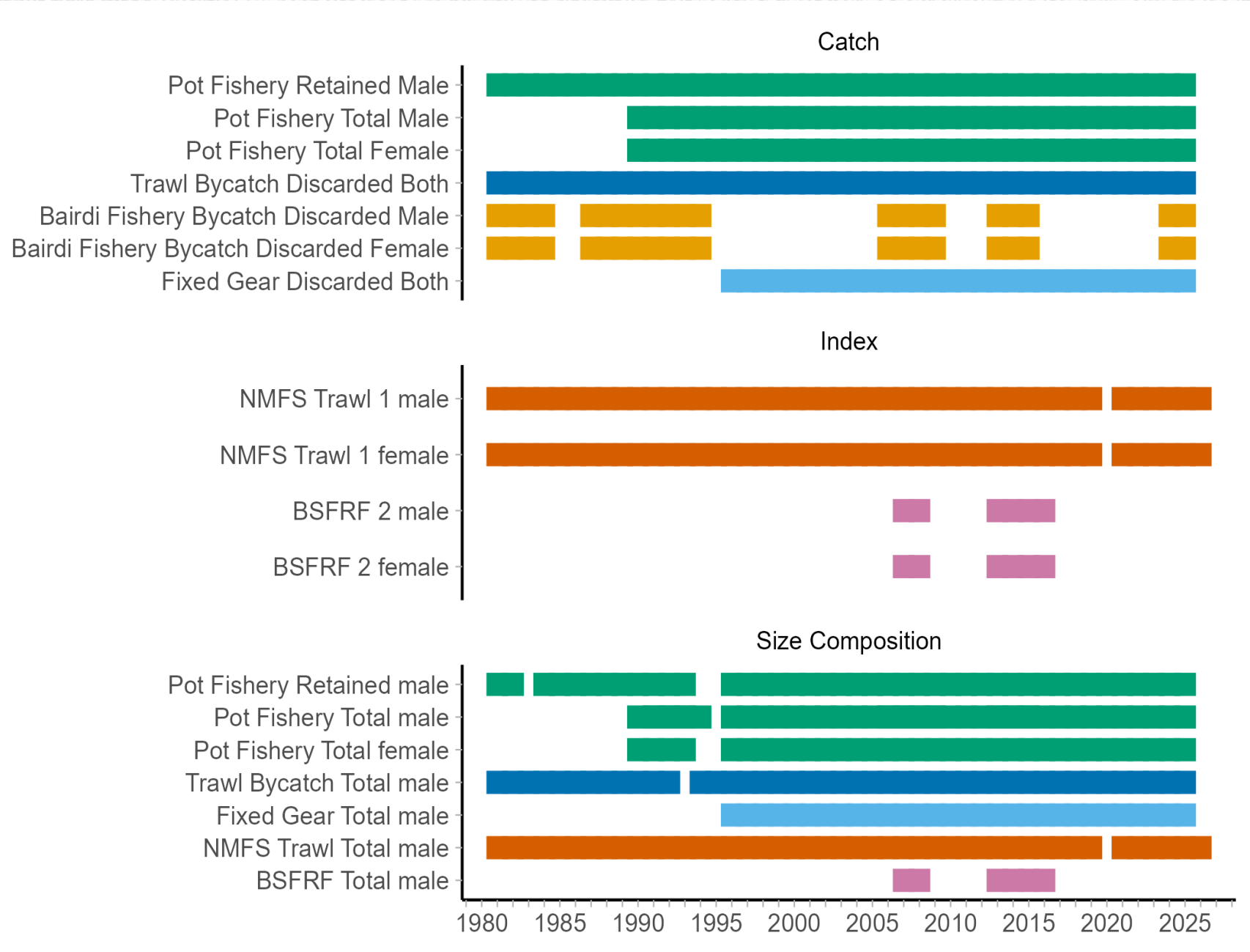
# CPT / SSC comments

- Some comments were addressed in May 2026, others are ongoing
- GMACS version updates – updated version from May due to error with catch data when size comps are aggregated (Tanner crab bycatch size comps in this model).
- Work will be continued for 2027 proposed model work
  - Increasing the additional size bins, reviewing growth data and assumptions, corrections to size-length relationship for higher size bins
  - Continued work on BSFRF data used as a prior on Q
    - Other recommendations related to selectivity and retention explorations
- Additional spatial exploration of fishery data
- Model-based indices on the list for 2027 (co-author with Caitlin Stern)
  - Potential for including crab north of Bristol Bay boundary

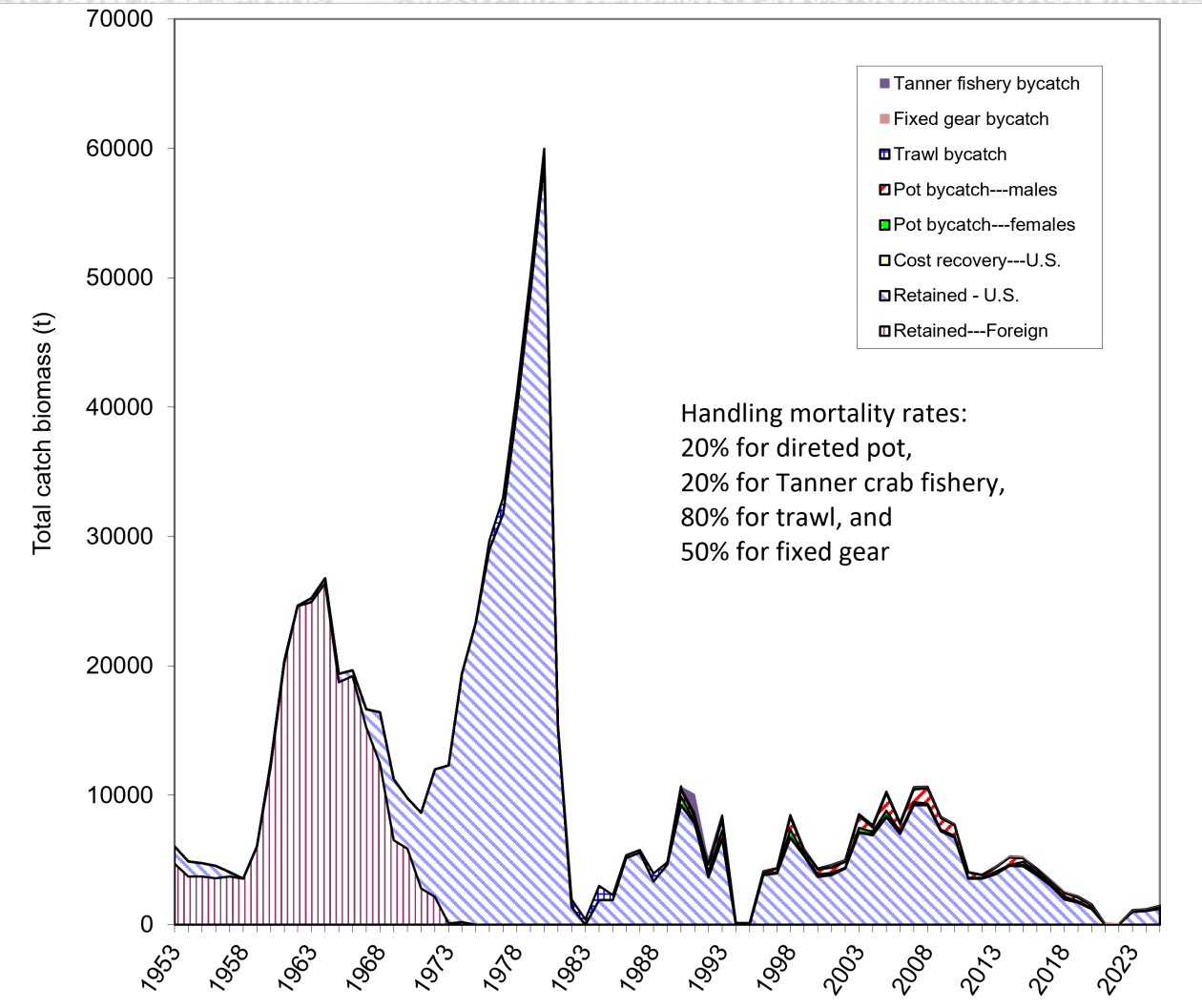
# Outline

- **Data and catch updates for 2026**
- Bridging to GMACS v2.20.44 from spring version v2.20.34a
- Bridging with new data for crab year 2025/26
- Model explorations
  - Model 24.0c.2 – base model
  - Model 26.0 – base model + additional size bins

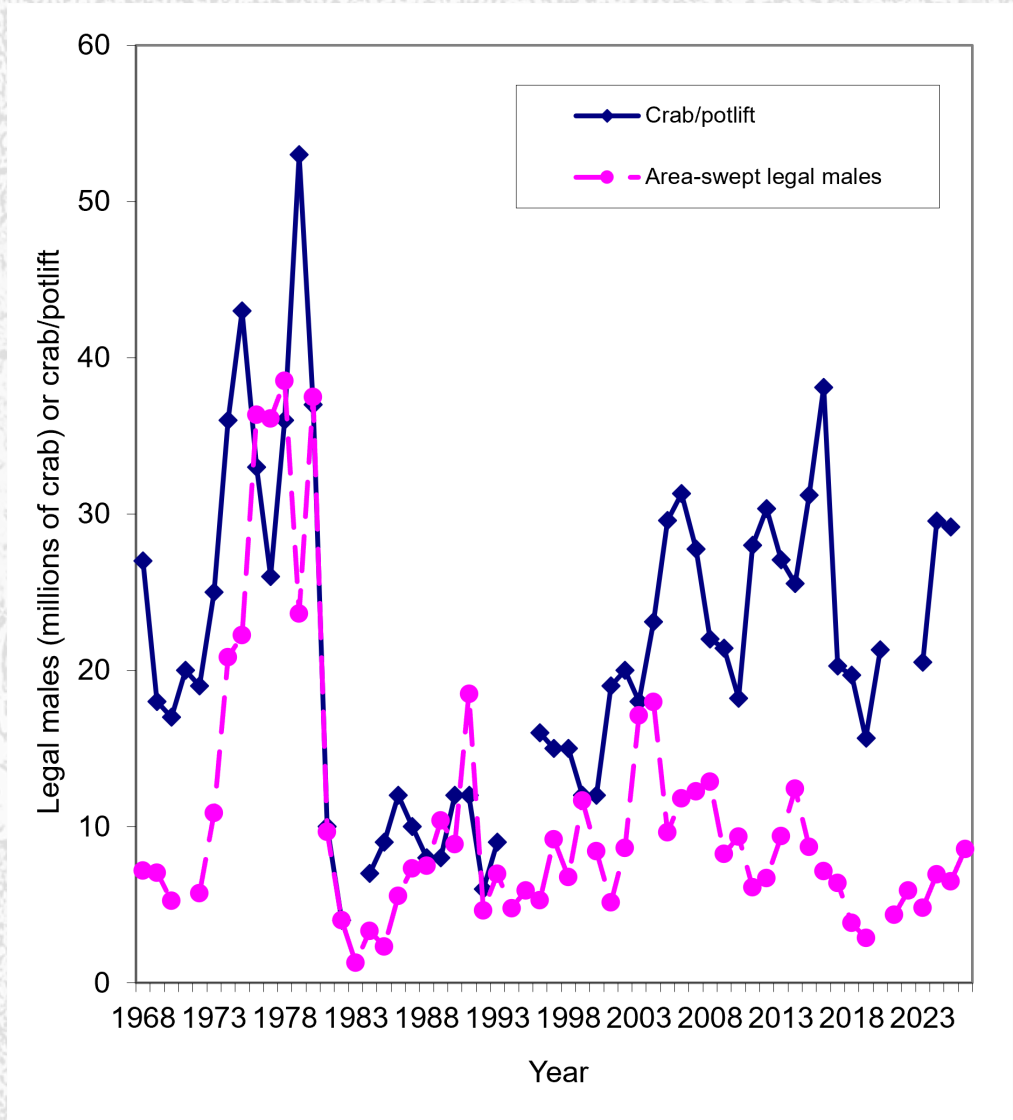
# Data extent and new data for 2026



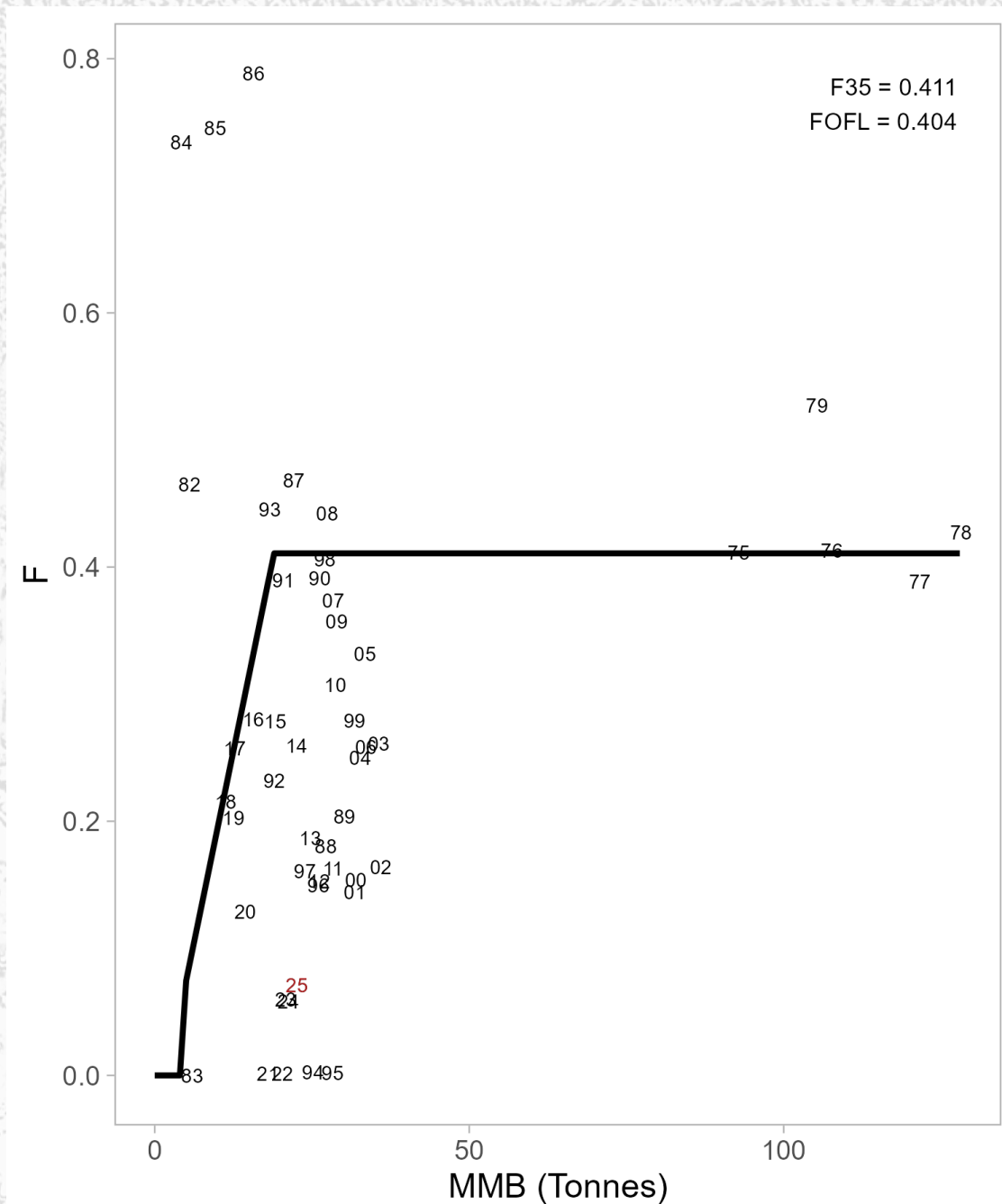
Retained and bycatch mortality (t)



Survey legal male abundance and CPUE for directed BBRKC fishery

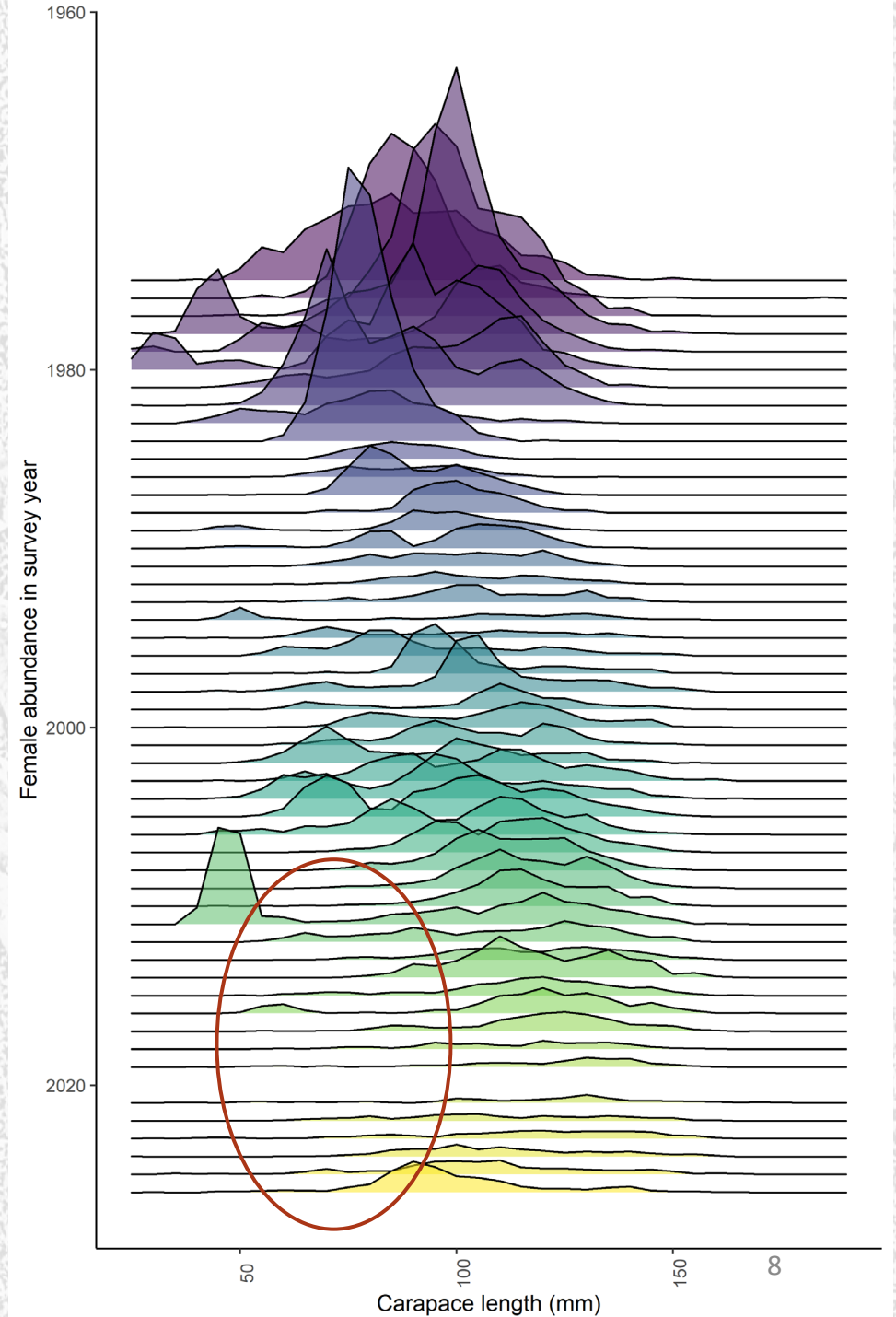
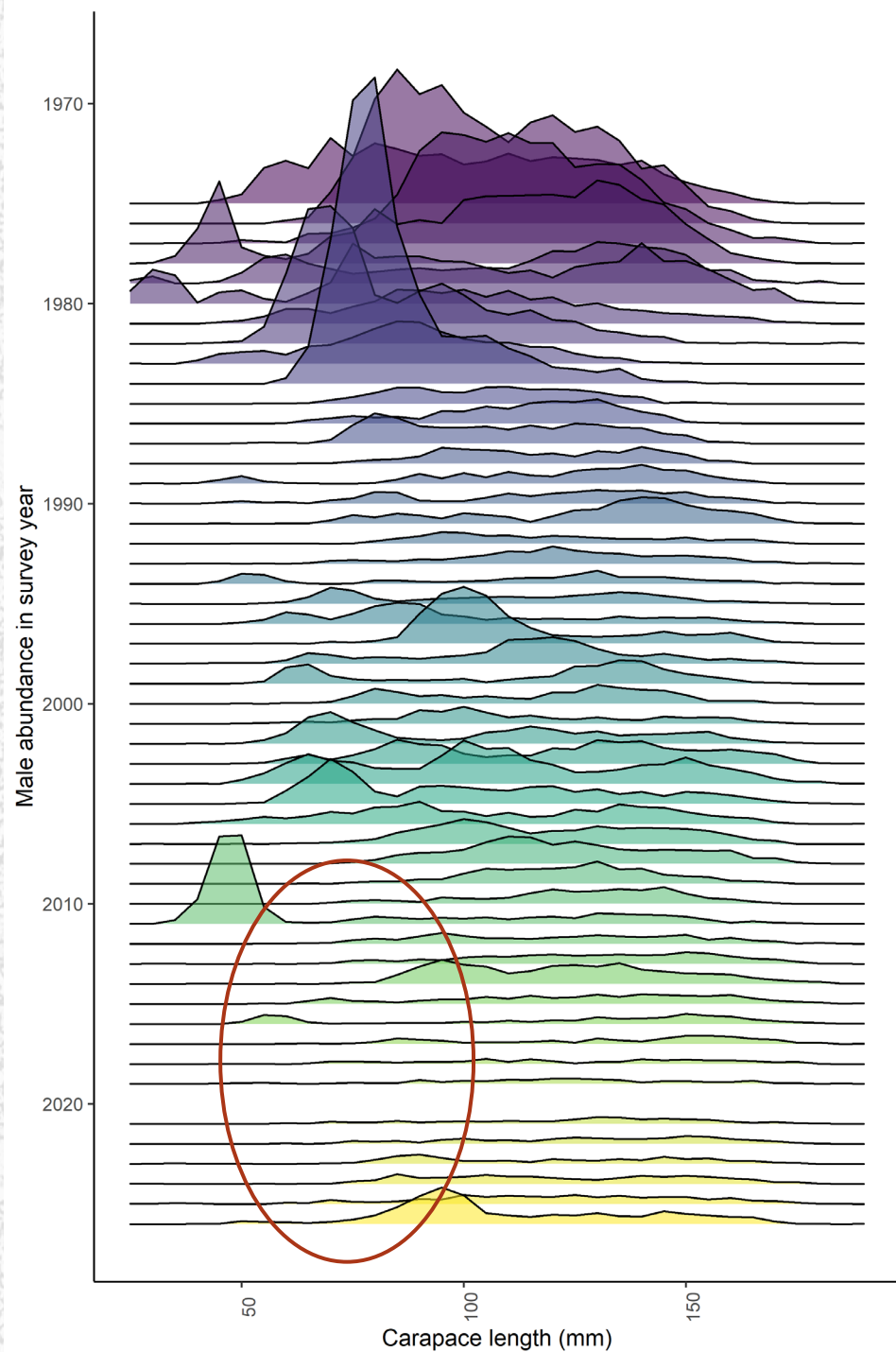


