Proposed Tier 4 for GOA Rougheye/Blackspotted Rockfish

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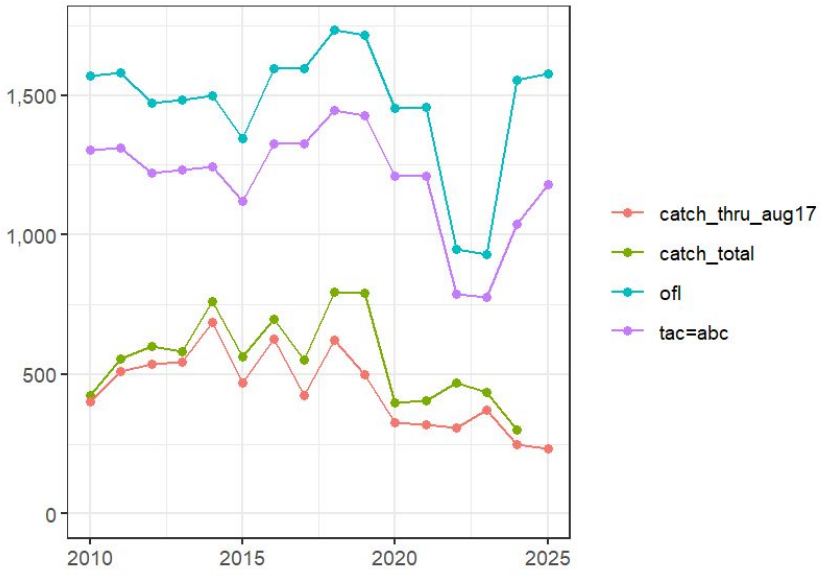
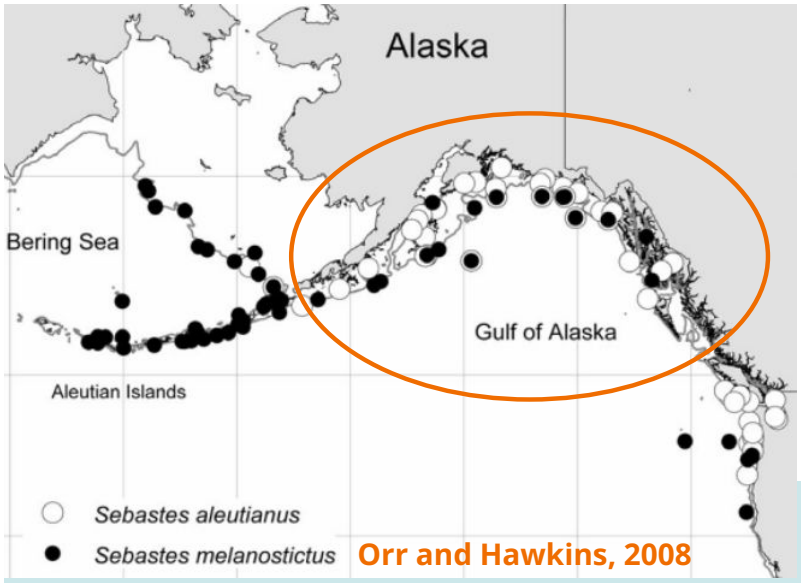
Sep 2025 Groundfish Plan Team

2025 Sept doc, 2023 SAFE

RE/BS Background

1. Cryptic species, no directed fishery, lightly exploited, catch << ABC == TAC
2. SCAA first accepted in 2007 (Shotwell et al., 2007)
3. RE/BS verified as distinct species (Orr and Hawkins, 2008)
4. SCAA combined RE/BS data with averaged biology → SSC/GPT have repeatedly flagged risks with this approach (Appendix A)
    a. Notable uncertainty in species comp of catch and recruitment
5. 2023 assessment: major concerns with assessment/pop dy
6. Poor fits to index and comp data, retro bias, high uncertainty in stock scale/trend, downward trends in trawl/longline survey indices → reduction from maxABC

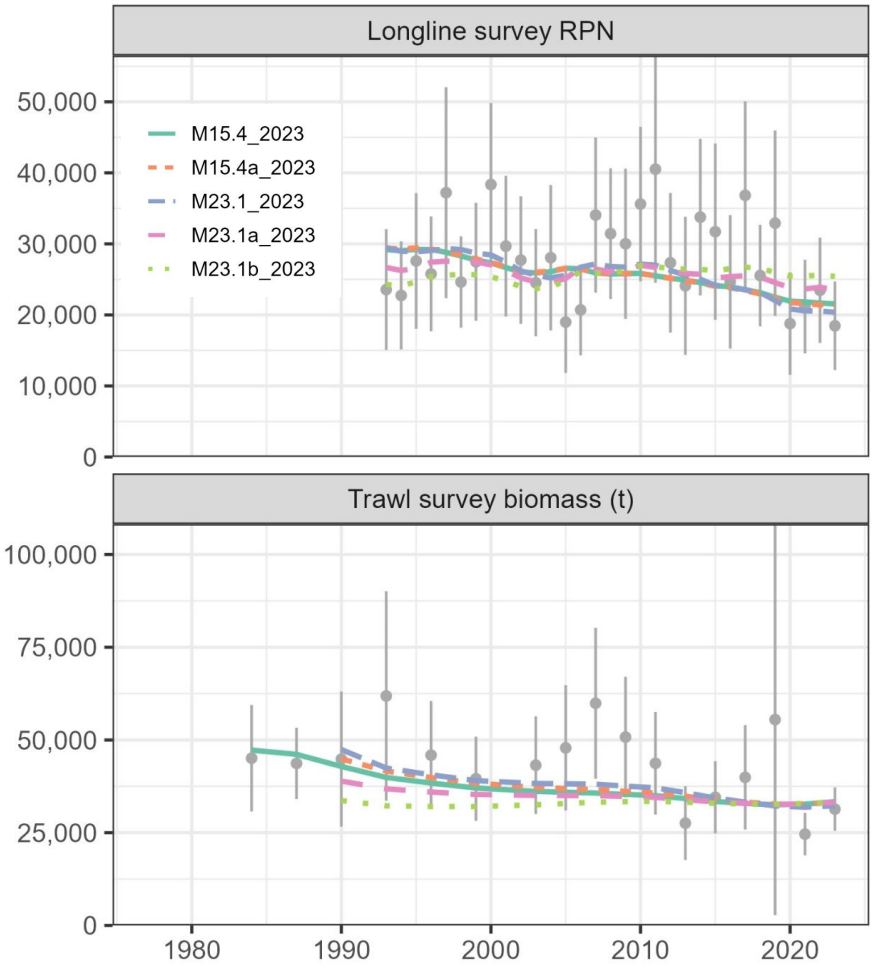




2023 RE/BS Assessment Summary

- Base model M15.4 first accepted in 2015

  Sep 2023: new M, maturity, age error,growth
- When new data were added, the retrospective bias went from bad in 2021 (Mohn's rho=0.61) to worse (Mohn's rho=1.05)
- Bias caused by large retro patterns in both survey catchabilities (q_trawl>2), M, and recruitment (all estimated in M15.4)
- Constrained scaling parameters in recommended M23.1b stabilized the model (Mohn's rho=0.14); however, M23.1b has degraded fits to the survey data and biomass trajectories that are inconsistent with recent trends in survey abundance



GPT/SSC recommendations: Selectivity

The dome-shaped **trawl survey selectivity** for this complex is expected given that adult habitat is typically in rocky areas along the shelf break where the trawl survey gear's sampling is limited. However, estimates in this assessment suggest that selectivity is changing considerably for older fish in the survey, which is unexpected given occupied habitat should not change above a certain age. For example, the GOA GPT noted it was unclear why 40-year-old fish would be so much less selected than a 30-year-old fish. Future research could consider alternative parameterizations that would allow for more constrained estimates of selectivity at older ages. (SSC 2021)

The Team recommended that the author investigate how selectivity is modeled. In particular, there were some abrupt changes between ages in the average **fishery selectivity**." (Plan Team, November 2019)

"The SSC supports the author's plan for future work on the s**urvey and fishery selectivity** parameterization, and on weightings of compositional information. (SSC, December 2023)

Appendix B

GPT/SSC recommendations: Skip Spawning

"The Team recommended using the authors approach. Additionally, the Team recommended alternative methods be explored that take **skip spawning** into account." (GOA GPT, September 2023)

"The SSC supports incorporating maturity data not previously used that comes from both rougheye and blackspotted rockfish determined through visual species identification and supports exploring alternative methods that account for **skip spawning**." (SSC, October 2023)

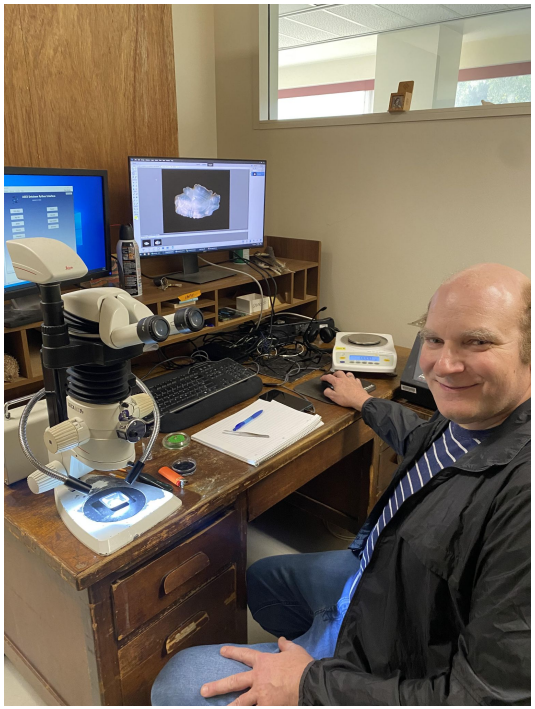
"The SSC also reiterates its October 2023 recommendation to investigate methods to incorporate the effects of **skip spawning**." (SSC, December 2023)

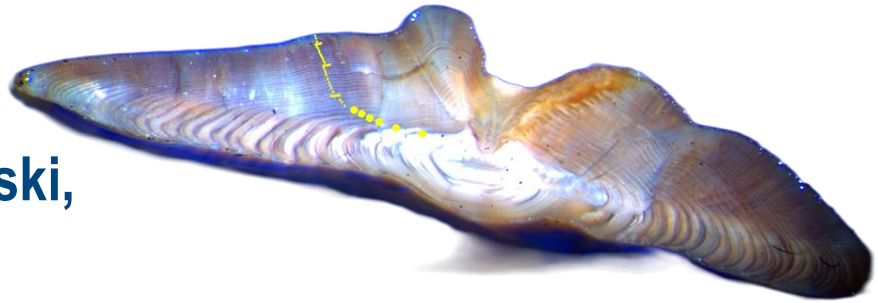
Appendix B

Research: Skip Spawning & RE/BS maturity

Objectives:

1. Validate Conrath (2017) species-specific maturity and skip spawning rates using otolith morphology for species ID (Harris et al., 2019)
2. Estimate species-specific biological and functional maturity using flexible generalized additive models (GAMs)
3. Impacts of misidentification rates to stock assessment (YPR/SBPR)





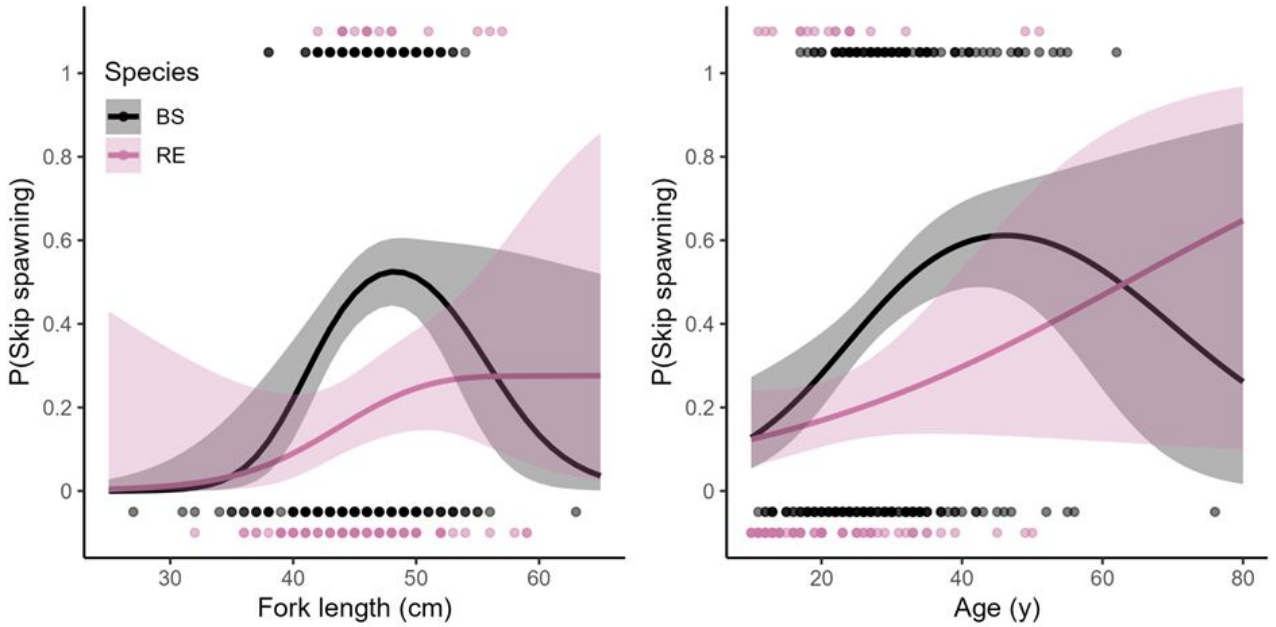
Coauthors: Todd TenBrink, Chris Gburski, Grant Adams

