



Bristol Bay red king crab

Final SAFE

September 2024

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ADF&G

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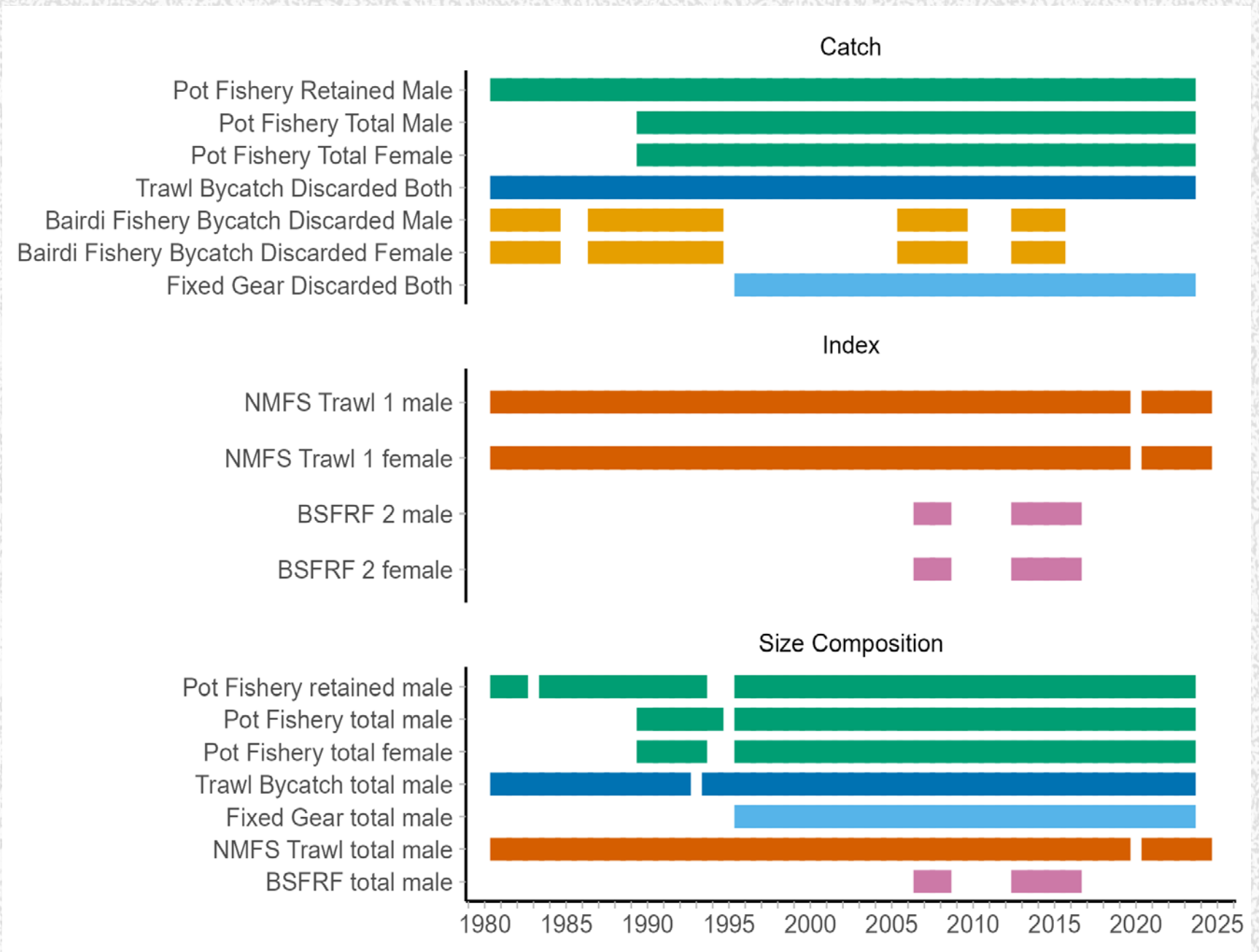
Summary

- Mature male biomass increased from 2023, still low compared to long term average
- Directed fishery was open in 2023/24 after two seasons of closures (2021/22 and 2022/23) due to low mature female abundance.
- Estimated mature female biomass is higher than recent years but still lower than it's been since the mid-90s
- 2024 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 8-12 years), projected decline in biomass with higher exploitation rates without a large recruitment event

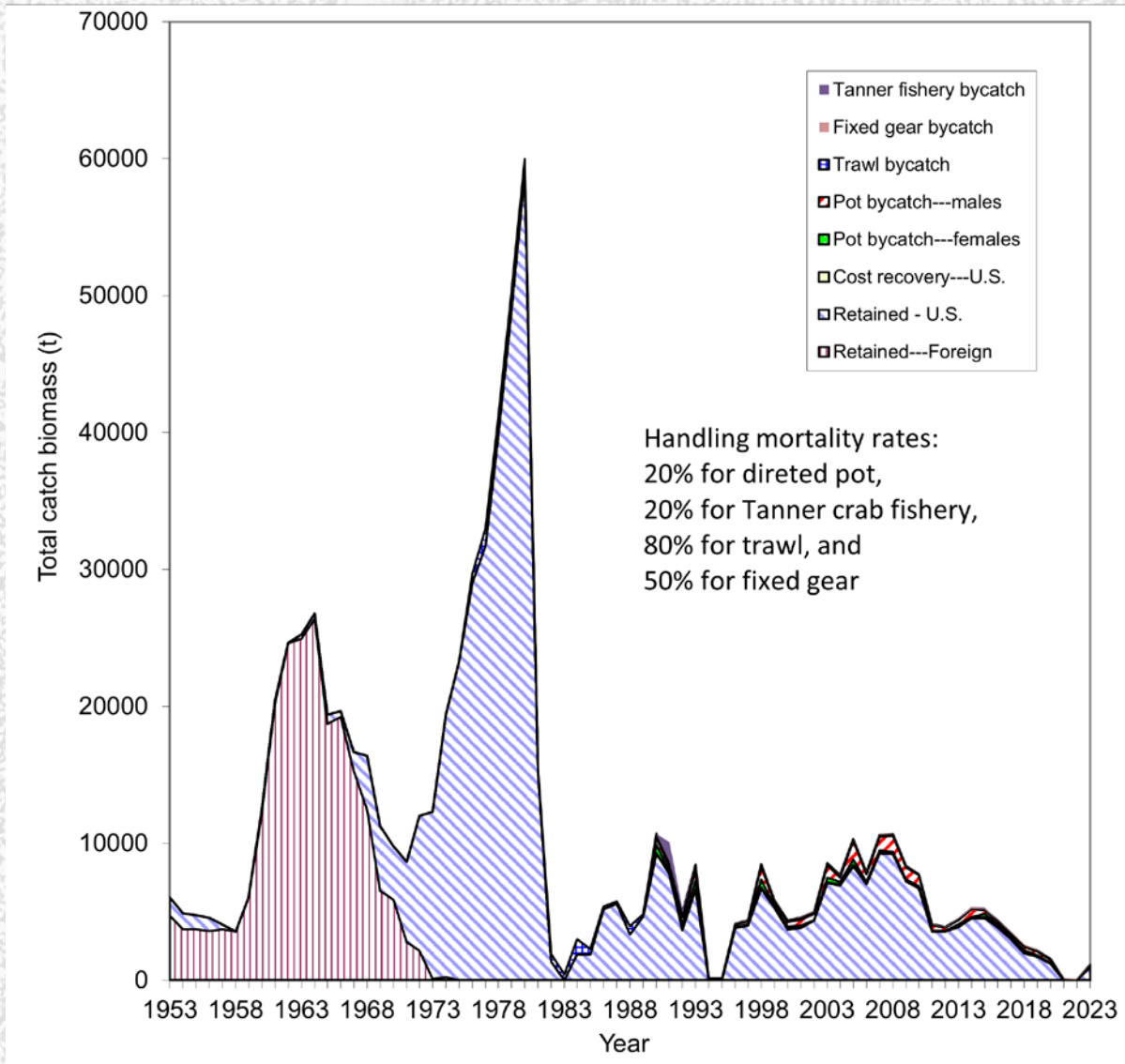
CPT / SSC comments

- Some comments were addressed in May 2024, others are ongoing
- Work will be continued for 2025 proposed model work
 - Simplify model to reflect current model parameters (removing shell condition)
 - Continued work on BSFRF data used as a prior on Q
 - Other recommendations related to selectivity and retention explorations
 - Growth investigation of original data to explore expanding size bins
- Focus here on models recommended for specification in May 2024

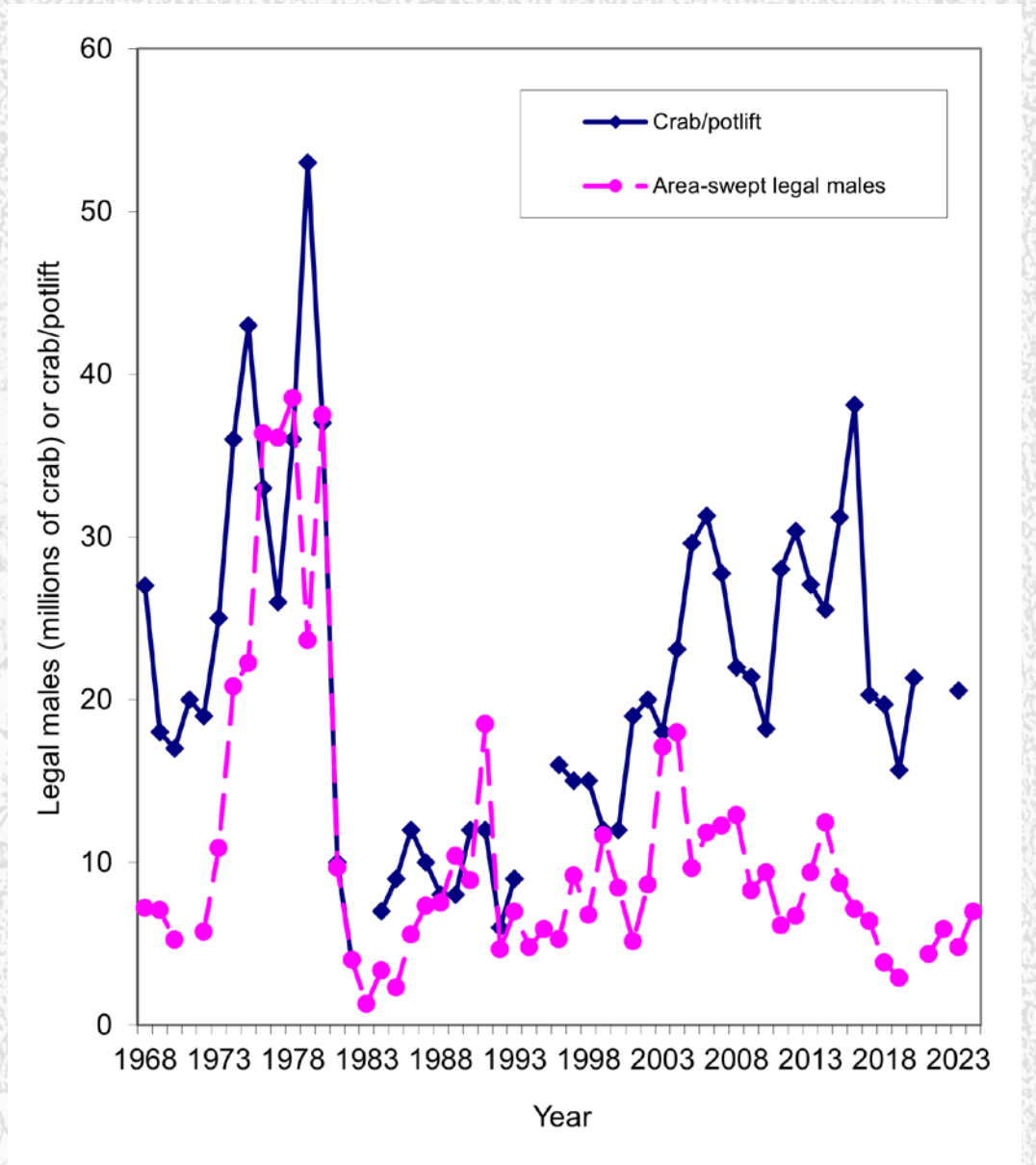
Data extent and new data for 2024



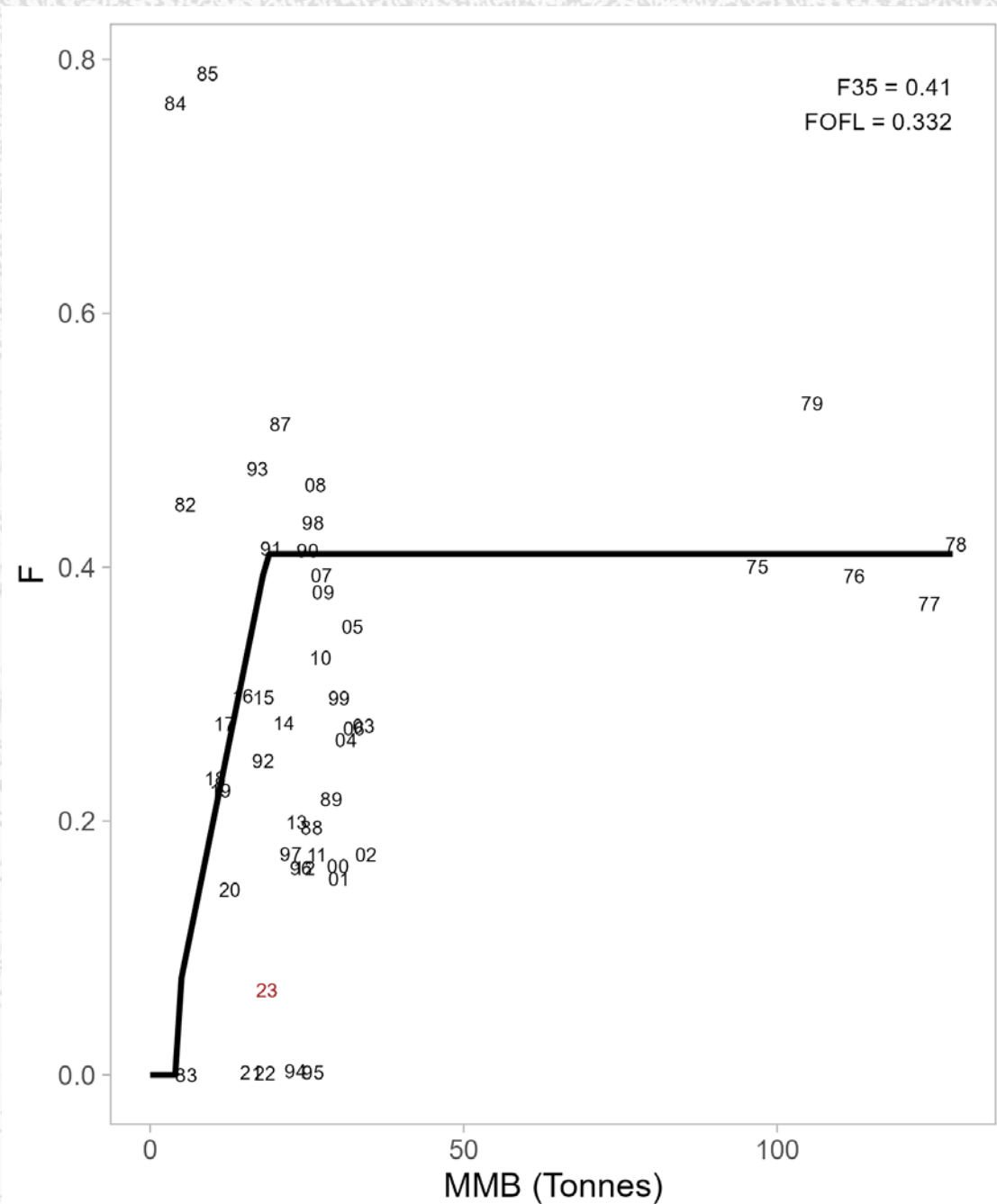
Retained and bycatch mortality (t)



