Bristol Bay red king crab

Final SAFE

September 2025

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ADF&G

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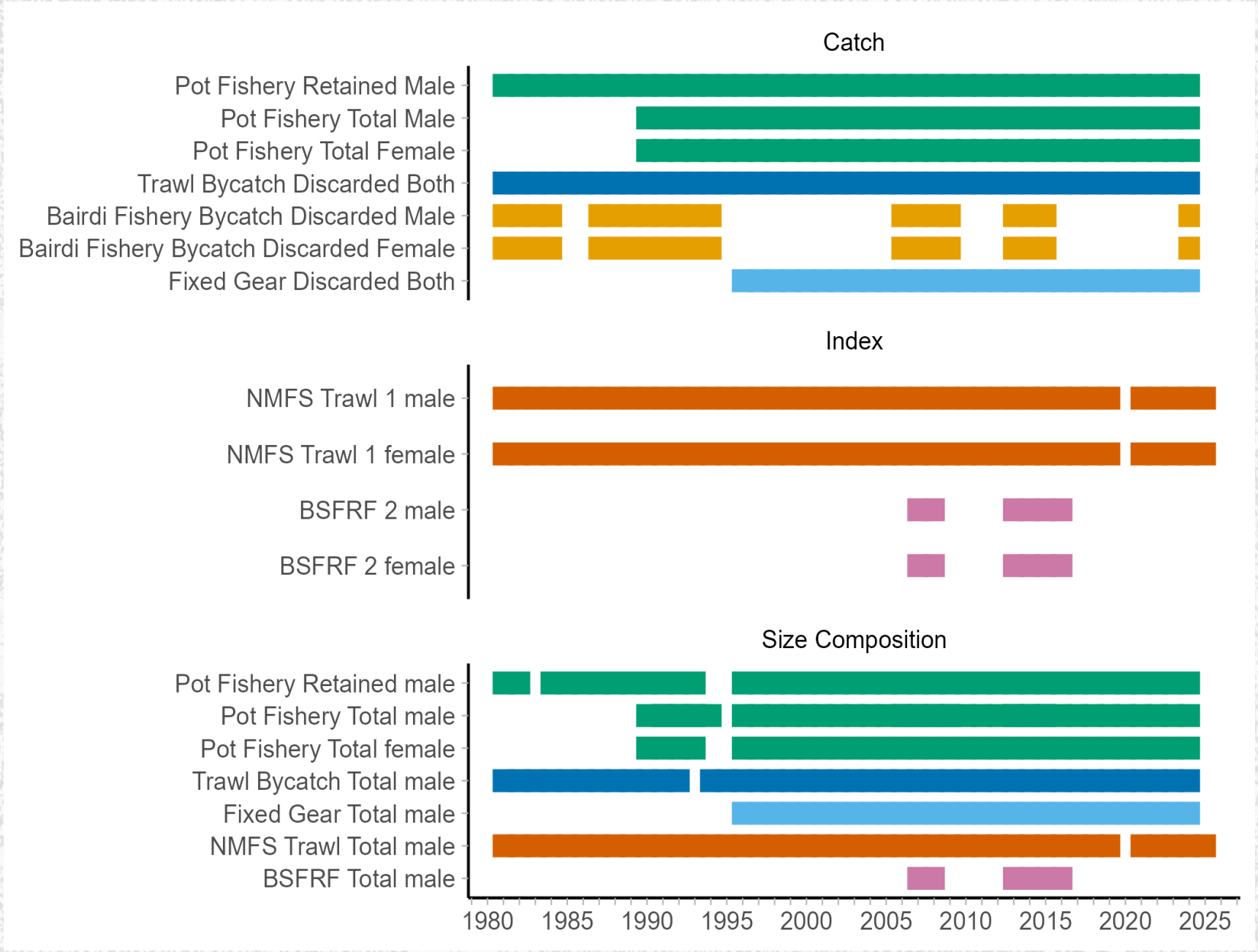
Summary

- Mature male biomass increased from 2024, still low compared to long term average
- Directed fishery was open in 2024/25, with higher CPUE (crab/pot) than the previous season
- Estimated mature female biomass is higher than recent years but still lower than it's been since the mid-90s
- 2025 area-swept and State of Alaska LBA model estimates of female abundance are above the State Harvest strategy thresholds (8.4 million) this year.
  - ADF&G will complete the process of determining an appropriate TAC after the CPT and Council process.
- Low recruitment in recent years (last 10-15 years), projected decline in biomass with higher exploitation rates without a large recruitment event

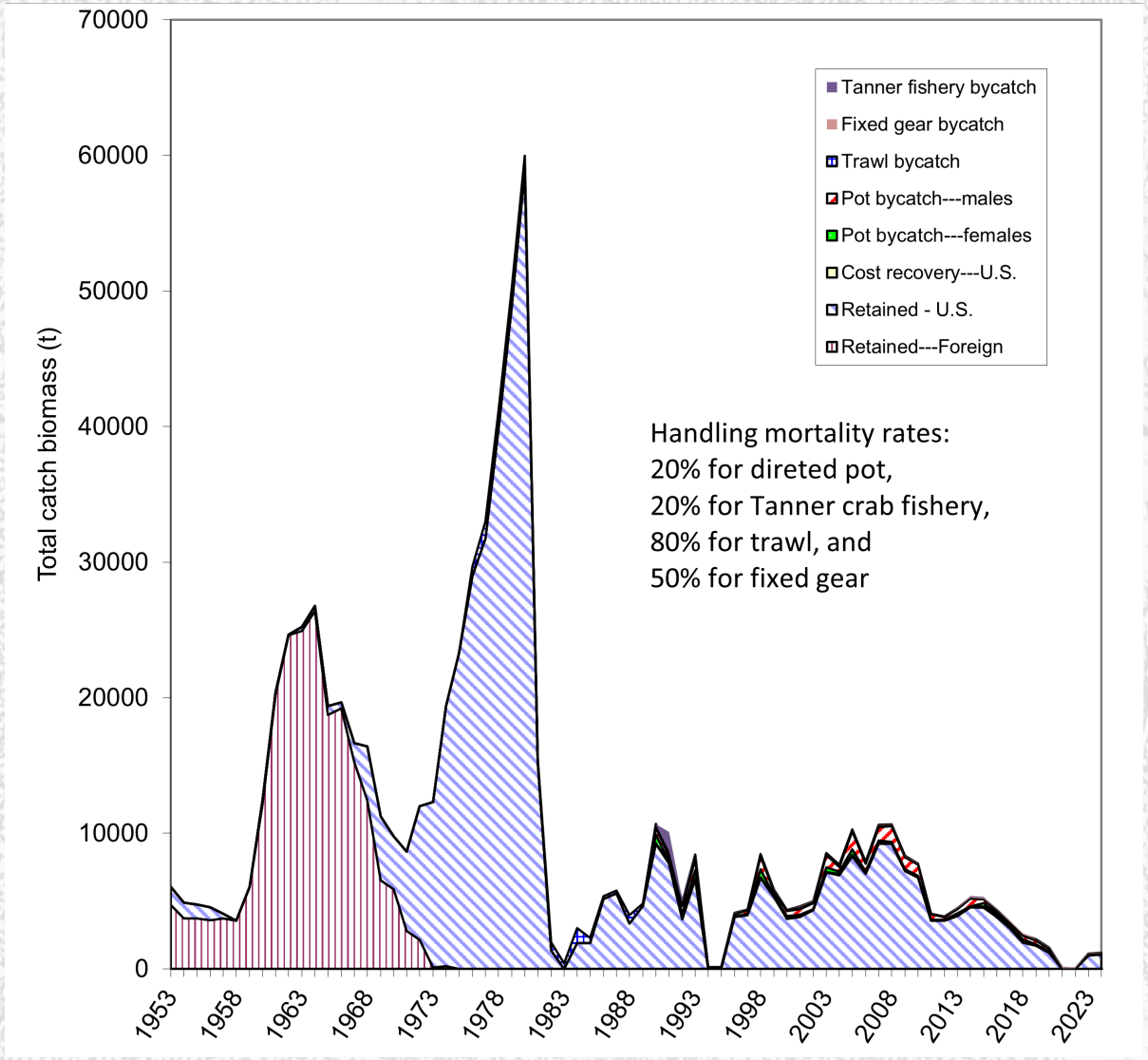
CPT / SSC comments

- Some comments were addressed in May 2025, others are ongoing
- GMACS version updates – same version here as May 2025.
- Work will be continued for 2026 proposed model work
  - Explore expanding size bins to deal with build up of plus group size bin
  - Continued work on BSFRF data used as a prior on Q
    - Other recommendations related to selectivity and retention explorations
- 2024/25 exploration of fishery data
  - Some done by Ethan/Ben in catch presentation
  - Female bycatch was greatly reduced in the recent fishery
- Model-based indices on the list for 2026 (co-author with Caitlin Stern and based on NSRKC work)
- Essentially base model with small updates recommended for 2025 specs (model 24.0c.2)

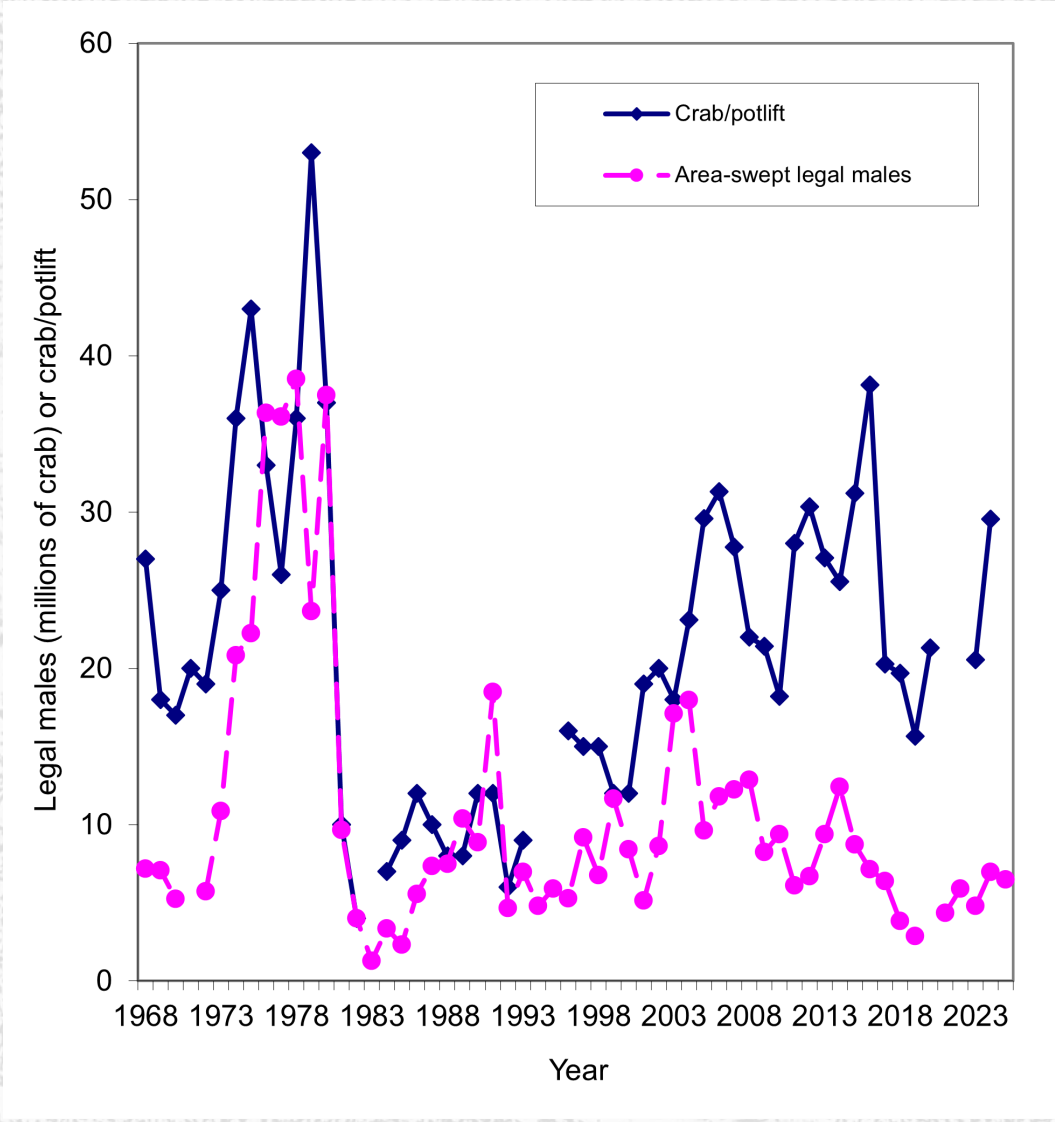
Data extent and new data for 2025



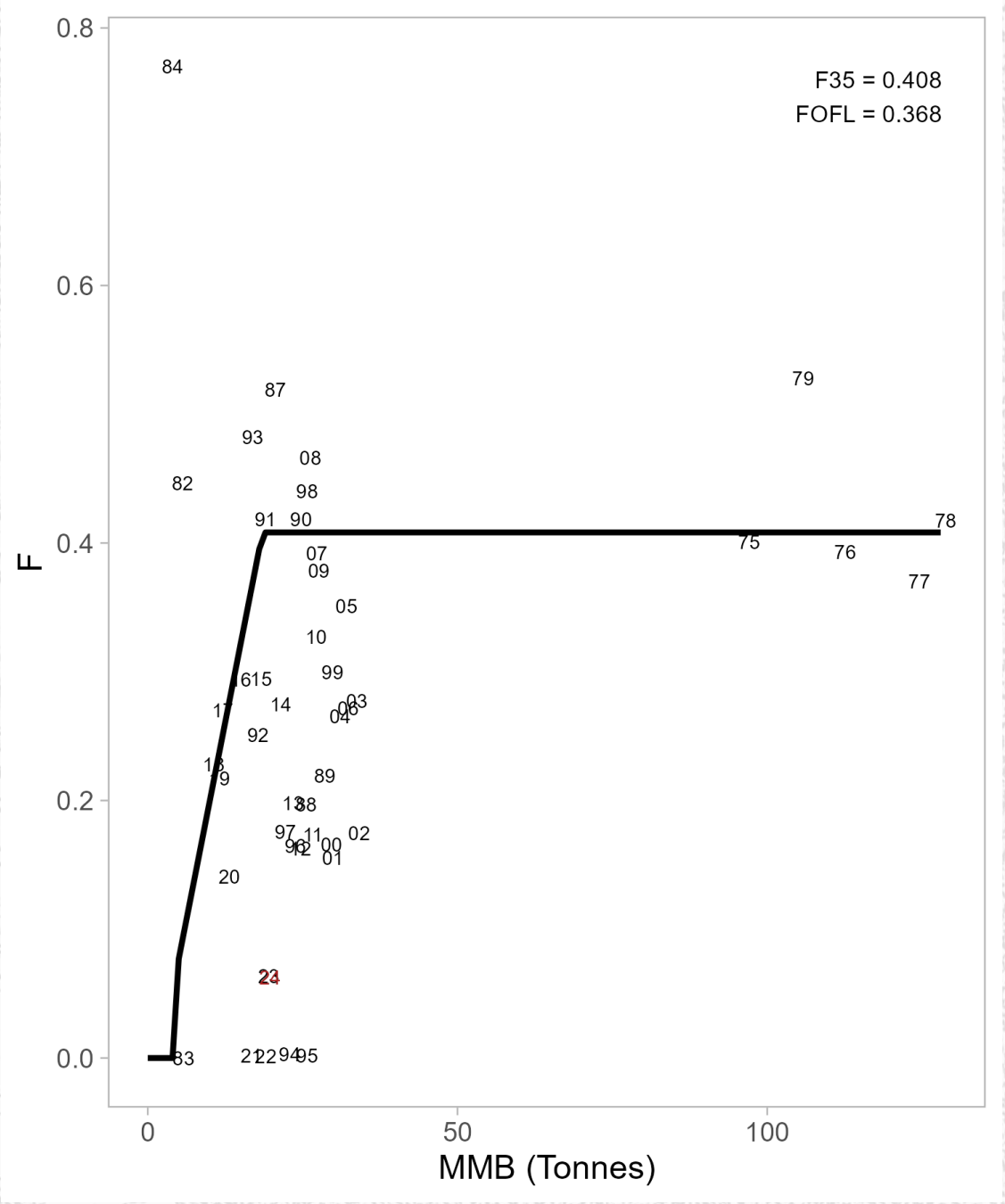
Retained and bycatch mortality (t)