Results

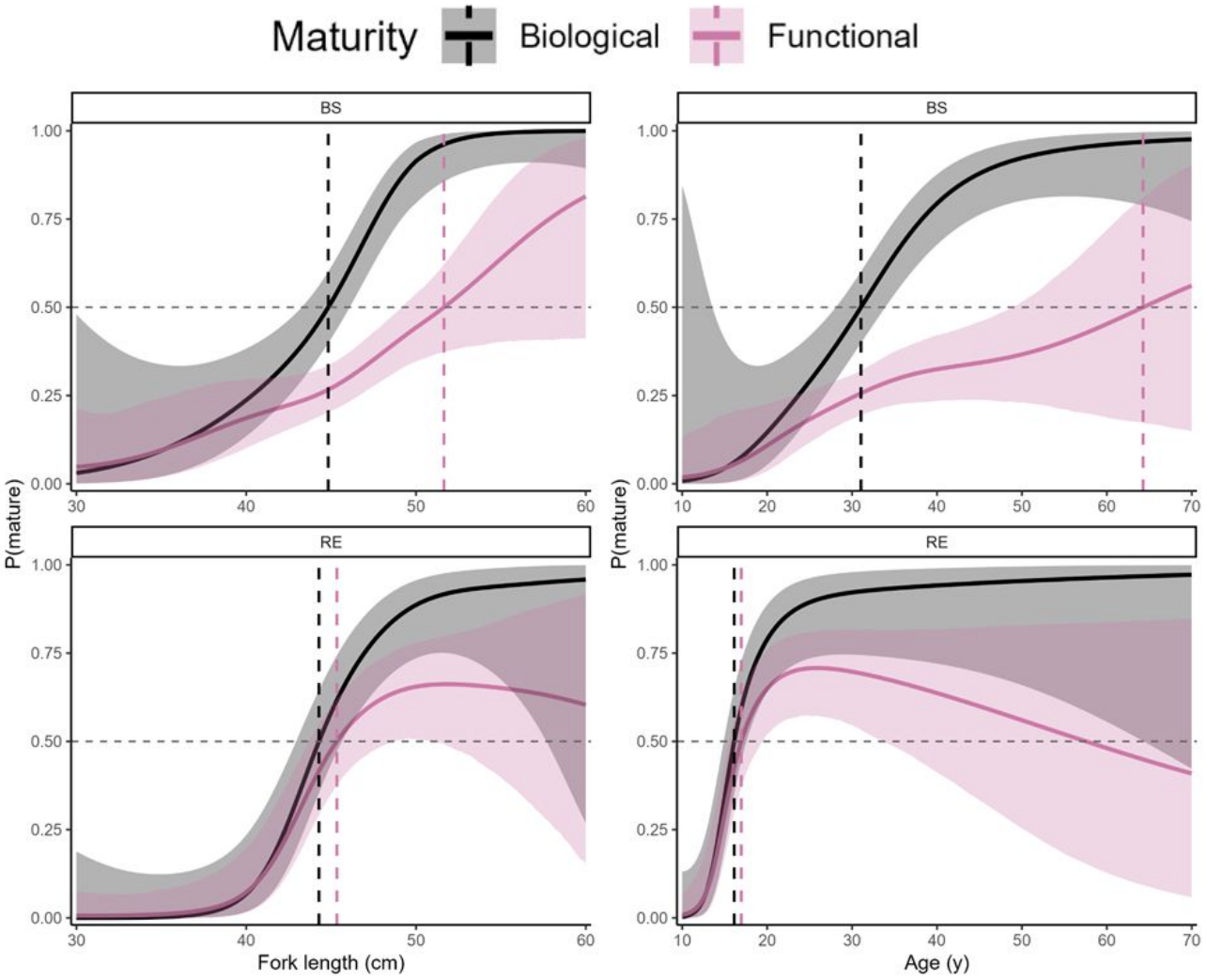
High misidentification rates in Conrath (2017)

- 40% of field-ID RE were BS
- 2% of field-ID BS were RE

High rates of skip spawning



Biological vs. functional maturity

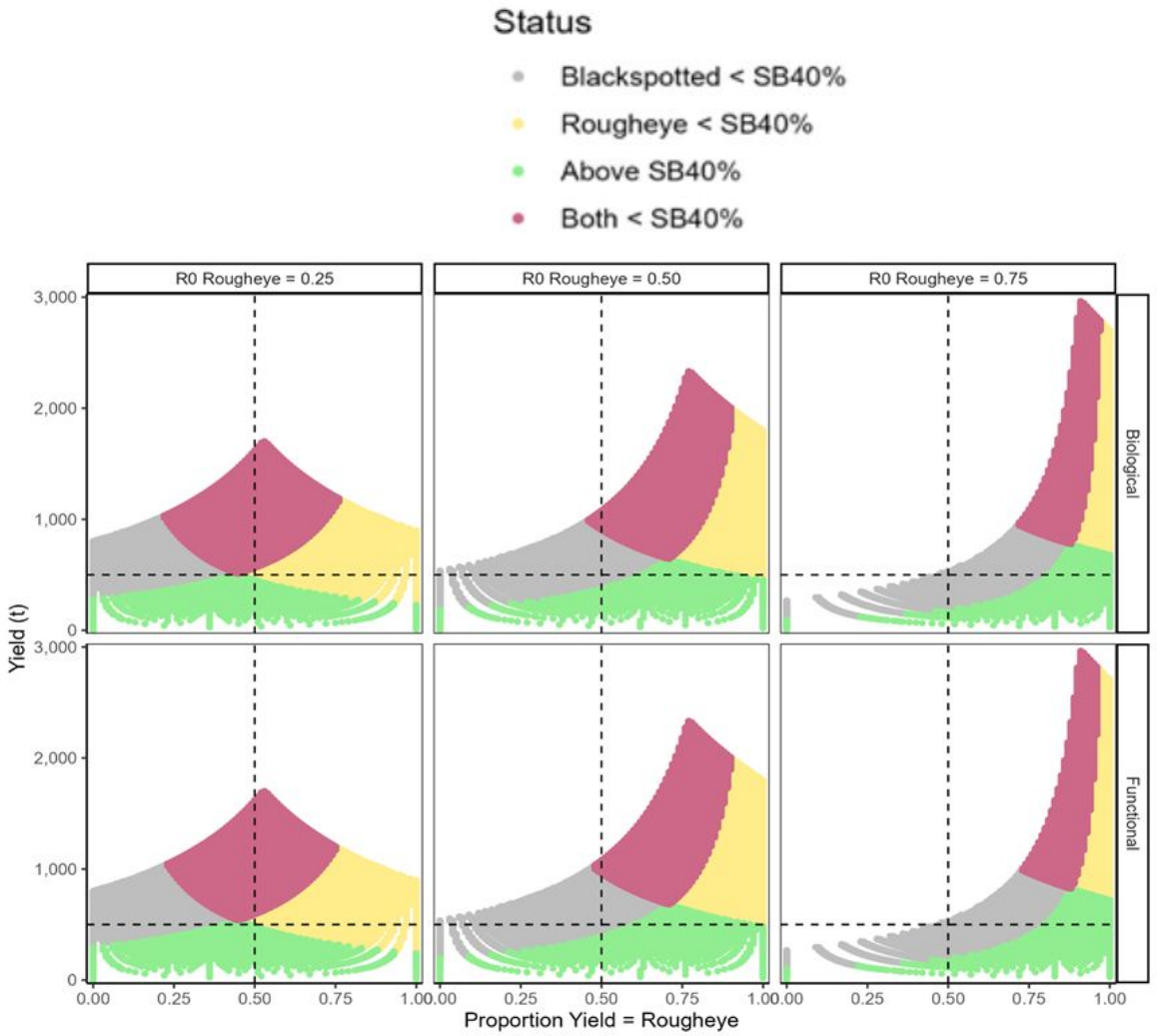


Impacts on management (YPR/SBPR)

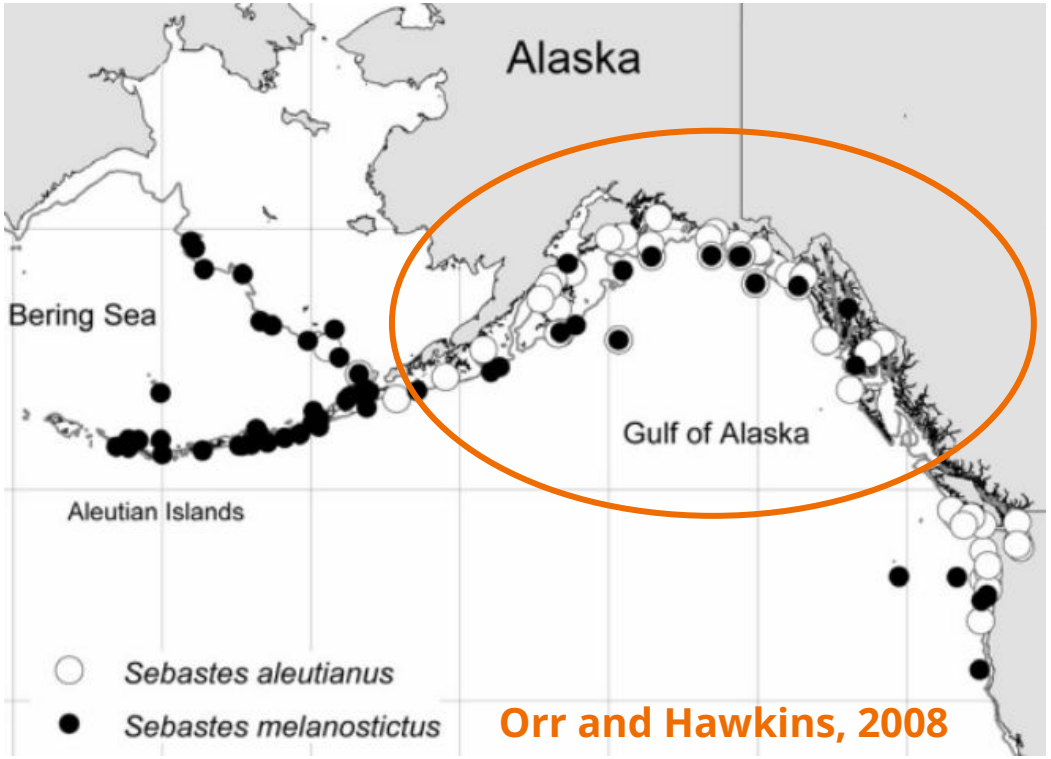
Primary axes of uncertainty

Yield: proportion RE and BS in the catch

Equilibrium recruitment (R0): proportion RE and BS making up R0







Orr and Hawkins, 2008

Same habitat

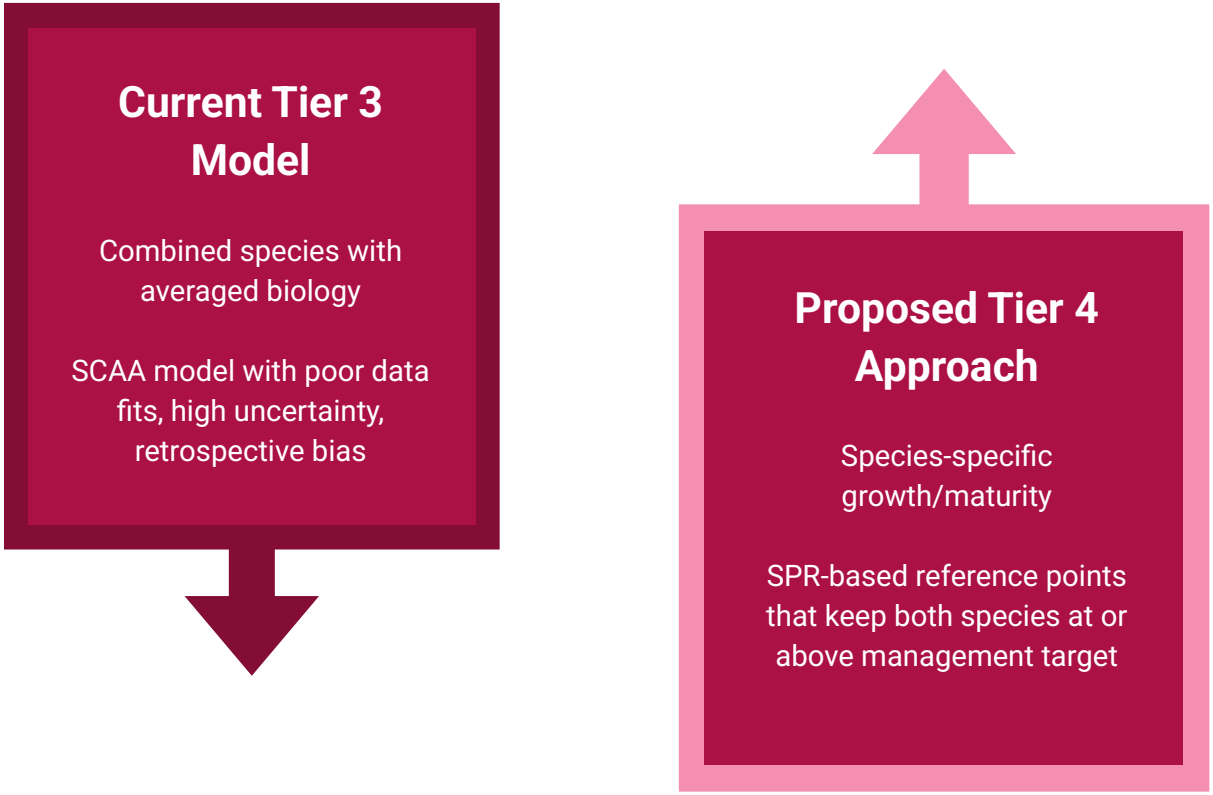
Same look

Same stock assessment…

Different life histories (growth, maturity)

Extremely long lived species (max age at AFSC = 144 y)

Consideration of Tier 4 (and Tier 5)