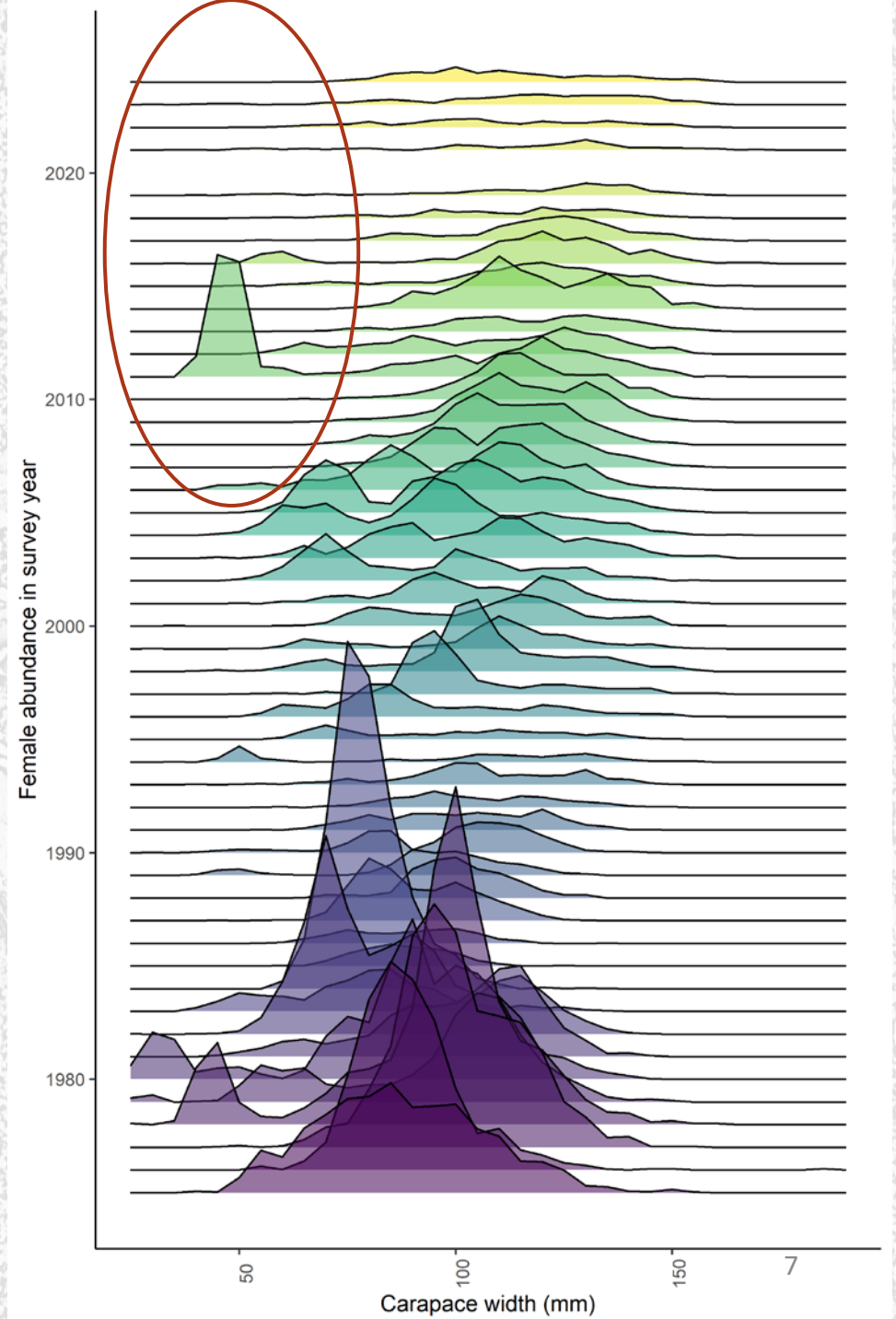
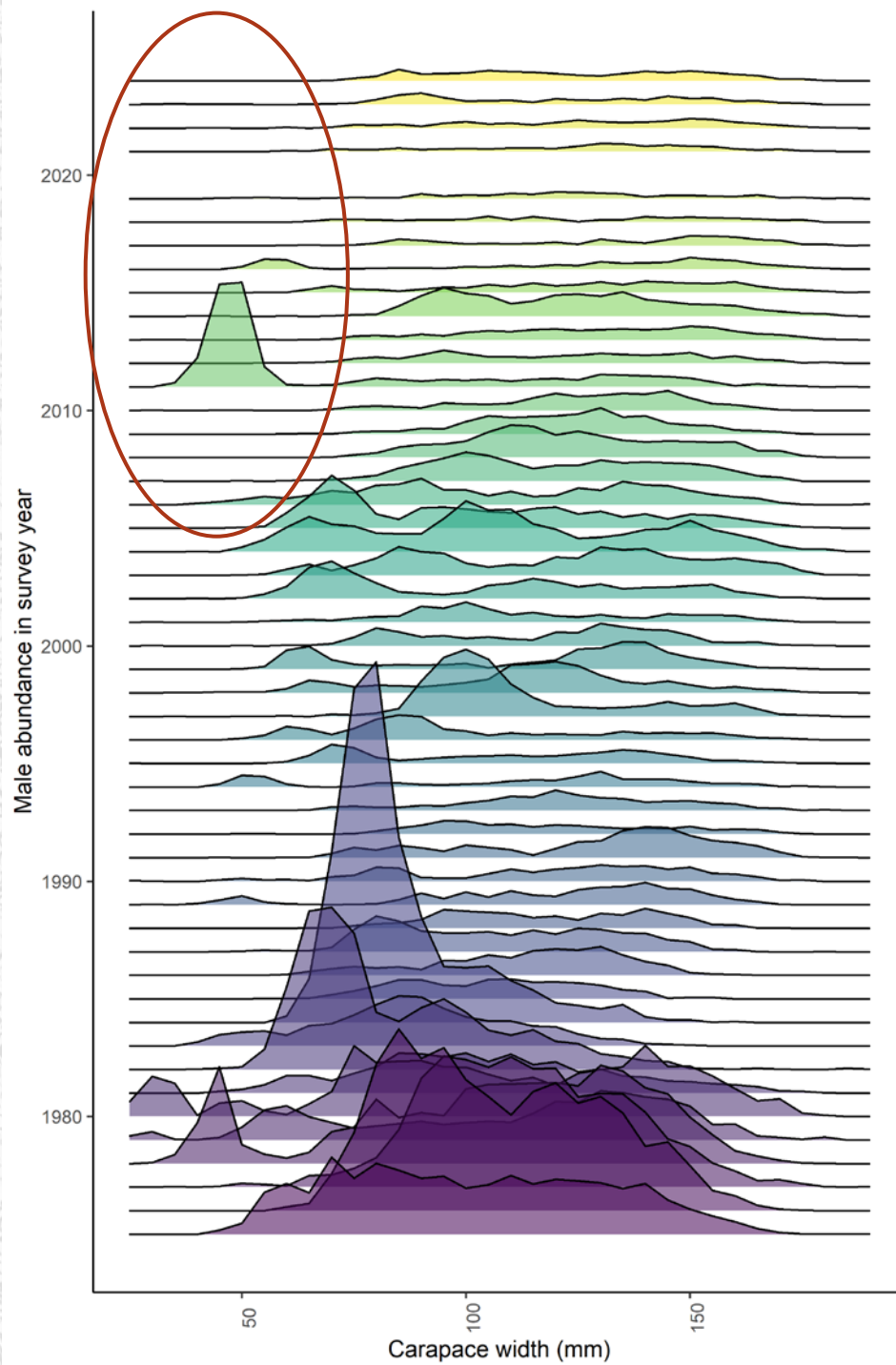
Survey legal male abundance and CPUE for directed BBRKC fishery

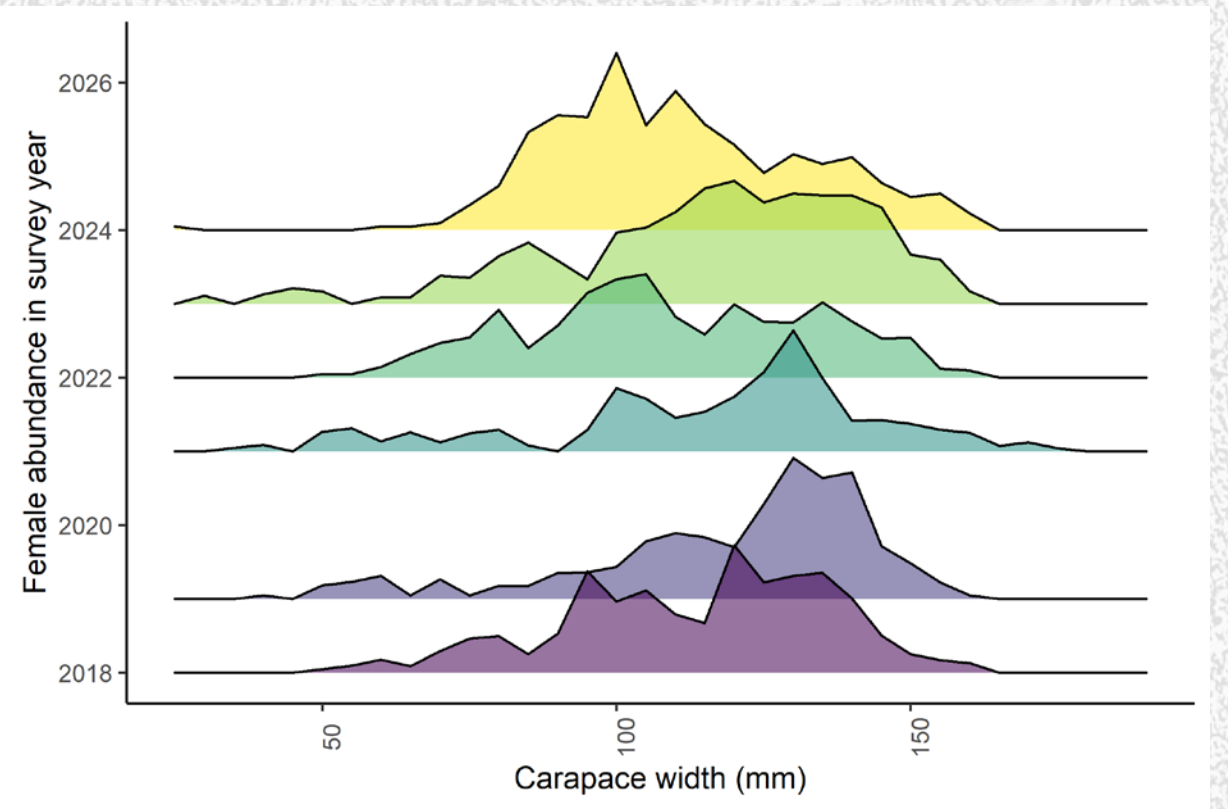
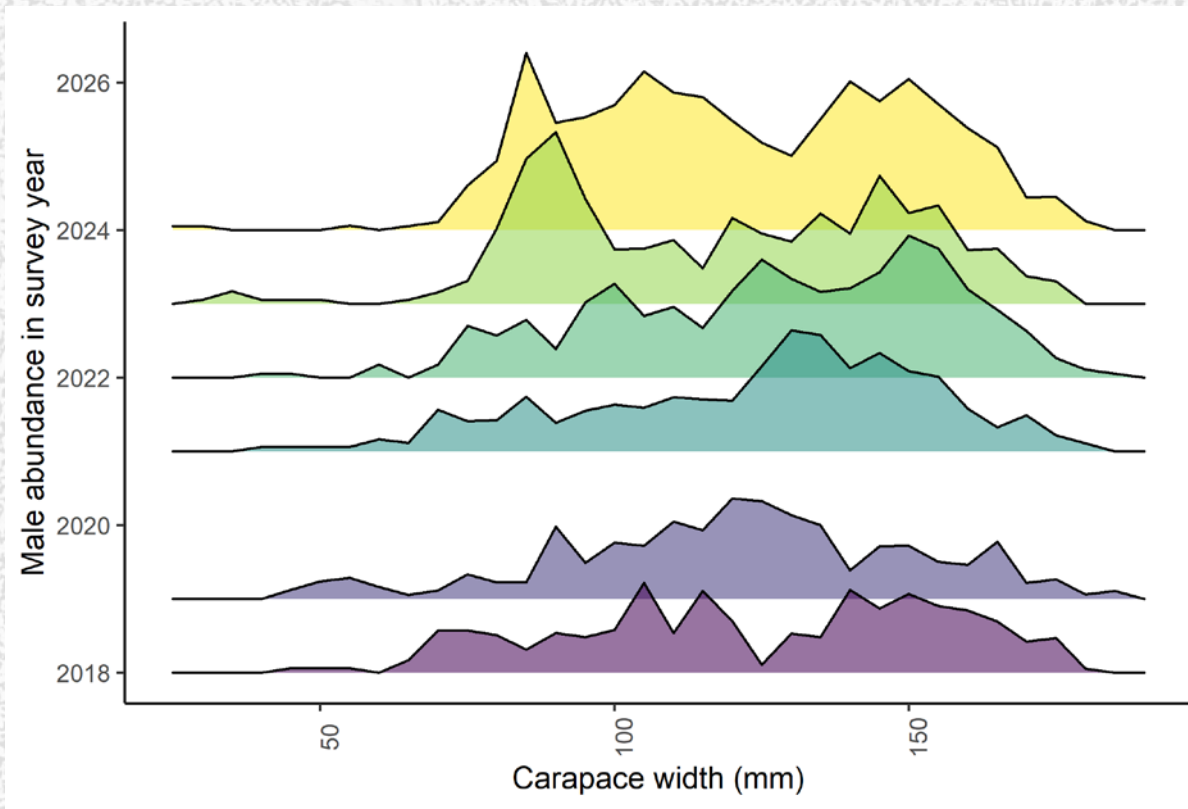


Fishing mortality and MMB relationship over time (model 24.0c)



