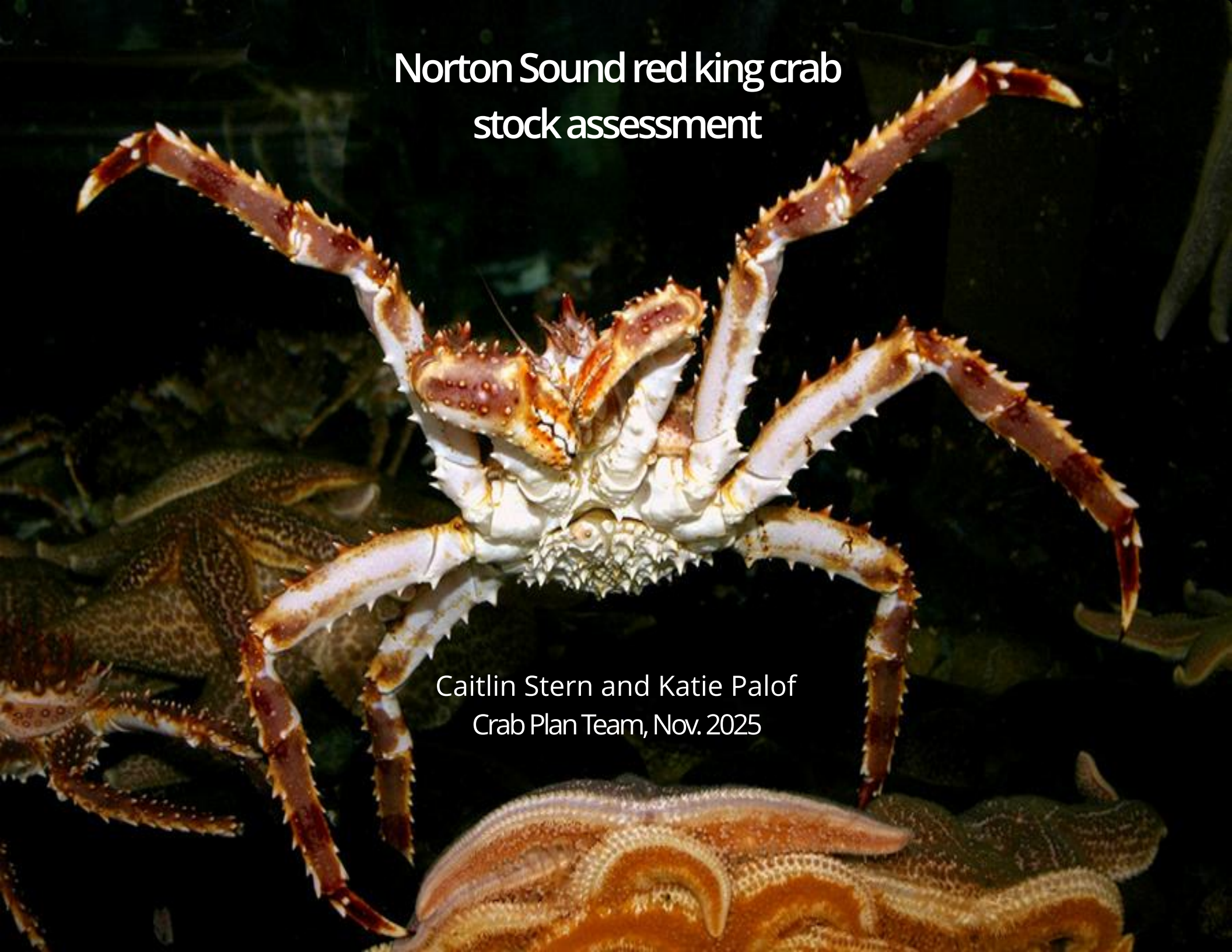
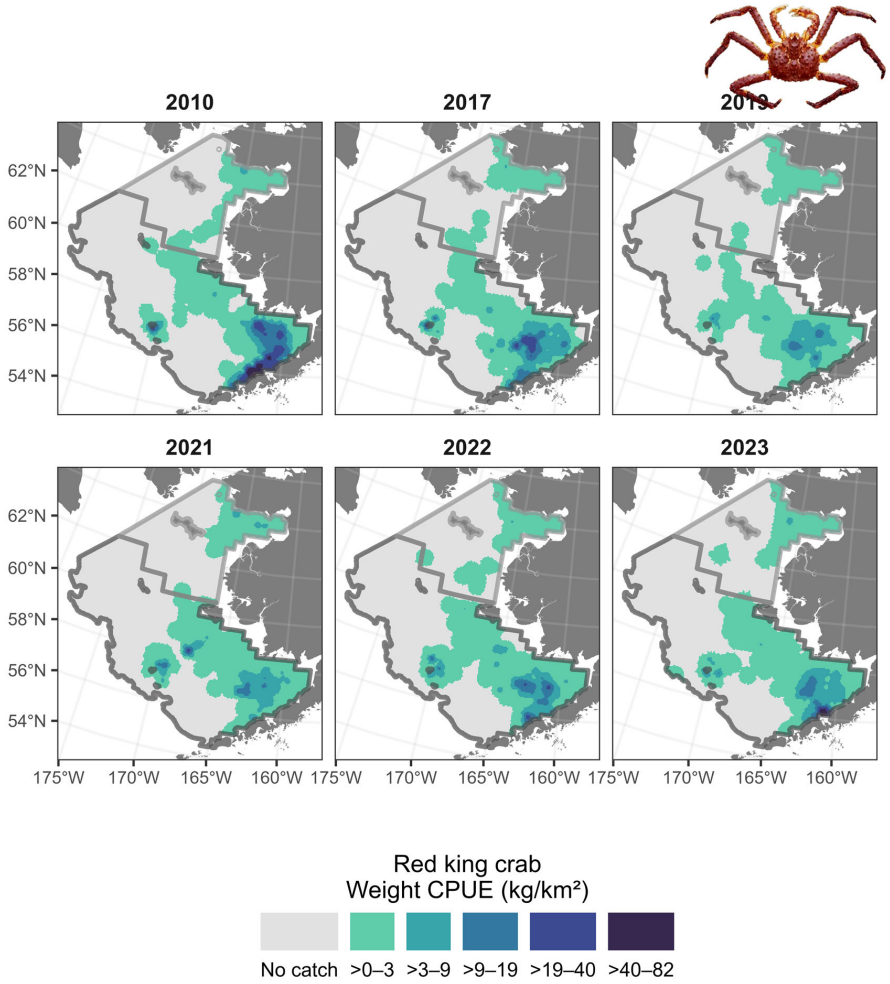
Norton Sound red king crab stock assessment



Caitlin Stern and Katie Palof
Crab Plan Team, Nov. 2025

Norton Sound red king crab stock



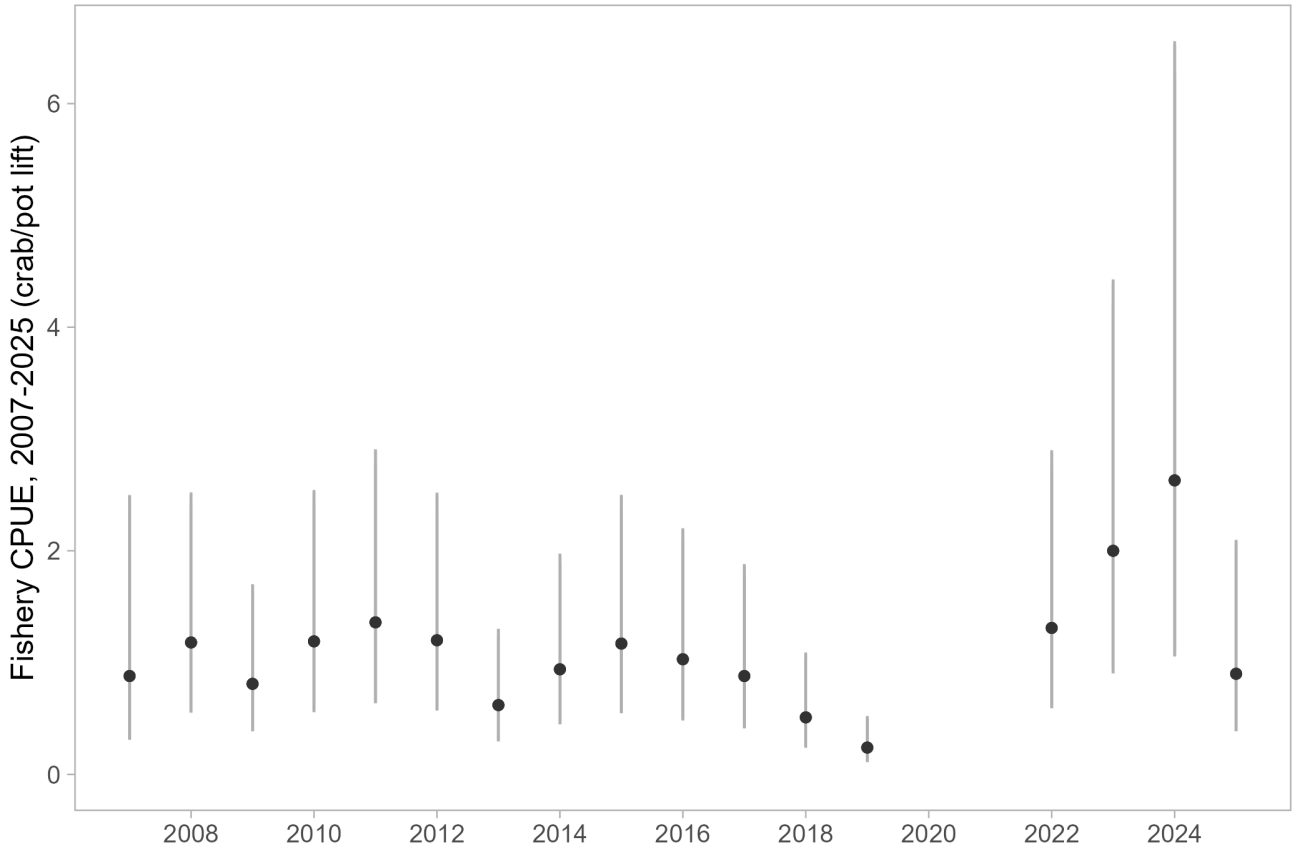
Norton Sound red king crab fisheries

Commercial: summer small vessel and winter through the ice

Subsistence: year-round

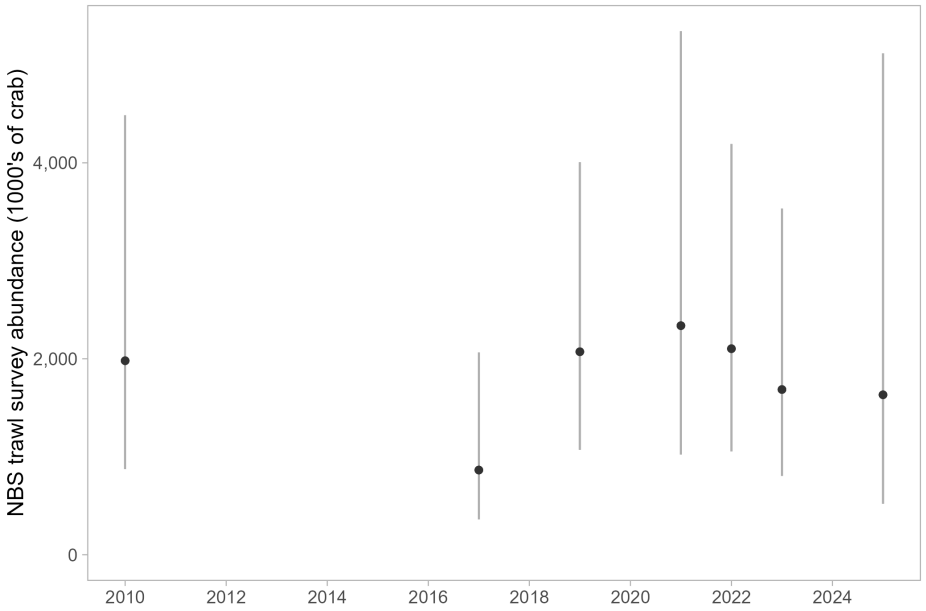
Photos: Johnnie Noyakuk, Scott Kent

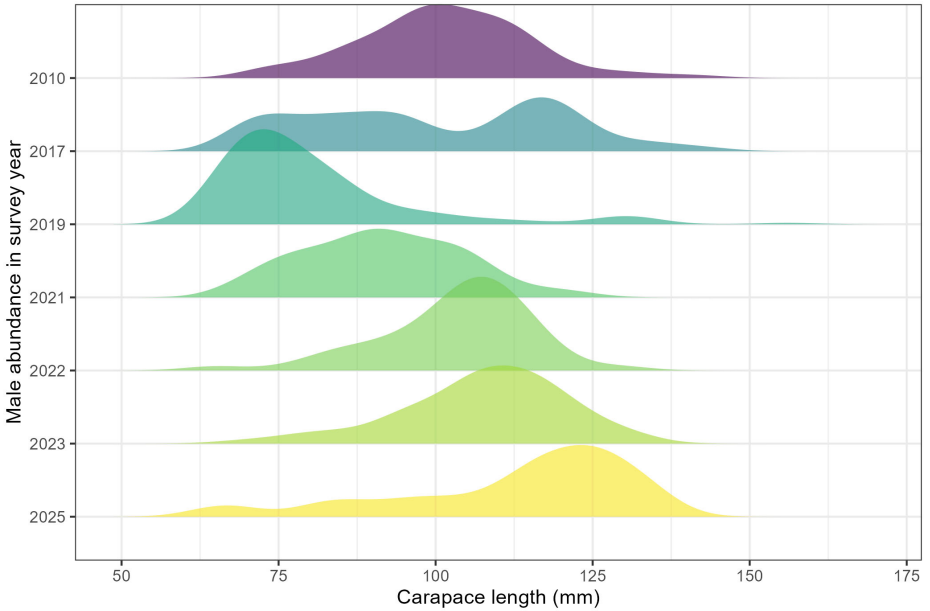
2025 data updates: fishery CPUE



Standardized CPUE in the 2025 summer commercial fishery (0.9 crab/potlift) was down 57% from 2024 (2.1) and 22% below the time series mean (1.16)

2025 data updates: NOAA NBS survey





Estimated abundance in the 2025 NBS survey was down 3% from 2023 and 10% below the time series mean

Size comps show recruitment pulse moving through population

Other 2025 data updates

- winter subsistence fishery total and retained catch
- winter commercial fishery retained catch
- summer commercial fishery retained catch and size comps

Models 24.0b - May and 24.0b compared: no unexpected effects of adding 2025 data

Base model: 24.0b

- males $\geq$ 64 mm only, 8 size classes
- catch: winter com. retained, sub. retained, sub. total, summer com. retained
- relative abundance: 3 trawl surveys, standardized summer com. fishery CPUE in 3 time blocks
- size comps: winter com. retained, summer com. retained, summer com. discards, summer com. total, 3 trawl surveys, winter pot survey (all include shell condition)
- size-dependent M = 0.18 for males with CL $\leq$ 123 mm, est. for CL $>$ 123 mm (2 largest size bins)
- fishery selectivity: logistic for summer com., dome-shaped for winter com. and subsistence (mirrored to winter pot survey)
- trawl survey selectivity: only estimated for NOAA NS trawl survey, other trawl survey selectivities mirrored to that value. Estimated trawl survey selectivity = 1 for all size classes
- survey catchability = 1 for ADF&G trawl survey, estimated for other trawl surveys and fishery CPUE indices

SSC and CPT comments

Include models 24.0b and 25.0a (no shell condition, M = 0.23 for males $\leq$ 123 mm)

These models are included in the SAFE

Address unrealistically high values of F estimated for the winter commercial fishery by placing a prior in F, or exploring alternative parameterizations of selectivity

Models 24.0b6 and 25.0a1 use a prior on *F*
Models 24.0b7 and 25.0a2 have an alternative parameterization of selectivity

Develop model-based indices of abundance in a research model framework

Progress presented at the Sept. 2025 CPT; further updates to come in 2026

Prior on *F* for winter comm. fishery

Models 24.0b, 24.0b7, 25.0a, 25.0a2:

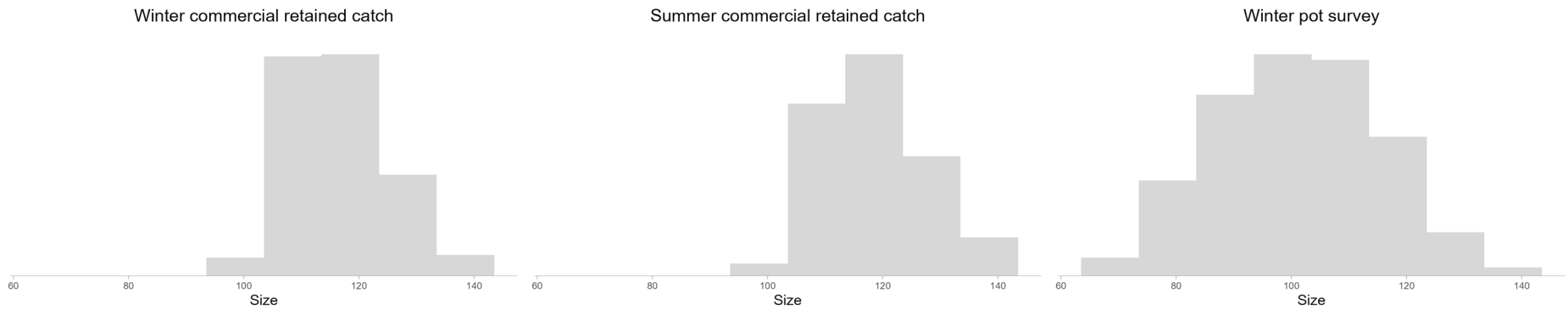
- Lower annual male *F* = -10.0
- Upper annual male *F* = 10.0

Models 24.0b6 and 25.0a1:

- Lower annual male *F* = -10.0
- Upper annual male *F* = 2.95

2.95 value used for the BBRKC directed pot fishery

Alternative selectivity configurations



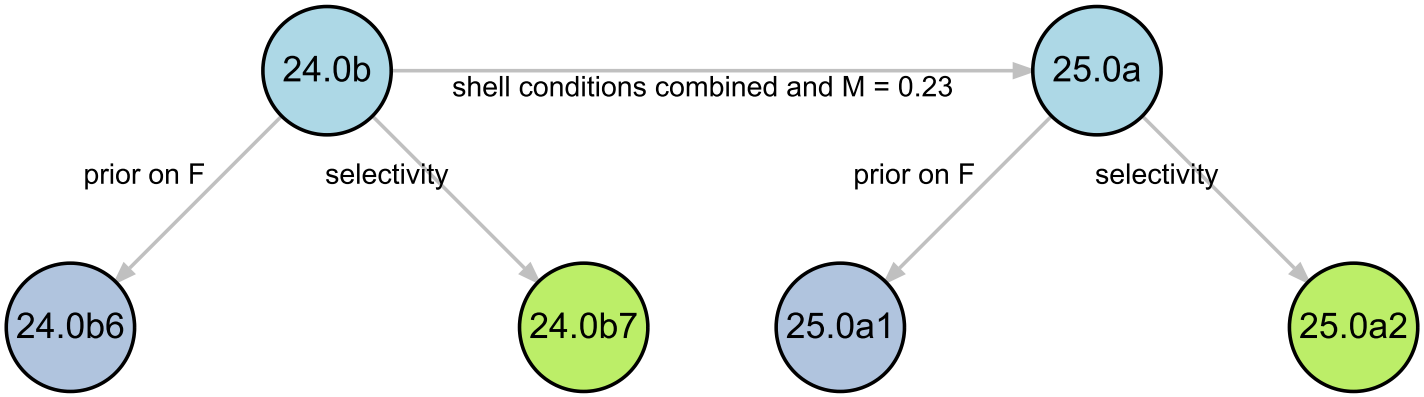
Models 24.0b, 24.0b6, 25.0a, 25.0a1

Summer commercial fishery slx: logistic function of length
Winter pot survey slx: dome-shaped
Winter commercial and subsistence fisheries: mirrored to winter pot survey

Models 24.0b7 and 25.0a2

Summer commercial fishery slx: logistic function of length
Winter pot survey slx: dome-shaped
Winter commercial and subsistence fisheries: mirrored to summer commercial

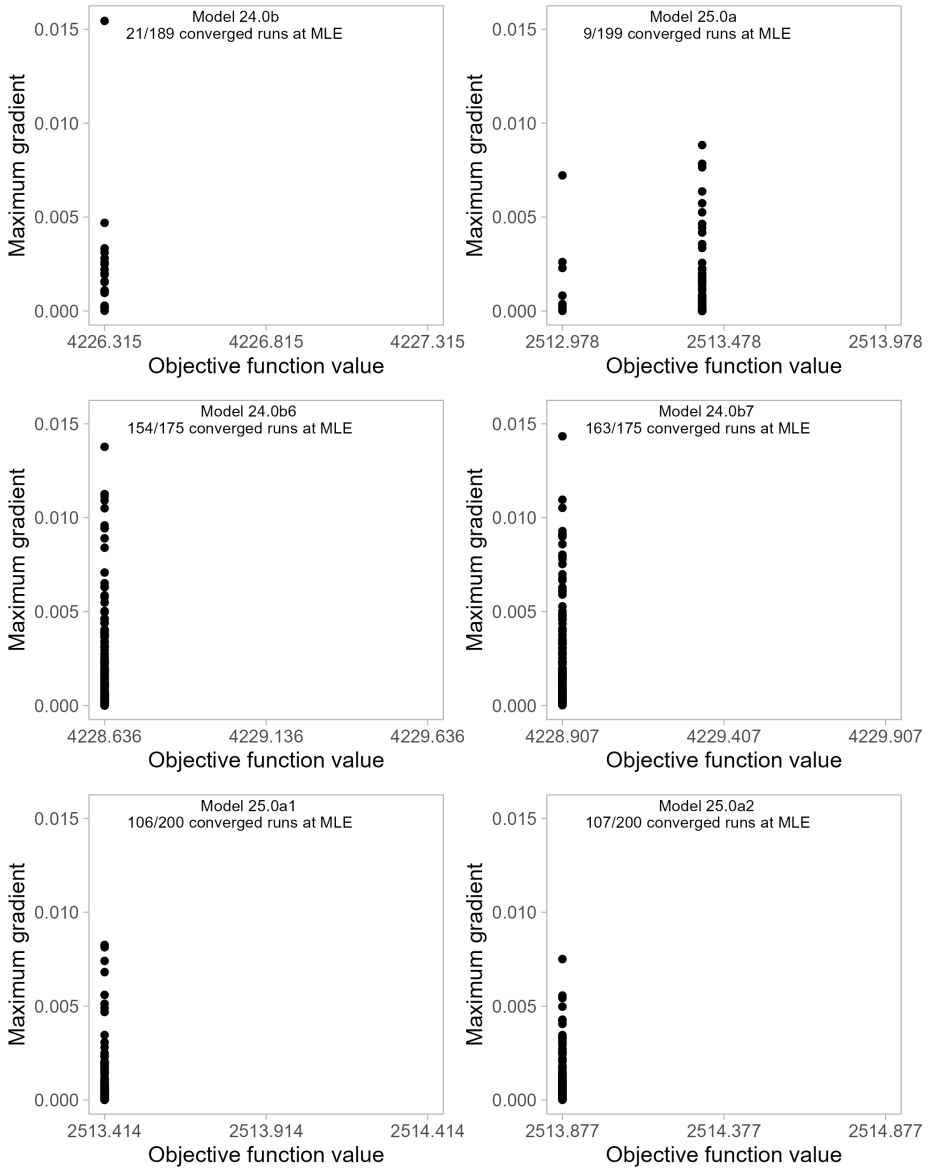
Models flow chart



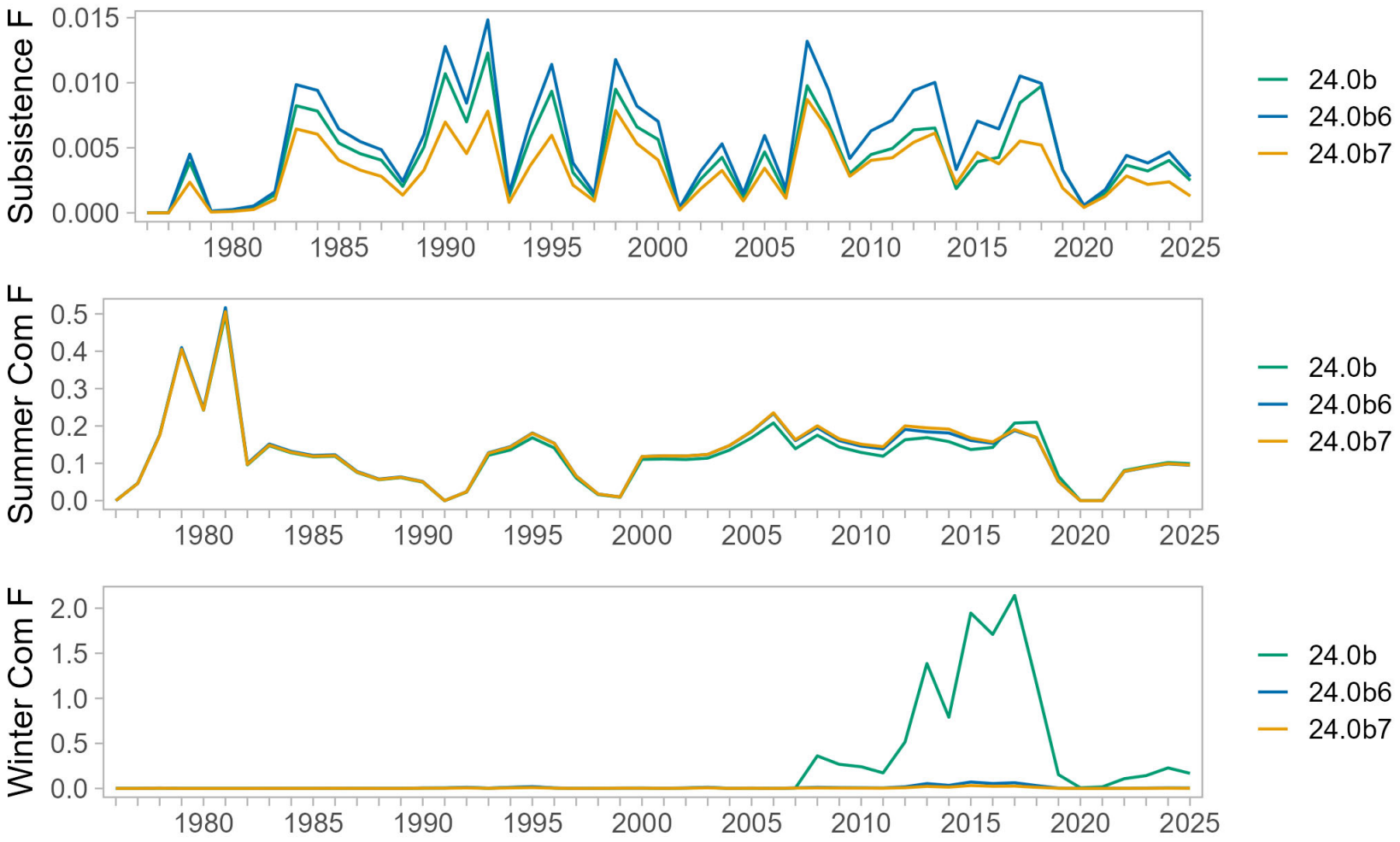
Model results

- Jittering analyses
- Fishing mortality, fishery selectivity, natural mortality
- Fits to time series: catch, indices, size comps
- Recruitment, MMB
- Stock projections
- Reference points