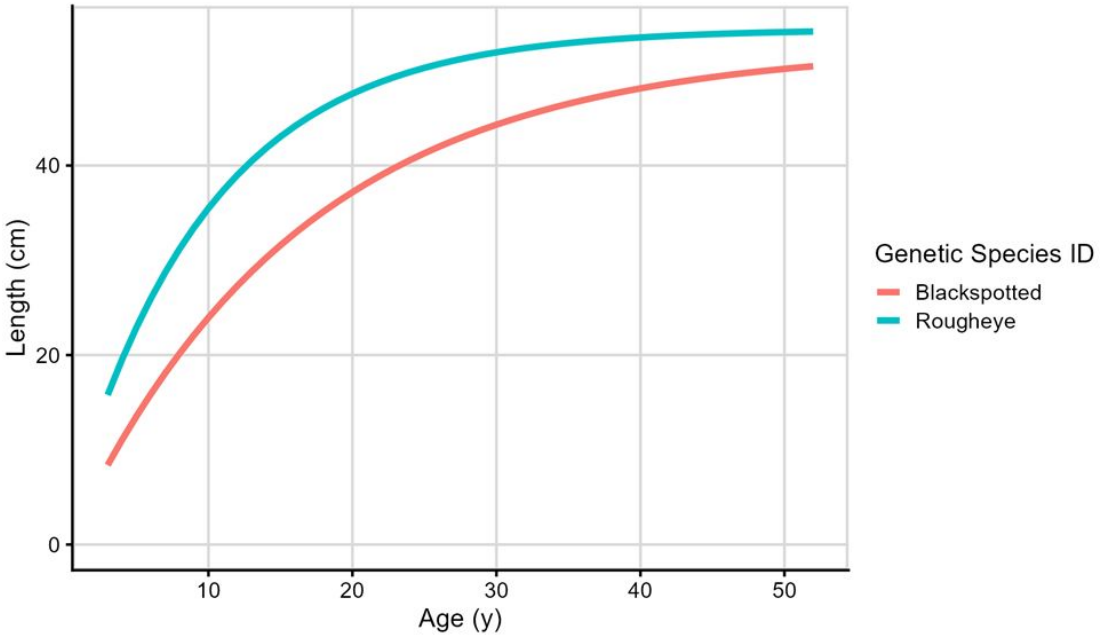
Tier 4 inputs

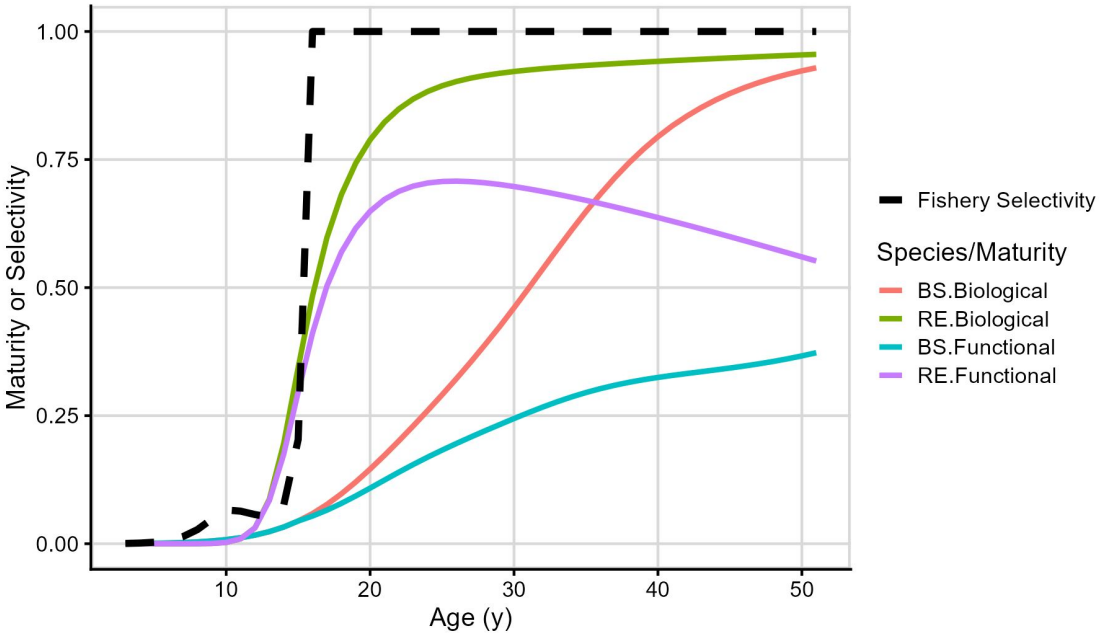
Assume equal RE/BS recruitment

Species-specific growth & maturity

Natural mortality based on available data (M=0.042; Sullivan et al. 2023)

Combined fishery and selectivity curve (Model 23.1b)





Summary of Tier 4 approach

1. Biological maturity Model 25.1a
2. Functional maturity (skipped spawning) Model 25.1b

Female spawning biomass per recruit under fishing ($SBPR_F$) was calculated as:

$$SBPR_F = \sum_a N_{a,F}^f \cdot w_a \cdot m_a$$

where $N_{a,F}^f$ is the number of females at age a under fishing mortality F, w_a is weight-at-age, and m_a is maturity-at-age. The unfished spawning biomass per recruit ($SBPR_0$) was calculated similarly, assuming F=0. The spawning potential ratio $SPR(F)$ was then defined as:

$$SPR(F) = \frac{SBPR_F}{SBPR_0}$$

The reference points $F_{40\%}$ and $F_{35\%}$ are the fishing mortalities at which $SPR(F_{40\%})$=0.4 or $SPR(F_{35\%})$=0.35, respectively.

The female abundance at age under fishing ($N^f_{a,F}$) was calculated recursively:

$$N^f_{1,F} = R_0 \cdot s$$

$$N^f_{a,F} = N^f_{a-1,F} \cdot e^{-Z_{a-1}}, \text{ for } a = 2, \ldots, A-1$$

$$N^f_{A,F} = \frac{N^f_{A-1,F} \cdot e^{-Z_{A-1}}}{1-e^{-Z_A}},$$

where s=0.5 is the assumed sex ratio, R_0=1 is the unit-less equilibrium mean recruitment, $Z_a = M + F \cdot S_a$ is total mortality at age, and A=52 is the maximum age class (same as Model 23.1b).

Numbers caught by age were calculated using the Baranov catch equation:

$$C_{a,F} = \frac{F \cdot S_a}{F \cdot S_a + M} \cdot (1 - e^{-Z_a}) \cdot N_{a,F}.$$

Total equilibrium YPR was obtained by summing the product of yield-at-age and weight-at-age.

Results: Tier 4 species-specific F rates

Per-recruit quantities are modeled separately, then we propose one complex-level F such that each species meets or exceeds the SPR target

F_complex = min(RE_F40%, BS_F40%) or

min(RE_F35%, BS_F35%)

Tier 4	**RE $F_{35\%}$**	**RE $F_{40\%}$**	**BS $F_{35\%}$**	**BS $F_{40\%}$**
Model 25.1a (biological)	0.058	0.048	0.033	0.028
Model 25.1b (functional)	0.067	0.055	0.037	0.031

Why are F40/F35s higher for functional maturity?

Explained by relationships between maturity & selectivity curves

Functional maturity is depressed relative to biological maturity at ages where selectivity/vulnerability to fishery is highest (~15-30 y)

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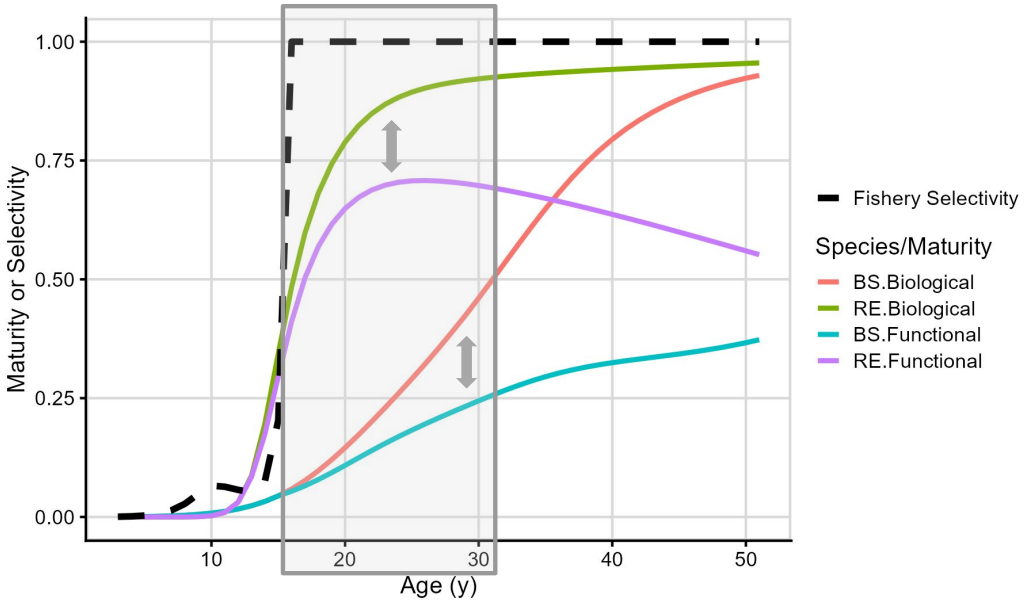
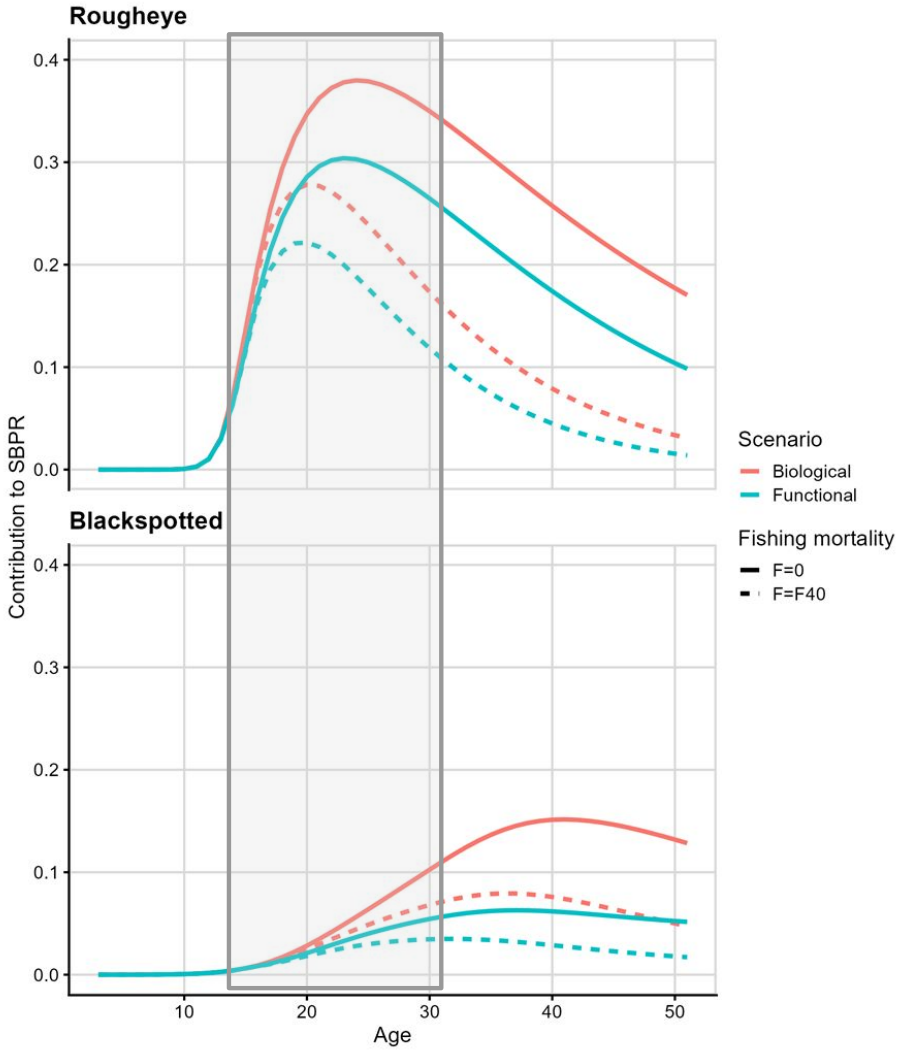


Why are F40/F35s higher for functional maturity?

In an unfished state, fewer spawners contribute at those vulnerable ages under functional maturity than under biological maturity

⟶ fishing therefore removes relatively less spawning potential under functional maturity

⟶ have to fish harder to reach F40% under functional maturity scenarios despite lower productivity



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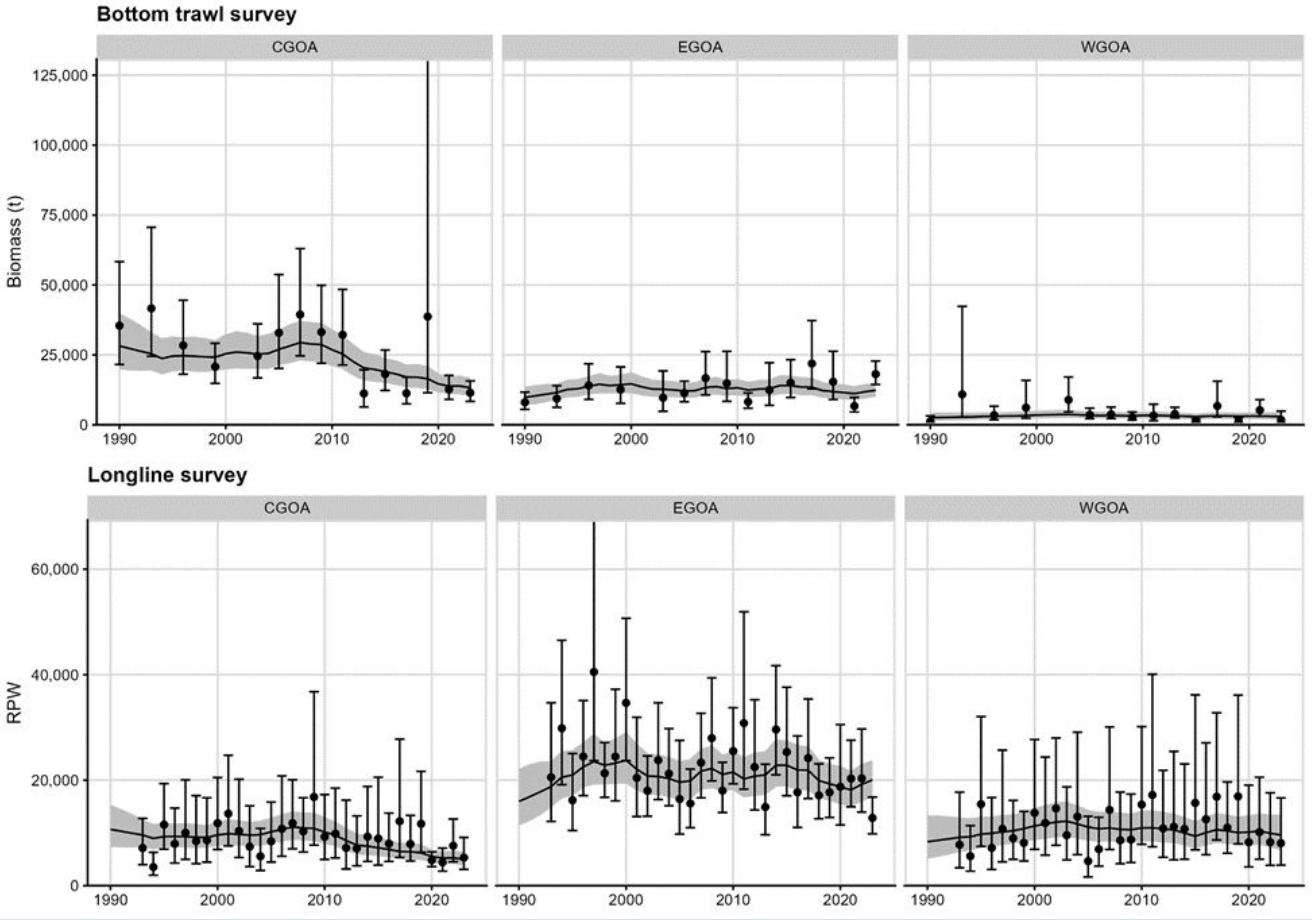
Biomass estimation for Tiers 4 and 5