# Fishing mortality and MMB relationship over time (model 26.0)



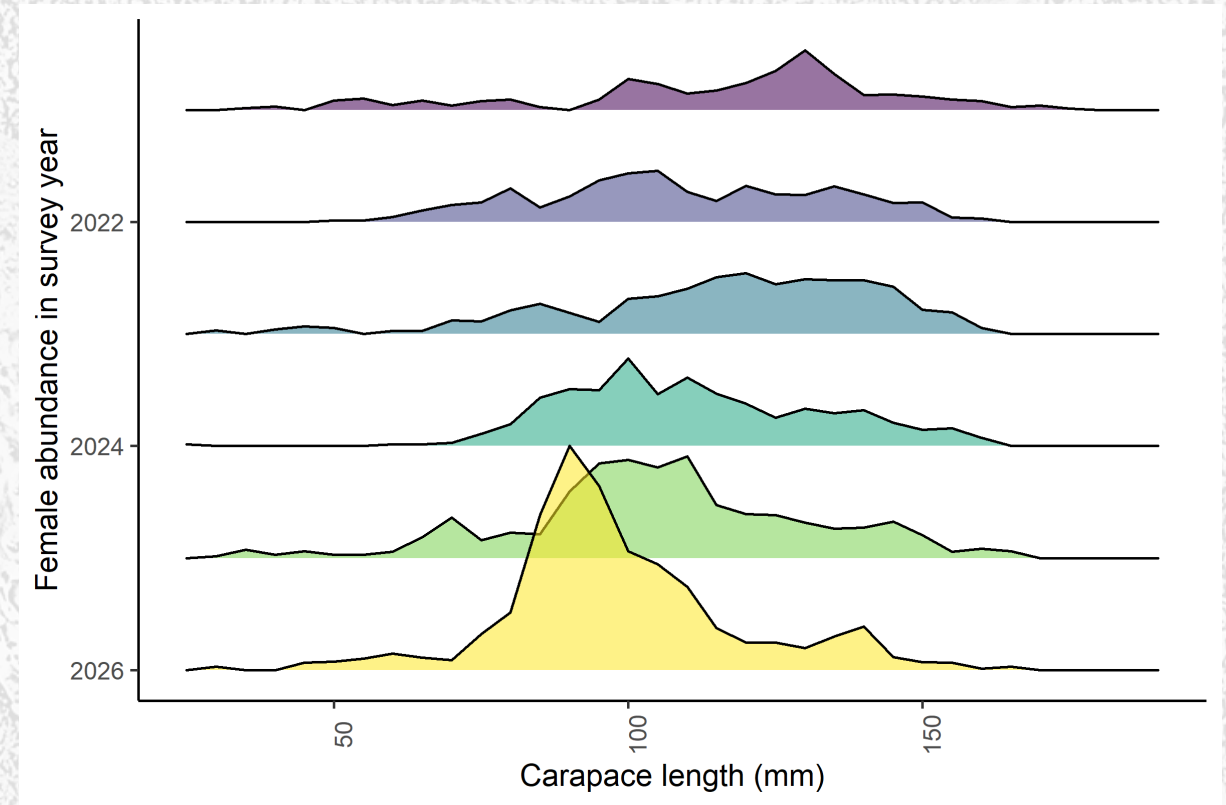
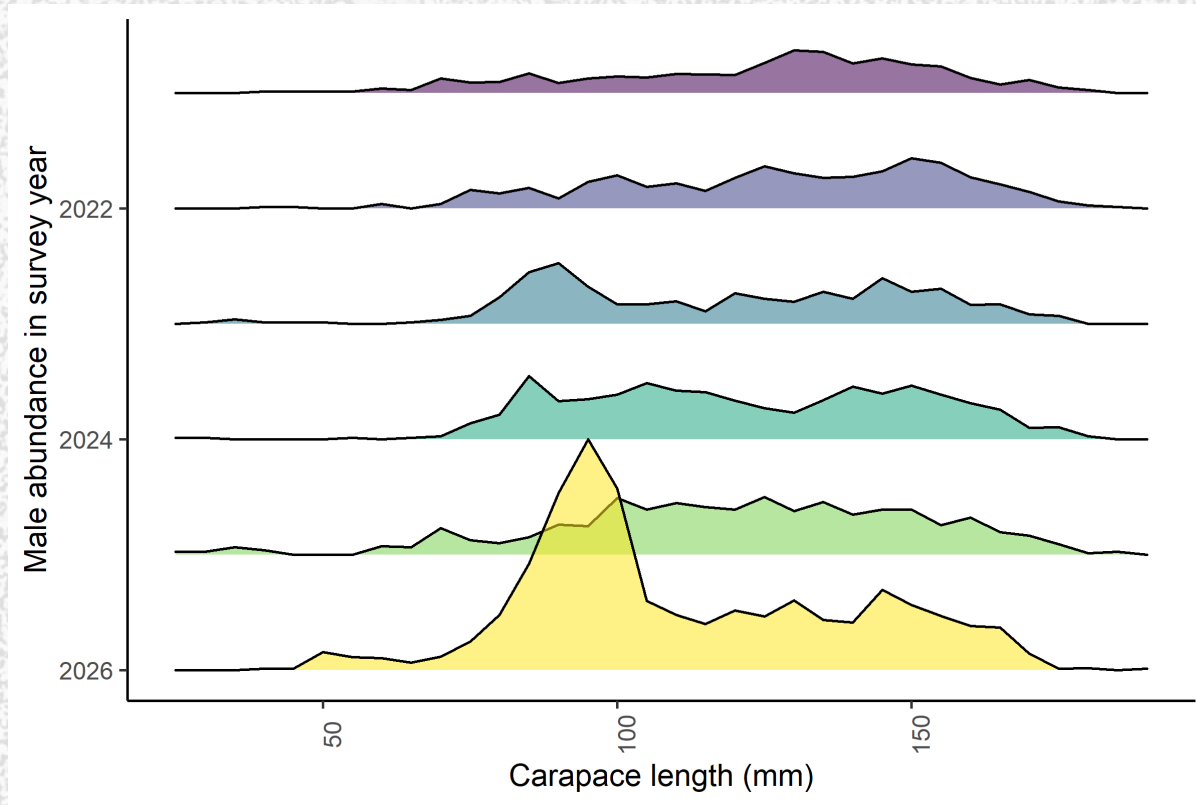
# Length composition from NMFS survey

- model  
"recruitment" at  
65mm

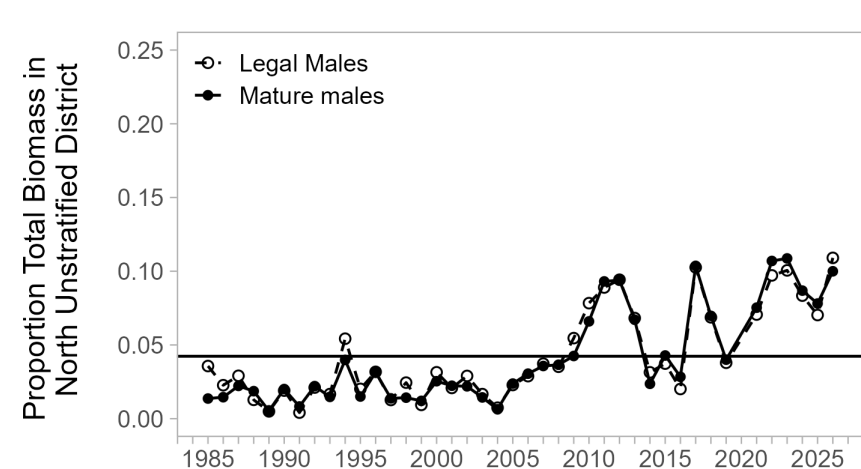
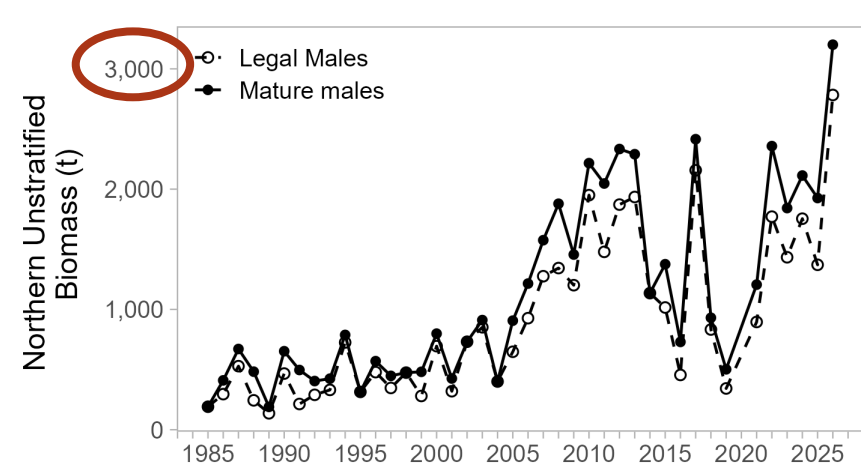
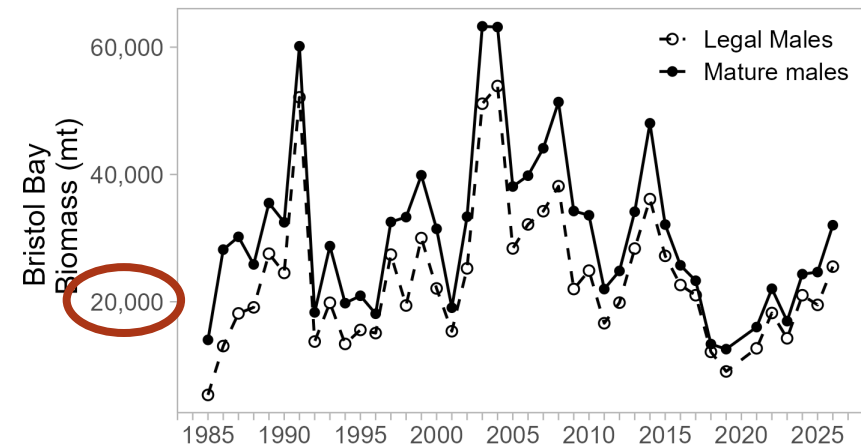
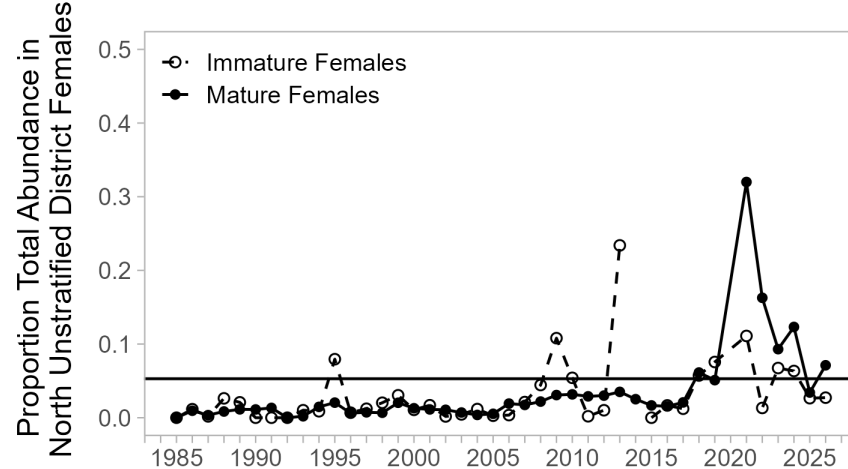
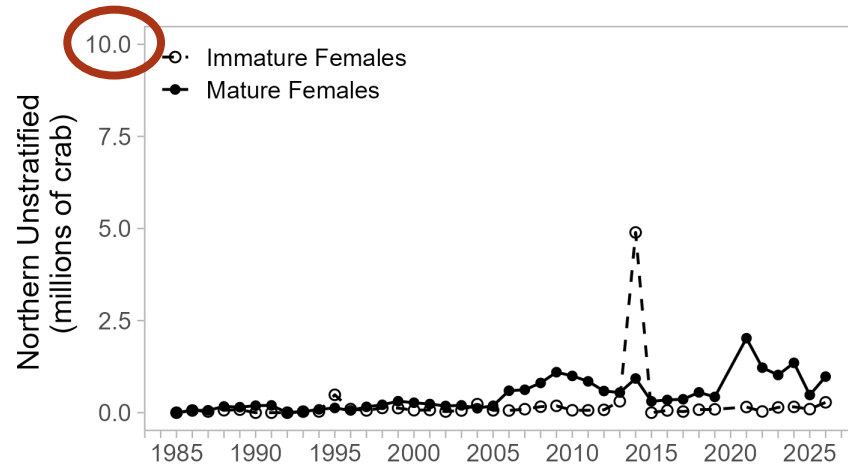
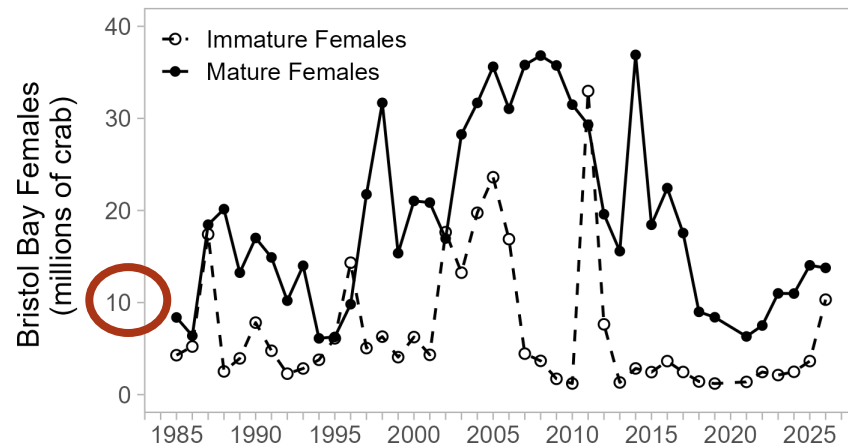


# Length composition from NMFS survey

- model “recruitment” at 65mm



# Northern area RKC



# Model explorations

**24.0c.2\_v34a** – May 2026 version

**26.0\_v34a** – May 2026 version

**24.0c.2\_v44:** 2025 accepted model (based on model 24.0c in 2024, and model 23.0a (2023 base model, starts in 1975, mortality event in 80s, stable in GMACS since 2018 + base M for males *estimated* in the model) + no time block for molt probability)

+ **GMACS updated version** (version 2.20.44)

**24.0c.2:**

+ **2025/26 data** (directed fishery, bycatch (crab and groundfish), and survey data)

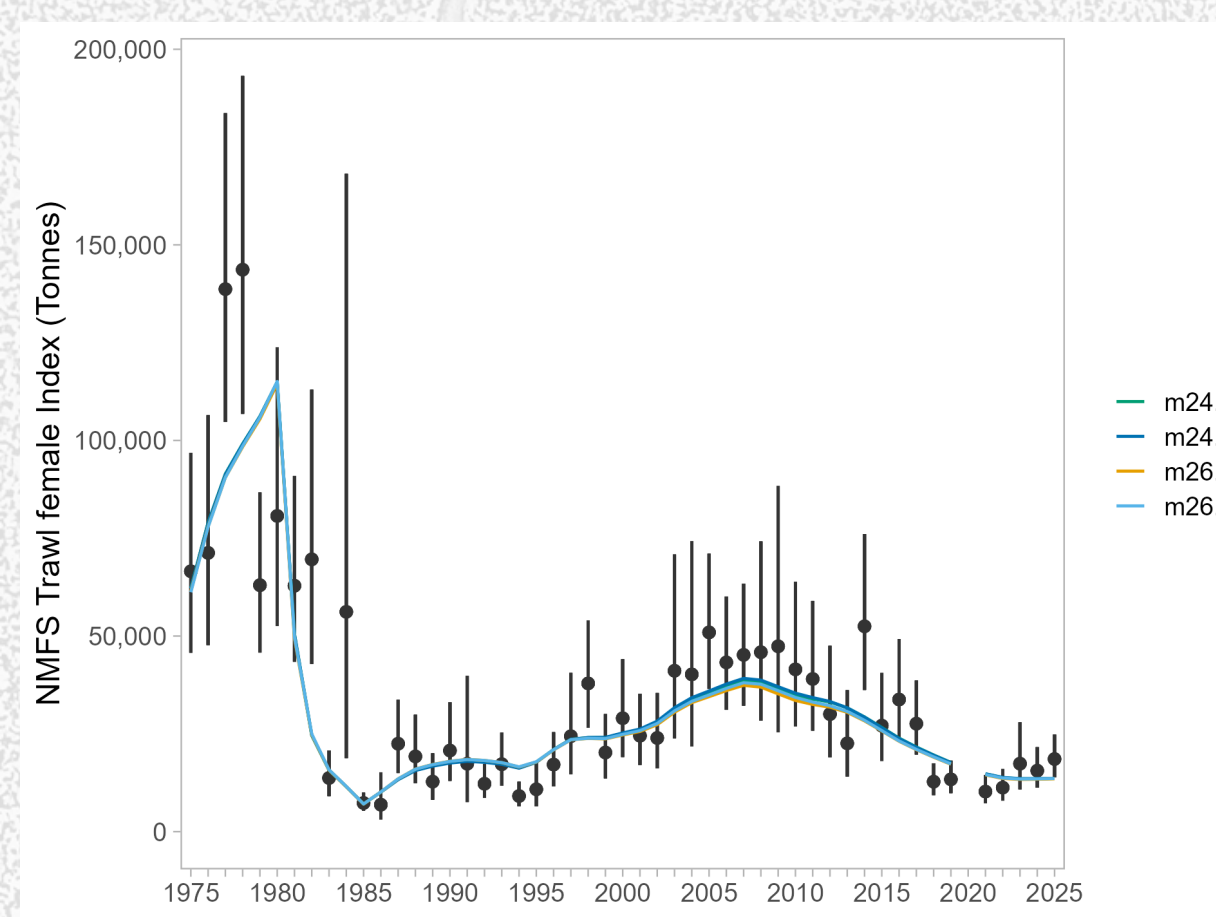
**26.0\_v44:** May 2026 version of model 26.0 updated to GMACS version 2.20.44