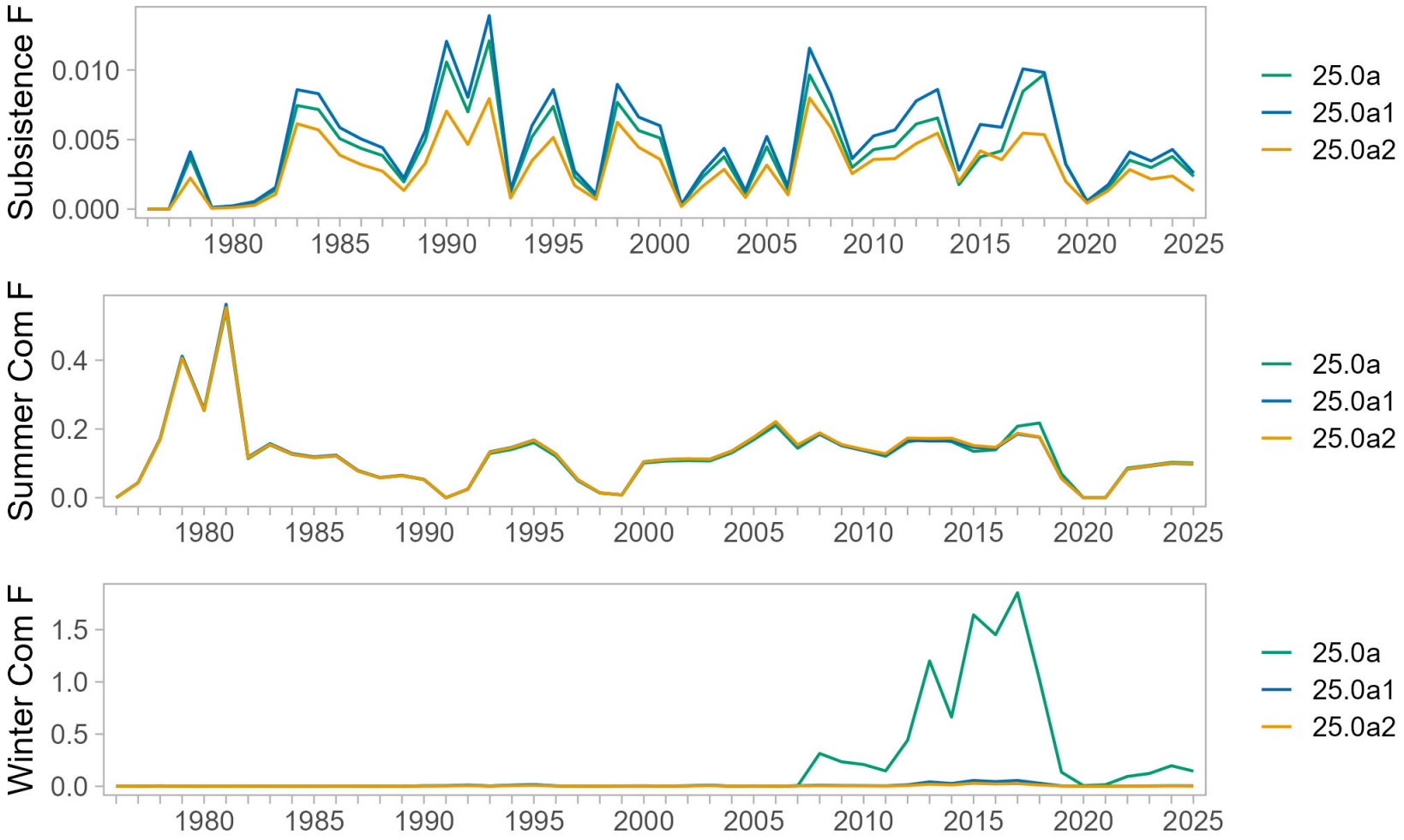
Jittering analyses



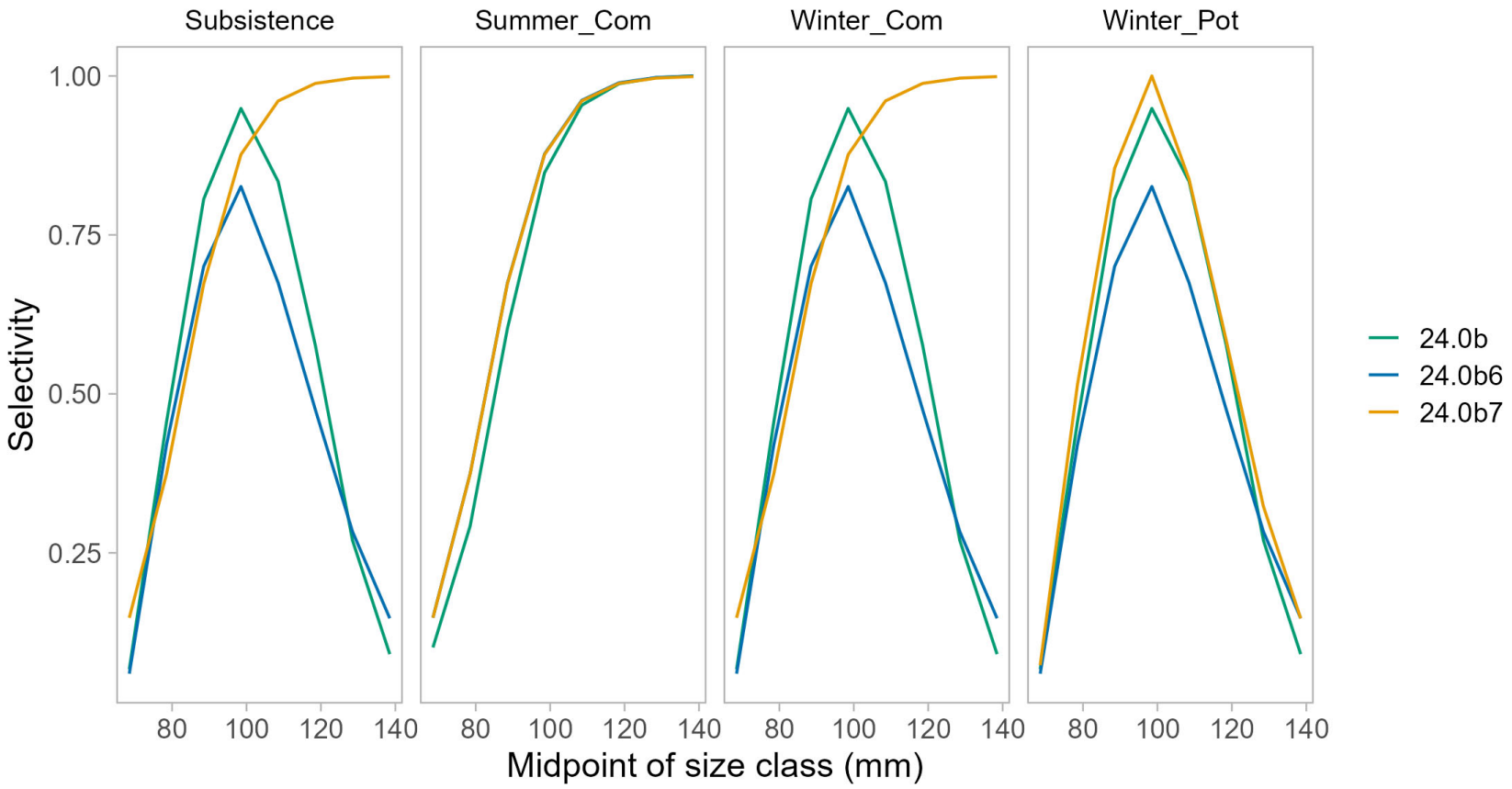
Fishing mortality - 24.0b models



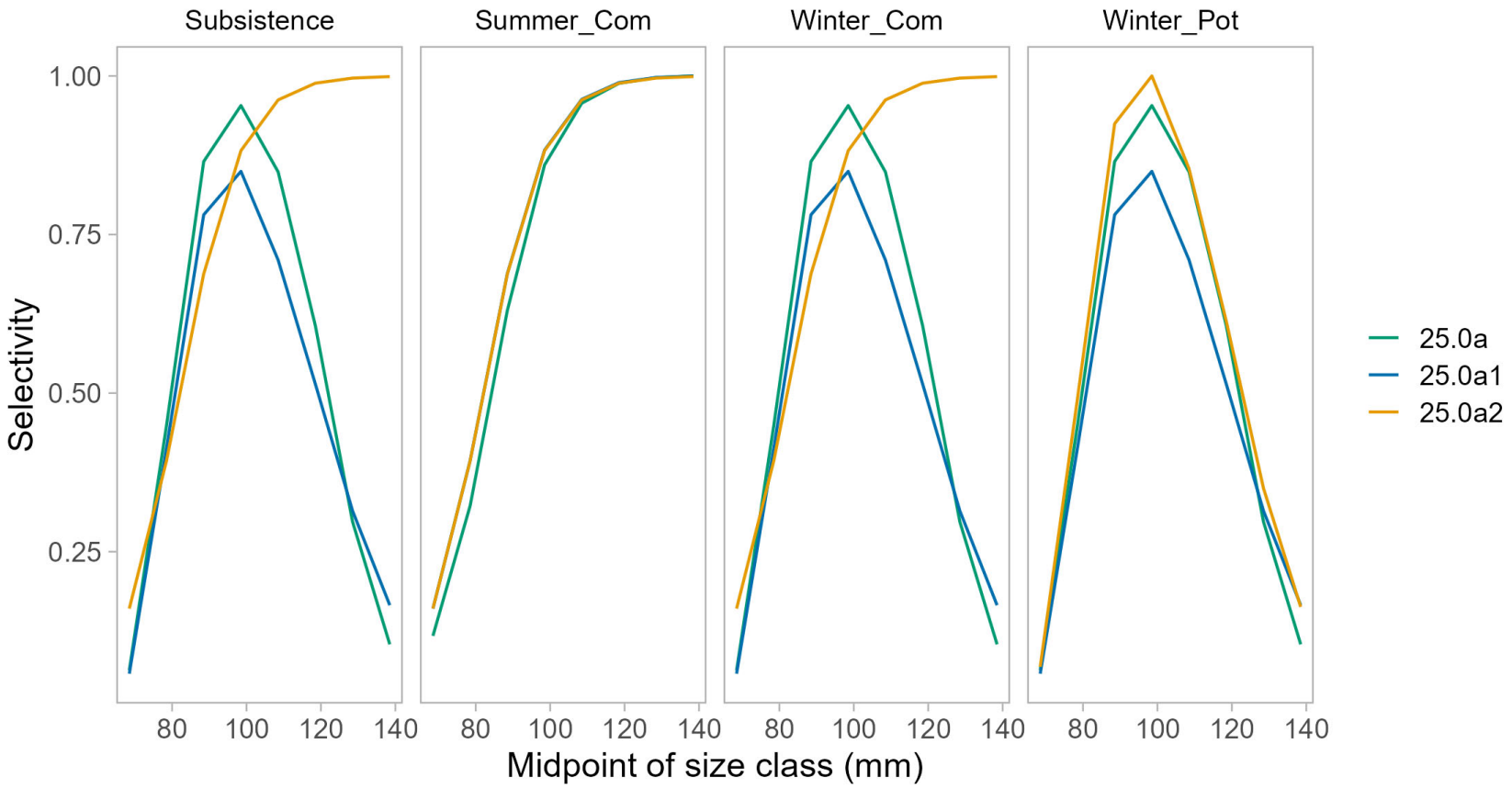
Fishing mortality - 25.0a models



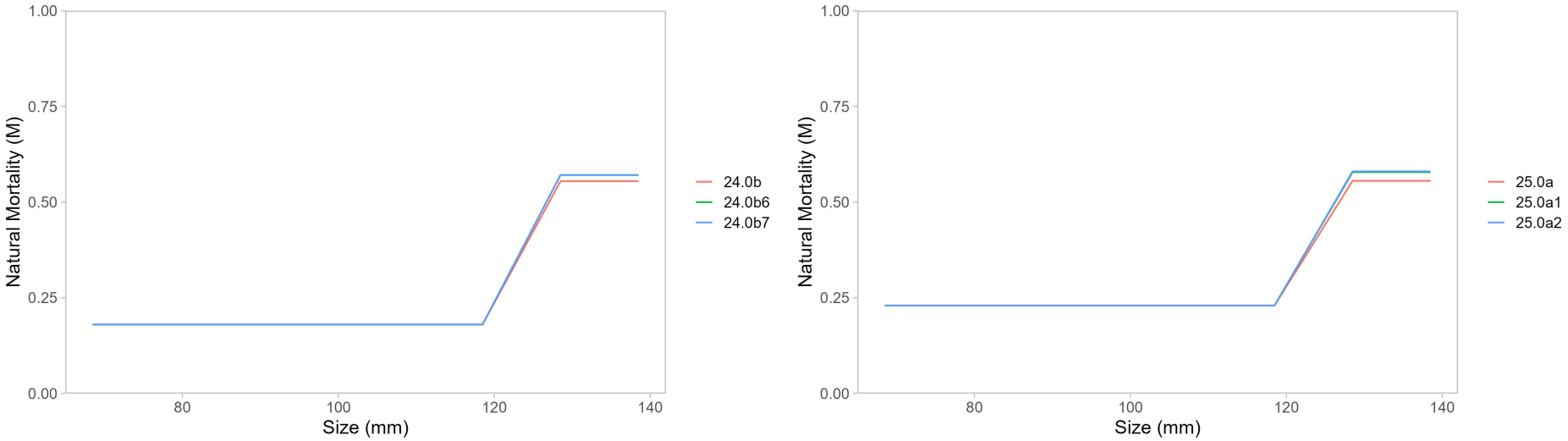
Fishery selectivity - 24.0b models



Fishery selectivity - 25.0a models



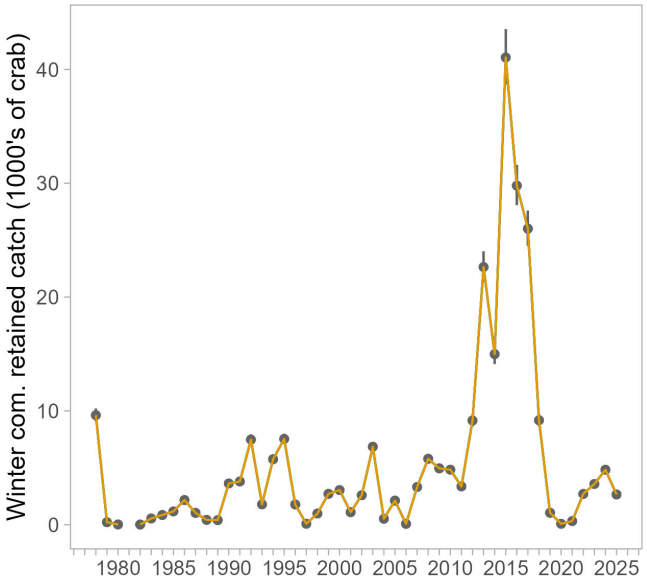
Natural mortality

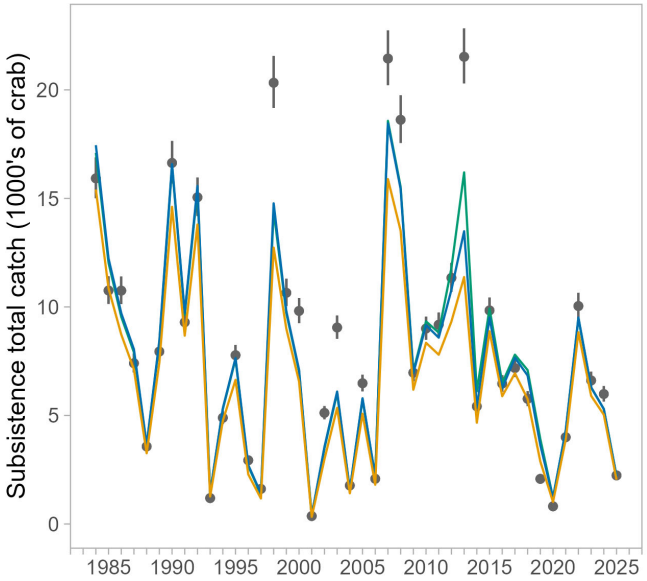


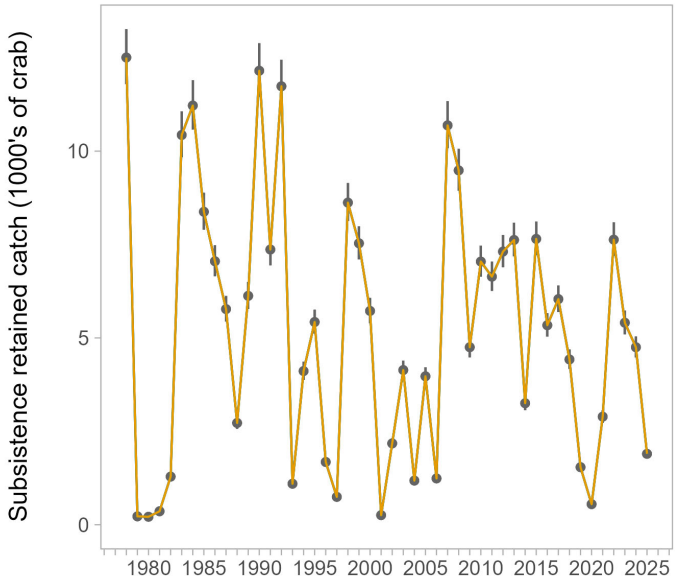
M = 0.18 for males $\leq$ 123 mm CL for 24.0b, 24.0b6, 24.0b7

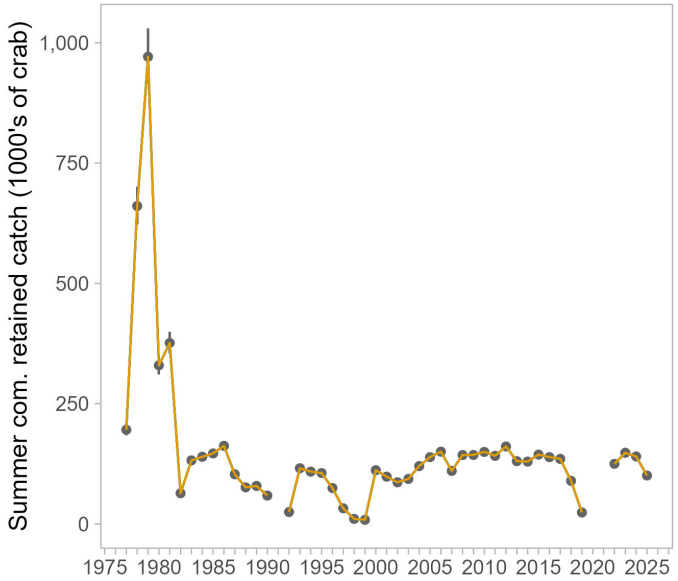
M = 0.23 for males $\leq$ 123 mm CL for 25.0a, 25.0a1, 25.0a2