Survey legal male abundance and CPUE for directed BBRKC fishery

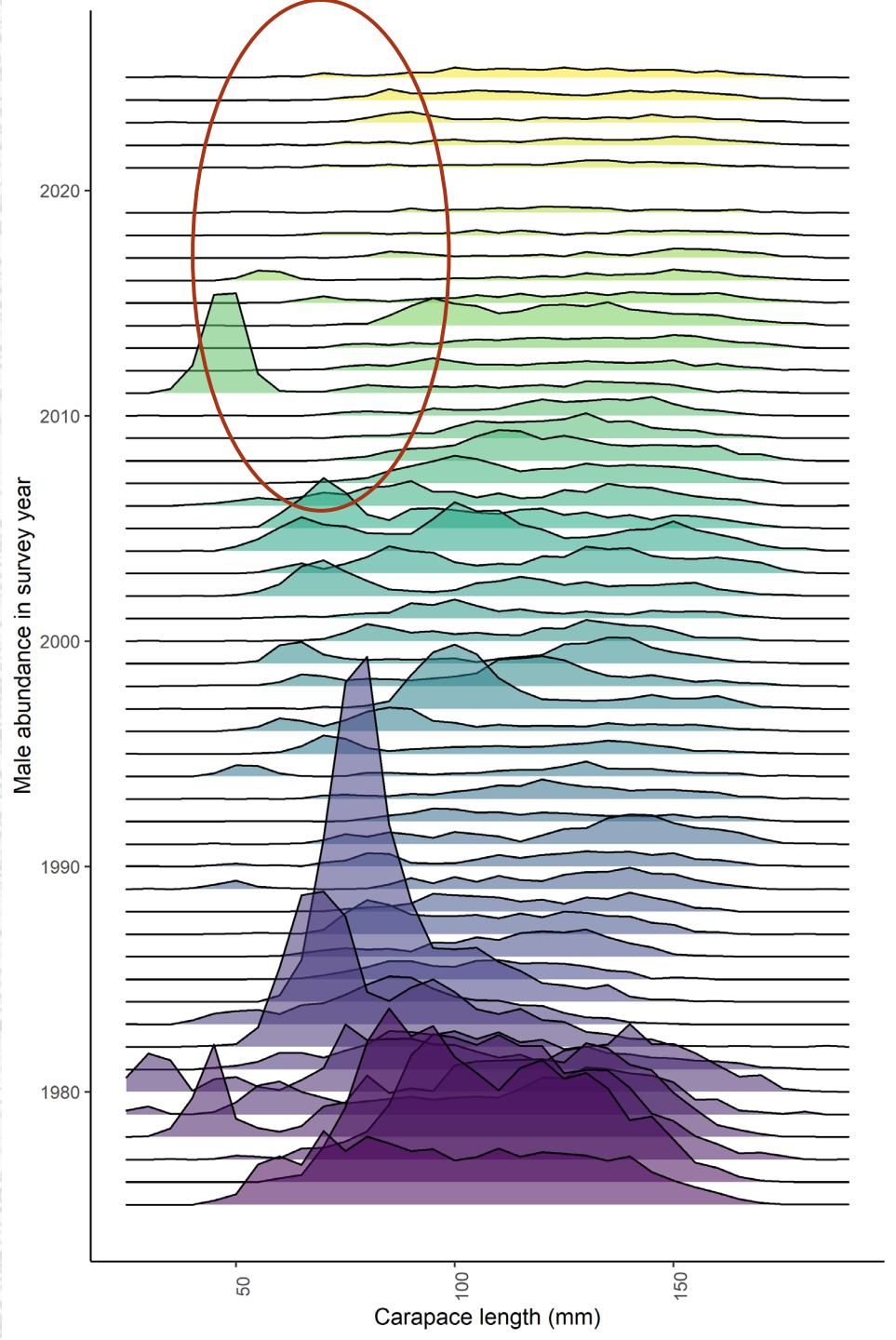


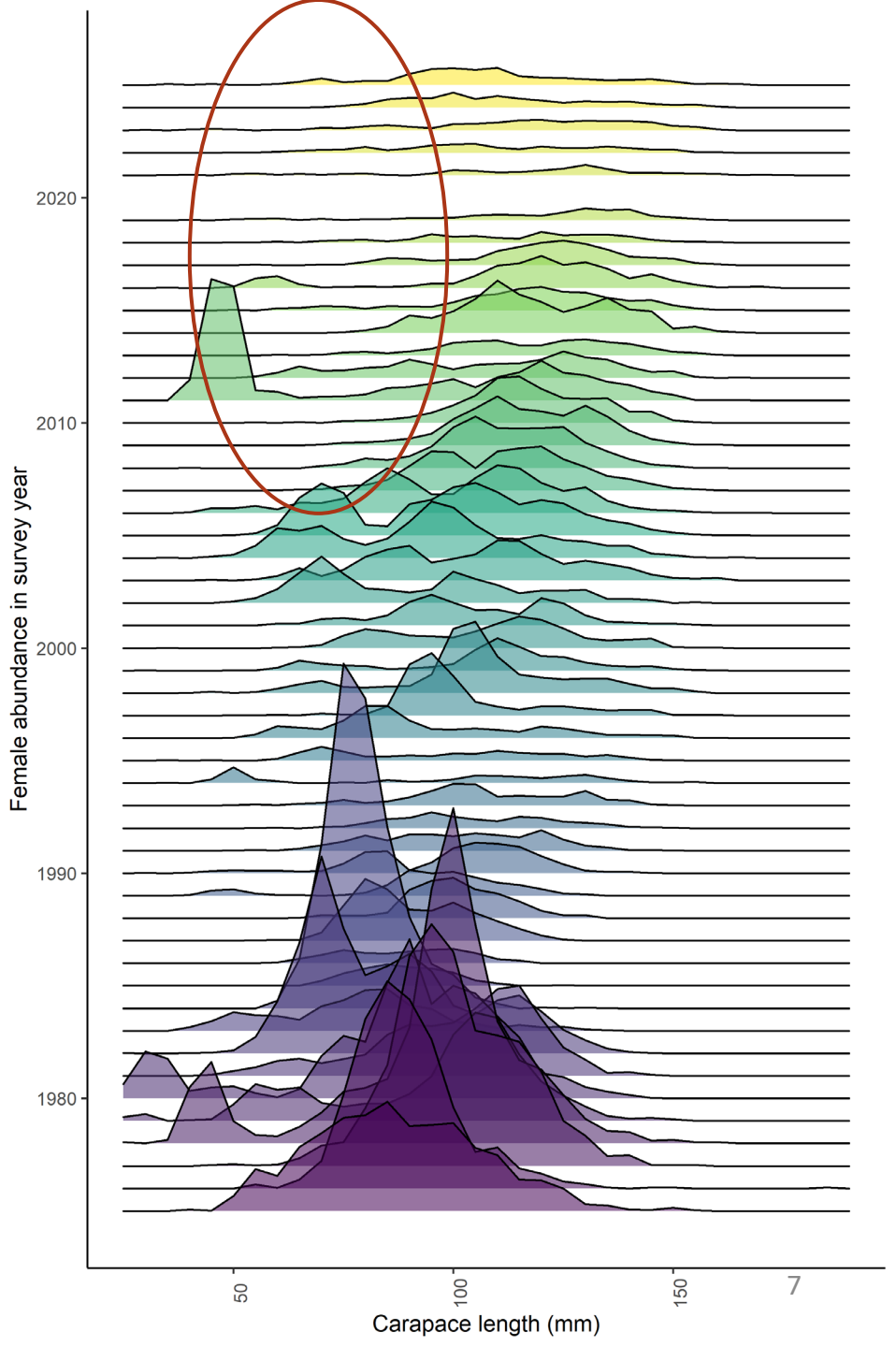
Fishing mortality and MMB relationship over time (model 24.0c.2)