**26.0:**

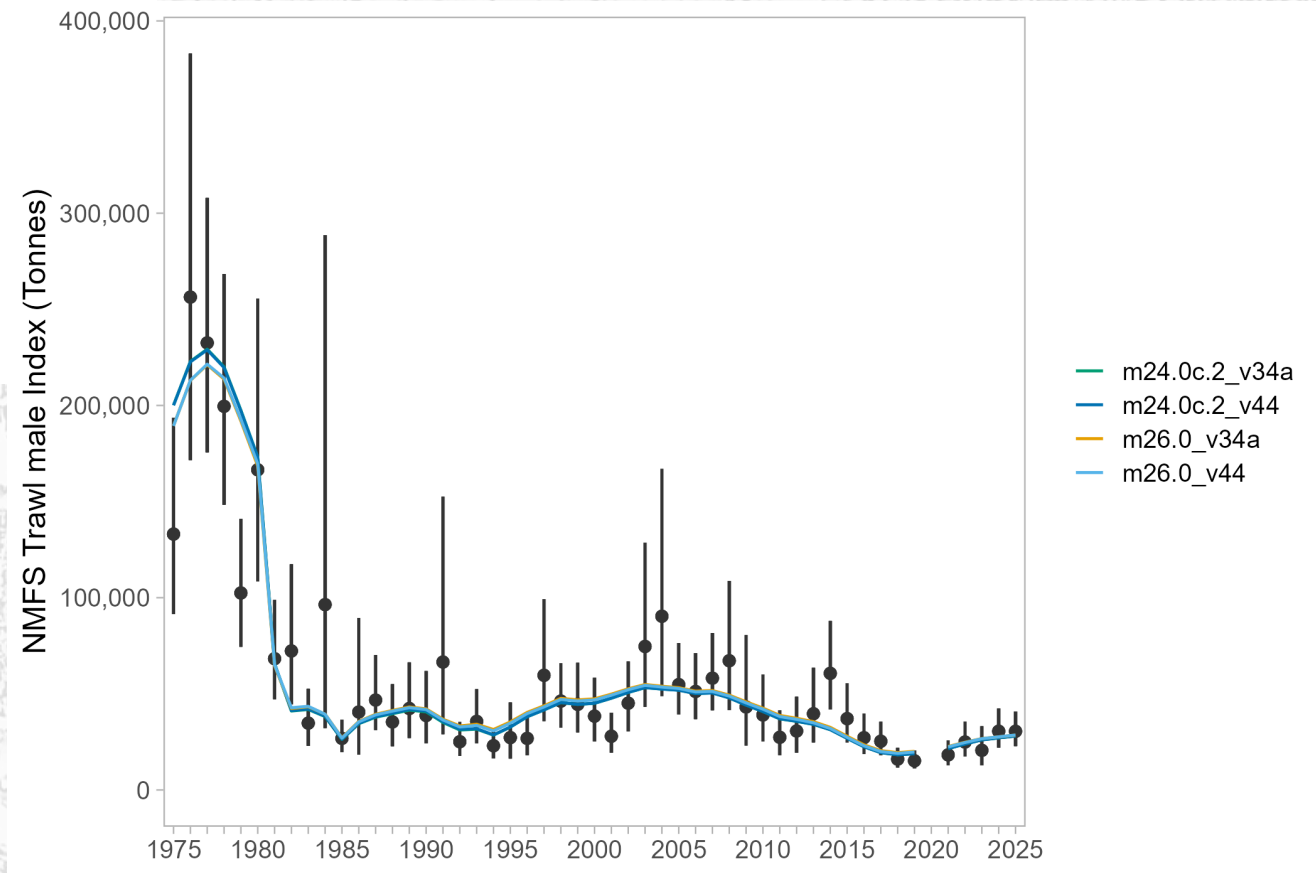
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- Model explorations
  - Model 24.0c.2 – base model
  - Model 26.0 – base model + additional size bins



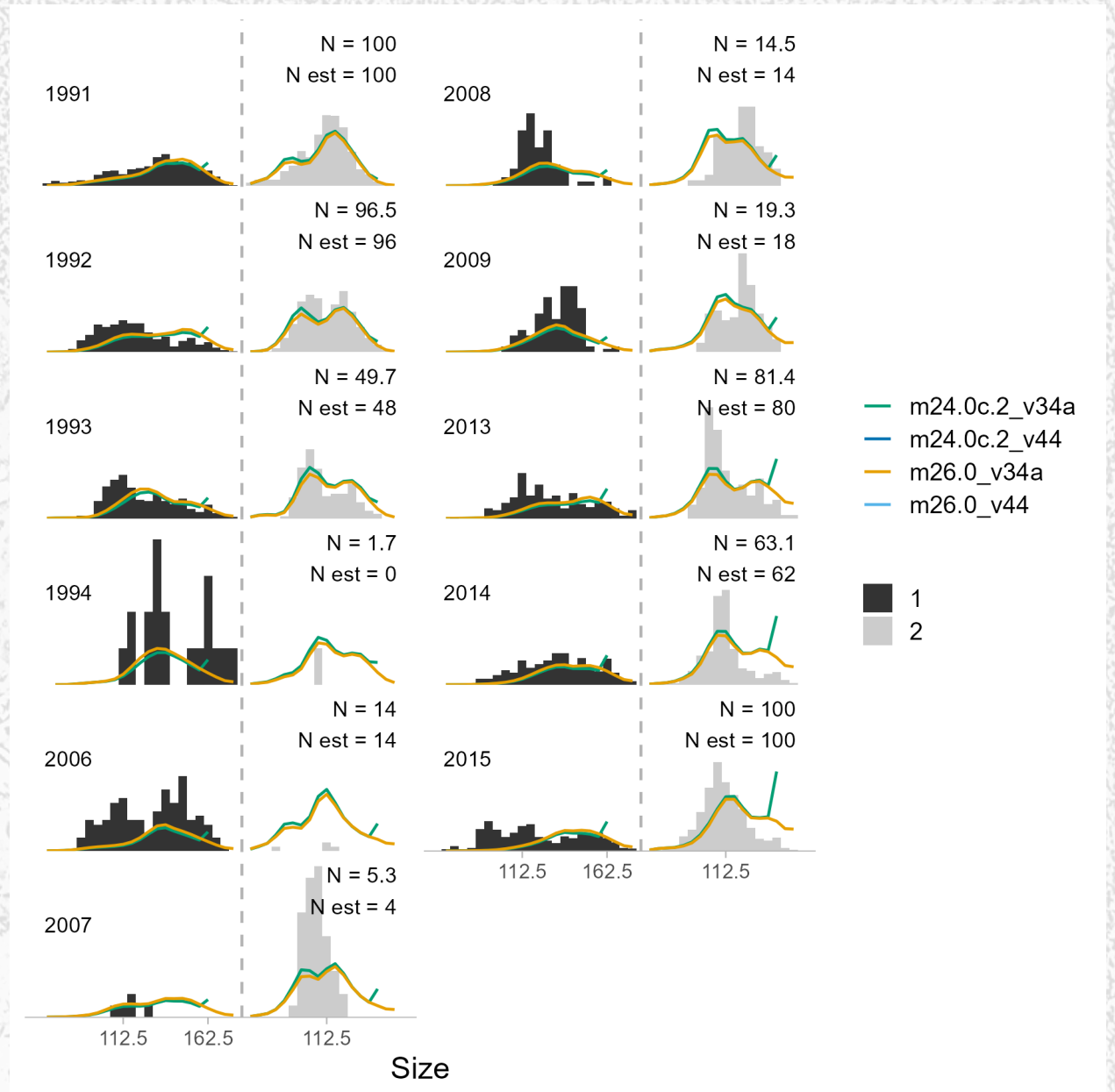
No difference in GMACS version  
survey estimation



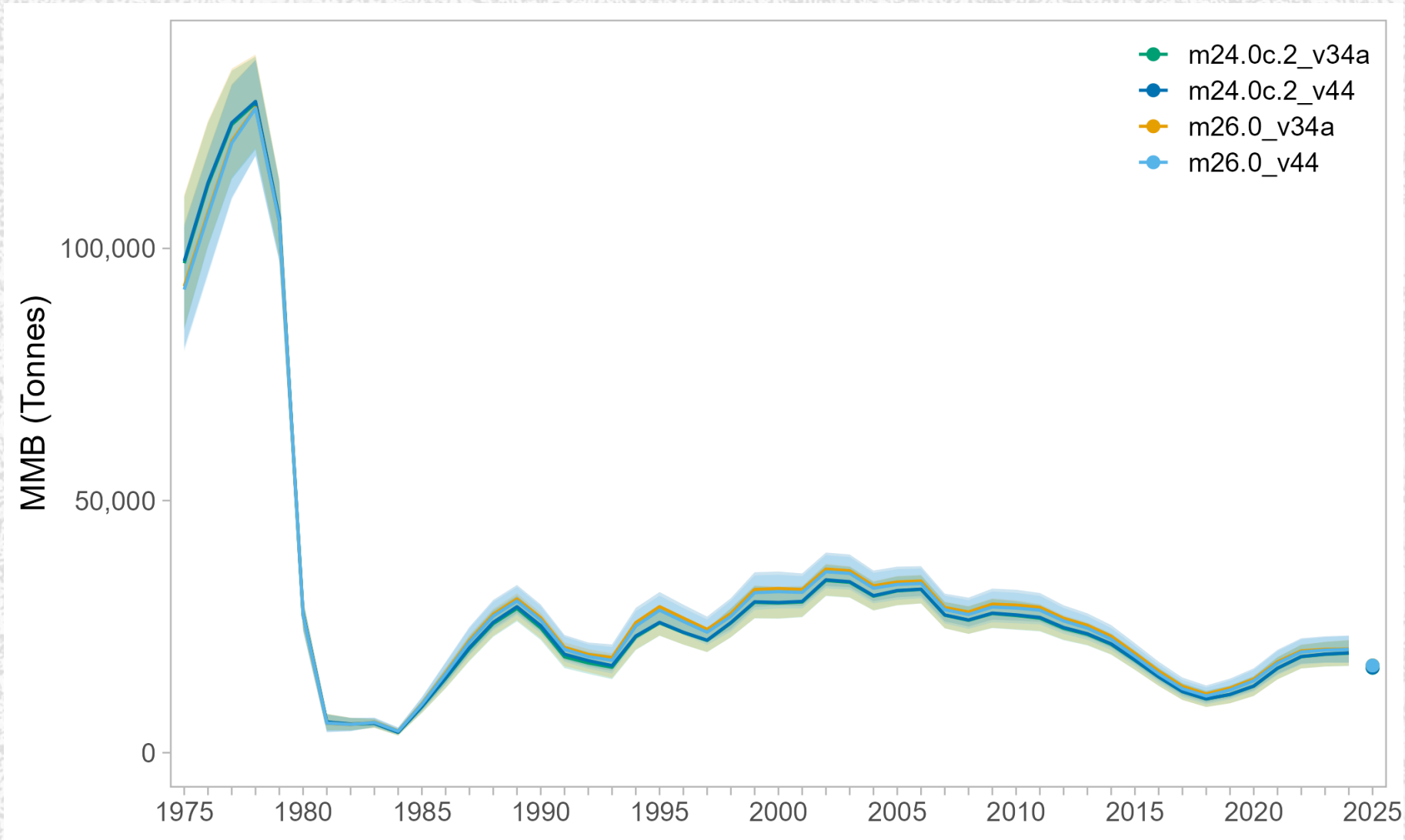
# GMACS version bridging

Tanner crab bycatch size  
comps.

- Represent likelihood  
changes in version bridging
- No noticeable differences  
in fit



# Mature male biomass



- No substantial difference between versions

# GMACS versions

## - likelihood comparison

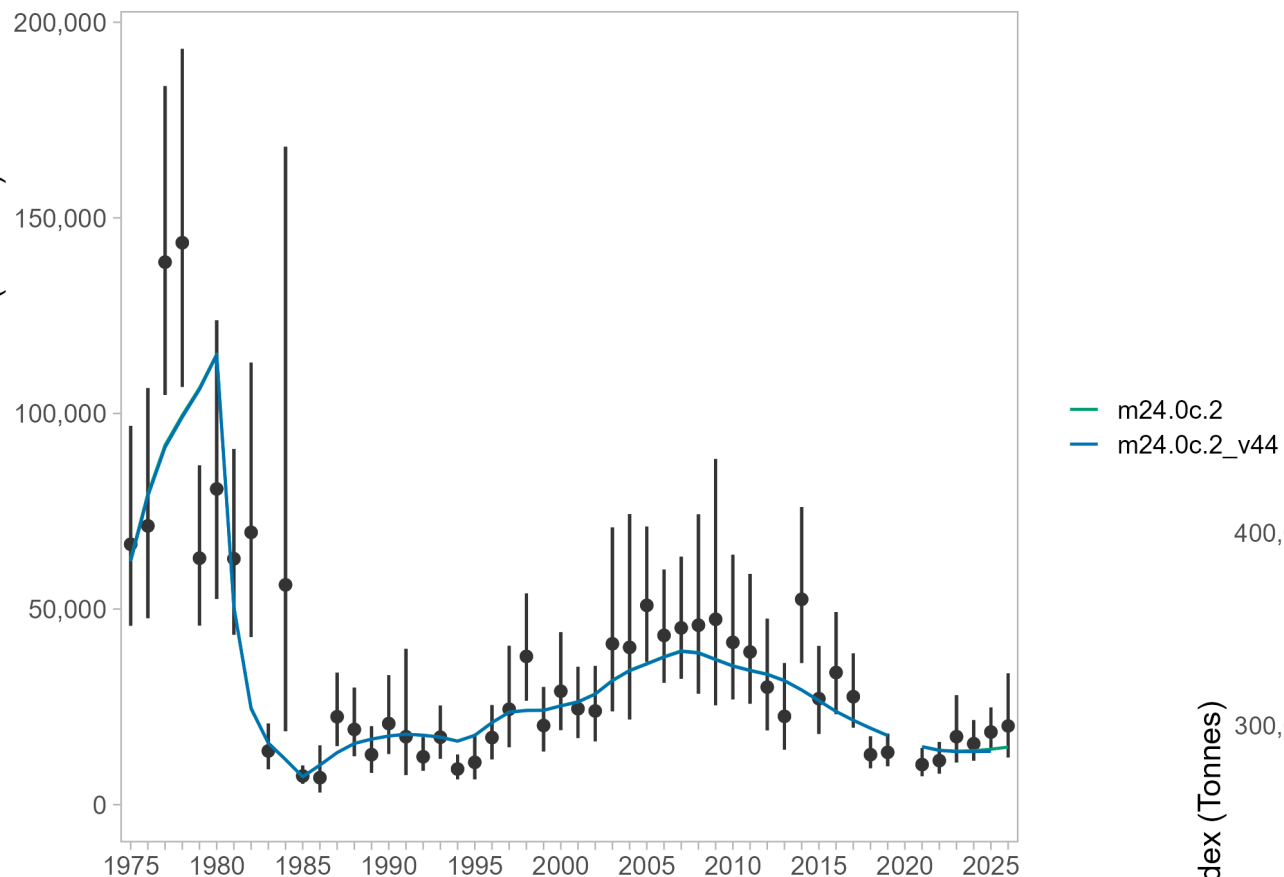
Table 17: Comparisons of negative log-likelihood values and some parameters for models 24.0c.2 and 26.0, versions 34a (May 2026) and version 44.

| Component        | m24.0c.2-v34a | m24.0c.2-v44a | diff    | m26.0-v34a | m26.0-v44 | diff    |
|------------------|---------------|---------------|---------|------------|-----------|---------|
| Pot-ret-catch    | -63.56        | -63.81        | 0.25    | -64.98     | -65.27    | 0.28    |
| Pot-totM-catch   | 28.82         | 28.47         | 0.35    | 27.56      | 27.37     | 0.18    |
| Pot-F-discC      | -60.93        | -60.93        | 0.00    | -60.94     | -60.94    | 0.00    |
| Trawl-discC      | -67.91        | -67.91        | 0.00    | -67.90     | -67.90    | 0.00    |
| Tanner-M-discC   | -45.28        | -45.28        | 0.00    | -45.28     | -45.28    | 0.00    |
| Tanner-F-discC   | -45.24        | -45.24        | 0.00    | -45.24     | -45.25    | 0.00    |
| Fixed-discC      | -40.20        | -40.20        | 0.00    | -40.20     | -40.20    | 0.00    |
| Trawl-suv-bio    | -41.39        | -42.11        | 0.72    | -38.52     | -39.63    | 1.11    |
| BSFRF-sur-bio    | -5.13         | -5.14         | 0.01    | -5.81      | -5.43     | -0.38   |
| Pot-ret-comp     | -4173.13      | -4172.86      | -0.27   | -4808.88   | -4809.02  | 0.14    |
| Pot-totM-comp    | -2603.18      | -2602.87      | -0.31   | -3045.89   | -3048.96  | 3.07    |
| Pot-discF-comp   | -1583.69      | -1583.81      | 0.12    | -1832.65   | -1831.95  | -0.70   |
| Trawl-disc-comp  | -6171.05      | -6171.17      | 0.12    | -7070.20   | -7065.67  | -4.54   |
| Tanner-disc-comp | -1276.73      | -1087.27      | -189.45 | -1487.69   | -1305.34  | -182.35 |
| Fixed-disc-comp  | -3734.15      | -3732.61      | -1.54   | -4301.64   | -4301.33  | -0.31   |
| Trawl-sur-comp   | -7440.87      | -7443.06      | 2.19    | -8724.29   | -8727.73  | 3.44    |
| BSFRF-sur-comp   | -844.86       | -845.23       | 0.37    | -988.86    | -988.35   | -0.51   |
| Recruit-dev      | 74.65         | 74.64         | 0.01    | 74.54      | 74.74     | -0.20   |
| Recruit-ini      | 0.00          | 0.00          | 0.00    | 0.00       | 0.00      | 0.00    |
| Recruit-sex-R    | 82.02         | 81.98         | 0.04    | 81.98      | 81.97     | 0.01    |
| Sex-specific-R   | 0.00          | 0.00          | 0.00    | 0.00       | 0.00      | 0.00    |
| Ini-size-struct  | 223.68        | 223.08        | 0.60    | 242.11     | 240.18    | 1.93    |
| PriorDensity     | 0.07          | 0.08          | -0.01   | 0.05       | 0.06      | -0.01   |
| Tot-likelihood   | -27754.69     | -27567.96     | -186.73 | -32131.88  | -31952.87 | -179.01 |
| Tot-parms        | 390.00        | 391.00        | -1.00   | 395.00     | 396.00    | -1.00   |
| MMB35            | 18524.40      | 18590.55      | -66.14  | 18911.08   | 18831.68  | 79.40   |
| MMB-terminal     | 16836.02      | 16891.45      | -55.43  | 17309.41   | 17291.97  | 17.45   |
| F35              | 0.40          | 0.40          | 0.00    | 0.40       | 0.40      | 0.00    |
| <i>Fofl</i>      | 0.36          | 0.36          | 0.00    | 0.36       | 0.37      | -0.01   |
| OFL              | 5851.79       | 5864.22       | -12.43  | 6165.62    | 6161.98   | 3.64    |