Length composition from NMFS survey

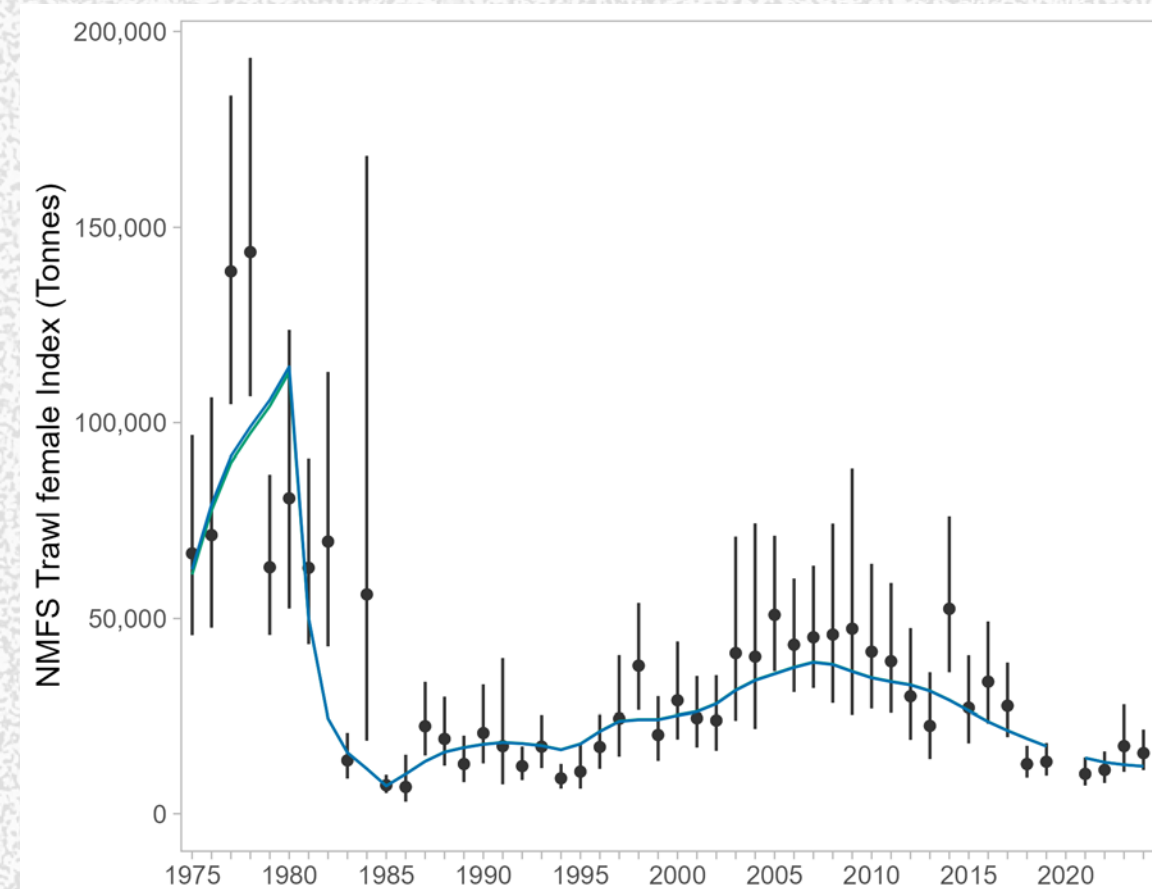




Model explorations

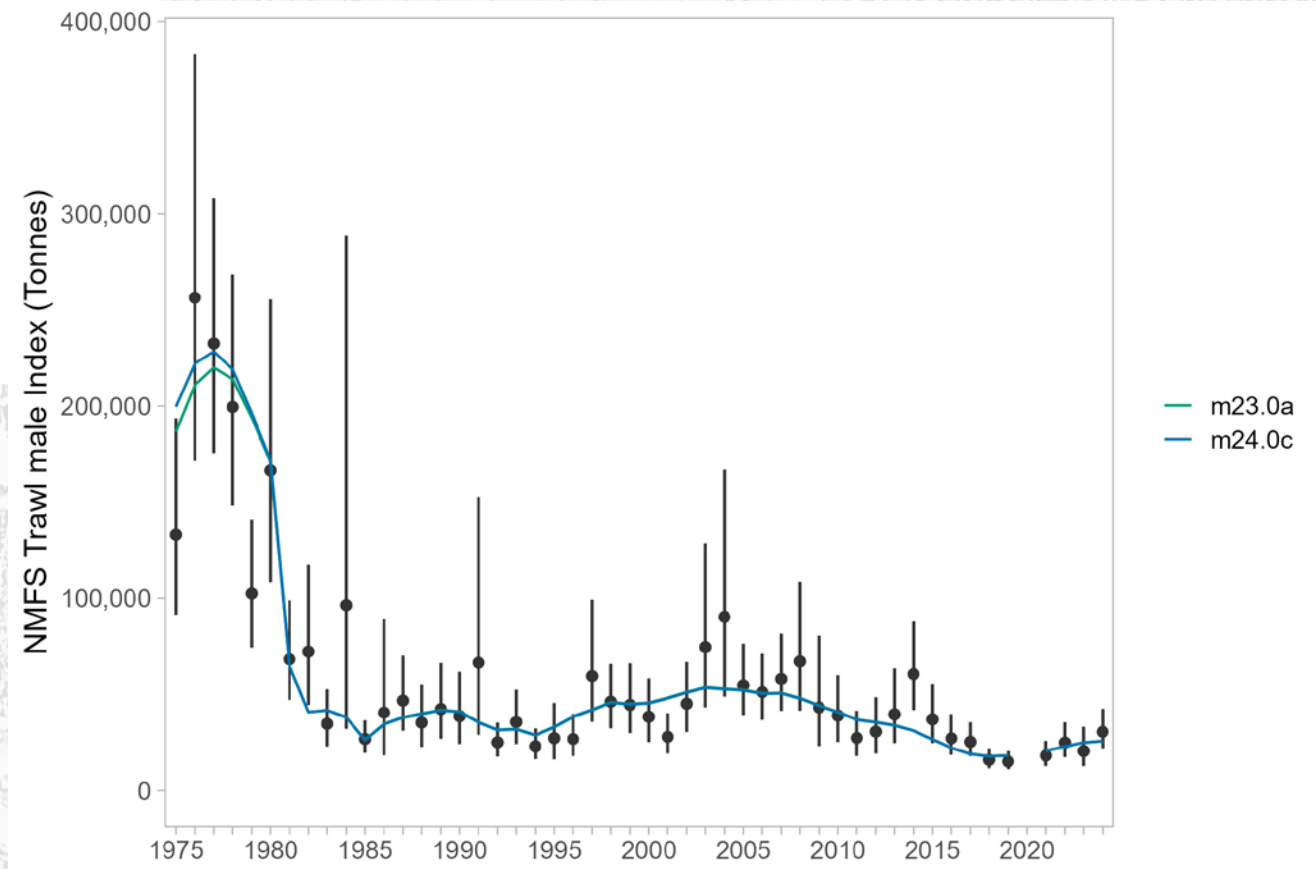
23.0a: model 21.1b (2022 base, starts in 1975, mortality event in 80s, stable in GMACS since 2018) + base M for males *estimated* in the model
+ **GMACS updated version** (version 2.20.14, 2025-05-20)
+ **2023/24 data** (fishery, bycatch, survey, etc.).

24.0c: model 23.0a
– removing time block for molt probability from 1975 to 1979.

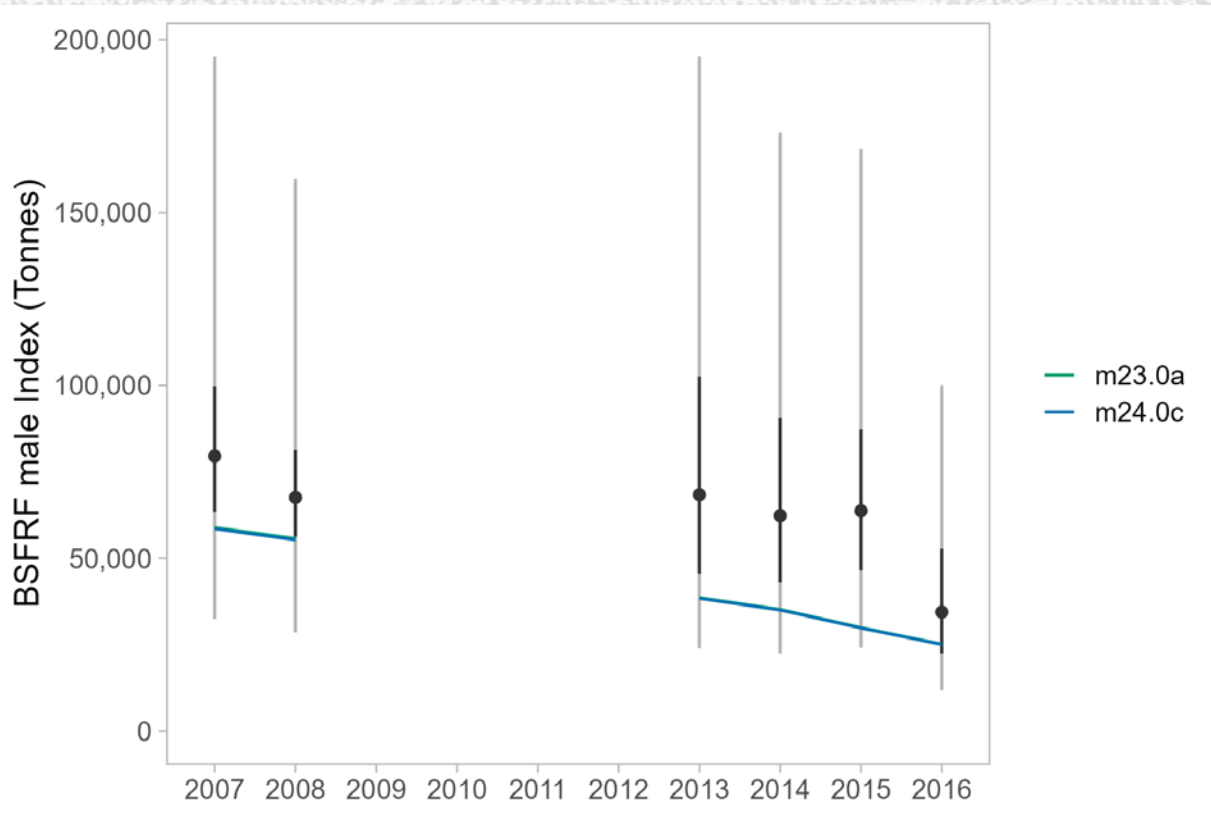


- Model fits to survey data are similar in both models
- Early difference in males due to molt prob time block (75 to 79)

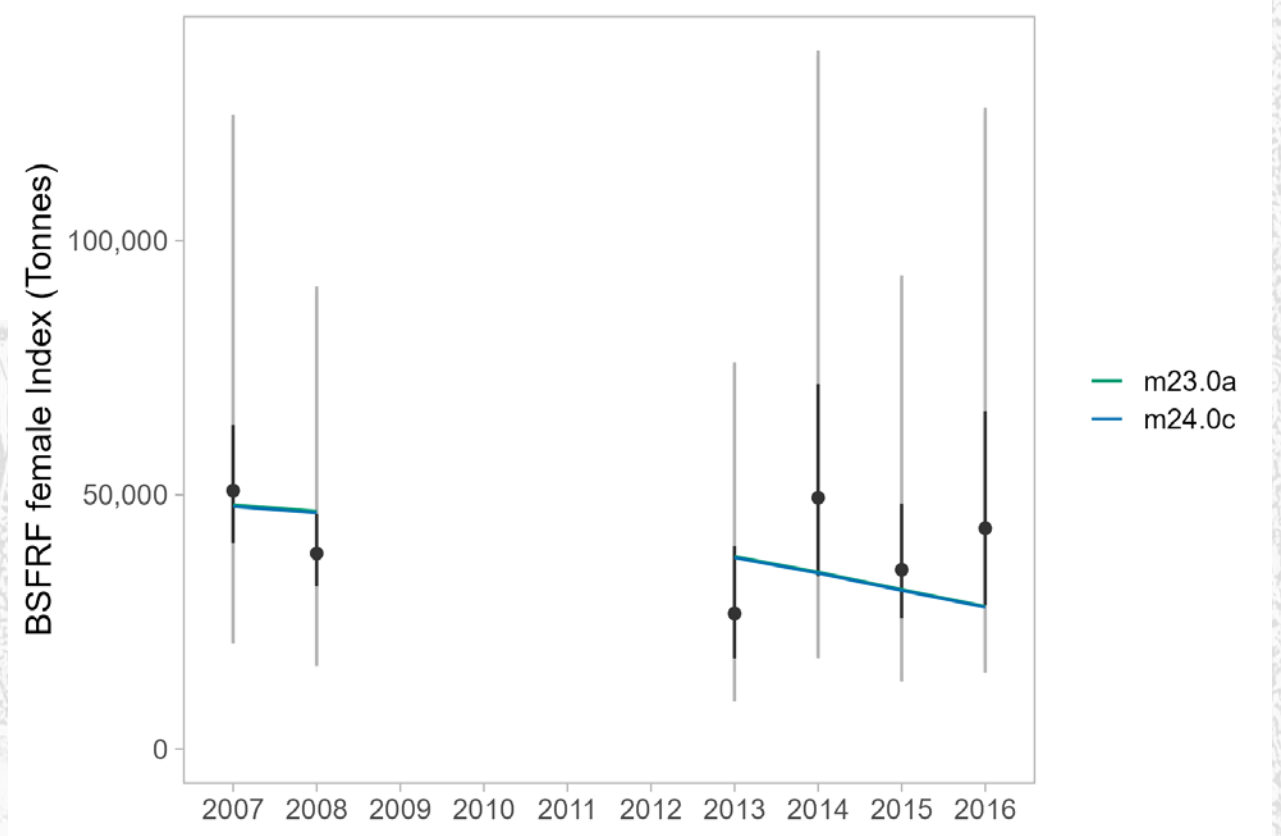
m23.0a
m24.0c



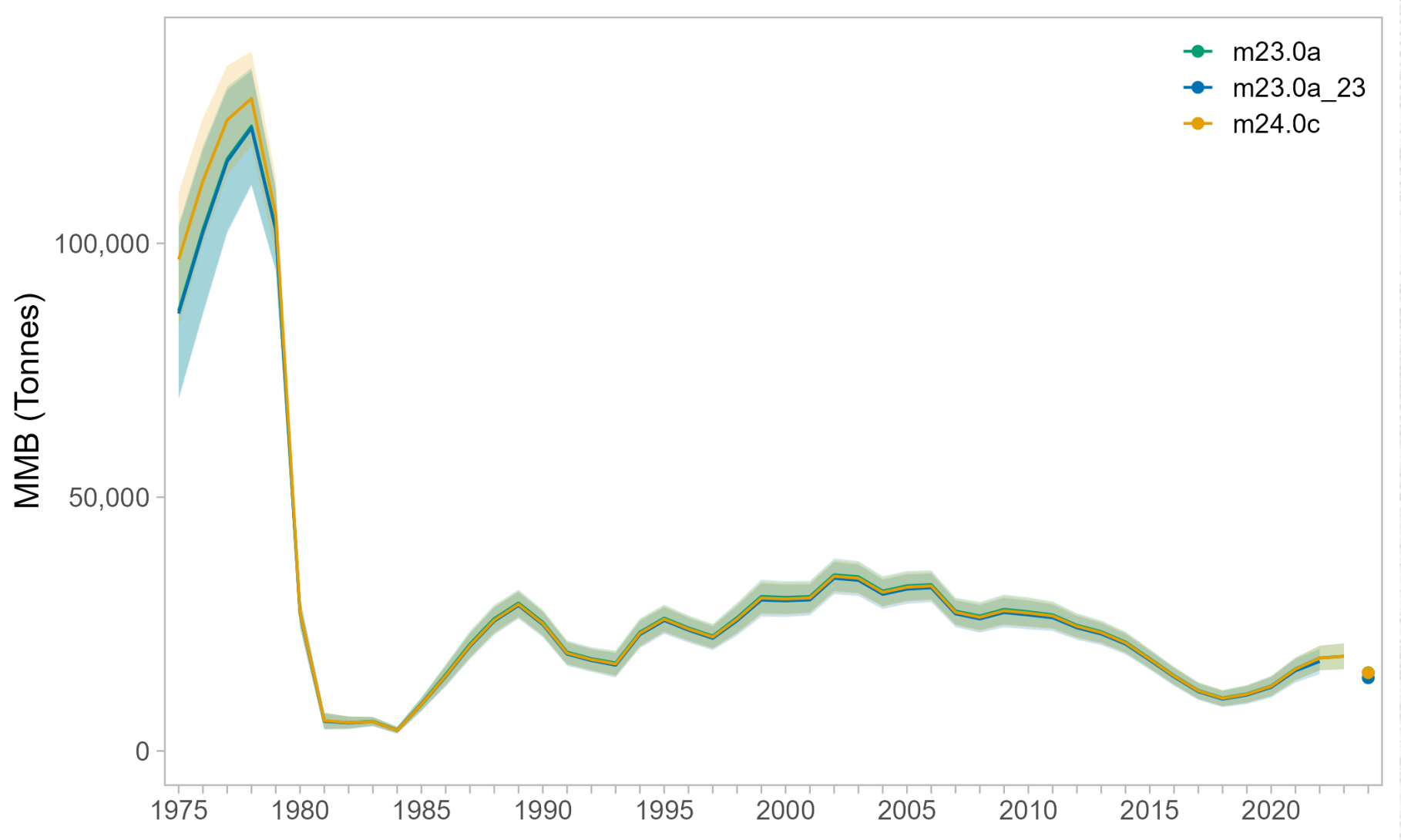
m23.0a
m24.0c



- Error bars show additional error
- BSFRF survey catchability is assumed to be 1.0
- Similar fits