Fits to fishery catch data - 24.0b models

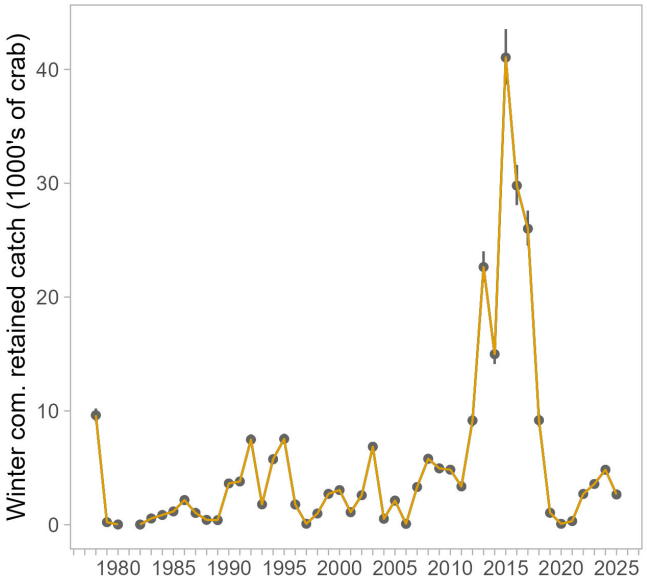


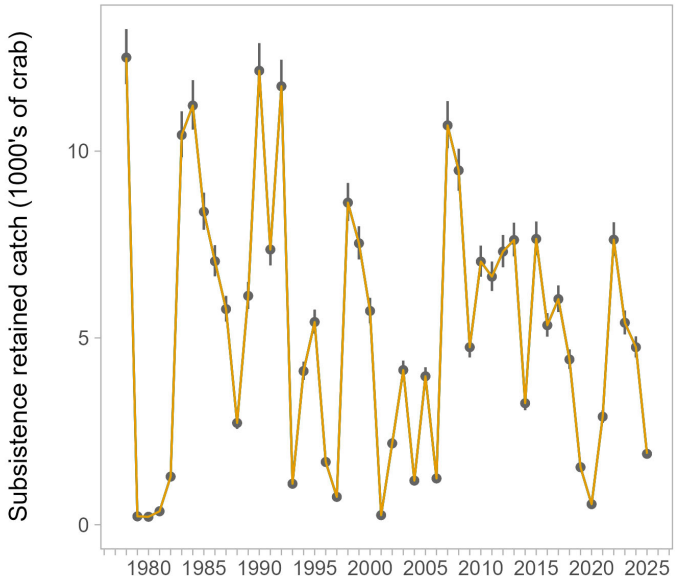


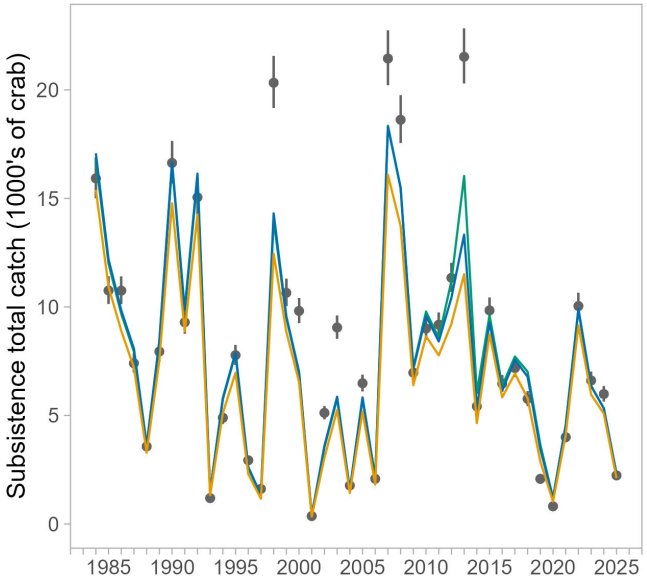


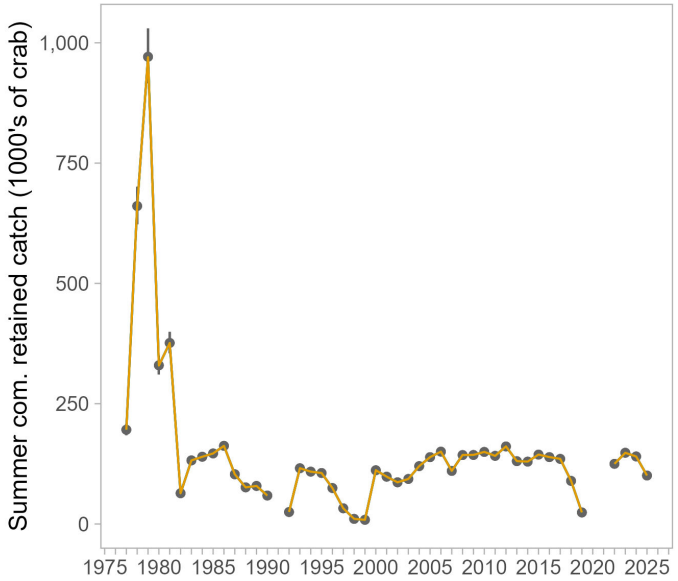


Fits to fishery catch data - 25.0a models

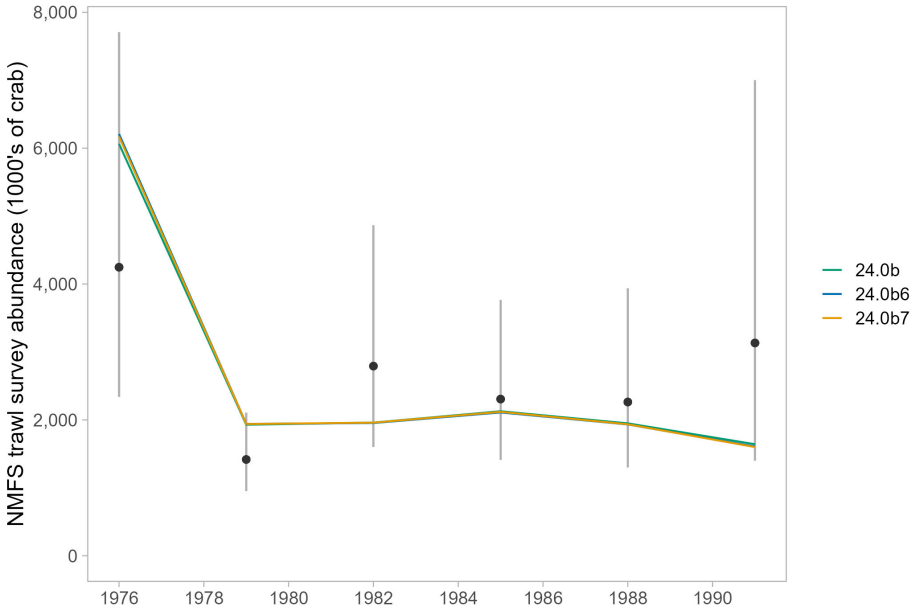


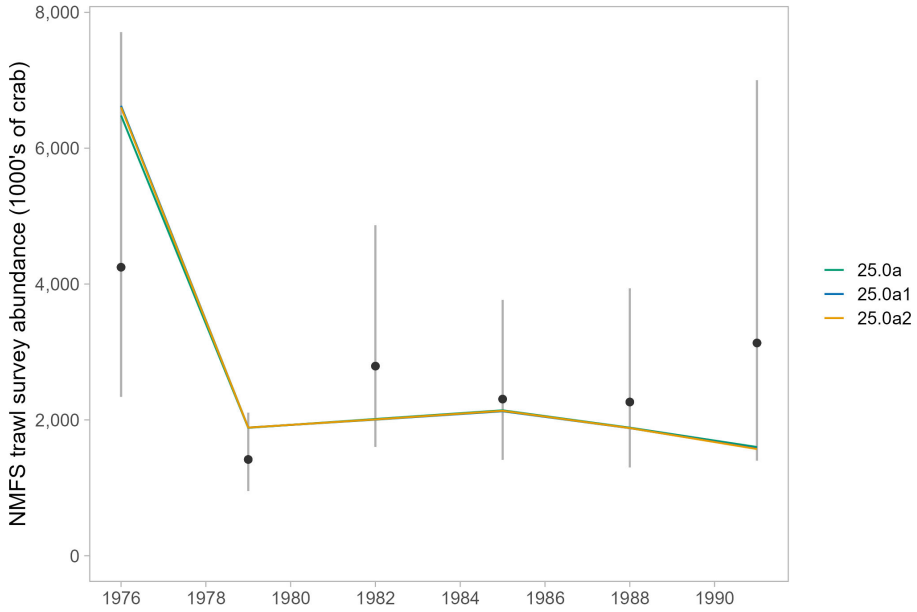






Fits to NOAA NS survey index



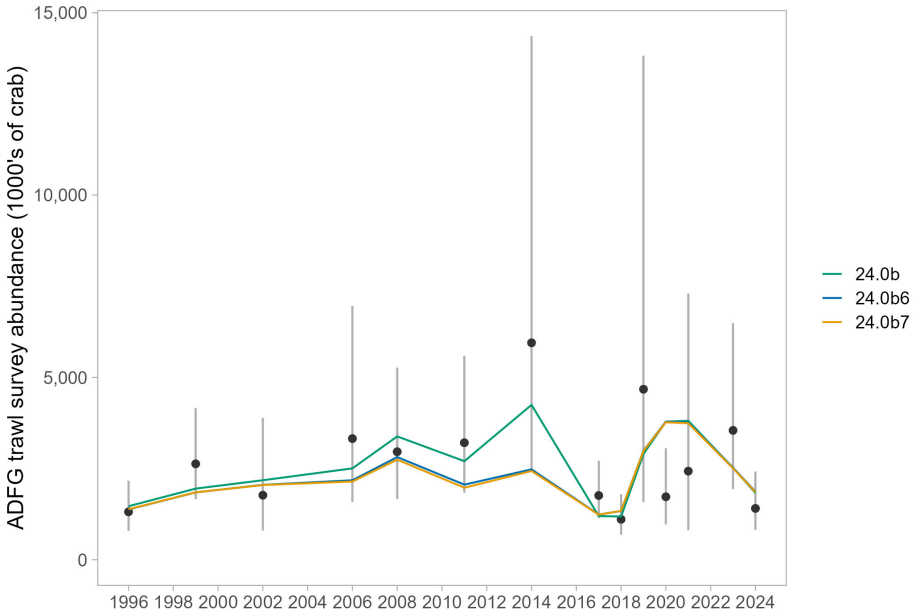


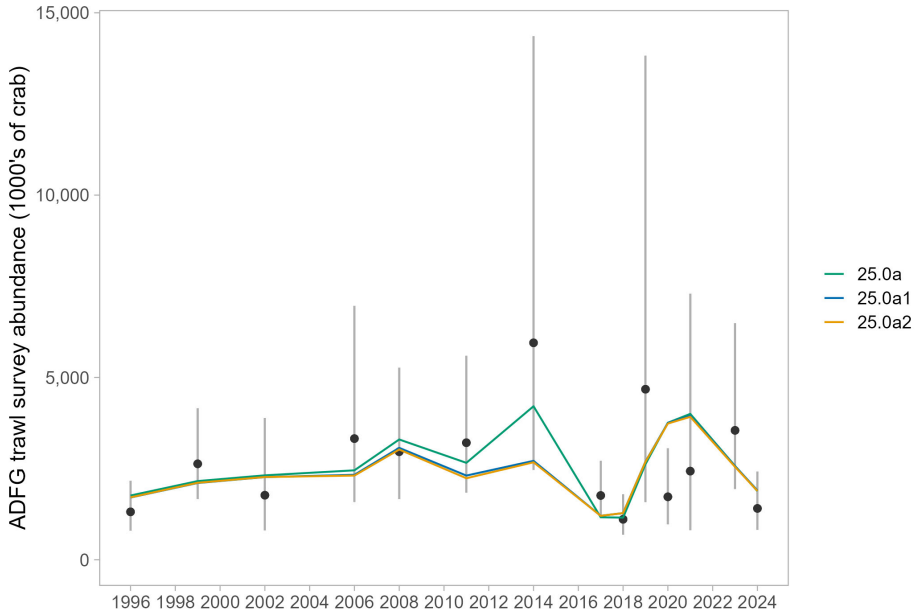
Ranking of fits:

24.0b > 24.0b7 > 24.0b6

25.0a > 25.0a2 > 25.0a1

Fits to ADF&G survey index



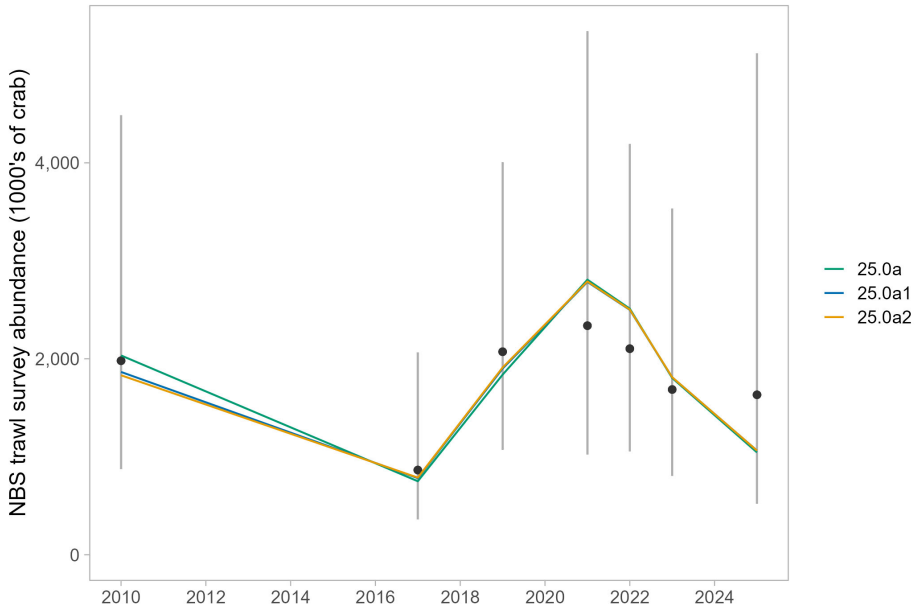


Ranking of fits:

24.0b > 24.0b6 > 24.0b7

25.0a > 25.0a1 > 25.0a2

Fits to NOAA NBS survey index

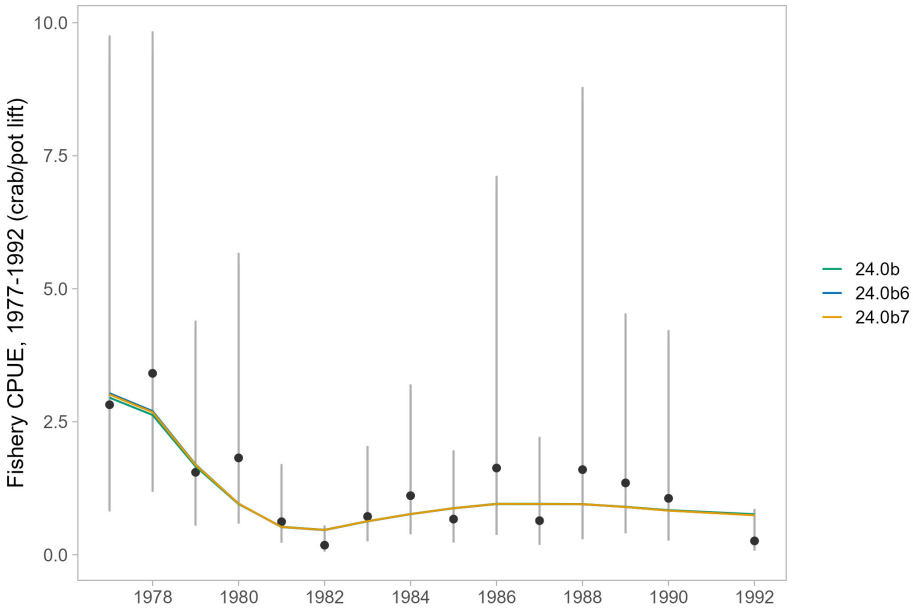


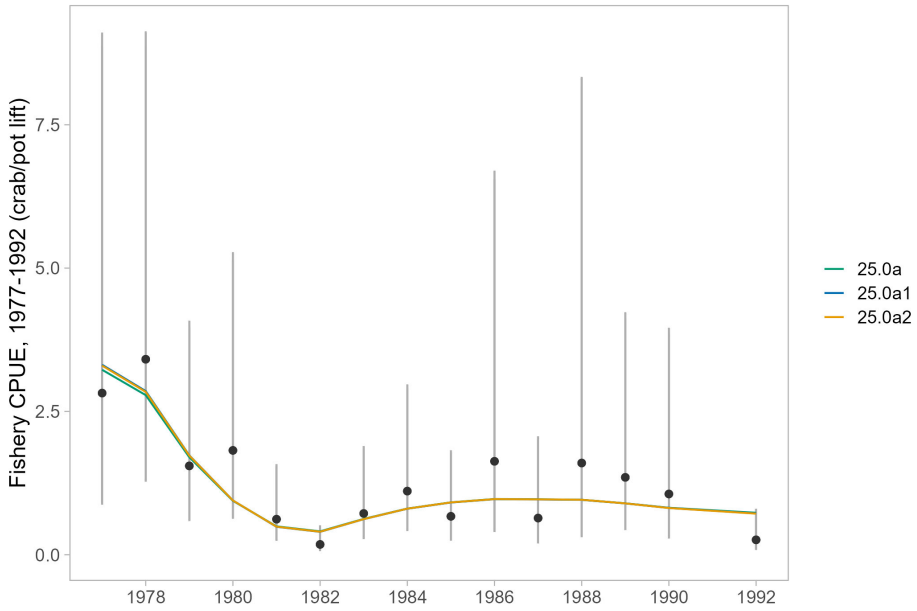
Ranking of fits:

24.0b > 24.0b6 > 24.0b7

25.0a1 > 25.0a2 > 25.0a

Fits to CPUE index, 1977-1992



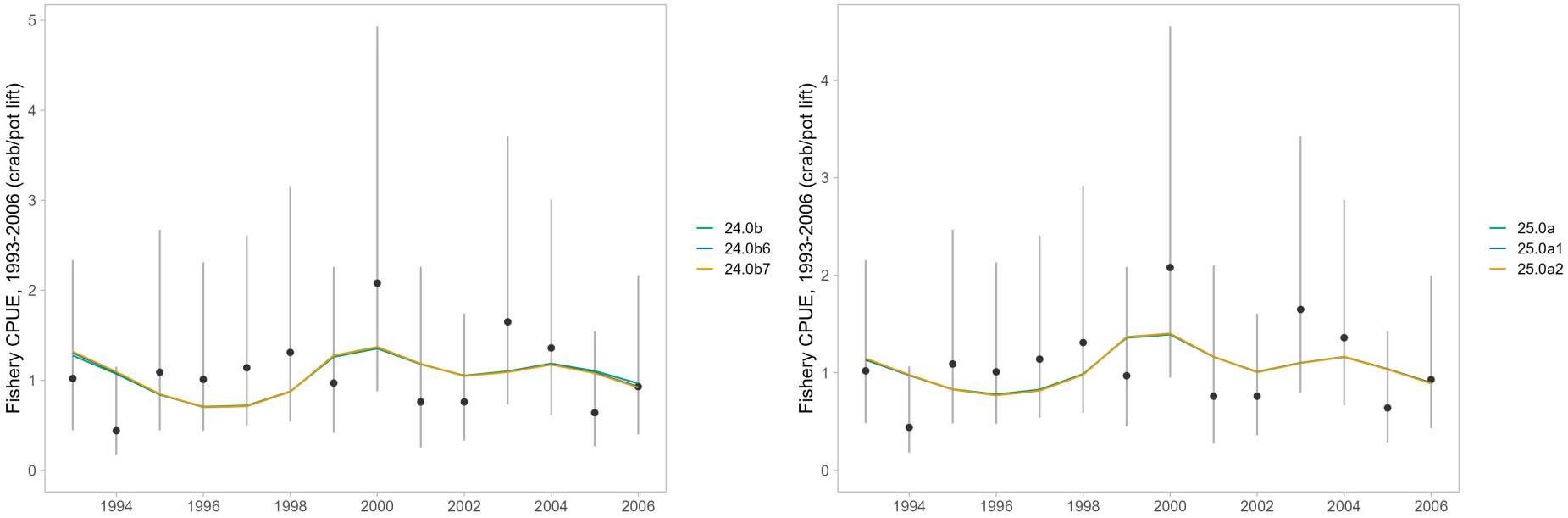


Ranking of fits:

24.0b7 > 24.0b6 > 24.0b

25.0a2 > 25.0a1 > 25.0a

Fits to CPUE index, 1993-2006

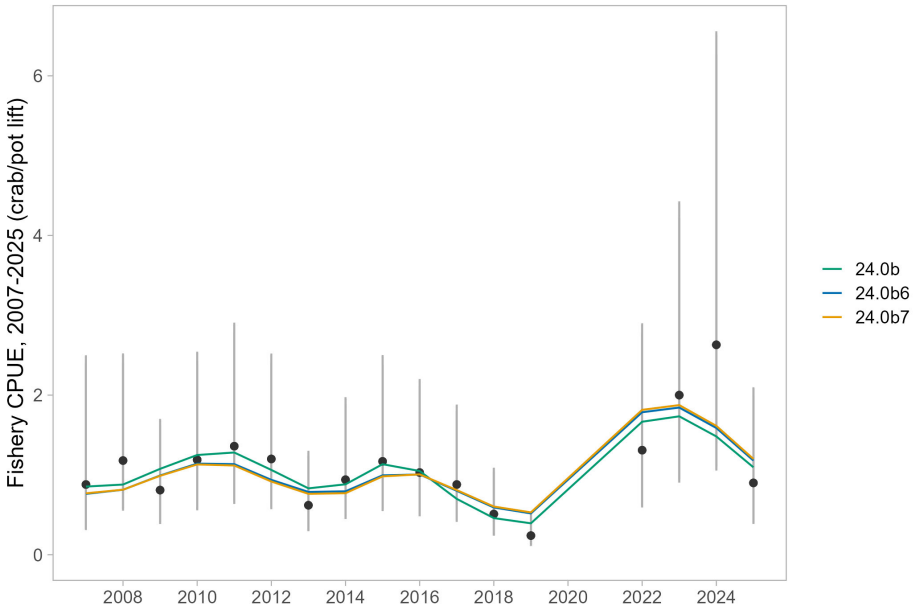


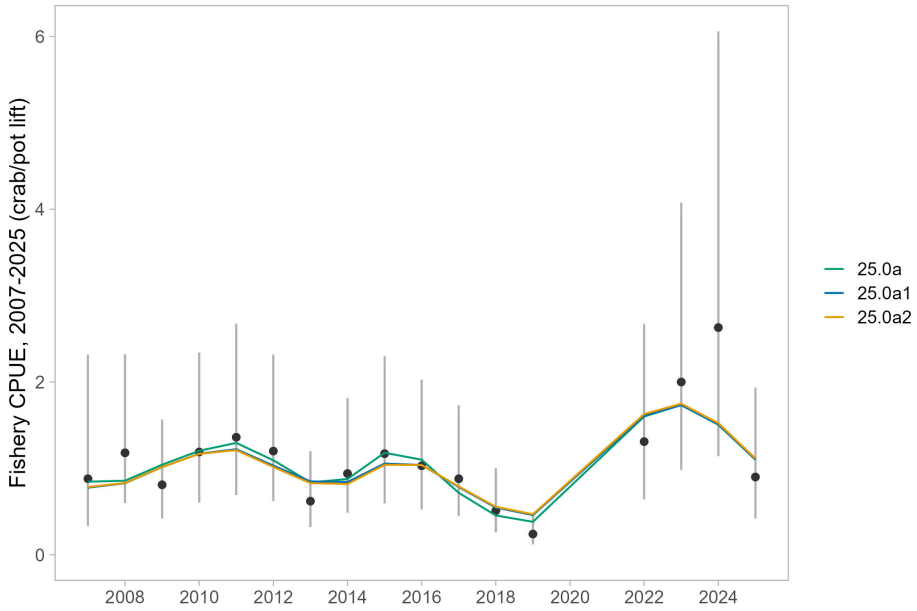
Ranking of fits:

24.0b7 = 24.0b6 > 24.0b

25.0a1 > 25.0a2 > 25.0a

Fits to CPUE index, 2007-2025



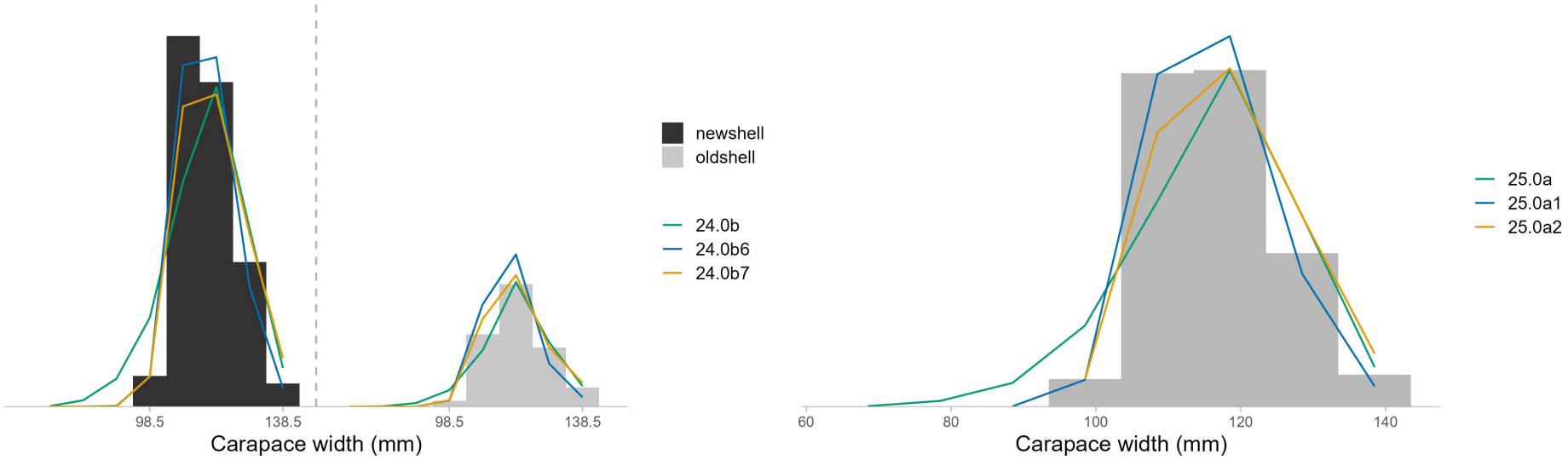


Ranking of fits:

24.0b > 24.0b6 > 24.0b7

25.0a > 25.0a1 > 25.0a2

Fits to size comps - winter retained

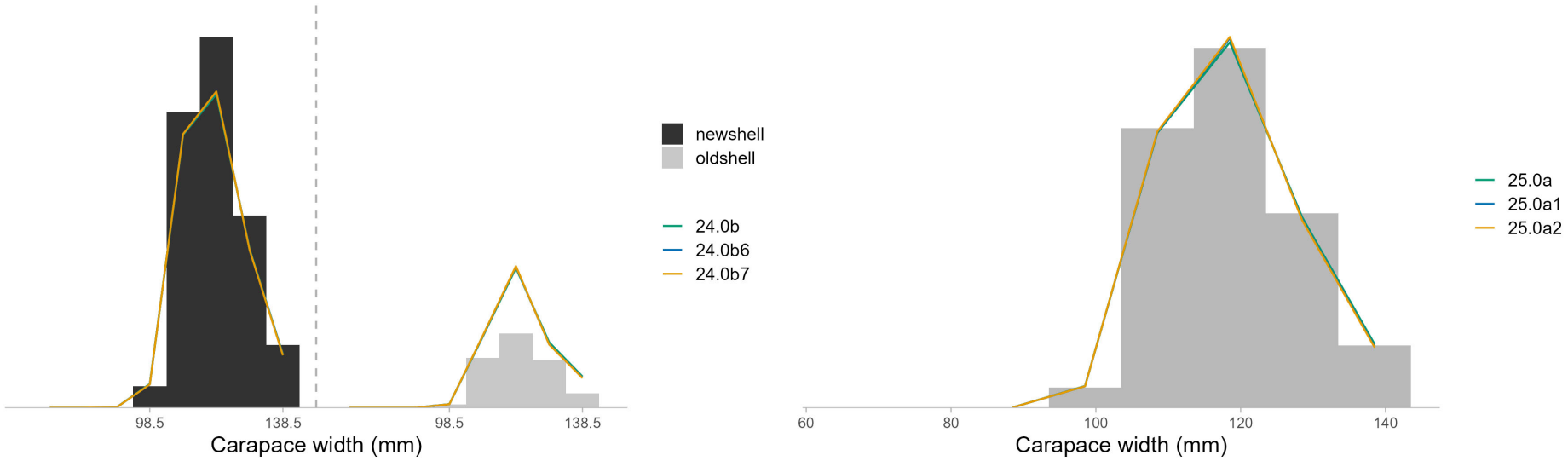


Ranking of fits:

24.0b7 > 24.0b6 > 24.0b

25.0a1 > 25.0a2 > 25.0a

Fits to size comps - summer retained

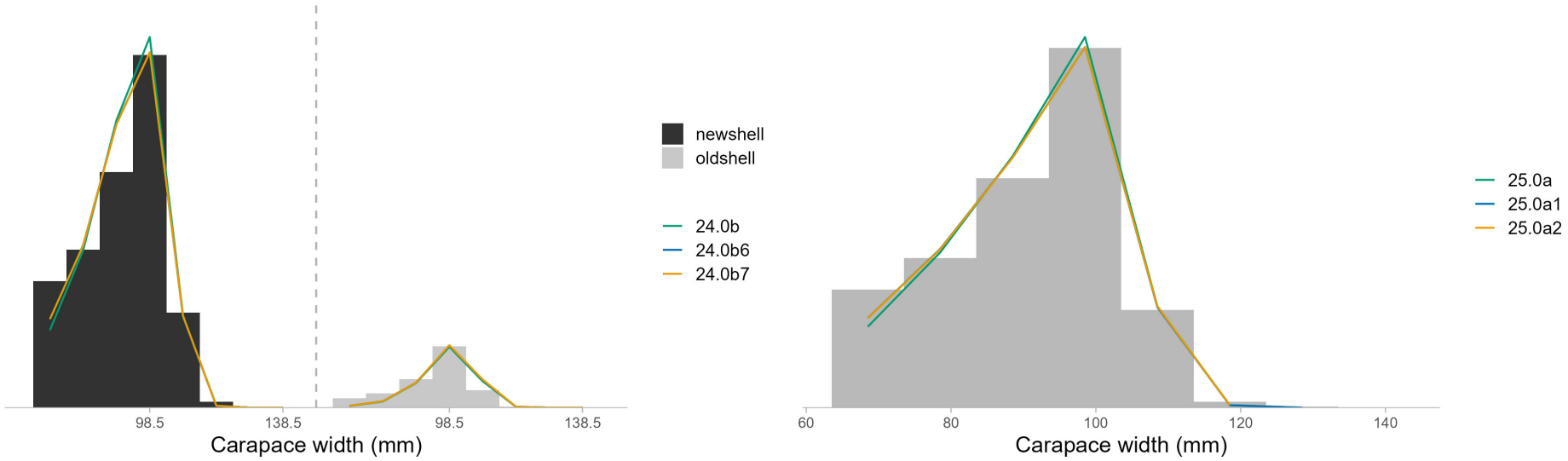


Ranking of fits:

24.0b6 > 24.0b > 24.0b7

25.0a > 25.0a2 > 25.0a1

Fits to size comps - summer discarded

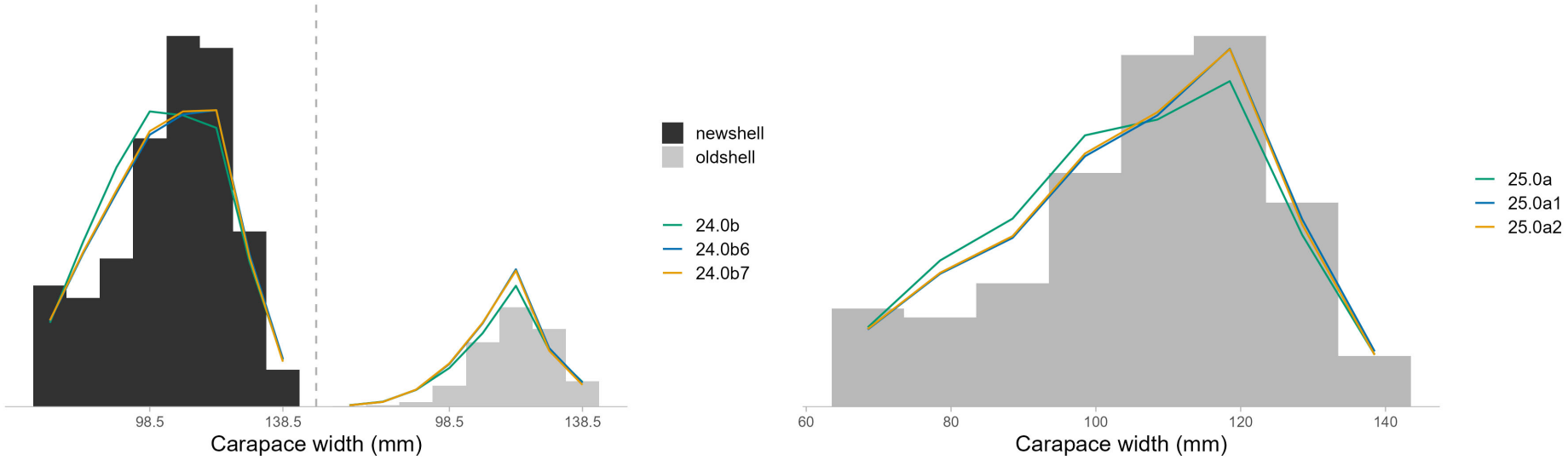


Ranking of fits:

24.0b7 > 24.0b6 > 24.0b

25.0a2 > 25.0a1 > 25.0a

Fits to size comps - summer total

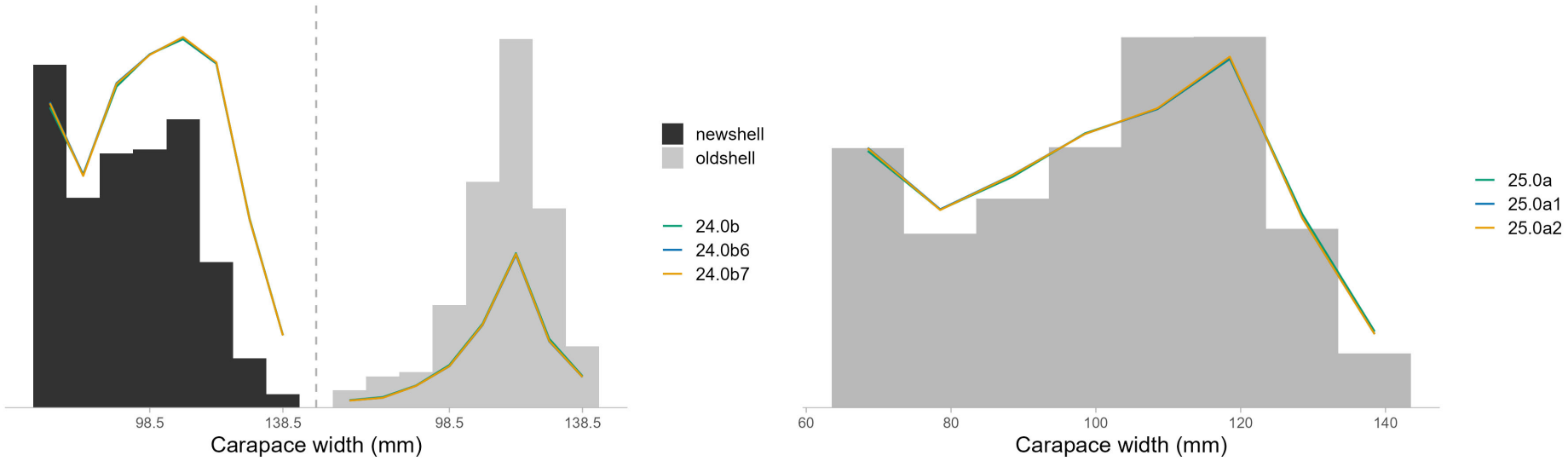


Ranking of fits:

24.0b > 24.0b7 > 24.0b6

25.0a2 > 25.0a1 > 25.0a

Fits to size comps - NOAA NS survey

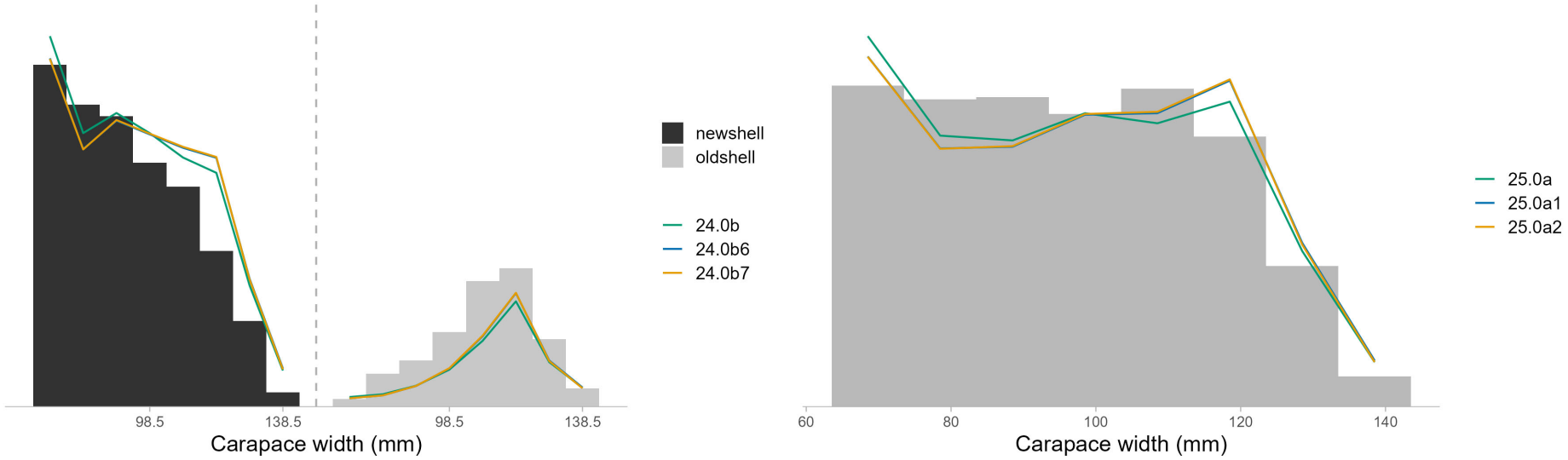


Ranking of fits:

24.0b > 24.0b7 > 24.0b6

25.0a1 > 25.0a2 > 25.0a

Fits to size comps - ADF&G survey

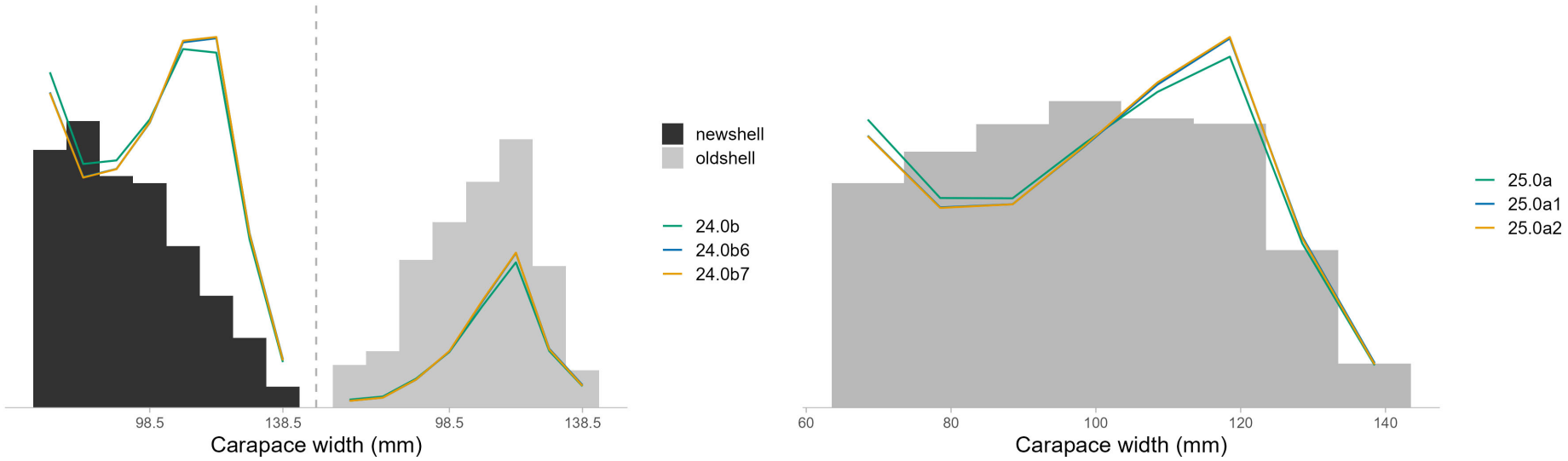


Ranking of fits:

24.0b > 24.0b6 > 24.0b7

25.0a > 25.0a2 > 25.0a1

Fits to size comps - NOAA NBS survey

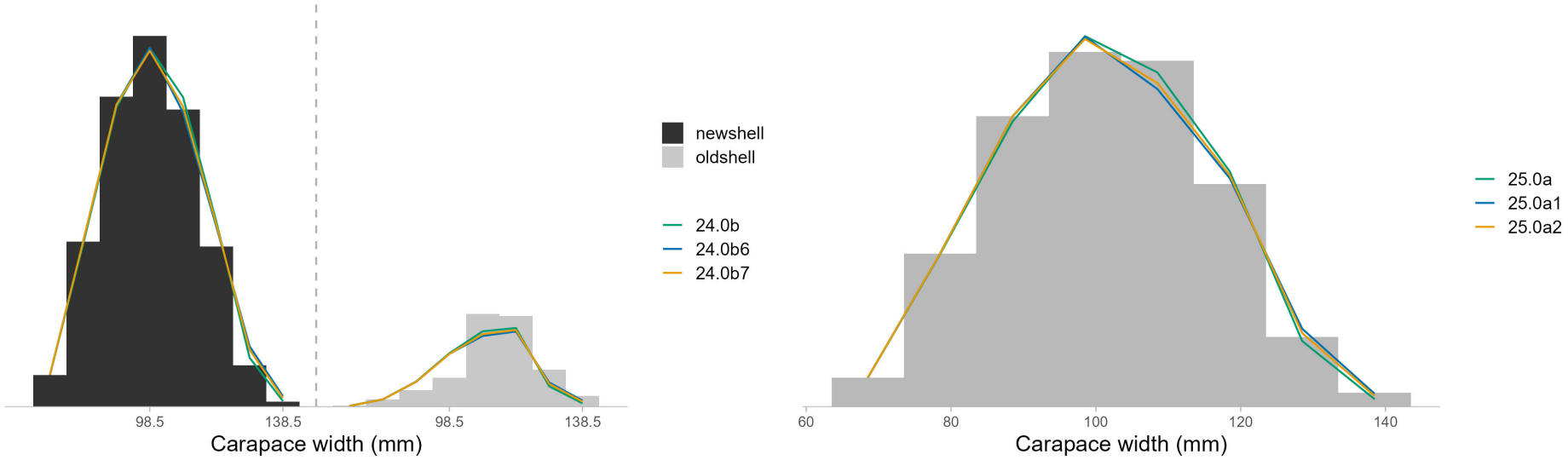


Ranking of fits:

24.0b > 24.0b6 > 24.0b7

25.0a > 25.0a1 > 25.0a2

Fits to size comps - winter pot survey

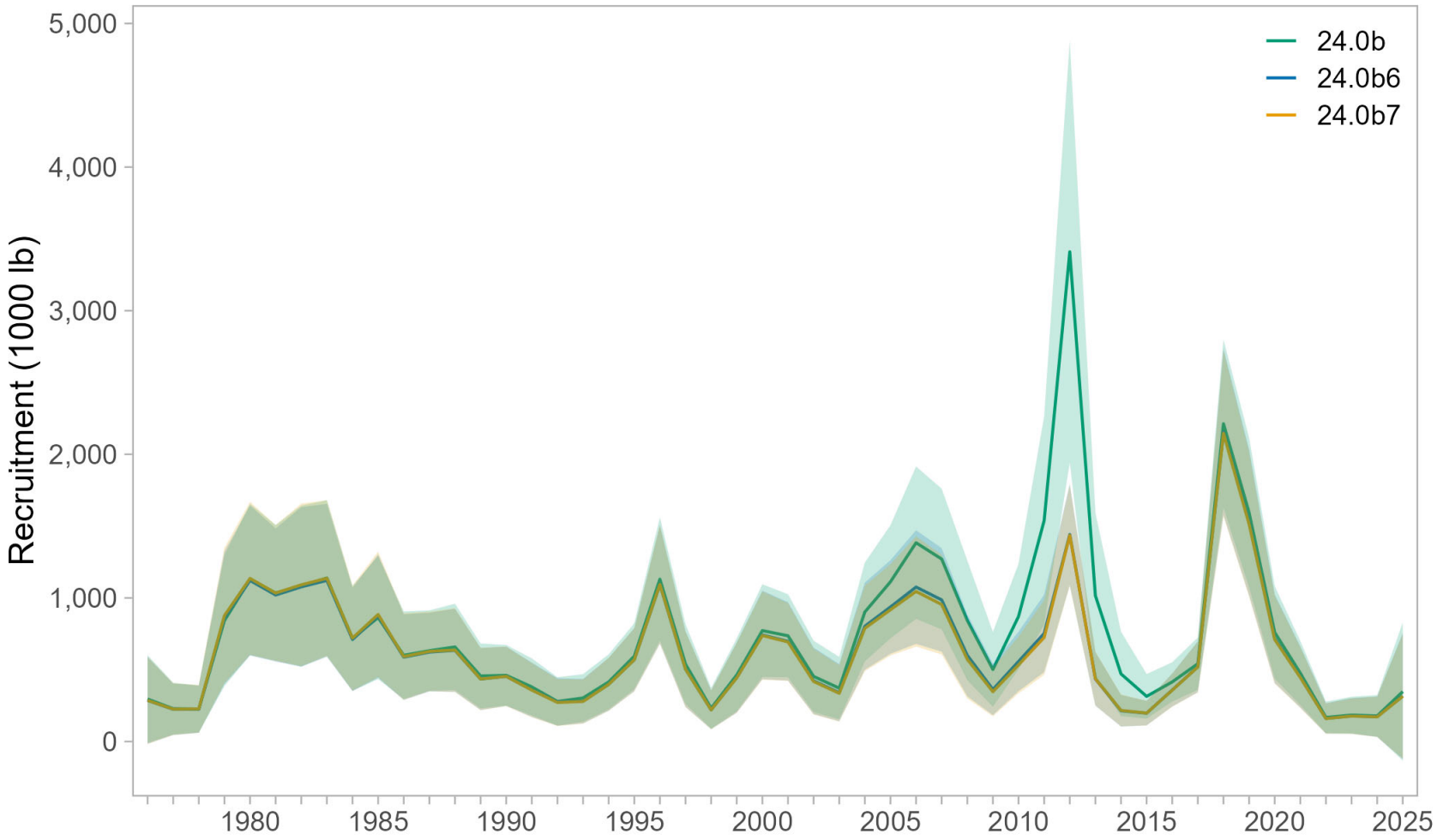


Ranking of fits:

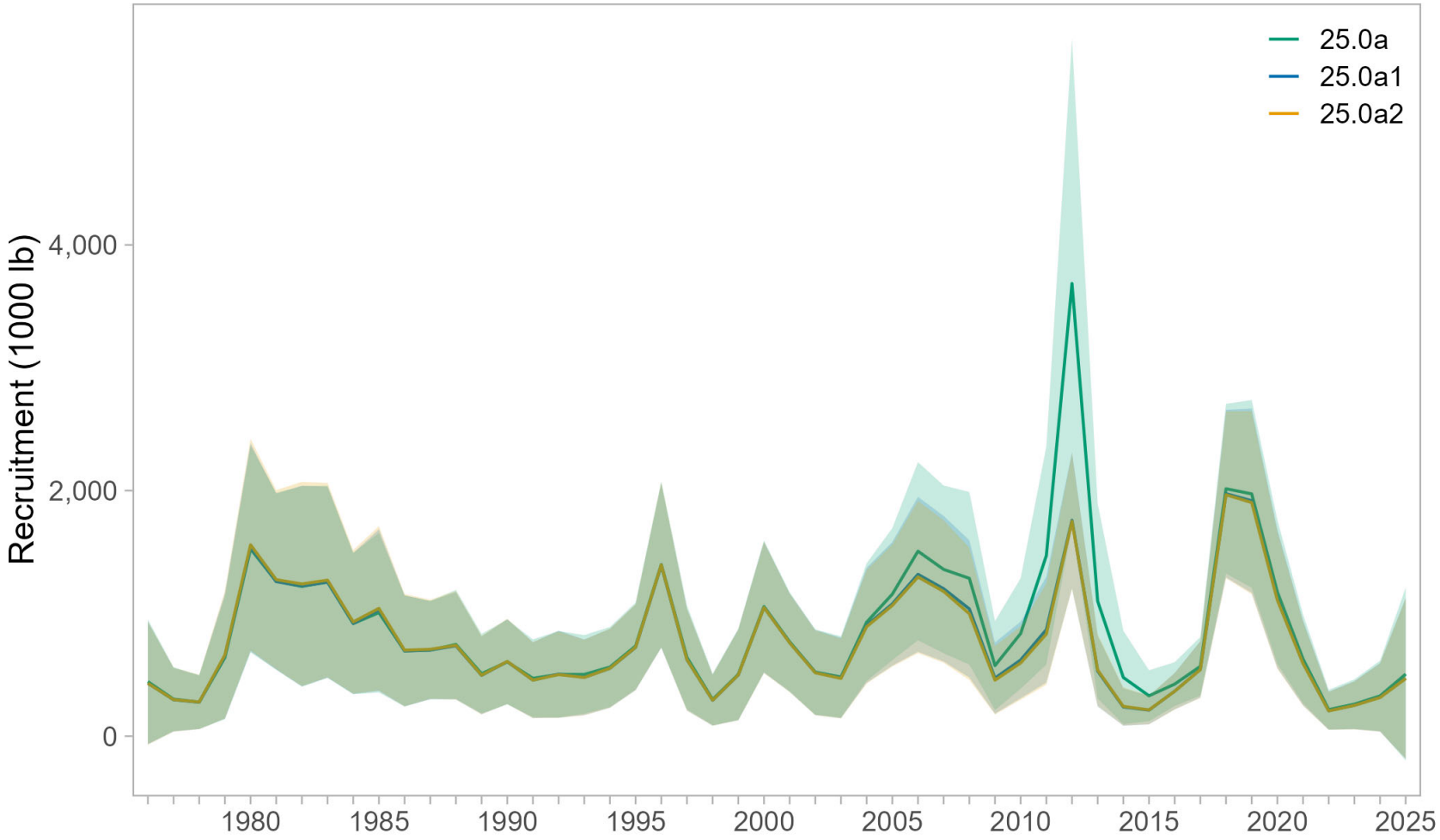
24.0b7 > 24.0b6 > 24.0b

25.0a2 > 25.0a1 > 25.0a

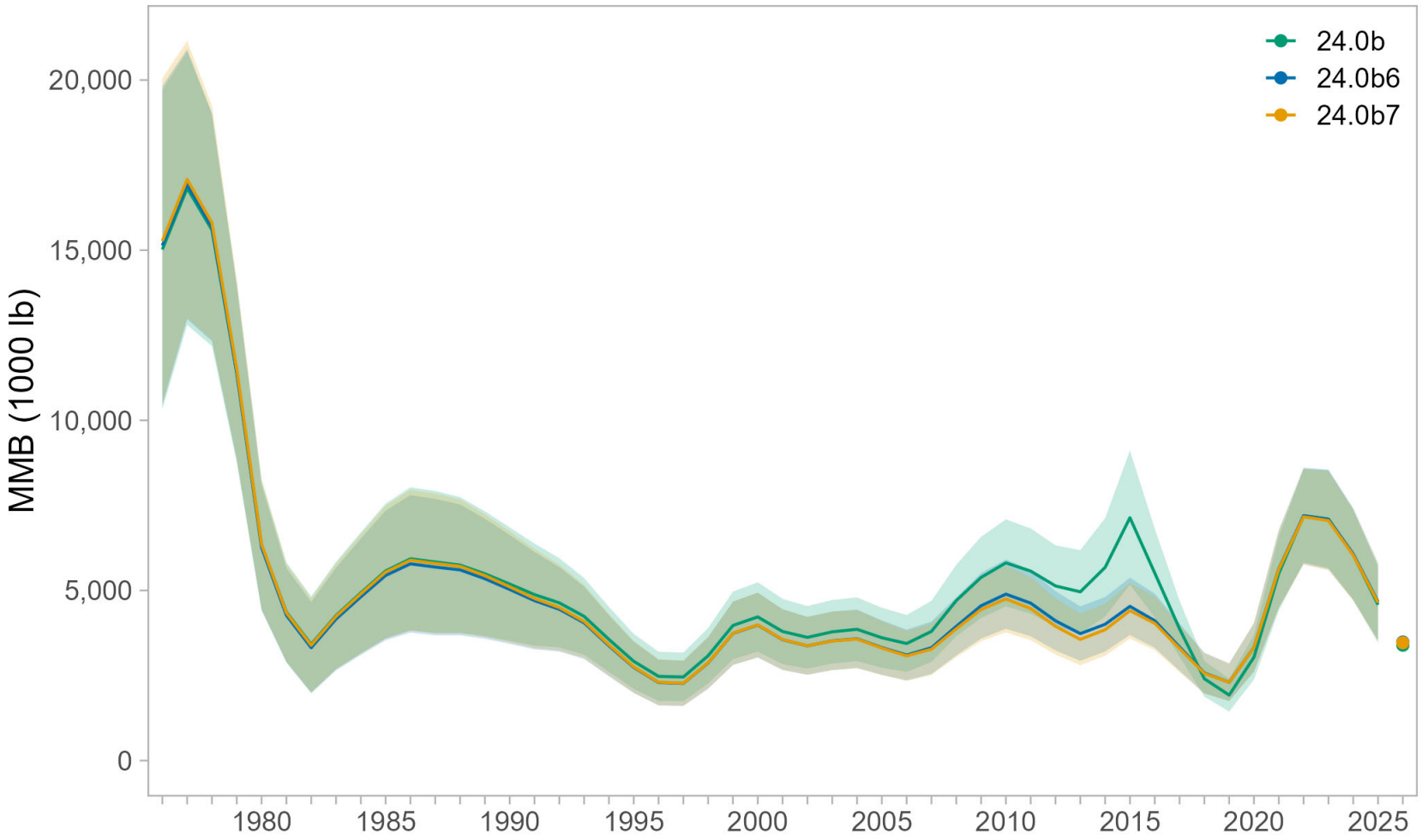
Recruitment - 24.0b models



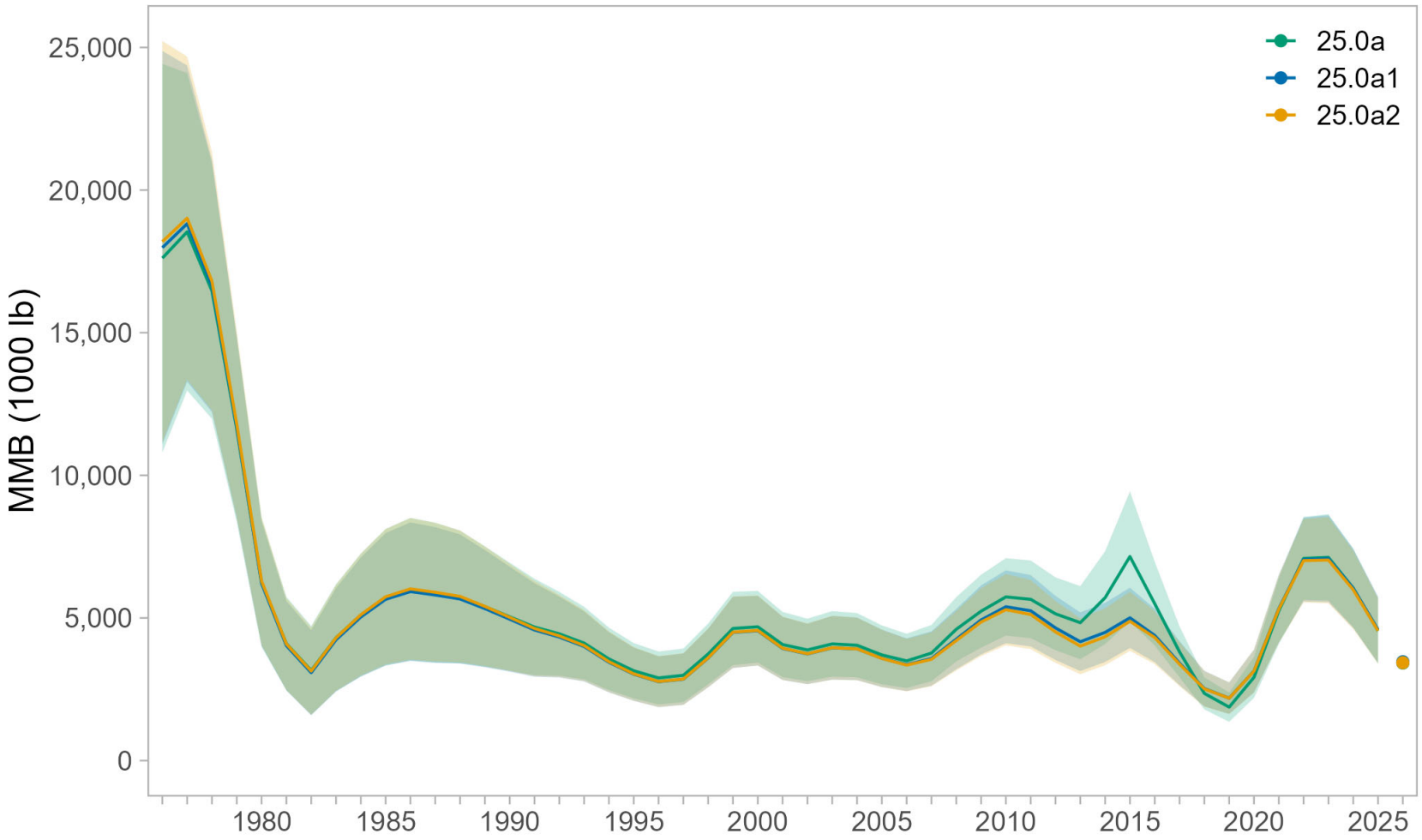
Recruitment - 25.0a models



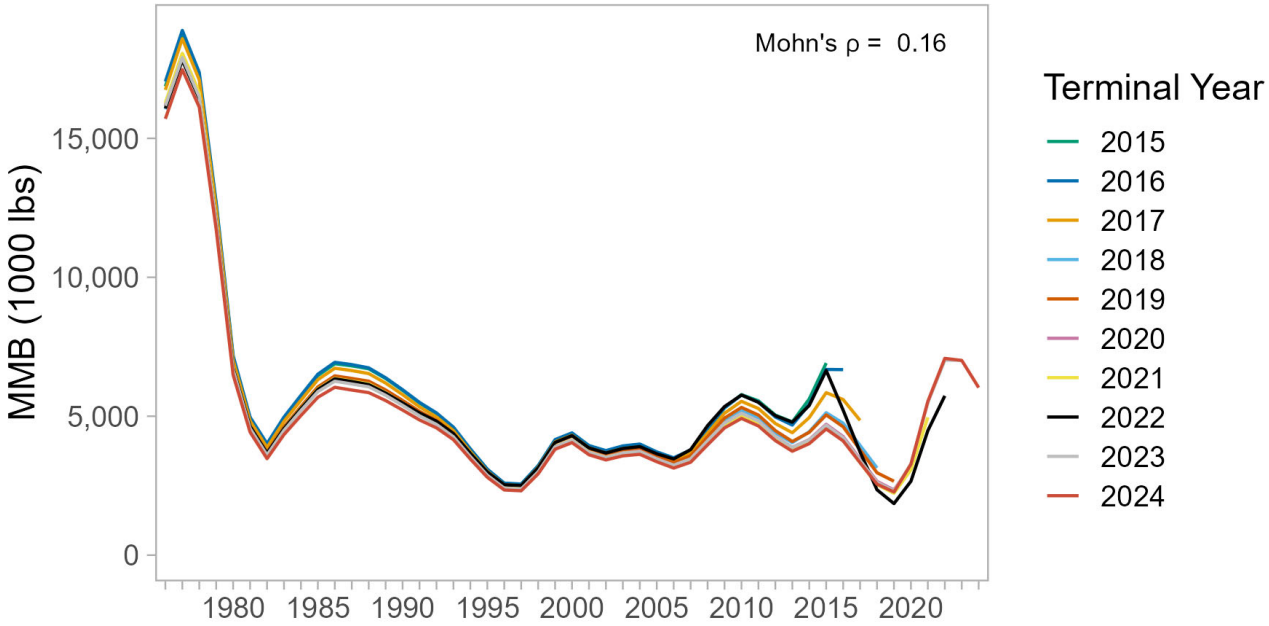
Mature male biomass - 24.0b models

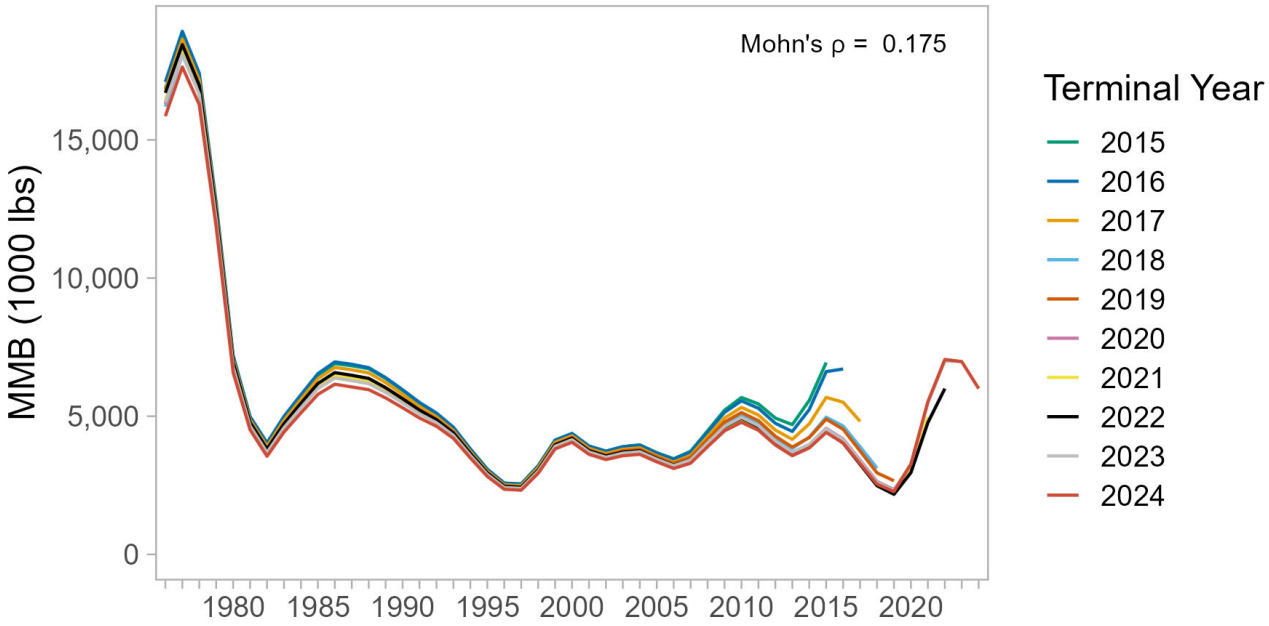


Mature male biomass - 25.0a models

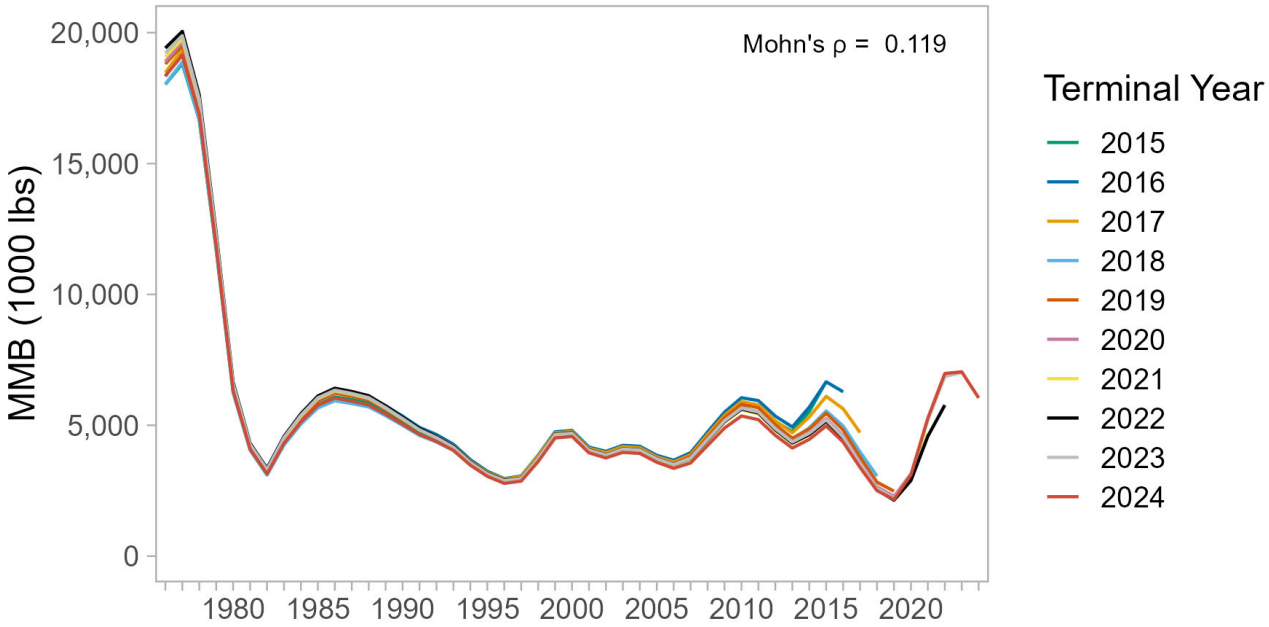


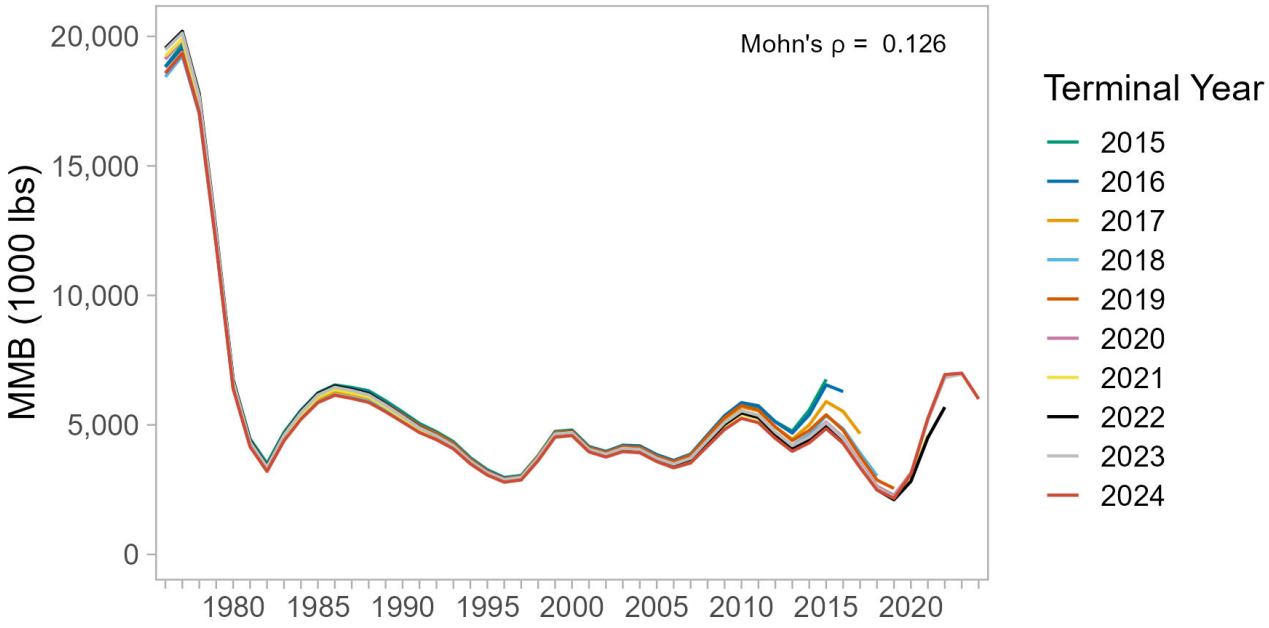
Retrospective analysis - 24.0b6, 24.0b7



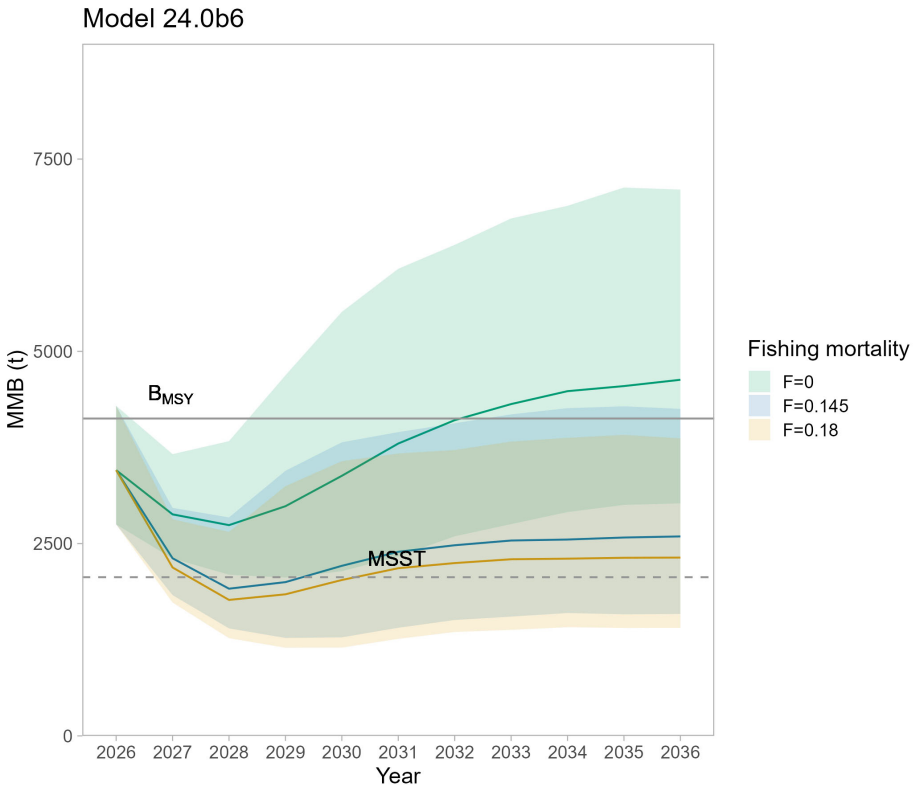


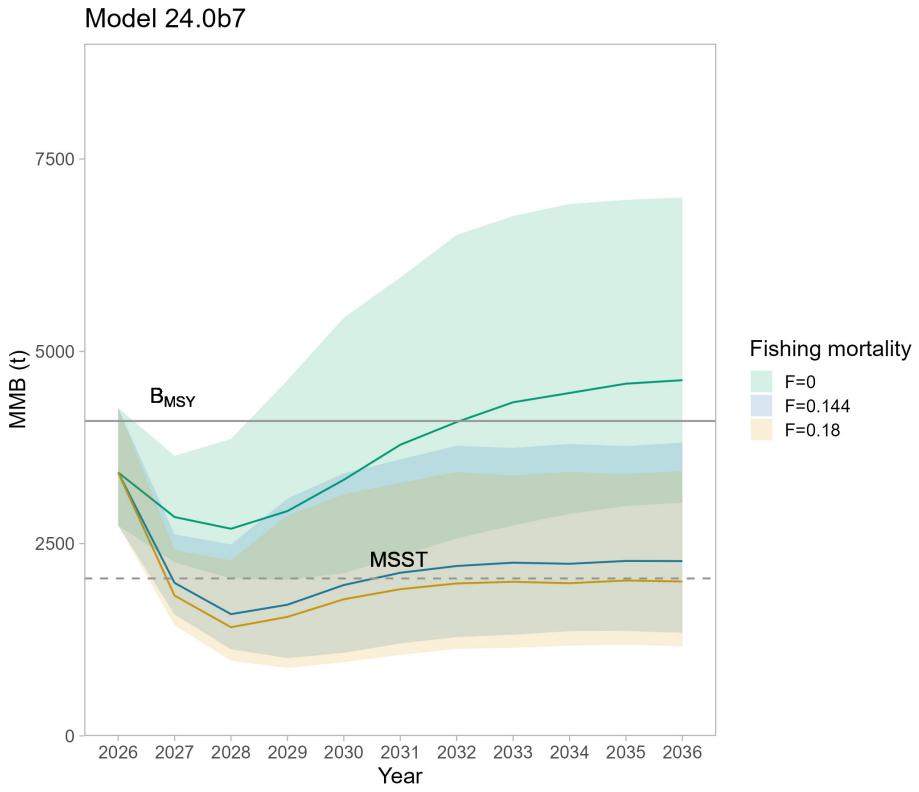
Retrospective analysis - 25.0a1, 25.0a2



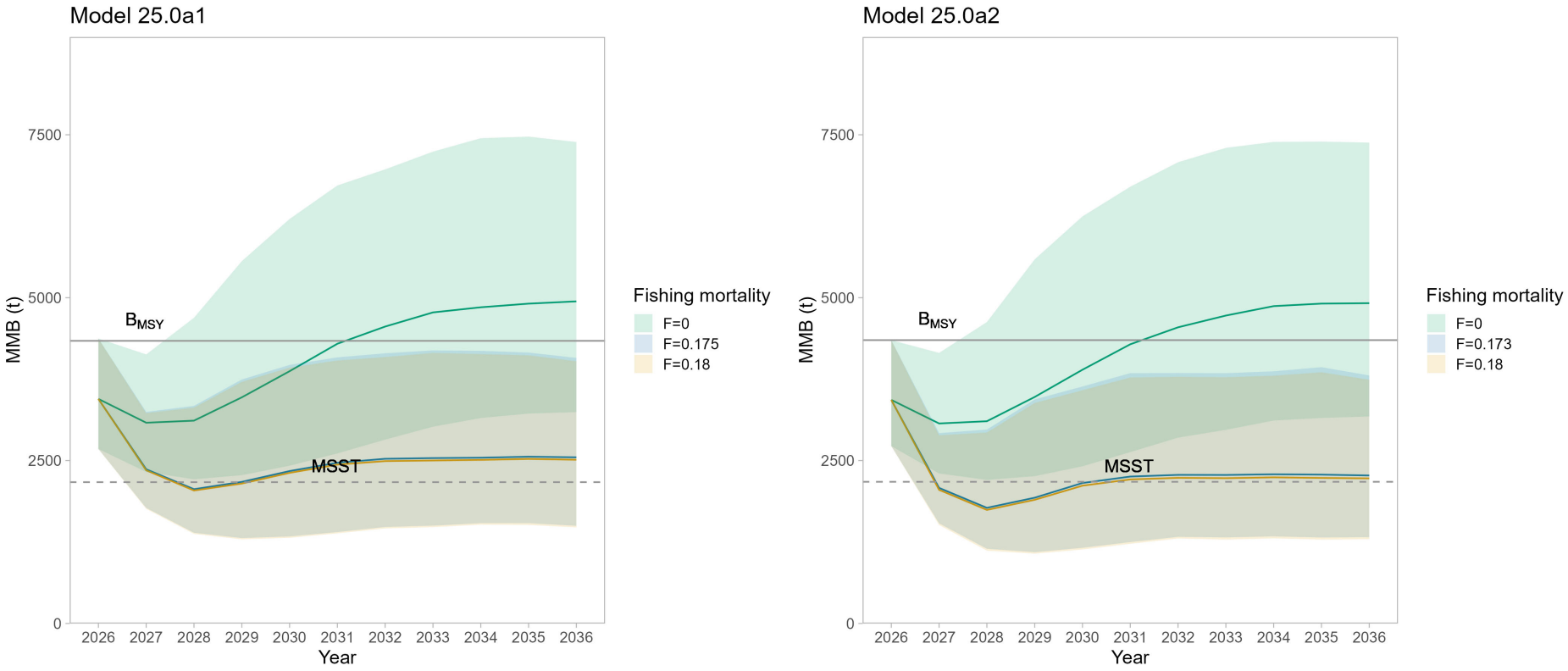


Stock projections - 24.0b6, 24.0b7





Stock projections - 25.0a1, 25.0a2



Reference points - 24.0b models

	24.0b	24.0b6	24.0b7
MMB_{2026}	1539	1580	1571
B_{MSY}	2080	1919	1917
MMB/B_{MSY}	0.74	0.823	0.82
F_{OFL}	0.13	0.14	0.14
OFL_{2026}	62	158	169
ABC_{2026}	44	111	118

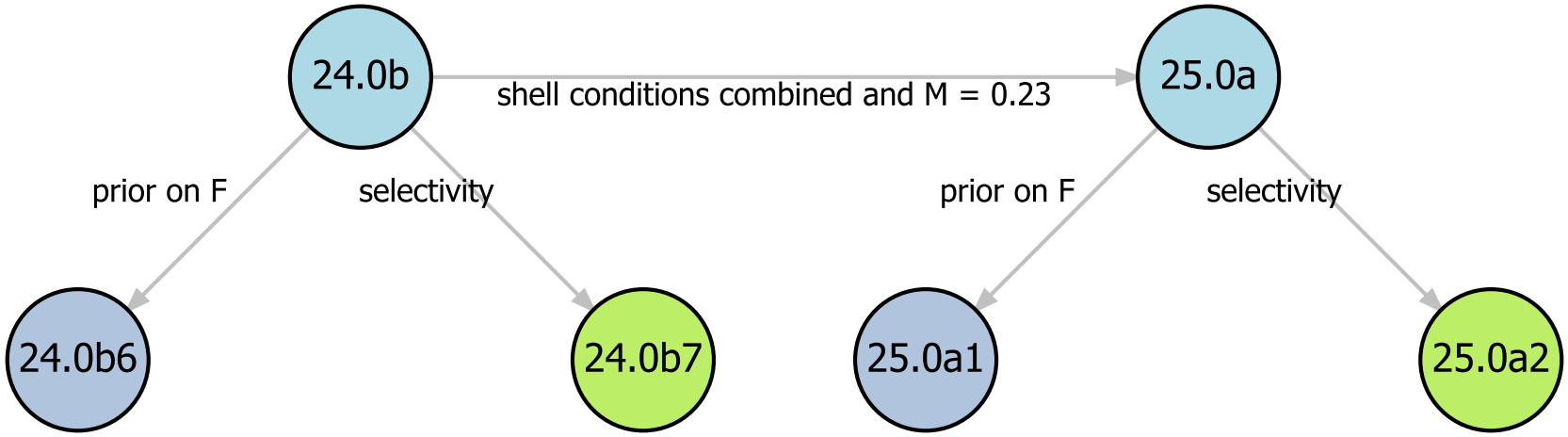
units: metric tons

Reference points - 25.0a models

	25.0a	25.0a1	25.0a2
MMB_{2026}	1551	1571	1556
B_{MSY}	2103	2007	2005
MMB/B_{MSY}	0.74	0.783	0.78
F_{OFL}	0.16	0.17	0.17
OFL_{2026}	86	186	193
ABC_{2026}	60	130	135

units: metric tons

Comparison of model scenarios



24.0b and 25.0a not recommended due to unrealistically high *F* values

Fits very similar between 24.0b6 and 24.0b7, and between 25.0a1 and 25.0a2

Are combining shell conditions and using *M* = 0.23 desirable changes to the base model approach?

Is using a prior on winter commercial fishery *F* or mirroring winter commercial fishery selectivity to that of the summer commercial fishery preferred as an approach to improving *F* estimation?

Author recommendations: model

Model 25.0a2

MMB_{2026}	B_{MSY}	MMB/B_{MSY}	F_{OFL}	OFL_{2026}	ABC_{2026}