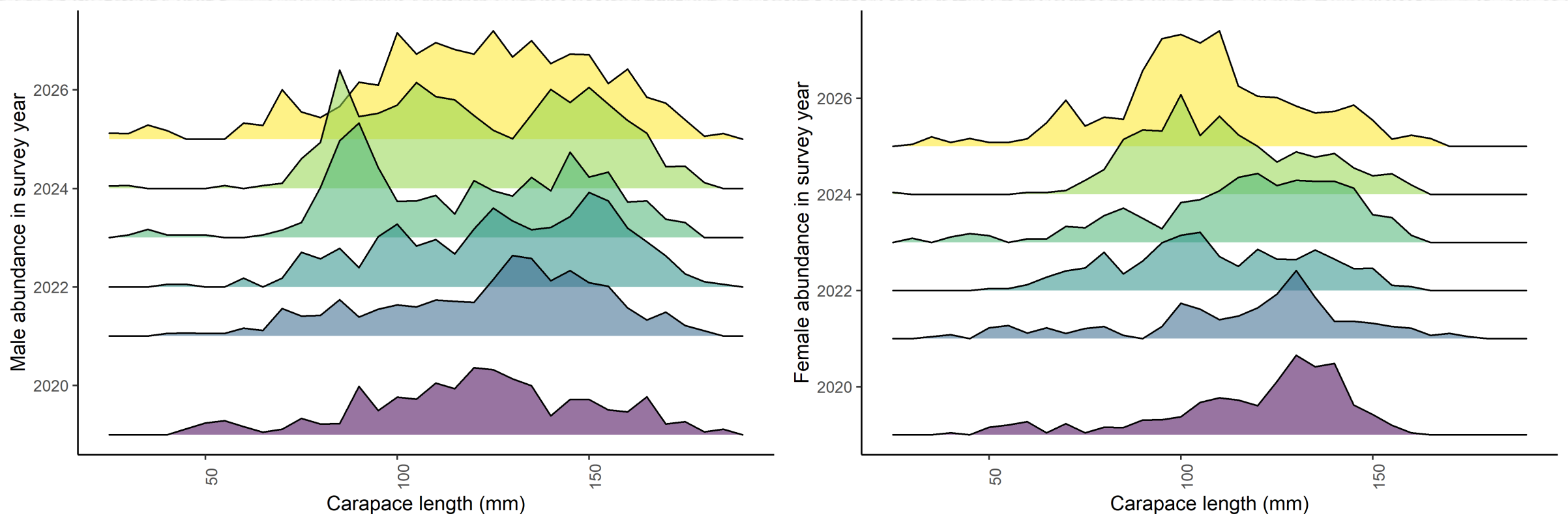


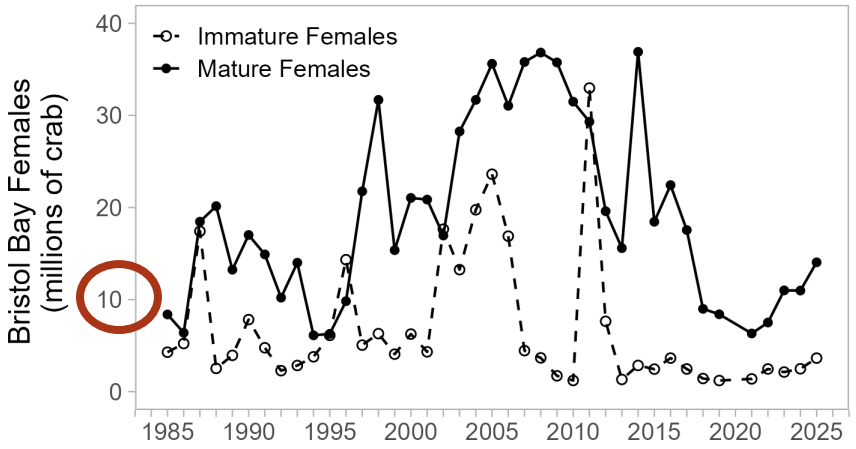
Length composition from NMFS survey

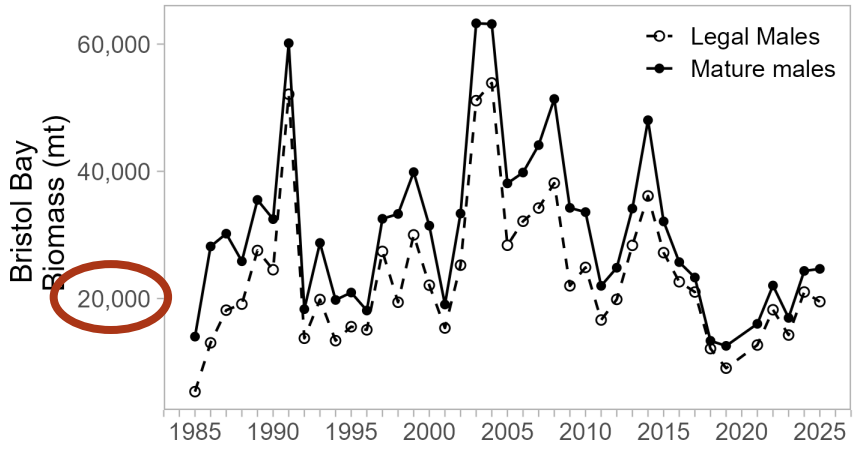
- model “recruitment” at 65mm

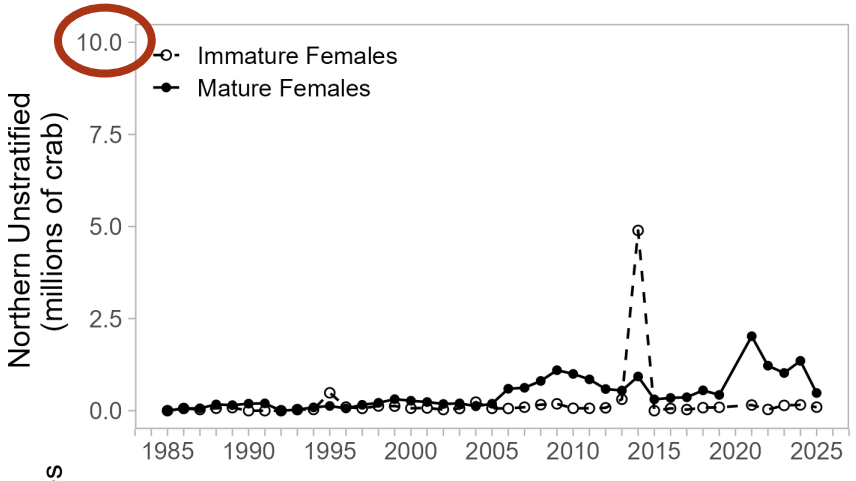


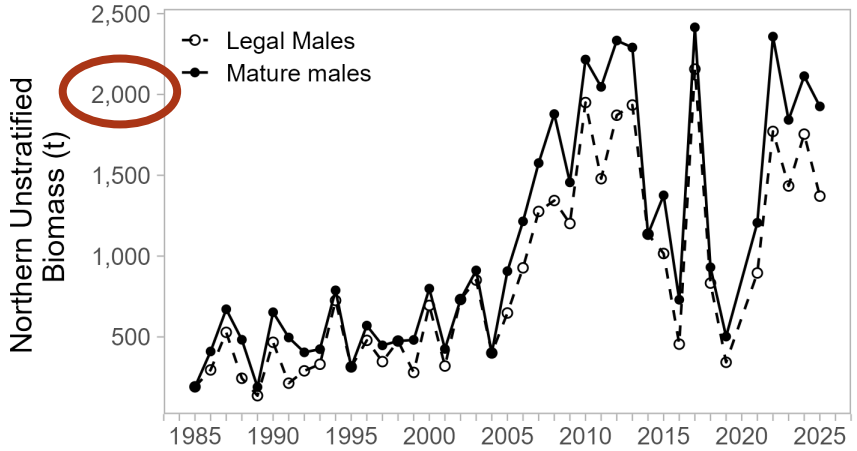


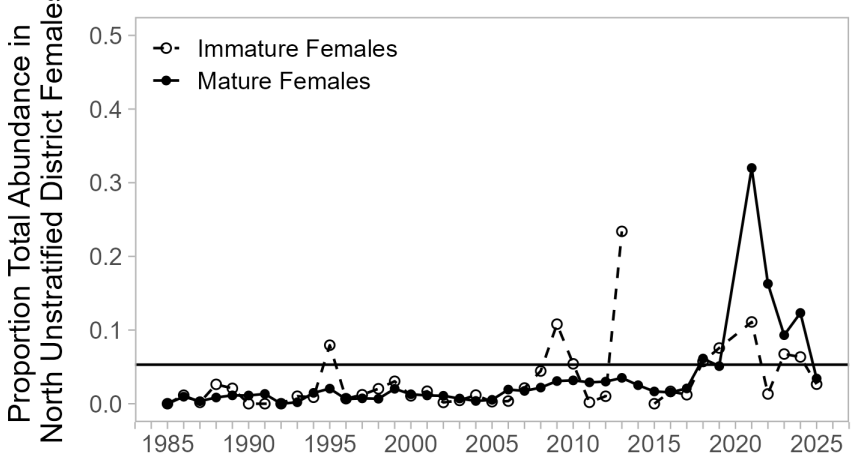

Male abundance in survey year
2026
2024
2022
2020
50
100
150
Carapace length (mm)
Female abundance in survey year
2026
2024
2022
2020
50
100
150
Carapace length (mm)

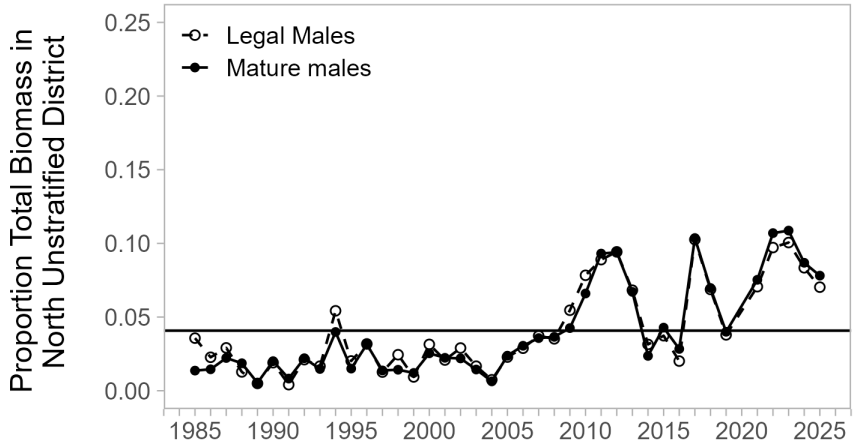

Bristol Bay Females (millions of crab)
Immature Females
Mature Females
40
30
20
10
0
1985
1990
1995
2000
2005
2010
2015
2020
2025


Bristol Bay Biomass (mt)
Legal Males
Mature males
60,000
40,000
20,000
1985
1990
1995
2000
2005
2010
2015
2020
2025


Northern Unstratified (millions of crab)
Immature Females
Mature Females
10.0
7.5
5.0
2.5
0.0
1985
1990
1995
2000
2005
2010
2015
2020
2025


Northern Unstratified Biomass (t)
Legal Males
Mature males
2,500
2,000
1,500
1,000
500
1985
1990
1995
2000
2005
2010
2015
2020
2025


Proportion Total Abundance in North Unstratified District Females
Immature Females
Mature Females
0.5
0.4
0.3
0.2
0.1
0.0
1985
1990
1995
2000
2005
2010
2015
2020
2025


Proportion Total Biomass in North Unstratified District
Legal Males
Mature males
0.25
0.20
0.15
0.10
0.05
0.00
1985
1990
1995
2000
2005
2010
2015
2020
2025

Model explorations

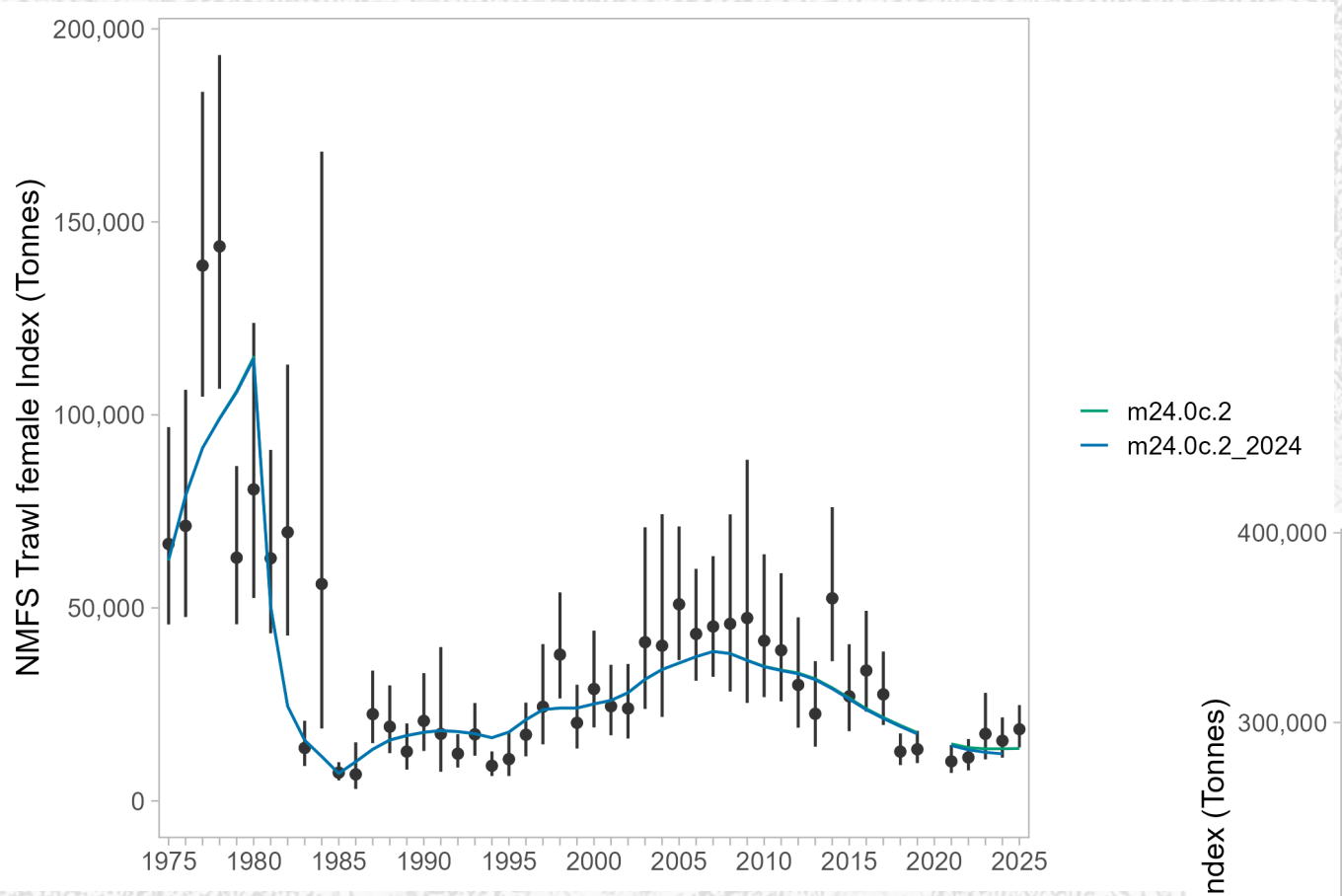
24.0c.2 (2024): model 24.0c – 2024 [illegible] model (model 23.0a (2023 base model, starts in 1975, mortality [illegible] 80s, stable in GMACS since 2018 + base M for males *estimate* [illegible] model) + no time block for molt probability)

+ **GMACS u[illegible]ersion** (version 2.20.20, 2025-01-30)
+ Updat[illegible]&G catch time series (May 2025)
+ Rem[illegible] of shell condition place holders in the input files

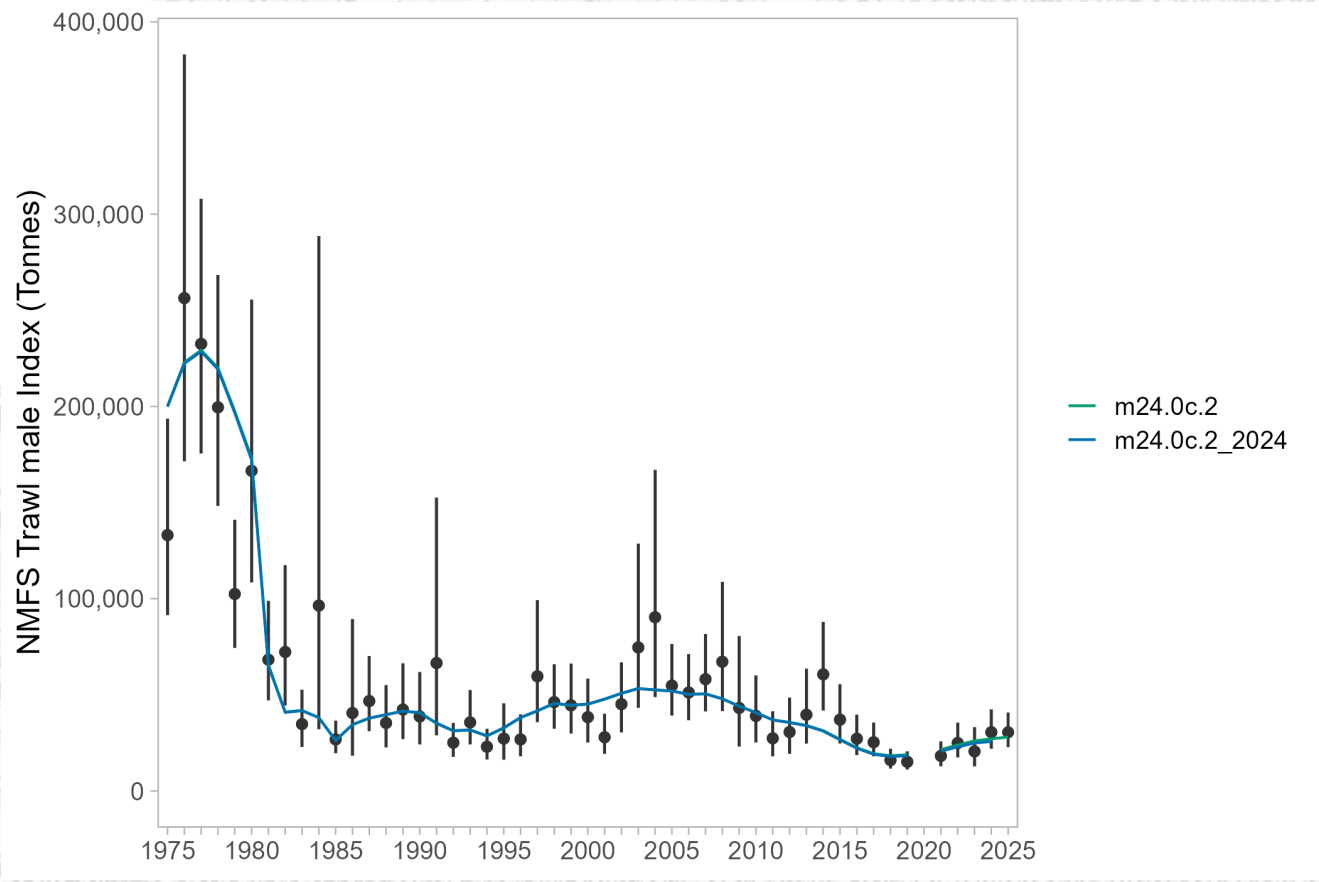
2024 provided for comparison

24.0c.2:

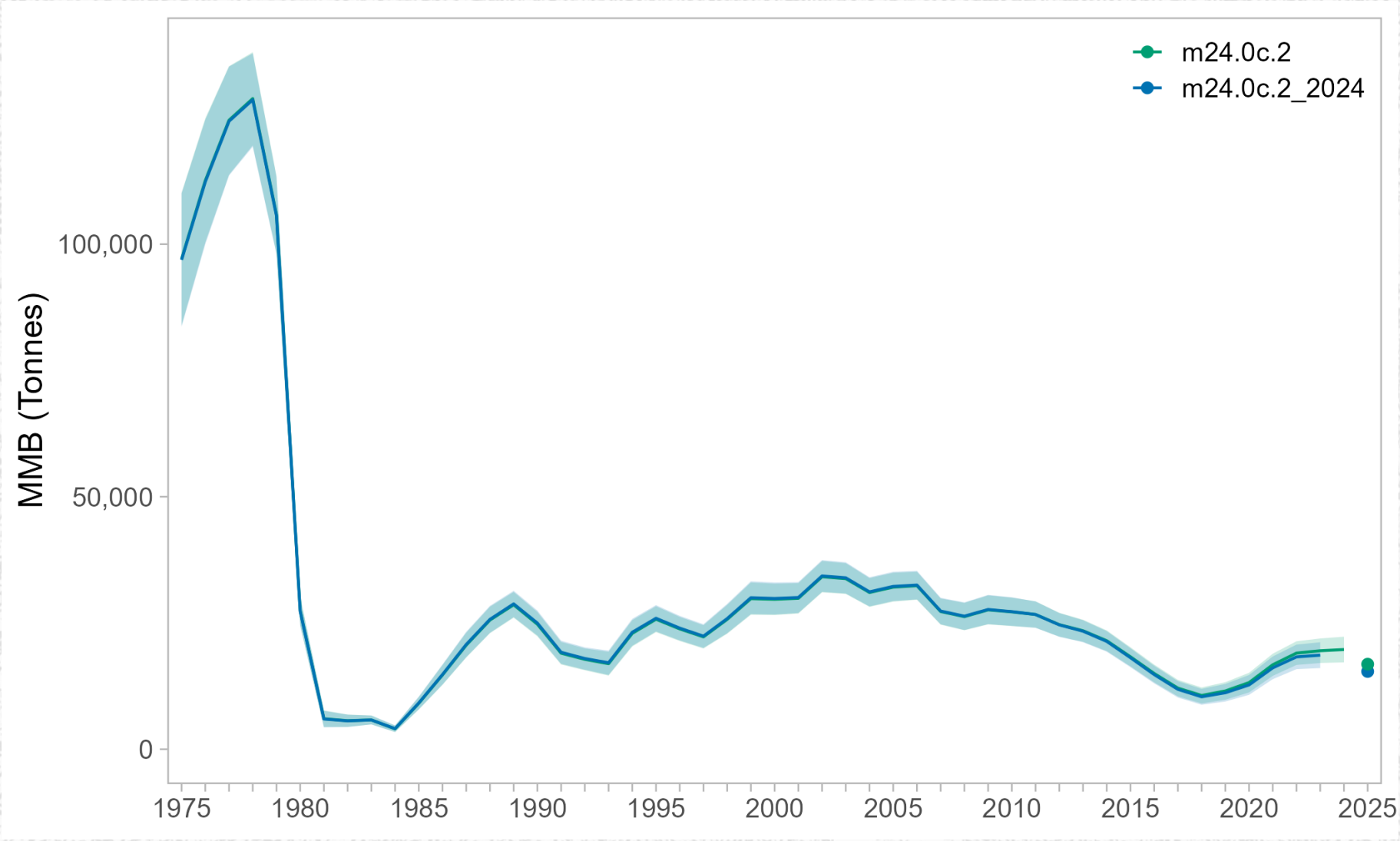
+ **2024/25 data** (directed fishery, bycatch (crab and groundfish), and survey data)



- Base model fit to survey data consistent with 2024
- No difference in fits to BSFRF data (not pictured – figures 19&20)



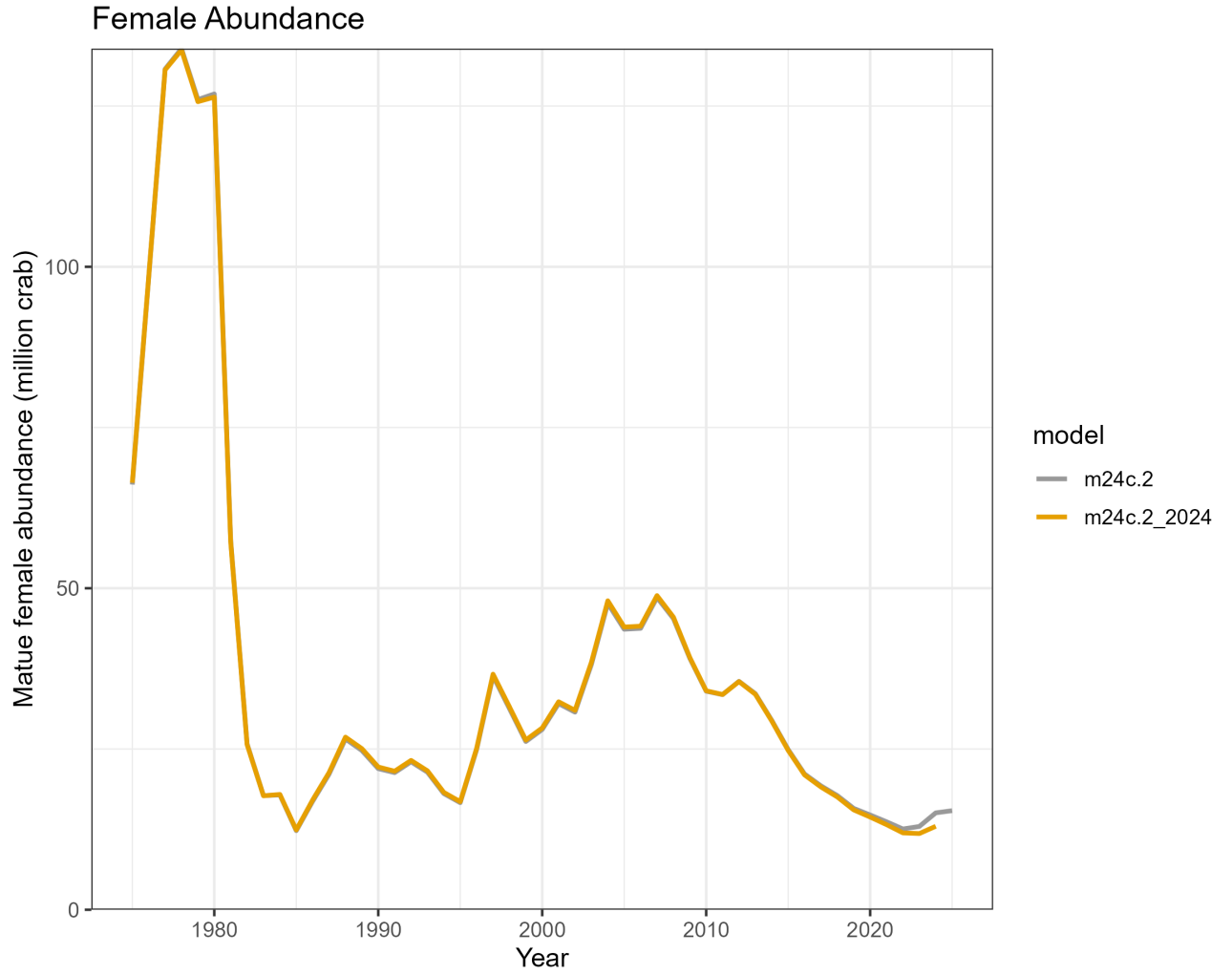
Mature male biomass



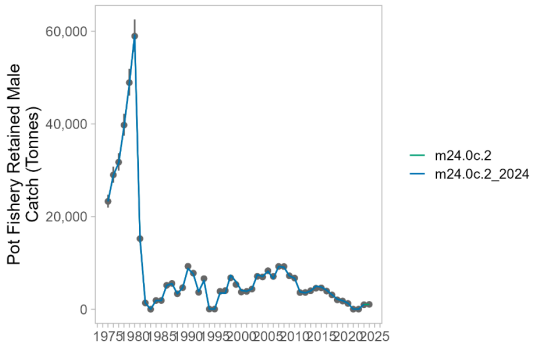
- Stable base model estimate of MMB
- Small increase

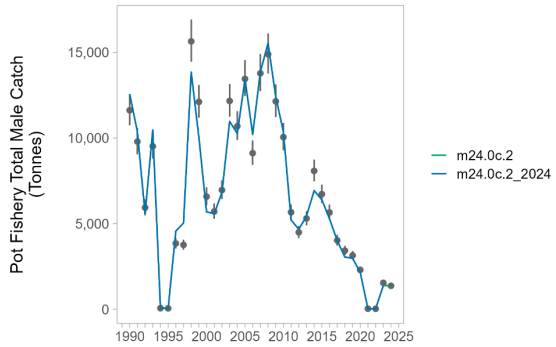
Mature female abundance

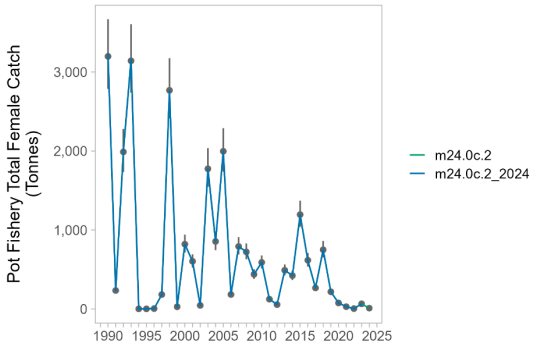
- Model estimated
- Mature females defined as >= 90mm CL

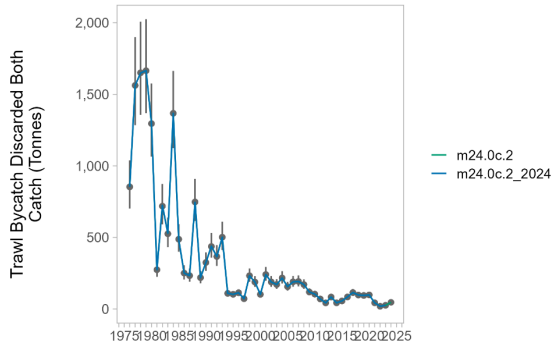


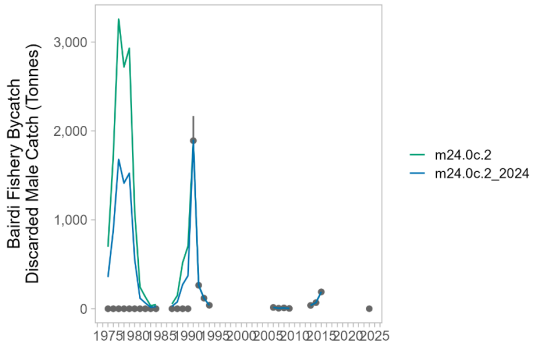
Mortality biomass (equal to catch biomass times handling mortality rate)

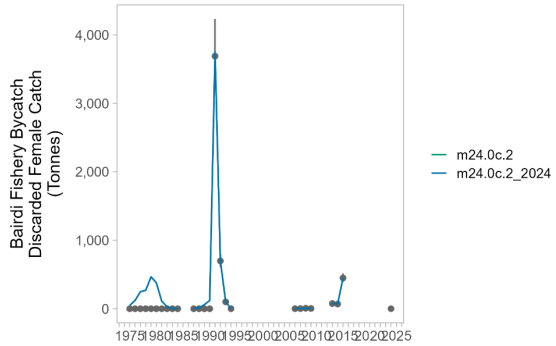


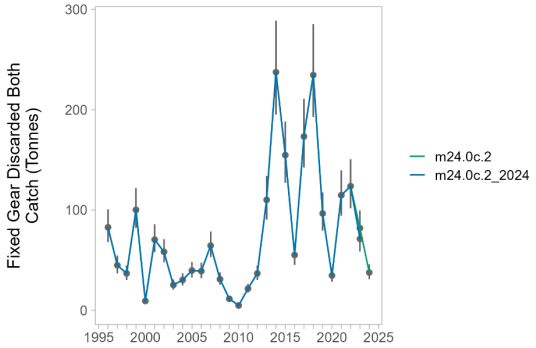










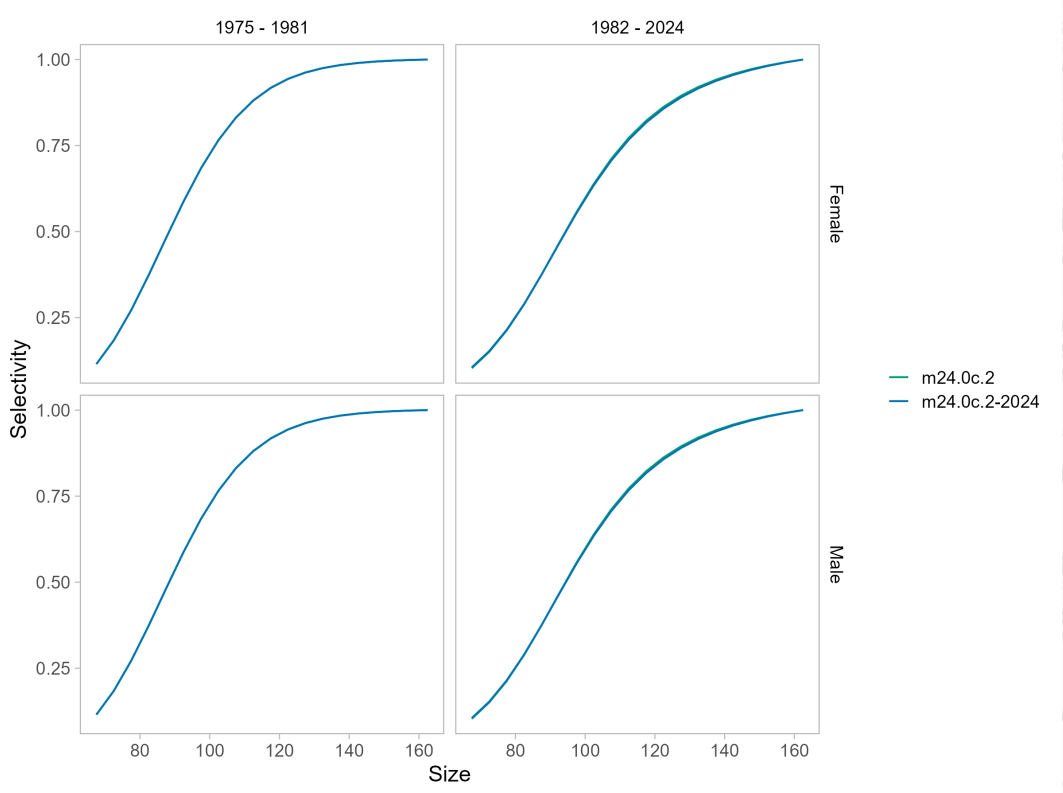


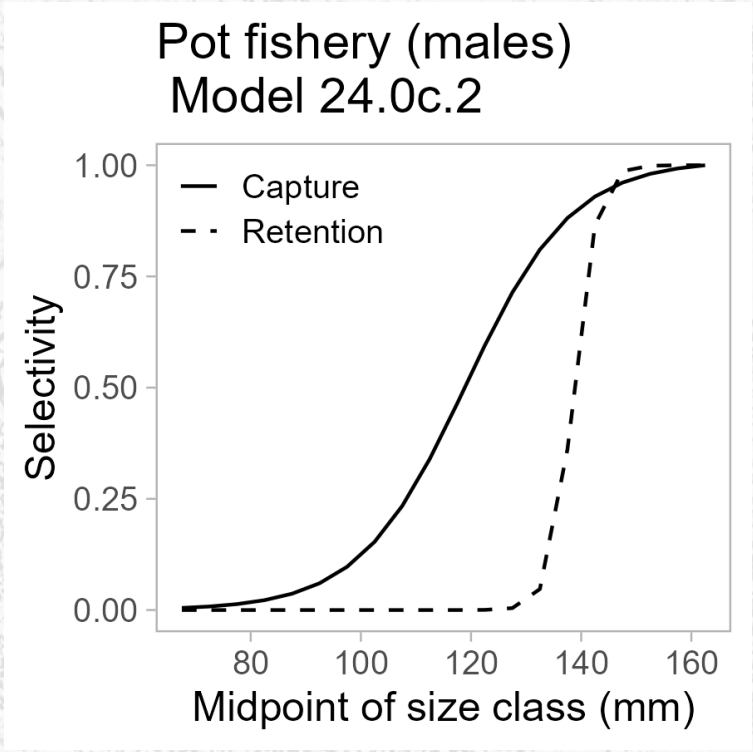
Natural Mortality & Selectivity

Table 13: 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	1.02
m24.0c.2-2024	female	0.26	1.16
m24.0c.2-2024	male	0.23	1.01
m24.0c.v14	female	0.26	1.16
m24.0c.v14	male	0.23	1.01