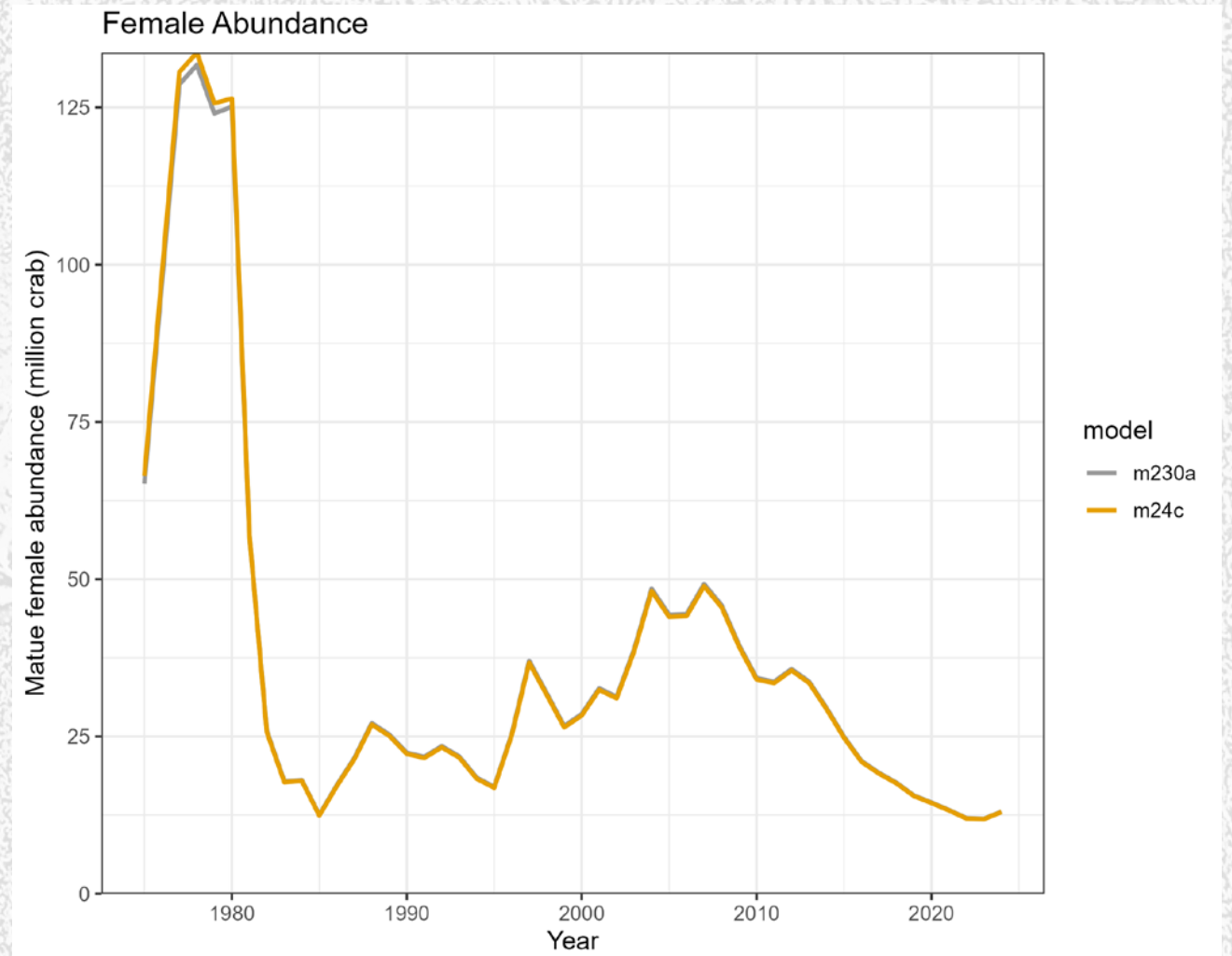
Mature male biomass



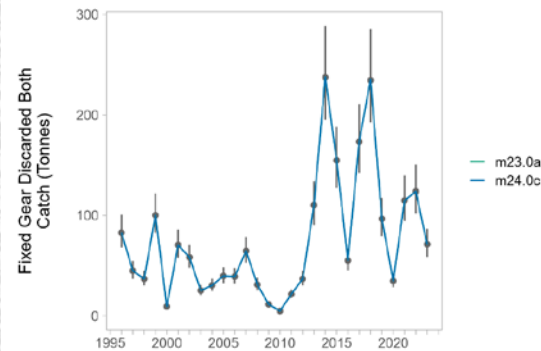
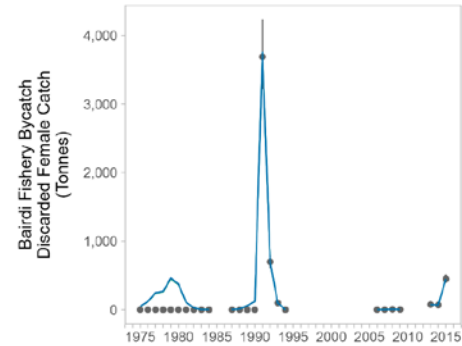
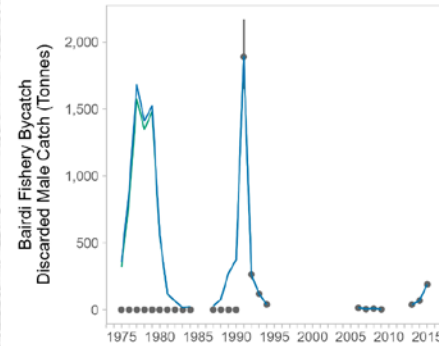
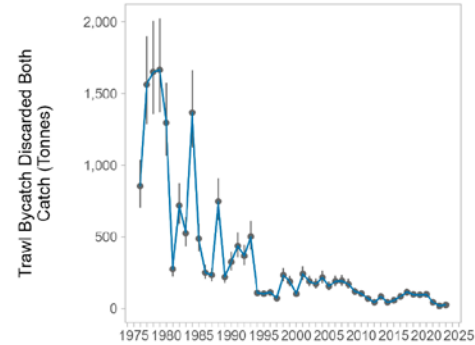
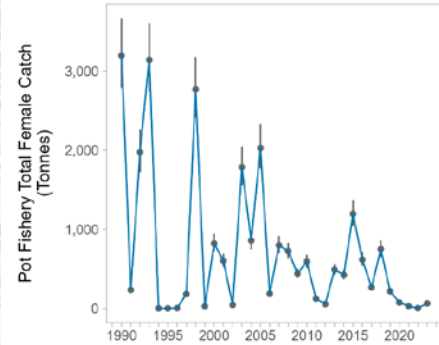
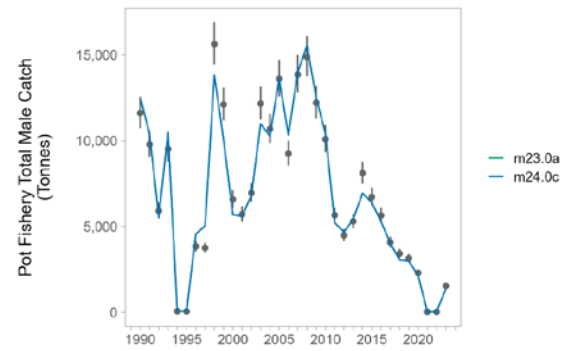
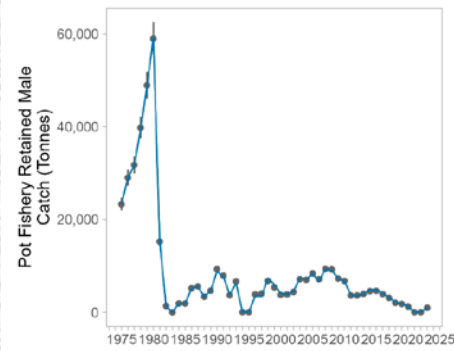
- Base model 23.0a similar with new 2024 data
- Current trajectory and estimation of stock very similar with both models

Mature female abundance

- Model estimated
- Mature females defined as $\geq 90\text{mm CL}$



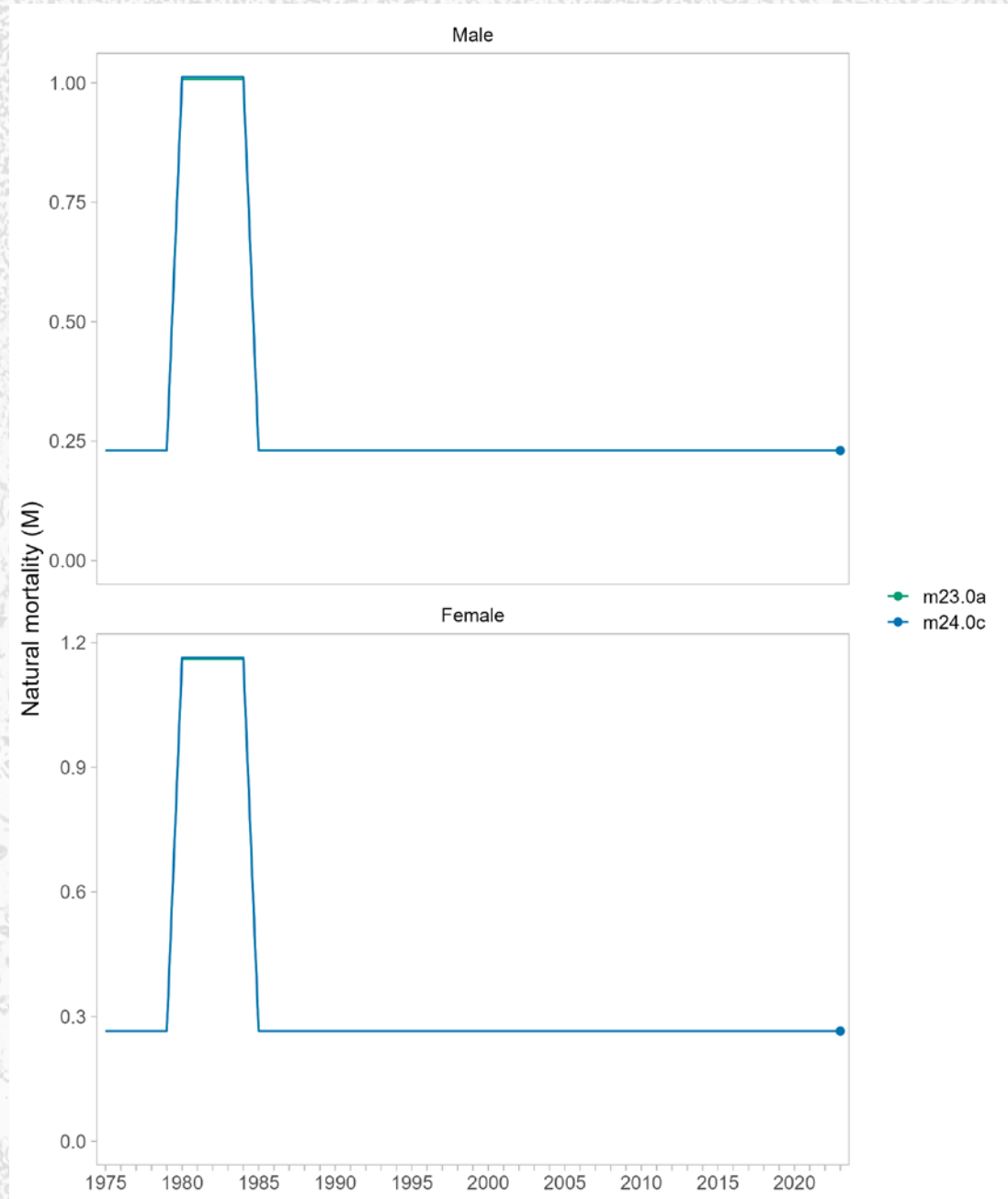
Mortality
biomass
(equal to
catch
biomass
times
handling
mortality
rate)



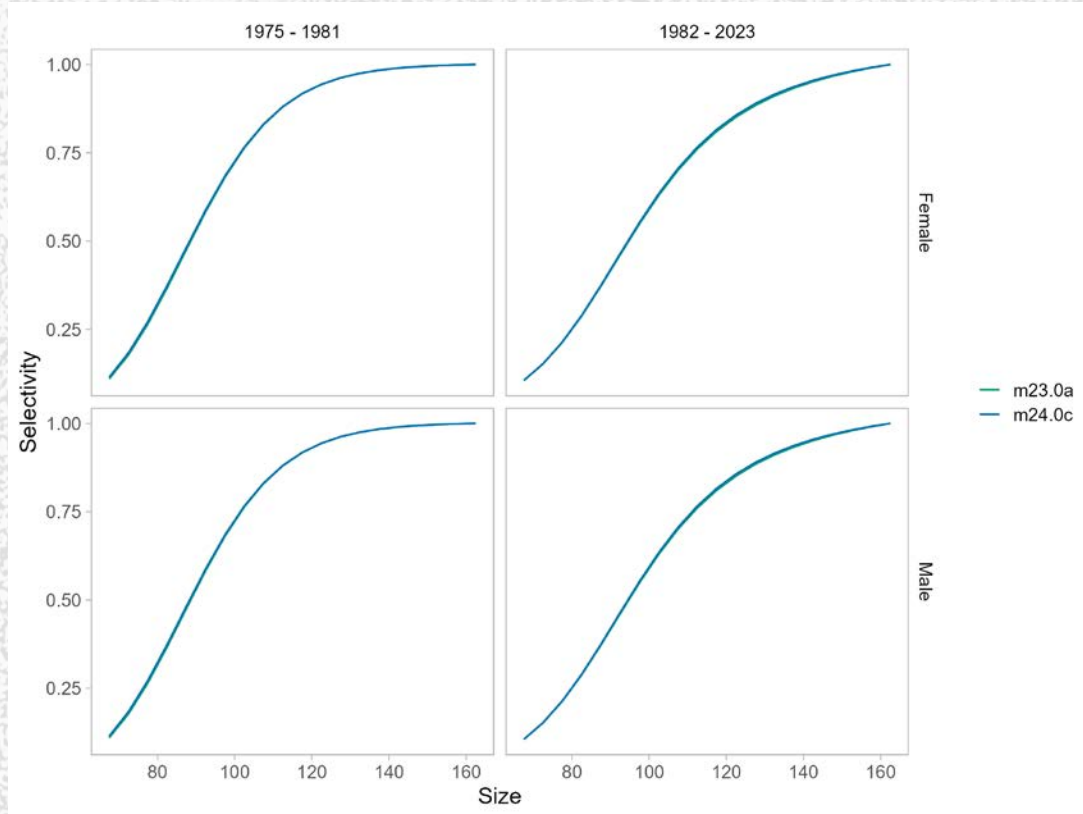
Natural Mortality

Table 13. Natural mortality estimates for the model scenarios during different year blocks.