# Outline

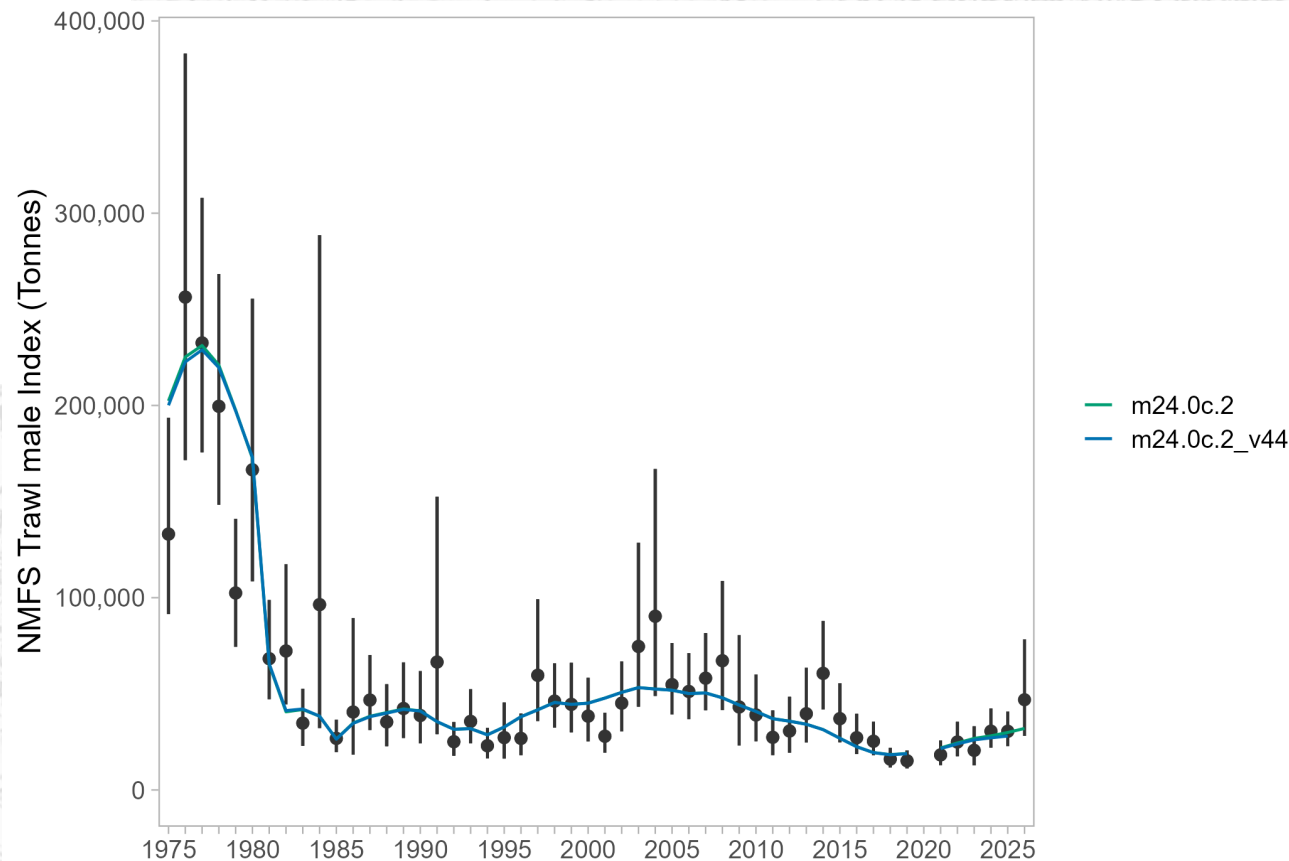
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NMFS Trawl female Index (Tonnes)

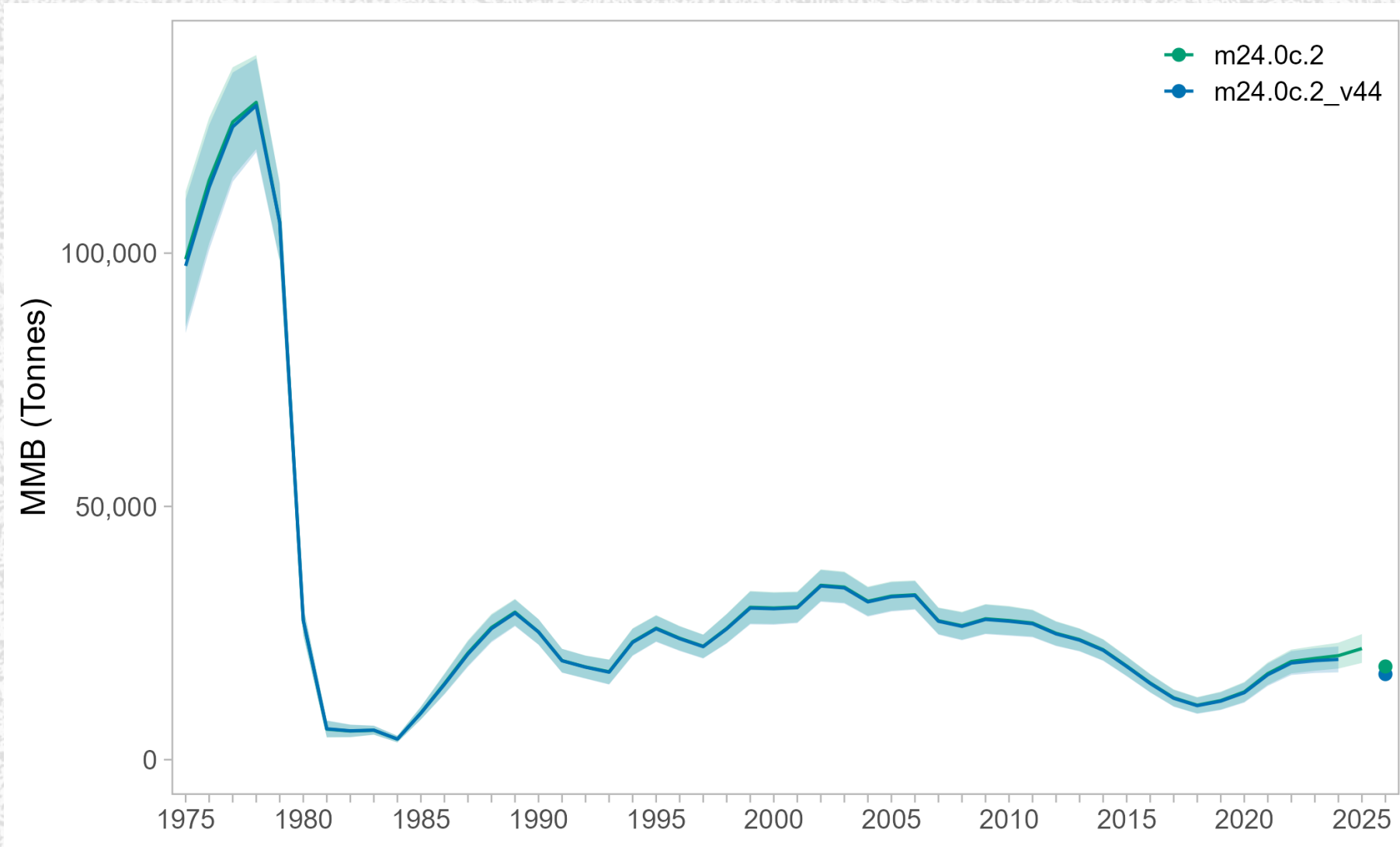


- NMFS survey data estimation consistent
- Model estimates do not capture upswing in recent data (likely due to increased variability)

NMFS Trawl male Index (Tonnes)



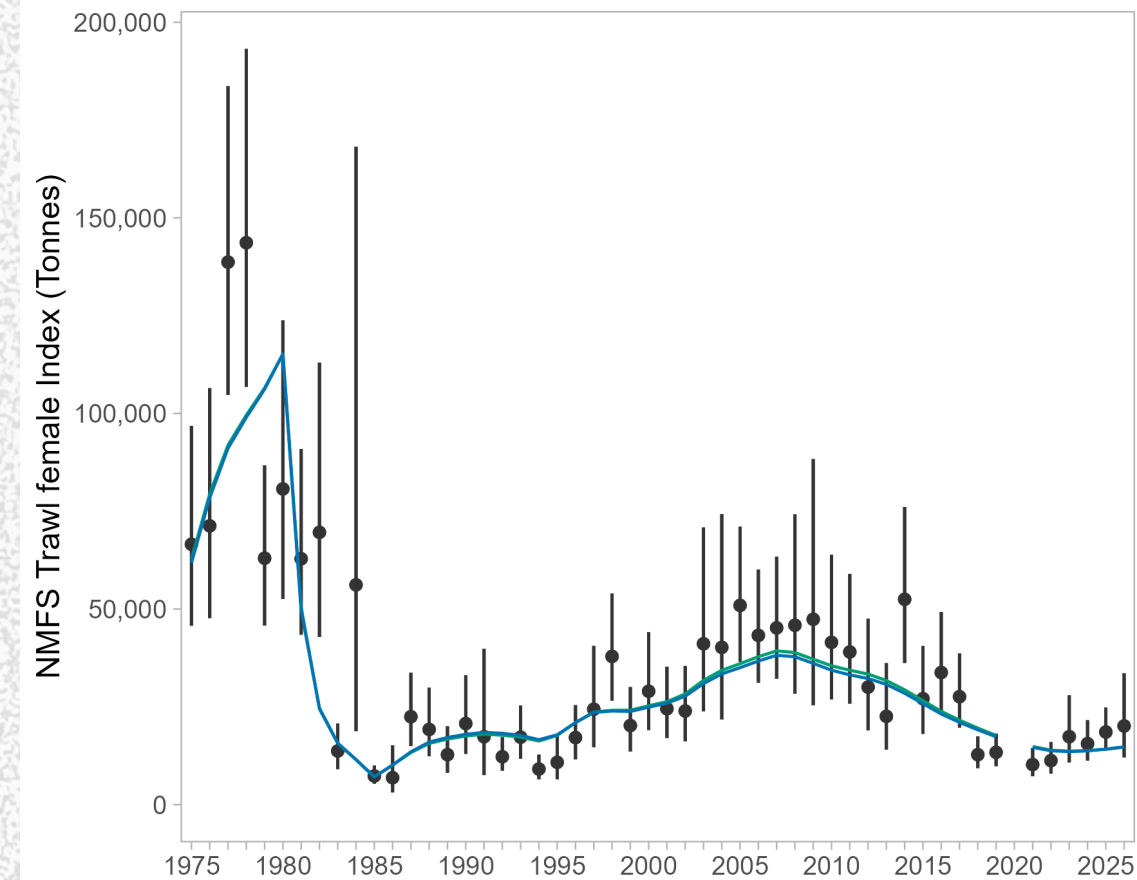
# Mature male biomass



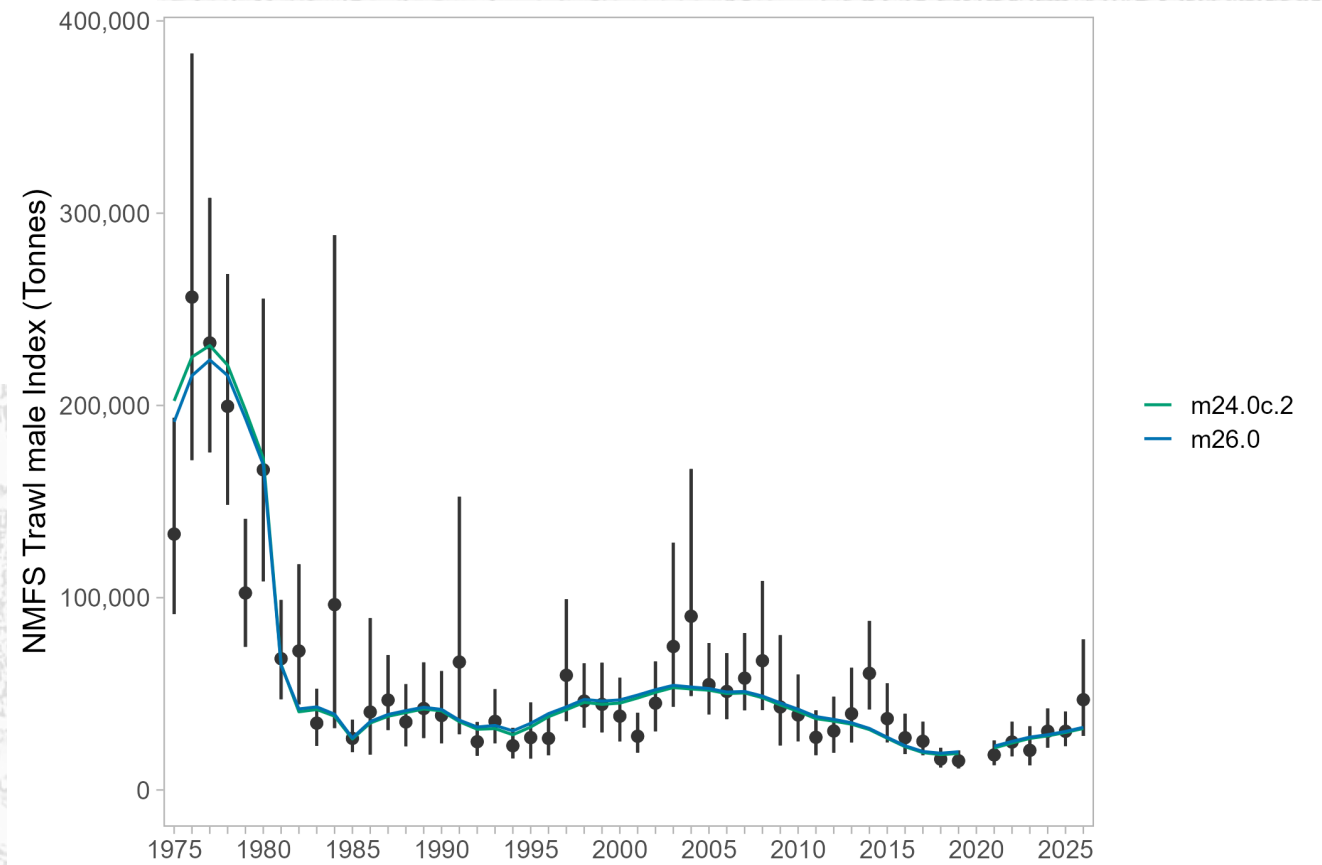
- Addition of 2025/26 data
- Increase in MMB from 2025

# Outline

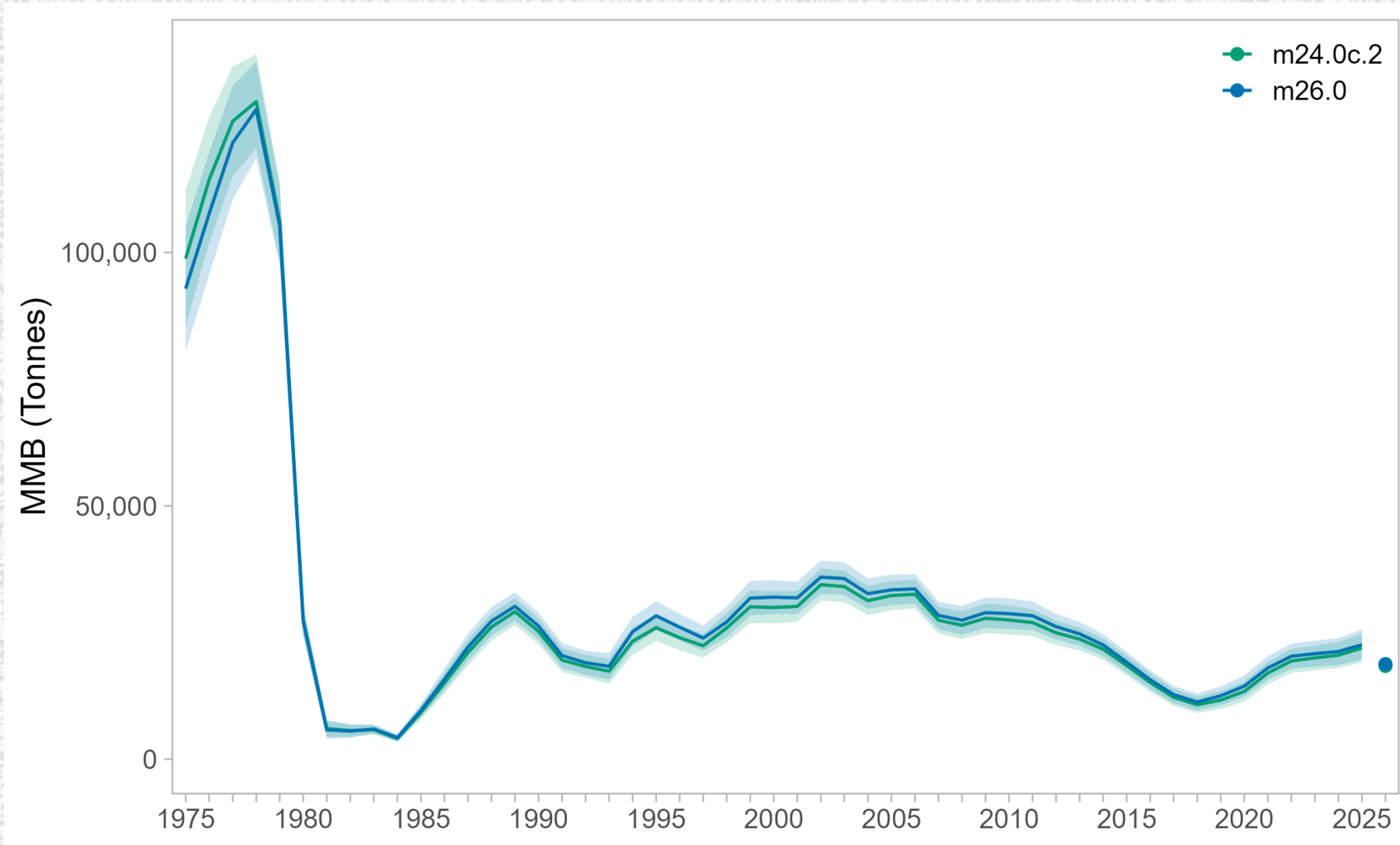
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- Estimates of NMFS survey biomass similar between models.