- REMA model used for GOA RE/BS apportionment
- Uses trawl survey biomass & longline survey RPWs by area
- Single process error, area-specific scaling parameters



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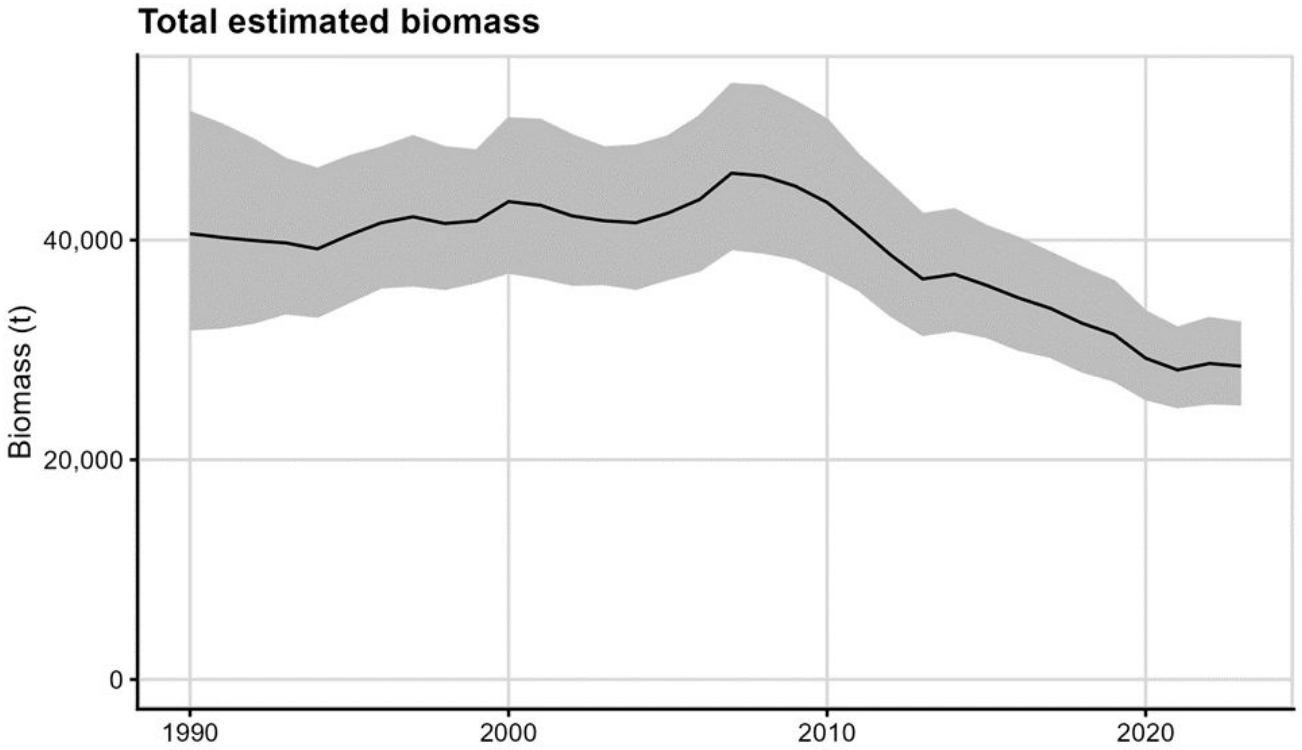


Quantity	*As estimated or recommended in 2023*:		**Quantity**	*As estimated or recommended in 2023:*		
	2024	2025		2024/25		
Model	Model 23.1b		Model	Model 25.1a	Model 25.1b	Model 25.2
M (natural mortality rate)	0.042	0.042	*M*	0.042	0.042	0.042
Tier	3a	3a	Tier	4	4	5
Projected total (ages 3+) biomass (t)	46,029	46,109	REBS estimated biomass (t) from REMA model	28,531		
Projected female spawning biomass (t)	12,986	13,005				
$B_{100\%}$	21,878	21,878				
$B_{40\%}$	8,751	8,751				
$B_{35\%}$	7,657	7,657				
			Rougheye F_{OFL}	0.058	0.067	
			Rougheye F_{ABC}	0.048	0.055	
			Blackspotted F_{OFL}	0.033	0.037	
			Blackspotted F_{ABC}	0.028	0.031	
F_{OFL}	0.045	0.045	F_{OFL}	0.033	0.037	0.042
$maxF_{ABC}$	0.038	0.038	$maxF_{ABC}$	0.028	0.031	0.032
F_{ABC}	0.030	0.030	F_{ABC}	0.028	0.031	0.032
OFL (t)	**1,555**	**1,566**	OFL (t)	**942**	**1,056**	**1,198**
maxABC (t)	1,302	1,310	maxABC (t)	799	884	913
ABC (t)	**1,037**	**1,041**	ABC (t)	**799**	**884**	**913**

Author recommendations for Nov 2025

Models:

Model 23.1b (Tier 3 base)

Model 25.1a (Tier 4 biological maturity)

Model 25.1b (Tier 4 functional maturity)

Model 25.2 (Tier 5)

Sensitivities:

Fishery selectivity (age at full selection)

Species composition of recruitment (assumes 50:50 in 25.1a and 25.1b)

Biggest data gap:

Species composition of catch

2025 survey updates

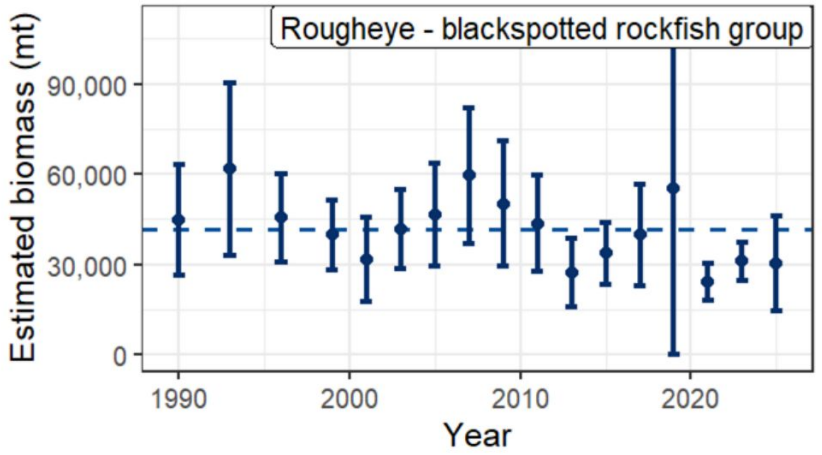
GOA bottom trawl survey:

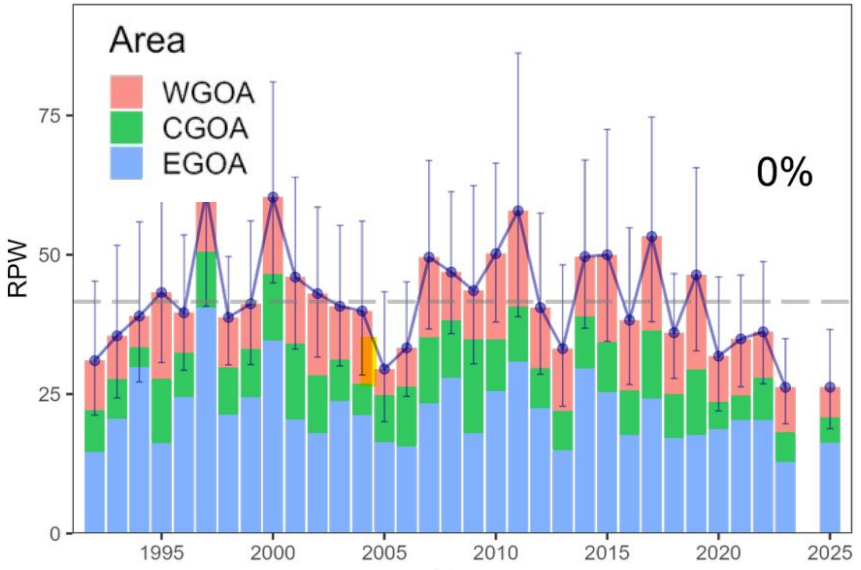
-2.3% since 2023

GOA longline survey:

0% change since 2023

Thx survey teams :)

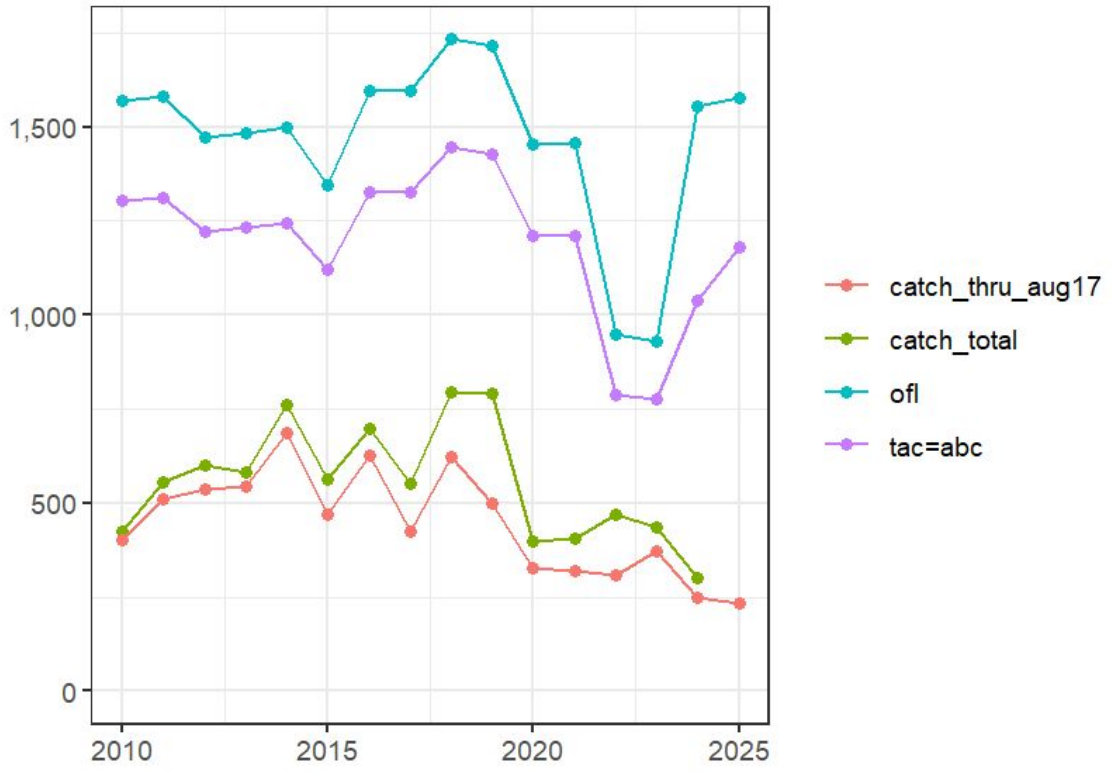




2025 fishery updates

Catch << TAC

Mostly rockfish trawl in the WG and CG, sablefish hook and line in the EG

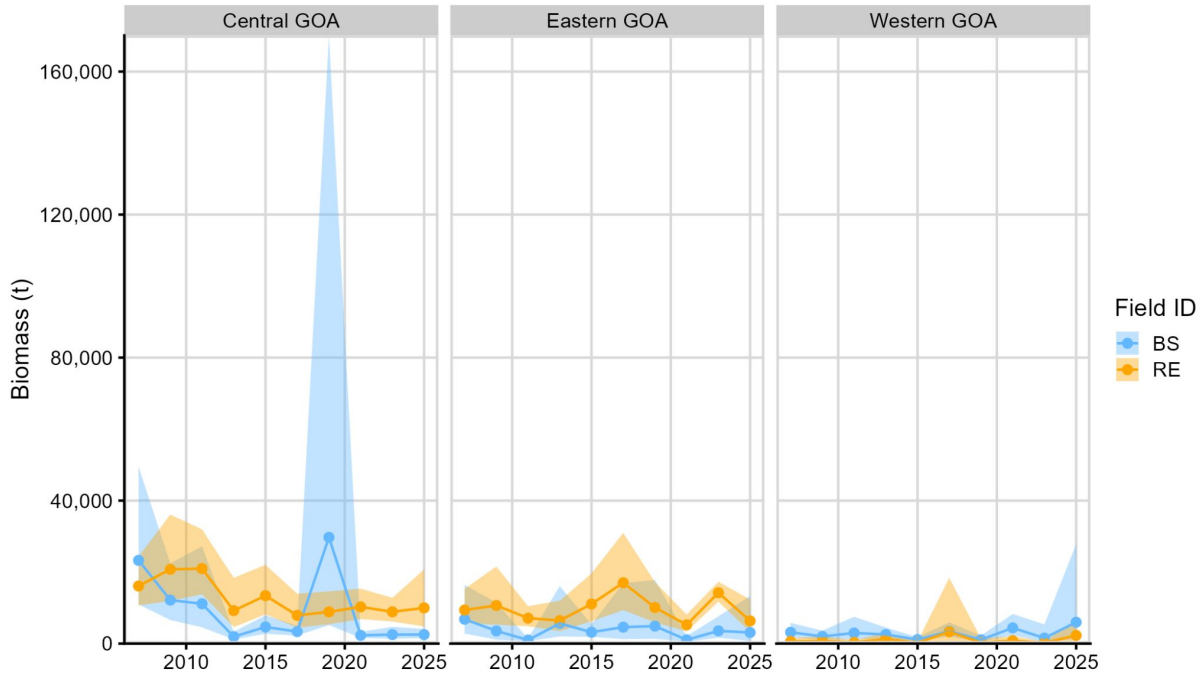


Extra slides

Trawl Survey Field ID since 2008

Proportion RE range: 0.45-0.75

Don’t want to use these in stock assessments because of high misidentification rates