Model	Sex	1975-1979, 1985 - 2024	
		1985 - 2024	1980-1984
23.0a	Females	0.27	1.16
	Males	0.23	1.01
24.0c	Females	0.26	1.16
	Males	0.23	1.01



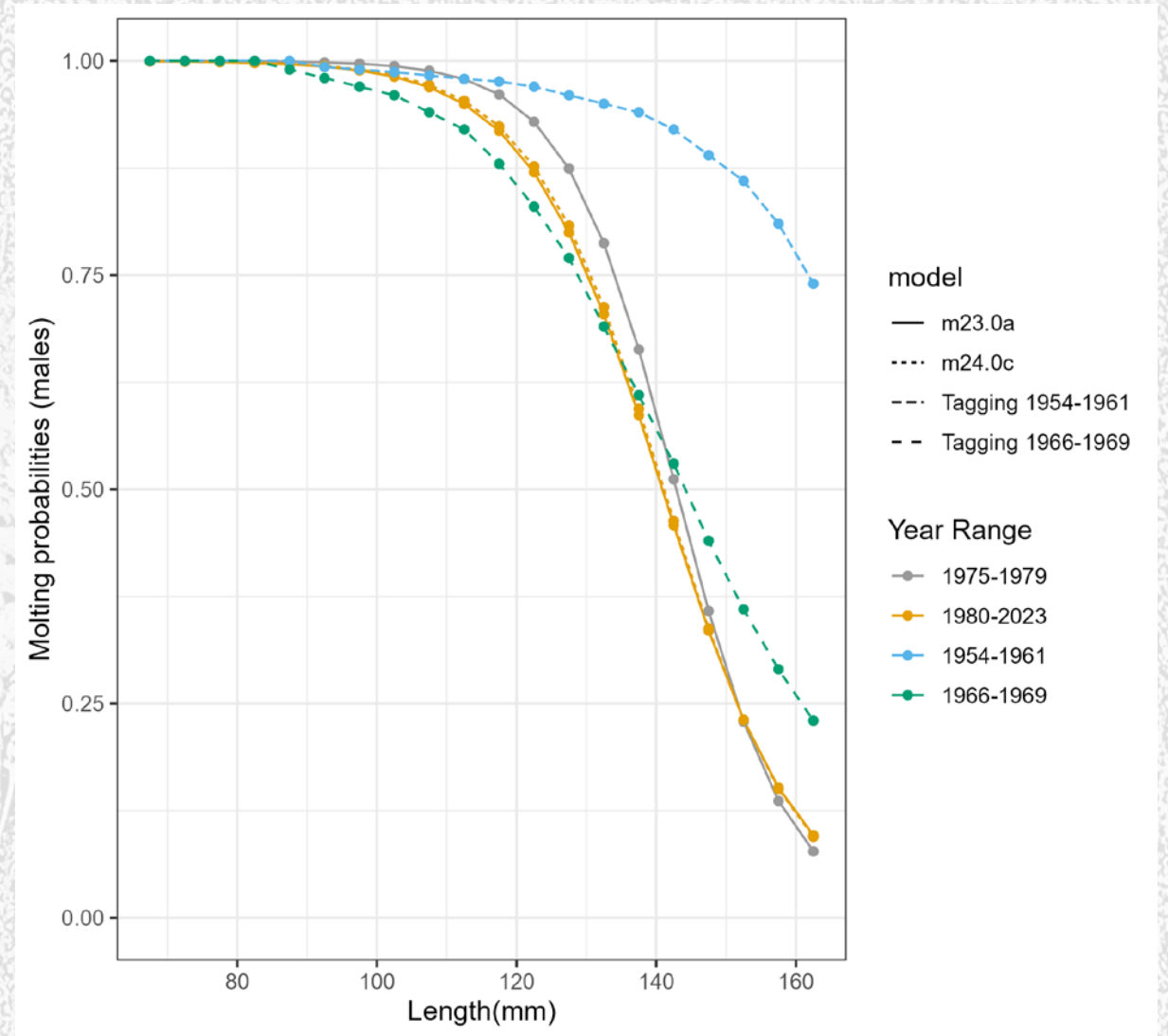
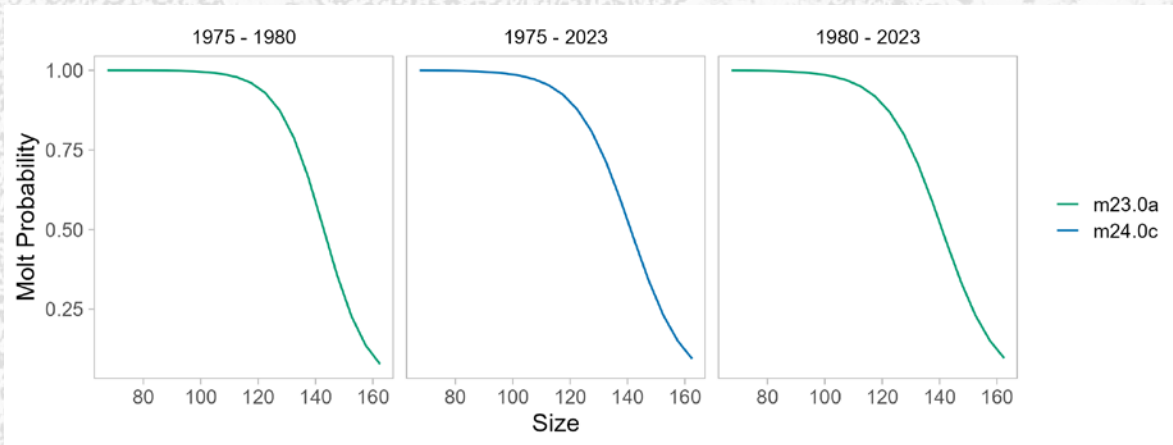
NMFS selectivity



- no differences between the two models

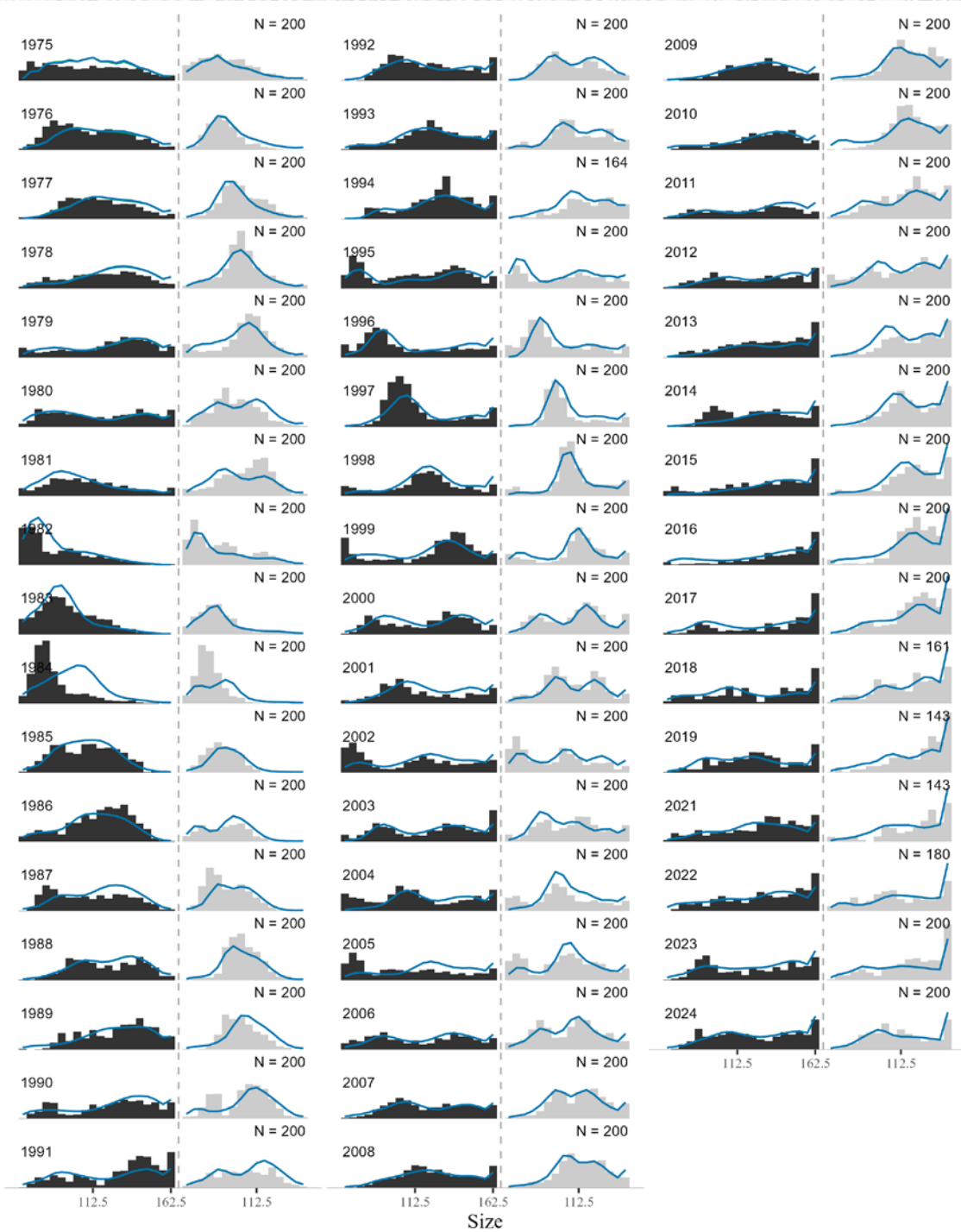
Molting probabilities

- Model 24.0c 1975 to 2023 molt prob almost exactly 1980 to 2023 molt prob from model 23.0a

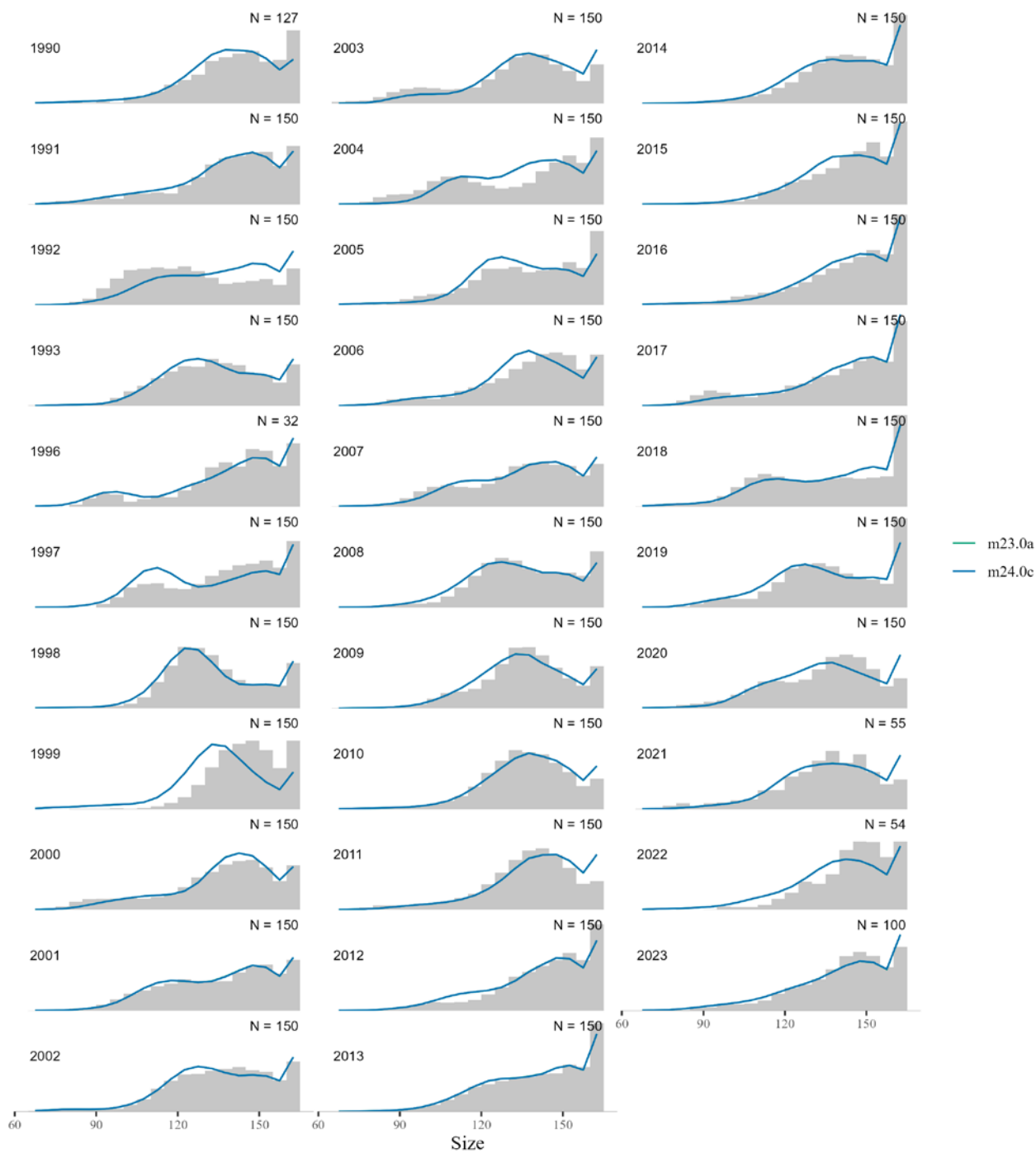


Size composition fit

- Similar for all models 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



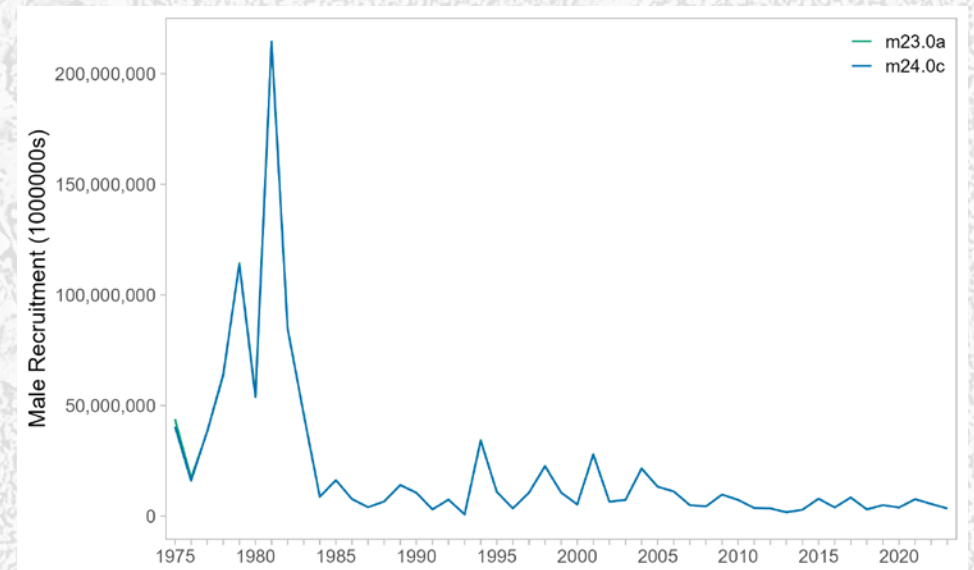
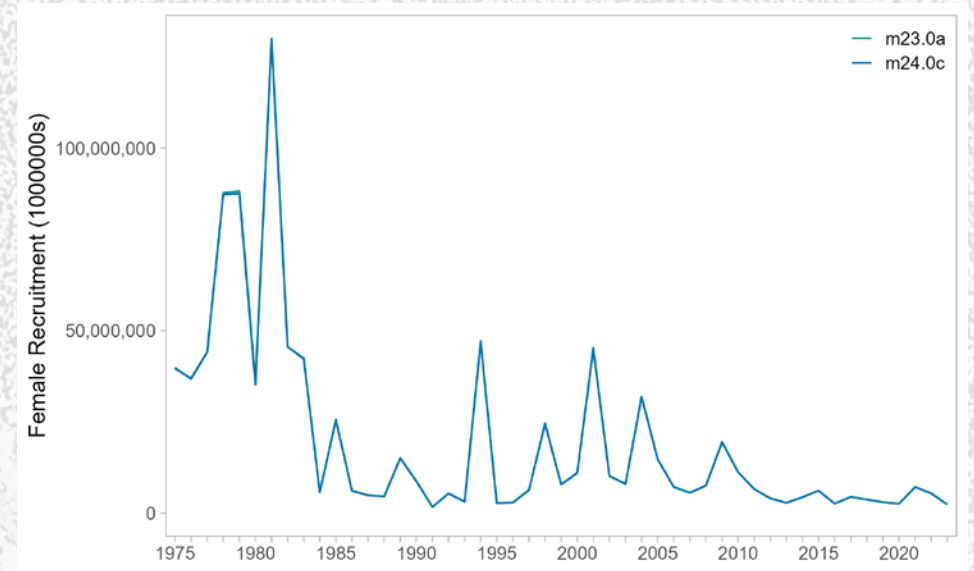
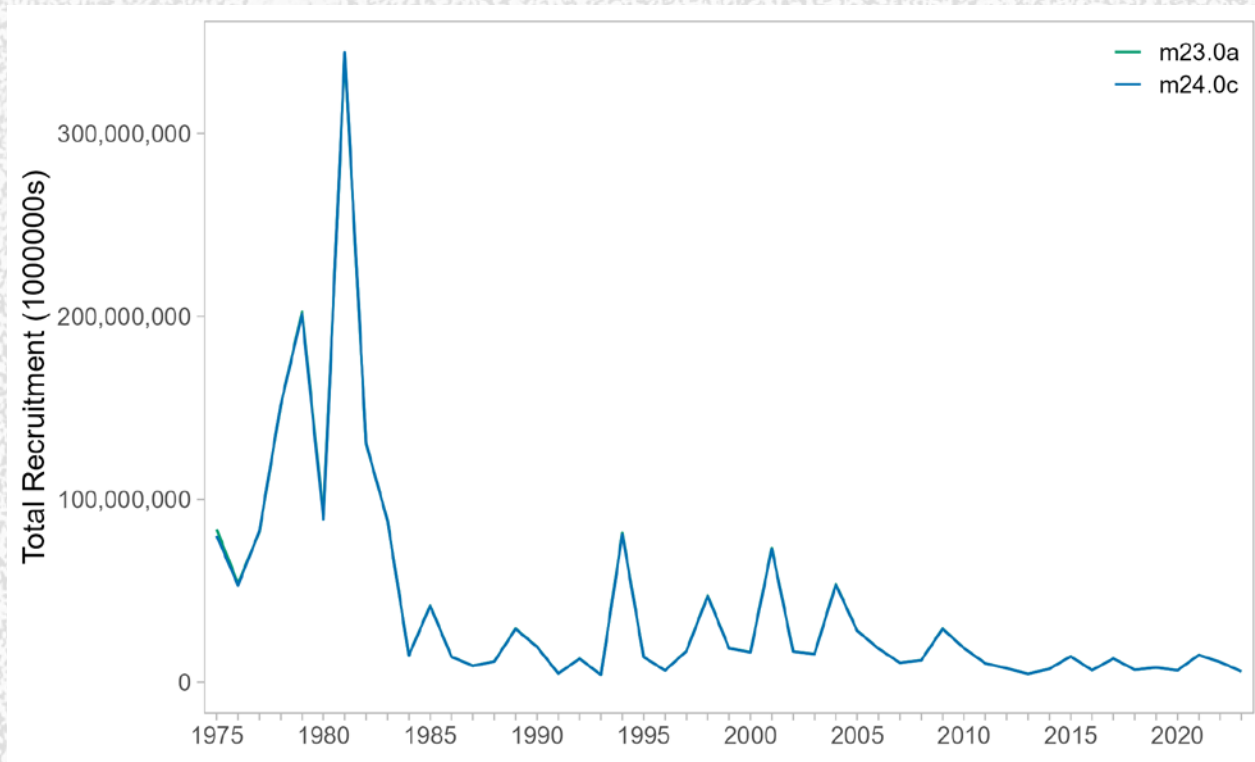
NMFS trawl
survey size comps
- males (1 black)
- females (2 gray)