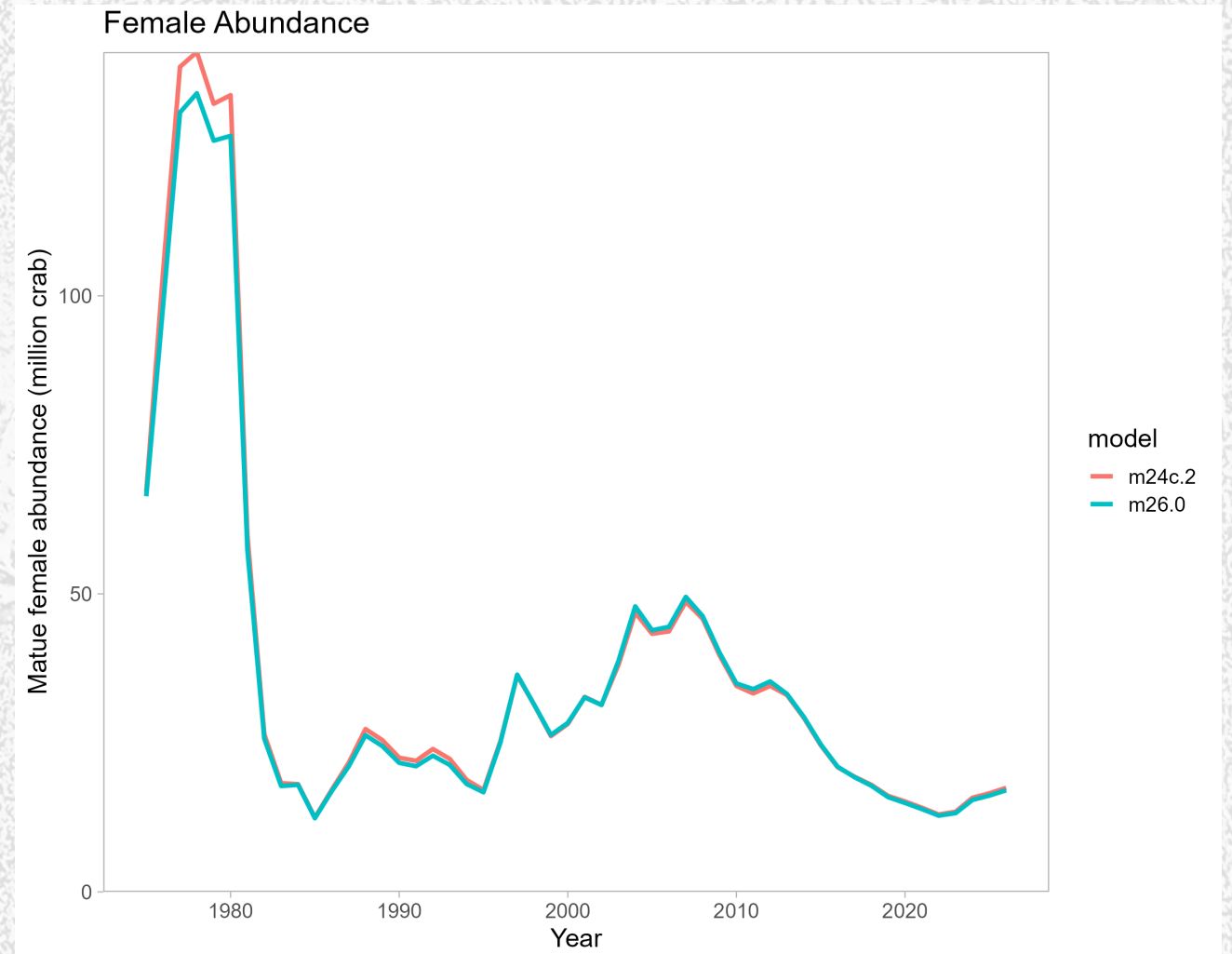
# Mature male biomass



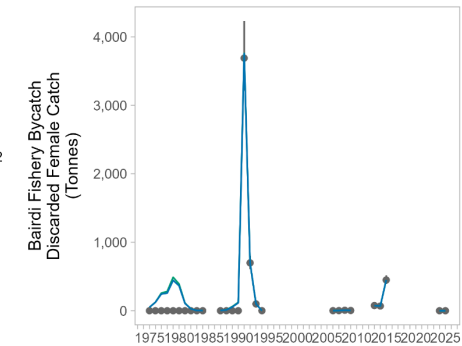
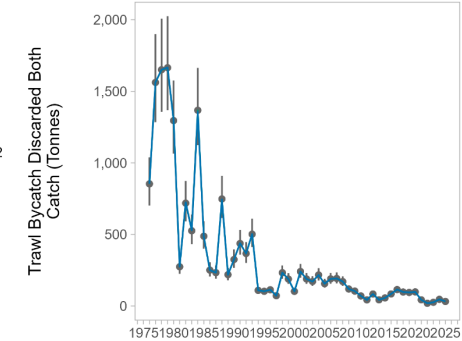
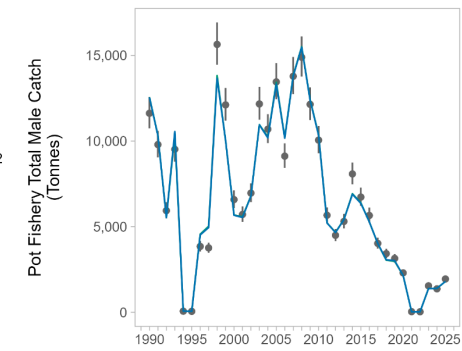
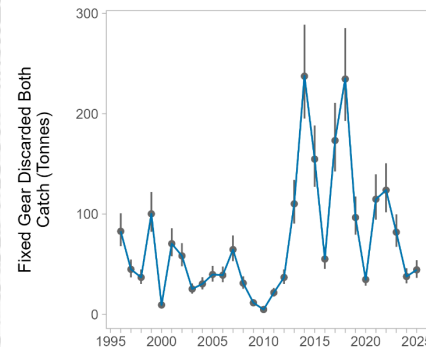
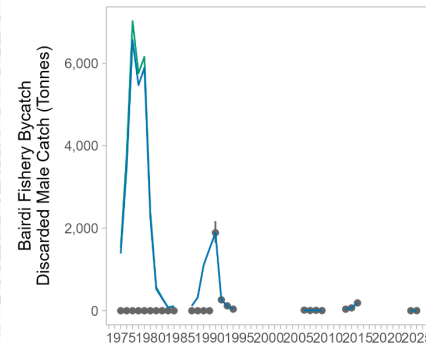
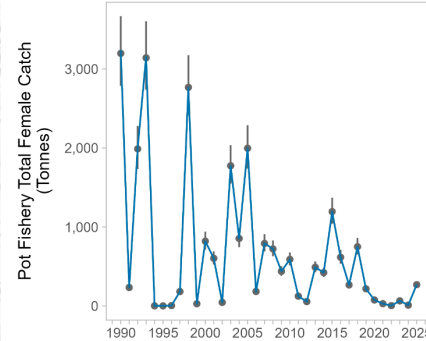
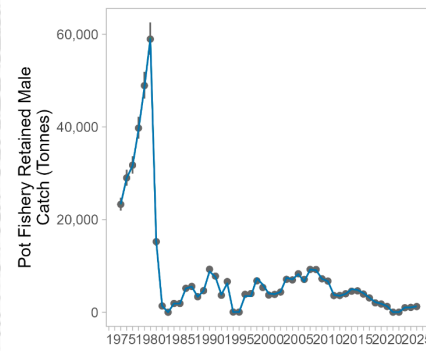
- Very similar output for both models, which is expected

# Mature female abundance

- Mature females defined as  $\geq 90\text{mm CL}$
- Not visual maturity



Mortality biomass  
(equal to catch  
biomass times  
handling mortality  
rate)

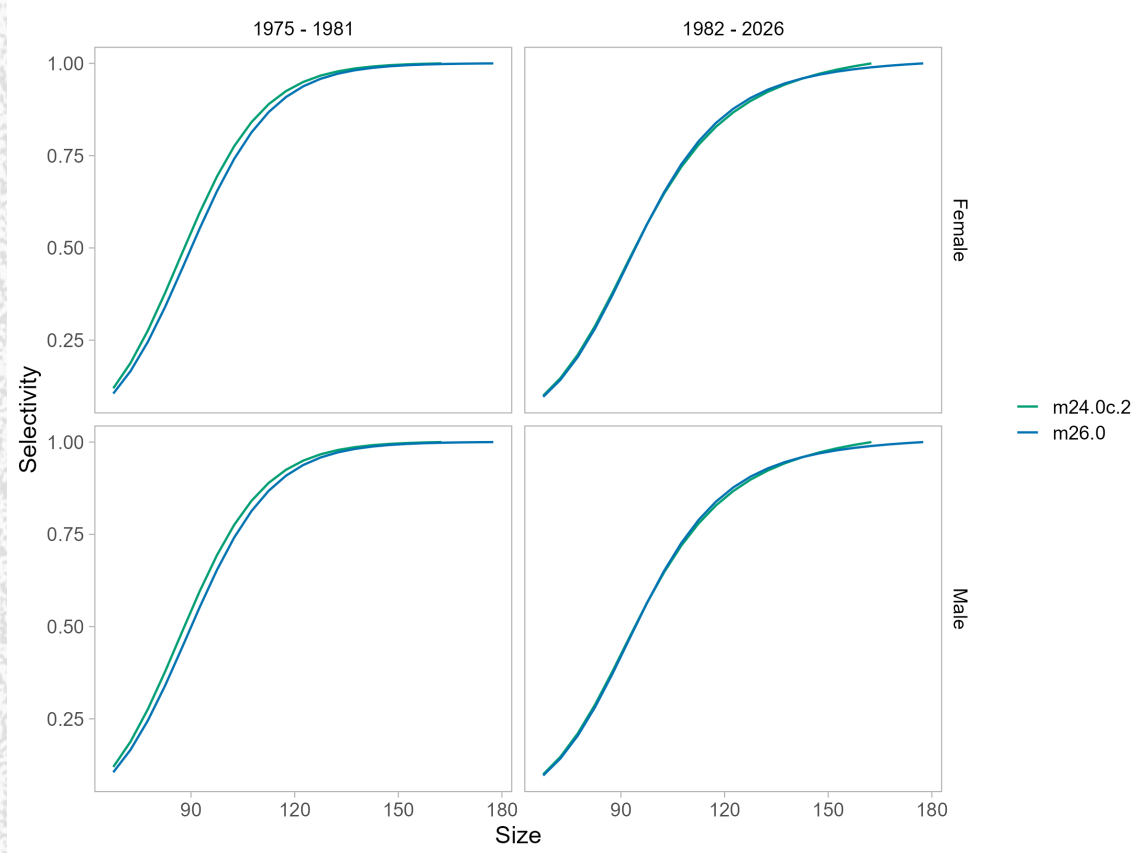


# Natural Mortality & Selectivity

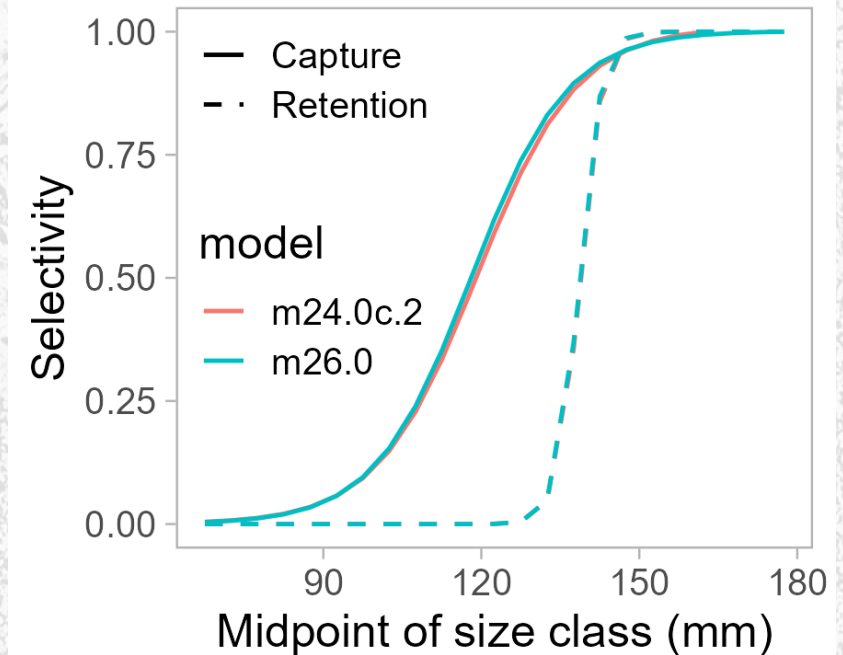
Table 14: Natural mortality estimates for model scenarios during different year blocks.

| Model    | Sex    | baseM | 1980-84 |
|----------|--------|-------|---------|
| m24.0c.2 | female | 0.26  | 1.16    |
| m24.0c.2 | male   | 0.23  | 1.01    |
| m26.0    | female | 0.27  | 1.19    |
| m26.0    | male   | 0.23  | 1.02    |

## NMFS selectivity

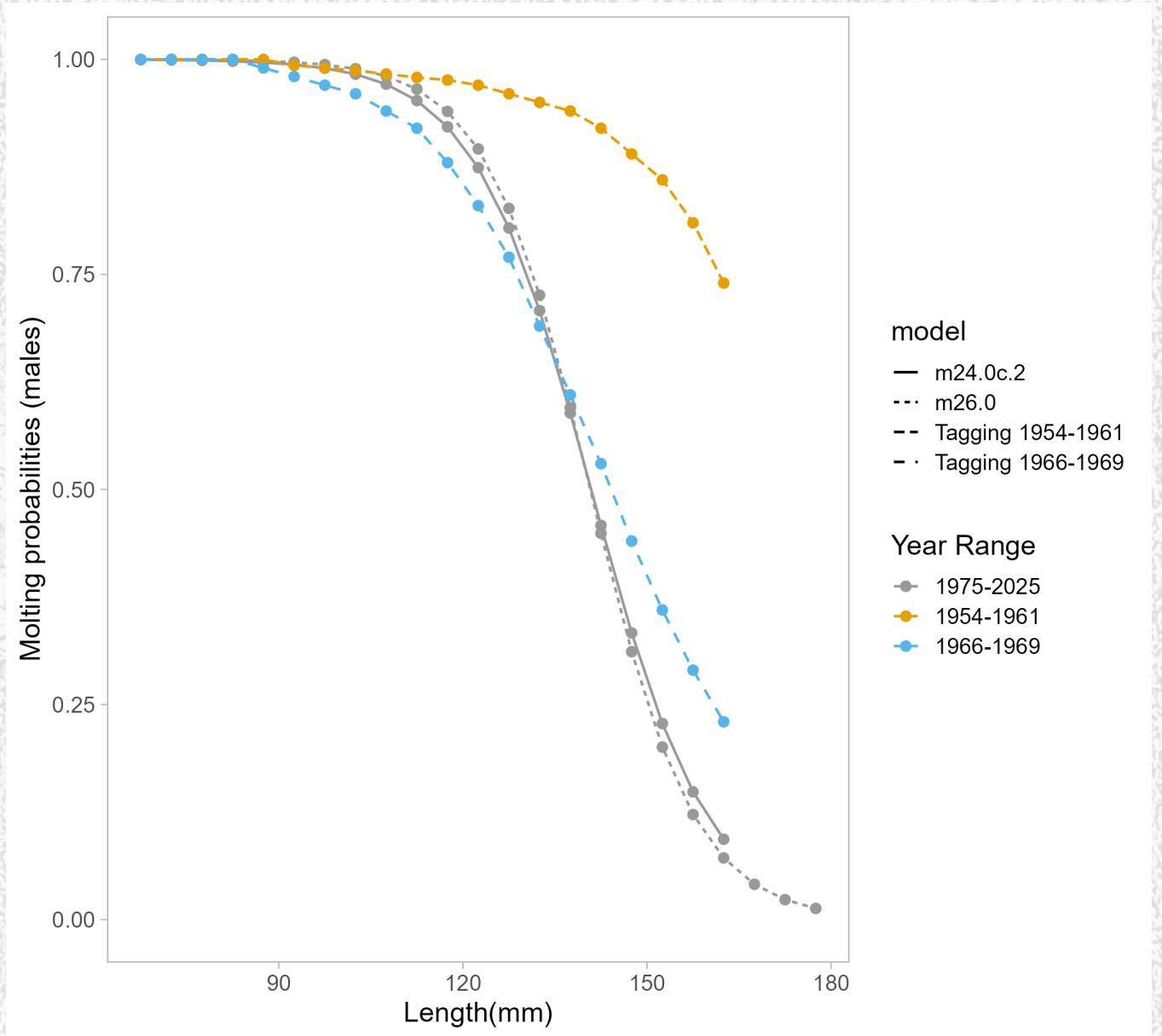


## Directed pot fishery (males)



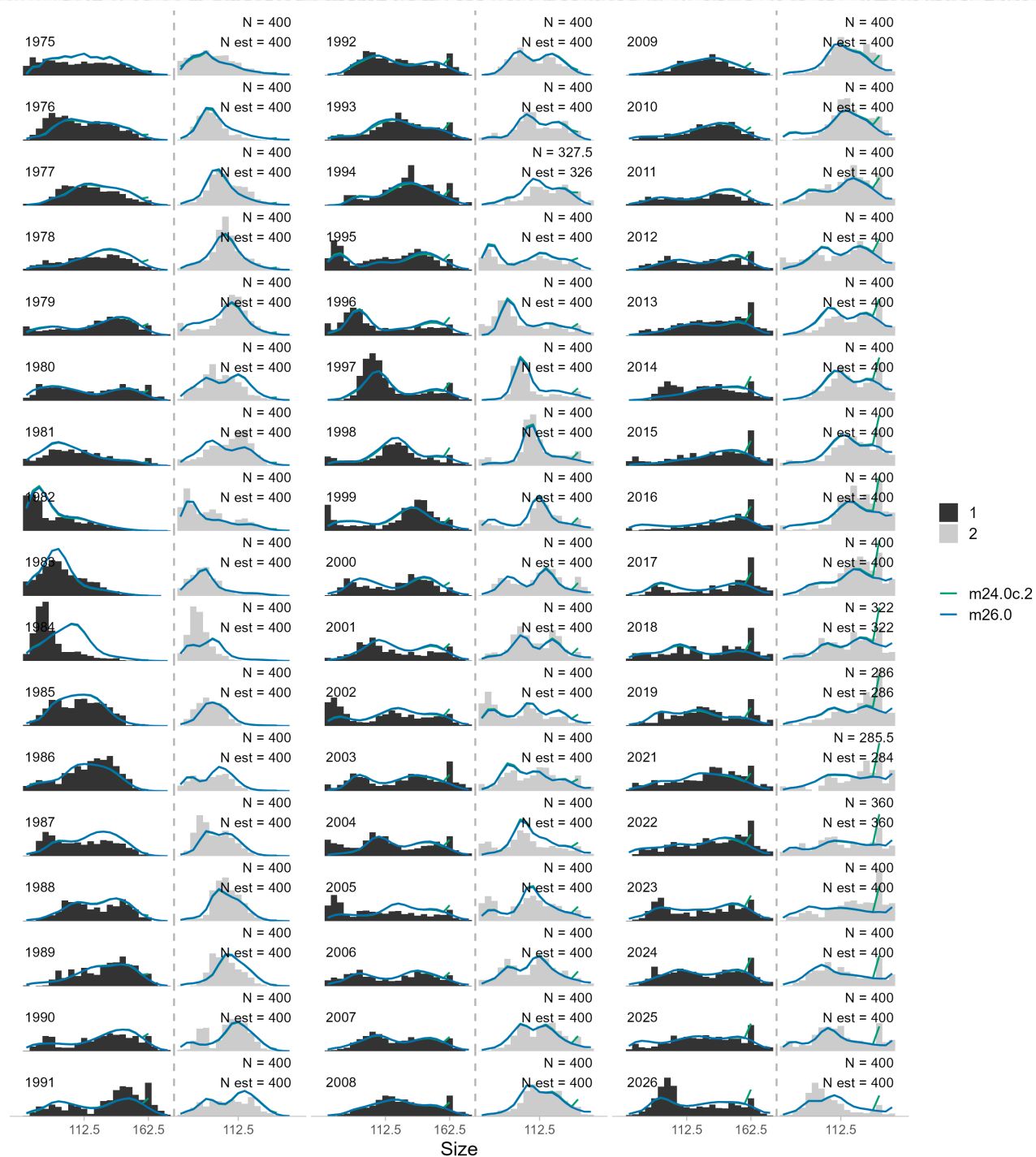
# Molting probabilities

- Similar between models

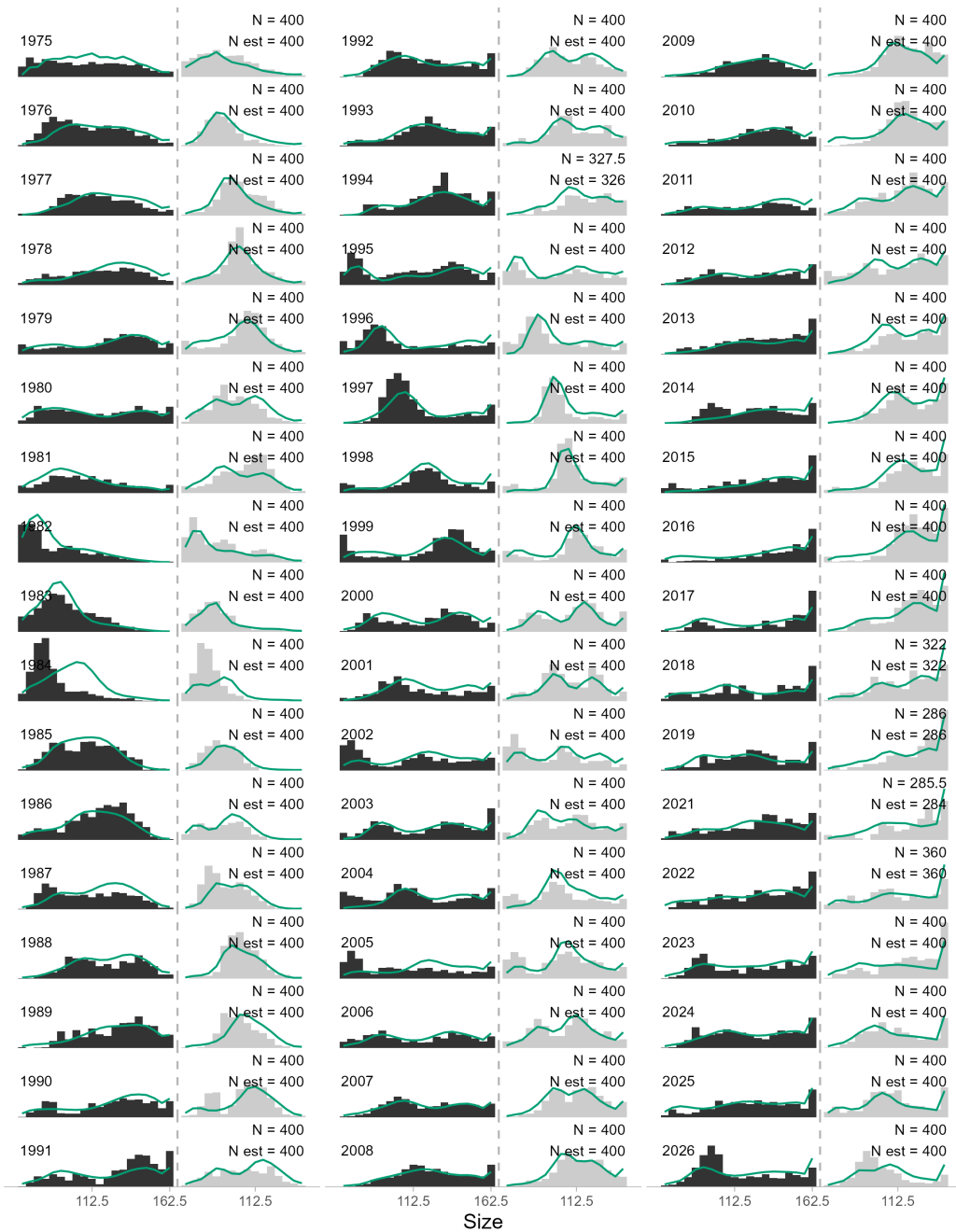


# Size composition fit

- No differences in fit from 2025 in bycatch and directed fisheries for the base model
  - See document for all size composition fits
- Survey data suggests some build up of plus group which expected with low recruitment
  - Model 26.0 attempts to begin the process of improving model fit to incorporate larger size bins groups