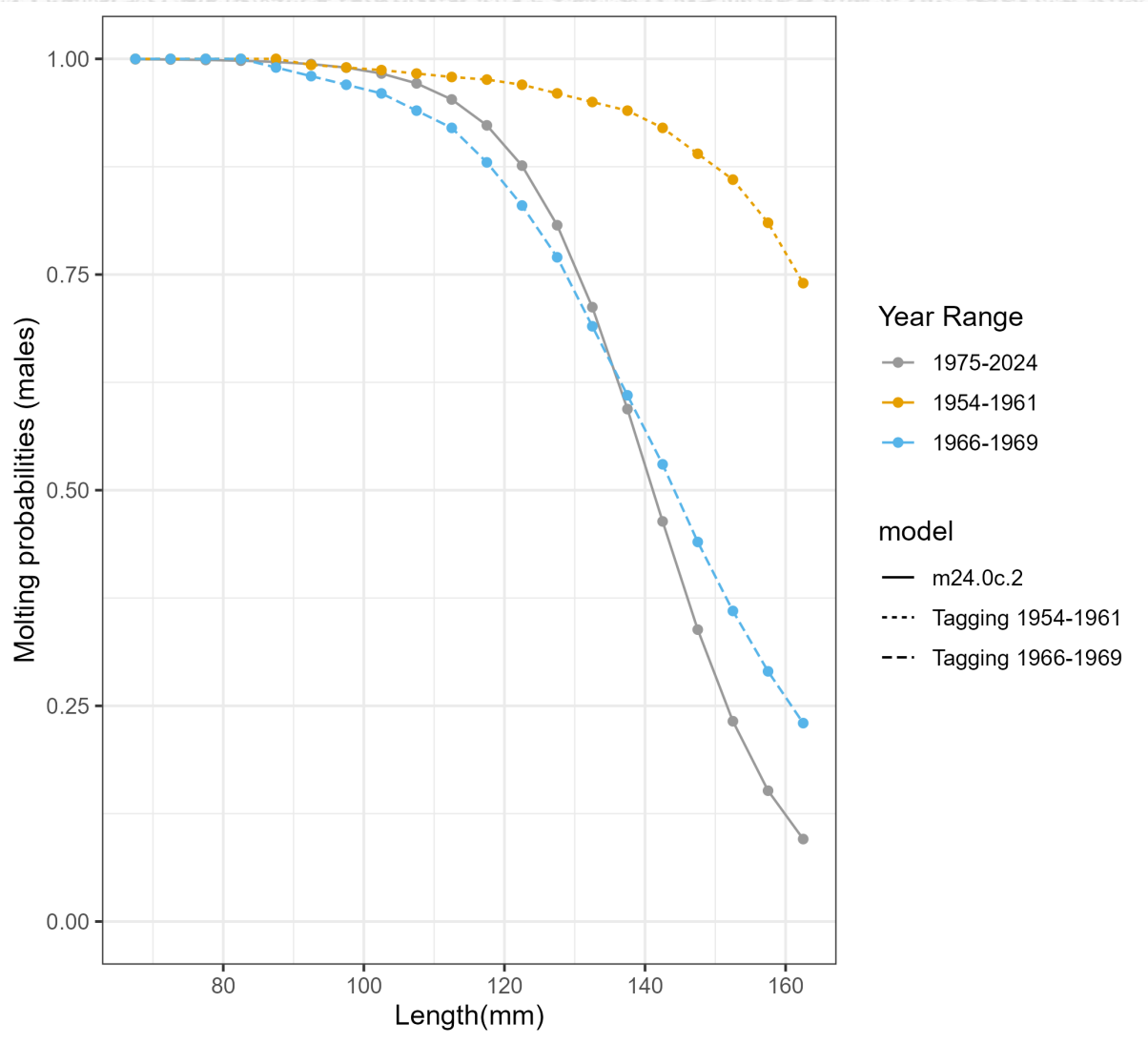
NMFS selectivity





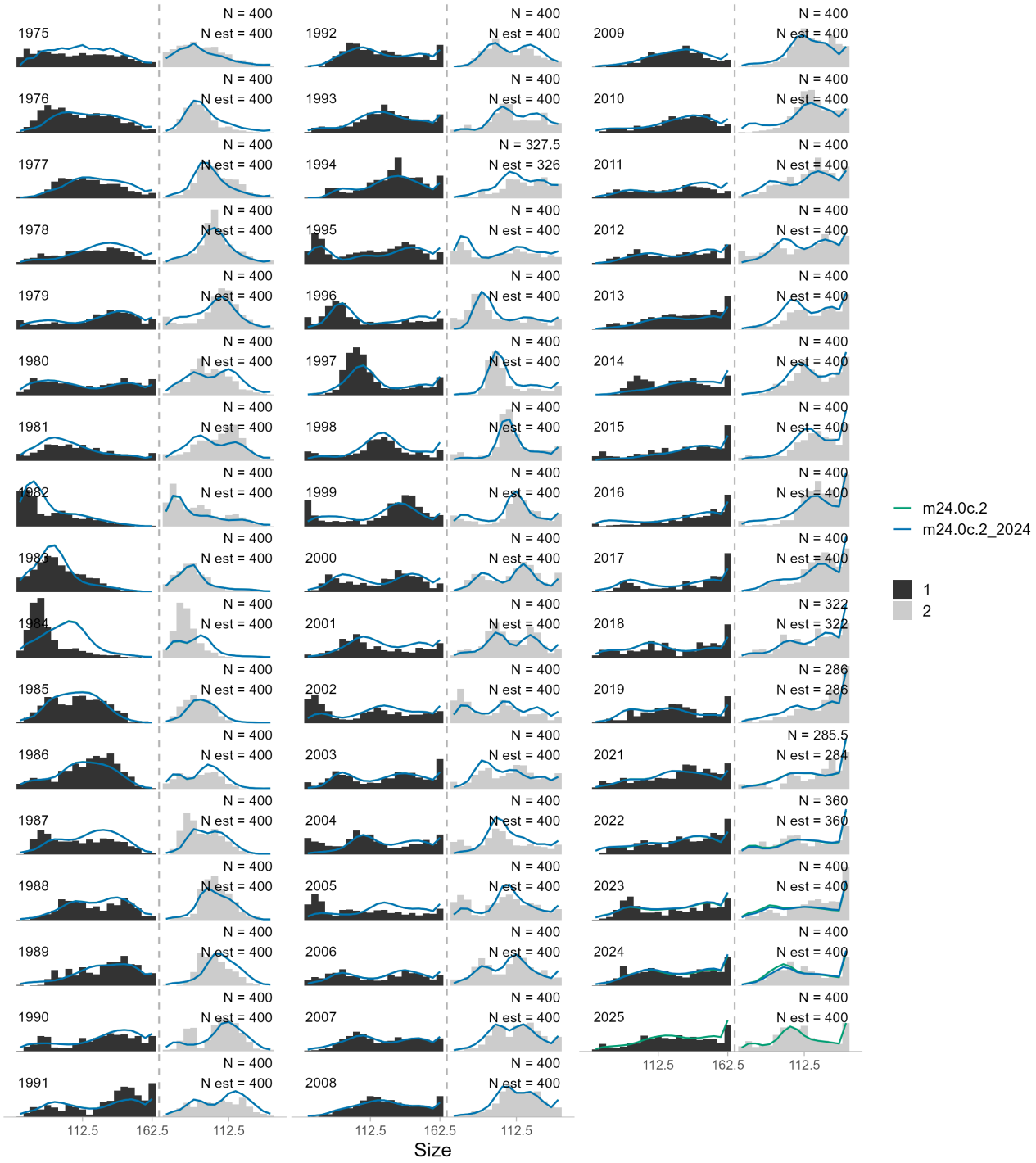
Molting probabilities

- Model 24.0c.2



Size composition fit

- No differences in fit from 2024 in bycatch and directed fisheries
  - See document for all size composition fits
- Survey data suggests some build up of plus group since 2014 in size comps, expected with low recruitment
  - Model exploration priority for 2026 would be increased size bins to accommodate plus group build up

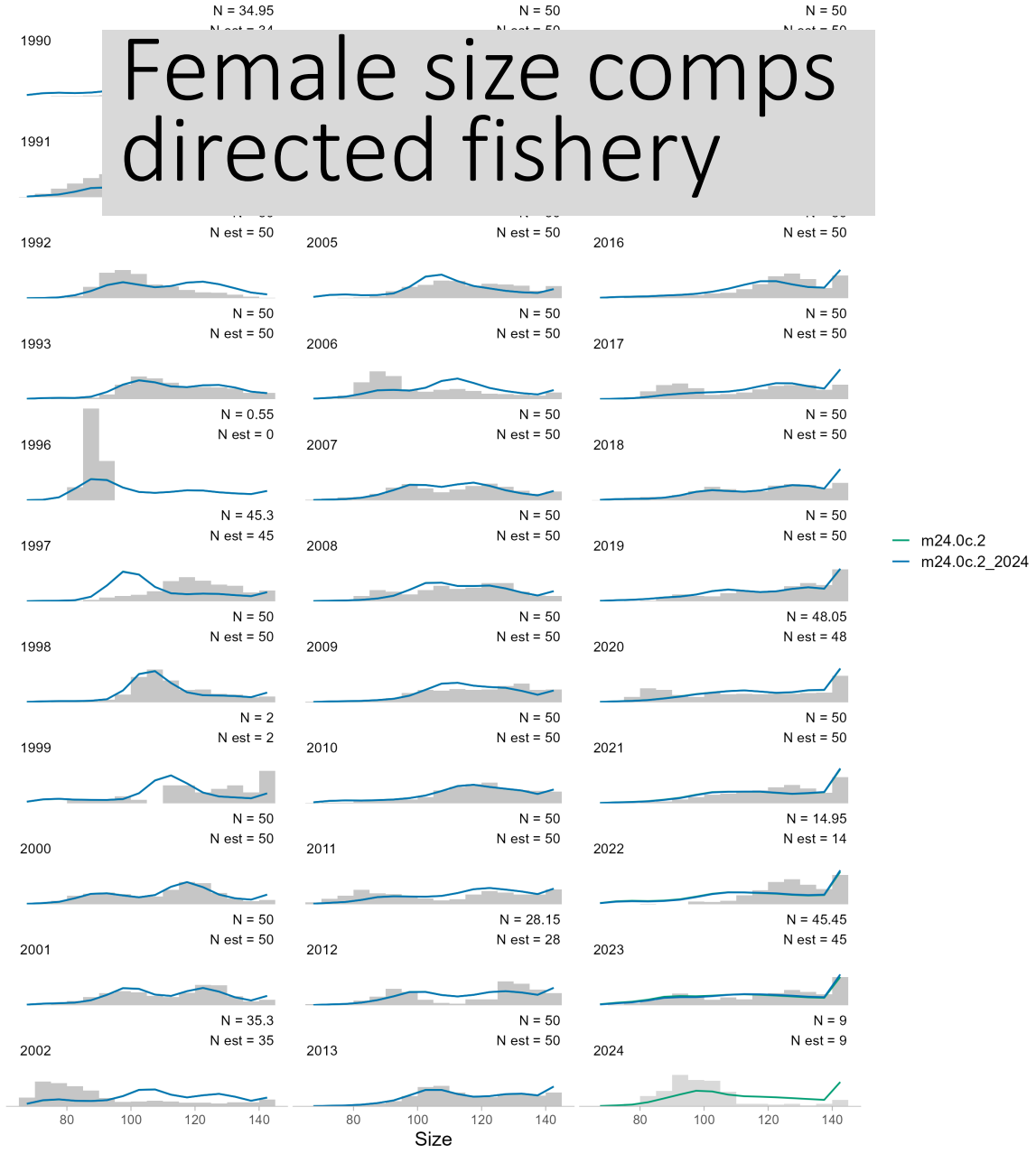


NMFS trawl survey size comps

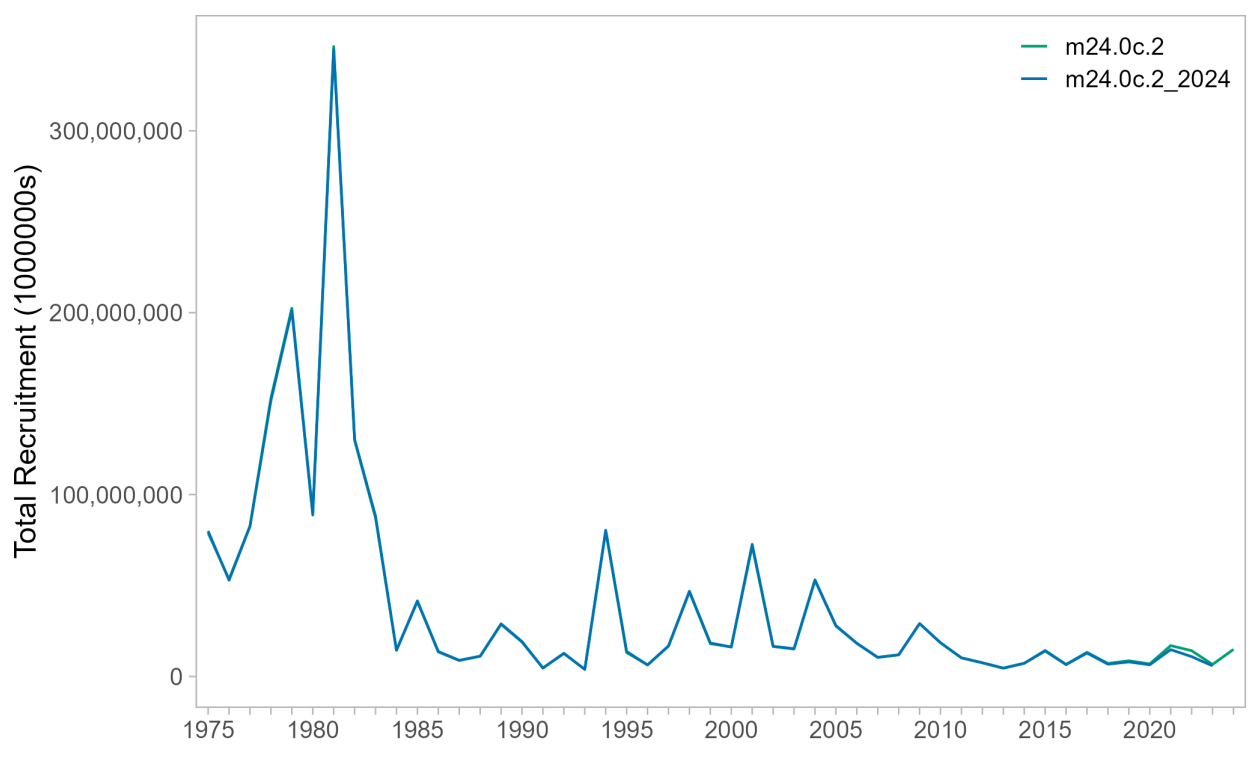
- males (1 black)
- females (2 gray)