1556	2005	0.78	0.17	193	135

- combining shell conditions removes uncertainty unaccounted for in the model
- using M = 0.23 for males with CL $\leq$ 123 mm aligns with BBRKC and SMBKC and uses best available estimate for RKC in the Bering Sea
- mirroring selectivity for the winter commercial fishery to the summer commercial fishery is consistent with use of escape rings in both fisheries, size comps
- less extreme retrospective pattern than 24.0b6 or 24.0b7

Author recommendations: ABC buffer

Rationale for 30% buffer applied to 2025 OFL:

- natural mortality and size-at-maturity are borrowed from other stocks
- impact of seasonal movement on survey estimates
- uncertainty in stock vs. survey areas
- lack of information about discards
- overestimation of the abundance of the largest male crab
- use of a higher natural mortality value for larger males in order to correct for this overestimation rather than using a size-independent natural mortality
- retrospective pattern in model-estimated MMB

Most/all concerns still apply. Recommend 30% ABC buffer

Risk table

Assessment-related considerations	Population dynamics considerations	Environmental/ ecosystem considerations	Fishery performance considerations
Level 2: uncertainty in stock versus survey areas; lack of discard data; higher M for large males	Level 1: low recent recruitment	Level 1: corrosive bottom waters (pH < 7.8) in Norton Sound	Level 1: crab per pot lift down from 2024 and below time series mean

Future work

- incorporate model-based indices of abundance
- add winter subsistence total catch and summer subsistence catch data
- ensure that area used for size composition data matches area for abundance estimation
- review and potentially revise CPUE standardization methods

Thanks!