Risk Table Summary from 2023

Recommend reduction from max ABC
Author-recommended model was not reviewed in September

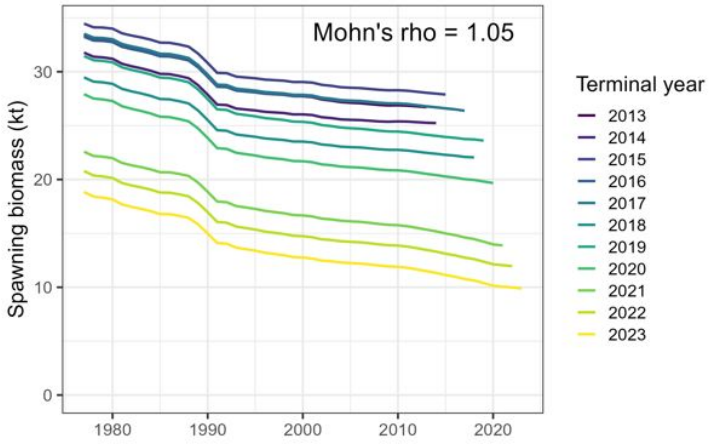
Assessment	Population Dynamics	Ecosystem	Fishery
2 - Major Concern	**2 - Major Concern**	1 - None	1 - None
(Base model) ● Severe one-way positive retrospective bias ● High uncertainty in stock scale **(Recommended model)** ● Improved stability, but unable to account for recent declines in survey indices	● Declines in LLS and BTS indices in recent years ● 2023 LLS abundance lowest on record ● 2021 BTS lowest on record	● Average environmental conditions ● Some evidence of long-term declines in structural epifauna	● Incidental catch only ● Catch << ABC ● Not currently constraining target fisheries

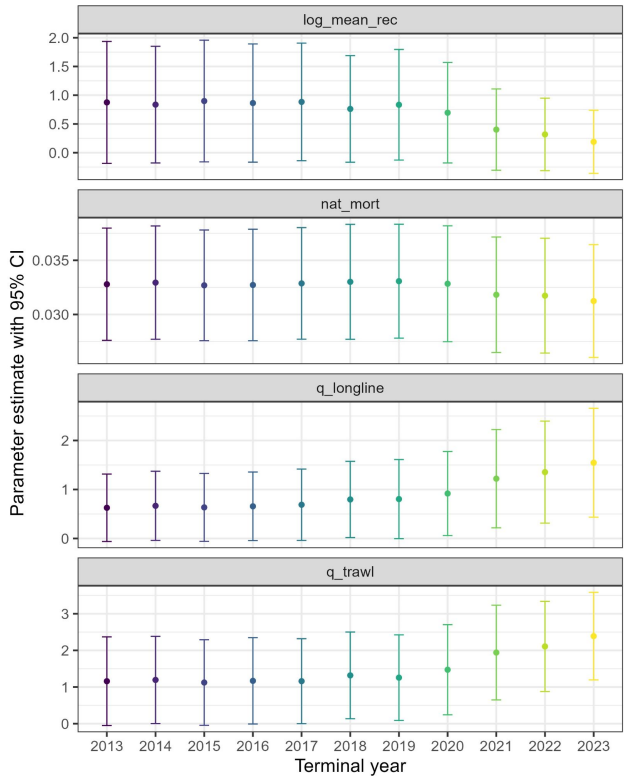
LLS = longline survey
BTS = bottom trawl survey

Assessment summary

- Base model M15.4 first accepted in 2015
- In Sep 2023, we presented new *M*, maturity, ageing error, growth, and apportionment
- When new data were added, the retrospective bias went from bad in 2021 (Mohn's rho=0.61) to worse (Mohn's rho=1.05)
- Why? Recent trends in data caused large retrospective patterns in both survey catchabilities, *M*, and recruitment, which are all estimated in M15.4
- Constraining catchability, *M*, and recruitment variability stabilized the model (recommended M23.1b, Mohn's rho=0.14)
- However, M23.1b has degraded fits to the data and biomass trajectories that are inconsistent with recent trends in survey abundance

Assessment	Population Dynamics
2 - Major Concern	**2 - Major Concern**





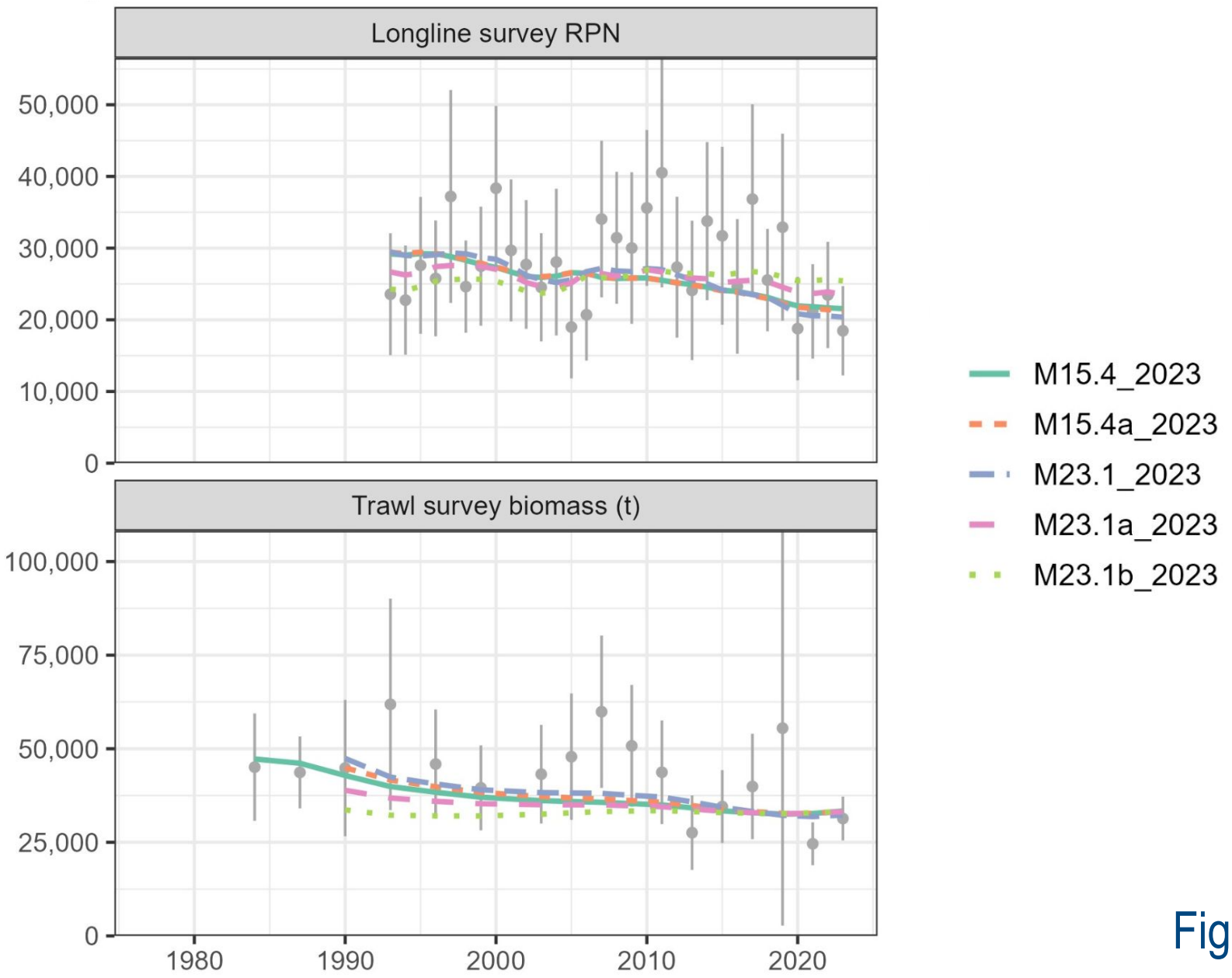
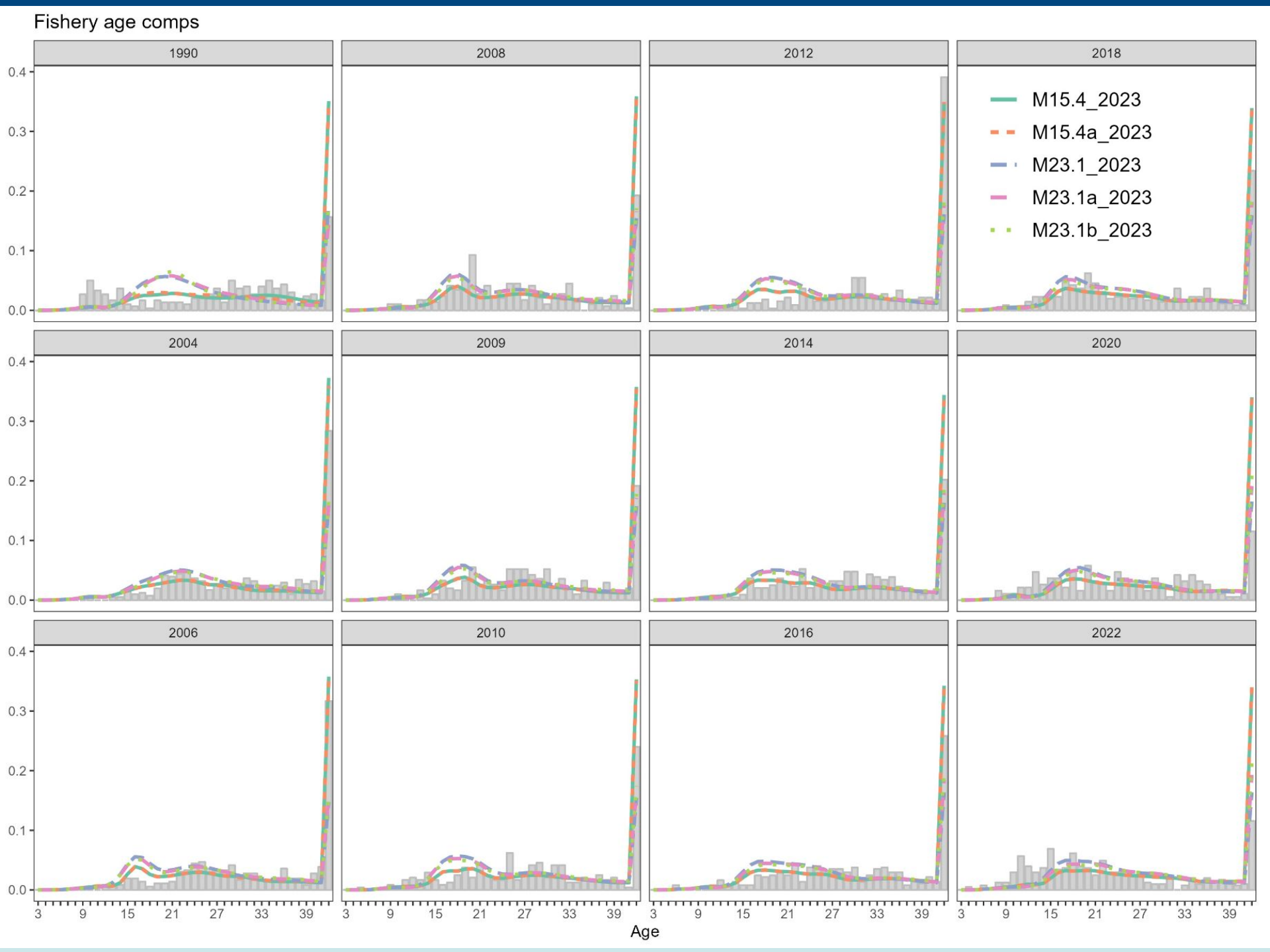
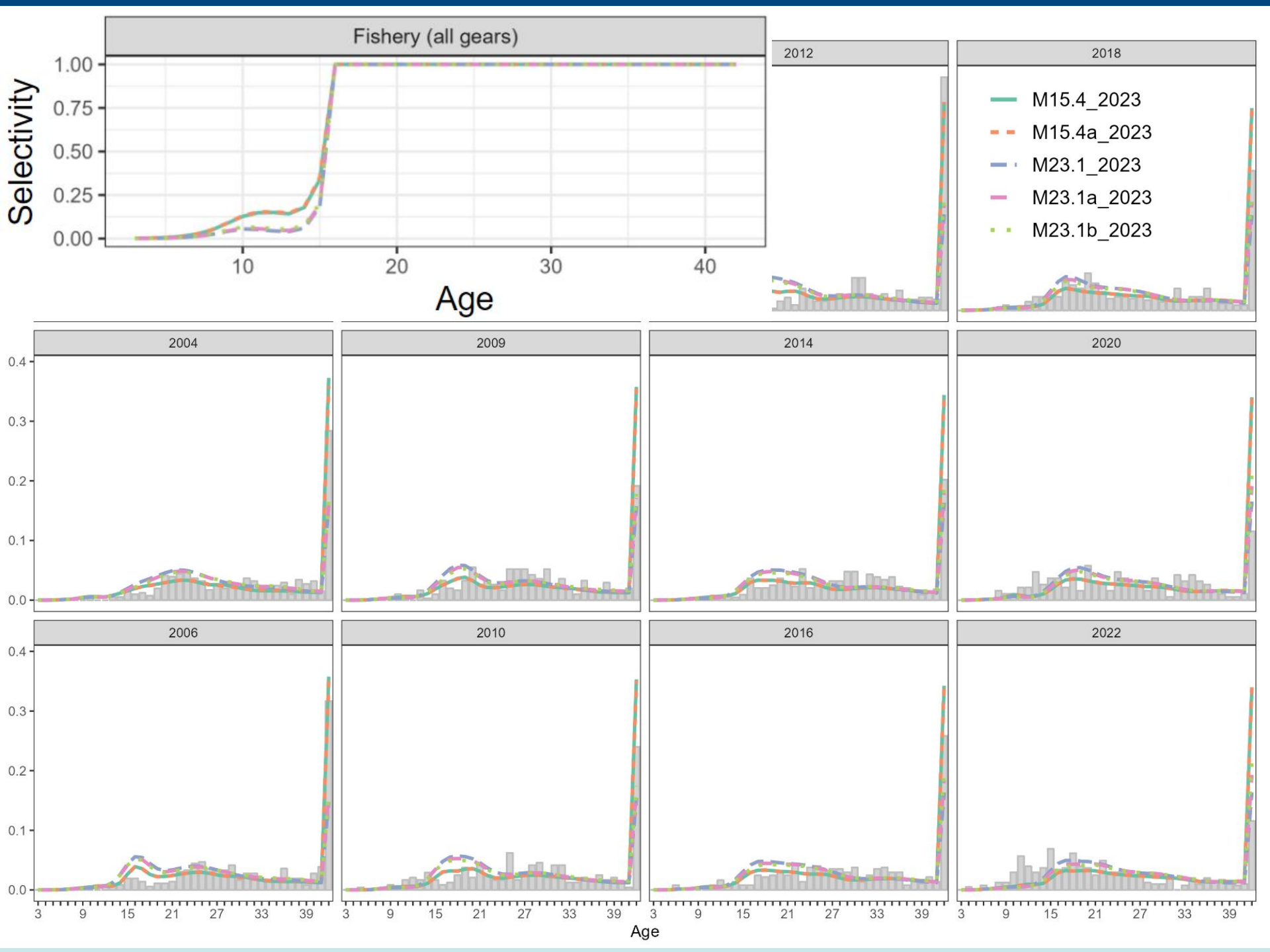
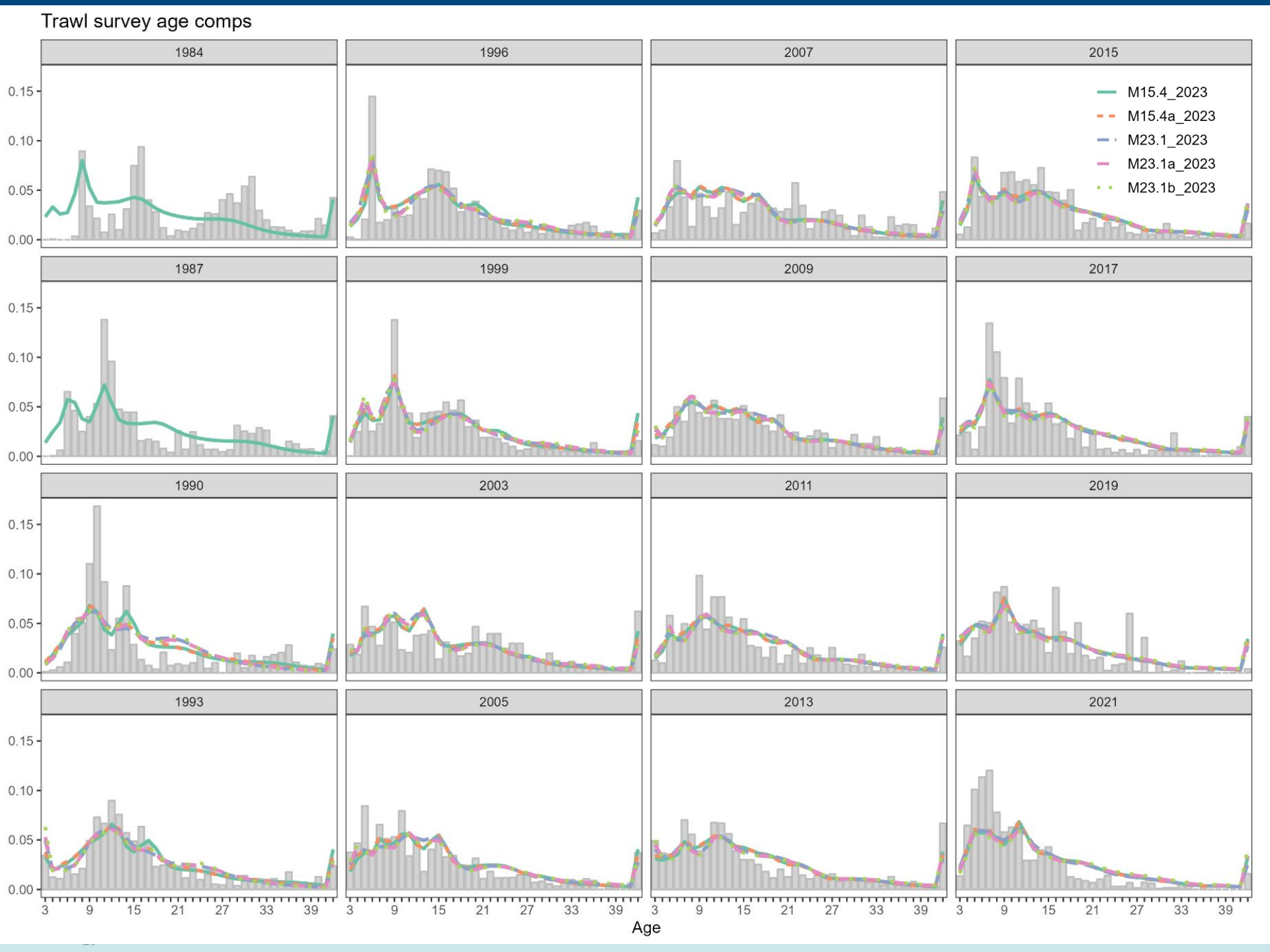
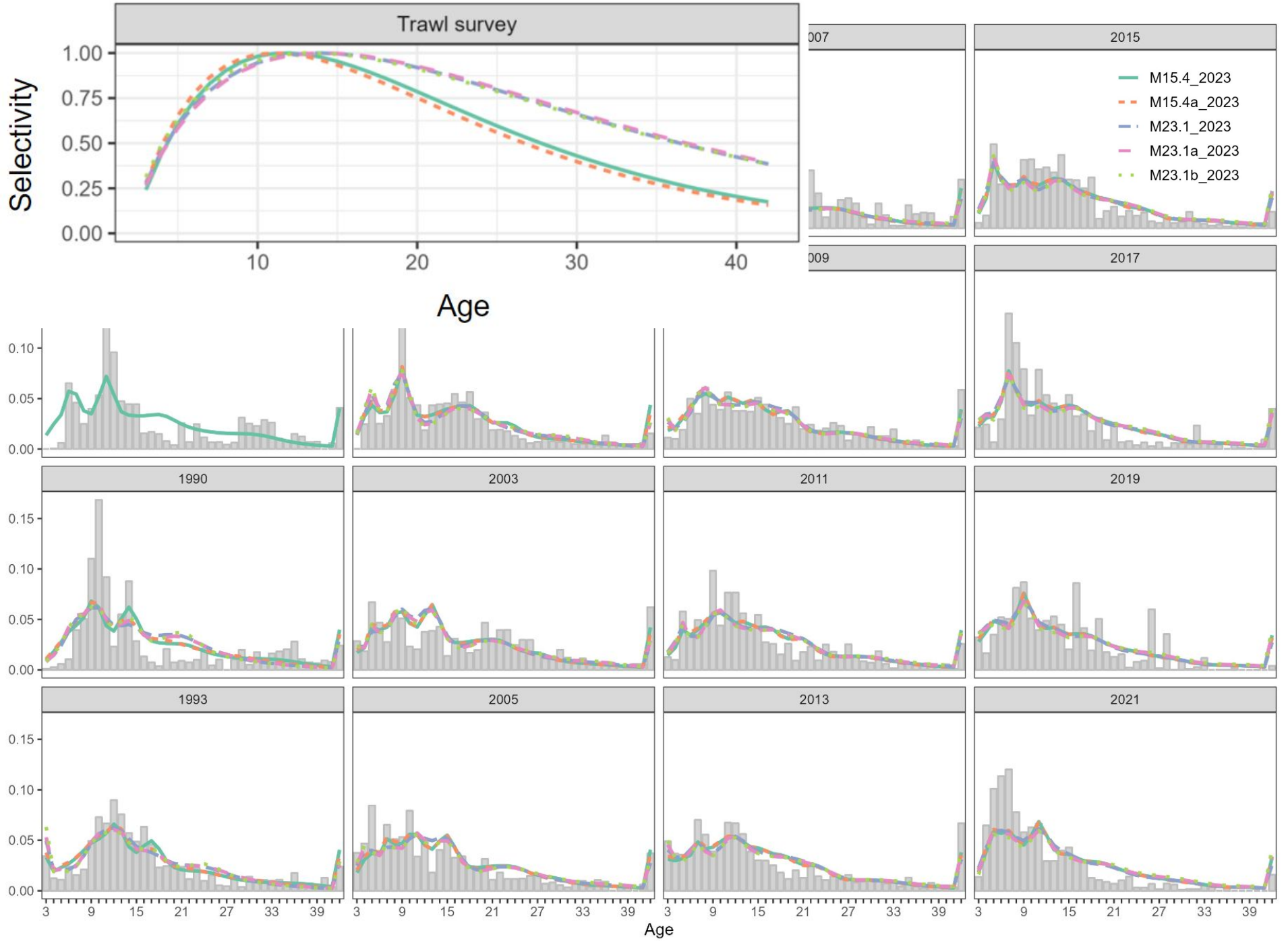