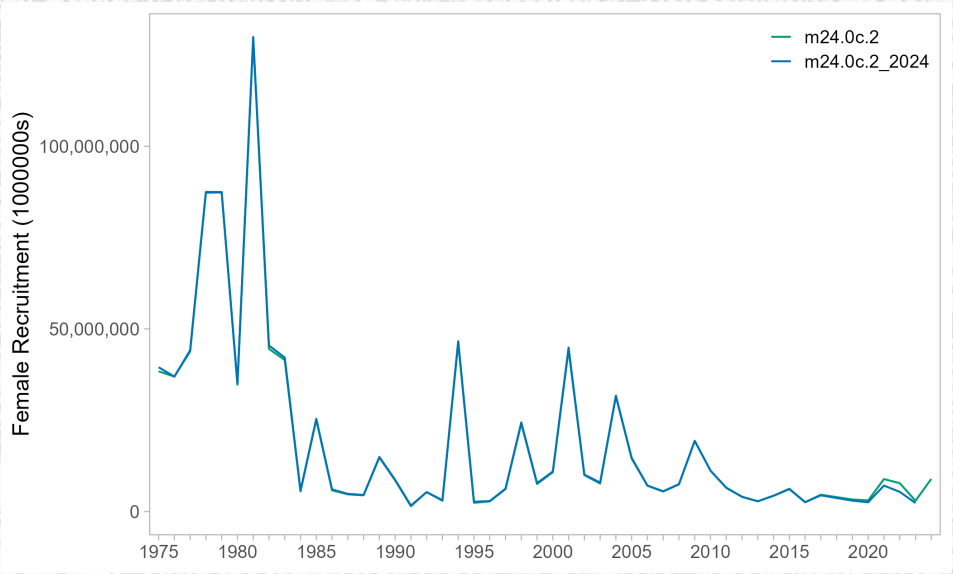
Directed fishery - total male size comps

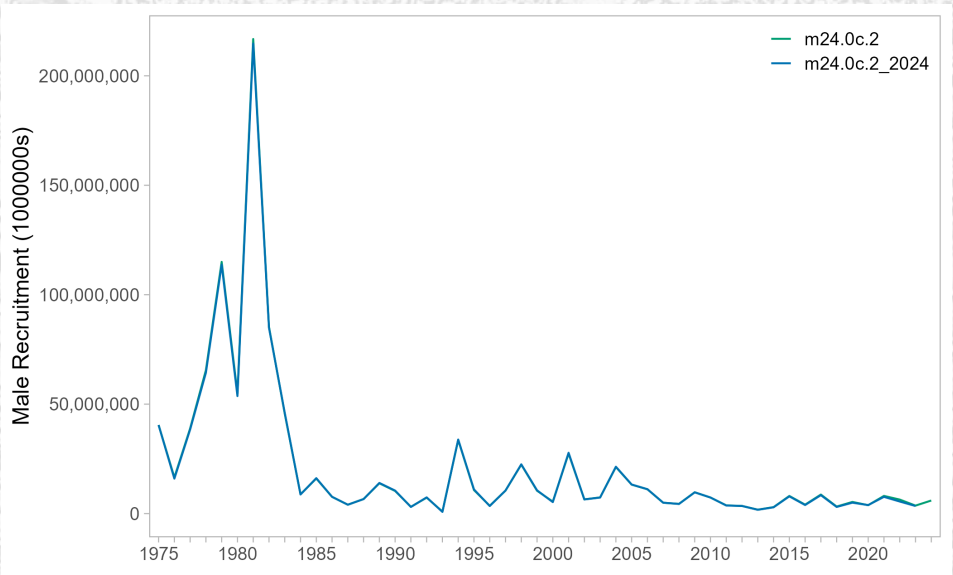
Female size comps directed fishery



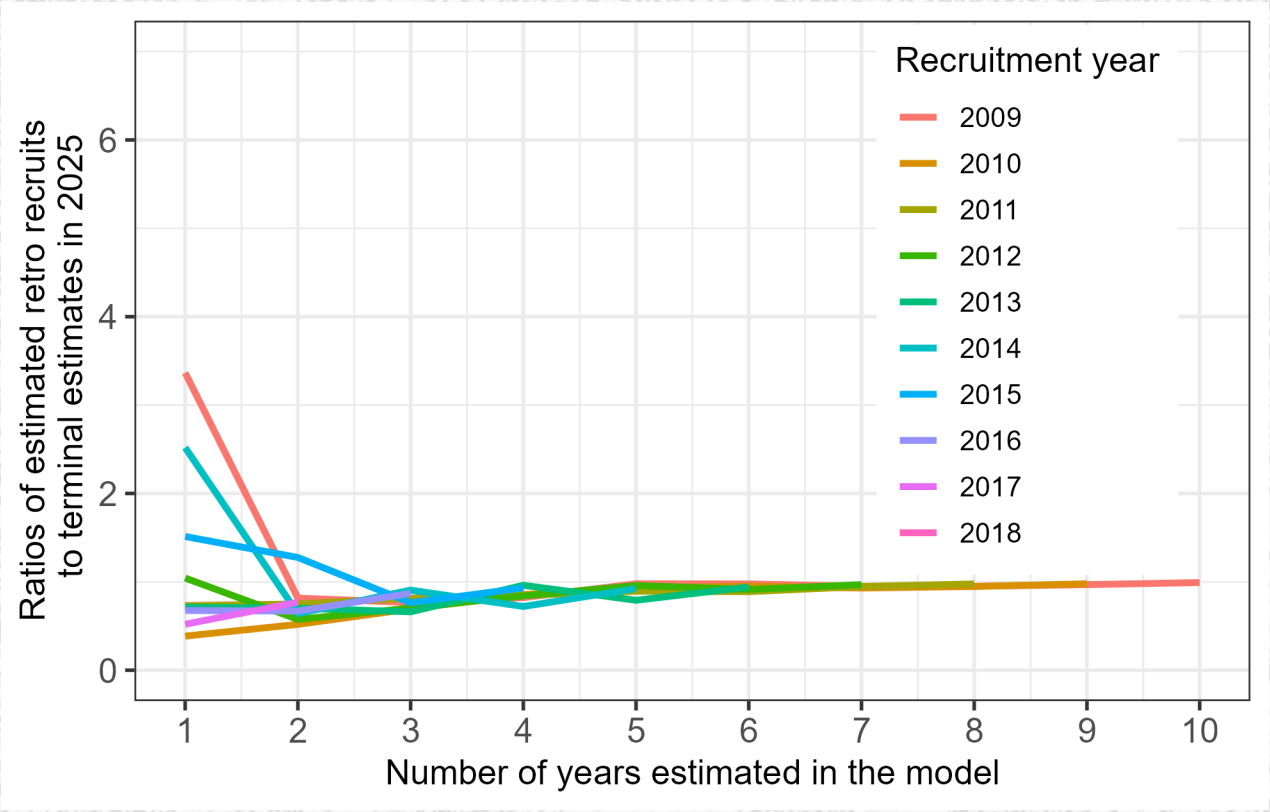
Recruitment

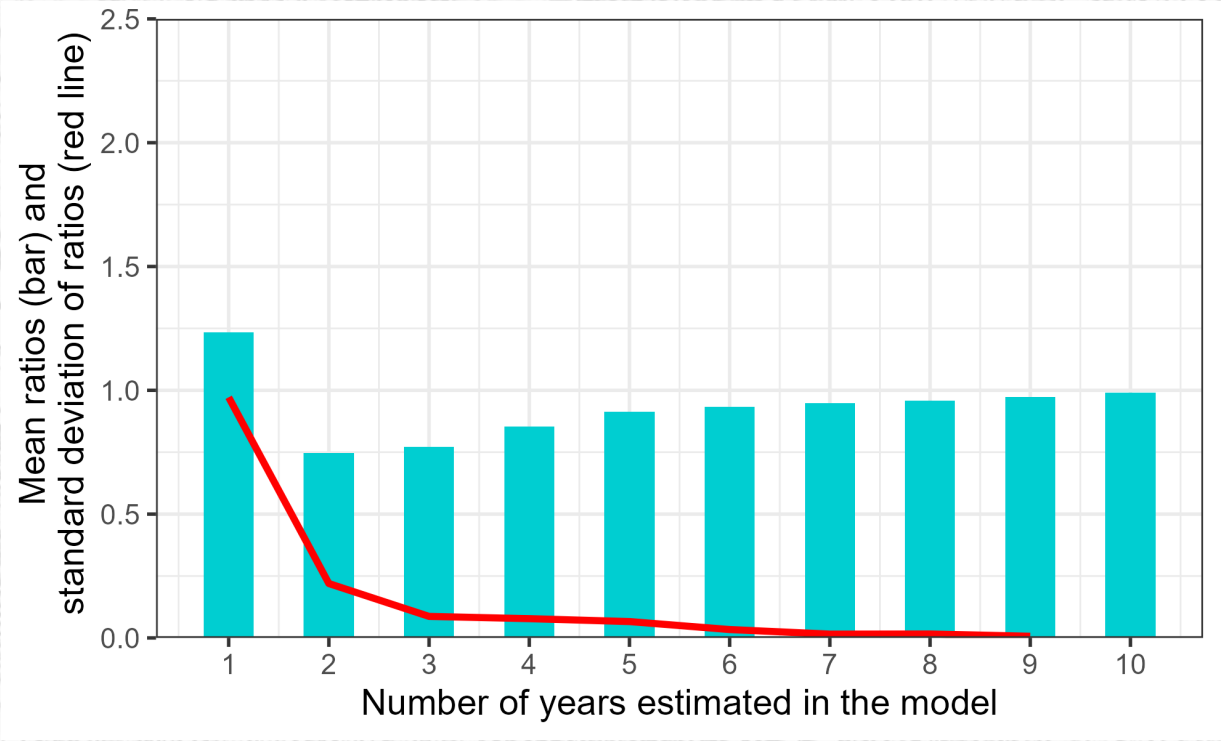






Recruitment to exclude from reference point calculations (model 24.0c.2)





Prior density values and total negative likelihood values

Table 16: Comparisons of negative log-likelihood values and some parameters for model 24.0c.2 for 2025, model 24.0c.2 (2024) and the 2024 accepted model, 24.0c, for reference.

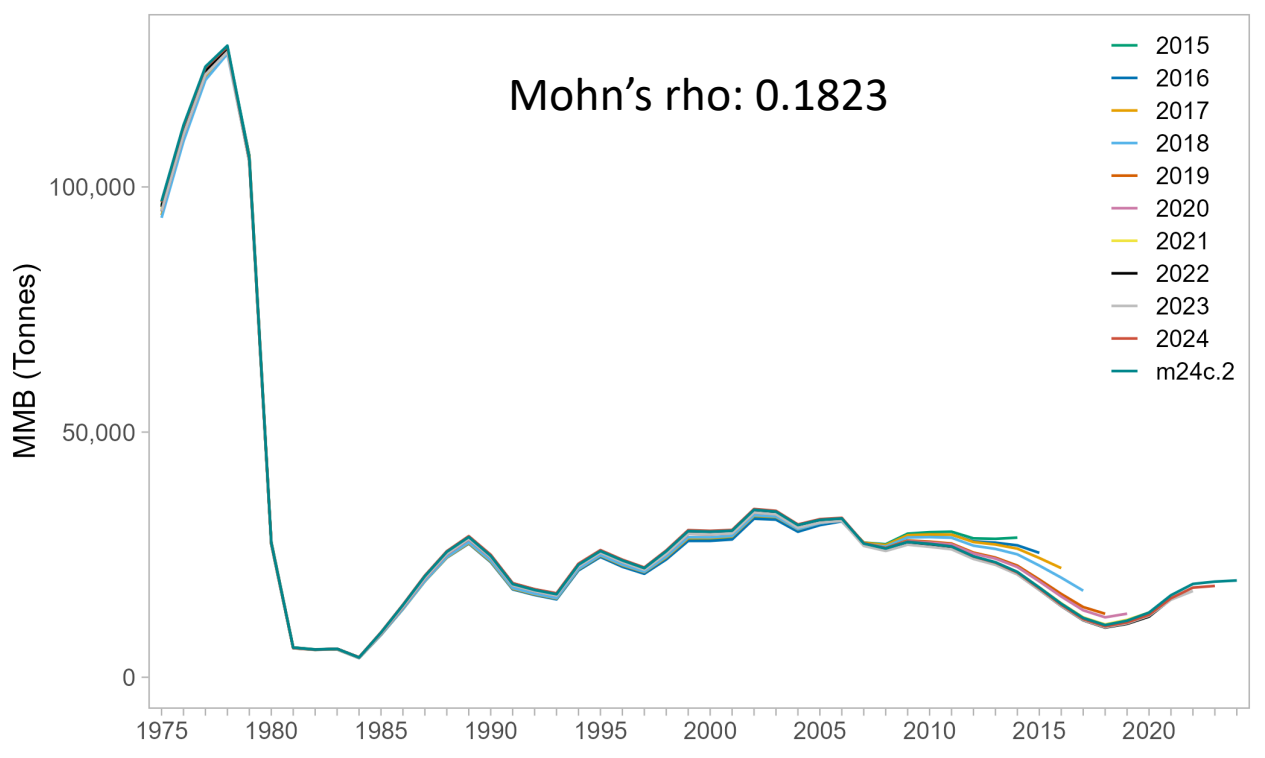
Component	m24.0c(2024 ref)	m24.0c.2(2024)	m24.0c.2
Pot-ret-catch	-61.35	-61.23	-63.56
Pot-totM-catch	30.40	30.74	28.82
Pot-F-discC	-59.19	-59.19	-60.93
Trawl-discC	-66.52	-66.52	-67.91
Tanner-M-discC	-43.54	-43.54	-45.28
Tanner-F-discC	-43.51	-43.51	-45.24
Fixed-discC	-38.81	-38.81	-40.20
Traw-suv-bio	-39.35	-39.44	-41.39
BSFRF-sur-bio	-5.00	-5.01	-5.13
Pot-ret-comp	-4084.32	-4084.38	-4173.13
Pot-totM-comp	-2523.39	-2523.04	-2603.18
Pot-discF-comp	-1546.63	-1546.63	-1583.69
Trawl-disc-comp	-6052.16	-6052.36	-6171.05
Tanner-disc-comp	-1276.39	-1276.45	-1276.73
Fixed-disc-comp	-3598.44	-3598.29	-3734.15
Trawl-sur-comp	-7288.60	-7288.44	-7440.87
BSFRF-sur-comp	-844.58	-844.63	-844.86
Recruit-dev	74.44	74.46	74.65
Recruit-ini	0.00	0.00	0.00
Recruit-sex-R	80.45	80.46	82.02
Sex-specific-R	0.06	0.06	0.07
Ini-size-struct	33.22	33.24	33.36
PriorDensity	224.79	224.80	223.68
Tot-likelihood	-27128.41	-27127.70	-27754.69
Tot-parms	383.00	383.00	391.00
MMB35	18690.28	18648.50	18524.40
MMB-terminal	15426.58	15403.24	16836.02
F35	0.40	0.40	0.40
$Fofl$	0.32	0.32	0.36
OFL	5021.76	5018.15	5851.79