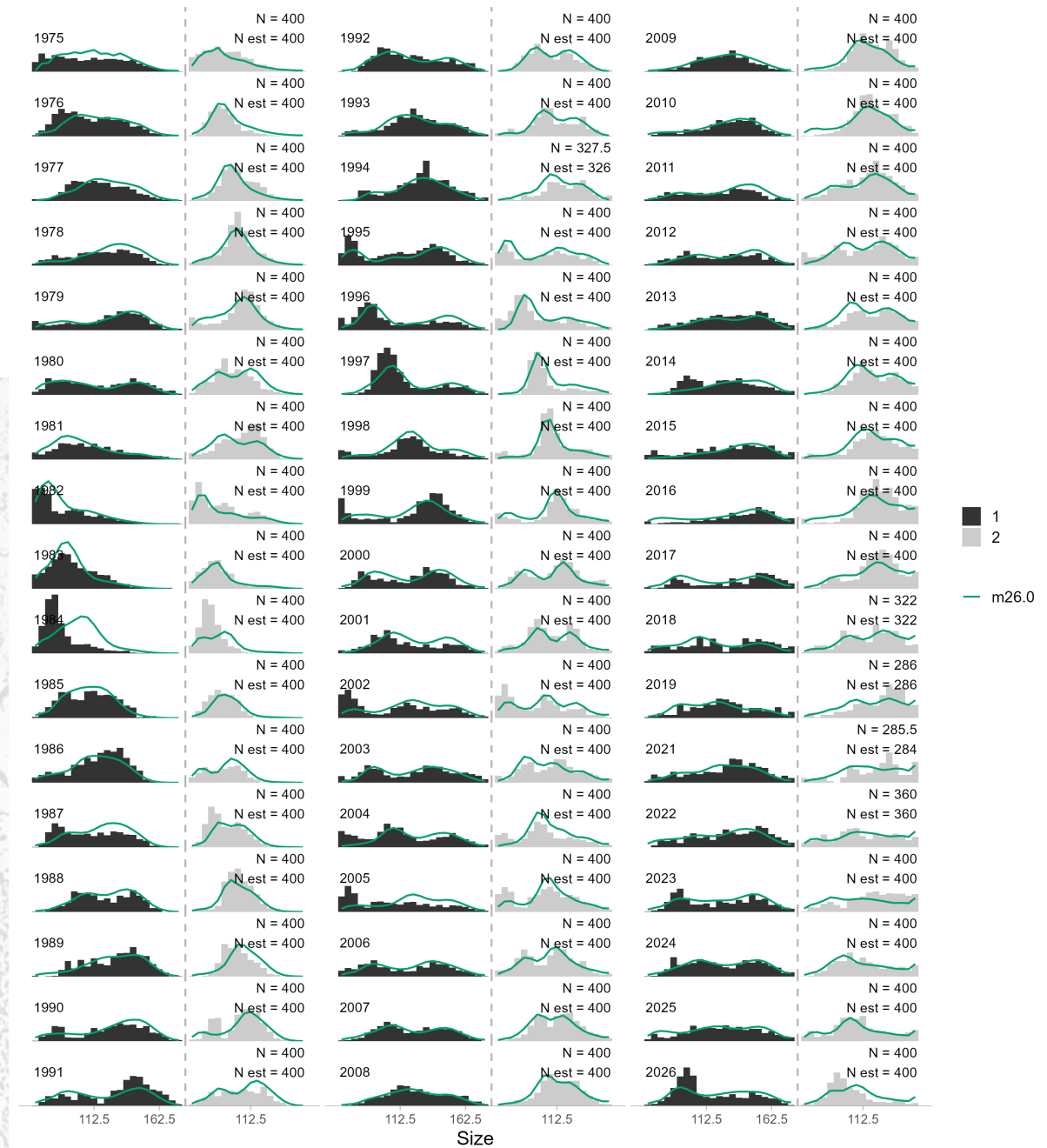


NMFS trawl  
survey size comps  
- males (1 black)  
- females (2 gray)



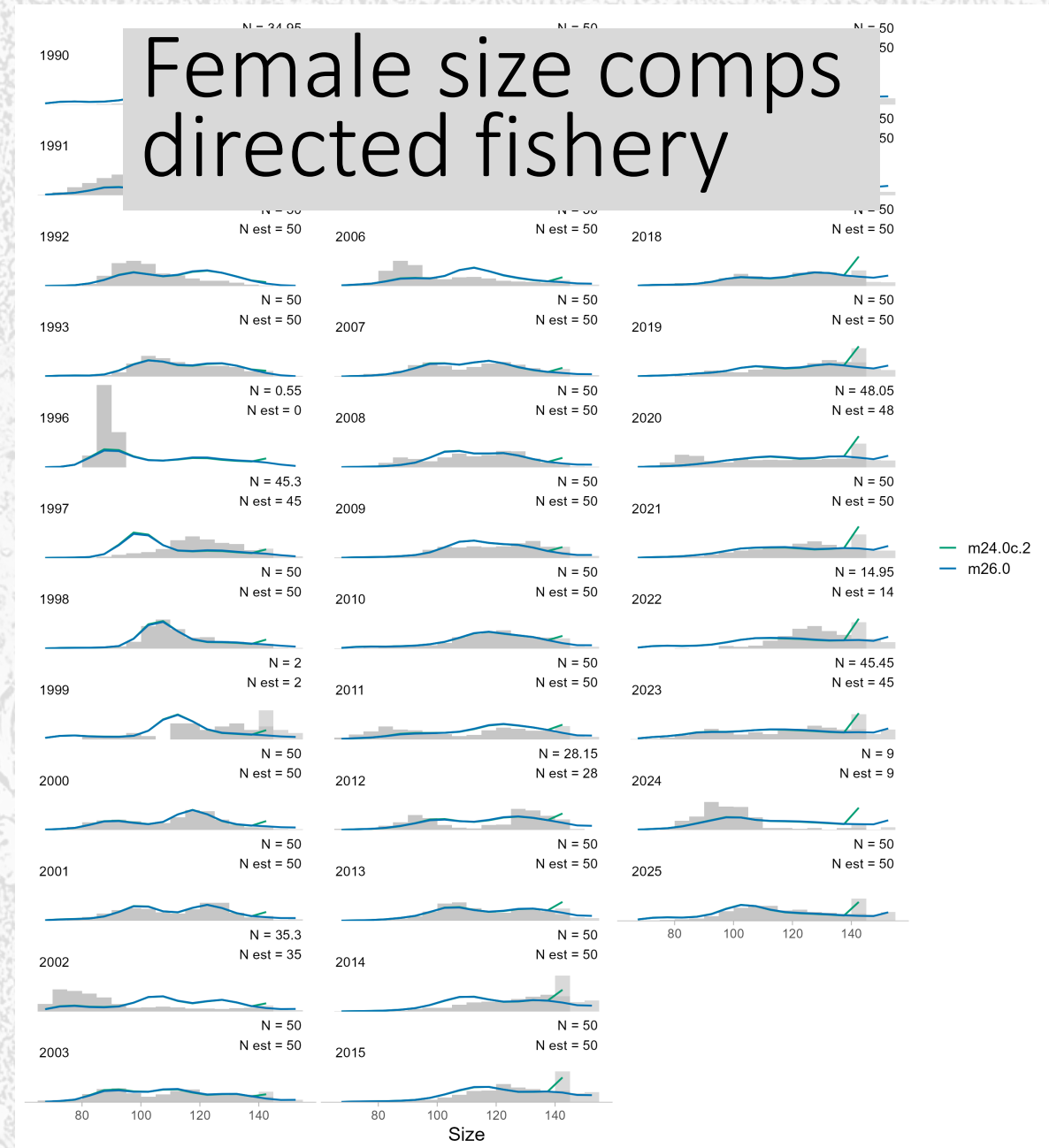
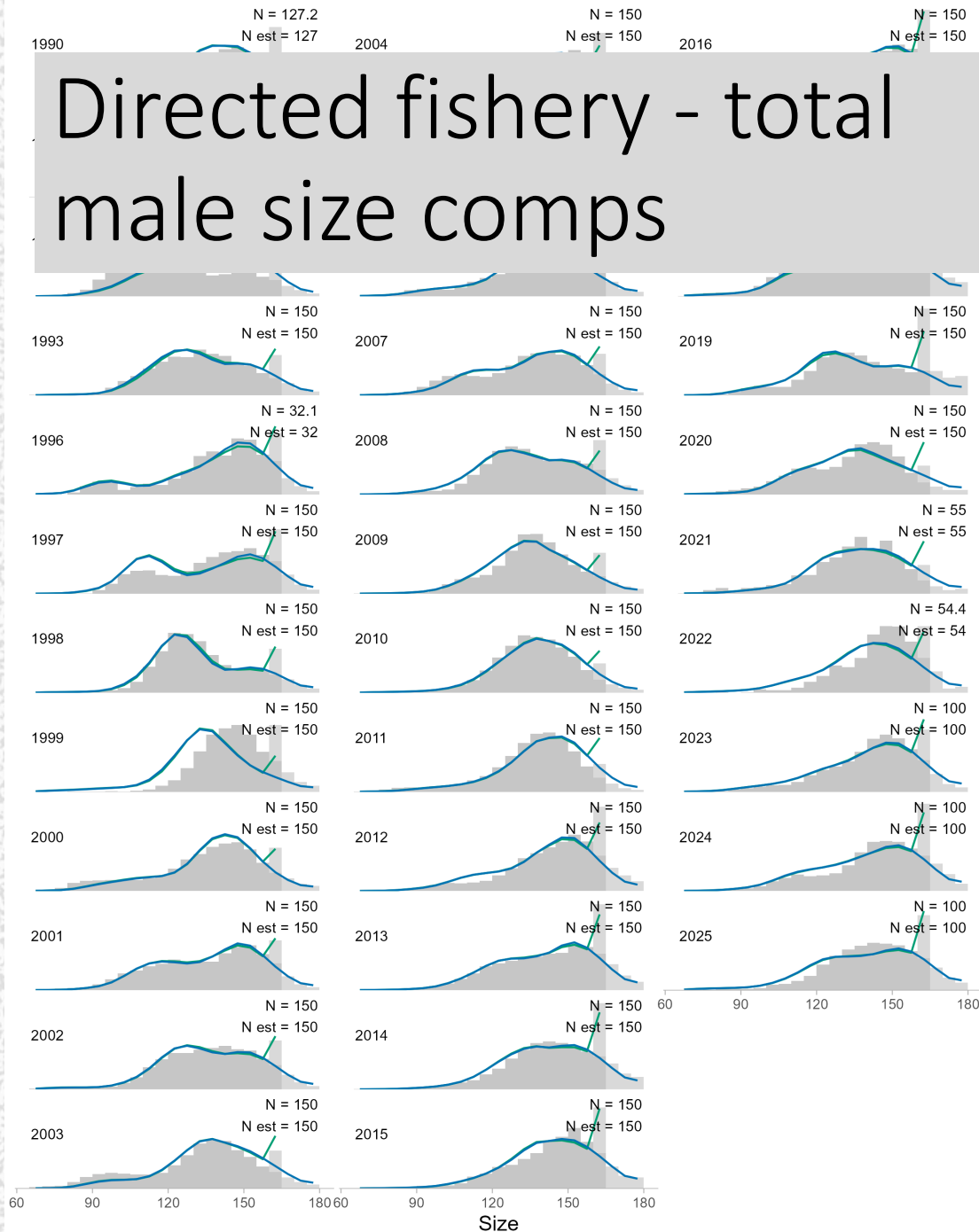
NMFS trawl  
survey size  
comps  
- males (1  
black)  
- females (2  
gray)

