

**St. Matthew Island blue king crab**  
**May 2024 proposed models**

Caitlin Stern and Katie Palof

# Overview

- Last full assessment: September 2022
- Declared overfished in 2018; no directed fishery since 2015/2016
- Under a rebuilding plan since 2020
  - No changes to fishing regulations
  - No further bycatch restrictions
  - Focused on recruitment expectations
- Core model issues
  - Differences between the pot and trawl surveys
  - Poor fit of models to recent years' survey data (2010+)
- Model explorations around natural mortality
- Planned development of single survey index using, e.g., sdmTMB



# Model explorations

# Model explorations

## 16.0 - 2022:

- 2022 accepted model with updated GMACS version (2.01.M.10, 2024-02-27)
- fixed  $M = 0.18$  for all years except 1998 time block (in which  $M$  is estimated)

# Model explorations

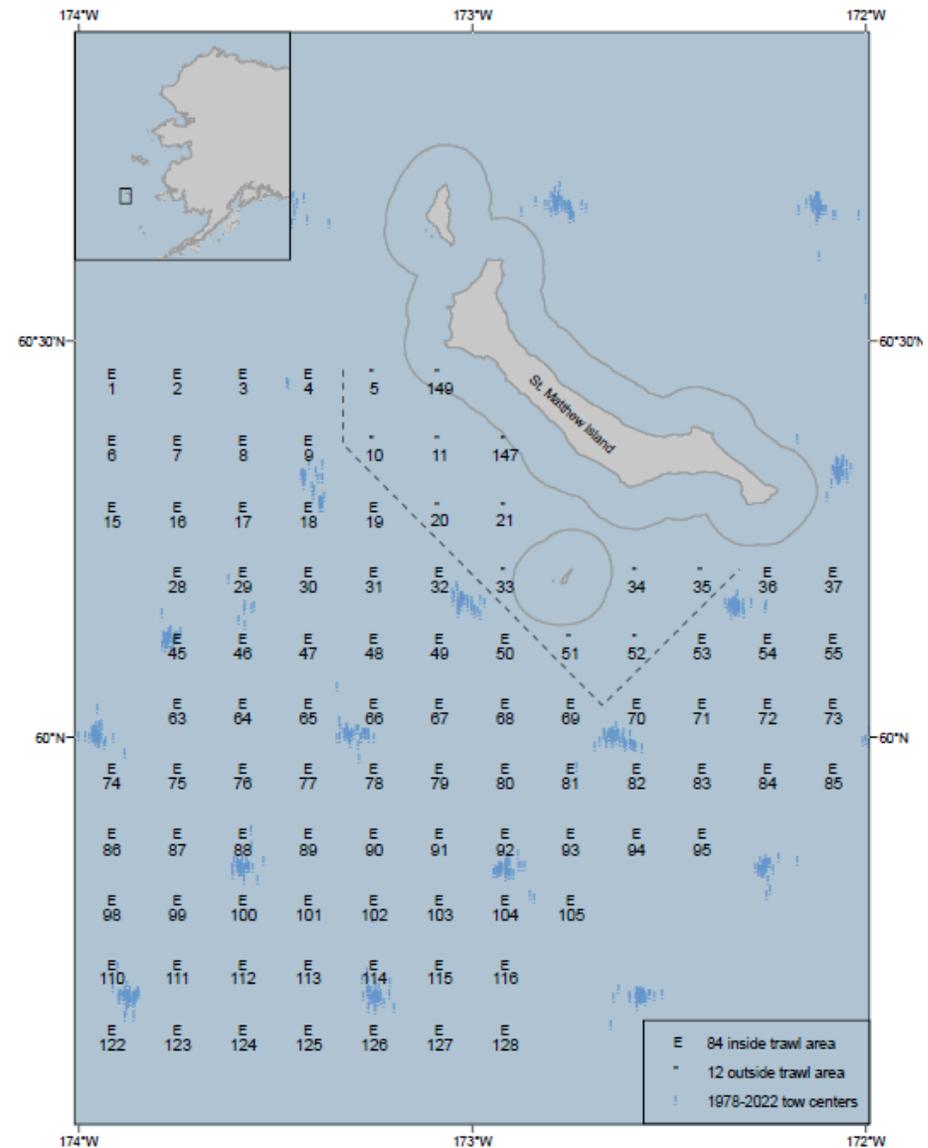
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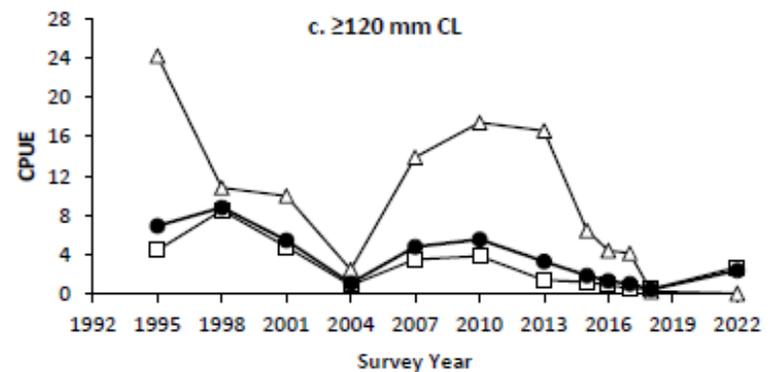
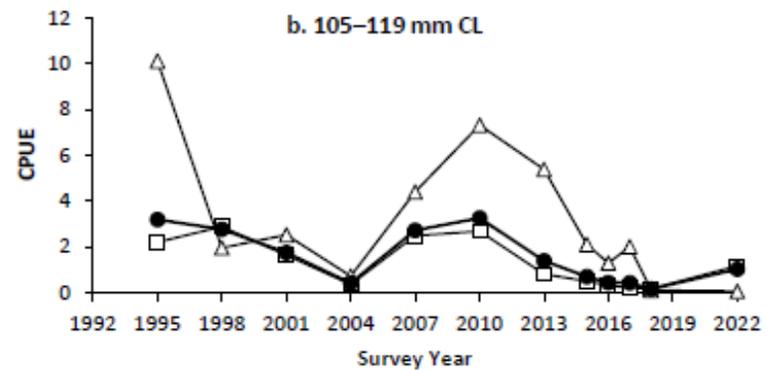
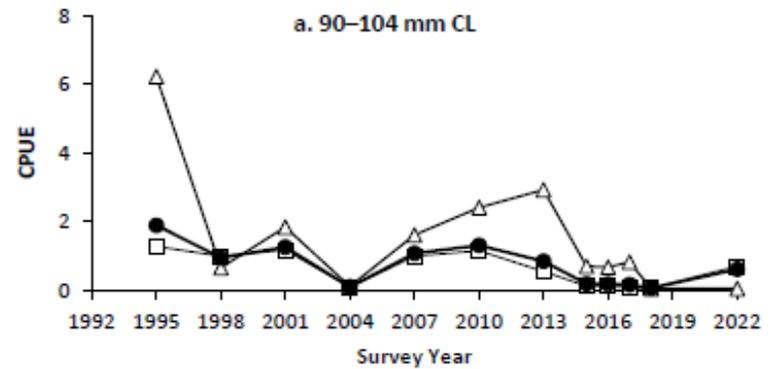
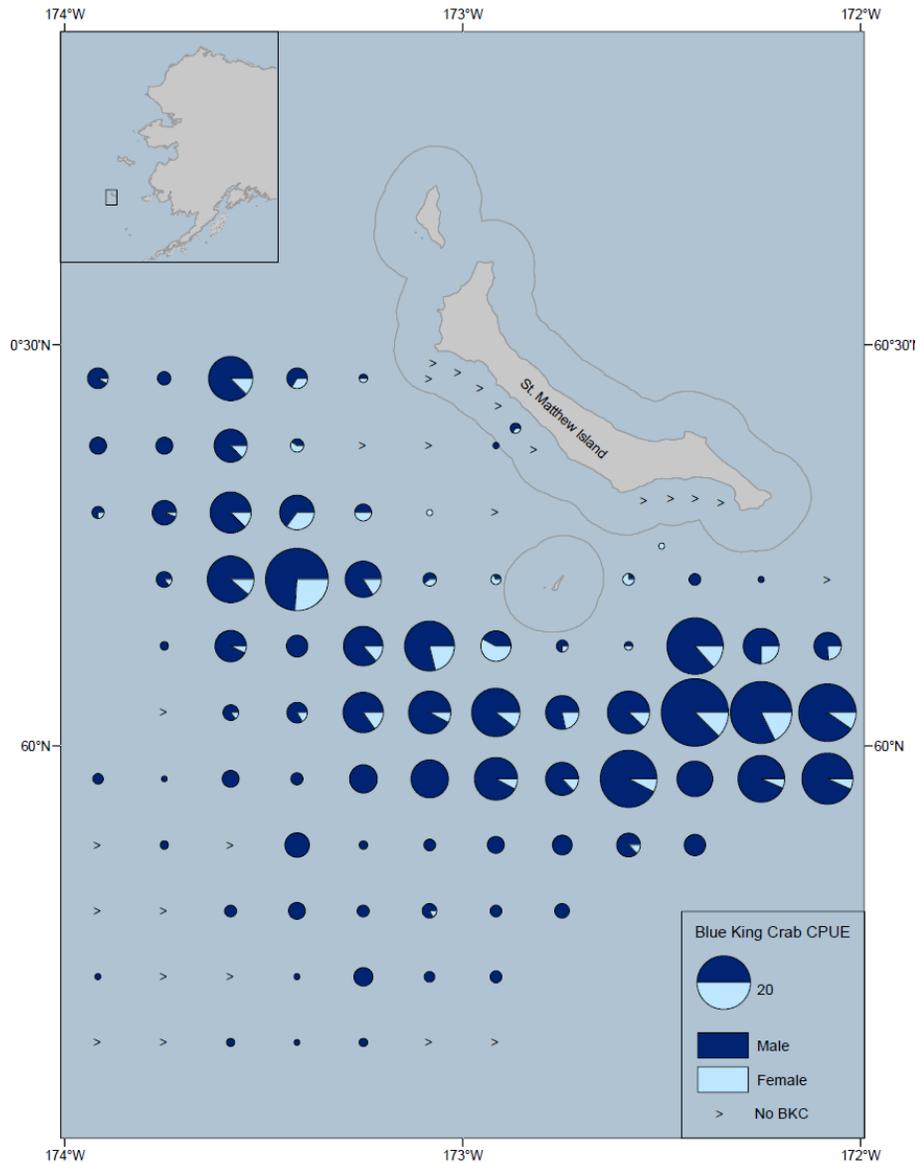
- 2022 accepted model with updated GMACS version
- fixed  $M = 0.18$  for all years except 1998 time block (in which  $M$  is estimated)
- data: 2022/23 groundfish bycatch, 2023 NMFS trawl survey, 2022 ADF&G pot survey

# 2022 ADF&G SMBKC pot survey

- Survey report by Vicki Vanek, Andrew Nault, and Danielle Lampe
- Survey conducted since 1995
  - Triennially to 2013, annually 2015–2018, and 2022
  - Finer spatial resolution than trawl survey
  - Samples untrawlable nearshore area
- 96 core stations in two strata
  - 65 offshore stations (Stratum 1)
  - 31 nearshore stations (Stratum 2); 12 don't overlap with trawl survey grid
  - Stations 5 nmi apart
  - 4 pots sampled per station (~1/8 nmi apart)