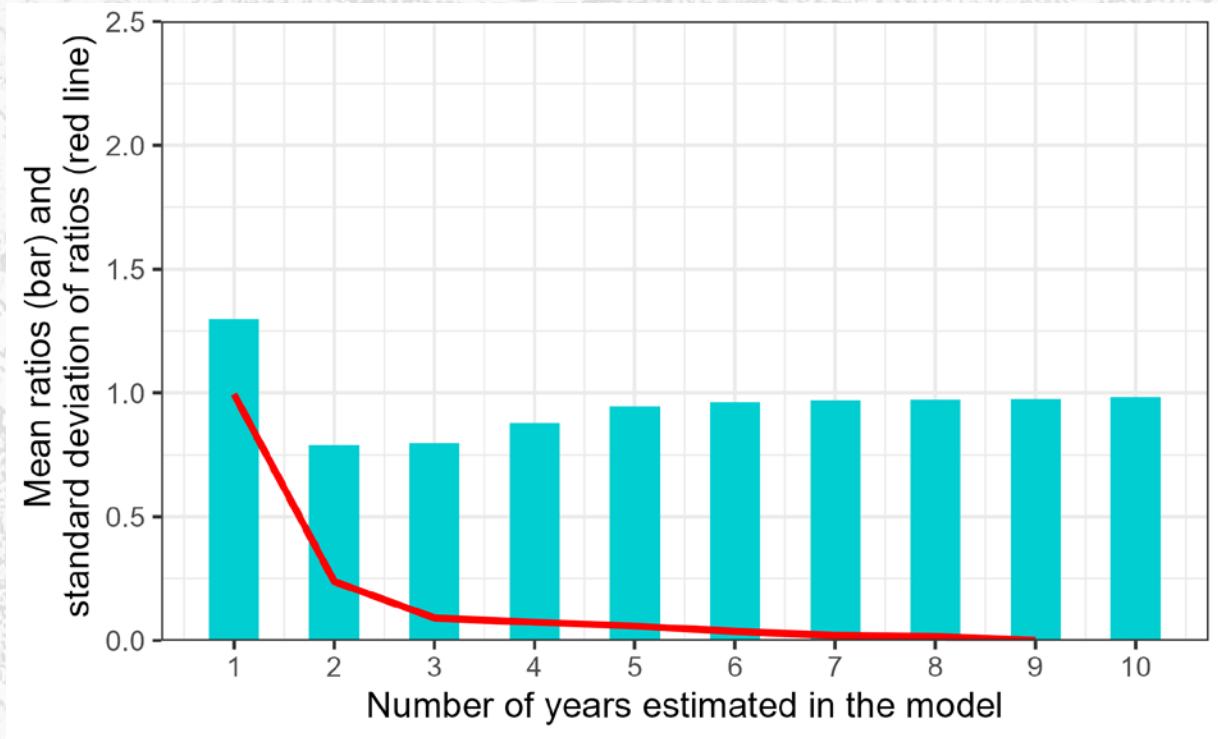
Directed fishery - total male size comps

m23.0a
 m24.0c

Recruitment



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



Prior density values and total negative likelihood values

Table 16: 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)	m24.0c
Pot-ret-catch	-61.52	-61.35
Pot-totM-catch	30.37	30.40
Pot-F-discC	-59.19	-59.19
Trawl-discC	-66.52	-66.52
Tanner-M-discC	-43.54	-43.54
Tanner-F-discC	-43.51	-43.51
Fixed-discC	-38.81	-38.81
Traw-suv-bio	-39.76	-39.35
BSFRF-sur-bio	-5.11	-5.00
Pot-ret-comp	-4086.55	-4084.32
Pot-totM-comp	-2523.23	-2523.39
Pot-discF-comp	-1546.61	-1546.63
Trawl-disc-comp	-6049.77	-6052.16
Tanner-disc-comp	-1276.34	-1276.39
Fixed-disc-comp	-3598.19	-3598.44
Trawl-sur-comp	-7290.66	-7288.60
BSFRF-sur-comp	-844.56	-844.58
Recruit-dev	74.51	74.44
Recruit-ini	0.00	0.00
Recruit-sex-R	80.42	80.45
Sex-specific-R	0.06	0.06
Ini-size-struct	33.76	33.22
PriorDensity	231.69	224.79
Tot-likelihood	-27123.07	-27128.41
Tot-parms	385.00	383.00
MMB35	18726.92	18690.28
MMB-terminal	15424.70	15426.58
F35	0.40	0.40
<i>Fofl</i>	0.32	0.32
OFL	5017.68	5021.76

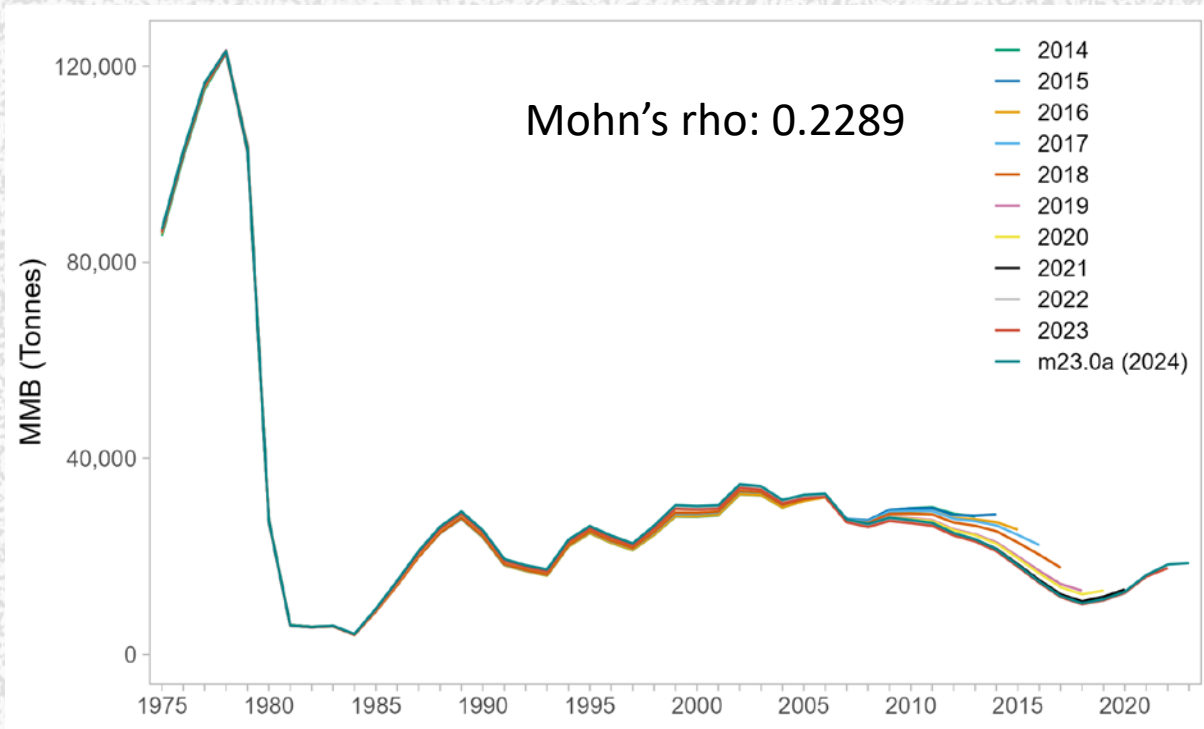


Retrospective analysis and projections

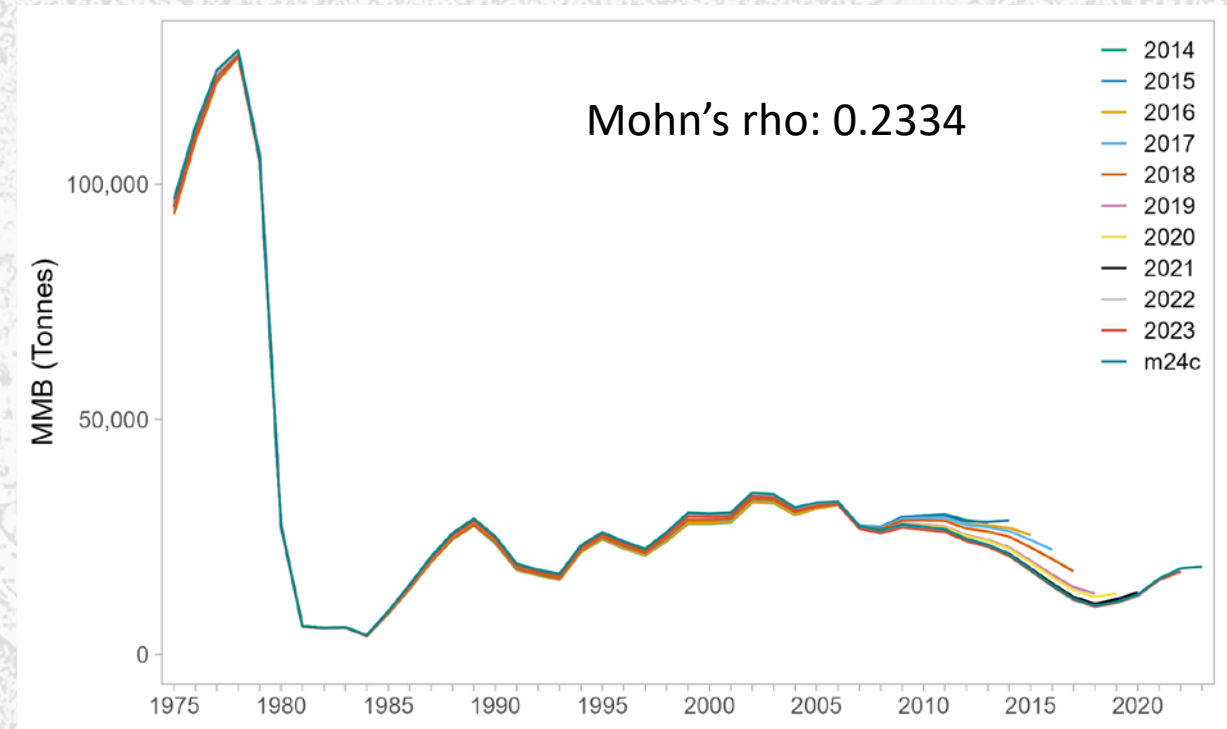
- Retrospective analysis – done for all model runs
- Jitter – run on all models, >90% of jitter runs converged to MLE and those that didn't were worse model fits
- MCMC runs to look at model variability
 - Performed on all models - model 24.0c highlighted here
 - Other models were similar, nothing unexpected in results
- Projections
 - To inform population trajectory and the probability of “approaching an overfished condition”
 - Used low recruitment since 2013