1  
2  
m24.0c.2



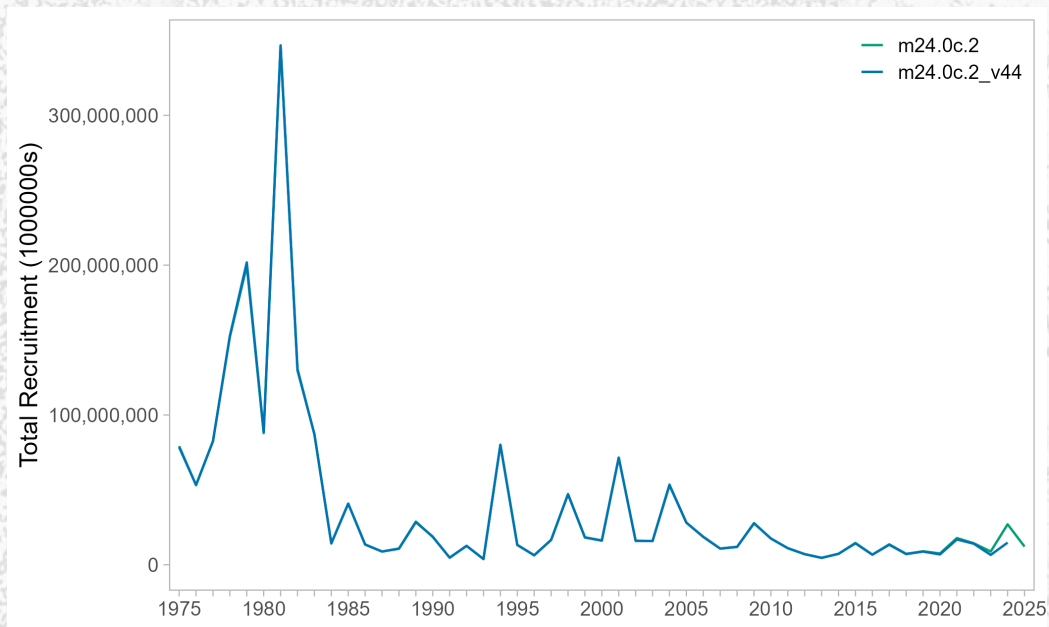
1  
2  
m26.0

# Directed fishery - total male size comps

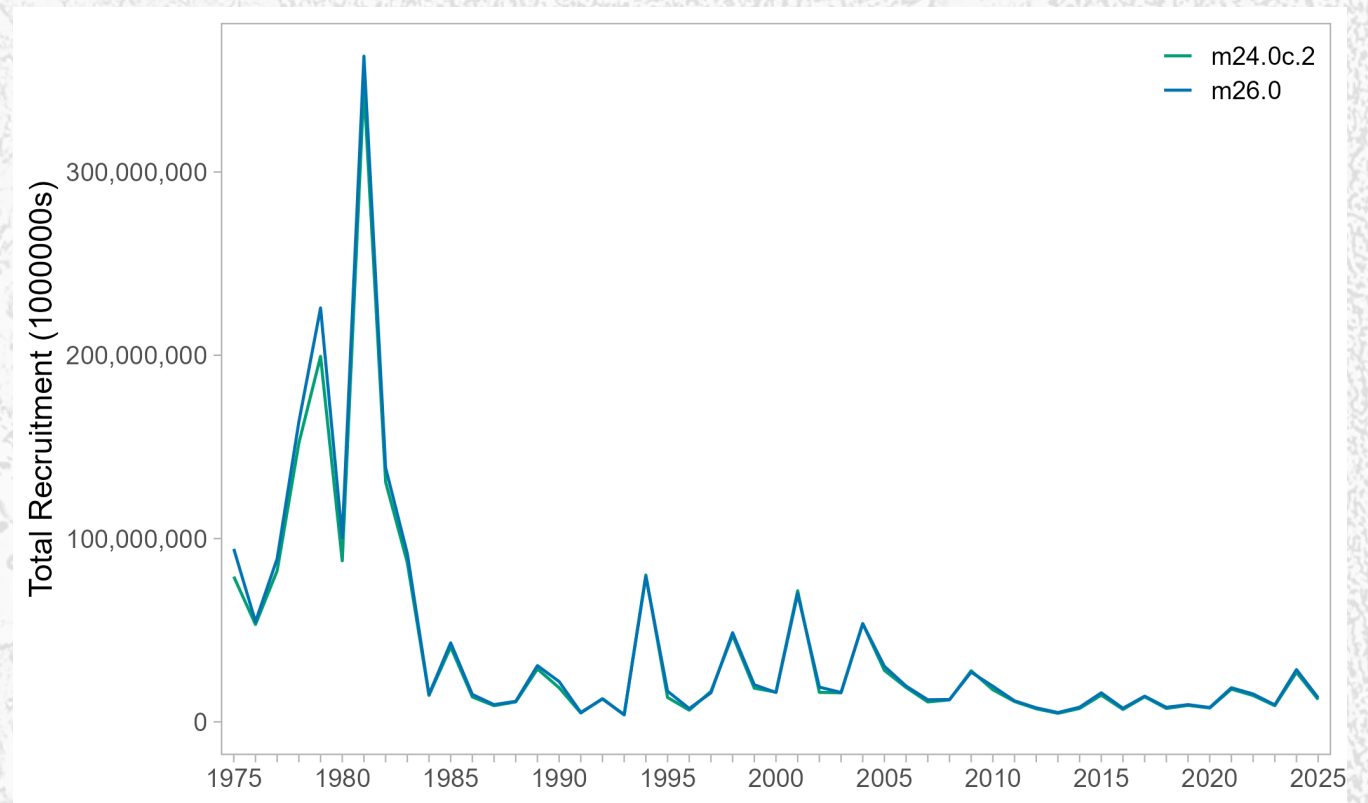


# Recruitment

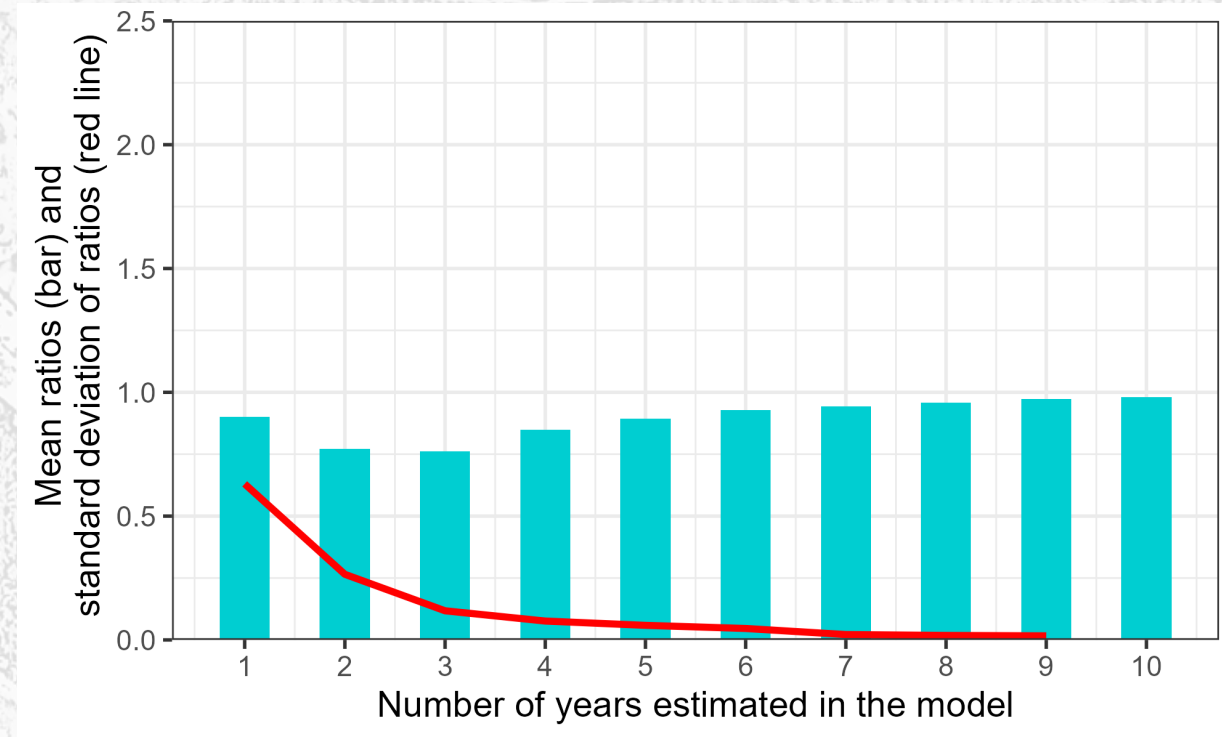
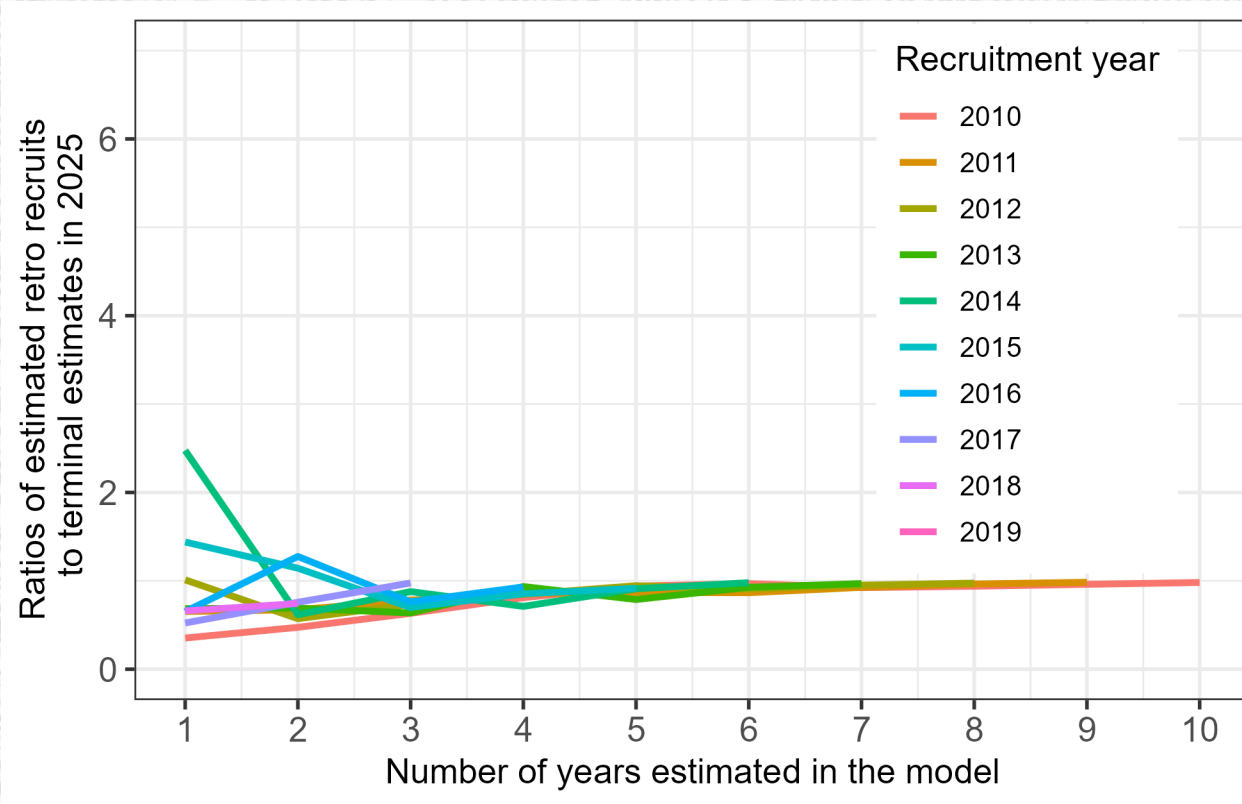
New Data : addition of new data increases last years recruitment estimate



Model exploration: no noticeable differences



# Recruitment to exclude from reference point calculations (model 26.0)



# Prior density values and total negative likelihood values

Table 18: Comparisons of negative log-likelihood values and some parameters for models 24.0c.2 (2025 accepted model), and model 26.0.

| Component        | m24.0c.2  | m26.0     | diff     |
|------------------|-----------|-----------|----------|
| Pot-ret-catch    | -65.66    | -67.27    | -1.61    |
| Pot-totM-catch   | 27.47     | 26.16     | -1.31    |
| Pot-F-discC      | -62.67    | -62.68    | -0.01    |
| Trawl-discC      | -69.30    | -69.29    | 0.01     |
| Tanner-M-discC   | -47.02    | -47.02    | 0.00     |
| Tanner-F-discC   | -46.98    | -46.99    | -0.00    |
| Fixed-discC      | -41.58    | -41.58    | 0.00     |
| Trawl-suv-bio    | -43.34    | -40.85    | 2.49     |
| BSFRF-sur-bio    | -5.24     | -5.51     | -0.26    |
| Pot-ret-comp     | -4261.13  | -4910.25  | -649.11  |
| Pot-totM-comp    | -2680.66  | -3139.43  | -458.77  |
| Pot-discF-comp   | -1634.45  | -1890.13  | -255.68  |
| Trawl-disc-comp  | -6284.63  | -7196.05  | -911.41  |
| Tanner-disc-comp | -1087.27  | -1305.34  | -218.07  |
| Fixed-disc-comp  | -3875.54  | -4464.36  | -588.82  |
| Trawl-sur-comp   | -7576.57  | -8884.72  | -1308.16 |
| BSFRF-sur-comp   | -845.14   | -988.24   | -143.10  |
| Recruit-dev      | 74.84     | 74.87     | 0.03     |
| Recruit-ini      | 0.00      | 0.00      | 0.00     |
| Recruit-sex-R    | 83.63     | 83.60     | -0.03    |
| Sex-specific-R   | 0.00      | 0.00      | 0.00     |
| Ini-size-struct  | 223.44    | 240.92    | 17.48    |
| PriorDensity     | 0.07      | 0.05      | -0.03    |
| Tot-likelihood   | -28184.59 | -32663.32 | -4478.73 |
| Tot-parms        | 399.00    | 404.00    | 5.00     |
| MMB35            | 19012.32  | 19229.76  | 217.44   |
| MMB-terminal     | 18397.75  | 18765.73  | 367.99   |
| F35              | 0.40      | 0.41      | 0.01     |
| <i>Fofl</i>      | 0.39      | 0.39      | 0.00     |
| OFL              | 6814.20   | 7134.44   | 320.24   |

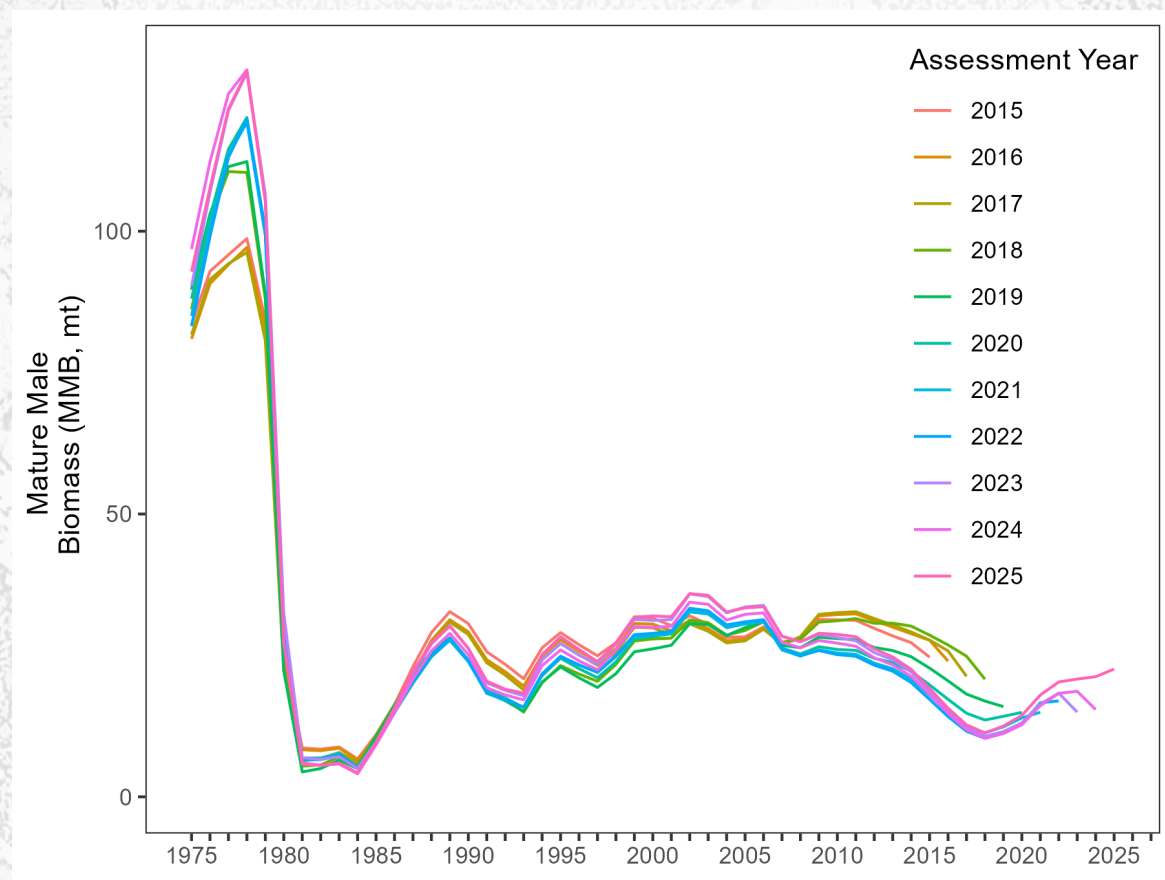
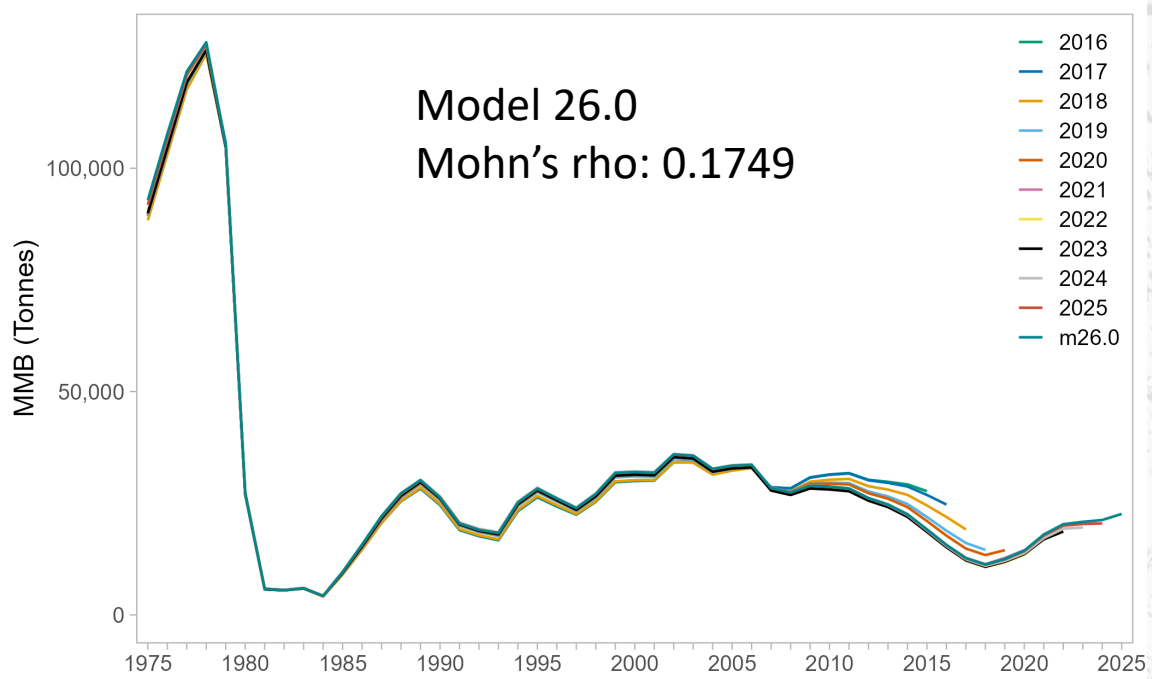
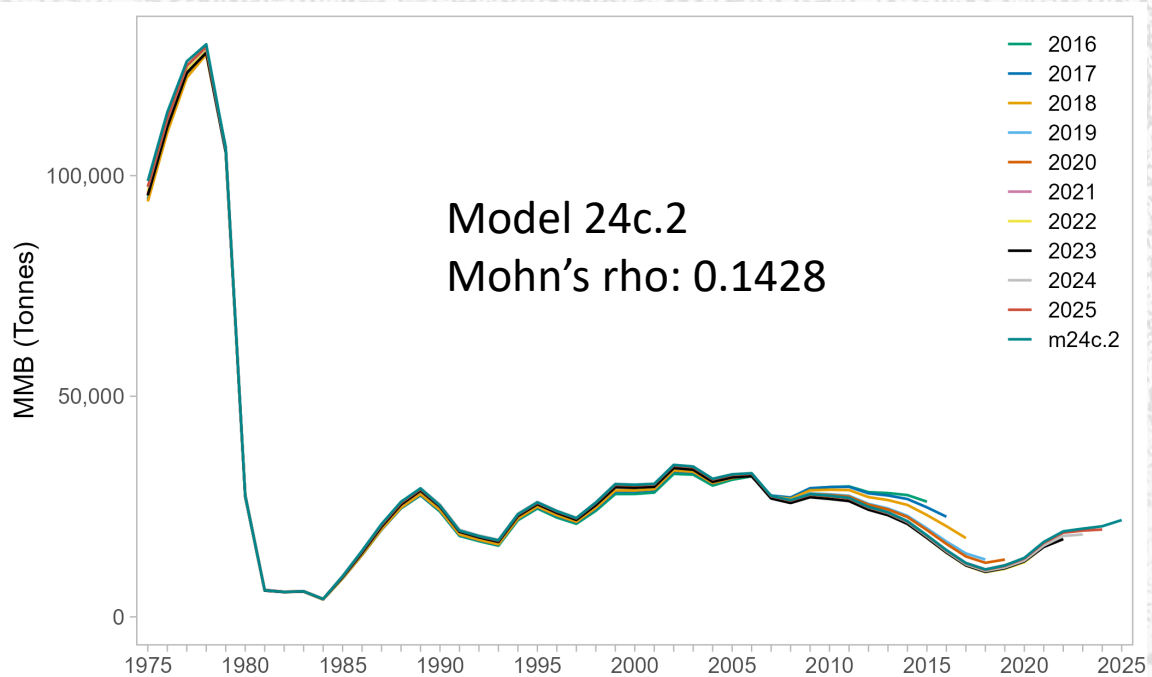


# Retrospective analysis and projections

- Retrospective analysis – both retrospective and historical retrospective
- Jitter – run on all models, >80% of jitter runs converged to MLE and those that didn't were worse model fits (~100 runs with sd =0.1 and 0.3)
- MCMC runs to look at model variability
- Projections
  - To inform population trajectory and the probability of “approaching an overfished condition”
  - Used low recruitment since 2015 (last ten years)

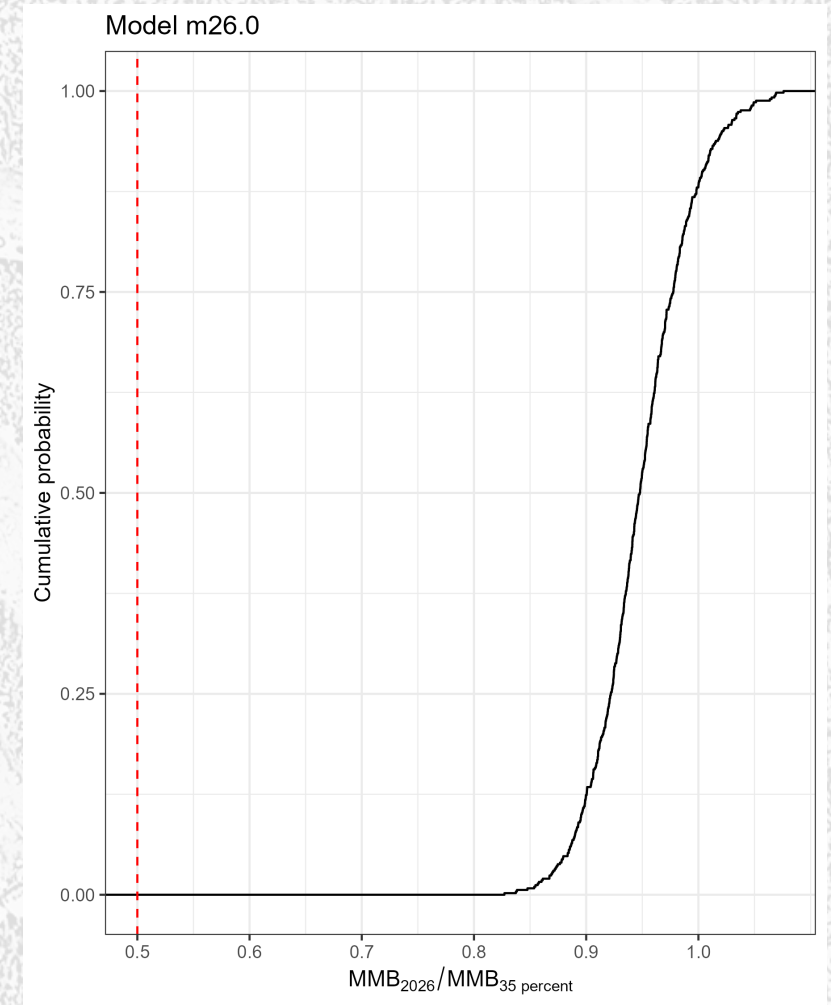
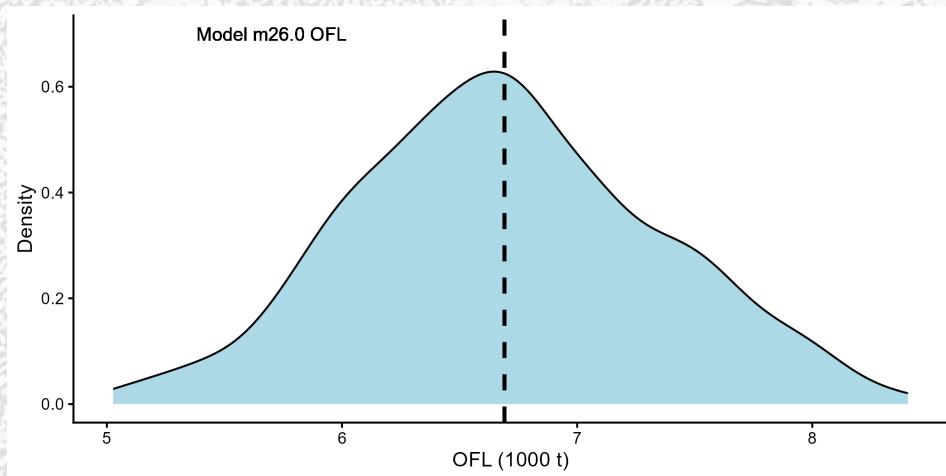
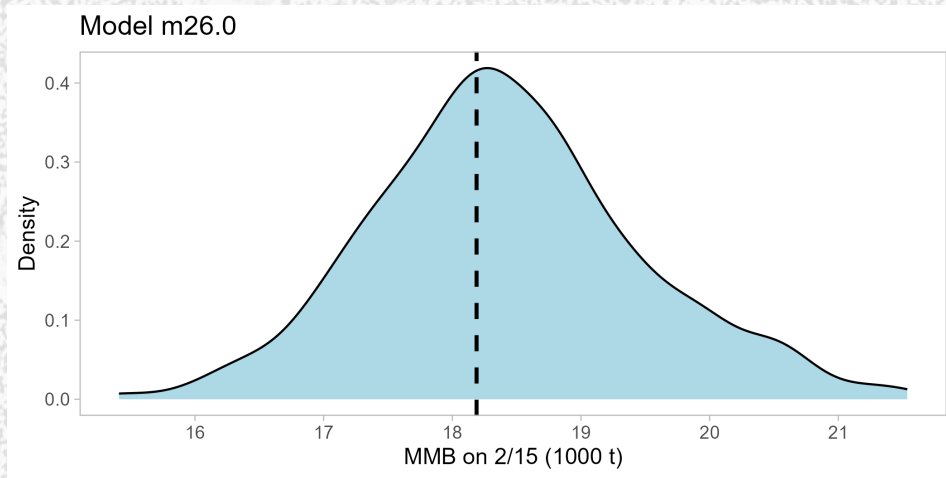
# Retrospective patterns