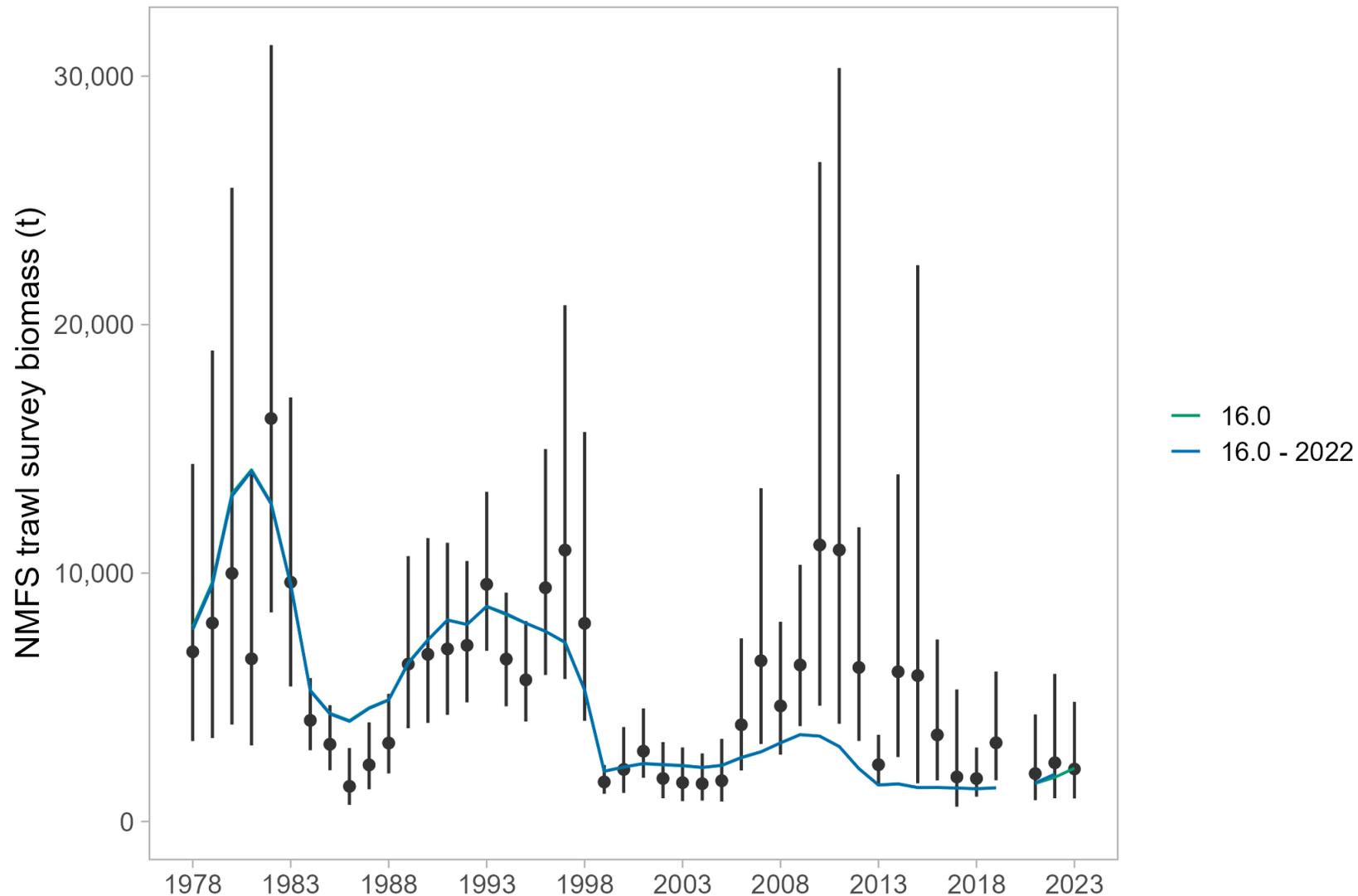
# 2022 ADF&G SMBKC pot survey



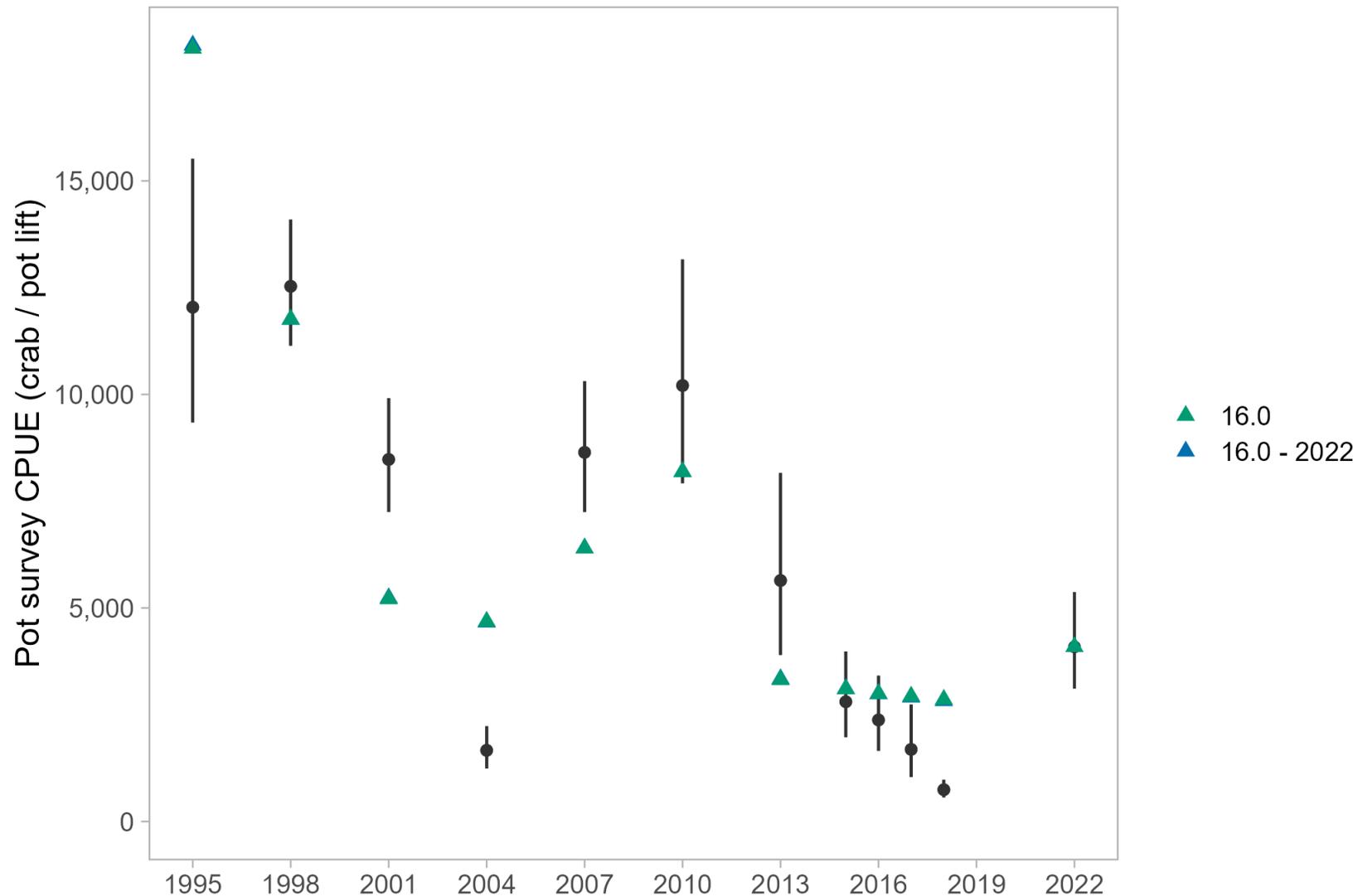
Reduced contribution of nearshore area

—□— 84 inside —△— 12 outside —●— All 96

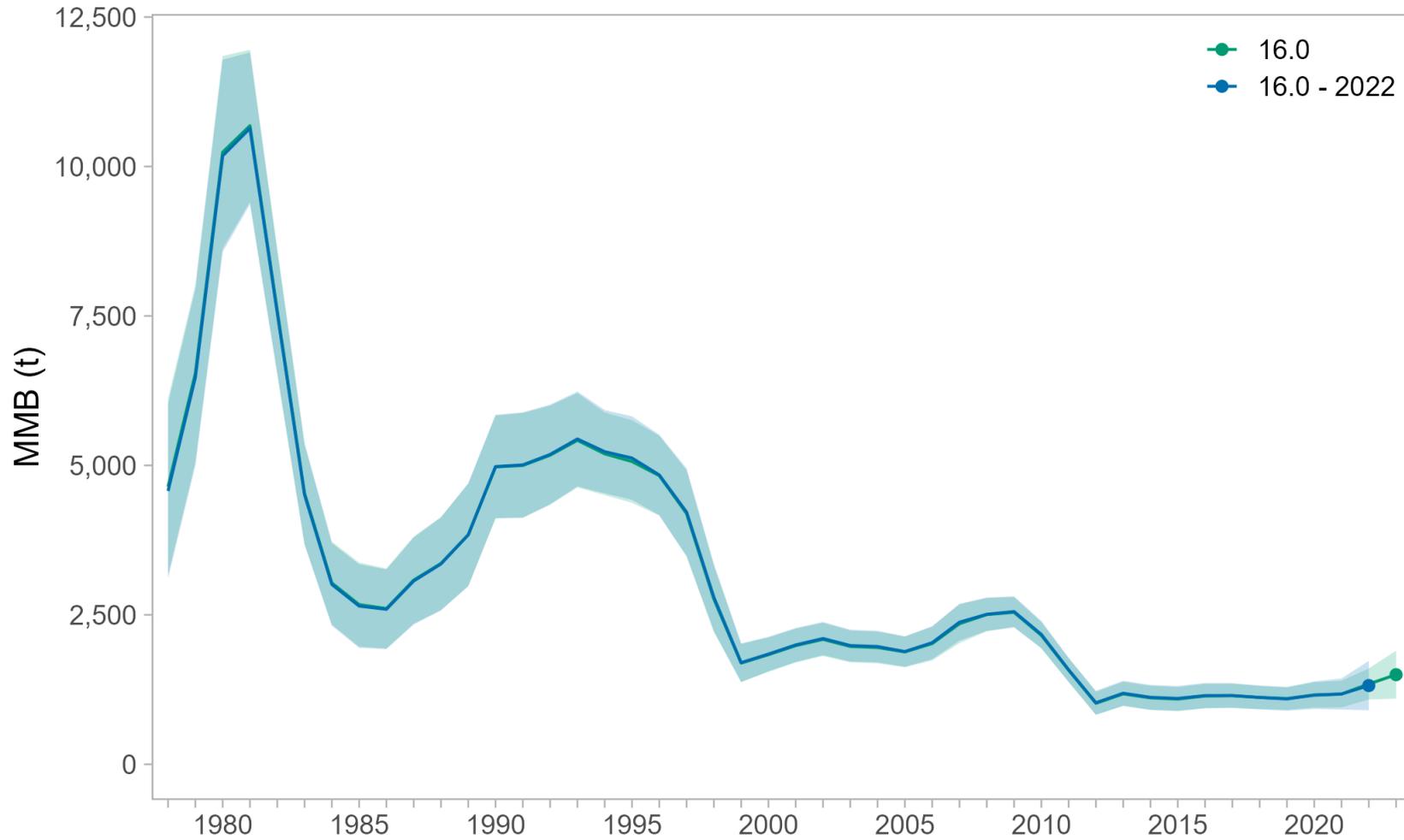
# Addition of new data: model fits to NMFS trawl survey data