Retrospective patterns

Model 23.0a

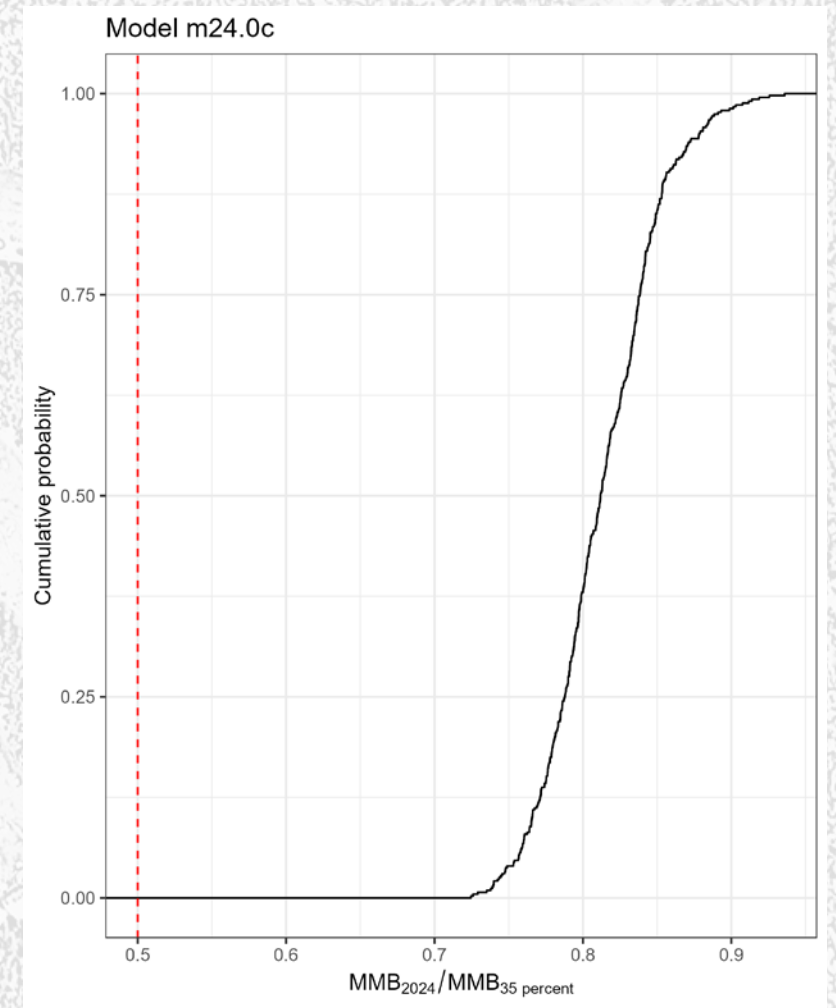
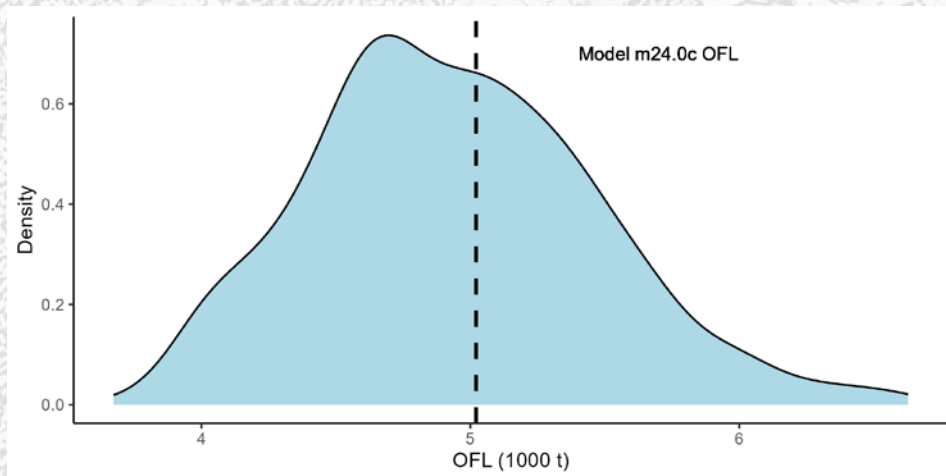
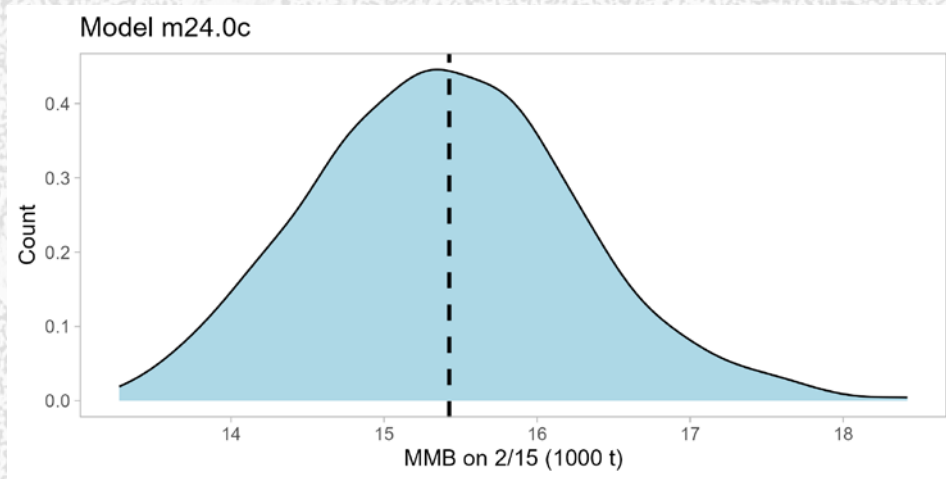


Model 24.0c

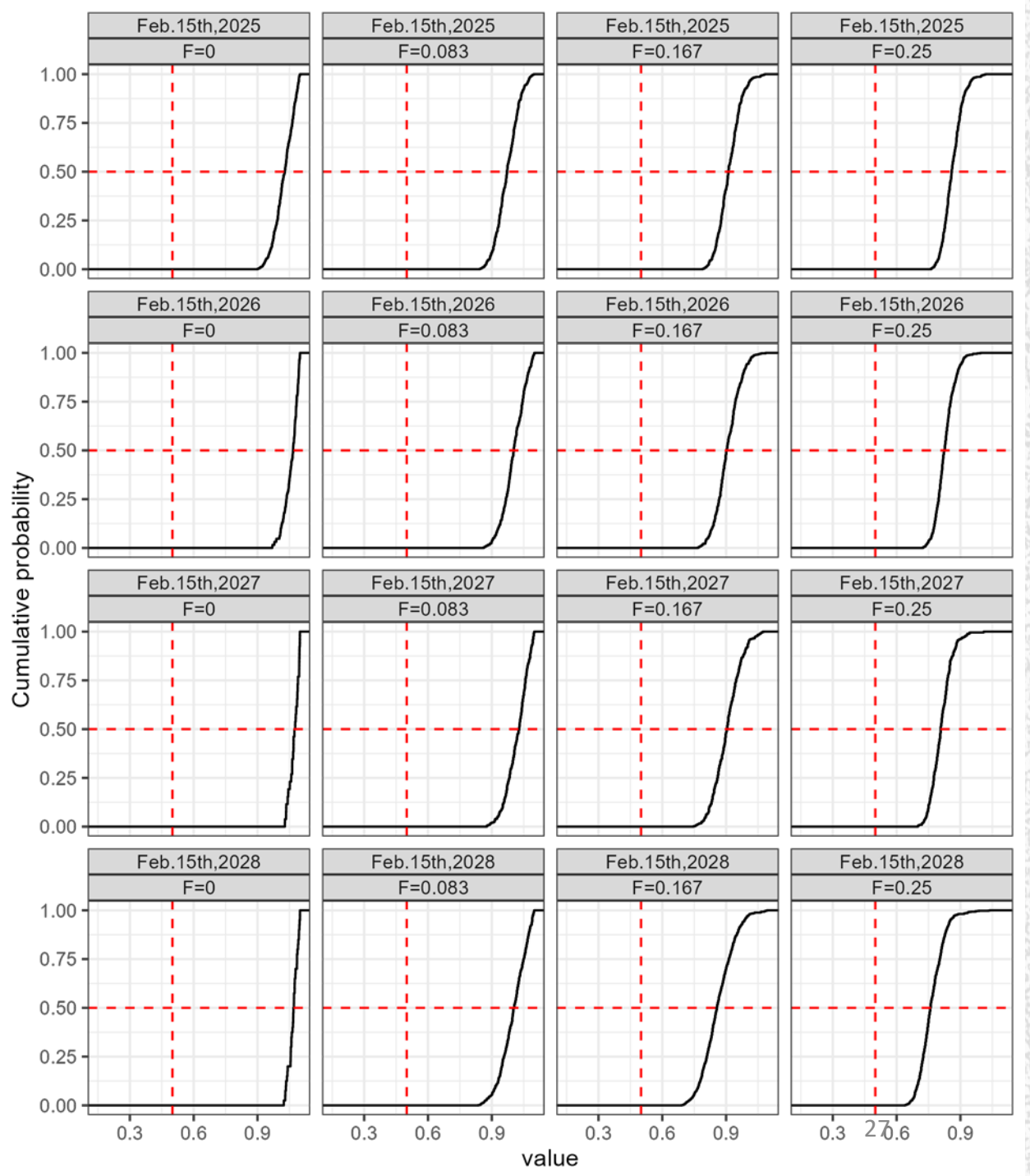
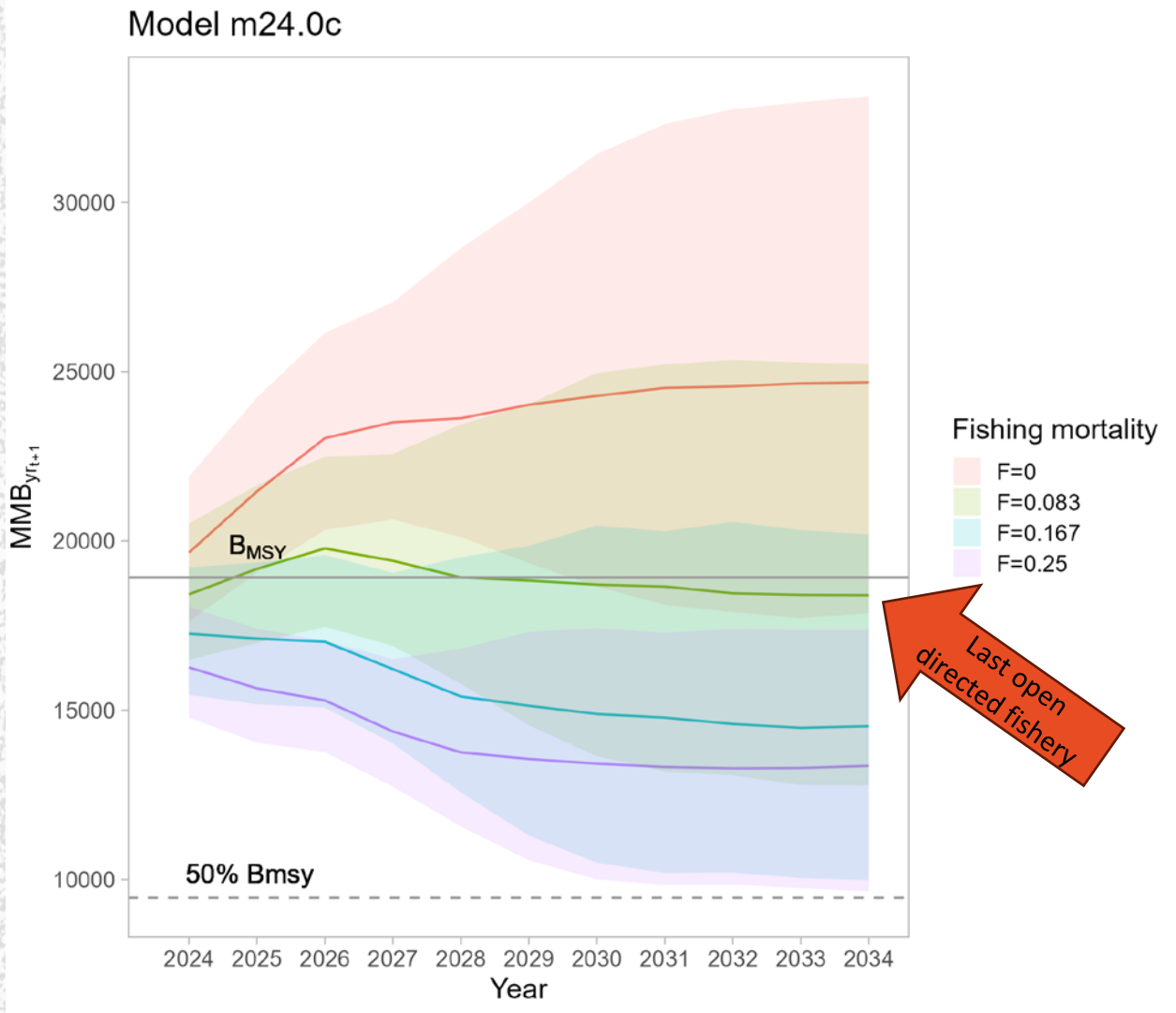


MCMC output (Model 24.0c)

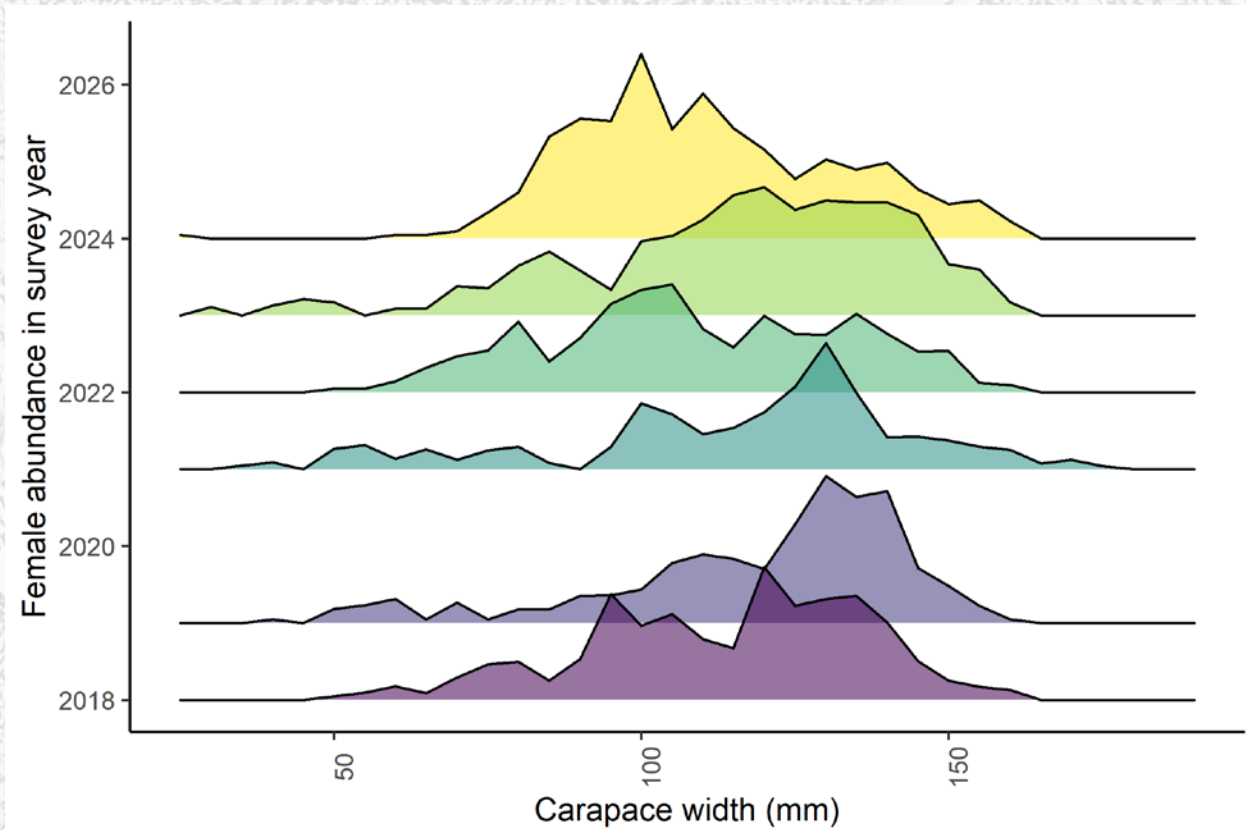
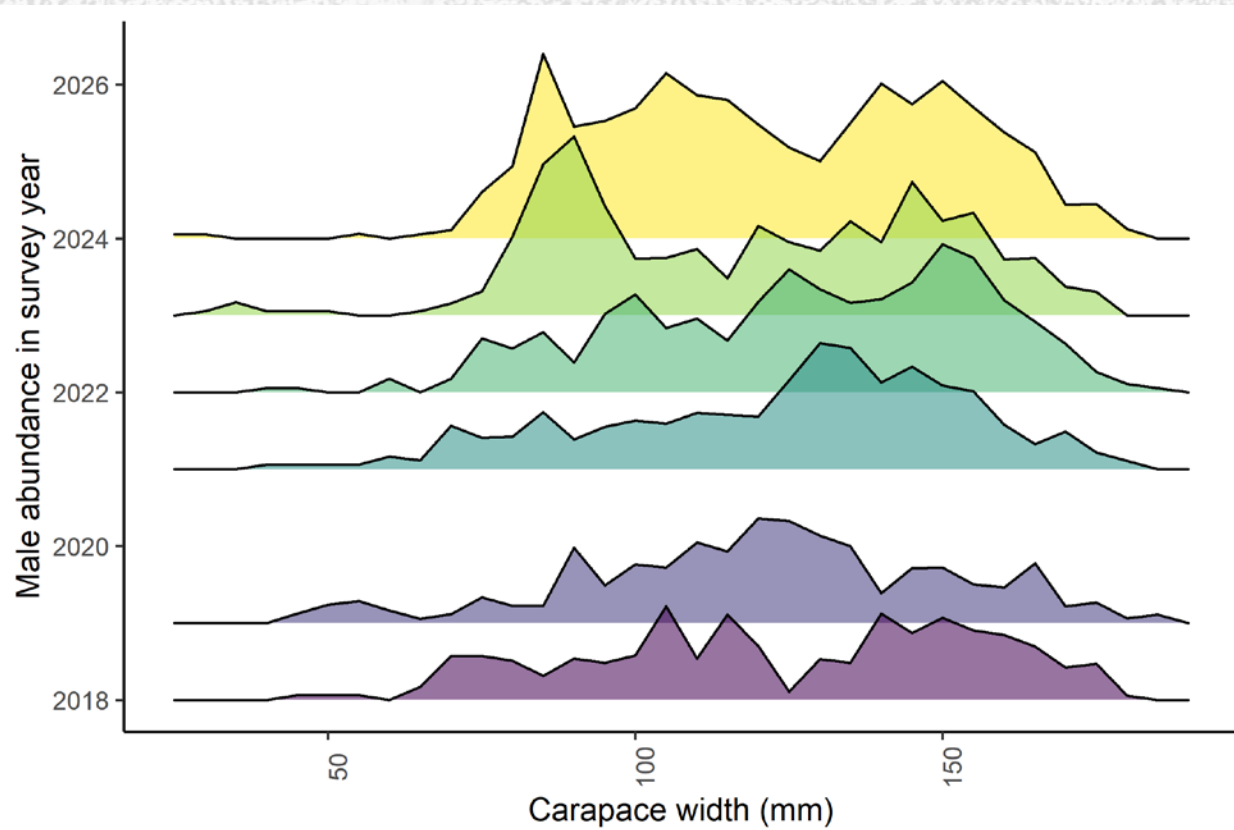
Cumulative probabilities of estimated ratios of MMB in 2024 (Feb. 15th, 2025) to corresponding estimated $B_{35\%}$ values under model 24.0c with the MCMC approach.