Retrospective analysis and projections

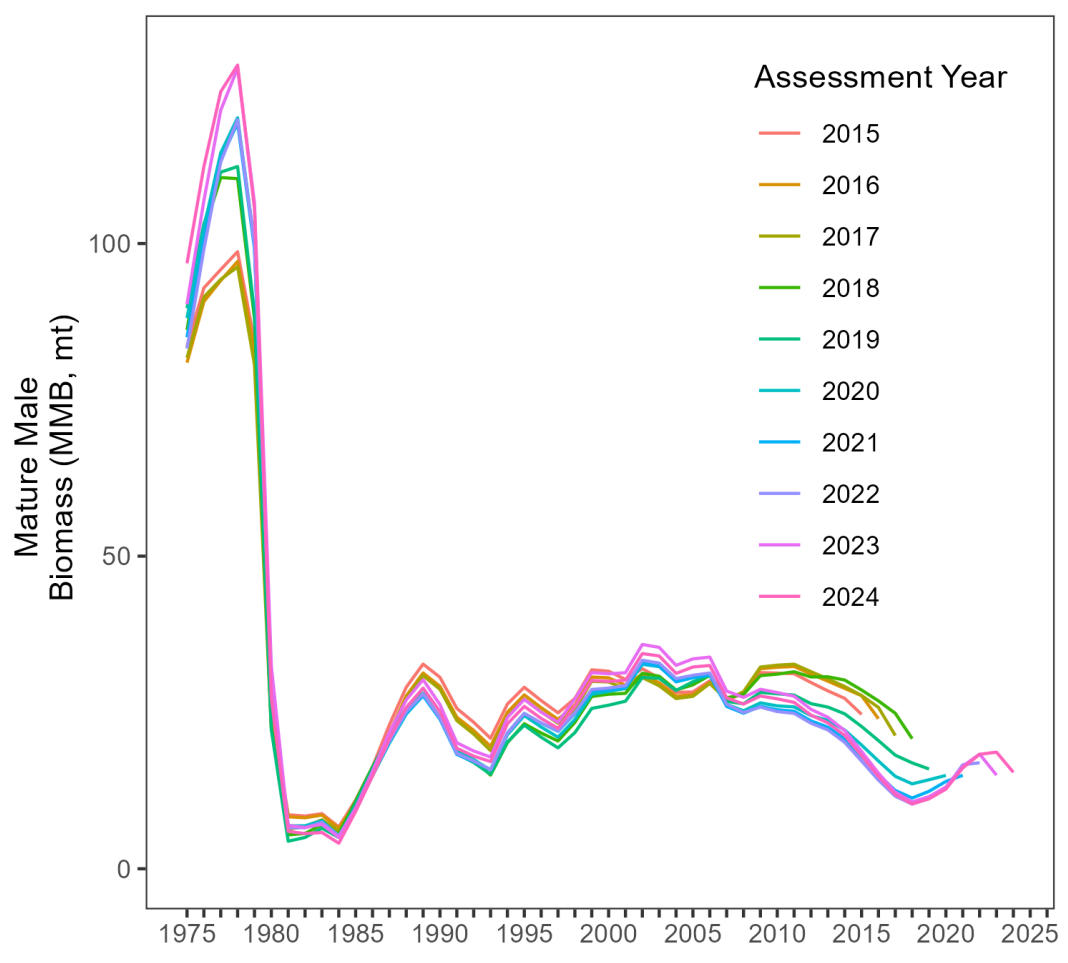
- Retrospective analysis – both retrospective and historical retrospective
- Jitter – run on all models, >90% of jitter runs converged to MLE and those that didn’t were worse model fits (~100 runs with sd =0.1 and 0.3)
- MCMC runs to look at model variability
- Projections
  - To inform population trajectory and the probability of “approaching an overfished condition”
  - Used low recruitment since 2014

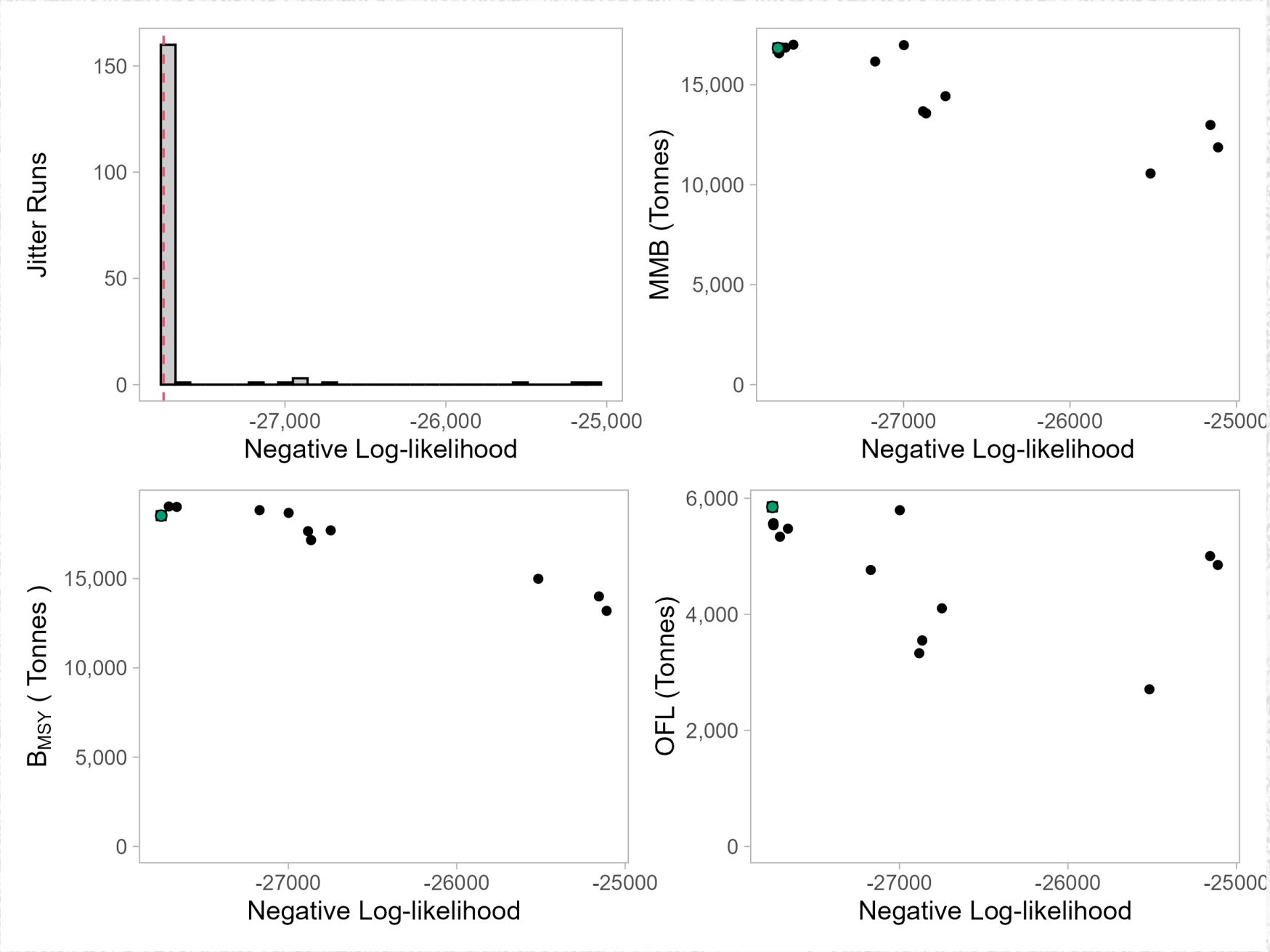
Retrospective patterns

Model 24.0c.2



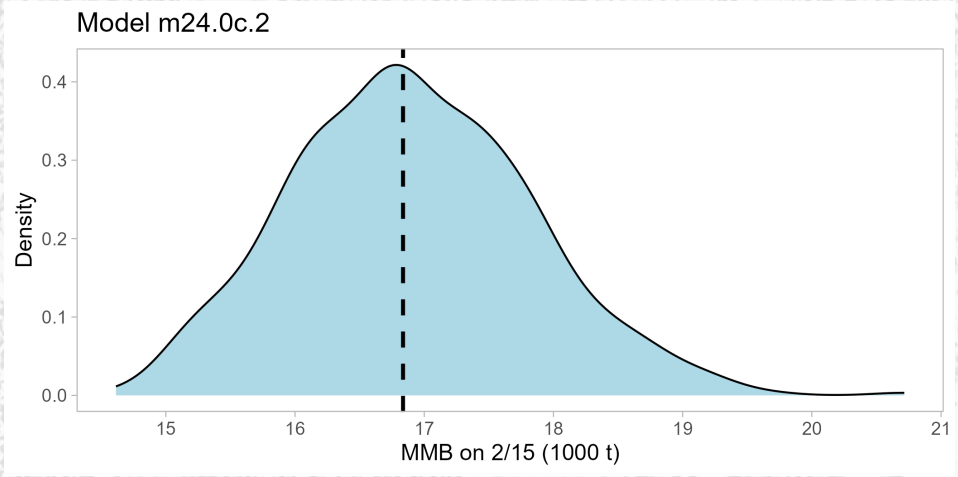
Historic retrospective – uses accepted model output in that assessment year (source SAFE documents

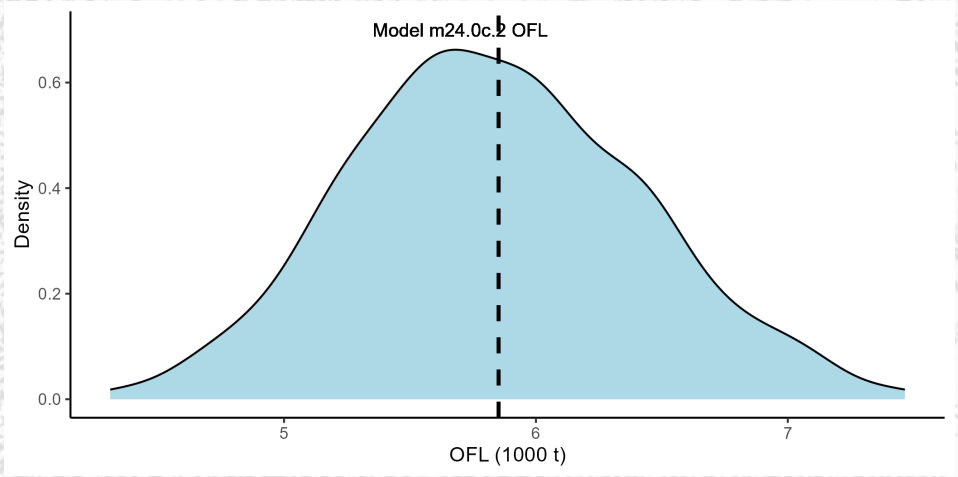


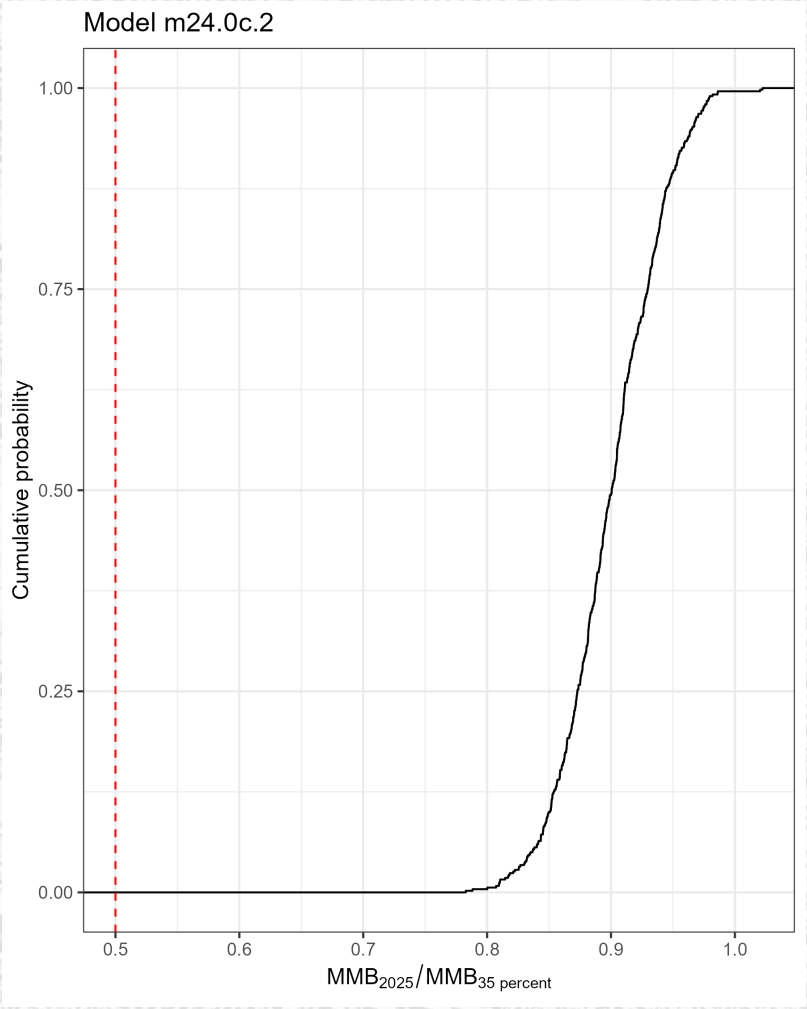

Jitter Runs
150
100
50
0
-27,000
-26,000
-25,000
Negative Log-likelihood
MMB (Tonnes)
15,000
10,000
5,000
0
-27000
-26000
-25000
Negative Log-likelihood
B_{MSY} (Tonnes)
15,000
10,000
5,000
0
-27000
-26000
-25000
Negative Log-likelihood
OFL (Tonnes)
6,000
4,000
2,000
0
-27000
-26000
-25000
Negative Log-likelihood

MCMC output (Model 24.0c.2)

Cumulative probabilities of estimated ratios of MMB in 2025 (Feb. 15th , 2026) to corresponding estimated $B_{35\%}$ values under model 24.0c.2 with the MCMC approach.