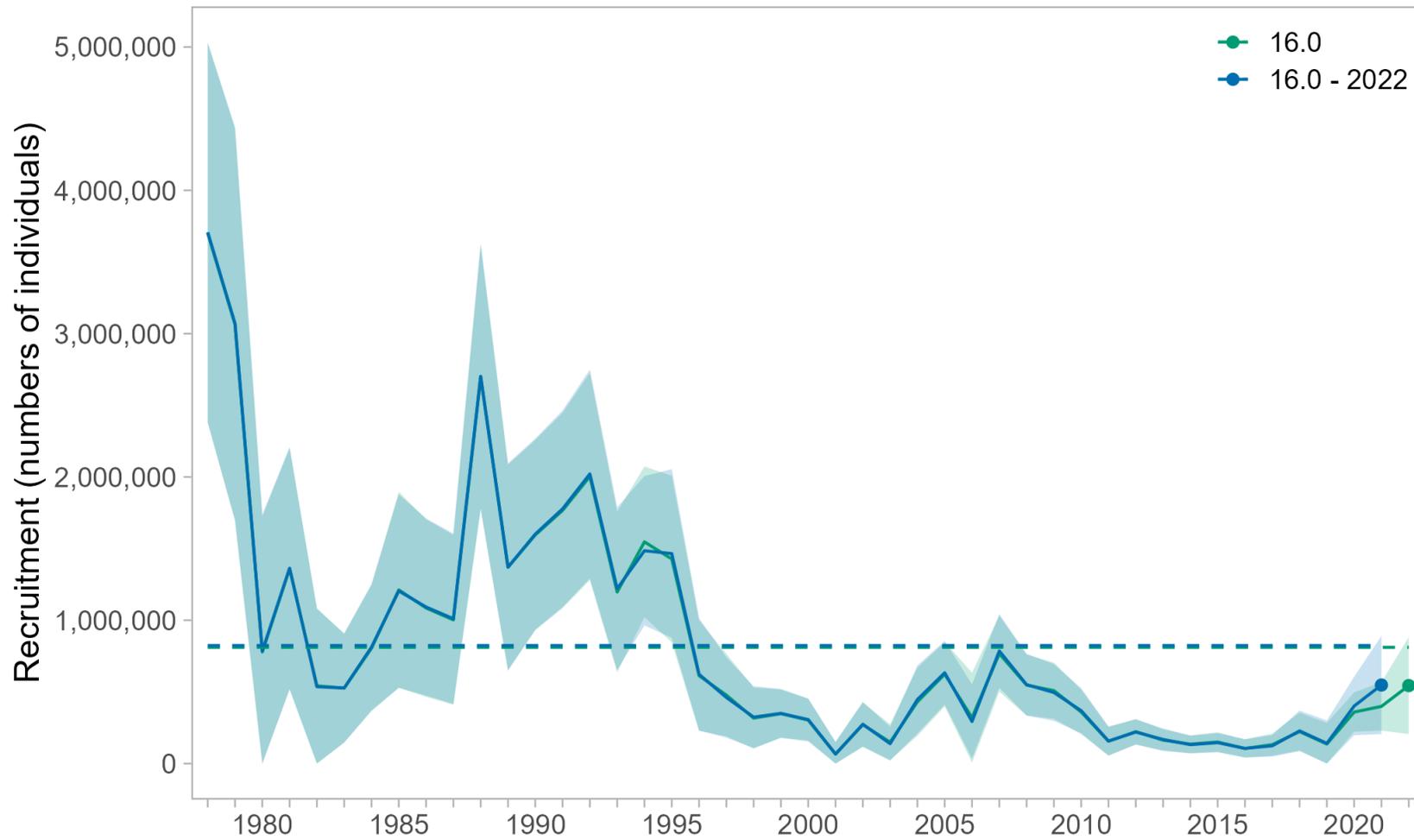
# Addition of new data: model fits to ADF&G pot survey data



# Addition of new data: MMB



# Addition of new data: recruitment



# Model explorations

**16.0 - 2022:** 2022 accepted model with updated GMACS version

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# Model explorations

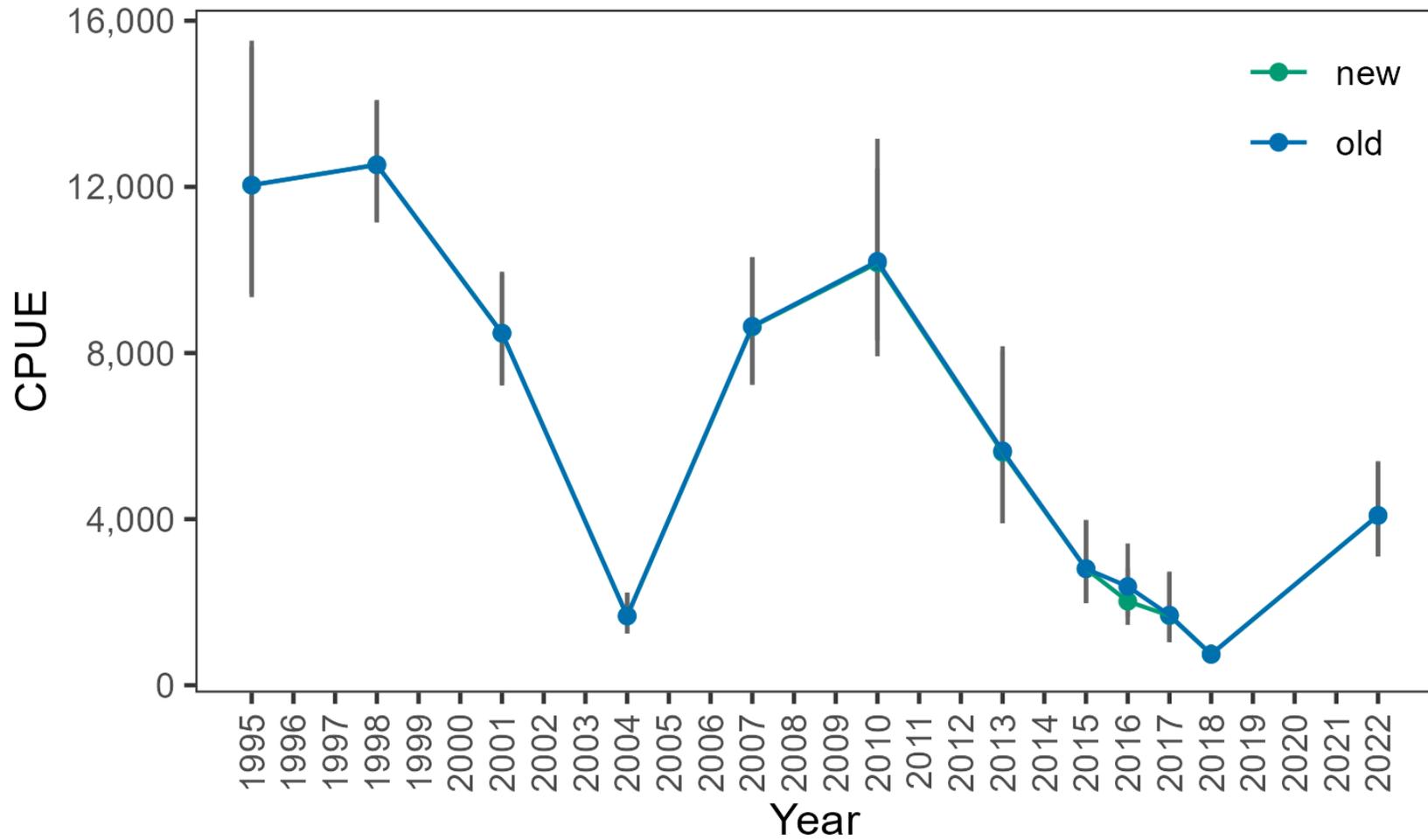
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**16.0a:**

- model 16.0 with updated historical ADF&G pot survey time series
- transparent, replicable data processing procedure
- identified and corrected erroneous 2016 data

# Model explorations



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- GMACS estimates SSB at the beginning of a season
- SSB should be estimated on 15 February, and 15 February is the dividing date between seasons 4 and 5 in this model, so SSB estimation should take place in season 5

Season 1	Season 2	Season 3	Season 4	Season 5
July 1	July 1 - Oct 15	Oct 15	Oct 15 - Feb 15	Feb 15 - June 30
Instantaneous Surveys	Natural mortality Trawl and fixed gear bycatch	Instantaneous Pot fishery	Natural mortality	SSB is calculated Molting, growth, recruitment