Longline survey RPN
50,000
40,000
30,000
20,000
10,000
0
Trawl survey biomass (t)
100,000
75,000
50,000
25,000
0
1980
1990
2000
2010
2020
M15.4_2023
M15.4a_2023
M23.1_2023
M23.1a_2023
M23.1b_2023

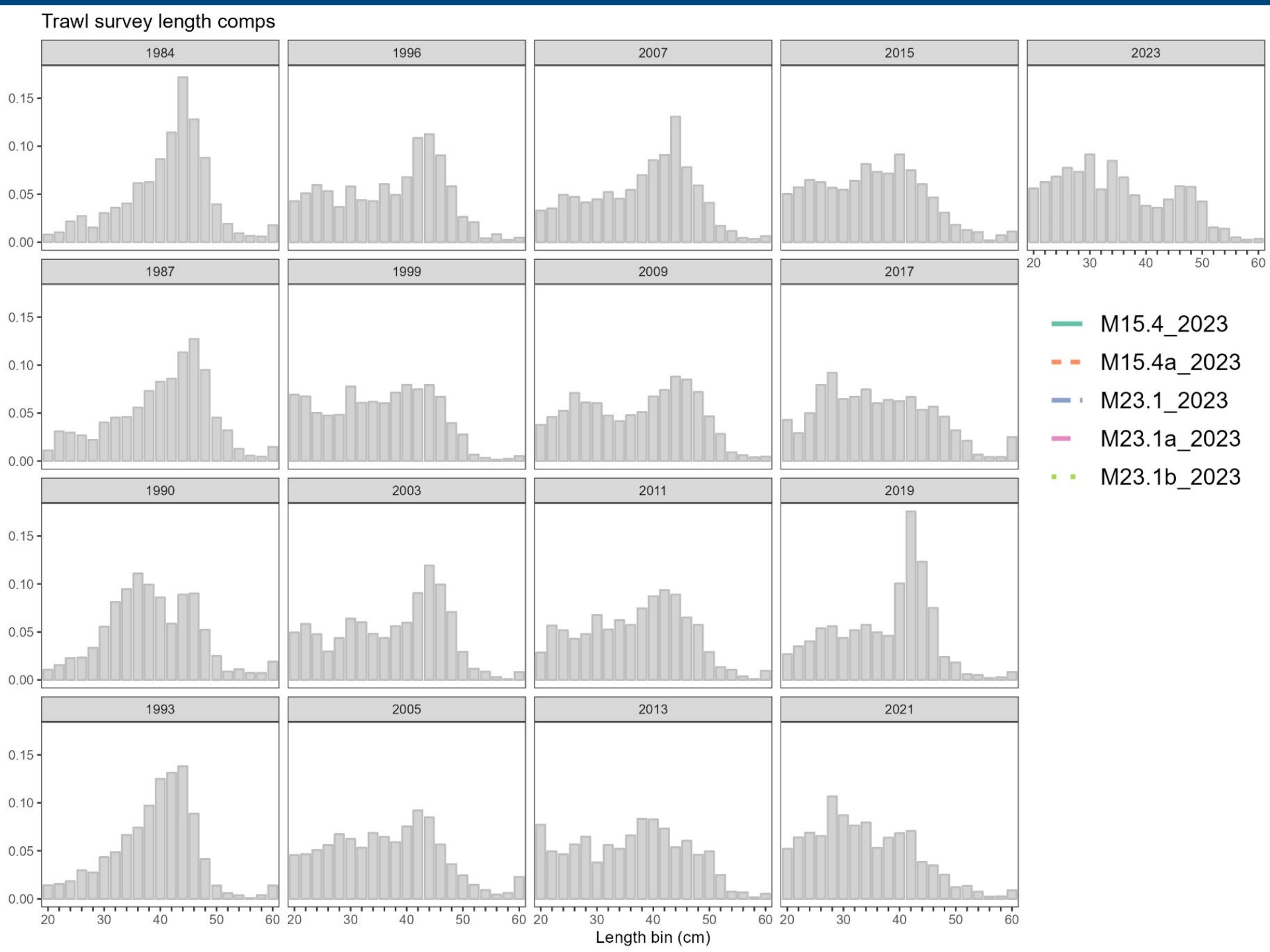
Figure 13-1


Fishery age comps
1990
2008
2012
2018
2004
2009
2014
2020
2006
2010
2016
2022
0.0
0.1
0.2
0.3
0.4
3
9
15
21
27
33
39
Age
M15.4_2023
M15.4a_2023
M23.1_2023
M23.1a_2023
M23.1b_2023