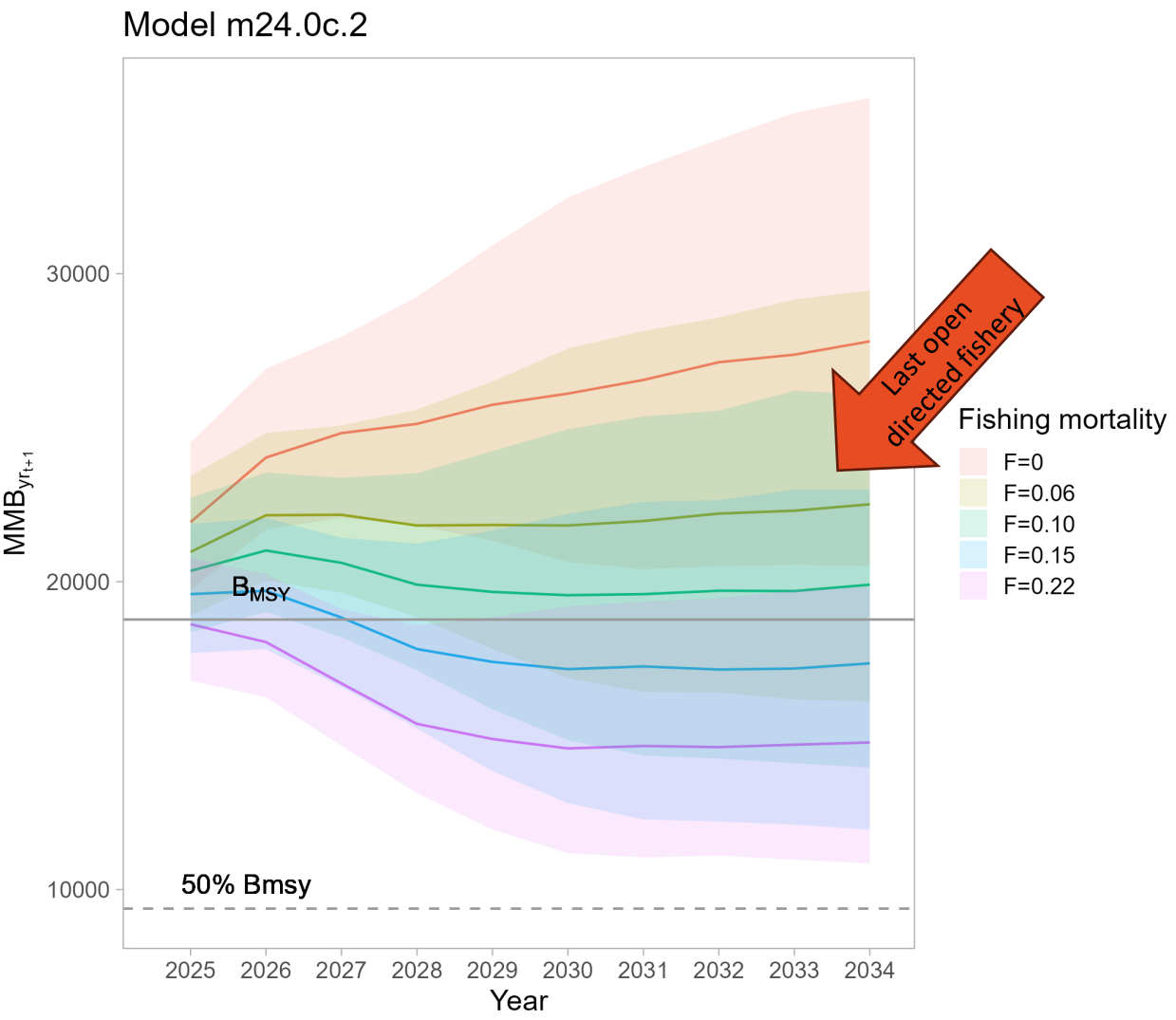


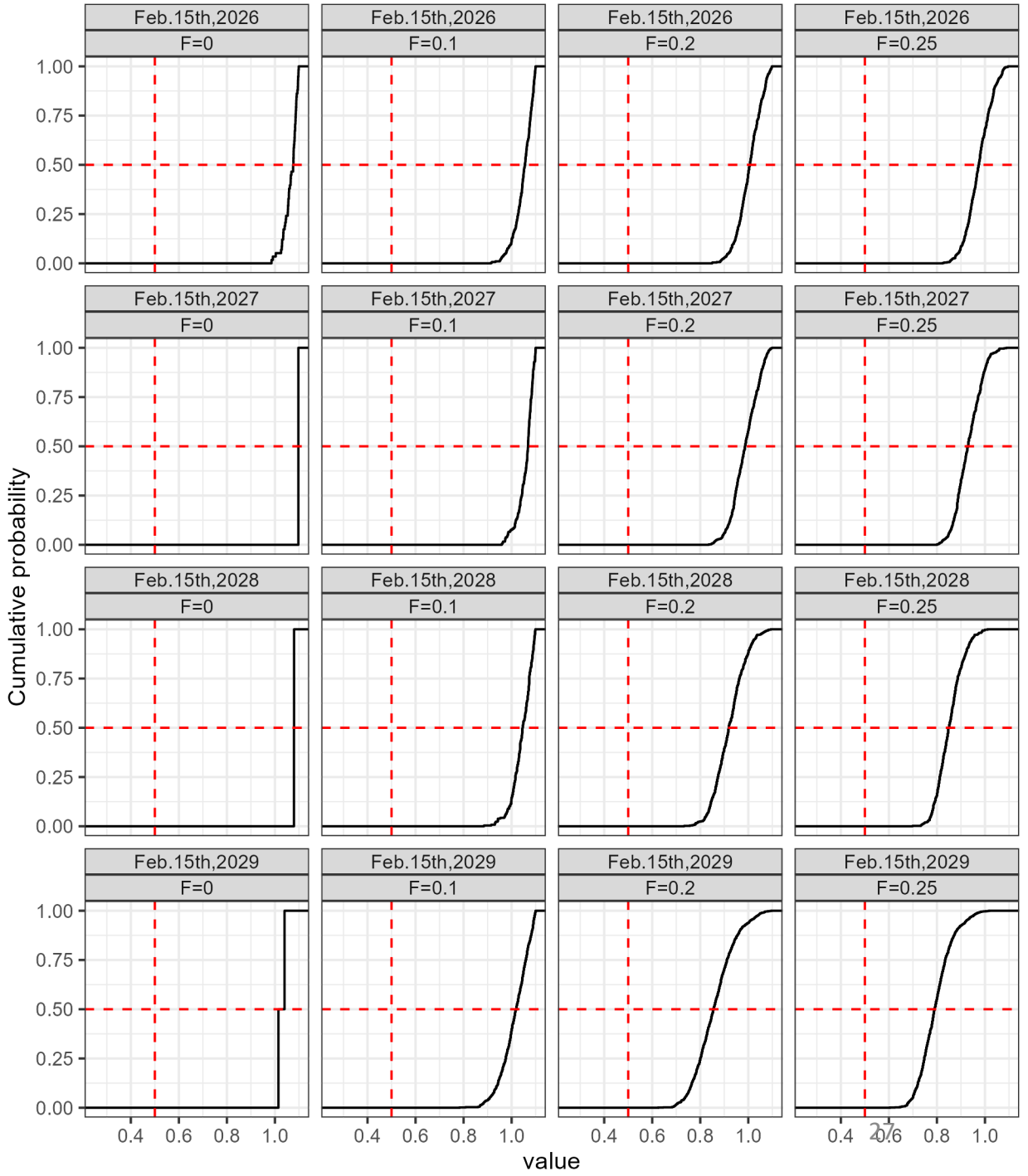




Projections for future status (24.0c.2 MCMC output)

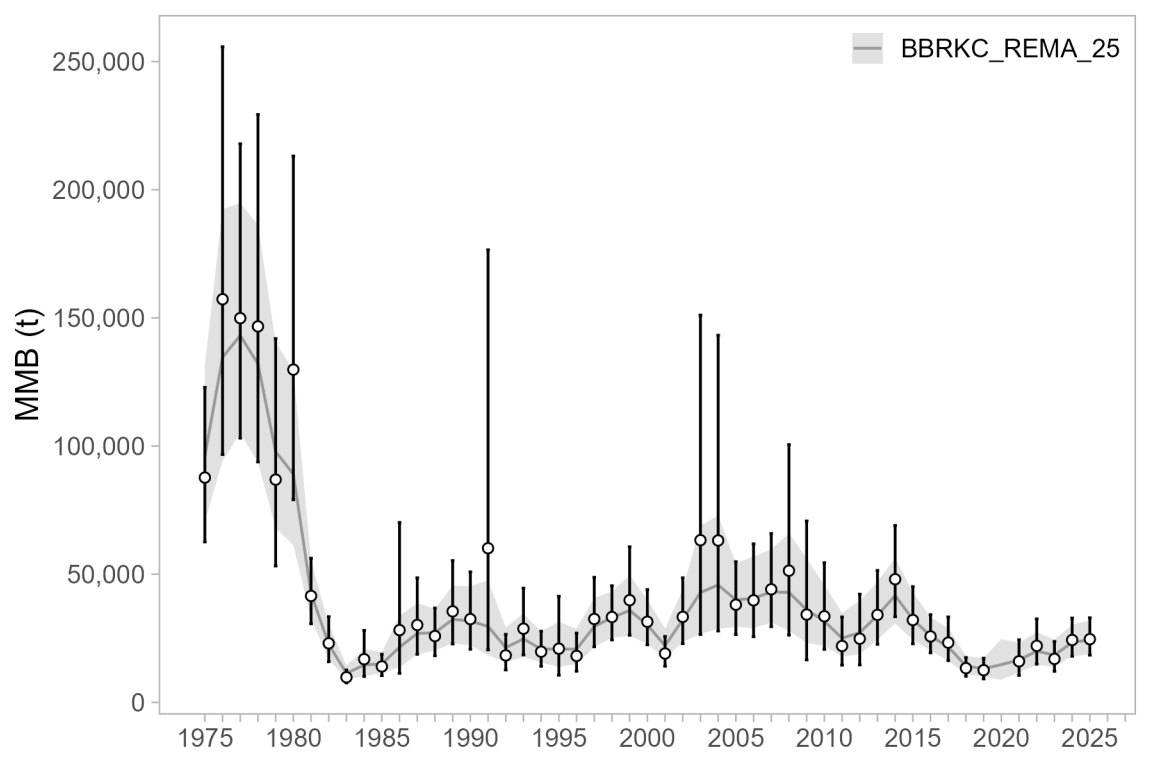
[2025 = projected MMB Feb 15th , 2026]





Tier 4 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 2024 (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
27.85	24.44	0.88	0.23	0.20	4.86	3.88	4.13

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 2025 and not likely “approaching an overfished condition” in the next two years
- Recommend model 24.0c.2 for status determination

Table 1: Status and catch specifications (1000 t) for the CPT recommended model (24.0c.2).

Year	MSST	Biomass (MMB_{mating})	TAC	Retained Catch	Total Catch	OFL	ABC
2021/22	12.01	16.64	0	0.02	0.10	2.23	1.78
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		16.84				5.85	4.68

Table 3: Basis for the OFL (1000 t) from the CPT recommended model (24.0c.2).

Year	Tier	B_{MSY}	Biomass (MMB_{mating})	B/B_{MSY}	F_{OFL}	Basis for B_{MSY}	Natural mortality
2021/22	3b	24.2	14.9	0.62	0.17	1984-2020	0.18
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

BBRKC

Risk Table 2025 (App D)

Assessment-related considerations	**Population dynamics considerations**	**Ecosystem considerations**	**Fishery-informed Stock Considerations**
• Retrospective pattern in MMB (high Mohn's rho). This has been present for the last few years • Stable GMACS reference model since 2018 • Historic natural mortality event (early 80s) **Conclusion: Level 1**	• Unknown reasons behind recruitment failure • Potential shifting spatial distributions **Conclusion: Level 1**	• Corrosive bottom waters and increased wind stress in Bristol Bay remain a concern for growth and survival of larval and juvenile BBRKC • BB bottom waters were warm in 2025 but there is uncertainty what impacts this has on the stock **Conclusion: Level 1**	• Recent year fishery CPUE was higher than last 10-year average • Total potlifts and number of active vessels at or near historic lows • Skipper survey reported high CPUE and majority saw an increase in legal males **Conclusion: Level 1**

Sept/Oct 2024 recommended ABC = 80% of max ABC (20% buffer).

Appendix E: History of buffer considerations

- 20% (no large changes or improvements in uncertainty)
  - Retrospective pattern (slightly improved but still present)
  - General variable environmental conditions
    - Cold pool distributional shifts
    - Warm waters
  - Lack of fit to last three years of NMFS female survey biomass
  - Unknown reasons behind recruitment failure

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
2020	25%	- increased from previous years buffer due to lack of survey data (increase from 20% to 25%)
2021	20%	- continued lack of recent recruitment - poor environmental conditions (as reflected in the ESP) - continued decline in female survey biomass in 2021 - model's lack of fit to the 2018-2021 female survey biomass
2022	20%	- continued lack of recent recruitment - poor and variable environmental conditions - NMFS female survey biomass in 2022 remains at historically low levels - lack of fit to the 2018-2022 NMFS female survey biomass - restrospective patterns exhibited by the recommended model
2023	20%	- continued lack of recent recruitment - poor and variable environmental conditions (e.g., cold pool distributional shifts) - 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) - lack of fit to 2018-2023 NMFS female survey biomass - retrospective patterns exhibited by the recommended model, even though this was improved over last year's assessment model (21.1b)
2024	20%	- continued lack of recent recruitment - poor and variable environmental conditions (e.g., cold pool distributional shifts) - lack of fit to 2021 - 2024 NMFS female survey biomass - retrospective patterns exhibited by the recommended model

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