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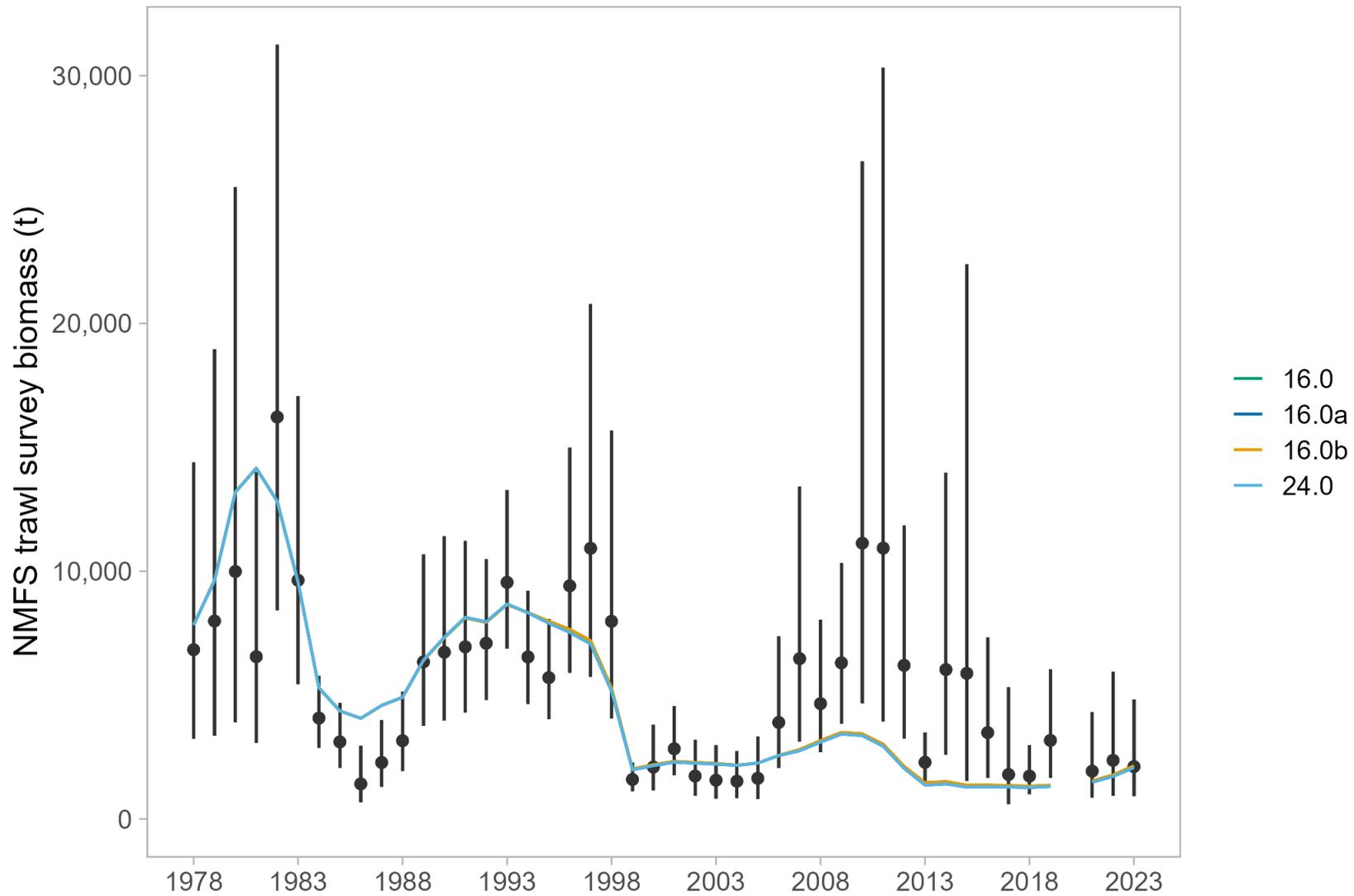
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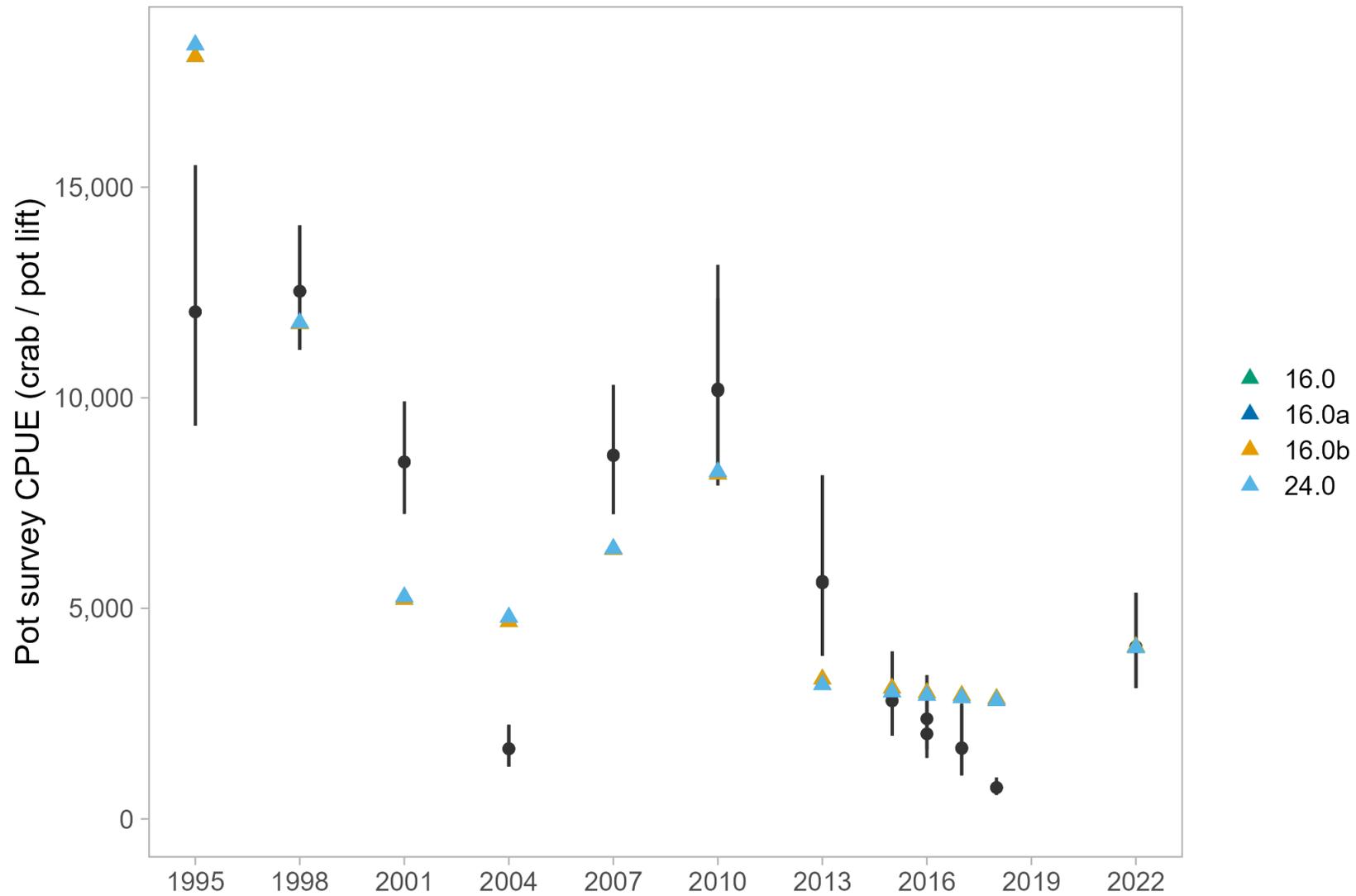
**24.0:** new base model, combining changes made in models 16.0a and 16.0b

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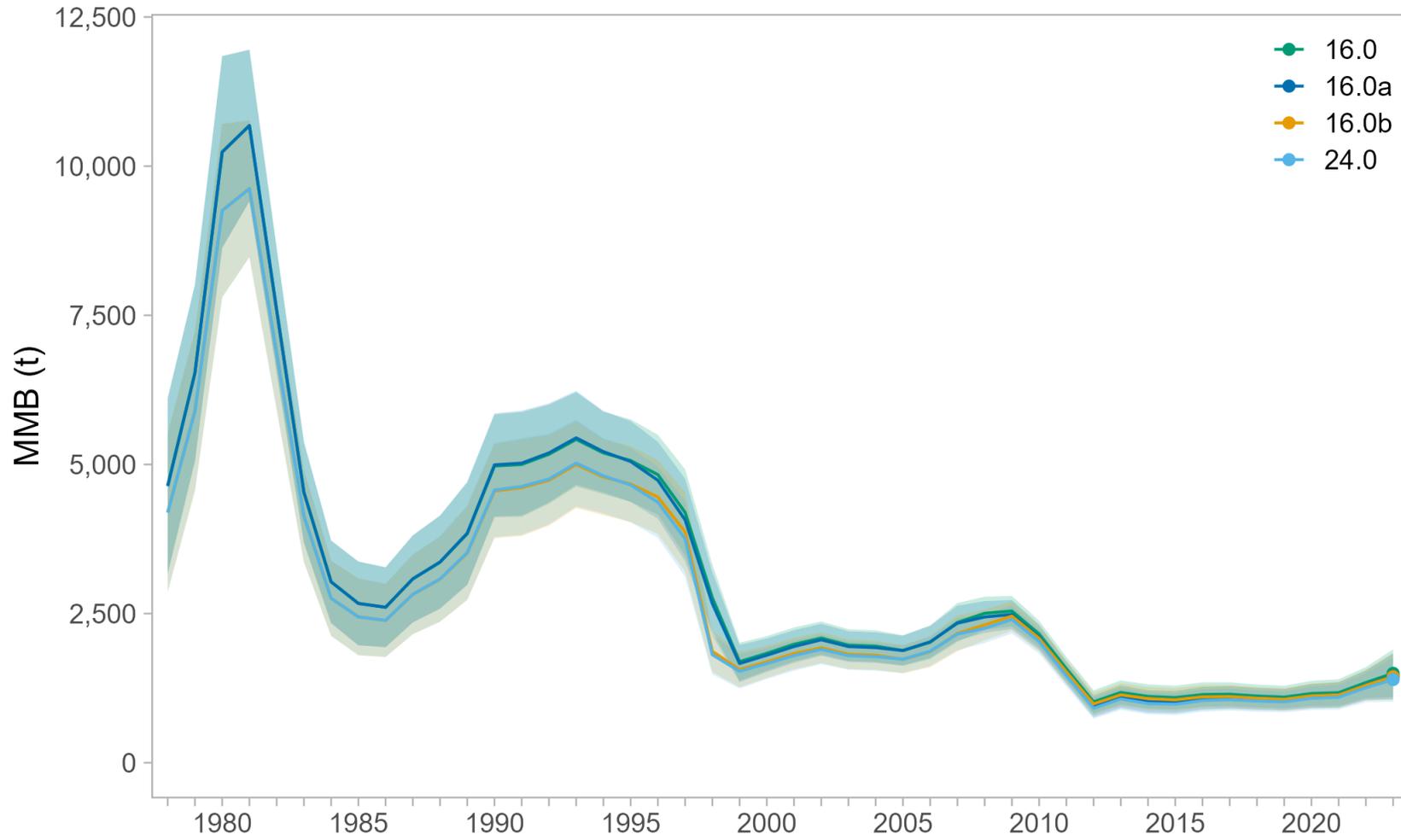
# Model fits to NMFS trawl survey data



# Model fits to ADF&G pot survey data

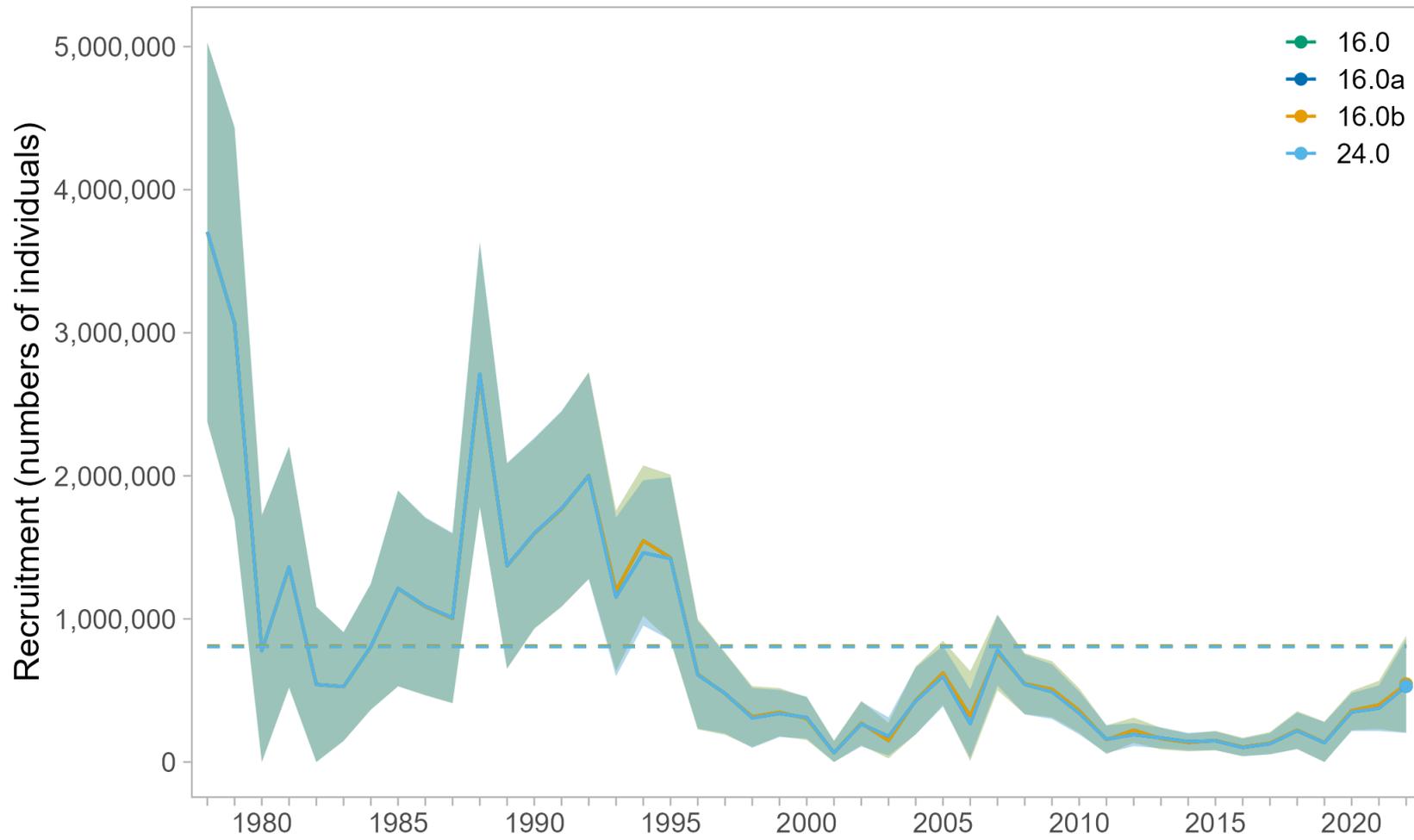


# MMB



Estimated 2023 MMB is 1498 t for model 16.0 and 1394 t for model 24.0

# Recruitment



# Model explorations

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**24.0a:** model 24.0 with  $M$  estimated using a tight prior (mean = 0.18, CV = 0.04)