Historic retrospective – uses accepted model output in that assessment year (source SAFE documents)

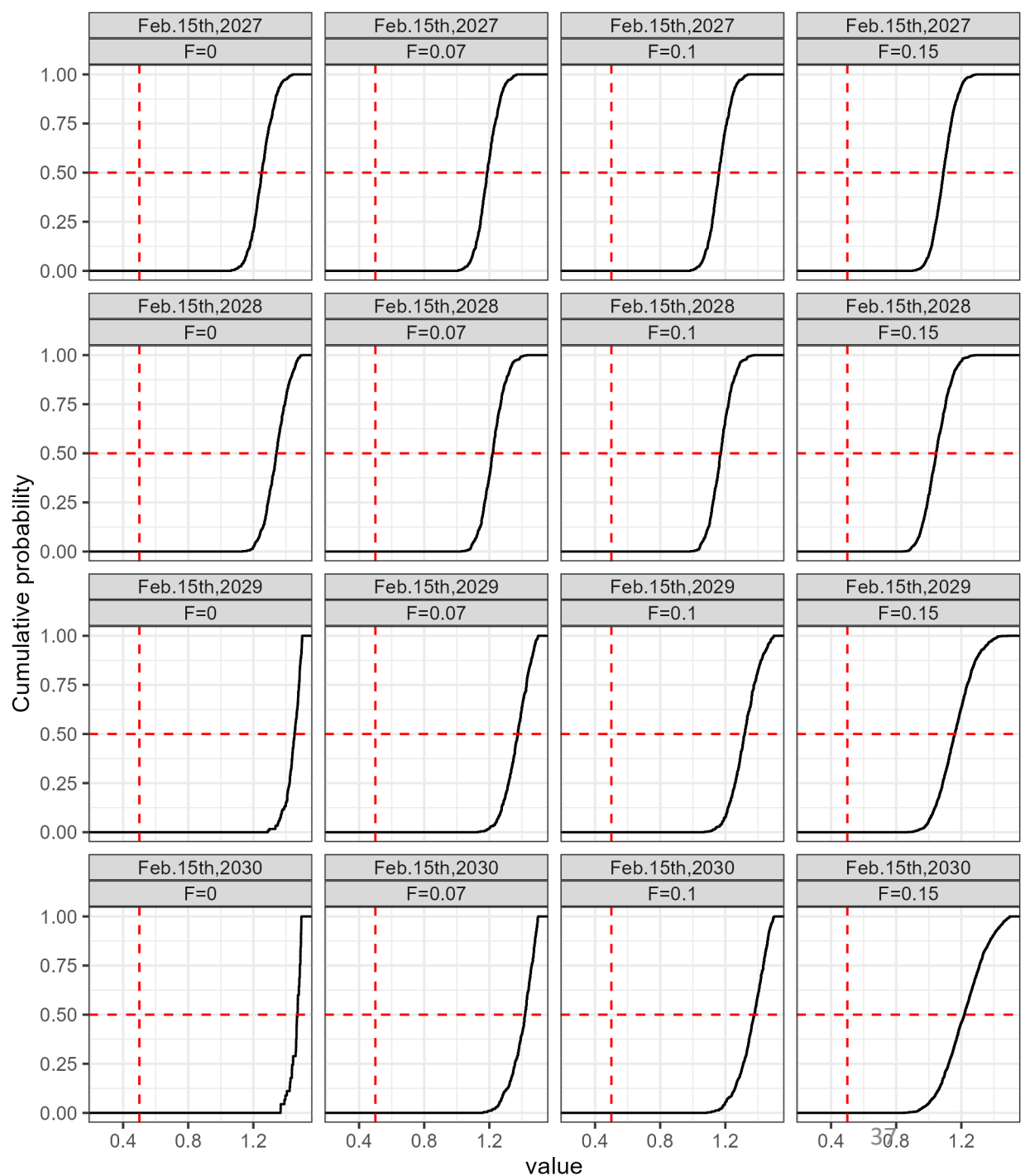
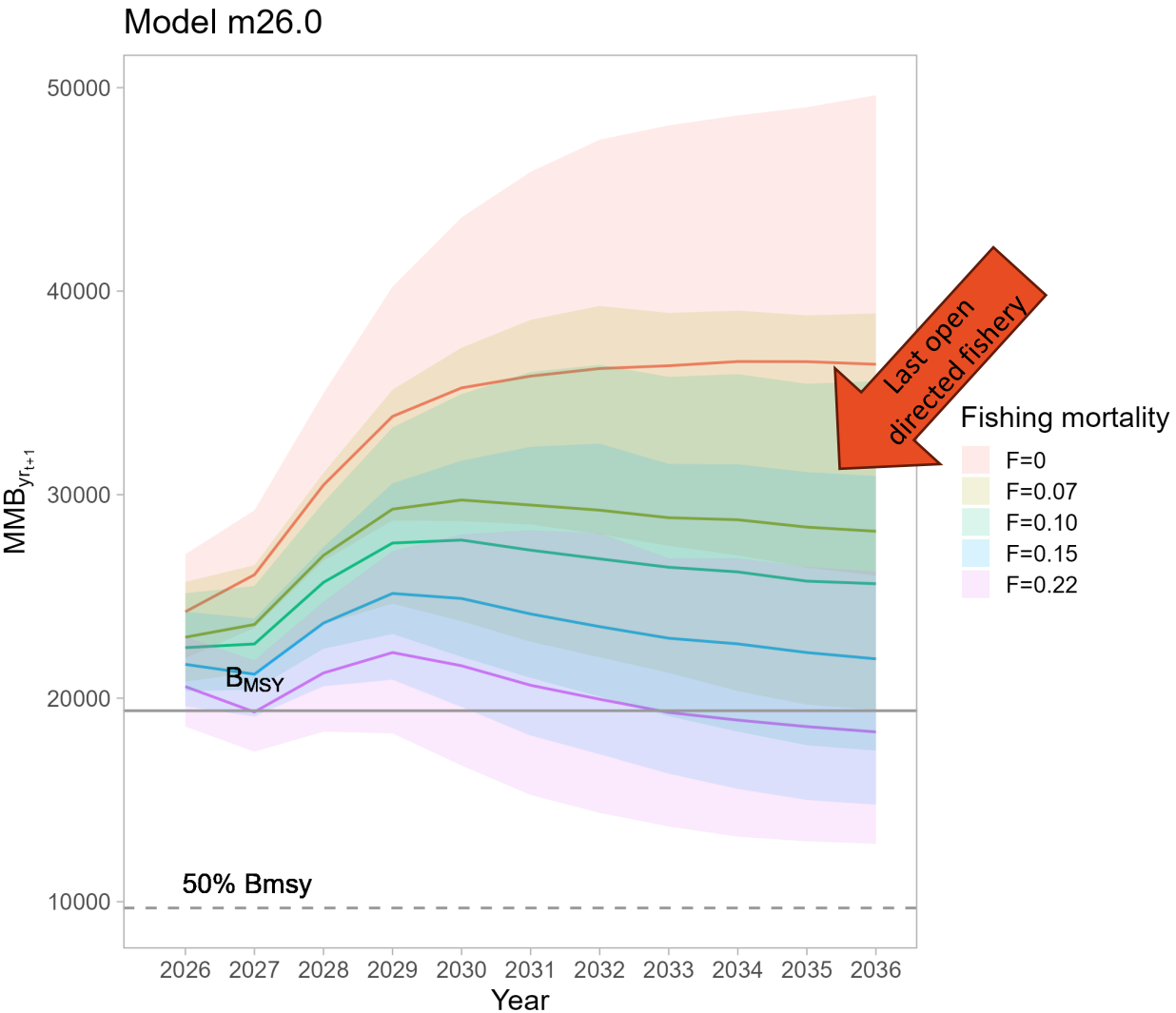


# MCMC output (Model 26.0)

Cumulative probabilities of estimated ratios of MMB in 2025 (Feb. 15<sup>th</sup>, 2027) to corresponding estimated  $B_{35\%}$  values under model 26.0 with the MCMC approach.

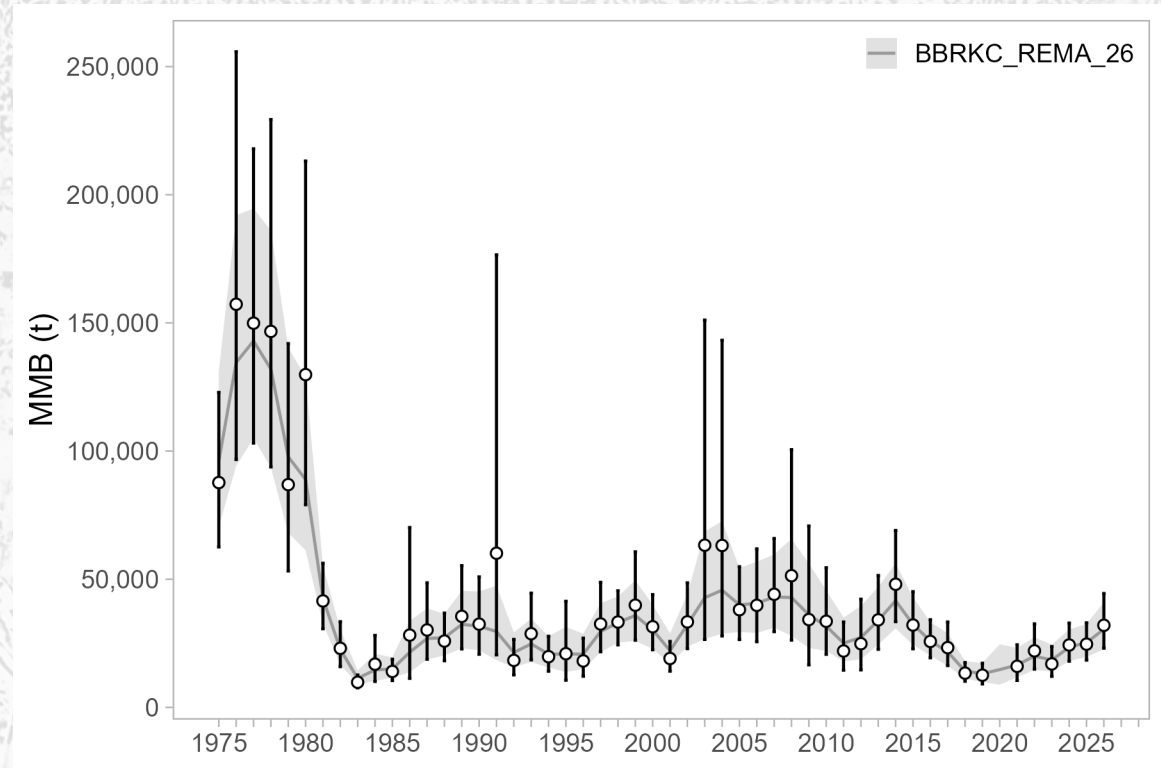


# Projections for future status (26.0 MCMC output) [2026 = projected MMB Feb 15<sup>th</sup> , 2027]



# Tier 4 REMA simple modeling workgroup option

- Based on the simpler modeling working group discussions
- Mature male biomass (legal size + one growth increment below = mature for BBRKC)
- Average B – calculated using MMB from 1984 to 2025 (matches current Tier 3 assessment  $B_{35\%}$  calcs)
- Tier 3 20% buffer – ABC
- 15% buffer; buffer as CV of final year of REMA output rounded to the nearest 5% - ABC 2



| avgBb (t) | Current B | MMB/ $B_{msy}$ | M    | $F_{OFL}$ | OFL  | ABC  | ABC 2 |
|-----------|-----------|----------------|------|-----------|------|------|-------|
| 27.78     | 30.50     | 1.10           | 0.23 | 0.26      | 7.78 | 6.22 | 6.61  |

# Summary & Recommendations

- Updates to GMACS and current year data have minimal impacts on model performance
- Trend in mature male biomass expected with addition of new year of data
- Stock is not overfished in 2026 and not likely “approaching an overfished condition” in the next two years
- Recommend model 26.0 for status determination
  - Encompasses size composition better
  - Recognize this should also be accompanied by growth updates (which are needed)

Table 1: Status and catch specifications (1000 t) for the CPT recommended model (26.0).

| Year    | MSST | Biomass<br>( $MMB_{\text{mating}}$ ) | TAC   | Retained<br>Catch | Total<br>Catch | OFL  | ABC  |
|---------|------|--------------------------------------|-------|-------------------|----------------|------|------|
| 2022/23 | 9.68 | 18.34                                | 0     | 0.02              | 0.11           | 3.04 | 2.43 |
| 2023/24 | 9.35 | 18.65                                | 0.975 | 0.96              | 1.34           | 4.42 | 3.54 |
| 2024/25 | 9.26 | 19.74                                | 1.05  | 1.05              | 1.20           | 5.02 | 4.02 |
| 2025/26 | 9.61 | 22.6                                 | 1.22  | 1.22              | 1.48           | 5.85 | 4.68 |
| 2026/27 |      | 18.77                                |       |                   |                | 7.13 | 5.7  |

20 % ABC buffer recommended due to similar reasons as previous years – will cover in risk table

Table 3: Basis for the OFL (1000 t) from the CPT recommended model (26.0).

| Year    | Tier | $B_{MSY}$ | Biomass<br>( $MMB_{\text{mating}}$ ) | $B/B_{MSY}$ | $F_{OFL}$ | Recruitment years<br>Basis for $B_{MSY}$ | Natural<br>mortality |
|---------|------|-----------|--------------------------------------|-------------|-----------|------------------------------------------|----------------------|
| 2022/23 | 3b   | 24.03     | 17.0                                 | 0.71        | 0.20      | 1984-2021                                | 0.18                 |
| 2023/24 | 3b   | 19.36     | 14.98                                | 0.77        | 0.30      | 1984-2022                                | 0.23                 |
| 2024/25 | 3b   | 18.69     | 15.43                                | 0.83        | 0.33      | 1984-2023                                | 0.23                 |
| 2025/26 | 3b   | 18.52     | 16.84                                | 0.91        | 0.37      | 1984-2024                                | 0.23                 |
| 2026/27 | 3b   | 19.23     | 18.77                                | 0.98        | 0.4       | 1984-2025                                | 0.23                 |

# BBRKC - Risk Table 2026 (App E)

| Assessment-related considerations                                                                                                                                                                          | Population dynamics considerations                                                                                                                                                                                                             | Ecosystem considerations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Fishery-informed Stock Considerations                                                                                                                                                                                                                                             |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>• Retrospective pattern in MMB (high Mohn’s rho).</li><li>• Stable GMACS reference model since 2018</li><li>• Historic natural mortality event (early 80s)</li></ul> | <ul style="list-style-type: none"><li>• Potential shifting spatial distributions</li><li>• Weak to no stock-recruit relationship</li><li>• Low levels of abundance compared to historic levels (shifting baseline, non-stationarity)</li></ul> | <div>Recommended ABC = 80% of max ABC (20% buffer).</div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <div></div> <div>Recommended ABC = 80% of max ABC (20% buffer).</div>                                                                                                                          |
| <ul style="list-style-type: none"><li>• Female size composition data potentially skewed due to late molt/mate cycle</li></ul> <p>Conclusion: <b>Level 1</b></p>                                            | <ul style="list-style-type: none"><li>• Stock-specific indicators suggest no apparent population dynamics concerns</li></ul> <p>Conclusion: <b>Level 1</b></p>                                                                                 | <ul style="list-style-type: none"><li>• Thermal conditions over the EBS shelf and in Bristol Bay from winter 2025 through summer 2026 have been cool with an extensive cold pool in summer 2026. Pelagic feeding conditions have been favorable in 2025 and 2026; benthic prey indicators were mixed in 2025. Competition for space remained high, in 2025 while competition for prey remained low Predation pressure was near-average in 2026.</li><li>• Overall, ecosystem concerns are minor with uncertain impacts on the stock.</li></ul> <p>Conclusion: <b>Level 1</b></p> | <ul style="list-style-type: none"><li>• Fishery-informed indicators are generally consistent with stable stock condition and distribution. No considerations observed in the most recent fishery suggest greater than normal concern.</li></ul> <p>Conclusion: <b>Level 1</b></p> |

# Appendix E: History of buffer considerations

- 20% (no large changes or improvements in uncertainty)

Table 1: History of Acceptable Biological Catch (ABC) buffers and buffer justifications for the Bristol Bay red king crab stock. Source: Crab Stock Assessment and Fishery Evaluation (SAFE) Report Introductions, <https://www.npfmc.org/library/safe-reports/>.

| Year | ABC buffer | Justifications                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|------|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2021 | 25%        | <ul style="list-style-type: none"><li>- continued lack of recent recruitment</li><li>- poor environmental conditions (as reflected in the ESP)</li><li>- continued decline in female survey biomass in 2021</li><li>- model's lack of fit to the 2018-2021 female survey biomass</li></ul>                                                                                                                                                                                                                                                                                                                                 |
| 2022 | 20%        | <ul style="list-style-type: none"><li>- continued lack of recent recruitment</li><li>- poor and variable environmental conditions</li><li>- NMFS female survey biomass in 2022 remains at historically low levels</li><li>- lack of fit to the 2018-2022 NMFS female survey biomass</li><li>- retrospective patterns exhibited by the recommended model</li></ul>                                                                                                                                                                                                                                                          |
| 2023 | 20%        | <ul style="list-style-type: none"><li>- continued lack of recent recruitment</li><li>- poor and variable environmental conditions (e.g., cold pool distributional shifts)</li><li>- NMFS female survey biomass in 2023 increased above historically low levels for the first time in 5 years, but this was predicated on a single exceedingly large tow (thus the accompanying uncertainty was large)</li><li>- lack of fit to 2018-2023 NMFS female survey biomass</li><li>- retrospective patterns exhibited by the recommended model, even though this was improved over last year's assessment model (21.1b)</li></ul> |
| 2024 | 20%        | <ul style="list-style-type: none"><li>- continued lack of recent recruitment</li><li>- poor and variable environmental conditions (e.g., cold pool distributional shifts)</li><li>- lack of fit to 2021 - 2024 NMFS female survey biomass</li><li>- retrospective patterns exhibited by the recommended model</li></ul>                                                                                                                                                                                                                                                                                                    |
| 2025 | 20%        | <ul style="list-style-type: none"><li>- similar concerns to 2024</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

# Future work

- Revisit previous SSC/ CPT comments (earlier slide)
- Resampling protocol
  - Model sensitivities to female biomass and size composition data related to retow years
  - Assist NMFS staff with potential retow protocols
- Growth review
  - Reanalyze historic growth data
  - Determine adjustments to growth and molting assumptions with additional size bins
- Model based indices for sensitivity to northern area crab

# Thanks!

- Tyler Jackson for 'gmacsr' code for visualization of GMACS output
- Caitlin Stern and Tyler Jackson for internal review (ADF&G)
- Ben Daly, Ethan Nichols, Mark Stichert, and other ADF&G staff for fishery and observer data assistance



# MCMC output (Model 24.0c.2)

Cumulative probabilities of estimated ratios of MMB in 2025 (Feb. 15<sup>th</sup>, 2027) to corresponding estimated  $B_{35\%}$  values under model 24.0c.2 with the MCMC approach.