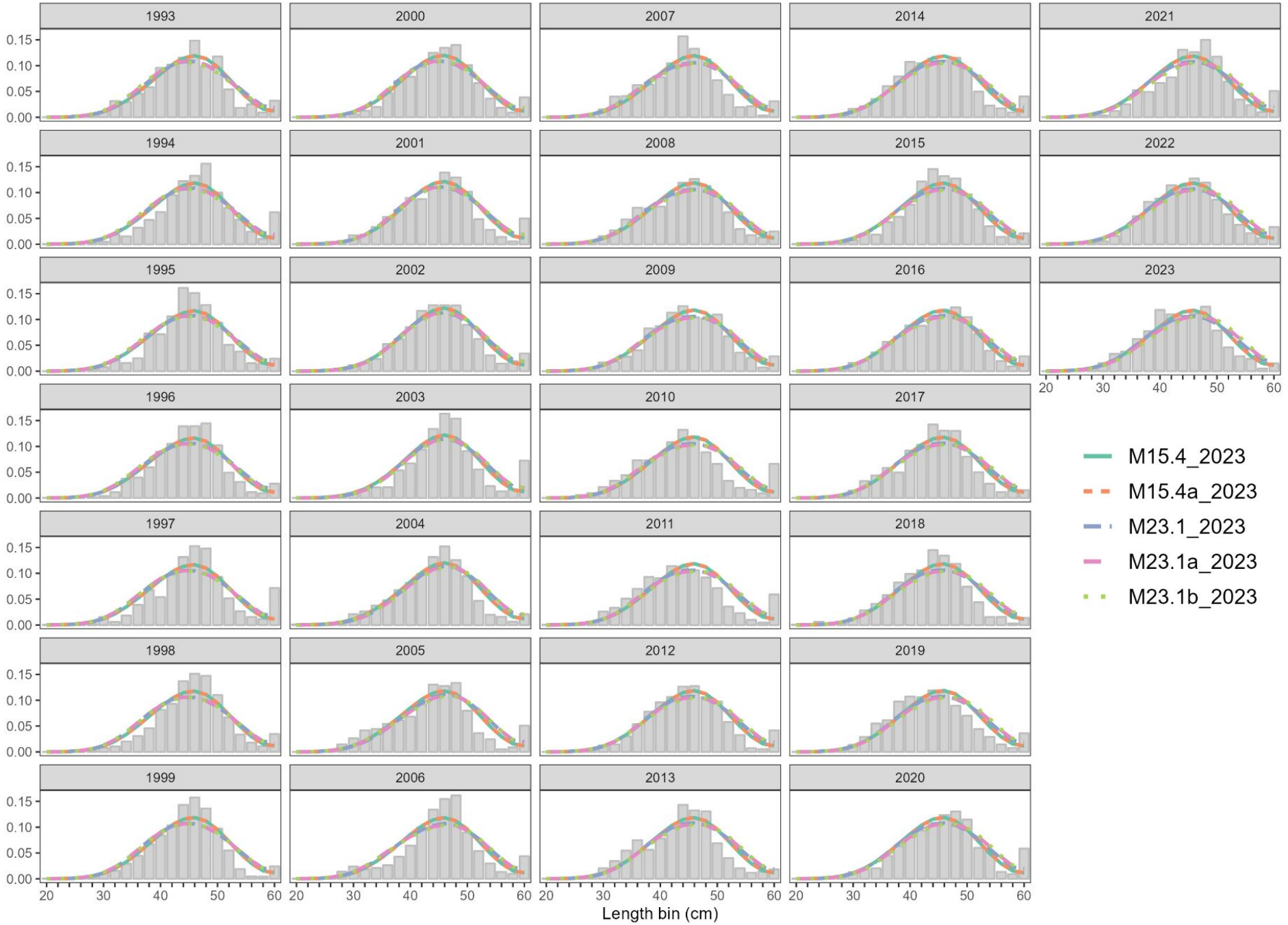

Fishery (all gears)
Selectivity
1.00
0.75
0.50
0.25
0.00
10
20
30
40
Age
2012
2018
M15.4_2023
M15.4a_2023
M23.1_2023
M23.1a_2023
M23.1b_2023
2004
2009
2014
2020
2006
2010
2016
2022
0.4
0.3
0.2
0.1
0.0
3
9
15
21
27
33
39
Age

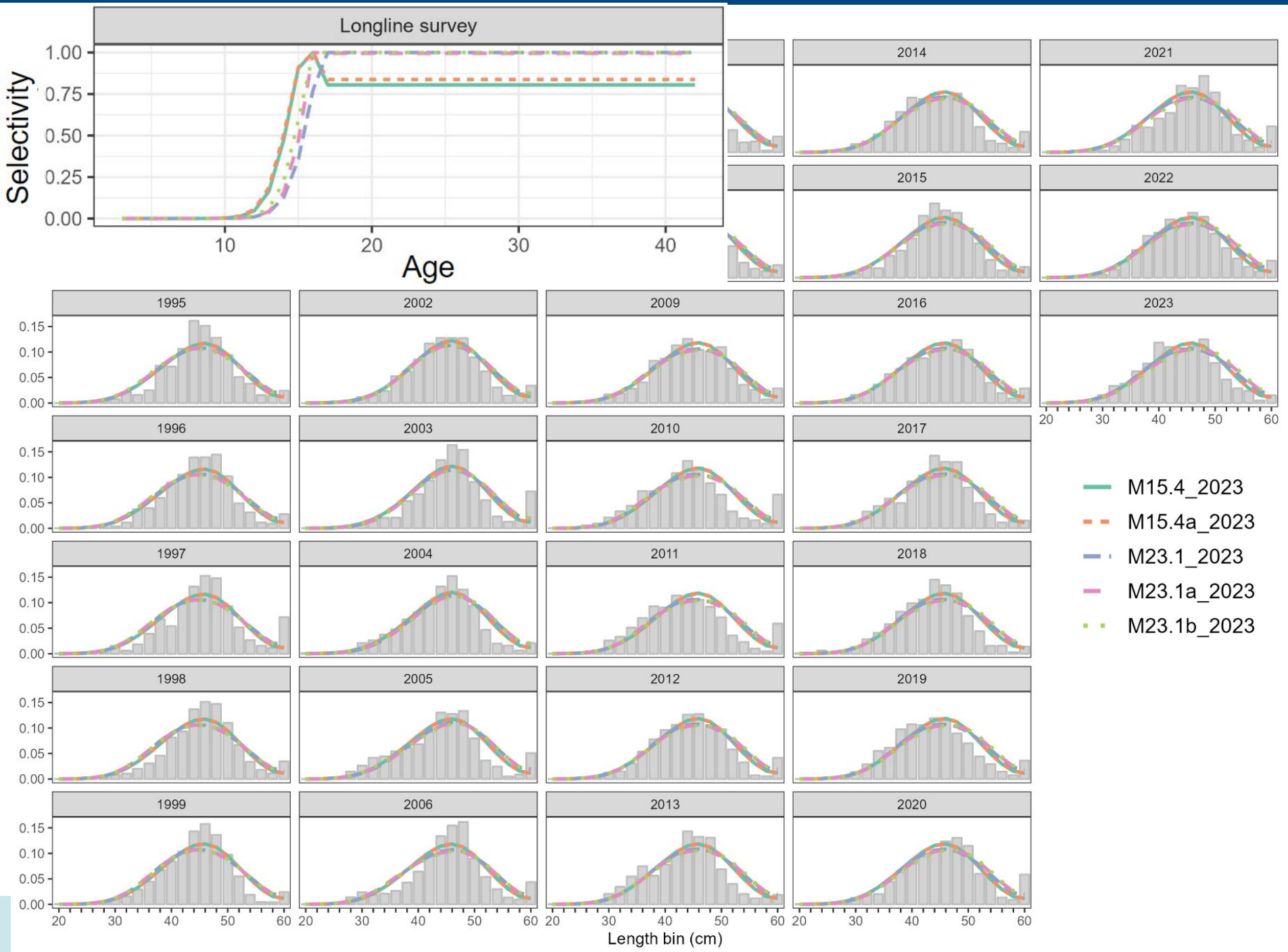

Trawl survey age comps
1984
1996
2007
2015
1987
1999
2009
2017
1990
2003
2011
2019
1993
2005
2013
2021
M15.4_2023
M15.4a_2023
M23.1_2023
M23.1a_2023
M23.1b_2023
0.15
0.10
0.05
0.00
3
9
15
21
27
33
39
Age

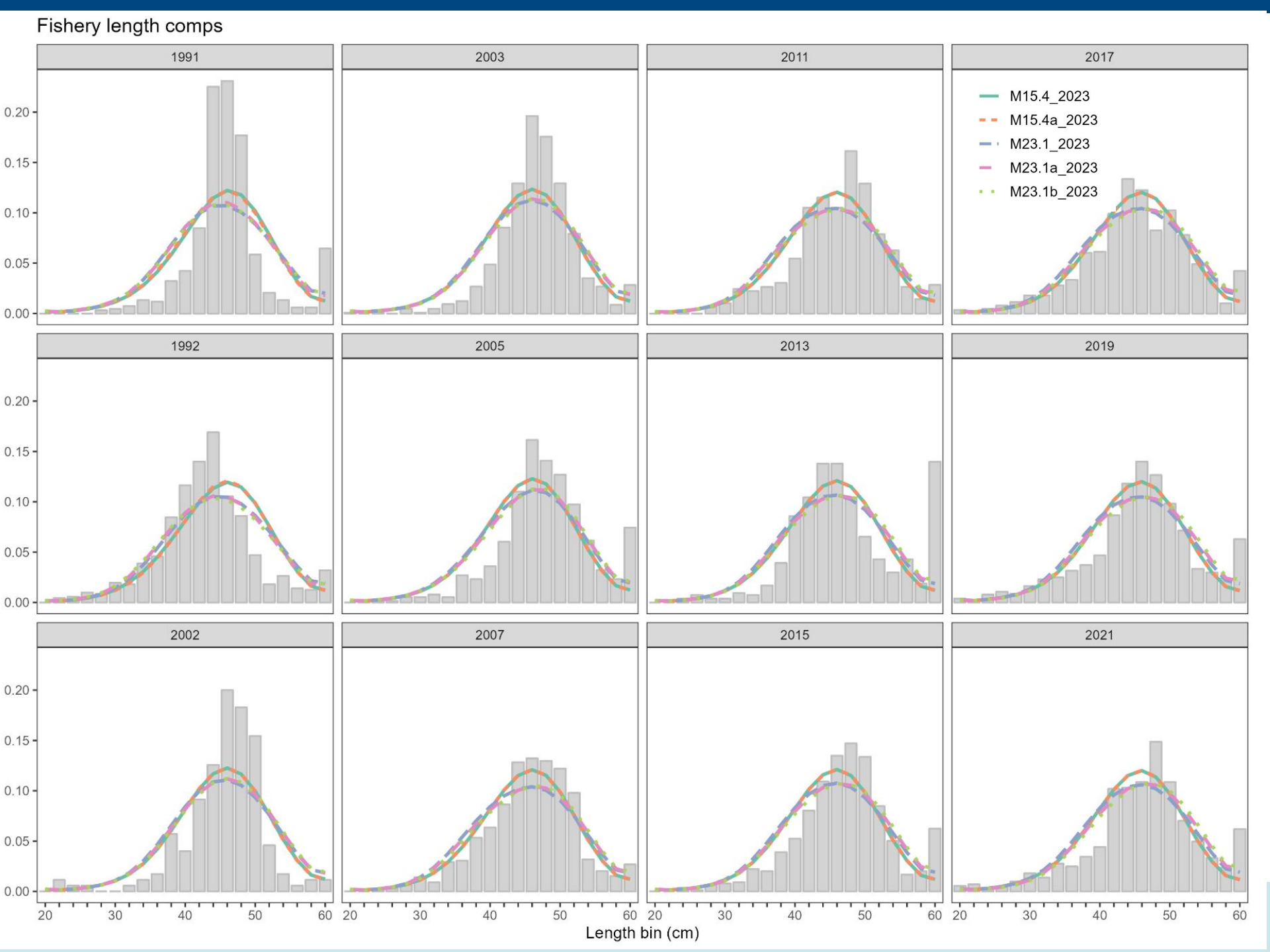

Trawl survey
Selectivity
1.00
0.75
0.50
0.25
0.00
10
20
30
40
Age
M15.4_2023
M15.4a_2023
M23.1_2023
M23.1a_2023
M23.1b_2023
007
2015
009
2017
1990
2003
2011
2019
1993
2005
2013
2021
0.10
0.05
0.00
0.15
3
9
15
21
27
33
39
Age


Trawl survey length comps
1984
1996
2007
2015
2023
1987
1999
2009
2017
1990
2003
2011
2019
1993
2005
2013
2021
0.00
0.05
0.10
0.15
20
30
40
50
60
Length bin (cm)
M15.4_2023
M15.4a_2023
M23.1_2023
M23.1a_2023
M23.1b_2023