- as in the BBRKC stock assessment

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**24.0c:** model 24.0 with  $M$  fixed at the value estimated in model 24.0a

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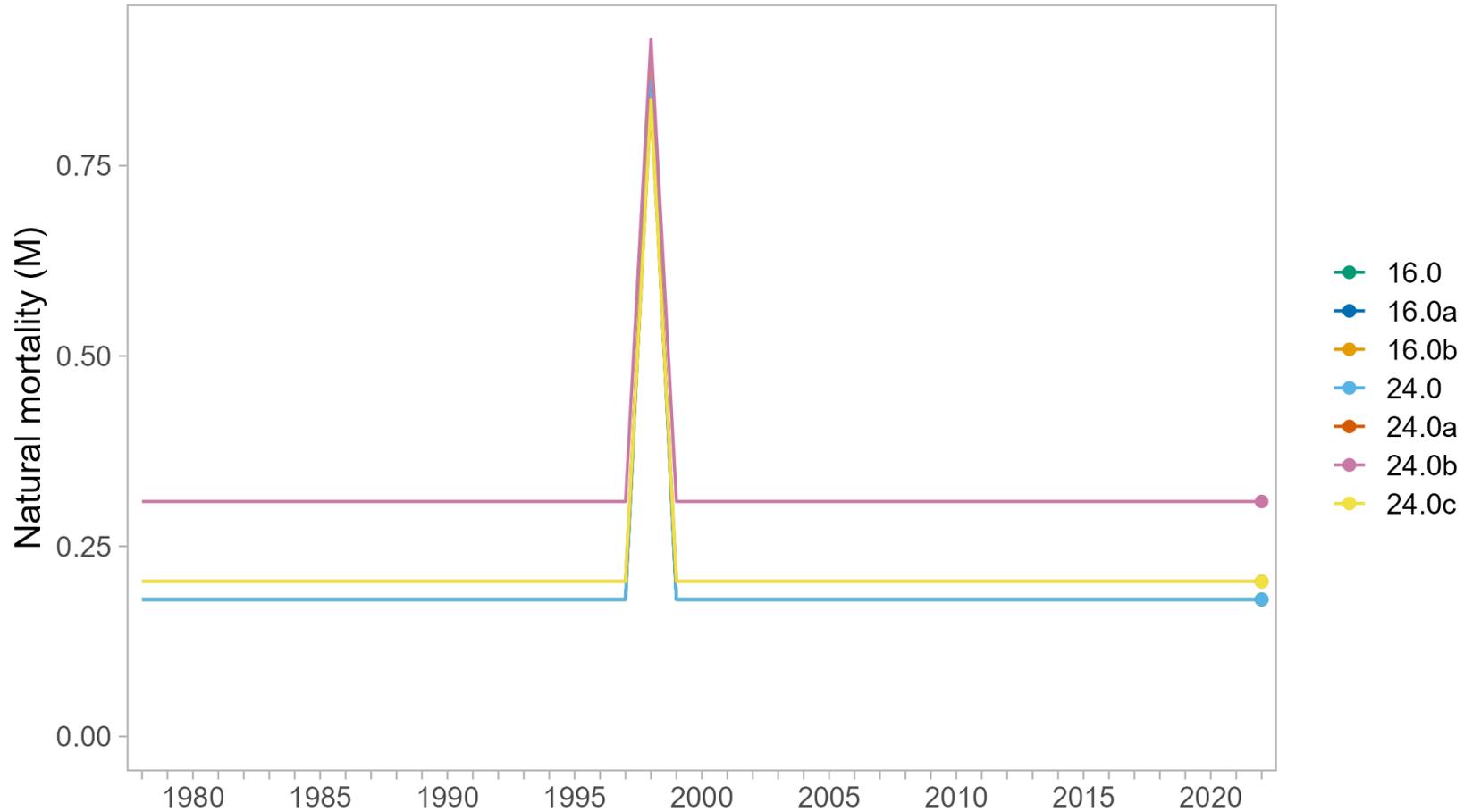
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# Natural mortality estimates