Projections for future status (24.0c MCMC output) [2024 = projected MMB Feb 15th, 2025]



Last 6 years of size compositions NMFS survey data



Summary & Recommendations

- Models have similar output
- Trend in mature male biomass similar
- Stock is not overfished in 2024 and not likely “approaching an overfished condition” in the next two years
- Recommend model 24.0c or reference (base) model 23.0a for status determination
 - Author recommended is model 24.0c

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

Year	MSST	Biomass (MMB_{mating})	TAC	Retained Catch	Total Catch	OFL	ABC
2020/21	12.12	13.96	1.20	1.26	1.57	2.14	1.61
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		15.43				5.02	4.02

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

Year	Tier	B_{MSY}	Biomass (MMB_{mating})	B/B_{MSY}	F_{OFL}	Basis for B_{MSY}	Natural mortality
2020/21	3b	25.4	14.9	0.59	0.16	1984-2019	0.18
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

All model specifications

Table 14: 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	MMB/B_{MSY}	F35	F_{OFL}	OFL	Avg Male Rec	Male M
m23.0a	15.42	18.73	0.82	0.40	0.32	5.02	9.88	0.23
m24.0c	15.43	18.69	0.83	0.40	0.32	5.02	9.84	0.23



Buffer considerations

- Current at 20% - recommend 20% for upcoming year (no large changes or improvements in uncertainty)
- Cold pool distributional shifts
- Declining trend or low levels of mature male biomass and mature female biomass
- Lack of recruitment events
- Retrospective pattern

BBRKC

Draft Risk Table Evaluation in 2024 (App D)



Assessment-related considerations	Population dynamics considerations	Environmental/ecosystem considerations	Fishery Performance
<p>Strong retrospective pattern in MMB (high Mohn's rho)</p> <p>Stable GMACS reference model since 2018</p> <p>Historic natural mortality even (early 80s)</p> <p>Conclusion: Level 1, No increased concerns</p>	<ul style="list-style-type: none"> - Low, recent recruitment (last 10+ years) - Unknown reasons behind recruitment failure - Potential shifting spatial distributions - Low mature female abundance the last few years <p>Conclusion: Level 2, increased concerns</p>	<ul style="list-style-type: none"> - Steady decline in bottom water pH in last two decades - Predation risk higher for juvenile crab (i.e. sockeye salmon) - Poor larval feeding conditions due to competition and low chlorophyll a - Slight increase in mature females with empty clutches <p>Conclusion: Level 1, No increased concerns</p>	<ul style="list-style-type: none"> - Fishery closure 21/22 and 22/23 - 23/24 CPUE was similar to last open season 20/21 - Bycatch at recent average levels <p>Conclusion: Level 1, No increased concerns</p>

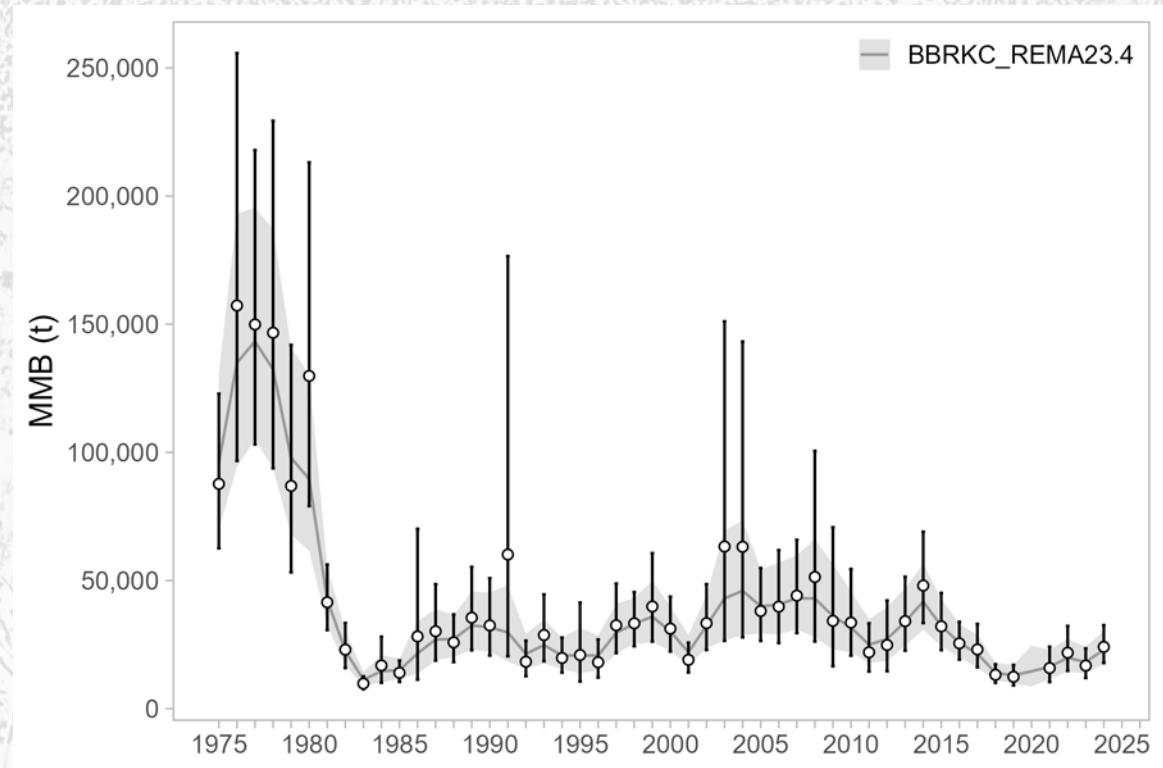
Should this be changes in concern or reflect current concerns? 1 or 2????

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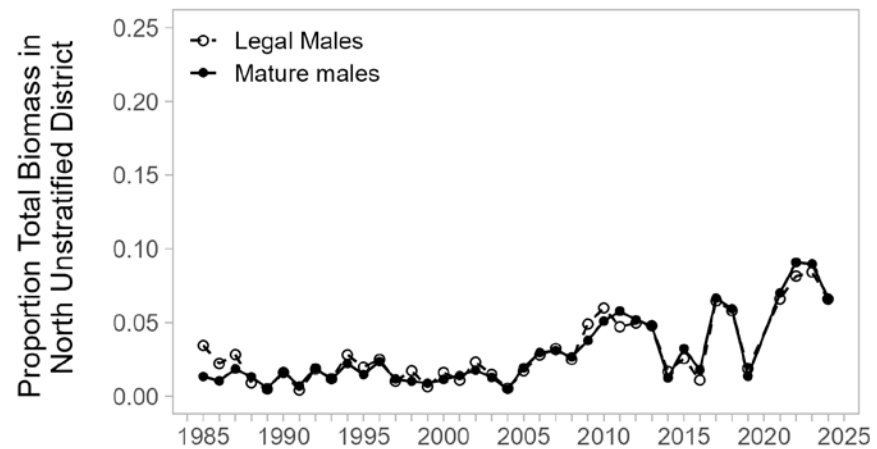
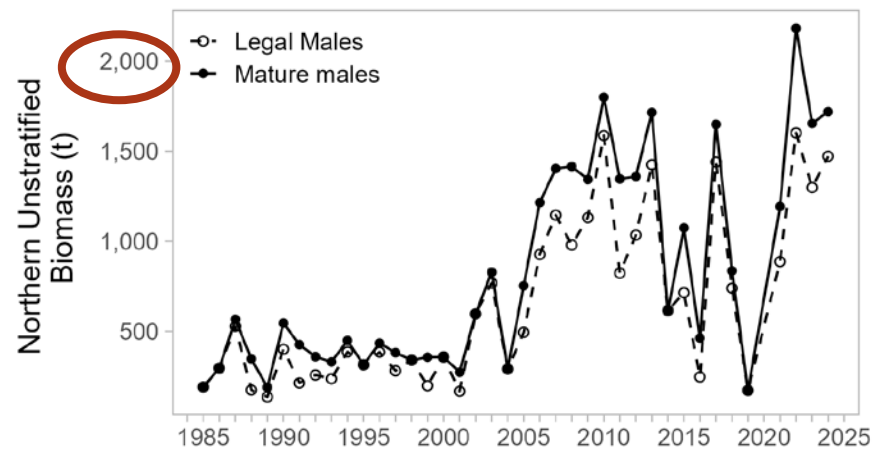
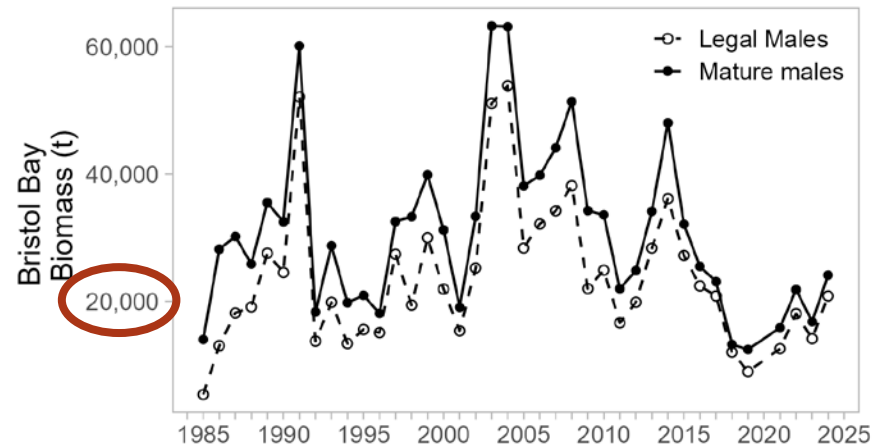
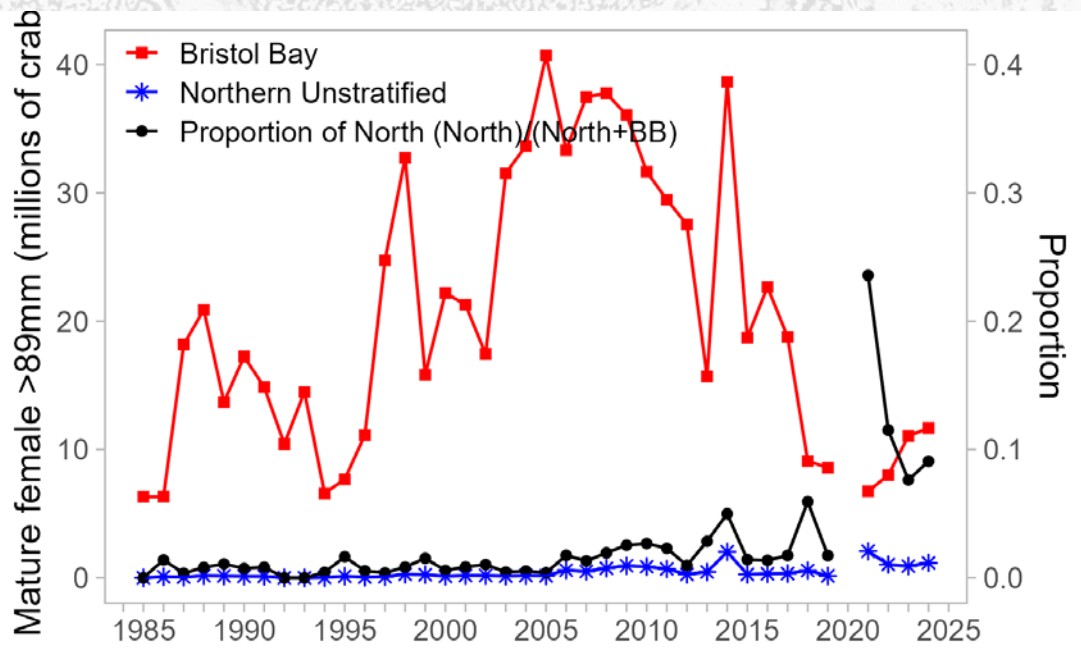
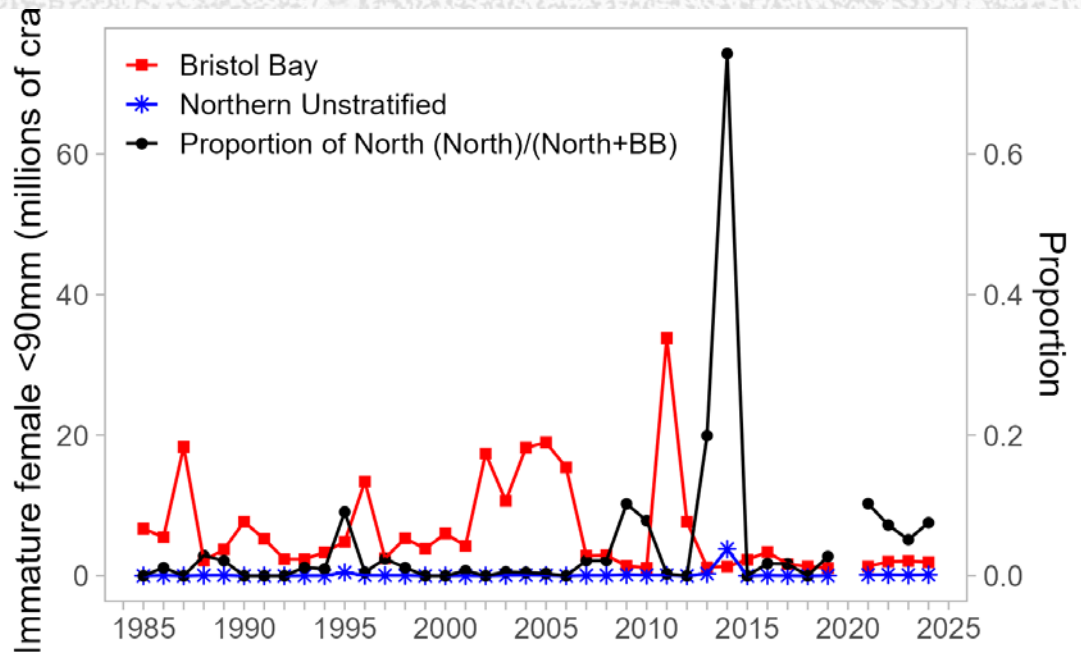
Product 2023 recommended ABC = 80% of ma

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 2023 (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
27.94	22.98	0.82	0.23	0.18	4.24	3.39	3.60



Thanks!

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