Longline survey length comps



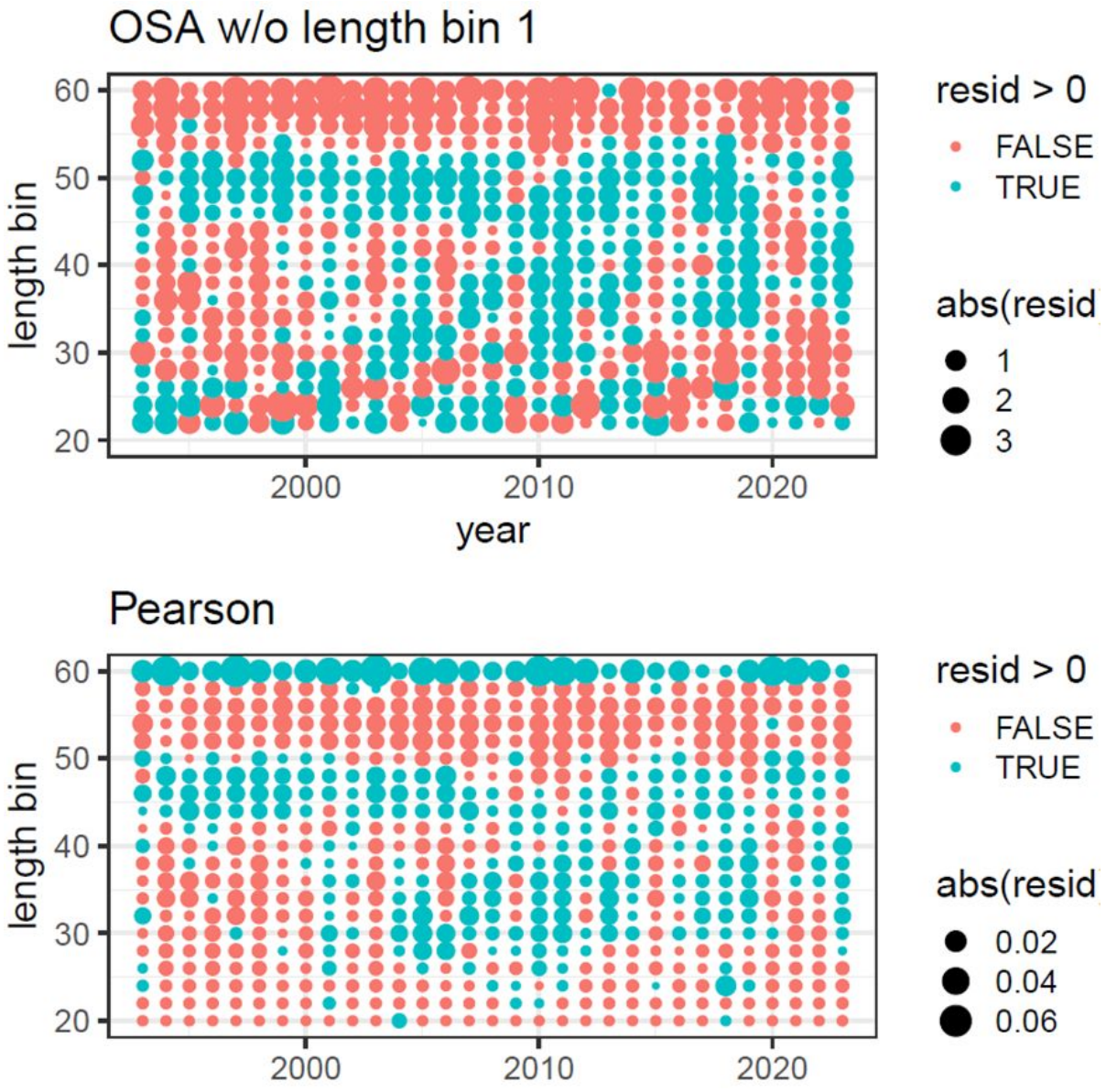

Longline survey
Selectivity
1.00
0.75
0.50
0.25
0.00
10
20
30
40
Age
2014
2021
2015
2022
1995
2002
2009
2016
2023
1996
2003
2010
2017
1997
2004
2011
2018
1998
2005
2012
2019
1999
2006
2013
2020
0.15
0.10
0.05
0.00
20
30
40
50
60
Length bin (cm)
M15.4_2023
M15.4a_2023
M23.1_2023
M23.1a_2023
M23.1b_2023


Fishery length comps
1991
2003
2011
2017
1992
2005
2013
2019
2002
2007
2015
2021
M15.4_2023
M15.4a_2023
M23.1_2023
M23.1a_2023
M23.1b_2023
0.00
0.05
0.10
0.15
0.20
20
30
40
50
60
Length bin (cm)

All around poor fits to comp data

Red = overestimating

Blue = underestimating



Figures 13-11 – 13-14

What are “reasonable” estimates of q?

q < 1.0
Survey underestimates abundance
(e.g., untrawlable habitat)

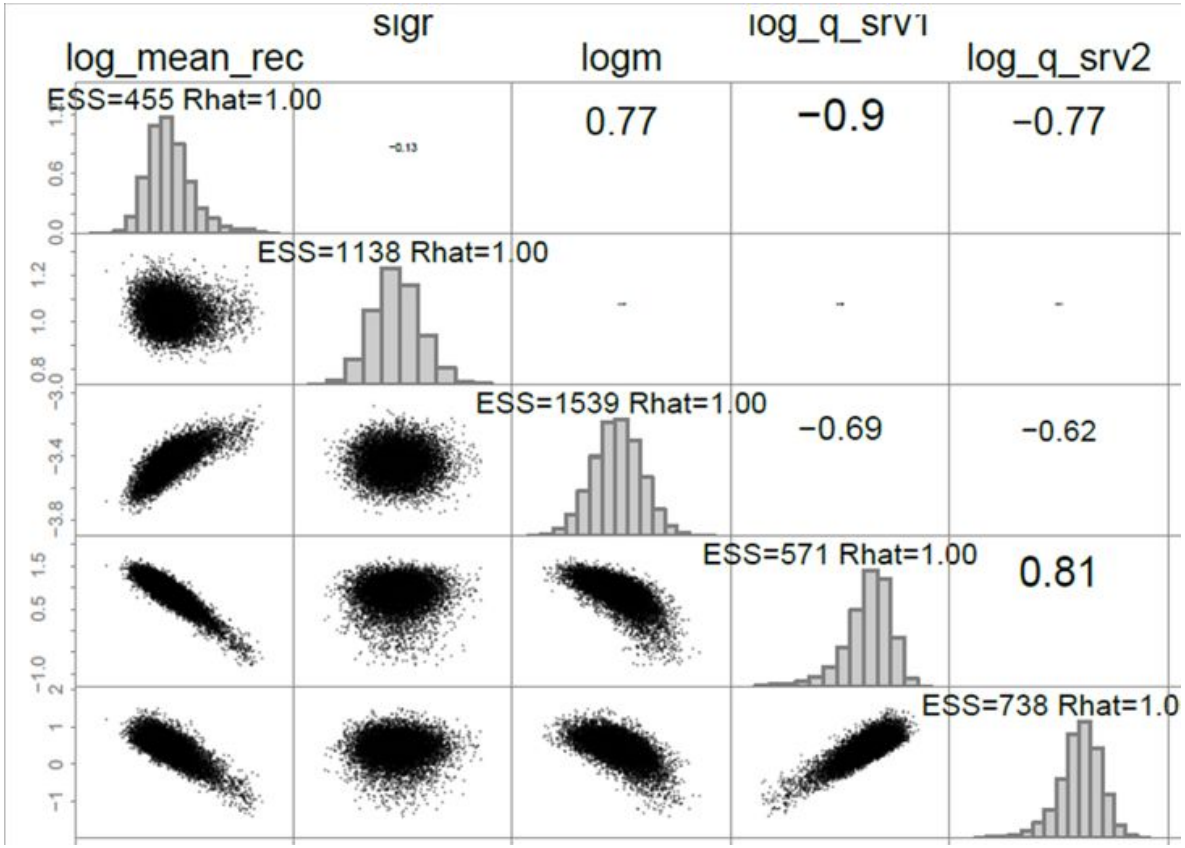
q = 1.0
Survey abundance = True abundance

q > 1.0
Survey overestimates abundance (e.g., herding fish into trawl gear)

- Jones et al. 2021, Somerton et al. 1999, Krieger and Sigler 1996 - no mention of slope rockfish, all highlight the importance of size-selectivity
- No clear mechanism for high q of RE/BS in trawl or longline gear

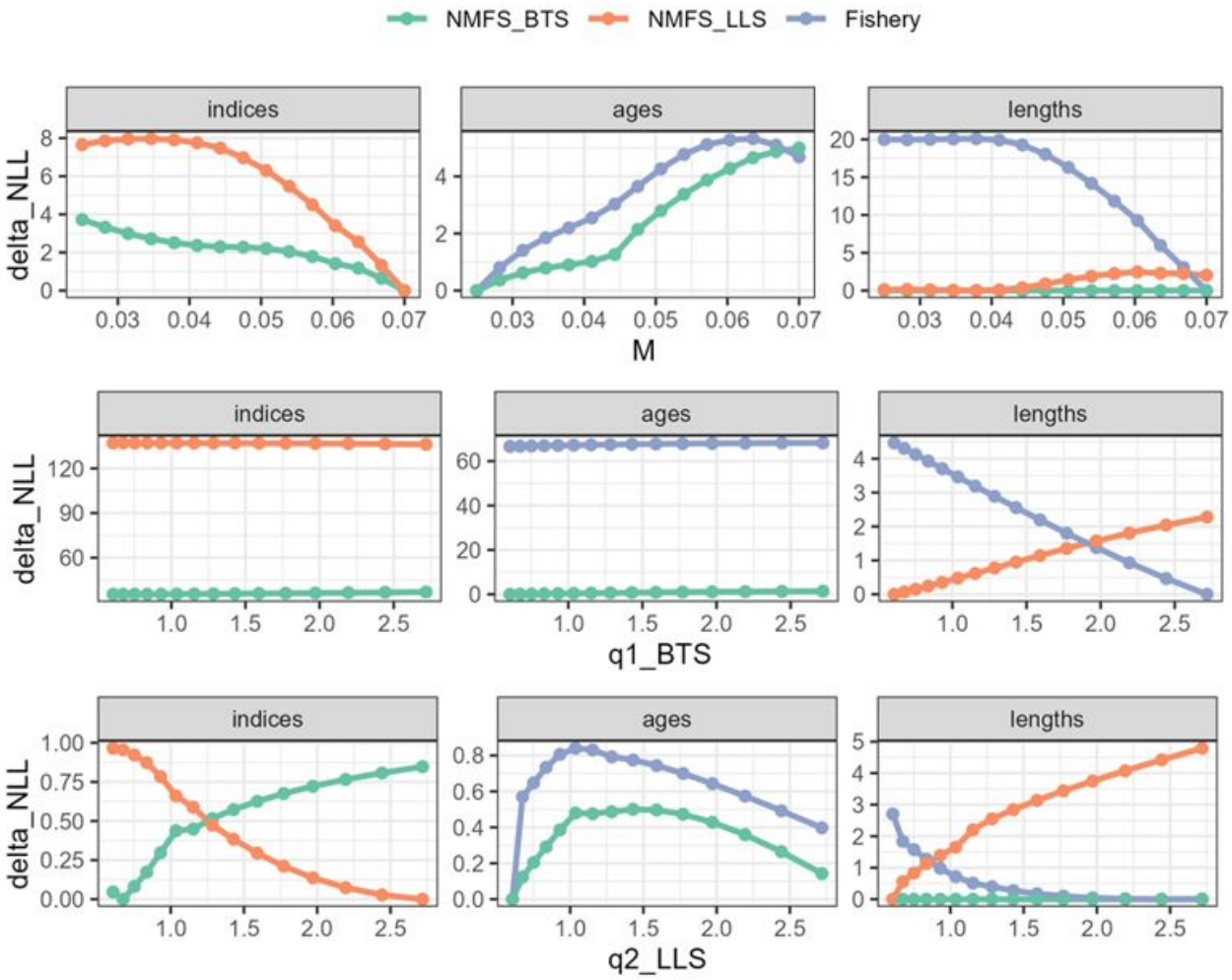
High parameter correlation

M15.4a pairwise plots of the MCMC marginal posterior distributions (Figure 13-10)



What data is informing scale?

M15.4a likelihood profiles/Piner plots (Figure 13-14)



Model	Quantity	MLE Mean	CI-Lower	CI-Upper	MCMC Mean	MCMC Median	BCI-Lower	BCI-Upper
M15.4a_2023	Log Rbar	0.156	-0.394	0.712	-0.073	-0.114	-0.619	0.709
M23.1_2023	Log Rbar	0.142	-0.177	0.464	-0.285	-0.283	-0.676	0.106
M23.1a_2023	Log Rbar	0.934	0.611	1.261	0.581	0.579	0.268	0.898
M23.1b_2023	Log Rbar	0.478	0.249	0.708	0.161	0.162	-0.099	0.419
M15.4a_2023	M	0.031	0.026	0.036	0.032	0.032	0.027	0.038
M23.1_2023	M	0.044	0.039	0.049	0.044	0.044	0.039	0.049
M23.1a_2023	M	0.052	0.047	0.056	0.052	0.052	0.048	0.057
M23.1b_2023	M	0.042	-	-	0.042	0.042	-	-
M15.4a_2023	Longline q	1.54	0.41	2.67	1.64	1.59	0.73	2.84
M23.1_2023	Longline q	2.53	1.84	3.24	2.64	2.64	1.94	3.37
M23.1a_2023	Longline q	1.00	0.90	1.10	1.01	1.01	0.92	1.11
M23.1b_2023	Longline q	1.01	0.92	1.11	1.02	1.02	0.93	1.11
M15.4a_2023	Trawl q	2.63	1.25	4.03	2.54	2.53	1.15	3.96
M23.1_2023	Trawl q	2.72	1.95	3.50	2.70	2.69	1.96	3.52
M23.1a_2023	Trawl q	1.04	0.93	1.14	1.03	1.03	0.94	1.12
M23.1b_2023	Trawl q	1.06	0.97	1.16	1.06	1.05	0.96	1.15
M15.4a_2023	sigmaR	0.78	0.69	0.88	1.04	1.04	0.92	1.17
M23.1_2023	sigmaR	0.81	0.71	0.91	1.08	1.08	0.96	1.22
M23.1a_2023	sigmaR	1.10	-	-	1.10	1.10	-	-
M23.1b_2023	sigmaR	1.10	-	-	1.10	1.10	-	-

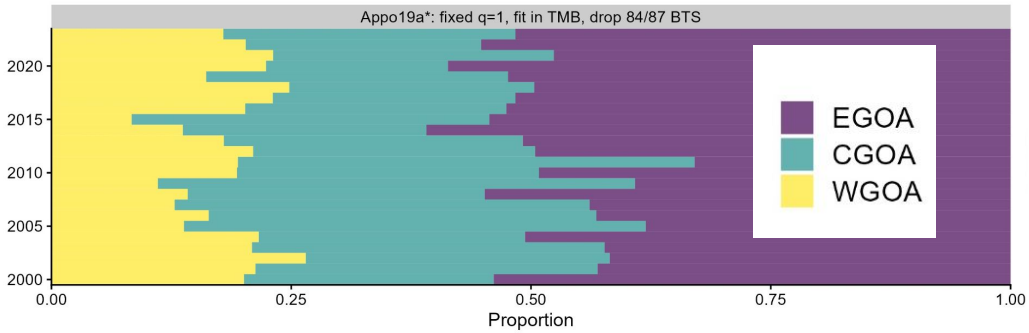
Table 13-15

RE/BS Apportionment Summary

- Two-survey random effects (REMA) model first accepted in 2019
- LLS scaling parameters fixed at 1.0 to balance LLS/BTS data conflict
- Recommend estimating area-specific scaling parameters, greatly improves model performance
- Recommend using the average area-specific proportions of REMA-predicted biomass and REMA-predicted relative population weights from the LLS in order to more appropriately balance BTS/LLS data

Stock/ Assemblage	Area	2023 OFL	2023 ABC	2023 TAC	2023 Catch[2]	2024 OFL	2024 ABC
RE/BS complex	W		180	180	101		197
	C		232	232	135		315
	E		363	363	149		525
	Total	930	775	775	385	1,555	1,037

Apportionment based on fixed q and predicted biomass by area (CURRENT)



Apportionment based on predicted biomass and RPWs by area (PROPOSED)