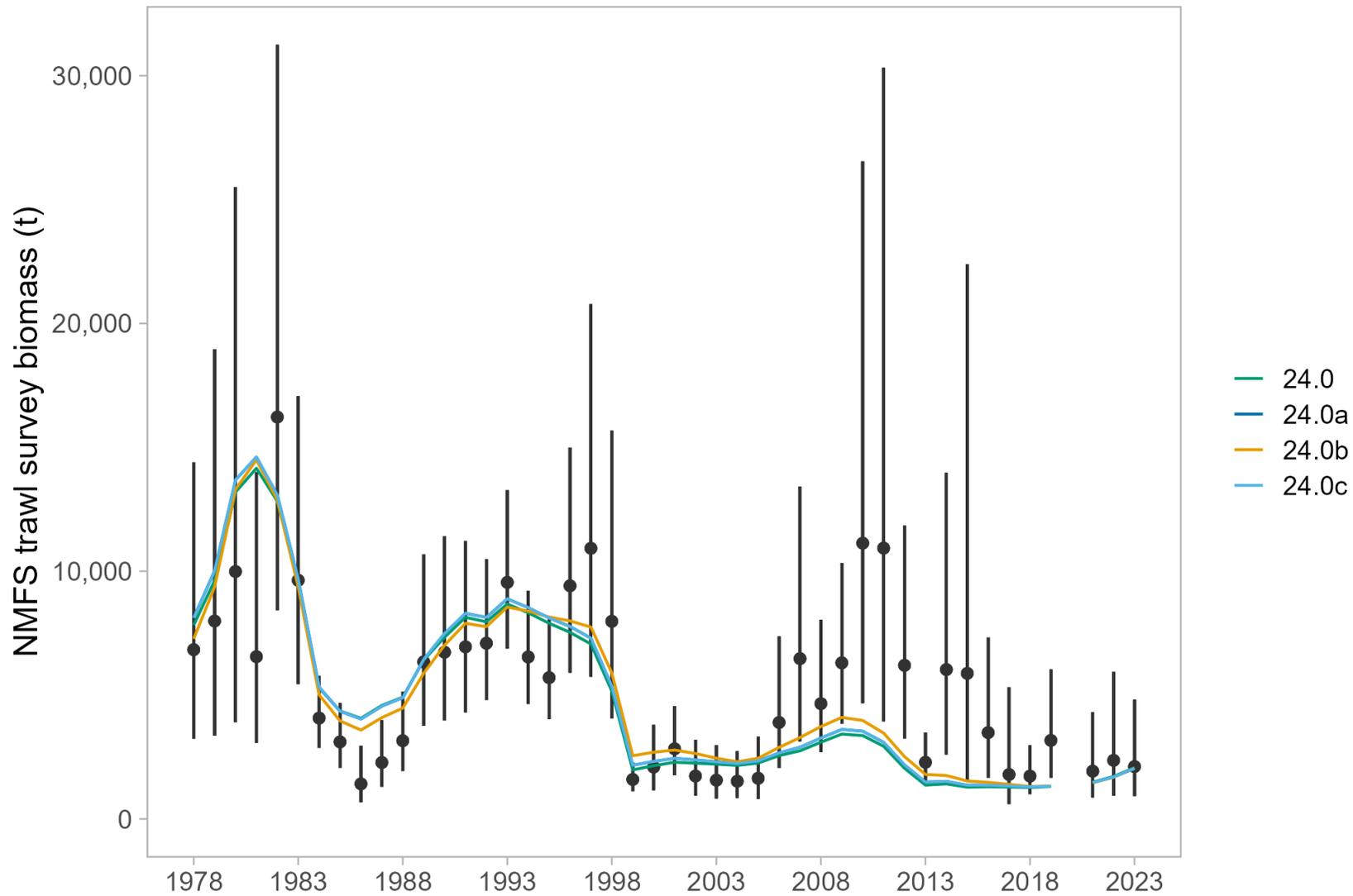


Model 24.0b:  $M = 0.31$

Models 24.0a and 24.0c:  $M = 0.20$

All others:  $M = 0.18$

# Model fits to NMFS trawl survey data

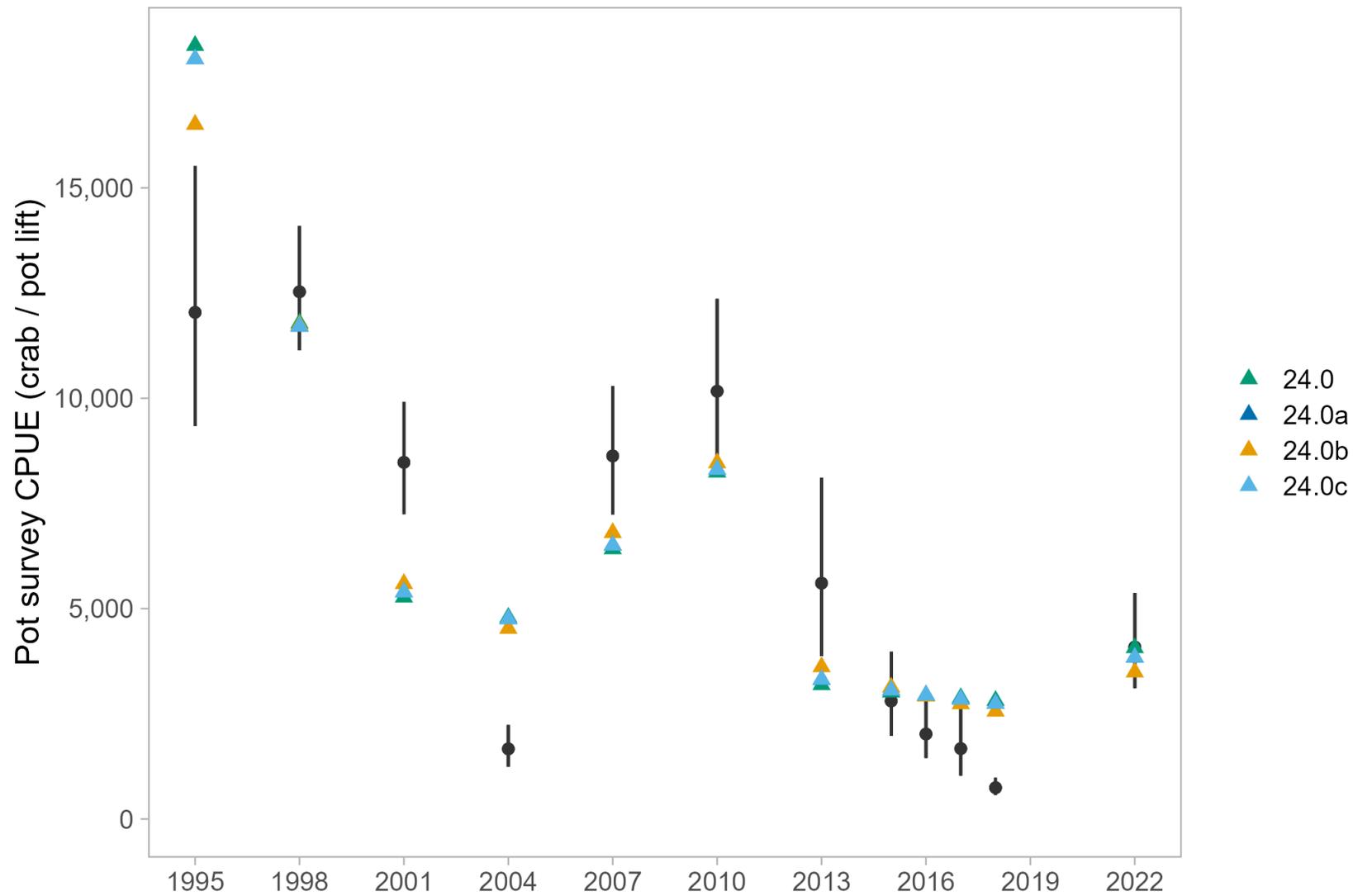


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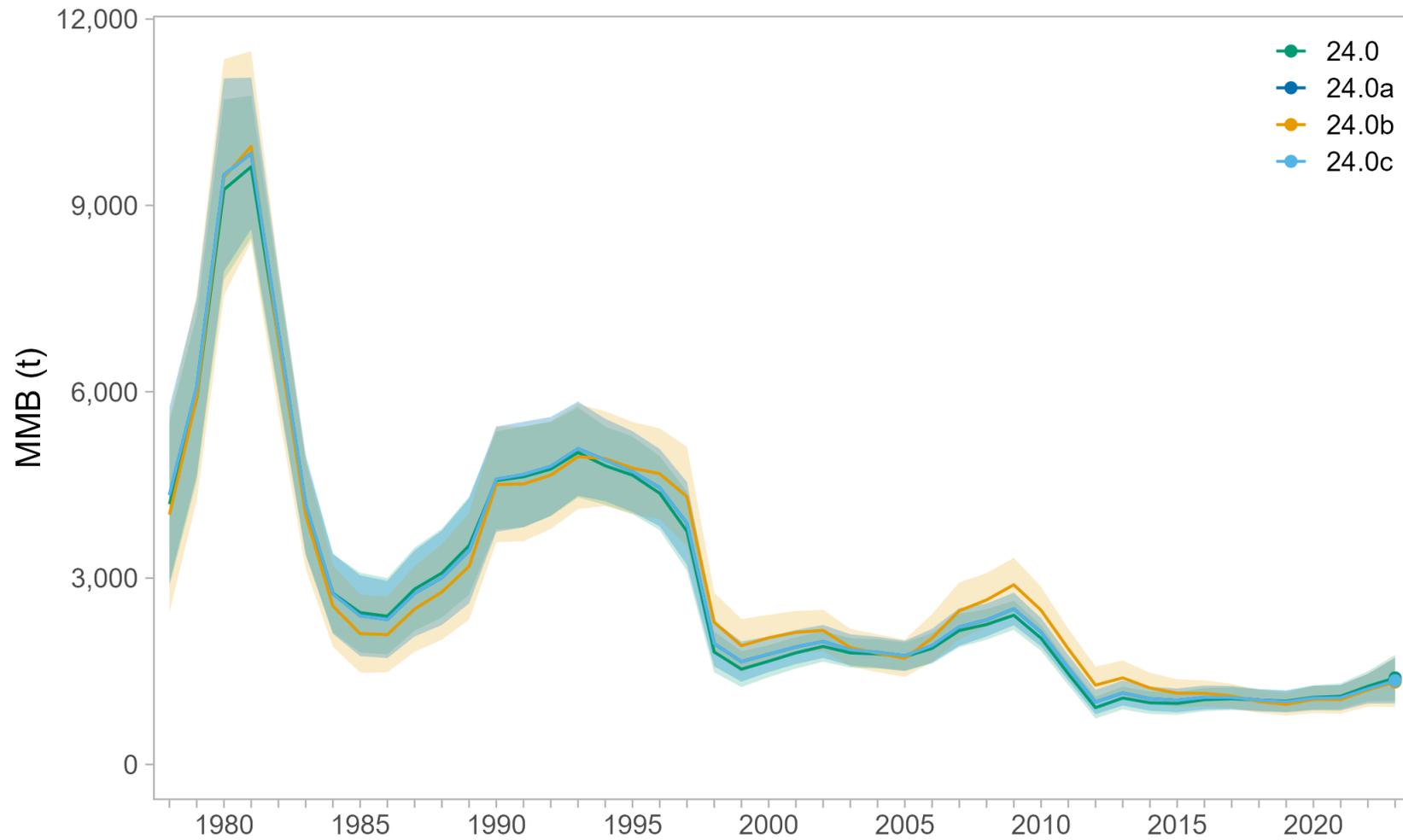


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# MMB

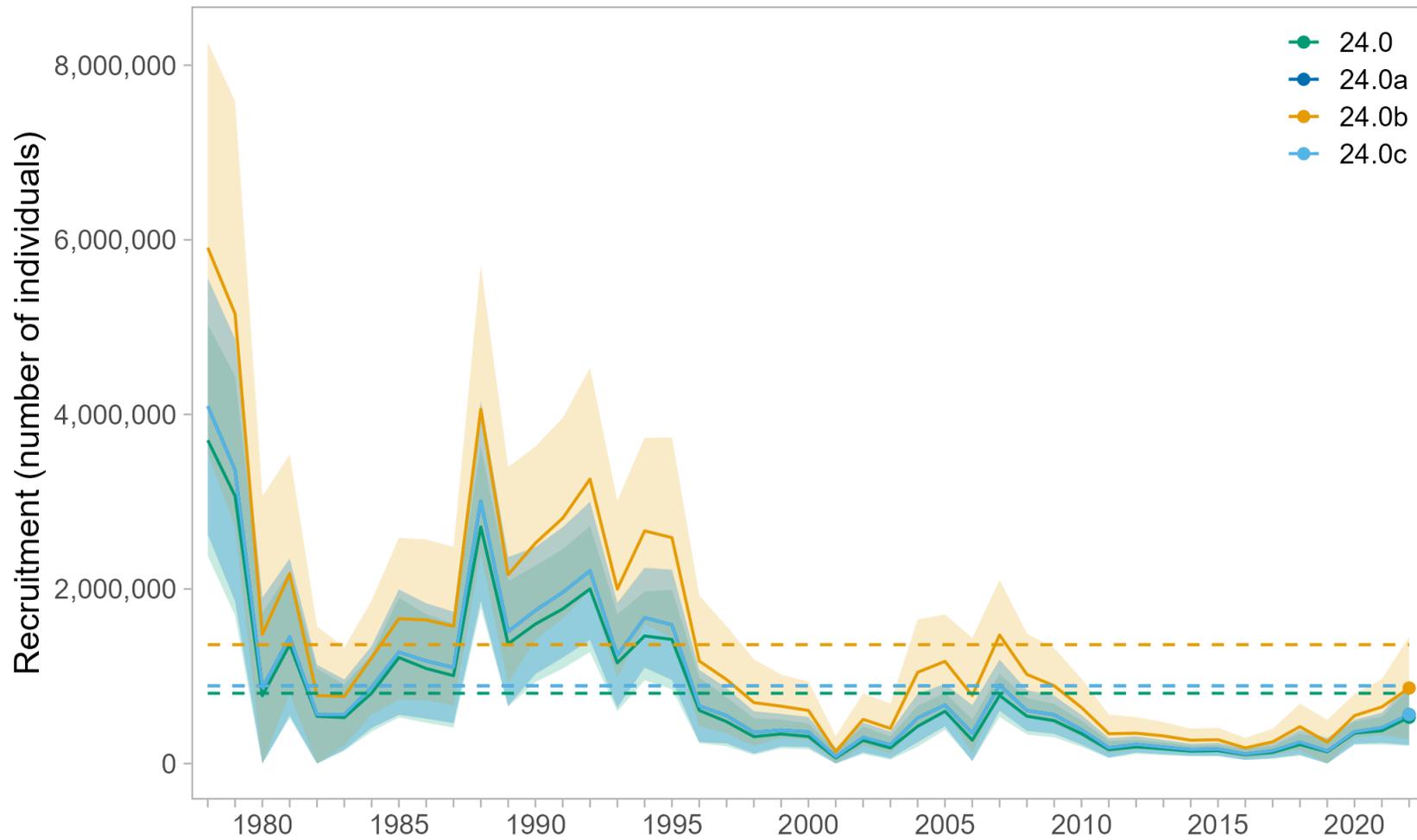


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# Recruitment

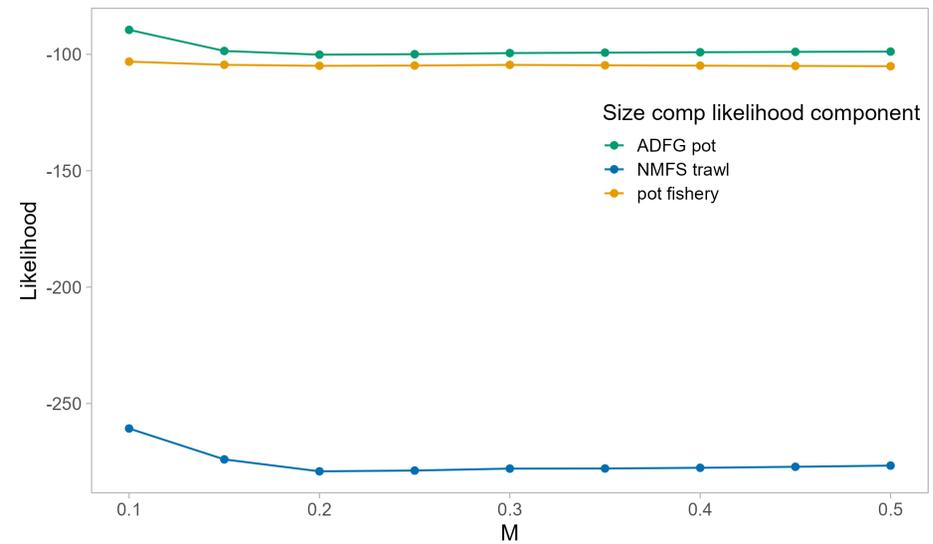
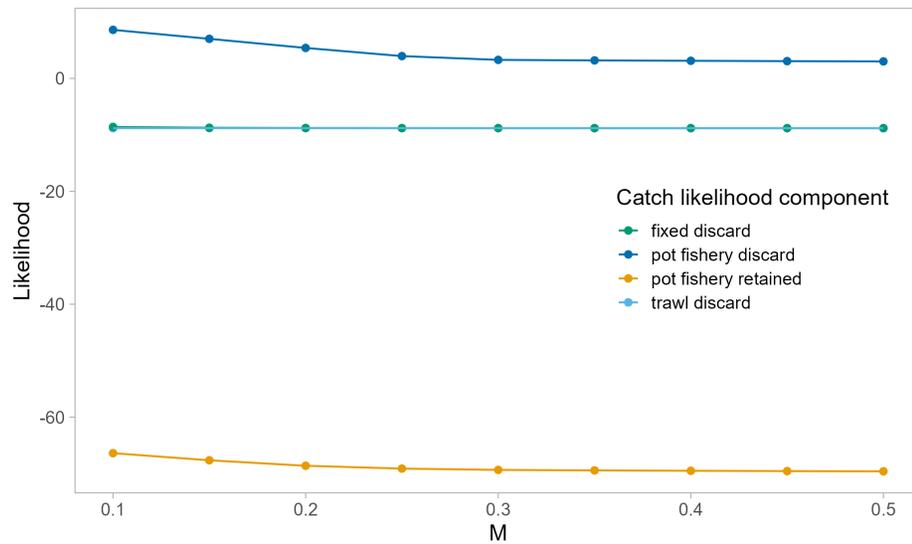
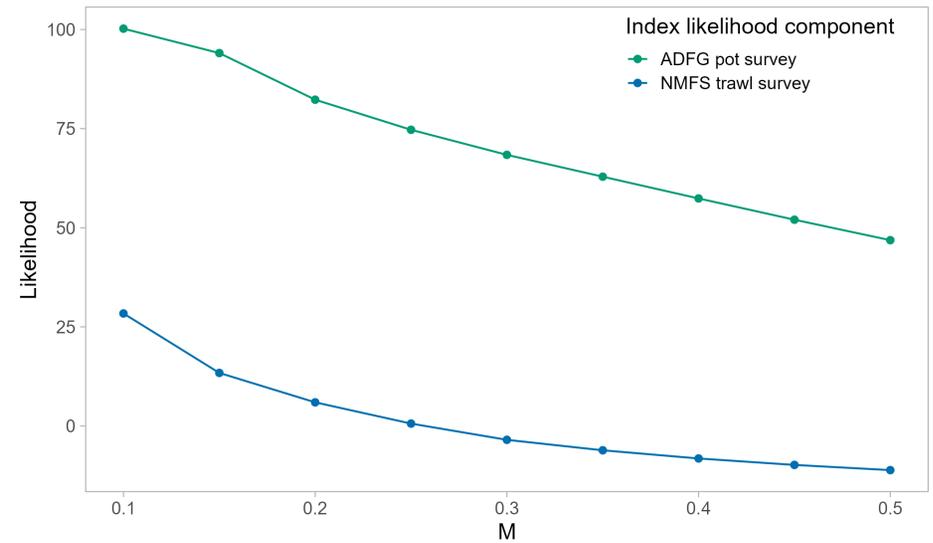
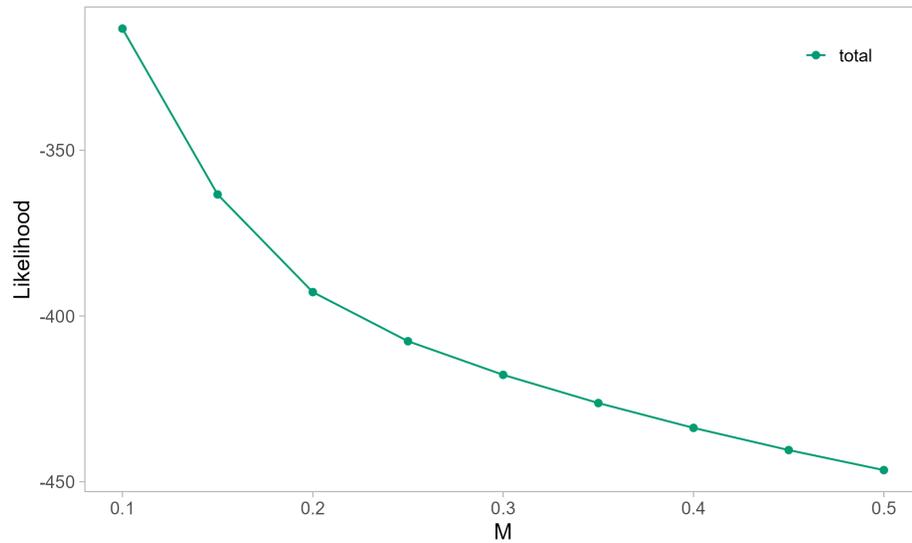


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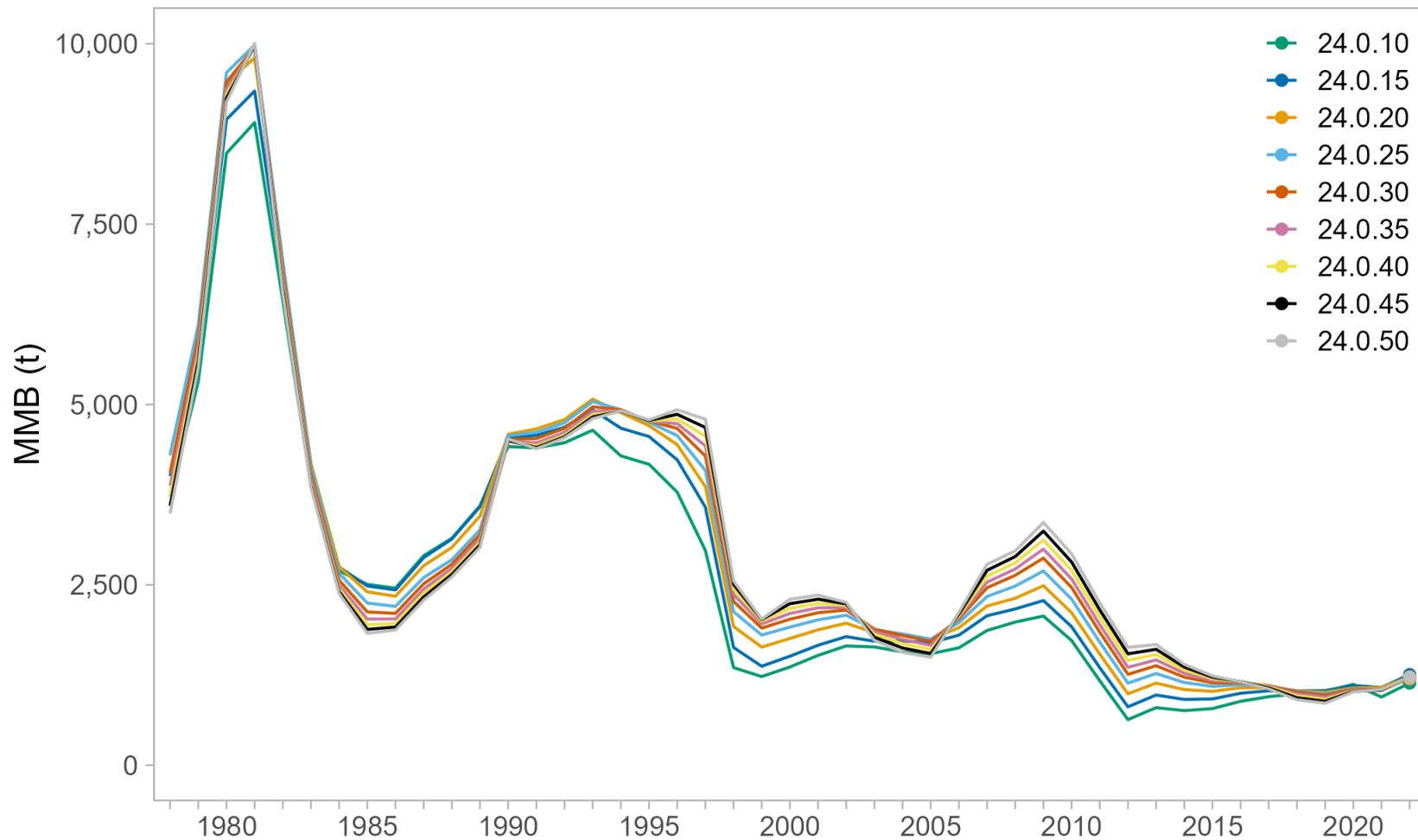
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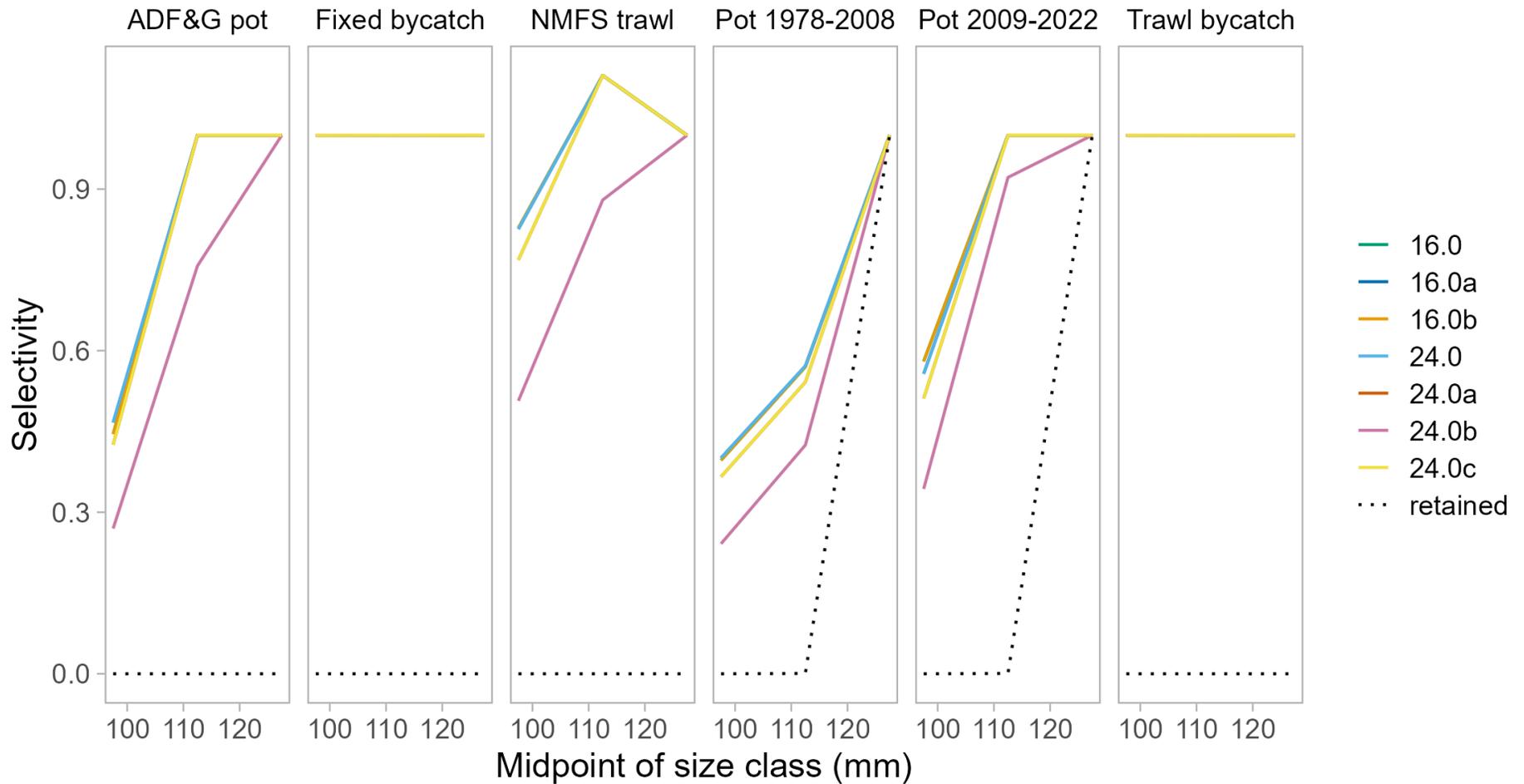
# Natural mortality likelihood profile



# Natural mortality likelihood profile



# Selectivity



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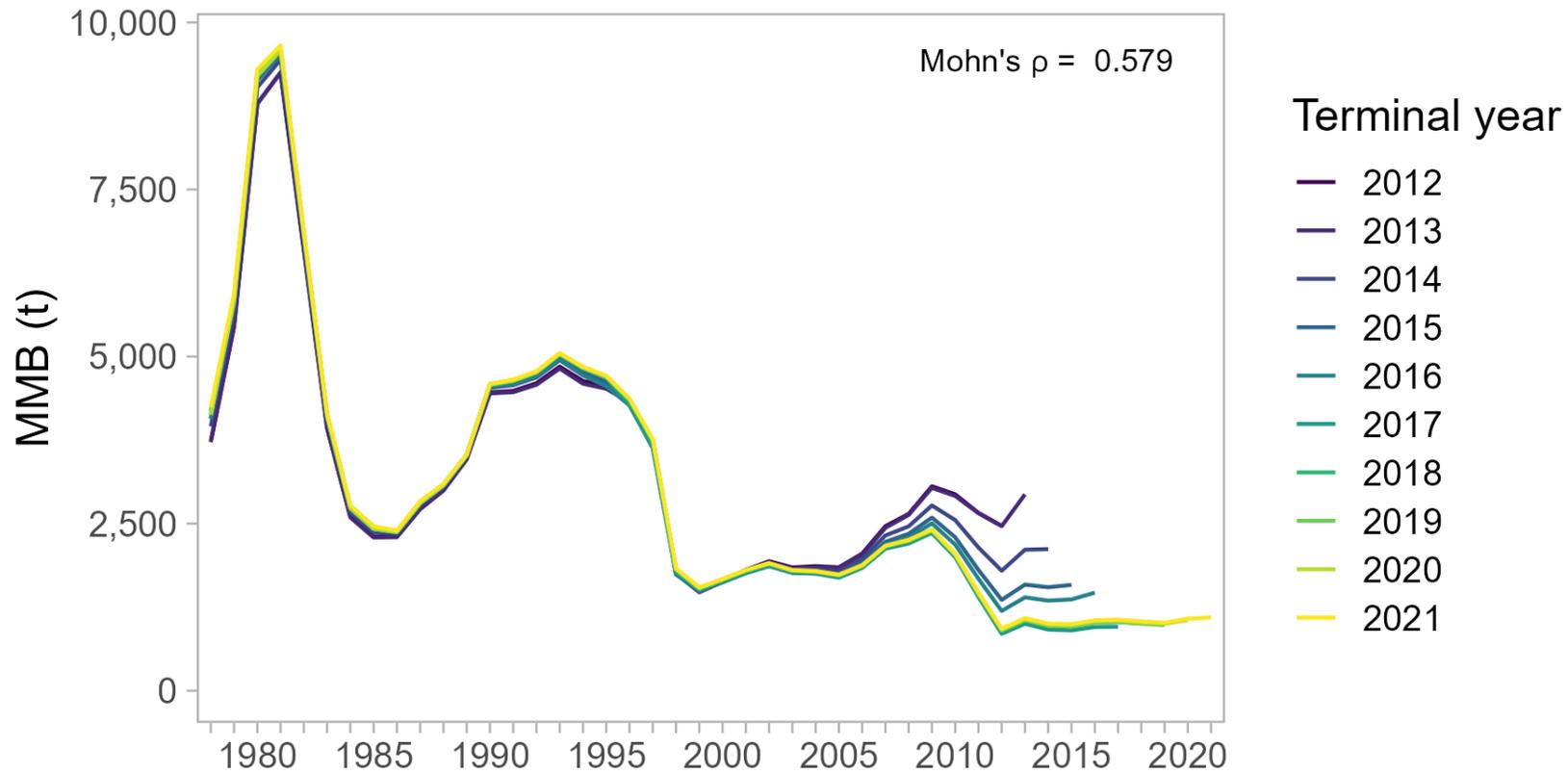
# Negative log-likelihood values

Component	Model.16.0	Model.16.0a	Model.16.0b	Model.24.0	Model.24.0a	Model.24.0b	Model.24.0c
Pot retained catch	-68.4	-68.3	-68.4	-68.3	-68.7	-69.4	-68.7
Pot discarded catch	6.7	6.0	6.7	6.0	5.3	3.3	5.3
Trawl bycatch discarded catch	-8.8	-8.8	-8.8	-8.8	-8.8	-8.8	-8.8
Fixed bycatch discarded catch	-8.8	-8.8	-8.8	-8.8	-8.8	-8.8	-8.8
NMFS trawl survey	5.1	8.6	5.1	8.6	5.6	-4.0	5.6
ADF&G pot survey CPUE	84.9	86.6	84.9	86.6	81.5	67.4	81.5
Directed pot LF	-104.6	-104.9	-104.6	-104.9	-104.9	-104.6	-104.9
NMFS trawl LF	-276.2	-277.8	-276.2	-277.8	-279.3	-278.0	-279.3
ADF&G pot LF	-99.9	-100.0	-99.9	-100.0	-100.1	-99.4	-100.1
Recruitment deviations	63.9	64.0	63.9	64.0	63.7	62.7	63.7
F penalty	9.7	9.7	9.7	9.7	9.7	9.7	9.7
M penalty	6.5	6.5	6.5	6.5	6.5	6.4	6.5
Prior	13.7	13.7	13.7	13.7	14.6	25.7	13.7
Total	-385.8	-383.2	-385.8	-383.2	-393.4	-407.3	-394.2
Total estimated parameters	156.0	156.0	156.0	156.0	157.0	157.0	156.0

# Negative log-likelihood values

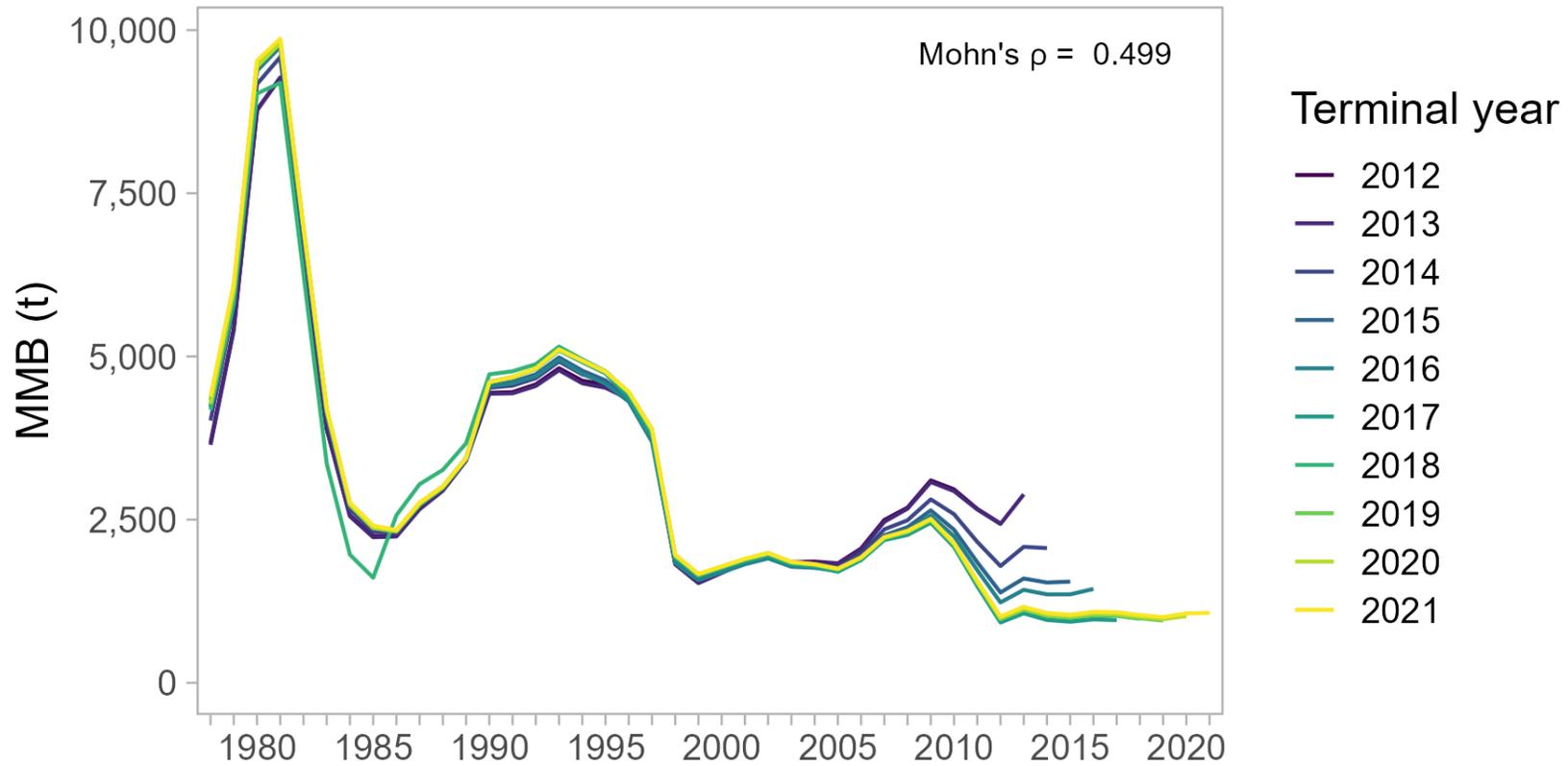
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Total estimated parameters	156.0	156.0	156.0	156.0	157.0	157.0	156.0

# Retrospectives: model 24.0



Mohn's  $\rho = 0.037$  for 5 years

# Retrospectives: model 24.0c



Mohn's  $\rho = 0.052$  for 5 years

# Management quantities

Component	Model.16.0	Model.16.0a	Model.16.0b	Model.24.0	Model.24.0a	Model.24.0b	Model.24.0c
$MMB_{2023}$	1498.48	1447.05	1442.97	1393.54	1347.94	1326.50	1347.94
$B_{MSY}$	3212.34	3184.00	2943.08	2916.92	2972.17	3012.62	2972.17
$MMB/B_{MSY}$	0.47	0.45	0.49	0.48	0.45	0.44	0.45
$F_{OFL}$	0.07	0.07	0.08	0.08	0.08	0.12	0.08
$OFL_{2023}$	85.62	80.26	90.92	85.28	86.18	115.09	86.18
$ABC_{2023}$	64.21	60.19	68.19	63.96	64.63	86.31	64.63

Biomass and OFL are in tons.

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# Summary

- Models 24.0 (new base model) and 24.0c (fixed  $M = 0.20$ ) recommended for Sept.
- Future work:
  - Single index of abundance integrating data from both surveys
  - Model runs without NMFS survey corner stations to match the 2024 survey
  - Likelihood profile on selectivity
  - Explore increasing the number of size bins



Don Urban